



# Route Reader

US Patent Pending  
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## Why it Exists

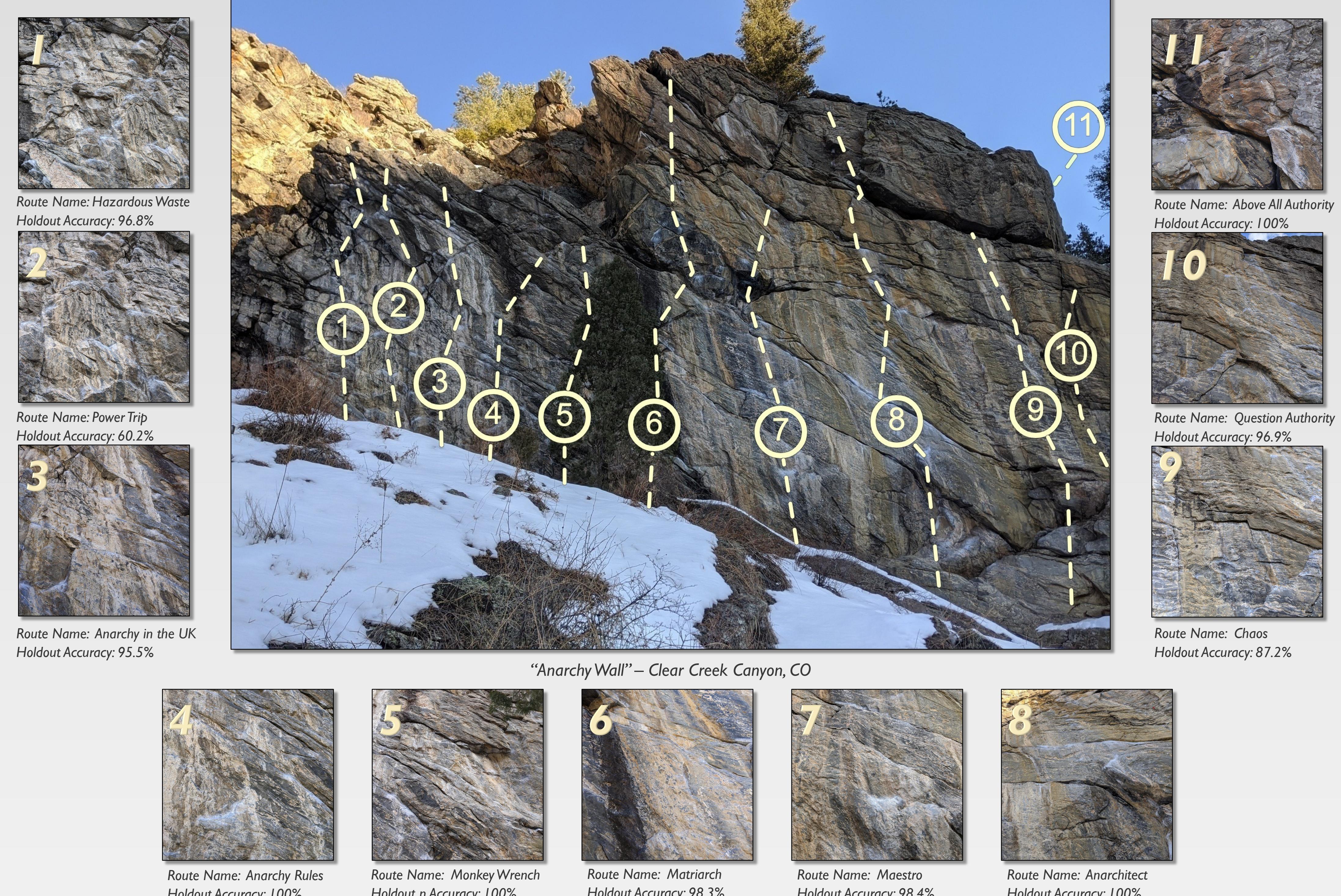
- Finding a specific climbing route outside is hard.** As new rock climbers venture outside they are faced with the challenge of navigating outdoor climbing areas (known as "craggs").
- Some crags can have over 100+ separate climbing routes.** A route is composed of a line of bolts going up the rock wall. These bolts are what the climber clips the rope into when he/she is climbing.



Image: <https://www.rei.com/learn/expert-advice/sport-climbing-basics.html>

- If a climber mis-identifies a route:** it can lead to serious safety concerns, lost climbing gear, and a terrible day of climbing.

**The Route Reader identifies outdoor rock climbing routes**



## How it Works

The Route Reader utilizes a method of "Deep Learning": a Convolutional Neural Network (CNN). CNN's excel at the field of computer vision – training a computer to "see" and classify or label different types of images. The network is trained by analyzing over 15,000 images of the routes and "learning" which image represents which route.

