Image Segmentation using fast.ai

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Outline

- Semantic segmentation
- CNNs
- U-Net
- Transfer learning
- Fast.ai
- Mask creation
  - Matlab
- Fast.ai code example

Semantic Segmentation

Automatically color an image according to the category of each pixel.

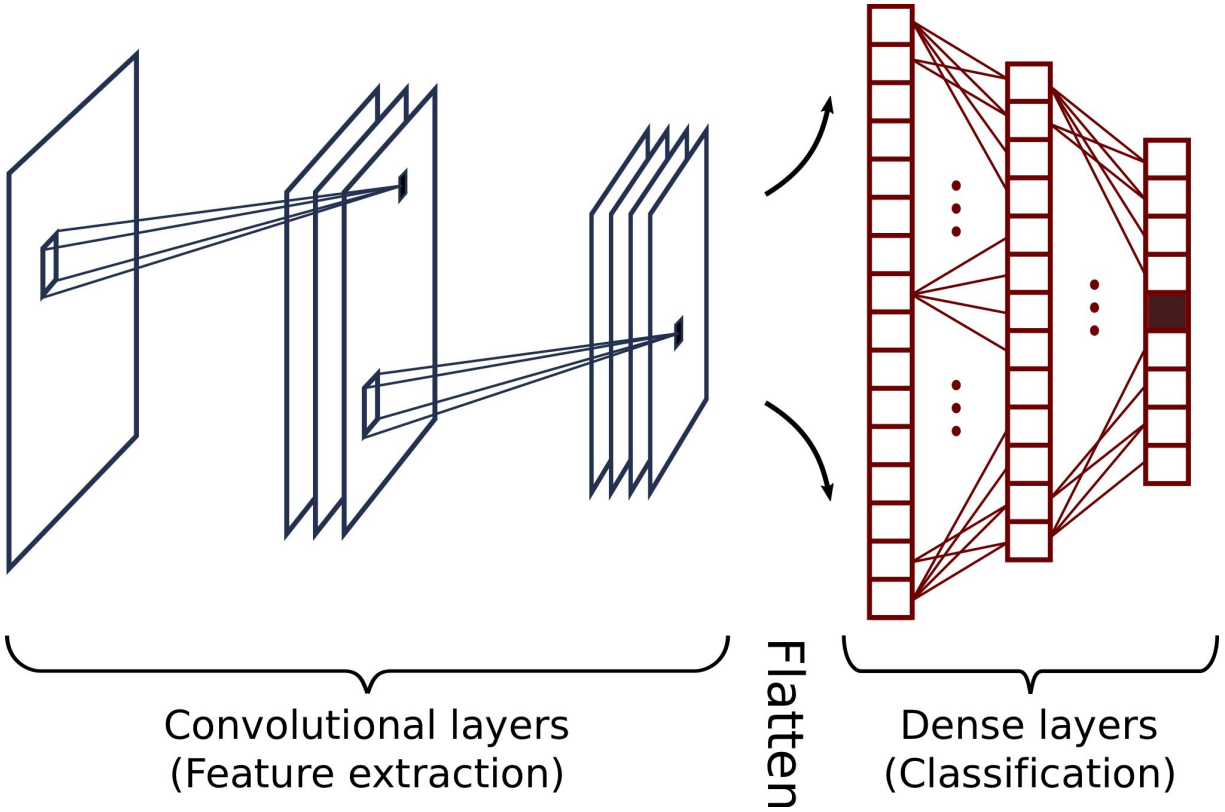
Sometimes done using a form of convolutional neural network.

(A related task is “instance segmentation,” which categorizes each pixel *and* distinguishes between objects within each category.)

Images from fast.ai notebook at:
https://github.com/fastai/course-v3/blob/master/nbs/dl1/lesson3-camvid.ipynb

