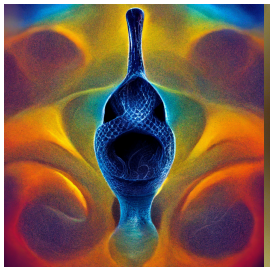
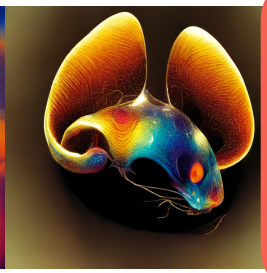

Topological analysis of the neuronal activity in mouse visual cortex

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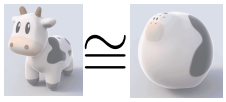
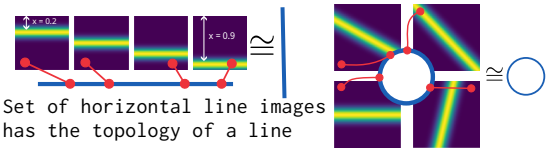
1. The neuronal activity in the visual cortex during grating stimuli is topologically isomorphic to the shape of the stimuli set – the Klein bottle.
2. The activity of neurons responsive to the same image segment is isomorphic to a Klein bottle with the orientation of the corresponding grating as its parameter. Thus, an image is locally represented as a grating.

Topology

Study of structure of shapes

Continously deformed shapes are considered isomorphic



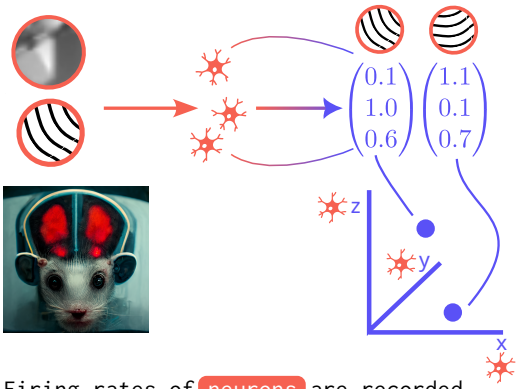


Set of horizontal line images has the topology of a line

Set of grating images has the Klein bottle topology

Process

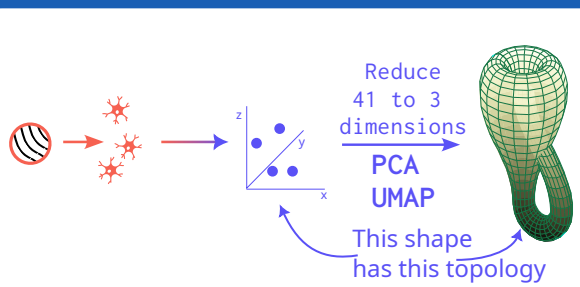
Calcium imaging with visual stimulus, then topological data analysis



Firing rates of neurons are recorded. For each image, there is a point with firing rates as coordinates. These points make up the shapes we study.

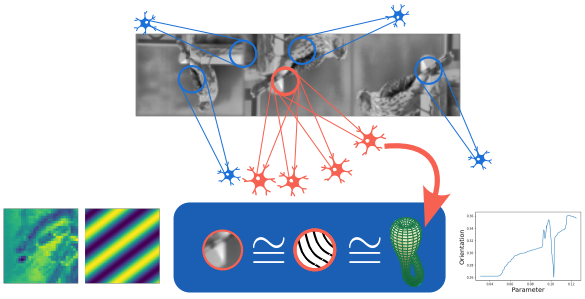
Gratings

Neuronal activity for gratings has the Klein bottle topology



Natural images

Activity of neurons responsive to the same image segment is isomorphic to a Klein bottle



Conclusion

Images are locally represented in the brain as gratings. This is similar to convolutional neural networks and compression algorithms, e.g. JPEG.

More info, references, interactive shapes:

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