Applications of Deep Learning in Heliophysics

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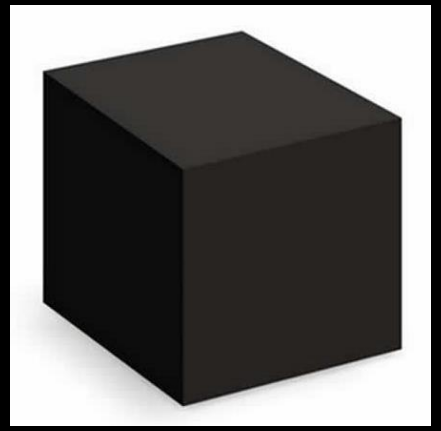
What is deep learning?

What business people think it is

What neophytes think it is

What it really is



What skeptics think it is

What the public thinks it is

A tool that helps us find new things in our data

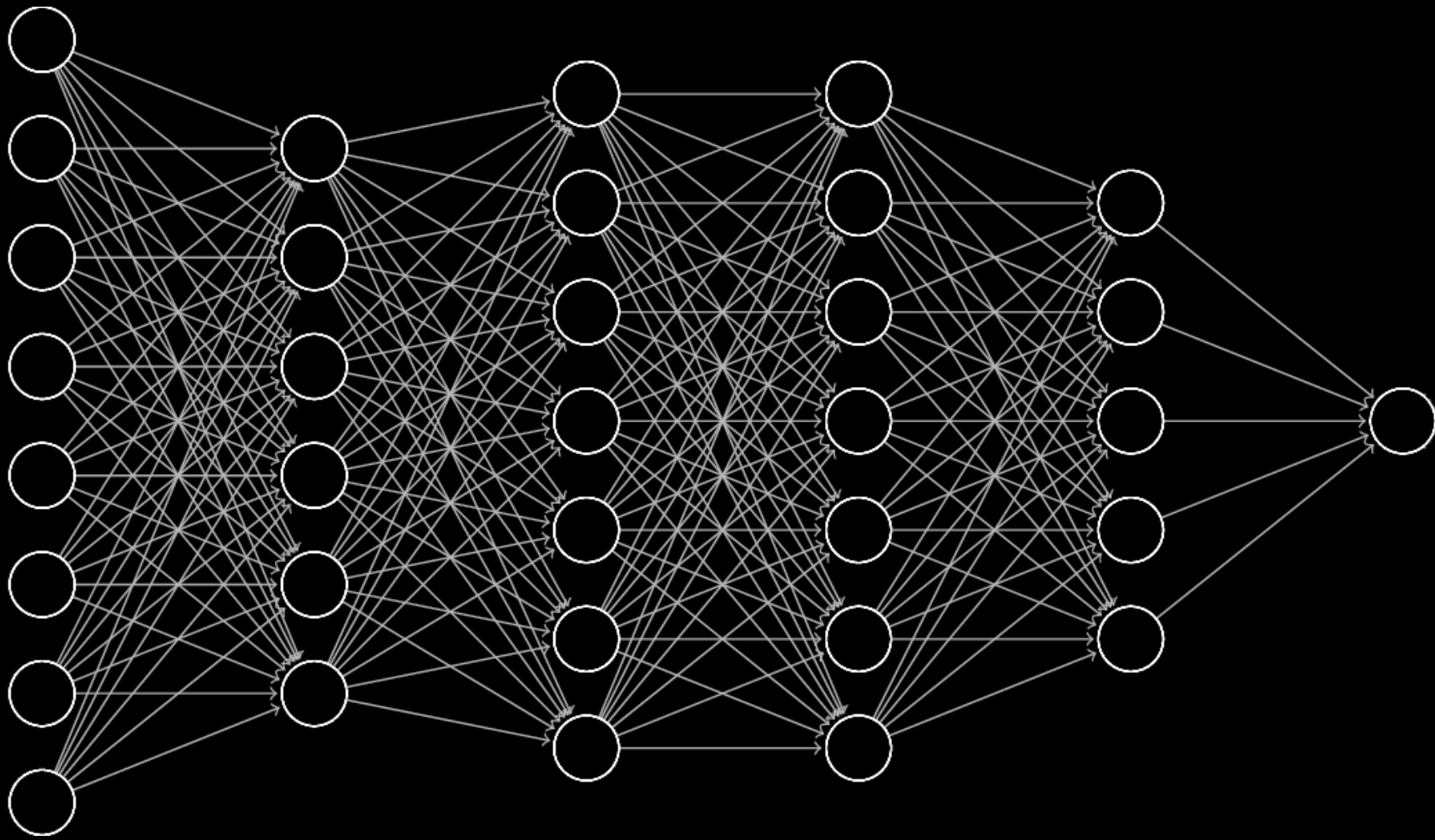
What is deep learning?*

A class of machine learning algorithms that:

- Use a cascade of multiple layers of nonlinear processing units for feature extraction and transformation.
- Learn multiple levels of representations that correspond to different levels of abstraction (i.e. the levels form a hierarchy of concepts).

