

Pupil Data Analysis Updates

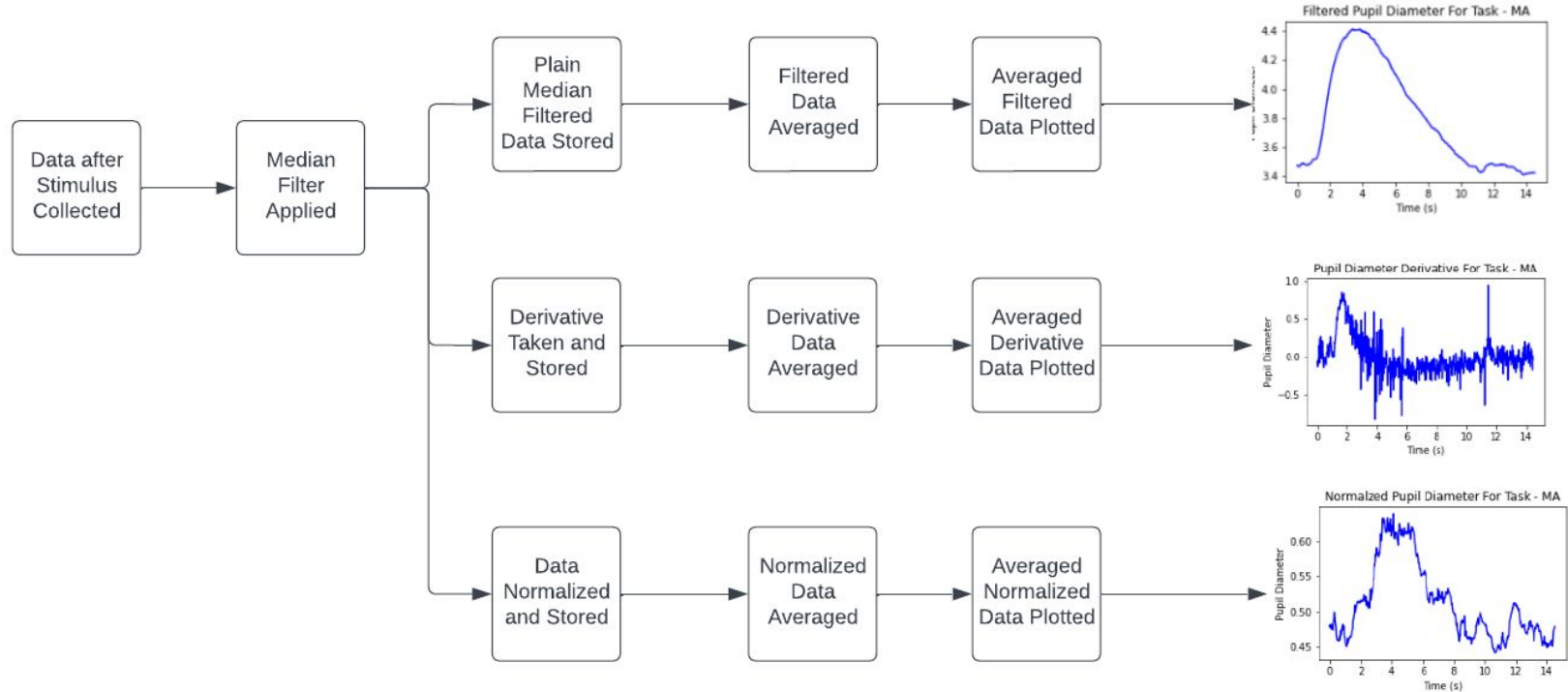
4/12/2023

Graph Generation Process

Graph Generation Process

1. We start by going through a subjects time series for a given task and collecting the relevant data after a stimulus onset
2. We then pass this data through the median filter Murat Provided to detect and resolve outliers
3. We then use this filtered data to calculate the local derivative and local normalization (these processes are separate from each other)
4. We then store the plain filtered data, derivative of data, and normalized data and continue this process for every stimulus onset for a given subject and task
5. Lastly we average all the plain filtered data, all the derivative data, and all the normalized data separately and graph them.

Subject Plots Generation Process Visual

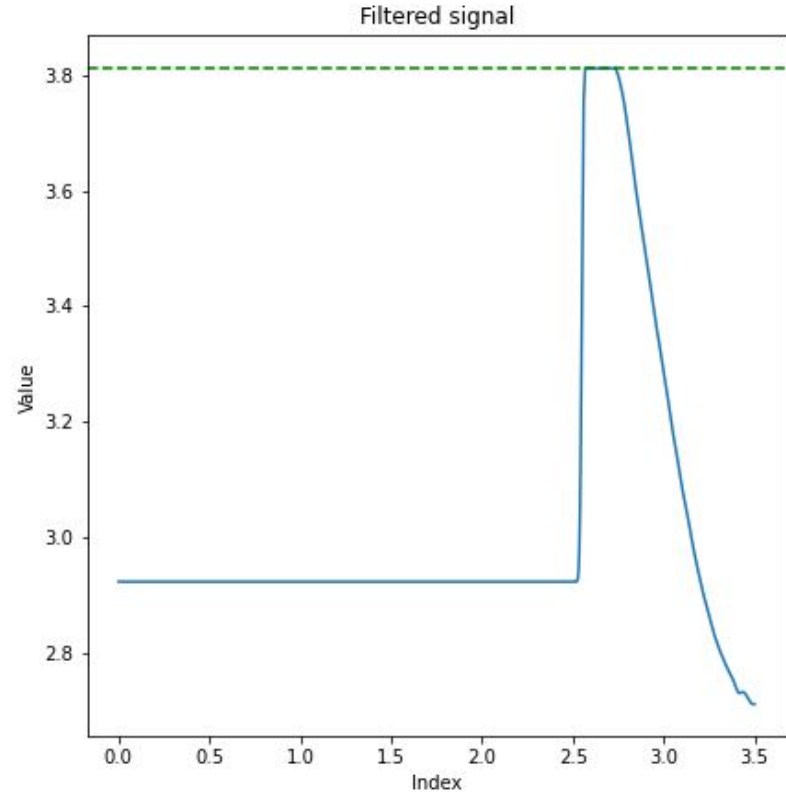
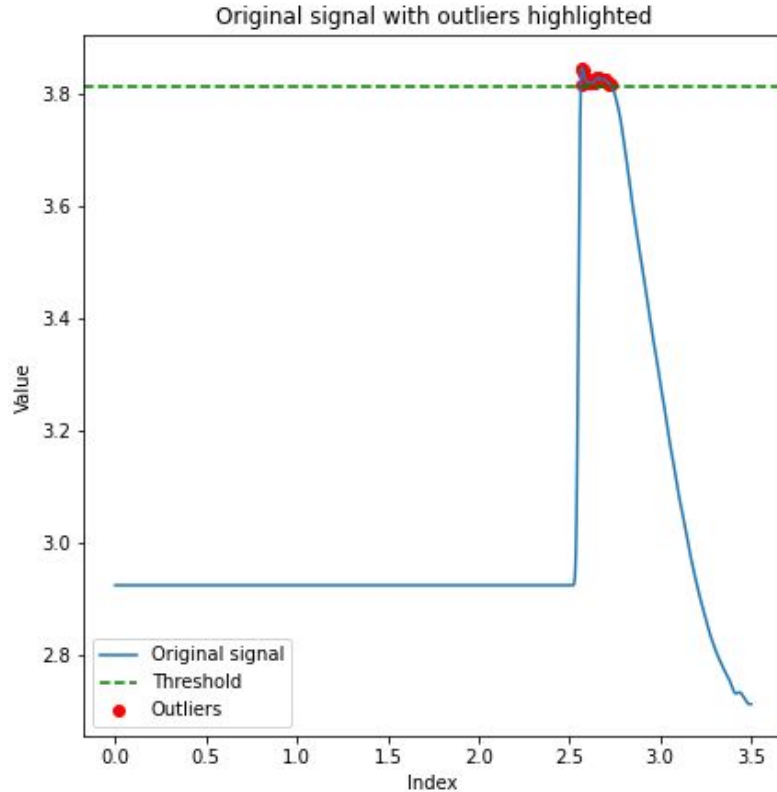


