
Skeggøx Automatic Axe Scoring

Mitchell Karchemsky, Lynn Marciano, Parham Motameni

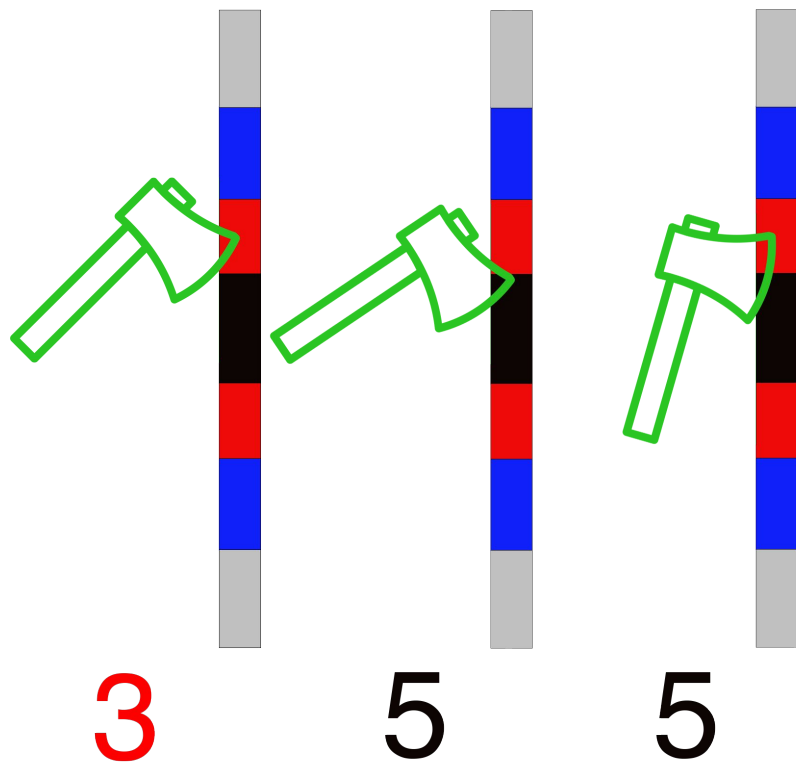
Motivation



- Axe Throwing!
- Human-Reliant Scoring System
- Lots of variability



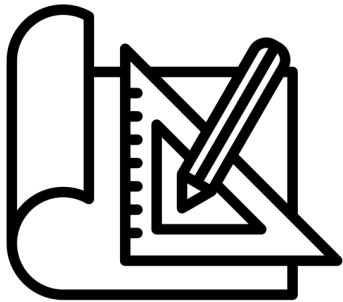
Picture of different scoring scenarios



Difficulty in scoring: Cross sectional view

Can we classify
axes with a
single image?

Design Rational



Design Rational

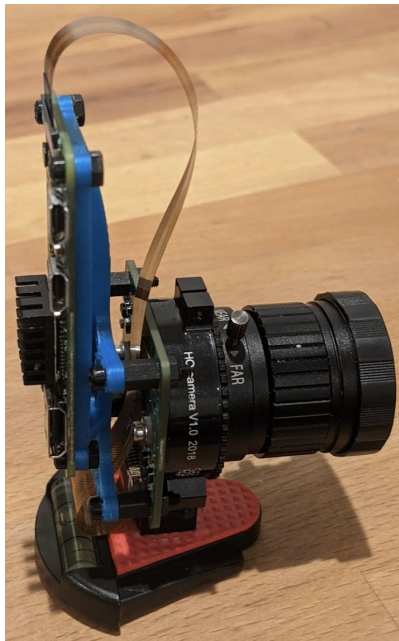
- Single point camera
 - No interventions or augmentations of existing setup
 - Collect and label our own data
 - Automatic reporting from video stream
-

