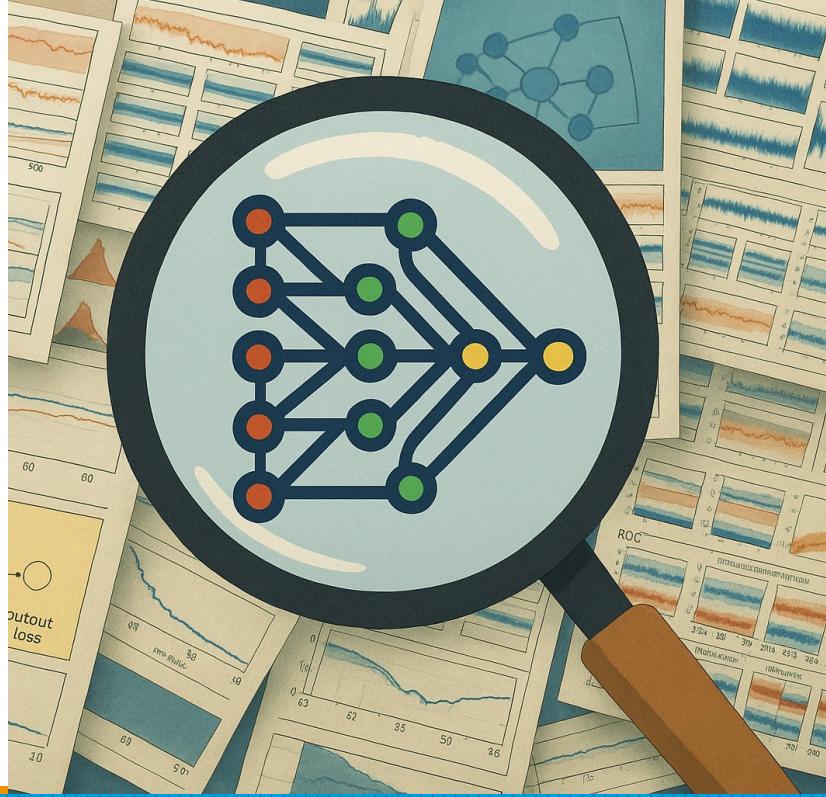


Neural Network Visualization Techniques for Better Troubleshooting



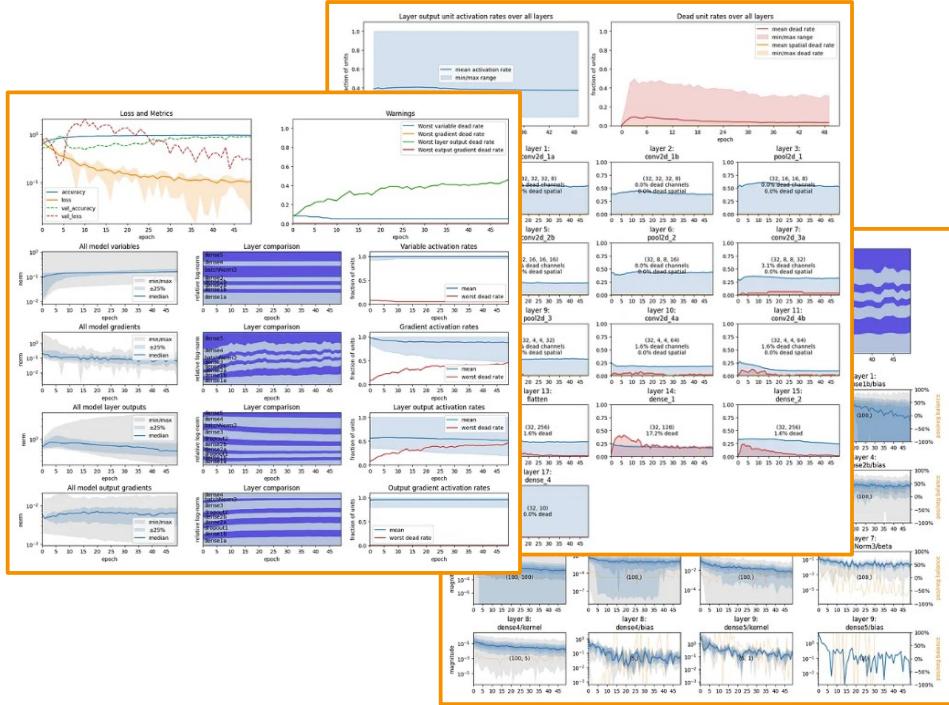
Malcolm Lett
Azure Skillup Session Aug-2025

