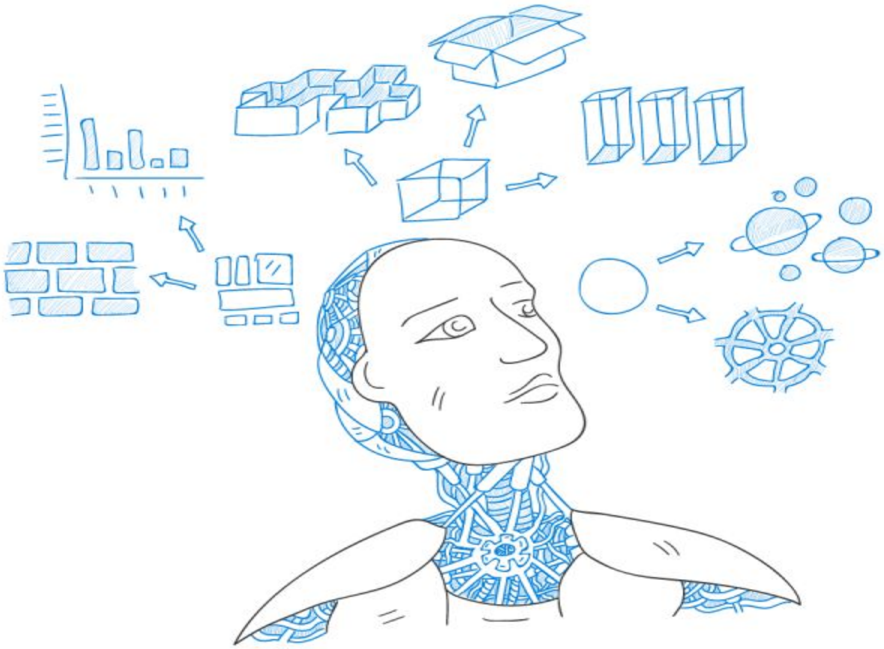
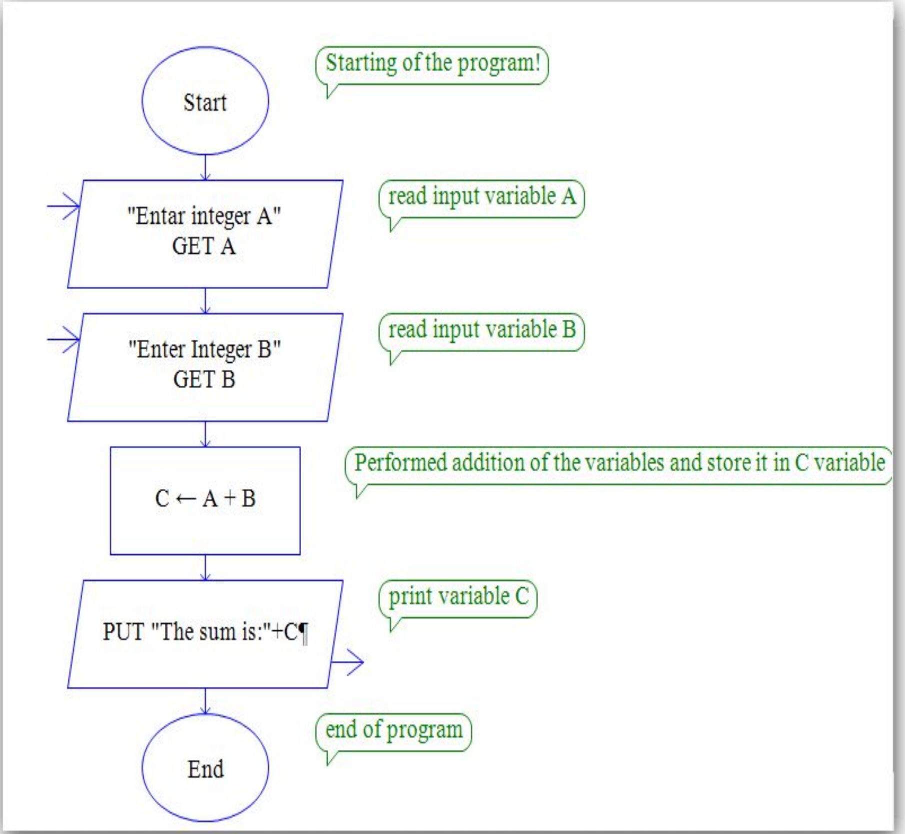
Introduction to Machine Learning



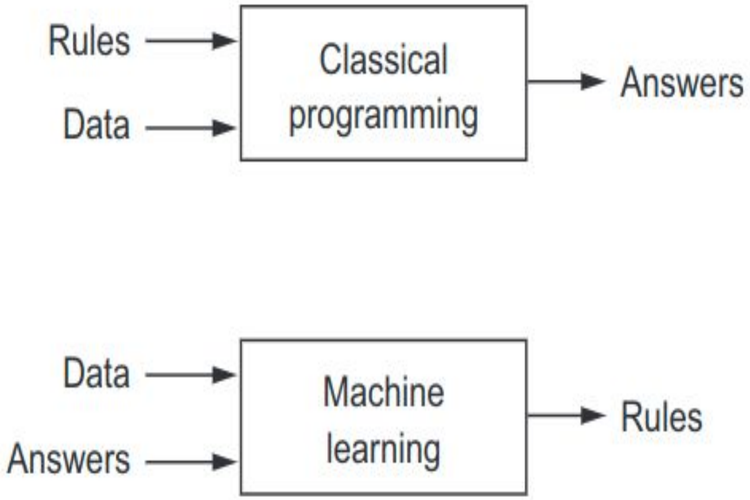
By-Ashish Vishwakarma
Mtech CSE IITBhilai



Write a program to classify between dog and a cat ?

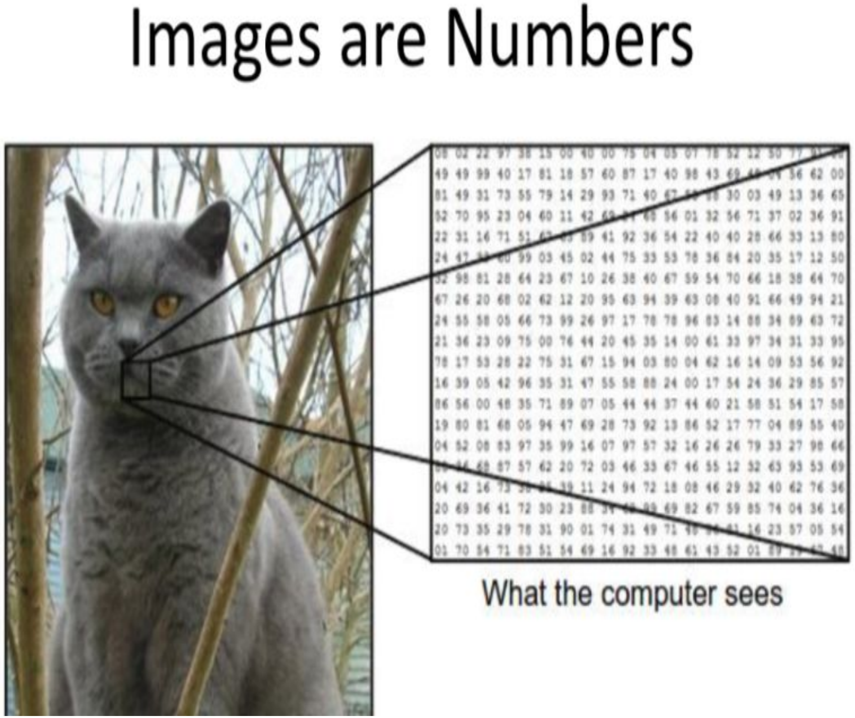
Machine learning: a new programming paradigm

A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E



When to Use Machine Learning ?

<u>Can't code the rule:</u> When rules depend on too many factors and many of these **rules overlap** or need to be tuned very finely, it soon becomes **difficult for a human to accurately code the rules**. You can use ML to effectively solve this problem.



<u>Can’t scale :</u> You might be able to manually recognize a few hundred images and decide whether they are dog or cat. However, this task becomes tedius for millions of emails. ML solutions are effective at handling large-scale problems.

You don’t need ML if you can determine a target value by **using simple rules**, computations, or **predetermined steps** that can be programmed without needing any data-driven learning.

