IN5480 Individual assignment fall 2021, Module 1, Iteration 1

1.1 Concepts, definition and history of AI and interaction with AI

The origins of AI

People have been interested in artificial beings for ages. Ever since we've had lifelike statues, we've imagined how they might behave if they were actually alive. (Chiang 2019). In the first half of the 20th century, science fiction in literature as well as in films introduced the world with the concept of artificially intelligent robots (Aniyoha 2017).

More recently, our ideas of how robots and intelligent systems might function are shaped by our perception of how good computers are at certain tasks (Chiang 2019).

After World War II and Turner's development of the first computer, the development of what we today call artificial intelligence began (Grudin, 2009).

Mathematics and logician John McCarthy used the term artificial intelligence (AI) for the first time in 1956. This started a debate about what and in what extend machines can do the same tasks as humans. In the late 60s to early 70s AI develops as a separate field of research. In the 70's, a lot of research started on voice recognition and language processing, which was considered an important step in creating "intelligent" machines. However, it is not until the late 90s and 2000s that AI research has had a major breakthrough. In 1997, the computer program Deep Blue managed to beat chess master Gary Kasparov, which is considered a major turning point in AI research. Later, there have been more breakthroughs such as the Mars Rover, self-driving cars and further development of machine learning. Today, the reduced costs of storage, processing, and browser access to servers has enabled the use of AI on standard PCs. The developments open up for many new possibilities (Grudin, 2009).

The definition of AI

There are several different definitions of artificial intelligence (AI) and the definitions often change as technology develops. I chose to look at three different definitions, one from a policy making perspective and two different academic definition.

The first definition is formulated by the Independent High Level Expert Group set up by the European Commission (EC). EC aims to clarify aspects of AI as a scientific discipline and as

a technology and also formulate a definition that can be used "to achieve a shared common knowledge of AI that can be fruitfully used also by non-AI experts, and to provide useful details that can be used in the discussion on both the AI ethics guidelines and the AI policies recommendations." The definition is as follows:

"Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g. voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or Internet of Things applications)."

I chose the second definition based on an academic paper by Vinuesa et al (2020) regarding the role of artificial intelligence in achieving sustainable development for AI – based technology.

"we considered as AI any software technology with at least one of the following capabilities: perception—including audio, visual, textual, and tactile (e.g., face recognition), decision-making (e.g., medical diagnosis systems), prediction (e.g., weather forecast), automatic knowledge extraction and pattern recognition from data (e.g., discovery of fake news circles in social media), interactive communication (e.g., social robots or chat bots), and logical reasoning (e.g., theory development from premises). This view encompasses a large variety of subfields, including machine learning." (Vinuesa et al, 2020)

I chose the third definition of AI from our curriculum in this course. One of the mandatory readings in this course is an article by Bratteteig and Verne (2018). The authors focus on participatory design and are discussing whether AI can replace human participation in the design process and pose the question what is the objective when developing AI. In their article they reference to Russel et al's (2010) definition of Artificial Intelligence:

"AI is a subfield of computer science aimed at specifying and making computer systems that mimic human intelligence or express rational behaviour, in the sense that the task would require intelligence if executed by a human (Russel et al, 2010 in Bratteteig and Verne, 2018).

Based on these three definitions, and my humble knowledge of Artificial Intelligence, my personal understanding of AI is also based on my perception of how AI-based technology function through my interaction with intelligent systems in my daily life.

However, before I come with a definition on my own, I feel the urge to explore what constitutes intelligence and how (real) intelligence differ from an artificial one. This is a discussion I would like to follow up on later in my studies, but for this paper, I will have to settle without a further examination of what can be defined as intelligence.

As for my own understanding of AI, I would say my (tentative) definition of AI is: *Computer systems that can do tasks which earlier were bound to be executed by humans and that, based on pattern recognition the systems are able to recognize patterns on their own and utilize this information when performing a task.*

Another definition I would like to explore further is the difference between AI and automatization as I cannot see a distinct line between these two in the articles I have read on the subject.

