31 August 2025 10:11

=> Models : Raw Py Implementation & sklearn → Py, ML

=> MVC & REST API : Web Terms → Web Dev

=> ML :

Math

Calc | Lin Alg

Complex Nos | Stats

(Stats)

Historical Data Analysis

Descriptive → History

Inferential → Prediction (Probability)

Predictive Analytics

ML | DL | AI

Sequence Models LSTMs, RNN, Transformers

Enc BERT | Dec GPT

LLM

LLM

=> ML : Supervised

University Exam

| Questions | Answers |
|---|---|
| a | 1 |
| b | 2 |
| c | 3 |
| d | 4 |

Data — Label

Unsupervised

GATE, GRE, IELTS

| Questions | Answers |
|---|---|
| a | 1 |
| b | 2 |
| c | 3 |
| (vi) | (iv) |

## Supervised Learning :

### Regression (Continuous)

Predict temp of day after tomorrow

26.2C

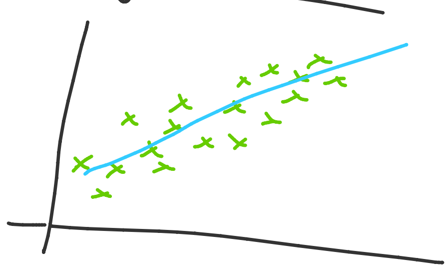
### Classification (Discrete)

Lion — 1

Tiger — 1

Puma — 1

## Linear Regression :



Dependent Variable

Variable

$$\hat{y} = \underbrace{\beta_0 + \beta_1}_{\text{Parameters}} \cdot x_i \quad (\text{Line}) \quad (y = mx + b)$$

Independent Variable

$$\Rightarrow \beta_0 = \bar{y} - (\beta_1 \cdot \bar{x})$$

$$\Rightarrow \beta_1 = \frac{\sum (x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sum (x_i - \bar{x})^2} = \frac{SSxy}{SSx}$$

$\Rightarrow$ Systems:

Heights = [173, 182, 165, 154, 170] = X

Weights = [68, 79, 65, 57, 64] = y

| x | y | $x_i - \bar{x}$ | $y_i - \bar{y}$ | $(x_i - \bar{x})^2$ | $(x_i - \bar{x}) \cdot (y_i - \bar{y})$ |
|---|---|---|---|---|---|
| 173 | 68 | 173 − 170 | | | |
| 182 | 79 | 182 − 170 | | | |
| 165 | 65 | | | | |
| 154 | 57 | | | | |
| 170 | 64 | | | | |
| $\bar{x} = 169$ | $\bar{y}$ | $\Sigma$ | $\Sigma$ | $\Sigma$ | $\Sigma$ |

$$\hat{y} = \beta_0 + \beta_1 \cdot x_i$$

$$\beta_0 = \bar{y} - (\beta_1 \cdot \bar{x})$$

$$\beta_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

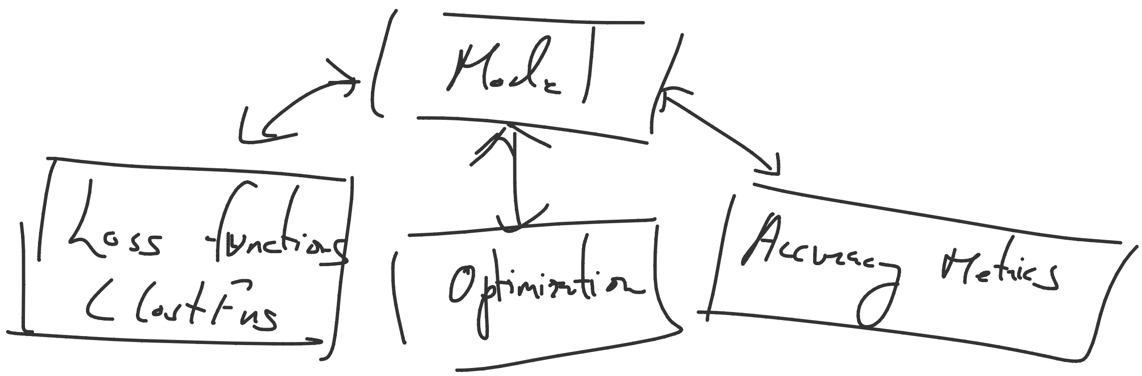
$$\beta_0 = -57.82$$

$$\beta_1 = 0.737$$

$$\hat{y} = \beta_0 + \beta_1 \cdot x_i$$

$$= -57.82 + 0.737 \times 176$$

=> Generalized Flow :




