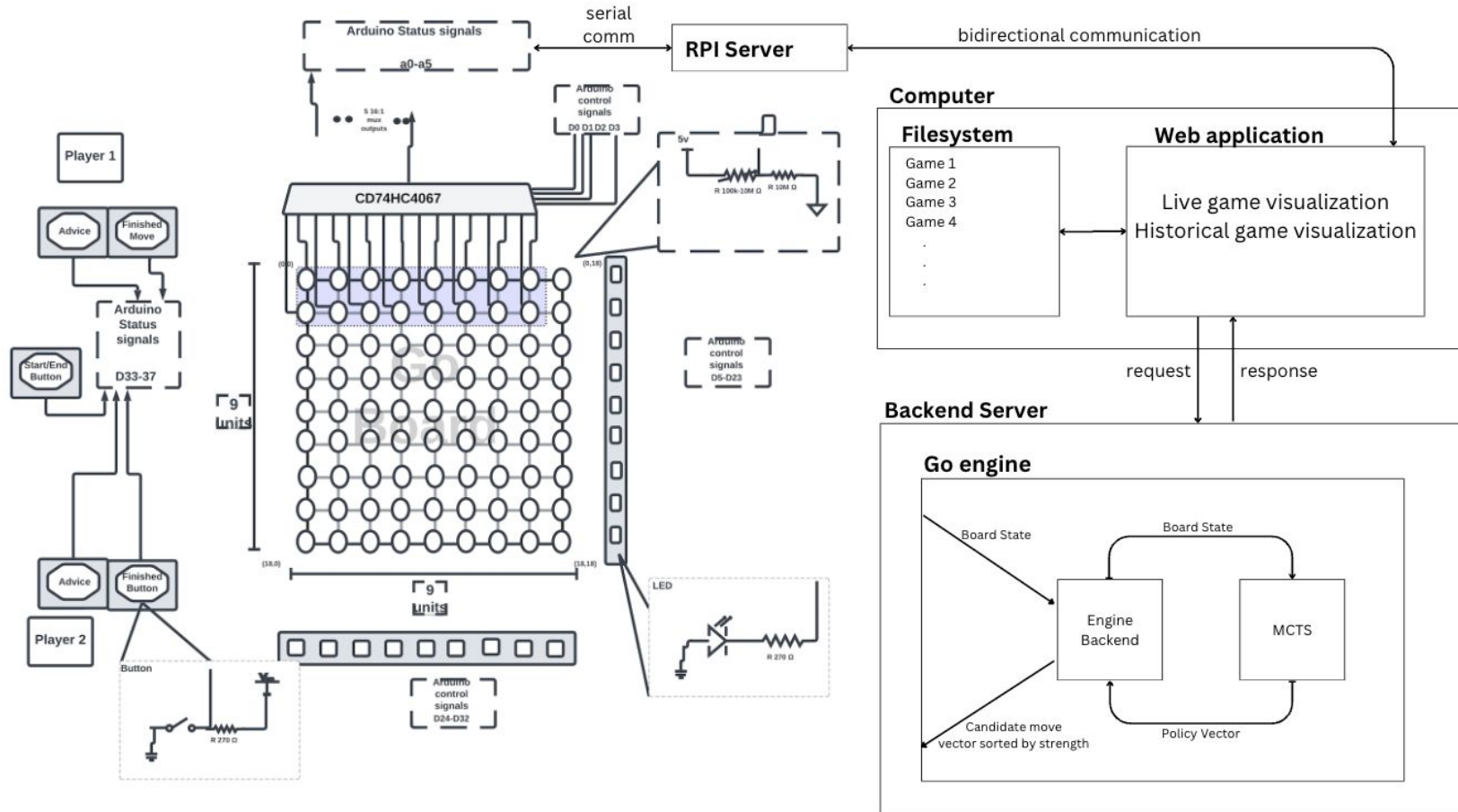Our product helps those learning the game of Go, especially beginners, improve their skills, which can then translate from a 9x9 board