An article from the curriculum – Don Norman - The problem of automation: Inappropriate feedback and interaction, not over-automation.

Don Norman (1990) discusses the increased use of automatization in the industry and how it is often blamed for causing unwanted incidents and that this technology contributes to human error when in use. However, Don Norman suggests that it is not the automatization that is the core problem, but rather wrongful or misunderstood design of the systems. When a process is fully automated, we, as humans will lose the understanding of what is happening in the process. In case of an emergency, when a person must regain control and override something manually, this can become impossible due to the lack of knowledge of the process itself. The problem, as suggested by Norman, is the lack of feedback and interaction with humans who must control the overall performance of the task. The problem is that the automation is at an intermediate level of intelligence, powerful enough to take over control that used to be done by people, but not powerful enough to handle all unwanted incidents. The level of intelligence is insufficient to provide the continual feedback that occurs naturally among human operators. To solve this problem the author suggests that the automation should either be made less intelligent or more intelligent and proposes a more soft, compliant technology which could continuously interact with human operators (Norman, 1990).

This article is from 1990 but I think it still has many valid concerns. Although the technology development has evolved tremendously the past 30 years and we live now in an era where technology is more sophisticated and even intelligent in ways such as being able to act and solve new problem on its own - the operator (humans) still do not understand all the steps in

the processes or performance of tasks a computer system executes. More so, with the evolvement of artificial design, where algorithms are able to acquire new knowledge and act accordingly, what will happen when humans will no longer understand the basis of the operating systems' logic? Another question I am curious about is what happens when intelligent software technology provided for e.g. banks to automatically consider a loan for a customer is no longer understood by the operator? The data and algorithms the software decisions are based on is often not available to the operator (bank employee) as this is proprietary technology owned by the service provider.

A contemporary company that works with AI – Boston Dynamics

Boston Dynamics is an American engineering and robotics design company best known for the development of a series of dynamic highly mobile robots. The robots are advertised as being intelligent and they can perform numerous tasks. They use for instance sensors and image processing. In September 2019, Boston Dynamics released a commercial robot named "Spot". They deployed Spot robots for data collection, however, to understand the collected data and turn it into actionable insights became more of a challenge. "Spot can maneuver unknown, unstructured, or antagonistic environments and can collect various types of data, such as visible images, 3D laser scans, or thermal images," according to Michael Perry, Vice President of Business Development at Boston Dynamics (Carrol, 2020).

This indicated that they have launched AI-technology in their robots but might have lacked the expertise to develop it properly. In 2020 they therefore entered a partnership with Visual AI Solution, Vinca, and have provided since robots with intelligent software used on electric utility sites, oil and gas sites. They also inform on their website that the use something they call "athletic intelligence" which allows their robots to walk steadily on a wide variety of terrains.

However, as this is proprietary technology, there is no detailed information about the technology accessible on the website. I am not sure if they for instance use machine learning in their algorithms, but my overall impression is that their robots definitely are equipped with some degree of AI. (Source: bostondynamics.com)

Biased code (2020) – a documentary on AI

This is a documentary that addresses prejudice in algorithms after MIT Media Lab researcher Joy Buolamwini revealed flaws in face recognition technology. The documentary portrays a rather worrisome perspective on the use of artificial intelligence to assess the everyday lives

of billions of people. The documentary investigates how AI-based systems are (often without our knowledge) making decisions about who gets housing, or a car loan or a job. The problematic part is that people affected by these decisions don't even know the criteria used by the software to adjudicate their lives, since it is proprietary technology. The documentary also discusses human rights when it comes to surveillance and systems for punishment as it has been introduced in China. In conclusion the documentary raises the question if, or that, the society has become guinea pigs, testing the extents of the artificial intelligence technology.

1.2 Robots and AI systems

The word Robot was first used in its modern form by the author Karel Čapek in 1920 in his play R.U.R: Rossum's Universal Robots and has its origins in the Czech word "robota" which means work (Wikipedia).