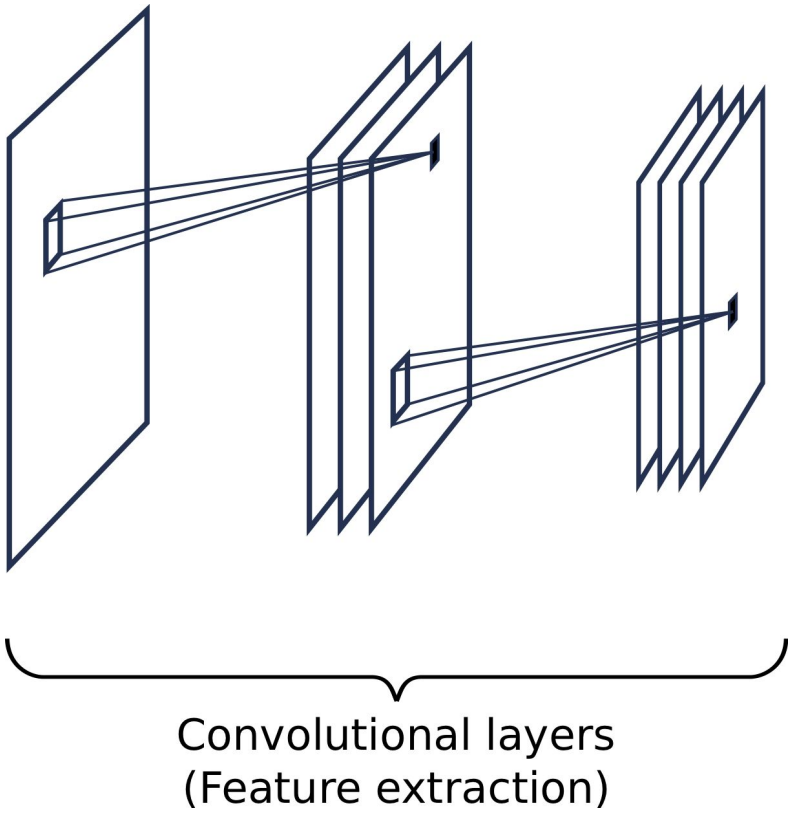
Convolutional Neural Network (CNN)

First,
a review of
CNNs for
image
classification



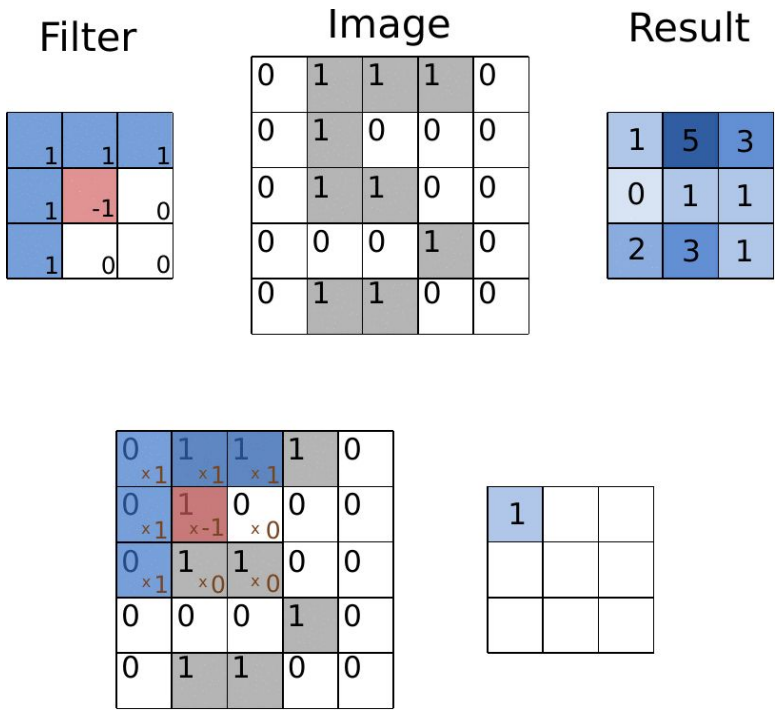
Convolutional Neural Network (CNN)

A convolutional neural network is made up (in part) of convolutional layers.



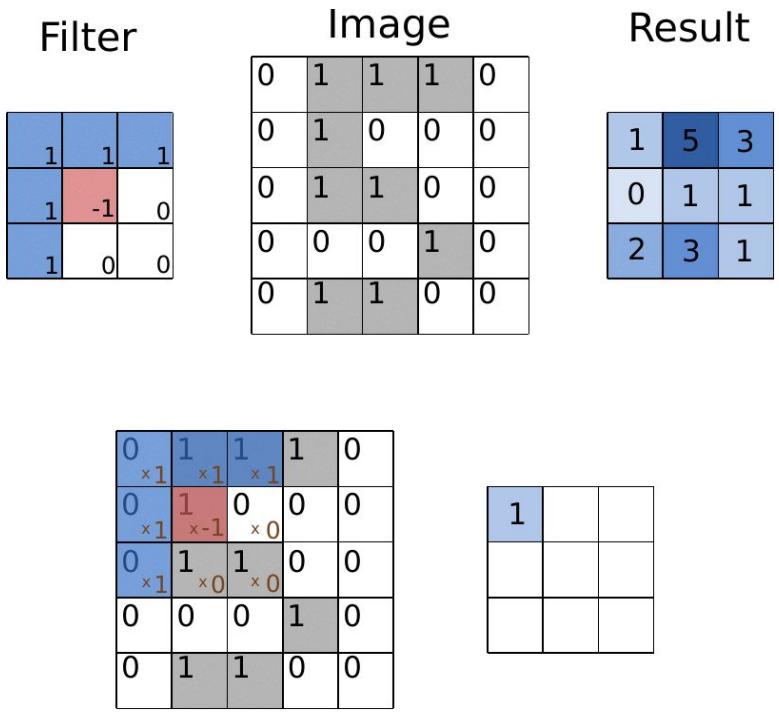
Convolutional Neural Network (CNN)

