Neural Networks for Structured Data

Sub-Topics: Perceptron, MLP, Backpropagation, Implementation

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Best learning system known to us?

Learning

Supervised Learning

- Classification
- Support Vector Machines, Logistic Regression, Decision Trees, Random Forest (Boosting, Bagging, …), Naïve Bayes,
- Regression
- Linear Regression, Multiple Linear Regression (Regularization)
- Time Series

Unsupervised Learning

- Clustering
- K-Means, kNN, DB Scan, Hierarchical clustering,
- Dimensionality Reduction
- PCA, Stochastic Neighbour Embedding, Recursive Feature Elimination, Variance Inflation Factor
- Association Rule Mining
- Recommendation Systems

Neural Networks?
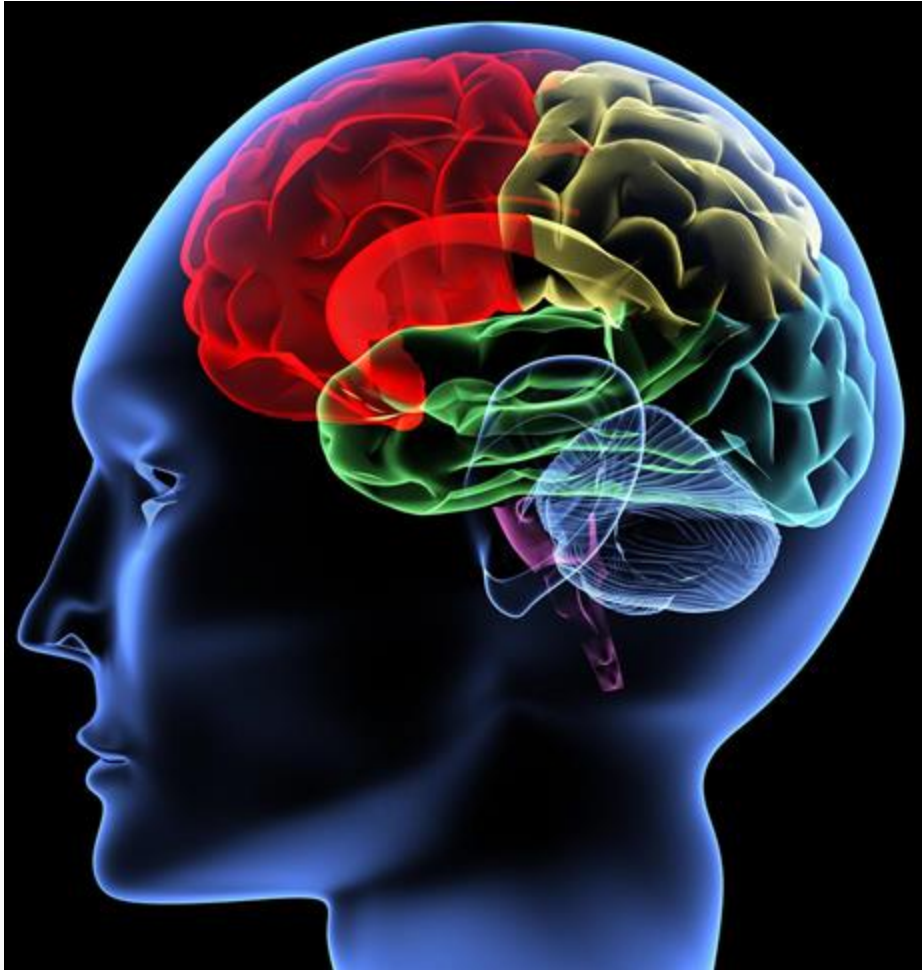
Data

Structured Data

- Tabular form

Unstructured Data

- Tabular form not possible?
- Text – Newspaper article, Twitter posts, ~~images?, videos?~~ Audio files?

