THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
CREATE CHANGE

# Pattern Analysis

## Visualisation of CNNs

Dr Shekhar “Shakes” Chandra
shekhar.chandra@uq.edu.au

V1.0

> “The desire to dominate is not correlated with intelligence, in fact, we have many examples of this... in the world. It's not the smartest of us that necessarily wants to be the chief.”
>
> Yann LeCun (link)
> (1960-)

# Small Datasets

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  - Over-fitting
  - Poor generalisation
  - Poor performance
- Solution?

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  - Slow/no convergence
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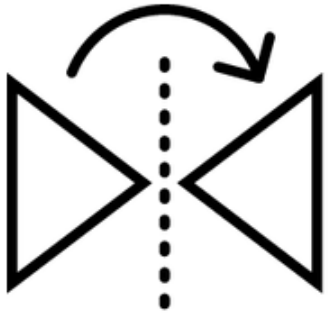
  - Poor generalisation
  - Poor performance
- Solution? Augment your data!
  - We need to create “fake” samples that mimic an expanded dataset
  - Spatial transforms
  - Greyscale transforms



# Augmentor

Augmentor is an image augmentation library in Python for machine learning. It aims to be a standalone library that is platform and framework independent, which is more convenient, allows for finer grained control over augmentation, and implements the most real-world relevant augmentation techniques. It employs a stochastic approach using building blocks that allow for operations to be pieced together in a pipeline.

Augmentor v0.2.6 | python 2.7 | 3.4 | 3.5 | 3.6 | docs passing | build passing | license MIT | repo status Active | launch binder

## Installation

Augmentor is written in Python. A Julia version of the package is also being developed as a sister project and is available here.

Install using `pip` from the command line:

```
pip install Augmentor
```

# Visualising CNNs

- How can we find out what CNNs are looking at and interpret they analyses?

