Introduction to Machine Learning

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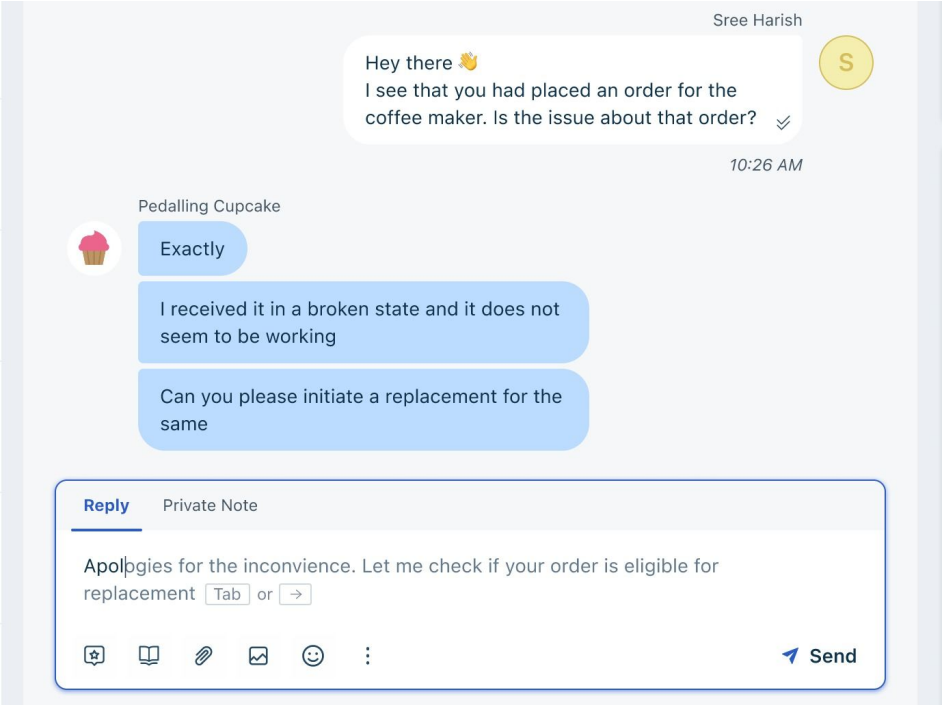
What is Machine Learning?

"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." – Tom Mitchell

Machine Learning focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

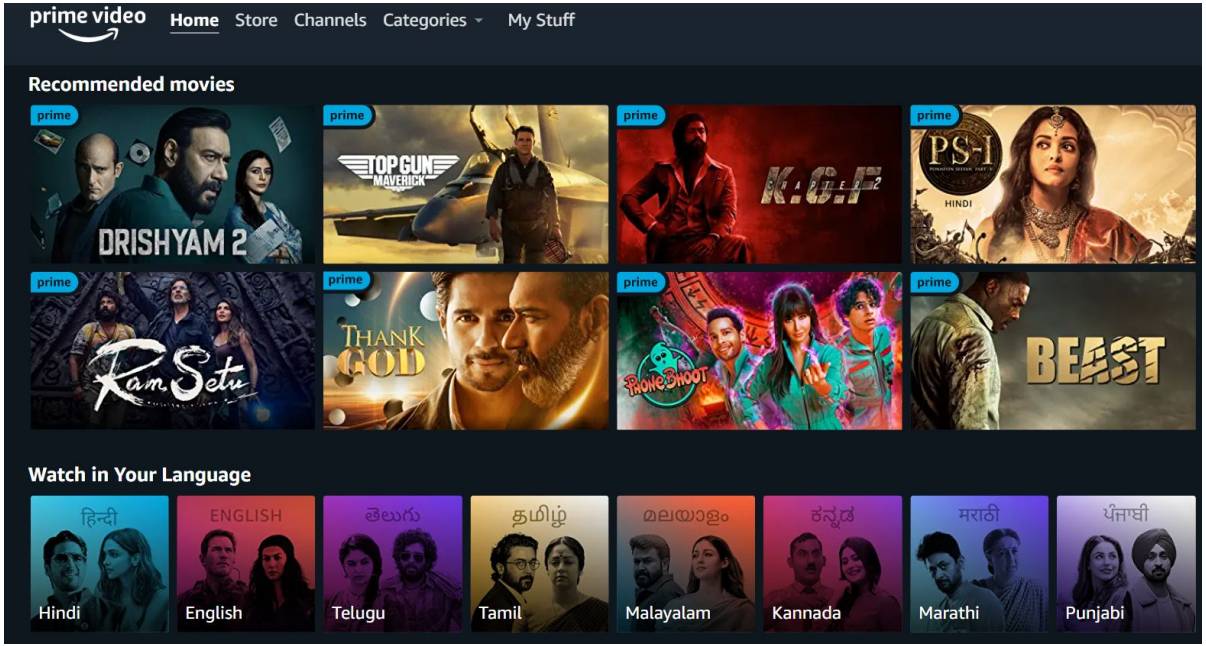
What is Machine Learning?

