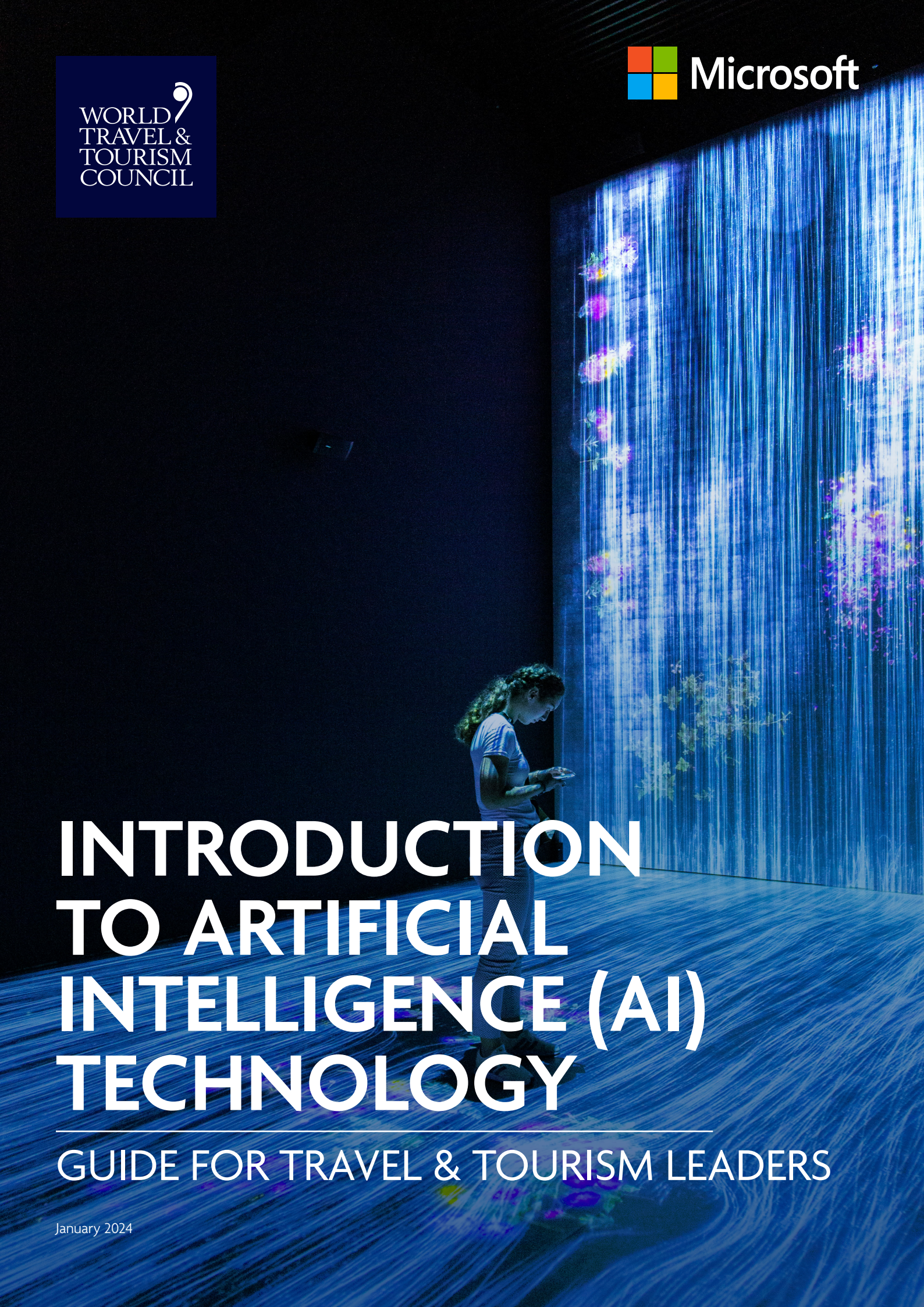




INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI) TECHNOLOGY

GUIDE FOR TRAVEL & TOURISM LEADERS

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A night cityscape, likely Singapore, with the Petronas Towers and other skyscrapers illuminated. Overlaid on the image is a complex, glowing blue and purple network of lines and dots, resembling a digital or neural network.

FOREWORD

In 1950, codebreaker and now celebrated computer scientist, Alan Turing, posed one of the most interesting questions ever faced by humankind - can machines think?

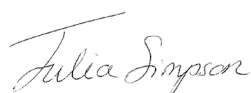
Artificial Intelligence (AI) has occupied scientists for decades. But in 2023, it caught the attention of global businesses, policymakers and civil society alike. In the UK, King Charles III called it “one of the greatest technological leaps in the history of human endeavour”. The UN Secretary General described AI as “unprecedented” and even the Pope stated that AI “has the potential to contribute in a positive way to the future of humanity” before dedicating World Peace Day 2023 to the use of AI.

As business leaders in Travel & Tourism it is vital that we understand the opportunities and challenges of this transformative technology. I am therefore delighted that the World Travel & Tourism Council (WTTC) has partnered with Microsoft, one of our members and a leading technology company, to bring you the very latest insights into AI and what it could mean for our sector.

What follows is the first report in a four-part initial series on artificial intelligence. We begin with an introduction to AI: how it works, where it came from and the different types of AI available today. Three further publications will explore how AI is currently being used in Travel & Tourism, and the fast-moving world of AI governance, safety and regulation.

By understanding these trends, we aim to help Travel & Tourism business leaders to prepare for the future and navigate the complexities of AI. But this report isn't just technical facts and figures. We also examine how AI can help tourism grow and do good over the years to come, opening up new and exciting possibilities for personalised, seamless and sustainable travel experiences.

Ultimately, AI is just an engine. The task now is to ensure that it fuels us towards a destination of our choosing – a sector that is greener, safer, more prosperous and more free. After all, as Alan Turing said back in 1949, we may be experiencing “only a foretaste of what is to come, and only the shadow of what is going to be”. If we get it right with AI, that destination could be very bright indeed.

A handwritten signature in cursive script that reads "Julia Simpson".

Julia Simpson

Julia Simpson
President & CEO
World Travel & Tourism Council

INTRODUCTION

“...It happened gradually, then suddenly...”

This famous quote from Ernest Hemingway’s 1926 novel, *The Sun Also Rises* could be used to describe some of the world’s most profound technological changes. Small advancements accumulate and then all of a sudden, the world is a different place.

That could describe the world before and after the birth of the internet and could now be applied to Artificial Intelligence (AI), which has ‘gradually, then suddenly’ burst onto the scene after nearly a century of research. It is almost impossible to browse the news or social media today, without seeing mention of Artificial Intelligence and the magazines Time, Science, Cosmopolitan and The Economist (to name only a few) have all dedicated cover stories to AI in 2023.



Cosmopolitan

www.cosmopolitan.com



Time

<https://time.com>



The Economist

www.economist.com



Science

www.science.org

But where has AI come from and why is it suddenly such big news?

This report aims to answer those questions, by providing a general introduction to Artificial Intelligence technology, its business applications and its relevance to Travel & Tourism.

BRIEF HISTORY OF ARTIFICIAL INTELLIGENCE (AI)

AI has gained significant attention in recent years – and especially in 2023 – but AI is not new and can trace its history back to the development of computers after the Second World War, with the Dartmouth Conference in 1956 bringing together researchers from multiple fields to explore “thinking machines”. This is widely considered the start of AI as a distinct field of study and where the term “Artificial Intelligence” was used for the first time by the visionaries at that conference.

But it was not until the turn of the century that AI really came to the public’s attention, when the **IBM Deep Blue** supercomputer beat chess grandmaster Gary Kasparov in 1997, with artificial intelligence algorithms developed by IBM engineers. A few years later, in 2011, the **IBM Watson** computer won the US gameshow Jeopardy, after

being trained on a huge data set. These events showed the world for the very first time that computers powered with large amounts of data and artificial intelligence software – albeit very powerful computers out of reach of the general public - were capable of outperforming humans at very complex tasks.

Over the past decade several companies have taken this a step further and developed AI systems that have achieved incredible results and performed tasks not possible by humans, due to the huge scale and complexity of the challenge. **AlphaFold** from **Google Deepmind** is one example. The programme uses AI to predict the 3D structure of nearly every protein in the human body. This improves our understanding of diseases like Alzheimer's and can massively accelerate research into medicines, vaccines and drugs. Healthcare is therefore one of the most important and useful applications of AI.

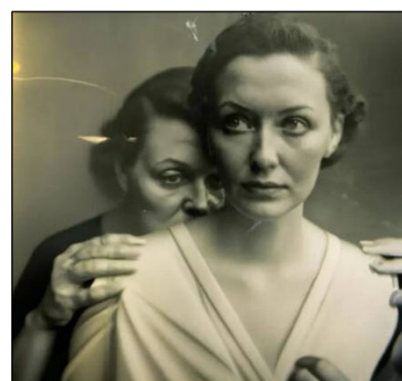
In 2018 a painting called “Edmond de Belamy, from La Famille de Belamy” was sold at Christie's auction house in New York for a staggering \$432,500 (USD). It was generated with artificial intelligence after being trained on many images of portraits from the 18th and 19th centuries and was the first piece of AI art sold at auction. The sale sparked a significant debate about the future role of humans in creative professions, such as art and digital media.



AI Painting (2018)
Edmond de Belamy



AI Painting (2023)
Girl with Glowing Earrings



AI Photo (2023)
Pseudomnesia : The Electrician

But this was only the start of a ‘boom’ in AI generated creative content. In 2023, a museum in The Hague (Netherlands) loaned the world famous, *Girl with Pearl Earring* (c. 1665) by Johannes Vermeer to an international exhibition and temporarily replaced it in their gallery with an AI inspired version entitled *Girl with Glowing Earrings*, with many visitors to the gallery believing it was a real painting. In April 2023 the German artist Boris Eldagsen won the 2023 Sony World Photography Award with an image entitled *Pseudomnesia: The Electrician*, before refusing the prize after revealing it was created by AI. (Pseudomnesia is Latin for fake memory!)

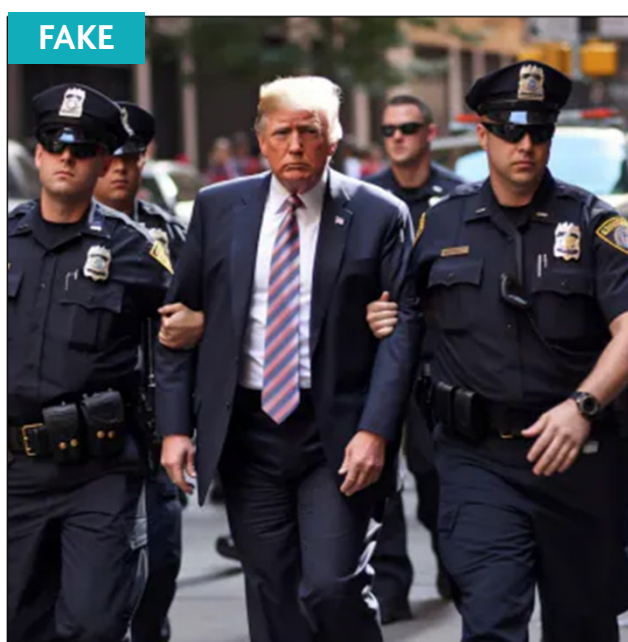
These images show how far AI creative technology has advanced in only a few short years, from an ability to generate low quality AI portraits in 2018, to high quality AI paintings and photorealistic AI images today. Both the *Girl with Pearl Earring* and *Pseudomnesia* images were created with AI software that is now available to everyone online and is partly why AI has taken off with the public in 2023, enabling any of us to become potential artists.

But paintings and photography are not the only form of art that has been shaped by AI. In 2023 the Grammys announced that music created with AI would be eligible for awards and Paul McCartney announced he had used AI to extract John Lennon's voice from an old demo tape. In late 2023, this track was released as the final Beatles Song *Now and Then*¹ which drew considerable public attention to AI across all generations. Canadian singer Grimes has also invited anyone to create new songs with an AI copy of her voice, offering to split the royalties equally on any AI track that is commercially successful.

Going a step further, an area of AI that is still in development is AI generated video. Imagine being able to produce a corporate marketing video easily and in only a few moments on your office laptop, or even turning your favourite book into a movie using AI. Whilst AI generated video does not currently exist at this advanced level yet, it is clear that AI is rapidly moving forward and has huge potential for both businesses and society.

But there are also risks and concerns about the widescale adoption of AI, which are covered later in this report. The use of AI has led to some highly publicised events, such as a strike by Hollywood actors and writers in 2023, partly due to concerns about AI's impact on the movie industry. Their concerns include the ability of AI to write scripts and the potential to create an AI digital replica of an actor (or extra), which could be included in films, without the physical actor present and potentially long after they have died. The full impact of AI on jobs of the future is yet to be determined, but it is possible that labour strikes will be experienced in other industries as AI rolls out further into society and other areas of work.

There is also a concern that AI could be used for disinformation (the deliberate sharing of false information), especially to interfere with political elections. High quality, photorealistic – but fake – images have already gone viral on the internet, such as an AI generated image of the Pope wearing a puffer jacket and an image purporting to show the arrest of former US President Donald Trump. Both images were generated by AI and both are fake, but they are photorealistic, very convincing, generated on a home computer in only a few minutes and were shared very widely across the internet and social media. It is therefore clear that the wide scale implementation of AI across society needs 'guardrails' for its appropriate use, which could range from formal regulations to codes of conduct and best practice guidance. These options are discussed further in an accompanying WTTC report on '**AI Risks & Governance**'.



