Crowdoscope

Collaborative Cognition

When Human and Machine Intelligence Combine

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Artificial Intelligence is an inescapable reality of today's Information Age. This report aims to provide a comprehensive overview on a topic that has drawn interest from multiple disciplines – discussing its impact on society, as well as its implications for market and opinion research.

We advocate the narrative of AI as 'Augmented Intelligence', a symbiosis of Collaborative Cognition whereby technology and humans complement each other by performing the tasks most suitable to them. These cognitive technologies are a necessary companion in our modern world, characterised by vast swathes of unstructured data, and more crucially, a catalyst to human progress. Outsourcing the menial yet necessary data-processing tasks to such machines is not only faster and more accurate, but leaves humans with more time to engage in creative pursuits; space to conceive, create, evaluate, learn and improve.

Shying away from the possibilities opened by AI technologies out of fear of machine domination is not only hysterical and narrow-sighted, but fundamentally mistaken. The current landscape sees technologies firmly in the realm of *narrow AI*, rather than the *general AI* of common-sense and reactive reasoning which can be likened to human intelligence.

Despite the apparent mystical capabilities of algorithms, fundamentally, they are only as good as the information they have available to them; a state of dependence that infers this technology will always have a human master. It is important to remember that no matter how sophisticated AI technologies become, humans will always have an opinion, and with this comes the power to control the fate of such technologies.

I hope those working in Digital Social Innovation, Market Research, Internal Communications, Computer Science and Human Resources find this report is valuable. Many thanks to Miriam Harzenmoser and Charlotte Lord-Sallenave for their work on this report.

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1. Introduction

The increased presence of Artificial Intelligence (AI) within public discourse has produced colourful discussions and debates concerning its likely impact on society. At one extreme, AI personifies the end of the world we know today; a perception inspired by people such as Stephen Hawking, Elon Musk and Bill Gates, who repeatedly warn that AI is a threat to the human race. [1]

People fear that AI will take control over our lives and that humanoid robots will turn against us as soon as they've reached technological "singularity"; a term coined by philosopher Nick Bostrom when entertaining the possibility that artificial intelligence will one day exceed human intelligence. The fear of AI is manifested by the actions of some of Silicon Valley's super rich who have been building hide-away bunkers in New Zealand to prepare for the expected collapse of civilisation, and captured in movies such as Kubrick's 1968 classic "2001: A Space Odyssey", which sees HAL 9000, an English-speaking computer capable of reasoning, murder some of the crew members after developing human emotions such as jealousy and fear.

On the other hand, some believe that AI will further augment human intelligence, where both artificial and human intelligence complement each other constructively. This perspective highlights the innumerable opportunities that AI will establish in accelerating and improving services and generally facilitating our everyday lives.

Today, human intelligence is already augmented artificially: when we navigate with GPS, when we use internet search engines, when we use online translators to understand a foreign language. However, AI research aims to achieve a lot more. It hopes to revolutionise our lives by providing things such as augmented smart homes and cities, where self-driving cars, humanoid robots, drones, and many other interconnected gadgets will improve services and increase safety.

In a recent TedTalk, the futurist Maurice Conti introduced the idea of the "The Augmented Age,"[2] – the next major era to follow the Information Age in which we currently find ourselves. In the Augmented Age, he believes the world will become more connected and more dynamic. In support of this forecast, Conti presents a project by MX3D (a company that researches and develops robotic 3D print technology), where humans and robotic AI have constructed a 3D-printed pedestrian steel bridge in Amsterdam[3] – an example of productive collaboration between humans and intelligent technology that is far removed from the concern that AI will one day replace humans altogether.

