University of the West of Scotland

School of Computing, Engineering and Physical Sciences

MSc Project Specification

Student name:

Banner ID:

Email:

Project being undertaken on part-time or full-time basis: Full-time basis

MSc Programme/stream: Big Data

MSc Programme Leader:

Project Title:

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| Predictive maintenance on the Turbofan engines (NASA): Regression on the remaining useful life of the engines with Machine Learning and Deep Learning approaches |

Research Question to be answered:

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| How do machine learning and deep learning provide data-driven solutions for predictive maintenance and what are their performances? |

Outline (overview) and overall aim of project:

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| This study will attempt to identify the most efficient techniques in Big Data to answer a predictive maintenance problem applied to turbofan engines. What are the best algorithms and why are they better in predicting the remaining useful life (RUL)?  We can find on the NASA website, data on turbofan engines (simulated with a software). The datasets have different features such as settings values, sensor measurements until failure of the engines. An exploration of the literature will be conducted to guide us to build our own predictive models. The research will also follow the steps of a typical data science project: an examination of the data, finding patterns and visualising the different features, selecting the most adequate algorithms, determining the optimal parameters, and evaluating the performances of our models. |

Objectives (list of tasks to be undertaken to achieve overall aim of the project and to answer the research question posed):

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| To reveal insights and patterns on the functioning of the turbofan engines  To identify the most significant variables that characterize an incoming failure   * We will conduct an exploratory data analysis (EDA) * Statistical analyses will be conducted     To build predictive maintenance system on the turbofan engines   * We will create a pipeline to transform, encode and prepare the raw data for our models * We will create models that predict the remaining useful life of the engines     To summarize the best algorithms that we have created, and their pros and cons.   * We will evaluate the performance of the various algorithms and search in the literature their strengths and weaknesses * We will compare the performance of the algorithms with a chosen metric (mean squared error for instance) |

Relationship of proposed project to MSc programme/stream:

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| This project requires knowledge in Data Science and this fits well with courses taught during the MSc Big Data (Data Mining and Visualisation, Advanced Data Science). It is an opportunity to apply and develop skills that I learnt during the MSc. |

Indicative reading list and resources:

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| Kolokas, N., Vafeiadis, T., Ioannidis, D. and Tzovaras, D. (2018) Forecasting faults of industrial equipment using machine learning classifiers. In: 2018 Innovations in Intelligent Systems and Applications (INISTA). Presented at the 2018 Innovations in Intelligent Systems and Applications (INISTA), pp.1–6.    Li, X., Wei, L. and He, J. (2018) Design and Implementation of Equipment Maintenance Predictive Model Based on Machine Learning. IOP Conference Series: Materials Science and Engineering. Vol.466, p.012001.    Mathew, V., Toby, T., Singh, V., Rao, B. M. and Kumar, M. G. (2017) Prediction of Remaining Useful Lifetime (RUL) of turbofan engine using machine learning. In: 2017 IEEE International Conference on Circuits and Systems (ICCS). Presented at the 2017 IEEE International Conference on Circuits and Systems (ICCS), pp.306–311.    Mode, G. R. and Hoque, K. A. (2020) Adversarial Examples in Deep Learning for Multivariate Time Series Regression. arXiv:2009.11911 [cs, stat]. [Online]. Available: <http://arxiv.org/abs/2009.11911> [Accessed 4 May 2021].    Onanena, R., Chamroukhi, F., Oukhellou, L., Candusso, D., Aknin, P. and Hissel, D. (2009) Estimation of Fuel Cell Lifetime Using Latent Variables in Regression Context. In: 2009 International Conference on Machine Learning and Applications. Presented at the 2009 International Conference on Machine Learning and Applications, pp.632–637.    Pan, Z., Ge, Y., Zhou, Y. C., Huang, J. C., Zheng, Y. L., Zhang, N., Liang, X. X., Gao, P., Zhang, G. Q., Wang, Q. and Shi, S.-B. (2017) Cognitive Acoustic Analytics Service for Internet of Things. In: 2017 IEEE International Conference on Cognitive Computing (ICCC). Presented at the 2017 IEEE International Conference on Cognitive Computing (ICCC), pp.96–103.    Praveenkumar, T., Saimurugan, M., Krishnakumar, P. and Ramachandran, K. I. (2014) Fault Diagnosis of Automobile Gearbox Based on Machine Learning Techniques. Procedia Engineering. Vol.97, pp.2092–2098.    Prytz, R., Nowaczyk, S., Rögnvaldsson, T. and Byttner, S. (2015) Predicting the need for vehicle compressor repairs using maintenance records and logged vehicle data. Engineering Applications of Artificial Intelligence. Vol.41, pp.139–150.    Saxena, A., Goebel, K., Simon, D. and Eklund, N. (2008) Damage propagation modeling for aircraft engine run-to-failure simulation. International Conference on Prognostics and Health Management.    Schöpka, U., Roeder, G., Mattes, A., Schellenberger, M., Pfeffer, M., Pfitzner, L. and Scheibelhofer, P. (2013) Practical aspects of virtual metrology and predictive maintenance model development and optimization. In: ASMC 2013 SEMI Advanced Semiconductor Manufacturing Conference. Presented at the ASMC 2013 SEMI Advanced Semiconductor Manufacturing Conference, pp.180–185. |