Median Filter

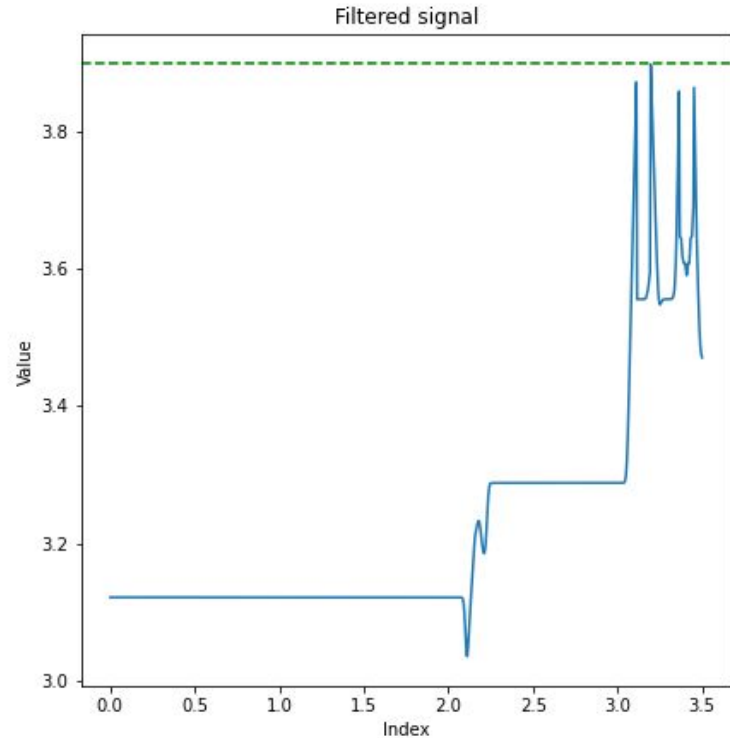
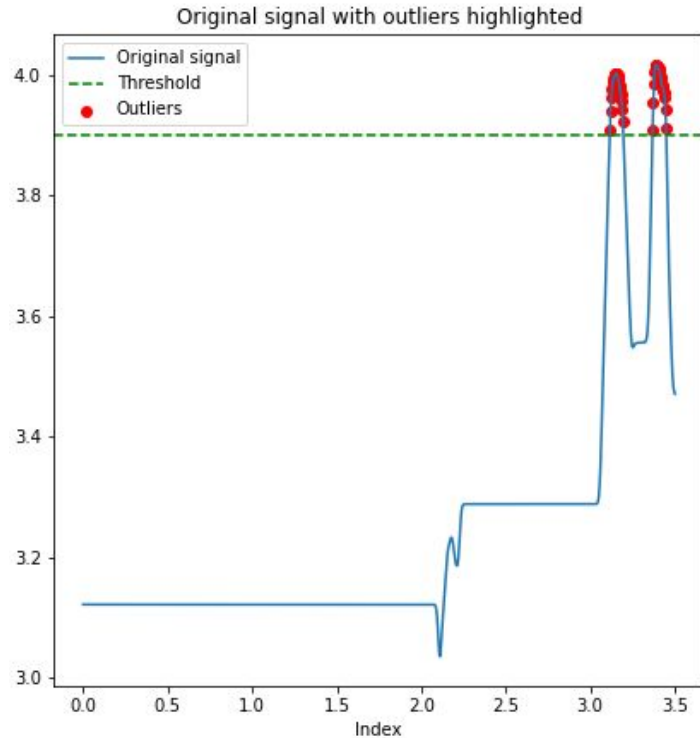
Applying the Median Filter

- We apply the median filter before doing anything else with the data to detect and mitigate outliers
- If there are no outliers, the median filter will not run on the data
- **Applying the median filter will manipulate the values of data points**

Outlier Detection Example (Median Filter)



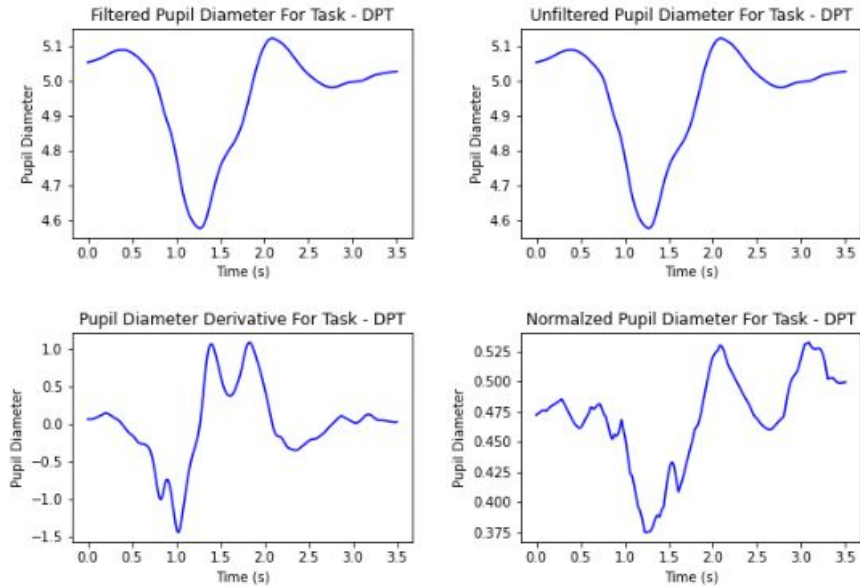
Outlier Detection Bad Example (Median Filter)



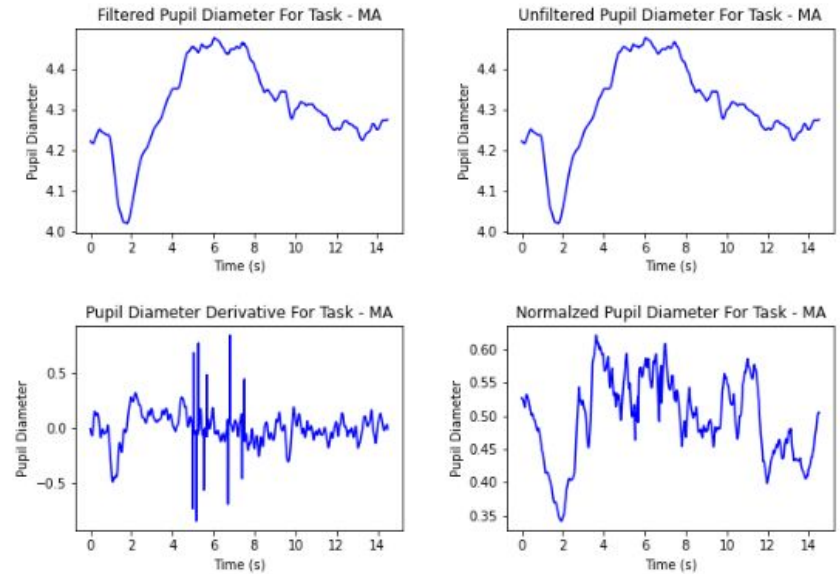
Pupil Diameter Graph Examples

Subject Graph Examples (Pupil Diameter)

