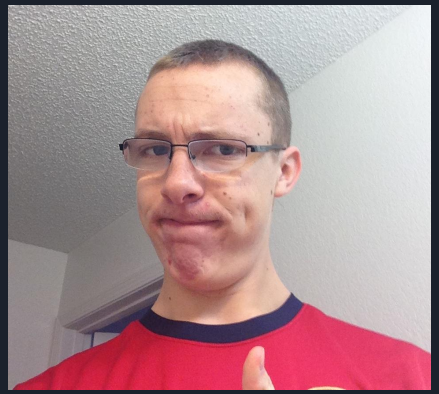
Pong Innovation

Better Ping Pong Through Science

Team



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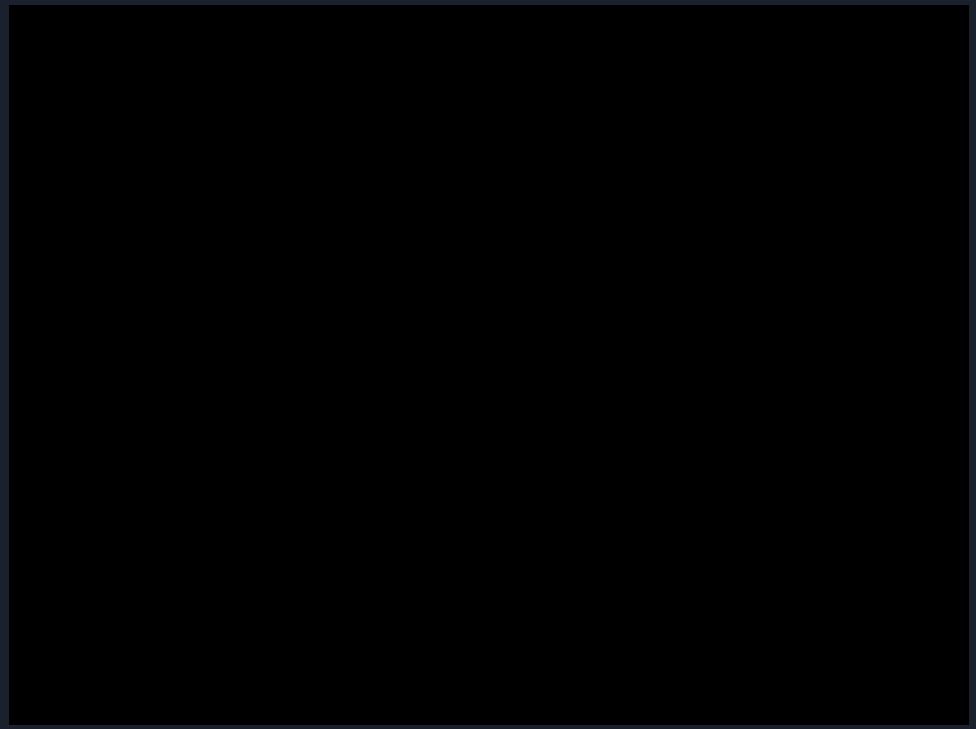
Project Description

Utilizing computer vision and machine learning to handle the least fun part of ping pong, keeping score, while providing statistical insights

Demo



Implementation - Stack

Match Referee:

- YoloV3
- Darknet
- Python

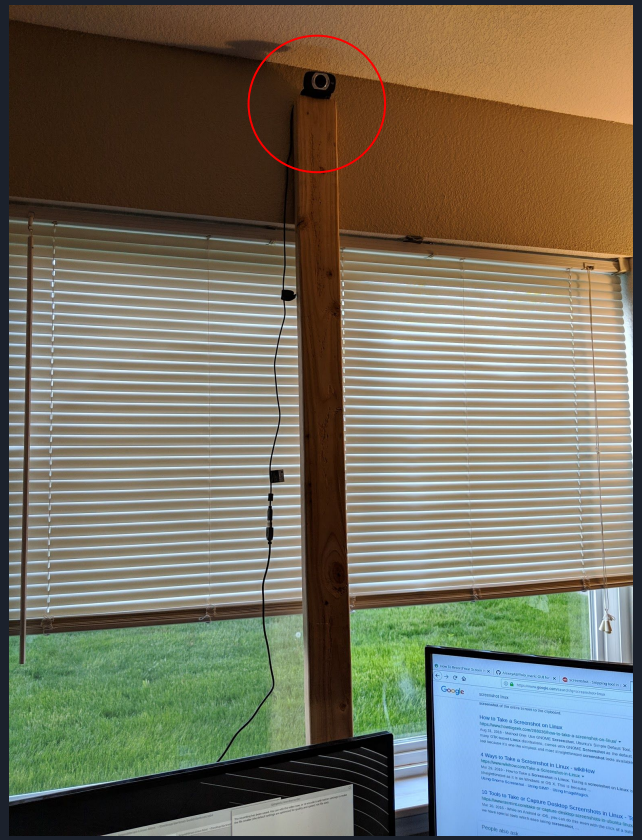
Stats Server:

- Bootstrap
- BoltDB
- Go

Project Management

- Agile... or not
- Simpler task tracking with schedule
- Open communication with group messaging
- Pair programming

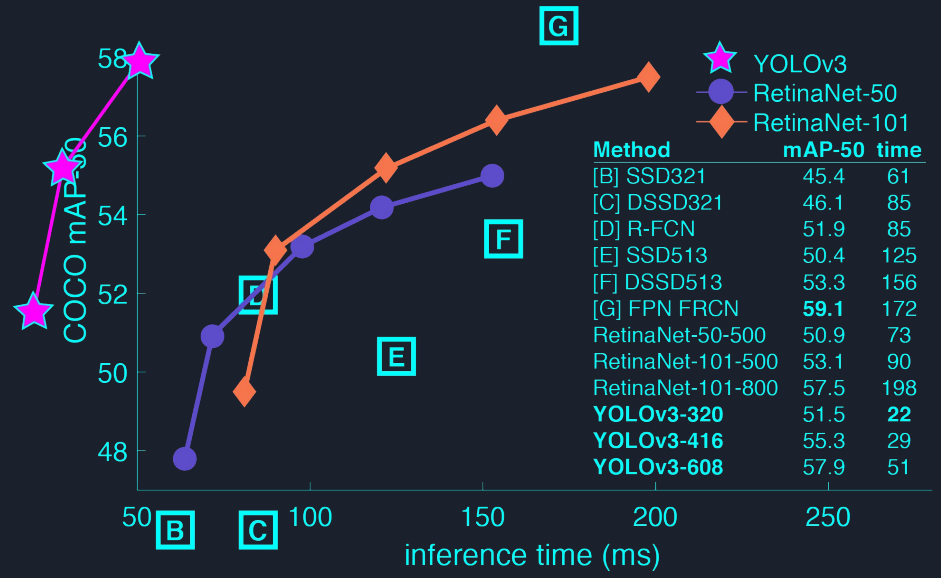
Implementation - Hardware



- Logitech - Full HD Portable Webcam
- Geforce GTX 1070ti
- 9 foot 2x4 (camera mounting apparatus)
- 2 Linen Sheets
- 5000 Lumen Light