In a convolutional layer, a set of “filters” scan across the input image (or across the output of a previous layer).



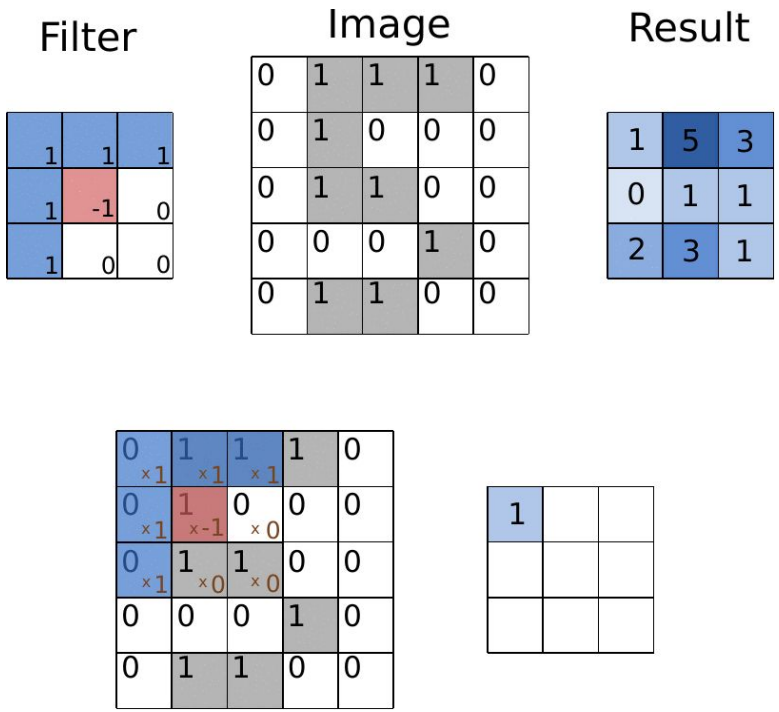
Convolutional Neural Network (CNN)

Filters correspond to visual features in the image (e.g. corners, diagonal lines, etc.)



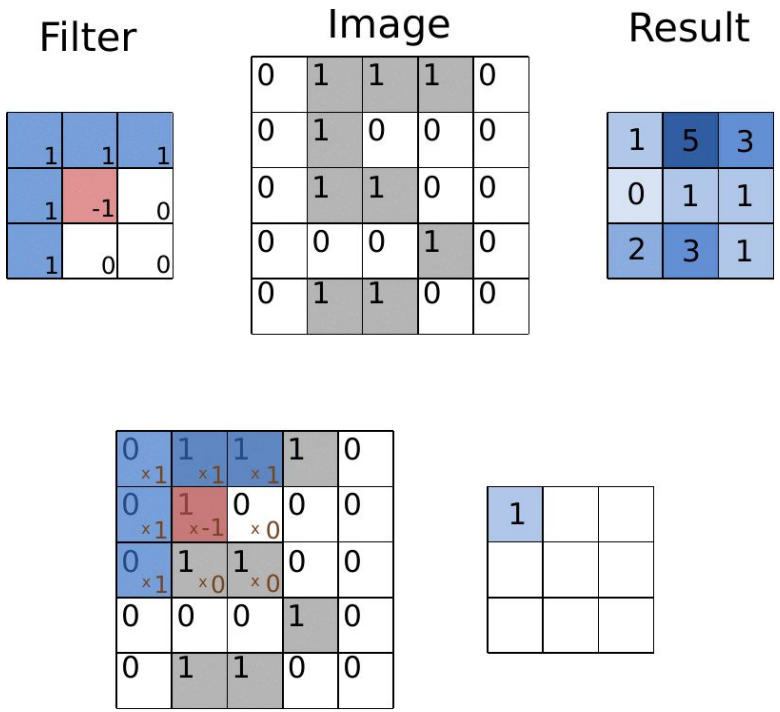
Convolutional Neural Network (CNN)

A high value shows a good match between the filter and the image at that location.



