

# Deep Learning Note

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## 1 Chapter 1

### 1.1 Donald Hebb

Organization of behaviour - 1949 learning mechanism:

- When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased.
- As A repeatedly excites B, its ability to excite B improves.
- Neurons that fire together wire together.

### 1.2 Hebbian Learning

- If neuron  $x$  repeatedly triggers neuron  $y$ , the synaptic knob connecting  $x$  to  $y$  gets larger.
- In mathematical model:
$$w_{xy} = w_{xy} + \eta xy$$
- Weight of the connection from input neuron  $x$  to output neuron  $y$ .
- This simple formula is actually the basis of many learning algorithms in machine learning.

This idea however is fundamentally unstable:

- Stronger connections will enforce themselves.
- No notion of "competition".
- No *reduction* in weights.
- Learning is unbounded.

People came up with all kinds of modifications for it to try to make it more stable:

- Allowing for weight normalization.
- Forgetting

This led to the Generalized Hebbian learning, aka Sanger's rule where the contribution of input is *incrementally distributed* over multiple outputs.

$$w_{ij} = w_{ij} + \eta y_j \left( x_i - \sum_{k=1}^j w_{ik} y_k \right)$$

### 1.3 A better model

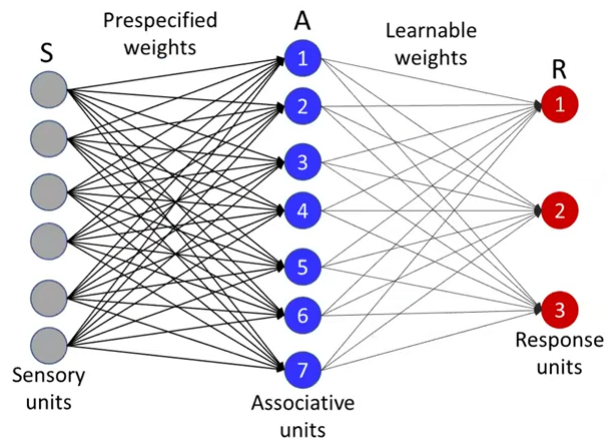
Frank Rosenblatt

- Psychologist, Logician
- Inventor of the solution to everything, aka Perceptron

**Original perceptron model** Consider the eye structure:

- Groups of sensors on retina combine into cells in association in the **projection area**.
- Groups of **projection area** combine into Association cells in **association area**.
- Signals from **association area** cells combine into response cell **R**.
- All connections may be excitatory or inhibitory.

Rosenblatt's perceptron model can then be further simplified:



**Simplified perceptron model**

- Association units combine sensory input with fixed weights.
- Response units combine associative units with learnable weights.