1	Course Code:	**CIVL4100R (Spring 22-23)**
2	Course Title:	Practical Machine Learning for Smart Infrastructure Systems
3	Course Credits:	3
4	Class Quota:	50
5	Duration / Offering Term:	Spring semester
6	Lecture/tutorial/lab hour per week	Two 1.5-hour lectures per week
7	Targeted Student Group:	Years 3 and 4 UG students, PG Students
8	Prerequisite (if any):	MATH1014/1024, MATH 2350, and COMP1021/1022P/2011/2012H
9	Exclusion (if any):	
10	Corequisite (if any)	
11	Instructor:	Prof. Jize ZHANG (cejize@ust.hk) Prof. Zhe WANG (cezwang@ust.hk)
12	Enrollment requirement (e.g., Instructor's approval is required):	
13	Course Description: (within 150 words)	This course covers fundamental machine learning concepts and hands-on experience about smart infrastructure system applications. Lectures will cover the "full stack" of machine learning, including data cleaning and pre-processing, machine learning, and reinforcement learning. The covered topics include: collecting and processing real-world project data, detecting abnormal data, and imputing missing data; analyzing the data with a variety of machine learning methods including linear & logistic regression, decision tree, SVM, unsupervised learning (clustering, PCA), and advanced machine learning methods (ensemble learning and deep learning). Last, we will introduce reinforcement learning to build autonomous infrastructure systems that learn to make good decisions. One key feature of this course is its application-driven nature. All applications of this course are about smart infrastructure systems. Through those applications, students will know how ML can be applied in their future career and research.
14	Tentative course structure:	This course will have four project-themed modules: smart building with supervised learning, smart structure with deep learning, smart structure with time-series machine learning, and sustainable building operation with reinforcement learning. The syllabus of this course is attached at the end of this document.
15	Intended learning outcomes (ILOs) of the course:	On successful completion of this course, students are expected to be able to: 1. Learn the fundamentals concepts and experience hands-on applications of machine learning to smart infrastructure systems 2. Understand the domain knowledge of smart building, smart structures, and sustainable building operations

		3. Apply a variety of supervised, unsupervised and reinforcement learning algorithms to practical civil engineering problems 3. Learn practical skills to improve the machine learning models
16	Rationale for introducing the course:	Machine learning is the fundamental skillsets that students need to master in this artificial intelligence era. Learning machine learning can help our students to lead the digitalization and smart transition of our industry. The proposed course and syllabus is aligned with the following programme objectives for our UG programmes: POE1 Provide students with professional skills in the design, construction and management of the civil infrastructure, as well as an awareness of environmental sustainability. POE3 Challenge students with research-type and open-ended design problems to stimulate self-learning and innovative problem solving skills. POE4 Expose students to real world engineering projects as well as cutting edge research to improve their understanding of the profession and technological advancements that can improve current practice.
17	Textbook / Reference books:	1. Python for Data Analysis 3rd Edition, Wes McKinney, O'Reilly Media, Inc: https://wesmckinney.com/book/ 2. Probabilistic Machine Learning: An Introduction Kevin Patrick Murphy, MIT Press: https://github.com/probml/pml-book/releases/latest/download/book1.pdf
18	Grading Scheme	Projects (20% * 4), In-class Quiz (5%*4)
19	Grading Type (PP/P/F/Letter)	Letter
20	With endorsement of UG coordinator	

Course Schedule

Week	Lecture Topic		Project
1	Course introduction	Pandas Ⅰ	
2	Pandas Ⅱ	Time series data	
3	Data cleaning	Data visualization	
4	Supervised learning: linear & logistic regression	Supervised learning: decision tree, SVM	P1: Thermal preference prediction
5	Unsupervised learning: clustering, PCA	Ensemble learning: bagging, boosting, random forests	
6	Neural networks	Introduction to computer vision problems	
7	Deep convolutional neural networks I	Deep convolutional neural networks II	P2: Structural defects detection
8	Practical strategies: regularization, optimizers	Hyper-parameter tuning	
9	Introduction to time series problem	Recurrent neural networks	P3: Structural response prediction
10	Rethink time series problems	RL: problem statement and introduction	
11	Markovian Decision Process	Imitation Learning & model-based RL	
12	Reinforcement learning algorithms I	Reinforcement learning algorithms II	P4: Building energy system control
13	Course review		