CMACS Education Program

Nancy Griffeth
Educational Program Director

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Co-Directors

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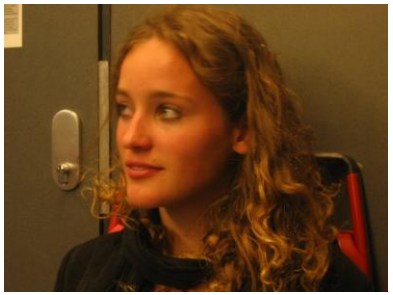
Objectives

- Motivate students to work in STEM fields
- Broaden understanding of STEM disciplines and research
- Encourage participation from under-represented groups
- Find graduate students for CMACS institutions

Outcomes

- Successful workshops based on challenge problems:
  - 2010 Workshop on **Signaling Pathways and Pancreatic Cancer**
  - 2011 Workshop on **Atrial Fibrillation**
  - 2012 Workshop on **Signaling Pathways and Pancreatic Cancer** (being planned)
- Students attracted to STEM fields and graduate work with CMACS
- Course materials, modules and curricula



Outcomes

	Individual mentoring	NSF CMACS Workshop	Short course
Post-docs	9	1	
Doctoral students	34	4	
Master's students	7	3	60
Undergraduates	12	30	12
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Outline

- 2010 Workshop on Signaling Pathways and Pancreatic Cancer
- 2011 Workshop on Atrial Fibrillation
- Impacts of Workshops on Students
- Course materials
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- Future plans

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2010 Workshop Contributors

Chris Langmead
CMU

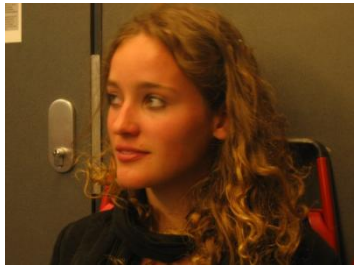
Jim Faeder
Pitt

Nancy Griffeth
Lehman

Bud Mishra
NYU

2010

Ziping Liu
CUNY



Loes Loohuis
CUNY, NYU

Fred Dieckamp
Hunter

Information For...

- Prospective Students
- Current Students
- Faculty and Staff
- Alumni and Friends

CMACS

Computational Modeling and Analysis for Complex Systems

- + 2012
- + 2011
- 2010
  - Main
  - Pre-Workshop Materials
  - Staff
  - Lectures and Readings
  - Downloads and Manuals
  - Student Exercises and Projects

Lectures and Readings

NSF-CMACS Workshop -- Winter 2010

I. Introduction

Additional Reading:

Systems Biology Q and A from Nature

A. The life cycle of a cell

B. Mac OS X and Unix

An index of bash commands

C. The role of signaling in the cell's life cycle

D. Discussion slides for modeling

E. Modeling Biochemical Systems

F. Chemical kinetics

G. Exercise: Modeling a toy signaling pathway

Course Materials : Workshops

II. Visiting lecture by Jim Faeder: Using Modeling to Bridge Scales in Biology

III. Wiring Diagrams

IV. A normal signaling pathway: the unreplicated DNA checkpoint (G2 to M)

A. Exercise:

- G2 Checkpoint in the Frog Cell Cycle
- G2 Checkpoint Exercises
- Using Mathematical Modeling for Understanding Cell Behavior

B. Additional Reading:

- Novak and Tyson (1993), M-phase control
- Csikasz-Nagy et. al., Analysis of a generic Model of Eukaryotic Cell-Cycle Regulation
- On-line supplement to Csikasz-Nagy et. al.

