Artificial Intelligence

Part 1. The Technology

Minority Report.

I, Robot.

Iron Man.

Siri.

Alexa.

Tesla's self-driving cars.

From pop culture to mainstream news, home appliances to cars of the future, Artificial Intelligence has gone from being an abstract fictional concept to playing an integral role in our daily lives.

What IS Artificial Intelligence?

Artificial Intelligence (AI) is the replication of human intelligence using computers. AI evolves (grows) by **learning from data**—a computer's version of a human's life experience.

Some find the technology fascinating while others remain cautious about its potential in the wrong hands.

How Did We Get Here?

To truly grasp the value and significance of AI in advancing modern civilization, we have to travel back in time to see how far humanity has progressed and to appreciate how far AI can take us.

There used to be a time when *everything had to be done using one's two hands*. This was the **Pre-Industrial Age**: there were no machines, no computers, and no powered tools; it was the age of hard manual labour. Production was basic with a limited number of specialized crafts.

Then came the **Industrial Revolution** in the late nineteenth century, marking the transition from hand production methods to machines and the rise of the mechanized factory system. *Humans started operating machines with their hands.*

The Industrial Age brought us the digital revolution in the mid-twentieth century, spurring the emergence of the **Information Age**. *Humans now started telling computers what to do* by issuing specific commands. Information became a commodity that could be accessed quickly and easily through personal computers.

This inevitably led to the next big shift: the **Machine Learning Age**. We went from telling computers what to do, to *teaching these machines to learn to do things* by exposing them to vast amounts of data (i.e. big data).

In self-driving cars, the computer is taught to respond to a video feed of the road with data cues that prompt it to make a turn, slow down, stop, accelerate, etc.

On the agricultural front, farmers are using drones and sensors to optimize planning by identifying at risk crops, determining the best hybrid seed choices, optimize resource utilization, and more, to boost yields and increase efficiency.

We've also seen AI aiding in simple customer service tasks such as answering commonly asked questions online in the form of a chatbot.

Though it's difficult to pinpoint the moment we officially entered this radical new phase, AlphaGo (Google DeepMind's AI-based computer) beating world champion Go player, Lee Sedol in March 2016 marked a historic milestone in Artificial Intelligence.

Due to the game's mind-boggling number of possible moves, winning Go requires **strategy** over brute force computing. According to Sedol himself, *"AlphaGo's strategy was **'excellent'**."*

Deep Learning, here we come.

The *"Big Bang of Modern AI"*: Deep Learning

Modelled after the human brain, the multi-layered artificial neural network (ANN) is the computing system designed to mimic the way a human brain analyzes and processes information.

Following computer scientist Andrew Ng's determination that graphics processing units (GPUs) could accelerate the speed of deep-learning systems by about 100 times, NVIDIA's GPUs were subsequently used in training deep-learning neural networks, facilitating the *"big bang of AI"*.

GPUs break down complex problems into thousands or millions of separate tasks and work them out at the same time (also known as parallel computing). This makes GPU computing ideal for advancing deep learning technologies and accelerating applications exponentially.

The 3 Methods of Machine Learning

Machine Learning allows systems to automatically learn and improve from experience without being explicitly programmed. The learning happens from observing vast amounts of data to explore potential underlying patterns embedded in the data, and can be categorized in the following three ways.

- **Supervised Learning**
  The simplest of the three, supervised learning involves learning from examples to predict output variables, much like the way humans learn in a classroom setting.

  A typical example would be to say *"you want to predict when Netflix users in Hong Kong will cancel their subscriptions"*. The algorithm can be trained to identify recurring patterns amongst users who have cancelled versus those who haven't, to predict the desired output.

- **Unsupervised Learning**
  Also known as self-organized learning, unsupervised learning aims to explore underlying patterns in unlabeled data and predict the output on its own without any predetermined outcomes.

  Continuing the previous example of the Netflix users' data, with unsupervised learning, the algorithm might organise the users into different groups. Upon analysis, you might find that the groups are organized based on education level. To get a different output, you can remove the data about users' education to generate a different segmentation.