Viral AI-generated (fake) images of the Pope and former US President Donald Trump

But not all celebrities are against AI and digital replicas – often known as 'deepfakes'. For example World Cup winning Argentinian footballer Lionel Messi has allowed a deepfake version of himself to advertise snacks, as part of his sponsorship deal with PepsiCo. At the website www.messimessages.com anyone can generate and download to their phone a short personalised deepfake video message from Messi who invites your friends by name, to bring food and watch the big game with him – and it can even get Messi to provide the message in his voice in English, Spanish, Portuguese or Turkish!



Argentinian footballer Lionel Messi : Deepfake Messi Messages

AI has therefore been regularly hitting the news headlines and as with all new trends, a few high profile cases can propel a technology that is initially only used by a few early adopters, into global mass adoption. For AI this happened with the international release of a sophisticated AI powered chatbot, named **ChatGPT**, in November 2022 from a company called OpenAI. This caught the public's attention, registering over 100 million users in only 2 months and making it (at the time) the fastest growing consumer product of all time. This tipped AI into the public mainstream in 2023 and sparked the current worldwide interest in AI.

While ChatGPT was the first AI chatbot to reach mass consumption, others are now available including **Google Bard**, **IBM Watsonx.ai** and **Microsoft Copilot**, with others produced around the world, such the **Ernie** AI chatbot from Baidu in China.

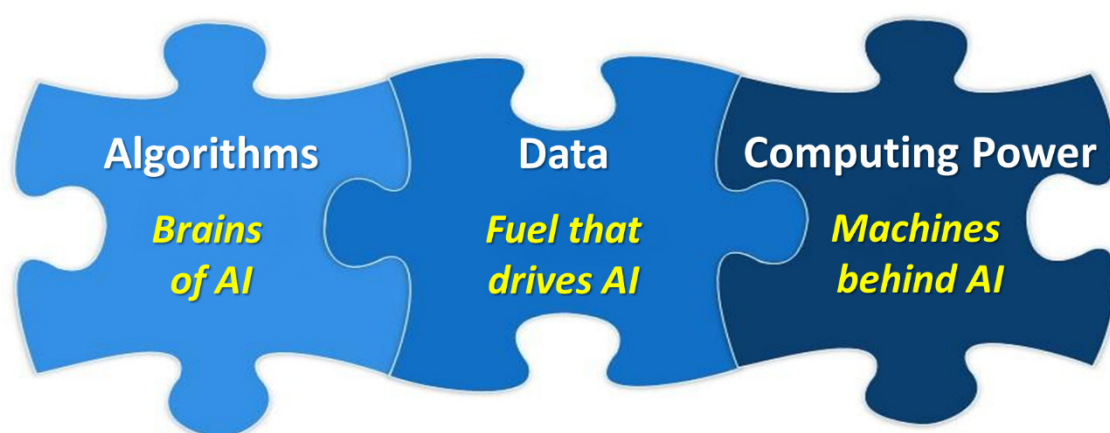
These sophisticated AI chatbots are not the only way to use AI, but they have exposed the power of AI to the general public, which everyone can now access on their desktop computers and smartphones (and through digital connections to the 'cloud'), unlike the 1990's when the use of AI was limited to a very small number of owners of supercomputers (such as IBM Deep Blue). The future of AI is exciting and evolving very fast. It is impossible to accurately predict how AI will shape our lives over the next 5 to 50 years, but the following section explains why now is a crucial moment for the future of AI and society.

WHAT IS ARTIFICIAL INTELLIGENCE & WHY THERE IS GLOBAL INTEREST NOW

One of the most important aspects of **AI is that it is a multi-use technology**. Like electricity it can be applied in lots of different ways, to lots of different scenarios.

There is no single, universally accepted definition for Artificial Intelligence, but the Oxford English Dictionary defines AI as “*the capacity of computers, or other machines, to exhibit intelligent behaviour*”. This means AI systems appear to think, learn and act like humans and in some cases exceed the capabilities of humans. AI systems can analyse vast amounts of data, solve complex problems, make decisions and perform creative tasks.

Some AI technologies have been around for more than 50 years, but advances in computing power, the availability of enormous quantities of data and new developments in software algorithms have led to major AI breakthroughs in recent years. It is these three components of **advanced algorithms, data** and **computing power**, that explain how machines can exhibit intelligent behaviour and why AI has suddenly exploded into our everyday lives.



*Algorithms tell computers what to do. Data tells computers what to learn.
Computing power gives machines the power to learn and make decisions*

ALGORITHMS : THE BRAINS OF AI

‘Traditional programming’ involves encoding human knowledge and experience into a set of precise rules that a computer can follow, step-by-step, which make the computer appear to respond intelligently.

These **rules, called algorithms, tell computers how to perform tasks** and in traditional programming are often expressed in an ‘IF-THEN-ELSE’ format, which resembles a decision tree. For example to create a ‘digital doctor’, an algorithm might look like:

IF *the patient has a fever*

THEN *prescribe Drug X*

ELSE *send the patient home*

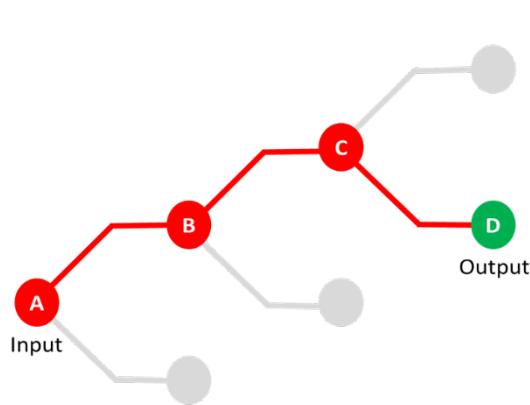
The intelligence in traditional computer systems comes directly from human knowledge and expertise being recorded into a format that a computer can process. Humans can read this ‘computer code’ and understand how these digital systems make specific decisions and can therefore identify mistakes and improve the system. For example, in the ‘digital doctor’ scenario, new clauses could be added to deal with special cases, or to reflect new medical knowledge. For example:

IF *the patient has a fever* **AND** *is allergic to Drug X*

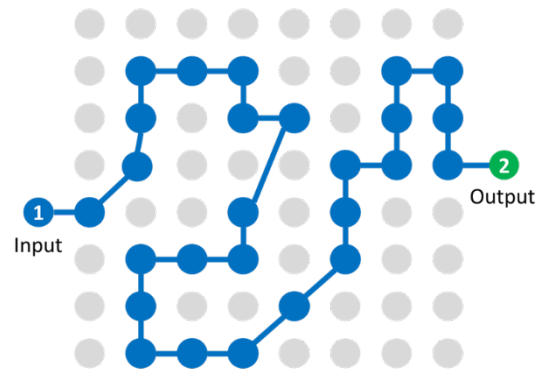
THEN *prescribe Drug Y*

ELSE *prescribe Drug X*

This example now starts to illustrate a key limitation of traditionally programmed systems. To develop a useful and reliable ‘digital doctor’, a huge number of rules and exceptions would be required that the system would very quickly become very large and very complicated. Thousands of IF-THEN-ELSE rules would still be unlikely to capture all of a real doctor’s expertise and experience gained over time. Therefore **traditional programming of ‘intelligent systems’ is best suited to constrained environments which do not change much over time and where the rules can be strictly defined**. A good example of this could be an intelligent ‘tax calculator’ which when presented with an individual’s financial income and other relevant circumstances could efficiently review a series of ‘IF-THEN-ELSE’ rules to calculate their tax liability.



Traditional Programming

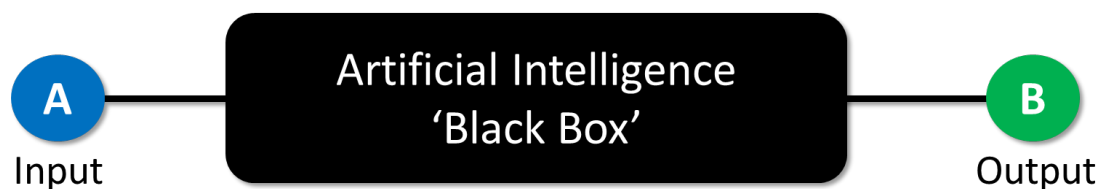


Artificial Intelligence (AI)

Unlike traditional programming, **AI systems are not explicitly coded in a series of precise steps, but instead ‘learn’ how to solve a problem by examining training data**. In the example above, a traditional programme (**in red on the left**) goes through a series of defined steps and pre-programmed decision points at A, B and C to reach an outcome D (**in green**), whereas in the AI example (**in blue on the right**) the system calculates the best route to the outcome (the snake to point 2) based on the data it has been trained on (at point 1), not on explicitly defined and pre-programmed decision points. **AI systems can also continuously ‘learn from experience’** and therefore the route taken to the outcome might be different each time the AI system is run (like a car driver taking different routes through a city based on experience of traffic conditions at different times of day).

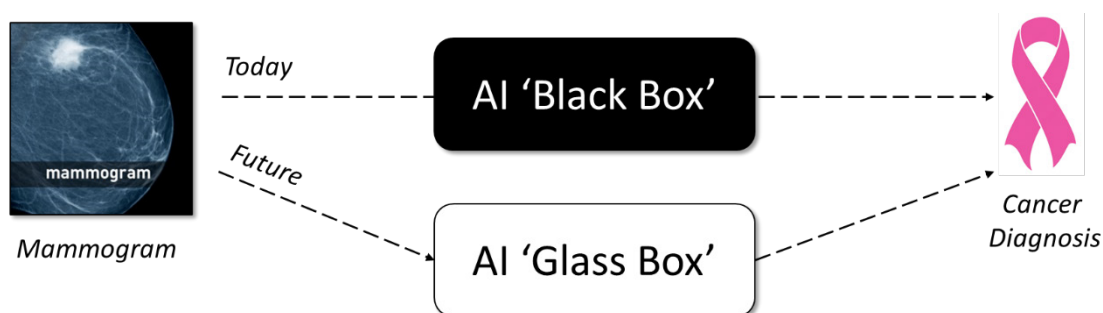
Returning to a ‘digital doctor’ example, an ‘AI digital doctor’ could be trained on thousands (or millions!) of medical scans from sick and well patients to learn how to detect tumours, without following pre-defined rules which are otherwise very difficult to codify and write. Many human doctors may say that experience plays a significant role in clinical diagnosis, but an AI system can be trained on far more x-ray images than a doctor could ever experience, leading to AI systems having remarkable capabilities in areas such as breast cancer detection. For example a Swedish AI study in 2023 found that AI-supported breast cancer screening (the analysis of mammogram images) was as good as two radiologists working together ². It also reduced their workload by 50% and led to 20% more cancers being detected early for treatment ³. This illustrates some of the incredible capabilities of AI and its benefit to society.

But this also leads to an important concept in AI called ‘**Explainable AI**’. It is possible to verify the output of an AI system as correct (for example did a patient really have cancer or not), but it may not be possible to know exactly how the AI system got to a decision or outcome, as the AI has calculated the ‘interim steps’ (e.g. the blue snake in the diagram above) by itself, without human programming of the specific steps to be taken. **AI systems are therefore sometimes referred to as ‘black boxes’ with details of exactly how they work and operate - in some cases - not fully known, or understood**. This can even include their developers, as they too can often only verify the output and not the steps taken by the AI.

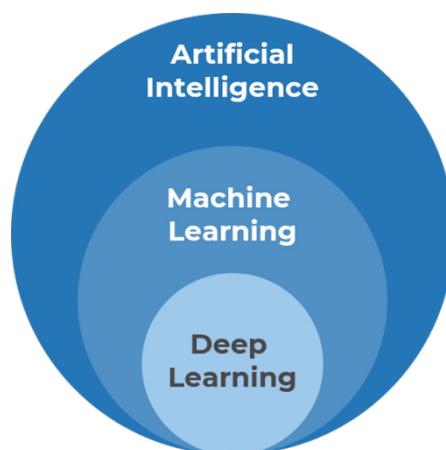


'Explainable AI' is therefore an active and ongoing field in which researchers are trying to understand and articulate how AI systems reach an output. This is crucial to **improve trust in artificial intelligence systems** (i.e. to understand the magic inside the black box and to turn a 'black box' into a 'glass box').

The 'digital doctor' example nicely illustrates why 'explainable AI' is so important (in this case for both the patient and the doctor) to understand why an AI system has made a decision and believes a patient has breast cancer before sending them for intrusive cancer treatment.

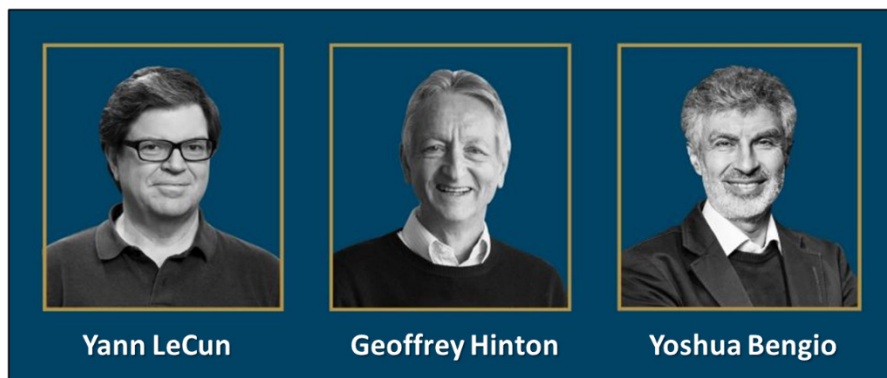


When considering how an AI system is constructed, there are **two primary methods for how an AI system 'learns' to perform a task**, which are machine learning and deep learning.



