



INFORMATION DOCUMENT

Glossary

A

Activation function: “Activation function is a function used to transform the activation level of a unit (neuron) into an output signal.”¹

AI Act: This is a proposed regulation of AI systems by the European Union, the first part of which came into effect in August 2024.

AI agent: This is an autonomous intelligent digital entity capable of making decisions and taking actions to achieve specific goals.

Algorithm: “A computer algorithm is a set of steps to accomplish a task that is described precisely enough that a computer can run it”.²

Algorithmic bias: Algorithmic bias refers to the phenomenon of the output of a machine learning algorithm reflecting the biases of the data used to train it, or the person who trained it.³

AlphaGo: This is a DeepMind program that combines deep convolutional networks and reinforcement learning to successfully play the board game Go, ultimately beating a human champion.⁴ AlphaGo is a derivative of a few DeepMind programmes applied to solve different problems, including AlphaFold and AlphaZero.⁵

Amara’s law: After technologist Roy Amara, society tend to overestimate the impact of a technology in the short run, yet underestimate its impact in the long run.⁶

Application-specific integrated circuit (ASIC): This is a specialised hardware designed for a particular application, such as optimised processing in AI and machine learning tasks.

Argument from consciousness: This refers to an argument against the existence of true AI based on the view that “the only way by which one could be sure that a machine thinks, is to **be** the machine and to feel oneself thinking. One could then describe these feelings to the world.”⁷

Argument from continuity in the nervous system: This argument is against the existence of true AI that is based on the objection that “the nervous system is certainly not a discrete-state machine. A small error in the information about the size of a nervous

¹ Changhau, I. 2017. *Activation functions in neural networks*. Available:

https://isaacchanghau.github.io/post/activation_functions/ [2019, February 26].

² Comen, T.H. 2013. *Algorithms unlocked*. USA: Massachusetts Institute of Technology.1.

³ Wooldridge, M. 2018. *Artificial intelligence*. UK: Penguin House. 46.

⁴ Op cit42.

⁵ DeepMind. 2019. *AlphaFold: Using AI for scientific discovery*. Available:

<https://deepmind.com/blog/alphafold/> [2019, March 28].

⁶ Cox, L. 2017. *At a glance – Amara’s law*. Available: <https://disruptionhub.com/glance-amaras-law/> [2019, April 4].

⁷ Turing, A.M. 1950. Computing machinery and intelligence. *A quarterly review of psychology and philosophy*, 236: 433-460

impulse impinging on a neuron, may make a large difference to the size of the outgoing impulse. It may be argued that, this being so, one cannot expect to be able to mimic the behaviour of the nervous system with a discrete-state system.”⁸

Argument from extrasensory perception: This argument is against the existence of true AI developed from the objection that human beings have extra-sensory perception, while computer systems do not have the same abilities.⁹

Argument from informality of behaviour: This is an argument against the existence of true AI stating that “it is not possible to produce a set of rules purporting to describe what a man should do in every conceivable set of circumstances... To attempt to provide rules of conduct to cover every eventuality... appears to be impossible” in order to recreate human behaviour in machines.¹⁰

Argument from various disabilities: This is an argument against the existence of true AI stating that a machine cannot be said to be intelligent until it can do X, where X refers to the capacity to “be kind, have a sense of humour, fall in love, enjoy strawberries, make mistakes, etc.”¹¹

Artificial general intelligence (General AI): “The goal of building machines that can demonstrate ‘general-purpose intelligent behaviour’ is artificial general intelligence.”¹²

Artificial neural network: “An artificial neural network is an attempt to simulate the network of neurons that make up a human brain so that the computer will be able to learn things and make decisions in a human-like manner. ANNs are created by programming regular computers to behave as though they are interconnected brain cells.”¹³

Attention Head: This is a component within the attention mechanism in transformer neural networks that focuses on different parts of the input data to improve the model's performance on tasks like language translation.

Autoencoder: Autoencoders are techniques used for data representation, compression, and generation. They have fast become powerful unsupervised learning techniques.¹⁴ “They learn a compressed, latent representation of input data and then reconstruct the input data from this lower-dimensional representation with minimal loss of

⁸ Op cit. 451.

⁹ Edgar, S.L. 2003. *Morality and machines: Perspectives on computer ethics*. UK: Jones and Bartlett Publishers. 452.

¹⁰ Turing, op cit. 452.

¹¹ Bradley, P. 2002. *Turing test and machine intelligence*. Available: http://www.mind.ilstu.edu/curriculum/turing_machines/turing_test_and_machine_intelligence.php [2019, March 20].

¹² Wooldridge, op cit. 10.

¹³ Marr, B. 2018. *What are artificial neural networks – a simple explanation for absolutely anyone*. Available: <https://www.forbes.com/sites/bernardmarr/2018/09/24/what-are-artificial-neural-networks-a-simple-explanation-for-absolutely-anyone/#1df60edf1245> [2019, February 26].

¹⁴ Kumar, A. 2023. *Autoencoder vs Variational Autoencoder (VAE): Differences*. Available: <https://vitalflux.com/autoencoder-vs-variational-autoencoder-vae-difference/> [2023, June 19].

information.” The goal is to minimise the difference between the original input and its reconstruction. Types of autoencoders include denoising, sparse, variational, and convolutional autoencoders.¹⁵

Automation: “The creation and application of technology to monitor and control the production and delivery of products and services.”¹⁶

Autonomous vehicle (AV): This is a vehicle programmed to enable decision-making in traffic that is consistent with the rules and constraints used during its programming.¹⁷

B

Backpropagation: Backpropagation is a technique that uses gradient descent to calculate the gradient of the loss function at the output layer of a deep neural network and distributes it back through the layers. “The result is adjusted weights for neurons... Although backpropagation may be used in both supervised and unsupervised networks, it is usually characterized as being a supervised learning method.”¹⁸

Bayesian learning: Bayesian learning refers to a method of machine learning that allows for the adjustment of beliefs about the specifics of models when given new data or evidence.¹⁹

Benchmark: A benchmark is a standard test or set of tests used to evaluate and compare the performance of certain models or systems.

Bias: “A bias is a tendency, inclination, or prejudice toward or against something or someone”.²⁰

Binary classification problems: These are instances where the machine is required to classify input into one of only two categories, usually 1 or 0 values.²¹

¹⁵ Hinton, G., & R, Salakhutdinov. 2006. *Reducing the dimensionality of data with neural network*. Available: <https://pubmed.ncbi.nlm.nih.gov/16873662/> [2023, June 5].

¹⁶ ISA. n.d. *What is automation?* Available: <https://www.isa.org/about-isa/what-is-automation/> [2019, February 26].

¹⁷ Deep AI. n.d. *Backpropagation*. Available: <https://deepai.org/machine-learning-glossary-and-terms/backpropagation> [2019, March 28].

¹⁸ Technopedia. n.d. *Backpropagation*. Available: <https://www.techopedia.com/definition/17833/backpropagation> [2019, February 28].

¹⁹ Wooldridge, op cit. 52.

²⁰ Psychology Today. n.d. *Bias*. Available: <https://www.psychologytoday.com/us/basics/bias> [2019, February 26].

²¹ Fumo, D. 2017. *Classification versus regression – Intro to machine learning*. Available: <https://medium.com/simple-ai/classification-versus-regression-intro-to-machine-learning-5-5566efd4cb83> [2019, February 26].

Binet-Simon scale: This is a measurement instrument used to identify levels of intelligence. Initially, this instrument was used to identify children whose intelligence levels were below average compared to others in their age group.²²

Blocks world: This refers to “A simulated ‘microworld’ in which the task is to arrange various objects like blocks and boxes.”²³

Bodily-kinaesthetic intelligence: “Abilities to control one’s body movements and handle objects skilfully.”²⁴

Broad AI: These are AI systems with the capacity to do more than one task and execute various different tasks across different fields.²⁵ Broad AI differs from general AI because it only works with related tasks.

