

PRIME

PACIFIC RIM UNDERGRADUATE EXPERIENCES

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



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Outline

- Background
 - Heart Disease
 - Heart Failure
 - Biventricular 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

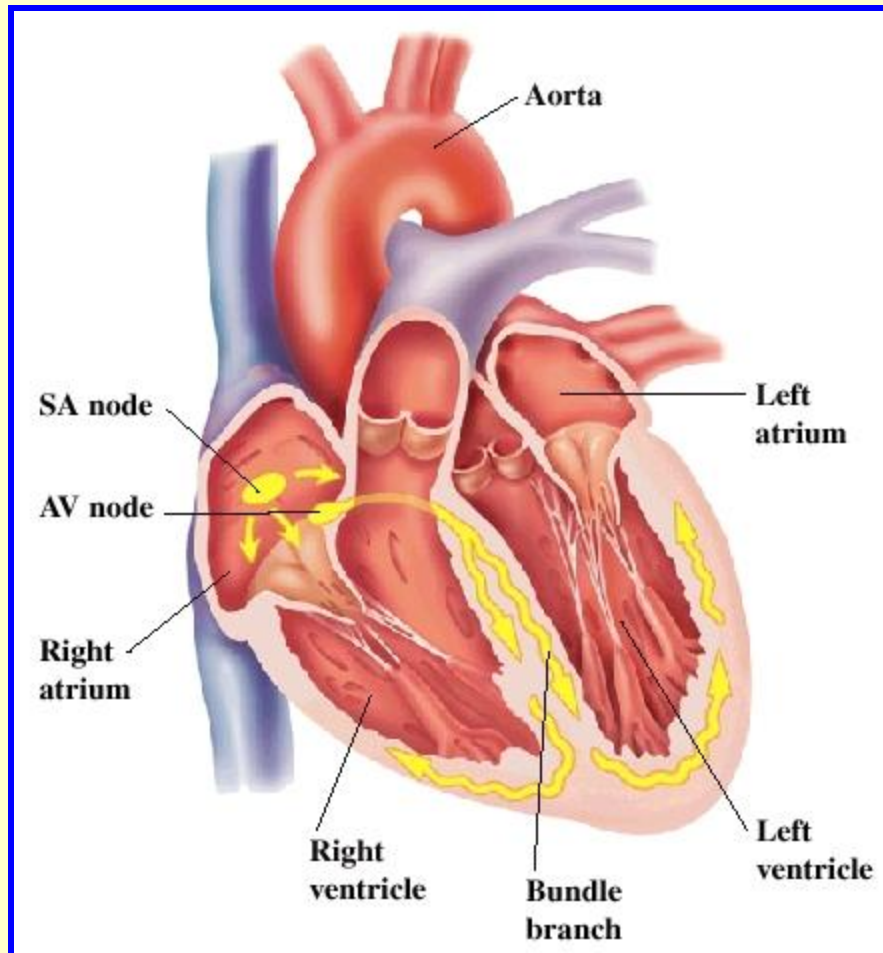
As of June 2011, the leading cause of death is ischemic heart disease (WHO 2011).



