Convolutional Neural network

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Summer School – FIT@HCMUS

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Outline

- ❑ Convolutional neural network
- ❑ Practice with Google Colab

Problems in computer vision

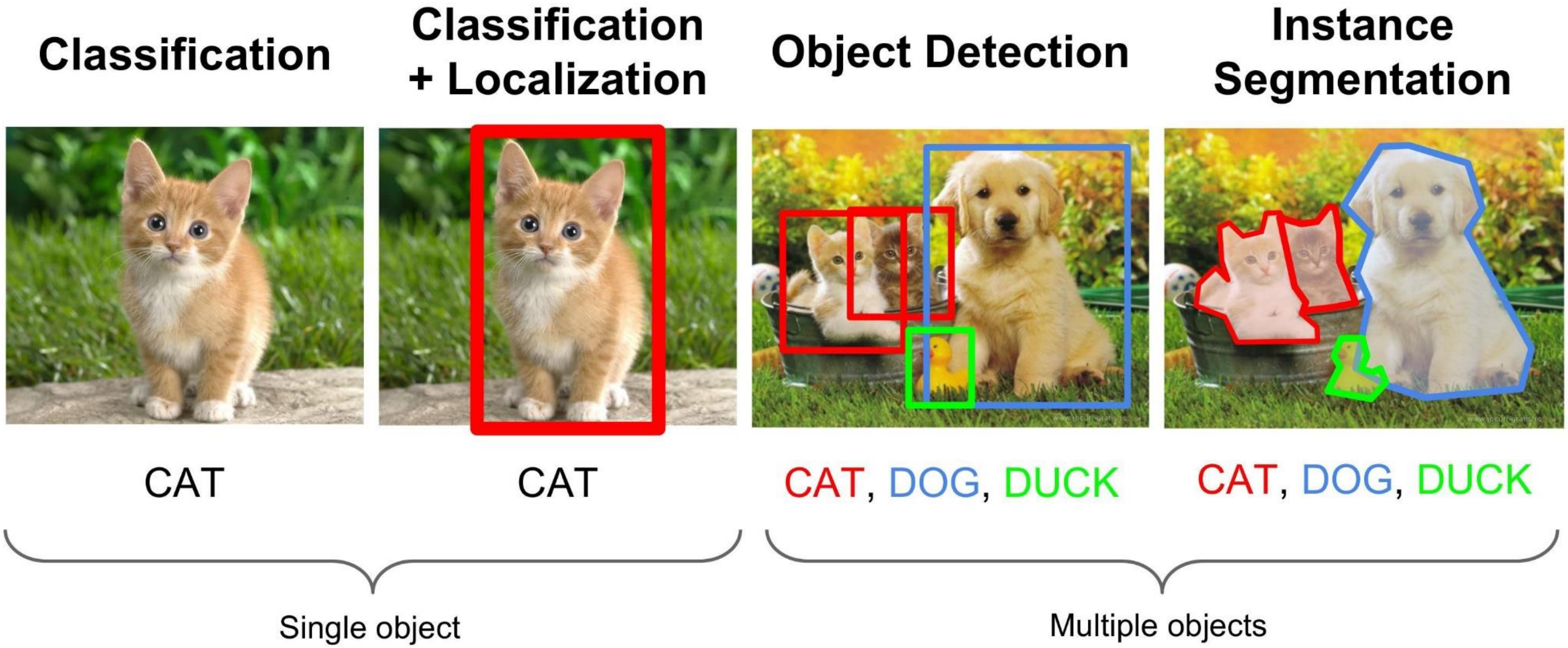
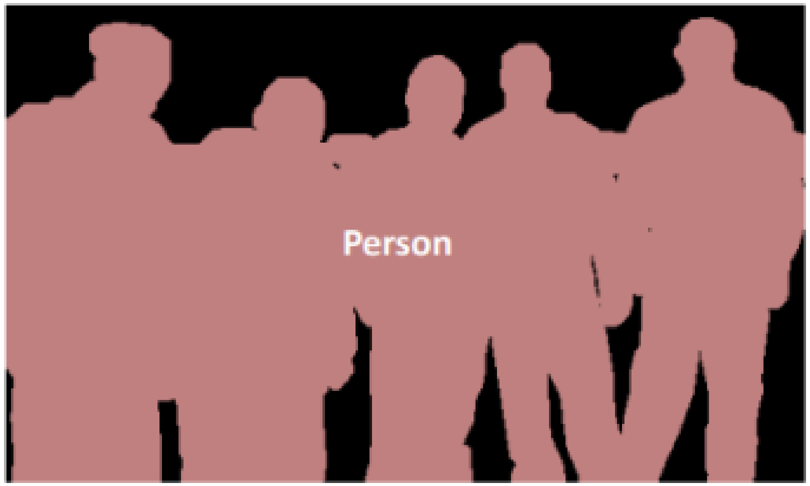
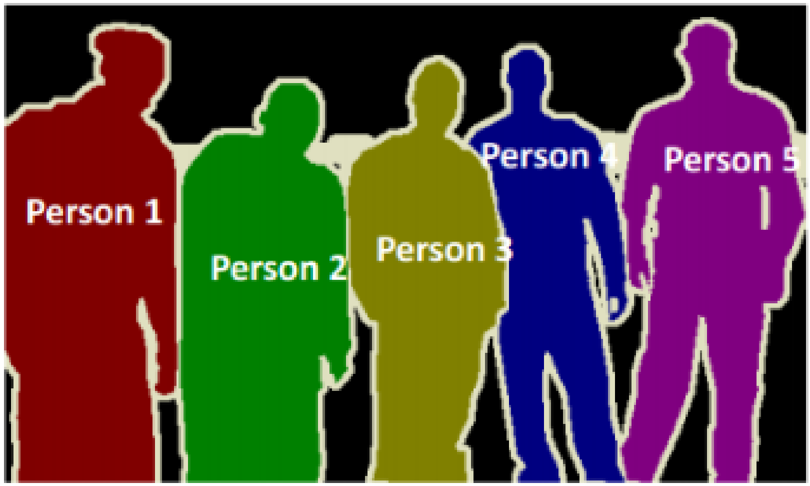


