Causality in Applications for Human Decision Processes and Human Psychology

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Abstract

To depict how Causality, Technology, and Human Psychology can interconnect and benefit each other, this paper explains the following trends: 1) The role of nudging in damping the effect of inefficient decision making 2) The usage of Causal Inference to improve how AI agents learn from humans. 3) Intelligent machines and the way they can benefit from Artificial Intuition. 4) Mental Health Apps and their ability to support psychological treatment, especially where therapists are not available. 5) How will the service sector become more automated? 6) AI for the prediction of human behavior. The aim behind these trends is to imagine new possible research directions and areas, starting from all the observations one can make based on the current focus in academia and different persistent industries and going beyond that. Due to the importance of decision making and the complexity of Human psychology, the focus in this paper was to come up with trends, varying both in impact and uncertainty but presenting what we, the authors, believe to be relevant as new ideas having the potential to shape the world Humans are living in for years to come if the challenges that lie ahead are addressed properly.

1 Introduction

Causality plays an important role in human decision processes and human psychology, as is discussed in many literary works such as Daniel Kahneman's "Thinking, Fast and Slow"[1]. There are multiple factors that can influence human decision processes, such as evolutionary and social biases, past experiences, or emotions. Currently, there are many approaches where Artificial Intelligence benefits from psychological knowledge but also approaches to support human decision processes and human psychology with technology. While this topic may seem frightening to someone who hears about AI in human psychology for the

first time, it is certainly an interesting and diverse research area. With some insight, one can recognize the advantages and possibilities of combining these two research areas. For example, understanding the effect of emotions on decision processes combined with Emotion Recognition in AI enabled the development of Mental Health Apps for smartphones to improve the user's well-being and decision making, as depicted in one of the trends. In addition to psychological treatment, there are also applications in automation of other work primarily done by people. Particularly the service sector and the way it can benefit from the knowledge about psychology is presented. Another aspect that influences decisions is nudging, which is an encouragement for action. In terms of causality, it is an intervention on the Decision Process. Lastly, we take a look at how technology, especially AI agents, can benefit from human psychology. Analyzing human intuition and developing Artificial Intuition from it can improve a machine's behavior, too, as stated in the third trend. However, Artificial Intelligence applications can not just learn from human behavior, they can also predict it, as depicted in the sixth trend.

2 Trends

2.1 Role of nudging in damping the effect of inefficient decision making

One relatively new concept that sparked the interest of many researchers in the last decades is nudging [2]. People tend sometimes to take decisions without being fully aware of all the variables that may underline their choices. Due to some evolutionary biases which can be more or less influential in guiding human thoughts, people may end up taking inefficient decisions that could potentially make them worse off in comparison to other choices they could have potentially taken, which end up lessening their personal and/or on an aggregated national level, welfare. To this end, Richard Thaler [3] proposed this new concept that could influence behavior in a sustainable way without really setting limits to people's choices. In general, nudging is meant to help a person make better choices for the sake of environment and personal health. The concept has also gained a lot of attention in politics and among policymakers in different areas like safety, diet, physical activities, pension plans, private economy, recycling, and much more. This new perspective of tuning existing policies and providing additional tools and strategies to cope with the complex behavior of individuals is gaining attention and raising questions about the role of the government in setting up such policies. Are the governments exploiting this somehow predetermined behavior to influence people? Or are they trying to push people into better dealing with their own lives for the sake of the nation as a whole? That's the dilemma. In this chapter, we mainly focus on nudges and their efficiency to shape better decisions on the long run for different groups of people and we don't focus necessarily on all the psychological factors like intuition, emotion, environmental and historical biases that could also affect the human behavior

to a lesser or greater extent. The main purpose is to showcase the feasibility in using nudges to influence the causal decisions of the majority of the population even though some outliers may always arise and cannot be captured by a specific policy.

