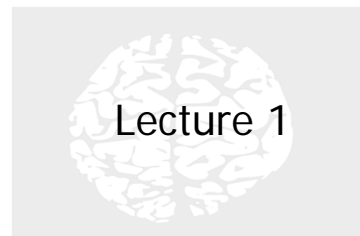
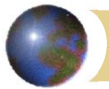


Neural Networks : Introduction




1



Movies on Brain

- | | |
|---------------------------------------|---------------------------------------|
| ✦ Arena Brains - 1988 | ✦ Brain, The - 1988 |
| ✦ Big Brain, The - 1933 | ✦ Braindead - 1992 |
| ✦ Billion Dollar Brain - 1967 | ✦ Brainscan - 1994 |
| ✦ Bird-Brain Bird Dog - 1954 | ✦ Brainstorm - 1965, 1983, 1994 |
| ✦ Brain Again - Spot - 1994 | ✦ Brainwaves - 1982 |
| ✦ Brain Candy - 1996 | ✦ Creature with the Atom Brain - 1955 |
| ✦ Brain Damage - 1988 | ✦ Donovan's Brain - 1953 |
| ✦ Brain Dead - 1990 | ✦ Great Brain, The - 1978 |
| ✦ Brain Donors - 1992 | ✦ Hare-Brained Hypnotist, The - 1942 |
| ✦ Brain Eaters, The - 1958 | ✦ Man with Two Brains, The - 1983 |
| ✦ Brain from Planet Arous, The - 1957 | ✦ Runaway Brain - 1995 |
| ✦ Brain Leeches, The - 1977 | ✦ Scatterbrain - 1940 |
| ✦ Brain Machine, The - 1956, 1977 | ✦ Scrambled Brains - 1951 |
| ✦ Brain of Blood - 1972 | ✦ Train on the Brain - 2000 |
| ✦ Brain Smasher...A Love Story - 1993 | ✦ Tricky Brains - 1991 |
| ✦ Brain that Wouldn't Die, The - 1959 | ✦ Twisted Brain - 1974 |

2



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Mouse With Human Brain May Live

By Bill Christensen
posted: 17 February 2005 07:02 am ET


Share this story

Animals have been getting a real work-out in science lately. [Methuselah mice](#) are helping humanity with aging, [pigs are trying artificial corneas](#) and [monkeys get gene manipulations](#) that force them to work hard with no thought of reward.


Now, Stanford University has given famed researcher Irving Weissman permission to create a mouse-human hybrid. The intent is to inject human brain cells into the brains of developing mice to see what happens. The National Academy of Sciences will unveil guidelines on chimera and stem cell research this spring.

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http://www.livescience.com/technology/technovel_mouse_050217.html

3








"Pinky, are you thinking what I'm thinking?"
"Yes, Brain, but isn't that dangerous?"

4

2



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Infosys co-founder Kris Gopalakrishnan bets \$50 mn on research to create brain-inspired computing


By Pankaj Mishra & Jayadevan PK, ET Bureau | 30 Jan, 2015, 06:38AM IST

[Post a Comment](#)

BENGALURU: He's bet \$50 million of his \$1.5 billion net worth on brain, and he's convinced there will be a big payoff.



When **Kris Gopalakrishnan**, the now-retired Infosys cofounder, put one chunk of his net worth on research that aims to create the next computing revolution — computers modeled on brain functioning — he was going off the beaten track. HNI backing of new ventures tend to be more conservative and few take big bets on frontier research.


His funding of brain research, through \$36 million for Indian Institute of Science (IISc) as well as funding six chairs in the institute and IIT-Madras, puts Gopalakrishnan in good company. Microsoft cofounder **Paul Allen** and Google cofounder **Sergey Brin** have backed similar moonshots. And the **US government** is backing a \$ 300-million 'Brain Initiative'.



Infosys cofounder Kris Gopalakrishnan has put one chunk of his net worth on research that aims to create the next computing revolution.


