NIMBioS-MBI-CAMBAM 2017 Summer Graduate Program:
Connecting Biological Data with Math Models
June 19-23, 2017
All Sessions are in Rooms 205 and 206, NIMBioS

Monday

8:00	Meet Eric Carr for software assistance if needed, NIMBioS 105
8:30	Breakfast in Breakroom near 105
9:00-9:30	Introductions and Discussion about Computer Software Issues
9:30-10:30	Ariel Cintron-Arias, Ordinary Least Squares (OLS) Estimation for a Logistic Model
10:30	Break
10:50-12:00	Computer session lead by Cintron-Arias (help from Nourridine Siewe and Christina Edholm)
12:00-1:10	Lunch
1:15-2:15	Ariel Cintron-Arias, OLS Estimation for a Single-Outbreak SIR Model
2:15	Break
2:30 -3:45	Computer session led by Cintron-Arias (help from Sarah Flanagan and Siewe)
3:50 -5:00	Nina Fefferman, Network Analysis: Structure: Centralities and Communities

Tuesday

8:30	Breakfast in Breakroom near 105
9:00-10:10	Ben Bolker, Introduction to Parameter Estimation for Nonlinear Stochastic Dynamical Models
10:10	Break
10:30-11:30	Ben Bolker, continued
11:30-12:40	Lunch
12:50-2:35	Computer session led by Bolker (help from Flanagan and Eric Carr)
2:35	Break
3:00-5:00	Discussion sessions for feedback on students' work, Bolker, Cintron-Arias, Marino(Break into three groups)
5:00	Reception in Breakroom

Wednesday

8:30	Reception in Breakroom
9:00-10:10	Simeone Marino, Uncertainty and Sensitivity (US) Analysis: Latin Hypercube Sampling (LHS) and Partial Rank Correlation Coefficient (PRCC)
10:10	Break
10:30-11:30	Marino, continuing with deterministic and stochastic models, immunology and infectious diseases
11:30-12:40	Lunch
12:50 -2:30	Computer session led by Marino(help from Christina Edholm and Oyita Udiani) Matlab code to perform US analysis on your models
2:30	Break
3:00-4:15	Fefferman, Introduction to Evolutionary Game Theory
4:15-4:45	Group photo and check that travel paperwork has been processed

Thursday

8:30	Reception in Breakroom
9:00-10:10	Joe Tien, Using Dynamical Systems Theory in Model Selection and Fitting
10:10	Break
10:30-11:30	Joe Tien, continued
11:30-12:40	Lunch
12:50-2:30	Computer session led by Tien (help from Udiani and Cintron-Arias)
2:30	Break
3:00-5:00	Discussion sessions for feedback on students' work, Eisenberg, Tien, Cintron-Arias (Break into three groups)

Friday

9:00-10:10	Marissa Eisenberg, Introduction to Identifiability Issues and Methods for Dynamic Models
10:10	Break
10:30-11:45	Computer session led by Eisenberg (help from Siewe and Cintron-Arias)
11:50	Closing remarks
Noon	Lunch

More details

Ariel Cintron-Arias, Ordinary Least Squares (OLS) Estimation for a Logistic Model
(1) OLS estimation for the logistic model
- Point estimates: by local & gradient-based optimization, OPTIM(); by global optimization, GA();
- Bootstrap sampling to compute mean estimates and standard errors.

(2) OLS estimation for the single outbreak SIR model:
- Mean estimates and standard errors using bootstrap sampling
- Forward sensitivity equations: absolute (traditional) sensitivity functions; relative sensitivity functions (e.g., elasticity)

(3*) OLS estimation for a Leslie matrix model
- Point estimates
- Elasticity matrix
- Exponential growth versus decay

* - denotes optional content.

Ben Bolker, Introduction to Parameter Estimation for Nonlinear Stochastic Dynamical Models
 Hour 1:
- Overview of stochastic models
- Process vs observation error
- Trajectory-matching - gradient-matching

 Hour 2:
- Overview of Bayesian inference
- MCMC
- Fitting discrete-time dynamical models with MCMC

Simeone Marino, Uncertainty and Sensitivity (US) Analysis: Latin Hypercube Sampling (LHS) and Partial Rank Correlation Coefficient (PRCC)
- Uncertainty and sensitivity (US) analysis
  - Definitions, examples, recipes, etc.

Review US analysis techniques in the context of deterministic (ODE, DDE) and stochastic dynamical models (ABM or Agent-based models). The context will be immunology and infectious disease.

Matlab code to perform US analysis on your models.

Throughout the session, I will constantly go back and forth between the "theory" and the implementation (i.e., Matlabscripts).

The main reference is my 2008 paper on Uncertainty and Sensitivity Analysis (**paper is in basecamp**). I will actually use the example shown in the paper. The students should go through it before the Wed session, if possible. I will post some material (Matlabscripts) later next week. There's a link on the paper for downloading US Analysis scripts in Matlab.

Joe Tien
Lecture 1: Using Dynamical Systems Theory in Model Selection and Fitting – Fixed Points.
- Fixed points and linearization
- Some examples from epidemiology:
  - Incidence, prevalence, and relationships between them
  - An example: infection-derived immunity, SIS vs. SIR
  - Exponential growth, generation interval and R_0
- Fast-slow systems and model comparison (time permitting)

Lecture 2: Using Dynamical Systems Theory in Model Selection and Fitting -- Periodic Orbits.
- Challenges in fitting oscillations
- Poincare maps and shooting algorithms.
- Geometry and estimation -- fitting in the space of periodic orbits (R. Casey)
- Some examples from neuroscience: spiking
- Fast-slow systems and fitting bursting periodic orbits (time permitting)