V. Model checking to understand signaling pathways that lead to cancer

A. Temporal Logic

B. Model Checking

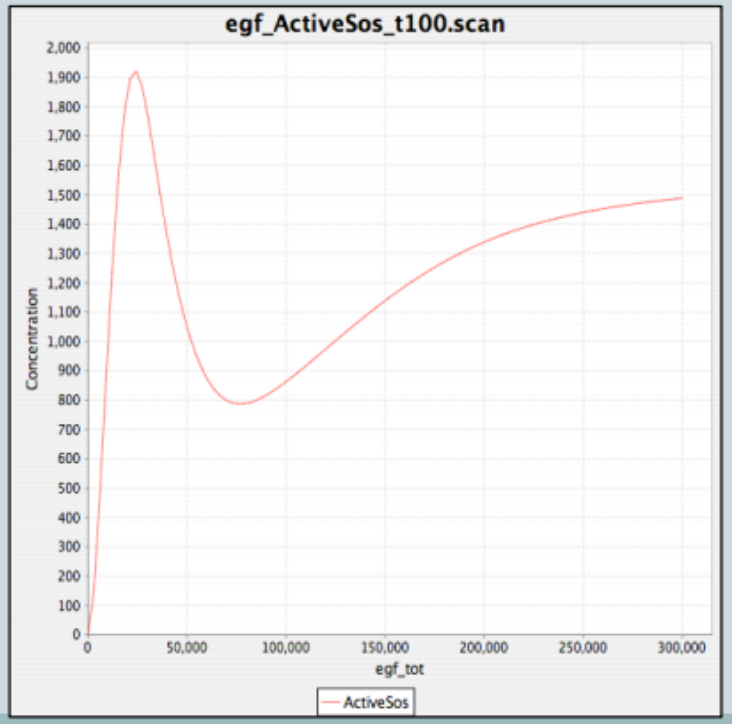
C. Extending the model of the EGFR signaling pathway

Reading: A Model of the Epidermal Growth Factor Receptor (EGFR) Pathway

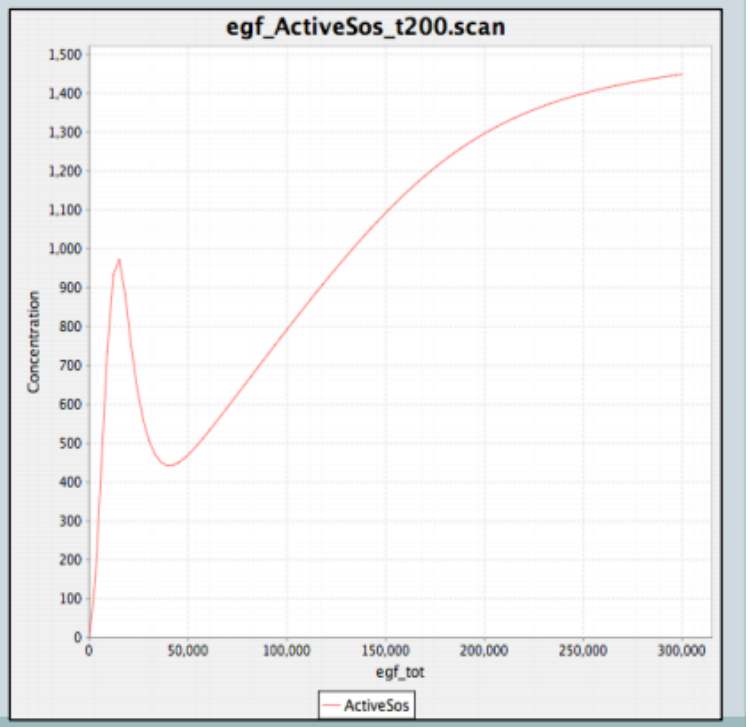
Student projects on EGFR Pathway

The effect of stimulation on Sos activation: Parameter scan of EGF (ligand) concentration

Total Sos activation against dose
Time = 100



Total Sos activation against egf dose
Time = 200



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2011 Workshop Contributors


Radu Grosu
Stony Brook


Scott Smolka
Stony Brook


Flavio Fenton
Cornell


Nancy Griffeth
Lehman


James Glimm
Stony Brook


Robert Gilmour
Cornell


Ezio Bartocci
Stony Brook


Kai Zhao
CUNY


Aron Wolinetz
Lehman


Terri Grosso
CUNY

Lectures and Readings

Week 1

Monday (Jan 3):

- Introduction (Nancy Griffeth)
- The Secret Life of Chaos (video)
- Excitable Systems (Flavio Fenton)

Tuesday (Jan 4):

- Spiral Waves and Modeling Action Potentials (Flavio Fenton)
- Saline Density Oscillator (Rupinder Singh)
- Pictures of the Saline Oscillator in the Lab

Wednesday (Jan 5):

