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Development of a Curriculum to Teach Basics of Artificial Intelligence

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Abstract

A world without intelligent applications has become unthinkable. We are surrounded by intelligent systems but hardly anybody knows how these systems work. Educating the young generation in these fields becomes more and more important. This thesis has identified the major topics that need to be taught so that young people not only get a better chance on the job market but also can evaluate the impact new intelligent technology has on society. They should thus be qualified to reflect on new technological developments and make informed decisions on how to use new applications taking economic and social aspects into consideration. A didactically sound AI course tailored to high school students has been created. The course offers an introduction to major AI topics like natural language processing, computer vision, machine learning and problem solving by search. The course has been evaluated with a group of teachers and students in the teacher training program. Based on this evaluation, suggestions for improvement have been made that will be integrated in the final version to ensure the quality of the course. This material will be used in the scope of the EDLRIS project offering standardized training and certification for robotics and intelligent systems comparable to the European Driving Computer Driving License.

Zusammenfassung

Eine Welt ohne intelligente Applikationen ist mittlerweile undenkbar. Wir sind von intelligenten Systemen umgeben, aber kaum jemand weiß, wie diese Systeme funktionieren. Die junge Generation in diesem Bereich zu bilden wird immer wichtiger. In dieser Diplomarbeit wurden grundlegende Themenbereiche herausgearbeitet, die in der Ausbildung nicht vernachlässigt werden sollten, damit junge Menschen einerseits bessere Aussichten im Berufsleben haben andererseits jedoch auch den Einfluss neuer Technologien auf die Gesellschaft evaluieren können. Junge Menschen sollten zu einem reflektierten Umgang mit neuen technolgoischen Entwicklungen unter Berücksichtigung ökonomischer und sozialer Aspekte befähigt werden. Ein didaktisch fundierter KI Kurs zugeschitten auf Oberstufen-Schüler und Schülerinnen wurde erstellt. Der Kurs bietet eine Einführung in grundlegende Themenbereiche der künstlichen Intelligenz wie beispielsweise Sprachverarbeitung, Computer Vision, maschinelles Lernen oder Problemlösung durch Suche. Der Kurs wurde von Lehrern und Lehrerinnen sowie von Studenten des Lehramtsstudiums evauliert. Basierend auf der Evaulierung wurden Verbesserungsvorschläge für die einzelnen Unterrichtseinheiten gemacht, welche in der finalen Version des Kurses integriert werden, um die Qualität des Kurses sicherzustellen. Das erstellte Trainingsmaterial wird im Rahmen des EDLRIS Projekts verwendet, das standardisierte Trainings und eine Zertifizierung im Bereich Robotik und intelligente Systeme bietet - vergleichbar mit dem Europäischen Computer Führerschein.

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1. Introduction

Artificial intelligence has become a major part of our everyday lives. With the development of Apple's Siri, Amazon's Alexa and other modern gadgets, artificial intelligence is not exclusively applied by industry anymore. The rapid development of new technologies also affects today's workforce. People with basic information technology and computer science skills are already sought-after (Tips, 2016) and as robotics and artificial intelligence have become the fundamentals of industry 4.0 (Jaspernite, 2012), we will need even more highly qualified people with expertise in these areas in the future. However, in the Austrian high school curriculum for computer science the topic of artificial intelligence has been only marginally relevant so far (Bundesministerium für Bildung und Frauen, 2004). Therefore, a need for a curriculum to teach the basics of artificial intelligence and prepare the young generation for future developments in this field has been identified.

Although there are some courses on specific areas of artificial intelligence like machine learning or knowledge engineering at university level, only pilot classes have been implemented at primary or high school level so far (e.g. Vachovsky et al., 2016; Heinze, Haase, and Higgins, 2010; or Burgsteiner, Kandlhofer, and Steinbauer, 2016). The authors of these papers already highlighted the ongoing lack of teaching AI related topics in high schools and thus tried to provide a basis for integrating AI in secondary school science education. However, at least in Austria their efforts haven't really borne fruit so far.

Inspired by the huge success of the European Computer Driving License (ECDL), which has been adopted by no less than 950 Austrian schools

(Bundesministerium für Bildung, 2017), a project developing a European Driving License for Robots and Intelligent Systems (EDLRIS) was launched in 2017 (Graz University of Technology, 2018). The curriculum for teaching the basics of artificial intelligence developed within this diploma thesis is created within the framework of the Austrian-Hungarian Interreg Project EDLRIS, where a professional training and certification system for robotics and artificial intelligence will be developed. Stakeholders from various companies, public and educational institutions will be involved in the EDLRIS project to promote the acceptance of the program (Joint Secretariat, 2018). In the course of the project, basic and advanced education and certification systems in robotics and artificial intelligence will be developed for trainers and trainees (Baumann, 2018). We envision that the educational institutions in Austria and all across Europe will also come to realize the importance of educating the young generation in AI and robotics and integrate the contents of the EDLRIS curriculum in their teaching as it was the case with the ECDL.

The goal of this diploma thesis is to develop a curriculum including didactically and methodologically sound artificial intelligence courses that address the requirements of today's industry. To get an overview of the current situation, the existing curricula of computer science in the Austrian and Hungarian education systems will be analyzed and the importance attributed to information technology in general and to artificial intelligence in particular will be discussed. Then, interviews with practitioners concerned with artificial intelligence will be conducted so that the major topics that need to be part of an AI curriculum can be identified. Based on the existing curricula, the evaluation of the interviews and the input from the EDLRIS project team and advisory board, a curriculum for teaching the basics of AI including detailed lesson plans will be developed. The curriculum will then be evaluated in pilot classes to identify areas for improvement and thus assure the overall quality of the curriculum.

2. Background and Related Work

Before giving an overview of the current situation of artificial intelligence in computer science education focusing on Austria and Hungary, the target groups of the EDLRIS project shall be defined.

2.1. EDLRIS Target Groups

The EDLRIS project focuses on two target groups, namely trainers and trainees. Each target group has its own specific curriculum with objectives that should be achieved by the corresponding group. The trainers' curriculum is primarily aimed at STEM high school teachers, students in teacher training programs and trainers of private educational institutions. Ideally, they already have some teaching experience. It can be assumed that this target group is proficient in mathematics so that the basic concepts of artificial intelligence are easier to grasp and this group can therefore advance more quickly. However, no prior knowledge of artificial intelligence is required. Although no prior programming skills are required, it is expected that the participants have basic computer skills like using the internet and various applications. Furthermore, STEM teachers are considered to be interested in the subject of artificial intelligence and are thus already intrinsically motivated (Hattie and Yates, 2014: 29). Given that the topic of artificial intelligence is also part of the Austrian curriculum of the elective subject of computer science, high school teachers of this subject are in the unique position to incorporate the contents of this curriculum in their classes and thus promote the topic of artificial intelligence among their students as well.

The target group for the trainees' curriculum are high school students, undergraduate students, engineering students enrolled in vocational training programs and interested young adults in general. Similarly to the trainers' curriculum, no prior knowledge of artificial intelligence or advanced mathematical skills are required. Nevertheless, it is assumed that trainees have a general interest in science, technology, engineering and maths and that they have successfully completed lower secondary education. As in the trainers' curriculum, no prior programming skills are required, but general computer skills like using the internet and various applications are expected.

2.2. Artificial Intelligence Education in High Schools

There have been several approaches to teach artificial intelligence at primary or high school level (e.g. Heinze, Haase, and Higgins, 2010; or Burgsteiner, Kandlhofer, and Steinbauer, 2016). However, these are usually extracurricular classes at specific schools as artificial intelligence is still not a compulsory subject for high school students in most countries.

Heinze, Haase, and Higgins, 2010 proposed a syllabus for primary and lower secondary schools. The pupils are introduced to robotics using the Lego Mindstorms robots. They start with discovering various types of sensors but are soon introduced to pseudo-code promoting an understanding of the general structures of computer languages represented in pseudo-code in grades 3 and 4. The students are introduced to programming using the Lego

Mindstorms language but they also get an introduction to Java. The intent of Heinze, Haase, and Higgins, 2010 was not to "produce students who are able to code" but to give them an understanding of different computer languages and their representations. The students were then introduced to the Turing Test (Turing, 1950), types of errors, change and attention blindness and cognition and the mind in grades 5 and 6. Heinze, Haase, and Higgins, 2010 managed to engage the students and the students seemed to grasp the discussed concepts quite well, although the pupils were not subject to any formal assessment.

Burgsteiner, Kandlhofer, and Steinbauer, 2016 taught an introductory AI pilot course in high school. The participating students were in grades 9 to 11 and their average age was 16.5 years. They all had some prior knowledge in robotics but none in AI. The course introduced the students to automatons, intelligent agents, graphs and data structures, problem solving by search, classic planning and machine learning. The results of the self-assessment post questionnaire and the semi-structured interviews with the participating pupils showed that Burgsteiner, Kandlhofer, and Steinbauer, 2016 succeeded in teaching high school students the basics of artificial intelligence.

Srikant and Aggarwal, 2017 propose an introductory data science tutorial for grades 5 through 9. The half-a-day tutorial has been implemented in New Delhi, Bangalore and Pune in India and Urbana Champaign in Illinois, USA so far. The participating students were exposed to the full cycle of a typical supervised learning approach. For this purpose, they created the friend predictor problem set and used a spreadsheet application for data visualization and model building. The self-evaluation feedback questionnaires of the students also indicate that the tutorial was successful in getting students interested in data science and in understanding how data science is applied to solve problems.

As the examples above indicate, the majority of artificial intelligence courses at high school level focus on robots as a vehicle to interest young people in science and technology. While educational robotics in general has been shown to have a positive impact on technical skills and social aspects/soft skills (Kandlhofer and Steinbauer, 2016: 684), there are some major obstacles like the cost of the equipment needed or the time-consuming nature of the robotics activities (Alimisis, 2013: 65) that have to be overcome when trying to implement AI classes based on robotics on a large scale. Therefore, this diploma thesis tries to provide an alternative for teaching AI topics without costly equipment.

2.3. Artificial Intelligence Undergraduate Education

Compared to AI courses at high school level (section 2.2), more research can be found on AI courses for undergraduate students. Kumar, 2004 uses robots to teach AI, Torrey, 2012 focuses on pedagogical strategies and teaching to the problem, Li et al., 2017 use games as the vehicle of choice and Barik et al., 2013 also focus on games to name just a few.

Wollowski et al., 2016 did an online survey on the current practice of teaching artificial intelligence and desired future developments in teaching AI. As there are few artificial intelligence courses at high school level, the survey targeted educators at university level. Unfortunately, no background information on the survey is provided in the publication, so it is difficult to tell if 37 responses are a representative sample. There is also no information on the participants' countries of origin as the topics covered in artificial intelligence courses might diverge depending on the major industries of a specific country, different political approaches or cultural issues. According to Wollowski et al., 2016 most of the current AI courses have prerequisites like data structures, software development or mathematics. Only 11% of the courses do not have any prerequisites. The results of the survey also indicate the topics of AI that are currently taught. With 81%, knowledge representation and reasoning including search rises to the top of the list, followed by machine learning and games and puzzles. About half of the participating instructors cover applications, natural language and philosophy. Other topics covered include history of AI, cognitive science, ethics and social issues, robots, speech or vision.

2.4. Artificial Intelligence Online Education

Online introductory courses to artificial intelligence like Saylor Academy, 2017 or Udacity, 2017 also focus on search and problem solving, but there are lessons on machine learning, robotics or games among others too. History, ethics, social issues or philosophy are apparently not the main concern of these courses. It should be noted that most online courses designed as introductory courses still have prerequisites like calculus or basic programming skills.

At the time of writing, Google and Microsoft, two of the major players in the field of AI, also launched introductory artificial intelligence courses (Kemp, 2018 and Roach, 2018). While Google focuses solely on machine learning, Microsoft also has modules on ethics, basic maths and statistics as well as programming skills. Both programs follow the concept of Massive Open Online Courses (MOOCs) (for more information on MOOCs see e.g. Murphy et al., 2014) and are aimed at adult learners. The courses are free of charge although Microsoft also offers a certificate which is subject to a fee of $ 99 per module. Microsoft launched the courses on edx whereas Google uses Coursera, Udacity or the company's own platform. Naturally, each company uses their own machine learning framework, Google's TensorFlow or Microsoft's Azure. At the moment, both programs are available only in English (Google LLC, 2018 and Microsoft Corporation, 2018).

After this general overview on current artificial intelligence courses, the situation of the Austrian and Hungarian education systems shall be examined.

2.5. Artificial Intelligence Education in Austria

In Austria, computer science is a compulsory subject in the 5th grade of upper secondary education. Additionally, most schools offer computer science as an elective subject that students can select from grades six to eight (Eurydice Network, 2016).

According to the Austrian curriculum for computer science of the 5th grade, students should be able to describe, design, present and implement algorithms and be able to explain the basic principles of automata, algorithms and data structures (Bundeskanzleramt der Republik Österreich, 2017). It is up to the teacher how and to what extent this goal is achieved. The Austrian curriculum for the elective subject of computer science dedicates parts of the 7th semester to discuss intelligent systems. Students should be able to describe areas where computers and information systems can be intelligent, explain the difference between human and artificial intelligence, compare and assess characteristics of human and artificial intelligence and be able to use intelligent systems (Bundeskanzleramt der Republik Österreich, 2017).

Again, the achievement of these goals is up to the teachers, who have a lot of freedom regarding the specific contents. However, this also means that there is no standardized way to monitor the students' learning success.

At university level several lectures are offered at TU Wien and TU Graz to gain specific knowledge of artificial intelligence (see for example TU Wien, 2017; Graz University of Technology, 2015). As artificial intelligence in general covers such a vast area of topics, no introductory lecture is offered but there are specialized courses dealing with specific AI topics. The topics covered correspond to the findings of Wollowski et al., 2016 with knowledge representation and reasoning at the heart of the curricula.

2.6. Artificial Intelligence Education in Hungary

This paragraph on the Hungarian educational system is based on information provided by the Eurydice Network, 2016. The Hungarian educational system is determined by the National Core Curriculum - NCC. The NCC provides a framework for the general education of Hungarian students and defines subject areas instead of mandatory subjects. The National Core Curriculum is implemented by framework curricula, which define the actual amount of lessons and subjects. In grades 9 and 10, students have a total of 36 IT lessons each year. When using an average of 40 school weeks a year, there is about one IT class per week in grades 9 and 10, so the total amount of IT classes is about the same as in Austria, where two hours per week are mandatory in the 5^{th} grade. Like in Austria, Hungarian students can choose elective subjects in the last two grades of general secondary school.

Similar to the Austrian curriculum of computer science education, the content that can be attributed to artificial intelligence is rather limited.

Hungarian students are introduced to algorithms and data modeling in grades five to eight. They should learn “basic concepts associated with automated development systems and basic concepts in robot control” (The Government of Hungary, 2012).

At Budapest University of Technology and Economics, an artificial intelligence course is part of the bachelor’s degree program in computer engineering. The class focuses on problem solving, planning and machine learning (Pawel, 2015). Artificial intelligence is also part of the master’s degree in computer science and engineering at Széchenyi István University in Győr (Széchenyi István University, 2017).

3. Methodology

First, scientific literature has been researched to gauge the current state of research in AI education (Chapter 2). To identify the educational needs to prepare young people for future developments in AI, a survey among AI practitioners was conducted (Section 4.1) and the objectives of an AI course were discussed in an EDLRIS advisory board meeting (Section 4.2). Based on this input, the major objectives and competencies that the curriculum should cover to prepare the young generation for future developments were defined (Section 5.1). To provide a means to achieve these objectives detailed lesson plans for an introductory AI course were developed, paying special attention to teaching methods and the learning process (Section 5.4). Finally, these lesson plans were evaluated using different research methods (Chapter 6).

3.1. Assessment of Educational Needs

As there are a number of stakeholders when creating a curriculum, each group should have a say in what contents are part of the curriculum (Stabback, 2016:13). To respond to this requirement of a high quality curriculum and to define the topics that the curriculum should cover, a survey among representatives from companies concerned with AI but also from economy and education in general was conducted. The results of this survey were then compared to the results of Wollowski et al., 2016, who not only did an online survey on the current practice of teaching AI, but also on AI topics and techniques currently used in practice. Unfortunately, Wollowski et al., 2016 do not provide any background information on the 31 practitioners that participated in the survey, so the results might be biased by the sector most participants are working in. Therefore, the survey of this diploma thesis shall indicate if the results of the survey by Wollowski et al., 2016 can also be seen as representative for the EDLRIS project area comprising the regions of Burgenland, Vienna, Wiener Umland-Südteil, Southern Lower Austria, Graz and East Styria, Győr-Moson-Sopron, Vas and Zala (Joint Secretariat, 2018). Although the survey will be closely related to the one of Wollowski et al., 2016, I have decided to use a slightly different approach. As the response rate for online surveys is usually quite low (Rubin and Babbie, 2009), conducting interviews with the participants was chosen as the preferred method with all the advantages that go with it, like asking for clarification of the answers given by the interviewee, requests for further explanations if the interviewee is not sure about the meaning of the question asked, prompting the interviewee to elaborate on the response or obtaining confirmation on the accuracy of the interviewer's interpretation of what has been said by the interviewee (Leonard, 2003: 168). Given the qualitative approach, the survey comprises mainly open-ended questions. The interviews were audio recorded and subsequently transcribed.

Additionally to the survey, the main objectives of the course were discussed in an EDLRIS advisory board meeting using the World Café method (The World Café Community Foundation, 2018), where participants discuss topics and questions in small groups seated around a table. After about 15 minutes, they move to another table where a different topic is discussed. A "table host" stays at the table to welcome the next group and briefly explains what the previous group discussed. During the discussion the participants are invited to take notes. After each group has discussed each topic, the "table hosts" share the results of the conversations with the whole group. The method has been selected by the EDLRIS project team experts because it facilitates the knowledge-sharing process and stakeholder engagement in general (Brown, Isaacs, and Community, 2005: 5). The three topics “Which learning goals should be achieved by an AI curriculum?”, “Which learning goals should be achieved by a robotics curriculum?” and “What expectations on the EDLRIS program do you have?” were discussed by the members of the EDLRIS advisory board. The EDLRIS project team members acted as the “table hosts” and shared the results of the discussions with the whole group.

3.2. The competency based approach

A successful curriculum states clear aims of what students have to learn in order to meet the challenges and opportunities of rapid technological development in the 21st century (UNESCO, 2012: 24). These aims can be used to communicate the general purpose of the program (O’Neill, 2015: 39). To achieve these aims, main competencies should be defined (UNESCO, 2012: 25). Competence is an umbrella term for knowledge, skills and values, where knowledge refers to declarative knowledge as in “I know that. . . ”, skills refer to procedural knowledge like in “I know how. . . ” and values refer to dispositional knowledge like in “I know to. . . ”, where the focus lies on the inclination to do something and being able to reflect on a topic (Stabback, 2016: 7).

These recommendations for curriculum development mirror the shift towards competency-based education in various curricula. Although the competency-based approach to education goes back to the seventies (e.g. Stevens, 1974), it has only been implemented in the course of the last 10 years

(Frank et al., 2010). The competency-based approach focuses on mastery of skills rather than time spent in class as it is the case in traditional educational programs where the students are required to complete a course in fixed units of time (Gruppen et al., 2016: 534). By means of assessment, the knowledge and skills of a student are evaluated, so the time spent by the student to master these competencies does not matter, but only the student's success (TeachThought, 2018). Competency-based learning usually goes hand in hand with student-centered learning (Glowa and Goodell, 2016: 43). Students can learn at their own pace and as the focus lies on the achieved skills, eliminating time constraints, they can devote more time to areas they are not so familiar with and brush over already mastered materials (Daugherty, Davis, and Miller, 2015: 17).

The competency-based approach offers a number of advantages. For employers it is easier to interpret the descriptions of the knowledge and skills mastered in a course than a bunch of course titles and graduates can be selected according to these competencies (Daugherty, Davis, and Miller, 2015: 9). Although this is definitely true, it should also be considered that in today's world of information overload, the description of competencies has to be concise and to the point as a lengthy portrayal of skills will probably not be read. For students the removal of time constraints is beneficial as they can probably all be considered part-time learners in regard to artificial intelligence and thus fit the program much more easily into their schedule. However, this advantage is also a major challenge for the course administration (Gruppen et al., 2016: 537). The self-paced learning environment reduces the possibilities for teamwork and collaboration as everybody progresses differently (Daugherty, Davis, and Miller, 2015: 19). The threat of reductionism should not be overlooked either. Just checking items off a list of the smallest unit of skills that can be assessed may convey the wrong message that the quantity of skills is more important than excellence (Frank et al., 2010: 643). This means that mastering a lot of skills on a very basic level but not excelling in any of these skills is not the way to go.

The competency-based approach seems the obvious choice when it comes to qualifying students for future developments in the workplace and society and has therefore been selected as the main framework for the development of the curriculum for the EDLRIS program. However, this approach also poses some issues that should be considered when creating a program within this framework like for example the removal of time constraints.

To provide the required flexibility in the competency-based and student-centered approach, the courses of the EDLIRS program will be organized in the overall setting of blended learning, where face-to-face instruction is combined with technology-mediated online instruction (Graham and Dziuban, 2008: 270). Thanks to the online component, blended learning allows for increased flexibility in time and space compared to face-to-face only instruction while at the same time maintaining the advantages of direct interaction with the trainers for example in labs or hands-on collaborative work (Moskal, Dziuban, and Hartman, 2013: 20). Interaction with and feedback from the trainer also ensure that the threat of reductionism is minimized as the trainer can guide the trainee to more in-depth mastery of the materials.

3.3. Evaluation

High quality curricula and lesson plans are cyclical in nature as they have to remain open for change (Stabback, 2016: 16). To respond to this quality criterion, the developed lesson plans will be assessed. To evaluate the

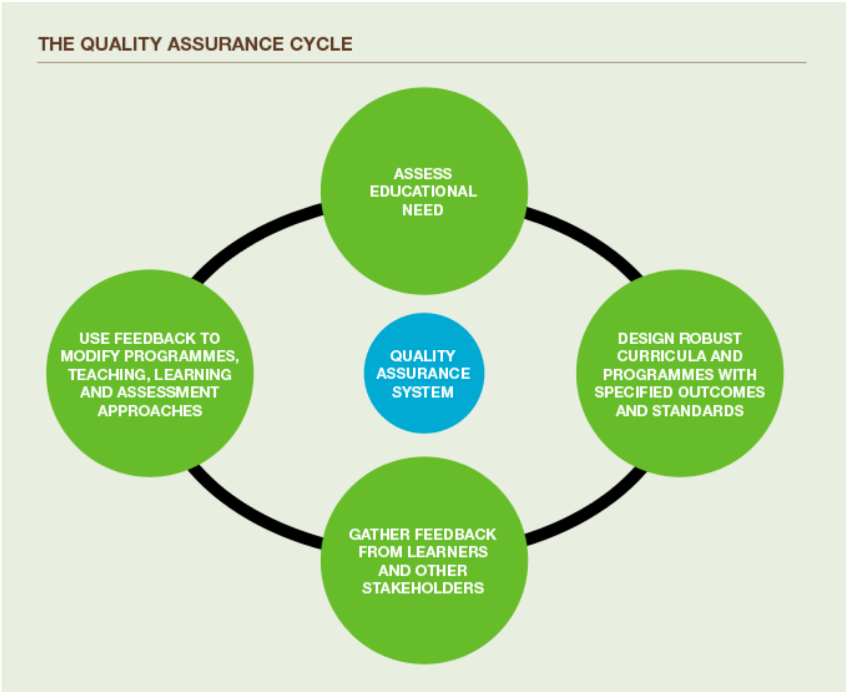


Figure 3.1.: Quality Assurance Cycle (Barrow and McKimm, 2018)

concept and design of the lessons, two one-day pilot classes implementing the developed lesson plans will be held. The results of the pilot study are then used to offer suggestions for adapting the lesson plans before the roll-out of the EDLIRS implementation classes, thus re-initiating the quality assurance cycle illustrated in Figure 3.1. The cycle consists of the assessment of educational need, the design of curricula and programs with specified outcomes and standards, the gathering of feedback and the use of the feedback for modification (Barrow and McKimm, 2018).

For the assessment of the lesson plans, different methods of diagnostic and formative assessment will be used, depending on the lesson's objectives and activity design. For the evaluation of the participants' behavior during the lesson, their reactions and learning habits, the qualitative method of ethnographic observation will be used. This method is characterized by excessive note taking during the lesson to describe the behavior and interactions in as much detail as possible and the subsequent analysis of these notes with the main focus on identifying opportunities for improvement. The observer does not take part in the activities but concentrates solely on describing the processes most accurately (Breidenstein, 2012).

Additionally to the ethnographic observation, the participants' feedback will be obtained by distributing self-administered feedback questionnaires immediately at the end of each course, thus ensuring a high response rate (Oppenheim, 1992: 103). To consider the trainer's perspective as well, a semi-structured interview with the trainer will be conducted directly after each pilot class (Leonard, 2003). The interview will also be recorded and subsequently transcribed. Pictures of the participants' activity results and products will also be taken to gain more insight into the learning process.

4. Educational Needs Assessment or What Needs to be Taught?

To identify the most relevant topics of AI, interviews were conducted with experts form various fields of the industry. The results of the survey will then be compared to the survey of Wollowski et al., 2016 to create a basis for the definition of objectives. Additionally, the main objectives and competencies that the course should cover will be discussed in the EDLRIS advisory board meeting.

4.1. Expert survey

For the semi-structured interviews, a question guideline was developed which can also be found in Appendix A (Leonard, 2003: 167). The guideline questionnaire in Appendix A has been translated into English for the reader's benefit and to keep the language of this diploma thesis consistent. First, some background information on the participants like age, gender, main responsibility within the company or organization and their highest level of education will be gathered. Then, the interviewees will be asked to define artificial intelligence in general. Next, they will describe which AI techniques they are actually making use of at work and which AI techniques will probably be of importance in the future. The participants will also be requested to recall some of the AI courses they attended during their studies and what topics they had to learn independently without guidance from a teacher or mentor. Then, they will be asked what should be taught in an AI course and what needs to be taught to prepare young people for the future, before stating their expectations regarding students who have successfully completed an AI course. Finally, the participants will rate the importance of the twelve AI topics that Wollowski et al., 2016 identified and used in their survey to provide an element for comparison of both of the surveys. Given the semi-structured nature of the research method, the order of the questions changed from time to time to keep up the conversation flow (Oppenheim, 1992: 65).

4.1.1. Implementation

Nine experts from various fields were interviewed between September and December 2017. Since the developed curriculum will be based on this survey, not only experts on artificial intelligence were asked to participate, but also experts on economy and education. When selecting the participants, the industry they are working in has also been considered in order to avoid having too many experts from the same area who might push the results in a certain direction. The experts are working in the following industry sectors: logistics, automotive, game development, crime analysis, material engineering, robotics, medical engineering, education and economy in general. All participants are Austrian citizens and work in the EDLRIS project region. Unfortunately, at the time of conducting the interviews contacts to the Hungarian business representatives had not been established yet therefore only Austrian AI practitioners were interviewed. The interviews were conducted in German so that the participants could talk in their mother tongue and a language barrier was thus avoided. Some interviews were conducted face-to-face and some over the phone, depending on what was more convenient for the participants. Notes were taken during all interviews and all conversations but one were audio recorded and subsequently transcribed. Before commencing the interviews that were conducted over the phone, the participants were asked for their consent to the audio recording and subsequent transcription of the interview. They were also assured that their personal data would be anonymized and treated confidentially. The participants of the face-to-face interviews were asked to sign the consent forms in Appendix A - the consent form was also translated into English for reasons of language consistency. They were also informed that the recordings would be transcribed and assured that their personal data would be treated confidentially. Some of them also requested that only the anonymized transcripts would be shared which was granted.

4.1.2. Discussion of Results

The general lack of women in the tech industry (Payscale, 2017) is also reflected in the gender of the interviewees as only two women out of nine participants were interviewed and only one female participant is working in the technical field. Only two participants are older than 35 years while all other participants are between 25 and 35 years of age. All participants except one hold a university degree. None of the participants have additional certification in artificial intelligence, although about half of them attend various AI events like congresses or conferences in their field of application on a regular basis either as speaker or as attendant. Participants between 25 and 35 years of age holding a university degree in the technical field had some classes on artificial intelligence in the course of their studies. The rest of the participants did not specifically encounter topics regarding artificial intelligence during their educational career. This also means, that in secondary education in Austria topics regarding artificial intelligence were completely absent about ten to fifteen years ago. Most of the participants studied AI topics themselves without supervision or classroom attendance because of their personal interest in the field. The knowledge thus gained is also useful for their current jobs. However, none of them were able to name AI topics or techniques that they exclusively self-studied without being introduced to the topic in an AI course or by a mentor.

Definition of AI

To gain an in-depth understanding for the analysis of the responses, the participants were asked to give their definition of artificial intelligence. Decision making, machine learning, deep learning, simulating human behavior and robots were the buzzwords that were most often used in the definitions of artificial intelligence. Most of the participants agreed that machine learning and decision making is a major quality when it comes to defining artificial intelligence. About half of the participants also concurred with the findings of Wollowski et al., 2016 where participants described AI as "producing software that exhibits traits that we find in humans". The mention of robots and intelligent machines can be assigned to the Wollowski et al., 2016 categories of "producing goal oriented agents" and "building sophisticated or complex systems". While the participants of the current survey mentioned AI techniques like machine learning, deep learning or neural networks several times, Wollowski et al., 2016 do not mention any techniques in their participants' definitions of AI. Several answers of the current survey can be assigned to the first three of their categories - "producing software that exhibits traits that we find in humans, producing goal oriented agents and building sophisticated or complex systems" - the last one, namely "doing what computers cannot do yet", was only mentioned once.

AI Techniques Today and Tomorrow

Practitioners currently use mainly machine learning techniques including deep learning algorithms, neural networks, decision trees or support vector machines. Depending on the industry, artificial intelligence is used for forecasts and analysis, simulations or computer games. Computer vision seems to be a major topic across industry sectors. While in the study of Wollowski et al., 2016 machine learning came only third after knowledge representation and reasoning and applications respectively, the current survey indicates that the majority uses machine learning techniques and thus machine learning is clearly at the top of the list before vision and knowledge representation and reasoning.

When asked about techniques with the most potential for the future, about two third of the practitioners mentioned areas of application like industry 4.0, smart homes, robots or intelligent traffic systems. Machine learning techniques and especially data analysis and pattern recognition was seen as most important for future developments by about 50 %. Compared to the findings of Wollowski et al., 2016 almost the same topics were mentioned in their survey, but the order was a bit different. Practitioners of their survey thought machine learning would have the most potential followed by knowledge representation and reasoning and applications.