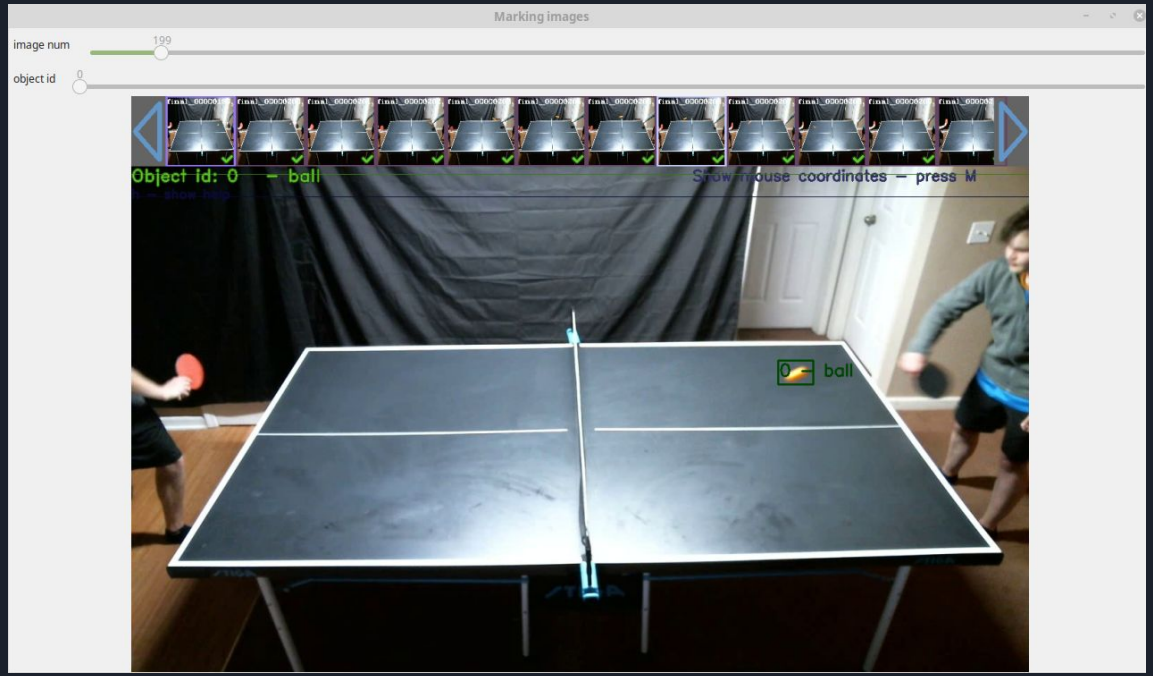
Implementation - Tracking the Ball

- YoloV3
  - You only look once (YOLO) is a state-of-the-art, real-time object detection system
  - Large Dataset (2000+ images per object for training)



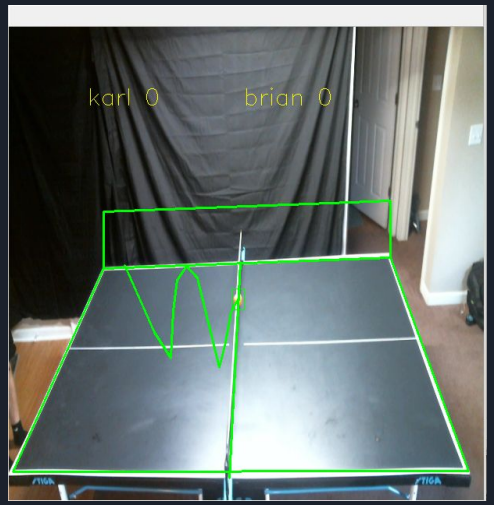
Implementation - Building Dataset

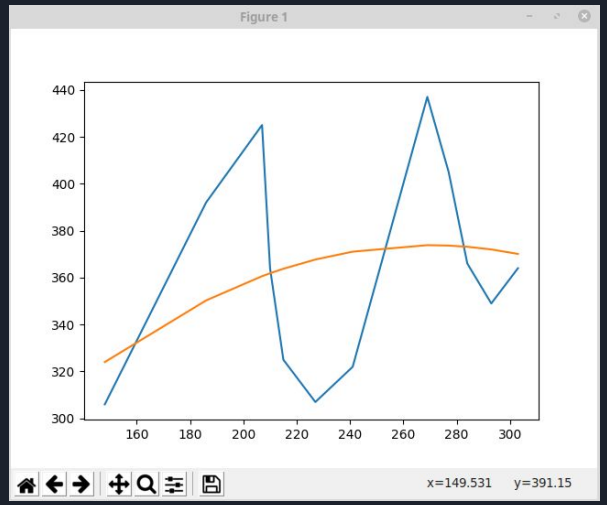
- Yolo Mark - Label bounding boxes
- Split up video into frames to draw the boundary boxes around object



Implementation - Side/Bounce Detection

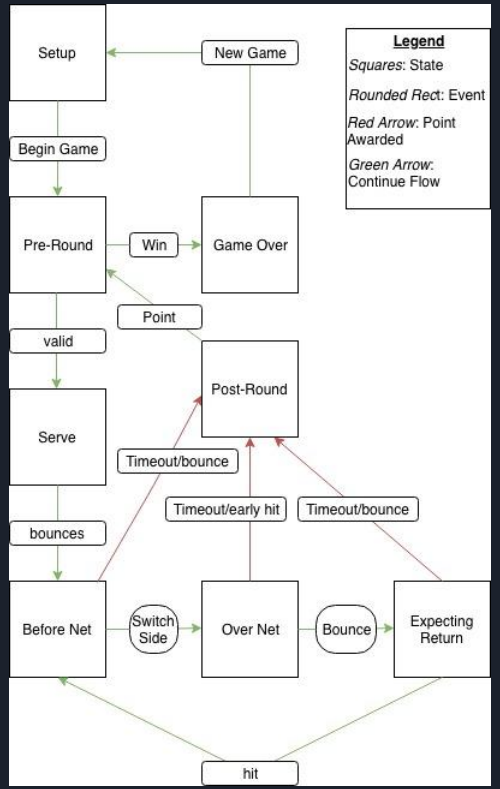
- Manually draw in boundaries of the table and the net
- Use the equation of the line that was drawn to determine what side the ball is on and if it is within the table boundary
- Bounce Detection is handled by storing the previous locations of the ball (x, y) in a list until the ball changes sides or timeout
    - Find change in direction by parsing the list





State System and Scoring

- Keep track of valid bounces to determine state of game
- Timer starts when the ball changes side (except on serves)
- Expected return when the timer starts
- Score points on timeouts