Figure 1: Illustrating an example of a Nudge making people aim for smaller portions by reducing the size of their plates [4]

2.1.1 Facts

- Nudges are by definition human-centered [3]. This means that their main goal is to make people move in predefined directions that will make their lives better. Policy makers first try to understand people's needs and then design the decision environment in a convenient way.
- Nudging gained enormously in interest from countries like the USA, the UK, EU, Norway, and Denmark. In the USA, nudging was institutionalised at the Office of Regulatory Affairs taking action in developing and overseeing the implementation of government policies. In the UK, nudge was firmly institutionalized when the Behavioural Insights Team (Nudge Unit) was established at the UK Cabinet Office in 2010 [5]. Denmark, for example, set an active non-profit organisation "iNudgeYou" [6] outside the government that supports the use of nudges in policy making and Norway has an independent organization promoting and supporting the use of nudges, "GreeNudge" which among other activities already established some reports on the potential for nudging in the country's climate policy.
- Nudging has been effective in different areas from which we can cite few examples:
  - Humanitarian goals: One study showed that decreasing plate sizes reduced the amount of food waste in Hotels and restaurants by around 20% [7]. The results from the study were statistically significant and

provided an environmental policy that could reduce harmful impacts on climate change as waste in general is a major contributor to greenhouse emissions.

- Default settings: In countries where people must actively take the decision to be organ donors generally can't surpass the 30% of the population registration barrier. In countries where people automatically get registered as organ donors and have to decide on opting out, only 10 to 15% of the people bother to leave the pool of donors [8].
- Social proof: In the UK, people to whom Social Normative Messages like "9 out of 10 people in your area have already complied with tax payments" had more incentive to pay their taxes not to seem like outliers to the group of taxpayers [9].

2.1.2 Key drivers

- Different studies [3] argue for the great impact of nudges taking into consideration the ease and low cost required for implementing them.
- Some research on human motivation demonstrated that imposed methods or regulations may reduce a person's intrinsic willingness to behave in a desired way and may even lead him to defy the rules and oppose them strongly [10]. Nudges on the contrary are likely to avoid such effects leading people to voluntarily take the best decisions.
- Nudging is showing some great potential in Business. One simple example is in modifying the work environment. Knowledge sharing and communication can be for example facilitated through enabling regular encounters between employees in "creative spaces" equipped with healthy food and a comfortable convenient for interactions environment? (working environment Google is offering for employees).

2.1.3 Challenges

- There should be good reasons justified by some empirical studies to believe that the behavior being encouraged will improve the welfare of those being nudged.
- All nudging should be transparent and never misleading so that people can easily interpret whether they are being manipulated for the sake of some third-party intentions.
- The ethical question of whether the Nudging approach is infringing civil liberties is still open to debate. In fact it is not always clear whether the authorities are legitimate in their endeavour to guide choices for achieving a desired outcome, people might feel uneasiness with the concept as a whole.

- Nudges can be limited. It is in fact not always easy to validate the effectiveness of a nudge on a larger scale since most of experiments are conducted on samples of the population that can be naturally biased by some cultural specificities.

2.1.4 Impact

In the recent years, nudges have been helping policy makers in different countries and sectors to integrate behavioral insights into the design of certain consumer and competition policies. This was helpful in providing standard options in situations with high level of complex information. (e.g. pension funds and financial services (Investment strategies, Securities ...)). Making that key information salient to everyone or setting them as the most convenient options have positive impacts on the undertaken decisions. From another similar angle, and even when taking into consideration the uncertain outcomes of nudges, they are seen as great complements to traditional policy instruments [11]. Rather than substituting imposed measures like governmental regulations or economic tools like taxes and fees, nudging is showing potential in impacting behavior change when implemented alongside some traditional instruments.To this end, more people in academia are trying to come up with a "trial and error" framework to validate feasible effective nudging policies on national levels.

2.2 Using Causal Inference to improve Imitation Learning

Humans have proven to be very passionate about pushing the limits of technology since the 4^{th} industrial revolution and to come up with some of the most innovative ideas, nature played an important role. Taking into consideration the favourable side of imitation, some human experts are proven to be very efficient in getting some specific tasks done or making the best decisions under some predefined constraints. In this regard and by analogy to nature imitation, making robots or AI agents learn how to make the most correct decision can be taught through demonstrations made by experts in given circumstances. This sort of learning is called imitation learning [12]. Having some previous knowledge about the most efficient way of conduct can ultimately cause the agent to converge faster to the ultimate decision in which it requires less time and computational resources to achieve the set goals. Nowadays, imitation learning is an essential tool for robotics. It is considered a key technology and an efficient and intuitive way for robots, that are expected to work closely with humans (service industry, eldercare, etc.), to be taught by experts of their respective domain with no special skills or knowledge about robotics. Having the necessary hardware capabilities to do a multitude of tasks, imitation learning can be the solution to make the AI agent an expert in all those different tasks with much less computational power and with less required resources than with other potential ML-algorithms. Interestingly enough, most Imitation Learning (IL) research has focused on sensorimotor control, with minimal cognitive processing. Although cognitive science states that imitation learning for humans

should and does involve understanding the intentions of the demonstrator, the connection between cause-effect reasoning and robotic imitation learning is still fairly unexplored.