Examples:

- ➢ Arithmetic operation ,eg : ADD,SUB,MUL,..
- ➢ Logical operation,eg: AND ,OR ,NOT,....
- ➢ Sorting numbers eg: Increasing ,Decreasing.
- ➢ Rule based eg: Direct Formulas(V=IR),factorial,..

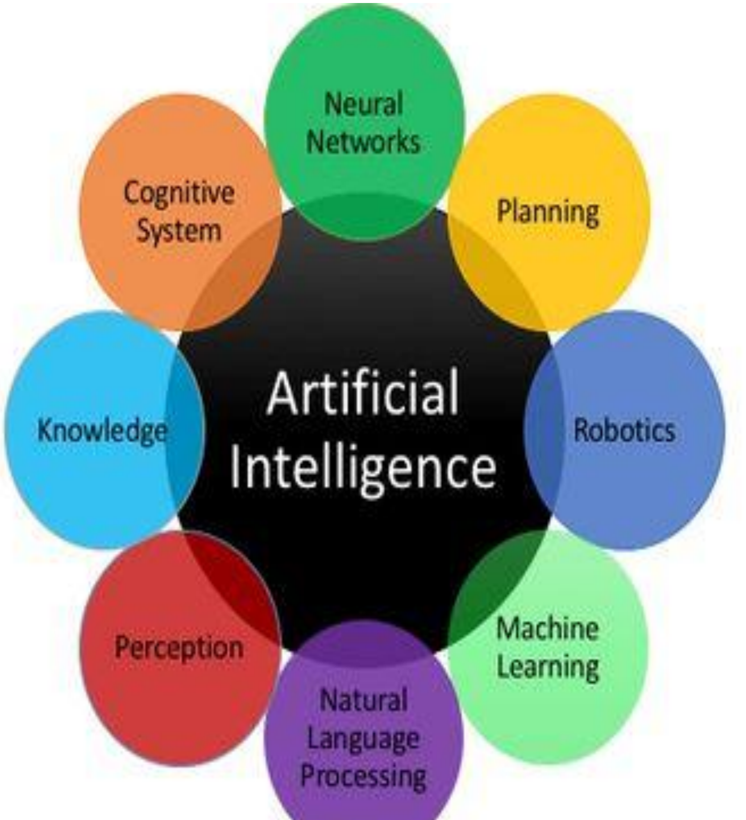
From where idea of ML come's from ?

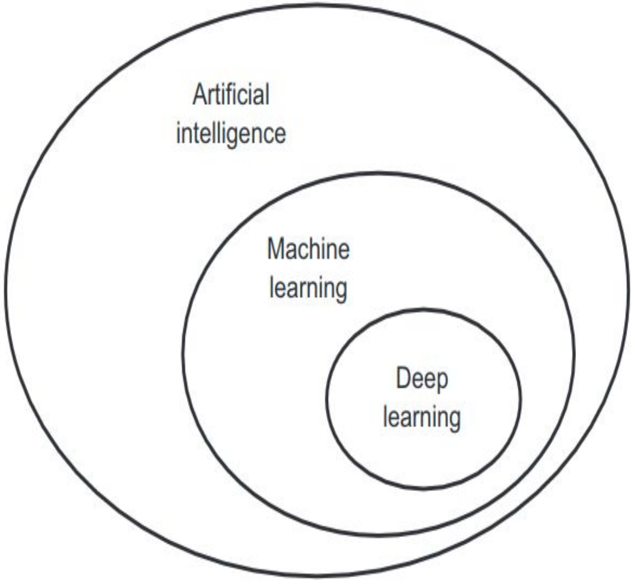
“AI began with an ancient wish to forge the gods.”

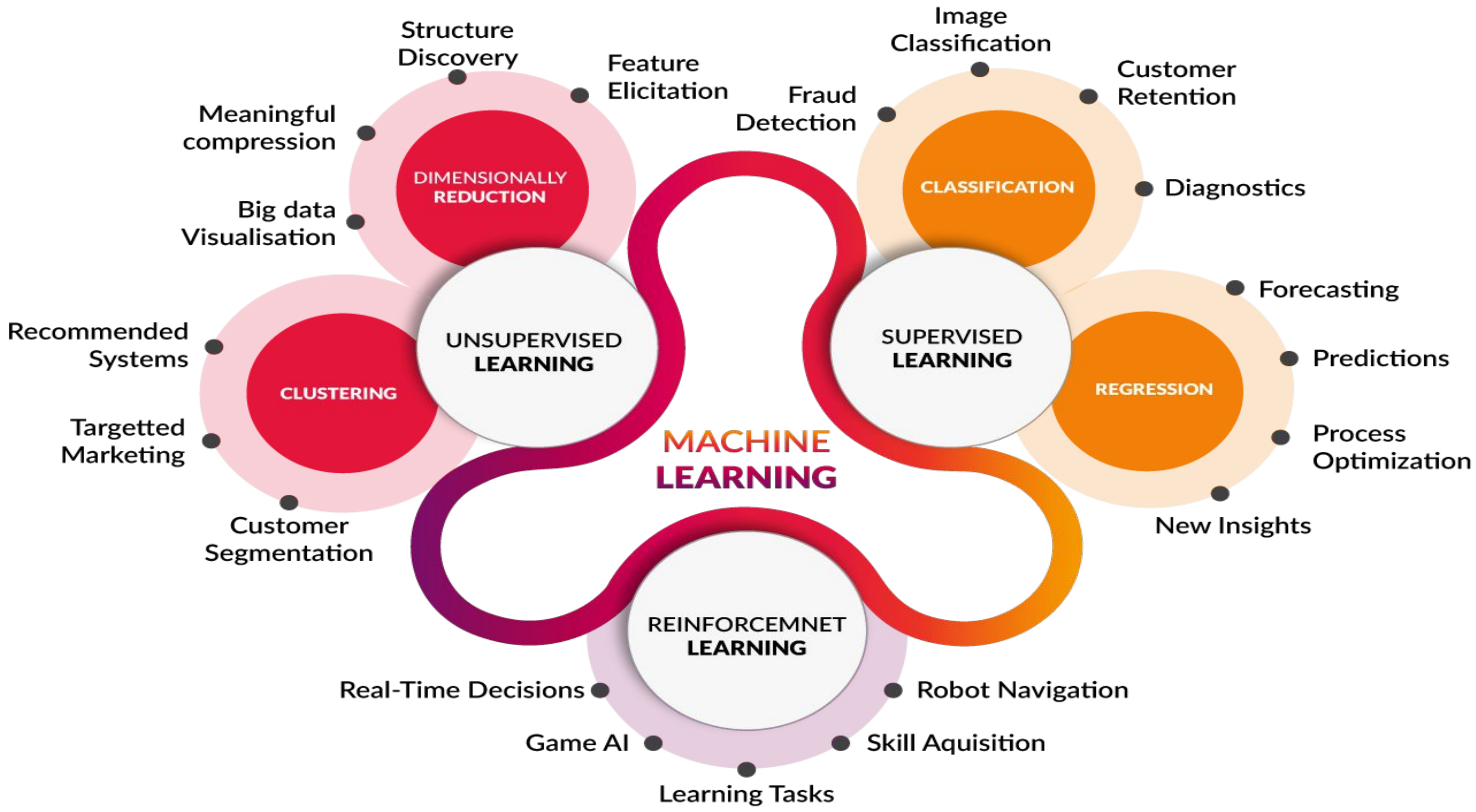
- Pamela McCorduck, Machines Who Think, 1979

An effort to automate intellectual tasks normally performed by humans.

.






Structure Discovery
Feature Elicitation
Meaningful compression
DIMENSIONALLY REDUCTION
Big data Visualisation
Image Classification
Customer Retention
Fraud Detection
CLASSIFICATION
Diagnostics
Forecasting
Predictions
REGRESSION
Process Optimization
New Insights
Recommended Systems
CLUSTERING
UNSUPERVISED LEARNING
SUPERVISED LEARNING
Targetted Marketing
Customer Segmentation
MACHINE LEARNING
REINFORCEMNET LEARNING
Real-Time Decisions
Robot Navigation
Game AI
Skill Aquisition
Learning Tasks

Some achievement’s:

- ➢ Near-human-level image classification.
- ➢ Near-human-level speech recognition.
- ➢ Near-human-level handwriting transcription.
- ➢ Improved machine translation.
- ➢ Improved text-to-speech conversion.
- ➢ Digital assistants such as Google Now and Amazon Alexa.
- ➢ Near-human-level autonomous driving.
- ➢ Improved ad targeting, as used by Google, Baidu, and Bing.
- ➢ Improved search results on the web.
- ➢ Ability to answer natural-language questions.
- ➢ Superhuman Go playing.

