SHORT REPORT

Artificial Intelligence: Broken Promises and Achievements

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Introduction: Broken Promises and Achievements of AI

Since Artificial Intelligence (AI) is on everyone's lips in a surprising variety of contexts, it has created huge expectations across industries and professions – both good ones like more efficiency or less biases in decisions, and bad ones like AI taking over world leadership (or at least humans' jobs). However, the current status of the abilities of AI systems and their actual usefulness for management decision-making often remains unclear.

Therefore, we used a series of talks with academics and practitioners to gather their opinions on broken promises and real achievements of today's AI applications in a managerial context. This short report summarizes the authors' key learnings from these talks with experts from a broad range of fields including Cybersecurity, Data Science, Entrepreneurship and Marketing about the status quo of Artificial Intelligence (AI) in managerial decision-making.

According to the interviewed experts, some of the big expectations of AI have not yet been met. For example, AI systems so far are restricted to specific, limited tasks and are no universal, human-like intelligence. In addition, their results have proven often enough being not as rational and neutral as expected. On the other hand, the growing ability of AI systems to perform increasingly complex tasks in combination with reliable classi-fications and high predictive accuracy makes AI already today a valuable decision support tool in many situations, that can guide humans to make better and even more creative decisions than before.

Broken Promise 1:
An AI can be a universal, human-like intelligence

Broken Promise 2:
AI leads to reliable and ethically correct results

Broken Promise 3:
"White Box" AI produces comprehensible and interpretable results

Achievement 1:
AI performs increasingly complex tasks

Achievement 2:
Reliable classifications and high predictive accuracy

Achievement 3:
Real-time data analysis and decision-making

Achievement 4:
AI sparks human imagination

Achievement 5:
Valuable decision support

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BROKEN PROMISES OF AI

Three major promises that AI failed to fulfill so far

1. Broken Promises of AI

From the perspective of our interviewed experts, there are three major promises regarding decision-making in a managerial context that AI failed to fulfill so far:

1. An AI can be a universal, human-like intelligence
2. AI leads to reliable and ethically correct results
3. "White Box" AI produces comprehensible and interpretable results

The term Artificial Intelligence might induce intelligence. But intelligence, the human ability to understand the environment, learn, adapt and transfer learned skills to new environments, has not been achieved. Only very specific tasks can be "AI'ed", usually those with a quantifiable desired outcome. Artificial Intelligence is very different from human intelligence. AI systems have been able to defeat humans in a variety of different games, for example Chess, Jeopardy or more recently Go. Our experts take this as an indicator that AI systems can solve even relatively complex problems already way better than humans. However, all these games – no matter how complex they seem – have in common, that enough training data is available or can be generated, plus clear rules for the outcome exist – making them complex but narrow problems to solve.

In comparison, other tasks like identifying fake news or hate speech in online postings that at first seem way easier than for example Go, remain the domain of humans. Given the sheer amount of online content that is constantly produced, letting humans check the whole content becomes impossible for companies like Facebook or YouTube. However, the results of tests with AI systems have not been convincing so far. The algorithms missed content that was obviously fake news or hate speech. The same applies to many other potential use cases for AI systems, like diagnosing patients and prescribe a therapy – although at interpreting X-ray pictures AI systems already outperform humans – or chat bots doing the job of customer service agents. In all those cases, AI systems fell short of expectations.

Actual human-like intelligence, the ability of generalizing and transferring skills from one domain to another, has not been achieved by AI systems yet. Some of the interviewed experts doubt that it will ever be solved. So far, AI systems can only learn to perform specific tasks with a quantifiably desired outcome for which enough training data exists. This is also a major limitation to the use of AI in the context of management decision-making because most real-world problems, particularly strategic decisions, cannot be transformed into AI optimization problems due to a lack of suitable data.

Broken Promise 2:
AI leads to reliable and ethically correct results

Another important expectation was that AI will enhance our ability to derive robust, neutral and unbiased results. However, ethical norm standards and corresponding algorithms are still largely missing. AI is still as biased as its underlying data. De-biasing algorithms are still in their infant stages. Due to actual setbacks – like Amazon's secret AI recruiting tool that showed a bias against women – the knowledge about biases in data sets grows and researchers become increasingly aware of this issue. Consequently, our experts expect new methods to avoid and repair biases as well as guidelines for an ethical use of AI to be developed in the future.