* Taken from Wikipedia

What is deep learning?*

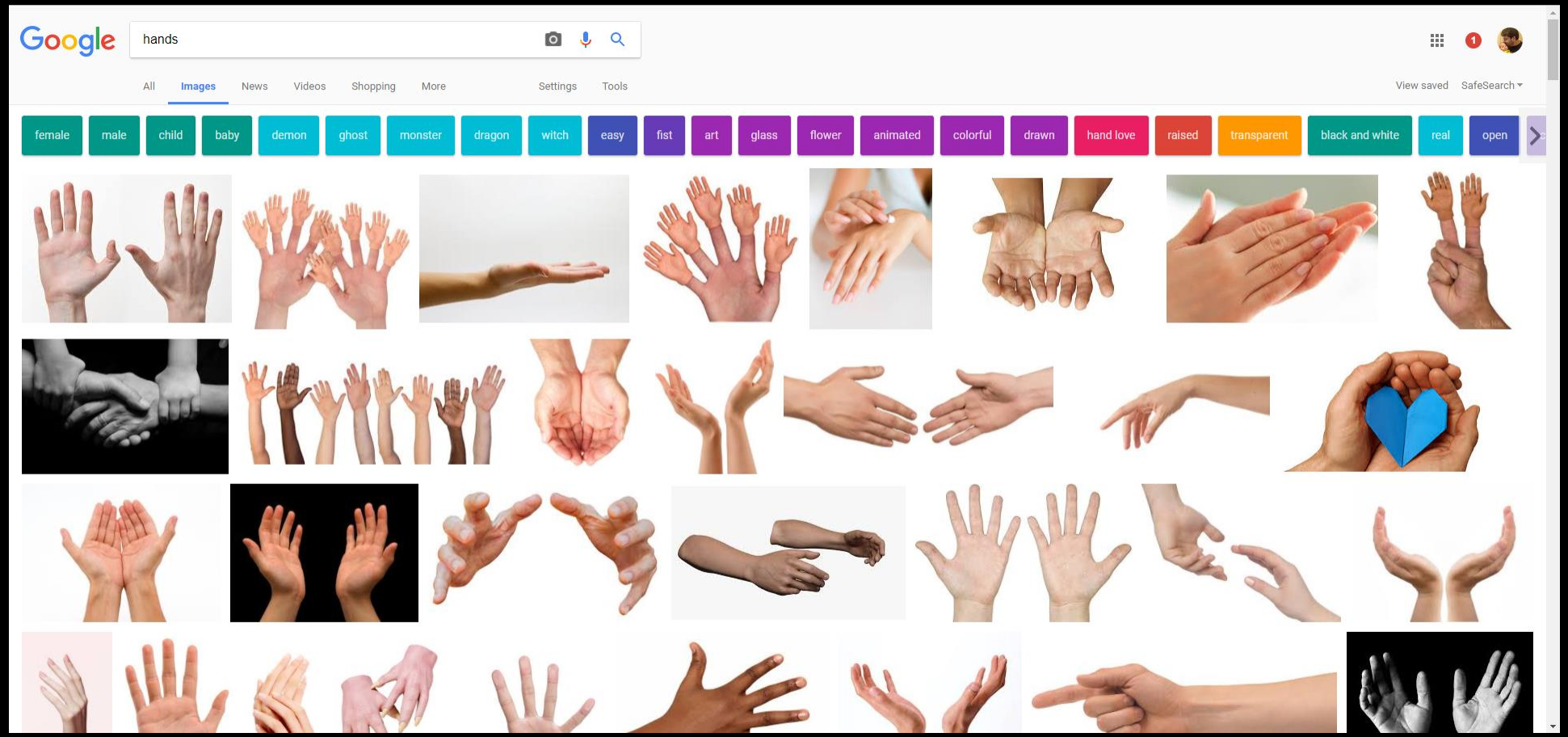


* Taken from Wikipedia

Why deep learning?

Count how many times
the players wearing
white pass the ball

Deep learning has important limitations too

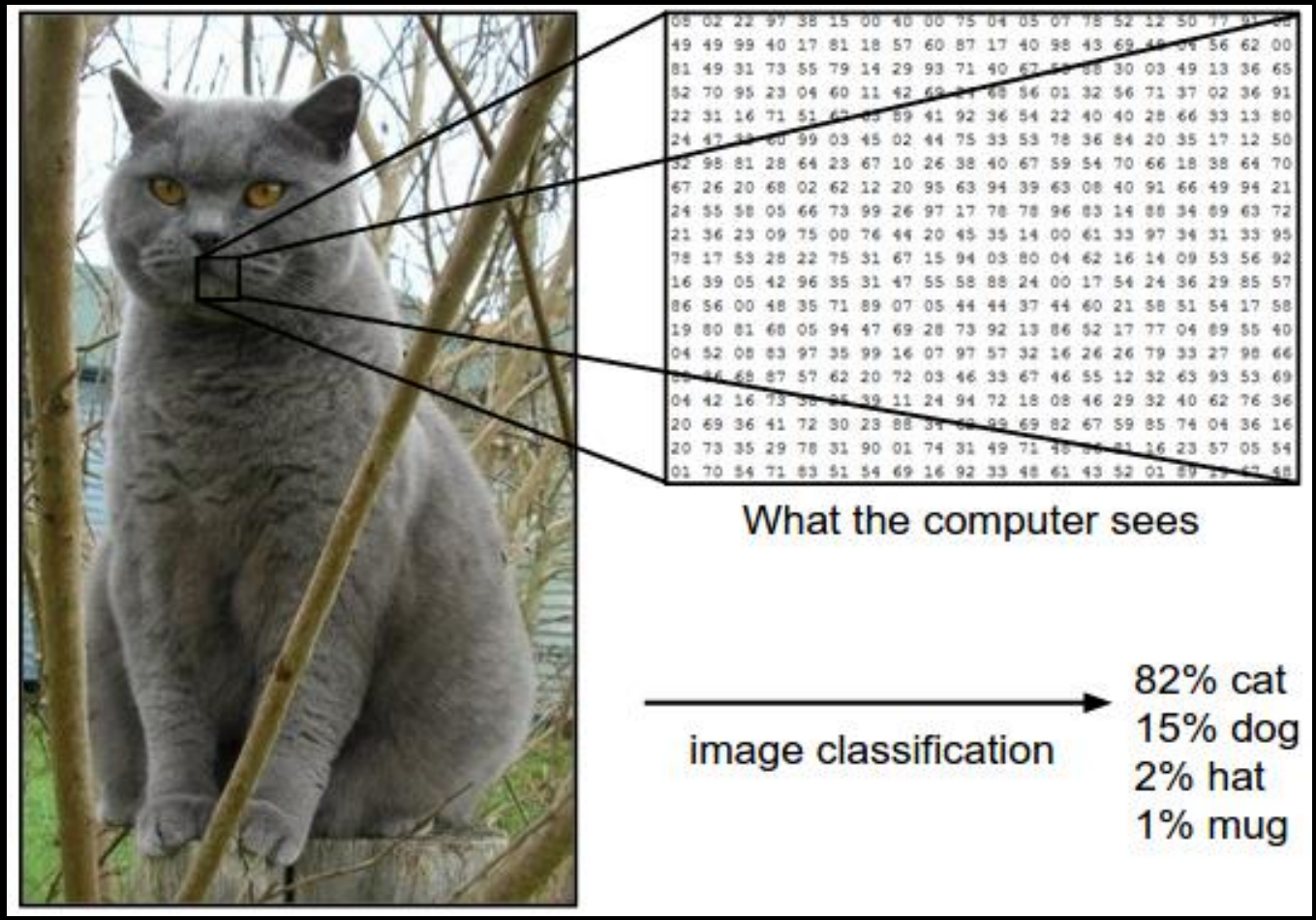


Deep learning has important limitations too

Deep learning has Important limitations too

- Deep learning algorithms are naïve and single-minded in the way they learn.
- Training data selection is absolutely critical for their success.

