To access on Prezi:

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Each step in the presentation will represent a point in the Framework Mohammed has made earlier.

Below is a more detailed outline of our work - modify if needed -

## 1- Literature Review

- introduction about visual systems in general

- Understand the Dataset: Familiarise yourself with the structure and content of the dataset. Identify the variables/features available, their data types, and the meaning of each variable. Determine the format of the stimulus information and the neuro response measurements.

* We have two data sets.
* Literature review to understand the experiment conducted to obtain the data.
* Conducting literature review to determine which data to work with.
* Deciding to continue with Orientation data.

## 2- Data Preprocessing: Clean the dataset by handling missing values, removing irrelevant or noisy data, and performing any necessary data transformations. This step ensures that the data is in a suitable format for analysis.

* No NaN
* Meanwhile, analysing the position of neurons from both data to determine if they are obtained from the same  
  experiment, same neurons.
* They are not!!
* Subtracting the mean of the neuron response using the spont\_mean

## 3- Feature Engineering: Extract or derive relevant features from the dataset that may be useful for understanding the neuro responses. This could involve aggregating or calculating statistical measures, creating new variables, or encoding categorical variables.

* Convert istim from radians to degrees for convenience
* Neuron responses were binned over the degrees, normalised using z-scored.
* Now we have a dataframe with orientation in degrees and normalized neuron responses
* We can show here the 3d plot as a transition to the EDA

## 4- Exploratory Data Analysis (EDA): Conduct exploratory data analysis to gain insights into the dataset. Visualize the data using plots, histograms, scatter plots, or other appropriate techniques to identify patterns, relationships, or anomalies. EDA helps in understanding the distribution of variables, detecting outliers, and formulating hypotheses.

* 3d representation of the data with respect to their preferred orientation.
* Scatter plot of bi-modal neuron —> data can be pooled so that we have 0 - 180 degrees —-> go back to feature engineering to calculate the mean of each neuron with respect to the pooled orientation.

## 5- Hypothesis Formulation: Based on the initial observations from the EDA, formulate hypotheses about the relationships between the external stimuli and the neuro responses. Define the specific research questions or objectives that you aim to address through analysis.

* We can confirm now that our data is sufficient to answer the question of the orientation selective neuron in the mouse’s V1 or add new discoveries about it.
* Most of the neurons in the primary visual cortex of the mouse are selective to specific orientation, however, it is unclear what is the architecture of these neurons. Can we draw a map of their distribution, or is it “salt and pepper”

## 6- Statistical Analysis: Select appropriate statistical techniques or models based on the nature of the data and the research questions.

* One metric to investigate is, Orientation Selective Index OSI, but first, generate tuning curves, fit them, get OSI.
* Easy, no.....
* to fit the tuning curves, we first used von mises fitting, however out of the 20,000+ neurons we had many neurons that we couldn’t fit
* Ok exclude them and get the OSI. Done we have a 3d visualization of the distribution of neurons in the v1 of the mouse.
* But what about the bimodal neurons?
* how about, sine wave, worst, the local minimum is considered as the preferred angle.
* ok, more complex, mixture gaussian, no
  + gaussian1 = A1 \* np.exp(-0.5 \* ((theta - mu1) / sigma1) \*\* 2)
  + gaussian2 = A2 \* np.exp(-0.5 \* ((theta - mu2) / sigma2) \*\* 2)
  + response /= np.max(np.abs(response))
  + Didn’t work at all very odd values, it seems doesn’t have much potential.
* what now, ok technically speaking we are rotating a square, hence, 0 == 360, 90 == 270 so why don’t we pool the data so that the angles range is 0-180
* ok now, lets try Polynomial regression !!!! great, degree 7 works fine.
* Wait the OSI is off.
* Go back to von mises:
  + A \* np.exp(k \* np.cos(theta - mu)) mathematical form
  + power\_transformation(mirror, power=3)
  + We can include the whole cell of von mises fitting
  + Examples of how it works and the fitting for the odd neurons from the previous model

## 7- Interpretation and Conclusion: Analyse the results of your statistical analysis or predictive models. Interpret the findings in the context of your research question.

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## 8- Visualization and Communication: Communicate your findings effectively through visualisations, graphs, or charts. Prepare clear and concise summaries or reports that convey your analysis approach, results, and conclusions to the intended audience, whether it's the scientific community, stakeholders, or colleagues.

Structure suggested by Mr. Mohamed:

* Maps in the brain in general, humans, sensory information, orientation maps in the human, we want to check if there is an orientation map in the rodent as they have different visual system than primates - we have two paths-. Rodents are not visual animals they rely on other sensory information. <https://media.npr.org/programs/morning/features/2009/march/motorcortex_200-9156b27e698b914a96208b9a2e937f1bd63c6bb5.jpg>
* So we did this.
* Calculations, fitting, OSI, location model.
* We knew that there are some articles about the salt and pepper, we either confirm it or add something to it
* Don’t discuss much about the dataset,

**Maps in brain:**

Brain mapping is a way to understand and study the human brain. It's like making a detailed map of the brain to see which areas are responsible for different functions and activities.

In general, brain maps refer to visual representations or diagrams that show the organization and functions of different regions in the brain. These maps can be created using various techniques, such as brain imaging, electrophysiology, and anatomical studies. The goal is to understand the spatial arrangement of different brain areas and how they relate to each other.

Structural Brain Maps: These maps show the physical structures of the brain

Functional Brain Maps: These maps illustrate brain activity during specific tasks or functions.

Connectivity Maps: These maps show the connections between different brain regions.

Cognitive Maps: Cognitive maps are related to how the brain processes information about space and navigation.

Types of functional maps:

1. Retinotopic map
2. Orientation map
3. Emotion map
4. Language activation map

Orientation maps are a specific type of functional brain map that reveals the organisation of neural responses to visual stimuli, particularly related to the orientation of edges or lines in the visual field. These maps are found in the primary visual cortex (V1), which is one of the first brain areas to process visual information from the eyes. The primary visual cortex contains neurons that are highly responsive to specific orientations of visual stimuli. This selectivity towards a specific orientation (orientation selectivity) is one of the fundamental findings in humans.

The orientation selective neurons can either be in columnar organization (humans) or in salt and pepper organization, as proposed in the case for mice.