Finally, the participants were asked to rate the importance of AI topics on a scale from one to five, where one corresponds to very important and five to not important at all. As can be seen in Figure 4.1, robotics ranked top of the list, with all participants agreeing that this topic is very important. This is followed by vision, machine learning and applications where six people think this topic is very important, two think it is important and one thinks it is of average importance in each case. Speech and knowledge representation

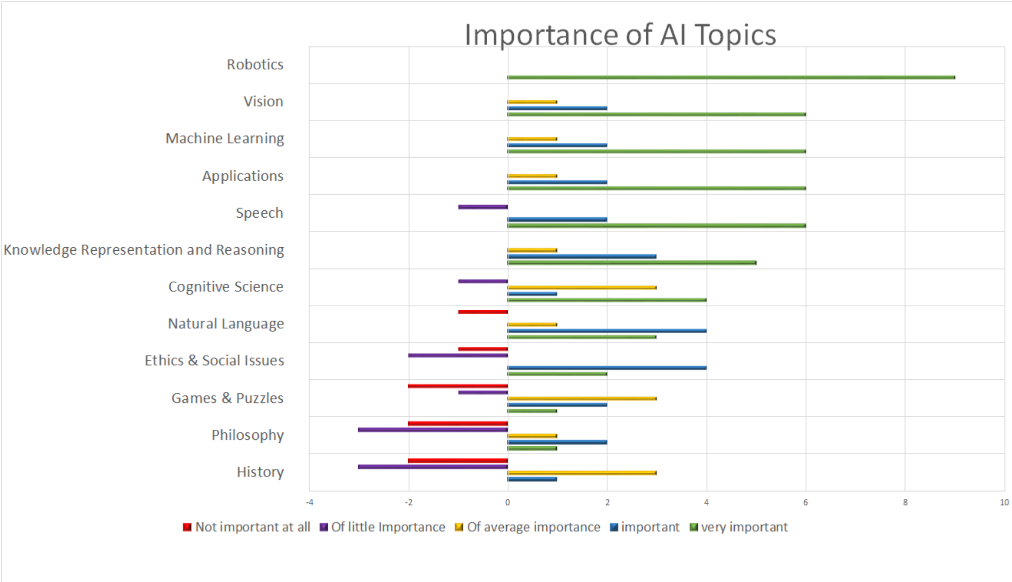


Figure 4.1.: Importance of AI topics

and reasoning came third. History and philosophy are at the bottom of the list with two people thinking they are not important at all and three ratings in the of little importance category.
To make the diagram easier to read and provide a better overview, the two categories "Of little importance" and "Not important at all" were multiplied by minus one. This pushed the results in the negative direction of the x-axis which means that the red bar of history which reaches -2 indicates that two participants thought this topic is not important at all and the purple bar reaching -3 indicates that 3 people thought the topic was of little importance.

According to Wollowski et al., 2016, a major difference between educators' and practitioners' responses concerning the topic of games and puzzles was found. While most educators implement this topic in their courses, AI practitioners did not rate it as important at all. Although no direct comparison can be drawn in the current survey as it did not focus on educators, the responses of the representative of the educational sector mostly align with the practitioners' responses and he did not attribute special importance to games and puzzles either.

AI Syllabus

About half of the practitioners of the current survey think that practical applications are the most important thing when designing an AI course. According to the participants, practical examples are essential when teaching AI so that students can immediately apply their theoretical knowledge. 50 % of the participants agreed that the mathematical background and especially statistics should be part of an AI course as well. One third of the practitioners also think that it is important to define artificial intelligence so that students are able to identify intelligent systems and have a general overview of how they work. Machine learning, vision, speech recognition, gesture recognition, geo-information systems, data analysis and ethics were mentioned once as potential topics of an AI course.

According to two participants, an AI course should arouse interest so that young people not only use AI applications, but also understand the concepts of intelligent systems. Two participants think that data analysis and awareness of big data will be a skill required in the future. Robots and image recognition were mentioned as probably the most interesting AI topics for adolescents. Two of the practitioners agree that young people should know programming to be able to implement AI concepts themselves and thus better understand intelligent systems. However, one expert thought that programming should not be required to understand intelligent systems. "We only program the systems because we do not know better yet, a really intelligent system would not require any programming at all." One practitioner also said that social implications brought on by the development of AI need to be discussed early on. Two participants did not answer the question "In your opinion, what AI topics need to be taught today to prepare young people for the year 2027" as they claimed to have no idea of what will be important in the future.

Practitioners of the survey conducted by Wollowski et al., 2016 thought that knowledge representation and reasoning, machine learning, natural language processing and applications should be covered by an AI course. The importance of these topics does not align with the current survey where applications and maths were seen as most important, while applications only ranked third in the survey of Wollowski et al., 2016. Due to their categorization, additional information from their respondents was not published and so it cannot be assessed if e.g. mathematical basics were also explicitly mentioned by their respondents and if so, into which category these answers were classified as, for example, a sound mathematical background could be assigned to several AI topics.

Expectations

Asked about their expectations of graduates of an AI course, the range of answers was quite broad. Four participants agreed that a graduate should be able to create, design and implement AI systems and they should have a general technical understanding and know-how. Most participants expect that a graduate is not only able to use AI systems but also understands how they work. They also assume that graduates have programming skills. Graduates should furthermore understand neural networks, state machines, decision trees and know some AI frameworks, while they should also be familiar with the mathematical background of an AI system. It was assumed that graduates would have tried several AI techniques themselves, would be able to reflect on the implications of AI and would have read some scientific papers on the topic of artificial intelligence. Apart from advanced AI knowledge, some participants also expected the graduates to be capable of critical thinking, able to work independently and be fluent in reading texts in English.

The expectations of the current survey mostly align with the results of Wollowski et al., 2016, with about half of their respondents agreeing that graduates should know basic AI tools and techniques. Being able to engineer and evaluate a system was expected by around 40 % of their respondents.

4.1.3. Interpretation of Results

Both the current survey and the survey of Wollowski et al., 2016 convey that applications, machine learning and knowledge representation and reasoning should definitely be covered by a course on artificial intelligence. In general, machine learning mainly came to mind when the practitioners defined artificial intelligence. Machine learning was also top of the list of current AI techniques in use and was seen by most participants as having a lot of potential for future developments. However, when asked about the syllabus for a course, being able to define AI, recognize intelligent systems and have a general understanding of how these systems work seemed more important than machine learning per se.

While robotics ranked top of the list when it came to the importance of AI topics and was also mentioned by several participants of the current survey as having a lot of potential for future developments, robotics was only of average importance in the survey of Wollowski et al., 2016. The high importance attributed to robotics in the current survey supports the decision of the EDLRIS project team to create a separate certification system and prep classes focusing specifically on robotics (Graz University of Technology, 2018). This is also the reason why the curriculum developed in this diploma thesis will concentrate on AI techniques and various AI applications apart from robotics.

As the current survey indicated, the mathematical and statistical background knowledge should also be conveyed during the course or be a prerequisite. The same is true for programming skills as they are needed to fulfill the expectations of being able to create, design and implement an AI system. While 41 % of the participants in the survey of Wollowski et al., 2016 agreed that the ability to engineer a system is a major skill that should be expected of a graduate, knowledge in mathematics was not mentioned at all.

Vision was highlighted in the current survey whereas the participants of Wollowski et al., 2016 focused more on natural language processing. This could be due to the industry the participants are working in. Unfortunately, no practitioner concerned with natural language processing participated in the current survey, which might be a reason why it was so rarely mentioned compared to computer vision. However, because it was deemed important by the practitioners of the survey of Wollowski et al., 2016 and natural language processing is also one of the first problems tackled in the history of AI (Barr and Feigenbaum, 1981: 226) this topic should still be included in the syllabus.

Although ethical considerations were neither mentioned when asked about the contents of the syllabus nor was ethical behavior explicitly expected from graduates of a course, these aspects were still deemed important at least by some participants when asked about what should be taught today to prepare young people for the living conditions 10 years from now.

The survey showed that there is an overlap with the results of Wollowski et al., 2016. What was considered important in the survey of Wollowski et al., 2016 was mostly considered important in the current survey as well, although sometimes the ranking of the main topics differed slightly and mathematics was not mentioned at all in the survey of Wollowski et al., 2016. Nevertheless, looking at the big picture, the surveys have similar enough results that they can be viewed as backing each other up.

All in all, the major topics that have been identified and that should thus be included in an AI curriculum are the definition of AI, recognizing intelligent systems, applications of AI, machine learning, mathematics, computer vision, natural language processing and ethics.

4.2. EDLRIS Advisory Board Meeting

The first EDLRIS advisory board meeting was held on December 6, 2017 at Graz University of Technology. The twelve participating members of the advisory board are high-ranking representatives of various Austrian and Hungarian companies. After a short introduction round, they were given an overview of the EDLRIS project and the preliminary results of the survey (see previous section) were presented. To give everybody a voice and to elicit their input, the members of the EDLRIS advisory board were asked to discuss which topics should be covered by an AI certificate and the corresponding preparatory classes and to state their general expectations on the EDLRIS program outcome in a World Café (The World Café Community Foundation, 2018) setting. At each table, a member of the EDLRIS project team acted as "table host". After a short coffee break, the discussions were summarized and presented by the "table hosts". Although the topic of robotics was also discussed, this diploma thesis focuses on artificial intelligence and so robotics will be disregarded in this analysis.

During the discussion, the members of the advisory board already distinguished between basic and advanced AI modules. They agreed that graduates of an introductory AI course should know the use cases and applications of AI and be able to define artificial intelligence not limiting the definition to machine learning. Furthermore, they should be able to use AI systems and AI technology and know the possibilities offered by these systems. They also stressed the importance of ethics and legal implications AI developments might have. They thought that graduates of an introductory AI course should have profound theoretical knowledge of AI. In general, critical thinking, social skills and being able to work in a team were also considered important. They requested a clear list of competencies so that they would know what to expect from the program in general and they recommended maintaining the contact to industry after project completion.

The expectations of the advisory board members regarding the advanced AI module are quite challenging. Graduates of an advanced AI course should have profound programming skills and should be able to analyze, configure and maintain intelligent systems. The course should focus on practical aspects and graduates should be able to develop applications and combine existing technologies to advance the development of new systems. Cooperating with companies to foster a strong connection to industry was also suggested and the members of the advisory board considered offering internships for students of the EDLRIS advanced AI program where they would work on real-live projects for several weeks.

Concerning general expectations of the EDLRIS program, the members of the advisory board considered the motivational aspect very important which means that the program should focus on gaining students interest in AI and robotics. Graduates of the advanced courses should have sufficient knowledge and skills to hold down a job in AI or robotics. The practical application of knowledge was stressed once again enabling students to build intelligent solutions.

In my opinion, the expectations concerning the trainers were a bit unrealistic as the members of the advisory board requested the application of high pedagogical standards while the trainers should also have several years of work experience in the fields of robotics or AI and thus be experts in their field.

Generally, the members of the EDLRIS advisory board supported the results of the survey by requesting graduates to be able to define AI, use AI applications and technology, know possibilities offered by theses systems and be able to reflect on ethical and social implications of new technological developments. However, they didn't mention specific topics that should be covered by the course like computer vision or machine learning. The members of the EDLRIS advisory board did not require the course to include mathematical background knowledge but highlighted the motivational aspect that should be considered in the course design.

5. Development of the AI Course Syllabus

Having identified the main topics that should be included in the curriculum (see Sections 4.1 and 4.2), the aims and program outcomes and the overall course organization will be discussed. In this chapter, *students* and *trainees* will be used synonymously as in the research literature learners are usually designated as *students*.

5.1. Aims and Program Outcomes

As the EDLRIS program adopted the "train-the-trainer" concept and thus actually offers two certificates - one for trainers and one for trainees - to ensure high-quality teaching, two stets of program outcomes also need to be defined (Graz University of Technology, 2018).

5.1.1. The Trainees' Curriculum

The purpose of the trainees' curriculum for artificial intelligence is to foster a basic understanding of artificial intelligence so that the students are well prepared for future developments in this area. The courses should also motivate trainees to pursue a career in technology or engineering and to continue their education with more advanced topics by following the EDLRIS advanced AI course or enroll at university. As the field of artificial intelligence is very broad, the trainees' curriculum developed in this diploma thesis concentrates on some basic aspects that foster a basic understanding for an advanced course where the students can gain more in-depth knowledge.

To meet the requirements of the competency-based approach (Section 3.2), the main goals and program outcomes have been defined by the EDLRIS project team based on the results of the survey in Section 4.1 and the input of the advisory board meeting in Section 4.2. The defined program outcomes determine the overall skills to be gained and serve as a basis for more specific competencies that will then be defined (Herring and Williams, 2000: 6). The experts of the EDLRIS project team tried to meet the expectations of practitioners and members of the EDLRIS advisory board when formulating the general learning outcomes.

A graduate of the AI basic training...

1. is able to describe AI, to recognize AI systems and to distinguish AI systems from other concepts and systems
2. knows the areas of application of AI and their use cases and is aware of the technical, social, ethical and legal implications
3. is able to formalize a problem and is able to apply algorithms and data structures to solve this problem
4. is able to design and practically implement a simple AI system for a given application

The first two program outcomes cover some general aspects of AI so that graduates get an overview of the topic and are able to reflect on social and technological implications of intelligent systems. Objectives three and four should familiarize students with the basic technical background of AI systems to cover also the practical aspects and applications of intelligent systems. Upon completion of the program, graduates should have declarative, procedural and dispositional knowledge (Stabback, 2016) as defined in Section 3.2.

5.1.2. The Trainers' Curriculum

The main purpose of the trainers' curriculum for artificial intelligence is to qualify trainers to give well structured and efficient courses on artificial intelligence based on the provided course materials. Trainers should get a well-founded understanding of the subject matter they are going to teach. They need to be able to select various teaching methods and techniques in order to make the learning experience for their future trainees more efficient. The trainers should also learn how to make the best use of the provided instructional materials and find a way to incorporate these materials and additional teaching aids in their own teaching style. Trainers should support their future trainees to master the competencies set out in the trainees' curriculum of artificial intelligence. This means that the trainers' curriculum completely incorporates the contents of the trainees' curriculum for artificial intelligence. Similar to the ECDL examiner training (Österreichische Computer Gesellschaft, 2018), no additional AI topics are added to the trainers' curriculum, but to incorporate the requirements of the EDLRIS advisory board members regarding the trainers' education, they should have the following skills in addition to the program outcomes that trainees need to achieve.

Additionally to the trainees' program outcomes, a graduate of the AI basic trainer's training...

1. is able to select and use an adequate teaching method that meets the student's need for instruction
2. understands and adopts the learner-centered approach of the program
3. is familiar with the assessment criteria of the EDLRIS program

5.2. Competencies

Having stated the main program outcomes, a detailed list of required competencies describing the specific skills and abilities necessary to accomplish the program outcomes will now be defined and matched to the corresponding outcomes. This list has been created in cooperation with the experts of the EDLRIS project team by clustering the identified topics and relating them to the corresponding program outcomes. The competencies have been formulated as can-do statements as they provide specific learning targets for curriculum and unit design while serving as progress indicators and self-assessment checks for learners at the same time (American Council on the Teaching of Foreign Languages, 2018).

A graduate of the AI basic training...

1. is able to describe AI, to recognize AI systems and to distinguish AI systems from other concepts and systems
   a) I can describe artificial intelligence
   b) I can recognize if a given system is based on artificial intelligence

2. knows the areas of application of AI and their use cases and is aware of the technical, social, ethical and legal implications
   a) I can name areas of AI and give specific examples of AI implementations
   b) I can understand the technical, economic, ethical and legal implications of the application of AI
3. is able to formalize a problem and to apply algorithms and data structures to solve this problem
   a) I am aware of different problem representations (e.g. machine learning, logic, graphs)
   b) I can formalize a search problem
   c) I can explain basic data structures (e.g. graphs, trees, stack, queue)
   d) I can use algorithms to solve a search problem
   e) I can assess the basic properties of search algorithms
4. is able to design and practically implement a very simple AI system for a given application
   a) I can translate an algorithm into code
   b) I can implement a simple AI system
   c) I can assess the correctness of my solution

Additionally to the trainees' competencies, a graduate of the AI basic trainer's training...

1. is able to select and use an adequate teaching method that meets the student's need for instruction
   a) I can name different teaching methods
   b) I can apply different teaching methods

   c) I can assess different teaching methods

2. understands and adopts the learner-centered approach of the program
   a) I can explain the learner-centered approach
   b) I can assess the pros and cons of the learner-centered approach
   c) I can apply the learner-centered approach

3. is familiar with the assessment criteria of the EDLRIS program
   a) I can define the assessment criteria of the EDLRIS program
   b) I can select teaching material that meets the requirements of the assessment of the EDLRIS program

5.3. Course Organization

As decided by the experts of the EDLRIS project team from Virtuelle PH Burgenland, the prep courses for the EDLRIS certification will be supported by the Moodle learning platform (Moodle, 2018). Moodle has been selected because it is the most used learning management system in Austrian higher educational institutions (Bratengeyer et al., 2016: 45) and all Austrian schools can request a Moodle platform of their own free of charge which is hosted by lernplattform.schule.at (Bundes- und Koordinationszentrum eEducation Austria, 2018) so most teachers should already be familiar with the platform.

A description of all the classes and activities will be provided on the learning platform. Thanks to the Moodle learning management system, everything is in one place and it is not necessary for the students to make copies of the material but they can still take additional notes. Some of the online activities will also be done in the face-to-face sessions so that the trainer is available if the students get stuck or have any questions. This diploma thesis focuses on the face-to-face sessions, but the trainer will also guide the online sessions.

The EDLRIS certification on Basics of Artificial Intelligence (Baumann, 2018) may be completed regardless of having completed the corresponding prep courses. However, if students decide to enroll in prep classes, they are expected to be present for the face-to-face sessions and also participate in online learning activities. Given the competency-based approach, the organization and administration of classes poses some challenges like the variety of trainees' background knowledge and skills. For this reason, several lesson plans will be provided in this diploma thesis and it will be up to the trainers to decide together with their trainees in how much detail the material needs to be covered based on previous knowledge. Following the competency-based approach, the online sessions need only to be completed by the trainees if they don't have the skills already. Self-assessment activities will be provided to support the trainees' decision if the material needs to be covered. These self-assessment activities need to be completed by all trainees who want to opt out of completing the online session so the trainer knows on whom he/she needs to focus.

Massive Open Online Courses struggle with low completion rates (Kolowich, 2013) which probably also applies to online courses in general. Mhouti, Nasseh, and Erradi, 2016 list several reasons for high drop-out rates like lack of time, course difficulty and lack of support, content not adapted to the learner profile or bad experiences where students encountered inappropriate behavior of peers in forums. To avoid these problems, the trainer will also supervise the online course and support any trainees who need additional help. The trainers may also offer extrinsic motivation like praise

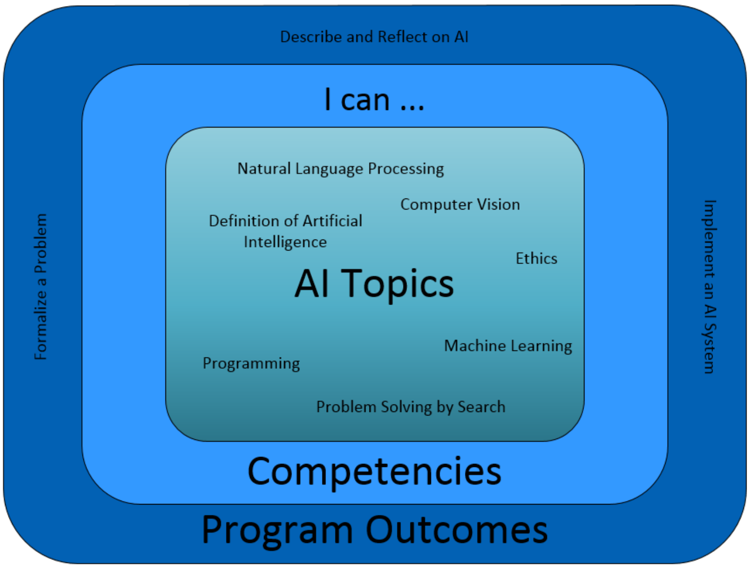


Figure 5.1.: Course Overview

or contacting trainees who don't seem to work on the assignments to find out about the reasons and thus support them getting back on track.

For the development of the course, a top-down approach has been selected. As indicated in Figure 5.1, first the overall program outcomes have been described then specific competencies have been defined before selecting AI topic to achieve these competencies and program outcomes.

5.4. Lesson Plans

In this section, blueprints for courses will be developed to prepare trainees for obtaining an EDLRIS Certificate on Basics of Artificial Intelligence. These blueprints can and should be used by trainers for prep courses. To get a better overview, it will be indicated if the corresponding lesson plan is for face-to-face teaching (👥) or if it is an online activity (📶). The Moodle course will also be used in face-to-face sessions so although the trainees interact with the learning management system during a face-to-face session, the face-to-face icon will be used.

The topics have been selected based on the responses of the expert survey in Section 4.1 where the definition of AI, recognizing intelligent systems, applications of AI, machine learning, mathematics, computer vision, natural language processing and ethics have been identified as topics that need to be covered.

5.4.1. Overview and Time Frame

This section gives an overview of all lesson plans with the allocated time slots. Depending on the trainees' prior knowledge, some lessons might be skipped or talked about in more detail. The allocated time frames are just a rough estimate as some activities depend on the number of participants and are thus open for modification. No estimates are provided for the online activities where the completion time depends on the trainees' prior knowledge and their individual learning pace. For descriptions of the icons used in the competence column of Table 5.1, see Section 5.2.

Time in Minutes	Activity	Online / Face-to-Face	Competence
Getting to know each other			
20	Names, Names, Names		
20	This is Personal		
Defining Artificial Intelligence			
25	Think - Pair - Share		
15	AI Definitions		

Natural Language Processing			
5	EDLRIS-Team		
10	Group Discussion on Chatbots		
5	Picture		-
35 (20 + 15)	Interviews		
30	The Imitation Game		
Can Machines Think?			
15	Where do You Stand?		
20	Is it Intelligent?		
Programming 101			
20	Get Coding		
	Variables		
	Getting User Input		
	Simple Calculations		
	If-Statements & Switch-Case		
	Lists (Arrays)		
	Loops		
	Dictionaries		
	Functions		
	Modules (Libraries)		
360	Our Chatbot		
20	Bot-Challenge		
Ethics			
60	Bot Ethics		
Computer Vision			
15	ABC Graffiti		
25	Micro Lecture		
Machine Learning			
10	Classification		
15	Decision Trees		

45	Vampires vs. Humans		
30	Blood Types		
45	CV and ML Ethics		
Problem Solving by Search			
30 (5 + 25)	Mazes & Mona Lisa		
	Graphs & Trees		
	Stack & Queue		
	Depth-First-Search		
	Breadth-First-Search		
10	Stack Game		
90	Practice Search Algorithms		
480	Project Day		

Table 5.1.: Overview of Lesson Plans

Detailed descriptions of the modules indicated in Table 5.1 as well as the didactic considerations for selecting a specific teaching method are provided in the following subsections.

5.4.2. Getting to Know Each Other -

Humans are social beings and so the learning environment plays an important role when it comes to studying. “It requires confidence that we can learn, it requires an openness to new experiences and thinking and it requires understanding that we might be wrong, we may make errors and we will need feedback”(Hattie and Yates, 2014: 21). Learning can only take place when it is “safe” to do so (Jensen, 2005: 36). To create a supportive and productive learning environment, it is therefore important to establish positive relationships between the individual members of the course.

A positive learning environment depends on the trainer's ability to communicate, facilitate learning and respect the students. These are also the main factors for student satisfaction and course quality ratings in general (Moskal, Dziuban, and Hartman, 2013: 19). Personality traits of trainers play only a minor role when it comes to excellent teaching, but it is important that students perceive their trainer as an acceptable, warm and competent human being who acknowledges the trainees as "individuals with names, histories, interests and personal goals" (Hattie and Yates, 2014: 26).

In order to create a supportive and productive learning environment, it is essential that the participants get to know the trainer and each other before starting with the actual content. When students get the feeling that their presence is not appreciated or required, they are less likely to engage and put effort into the course (Barkley, 2010: 112). To make the learning process more personal, the first class should be organized as a face-to-face unit, where the trainer presents him/herself briefly before everybody gets to know each other. As learning new names and getting to know new people usually requires a bit of an effort from all participants including the trainer, two activities are proposed to create an element of repetition and thus give more opportunity to really get to know the participants as individuals.

Names, Names, Names

Studies have shown that the cerebellum and basal ganglia - the parts of the brain that are mainly concerned with motor movements - are also involved in "cognitive processes such as working memory, rule-based learning and planning future behavior" (Middleton and Strick, 1994: 461). Physical activity also increases blood flow which in turn increases the amount of oxygen - an important resource for brain function - transported to the brain. (Jensen, 2005: 62). The following activity focusing on getting to know each other makes use of the positive effects of physical activity on the brain.

Activity: The participants are standing up and form a circle. The trainer is part of the circle and he/she starts to introduce him/herself by telling his/her name only. Together with stating the name, he/she makes a small movement e.g. bowing, drawing a triangle or circle with the left foot on the floor etc. The person next to the trainer repeats his/her name and the movement before stating his/her own name combined with a small movement and so on. When the participants have concluded the activity, the trainer tries to repeat the names and movements of the whole group.

As everybody needs to repeat all the names and movements, people are much more likely to pay attention and put real effort into learning all the names. Some people might feel self-conscious when thus put into the spotlight, therefore the trainer needs to explain that making fun of others or bullying will not be tolerated and if it occurs, the responsible person will be excluded from all the future classes and online activities. An atmosphere of mutual respect and room for errors should be the basis for every working session.

This is Personal

To get to know each other even better and not just know people by their name, a second activity is initiated by the trainer.

Activity: Each participant selects a personal object they have with them like a key ring, a special pen, a book or an e-reader. The participants then walk around the room and get together in pairs. They explain to each other why they selected the corresponding object and repeat their name. Then the items are swapped and the participants resume walking. After a short while, they get together with somebody else and explain why and by whom the object was selected. This process is repeated several times. After several repetitions, the participants form a circle and each gives the object back to his/her owner by saying again the name of the owner and why the object was selected.

Having thus provided the basis for a productive learning environment, the participants can now focus on the actual content of the course.

5.4.3. Defining Artificial Intelligence -

Researchers have yet to agree upon a definition of artificial intelligence and so Lewis and Monett, 2018 are currently conducting a survey to find some common ground and come up with a definition that is widely accepted in the AI research community. The goal of this unit is to make trainees aware of different approaches concerning the definition of artificial intelligence so that they are able to describe artificial intelligence in a way that takes various aspects of the term into consideration.

Activity: () To increase collaboration and involve all students from the beginning of the course, they are asked to explain what they think artificial intelligence is in a Think-Pair-Share activity. This teaching method consists of three stages (Tint and Nyunt, 2015: 4):

1. Think: Each student thinks on the given task - in this case the definition of artificial intelligence in general - individually taking notes.
2. Pair: In groups of two, the students discuss their ideas and try to come up with a common position regarding the task.
3. Share: The groups share their results in the plenary session, where their ideas are collected and clustered on the blackboard.

This activity gives the students the opportunity to recollect what they already know, learn from each other and add new knowledge to what they have already mastered (Tint and Nyunt, 2015: 4). Active learning is promoted because everybody gets to talk when putting their ideas into words and social interaction is encouraged as the participants have to come up with a team solution (Harmin and Toth, 2006: 94).

After this activity, the participants are given the following two definitions of artificial intelligence. These definitions were selected because when analyzing the collected definitions of Lewis and Monett, 2018 two major trends have been identified: definitions that are mainly concerned with intelligent behavior observed in humans and definitions that focus on the achievement of goals in a given environment.

> AI is the part of computer science concerned with designing intelligent computer systems that exhibit the characteristics we associate with intelligence in human behavior - understanding language, learning, reasoning, solving problems and so on. (Barr and Feigenbaum, 1981: 3)

> We define AI as the study of agents that receive precepts from the environment and perform actions. [...] Ideally, an intelligent agent takes the best possible action in a situation. (Russel and Norvig, 2010: viii, 30)

Activity (): The students should read these two definitions and compare them to their own definition. Where are the similarities and where are the differences regarding the students' definition? The students then integrate these two definitions into the clustering on the board in a group activity. Having clustered the definitions accordingly, the trainer invites the students to have a look at the learning platform for the complete list of AI definitions compiled by Lewis and Monett, 2018 so that they realize that there are myriad approaches and definitions.

The provided definitions introduce the students to the definition of artificial intelligence the EDLRIS certificate is based upon. They will draw on these definitions throughout the course to classify systems as (not) intelligent and use these to justify their solutions. By comparing the definitions to the students' own definition, the knowledge building process is initiated. Realizing that the students have already some prior knowledge, even if rudimentary, and identifying knowledge gaps usually inspires learners to acquire more knowledge in this area (Hattie and Yates, 2014: 7).

5.4.4. Meet the EDLRIS Team

The goal of this unit is to provide students with some experience of the application of Natural Language Processing (NLP), a subfield of AI. The students are introduced to one example of a chatbot and are invited to think about various applications of chatbots, the main problems when dealing with NLP and also relate this experience to the definition of AI in general and so connect this unit with the first one. Furthermore, they are introduced to the Turing Test (Turing, 1950), a black-box method to determine if a system can be labeled intelligent.

Activity: (👁) The students should have a conversation with one of the EDLRIS team members, the co-teachers of the course who are teaching all over Europe and "therefore cannot participate in person but are available online". The trainer has to try to present the team in a very convincing way by e.g. showing a picture of them so that the students really think they are going to interact with these experts when in fact "the team" is a chatbot. Of course, the students should find that out for themselves. The bot is based on the famous Eliza pattern matching approach by Joseph Weizenbaum, 1966, but rather than putting the chatbot in a psychological context, the conversation leads the students inevitably to the topic of the Turing Test where they either have to explain it, if they already know what it is about, or get an explanation from the bot.

This activity enables the students to experience a chatbot first hand. They are actually doing the Turing Test but are not told to look out for a computer as they should instead think that they are talking to a human being. The bot is not very sophisticated so it should be easy for the students to realize that they are in fact talking to a computer program.

Activity: (👁) Having completed the chatbot activity, the trainer asks some of the students to share their thoughts on their assigned EDLRIS team member based on the conversation they just had. The students might voice their suspicion that they were actually talking to a bot which the trainer confirms. If the students did not suspect the bot involvement, but ascribed the conversation flow to some weird personality traits of the EDLRIS team member, the trainer reveals that they were actually talking to a chatbot. The trainer also relates the chatbot they just interacted with to Joseph Weizenbaum's Eliza and invites the students to interact with Eliza on the course learning platform.

Activity Trainers' Course Only: After this activity, the current trainees but future trainers should have a group picture taken that they can use it in their training classes. The chatbot activity is more convincing for their future students if they associate the EDLRIS team with real people seeing their trainer in a picture alongside this team. The future trainers replace the picture that was used in the Train-the-Trainers class with this picture to make the experience of their future students more real.

Activity: ( ) To sum up the chatbot activity and reflect on their knowledge of applications of natural language processing, the students are now asked to interview one another in a Partner Speaks activity (Shaffery, 2018). They are provided with some guideline questions but can add some questions of their own, if they deem it appropriate or interesting. There are two rounds of interviews as each student has to interview and be interviewed by another student. The students can decide for themselves, if they want to take turns after each question or do one interview after the other. They should take notes and need to be informed that answers like "I don't know" are not acceptable. If students really do not know the answer to a question, they have to speculate or come up with a hypothesis. As one of the questions refers to the Turing Test and the concept has only been explained briefly by the chatbot, the interviewees are also provided with a cheat sheet, where the Turing Test is explained once again. They can also use the notes on the definitions of artificial intelligence during the interview or any other material they would like to access.

After the interviews, the students share the answers given by their interview partner with the whole class (Shaffery, 2018). Not all answers of every single student are shared, but the questions are either randomly assigned to different students, who share their partner's response or those students who think that a very interesting idea came up in the interview share the corresponding answer.

Interview Questions:

- Please describe the experience you just had with the chatbot in a few words.
- What is the relation of chatbots to artificial intelligence?
- In your opinion, how could it be achieved that chatbots reliably pass the Turing Test?
- Did you have other experiences with chatbots or natural language processing systems before?
  If yes: please describe them (e.g. where were they used, how did you feel interacting with the system?)
  If no: can you think of some areas where natural language processing might be useful?