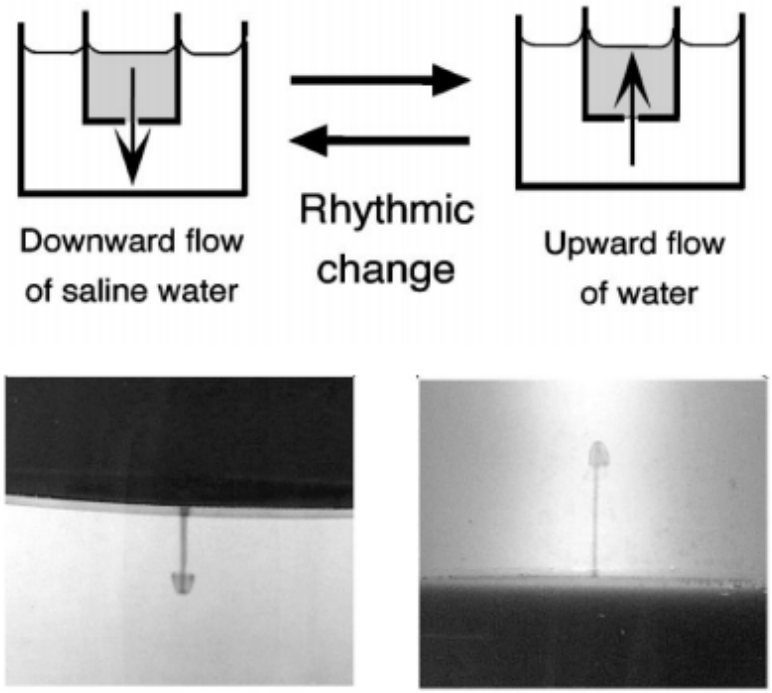
- Simplified Models of Cardiac Action Potentials (Flavio Fenton)
- Pictures of Oscillations in Fluids in the Lab

Thursday (Jan 6):

- More Complex Cardiac Models (Flavio Fenton)
- Robert Gilmour Lecture

Saline Oscillator:

- A "hydrodynamic curiosity" first described by Seelye Martin in 1970.[1]
- S. Martin observed that a partially submerged syringe of salt water in fresh water exhibits oscillations.
  - downward jet of salt water followed by an upward jet of fresh water
- Oscillations were discovered by accident while setting up a demonstration of a buoyant jet for a class in meterology.[2]