Image segmentation



Semantic Segmentation



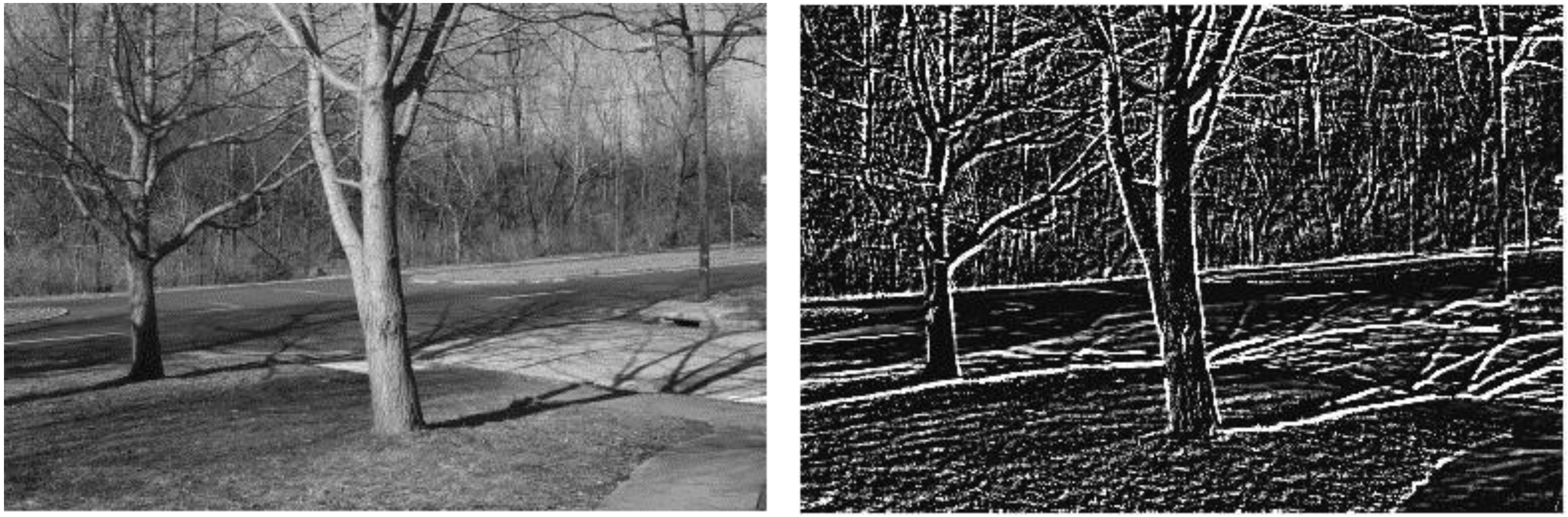
Instance Segmentation

Segmentation techniques

- ❑ The pixel values will be different for the objects and the image's background → **Threshold Segmentation**
- ❑ **Edge Detection Segmentation -** There is always an edge between two adjacent regions with different grayscale values.
- ❑ **Image Segmentation based on Clustering**

Convolutional neural network

- High resolution images contains O(millions) of pixels
- A neural network which can handle that kind of images would also have O(millions) of weight



