CMACS
Computational Modeling and Analysis for Complex Systems

\Workshops on Computational Modeling of Complex Systems

Flavio Fenton and Nancy Griffeth

March 28, 2011

Workshop Objectives

- Disseminate project work among promising students
- Encourage enthusiasm for research and modeling complex systems
- Find good prospects for REU and graduate programs
- Encourage under-represented minorities to enter STEM fields
- Encourage inter-disciplinary work
- Develop course materials

Outline

- Recruiting and Admission: Nancy
- 2011 Workshop on Atrial Fibrillation
  - Week 1: Flavio
  - Weeks 2-3 and Evaluation: Nancy
- Student Results and Paper: Flavio
- 2012 Workshop on Cellular Signaling Pathways

2011 Workshop: Recruiting and Admission

- Target Colleges: Lehman, Hunter, Brooklyn, Queens, CCNY
- Applicants:

	2010		2011	
	Applied	Admitted	Applied	Admitted
Brooklyn	5	4	4	2
Hunter	8	4	6	6
Lehman	11	6	6	4
Queens	0	0	4	3
Stony Brook	1	1		
Total	25	15	20	15

2011 Workshop: Student Characteristics

Ethnicity	Number	Major	Number
African-American	3	Math	6
Woman	5	Bio	4
Hispanic	3	CS	7

Workshop Attendees

Workshop Outline

- Biology background: Week 1 (Flavio Fenton, Rupinder Singh)
- Mathematical and Programming background: Week 2
- Student Project: Week 3

Week 2

- Mathematical preliminaries
  - Modeling exercise and differential equations – Terri Grosso
  - Numerical Integration – Kai Zhao
  - Introduction to CUDA – Joshua Rogers
  - The 4V Model and Code – Ezio Bartocci

Week 3

- Students worked in 5 groups (same as week 2)
- Flavio assigned parameters to each group
- Using Ezio's code on various CUDA machines*, students generated data
- Flavio reviewed the work via Skype

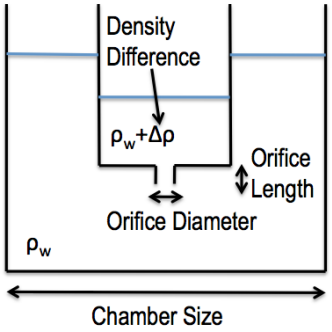
*Thanks to Brian Murphy and NVIDIA

Week 1

- Complex Systems and Biological Background
  - CMACS and its goals
  - Chaos and complex systems
  - Experimental exercises with oscillators
  - Relation between oscillators and cardiac cells
  - Mathematical modeling of cardiac cells
  - Cardiac arrhythmias and its study by computer simulations

Week 1

- Saline Oscillator



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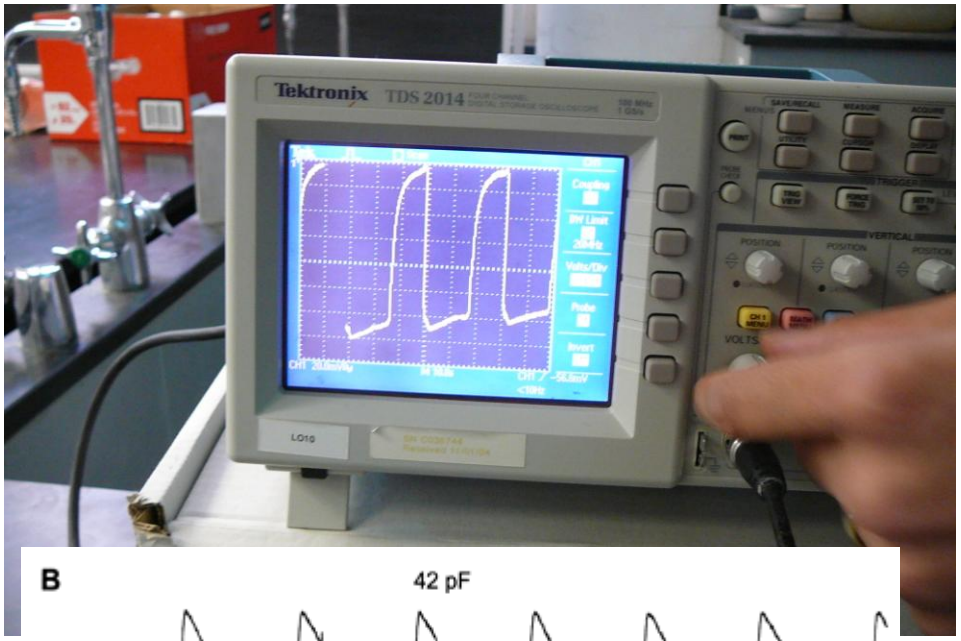

