Technological and Higher Education Institute of Hong Kong
Department of Construction, Environment and Engineering

Programme Title:	BEng (Hons) in Building Services Engineering
Programme Code:	ST125103/ST145103
Academic Year:	AY2024/25
Semester:	1
Module Code and Title:	SBS4115 Fundamentals of AI & Data Analytics
Module Convenor:	Roger NG
Module Lecturer(s):	Kelvin SIU
Moderator:	Roger NG

Question No.		Solutions	Marks
Q.1	(i)	Supervised learning is a machine learning approach where an algorithm is trained on a labeled dataset. In this type of learning, the model learns to map inputs to the desired outputs using historical examples.	2
		Unsupervised learning, in contrast, operates on unlabeled data where the algorithm attempts to find hidden patterns or intrinsic structures in the data without any predefined output labels.	2
		Supervised learning is valuable for applications requiring specific predictions, enhancing decision-making processes, while unsupervised learning provides insights by revealing data patterns, especially useful in exploratory data analysis. Supervised learning depends on labeled data for accuracy, while unsupervised learning is more versatile but less specific in prediction.	2
	(ii)	Narrow AI, also known as weak AI, refers to AI systems that are designed and trained for a specific task. These systems operate within predefined boundaries and lack the flexibility to perform beyond their trained functions. Examples of Narrow AI include language translation software, image recognition programs, and personal assistants like Siri.	3
		General AI, also called strong AI, is an advanced form of AI that would theoretically possess the ability to understand, learn, and apply intelligence in a way similar to a human, enabling it to perform any intellectual task that a human can. If developed, General AI could handle tasks ranging from reasoning and problem-solving to creativity and complex decision-making across different fields.	3

		While Narrow AI is task-specific and practical in today's applications, General AI remains a future ambition in AI research. Narrow AI excels in narrowly defined roles and lacks the adaptability of General AI, which aims to mimic human intelligence across diverse contexts. General AI, though not yet realized, has potential applications in areas where human-like reasoning and adaptability are crucial.	3
	(iii)	Narrow AI improves efficiency by automating repetitive tasks, allowing specific processes to operate faster and with fewer errors than manual handling. For example, Narrow AI in robotic process automation (RPA) enables businesses to perform high-volume tasks efficiently, such as data entry and customer service responses. General AI, if achieved, would theoretically optimize processes across various domains, adapting its intelligence to handle diverse tasks, which could revolutionize industries by providing a universal AI workforce capable of complex multitasking. Narrow AI plays a crucial role in enhancing safety in specific environments. For example, in autonomous driving, Narrow AI is used to detect obstacles, pedestrians, and traffic signals to reduce accident risks. General AI, with human-like adaptability, would be capable of handling complex and unpredictable safety scenarios in real-time, potentially leading to advanced safety mechanisms in healthcare, defense, and public infrastructure by adapting to unique situations beyond pre-defined algorithms. Narrow AI drives innovation within specialized fields by focusing on problem-solving in particular areas. General AI, due to its	3 3 2 2

		theoretical capability for broad application, could foster transformative innovation across disciplines, breaking barriers in scientific research, creativity, and cross-disciplinary problem-solving.	

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Question No.		Solutions	Marks
Q.2	(a) (i)	Traffic Optimization: AI systems analyze real-time traffic data, predicting and managing congestion. For example, in cities like Los Angeles, AI-based adaptive traffic signals adjust light timings based on current traffic, reducing commute times and emissions.	2
		AI enables intelligent energy distribution by monitoring usage patterns and balancing supply. For instance, smart grids using AI dynamically adjust energy flow, which reduces wastage and lowers costs.	2
		AI-powered waste monitoring systems help optimize collection routes and improve recycling rates. In cities like Singapore, smart bins equipped with sensors notify waste collection teams, reducing unnecessary trips and fuel consumption.	2
		AI contributes to resource conservation by optimizing city services to match demand. In energy management, AI reduces consumption by adjusting lighting and heating in public buildings.	2
	(a) (ii)	AI systems analyze medical images from X-rays, MRIs, and CT scans, detecting anomalies such as tumors and fractures that might be missed by the human eye. By applying image recognition and machine learning, AI can identify and classify medical conditions with high precision.	2
		In diagnostics, AI algorithms provide decision support, enhancing accuracy in early detection. For example, IBM Watson Health uses AI to recommend treatments based on historical data, improving diagnosis accuracy and supporting personalized care.	2

		For instance, AI systems can detect early-stage lung cancer from CT scans, improving survival rates due to earlier intervention. Also, AI-driven imaging software can highlight suspicious areas for radiologists, reducing diagnostic errors.	2
		These advancements result in improved patient outcomes, as AI enhances diagnostic speed and accuracy, allowing for timely, tailored treatments. Such precision reduces the need for unnecessary biopsies and lowers healthcare costs, benefiting both patients and providers.	2
	(b)	Predictive analytics assists in project planning by forecasting material needs, timelines, and costs based on historical data. AI models predict potential delays and cost overruns, enabling proactive adjustments to keep projects on track. For example, AI systems in construction planning software can allocate resources more efficiently and prevent budget overruns by analyzing past project data and current project conditions.	3
		By optimizing these processes, companies can reduce costs associated with rework and resource misallocation, resulting in substantial savings. AI-driven energy management systems help reduce building energy consumption by monitoring and controlling HVAC, lighting, and electrical systems.	3
		Predictive maintenance also uses AI to anticipate equipment failures, scheduling maintenance before breakdowns occur, thereby reducing downtime and repair costs. AI enhances safety by monitoring construction sites in real time and providing alerts about potential hazards. AI-powered computer vision systems can detect if workers are wearing protective gear and alert supervisors if safety protocols are breached.	3

