# Toronto AI IOL Model: Preliminary Analysis

Aaron Tan MASc PhD(C)
Luqmaan Moolla MEng MD(C)
Austin Pereira MD MEng

1. Faculty of Applied Science & Engineering, University of Toronto
2. Faculty of Medicine, University of Toronto
3. Department of Ophthalmology and Vision Sciences, University of Toronto

# What is Artificial Intelligence?

The theory and development of computer systems able to perform tasks that normally require human intelligence

How will it help us?

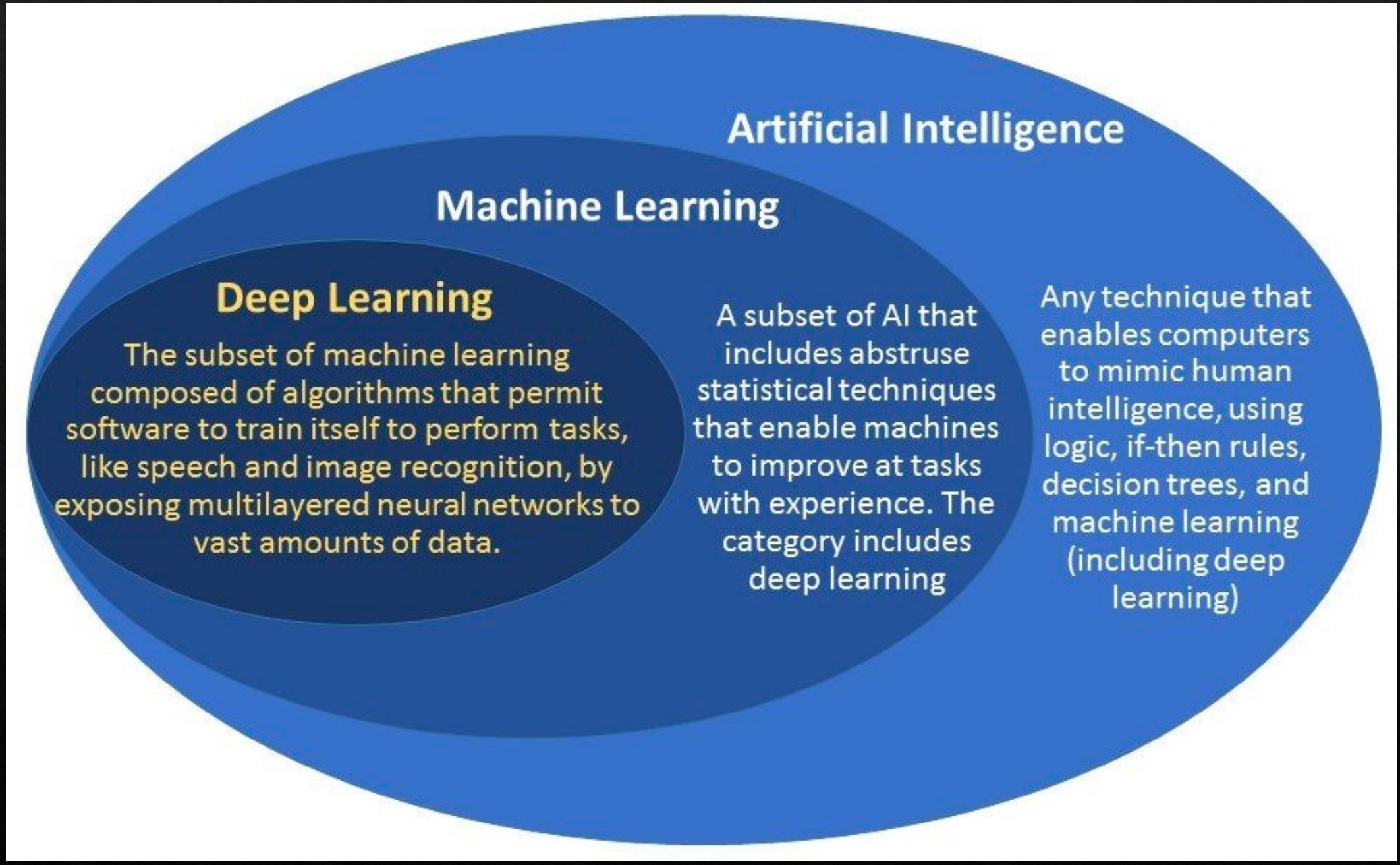
- It can analyze large data sets
- Identify intricate relationships (ex. Impact of biometric parameters on refractive error)
- Models can be continually be optimized

# Machine Learning and Deep Learning

## Simplified Definitions

**Machine Learning**: The use of algorithms to analyze data, learn from it, and then predict a particular endpoint.

**Deep Learning:** A specialized subset of machine learning that utilizes neural networks to enable the computer to learn through example. It does this though using multiple layers of non-linear processing units to extract features from data.


Artificial Intelligence
Any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning)
Machine Learning
A subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning
Deep Learning
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.

Data Flair

# Deep Learning Vs Machine Learning

| Factors | Deep Learning | Machine Learning |
| --- | --- | --- |
| Data Requirement | Requires large data | Can train on lesser data |
| Accuracy | Provides high accuracy | Gives lesser accuracy |
| Training Time | Takes longer to train | Takes less time to train |
| Hardware Dependency | Requires GPU to train properly | Trains on CPU |
| Hyperparameter Tuning | Can be tuned in various different ways. | Limited tuning capabilities |

# Our AI Model

Based off deep learning algorithms

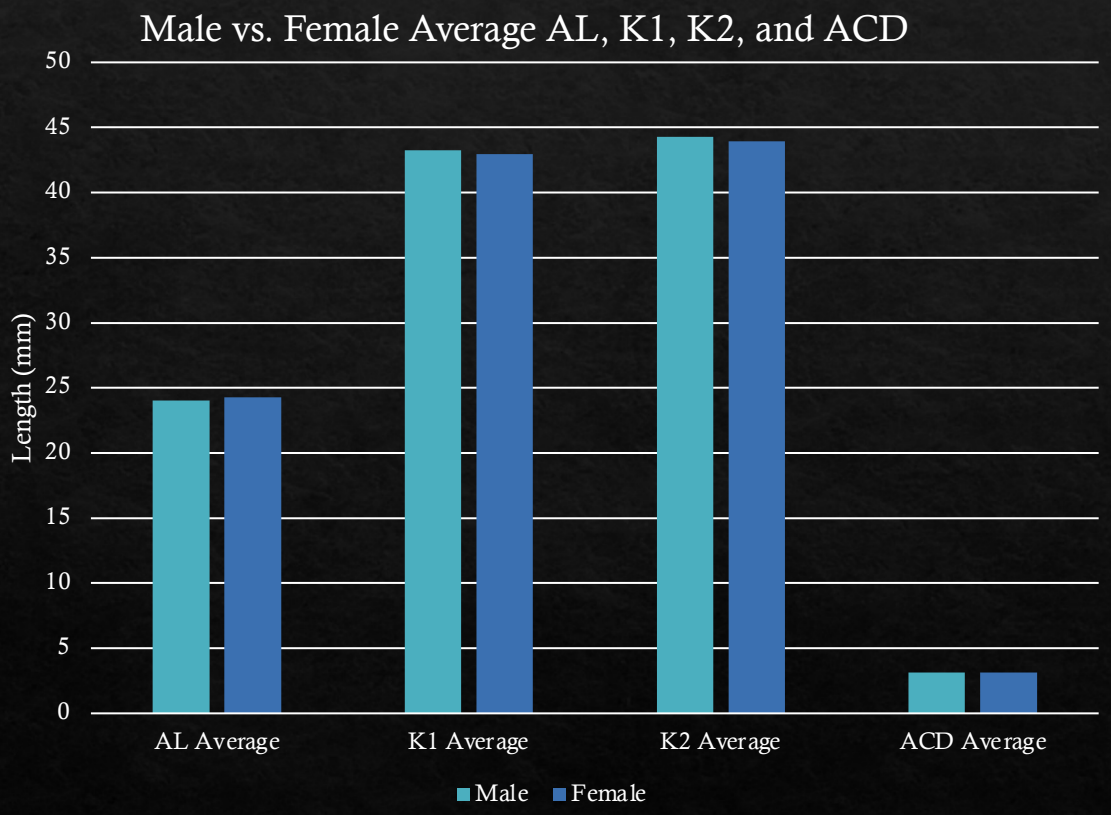
Allows for a complex analysis of biometric parameters and refractive error