Convolutional filter

Convolutional neural network

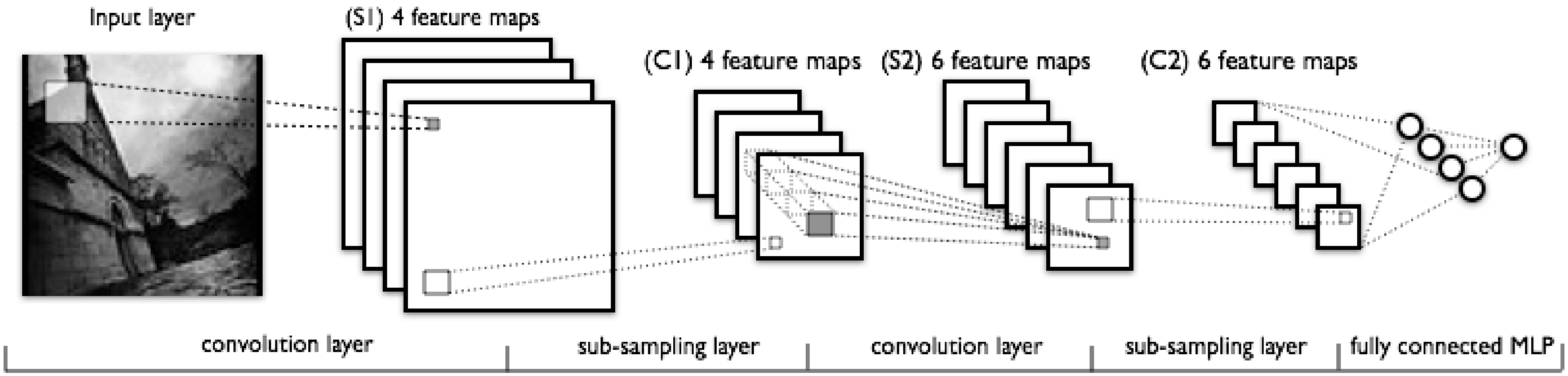
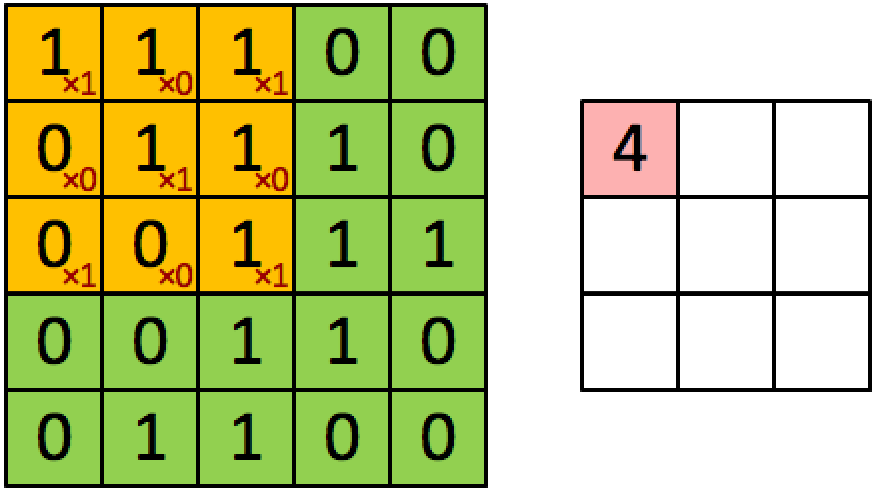


Illustration: Theano documentation

This kind of architecture will learn filters and build an internal representation of the input data using many stacked layers and finally use this representation on a classification task.

