

From Regression to Deep Learning

ICMR Sponsored Seminar On Deep Learning Techniques and
Tools for Medical Applications
Practice **LESS** Deep Learning
Learn - Experiment - Share - Seek

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Outline

Opportunities - NLP

ML Introduction

Regression to Deep Learning

Need of Deep Learning

Matrix Representation



Opportunities

[Find Jobs](#) [Company Reviews](#) [Find Salaries](#) [Find Resumes](#) [Employers / Post Job](#)

[Upload your resume](#)



what

where

Natural Language Processing

Find Jobs

Advanced Job Se

job title, keywords or company

Tip: Enter your city or zip code in the "where" box to show results in your area.

Natural Language Processing jobs

Sort by: **relevance** - date

Salary Estimate

\$55,000 (1814)
\$80,000 (1490)
\$95,000 (1152)
\$110,000 (778)
\$125,000 (401)

Job Type

Full-time (2470)
Contract (87)
Part-time (66)

[Upload your resume](#) - Let employers find you

Jobs 1 to 10 of 2,596

NLP Research Scientist, Siri

Apple - ★★★★★ 3,964 reviews - Santa Clara Valley, CA

Research Scientists at Siri are taking this a step further by redefining artificial intelligence, and creating groundbreaking technology for natural language...

1 day ago - [save job](#) - [more...](#)

Natural Language Processing (NLP) Research Scientist

Bloomberg - ★★★★★ 509 reviews - New York, NY

A PhD in Natural Language Processing, Machine Learning or equivalent experience. Bloomberg's Natural Language Processing (NLP) group - a group of specialists,...

12 days ago - [save job](#) - [more...](#)

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Source: www.indeed.co.in


Opportunities


glassdoor Sign In

Natural language processing Jobs in India 745 Jobs





Natural Language Processing 
DynPro India - Gurgaon 21 days ago
3.1 ★



Machine learning ml natural language processing nlp c java python Years 
Cyborg Technologies - Noida 8 days ago
2.2 ★

Natural Language Processing

3.1 ★ DynPro India - Gurgaon

[Apply on Company Site](#)   [Save](#)

[Job](#) [Company](#)

Source: www.glassdoor.com

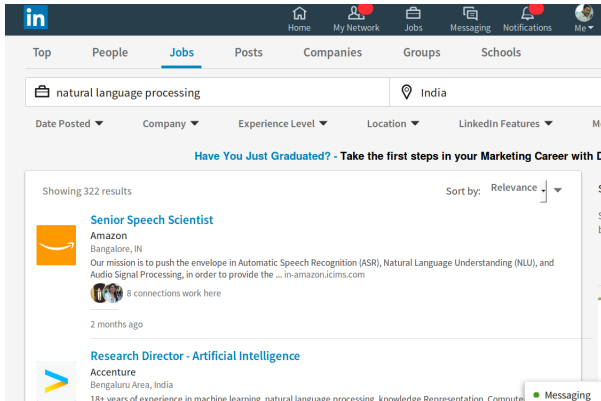


Opportunities

The screenshot shows the naukri.com website interface. At the top, there's a navigation bar with icons for Jobs, Recruiters, Companies, Services, More, and Login. Below this is a secondary navigation bar with tabs for All Jobs, IIT/IIM Jobs, Govt. Jobs, International Jobs, and Walk-in Jobs. The main search area has a search bar with the text 'natural language processing', and filters for Location, Experience, and Salary. A blue 'Search' button is next to it. Below the search bar, there's a section titled 'Find Jobs For' with a list of designations: Advanced Software Engineer, Analyst Developer, Scientist B, and Module Lead. To the right of this list, it shows '1-50 of 489 Natural Language... Jobs' and a 'Sort by: Relevance' dropdown. The first job listing is for 'Natural Language Processing/ Algorithm Development Engineer' at 'Excelra Knowledge Solutions', located in 'Hyderabad', with '4-9 yrs' of experience. The 'KeySkills' listed are 'C, Natural Language Processing, C++, NLP, Python, Machine Learning'.

Source: www.naukri.com

Opportunities



The screenshot shows the LinkedIn Jobs interface. The search bar contains 'natural language processing' and the location is set to 'India'. The results are sorted by 'Relevance'. The first job listing is for 'Senior Speech Scientist' at Amazon, Bangalore, IN. The description mentions 'Automatic Speech Recognition (ASR), Natural Language Understanding (NLU), and Audio Signal Processing'. The second job listing is for 'Research Director - Artificial Intelligence' at Accenture, Bengaluru Area, India. The description mentions '18+ years of experience in machine learning, natural language processing, knowledge Representation, Compute'.

