Deep Learning
MSDS 631

Multi-Task, Data Augmentation, Transfer Learning

Michael Ruddy

Questions?

- From last lecture?

Overview

- Small Datasets
- Transfer Learning
- Data Augmentation
- Multi-Task Learning

Small Datasets

- Not enough data
  - Expensive to obtain
  - Too big to store

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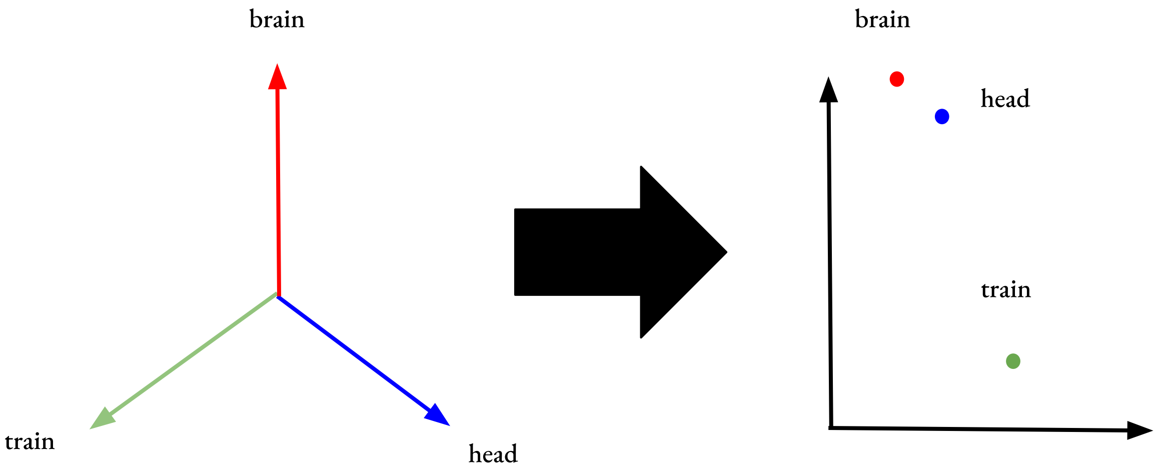
Transfer Learning

- Transfer features from one task/dataset to another
- Word Embeddings
    - Learn from context (lots of data)
    - Use for all sort of NLP tasks (maybe less data/labels)

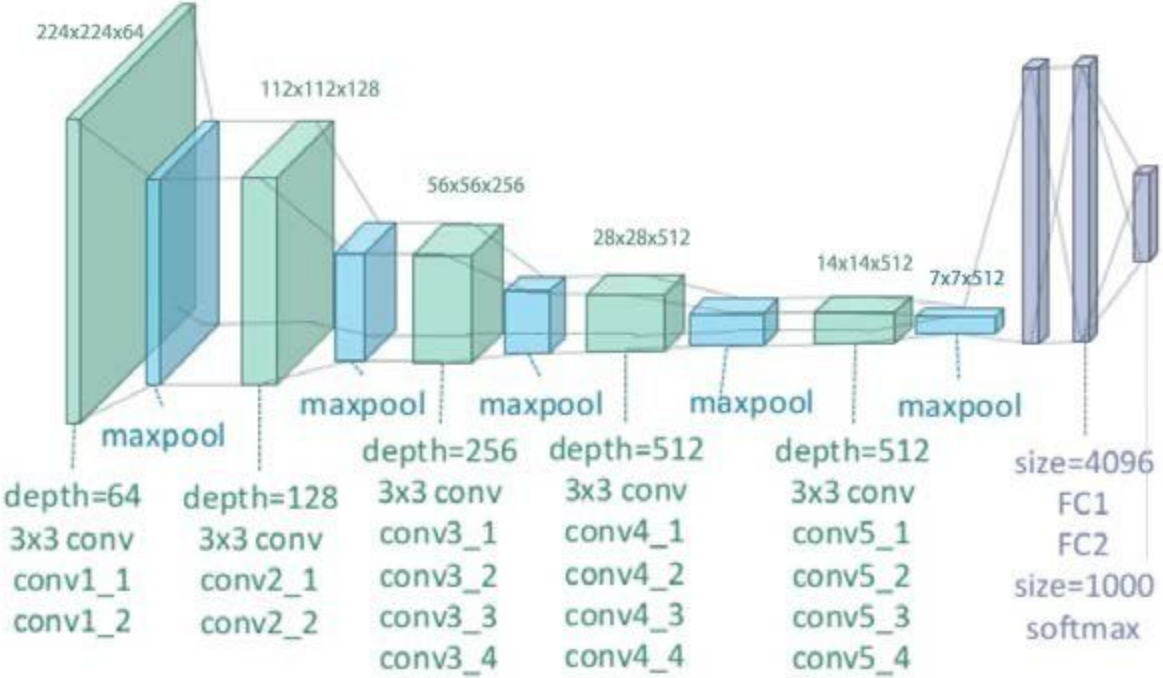
$$\begin{array}{ccc} \begin{bmatrix}1\\0\\0\end{bmatrix} & \begin{bmatrix}0\\1\\0\end{bmatrix} & \begin{bmatrix}0\\0\\1\end{bmatrix} \\ \text{brain} & \text{head} & \text{train} \end{array}$$



