Computational Heart Modelling:
Using Coupled Electro-mechanics Models to Find the Optimal Placement for Biventricular Pacemaker Leads

MONASH University

Jennifer Kaehms
Monash University
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Outline

- **Background**
  - Heart Disease
  - Heart Failure
  - Biventicular Pace Making
- **PRIME Project**
- **PRIME Experience Outcomes**

Back Ground
On Cardiovascular Disease

HEART HEALTH, IT IS WHAT MAKES US TICK!

Australia
- Affects 3.4 million Aussies
- Disables 1.4 million
- Kills a person every 11 minutes

America
- 2010, $400+ billion was spent on cardiovascular disease
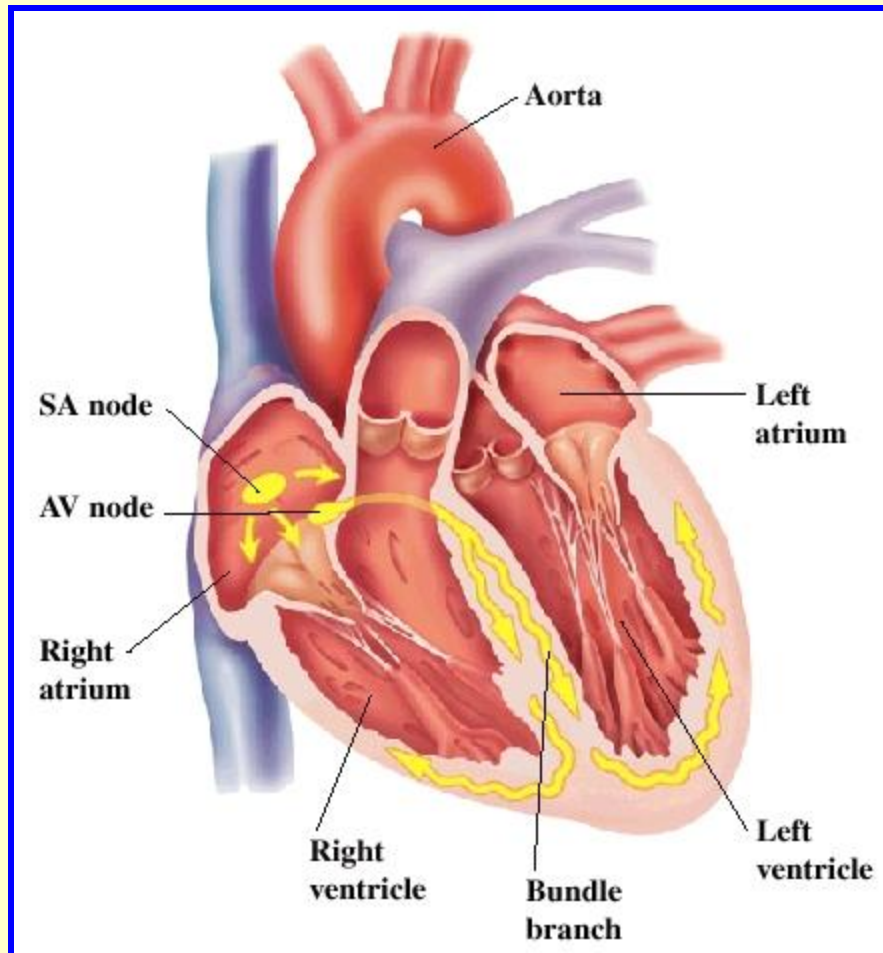- Half a million Americans die annually

World
As of June 2011, the leading cause of death ischemic heart disease (WHO 2011).

Heart Foundation

American Heart Association®
Learn and Live SM

Heart Failure

- Heart is not pumping enough blood
  - Left sided heart failure
    - Systolic failure (can't contract)
    - Diastolic failure (can't fill)
  - Right sided heart failure
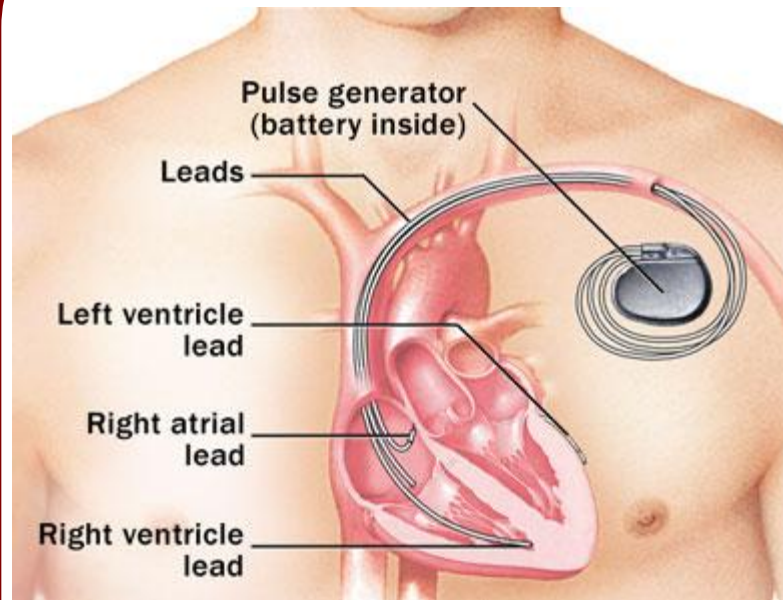   - Can't pump blood to lungs