Showing 322 results

Sort by: Relevance

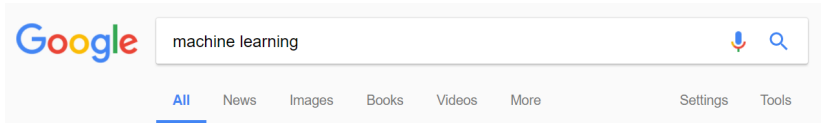
Senior Speech Scientist
Amazon
Bangalore, IN
Our mission is to push the envelope in Automatic Speech Recognition (ASR), Natural Language Understanding (NLU), and Audio Signal Processing, in order to provide the ... in-amazon.icims.com
8 connections work here
2 months ago

Research Director - Artificial Intelligence
Accenture
Bengaluru Area, India
18+ years of experience in machine learning, natural language processing, knowledge Representation, Compute

Source: in.linkedin.com



Machine Learning Introduction



About 31,00,00,000 results (0.50 seconds)

Machine learning - Wikipedia

https://en.wikipedia.org/wiki/Machine_learning ▼

Machine learning is a field of computer science that gives computers the ability to learn without being explicitly programmed. Arthur Samuel, an American pioneer in the field of computer gaming and artificial intelligence, coined the term "**Machine Learning**" in 1959 while at IBM.

[Machine learning](#) · [Machine Learning \(journal\)](#) · [Timeline of machine learning](#) · [H2O](#)

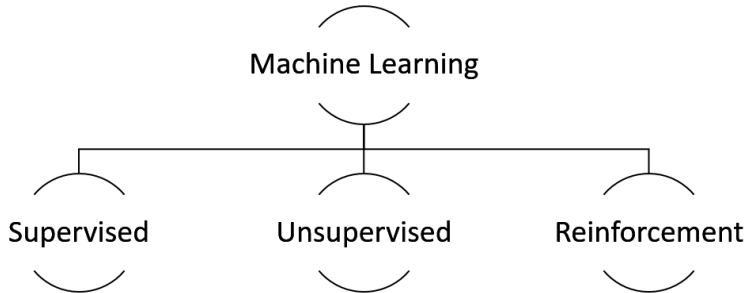


- Reducing human/machine efforts required to perform a task (time optimization).
- Increasing the performance of a task (efficiency optimization).

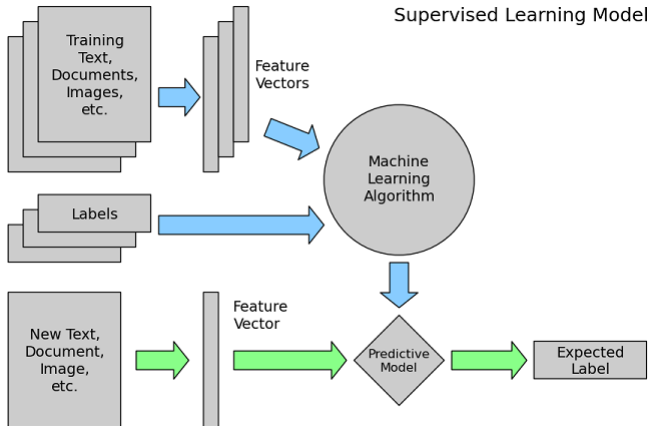


Steps in Machine Learning

- Collecting data
- Preparing the data
- Training a model
- Evaluating the model
- Improving the performance



Supervised Learning



source: www.allprogrammingtutorials.com/tutorials/introduction-to-machine-learning.php



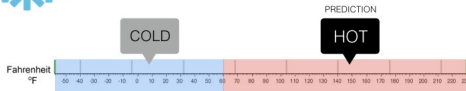
Regression

What is the temperature going to be tomorrow?



Classification

Will it be Cold or Hot tomorrow?



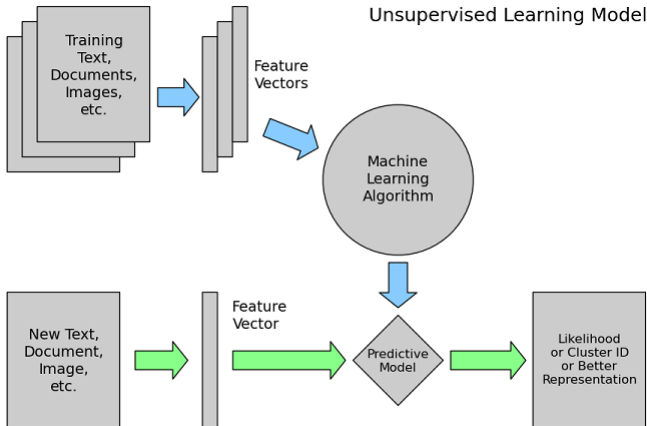
source: https://medium.com/@ali_88273/regression-vs-classification-87c224350d69



