

البرنامج الوطني للذكاء الاصطناعي  
NATIONAL PROGRAM FOR ARTIFICIAL INTELLIGENCE



AI GUIDE

# FOREWORD

For a very long time, philosophers, mathematicians, and scientists have envisioned the possibilities of building intelligent machines that can perform human tasks. Fast-forward today, this dream is closer to becoming a reality within the field known as Artificial Intelligence (AI), also referred to as machine intelligence. Large-scale research and investment efforts are currently being poured into designing machines that think, learn, and make decisions like humans. Like any other technology, AI is a double-edged sword that presents unique opportunities and poses potential risks, which must be carefully addressed through the involvement of key stakeholders and comprehensive governance strategies.

In the United Arab Emirates (UAE), we have long understood the potential and power of AI to transform society for the better. That is why we took initiative to build the UAE to become a powerhouse in the AI field, driven by its visionary leadership and the desire to ensure that technology better serves humanity. Dubai has already attracted USD 21.6 billion foreign direct investment in high-end technology transfers between 2015 and

2018 – propelling the UAE to achieve global recognition.

I would like to invite you all to read our ‘Artificial Intelligence Guide’, as part of The National Program for Artificial Intelligence. In this guide, we provide an overview of AI, its history, and some of its main components: machine learning, deep learning, and data science. We further summarize relevant applications already deployed across various industries in the UAE, and the efforts undertaken by our different government entities to account for and ensure that AI is deployed for the betterment of society. Finally, we propose a framework for building AI capabilities and list our recent initiatives, ranging from K-12 to higher education.

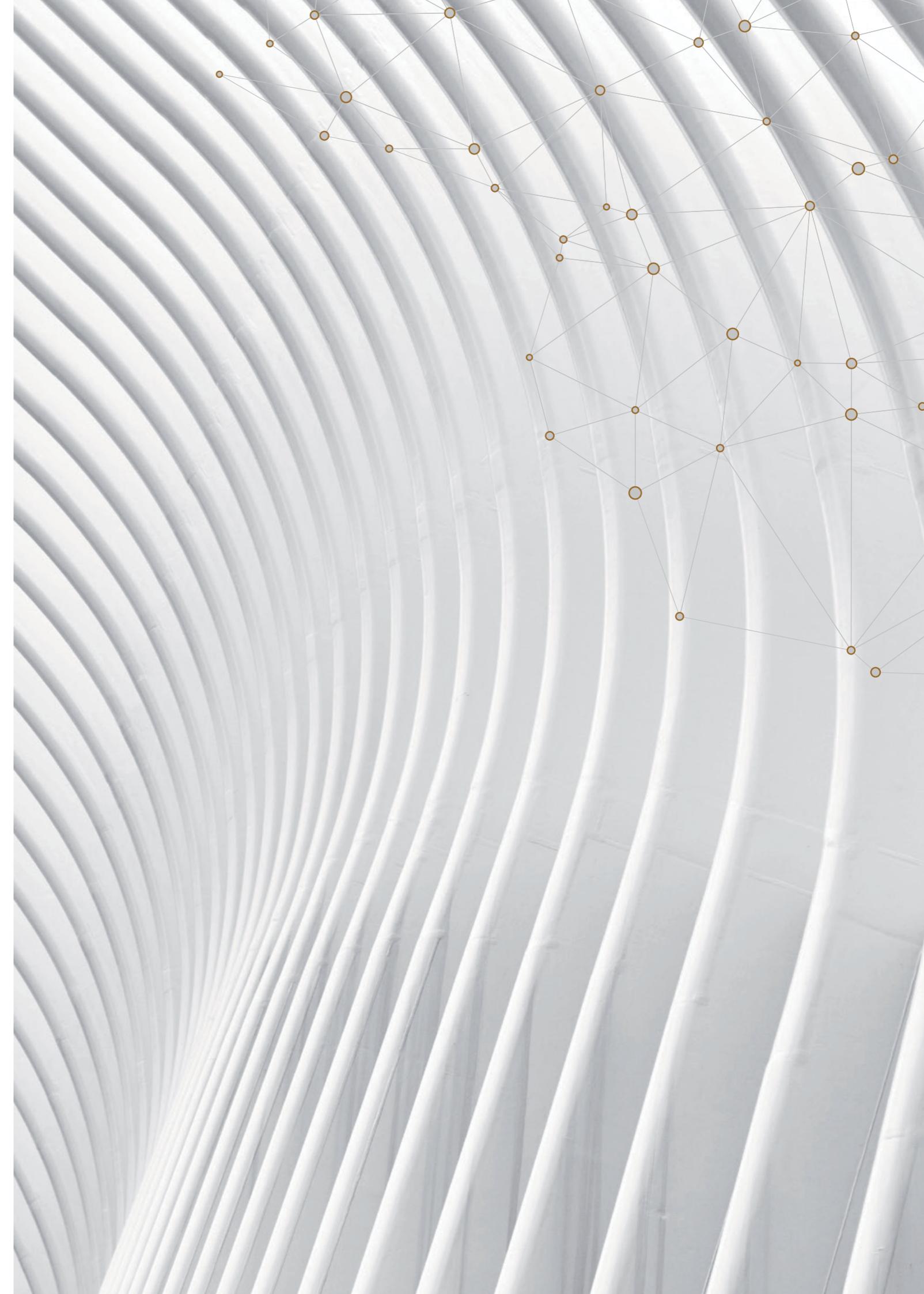
We hope that the reader takes advantage of this guide to gain an understanding of AI, its opportunities and risks, and the prominent steps that the UAE has already taken to lead the modern-day development of AI.

**Omar Sultan Al Olama**  
**Minister of State for Artificial**  
**Intelligence**



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# 1. INTRODUCTION & OVERVIEW





**Can humanity  
build a machine  
that can think  
and act as  
humans do?**

# 1. INTRODUCTION & OVERVIEW

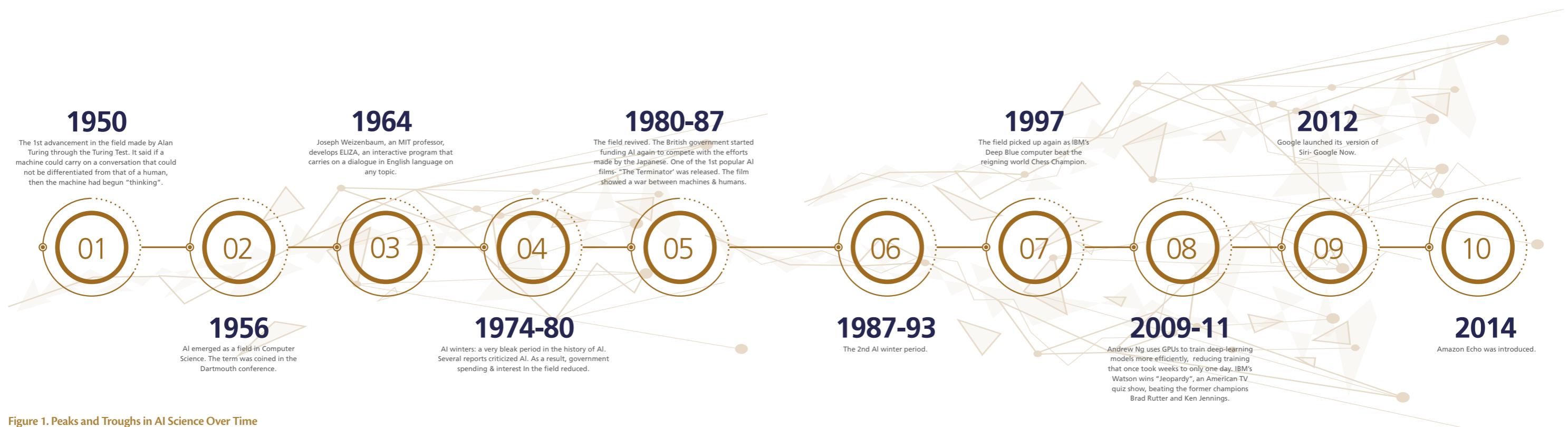
## 1.1 HISTORY OF ARTIFICIAL INTELLIGENCE

The notion of machine intelligence existed since Greek mythology. For example, some Greek myths revolved around an intelligent robot named *Talos* that protected Crete from its enemies. In many decades to follow, the foundations of mathematics and

computer science of the intelligent machine were formalized by several mathematicians and philosophers, such as by René Descartes, Gottfried Leibniz, Charles Babbage & Ada Lovelace to name a few.



# 1. INTRODUCTION & OVERVIEW



With the advent of the programmable computer in the wake of World War II, Alan Turing introduced the Turing test in 1950, which considered the question, “Can machines think?” while working at the University of Manchester. The test involves a human interrogator who converses with a human and a machine that generates human-like language. If the interrogator is unable to distinguish between the human and the machine, then the machine would have passed the test of being able to act like a human. Since then, the Turing test has become an important concept in the

philosophical discussions of AI.

The term “Artificial Intelligence” was actually first coined by the American computer scientist John McCarthy at a scientific conference at Dartmouth University in 1956. While constituents at the conference were unable to reach an agreement about what the term actually meant, the general consensus was that AI was about making machines that were as intelligent as humans.

The history of AI experienced several periods of disappointment and reduced

funding (Figure 1). The first AI winter occurred in the beginning of the 1970s as research projects failed to meet their objectives. In the 1980s, AI revived in the form of ‘expert systems’, which were computer programs designed using human expert knowledge in the form of ‘if-then’ rules. However, the second AI winter soon followed in the late 1980s as expert systems became unfeasible and expensive to maintain.

Due to unprecedented advances in hardware computing capabilities and

internet connectivity, AI later achieved several successes that allowed it to regain popularity. In 1997, IBM developed the Deep Blue computer that defeated the world’s best chess player. In 2016, Google developed AlphaGo, which also beat the world champion in the Go game. And just in 2019, Open AI team was able to beat their human component consisting of five pros in video game Dota 2; a complex and real strategy game. Today, AI applications extend beyond gaming to natural language processing, computer vision, and predictive modelling.

# 1. INTRODUCTION & OVERVIEW

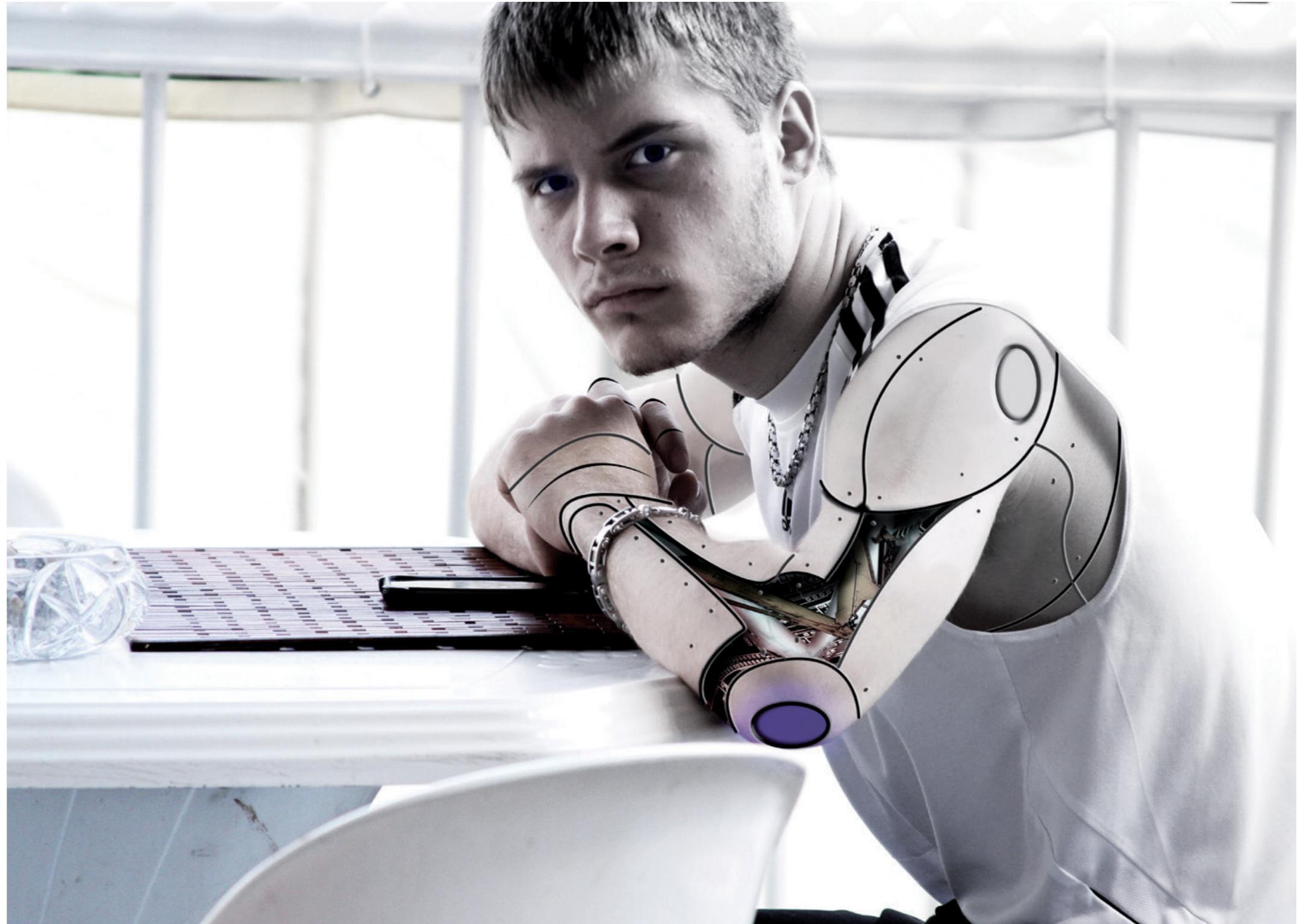
## 1.2 WHAT IS ARTIFICIAL INTELLIGENCE?

While the original definition of AI as the ability of a machine to think or act as a human might still hold, it has become more nuanced in the past decade.