Broken Promise 3:
"White Box" AI produces comprehensible and interpretable results
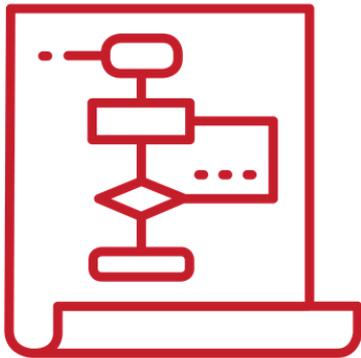
Interpretability means that AI results can be explained based on transparent rules. This may be possible for the case of low dimensional tasks. But even methods that claim interpretability cannot be interpreted in cases of high dimensional feature spaces.

There is a trade-off between interpretability and predictability: Either the results of the AI are comprehensible, but the quality of the prediction is relatively poor, or the predictions are relatively good, but the results are too complex to retrace the processes leading to them. Even though our experts expect that better understandable models will also reach higher levels of prediction quality in the future, the trade-off between understandability and quality of the prediction will continue to exist.

One promising approach for overcoming the situation that AI findings often remain opaque and not fully explainable is according to our experts to use different AI systems for the same problem and learn from the differences between the results. However, this would probably not be the white box AI many people dream about.

Consequently, our experts expect new methods to avoid and repair biases as well as guidelines for an ethical use of AI to be developed in the future.

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ACHIEVEMENTS OF AI

Five major achievements in the field of AI supporting managerial decision-making

2. Achievements of AI

While our experts indicated that today's AI applications fail to meet various expectations, they also agreed that there was rapid progress regarding the capabilities of AI tools within the last years. Below, we will illustrate five major achievements that were made in the field of AI according to our experts:

1. Ability to perform increasingly complex tasks
2. Reliable classifications and high predictive accuracy
3. Real-time data analysis and decision-making
4. AI sparks human imagination
5. Valuable decision support

Achievement 1:
Ability to perform increasingly complex tasks

With regards to specific and distinct application areas, the capability of AI to perform increasingly complex tasks has improved significantly over the course of the last years. AI is increasingly powerful at performing in huge, complex problem spaces if they are specific enough to apply a reward function. Think of games like Go with an almost infinite number of possible moves. Our experts expect that it will very soon be impossible for humans to compete AI in games.
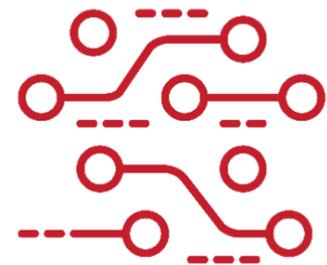
Besides games like Chess, Jeopardy and Go, AI has boosted voice and image recognition and the voice assistants are getting better every year. What started as the equivalent of "I google this for you" can now provide users with a small selected number of highly relevant options when being asked about a recommendation for an Italian restaurant nearby for example – instead of simply listing all available options. AI is also able to make appointments and handle many more simple tasks than before. Soon, businesses won't even know if it's a human making a request for a reservation or a delivery.

However, it is one thing to forecast the technical possibilities of intelligent voice assistants, but another – way more complicated one – to estimate their disruptive effects on other players in markets. For instance, voice assistants may change the way people interact with brands and thus impact the role and importance of brands. When product alternatives are only presented to customers in verbal form and without any advertising, brands become more difficult to differentiate. Consequently, voice assistants are especially a threat for brands which rely heavily on advertising and brands in product categories where consumers have no strong preferences. Thus, an increasing number of products in those categories may become commoditized. As the cost for training data and computing power is expected to decrease further, the interviewed experts also imagined that there may be a higher number of specific AI systems that solve a broad range of narrow problems. A smart combination of such specific AI systems might enable businesses to use AI tools even in the context of broader problem scenarios.

Achievement 2:
Reliable classifications and high predictive accuracy

According to our experts, AI and machine learning have improved classification approaches dramatically, for example customer segmentation or automatic satellite image classification. Consequently, professions like marketing must no longer work with rather unprecise customer segments but can target much more specific segments or personalize messages for every single customer.

Our experts speculate that increasing usage of AI will lead to new methods for marketing and market research that could make existing classifications obsolete.

Moreover, they expect that more customer segmentations will be based on features self-selected by an AI and not predefined by researchers. This development is fueled by the growing amount of user data collected through apps and ubiquitous sensors in exchange for services and personalization for people.

Achievement 3:
Real-time data analysis and decision-making

The promise that AI will speed up management decision-making has been achieved in many scenarios, ranging from the stock market trading floor to online advertising and targeting. To be able to compete for example in the area of high frequency trading, investors make use of AI applications which evaluate multiple data sources, including semantic analyses of current news and affairs interlinked with stock prices, in real time.