Common Supervised Learning Algorithms

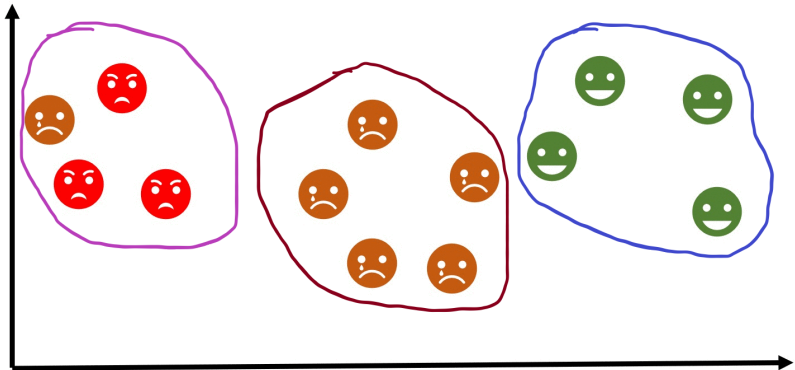
- Linear Regression
- Logistic Regression
- Support Vector Machines
- Support Vector Regression
- Decision Trees
- Random Forest Tree
- Naive Bayes

Unsupervised Learning



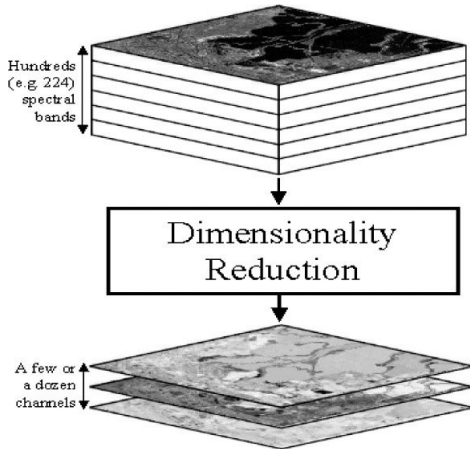
source: www.allprogrammingtutorials.com/tutorials/introduction-to-machine-learning.php

Clustering



source: <https://towardsdatascience.com/clustering-unsupervised-learning-788b215b074b>

Dimensionality Reduction



source: <http://spie.org/newsroom/3560-dimensionality-reduction-of-multidimensional-satellite-imagery?SS0=1>

[//spie.org/newsroom/3560-dimensionality-reduction-of-multidimensional-satellite-imagery?SS0=1](http://spie.org/newsroom/3560-dimensionality-reduction-of-multidimensional-satellite-imagery?SS0=1)



Common Unsupervised Learning Algorithms

- K-means
- Affinity Propagation
- Singular Value Decomposition
- Non-negative matrix factorization



You have already learned the Machine Learning. When?

?



You have already learned the Machine Learning. When?

$$2x = 6 \quad (1)$$

$$(2x - 6) = 0 \quad (2)$$

$$x = ? \quad (3)$$



You have already learned the Machine Learning. When?

$$2x = 6 \quad (4)$$

$$(2x - 6) = 0 \quad (5)$$

$$x = ? \quad (6)$$

$$x = 6/2 = 3 \quad (7)$$

$$2(3) - 6 = 0 \quad (8)$$



You have already learned the Machine Learning. When?

$$2a + b + c = 4 \quad (9)$$

$$a + 3b + 2c = 5 \quad (10)$$

$$a = 6 \quad (11)$$



You have already learned the Machine Learning. When?

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (12)$$



You have already learned the Machine Learning. When?

$$A = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix}, x = \begin{bmatrix} a \\ b \\ c \end{bmatrix}, b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (13)$$



You have already learned the Machine Learning. When?

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (14)$$

$$Ax = b \quad (15)$$

$$(Ax - b) = ? \quad (16)$$



You have already learned the Machine Learning. When?

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (17)$$

$$Ax = b \quad (18)$$

$$(Ax - b) = 0 \quad (19)$$

$$x = \begin{bmatrix} a \\ b \\ c \end{bmatrix} = ? \quad (20)$$



What is Regression

Regression?



What is Regression

$$x + y = z$$



Solving $Ax=b$

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (21)$$

$$X W = Y \quad (22)$$

$$(X W - Y) = 0 \quad (23)$$

$$W = \begin{bmatrix} a \\ b \\ c \end{bmatrix} = ? \quad (24)$$

$$X^\dagger X W = X^\dagger Y \quad (25)$$

$$I W = X^\dagger Y \quad (26)$$

$$W = X^\dagger Y \quad (27)$$



Decimal Value Prediction

ID	digit1	digit2	digit3	value
1	0	0	0	0
2	0	0	1	1
3	0	1	0	2
4	0	1	1	3
5	1	0	0	4
6	1	0	1	5
7	1	1	0	6
8	1	1	1	7