Introductions



Malcolm Lett
ML Engineer **NEW!**
Software Engineer

Training Instrumentation Toolkit

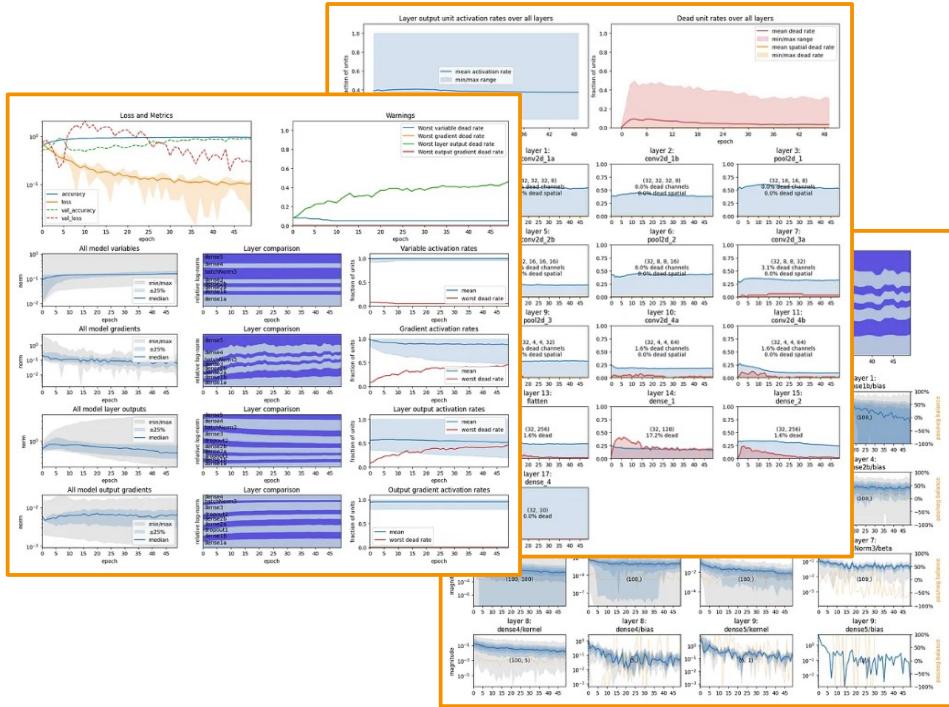


Introductions

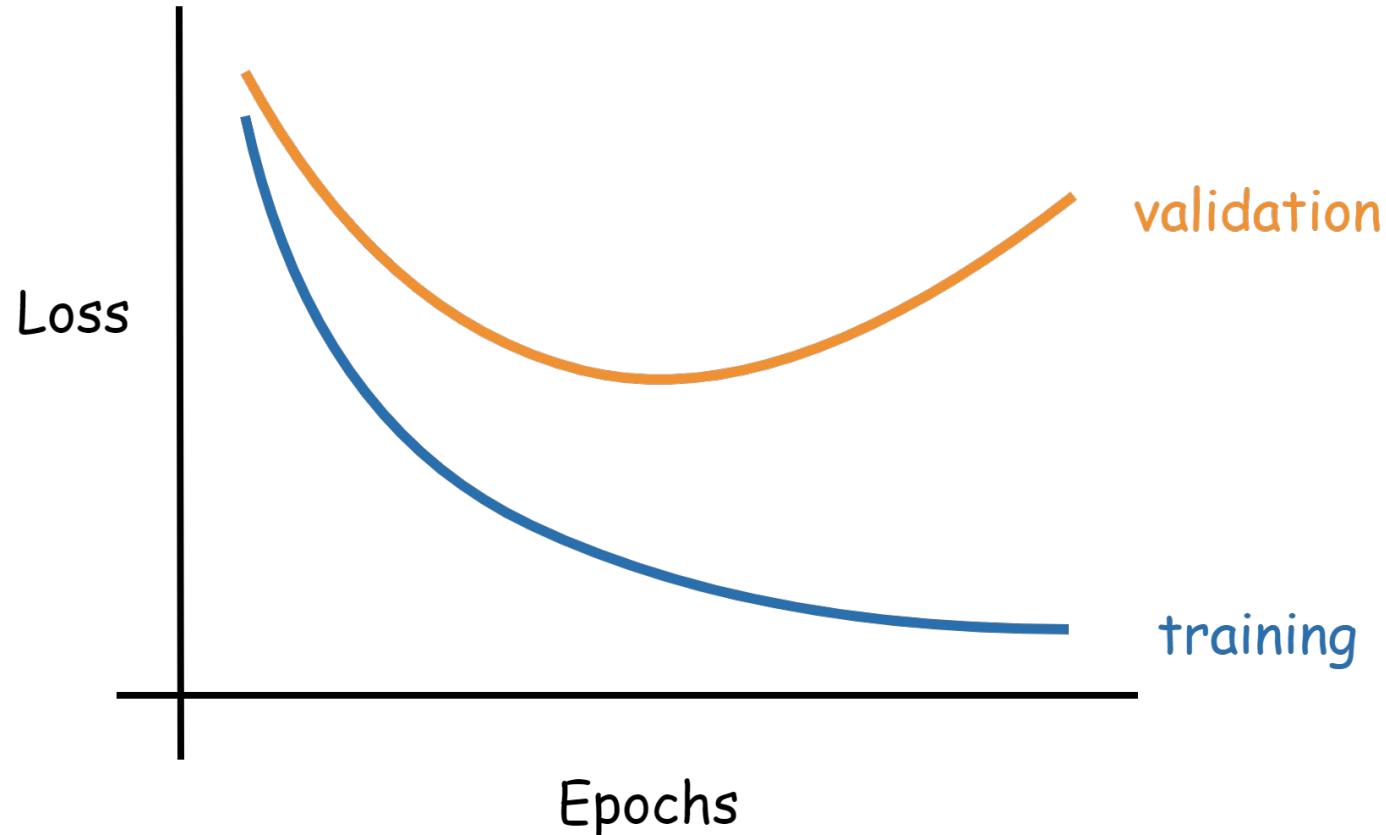
- GitHub repo
- Blog posts

Links at the end

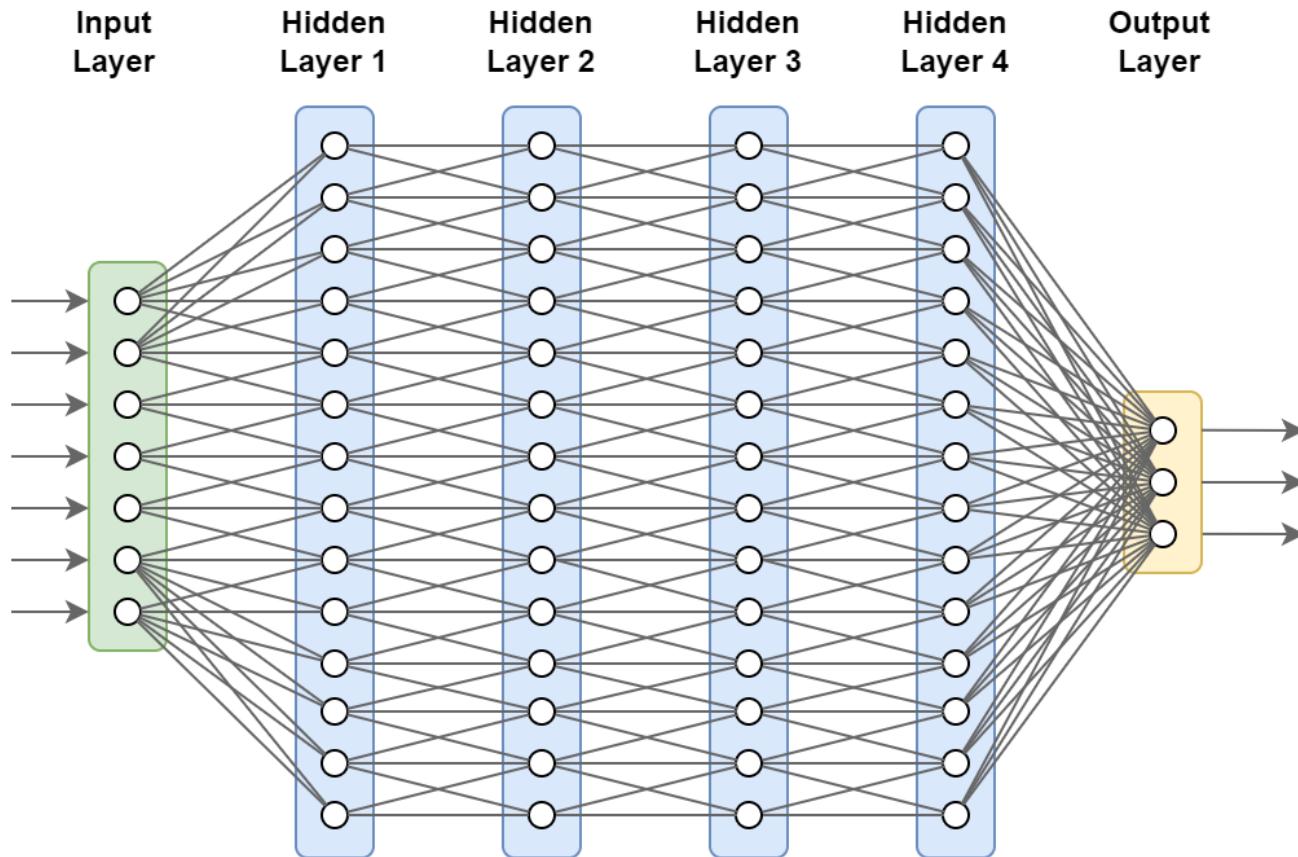
Training Instrumentation Toolkit



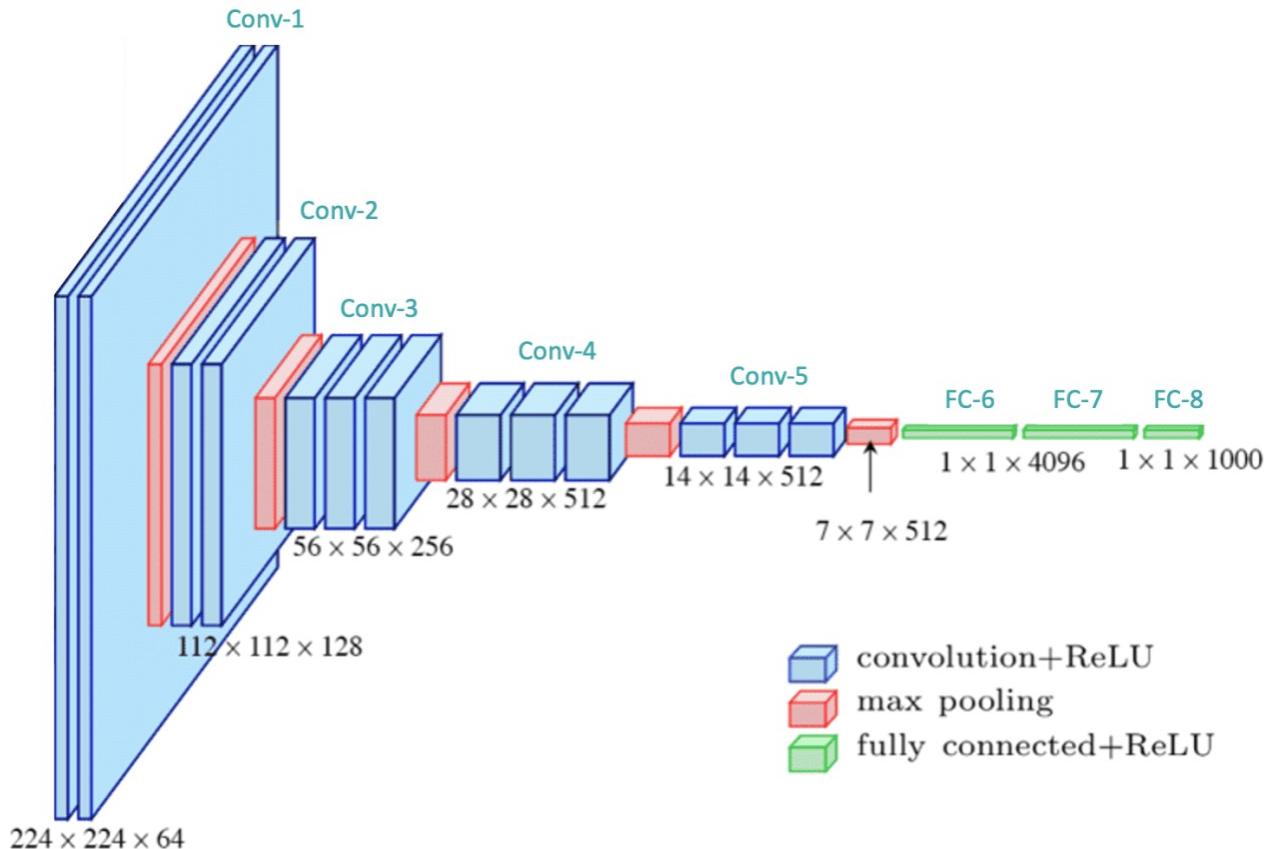
Quiz



Quiz



Quiz

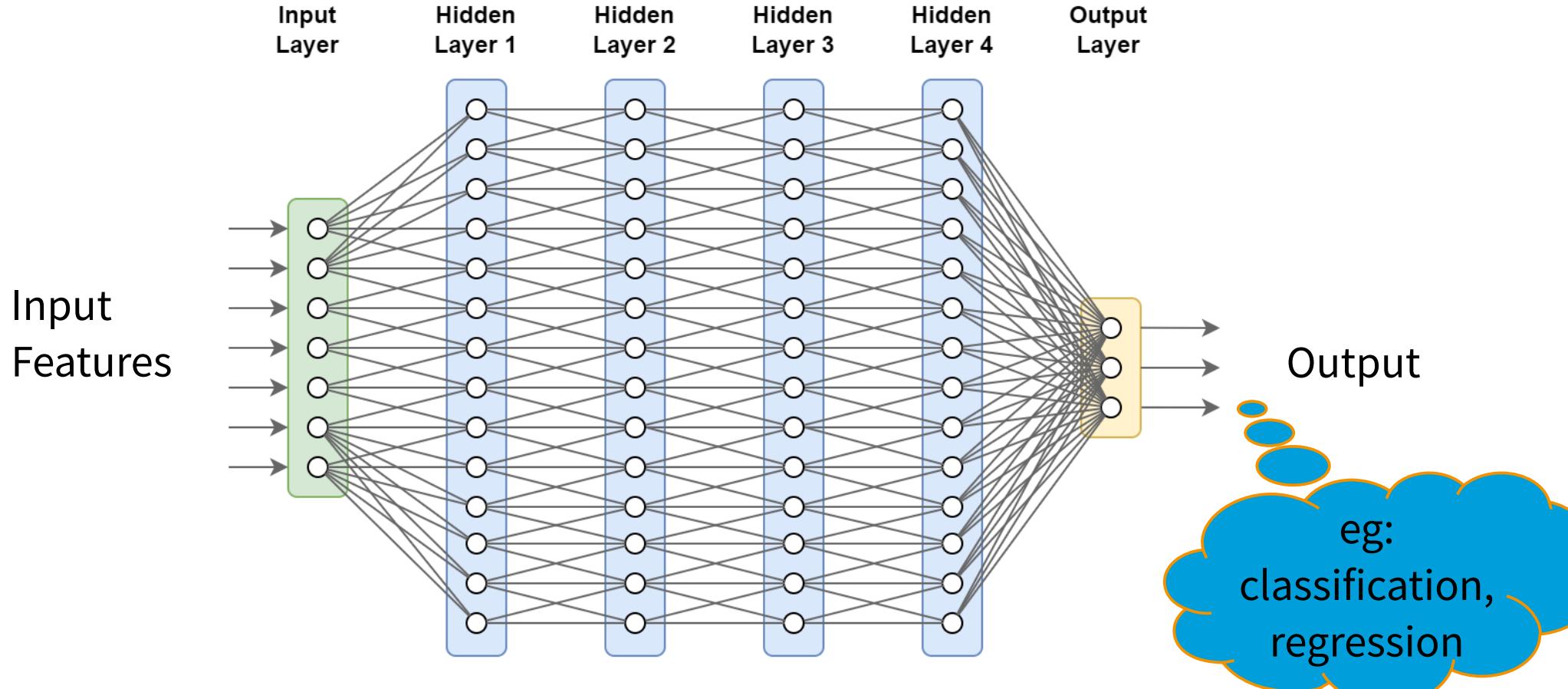


Quiz

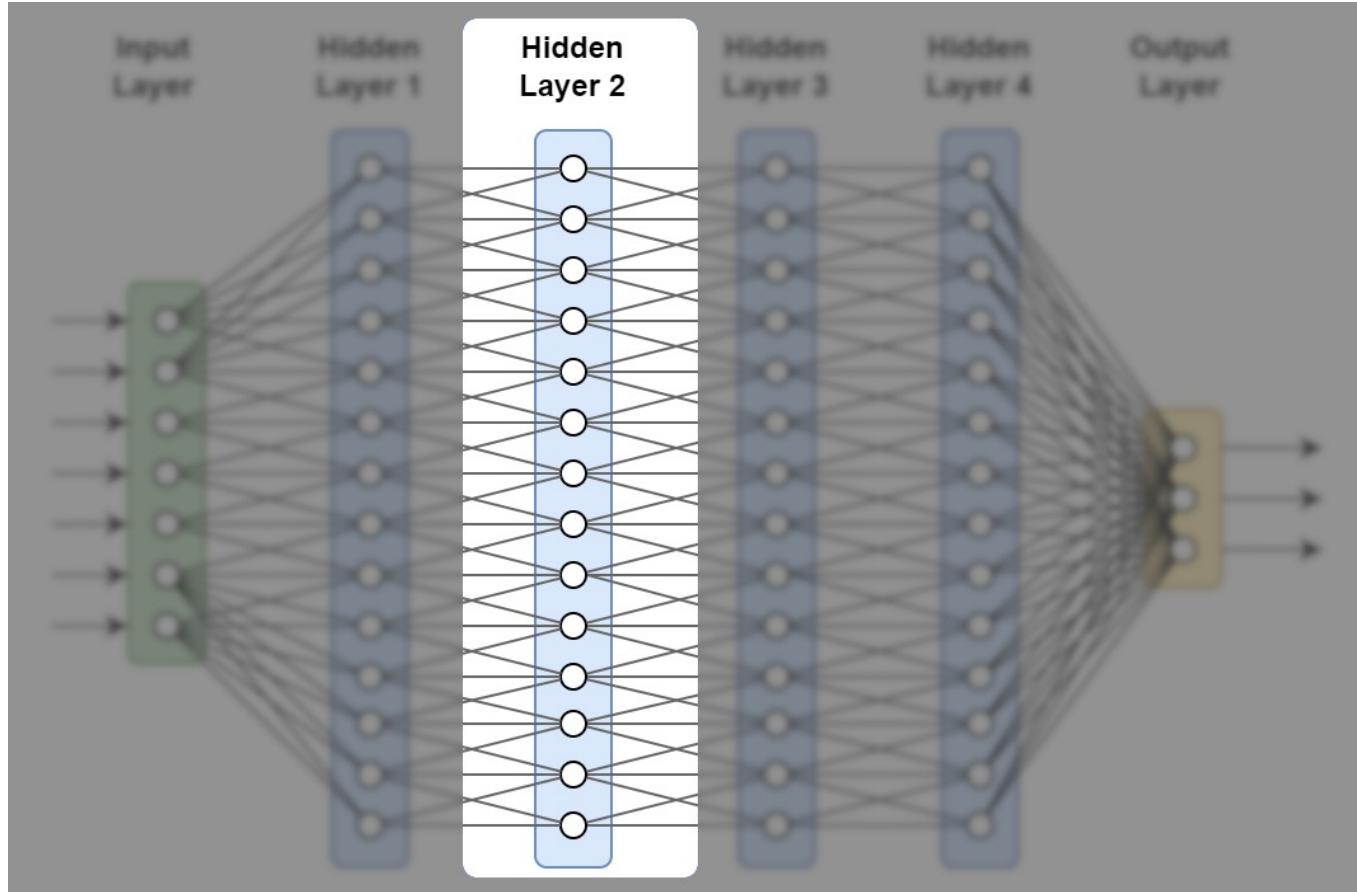


```
model = tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(28, 28)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(10)
])
model.compile(optimizer='adam', loss='ce', metrics=['accuracy'])
model.fit(x_train, y_train, epochs=50)
```

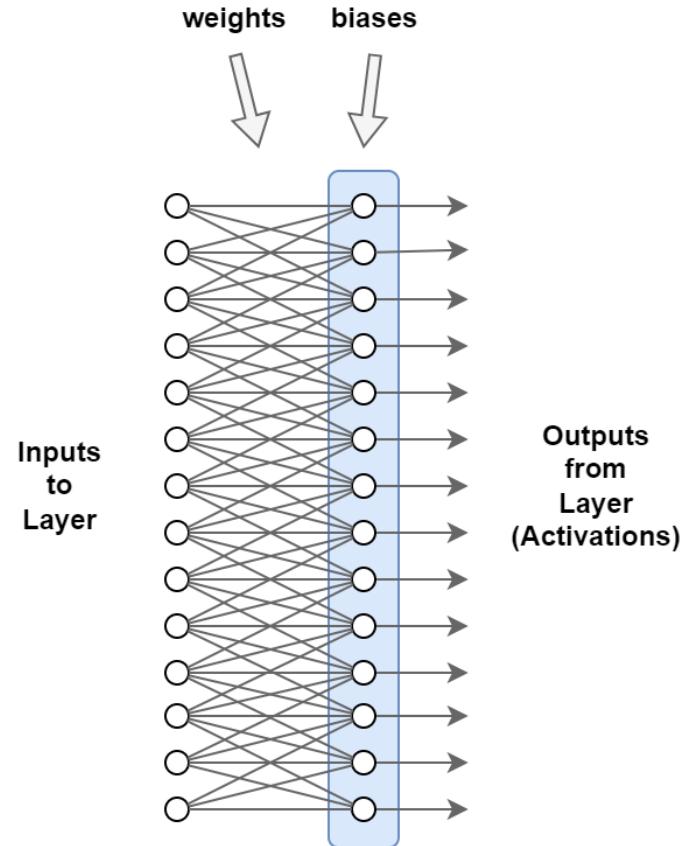
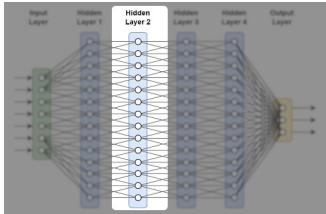
Neural network



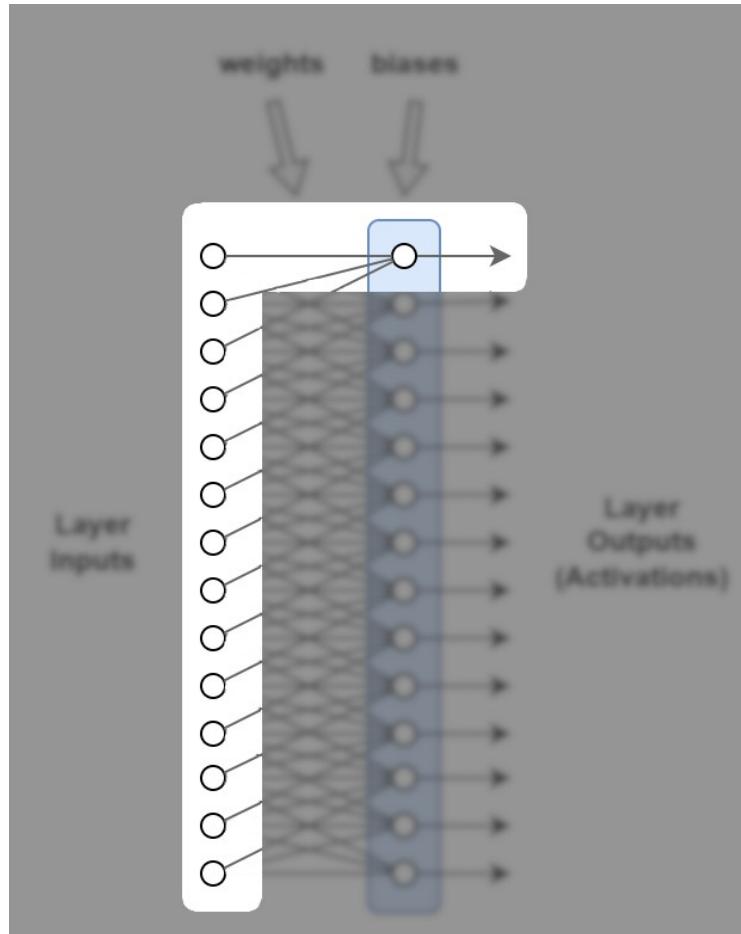
Neural network



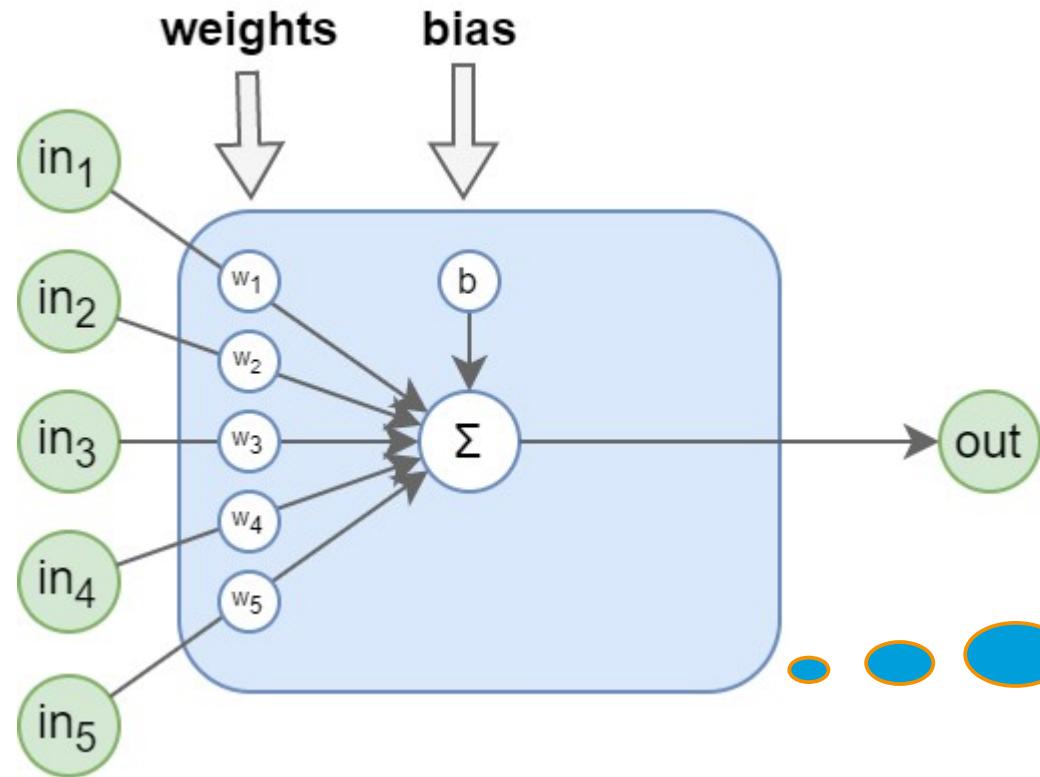
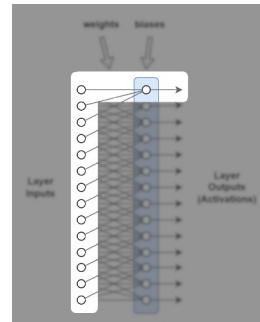
Neural network layer



Neural network layer

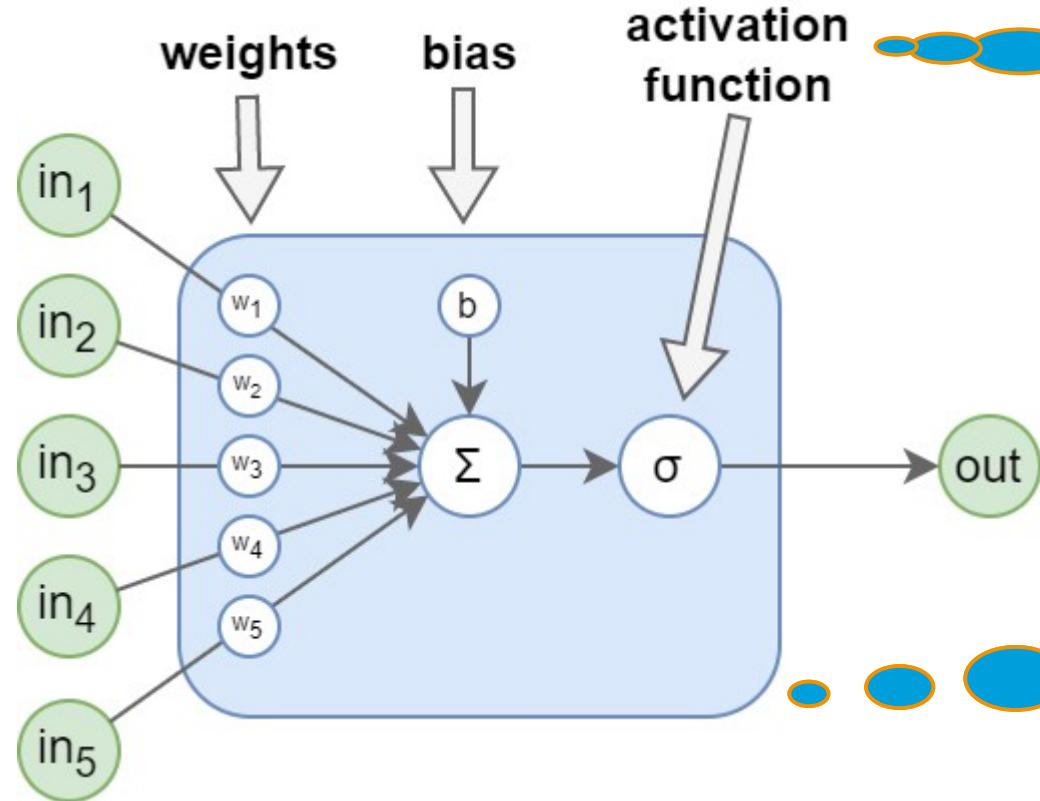
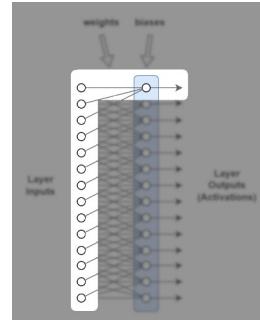


Neural network neuron



Linear
regression

Neural network neuron

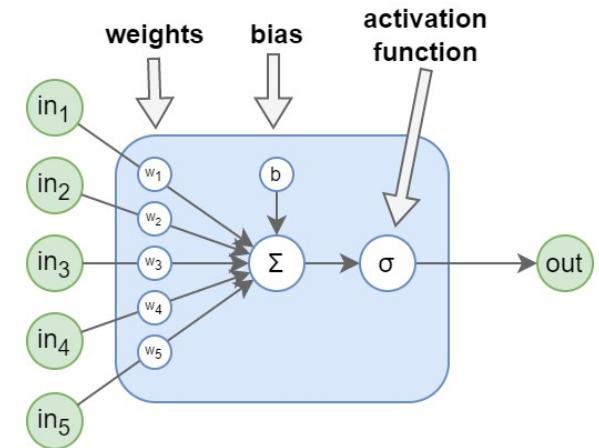
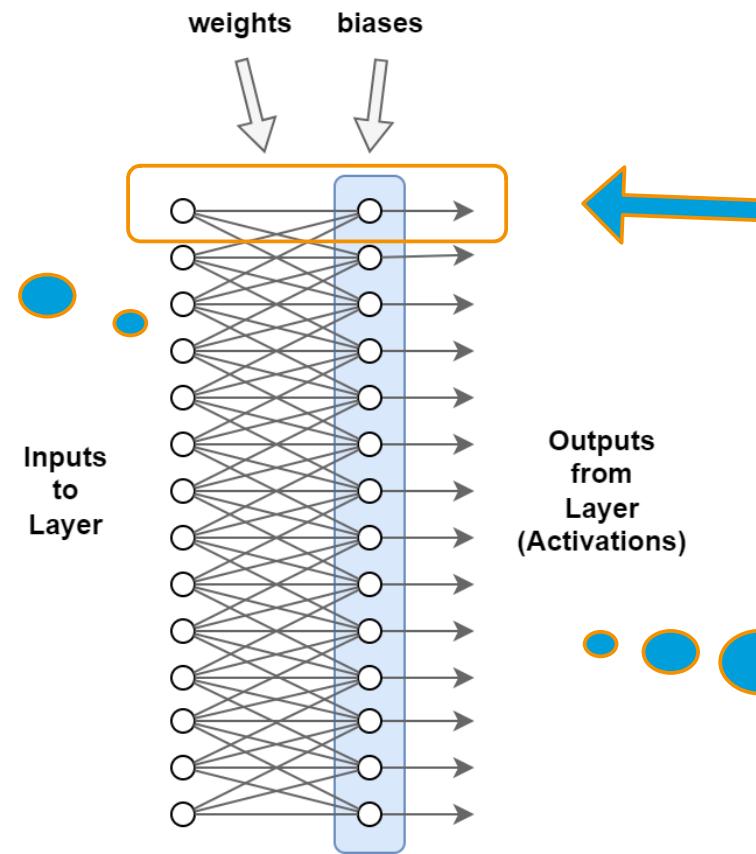