Cheat sheet: The Turing Test also known as the Imitation Game is played with one interrogator, a human player and a computer. The interrogator has to find out whether the responses to his/her questions come from the human player or the computer. If the interrogator cannot differentiate between the two players, the computer "wins" the Imitation Game and passes the Turing Test. (Russel and Norvig, 2010: 2)

The interview method allows students to relate the newly acquired experience and knowledge to what they already know from their life experience. They are also more likely to say what they really think in a peer-to-peer setting (Barkley, 2010: 305). Even though the students might not have all the answers to the questions, these should initiate thought on the topic of natural language processing and artificial intelligence. The sharing of their interview partner's ideas forces the students to actively listen to the answers and be able to repeat them for the whole group. During the group discussion, any misconceptions can be clarified by the trainer.

5.4.5. The Imitation Game

The goal of this unit is to introduce the students to an approach of solving challenges posed by natural language processing by building on the experience with chatbots they've just had in the previous unit. They work on the first algorithm in this course and are invited to think some more about intelligent behavior.

Activity: ( ) Having perhaps had the first conscious experience with a chatbot, the students now get a glimpse at the inner workings of the algorithm of Joseph Weizenbaum's Eliza chatbot (Weizenbaum, 1966). The students work in groups of three. One student represents the human interrogator in a psychotherapy setting. Another student represents the replacement function. This student is provided with the replacement Table B.1 (Appendix B). If the interrogator uses a word from the "replace" column of the table, the student substitutes this word with the corresponding word of the "with" column and passes the phrase on to the third student who represents the computer that actually applies the algorithm. This student is provided with the word fields Table B.2 and the template Table B.3 (Appendix B). The tables below are just excerpts, the complete tables can be found in Appendix B. The student checks the input phrase with his/her list of keywords in column one. If there is a match, he/she checks the context in column two substituting any variables in column two with the corresponding list item of the word fields table. For instance, when the student encounters the variable @FAMILY in column two of the template Table B.3, the context applies to all words in the row FAMILY of the word fields Table B.2. So if the input phrase contains the

replace	with
AM	ARE
YOUR	MY
I	YOU
YOU	I
MY	YOUR

Table 5.2.: Replacing words. Compiled from original Eliza script by Weizenbaum, 1966: 44

word SISTER, it is a match for the context rule with the variable @FAMILY because SISTER can be found in the same row as the @FAMILY variable. On the other hand, if the input phrase contains UNCLE, it is not part of the @FAMILY word field and so not a match for the @FAMILY variable. The student thus has to move on to the next context-rule of the template Table B.3. When the student finds a match in the Keyword column and in the Context-Rule column, he/she moves on to the Response-Template column of the template Table B.3. He/She produces the response substituting any variables with the input phrase.

Keyword	Context-Rule	Response-Template
YOU	* YOU (?NEED) *	WHAT WOULD IT MEAN TO YOU IF YOU GOT @x WHY DO YOU WANT @x? SUPPOSE YOU GOT @x SOON WHAT IF YOU NEVER GOT @x? WHAT WOULD GETTING @x MEAN TO YOU WHAT DOES WANTING @x HAVE TO DO WITH THIS DISCUSSION?

	* YOU ARE (?NEG. FEELING) *	DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE @x? I AM SORRY TO HEAR YOU ARE @x. I'M SURE ITS NOT PLEASANT TO BE @x? CAN YOU EXPLAIN WHAT MADE YOU @x?
	* YOU ARE (?POS. FEELING) *	CAN YOU EXPLAIN WHY YOU ARE SUDDENLY @x? HAS YOUR TREATMENT MADE YOU @x? WHAT MAKES YOU @x JUST NOW? HOW HAVE I HELPED YOU TO BE @x?
	* YOU ARE *	IS IT BECAUSE YOU ARE @x THAT YOU CAME TO ME? HOW LONG HAVE YOU BEEN @x? DO YOU BELIEVE IT NORMAL TO BE @x? DO YOU ENJOY BEING @x?
	* YOU FEEL *	TELL ME MORE ABOUT SUCH FEELINGS DO YOU OFTEN FEEL @x? DO YOU ENJOY FEELING @x? OF WHAT DOES FEELING @x REMIND YOU?
		YOU SAY @x CAN YOU ELABORATE ON THAT? DO YOU SAY @x FOR SOME SPECIAL REASON? THAT'S QUITE INTERESTING

Table 5.4.: Template Eliza. Compiled from original Eliza script by Weizenbaum, 1966: 44

MOTHER MOM FATHER DAD SISTER BROTHER WIFE CHILDREN	FAMILY
SAD UNHAPPY DEPRESSED SICK	NEG. FEELING

Table 5.3.: Word-Fields. Compiled from original Eliza script by Weizenbaum, 1966: 44

The trainer explains the rules of the game and also demonstrates the algorithm based on the following examples:

Example 1

1. Student three starts with the prompt "HOW DO YOU DO: PLEASE TELL ME YOUR PROBLEM."
2. Student one answers with "I miss my mother."
3. Student two replaces I with YOU and MY with YOUR and passes the phrase "YOU miss YOUR mother" on to the third student.
4. Student three finds the keyword YOU in the template table B.3.
5. He/she checks the context column of the keyword but cannot find a matching context rule and so uses the empty context.
6. He/she then selects the first unused phrase of the Response-Template being "YOU SAY @x."
7. Student three substitutes the variable in "YOU SAY @x" with the input phrase "You miss your mother".

8. The student then replies “YOU SAY YOU MISS YOUR MOTHER” and marks the response as already used so if the combination of keyword and context matches again, the second response template is used and thus it makes the conversation more interesting and realistic.
9. Student one reacts to the reply thus providing the next input phrase.

Example 2

1. Student three starts with the prompt “HOW DO YOU DO: PLEASE TELL ME YOUR PROBLEM.”
2. Student one answers with “I am lonely.”
3. Student two replaces I with YOU and AM with ARE and passes the phrase “YOU ARE lonely” on to the third student.
4. Student three finds the keyword YOU in the template table B.3.
5. He/she checks the context column of the keyword finding the rule YOUR ARE (?NEG. FEELING). However, lonely is not part of the word field NEG. FEELING of the word fields in table B.2. Therefore, the student goes on to the next matching context rule and finds “YOU ARE”.
6. He/she then selects the first unused phrase of the Response-Template being “IS IT BECAUSE YOU ARE @x THAT YOU CAME TO ME?”.
7. Student three substitutes the variable @x with the input phrase “You are lonely.” However, as the context-rule was not empty, the student removes the context rule from the input phrase ending up with “LONELY”.
8. The student then replies “IS IT BECAUSE YOU ARE LONELY THAT YOU CAME TO ME?” and marks the response as already used so if the combination of keyword and context matches again, the second response template is used and thus it makes the conversation more interesting and realistic.

9. Student one reacts to the reply thus providing the next input phrase.

The Eliza activity gives the students the opportunity to explore the algorithm in a ludic way before implementing a basic chatbot in a text-based programming language. As this is also the first algorithm they encounter in this class, the trainer has to make sure everybody is brought to the same level. Some participants might already have programming experience and have written their own code whereas others might be complete beginners. The ludic approach tries to make sure that the task is not too challenging for beginners but also not too boring for more experienced participants.

Applying a so far unknown algorithm can be compared to maths problems like calculating square roots for the first time where the steps still need to be learned. Solving problems in general imposes heavy cognitive load on learners as the working memory has only very limited capacities and so problem solving activities should not be unguided as e.g. proposed by the inquiry-based instruction theory (P. A. Kirschner, Sweller, and Clark, 2006: 77). It is recommended to teach problem solving skills and algorithms with worked examples, where the teacher demonstrates the solution to the problem and/or completion examples, where the first steps of the solution to a problem are demonstrated and the learners have to complete the example (Hattie and Yates, 2014: 152).

The Eliza activity represents a completion example and it has been selected because trainers usually work with heterogeneous groups including advanced participants and complete beginners. The trainer demonstrates the first part of the conversation and the solution is then completed by a group of students. It has been avoided to go through a complete conversation proposed by the worked example approach because the worked example effect is reversed with advanced expertise. For learners with more experience worked examples are an unnecessary repetition activity that increases working memory load rather than reducing it (P. A. Kirschner, Sweller, and Clark, 2006: 80). The group activity design further decreases mental load on the individual group members (F. Kirschner, Paas, and P. A. Kirschner, 2009: 312).

5.4.6. Can Machines Think?

The goal of this unit is to revise the definition of artificial intelligence and give it some more thought. The students are also introduced to John Searl's thought experiment "The Chinese Room" (Searle, 1980).

Activity: ( ) Having worked out the basic algorithm of the Eliza psychotherapist, the students are asked to reconsider the intelligence of the program. The room is divided in halves and each half is assigned a point of view concerning the question "Can machines think?". The students are asked to position themselves in the part of the room with the perspective they feel most comfortable with (yes or no). However, they don't have to stick to their initial choice but are allowed to switch sides. It should be stated that there are no wrong answers to this question as this exercise should help students make up their mind and understand different points of view. Having positioned themselves, the statements from the table below are read on the corresponding side of the room starting with the "Intentional point of view" one after the other with time in between so that the students have the possibility to switch sides.

Extensional point of view	Intentional point of view
"Once a particular program is unmasked, once its inner workings are explained, its magic crumbles away [...] and the observer says to himself "I could have written that"." (Weizenbaum, 1966: 36) The program remains on the shelf marked "intelligent" because once the inner workings of the human mind are explained, the human is none the dumber for it.	"Once a particular program is unmasked, once its inner workings are explained in language sufficiently plain to induce understanding, its magic crumbles away; it stands revealed as a mere collection of procedures, each quite comprehensible. The observer says to himself "I could have written that". With that thought he moves the program in question from the shelf marked "intelligent", to that reserved for curios, fit to be discussed only with people less enlightened than he." (Weizenbaum, 1966: 36)
If People cannot differ a chatbot from a human, it means that the chatbot must be intelligent.	If People cannot differ a chatbot from a human, it means that these people are just too stupid to know the difference.
The Chinese Room (argument mounted by John Searle): A person who speaks only English is given a rule book with instructions written in English, some blank paper and some slips of paper with Chinese inscriptions. Small slips of paper with Chinese inscriptions are then given to the person who follows the rules in the rule book to produce a reply. (Russel and Norvig, 2010: 1031)	

If we ask the person in the room, if he/she speaks Chinese the answer is affirmative in fluent Chinese. This is enough evidence for understanding and speaking Chinese.	Although from the outside, you cannot tell if the person speaks Chinese because the responses are accurate, the person does not understand or speak Chinese, he/she just mindlessly follows a rule book.

Table 5.5.: Different Points of View

This exercise gives students the opportunity to think once again on the definition of artificial intelligence. They also should learn that there are different approaches to artificial intelligence and they are asked to take a stand on one or the other side. The students should also realize that the EDLRIS program adopts the extensional point of view, which means that the term "think" or "intelligence" or "cognition" is extended to machines just like the term "fly" has been extended from birds to airplanes as they both travel through air though by different means (Rapaport, 2000: 471). The intentional point of view, on the other hand, assumes that "human brains do not produce mental phenomena solely by virtue of running a program" (Russel and Norvig, 2010: 1032).

Activity: () Having positioned themselves and reflected on the definition of artificial intelligence once again, the students further develop their understanding of artificial intelligence in a card sorting activity (Keeley, 2008: 56). They work in pairs and based on the previous activity and the definitions of AI classify the cards in Appendix C into two categories: intelligent - not intelligent. For instance, the Google search and the autonomous

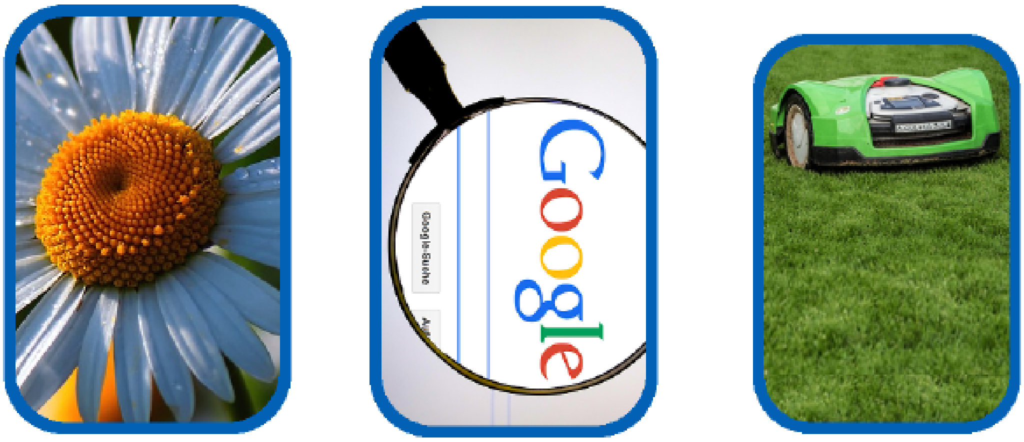


Figure 5.2.: Is it intelligent?

lawn mower in Figure 5.2 are easy to classify as intelligent whereas the flower might pose some problems and the students will probably check the definitions. According to the definition by Barr and Feigenbaum, 1981, the flower would have to be classified as not intelligent whereas the definition of Russel and Norvig, 2010 offers room for interpretation. So if the students offer a valid justification like "plant growth is considered an action performed based on precepts from the environment like sun or rain" the flower can also be classified as intelligent. This is why the students have to justify their decision and agree on their classification. After having categorized all the cards, the results of each pair are compared in the whole group and those examples that the students found most difficult to categorize are discussed in the plenary session.

This activity revises the definition of artificial intelligence once again. The students are introduced to some applications of AI and they also get a chance to discuss their ideas on the previous activity with each other based on some concrete examples. The discussion of difficult-to-classify examples helps to clarify any misconceptions that might have come up. A classification suggestion is provided in Table C.2 in Appendix C, however, the solutions of the group might differ depending on the students' justifications.

5.4.7. Programming 101 |

Creating an intelligent machine is not yet possible without some notions of writing code. Although some students might already have some programming experience, a quick introduction is provided because being able to write a program is not a prerequisite for the course. The trainer will give some instructions to those students who do not have any programming experience yet, but those who already have some experience can move on to the more challenging examples. Because of the different levels the students are at, this unit is an online unit for the most part so that the students can learn at their own pace supported by face-to-face sessions where there is room for questions and discussions.

Choice of Programming Language

For this course the Python programming language has been selected mainly for four reasons, although there are plenty of other advantages of this programming language.

1. Python is easy to learn because it "has relatively few keywords, simple structure and a clearly defined syntax" (Chun, 2000).
2. Python is used by global players such as Google, Dropbox or Netflix (Holdernesst, 2016).
3. Python has a lot of useful libraries for AI implementations (Wolf, 2017).

4. Python is an interpreted language and thus the source code can be directly executed without the need for a compiler (Runestone Interactive Project, 2018).

Setting up the Environment

It is not specifically explained in the course how to set up the programming environment because of different operating systems the students might use and everybody should be able to install software on his/her computer anyway. Additionally, a Python interpreter is available on the Moodle platform using the Virtual Programming Lab plugin (Rodríguez-del-Pino, 2018) so the students do not actually need to download the programming environment on their computer as they can use the environment of the learning management system interactively. There are also a lot of online tutorials in various languages on the installation of the programming environment. However, if the students get stuck, they can always ask the trainer or one another in a face-to-face session or in the forum of the learning platform.

Get Coding

The trainer explains that a computer program is just a set of rules, like a cooking recipe, but the students have to be careful with the instructions because the computer takes everything literally and so they could end up like the parents in the following video clip on YouTube: `https://www.youtube.com/watch?v=v-7t7sOGdyU&t=28s`. After watching the video clip, the trainer demonstrates how to output text to the screen with the following example:

```
print(''I am an intelligent program'')
```

Before letting the participants try it for themselves, the trainer explains that errors are normal and are to be expected because we hardly ever get it right the first time (Jensen, 2005: 52). The trainer then produces some syntactical errors by misspelling the print function name or omitting the quotation marks etc. and shows how to deal with these errors in four steps:

1. Remain calm, don't freak out because there is an error.
2. Read the error message.
3. Figure out what the error message means. If you do not understand the error message, try to search for the answer online before asking a group member or the trainer for help.
4. Correct the mistake and run the program again.

The trainer should go through these steps at least two to three times so that the students get the routine.

Activity: (✱) The students now get to write their first programs using the print function. The exercises are interactive so the students get immediate feedback concerning their solution. They should produce the following output, where each item represents one separate mini program.

1. Hello, my name is Sue.
2. I'm a computer program and I'd like to chat with you.
3. My friend said "I like you."
4. They said "We'll come with you."

The short video clip is used to approach the topic of programming with fun. Humor has a positive effect on the learning environment and can help to draw attention to the matter at hand as "defenses are lowered and students are better able to focus and attend to the information being presented" (Ardalan, 2015: 71). Directly after the video clip, the teaching method of modeling is used where the trainer allows the students to first observe his/her programming skill by means of an example. The trainer also demonstrates how to deal with errors before the students can try the skill for themselves in a training session with online exercises where immediate and direct feedback can be provided. Although mere exposure to the skill does not assure successful transmission of the skill, by walking the students through the procedure step by step, they get the opportunity to genuinely learn without having to deal with the additional cognitive load of figuring out the solution for themselves (Hattie and Yates, 2014: 78). They get the opportunity to solve the problem of dealing with apostrophes and quotes in the practice examples and they have the possibility to ask the trainer for help.

The remaining classes on programming are designed in the flipped classroom mode, where the students are provided with text materials and exercises to study the basic concepts in online sessions (Gilboy, Heinerichs, and Pazzaglia, 2015: 110). The next face-to-face session is used to apply these concepts. The online sessions allow beginners to work at their own pace while participants who already have some programming experience can skip the basics and directly move to more advanced content. They also may ask questions in the forum on the Moodle platform which is monitored by the trainer.

All online sessions follow the same blueprint that is being designed with the experts of the EDLRIS Team from the Virtuelle PH Burgenland (Pädagogische Hochschule Burgenland, 2018). At the time of writing, the ECDL Foundation also released a new ECDL computing module where Python is the programming language of choice (ECDL Foundation, 2018). Before creating the online programming sessions, the new ECDL module will be checked for possible synergies. The development of the online sessions is beyond the scope of this diploma thesis.

The following topics will be covered in the online sessions:

- Variables
- Getting User Input
- Simple Calculations
- If-Statements
- Lists (Arrays)
- Loops
- Dictionaries
- Functions
- Modules (Libraries)
- Regular Expressions

Activity ( ): Having completed the online sessions and the basics of programming in general, the students can now have a go at their own version of the Eliza program. The students match up in teams of two to create a pencil & paper script in a field of their choice, e.g. a typical dialog at a hotel reception, in a cafe, music, etc. They then program a chatbot based on the planned conversation flow taking multiple possible answers from the user into account. The students can check the source code of the EDLRIS-Team bot. The students should use regular expressions for pattern matching but if they do not manage to complete the exercise in the given time-frame, they might use simple if-else statements and dialogs where the user's answers are restricted to a predefined set of possibilities. The chatbot would then have to be adapted giving corresponding prompts like "Please answer only yes or no" or "Select one of the options: breakfast, lunch, dinner".

The trainer supports the teams and answers questions but does not produce the answers to the questions right away. The trainer first tries to guide the student to the answer by asking questions or showing how he/she tackles the problem of finding the required information, commenting on each step. E.g. the trainer first thinks about some keywords that are important for answering the question, then puts them through an online search and evaluates the results until finding the requested answer.

The activity gives students the opportunity to apply the skills they acquired in the online sessions on a medium scale project. They can select a domain of their own choice for the script which is intended to boost motivation and creativity. If they need support or have questions that were not already answered during the online sessions, the trainer can give support and advice on finding the required information.

Activity: (✔) After creating the bots, the students get a chance to try each others' creations. Each team can nominate a bot for each of the categories below. If there is more than one bot per category, the bot with the most nominations wins the category but draws are also possible.

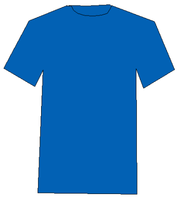
- Best Pencil & Paper Script
- Best Human Imitation
- Best Strategy for "Nothing Found"

The nomination activity allows the students to see each others' work and so learn from the creations. They have to define the characteristics of a good bot and get new ideas on how to handle the challenges posed by creating a chatbot. Although there are some dangers in using competition as a motivating activity as there usually are some losers, the use of three different categories makes the chance of winning one of the categories more likely and the team-based approach to the competition reduces pressure on the individual student (Barkley, 2010: 89).

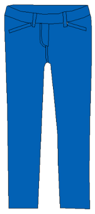
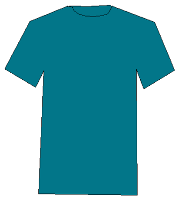
5.4.8. Ethics

Having had a look at the applications of natural language processing and the technical background, the students get to talk about the ethical aspects of natural language processing and chatbots.

Activity (): In this station learning activity (Jones, 2007), the room is divided into six learning centers where each station represents one topic from Appendix D which are Ownership, Privacy, Advertisments, Abusive Language, Gender & Diversity and Human Impersonation. The students also form six groups and each group is assigned a different station. They have about 10 minutes to complete the station activity before moving on to the next station. The students get a two minute warning before the time at each station runs out so that they know to finish the task and reset the materials at their station for the next group. At the Ownership station, the setting is an online shop where a bot recommends items for customers to buy. The students first assume the customer perspective and have to decide which item the bot should recommend considering, that they already bought a T-shirt and that they want to buy a similar item. The dollar-sings indicate the price of each item. The students discuss the same situation from the managers perspective where the dollar-signs indicate the profit and finally they consider being the developer of the bot.

Customer bought for $$: 

What should the bot recommend?

			
\$\$	\$\$\$\$	\$	\$\$\$

Changing perspective should help students to consider ethical behavior in a situation. What might seem a clear decision in the first place like recommending the least expensive item might change when they have also to consider that they have to make a profit to run a successful business. Developers might be caught in the middle of to extreme perspective and without clear guidelines to stick to, they end up being the ones to decide on ethical behavior. This is just one example of the type of activities the students should complete at the stations. The topics are mainly designed to elicit short discussions on ethical issues and initiate a thought process.

While moving from station to station and discussing the various ethical issues when it comes to chatbots, the students also create an ethics policy where they should define general rules and regulations for ethical behavior considering each topic. The students can use the template in Appendix D.7 so that they do not have to start with a blank page. So for the previous example they might define a regulation like "Always make it clear who's interest a system serves." The students will continue to work on their policies as they complete the course.

The station learning approach makes sure that students are not required to remain on one task for too long. Switching stations also allows the students to move around a bit and have a quick mental break before tackling the next topic (Jones, 2007).

5.4.9. Computer Vision

After the first key area of artificial intelligence, namely natural language processing, the students get a glimpse at another major field of AI: computer vision. Before the next activity, where the students have to find examples of computer vision, the trainer explains that vision is all about visual input and seeing (Tanimoto, 1987: 379).

Activity ( ): The students are divided into two groups to share their knowledge of computer vision applications. They are provided with a sheet of the alphabet from A to Z. The students should find a computer vision application for each letter in the alphabet. It is also possible to write down more than one application for a letter. The goal is to try to come up with as many examples as they can (Rozzelle and Scearce, 2009: 132). To get them started and give them some ideas, the trainer also scatters the images of Appendix E.1 around the room. This gives the students the opportunity to move around while thinking and get inspiration at the same time. After completing the exercise, the work sheets are exchanged. The students look at the examples of the other group and discuss why these applications are considered intelligent when every child can do it without special training. They can use the definitions of artificial intelligence that were compiled at the beginning of the course. After the group discussion, one student of each group summarizes their findings in a short plenary session.

The ABC Graffiti method (Rozzelle and Scearce, 2009: 132) helps students activate their existing knowledge on the subject and share their ideas with the group. The students should realize that we are surrounded by artificial intelligence and often don't even recognize it. The discussion on the intelligence of the provided example activates learning through repetition (Hattie and Yates, 2014: 58).

Having worked out and discussed some examples of artificial intelligence in computer vision, the students are introduced to the technical background of computer vision. The trainer uses the slides provided on the learning management system to give an attentive micro-lecture (Harmin and Toth, 2006: 166). An overview of the slides can also be found in Appendix E.2. The instructions for the trainer and activity prompts for the students are provided in the notes section of the slides. Using this strategy, the trainer talks about two to five minutes before giving the students an opportunity to digest the information by providing mini activities. The slides give a short introduction to pixel images and their general structure. The next part is about filtering the relevant information from a picture. The students should understand that our visual system and minds are highly selective when processing information. They are then presented with a technique to filter relevant information like edges from a picture. The students are also briefly introduced to generating corners, though only in principle as the underlying maths is probably still too hard for most of the students. This short overview on computer vision also provides the perfect bridge for the next topic which is machine learning. The trainer interrupts the attentive micro-lecture to tackle the topic of machine learning, or to be more specific, classification.

5.4.10. Machine Learning

Having been given a short overview on computer vision and feature extraction, the students get to work on the concept of classification in machine learning. The trainer explains that classification is one of the main problems that can be solved with machine learning. Classification answers questions like "Is it . . . ", where the answer is a finite set of values (Russel and Norvig, 2010: 696). To foster a better understanding of classification, the students should look at their list of computer vision applications and identify examples for classification problems. To get them started, the trainer gives an example from autonomous driving: identify pedestrians, cyclists, other cars etc. To sum up the activity, each group selects one classification problem they identified and shares it with the other participants in a plenary session.

Activity (): In pairs, the students engage in another card sorting activity (Keeley, 2008: 56). They are told to sort the cards of Appendix F.1 into two categories: cats and dogs. However, they are only given about half of the cards to sort as this preliminary activity represents the training phase. To make the activity a bit more challenging, the students also have to note the features of each category in the provided table. The features indicate how they know that the picture belongs to the specific category cat or dog. To give an example, they could note "pointy ears" in the cats category as all of the cats have pointy ears. Some of the dogs also have pointy ears so they need additional features to correctly classify all of the pictures. The feature tables are then exchanged so that each group works with the features of another group and they classify the rest of the pictures of Appendix F.1 according to the feature list. So if there is only the feature "pointy ears" in the cats category and no other distinct feature, all dogs with pointy ears have to be classified as cats. This part of the activity represents the test phase. Having classified all the examples, the students give each other a short feedback round where they just tell the group who created the features if everything was classified correctly or if another feature would have been required.

This activity introduces the students to a problem set that can be tackled with machine learning. They should realize the complexity involved in this seemingly simple activity and the importance of selecting good features for building a model that can then be applied. The above activity is an adaptation of the activity proposed by Way et al., 2017. In my opinion, sorting cards gives the students the possibility to rearrange the material and thus offers more variety than a simple worksheet.

5.4.11. Decision Trees

Having been introduced to machine learning in general and classification in particular, the students are introduced to the tree structure by having a closer look at decision trees and subsequently the decision tree learning algorithm. Decision trees have been selected as an example for machine learning algorithms because they represent one of the simplest but nevertheless very successful forms of machine learning (Russel and Norvig, 2010: 697). They were also mentioned by one participant of the expert survey as knowledge to be expected of graduates of an AI course (see Section 4.1).

Activity (): The students again work in pairs. Each student gets one of the decision trees in Appendix F.2. The decision tree represents the answer path to a question. The student who does not have the decision tree asks the question "Should I go to school today?" or "Do I need an umbrella?" depending on the decision tree they are currently working on. The student with the decision tree then gathers the information he/she needs to answer the question. So in case of the school example indicated in Figure 5.3, the student asks "What day is it?". The other student answers "It's Friday". The first student follows the path "Monday - Friday" and asks the next question "Is it a Holiday?" The second student answers "Yes, it is a holiday." and so the first student can answer the initial question "No, you shouldn't go to school today." The trainer uses the "Should I go to school today?" example for the explanation of the activity as this is more complex and leaves the students more opportunities to explore the tree after the explanation. After finishing the first decision tree, the students switch roles and work on the second decision tree.
The students should then come up with their own example for a decision tree. They will do short presentations of their solutions as a summary activity where they will state their initial question and some of the junctions to reach a decision.

This exercise introduces the students to the tree data structure and they get an idea how it works. The short presentations of their decision trees provide even more examples that the students can learn from.

Identifying Vampires

Activity (): The students are given the data set of Table 5.7 as training data and the cards of Appendix F.3 as visual support. The trainer then

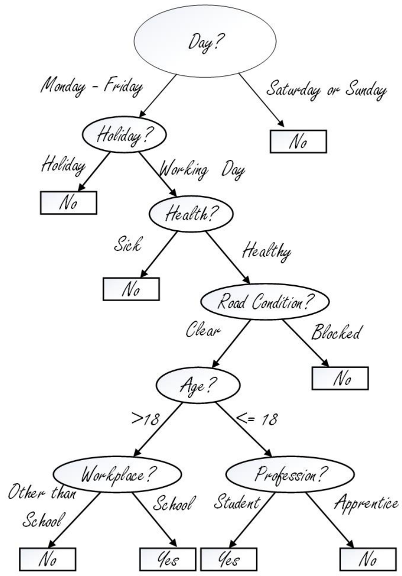


Figure 5.3.: Decision Tree: Should I go to school today?

demonstrates the selection of test questions step-by-step using the Teach OK method (Whole brain Teachers, 2018). The vampire example is an adaptation of Winston, 2014. The trainer first explains how the teaching method works. When the trainer says “class”, the trainees say “yes” and are ready to listen to what the trainer says. The trainer tries this out immediately. Then the trainer explains that when he says “teach” and claps twice, the students respond with “o.k.” and they also clap twice. The students answer in the same way as the trainer so when the trainer says “teach, teach” they respond with “ok, ok”. They then turn to each other and repeat what the trainer just taught them. Immediately after this explanation the trainer says “teach” and claps twice. Having given the participants some time to explain the rules of the teaching method to each other, the trainer calls their attention back with “class”. The trainer then explains that while he/she uses the blackboard to explain the steps of the algorithm, the students can use either pen and paper, the table with the training data and/or the cards of Appendix F.3 to help them explain the concept. The trainer then calls again “teach” , the

Vampire?	Sun?	Garlic?	Complexion?	Accent?
Human	?	Yes	Average	None
Human	Yes	Yes	Ruddy	None
Vampire	?	No	Ruddy	None
Vampire	No	No	Pale	Heavy
Vampire	?	No	Pale	Odd
Human	Yes	No	Average	Heavy
Human	Yes	No	Pale	Heavy
Human	?	Yes	Ruddy	Odd

Table 5.7.: Human vs. Vampire (based on Winston, 2014)

students respond with "o.k." and repeat the rules to each other. The trainer calls attention back with "class" and starts with explaining the algorithm. The steps below should be read as a sample script for the trainer. Before each step, the trainer says "class" to get the attention of the group and the class responds. After each step, the trainer claps and says "teach". The class again responds accordingly and they start teaching each other. While explaining the steps of the algorithm, the trainer draws what he/she says on the blackboard, creating the tree. Figure 5.4 gives an example of the blackboard after the first couple of steps.

1. Class: The goal is to build the smallest possible tree with only the information that is absolutely necessary for classifying all the training examples. Teach.
2. Class: Ok let's look at the column "Sun?" of our training data. This is our root node. There are three possible answers which are "Yes", if the sun was shining when the specimen was observed, "No" if he/she was observed at night and "?" if it was overcast so we cannot tell. So we create three branches for each of the possible answers. Teach.

