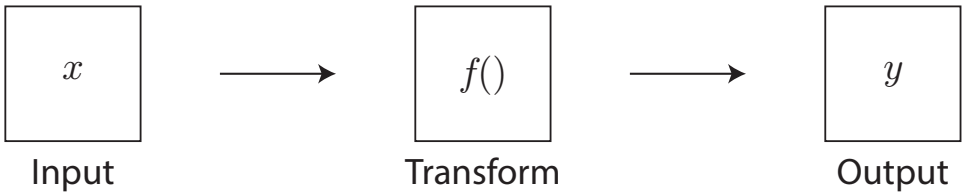
# Computational Neuroscience

2016

**Introduction - Continued**

Instructor: Odelia Schwartz

# Computational neuroscience



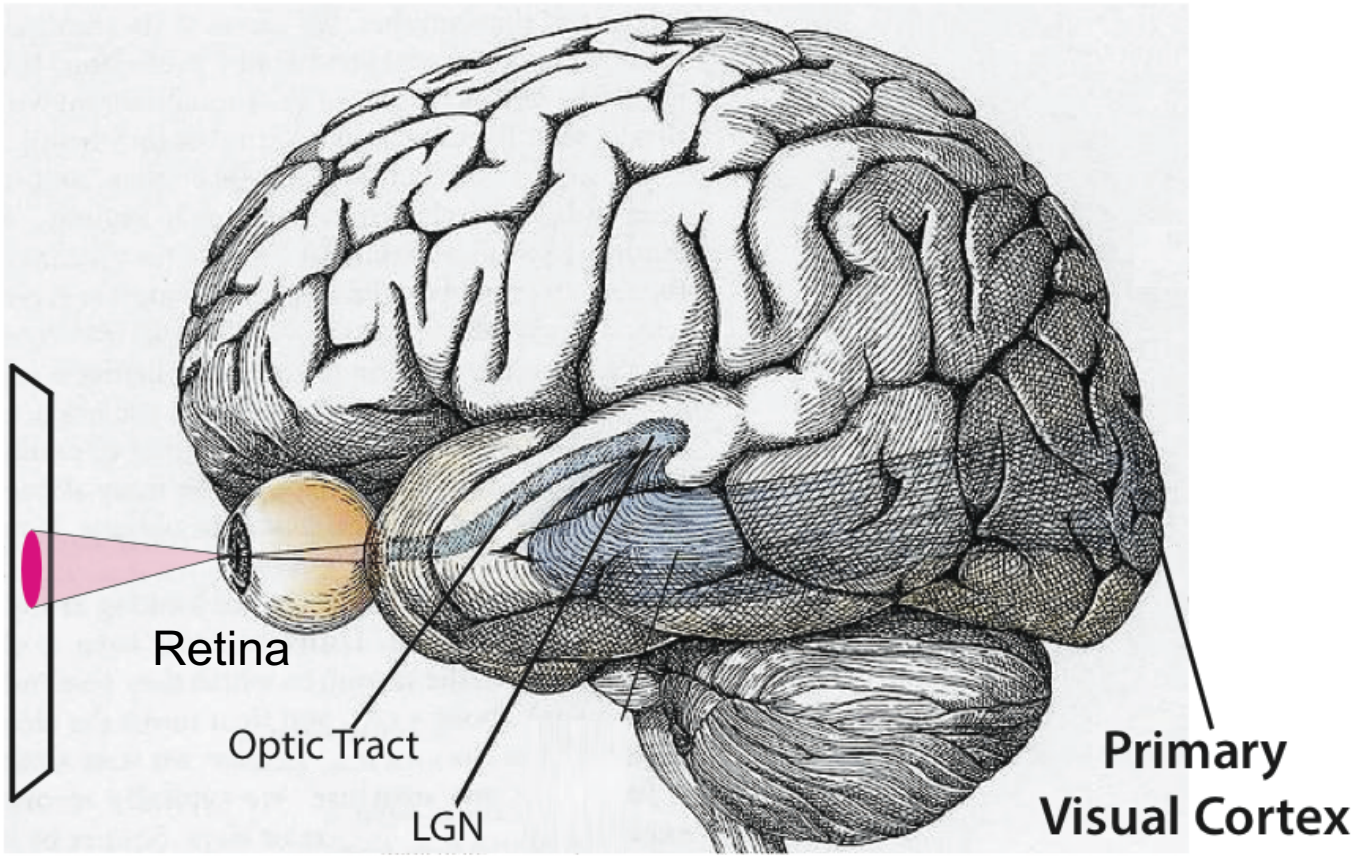

- **Descriptive (what):** **What is the transform between input and output?**
- **Mechanistic (how):** **How does the system transform the input into the output?**
- **Interpretive/normative (why):** **Why does the system transform the input into the output?**

# Example: Receptive fields

**Classical definition:** A region of the visual field that must be Stimulated directly in order to obtain a response from a neuron.

**Modern / Computer Science / engineering:** filter that captures those attributes of the stimulus that generate responses.
Often assumed linear.