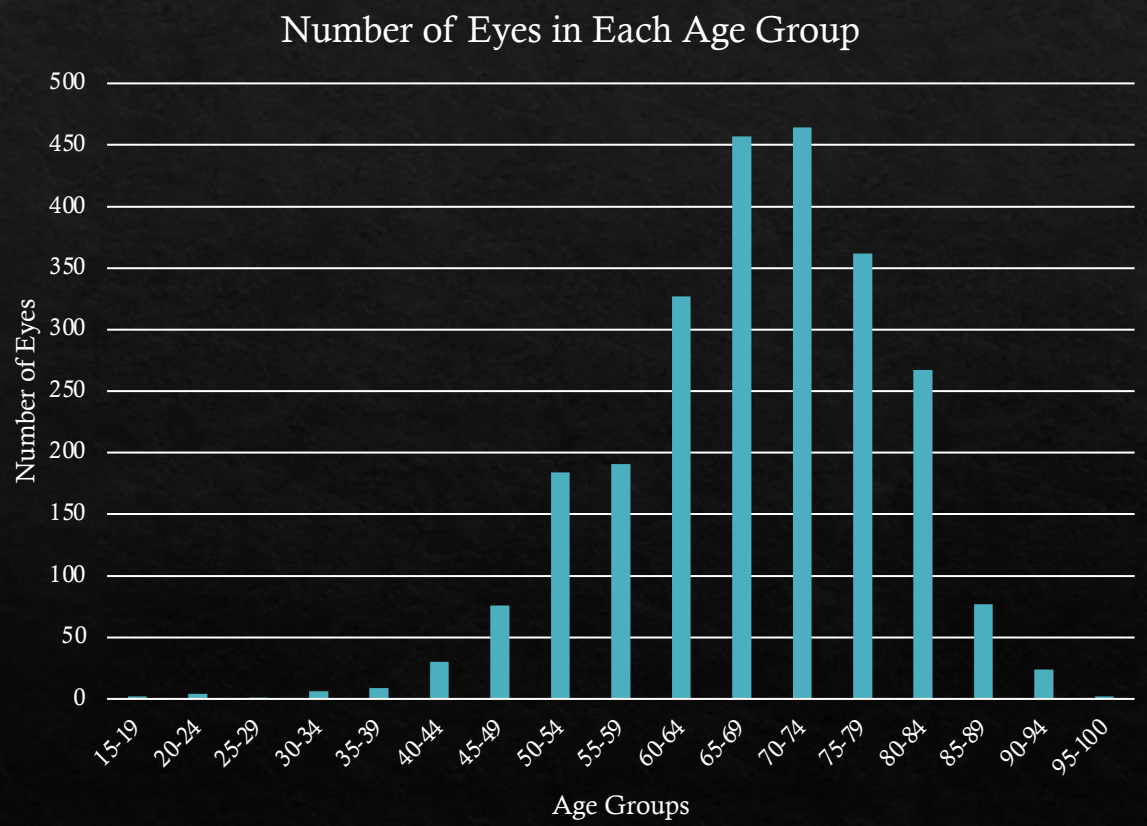
Will be structured to facilitate large data sets

# Preliminary Analysis

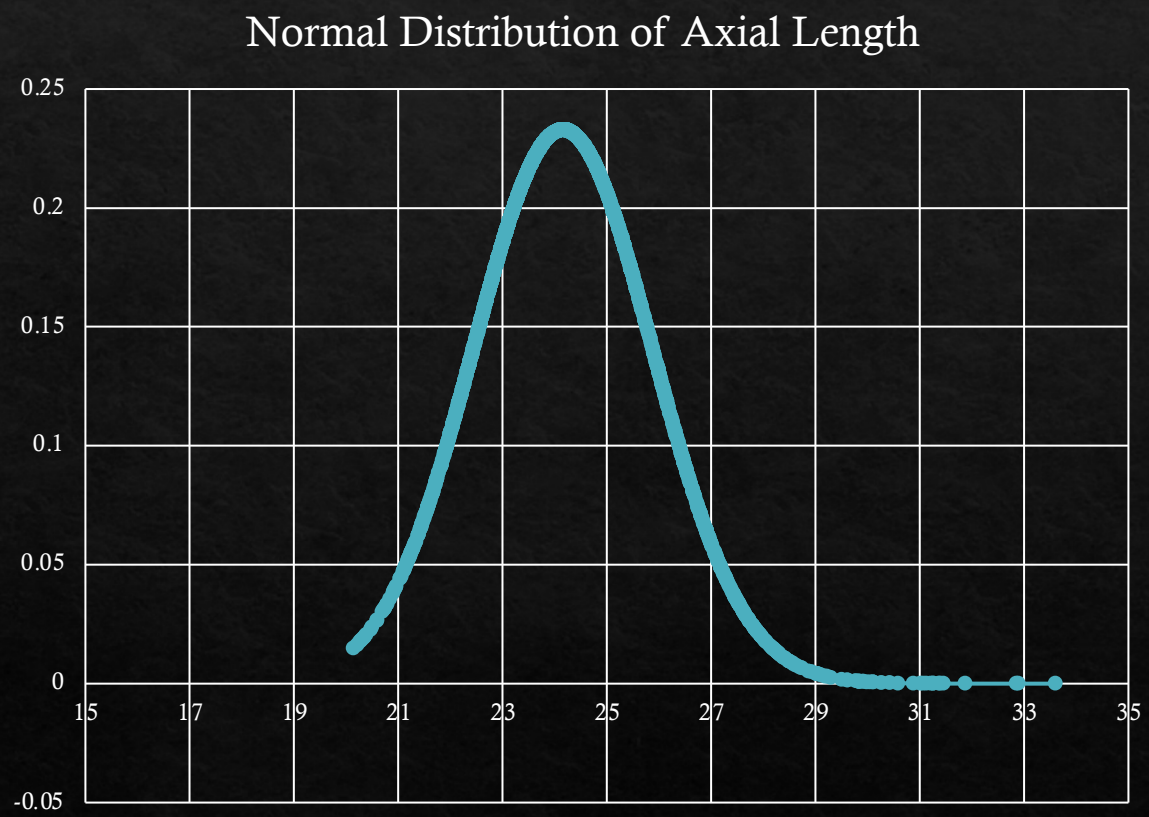
- Used database from retrospective study (n = 764) and database from 2018 FLACS study (n = 2089) *Some eye were excluded for missing variables
  - A total of 2490 eyes were included in the development of the AI model
  - Demographic parameters included: age, sex
  - Biometric parameters included: Axial Length , Anterior Chamber Depth, K1, K2, A constant,
  - Not included: Lens Thickness, White to White Diameter, Central Corneal Thickness

