Subject Description Form

Subject Code	BRE 368
Subject Title	AI and Data Analytics for Smart Construction
Credit Value	3
Level	3
Pre-requisite /Co-requisite/ Exclusion	Nil
Objectives	This subject is intended to: 1. Equip students with the ability of using data analytics and machine learning in building engineering and management. 2. Enable the students appreciate the mathematical basis and the applications of the main models and methods used in the analysis of problems in the built environment. 3. Provide students an understanding of data-driven or AI-supportive building development and optimized operation of efficient building systems as a part of the integrated system of building fabric, building space, occupants, building services and controls. 4. Introduce applications of various digital construction technologies that can benefit from AI and DA, including robotic technologies, Modular Integrated Construction (MIC), and Building Information Modelling (BIM) in building design, construction, maintenances and operations.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Apply data analytics and AI tools to building and construction data. b. Apply mathematical modelling tools to analyse problems in the built environment. c. Understand the data-driven decision making process for practical construction engineering and management issues. d. Evaluate appropriateness of digital technologies in building construction, maintenance and operations.

Subject Synopsis/ Indicative Syllabus	This multi-faceted subject encompasses technologies in building construction, maintenance and operations. Combined with tools from big data analytics, AI, robotics and BIM, the subject enables better strategic decisions for designers, building managers and property owners to consider the building in the context of smartness and future needs. 1. Introduction to AI and DA applications in construction • Importance of big data in construction • Theoretical background of AI and DA • Concept of data-driven decision making and problem solving • Advanced technologies for field data collection and analysis • Examples of AI and DA applications in construction • Required knowledge and skill sets 2. Machine learning theory and tools • Introduction to machine learning • Supervised and unsupervised learning • Mathematical models for machine learning e.g., regression, classification, clustering etc. • Machine learning tools e.g., MATLAB machine learning tool box, Weka 3. AI and DA applications with construction data • Data mining and data analytics for construction management • Sensor data analysis for construction safety and health o Motion data analysis for unsafe behaviour identification o Physiological data analysis for physical and mental fatigue assessment • Video analytics o Construction activity recognition based on computer vision o Construction worker behaviour analysis based on computer vision o Construction component defects identification based on computer vision • 3D point cloud analysis o Object localization, detection, and identification based on 3D point clouds 4. Applications of digital construction technologies • Robotic technologies for various construction operations (e.g., plastering, rebar installation, curtain wall installation, cleaning and air quality control etc.) • Sensing technologies • Modular Integrated Construction (MIC) • Building Information Modelling (BIM)

Teaching/Learning Methodology

The concept, theory and applications of AI and DA in construction will be delivered through lectures. Tutorials will provide hands-on exercises on AI and DA tools to learn how to apply these tools with given data. Through a group project, students will explore the use of AI and DA tools for practical problem solving in construction. Students will be also required to study online learning materials.

Online learning materials:

- MATLAB Onramp (about 2hrs): https://www.mathworks.com/learn/tutorials/matlab-onramp.html
- WEKA Tutorials: https://www.tutorialspoint.com/weka/index.htm

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d		
1. Individual Assignments (Tutorials)	20	√	√	√	√		
2. Focus Study Report (Group project)	30	√	√	√	√		
3. Written Examination	50	√	√	√	√		
Total	100%						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Coursework and examination will each constitute 50% of the overall assessment for the subject. The coursework mark will be based on the individual assignments and one group project (i.e., a focus study on AI and DA applications in construction practice).

The examination will be based on a 2 hours examination gearing towards the materials covered in the lecture periods and background readings. Coursework by assignment and group projects will be set to assess the students' abilities and skills required in this subject.

Student Study Effort Required

Class contact:	
• Lecture	26 Hrs.
• Tutorial	13 Hrs.
•	
Other student study effort:	
• Self-study, assignments, e-learning	40 Hrs.
• Group projects	40 Hrs.
Total student study effort	119 Hrs.

Reading List and References	Recommended: • Rafael Sacks, Chuck Eastman, Ghang Lee, Paul Teicholz (2018) BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, 3rd Edition. Wiley. • Zacharias Voulgaris and Yunus Emrah Bulut (2018) AI for Data Science: Artificial Intelligence Frameworks and Functionality for Deep Learning, Optimization, and Beyond First Edition, Technics Publications • Bock, T., & Linner, T. (2016). Construction Robots Elementary Technologies and Single-Task Construction Robots. In Construction Robots: Elementary Technologies and Single-Task Construction Robots (p. I). Cambridge: Cambridge University Press. • Wang, D., Dai, F., & Ning, X. (2015). Risk Assessment of Work-Related Musculoskeletal Disorders in Construction: State-of-the-Art Review. *Journal of Construction Engineering and Management*, *141*(6), 04015008. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000979 • Hou, L., Wu, S., Zhang, G. (Kevin), Tan, Y., & Wang, X. (2020). Literature Review of Digital Twins Applications in Construction Workforce Safety. *Applied Sciences*, *11*(1), 339. https://doi.org/10.3390/app11010339 • Guo, B. H. W., Zou, Y., Fang, Y., Goh, Y. M., & Zou, P. X. W. (2021). Computer vision technologies for safety science and management in construction: A critical review and future research directions. *Safety Science*, *135*, 105130. https://doi.org/10.1016/j.ssci.2020.105130 • Wang, Q., & Kim, M.-K. (2019). Applications of 3D point cloud data in the construction industry: A fifteen-year review from 2004 to 2018. *Advanced Engineering Informatics*, *39*, 306–319. https://doi.org/10.1016/j.aei.2019.02.007
	• Fan, H. and Li, H. (2012). "Retrieving similar cases for alternative dispute resolution in construction accidents using text mining techniques ". Automation in Construction, Elsevier, Vol. 34, pp.85-91 (2013). • Fan, H., Xue, F. and Li H. (2015). Project-based As-needed Information Retrieval from Unstructured AEC Documents, ASCE Journal of management in Engineering, January 2015, Vol. 31, No. 1. • Shen, L., Yan, H., Fan, H., Wu, Y., & Zhang, Y. (2017). An integrated system of text mining technique and case-based reasoning (TM-CBR) for supporting green building design. Building and Environment, 124, 388-401. • Yan, H., Yang, N., Peng, Y., & Ren, Y. (2020). Data mining in the construction industry: Present status, opportunities, and future trends. Automation in Construction, 119, 103331. • https://www.coursera.org/learn/machine-learning/home/welcome • https://www.mathworks.com/solutions.html?s_tid=gn_sol