Some academics have responded by forming collaborative platforms, bringing experts from different fields together to address the challenge collectively. This can be seen in institutes such as "The Leverhulme Centre for the Future of Intelligence (CFI)", an "interdisciplinary community of researchers with strong links to technologists and the policy world." [4]

Outside of academia, Silicon Valley's Tech Giants – Google, Facebook, Amazon, IBM, Microsoft, Apple, Elon Musk's Open AI and others – have formed an independent and non-lobbying alliance to investigate the topic; "The Partnership on AI to Benefit People and Society" whose purpose is

> *To study and formulate best practices on AI technologies, to advance the public's understanding of AI, and to serve as an open platform for discussion and engagement about AI*

and its influences on people and society. [5]

The variety of discussion surrounding AI emphasises its complexity. Many critical voices are trying to understand its impact on our lives and on our future – it has become an interdisciplinary field, where computer science, neuroscience, psychology, philosophy, politics and many other disciplines play an important part in contributing and shaping the discourse. This report will provide an overview of the current debates and issues within AI – focusing particularly on how AI has affected, and will continue to impact, market and opinion research. We will also explore the implications of AI for society and human psychology.

2. What is Artificial Intelligence?

AI has its origins in mathematics and game theory. After Alan Turing developed a computation machine in the 1930s, he published a landmark paper introducing the Turing Test in 1950, a test that (together with other tests) is still used today to determine if a computational system is eligible of AI status. For instance, at an event hosted by the University of Reading in 2014, a computer program that simulates a 13-year-old boy passed the Turing test because people could not detect that they were talking to a machine and instead believed they were conversing with a human. [6]

AI received formal recognition in the 1950s when AI pioneers gathered at the Dartmouth Conference in 1956. After an initial high, the subsequent research followed a less stable trajectory and stalled altogether in the 1970s following funding cuts. However, AI came back into public interest when, in 1997, IBM's DeepBlue had beaten the world's best chess player. Another huge success of computer science followed in 2011, when IBM's Watson computer defeated the champions on the TV game show "Jeopardy!", a feat considered more impressive due to the complex demand required in processing a natural language.

In recent years, Google DeepMind's "AlphaGo" has beaten European and World champions at "Go", the most complex game a computer has ever won as it requires a degree of intuition rather than sequential reasoning; an ability that had previously been exclusively attributed to humans.

All of AI's breakthroughs were once considered impossible. Throughout its development, AI has evolved from being something exclusively mathematical to being an interdisciplinary field of research where psychology, neuroscience, philosophy, computer science and cognitive robotics come together to better understand its potential impact.

2.1 Definitions and Conceptualisations

The Merriam-Webster Dictionary defines Artificial Intelligence in two parts. The first part of the definition refers to AI as a scientific discipline: "A branch of computer science dealing with the simulation of intelligent behaviour in computers". The second part of the definition captures a particular characteristic unique to AI: "The capability of a machine to imitate intelligent human behavior". [7]

The Oxford Dictionary defines AI even more explicitly by naming examples of human intelligence:

> *The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.* [8]

Both definitions describe AI as a machine or computer with human intelligence. Other conceptualisations try to capture AI through different classifications, such as the common distinction of "narrow AI" and "general AI".

Narrow, weak or applied AI refers to specific problem solving or reasoning tasks that rely on simple sequential computation. Until now, nearly all forms of AI can be subsumed under this category, i.e. personal computer assistants such as Siri (Apple) and Alexa (Amazon).

General, strong, real or full AI (AGI) refers to more sophisticated technology that builds on learning mechanisms inspired by the human brain. Some argue that IBM's Watson and Google's DeepMind do incorporate general AI. This implies the ability of a machine to perform general intelligent action that is similar human general intelligence (IQ).

2.2 Research Areas and Related Concepts

The definitions and conceptualisations of AI explored in the previous section reveal how closely it is interconnected with related concepts, such as robotics and machine learning (ML). This section will discuss these related concepts (some of which overlap) to provide a more precise understanding of AI and its subcategories.

2.2.1 Machine Learning (ML)

The goal of ML is to develop computers with an ability to learn independently; to change and adapt autonomously when confronted with new data without the need for humans to program new features.

Deep Learning

Deep learning is a particular machine learning technique that builds on learning algorithms in a method inspired by the neural network structure of the human brain. The term deep learning may seem a bit misleading because it does not refer to *deep* in a psychological sense, but *deep* in the sense of multi-layered, complex, non-linear structures. Machines do not understand the deeper context of language, for instance, when they translate and analyse text, but they can train themselves in building and extracting relevant connections between data points (artificial neurones).