Challenges

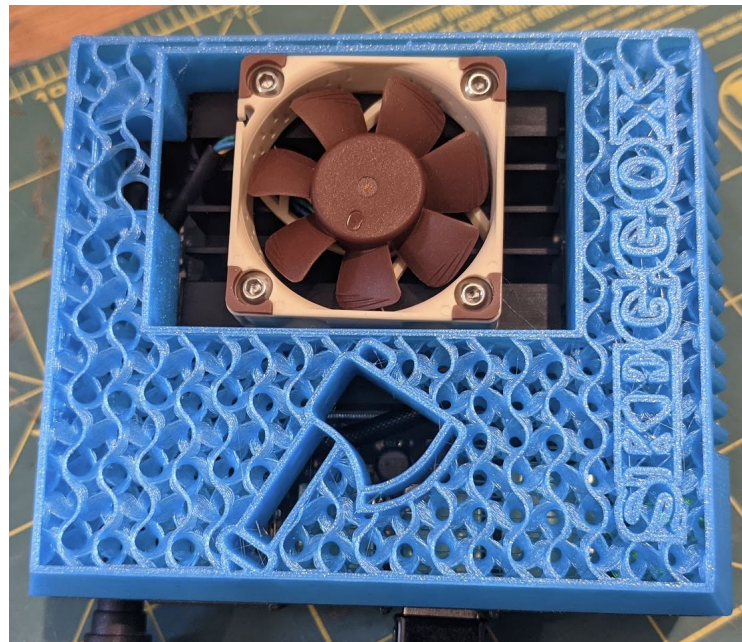


- Single point camera (No depth!)
 - Camera setup
 - Different axes
 - Different boards
 - Scoring is difficult
 - Human scoring
-

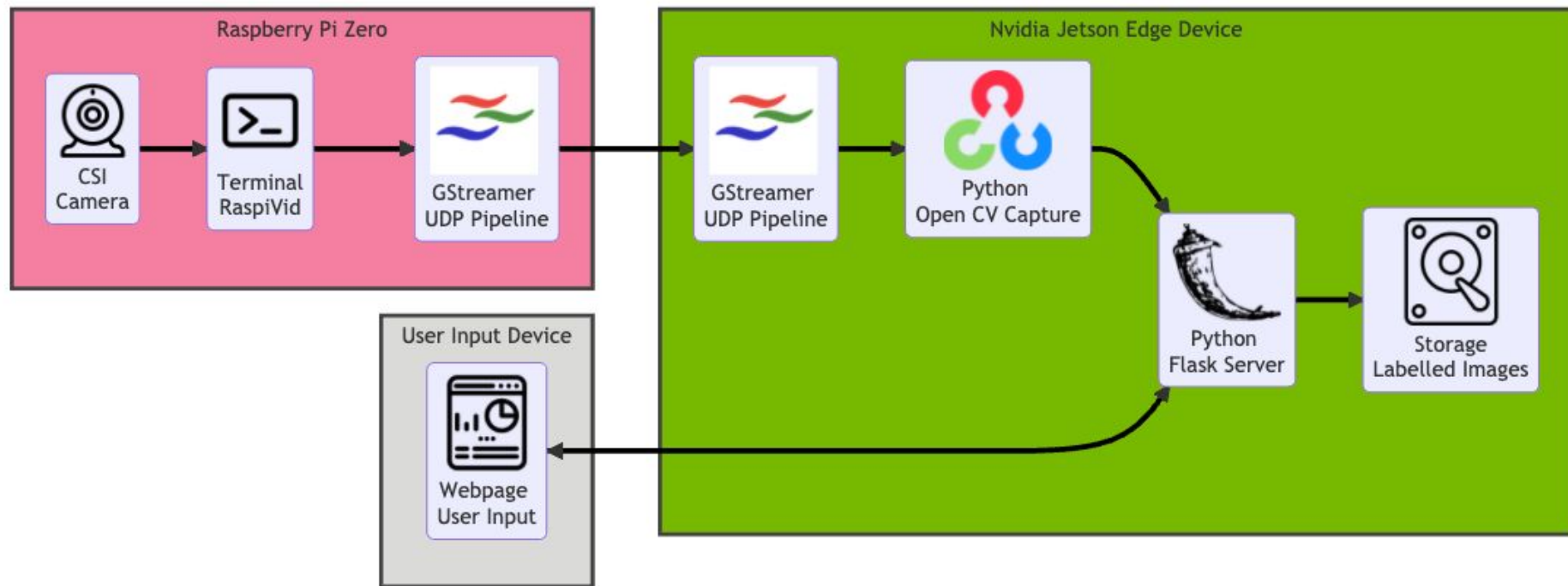
Implementation



Raspberry Pi 0
+ HQ Camera



Nvidia Jetson Nano





Camera




Skeggox

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Search, Share, Star, User icons