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} \quad (28)$$

$$X \mathbf{w} = \mathbf{y} \quad (29)$$

$$X^\dagger X \mathbf{w} = X^\dagger \mathbf{y} \quad (30)$$

$$\mathbf{w} = X^\dagger \mathbf{y} \quad (31)$$



$$\mathbf{w} = X^\dagger \mathbf{y} = X^\dagger \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} w1 \\ w2 \\ w3 \end{bmatrix} \quad (32)$$

$$X \mathbf{w} = \mathbf{y} \quad (33)$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} \quad (34)$$

$$X \mathbf{w} = \mathbf{y}^{pre} \quad (35)$$

$$training \ error = abs(\mathbf{y} - \mathbf{y}^{pre}) \quad (36)$$



$$\text{training error} = \text{sum}(\text{abs}(\mathbf{y} - \mathbf{y}^{pre})) \quad (37)$$

$$\mathbf{y} - \mathbf{y}^{pre} = \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} - \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} = \text{sum} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = 0 \quad (38)$$



$$\begin{bmatrix} digit1 & digit2 & digit1 \end{bmatrix} \begin{bmatrix} w1 \\ w2 \\ w3 \end{bmatrix} = [value] \quad (39)$$

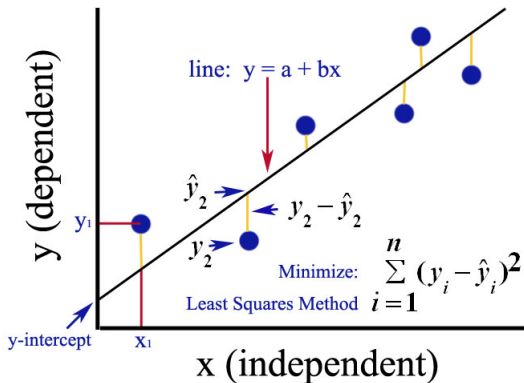
$$digit1 * w1 + digit2 * w2 + digit3 * w3 = value \quad (40)$$

$$\begin{bmatrix} digit1 & digit2 & digit1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix} = [value] \quad (41)$$

$$digit1 * 4 + digit2 * 2 + digit3 * 1 = value \quad (42)$$



Linear Regression



source: solutions4statistics.com



Decimal Value Prediction

ID	digit1	digit2	digit3	value	decision
1	0	0	0	0	0
2	0	0	1	1	0
3	0	1	0	2	0
4	0	1	1	3	0
5	1	0	0	4	1
6	1	0	1	5	1
7	1	1	0	6	1
8	1	1	1	7	1

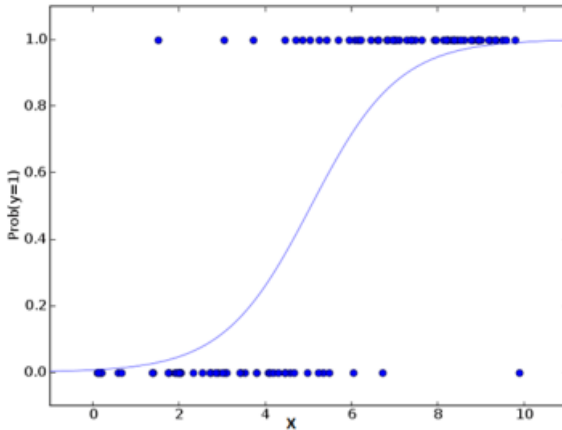


$$\begin{bmatrix} digit1 & digit2 & digit3 \end{bmatrix} \begin{bmatrix} w1 \\ w2 \\ w3 \end{bmatrix} = [value] \quad (43)$$

$$digit1 * w1 + digit2 * w2 + digit3 * w3 = value \quad (44)$$

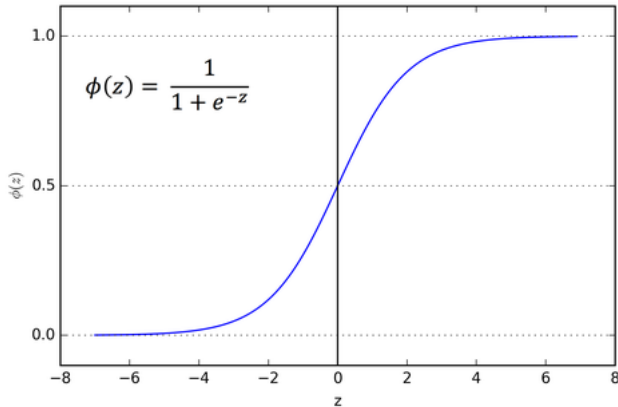
$$Prediction = \begin{cases} 1 & \text{if } 4 \geq value \\ 0 & \text{else} \end{cases} \quad (45)$$

