THE NEURON:

- Neuron integrates excitation and inhibition to get total net activations.

- If activation is above the threshold, it spikes and sends an action potential down the axon.

- **Inhibition:** negative stimulation
- **Excitation:** positive stimulation

- There are no such things as multiple action potentials at the same time.

- All action potentials are the same.

- After firing, the neuron reset (2ms refractory period).

- If it is still being stimulated over the threshold, it fires again.

- Hence the firing rate indicates the level of activation.

- **Neurons in Action:**
    - McCulloch and Pitts: Neurons are little computing devices.

    - Summation/integration and thresholding.

    - A neuron takes excitatory/inhibitory (0/1) inputs and the activation is the sum of the inputs, which causes the neuron to fire.

    - Anything you can do on a computer, you could do with an **artificial neuron.**

    - Brains can do the same computations as computers and vice versa.

- You can make logic gates out of neurons.

- Inputs for neurons are either a 0 or 1 and the threshold could be 1 or 2 depending on how many inputs it needs for it to fire.

- Like an **AND gate**, some neurons will need a sum of **2 from inputs for it to fire**, just like for an **AND gate** to light up an output.

- Like an **OR gate**, some neurons will need a sum of **1 from inputs for it to fire**, just like an **OR gate** to light up and output.

- Like an **NOT gate**, some neurons will need a sum of **0 from inputs for it to fire**, just like an **NOT gate** to light up and output.

- Neurons have a simple “dumb rule” just like logic gates in order to fire and to output something.

NATURE VS. NURTURE:

- What is knowledge? Where does it come from?

- Locke believes everything we learn comes from experience, which is known as nurture.

- The opposing idea by Descartes and Kant is that eventing comes in within and people are born with certain knowledge, which is the nature side.

- **Empiricism:**
    - Based on experience

    - Everything starts on a blank slate

    - Association

    - Behaviorism

    - General learning mechanism

- **Rationalism:**
    - Based on reason

    - Innate knowledge (Nativism)

    - Cognitivism

    - Domain-specific innate modules

- **Behaviorism:**
    - Science should focus on observable, measures entities and behaviors (Watson, Hull, Tulman)

    - The most objective way back then in science was to focus totally on measurable entities and behaviors.

    - A thesis of what science should be oriented towards and what sort of explanations it should utilize.

    - **B.F. Skinner:** All learning is conditioned responses to stimuli.

- **Empiricism/ Associatism / Behaviroism / Connectionism:**
    - All knowledge comes from experience

    - **There is only one general principle of learning:**
        - **Locke:** The formation of associations among sensory inputs.

        - **Skinner:** Conditioned reinforcement of behavior

        - **Connectionism:** Modification of neural weights based on experience.

    - **Evidence Against Associationism:**
        - Species-specific learning biases, not all species learn the same.
            - **E.g.** rats associating smells with danger, etc

        - **Critical periods for learning:**
            - **Bird Song:** Certain songbirds need to hear their species' song within a 2-week period.

            - Children need to be exposed to their language at a young age in order to pick it up during their **critical period.**

    - These phenomena suggest that innate aspects of brain structure play an important role in learning.

THE COGNITIVE REVOLUTION:

- In 1960, many scientists rebelled against the Behaviorist paradigm.

- They argued that stimulus-response pairings were **insufficient** to explain the complexities of human cognition.
    - **E.g.** Chomsky's review of Skinner's Verbal Behavior.

- And they had a new model of the information processing inside the head: **the computer.**

SPELKE (1998) ON OBJECTS:

- Empiricist accounts of knowledge assume that people's knowledge of objects is based on experience with objects.

- In order to interpret something as a signal coherent thing, you need to know they need to exist.

- Rationalist account assumes that some object knowledge is innate.

- But even newborn chicks who have never experienced occlusion know that objects are complete behind occluders.

- Human infants similarly are surprised when objects disappear.

- If an infant sees something that it is surprised at, it will suckle a lot faster.

- **The object concept:** The idea that objects have continued existence and properties over time.

- The rationalist expression is you start with nothing while the empiricist expression is you are a blank slate.

- **Beyond Objects:**
    - **Similarly, many areas of cognition are now thought to build from innate knowledge:**
        - **Innate Physics:** Ideas of mass and solidity.

        - **Innate Math:** Basic concepts of number, summation, and subtraction.

        - **Innate Biology:** Naive notions of life and growth.

        - **Innate Psychology:** AKA **The Theory of Mind** where other people have minds, including intentions and goals.