Two definitions of Robot

To define what is a robot is not easy. According to Kerstin Dautenhahn (2018) There is no common definition of "robot" because "robot designs change rapidly, models become obsolete, new robotics companies arise, and other companies may stop trading. Thus we, as a community, do not have a common reference point when we refer to "robot," not even a sample of widely agreed-upon reference points. "

According to Sostero (2020), the official definition of "robot" and much cited in the scientific and technical literature, is laid out in the ISO 8373:2012 standard (International Organization for Standardization [ISO], 2012)): *"Robot. Actuated mechanism programmable in two or more axes with a degree of autonomy (i.e., the ability to perform intended tasks based on current state and sensing, without human intervention), moving within its environment, to perform intended tasks."*

As cited in Thrun(2004): *"From a technological perspective, robotics integrates ideas from information technology with physical embodiment. Robots share with many other physical devices, such as household appliances or cars, the fact that they "inhabit" the same physical spaces as people do in which they manipulate some of the very same objects. As a result, many forms of human–robot interaction involve pointers to spaces or objects that are meaningful to both robots and people" (Hortenkamp, Huber, & Bonasso, 1996).*

Both definitions define robots as a mechanism that complete an intended task. Hortenkamp et al's definition includes a physical embodiment while the Iso Standards' definition on the other hand includes a form of autonomy. To me, robots have a physical embodiment, although some may say that for instance chatbots are robot as well.

I would define a robot as such: *A physical object programmed to complete an intended task based on current state and sensing in the same physical spaces as people, without the interventions of humans.*

So to me, robots need to have the physical embodiment in order to not be classified just as a AI-system. Hence the interaction is also tangible in addition to visual and/or voice and text commands.

The relation between AI and Robots

My understanding is that there is a blur line between AI and robots, especially based on the Iso Standards definition. If we add the criterion "physical embodiment", the difference becomes more distinct. But it seams also that AI and Robots are dependent on each other, for instance, can a robot function properly without some sort of AI technology?

A contemporary physical robot

An example of robots much discussed in the articles in the curriculum for this course is the robot vacuum cleaner. It is maybe one of the most sold commercial robots and they get more advanced and sophisticated every year. It moves on the floors in many private homes to perform vacuuming (and in some cases mopping) tasks. To perform these tasks, they must map the environment, keep track of its previous paths and avoid obstacles, both mobile and immobile. They are however dependent on interaction with humans to perform many of their tasks. Firstly, the robot must be started and get direction from humans regarding which spaces are ready for cleaning (in theory the robot can be set to clean regularly any given spaces, but let's be honest, who has a clean floor, ready for vacuuming at any given time?). Secondly, the robots need help when it gets stuck or has another type of malfunction.

1.3 Universal Design and AI systems

Definition

According to Council of Europe's Tomar Resolution "Universal Design is a strategy which aims to make the design and composition of different environments, products, communication, information technology and services accessible and understandable to, as

well as usable by, everyone, to the greatest extent in the most independent and natural manner possible, preferably without the need for adaptation or specialized solutions" (Ginnerup, 2009).

In other words, the aim of the Universal Design concept is to simplify life for everyone by making the built environment, communication, products and services equally accessible, usable and understandable. It is to include everyone as much as possible.

The potential of AI with respect to human perception, human movement and human cognition/emotions

AI technology solutions are continuously being developed with the aim to improve the quality of life for people with different types of impairment, by assisting them in specific situations identified as relevant to maintain independence (Pigini et al, 2012). One significant contribution to the research field addresses how AI technology can support elderly people in their daily life.

The group "elderly people" is quite multi-faceted. Within the group there are people who are often affected by one or several of conditions such as impaired vision, hearing or motor skills as well as cognitive impairment. When I present two examples of AI systems for including "more" users, I want to focus on smart technology intended for aiding elderly people being independent and thus being included in the society.

Many research projects are motivated by the challenges of ageing population with the aim of covering both care and social needs by designing assistive technology such as smart robots. However, the acceptance of robots by the elderly has been ambiguous. Negative attitudes towards robots are considered as an important factor preventing humans from interacting with robots in daily life. The robots might need to be more intelligent to be accepted by people as their personal assistants (Pigini et al, 2012).