The definition of AI varies across the literature. In the Merriam-Webster dictionary, AI is defined as:

**“A branch of computer science dealing with the simulation of intelligent behavior in computers.”**

Other definitions seek to highlight AI’s abilities in performing certain behaviors associated with human intelligence: planning, learning, reasoning, problem-solving, knowledge representation, perception, motion, manipulation and, to a lesser extent, social intelligence and creativity. In general, AI defines a collection of technologies enabling a machine or system to comprehend, learn, act, and sense like a human.



# 1. INTRODUCTION & OVERVIEW

## 1.2.1 TYPES OF ARTIFICIAL INTELLIGENCE

There are two main types of AI: general and narrow (Figure 2). General AI, also known as strong AI or Artificial General Intelligence (AGI), refers to a machine that can successfully perform any intellectual, physical or emotional human tasks. Leading scientists in the field nowadays, such as Yann Le Cun, even argue that the

notion of 'general intelligence' does not exist in the first place.

Narrow AI, also referred to as weak AI, are specialist systems that can only handle a narrowly defined set of tasks. For example, while AlphaGo is able to defeat any human at Go, it is incapable of playing a game of

poker. Yet, this specialization has proved the commercial viability of AI, and it has seeped into our daily lives. In fact, most of the existing AI applications can be considered as narrow AI, such as spam filters, recommendation systems, Google Translate, or Siri.

A third category is super AI. Super AI refers to machines with cognitive abilities that surpass human intelligence. This perception of AI often appears in science fiction movies, and it currently does not exist.

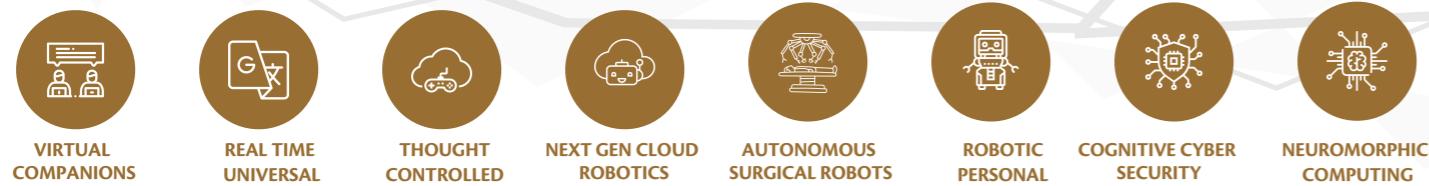
## 3 SUPER AI

**A machine with cognitive abilities that surpasses human intelligence.**

## 1 NARROW AI

**A machine that can perform specific human tasks.**

### LEFT BRAIN



### RIGHT BRAIN

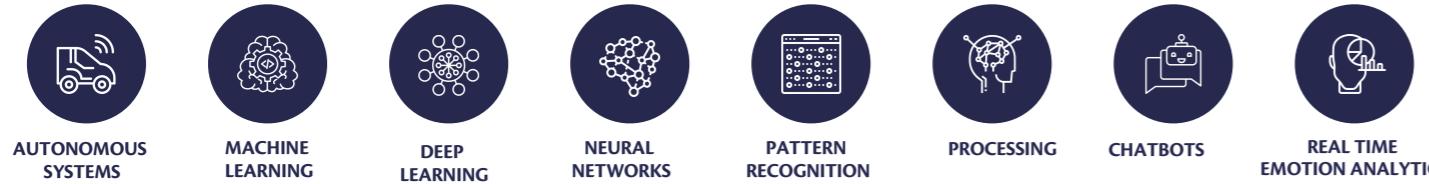


Figure 2. Types of Artificial Intelligence

## 2 GENERAL AI

**A machine that can perform intellectual, physical, and emotional human tasks.**

— DOES NOT EXIST

— DOES NOT EXIST

# 1. INTRODUCTION & OVERVIEW

## 1.3 MACHINE LEARNING

Existing applications within AI are characterized by their ability to continuously learn from new experiences and make inferences based on past experiences. Those 'experiences' are often summarized in the form of data. Machine learning (ML) is an application of AI that teaches machines how to perform specific tasks by learning from this data. It is

currently used within various applications, such as speech recognition, spam filtering, and targeted advertisement. There are three main types of ML that we will explore in the following sections (Figure 3): supervised learning, unsupervised learning, and reinforcement learning. The types of learning differ in terms of the task to be performed.

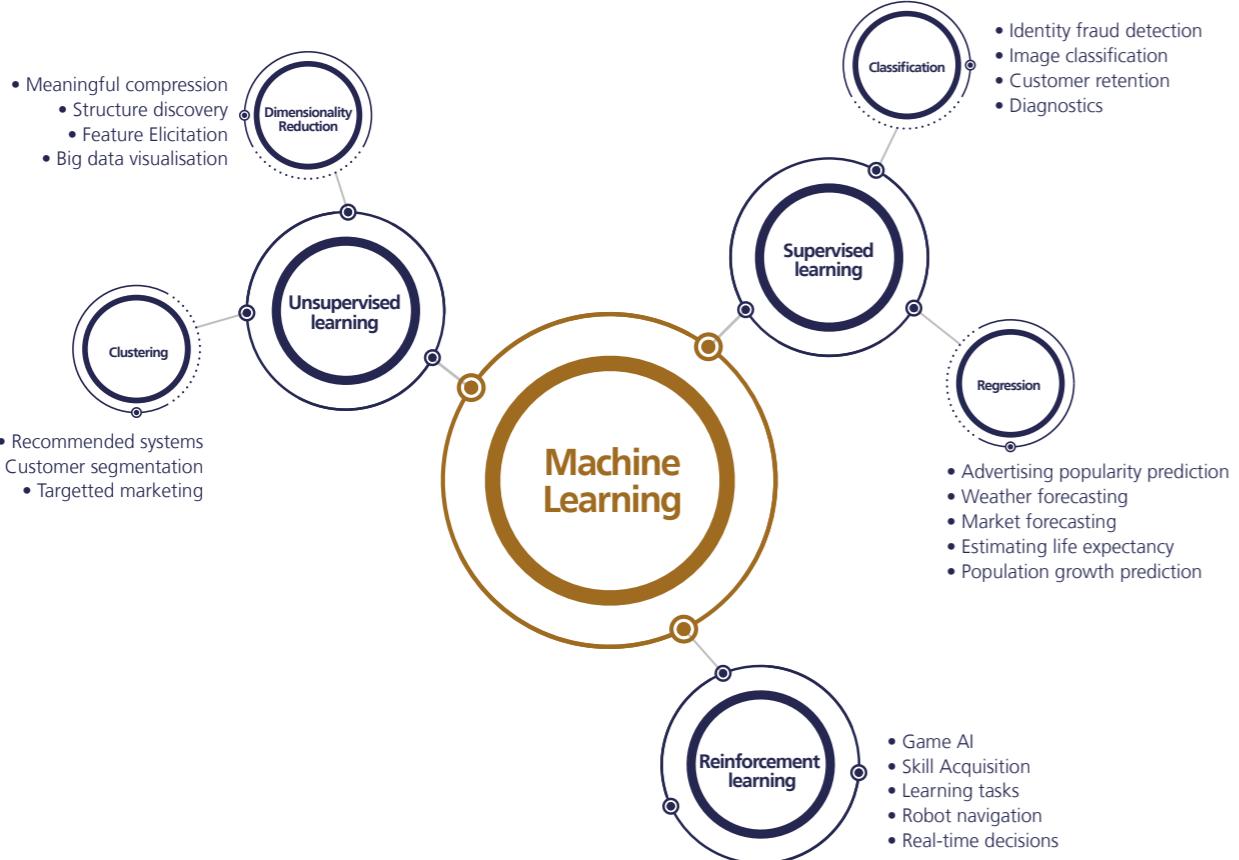


Figure 3. Machine Learning Algorithm

### 1.3.1 SUPERVISED LEARNING

Supervised learning is used to learn a **function** that maps an **input** to an **output**, by recognizing patterns amongst existing input-output examples. We hereafter refer to this learned function as

a **model**. It is often visualized as the black-box model shown in Figure 4 below. Based on the format of the output, supervised learning can perform **classification** or **regression** tasks.

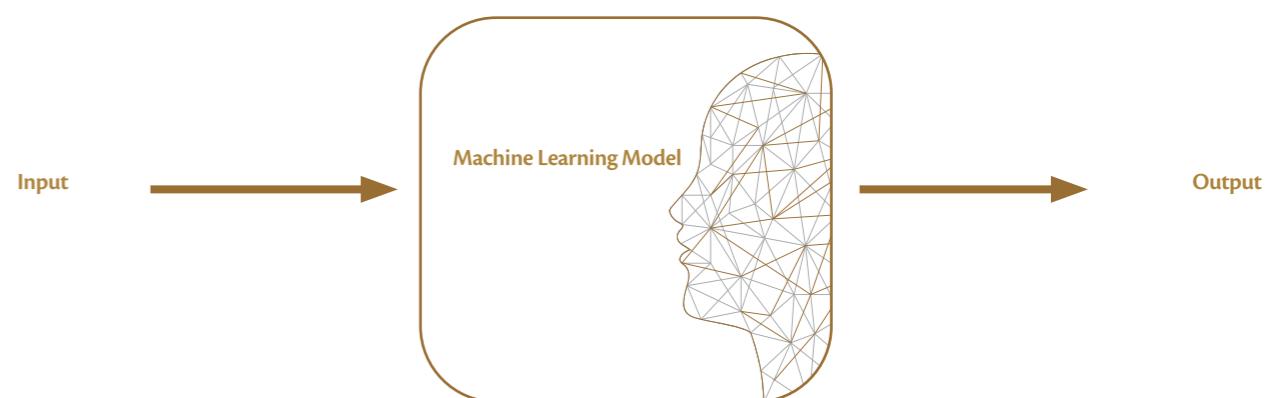


Figure 4. Machine Learning Model

In the classification scenario, the model maps the input to a finite set of possible outputs. For example, in spam filtering applications, the model classifies whether a received email is spam or not. The input is the contents of the email, while the possible outputs are restricted to spam or not spam. When the model is able to consistently predict correct outputs, it is said to be 'trained'.

In regression tasks, the output consists of continuous values. For example, in a house

price prediction application, the model estimates the price of a house given a set of inputs. Here, the output is not restricted to a set of pre-defined categories as in the spam filtering example.

Supervised learning relies on the availability of labelled data to learn from. Examples of supervised learning algorithms are support vector machines, logistic or linear regression, decision trees, or neural networks.

# 1. INTRODUCTION & OVERVIEW

## 1.3.2 UNSUPERVISED LEARNING

Unsupervised learning involves recognizing patterns in unlabeled data. It is commonly used for **clustering** or **dimensionality reduction**. Clustering involves grouping data points based on a similarity metric. For example, given data on customer behavior of a retail shop, the unsupervised learning algorithm would segment the customers based on age or consumption behavior. This would support the shop's marketing strategy in targeting specific customer groups that the algorithm discovered. This application is also known as customer segmentation. An example of a clustering algorithm is K-means clustering.

## 1.3.3 REINFORCEMENT LEARNING

Reinforcement learning is an area of machine learning that teaches the agent, or the machine, to interact with its environment to maximize a particular reward. By continuously interacting with its environment, the agent's behavior is 'reinforced' by learning from its mistakes.

Data used in machine learning applications is often high-dimensional and thus difficult to process. In the house price prediction application, the input features (e.g., number of rooms, number of floors, or year it was built) can be considered as the 'dimensions' of the dataset. Some datasets may have thousands or millions of features, such as in bioinformatics datasets. Therefore, dimensionality reduction algorithms transform the dataset into a lower-dimensional space by extracting the most important explanatory factors of the data. Principal component analysis and autoencoders are examples of dimensionality reduction algorithms.

This is a very common learning strategy in teaching machines how to master Atari games. Reinforcement learning has also been used to teach agents autonomous driving within simulated environments. Q-learning is an example of reinforcement learning algorithms.

## 1.4 NEURAL NETWORKS AND DEEP LEARNING

Many of the learning tasks can be achieved using neural network algorithms. Inspired by the human brain, artificial neural networks consist of a set of connected nodes that transform an input using a series of non-linear activation functions. Early versions of neural networks consisted of a simple **perceptron**, which was first invented by Frank Rosenblatt in 1958.

As the number of hidden layers increases, the neural network becomes a 'deep' neural network (Figure 5) – a field often referred to as deep learning. Deep learning is the most widely adopted approach to machine learning since Google reintroduced this method for image recognition in 2012 (Figure 6). Training deep learning models is

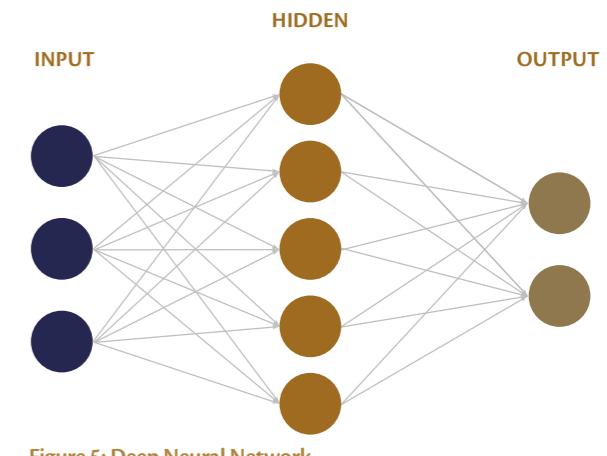


Figure 5: Deep Neural Network

a computationally intensive process during which the algorithm learns to adjust its parameters to successfully perform a task. Popular neural network architectures are convolutional neural networks, which are mainly used for image classification, and recurrent neural networks, which are often used for processing temporal data.

