**James Perrett 1672539 Synoptic Mechanical engineering Coursework 1 (Midterm)**

**Topic: Intelligent Systems | Prof. DT Pham**

**Essay Title: Why should engineers be interested in intelligent systems?**

**Statement of good academic conduct**

By submitting this assignment, I understand that I am agreeing to the following statement of good academic conduct.

I confirm that this assignment is **my own work** and I have not worked with others in preparing this assignment.

I confirm this assignment was written by me and is in my own words, except for any materials from published or other sources which are clearly indicated and acknowledged as such by appropriate referencing.

I confirm that this work is not copied from any other person's work (published or unpublished), web site, book or other source, and has not previously been submitted for assessment either at the University of Birmingham or elsewhere.

I confirm that I have not asked, or paid, others to prepare any part of this work for me.

I confirm that I have read and understood the University regulations of plagiarism.

I understand that if concerns are raised about my work I may need to participate in a viva (oral examination) of my work.

# Why **should engineers** be **interested** in **intelligent systems**?

## Problem Definition

On March 11th, 2016, AlphaGo, a computer program, played a move which confused every professional Go player and enthusiast around the globe. In move 37 of game 2, AlphaGo chose to play a unique shoulder move on its way to beating 18 -time world Go champion Lee Sudon, who would later describe the move as “creative” and “beautiful” [1].

Many considered the 3000-year-old Chinese board game untouchable by current AI (Artificial Intelligence) but AlphaGo proved them wrong. This naturally stirred a mixture of emotions for programmers, the Go community (40 million strong) and humankind alike. On the one hand, AI with the potential to learn and generate new ideas can offer so much to humanity. On the other, it is natural to be scared of such power [1]. As artificial intelligence continues to rapidly accelerate and integrate with our lives, as engineers, it is essential we yield this power with ethical and moral responsibility.

AI’s short history began in the 1940’s, when the science was more fiction than reality. Isaac Asimov’s short story *Runaround* inspired many into fields of computer science, AI and robotics [2]. The enigma himself Alan Turing saved millions of lives by constructing “*the bombe”*,a huge electro-mechanical computer capable of breaking the Germans Enigma code [3]. Turing’s great mind also pondered consciousness. He developed a test to see if a computer could pass for a human? Turing predicted that by the year 2000, machines with 100 megabytes of memory would easily pass his test. However, 70 years have passed, and no such AI has been able to grasp human intuition [4].

## Theory

Neural networks are identifiable as a rudimentary computational model of the brain and lie deep in the heart of AlphaGo and the best performing AI systems. First conceptualised by McCullough and Walter Pitts in 1944, NNs have cycled through various phases of interest within academia until their capabilities were amplified by the arrival of the mass-market video game industry in 1990 [5].

Simply put, NNs consist of an input layer and an output layer with several hidden layers in-between. These layers consist of many activation functions or “Neurons”. Each function receives inputs from all neurons in the previous layer and then outputs a unanimous value to every neuron in the next layer. Weights are applied to each link to indicate the strength of the connection, and in some cases, if the output value does not reach a certain threshold, the neuron will not fire. Initially connection weights and thresholds are chosen at random. The NN will adjust itself accordingly as training data is fed through, over time providing more accurate results and dealing increasingly well with ambiguity. “Deep learning” refers to the depth of layers within NNs and was critical to the success of AlphaGo*.*

AlphaGo employed a Monte Carlo tree search guided by a “value” and “policy” network. These networks reduced the depth and breadth of the tree search respectively to allow for realistic computation times [6]. AlphaGo was computing 60 moves ahead in some instances; remarkable considering there are more possible moves in Go than atoms in the universe. Both these networks had been trained using a historical database of around 30 million moves from expert players [7]. The neural nets were then reinforced by AlphaGo playing against itself, thousands of times over, and learning from its’ mistakes. Mitchell Feigenbaum stated, “machines know very little today, however, we can cause them to know a great deal about narrow things”. The key to AlphaGo’s effective deep neural networks was the pool of human knowledge it could initially draw upon.

This knowledge is essential to an expert system, yet, the creators of AlphaGo have now revealed *AlphaGo-Zero*. Trained not with data from human games but with completely random data sets. AlphaGo-Zero is no longer constrained by the limits of human knowledge. Just like nature adapting to the limits of its surroundings, the true potential of AI is still being realised. As engineers, it is our responsibility to implement and develop this technology to provide solutions to mankind’s greatest challenges. Chui, M et al. lists 10 domains in which AI can be used for social good, including crisis response; equality and inclusion; educational and environmental challenges; health and hunger et cetera [8].

## With Power Should Come Responsibility

AI and Big data have already been exploited by political parties and multinational conglomerates alike, to occupy unwitting victims’ views and privacy [9, 10].

In recent news, Boston Dynamics has condemned a US art gallery for attaching a paintball gun to ‘Spot’, the incredibly advanced robo-dog [11]. The images are worrying yet unsurprising.

