GLAUCOMA CLASSIFICATION WITH EYE-TRACKING

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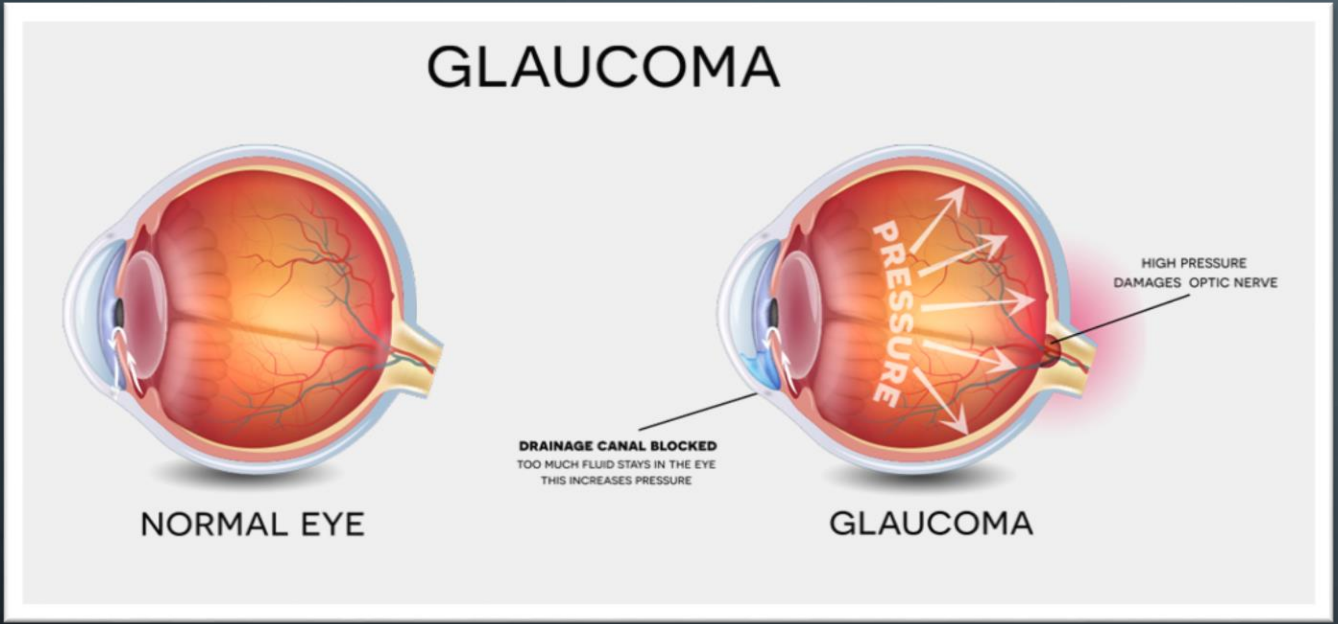
GLAUCOMA

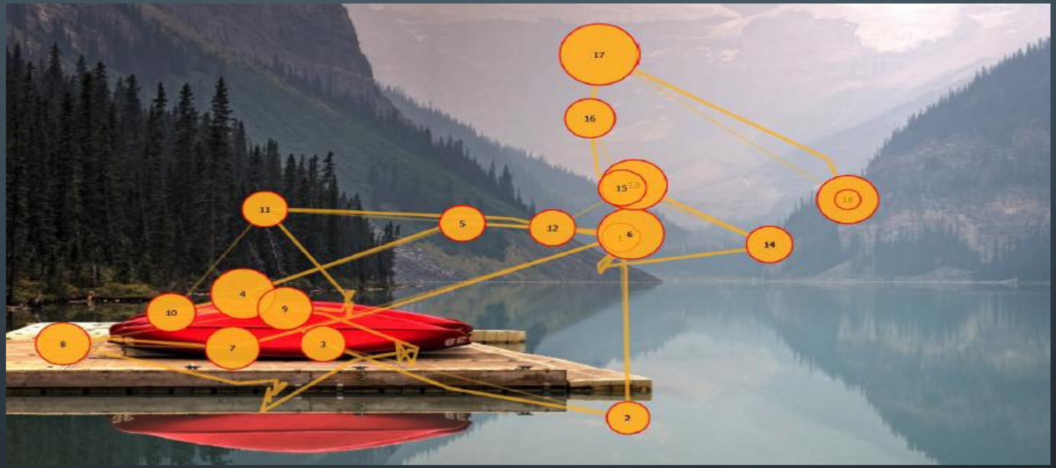


Motivation:

- Early treatment can prevent vision loss
- Absence of cure
- Big risk group
- Convenience of diagnosis procedure
- Eye movements of glaucoma patients differ from age-similar control groups performing everyday tasks, such as reading, viewing static images, etc.