Deep learning should not be interpreted in the same way as human learning processes, where individuals create contextual meaning and understanding. In the case of machines, learning refers to refining statistical estimates. A machine can generate more accurate statistical estimates because it has access to an ever-increasing amount of complex, multi-layered data. In this regard, we can state that general AI or artificial neural networks are based on statistical inference, not human brain intelligence.

Nevertheless, current AI research is most definitely inspired by the functionality of the human brain and puts a lot of effort into artificial brain simulations. IBM, for instance,

runs a project called SyNAPSE, which is working on a chip that aims to combine traditional computing with neurosynaptic computing. Traditional computing is inspired by the functionalities of the left part of the human brain, namely sequential thinking with a focus on language and analytical reasoning. Neurosynaptic computing on the other hand is inspired by the right part of the human brain, with a focus on senses and pattern recognition. By combining these two approaches, IBM hopes to create a "holistic computing intelligence".[9]

2.2.2 Data Mining and Context-aware Computing

Similarly to ML, data mining is about pattern recognition and establishing relationships between data points. However, while in the case of ML the patterns help machines to adjust themselves, data mining is about extracting data specifically for human's immediate use. [10]

Context-aware computing is a particular form of data mining. It refers to the ability of a system to collect information about its environment and to constantly adjust its actions accordingly.[11] Examples of context-aware computing include smartphones switching the orientation of the screen or adjusting screen brightness, and maps orientating themselves with the user's current positioning. [12]

While context-aware computing is a "nice-to-have" for the user end, Natural Language Processing (NLP) is particularly relevant for market and opinion research.

2.2.3 Natural Language Processing (NLP)

A lot of current research in AI is concerned with Natural Language Processing (NLP). It describes the ability of a computer to understand what a human is saying (and sometimes to respond using natural language). [13] Typical examples here are so-called digital personal assistants like Apple's Siri and Amazon's Alexa, which are able to understand natural language and then use natural language to respond to questions, make recommendations and perform actions.

Arguably, these digital personal assistants are still quite primitive, though the future is likely to bring many more refined NLP features. More detailed discussion on the impact of NLP on market and opinion research can be found in the chapter on the implications of AI.

2.2.4 Internet of Things (IoT)

The Internet of Things (IoT) is "a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction". [14]

An important pillar of IoT is *pervasive or ubiquitous computing.* The goal of pervasive computing is to make devices "smart" and it refers to the computational capabilities embedded into objects in the form of microprocessors. These enable independent communication between objects constituent of continuously collecting, processing and sending data "at any time, in any place and in any data format across any network [...]". [15]

A prominent example of IoT is the smart home. The key drivers in smart home adoption are home security, energy efficiency, entertainment, convenience/ productivity and health monitoring. [16] However, the ambition of the IoT extends to concepts as large as smart cities, while institutions such as the UK's National Health Service hope to become more efficient, effective and affordable by utilising the IoT.[17]

For market research, the IoT is becoming far more relevant, as wearable gadgets and other objects collect huge amounts of data which can be used to better understand people's needs and behaviours.

2.2.5 Robotics

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. It overlaps with other fields such as AI and computer science. [18]

In the coming years, research in AI and robotics will prove particularly valuable in manufacturing and construction. Robotic 3D printing is also used in healthcare, for products such as highly sophisticated prosthetics, in the automobile industry for specific parts of a car, in fashion, food, war, architecture – you name it. We can expect that as AI becomes more 'intelligent', robots will become more sophisticated, making the prospect of fantasies such as self-driving cars and housework robots seem all the more likely.

2.2.6 Collaborative Cognition

This term is generally used to describe group intelligence and refers to the interplay of cognition among groups of people. Sometimes, it is understood as a strengths-based team work model, where the output is believed to be maximised in that each team member is aware of their personal strengths and their unique contributions. [19]

In the context of AI, collaborative cognition refers to the capability of humans and AI to constructively collaborate and maximise output. Research has shown that the combination of humans, computers and a well defined *process* of the interplay results in better outcomes as compared to talented humans or sophisticated computer systems working in isolation. [20]

Cognitive Computing

Cognitive computing is another term that tries to capture how human brain functionalities are simulated in computerised models. It is therefore closely related to machine learning and deep learning.