Eccentric billionaire Elon Musk’s latest ground-breaking company, Nueralink, has begun trials with monkeys [12]. The brain chip is marketed to potentially solve neurological conditions and paralysis, with a further long-term goal of achieving human-AI symbiosis. This will allow mortals to integrate seamlessly into the internet of things; with advances in microfluidics and cloud storage, could this result in a *human digital twin*? What would Alan Turing make of such inherently unsettling technology?

Innovation is occurring at an alarming rate. Researchers from MIT have just developed tiny-agile drones capable of withstanding collisions. The 0.6-gram drones have actuators which can flap 500 times a second, giving them insect-like resilience [13]. Applications include: inspection of enclosed spaces, search and rescue missions, and even *artificial pollination*. The last-mentioned provokes unwanted thoughts of dystopian sci-fi Black Mirror; in which autonomous drone insects, deployed to combat the loss of bees, commit mass murder [14]. Nevertheless, providing Pham’s *Fourth Law of Robotics* is not violated, like Asimov’s previous three, the robots are here to stay [15].

## Lessons Learnt

Mankind is currently living through arguably the most comfortable period in human history due to 150 years of technological advancement. Engineers are curious and compassionate beings who find purpose in innovation. They must continue to support global civilisation through the implementation of new intelligent systems. There will always be darkness to accompany the light, and we must stay vigilant for the great challenges ahead.

Modern problems require modern solutions. Powerful learning algorithms can provide fresh insight into messy real-world environments. Big data, robots, the internet of things and machine learning are already impacting every nuance of society today. The need for transparency and ethics within the field is becoming increasingly apparent. The true solution lies in human compassion and empathy, not engineering capability.

# References:

# (2021) Youtube.com. Available at: https://www.youtube.com/watch?v=WXuK6gekU1Y (Accessed: 10 March 2021). **AlphaGo - The Movie** | Full Documentary (Minutes: 52-53)

#### **I, Robot Runaround** Summary & Analysis | LitCharts (2021). Available at: https://www.litcharts.com/lit/i-robot/runaround (Accessed: 15 March 2021).

#### Haenlein M, Kaplan A. **A Brief History of Artificial Intelligence**: On the Past, Present, and Future of Artificial Intelligence. California Management Review. 2019;61(4):5-14. doi:10.1177/0008125619864925

#### (2021) Youtube.com. Available at: https://www.youtube.com/watch?v=3wLqsRLvV-c (Accessed: 12 March 2021). **The Turing Test: Can a computer pass for a human?** – Alex Gendler

1. **Explained: Neural networks** (2017). Available at: https://news.mit.edu/2017/explained-neural-networks-deep-learning-0414 (Accessed: 10 March 2021).
2. **AlphaGo: The story so far (2016).** Available at: https://**deepmind.com**/research/case-studies/alphago-the-story-so-far#muzero (Accessed: 8 March 2021).

#### Metz, C. (2016) In Major AI Breakthrough, Google System Secretly Beats Top Player at the Ancient Game of Go, Wired. Available at: https://www.wired.com/2016/01/in-a-huge-breakthrough-googles-ai-beats-a-top-player-at-the-game-of-go/ (Accessed: 11 March 2021).

#### Fosso Wamba, S. et al. (2021) "**Are we preparing for a good AI society?** A bibliometric review and research agenda", Technological Forecasting and Social Change, 164, p. 120482. doi: 10.1016/j.techfore.2020.120482.

1. **Artificial intelligence can save democracy, unless it destroys it first** (2018). Available at: https://medium.com/@drpolonski/artificial-intelligence-can-save-democracy-unless-it-destroys-it-first-7b1257cb4285 (Accessed: 15 March 2021).

#### **Want to Win an Election? Use AI And Machine Learning (2020)**. Available at: https://www.mygreatlearning.com/blog/how-ai-and-machine-learning-can-win-elections/ (Accessed: 12 March 2021).

1. <https://www.bbc.co.uk/news/technology-56182268>, **Spot: Boston dynamics condemns robot paintball gun rampage plan**
2. **Monkey Plays Video Games with Neuralink’s Brain Interface (2021)**. Available at: <https://www.manufacturing.net/home/video/21295419/monkey-plays-video-games-with-neuralinks-brain>. (Accessed: 15 March 2021).
3. Researchers introduce a new generation of **tiny, agile drones (2021).** Available at: https://news.mit.edu/2021/researchers-introduce-new-generation-tiny-agile-drones-0302 (Accessed: 8 March 2021).
4. **"Black Mirror"** Hated in the Nation (TV Episode 2016) - IMDb (2021). Available at: https://www.imdb.com/title/tt5709236/ (Accessed: 12 March 2021).
5. Pham, D. and Pham, D. (2014) **The Fourth Law of Robotics** (or **The Robots Are Staying**), CMM Magazine. Available at: http://www.cmmmagazine.com/cmm-articles/the-fourth-law-of-robotics/ (Accessed: 12 March 2021).