Transfer Learning

- Transfer features from one task/dataset to another
- Word Embeddings
- Train a CNN on ImageNet: multi-class problem with 1000 classes
  - Lots of images!

VGG-19



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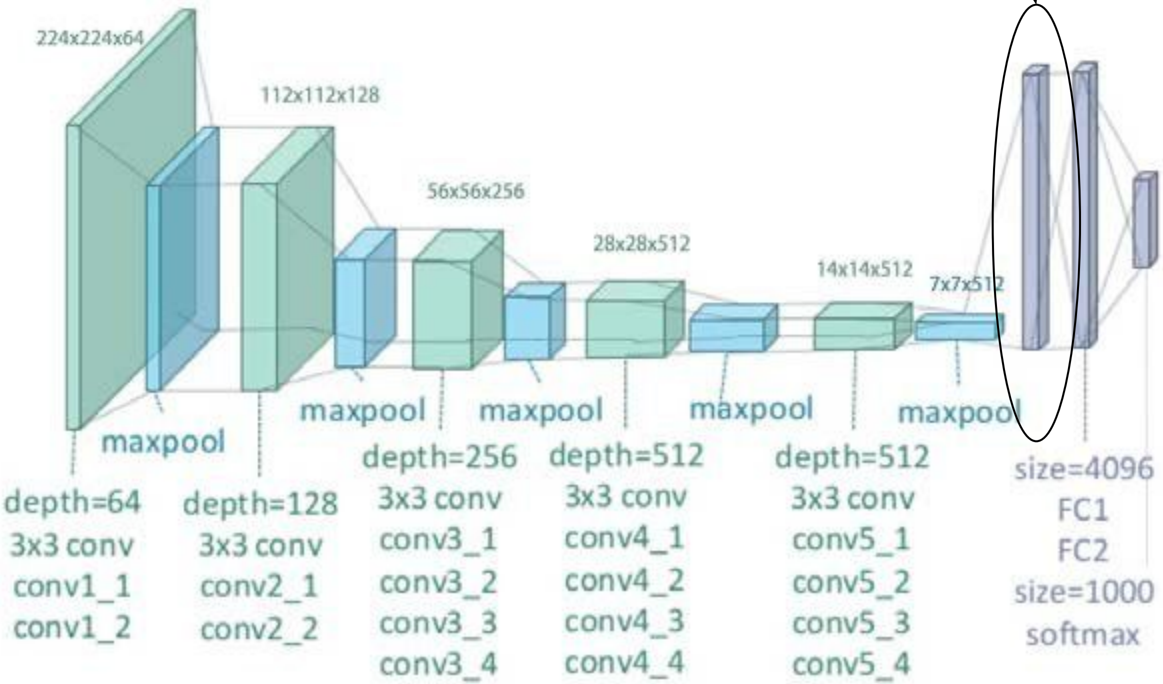