Deep learning and image data



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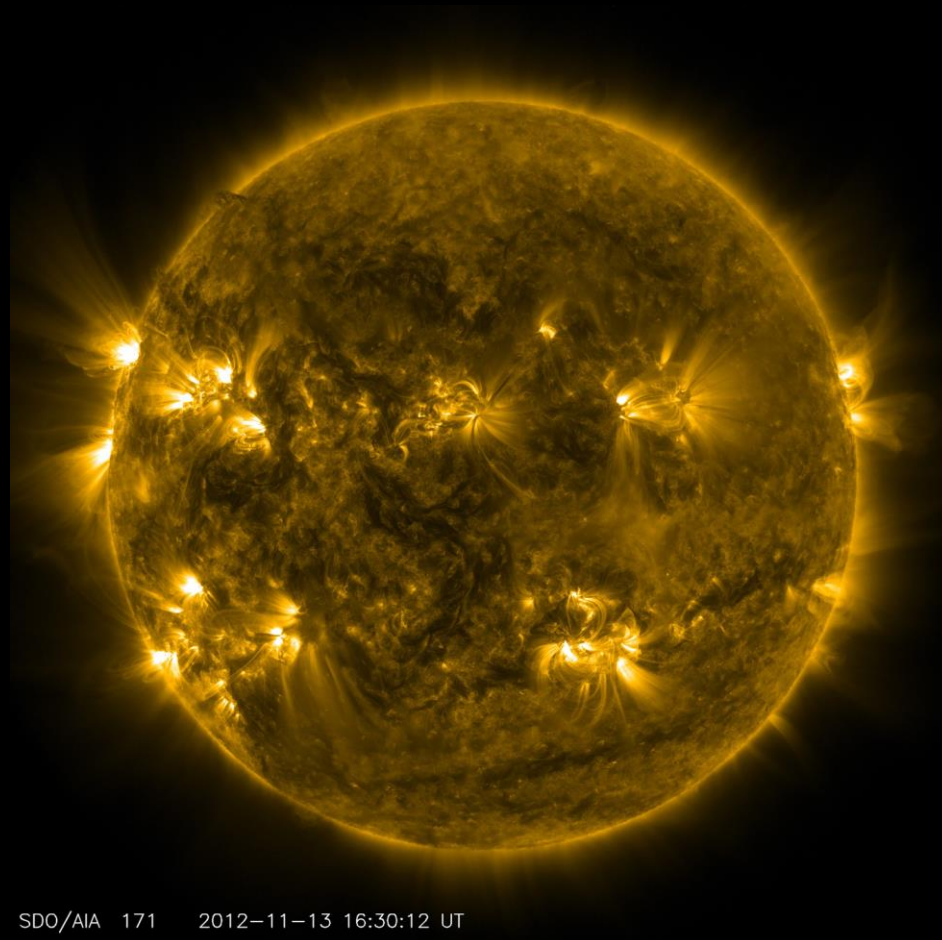
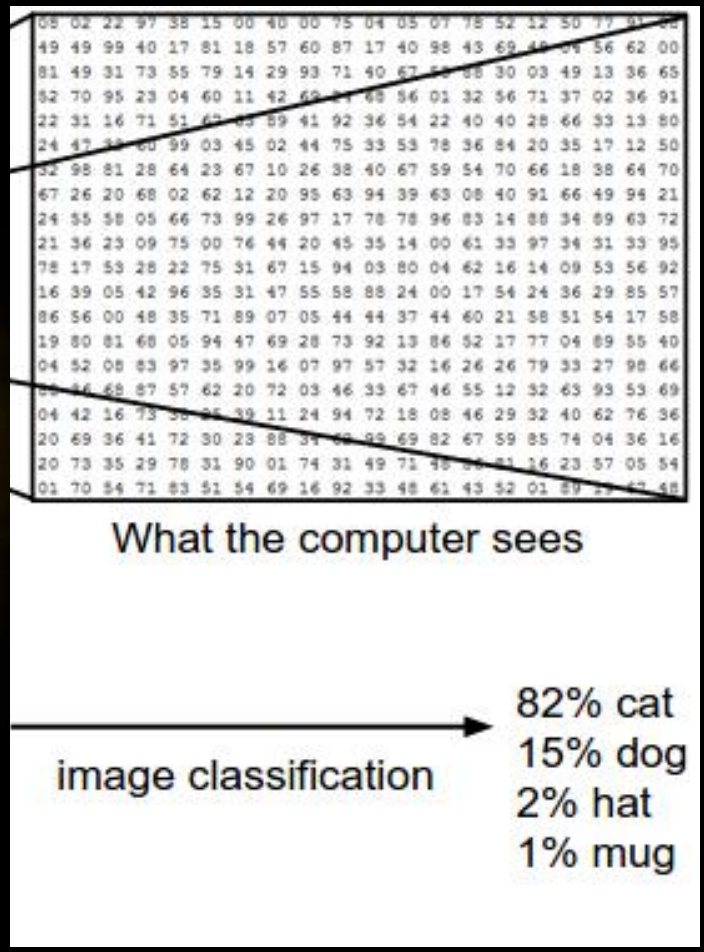
Deep learning and image data