Convolutional neural network

- Filters



1 ×1	1 ×0	1 ×1	0	0
0 ×0	1 ×1	1 ×0	1	0
0 ×1	0 ×0	1 ×1	1	1
0	0	1	1	0
0	1	1	0	0

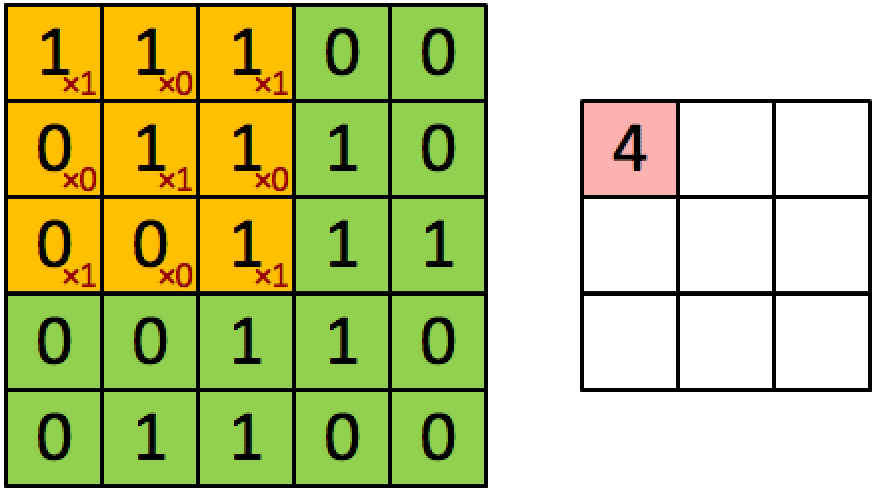
Image

4		

Convolved Feature

Convolutional neural network

- ❑ Filters



$1_{\times 1}$	$1_{\times 0}$	$1_{\times 1}$	0	0
$0_{\times 0}$	$1_{\times 1}$	$1_{\times 0}$	1	0
$0_{\times 1}$	$0_{\times 0}$	$1_{\times 1}$	1	1
0	0	1	1	0
0	1	1	0	0

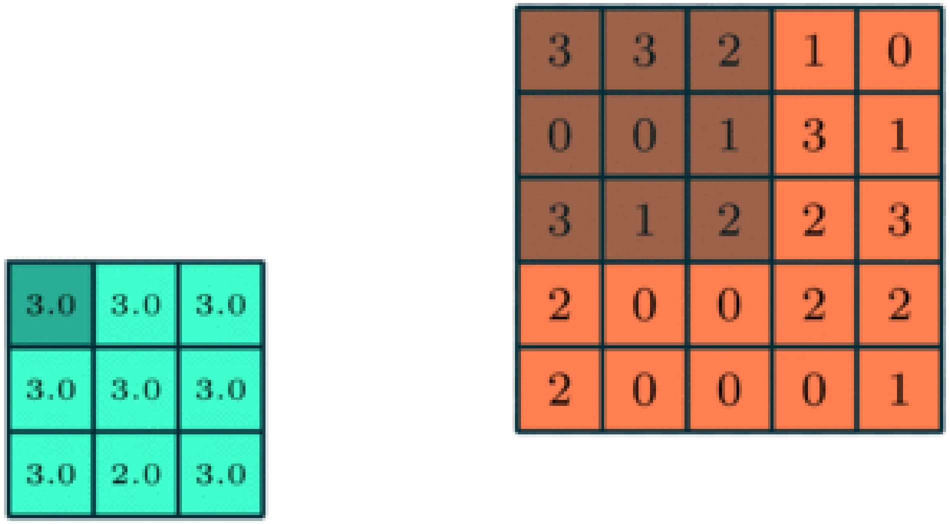
Image

4		

Convolved Feature

Convolutional neural network

- Pooling (Ma trận con)

