

# Digital Image Processing in Python

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<https://github.com/alonyan/DIP>

# Workshop goals

The workshop is an introduction to digital image processing, designed to give you a taste of what's possible with a specific emphasis on microscopy data.

By the end of the workshop, you should:

- Acquire basic understanding and familiarity with computer vision.
- Appreciate the importance of rigorous and systematic image analysis for reproducible and quantitative science.

# Computational Image processing

- Image processing is about *extracting* the relevant data from your measurements, but not about analyzing them.

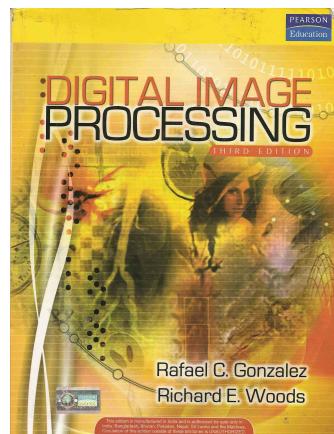


Something  
something  
computers  
...

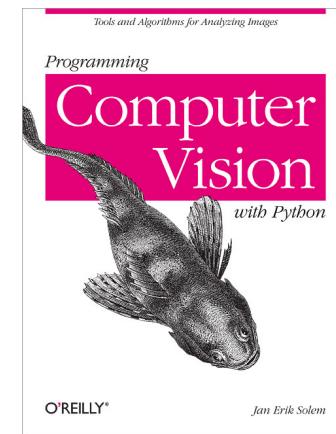
Monkey ID	M/F	size	Coat Color	Attr 1	Attr 2	Attr 3	...
1	F	24	...				
2	F	40					
3	M	87					
4	M	21					
5	F	31					
6	F	24					
7	F	54					

# Other resources

MOOC: <https://www.mooc-list.com/course/image-analysis-methods-biologists-futurelearn>