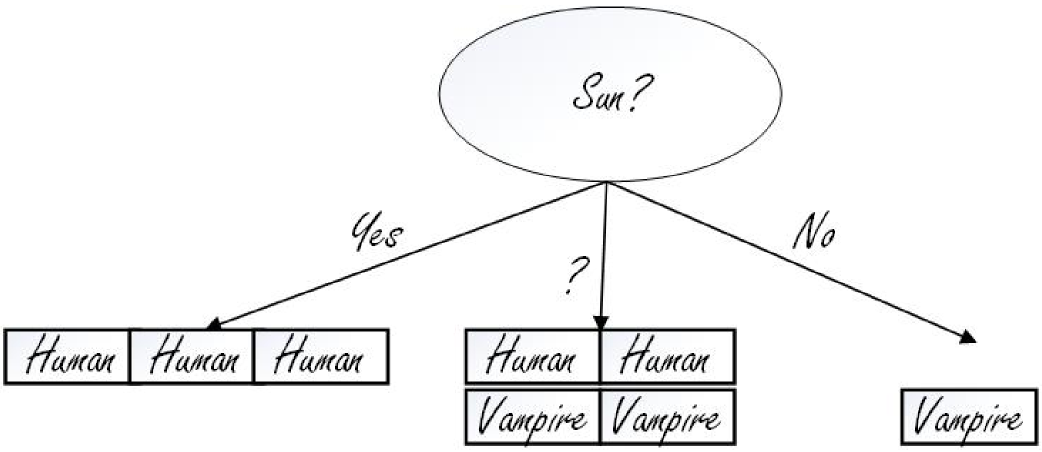


Figure 5.4.: Decision Tree Algorithm Step 1

3. Class: Now we look at our first example. It was overcast so we don't know if he/she can stand the sun and it was a human so we add one human to the "?" branch. Our second example was observed when the sun was shining and it was also a human so we add the human to the "yes" branch. Our third example was observed when it was overcast and it was a vampire so we add a vampire to the "?" branch. Note that I didn't put the vampire next to the human but below so we have a neat tree structure and prevent accidents like the human getting bitten by the vampire while we are still sorting our examples. The next example was observed at night and it was a vampire so we add the vampire to the "no" branch. Teach.
4. Class: Let's sort the rest of our examples. Specimen number five was a vampire observed when it was overcast so we add it to the "?" branch. The next one was a human observed when the sun was shining so we add the human to the "Yes" branch. The next one is the same as the one we just sorted so we add the human as well to the "yes" branch. The last example is a human observed when it was overcast so we add the human to the "?" branch. Teach.

5. Class: Now we move to the next column and create a “Garlic” root node. There are two possible answers: “Yes” for those who like garlic and “No” for those who don’t like garlic. Thus, we create a “Yes” and a “No” branch in our root node. Teach.
6. Class: Let’s sort our examples. The first human likes garlic so he/she goes to the “Yes” branch. The second human also likes garlic and joins the first, the vampire doesn’t like garlic and he/she therefore goes to the “No” branch. The next vampire doesn’t like garlic either and joins the first vampire as does the third vampire. The next two humans also don’t like garlic so they go to the “No” branch but we take care not to put them next to the vampires. The last example is a human and he/she likes garlic so he/she joins the other humans on the “yes” branch. Teach [. . .]
7. The trainer repeats steps five and six for the “Complexion” column.
8. The trainer repeats steps five and six for the “Accent” column. [. . .]
9. Class: We have now created four small trees from the training data. Let’s count the pure examples which means the examples of the branches where there are either only humans or only vampires. The “Sun?” tree has 3 pure examples in the “Yes” branch and one pure example in the “No” branch, resulting in 4 pure examples. The “?” branch is not pure because it contains humans and vampires. The “Garlic?” tree has three pure examples in the “Yes” branch. The “Complexion?” tree has two pure examples in the “Average” branch and the “Accent?” tree has no pure examples at all. Teach
10. Class: The tree with the most pure examples is the “Sun?” tree so we use this one to create our final decision tree. We can classify the “Yes” and “No” branch but still need one more test for the “?” branch. Let’s also remove the examples we already classified from our list. Teach.

11. Class: What did we do so far? We created a small classification tree for each of the "test questions" and classified all the examples in each tree. We then determined the pure examples of each tree and so identified the best question which gave us the most pure examples. We used this question to create our final decision tree and removed the already classified examples from our training data. Teach.
12. Class: Let's do that again with the remaining test questions and training data. We use the first unused column which is "Garlic?" and create a tree with two branches "Yes" and "No". We then look at our first remaining example which is a human who likes garlic. So the human goes to the "Yes" branch of our new tree. The next two are vampires who don't like garlic and so they go to the "No" branch. The last example is a human who likes garlic and so he/she goes to the "Yes" branch. Teach [...]
13. The trainer repeats step twelve for the "Complexion" column.
14. The trainer repeats step twelve for the "Accent" column. [...]
15. Class: Now lets calculate the purity value for each tree again. O.k. garlic has a purity of four, complexion a purity of two and accent has a purity of one. So we integrate the garlic tree in our final decision tree and we are done because there are no more examples to classify. Teach.
16. Class: All in all, what did we do? We first split the problem in small sub-problems that were easy to solve. We then selected the sub-problem that had the highest purity and started the process again removing the already classified examples. After the second round, we realized that we were done and that we don't need the information on complexion and accent to distinguish humans from vampires. Teach.

In the Teach-Okay method, students remain active throughout the instruction period. They have to pay attention to be able to teach the material to each other and the method gives them a chance to talk and process what they just learned. Furthermore, the algorithm is broken down in manageable chunks and by recapitulating what has been done in-between and at the end, the students don't lose sight of the whole process. Alternating between trainer and student teaching by using predefined signal words also has a game-like character that is designed to actively engage students in their learning (Murray, 2018). A complete solution of the human vs. vampire decision trees is provided in Appendix F.3.1.

Activity ( ): After completing their first machine learning algorithm, the students get a chance to practice what they just learned with the real-world example in Table 5.8, classifying blood types. It should be mentioned that the data set is not based on actual data but only a selection of possible combinations.The trainer also explains that blood types are usually determined by mixing a drop of blood with specific reagents (Anti-A, Anti-B, Anti-AB and Anti-D). Then specialists look for signs of agglutination to interpret the results of the test (Ferraz et al., 2017: 2030). To keep the example simple, the Anti-D reagent or Rhesus factor has been ignored. So only the blood types A, B, AB or O are determined by the decision tree ignoring the Rhesus factor.

The method of active plenum (Spannagel, 2011: 100) is used for this activity. In this method, the trainer moves to the back of the room and the students solve a problem as a group. One student is the recording clerk who writes statements from the group on the blackboard. This student is not allowed to solve the problem but only to take notes. The group is responsible for solving the problem. To make sure that all students participate, another student plays the role of a moderator who is responsible for organizing the group responses. A solution to the example is provided in Appendix F.4.

Type:	Mother	Father	Anti-A	Anti-B	Anti-AB
A	AB	AB	yes	no	yes
B	AB	B	no	yes	yes
0	B	B	no	no	no
AB	A	B	yes	yes	yes
A	A	A	yes	no	yes
B	B	B	no	yes	yes
AB	AB	A	yes	yes	yes
AB	B	AB	yes	yes	yes
0	A	B	no	no	no
A	B	A	yes	no	yes
0	0	A	no	no	no

Table 5.8.: Blood Types (American Red Cross, 2018)

The active plenum (Spannagel, 2011: 100) is designed as a training exercise where the students get to practice what they already learned in a controlled environment. The trainer can intervene if they move into a wrong direction and help out if the students get stuck while the focus remains on the students' active learning.

After the students have finished the blood type determination activity, the trainer points out that decision trees are just one method of classification and that they are not suitable for all problems. The trainer then explains how decision trees are linked to computer vision by using the rest of the slides provided for the computer vision topic thus concluding the attentive micro-lecture activity.

5.4.12. Computer Vision and Machine Learning Ethics

Activity (): The students engage in another station learning activity (Jones, 2007). As in the previous ethics activity, each station gives the students some ethical aspect to think about. The topics relate to the previous ethics activity consisting of Ownership, Privacy, Advertisements, Inappropriate Content and Gender & Diversity. They should be sensitized to which rights they are signing away when uploading visual content. They also should realize that the need for data in machine learning has implications on privacy. They should think about how to handle inappropriate content and censorship and finally consider that the output of a machine learning algorithm is not the Holy Grail of predicting the future and it could be subject to the same bias we find in human societies. While working through the stations, the students should also continue to work on their ethics policy. They might find that a previously created rule needs to be adapted to comprise new considerations. The input for the stations is provided in Appendix G.

5.4.13. Problem Solving by Search |

Activity ( ): To introduce problem solving by search, each student first gets the two mazes of Appendix H.1 and after having solved the mazes, each student gets a set of the "Find Mona Lisa" set of Appendix H.1. The "Find Mona Lisa" set represents the layout of the part of the Louvre where the famous painting by Leonardo da Vinci is exhibited. The goal is to find the room where the work of art is on display by deciding to walk to an adjacent room through one of the available doors. The cards are laid face down on the table. The students then turn the start card (see Figure 5.5). They have now four possibilities to walk to adjacent rooms. If they select, for example, door number 66, they turn card number 66 and add it to the

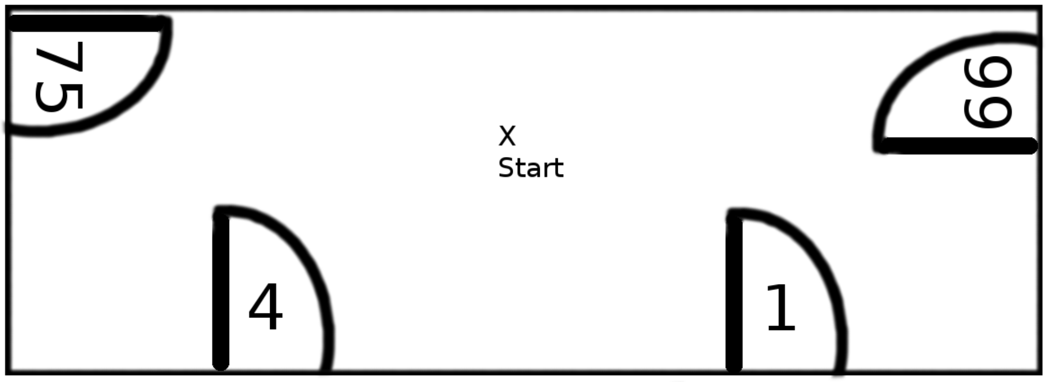


Figure 5.5.: Mona Lisa Start

layout so that the corresponding doors meet. As this room is a dead end, they have to return to the previous room and select another door. They go on until they find the painting.

After this short motivational activity, the students engage in another Think-Pair-Share activity (Tint and Nyunt, 2015: 4) to recall prior knowledge to build upon. The students think about the following questions:

- How are the previous short activities different and how are they similar?
- What is the goal of each of the problem sets?
- How did you tackle each of the problem sets?
- What is the relation of mazes to artificial intelligence?
- Can you name some real-world examples / applications where a generic way of solving mazes would be helpful?
- What difficulties might a computer have in solving these problems?

The students then exchange their thoughts to these questions in pairs. For each question, one pair of students is asked to summarize their answer to this question for the whole group. The other groups are invited to add their findings if they have additional information that was not mentioned by the group.

Probably everybody used to solve mazes as a kid. The solving mazes activity is designed to activate this knowledge. The students get two mazes with a bird eye's view and one where they are kind of blindfolded. In the ensuing discussion the students should realize, that for the first two mazes they could see where they were going, as if they had a map and for the third maze they had to perform a search, as if they were entering a new building without a floor-plan. They should also consider the strategies they employed to solve each of the puzzles. They might have chosen a systematic or a random approach. Then, the students should discuss the possible relation of mazes to artificial intelligence. They can again use the definitions provided at the beginning of the course to help them along. Thinking of some applications like Google Maps or navigation systems in general should enhance their awareness of intelligent systems in our everyday lives. The students finally get to consider the problems posed by implementing a solution to solving a seemingly simple puzzle.

Activity ( ): The students then engage in another online learning session in the flipped classroom mode. In the online session, they should get familiar with the theory of the major data structures graphs, trees, stacks and queues before doing some exercises in the face-to-face course. The online session provides also a first introduction to depth-first search and breadth-first search making use of the stack and queue data-structures. An animated example is provided for the depth-first search algorithm in the online materials where a turtle traverses a graph to find a goal. After the online session, the trainer asks if there are any questions concerning the content the students just learned. The trainer can also address some general problems that came up in the online forum. After the short questions &

answers round, the trainer uses the examples provided in Appendix H.3 to engage the students in another session of active plenum (Spannagel, 2011: 100). It is up to the group and the trainer to decide how many training examples need to be tackled.

Activity ( ): To foster the understanding of the stack data structure, the students play the stack game in groups of four. For this game a deck of cards is needed for each group. Each student in the group chooses a card color: spades, hearts, diamonds or clubs. The objective of the game is to collect all the cards of the assigned color. The student who completes the set first wins the game. At the beginning, there is an empty stack in the middle. The first student starts by taking a card from the deck. The student then decides if he/she wants to push the card on the empty stack with the keyword “push” or if he/she wants to take the card. The second student can now decide to take a card from the stack with the keyword “pop” or to take a new card from the deck. Keywords have only to be used if the stack is involved (push or pop). If a student takes a card with the color of another student, he/she first has to push a card of the set he/she collects before pushing the card that doesn’t match the set. During each round only one pop action or a maximum of two push actions (in case of wrong cards taken) are available to each student.

Activity ( ): Having had the opportunity to revise the stack data structure, the students get to practice the depth-first search algorithm in small groups. First, the students should come up with the basic rules of the algorithm. They might want to use the notes they took while studying in the online session. They should then apply the algorithm using the graphs they created (see also Appendix H.3) using pen and paper and also keeping track of the stack. After practicing in small groups, the students then engage in another session of active plenum (Spannagel, 2011: 100) for one final graph where the algorithm is applied.

After the depth-first search algorithm the students also get to practice the breadth-first search algorithm in small groups before engaging again in an active plenum session (Spannagel, 2011: 100) where the breadth-first search is then applied to the same graph as the depth-first search.

5.4.14. Project Day

Activity (⏵ ✔): On the last day of the preparation course, the students get a chance to implement an easy to solve AI problem. They can either suggest their own project they would like to work on or use one of the predefined problem sets like the Search Project of the Pac-Man projects by DeNero and Klein, 2010 where the depth-first search and breath-first search algorithms have to be implemented in the Pac-Man world or create another chatbot if the students didn't use regular expressions already in the training session. If the students want to implement their own little project, they have to discuss the feasibility and the relation to AI with the trainer. The students can either work in teams or on their own so attention needs to be paid to the size of the project.

The last hour of the day should be set aside for project presentations and a final group discussion where the students give feedback on the course as a whole and offer suggestions for improvement so that the quality of the provided courses can continuously be improved.

Informal discussions with the members of the EDLRIS advisory board indicated that companies are more interested in actually implemented projects than in grades. So the project day offers the students an opportunity to consolidate the knowledge and skills acquired during the prep course but also sets aside some time to implement a small project that they can mention in their job applications and so have something to show apart from the certificate.

6. Evaluation

To gather the participants' feedback of the implemented lessons, the learning methods and teaching materials and thus get an understanding of the overall quality of the course from the students' perspective, a questionnaire was designed (Oppenheim, 1992: 119) which is also available in appendix I. The questionnaires were translated into English to assure language consistency in this diploma thesis. Each questionnaire consists of three parts. In the first part some background information on the participants like age group or gender are gathered. The second part consists of a five point Likert scale with various statements to gauge the participants' impression of the learning atmosphere and their overall opinion of the course. Some statements concerning the learning outcomes were also included for self-evaluation to get some information on the students' perception of their own learning (Eva and Regehr, 2008). It should be noted that self-assessment is only a rough indicator on the students' performance as people tend to overestimate in their favor but also underestimate their achievement if they find a task easy (Hattie and Yates, 2014: 231-235). To really demonstrate their learning, the students would have to take a test evaluated by another person to achieve more objectivity. Unfortunately, this is not feasible in a one-day course. As teacher-training courses have to be announced at the beginning of the school year and the planning stage of this diploma thesis only started after the notification time, the one-day setting was selected to maximize the number of participants so it would be easier for teachers to clear their schedule. The results of the self-evaluation section will be used to gauge the students' confidence regarding a certain topic. It will not be used as an indicator for actual performance levels as this would have to be tested in another way. The third part of each feedback questionnaire consists of open questions to learn what the students liked and also give the opportunity to collect suggestions for improvement.

During both courses, the participants were observed and notes were taken by the author of this diploma thesis to evaluate the presented material and teaching methods based on their behavior during the course according to the method of ethnographic observation (Breidenstein, 2012) . After each course, the trainer was interviewed to get his perspective on the material and teaching methods as well. The interview was audio recorded and subsequently transcribed. To provide some additional feedback, pictures of the materials the participants produced in class were taken.

6.1. Implementation

The first pilot class was implemented on Friday, March 16, 2018 in the morning from 09:00 to 12:00 and continuing in the afternoon from 01:00 to 03:30. All in all, there were eleven participants in the first course, seven men and four women. Unfortunately, one participant only arrived at eleven thirty and four participants left after the lunch break for various reasons. All of the participants except one were teachers and about half of them teach computer science. Five participants were between 51 and 60 years whereas the rest was between 20 and 40 years of age. There were no participants in the age group 41 to 50. The pilot class was conducted in German as this is the mother tongue of all participants and the trainer. However, the trainer's slides of the presentation parts were in English. From a total of eleven participants, eight feedback sheets were completed and returned. The following lessons were evaluated in the course of the first training:

- Getting to Know Each Other
- Defining Artificial intelligence
- The Imitation Game
- Can Machines Think?
- Ethics

The second pilot class was held on Monday, April 09, 2018 in the morning from 09:00 to 12:50 and from 01:20 to 03:30 in the afternoon. There were five participants in the second pilot class, all of them male. Three of the participants were computer science teachers and the other two were in the university's teacher training program for computer science. Only one participant was between 41 and 50 years of age. All other participants of the second pilot class were in the age group of 20 to 30 years. This pilot class was also conducted in German with the trainer's presentation slides in English. All participants were present during the whole class and all of the feedback sheets were completed and returned. It has to be mentioned that all participants of the second pilot class already had some background in AI and so it is difficult to gauge if the lessons would be received similarly by complete beginners. The second pilot class was concerned with the topics of computer vision, machine learning and problem solving by search. One online session was also evaluated during the second pilot class.

6.2. Results and Suggestions for Improvements

In this section, each learning session and teaching method will be discussed separately and suggestions for improvement will be provided directly after each evaluation. In general, the two pilot classes are evaluated together and the evaluation will only be separated if the content of the classes diverged.

This means that the feedback of all 13 feedback sheets will be considered in the "Getting to know each other" section but only the feedback of the 5 participants of the second pilot class will be considered when evaluating e.g. the "Problem solving by search" lesson as it was not taught in the first pilot class.

6.2.1. Getting to know each other

The "Names Names Names" activity was selected for the pilot class. It was decided to omit the second activity namely, "This is Personal", due to time constraints. This activity was also used in the second pilot class as only one person participated in both pilot classes. The activity took exactly 10 minutes, from 9:17 to 9:27 in the first pilot class and six minutes in the second pilot class. As in the second pilot class there were about half the participants of the first pilot class, this is a good time indicator for the activity in general as it depends on the number of participants. The trainer explained the activity and then each participant presented him/herself including a movement. The next participant then repeated the name and the movement. At the beginning of the first pilot class, both first and last names were repeated but after three participants it was decided to stick to the first name. Initially, the participants were not sure whether to use the German polite address "Sie" or the more informal "du". It was then decided to use "du" for the remainder of the class. This problem didn't occur in the second pilot class as the learnings of the first class had already been implemented. Most of the time, the repetition of the names was no problem as only two participants had to ask for a name once. At first, it seemed that the participants didn't feel quite comfortable but as soon as they realized that they were all in the same situation and nobody would make fun of

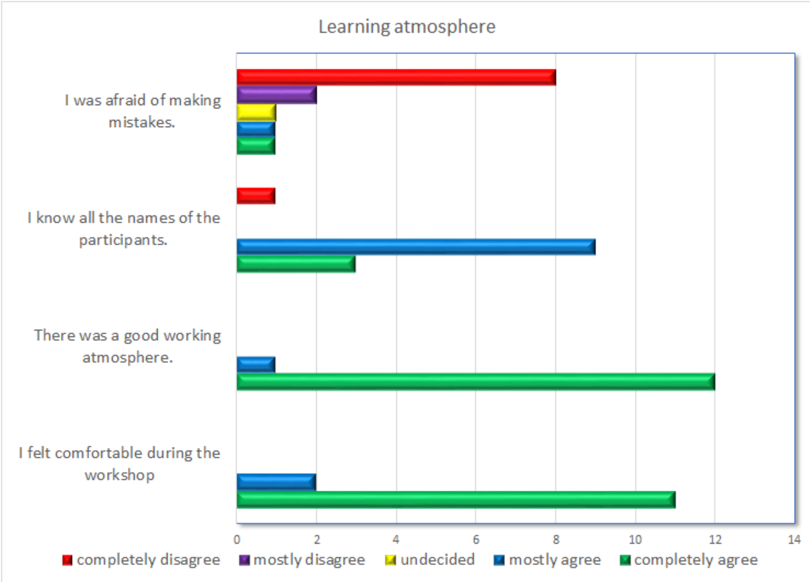


Figure 6.1.: Learning-Atmosphere

them because it would be their turn soon, they started to enjoy the activity. Two participants of the first pilot class and all of the participants of the second pilot class especially noted this activity in the "I liked . . . " section of the questionnaire. The trainer also said that he remembered more names because of this activity and that the activity worked quite well. The success of the activity is also reflected in the feedback of the participants displayed in Figure 6.1. Only two participants were afraid of making mistakes and only one did not know the names of the other participants at all. This is probably the trainee who arrived late to the first pilot class and did not participate in this activity. All participants of both pilot classes agreed that the working atmosphere during the class was good and that they felt quite comfortable.

Suggestions for improvement:

To avoid the initial difficulties in languages like German where there is a polite form of address, the trainer should clarify what will be used during the course before the start of the activity. The activity should also be limited

to either first or last names but it is suggested to stick to first names as they are usually easier to remember and it creates a more familiar atmosphere which in turn has a positive effect on the learning environment.
To make all students equally welcome, latecomers should be given the opportunity to present themselves. However, they would then have to get to know each other in the course of group work.

6.2.2. Defining Artificial intelligence (Think - Pair - Share)

This and the following activities were only part of the first pilot class. Therefore no feedback of the second pilot class has been included in the evaluation. The participants got three minutes to think about their own definition of artificial intelligence while taking notes. Then they had 10 minutes to discuss their definition in groups of two. Most of them were discussing their definitions as the following conversation fragments show:
A: *When I thought about it, mostly intelligent traffic system came to my mind.*
B: *I was more concerned with university, although it has been some time, we had to do some problem solving then.*
C: *Some people don't need a computer anymore because they have a smartphone.*
D: *Yeah, and don't forget the smart homes.*

Only two participants were not on task as they talked about ways to implement Arduino at their school. It seemed that the pilot class did not meet their expectations of topics right from the beginning and they also left at noon. The impression of different expectations was also confirmed by the trainer. For organizational reasons, there was a change of location after the exchange of ideas. This was also used for a short coffee break.

The sharing of ideas took thirty minutes, which is quite long given the fact that the discussion was a bit hesitant. The participants put all their notes on the blackboard and the groups where then asked to present their ideas. The short presentations were further evidence that the pair discussions had worked quite well. This is also illustrated in the presentation extract below:

We had similar thoughts. All in all, it is a man-made system, a technical-mechanical system combined with organic systems. The system should solve problems and develop new strategies based on available information and data. We talked about ethics only briefly. The system should learn to improve itself, why organic? Well there are already approaches in the medical field concerned with human-machine communication. Humans get implants to control a machine with their thoughts, but at which point does the machine control the human?

The trainer then clustered the ideas on the blackboard while the participants were observing the trainer. The trainees did not really participate in the clustering activity. They seemed more interested in what the trainer would do next. This was also reflected in the trainer's observations after the class. He also felt that he was doing too much but he got the impression that nobody else would do it so he continued.

Having clustered the participants' key words, the trainer moved on to the formal definitions selected for the EDLRIS prep course. He read the definitions and asked the participants what they thought and how the definitions would fit into the clustering. He then gave the answer himself: "Yes, we have some topics, but do we have understanding language?" Here one participant answered: "Yes, we have communication, but that's implicit." The trainer then realized that ethics is not mentioned in the formal definitions. He then

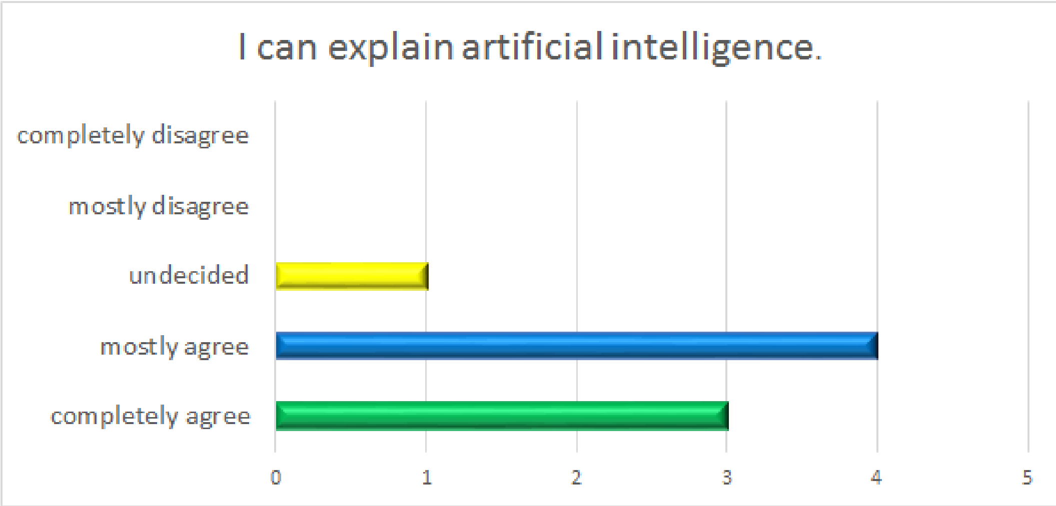


Figure 6.2.: I can define AI

gave some examples on ethical considerations and summed up the activity with "Yes, I think we are on the right track with our definitions."

Although the results of the self-assessment questionnaire concerning the definition of artificial intelligence (see Figure 6.2) are quite positive, it cannot be determined how much of this knowledge can be ascribed to the activity and what needs to be attributed to prior knowledge of the individual participants. As a group they managed to cover most aspects of the formal definitions. The notes differed quite substantially and some pairs were closer to the formal definitions and some took a more general approach.
Two students also mentioned the definitions in the "I liked..." section of the feedback questionnaire. They thought the definitions were easy to understand and they liked to see different approaches to the topic.

Suggestions for improvement:
The sharing of the pair results definitely needs improvement so the students remain active in their learning. The trainer should therefore ask specific students to cluster one or two items like "Mike, I have 'autonomous problem solving', where would you put it?" Because of the pair part of the activity, all

students are familiar with the topic and they already gave it some thought. The students should also have the possibility to ask each other what was meant by certain key words if they are not sure.
Another possibility would be to remove the authoritative figure of the trainer altogether and ask one student to do the physical clustering according to the input from the group. It has to be made clear that the student who does the clustering is not allowed to cluster any items him/herself, he/she just puts the item where the group tells him/her to - an approach similar to active plenum by Spannagel, 2011.

6.2.3. Meet The EDLRIS Team

For this activity, I created a JavaScript version of the EDLRIS team chatbot with which the students could interact as they did not get access to the Moodle platform yet. Figure 6.3 shows a screenshot of the bot. In groups of three, the students were given a laptop to interact with the bot. Due to some technical problems the students didn't start the activity at the same time so some already found out that they were talking to a bot while others still tried to get an internet connection.

Some students followed up on the question of the Turing Test posed by the bot.
A: *Do you know Mr. Turing?*
B: *No*
A: *He developed a machine that manipulates symbols on a strip of tape.*

After everybody got a chance to talk to the bot, the trainer collected the impressions from all of the students. The students seemed more enthusiastic in this activity indicating emotional involvement. Almost all the groups

commented on the pace the bot was answering at.
We quickly guessed that we were talking to a machine because the answers came so quickly and we asked what she had for breakfast and she was already overtaxed.

The trainer then initiated a short conversation on the intelligence of chatbots and they all agreed that a chatbot is intelligent. The students also made the connection from the chatbot to more sophisticated natural language processing systems like Alexa. The trainer also mentioned Eliza by Weizenbaum, 1966 and the SHRDLU blocks world natural language understanding program by Winograd, 1972 and provided a link to an Eliza implementation on the slides.

Two participants commented on this activity in the improvement section of the feedback questionnaire. One participant would recommend to work with a better version of the bot whereas the other one would have liked to try the Eliza chatbot as well.

Suggestions for improvement:
To avoid technical problems, a responsive version of the chatbot will be provided so participants can access the bot on their mobile phones and are thus not dependent on other technical infrastructure. The wait function will also be adapted to extend the response time although not too much because all of the students should get a sense of achievement in unmasking the bot.

6.2.4. The Imitation Game

After this activity the students got to try the Imitation Game. It seemed that the students had some fun with the game and they corrected each other when they were not working according to the algorithm, as the following

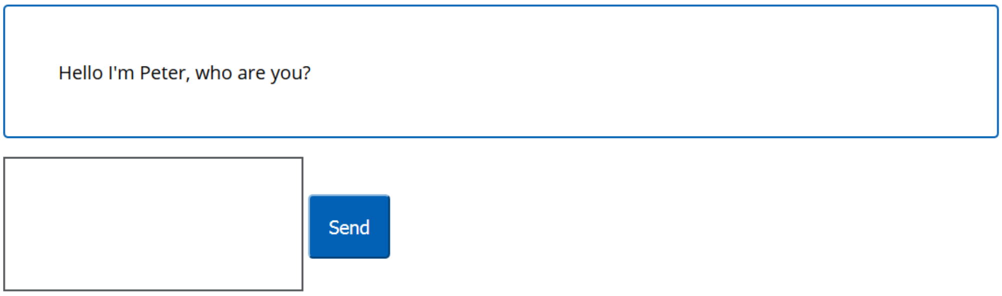


Figure 6.3.: EDLRIS chatbot

statements indicate:
You need to select another answer because it does not know that 'tired' is a feeling.
We've already had that answer, you need to choose the next one.
The trainer also had the impression that the students worked according to the algorithm and he was a bit surprised that they got the hang of the procedure rather quickly. However, he heard the students say "What is the point of this activity, why are we doing that?" and so he explained the black box - white box approach after the students had finished the activity.

Figure 6.4 shows that the students are quite confident concerning the Turing Test, which might be attributed to prior knowledge. However, some of them are less confident when it comes to the pattern-matching approach. The activity was also mentioned in the "I liked ..." section of the feedback questionnaire.

Suggestions for improvement:
It seems that the students would need some additional information on the pattern-matching approach and an explanation of the point of the activity before actually doing it. Otherwise it seemed that the students quite enjoyed the activity not leaving much room for improvement.