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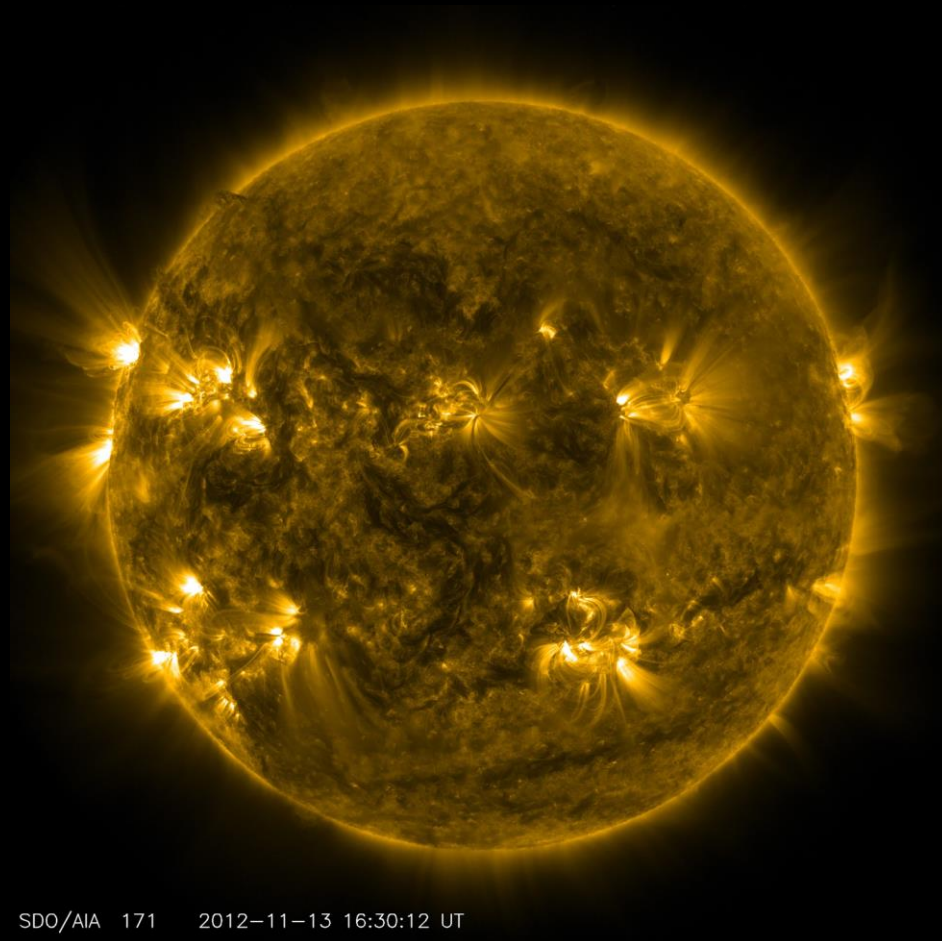

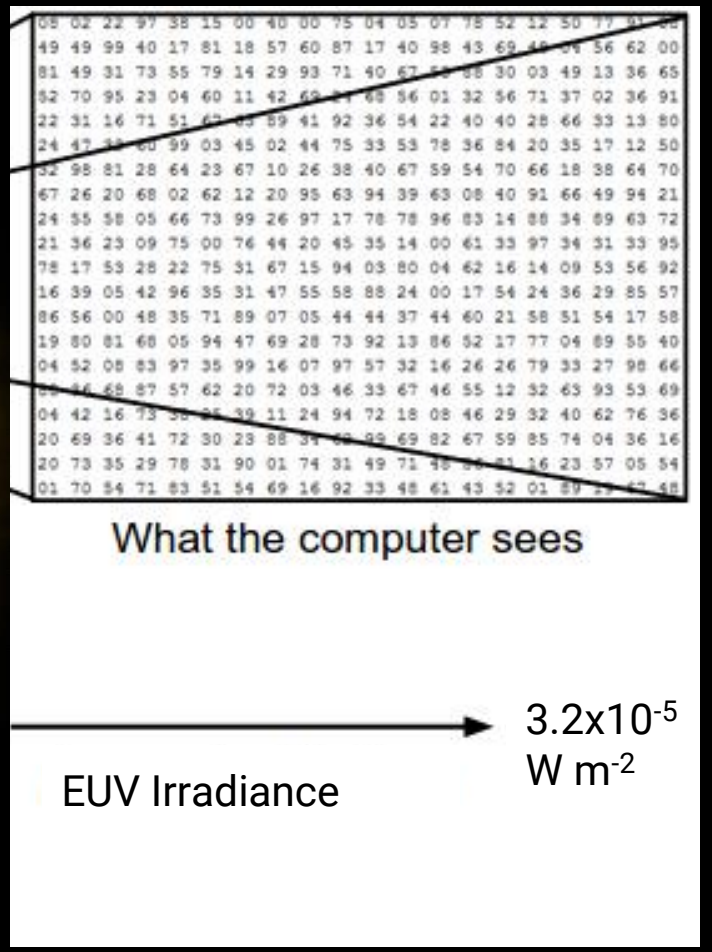

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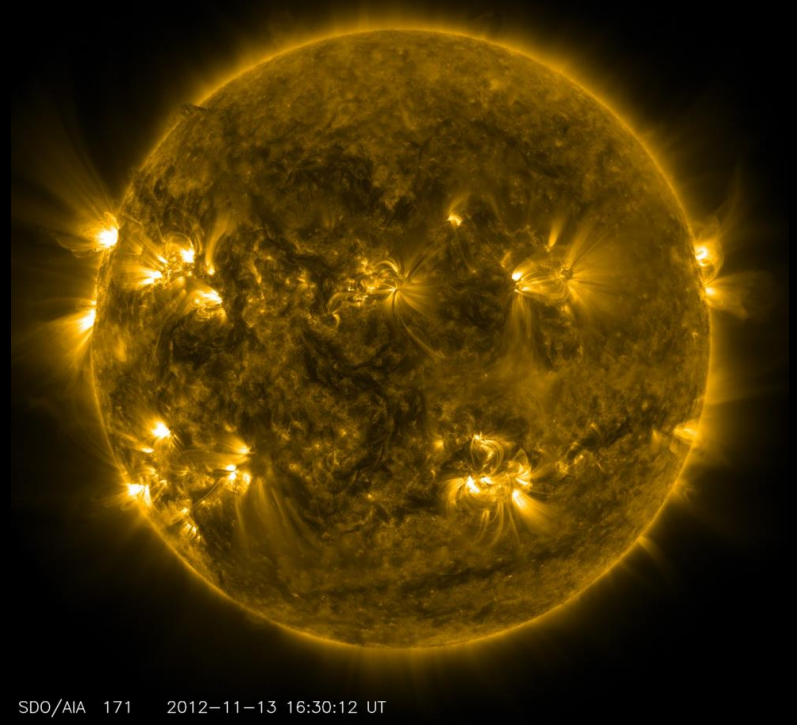
Convolutional Neural Networks