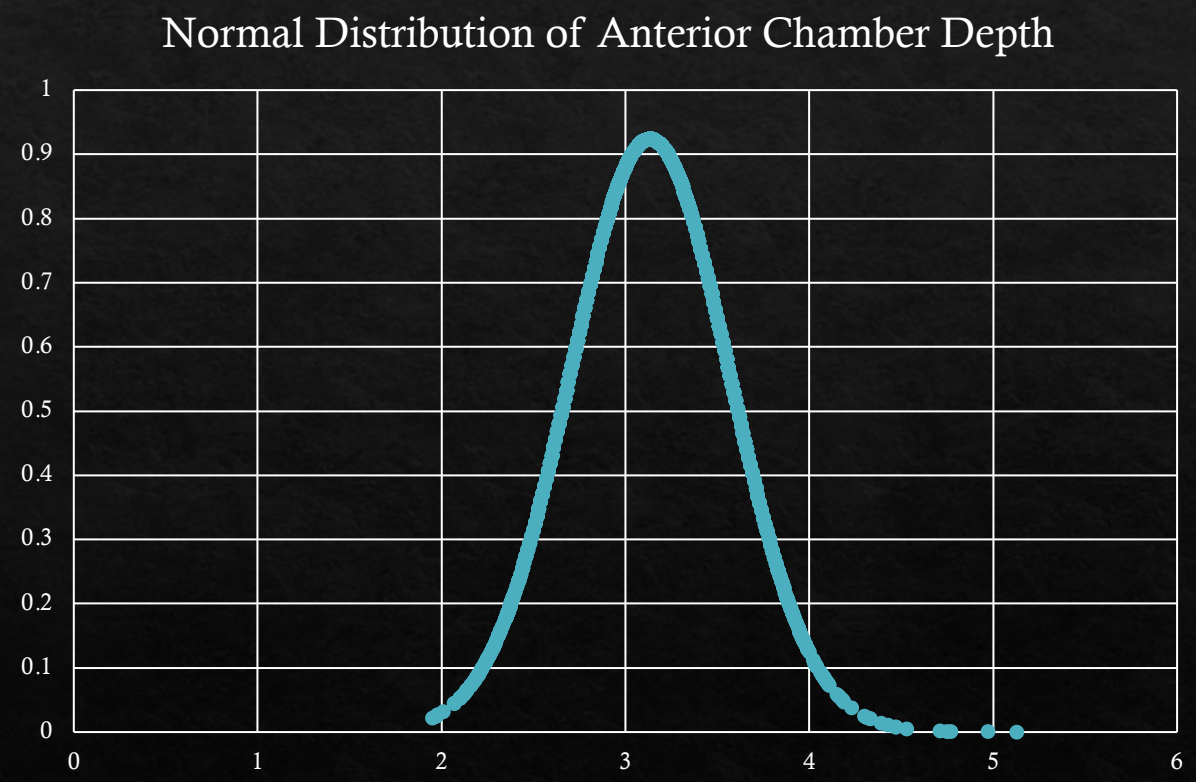
# Exploratory Data Analysis



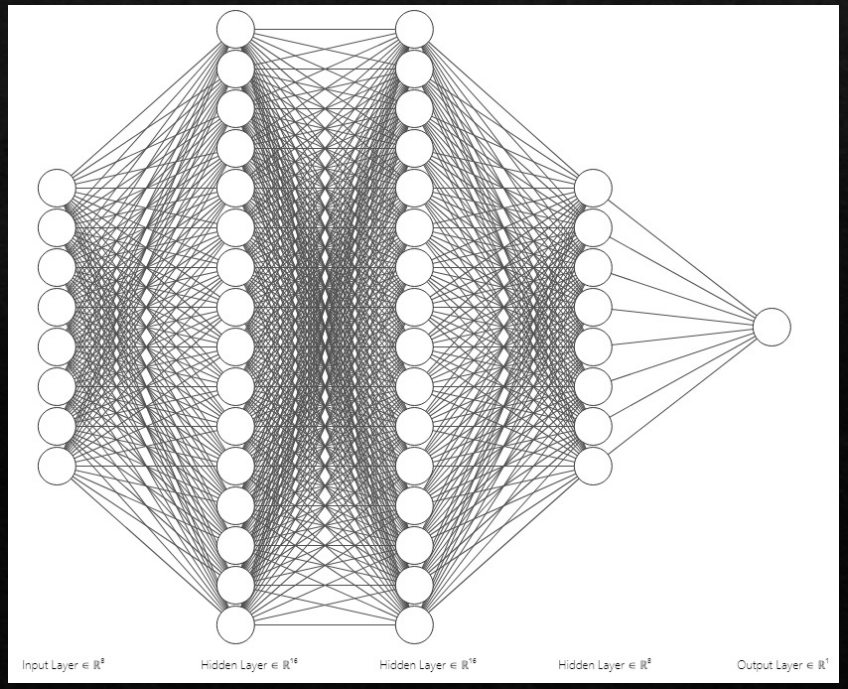
# Exploratory Data Analysis



# Preliminary Model Design

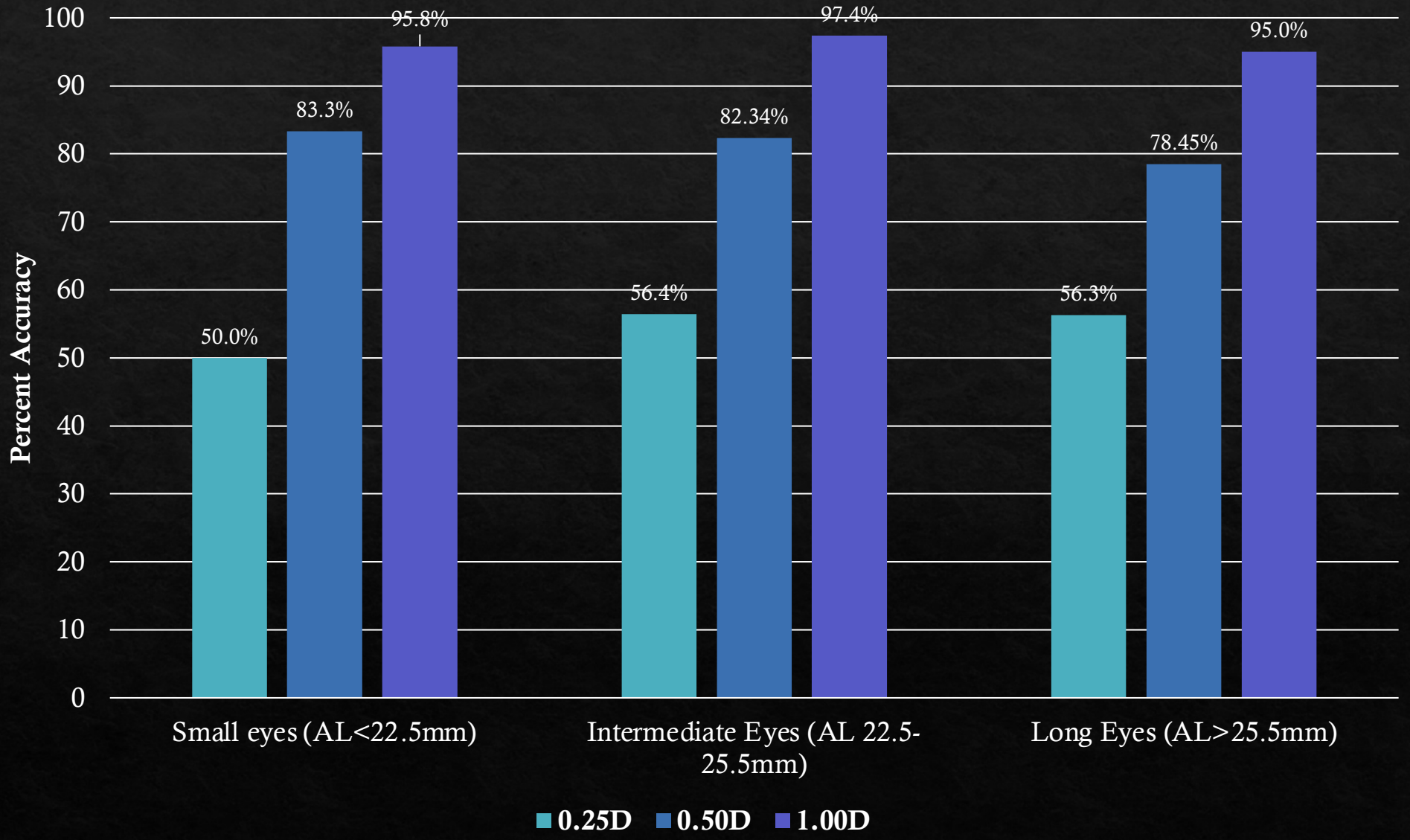
- The dataset was split in to 70% for training and 30% for testing (1743 eyes trained the model and 747 were used for testing)
- Built model using PyTorch, which is an open source machine learning framework
- Model features 5 layers
  - Input Layer Size: 8
  - Hidden Layer 1 Size: 16
  - Hidden Layer 2 Size: 16
  - Hidden Layer 3 Size: 8
  - Output Layer Size: 1
- Activation Function: Rectified Linear Unit (ReLu)