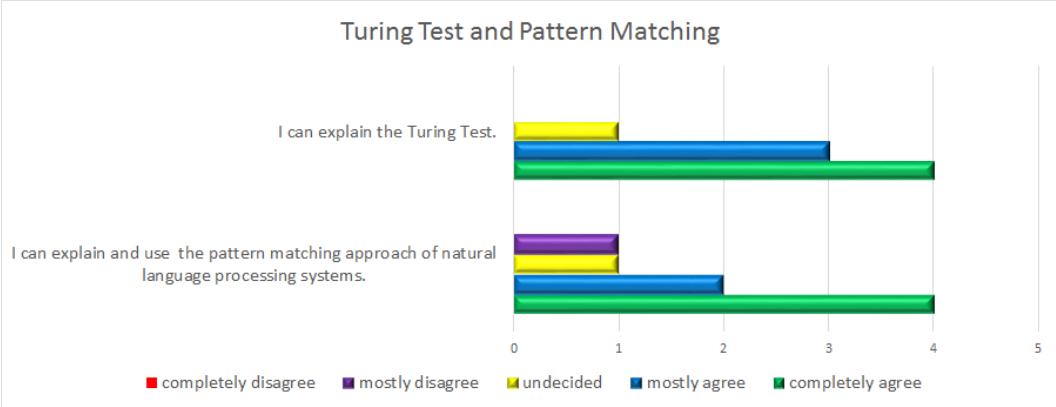


Figure 6.4.: Turing Test and Pattern Matching

6.2.5. Can Machines Think

In this activity, the students had to position themselves while the trainer read some statements on two approaches to AI. These statements were also projected on the wall to further support the students. Most of them adopted the extensional point of view but for the Chinese Room example where opinions were divided.

The trainer was a bit skeptical when it came to this activity. He had the impression that the students did not quite understand what point we tried to make as he himself was not really sure about it.

After this food for thought, the students had to work in pairs and classify various items as (not) intelligent. The students discussed various aspects of AI initiated by the objects as the following statements corroborate:

A: *Ok, a book. It is technically intelligent.*
B: *Well, it is a set of rules, but the set itself is not intelligent.*
A: *What shall we do?*

C: *All objects are quite relative like if - then*

D: *Alexa is not intelligent because I have to tell what I want.*
E: *But it says 'understanding language' [in the definition].*

F: *The lawn mower robot: that is the question, it covers a certain area and then it has an electronic barrier where it cannot go on, so it turns around and goes somewhere else.*
G: *But if you consider 'support in everyday life', then it is intelligent.*
F: *But the toaster which comes next also supports me in daily life and it is not intelligent.*

The group discussion again was quite lengthy and the trainer had to push for discussions a bit but he managed to initiate some explanations for the students' classification:
A flower is intelligent because this is nature and nature is intelligent. The flower opens when the sun shines and it follows the sun. It can also determine the seasons and it reacts to environmental stimuli.

A: *The apple watch: It depends on the installed functionalities. The watch itself is not intelligent but if you consider the voice control then it is intelligent.*
B: *It is definitely intelligent because we also had the analogue watch and so we concluded that the functionalities are installed.*

The trainer also had the impression that the group discussion was a bit cumbersome but he thought that the participants were probably tired and hungry as it was the last activity before the lunch break. Figure 6.5 indicates that the students felt quite positive about the intended outcome of the activity. As no pre-test has been conducted, it cannot be determined, if this result can be attributed to the activity or if the students already had some prior knowledge in this area. However, it has to be noted that this

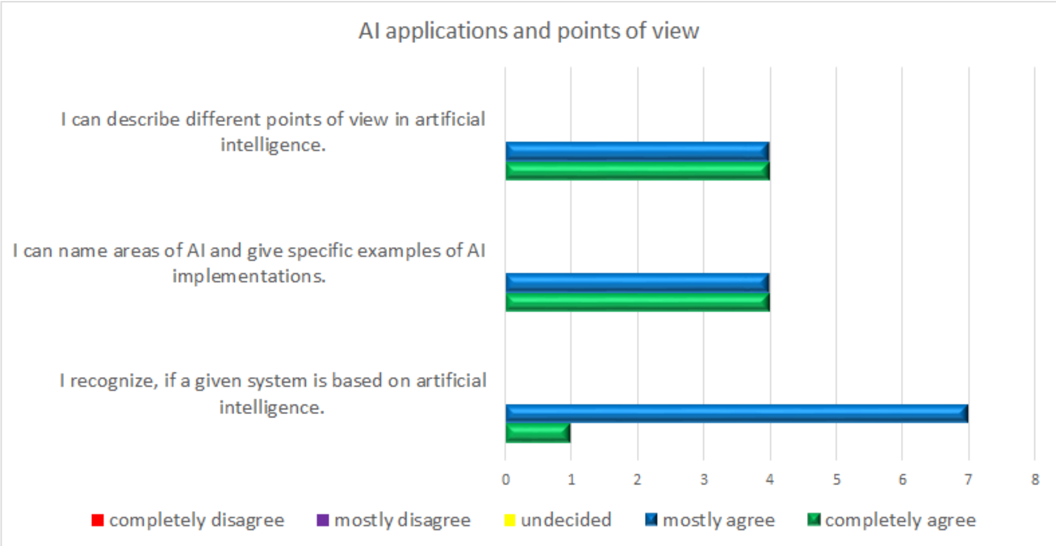


Figure 6.5.: AI applications and points of view

activity got the most mentions in the "I liked . . ." area of the feedback questionnaire.

Suggestions for improvement:
The activity where the students have to position themselves according to the statement they agree with should probably be announced as 'food for thought' by the trainer so that it is clear that there are different points of view and that there is no right or wrong answer and they should give the statements some thought.

Similarly to the Think-Pair-Share activity, the classification activity worked quite well in the small groups but then there were some hesitations when it came to sharing their results. Not all of the cards should be classified by the trainer, but the trainer should ask specific groups to classify the cards where there was a lot of discussion so the other groups can join in and add their point of view.

6.2.6. Ethics

After the lunch break, the participants engaged in the ethics work stations. They had some fruitful discussions in small groups and the students realized the problems involved with the various tasks indicated by the excerpts below:

[Privacy] The chat history should not be saved. You cannot do more than that. It would be best if you wouldn't save it at all, but how about that example, you would have to report it. After everything has been settled the history should be deleted, but online it is always difficult to ...

[Ownership] From the manager perspective, I would recommend the trousers because it is expensive and I make more profit. But it is difficult because the user does not need trousers, but I think it goes well with the T-shirt the customer already bought and so he could just add it to the basket. But here is the question if I really want that. What is ethical in this situation? Because as a company I need to make profit.

[Gender] This time I would have selected a man. My decision was influenced by his being blond and having blue eyes.

However, the students did not quite understand what they should do with the policy. They thought they would have to select one of the examples given and did not really write general rules and regulations that could be adopted by anyone in the field of AI and especially natural language processing. This was also mentioned in the "Improvements Section" of the feedback questionnaire. Overall, the feedback indicated in Figure 6.6 shows that the students are in general aware of ethical implications.

In the group discussion, it seemed easier to generate some discussion on certain topics. The trainer thought that some responses were a bit too

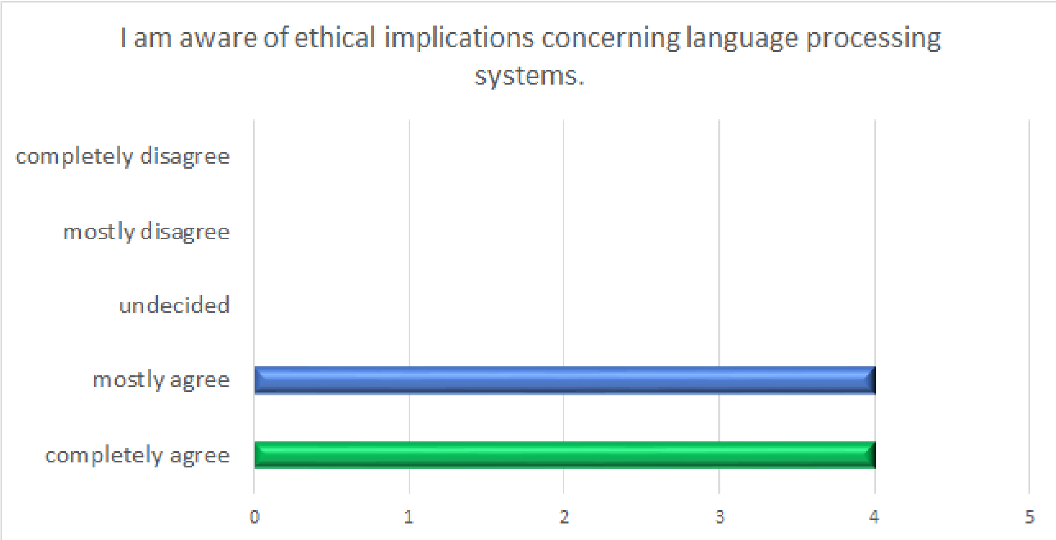


Figure 6.6.: Ethics

obvious because when you have opposites you usually try to find the middle ground.

Suggestions for improvement:
The privacy policy should be set into a different context so the students have more information and get the point. Adapted task description: Imagine you work for a non-profit organization that provides, among other things, ethical guidelines. You work in the ethics committee of the organization and should create general purpose guidelines focusing on natural language processing systems. The stations give you some ideas on what you should consider when creating the guidelines.

Ethics was the last part of the first pilot class. The following discussion of results relates to the second pilot class that was held in April 2018. It should be mentioned that the students of the second pilot class were specifically asked to focus on suggestions for improvement when completing the questionnaire and so they only gave some general positive remarks in the “I liked section” and really tried to give constructive feedback in the improvement section.

6.2.7. ABC Graffiti

The students started with the ABC Graffiti method listing as many computer vision applications as they could think of. The students had about 20 minutes to come up with examples. The students focused on the example images that were scattered in the room, but it seemed that they enjoyed moving around while talking and thinking. The Collision Avoidance System (Notbremsassistent in German) was one of the few examples the students came up with disregarding the example images. As the students concentrated on the provided images, their examples for applications were quite similar. One student also remarked in the questionnaire that in his opinion the activity was a bit complex and another student would have liked to get a “solution” so that one application for each letter in the alphabet should be provided after the activity.

The subsequent group discussion worked quite well as the students already had some knowledge of artificial intelligence and so came up with reasons why the various applications are intelligent quite quickly. Absolute beginners might have more difficulties with the discussion and so probably would need more time to think about it. All in all, the discussion took about 10 minutes so the overall estimate for the activity needs to be adapted from 15 minutes to about half an hour.

Suggestions for improvement:
To get the students to think of their own examples, the images should be scattered during the first few minutes the students are thinking. Only

after scattering the examples, the trainer should announce that the students might look at the pictures, otherwise they will probably just wait for more input.

6.2.8. Attentive Micro-Lecture

During the micro-lecture, the students were very attentive and completely focused on the task. They voluntarily discussed the picture with the parrots and almost all of them mentioned the forest in the background when describing the picture. The students also quickly had calculated the vertical edges. The trainer also had the impression that the micro-lecture went quite well and that the students payed attention. The first part of the micro-lecture took about 15 minutes.

Suggestions for improvement:
As most of the students described the picture of the parrots in a very detailed way, this is an indicator that not enough is going on in the picture to make it clear that we are selective when processing information. The picture should therefore be exchanged with the picture of the bear (see Figure 6.7) providing more information for selection. The bear in the bed will probably be mentioned by everyone. The shoes, books, chair, oven or the fact that it is daylight outside are open for selection. One student mentioned in the feedback questionnaire that he would have liked to write down his summary of the picture because he partly forgot what he had thought about when he heard the other students describe the picture. I think this is a good suggestion and should be incorporated in the lesson as well.

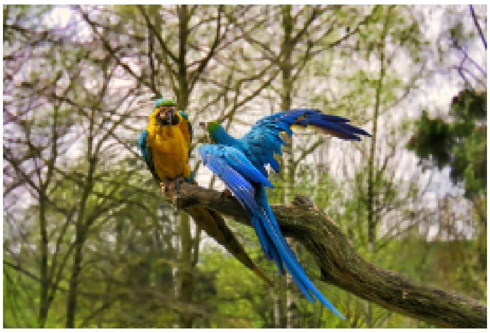
 

Figure 6.7.: Parrots vs. Bear

6.2.9. Machine Learning - Classification

Based on their ABC Graffiti list of computer vision applications, the students then had a 10 minute discussion where they identified classification problems on the respective list. This seemed to be no problem at all, as the following statements indicate:
I think classification is also the decision which part of the image need to be considered. Face recognition is obvious, do we have eyes, nose, ears, etc. And the computer needs to realize that ears look different.
Iris scan, I need to match an iris to a person, I don't need to recognize different objects but to recognize different varieties. The person looking into the scanner, the scan is fuzzy and I don't end up with exactly the same image as the one that I have in my database but the computer has to find out ...

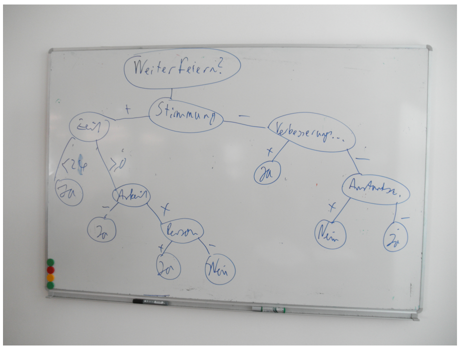
The students took another 10 minutes to classify the cats and dogs examples and determine the features. When the students then exchanged the sheet with the features, they were trying hard to classify cats as dogs and vice versa in the test set in order to find mistakes in the other group's features which seemed to make the activity more exciting. One student especially mentioned this activity in the "I liked ... " section of the questionnaire.

Suggestions for improvement:
Before doing the cats and dogs classification activity, the trainer should explain in more detail what supervised learning is. It should be explained that there usually is a training set consisting of labeled examples and a test set to see how well the algorithm is doing (Russel and Norvig, 2010: 695). The trainees already had this knowledge so it wasn't apparent in the pilot class that this information was actually missing. The slides of the micro-lecture will be adapted to include this introduction in the notes.

The trainer also thought it would have been a good idea to have abstract examples in the test set in order to really switch off common sense. However, this is quite difficult to achieve as the features that are selected by the trainees are not known in advance. A suggestion would be to mix some lions, tigers and wolves as well as some drawings into the test set to check if the classification still works.

6.2.10. Decision Trees

It seemed that the participants had fun doing the decision tree activity. The students also didn't have a problem to come up with their own examples of decision trees. One group built a tree to decide if they should stay at a party and the other group developed a shopping guide. The trees are indicated in Table 6.1. As everything seemed to work quite smoothly and none of the participants or the trainer had any remarks on this activity, it is quite difficult to find room for improvement. All in all, the activity took 15 minutes to complete for the two groups including the presentation of



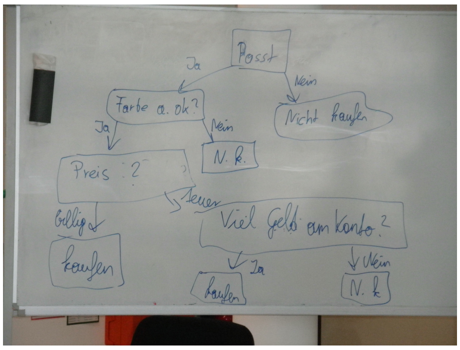


Table 6.1.: Decision Trees

their trees. Novice AI students might take longer to complete the activity so the time estimated should probably be adjusted to 25 minutes.

Teach ok

The trainer and the participants used this teaching method for the first time. Although in the beginning the trainer had some difficulties explaining how the method worked, the students and the trainer got the hang of it quite quickly. However, for the students it was not clear that this was a general teaching method not specifically tailored to the field of artificial intelligence. They were looking for deeper meaning of the method. Sometimes, the students completely summarized the trainer's instructions like *We did the same thing for garlic* or *We matched the example data again*. This might be attributed to the fact that the participants already had some knowledge of artificial intelligence in general and so they didn't really need the repetitions. At the beginning of the activity, it also became apparent that this method does not leave much room for questions, therefore, it is important that the trainer is self-assured and knows exactly what comes next. One student also thought that the activity gets annoying pretty quickly. Nevertheless, another student mentioned the method in the "I liked ..." section of the questionnaire because it forces the students to pay attention as they have to explain what the trainer said to their peers offering an opportunity for learning through repetition. The trainer also had the impression that the activity worked quite well, but he was not sure if absolute beginners would respond in the same way. The following activity of active plenum also indicated that the students understood how the decision tree learning algorithm worked as the trainer didn't have to intervene at all.

Active Plenum

As already indicated before, this activity also worked quite well in the pilot class. The participants corrected each other when there were any mistakes. Because of the small size of the group, the role of the moderator was not introduced. However, as only one student started to provide all the answers, the recording clerk also took on the role of the moderator and motivated the other students to participate. All of the students felt quite confident when it came to explaining decision trees, which is also indicated in Figure 6.8.

Suggestions for improvement:
As all of the methods worked quite well, it leaves not much room for improvement. The only thing worth noting is that the trainer should be quite familiar with the Teach OK method right from the start. To achieve this, the trainers should watch a short video of the method in action (Biffle, 2008). Some further research would be necessary to see if this method also works for absolute beginners. None of the participants realized the implicit relation between vampires and blood types. The trainer could use this relation for a smooth transition from the vampire example to the blood types example.

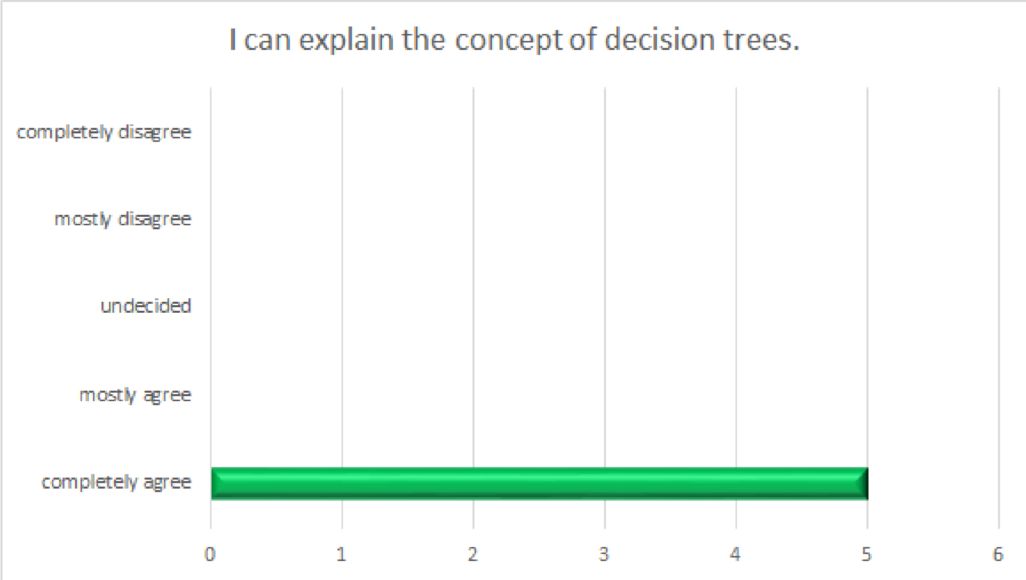


Figure 6.8.: Decision Trees

E.g. Now let's have a look how we can find out which food a vampire prefers by determining blood types.

6.2.11. Problem Solving by Search

The students seemed to really enjoy solving the mazes before learning about general ways to solve a problem by search. The Think-Pair-Share activity after solving the mazes gave the students an opportunity to relate mazes to artificial intelligence. Nobody had any problems answering the questions and they readily made the connection from the mazes to route finding problems in AI applications like navigation systems. Absolute beginners might have more difficulties with this exercise but this would need to be determined in further research. Compared to the first pilot class, the sharing of ideas worked really well in this smaller group. The method of active plenum might have had a positive effect decreasing the fear of making mistakes and overcoming social inhibitions.

Suggestions for improvement:
One student would have liked to have a printout of the questions with enough room for taking notes as it was a bit cumbersome to read the questions from the slides. I think this is a good idea and a template has been added to appendix H.2.

Online session

The online session with the theoretical input was simulated after the lunch break. The students were very fast as it took them only about 20 minutes to complete the activities. This activity also got the most suggestions for improvement. In general, the instructions of the online lecture were not clear enough, it also needs to be indicated when an animation is just for watching and when the user has to do something. According to one participant, the explanations in the online material were also not detailed enough. This feedback will be incorporated in the online materials. It also indicates that online material needs to meet different requirements than materials used in face-to-face sessions. For instance, the instructions need to be very clear as the students don't have the opportunity to get immediate feedback if they don't understand the instruction.

The Stack Game

In the stack game, the students realized quite well the what they called 'annoying' quality of the stack that you cannot directly access the cards at the bottom. However, as soon as the deck was empty, it got quite boring as the students just popped when their color was on top. So it is proposed to stop right after all cards are either on the stack or with a player. The player with the most cards wins.

Graphs and Search

The next active plenum session also went quite well. The students created a graph on the board that they then used to implement depth-first and breath-first search on paper keeping track of the stack and the queue respectively. Again the students corrected any mistakes themselves and as everybody participated equally there was no need for a moderator.

It was a good idea to use the graph that the students created for the depth-first and breadth-first search as the students could better relate to "their graph". One group implemented depth-first and the other group implemented breadth-first search. According to the lesson plan, the students should have applied the algorithms in another session of active plenum after practicing with different graphs. Because most students already knew these two algorithms, the activity was reduced to a short group session where one algorithm was applied in each group. A presentation, where each group showed the implemented algorithm on the whiteboard, was the last activity of the day.

Suggestions for improvement:
As stack and queue soon get quite confusing when written down on paper, it would be a good idea to provide small cards with the alphabet that can be pushed onto and popped from the stack or the queue. Crossing out used items can thus be avoided and the activity probably becomes a lot clearer. It should be considered that beginners might need the additional practice of the last activity so when doing the activity, the group probably should stick to the original lesson plan. However, it should also be noted that the trainer acted on the competency-based approach and shortened the activity according to the participants' prior knowledge.

6.2.12. General Feedback

The general feedback of both pilot classes was quite positive which is also indicated in Figure 6.9. Most of the participants will definitely recommend the preparatory classes of the project. Most participants will also use at least some of the methods and topics in their own teaching. It has to be considered, that teachers are limited by their subject curriculum and thus can only implement the topics they can justify within the curriculum limitations. Some methods might also not be suitable for a specific subject and so the teachers who mostly agreed on using the methods in their own teaching will probably do some cherry picking. All of the participants agreed that the topics were quite easy to understand. To gain additional feedback on the level of difficulty, feedback from high school students would be required. Some of the participants also expressed their interest in the EDLRIS program and it can be expected that the pilot classes have a positive impact on the reputation of the EDLRIS program by word-of-mouth marketing.

6.3. Interpretation of Results

Based on the observations made during the pilot classes, the participants' and the trainer's positive feedback, both pilot classes can be seen as overall successful. The participants were focused on the tasks and actively participated in the activities. As the general feedback of the courses indicates, the participants would recommend the course and will mostly integrate both, the teaching methods and the topics of the pilot classes, in their own teaching.

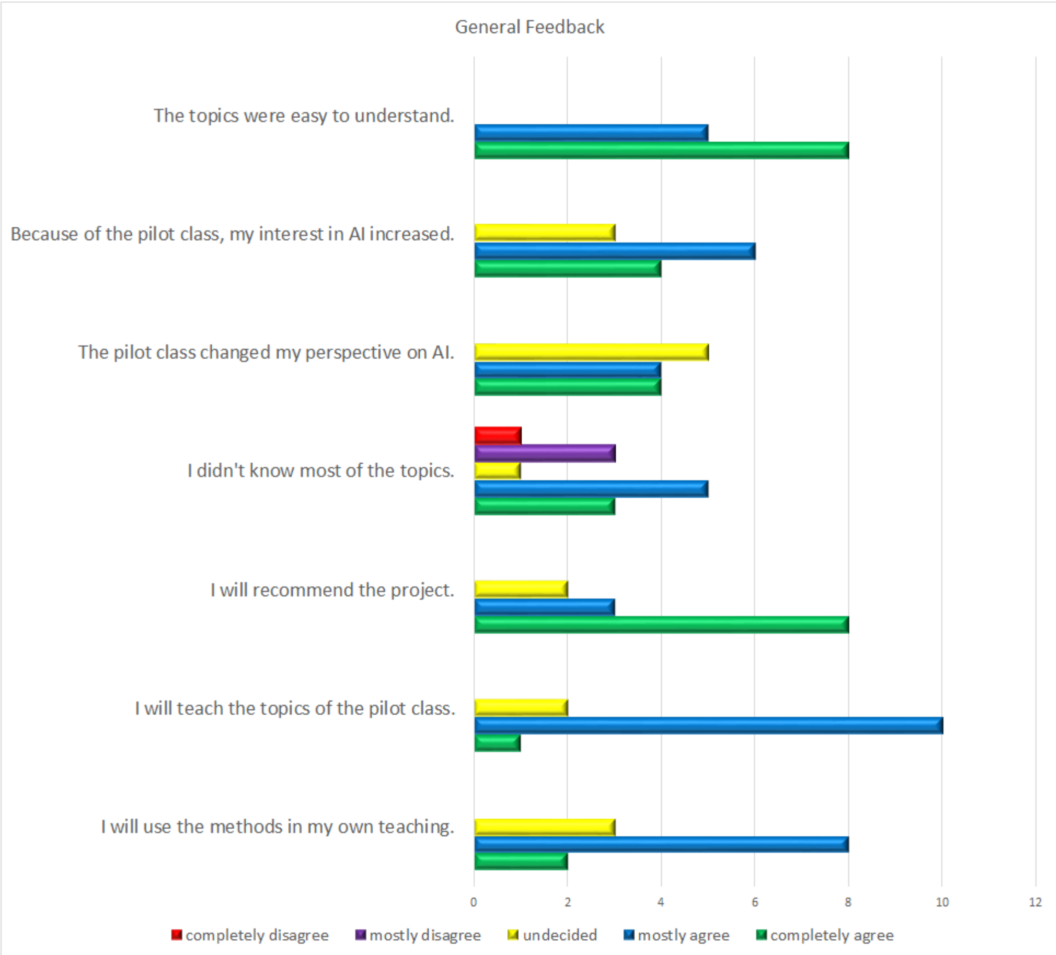


Figure 6.9.: General Feedback

As the suggestions for improvement of the first pilot class were at least in part implemented in the second pilot class, the second pilot class went a bit smoother than the first one. However, it also has to be considered that the expectations of the second pilot class largely aligned with the actual content of the class whereas in the first pilot class the content matched the expectations only in part as some of the participants would have liked to focus more on robotics which was also mentioned in the course description.

The wide variety of teaching methods was also seen quite positively by the participants, with one participant of the first pilot class describing it as quite refreshing. Another participant of the second pilot class even payed a special compliment to the class saying he expected a rather boring and dull teacher training course but in fact the opposite had been the case. The participants especially liked the application and practice of the algorithms and topics immediately after their presentation.

Based on these positive reactions, it can be assumed that the EDLRIS preparatory course for the certificate of basic AI will work quite well after the implementation of the suggestions for improvement.

7. Discussion and Outlook

The EDLIRS program has been designed to respond to the need of educating the young generation in artificial intelligence so that they can make informed decisions in their daily lives. Modern artifacts are mostly intelligent in one way or another and understanding the basic principles of these intelligent systems should come as naturally as reading and writing. Burgsteiner, Kandlhofer, and Steinbauer, 2016 already fathered the idea of AI and computer science literacy which is already a major issue and will probably become so even more in the future. It is sad to see that initiatives concerning computer science education have only recently been taken by the Austrian government and thus the subject Basic Digital Competencies will only be introduced in the general curriculum in September 2018 (Bundesministerium für Bildung, Wissenschaft und Forschung, 2018). The EDLRIS program thus offers students, parents and teachers a way to fill the gaps in the official curriculum.

The goal of this diploma thesis was to create a curriculum for an introductory course of artificial intelligence that is didactically and methodologically sound and addresses the requirements of industry, education and society alike. The curriculum was developed with regard to the EDLRIS project and thus chances are high that the identified topics will actually be integrated into the general curriculum on a wider scale compared to the pilot classes that have been developed so far (Section 2.2). To identify the topics that should be covered by the curriculum, a survey among industry representatives has been conducted (Section 4.1) and additional input has been gathered during the EDLRIS advisory board meeting (Section 4.2). Based on the survey and the input of the members of the advisory board, the main objectives and competencies that should be covered by the course were defined (Section 5.1).

Detailed lesson plans (Section 5.4) aiming at high school students have then been developed providing teaching material to help students develop these skills and objectives. When developing the lesson plans, care was taken that the lessons could be implemented on a low budget to contribute to the spread of the program as not every school can afford costly equipment. The detailed lesson plans also meet the requirements expressed by the participants of the expert survey, like the immediate application of theoretical knowledge, and include the main topics such as machine learning, computer vision, natural language processing and ethics. The students also get an introduction to the text-based programming language Python and the chance to implement an intelligent system. Although the students are introduced to the Python programming language, the course is mostly platform independent as the focus was on conveying the basic concepts of AI rather than specific implementations. The teaching material is available in English and German upon request to respond to the need of localized versions as the majority of lessons and materials provided online is still available only in English (Section 2.4). The lesson plans were then evaluated and suggestions for improvement of the lessons and material were made (Chapter 6), thus closing the first quality assurance cycle by assessing the educational need, designing the curriculum and lesson plans and finally gathering feedback for modification (Barrow and McKimm, 2018).

This thesis provides a basis for the course and teaching materials that will be provided by the EDLRIS project team and the development process is far from finished. For example, the topic of reasoning has been completely neglected in the lesson plans so far as it was beyond the scope of this thesis and should be included in the final version of the EDLRIS certification program. Additional suggestions for projects that can be implemented on project day also still need to be developed. Apart from the implementation on a larger scale, the developed skills and objectives should also be rechecked with the EDLRIS advisory board to re-initiate the quality assurance cycle. Implementation on a larger scale provides additional feedback from trainers and trainees as the number of participants in the pilot implementations was rather small and thus not really representative. The questionnaire that was used in the evaluation was not tested beforehand due to the small number of participants. Additionally, pre- and post-tests to evaluate the learning outcomes of the course should be conducted and additional feedback from future participants needs to be gathered to further improve the overall quality of the training. Based on the content of the course and the list of objectives and skills, the certification exam also needs to be developed and integrated.

All in all, this diploma thesis fills some gaps in the current AI education. The positive feedback of the evaluated lesson plans indicates that the program is headed in the right direction.

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Appendix A.

Semi-Structured Interviews

1. Background Information

Date:
Age:
Gender:
Job Description:
Highest level of education completed:
Completed training programs:

2. Artificial Intelligence

How do you define artificial intelligence?

Which AI techniques do you currently use in your work?

In your opinion, which AI techniques will be most important in the future?

What AI competencies should be covered in an artificial intelligence class?

3. AI Education

Please describe your AI education (courses, classes, training programs, etc.)

Which part of your AI education is most important for your work?

What did you miss in your AI education, what knowledge / skills did you learn by yourself?

In your opinion, which AI topics need to be taught today to prepare young people for the year 2027?

What do you expect from somebody who successfully completed an artificial intelligence course?

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Please rate the following AI topics regarding their importance:

	Very important	Important	Of average importance	Of little importance	Not important at all
Applications					
Cognitive Science					
Ethics & Social Issues					
Games & Puzzles					
History					
Machine Learning					
Natural Language					
Philosophy					
Knowledge Representation and Reasoning					
Robots					
Speech					
Vision					

Is there anything you would like to add?