Achievement 4:
## AI sparks human imagination

Although, as mentioned above, AI itself is not creative like humans can be, it can help humans to become more creative and innovative. AI applications foster the creativity of human decision makers by confronting them with outliers and totally new combinations of things that were identified as not being used so far.

Thus, AI enables humans to think about and to try options which they would not have considered otherwise. Moreover, AI tools can guide humans through creativity heuristics to develop new ideas.

Achievement 5:
Valuable decision support

AI has contributed to a simplification of decision-making by creating short lists of decision options from which humans can choose. Thereby, AI applications help to narrow down the list of possible alternatives to a small number of reasonable options and thus facilitate a faster decision-making process. Moreover, these applications can help humans to make decisions on topics where they do not have a lot of prior knowledge by reducing complexity through the elimination of unreasonable options. One prominent example mentioned by our experts which illustrates this development is navigation from one place to another which we can completely outsource to an AI. Google Maps, for example, gives you several options, you can choose between several criteria for evaluation, like distance or even time to arrival, use your experience to judge them and choose one final option.
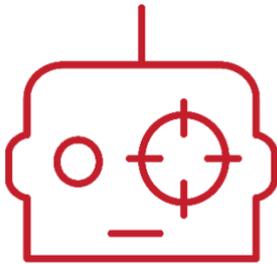
Simple and moderately complex administrative tasks can already be fully automated based on prior learning material or defined goals. This is a potential for cost reduction for many different companies. The interviewed experts anticipate that AI will take over more decisions in the future, step by step, as trust into AI predictions is expected to increase with the continuing improvement of prediction quality. This may allow managers to spend more time on more relevant higher-level decisions, delegating less important decisions to a trusted AI.

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## CONCLUDING THOUGHTS

3. Concluding Thoughts

"Whenever you have a double exponent it's going to be very difficult to predict, and people's predictions are always going to be too conservative." Elon Musk (2017)

On the one hand, AI systems still suffer from the huge expectations that they couldn't fulfill so far, on the other hand, they have already become indispensable for important decision problems and humans rely on them – maybe even without being aware of them. Even though it seems today, that the broken promises described in this short report will not be fulfilled too soon, predictions have all too often underestimated the pace of technological developments.

In various areas of life AI is improving at an incredible rate and the pace is expected to increase further. An army of companies, entrepreneurs and big tech alike, invest in the development of AI systems. In addition, since data and exact processing steps are more often published in research papers, researchers and developers have more possibilities to build on the results than ever before. Managers are well advised to include options that initially seem unlikely in their future scenarios and to ask themselves the question "what if" instead of stating "that's impossible".
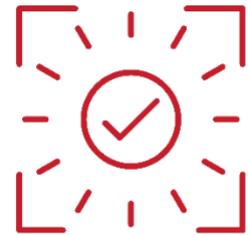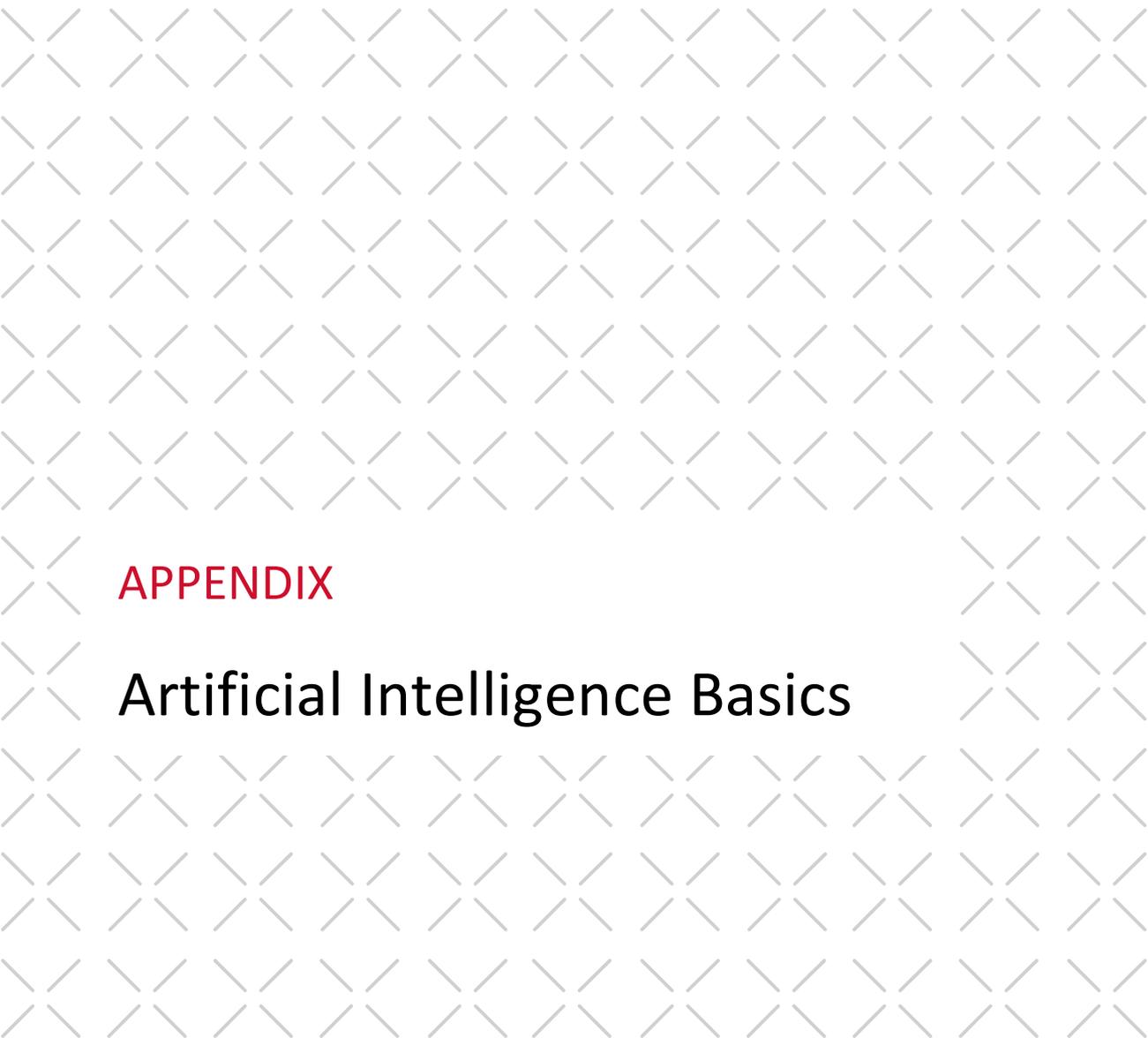
APPENDIX