- **Reinforcement Learning**
  Radically different from the other two, reinforcement learning uses a trial and error method in its quest to constantly improve and relies on a reward feedback system to learn which action is best within a specific context.

  This type of algorithm learns to react to an environment independently, constantly producing a variety of new learning algorithms. Reinforcement learning is often used in the field of Robotics and Gaming for research and development purposes.

Big Data & Deep Learning: A Symbiotic Relationship

Without big data, AI wouldn't hold any value, and without AI applications, organizations wouldn't be able to tap into the potential of their data stores. It's a symbiotic relationship.

"Today, we want as much [data] as we can get – not only to drive better insight into business problems we're trying to solve, but because the more data we put through the machine learning models, the better they get," Glenn Gruber, Senior Digital Strategist at Anexinet asserts.

Data has always existed as long as mankind has been around. The only difference is that in the past, there was no efficient way to properly collect, store, and process vast amounts of it.

Now that the required technologies have matured and converged to facilitate commercial applications, modern deep learning AI has finally taken off.

Every time we pay with a credit card, our transactional data is collected and stored by merchants and banks. The more you use Alexa, the more data your home IoT—Internet of Things network of connected devices—is collecting about your daily lifestyle, music preferences, favourite takeout restaurants, etc.

But before this data can be turned into useful information, it needs to be stored and sorted in a way that's secure and easy to access. More importantly, big data storage systems need to flexibly scale since the volume of data is constantly growing. Current systems are therefore constantly upgraded and optimized to meet these increasing demands.

To process big data, we needed a radical new computer platform. Deep learning as a new software model involves training billions of software-neurons and trillions of connections in parallel. The computer is essentially writing its own software in the process of deep learning. The answer: accelerated computing with GPU as the ideal processor. To quote Popular Science, *"GPU is the workhorse of modern A.I."*

Part 2. The Implications

How Will AI Benefit Us and Society in the Long Run?

#1 Smarter Living

The potential of AI is infinite; new applications are developed on a daily basis, spurring its widespread adoption in an ever-growing number of industries.

Based on the UN's forecast that global food production will need to increase by 70% if the world population reaches 9.1bn by 2050, farmers and agricultural producers are under pressure to boost yields and enhance efficiency.

The answer: *precision farming and smart agriculture*. Examples of AI applications currently in use include sensors providing data on soil conditions, drones surveying lands and monitoring crop growth, self-driving tractors to work the land, as well as satellite images to observe crop health and weather conditions.

Meanwhile, the term 'Smart City' takes on a whole new meaning with NEOM: Saudi Arabia's largest and most ambitious smart city designed to be the world's first fully-digitized cognitive and proactive city.

According to Joseph Bradley, head of tech and digital at NEOM, *"We will leverage 90 percent of the data we produce and utilize it in the city. It's never been done before. We want to build a citywide operating system that is aware, predictive and can take action."*

Whoa. Mind-blowing stuff!

What about AI's implications for our energy grid?

The Smart Grid features a two-way interactive capacity that allows for automatic rerouting when an equipment fails or outages occur. In essence, Smart Grid technologies provide far more efficient transmission of electricity, quicker restoration of electricity after power outages, lower energy costs, and increased integration of large-scale renewable energy systems.

#2 Autonomous Vehicles

In comparison with conventional robots that might be awkward for humans to interact with, a driverless car is the first autonomous robot we will be comfortable interacting with on a daily basis.

We will even go as far as trusting our lives with it, knowing that a driverless car is constantly learning and improving. Due to the way AI works and evolves, the more driverless cars there are

on the road, the better and SAFER these vehicles will be, which is a direct contrast of human drivers.

Driverless cars can essentially live many lives, learning and improving from different conditions and scenarios such as humidity levels, potholes, changing temperatures, snowstorms, etc. The ripple effect of its learning curve is exponential!

A driverless car can only become smarter and more intuitive over time, being immune to influences such as alcohol, stress, anxiety, and fatigue.

#3 Safety & Security

The rapid growth in digital payments has triggered a corresponding rise in digital frauds and international money-laundering, adding pressure on the finance and banking industry to constantly upgrade their security systems.