One research project which addresses this challenge is a project called "Multi-Role Shadow Robotic System for Independent Living" working on robots which can assist elderly people with domestic tasks. The aim is to supplement robotic intelligence with human intelligence in order to, over time, learn the robot to be more intelligent. Through automated learning and active teaching, the robot's abilities are increased, and its behavior is adapted to the local context. This will hopefully make the robots more intelligent and thus being more accepted by the users (Pigini et al, 2012).

Another example of AI technology which addresses the elderly community is the research with the aim to develop smart canes. A smart cane is a cane equipped with navigation and health monitoring functions. A set of sonar sensors are installed on the base for obstacle detection and localization. It has also sensors in a including accelerometer, gyroscopes, and force sensors to record the user's characteristics for decreasing the risk of fall while walking. The collected information is also transmitted through a wireless network to the physiotherapist helping for medical supervision and gait assessment (Goher and Fadlahah, 2020).

Potential of AI with respect to Universal Design

Artificial Intelligence has the potential to increase inclusion, participation and independence and can empower people with disabilities to participate more fully in all aspects of society. A great example is how Microsoft has started a research center, called "Microsoft Garage" where they, among other things, explore how AI technology can be used to increase accessibility. One of the results that has come from Microsoft Garage is the app "Binoculars" aimed at tackle color blindness. By using a camera, Colour Binoculars replaces difficult color combinations, like red and green, with more easily distinguishable combinations, like pink and green (Shanahan, 2016). The app is free of charge; however, it is only available for Iphone users, which to me seams bit problematic as it discriminates all users who doesn't have an Iphone. Pretty ironic if you ask me.

Another example of AI technology that addresses disability is how PowerPoint has made their presentation tool more accessible for people with hearing or sight impairments. You can add speech to the text in your slides and you can also adapt your slides for people with sight impairment (Microsoft, 2021).

On the other hand, bias in data sets used in machine learning have the risk of being biased which can lead to discrimination. One much used example is an AI-system used by judges in the United States to determine bail and sentencing. Judges get a score report as part of a report on a convicted criminal, where a higher number indicates the person is more likely to commit another crime in the future. The score is intended to influence a judge's decision about how much jail time someone should get. The score system can, however, generate incorrect conclusions, resulting in a tendency to discriminate certain groups, exemplified by the fact that people of color tend to get longer prison sentences or higher bails than the rest of the population in the U.S. (Chodosh, 2018).

Do machines understand?

The way I perceive the words “understand” and “understanding” as used in the WCAG 2.1 principles is that the service or software solution should be intuitive in use. “Intuition” can be defined as arriving at knowledge without relying on reason or inference (Epstein, 2010). A machines’ knowledge is based on reason, which will be the opposite of intuition as defined above. In addition, as Bratteteig and Verne discuss, context is important, and they argue that AI cannot understand as it cannot perceive the whole context (Bratteteig & Verne, 2018). Yet, machines are able to make decisions based on the current information, past similar situations and a set of rules in their programs. How is that different from humans who base their decisions on current information, past experiences and a normative set of rules learned throughout life?

1.4 Guideline for Human-AI interaction

Guideline nr 18 - Notify users about changes.

AI systems change over time. Changes need to be managed cautiously so the system doesn’t become unpredictable. This is to help users manage inherent consistencies in system behavior by notifying them about changes (Guideline 18). For instance, if a set of criteria for convicting a criminal will change over time in the AI-system used by judges in U.S (mentioned earlier in the assignment) due to pattern learning, it is important to notify the user, so it can be corrected. Or at least that the users still know what the criteria are and can rely on the system to be predictable and consistent.

Consistency is a classic design guideline, and one of Don Normans design principles. Consistency advocates for predictable behaviors and minimizing unexpected changes. This refers to designing interfaces to have similar operations and use similar elements for achieving similar tasks. Inconsistent interfaces, on the other hand, allow exceptions to a rule (Norman, 2013). AI software can be inconsistent because it may learn and adapt over time, but it is important that it is still predictable, or in other words have a consistent behavior.

