Why Elephants Don't Play Chess

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Intelligence

noun

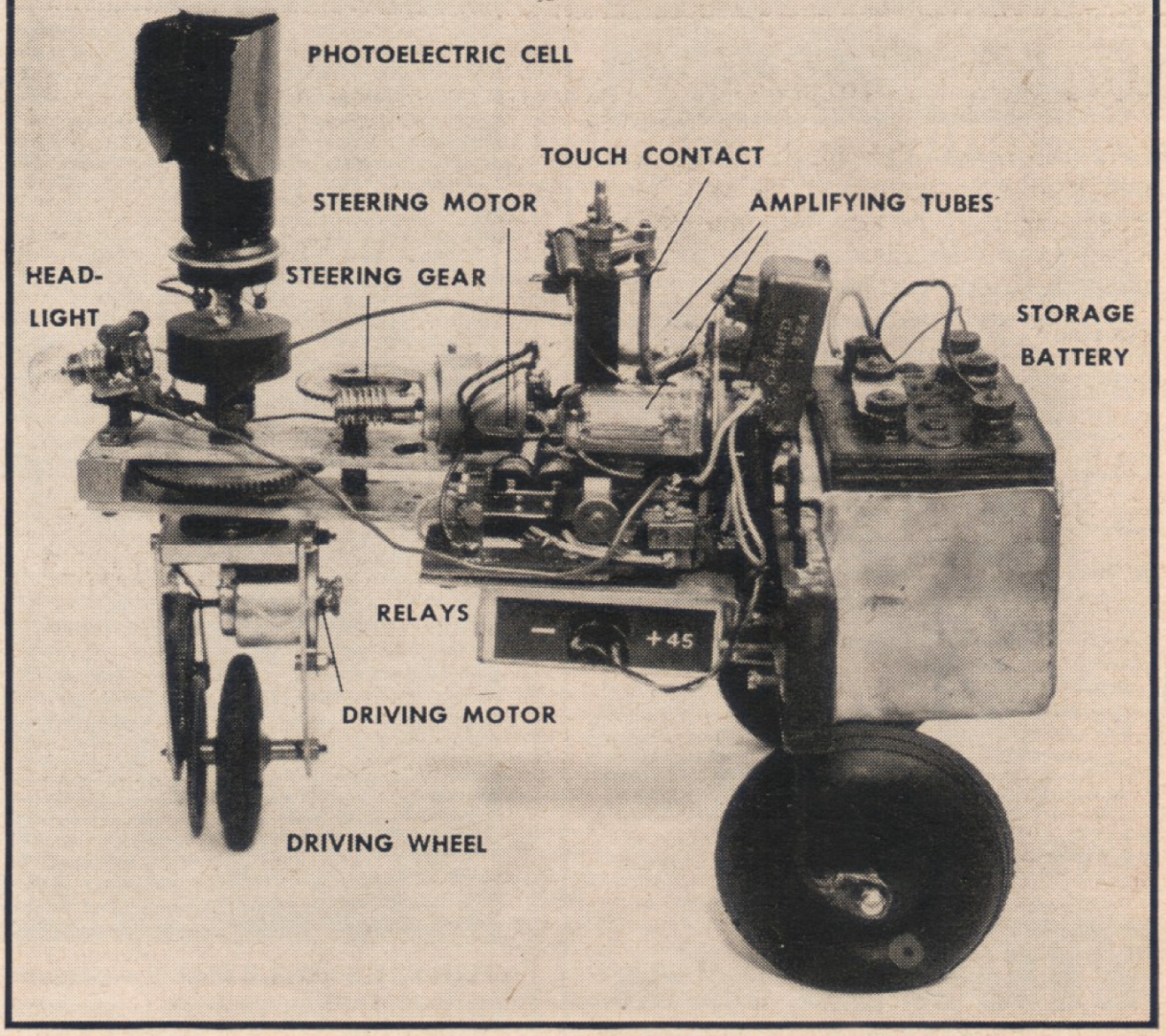
the ability to acquire and apply knowledge and skills

1943: Alan Turing and Grey Walter

- Context : After cracking ENIGMA, before ENIAC.
- Alan Turing, mathematician, tackled the concept of machines mathematically. This formed the foundation for cracking ENIGMA.
- Turing came up with the Turing Test , a test of a machine's ability to exhibit intelligent behavior indistinguishable from that of a human.