Auto-Complete
or
Smart Replies



What is Machine Learning?

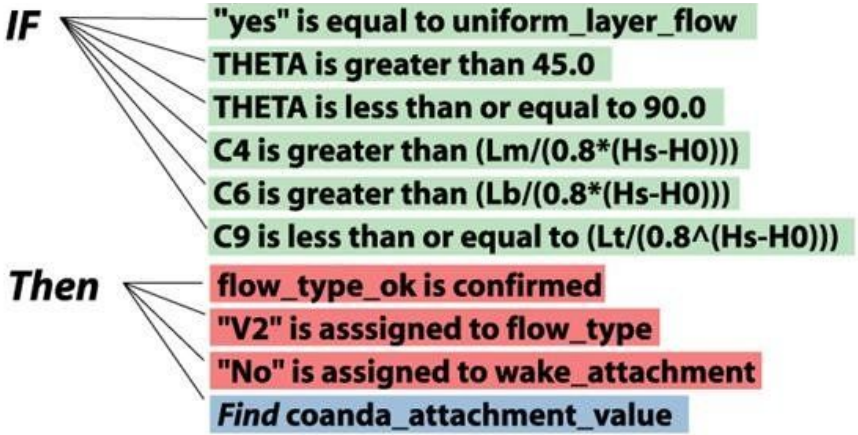
Movie Recommendation



What is NOT Machine Learning?

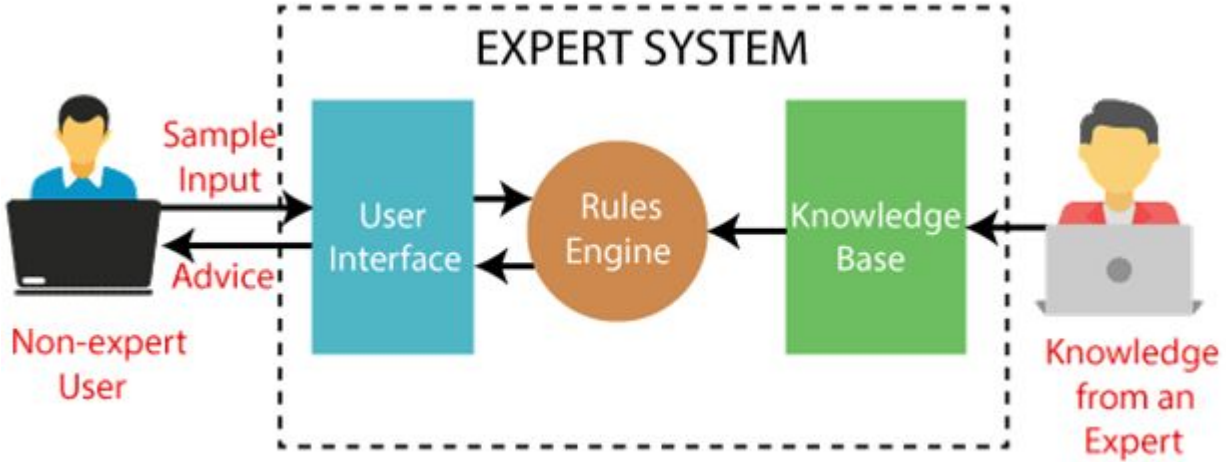
AI systems that **do not learn with experience**