However, IBM uses the term cognitive computing more in terms of collaborative cognition, in that they use it in lieu of AI to specifically highlight the importance of the coordination between people and machines. The goal is "augmenting the intelligence of people with what machines can do really well." [21]

3. Implications of Artificial Intelligence

This report has already provided a brief overview of how AI affects our lives today. AI algorithms that augment our performance are omnipresent in many daily tasks. Algorithms help us find the best restaurant in town, GPS guides us to our destination in the fastest way, internet searches provide us with the information we need to answer a specific question. Humans could not perform these tasks as well if not augmented by AI. Generally speaking: "To most people, all this progress in AI will manifest itself as incremental improvements to services they already use every day. Search engines will produce more relevant results; recommendations will be more accurate." [22]

In this section, we will take a closer look at the implications of AI from different

perspectives, examining how it impacts both market and opinion research and the world of work.

3.1 Impact on Market and Opinion Research

As modern technologies are becoming more reliable, AI is transforming the landscape of research. There are innumerable opportunities to collect data through interactive social technologies and highly efficient software products to process huge amounts of data, opening opportunities for both quantitative and particularly extensive qualitative research.

3.1.1 Social Collective Intelligence and Collaborative Cognition

As individuals, we all possess intelligence. However, there is arguably a richer form of intelligence that emerges when individuals form groups and share their knowledge and insight – this is *Collective Intelligence.* This concept has evolved alongside the rise of digital and social technologies in today's globalised society, which now sees people able to participate in technological systems that can orchestrate the collection and analysis of human social activity. This is the frontier of *Social Collective Intelligence*: networks of people and computers acting together in intelligent ways.

The term Collaborative Cognition can be used to describe going further than individual cognition to also consider the interactions with other people and, more importantly, AI systems. In this way, a much deeper level of collective intelligence can be produced.

Drawing strong parallels with collaborative cognition and Licklider's notion of a "symbiotic partnership"[23], a popular analogy sees this relationship as a social machine involving the participation of humans and technological components, with the expectation that each component will provide their distinctive capabilities to complement each other.

In the world of market and opinion research, this is typically via a platform within which large and dispersed groups can interact. In order to obtain Collective Intelligence from this environment, there must be mechanisms that transform private judgments into collective decisions – this is *aggregation*. Social technologies can facilitate large groups of people to rate each other's written responses on specific evaluation criteria. When these ratings are analysed alongside the text (using modern text analysis software), it is possible to identify which comments and themes resonate most with the community. As a result, rather than the output reflecting the constraints of a particular researcher's thinking, it is shaped authentically by members of the group.

It is also important that the opinions expressed through these tools have an equal chance of being read and can be accessed and interacted with by others in the group. Therefore, tools that present participants' input as comments in a list have serious limitations; they can quickly grow to overwhelming proportions and become impossible to navigate, meaning many ideas will never be properly evaluated. However, this design shortcoming can be aided by dynamic control algorithms, which work by deciding whether a comment requires more ratings to reach a specific confidence interval

and adjusts the frequency with which that comment is displayed.

Further still, these tools have the potential to reduce the vulnerability of the group to cognitive biases. When interacting in a face- to-face environment, participants' interpretation of information signals within the group (i.e. who's said what, and when) can have an impact their behaviour in ways that might not occur in a more anonymous environment. For example, keeping quiet in order to avoid negative penalties such as disapproval from peers and isolation within the group. While such biases can also exist in online social interactions, the immediate anonymity can allow for more candid and therefore representative responses from participant. There is also more scope to measure bias and design ways to recalibrate the output to take account of its impact.

