Why?

- Physicians use electric potential maps of the heart to treat and diagnose arrhythmias.
- Current method to map surface of heart is invasive and takes a long time.
- Is there a better way to diagnose arrhythmias?
Current Methods for 3-D Mapping of Heart

http://www.youtube.com/watch?v=lvqa1xQkxzU (last ~15 seconds were cut)
Background - Arrhythmias

- Approximately 350,000 people die of sudden cardiac death every year in the United States \(^1\)
- Half of all deaths caused by heart disease are sudden death \(^1\)
- Known that ventricular arrhythmias are linked to sudden death

ECGs are regularly used by doctors to diagnose patients with heart problems.

Normal ECG waveform:
- **P** – depolarization as signal moves through atria
- **QRS** – depolarization as signal moves through ventricles
- **T** – repolarization of ventricles
Background – SAI QRST

- Sum Absolute Integral QRST (SAI QRST) - absolute area under the QRST regions of the ECG

- Large group (n=355) studies that SAI QRST is a very good predictor of risk ventricular arrhythmia in conventional ECGs

Background - Body Surface Potential Maps (BSPM)

Background-Inverse Solution

- Map the surface of the heart from the ECGs recorded from surface of the body
- Re-creates heart map “comparable” to the ones you get from mapping with a catheter
- Non-invasive
- Computationally challenging: depends on patient’s geometry

Our Idea (Motivation)

- Combine SAI QRST and BSPM to provide a better way to predict ventricular arrhythmias

- Potential applications:
  - Cardiac Resynchronization Therapy
  - Prognostic and diagnostic information
  - Non-invasive mapping of a new marker of cardiac disease
Technical Approach (1)

- In order to even begin dealing with our 120-lead ECG data, we will need to develop a way of automatically detecting the fiducial points of each ECG signal and based on these points calculate the sum absolute and native integrals of the QRST interval.

- To accomplish this task, we plan on using the following 3 steps:
  1. PQ junction detection
  2. Automatic lead detection
  3. T-wave end detection

Having determined the sum absolute and native integrals of the QRST integral for each beat, we will then average across the beats to give us our averaged sum absolute integral for the individual leads.

After calculating the sum absolute integrals, we will then calculate a body surface map based on the sum absolute QRST intervals.

Finally, with the help of our mentor we will attempt to solve the inverse problem and create a map of the heart based of the body surface map.
Deliverables

- **Minimum**
  - Semi-automatically pre-processing 120-lead ECG data
  - Automatically detecting fiducial points
  - Calculating the sum absolute QRST integral
  - Averaging the sum absolute QRST integral for each lead

- **Expected**
  - In addition to above, constructing a body surface map of the sum absolute QRST integral

- **Maximum**
  - In addition to above, constructing a map of the heart using the inverse solution
Milestones

- Automatically detecting fiducial points
  - Criteria: graphical confirmation that our method finds and labels the correct fiducial point
- Calculating sum absolute and native integrals of QRST interval
  - Criteria: graphical confirmation that our method is calculating the correct integrals
- Averaging the sum absolute and native integrals for each lead
  - Criteria: see if averaging works for test data
- Constructing body surface map
  - Criteria: confirmation of methods and results with our mentors
- Constructing inverse heart map
  - Criteria: confirmation of methods and results with our mentors
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SPRING BREAK

- **Intro**: Background, Motivation, Technical Approach
- **Deliverables**: Milestones, Management
Management Plan

- Mentors:
  - Weekly Meetings with Dr. Tereshchenko: Fridays 3-4:30pm
  - Dr. Lardo - pending
  - Fady Dawoud – pending
- Markus and Sindhoora: working together on all aspects of the project
- Additional Tasks:
  - Markus: time management (making sure project keeps rolling)
  - Sindhoora: communications with mentors
Dependencies

- IRB Approval
  - Mentors need IRB approval to release data
  - Status: Resolved

- Data Source
  - See above
  - Status: Resolved

- Weekly support meetings with Dr. Tereshchenko
  - Assistance with first two stages of project
  - Status: Resolved

- Packages to help solve the inverse problem and create body surface and heart maps
  - When we reach Stage 3 (projected March 20), we can acquire these from Fady
  - Status: Pending

- Meetings with Dr. Lardo or Fady for help with constructing body surface and heart maps
  - Fady (Dr. Lardo’s PhD student) will be primary contact and provide assistance with constructing these maps
  - Status: Pending
Reading List