- Rule-Based Systems

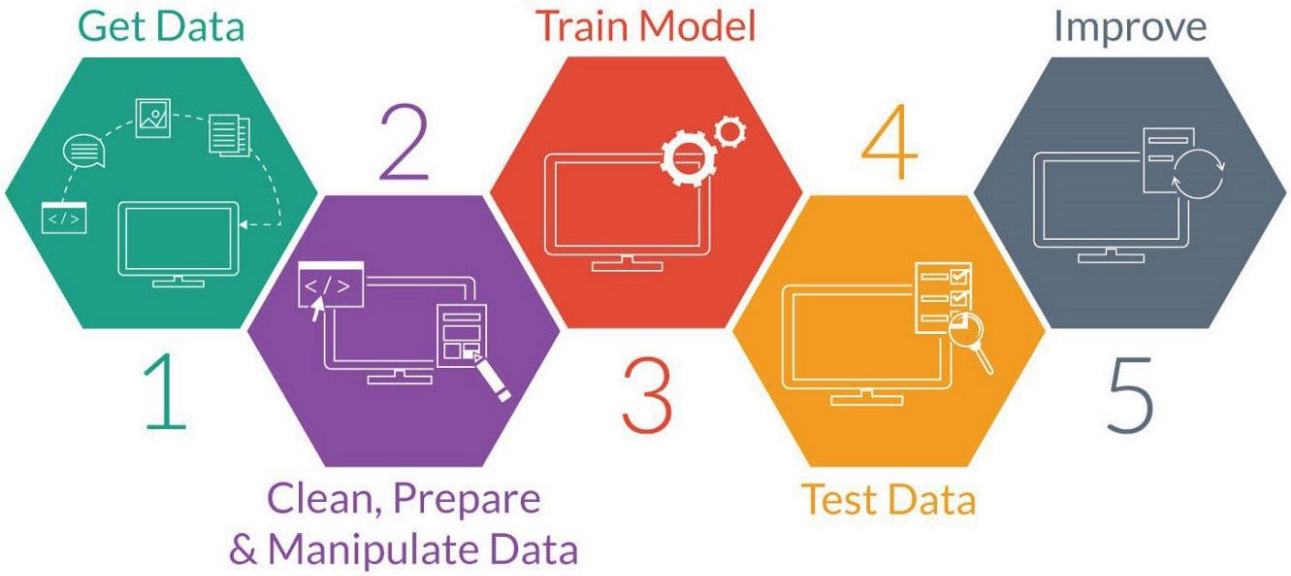


What is NOT Machine Learning?

- Expert Systems

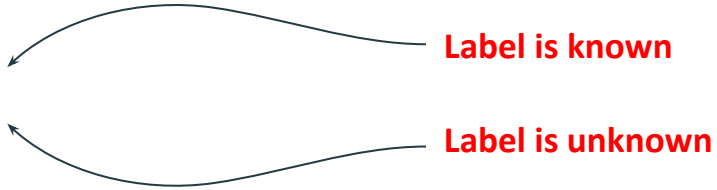


How do machines learn?