- **Machine Learning** : Machine Learning (ML) systems can learn from huge amounts of data and continuously improve their performance over time when provided with more and/or better quality training data. With this 'knowledge' gained from training data, machine learning powered AI systems can then make predictions (such as for weather forecasting), or recognise patterns in data (such as for image and speech recognition).
- **Deep Learning** : Deep Learning (DL) is a more sophisticated subset of Machine Learning and uses complex processes inspired by the human brain called Artificial Neural Networks (ANN). How neural networks function is beyond the scope of this 'Introduction to AI' report, but deep learning systems can excel at very complex tasks such as generating new works of art and medical drug discovery.

Researchers **Yann LeCun**, **Geoffrey Hinton** and **Yoshua Bengio** are credited with laying the foundations for how AI systems can ‘learn’. Their pioneering research on deep learning in the 1990’s and early 2000’s led to major breakthroughs and their work is now used in a variety of AI powered applications, from self-driving cars to medical diagnosis. In 2018 the three researchers – nicknamed the ‘**Godfathers of AI**’ - were awarded the **Turing Award**, which is considered the highest honour in computer science (equivalent to a Nobel Prize) for their fundamental contributions to artificial intelligence.



Media nicknamed “Godfathers of AI”¹⁴

The Turing Award is named after **Alan Turing** who was a brilliant British mathematician. He decoded the German Enigma machines during the Second World War (which were considered impossible to crack) by building one of the world’s first computers and was one of the main architects of modern computer science following the war. He is often considered one of the ‘founding fathers’ of modern computing.

In 1950 Alan Turing published a groundbreaking paper called ‘Computing Machinery and Intelligence’ which introduced the ‘**Turing Test**’ for artificial intelligence. This is still used today to test a machine’s ability to exhibit intelligent behaviour and if it is indistinguishable from a human. At this time (early 2024) no computer has decidedly passed the Turing Test, but there have been some very convincing contenders. Modern, sophisticated, AI chatbots (such as Google Bard and Microsoft Copilot) can be very difficult to distinguish from a human. The Turing Test is also a useful way to measure the progress of AI research, and since 1950 has helped to raise international awareness of the potential for machines to think and behave like humans.

Whether an AI system uses machine learning, or deep learning techniques to ‘**learn**’, there are different ways that AI algorithms can be ‘**trained**’, but the most common approaches are:

- **Comparing AI-generated outcomes or predictions to the correct answer:** this is known as ‘**Supervised Learning**’ in which AI models are trained on data that has been correctly labelled (for example an AI animal recognition system could be trained on images of animals correctly labelled as cats or dogs).
- **Finding patterns in data:** this is known as ‘**Unsupervised Learning**’ in which AI models are trained on data that has not been labelled. In this case the AI system learns by finding patterns in the data (for example edges, shapes, features, or colours in images of animals that are common to cats or dogs).
- **Trial & Error:** this is known as ‘**Reinforcement Learning**’ in which AI models ‘learn by doing’. Each outcome of the AI training is either mathematically **rewarded** or **punished**, in a ‘trial and error’ feedback loop (for example an AI animal recognition system that identified a certain breed of dog as a cat would be ‘punished’, but ‘rewarded’ it if correctly identified it as a dog, even though it had not seen that breed before)

At the core of every AI system is a set of algorithms (often using machine, or deep learning) and AI training techniques (such as supervised, unsupervised or reinforcement learning) which determine how the system processes information, learns patterns and makes decisions. As new algorithms are developed artificial intelligence is becoming increasingly capable. But AI requires two other important components to be successful – data and computing power.

DATA : THE FUEL THAT DRIVES AI

“Data is the new oil” is a phrase often associated with the digital age. Data is the fuel behind modern computing and AI algorithms, allowing them to learn, find relationships in data and make informed predictions and decisions.

In today’s world, huge volumes of data are created as we go about our everyday lives. From text messages, emails, documents and social media posts, to photographs and videos on our smart phones. Humanity is generating massive amounts of information every day and even more data is created by millions of sensors around the world and in our homes, cars, cities, public transport infrastructure and factories.



An often quoted statistic from a 2013 study ⁵ is that **90% of the worlds data has been generated in the last 2 years**. That rate is likely to be even quicker today. A 2023 paper by the European Parliament on ‘*Artificial Intelligence Threats & Opportunities*’ ⁶ estimates that by **2025 the volume of data produced in the world each year could be 175 zettabytes** (up from less than 1 zettabyte a year generated in 2010, which is a 175 x increase in the volume of data in just 15 years). To put that in context, a top-of-the-range laptop in 2024 may come with a 1 terabyte hard drive, which is a billion times smaller than a zettabyte. Therefore the volume of global data produced in a single year in 2025, may be equivalent to 175 billion laptop computers....or 21 laptops for every person on earth!

Data	Bytes	Size
1 Kilobyte (KB)	1,000	10 ³
1 Megabyte (MB)	1,000,000	10 ⁶
1 Gigabyte (GB)	1,000,000,000	10 ⁹
1 Terabyte (TB)	1,000,000,000,000	10 ¹²
1 Petabyte (PB)	1,000,000,000,000,000	10 ¹⁵
1 Exabyte (EB)	1,000,000,000,000,000,000	10 ¹⁸
1 Zettabyte (ZB)	1,000,000,000,000,000,000,000	10 ²¹

The volume of digital data in the world is rising so fast, and getting so large, that in 2022 scientists formally agreed two new units of measurement for the first time in 31 years. These are the **Ronnabyte (RB)** and the **Quettabyte (QB)**. A Ronnabyte is a billion, billion, billion bytes (!) and a Quettabyte is a thousand Ronnabytes...or 1 followed by 30 zeros! Scientists believe this will be sufficient for at least the next 25 years, but the relentless pace of digital innovation means we may all be using Quettabytes quicker than anyone expected!

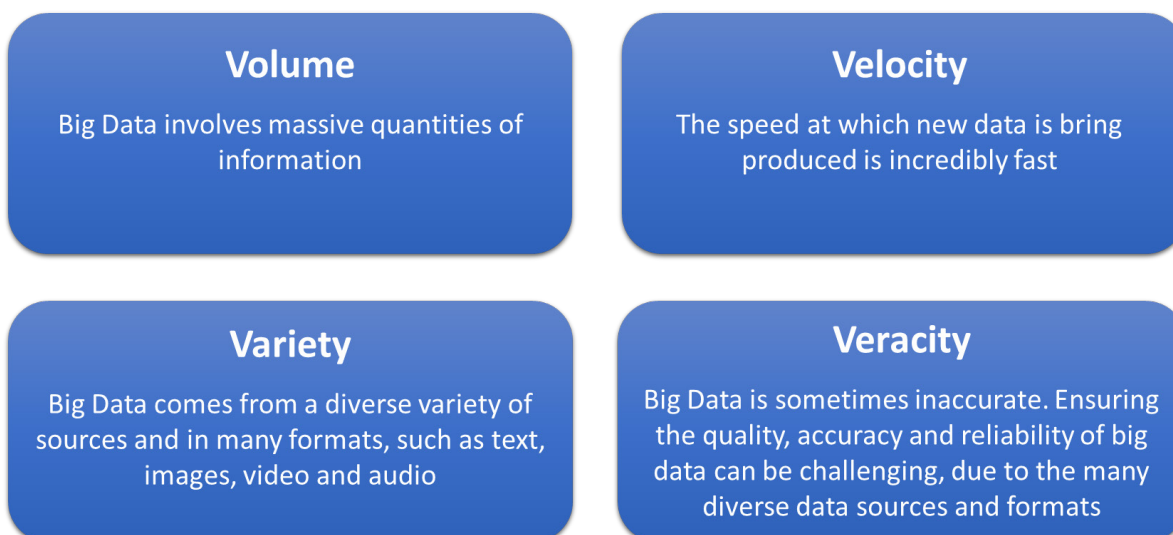
Data	Bytes	Size
1 Ronnabyte (RB)	1,000,000,000,000,000,000,000,000,000	10^{27}
1 Quettabyte (QB)	1,000,000,000,000,000,000,000,000,000,000	10^{30}

This data explosion is largely driven by three factors:

1. **Increasing numbers of smartphones and internet devices:** the number of devices connected to the internet grows every year. There are several estimates for the total number of networked devices in the world, but all agree that it is many billions of devices. The CISCO Annual Internet Report 2023 ⁷ estimates there are 29.3 billion networked devices in the world, which is more than 3 x the global population of 8 billion people (in 2023).
2. **Growth of social media:** social media platforms generate many terabytes of text, video and audio data every day (1 terabyte = approximately 1500 CD's) with billions of messages and posts made every minute. In 2020, during the height of the COVID-19 pandemic, the Head of WhatsApp (Will Catchcart) issued a tweet stating that approximately 100 billion messages were being exchanged every day on WhatsApp alone and it is estimated that videos shared on platforms such as TikTok and YouTube account for over half of all internet traffic. Social data is rising at an incredible pace, but is also very useful for AI systems to understand human behaviour.
3. **New data collection and storage technologies:** new technologies, such as sensors placed throughout our cities, energy grids and transport infrastructure, are generating huge amounts of data on human usage patterns. Similarly the '**Internet of Things (IoT)**', which are the networked everyday items (such as fitness trackers and Smart TV's) are growing in popularity and producing new streams of data. The CISCO Annual Internet Report 2023 estimates that of the 29.3 billion connected devices, 14.7 billion are IoT devices. Nearly 50% of these are connected home appliances (such as home security systems) and 30% are connected car applications (such as networked vehicle diagnostics tools, emergency calling systems and in car entertainment platforms).

This volume of data is also leading to a significant rise in **cloud computing and data storage centres**, with the U.S. hosting 10x more data centres than any other country in the world (in 2023) ⁸.

These extremely large and very complex datasets are often called '**Big Data**' and are characterised by their **volume, velocity, variety** and **veracity**, commonly referred to as the **4 V's**.



This **exponential rise in the quantity, availability, quality and diversity of data** around the globe is powering the current wave of AI technology. **Data provides the information required for AI models to learn and improve**, and is the fuel for AI systems to undertake very complex tasks at scale.

In particular 'big data' supports the rise of AI in the following ways :

1. **Training Data:** AI systems require substantial amounts of training data to learn patterns. This makes their predictions and decisions more accurate, which is especially important in areas such as self-driving cars where massive datasets of images and videos, from many different road scenarios, are captured and used to train AI algorithms, which can then perceive and navigate complex environments by themselves.
2. **Feature Extraction:** large and diverse datasets help AI algorithms to accurately identify and extract features from within data. This enables more accurate insights from AI systems, such as AI powered image recognition tools.
3. **Model Performance:** big data enhances the performance and robustness of AI models, allowing them to handle a wide range of situations and inputs. This is especially important in sectors such as healthcare, where AI systems can analyse extensive patient and medical data to assist in diagnosis, treatment and drug discovery.
4. **Predictive Analytics:** large datasets and AI can be used by businesses to forecast trends, customer behaviour and market shifts. This provides companies with actionable insights and helps with corporate decision making.
5. **Personalisation:** when AI systems can access large volumes of data on human behaviours, preferences, and interactions they can provide tailored suggestions and experiences for users. This is useful for e-commerce and social media platforms to suggest products, content, or services tailored to an individual user.
6. **Natural Language Processing (NLP):** NLP models, such as AI powered chatbots, virtual assistants and language translation systems, benefit from diverse and extensive language data, such as books, articles and social media posts. This allows an AI NLP model to understand and generate realistic human-like language very effectively.
7. **Real-Time Decision Making:** as the 'velocity' of big data accelerates, in areas such as banking transactions, AI systems can process and analyse this data in (near) real time to provide instant recommendations, or decisions, for functions such as fraud detection.

Companies have been working towards becoming more data-driven for many years, with some now using **cloud computing** to store and manage their vast quantities of data on remote cloud-based servers (rather than on premises computers), in either 'data lakes' or 'data warehouses' (or both).

A **data warehouse** is a repository that **stores structured data**, in a highly organised and optimised way. They can be thought of as very large, neatly organised, filing cabinets. Data warehouses could store information such as booking data, hotel occupancy rates, flight schedules, pricing information, financial transactions, web traffic statistics or marketing campaign performance data. This structured way of storage can be easily searched and is very good at quickly finding specific pieces of information such as "how many people booked trips to the Caribbean last year?" or "what was the average cost of a hotel room in Paris this summer?"

Alternatively a **data lake** is a repository that can **store all types of unstructured data**, such as social media posts, images, videos, customer feedback surveys, or online reviews. A data lake can be thought of as a big, open room, into which all sorts of information can be thrown, in an unstructured and disorganised manner. This form of storage is good for collecting many different types of data and for keeping all the relevant information (within privacy limits), even when you're not sure how, or when, it could be used in the future.

When the best aspects of a data warehouse and data lake are merged into one data management solution it is called a **data lakehouse**.



Data Warehouse

Data Lake

Data Lakehouse

The application of AI to each system has its advantages. For example:

AI applied with a data warehouse could:

- Optimise pricing strategies, based on historical booking data
- Predict customer preferences and recommend personalised travel packages

AI applied with a data lake could:

- Analyse social media sentiment to gauge public opinion on different travel destinations
- Use image recognition with social media photos to identify the most popular tourist attractions
- Analyse customer feedback to identify areas of concern and improve customer services

The combination of AI, data warehouses, data lakes and cloud infrastructure, provides a scalable and flexible environment for managing and gleaning insights from different forms of big data. Used together they can help a travel company provide amazing and personalised travel experiences!