C

Centaur approach: The centaur approach is a method where human labour is not replaced by AI but is rather augmented by the technology.²⁶

Chatbot: “It is an assistant [computer program] that communicates with us through text messages, a virtual companion that integrates into websites, applications or instant messengers and helps entrepreneurs to get closer to customers. Such a bot is an automated system of communication with users”.²⁷

Chinese room experiment: John Searle proposed the Chinese room experiment as an argument against the possibility of AI. His experiment aims to illustrate that machines cannot have understanding. Searle uses the following scenario to demonstrate his argument: “Imagine a room in which a man, who understands no Chinese, receives, through a slot in the door, questions written in Chinese. When he receives a question, the man carefully follows detailed instructions written in English to generate a response to the question, which he passes back out through the slot. Now suppose the questions and responses are part of a Chinese Turing test, and the test is passed”.²⁸

²² Stanford Binet Test. 2019. *Origins of the Stanford-Binet Test*. Available: <https://stanfordbinettest.com/> [2019, February 26].

²³ Wooldridge, op cit. 52.

²⁴ Gardner, H. & Hatch, H. 1989. Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational researcher*. 18(8): 4-10,.

²⁵ Finch, S. 2018. *At a glance – Broad AI*. Available: <https://disruptionhub.com/broad-ai/> [2019, February 26].

²⁶ Khan, T. 2017. *AI augmenting human behaviour: The centaur approach*. Available: <https://www.linkedin.com/pulse/how-ai-can-help-augment-human-behavior-centaur-approach-tariq-khan> [2019, February 26].

²⁷ Anadea. 2018. *What is a chatbot and how to use it for your business*. Available: <https://medium.com/swlh/what-is-a-chatbot-and-how-to-use-it-for-your-business-976ec2e0a99f> [2019, February 26].

²⁸ Wooldridge, op cit. 8.

Classification: “Classification is the process of finding or discovering a model (function) which helps in separating the data into multiple categorical classes. In classification, the group membership of the problem is identified, which means the data is categorized under different labels according to some parameters and then the labels are predicted for the data”.²⁹

Clustering: “An unsupervised learning approach of machine learning whereby data is grouped together into groups with similar properties or features.”³⁰

Cognition: Cognition refers to the “process by which sensory input is transformed, reduced, elaborated, stored, recovered and used.”³¹

Complements: Complements “are all the things other than algorithms and models needed to make commercial-grade AI work. These include data, redesigned workflows, training, regulation, human judgment, infrastructure and more”.³²

Complexity barrier: “Early AI systems demonstrating components of intelligence gave hope that progress would quickly be made on bigger problems. But this hope was not realized.”³³ A class of problems emerged for which finding a solution and verifying that solution required an impossibly large amount of time. The complexity barrier therefore refers to the “imaginary barrier separating simple systems from complex systems”.³⁴

Convolutional neural network (CNN): “When designing the connections between layers, units are not connected to all the input units because not all inputs are dependent. Instead, we define units that define a window over the input space and are connected to only a small **local** subset of the inputs. This decreases the number of connections and therefore the number of parameters to be learned”.³⁵

CYC: This is the longest ongoing AI project of creating a computer program that encompass all the knowledge of a reasonably educated person on how the world works, and the knowledge base used to go about life.³⁶

²⁹ TechDifferences. 2018. *Difference between classification and regression*. Available: <https://techdifferences.com/difference-between-classification-and-regression.html> [2019, February 26].

³⁰ Seif, G. 2018. *An easy introduction to Natural Language Processing*. Available: <https://towardsdatascience.com/an-easy-introduction-to-natural-language-processing-b1e2801291c1> [2019, February 27].

³¹ Greenwood, J.D. 2015. *A conceptual history of psychology: Exploring the tangled web*. UK: Cambridge University Press. 471.

³² Bérubé, V., Kelleher, J., Macklem, T. & Agrawal, A. 2018. *Competition for AI complements is heating up*. Available: <https://www.theglobeandmail.com/business/commentary/article-competition-for-ai-complements-is-heating-up/> [2019, February 26].

³³ Wooldridge, op cit. 20.

³⁴ Hull, D.B. 2001. *What is ‘complexity barrier’? How can we measure it?* Available: <http://www.madsci.org/posts/archives/2001-06/993132783.Ot.r.html> [2019, March 20].

³⁵ Alpaydin, E. 2016. *Machine learning*. USA: Massachusetts Institute of Technology. 101.

³⁶ Op cit. 26

D

DARPA: This is a US military research agency that organised the Grand Challenge for autonomous vehicles that was won by STANLEY in 2005.³⁷

Data: Data is known or assumed facts that form the basis of reasoning or calculation, generally in support of reaching a decision.³⁸

Decision-making: “A decision is the selection of a course of action (or decision) out of many available alternatives”.³⁹

Decision trees: These represent a tree-like model to make decisions, with the top representing the root, moving down the path to different branches, and consequently into the relevant decision (leaf). This approach to decision-making is fast and effective and is represented by various if-then rules.⁴⁰

Deep Blue: Deep Blue refers to an IBM computer that beat the world chess champion after a six-game match on 11 May 1997.⁴¹

Deepfake: A deepfake is “A computer-generated replication of a person.”⁴² The term merges deep learning with fake image.

DeepMind: This is a UK-based AI company acquired by Google in 2012 for \$400 million.⁴³

Deep neural networks: “Each hidden layer combines the values in its preceding layer and learns more complicated functions of the input. The fact that the hidden unit values are not 0 or 1 but continuous allows a finer and graded representation of similar inputs. Successive layers correspond to more abstract representations until we get to the final layer where the outputs are learned in terms of these most abstract concepts”.⁴⁴

Deep learning: “Methods that are used to train models with several levels of abstraction from the raw input to the output. For example, in visual recognition, the lowest level is an image composed of pixels. In layers as we go up, a deep learner combines them to form strokes and edges of different orientations, which can then be combined to detect longer

³⁷ Wooldridge, op cit. 36

³⁸ Blann, A. 2018. *Data handling and analysis*. UK: Oxford University Press. 2

³⁹ GK Today. 2017. *Decision-making: Meaning and definition*. Available: <https://www.gktoday.in/gk/decision-making-meaning-and-definition/> [2019, February 26].

⁴⁰ Gupta, P. 2017. *Decision trees in Machine Learning*. Available: <https://towardsdatascience.com/decision-trees-in-machine-learning-641b9c4e8052> [2019, February 28].

⁴¹ IBM. n.d. *Deep Blue*. Available: <https://www.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/> [2019, February 26].

⁴² Schwartz, O. 2018. *You thought fake news was bad? Deep fakes are where truth goes to die*. Available: <https://www.theguardian.com/technology/2018/nov/12/deep-fakes-fake-news-truth> [2019, February 26].

⁴³ Wooldridge, op cit. 42

⁴⁴ Alpaydin, 2016, op cit. 104

lines, arcs, circles, and so on. The units of each layer may be thought of as a set of primitives at a different level of abstraction.”⁴⁵

Diffusion models: Inspired by thermodynamics, diffusion models achieve state-of-the-art synthesis results on image data and beyond by decomposing the image formation process using denoising autoencoders. “...they slowly add random noise to data and then learn to reverse the diffusion process to construct desired data samples from the noise”⁴⁶ To enable training on limited computational resources while retaining quality and flexibility, diffusion models are applied in the latent space of powerful pre-trained autoencoders. Examples of frameworks based on diffusion models include Dall-E2, Imagen, and Midjourney.⁴⁷

Disruptive innovation: Disruptive innovation refers to a “change to the market that is so powerful and different that it requires others in the field to follow suit or be left behind.”⁴⁸

E

Emergence: This term describes the self-organising behaviours that emerge when a large group of things act and move collectively, such as a flock of birds, school of fish, or molecules of water in a wave. In the field of AI, emergence refers to the idea that large language models have a threshold of complexity beyond which their capability and functionality increase exponentially. This means that complex patterns can emerge from relatively simple processes.⁴⁹

Emotional intelligence (EQ): Emotional intelligence “refers to the processes involved in the recognition, use, understanding, and management of one’s own and other’s emotional states to solve emotion-laden problems and to regulate behaviour.”⁵⁰

⁴⁵ Alpaydin, 2016, op cit.