# The Visual System

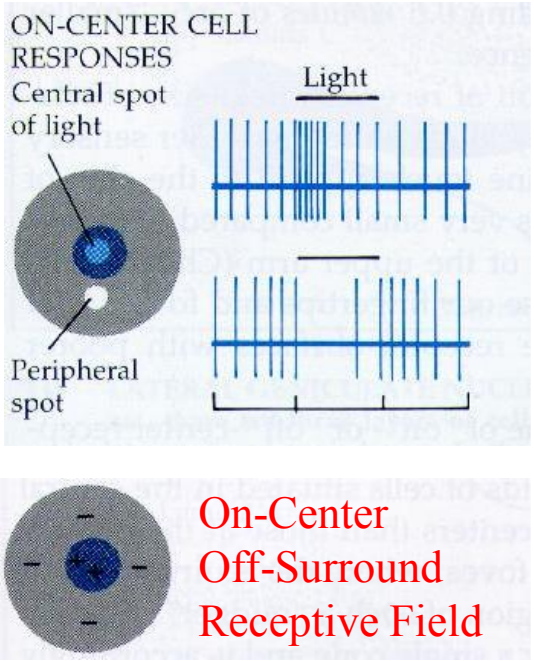



From Hubel

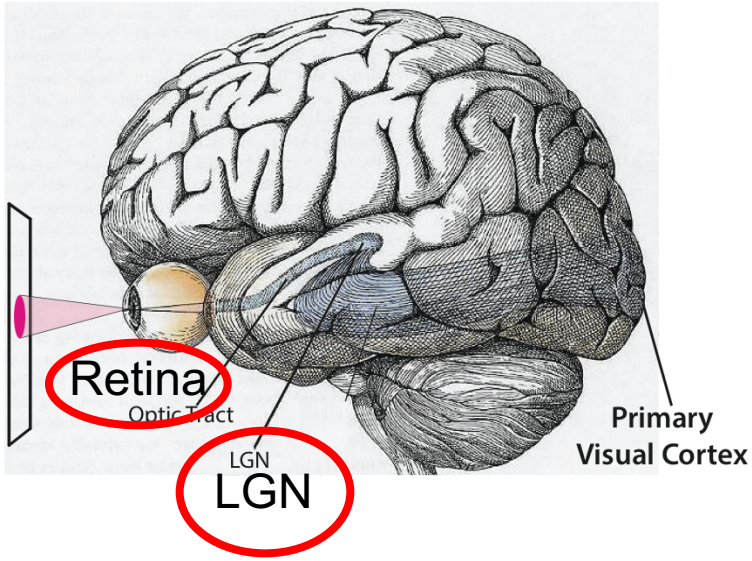
# Example: Receptive fields

- Receptive fields in Retina and LGN are similar
- Shown here LGN

# Example: Receptive fields




R. Rao, 528 Lecture 1




- Descriptive model: What

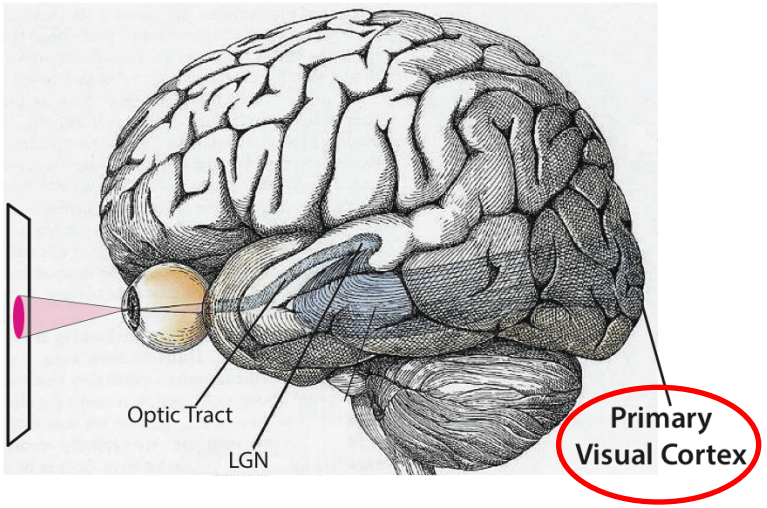
# Neural processing

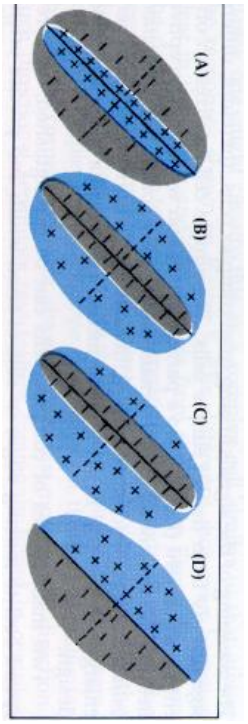