ReLU:
 $\sigma(z) = \max(0, z)$

Linear regression
+
non-linearity

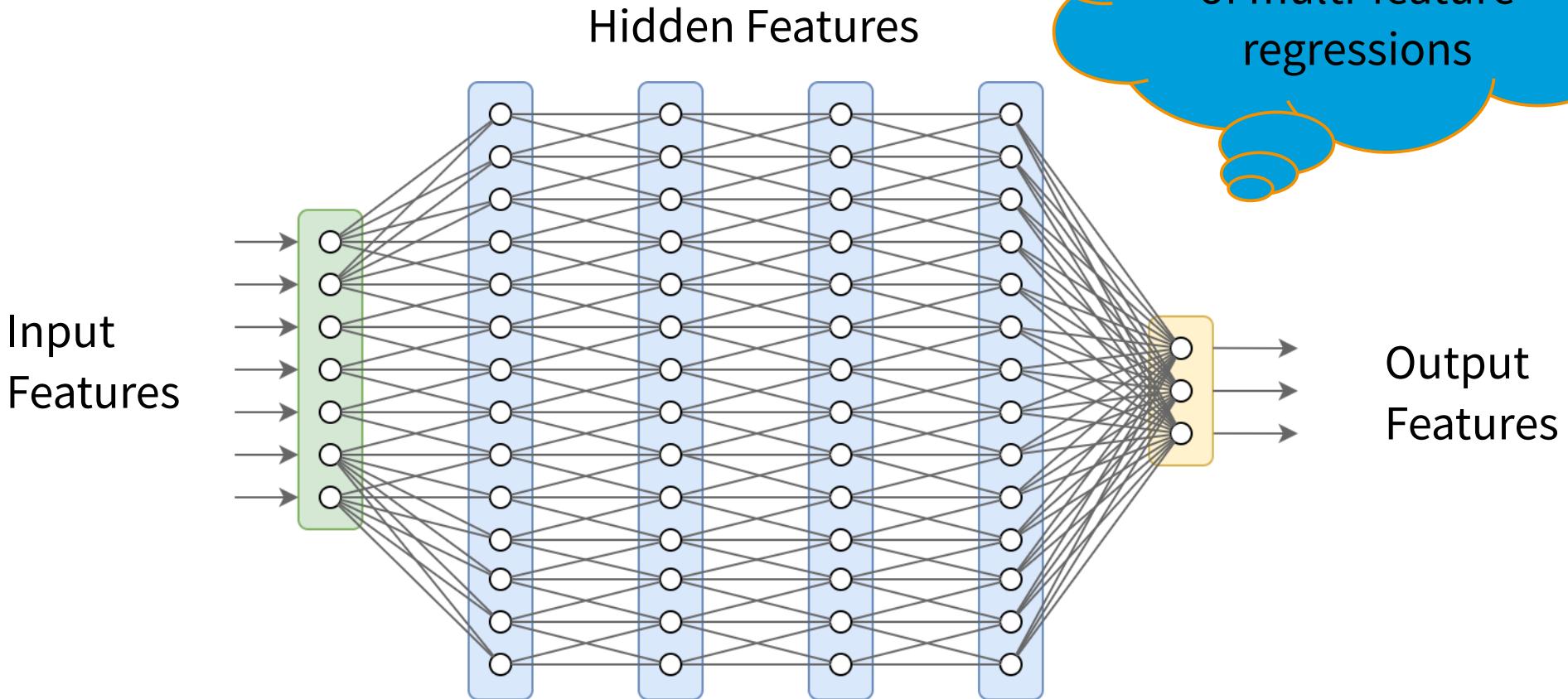
Neural network layer

multiple
(non-)linear
regressions

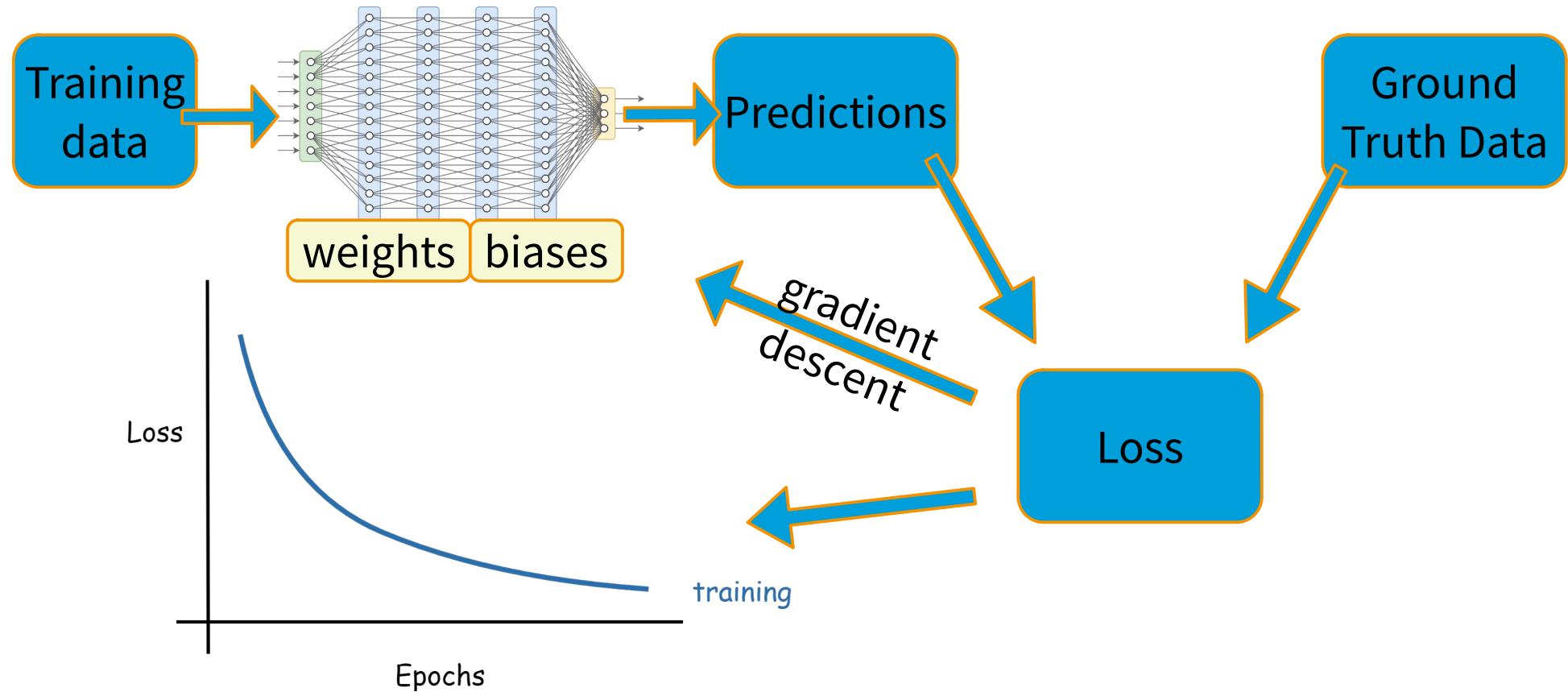


multiple
features

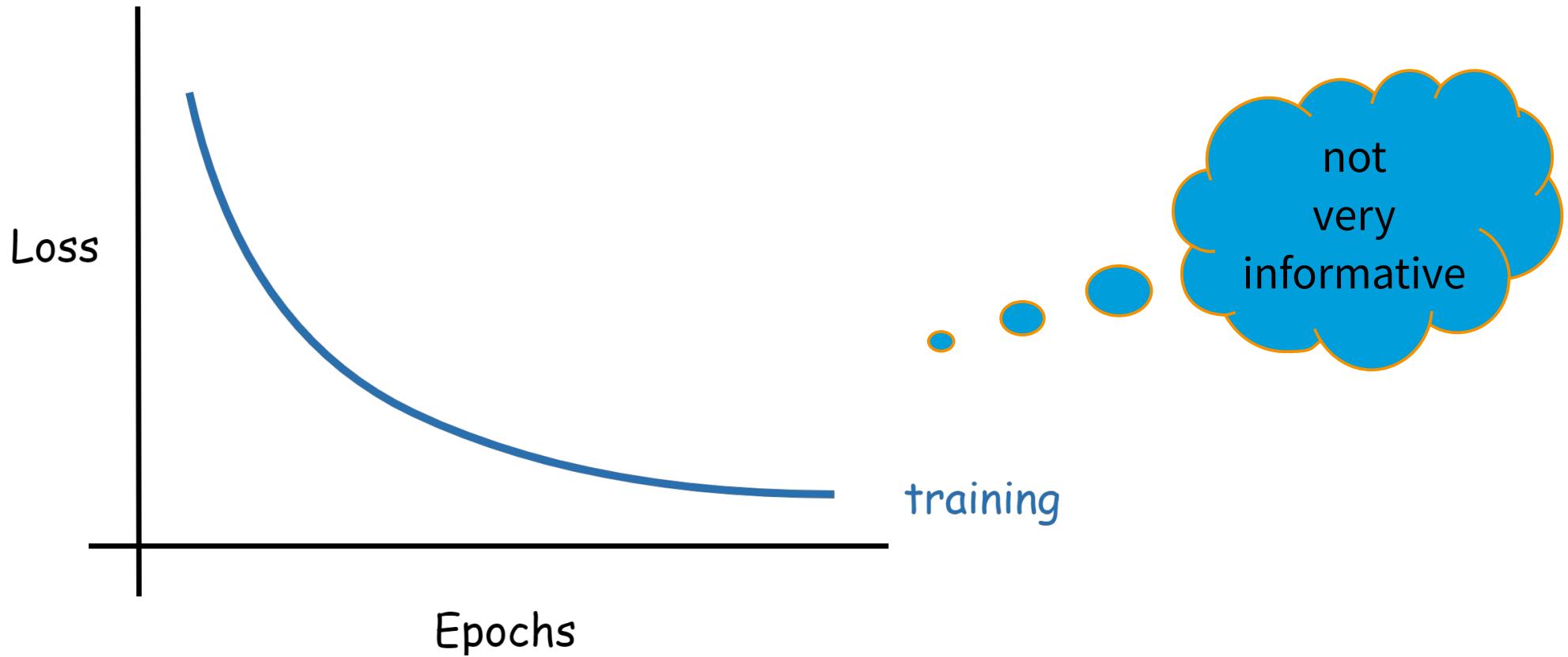
Neural network



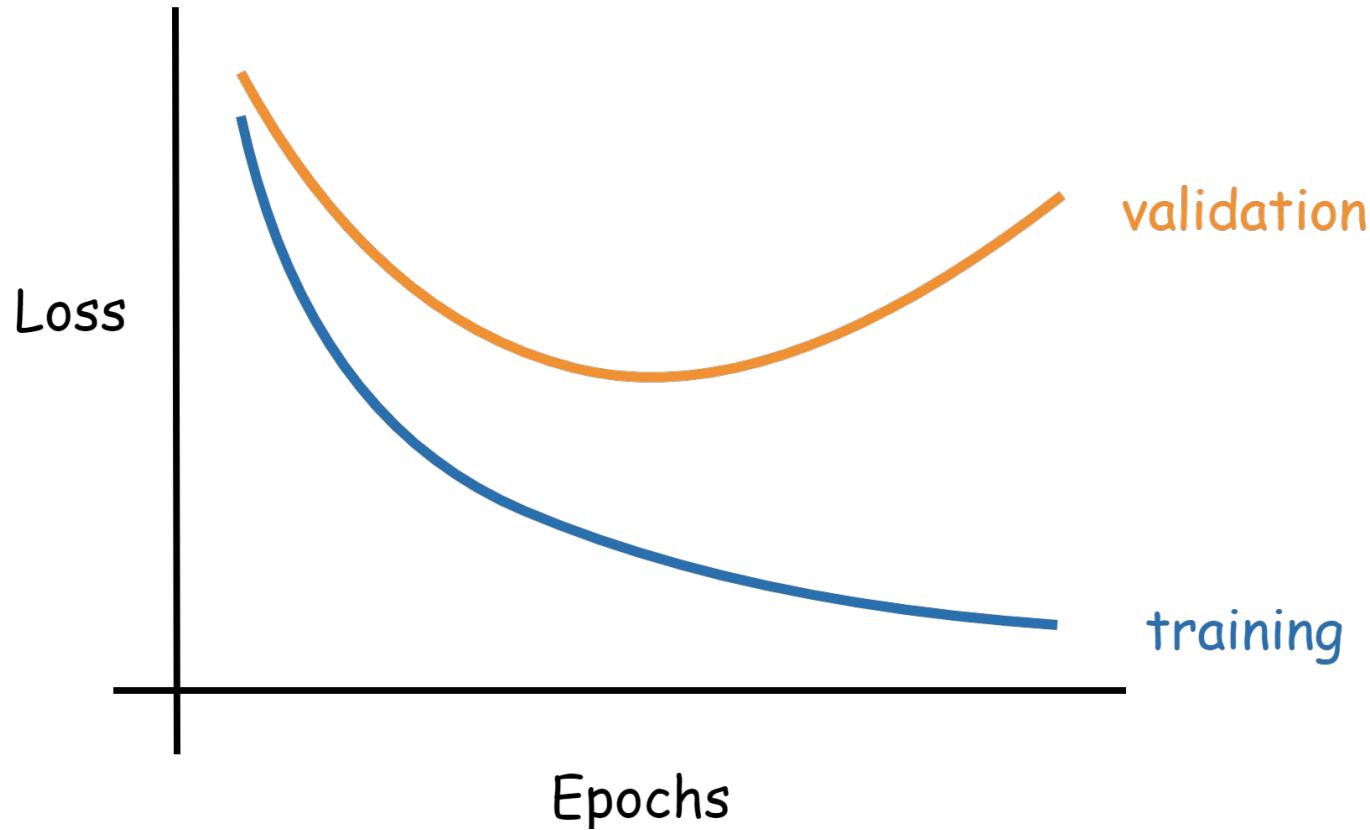
Training Neural Networks



Outcome



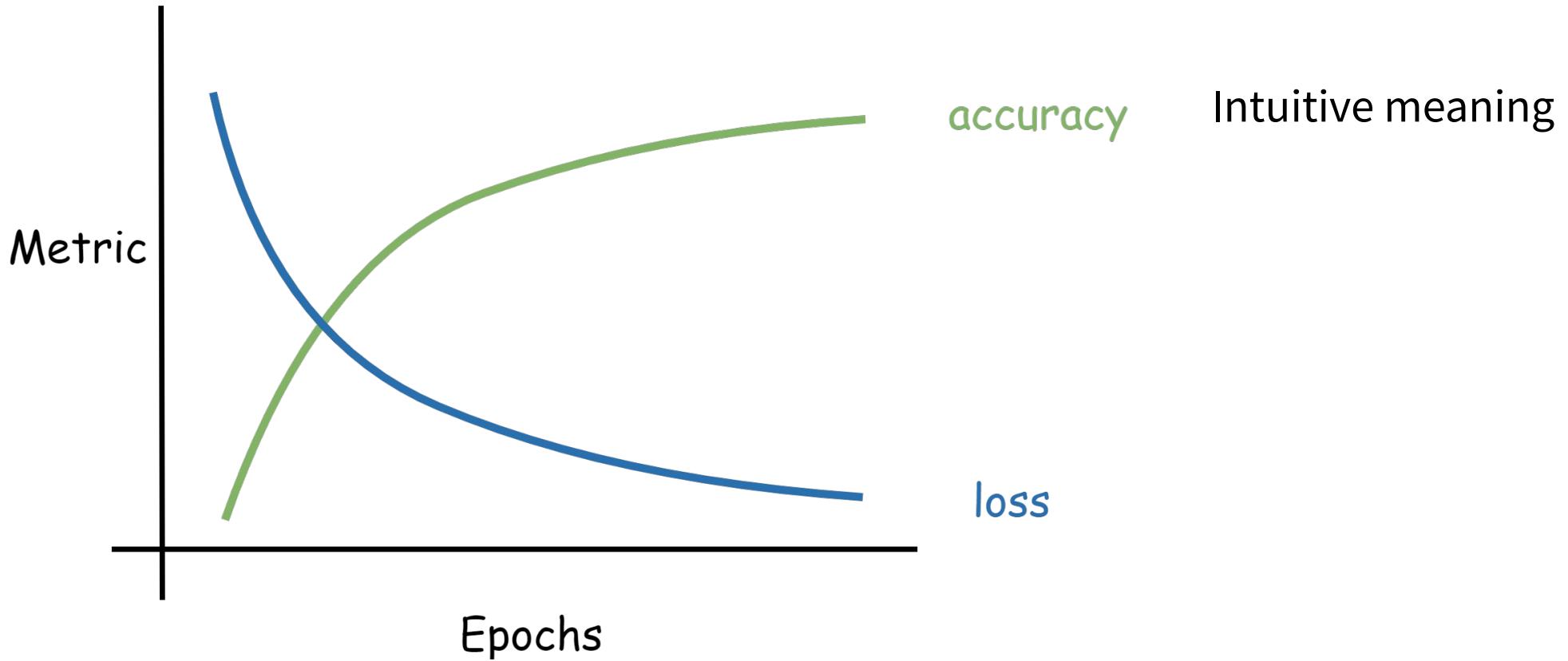
Outcome



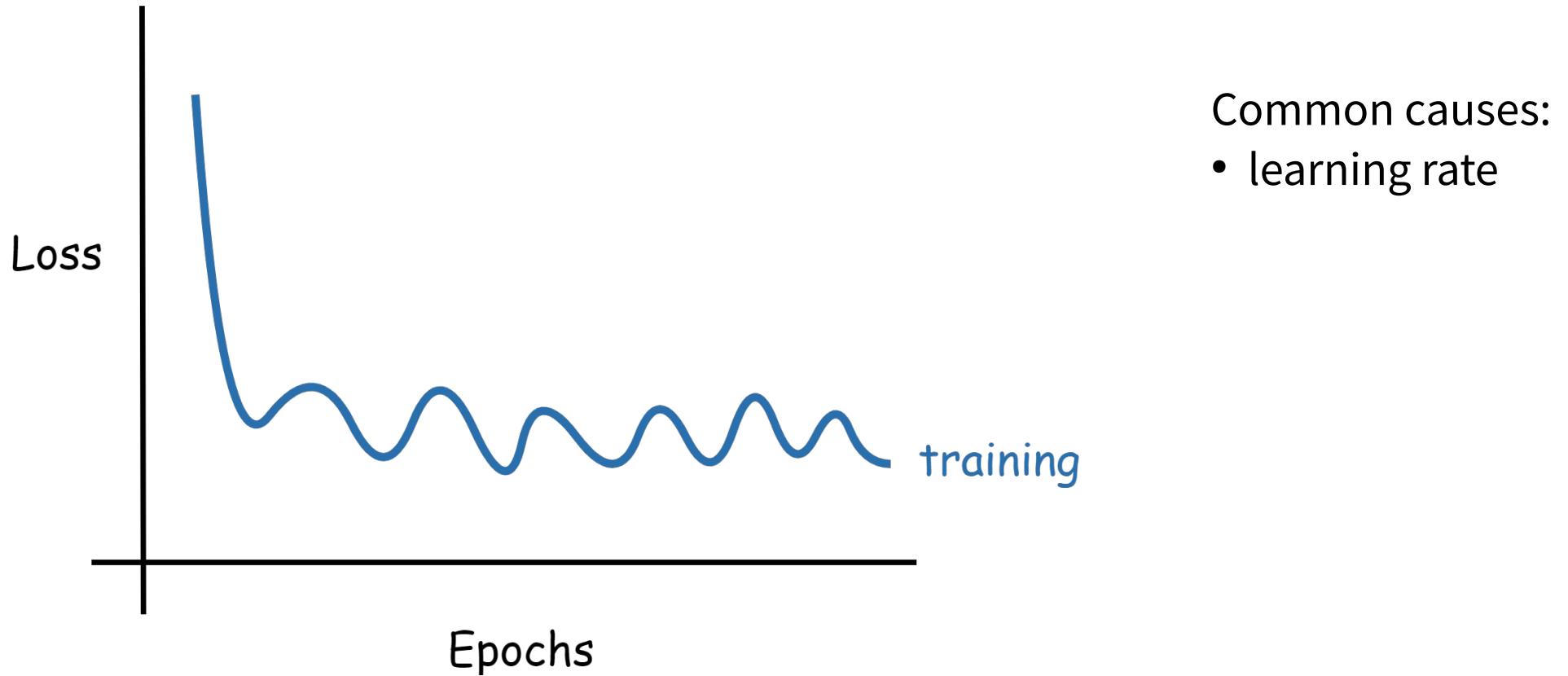
Identify problems:

- Underfitting
- Overfitting

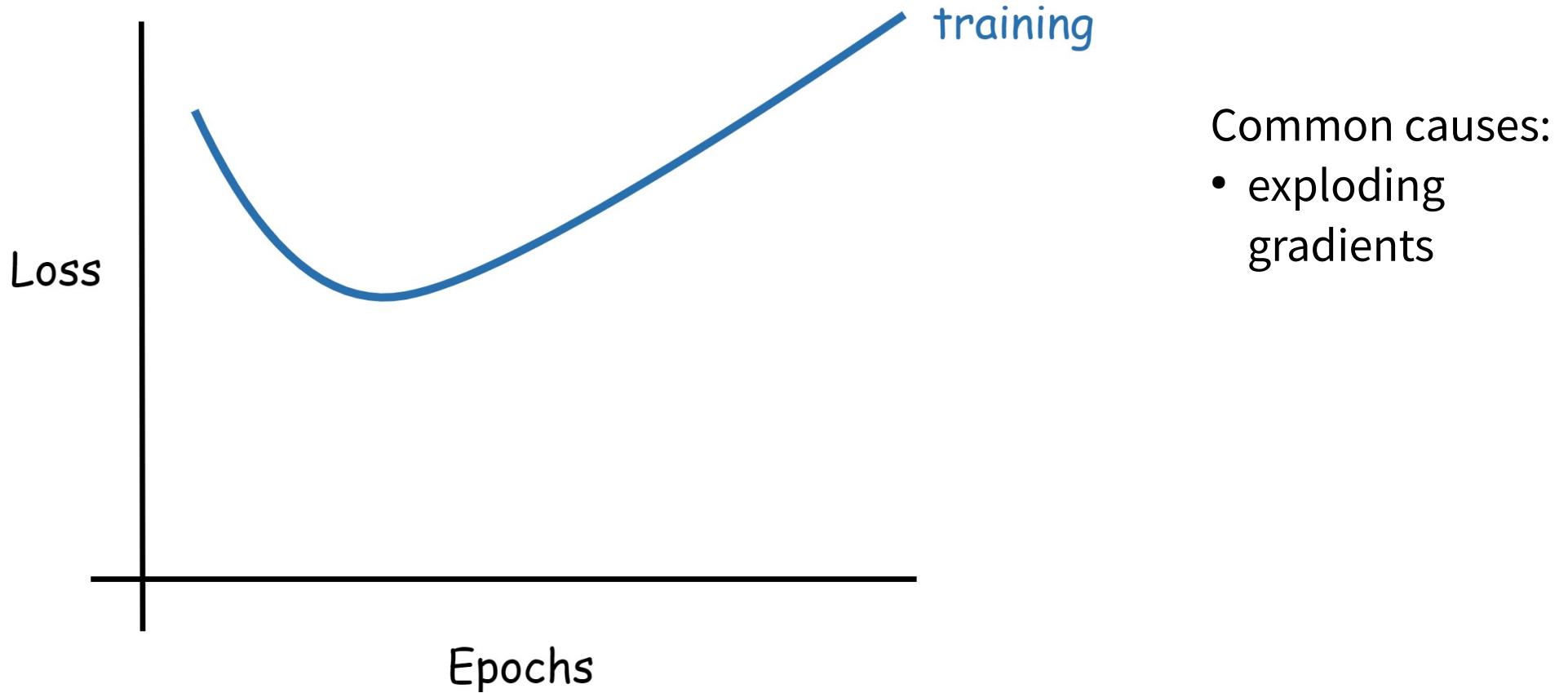
Outcome



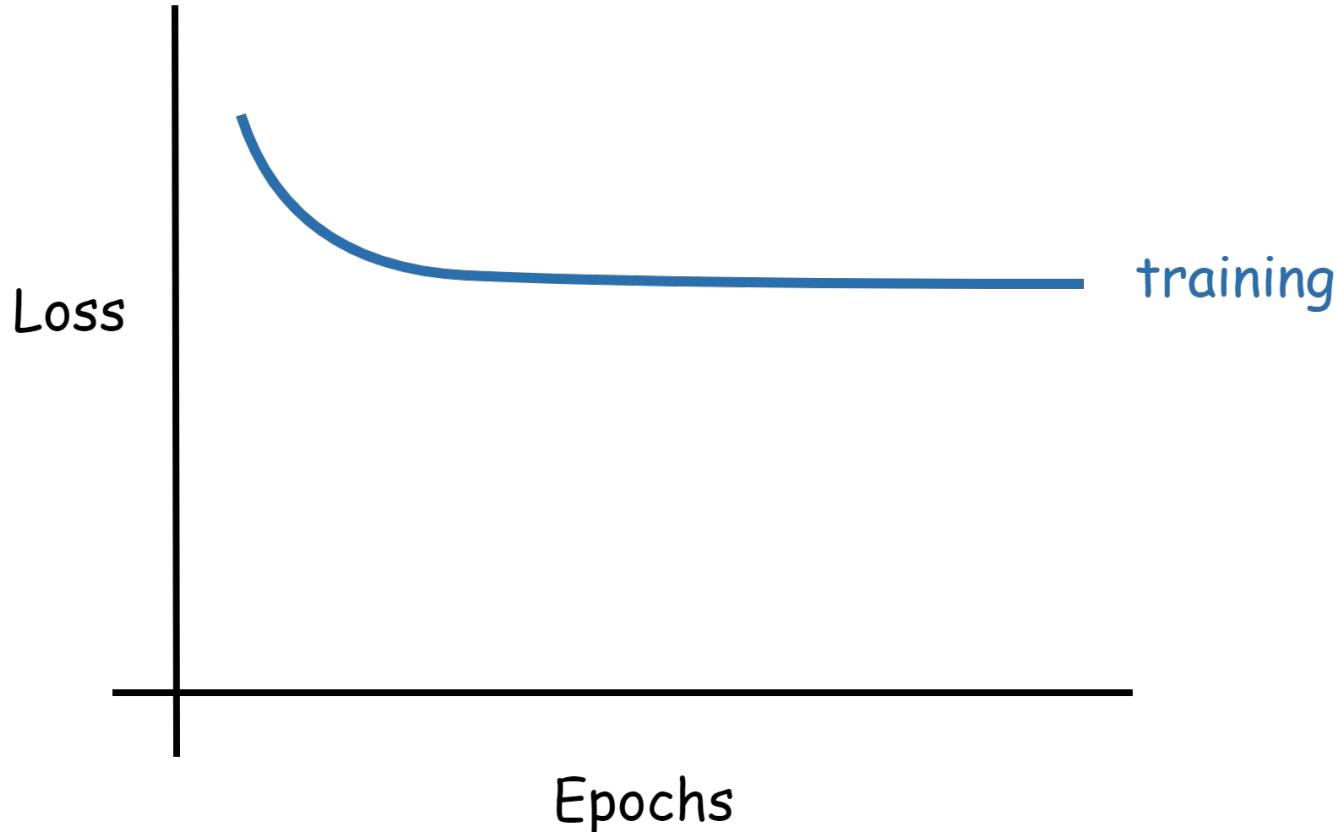
Troubleshooting



Troubleshooting



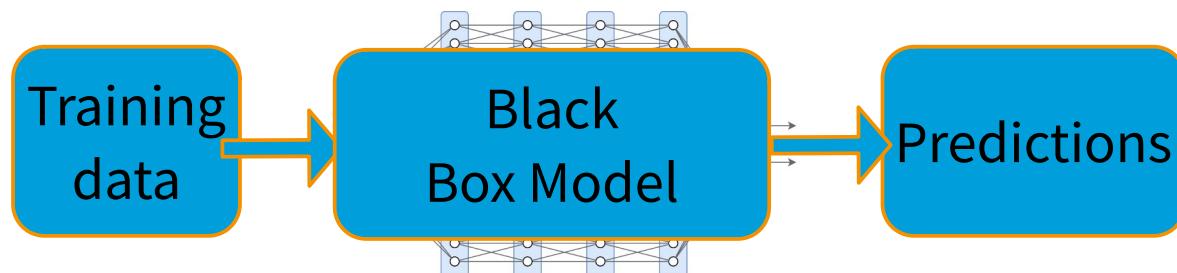
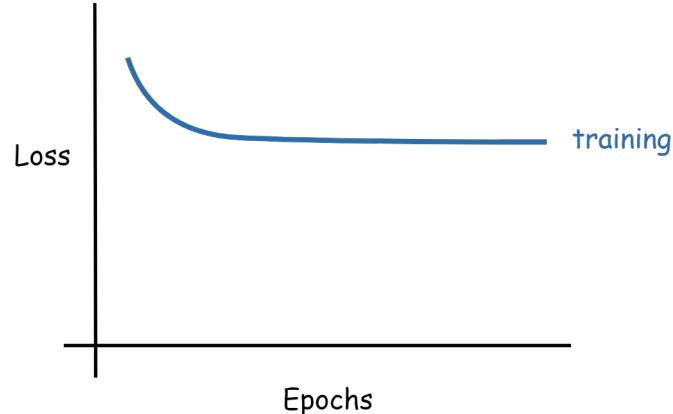
Troubleshooting



Common causes:

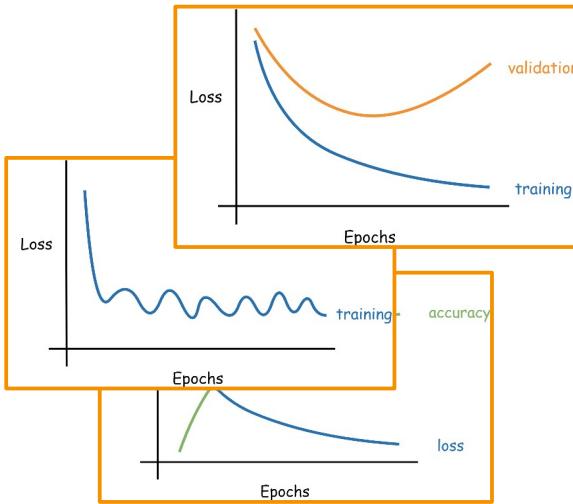
- vanishing gradients
- neuron death
- many others

Troubleshooting = Guessing



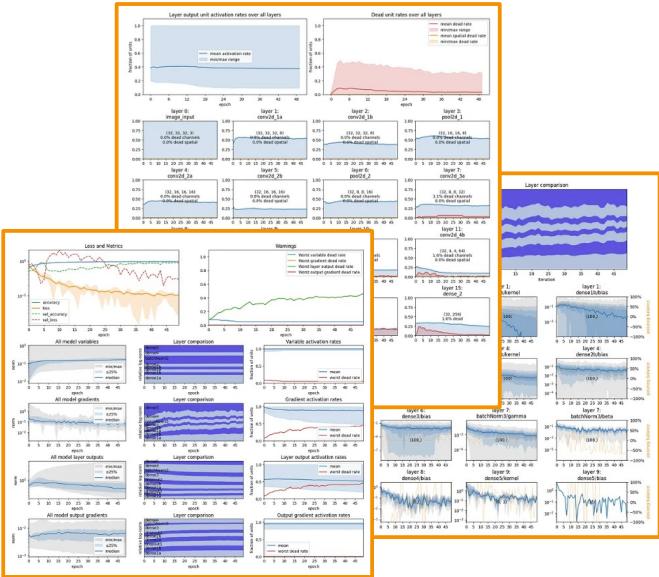
Troubleshooting

Textbooks

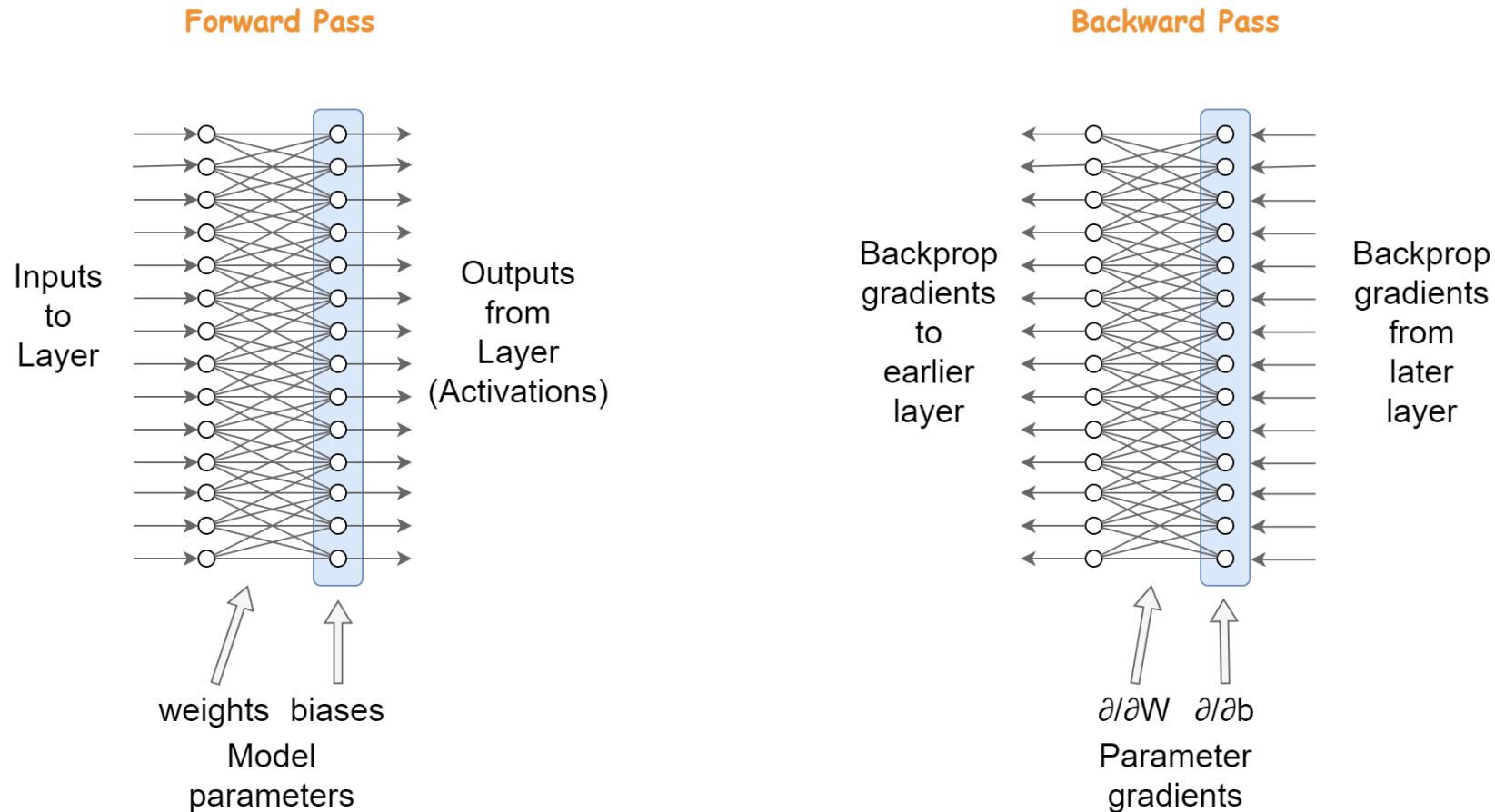


versus

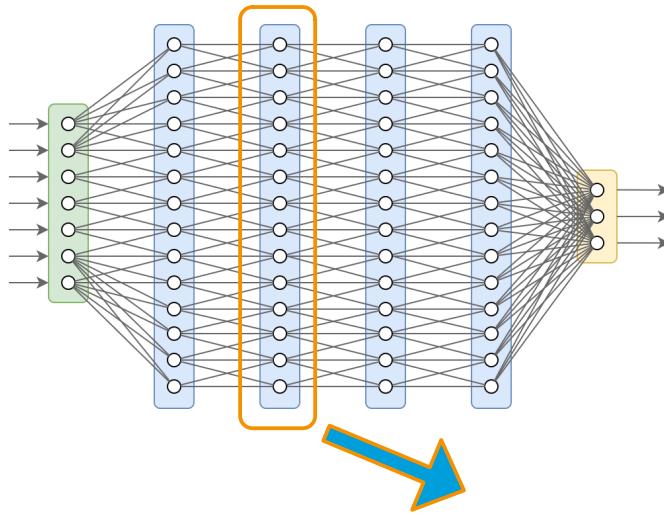
Training Instrumentation Toolkit



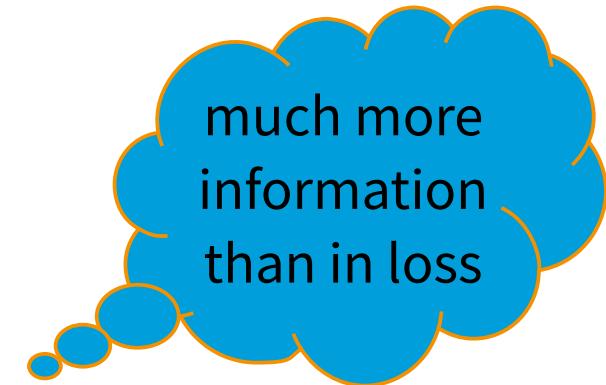
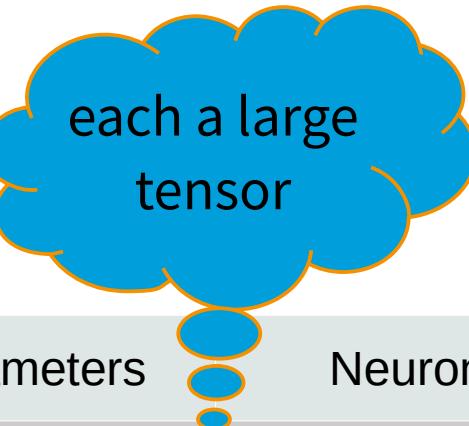
Training a Layer



Training a Layer

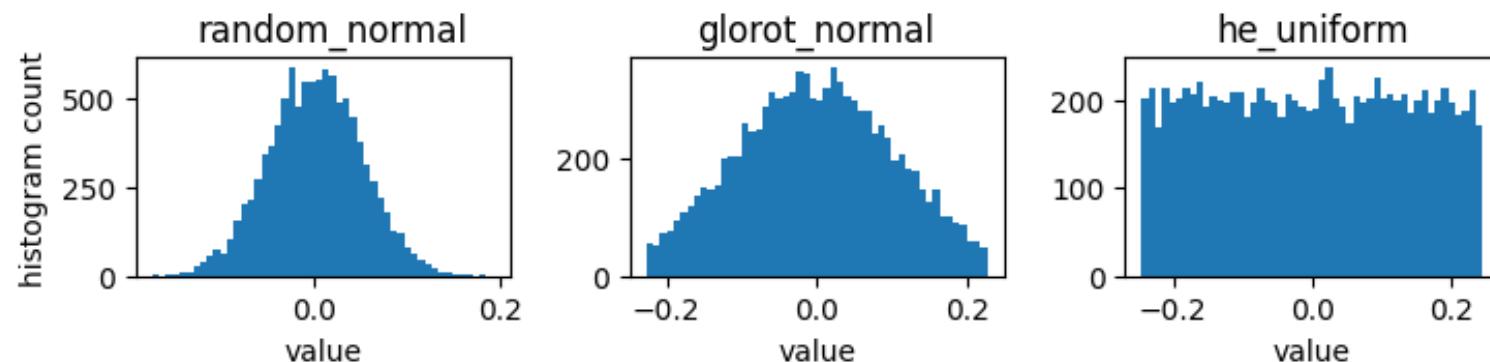


(tensor = multi-dimensional array)

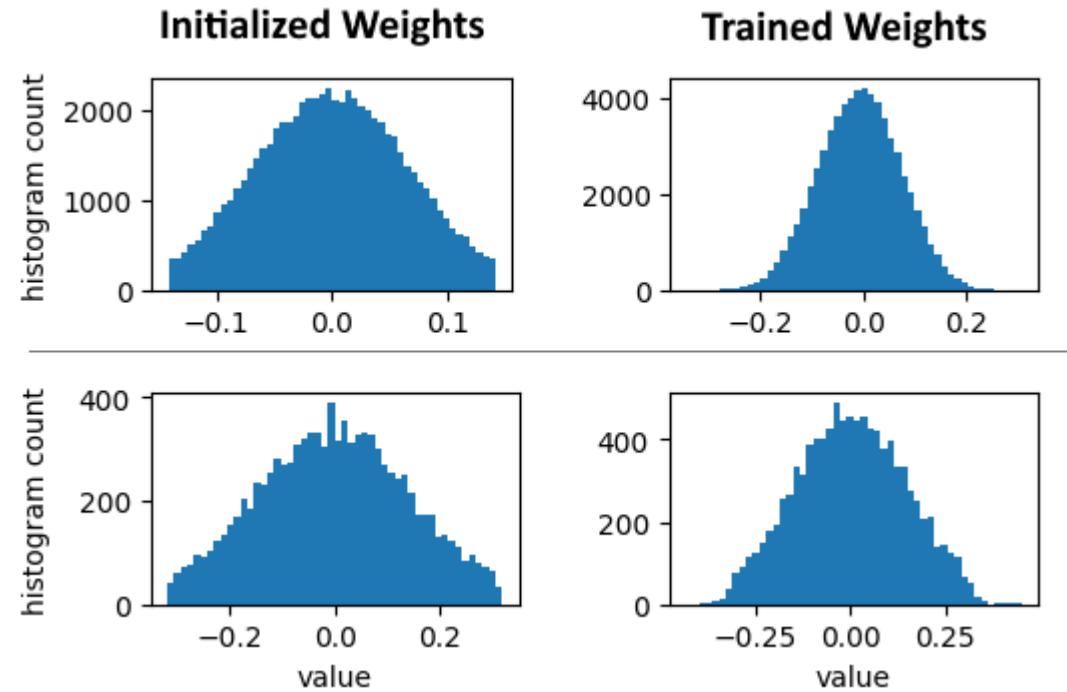


	Parameters	Neurons
Forward Pass	Weights	Activations
Backward Pass	Weight Gradients	Backprop gradients