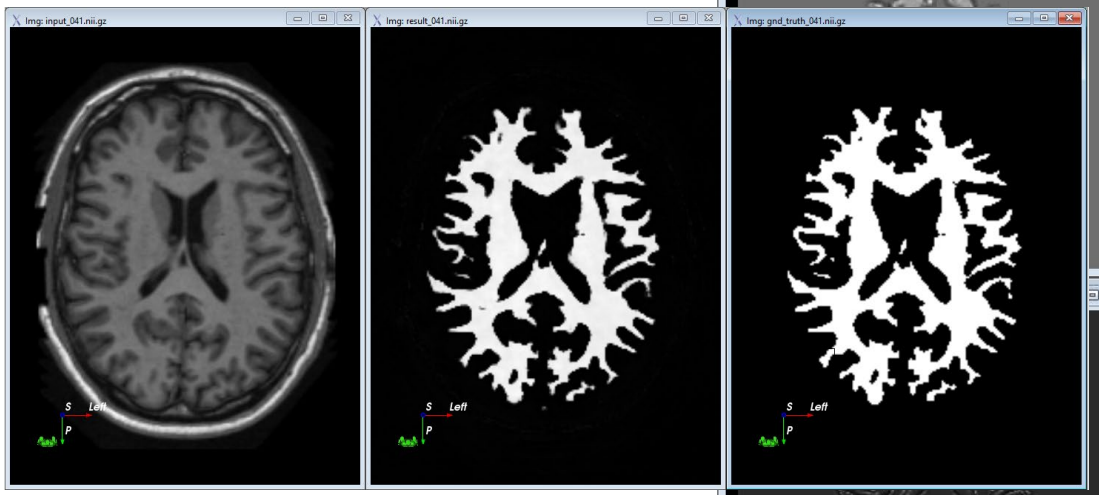
# Visualising CNNs

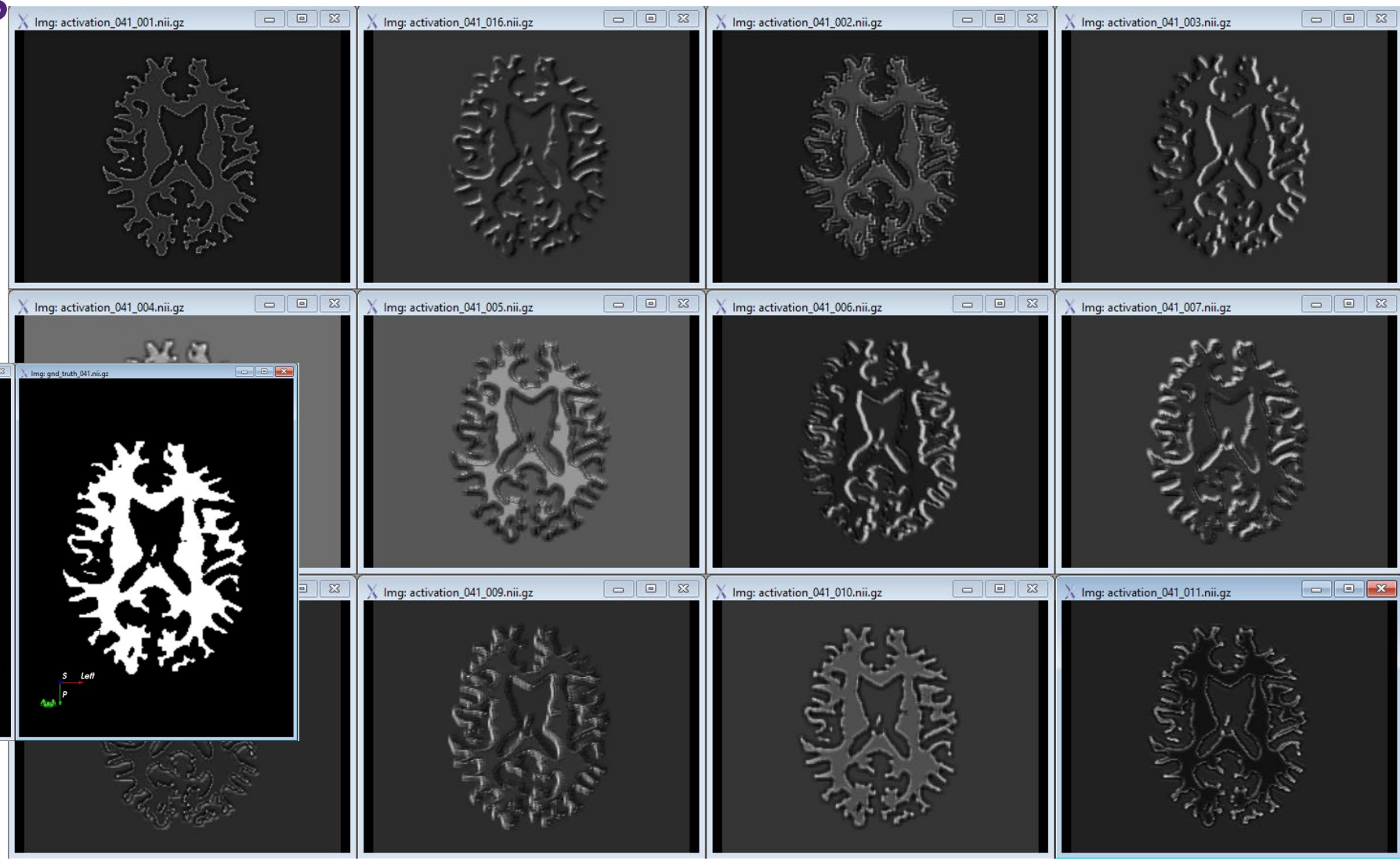
- How can we find out what CNNs are looking at and interpret they analyses?
  - Visualise the filters
  - Activation maps
  - Maximal response images
  - Manifold visualisation

# Activation Maps

https://github.com/philipperemy/keract

For given sample inputs, visualise what parts of the images cause activations in our choice of layer.



