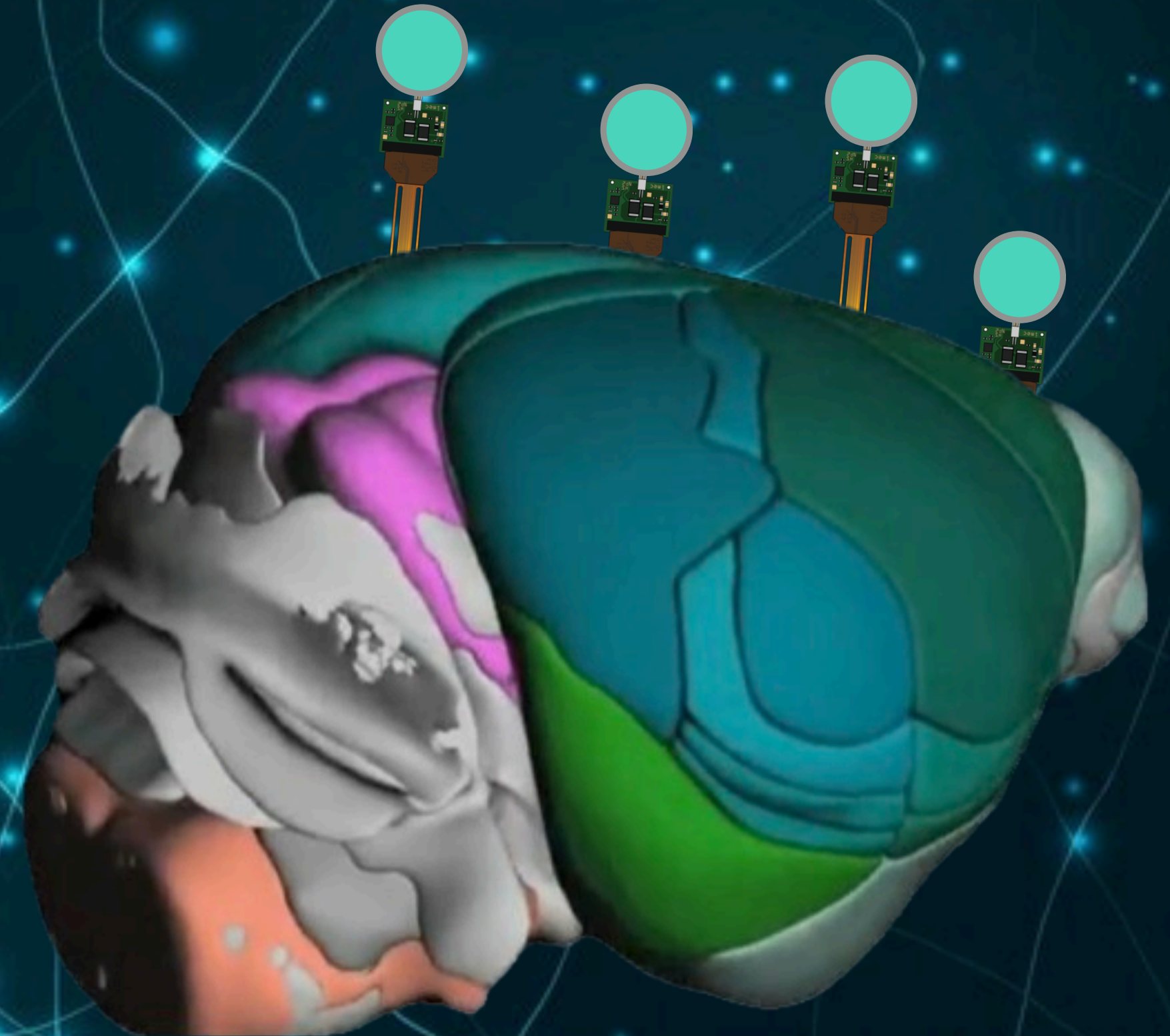


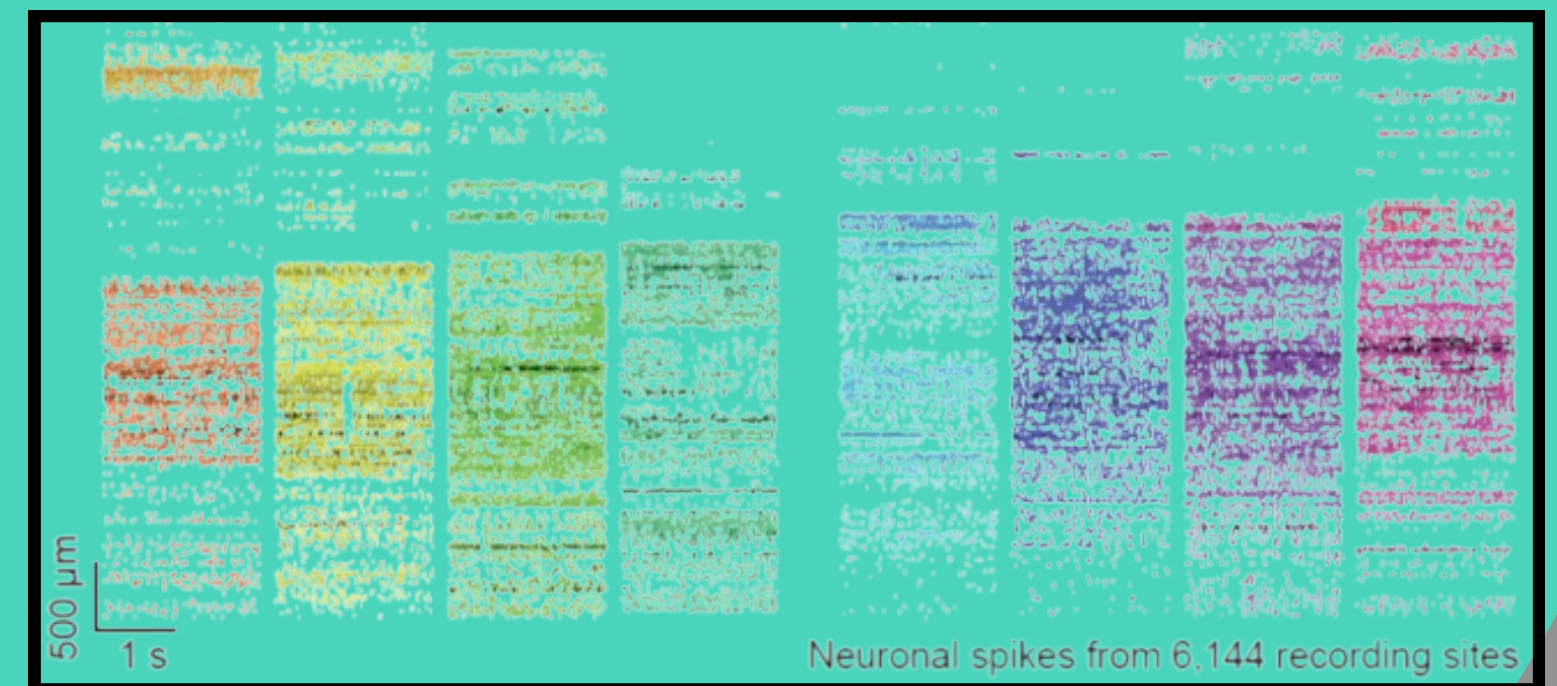
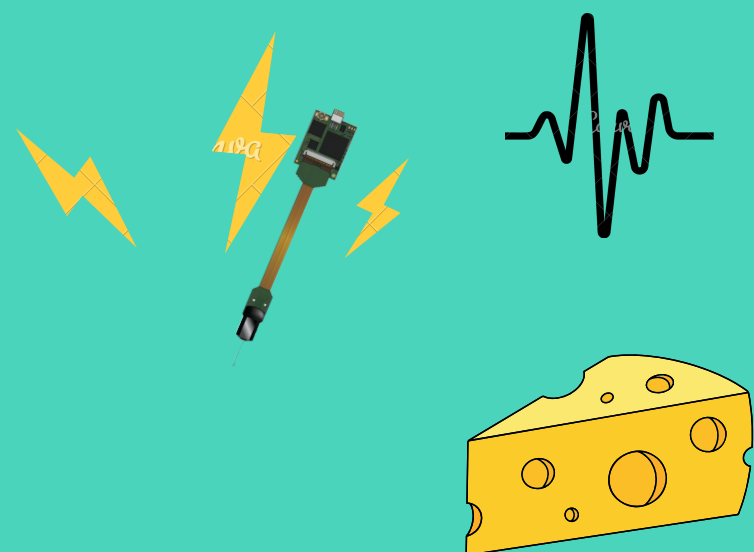
Functional Visualisation: Streamlining 3D Neuropixel Spike Mapping