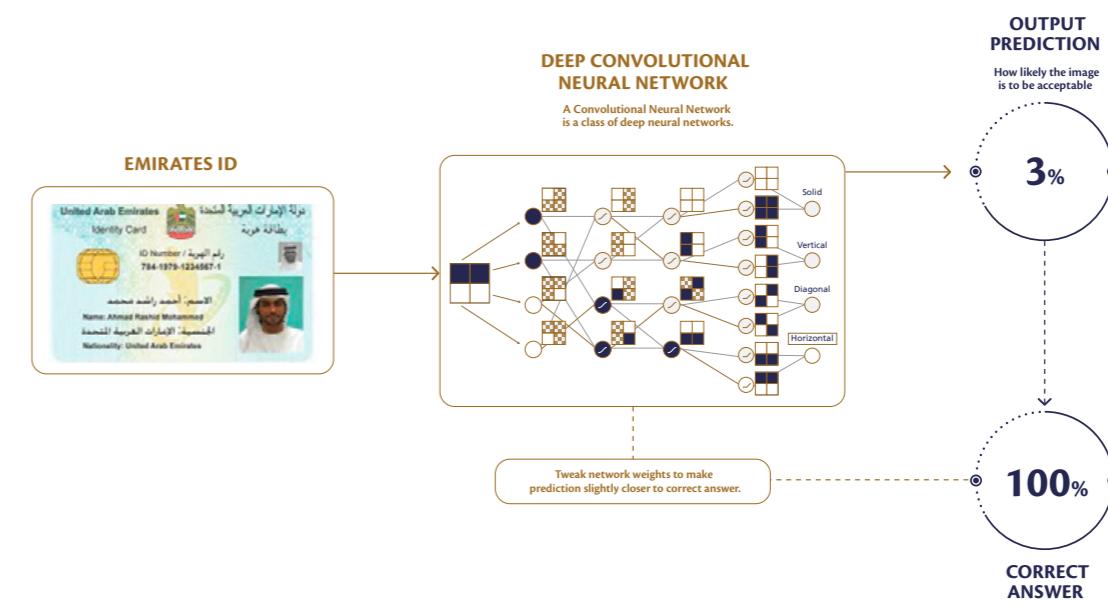


Figure 6. Deep Learning for Image Classification

# 1. INTRODUCTION & OVERVIEW

**Data science is a multi-disciplinary field that involves pre-processing and mining structured or unstructured data.**

## 1.5 DATA SCIENCE

Many AI and ML applications rely on the availability of data, as discussed in previous sections. Data is the collection and measurement of information, usually in the form of text, images, or numbers. The data could be structured and readily available in an organized database, or unstructured such as text or videos.

Data is often summarized in the format of a table, where the columns represent the ‘features’, and the rows represent the different examples. For example, let us consider a dataset of student grades that can be used to build an ML model that can predict the performance of students in the future. Each row would represent a unique student, and each column would present a specific feature of the student, such

as the midterm grade or extracurricular involvement.

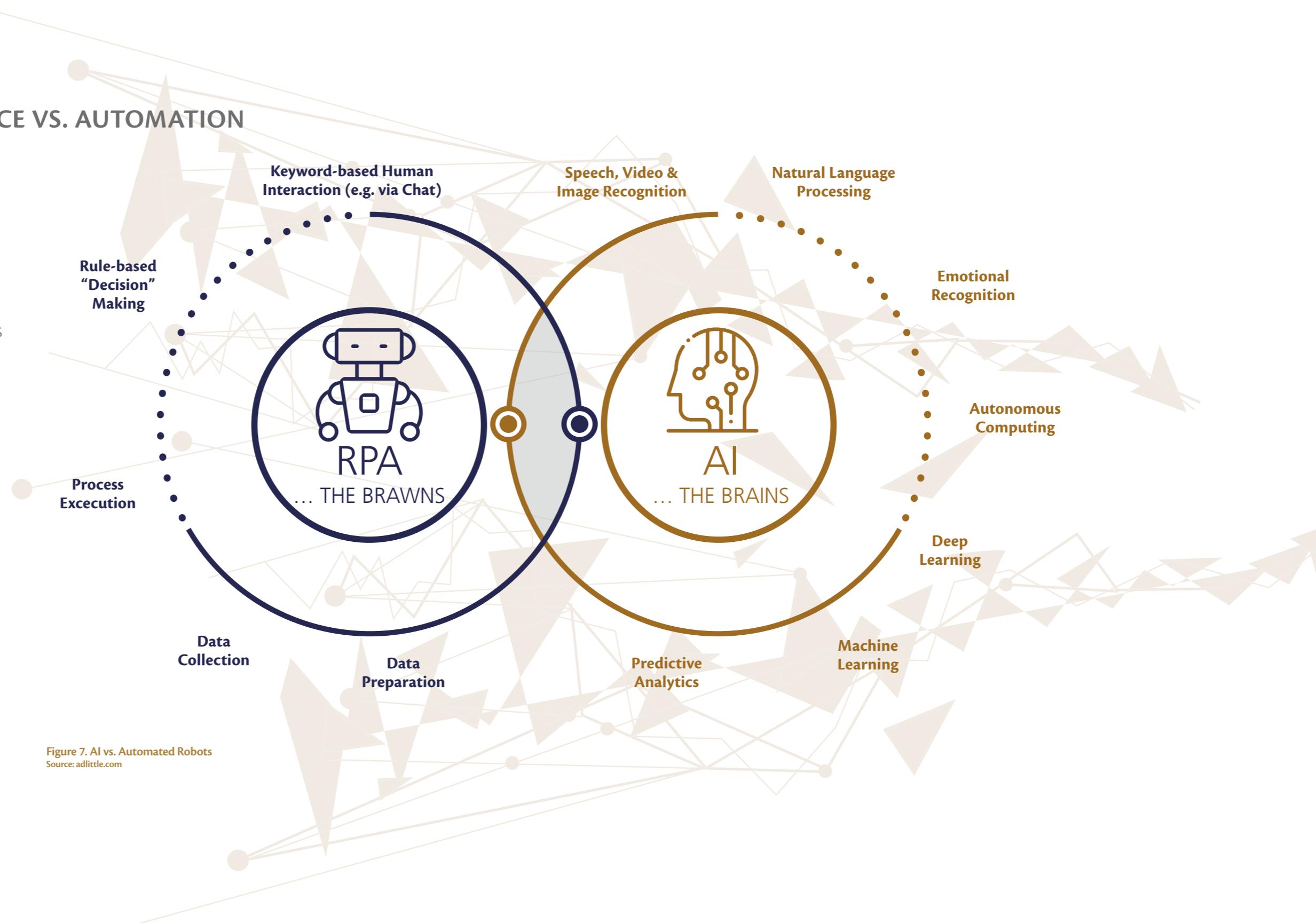
Data science is a multi-disciplinary field that involves pre-processing and mining structured or unstructured data. Pre-processing includes cleaning the data by removing missing or incorrect values, such as spelling mistakes within textual data. Another example of data pre-processing is transforming grayscale images into a numeric dataset using the pixel values. During the development of any ML application, it is commonly known that most of the time is spent on data pre-processing, while the rest of the time is spent on building and training the actual ML model.



# 1. INTRODUCTION & OVERVIEW

## 1.6 ARTIFICIAL INTELLIGENCE VS. AUTOMATION

At a first glance, AI may be difficult to distinguish from robots and automation. While robotics may use AI applications to perform certain tasks, robots are not artificially intelligent by nature. Common mass-market robots, such as ATM machines and even cooking robots that assist with chopping vegetables in restaurants, do not use any form of AI. Other automation solutions, including robocalls and some early types of chatbots, are still hardcoded and are not utilizing any AI component.



## 2. ARTIFICIAL INTELLIGENCE TODAY





## 2. ARTIFICIAL INTELLIGENCE TODAY

### 2.1 APPLICATIONS

ML algorithms already steer many technologies that we use on a daily basis. Many applications have been developed within the field of **natural language processing** (NLP). NLP combines linguistics with ML algorithms to read and understand natural languages. Gmail, Google's popular email service, uses ML to filter out spam through text-mining in order to prioritize relevant messages to the top of the inbox queue. The service also offers 'Smart compose', a predictive feature that suggests what text to type in emails. A similar feature exists on other text-based applications, such as WhatsApp. Several voice assistants have appeared on smartphones in recent years that also rely on NLP, such as Apple's Siri, Amazon's Alexa, or Microsoft's Cortana. Those technologies automatically process the user's speech to provide a suitable response.

**Computer vision** is another popular field

in AI. It involves developing computer algorithms that can interpret visual information. Image captioning is a common example, where the algorithm automatically identifies the content of the image and provides a suitable caption. Face recognition is another popular application that was developed to identify the person from an image. This is currently being used in the iPhone Face ID unlocking service, and in Facebook's automatic photo tagging feature. Computer vision is also used in medical applications, such as to recognize breast cancer from mammogram images.

With the vast amounts of data collected on users by web services, **recommender systems** have also become pervasive. Recommender systems perform information filtering to provide relevant suggestions to users. This is used to provide music recommendations by YouTube, TV shows or movies by Netflix, or products by Amazon.

## 2. ARTIFICIAL INTELLIGENCE TODAY

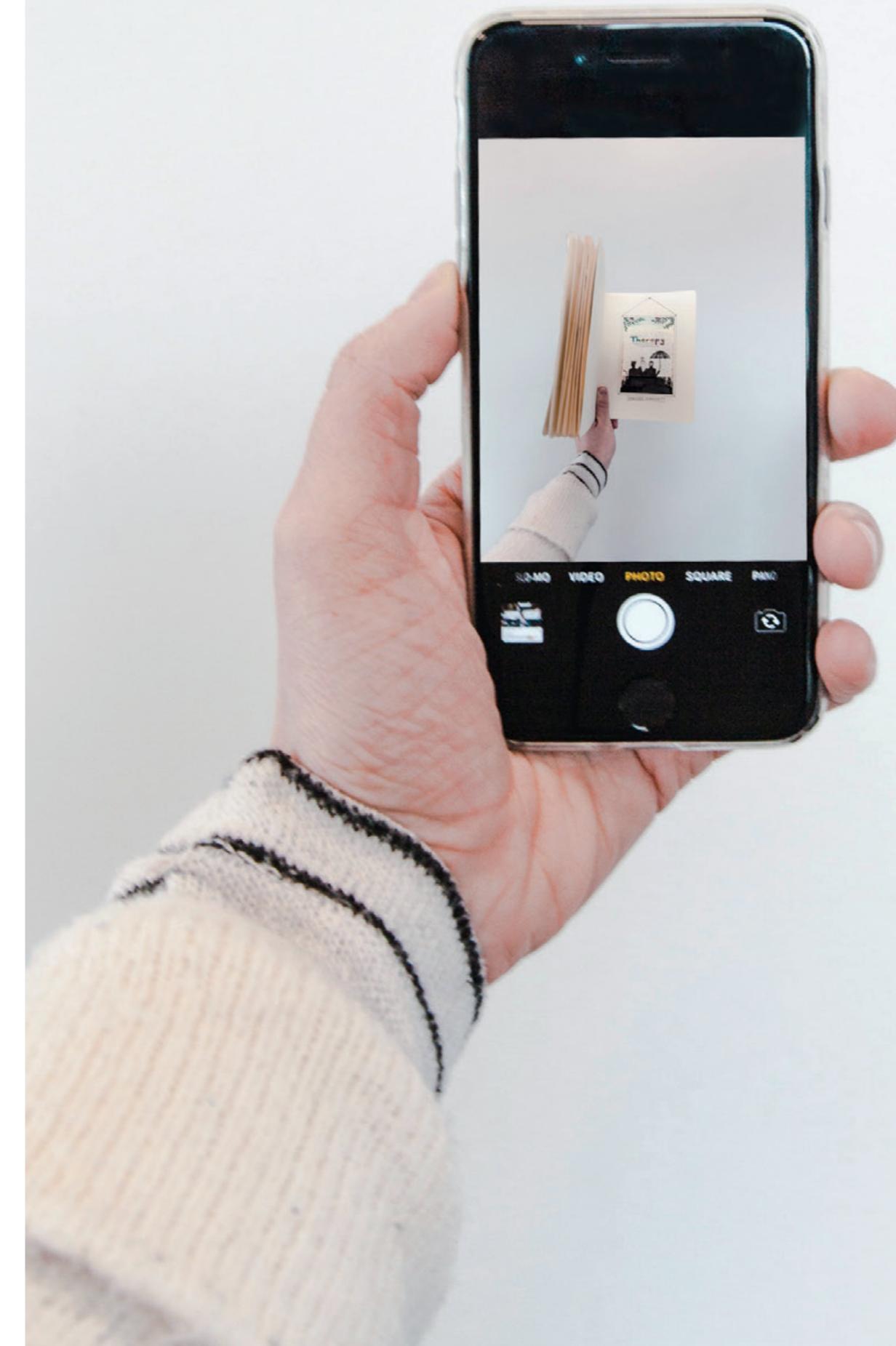
### 2.2 ROLE OF GOVERNMENT

Governments will play a pivotal role in the future of AI. Many governments have already embraced AI to improve their service delivery standards. A positive outlook for AI requires thoughtful regulation and innovative governments that understand its power and potential for the betterment of society.

The UAE Government has positioned itself as an early leader in the global race to define AI in the public sector. With an established commitment to supporting digital innovation to enhance public services and deliver improved experiences, the UAE government has built a strong foundation to incorporate AI into the fabric of public sector services. Starting in March 2014 with the Smart Dubai Initiative and the introduction of a local data law in October 2015, Dubai and the UAE have focused on establishing principles to guide how data is used, and to prioritize the societal benefits from utilizing data and advanced technology such as AI.

In 2017, the UAE became the first country to appoint a Minister of State for Artificial Intelligence. The appointment coincided with the release of the government's strategic direction - to use AI in everything from water management to education.

In April 2019 the UAE Cabinet approved a 10 years strategic plan – the National Strategy for Artificial Intelligence 2031 (Figure 8). Its eight objectives include (1) build a reputation as an AI destination, (2) increase the UAE competitive assets in priority sectors through deployment of AI, (3) develop a fertile ecosystem for AI, (4) adopt AI across government services to improve lives, (5) attract and train talent for future jobs enabled by AI, (6) bring world-leading research capability to work with target industries, (7) provide the data and supporting infrastructure essential to become a test bed for AI, and (8) ensure strong governance and effective regulation. The plan also prioritizes AI in existing sectors of strength - logistics,



## 2. ARTIFICIAL INTELLIGENCE TODAY

**This is a call to leading developers, theorists, and observers to use the country as a laboratory to test the practical applications of AI.**

energy, tourism – and two emerging areas of interest – healthcare and cybersecurity.

The UAE has signaled to the world that it will use AI across virtually all sectors of society. This is a call to leading developers, theorists, and observers to use the country

### UAE CABINET ADOPTS THE NATIONAL STRATEGY FOR ARTIFICIAL INTELLIGENCE 2031



Positioning the UAE as a world leader in artificial implementation by 2031



The strategy implementation is overseen by the Emirates Council for Artificial Intelligence and Blockchain.