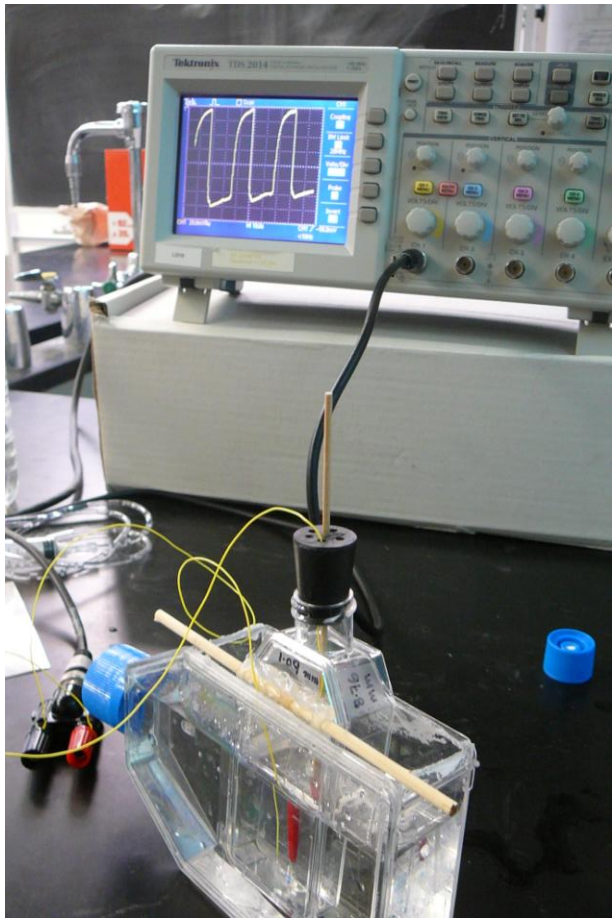

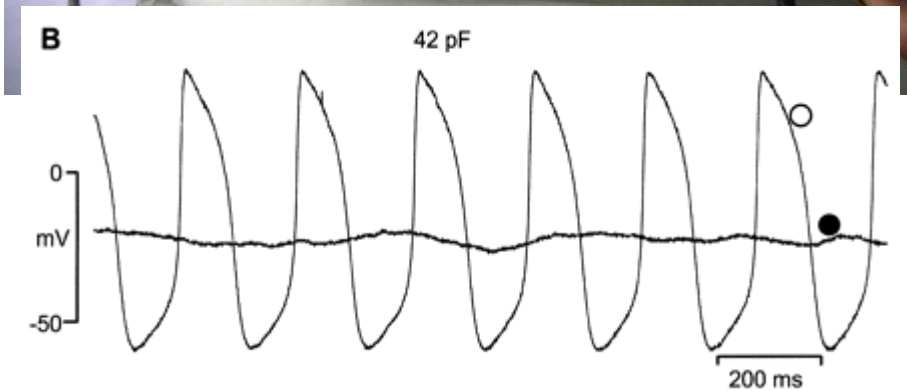

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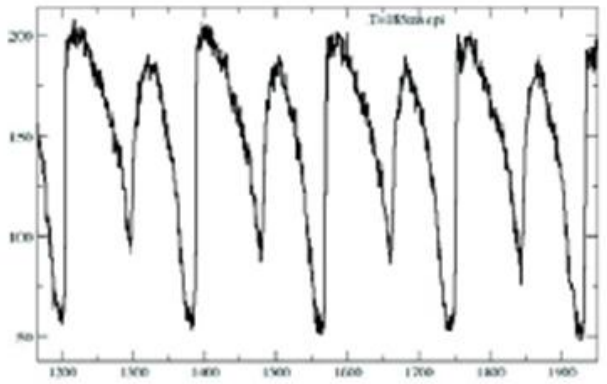