EYE-TRACKING

- Fixation - is the maintaining of the visual gaze on a single location.
- Saccade - is a quick, simultaneous movement of both eyes between two or more phases of fixation in the same direction.



Fixation and Saccade example

RELATED WORK

There are several approaches to work with eye-tracking data

- Fixation and Saccade points analyze. Working directly with eye-tracking time series.
- Trajectories and heat maps based on Fixations and Saccades. Working both with numerical and image data.

DATASET DESCRIPTION

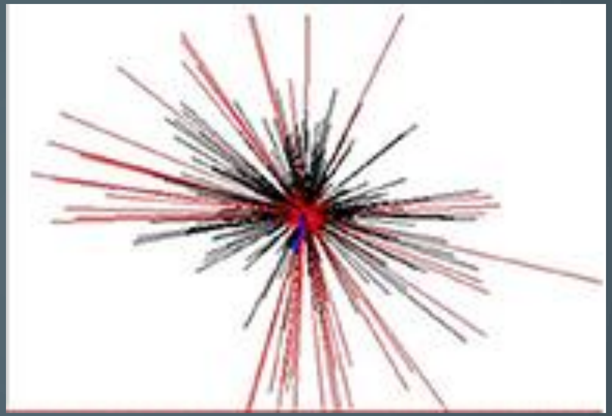
- Raw gaze was measured using an Eyelink 1000 eye-tracker
- Data was processed using a bespoke C++ program
- Finally processed data contains 1 table of clinical data and 76 files with time series for each patient : 32 healthy controls and 44 glaucoma patients between 50 and 80 years
- Data was recorded during the view of 3 different videos

Videos time codes

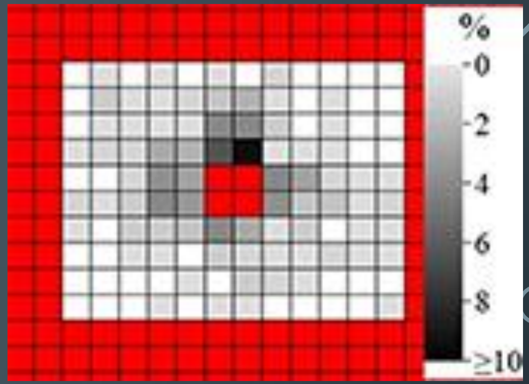
DATASET DESCRIPTION

4 Datasets

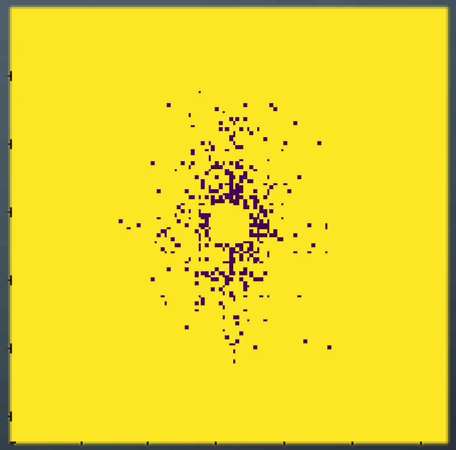
- From time series feature engineering (Clinical data, Mean Fixations/Saccades time, Number of Fixations/Saccades, Mean Saccades velocity/amplitude for each video)
- Centralized saccade scan path
- Centralized saccade heat map
- Histogram of change pupil's area by 1 saccade