## Primary visual cortex

Hubel and Wiesel, 1959

# Example: Receptive fields

# Example: Receptive fields



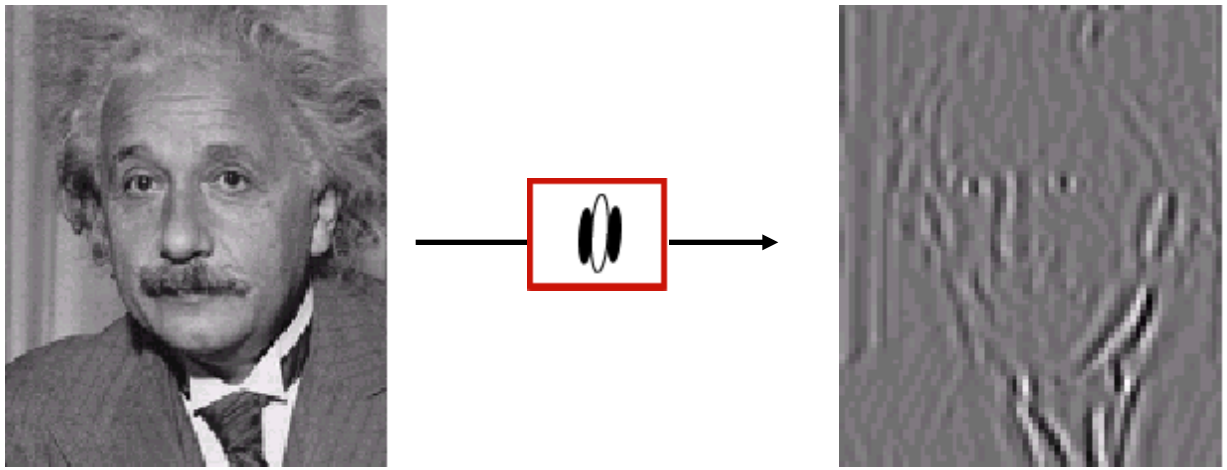

Examples of receptive fields in primary visual cortex (V1)

(From Nicholls et al., 1992)

- Descriptive model: What

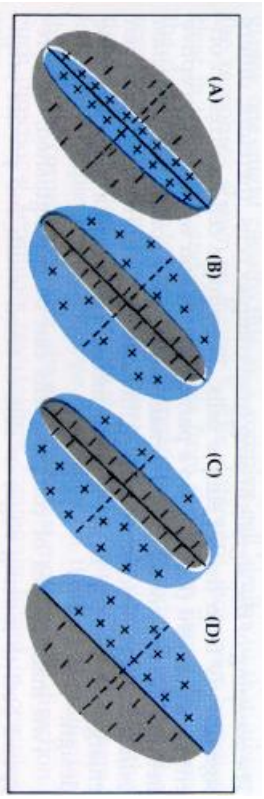
# Computer science / engineering

Visual receptive field or filter!