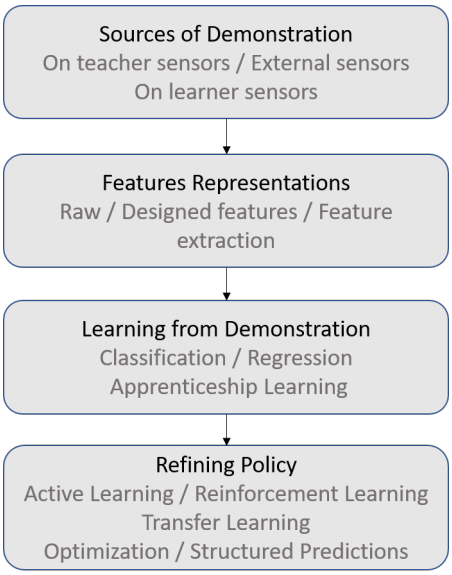

Figure 2: Imitation learning flowchart [13]

2.2.1 Facts

- In certain applications, AI agents are faced with the problem of executing one right action given a particular state taking into consideration the environment they operate in. The number of possible scenarios depending on the intended application can be huge and unfeasible to pre-program the agent explicitly. Many of the ML algorithms are based on some optimization techniques that could resolve the huge state space but it has been proven and hence accepted, that presenting the agents with some previous knowledge provided by some experts is more effective than searching for a solution with no prior input [13].
- One major roadblock for imitation learning is the distributional shift, a problem that arises, when training and testing state distributions are different. This may result in a so-called "causal confusion" where resulting policies fail to identify the causes of expert actions. Example: A neural network learning to drive using images of a windshield and dashboard as inputs. A yellow light on the dashboard, that comes on whenever the expert uses the brake, maybe wrongly interpreted as the cause instead of the effect, leading the AI to only use the brake whenever the light comes on.

- A second problem in imitation is generalization to unseen scenarios. Due to the dynamic nature of imitation learning applications, a demonstration can only cover a subset of possible states. When faced with an unfamiliar situation, the application does not know how to react.

2.2.2 Key Drivers

- The demand for intelligent AI-agents capable of mimicking human behavior in some settings is continuously growing. Advancement in fields like robotics has given rise to many applications that not only require AI that can make the best decisions but also AI that is able to perform more human-like realistic motor action in a variety of situations.

- Many future research fields are relying on the ability of AI-agents to behave as a human would have done when presented with similar situations. Examples would be assistive robots in healthcare, the hotel industry, and more general the service industry.

- To be maximally robust to covariate shift, a policy must rely solely on the true causes of expert actions. With this principle in mind, P. d. Haan et al.[14] recently proposed a framework using a functional causal model. By first jointly learning policies corresponding to various causal graphs and then performing targeted interventions the correct causal model can be found.

- Garrett Katz et al.[15] proposed an IL method with the goal replicating the *intentions* instead of the actions of the expert by instantiating a causal intention hierarchy for said actions. Besides lowering the required training data, the hope is for the robot to gain some proficiency in causal reasoning to the point where it can come up with its own solutions/actions even when confronted with situations that differ from the demonstrations.

2.2.3 Challenges

- In many cases, human reasoning is undesirable or suboptimal. AlphaGo, a computer program developed to play chess, which in its earlier stages was in part trained through many demonstrations of human players, improved greatly, when it discarded these and relied solely on reinforcement learning.

- Lastly, there is the problem of complexity, which increases greatly with the number of states. As of now, causal models have not been used to success in bigger projects, which leaves us with some uncertainty about the viability of causal inference in IL.

- A more general challenge is the one of observability [16] in which the agent is not able to infer information about the capabilities of the teacher but only distinguishes the effects of taking some actions. Therefore, by trying to replicate certain actions using its own kinematics to obtain the desired

effect, the agent can produce less efficient results than what it can actually do.