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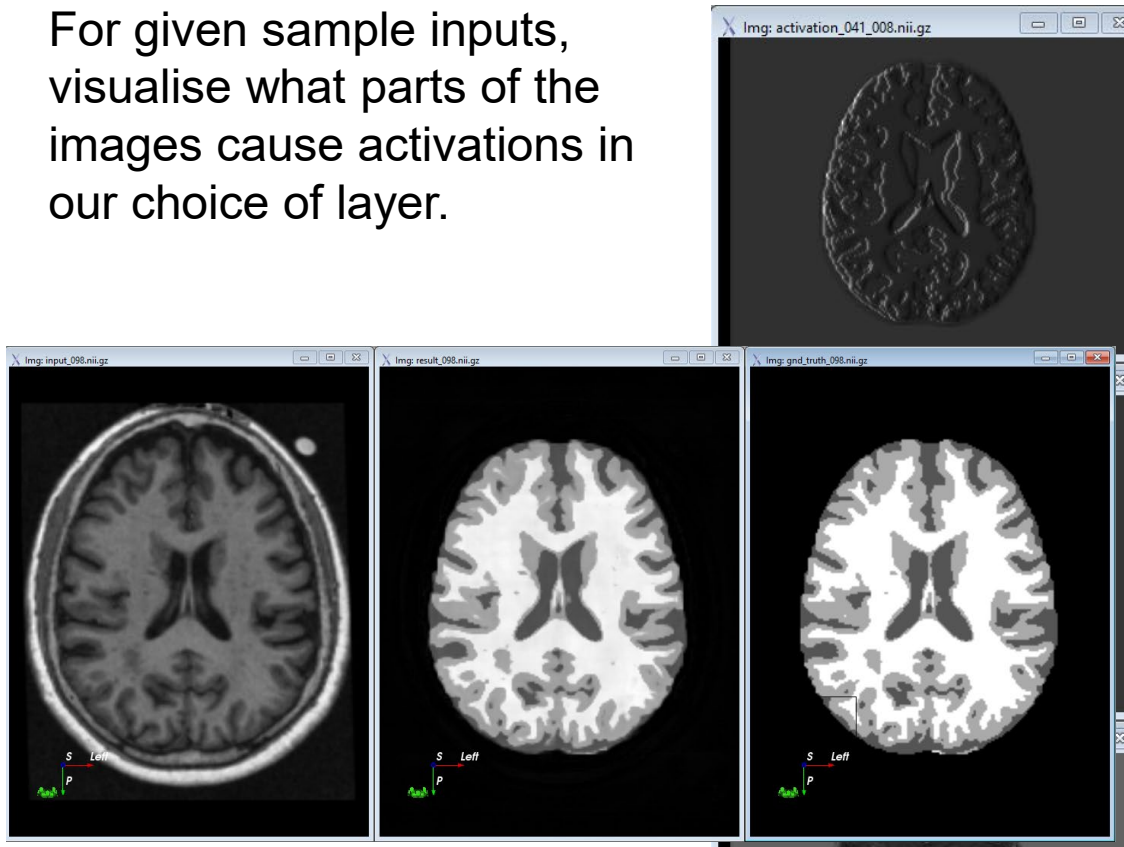