Subject 17 Graphs

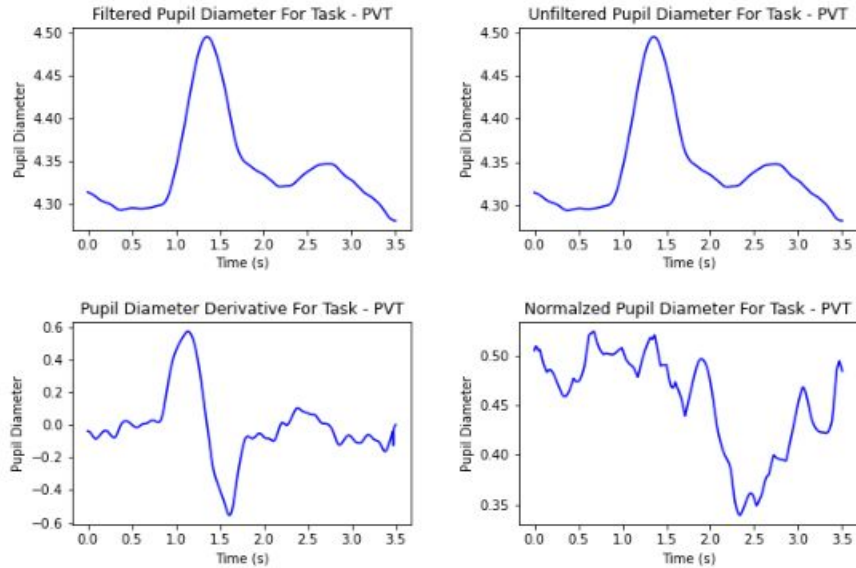


Subject 17 Graphs

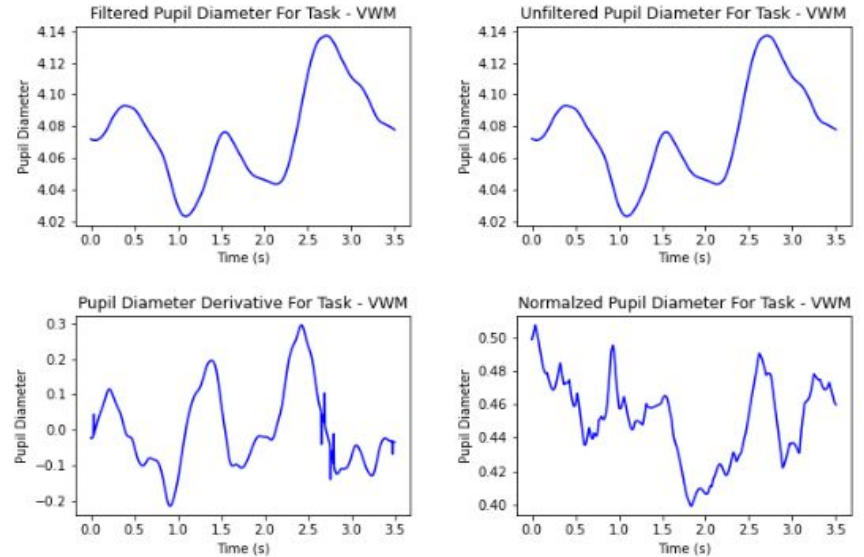


Subject Graph Examples (Pupil Diameter)

Subject 17 Graphs

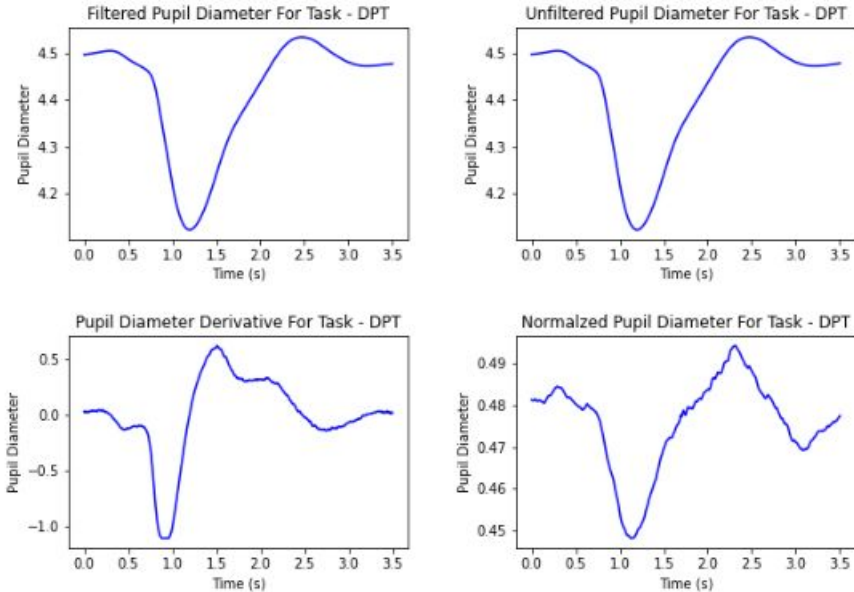


Subject 17 Graphs

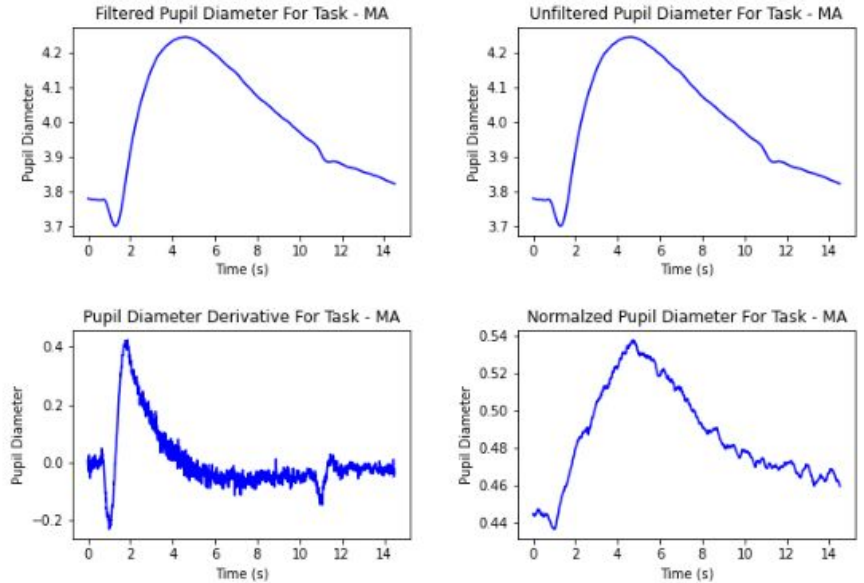


All Subject Graph (Pupil Diameter)