Increased productivity and economic growth by employing artificial intelligence technologies

### APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE FOLLOWING PRIORITY AREAS



RESOURCES AND ENERGY



LOGISTICS AND TRANSPORTATION



TOURISM AND HOSPITALITY



HEALTHCARE



CYBER SECURITY

UAE Government Communication Office

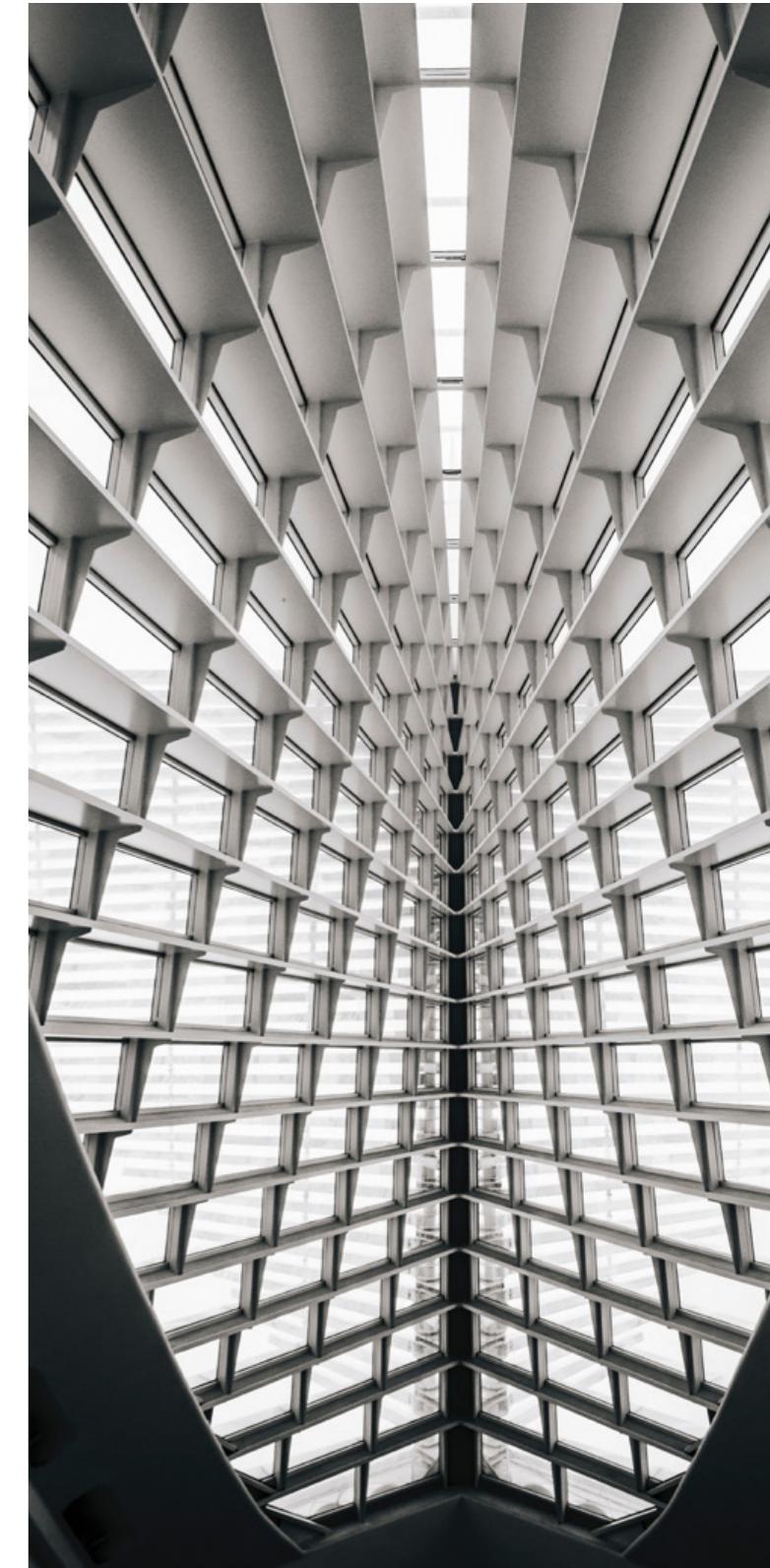
Figure 8. UAE Cabinet Decisions

### 2.3 MAIN INDUSTRIES

The AI market is on track to reach \$70 billion in 2020. In industries as diverse as finance and healthcare, companies are using AI to make business operations more efficient and effective, deliver enhanced customer experiences and exert a competitive advantage through proprietary algorithms. We summarize here the main steps already taken in industries within the UAE and globally.

#### FINANCE & BANKING

From evaluating home loans to cybersecurity efforts, AI is woven into the fabric of global banking. In the international financial sector, stock trading algorithms have been using forms of narrow AI for years. Investment houses around the world earn large portions of their capital by pointing AI algorithms to pick the right mix of stocks. In the next leap forward, AI will replace the traditional stockbroker.



## 2. ARTIFICIAL INTELLIGENCE TODAY

In the UAE, Emirates NBD has partnered with Amazon Web Services (AWS) to deploy AWS' artificial intelligence, data analytics, Internet of Things, image recognition and machine learning capabilities to improve its customer services. The local bank is already a leader in emerging technology, having previously launched its Eva customer service AI in 2016 and the Olivia AI for digital banking customers earlier in 2019.

### HEALTHCARE

Similar innovations are taking place with AI in medicine. Machines are being trained to spot abnormalities and diagnose disease. Doctors will be able to speed through MRI's and X-rays thanks to AI driven image recognition. Aided by AI, Doctors can focus on deeper issues related to patient care, where machine translation can also help remove language barriers between doctor and patient. While the medical industry is nowhere close to replacing doctors with robots, AI is already a valuable tool enabling doctors to treat patients holistically.

AI is actively deployed in the healthcare sector in the UAE. The Ministry of Health and Prevention uses AI to enhance medical fitness examinations for new residents. Image recognition algorithms

are deployed in conjunction with X-rays to detect communicable diseases. The technology can detect diseases with very high accuracy levels, markedly decreasing the need for a review by an X-ray specialist. Utilizing AI in this manner both saves time and promotes community health. The Ministry of Health and Prevention and The UAE Artificial Intelligence Office are also developing similar solutions to combat the global spread of tuberculosis (TB). TB is a major public health problem in the world, claiming a life every 20 seconds, and India has a quarter of the world's cases. The UAE aims to use AI for the betterment of humankind. In light of this, The UAE Artificial Intelligence Office has supported research into developing an AI algorithm for detecting Tuberculosis in patients via diagnosis of x-ray data. Using AI backed solutions, healthcare professions can efficiently diagnose and monitor the spread of the disease in afflicted communities.

Elsewhere in the UAE, healthcare providers are deploying AI to streamline processes and support care providers. In Abu Dhabi's leading hospitals, including the Cleveland Clinic and Sheikh Khalifa Hospital, AI robots assist with filling prescriptions, freeing pharmacists to focus on patient consultations. The Dubai Health Authority



has also demonstrated a human-free medical fitness centre deploying a suite of AI technologies, robotics and IoT to perform the medical fitness examination for new residents without a single clinician.

### AVIATION

Emirates Airline is implementing AI solutions at all levels of the aviation experience. The airline uses machine learning to inform myriad aspects of flight logistics from how much fuel to load to the right flight route to maximize efficiency. Emirates is also committed to automating the ground experience, delighting passengers with a seamless journey from start to finish. This means that security protocols will be bolstered with AI-powered algorithms while baggage services will be handled by special robotics. The infrastructure for these enhancements is already in place and will take full effect in a few years.

At the Dubai International Airport, one of the world's busiest aviation hubs, several AI

solutions are already in place. From self-driving electric vehicles that assist airside crew to passenger screening algorithms, AI allows the airport to streamline its operations while ensuring the highest level of safety and customer experience. At Dubai International Airport and other ports, Dubai Customs uses an AI-powered "productivity engine" to reduce costs and boost productivity. The AI system is expected to save 1.3 million work hours while ensuring total accuracy at ports.

### TRANSPORTATION

The Autonomous Transportation Strategy in Dubai aims to transform 25 per cent of the total transportation in the Emirate to autonomous mode by 2030. The strategy will help cut transportation costs by 44%, resulting in savings of up to AED 900 million a year. It aims to reduce traffic accidents and losses by 12%, equivalent to savings of AED 2 billion annually, and increase the productivity of individuals by 13%.

## 2. ARTIFICIAL INTELLIGENCE TODAY

Dubai's Roads and Transport Authority (RTA), who is leading the implementation of the strategy, has partnered with Tesla and other industry leaders to test and deploy autonomous vehicles in the city. The strategy addresses all modes of public transport fleet including metro, tram, bus, taxi, marine transport, cable cars and shuttle. Currently, Dubai's self-driving Metro is estimated to serve approximately 8.8% of all individual trips in Dubai.

The RTA also leverages AI to enhance the customer experience and streamline its workflow. RTA uses advanced AI technologies such as computer vision and automated recognition of facial expressions to analyze customer sentiment. The data is used to improve services and promote customer happiness. The RTA uses a special AI chatbot to field customer enquiries and requests. The chatbot is also able to gauge customer happiness in a more efficient manner than traditional officials.

The Dubai Taxi Corporation (DTC) operates a control centre outfitted with AI innovations to streamline operations and ensure that its smart transformation plan is carried out effectively. The DTC monitors negative practices of offensive drivers, attendance & dispersal of students

and bus conductors, tracks bus movement, and controls the fleet. It also manages the operation of 505 limousines, 'Mashaweer' and 'In Safe Hands' services as well as the smart towing service. It also enables electronic surveillance of taxi movement, verifies compliance with work controls, and moves stopping and late-coming vehicles.

On the pavement level, smart devices equipped with AI features have also been launched to monitor Dubai's paid parking zones. The smart scan system used by RTA inspectors helps monitor and enforce parking payment across Dubai. Parking inspectors simply drive around the different parking zones in the city and the scanners will automatically detect vehicles with expired parking tickets.

### RETAIL

In the commercial marketplace, leading UAE companies such as Dubizzle use AI to improve efficiency and user experience on their platform. The popular online marketplace uses AI for image recognition and product recommendations. Users upload an image of something they want to sell, and the platform's AI is able to identify the item and suggest details about it. Just as Spotify or YouTube uses machine learning algorithms to analyze user data

and make predictions, Dubizzle tracks what users do on their platform to assist with recommendations. AI is also employed across the platform to weed out spam and fraud. Irrelevant ads and fake products are detected and removed before users even encounter the material.

Customers will soon be able to purchase cinema tickets and groceries with an AI voice assistant thanks to a partnership between I.AM+, the Los Angeles-based technology firm owned by rapper will.i.am, and Majid Al Futtaim. The AI-powered voice assistant, Omega, will be available in English and in Arabic and will be able to engage in fluid, contextualized conversations with customers. The platform is being launched at various retail properties including Carrefour and VOX Cinemas.

### MEDIA

AI is transforming the media landscape. Standard press releases such as financial reports and sports scores are now written by AI in media outlets including the Washington Post and Bloomberg. AI is also delivering news broadcasts. Powered by advancements in speech synthesis, image detection and deep learning, a new generation of the news anchors physically resemble a professional human anchor and

can stay on-air 24/7.  
Abu Dhabi Media Company (ADM) has partnered with Sogou, a Chinese internet and AI company, to bring AI news anchor technology to the Middle East. ADM's newest anchor will be able to deliver news reports in English and in Arabic. With the integration of the AI news anchor, ADM's platform will be able to provide news broadcasts more efficiently, in a range of engaging formats, around the clock.

### ENERGY

The Abu Dhabi National Oil Company (ADNOC) has also embraced AI and its ability to harness the power of big data. With the goal of optimizing performance, ADNOC is using AI algorithms across all sectors of oil production from upstream to downstream and global distribution. AI is able to streamline efficiency across the network, drive efficiency, and create new performance benchmarks that will increase revenue.

## 2. ARTIFICIAL INTELLIGENCE TODAY

### SECURITY

The Abu Dhabi police, in their mission to ensure that the city remains one of the safest in the world, has embraced AI. The goal of using AI systems is to enhance productivity, increase HR efficiency, and use big data for better information security. AI products that have been launched in the capital already include predictive policing, AI simulation models for traffic prediction, and the dangerous violators program.

Predictive policing uses big data and AI-powered algorithms to determine how best to allocate policing resources across the city. This improves response time and enables the police force to handle their tasks in a more efficient manner. In a similar vein, the dangerous violators program uses an unsupervised clustering algorithm along with big data and supervised learning to automatically identify dangerous drivers in real time. These models allow police to accurately predict a driver's behavior and take swift action. Police can also predict dangerous hotspots around the capital and allocate resources accordingly.

The UAE Public Prosecution is also working with the Ministry of Artificial Intelligence to implement AI in the justice system. The goal is to streamline the work of the Public Prosecutor and ensure that AI advancements can be used to improve the judicial system.

### CUSTOMER SATISFACTION

The Dubai Electricity and Water Authority (DEWA) is using AI to identify weaknesses and streamline efficiency. The government body has already partnered with Google's AI platform to answer customer queries. An application called Rammas allows users to engage with a virtual employee that can handle limitless queries. By the end of January 2018, Rammas answered over 698,000 queries, a remarkable number considering the virtual assistant is only one year old. The Rammas customer agent is the first output of a multipronged AI roadmap at DEWA to deploy the technology to improve customer experiences, support staff functions and remotely manage complex operations.