Fast BPG	PPPG	Insulin	Family History	Hypertension	Age	Gender	Diabetes
			Uninteresting				Yes
			Mother-DM, MGM-DM, PGM-CVD,				No
			Siblings-DM, Parent-DM, CVD				No
							No
							Yes

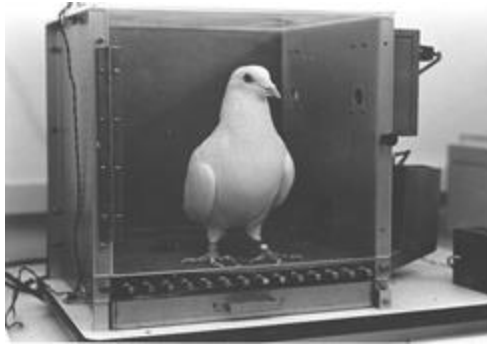# Structured Data

I = [r,g,b,a] for each pixel

    r, g, b, and a are all 2-dimensional matrices of equal size

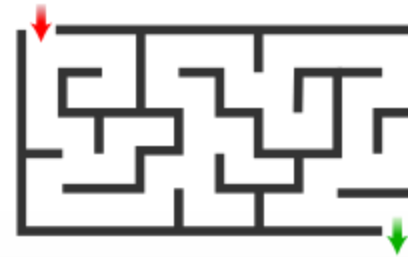Audio = [left, right]

    Left and right are vectors

Thinking is possible even with a "small" brain

Pigeons as art experts – 85% (Watanabe *et al.* 1995)
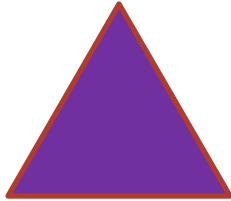
Source: https://en.wikipedia.org/wiki/Marc_Chagall
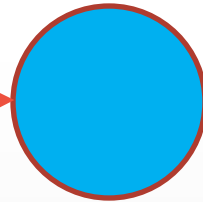https://en.wikipedia.org/wiki/Vincent_van_Gogh

Rats trained to run mazes[1], detect drugs[1][2]
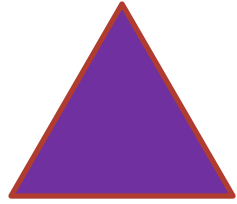
How many neurons are needed to learn?

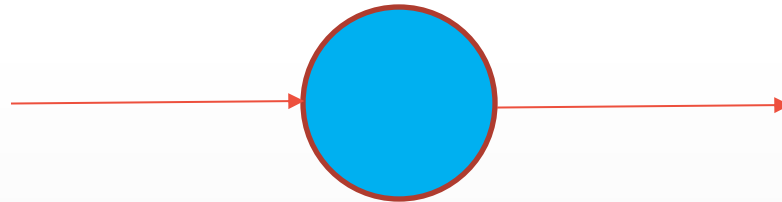| 124	99	255	99	40	10

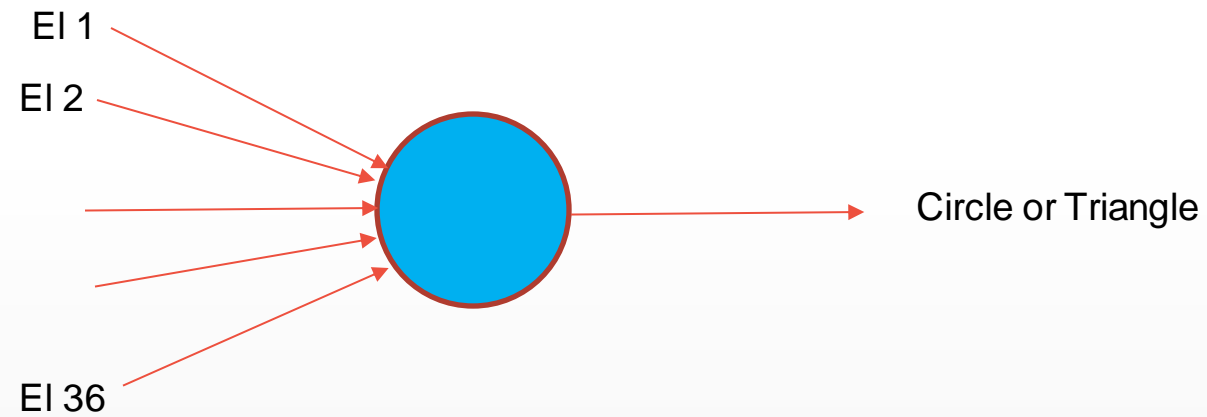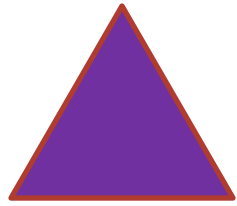Circle or Triangle

How many neurons are needed to learn?