All Subjects

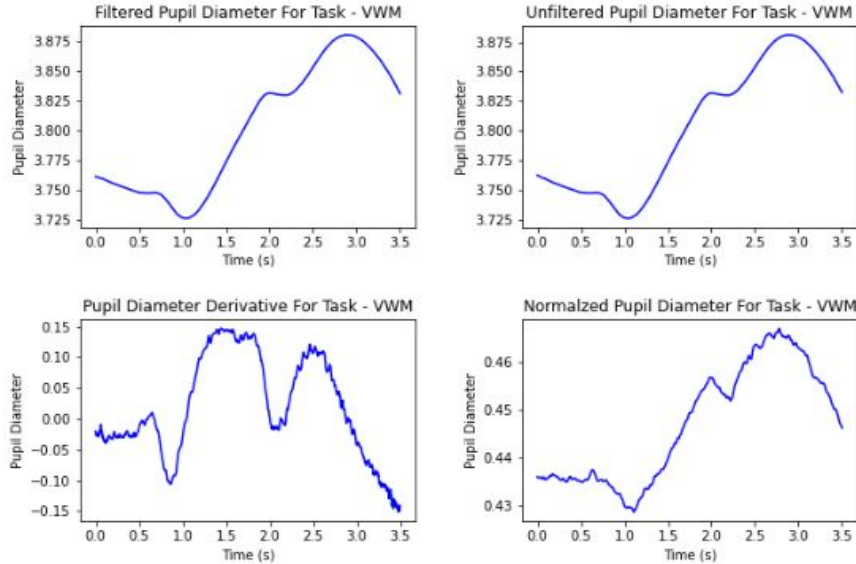


All Subjects

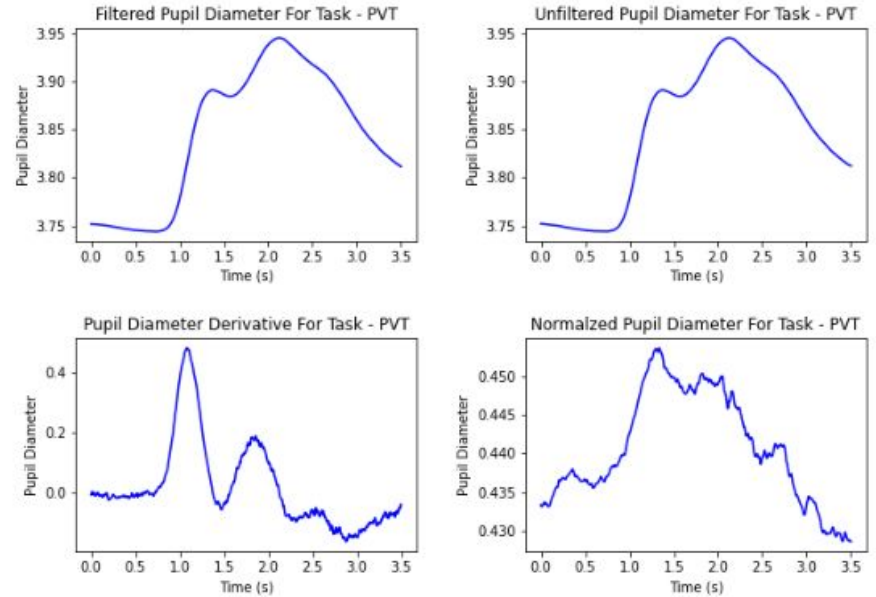


All Subject Graph (Pupil Diameter)

All Subjects



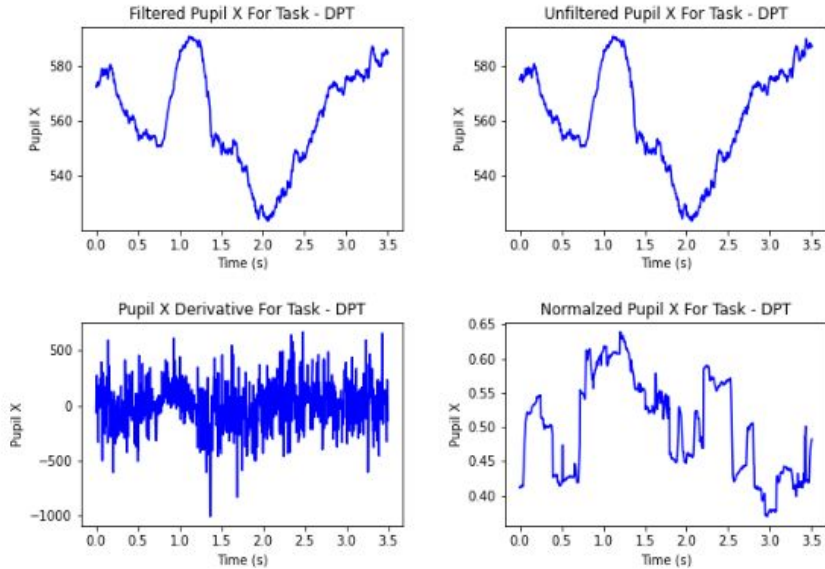
All Subjects



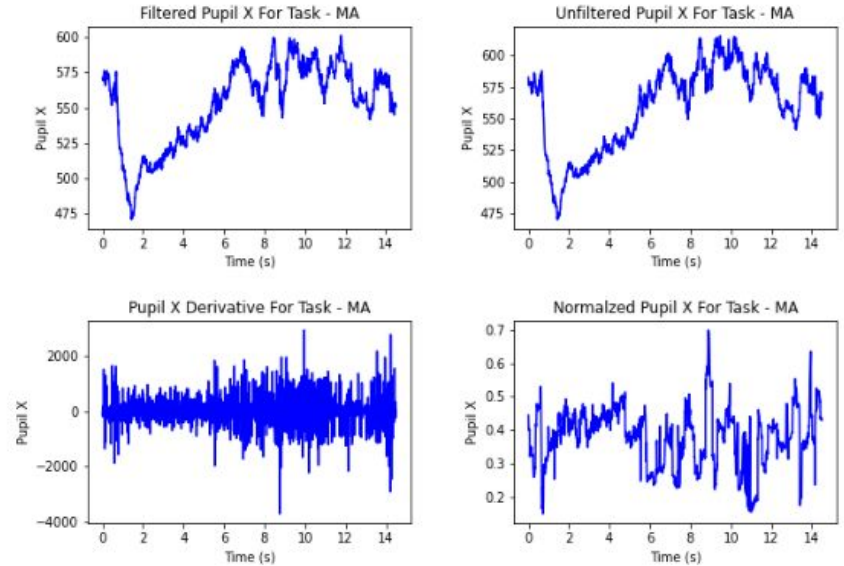
Pupil X Graph Examples

Subject Graph Examples (Pupil X)