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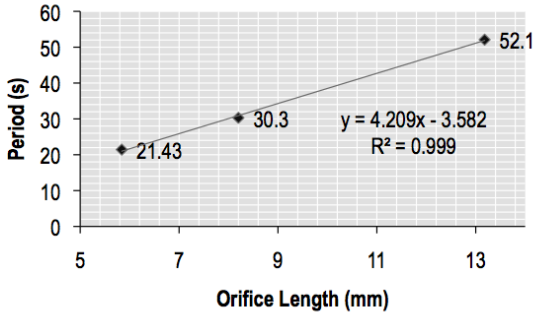
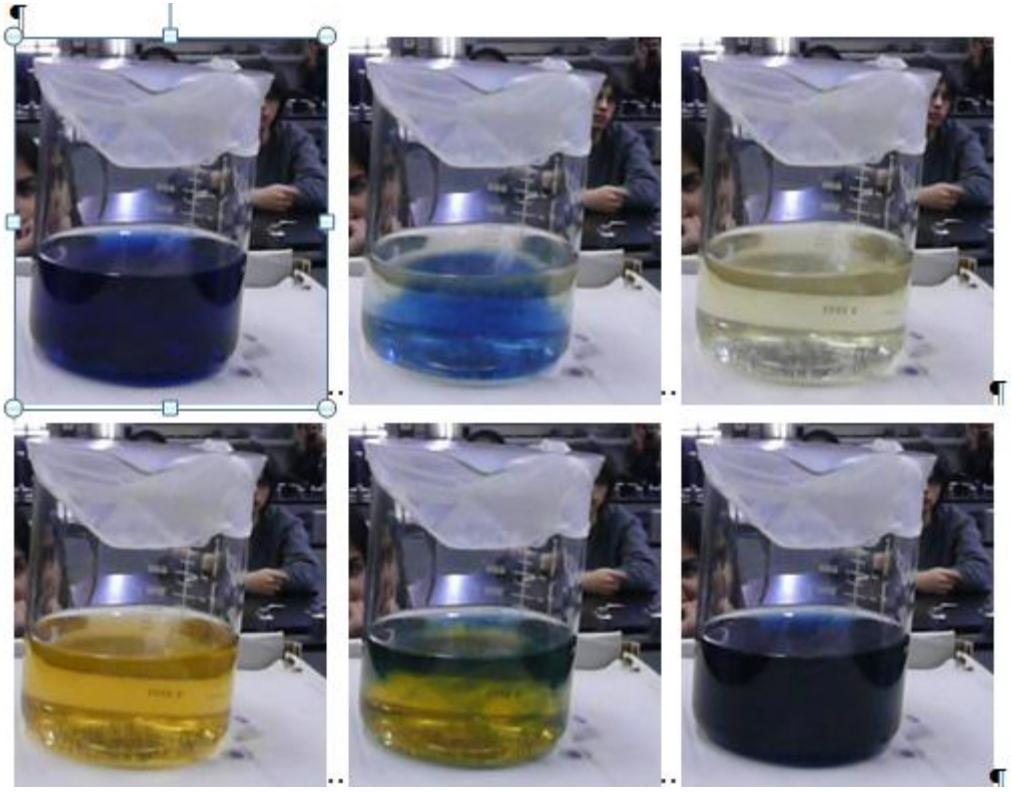