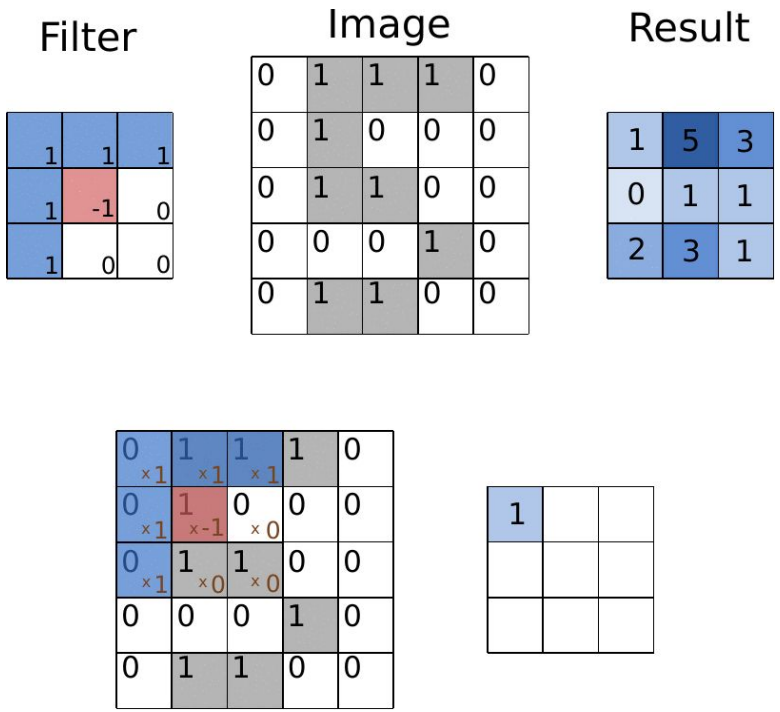
Convolutional Neural Network (CNN)

Convolutional layers can be “stacked” to capture more complex data.



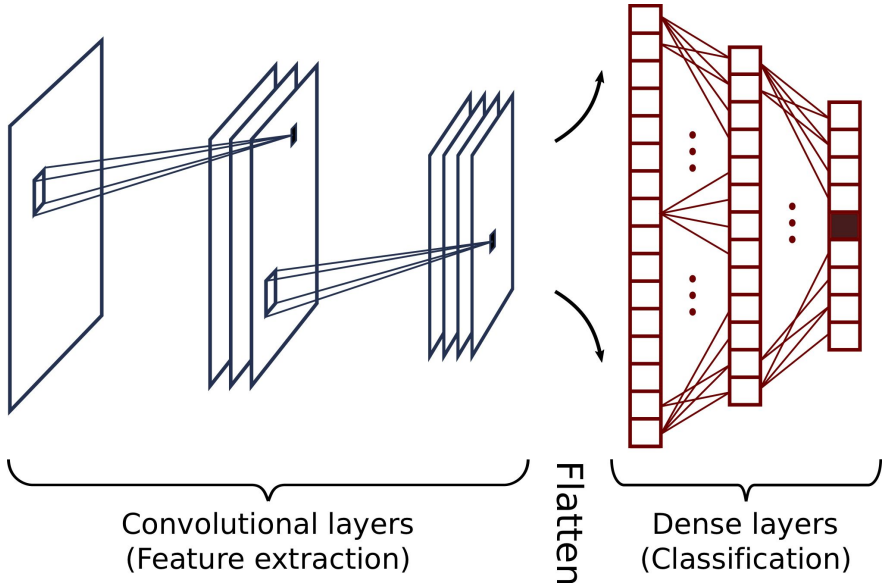
Convolutional Neural Network (CNN)

The filters are trained to pick out the most relevant features.



