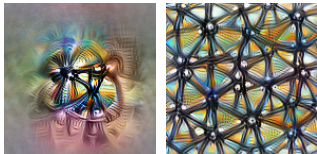


Interpretable Machine Learning

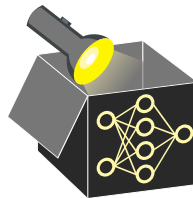
Post-hoc Methods for Neural Networks



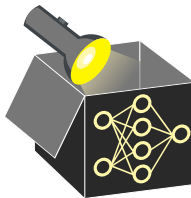
Learning goals

- Interpretability in neural networks
- Landscape of interpretability
- The difference between feature visualization and feature attributions

NEURAL NETWORKS AS COMPLEX ML MODELS

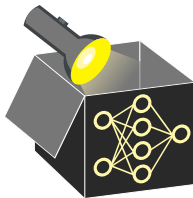


NEURAL NETWORKS AS COMPLEX ML MODELS

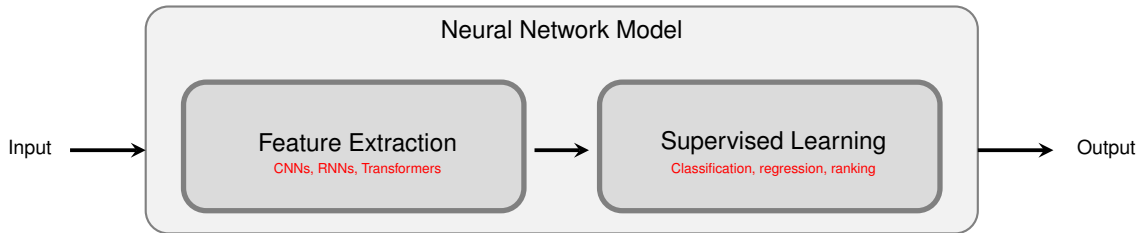


- Neural networks are over parameterised
 - Vision models and Language models routinely have > millions of params
 - Sometimes #parameters > #input instances
 - Which and how do the features, parameters, training instances contribute towards the final decision ?

NEURAL NETWORKS AS COMPLEX ML MODELS

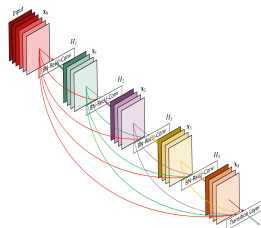
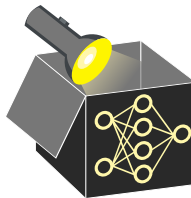


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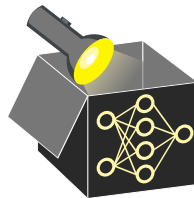


NEURAL NETWORKS AS COMPLEX ML MODELS

- Neural networks are compositional and non-linear systems
 - The success of neural networks is due to their depth
 - Depth results in compositional behaviour
 - Non-linearity between layers helps capture non-linear relationships
- Depth and non-linearity leads to lack of interpretability

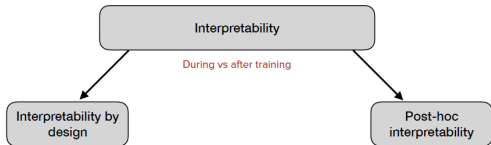
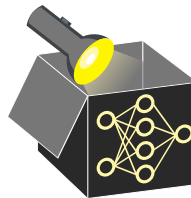


MODEL-SPECIFIC INTERPRETABILITY

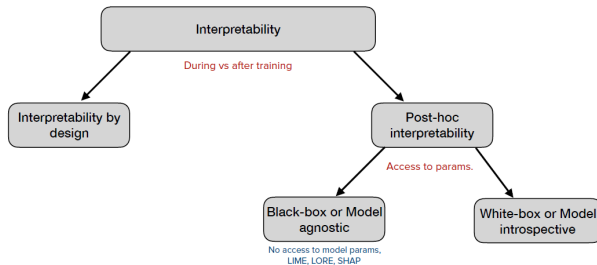
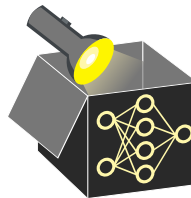


- What types of neural models are out there ?
 - For vision: Convolutional Neural Nets
 - For language, speech: Recurrent Neural Nets, Transformer Models
 - For recommendation systems, ranking: Factorization-based Models, Embeddings models
- Each of the domains have their challenges and have developed specific approaches for interpretability
 - We will focus on first principles that can be applied to most models
 - We will discuss adaptations to each data modality as and when required

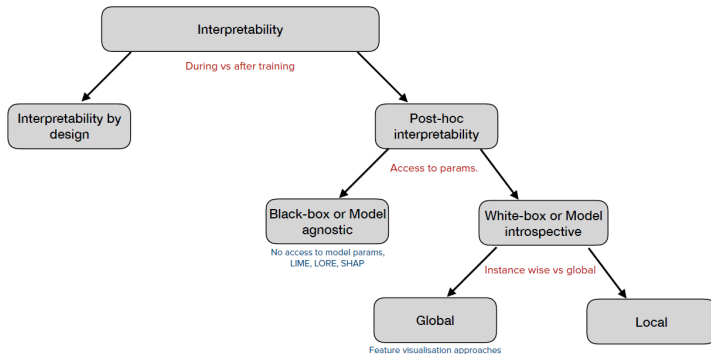
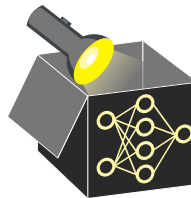
INTERPRETABILITY LANDSCAPE IN NEURAL NETWORKS