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

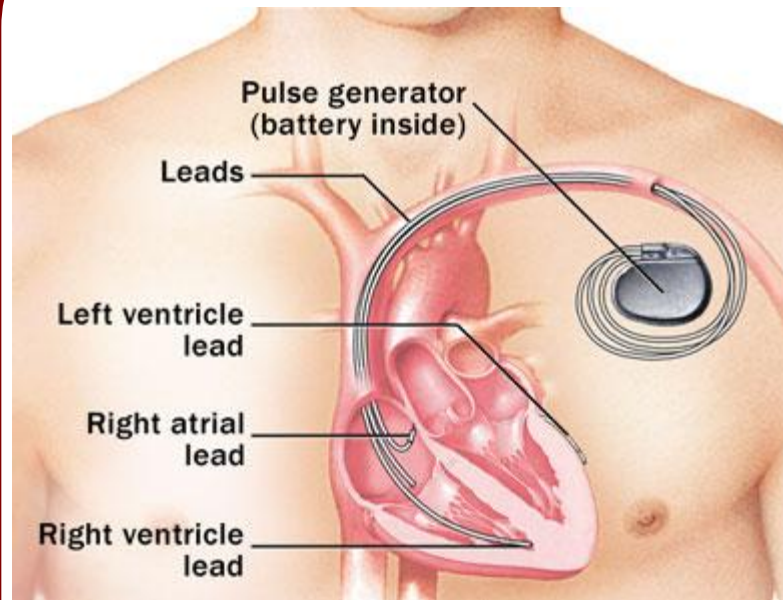


Heart's electrical conduction system is not working.

Figure 1: Heart Conduction system

<http://www.mountrittany.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>

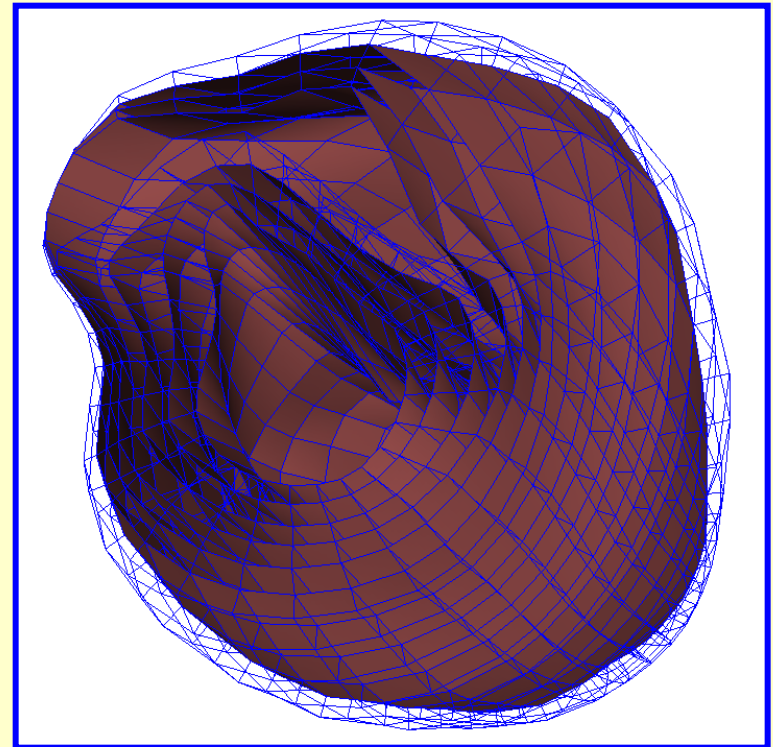
Three leads:

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

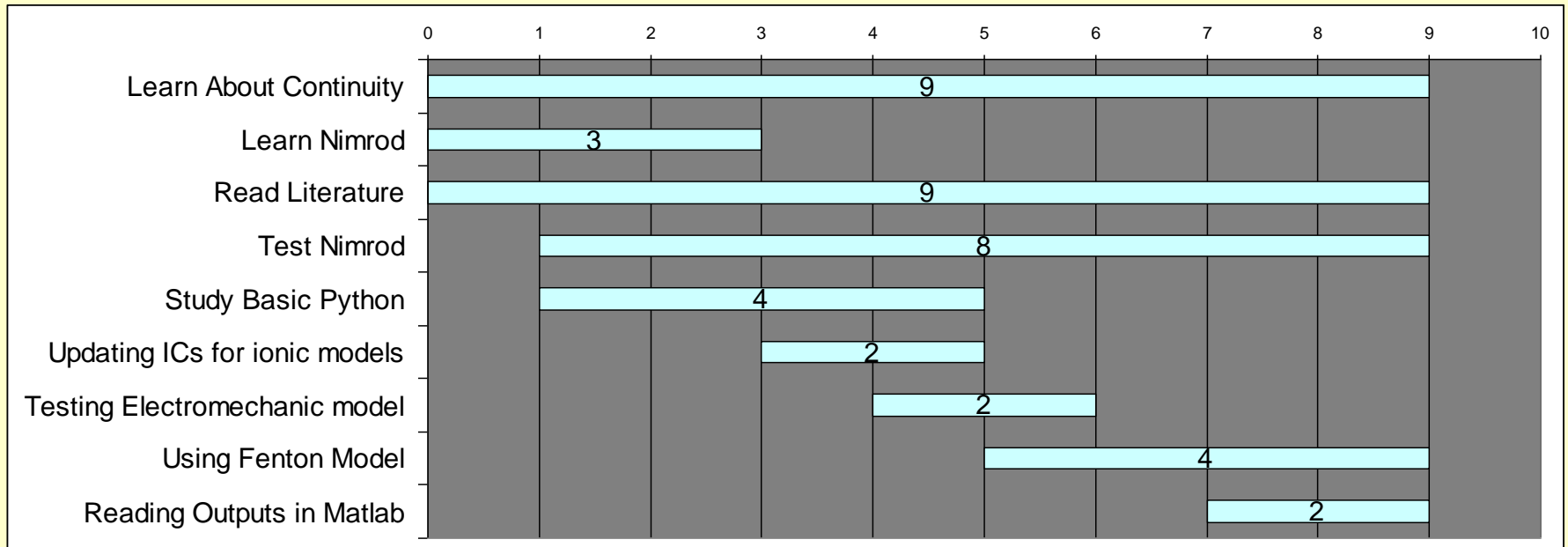
Project Proposal

- 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



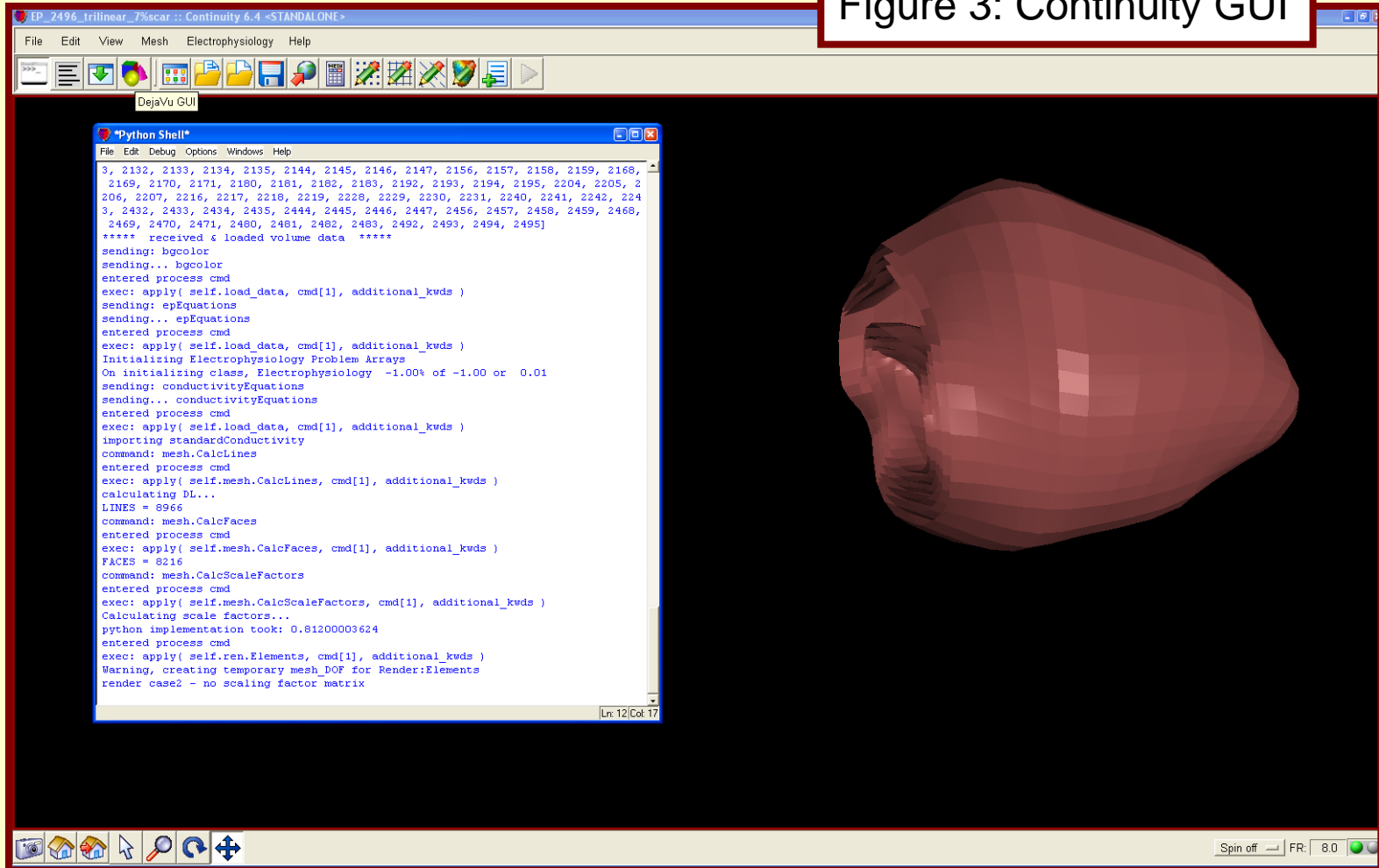
Project Progress



Key
X- Weeks
Y- Tasks

Tools: Continuity

Figure 3: Continuity GUI



Tools: MeSsAGE Lab

Figure 4: MeSsAGE lab homepage

MeSsAGE Lab
Monash eScience and Grid Engineering Laboratory

Latest News
August 2011 Carole Goble speaks at Monash on the Long-Term Scientist
July 2011 Technician seminar a success!!! View of the Harwood!!
June 2011 Images of Technician seminar and HD video to Monash
May 2011 Harwood partial adopts GridBench!!
May 2011 EURPA student in World first music crowd!
May 2011 Funoff presents at Monash Computational Science workshops
March 2011 Single Sign On and Short-Lived Credentials For Harwood
More News...

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MeSsAGE Lab

About the laboratory

The Monash eScience and Grid Engineering (MeSsAGE) Laboratory performs research and development on software tools and techniques for programming e-Science applications. Our research projects address life cycle issues as software evolves through the phases of development, deployment, test and execution. Importantly, we assume that this life cycle is performed continuously, that is, software evolution does not stop after execution but enters development again. We particularly focus on legacy systems in which existing software is brought into Grid computing environments. The MeSsAGE Lab is one of three collaborating laboratories that comprise the [Centre for Distributed Systems and Software Engineering \(DSSE\)](#). It