Logistic Regression



source: solutions4statistics.com

Logistic - Sigmoid Function



<https://sebastianraschka.com/images/faq/logisticregr-neuralnet/sigmoid.png>



Logistic - Sigmoid

$$\Phi(z) = \frac{1}{1 + \exp^{-z}} \quad (46)$$

$$\Phi(-6) = \frac{1}{1 + \exp^{-(-6)}} = \frac{1}{1 + 403.42} = 0.0024 \quad (47)$$

$$\Phi(0) = \frac{1}{1 + \exp^0} = \frac{1}{1 + 1} = 0.5 \quad (48)$$

$$\Phi(6) = \frac{1}{1 + \exp^{-(6)}} = \frac{1}{1 + 0.0024} = 0.997 \quad (49)$$



Logistic Regression

$$\Phi(z) = \frac{1}{1 + \exp^{-z}} \quad (50)$$

$$\mathbf{y} = \Phi(\mathbf{X} \mathbf{w}) = \frac{1}{1 + \exp^{-(\mathbf{X} \mathbf{w})}} \quad (51)$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} w1 \\ w2 \\ w3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \quad (52)$$

$$X \mathbf{w} = \mathbf{y} \quad (53)$$

$$X^\dagger X \mathbf{w} = X^\dagger \mathbf{y} \quad (54)$$

$$\mathbf{w} = X^\dagger \mathbf{y} \quad (55)$$



$$\mathbf{w} = X^\dagger \mathbf{y} = X^\dagger \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1.24054754 \\ -0.11269202 \\ -0.11269202 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} \quad (56)$$



$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1.24054754 \\ -0.11269202 \\ -0.11269202 \end{bmatrix} = \text{sigmoid} \left(\begin{bmatrix} 0.0 \\ -0.11269202 \\ -0.11269202 \\ -0.22538404 \\ 1.24054754 \\ 1.12785552 \\ 1.12785552 \\ 1.0151635 \end{bmatrix} \right) \quad (57)$$

$$X \mathbf{w} = \text{sigmoid}(\mathbf{y}^{pre}) \quad (58)$$



$$\text{sigmoid} \left(\begin{bmatrix} 0.0 \\ -0.11269202 \\ -0.11269202 \\ -0.22538404 \\ 1.24054754 \\ 1.12785552 \\ 1.12785552 \\ 1.0151635 \end{bmatrix} \right) = \begin{bmatrix} 0.5 \\ 0.47185 \\ 0.47185 \\ 0.44389 \\ 0.77565 \\ 0.75544 \\ 0.75544 \\ 0.73402 \end{bmatrix} \quad (59)$$

$$X \mathbf{w} = \text{sigmoid}(\mathbf{y}^{pre}) \quad (60)$$

$$\text{training error} = \text{sum}(\text{abs}(\mathbf{y} - \text{sigmoid}(\mathbf{y}^{pre}))) \quad (61)$$

$$\text{training error} = \text{sum}(\text{abs}(\mathbf{y} - \text{sigmoid}(\mathbf{y}^{\text{pre}}))) \quad (62)$$

$$\text{abs}(\mathbf{y} - \text{sigmoid}(\mathbf{y}^{\text{pre}})) = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad (63)$$

$$\text{training error} = 0 \quad (64)$$



$$\begin{bmatrix} 0.5 \\ 0.47185 \\ 0.47185 \\ 0.44389 \\ 0.77565 \\ 0.75544 \\ 0.75544 \\ 0.73402 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \quad (65)$$

$$Prediction = \begin{cases} 1 & \text{if } sigmoid(\mathbf{y}^{pre}) \geq 0.5 \\ 0 & \text{else} \end{cases} \quad (66)$$

$$\begin{bmatrix} digit1 & digit2 & digit3 \end{bmatrix} \begin{bmatrix} 1.24054754 \\ -0.11269202 \\ -0.11269202 \end{bmatrix} = [value] \quad (67)$$

$$digit1 * w1 + digit2 * w2 + digit3 * w3 = value \quad (68)$$

$$sigmoid(\mathbf{y}^{pre}) = \frac{1}{1 + \exp^{-(digit1 * w1 + digit2 * w2 + digit3 * w3)}} \quad (69)$$

$$Prediction = \begin{cases} 1 & \text{if } sigmoid(\mathbf{y}^{pre}) \geq 0.5 \\ 0 & \text{else} \end{cases} \quad (70)$$



Evaluating the model

- Accuracy

$$Accuracy = \frac{\# \text{ correctly classified instances}}{\text{total} \# \text{ instances}} \quad (71)$$