Dyssynchronous Heart Failure

SA node
AV node
Right atrium
Right ventricle
Aorta
Left atrium
Left ventricle
Bundle branch

Heart's electrical conduction system is not working.

Figure 1: Heart Conduction system
http://www.mountnittany.org/wellness-library/healthsheets/documents?ID=7488

Biventricular Pace Making

Figure 2: Bi-Ventricular Pace Maker

Mayo Clinic: http://www.mayoclinic.org/cardiacresynchronization-therapy/enlargeimage5604.html

Three leads:
- Right Atrium
  - Sinoatrial Node
- Right Ventricle
  - Right Apex
- Left Ventricle
  - Epicardium of lateral left ventricular wall, in a coronary vein

Project Proposal

- Make the patient an individual.
- Use computational modelling to find the ideal site on the left ventricle (LV) of a rabbit heart with scar tissue.

Figure 2: Rabbit Heart Model developed with *Continuity 6* by UCSD's CMRG

Project Progress

	0	1	2	3	4	5	6	7	8	9	10
Learn About Continuity						9					
Learn Nimrod				3							
Read Literature						9					
Test Nimrod						8					
Study Basic Python					4						
Updating ICs for ionic models					2						
Testing Electromechanic model						2					
Using Fenton Model								4			
Reading Outputs in Matlab									2		
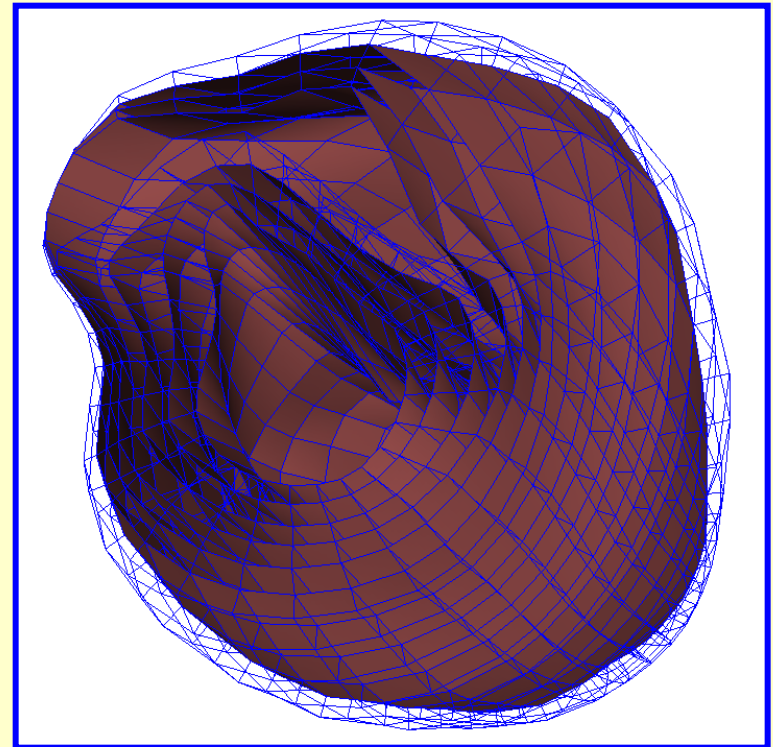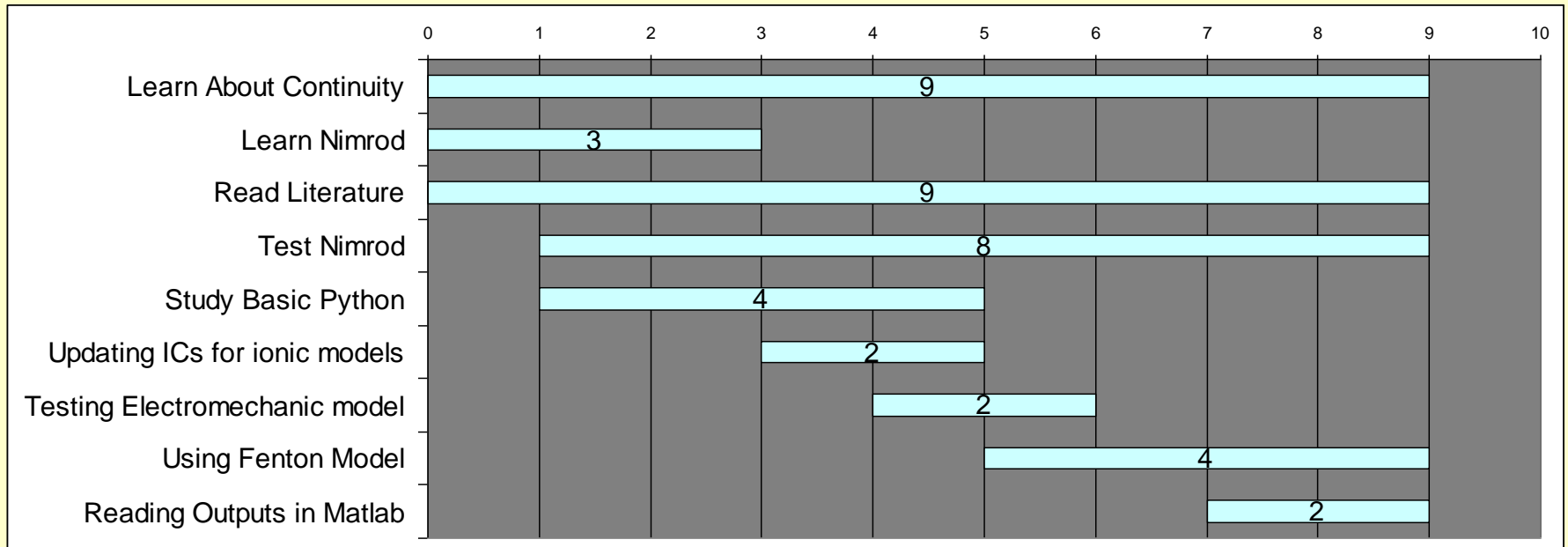
Key
X- Weeks
Y- Tasks