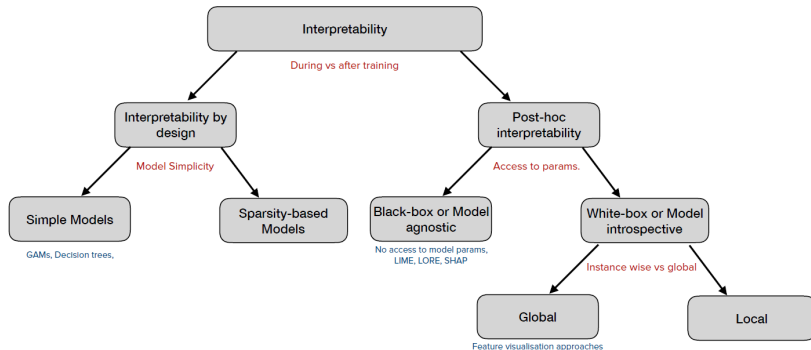
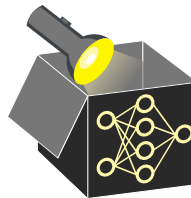
INTERPRETABILITY LANDSCAPE IN NEURAL NETWORKS



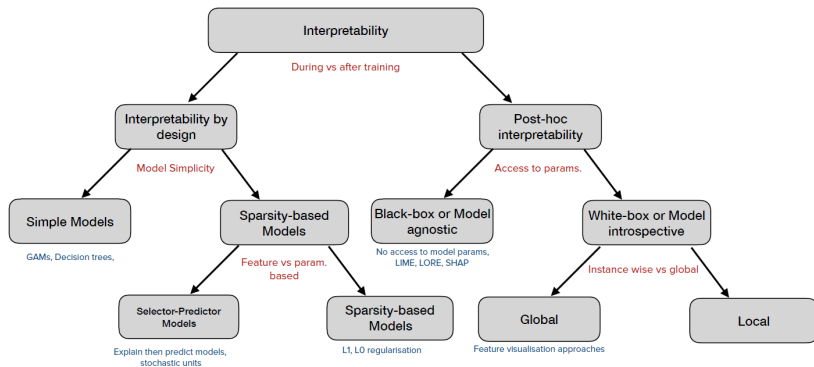
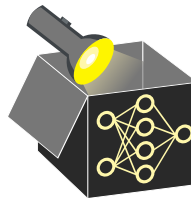
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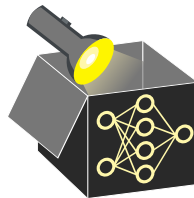
INTERPRETABILITY LANDSCAPE IN NEURAL NETWORKS



INTERPRETABILITY LANDSCAPE IN NEURAL NETWORKS



HOW CAN WE INTERPRET NEURAL MODELS ?



- Feature visualization: Visualizing components of the neural networks
 - Activations of neurons
 - Attention values
 - Gradient flow
- Feature attributions: relevant input features
 - Which input features are responsible for the given decision ?
 - Sensitivity analysis using gradient-based methods
 - Using black-box methods like LIME, SHAP, etc.

HOW CAN WE INTERPRET NEURAL MODELS ?

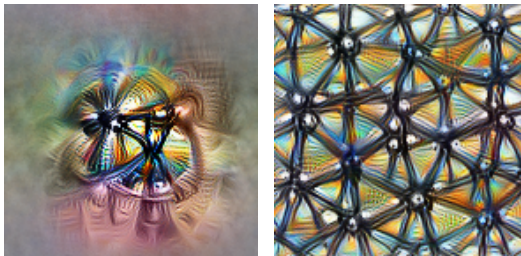
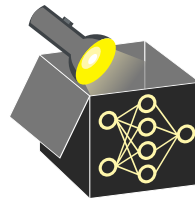


Figure: Feature visualization: Visualizing components of the neural networks

HOW CAN WE INTERPRET NEURAL MODELS ?

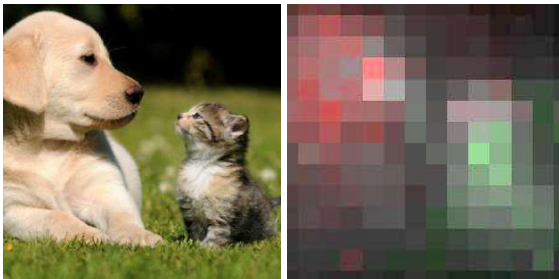
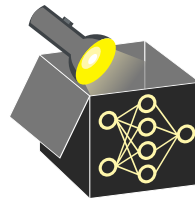


Figure: Feature attributions: relevant input features