### INNOVATION ECOSYSTEM

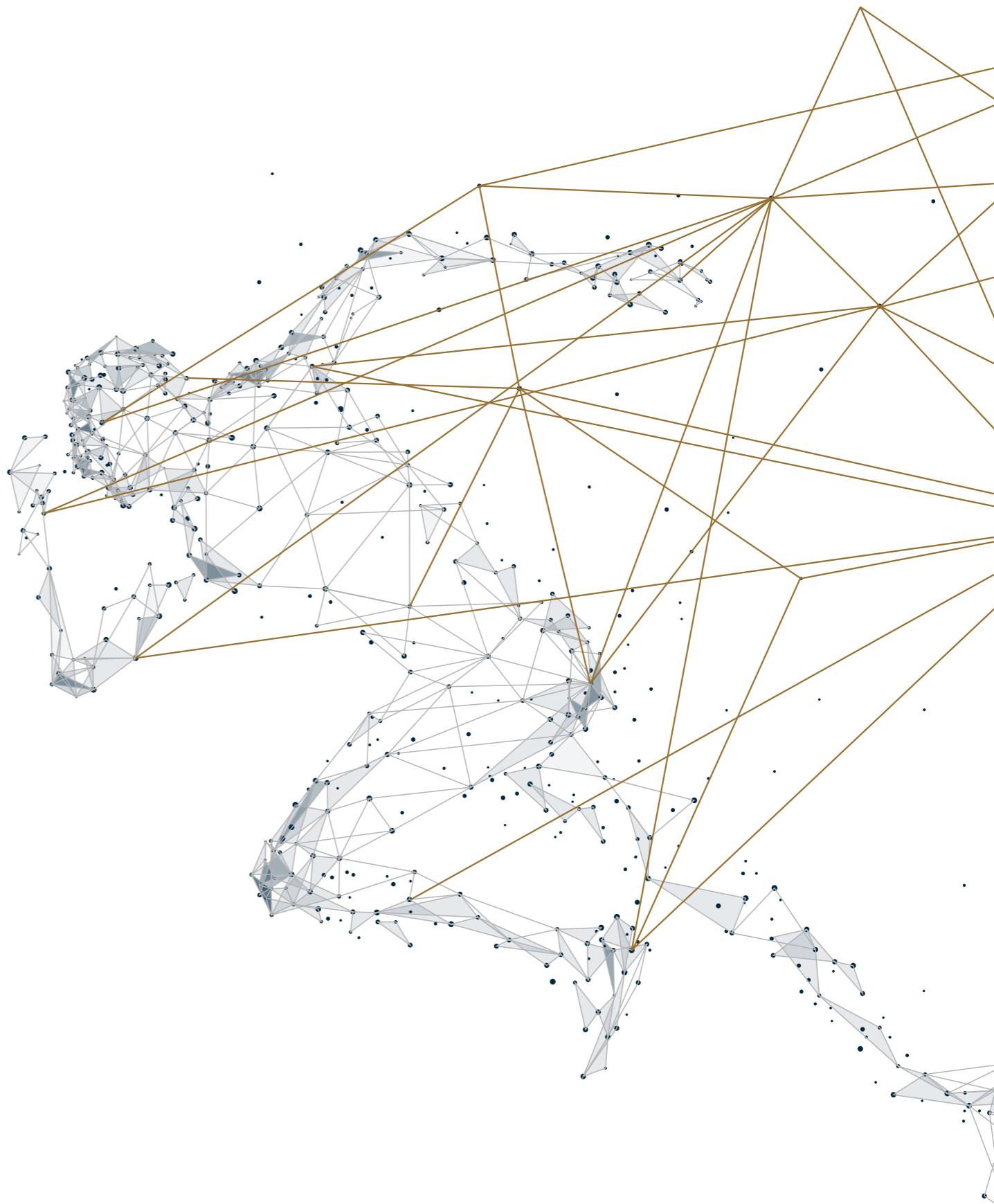
Smart Dubai and the Dubai Department of Economic Development have launched the Rashid AI, which use IBM's Watson cognitive computing system to assist with customer questions about business licensing and registration. Rashid will also be trained on questions related to buying and renting property in Dubai, with the ultimate objective of becoming an AI concierge for the city.

The UAE government is also experimenting on the leading edge of AI applications. The Dubai Future Accelerators (DFA), which issues yearly challenges to the international tech community, is pushing the boundaries of AI by accelerating ready-to-scale applications within the UAE government. In 5 cycles, DFA has supported more than 40 AI startups working on projects ranging from medical diagnostics to curriculum design. These developments continue to multiply as the nation embeds AI into its DNA.

A new smart centre in Dubai will combine artificial intelligence with the human touch to deliver personalised services of 14 government departments under one roof. The Services 1 Centre features artificial intelligence technology IBM Watson, robots, and one employee to represent 14 government bodies. Watson explains the services to customers and answers queries in English and Arabic through the Middle East's largest smart touch screen. Customers utilise the robots to record their suggestions (audio and video) to improve services or just give their feedback.

The centre provides customers with smart access to more than 100 government services offered by eight public entities: The Ministry of Interior, Ministry of Human Resources and Emiratisation, Sheikh Zayed Housing Programme, Emirates Post Group, Ministry of Infrastructure Development, Ministry of Climate Change and Environment, Ministry of Culture and Knowledge Development and the Telecommunications Regulatory Authority.

### 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE



### 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

The successful development and deployment of AI requires a few key considerations revolving around the governance of AI, data privacy, ethics, bias, and effects on employment.



## 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

### 3.1 AI GOVERNANCE

The urgent questions concerning data privacy, security, bias and the ethics of AI point to the critical role of governments in setting adequate regulation to manage any potential pitfalls of AI. This presents an opportunity in the UAE, with its benefits of multinational residents and an agile leadership, to refine best practices to advance the global conversation.

The UAE Cabinet appointed the UAE Artificial Intelligence and Blockchain Council to oversee the implementation of AI technology in society and across government. The Council will propose policies to create an AI-friendly ecosystem, advance research in the sector, and promote collaboration between the public and private sectors, including international institutions to accelerate the adoption of AI. The Council is further tasked with encouraging the exchange of knowledge and experience in the AI field, integrating AI in education, spreading awareness and knowledge in the public sector and using AI to ensure the happiness of individuals. The Council also oversees the positive use of artificial intelligence, privacy of user data, data security and integrity, and efficient data sharing with the competent authorities. The UAE Artificial Intelligence and Blockchain Council also handles blockchain and oversees ways to use blockchain across the

government. The formation of the council is one of the five themes outlined in the Government's AI strategy.

Elsewhere in the UAE, initiatives such as the federal RegLab offer an example of the agile approach that will accelerate the UAE in becoming a world hub for AI. The RegLab enables the UAE Cabinet to grant temporary licenses for the testing and vetting of innovations that utilise future technologies and its applications, such as AI. Similar regulatory sandboxes by the Abu Dhabi Global Markets (ADGM) and Dubai International Financial Centre (DIFC) will lead to further insights on the right mix of policies and regulations required to support a thriving AI business landscape in the UAE.

But the governance of AI is not the only question facing government leaders. AI also has the potential to influence the act of governance itself. As researchers come ever closer to AI systems that can make decisions, the nature of leadership and governance will also have to change. Will AI advance human intelligence in governance? Can the AI revolution be a call to action to better governance? The answer to both questions is yes, and the willingness of the UAE to adapt to these changes offers a blueprint for other countries.



### 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

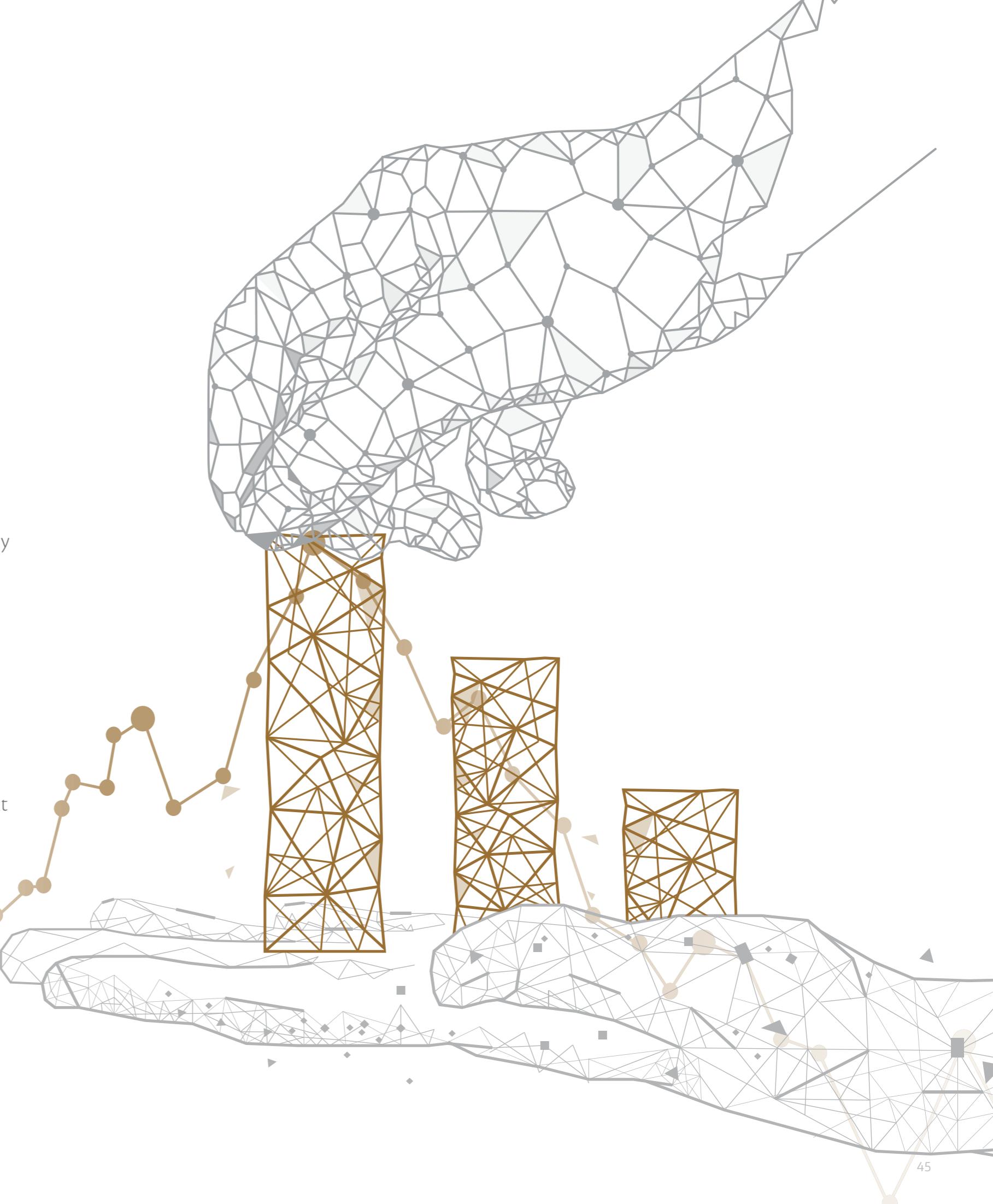
#### 3.2 DATA GOVERNANCE

Data plays a pivotal role in developing ML algorithms. However, the usage of data raises challenges around data privacy. First, private companies are collecting personal data to develop ML models, to ultimately generate profit. There is a tension thus in using personal data between creating value for businesses and improving user experiences. Reconciling how corporations use data in a transparent and fair manner is key.

As part of the UAE Government's commitment to maintaining satisfaction of its diverse community, government service providers regularly collect data from customers related to their happiness with a specific service transaction. The data from these 'Happiness Meters' is then analyzed and used to design interventions to increase customer happiness, such as expanding operating hours or opening more service channels.

The UAE Artificial Intelligence and Blockchain Council has established The Data Committee. Its main tasks include (1) identifying the main challenges of collecting data for artificial intelligence and blockchain, (2) making recommendations for the standardization, collection and inventory of data, (3) and designing specialized courses, policies, systems and standards for all data.

As the home of more than 200 nationalities, the UAE itself is a rich source of data that can be leveraged to inform globally relevant use cases. As AI projects continue to proliferate in the country, these rich data fields can be put to use for innovative applications and solutions across the sector.



## 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

### 3.3 CYBERSECURITY

The need to protect the security and integrity of data introduces a new dimension to the challenges facing AI today. As cyberattacks continue to increase in volume and intensity, AI algorithms are both an asset to protect and a means of defense (or attack).

The UAE Government treats cyber safety and digital security as a national priority. Cybersecurity protocols are hardwired into the country's digital infrastructure. UAE resident and citizen identities are secured through electronic, biometric identity cards and single-sign-on logins that allow access to online government service with one password. Systems are regularly monitored with the help of AI-powered programmes as outlined in the UAE's National Cyber Security Strategy. The UAE Artificial Intelligence and Blockchain Council has established The Cybersecurity and Risk Management Committee, with main tasks

to include (1) providing technical advice and proposing initiatives to disseminate knowledge, (2) making recommendations and proposals, (3) conducting surveys to document vulnerabilities and security threats, (4) maintaining a unified and modern record, (5) ensuring the effectiveness of cybersecurity protection systems, and (6) combating cybersecurity crimes in the field of artificial intelligence and blockchain.

AI can also be used to implement solutions for cybersecurity tasks. These include AI systems that scan fingerprints and retina for accuracy in biometric logins, or to detect malware and virus on data servers. More advanced applications assist with securing conditional access featuring dynamic, real-time, and global authentication frameworks for high-level data servers. The Dubai and Abu Dhabi police also use AI to protect sensitive data systems and prevent crime.

**The UAE Government treats cyber safety and digital security as a national priority.**



## 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

### 3.4 ETHICS

The ethical principles that guide how AI is created and used are perhaps the most important questions in the field of AI research. This is especially true given that ethics are cultural, and there is not one universal code of ethics. That being said, one positive development stemming from the intense interest in AI in the last decade has been the international push for responsible and ethical AI. The UAE has taken a leading role in this debate.

The Dubai Data Establishment within the Smart Dubai Office has published an Ethical AI Toolkit that defines guiding principles for ethical AI. The principles focus on four domains: ethics, security, humanity, and inclusiveness (Figure 9). The principles state that AI systems should be fair, transparent,

accountable, and understandable. Additionally, AI systems should be safe and secure, and should serve and protect humanity. Furthermore, AI should be beneficial to humans and aligned with human values, in both the long and short term. Finally, AI should benefit all people in society, be governed globally, and respect dignity and people's rights. The framework also provides guidelines to ensure the fairness, accountability, transparency and explainability of AI algorithms. Smart Dubai has also built a self-assessment tool for government entities, the private sector and individuals to evaluate AI solutions from an ethical perspective. Smart Dubai's approach to ethics is especially innovative and critical for this developing field.