Stats Server

Pong Innovation Matches

Time	Player 1	Player 2	P1 Score	P2 Score
2019-05-05 16:35:21.801727 -0500 CDT	Brian	Alex	10	6
2019-04-28 21:09:12.354845 -0500 CDT	play1	play3	4	10
2019-04-28 20:53:22.536735 -0500 CDT	play1	play3	10	9

- Simple REST API
- Hands out match IDs to clients
- Stores all matches in a database (BoltDB)
- Updates the score of a match at the completion of the game
- Presents a match history interface

Testing

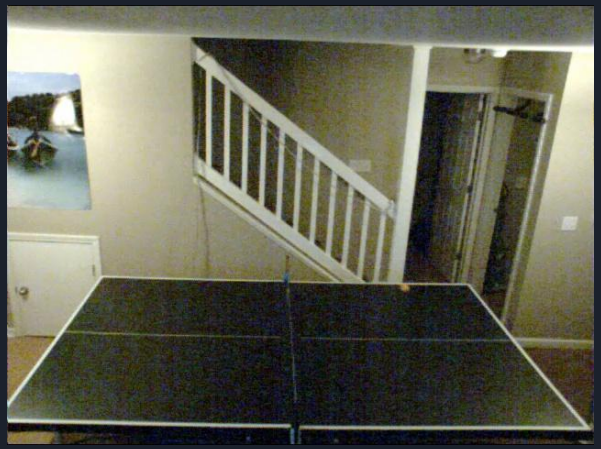
- Testing is challenging due to the highly variable nature of the game and tracking system
- Ability to feed captured video back into the system, which lets us test particular problematic cases
- A *lot* of manual iterative testing

Challenges - Tracking Method

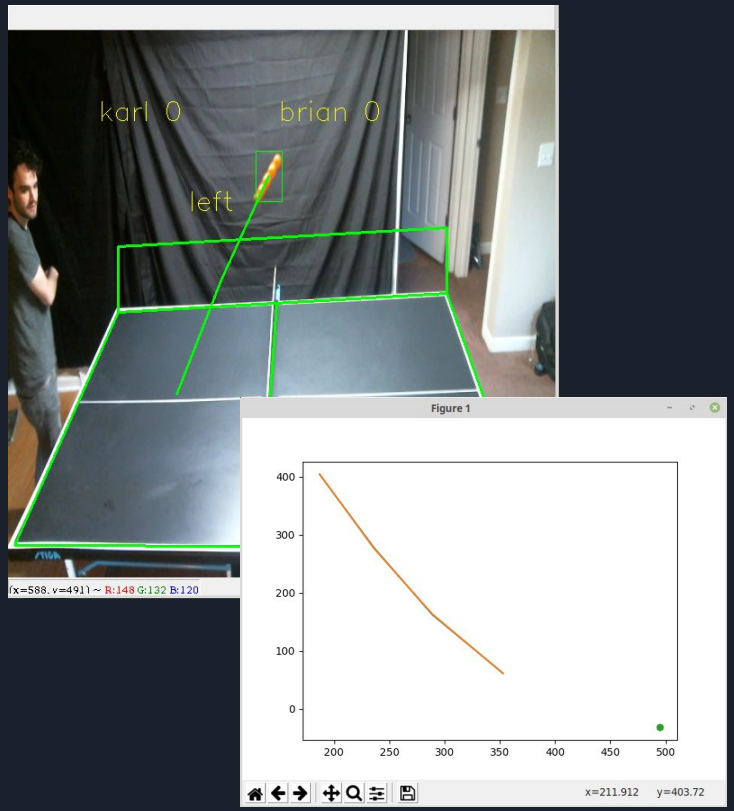
- Simple color detection inadequate at detecting ball due to lighting, camera quality, and the speed of the ball
- Building dataset for machine learning approach is time consuming
- Original datasets only consisted of 300-400 images and produced inaccurate detection of ball

Challenges - Camera and Environment

- Camera capability
  - PS3 eye camera boasts high frame rate, but inadequate fidelity
  - Single vs dual camera
- Lighting
  - bright, even lighting
  - consistency throughout the day



Challenges - Bounce Detection and Edge Cases



- 2D representation of 3D environment
- Parabola fitting (change in direction)
  - Always detects a min (location of bounce)
  - Too sensitive when bounce does occur
  - Occasionally only receive two data points before crossing sides (unable to verify if a bounce occured before crossing)
- Single low-budget camera
  - Limited GPU
- Alternate approach (sound)

Future Work

- Improving detection of edge cases and fine-grain ball tracking
- Opportunity for interesting statistics from historical match data
- Lowering the computational requirements

Questions?