Vittorio Migliorini, Chang Su, Nancy He, Zhuoling Shi,
Kangjun Ji, Ming Zhu, Yihan Zhao

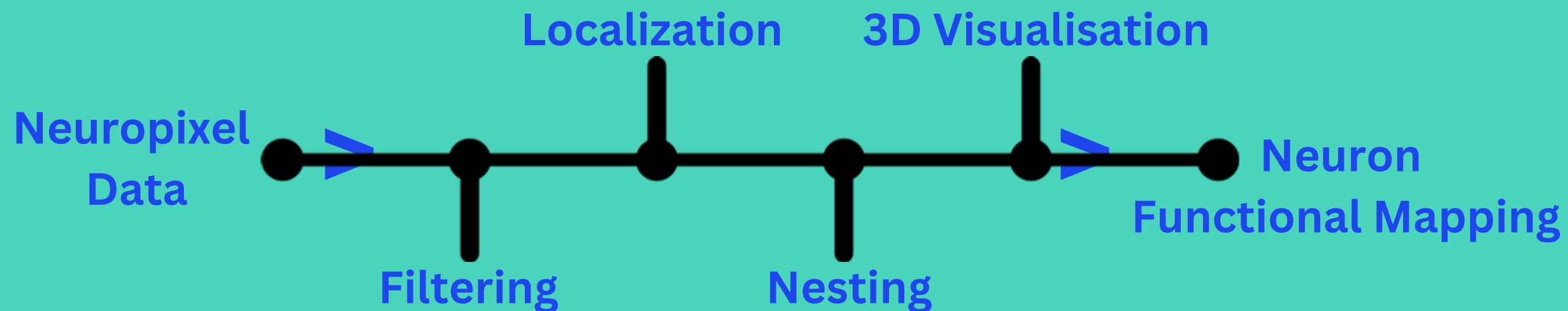
Background

- Brain activity is distributed across multiple regions.
- Different neurons encode different inputs/outputs.
- Neuropixel probes record from thousand of individual neurons simultaneously

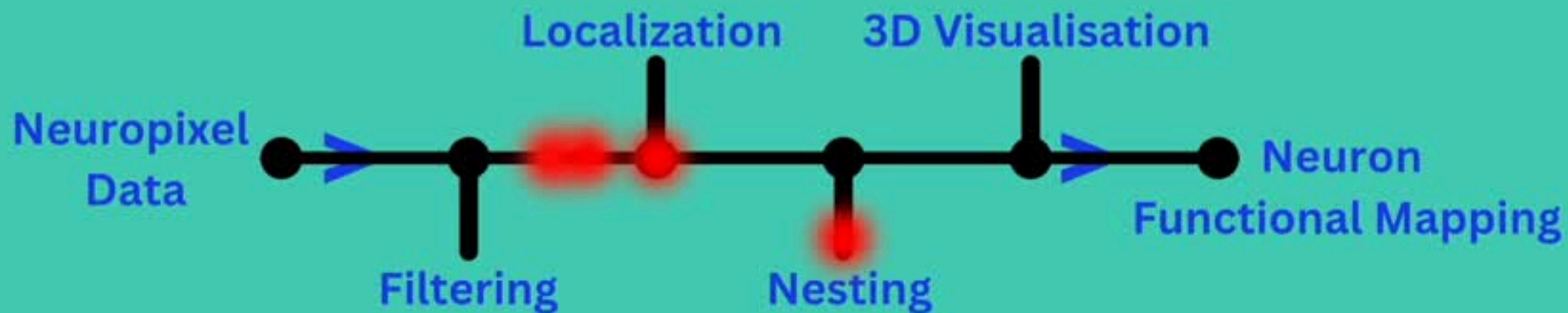


Research Questions

- Is it possible to accurately locate the position in space of a neuron group via neuropixel data ?
- Can we develop an automated pipeline for neuron classification and visualisation ?