=> Regression :

-> Mean Squared Error
-> Mean Absolute Error
-> Root Mean Squared Error

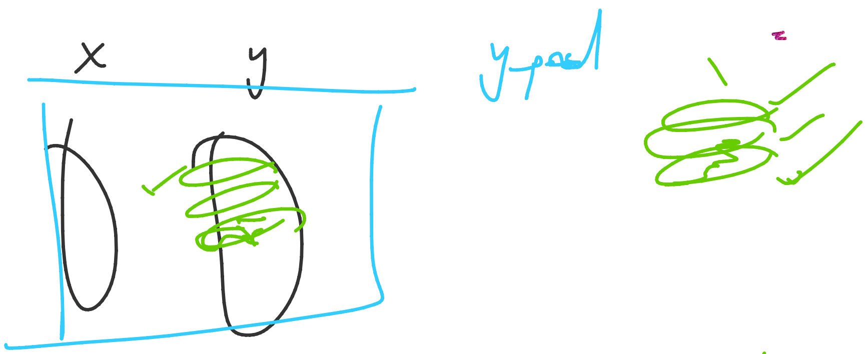
-> Loss Functions

R-Squared
Adjusted R-Squared

-> Goodness of Fit

$\begin{pmatrix} \text{Gradient Descent} \\ \text{Stochastic GD} \\ \text{RMS Prop} \\ \text{AdaGrad} \\ \text{Adam} \end{pmatrix} \rightarrow$ Optimizers

=> Mean Squared Error :




$$\text{Error} = \sum (y_i - \hat{y}_i)$$

$$\text{Sum Squared Error} = \sum (y_i - \hat{y}_i)^2$$

$$\text{Mean SE} = \sum (y_i - \hat{y}_i)^2$$

BMI, Activity . . . . . .

=> $\hat{y} = \beta_0 + \beta_1 \cdot x_1 + \beta_2 \cdot x_2 + \beta_3 \cdot x_3 \; \cdots\cdots \; \beta_n \cdot x_n$

Generalized : Self Adaptable

=> Least Square Estimates : (Linear Algebra)

$\hat{\beta}_0$

$$\hat{\beta} = \begin{pmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \\ \hat{\beta}_2 \\ \hat{\beta}_3 \\ \vdots \\ \hat{\beta}_n \end{pmatrix} = \underline{(X^T \cdot X)^{-1} \cdot X^T \cdot y}$$

$\Rightarrow$ Bias $\Rightarrow$ An arbitrary weight

| $(x_1)$ $\beta_1$ | P1 Sales | $(x_2)$ $\beta_2$ P2 Sales | Weekly Sales $(y)$ |
|---|---|---|---|
| | 1 | 4 | 1 |
| | 2 | 5 | 6 |
| | 3 | 8 | 8 |
| | 4 | 2 | 12 |

Bias

Data

$$X = \begin{pmatrix} 1 & 1 & 4 \\ 1 & 2 & 5 \\ 1 & 3 & 8 \\ 1 & 4 & 2 \end{pmatrix}_{4\times 3} \qquad X^T = \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & 2 & 3 & 4 \\ 4 & 5 & 8 & 2 \end{pmatrix}_{3\times 4}$$

$3\times 4 \times 4\times 3 = \underline{3\times 3}$

$$\underline{X^T X} = \begin{pmatrix} - & - & - \\ - & - & - \\ - & - & - \end{pmatrix}$$

$$(X^T X)^{-1} = \begin{pmatrix} - & - & - \\ - & - & - \\ - & - & - \end{pmatrix}_{3\times 3}$$

$$(X^T \cdot X)^{-1} \cdot X^T = \begin{pmatrix} - & - & - \\ - & - & - \\ - & - & - \end{pmatrix} \times \begin{pmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{pmatrix}$$

$$(X^T \cdot X)^{-1} \cdot X^T = \underbrace{\begin{pmatrix} - & - & - \\ - & - & - \\ - & - & - \end{pmatrix}}_{3\times 3} \times \underbrace{\begin{pmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{pmatrix}}_{3\times 4}$$