Embedding or Representation of an image

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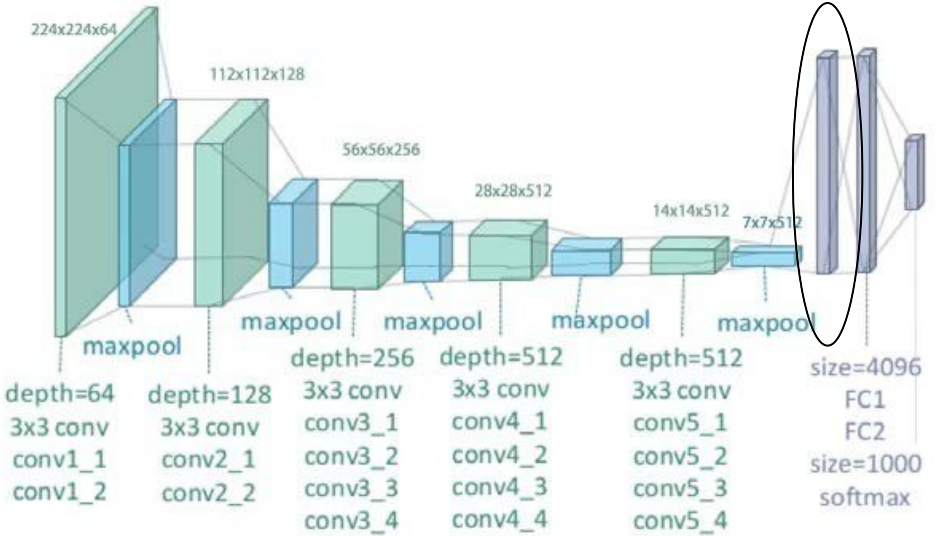
- Train a CNN on ImageNet: multi-class problem with 1000 classes
- Two approaches
  - Freeze your embedding/representation



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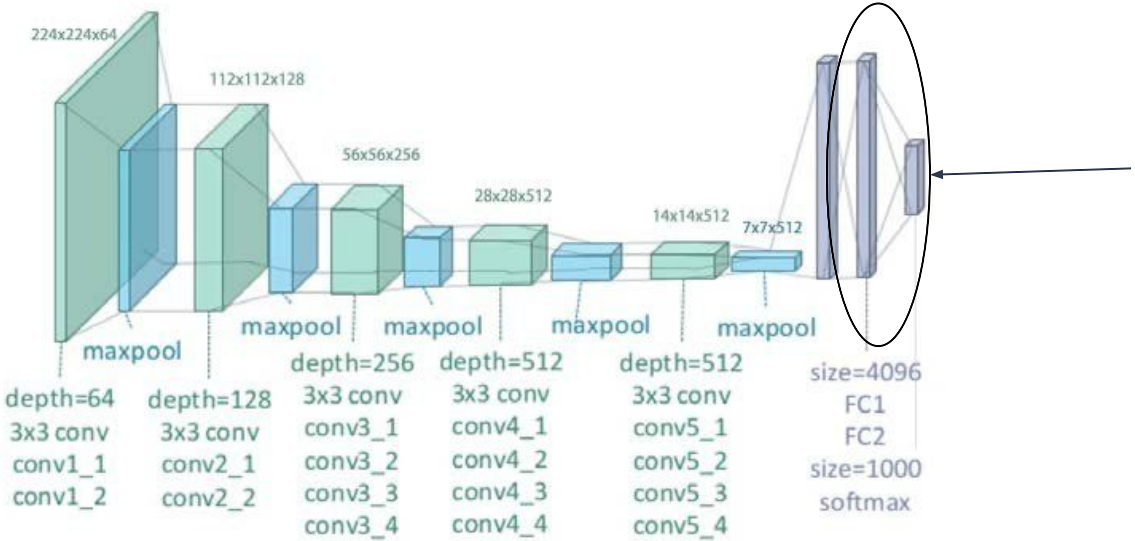

Train just these layers

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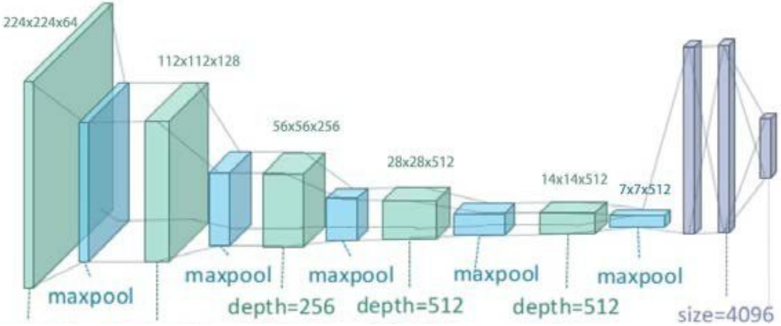