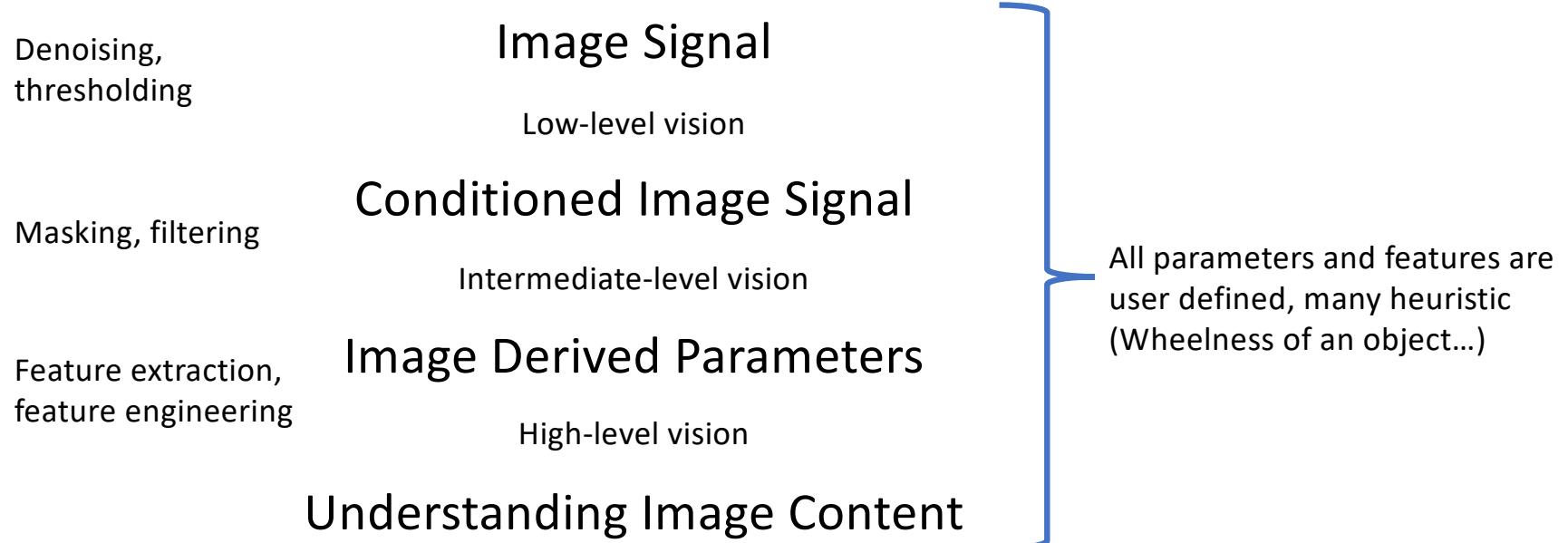


[http://web.ipac.caltech.edu/staff/fmasci/home/astro\\_refs/Digital Image Processing 2ndEd.pdf](http://web.ipac.caltech.edu/staff/fmasci/home/astro_refs/Digital%20Image%20Processing%202ndEd.pdf)



<http://programmingcomputervision.com/>

# Overview of approach



2012 – AlexNet : Breakthrough in computer vision

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## **ImageNet Classification with Deep Convolutional Neural Networks**

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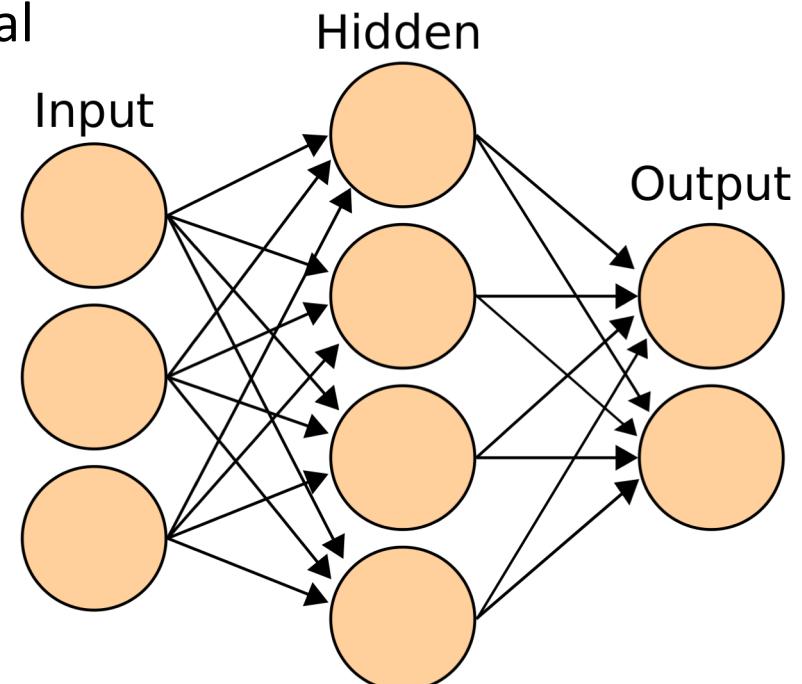
[hinton@cs.utoronto.ca](mailto:hinton@cs.utoronto.ca)