- ## Discussion, Conclusions, and Recommendations

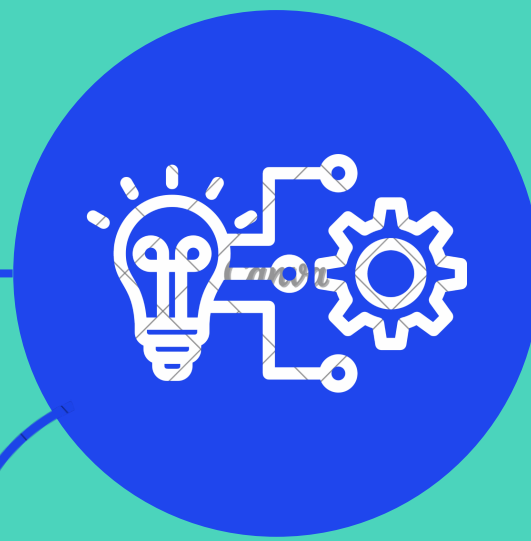


Aims & Rationale



AIM 1

Determine the significance of neuron firing rate



Aim 2

Identify Neuron Function



Aim 3

Determine spatial position of cluster



Aim 4

Map neuron in 3D space

Key Steps

```
graph LR; 01[01] --- B1[Background Research]; 02[02] --- B2[Expand on Research Focus]; 03[03] --- B3[Appropriate Data Filtration]; 04[04] --- B4[Explore Spatial Location Methods of Neuropixel Data]; 05[05] --- B5[Apply Kernel Function to Filtered Data]; 06[06] --- B6[Functional Mapping to 3D Brain Regions];
```

01

Background
Research

02

Expand on
Research
Focus

03

Appropriate
Data Filtration

04

Explore Spatial
Location Methods
of Neuropixel Data

05

Apply Kernel
Function to
Filtered Data

06

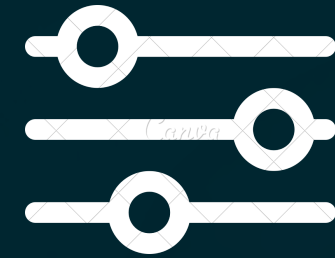
Functional Mapping
to 3D Brain Regions

Statistical & Location Processes



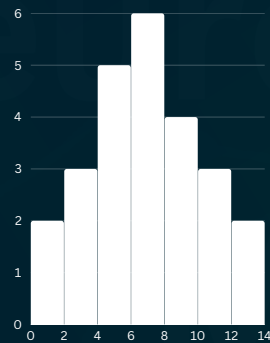
PTP Spike Localisation

Determine spatial location.



Kilosort

Automatically spike sort & filter data.



Nest Testing

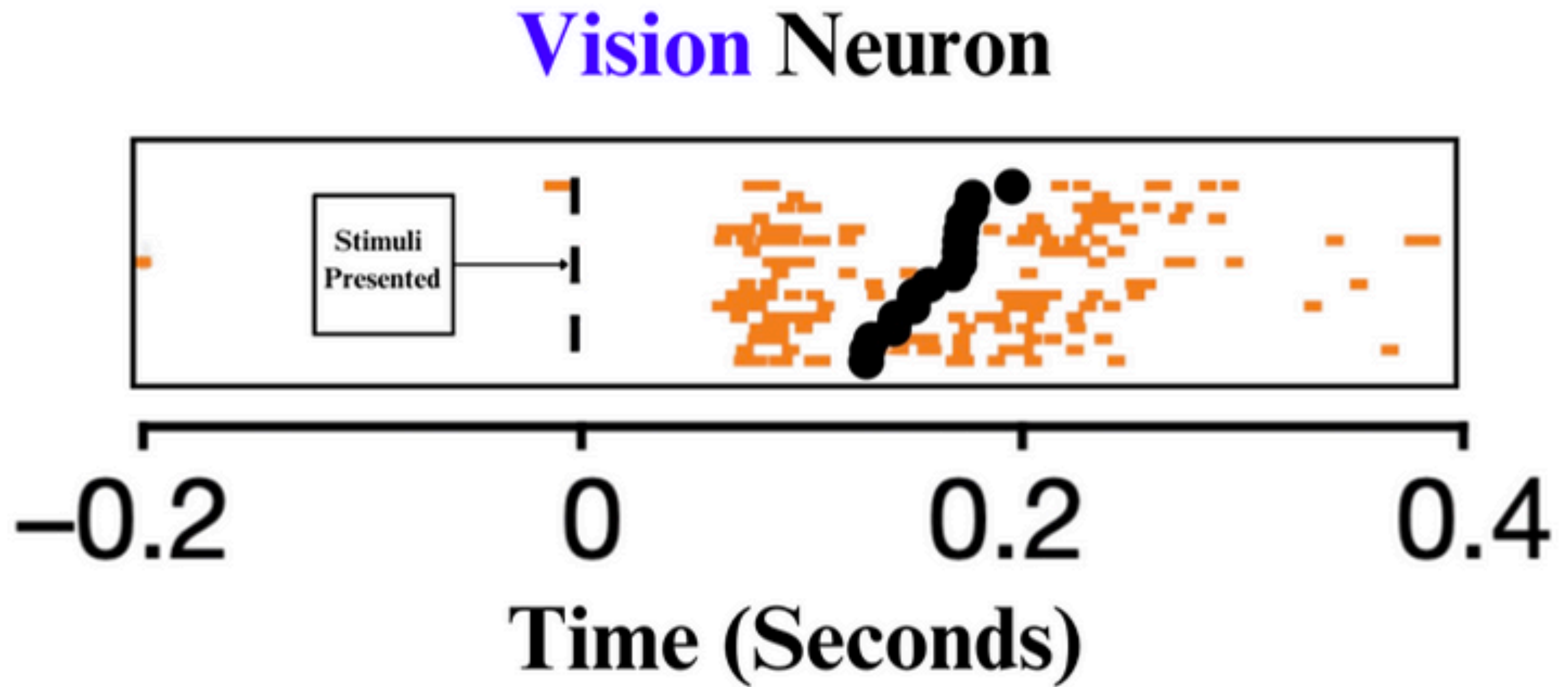
Determine which neurons encoded vision, action and choice.