Subject 17 Graphs

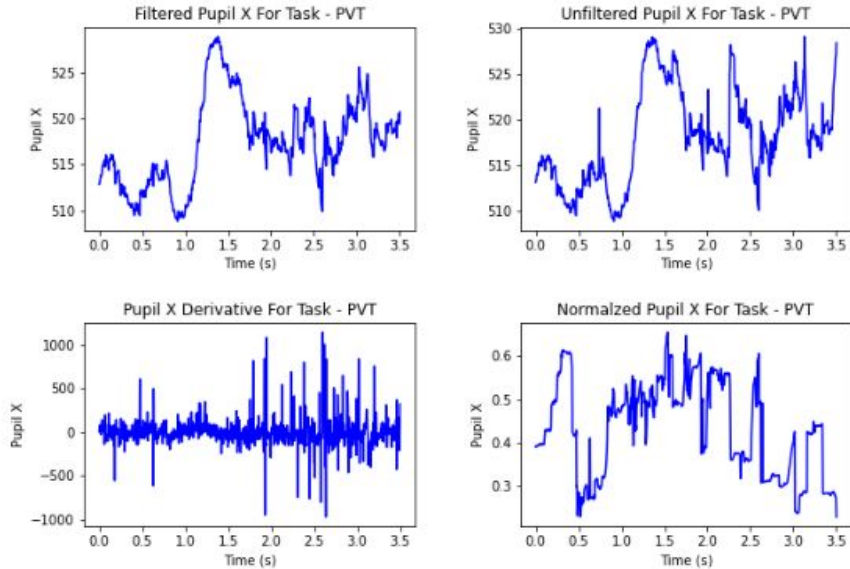


Subject 17 Graphs

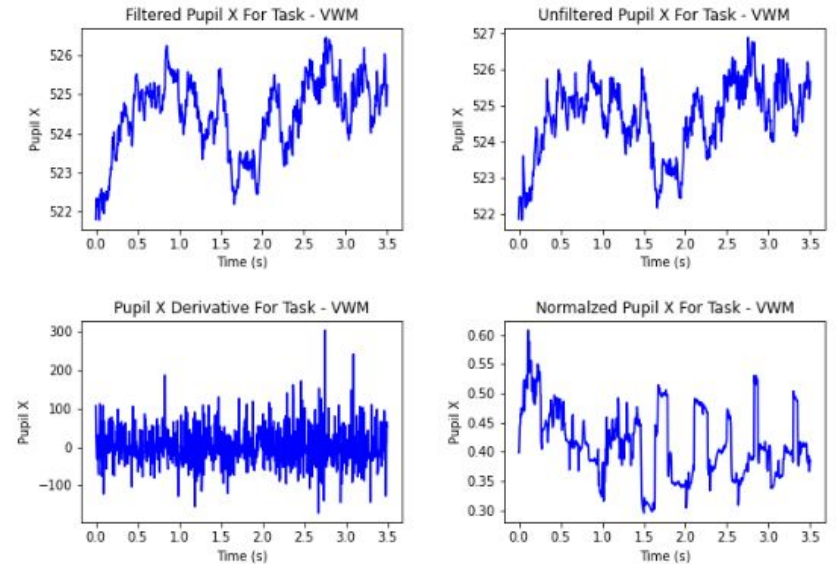


Subject Graph Examples (Pupil X)

Subject 17 Graphs

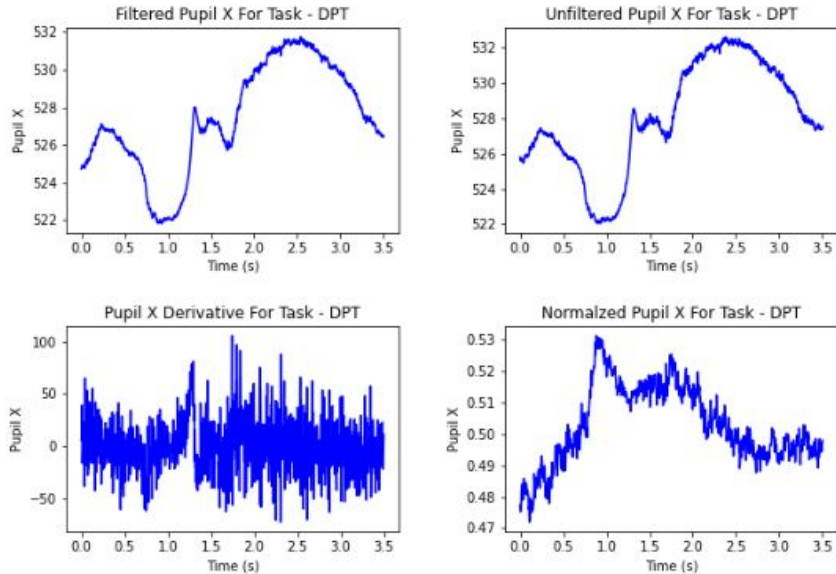


Subject 17 Graphs

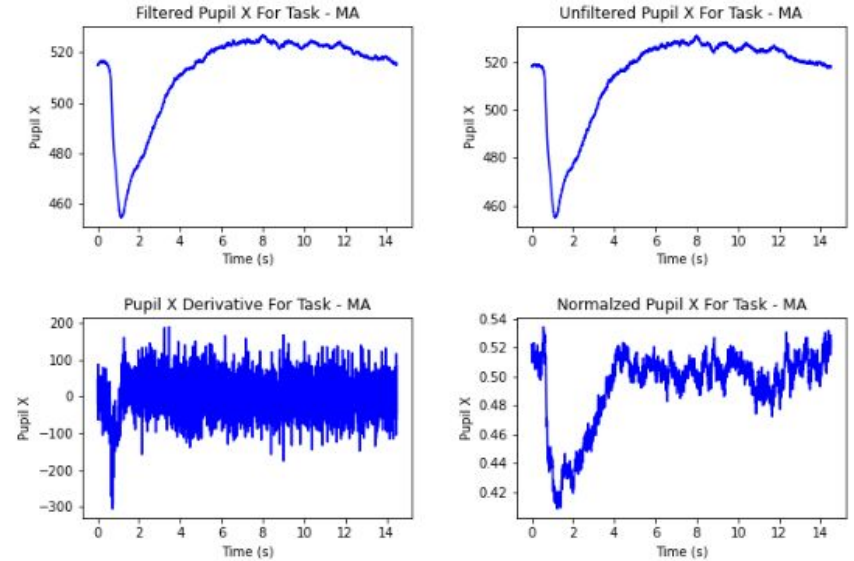


All Subject Graph (Pupil X)

