UArizona DataLab Workshop Series

Deep Dive Into Deep Learning

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Data Science Institute
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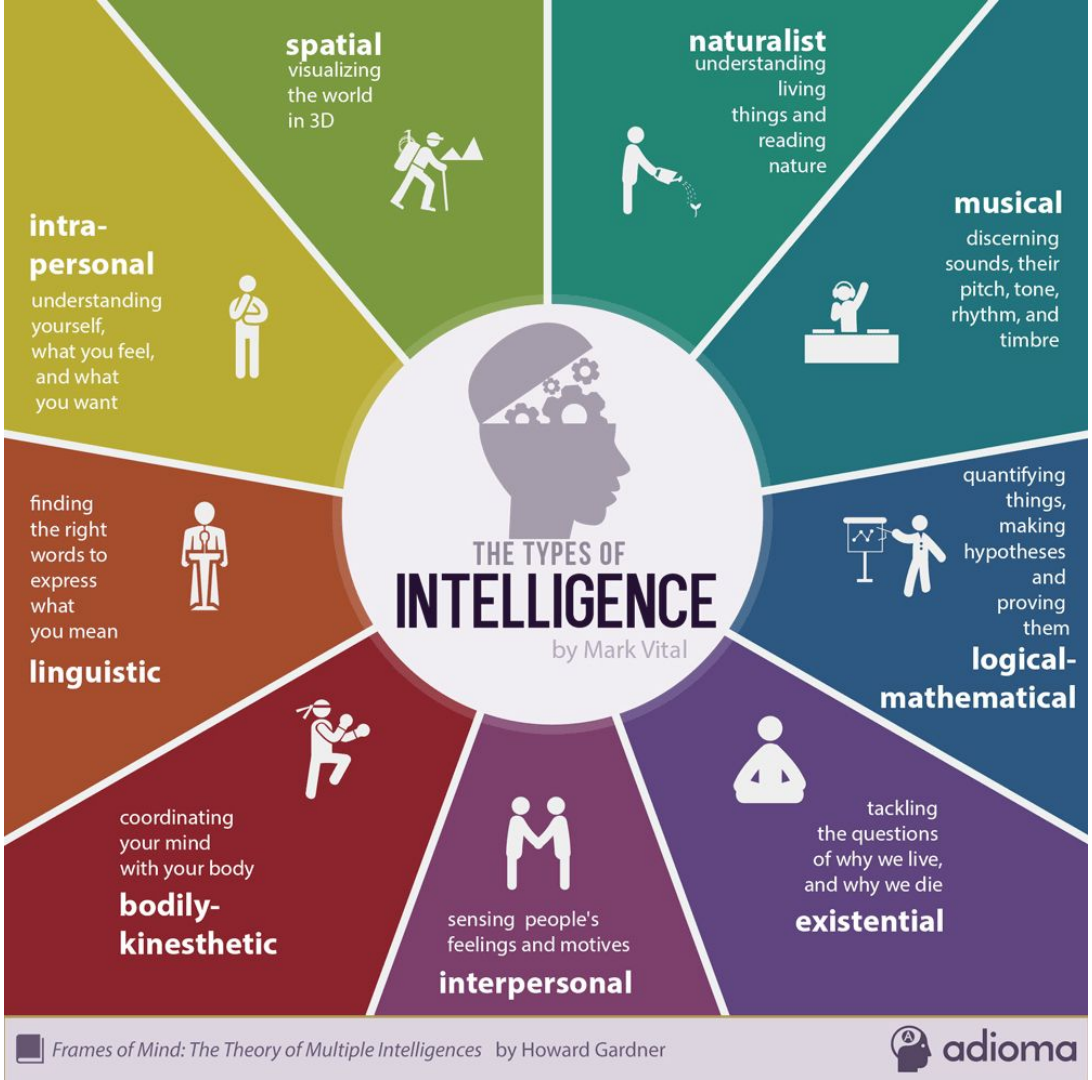
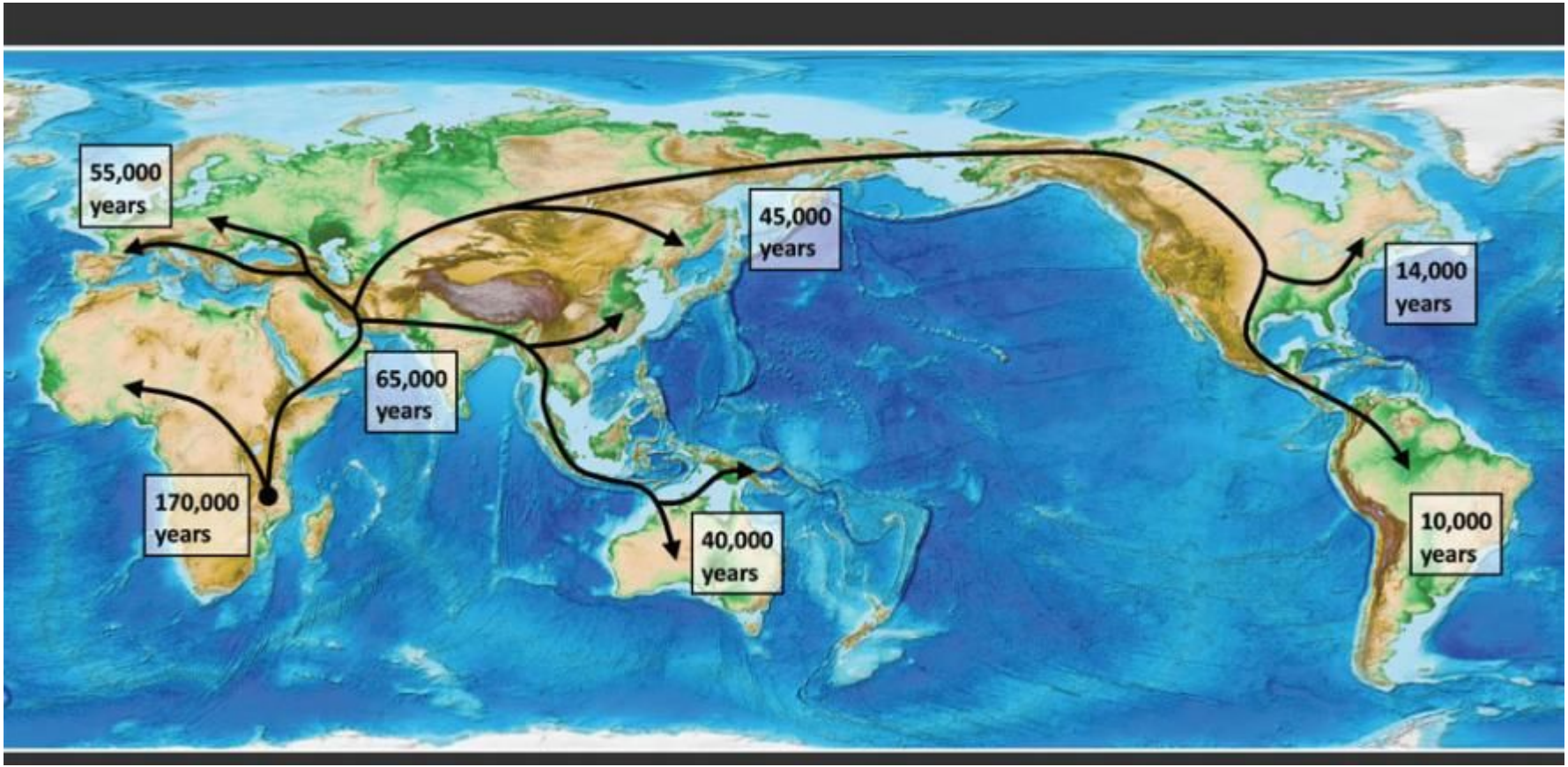
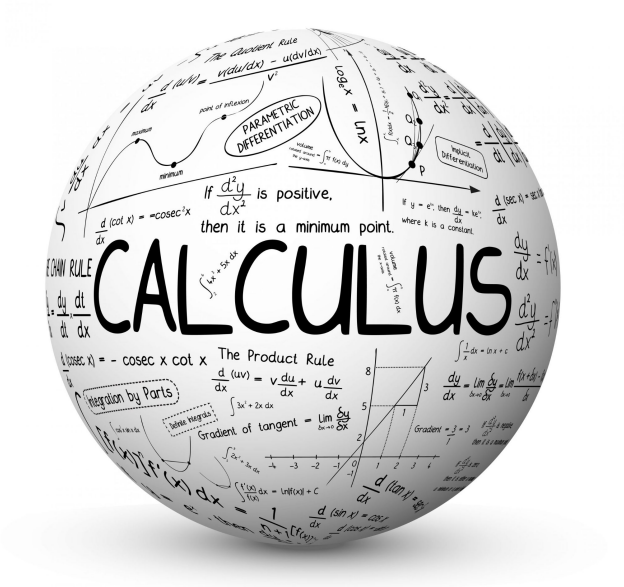
RESEARCH, INNOVATION & IMPACT
Data Science Institute

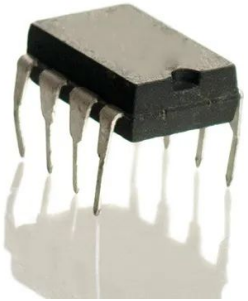
What is Intelligence?

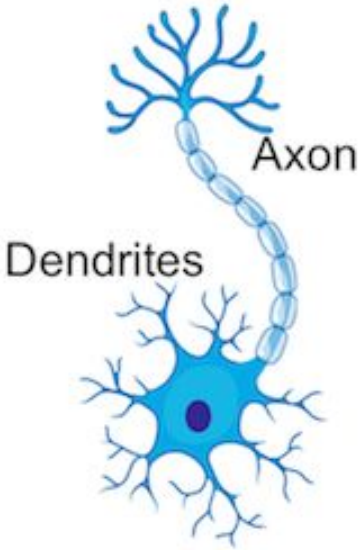

spatial
visualizing the world in 3D
naturalist
understanding living things and reading nature
musical
discerning sounds, their pitch, tone, rhythm, and timbre
intra-personal
understanding yourself, what you feel, and what you want
THE TYPES OF
INTELLIGENCE
by Mark Vital
quantifying things, making hypotheses and proving them
logical-mathematical
finding the right words to express what you mean
linguistic
coordinating your mind with your body
bodily-kinesthetic
sensing people's feelings and motives
interpersonal
tackling the questions of why we live, and why we die
existential
Frames of Mind: The Theory of Multiple Intelligences by Howard Gardner
adioma

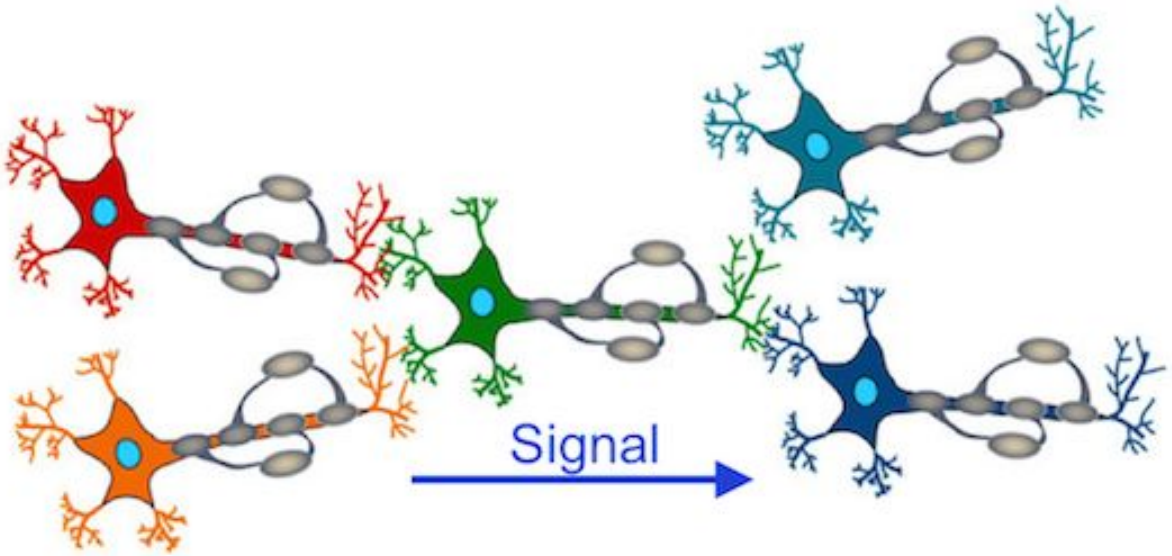

55,000
years
45,000
years
14,000
years
65,000
years
170,000
years
40,000
years
10,000
years

Approximations of Continuous World Using Discrete Tools

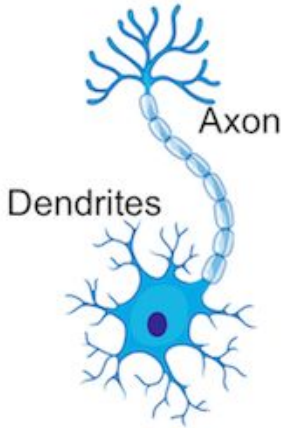


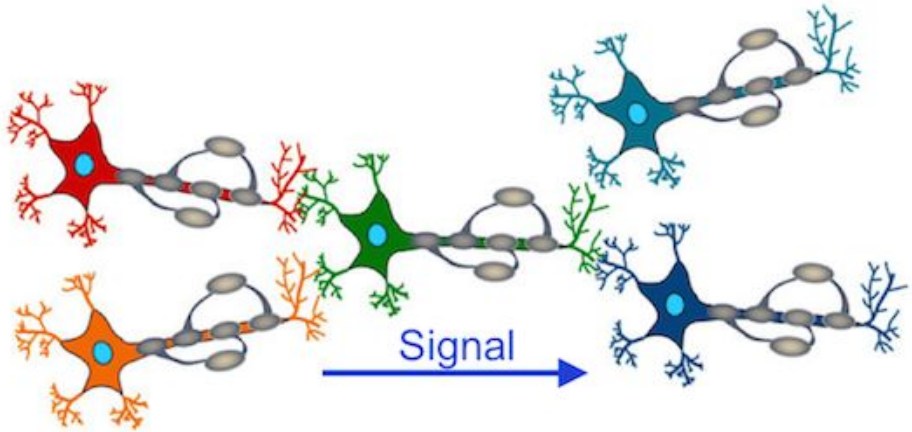



Axon
Dendrites

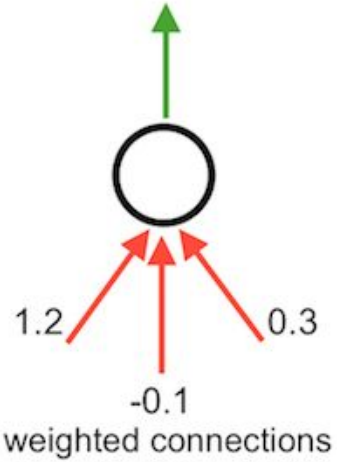

Signal

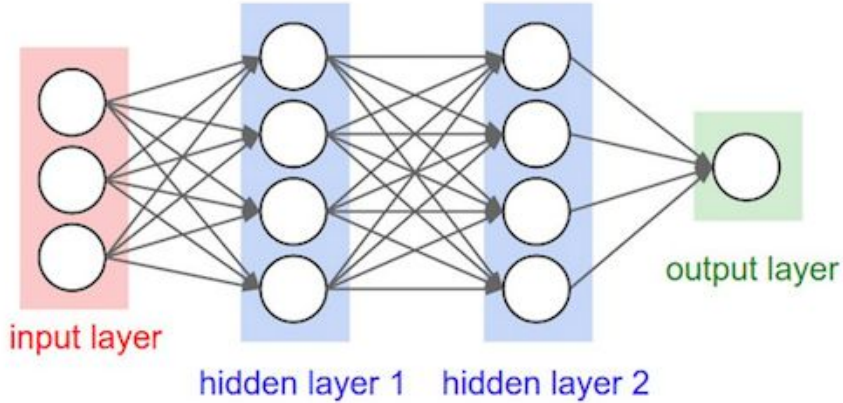
Biology



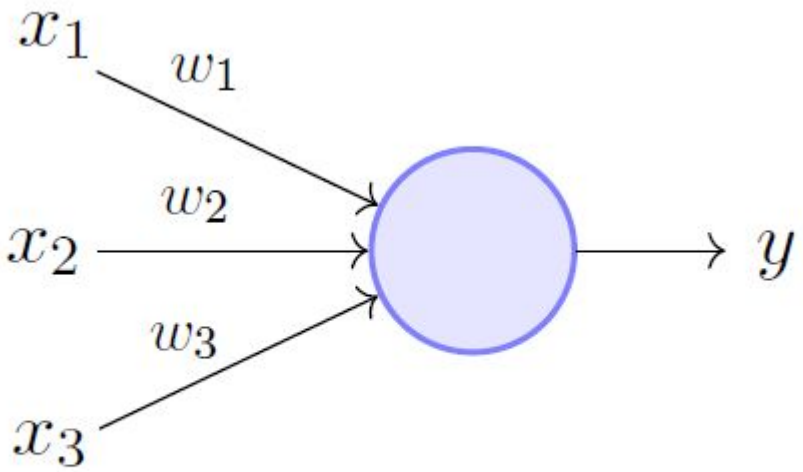


Deep learning





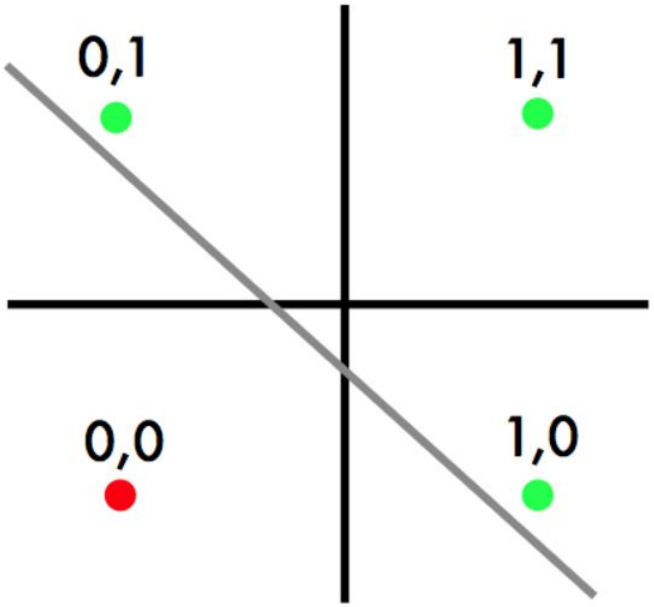
Perceptron: Single Layer Neural Network



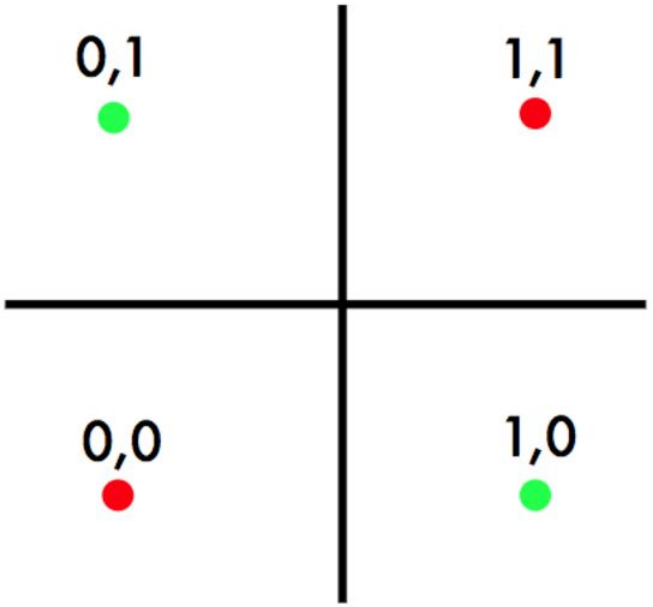
Perceptron Model (Minsky-Papert in 1969)


KASPAROV VS
DEEP BLUE
the rematch
1:57
1:58

The XO

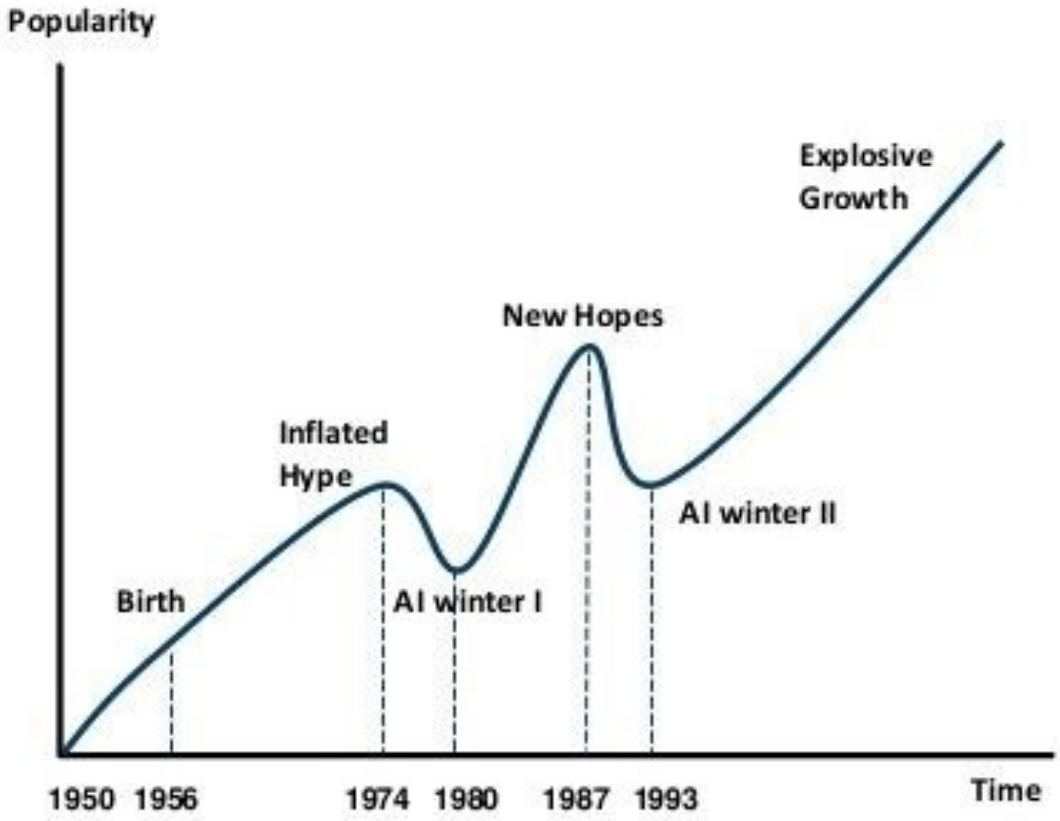


OR



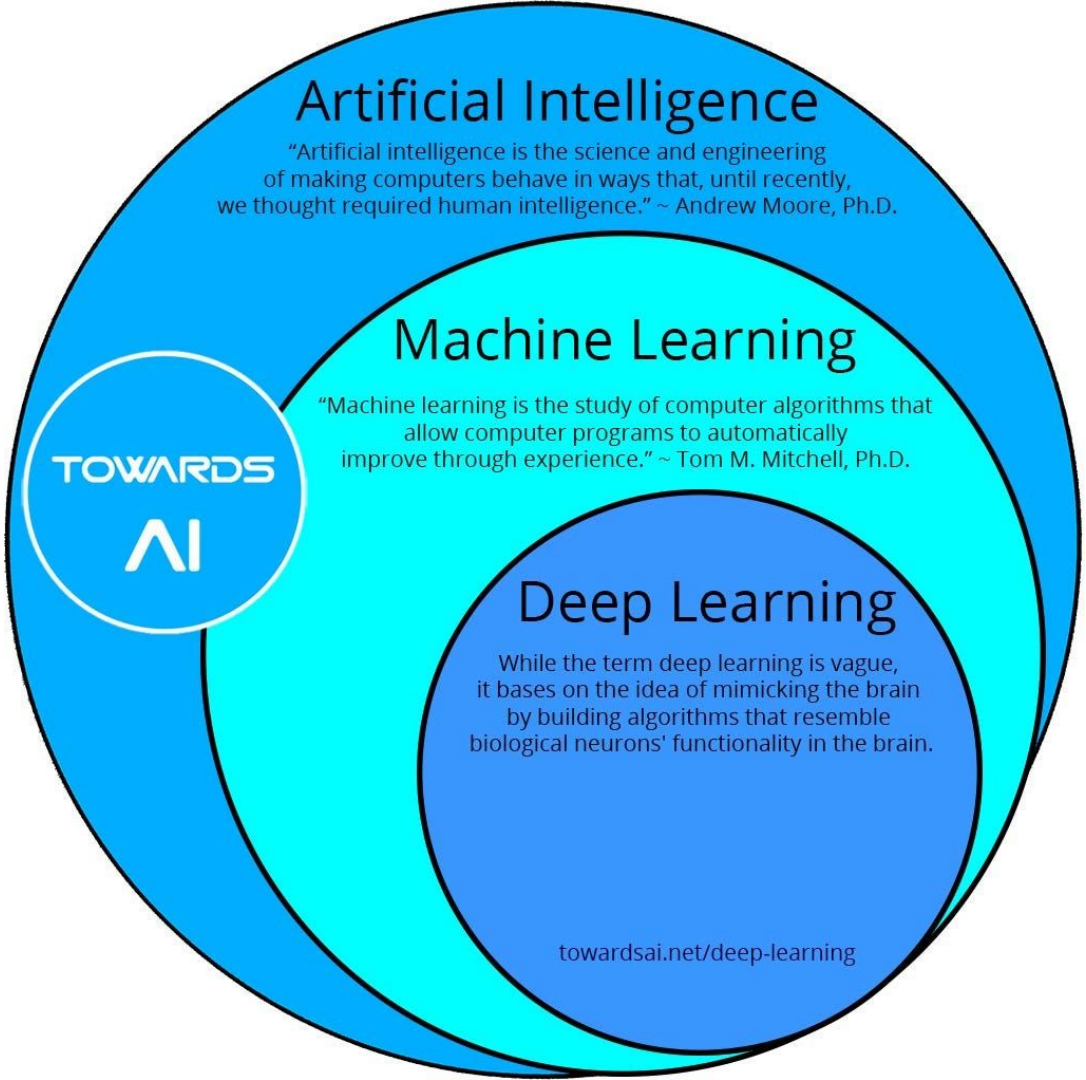
XOR

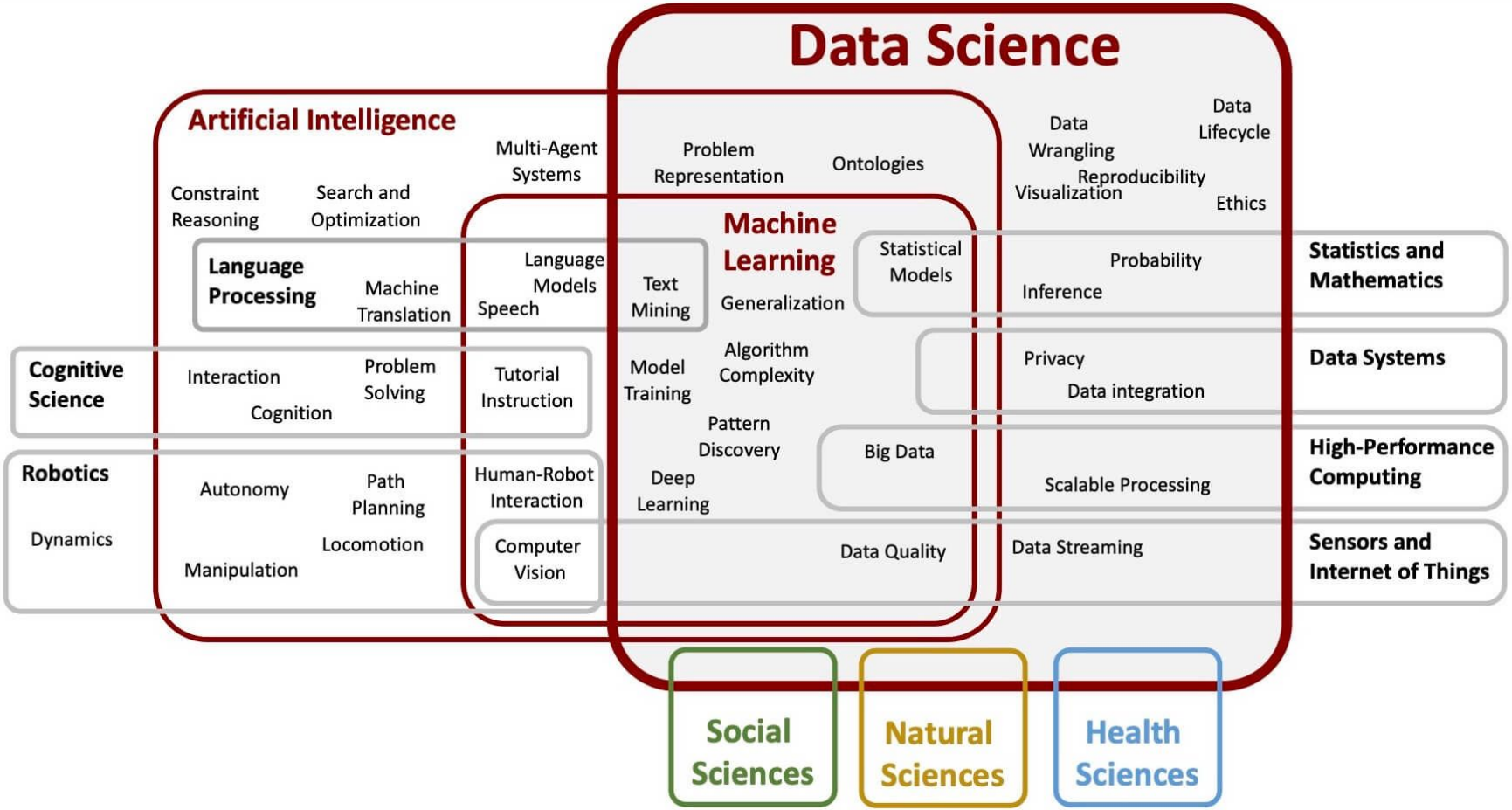
AI HAS A LONG HISTORY OF BEING "THE NEXT BIG THING"...



Timeline of AI Development

- **1950s-1960s**: First AI boom - the age of reasoning, prototype AI developed
- **1970s**: AI winter I
- **1980s-1990s**: Second AI boom: the age of Knowledge representation (appearance of expert systems capable of reproducing human decision-making)
- **1990s**: AI winter II
- **1997**: Deep Blue beats Gary Kasparov
- **2006**: University of Toronto develops Deep Learning
- **2011**: IBM's Watson won Jeopardy
- **2016**: Go software based on Deep Learning beats world's champions


Artificial Intelligence
"Artificial intelligence is the science and engineering
of making computers behave in ways that, until recently,
we thought required human intelligence." ~ Andrew Moore, Ph.D.
Machine Learning
"Machine learning is the study of computer algorithms that
allow computer programs to automatically
improve through experience." ~ Tom M. Mitchell, Ph.D.
TOWARDS
AI
Deep Learning
While the term deep learning is vague,
it bases on the idea of mimicking the brain
by building algorithms that resemble
biological neurons' functionality in the brain.
towardsai.net/deep-learning


Data Science
Artificial Intelligence
Multi-Agent Systems
Problem Representation
Ontologies
Data Wrangling
Data Lifecycle
Reproducibility
Visualization
Ethics
Constraint Reasoning
Search and Optimization
Machine Learning
Language Processing
Machine Translation
Language Models
Speech
Text Mining
Generalization
Statistical Models
Probability
Inference
Statistics and Mathematics
Cognitive Science
Interaction
Problem Solving
Cognition
Tutorial Instruction
Model Training
Algorithm Complexity
Privacy
Data integration
Data Systems
Pattern Discovery
Big Data
Robotics
Autonomy
Path Planning
Human-Robot Interaction
Deep Learning
Scalable Processing
High-Performance Computing
Dynamics
Locomotion
Computer Vision
Data Quality
Data Streaming
Sensors and Internet of Things
Manipulation
Social Sciences
Natural Sciences
Health Sciences

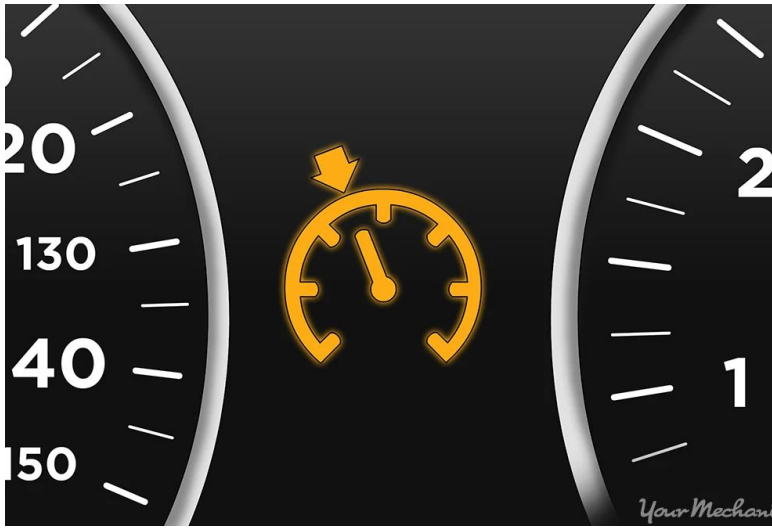
A Quick Deep Dive into Nuts and Bolts of Deep Learning

Core component 1: Loss Function

Qn) Where do you see this sign almost on a daily basis?

Answer

Cruise Control In Cars

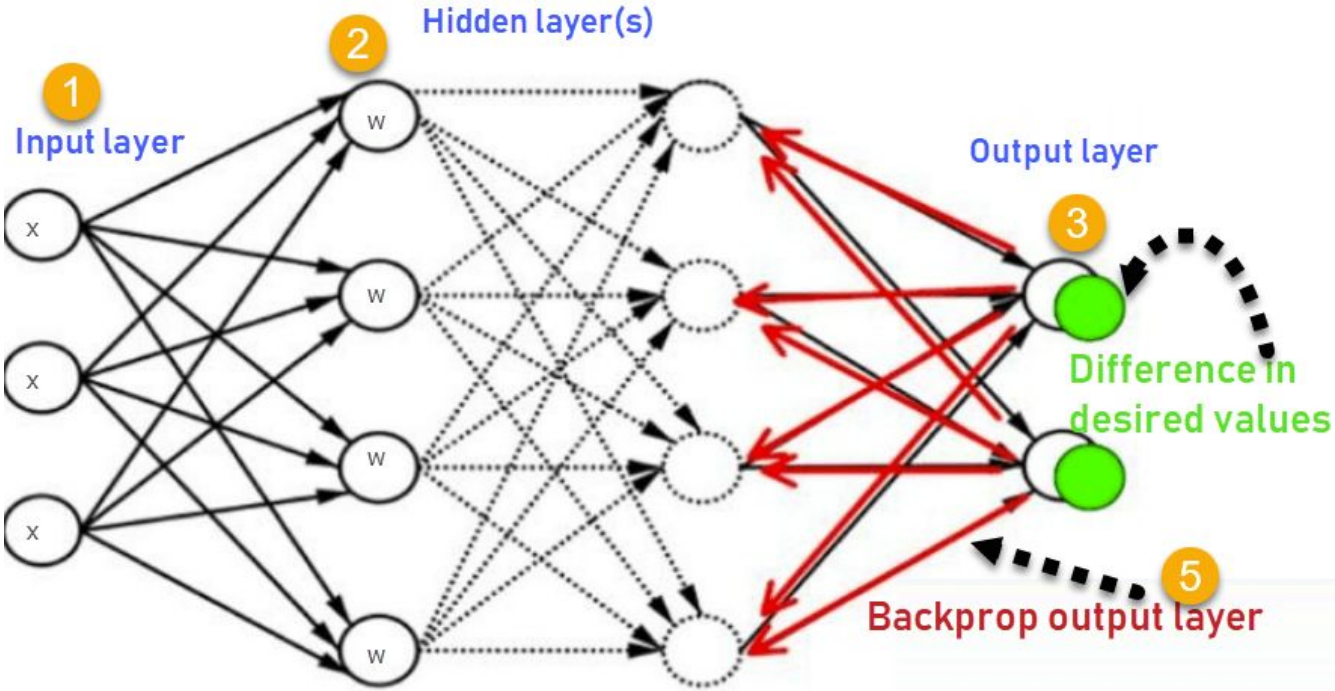


How Does Cruise Control Work?

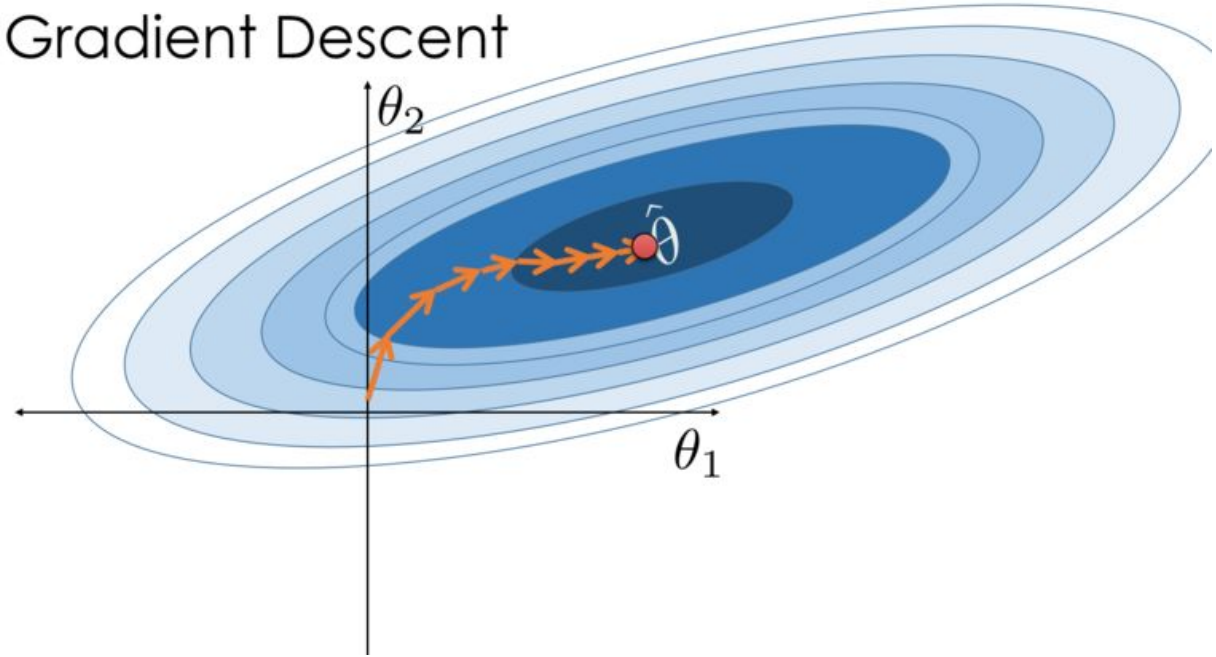
A constant feedback mechanism between
expected speed
and
current speed

Core Component 1: **Loss Function + Back Propagation**

A constant feedback mechanism between expected value and current value

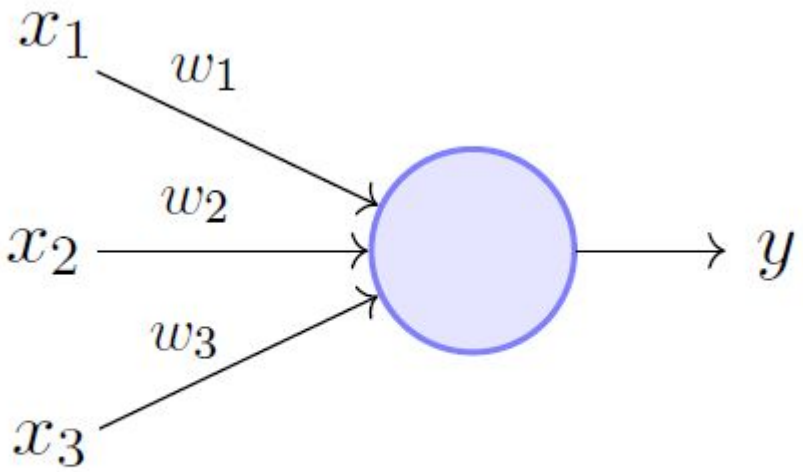


Core Component 2

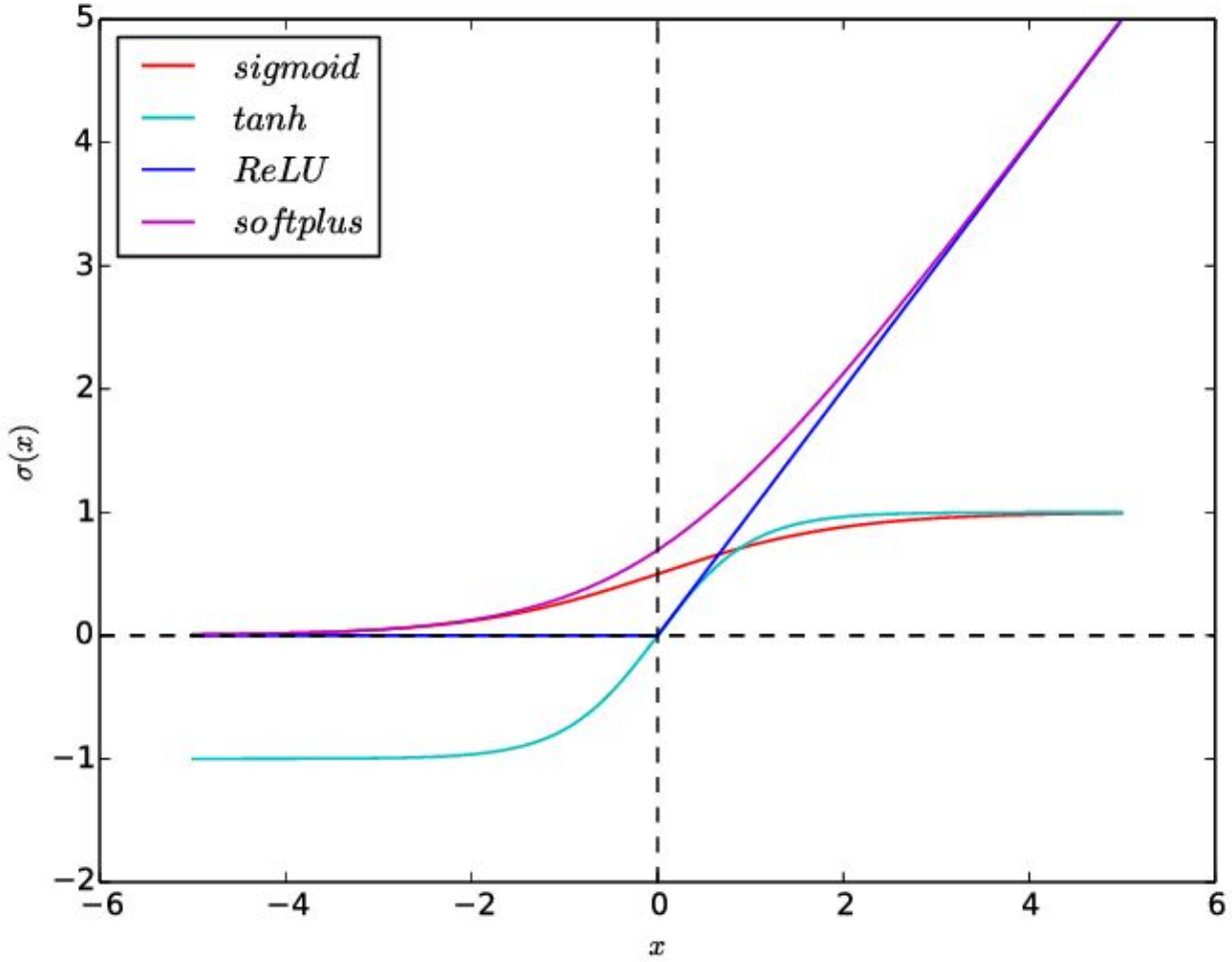


Core Component 3: Activation Function

Perceptron: Single Layer Neural Network

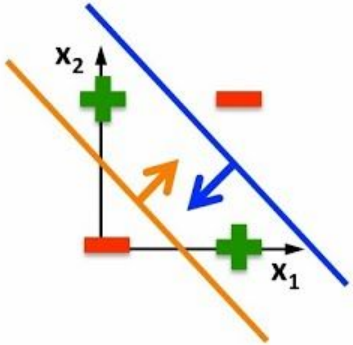


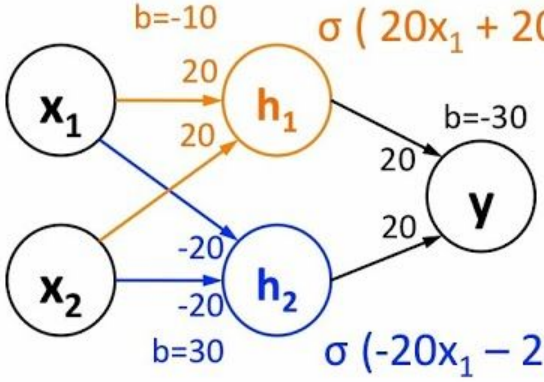
Perceptron Model (Minsky-Papert in 1969)


sigmoid
tanh
ReLU
softplus
$\sigma(x)$
x
5
4
3
2
1
0
−1
−2
−6
−4
−2
0
2
4
6

Solving XOR with a Neural Net

Linear classifiers
cannot solve this





σ(20*0 + 20*0 – 10) ≈ 0
σ(20*1 + 20*1 – 10) ≈ 1
σ(20*0 + 20*1 – 10) ≈ 1
σ(20*1 + 20*0 – 10) ≈ 1

σ (-20*0 – 20*0 + 30) ≈ 1
σ (-20*1 – 20*1 + 30) ≈ 0
σ (-20*0 – 20*1 + 30) ≈ 1
σ (-20*1 – 20*0 + 30) ≈ 1

σ (20*0 + 20*1 – 30) ≈ 0
σ (20*1 + 20*0 – 30) ≈ 0
σ (20*1 + 20*1 – 30) ≈ 1
σ (20*1 + 20*1 – 30) ≈ 1

Core Component 4: Architecture

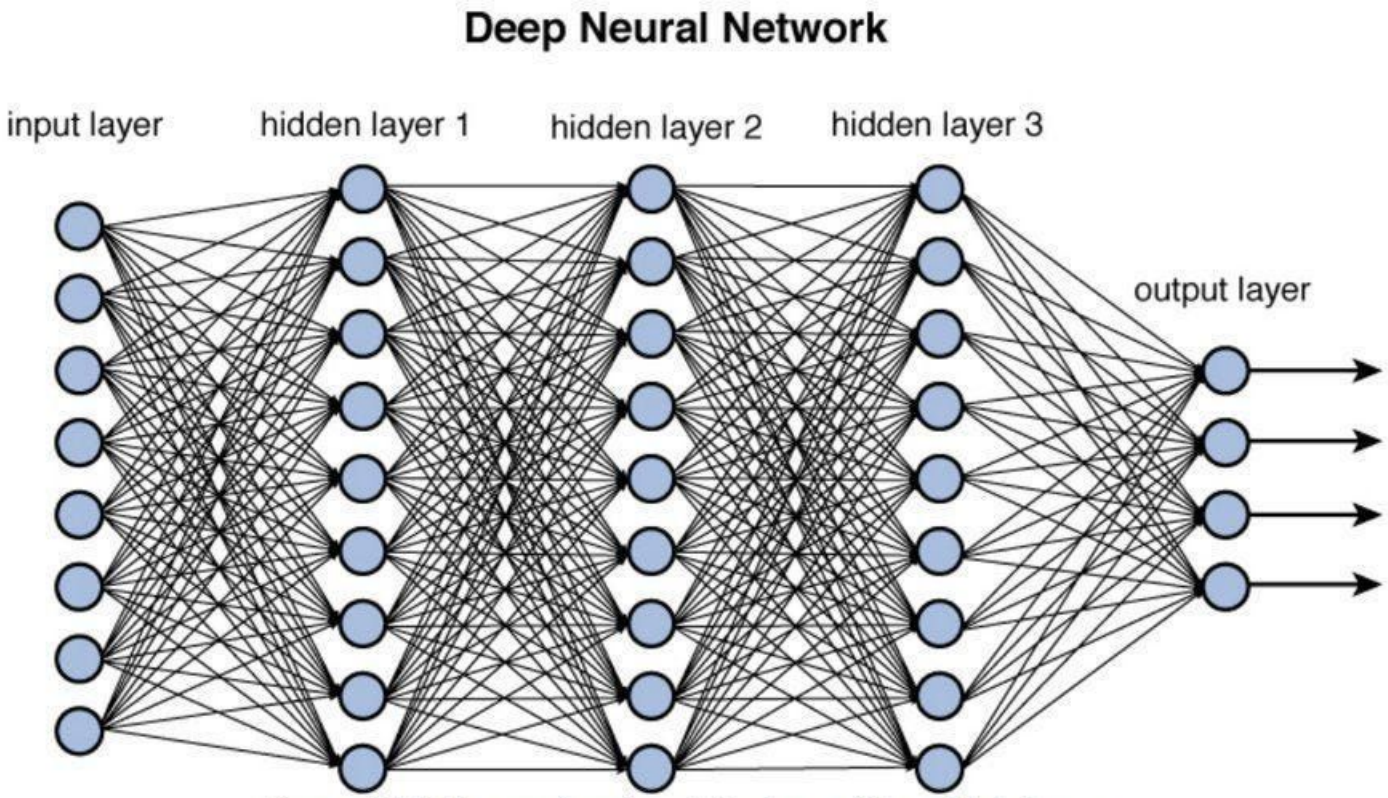


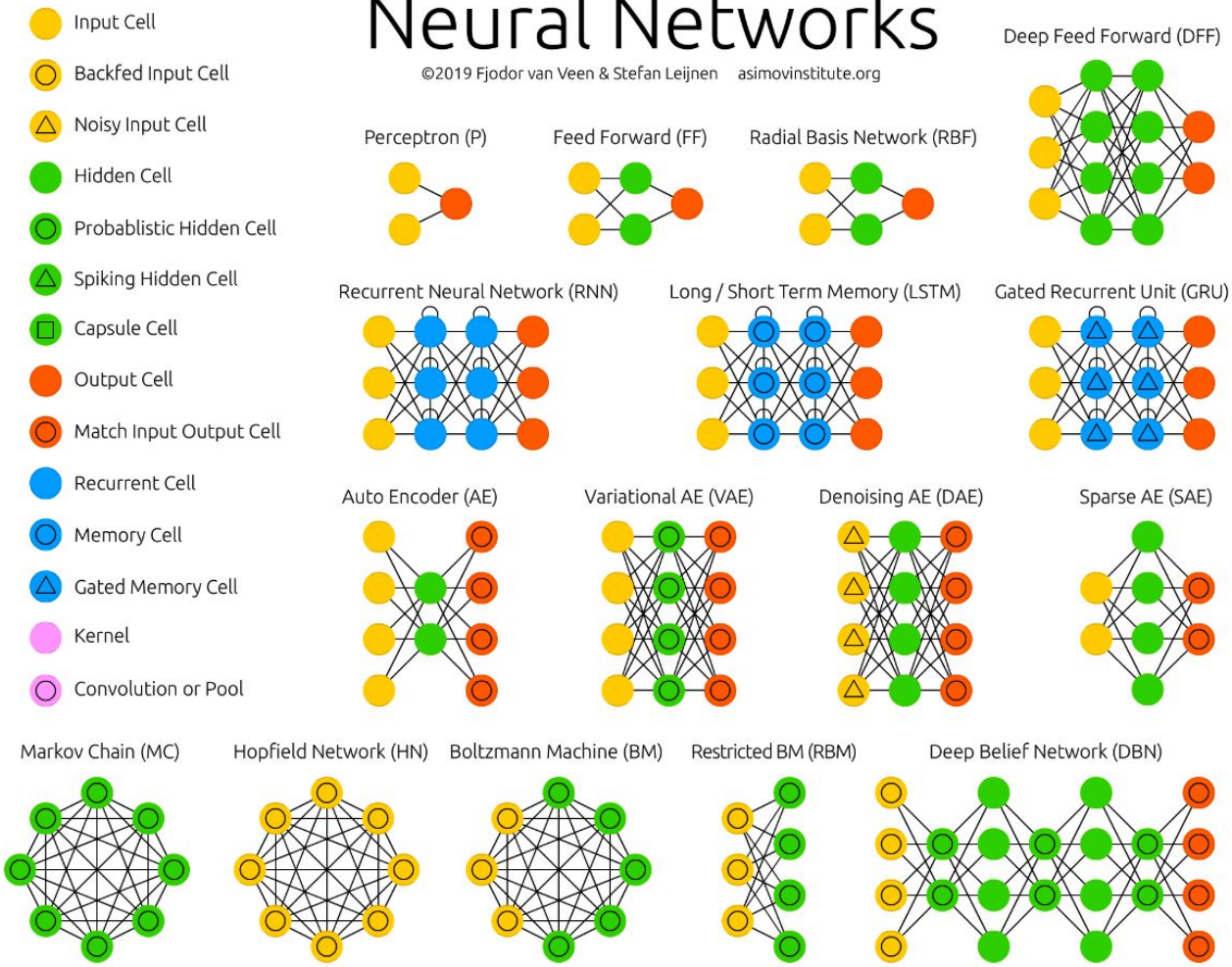
Figure 12.2 Deep network architecture with multiple layers.

A mostly complete chart of

Neural Networks

 asimovinstitute.org

- Input Cell
- Backfed Input Cell
- Noisy Input Cell
- Hidden Cell
- Probablistic Hidden Cell
- Spiking Hidden Cell
- Capsule Cell
- Output Cell
- Match Input Output Cell
- Recurrent Cell
- Memory Cell
- Gated Memory Cell
- Kernel
- Convolution or Pool



Core Component 5: Bag of Words

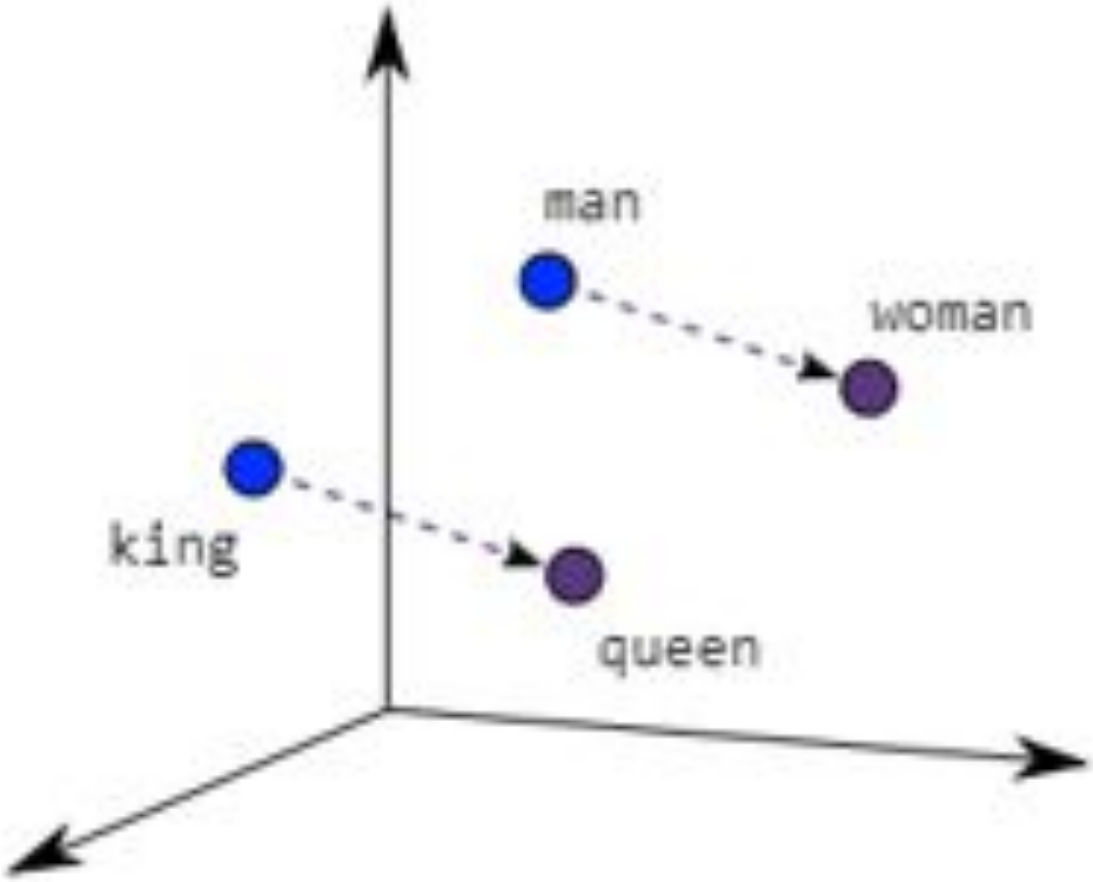
I love this movie! It's sweet, but with satirical humor. The dialogue is great and the adventure scenes are fun... It manages to be whimsical and romantic while laughing at the conventions of the fairy tale genre. I would recommend it to just about anyone. I've seen it several times, and I'm always happy to see it again whenever I have a friend who hasn't seen it yet!

it	6
I	5
the	4
to	3
and	3
seen	2
yet	1
would	1
whimsical	1
times	1
sweet	1
satirical	1
adventure	1
genre	1
fairy	1
humor	1
have	1
great	1
…	…

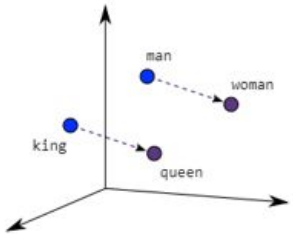
Intuition : Learn Language From Context

I love this movie! It's sweet, but with satirical humor. The dialogue is great and the adventure scenes are fun... It manages to be whimsical and romantic while laughing at the conventions of the fairy tale genre. I would recommend it to just about anyone. I've seen it several times, and I'm always happy to see it again whenever I have a friend who hasn't seen it yet!

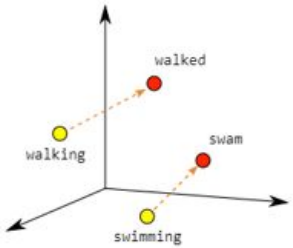
it	6
I	5
the	4
to	3
and	3
seen	2
yet	1
would	1
whimsical	1
times	1
sweet	1
satirical	1
adventure	1
genre	1
fairy	1
humor	1
have	1
great	1
…	…


man
woman
king
queen

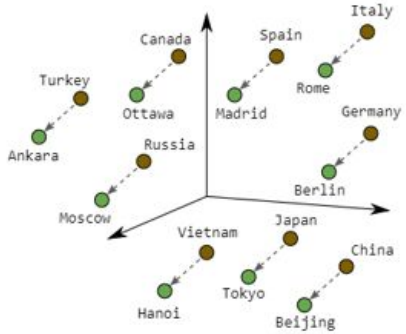
Word2Vec



Male-Female

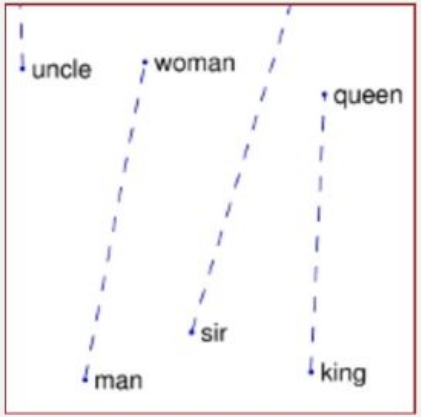


Verb Tense

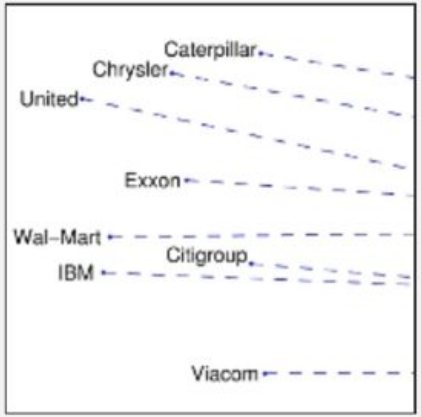


Country-Capital

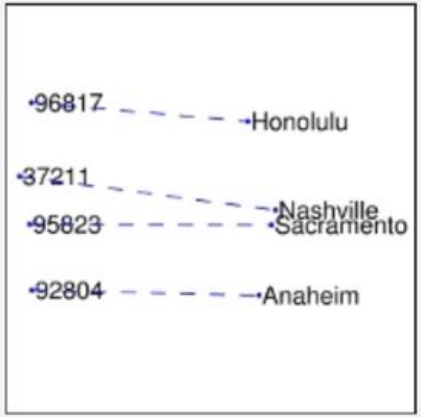
GloVe



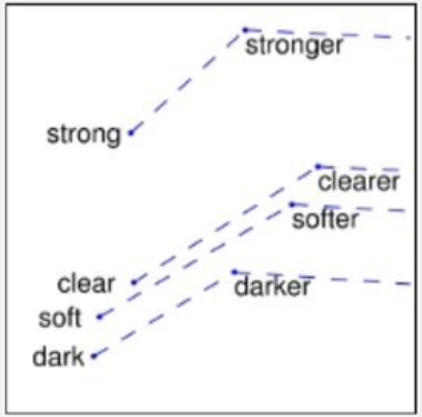
man - woman



company - ceo

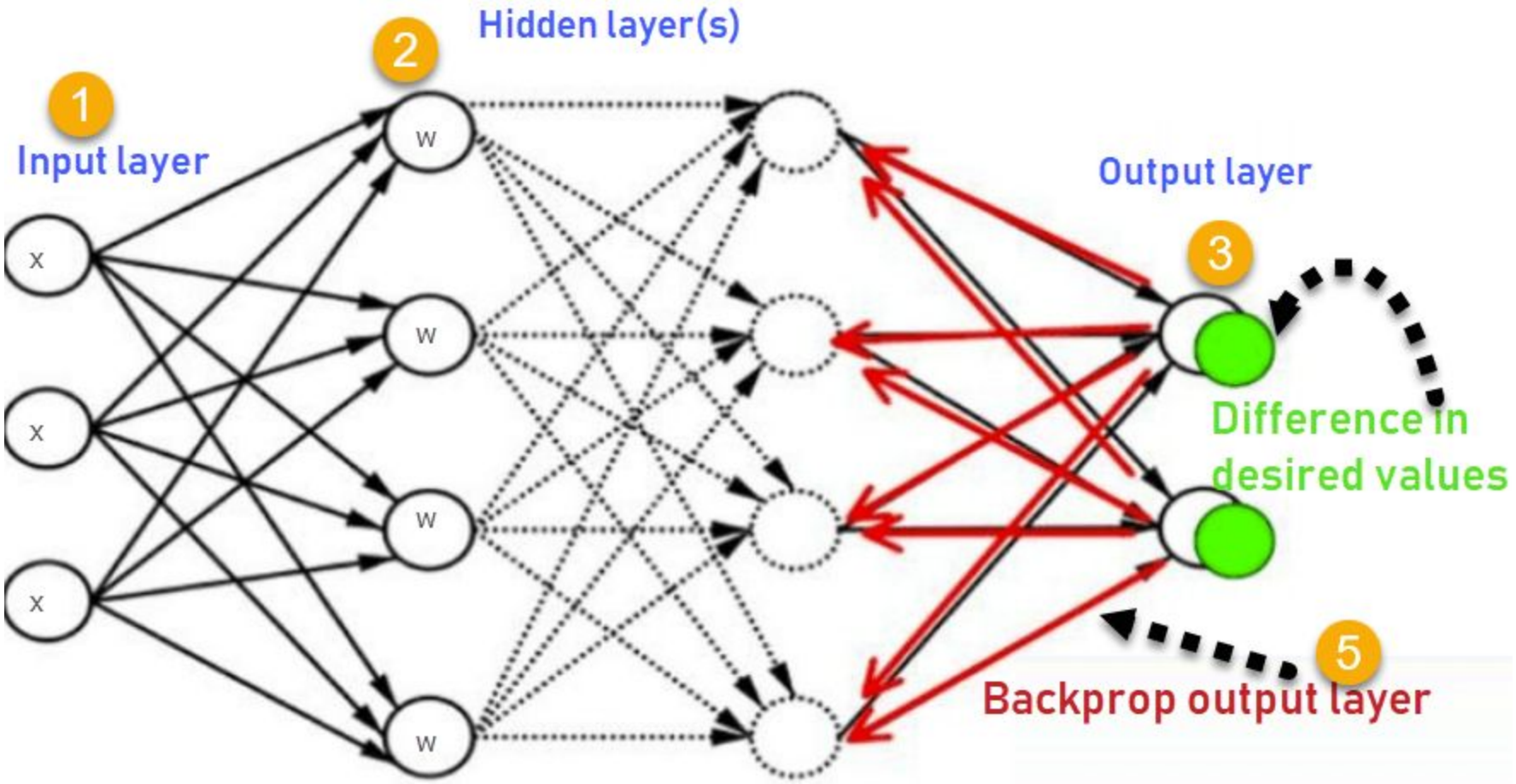


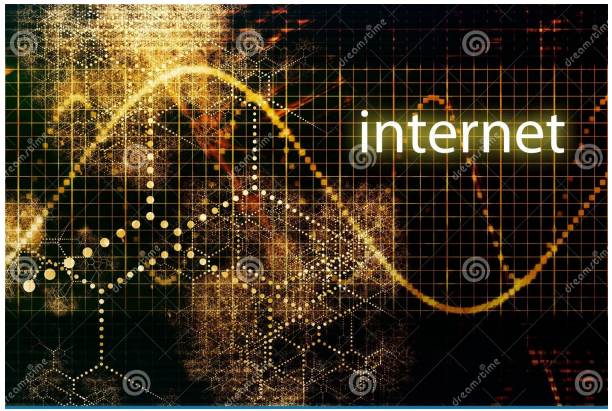
city - zip code

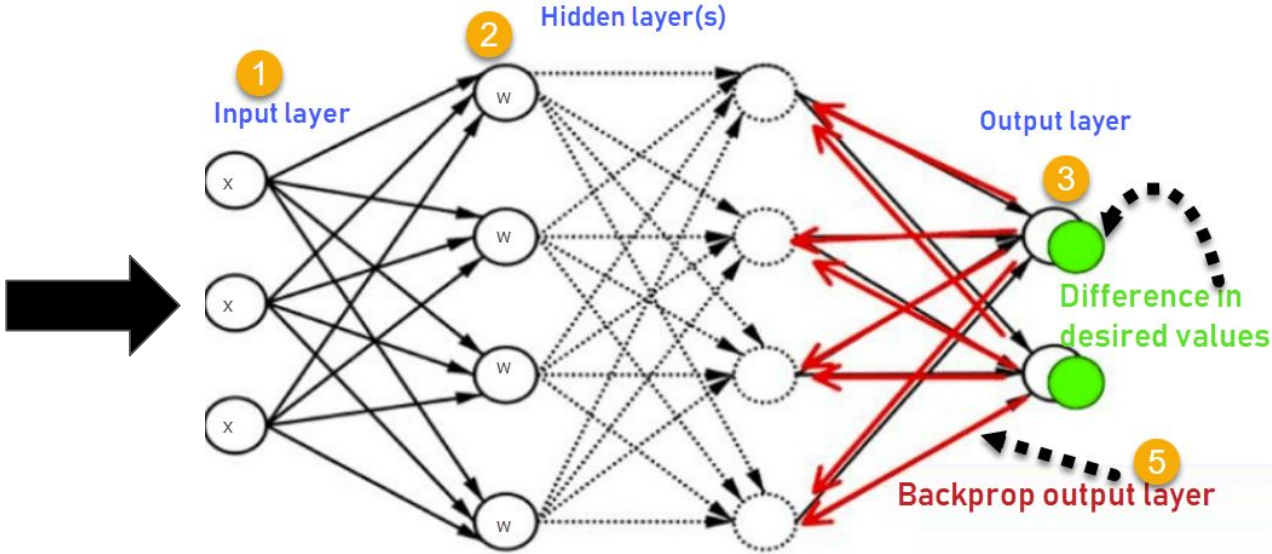


comparative - superlative

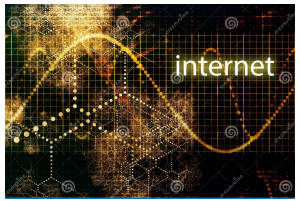
Core Component 6: Internet as Bag of Words

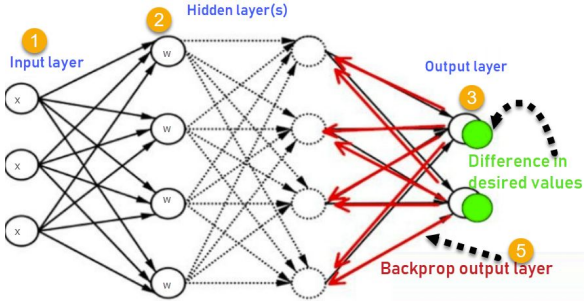

Hidden layer(s)
2
1
Input layer
Output layer
3
x
x
x
w
w
w
w
Difference in
desired values
5
Backprop output layer


internet


1
Input layer
2
Hidden layer(s)
Output layer
3
x
x
x
w
w
w
w
Difference in
desired values
5
Backprop output layer

Large Language Models






CHATGPT
OpenAI

Build Your Own Chat Bot

https://huggingface.co/

https://ai.meta.com/llama/

Build Your Own Chat Bot

https://github.com/ua-datalab/Workshops/blob/main/Deep_Dive_Into_Deep_Learning/llama_chatbot.ipynb