has strong connections and research contracts with other Monash University and internationally - our former researchers have played a significant role in the development of [Monash's e-Research Centre](#) since 2005, where Professor Abramson currently serves as the Science Director.

Our research group has built a number of software toolkits that address some of the challenges posed by non-WEB, web-based tools such as the Upper Middleware Tools in the diagram below. In particular, Harwood and GridBench target software development; Guard focuses on debugging; Grid MicroBench and DistAnt target deployment and Nimrod, GridLES, Active Sheets, REMUS and the Nimrod Portal all focus on execution.

Much of this work is done in collaboration with international partners. For example, research conducted on the [PRAGMA](#) testbed addresses data applications and middleware but primarily in collaboration with partners from the Pacific Rim. This not only resulted in improvements to our locally developed middleware (Nimrod), but also interesting science results (reported in [scientific journals](#)) and a better understanding on how to run international grids, reported in [computer science journals](#).

Personnel

MeSsAGE Lab has a core of 10 research scientists and developers/programmers, supplemented by an average of 100+ HLLU students, usually 100+ who assist the general research effort of the group in addition to working on their thesis. The group also has a very active visiting program, mostly funded by the external bodies who see value in their own partnership with such an e-Science/Grid-based Monash e-Research Centre staff also work closely with MeSsAGE Lab.