⁴⁶ Weng, L. 2021. *What are diffusion models?* Available: <https://lilianweng.github.io/posts/2021-07-11-diffusion-models/> [2023, June 19].

⁴⁷ Rombach, R., Blattmann, A., Lorenz, D., Esser, P. & Ommer, B. 2021. *High-resolution image synthesis with latent diffusion models*. Available: <https://arxiv.org/abs/2112.10752> [2023, June 5].

⁴⁸ Day, J. 2016. *What is the difference between an incremental change and disruption?* Available: <https://ideascale.com/what-is-the-difference-between-an-incremental-change-and-disruption/> [2019, February 26].

⁴⁹ Ornes, S. 2023. *The unpredictable abilities emerging from large AI models*. Available: <https://www.quantamagazine.org/the-unpredictable-abilities-emerging-from-large-ai-models-20230316/> [2023, May 24].

⁵⁰ Salovey, P. & Mayer, J.D. 2004. Emotional intelligence. In *Emotional intelligence: Key readings on the Mayer and Salovey model*. P. Salovey, M. A. Brackett & J. D. Mayer, Eds. New York: Dude Publishing. (Original chapter published in 1990). i

Encoder-decoder: These models allow a machine learning model to generate a sentence that describes an image or video. They receive media as an input and then generate an output in the form of words.⁵¹

Error: “The sum of the differences between the actual outputs the network estimates for an input and their required values specified by the supervisor in the training set; and in neural network training, for each training example, we update the connection weights slightly, in such a way as to decrease the error for that instance”.⁵²

Evaluation: This is the process of assessing the performance of an AI model using specific metrics and test datasets to determine its accuracy, efficiency, and generalizability.

Expert system: “A [computer] system that uses human expert knowledge and emulates the human decision-making ability to solve complex problems by making use of a series of if-then rules.”⁵³

Extra-sensory perception: This is a paranormal phenomenon associated with the transfer of energy or information, including telepathy.⁵⁴

F

False positive: This is a form of statistical error where the algorithm predicts that the input fits in a particular category, but in reality, it does not.⁵⁵

False negative: False negatives are a form of statistical error where the algorithm predicts that the input does not fit in a particular category, but in reality, it does.⁵⁶

Feature extraction: This technique is used in machine learning and refers to the process of organising a data set of raw variables into manageable sections (or features) used for processing or modelling. Even though the data is organised, it still accurately reflects the original data set.⁵⁷

⁵¹ Kumar, A. 2023. *Demystifying encoder decoder architecture & neural network*. Available: <https://vitalflux.com/encoder-decoder-architecture-neural-network/> [2023, May 24].

⁵² Alpaydin, 2016, op cit. 90

⁵³ Wooldridge, op cit. 52.

⁵⁴ Robinson, E. 2009. *Extra-sensory perception – a controversial debate*. Available: <https://thepsychologist.bps.org.uk/volume-22/edition-7/extra-sensory-perception-controversial-debate> [2019, March 20].

⁵⁵ Google Developers. 2018. *Machine Learning*. Available: <https://developers.google.com/machine-learning/crash-course/classification/true-false-positive-negative> [2019, February 28].

⁵⁶ Ibid.

⁵⁷ EliteDataScience. 2017. *Dimensionality reduction algorithms: Strengths and weaknesses*. Available: <https://elitedatascience.com/dimensionality-reduction-algorithms#feature-extraction> [2019, March 13].

Fine-tuning: This is the process of adjusting a neural network to achieve the desired performance or output by using the weights of an existing network that has already been trained. This means that the new network does not need to be trained from scratch using random weights, which would increase the amount of time required for it to be useful.⁵⁸

Forecasting: Forecasting refers to a “projection into the future of expected demand, given a stated set of environmental conditions.”⁵⁹

Forward propagation: Forward propagation refers to the process of generating an output from an input within an artificial neural network.⁶⁰

Foundation models: These models are trained on a broad dataset of unlabelled information that has a wide task application. They require minimal fine-tuning and can be used as a foundation for many applications. Foundation models apply learnt information from one situation to another.⁶¹

Frontier AI: This refers to cutting-edge artificial intelligence research and applications that push the boundaries of current technology and understanding.

Fuzzy logic: “Fuzzy logic is a generalization of standard logic, in which a concept can possess a degree of truth anywhere between 0.0 and 1.0. Standard logic applies only to concepts that are completely true (having degree of truth 1.0) or completely false (having degree of truth 0.0). Fuzzy logic is supposed to be used for reasoning about inherently vague concepts, such as ‘tallness’.”⁶²

G

GDPR: “The General Data Protection Regulation (GDPR) standardizes data protection law across all 28 European Union (EU) countries and imposes strict rules on controlling and

⁵⁸ Baretto, S. 2023. *What is fine-tuning in neural networks?* Available: <https://www.baeldung.com/cs/fine-tuning-nn> [2023, May 24].

⁵⁹ Mentzer, J.T. & Moon, M.A. 2005. *Sales forecasting management: A demand management approach*. USA: Sage Publications. 9

⁶⁰ Machine learning and optimisation. 2016. *Artificial neural networks - part 1: The XOR problem*. Available: <http://www.mlopt.com/?tag=forward-propagation> [2019, February 27].

⁶¹ Murphy, M. 2022. *What are foundation models?* Available: <https://research.ibm.com/blog/what-are-foundation-models> [2023, May 24].

⁶² Scientific American. n.d. *What is ‘fuzzy logic’? Are there computers that are inherently fuzzy and do not apply the usual binary logic?* Available: <https://www.scientificamerican.com/article/what-is-fuzzy-logic-are-t/> [2019, February 27].

processing personally identifiable information.”⁶³ The purpose of the GDPR is “to protect all EU citizens from privacy and data breaches in today’s data-driven world.”⁶⁴

General-purpose technology: General-purpose technology, or GPTs, are “those technologies that impact economic growth, and transform both household life and the ways in which firms conduct business.”⁶⁵

Generative artificial intelligence: These are deep learning models that use raw data as the basis for learning to create statistically probable outputs using a prompt. These models are able to generate high-quality text and media that may or may not be similar to the original data. Examples of these models are OpenAI’s ChatGPT, DALL-E2, and Google PaLM-2.⁶⁶

Generative adversarial networks (GAN): Generative adversarial networks are a type of machine learning technique that is able to produce and generate new content using data it has been trained on.⁶⁷

Generative pre-trained transformer (GPT) models: Based on the transformer architecture, these generative models are pre-trained on large [datasets](#) of unlabelled text. They can understand and execute a task as well as, or better than, other models that need to undergo supervised training. GPT models can perform tasks such as answering questions or summarising text in ways that mimic human capabilities. First introduced in 2018 by OpenAI, most large language models (LLMs) today are based on the GPT architecture.⁶⁸

Graph neural network (GNN): These neural networks can be directly applied to graphs to perform predictive tasks. GNNs apply the predictive abilities of deep learning models to the datapoints, called nodes, connected by lines, or edges, in a graph. This allows machine learning algorithms to make predictions at the level of individual nodes, edges, or the entire graph. GNNs can be used in any application that relies on finding patterns in relationships

⁶³ Forbes. 2018. *What is General Data Protection Regulation?* Available: <https://www.forbes.com/sites/quora/2018/02/14/what-is-general-data-protection-regulation/#2e34d1ed62dd> [2019, February 27].