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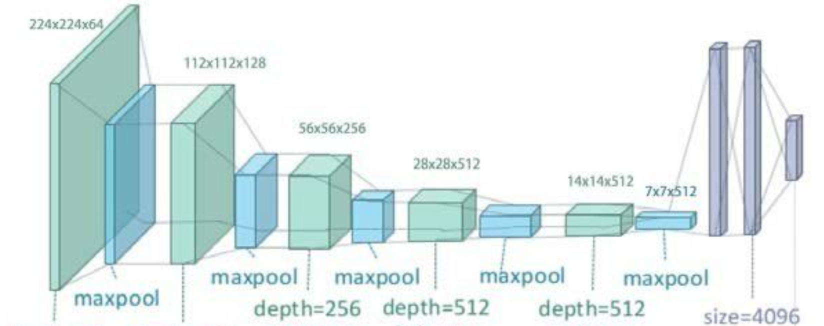

Low LR ↔ High LR

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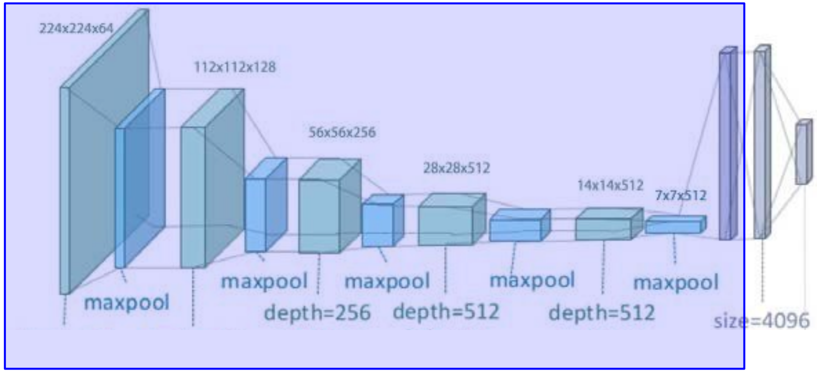

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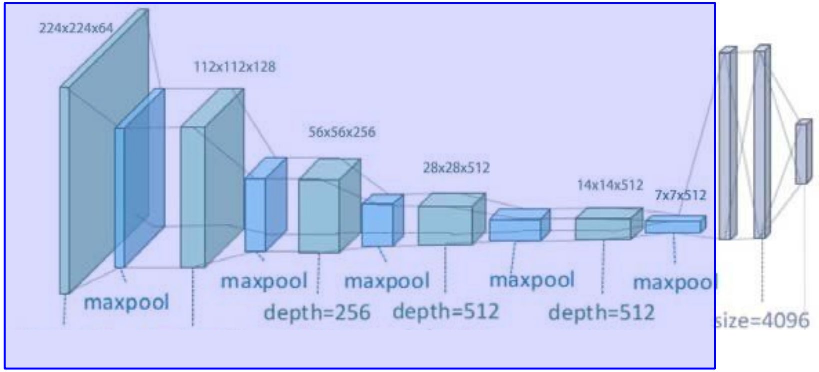

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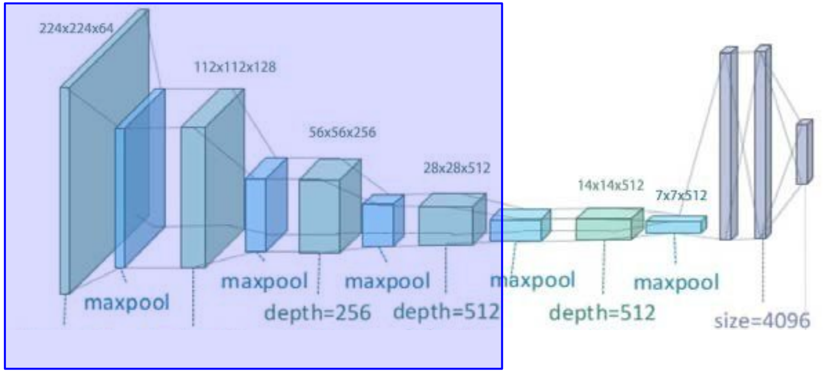