1943: Alan Turing and Grey Walter

- Grey Walter, neurologist and cyberneticist, built some of the first robots.
- Proved that rich connections between small numbers of brain cells can result in very complex behaviors. Essentially proving that the secret to how the brain works lies in the way it is wired up.

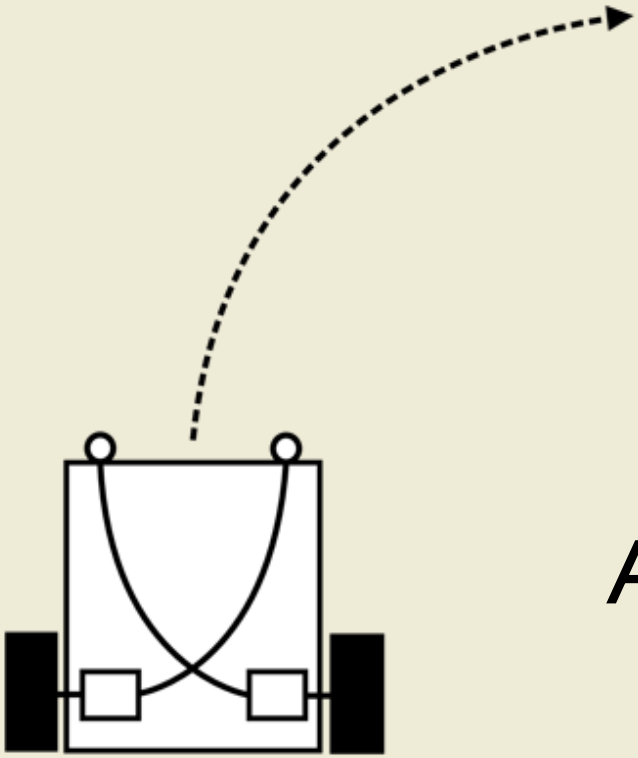


UNDER TURTLE'S SHELL are organs sensitive to both light and touch. They send electrical impulses to relays and tubes that control mechanical creature's two motors.

1958: Valentino Braitenberg

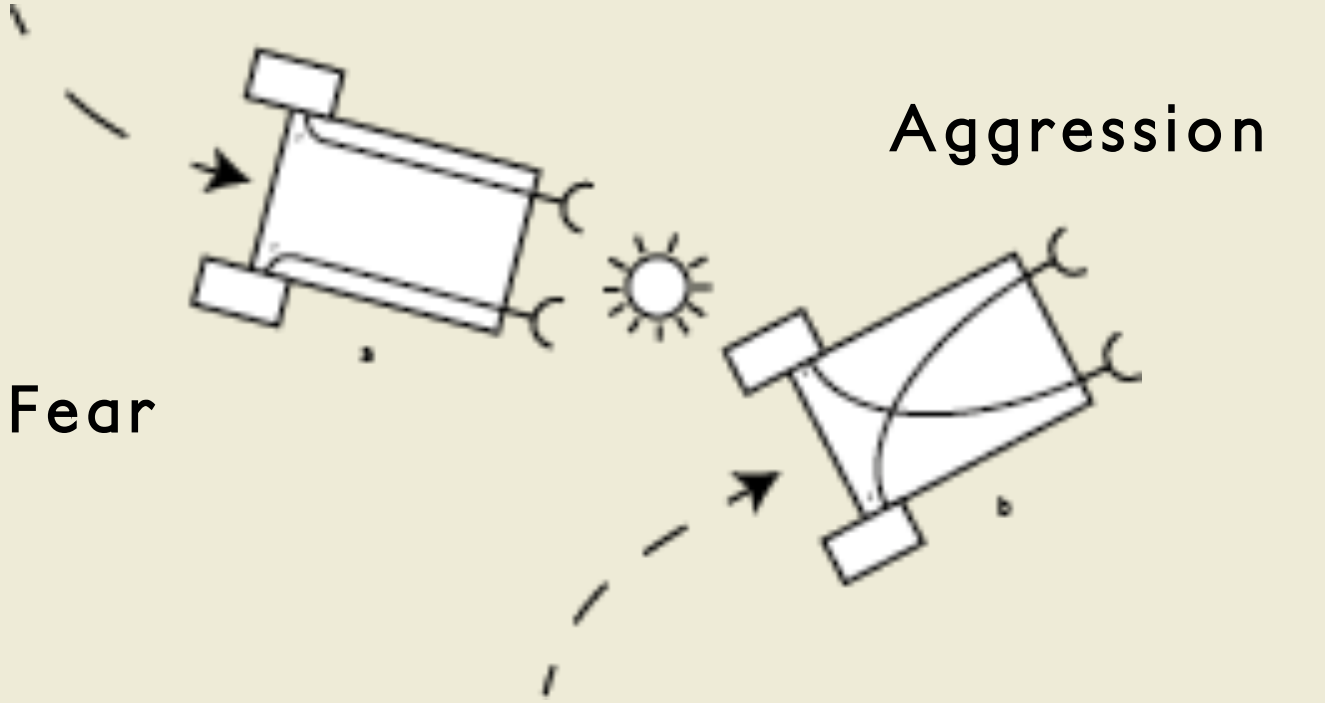
- Neuroscientist, cyberneticist.
- Invented Braitenberg vehicles, coincidentally a generalized framework around the work of Walter Grey on his tortoise robots.
- Braitenberg vehicles were thought experiments in which the complex behavior generated by simple machines was studied.

1958: Valentino Braitenberg



Aggression

1958: Valentino Braitenberg



1958: Valentino Braitenberg

- These simple vehicles exhibit very complicated behaviors.
- When vehicles are made complex, the complexity of behaviors increases exponentially.
- What would 100 billion neurons exhibit?

Neural Networks: Coming Up

1973: The AI Winter

- Millions in funding had been spent, with nothing to show for it.
- People believed that machines would only be capable of an amateur level of chess at most.
- Funding for the industry stopped, beginning what came to be known as the AI winter.

Elephants Don't Play Chess

1990: The Bottom-Up Approach

- Elephants are known to have superior intelligence, and yet they do not play chess. Our view of AI was wrong.
- People wanted AI that achieved specific goals, yet no foundation was laid yet.
- Rodney Brooks helped drive a revival of the bottom-up approach to AI. Starting with the fundamentals.

1997: Deep Blue

- Gary Kasparov lost a game of chess to a computer.
- Except this wasn't a display of true intelligence, only one of brute-forcing highly specific problems.

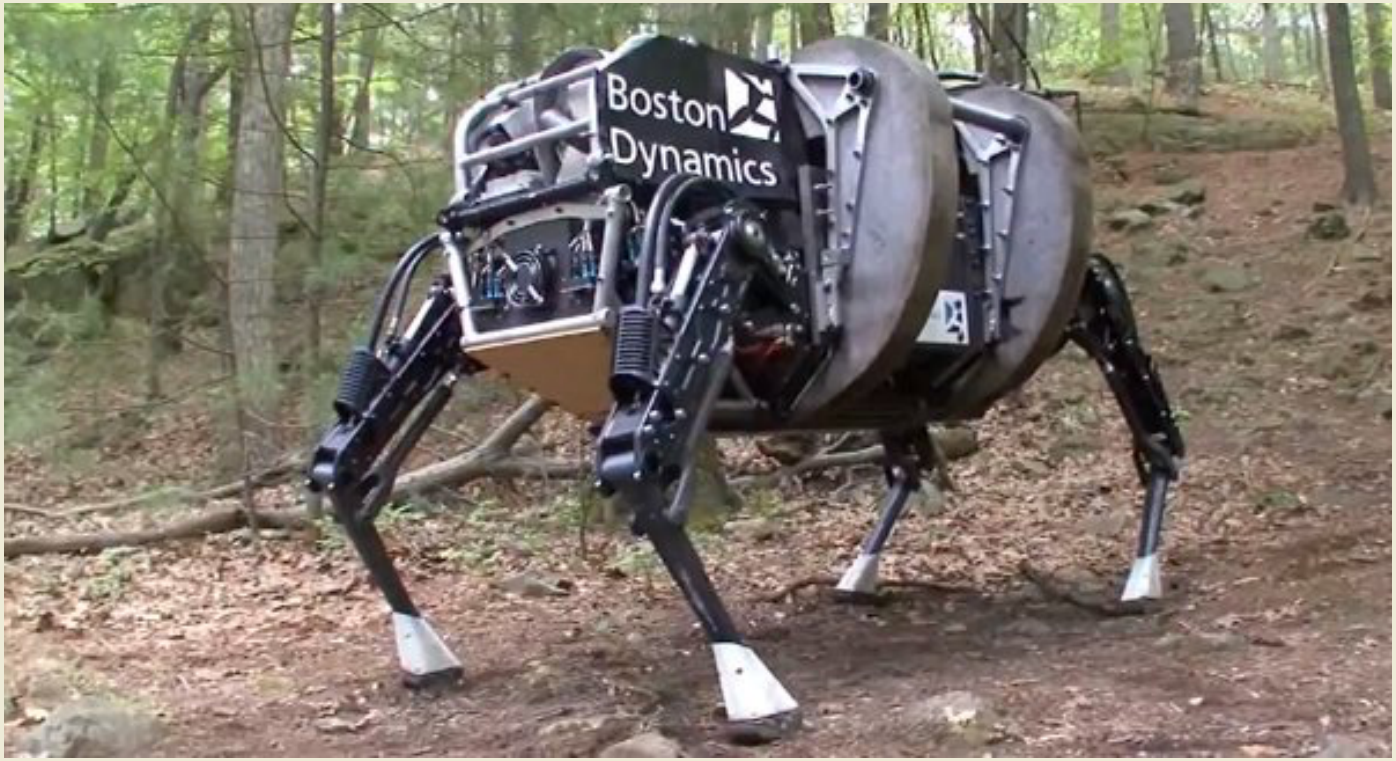
Problem

Takeaway: We cant try every possible solution to find best one. Need a more efficient way to search the space. Need optimization techniques.

2005: Autonomous Robots

- Boston Dynamics BIG DOG
- iRobot explosive sniffing and disposal robots

2005: Autonomous Robots



2005: Autonomous Robots

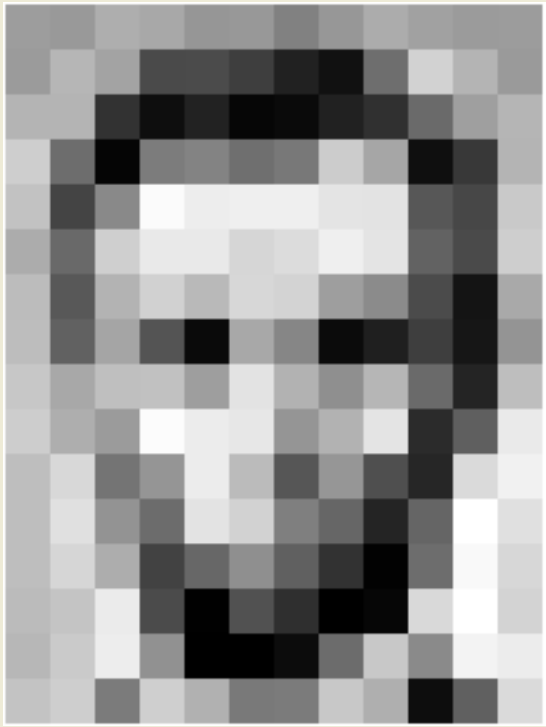
2005: Self Driving Car Race Begins

Computer Vision

Computer Vision

- Extracting information from images
- Object detection, object classification

Computer Vision



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

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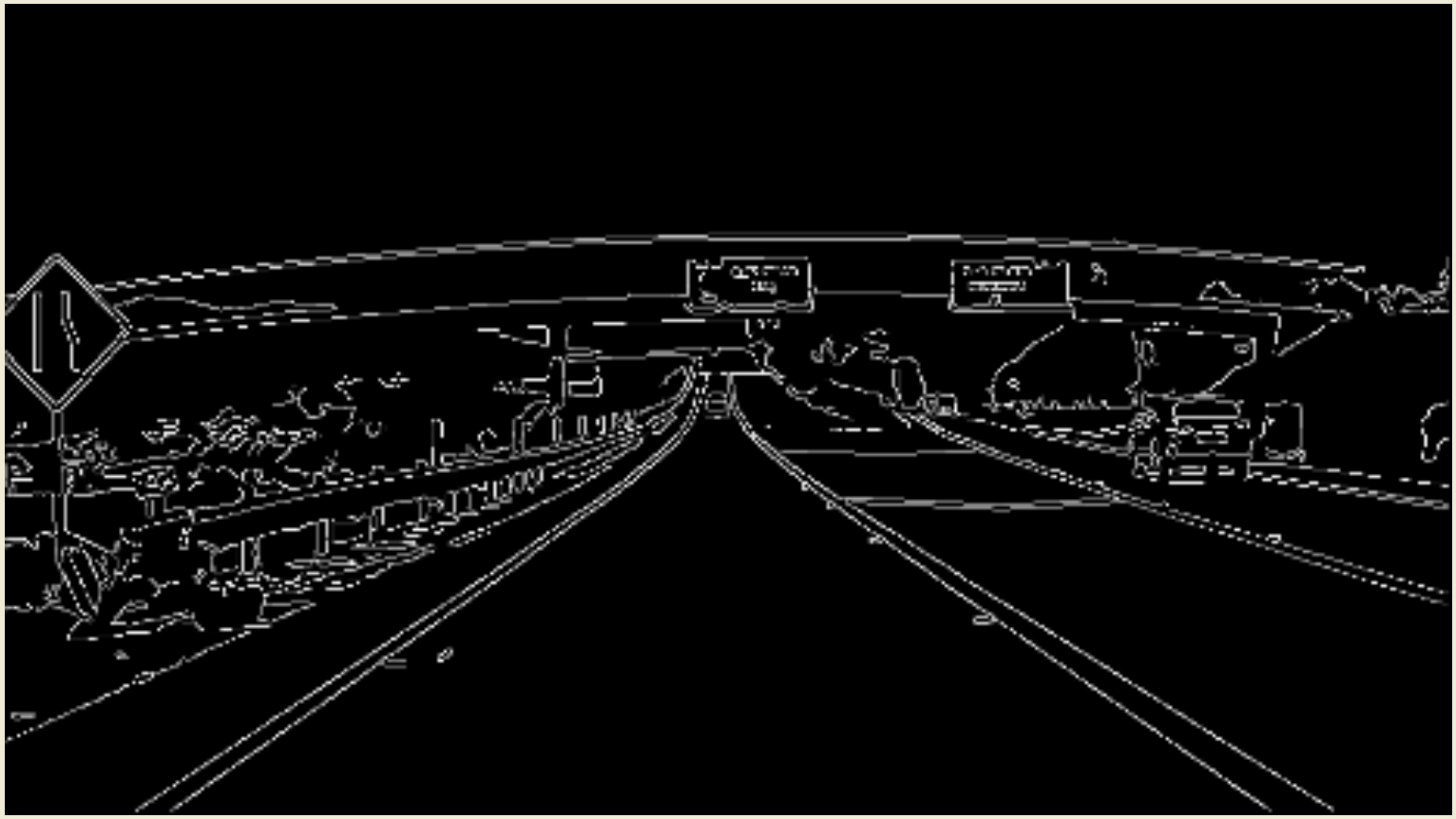
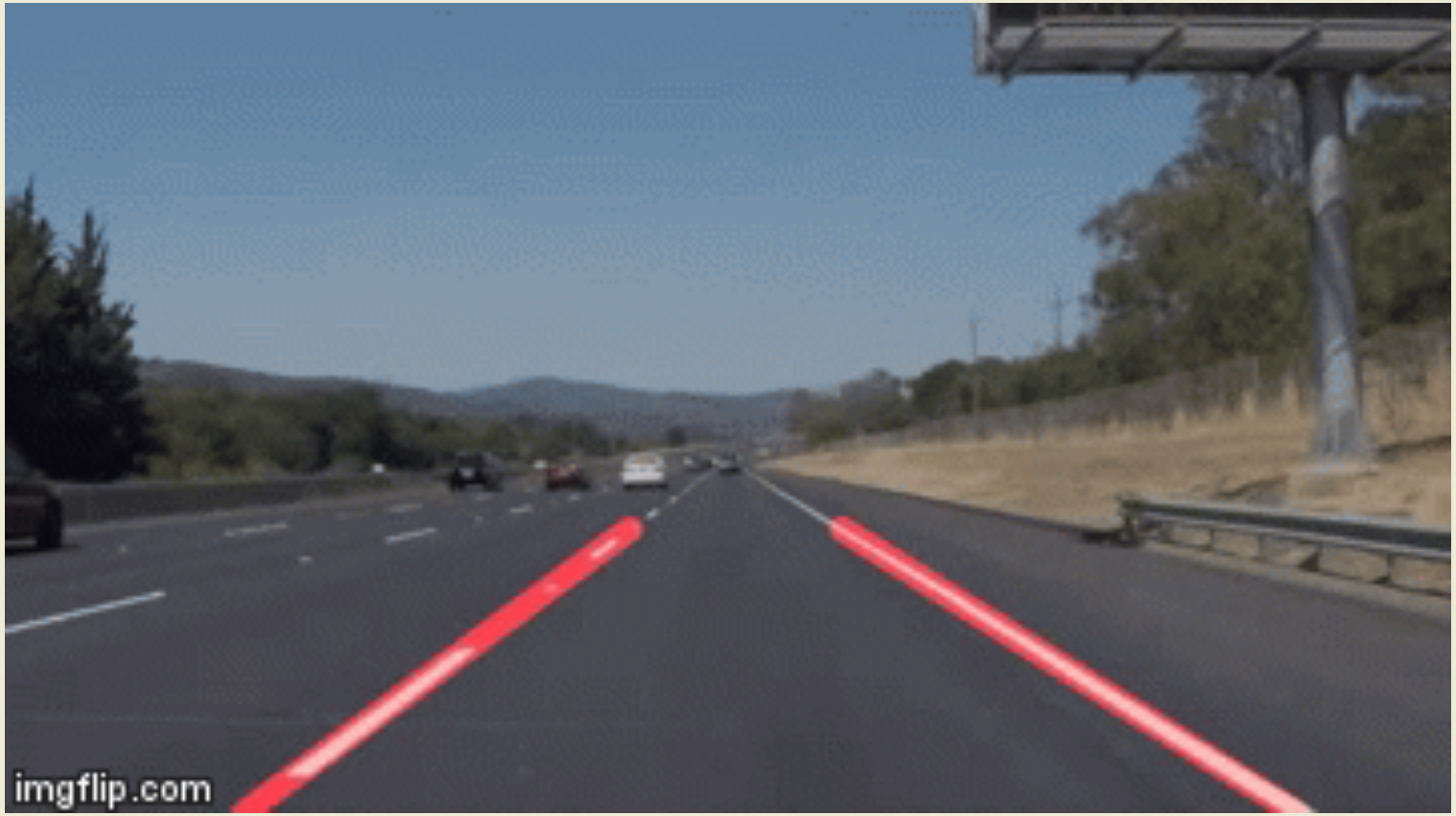
Computer Vision

- Let's work through the problem of steering a car, given only a video feed of the road

Computer Vision



Computer Vision



Computer Vision

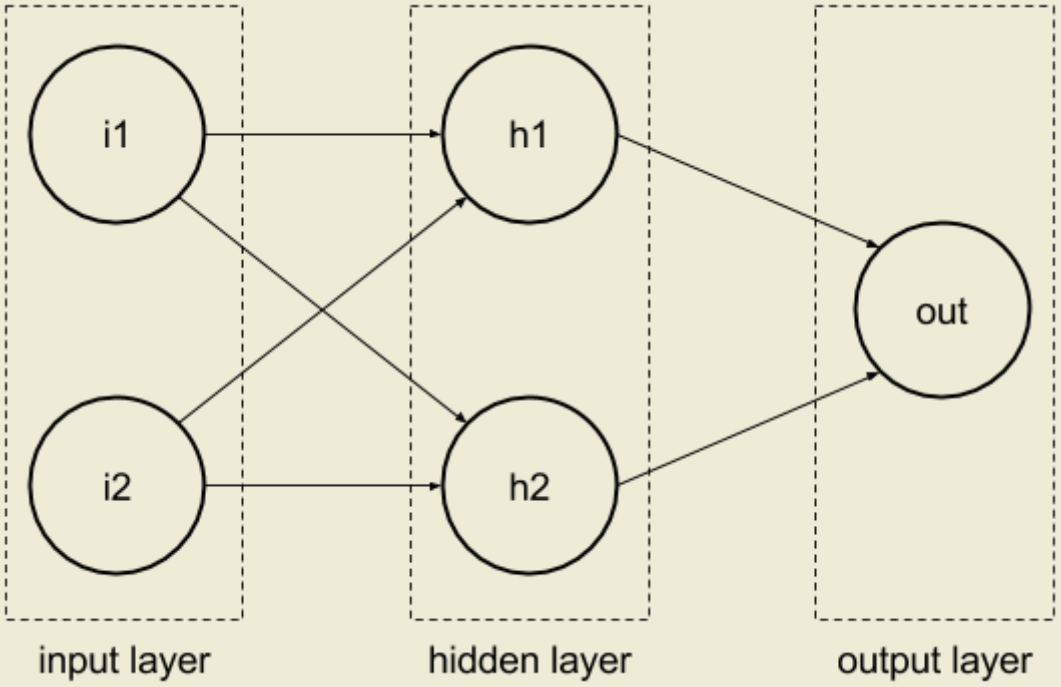
- How do we learn to drive?
- More specifically, how do WE understand what we see? No explicit math, so how does this work?