⁶⁴ EU GDPR.org. 2019. *The GDPR*. Available: <https://eugdpr.org/> [2019, February 27].

⁶⁵ Fabode, S. 2017. *Will AI, blockchain, AR and/or VR become a general purpose technology?* Available: <https://hackernoon.com/ai-blockchain-ar-vr-etc-which-one-is-a-general-purpose-technology-9b5510ca25e3> [2019, February 27].

⁶⁶ Mantineau, K. 2023. *What is generative AI?* Available: <https://research.ibm.com/blog/what-is-generative-ai> [2023, May 24].

⁶⁷ Rocca, J. n.d. *Understanding generative adversarial networks (GANs)*. Available: <https://towardsdatascience.com/understanding-generative-adversarial-networks-gans-cd6e4651a29> [2019, February 27].

⁶⁸ Bushwick, S. 2023. *What the new GPT-4 AI can do*. Available: <https://www.scientificamerican.com/article/what-the-new-gpt-4-ai-can-do/> [2023, May 24].

amongst datapoints, such as product or media recommendations, fraud detection, or drug discovery.⁶⁹

Graphics processing unit (GPU): This is hardware accelerator optimised for matrix multiplication, used to perform complex calculations for rendering graphics and running machine learning algorithms efficiently.

H

Hallucination: In the context of AI, this refers to the generation of incorrect or nonsensical outputs by a model, particularly in language models.

Head-in-the-sand objection: This is an argument against the existence of true AI, which “hopes and believes” that machine thinking is not possible as “the consequences of machines thinking would be too dreadful.”⁷⁰

Hebbian learning rule: The rule implicates that the strength of activation between two neurons connected to each other in different layers of an artificial neural network is increased if these two neurons are activated simultaneously. This learning rule is the method through which the weights between neurons is altered to enable an effective output.⁷¹

Hidden layer: A hidden layer is a layer of “neuron nodes stacked in between inputs and outputs, allowing neural networks to learn more complicated features.”⁷²

Hype cycle: “A hype cycle is a graphic representation of the maturity, adoption and business application of specific technologies. The hype cycle characterizes the typical progression of an emerging technology from business and media overenthusiasm through a period of disillusionment to an eventual understanding of the technology’s relevance and its role in a market or domain”.⁷³ Also refer to “Amara’s law”.

⁶⁹ Merritt, R. 2022. What are graph neural networks? Available: <https://blogs.nvidia.com/blog/2022/10/24/what-are-graph-neural-networks/> [2023, May 24].

⁷⁰ Turing, op cit. 444

⁷¹ Bullinaria, J.A. 2015. *Hebbian Learning and Gradient Descent Learning*. Available: http://www.cs.bham.ac.uk/~pxt/NC/l5_JB.pdf [2019, February 28].

⁷² Kang, N. 2017. *Multi-layer neural networks with Sigmoid Function*. Available: <https://towardsdatascience.com/multi-layer-neural-networks-with-sigmoid-function-deep-learning-for-rookies-2-bf464f09eb7f> [2019, February 27].

⁷³ Rümmler, R., Gluhak, A. & Aghvami, A.H. 2009. *Multicast in third-generation mobile networks: Services, mechanisms and performance*. UK: John Wiley & Sons Ltd. 82

I

Image processing: “Image processing is mostly related to the usage and application of mathematical functions and transformations over images regardless of any intelligent inference being done over the image itself. It simply means that an algorithm does some transformations on the image such as smoothing, sharpening, contrasting [and] stretching on the image”.⁷⁴

Incremental innovation: Incremental innovation refers to a “change that takes place slowly over time and allows for a gradual development of the product and its marketplace”.⁷⁵

Inference: “In logic, an inference is the process of deriving logical conclusions from premises known or assumed to be true. The term derives from the Latin term, which means ‘bring in.’ An inference is said to be valid if it’s based upon sound evidence and the conclusion follows logically from the premises”.⁷⁶

Intelligence: Intelligence is “the capacity to solve problems or to fashion products that are valued in one or more cultural settings”.⁷⁷

International law: “International law defines the legal responsibilities of States in their conduct with each other and their treatment of individuals within State boundaries. Its domain encompasses a wide range of issues of international concern.”⁷⁸

Interpersonal intelligence: This type of intelligence refers to the capacity “to discern and respond appropriately to the moods, temperaments, motivations, and desires of other people.”⁷⁹

Intrapersonal intelligence: This type of intelligence refers to one’s ability to access “one’s own feelings and the ability to discriminate among them and draw upon them to guide behaviour.” It also refers to a “knowledge of one’s own strengths, weaknesses, desires, and intelligences.”⁸⁰

⁷⁴ Sagar, R. 2018. *What is the difference between computer vision and computer processing*. Available: <https://www.analyticsindiamag.com/what-is-the-difference-between-computer-vision-and-image-processing/> [2019, February 27].

⁷⁵ Day, J. 2016. *What is the difference between an incremental change and disruption?* Available: <https://ideascale.com/what-is-the-difference-between-an-incremental-change-and-disruption/> [2019, February 26].

⁷⁶ Nordquist, R. 2019. *Inference in arguments: Glossary of grammatical and rhetorical terms*. Available: <https://www.thoughtco.com/inference-logic-term-1691165> [2019, February 27].

⁷⁷ Gardner & Hatch, op cit. 5

⁷⁸ United Nations. 2019. *What is International Law?* Available: <http://www.un.org/en/sections/what-we-do/uphold-international-law/> [2019, March 13].

⁷⁹ Op cit. 6

⁸⁰ Ibid.

J

No terms listed here.

K

K-means: “K-means clustering is a type of unsupervised learning, which is used when you have unlabelled data (i.e., data without defined categories or groups). The goal of this algorithm is to find groups in the data, with the number of groups represented by the variable K . The algorithm works iteratively to assign each data point to one of K groups based on the features that are provided. Data points are clustered based on feature similarity”.⁸¹

K-nearest neighbour (KNN): This represents a simple classification algorithm. The algorithm doesn’t make any assumptions about the underlying data distribution, but instead, focuses on feature similarity between the training data set and the desired output.⁸²

Knowledge-based AI: “The dominant paradigm for AI from about 1975 to 1985, which focused on using explicit knowledge about problems, often in the form of rules.”⁸³

L

Lady Lovelace objection: This objection is an argument against the existence of true AI based on the view that “[machines] can do whatever we know how to order it to perform.”⁸⁴

Large language model (LLM): These deep learning algorithms can predict and generate text and other content based on knowledge trained from broad sets of data. They can perform tasks such as recognising, summarising, or transforming information, which creates many opportunities for application. LLMs can be used to generate more direct, humanlike answers to search engine results, perform swift data analysis, create meeting transcripts, summarise calls, generate images and videos, or better understand life science elements like proteins.⁸⁵

⁸¹ Trevino, A. 2016. *Introduction to K-means clustering*. Available: <https://www.datascience.com/blog/k-means-clustering> [2019, February 26].

⁸² Bronshtein, A. 2017. *A quick introduction to K-Nearest Neighbors algorithm*. Available: <https://medium.com/@adi.bronshtein/a-quick-introduction-to-k-nearest-neighbors-algorithm-62214cea29c7> [2019, February 28].

⁸³ Wooldridge, op cit.52.

⁸⁴ Turing, op cit. 450

⁸⁵ Lee, A. 2023. *What are large language models used for?* Available: <https://blogs.nvidia.com/blog/2023/01/26/what-are-large-language-models-used-for/> [2023, May 24].

Large multimodal model (LMM): This AI model is capable of processing and integrating information from multiple modalities, such as text, images, audio and video, to perform complex tasks.