5



Budget 2018: Govt. Still Strong On Digital India; Allocates \$480 Mn To Promote AI, ML, IoT


As Announced By Arun Jaitley During The Budget Session, NITI Aayog Will Launch A National Programme For AI Research

 **Sukanya Mukherjee**

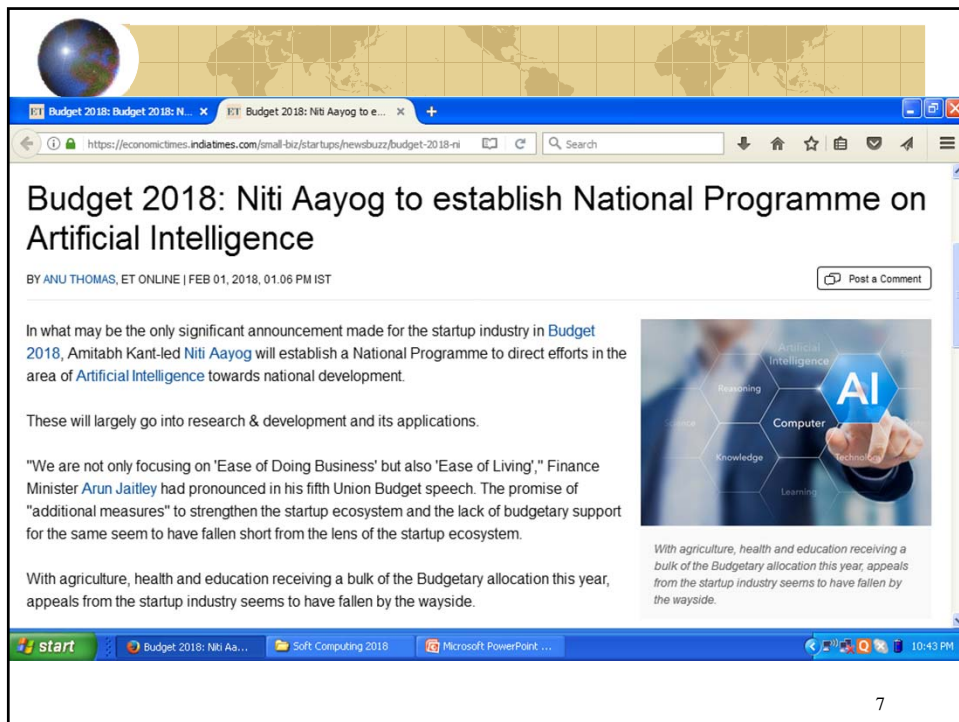
February 1, 2018 | 12 min read

How CleverTap leveraged behavioural analytics to touch close to \$10 Mn in ARR?

[Find Out Here →](#)



6



Budget 2018: Niti Aayog to establish National Programme on Artificial Intelligence


BY ANU THOMAS, ET ONLINE | FEB 01, 2018, 01:06 PM IST

In what may be the only significant announcement made for the startup industry in Budget 2018, Amitabh Kant-led Niti Aayog will establish a National Programme to direct efforts in the area of Artificial Intelligence towards national development.

These will largely go into research & development and its applications.

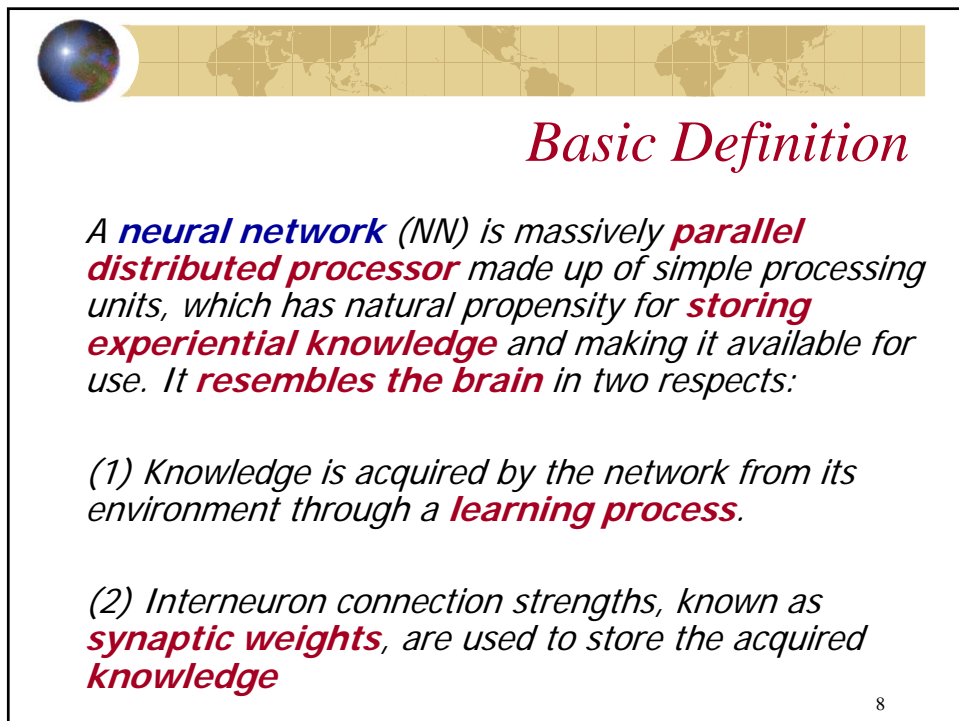
"We are not only focusing on 'Ease of Doing Business' but also 'Ease of Living'," Finance Minister Arun Jaitley had pronounced in his fifth Union Budget speech. The promise of "additional measures" to strengthen the startup ecosystem and the lack of budgetary support for the same seem to have fallen short from the lens of the startup ecosystem.

With agriculture, health and education receiving a bulk of the Budgetary allocation this year, appeals from the startup industry seems to have fallen by the wayside.



With agriculture, health and education receiving a bulk of the Budgetary allocation this year, appeals from the startup industry seems to have fallen by the wayside.

7



Basic Definition

A **neural network** (NN) is massively **parallel distributed processor** made up of simple processing units, which has natural propensity for **storing experiential knowledge** and making it available for use. It **resembles the brain** in two respects:

- (1) Knowledge is acquired by the network from its environment through a **learning process**.
- (2) Interneuron connection strengths, known as **synaptic weights**, are used to store the acquired knowledge

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What is all about NN ?

- ✦ Neuro-computing
- ✦ Artificial Neural Networks (ANN)
- ✦ Connectionism
- ✦ Artificial Computer Brain
- ✦ Parallel Distributed Processing (PDP) System
 - Now quite **common**
 - Not **black magic**
 - Just a **black box** that performs a function similar to nonlinear regression

9



What is NN Computing?

- ✦ Very loosely based on how the **brain** is thought to work
- ✦ It is an emulation of primitive neural processes in **software (or hardware)**
- ✦ It attempts to **mimic** (it cannot yet copy) the workings of a **biological brain**

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History of ANNs

- ✦ **McCullough and Pitts (1943)** - models of biological neural networks based on their understanding of neurology
- ✦ Initial computer simulations in the 1950's
 - ▣ research by IBM, Hebb and Milner
- ✦ **Rosenblat (1958)** - *the perceptron*
 - ▣ three-layer system that could connect or associate a given input to a random output unit

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- ✦ **Widrow and Hoff (1960)**
ADaptive **LINE**ar **E**lement (**ADALINE**)
 - ▣ used more complex learning rules to minimize the difference between the *observed* and *desired* output
- ✦ **Early 1960s** - a lot of follow-up research
- ✦ **Minsky and Papert (1969)** - pivotal paper which made an unfounded (*and later disproved*) argument regarding the limited potential of *multilayer perceptrons* (now the most common ANN)

12



- ✦ **Result of Minsky and Papert's paper:** no funding for ANN research !
- ✦ **Werbos (1974)** produced the first backpropagation method of learning for ANNs
- ✦ More significant research occurred in the late 70's and early 80's
 - ▣ adaptive networks
- ✦ **Rummelhart, McClelland, and others (1986)** - a book *Parallel Distributed Processing*
 - ▣ popularized the *backpropagation* method
- ✦ **Since 1986**, tremendous increase in ANN models, applications

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Characteristics of ANN

- ✦ **Classification :** They can extract classification (clustering) characteristics from a large number of input examples. e.g.
- ✦ **Pattern Matching :** They can produce the corresponding output patterns for given input patterns.
- ✦ **Pattern Completion:** For an incomplete pattern, networks can generate the missing portion of the input pattern.

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Characteristics of ANN

- ✦ **Learning** : Unlike expert systems, neural networks learn many example patterns and their associations i.e. desired outputs or conclusions.
- ✦ **Generalization** : The network responds in an interpolative way to noisy, incompetent, or previously unseen data. An associative network, where input is equal to desired output, can produce a full output if presented with a potential input. This property is called "generalization".

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Characteristics of ANN

- ✦ **Fault Tolerance** : In ANN, the memory is distributed and failure of some processing elements will slightly change overall behavior of the network.
- ✦ **Optimization** : For given initial values of a specific optimization problem, the networks help in arriving at a set of variables which represent a solution to the problem.

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Characteristics of ANN

- ✦ **Control** : Current state of a controller and the desired response for the controller as an input pattern, the networks generate proper command sequence to create the desired response.
- ✦ **Distributed Memory** : The connection weights are the memory units of the network. The value of weights represent the current state of knowledge of the network. A unit of knowledge, represented for example by an input/output pair is distributed across all the weighted connections of the network.

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Characteristics of ANN

- ✦ **Storage Memory** : There is one set of network weights capable of representing a large space of stored patterns. Thus it provides an advantage of lesser amount of storage memory.

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NN replaces the Mathematical Model .. How ?

- ✦ No need for a conventional equation
- ✦ Equations Maps or translates inputs onto outputs
- ✦ NN learns how to map based on input and output data
- ✦ It trains itself and learns to perform the task of prediction/forecasting

19



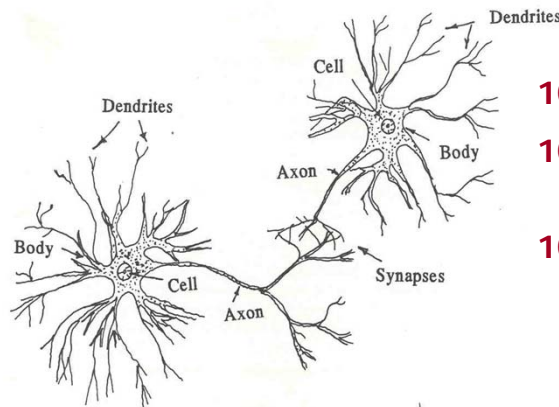
What else NN can offer ?

- ✦ NN **learns** how to model a given site itself
- ✦ Scope for **performance improvement** over time
- ✦ **Easy** to maintain
- ✦ **Cheap** and automatic
- ✦ **Same software** can be applied to all sites
- ✦ Possibility of **real-time** retraining
- ✦ NN handles **imprecise data**
- ✦ Possibility of testing off-line to establish **confidence**

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Biological Neuron



10^{10} - 10^{11} Neurons

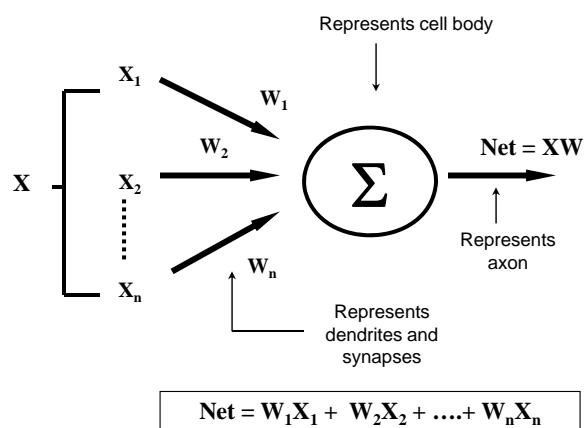
10^3 - 10^4 Connections
(synaptic)

10^{13} - 10^{15} Connections

21



Artificial Neuron

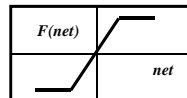


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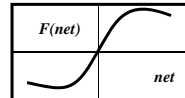


Activation Functions

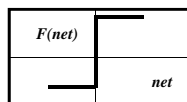
Linear Transfer Function



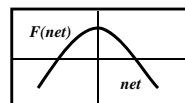
Sigmoid Function



Linear Step Function



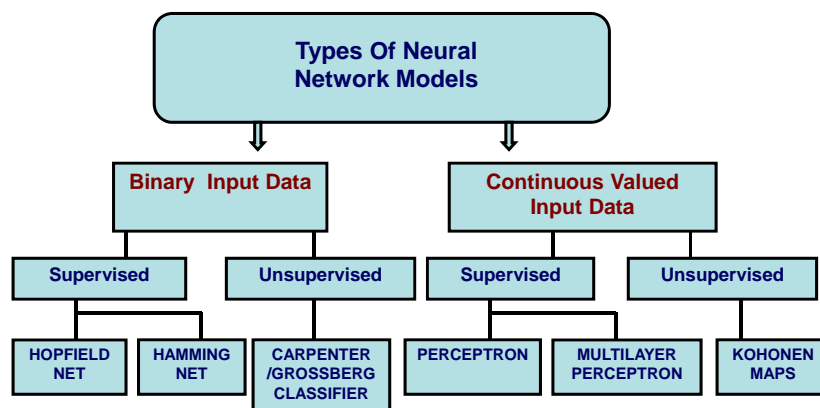
Gaussian Function



23



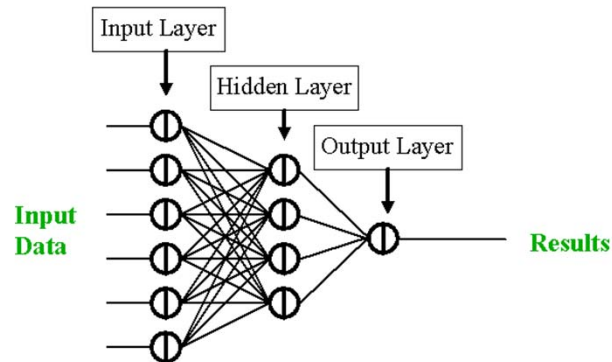
Existing Neural Models



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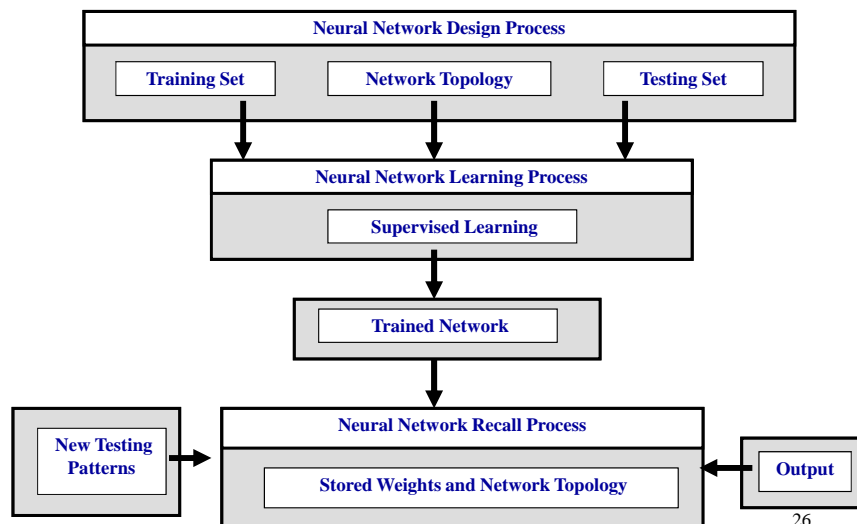
NN Architecture Representation



25



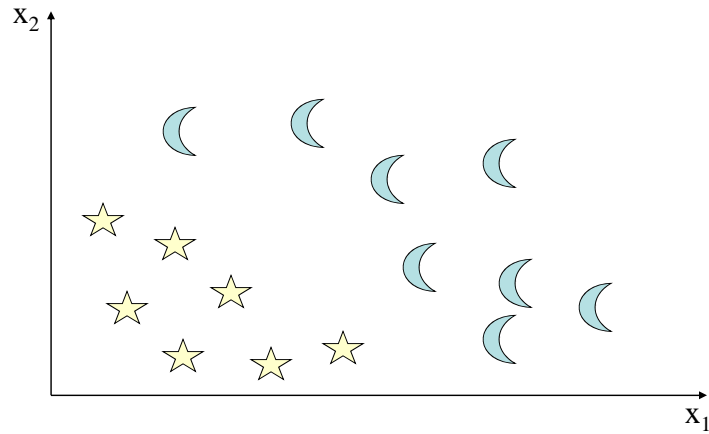
NN Modeling Phase



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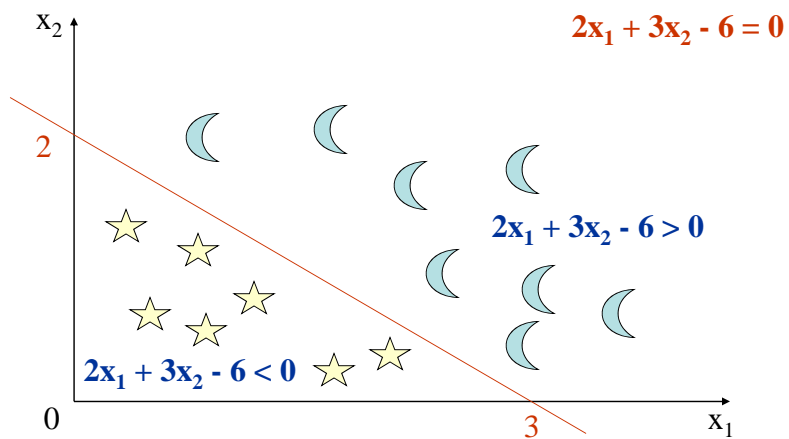
Classification Example