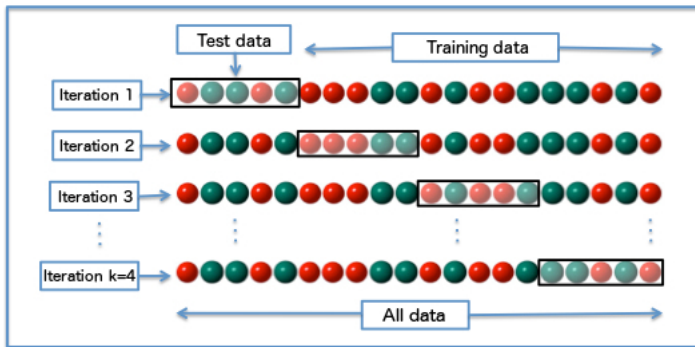
Evaluating the model

$$\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 0 \end{bmatrix} == \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} False \\ True \\ True \\ True \\ True \\ True \\ True \\ False \end{bmatrix} \quad (72)$$

$$\text{Accuracy} = 8 / 10 * 100 = 80 \%$$

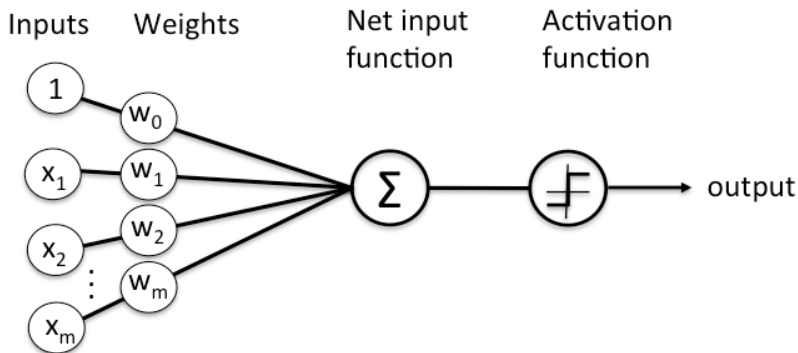
Improving the performance

10 - fold 10-cross validation



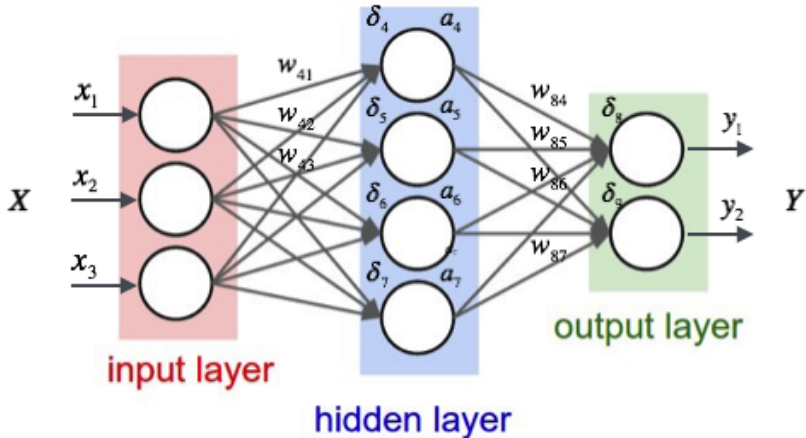
Source: wikipedia

Logistic Regression as a Neuron



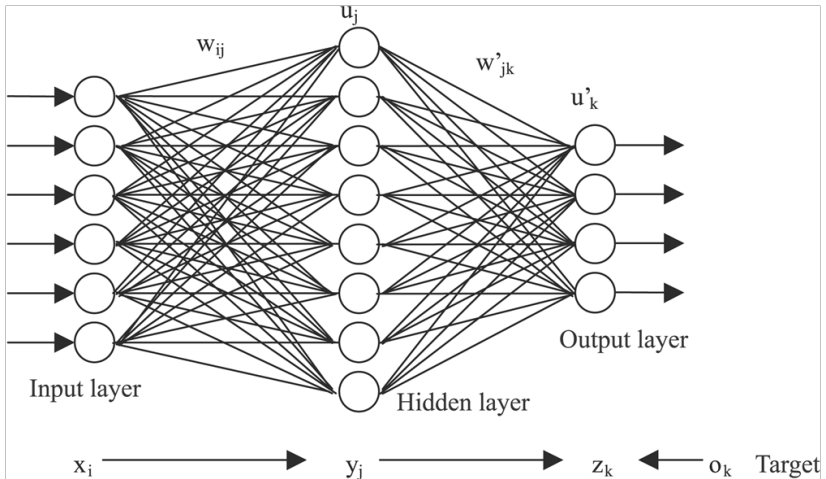
www.techmaru.com/technology/artificial-neural-networks/neural-network-elements

Neuron to Neurons



medium.com/@curiously/tensorflow-for-hackers-part-iv-neural-network-from-scratch-1a4f504dfa8