ML Categorization

- Supervised Learning
- Unsupervised Learning

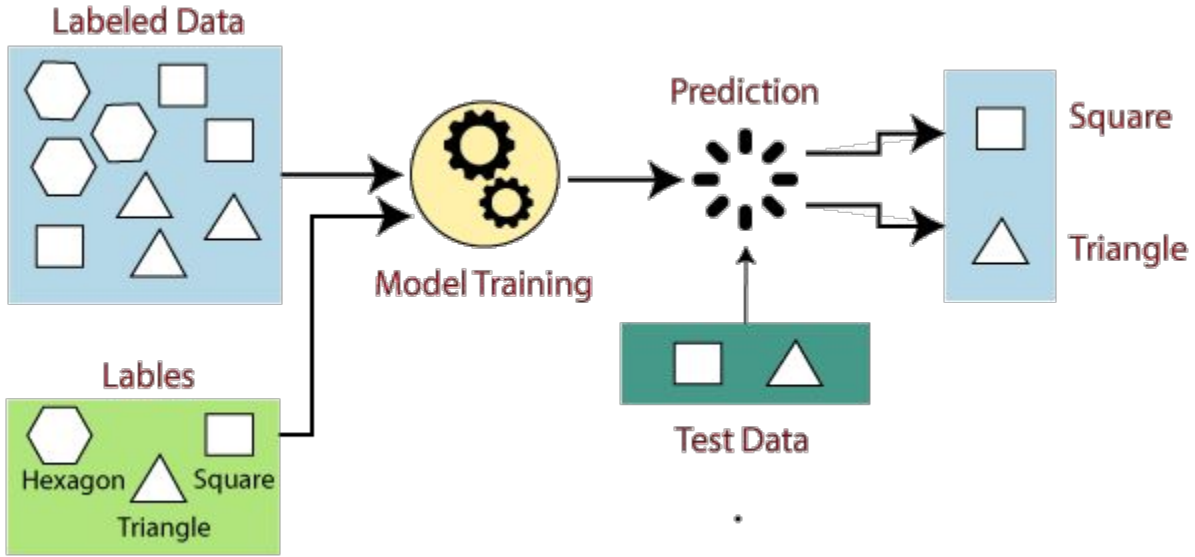


Label is known

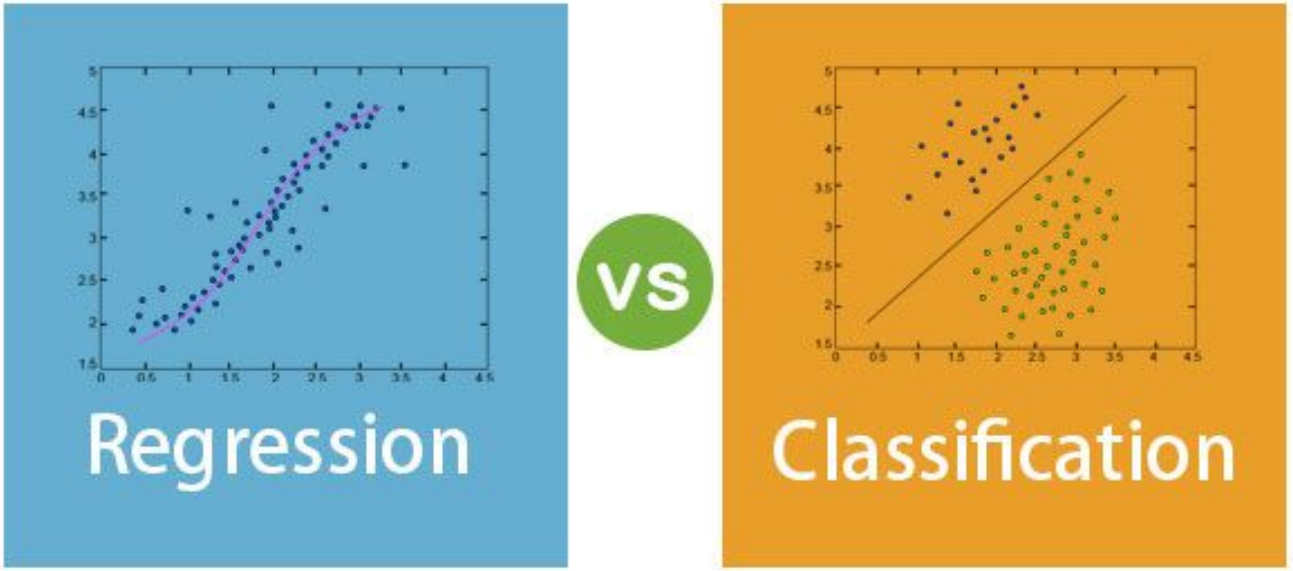
Label is unknown

- Semi-Supervised Learning
- Weakly Supervised Learning
- Self-Supervised Learning

