Module Template for New and Revised Modules[1]

Module Code	EEP55C31
Module Name	Data Science and AI for Transportation Engineering
ECTS Weighting[2]	5 ECTS
Semester taught	Semester 2
Module Coordinator/s	Prof. Biswajit BASU, Adjunct Assistant Prof. Andrea STAINO
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline	On successful completion of this module, students should be able to: **LO1**. Formulate and apply predictive models for transportation systems. **LO2.** Critically assess anomaly detection methods for transportation systems. **LO3.** Describe how time-series based models can be used for transport operation and maintenance. **LO4.** Apply special imaging techniques including deep learning for transportation applications such as maintenance and automated driving. **LO5**. Describe and critically assess AI techniques for multi-task learning. **LO6.** Describe industry standard digital tools for rolling stock analysis. **LO7.** Develop interactive tools for decision-making support for transport operation and maintenance. **LO8.** Describe, evaluate and apply signalling principles for railway transportation systems. **LO9.** Develop simulation tools for traffic scheduling and optimization. **LO10.** Formulate and solve problems in traffic management and passenger flow estimation and control. **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Attained To develop continuously - Enhanced To communicate effectively - Enhanced

[1] An Introduction to Module Design from AISHE provides a great deal of information on designing and re-designing modules.
[2] TEP Glossary

Module Content	Global mobility demand is rapidly increasing, and it calls for efficient and sustainable ways to move people and goods. Emerging technologies, digitalisation and advances in computing power have brought new tools and concepts for smart mobility development that will have a significant impact on people's lives and on society in general. This module covers aspects of computational algorithms in general with a focus on Data Science and Artificial Intelligence (AI) techniques applied to transportation systems with some special attention to railway transportation. Focus will be on techniques to approach a variety of topics on predictive systems, visualization tools, data management, image recognition, passenger flow estimation, traffic planning and control. Emphasis will be given to Machine Learning (ML) methods for classification, forecasting and anomaly detection. Due to strong industry connection in delivery, the module will make use of case studies from recent and ongoing research projects.
Teaching and Learning Methods	The module contains a mixture of tutorials and conventional lab sessions where students will be able to seek assistance on their assignments. There will be 22 lecture hours (i.e, 2 lecture hours per week from the start of the semester). The guideline for a 5 ECTS module is for 125 hours of student effort including class hours.

Assessment Details[3]
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Continuous Assessment	mixture of coding-based assignments, preparatory exercises and papers reading	LO1, LO4, LO5,LO7,LO9, L10	30%	3,7,11
Final Examination	2-hour written examination	LO1, LO2, LO3, LO5, LO6, LO7,LO8	70%	N/A

Reassessment Requirements	Final Examination (2 hours, 100%)
Contact Hours and Indicative Student Workload[3]	**Contact hours:** Scheduled hybrid lectures (synchronous online and in-situ f/f) 22 hours, Tutorials (f/f in-situ as appropriate) 22 hours.

[3] TEP Guidelines on Workload and Assessment

	Independent Study (preparation for course and review of materials): Independent student reading/Reflection using asynchronous materials in VLE 40 hours.
	Independent Study (preparation for assessment, incl. completion of assessment): Continuous assessment 26 hours, Summative assessment 15 hours.
Recommended Reading List	• I. Goodfellow, Y. Bengio, A. Courville, "Deep Learning," MIT Press, 2016. • R. A. Brooks, "Elephants don't play chess, " Robotics and Autonomous Systems 6 (1990) • T. Mitchell, "Does Machine Learning Really Work?", AI Magazine Volume 18 Number 3 (1997) • C. Calude, G. Longo, "The Deluge of Spurious Correlations in Big Data, "Foundations of Science 22 (3):595-612 (2016) • A. Y. Ng and M.I. Jordan, "On discriminative vs. generative classifiers: a comparison of logistic regression and naive Bayes, " In Proceedings of the 15th International Conference on Neural Information Processing Systems: Natural and Synthetic (NIPS'01). MIT Press, Cambridge, MA, USA, 841–848 • N. V. Chawla, K. W. Bowyer, L. O.Hall, W. P. Kegelmeyer, "SMOTE: synthetic minority over-sampling technique," Journal of artificial intelligence research, 321-357, 2002 • D. Rumelhart, G, Hinton, G. and R. Williams, "Learning representations by back-propagating errors," Nature, 323, 533–536 (1986). • S. Matzka, "Explainable Artificial Intelligence for Predictive Maintenance Applications," *2020 Third International Conference on Artificial Intelligence for Industries (AI4I)*, Irvine, CA, USA, 2020, pp. 69-74 • Lorenz, E. N. "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set off a Tornado in Texas,". American Association for the Advancement of Science, 1972. • G. Boeing. "Visual Analysis of Nonlinear Dynamical Systems: Chaos, Fractals, Self-Similarity and the Limits of Prediction" *Systems* 4, no. 4: 37, 2016 • C. Frazier, and K.M. Kockelman, "Chaos Theory and Transportation Systems: Instructive Example. Transportation Research Record, *1897*(1), 9-17, 2004
Module Pre-requisite	Introduction to programming, basic probability and statistics
Module Co-requisite	N/A
Module Website	
Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.	

Module Approval Date	
Approved by	
Academic Start Year	
Academic Year of Date	