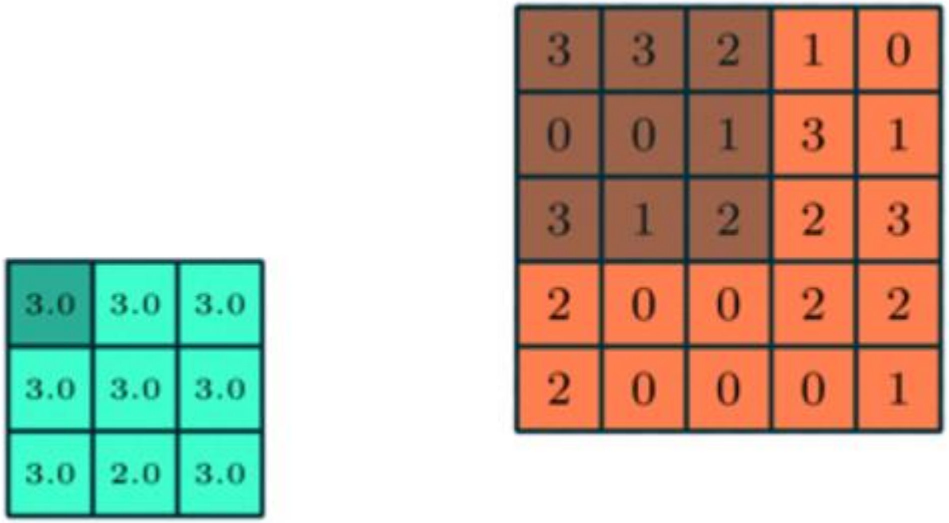


3.0	3.0	3.0
3.0	3.0	3.0
3.0	2.0	3.0

3	3	2	1	0
0	0	1	3	1
3	1	2	2	3
2	0	0	2	2
2	0	0	0	1

Convolutional neural network

- Pooling

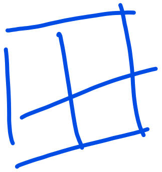


3.0	3.0	3.0
3.0	3.0	3.0
3.0	2.0	3.0

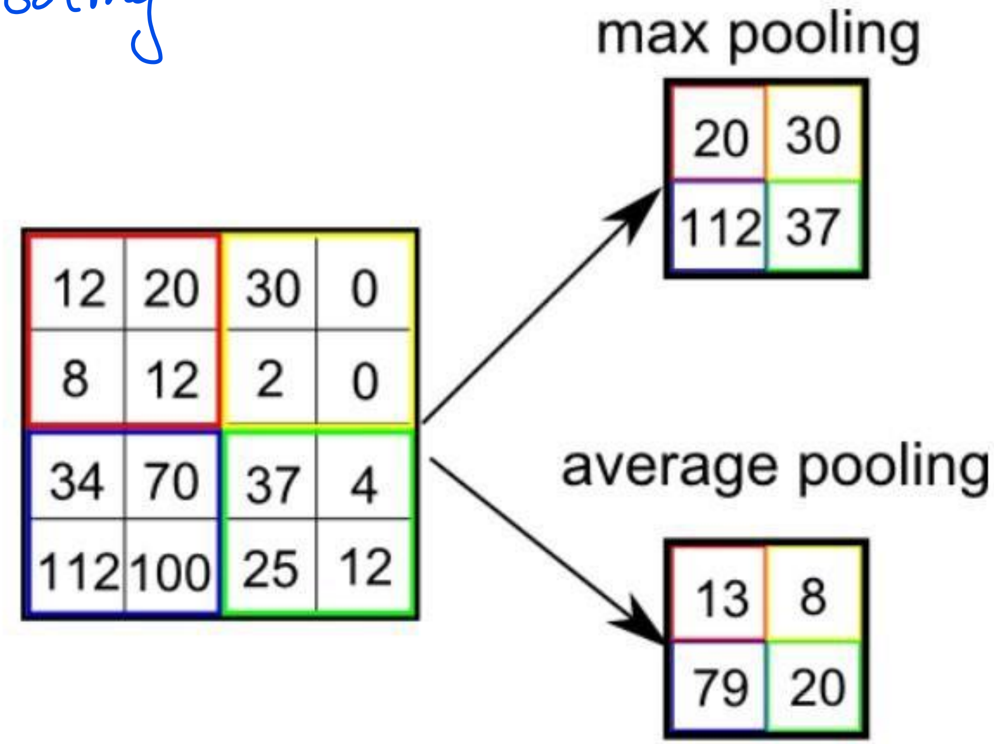
3	3	2	1	0
0	0	1	3	1
3	1	2	2	3
2	0	0	2	2
2	0	0	0	1