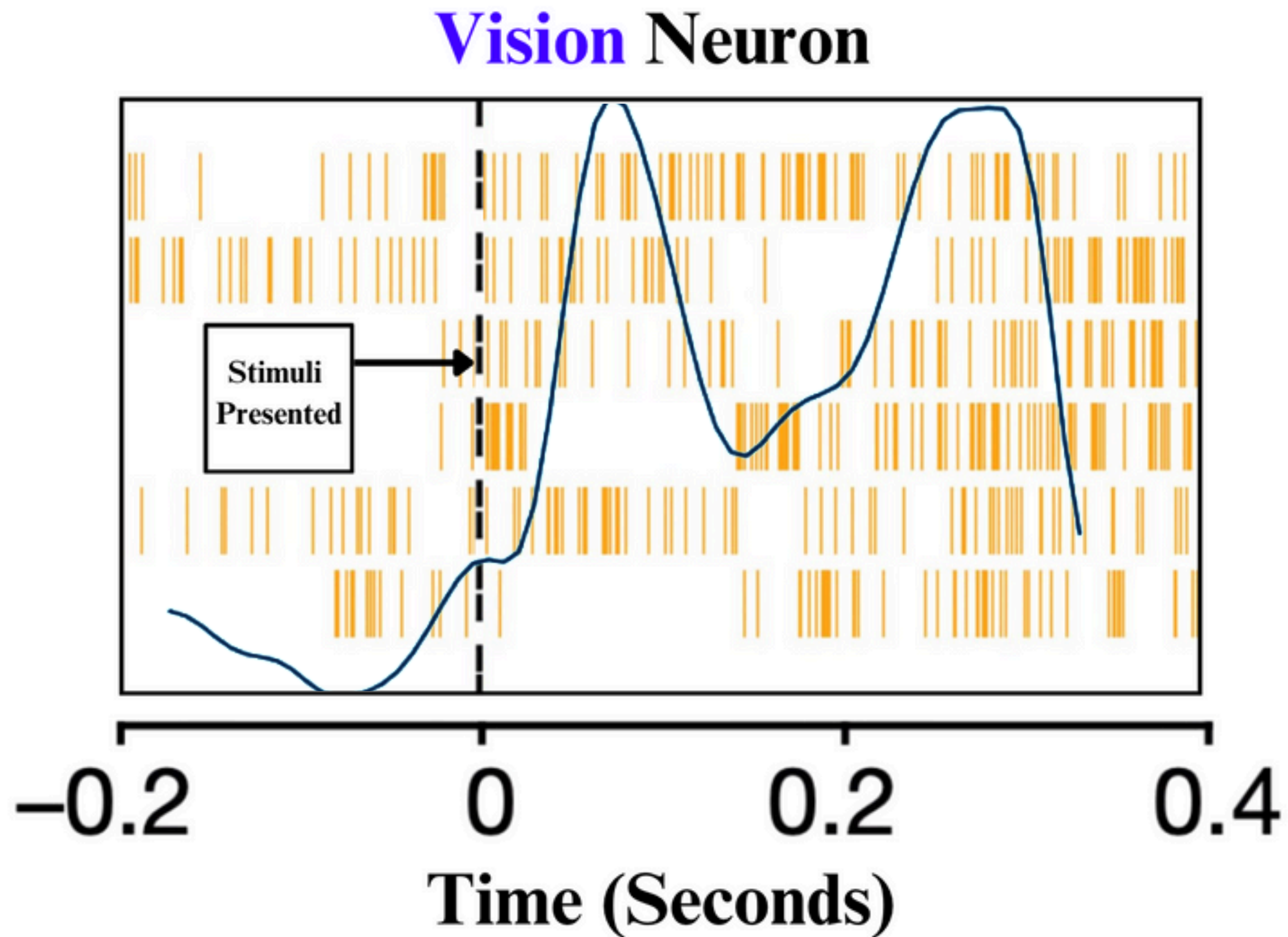
Gradient Descent

Calculate unknown variables via multiple iterations.

