**IT TECHNOLOGIES: DEVELOPMENTS IN MACHINE LEARNING**

1. What does it do? (600 words)

1a. What is the state of the art of this new technology?

Machine Learning is defined as "the technique that improves system performance by learning from experience via computational methods," (Zhou, 2021). It literally enables machines to learn from data and thus acquire knowledge. This is accomplished by making "learning algorithms" or experiences that can be used to predict outcomes or "models" (Zhou, 2021). With the myriad of data now available worldwide, it is imperative that a system is able to collect, manage, analyse and make sense of all this information and how it can be applied in the real world.

Data analysis is at the heart of machine learning. According to Baloglu, Ratifi and Nazha (2022), "when there are a large number of variables, or their relation to the output variable is too complex, or non-linear to be described by linear lines, or even there is no obvious output variable to be predicted in the dataset,... a different approach is needed. This alternative strategy is called ML." It is revolutionary as “machine learning,..approaches problems as a doctor progressing through residency might: by learning rules from data,.. [it can handle] enormous numbers of predictors — sometimes, remarkably, more predictors than observations — and combining them in nonlinear and highly interactive ways. This capacity allows us to use new kinds of data, whose sheer volume or complexity would previously have made analyzing them unimaginable.” (Obermeyer & Emanuel, 2016). In a manner of speaking, it is like The Terminator wherein the machine stores different outcomes or possibilities based on experience/data input and makes calculated decisions based on these experiences. With machine learning, though, millions of variables are stored and calculated.

1b. What can be done now?

The applications for this technology are numerous and wide in scope. For example, data collected from satellites are used for meteorological, energy and environmental research; from a business perspective, machine learning can be used for sales and investment analysis, optimising logistics and operations research ((Johra, Verma and Paul, 2020); from a lay person point-of-view, the humble “Google search” function is a product of extensive data analysis through machine learning - mapping associations and patterns generate what we have now regarded as a common search by keyword, or by photo (Zhou, 2021). Communications (including speech recognition), software engineering; architecture (Johra, Verma and Paul, 2020); and bioinformatics (which includes genetics and cancer research), (Baloglu, Ratifi and Nazha, 2022)and robotics are among the applications of ML.

Some examples of specific machine learning successes are:

* In the medical field, machine learning has been successfully applied in the fields of ophthalmology and radiology. "For example, in ophthalmology the diagnosis of diabetic retinopathy and retinopathy of prematurity, and in radiology the diagnosis of stroke or cancers from digital images is promising." (Baloglu, Ratifi and Nazha, 2022). The digital pixels in radiographs are now bits of data that are analysed as individual variables resulting in clusters that allow clinicians to learn “contours of fracture lines, parenchymal opacities, and more,” (Obermeyer & Emanuel, 2016), and covid-19 detection
* for the common person, we see an increase in the use of "Computer Vision and Natural Language Processing (NLP)" e.g. facial recognition in smartphones, Google translate, self-driving cars, conversational AIs such as Alexa, Siri, Google
* in the justice system, ML plays a big part in the implementation of cybersecurity

1c. What is likely to be able to do be done soon (say in the next 3 years)?

Increased automation is a direct effect of increased reliance on machine learning.

The medical field, for example, is expecting to.expand the applications of ML into the subspecialties of paediatrics, (Baloglu, Ratifi and Nazha, 2022). Machine learning will allow improved prognosis, reduce human error by allowing the machine to interpret images, and improve diagnostic accuracy (Obenmeyer & Emanuel, 2016)

Analysis of non-linear big data such as in ecosystem service research (Scowen and Athanasiadis, 2021);

In economics, "[the] staggering volumes of digital information relevant to measuring and understanding the economy are generated each second by an increasing array of devices that monitor transactions and business processes as well as track the activities of workers and consumers." This means that the time is ripe for machine learning to be incorporated into economic statistics (Abraham, Jarmin, Moyer, & Shapiro, M. D., 2022).

Automated machine learning (see 2a) and further use of augmented reality are futuristic developments.

1d. What technological or other developments make this possible?

The digitisation of raw data over the years has paved the way for this information to be readily available for mining and analyses. We now have a "staggering volume of information", (Abraham, Jarmin, Moyer, & Shapiro, M. D., 2022). Machine learning would have been ineffective had it not been for the existence of big data.

Hinton's 2006 Deep Learning theory paved the way for the idea that machines can learn image patterns.

Deep neural networks such as the one developed by Meta allowed the processing of larger data

1. What is the likely impact? (300 words)

2a. What is the potential impact of this development?

The surge in ML's popularity across various fields has given rise to the development of Automated Machine Learning (autoML). Simply put, it's machine learning without the or with limited interference from a human engineer. An application or software that can be installed and be expected to generate predictions with minimal intervention. According to Hutter, Kotthiff, and Vanschoren (2019), "this is particularly true in the booming field of deep learning, where human engineers need to select the right neural architectures, training procedures, regularization methods, and hyperparameters of all of these components in order to make their networks do what they are supposed to do with sufficient performance."

However, it should be noted that the increasing complexities of machine learning, particularly deep learning, while fascinating and far-reaching in its application, is still susceptible to bias. Zhou (2021) has enumerated the following deficiencies in machine learning: it requires an extensive amount of data which in itself can be expensive to acquire or in some cases infeasible; if the environment changes, the model may become useless; trained models are “blackboxes”. ML models are so complex that it is not possible to exactly understand and explain how the ML model produced its output. Resulting in bias (Baloglu, Ratifi and Nazha, 2022).

Therefore, improved validation techniques i.e. neutrosophic logic (Varona, Lizama-Mue, & Suárez, 2021),

2b.What is likely to change?

Machine learning will continue to displace human intervention in fields requiring data analysis.

Faster processing and more accurate data analysis will be imminent as scientists endeavour to develop more efficient algorithms that can minimise or identify biased outcomes.

2c. Which people will be most affected and how?

Review of existing machine learning literature points to the following industries currently benefiting from sophisticated machine learning technology:

1. Medicine and health care
2. IT
3. Business and finance
4. Environmental Science

From an end user perspective, machine learning will mostly impact us (i.e. patients, consumers).

2d.Will this create, replace or make redundant any current jobs or technologies?

Potentially, continued ML developments will replace its human counterparts in specific jobs such as construction work, medical technologists, factory work, face-to-face retailing such as banking, shopping and hospitality (as these are replaced by self serve kiosks).

1. How will this affect you? (300 words)

3a.In your daily life, how will this affect you?

As a millenial, the advent of machine learning has been

very helpful because in this day and age we have so much new information that was not there before. Machine learning enables us to filter out what is necessary and what is unnecessary for each individual. For example, as an IT student, my current google results and social media feeds are related to what I am studying, which saves a lot of time and effort.

It also enables me to generate results quickly and at my fingertips. Productivity is increased. The access to resources has become global and instant.

Robotics (which is an application of machine learning) is now, in a manner of speaking, child's play as exemplified by the increase in STEM toys even in places such as Kmart.

3b. What will be different for you?

Research as we know it has been extended to include machine computation as necessary rather than optional. Where data gathering was limited to a random sample of 30 or so, researchers now have access to billions of raw data. Data mining and deep learning are occupational realities. As a student, I need to be knowledgeable in basic data science to be able to progress in any profession. It is a new language to be acquired and applied in everyday living.

3c. How might this affect members of your family or your friends?

The older members of my family are now faced with the reality that computer technology and artificial intelligence are here to stay. Adjusting their lifestyle to accommodate this new way of doing things is a learning curve that they are growing into. Simple examples are online banking, virtual assistants, streaming and internet TV, Alexa and Google Home.

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