LASSO: “Lasso, or Least Absolute Shrinkage and Selection Operator, is quite similar conceptually to ridge regression. It also adds a penalty for non-zero coefficients, but unlike ridge regression which penalizes sum of squared coefficients (the so-called L2 penalty), lasso penalizes the sum of their absolute values (L1 penalty). As a result, for high values of λ , many coefficients are exactly zeroed under lasso, which is never the case in ridge regression”.⁸⁶

Learning: “An agent is learning if it improves its performance on future tasks after making observations about the world”.⁸⁷

Linear regression: Linear regression finds a linear relationship between the independent and dependent variable. There are two types of linear regression: simple regression and multiple regression.⁸⁸

Linguistic intelligence: This type of intelligence refers to having a “sensitivity to the sounds, rhythms, and meaning of words” as well as “sensitivity to the different functions of language.”⁸⁹

Logical-mathematical intelligence: This type of intelligence refers to having a “sensitivity to, and capacity to discern, logical or numerical patterns” as well as the “ability to handle long chains of reasoning.”⁹⁰

Logistic function: “The logistic function, also known as the sigmoid function was developed by statisticians to describe properties of population growth in ecology, rising quickly and maxing out at the carrying capacity of the environment. It’s an S-shaped curve that can take any real-valued number and map it into a value between 0 and 1, but never exactly at those limits.”⁹¹

Logistic regression: Logistics regression looks for an “association between a categorical dependent variable and a set of independent (explanatory) variables. The name logistic

⁸⁶ Oleszak, M. 2018. *Regularization: Ridge, LASSO and elastic net*. Available: <https://www.datacamp.com/community/tutorials/tutorial-ridge-lasso-elastic-net> [2019, February 27].

⁸⁷ Russell, S. & Norvig, P. 2016. *Artificial intelligence: A modern approach*. UK: Pearson Education Limited. 693

⁸⁸ Swaminathan, S. 2018. *Linear regression - Detailed view*. Available: <https://towardsdatascience.com/linear-regression-detailed-view-ea73175f6e86> [2019, February 27].

⁸⁹ Gardner & Hatch, op cit. 6

⁹⁰ Ibid.

⁹¹ Brownlee, J. 2016. *Logistic regression for machine learning*. Available: <https://machinelearningmastery.com/logistic-regression-for-machine-learning/> [2019, February 27].

regression is used when the dependent variable has only two values, such as 0 and 1 or Yes and No.”⁹²

Long short-term memory (LSTM): This is a type of recurrent neural network (RNN) architecture designed to better capture dependencies and long-term relationships in sequential data. They have been largely superseded by transformer networks.

M

Machine learning: Machine learning (ML), a branch of artificial intelligence, is the scientific study of algorithms with the purpose of enabling programs to do things without explicit programming.⁹³

Machine learning operations (MLOps): This refers to a set of practices that aim to deploy and maintain machine learning models in production reliably and efficiently, integrating ML with software engineering and operations.

Mathematical objection: Mathematical objection refers to “a number of results of mathematical logic which can be used to show that there are limitations to the powers of discrete-state machines.”⁹⁴

Mixture of Experts (MoE): This AI model architecture uses multiple expert models and dynamically selects the most relevant experts to process different parts of the input data.

Multiagent: This refers to AI systems involving multiple interacting agents, which can be either collaborative or competitive, to achieve complex objectives.

Multilayer perceptron (MLP): The MLP is developed from the early perceptron and represents what is referred to as a deep artificial neural network, usually applied to supervised learning problems. The MLP consists of an input layer, one or more hidden layers, and an output layer.⁹⁵

Multimodal AI: This is an emerging field that enables AI to process and relate various data modalities, or formats. By engaging with multiple modalities like image, text, speech, and video, the AI can better understand and analyse information, resulting in more desirable

⁹² NCSS Statistical Software. n.d. *Logistic regression*. Available: https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Logistic_Regression.pdf [2019, February 27].

⁹³ Wooldridge, op cit. 52.

⁹⁴ Turing, op cit. 444

⁹⁵ SkyMind. n.d. *A Beginner's Guide to Multilayer Perceptrons (MLP)*. Available: <https://skymind.ai/wiki/multilayer-perceptron> [2019, February 28].

outcomes. Examples of this type of AI are OpenAI's DALL-E3, Google's PaLM-2, and Deepmind's Gato.⁹⁶

Multiple intelligences theory: "This theory suggests that traditional psychometric views of intelligence are too limited. Gartner proposed that there are eight intelligences, and has suggested the possible addition of a ninth known as existentialist intelligence".⁹⁷

Musical intelligence: This type of intelligence refers to the ability "to produce and appreciate rhythm, pitch, and timbre" as well as to appreciate "the forms of musical expressiveness."⁹⁸

MYCIN: This is an early expert system designed to diagnose blood infections and intended to serve as an assistant to medical staff in providing expert advice about blood diseases.⁹⁹

N

Naïve Bayes model: "The model is comprised of two types of probabilities that can be calculated directly from your training data: 1) The probability of each class; and 2) The conditional probability for each class given each x value. Once calculated, the probability model can be used to make predictions for new data using Bayes Theorem".¹⁰⁰

NAFTA: NAFTA is a mnemonic that, for purposes of this programme, represents the framework to follow when making a business case for AI in an organisation – Needs, Alignment, Finance, Test, and Analyse.

Narrow AI: "Artificial Narrow Intelligence (ANI) also known as 'Weak' AI is the AI that exists in our world today. Narrow AI is AI that is programmed to perform a single task – whether it's checking the weather, being able to play chess, or analyzing raw data to write journalistic reports".¹⁰¹

⁹⁶ Reed, S., et al. 2022. *A generalist agent*. Available:

<https://openreview.net/forum?id=1ikK0kHjvj> [2023, June 5].

⁹⁷ Cherry, K. 2018. *Gardner's Theory of Multiple Intelligences*. Available:

<https://www.verywellmind.com/gardners-theory-of-multiple-intelligences-2795161> [2019, February 27].

⁹⁸ Gardner & Hatch, op cit. 6

⁹⁹ Copeland, B.J. n.d. *MYCIN: Artificial Intelligence Program*. Available:

<https://www.britannica.com/technology/MYCIN> [2019, February 28]; Wooldridge, op cit. 24

¹⁰⁰ Le, J. 2018. *A tour of the top 10 algorithms for machine learning newbies*. Available:

<https://towardsdatascience.com/a-tour-of-the-top-10-algorithms-for-machine-learning-newbies-dde4edffae11> [2019, February 26].

¹⁰¹ Jajal, T.D. 2018. *Distinguishing between Narrow AI, General AI and Super AI*. Available:

<https://medium.com/@tjajal/distinguishing-between-narrow-ai-general-ai-and-super-ai-a4bc44172e22> [2019, February 27].

Natural language processing (NLP): “A sub-field of Artificial Intelligence that is focused on enabling computers to understand and process human languages, to get computers closer to a human-level understanding of language.”¹⁰²

Neural radiance field (NeRF): This is a fully connected neural network that is able to generate new perspectives of complex three-dimensional scenes based on an input of incomplete, two-dimensional images.¹⁰³

Neural networks: This is an approach to machine learning that uses artificial neurons connected to each other in a complex network to generate a desired output from a given input.¹⁰⁴

Neuron: Neurons, in the context of machine learning, form part of the larger structure of artificial neural networks, which are inspired by the human brain to replicate the function of the human brain.¹⁰⁵

Non-linear regression: This is “a method of finding a nonlinear model of the relationship between the dependent variable and a set of independent variables.” This type of regression “can estimate models with arbitrary relationships between independent and dependent variables.”¹⁰⁶

NP-complete: This refers to a “class of computational problems that resist attempts to solve them efficiently.”¹⁰⁷ NP-complete is the intersection of NP-problems and NP-hard problems.