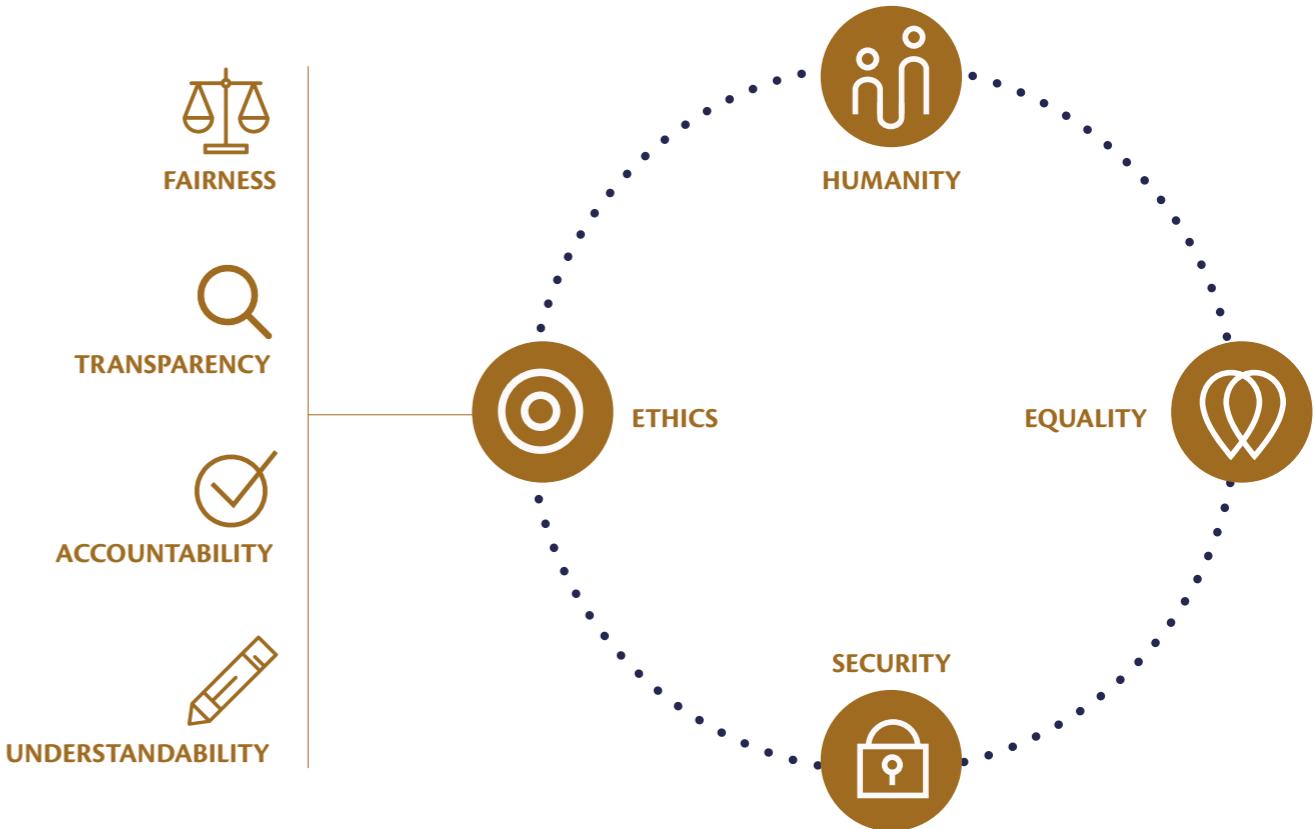


Figure 9. Dubai's Artificial Intelligence Principles

**The Dubai Data Establishment within the Smart Dubai Office has published an Ethical AI Toolkit that defines guiding principles for ethical AI.**

## 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

### 3.5 BIAS

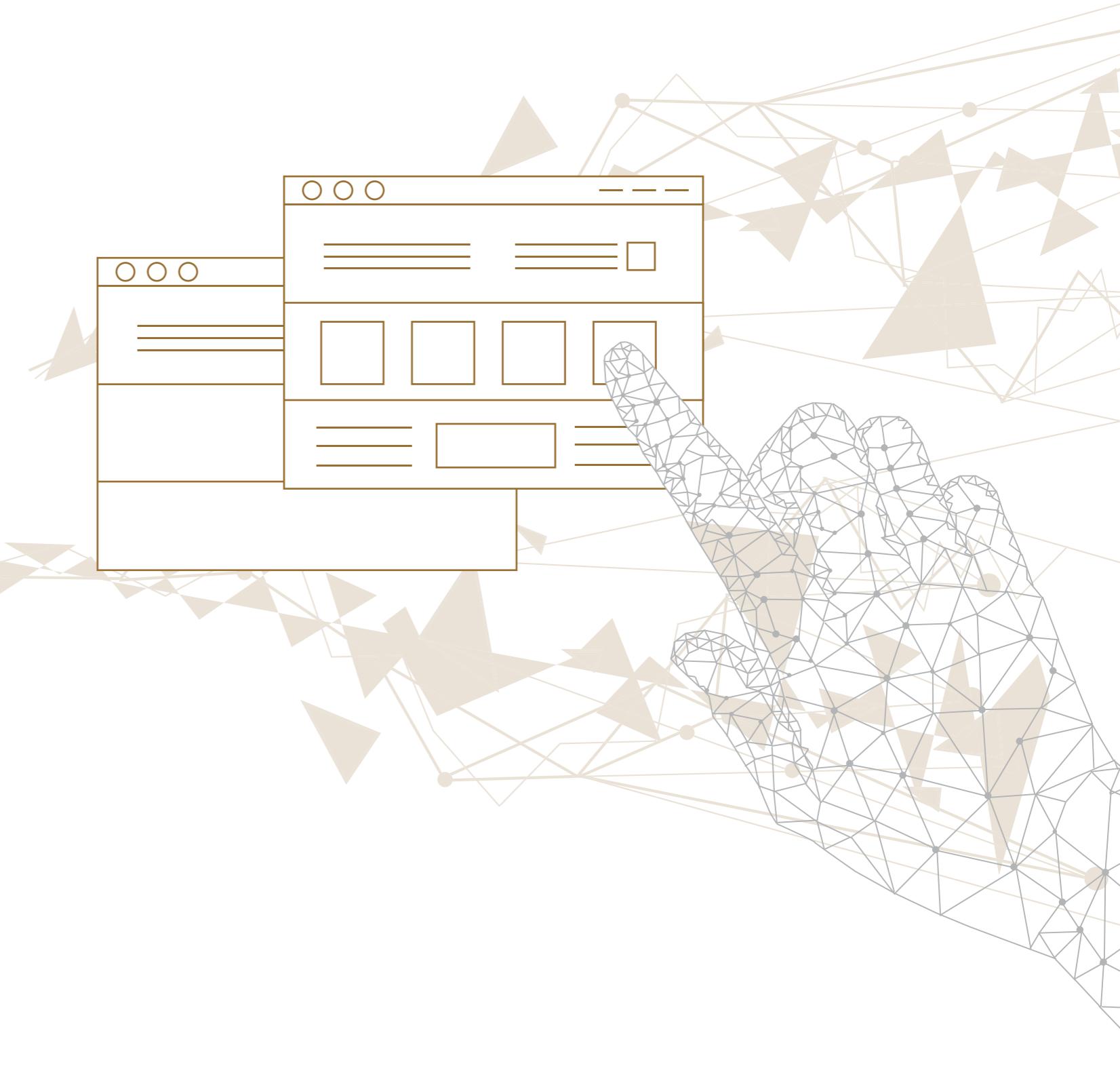
AI can identify patterns, conduct tasks and make predictions faster and more accurately than humanly possible. Yet AI is only as accurate as the data that it is trained on. This is why the quality of data that is fed to an AI is so important. Bad data will inevitably lead an AI to make the wrong decision, sometimes with life-altering consequences. For example, using data collected from publicly available records, an algorithm that was developed in the US found that criminals of color were assigned higher risk profiles than white criminals. The findings highlight how cultural bias can be easily embedded in seemingly objective algorithms. Statistically, people of color are not more likely to commit crimes, but historical bias reflected in the data caused the algorithm to make the wrong prediction since people of color are more likely to be prosecuted for crimes.

In another case of bias and AI, Amazon was forced to scrap an internal project that was trying to use AI to vet job applications after the software consistently downgraded female candidates. Because AI systems learn to make decisions by looking at historical data, they often perpetuate existing biases. In this case, that bias was the male-dominated working environment of the technology industry. The issue of bias is complex and will

continue to be a challenge as long as bias exists in our societies.

The UAE is focused on efforts to remove bias from AI systems. Following steps outlined under the Fairness Principle in the Dubai AI Ethics Guidelines, bias is mitigated by considering the effect of diversity on the development and deployment of a solution and evaluating whether the data ingested is representative of the affected population. Next, solution providers evaluate whether decision-making processes introduce bias by testing the algorithm prior to deploying it in the field. Providers also consider whether their AI systems are accessible and usable in a fair manner across user groups. Lastly, AI solution providers in the UAE are urged to continually evaluate fairness of significant decisions informed by AI in an effort to confront biases.

The question now is not *can* we build AI - but *should* we? The first six decades of AI development centered on the question of whether specific inventions and innovations were possible. Today the questions focus on whether the invention will be positive or negative for society. This is profound shift in how society understands AI and its role in society.



### 3. KEY CONSIDERATIONS & EFFORTS OF THE UAE

#### 3.6 EMPLOYMENT

Research is on the cusp of creating tools that are able to perform repetitive tasks better than humans. Just as technology irrevocably changed work during the Industrial Revolution, so too will AI change how people work today. Large parts of interconnected infrastructure already rely on AI, from virtual assistants to translation software.

The impact of AI on the workforce is threefold. AI is replacing employees in roles with repetitive tasks that follow a strict set of rules, such as factory work, or in roles that are dangerous to humans. AI is augmenting employees in roles that demand high levels of precision yet still require human intuition or empathy, such as in medicine. Finally, AI is assisting employees in tasks where large volumes of data need to be evaluated in order to make a decision, such as law or finance.

With the arrival of self-driving cars, the dream of increased productivity will be released onto the roads. Time spent driving can be spent elsewhere, and taxi drivers will have to find jobs in other sectors. Similar shifts will unfold in the medical industry. AI will aid doctors in evaluating patients, and individuals will be able to track and interpret their medical conditions through little more

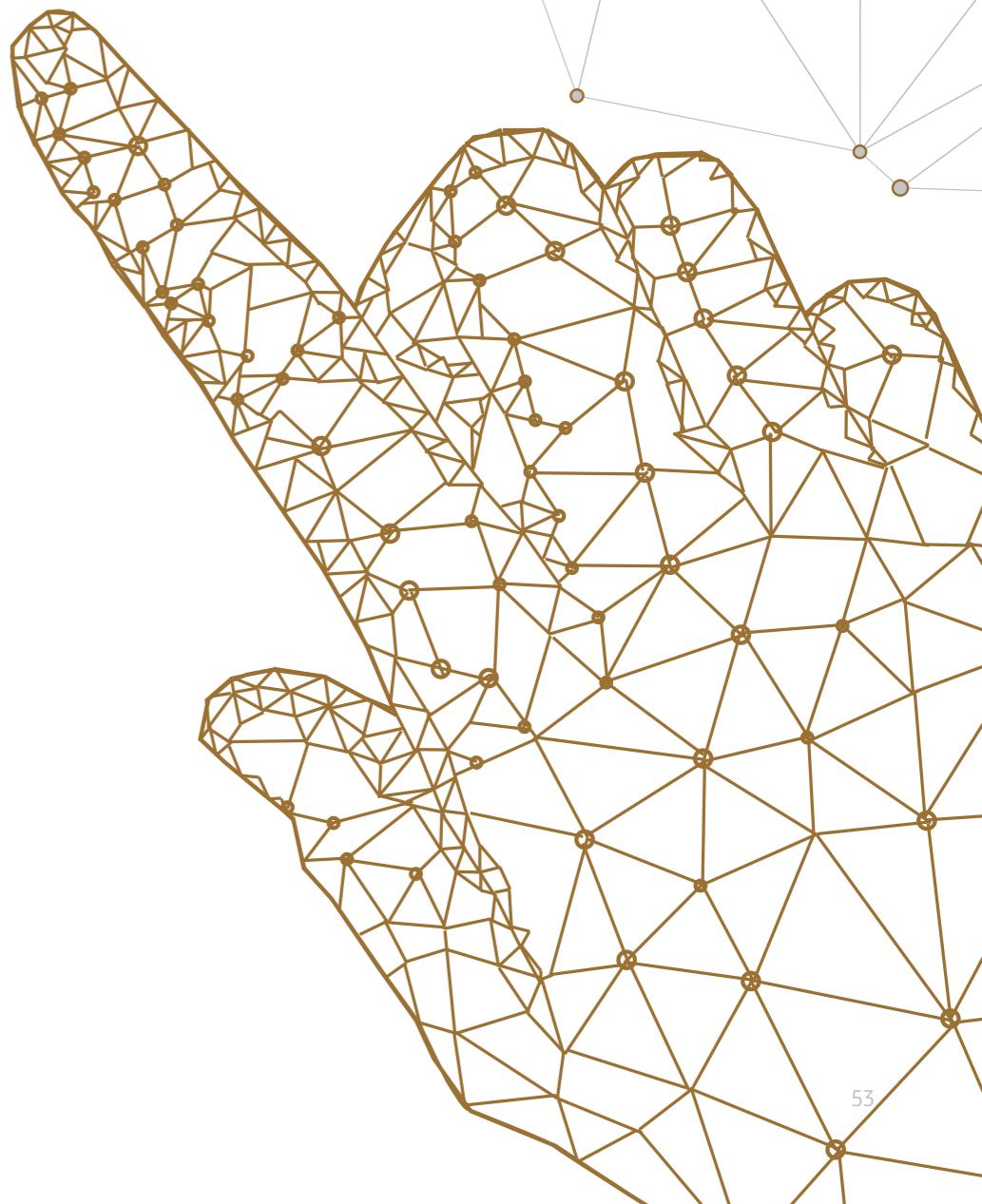
than a smartphone. In other scenarios, AI will replace human labor entirely, allowing us to focus on the creative and empathetic tasks that make us uniquely human.