ML in basic sciences

ML In Condensed Matter Physics:

“Understanding the wavefunction of a many-particle quantum system with relevant accuracy which can pave the way for the designing of new quantum materials and devices.”

Researchers are **using ML algorithms to understand the phases of matter**, which could lead to theoretical breakthroughs in quantum bit or even silicon

https://www.quora.com/profile/Juan-Felipe-Carrasquilla

Deep Learning for Tracking in High Energy Physics:

https://pdfs.semanticscholar.org/c2b3/951c35159a08d48c3624921927e98fd32302.pdf

The researchers deployed an LSTM approach and proposed an **end-to-end solution for the HL-LHC track pattern recognition challenge**

https://arxiv.org/pdf/1402.4735.pdf

deep learning techniques improved the classification metric by 8 percent

ML In Astrophysics:

processing the wide amount of astronomical data generated which are often heterogeneous in nature.

gain data-driven insights and visualize it further

https://arxiv.org/pdf/1411.5039.pdf

References:

PY 895 Machine Learning for Physicists. Fall 2018 http://physics.bu.edu/~pankajm/PY895-ML.html

A high-bias, low-variance introduction to Machine Learning for physicists
https://arxiv.org/pdf/1803.08823.pdf

https://www.quora.com/What-are-the-connections-between-machine-learning-and-physics

Junction Tree Variational Autoencoder for Molecular Graph Generation:

automate the design of molecules based on specific chemical properties

https://arxiv.org/abs/1802.04364

Using Deep Reinforcement Learning to Generate Rationales for Molecules:

Learn to identify molecular substructures – rationales – that are associated with the target chemical property.

http://chem.csail.mit.edu/deep-reinforcement-learning.pdf

Predicting Organic Reaction Outcomes with Weisfeiler-Lehman Network

Prediction of Organic Reaction Outcomes Using Machine Learning

Convolutional Embedding of Attributed Molecular Graphs for Physical Property Prediction

Automating drug discovery

Computational Protein Design with Deep Learning Neural Networks

References:

http://chem.csail.mit.edu/papers

Representation, optimization and generalization properties of deep neural networks

Robustness in unsupervised and supervised machine

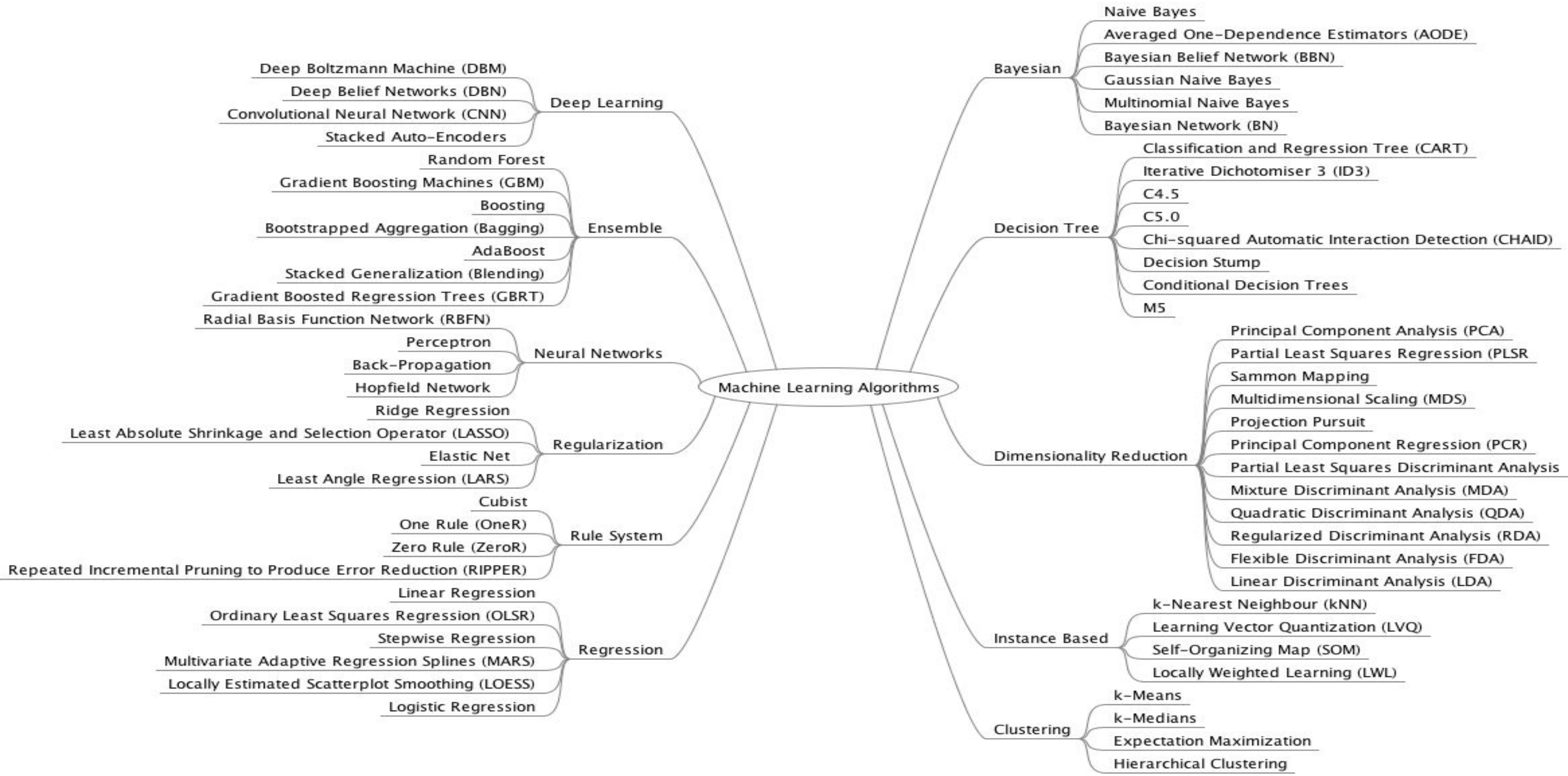
A modular analysis of adaptive online (non-)convex optimization

References:

http://www.crm.umontreal.ca/2018/Modern18/horaire_e.html

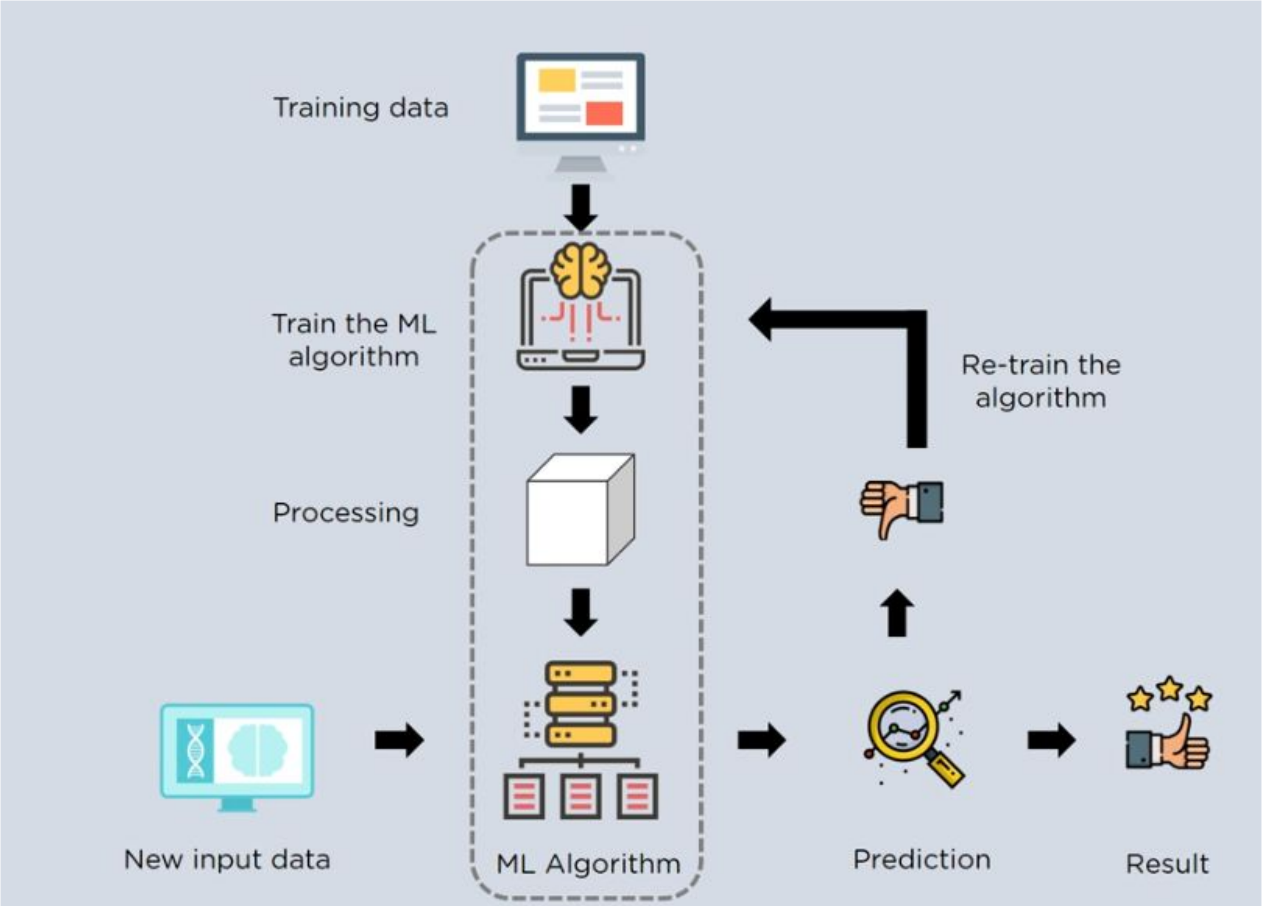
Some Insight !