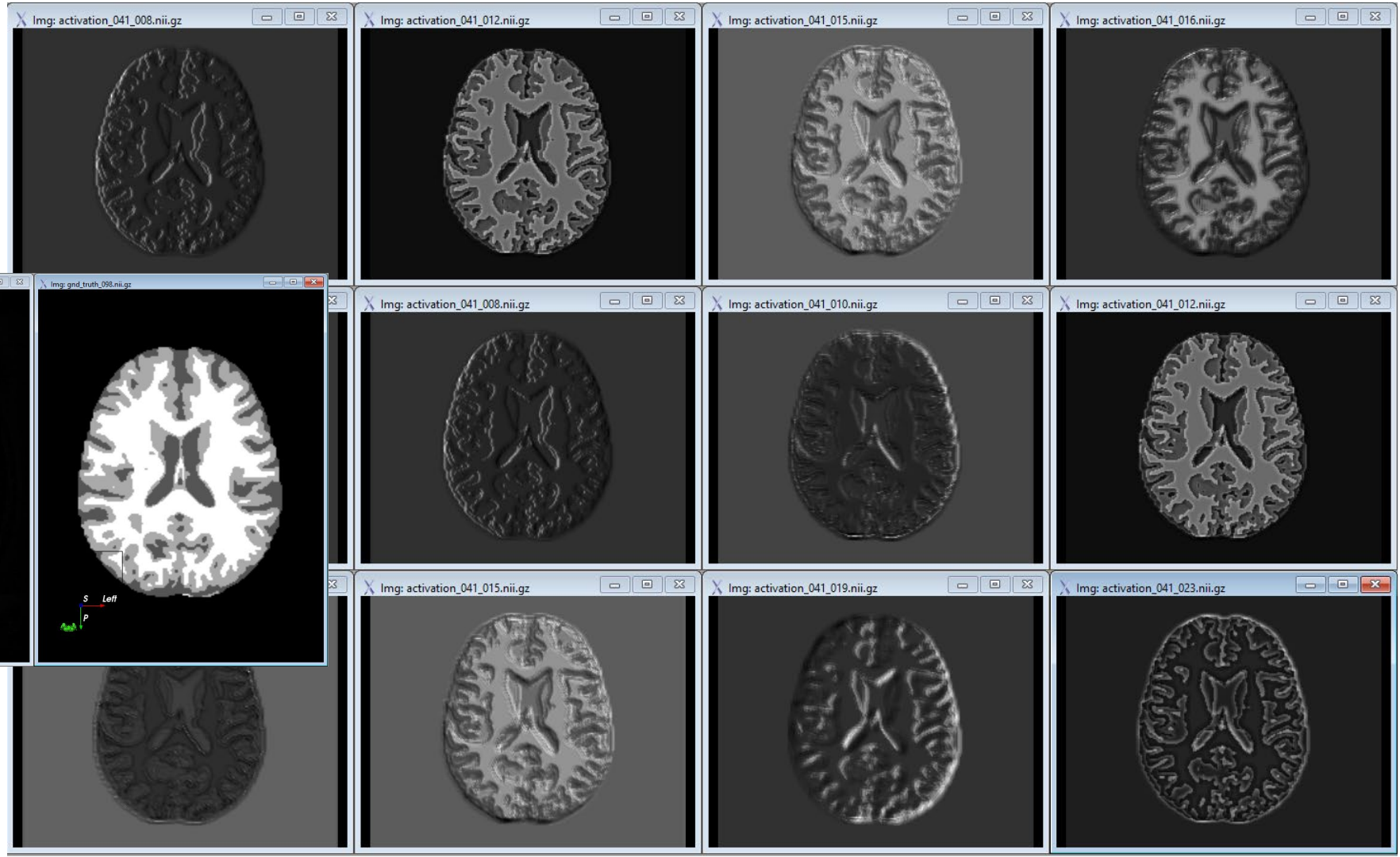
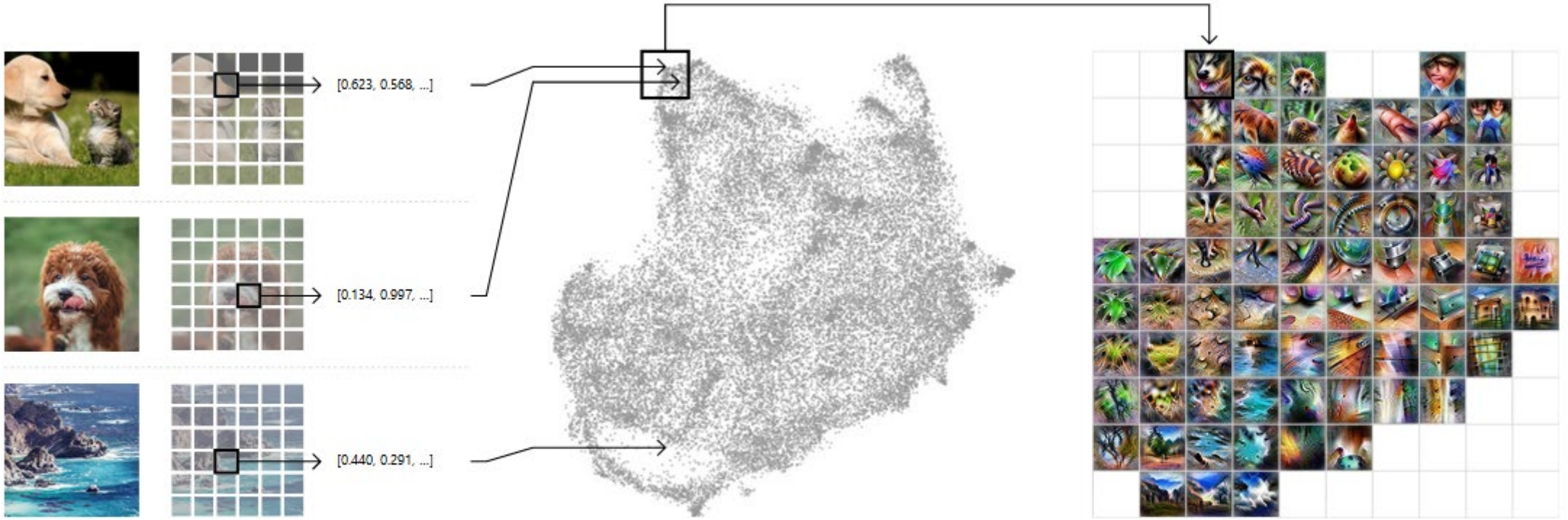