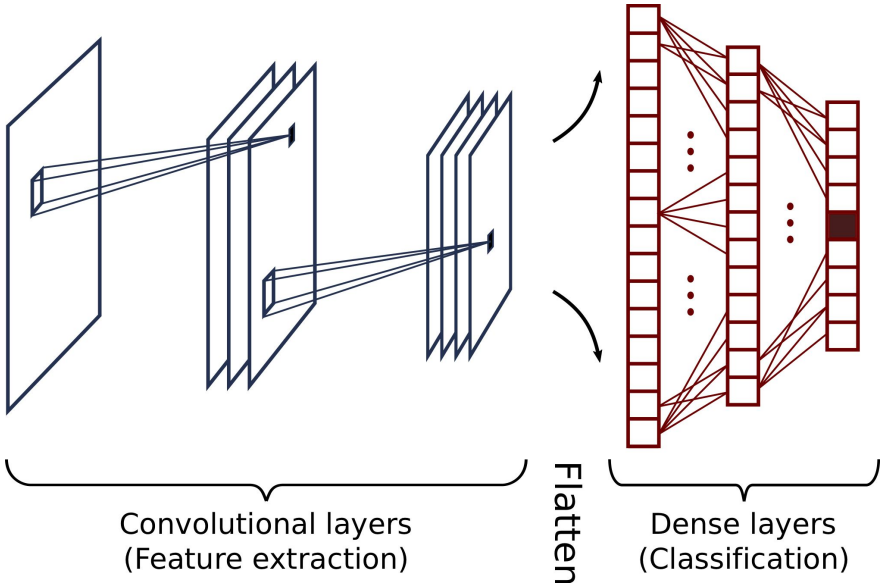
Convolutional Neural Network (CNN)

Those features can be flattened into a single 1D vector, and fed into the dense layers for classification.



Convolutional Neural Network (CNN)

(See our other workshop on Deep Learning to understand more about CNNs: https://github.com/greght/Workshop-Keras-DNN)



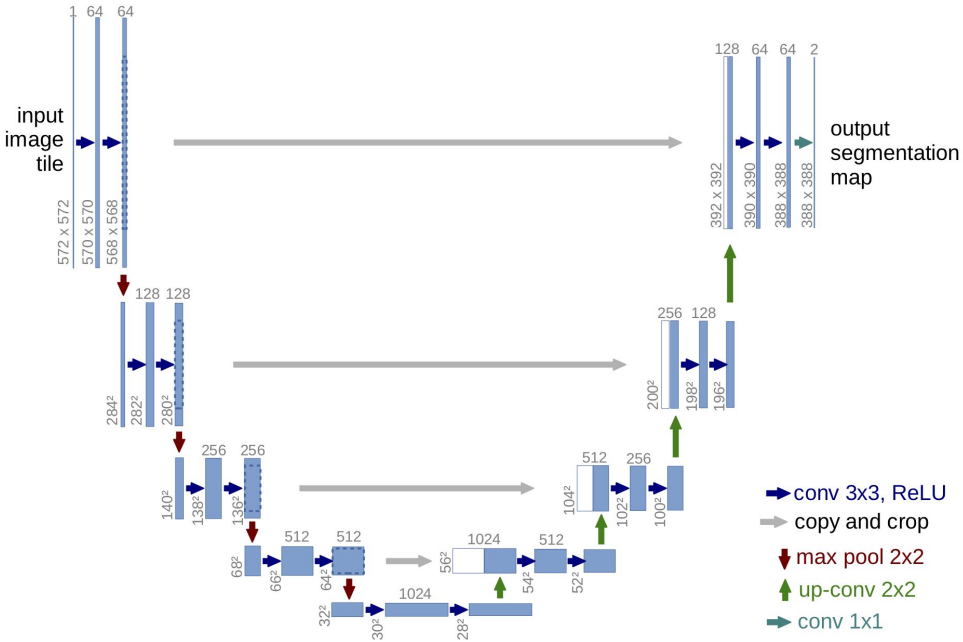
U-Net

U-Net: Convolutional Networks for Biomedical Image Segmentation

(2015)