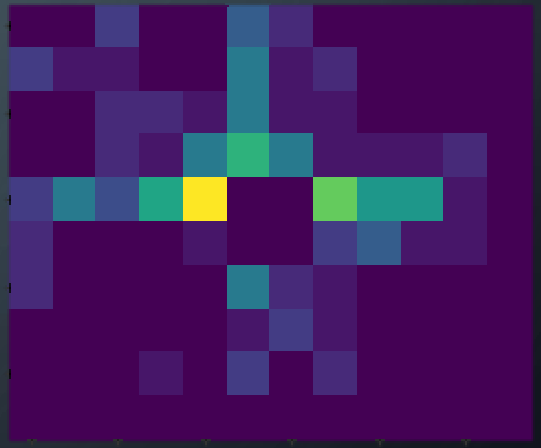
Original centralized saccade scan path



Original centralized heat map



Centralized saccade scan path

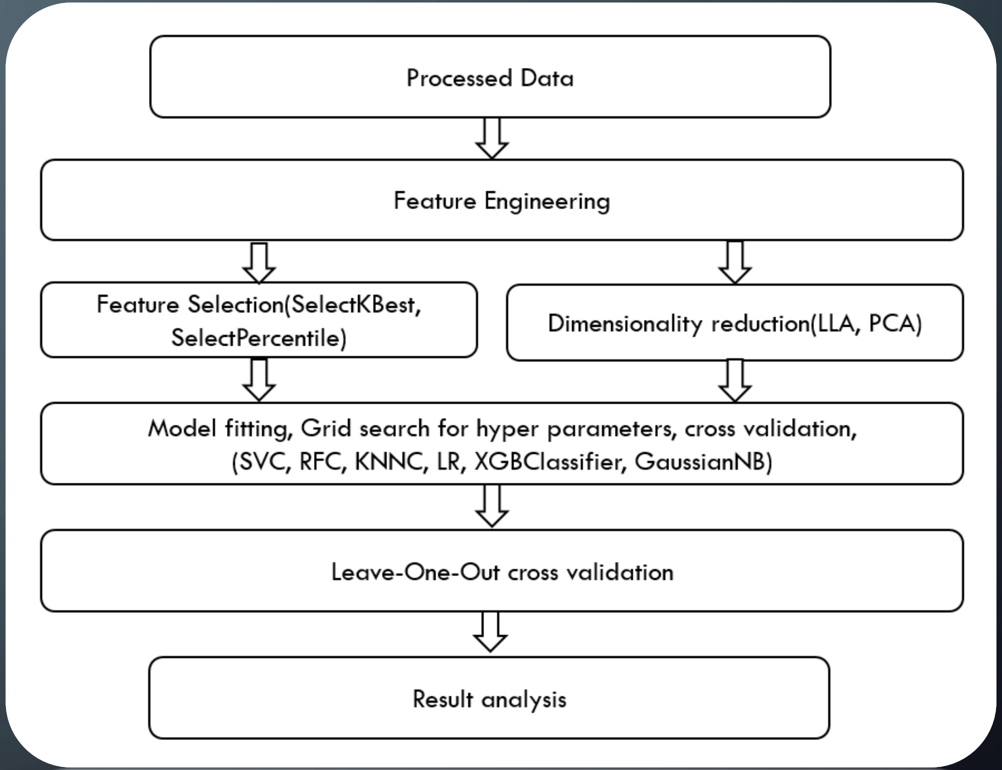


Centralized saccade heat map

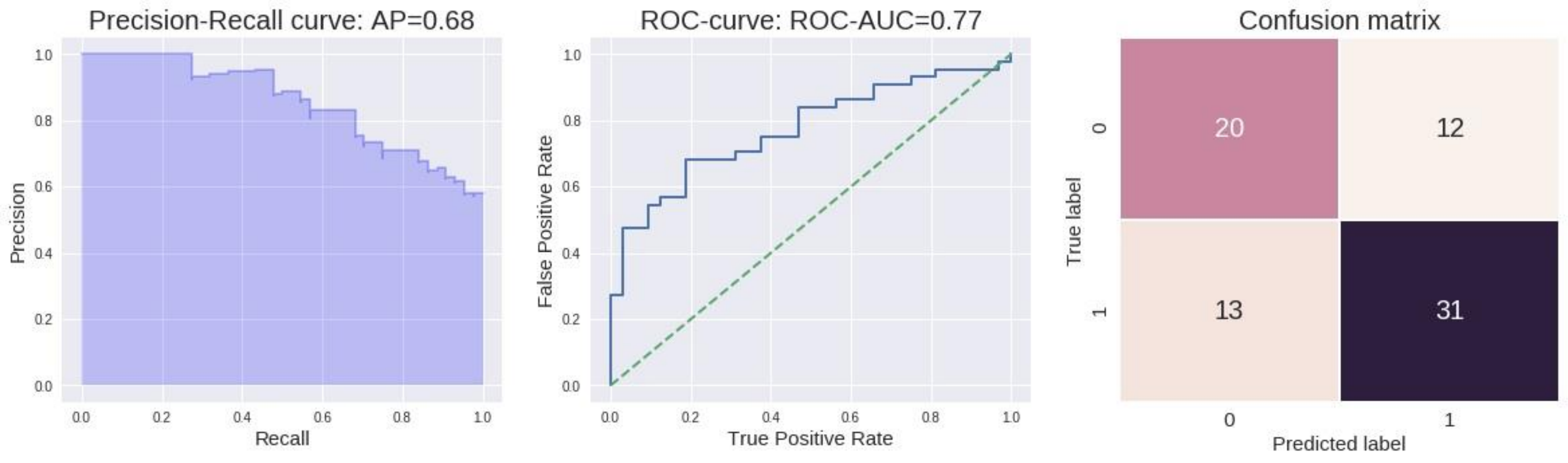
METHODOLOGY

- Machine learning pipeline on time series features
- Feature extraction with kernel PCA with custom kernel on saccade heat map images and change of pupil's area
- Neural Networks on saccade scan path images

