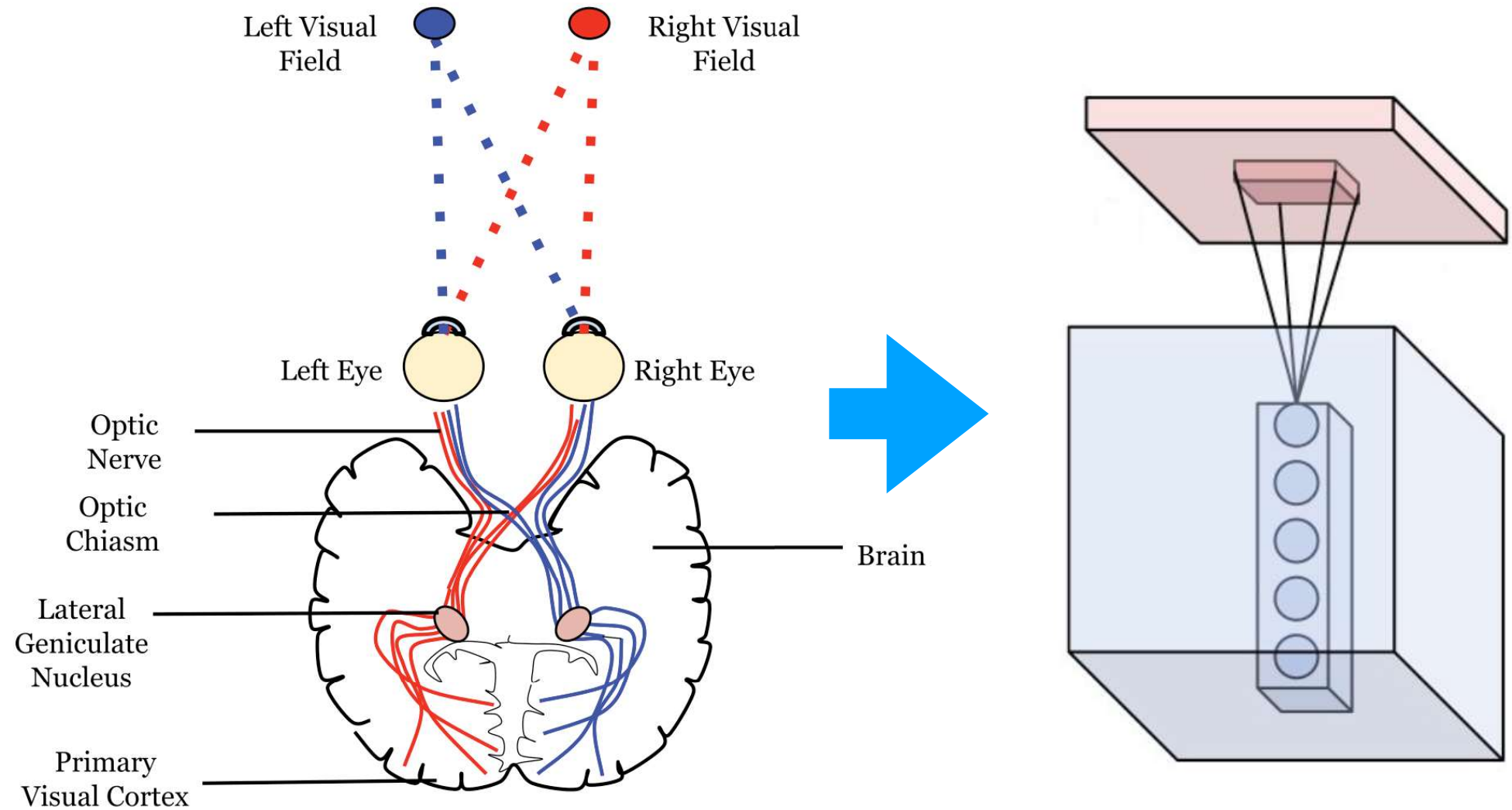# Lecture 25: Deep neural networks continued

Professor Ilias Bilionis
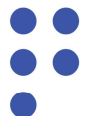
Image classification using convolutional neural networks