Data Filtering

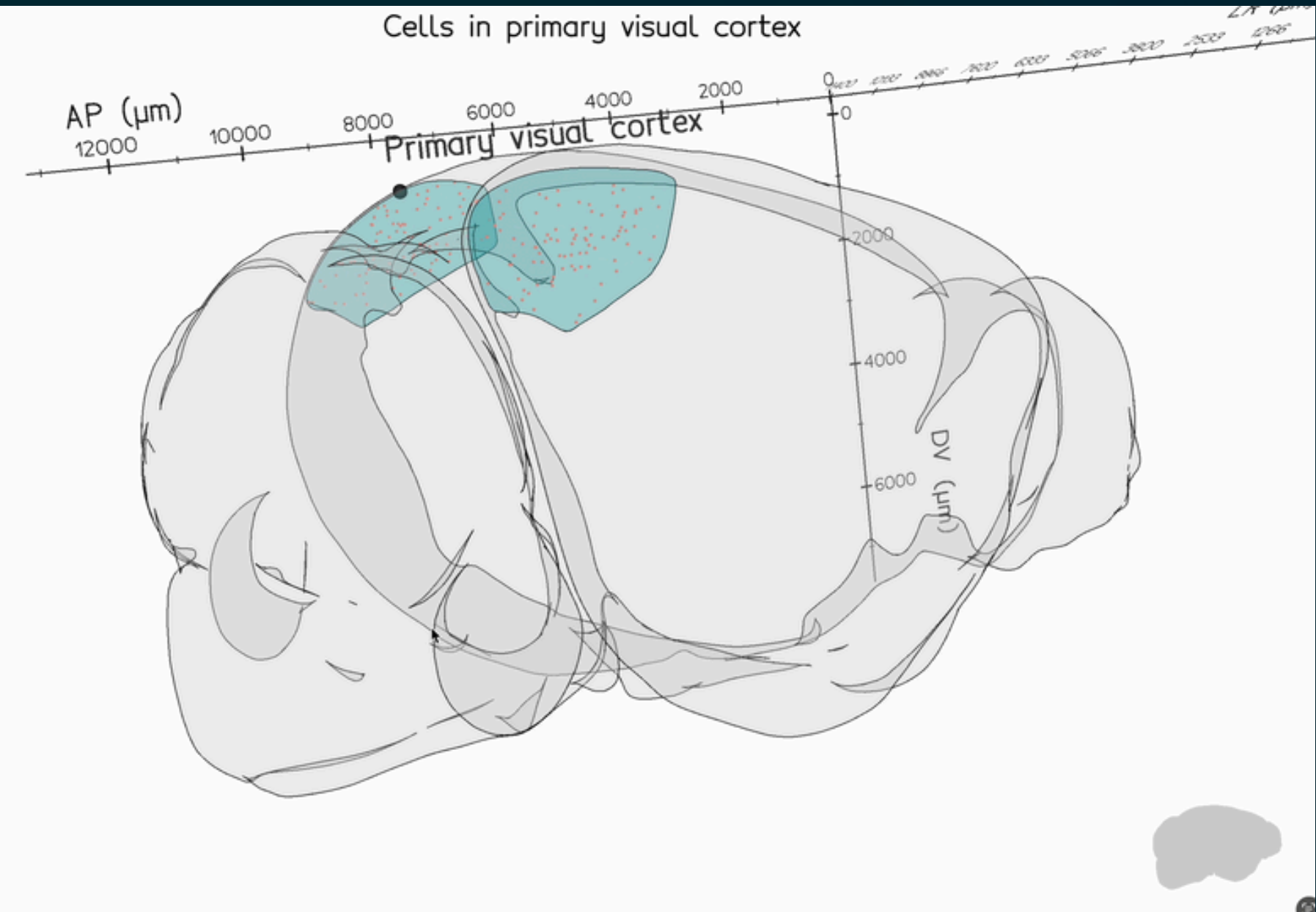
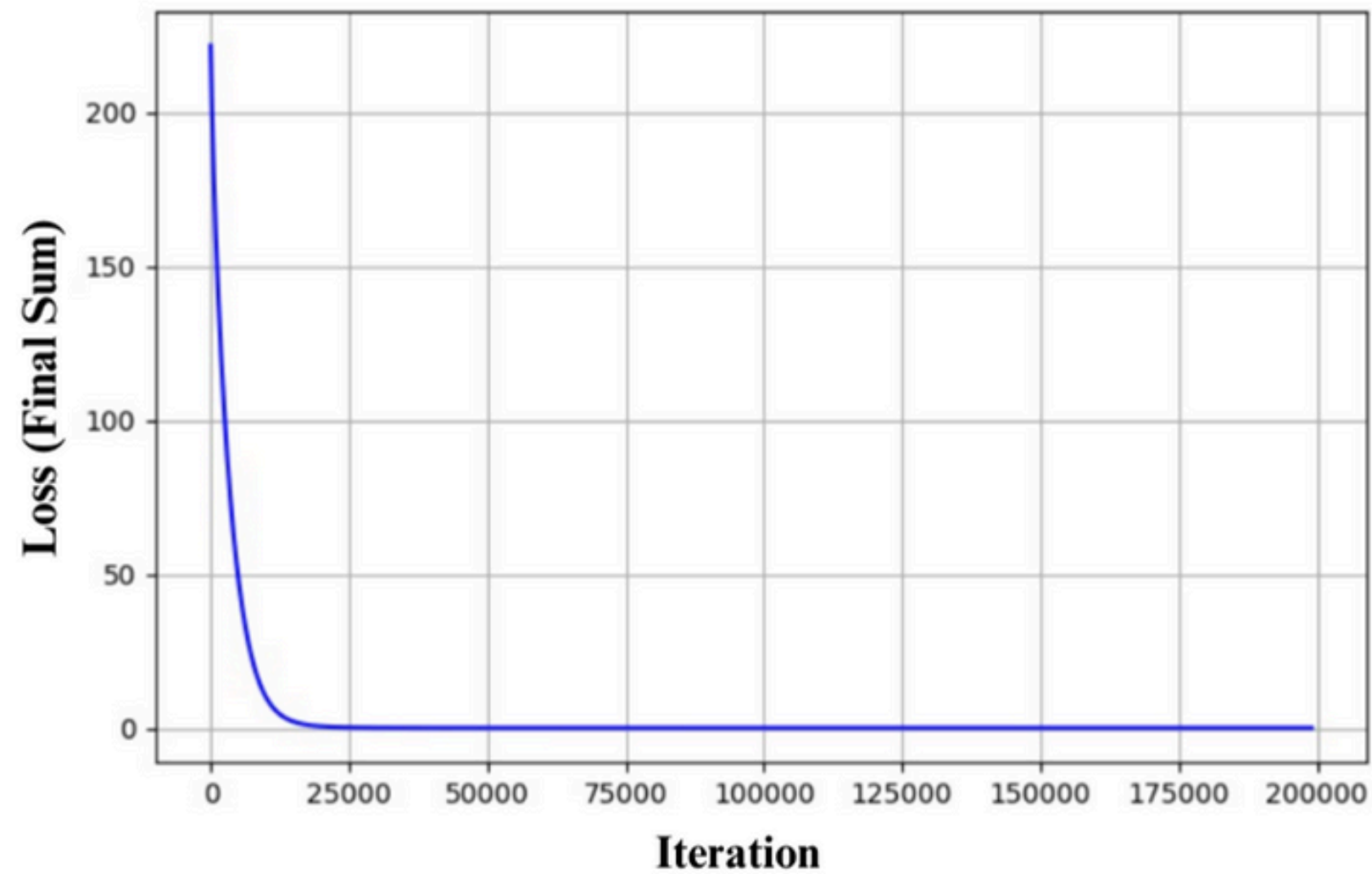