Module 2

Characteristics of AI-infused systems

AI-infused systems are ' systems that have features harnessing AI capabilities that are directly exposed to the end user' (Amershi et al., 2019).

Identify and describe key characteristics of AI-infused systems. Draw on the first lecture of Module 2 and three of the mandatory articles (Amershi et al. (2019), Kocielnik et al. (2019), Yang et al., (2020)).

Amershi et al (2019) defines AI-infused systems as "systems that have features harnessing AI capabilities that are directly exposed to the end user". In the second lecture of module 2 Følstad describes the key characteristics of such systems as **learning**, **improving**, that many of the processes are disguised (**black box)** and depending on **large data sets** (Følstad 2021, a).

Learning: AI-based systems are learning because they evolve as they are being used and thus gain access to more data. In other words, AI systems are dynamic and are constantly evolving. As the systems evolve due to more information, they perform the tasks better.

Improving: Amershi et al (2019) points out that since the systems are continually improving it implies that systems have errors, at least in the beginning. Therefore, the systems should be designed in a way that enables correcting of errors. Kocielnik et al. (2019)'s study shows how users' expectations of errors that can occur in a system is important for the perception of how accurate the system is in use. In short, if the users understand how the system work, and can correct or adjust the systems performance, the users will have a stronger understanding for errors and have a greater user satisfaction. This leads us to the next characteristic; "black box".

Disguised processes (black box): In AI-based systems, most of the functionality is hidden from the user. This can make it more challenging to use a system one cannot understand. Yang et al (2020) describes the challenges when designing for good user experience in AI-systems. On the one hand it is difficult to design for good user experience when one doesn't know in detail how the system works, and on the other hand, it is challenging enough to decide what to include in the output to the user when a system is very complex.

Fueled by large data sets: The last characteristic for AI-infused systems is the systems need of being fueled by large data sets. For AI-based systems to learn and improve, they depend on input in the form of large datasets. This often takes place both through pre-selected data sets and through further interaction with users (Young et al,2020).

Identify one AI-infused system which you know well, that exemplifies some of the above key characteristics. Discuss the implications of these characteristics for the example system, in particular how users are affected by these characteristics.

One system, that I know well, that comes to mind, is Youtube. One of the features in the system is that the system suggests videos to watch based on previous searches and probably other user data as well.

The system is learning in the way that the data algorithm is based on previous watched videos. Once you have watched one “funny cat” video, the system will suggest many other videos in the same category.

The system is also evolving, and the content is adjusted more specifically to the user, depending on how many times the user has visited the service. As a little experiment, I opened Youtube, without logging in, via my UiO Google Chrome account (which I have never used to watch Youtube earlier) and experienced that the suggested videos are quite random and absolutely not relevant to me.

This also illustrates that this system is fuelled by large datasets in form of user data to perform as intended. Which data the system need and how it uses it, is a bit unclear to me.

In fact, I don’t really know how this system works, neither how, nor for what purpose, the collected data is used for. To me, the systems algorithm is like a black box, and I feel that the proseses are not transparent or easy to understand.

Human-AI interaction design

Amershi et al. (2019) and Kocielnik et al. (2019) discuss interaction design for AI-infused systems. Summarize main take-aways from the two papers.

Kocielnik et al. (2019) looks at whether users' expectations of a system affect users' experience of a system. For instance, is the experience better if the user has lower expectations? They set up a number of hypotheses and conduct a quantitative study in which they examine further by creating a simulator for Microsoft Outlook's AI service "Schedule assistant" that deals with meeting planning based on dates found in emails. In their research they find that expectations do affect our perceptions of how well a system works. However, if the user gets a heads up for what they can expect from the system they tend to have a better experience when using the system than users who did not have clear expectations before using the system. Based on these findings, the authors emphasize the importance to shape the user's

mental model. If the user is aware of what to expect from the AI-system, they are more likely to accept an imperfect AI.