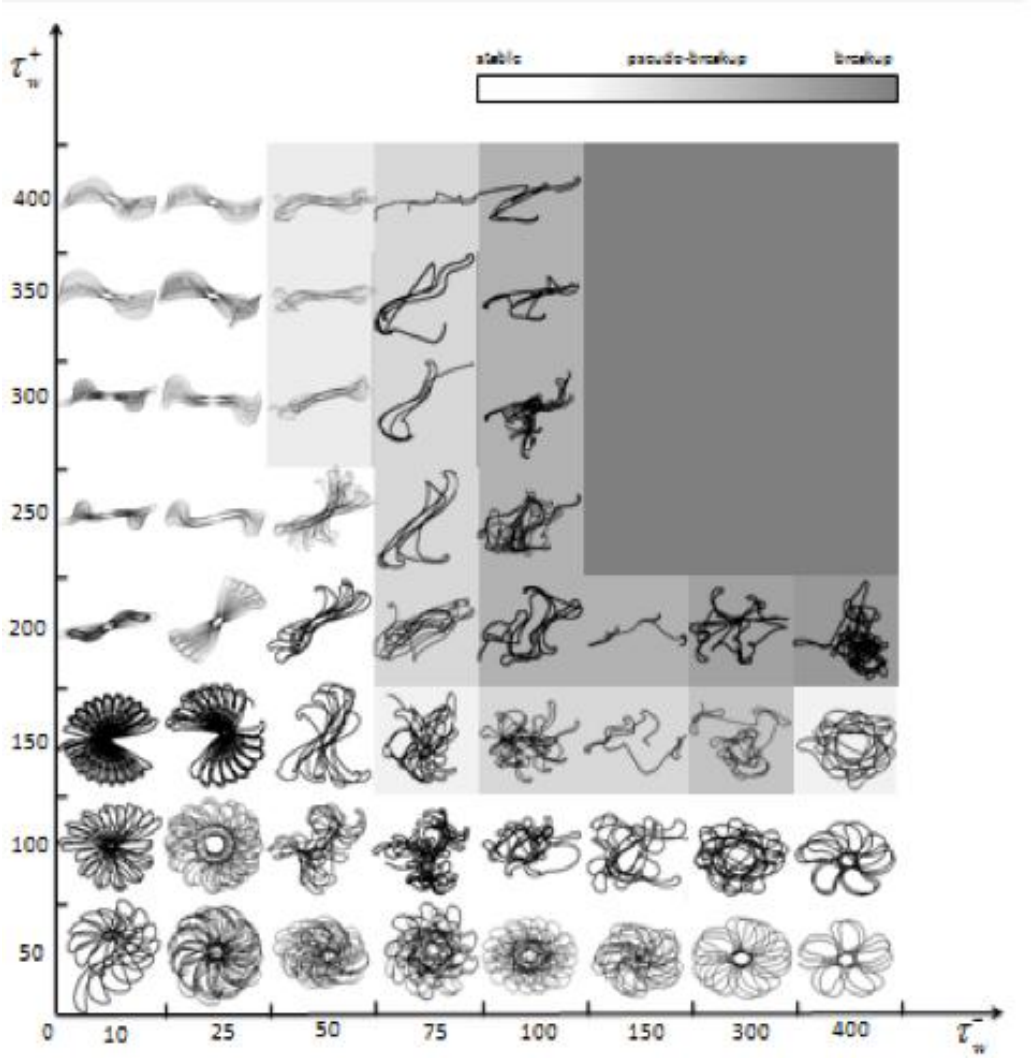


Borrowed from M. Okamura and K. Yoshikawa, Phys. Rev. E. 61, 2445 (2000).

[1] Martin S., 1970, *A hydrodynamic curiosity: the salt oscillator.* Geophys. Fluid Dynamics. 1;143.
[2] Stong, C. L., 1970, *The amateur scientist*. Scientific American. 223; 221.

Student Projects on Spiral Waves

- 2011



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Requirements and Expectations

- Inquiry-based learning
  - Small projects
  - Final presentation
- Team-oriented
- Active participation expected
- Some preliminary reading
- $1000 stipend

NSF CMACS Workshops

- 15 students a year for five years (2010-2014)

Career Plans		Current Status		Under-represented Groups	
Medical	4	In grad school	7	African-American	5
CS/Comp Bio	12	Applying to GS	4	Hispanic	5
Math	3	REU	4	Women	11
Chem	1	Undergrad research	4		
		Job hunting	2		
		Undergrad	10		

NSF CMACS Workshops

2011 Workshop Attendees

Workshop Impacts : Student Experience

Publication

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

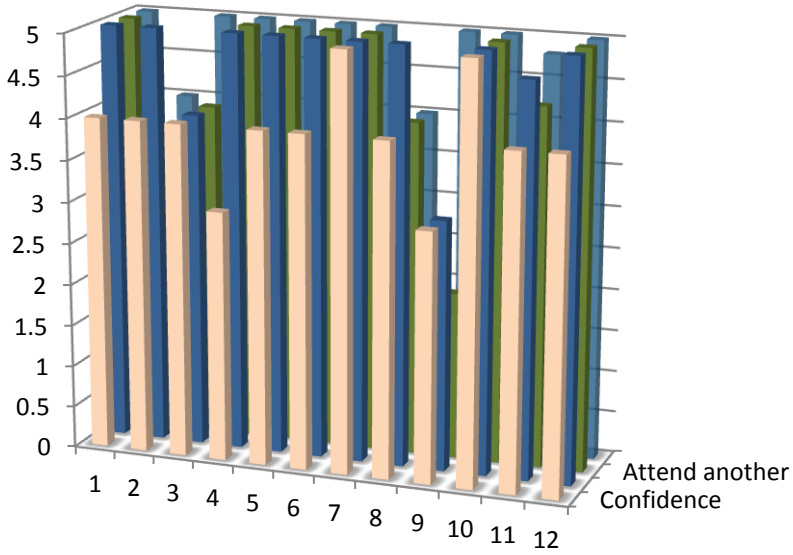
Ezio Bartocci[1], Rupinder Singh[2], Frederick B. von Stein[3], Avessie Amedome[4], Alan Joseph J. Caceres[4], Juan Castillo[4], Evan Closser[4], Gabriel Deards[4], Andriy Goltsev[4], Roumwelle Sta. Ines[4], Cem Isbilir[4], Joan K. Marc[4], Diquan Moore[4], Dana Pardi[4], Sandeep Sadhu[4], Samuel Sanchez[4], 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]