COMPUTING POWER : THE MACHINES BEHIND AI

Training AI systems typically requires a lot of data. **This data can be very large and very complex and needs to be processed very quickly, which requires a lot of computing power.**

For example, sophisticated AI chatbots (such as Google Bard, Microsoft Copilot) were **trained on datasets that included hundreds of billions of words** (for comparison the Bible contains fewer than one million words). To download this volume data on a typical home internet connection and then process it for AI training could take hundreds of years on a standard computer. This task therefore requires a special type of computing power.

Let's imagine you wanted to learn everything on the internet. In 2022 there were approximately 5.75 billion webpages online. If a person spent one minute studying every page, it would take a human approximately 11,000 years to 'learn the internet' (without any breaks!). The most advanced supercomputers in 2023, which contain advanced computing power, are now able to process this vast amount of data and use AI techniques (such as deep learning algorithms) to 'learn' all this information in only a few months! **This remarkable advancement in modern computing power is enabling the current wave of AI innovations and powering many applications of AI that were simply not possible only a few years ago.**

The history of increasing computing power can be traced back to the 1960's, when Gordon Moore (a co-founder of Intel) observed that the number of transistors on an integrated circuit was doubling around every two years. This became known as '**Moore's Law**'. This doubling led to exponential growth in the power of computer chips, which has enabled computers small enough, powerful enough and cheap enough to now sit on all of our desks and power the smartphones in our pockets. But to achieve AI breakthroughs required even more computing power.

In the 1990's a company called NVIDIA popularised the term '**Graphics Processing Unit**' (GPU), which was typically an electronic circuit board that plugged into a computer to accelerate its power. This became a critical piece of technology for computer gamers (and later Hollywood), as it enabled very fast and realistic rendering of graphics and special effects. GPU chips led computer games to advance from pixilated images to realistic graphics in just a few years, to the point where they are now almost indistinguishable from real life. The images below show just how much computer graphics, powered by GPU chips, have improved in only the last 3 years.

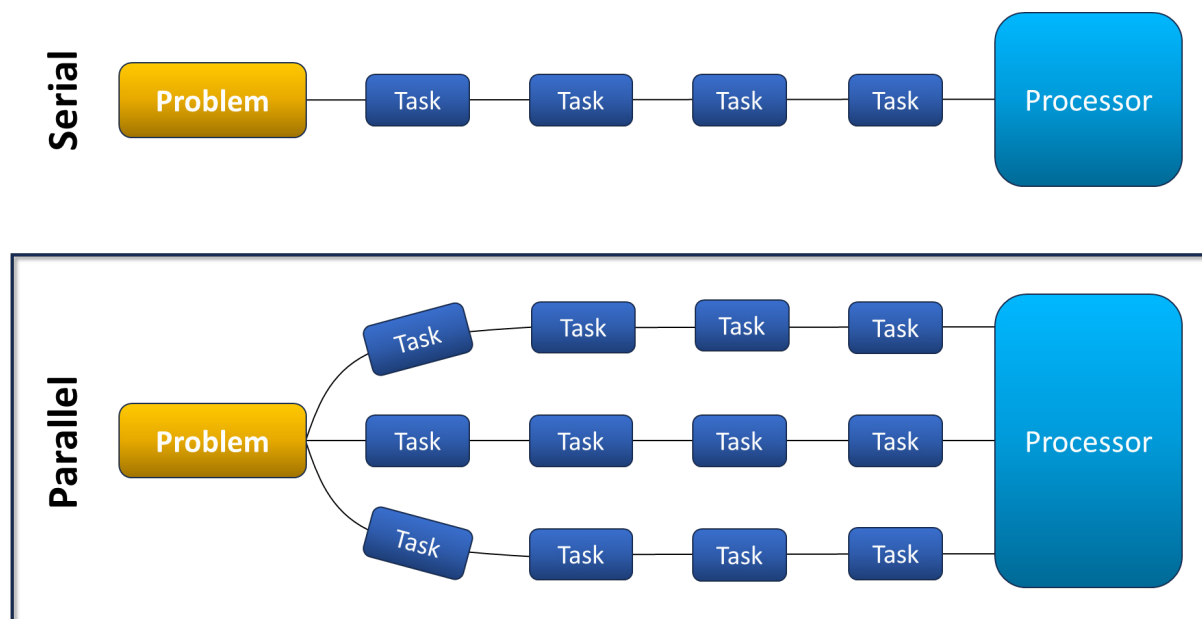


*eFootball Computer Game Graphics of Argentinian Lionel Messi
(2021 to 2023) ⁴¹*

Real Lionel Messi

The rapid advance of GPU chips partly explains why now is a global moment for AI. **As GPU technology evolved for computer games, a key innovation was their ability to process tasks in parallel (rather than sequentially as in normal computers) and it turns out the accelerated parallel processing required to create lifelike graphics in computer games and movies is ideal for powering AI applications and especially deep learning systems, such as sophisticated AI chatbots.** Therefore GPU computer chips, originally from the gaming industry,

are now a core and essential part of AI. This need has, in turn, propelled NVIDIA to become one of the world's most in demand and valuable companies, reaching a market valuation in excess of \$1 trillion in 2023, joining only 5 other companies in the world to have reached that level (who are **Alphabet [the parent company of Google], Amazon, Apple, Microsoft and Saudi Aramco**)

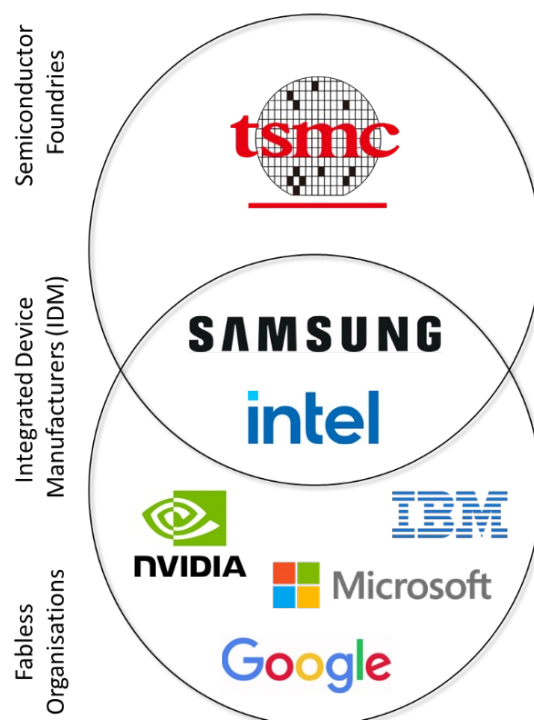


Demand for these cutting-edge GPU chips is growing very rapidly around the world, but **only a few companies and countries have the specialist knowledge and ability to produce them**. Computer chips are therefore a source of geo-political tension, especially between the U.S., China and the EU, who each have strategic ambitions for AI and have therefore announced plans, or legislation, to strengthen their local chip design and manufacturing capabilities.

China, for example, has published a '**Made in China 2025**' roadmap ⁹ which aims to improve the country's position as a manufacturing superpower by 2025 (including in the production of semiconductor chips). At the time of publication of this report, negotiations are underway to raise **300 billion Yuan (RMB)** ¹⁰ for an investment fund that can be put towards chip manufacturing in China. In Europe the '**EU Chips Act**' ¹¹ aims to secure the region's supply of semiconductors by investing **€42 billion (EUR)**, alongside a three pillar strategy to improve EU semiconductor R&D, increase the EU's production capacity and to set up a new EU monitoring and crisis response mechanism for any future chip shortages. In the U.S. the '**US Chips & Science Act**' ¹² includes **\$52 billion (USD)** for semiconductor R&D, manufacturing and workforce development. The Act also includes a 25% tax credit to encourage companies to build chip manufacturing plants in the U.S. (estimated to be worth \$24 billion [USD]) and when combined with other US regulations, places export restrictions on US designed semiconductor technology. **Such large investments and semiconductor strategies by the world's great powers illustrate the strategic importance of this chip technology.**

At the 2023 World Economic Forum in Davos, **Intel CEO Pat Gelsinger** said “*there is no innovation without semiconductors*”. As the global economy becomes increasingly dependent on digital technology, he argued that “*the world needs more geographically balanced and resilient chip supply chains*”¹³.

This is because many computer chip companies (including NVIDIA) are ‘**fabless**’ organisations, meaning they design and sell chips, but do not manufacture them. Their manufacturing is outsourced to a specialised ‘semiconductor foundry’, such as **TSMC** (Taiwan Semiconductor Manufacturing Company) which is by far the largest chip manufacturer in the world with approximately 55% market share. The second largest is **Samsung** in South Korea, with approximately 15% market share in 2023.

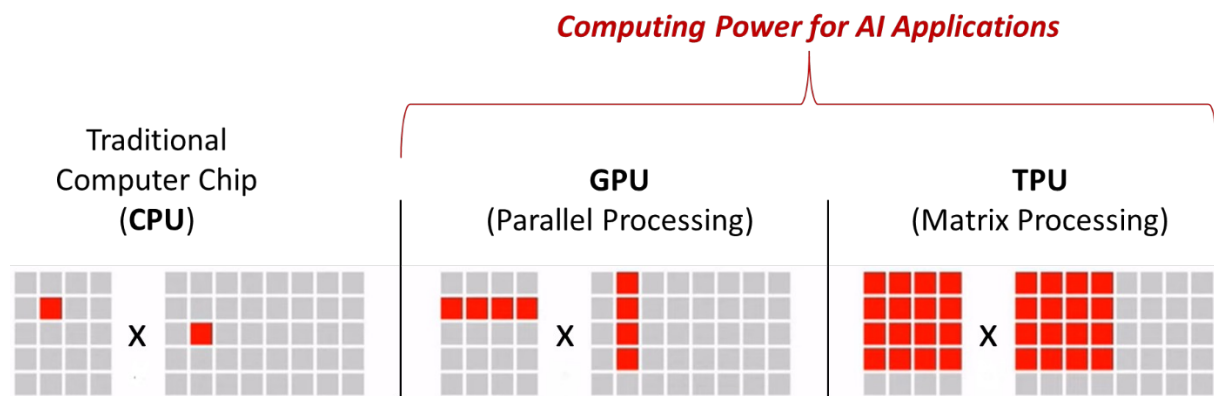


Example chip producers (not an exhaustive list)

This means around **70% of the world's computer chips are manufactured by just two organisations**. These power not only AI systems, but everything that requires a semiconductor chip, from cars to household appliances. As the world emerged from the COVID-19 pandemic, this dependence was brought into sharp focus with very public halts to car production lines due to a global chip shortage. Quite simply without TSMC the global digital economy would grind to a halt. Raising awareness of this risk has led to further geo-political tensions surrounding the future of Taiwan, where TSMC is based.

The very limited number of GPU chip designers and manufacturers around the world has therefore led several major technology companies to develop their own chips to power AI applications, including **Amazon, Apple, Google, IBM, Microsoft** and **Tesla**. Chip designers and manufacturers including **Intel, AMD** and **Qualcomm** are also building new production facilities. TSMC, for example, is building a plant in Arizona (its first production facility outside of Taiwan) and Intel is building a new plant in Ohio, with tax credits provided by the US Chips & Science Act.

Since 2016, **Google** has also developed its own chip that is specifically designed for AI, called a **TPU (Tensor Processing Unit)**. Although GPU chips are at the core of most AI computing power today and can perform tasks in parallel, a **TPU chip takes this a step further and can perform ‘matrix calculations’ which significantly accelerates machine learning tasks**. These differences could be thought of like a traditional newspaper printing press – a normal laptop computer could print one letter at a time, a GPU chip could print a whole line of text at a time, and a TPU chip could print an entire page at a time.



CPU vs GPU vs TPU

The ‘matrix’ capability of TPU chips makes them ideal for training and deploying very large AI models. They are already installed in many Google data centres, so when you use Google Translate today (which involves AI processing in the background), TPU’s are probably powering your query^{14 15}. The latest generation of Google TPU’s (TPU v5) are capable of nearly 400 trillion calculations per second!

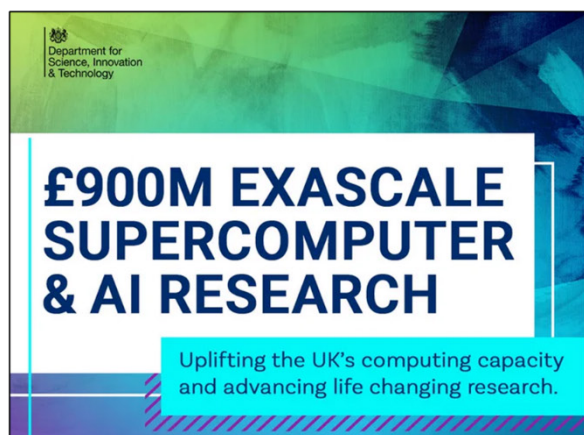
But despite this incredible ability, the real magic happens when thousands of chips are interconnected to create a single **supercomputer** that is capable of handling very demanding AI workloads. In 2020 **Microsoft** built the supercomputer used to train ChatGPT¹⁶. It used **10,000 GPU chips** and cost millions of dollars. At the time it was not only **the largest supercomputer built in the public cloud**, but also the **5th largest supercomputer ever built**¹⁷.

Semiconductor chip technology and cloud infrastructure have only recently made such large scale, powerful supercomputers possible. But most members of the general public and users of AI chatbots (or other sophisticated AI systems) probably have no idea about the massive scale of computing power required behind the scenes to train and drive these advanced AI capabilities.