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Question No.		Solutions	Marks
Q.3	(a)	The first step is gathering a dataset of images relevant to the recognition task. For effective recognition, a large and diverse dataset with labeled images is essential.	1
		Preprocessing involves resizing images to a consistent size, normalizing pixel values, and, if needed, converting to grayscale to simplify processing. These steps ensure that the images are uniform, which enhances model performance by reducing unnecessary complexity.	2
		Once the data is preprocessed, a suitable model is selected. For a simple system, a convolutional neural network (CNN) is commonly used due to its effectiveness in image-related tasks.	2
		After training, the model is evaluated using metrics such as accuracy, precision, recall, and error rates on a test set. These metrics help assess how well the model performs on unseen data, providing insights into any necessary adjustments. Evaluation is crucial to understand the model's strengths and weaknesses, allowing for refinement to reduce errors and improve accuracy before deployment.	3
	(b)	Face recognition systems identify unique facial features such as the distance between eyes, nose shape, and jawline contours. AI algorithms analyze these features and convert them into a digital template that uniquely represents each individual.	3
		A common application is in security systems at airports. These systems use facial recognition to match passengers' faces with their ID photos, verifying identities quickly and securely. Another example is mobile phone authentication, where facial recognition	3

		allows users to unlock devices with a glance. AI enhances accuracy by learning to distinguish subtle differences in facial features, even under varying lighting or facial angles. Advanced algorithms, like deep learning, improve detection speed, allowing real-time verification. This efficiency reduces waiting times in security checks or device unlocking, offering both convenience and enhanced security.	3
	(c)	Rule-based NLP systems use predefined linguistic rules to process and understand language. These systems rely on pattern matching, grammar rules, and lexicons to interpret inputs. Techniques include syntax analysis, pattern matching, and language parsers.	2
		Machine learning in NLP involves training algorithms on labeled datasets to recognize patterns in language data, such as sentiment or named entities. Techniques include supervised learning methods like logistic regression, Naive Bayes, and support vector machines (SVM).	2
		Sentiment analysis in social media monitoring uses machine learning to classify text as positive, negative, or neutral, helping companies gauge public opinion on their brand or products.	2
		Deep learning methods, such as recurrent neural networks (RNNs) and Transformers, handle more complex language tasks by learning contextual patterns from large datasets, often achieving high accuracy.	2

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Question No.		Solutions	Marks
Q.4	(a) (i)	One of the primary ethical concerns in AI decision-making is data privacy. In sensitive sectors like healthcare, AI systems require access to large amounts of personal data, including medical histories, genetic information, and lifestyle details, to make accurate predictions and recommendations.	2
		The handling of this sensitive information raises privacy concerns, as there is a risk of data breaches, unauthorized access, or misuse. If this information is mishandled, it can lead to breaches of confidentiality and compromise patient trust. For instance, if a healthcare provider's AI system is hacked, patients' personal health data could be exposed, leading to privacy violations and potential psychological harm.	3
		Another ethical issue is the accountability of AI decisions, particularly in sectors like healthcare and law enforcement, where decisions can have life-altering consequences.	2
		For example, in healthcare, AI might recommend treatments or diagnose diseases, but if it makes a mistake, it is unclear who should be held accountable – the developers, the healthcare providers, or the AI system itself.	3
		Alternative answer as one of the ethical issues: In law enforcement, AI is increasingly used in predictive policing, where it forecasts crime hotspots or assesses the risk of individuals reoffending. If these predictions are inaccurate, they can lead to unjust outcomes, such as unwarranted surveillance or wrongful arrests, raising concerns about fairness and accountability in AI-driven decision-making.	(5)

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	(a) (ii)	Algorithmic bias occurs when AI systems produce biased or unfair outcomes due to imbalanced or prejudiced data. Sources of algorithmic bias often include historical data reflecting societal biases, lack of diversity in training datasets, or flawed algorithm design. This bias can lead to discrimination against certain groups, undermining fairness and equality in AI applications. A well-known example of algorithmic bias is found in hiring algorithms used by some companies. An AI recruitment tool developed by Amazon was discovered to favor male applicants over female candidates for technical roles, as it had been trained on resumes submitted predominantly by men. This resulted in unfair hiring practices, disadvantaging female applicants and perpetuating gender inequality in the workplace. This example illustrates how algorithmic bias can lead to discrimination and reinforce existing inequalities, ultimately impacting diversity and inclusion in industries reliant on such AI tools.	3 3 3
	(b)	To prevent biases in AI systems, developers should use diverse and representative datasets that reflect various demographics and perspectives. Regular audits should be conducted to identify any biases in the AI system, with adjustments made as needed. Transparency in algorithm design can help stakeholders understand and trust AI decisions. By making the algorithms' decision-making processes interpretable, developers can allow users to see how decisions are reached, fostering greater accountability.	2 2

		Implementing fairness algorithms that adjust outcomes to reduce bias is essential. Setting clear ethical guidelines and developing accountability frameworks can ensure that AI deployment is responsible and fair.	2

MLO	Question 1	Question 2	Question 3	Question 4
1	V			
2			V	
3		V		
4				V

MLO1: Understand fundamentals concepts of AI and data analytics;

MLO2: Acquire the basic skills in using AI and data analytics technologies and applications;

MLO3: Articulate examples of how the adoption of AI and data analytics enhances the engineering industries; and

MLO4: Demonstrate awareness of ethical issues and the impact of the applications of AI and data analytics in daily life.