# Activation Atlases

For a large number of inputs, build a set of atlases of activation maps based on manifold learning.




A randomized set of one million images is fed through the network, collecting one random spatial activation per image.

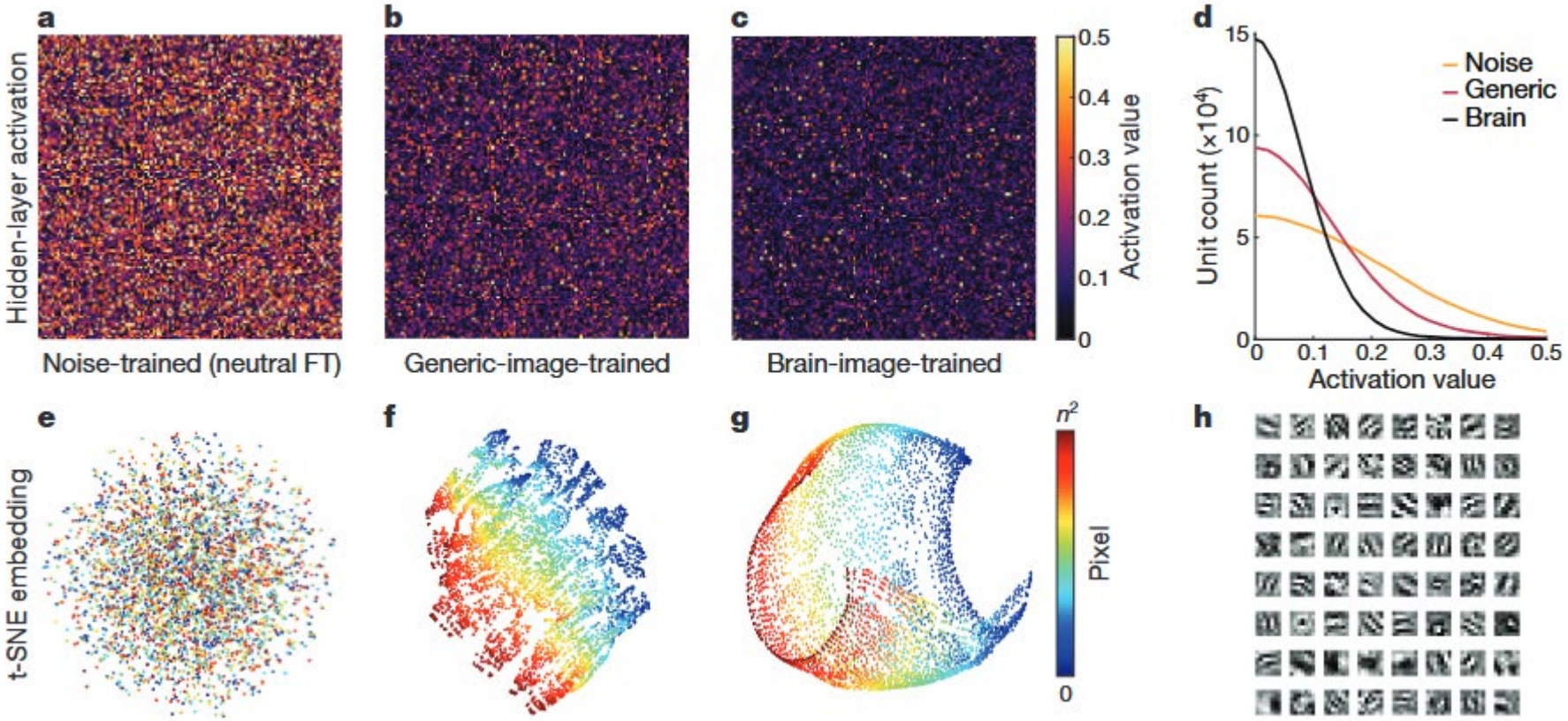
The activations are fed through UMAP to reduce them to two dimensions. They are then plotted, with similar activations placed near each other.

We then draw a grid and average the activations that fall within a cell and run feature inversion on the averaged activation. We also optionally size the grid cells according to the density of the number of activations that are averaged within.