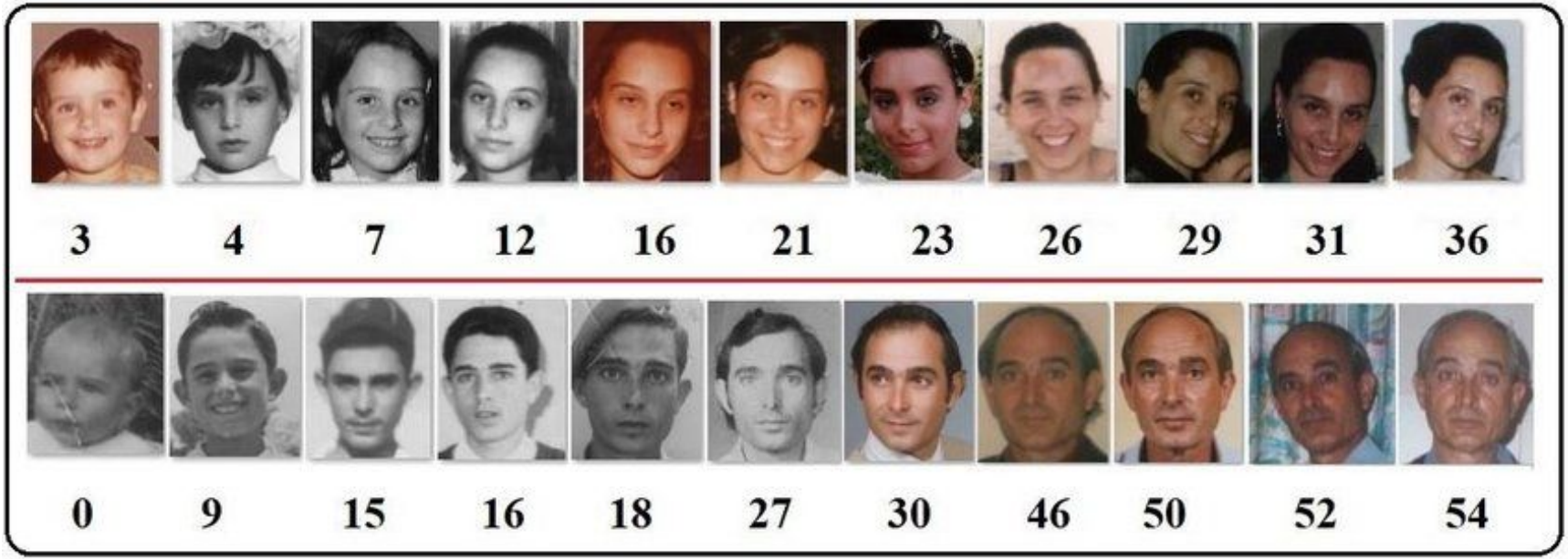
Supervised Learning



Types of Supervised Learning

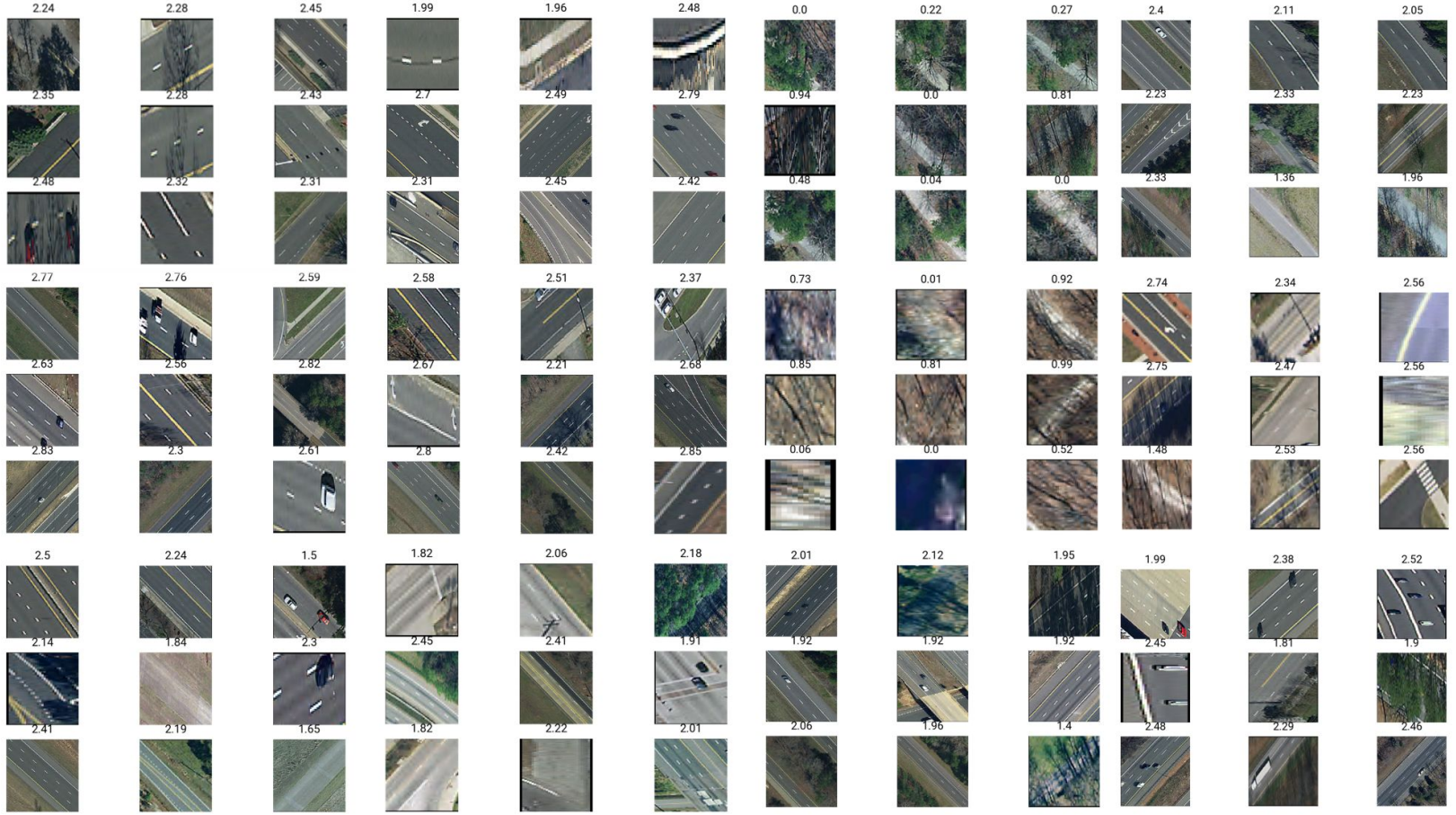


Examples of Regression


3 4 7 12 16 21 23 26 29 31 36
0 9 15 16 18 27 30 46 50 52 54

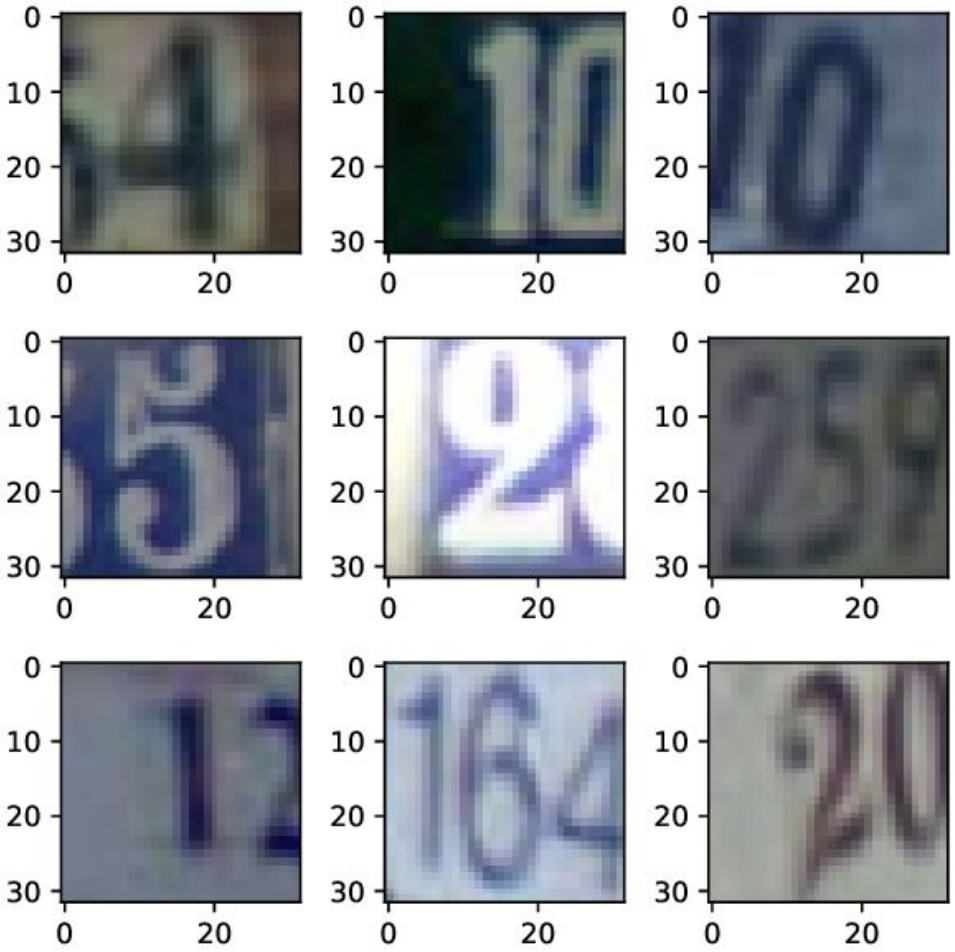

$869,500
$889,000
$910,000
$971,226

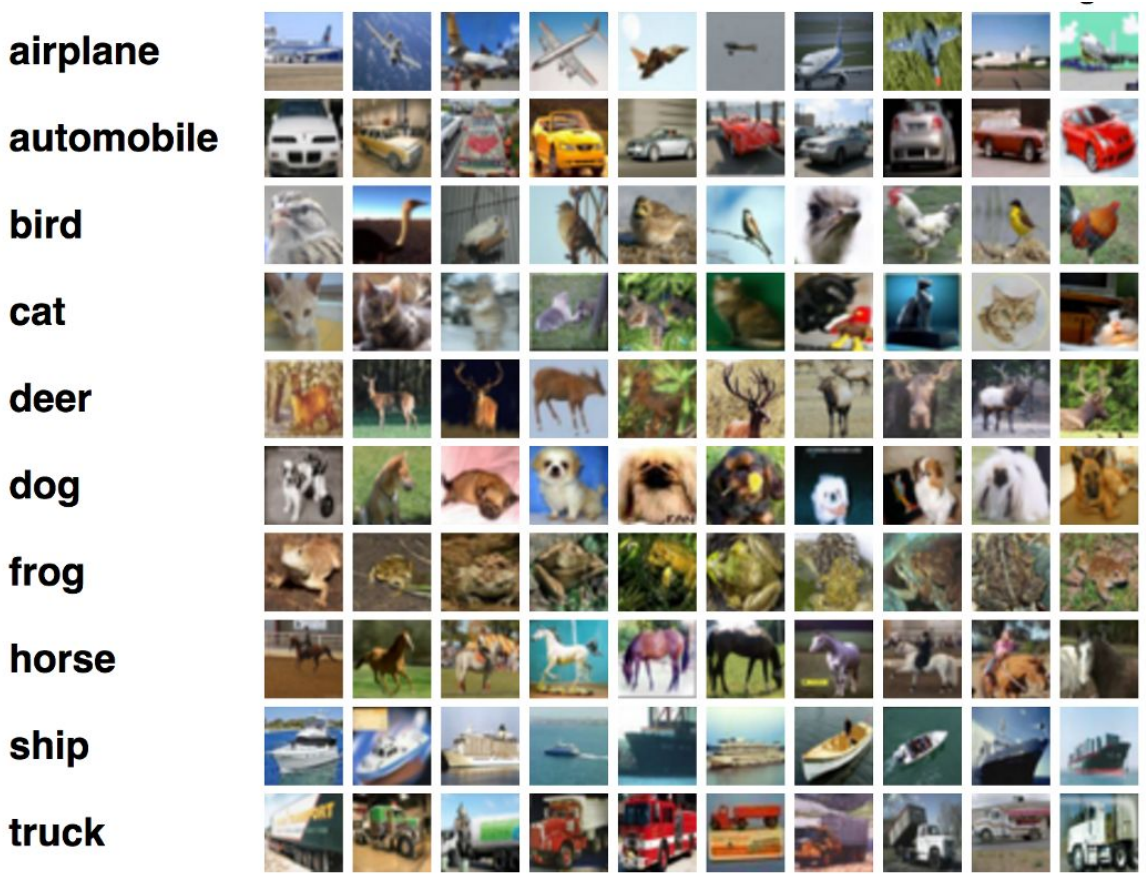