With Machine Learning, the system can quickly detect behaviour and usage anomalies in real-time based on historical data, minimizing risk and protecting users from fraudulent actions such as identity theft, credit card theft, document forgery, etc.

In the case of AI-enabled anti-money laundering solutions, the anomaly detection software seeks to identify changes in customer behavior and analyze them for patterns related to fraudulent money transfers.

In military applications, AI is being deployed in almost every field.

According to MarketsandMarkets.com, *"The Artificial Intelligence in Military market is projected to grow from USD 5.42 billion in 2016 to USD 8.70 billion by 2022"*

Drones with integrated AI are being used to patrol border areas, identify potential threats, and transmit information about these threats to response teams.

There's also the robotic submarine system being developed by the US Department of Defense (DoD), which is expected to be employed in applications ranging from detection of underwater mines to engagement in anti-submarine operations.

Meanwhile, intelligence and espionage services face an increasing need to embrace AI to boost national security, as cyber criminals and hostile nation states increasingly look to use the technology to launch attacks.

#4 AI-aaS (AI-as-a-service)

It was just a matter of time before companies started providing AI-as-a-service.

Amazon Sagemaker helps data scientists and developers prepare, build, train, and deploy high-quality machine learning (ML) models quickly, while Azure Machine Learning accelerates the end-to-end machine learning lifecycle with a wide range of productive experiences.

Google Cloud AutoML, on the other hand, goes to a whole different level by implementing automatic deep transfer learning that uses an existing deep neural network trained on other data. Compared to training a neural network from scratch, transfer learning requires a lot less data for training and runs a lot faster, making it far more efficient.

What About AI Applications in Business?

Evolv.ai is a prime example. It uses proprietary AI technology to help digital brands define their digital experience strategy and identify UX improvement ideas to optimize sales and revenue. Evolv's AI-based solution evaluates thousands of user experiences and finds winning ideas humans would never have conceived of.

Now that's what we call visionary.

#5 Collaborative AI

Just as early humans "collaborated" with dogs to develop their hunting skills, become more formidable fighters, and sleep more soundly at night, collaborating with AI could be the key to the next transformative phase in our evolution.

In February 2020, scientists at the Massachusetts Institute of Technology and Harvard discovered a novel antibiotic, halicin, using a deep learning neural network they built. Not only can it destroy a multi-drug resistant bacteria that can't be killed by existing antibiotics, but halicin could even help in the fight against coronavirus!

Meanwhile, in the field of telemedicine, AI is disrupting the entire value chain by offering radical new models of care and support. From home-based remote patient monitoring to eldercare-assistive robots—savvy machines that move semi-independently, perform tasks, and use sensors to comprehend their surroundings, AI is paving the way for accessible high-quality healthcare.

In recent years, China's pursuit of "intelligent education" has sparked explosive investment in AI-enabled teaching and learning. Tens of millions of students in the country now use some form of AI to learn—whether through AI tutoring programs, digital learning platforms, or in their main classrooms.

This could be the start of a completely new way of learning.

Part 3. The Future

We're merely scratching the surface of AI's full potential.

The Right Question Is Not "What Will Happen?" But *"What Will We Choose To Do?"*

Erik Brynjolfsson, director of the MIT Initiative on the Digital Economy and author of "Machine, Platform, Crowd: Harnessing Our Digital Future", shares his insights on the future with AI:

"AI and related technologies have already achieved superhuman performance in many areas, and there is little doubt that their capabilities will improve, probably very significantly, by 2030. … I think it is more likely than not that we will use this power to make the world a better place. For instance, ***we can virtually eliminate global poverty, massively reduce disease and provide better education to almost everyone on the planet****. That said, AI and ML [machine learning] can also be used to increasingly concentrate wealth and power, leaving many people behind, and to create even more horrifying weapons. Neither outcome is inevitable, so* ***the right question is not 'What will happen?' but 'What will we choose to do?' We need to work aggressively to make sure technology matches our values.*** *This can and must be done at all levels, from government, to business, to academia, and to individual choices."*

The choice is ours.

AI is, after all, a human invention; it is up to us to shape its evolution.

What We've Achieved So Far Using AI

The convergence of AI with other exponential technologies have shaken up industries and taken creativity and innovation to unprecedented new heights.