Convolutional neural network

- Max pooling vs Average pooling



→ pooling



12	20	30	0
8	12	2	0
34	70	37	4
112	100	25	12

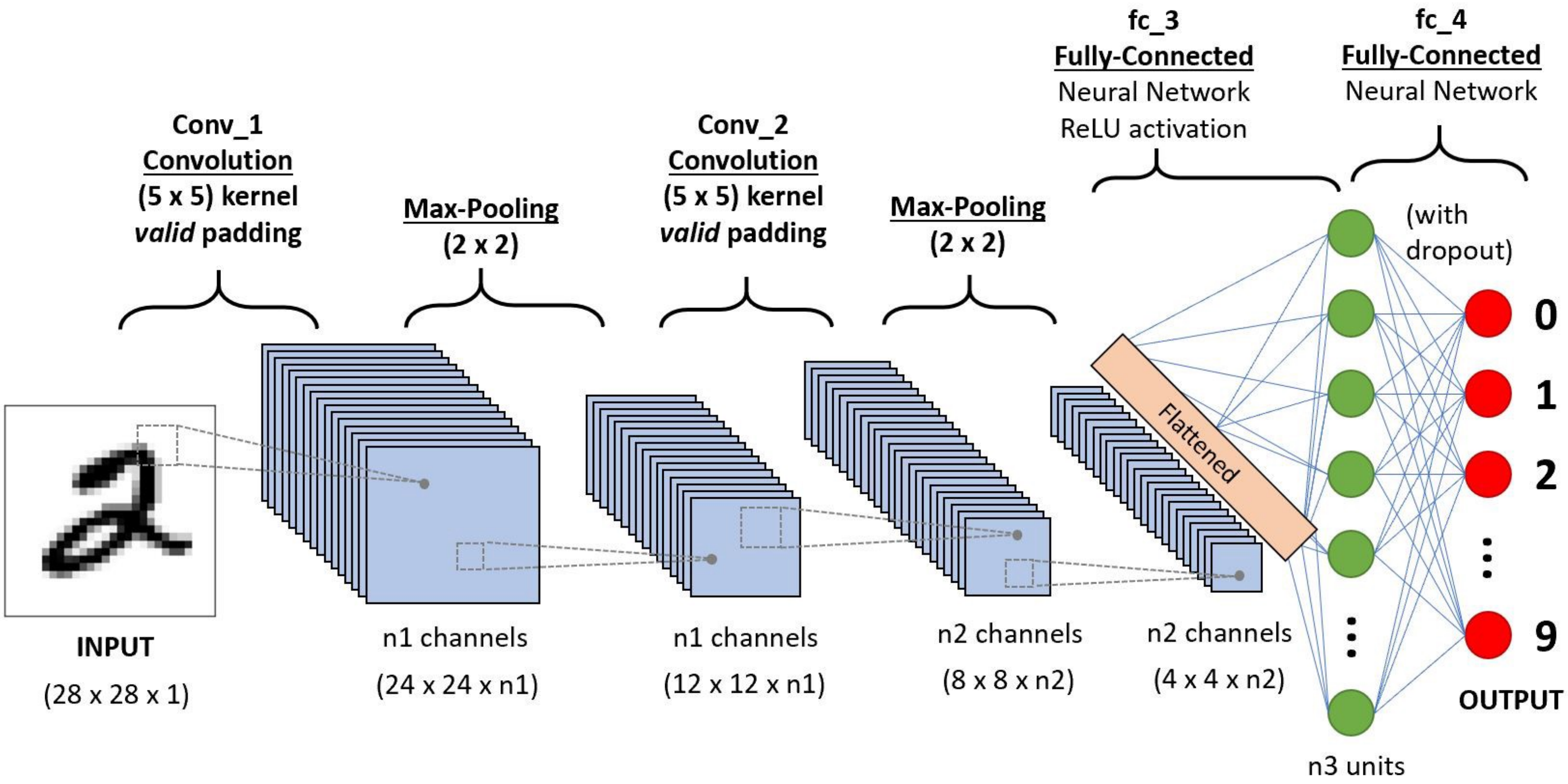
max pooling

20	30
112	37

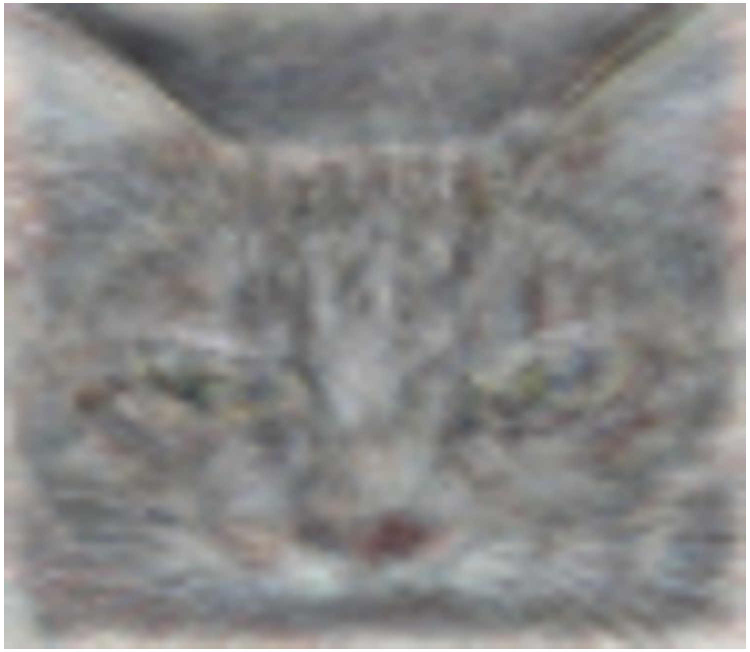
average pooling

13	8
79	20

Convolutional neural network

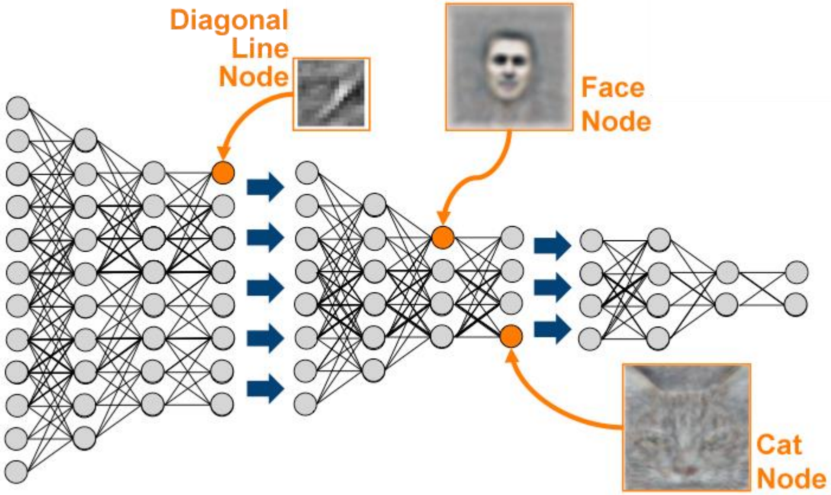


Learn high level features of a cat



"Best neuron" activation heat map

- ❑ Training: 16.000 CPU during 3 days
- ❑ Learned high levels features of cats, human faces by watching Youtube videos
- ❑ Totally unsupervised : unlabeled data