Won ImageNet – a image  
recognition competition by a  
wide margin

Onset of *Deep learning*

# Artificial Neural Networks (ANNs)

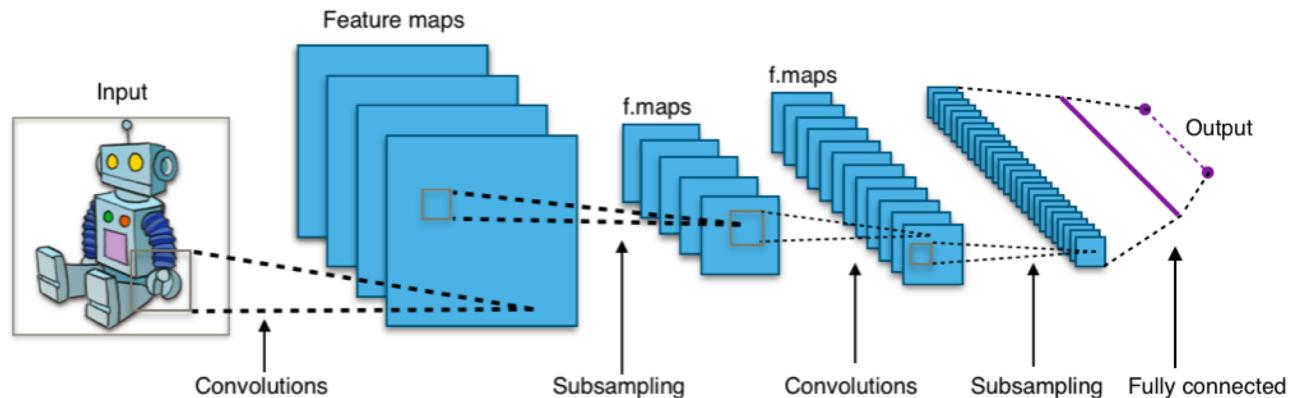
- Inspired by biology, ANNs are computational systems that can **learn** a set of parameters that translate a given input to a desired output.
- ANNs are **trained** by providing large sets of annotated data (training set).
- Ideally, after training, ANNs are capable of using the learned information to interpret new data.



The theory of these has been developed since the 40s  
Was always considered cute but computationally unfeasible

# Convolutional Neural Networks (CNNs)

- CNNs are ANNs that use convolution (e.g. filtering) as part of the network architecture.
- They are particularly useful for computer vision as they are able to learn features over a wide range of scales



# 2012 – AlexNet : Breakthrough in computer vision

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## **ImageNet Classification with Deep Convolutional Neural Networks**

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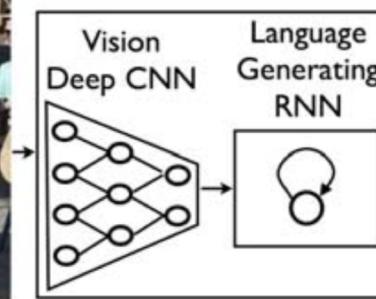
The big breakthrough was computing everything on GPUs, which are  
way more efficient for these tasks.

>47000 citations as of Oct. 2019

\*not technically first, but most influential

# 2014 – From image classification to image description

- Image classification was then extended to the more challenging task of generating descriptions (captions) for images.



**A group of people shopping at an outdoor market.**  
**There are many vegetables at the fruit stand.**

Google, Stanford University

# 2014 – From image classification to image description

- Image classification was then extended to the more challenging task of generating descriptions (captions) for images.



"man in black shirt is playing guitar."



"construction worker in orange safety vest is working on road."



"two young girls are playing with legos toy."

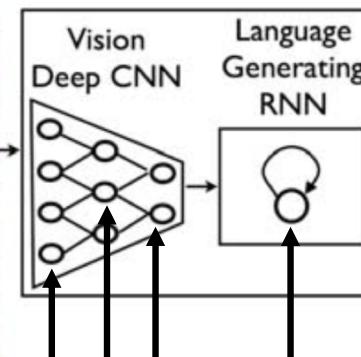


"boy is doing backflip on wakeboard."

Google, Stanford University

# 2014 – From image classification to image description

- Image classification was then extended to the more challenging task of generating descriptions (captions) for images.



**A group of people shopping at an outdoor market.**  
**There are many vegetables at the fruit stand.**

All of these parameters are ***learned*** by the computer during ***training***

Google, Stanford University

# Conceptual differences

Traditional programming:



Logic is predefined by the programmer

Machine learning:



Logic is learned from examples

## Open questions

- **Interpretability** of hidden layers
- **Learning from few examples:** On a large no. of problems, humans learn from very few examples, like hand-writing recognition. Machines require many more examples.

## For more on this

- <https://qcb.ucla.edu/collaboratory-2/workshops/w17-machine-learning-with-python/>
- <https://www.coursera.org/learn/machine-learning>
- <https://www.fast.ai/>
- <https://www.udemy.com/course/advanced-computer-vision/>
- <https://www.udemy.com/course/python-for-computer-vision-with-opencv-and-deep-learning/>
- <https://www.udacity.com/course/deep-learning-nanodegree--nd101>