Tools: Continuity

Figure 3: Continuity GUI
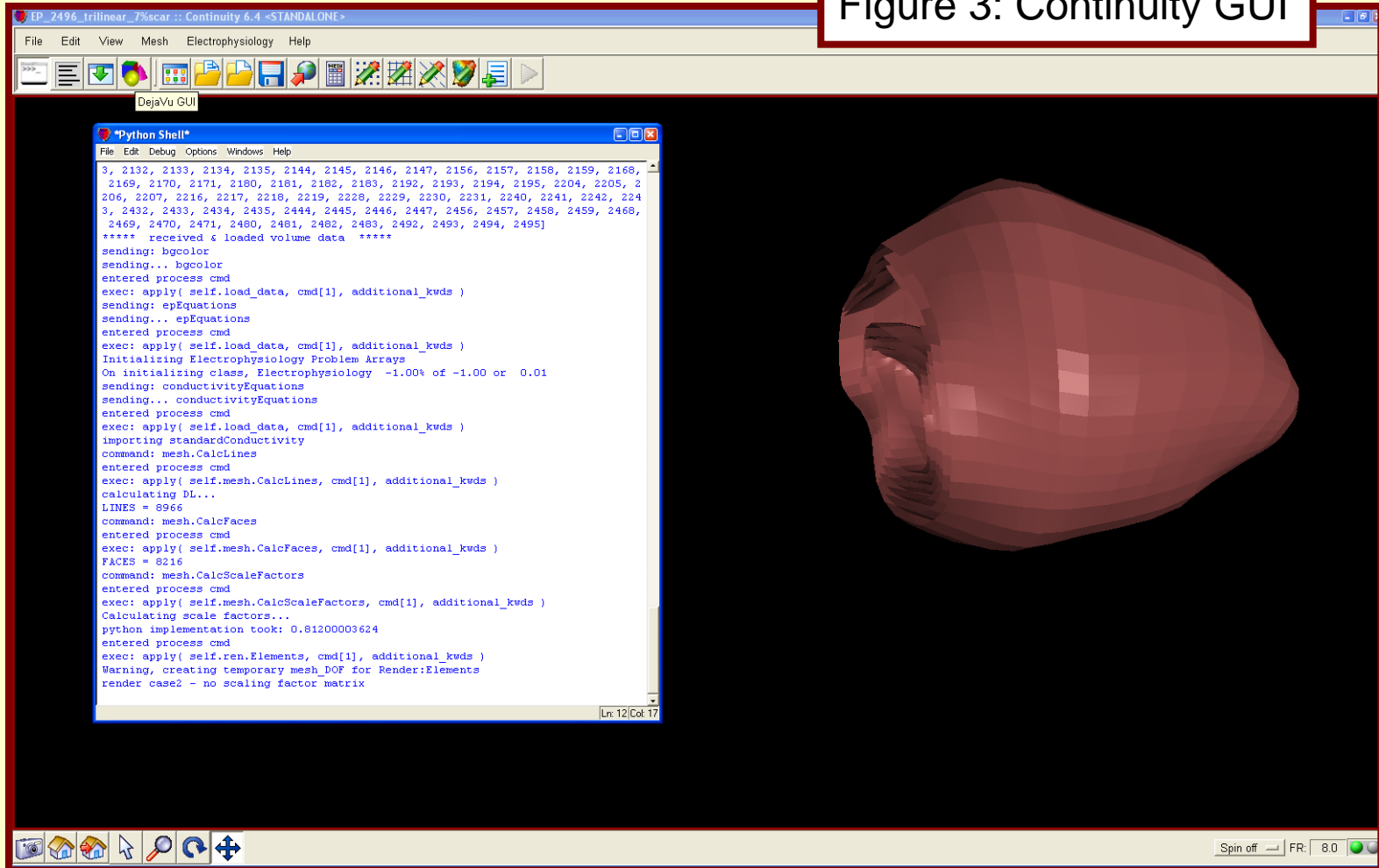
Tools: MeSsAGE Lab