Data Filtering

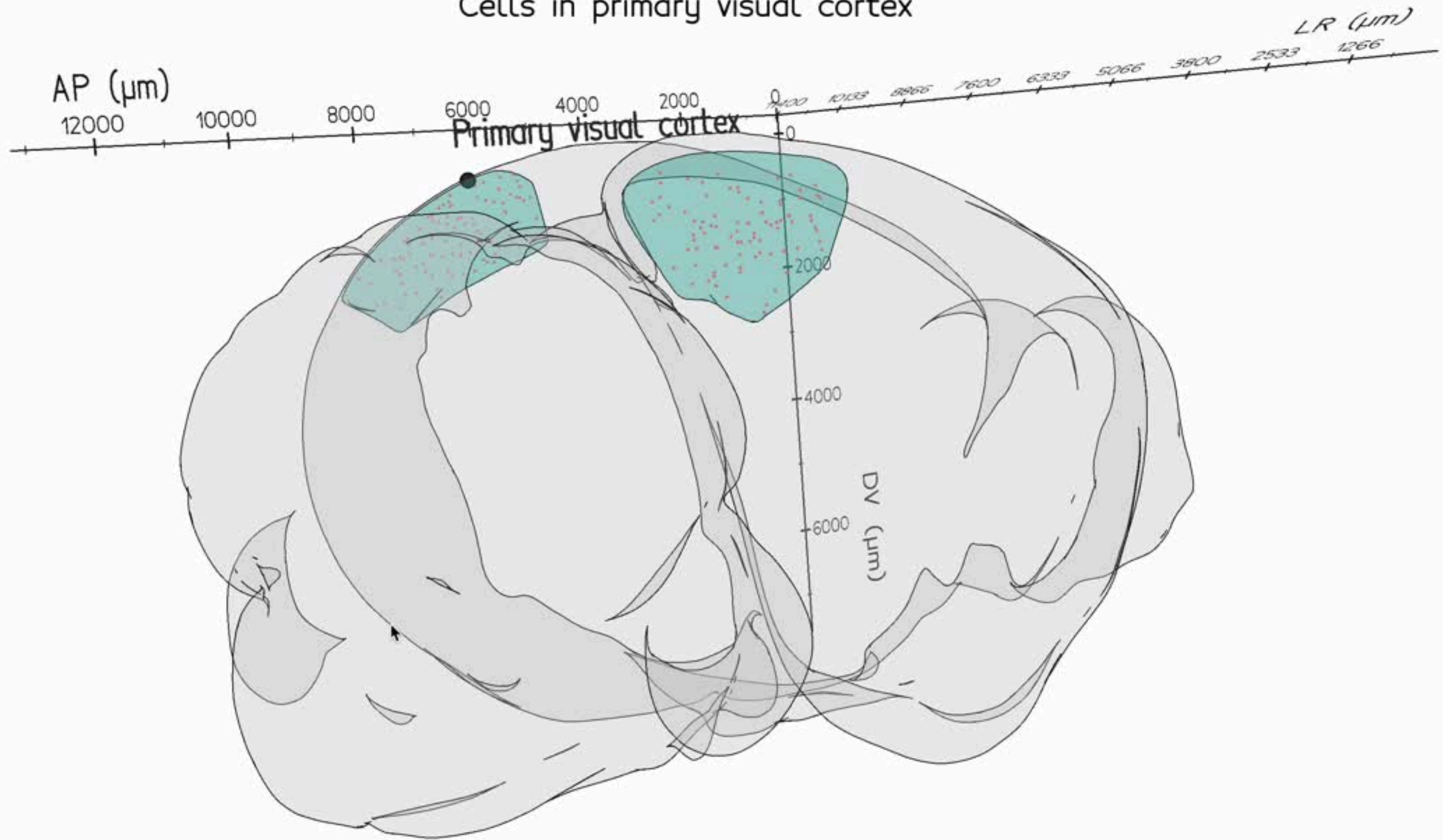


PTP Spike Localisation

Gradient Descent



Cells in primary visual cortex

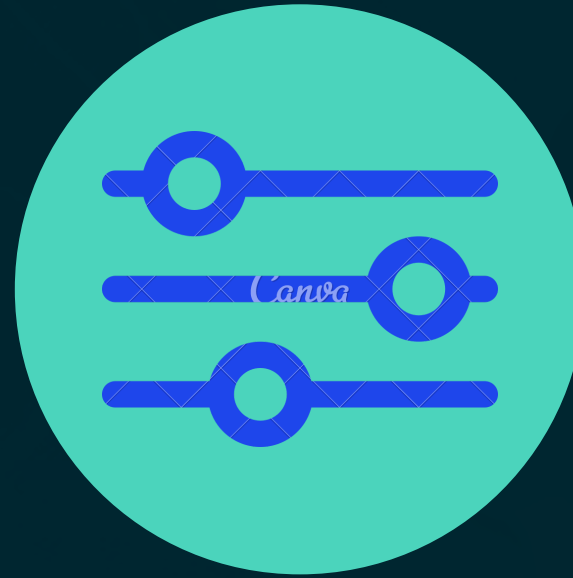


Contingency Plan



**Unable to find
spatial location**

Change in scope of
project/methodology



**Filtering
Unsuccessful**

Research alternative
methodologies



**Processing
requirements**

3rd Party processing
required

Project Schedule

Week	Week Beginning	Deadlines	Due Date	Tasks						
1	07/10/2024			Research						Completed
2	14/10/2024				Supervisor Presentation					In Progress
3	21/10/2024	Decide on a Project	22/10/2024 12:00:00							To Be Done
4	28/10/2024									Deadline
5	04/11/2024									Holiday
6	11/11/2024				Design MindMap					
7	18/11/2024	Literature Mindmap & Literature Highlights	21/11/2024 10:00:00			Write Literature Highlights				
8	25/11/2024									
9	02/12/2024									
10	09/12/2024						Analyse GitHub Code & Data			
11	16/12/2024									
12	23/12/2024									
13	30/12/2024							Replicate Data		
14	06/01/2025									
15	13/01/2025									
16	20/01/2025									
17	27/01/2025									
18	03/02/2025				Design Project Pitch					
19	10/02/2025									
20	17/02/2025									
21	24/02/2025									
22	03/03/2025	Project Pitch	06/03/2025 10:00:00		Practice Project Pitch					
23	10/03/2025									
24	17/03/2025									
25	24/03/2025									
26	31/03/2025									
27	07/04/2025									
28	14/04/2025	Final Report + Project Management Assessment	15/04/2025 10:00:00							
29	21/04/2025									
30	28/04/2025									
31	05/05/2025									
32	12/05/2025									
33	19/05/2025									
34	26/05/2025									
35	02/06/2025	Brochure Pitch	05/06/2025 10:00:00							

Any Questions ?



Visit our website for more in-
depth info.