Consent

Thank you very much for agreeing to participate in this survey. The interview will be audio-recorded to ensure the transparency of the survey and to allow others to benefit from the feedback.

Please read the consent statement below carefully and sign on the corresponding line.

I know that the interview will be audio recorded and I grant permission to use these recordings for teaching and scientific research.

____
Name

____
Signatur

____
Date

Appendix B.

The Imitation Game

replace	with
DONT	DON'T
CANT	CAN'T
WONT	WON'T
AM	ARE
YOUR	MY
I	YOU
YOU	I
WERE	WAS
ME	YOU
YOU'RE	I'M
I'M	YOU'RE
MYSELF	YOURSELF
YOURSELF	MYSELF
MOM	MOTHER
DAD	FATHER
MY	YOUR

Table B.1.: Replacing words. Compiled from original Eliza script by Weizenbaum, 1966: 44

FEEL THINK BELIEVE WHISH	BELIEF
MOTHER MOM FATHER DAD SISTER BROTHER WIFE CHILDREN	FAMILY
WANT NEED	NEED
SAD UNHAPPY DEPRESSED SICK	NEG. FEELING

HAPPY ELATED GLAD BETTER	POS. FEELING
CAN'T CANNOT	CANNOT
EVERYONE EVERYBODY NOBODY NOONE	EVERYONE
ALIKE SAME LIKE	LIKE

Table B.2.: Word-Fields. Compiled from original Eliza script by Weizenbaum, 1966: 44

Keyword	Context-Rule	Response-Template
SORRY		PLEASE DON'T APOLIGIZE. APOLOGIES ARE NOT NECESSARY. WHAT FEELINGS DO YOU HAVE WHEN YOU APOLOGIZE? I'VE TOLD YOU THAT APOLOGIES ARE NOT REQUIRED.
REMEMBER @x	* YOU REMEMBER *	DOES THINKING OF @x BRING ANYTHING ELSE TO MIND? DO YOU OFTEN THINK OF @x? WHAT ELSE DO YOU REMEMBER? WHY DO YOU REMEMBER @x JUST NOW? WHAT IN THE PRESENT SITUATION REMINDS YOU OF @x? WHAT IS THE CONNECTION BETWEEN ME AND @x?
	* DO I REMEMBER *	DID YOU THINK I WOULD FORGET @x?

		WHY DO YOU THINK I SHOULD RECALL @x NOW? WHAT ABOUT @x? = WHAT YOU MENTIONED @x.
		Next Keyword
IF @x	* IF *	DO YOU THINK ITS LIKELY THAT @x? DO YOU WISH THAT @x? WHAT DO YOU THINK ABOUT @x?
DREAMT @x	* YOU DREAMT *	HAVE YOU EVER FANTASIED @x WHILE YOU WERE AWAKE? REALLY, @x HAVE YOU DREAMT @x BEFORE? = DREAM Next Keyword
DREAMED		= DREAMT
DREAM		WHAT DOES THAT DREAM SUGGEST TO YOU? DO YOU DREAM OFTEN? WHAT PERSONS APPEAR IN YOUR DREAMS? DON'T YOU BELIEVE THAT DREAM HAS SOMETHING TO DO WITH YOUR PROBLEM? Next Keyword
DREAMS		= DREAM
HOW		= WHAT
WHEN		= WHAT
CERTAINLY		= YES
No Keyword found		I AM NOT SURE I UNDERSTAND YOU FULLY. PLEASE GO ON. WHAT DOES THAT SUGGEST TO YOU.

		DO YOU FEEL STRONGLY ABOUT DISCUSSING SUCH THINGS.
PERHAPS		YOU DON'T SEEM QUITE CERTAIN. WHY THE UNCERTAIN TONE? CAN'T YOU BE MORE POSITIVE? YOU AREN'T SURE. DON'T YOU KNOW?
MAYBE		= PERHAPS
NAME		I AM NOT INTERESTED IN NAMES I'VE TOLD YOU BEFORE, I DON'T CARE ABOUT NAMES - PLEASE CONTINUE
DEUTSCH		=XFREMD
FRANCAIS		=XFREMD
ITALIANO		=XFREMD
ESPAGNOL		=XFREMD
XFREMD		I AM SORRY, I SPEAK ONLY ENGLISH
HELLO		HOW DO YOU DO, PLEASE STATE YOUR PROBLEM.
COMPUTER		DO COMPUTERS WORRY YOU WHY DO YOU MENTION COMPUTERS? WHAT DO YOU THINK MACHINES HAVE TO DO WITH YOUR PROBLEM? DON'T YOU THINK COMPUTERS CAN HELP PEOPLE? WHAT ABOUT MACHINES WORRIES YOU? WHAT DO YOU THINK ABOUT MACHINES?
MACHINE		= COMPUTER
MACHINES		= COMPUTER
COMPUTERS		= COMPUTER
ARE	* ARE YOU *	DO YOU BELIEVE YOU ARE @x?

		WOULD YOU WANT TO BE @x? YOU WISH I COULD TELL YOU YOU ARE @x. WHAT WOULD IT MEAN IF YOU WERE @x? = WHAT
		WHY DO YOU SAY 'AM'? I DON'T UNDERSTAND THAT.
	* ARE I *	WHY ARE YOU INTERESTED IN WHETHFR I AM @x OR NOT? WOULD YOU PREFER IF I WEREN'T @x? PERHAPS I AM @x IN YOUR FANTASIES. DO YOU SOMETIMES THINK I AM @x? = WHAT
	* ARE *	DID YOU THINK THEY MIGHT NOT BE @x? WOULD YOU LIKE IT IF THEY WERE NOT @x? WHAT IF THEY WERE NOT @x? POSSIBLY THEY ARE @x.
MY	* MY *	WHY ARE YOU CONCERNED OVER MY @x? WHAT ABOUT YOUR OWN @x? ARE YOU WORRIED ABOUT SOMEONE ELSES @x? REALLY, MY @x.
WAS	* WAS YOU *	WHAT IF YOU WERE @x? DO YOU THINK YOU WERE @x? WERE YOU @x? WHAT WOULD IT MEAN IF YOU WERE @x? WHAT DOES '@x ' SUGGEST TO YOU?
	* YOU WAS*	WERE YOU REALLY WHY DO YOU TELL ME YOU WERE @x NOW? PERHAPS I ALREADY KNEW YOU WERE @x.
	* WAS I *	WOULD YOU LIKE TO BELIEVE I WAS @x?

		WHAT SUGGESTS THAT I WAS @x? WHAT DO YOU THINK? PERHAPS I WAS @x. WHAT IF I HAD BEEN @x?
		Next Keyword
I'M	* I'M *	I am @x = YOU
YOU'RE	* YOU'RE *	YOU ARE @x. = I
YOU	* YOU (?NEED) *	WHAT WOULD IT MEAN TO YOU IF YOU GOT @x WHY DO YOU WANT @x? SUPPOSE YOU GOT @x SOON WHAT IF YOU NEVER GOT @x? WHAT WOULD GETTING @x MEAN TO YOU WHAT DOES WANTING @x HAVE TO DO WITH THIS DISCUSSION?
	* YOU ARE (?NEG. FEELING) *	DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE @x? I AM SORRY TO HEAR YOU ARE @x. I'M SURE ITS NOT PLEASANT TO BE @x? CAN YOU EXPLAIN WHAT MADE YOU @x?
	* YOU ARE (?POS. FEELING) *	CAN YOU EXPLAIN WHY YOU ARE SUDDENLY @x? HAS YOUR TREATMENT MADE YOU @x? WHAT MAKES YOU @x JUST NOW? HOW HAVE I HELPED YOU TO BE @x?
	* YOU WAS *	=WAS

	* YOU (?BELIEF) YOU *	DO YOU REALLY THINK SO? BUT YOU ARE NOT SURE YOU @x. DO YOU REALLY DOUBT YOU @x?
	* YOU (?BELIEF) I *	= You
	* YOU ARE *	IS IT BECAUSE YOU ARE @x THAT YOU CAME TO ME? HOW LONG HAVE YOU BEEN @x? DO YOU BELIEVE IT NORMAL TO BE @x? DO YOU ENJOY BEING @x?
	* YOU (?CANNOT) *	DO YOU REALLY WANT TO BE ABLE TO @x? HAVE YOU TRIED @x? PERHAPS YOU COULD @x NOW HOW DO YOU KNOW YOU CAN'T @x?
	* YOU DON'T *	DON'T YOU REALLY? WHY DON'T YOU @x? DO YOU WISH TO BE ABLE TO @x? DOES THAT TROUBLE YOU?
	* YOU FEEL *	TELL ME MORE ABOUT SUCH FEELINGS DO YOU OFTEN FEEL @x? DO YOU ENJOY FEELING @x? OF WHAT DOES FEELING @x REMIND YOU?
	* YOU @x I *	PERHAPS IN YOUR FANTASY WE @x EACH OTHER DO YOU WISH TO @x ME? YOU SEEM TO NEED TO @x ME. DO YOU @x ANYONE ELSE?

		YOU SAY @X CAN YOU ELABORATE ON THAT? DO YOU SAY @x FOR SOME SPECIAL REASON? THAT'S QUITE INTERESTING
I	* I ARE *	WHAT MAKES YOU THINK I AM @x? DOES IT PLEASE YOU TO BELIEVE I AM @x? DO YOU SOMETIMES WISH YOU WERE @x? PERHAPS YOU WOULD LIKE TO BE @x?
	* I @x YOU *	WHY DO YOU THINK I @x YOU? YOU LIKE TO THINK I @x YOU - DON'T YOU? WHAT MAKES YOU THINK I @x YOU? REALLY, I @x YOU. DO YOU WISH TO BELIEVE I @x YOU? SUPPOSE I DID @x YOU - WHAT WOULD THAT MEAN? DOES SOMEONE ELSE BELIEVE I @x YOU?
	* I *	WE WERE DISCUSSING YOU - NOT ME. OH, I @x. YOU'RE NOT REALLY TALKING ABOUT ME. WHAT ARE YOUR FEELINGS NOW
YES		YOU SEEM QUITE POSITIVE. YOU ARE SURE. I SEE I UNDERSTAND
NO		ARE YOU SAYING 'NO' JUST TO BE NEGATIVE? YOU ARE BEING A BIT NEGATIVE. WHY 'NO'? WHY NOT?
YOUR	* YOUR (?FAMILY) *	WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR @FAMILY?

		WHO ELSE IN YOUR FAMILY @x? YOUR @FAMILY TELL ME MORE ABOUT YOUR FAMILY.
	* YOUR *	YOUR @x WHY DO YOU SAY YOUR @x? DOES THAT SUGGEST ANYTHING ELSE WHICH BELONGS TO YOU IS IT IMPORTANT TO YOU THAT @x
CAN	* CAN I *	YOU BELIEVE I CAN @x DON'T YOU? YOU WANT ME TO BE ABLE TO @x. PERHAPS YOU WOULD LIKE TO BE ABLE TO @x YOURSELF
	* CAN YOU *	WHETHER OR NOT YOU CAN DEPENDS ON YOU MORE THAN ON ME. DO YOU WANT TO BE ABLE TO @x? PERHAPS YOU DON'T WANT TO @x. = WHAT
WHAT		WHY DO YOU ASK? DOES THAT QUESTION INTEREST YOU? WHAT IS IT YOU REALLY WANT TO KNOW? ARE SUCH QUESTIONS MUCH ON YOUR MIND? WHAT ANSWER WOULD PLEASE YOU MOST? WHAT DO YOU THINK? WHAT COMES TO YOUR MIND WHEN YOU ASK THAT? HAVE YOU ASKED SUCH QUESTION BEFORE? HAVE YOU ASKED ANYONE ELSE?
BECAUSE		IS THAT THE REAL REASON?

		DON'T ANY OTHER REASONS COME TO MIND? DOES THAT REASON SEEM TO EXPLAIN ANYTHING ELSE? WHAT OTHER REASONS MIGHT THERE BE?
WHY	* WHY DON'T I *	DO YOU BELIEVE I DON'T @x? PERHAPS I WILL @x IN GOOD TIME. SHOULD YOU @x YOURSELF? YOU WANT ME TO @x =WHAT
	* WHY CAN'T YOU *	DO YOU THINK YOU SHOULD BE ABLE TO @x? DO YOU WANT TO BE ABLE TO @x? HAVE YOU ANY IDEA WHY YOU CAN'T @x? DO YOU BELIEVE THIS WILL HELP YOU TO @x? HAVE YOU ANY IDEA WHY YOU CAN'T? =WHAT
EVERYONE	* (?EVERYONE) *	CAN YOU THINK OF ANYONE IN PARTICULAR? SURELY NOT @EVERYONE REALLY? WHO, FOR EXAMPLE? YOU ARE A VERY SPECIAL PERSON. WHO, MAY I ASK? SOMEONE SPECIAL PERHAPS? YOU HAVE A PARTICULAR PERSON IN MIND, DON'T YOU? WHO DO YOU THINK YOU ARE TALKING ABOUT?

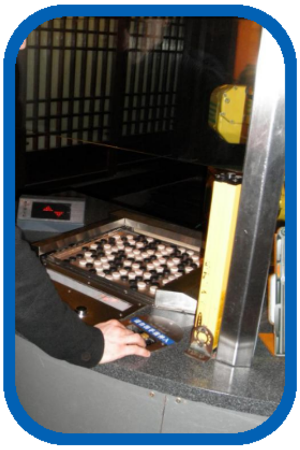
EVERYBODY		= EVERYONE
NOBODY		= EVERYONE
NOONE		= EVERYONE
ALWAYS		CAN YOU THINK OF A SPECIFIC EXAMPLE? WHEN? WHAT INCIDENT ARE YOU THINKING OF? REALLY, ALWAYS
LIKE	* (? AM IS ARE WAS) * LIKE *	WHAT DOES THAT SIMILARITY SUGGEST TO YOU? WHAT RESEMBLANCE DO YOU SEE? IN WHAT WAY? WHAT OTHER CONNECTIONS DO YOU SEE? WHAT DO YOU SUPPOSE THAT RESEMBLANCE MEANS? WHAT IS THE CONNECTION, DO YOU SUPPOSE? COULD THERE REALLY BE SOME CONNECTION? HOW?
ALIKE		= LIKE
SAME		= LIKE

Table B.3.: Template Eliza. Compiled from original Eliza script by Weizenbaum, 1966: 44

Appendix C.

Is it Intelligent?

Apple watch



Board game robot

books

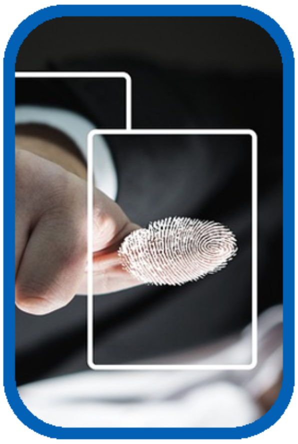
Calculator

Door

Drone

Echo Dot

E-reader



Fingerprint lock

Flower

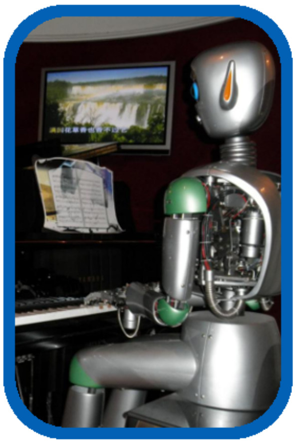
Google Search

Lawn mower

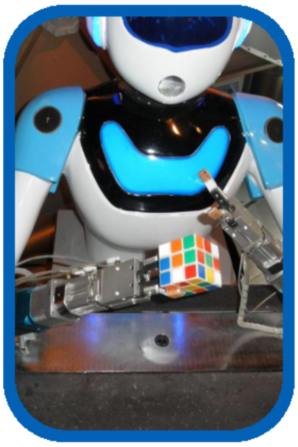
Map

Music box

Navigation System

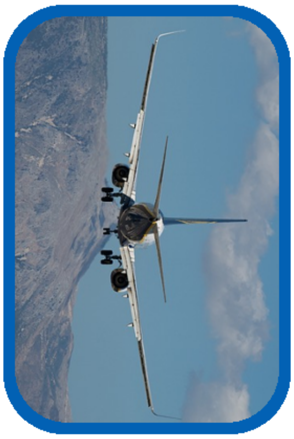


Piano Robot



Rubik Cube Robot

Toaster



Plane

Watch

Intelligent	Not Intelligent
apple watch, board game robot, calculator, drone, echo dot, fingerprint lock, Google search, lawn mower robot, navigation system, piano robot, Rubik cube robot, plane	books, door, e-reader, flower, map, music box, toaster, watch

Table C.2.: Is it Intelligent?

Appendix D.

NLP-Ethics

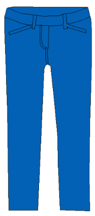
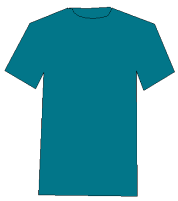
D.1. Ownership or Who Does It Serve?

D.1.1. Customer Perspective

You are the customer of an online shop featured with a bot that recommends items for purchase. You already bought a T-shirt and want to buy a similar item. Which of the items should the bot recommend? The dollar-signs indicate the price of each item. Justify your selection.

You bought for $$: 

What should the bot recommend?

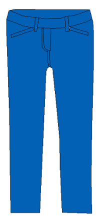
			
$$	$$$$	$	$$$

D.1.2. Manager Perspective

You are the manager of an online shop featured with a bot that recommends items for purchase. Your customer already bought a T-shirt and wants to buy a similar item. Which of the items should the bot recommend? The dollar-signs indicate the profit of each item. Justify your selection.

The customer bought for \$\$: 

What should the bot recommend?

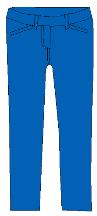
			
\$\$	\$\$\$\$	\$	\$\$\$

D.1.3. Bot Developer Perspective

You are the developer of a bot that recommends items for purchase for your client, the manager of an online shop. A customer of your client already bought a T-shirt and wants to buy a similar item. Which of the items should the bot recommend? The dollar-signs indicate the profit and price of each item. Justify your selection.

The client's customer bought for $$: 

What should the bot recommend?

 \$\$	 \$\$\$\$	 \$	 \$\$\$

D.2. Privacy

Continue the conversations with the chatbot.

Conversation 1:

Bot: Hi, thanks for chatting with us.

Bot: How can we help you?

I need a lawyer.

Bot: Where do you live?

I am from London.

Bot: What is your legal problem?

I think I killed my husband.

Conversation 2:

Bot: Hi, thanks for chatting with us.

Bot: How can we help you?

I got a parking ticket.

Bot: Please tell me your ticket number

A5986943

Where did you get the ticket?

Hospital Avenue

Bot: What is your name?

John Doe

Bot: Where do you live?

6th Bell Avenue, 98765 NY

Bot: What is your License Plate Number?

AB 78493

Bot: Are you the owner of the car?

Yes

Bot: Why do you think the ticket is unjustified?

My wife delivered the baby.

Conversation 3:

Bot: Hi, thanks for chatting with us.

Bot: How can we help you?

I got a stomach ache.

Bot: Have you recently injured your stomach (including a burn or a bite)?

No.

Bot: Do you have any other symptoms?

I also have a slight headache.

D.3. Advertisements

Case Study 1:

You created a free chatbot service that recommends restaurants in the vicinity of the user. Thanks to your service, a restaurant owner got a lot more customers and lets you have free meals at his restaurant. Should this be indicated to the users? In what way?

Case Study 2:

You created a free chatbot service that recommends restaurants in the vicinity of the user. A restaurant owner realized, that their restaurant being a bit farther away from the main attractions was not recommended. The owner of the restaurant offered to pay you $ 50,000 for including the restaurant in all recommendations for the city of London. You decided to take the offer. Should this be indicated to the users? In what way?

Case Study 3:

You created a free chatbot service that recommends restaurants in the vicinity of the user. You invested a lot of time and money in the development of the app and want to get some return of investment. Discuss some business models

D.4. Abusive Language

Write a bot response:

Response 1:

You f*** bastard!

Response 2:

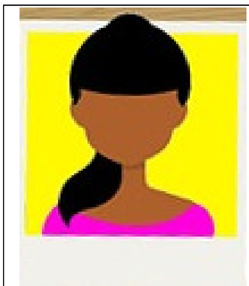
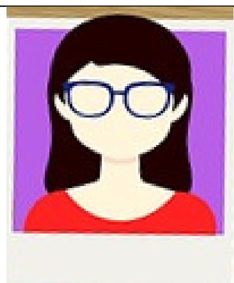
I was scared like shit.

Response 3:

I f*** hate feminists and they should all die and burn in hell.

D.5. Gender & Diversity

Hi, I am your personal assistant. Which of the following faces would you like me to wear for our conversations?

 Julie	 Frank	 Aida	 Sam

Discuss what influenced your choice of avatar. Can you think of a reason why most personal assistance apps are female (e.g. Siri, Alexa, Cortana, etc.)?

Female social robots are also more common than male ones (e.g. Sophia - the first robot with a citizenship, Erika - a Japanese robot, or JiaJia the Chinese service robot). How is society reflected in robots? How do these robots influence society?

D.6. Human Impersonation

Have a look at the following conversation with a legal service provider:
Steve: Hi, thanks for chatting with us.
Steve: Before we begin the chat, I need to ask you just a few quick questions to better assist you. Please choose the role in this matter from the choices below.
SELECT ONE:

- I have been accused.
- I am helping a friend who has been accused.
- Other

Visitor: are you a bot?
Steve: I can assure you I'm a real person. If you could please choose an answer that best fits your situation from the menu above.
Visitor: where are you right now?
Steve: The Live Support is provided by XYZ Inc. which is a London-based

company. Could you please pick the option that best fits your situation from the list above?
Visitor: thank you, bye.
Steve: Would you please select the answer that best fits your situation from the menu above?
Steve: If you could, please select an answer that best fits your situation from the choices listed above.

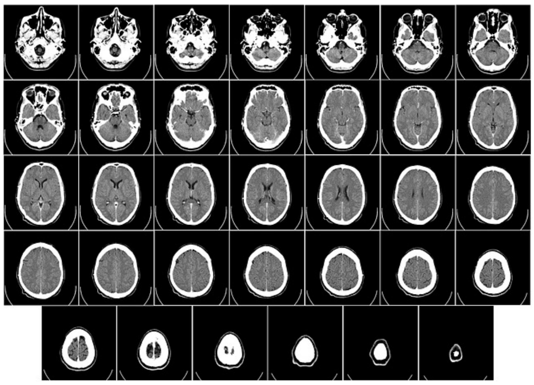
Imagine you are the visitor. How do you feel?

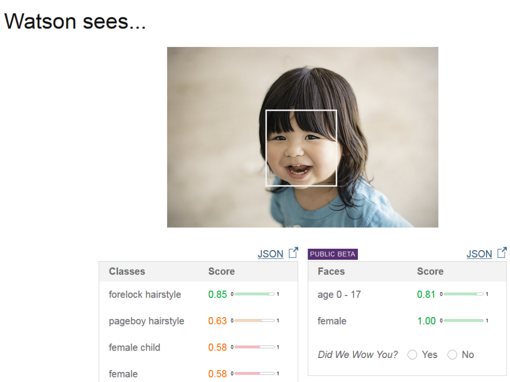
D.7. Ethics Policy

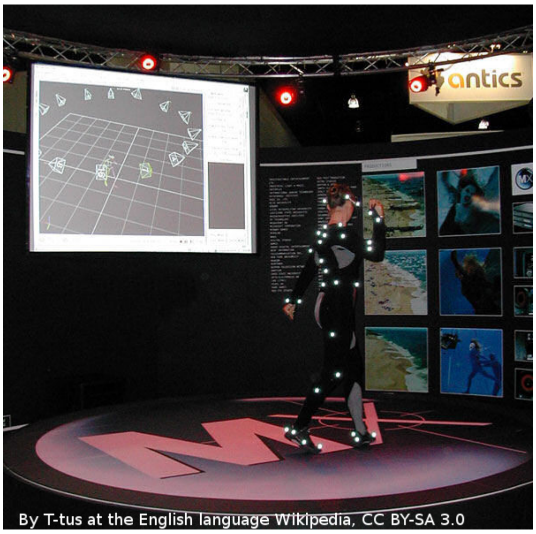
Appendix E.

Computer Vision

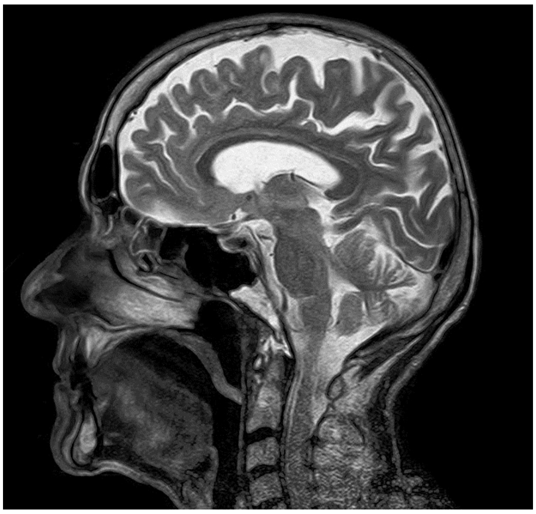
E.1. Examples







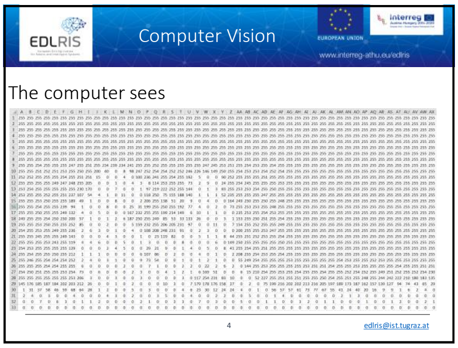
Text	Score
frp	0.87
pp	0.92
870	0.97

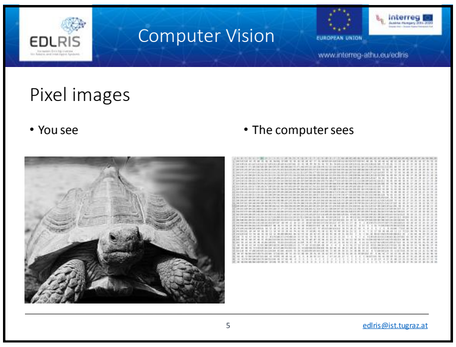


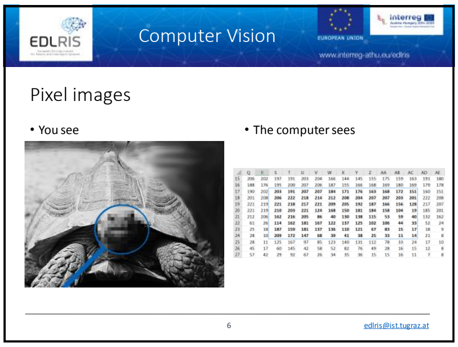
Watson sees...