Skeggox: Capture



A large wooden board with a target consisting of three concentric circles: a small black inner circle, a medium red middle circle, and a large blue outer circle. A white marker is positioned vertically on the left side of the board. The board is set against a background of plywood and a chain-link fence. At the bottom, a black banner with the text '@LAXOFFICIAL' is visible.

1

3


5

L Clutch

R Clutch

0

Empty



static/caps/b7ba9c2d-4cb9-4732-83e8-11fde9366925_LC.jpg

1

3

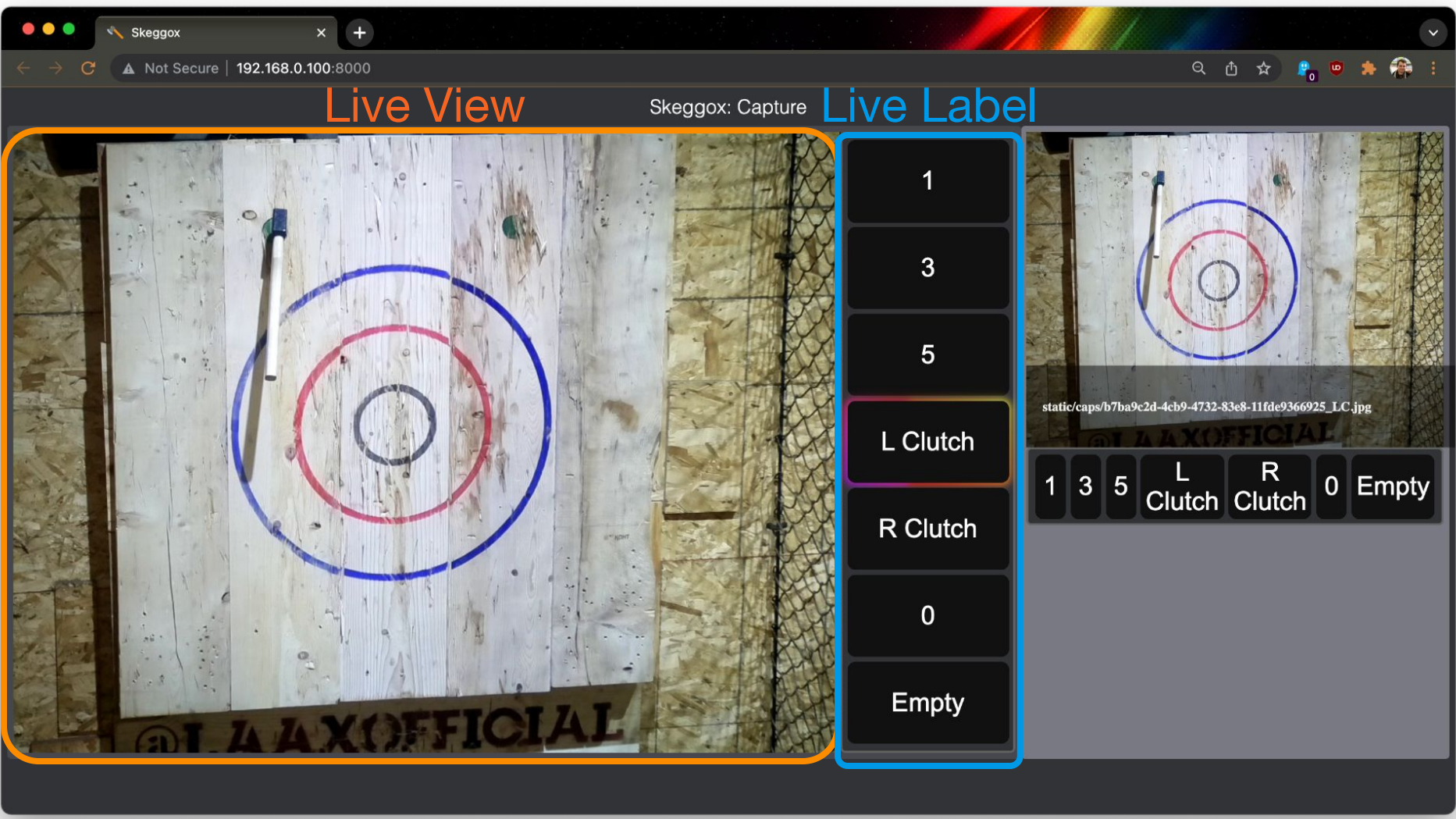
5

L Clutch

R Clutch

0

Empty



Skeggox

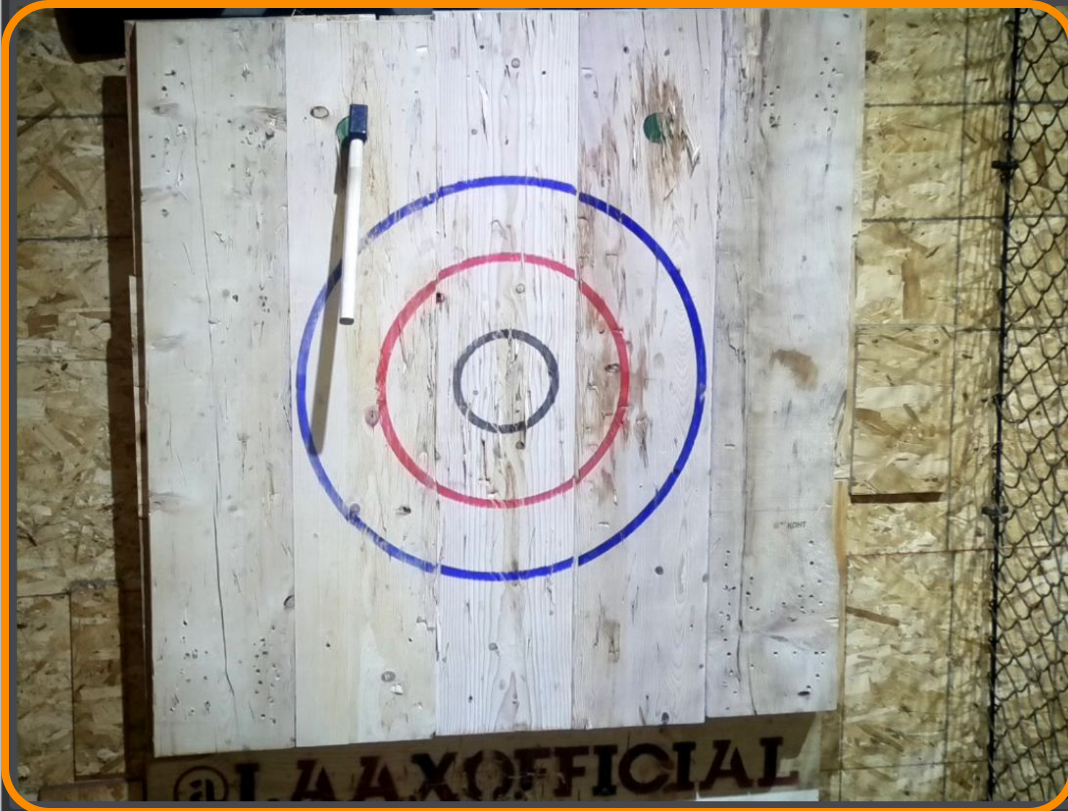


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Live View

Skeggox: Capture Live Label



1

3

5

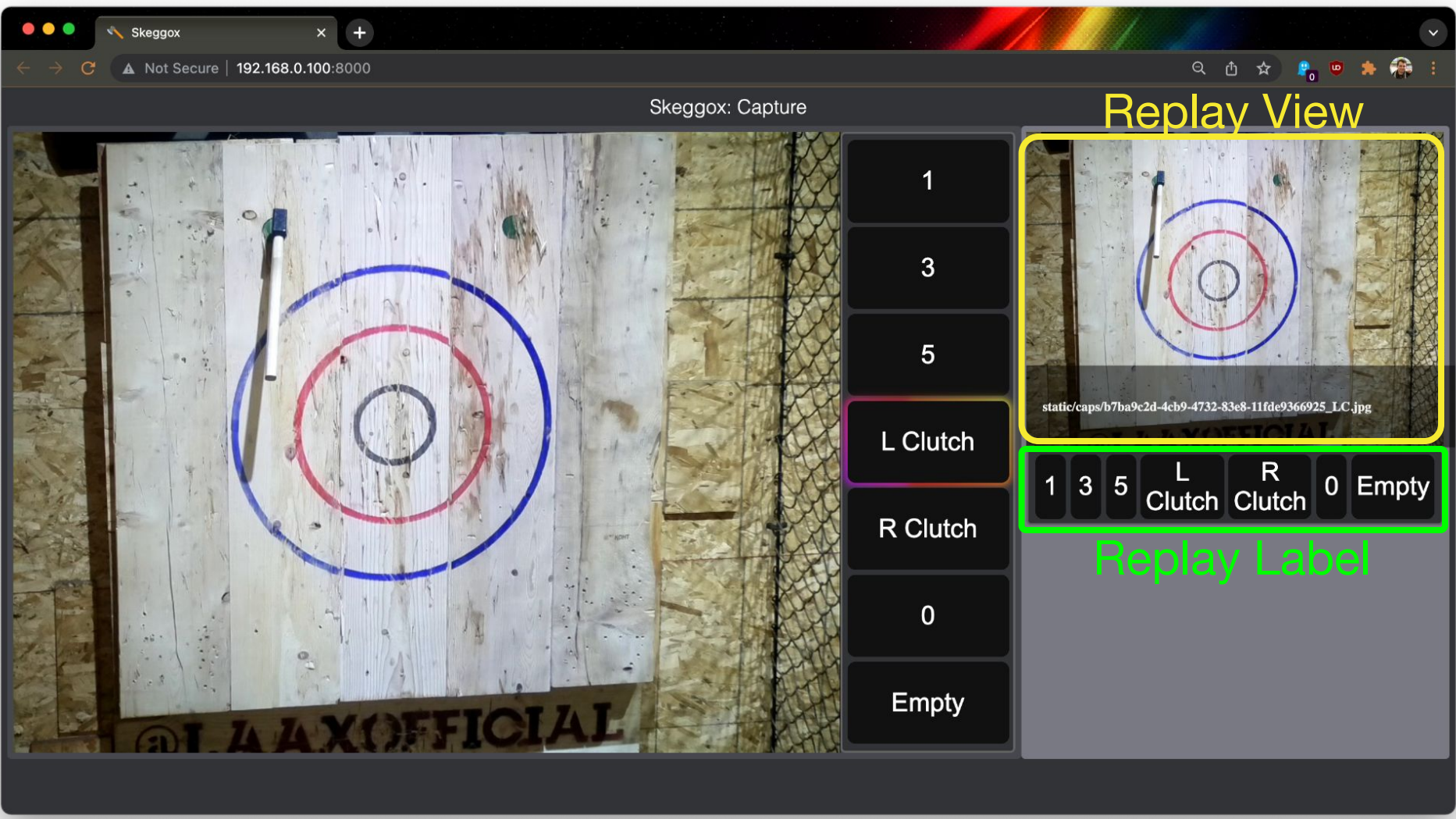
L Clutch

R Clutch

0

Empty