Animal visual cortex
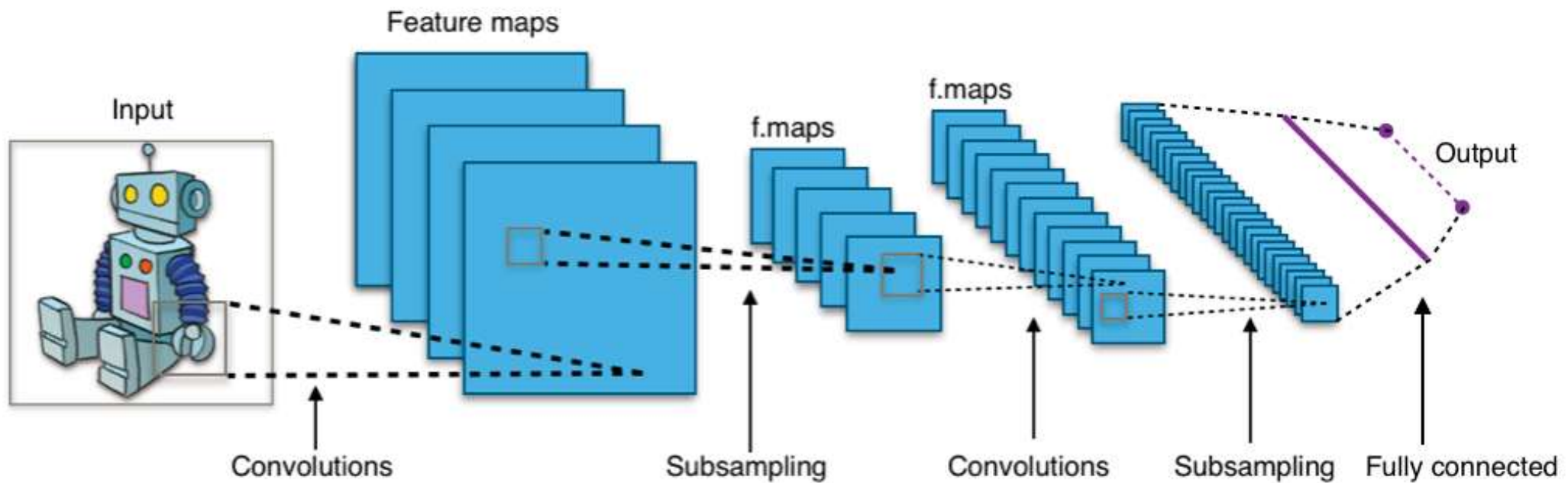
A typical CNN architecture

https://en.wikipedia.org/wiki/Convolutional_neural_network#/media/File:Typical_cnn.png

PREDICTIVE SCIENCE LABORATORY

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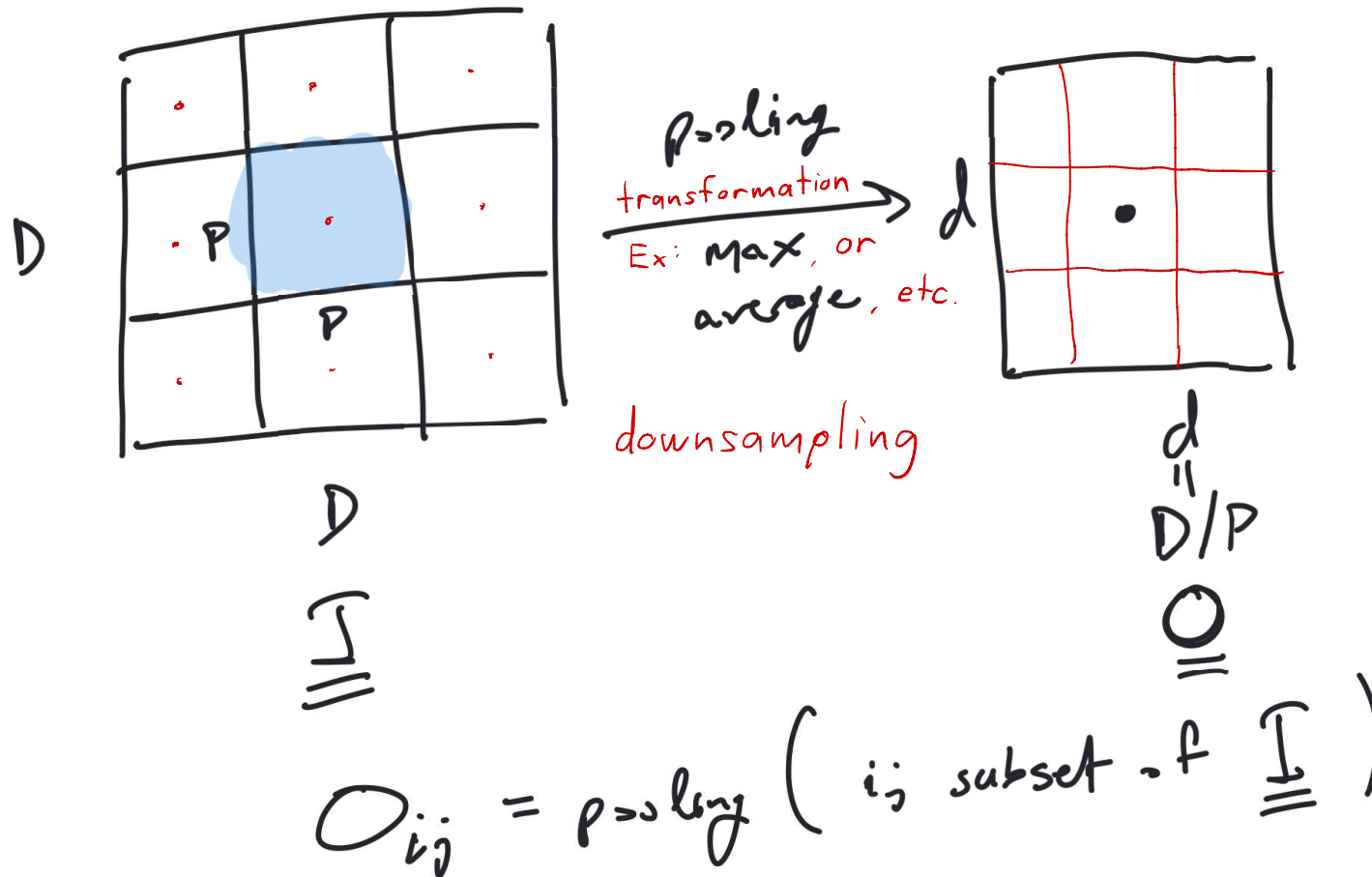# Why do they work well for image recognition?