Marking scheme:

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| Introduction 5%  Literature review 15%  Explanatory Data Analysis 15%  Pipelines (data pre-processing) 10%  Implementation of Machine Learning / Deep learning models 30%  Evaluation (metric performances and reflection on the academic/theorical underpinning) 10%  Conclusion 5%  Critical self-evaluation 10% |

Supervisor:

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Moderator:

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Programme Leader:

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Date specification submitted:

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Please complete the ‘ethics’ form below for all projects.

**School of Computing, Engineering and Physical Sciences**

**MSc PROJECT – REQUIREMENT FOR ETHICAL APPROVAL**

**SECTION 1: TO BE COMPLETED BY THE STUDENT**

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| **Please answer the following questions:** | Select Yes or No |
| Does your project involve: human subjects, access to unpublished company documents/records, private personal data, questionnaires, surveys, focus groups and/or other interview techniques? | No |
| If your answer above is **Yes**, have you discussed with your supervisor and applied for ethical approval using the university’s Ethical Review Manager online system? | Choose an item. |
| If you haven’t applied for the ethical approval, have you started preparing necessary documents required for the ethical approval, e.g. information sheet, consent form, questionnaires, etc? | Choose an item. |
| I confirm that I will not start the above mentioned project work before obtaining formal ethical approval. | Choose an item. |

**If answering yes** to the first question above, and if you have not done so already, please prepare and submit an application for ethical approval through the university’s “Ethical Review Manager” (ERM) system, which is available at <https://uws.forms.ethicalreviewmanager.com>.

Before doing so, please consult the ERM applicant user guide, which can be downloaded from: <https://www.uws.ac.uk/media/5364/erm-applicant-user-guide.pdf>

The process for making applications and the principles applied in the School of CEPS are contained within the [Ethical Approval Process](file:///C:\Users\66668065\OneDrive%20-%20University%20of%20the%20West%20of%20Scotland\ETHICS\CEPS%20Ethical%20Approval%20Process%202020.docx). Please read this document before making an application for ethical approval.

Please provide any additional information, comments and suggestions:



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**Name of Student (Print name):**

**Signature:**

**Date:**

**SECTION 2: TO BE COMPLETED BY THE PROJECT SUPERVISOR**

I understand that the above project requires/does not require\* ethical approval (\*please delete as appropriate).

**Supervisor (print name):**

**Signature**:

**Date:**

**IMPORTANT: please note that by signing this form all signatories are confirming that any potential ethical issues have been considered and, where necessary, an application for ethical approval has been/will be made via the Ethical Review Manager software.**

**Any project requiring ethical approval but which has not been given approval will not be accepted for marking.**

**Ethical approval cannot be sought in retrospect.**