**Images are taken based off the following guidelines:**

- 10' back from the rock-wall
- Perpendicular to the route
- Center the image on the first bolt of the route
- 1.0x zoom

## Model Architecture

| Layer(Type)    | Output Shape   | Parameters |
|----------------|----------------|------------|
| Conv2D         | (248, 248, 32) | 896        |
| MaxPooling2D   | (124, 124, 32) | 0          |
| Conv2D 1       | (122, 122, 64) | 18496      |
| MaxPooling2D 1 | (61, 61, 64)   | 0          |
| Conv2D 2       | (59, 59, 64)   | 36928      |
| MaxPooling2D 2 | (29, 29, 64)   | 0          |
| Conv2D 3       | (27, 27, 96)   | 55392      |
| MaxPooling2D 3 | (13, 13, 96)   | 0          |
| Conv2D 4       | (11, 11, 34)   | 27680      |
| MaxPooling2D 4 | (5, 5, 32)     | 0          |
| Dropout        | (5, 5, 32)     | 0          |
| Flatten        | (800)          | 0          |
| Dense          | (128)          | 102528     |
| Dense 1        | (11)           | 128        |

**Total Parameters: 243,339**

**Convolution / Max Pool Layers: 4**

**Fully-Connected Layer: 128 nodes**

## Model Performance

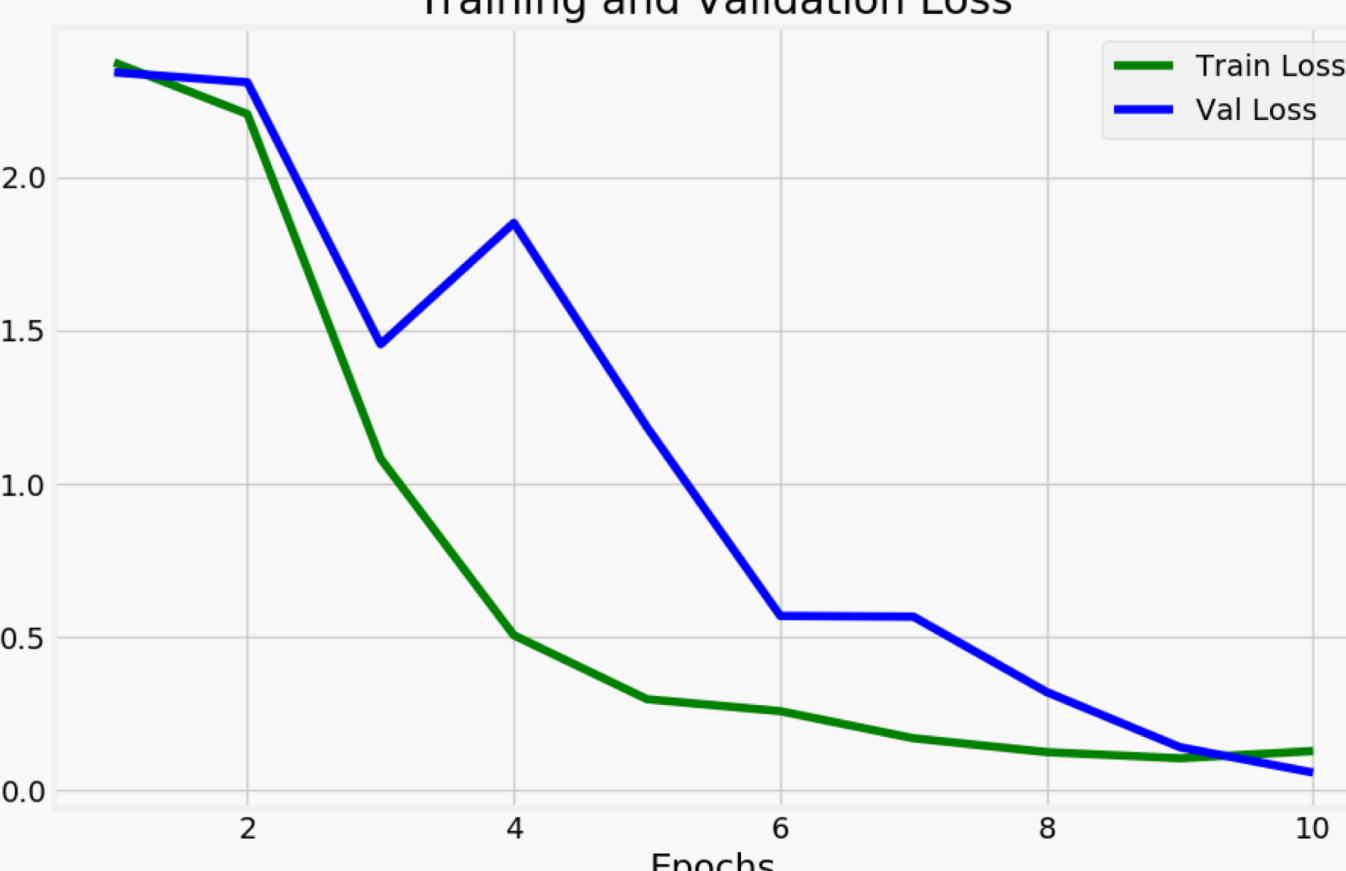
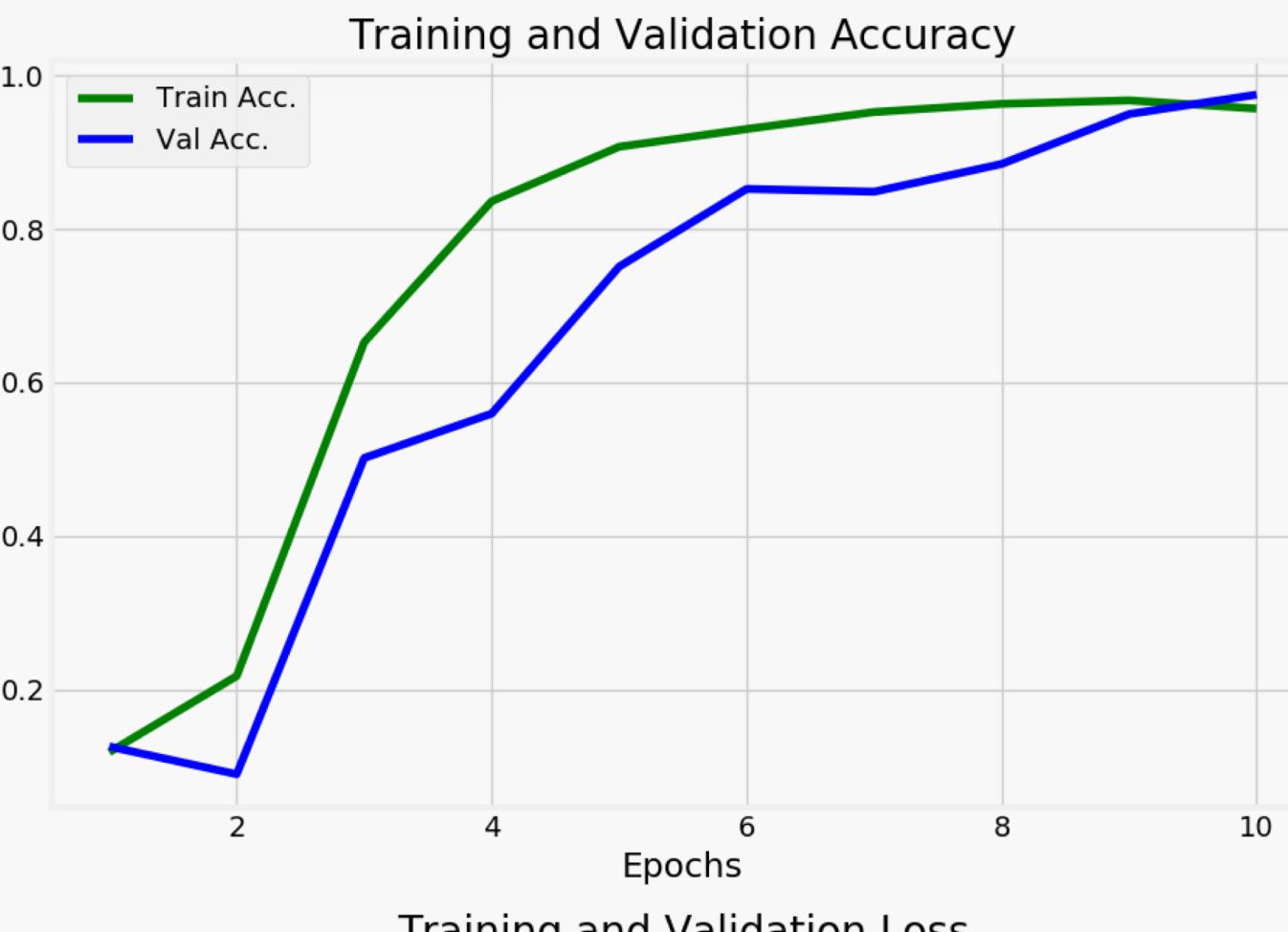
Training images: ~1200 per epoch

