AI for Medicine

Proponents
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Format
5 classes, 4h each (2.5h theory + 1.5 practice)

Target
BSc, MSc and (possibly) PhD students in Computer Science/Computer
Engineering/Bioengineering. Medical students, lecturers, instructors and professionals can also gain
basic knowledge about the application of AI in Medicine.

Recommended background knowledge
Linear algebra
Probability and basic statistics
Calculus

Objectives

This course aims at providing the basics of Artificial Intelligence for biomedical applications.
Students will learn machine and deep learning methods and how to set up an experimental
pipeline that guarantees reproducible results. All classes are divided into theory and
practice.

- Slides used in class

Materials Jupyter notebooks in Python (Google Colaboratory platform)
[with standard libraries such as NumPy, SciPy, Scikit-learn, PyTorch/Keras]
- Bibliography

Syllabus

1) Introduction to Artificial Intelligence
   Theory [2.5h]
      a) Examples of AI in medicine and biology
      b) Data driven methods: supervised /unsupervised
      c) Supervised: classification/regression
      d) Shallow learning: regularization methods
      e) Deep learning: artificial neural networks
      f) Experimental design (cross-validation, model selection, over-/underfitting,
         confusion matrix, performance metrics [F1-score, accuracy, precision/recall]; out-
         of-sample, BIC/Akaike, stability)
   Practice [1.5h]
      - bias/variance
      - overfit
2) Machine learning methods for prediction

Theory [2.5h]
- a) Examples of predictive methods for diagnosis or prognosis
    - i) Early detection of disease
    - ii) Disease progression prediction
    - iii) Disease staging
- b) Shallow learning: regularization methods
    - i) RLS
    - ii) SVM
    - iii) RF

Practice [1.5h]
- Dataset on diabetes [https://www.kaggle.com/datasets/mathchi/diabetes-data-set]
- Experimental design for model selection
- Resampling strategies and methods comparison for classification

3) Deep learning methods for prediction
   Theory [2.5h]
   - a) Examples of predictive methods for diagnosis or prognosis
       - i) Early detection of disease
       - ii) Disease progression prediction
       - iii) Disease staging
   - b) Deep learning
       - i) Multilayer perceptron
       - ii) FeedForward NN

   Practice [1.5h]
   - Dataset on diabetes [https://www.kaggle.com/datasets/mathchi/diabetes-data-set]
   - Model dependency on learnable parameter and model stochasticity

4) Applications of AI in medicine
   Medical image prediction [2h]
   - Deep learning (CNN)
   - Skin cancer prediction on ISIC dataset [https://www.kaggle.com/datasets/nodoubttome/skin-cancer9-classesisic]

5) Biomarker identification
   Theory [2.5h]
   - a) Examples of variable selection in medicine
   - b) Case study:
     identification of pathogenic molecular variables
   - c) SVM-RFE
   - d) Lasso

   Practice [1.5h]
   - Variable selection for genomics