Neural Networks

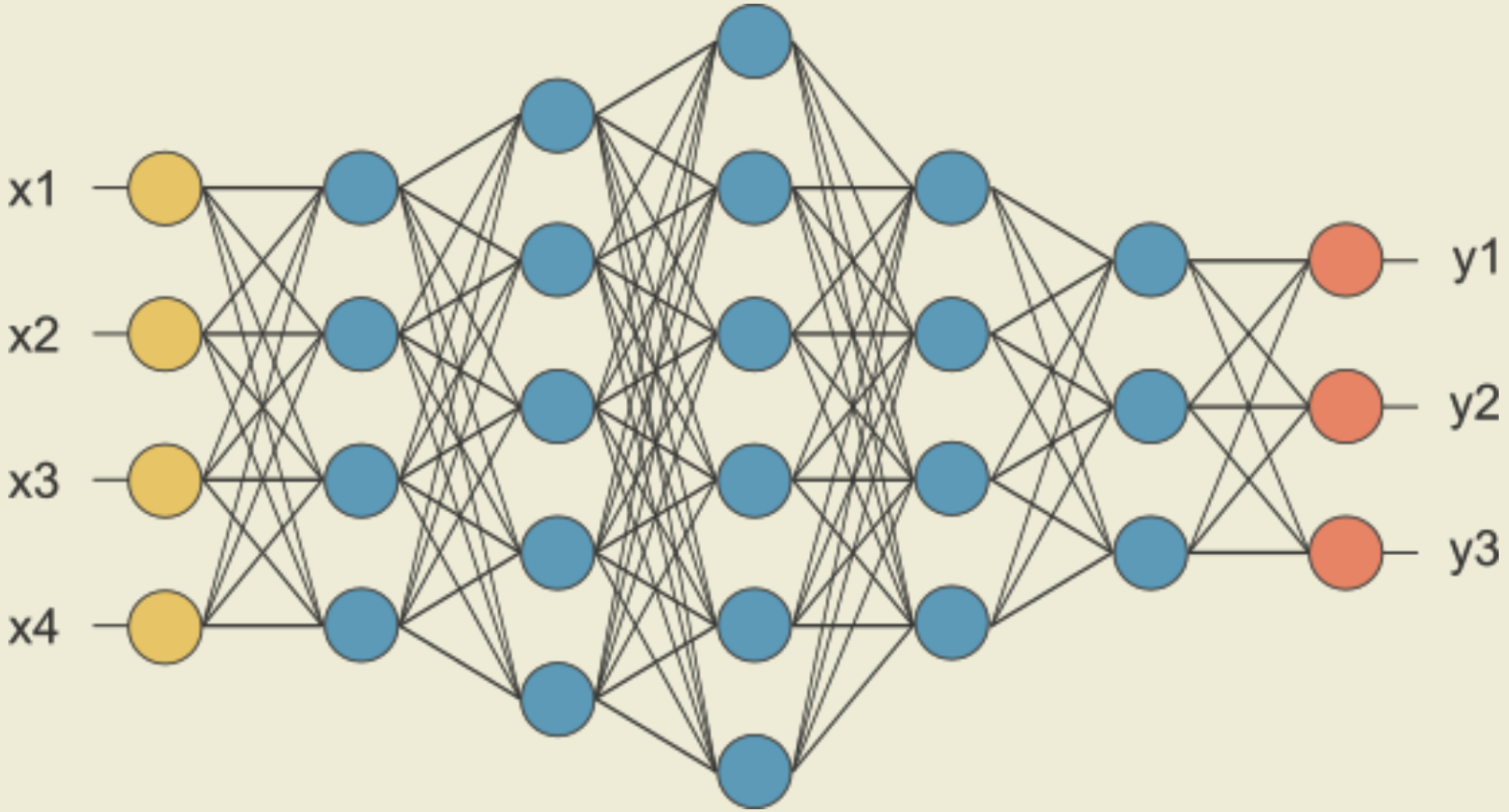
Neural Networks

- Inspired by the biological neuron, an attempt to create virtual brains

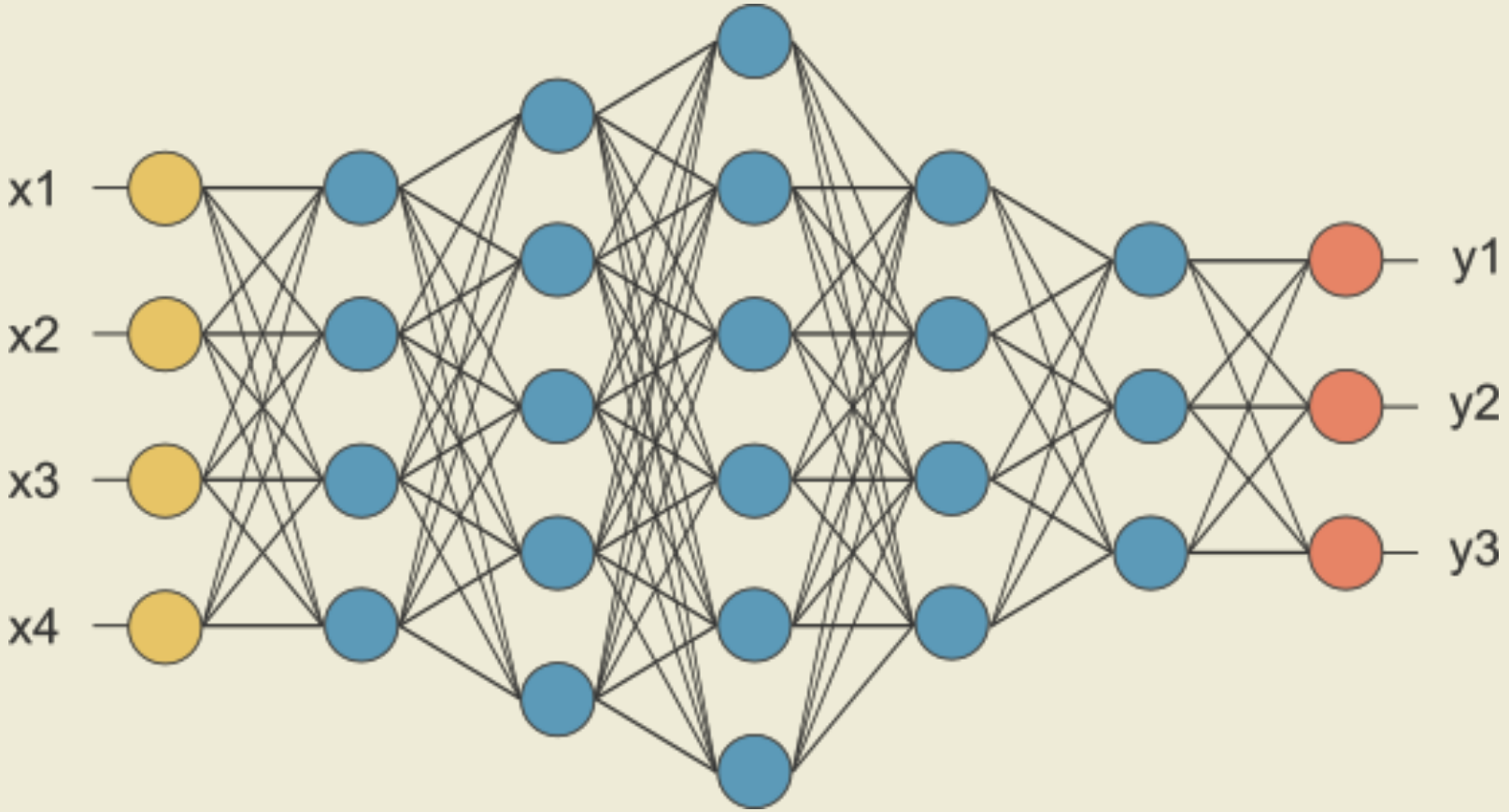
Neural Networks



Neural Networks



Neural Networks



Neural Networks

- Used in computer vision, classification tasks, regression tasks

- Regression: predicting numbers from numbers
- Classification: predicting categories from numbers

2008: Accurate Speech Recognition

- Decades of investment in speech recognition never got above 80% accuracy
- Google crowd-sourced data at immense volumes and trained neural networks to achieve around 92% accuracy

Applications

Dispatch – Automated Grocery Shopping and Delivery

Generative Design

Generative Design

Generative Design

Optimization

Problem

- Find a hidden sentence, given only a function that measures the "distance" between your guess and the actual sentence.
- Distance is measured between characters as the integer value of a character minus that of the other, in absolute value. d('A', 'B') = 1, d('A', 'Z') = 26. For more than 1 letter, just average distances.

Problem

- Example guess 1 : ElUhhukt ndirntli wyds kjoess. (26 letters)
- Another guess 2: Animals like to eat freely. (26 letters)
- d (guess 1, S) = 0.5
- d (guess 2, S) = 2.5

Problem

- Need an intelligent program that can SEARCH the SPACE of solutions to find my GOAL.
- How large is the space ? In other words, how many solutions are there ?

Problem

$$27^{26}$$

=164232030000000000000000000000000000000 solutions