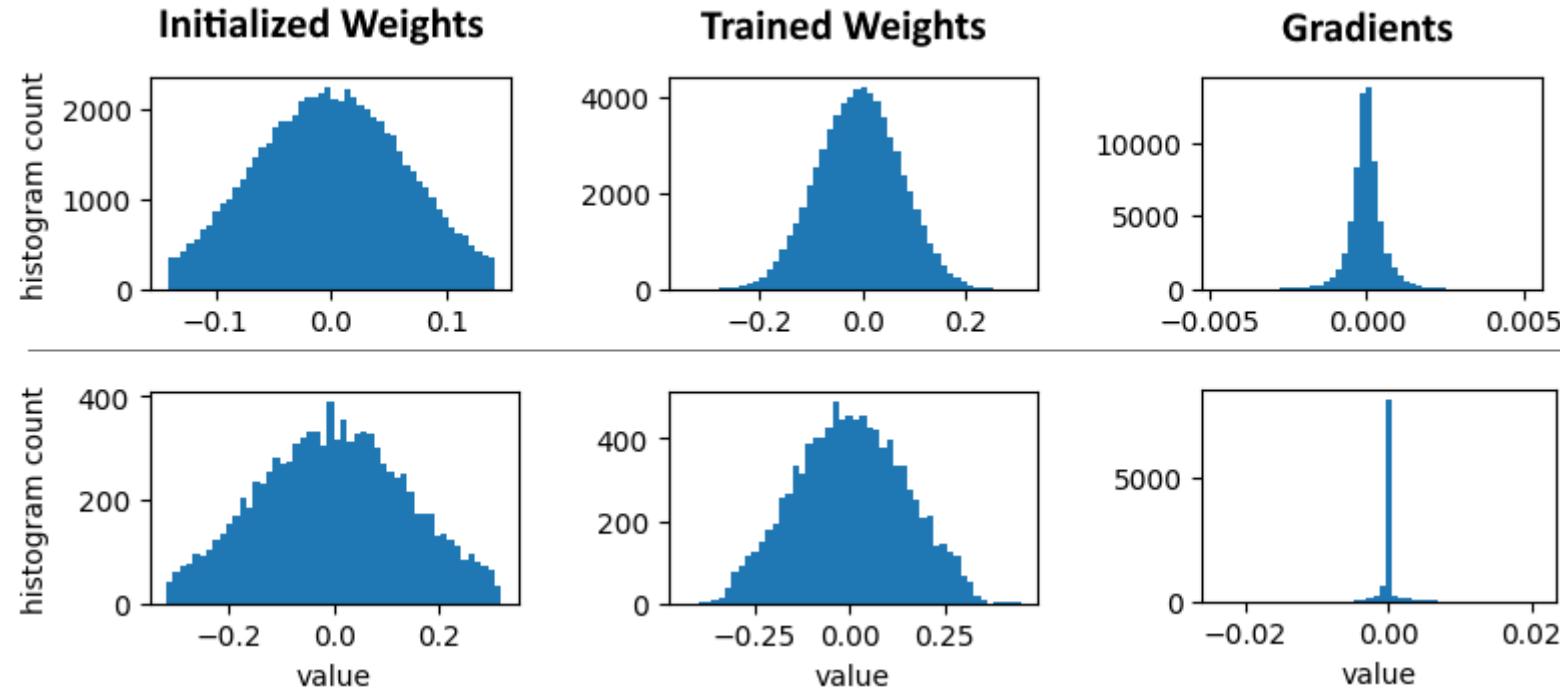
Weights - Initialization



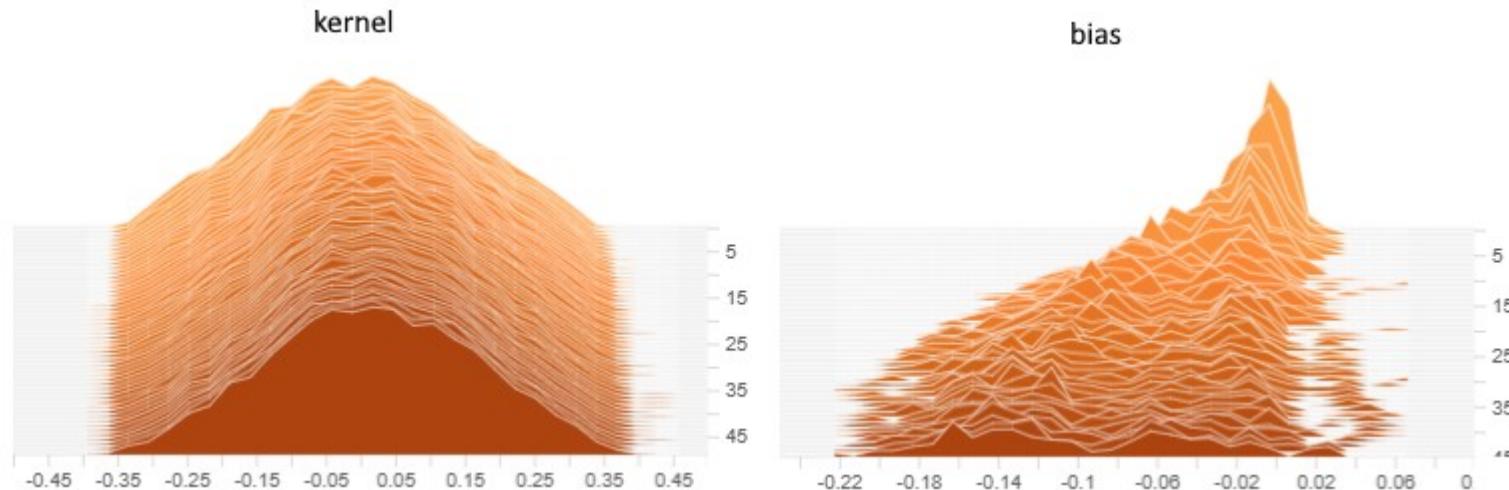
Weights



Weights & Gradients

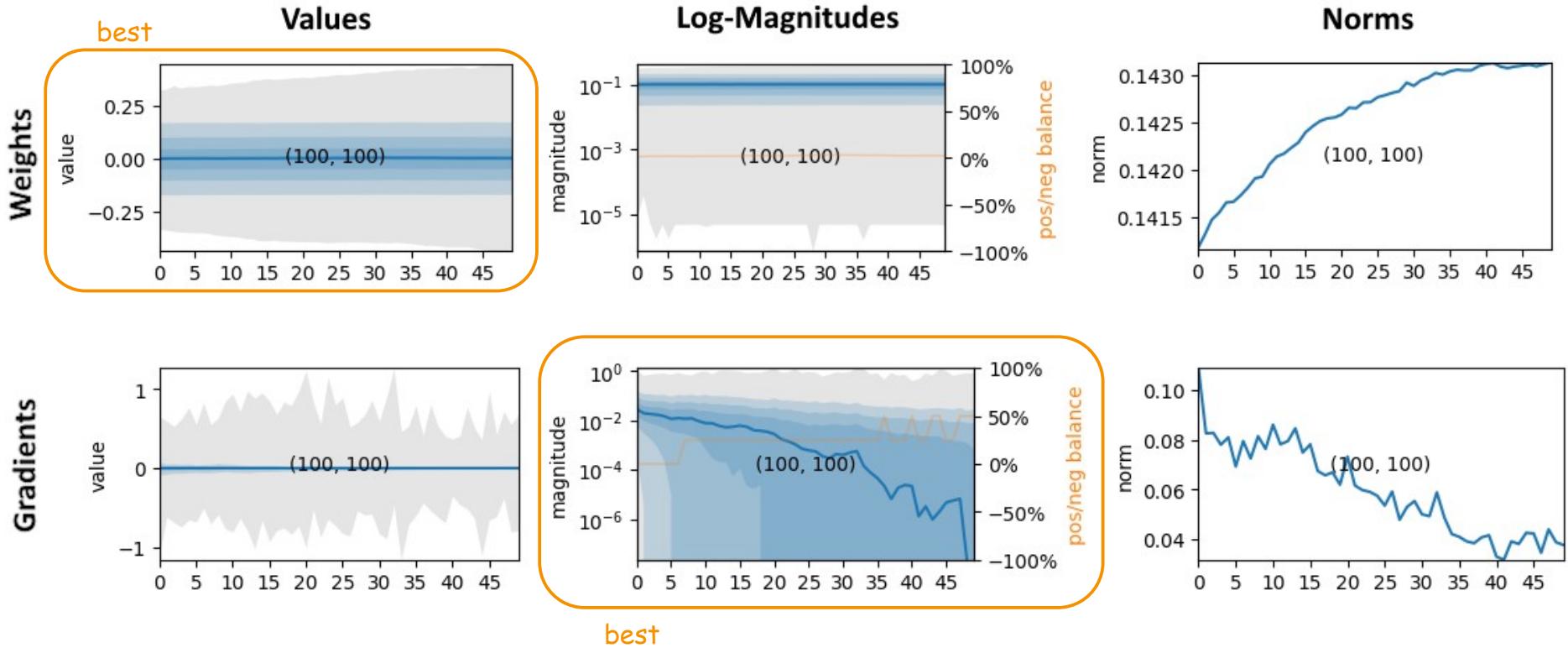


Weights over time



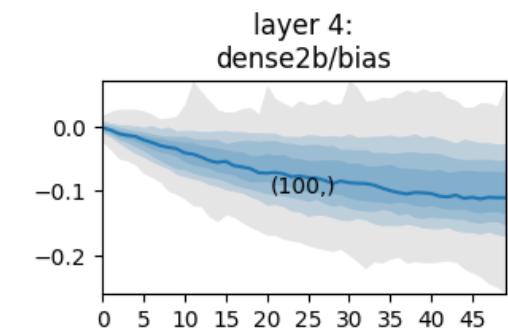
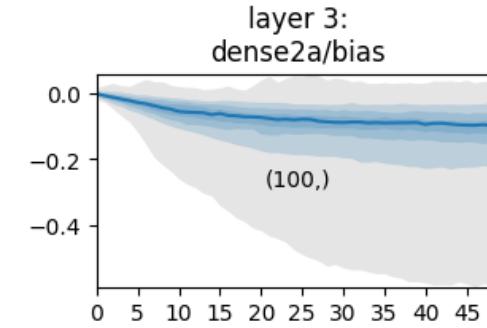
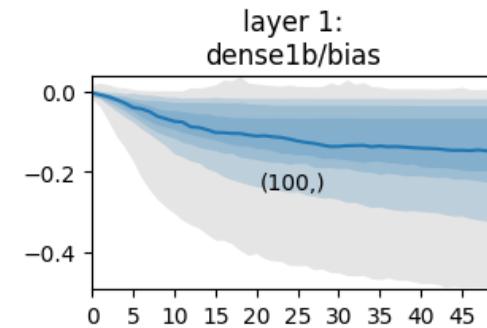
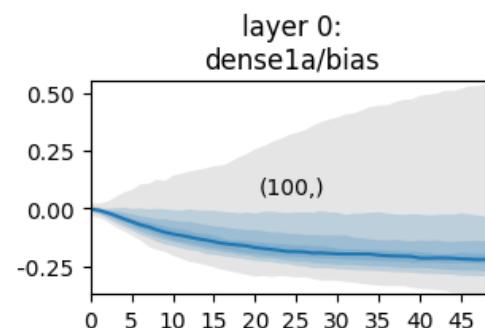
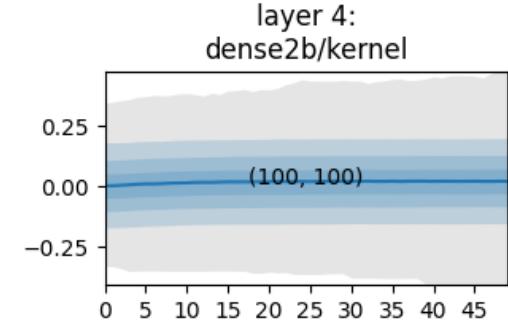
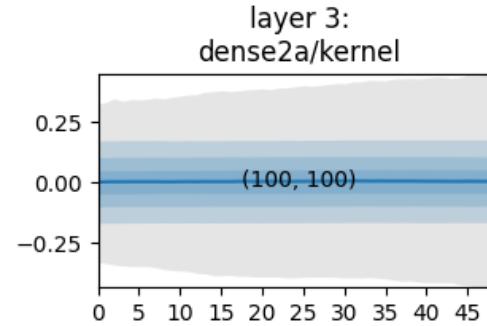
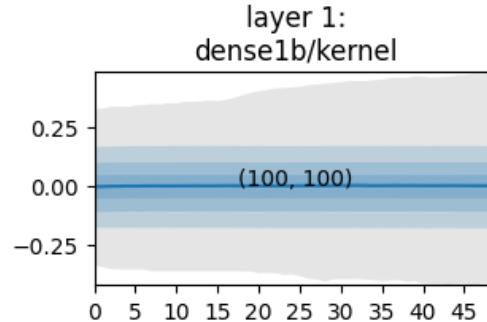
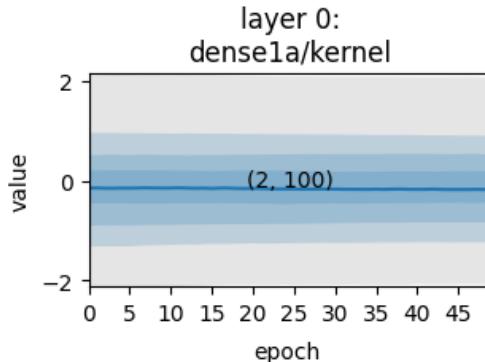
source: TensorFlow Tensorboard

Weights & Gradients over time



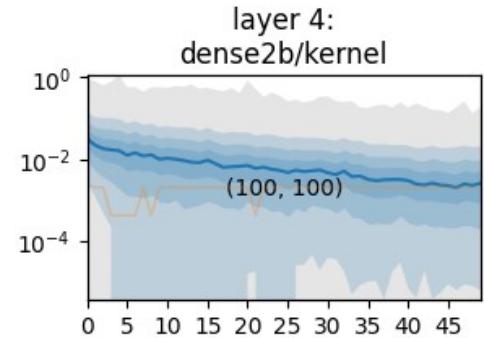
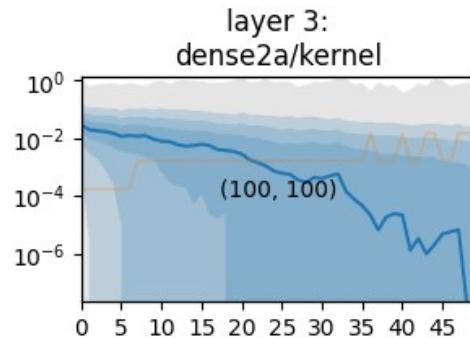
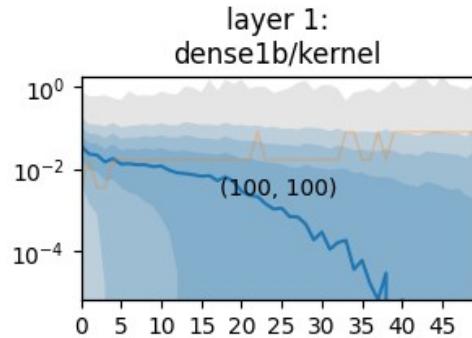
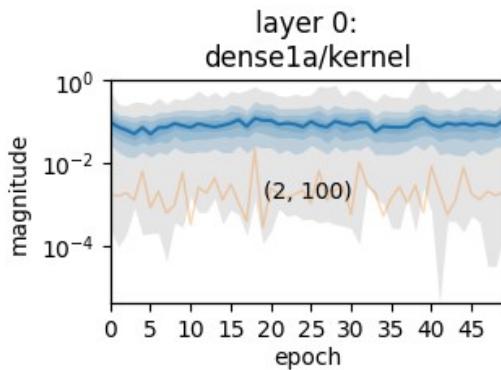
Weights over time

Weights are
usually
boring



Gradients over time

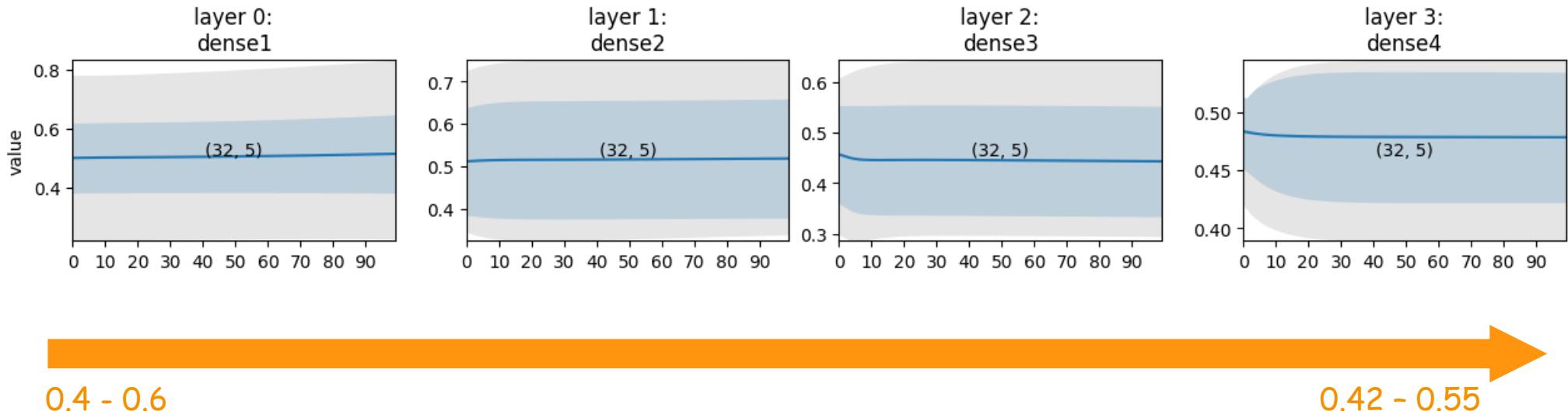
Weight gradients are usually the most informative metric



Vanishing gradients

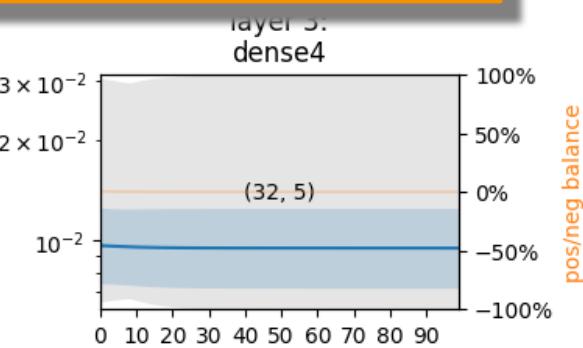
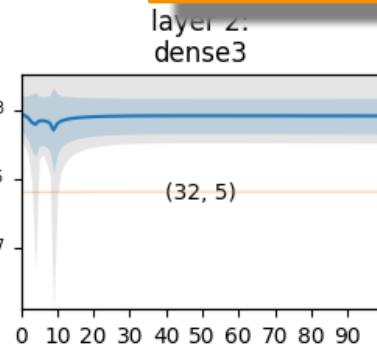
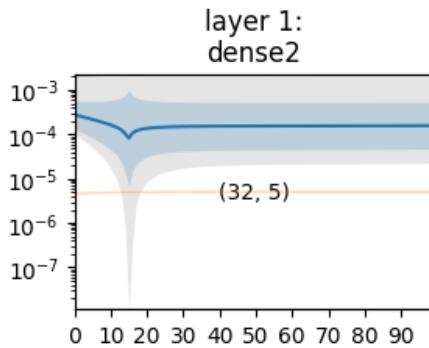
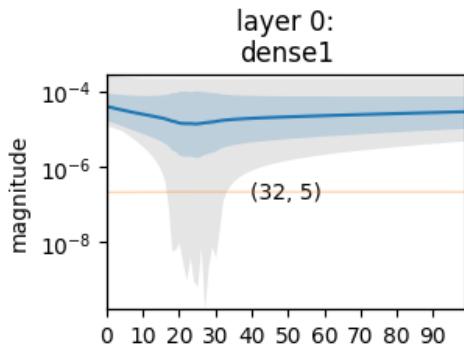
Simple binary classification model using sigmoid activation function