These very large and very expensive supercomputers can take up entire warehouses of space and cost many millions of dollars to build and run. This has caused concern with some university academics and national governments who may not be able to afford these very large investments, or have the technological capability to build and operate supercomputers themselves. There is therefore a legitimate concern that the computing power required for AI may mean that AI cannot be studied by everyone, or benefit everyone in society. This disparity may lead to a greater ‘**digital divide**’ in the world (discussed later in this report).

It is important that the benefits of AI are able to reach everybody on the globe and some governments have taken a strategic decision to invest in national computer infrastructure capable of training and running large scale AI applications. The UK, for example, committed £900 million (GBP) in March 2023 to build an **exascale UK supercomputer**¹⁸ called ‘**Isambard AI**’^{19 20} (named after the famous British engineer Isambard Kingdom Brunel) that will enable ‘*researchers in the UK to better understand climate change, power the discovery of new drugs and maximise the potential of AI*’.

An exascale supercomputer is a computer that can carry out 1 quintillion calculations a second – that is a billion, billion, calculations per second (or **1,000,000,000,000,000,000 calculations every second!**), a metric known as an ‘**exaflop**’.

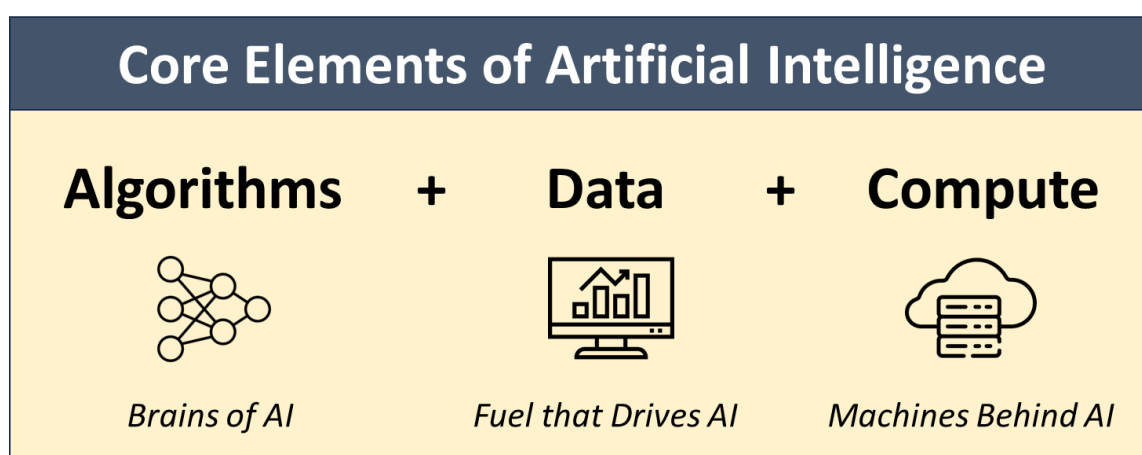


UK £900 million (GBP) investment in an 'exascale' computer for AI research

But Travel & Tourism companies wishing to develop their own AI applications do not need their own dedicated, or purpose-built supercomputer, because several technology companies (including Google, Microsoft, IBM and others) provide access to AI models and data management tools with their cloud technology which connects to the providers supercomputers.

For example, a Travel & Tourism company could take a sophisticated AI chatbot that has been 'pre-trained' on a supercomputer (with huge amounts of data from the internet) and with a technology partner '**fine tune**' it for their specific business tasks. This uses far fewer computing resources and allows the Travel & Tourism business to use their own data that is specific to their company, combined with the already pre-trained general data from the internet. As this paper is an 'Introduction to AI', it does not include more details on 'fine tuning' AI models for specific business uses, but additional AI guidance material on this topic may be developed by WTTC in the future.

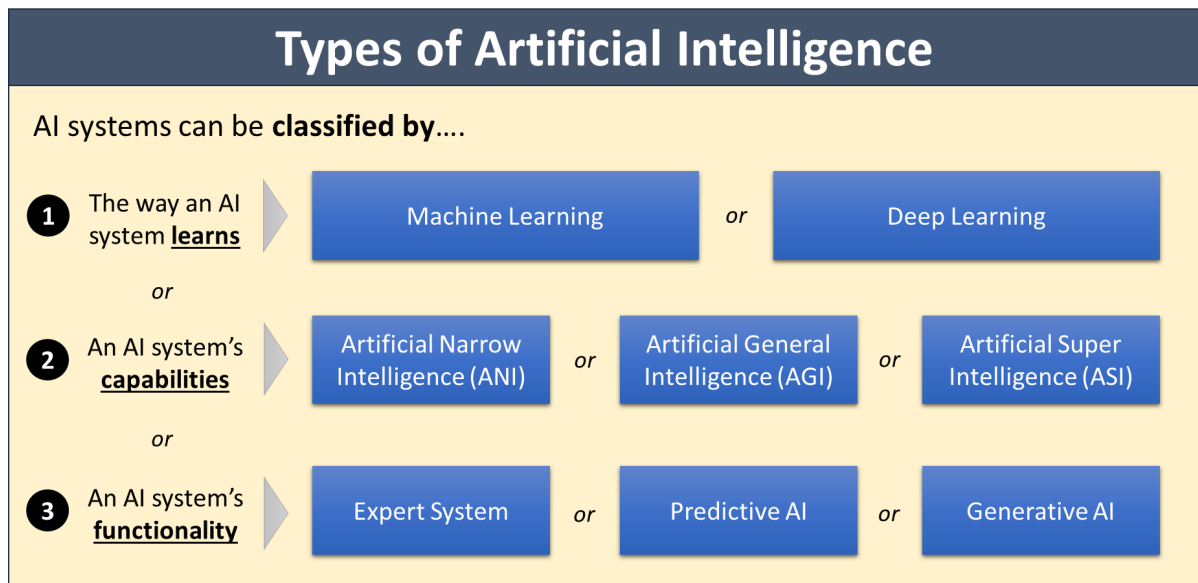
Cloud computing is the general term for anything that involves delivering computer resources over the internet. Companies, or individual users, can now pay for and access large amounts of computing power on demand via the cloud. But when referring to the total cloud computing system, which involves not only the processing power (e.g. GPU's or TPU's), but also the memory, networking and storage requirements, the term '**compute**' is used. Therefore the jigsaw puzzle image at the start of this chapter, with the three core elements of AI, is more often referred to as **Algorithms + Data + Compute** (rather than computing power) to reflect the essential elements of AI.



As these three core components of AI get increasingly more **capable**, **accessible** and **affordable** to businesses and the public, **what AI can really achieve in the future is yet to be determined!**

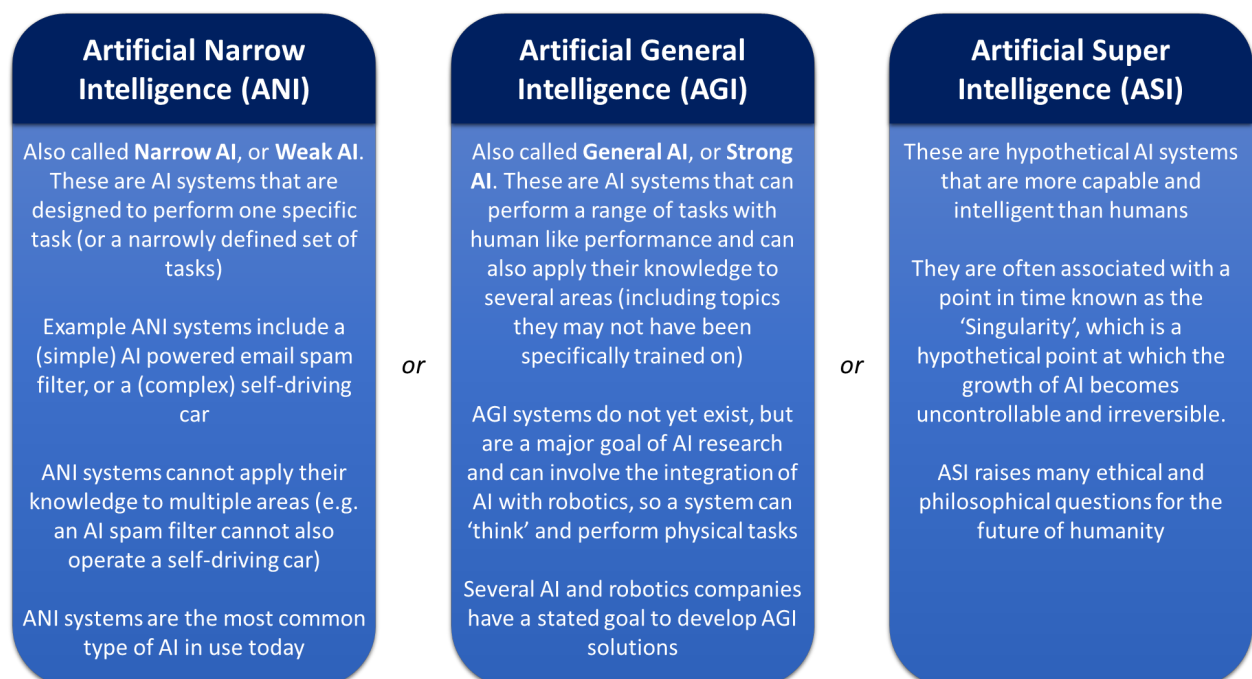
TYPES OF ARTIFICIAL INTELLIGENCE

As noted at the start of this chapter, **artificial intelligence is a multi-use technology**, with many different applications. There are therefore different ways that AI systems can be categorised, but they are normally segmented into one of three categories - either by the **way they learn**, by their **capabilities** or by their **functionality**.



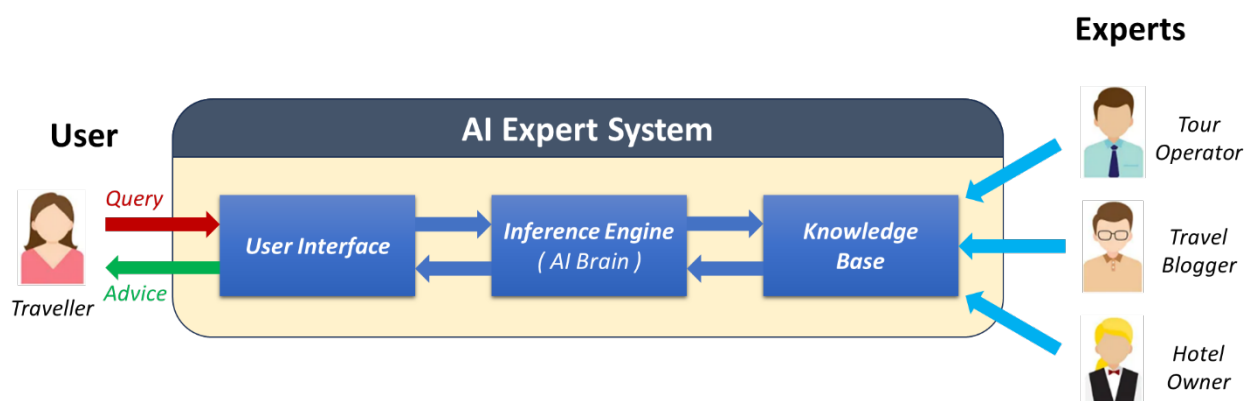
The previous section of this report summarised the different ways that AI systems can be **categorised based on the way they learn**. This includes **machine learning** and **deep learning**, with different techniques for training these AI systems including **supervised learning**, **unsupervised learning** and **reinforcement learning**.

The second useful way to group, or classify, an AI system is based on its **capability**, which means an AI system delivers either **artificial narrow intelligence (ANI)**, **artificial general intelligence (AGI)**, or **artificial super intelligence (ASI)**.



The third useful way to classify an AI system is based on its **functionality**. For many years this involved an AI solution either being considered as an **Expert System**, or as **Predictive AI**, but now also includes a relatively new field of artificial intelligence functionality called **Generative AI**.

An **AI Expert System** is a smart computer program that uses AI to simulate the expertise of humans in a specific area, such as for travel planning, medical diagnosis or financial advice. Expert systems contain a knowledge base of rules and facts about a specific domain, which are combined with AI (in a system called an ‘inference engine’) to reason through problems and provide advice, or recommendations.



For example a **travel AI expert system** could help travellers to plan and book their trips. This would start with the collection of a large amount of data relating to travel, such as information on destinations, hotels, airlines, restaurants, excursions and travel regulations, which would be fed into a knowledge base. Travellers could interact with the AI expert system through a friendly user interface (such as a website, smartphone app, or chatbot) in a natural, conversational way to communicate their travel dates, budget and interests, and the AI ‘brain’ could provide personalised recommendations and itineraries. To complete the process, AI expert systems can also be integrated with booking platforms to enable travellers to make reservations directly through the system.

AI expert systems therefore capture human knowledge and combine it with AI to provide expert level advice and conclusions. The knowledge base represents the domain expertise, while the inference engine provides the AI reasoning capabilities. Benefits of AI expert system include:

- **Time & Cost Savings:** AI expert systems can search through large amounts of data and generate travel itineraries very quickly and efficiently.
- **Personalised Customer Service:** AI expert systems can take account of a traveller’s individual preferences and requirements to provide them with highly tailored recommendations.
- **Wide Expert Knowledge:** AI expert systems can draw from the expertise of many stakeholders who have fed into the ‘knowledge base’, which for Travel & Tourism could include travel agents, travel bloggers, tour operators and other travel professionals.