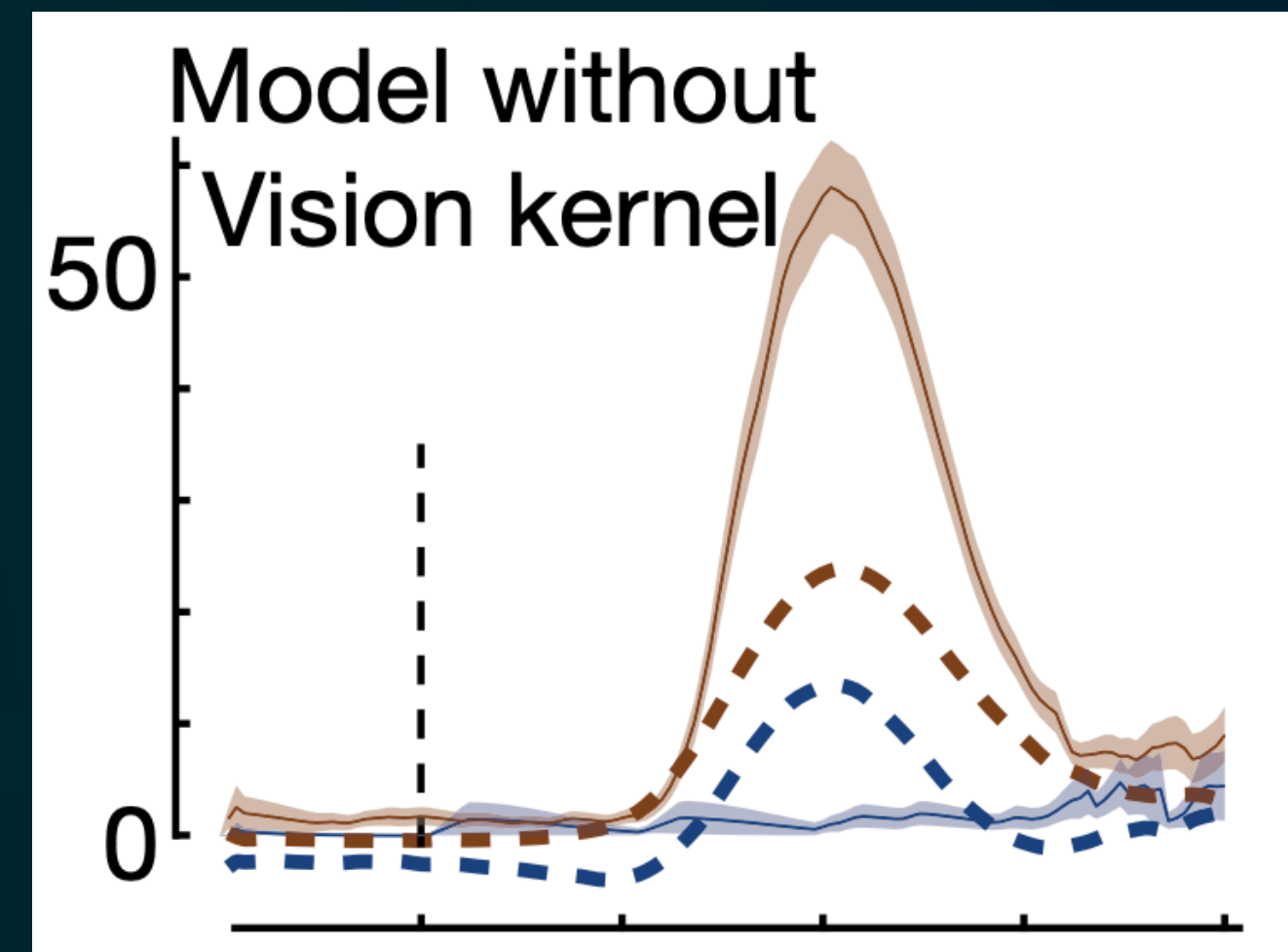
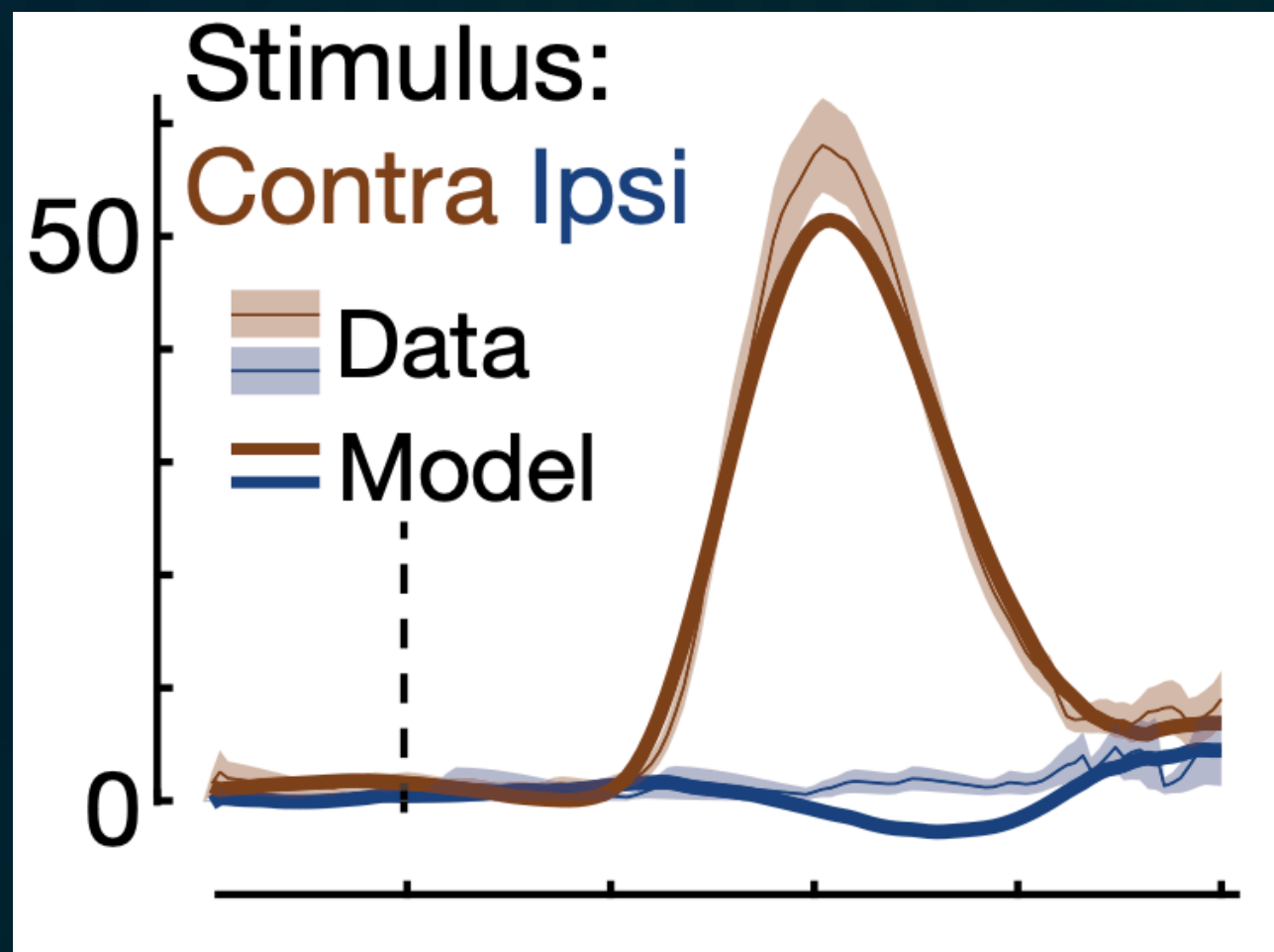
PTP Equation

$$\left(\sum \left(\text{ptp}_c - \frac{\alpha}{\sqrt{(\mathbf{x} - \mathbf{x}_c)^2 + (\mathbf{z} - \mathbf{z}_c)^2 + \left(\mathbf{y} - \sqrt{(\mathbf{x} - \mathbf{x}_c)^2 + (\mathbf{z} - \mathbf{z}_c)^2} \right)^2}} \right) \right)^{2.5}$$