Output activations

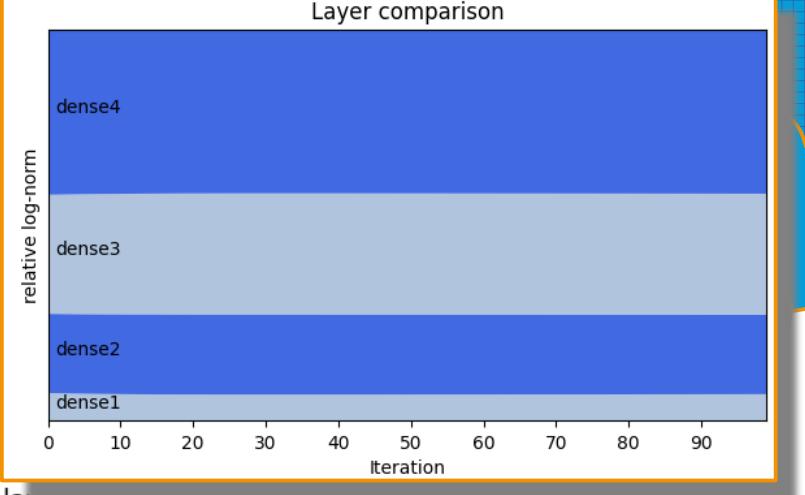


Vanishing gradients

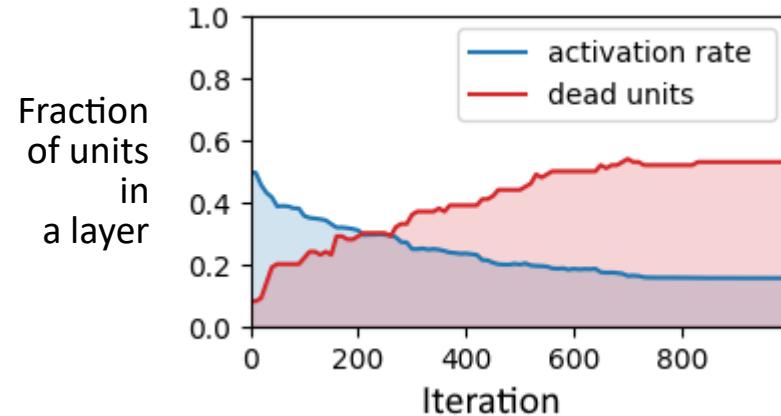
Backprop gradients



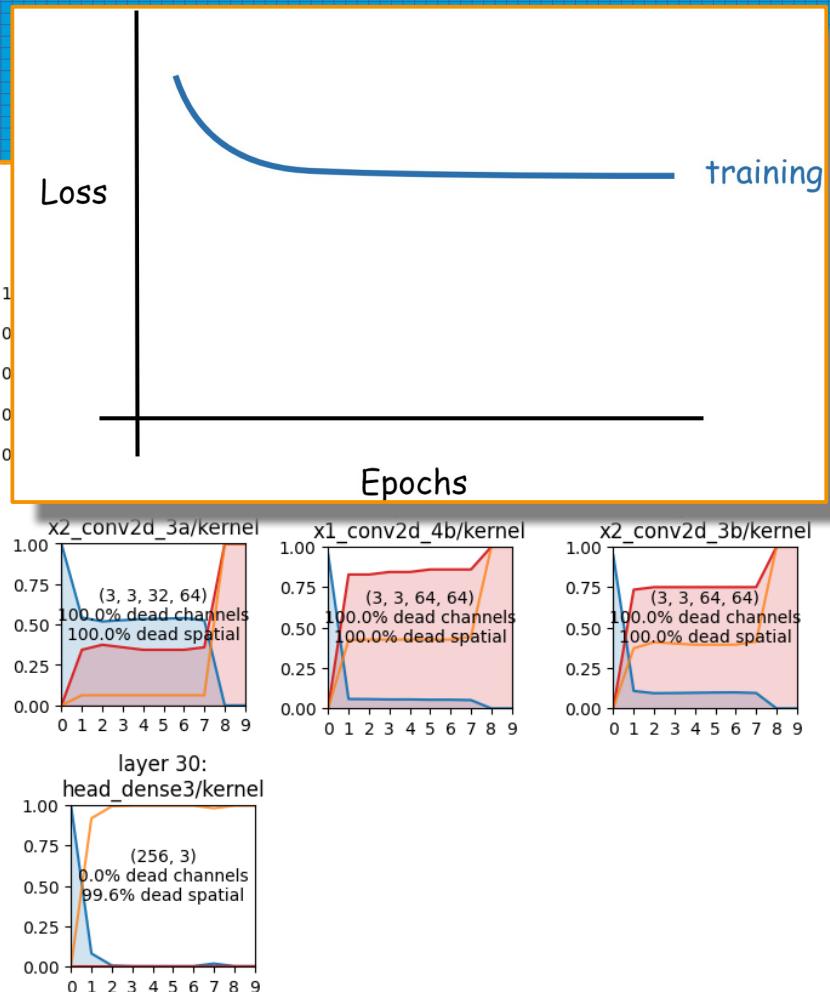
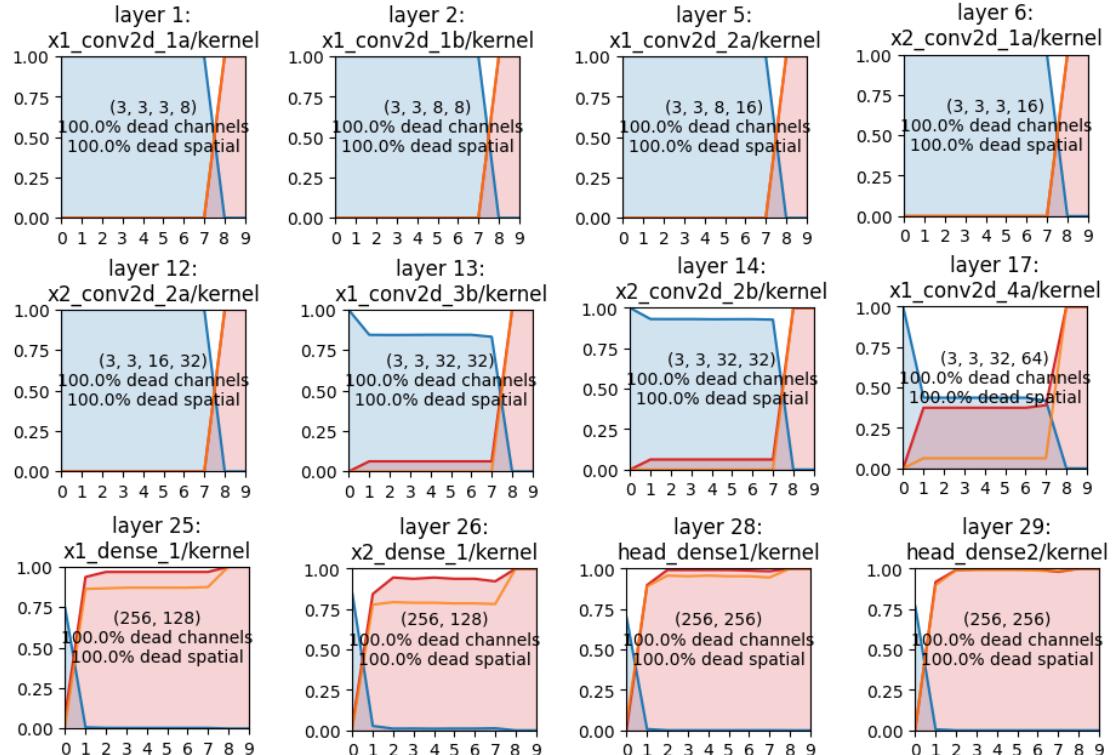
~0.00001 ~0.0001 ~0.001 ~0.01



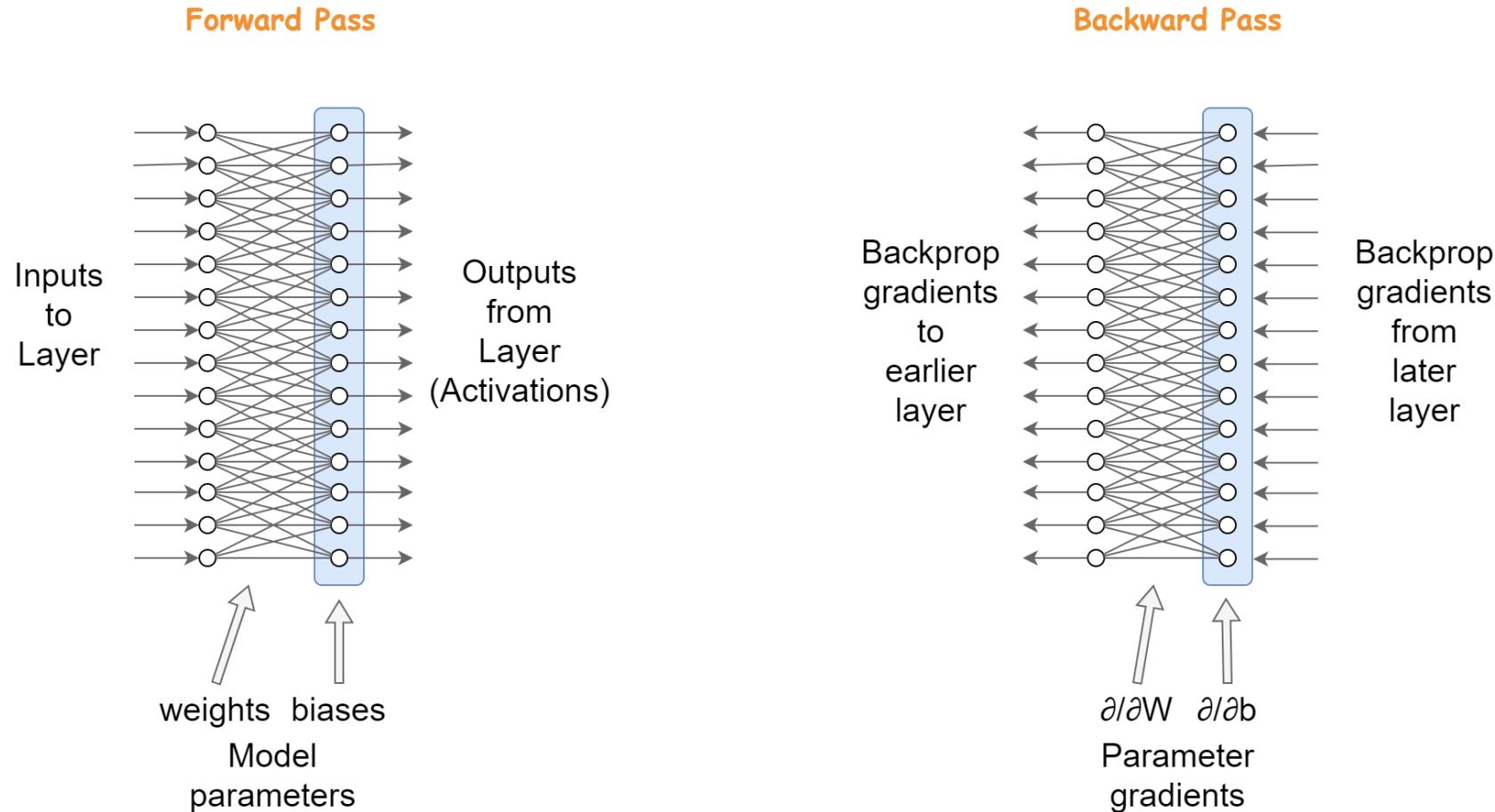
Neuron Death



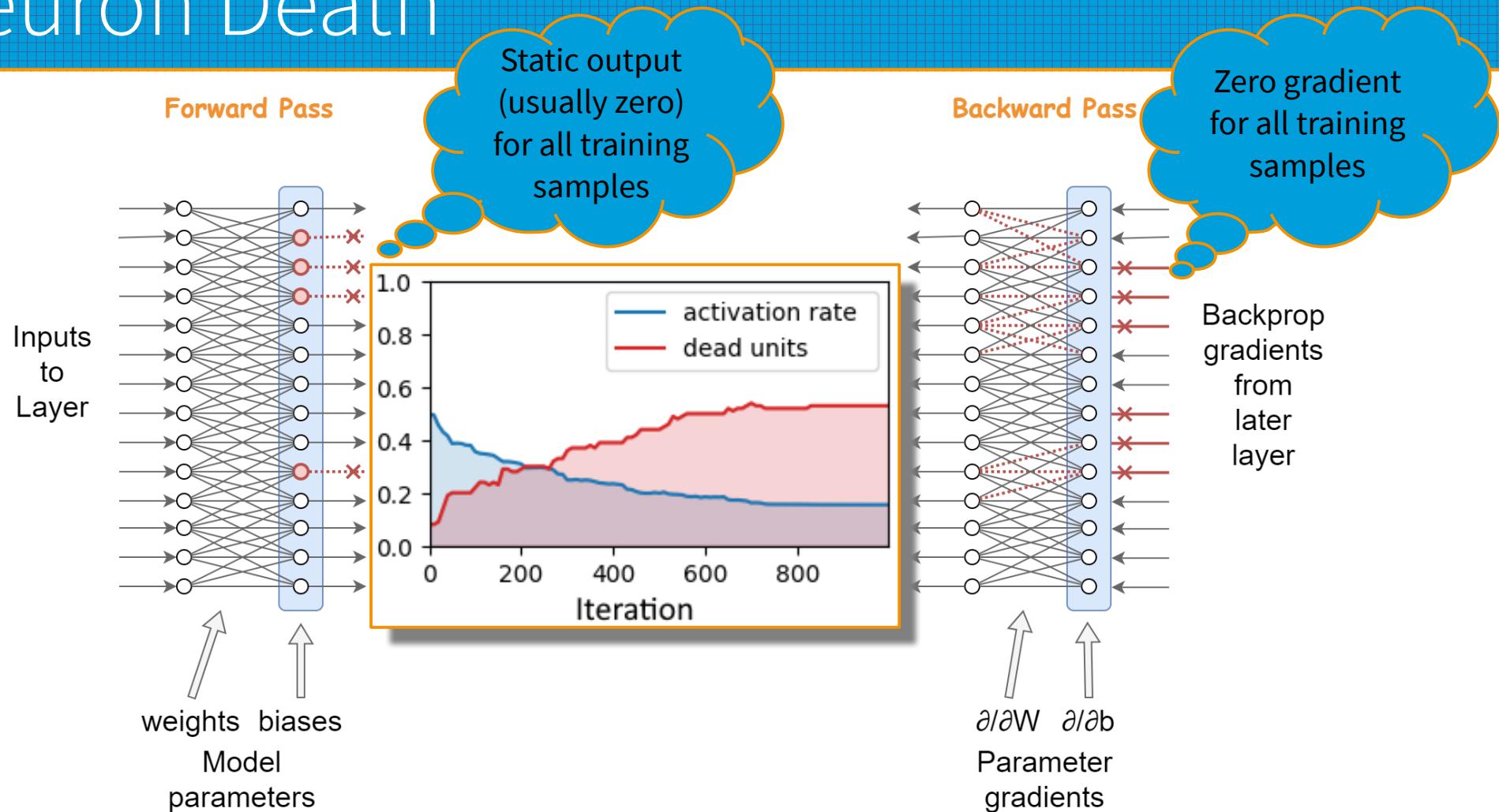
Neuron Death



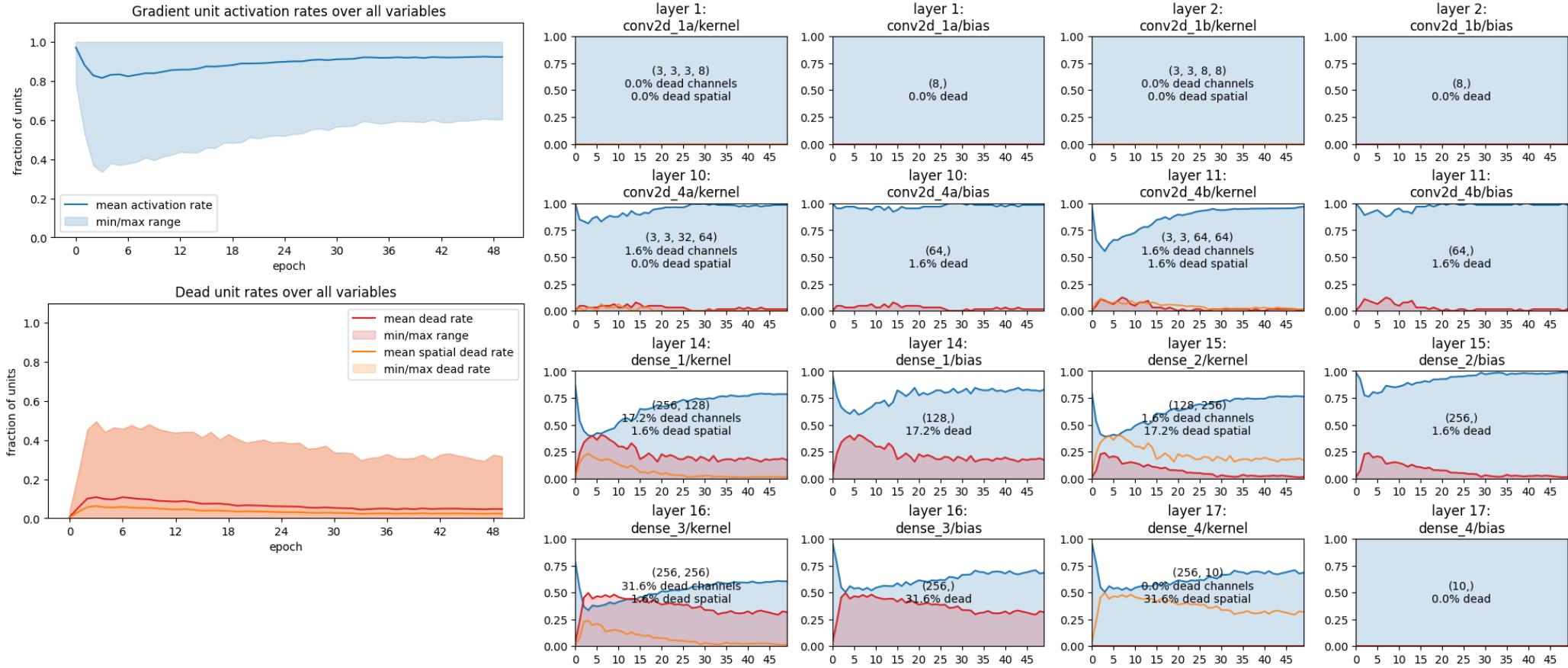
Neuron Death



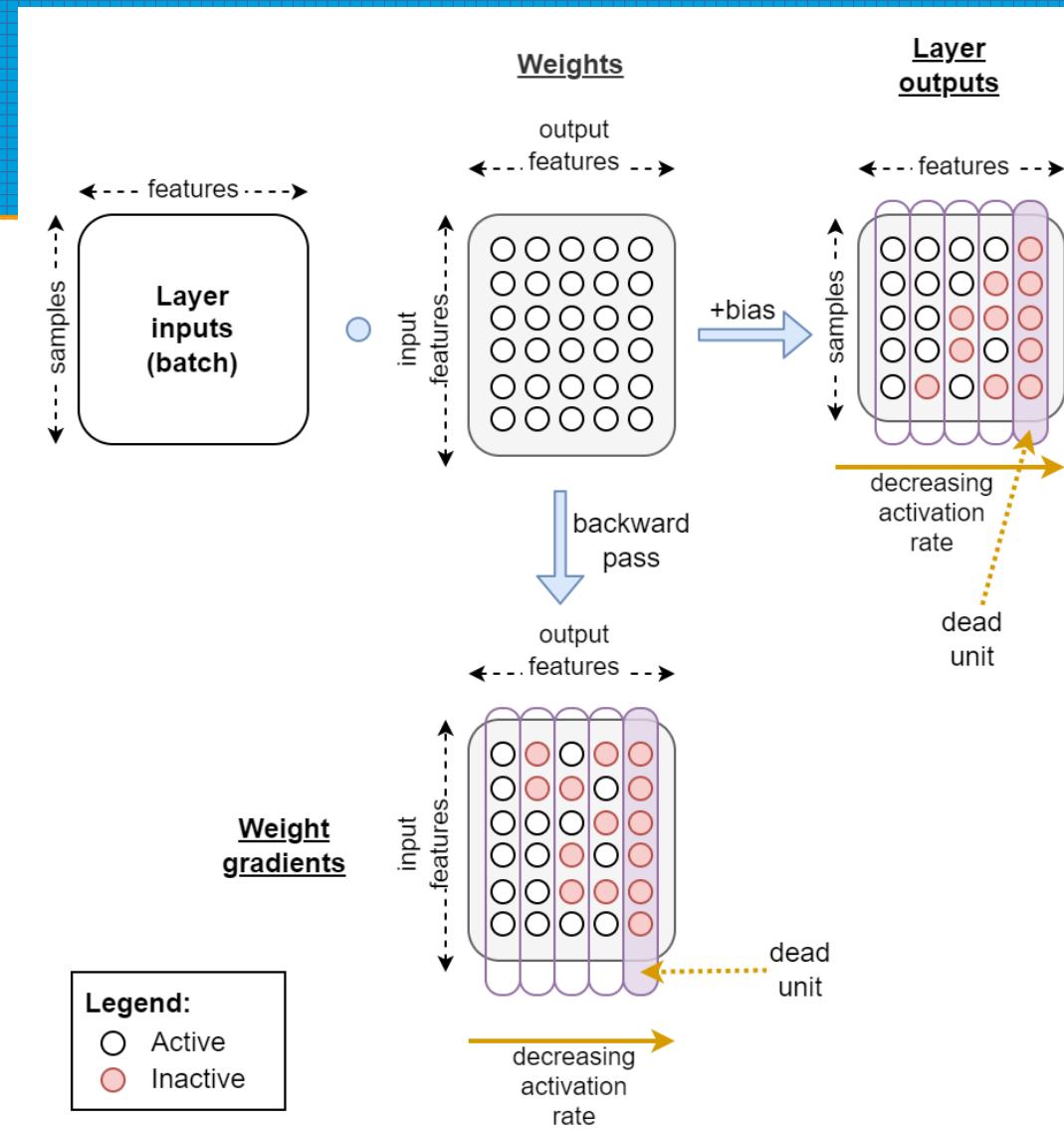
Neuron Death



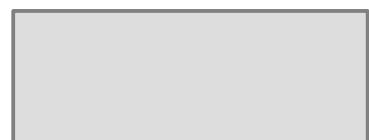
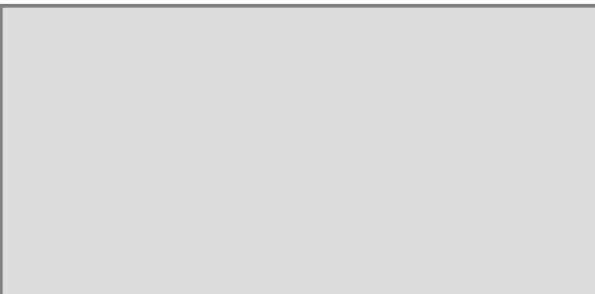
Neuron Death



