# 2011 CMACS Workshop on Modeling Biological Systems

Ezio Bartucci, Flavio Fenton,
Radu Grosu, Nancy Griffeth, Terri
Grosso-Applewhite, Scott Smolka

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# Workshop schedule

- Three weeks (most of January) each year
- Rotate two workshops:

| Theme | Year |
|---|---|
| 1. **Signaling Pathways in Pancreatic Cancer** | Jan 6 – Jan 26, 2010 Faeder, Langmead |
| 2. **Fibrillation Onset in Cardiac Tissue** | Jan 3 – Jan 21, 2011 Flavio Fenton, Radu Grosu, Scott Smolka |
| 3. **Signaling Pathways in Pancreatic Cancer** | Winter 2012 Pitt/CMU/NYU |
| 4. **Fibrillation Onset in Cardiac Tissue** | Winter 2013 Stony Brook |

# Workshop Objectives

- Get students excited about the research problems and the use of our modeling techniques

- Begin training students to use our tools and techniques

- Find good prospects for REU, internship, and graduate programs

- Encourage under-represented minorities to enter STEM fields

- Encourage inter-disciplinary work

# 2010 Workshop Outcomes

- 15 students attended (6 women, 4 minority)
- 2 students spent summer in Pittsburgh
- 2 papers
- Student status (out of 9 responses):
  - Summer internships 3
  - Research projects 5
  - Graduate school 7
  - Teaching job 1

# 2011 Workshop Status

- Workshop content planned

- Pre-workshop tutorial materials
    - Biology tutorial drafted
    - Math tutorial planned

- Two weeks of exercises planned
    - Only 1 exercise set "tested"
    - Third week still in planning stage
    - Need to test remaining exercises

- Hardware ~~availability uncertain~~ through NYU, courtesy of Bud

# 2011 Workshop Status

- Workshop staff arranged:
  - Two PhD students (Terri Grosso, Kai Zhao)
  - Two master's students (Fred Dieckamp, Joshua Rogers)
- 18 applicants on Oct 29 (Nov 1 deadline)
  - Decisions by Nov 8
  - Evenly divided among Lehman, Hunter, Brooklyn, Queens

# 2011 Workshop Content

- Students should learn:
  - Biological concepts
    - Action potentials, cell cables, spiral and scroll waves
  - Important models
    - Hodgkin-Huxley, Morris-Lecar, Fitzhugh-Nagumo, Fenton 3/4V model

# 2011 Workshop Content

- **Analytical techniques**
  - Phase plane analysis, restitution analysis, curvature analysis
- **Simulation**
  - CUDA architecture for using GPUs

# 2011 Workshop Outline

- Part 1: Biology of atrial fibrillation (Flavio)
  - Action potentials and models
  - Cable models
  - Flavio's models
  - Exercises: HHSim

# 2011 Workshop Outline

- Part 2: Analysis
  - Phase Plane Analysis
  - Restitution analysis
  - Exercises: Ermentrout, Bartocci

# 2011 Workshop Outline

- **Part 3: Simulation (Ezio Bartocci)**
  - CUDA processors
  - Simulation problems
  - Cell cable model
    - Start with 1D
    - Extend to 2D
  - Use uniprocessors first, then CUDA emulator, then NYU machine

# Initial Exercises

- Use Hodgkin-Huxley simulator exercises
  - Computing equilibrium potentials
  - Analysing behavior of action potentials
- Phase Plane Analysis of Morris-Lecar from Ermentrout

# CMACS HHSim

# Simulation

- Use CUDA on NVidia processors to build or improve simulations

# Resources

- Thevirtualheart.org
- Flavio's recent tutorial
- Ermentrout's new book
- Hodgkin-Huxley simulator
- Other Web sites:
  - Berkeley
  - CMU

# Challenges and Issues

- Problems that will be interesting and accessible to undergraduates
  - Requirement: do-able problems
  - Test: I can do them
- Attracting the "right" kind of student
  - Smart, hard-working
  - Inquisitive, willing to take risks
  - Able to work as part of a team

# Curriculum

- New course on "Modeling and Simulation of Biological Systems" to be offered in the spring at Lehman

- New minor in "Quantitative and Systems Biology" will be proposed in the spring