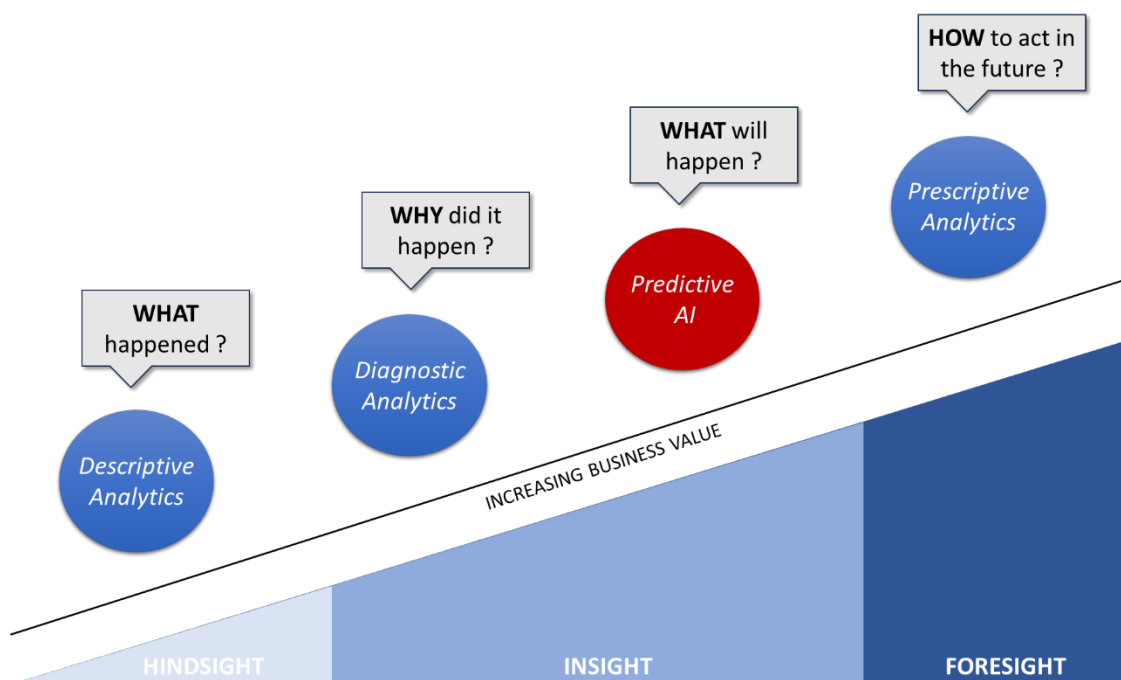
Predictive AI is another way to classify an AI system’s functionality and refers to AI that uses current and historical data to make predictions about future events, outcomes, or behaviours. They do this by analysing large amounts of data to identify patterns, trends and relationships that can help to anticipate the future. A common form of predictive AI is weather forecasting, which analyses historical weather data and current conditions to predict the likely future weather.

An example of how predictive AI can be used in travel is for **flight delay predictions**. An airline may use a predictive AI system to analyse a variety of historical and real time data including weather conditions, aircraft maintenance issues, airport congestion and other factors that could impact delays such as air traffic control data. The AI system can identify patterns in this data and create models that estimate the likelihood and potential length of

future flight delays, under various conditions. With this information airlines can better schedule crews, gates, and other resources to proactively minimise passenger inconvenience. Predictive AI therefore allows airlines to get ahead of potential disruptions to their operations.

Predictive AI can also be combined with other forms of data analytics to create more comprehensive and powerful approaches to solving complex problems and gaining valuable business insights. Examples of other data analytical techniques that can be combined with predictive AI include:

- **Descriptive Analytics:** this summarises the past using historical data and helps to answer questions such as WHAT, WHERE and WHEN something happened by using methods such as dashboards, reports and other visual imagery to see and analyse patterns. For example this could involve analysing flight delay reports and displaying key information on a dashboard.
- **Diagnostic Analytics:** this aims to understand WHY something happened by investigating its root cause. For example by analysing weather data and aircraft maintenance logs it may be possible to diagnose why flight delays occurred. These important insights from diagnostic analytics can also improve the accuracy of predictive AI models. For example, by understanding the reasons for past flight delays, it can help to better predict potential future delays.
- **Prescriptive Analytics:** this suggests HOW to act in the future based on the data insights. By combining predictive AI forecasts with prescriptive recommendations it enables better planning and responses to potential future events. For example airlines could prepare and rapidly reallocate crews if significant delays are predicted.



GENERATIVE AI

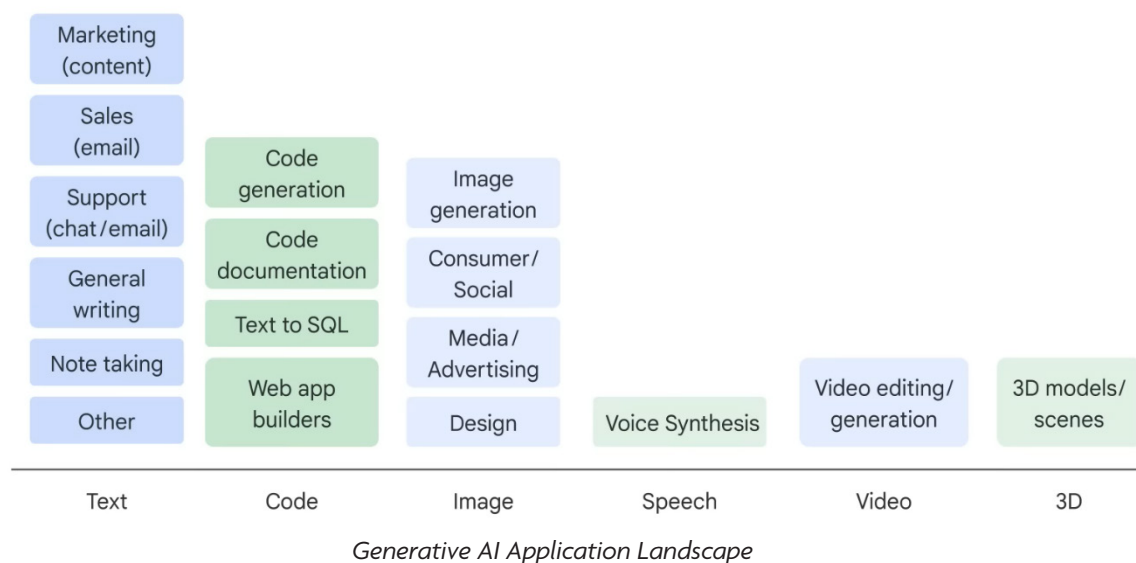
Generative AI (sometimes abbreviated to “Gen AI”) is a relatively new form of AI that burst onto the global scene in late 2022 with the release of a sophisticated AI chatbot called **ChatGPT**.

ChatGPT took the world by storm with its ability to generate intelligent and amusing written content that resembles human speech, combined with its capability to generate useful, high quality content very quickly, such as emails, poems, business plans, holiday schedules and much more.

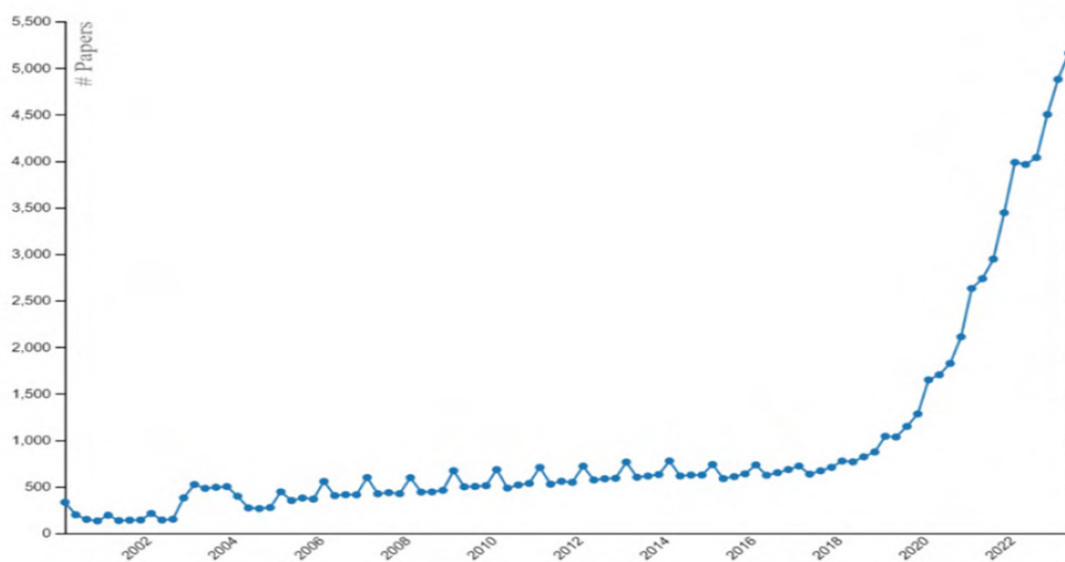
As illustrated in the earlier chapters of this report, AI technology has been around for many years and routinely used in applications such as weather forecasting, or email spam filters, but these are often hidden and unknown to the users of systems. ChatGPT, along with other sophisticated AI chatbots released in 2023 such as **Google Bard** and **Microsoft Copilot**, could be credited with really exposing the power and potential of AI to corporate businesses and the mass general public.

AI chatbots are powered by generative AI, which is a type of AI technology that can produce new and creative content such as text, imagery, video and audio, from a user ‘**prompt**’. It creates this new content based on the prompt and what it has learned from very large quantities of training data (sometimes many millions of internet pages) to produce a **generative AI model**.

An example of this is **foundation models** which can be defined as “AI models trained on a broad data set that can applied to a wide range of downstream tasks” ²¹. These enable anyone to automate projects and generate amazing content on a standard computer. The diagram below illustrates just some of the possible outputs (such as text, computer code, images and video) and tasks (such as producing marketing and advertising material, website building, video editing and document summarisation) that generative AI foundation models can achieve.

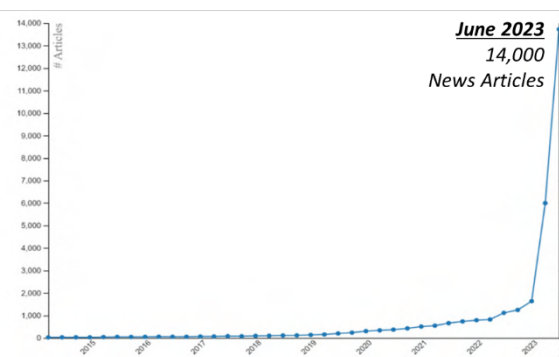


Generative AI has its origins in a 2017 Google research paper entitled “**Attention Is All You Need**” ²², which introduced a new type of AI architecture for language understanding called ‘**Transformers**’. Many research organisations, universities and companies have investigated this technique to develop innovative AI applications. Since 2017, the number of scientific publications focussed on generative AI has grown fivefold and venture capital (VC) investment in generative AI solutions reached \$12 billion (USD) in the first six months of 2023 alone.

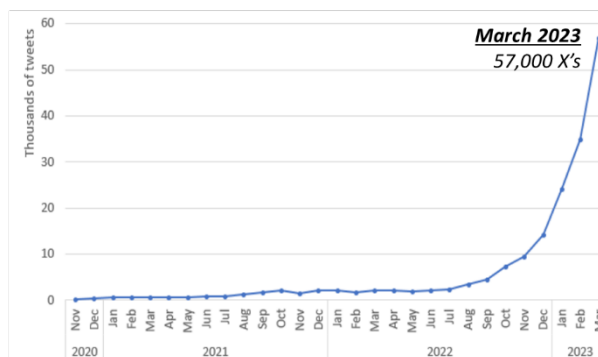


Number of Scientific Publications on Generative AI (by year)

Generative AI's ability to produce new, exciting and creative content is predicted to create considerable global business and economic value, but also comes with potentially significant challenges and risks (discussed further in the accompany WTTC report on '**AI Risks & Governance**'). As a result generative AI has taken centre stage in many public, academic and political discussions. This can be illustrated by the huge rise in global news stories and posts on X (formerly Twitter) dedicated to generative AI worldwide, with international news stories on generative AI increasing from just under 2000 in late 2022, to nearly 14,000 by June 2023. The number of posts on X (tweets) rose from 7000 in October 2022, to 57,000 in March 2023 (an 8x increase) ²³. The global interest in this new form of AI is phenomenal and is therefore an important technology for all Travel & Tourism businesses to recognise.



Number of Global News Articles



Number of posts on X (formerly Twitter)

A specific type of generative AI foundation model is a **large language model (LLM)**, which is a sophisticated AI model designed to generate human like text responses to a user's prompt. It is the underlying AI model driving AI chatbots (such as **Google Bard** or **Microsoft CoPilot**). The user 'prompt' is commonly a text input, but could also be something else, such as an image or audio input for example.

A prompt allows the user to provide instructions to an LLM (often an AI chatbot) in a natural conversational style, which is understood by the AI in a process called **natural language processing (NLP)**. This natural, conversational way of providing instructions to an AI system is the same way that instructions are provided to 'home smart speakers' and is a new, exciting and innovative way for humans to interact with computers.

A simple example of a text prompt and response from a LLM could be:



What is the world record for the 100m sprint?

The world record for the 100m sprint is 9.58 seconds, set by Usain Bolt of Jamaica on 16 August 2009 at the World Athletics Championships in Berlin, Germany.



Sophisticated AI chatbots, powered by LLM's, are also able to remember the details and context of a conversation and reply as part of a free flowing discussion. For example if the prompt "*how does this compare to a cheetah*" is added after the above response, the AI system knows to compare it to Usain Bolt over 100m, without the user specifically having to ask how a cheetah compares to the runner. This natural way of communicating and remembering previous parts of a discussion is how a human conversation would flow and is being replicated by the generative AI system.