# AI Model Results

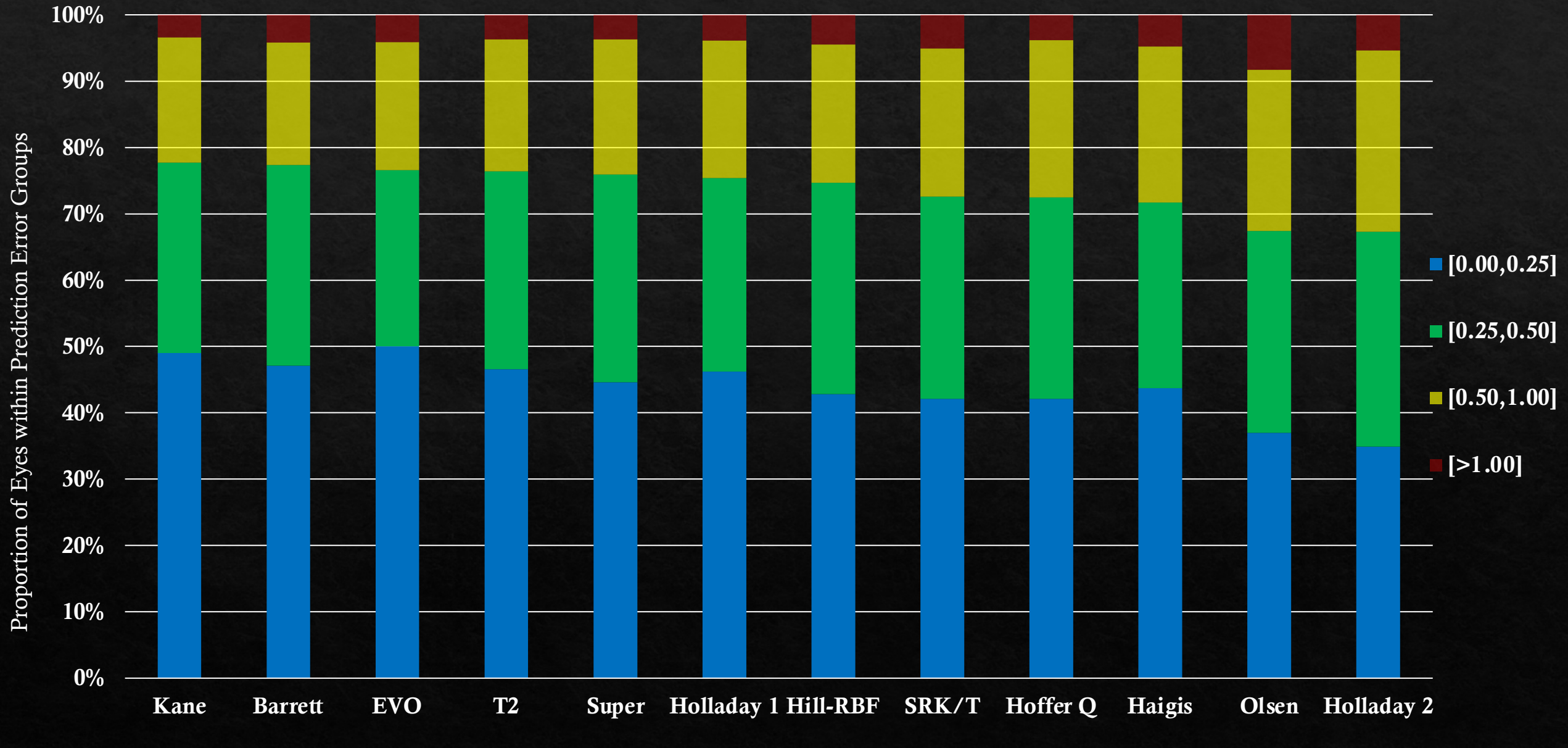
Overall Analysis: 81.5%

# AI Model Accuracy

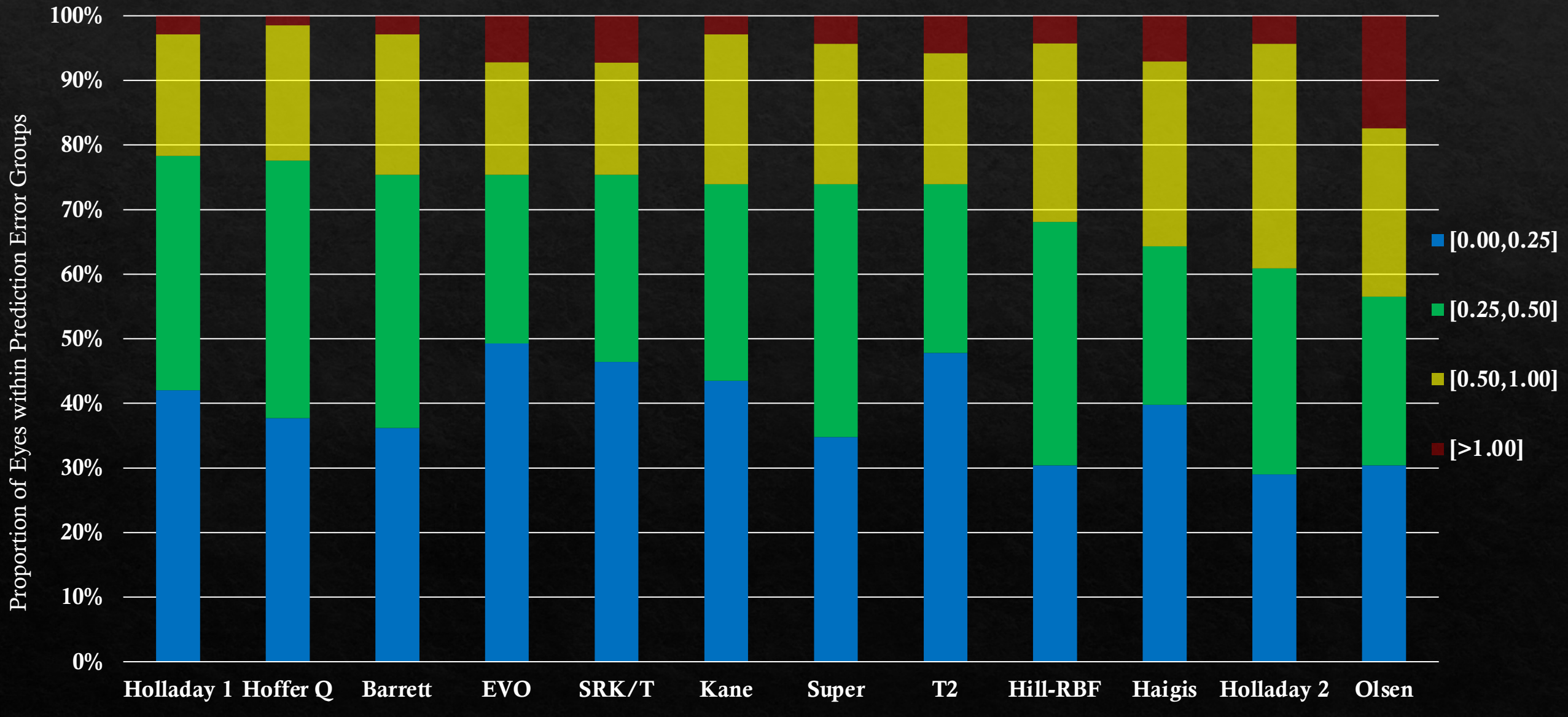


Overall Analysis: 81.5%

# Retrospective Study Accuracy (Overall Analysis)

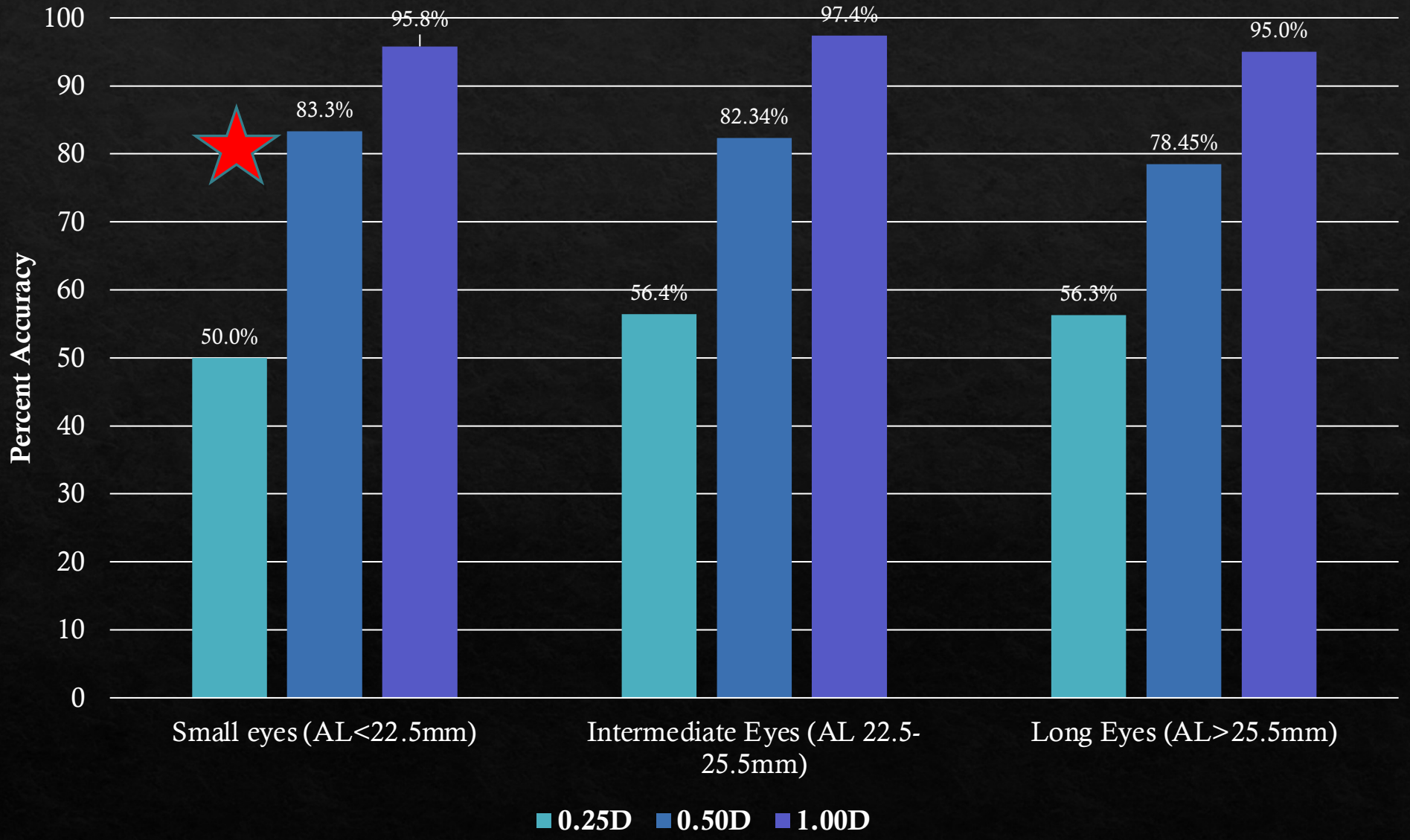