$$= \begin{pmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{pmatrix}_{3\times 4}$$

$$\left((X^T \cdot X)^{-1} \cdot X^T\right) y = \underbrace{\begin{pmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{pmatrix}}_{3\times 4} \times \underbrace{\begin{pmatrix} - \\ - \\ - \\ - \end{pmatrix}}_{4\times 1} \quad 3\times 1$$

$$\begin{pmatrix} - \\ - \\ - \end{pmatrix} \quad \underbrace{\begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{pmatrix}}_{(3\times 1)} \sim \hat{\beta}$$

$$\hat{y} = \beta_0 + \beta_1 \cdot x_1 + \beta_2 \cdot x_2$$

$$= (1\times 3) \rightarrow (1\times 1) \text{ Scalar Val}$$

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=> **Classification** : Discrete Values

=> Logistic Regression : Binary Classification

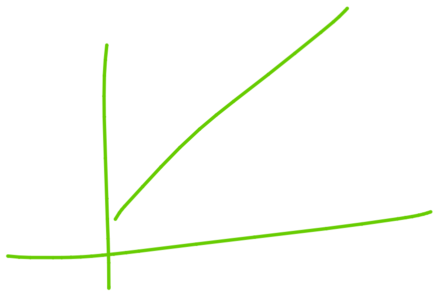
T/F, 0/1, Yes/No

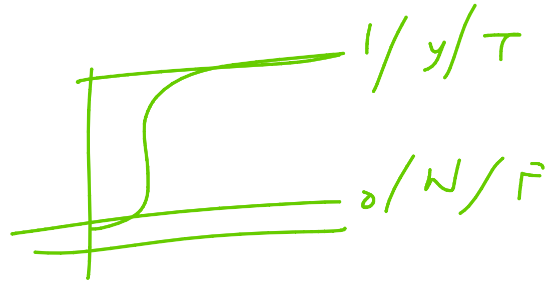
Logit Fn

⇓

Sigmoid (Activation)

Sigmoid (Activation)






$$z = \left( \hat{y} = \beta_0 + \beta_1 x_i \right)$$

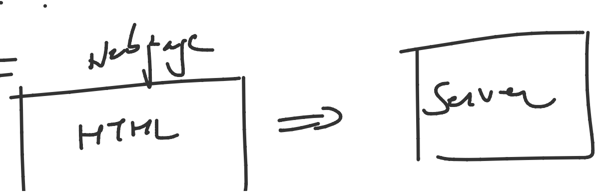
$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1 \cdot x_i)}}$$

<u>Loss</u>:
- ↳ Logarithmic Loss - Binary Cross-Entropy
- ↳ Categorical Cross-entropy

<u>Accuracy Metrics</u>:
- ↳ Confusion Matrix => (TP, TN, FP, FN) ≈ (Type I & Type II Error)
- ↳ <u>Precision</u> & <u>Recall</u>
- ↳ $F_1$-Score - Harmonic Mean of Precision & Recall.

=> <u>Model Deployment</u>:



HTML ⇒ Server

Server

2-tier System : HTML ⇔ DB

| Ruby | Python | Java | JS | Go |
| --- | --- | --- | --- | --- |
| Ruby on Rails | Flask | Servlets ✗ | NodeJS | Golang |
| | Django | JSP | Express | |
| | FastAPI | Spring | | |
| | | SpringBoot | | |

⇒ Methods : HTTP :

| C | R | U | D |
| --- | --- | --- | --- |
| Create | Retrieve | Update | Delete |
| ↓ | ↓ | ↓ | ↓ |
| Get | Post | Put | Delete |

HTTP Methods

G, P, P, T

Methods ⇒ Forms ⇒ form ⇒ SQL ⇒ RDBMS

=> Feature Engg : One Hot Encode

[Male , Female]

[0 , 1] -> Ordinal Scale

[0 . . . . . . 1]