Crucially, it's important to understand that not all Collective Intelligence is created equally and to remain mindful of the obstacles and pitfalls that need to be addressed in the design of Collective Intelligence systems. However, when designed with these considerations in mind, social technologies can help establish the optimal environment for Social Collective Intelligence, whereby the quality of discussion and insights gathered are fair, valid, representative, authentic and fundamentally far richer than that collected without the use of such technologies.

3.1.2 Data collection

Modern digital technologies are revolutionising data collection. For example, more sophisticated translation software helps to eliminate language barriers, which in turn enables a global outreach in finding adequate samples. Mobile technologies, together with the extensive dissemination of smart phones, facilitate data collection tremendously. It is now easier than ever to track and transmit data with regard to health, lifestyle and consumer behaviour. It is conceivable that this information could be synthesised into complex neural networks that will, thanks to advanced deep learning algorithms, assist in research independent from human input.

Radio-frequency identification (RFID) tags

Implanted into the skin or inserted into a regular badge, RFID technology builds on existing microchip implants that are currently used to identify humans and track movements. In 2015, a pioneering tech company in Sweden, Epicentre, had their employees implant microchips into their hands – the RFID signal could be used to open doors, for secure printing and to communicate with their mobile phones.[24] They predict the future use of RFID in services that are now dependent on cards and pins, such as payments, as well as in health tracking.

Sociometric badges

This technology refers to wearable electronic badges (and has potential to also be an RFID tag) that focus on measuring social data: the amount of social interactions (virtual versus face-to-face), the duration of conversations, physical proximity in face-to-face situations, activity levels using social signals such as vocal features, body motion and location. In regards to market research, participants of a study could agree to wear sociometric badges and the collected data could be used to detect patterns of behaviour. This in turn could be used for marketing purposes and product development.

Employee monitoring in organisations

Sociometric data collection could also be used within an organisational context, while the data itself could be used to analyse and improve team behaviours and collaboration.

With regard to well-being at work, organisations have started using Fitness Trackers to motivate employees to participate in health activities such as competitions. According to a study by AXA [25], nearly two thirds of working adults are open to wearing a fitness band or similar device and would also be comfortable in sharing health data with their employer. Probably less common are EEG Monitors, which measure electrical activity of the brain and can track posture; whether or not employees remain in healthy seating positions and whether employees who conduct monotonous tasks remain alert or get fatigued. Telematics is another safety-related tool. This can be used to track things such as driving styles and can therefore be useful for insurance purposes as well as helping to tailor internal communications.

3.1.3 Data Analysis

With respect to data analysis, modern technologies enable this stage of research to become quicker and more sophisticated. However, while technologies certainly help with processing quantitative data very efficiently, most technologies still lack the maturity to effectively assist in qualitative research. Google, Microsoft and IBM have made certain AI services, such as speech recognition, sentence parsing and image analysis freely available to certain groups. Trends suggest that natural language processing technologies such as automated text analysis, voice recognition and video reporting tools are being developed and improved and will hopefully be available as supportive research methods soon.

An interesting asset of AI to data analysis is that AI algorithms will help to minimise cognitive biases in analysis and diagnosis. This should not imply that humans should not analyse data, but that they should use AI to get to more accurate results more efficiently.

NLP, text and sentiment analysis

We have already come across natural language processing (NLP), the ability of a computer to process natural language. Apart from digital personal assistants for personal use, companies are increasingly using use NLP for digitising customer services (i.e. chatbots). Chatbots can handle large amounts of customer feedback through text analysis functionalities, while AI can accelerate reaction time in responding to an enquiry after the issue is detected. In addition, text analysis tools can recognise meta-level patterns that can help improve services and marketing activities.

Sentiment analysis tools have the capacity to analyse user-generated content such as social media, email, image and video sources with regard to feelings. An example is software capable of inferring people's emotional states from webcam videos of their facial expressions. This technology could be teamed with chatbots to aid them in detecting the extent of a customer' satisfaction dependent on their facial expression.

