# Image-Based Rock-Climbing Simulator

## Artificial Intelligence Final Project

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CS 151

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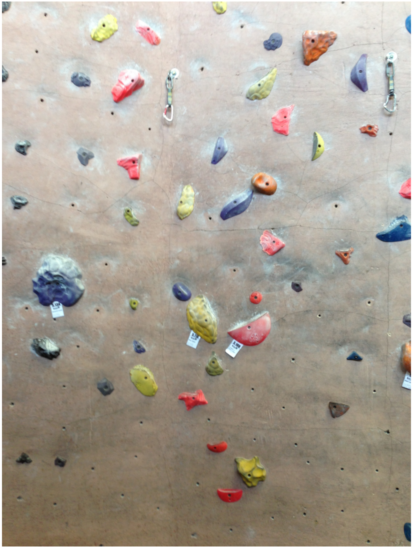
# Rock Climbing



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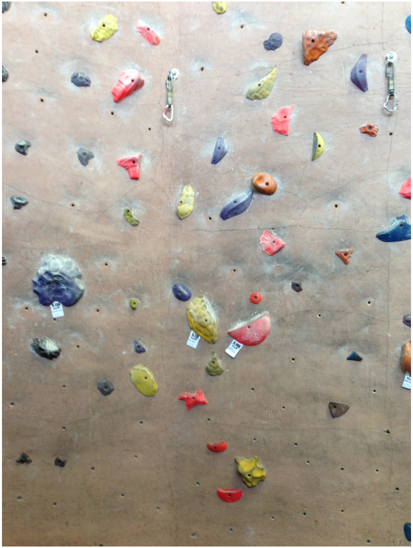
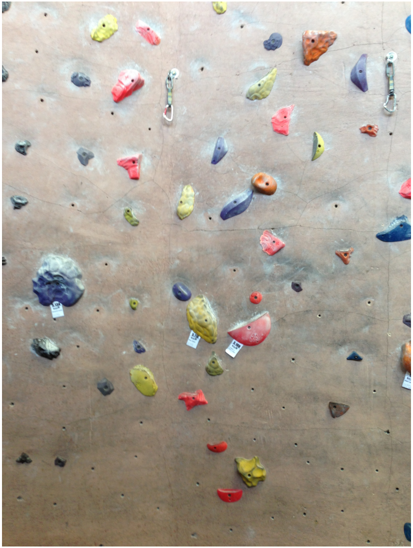


Problem Definition

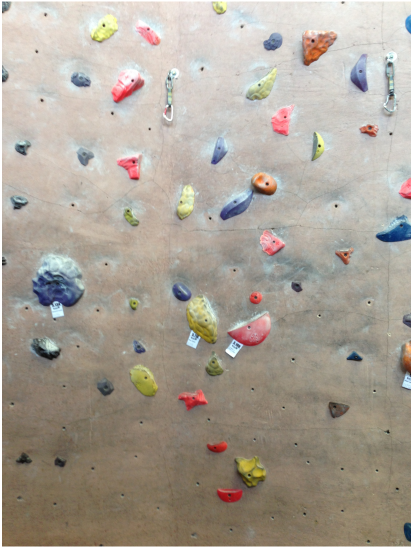
- Routes are color-delimited
- Use any subset of designated grips to get to the top
- Difficulty determined by size, spacing and surface properties of the grips
- Climbers have to determine a path

# Rock Climbing



## Challenges

# Rock Climbing



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- Physically-viable arrangements
- Balance forces
- Minimize muscle strain
- Path efficiency

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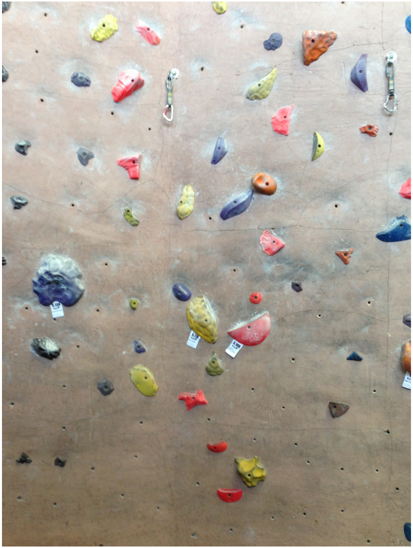

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Constraints

- Motion in 2D plane – no overhang
- Depth correlated to grip size

# Solution Specifications

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- Single pixel selection by user that maps to one of the grips in the desired route

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Tools:

- OpenCV Library
- Qt C++ Framework

# Pipeline

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**Image Processing**

- Route Detection
- Grip Analysis

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## Heuristic Analysis

- Modeling Grip Support

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- Modeling a Human
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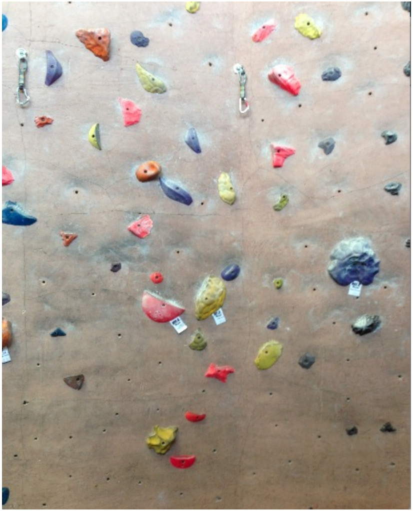
## Path Search

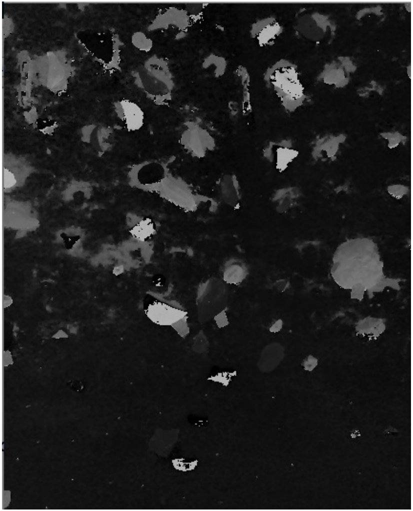
- Starting a Route
- BFS & A*

# Image Processing



Steps:

# Image Processing



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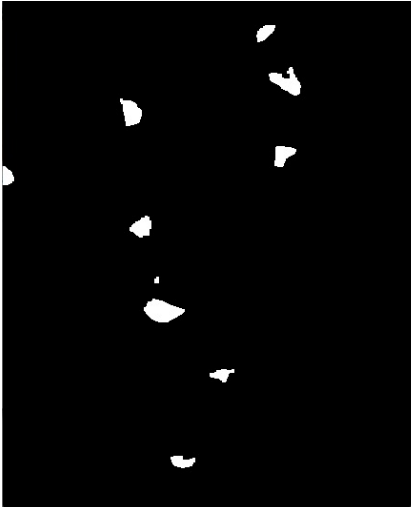

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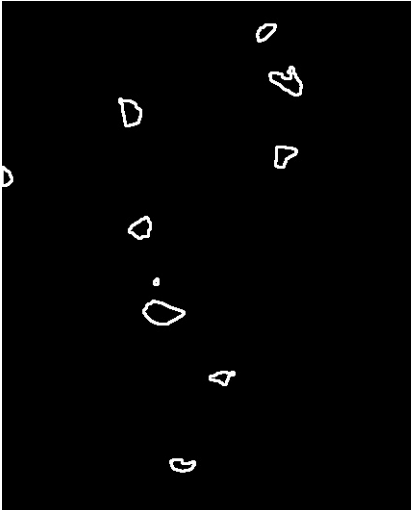

Steps:

- Convert to HSV color space
- Threshold image by hue of user selection
- Denoise image using dilation & erosion
- Represent grips as contour

# Grip Analysis

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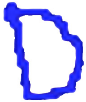
Physical Properties:

- Area
- Perimeter
- Center of Mass
- Convexity Defects

# Grip Analysis

## Orientation Estimation



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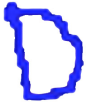

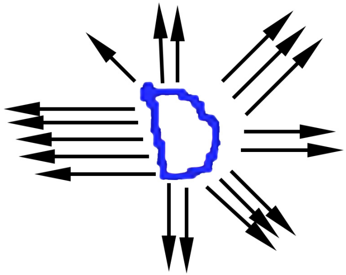

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$$F = f(a, p, d, N, \theta)$$

where $a$ is area, $p$ is perimeter, $d$ are the convexity defects, $N$ is the normal field, and $\theta$ is the angle at which the grip is grabbed.

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where $a$ is area, $p$ is perimeter, $d$ are the convexity defects, $N$ is the normal field, and $\theta$ is the angle at which the grip is grabbed. As an approximation,

$$F = a \cdot N[\theta] + \mathrm{hardlim}(d) \cdot |d|.$$

crap

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