NP-hard: NP-hard problems refer to a class of problems for which no solution can be quickly found; however, if provided with the solution, the solution can be quickly verified. The most notorious NP-hard and NP-complete problem is the travelling salesman problem.¹⁰⁸

¹⁰² Seif, G. 2018. *An easy introduction to Natural Language Processing*. Available: <https://towardsdatascience.com/an-easy-introduction-to-natural-language-processing-b1e2801291c1> [2019, February 27].

¹⁰³ Datagen. n.d. *Neural radiance field (NeRF): a gentle introduction*. Available: <https://datagen.tech/guides/synthetic-data/neural-radiance-field-nerf> [2023, May 24].

¹⁰⁴ Wooldridge, op cit, p. 40

¹⁰⁵ Dormehl, L. 2019. *What is an artificial neural network? Here's everything you need to know*. Available: <https://www.digitaltrends.com/cool-tech/what-is-an-artificial-neural-network/> [2019, February 27].

¹⁰⁶ IBM. n.d. *Nonlinear Regression*. Available: https://www.ibm.com/support/knowledgecenter/en/SSLVMB_24.0.0/spss/regression/dh_nlre.html [2019, February 27].

¹⁰⁷ Wooldridge, op cit. 52.

¹⁰⁸ Op cit. 20

O

Oja's learning rule: This rule is an extension of the Hebbian rule and leads to a limitation of the indefinite increasing of the weights in a neural network, so that they remain between 0 and 1.¹⁰⁹

Output: This is the result of an artificial neural network.¹¹⁰

Overfitting: This problem occurs when the “network has memorized the training examples, but it has not learned to generalize to new situations.”¹¹¹ This means that, even when the error on the training set is reduced to a small value, a large error value occurs when the network is presented with new data.

P

Parametric updating: This is the use of supervised machine learning to update a critical operational parameter in a model in order to, for example, define the appropriate quantity in a supply chain context.

Perceptron: The perceptron is a simple algorithm typically applied to perform binary classification, whereby it predicts whether the input belongs to a specific category or not. It represents the early version of the multilayer perceptron, without any hidden layers.¹¹²

Pervasive technology: This refers to the inclusion of computational capabilities in everyday devices to perform useful tasks and reduce the amount of time the end user needs to spend on conventional computers. These technologies or devices are usually connected to the internet.¹¹³

¹⁰⁹ Bullinaria, J.A. 2015. *Hebbian Learning and Gradient Descent Learning*. Available: http://www.cs.bham.ac.uk/~pjt/NC/I5_JB.pdf [2019, February 28].

¹¹⁰ Dormehl, L. 2019. *What is an artificial neural network? Here's everything you need to know*. Available: <https://www.digitaltrends.com/cool-tech/what-is-an-artificial-neural-network/> [2019, February 27].

¹¹¹ Math Works. n.d. *Improve shallow neural network generalization and avoid overfitting*. Available: <https://www.mathworks.com/help/deeplearning/ug/improve-neural-network-generalization-and-avoid-overfitting.html;jsessionid=e15cd5a054790e9e8e67498db41e> [2019, February 27].

¹¹² SkyMind. n.d. *A Beginner's Guide to Multilayer Perceptrons (MLP)*. Available: <https://skymind.ai/wiki/multilayer-perceptron> [2019, February 28].

¹¹³ Rouse, M. n.d. *Pervasive computing (ubiquitous computing)*. Available: <https://internetofthingsagenda.techtarget.com/definition/pervasive-computing-ubiquitous-computing> [2019, February 27].

Pixel: “A pixel is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device [...] Pixels are combined to form a complete image, video, text or any visible thing on a computer display”.¹¹⁴

P-problem: P-problem refers to a class of problems for which the solution can be found quickly and verified quickly.¹¹⁵

Prediction: Prediction is when data is used to make probable inferences of what is to come.¹¹⁶

Predictive policing: “The application of analytical techniques – particularly quantitative techniques – to identify likely targets for police intervention and prevent crime or solve past crimes by making statistical predictions.”¹¹⁷

Profiling: “The recording and analysis of a person’s psychological and behavioural characteristics, so as to assess or predict their capabilities in a certain sphere or to assist in identifying a particular subgroup of people.”¹¹⁸

Prolog: This is a type of programming language where a “programmer expresses their goal and their knowledge about a problem in a single logical form, and the computer tries to solve the problem using logical deduction”.¹¹⁹

Prompt engineering: This describes the act of writing prompts to receive the desired results from an AI, or creating the copy that will be used to train and test an AI system. The goal is to use quality prompts to generate high-value outputs. To succeed, a prompt engineer must be a skilled writer that can include specific problem details to get the desired results.¹²⁰

¹¹⁴ Technopedia. n.d. *Pixel*. Available: <https://www.techopedia.com/definition/24012/pixel> [2019, February 27].

¹¹⁵ Russell & Norvig, op cit. 1054

¹¹⁶ Marr, B. 2018. *The economics of Artificial Intelligence – How Cheaper Predictions will Change the World*. Available: <https://www.forbes.com/sites/bernardmarr/2018/07/10/the-economics-of-artificial-intelligence-how-cheaper-predictions-will-change-the-world/#1573e8d45a0d> [2019, March 13].

¹¹⁷ Perry, W.L., et al. 2013. *Predictive policing: the role of crime forecasting in law enforcement operations*. Available: https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR233/RAND_RR233.sum.pdf [2019, February 27].

¹¹⁸ IGI Global. 2019. *What is profiling*. Available: <https://www.igi-global.com/dictionary/a-framework-for-profiling-prospective-students-in-higher-education/23752> [2019, February 27].

¹¹⁹ Wooldridge, op cit. 28

¹²⁰ Griffith, E. 2023. *Weird new job alert: what is an AI prompt engineer?* Available: <https://www.pcmag.com/how-to/what-is-an-ai-prompt-engineer> [2023, May 24].

Q

Q-learning: This is a reinforcement learning method where the quality values of various actions in each potential state are recorded in a table. The algorithm then uses this table to make decisions given a current state in order to maximise future rewards.¹²¹

R

Random decision forests: This is a supervised learning algorithm that “builds multiple decision trees” and merges them together “to get a more accurate and stable prediction.”¹²²

Reasoning: Reasoning refers to the “rational intellectual process of arriving at a conclusion, result, goal, decision, judgment, assessment, understanding, or other outcome that is thoroughly and convincingly justified through a rational thought process grounded in facts, competent and credible analysis, and sound judgment which involves intentional, considered, thoughtful, orderly, credible, sensible, and otherwise rational steps or arguments, such as argumentation or logic”.¹²³

Recommendation engines or recommendation systems: By making use of machine learning tools, these systems predict how a person would rate a specific range of items, and then displays the items that the person is most likely to rate the highest.¹²⁴

Recurrent neural network (RNN): This is a form of neural network that includes loops or connections between the different layers in the network, and the neurons in the same layer. “A recurrent neural network can be thought of as multiple copies of the same network, each passing a message to a successor”.¹²⁵

¹²¹ ADL. 2018. *An introduction to Q-Learning: reinforcement learning*. Available: <https://medium.freecodecamp.org/an-introduction-to-q-learning-reinforcement-learning-14ac0b4493cc> [2019, February 28].

¹²² Donges, N. 2018. *The random forest algorithm*. Available: <https://towardsdatascience.com/the-random-forest-algorithm-d457d499ffcd> [2019, February 27].

¹²³ Krupansky, J. 2018. *What is reason?* Available: <https://medium.com/@jackkrupansky/what-is-reason-a3f2c7a72209> [2019, February 27].

