The Story of a Neuron

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How Do We Recognize a Baby Panda?

Below you are shown a mysterious black-and-white animal photo. Is it a panda, a sloth, a Dalmatian puppy, or something else? This is not just a fun guessing game, its a real-life example of how our brains make decisions, and how we can model this process in AI.

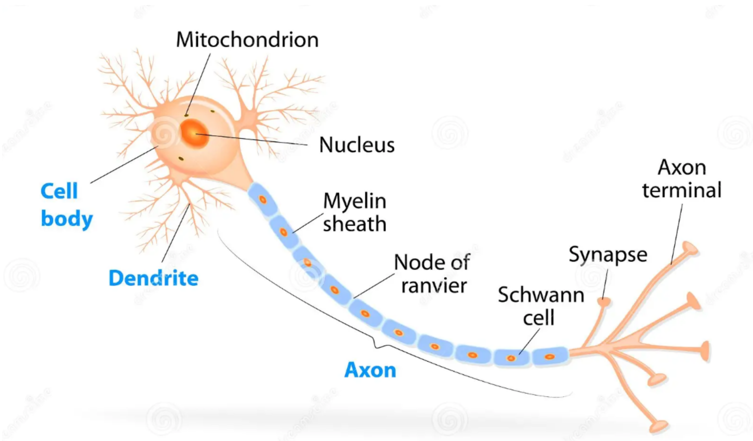
1. Observing and Deciding: The Human Way

- **Scenario:** You see an ambiguous animal image. People guess: panda, sloth, seal, otter, Dalmatian, etc.
- **Process:** Everyone bases their answer on features: fur, color, shape of nose, ears, paws, etc.
- **Reflection:** You recall memories—maybe you saw a panda in a zoo, or a Dalmatian in a movie. Your brain aggregates all these cues before making a decision.

2. Learning from Experience: Schema Formation

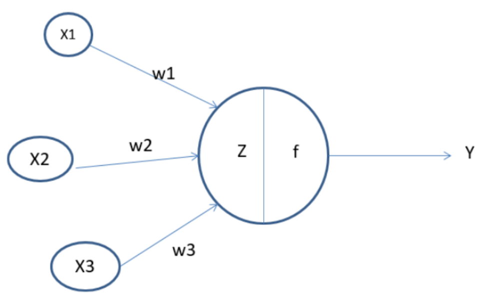
- **Example:** A child learns what a "dog" is by seeing different dogs: brown, black, white, big, small.
- **Feedback:** Each new example refines the child's "dog" schema.
- **Key Point:** This process is called **schema formation**. It's iterative and feedback-driven—the more you see, the better you recognize.

3. The Biological Neuron: Inspiration for AI



- **Parts:** Dendrites (inputs), Nucleus (center), Axon (output path), Synapse (connection to next neuron).
- **Analogy:** Each feature (fur, ear, paw) is like a signal entering via a dendrite.
- **Decision:** If enough strong signals are received, the neuron "fires" and passes the information along.
- **Important:** A neuron is a *decision-making unit*, not an intelligence unit. Intelligence emerges from many neurons working together.

4. Modeling the Neuron: From Brain to Code



- **Goal:** Mimic the brain's decision process in a computer.
- **Inputs** $(x_1, x_2, ..., x_n)$: Features detected (e.g., fur, ear, paw).
- **Weights** $(w_1, w_2, ..., w_n)$: How confident you are in each feature.
- **Linear Combination:**

$$z = x_1 w_1 + x_2 w_2 + \ldots + x_n w_n$$

- **Activation Function:** If z exceeds a threshold F, the neuron "fires" (decision: yes); otherwise, it does not (decision: no).

5. Recognizing a Cat

Suppose your job is to decide if an animal is a cat, based on three features:

- x_1: Pointed ears (1 if present, 0 if absent)
- x_2: Whiskers (1 if present, 0 if absent)
- x_3: Fur (1 if present, 0 if absent)

You assign confidence weights:

- $w_1 = 0.5$ (50% sure from ears)
- $w_2 = 0.7$ (70% sure from whiskers)
- $w_3 = 0.6$ (60% sure from fur)

You compute:

$$z = x_1w_1 + x_2w_2 + x_3w_3$$

Set a threshold $F = 1.2$. If $z \geq F$, output "cat"; else, "not a cat".

fx =B3 * C3 + B4 *C4 + B5*C5

A	B	C	D	E	F
Task	Recognize Cat				
	x	w			
Ear	1	0.5	Z =	1.1	
Whisker	0	0.7	f	1.2	
Fur	1	0.6			

Finding the same using excel formula, link

Python Code

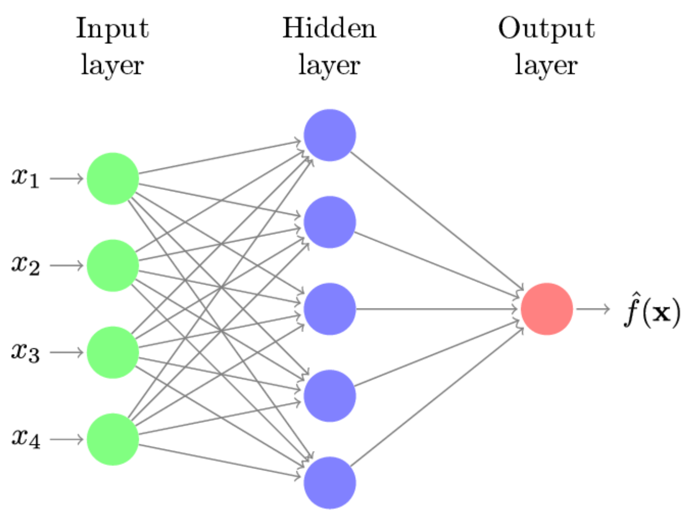
```
inputs = [1, 0, 1]  # ears, whiskers, fur
weights = [0.5, 0.7, 0.6]
threshold = 1.2

weighted_sum = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2]
if weighted_sum >= threshold:
    print("Neurons fired: Cat detected")
else:
    print("Not a cat")
```

6. The Role of Threshold and Weights in Decisions

- The threshold (F) is the minimum score to make a decision.
- Weights (w_i) reflect your confidence in each feature (contribution of each feature).
- Both can be adjusted over time as you get feedback and learn.

7. From a Single Neuron to a Neural Network

- One neuron is just one decision-maker. Real intelligence comes from networks of neurons.
- **Layers:**
  - **Input Layer:** Receives features.
  - **Hidden Layers:** Intermediate decision-makers.
  - **Output Layer:** Final decision.
- Information flows *unidirectionally* from input to output through hidden layers.



A Neural Network, credits

8. Real-World Reflection

- If your features and weights are not enough to cross the threshold, you cannot confidently decide—just as in real life, sometimes you need more information or experience.
- The threshold is not fixed—it can and should be learned and improved as you see more examples.

9. Summary Table: Biological vs. Computational Neuron

Biological Neuron	Computational Model
Dendrites (inputs)	Feature inputs $(x_1, x_2, \ldots)$
Weights (synaptic strength)	Weights $(w_1, w_2, \ldots)$
Axon (output)	Output (y)
Activation (firing)	Activation function (threshold)
Synapse (connection)	Connection to next neuron

10. Key Takeaways

- The brain and neural networks make decisions by aggregating evidence from features, weighing them, and checking if the combined evidence is strong enough.
- Learning is iterative: as you see more examples and get feedback, your "weights" and "thresholds" improve.
- The single-neuron model is the building block for much more complex neural networks.