# Optimal Sailor

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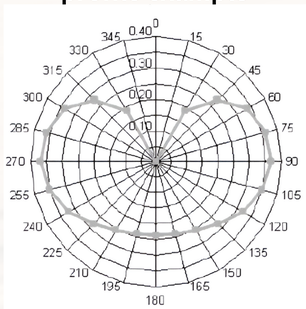
## PROBLEM

### Sailing Route Optimization

The driving force of a sailboat is wind. A sailor will take wind speed and wind direction into account when adjusting the sails for optimal travel.

- **Dead zone** - range in which a sailboat cannot travel, 45° to either side of wind direction
- **Tacking** and **jibing** are maneuvers used to change direction
- Complex due to dynamic inputs: **wind direction**, **wind speed**, and **geography**

**Figure 1: Sailboat speed profile example**




### Objective

- Develop a software application to handle environmental conditions and provide an optimal path out at sea
- Completely automate personal and recreational sailboats
- Reduce carbon emissions through sustainable shipping methods

## METHODOLOGY

### Dynamic Objective Approach

- Set objectives depending on performance of previous sprint
- Emphasis on client feedback
- Due to complex nature of project, determining minimum viable product was crucial

## SOLUTION OVERVIEW

### Pygame Application

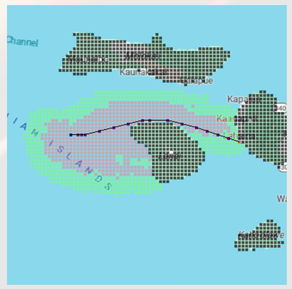
- Analyzes map images and distinguishes land from water
  - Option to edit traversable areas
  - Dynamic wind speed and direction
- Allows designation of start and end points
- Calculates optimal path using a specialized algorithm
- Saves map for subsequent use
- Translates Cartesian coordinates to Geographic coordinates

**Figure 2: Maui to Oahu Sailing Route**


**Figure 3: Sailing upwind**

**Figure 4: Sailing downwind**

**Figure 5: Sailing crosswind**



## CHALLENGES

### Performance

- Algorithmic time-complexity
  - Minimal time complexity is required in order to be able to provide live navigation to a sailcraft
- Finding a good heuristic for the A* algorithm
  - Vital for reducing runtime while still finding a near optimal path

### Usability

- Must be usable and modifiable by the engineering team at Rice University building the autonomous sailcraft
  - Code must be well organized
  - Code must be easily interpretable

## LEARNINGS

### Real Sailboat Experience

- Opportunity to sail hands-on with ASA 101 class run by Sail Hawaii
- Verified kinematics established in Optimal Sailor

**Figure 6: Sailing in Kaneohe**


## NEXT STEPS

### Integrate with Rice University Sailboat Team

- Incorporate GRiB data for weather forecasting prediction
- Deploy Optimal Sailor onto autonomous sailboat