University of Wisconsin-Madison | Spring 2022
BMI/CS 776: Advanced Bioinformatics | Project ideas
Prof. Daifeng Wang

Overview

The goals of the class project are to gain experience working on a (small) bioinformatics research problem using real biological data. In order to encourage creativity and ambitious projects, you will not be graded based on whether or not your idea works. Grades will be based on whether your project was completed, thoughtful, executed carefully, and built upon sound computational and biological principles. Contributions to the bioinformatics research community (e.g. releasing your new method as open source software; sharing trained models; or contributing patches, new features, or documentation to existing software) will be viewed favorably.

In contrast to the homework, you are encouraged to use existing software and packages for the project and may use any programming language(s). You are required to reference all data sources, software, and other resources in your project reports. Reusing code, text, or images without proper attribution is unacceptable and will be treated as academic misconduct.

Each student will implement their own project individually. However, multiple students may elect to work on the same topic as long as they work independently. You do not need to run your code on the biostat server, but your project must be reproducible. This means that you must provide the source code and sufficient documentation for running your code.

Types of projects include:

- A computational project where a new algorithm is implemented or an existing algorithm is extended and compared with the original
- Benchmarking projects where multiple computational approaches are run on multiple datasets to assess their relative strengths.
- Applied projects where two or more computational methods are run on a single dataset of interest and the evaluation focuses on the biological interpretation of the results. For such projects you must analyze how your results are affected by using different parameter values for the methods used, whenever possible.
- An extension of your current research, in which you use a dataset that you are already studying but analyze it with new types of computational methods. *The project should not be something that you were already planning to do as part of your research.*

A handful of specific ideas

- Implement a solution to a closed DREAM challenge http://dreamchallenges.org/project-list/closed/ Be sure to only use the training data when building your model, and choose a challenge for which the test set is already available so that you can evaluate your performance. Avoid reimplementing methods that have already been described in the challenge summary papers.
- Participate in a current CAMDA Contest Challenge http://contest.camda.info/
- Participate in the current Critical Assessment of Metagenome Interpretation (CAMI) challenge https://data.cami-challenge.org/cami2
- Develop a method for inferring the cell type composition of a tissue sample given RNA-seq data or other omic data

  - Benchmarking single cell deconvolution: https://www.biorxiv.org/content/10.1101/2020.01.10.897116v1.full
- ENCODE Imputation Challenge is to empirically compare methods for imputing data produced by various types of genomics assays: https://www.synapse.org/#!Synapse:syn17083203/wiki/587192
- Benchmark single-cell RNA-Seq trajectory inference algorithms, building upon the tools and assessments described in https://doi.org/10.1101/276907
- Run multiple network algorithms to predict pathways from genome-wide datasets and compare the results. Potential network algorithms include:
  - ResponseNet, which we will learn in class
  - Forest from Omics Integrator https://github.com/fraenkel-lab/OmicsIntegrator
  - PathLinker https://github.com/Murali-group/PathLinker
  - TieDIE https://github.com/epaull/TieDIE
- Benchmark multiple algorithms for reconstructing cell-type specific gene regulatory networks.
  - BEELINE: https://github.com/Murali-group/Beeline

Ideas from previous semesters

- BMI/CS 776 Spring 2015 project ideas https://www.biostat.wisc.edu/bmi776/spring-15/project.html
- BMI/CS 776 Spring 2016 project ideas https://www.biostat.wisc.edu/bmi776/spring-16/project_ideas.pdf
- BMI/CS 776 Spring 2017 project ideas https://www.biostat.wisc.edu/bmi776/spring-17/project_ideas.pdf
- BMI/CS 776 Spring 2018 project ideas https://www.biostat.wisc.edu/bmi776/spring-18/project_ideas.pdf
- BMI/CS 776 Spring 2019 project ideas https://www.biostat.wisc.edu/bmi776/spring-19/project_ideas.pdf
- BMI/CS 776 Spring 2020 project ideas https://www.biostat.wisc.edu/bmi776/spring-20/project_ideas.pdf
- BMI/CS 776 Spring 2021 project ideas https://www.biostat.wisc.edu/bmi776/spring-21/project_ideas.pdf