Neural networks with layers made of tunable convolution filters



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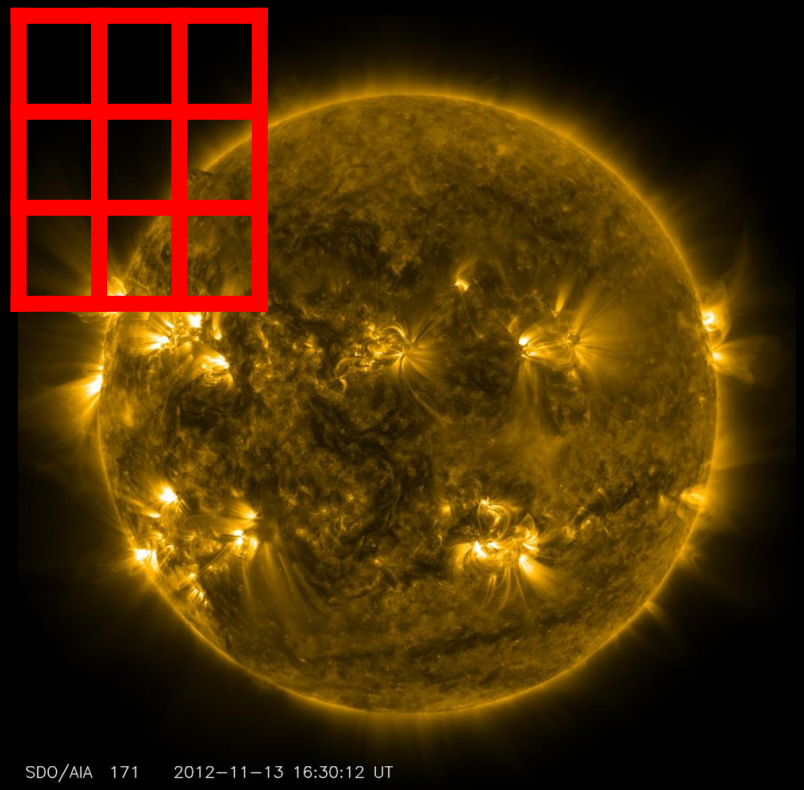

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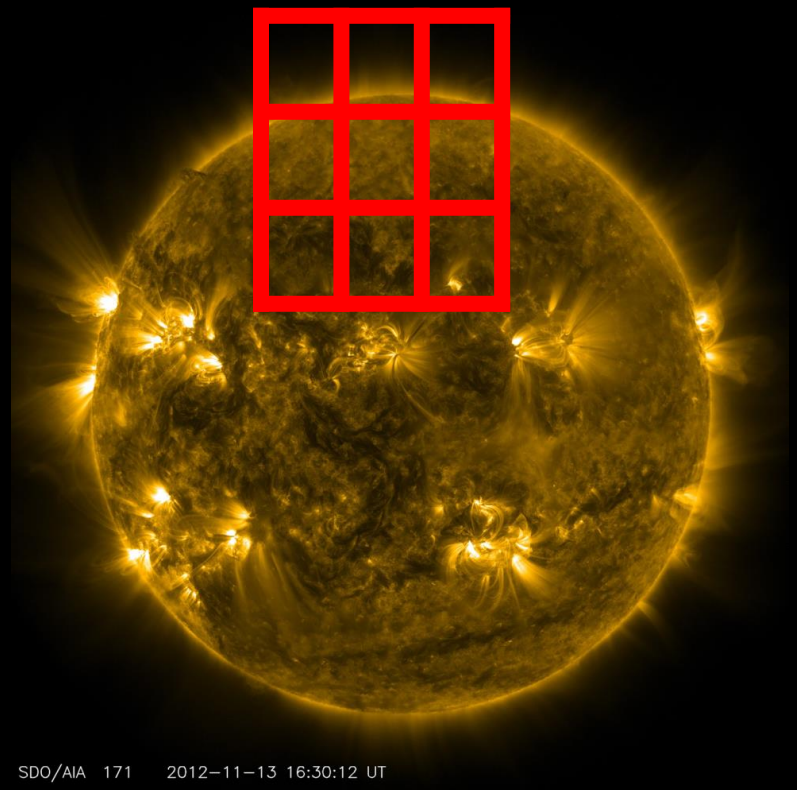

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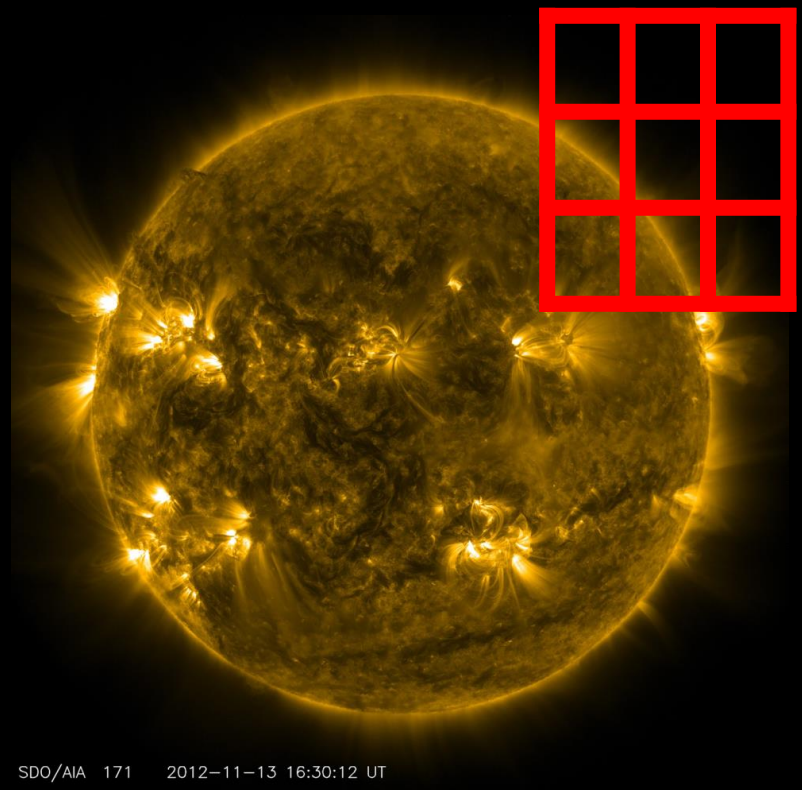