2.2.4 Impact

Due to its intuitive nature and ease of implementation, Imitation learning is often used to impart expert knowledge into AI applications. Consequently, with the growing interest in intelligent applications in research fields like autonomous driving or general services (section 2.5) and human computer interaction, it is no surprise that it has gained quite a bit of relevance in recent years. If causal inference can be used to solve two of its key challenges - generalization to unseen scenarios and causal confusion - and also help AI behave more human-like, the future for imitation learning might be bright.

2.3 Artificial Intuition

The human brain is capable of making fast and efficient decisions by using intuition. So not just through straightforward logic, but also through more unconscious processes. We are also good at reducing available data to important information for the specific task. As Daniel Kahneman introduced, the human brain can be separated into two parts, called system 1 and 2 [1]. System 1 is working subconscious and automatic. It is less precise than system 2, but also faster. It is basically responsible for our intuitive decision making and relies heavily on experience. The way AI mostly makes decisions is comparable to our system 2. In the boundaries of the underlying model and available data, the calculations are exact and reliable. It just does not make use of possible shortcuts through intuition. In complicated tasks, where good, fast, and bounded decisions have to be made rather than well examined ones, intuition can help. As Perez is interpreting this, "rational thought is a consequence of intuitive thought". So, causal reasoning would base on intuition and therefore experience. The experience is built upon reasoning in the past. This makes inefficient recurring similar reasoning obsolete [17]. So, is it actually possible to get AI to make intuitive decisions? This concept is called Artificial Intuition (AIn). With this, the goal is not to try to somewhat make AI "more human" in the sense of being inaccurate and driven by emotions or empathy, but to let decisions be influenced by experience (training) and also be able to generalize concepts and adapt to new and different situations. "Artificial intuition is more like human instinct because it can rapidly assess the totality of a situation, including very subtle indicators of specific activity" [18]. It is a method of arriving at conclusions with incomplete knowledge. Pattern recognition is a main part of AIn, since it enables the AI to detect similarities and transfer earlier concepts to the new environment. As Perez states, Artificial Intuition can be implemented with Deep Learning [19].

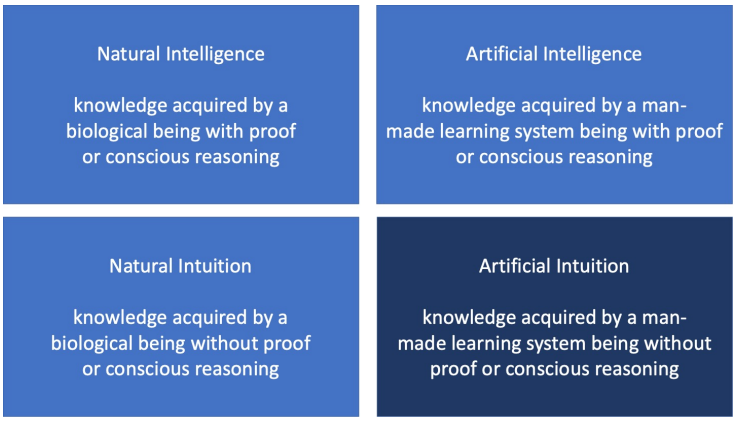

Figure 3: Intelligence versus Intuition [20]

2.3.1 Facts

- When facing complex and chaotic systems, some key features are needed for an AI to be able to solve problems. As Perez states in his book, it has to be robust to become more tolerant of failure and be able to adapt to unexpected environments. A diversity in methods is needed, which may be less efficient in specific cases, but in general superior. Also, abstraction has to be performed to tackle tasks in complex environments. An important feature is to be able to perform predictions in a timely manner, if the task demands it. Therefore, the system needs to optimize its predictions and make compromises to the exactness in order to be faster [19].

- Some algorithms have already been designed to implement Artificial Intuition aspects. The target was to make a more powerful version of pattern recognition. Some patterns were too subtle to be detected before. They try to find interrelationships in data. For example, eigenvectors were used to extract and categorize characteristics. By using AIn, it is possible to perform analysis with little human intervention, rules, models and less information about the searching target. "Practically speaking, the algorithms have been able to identify suspicious and dangerous activity" [18].

- AlphaZero, which evolved from DeepMinds's Go play program AlphaGo Zero, was used to learn and play chess. It used a more intuition-like approach through Deep Learning and was capable of learning chess in a few hours and needs to do 1000 times fewer evaluations than Stockfish, which was the best chess-playing program before [19]. The similarity to human intuition is, that it used training data as experience to support the decisions. Alpha Zero was capable of winning 28 of 100 games against Stockfish, the rest were draws [21].