We've seen it in *"smart farming"*: a new data-driven approach where farmers use technologies such as IoT, robotics, drones, and AI to increase the volume and quality of products while optimizing their resources to work smarter and more efficiently.

In the construction industry, *autonomous construction robots* are being deployed directly on job sites. Examples include bricklaying robots, autonomous compactors and plows, autonomous surveillance and job site tracking applications.

On the renewable energy front, *SmartFlower uses advanced robotics and automation to intelligently track the sun*, generating up to 40% more energy than traditional stationary solar panels. Inspired by sunflowers that open, close, and follow the sun for optimal energy conversion, **SmartFlower is the world's only solar solution that uses an all-in-one sculptural design and intelligent solution to produce clean, sustainable energy for the home, car, or business.**

How incredible is that?

But there's more….. AI has also been used to produce *autonomous asteroid mining self-replicating probes*! Wait, what?

In essence, these self-replicating probes are spacecraft with the ability to clone themselves for the purpose of exploring space. They replicate using whatever space resources they can get, such as planets, moons, or asteroids. Self-replication allows for exponential growth of the number of these probes, enabling rapid exploration of space or rapid bootstrapping of space infrastructure.

If *that* doesn't blow your mind, we're pretty certain what's coming next will!

You've probably heard of the term Quantum Computing.

In essence, Quantum Computing is the ability to compute an exponential number of calculations simultaneously. Quantum computers are expected to surpass even the most capable of today's—and tomorrow's—supercomputers.

In AI, classical machine learning algorithms deal with complex computations that are sometimes too taxing for classical computers.

Imagine combining the forces of both!

The result: Quantum Machine Learning (QML), where a classical machine learning algorithm is translated into a quantum circuit that can be run on a quantum computer. To achieve this, a quantum neural network (QNN) is used, which is a hybrid of artificial neural networks and quantum computing concepts.

While this sounds impressive, what does it actually mean? *How will QML affect our daily lives?*

Besides advancing research and innovation on specialized fields such as nanotechnology, QML will allow for creation of new materials through molecular and atomic maps, molecular modeling to discover new drugs and medical research, merging IoT and blockchain to create complete connected security, and much, much more.

What's Next?

The convergence of AI with these other emerging technologies inevitably paves the way for new potentially multi-trillion-dollar industries.

The global autonomous vehicle market, for example, is expected to grow from $54.23 billion in 2019 to a staggering $556.67 billion by 2026, according to a recent report by Allied Market

Research. These autonomous vehicles include ridehail, rideshare, self-driving trucks, self-driving buses, and more.

In a separate report by Fortune Business Insights, the autonomous car segment is projected to reach $1.33 billion by 2027. In comparison, the global air taxi market is predicted to reach $6.63 billion by 2030, according to Allied Market Research.

It's a surprising contrast as one would expect self-driving cars to be a bigger market than air taxis, though the latter is definitely an exciting development to keep an eye on.

Are you recalling scenes from The Fifth Element?

Uber is (once again) poised to disrupt the urban transportation landscape with its development of air taxis via Uber Elevate—a shared air transportation service expected to launch in 2023. The company plans to launch fleets of small, electric VTOL (vertical takeoff and landing) aircraft in Dallas, Los Angeles, and Melbourne, their first international market.

Speaking of air transportation..... in the field of remote healthcare, drones have proven a useful way to distribute drugs, vaccines, and medical aid to remote and adverse environments.

Zipline International, a Silicon Valley startup, delivers life-saving medicines and health treatments to medical clinics in Rwanda. The drones fly using parachutes and take 15 minutes for a journey that usually takes four hours. This kind of on-demand distribution system is ideal for delivering emergency aid and diagnostic tools to developing countries with poor infrastructure and limited access to medical support.

There are many more examples that demonstrate the phenomenal ability of AI, especially when used in tandem with other emerging technologies.

Its potential is clear, and as we've established, we're only seeing the tip of the iceberg at the moment.

The question is, ***"What problems should we focus on solving next?"***

[Note: excluded smart cities as it's already been referenced in Part 2.]