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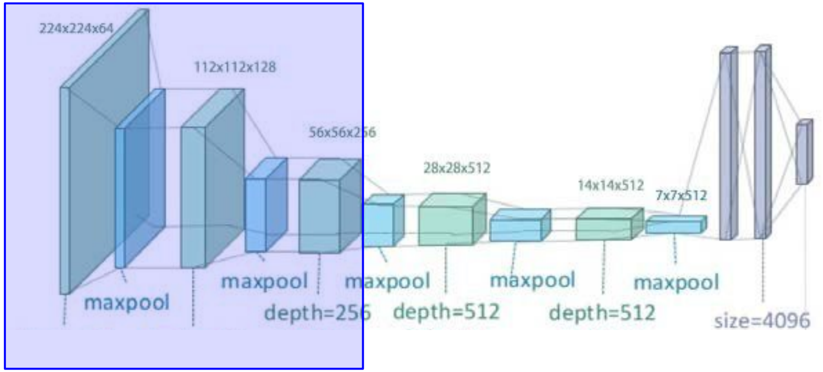
Epoch 3



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- Create synthetic data
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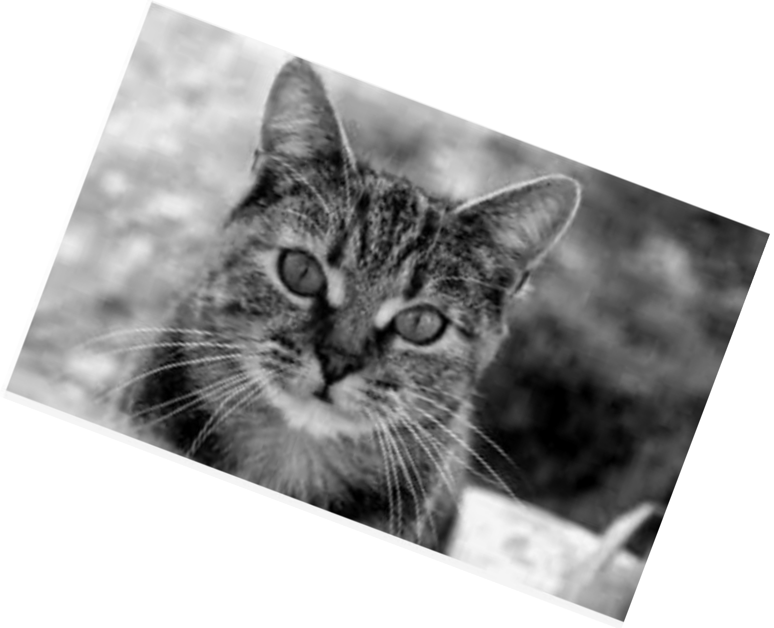

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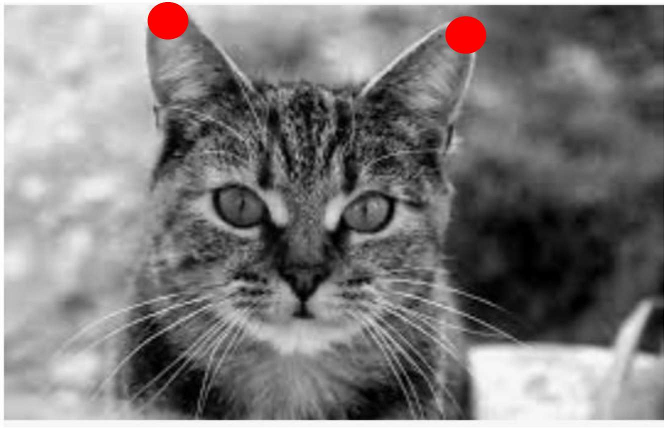

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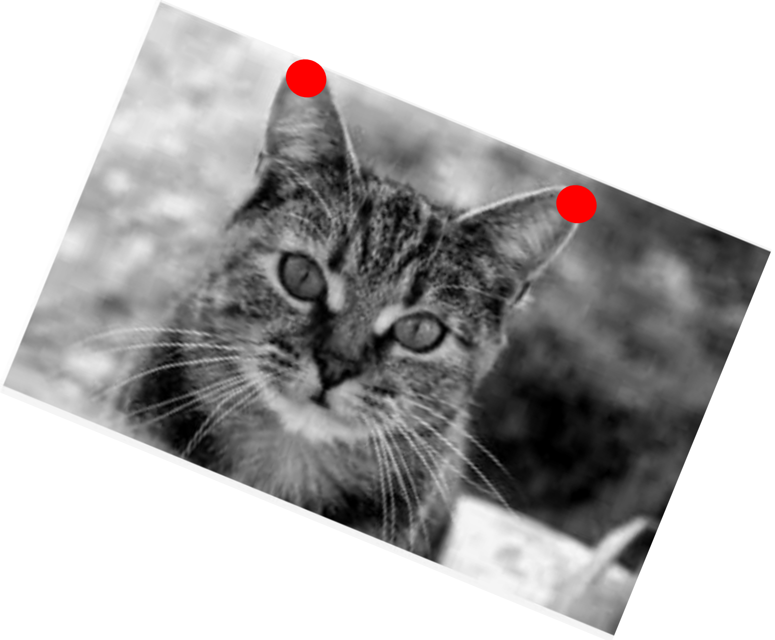