2.3.2 Key Drivers

- With Artificial Intuition, we are capable of implementing systems, which can make faster decisions. With tasks, where being fast or on time plays an important role, this possibility can be vital. However, this can come with a sacrifice of a certain amount of accuracy.
- By introducing the concept of experience and being able to analyze systems on an abstract level, the AI can adapt to different, but somehow similar situations. This way, less human intervention is needed and the AI is capable of performing a broader range of tasks.
- For very complex tasks like efficient plane route design, algorithms are still not as effective as humans. So, it is examined, whether intuition can improve their performance. The complexity with the plane routes is, that multiple constraints have to be satisfied, which might be conflicting. A perfect or correct solution does not exist in general. Since in an experiment, a group of students performed better than the algorithms in this task, they tried to capture their strategies through linear temporal logic to include those in the task definition [22].

2.3.3 Challenges

- A general formalization of intuitive reasoning is still to be developed, although first efforts have been made. A proposition was to concentrate on the connection between memory and perception to generate credible intuitive results [23].
- Artificial Intuition tends to result in a black-box-appearance for humans, where it is unclear how the conclusion is derived. So, trusting the AI can be an issue, as well as programming defined behavior [24].
- Even human Intuition can fail sometimes, and Artificial Intuition is also not meant to be exact. It can be prone to biases, based on the data that is provided. Trained intuition can fail at tasks out of their scope [24].

2.3.4 Impact

Artificial Intuition is already present in some applications and will certainly be developed further. It seems, like it will have some well recognizable impact on suiting tasks. Some engines like AlphaZero have already proven to be superior to prior methods. In times, where the amounts of data to be processed are still rising, AIn might be an interesting alternative to more traditional methods of learning.

2.4 Artificial Intelligence Applications and Emotional AI for Mental Health Treatment

A major topic of human psychology is mental health and mental diseases. The latter can also cause poor decision-making and therefore create more negative experiences in a person's life. Unfortunately, the availability of mental healthcare differs a lot around the world [25]. But technologies can offer solutions in this field, too. Mental Healthcare Apps use especially the methods of Cognitive Behavioral Therapy (CBT) and Behavioral Activation (BA). These are standard methods of psychological treatment in general and commonly used for self-helping without the supervision of a trained therapist [26]. As studies show, individually-administered Cognitive Behavioral Therapy can, for example, support the treatment of Social Anxiety Disorder [27]. To understand how these mental health applications can work, one should know the goals of CBT and BA first. Within Cognitive Behavioral Therapy, a patient's behavior, cognition, and emotions are observed to develop more beneficial behavioral and cognitive techniques. Within Behavioral Activation, the patients' behavior and activities are monitored, too. But here, they are rated according to the criteria pleasure and mastery. Based on that, pleasant and avoided activities can be scheduled [26]. Also, the latest developments in Emotional AI and Emotion Recognition by algorithms can support and improve applications for mental healthcare, because emotions can have a major impact on human decision-making.

2.4.1 Facts

- In 2017, with a total number of 264 million affected people, 3.4% of the world population suffered from depression. And more than every tenth person (792 million) on the earth suffered from some psychological disease [28].
- According to the World Health Organization's (WHO) last "Mental Health Atlas" [25] European and American governments spend a much higher amount of money on mental healthcare than other regions of the world. Especially in the African (43% of countries) and in the South-East-Asian (40% of countries) regions patients have to pay the majority of the fee for mental health service by themselves. There are similar numbers for the payment of psychotropic medications (AFR: 45%, SEAR: 30%).
- With 50 mental health workers per 100 000 population, European countries have by far the highest number, followed by the American region with 10.9 workers per 100 000 population, as shown in figure 4. Another statistic of the WHO Mental Health Atlas shows that this depends primarily on the average income, too [25].
- Less than 25% of the world population have access to treatment for depression. And while the median rate of untreated depressions seems already very high with around 50%, the rate in some countries is even above 90% [29].

- About two-thirds of people affected by mental diseases do not seek professional help, often because of social stigma [30].
- To sum up these points, there are no significant differences in the number of people affected by mental diseases around the world, whereas the availability of mental healthcare depends a lot on the region a patient lives in.