Figure 4: MeSsAGE lab homepage

Methods

- Taking previous PRIMES BM models and Changing them to EPs

- Updating data to reflect current values

- Reading output in Matlab to get activation times
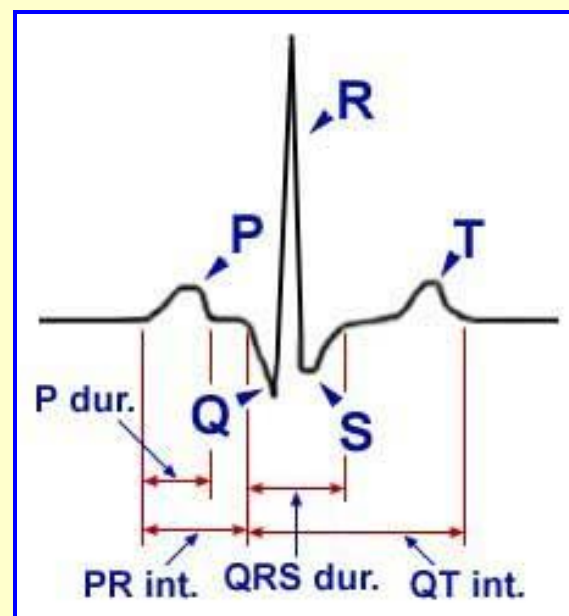
Figure 5: ECG
http://www.vetgo.com/cardio/concepts/images/qrs_durs.JPG

Future Work

- Calculate QRS lengths for all the models
- Pick a few of the activation times and run them using a separate mechanic model
- Run project on Michailova Model

Lessons Learned

- This project is really stressing the idea that if you are waiting for something and have hit a proverbial wall (i.e. lost your way), try running something else in **parallel** while you are figuring out how to deal with your current problem.
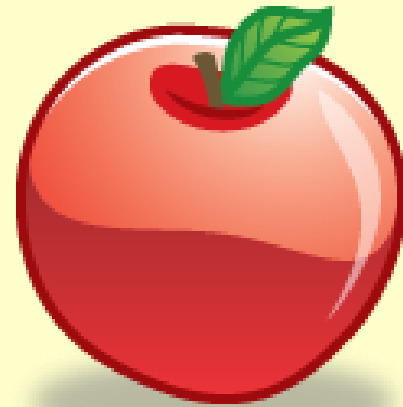
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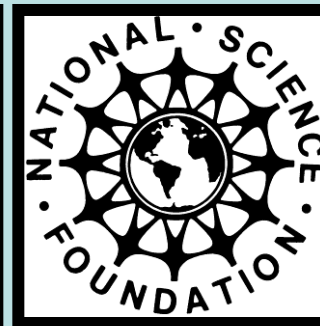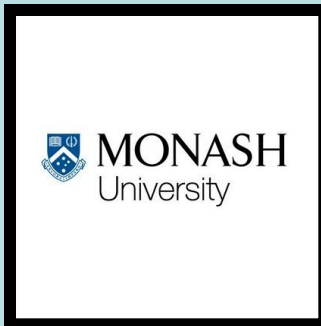Dr. Gabriele Wienhausen, Associate Dean of Education, Division of Biology, UCSD
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