1 3 5 L Clutch R Clutch 0 Empty



Skeggox: Capture

Replay View



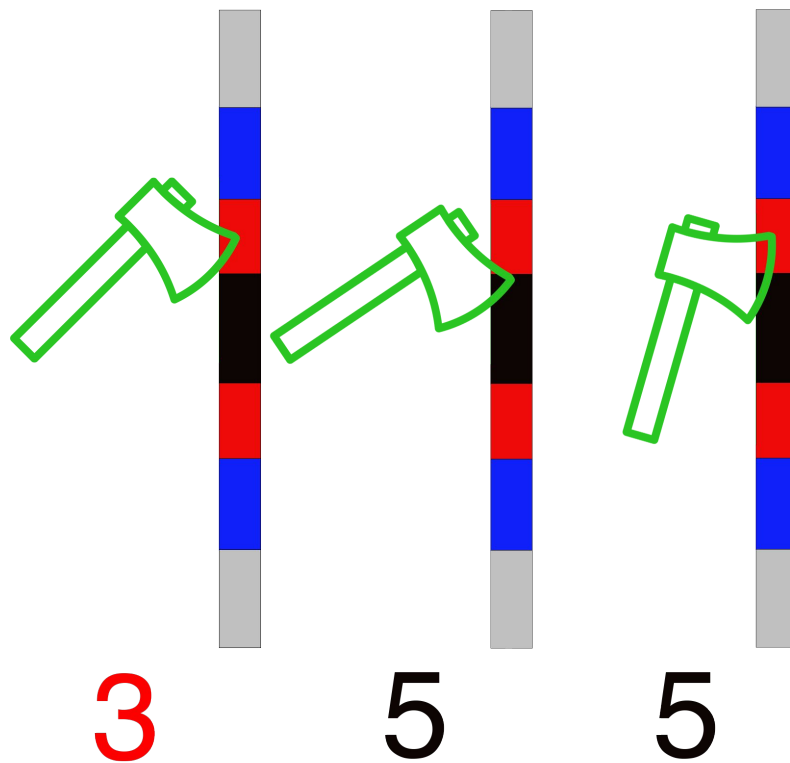
Replay Label

Data



Label	Count
5 Points	1588
3 Points	610
0 Points	291
1 Point	148
Right Clutch	82
Empty Board	82
Left Clutch	74

- Approximately 3000 Data points/photos
- Collected over 8 weeks
- High Data bias



Difficulty in scoring: Cross sectional view



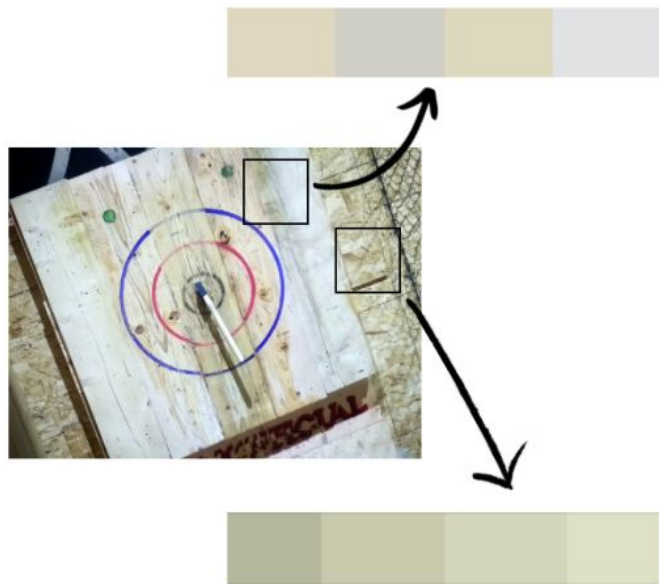
Difficulty in scoring: “Edge” Cases

Automated Scale and Crop

Challenges

Unreliable Edge Detection

Similar Board and Background Colors



Various Geometric Distortions



Pre-Processing Steps



Original



Blur + Binary +
Morphological
Transformation



Canny Edge
Detection



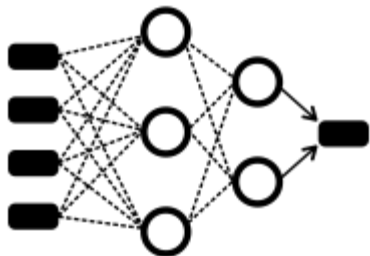
Probabilistic
Hough
Transformation +
Perpendicular
Line Coords