Algorithms:



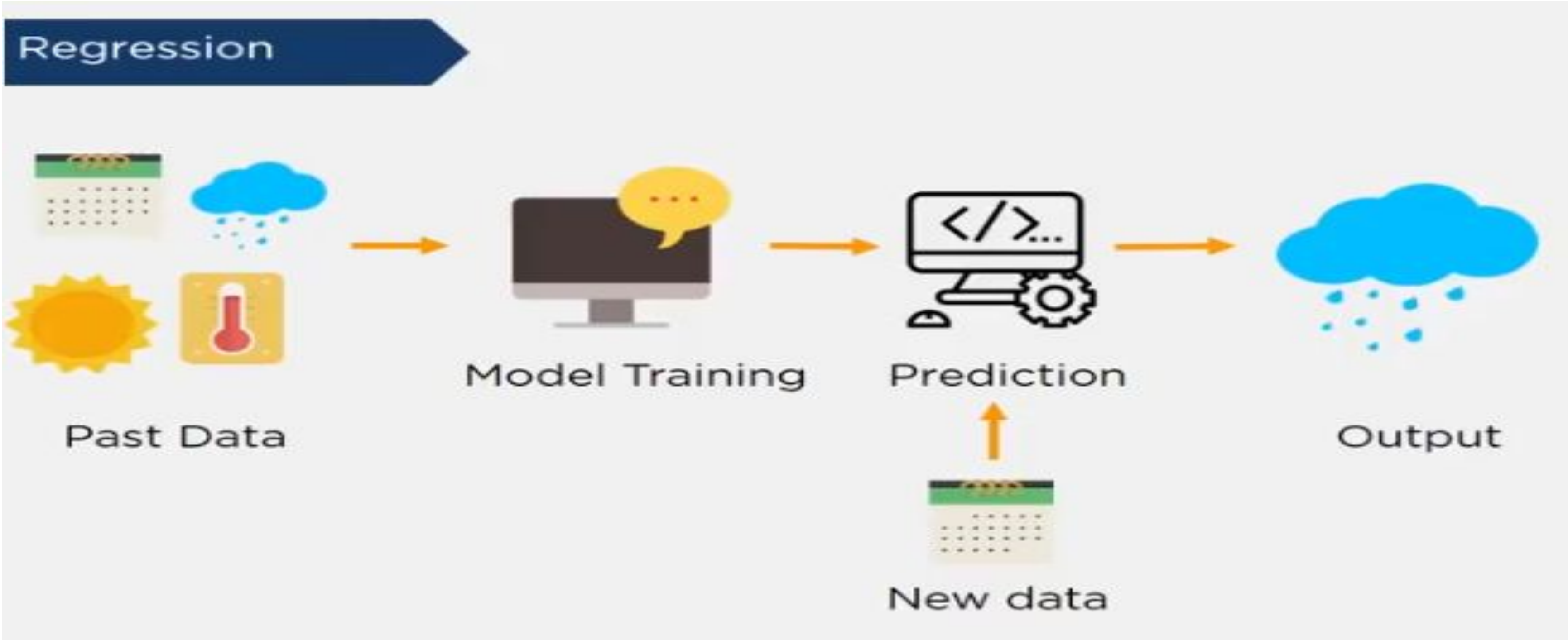
Machine Learning Algorithms
Deep Learning
Deep Boltzmann Machine (DBM)
Deep Belief Networks (DBN)
Convolutional Neural Network (CNN)
Stacked Auto-Encoders
Ensemble
Random Forest
Gradient Boosting Machines (GBM)
Boosting
Bootstrapped Aggregation (Bagging)
AdaBoost
Stacked Generalization (Blending)
Gradient Boosted Regression Trees (GBRT)
Neural Networks
Radial Basis Function Network (RBFN)
Perceptron
Back-Propagation
Hopfield Network
Regularization
Ridge Regression
Least Absolute Shrinkage and Selection Operator (LASSO)
Elastic Net
Least Angle Regression (LARS)
Rule System
Cubist
One Rule (OneR)
Zero Rule (ZeroR)
Repeated Incremental Pruning to Produce Error Reduction (RIPPER)
Regression
Linear Regression
Ordinary Least Squares Regression (OLSR)
Stepwise Regression
Multivariate Adaptive Regression Splines (MARS)
Locally Estimated Scatterplot Smoothing (LOESS)
Logistic Regression
Bayesian
Naive Bayes
Averaged One-Dependence Estimators (AODE)
Bayesian Belief Network (BBN)
Gaussian Naive Bayes
Multinomial Naive Bayes
Bayesian Network (BN)
Decision Tree
Classification and Regression Tree (CART)
Iterative Dichotomiser 3 (ID3)
C4.5
C5.0
Chi-squared Automatic Interaction Detection (CHAID)
Decision Stump
Conditional Decision Trees
M5
Dimensionality Reduction
Principal Component Analysis (PCA)
Partial Least Squares Regression (PLSR
Sammon Mapping
Multidimensional Scaling (MDS)
Projection Pursuit
Principal Component Regression (PCR)
Partial Least Squares Discriminant Analysis
Mixture Discriminant Analysis (MDA)
Quadratic Discriminant Analysis (QDA)
Regularized Discriminant Analysis (RDA)
Flexible Discriminant Analysis (FDA)
Linear Discriminant Analysis (LDA)
Instance Based
k-Nearest Neighbour (kNN)
Learning Vector Quantization (LVQ)
Self-Organizing Map (SOM)
Locally Weighted Learning (LWL)
Clustering
k-Means
k-Medians
Expectation Maximization
Hierarchical Clustering

How does Machine Learning works?



Supervised Learning

Machine learning model learns from the past input data and makes future prediction as output



Price of a house

$70,000

?

$160,000

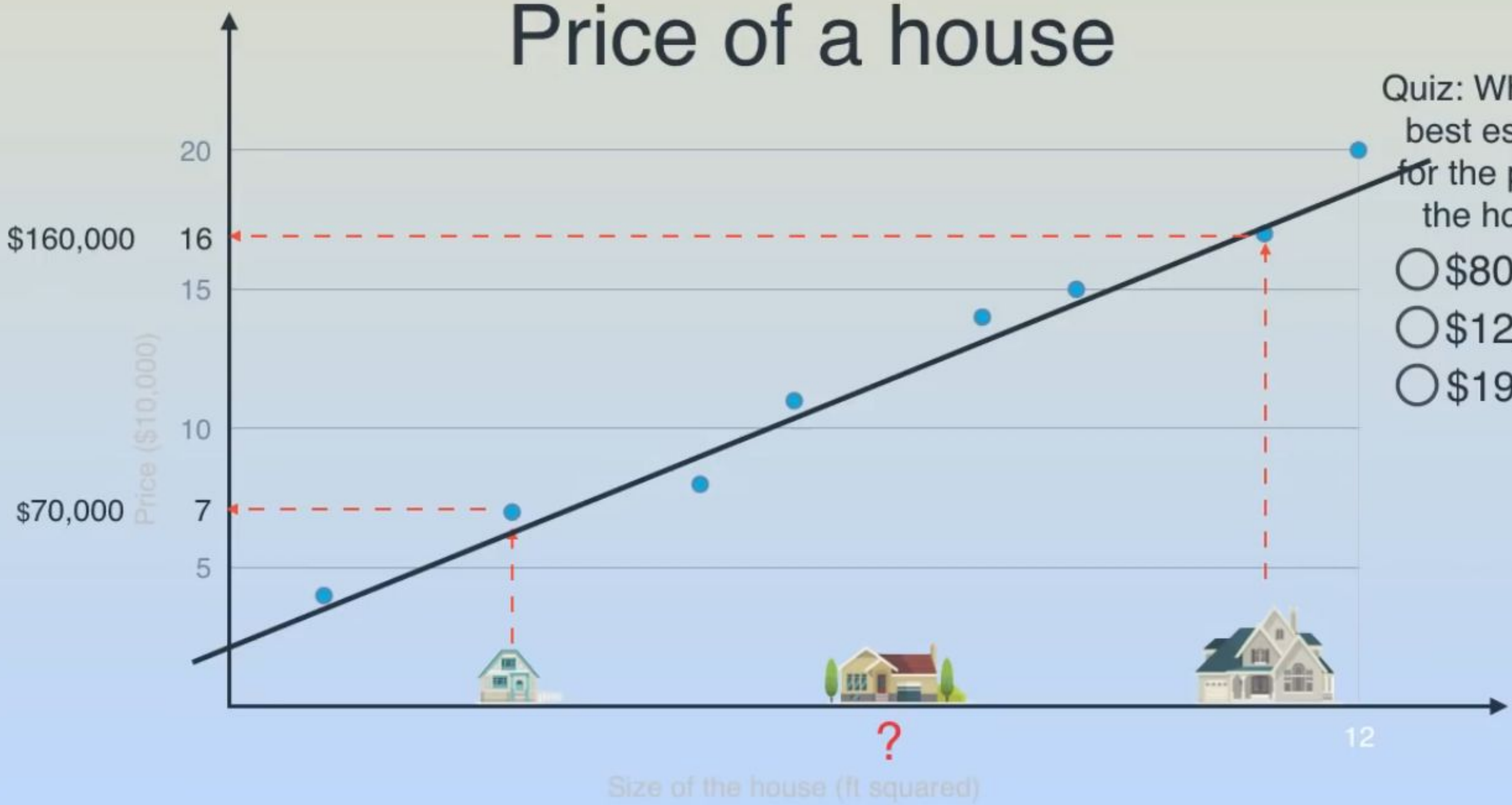
Price of a house

Price of a house

Quiz: What's the best estimate for the price of the house?

- ◯ $80,000
- ◯ $120,000
- ◯ $190,000

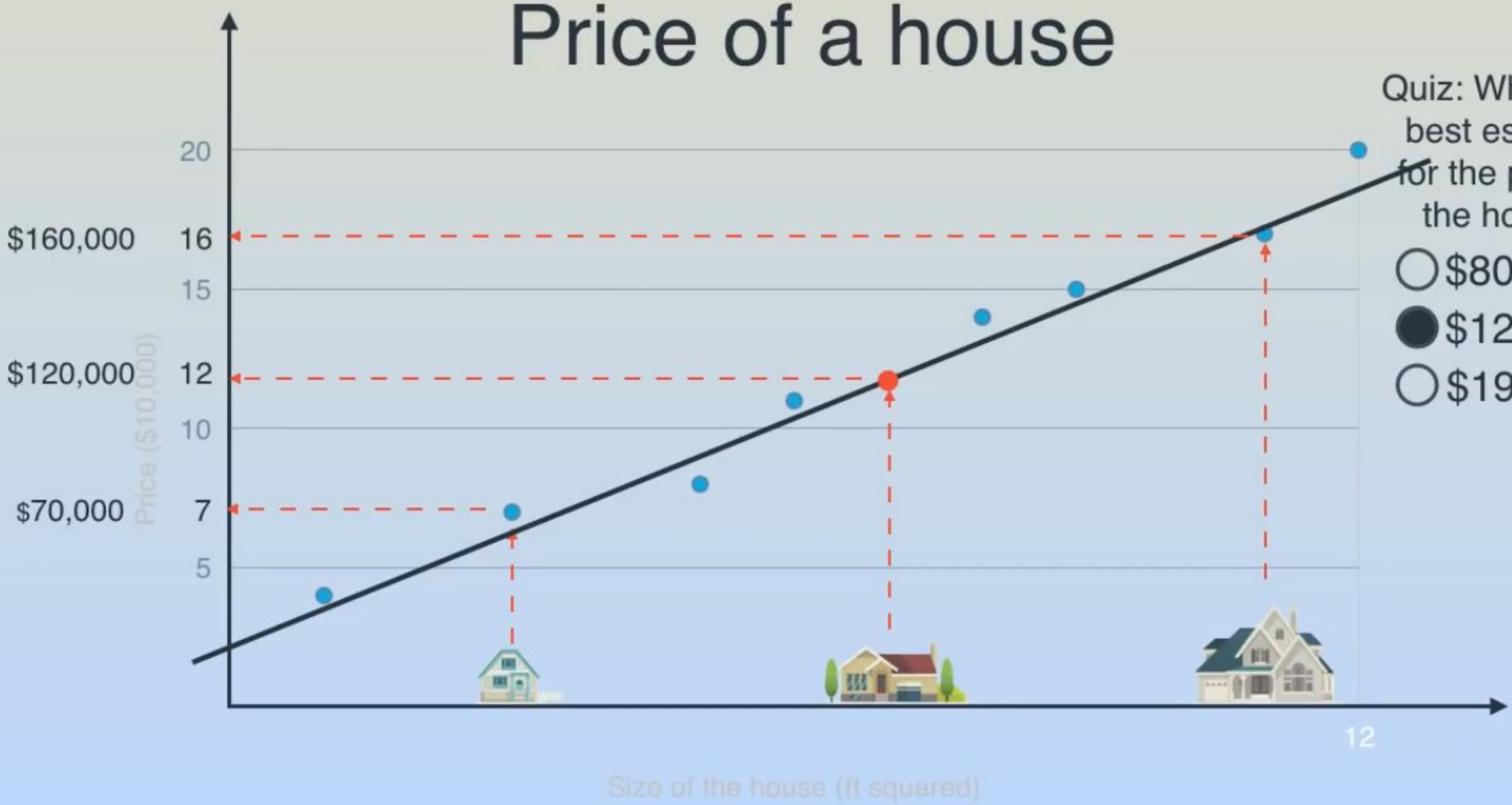
Price of a house



Quiz: What's the best estimate for the price of the house?

- $80,000
- $120,000
- $190,000

Price of a house



Quiz: What's the best estimate for the price of the house?

- $80,000
- $120,000
- $190,000

Price of a House

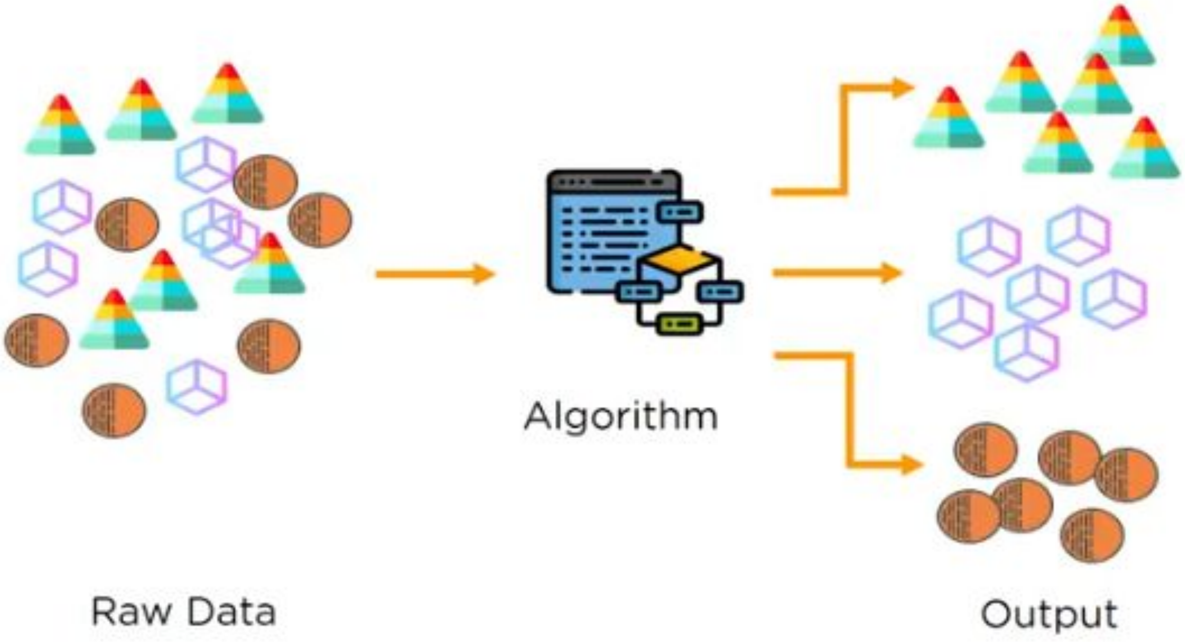
This Method is Called Linear Regression

How You Find This Line ?

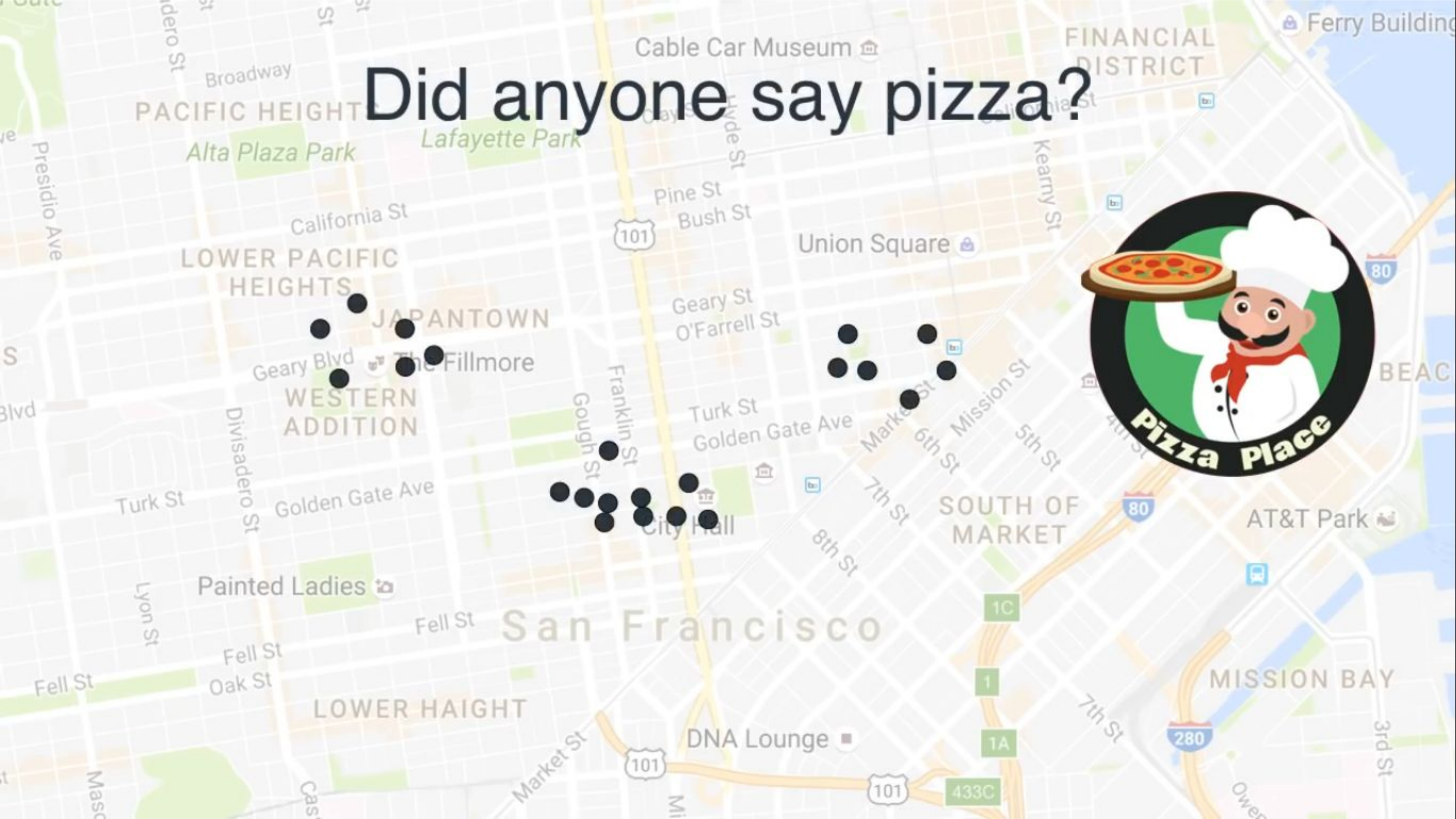
Answer : Gradient Descent Method

Un-Supervised Learning

Machine Learning Model uses unlabelled input data and allows the algorithm to act on that information without guidance



Did anyone say pizza?



Did anyone say pizza?

Did anyone say pizza?

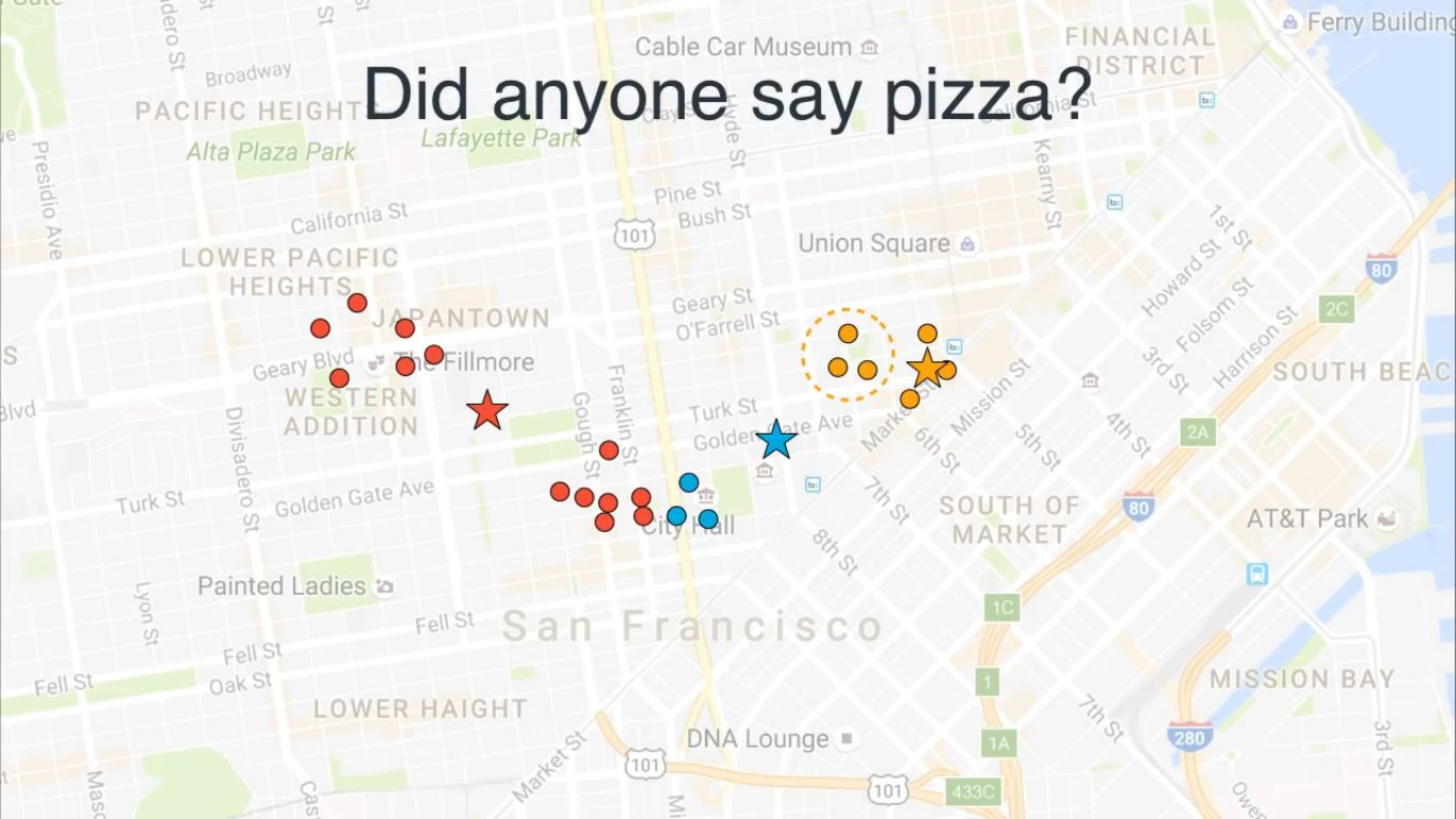
Did anyone say pizza?

Did anyone say pizza?

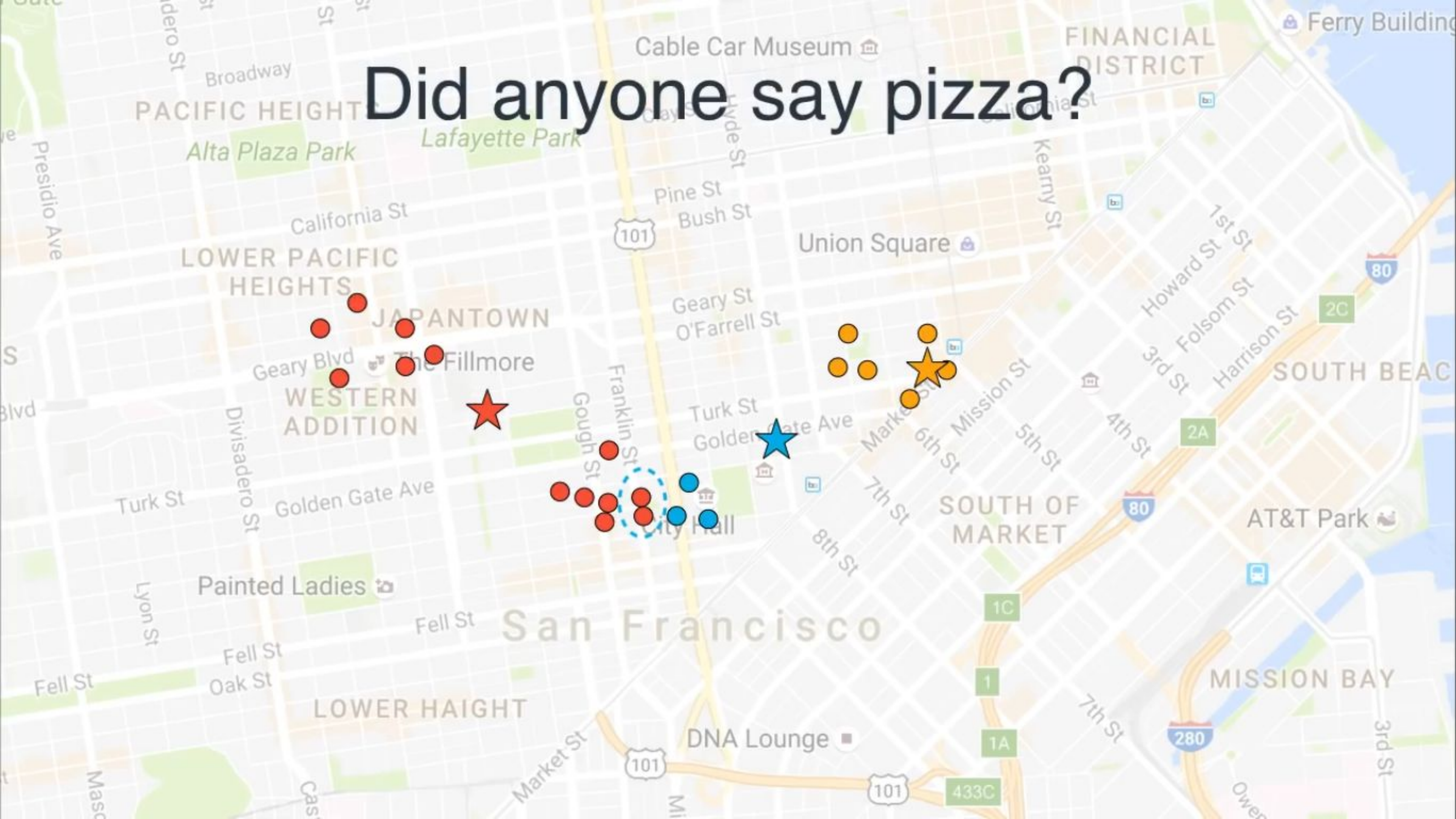
Did anyone say pizza?

Did anyone say pizza?

Did anyone say pizza?



Did anyone say pizza?



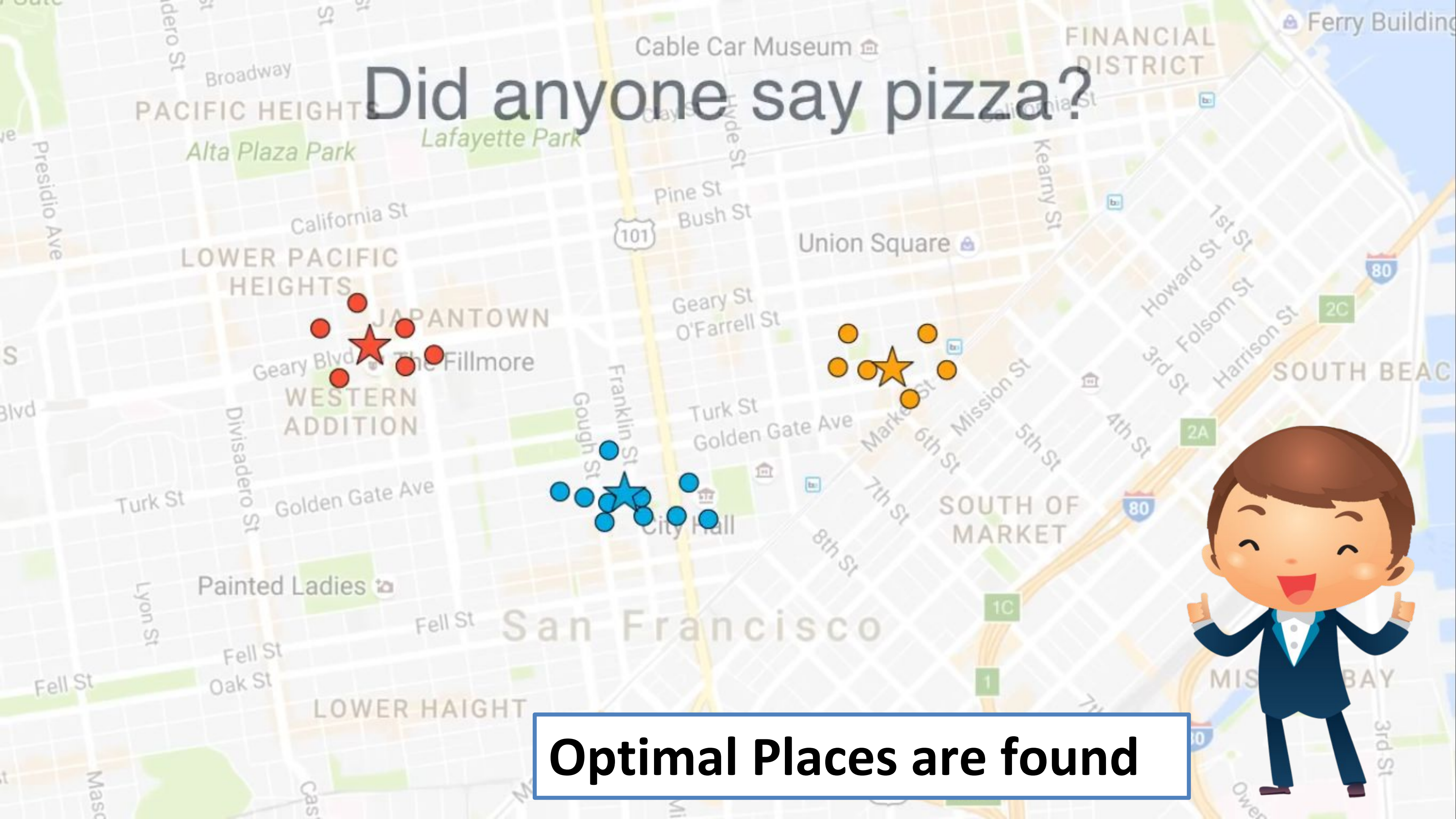
Did anyone say pizza?

Did anyone say pizza?

Did anyone say pizza?

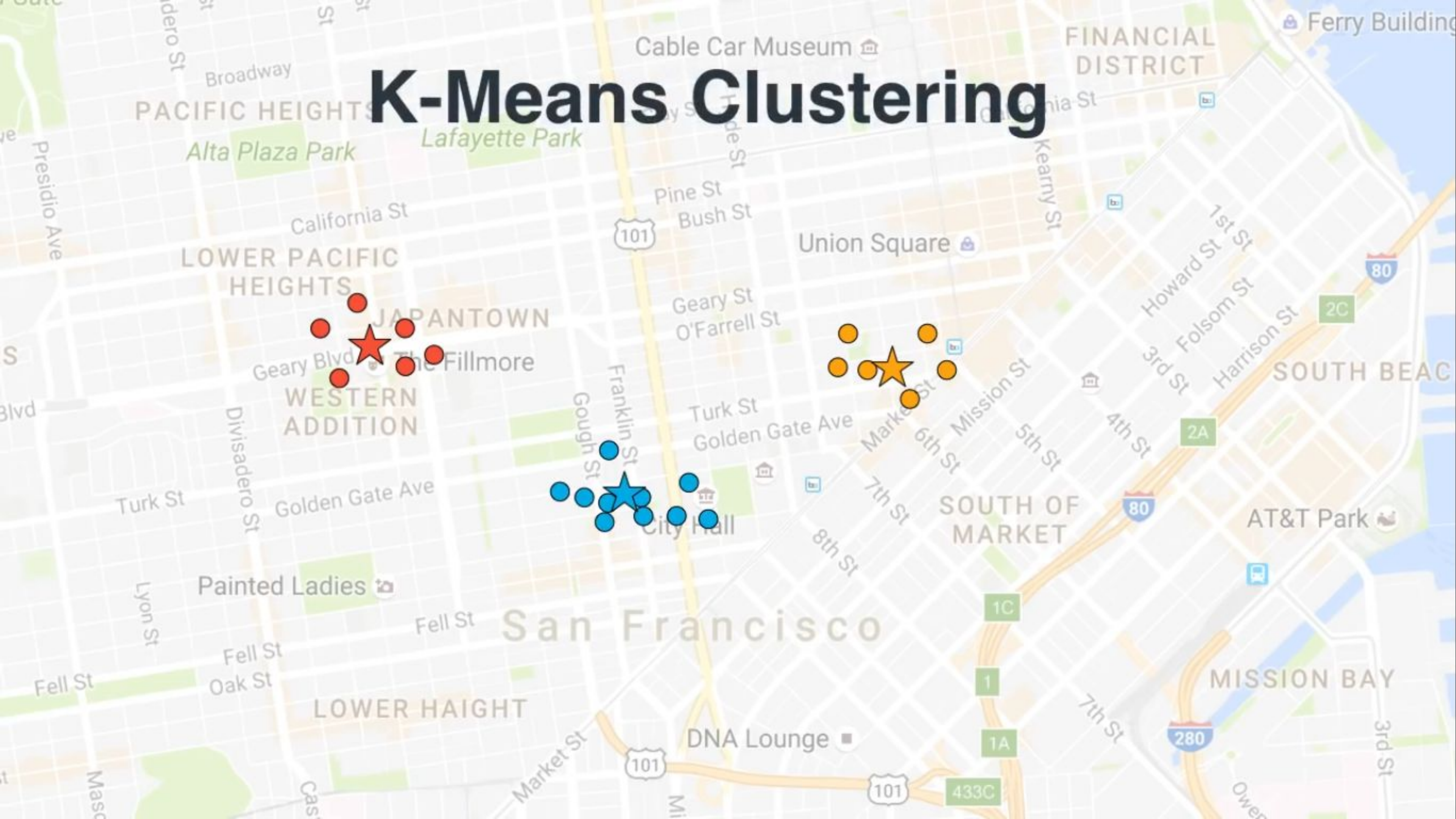
Did anyone say pizza?

Did anyone say pizza?



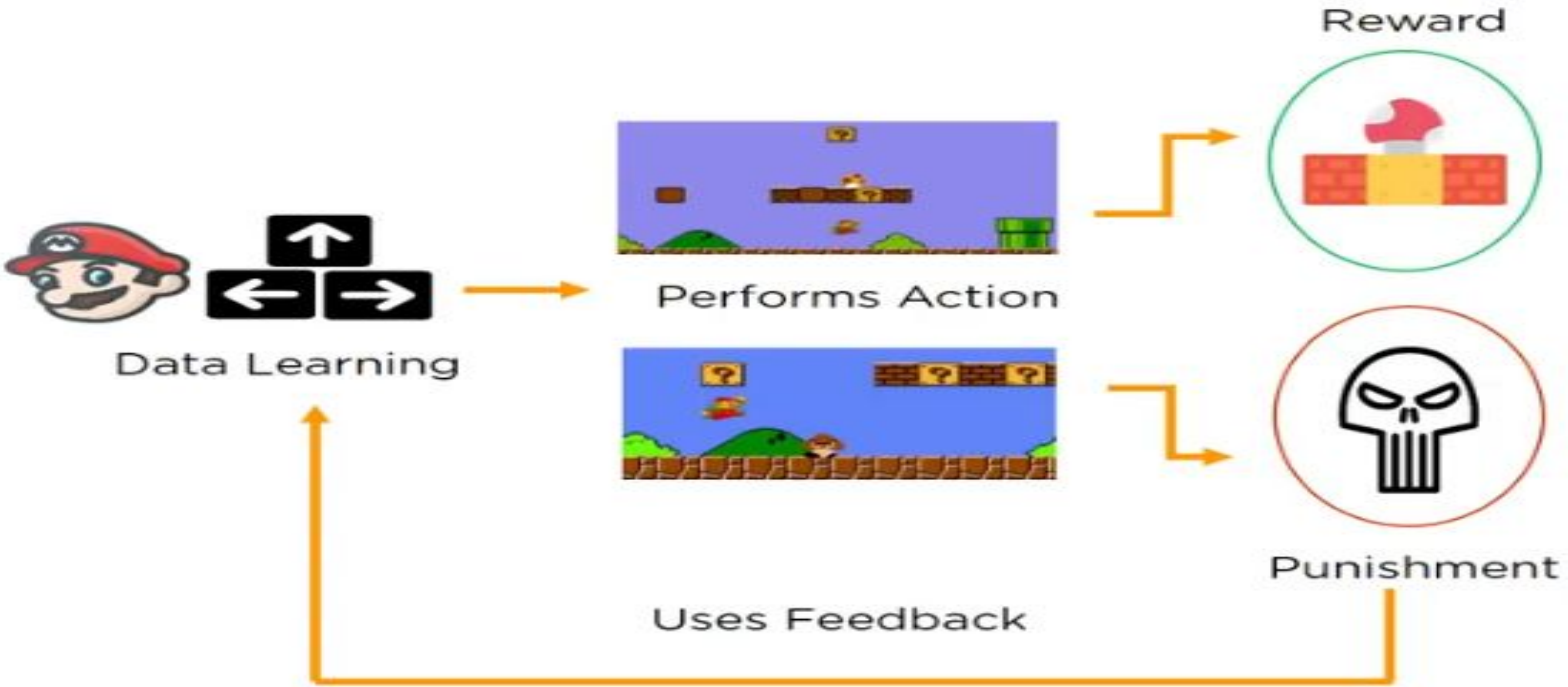
Optimal Places are found

K-Means Clustering



Reinforcement Learning

Reinforcement Learning involves teaching the machine to think for itself based on its past action reward.



Special Thanks!

Mr Vishal Sathwane

Mr. Shivaram (Prof . Vashikaran !)

Good Starting point...

https://codelabs.developers.google.com/codelabs/cloud-tensorflow-mnist/#0

https://www.coursera.org/learn/machine-learning

https://www.kaggle.com/learn/machine-learning

https://mlcourse.ai/prerequisites

https://www.fast.ai/

https://deeplearning.mit.edu/

Coding!

time