COMPUTATIONAL SYSTEMS BIOLOGY

(MCP, 2 credits, Graded)

Course Directors: Christian Hong, Ph.D. and Tongli Zhang, Ph.D.

TA: Richard Ballweg

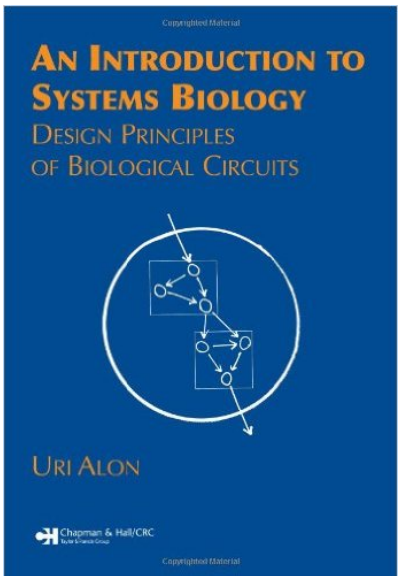
Time and location: Spring 2019, Friday afternoons 1-3 pm, MSB E161.

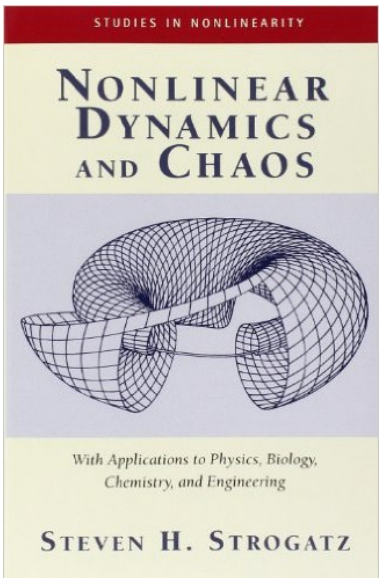
- *Class begins January 18, 2019 and ends on April 26, 2019.*

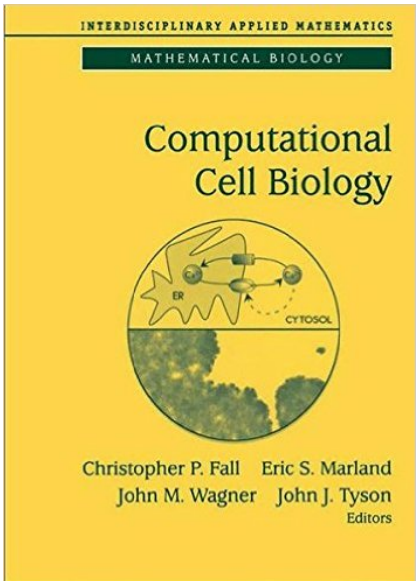
Prerequisites: though there is no hard- prerequisites, students with biological background are encouraged to take courses on differential equations and mathematical modeling (e.g. *MATH2073, MATH2074, MATH3006/MATH9062*); students with mathematical background are encouraged to take a course of molecular and cellular biology (*GNTD7001*) or a course of human physiology (*MCP7000*).

Recommended textbooks:

- *An Introduction to Systems Biology: Design Principles of Biological Circuits- by Uri Alon*
- *Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering - by Steven H. Strogatz*
- *Computational Cell Biology- by Christopher P. Fall (Editor), Eric S. Marland (Editor), John M. Wagner (Editor), John J. Tyson (Editor)*







Course Description:

Computational modeling is an emerging tool for biological research. In this course, students will learn how this tool could be used to help biological research. By the end of the course, the students are expected to gain insights on when and how to apply the modeling tool to help with their ongoing projects.

This course will provide the students an opportunity to learn different tools of systems biology by reading and presenting published papers in the field. Also, the students are to gain some hands-on experience by reproducing some figures that are published in these papers.

Student Learning Objectives

Students in this course will:

a) Learn a global picture of how computational modeling could help with biological research
b) Obtain hands-on experience in model simulation and analysis by reproducing some figures
c) Gain some knowledge to make an informed decision on whether he/she should bring in mathematical modeling approaches to his/her own research
d) A core set of technical skills to implement differential equation based mathematical models

Grading:

Home work (0-50): Students will be able to collect these points from implementing modeling figures from an introductory paper (Sniffers, buzzers, toggles and blinkers: dynamics of regulatory and signaling pathways in the cell. Curr Opin Cell Biol. 2003 Apr;15(2):221-31.) the other review, Network motifs: theory and experimental approaches. By Alon U. can also be used for collecting points. 5 points for each figure. PPT, doc or pdf summary, with simulated figures and the original codes.

Presentation (0-20): In addition, the students will be able to collect points by presenting a logical story on a chosen paper (20 points in total).

Final examination (0-30): in the final exam, the students need to reproduce figures from two publications chosen by the instructors.

A: 90-100 points
B+: 85-90 points
B: 75-85 points
C+: 70-75 points
C: 60-70 points
D+: 55-60 points
D: 50-55 points
F: < 50 points

Period one: preparation period		
Week 1, Jan 18	Why modeling – Dr. Christian Hong and Dr. Tongli Zhang	Introduction to the basis of mathematical modeling and its application in biology; selection of papers; install XPP and AUTO
Week 2, Jan 25	Basics of mathematical modeling – Dr. Christian Hong	Introduce the basic principles of how models can be constructed; go through tutorials for XPP and AUTO; start to make figures from the review paper
Week 3, Feb 1	Basics of mathematical modeling – Dr. Christian Hong	Introduce the basic principles of how models can be constructed; go through tutorials for XPP and AUTO; start to make figures from the review paper
Week 4, Feb 8	Basic theories of mathematical modeling – Dr. Sookkyung Lim	Introduce basic theories of math modeling
Period two: Hand on experience on modeling		
Week 5, Feb 15	Modeling of segmentation clock – Dr. Ertugrul Ozbudak	Introduce how modeling has been used to study segmentation clock
Week 6, Feb 22	Dr. Hang Kim	TBD
Week 7, Mar 1	Dr. Emily Miraldy	TBD
Week 8, Mar 8	Integration of modeling and machine learning – Dr. Tongli Zhang	Illustrate how modeling and machine learning are integrated to study stem cell differentiation
Period three: presentation by students and guest lecturers		
Week 9, Mar 15	Dr. Yanyu Xiao	TBD
Week 10, Mar 22	Spring Break	
Week 11, Mar 29	Dr. Yan Yu	TBD
Week 12, Apr 5	Student presentation	
Week 13, Apr 12	Student presentation	
Period three: evaluation state		
Week14, Apr 19	Student presentation	
Week 15 Apr 26	Final Exam	

Note: two student presentations each week; this will give sufficient time for questions and discussions.