How does this compare to a cheetah?

A cheetah is significantly faster than a human. In a 100m race, a cheetah would cross the finish line in about 5.95 seconds, while Usain Bolt would take 9.58 seconds. Cheetahs have a top speed of around 70 miles per hour, while Usain Bolt's top speed for the 100m sprint is approximately 23 miles per hour.



To achieve such impressive abilities, LLM models are typically trained on enormous amounts of text data (sometimes called a '**corpus**', meaning a large collection of documents) to learn the patterns, grammar, and semantics of one, or more, languages and use AI **deep learning** techniques to understand and generate coherent, conversational and contextually appropriate responses in only a few seconds.

LLM's, such as those that power sophisticated AI chatbots, are remarkably versatile and accurate in comprehending and generating text across a very wide range of topics and writing styles. Below are a few more examples of complex prompts provided to an AI chatbot that demonstrate their ability to remember the previous parts of a conversation, perform translation, summarise text, draw tables and populate them with content drawn from multiple sources.



Explain what WTTC does in 1 sentence that is suitable for a WhatsApp message

WTTC is a global organisation that works with governments and businesses around the world to promote the travel and tourism industry





Translate the first sentence to Spanish, the second sentence to Japanese and the third sentence to Icelandic



1. La Junta Mundial de Viajes y Turismo (WTTC) es una plataforma única para que los gobiernos interactúen con las empresas para dar forma conjuntamente al futuro del Viaje y Turismo y garantizar su competitividad, inclusividad y sostenibilidad a largo plazo.

2. WTTC は、高レベルの政府イベントに参加し、連邦、州、地方政府と積極的に多利益関係者対話に参加し、セクター全体の連携を達成します。

3. Til að upplýsa ákvarðanatöku á opinberum vettvangi framleiðir WTTC trausta rannsóknir og innsæi leiðtogaskýrslur, frá neyðarbúnaði til áfangastaðar 2030, auk mælanleiðra bestu framkvæmda sem spanna frá öryggi, þróun starfsfólks, sjálfbærni og áfangastaðastjórnun.



Draw a table of reports published by WTTC in 2022 and include a short description of each report.



Report Title	Description
Economic Impact Research	This report provides an in-depth analysis of the economic impact of the travel and tourism industry, both globally and in individual countries. It also provides forecasts for the future of the industry.
Digital Travel Portals	This report provides guidance on how governments can implement a digital travel portal to facilitate safe and seamless travel.
Codes to Resilience	This report identifies the key factors that will determine the resilience of the travel and tourism industry in the face of future shocks.
Destination 2030	This report assesses the readiness of global cities to achieve sustainable tourism growth by 2030.
Nature Positive Travel & Tourism	This report outlines the steps that the travel and tourism industry can take to become nature positive, meaning that it contributes more to the environment than it takes away.
Staff Shortages	This report examines the challenges that the travel and tourism industry is facing in terms of staff shortages and proposes solutions to address this issue.
Best Practices for Short-Term Rentals	This report provides guidance on how to regulate short-term rentals in a way that benefits both tourists and local communities.



Add a column including the month they were published.

Report Title	Description	Month Published
Economic Impact Research	This report provides an in-depth analysis of the economic impact of the travel and tourism industry, both globally and in individual countries. It also provides forecasts for the future of the industry.	February 2022
Digital Travel Portals	This report provides guidance on how governments can implement a digital travel portal to facilitate safe and seamless travel.	March 2022
Codes to Resilience	This report identifies the key factors that will determine the resilience of the travel and tourism industry in the face of future shocks.	June 2022
Destination 2030	This report assesses the readiness of global cities to achieve sustainable tourism growth by 2030.	September 2022
Nature Positive Travel & Tourism	This report outlines the steps that the travel and tourism industry can take to become nature positive, meaning that it contributes more to the environment than it takes away.	October 2022
Staff Shortages	This report examines the challenges that the travel and tourism industry is facing in terms of staff shortages and proposes solutions to address this issue.	November 2022
Best Practices for Short-Term Rentals	This report provides guidance on how to regulate short-term rentals in a way that benefits both tourists and local communities.	December 2022



It is important to remember that **the text output from the AI chatbot in the above examples is generated entirely by AI** and based on the vast amounts of information it has been trained on from the internet. It has not simply copy-and-pasted these responses from the WTTC website, as these exact paragraphs, descriptions and tables do not exist in this format on the WTTC website.

However in the last example, where the AI chatbot was asked to provide the months that the reports were published, it has provided incorrect information. This is known as a **'hallucination'** and is a feature of all AI chatbots today. Sometimes they produce answers, information and statistics that look accurate and sound convincing, but are in fact incorrect. This is due to the complex way that large language models produce their output. Some common reasons for hallucinations are illustrated below.

- ! The model is not trained on enough data
- ! The model is trained on noisy or dirty data
- ! The model is not given enough context
- ! The model is not given enough constraints

Reasons for Generative AI Hallucinations

In the AI chatbot example above, the table is also incomplete as it has missed other reports published by WTTC in 2022, including a report on 'Critical Factors to Attract Hotel Investment' (published in June 2022) and a joint report with Harvard University on the 'Circular Economy in Travel & Tourism' (published in May 2022). Nevertheless, the AI has done a remarkable job of finding and correctly summarising the majority of WTTC reports, in only a few seconds, from a single sentence text prompt asking for information on the reports published by WTTC in 2022 (written in a natural conversational way).

Hallucinations are a well known feature of current generative AI systems and many researchers are working on solutions, so that future versions of AI systems will have improved accuracy and better performance. All users of generative AI systems today (including Travel & Tourism businesses) should therefore be aware of their current limitations and are advised to verify any AI generated outputs that may be business, safety or operationally critical.

Whilst AI chatbots may be many peoples first introduction to generative AI applications there is a very rapidly growing market of AI applications and open source AI models. Open source tools are freely available to download and use and in some cases they can be manipulated to your exact user needs and with your own data in a process called '**fine tuning**'.

The diagram below from Sequoia Capital (a U.S. venture capital firm) attempts to map the generative AI market by use case ²⁴ . It illustrates the many and varied generative AI applications available in September 2023, but this still does not capture all available applications.



Generative AI Market Map v3 (by Sequoia Capital)



This ‘explosion’ of generative AI applications has caused many world leaders to call for a proper debate on the opportunities and challenges related to generative AI and the regulatory needs and guidelines required for its safe and responsible use. The UK government therefore hosted the world’s first **AI Safety Summit** in November 2023.

Many countries are currently leveraging their existing legal and policy frameworks to manage the risks of AI, whilst in Europe the EU is advancing a continent wide ‘AI Act’ to responsibly seize the opportunities presented by AI. Many other multinational groups including several UN bodies, the G7 and private sector companies are also developing responsible AI guidelines. These are discussed further in the ‘AI Risks & Governance’ report from WTTC.

In September 2023, an OECD report prepared for the 2023 Japanese G7 Presidency identified seven common challenges posed by generative AI that require international alignment and collaboration²³. The report noted that international policy frameworks for generative AI should be inclusive and feature input from a diverse range of stakeholders, not just ‘AI experts’ and include the perspectives of governments from both developed and developing countries, private companies, civil society and interested sectors of the economy. This includes international Travel & Tourism.

GLOBAL DIGITAL DIVIDE & AI SKILLS GAP

As noted earlier in this chapter, as AI systems access more high quality data and use greater computer power, they become more accurate, creative and insightful. However it is also important to note that handling massive amounts of data can present privacy, security and data governance challenges for AI developers and users and that there is a significant data and ‘**digital divide**’ in the world.

The International Telecommunications Union (ITU) – the UN agency responsible for advancing digital technology – estimates that **34% of the world has never been connected to the internet (in 2022), representing 2.6 billion people**²⁵. Therefore a third of the world’s population does not have access to AI.

The ITU considers that ‘*universal and meaningful digital connectivity*’²⁶ (defined as a ‘*the possibility for everyone to enjoy a safe, productive and affordable online experience*’) should be a global priority. The ITU states that the **AI revolution should benefit everyone in the world and should not worsen the international digital divide**.

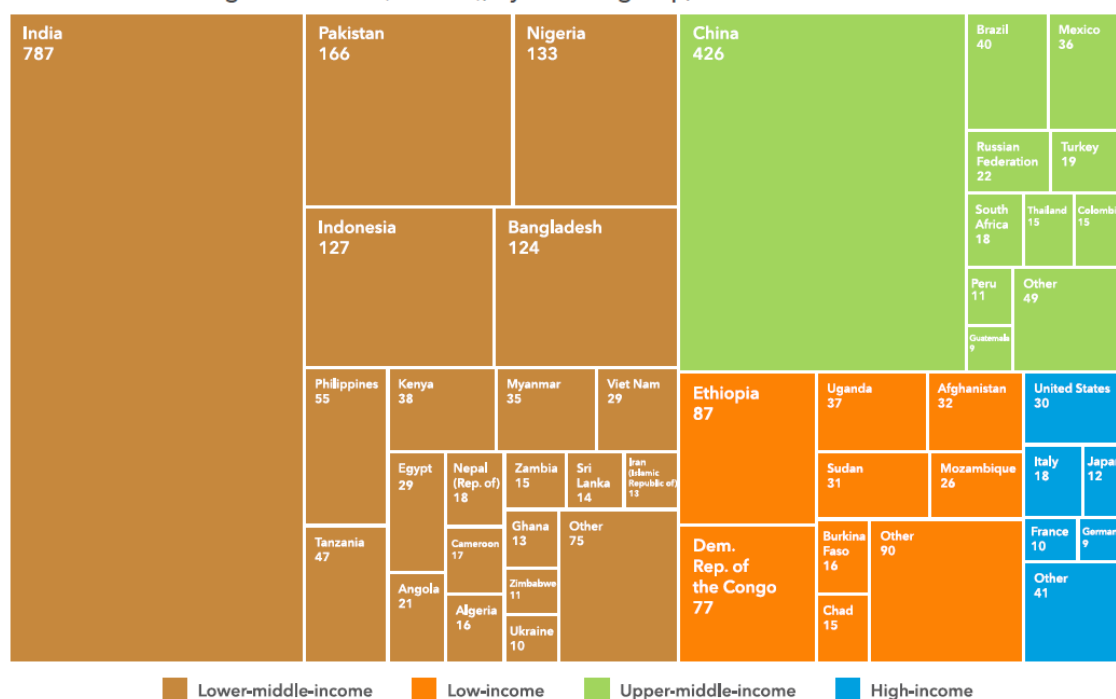
ITU data shows that the global youth are the driving force behind connectivity, with **75% of all 15-24 year olds in the world now online**, compared to 65% amongst the rest of the population. Sadly the affordability of entry level fixed and mobile internet services is leaving populations in the least developed countries (LDCs) behind.

ITU data from 2022 finds that in a typical low income economy, the cheapest mobile broadband costs 9% of a person’s income (over 6x the global average) and in those **least developed countries 64% of the population is not connected to the internet** (almost double the global average of 34% who are not online).

To begin to address this issue, the UK and Canada announced an ‘**AI for Development**’ vision at the 2023 UN General Assembly (UNGA)²⁷, which **aims to boost local AI skills, innovation and computing power in the world’s poorest nations**, with an initial focus on Africa. Then UK Foreign Secretary, James Cleverly stated at the UN launch that “*the opportunity of AI is immense...and the UK alongside our allies and partners is making sure that the fulfilment of this enormous potential is shared globally*”

In addressing digital inequality, the science fiction writer William Gibson (who first used the term ‘cyberspace’ in his 1984 novel *Neuromancer*) is reported to have said over 30 years ago that “**the future is already here, it’s just not evenly distributed yet**”. This could be used to describe the global digital divide and AI situation today.

Individuals not using the Internet (millions), by income group, 2020



The Worlds Offline Population : ITU Global Connectivity Report 2022
 (Size of tile represents the country's share of the world's offline population)

At the annual UN mid-year policy discussions on urgent global issue in July 2023, the ITU Secretary General , Doreen Bodgan-Martin said that “in a world where 95% of the global population is within range of a mobile broadband network, mere connectivity is not sufficient” adding “too many people who could go online decide against it because they do not have the digital skills” ²⁸. **IT illiteracy and the digital skills gap are therefore barriers to a successful AI future for everyone.**



UN ITU Secretary General, Doreen Bodgan-Martin

This digital skills gap affects both developed and developing countries. In 2023, international HR and recruitment company Randstad surveyed 7,000 employees in companies of all sizes, across 34 countries and found that **only 13% of workers had been offered any form of AI training in the last 12 months**²⁹. This is despite a huge global surge in AI, with Randstad also observing a 20x increase in the number of new job postings across all industries requiring AI skills in 2023³⁰. Their research also found that **AI training was the third most requested form of development requested by workers**, after leadership and wellbeing training.

A similar result was found in the GitLab 2023 global survey of software development companies³¹. It's showed that even **when AI training was provided within organisations, there was a significant difference in the quality and availability of training across seniority levels**. Those lower in organisations were most concerned about job losses from AI, yet were not provided the skills necessary to work with and alongside AI technology, with the report noting that *"although this suggests that organisations are making a top-down attempt to make AI resources available to employees, those resources may not be adequate at lower levels"*

Commenting on the report, the training organisation Skillsoft said *"investing in reskilling and upskilling is vital to ensure everyone can benefit from AI"*. To ensure this, the firm argued *"organisations must take a stronger stance on training employees to use AI strategically and responsibly within their existing roles"*. A 2023 global survey of corporate executives by the **IBM Institute of Business Values also found that most business leaders estimate that implementing AI and automation within their company will require at least 40% of their workforce to re-skill over the next three years**³².