All Subjects

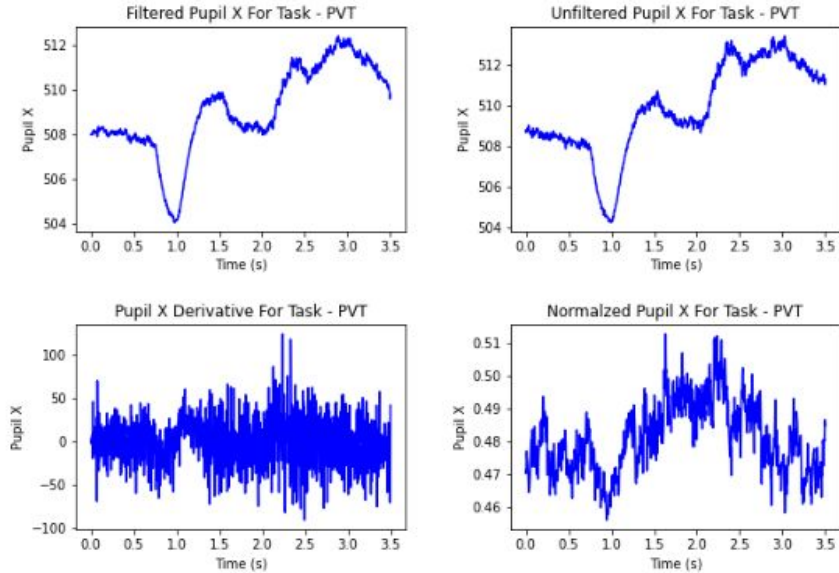


All Subjects

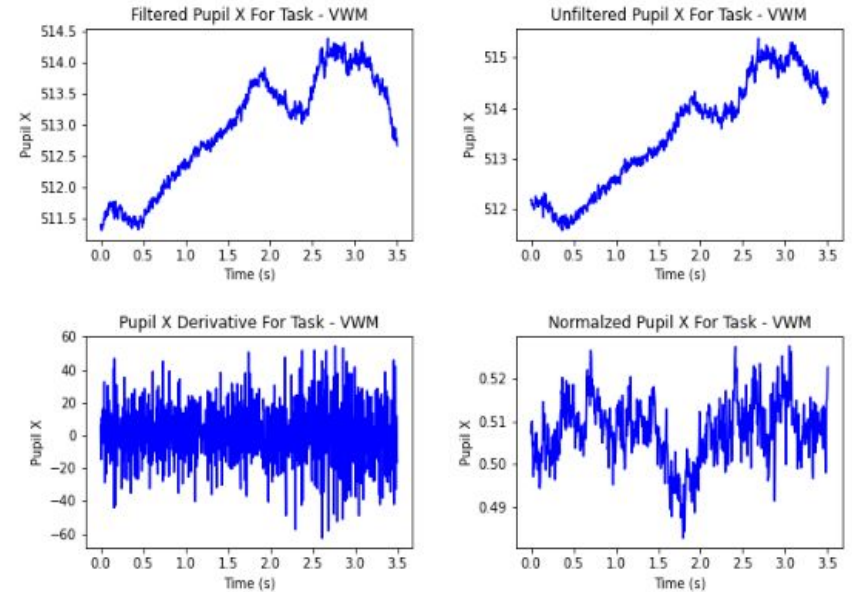


All Subject Graph (Pupil X)

All Subjects



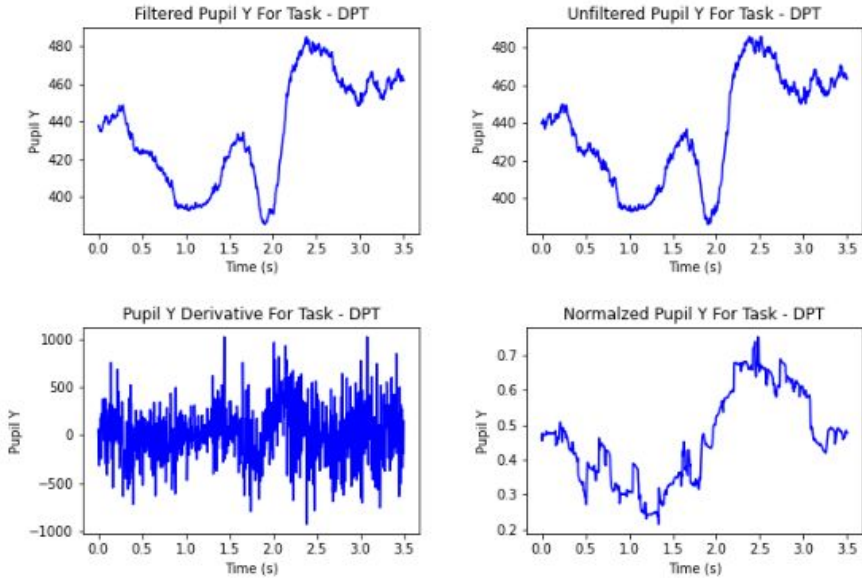
All Subjects



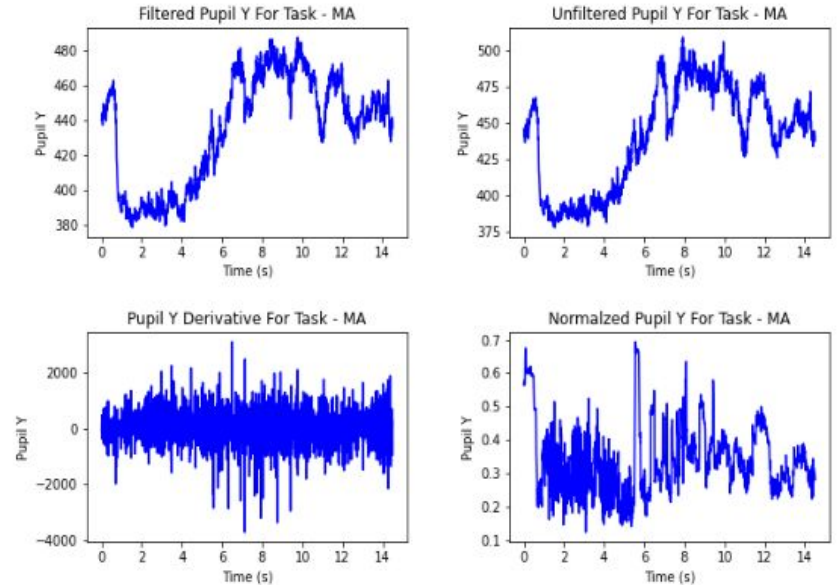
Pupil Y Graph Examples

Subject Graph Examples (Pupil Y)

Subject 17 Graphs

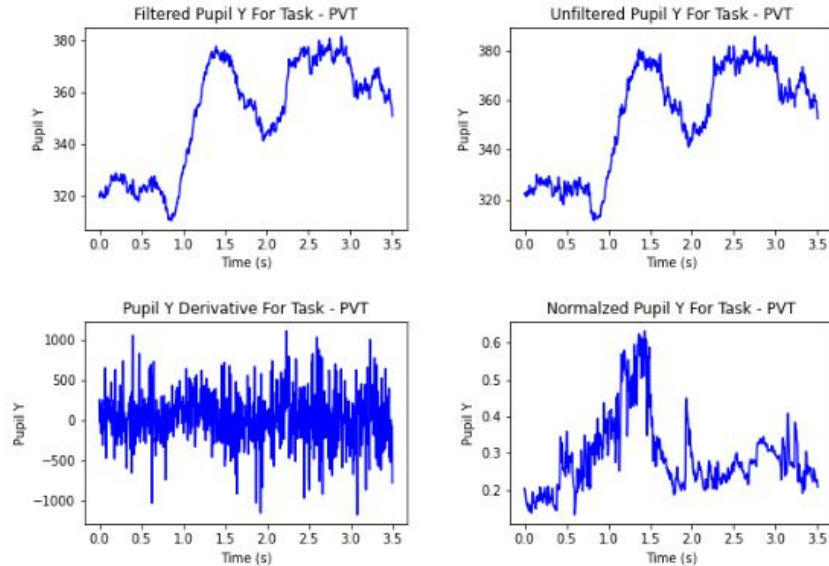


Subject 17 Graphs

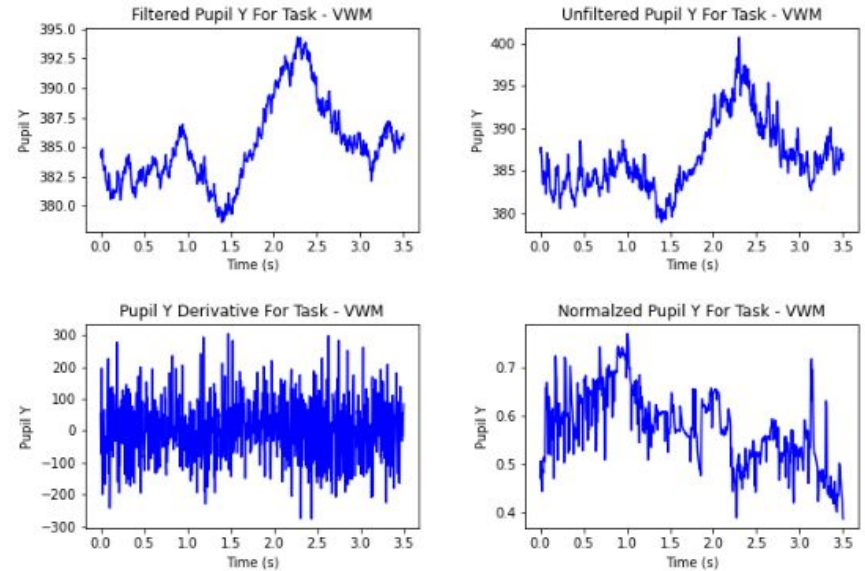


Subject Graph Examples (Pupil Y)