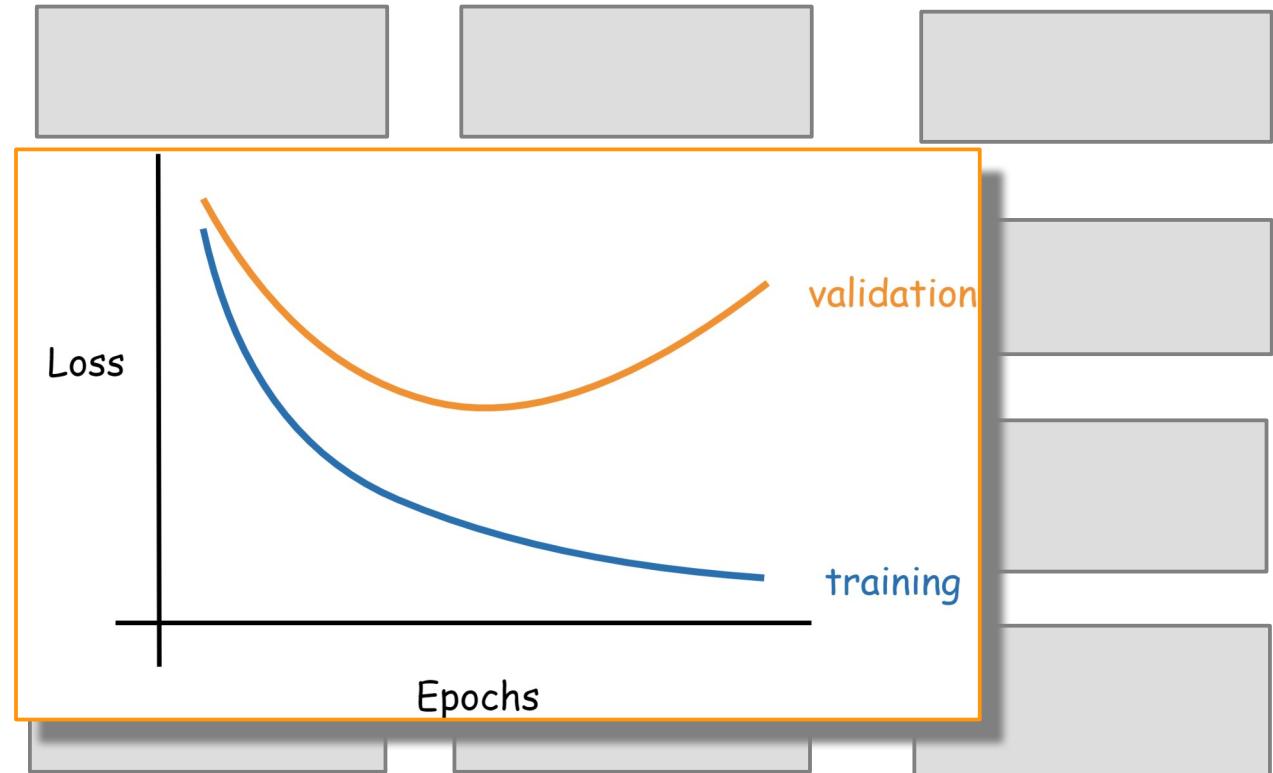
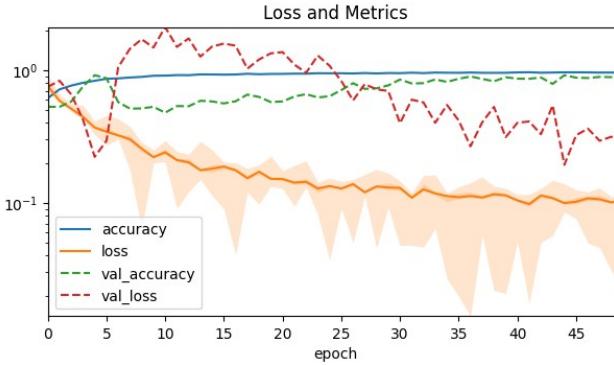
Neuron Death



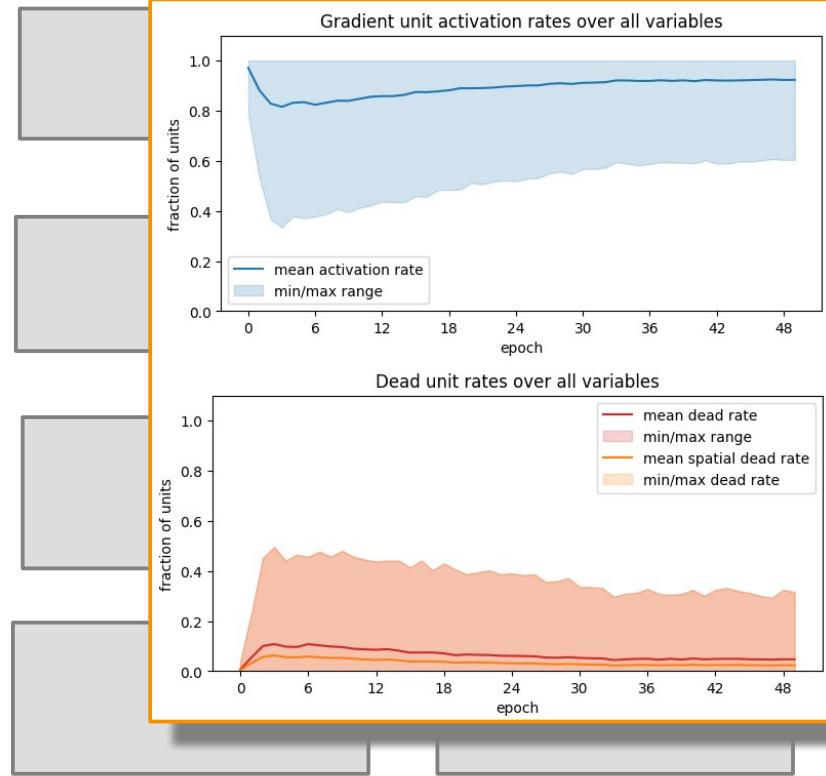
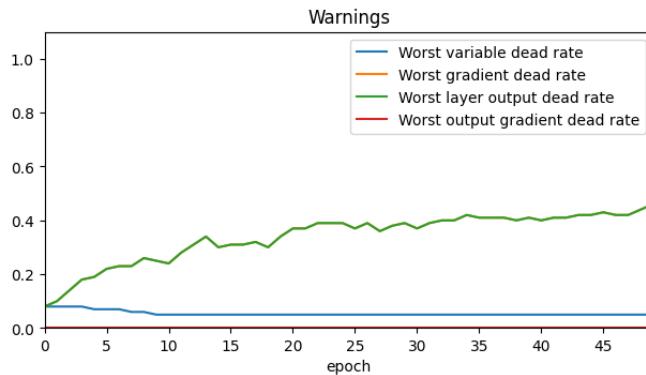
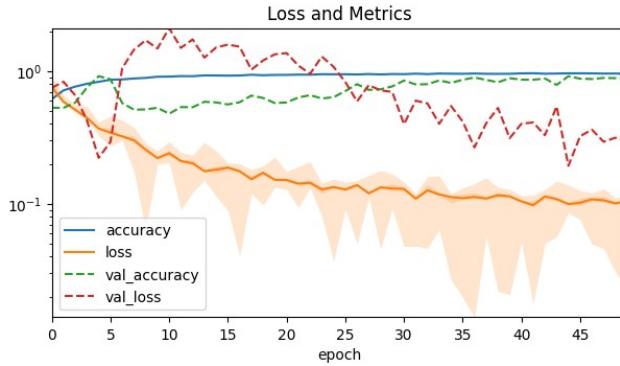
Model Overview



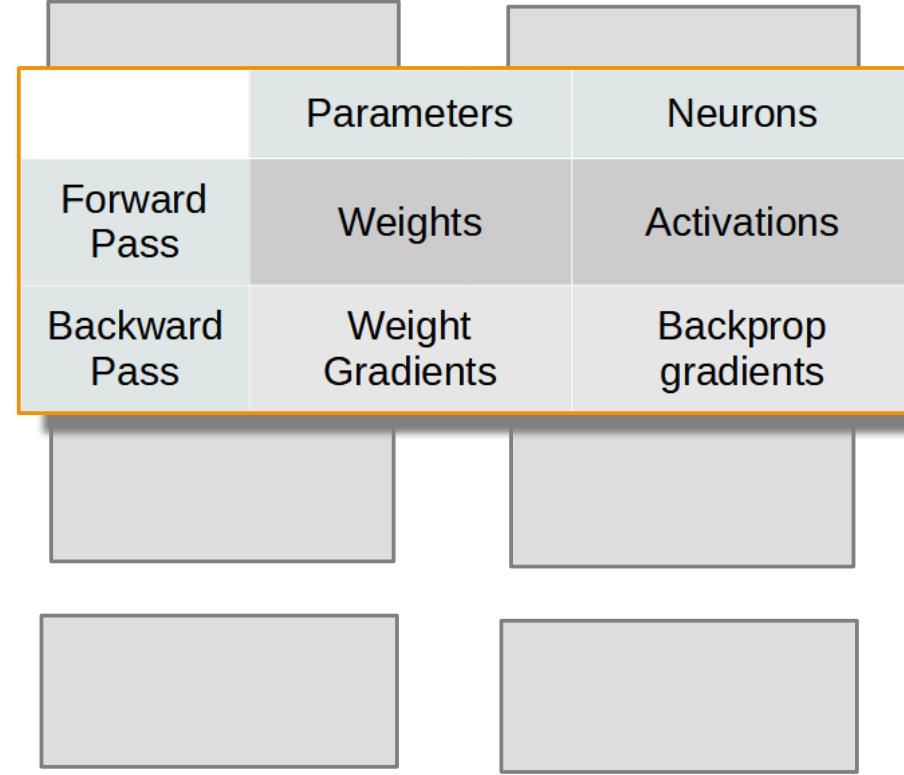
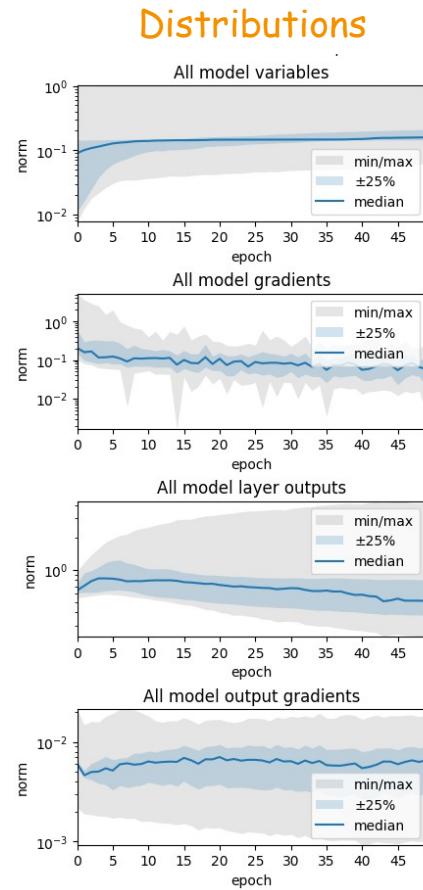
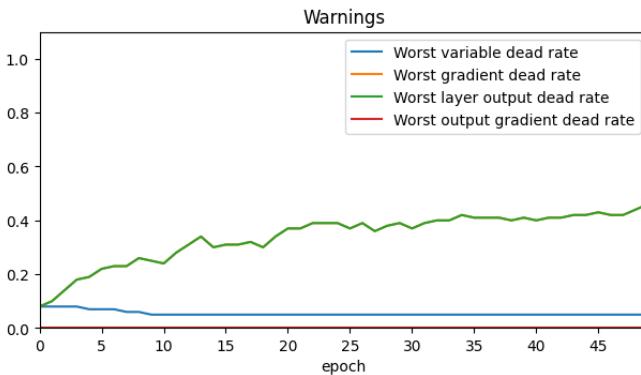
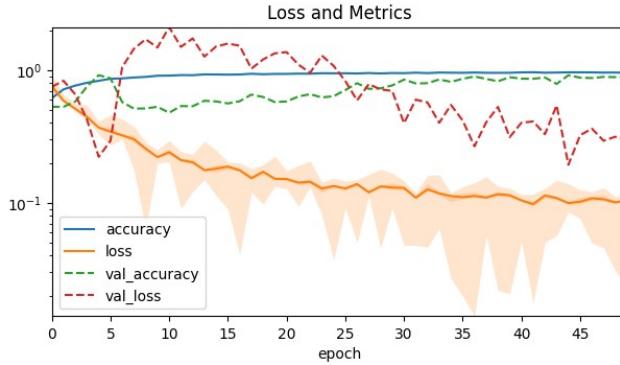
Model Overview