# Example: Receptive fields

- The Question: *How* are receptive fields constructed using the neural circuitry of the visual cortex?

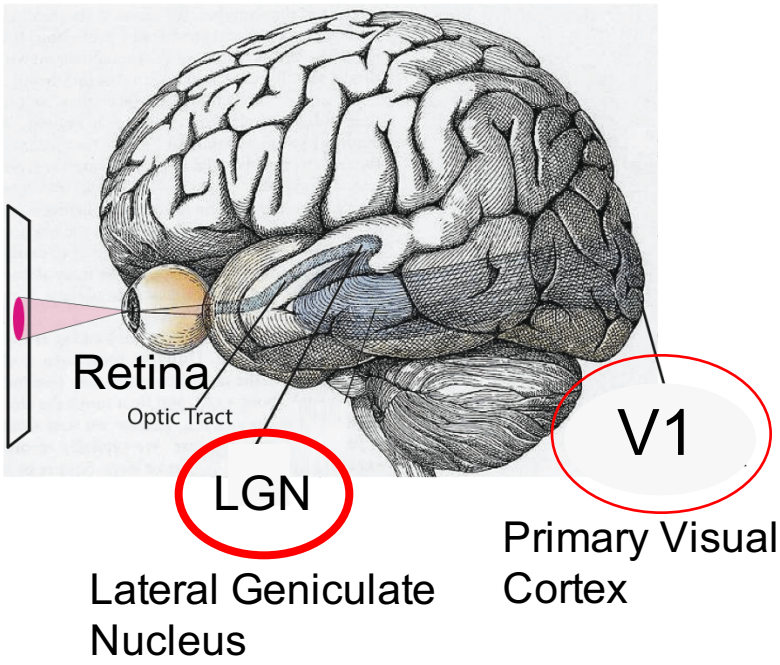


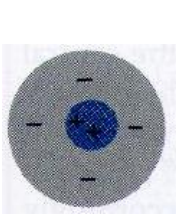

How are these *oriented* receptive fields obtained?