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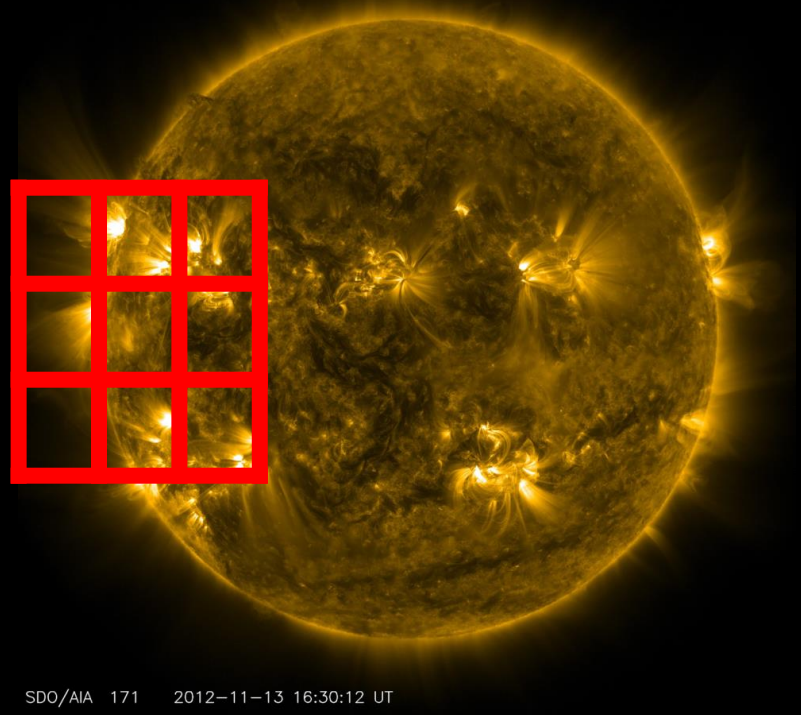

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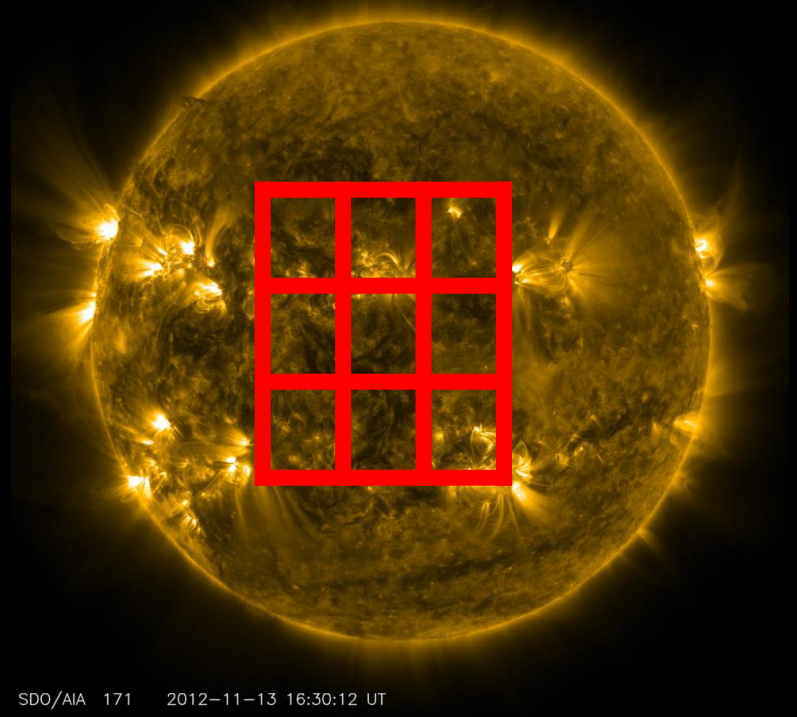

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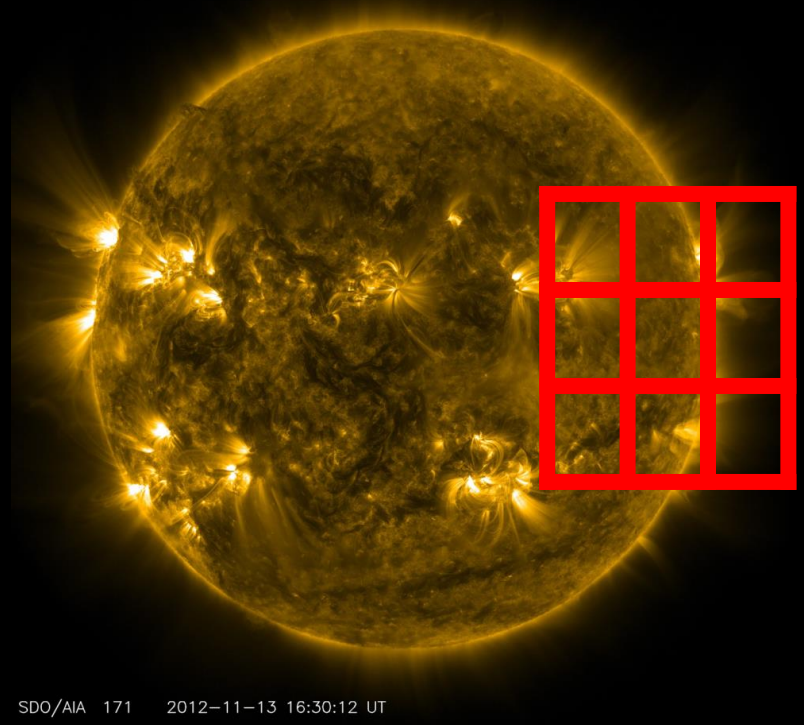