# Retrospective Study Accuracy (Short Eye Analysis)

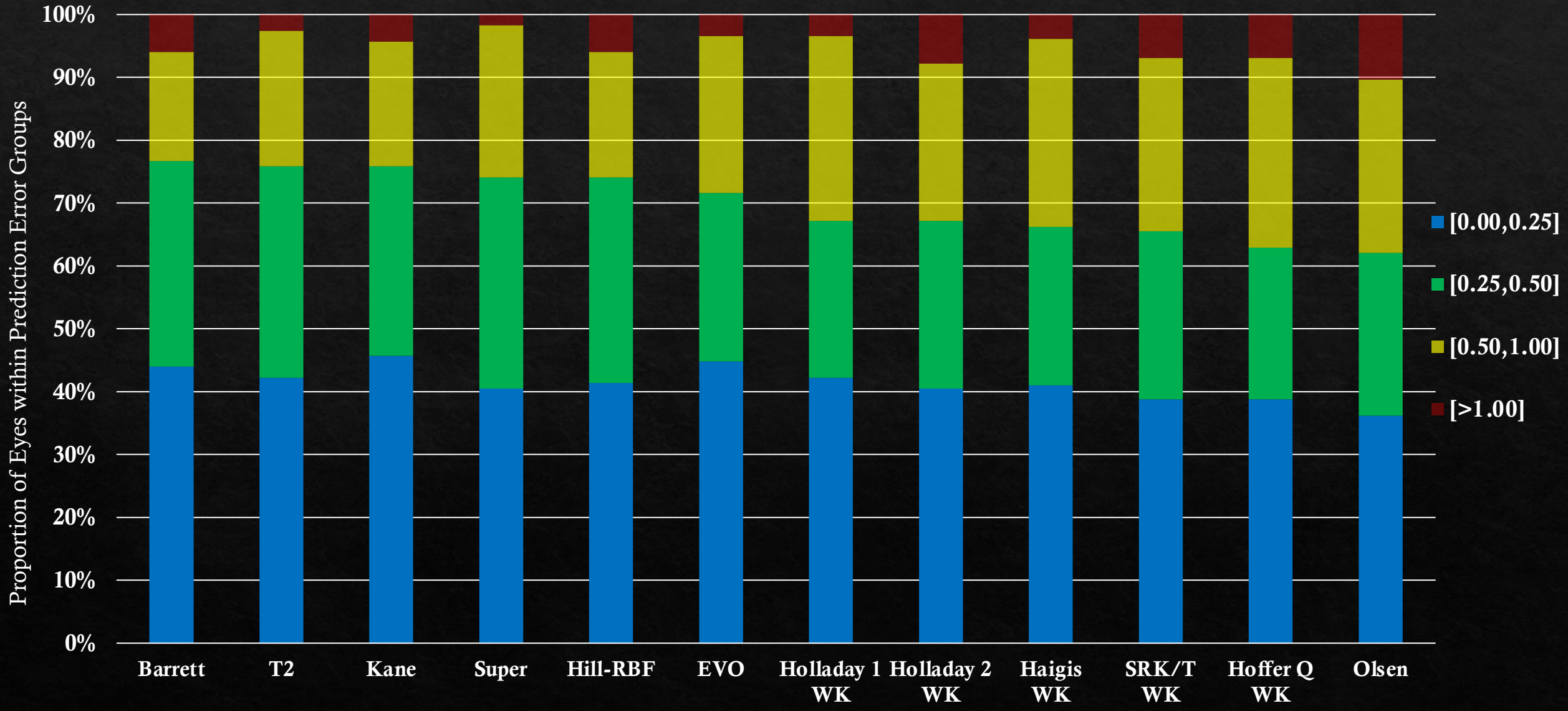


N = 96

# AI Model Accuracy

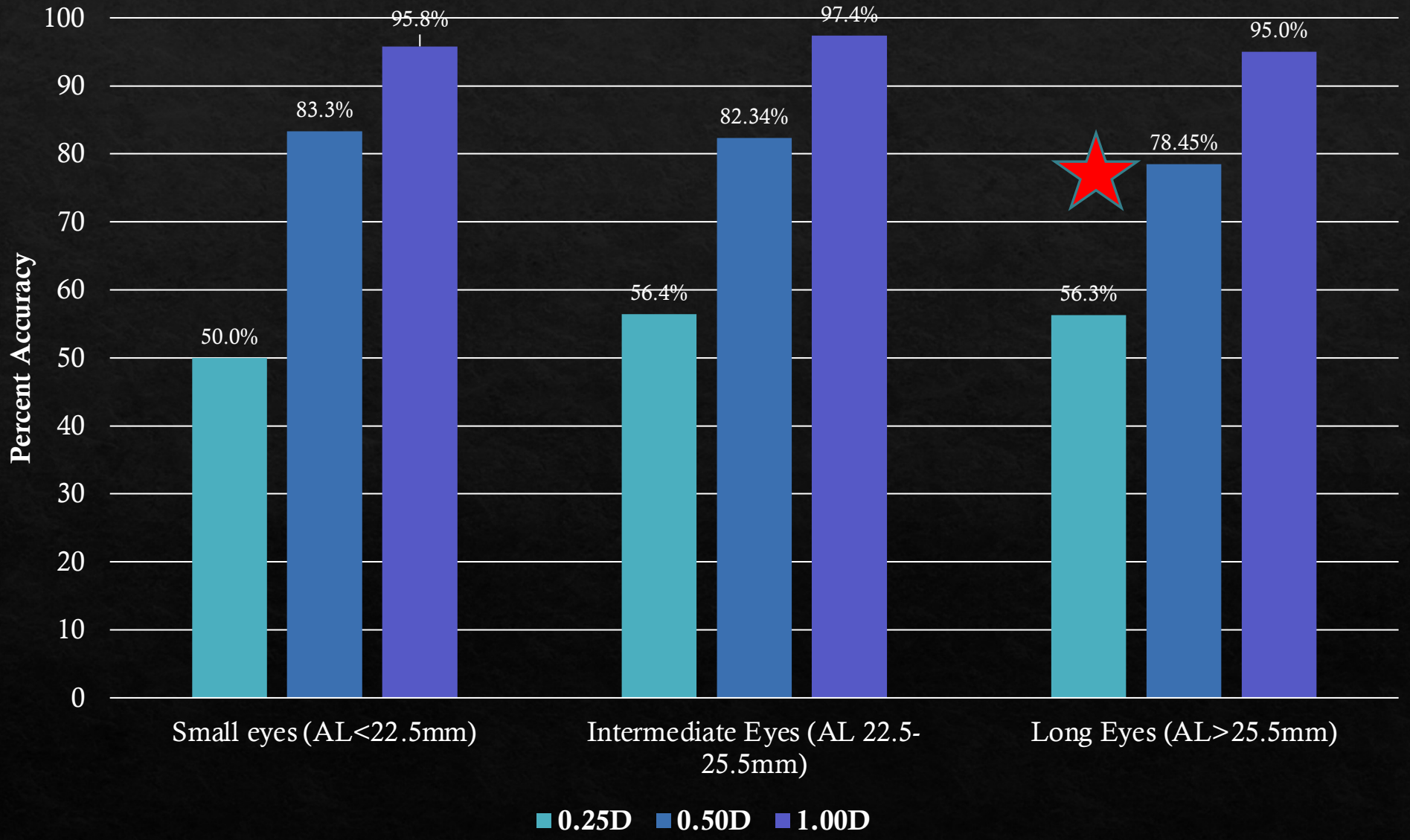


# Retrospective Study Accuracy (Long Eye Analysis)

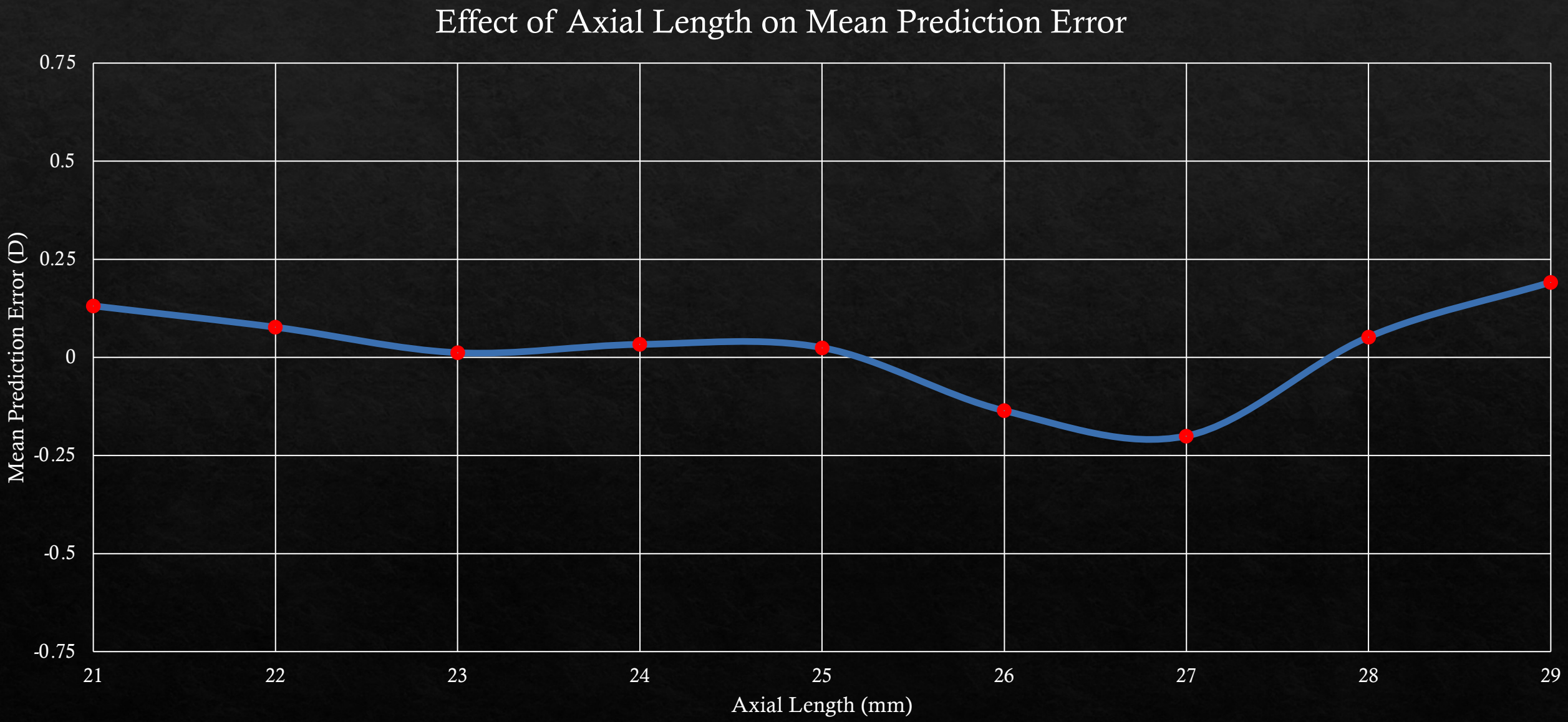


N = 181

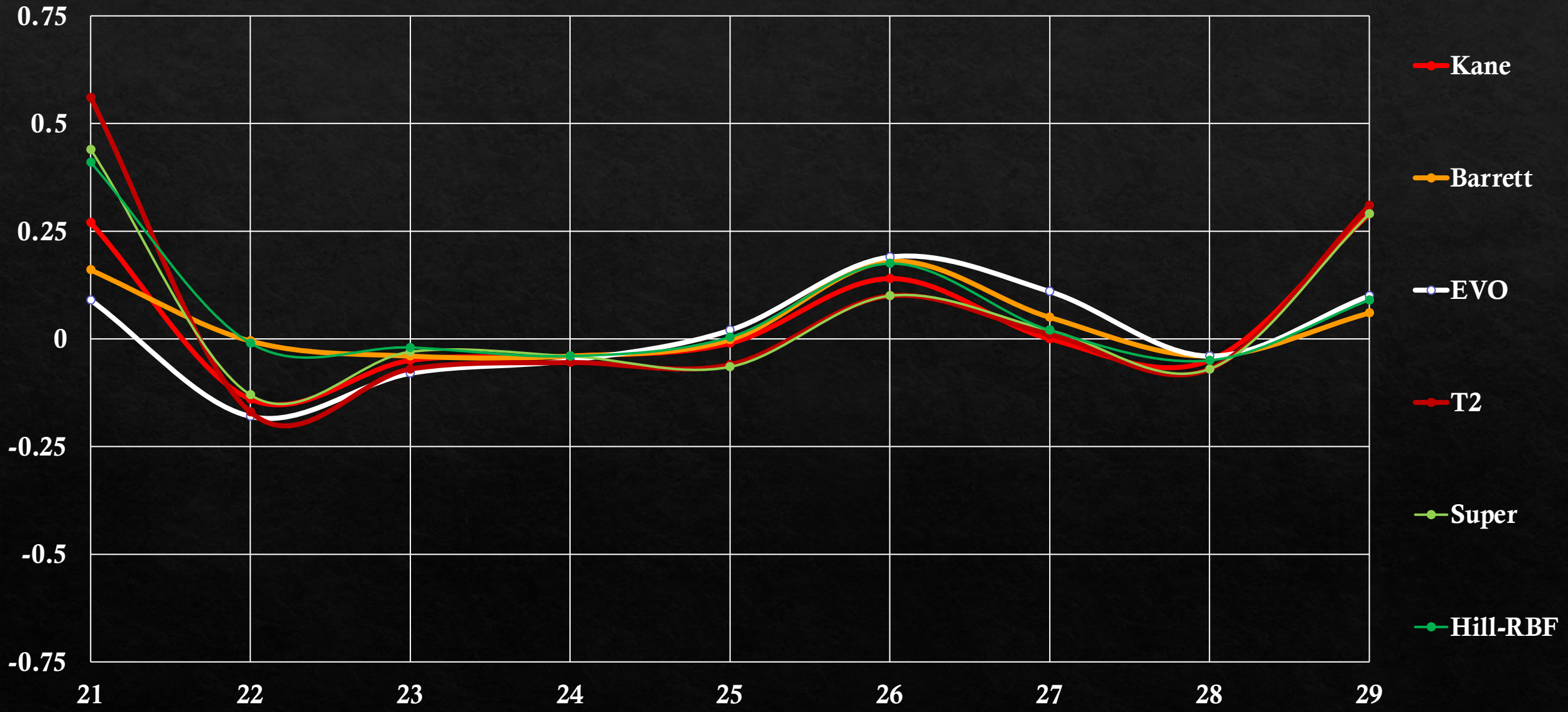