Adam Optimization (Moments) -> AdaGrad Optimization (Cumulative Squared Gradient)

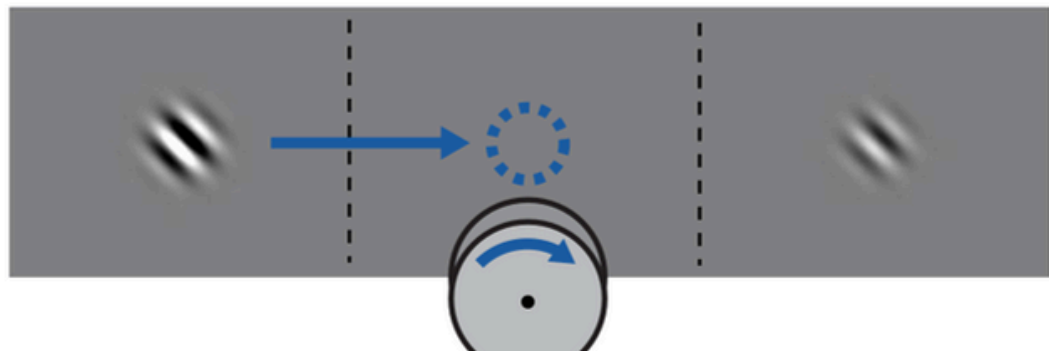
Kernel Regression

$$f_n(t) = \sum_c \sum_{t_s \in S_c} K_{c,n}(t - t_s) + \sum_{t_m \in M} \left(K_{m,n}(t - t_m) + D_m K_{D,n}(t - t_m) \right)$$

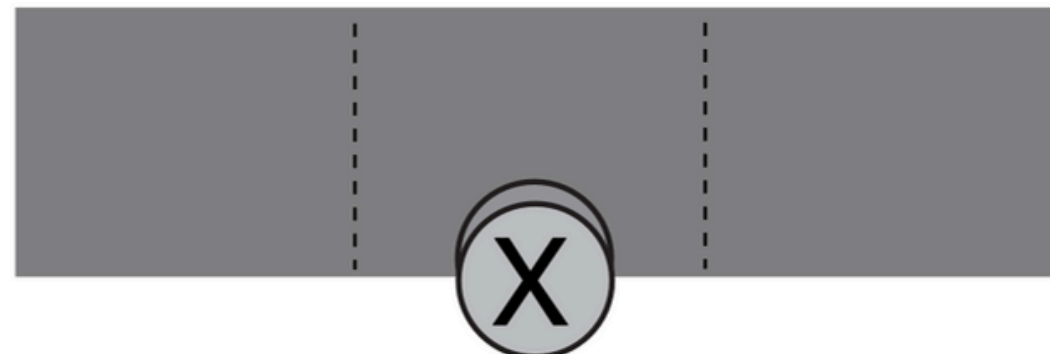


Background Paper

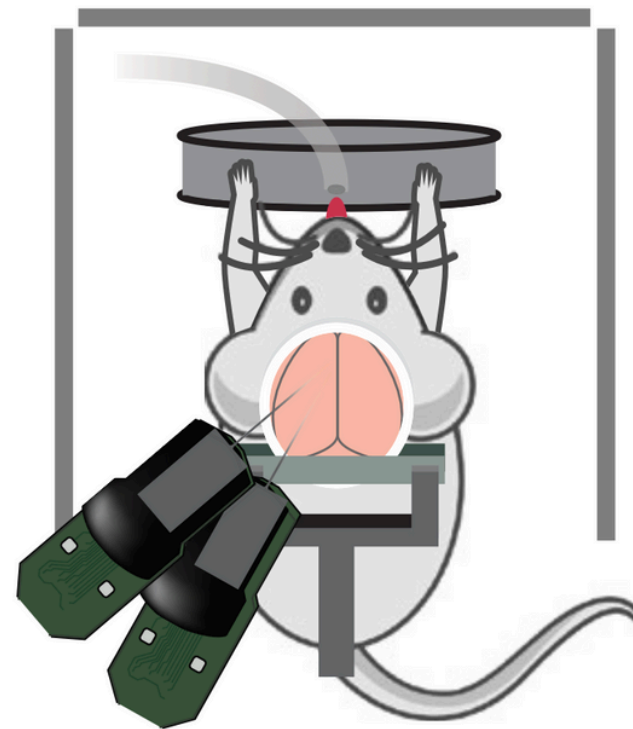
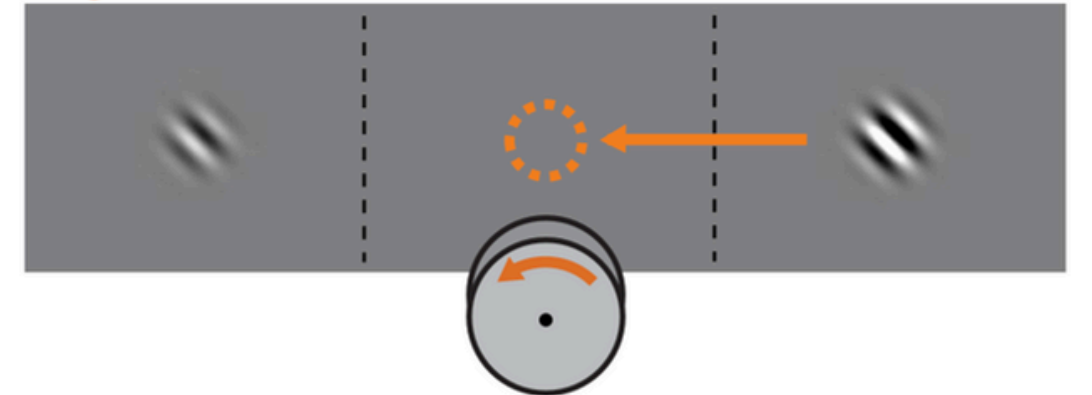
Left



NoGo



Right



Neuropixels