Amareshi et al. (2019) argue that despite the great potential of AI-infused systems, the lack of understanding of what AI can do can lead to negative consequences for users. Human AI interaction has relied heavily on the principles of Human Computer Interaction, but Amareshi et al. think now it's time with own guidelines for Human-AI interaction and presents 18 guidelines to support the interaction. The authors hope the guidelines, along with the research they conducted in AI-based systems, can serve as a resource for designers working on AI and facilitating future research.

Select two of the design guidelines in Amershi et al. (2019). Discuss how the AI-infused system you used as example in the previous task adheres to, or deviates from, these two design guidelines. Briefly discuss whether/how these two design guidelines could inspire improvements in the example system.

Guideline nr 4 “Show contextually relevant information”
Guidelinr nr 12 “Remember recent interactions”

I would argue that both these guidelines are present in Youtube as the system suggests videos relevant to me as a user, based on the data the system has of me. Additionally, the system remembers recent interactions in form of previous searches and suggests videos in the same category. However, the system is not perfect, and sometimes the suggestions can be a bit off topic. If the user would know what is the reason some of the videos suggested are not relevant, maybe the user could as well be able to correct the system to match the users preferences better.

Bender et al. (2021) conduct a critical discussion of a specific type of AI-infused systems – those based on large language models. Summarize their argument concerning problematic aspects of textual content and solutions based on large langue models.

Bender et al (2021) addresses problematic aspects of deep learning and large language models (LM). The authors describe several negative aspects to the continuously growing computing power put into natural language models. They depict several costs and risks concerning social and environmental issues as well as financial costs, opportunity costs and harms like language on internet (that is part of the big datasets) that can lead to stereotyping and increases in extremist ideologies. This is because language models of a large size do not equal diversity,

because internet, access, gender and age representation are not equally distributed on the Web. Another risk comes from the training data itself. When LM has distorted training data, it will make patterns representing biases, profanity language, racist, sexist, extremist and other potentially harmful ideologies. Bender et al also discuss how people can confuse the language models for real human interaction, believing that they're talking with a person or reading something that a person has written, when in reality the communication comes from a machine.

Chatbots / conversational user interfaces

Chatbots are one type of AI-infused systems. Based on the lectures, and the mandatory articles, discuss key challenges in the design of chatbots / conversational user interfaces.

According to Følstads lecture and the articles for this module, the main challenges in the design of chatbots/conversational user interfaces is (natural) language and understanding, the users expectations of what a AI-system can do, and the datasets used for machine learning.

According to Kocielnik et al. (2019), natural language understanding is crucial for all AI-infused systems, including chatbots. As chatbots do not understand the whole concepts, they risk misunderstanding the actual meaning of the conversation.

As mentioned earlier, Amershi et al (2019) describes the users expectation when interacting with ai related to the user satisfaction and lastly, the conversational user interfaces are based on data sets fed in to the system and as Bender et al points out, the datasets have the risk of being biased as different users are not equally represented.

Revisit Guidelines G1 and G2 in Amershi et al. (2019). Discuss how adherence to these could possibly resolve some of the challenges in current chatbots / conversational user interfaces. Optionally, you may read Følstad & Brandtzaeg (2017), Luger & Sellen (2016), and Hall (2018) from the optional literature to complement your basis for answering.

Guideline G1 “make clear what the system can do” and Guideline G2 “Make clear how well the system can do what it can do” are both guidelines meant for the initial phase of the interaction. By making it clear what the system can, and cannot do (and how well it can do it) at the start of the interaction may lead to a more positive user experience. If, for instance, the first message in a chatbot states clearly what services, and to what extend the service can be provided, the user will potentially not lose time on interaction with the chatbot, if the user

know that the chatbot cannot provide certain answers. In this way, it may be possible to reduce a user frustration, and the user may concentrate on asking for feedback the user know the chatbot can provide.

Appendix

Feedback:

Overall, the feedback was very positive and there was not much I was to change, except maybe describe more about Boston Dynamics and their technology and a bit more about what I mean when I come with my own definition of what a robot is. I have now added more information in these two sections.

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