- Mechanistic model: How

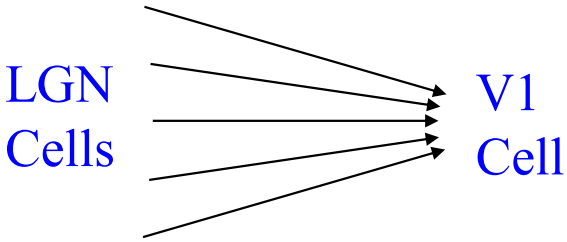
# Example: Receptive fields



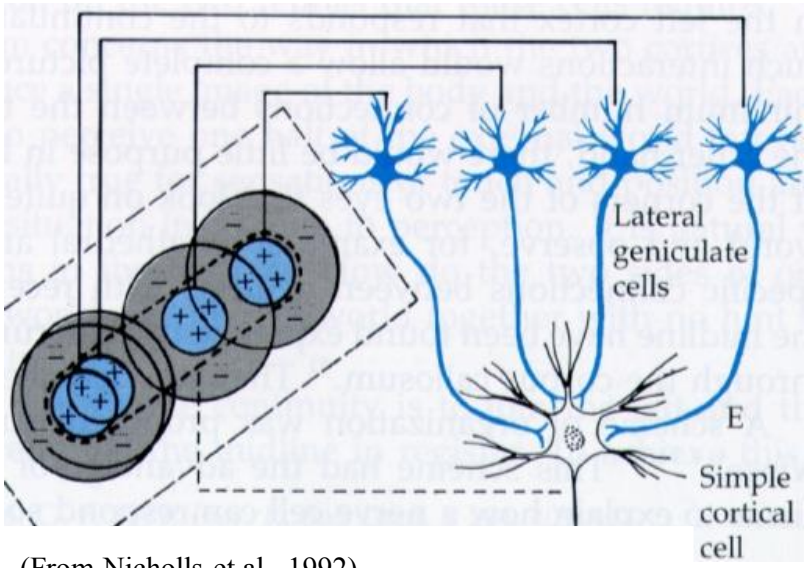
LGN RF

V1 RF




- Mechanistic model: How

# Example: Receptive fields




(From Nicholls et al., 1992)

Model suggested by Hubel & Wiesel in the 1960s: V1 RFs are created from converging LGN inputs

Center-surround LGN RFs are *displaced along preferred orientation* of V1 cell

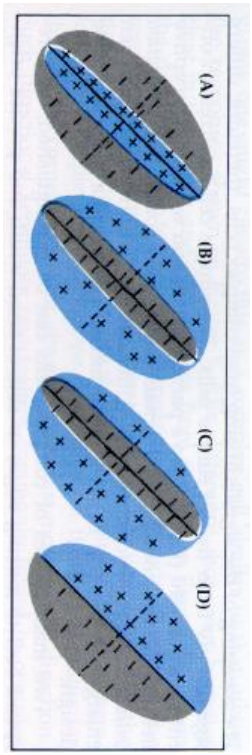
This simple model is still controversial!



- Mechanistic model: How

# Example: Receptive fields

- The Question: *Why* are receptive fields in V1 shaped in this way?




What are the computational advantages of such receptive fields?



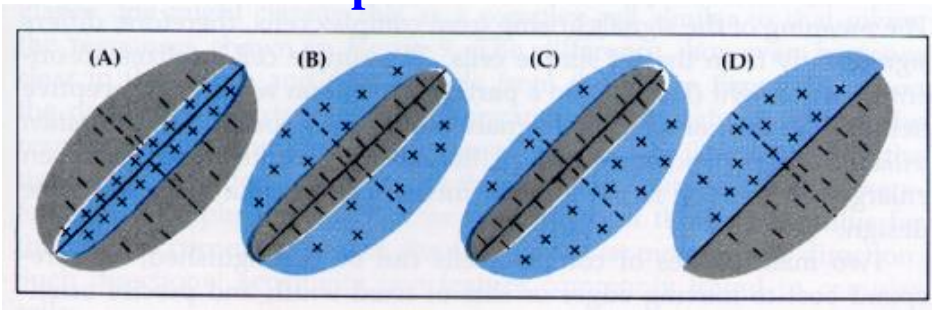
- Interpretive/normative model: Why

# Example: Receptive fields

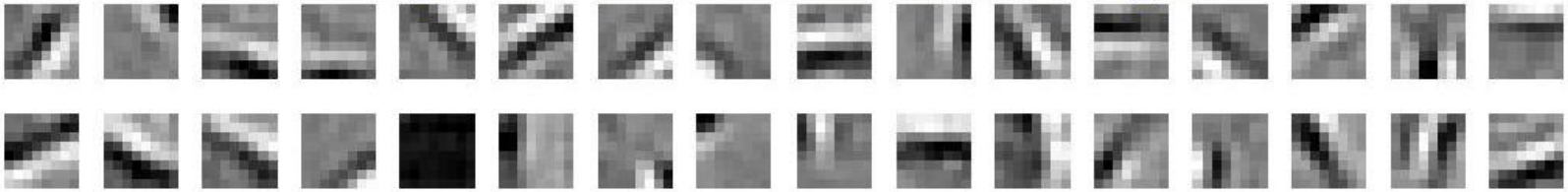
- Interpretive/normative model: Why
- Brain optimized to the structure of images

# Example: Receptive fields

**Receptive Fields in V1**




**Receptive Fields from Natural Images**



- Interpretive/normative model: Why
- More on later!