¹²⁴ Emmanuel, O. 2018. *Day 1: Building a recommendation system using machine learning (ML) and artificial intelligence (AI)*. Available: <https://medium.com/the-happiness-of-pursuit/day-1-building-a-recommendation-system-using-machine-learning-ml-and-artificial-intelligence-c8b2c5ef53a8> [2019, February 27].

¹²⁵ Banerjee, S. 2018. *An introduction to recurrent neural networks*. Available: <https://medium.com/explore-artificial-intelligence/an-introduction-to-recurrent-neural-networks-72c97bf0912> [2019, February 28].

Recursive neural network: Recursive neural networks refer to “non-linear adaptive models that are able to learn deep structured information”.¹²⁶

Regression: This is a method of estimating or predicting the variables that will impact the result. It therefore investigates the relationship between a dependent variable and multiple independent variables.¹²⁷

Regularisation: This technique is used to avoid the problem of overfitting in machine learning, used, for example, in LASSO and ridge regression.

Reinforcement learning: This is an approach to machine learning where the agent learns how to behave by performing actions and getting feedback from the environment. It gets positive feedback for getting a desired outcome and negative feedback for getting an undesired outcome. After each iteration, the algorithm makes adjustments to attempt to maximise the reward.¹²⁸

Reinforcement Learning from AI Feedback (RLAIF): In this approach, AI systems are trained using feedback from other AI models to improve their performance.

Reinforcement Learning from Human Feedback (RLHF): This is an approach in which AI models are trained and optimised based on feedback provided by humans to align their behaviour with human values and preferences.

Replication: One of the three pitfalls of AI is the inability to replicate a decision made by AI, which means that the programmers that designed the technology do not understand why the AI makes one decision and not another.¹²⁹

Retrieval-Augmented Generation (RAG): A method that combines pre-trained language models with information retrieval techniques to generate more accurate and timely responses.

Ridge regression: This is “a technique for analyzing multiple regression data that suffer from multicollinearity.”¹³⁰

¹²⁶ Chinae, A. 2009. *Understanding the principles of recursive neural networks: A generative approach to tackle model complexity*. Available: <https://arxiv.org/ftp/arxiv/papers/0911/0911.3298.pdf> [2019, February 27].

¹²⁷ Gallo, A. 2015. *A refresher on regression analysis*. Available: <https://hbr.org/2015/11/a-refresher-on-regression-analysis> [2019, February 28].

¹²⁸ Kurama, V. 2018. *Reinforcement Learning with Python*. Available: <https://towardsdatascience.com/reinforcement-learning-with-python-8ef0242a2fa2> [2019, February 28].

¹²⁹ Gershgorn, D. 2017. *AI is now so complex its creators can't trust why it makes decisions*. Available: <https://qz.com/1146753/ai-is-now-so-complex-its-creators-cant-trust-why-it-makes-decisions/> [2019, February 27].

¹³⁰ NCSS Statistical Software. n.d. *Ridge Regression*. Available: https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Ridge_Regression.pdf [2019, February 27].

Right to explanation: In terms of Article 22 and Recital 17 of the GDPR, individuals have the right to receive an explanation for a particular output generated by an algorithm.¹³¹

Robo-advisor: “Online investing platforms that seek to emulate the services of a financial advisor.”¹³²

Robotics: This represents technology that deals with robots, which are programmable machines designed and programmed to conduct a series of actions autonomously or semi-autonomously. Robotics overlaps with AI only when the robot becomes intelligent.¹³³

S

Sampling: Sampling refers to a method of estimating the parameters of the whole population by examining the properties of a smaller number of examples from within that population.¹³⁴

Semi-supervised learning: Semi-supervised learning algorithms are “trained on a combination of labeled and unlabeled data”, which “tends to improve the accuracy of the final model while reducing the time and cost spent building it.”¹³⁵

SHRDLU: This is a system based on “Blocks World...a simulated environment containing a number of coloured objects (blocks, boxes and pyramids).” SHRDLU arranged the objects “according to instructions from a user, using a simulated robot arm to manipulate them.”¹³⁶

Singularity: This refers to the hypothesis that General AI systems will eventually become smarter than people.¹³⁷

Sigmoid function: See logistics function.

¹³¹ Jongerius, S 2018. *Artificial intelligence and the right to explanation under the GDPR*. Available: https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Ridge_Regression.pdf [2019, February 27].

¹³² Rosenberg, E. 2019. *Betterment vs. Wealthfront*. Available: <https://www.thebalance.com/robo-advisors-wealthfront-vs-betterment-4154714> [2019, February 27].

¹³³ Owen-Hill, A. 2017. *What's the difference between robotics and artificial intelligence?* Available: <https://blog.robotiq.com/whats-the-difference-between-robotics-and-artificial-intelligence> [2019, February 27].

¹³⁴ Hajishirzi, H. n.d. *Bayesian Networks: inferences*. Available: <https://courses.cs.washington.edu/courses/cse473/14sp/slides/23-BN-sampling.pdf> [2019, March 13].

¹³⁵ Castle, N. 2018. *What is semi-supervised learning?* Available: <https://www.datascience.com/blog/what-is-semi-supervised-learning> [2019, February 27].

¹³⁶ Wooldridge, op cit. 16

¹³⁷ Op cit. 48

Small language model (SLM): This is a compact language model designed to perform specific language tasks efficiently, with fewer computational resources and parameters than LLMs.

Small multimodal models (SMM): A compact AI model that integrates information from multiple modalities, optimised for efficiency and specific tasks with limited computational resources and parameters.

Sophia: Sophia is “Hanson Robotics’ latest human-like robot, created by combining [their] innovations of science, engineering and artistry.”¹³⁸

Spatial intelligence: “Capacities to perceive the visual-spatial world accurately and to perform transformations on one’s initial perceptions.”¹³⁹

Speech recognition: Speech recognition refers to the “capability of an electronic device to understand spoken words.”¹⁴⁰

STANLEY: This is the name of the first autonomous vehicle to complete the DARPA challenge in under seven hours, at an average speed of 20 mph.¹⁴¹

Strong AI hypothesis: “The assertion that machines that [act as if they were intelligent] are **actually** thinking (not just **simulating** thinking) is called the strong AI hypothesis.”¹⁴²

Structured data: “Data that has been organised into a formatted repository, typically a database, so that its elements can be made addressable for more effective processing and analysis.”¹⁴³

Supervised learning: This is a machine learning approach where the algorithm is taught how to generate the correct output for any given input by training it with labelled data. Classification and regression are algorithms associated with supervised learning.¹⁴⁴

Support vector machine: This refers to a “supervised machine learning algorithm which can be used for both classification and regression challenges [...] In this algorithm, we plot

¹³⁸ Hanson Robotics. 2019. *Hi, I am Sophia...* Available: <https://www.hansonrobotics.com/sophia/> [2019, February 27].

¹³⁹ Hatch & Gardner, op cit. 6

¹⁴⁰ Tech Terms. n.d. *Speech recognition*. Available: https://techterms.com/definition/speech_recognition [2019, February 27].

¹⁴¹ Wooldridge, op cit. 36

¹⁴² Russel & Norvig, op cit. 1020

¹⁴³ Rouse, M. n.d. *Structured data*. Available: <https://whatis.techtarget.com/definition/structured-data> [2019, February 27].

¹⁴⁴ Soni, D. 2018. *Supervised vs. Unsupervised Learning*. Available: <https://towardsdatascience.com/supervised-vs-unsupervised-learning-14f68e32ea8d> [2019, February 28].

each data item as a point in n -dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate.”¹⁴⁵

T

Technology-driven change: This is a change in an organisation enabled by the implementation of new technology.¹⁴⁶

Testing error: The error is the difference between the desired output and the actual output when an artificial neural network is trained with test data, which is then used to adjust the weights between the nodes within the network.¹⁴⁷

Testing set: This is a set of data that is given to a neural network, and its corresponding labels, which are used to determine the accuracy of the neural network’s predictions.¹⁴⁸ Also see training set and validation set.