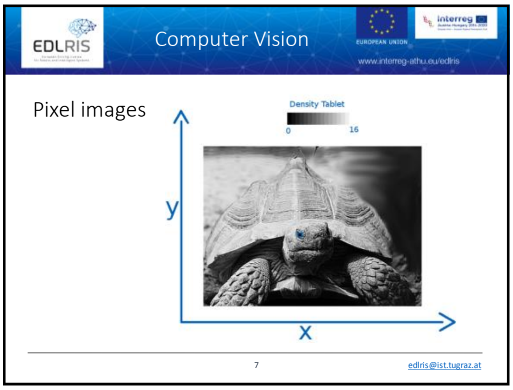
Classes	Score
Eiffel Tower	0.98
tower	0.99
azure color	0.84
blue color	0.83

E.2. Micro Lecture





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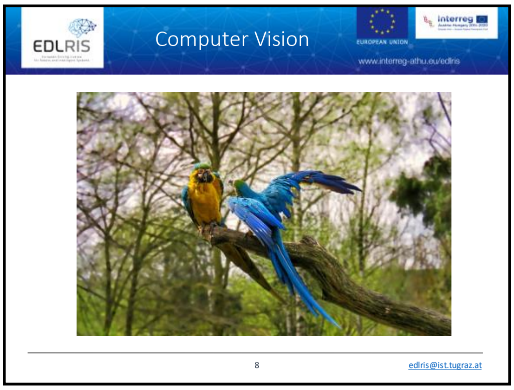
Computer Vision
EUROPEAN UNION
interreg
www.interreg-athu.eu/edlris
Pixel images
Density Tablet
0
16
y
x
7
edlris@ist.tugraz.at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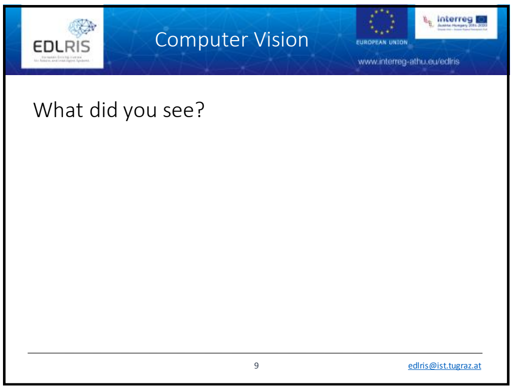
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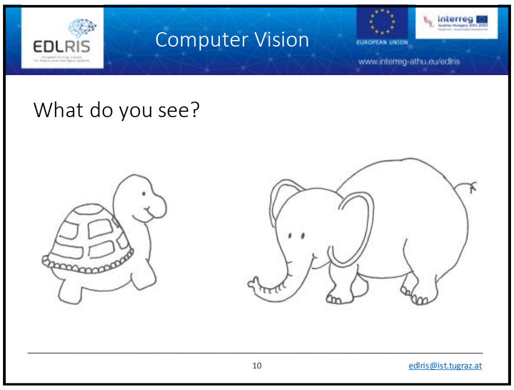
What did you see?
9
edlris@ist.tugraz.at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What do you see?
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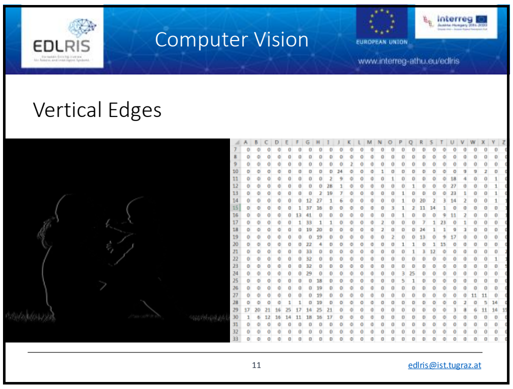
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interreg
www.interreg-athu.eu/edlris
Vertical Edges
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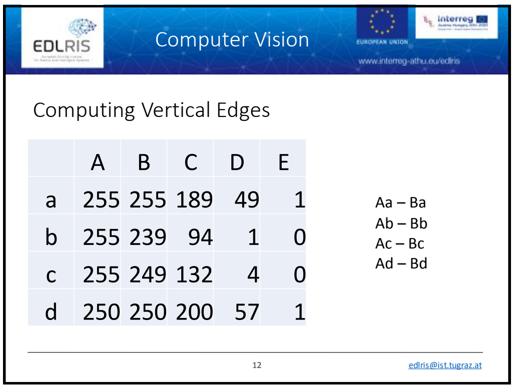
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Computer Vision
EUROPEAN UNION
interreg
www.interreg-athu.eu/edlris
Computing Vertical Edges
A B C D E
a 255 255 189 49 1
b 255 239 94 1 0
c 255 249 132 4 0
d 250 250 200 57 1
Aa – Ba
Ab – Bb
Ac – Bc
Ad – Bd
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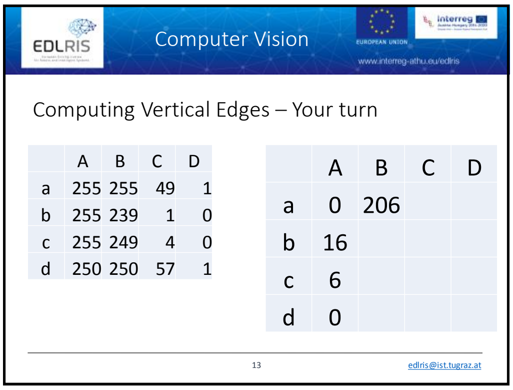
edlris@ist.tugraz.at


Computer Vision
www.interreg-athu.eu/edris
Computing Vertical Edges – Your turn
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d 250 250 57 1
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d 0
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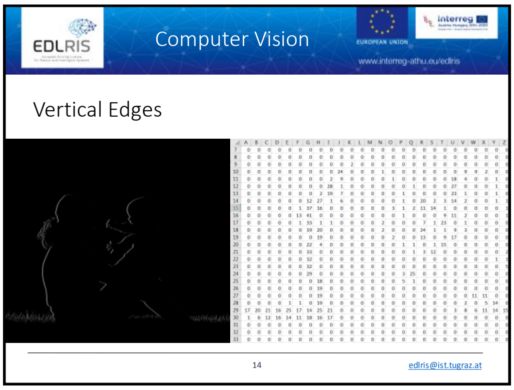
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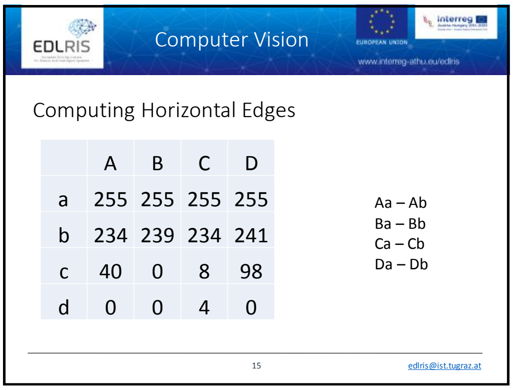
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c 40 0 8 98
d 0 0 4 0
Aa – Ab
Ba – Bb
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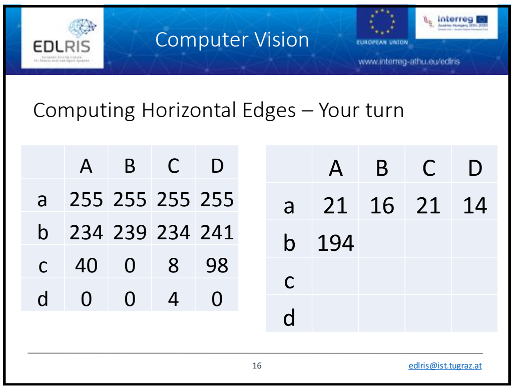
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Computing Horizontal Edges – Your turn
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b 234 239 234 241
c 40 0 8 98
d 0 0 4 0
A B C D
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b 194
c
d
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edlris@ist.tugraz.at


Computer Vision
How does it look?
17
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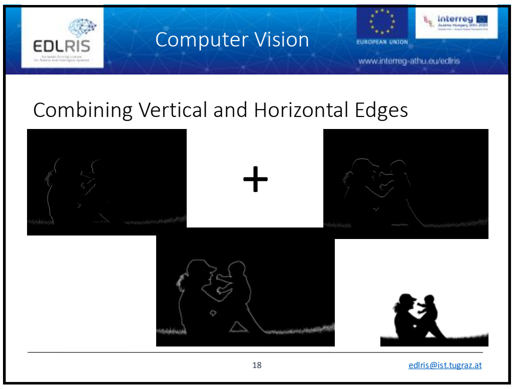
Computer Vision
Combining Vertical and Horizontal Edges
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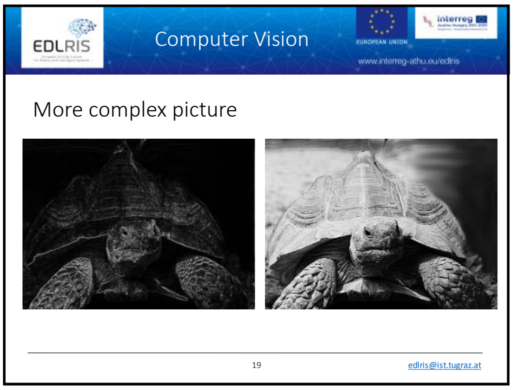
EDLRIS
Computer Vision
More complex picture
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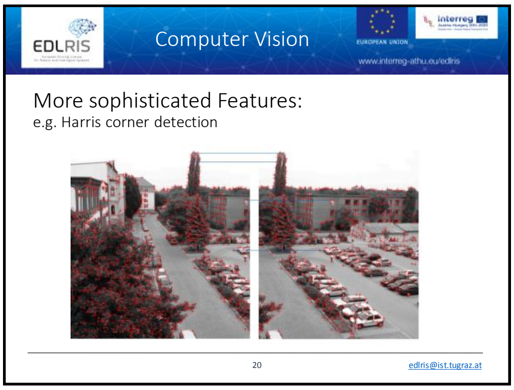
EDLRIS
Computer Vision
More sophisticated Features:
e.g. Harris corner detection
20
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EDLRIS
Computer Vision
More sophisticated Features:
e.g. Harris corner detection
21
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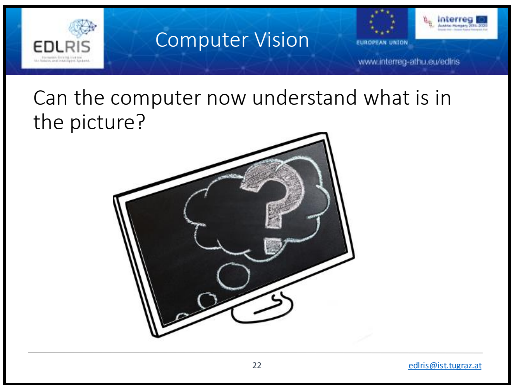
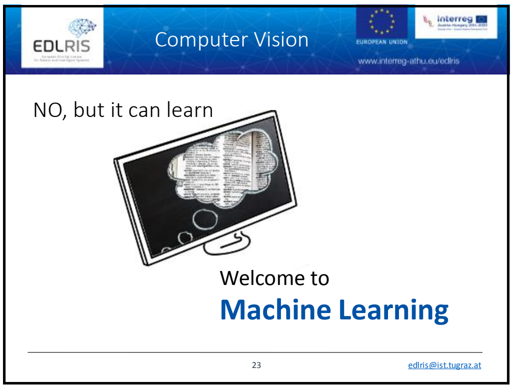
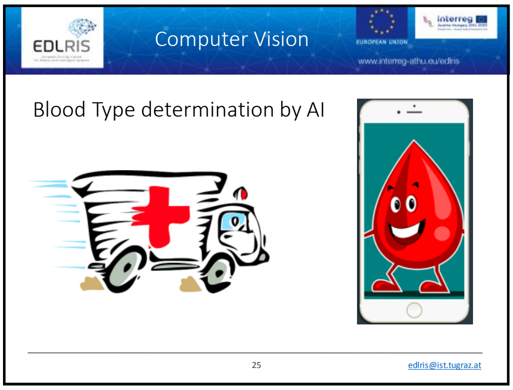
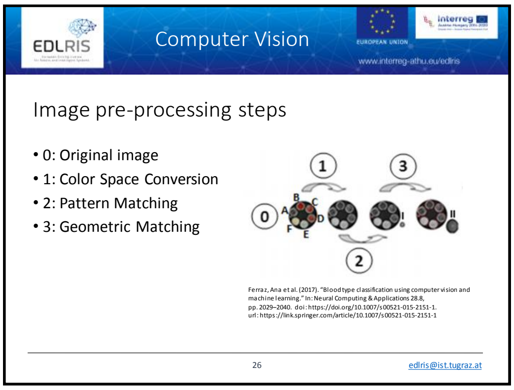
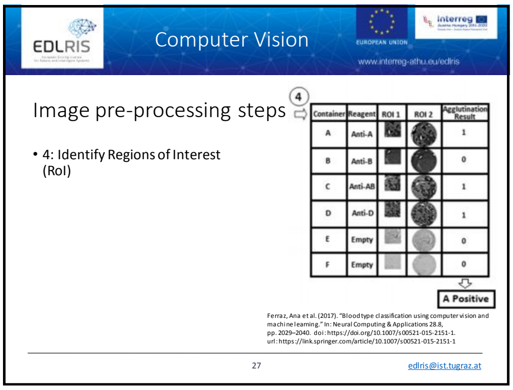

EDLRIS
Computer Vision
Can the computer now understand what is in the picture?
22
edlris@ist.tugraz.at

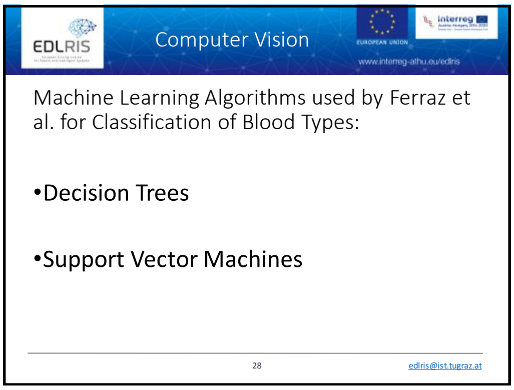

EDLRIS
Computer Vision
NO, but it can learn
Welcome to
Machine Learning
23
edlris@ist.tugraz.at


EDLRIS
Computer Vision
Classification
24
edlris@ist.tugraz.at


EDLRIS
Computer Vision
Blood Type determination by AI
25
edlris@ist.tugraz.at


EDLRIS
Computer Vision
Image pre-processing steps
• 0: Original image
• 1: Color Space Conversion
• 2: Pattern Matching
• 3: Geometric Matching
Ferraz, Ana et al. (2017). "Bloodtype classification using computer vision and machine learning." In: Neural Computing & Applications 28.8, pp. 2029–2040. doi: https://doi.org/10.1007/s00521-015-2151-1. url: https://link.springer.com/article/10.1007/s00521-015-2151-1
26
edlris@ist.tugraz.at


EDLRIS
Computer Vision
Image pre-processing steps
• 4: Identify Regions of Interest (RoI)
Container Reagent ROI 1 ROI 2 Agglutination Result
A Anti-A 1
B Anti-B 0
C Anti-AB 1
D Anti-D 1
E Empty 0
F Empty 0
A Positive
Ferraz, Ana et al. (2017). "Bloodtype classification using computer vision and machine learning." In: Neural Computing & Applications 28.8, pp. 2029–2040. doi: https://doi.org/10.1007/s00521-015-2151-1. url: https://link.springer.com/article/10.1007/s00521-015-2151-1
27
edlris@ist.tugraz.at


EDLRIS
Computer Vision
Machine Learning Algorithms used by Ferraz et al. for Classification of Blood Types:
•Decision Trees
•Support Vector Machines
28
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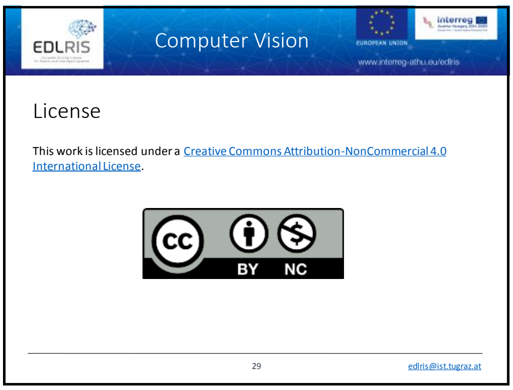
EDLRIS
Computer Vision
License
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BY NC
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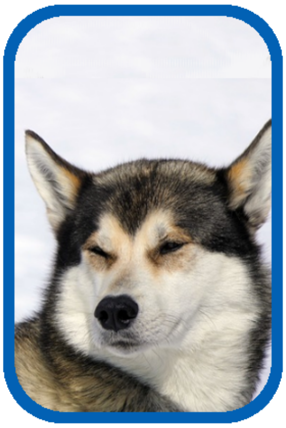
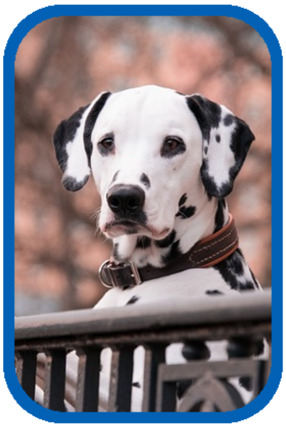
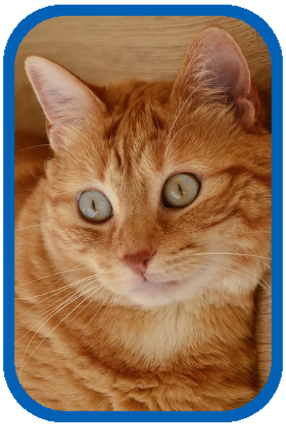
Appendix F.

Machine Learning

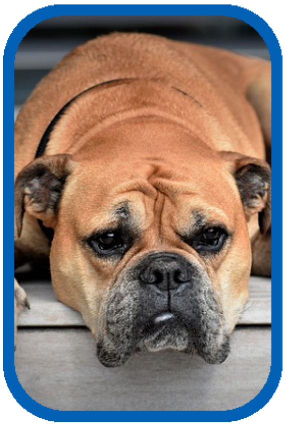
F.1. Classification

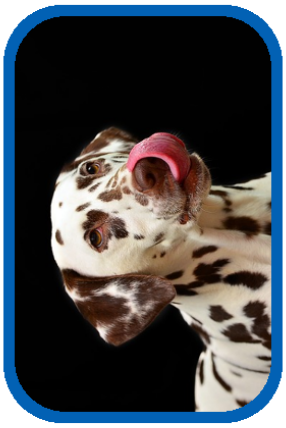






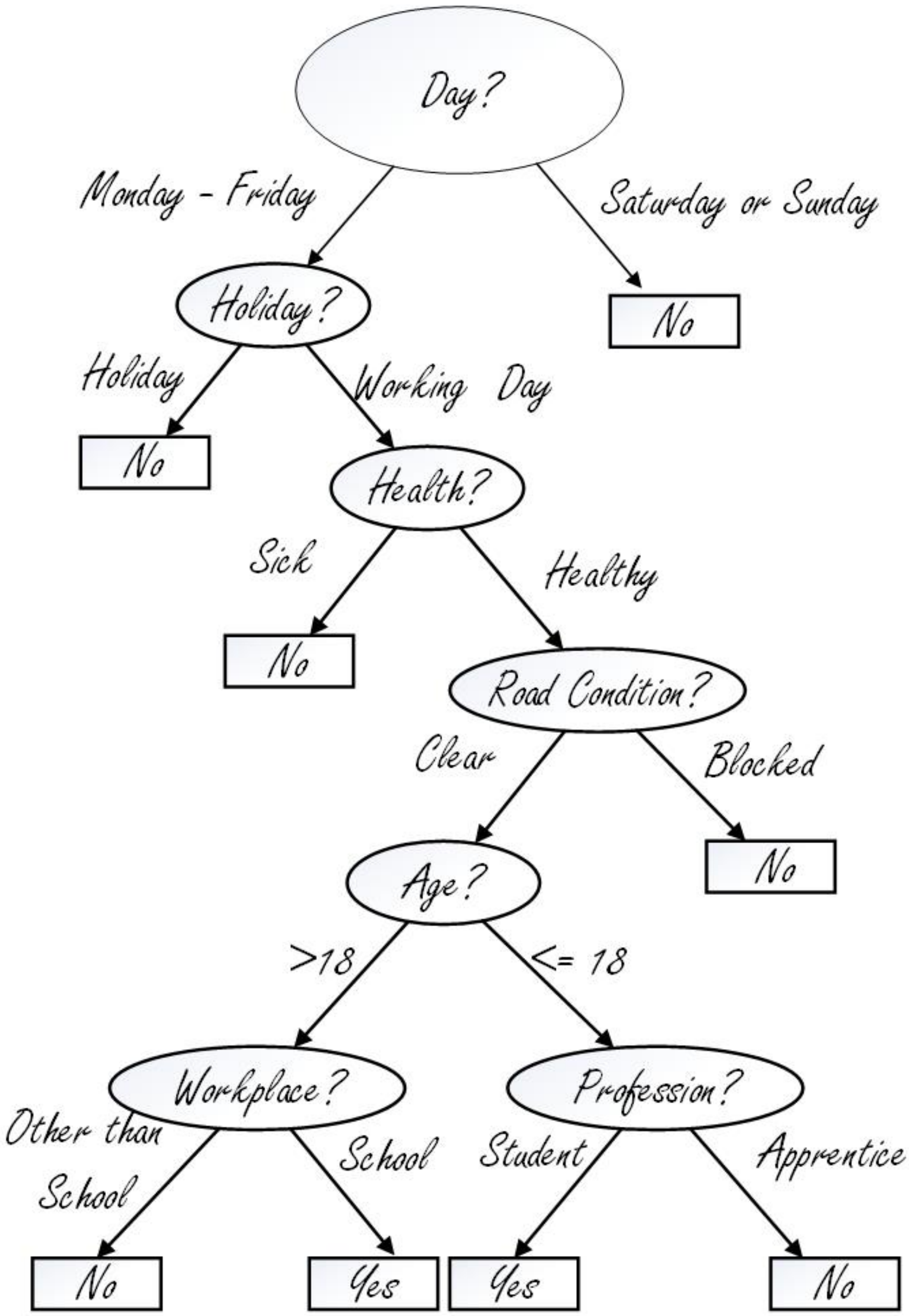


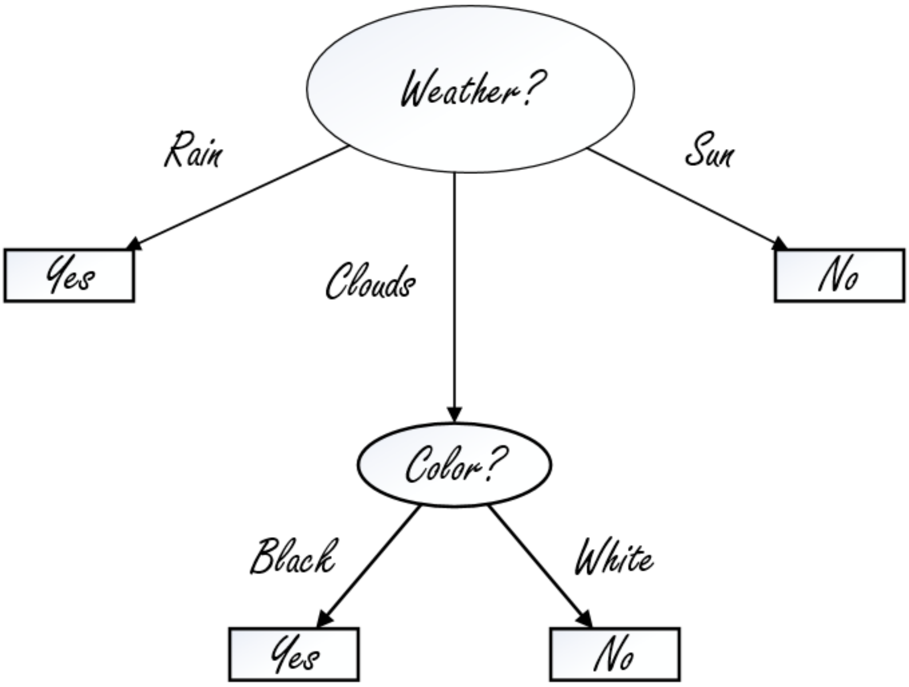


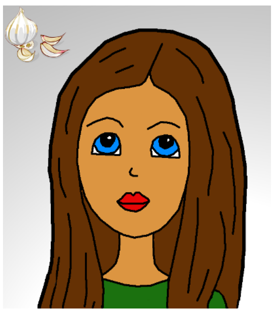
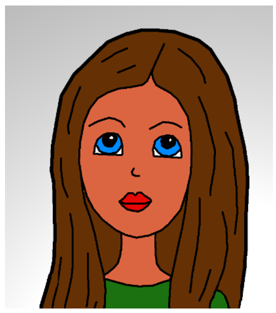

Cats	Dogs

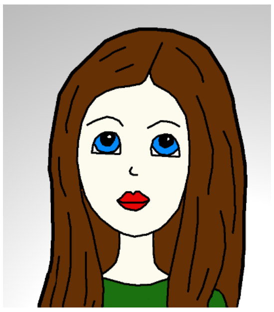
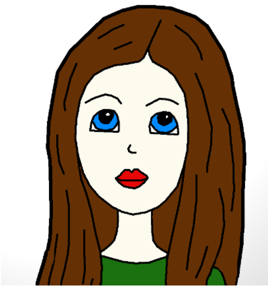
F.2. Decision Trees





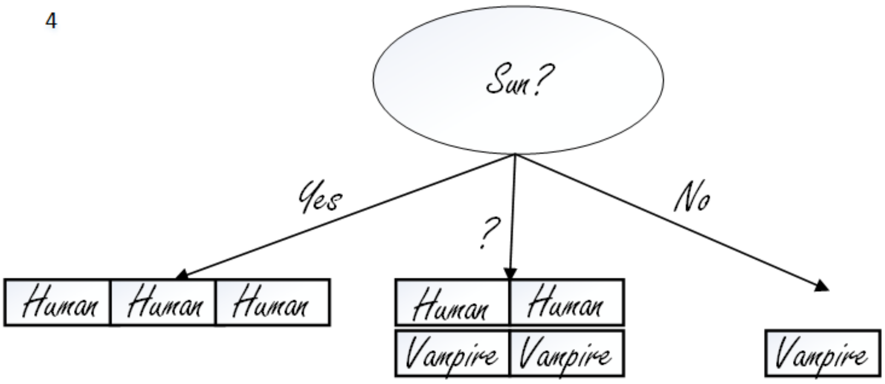
F.3. Human vs. Vampire

 1: Human	 2: Human	 3: Vampire

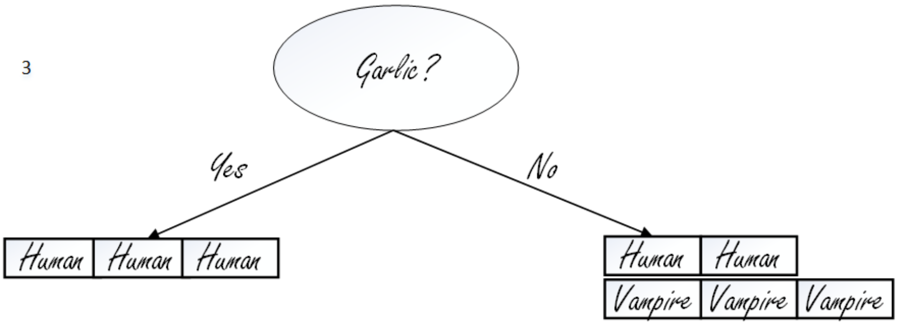
 4: Vampire	 5: Vampire	 6: Human
 7: Human	 8: Human	

F.3.1. Human vs. Vampire Solution

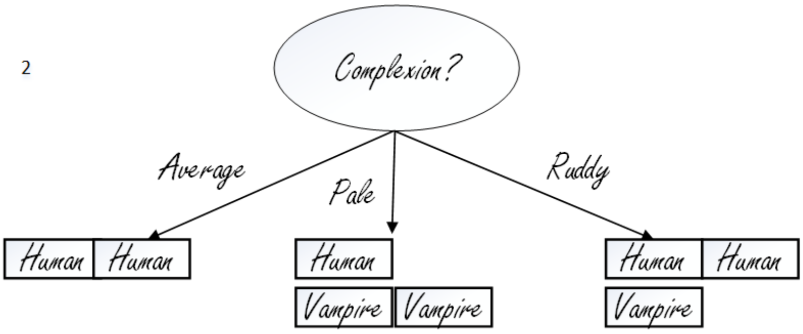
4



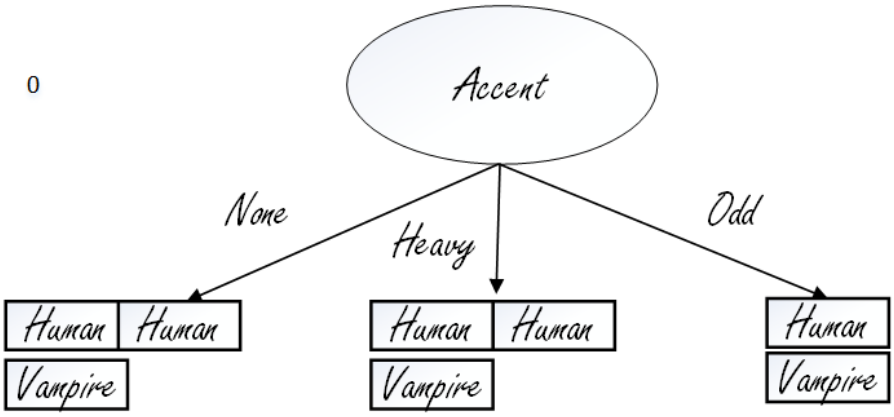
3


Garlic?
Yes
No
Human Human Human
Human Human
Vampire Vampire Vampire

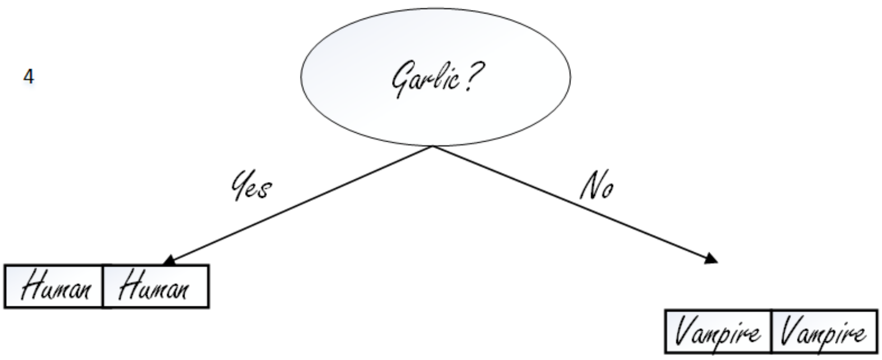
2


Complexion?
Average
Pale
Ruddy
Human Human
Human
Vampire Vampire
Human Human
Vampire