to the official 19x19, through:
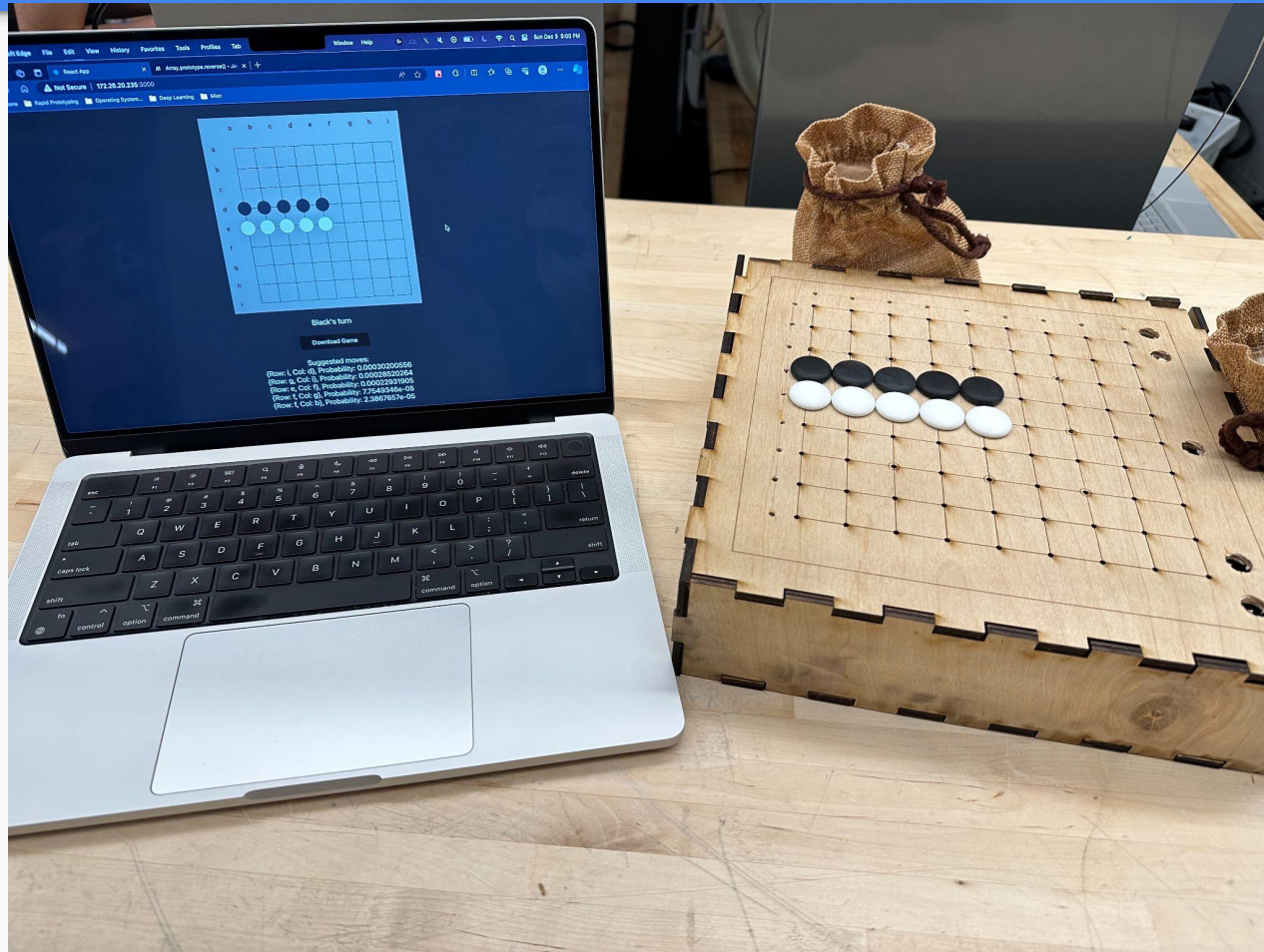
- Real time over-the-board analysis
- Historical Analysis and Suggestions via Monte Carlo Tree Search