# AI Model Accuracy



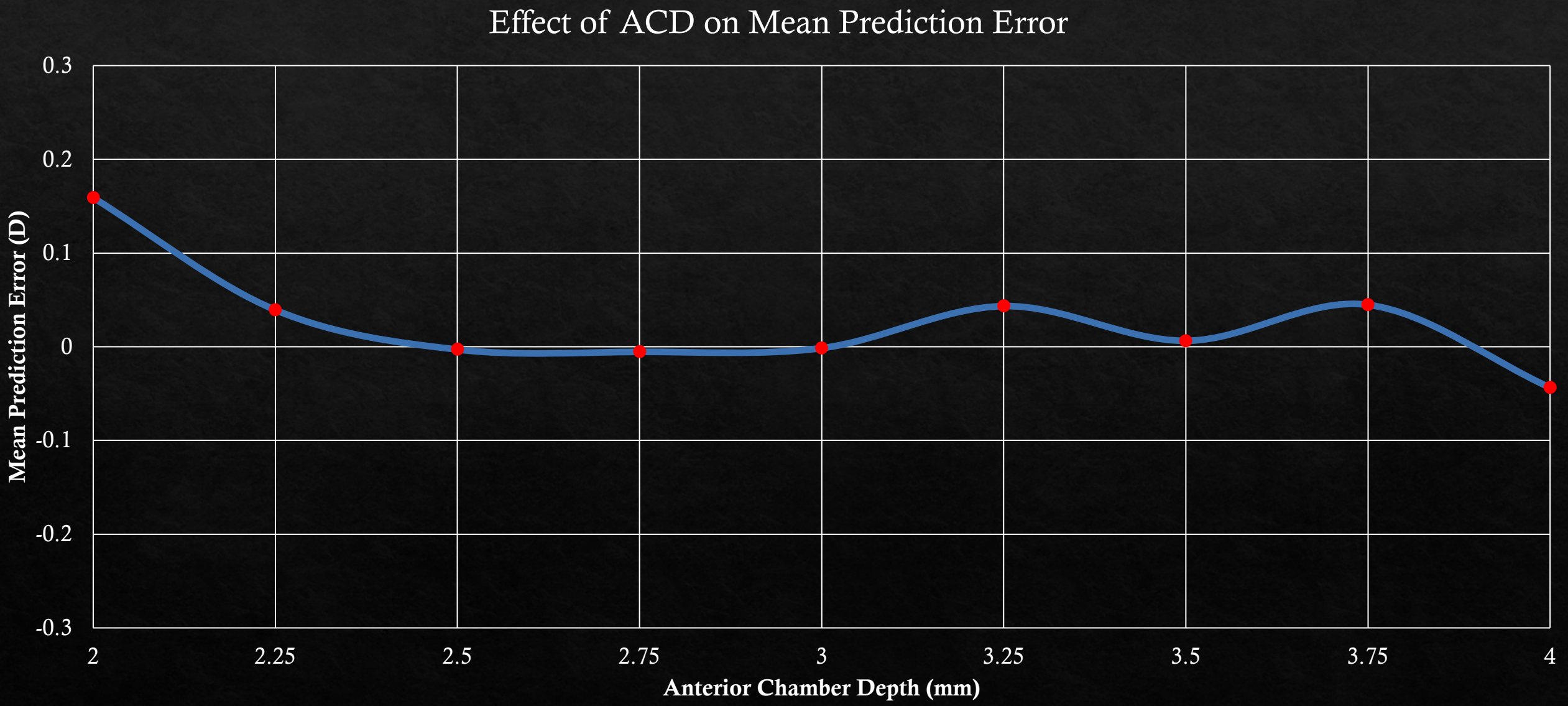
# AI Model Precision



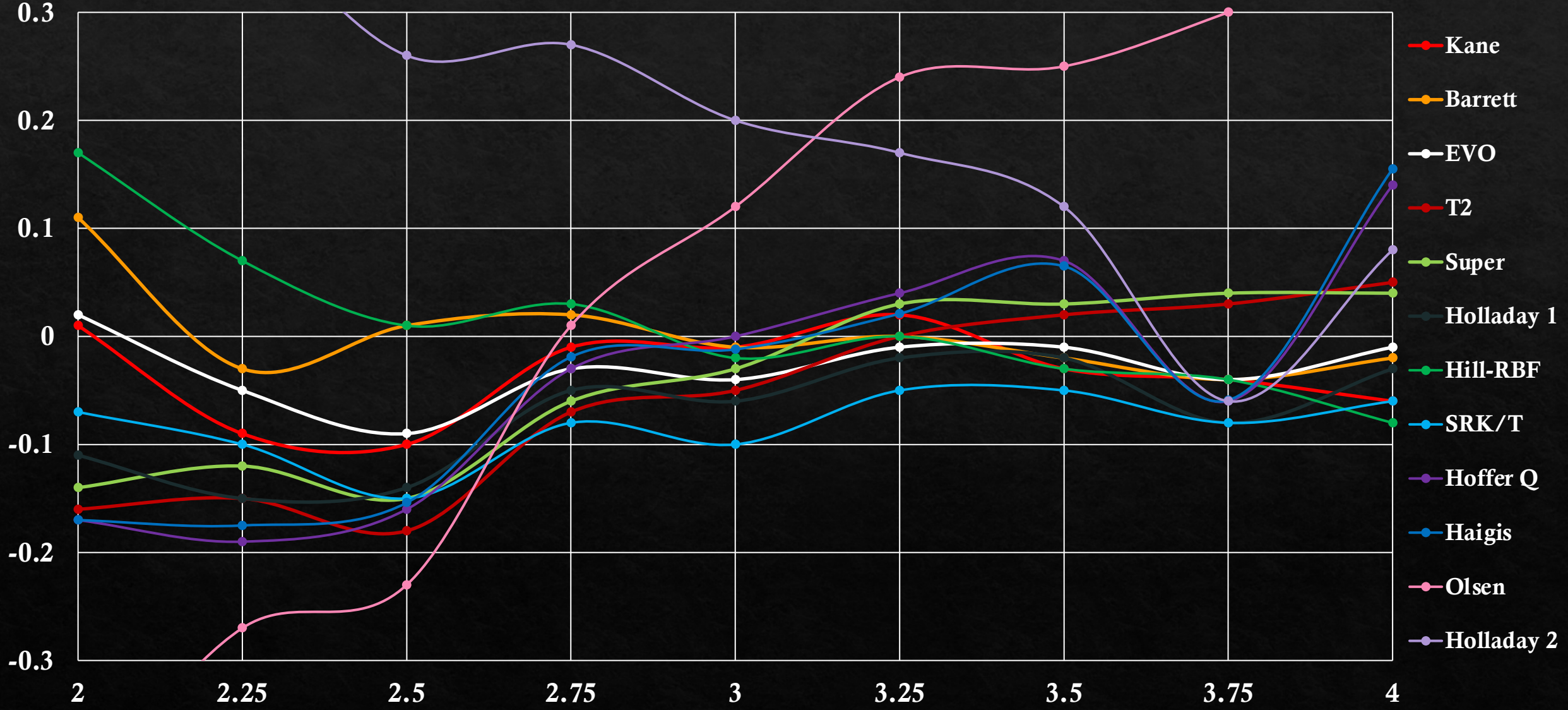
# Retrospective Study Precision (Axial Length)



# AI Model Precision



# Retrospective Study Precision (ACD)



# Conclusions

- Initial AI model preliminary analysis of 747 cataract cases led to the following percentage of cases within 0.50D of refractive error:
  - Overall Analysis: 81.5% (Kane: 77.7%)
  - Short Eyes: 83.3%  (Holladay 1: 78.3%)
  - Intermediate Length Eyes: 82.3% (Kane: 78.6%)
  - Long Eyes: 78.6%  (Barrett: 76.7%)
- Within 0.25D of error across entire range of ALs (only Barrett and EVO were that precise in retrospective study)
- Within 0.05D of error across the range of ACDs except for extreme shallow cases (<2.12m)

# Future Direction

## OPTIMIZATION OF OTHER FORMULAS!

# Thank You!