Standing in Photo (left to right): Miralim, Colin Faircliff, Shweta Gauri, Bibi Behrwalde, Trish Ramfoss, Jeffery Tan, Danny Kraemer

Seated: Terry Peachey, David Abramson, Rob Gray

Missing from Photo: Phillip Chan, Shaheen Ayyub, A.B.M. Ruseel, Wotek Cosciorecki, Chao Jin

Goals

MeSsAGE Lab is aimed at supporting scientists in what they do best - Science. It does this by a combination of Middleware and Software tools designed to work over computing grids. MeSsAGE Lab's most well-known software is a suite called Nimrod, but the laboratory has produced many other prototypes over the years.

e-Science and e-Research

e-Science enabled by the Grid computing paradigm (and more recent emergent technologies such as Cloud computing), tightly-coupled scientists, their instruments, massive storage devices and powerful computational devices. It uses high-performance computers (or clusters of them - computers) huge databases and massive or multi-terabyte instruments, to link researchers together intentionally and solve previously intractable problems in areas as diverse as crop and engine design, climate modelling and drug design.

The computational grid has provided a great deal of support for innovative applications, particularly in science and engineering but developing applications can be demanding. A range of user middleware services and tools are being developed with the aim of solving the software engineering challenges in building real applications.

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

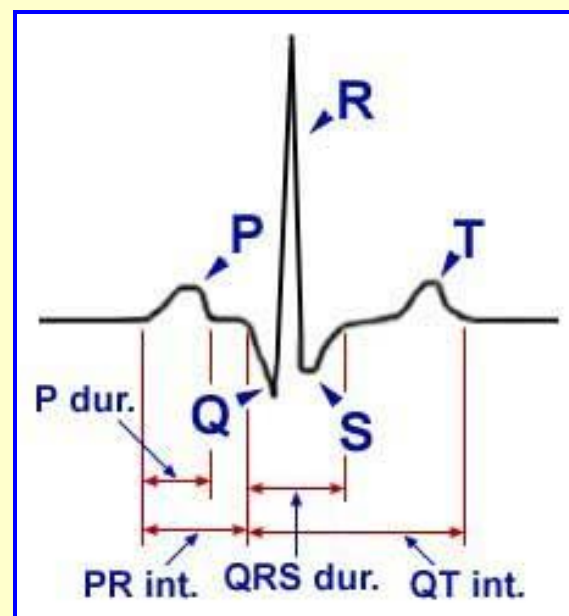


Figure 5: ECG

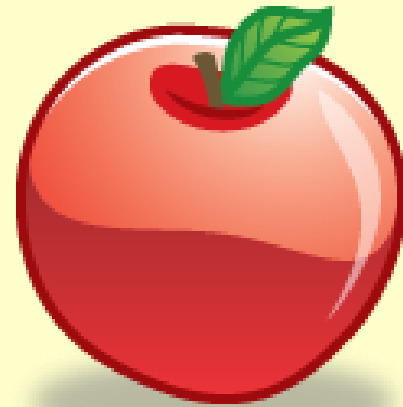
http://www.vetgo.com/cardio/concepts/images/qrs_durs.JPG

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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UCSD PRIME

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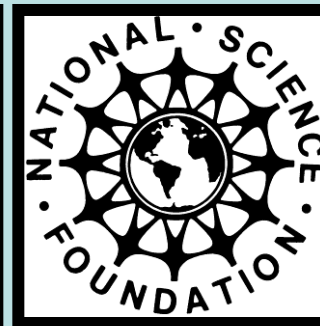
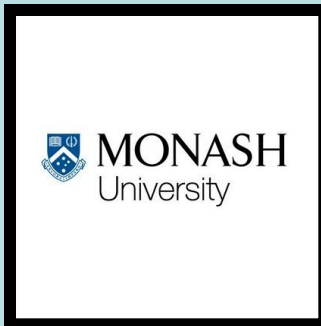
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