Jobs have been made redundant but not all will be eradicated. Robots and AI could lead to hiring sprees as companies focus on new areas of productivity once menial jobs are outsourced to AI. However, the new kinds of jobs that will be done in the digital economy will require technical skills or social intelligence. Thus, up-skilling of the labor force will be critical to handling this transition.

Around 22% of graduates in the UAE study STEM subjects, ahead of 16% in the US for example. From programming to overseeing AI systems across society, the AI industry will soon be one of the major drivers of the UAE economy. The top three industries for fresh UAE university graduates are professional services, architecture and engineering, and financial services. Each of these fields is affected positively by the growth of AI applications in the workforce. In the finance sector, for example, analysts work alongside AI systems to evaluate market trends. The partnership boosts job performance and ensures time is spent as effectively as possible. The same is true for virtually every job in

these sectors. Far from stealing jobs away, AI will create more jobs while ensuring that existing positions are more productive.

Job titles such as algorithm manager, AI data analyst, machine learning engineer, data curator, digital knowledge manager, cognitive copywriter, and AI integration designer will soon be featured across all employment sectors.



## 4. BUILDING AI CAPABILITIES AT YOUR ORGANIZATION



## 4. BUILDING AI CAPABILITIES AT YOUR ORGANIZATION

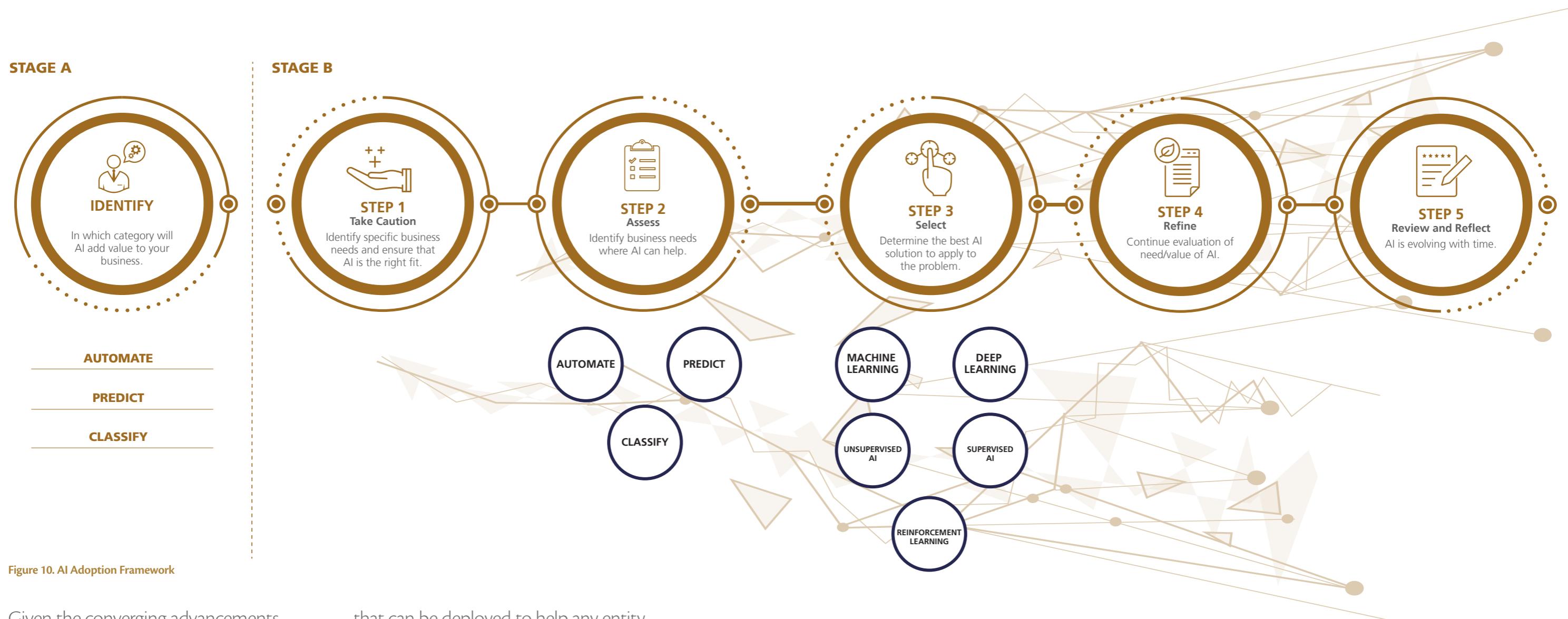


Figure 10. AI Adoption Framework

Given the converging advancements in deep learning, data availability and computational power, it is no longer a question of if AI will disrupt any industry, but when. The opportunity for AI is apparent, yet in a field that is both so broad and dynamic, the obvious question becomes – where to begin? (Figure 10)

Embarking on an AI project may sound daunting to even the most seasoned executive. Yet at its core, AI is another tool

that can be deployed to help any entity complete its objectives more efficiently. When applied correctly, AI can deliver the ultimate win-win: a solution that both improves customer experiences and controls costs. However, leaders should be careful to avoid the pitfalls of defaulting to vanity projects that do little to leverage available data or support entity objectives.

The first step to getting started in AI is to conduct an internal readiness assessment

to determine if the right people, processes and standards are in place to guide a successful implementation. Although senior level managers do not require a strong technical grounding, it is important to conduct proper education sessions with all stakeholders to ensure a shared foundational understanding. A strong internal technical team with experience in data science and machine learning is critical

to lead the project internally and to act as a counterpoint to an external supplier.

A successful AI solution relies on well-defined and sustainable data management. Prior to beginning in AI, data should be valued as a corporate asset. Investment in cloud-based technologies optimized for effective data-sharing is a good data maturity indicator. Entities should also

## 4. BUILDING AI CAPABILITIES AT YOUR ORGANIZATION

evaluate how much data the company uses and produces and what data governance standards are in place to reflect well-organized data protocols.

Finally, entities should also evaluate their corporate policy to ensure the right guidelines are in place for any AI implementation to be ethical, fair, accountable, transparent and explainable. This step may require an entity to refine its corporate policy before proceeding with any implementation. Alignment on the ethical use of AI prior to deployment ensures the solution will both boost innovation and deliver human benefit and happiness.

In terms of selecting the right AI use case, the first step is to examine the entity portfolio to identify where AI can benefit existing workflows. AI can help entities automate tasks that are well-defined, low-risk and repetitive, classify vast amounts of data to identify patterns, and make predictions by comparing real-time inputs against historical data. In a retail setting, for example, AI could be used to automate the nightly stock inventory, detect patterns in product purchasing habits to identify cross-merchandising opportunities, and predict buying habits to pre-order inventory. This is taking place

in leading grocery stores such as Carrefour across the UAE.

Once an entity has identified a challenge that an AI will help solve, the next step is to determine exactly what type of AI is needed. For a repetitive task with clearly defined inputs and a definitive output, a machine learning algorithm trained in supervised learning would be appropriate. If there are large volumes of data that need to be reviewed and anomalies detected, such as security footage, a computer vision neural network trained in unsupervised learning is a good solution. If the solution will need to interact with humans through text or voice commands, an AI trained in natural language processing through deep learning will be able to get the job done. The more tightly defined the use case is, the higher likelihood of identifying the best AI fit for an entity.

Unlike a traditional computer program, AI doesn't operate in a vacuum. Entities need to constantly review whether the AI is performing as intended and in line with entity objectives. Change is a good thing. With the rapid advances in technology, AI platforms are always changing and refining their offerings. Leaders should embrace that change and

understand how innovation will make their operations better.

The revolutionary aspect of getting started with AI is that entities are not doing anything dramatically new. Getting started in AI doesn't require creating a new workstream or entering a new market. The difference is that AI can refine, streamline, and accelerate existing processes. Using intelligent algorithms, these processes can be augmented and tailored for even better results.

It is useful to keep in mind that, while most AI innovation is taking place at a sophisticated level, there is ample potential for AI to transform how people work, from the most mundane tasks to the most advanced. Thus, getting started with AI to address evergreen challenges can yield practical and long-lasting results. That is why the UAE has invested so much in AI programmes, initiatives, and implementations. The UAE has seen the second highest AI investment in the region over the past decade, estimated more than Dh7.9 billion. 94% of companies in the UAE report involvement in AI at executive management level - the highest percentage of any surveyed country in the Middle East. This is

due to the fact that UAE companies are heavily focused on customer engagement when it comes to AI. The use of chatbots in the marketing space has become common largely because they enhance the customer experience, ultimately demonstrating obvious value to management. Figure 11 shows sample of guiding questions in evaluating own AI capabilities, while further consultation is advised for each case.



# 4. BUILDING AI CAPABILITIES AT YOUR ORGANIZATION

## PEOPLE

The right skill set is essential to your AI journey. Consider your team.



1. We have in-house data science and/or ML engineering expertise.  
 Yes    No    Unsure
2. We have a Chief Data Officer, CIO, CTO or similar senior role focused on data.  
 Yes    No    Unsure
3. We have executive support for AI initiatives.  
 Yes    No    Unsure

## PROCESS

Weak or inefficient processes won't be improved by automation. Consider the state and purpose of your current business processes.



1. Our business processes are well defined and stable.  
 Yes    No    Somewhat
2. We value data as a corporate asset.  
 Yes    No    Unsure

## TECHNOLOGY

Integrated technologies that leverage the Cloud are foundational for AI success. What technologies do you currently use?



1. Our organization uses Cloud-based technologies.  
 Yes    No    Unsure
2. Our systems are integrated, with viable, effective data-sharing.  
 Yes    No    Somewhat

## DATA

Machine learning algorithms require vast amounts of categorized data. How does your organization handle data?



1. Our data is clean and well organized.  
 Yes    No    Unsure
2. We have data governance processes in place.  
 Yes    No    Unsure

## CULTURE

AI spurs transformation. Can your team embrace an evolutionary culture?



1. Our culture encourages cross-functional collaboration.  
 Always    Sometimes    Never
2. Our organization prioritizes and funds R&D initiatives and PoCs.  
 Always    Sometimes    Never

Figure 11. Sample Questions for AI Readiness

## 5. AI LITERACY, RESOURCES & INITIATIVES



## 5. AI LITERACY, RESOURCES & INITIATIVES



The wide-ranging impact of AI means that individuals at all levels, from young students to seasoned professionals, will need to deepen their understanding of the technology in order to participate as active members of society in the near future. The best way to do that is to approach AI as an executive might. Start with a basic understanding of data, how it is used, stored, and its limitations.

With a foundation in data literacy, the next step is to gain a grounding in the ethical debates surrounding AI. The influence of the life experiences of programmers on their AI creations is one example of a dilemma society must be able to consider. Basic understanding of coding languages or at least the programming principle behind them is an additional skill needed to chart AI progress. The best way to develop these skills at a societal level is to introduce computer science as a core capability beginning at an early age.

Starting children early in AI education programs is critical for the development of

a strong AI sector. This begins with strong data science and programming education. In the UAE, focus on future skills training is a pillar of the National Strategy for Advanced Innovation. The Government is developing a new K-12 curriculum for AI, which will place AI-based coding courses and data science at the core of the curriculum. The UAE Artificial Intelligence and Blockchain Council has endorsed the use of AI in education to predict student behavior, facilitate in-class automation and design customized course curriculum. Through partnerships with leading AI education companies, the UAE has seen productivity soar.

Take Alef Education, a company that is helping students in Abu Dhabi. Alef uses AI to assess how well students are understanding concepts and what resources they need to succeed. After 12 months of using Alef, 240 grade 6 students in Abu Dhabi saw their scores soar. English scores improved by 27%, Math results soared by 78%.

## 5. AI LITERACY, RESOURCES & INITIATIVES

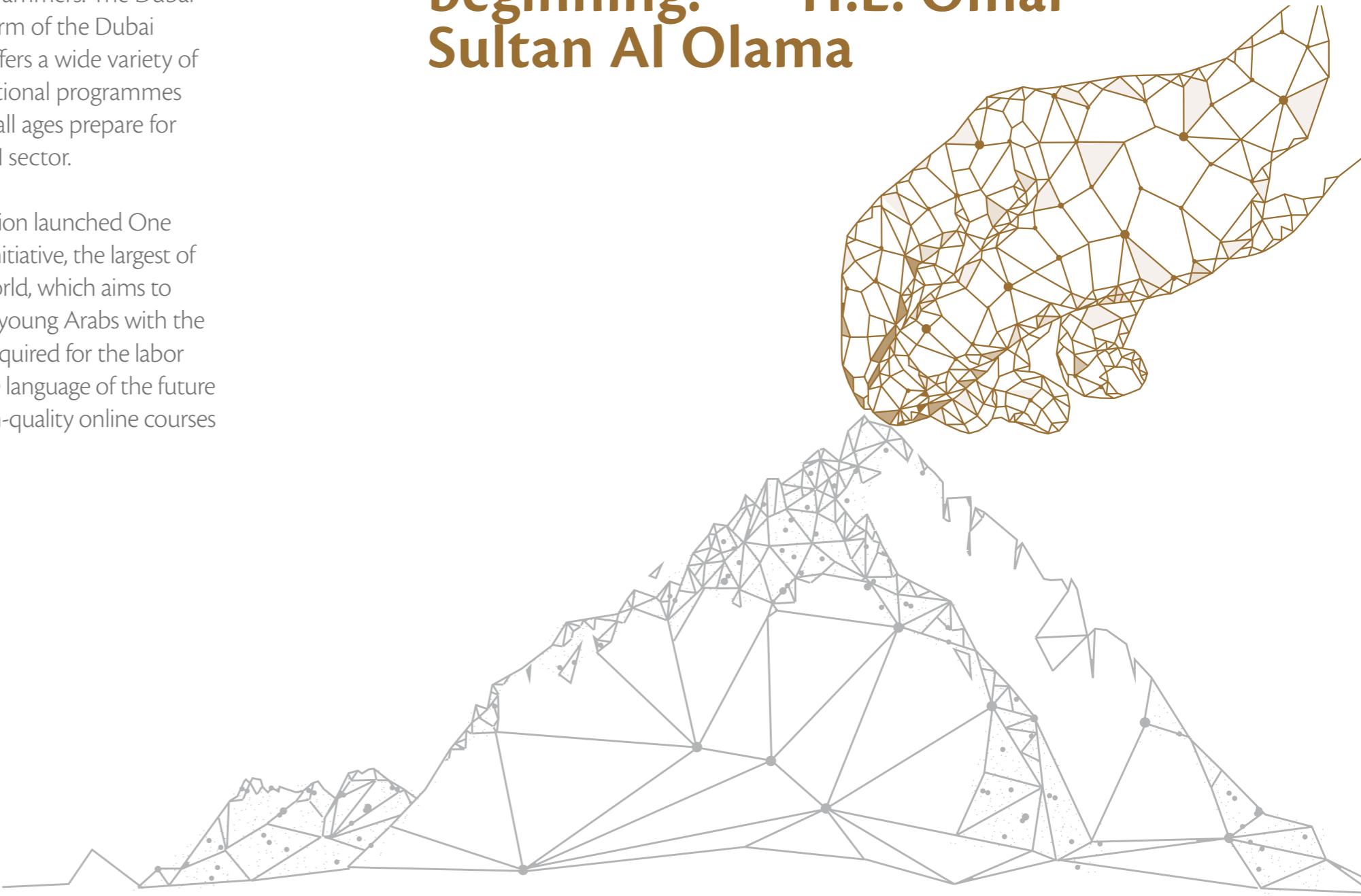
As part of the National Program for Artificial Intelligence, UAE Office for Artificial Intelligence launched the UAE AI Camp, which offers spring and summer camp programs for high school and college students and government employees. The camp provides both theoretical and technical skill training in partnership with leading practitioners including Careem, AutoDesk, DGWorld, IBM and Microsoft. Dell EMC has also signed an agreement to train 500 Emirati students in a specialized AI internship programme in 2018.