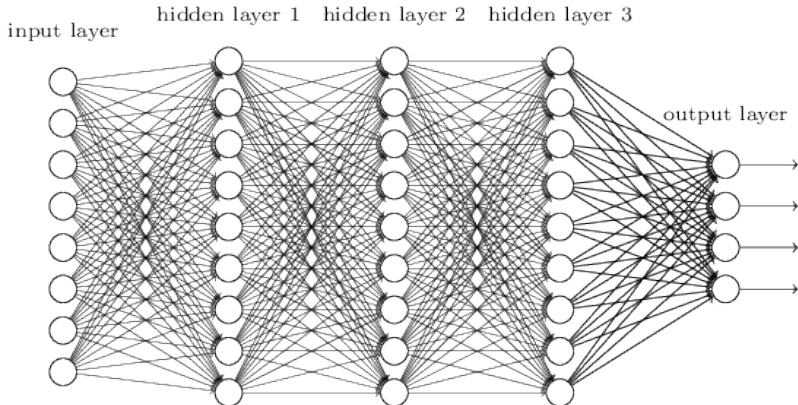
Single Layer Network



www.extremetech.com/extreme/

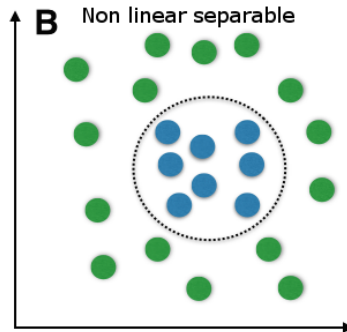
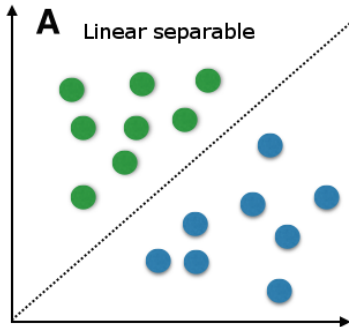
215170-artificial-neural-networks-are-changing-the-world-what-are-they

Multi Layer Network



in.mathworks.com/matlabcentral/fileexchange/64247-simple-neural-network

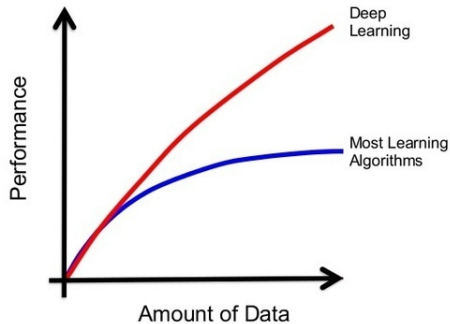
Why Deep Learning?



Source: https://leonardoraujosantos.gitbooks.io/artificial-intelligence/content/linear_classification.html

Why Deep Learning?

BIG DATA & DEEP LEARNING



Source: <https://qph.ec.quoracdn.net/main-qimg-bf69c291005e68620a1bef39ae8f029e-c>

Why now Deep Learning?

WHY IS DEEP LEARNING HOT NOW?

Three Driving Factors...

Big Data Availability	New ML Techniques	Compute Density
facebook 350 millions images uploaded per day	Deep Neural Networks	GPUs
Walmart ✱ 2.5 Petabytes of customer data hourly		
You Tube 100 hours of video uploaded every minute		

ML systems extract value from Big Data

<https://www.slideshare.net/DataScienceMD/deep-learning-with-gpus>



Common Deep Learning Algorithms

- Convolutional Neural Network
- Recurrent Neural Network
- Long-Short Term Memory Network
- Deep Neural Network
- Auto Encoders



Matrix Representation



Linear Equations to Matrix

$$2a + b + c = 4 \quad (73)$$

$$a + 3b + 2c = 5 \quad (74)$$

$$a = 6 \quad (75)$$



Linear Equations to Matrix

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (76)$$



Linear Equations to Matrix

$$A = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix}, \mathbf{x} = \begin{bmatrix} a \\ b \\ c \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix} \quad (77)$$



Text to Matrix

- **S1:** We are in CEN.
- **S2:** CEN is in Amrita.
- **S3:** Amrita is in CBE.



Text to Matrix

- **S1:** We are in CEN.
- **S2:** CEN is in Amrita.
- **S3:** Amrita is in CBE.