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- Create synthetic data
- Transform your original data
  - Encode invariance/equivariance for a model
  - Idea: model learns a bit of Euclidean geometry this way
  - Make your model less sensitive to noise

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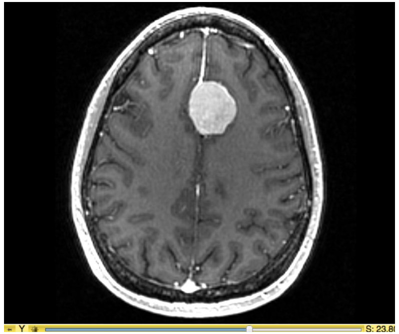
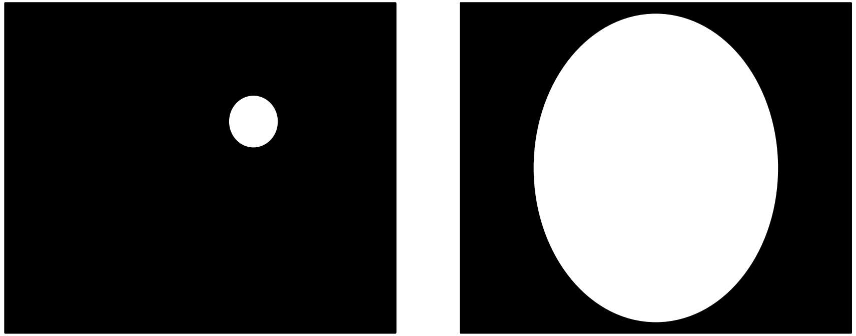
Multi-Task Learning

- Two tasks where computed features can be shared
  - For example: Classification + Localization
- Usually helpful when there is less data than desired somewhere
  - More labels on the same inputs potentially lets you learn “more” about the image
  - Maybe one task has a lot of data and another similar task does not
- Careful!
  - Don’t want a model that is just mediocre at both
  - One task can take over

Multi-Task Learning

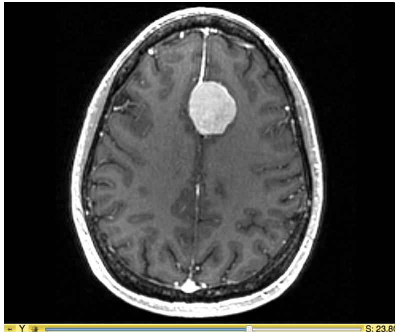


Input



labels

Multi-Task Learning



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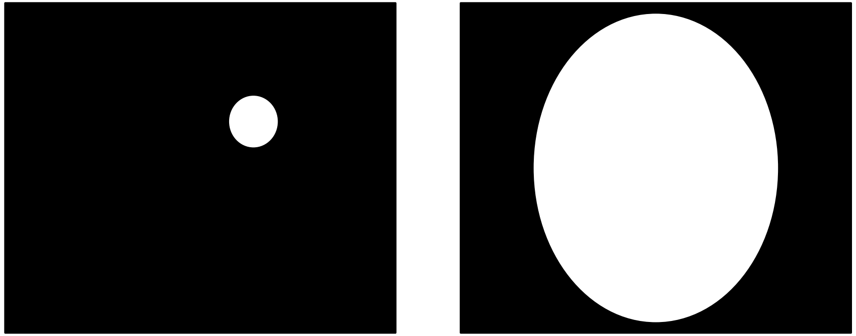

