02-740 Bioimage Informatics (12 Units)

Fall 2019

Instructor

Min Xu, Ph.D.

Assistant Research Professor, Computational Biology Department

Instructor Contact Information

- Email – mxu1@cs.cmu.edu

- Preferred communication approach is by email. Please include CBD-02-740 in the subject.

Instructor Office Hour & Location

- Wednesday after class, 6:00 - 7:00. 7709 Gates Hillman Complex

Pre-requisite or Co-requisite

- Image processing: Background in computer vision and/or medical image analysis is helpful but not essential.

- Proficiency in programming: Basic familiarity with Python.

Class Times & Locations

- Monday & Wednesday, 4:30AM - 5:50PM, Newell-Simon Hall (NSH) 3002

Class Website

- CMU Canvas 02-740

Teaching Assistant and Contact Information:

Xiangrui Zeng

Email: xiangruz@andrew.cmu.edu

Office: 7409 Gates Hillman Complex

Directions: http://www.cbi.cmu.edu/contact/directions/index.html

Office hour: TBD.

Course description & objectives

With the rapid advance of bioimaging techniques and fast accumulation of bioimage data, computational bioimage analysis and modeling are playing an increasingly important role in understanding of complex biological systems. The goals of this course are to provide students with the ability to understand a broad set of

practical and cutting-edge computational techniques to extract knowledge from bioimages. Such techniques include image filtering, image feature detection, image classification, image segmentation, object detection, object tracking, image retrieval, image mining and image modeling using both traditional and deep learning methods. Upon successful completion of this course, the student will be able to:

- Explain the importance of and understand the principles and uses of both geometrical and machine learning-based bioimage analysis techniques;

- Understand how these techniques can be combined for various applications;

- Develop code to implement basic techniques;

- Solve specific bioimage analysis tasks using image-processing libraries.

Required Textbook(s)

None.

Recommended References

TBD

Classroom Policy

- Lectures will start on time. If you are late, you should enter the class without causing disruptions.

- Use of cell phones during class is prohibited.

Academic Integrity

- University regulations will be followed. See http://www.studentaffairs.cmu.edu/acad_integ/acad_integ_text.html

Programming and Project Assignments:

- Instructions for programming and project assignments will be posted online.

- Completed project assignments must be submitted before the deadline. Late assignments will not be accepted. Exception will only be considered on a case-by-case basis by the instructor.

Grading*

Assignment (3 in total) 30%

Midterm tests (2 in total) 30%

Final project (1 in total) 40%

Total 100%

- The instructor reserves the rights to make small adjustments to the percentage scores.

List of topics

Note: For reference only. Adjustments are likely as the class proceeds.

Lecture	**Topics**
Lecture 1	Introduction
Lecture 2	Fundamentals of light and electron microscopy
Lecture 3	(labor day)
Lecture 4	Image basic operations, filtering, kernel method
Lecture 5	Overview of image databases, processing and segmentation
Lecture 6	Introduction to computer cluster
Lecture 7	Python programming tools for image analysis
Lecture 8	Point feature detection
Lecture 9	Edge, line and curve detection
Lecture 10	Bioimage classification: geometrical methods
Lecture 11	Introduction to deep learning
Lecture 12	Bioimage classification: deep learning methods
Lecture 13	Midterm 1
Lecture 14	Bioimage dimension reduction and clustering
Lecture 15	Bioimage segmentation: geometrical methods
Lecture 16	Bioimage segmentation: deep learning methods
Lecture 17	Object detection in bioimages
Lecture 18	Object tracking in bioimages
Lecture 19	Bioimage registration
Lecture 20	Special machine learning techniques
Lecture 21	Generative models for bioimage synthetics and understanding
Lecture 22	Bioimage informatics: database, retrieval, data mining, distributed computation

Lecture 23	Midterm 2
Lecture 24	(Final project)
Lecture 25	(Final project)
Lecture 26	(Final project)
Lecture 27	(Final project)
Lecture 28	(Final project)
Lecture 29	Project presentation