Vocabulary = amrita, are, cen, cbe, in, is, we

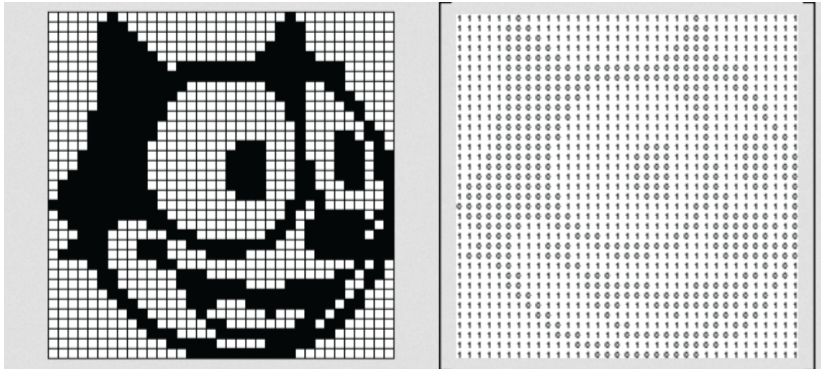


Text to Matrix

Table: Text Representation

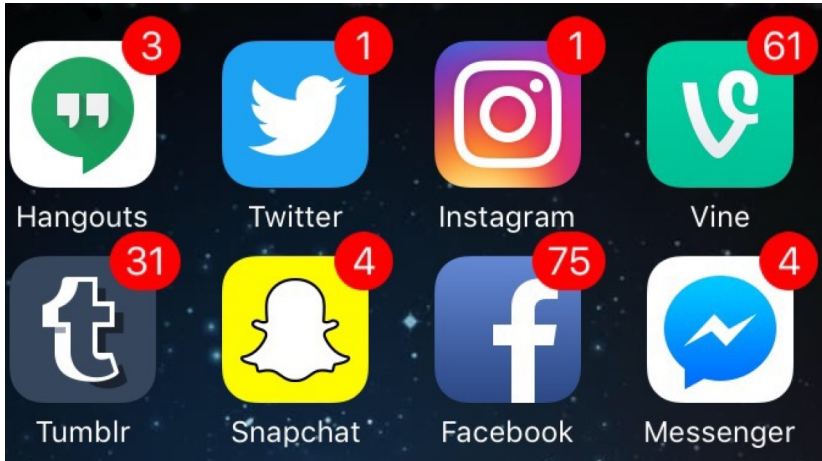
	amrita	are	cen	cbe	in	is	we
S1	0	1	1	0	1	0	1
S2	1	0	1	0	1	1	0
S3	1	0	0	1	1	1	0

Image to Matrix



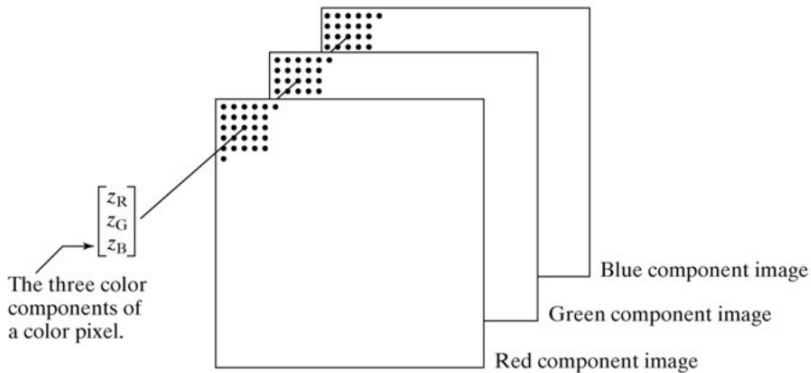
Source: blog.kleinproject.org/?p=588

Image to Matrix



Source: www.cbc.ca/news/trending

Image to Matrix



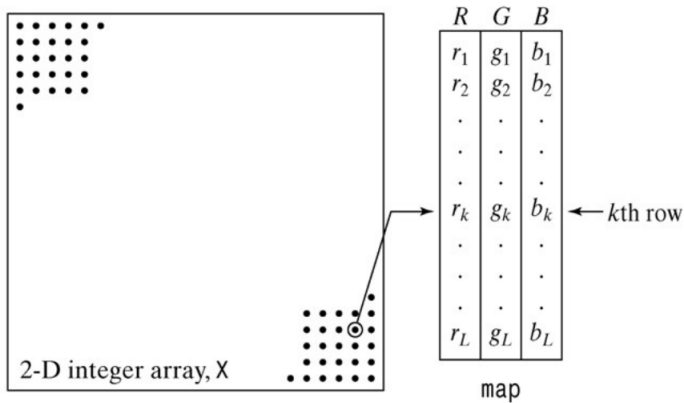
Source: <http://slideplayer.com/slide/8752313/>

Image to Matrix

88	82	84	88	85	83	80	93	102
88	80	78	80	80	78	73	94	100
85	79	80	78	77	74	65	91	99
38	35	40	35	39	74	77	70	65
20	25	23	28	37	69	64	60	57
22	26	22	28	40	65	64	59	34
24	28	24	30	37	60	58	56	66
21	22	23	27	38	60	67	65	67
23	22	22	25	38	59	64	67	66

Source: www1.adept.com/main/KE/DATA/ACE/AdeptSight_User/Vision_Basics_Mode.html

Image to Matrix



Value of circled element = k

Source: slideplayer.com/slide/8752313/



Thank You.

you can follow me through:

www.linkedin.com/in/barathiganeshhb

<https://barathiganesh-hb.github.io/>

<https://github.com/BarathiGanesh-HB/>