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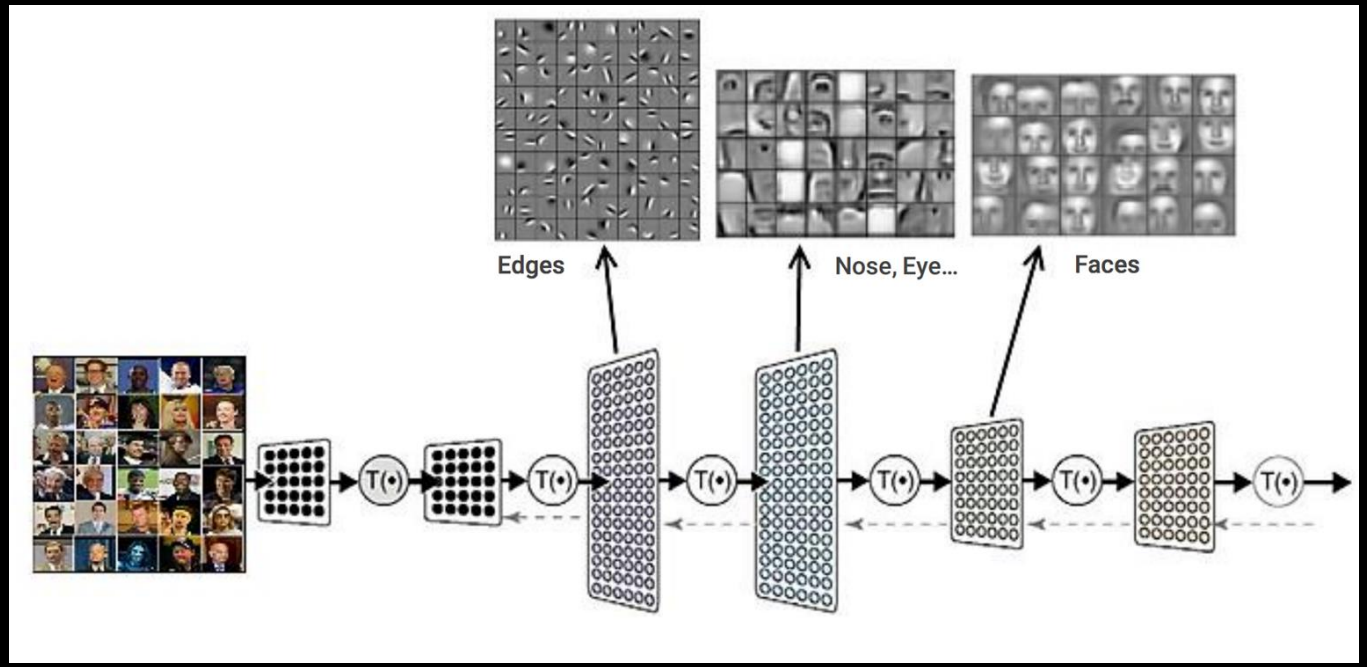

Several convolutional layers allow the neural network to recognize features of increased complexity

Convolutional Neural Networks

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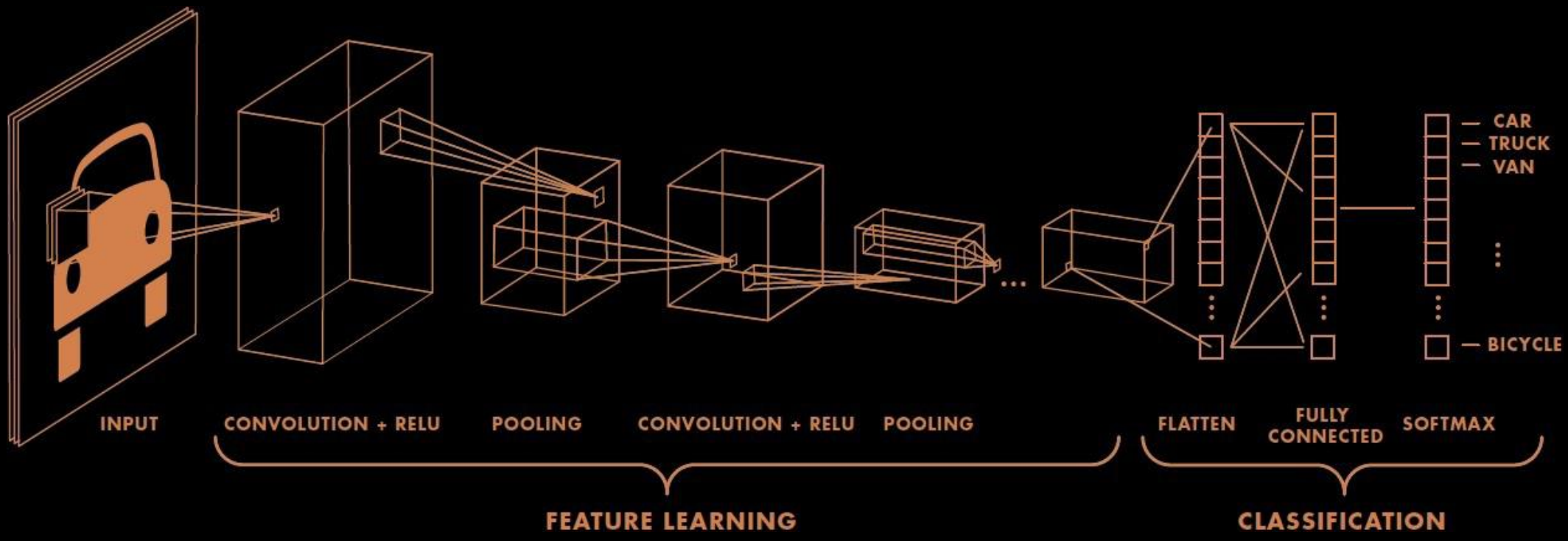