Solution Approach

Verification, Testing, Validation - Quantitative Measurements

Specific Test	Target Result	Measured Result
Game State Read Latency	50 microseconds	45 microseconds
Light Configuration Latency	50 microseconds	49 microseconds
Board Accuracy	100%	100%
Backend Server Response	3 seconds	1.777 seconds (median)
RPi Server Response Time	.5 seconds	0.052 seconds (median)
Engine Strength	Amateur 5-Dan	Not Applicable
Board Classification	90%	94.98%

Hardware Results

Electrical readings when piece is placed on board
- 1M resistor selection
- 10M resistor Selection

Electrical readings when piece is not placed on board
- 1M resistor selection
- 10M resistor Selection

Hardware latency performance
- Setup time
- Gamestate read time
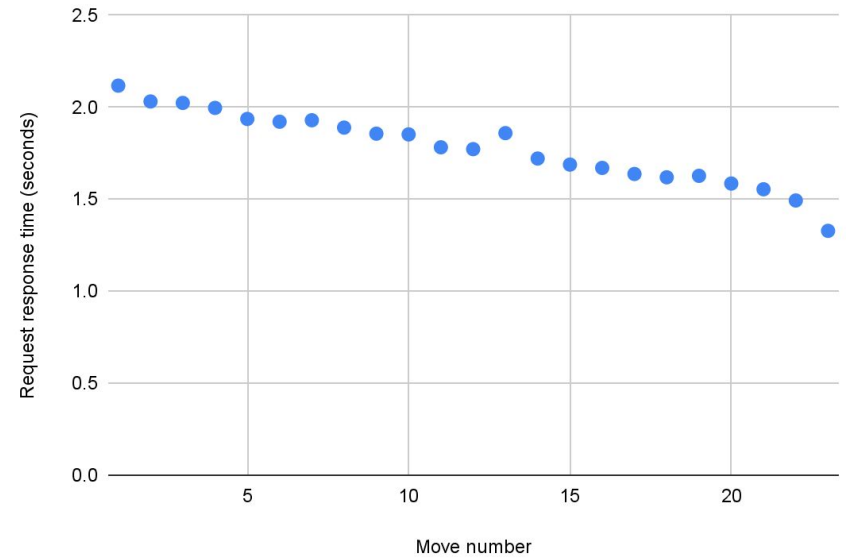
Software Results

Response times for requests to engine endpoint
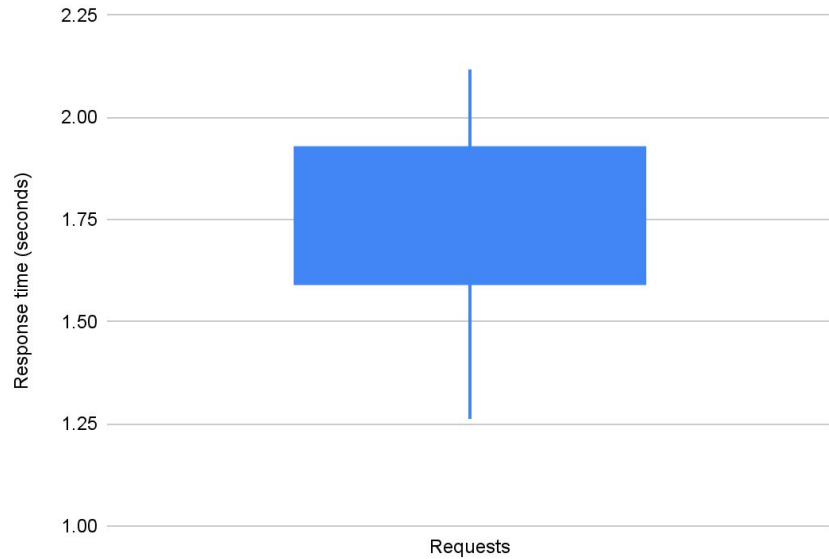
Response times for request at a specific move number