High level feature learning

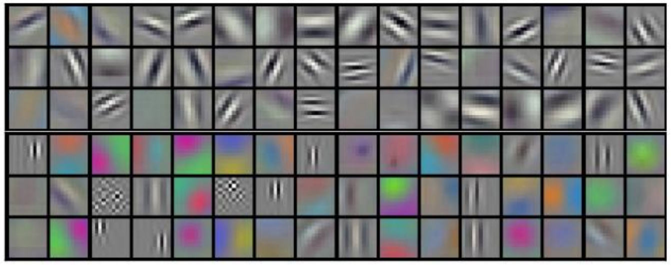
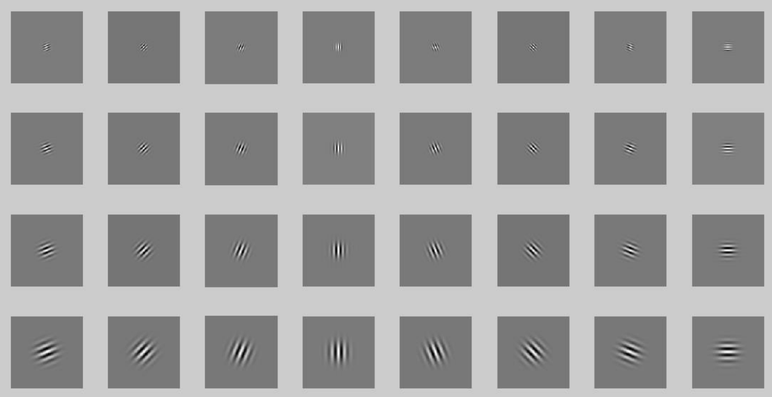


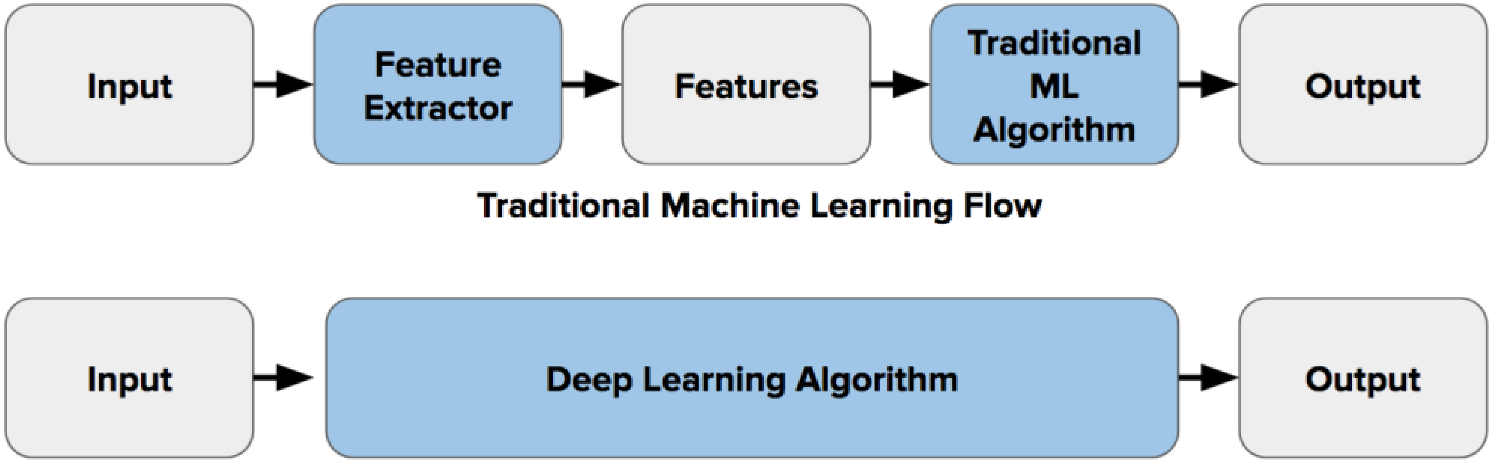
Figure 3: 96 convolutional kernels of size 11×11×3 learned by the first convolutional layer on the 224×224×3 input images. The top 48 kernels were learned on GPU 1 while the bottom 48 kernels were learned on GPU 2. See Section 6.1 for details.