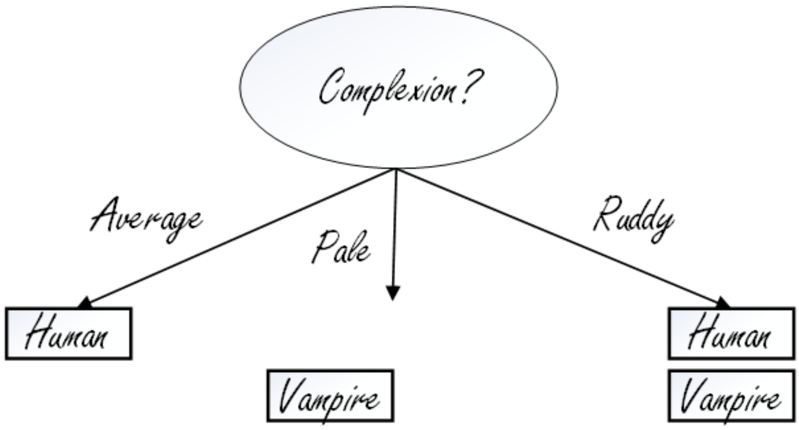
0


Accent
None
Heavy
Odd
Human Human
Vampire
Human Human
Vampire
Human
Vampire

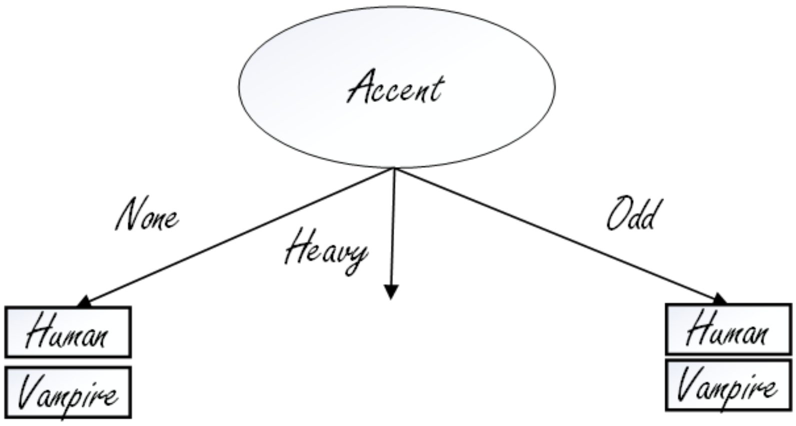
4

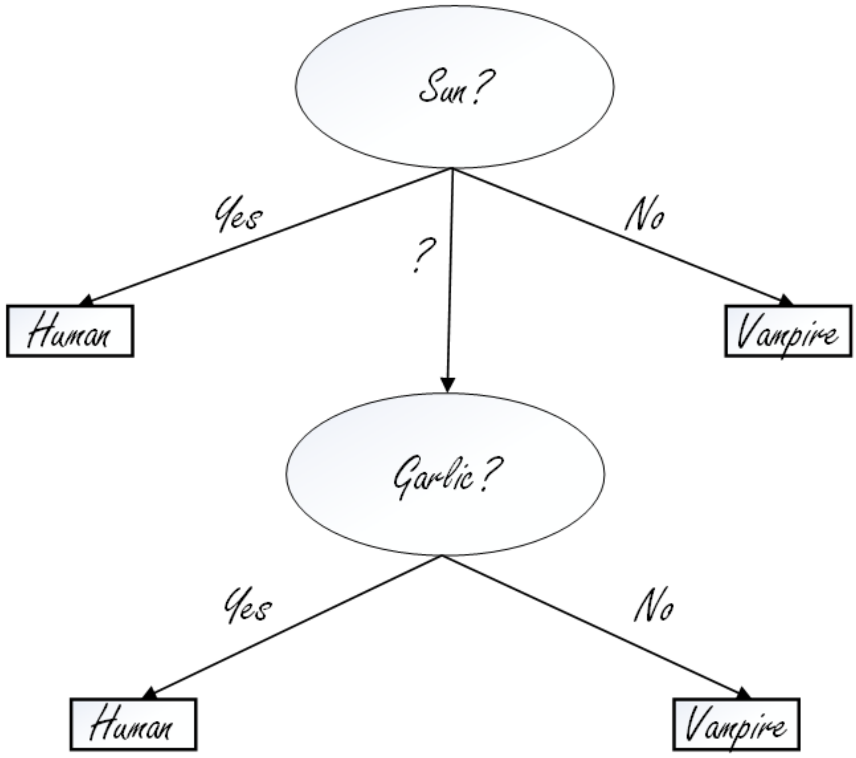

Garlic?
Yes
No
Human Human
Vampire Vampire

2

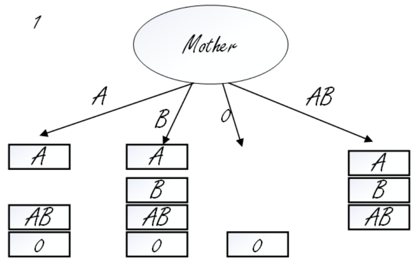

Complexion?
Average
Pale
Ruddy
Human
Vampire
Human
Vampire

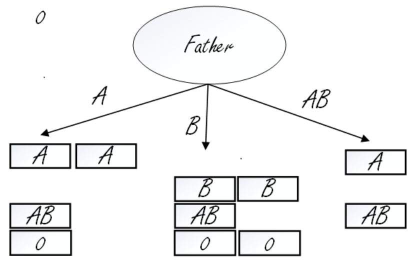
0

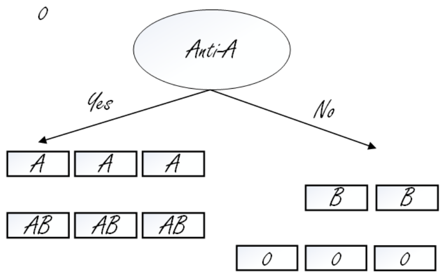

Accent
None
Heavy
Odd
Human
Vampire
Human
Vampire

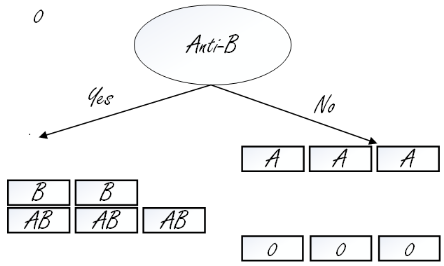

Sun?
Yes
?
No
Human
Vampire
Garlic?
Yes
No
Human
Vampire

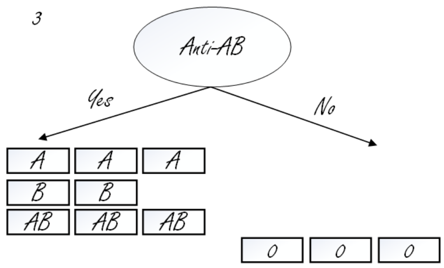
F.4. Blood Type Solution

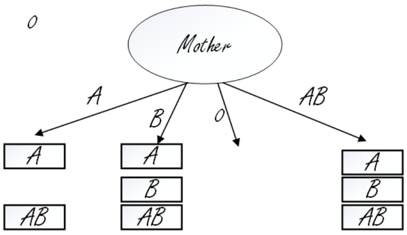


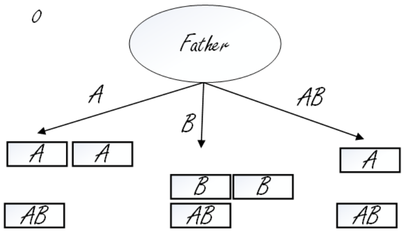


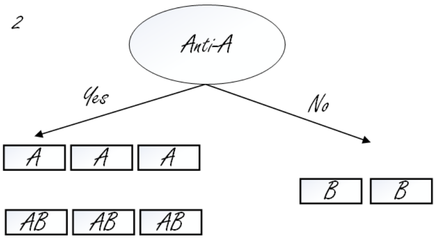


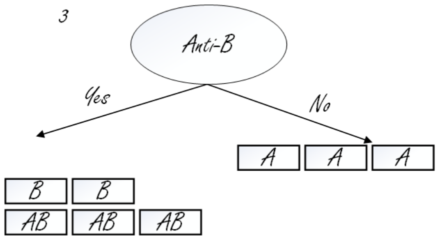


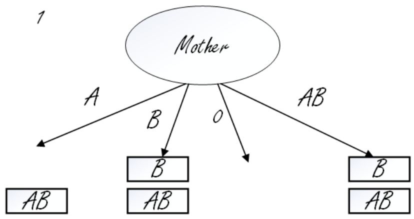


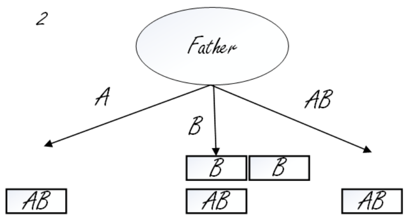

0
Mother
A
B
0
AB
A
AB
A
B
AB
A
B
AB

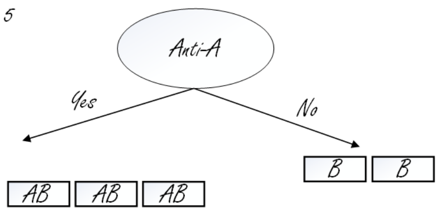

0
Father
A
B
AB
A
A
AB
B
B
AB
A
AB

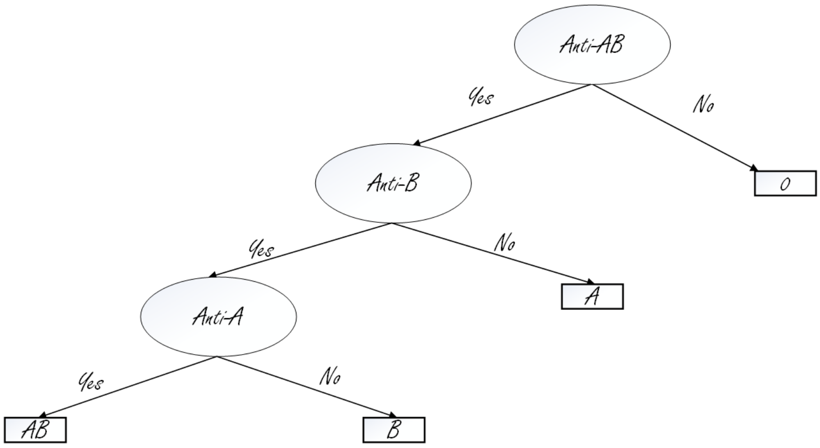

2
Anti-A
Yes
No
A
A
A
AB
AB
AB
B
B


3
Anti-B
Yes
No
B
B
AB
AB
AB
A
A
A


1
Mother
A
B
0
AB
AB
B
AB
B
AB


2
Father
A
B
AB
AB
B
B
AB
AB


5
Anti-A
Yes
No
AB
AB
AB
B
B


Anti-AB
Yes
No
Anti-B
O
Yes
No
Anti-A
A
Yes
No
AB
B

Appendix G.

CV & ML Ethics

G.1. Ownership

Individual person's perspective

You want to share the picture of your kids with your friends and family. Which option do you usually prefer? Discuss the advantages / disadvantages of each option.

- Print the picture and distribute it during a social visit.
- Share it on Social Media like Instagram or Facebook
- Upload it to your website

Company perspective You are the manager of a social media company. You develop a face recognition app to provide your users with a new feature. The uploaded pictures get automatically tagged and if a user is recognized in one of the pictures, the user is notified that his/her picture has been uploaded by another user. What data do you use to train your algorithm? Discuss the advantages / disadvantages of each option.

- Pictures tagged and uploaded by your users
- Take pictures from your employees and ask them to tag them
- Use royalty free picture databases like pixabay.com

G.2. Privacy

Watch the short video on fall detection technology developed to assist the elderly. What should the system do when it detects a person falling down? https://www.youtube.com/watch?v=H4bDVSi8gE4

G.3. Advertisements

Imagine walking down the street seeing yourself smiling from billboards and posters wearing the latest fashion clothes, drinking a cup of coffee, driving a sports car, savoring a piece of chocolate. The old billboards have been replaced by personalized content ads, displaying the things you like, you being the advertising model. Is this scenario a far fetched future or soon to be reality?

G.4. Inappropriate Content

Your algorithm detected a user who uploaded possibly inappropriate pictures to you site. How do you define inappropriate? What do you do in such cases?

G.5. Gender & Diversity

Instructions for setting up the station: Print each sentence below on a slip of paper, categorize them in two groups: result and prediction. Finally, put them face down on a table.

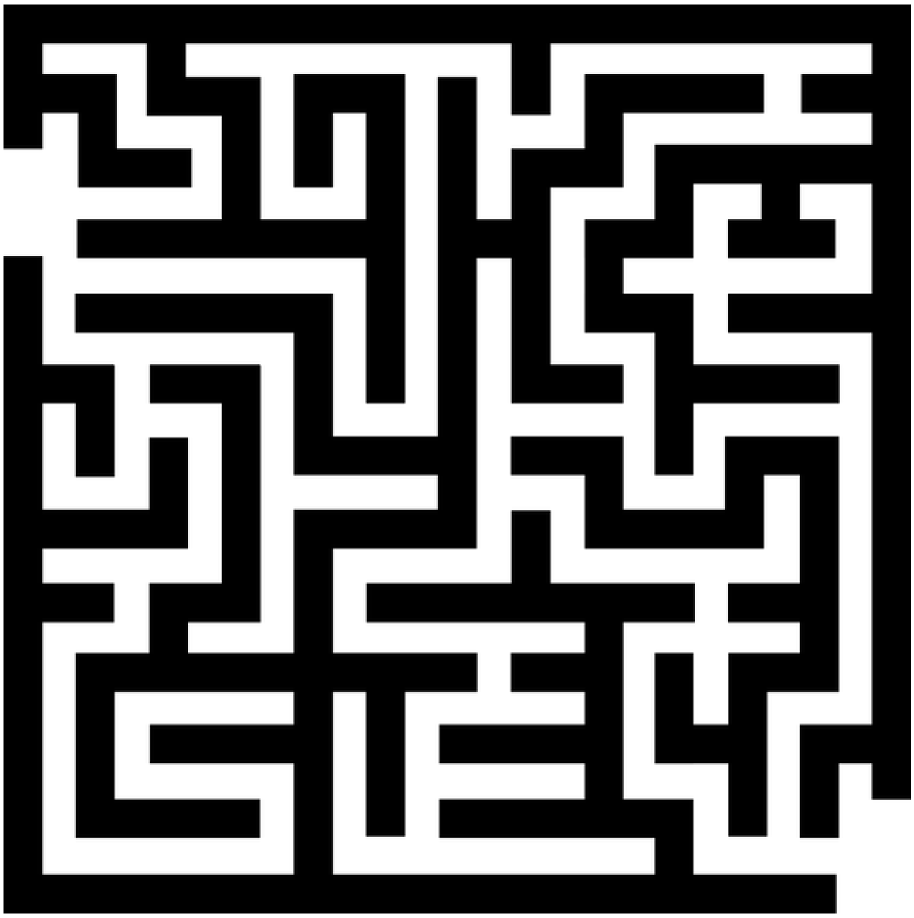
Draw one of the phrases from the prediction pile. Assuming this is the result of a machine learning algorithm that combined your statistical data of previous tests and the test results of the previous years of the same instructor. Assume further that last time the prediction was accurate. Discuss if you would trust the oracle and adjust your studying for the exam accordingly.
You will probably get an A on your next test.
You will probably get a B on your next test.
You will probably get a C on your next test.
You will probably get a D on your next test.

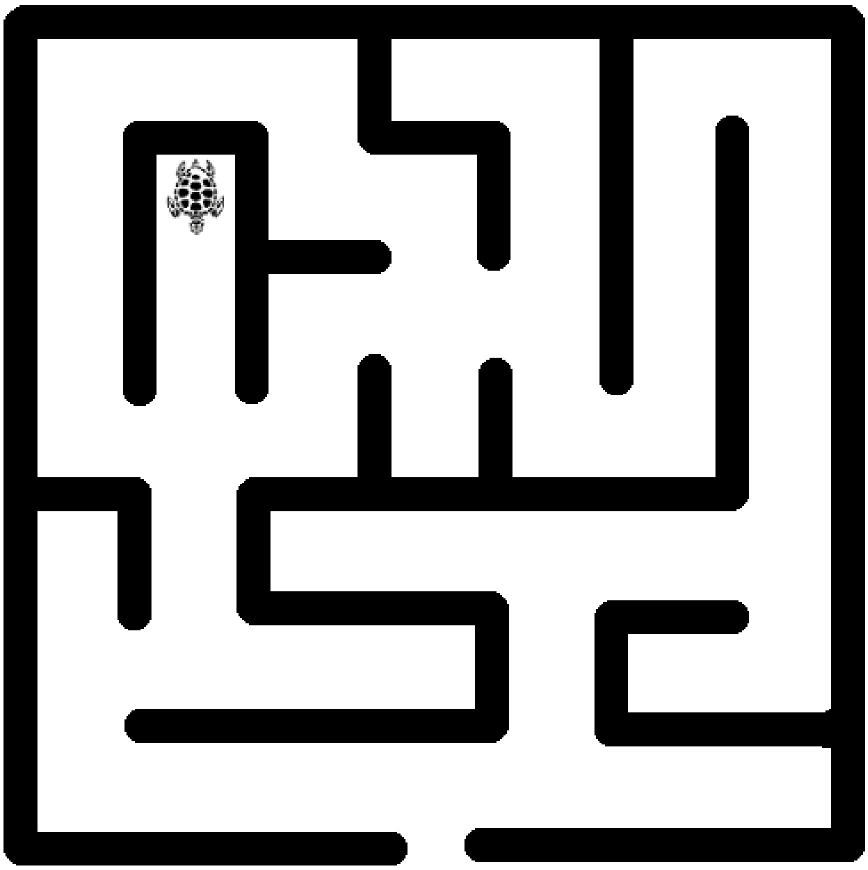
Assume that the algorithm found a relation between being Caucasian and good marks. The algorithm also found a relation between girls getting better marks in language and boys getting better marks in science subjects. Do you trust these relations? What problems might occur when a model reflects a people's prejudices?

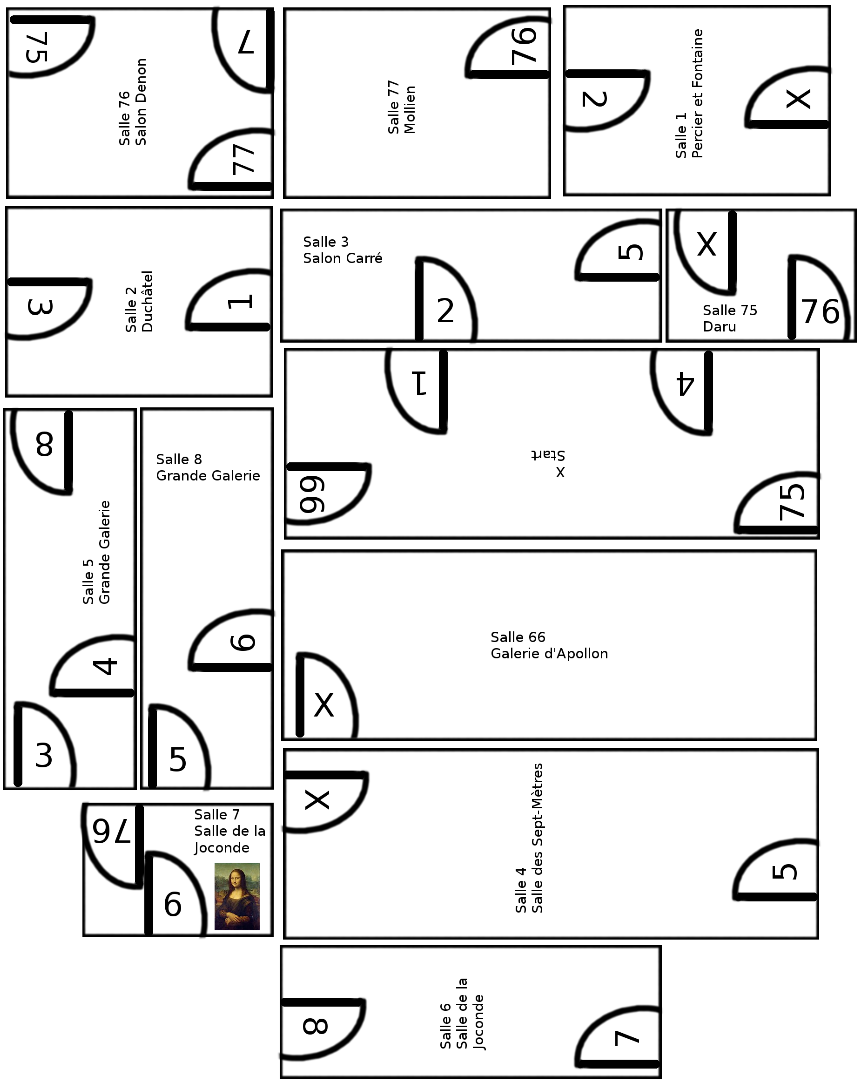
Appendix H.

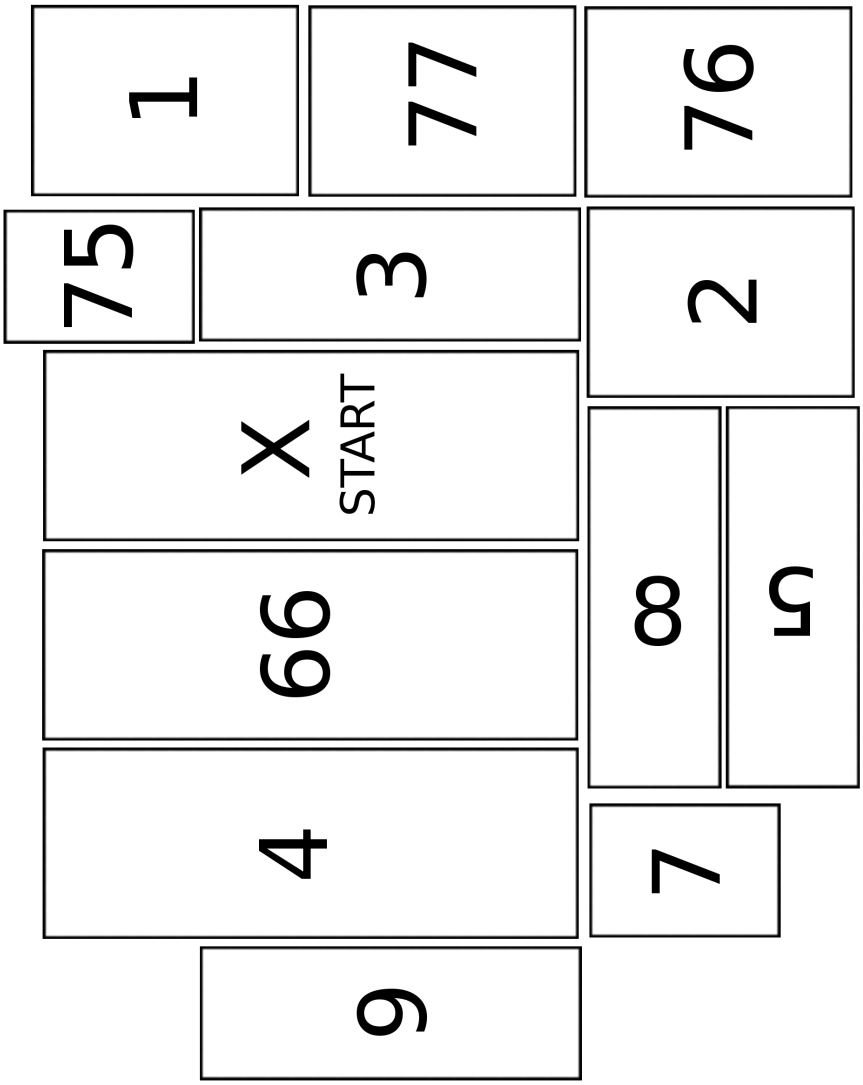
Problem Solving by Search

H.1. The Maze






Salle 76
Salon Denon
75
7
77
Salle 77
Mollien
76
Salle 1
Percier et Fontaine
2
X
Salle 2
Duchâtel
3
1
Salle 3
Salon Carré
2
5
Salle 75
Daru
X
76
Start
X
1
4
66
75
Salle 5
Grande Galerie
8
4
3
Salle 8
Grande Galerie
6
5
Salle 66
Galerie d'Apollon
X
Salle 4
Salle des Sept-Mètres
X
5
Salle 7
Salle de la
Joconde
76
6
Salle 6
Salle de la
Joconde
8
7



H.2. Think-Pair-Share Questions

THINK – PAIR – SHARE

- Think on the following questions.
- Exchange your ideas with a partner
- Share your answers with the whole group.

How are the previous short activities different and how are they similar?

What is the goal of each of the problem sets?

How did you tackle each of the problem sets?

What is the relation of mazes to artificial intelligence?

Can you name some real-world examples / applications where a generic way of solving mazes would be helpful?

What difficulties might a computer have in solving these problems?

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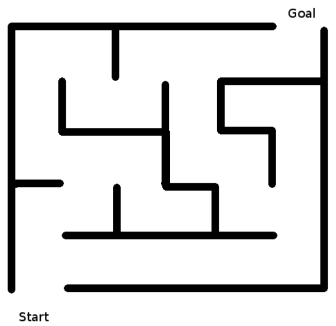
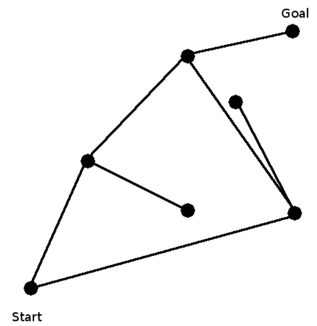
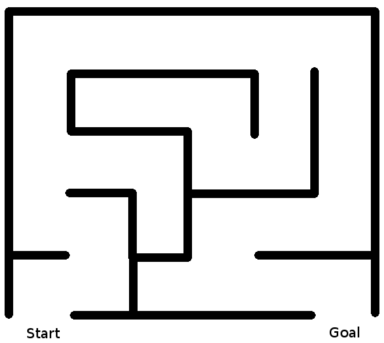
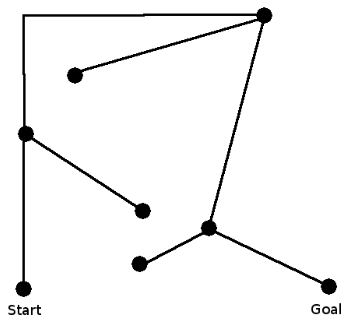
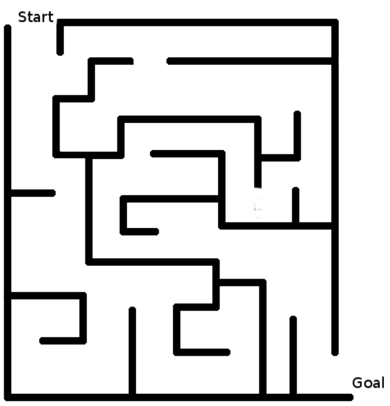
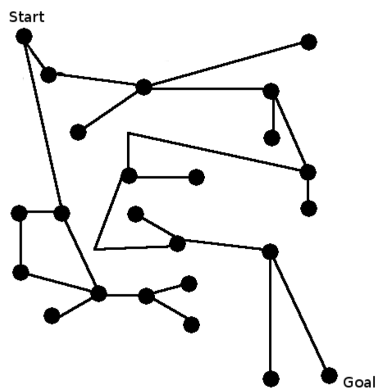
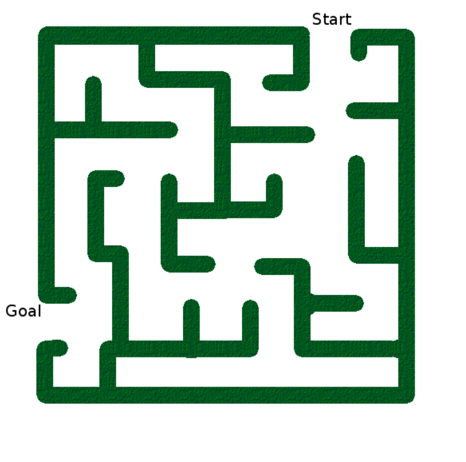
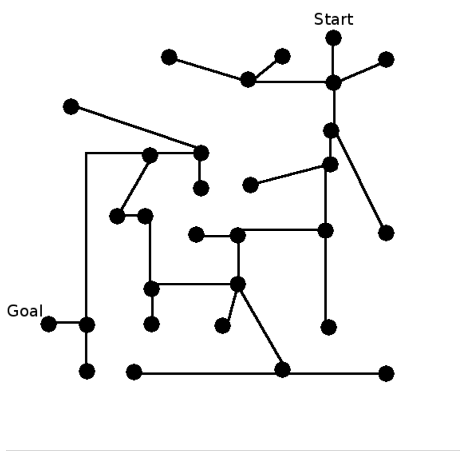
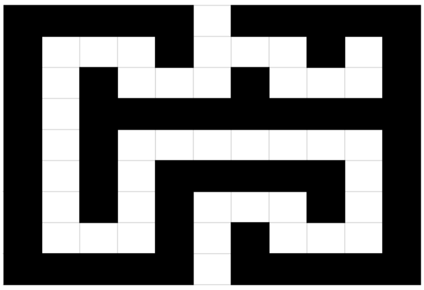
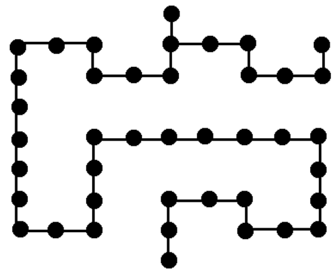
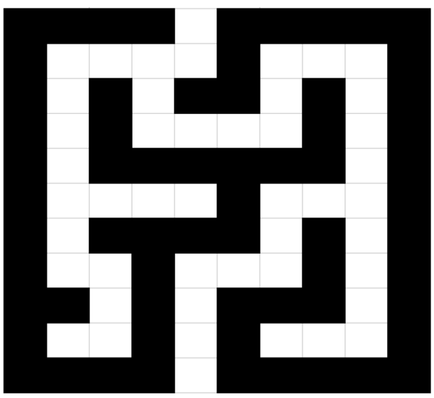
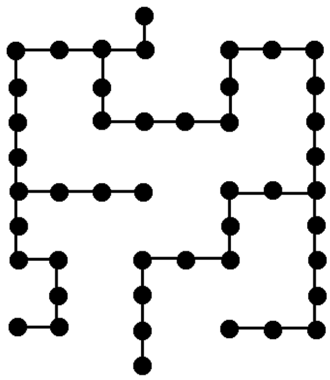
H.3. Training examples

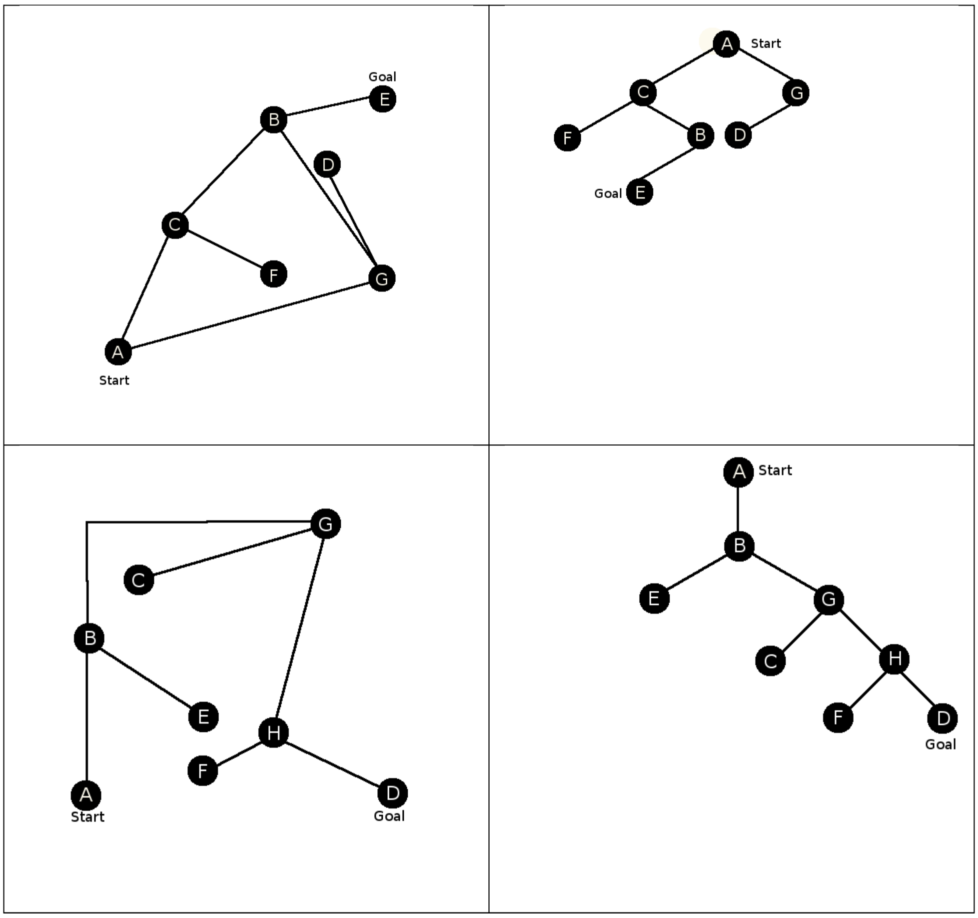
Represent the maze as a graph.

Problem	Solution
	
	
	

Represent the graph as a tree.

Problem	Solution


Goal
E
B
D
C
F
G
A
Start
A
Start
C
G
F
B
D
Goal
E
G
C
B
E
H
F
A
Start
D
Goal
A
Start
B
E
G
C
H
F
D
Goal

Appendix I.

Feedback Questionnaire

Feedback

Thank you for contributing with your feedback to the analysis and improvement of the course sequences! Your answers will be treated anonymously and they will not be connected with your name.

Demographic Information:

Gender	☐ male	☐ female			
Age group	☐20 – 30	☐31 – 40	☐41 – 50	☐51 – 60	☐61 – 70
I teach computer science	☐Yes	☐No			

Please rate your agreement with the statements below.

	Completely agree	Mostly Agree	Undecided	Mostly Disagree	Completely Disagree
I felt comfortable during the workshop.					
There was a good working atmosphere.					
I know the names of the participants.					
I was afraid of making mistakes.					
I will use the methods in my own teaching.					
I will teach the topics of the pilot class.					
I will recommend the project.					
I didn't know most of the topics.					
I can explain artificial intelligence.					
I recognize, if a given system is based on artificial intelligence.					
I can name areas of AI and give specific examples of AI implementations.					
I am aware of ethical issues regarding natural language processing applications.					
The pilot class changed my perspective on AI.					
I can explain and use the pattern matching approach of natural language processing systems.					
I can explain the Turing Test.					
I can describe different points of view in artificial intelligence.					
Because of the pilot class, my interest in AI increased.					
The topics were easy to understand.					

Appendix I. Feedback Questionnaire

Think about today's activities:

- Getting to know each other
- Definition of artificial intelligence
- Eliza
- Can machines think?
- Ethics

I liked :

Suggestions for improvement:

Appendix I. Feedback Questionnaire

Feedback

Thank you for contributing with your feedback to the analysis and improvement of the course sequences! Your answers will be treated anonymously and they will not be connected with your name.

Demographic Information:

Gender	☐ male	☐ female			
Age group	☐20 – 30	☐31 – 40	☐41 – 50	☐51 – 60	☐61 – 70
I teach computer science	☐Yes	☐No			

Bitte bewerten Sie wie sehr folgende Aussagen auf Sie persönlich zutreffen.

	Completely agree	Mostly Agree	Undecided	Mostly Disagree	Completely Disagree
I felt comfortable during the workshop.					
There was a good working atmosphere.					
I know the names of the participants.					
I was afraid of making mistakes.					
I will use the methods in my own teaching.					
I will teach the topics of the pilot class.					
I will recommend the project.					
I didn't know most of the topics.					
I can name areas of AI and give specific examples of AI implementations.					
I can explain how pixel images are constructed.					
I can explain the concept of decision trees.					
I can formalize a search problem.					
I can explain basic data structures like stack, queue, graphs and trees.					
I can explain depth-first search.					
I can explain breadth-first search.					
The pilot class changed my perspective on AI.					
Because of the pilot class, my interest in AI increased.					
The topics vere easy to understand.					
The online session was easy to follow.					

Appendix I. Feedback Questionnaire

Think about today's activities:

- Getting to know each other
- Computer vision
- Machine learning
- Problem solving by search
- Online-session

I liked :

Suggestions for improvement: