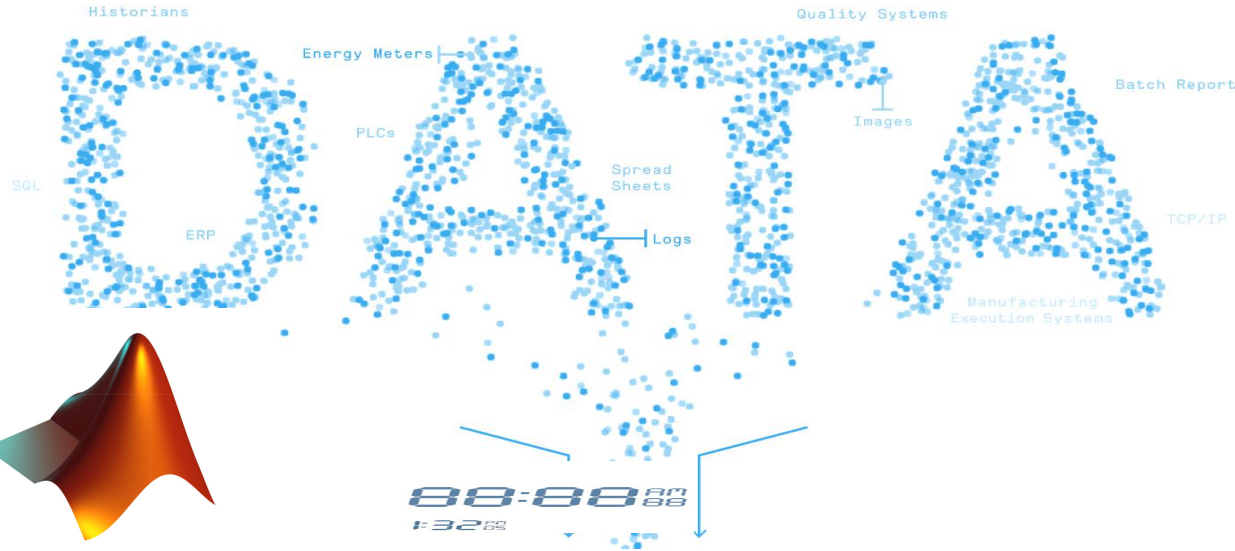
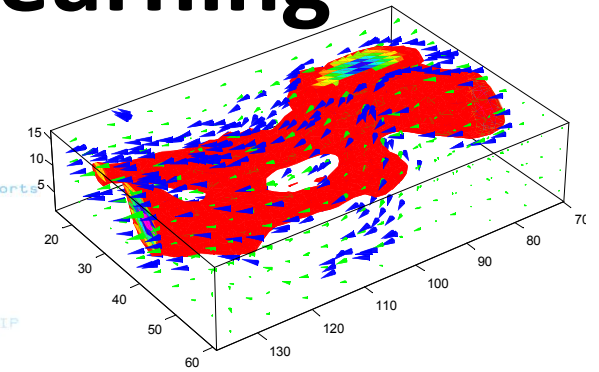
Introduction to Artificial Intelligence
- 05-01-02 Supervised Learning





Dr Leo Chen
leo.chen@ieee.org
06/Sep/2021

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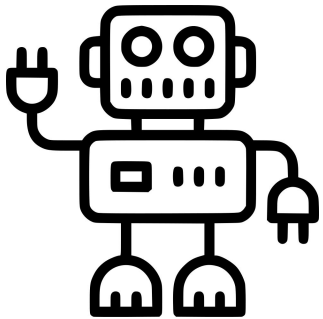
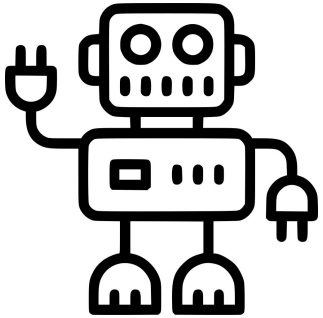
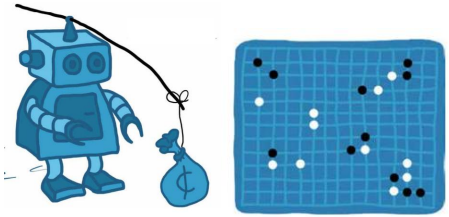


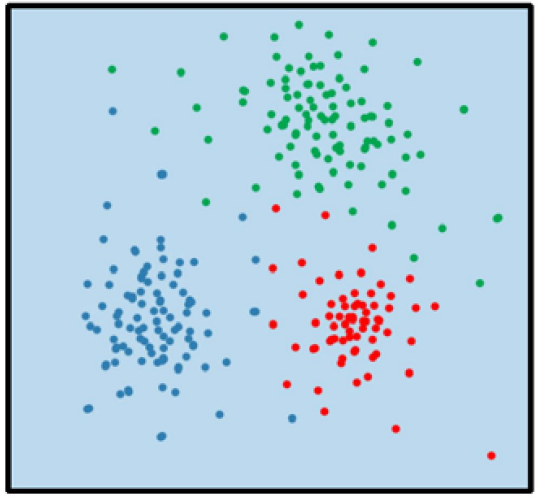
Chapter Contents



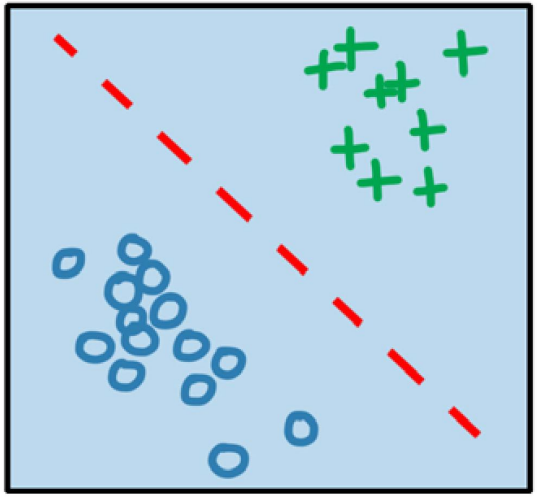


machine learning

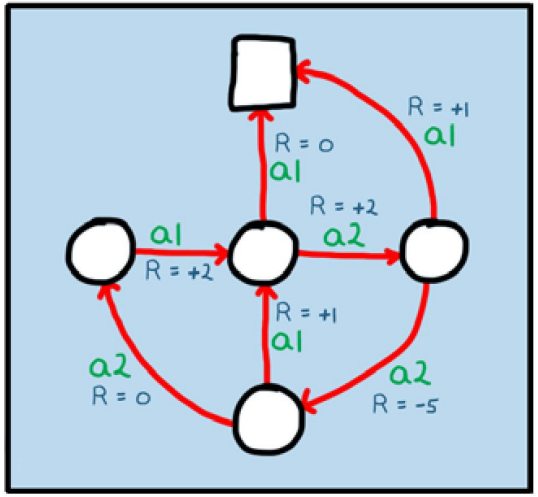
unsupervised learning



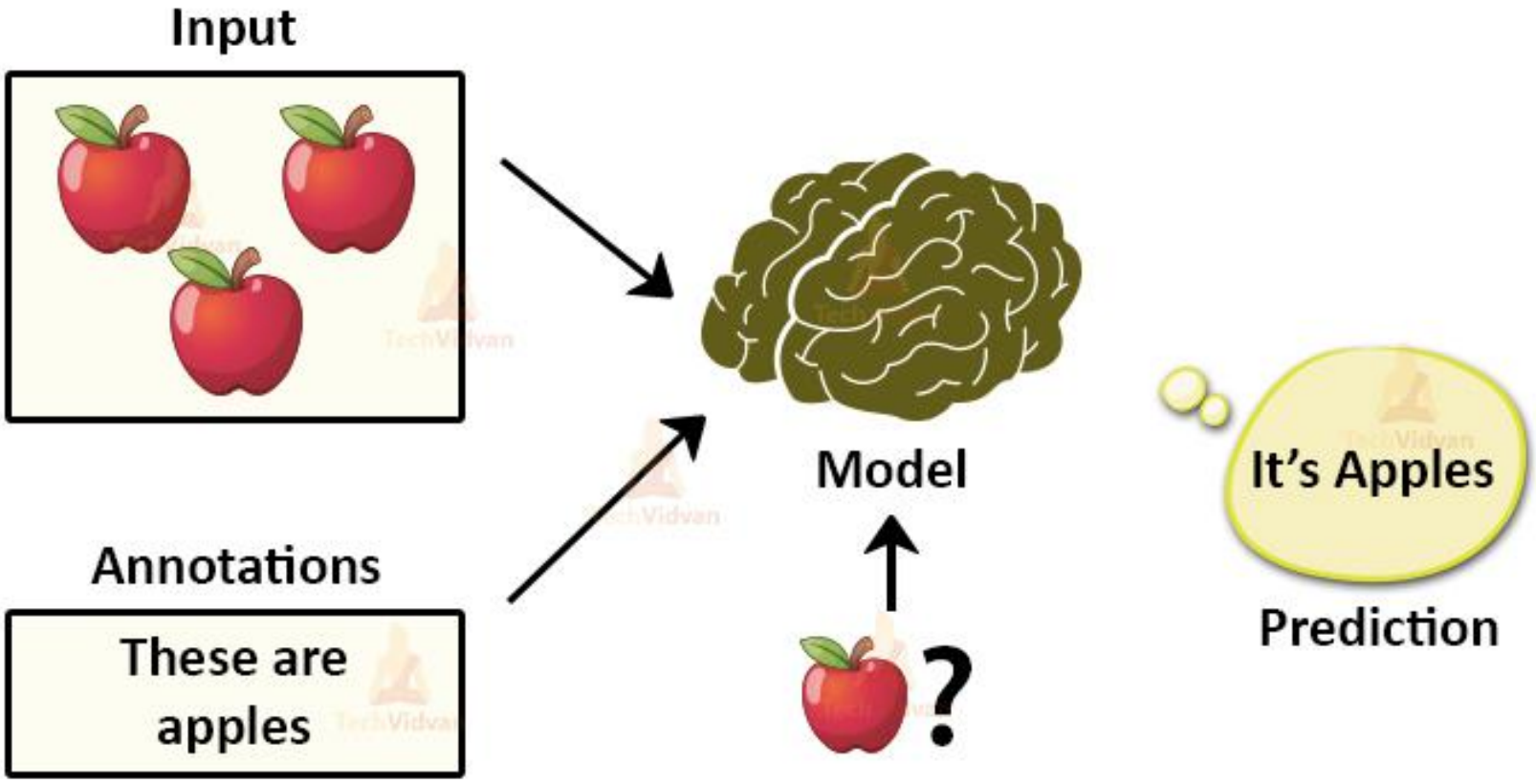
supervised learning



reinforcement learning

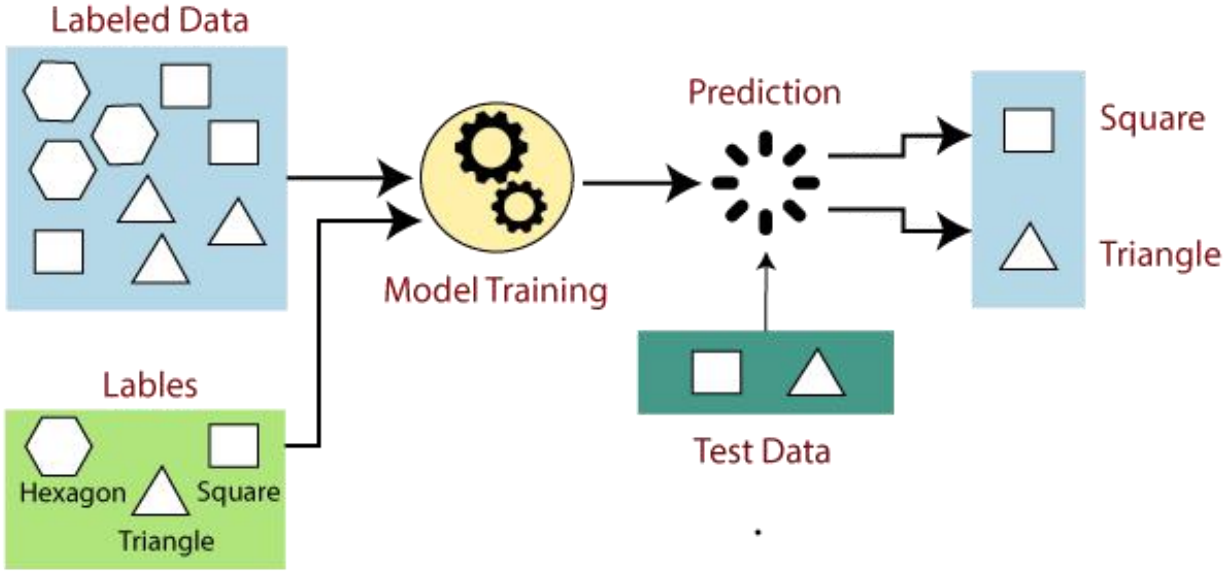


Supervised Learning in ML



Section Contents

1. What Is Supervised Learning
2. Why Use Supervised Learning
3. Fundamentals of Supervised Learning
4. Applications



1 What Is Supervised Learning[1,2]

- Supervised learning is a **subcategory** of machine learning.
- It is defined by its **use of labeled datasets** to train algorithms that to classify data or predict outcomes accurately.
- As input data is fed into the model, it adjusts its weights until the model has been fitted appropriately, which occurs as part of the cross validation process.

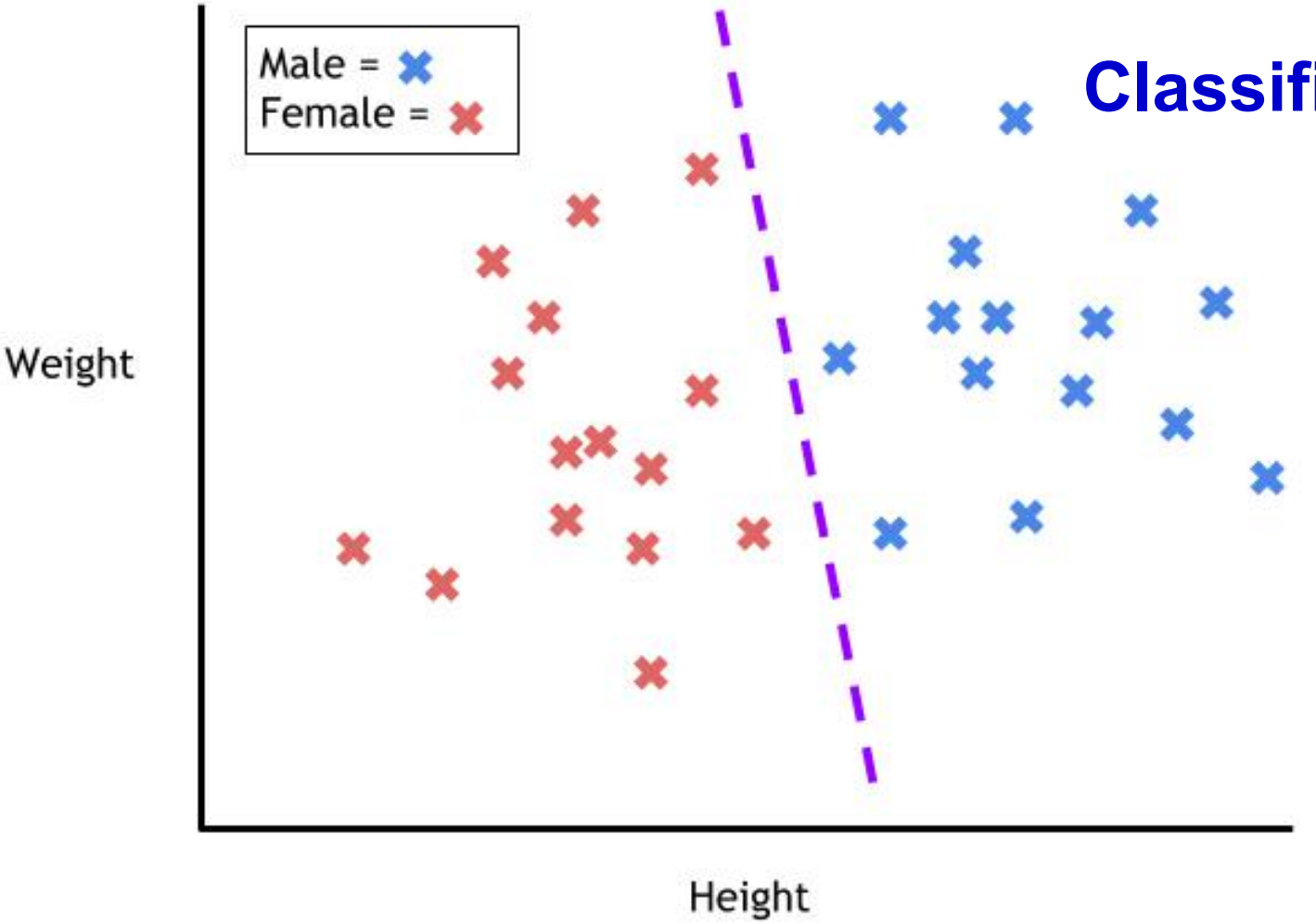
2 Why Use Supervised Learning[3]

- Use supervised learning if you have **existing data** for the output you are **trying to predict.**
- A supervised learning algorithm takes a **known set** of input data (the training set) and known responses to the data (output), and trains a model to generate reasonable predictions for the response to new input data.
- Supervised learning can be split into **two** subcategories: **Classification** and **regression**.

3 Fundamentals of Supervised Learning

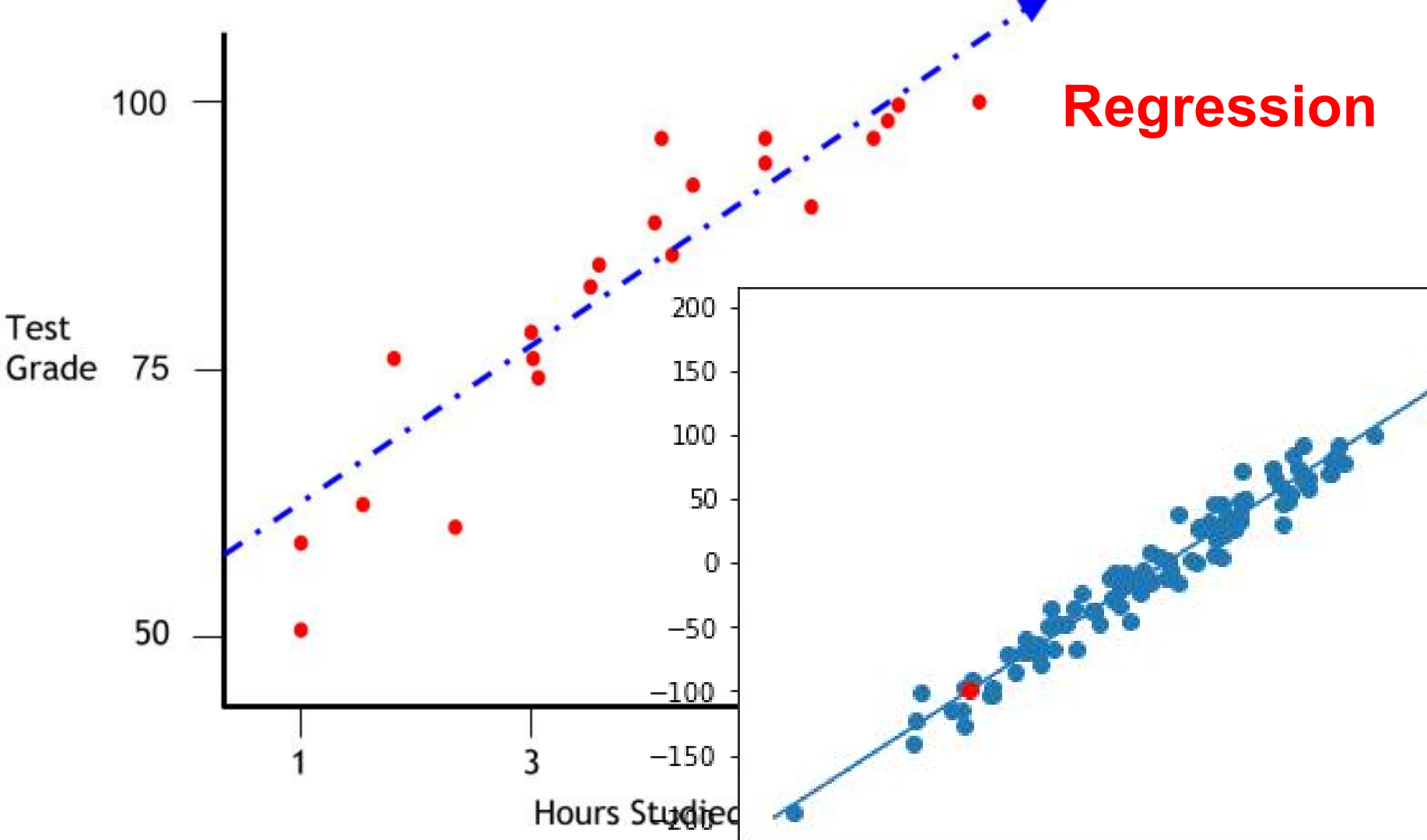
- **Classification** uses an algorithm to accurately **assign** test data into specific **categories**.

- **Regression** is used to understand the **relationship** between **dependent** and **independent** variables. It is commonly used to make projections.



Classification

Regression


100
75
50
Test Grade
1
3
Hours Studied
200
150
100
50
0
−50
−100
−150

Regression

Indice:

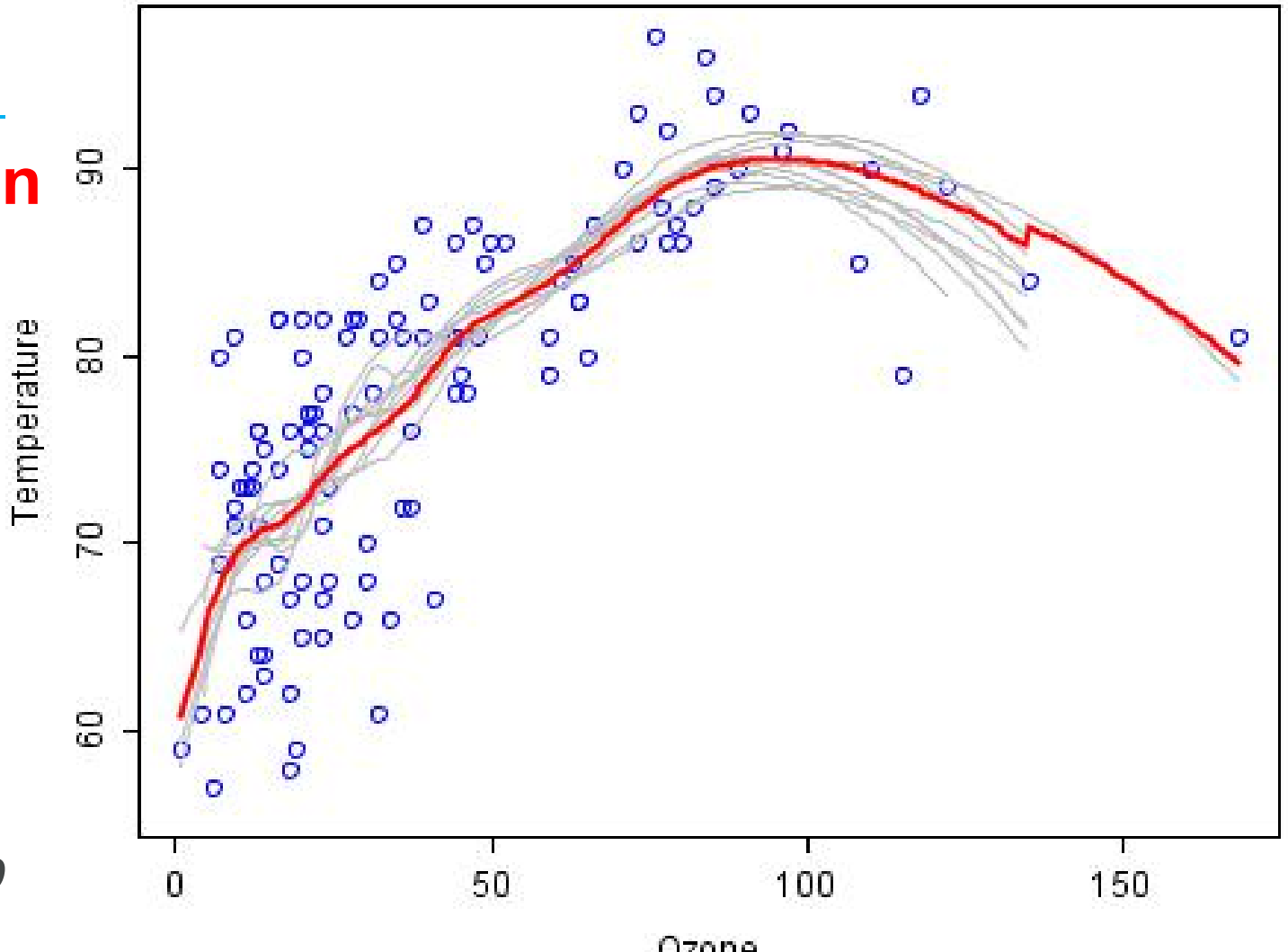
R-square

Adjusted R-square

AIC

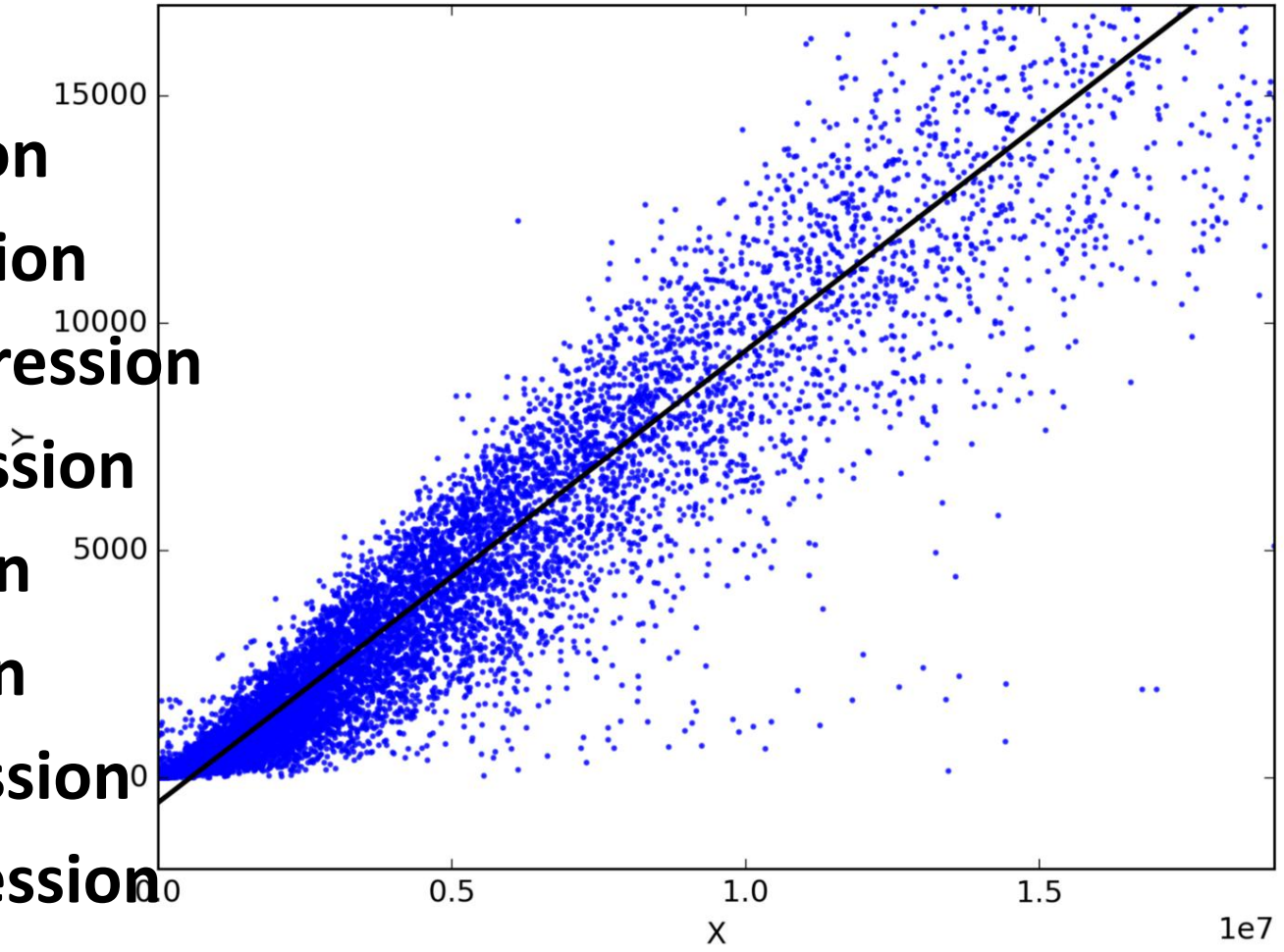
BIC

Mallows' Cp



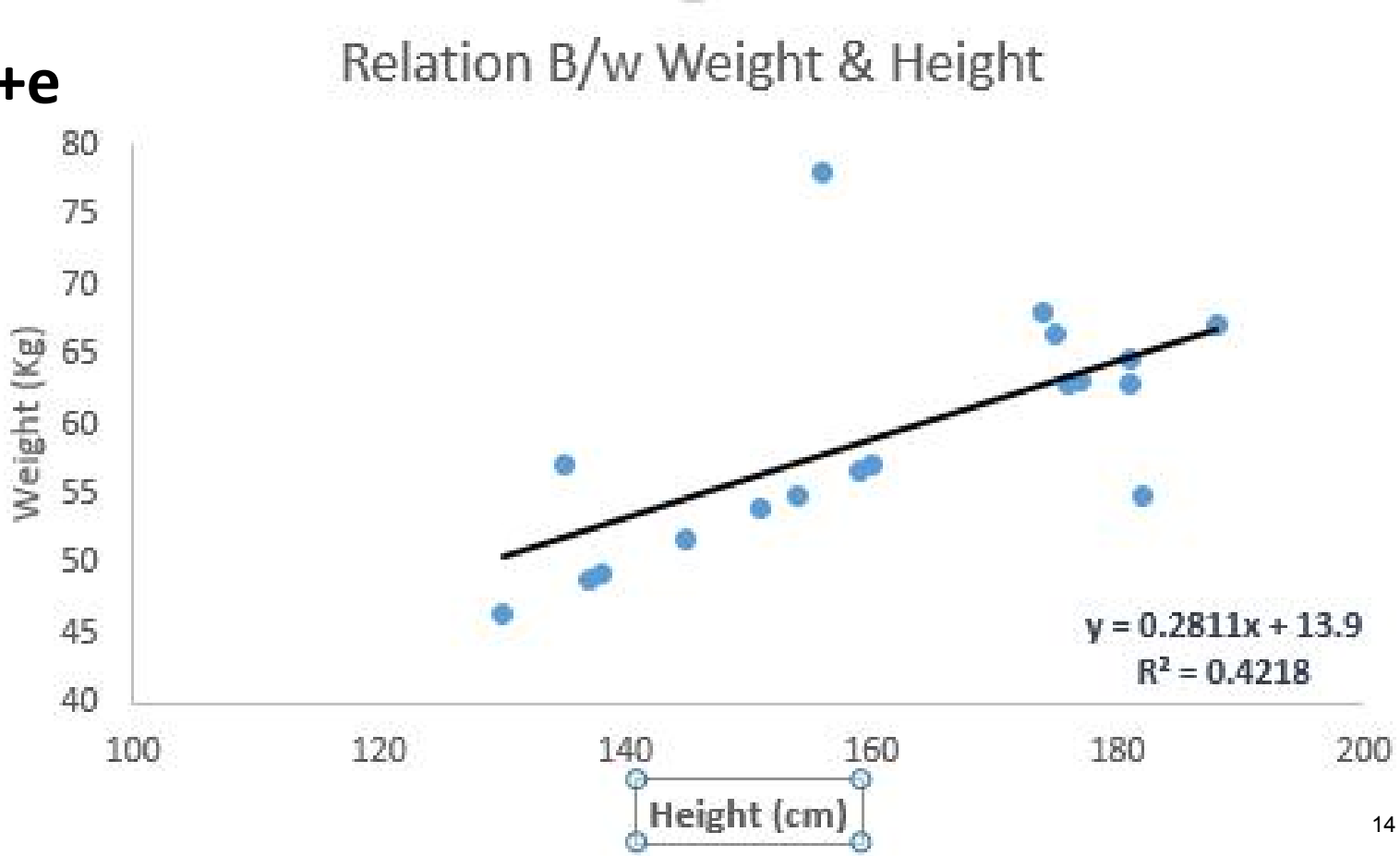
Regression

- Linear Regression
- Logistic Regression
- Polynomial Regression
- Stepwise Regression
- Ridge Regression
- Lasso Regression
- Bayesian Regression
- Ecological Regression
- Robust Regression



Linear Regression

- Y=a+b*X+e
- R-square

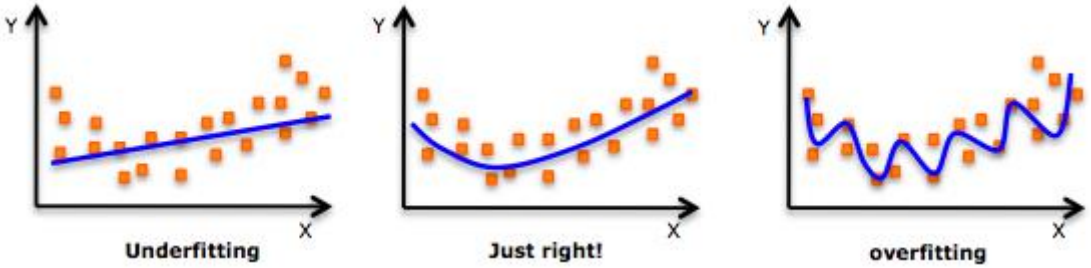


Logistic Regression

$$P = \frac{e^{a+bX}}{1+e^{a+bX}}$$

- **Logistic regression** is the appropriate regression analysis to conduct when the dependent variable is dichotomous (**binary**).
- Logistic regression is a **predictive** analysis.
- Logistic regression is used to describe data and to explain the relationship between **one dependent** binary variable and one or more **nominal**, **ordinal**, interval or ratio-level **independent** variables.

Polynomial Regression



- y=a+b*x^2

Stepwise Regression

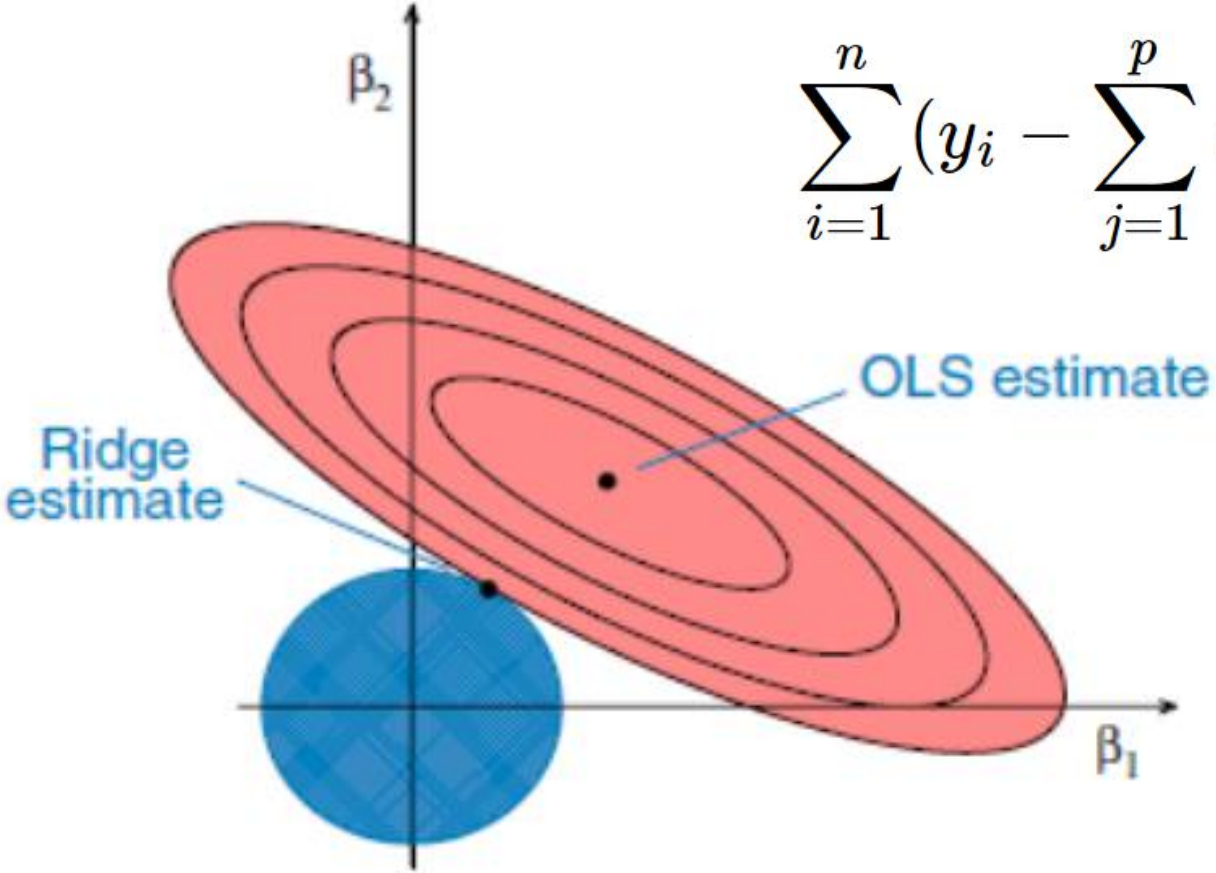
- **R-square, F-tests or t-tests.**
- Stepwise regression is the step-by-step iterative construction of a regression model that involves the selection of independent variables to be used in a final model.
- It involves adding or removing potential explanatory variables in succession and testing for statistical significance after each iteration.