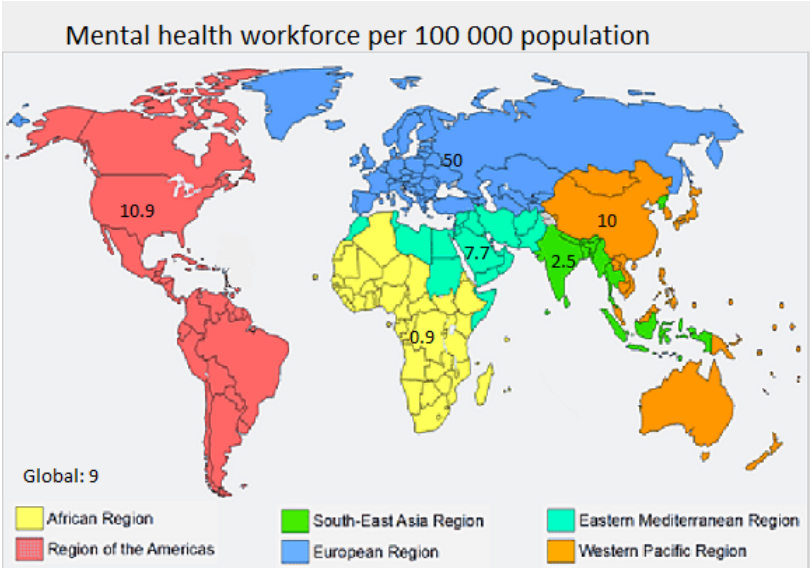

Figure 4: World map: Number of available mental health workforce per 100 000 population [25]

2.4.2 Key Drivers

- Mental healthcare apps are supposed to improve the user's mood, lower stress, prevent mental diseases or help to handling them.
- Some apps are developed with the help of psychological specialists [31].
- There are algorithms which are better at recognizing human emotions than robots [32]. Emotions can be read from facial expressions, speech or written word, but also based on signals from sensor wristbands.
- Using that information, the applications respond empathic in the chat functions, suggest beneficial behavior or reinforce and reward actions. Those applications also provide an overview of the emotional progress. Common functionalities are educational features or diagnostic support, but some also offer social support and other services [26].

- In a study from 2017 about the efficacy of the mental healthcare app WoeBot [33], participants using it showed a significant reduction in symptoms of depression compared to a second group, who got an eBook with information about depression instead.

- The use of smartphones has increased the past few years (45% of the world population) and predictions say, this trend will not stop the next years. Some statistics even state that by 2025, 72% of internet users will access the internet exclusively through smartphones. While the smartphone penetration (percentage of smartphone users of a population) also depends on the prosperity of a region or country, the difference in smartphone usage between developed and developing countries is not as big as the difference in mental healthcare. For example, about 80% of Germans and around a quarter of India's population possess smartphones [34].

2.4.3 Challenges

- There are multiple studies evaluating the efficacy of mental healthcare apps. According to a study from 2016 that evaluated 117 apps, there are many apps on the market, which claim to support mental health treatment, but lack core elements of CBT and BA, such as monitoring physical sensations or behaviors [26].

- Another study from 2018 [35] agrees with the use of different features in mental healthcare apps, including many functionalities not based on CBT. Though, they were accepted by many users including health professionals. User evaluations lead to the conclusion that the acceptance, and therefore the efficacy also relies on the app design. Major concerns are about privacy, security and trust, which should be improved in the next years.

- Unfortunately, there are also potentially harmful apps among suicide prevention apps [36] and apps for bipolar disorder [37] or for depression [38].

2.4.4 Impact

With a few hundred already existing mental health care apps, one can definitely see this as a trend and Market Analysis expects a growth rate of 23.7% in the revenue of mental health apps from 2019 to 2027 [30]. In the US alone the download numbers of the top 20 mental wellness apps increased by 29% from January to April this year [39], which may have Covid-19 as accelerator. This shows that such unusual situations can cause a sudden increase in the need of psychological treatment, too. But even without such situations the number of people affected by mental diseases is rising further. With the growing trend of smartphone usage and the still existing stigma of mental diseases, the number of potential users of mental health apps is increasing. Further beneficial aspects are the permanent availability and the low costs compared to a trained therapist.