3.1.4 Moving Forward with Market Research and AI Technologies

Promisingly for market research, The Gartner Hype Cycle for Emerging Technologies[26] indicates that Natural Language Question Answering and Machine Learning will be ready for mainstream adoption in the next two to five years. This will boost the collection and analysis of qualitative data, as AI will assist in collecting qualitative data

from large samples and Machine Learning technologies will enable the efficient processing and pattern recognition within that data. In five to ten years, we can expect technologies such as Virtual Reality, Smart Homes, Smart Robots and IoT platforms to augment market research.

Increasing Investments in AI

Increasing investments into AI technology will enable market research to take a huge leap forward. Worldwide investments in AI will grow from $8 billion in 2016 to $47 billion in 2020.[27]The report further states that AI will be a differentiating factor for companies to identify, understand and act on their respective growth opportunities. In 2016, most investments went towards automated customer service agents (i.e. chatbots) and recommendation systems – both of which are very central to market research – as well as diagnosis and treatment systems, and fraud analysis and investigation. In the period between 2016 to 2020, the report predicts that the greatest revenue growth will be for healthcare and discrete manufacturing, followed by education and process manufacturing.

The more AI advances, the more it will influence not only market research but our societies and the way we live together today. That said, we must not ignore AI's existing and potential downsides; if AI is to be truly progressive, we should consider how these should be addressed.

3.2 Impact on the World of Work

Technological advances transform workplaces and jobs. More and more tasks, particularly those of knowledge workers, depend on some sort of technology. After all, many jobs are dependent on computers and the internet today.

Automation and Deskilling

Technological progress obviously infers some sort of convenience, such as the possibility to automate repetitive tasks that may be boring for a human. Additionally, it may be argued that automatisms can execute monotonous tasks more reliably than humans, resulting in fewer errors and therefore assuring a better outcome.

However, the trend of automating tasks and jobs in order to create more workplace efficiency involves the danger of making jobs – and people – redundant. A study by PwC found that 30% of existing jobs in the UK are at potential risk of automation.[28] This tendency can already be observed in situations where people lose their jobs as a result of automated manufacturing, when smartphone's digital personal assistants replace secretaries, when chatbots replace human customer service personnel, and when, in the future, self-driving cars will replace chauffeurs, drones the postman, humanoid robots cleaners and nannies – the list will continue to grow.

Apart from the social obstacle of sweeping job loss, this trend has a direct impact on human skill sets. When computers outperform people in various tasks, what is left for the human to do? This is a question to address both practically and ethically. Answers reach from actionable suggestions of job design to the more utopian (at least for now) demand for basic income.

4. Discussion

There are two main narratives concerning how people engage with AI; one that perceives AI as an existential threat to the stability and continuation of humanity as we know it, and one that sees AI as an augmenting technological advancement that will make our lives safer, more convenient and more interconnected.

We support this latter view and believe that establishing a positive relationship with how we perceive AI will ensure current methods are better accepted, implemented and developed to further realise the full potential of AI technologies. This stance infers that concerns towards AI must be addressed; concerns that largely amount to a fear associated with AI, which we believe stems from ignorance of the topic.

A first step towards dispelling this fear may be to change people's relationship with the term itself. Artificial Intelligence is arguably an oxymoron, with the word 'artificial' producing unsettling feelings of difference when put with the word 'intelligence', an ability often considered as being exclusively human. The term 'Augmented Intelligence' can be used to emphasise the necessarily complementary nature of the relationship between humans and computers more accurately.

Furthermore, bringing discussions surrounding AI outside of academia and business circles could serve to demystify the topic by increasing transparency and understanding about it. While this may encourage the general public not to take existing Hollywood fantasies of an AI-induced apocalypse literally, more importantly, it would provide the opportunity for alternative (and perhaps, more representative) perspectives on AI to reach a mass audience through similar pop-cultural artefacts.

As supporters of AI, we view cognitive technologies not only as a necessary companion in our modern world characterised by vast, and otherwise unmanageable, swathes of 'unstructured data', but more crucially, as a catalyst to human progress. Outsourcing the tasks to such machines is not only faster and more accurate, but leaves humans with more time to engage in more meaningful pursuits.