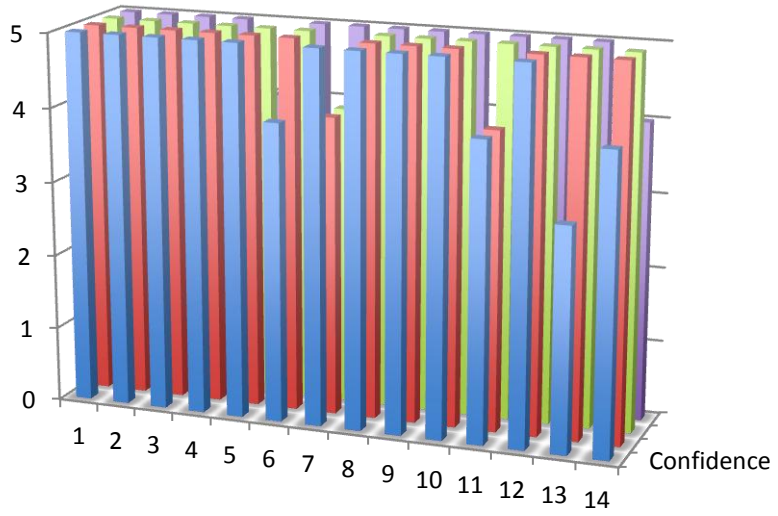
[1]Department of Applied Mathematics and Statistics, Stony Brook University, NY. [2]Department of Biomedical Engineering, Cornell University, Ithaca, NY. [3]Department of Biomedical Sciences, Cornell University, NY. [4]The City University of New York. [5]Department of Software Engineering, Rochester 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

Best things about workshop…

- Learning experience
  - A ground-up exposure to the process of formulating a model
  - Using the tools
  - Learning how fibrillation/signaling works
  - Learning about the resources and technology … necessary for … research
  - Applications of parallel computation
- 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