27



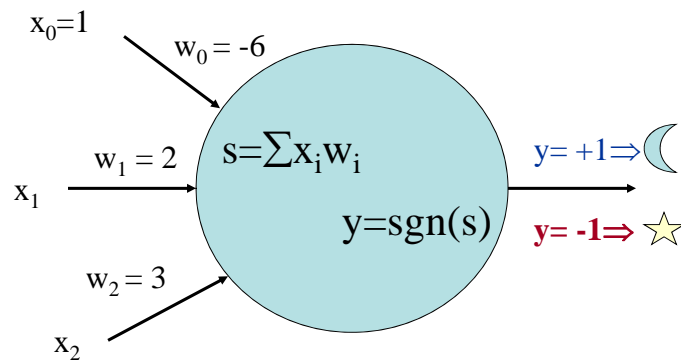
Equation of a Line



28



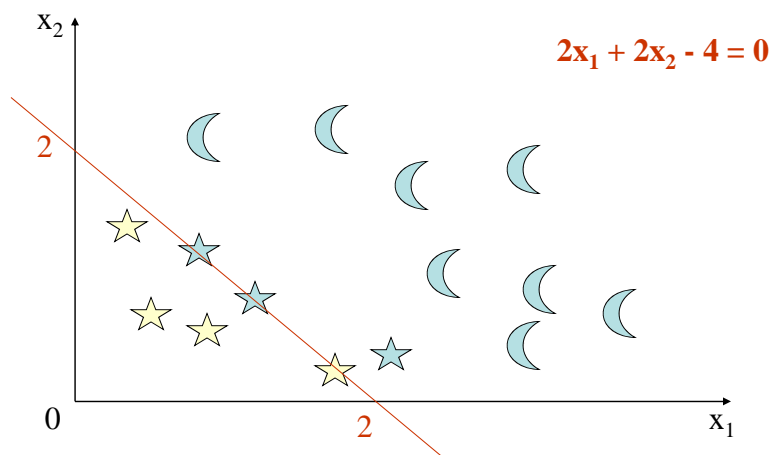
Neural Classifier



29



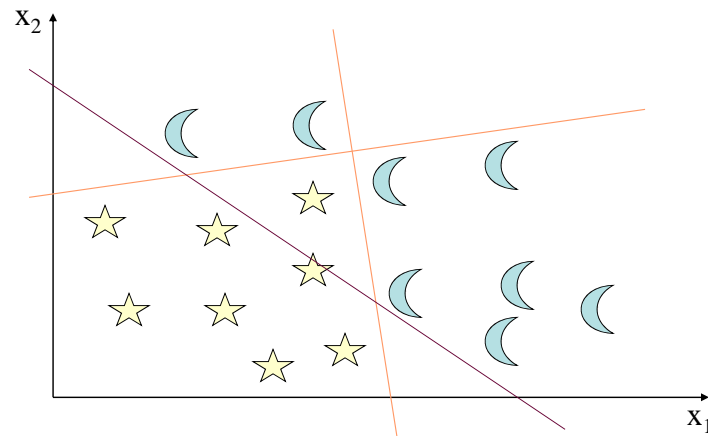
Equation of a Line is Wrong



30



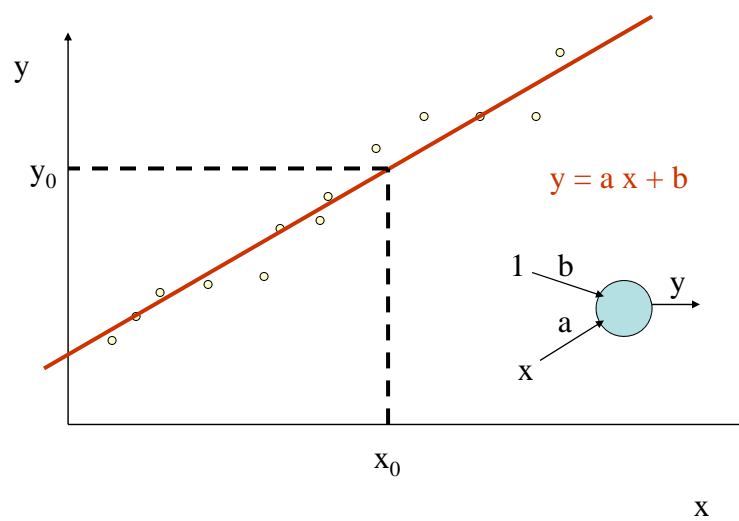
Linearly Separable -- Not



31



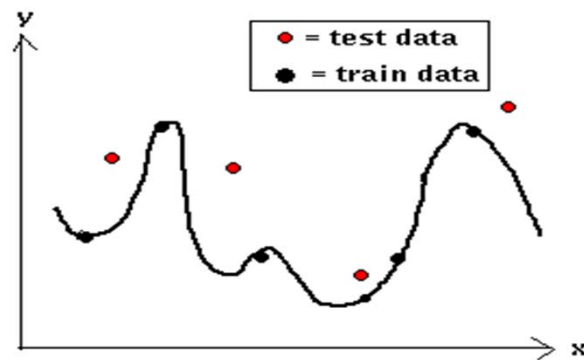
Linear Regression



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Over-fitting



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Text Book Reference

✦ **Simon Haykin** – Neural Networks – A Comprehensive Foundation, Pearson Education Asia, Low Price Edition

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