2.5 Psychology based general services

A quick look at the current political debates and social discourses is enough in most cases to understand that yesterday's issues are no longer the same as today's. One cause of growing unemployment in the 21st century is going to be automation. For the time being, some sectors including transportation seem to be at risk of being replaced. Recent technological advancements and technical exposition brought to light another sector that could fall victim to automation, the service sector. Indeed, certain low-end occupations seemingly do not require a high level of autonomy and could in theory be done by programs and algorithms. Even so, human secretaries and guides are still preferred to do the job. However, the situation might not stay the same for long as hologram technology and a more efficient AI born from machine-learning are being iterated upon and are perfected to offer the same level of adaptability a human could. Moreover, breakthroughs in both psychology, anthropology and computer vision could offer us a reliable way to gaze, if only a little, into the human mind. Those innovations paired with the innate ability of an AI to act consistently based on a robust data set could open the door to a future where every shop, every information desk or office is "manned" by a hologram showing us a smiling handsome figure that will best adapt its behaviour and personality to suit us.

Figure 5: AVA, the airport virtual assistant [40]

2.5.1 Facts

- Holographic assistants such as AVA have been used in several occasions. For example, in 2012 the company "AirportOne" deployed several anthropomorphic holograms in the New York Airport in order to welcome, guide and inform passengers [41].

- Most, if not all, new smartphones and computers run some version of a virtual assistant. Programs like Siri, Alexa or Google Assistant use their users' tonalities, preferences and schedules to learn and adapt. In the newest versions, these AI agents are even capable of predictive behaviour [42].

- A study made in 2014 showed that on a web site, online customers were in general more inclined to trust the automatically generated sales speech if it was spoken by an anthropomorphic figure on the screen. Because of that virtual presence, both their level of trust towards the site and their overall quality of experience increased [43].

2.5.2 Key Drivers

- By using consistent nature of the mode of expression of the six basic human emotions, Dr. Joo from Kunsan National University developed an algorithm using the distance between the eyes and mouth to correctly identify them and predict with a relatively high accuracy the emotional state of a person based only on a frontal image of them [44].

- Researchers from BISE are currently investigating several methods aimed at developing AI agents capable of indirection and cooperation in the workplace with human beings. A research model has been conceived to present the correlation between the frequency and complexity of an interaction with a human and the level of intelligence of the AI [45].

- The cost of installation and operation of a holographic virtual assistant compared to the annual pay of a secretary or receptionist is already a drive strong enough to attract investors into this field. The predictive nature of an interaction with an AI agent could also be enough to produce a superior customer experience [46].

2.5.3 Challenges

- How and through which medium the AI expresses emotions and interacts with human beings can prove to be critical in the process of acceptance of this new technology. An unsatisfactory imitation can trigger an aversion described in the theory of "the uncanny valley" [47].

- From a study done by The American Psychological Association, in Washington, D.C. targeted to verify the veracity of the claim about the six universal emotions hypothesis, it has been concluded that subjects from different cultures perceive them differently. In that study researchers found out that western civilisations tend to express their feelings more with their eyebrows and mouth whereas eastern ones tend to do it using their eyes primarily [48].

- Even though wide spread facial recognition is currently present in certain countries, the utilisation of this global database in order to train AIs to properly recognize emotions throughout the world can provoke ethical and diplomatic dilemmas.

2.5.4 Impact

Replacing low-end services with AI powered holograms is not a phenomenon that will happen abruptly. There will be transitory periods where unemployment will soar and a major part of the population will actively seek to reconvert to another profession. This idea alone will also rise ethical debates questioning the ability of robots in actively reading and manipulating human emotions instigating resistance from the population. Nonetheless, as with the automation of the industrial and transport field, the rise of holographic AIs could come before we know it. It is up to us to prepare for the transition.

2.6 Behavior Prediction

Humans were always seen as a black box. We thought of ourselves as something unpredictable, that we do things for no other reason than because we want to. The truth is, we are complicated. With the major development that has been happening in the last decades in the sector of psychology, we started to understand the intricacies behind the functioning of the human mind. The reasoning of human decision making became more logical, simpler and easier to understand. AI and data analysis have also shown some tremendous growth these past decades. Some researchers started to ask themselves, whether both sciences could be combined to predict human behavior. This technology could greatly improve people's everyday life, help businesses bloom or even attenuate casualties in case of catastrophes. Recently this has started to become a reality. Roni Rosenfeld, the leader in the Centers for Disease Control and Prevention, used the algorithm wisdom of the crowd to combat the spread of Covid-19, it was used to predict where exactly crowds of people were most likely to move, thus knowing where exactly the virus was more likely to spread by, quoting him "Wisdom of crowds taps into the collective reasoning and common sense of many people" [49].