Software Results

Response times for bidirectional communication
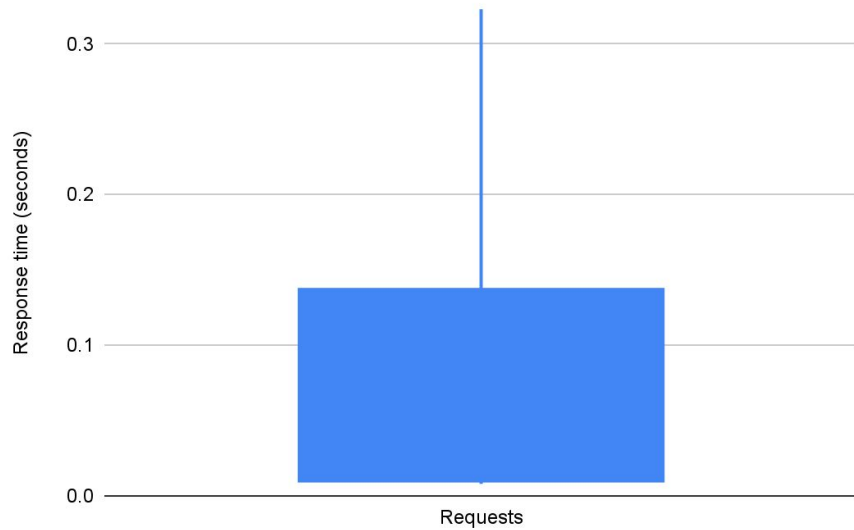
Response time for bidirectional communication
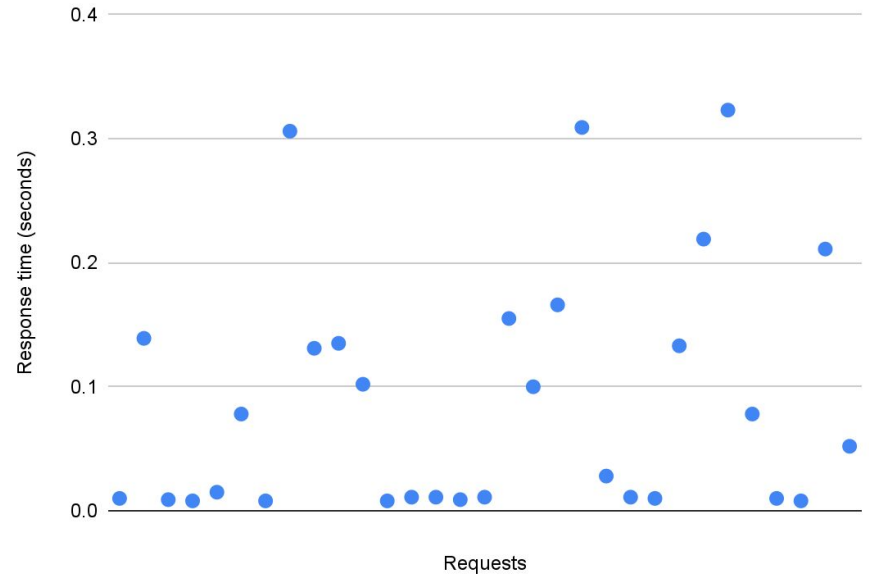
Engine classification results:
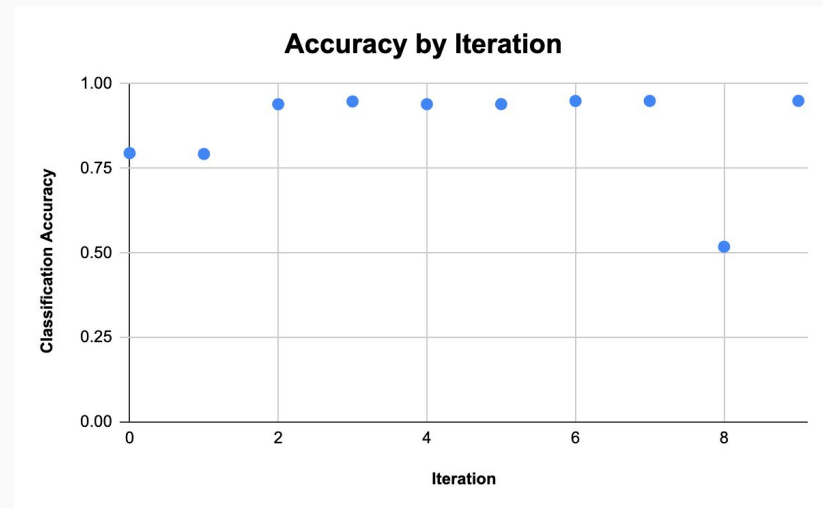
Design Trade-Offs - Engine