Artificial Intelligence Basics

Appendix: Artificial Intelligence Basics

The term AI usually means an algorithm based on historical data solving new problems. AI systems are basically algorithms that learned how to respond to certain states by analyzing existing datasets. That is why they are often also called Machine Learning algorithms. Based on this so-called "training data" a propensity model is built that can be used to make predictions for similar but new problems.

To train an AI system using machine learning, training data is key. Three methods to train an algorithm are widely used:

> *Supervised Learning* uses labelled, so-called annotated data to train an algorithm. That means datasets with a huge number of solved problems, for example handwritten letters together with the correct typed letter in case of a computer vision application. Analyzing such datasets, a computer builds an algorithm that best predicts the outcome based on the given input.

> *Unsupervised Learning* applies in cases where only input data is available while the data contains no ground truth to evaluate the algorithm's prediction accuracy. The computer then tries to model the underlying structure or distribution in the dataset by extracting useful features and analyzing its structure. Confronted with a new input, the AI is then able to compare it with the patterns it found in the training data. This method is for example used to detect unusual patterns in customers' credit card data to prevent fraudulent use.

> *Reinforcement Learning* uses a definition of a "reward function" as input for the machine. In other words, a description of a positive outcome, for example in which cases a game is won. The machine then automatically takes actions, measures the outcome and compares it against the reward function. The aim of this learning by trial and error is to figure out how to maximize the reward function. This way of training was for example used to prepare Google's Alpha Go AI to compete with human players in the game Go.
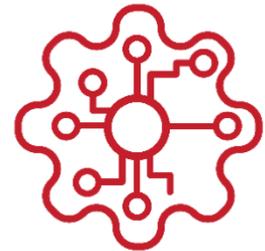
High quality data is key for AI: The described ways of training an AI system lead to one important characteristic of AI: Every AI is only as good as the dataset that has been used to train it. If important aspects of reality are not included in the data, they cannot be known by the AI system and will therefore not be considered in its predictions. If the dataset contains biases, these biases will also distort the AI's prediction, as it was recently discussed in connection with gender biases of AI systems used to predict career success of employees.
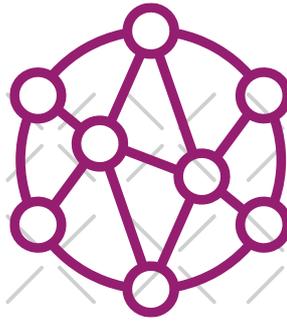
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