Subject 17 Graphs

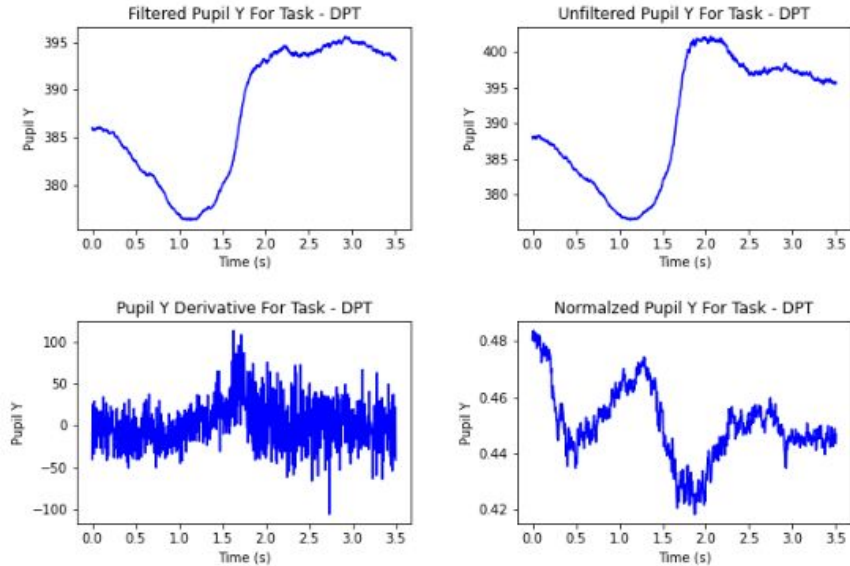


Subject 17 Graphs

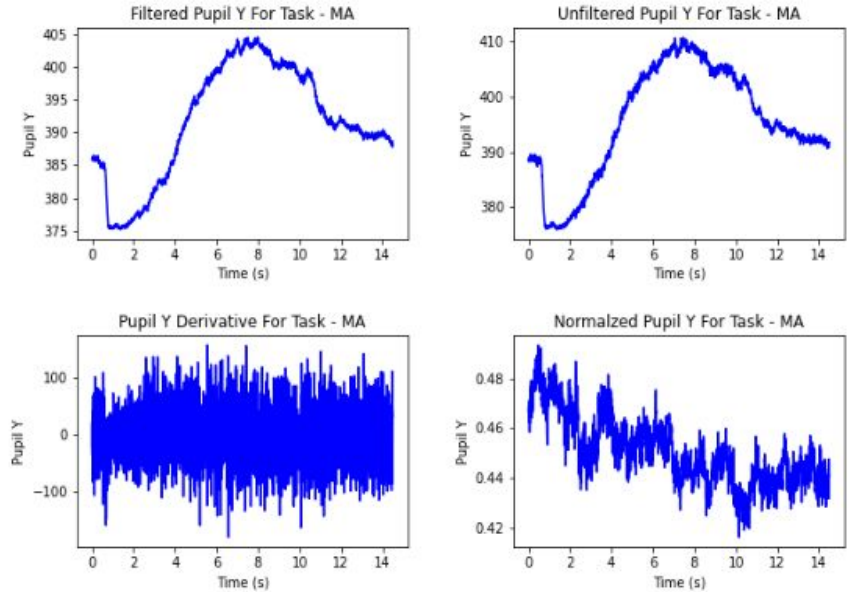


All Subject Graph (Pupil Y)

All Subjects

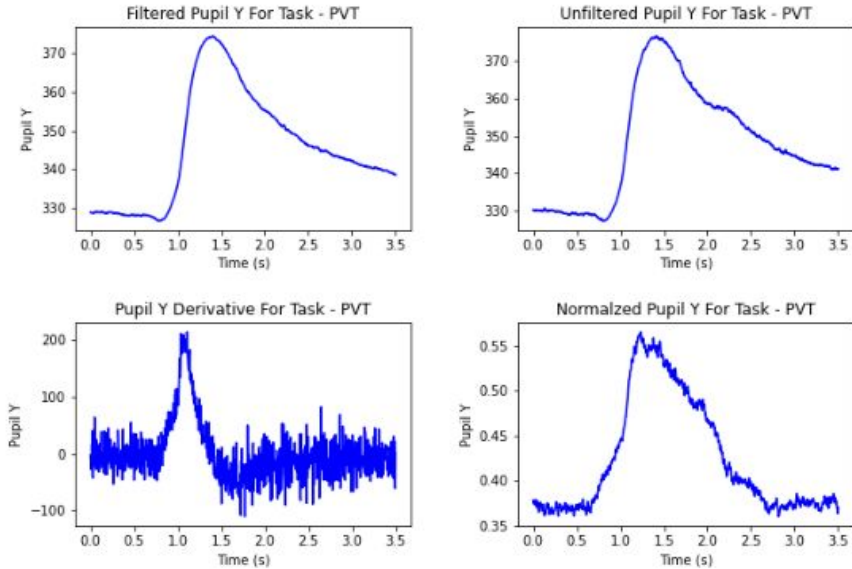


All Subjects

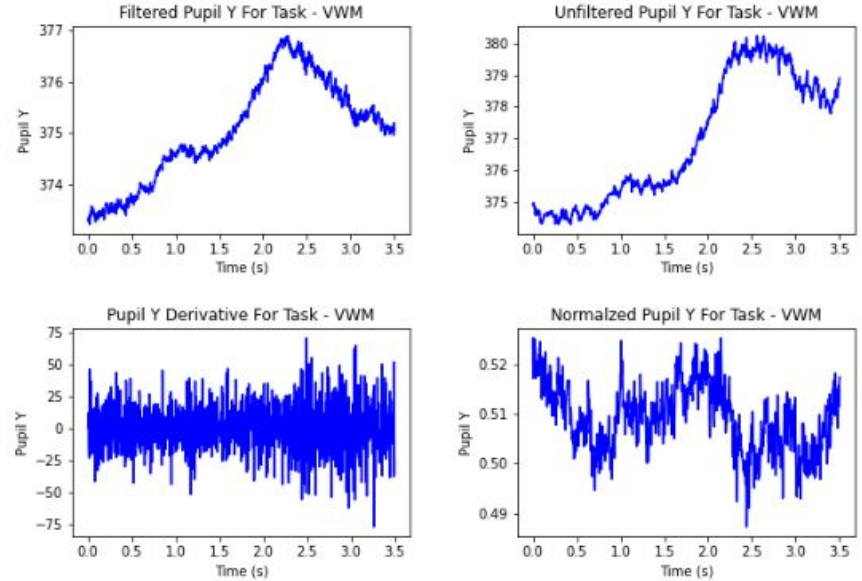


All Subject Graph (Pupil Y)

