AI in healthcare - Final projects

The goal of the project is to provide an opportunity to gain in-depth experience developing an AI-based approach to a healthcare problem. The project should be done in small groups (exact number depending on the number of students in the course).

The projects will be based on at least one published scientific article, and the contributions can be diverse:
- either reproducing some of the results on a different dataset, especially if the original dataset in the article is not publicly available (see if a gain in performance is reproducible on several datasets)
- or comparing the proposed method to other approaches or baselines (see for instance if deep learning really improves on
- if the method is not implementable (with strong justification), an experiment with something simpler but close

The evaluation will be a project plan + some code (a github repo with a good documentation to reproduce your work, and a readme to introduce the background) + a group oral presentation

First deliverable: Project plan (15% of the grade)

Your project proposal is due on Friday, January 31. It should be a 1-1.5 page document excluding references and figures, using the NeurIPS template. The proposal should include the following (with grade breakdown):

- Title, Authors(s)
- (25%) What is the problem that you will be investigating? Explain the task thoroughly. Why is it interesting?
- (25%) What is the data you will be using? Please include relevant characteristics such as the source of the data, the size of the dataset, and a sample of the data. Explain clearly which parts of the data will be used as well as potential obstacles.
- (25%) What methods do you plan to experiment with? Please thoroughly describe them. If there are existing related implementations, will you use them and how? How do you plan to improve or modify such implementations? This can be subject to change, but you should have a general sense of how you plan to approach the problem you are working on.

- (25%) How will you evaluate your results? Qualitatively, what kind of results do you expect (e.g. plots or figures)? Quantitatively, what kind of analysis will you use to evaluate and/or compare your results (e.g. what performance metrics or statistical tests)? What is your hypothesis regarding your results compared to baselines?

Submission: TBA

Second deliverable: Project progress report (15% of the grade)

Your project progress report is due on Friday, February 28. It should be a 2-2.5 page document excluding references and figures, using the NeurIPS template, with the same sections as the project proposal, indicating your progress on each of those topics, some changes in the plan that you have to make, and why.

Third deliverable: Project repository and final presentation (70% of the grade)

Presentation length will be determined depending on the number of students.
Final reporting and presentation should highlight

- Title, Authors(s)
- Abstract. A paragraph overview of the problem, approach, contribution, and key results.
- (15%) Introduction. Introduce your problem, and the landscape for why the problem is interesting and what has been done before in this space. Describe your overall plan for approaching the problem, why this is an interesting contribution in the context of the described landscape, and a summary of your results.
- (15%) Related Work. Describe in detail existing work related to your problem, how they are related to each other, and how your work relates to these. We expect this to be comprehensive and thorough and with at least 10 citations discussed and cited accordingly.

- (15%) Data. Describe in detail the data that you are using, including the source(s) of the data, relevant statistics, and qualitative examples if appropriate.
- (20%) Approach. Describe in detail the methods that you use in your approach. Importantly, through this section and the experiments section (which may include implementation details), there should be sufficient information for others to reproduce your results.
- (25%) Experiments. Describe experiments that you performed to support your approach and contribution. The exact experiments may vary depending on the project, but we will be looking for the thoughtfulness of your analysis. Examples may include performing comparison of your main approach with other baselines or methods, error analyses to investigate the performance of the model, ablation studies to determine the impact of various components of the approach, analyses to provide insight into the effect of different hyperparameter choices, techniques to interpret how the model is working, etc. You should include graphs, tables, or other figures to illustrate the experimental results.
- (5%) Conclusion. Summarize the key results, what has been learned, and avenues for future work.
- (5%) Writing/Formatting. Your paper should be clearly written and nicely formatted, comparable to published NeurIPS papers.
- Contributions. Specify the contributions of each author on the paper. This includes discussion, implementation, and writing for each part of the paper. You should also describe the contributions of any contributors not enrolled in the course (see Additional Submission Requirements below). For an example of appropriate format, please see the author contributions for AlphaGo (Nature, 2016).

Some relevant resources to help you select a project

general dataset sources + health open datasets (EHRs)

- https://archive.ics.uci.edu/datasets
- https://www.physionet.org/

- https://www.kaggle.com/datasets?topic=healthDataset
- MIMIC (Medical Information Mart in Intensive Care) https://mimic.mit.edu/
- eICU https://eicu-crd.mit.edu/
- AMDS https://doi.org/10.17026/dans-22u-f8vd
- https://hirid.intensivecare.ai/ (available from physionet)
- https://www.hmhospitales.com/prensa/notas-de-prensa/comunicado-covid-data-save-lives
- https://landing.sanitasweb.es/data/opendatacovid/english.html
- a very extensive list of datasets https://github.com/beamandrew/medical-data

Interesting projects (will be updated)

- https://github.com/mims-harvard/Clinical-knowledge-embeddings
- https://arxiv.org/pdf/2408.12980
- Barda, N., Yona, G., Rothblum, G. N., Greenland, P., Leibowitz, M., Balicer, R., ... & Dagan, N. (2021). Addressing bias in prediction models by improving subpopulation calibration. *Journal of the American Medical Informatics Association*, *28*(3), 549-558.
- Caruana, R., Lou, Y., Gehrke, J., Koch, P., Sturm, M., & Elhadad, N. (2015, August). Intelligible models for healthcare: Predicting pneumonia risk and hospital 30-day readmission. In *Proceedings of the 21th ACM SIGKDD international conference on knowledge discovery and data mining* (pp. 1721-1730).
- Razavian, N., Blecker, S., Schmidt, A. M., Smith-McLallen, A., Nigam, S., & Sontag, D. (2015). Population-level prediction of type 2 diabetes from claims data and analysis of risk factors. *Big Data*, *3*(4), 277-287.
- some ideas from a similar course at MIT https://ocw.mit.edu/courses/6-s897-machine-learning-for-healthcare-spring-2019/pages/projects/final-project-suggestions/