The model learns some edge detection filter. We find a similar process in the cells of the primary visual cortex of the human brain

Edge detectors filters :



Traditional ML vs Deep learning



Traditional Machine Learning Flow

Deep Learning Flow

Practice with Google Colab

https://colab.research.google.com/drive/1UA-wUXx2QziKgZXTDLVo1gn0xImlwj2H

Model evaluation

- Measurements
  - Precision, recall
  - Accuracy
  - F1-score
- Depending on problems, we need some suitable measures

Model evaluation

predict

	P	N
P	TP	FP
N	FN	TN

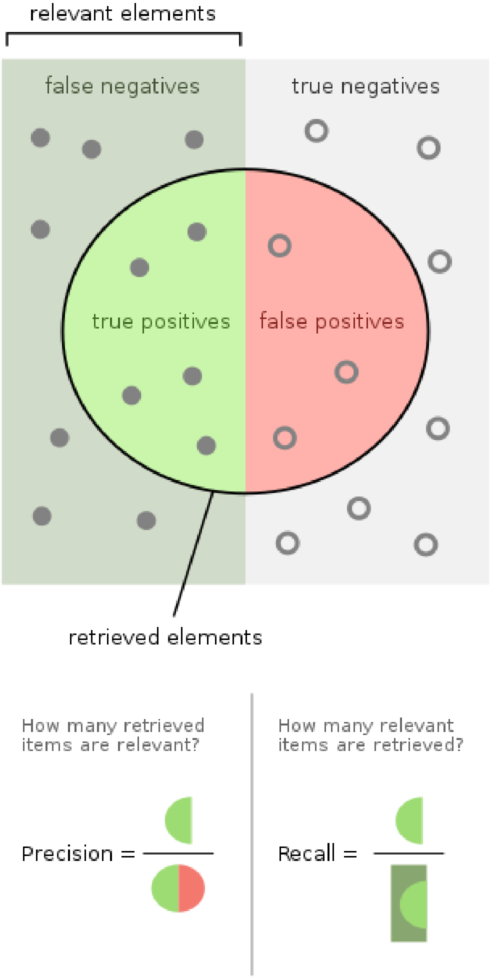
- Precision $= \dfrac{\text{True positive}}{\text{Predicted positive}}$ $= \dfrac{TP}{TP + FP}$

- Recall $= \dfrac{\text{True positive}}{\text{Positive}}$ $= \dfrac{TP}{TP + FN}$

- F1 – score $= \dfrac{2 \text{ x Precision x Recall}}{\text{Precision +Recall}}$

- Accuracy $= \dfrac{\text{True positive + True negative}}{\text{Positive + Negative}}$

$= \dfrac{TP + TN}{TP + FN +}$

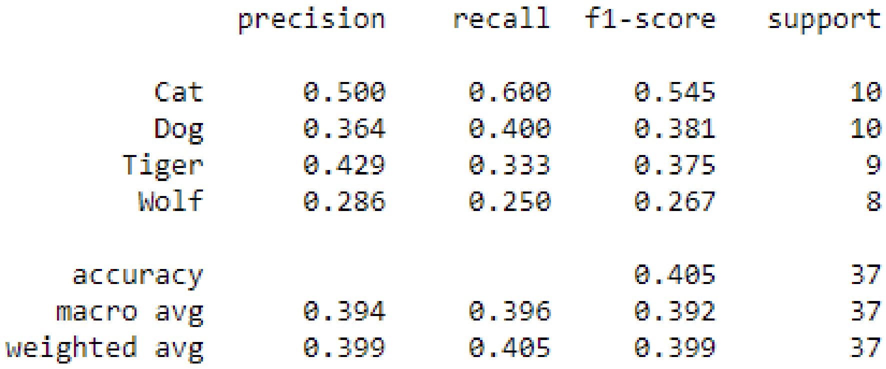


Source: Wikipedia

Confusion matrix

		Predicted				Total
		Cat	Dog	Tiger	Wolf	
Actual	Cat	**6**	0	3	1	10
	Dog	2	**4**	0	4	10
	Tiger	3	3	**3**	0	9
	Wolf	1	4	1	**2**	8
Total		12	11	7	7	

```
>>> sklearn.metrics.classification_report
>>> y_true =  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, …]
>>> y_pred = [0, 0, 0, 0, 0, 0, 2, 2, 2, 3, …]
>>> target_names = [‘Cat', ‘Dog', ‘Tiger’, ‘Wolf’]
```



```
              precision    recall  f1-score   support

         Cat      0.500     0.600     0.545        10
         Dog      0.364     0.400     0.381        10
       Tiger      0.429     0.333     0.375         9
        Wolf      0.286     0.250     0.267         8

    accuracy                          0.405        37
   macro avg      0.394     0.396     0.392        37
weighted avg      0.399     0.405     0.399        37
```

Thank you for your attention