Validation images: 256 per epoch

Training Iterations: 10 Epochs

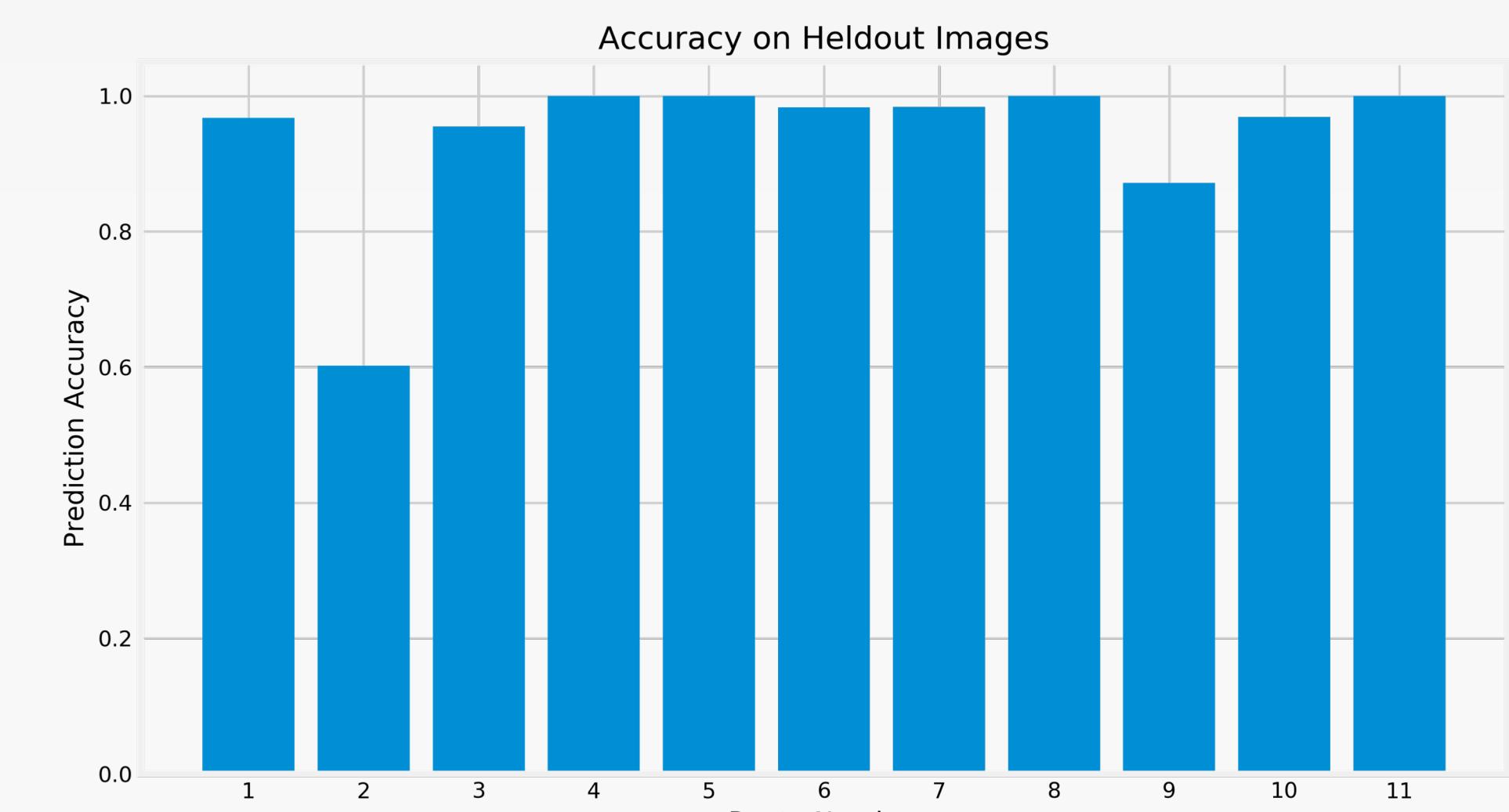
Training Acc: 97.1%

Validation Acc: 98.2%



## User Results

3 people took an additional ~800 photos of the 11 routes at Anarchy Wall. Each user was only given the instructions from the "How it Works" section for each route.



Route 2 Breakdown: Of the 40% of Route 2 wrong predictions, 90% were Route 8. Shadows cast in the heldout image set appear to mimic the geometry of rock features found on the right side of Route 8. An example training image of route 2 without shadows is shown on the right. To combat this issue a gray-scale color layer will be added to RRV2 (currently it is RGB).

