# Notes on the series of articles on the topic Deconstructing Neural Networks using Circuits

compiled by D.Gueorguiev, 5/18/2024

## Introductory notes

Given the popularity of the Neural Networks for Computer Vision it is clear that the scientific community needs *mechanistic interpretability* for those neural network architectures.

Speculative claims about Neural Networks operations and explainability of the latter

**Features**: *Features* are the fundamental unit of Neural Networks. They correspond to *Directions*. By *Directions* the authors mean linear combination of neurons in a layer. One can think of this as a direction vector in the vector space of activations of neurons in a given layer. Often individual neurons will be discussed and analyzed but there are cases where analyzing combinations of neuronal output is the best way to understand the functioning of the neural net. This becomes even more important when we will be dealing with polysemantic neurons.

**Feature Visualization by Optimization**:

Neural networks are differentiable with respect to their inputs. This means that

//TODO: finish the section on Feature Visualization by Optimization

**Polysemantic Neurons**: Neural networks often contain polysemantic neurons that respond to multiple unrelated inputs. For example, [InceptionV1](https://distill.pub/2020/circuits/early-vision/) contains one neuron that responds to cat faces, fronts of cars and cat legs.

//TODO: finish the section on Polysemantic Neurons

## Discussion on *Early Vision* of InceptionV1

*Early Vision* denotes the first five layers of the neural net InceptionV1 which is shown below:

A screenshot of a computer

Description automatically generated

Figure 1: The InceptionV1 network with the first five layers shown in orange.

The first convolution layer is denoted as conv2d0 and is comprised of two kinds of features: color-contrast detectors and Gabor filters.

//TODO: finish the section on the EarlyVision part of InceptionV1

## Appendix

### Gabor filter

The Gabor filter is

//TODO: finish the section on Gabor filter

## References

[Zoom In: An Introduction to Circuits, Chris Olah et al, OpenAI, 2020](https://distill.pub/2020/circuits/zoom-in)

[An Overview of Early Vision in InceptionV1, Chris Olah et al, OpenAI, 2020](https://distill.pub/2020/circuits/early-vision/)

[Curve Detectors, Nick Cammarata et al, OpenAI, 2020](https://distill.pub/2020/circuits/curve-detectors/)

[Naturally Occurring Equivariance in Neural Networks, Chris Olah et al, OpenAI, 2020](https://distill.pub/2020/circuits/equivariance/)

[High-Low Frequency Detectors, Ludwig Schubert et al, OpenAI, 2021](https://distill.pub/2020/circuits/frequency-edges/)

[Curve Circuits, Nick Cammarata et al, OpenAI, 2021](https://distill.pub/2020/circuits/curve-circuits/)

[Visualizing Weights, Chelsea Voss et al, OpenAI, 2021](https://distill.pub/2020/circuits/visualizing-weights/)

[Branch Specialization, Chelsea Voss et al, OpenAI, 2021](https://distill.pub/2020/circuits/branch-specialization/)

[Weight Banding, Michael Petrov et al, OpenAI, 2021](https://distill.pub/2020/circuits/weight-banding/)

[Visualizing Higher Level Features of a Deep Network, Dumitru Erhan et al, Universite de Montreal, 2009](https://github.com/dimitarpg13/deep_learning_for_image_processing/blob/main/literature/articles/interpretability/Visualizing_Higher-Layer_Features_of_a_Deep_Network_Erhan_2009.pdf)

[Gabor Filter, Wikipedia](https://en.wikipedia.org/wiki/Gabor_filter)