Theological objection: “Thinking is a function of man’s immortal soul. God has given an immortal soul to every man and woman, but not to any other animal or to machines. Hence no animal or machine can think.”¹⁴⁹

Tokenisation: Tokenisation is the process of converting input data, such as text, into a sequence of tokens (words, subwords, or characters) that can then be processed by ML models.

Training error: This type of error serves as a function of the iterative process of training an artificial neural network using the data it had been trained with to adjust the weights between the nodes within the network.¹⁵⁰

Training set: This is a set of labelled data given to a neural network to teach it what the desired output is for any of the given inputs.¹⁵¹ Also see validation set and testing set.

¹⁴⁵ Course Hero. n.d. *Support vectors can be used for*. Available: <https://www.coursehero.com/file/p7r2qrt/Support-vector-machines-can-be-used-for-classification-or-regression-As-with/> [2019, February 27].

¹⁴⁶ The Conference Board of Canada. n.d. *Navigating and Managing Technology-Driven Change*. Available: https://www.conferenceboard.ca/docs/default-source/network-public/navigating_brochure_web.pdf?sfvrsn=0&AspxAutoDetectCookieSupport=1 [2019, February 27].

¹⁴⁷ Dias, M.F. & Antunes, A. n.d. *Test error versus training error in artificial neural networks for systems affected by noise*. Available: http://www.cce.uma.pt/morgado/down/train_test_naun.pdf [2019, February 27].

¹⁴⁸ Dormehl, L. 2019. *What is an artificial neural network? Here’s everything you need to know*. Available: <https://www.digitaltrends.com/cool-tech/what-is-an-artificial-neural-network/> [2019, February 27].

¹⁴⁹ Turing, op cit. 443

¹⁵⁰ Dias & Antunes, op cit.

¹⁵¹ Dormehl, op cit.

Transformers: These are neural networks that learn context and meaning by tracking relationships in sequential data via an attention mechanism. Transformer models can detect the ways that elements in a series influence and depend on one another. They can be used to translate speech and text almost in real time, allowing hearing-impaired individuals or non-native speakers of a language to understand what is being written or said. They can also be leveraged in drug design, fraud prevention, or online recommendations.¹⁵²

Travelling salesman problem: “A salesman must visit some cities in his car, eventually returning to his origin. His car only has a certain amount of fuel. Is there a route that will complete the tour without running out of fuel?”¹⁵³

Turing test: This is “a test for AI, in which an interrogator tries to determine whether they are interacting with a person or a computer program.”¹⁵⁴

U

Underfitting: “Underfitting refers to a model that can neither model the training data nor generalize to new data. An underfit machine learning model is not a suitable model and will be obvious as it will have poor performance on the training data”.¹⁵⁵

Unstructured data: This refers to information “that doesn’t hew to conventional data models and thus typically isn’t a good fit for a mainstream relational database.”¹⁵⁶

Unsupervised learning: This is a machine learning approach where the algorithm is trained to learn the inherent structure of data without explicit labels. Unsupervised learning aims to find regularities in the input to produce an output.¹⁵⁷

¹⁵² Merritt, R. 2022. *What is a transformer model?* Available: <https://blogs.nvidia.com/blog/2022/03/25/what-is-a-transformer-model/> [2023, May 24].

¹⁵³ Wooldridge, op cit. 20

¹⁵⁴ Wooldridge, op cit.

¹⁵⁵ Brownlee, J. 2016. *Overfitting and underfitting with machine learning algorithms*. Available: <https://machinelearningmastery.com/overfitting-and-underfitting-with-machine-learning-algorithms/> [2019, February 27].

¹⁵⁶ Rouse, M. n.d. *Unstructured data*. Available: <https://searchbusinessanalytics.techtarget.com/definition/unstructured-data> [2019, March 13].

¹⁵⁷ Soni, D. 2018. *Supervised vs. Unsupervised Learning*. Available: <https://towardsdatascience.com/supervised-vs-unsupervised-learning-14f68e32ea8d> [2019, February 28].

V

Validation set: This set is used to fine-tune the functionality of a neural network after it has been trained with the training set.¹⁵⁸ It refers to a dataset that is held back from training the neural network to estimate the skill of the network in making accurate predictions.¹⁵⁹ Also see “training set” and “test set”.

Variational autoencoders (VAE): Variational autoencoders are probabilistic generative models that require a neural network encoder and decoder as a part of their overall structure. The encoder maps the input variable to a continuous latent space, while the decoder maps from the latent space to the input space to produce or generate data points. This type of machine learning model can be used for supervised and unsupervised learning.¹⁶⁰

Variable: “A variable is a quantity that may change within the context of a mathematical problem or experiment. Typically, we use a single letter to represent a variable. The letters x, y, and z are common generic symbols used for variables”.¹⁶¹

Vector database: This database stores input information in various formats as high-dimensional mathematical representations of features or attributes (multidimensional vectors). This enables swift and accurate similarity search and retrieval of data based on the distance or similarity of the vector to other vectors. Vector databases enable users to find images similar in content or style to a sample image, find documents similar to a sample document based on topic, or discover products based on their features and ratings.¹⁶²

Vector embedding: This is a numerical representation of data, such as words or images, in a continuous vector space, capturing the semantic meaning and enabling efficient comparisons and operations by ML models.

Video processing: This process is used to extract “insights from videos.”¹⁶³ Video processing is similar to image processing, but is predominantly used for moving frames in images.

¹⁵⁸ Dormehl, op cit.

¹⁵⁹ Brownlee, J. 2017. *What is the difference between test and validation datasets?* Available: <https://machinelearningmastery.com/difference-test-validation-datasets/> [2019, March 22].

¹⁶⁰ Kingma, D. & Welling, M. 2013. *Auto-encoding variational Bayes*. Available: <https://arxiv.org/abs/1312.6114> [2023, June 5].

¹⁶¹ Nykamp, D. Q. n.d. *Variable definition*. Available: <https://mathinsight.org/definition/variable> [2019, February 27].

¹⁶² Microsoft. 2023. What is a vector database? Available: <https://learn.microsoft.com/en-us/semantic-kernel/memories/vector-db> [2023, 24 May].

¹⁶³ Gada, M. 2018. *How is AI for video different from AI for images*. Available: <https://azure.microsoft.com/en-us/blog/how-is-ai-for-video-different-from-ai-for-images/> [2019, February 27].

W

Watson: “IBM Watson was developed as a research project and first attracted headlines as the supercomputer to beat human contestants in the US TV show Jeopardy, but the system is now being used across sectors around the world to boost revenue, efficiency and even save lives”.¹⁶⁴

Weak AI hypothesis: “The assertion that machines could act **as if** they were intelligent is called the weak AI hypothesis.”¹⁶⁵

Weight: “Each link [in a neural network] has a numeric weight associated with it, which determines the strength and sign of the connection.”¹⁶⁶

X

No terms listed here.

Y

You only look once (YOLO): This is a real-time object-detection system used to identify specific objects from images or videos.¹⁶⁷

Z

No terms listed here.

¹⁶⁴ Computerworld. 2019. *How companies are using IBM Watson’s AI to power business success*. Available: <https://www.computerworlduk.com/galleries/it-vendors/innovative-ways-companies-are-using-ibm-watson-3585847/> [2019, February 26].

¹⁶⁵ Russell & Norvig, op cit. 1020

¹⁶⁶ Op cit. 728

¹⁶⁷ Hui, J. 2018. *Real-time Object Detection with YOLO, YOLOv2 and now YOLOv3*. Available: https://medium.com/@jonathan_hui/real-time-object-detection-with-yolo-yolov2-28b1b93e2088 [2019, February 26].