Week 1

- Chemical Oscillators

  Briggs-Rauscher and Belousov-Zhabotinsky



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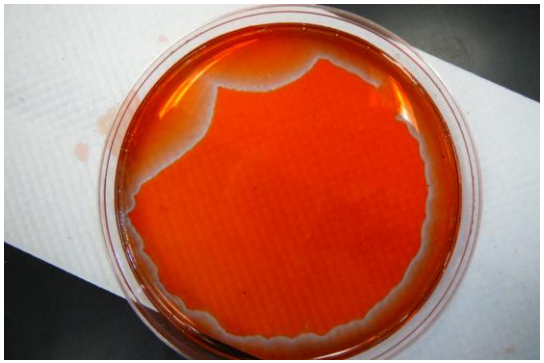
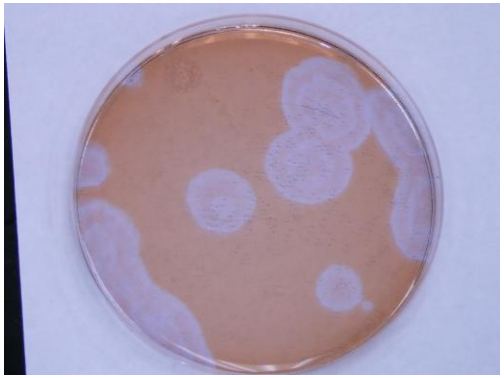
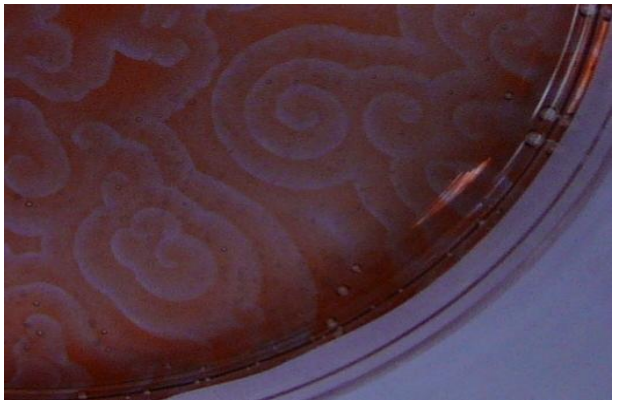
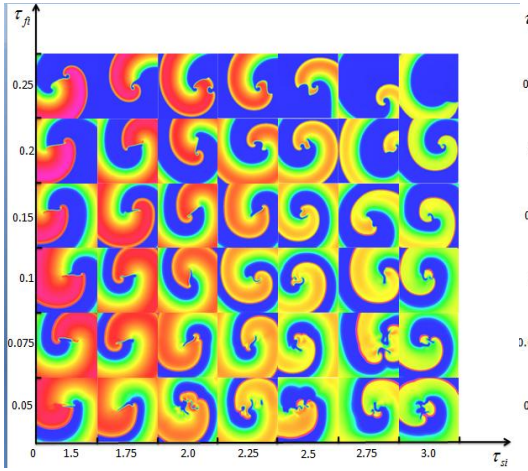
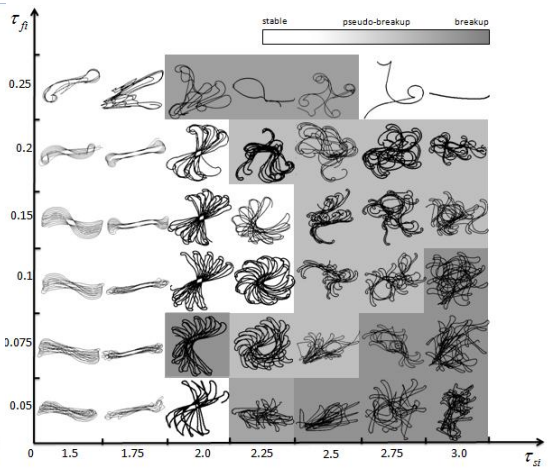