Olaf Ronneberger, Philipp Fischer, Thomas Brox

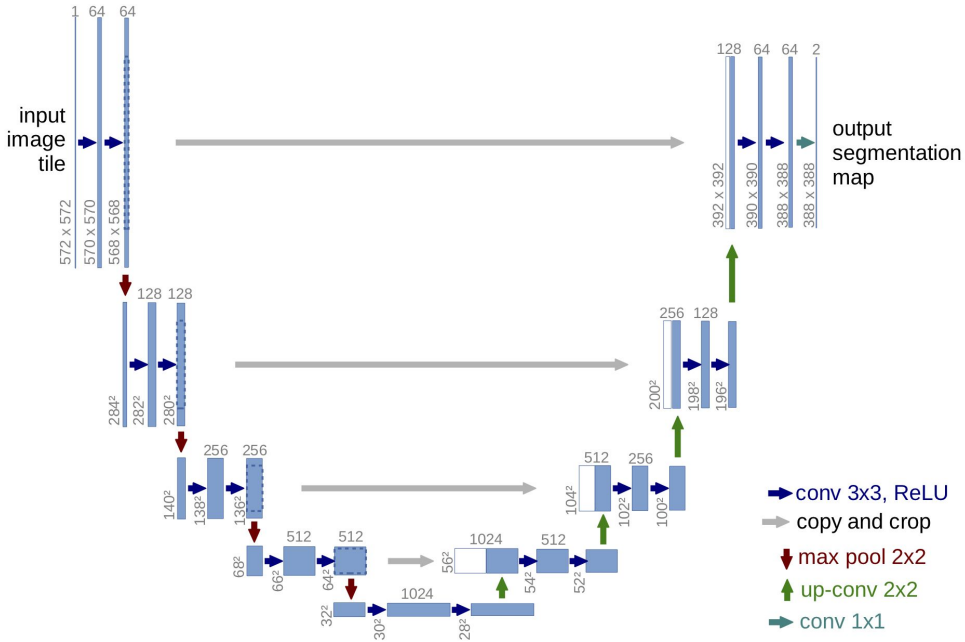
https://arxiv.org/abs/1505.04597



(Schematic from paper)

U-Net

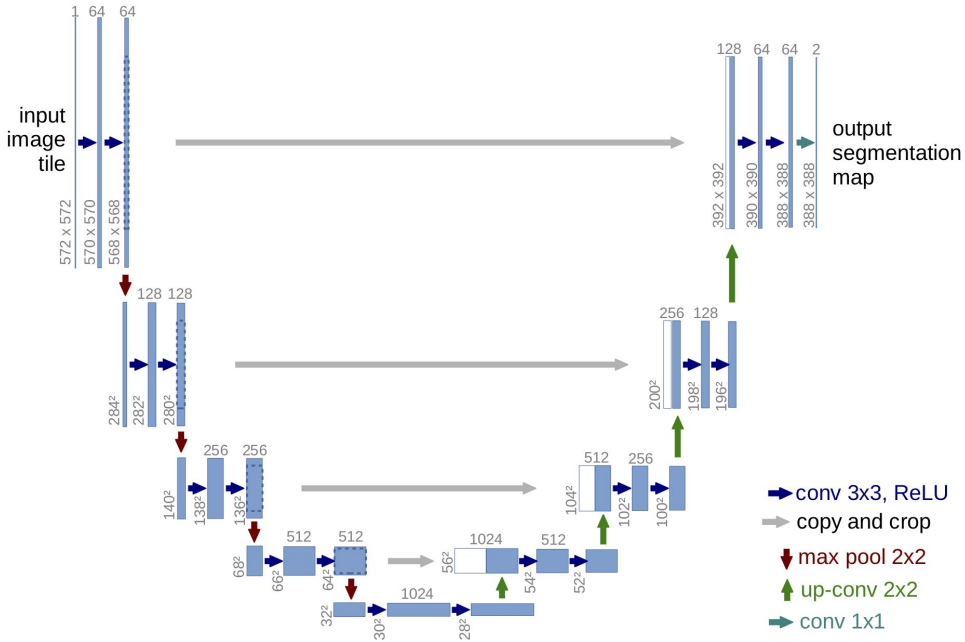
U-Net allows classification of *each pixel* (instead of each image) using convolutional layers.



(Schematic from paper)

U-Net

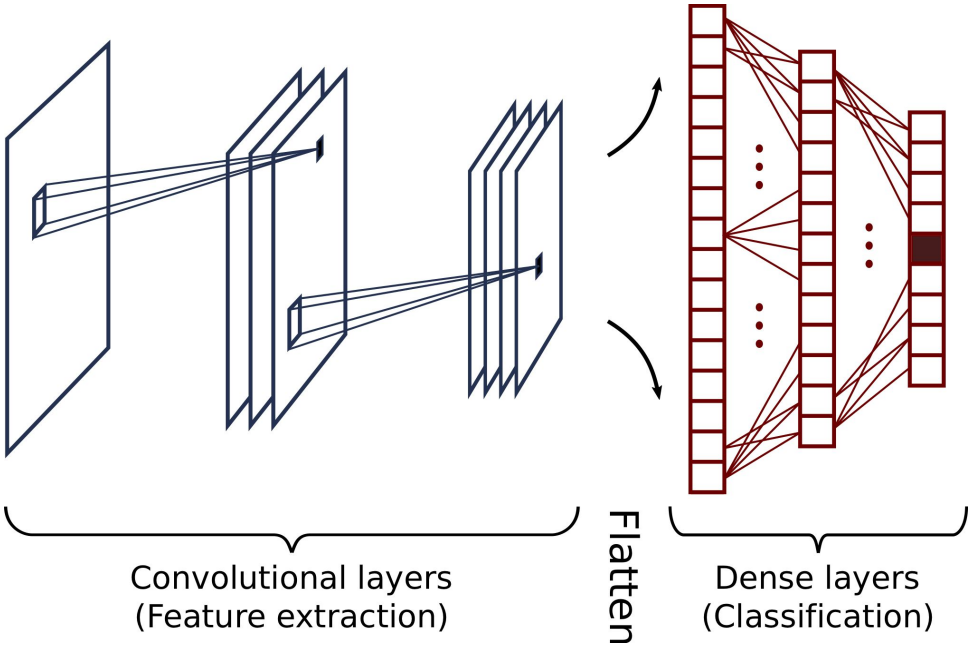
"The architecture consists of a contracting path to capture context and a symmetric expanding path that enables precise localization" (paper abstract, color added)