Stepwise Regression

- The underlying goal of stepwise regression is, through a series of tests (e.g. F-tests, t-tests) to find a set of independent variables that significantly influence the dependent variable.
- This is done with computers through iteration, which is the process of arriving at results or decisions by going through repeated rounds or cycles of analysis.
- Conducting tests automatically with help from statistical software packages has the advantage of saving time and limiting mistakes.

Ridge Regression

$$\sum_{i=1}^{n}(y_i - \sum_{j=1}^{p} x_{ij}\beta_j)^2 + \lambda \sum_{j=1}^{p} \beta_j^2$$



Lasso Regression

- The acronym "**LASSO**" stands for **Least Absolute Shrinkage** and **Selection Operator**.
- Lasso regression is a type of **linear** regression that uses shrinkage.
- **Shrinkage** is where data values are shrunk towards a central point, like the mean.

$$\sum_{i=1}^{n}(y_i - \sum_{j} x_{ij}\beta_j)^2 + \lambda \sum_{j=1}^{p} |\beta_j|$$

Lasso Regression

- The lasso procedure encourages simple, **sparse models** (i.e. models with fewer parameters).
- This particular type of regression is well-suited for models showing **high levels of muticollinearity** or when you want to automate certain parts of model selection, like variable selection/parameter elimination.

ElasticNet

- When p > n (the number of covariates is greater than the sample size) lasso can select only n covariates (even when more are associated with the outcome) and it tends to select one covariate from any set of highly correlated covariates.
- Additionally, even when n > p, ridge regression tends to perform better given strongly correlated covariates.

$$\min_{\beta \in \mathbb{R}^p} \left\{ \|y - X\beta\|_2^2 + \lambda_1 \|\beta\|_1 + \lambda_2 \|\beta\|_2^2 \right\}$$

Advantages

- With the help of supervised learning, the model can **predict** the output on the basis of **prior experiences**.
- In supervised **learning**, we can have an **exact** idea about the classes of objects.
- Supervised learning model helps us to solve various real-world problems such as **fraud detection, spam filtering**, etc

Disadvantages

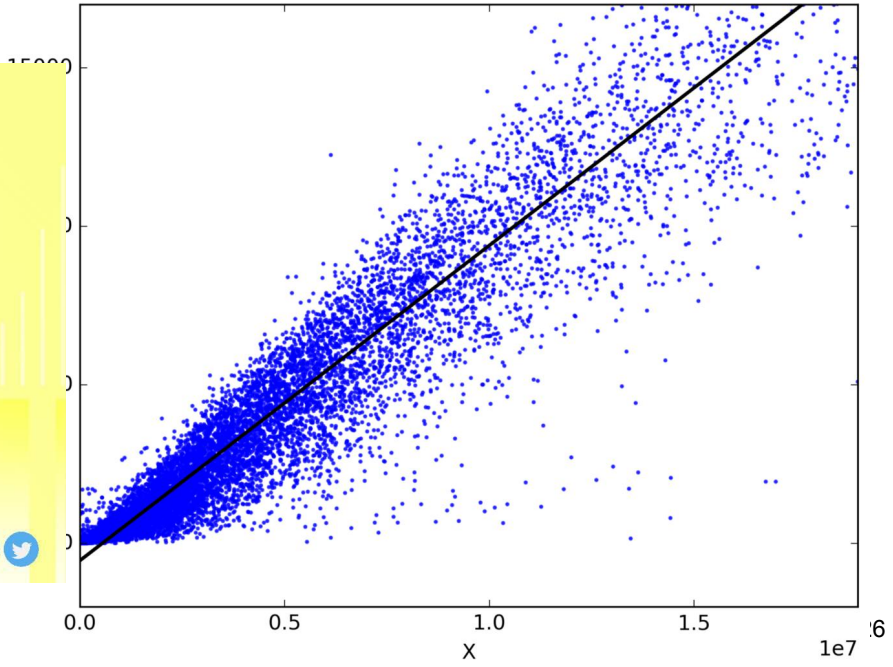
- Supervised learning models are **not suitable** for handling the complex tasks.
- Supervised learning **cannot predict** the correct output if the **test data is different from** the training dataset.
- Training required **lots of computation** times.
- In supervised learning, we need enough **knowledge** about the classes of object.

4 Applications

- Text categorization.
- Face Detection.
- Signature recognition.
- Customer discovery.
- Spam detection.
- Weather forecasting.
- Predicting housing prices, stock price predictions

Videos

1. [Supervised VS Unsupervised Learning (5mins)]
2. [Supervised Learning Crash Course AI (15mins)]



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Thanks and Questions