The British University in Dubai recently launched a bachelor's degree in AI that will be available for free to Emirati students. Full and partial scholarships are also available to any student who wishes to enroll. Abu Dhabi Polytechnic offers the world's first applied bachelor's degree in Artificial Intelligence and Data Science.

Rochester Institute of Technology in Dubai offers the world's first Master degree in Data Analytics. These degrees are part of a nationwide effort to bolster STEM course offerings in the universities, which are part of the foundation in creating the next generation of AI programmers. The Dubai Future Academy, an arm of the Dubai Future Foundation, offers a wide variety of AI courses and educational programmes that help students of all ages prepare for employment in the AI sector.

Dubai Future Foundation launched One Million Arab Coders initiative, the largest of its kind in the Arab world, which aims to empower one million young Arabs with the essential future skills required for the labor market by learning the language of the future "Coding" through high-quality online courses and certifications.

**"The potential for AI is obvious, and educating our future generation is just the beginning." – H.E. Omar Sultan Al Olama**



## 6. LOOKING AHEAD



## 6. LOOKING AHEAD

The UAE has embraced the future of AI today. With the UAE Artificial Intelligence Office and the adoption of the National Strategy for Artificial Intelligence as part of the UAE centennial 2071 plan, AI is core to the national aspirations of the country. The UAE is a global model for adopting AI in government and future strategies. The UAE aims to become a hub for AI.

The UAE 10-year strategic plan – the National Strategy for Artificial Intelligence 2031 – is core to the nation's plans for AI. The vision is for the UAE to be one of the global leading nations in AI by 2031. The plan is based on an integrated approach that focusses on developing the nation's capabilities and benefitting from global expertise to create advanced technological solutions for government and private sector, and to develop legal and organisational frameworks to steward the responsible adoption of AI.

"The UAE launched an integrated strategy that focusses on developing the nation's capabilities and benefitting from global expertise, to create advanced technological solutions for government and private

sector challenges, and develop legal and organisational legislation that comply with the adoption of AI." — H.E. Omar Sultan Al Olama.

The strategy's objectives mentioned in the Government section above aim at employing AI in vital areas such as education, government services and community wellbeing.

The strategy includes a plan to build a well-established UAE brand of artificial intelligence through artificial intelligence activities that will make the UAE a test platform for artificial intelligence technology, provide enhanced services with advanced technology, training and qualification programmes, talent building, research, data development and governance.

The UAE has been ranked top in the Middle East in respect of its readiness to navigate advances in artificial intelligence. With this foundation in place, the UAE is well positioned to lead the next wave of opportunities in the AI sector and guide their successful incorporation into society.

The future of AI is not difficult to imagine. The constant stream of data that defines the majority of people's lives – from social media check-ins to online banking, to mapping applications – will power future machine learning. The more data society invests in the system, the better machines will be at detecting everything from early signs of illness to the safest route kids can take to school.

The importance of AI innovation as it pertains to advancing humanity, making the world a safer, cleaner, and more prosperous place, and addressing global challenges, rests firmly in the hands of the private companies and governments developing it. If the products they create don't improve lives, then the promise of AI as a positive force will be limited and collective anxiety will deepen. However, if machine learning is open source and regulated in a manner that prioritizes the public good, then AI could transform humanity for the better. The promise of AI ultimately lies in how people organize society, and which values they choose to uphold and choose to ignore.



## 7. GLOSSARY OF KEY TERMS



## 7. GLOSSARY OF KEY TERMS

### **Artificial Intelligence**

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

### **General AI**

General AI refers to a machine that can perform any intellectual, physical and even emotional task that a human being could.

### **Narrow AI**

Narrow AI is artificial intelligence that is focused on one narrow task.

### **Machine Learning**

Machine learning is an application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

### **Deep Learning**

Deep learning is a subset of machine learning where artificial neural networks, algorithms inspired by the human brain, learn from large amounts of data.

### **Neural Network**

A computer system modeled to simulate the human brain and nervous system.

### **Supervised learning**

Supervised learning is the machine learning task of learning a function that maps an input to an output based on example input-output pairs. It infers a function from labeled training data consisting of a set of training examples.

### **Unsupervised learning**

Unsupervised learning is a type of machine learning algorithm used to draw inferences from datasets consisting of input data without labeled responses.

### **Reinforcement learning**

Reinforcement learning is a field of machine learning concerned with how software agents ought to take actions in an environment so as to maximize some notion of cumulative reward.

### **Federated Learning**

Federated Learning is a machine learning setting where the goal is to train a high-quality centralized model with training data distributed over a large number of clients, each with unreliable and relatively slow network connections.

### **Bias**

Inclination or prejudice for or against one person or group, especially in a way considered to be unfair.

### **Ethics**

Moral principles that govern a person's behavior or the conducting of an activity.

### **Automation**

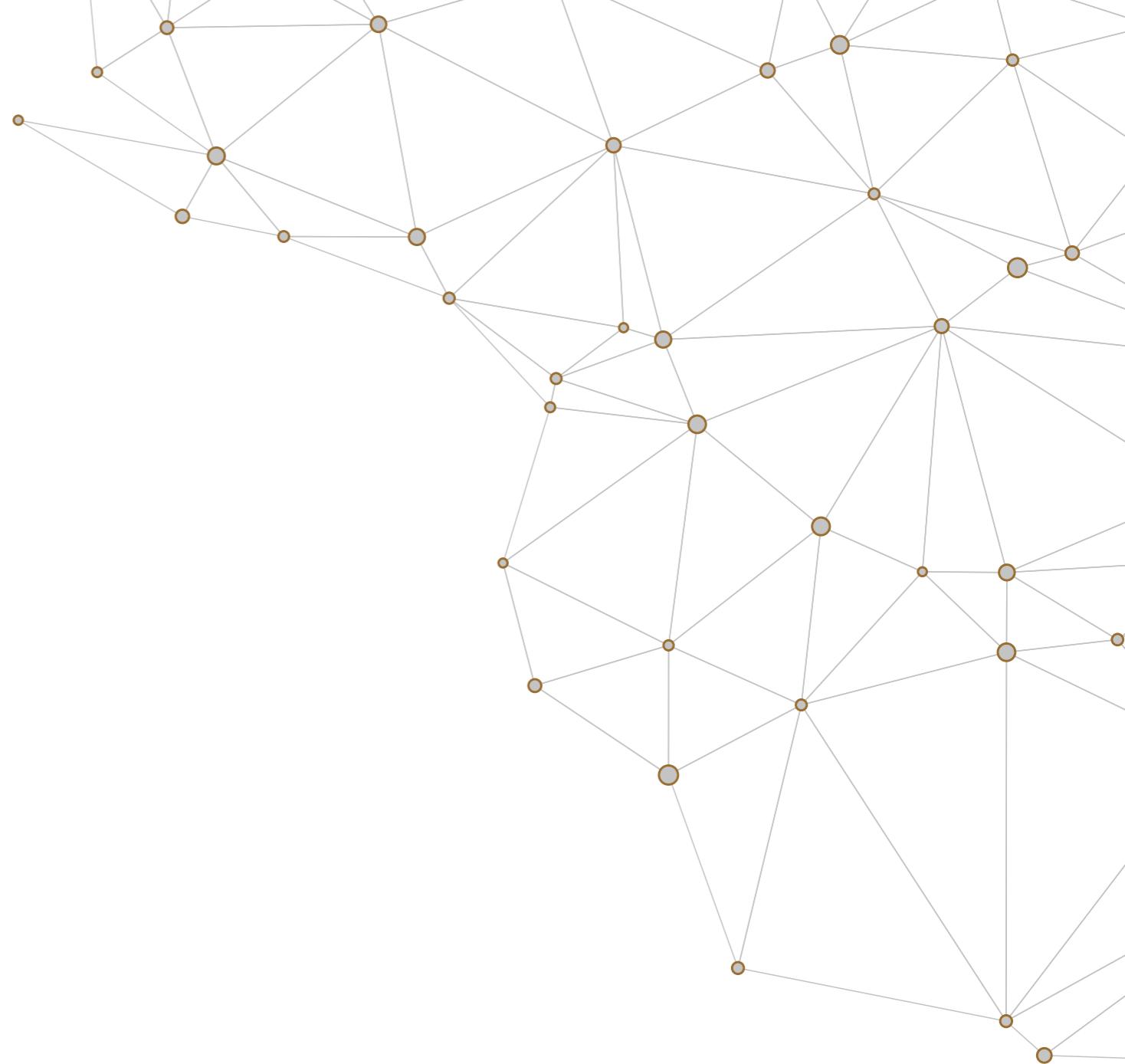
The use or introduction of automatic equipment in a manufacturing or other process or facility

### **Robotics**

Branch of technology that deals with the design, construction, operation, and application of robots.

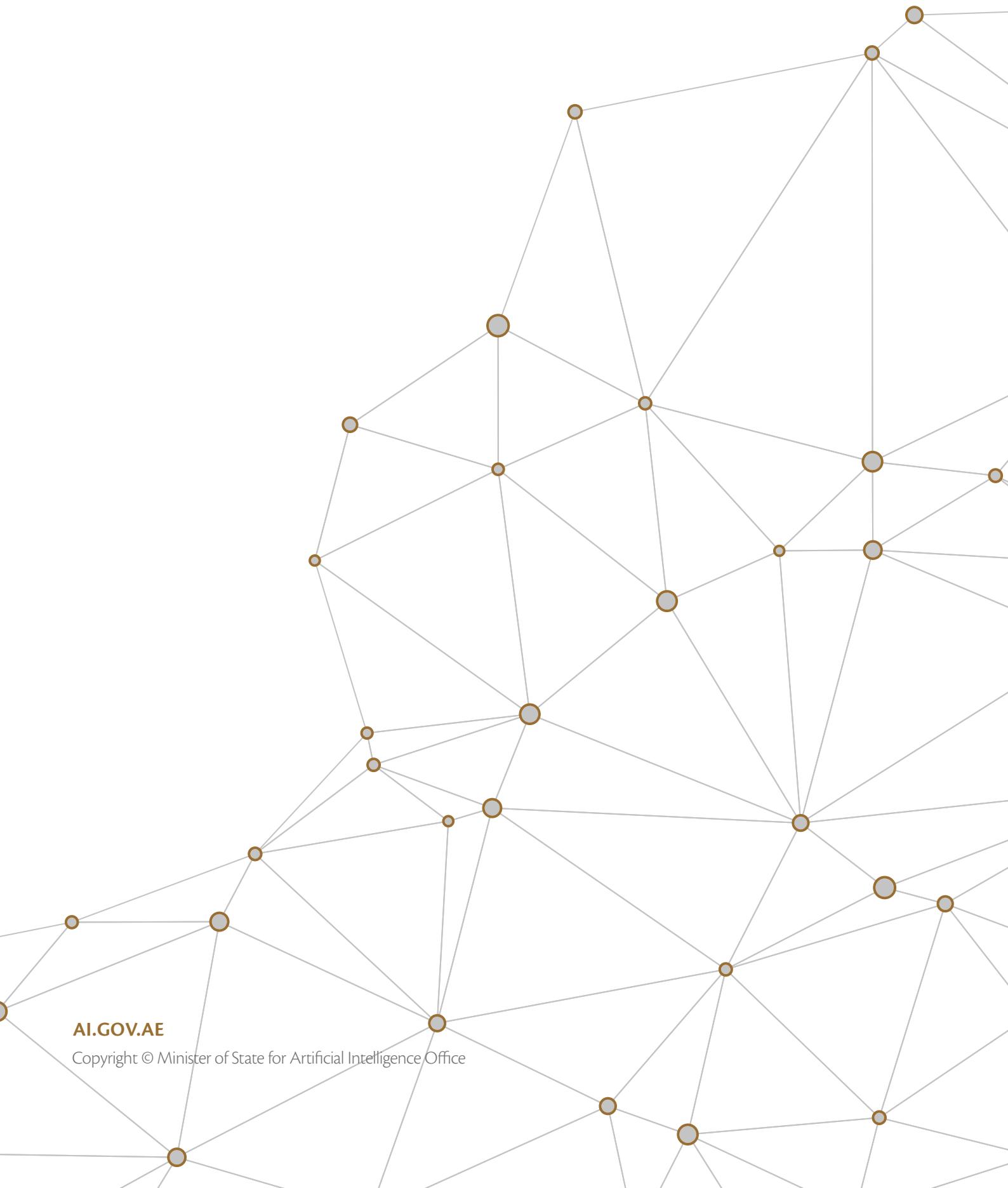
### **Autonomous Cars**

An autonomous car is a vehicle that can guide itself without human conduction.



# البرنامج الوطني للذكاء الاصطناعي

## NATIONAL PROGRAM FOR ARTIFICIAL INTELLIGENCE



AI.GOV.AE

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