(Schematic from paper)

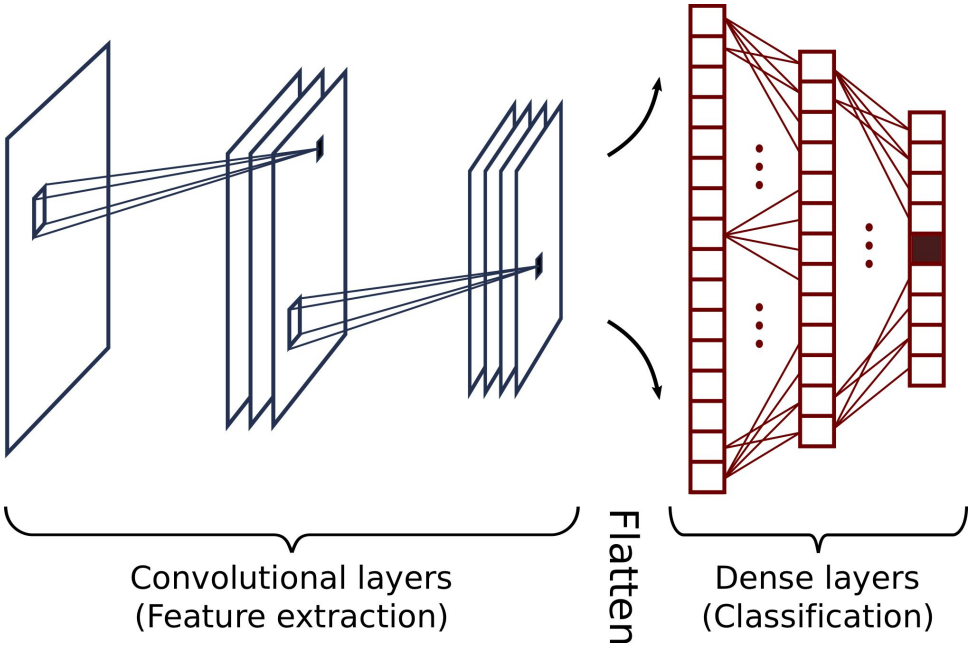
Transfer learning

Transfer learning can speed up the training process by applying “knowledge” learned by a different neural network to a new training set.



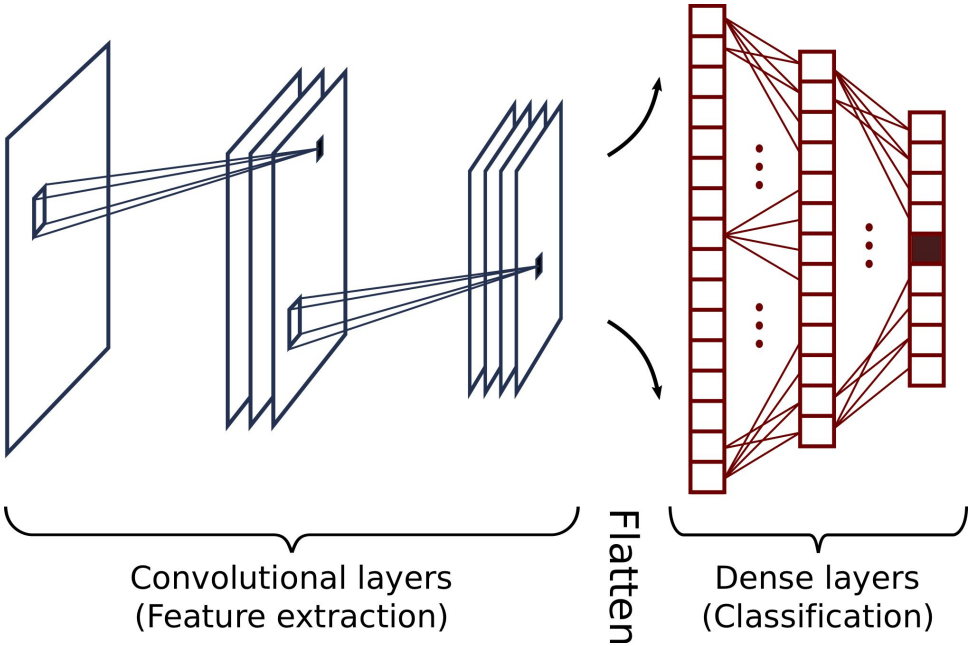
Transfer learning

Take the trained *filters* from a network trained on a different training set (convolutional layers).