- Network Strength vs Evaluation Speed:
  - Larger, more complex networks take more time to evaluate positions
  - Stronger networks require less depth to achieve similar accuracy
  - A stronger policy network requires fewer value network evaluations

Binary Cross-Entropic Loss	Epoch Training Time (s)
.1295	220
.1113	400
.0943	450
.6925	600
.0946	650

Design Trade Offs - Software

	Server side engine computation	**Client side engine computation**
Pros	Computation time generally consistent	No need to communicate over the network → no added latency
Cons	Communication over network adds latency (.02 seconds latency)	Computation time depends on device Need to translate engine code into javascript (tf.js 10-15x slower than tensorflow)

Design Trade Offs - Hardware

	Laser-cut GO board vs pre-made board	**Wired Circuitry vs Vector Board/PCB**	**Photoresistor vs Photosensor**
Pros	Laser-cut board is easily constructed and more customizable.	Wired circuits can be mounted on top of board. Less need for precise measurement.	Photoresistors are very cheap for larger quantities. They simplified circuit design.
Cons	Required laser cutting experience.	Integration and development very time consuming and hard to manage.	Their threshold is more inconsistent

Project Management

	Sep 18 - Sep 24	Sep 25 - Oct 1	Oct 2 - Oct 8	Oct 9 - Oct 15	Oct 16 - Oct 22	Oct 23 - Oct 29	Oct 30 - Nov 5	Nov 6 - Nov 12	Nov 13 - Nov 19	Nov 20 - Nov 26	Nov 27 - Dec 3	Dec 4 - Dec 10

Milestones: FALL BREAK · Integration pt1 · Interim demo · Integration pt2 · Final Demo

Israel

- Develop software for Interfacing Protocol — Done — I
- Laser Cut 19x19 board — Done — I
- Design vector board layout — Done — I
- Modify board and board interior for sensor placement — Done — I
- Start light sensors placement — I
- Light sensor mini-circuit soldering — I
- Laser cut 9x9 board — I
- Create custom board schematic for build — Done — I
- Order test-parts — Done — I
- Second parts order — Done — I
- Test threshold for resistor — I
- Test sensor and configurations for software — In Progress — I

Hang

- Setup React Web Page — Done — H
- Start visualization of the live gameplay — H
- Start virtualizing game history and analysis — Done — H
- Work on saving Game History — Done — H
- Loading saved game states — Done — H
- Develop backend server — Done — H
- Set up raspberry pi to host server for bidirectional communication — Done — H
- Create the server for bidirection Arduino + adapting UI to 9x9 board — Done — H
- Slack — Done — H
- Serial comm between Arduino and RPi — In Progress — H

Nathan

- Build Go Framework — Done — N
- Build Training Framework — Done — N
- Training Data Sourcing — Done — N
- Value Network Architecture & Training — Done — N
- MCTS Debug — Done — N
- Continual MCTS and Network Tuning — Done — N
- Adaptation to 9x9 Board — Done — N
- Extra 9x9 MCTS — In Progress — N