Occurrence ✓

| M | F |
|---|---|
| 0 | 1 |
| 1 | 0 |

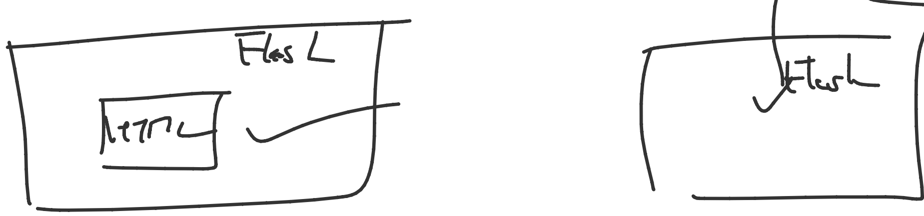
=> MVT : Model View Template

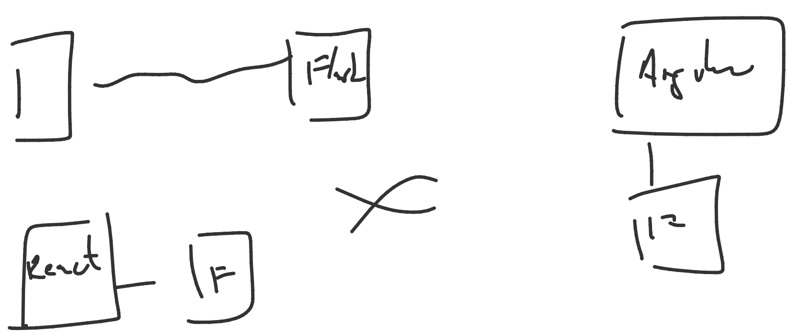
DB Appy.py HTML

MVC - Model View Controller

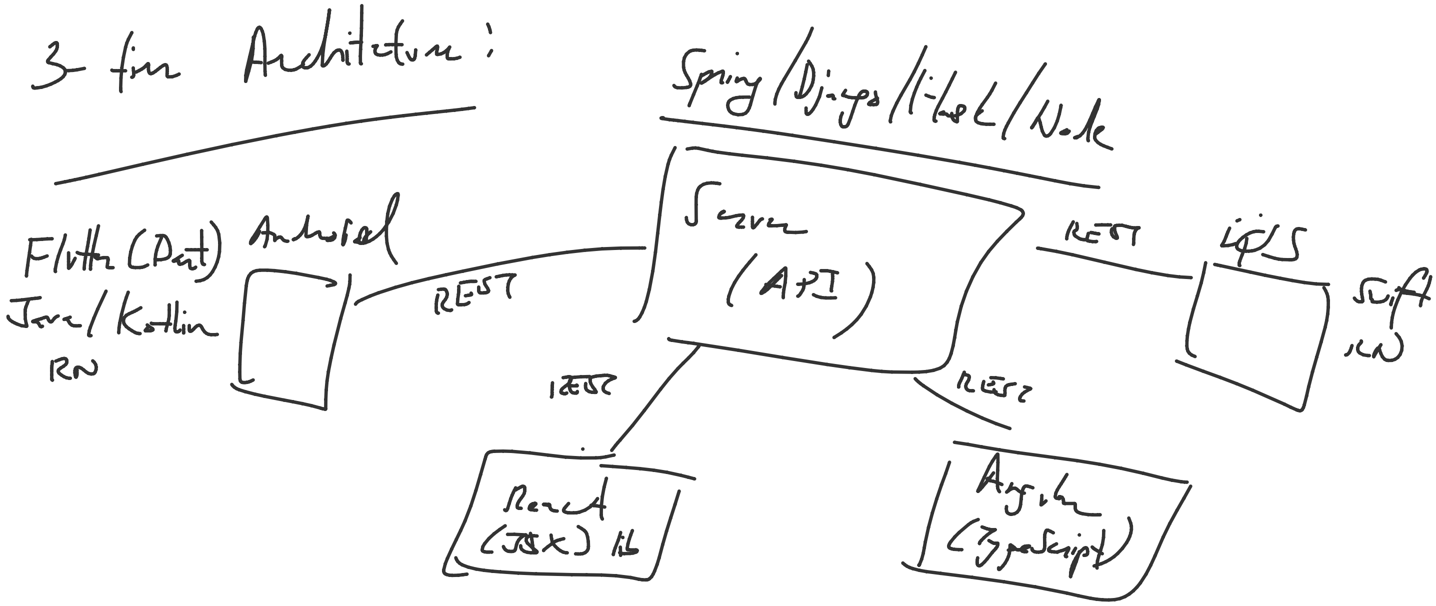
DB Template Server

(Swift
Kotlin
React Native
Flutter)



3 tier Architecture:




API - Application Programming Interface

REST = REpresentational State Transfer

(JSON)

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JavaScript Object Notation