EyeSpy – Gaze Prediction

Gus LeTourneau | Min Seong Kang

CSCI 1430

Motivation

Uses of Gaze Prediction:

- UI/UX design and development
- Psychology and market research
- Accessibility tools

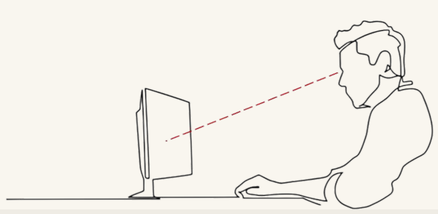
Limitations to State-of-the-Art Tech:

- Cost
- Portability

Project Goals

Create web application that:

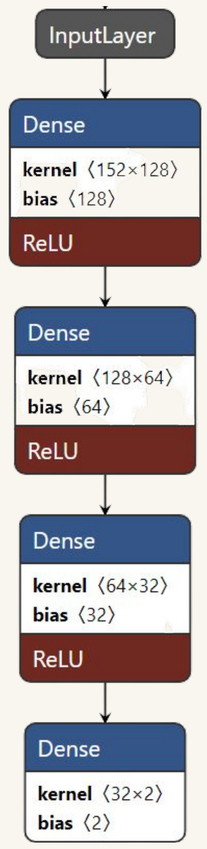
- Collects eye data from webcam
- Trains model using collected data
- Visualizes predicted live user gaze



Model

Architecture

- Multiple regression via feed-forward NN
  - 3 hidden dense layers decreasing in size
  - ReLU activation function
  - Linear output → predicted gaze coords



Optimizer

- Adam (SGD + adaptive moment estimation)
  - Learning rate: 5e-4

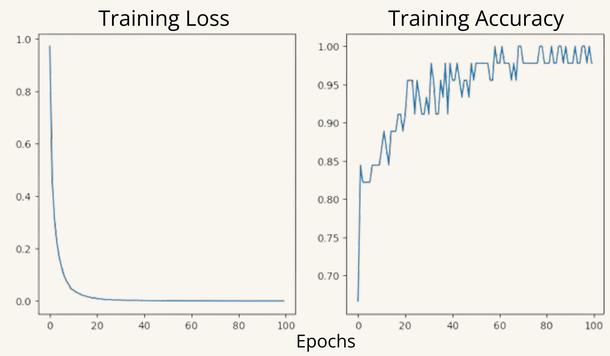
Loss Function

- Mean squared error
  - Seeks to minimize distance between prediction and true gaze location
  - Penalizes large error

$$\frac{1}{n}\sum(y_i - \hat{y}_i)^2$$

Results

Quantitative



- Test average Euclidean distance: ~125 relative pixels

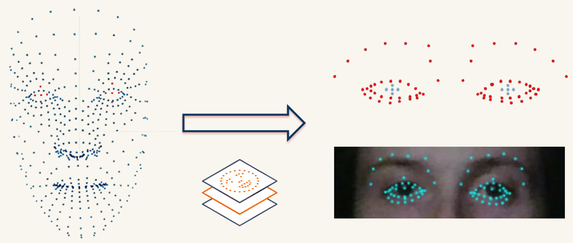
Qualitative

- Predictions are jumpy, even when gaze is stationary
- Some gaze regions are more accurate than others
- Sensitive to shifts in user position and head orientation

Data

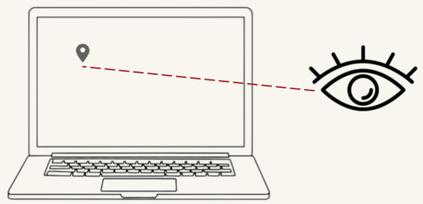
Samples

- TensorFlow.js face landmark model
- 76 eye points → 152 features (x,y)



Labels

- (x,y) coordinates of user gaze on screen



Preprocessing

- Samples and labels are on different scales
- Standardize all training features
- Necessary to get low loss

$$z = \frac{x - \mu}{\sigma}$$

Future Enhancements

- Restrict sample space to face box
- Input data augmentation
  - Apply shifts, scale changes and small rotations
- Adjust the model
  - Modify complexity, fine-tune hyperparameters

References

[1] A. Papoutsaki, P. Sangkloy, J. James Laskey, N. Daskalova, J. Huang, J. Hays. WebGazer: Scalable Webcam Eye Tracking Using User Interactions
[2] G. Ahmad. A Study of Eye Tracking Data based on Multiple Regression Analysis
[3] A. Yuan, A. Vakunov. Iris landmark tracking in the browser with MediaPipe and TensorFlow.js

Acknowledgements

Mentor TA: Jared Cambier