MEM T380 – Applied Machine Learning in Mechanical Engineering

Project Spring 2023

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Presentations June 8, 2022; Deliverables due June 11, 2022

Students' names & ID:

1. _____ _____
2. _____ _____

Submit your files (`.ipynb`), the presentation and a report (`.pdf`) on Blackboard by due date. Work in groups of two (2) as you did in the mini case studies assignments.

1 Project Case Studies

The following case studies are available for you to choose for your term team project.

1. **P1: - Prediction and Analysis of Tensile Properties of Austenitic Stainless Steel Using Artificial Neural Network**, by Wang, Y.; Wu, X.; Li, X.; Xie, Z.; Liu, R.; Liu, W.; Zhang, Y.; Xu, Y.; Liu, C., Metals 2020, 10, 234. `https://doi.org/10.3390/met10020234`.
   Note: this is a supervised regression problem solved with artificial neural networks. Do the same!

2. **P5: - Weld defect classification in radiographic images using unified deep neural network with multi-level features**, Yang, L., Jiang, H., J Intell Manuf 32, 459–469 (2021). `https://doi.org/10.1007/s10845-020-01581-2`
   Note: this is a supervised multi-class classification problem solved with artificial neural networks. Do the same!

3. **BYOT: -** Bring Your Own Topic. If you have data and you would like to explore them and build machine learning models using the techniques you learned in this course, you are more than welcome to bring them and demonstrate your case study.
   Note: It is required that you used artificial neural networks to model your own project. Other machine learning techniques are welcome, in addition!

2 Data Availability

For the case studies P1 and P5 listed in section 1, the data are available to you in the following format:

1. For **P1: -** the data modeled in the accompanied paper were downloaded from the **Materials Algorithms Project** databases of the University of Cambridge, UK. The link `https://www.phase-trans.msm.cam.ac.uk/map/data/materials/austenitic.data.html` directly leads you to the original dataset and a short explanation of the data. You may navigate the website to find other material's related datasets and build `ML` models of your interest. For your convenience and for the purposes of the term team project, the dataset is available to you through the **Project** post in the **Assignments** tab under the name `P1_STMECH_AUS_SS.xls`.
   `CAUTION:` the data in the excel worksheet `P1_STMECH_AUS_SS.xls` are **NOT** clean! That said, you have to explore the data following the procedure we have learned in class, and in particular through case study assignment 1.

2. For **P5: -** the data are available as electronic supplementary material, through the link `https://doi.org/10.1007/s10845-020-01581-2`. These data have been also available to you for the case study assignments 2A, 2B, 2C.

3 Your Work!

Your Tasks:

1. Replicate the ML modeling, analysis and the results published in the papers!

2. You should follow the general workflow procedure of `ML` modeling, as shown in Fig. 1.

3. You should follow an approach, analysis, exploration, modeling, etc., similar to the mini case studies assignments.

4. Work together as a team!

5. Prepare a short presentation of 15 minutes to present on last day of lectures, June 2nd, 2022.

6. Prepare a report that collects all your data preparation, exploration, feature derivation, model training, model improvement, and final results and discussion.

7. Submit all your files (`python/Jupyter` codes, presentation, `pdf` report), due Sunday June 5th, 2022 (midnight).

8. Enjoy the `ML` adventure!

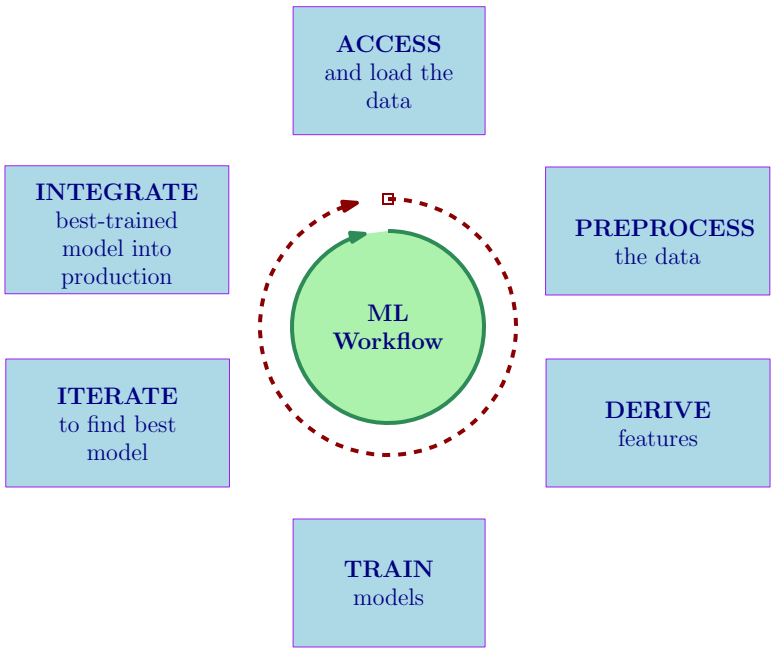

Figure 1: Workflow of `ML` modeling.

4 Evaluation Rubric

The presentation and the final report will be graded based on the following criteria:

- Explain the background information: What is the application domain or field of research? Why is the problem important? What specific questions will you try to answer?
- Talk about what datasets, including the numbers of samples, features, and response variables. Include illustrations as in lectures and homework assignments.
- Explain the `ML` methods you are planning to use and why.
- The presentation should be clear and understandable, describing everything you think is important about your project (motivation, description, techniques, results, etc.).
- Conduct all necessary numerical experiments (split the data into training/validation/test sets); make comparative result tables using validation or cross-validation; use the test sets only for final assessment; add graphs and other good means of visualization; provide sound explanations.
- Replicate the analysis and results of the accompanying research paper as close as possible!
- Do not just print figures without explaining what you are displaying!
- Interpret the data and express with your words the story they want to tell you.

Good luck!