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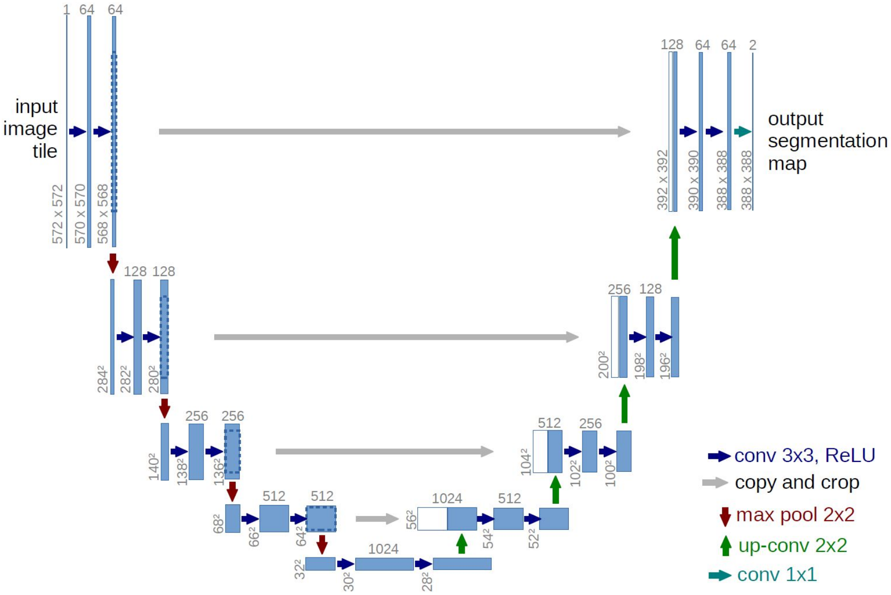
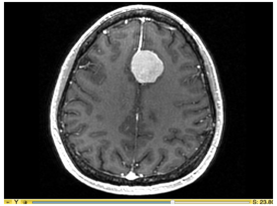
Benign or Malignant

Multi-Task Learning





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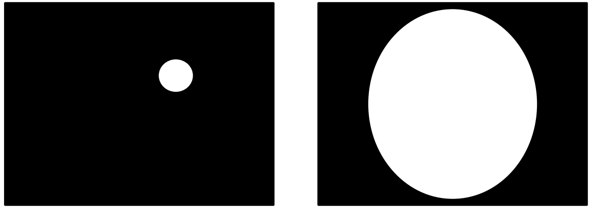

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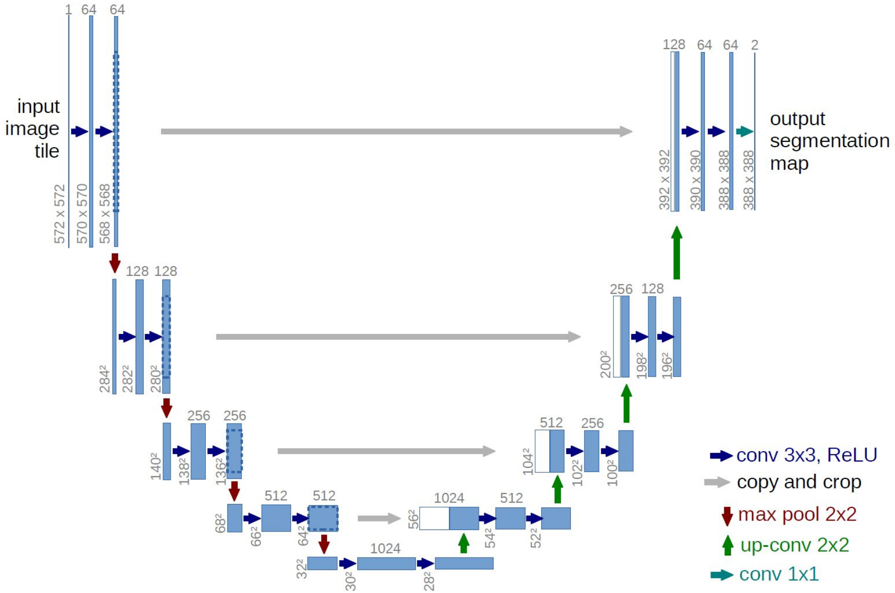

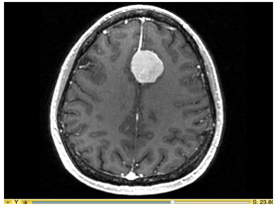

Input

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Benign or Malignant

Unroll to Linear Layer then Classification

Summary

- Transfer Learning
  - Transfer features learned from one dataset/task to another
- Data Augmentation
  - Augment your dataset
  - Synthetic Data
  - Transformed Data
  - Encode invariance/equivariance to nuisance transformations
- Multi-Task Learning
  - Leverage other tasks to improve the target task
  - Like simultaneous transfer learning!