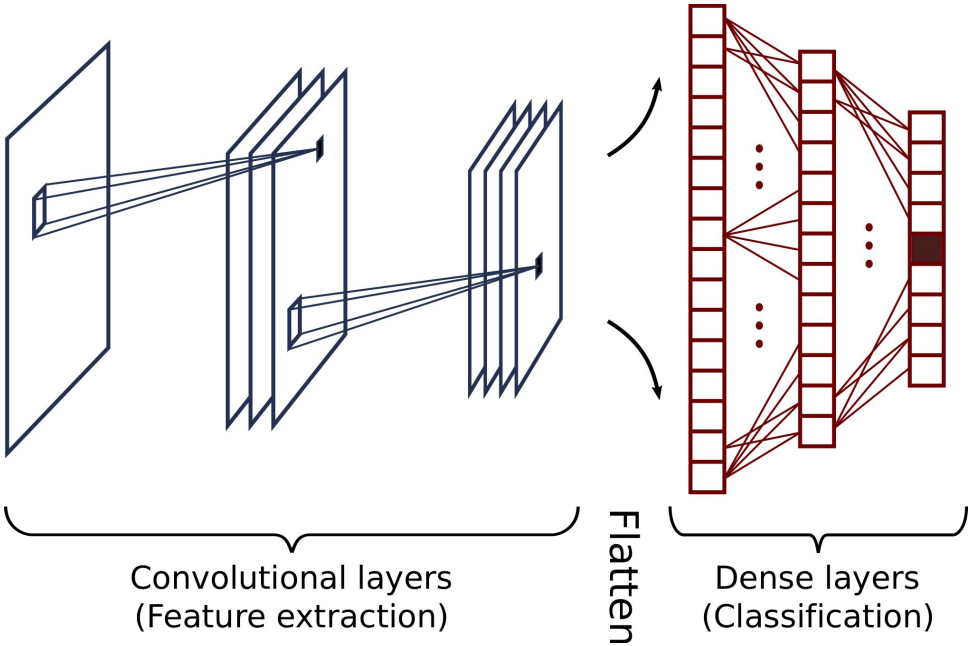
Transfer learning

Freeze the values of the filters while performing training on the weights for the final, classification layers.



Transfer learning

Once can then *unfreeze* the filters if fine-tuning is desired. Usually a very small learning rate is used.



fast.ai (built on PyTorch)

“Deep learning is transforming the world. We are making deep learning easier to use and getting more people from all backgrounds involved through our:

- free courses for coders
- software library
- cutting-edge research
- community

“The world needs everyone involved with AI, no matter how unlikely your background.”

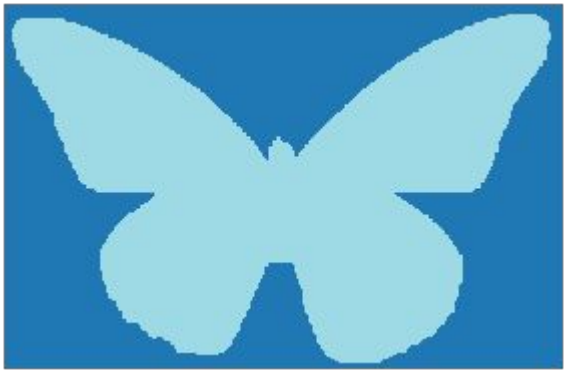
(from the fast.ai website)

Mask Creation

There are a range of mask creation tools that can be used.

We will use Matlab.

(Go to https://midesktop.umich.edu/)



Images from http://www.josiahwang.com/dataset/leedsbutterfly/
Josiah Wang, Katja Markert, and Mark Everingham
Learning Models for Object Recognition from Natural Language Descriptions
In *Proceedings of the 20th British Machine Vision Conference* (BMVC2009)

Fast.ai code example

https://colab.research.google.com/github/greght/Workshop-FastAi-Segmentation/blob/main/ImageSegmentation_fastAI_v1.ipynb