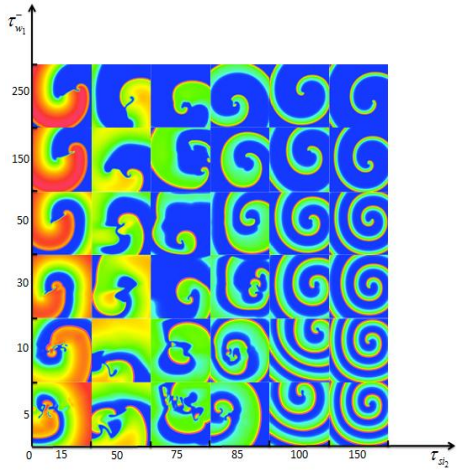


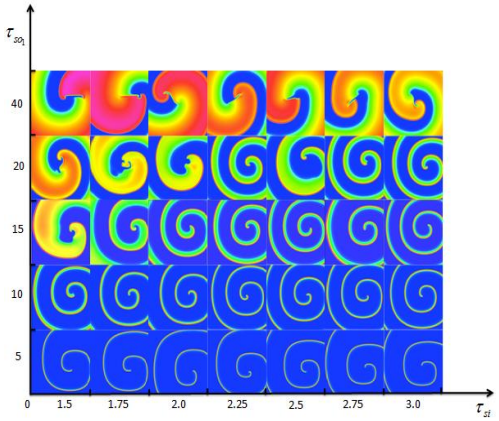


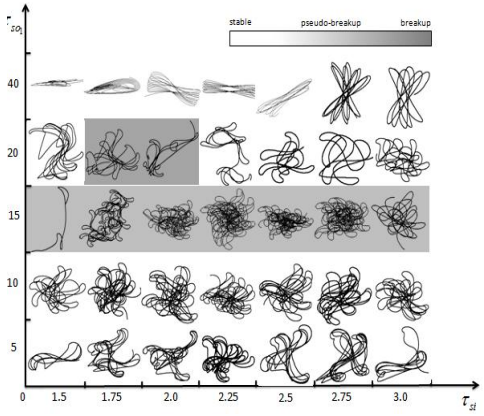
Students Results