Evaluations





Continuing in STEM
Attend another
Worthwhile
Confidence

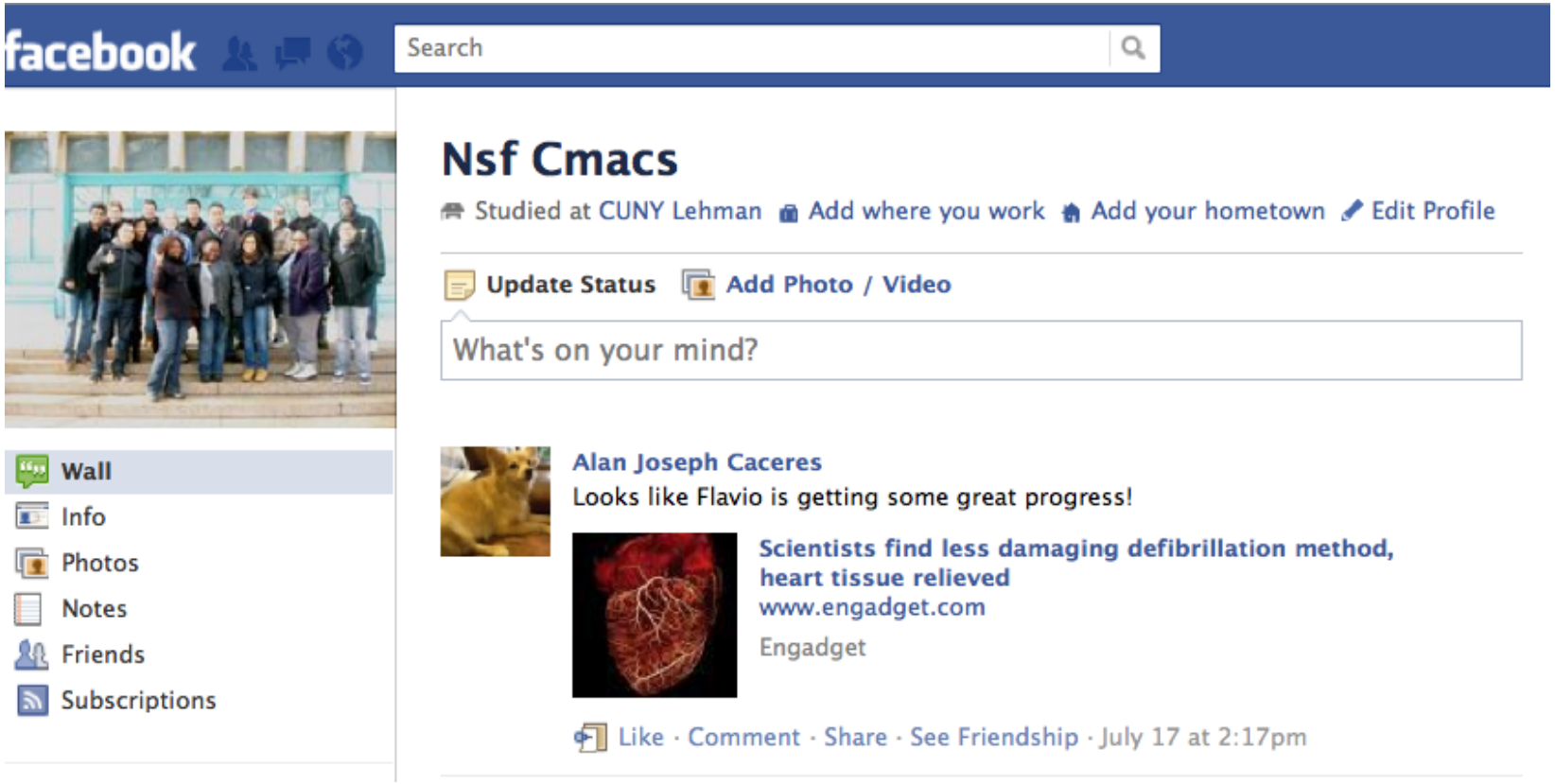
Unsolicited Student Comments

... the workshop is still my favorite thing about this year

... After the workshop, I realized that this was something that I could see myself doing. ... none of this would be possible without that winter CMACS workshop. I guess the workshop "worked." :)

…Congratulations to Flavio

Flavio's fibrillation work



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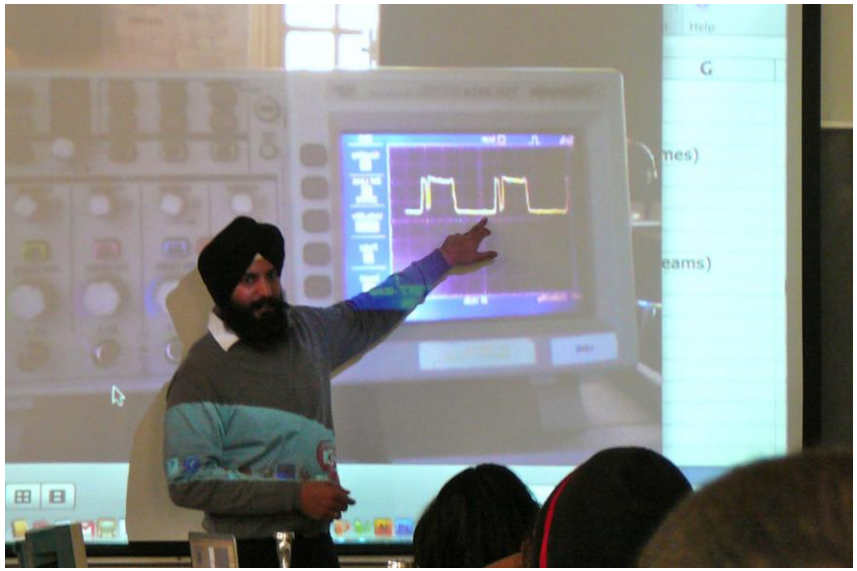
New Courses and Programs

- Lehman College
  - New course “Simulation and Modeling of Biological Systems” (Griffeth)
  - New minor “Quantitative and Systems Biology” (Griffeth/Redenti)
- CMU
  - New course Logical Analysis of Hybrid Systems (Platzer)
  - Abstract interpretation added to Model-Checking courses (Clarke)
- NYU
  - Special topics course “Signals and Cancer” (Mishra)

Course Module

- Atrial Fibrillation module
  - NSF CMACS Workshops (week 1)
  - Campus Bio-Medico University in Rome (~60 students)
  - Ernie Davis Middle School (~15 students)
  - Lehman College (~8 high school students)



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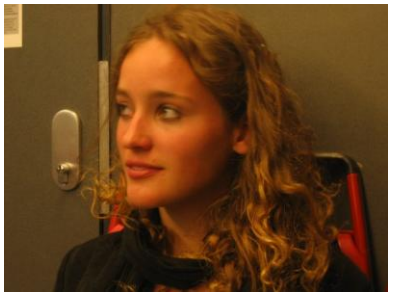

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Future Plans

- Workshops
- Additional course modules from workshop materials and from CMACS research
- Additional courses
- Curriculum recommendations for a program in Complex Systems Science and Engineering (CSSE)
- Summer REU program at Carnegie Mellon

Future Workshops

- 2012 Workshop
  - Tape/broadcast live
  - Project: Completion time distributions for FCeRI pathway
- 2013 Workshop – Atrial fibrillation
- 2014 Workshop – Signaling pathways

Curriculum Recommendations

- Investigate current programs in computational biology and embedded systems engineering
- Interview industry figures about skills needed
- Incorporate courses and course modules developed by CMACS researchers