4.1 AI in the near Future

Technological developments will continue to rapidly change our world. Pertaining to predictions that computing capabilities and financial investments in AI will increase substantially over the coming years, it is likely that today's AI market, which is currently dominated by narrow-focus technologies such as face-recognition, will make room for more holistic, cognitive systems with deep learning capabilities.

Despite this, and although incredibly powerful and advanced, the sophistication of computer 'intelligence' remains vastly inferior to that of humans who are fundamentally sentient. Machines lack the human intuition that allows for common-sense reasoning when reacting to new situations that have never been encountered before. Such a need is illustrated by the concerns surrounding driverless cars, in that no existing degree of programming or machine learning can prepare such technology for unpredictable conditions. For the moment, many AI systems require a degree of human monitoring and supervision – providing yet another case against the concern that machines will eventually be self-governing.

With regard to research, business and the general world of work, it seems crucial to start defining regulatory frameworks of how we want to shape Collaborative Cognition in the future.

4.2 Conclusion

AI's many existing and potential applications inspire a variety of different responses, ranging from apocalyptic fear to fascination and excitement.

As the investment in and development of AI increases over the coming years, society must be aware of, and prepared to cope with, the likely implications on humanity as we know it. It is important that society determines a legal and moral framework surrounding AI, particularly with regards to robotics, to ensure that the questions and existential doubts likely to result from the increased interaction between such technologies and humans can be effectively managed.

In the interests of self-preservation, particular focus must be given to negative impacts, such as the likely job-losses following the automation of human roles. While society is challenged to reflect on these implications in an ethical manner, it is the duty of those in our political institutions to come up with solutions to these possibilities, such as the provision of a basic income or resettlement schemes for existing employees.

Fundamentally, we believe that the future holds many exciting opportunities for the world of AI. We advocate the narrative of AI as 'Augmented Intelligence', whereby technology and humans complement each other by owning and performing the tasks most suitable to them. This symbiosis of Collaborative Cognition is fundamentally progressive in nature as it leads to more accurate and efficient outcomes and insights that may be helpful in addressing some of the major challenges of our time.

5. Glossary

Anthropomorphism	Attribution of human characteristics or behaviour to non-human entities, such as animals, objects, or a god.
Artificial Intelligence	• AI is everything computers can't do today • *Narrow AI*: specific problem solving or reasoning tasks that rely on simple sequential computation • *General AI*: sophisticated technology that builds on learning mechanisms inspired by the human brain
Collaborative Cognition	The capability of humans and AI to constructively collaborate and maximise output by interacting together.
Cognitive Computing	• Computer simulation of the human brain • Or, synonym of collaborative cognition.
Collective Intelligence	An emergent property that arises from individuals acting together to combine their knowledge and insight.
Context-aware Computing	Context-aware computing is a particular form of data mining. It refers to the ability of a system to collect information about its environment and to constantly adjust actions accordingly.
Data Mining	Data mining is about pattern recognition and extracting data specifically for human's immediate use.
Deep Learning	Deep learning is a particular machine learning technique that builds on learning algorithms inspired by the neural network structure of the human brain.
Internet of Things IoT	A system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Machine Learning (ML)	The goal of ML is to develop computers with the ability to learn independently, without humans needed to program new features.
Natural Language Processing NLP	The ability of a computer to understand and process what a human is saying and then to respond using natural language.
Pervasive / Ubiquitous Computing	Computational capabilities embedded into objects in form of microprocessors, making IoT possible.
Robotics	Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots.

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About Crowdoscope

Crowdoscope is a new type of survey and discussion tool that has been designed to capture Social Collective Intelligence - this is a form of insight that only emerges when groups of people are interacting. Crowdoscope provides a powerful feedback mechanism that gives people the opportunity to interact in a visual forum. Rather than feedback disappearing into a black hole, participants have the ability to be heard, receive individual feedback and see what comments and themes are resonating with the community. Crowdoscope is a highly efficient and user-friendly tool for decision-makers to quickly being able to extract actionable insights validated by the community. We work with some of the world's biggest organisations, harnessing the collective intelligence of employees and consumers. Clients include companies such as Unilever, Deloitte, Johnson & Johnson, Penguin Random House and Standard Life.

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