# T-SNE and UMAP

Using two dimensional manifold learning to visualise data

https://www.nature.com/articles/nature25988



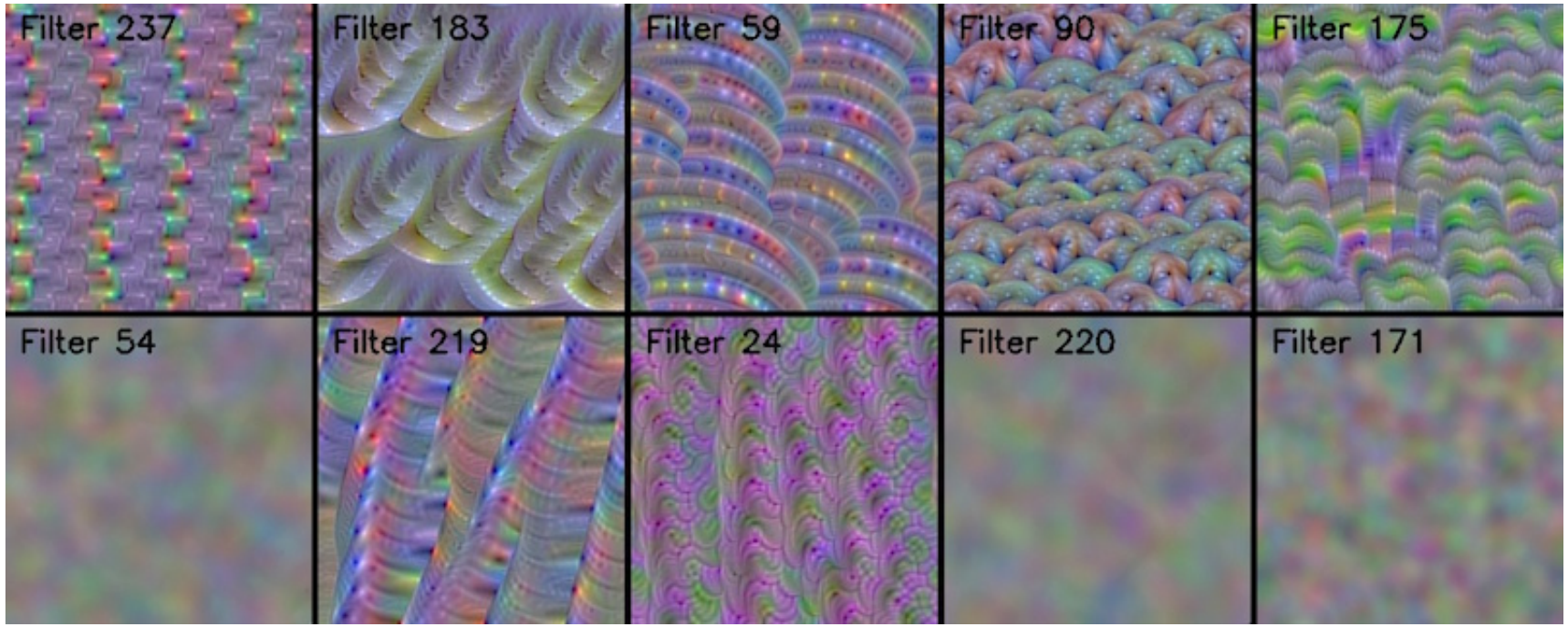
# Visualising Responses

https://github.com/raghakot/keras-vis

Gallery

https://ai.googleblog.com/2015/06/inceptionism-going-deeper-into-neural.html

Using back propagation, determine the input image that gives the most activations




*Convolutional filters learn 'template matching' filters that maximize the output when a similar template pattern is found in the input image. Visualize those templates via Activation Maximization.*

# Conclusion

- We can handle small datasets by using data augmentation
- We can improve generalizability with augmentation
- We can visualize CNNs by:
  - Looking at the activation maps
  - Manifolds they learn
  - Filters they learn and respond to

# What's Next?

We will finish off the course with some advanced specialist topics and a course summary (what to look out for in exams!)

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# Thank you

Dr Shekhar “Shakes” Chandra | Lecturer
School of Information Technology and Electrical Engineering
shekhar.chandra@uq.edu.au
+61 7 3365 8359

@shakes76
shekhar-s-chandra