- Translation invariant.

- Shared parameters -> Less prone to overfitting.
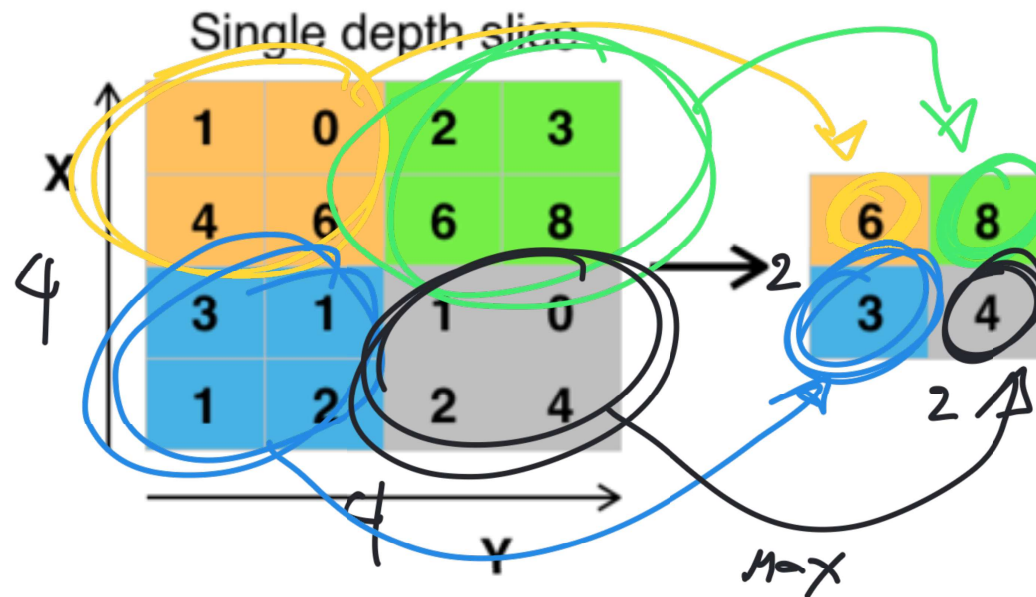
- Hierarchical pattern recognition.

PREDICTIVE SCIENCE LABORATORY

The convolutional layer

$$S_{ij} = \sum_{m,n=1}^{M} I_{i+m, j+n} K_{mn}$$

kernel parameters

what is learned

could also have a symmetric kernel?

The pooling layer (max)

pooling transformation $\longrightarrow$ d
Ex: max, or average, etc.

downsampling

D

$d = D/P$

$\underline{\underline{I}}$

$\underline{\underline{O}}$

$$O_{ij} = pooling\left(ij \text{ subset of } \underline{\underline{I}} \right)$$

Example of pooling