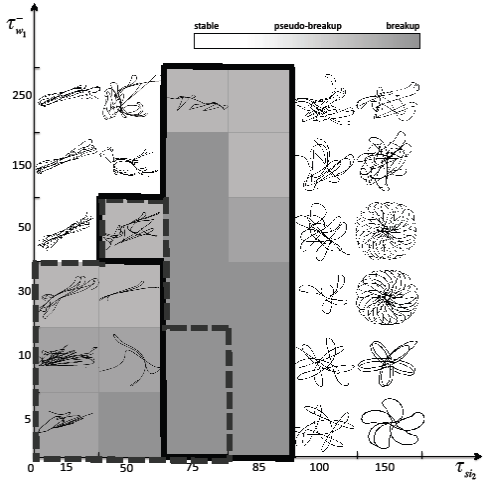












Students Results

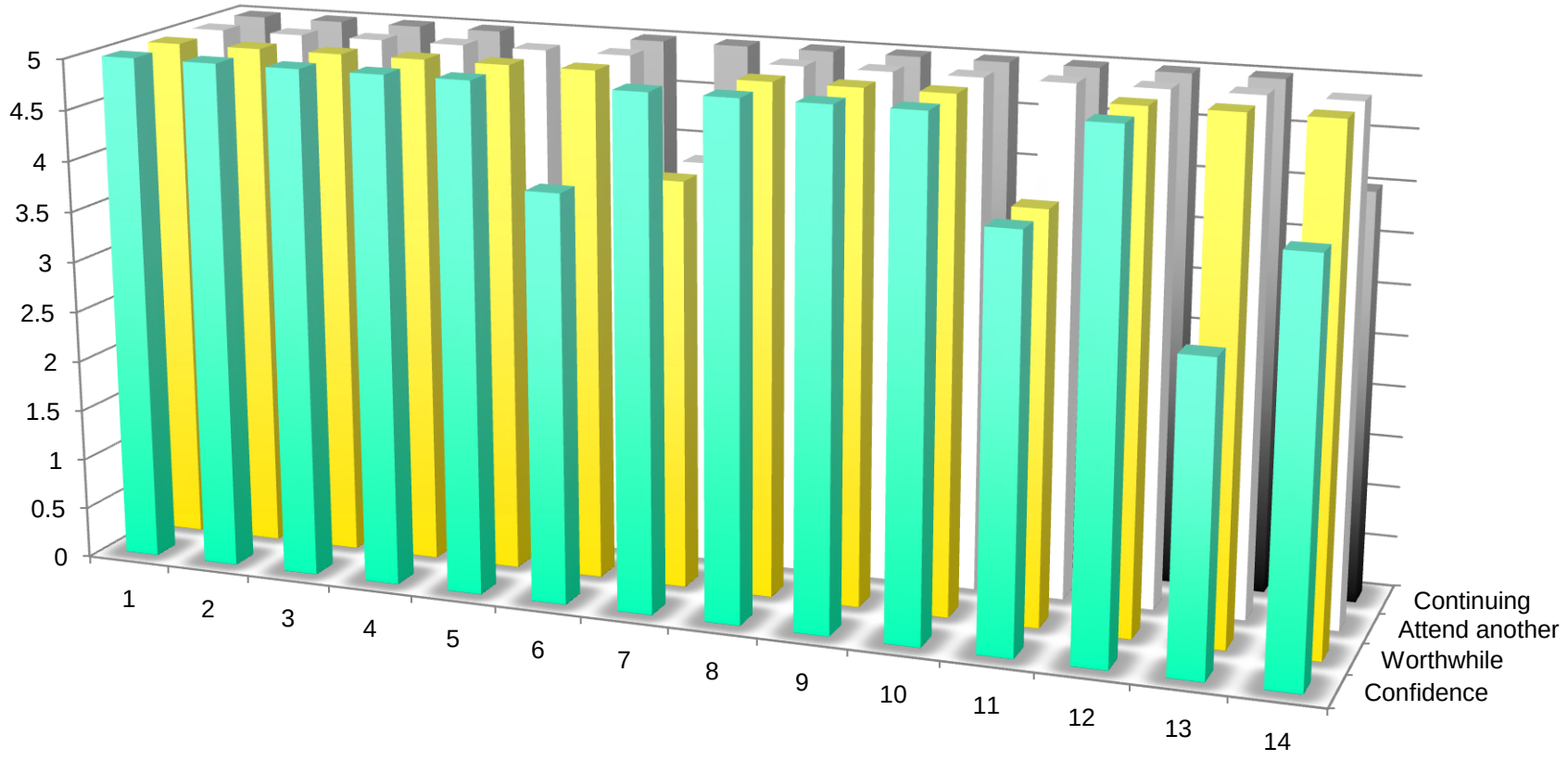
American Physiological Society | Advances in Physiology Education