But the thought of digitally retraining half, or more, of an entire workforce can seem like a daunting and expensive task. That is why organisations, such as Microsoft, Google and IBM offer basic AI training for free via their YouTube channel and website (such as online at **Microsoft Learn**³³, **Grow with Google**³⁴ or **IBM Training**³⁵), often in partnership with organisations such as LinkedIn Learning, Coursera and edX. In September 2023, **IBM also announced a plan to help close the AI skills gap by training 2 million people in AI by the end of 2026, with a focus on underrepresented communities**³⁶. To achieve this goal IBM is collaborating with universities and training providers around the world to deliver adult education and launching new generative AI coursework on topics such as 'Prompt Writing' and 'Improving Customer Service with AI' through **IBM SkillsBuild**³⁷.

Many online creators are also making videos on how to use AI and there have been more than 1.7 billion views of videos related to AI tools on YouTube in 2023 alone³⁸. More sophisticated, paid for training courses are also available from several universities (both in person and online) and many training providers who may also offer consulting services to tailor training to your specific organisational needs.

A simple, useful tool, for training an entire workforce can also be **peer-to-peer training**, where an employee who attends a training course (or workshop/seminar) shares the key learnings with other members of the team. **Awareness training** and **co-mentoring**, where teams coach each other and swap expertise in one-to-one sessions, can also allow organisations to make the best use of staff that already have specific digital skills.

Many countries and companies are right at the start of their AI journey, with AI education and training essential to ensuring everyone benefits from AI. But **this is not only the responsibility of businesses and starts with government driven digital education in schools**, with AI training made available to everybody, at all stages of life, and especially in the least developed counties to help close (not expand) the global 'digital divide'.

QUIZ

Can you tell the difference between AI and human generated content?

Can you identify if the below text and images are generated by AI?

The answer is at the back of this report...

Q : Explain how AI could change travel and tourism over the next 10 years ?

Example Answer 1:

Over the next decade, AI is set to reshape the travel and tourism industry in various ways. With its ability to process vast amounts of data, AI will offer personalised travel recommendations, optimise travel operations, and enhance customer service through virtual assistants and chatbots. AI will act as a virtual travel concierge, providing real-time assistance during travel and AI-powered smart recommendations will help travellers make better informed decisions. However, the industry will need to navigate ethical considerations and strike a balance between the benefits of AI and maintaining a human touch in the travel and tourism experience.

Example Answer 2:

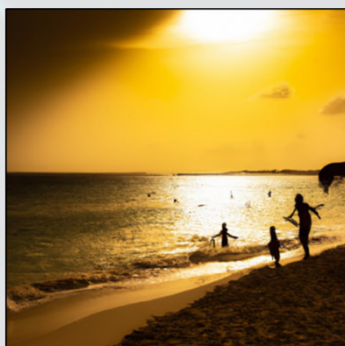
Over the next decade, artificial intelligence will have a major impact on the travel and tourism industry. AI tools will be used to provide hyper-personalised recommendations for travellers, allowing companies to tailor suggestions based on individual interests and budgets. AI chatbots and virtual assistants will become ubiquitous, helping tourists research, book, and manage trips. AI could also help optimise routes and itineraries, reducing transit times and creating more seamless journeys. Behind the scenes, AI will enable businesses to forecast demand more accurately, adjust pricing dynamically, and target marketing campaigns more precisely. But while AI will streamline many processes, human oversight and creativity will still be essential for delivering meaningful and memorable travel experiences.

Q : Are any of the below holiday photos generated by AI ?

1



2



3



ANNEX : AI TERMINOLOGY

AI has introduced many new concepts and technical terms into business and everyday language. The below table summarises some key terms that would be helpful for every business leader to have a basic appreciation of at a high level. **By understanding the basics of these concepts it will help to ground AI systems into practical situations that business leaders can relate to.**

	Description	Examples
Narrow AI	Narrow AI (sometimes called weak AI) is a type of AI that is designed to only perform a specific task, or set of tasks.	Examples of narrow AI include smart speaker voice assistants, computers capable of playing chess, or AI medical systems able to analyse images and detect cancer. These are narrow AI examples as they are only able to perform tasks that they have been specifically trained for – for example the AI medical imager is not able to also play chess. Business leaders could use narrow AI systems to automate tasks such as repetitive data entry, transcribing speech, or recommending products.
General AI	General AI (sometimes called strong AI, of Artificial General Intelligence [AGI]) is a type of AI that is designed to perform any intellectual task that an ‘average’ human can do. Whilst sophisticated AI chatbots have been trained with very large non-topic specific datasets and are therefore able to do many impressive things and recognised by Microsoft researchers as able to exhibit early “sparks of artificial general intelligence”³⁹, true general AI, which can rival human intelligence in all aspects, remains a theoretical concept and has not yet been achieved. True general AI would also require the AI to be able to interact with the real world (to perform tasks humans can do) and therefore require embodiment – see next definition.	While AI is advancing rapidly, it is important for business leaders to understand the current limitations of AI to manage expectations. Today’s AI business applications utilise narrow AI capable of on an individual task, or set of tasks, which can enhance or augment business capabilities. A true general AI assistant would be able to perform any office management task that a human could do and have transformative capabilities such as fully autonomous decision making, creative problem solving skills and an ability to conduct strategic planning across various business functions. This does not yet exist.

Embodiment	Embodiment refers to the concept of giving AI systems a physical or virtual form that enables them to interact with a world. This could involve embedding AI into robots for interaction with the physical world, or AI in virtual avatars that can perceive and act upon a virtual environment (such as in the ‘metaverse’).	An example of AI embodiment could be a hotel that implements an AI powered check in, or concierge robot, to assist guests in the lobby and interact with them in a safe and productive way. Whilst embodiment is required for true General AI to be realised, this hotel example is a form of Narrow AI with embodiment, as the robot is only able to perform specific tasks – it cannot do all tasks that a human could do, such as carry guests’ luggage to their room.
Machine Learning	Machine learning is a type of AI that involves training algorithms with large amounts of data, so that a computer is capable of making predictions, or decisions.	An email spam filter can be an example of an AI system using machine learning. By training an AI algorithm on a dataset of known spam and non-spam emails, it can learn to distinguish between the two and is then able to automatically detect and filter out new spam messages, even though it has never seen them before.
Deep Learning	Deep learning is a type of advanced machine learning, which uses complex mathematical structures inspired by the human brain called ‘neural networks’. This enables a computer to identify complex patterns in data that would otherwise be too difficult to identify using traditional machine learning techniques.	A bank could use deep learning algorithms to detect fraudulent transactions, by identifying patterns in complex financial data.
Predictive AI	Predictive AI is the general term for a type of AI that uses data with either machine learning, or deep learning, to forecast future outcomes or behaviours.	An airline could use predictive AI to forecast future ticket demands and optimise its pricing and sales strategy, or a retailer could use predictive AI to forecast the future demand for products, which would help them to make informed decisions on stock management and production planning
Generative AI	Generative AI is the general term for AI systems that can create new and original material such as text, images, video or audio, which resembles human created content. The roll out of Generative AI capabilities to the public is widely regarded as launching the current global interest in AI.	AI chatbots are a form of Generative AI. A business could use generative AI tools to produce product descriptions, press releases or marketing copy, whereas a media company could use Generative AI to compose new music, or develop visual advertising materials.

Large Language Models (LLM)	Large Language Models (LLM's) are a type of underlying AI architecture that are specifically designed to understand and generate human-like language. They are trained on massive datasets of text and computer code (hence the name Large - Language Models) to develop a deep understanding of language patterns, grammar and semantics, enabling them to generate new coherent, relevant and natural sounding text	Large Language Models (LLM's) can perform a wide range of language related tasks, such as real time translation, writing documents, or answering questions in an informative way. The terms LLM and Generative AI are sometime used interchangeably, but are in fact different. An LLM is the underlying AI model that powers the language capabilities of a Generative AI system (such as an AI Chatbot).
Foundational Models	Foundational Models are a broader category of underlying AI architecture, which includes LLM's, but also AI models trained with more than just text, such as large datasets of images, video or audio Foundational models are also referred to as 'General Purpose AI' in the EU⁴⁰. However business leaders should note that EU General Purpose AI are foundational models able to be applied to lots of areas and is not the same as General AI, or Artificial General Intelligence (AGI) which is described earlier in this table and refers to AI that has the full intellectual capabilities of humans.	Foundational models can serve as the basis (hence the name Foundational) for developing more specialised models. They have wide uses and can be adapted (often referred to as 'fine tuned') with industry specific data and knowledge. For example a business may 'fine tune' an LLM with its company policies to create an AI chatbot for its website, or a manufacturer may fine tune a foundational 'vision' model with specific product information to automatically identify defects on its assembly line.
Prompting, Prompt Engineering and Prompt Design	Prompting is the process of providing instructions and examples to an AI system to guide it towards a desired output. Prompts could be in the form of text, images or other types of data, depending on the AI system and its capabilities. How a user prompts an AI system can significantly influence the outcome and results and therefore the related field of Prompt Engineering and Prompt Design is about experimenting and carefully crafting prompts to produce better, safer and more useful results.	For example a marketing team may use prompt engineering to test multiple variations of prompts with an AI writing assistant, so that it generates the best social media captions that are accurate, in the desired style and friendly. Prompts could include information such as the: • Task: For example to tell a Generative AI system to write a poem • Context: For example the genre of the poem to write • Constraints: For example if there is a limit to the number of words A prompt could therefore be: "Write a limerick poem about AI in less than 20 words"

Hallucinations	Hallucinations are outputs from AI systems that may seem real, but are in fact incorrect, or unrealistic. They may come as the output from either Predictive or Generative AI systems and are most likely to occur when the AI algorithms have been trained on incomplete, or inaccurate data. Hallucinations can be misleading (or even dangerous) if not properly understood, but can also be useful for generating new creative content or exploring new ideas, such as for drug discovery.	An example of hallucination may be an AI chatbot providing a false answer, rather than saying it doesn't know the answer to a question, or an AI powered image recognition system that mistakenly classifies products, leading to incorrect order fulfilment. Hallucinations can sometimes be hard to spot. For example if an AI system output that $92 \times 53 = 6784$ (which is wrong), it would be hard to spot as a hallucination without manual verification. Preventing hallucinations in business commercial arrangements is especially important. For example an AI system could incorrectly give the wrong price to a customer for a holiday.
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Tokens & Parameters	Tokens and Parameters are technical concepts within AI large language and foundational models, that do not need to be understood in detail by business leaders, but are included here as the performance of AI systems are sometimes publicly referred to by their token and parameter count and can offer an approximate insight into the capability of an AI system. It is therefore useful to have an awareness of these terms. In general more tokens and more parameters usually mean better, with bigger AI systems able to process, learn and generate better outputs, but bigger also means more computing resource, power, time and money is required to train and operate the AI system, so it can also be a trade-off decision.	For example two AI chatbots developed in the UAE are called Falcon 7B and Falcon 40B which refers to their size of 7 billion parameters and 40 billion parameters. Models with smaller parameter counts are best suited to simpler tasks and tasks that require rapid responses, whereas models with very large parameter counts are best equipped to handle very complex and highly creative tasks. It is also useful for business leaders to understand the basic concept of tokens and 'token limits' when selecting, or interacting with AI chatbots. A rough 'rule of thumb' is that 1 token = 0.75 words (75%). Therefore 100 tokens are approximately equivalent to 75 words. If for example an AI chatbot states its combined input and output is limited to 2000 tokens, this means if a user question (e.g. prompt) is 100 tokens (~75 words), the maximum output could be 1900 tokens (~1425 words). Deliberately implementing token limits can be disappointing to some and prevent AI chatbots from generating very long form outputs (such as many page documents), but these limitations ensure the AI system can generate coherent responses, manage computational resources efficiently, and generalise well across various contexts. However ongoing AI research aims to maintain high quality outputs, with larger token limits.
Alignment & Guardrails	Alignment and Guardrails are two very important concepts related to the ethical development and deployment of AI. Alignment refers to ensuring that AI systems objectives and behaviours match human values and goals. Guardrails can be guidelines, regulations, or formal constraints implemented to prevent AI systems from causing harm, or behaving inappropriately.	As a business leader, it is crucial to establish alignment by defining the ethical boundaries for AI usage in your organisation (such as respecting user privacy). Implementing guardrails ensures that AI systems operate within those defined boundaries. For example when using an AI recruitment tool, an alignment mechanism could be used to ensure the AI system does not discriminate against certain groups of people and a guardrail might be used to prevent the AI system from accessing certain types of data, such as personal medical records.

QUIZ ANSWER

Could you identify the AI generated content...?

It was a trick question – all of the text and images were generated by AI !

If you thought any were made by a human, this has hopefully demonstrated the power of AI.

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AUTHOR

James McDonald

Director, Travel Transformation
World Travel & Tourism Council (WTTC)

CONTRIBUTORS

Julie Shainock

Managing Director, Travel, Transport & Logistics (TTL)
Microsoft

Shane O'Flaherty

Global Director, Travel, Transportation and
Hospitality
Microsoft

Smith Codio

Director, Customer Experience of Automotive,
Mobility & Transportation Industry
Microsoft

DESIGN

Name

Zoe Robinson

IMAGES

Cover: Mahdis Mousavi, Unsplash; Page 2, 3, 12 & 16:
Shutterstock; Page 34 Umberto Few, Unsplash



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