Final
Scale + Crop

Neural Network

Neural Network Setup

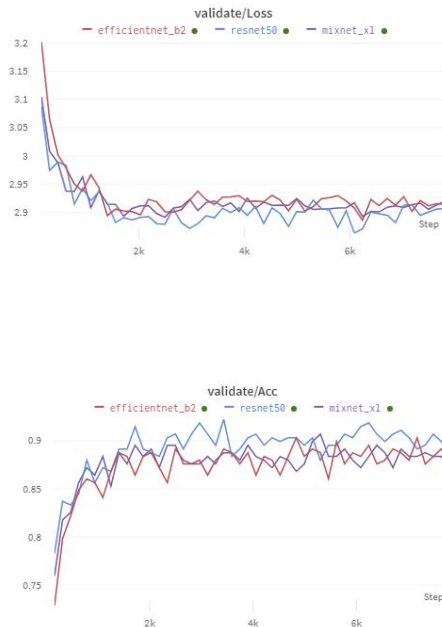


- Pytorch
 - Multiple architectures tested
 - resnet50, mixnet-xl, efficientnet_b2
 - Preprocess vs Raw
 - Visual Data transformations
 - Blur
 - Random Rotation (-10,10 degrees)
 - Random horizontal flip
 - {Left, Right} Clutch → Clutch
-

Model Summary Results

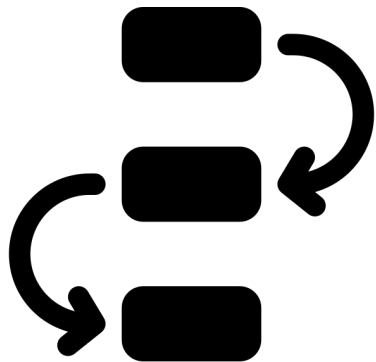
Unmodified Dataset

Model Architecture	Dataset Used	Validation Accuracy	Test Accuracy
MixNet-XL	Original 2700	93.18%	91.00%
MixNet-XL	Original 3031	90.70%	87.91%
ResNet50	Original 3031	92.25%	90.11%
EfficientNet B2	Original 3031	90.31%	89.23%



Utilizing Scale and Crop

Model Architecture	Dataset Used	Validation Accuracy	Test Accuracy
ResNet50	Scale + Crop 3031	91.47%	91.43%
MixNet-XL	Scale + Crop 3031	90.31%	89.45%
EfficientNet B2	Scale + Crop 3031	89.53%	87.47%



No-Pre-Process Network: Mixnet-xl

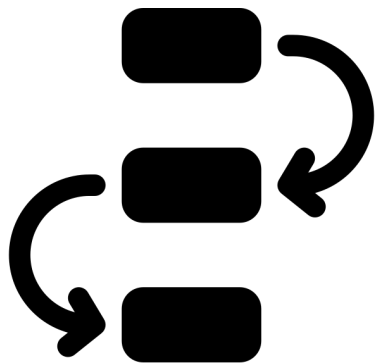


Score:

- 91% on validation dataset

Takeaways:

- Preprocessing may not be necessary
- Confusion Matrix looks good even with imbalance



Pre-Process Network: Mixnet-xl

Utilizing the Scale and Crop Images



Score:

- 91% on validation dataset

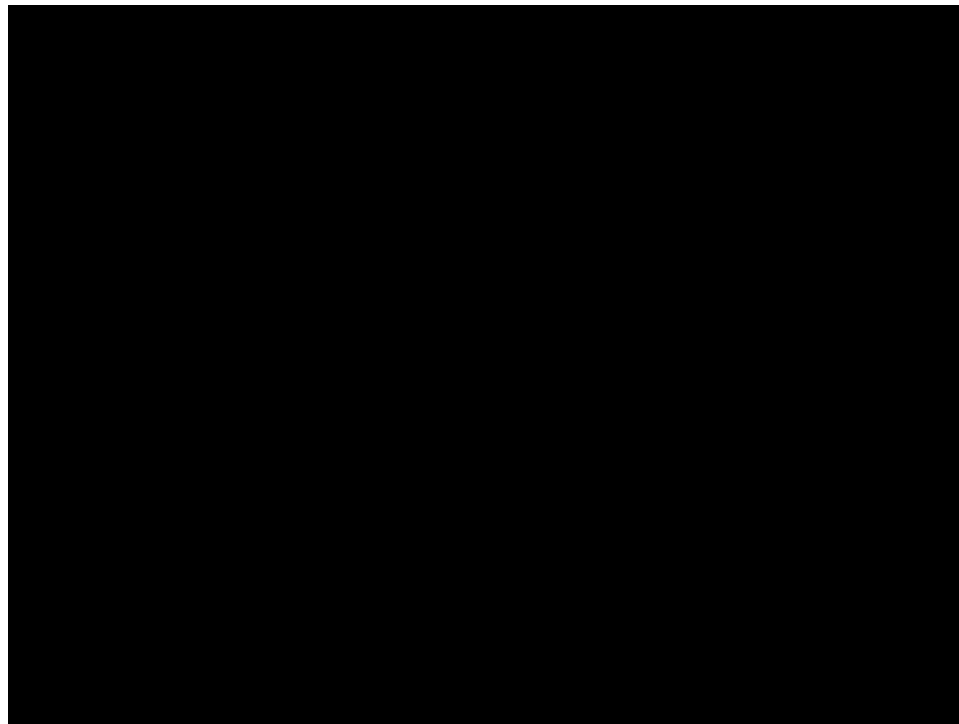
Takeaways:

- Only a slight improvement than original images

Results

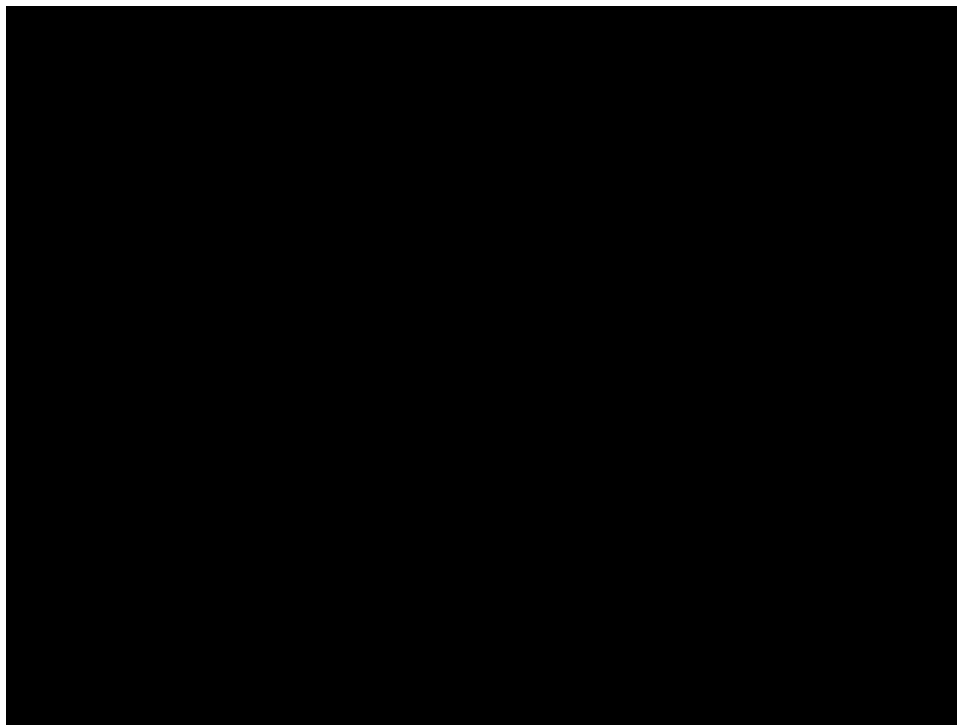


Results





Results



Discussion



Discussion and Acknowledgements

- More diverse data
 - Augmented Data Generation
 - Data Preprocessing - Overfitting?
 - More cameras/sensors
-

Skeggox

Automatic Axe Scoring

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actual:3 but predicted 5

f136ffe6-6cdb-46be-96e6-6d49c78d546d_3.jpg



actual:3 but predicted 1

a6dfbe32-3399-4ba5-83e1-ceb9d5e7650b_3.jpg



actual:0 but predicted 11

89e8a3ea-2a88-407e-8f49-6762ab268cf5_0.jpg



actual:3 but predicted 1

8644a60b-851a-4b85-97df-08ce3c4b0e55_3.jpg



actual:11 but predicted 0

88fe7936-07b3-4c8e-82f8-5f1a9510e230_LC.jpg



actual:5 but predicted 3

c1701a29-f578-4c86-a732-cc3a769eca34_5.jpg