Teaching cardiac electrophysiology modeling to undergraduate students: Lab exercises and GPU programming for the study of arrhythmias and spiral wave dynamics

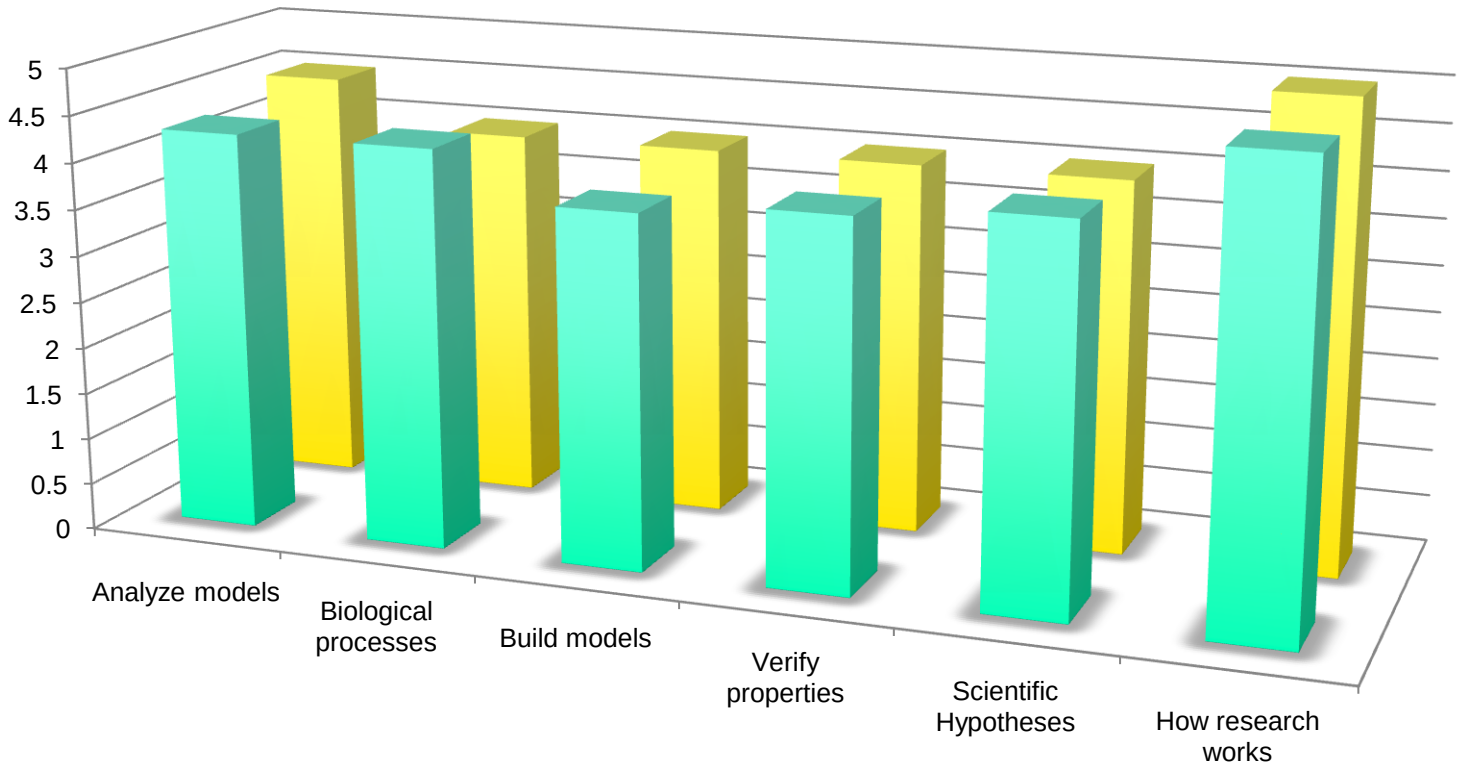
Ezio Bartocci[1], Rupinder Singh[2], Frederick B. von Stein[3], Avessie Amedome[4], Alan Joseph J. Caceres[4], Juan Castillo[4], Evan Closser[4], Gabriel Deards[4], Andriy Goltsev[4], Roumwelle Sta. Ines[4], Cem Isbilir[4], Joan K. Marc[4], Diquan Moore[4], Dana Pardi[4], Sandeep Sadhu[4], Samuel Sanchez[4], Pooja Sharma[4], Anoopa Singh[4], Joshua Rogers[4], Aron Wolinetz[4], Terri Grosso-Applewhite[4], Kai Zhao[4], Andrew B. Filipski[5], Robert F. Gilmour Jr[3], Radu Grosu[5], James Glimm[1], Scott A Smolka[5], Elizabeth M. Cherry[3,7], Edmund M. Clarke[8], Nancy Griffeth[4], Flavio H. Fenton[3]

[1]Department of Applied Mathematics and Statistics, Stony Brook University, NY. [2]Department of Biomedical Engineering, Cornell University, Ithaca, NY. [3]Department of Biomedical Sciences, Cornell University, NY. [4]The City University of New York. [5]Department of Software Engineering, Rochester Institute of Technology, NY. [6]Department of Computer Science, Stony Brook University, NY. [7]Department of Applied Mathematics, Rochester Institute of Technology, NY. [8]Computer Science Department, Carnegie Mellon University, PA

Student Evaluations – General Objectives



Student Evaluations – Specific Learning Objectives



Best things about workshop…

- Learning experience
  - A ground-up exposure to the process of formulating a model
  - Running the Simulations of the Spiral waves on the cuda GPU
  - Learning how heart fibrillation works
  - Learning about the resources and technology … necessary for … research
  - Applications of parallel computation to simulate the human heart
- Collaboration
  - The opportunity to collaborate with other peers in different disciplines.
  - Seeing how every area of science (Biology, Math) work together to solve the real world problems from very distinguished professors
- Future plans
  - This workshop inspired me to pursue information outside of my own discipline.
  - Getting a sense that I am capable of doing similar research

Suggested improvements

- More of the biological background relevant to our models. I really enjoyed Robert Gilmore's presentation … it would have been more helpful to begin with [it].
- [Topics], whether biology, math, or programming, [were] first presented in a complex manner and then more simply.
- More time to working on projects and presentations
- I would do the Math first.
- [More on] how to construct a basic differential equation that describes some simple behavior
- **Week one**: general introductions of the concept to students of all majors.
  Week two: separate students by majors and provide more intense learning in the field related to each group
  Week three: final project

Planned 2012 Workshop

- Challenge problem: Pancreatic Cancer
- Collaborators: Jim Faeder, Ed Clarke, …