ML pipeline



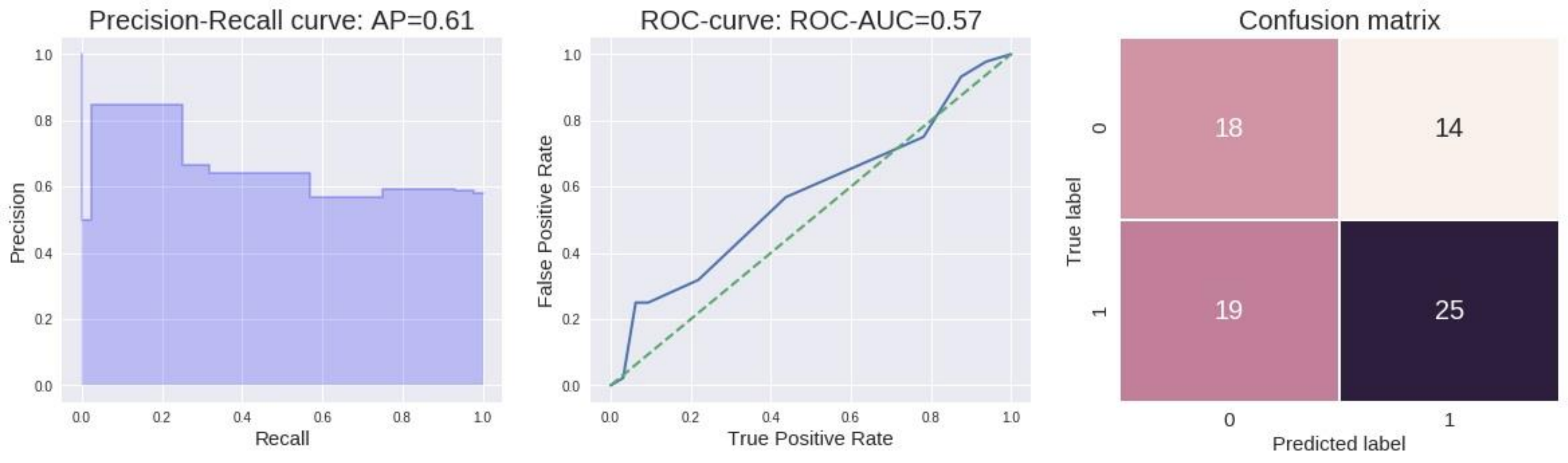
OBTAINED RESULTS FOR PIPELINE ON TIME SERIES FEATURES DATASET



Random guess recall = 0.58

	precision	recall	f1-score
Control	0.55	0.66	0.6
Glaucoma	0.71	0.61	0.66

Best model after Grid Search with irrelevant clinical features on repeated Leave-One-Out cross validation (LogisticRegression roc_auc_score = 0.79 +- 0.10)



	precision	recall	f1-score
Control	0.49	0.56	0.52
Glaucoma	0.64	0.57	0.60

Best model after Grid Search without irrelevant clinical features on repeated Leave-One-Out cross validation (KNeighborsClassifier roc_auc_score = 0.61 +- 0.12)

KERNEL PCA

- Saccade scan paths
- Density maps
- Histogram of change pupil’s area by 1 saccade

Here for each dataset we tried to find feature space, where data is linearly separable

OBTAINED RESULTS FOR IMAGES OF CENTRALIZED SACCADE SCAN PATH

- Deep Convolutional Neural Network with 19 layers
- Performance of Neural Network is similar to ML pipeline's results

REFERENCES

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- [4] Claudio Aracena , Sebasti´an Basterrech , V´aclav Sn´aˇsel†, and Juan Vel´asquez ”Neural Networks for Emotion Recognition Based on Eye Tracking Data”
- [5] David P. Crabb, Nicholas D. Smith and Haogang Zhu ”What’s on TV? Detecting age-related neurodegenerative eye disease using eye movement scanpaths” Front. Aging Neurosci., 11 November 2014.

THANK YOU FOR ATTENTION!