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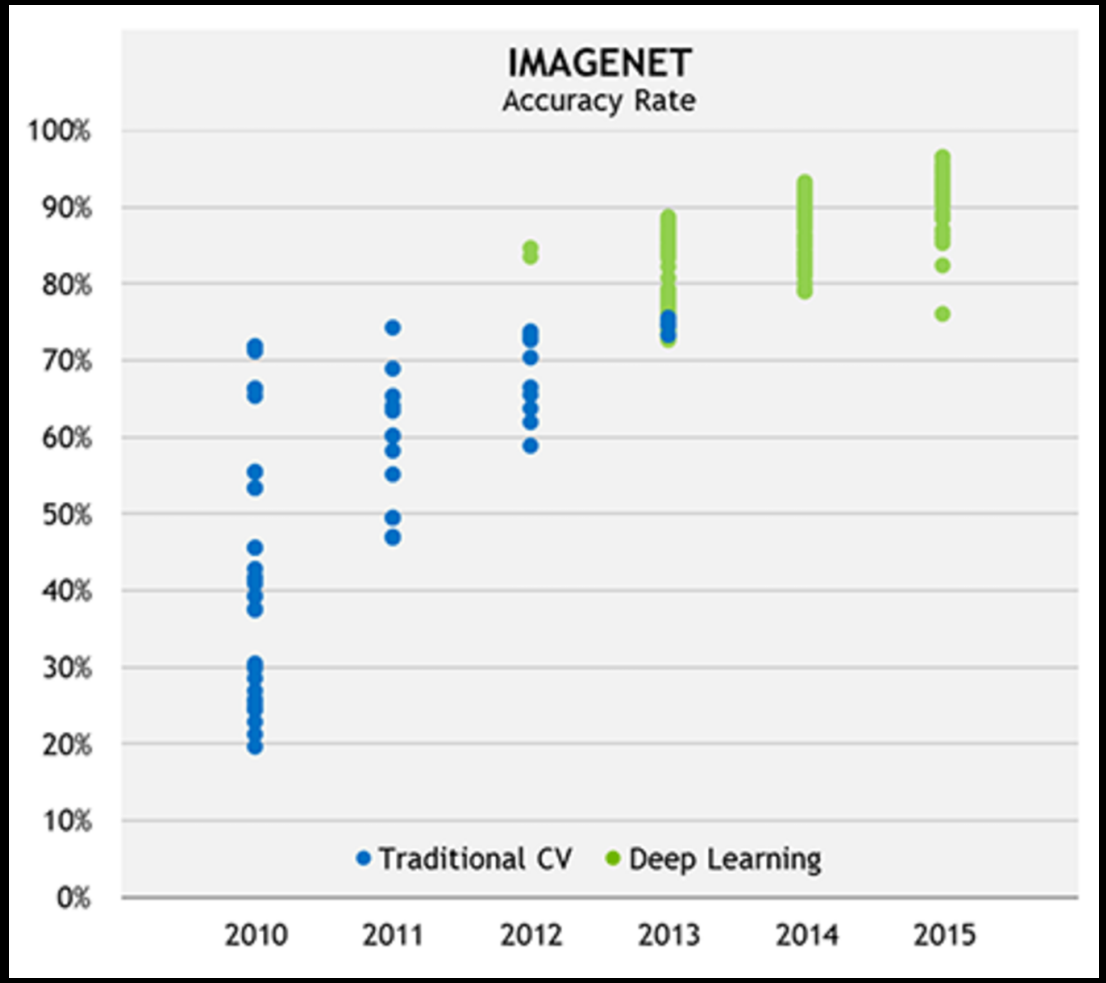
Convolutional Neural Networks



CNNs have revolutionized the way we do image classification.

Grad-CAM: Why did you say that?
Visual Explanations from Deep Networks via Gradient-based Localization

Ramprasaath R. Selvaraju Abhishek Das Ramakrishna Vedantam Michael Cogswell
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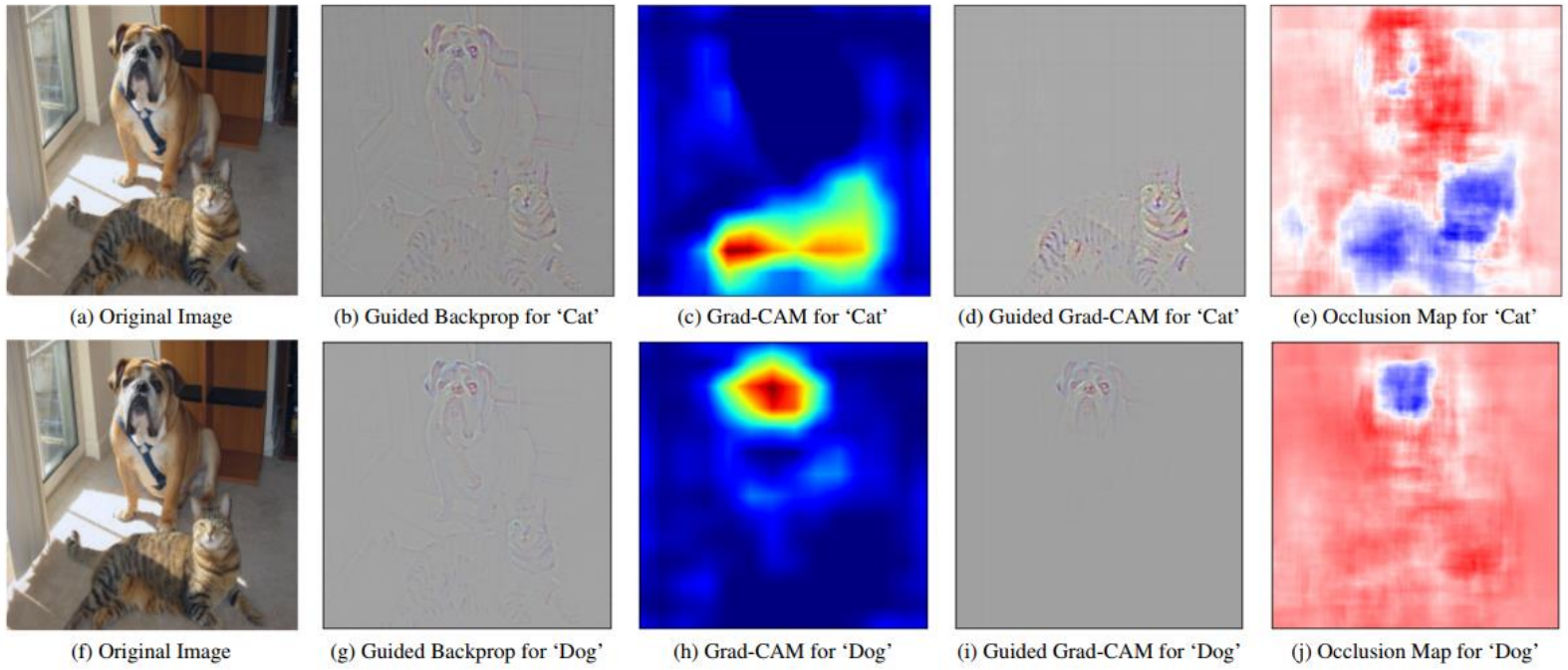
391v1 [cs.CV] 7 Oct 2016



(a) Original Image (b) Guided Backprop for 'Cat' (c) Grad-CAM for 'Cat' (d) Guided Grad-CAM for 'Cat' (e) Occlusion Map for 'Cat'

(f) Original Image (g) Guided Backprop for 'Dog' (h) Grad-CAM for 'Dog' (i) Guided Grad-CAM for 'Dog' (j) Occlusion Map for 'Dog'

NEURAL NETWORKS ARE NOT BLACK BOXES AND CAN BE MINED FOR SCIENTIFIC INSIGHT