2.6.1 Facts

- Forecasting consumer behavior is realized through merging Big Data with AI. According to predictions from Forrester [51], there will be increased adoption of Big Data and AI among 70% of businesses globally; this is a 51% increase than in 2017.

- MIT trained a Predictive Vision system on YouTube videos from shows like "The Office" and "Desperate Housewives" to predict whether two persons will hug, kiss or shake hands. The researchers trained the Deep Learning system on 600 hours of video [52]. The system was able to

Figure 6: AI trying to predict the characters' next action [50]

correctly predict an action 43% of the time. This compares to previous algorithms that could only make a correct prediction 36% of the time.

- Brains4Cars uses a sensor fusion deep learning system based on Long Short Term Memories (LSTMs) by using a collection of sensors such as cameras, tactile sensors, and wearable devices to anticipate driver behavior 3.5 seconds before it happens [53].

2.6.2 Key Drivers

- By using predictive analytics combined with AI, companies can predict what the consumer would want to buy as well as creating specific marketing plans to target each customer specifically [54].
- By using AI, one is able to predict the behavior of a crowd of people, which makes it possible to simulate the optimal solutions in case of catastrophes, pandemics or riots to alleviate any potential losses [49].
- By improving the ability of AI to understand human psychology and decision making, the sector of AI assistants will jump a huge leap as it would be able to address our needs before we become aware of them.

2.6.3 Challenges

- Having AI predict human decision making might bring some heavy ethical issues. There would be two main points, the first one being that the sole occurrence of it working would oppose the concept of free will which could offend some individuals. The second point is that such technology would require a large amount of personal data that would have some people opposed to their private data being collected.
- When predicting people's decision, we do not only want to know what the decision will be but also the reason behind it. Unfortunately, even though data-driven methods usually have a very good predictive performance, their outputs are rarely easily explainable [55]. Which makes the evolution of this technology trickier.

2.6.4 Impact

Even though this predictive technology is still in its beginning stages, one can clearly see how many uses it already has or can have and perfecting it will be a big leap for the future of humanity. By accurately predicting human decisions, AI would, in a way, be able to forecast a person's future. In this sense, potential problems people might face would probably be avoided/resolved without them even realizing it.

3 Driver Matrix

To summarize both levels of Impact and Uncertainty related to each of the trends discussed above, we present the following driver matrix. Because of the key drivers and the undergoing research in the different fields discussed, we came up with the following representation:

4 Conclusion

We presented our different trends using both the results of our debates and our extended researches about our varied subjects. We went through both aspects of the themes: first is the active aspect where the goal was to imitate human psychology. Second was the passive aspect where the AI would analyze the human psychology. Furthermore, we discussed a combination of both aspects. All in all, building an AI using human psychology is certainly popular nowadays. Despite this significant interest, the future results of these researches are still questioned, and the general reason is that the human mind is complex. Focusing on one specific aspect of human psychology at a time seems to be the most efficient first step for our long journey to psychology based AI. But do we really need to completely understand the functionality of the human mind in order to achieve this goal? Or is it sufficient to treat it as a black box? It appears to be

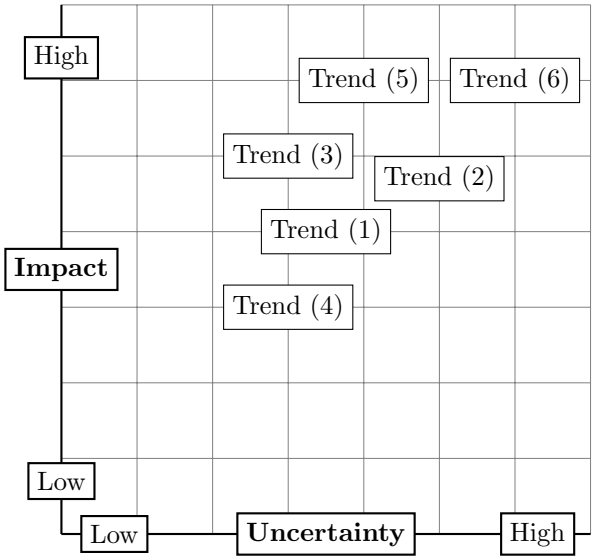

Figure 7: Driver matrix

the best deal to combine both methods. In all the cases, we can agree on one certain thing, that progress will be seen in the next decades.

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