All Subjects



All Subjects



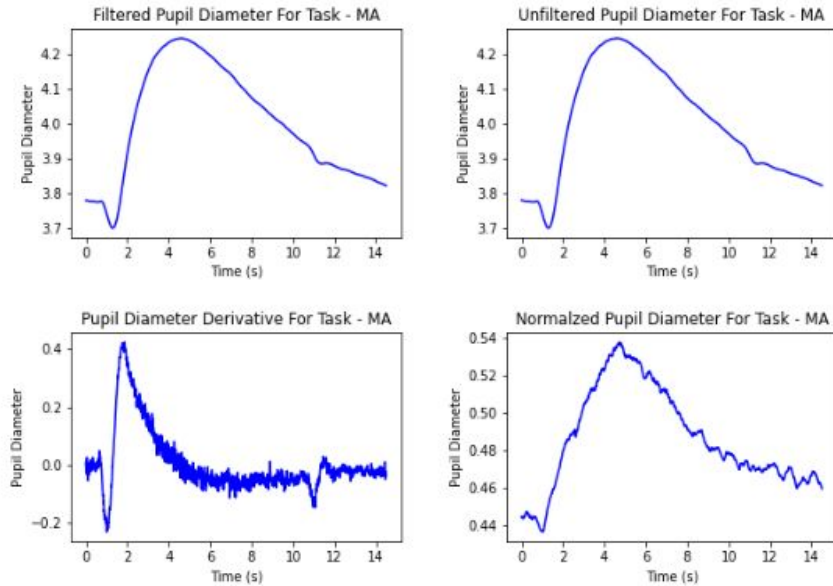
Low Pass Filter

Low Pass Filter Process

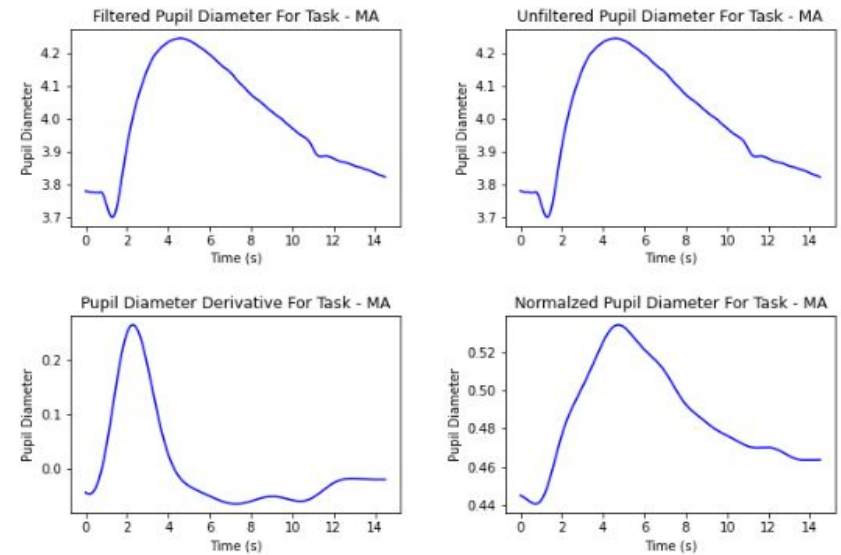
- We apply a low pass filter after averaging the plain data, derivative, and normalized data to get rid of noise
- We set the threshold to be $3 * \text{local standard deviation from the mean}$ (similar to the median filter)
- This will modify the data points

Low Pass Filter (Example 1)

All Subjects

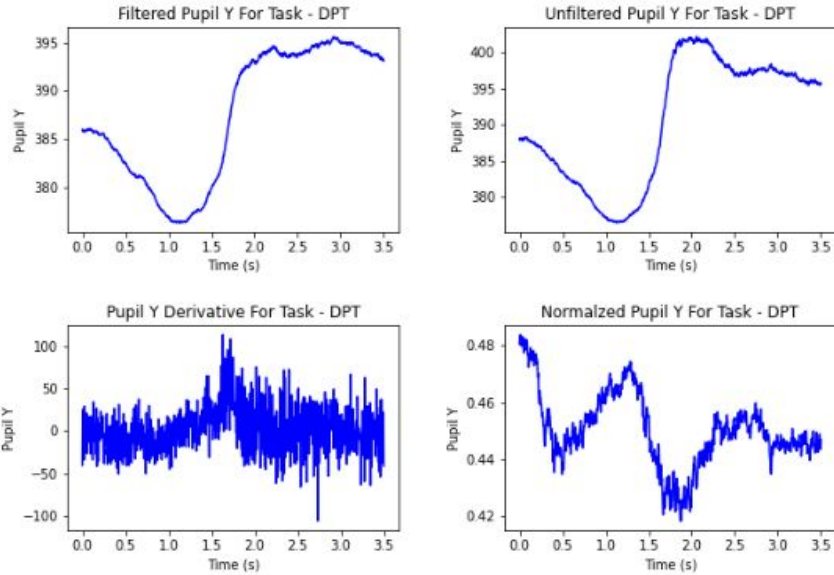


All Subjects (Low Pass Filtered)

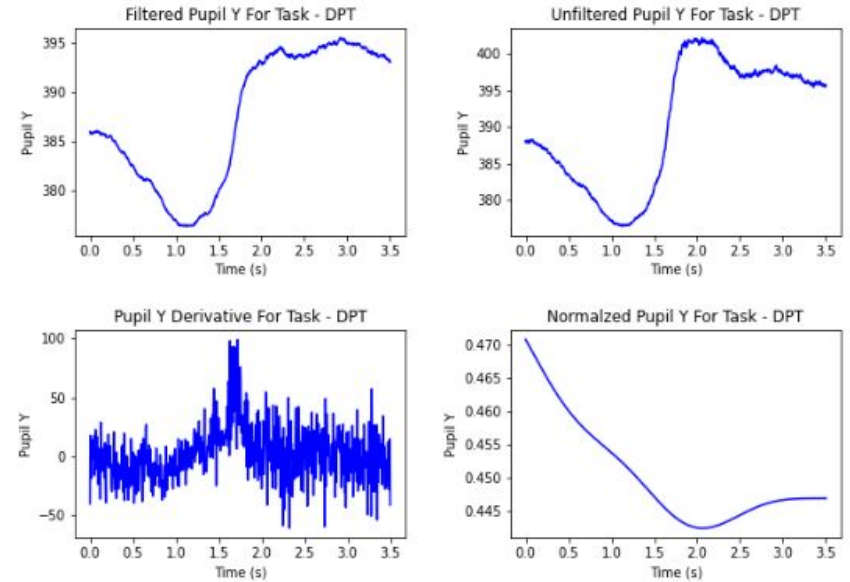


Low Pass Filter (Example 2)

All Subjects



All Subjects (Low Pass Filtered)



Missing Data

Handling Missing Data

To handle missing data, for each block of data after a stimulus onset time we check what percentage of the data is missing:

- If 50% of the data is nan (missing) then we discard that block of data for the subject
- Otherwise we keep the data and replace it with the average value in that block of data.

	DPT	MA	PVT	VWM
Pupil Diameter	0	188,500	245,875	0
Pupil X	6,089,125	4,672,625	1,550,500	2,395,750
Pupil Y	6,089,125	4,672,625	1,550,500	2,395,750

Recap

- Analyzed Pupil X and Y Data
 - Graphed Gaze Position (X, Y), Gaze Speed as well
- Implement filter on data for each time trial
- Included half a second before stimulus onset time
- Included side by side of graphs after filter is applied
- Changed code to calculate derivative and normalize (independently) on each individual time series instead of on averaged data
- Include more behavioral data in the dataframe Dr. Brooks requested
- Created Graphs with Low Pass Filter Applied