A (6,6) matrix or flatten it and give it as 36-member vector

Circle or Triangle

How many neurons are needed to learn?

El 1
El 2
El 36
Circle or Triangle

mtcars data

Predict mpg using all other features - Regression

Predict the transmission type given the weight and the horse power - Classification

```
> mtcars
                     mpg cyl  disp  hp drat    wt  qsec vs am gear carb
Mazda RX4           21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag       21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
Datsun 710          22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive      21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout   18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
Valiant             18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
Merc 240D           24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
Merc 230            22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
Merc 280            19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
Merc 280C           17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
Merc 450SE          16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
Merc 450SL          17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
Fiat 128            32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
Honda Civic         30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
Toyota Corolla      33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
Toyota Corona       21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

mtcars data

Predict mpg using all other features - Regression
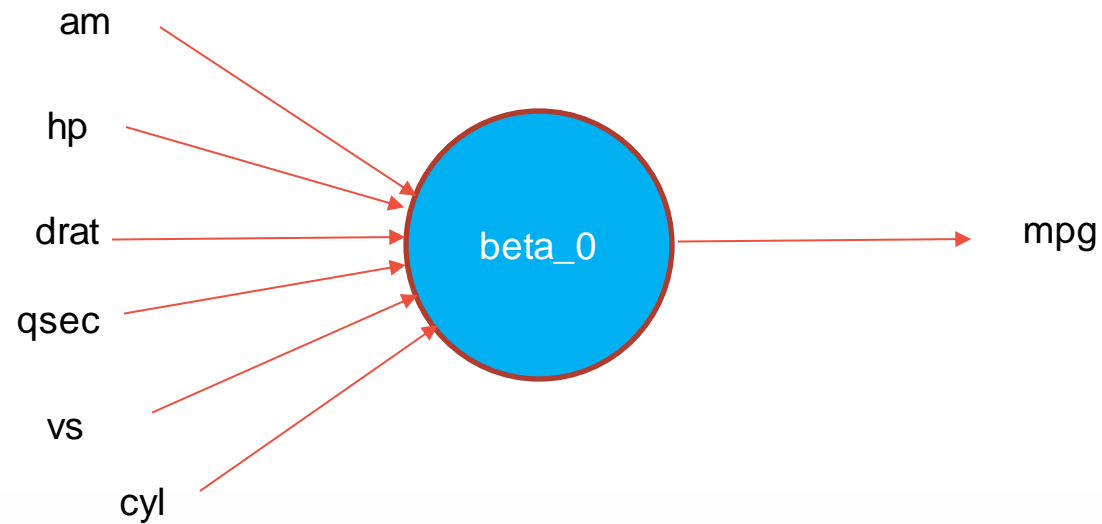
Mpg = beta_0 + summation(beta_I * vari_I): Proposed Model

Selected the best set of parameters minimizing a cost function

We used SSE as our cost function

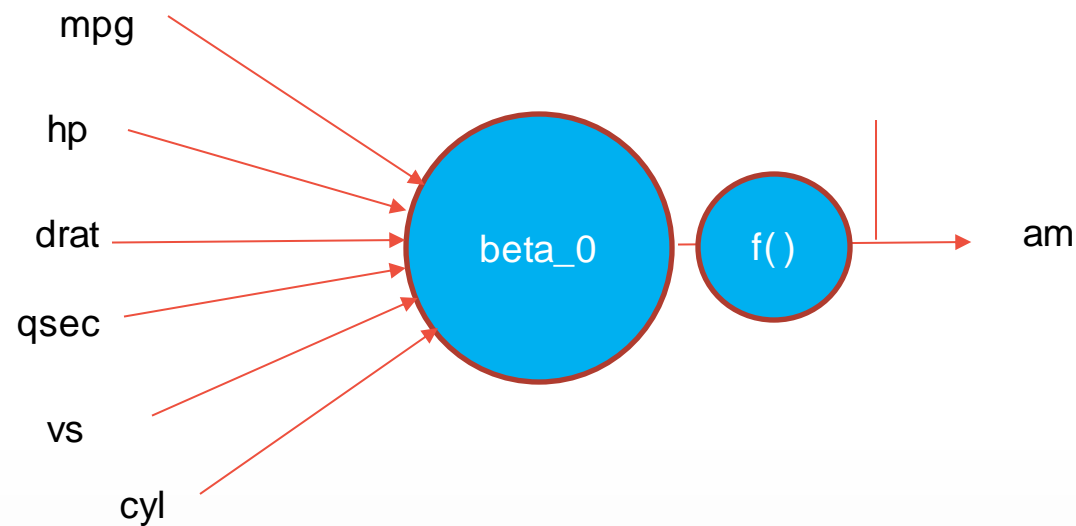# mtcars – Regression – Linear Regression

am*beta_am + +hp*beta_hp + ... + cyl*beta_cyl + beta_0 = mpg

mtcars – Classification – Logistic Regression Problem

mpg*beta_mpg +hp*beta_hp + … + cyl*beta_cyl + beta_0 = am

Logistic function

Set threshold   **Logistic function value > threshold give 1; otherwise 0**

mtcars – Classification – Logistic Regression Problem

Input = X = [x1,x2,...,xn]

Neuron's background activity = b: "bias"

~~Neuronal~~ Weights = W = [w1,w2,...,wn]

Output = f(WX + b)

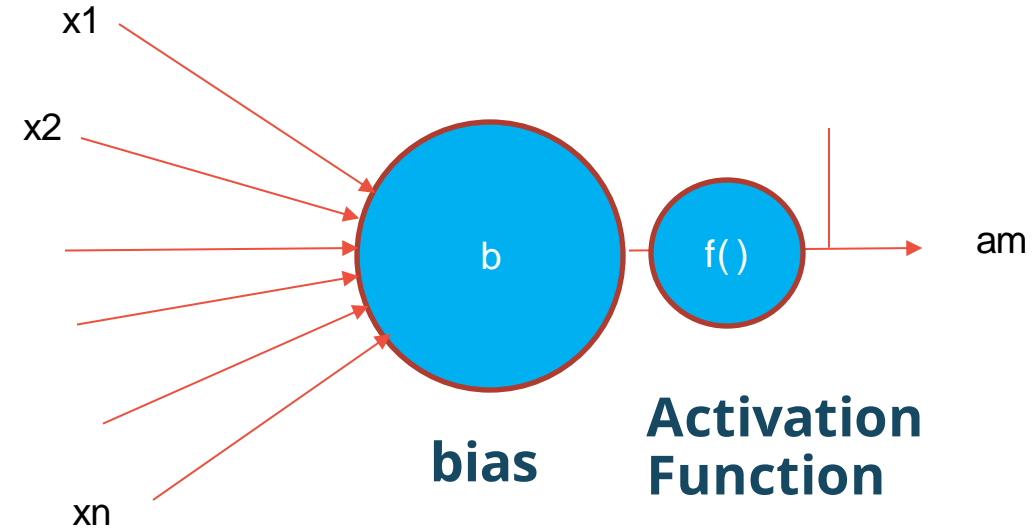f(WX + b) = 1/(1+exp(WX+b))   Sigmoid   Logistic Regression

f(WX + b) = WX +b   Linear Regression

x1

x2

xn

b

f( )

am

bias

Activation Function

INSOFE's Vision

The BEST GLOBAL DESTINATION for individuals and organizations to learn and adopt disruptive technologies for solving business and society's challenges.

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CLEVELAND
RENNES
ROPAR
MUMBAI
HYDERABAD
BENGALURU

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