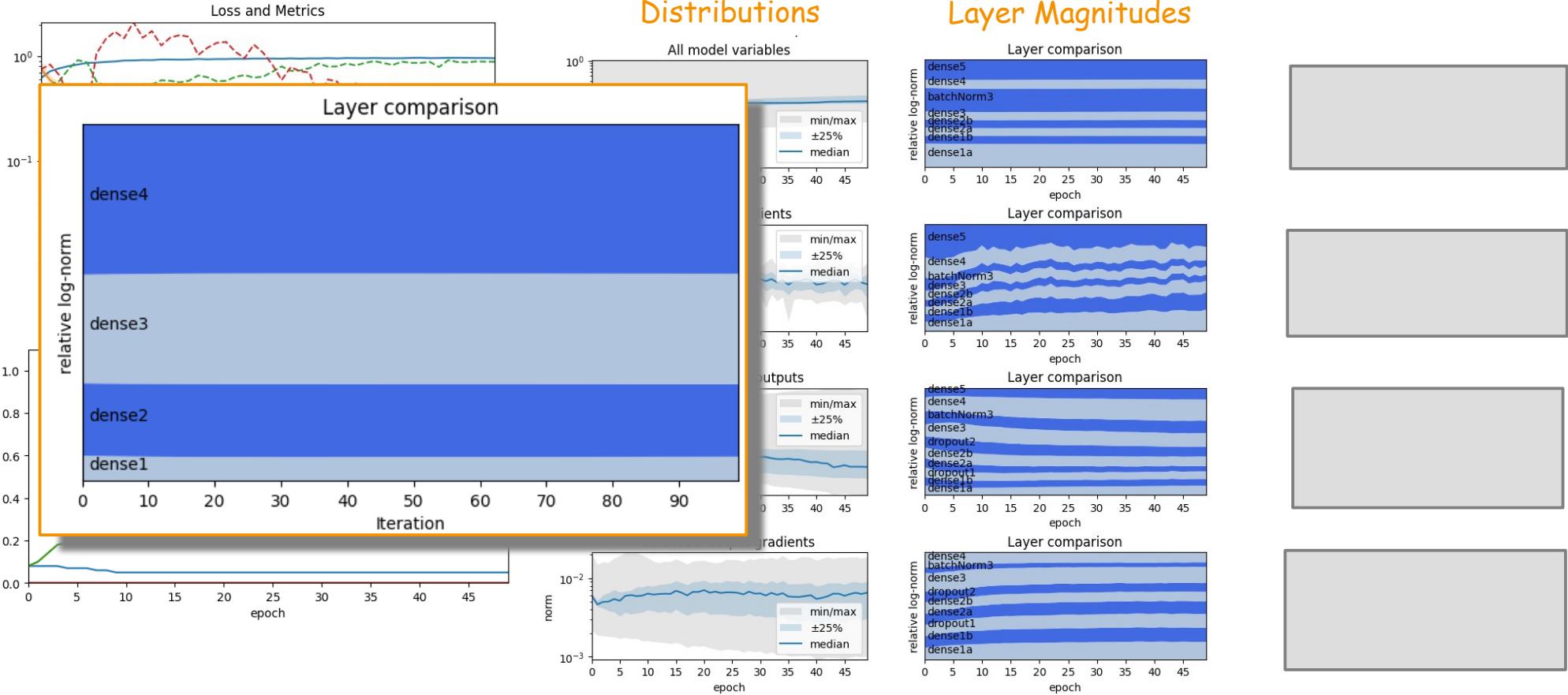
Model Overview



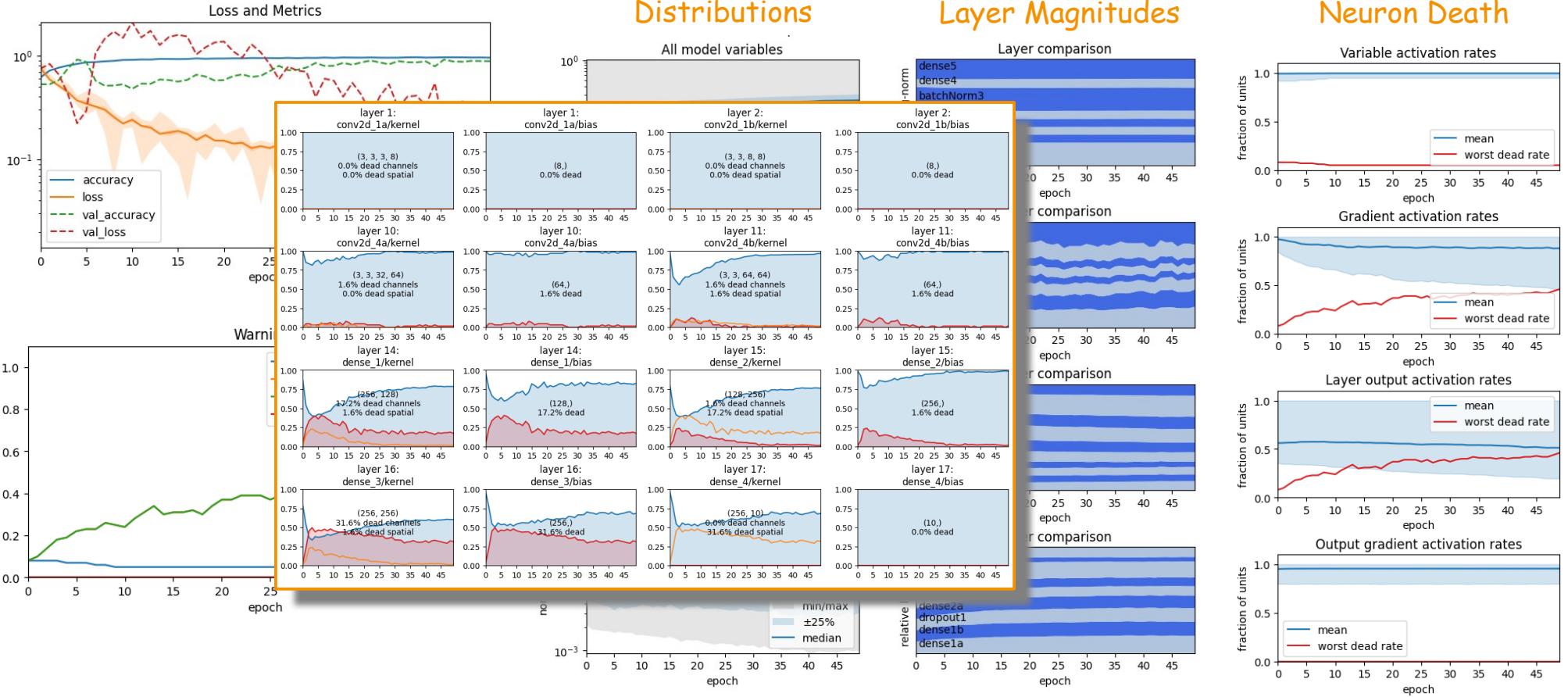
Model Overview



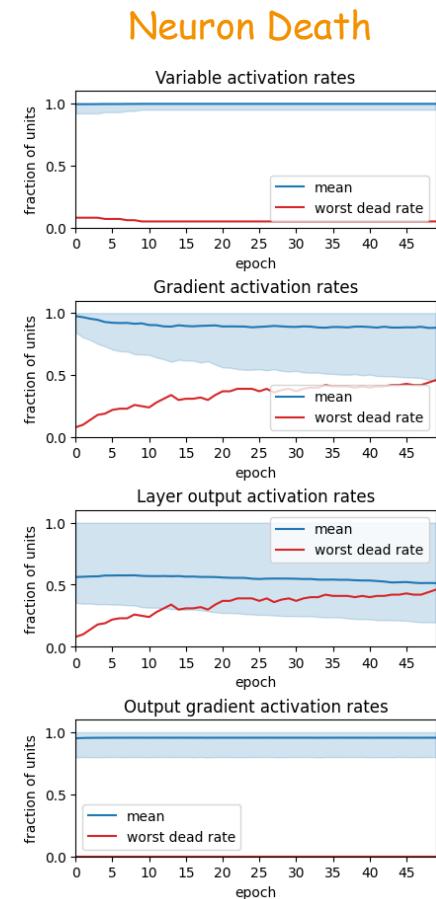
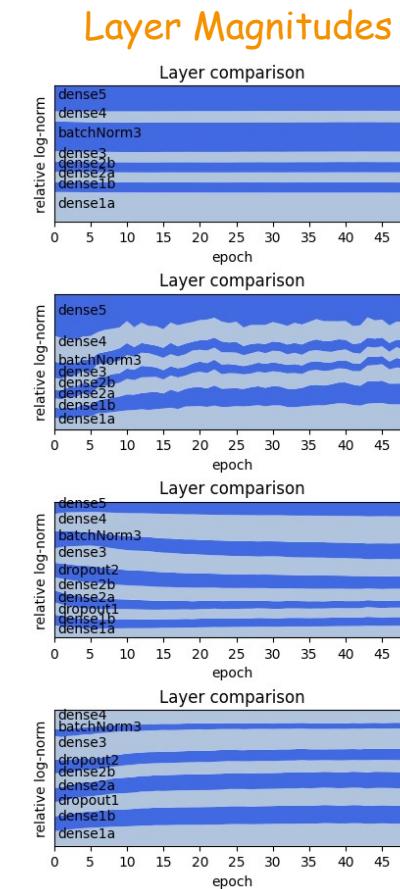
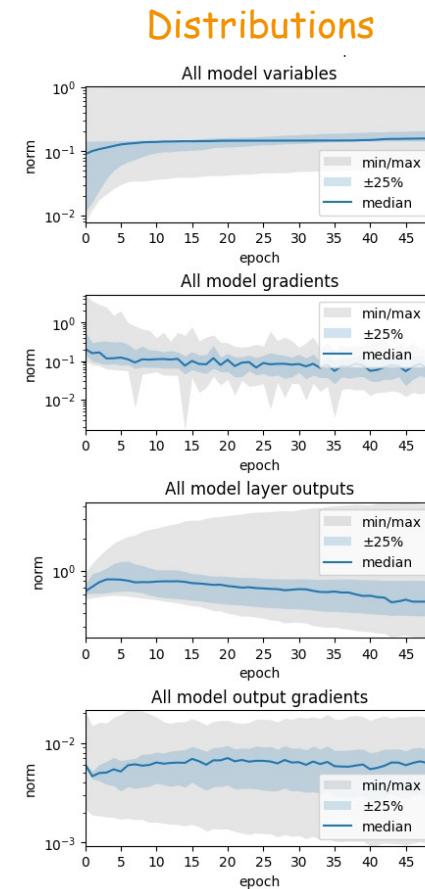
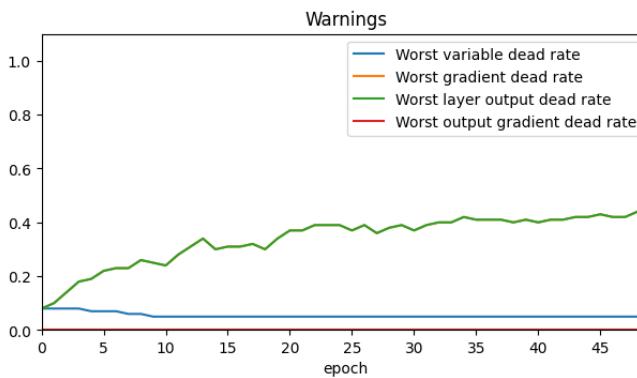
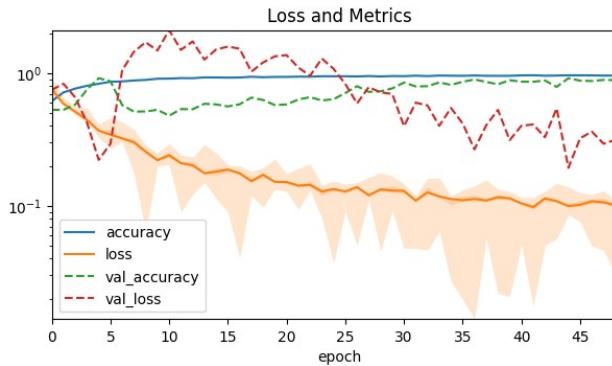
Model Overview



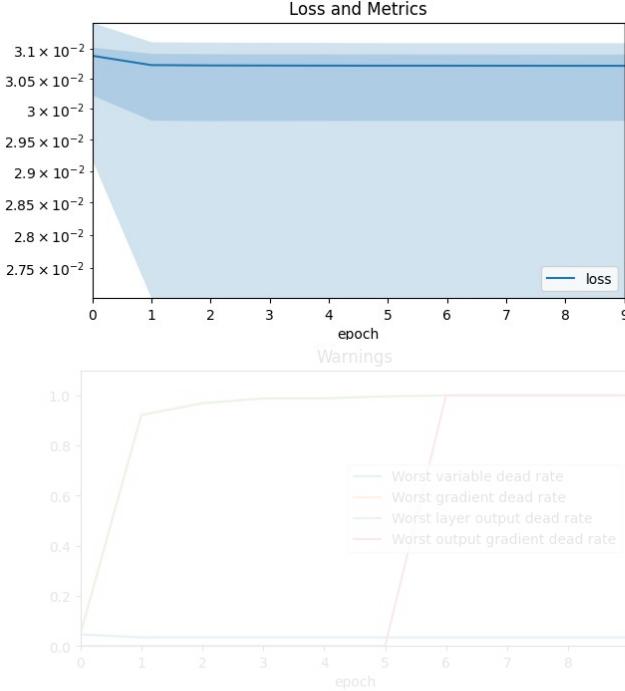
Model Overview



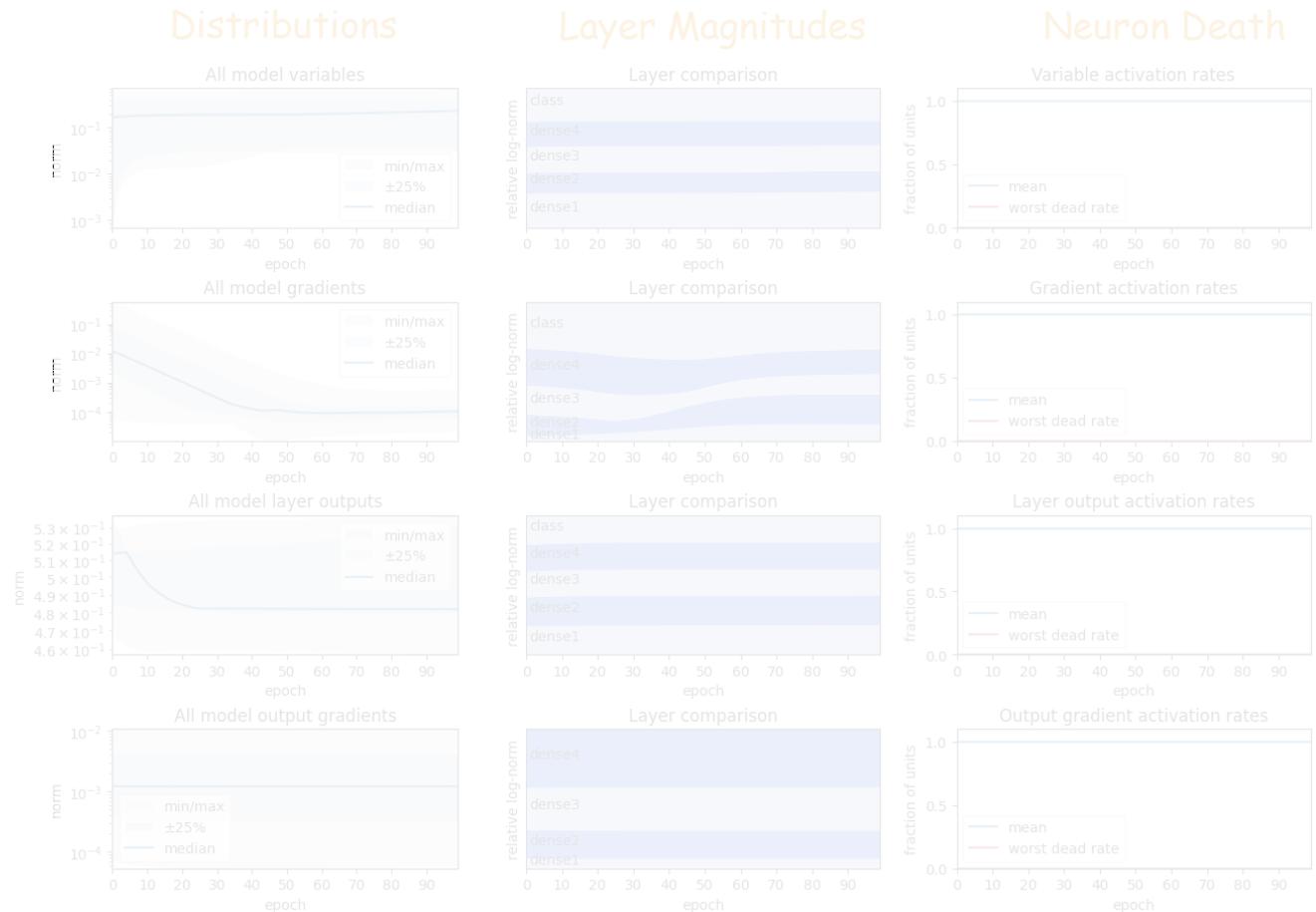
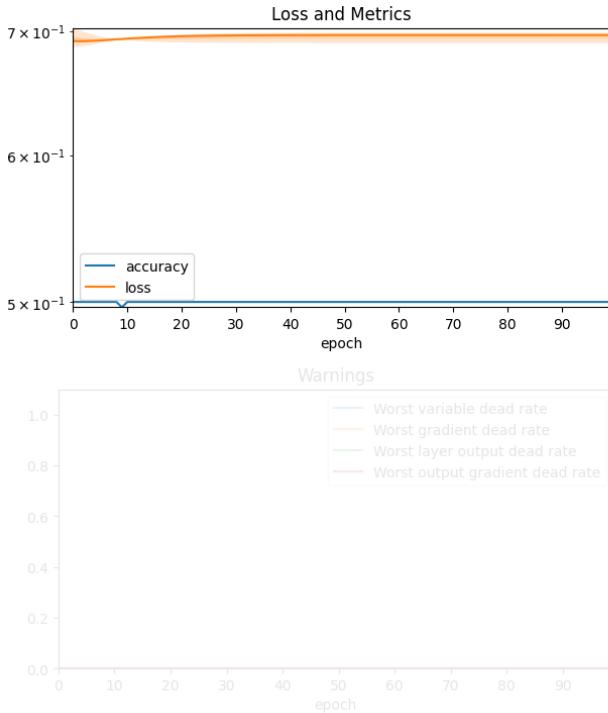
Model Overview



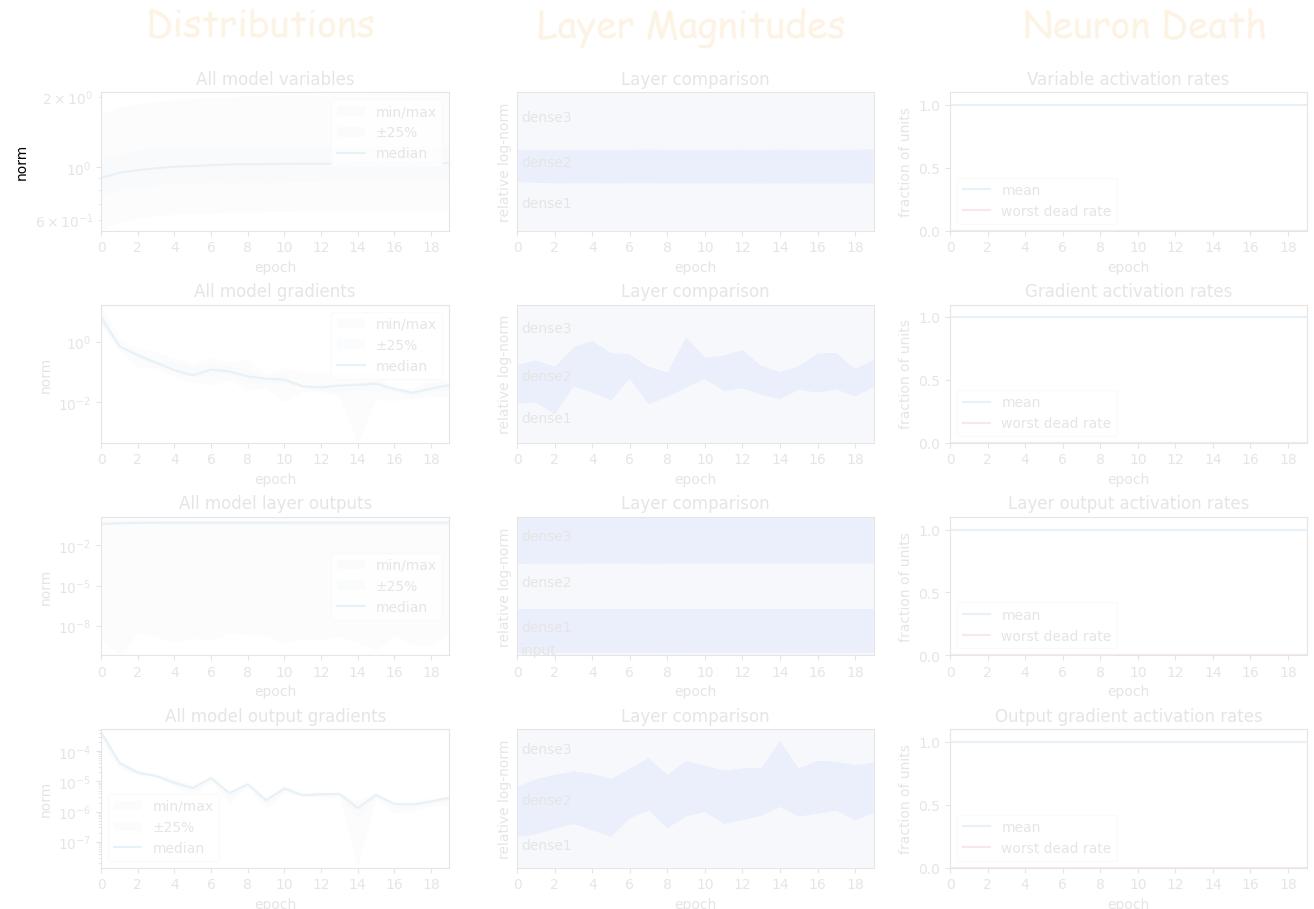
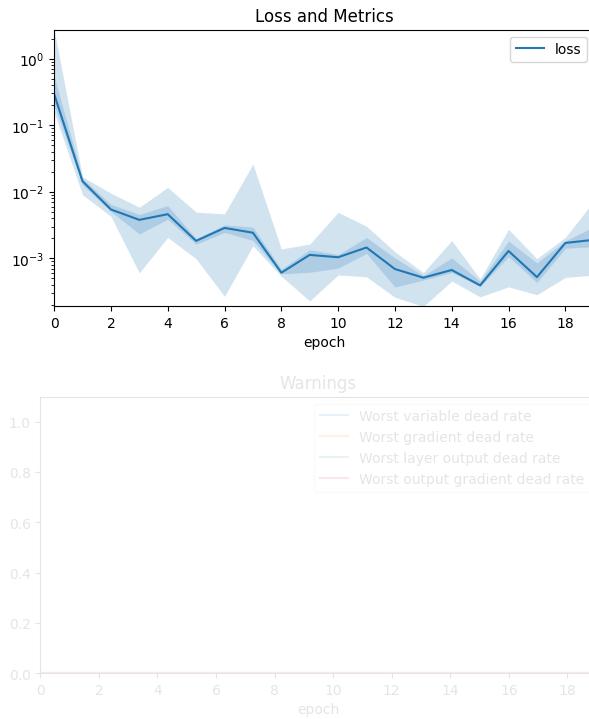
Example – Neuron Death

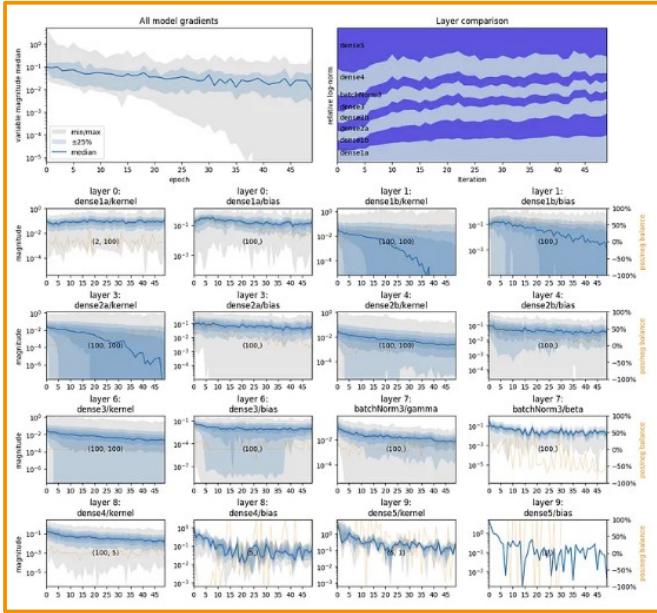
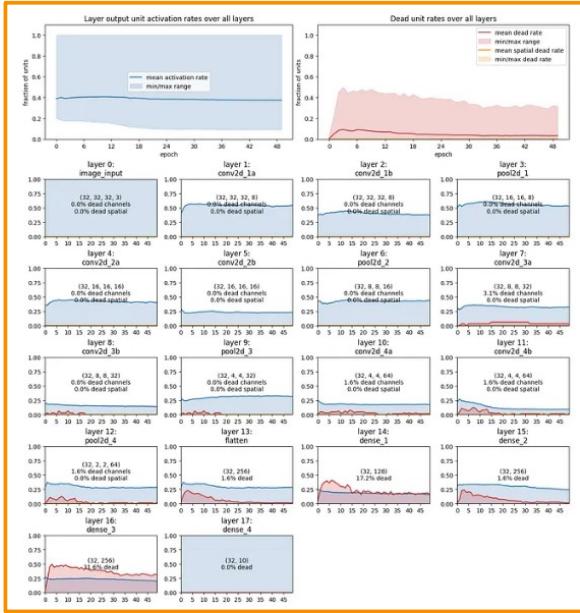
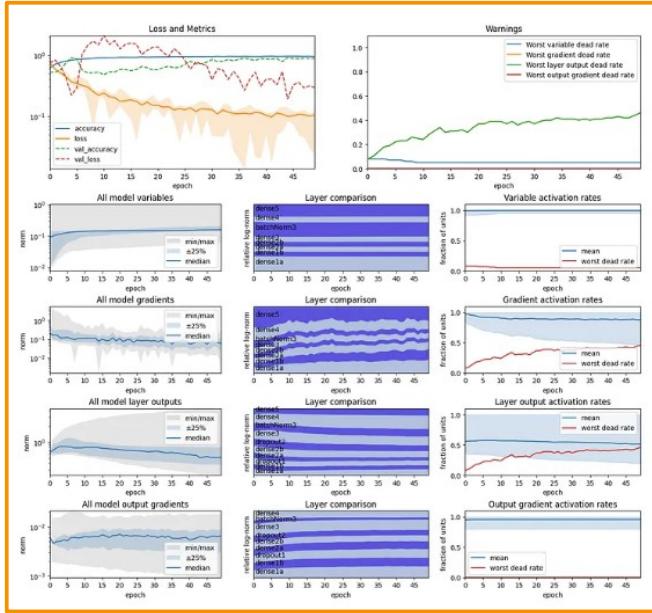


Example – Vanishing Gradients



Example – Gradient Oscillations





Thank you!

Neural Network Visualization Techniques for Better Troubleshooting





www.linkedin.com/in/malcolmlett/



github.com/malcolmlett/training-instrumentation-toolkit

Thank you!

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