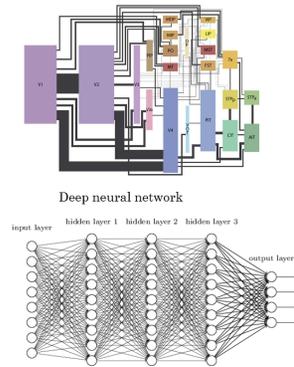


what determines the weights w_{ij} as one proceeds up levels (j) of the hierarchy?



?

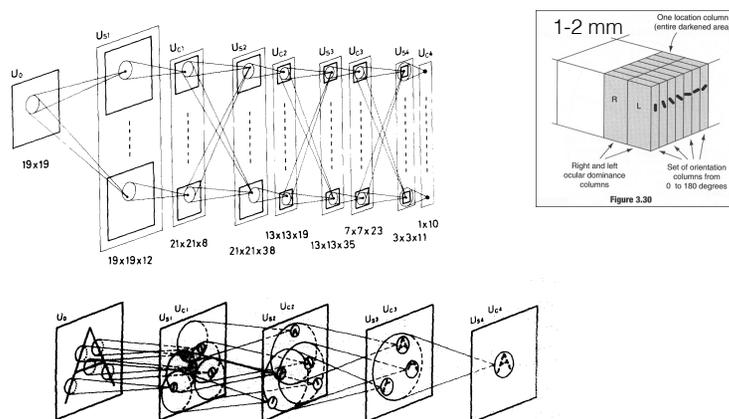
the tasks of vision,
e.g. "core" recognition

the regularities in images,
e.g. high correlations between nearby pixels

hierarchical models for feature extraction given task constraints, e.g. core recognition

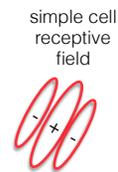
- Local features progressively grouped into more structured representations
- edges => contours => fragments => parts => objects
- Selectivity/invariance trade-off
- Increased selectivity for object/pattern type
- Decreased sensitivity to view-dependent variations of translation, scale and illumination

Fukushima 1988



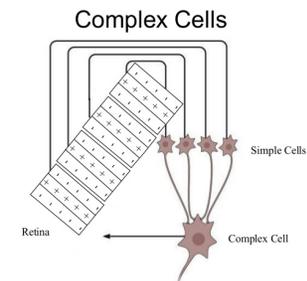
Fukushima, K. (1988). Neocognitron - a Hierarchical Neural Network Capable of Visual-Pattern Recognition. *Neural Networks*, 1(2), 119-130.

simple and complex cells in V1



"AND-ing"

one model illustrating local translation invariance



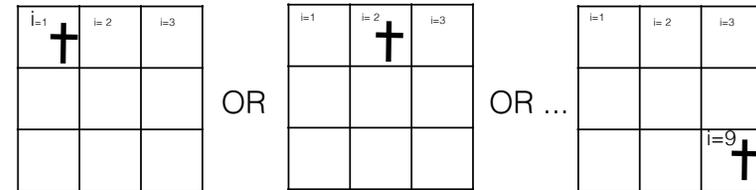
"OR-ing"

simple & complex cells in V1

- Simple cells
 - “template matching”, i.e. detect conjunctions, logical “AND”
- Complex cells
 - insensitivity to small changes in position, detect disjunctions, logical “OR”
- Recognition as the hierarchical detection of “disjunctions of conjunctions”

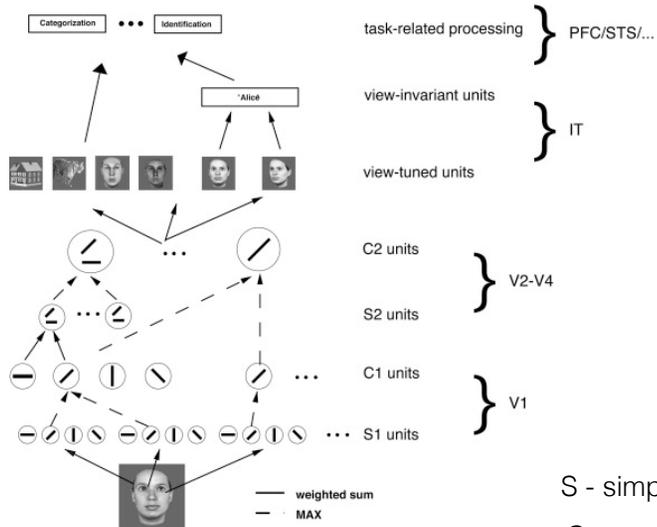
Recognize the letter “†”

“†” is represented by the conjunction of a vertical and horizontal bar | AND — = †



which can occur at any one of many locations i

$$\text{“†”}: h_1 \&\& v_1 \parallel h_2 \&\& v_2 \parallel h_3 \&\& v_3 \dots$$



S - simple cell like
C - complex cell like

Riesenhuber & Poggio, 1999

volunteers to lead next week paper discussions?

- Serre, T., Wolf, L., Bileschi, S., Riesenhuber, M., & Poggio, T. (2007). Robust object recognition with cortex-like mechanisms. *Pattern Analysis and Machine Intelligence*, 29(3), 411–426.
- Serre, T., Oliva, A., & Poggio, T. (2007). A Feedforward Architecture Accounts for Rapid Categorization, *104(15)*, 6424–6429.
- Riesenhuber, M., & Poggio, T. (1999). Hierarchical models of object recognition in cortex. *Nature Neuroscience*, 2, 1019–1025.
- Wu, C.-T., Crouzet, S. M., Thorpe, S. J., & Fabre-Thorpe, M. (2015). At 120 msec You Can Spot the Animal but You Don't Yet Know It's a Dog. *Cognitive Neuroscience, Journal of*, 27(1), 141–149. http://doi.org/10.1162/jocn_a_00701