Los Angeles
New Delhi
Beijing
London
Santiago
Lagos


2.24 2.28 2.45 1.99 1.96 2.48 0.0 0.22 0.27 2.4 2.11 2.05
2.35 2.28 2.43 2.7 2.49 2.79 0.94 0.0 0.81 2.23 2.33 2.23
2.48 2.32 2.31 2.31 2.45 2.42 0.48 0.04 0.0 2.33 1.36 1.96
2.77 2.76 2.59 2.58 2.51 2.37 0.73 0.01 0.92 2.74 2.34 2.56
2.63 2.56 2.82 2.67 2.21 2.68 0.85 0.81 0.99 2.75 2.47 2.56
2.83 2.3 2.61 2.8 2.42 2.85 0.06 0.0 0.52 1.48 2.53 2.56
2.5 2.24 1.5 1.82 2.06 2.18 2.01 2.12 1.95 1.99 2.38 2.52
2.14 1.84 2.3 2.45 2.41 1.91 1.92 1.92 1.92 2.45 1.81 1.9
2.41 2.19 1.65 1.82 2.22 2.01 2.06 1.96 1.4 2.48 2.29 2.46

Examples of Image Classification

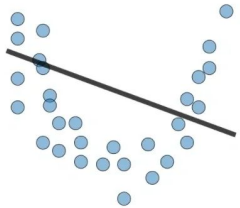
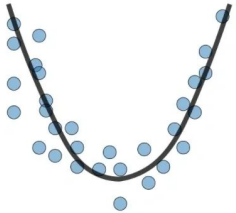
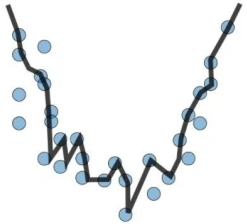
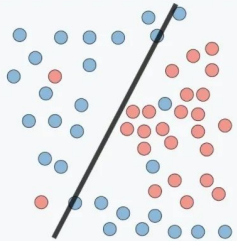
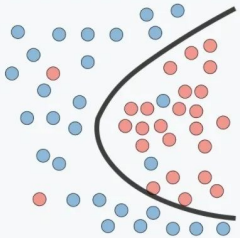
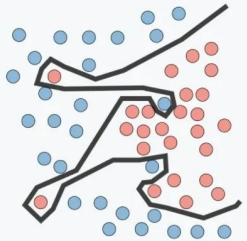

Neutral
Happy
Angry
Fearful
Sad
Disgusted


0
10
20
30
0
20


airplane
automobile
bird
cat
deer
dog
frog
horse
ship
truck


IMAGENET

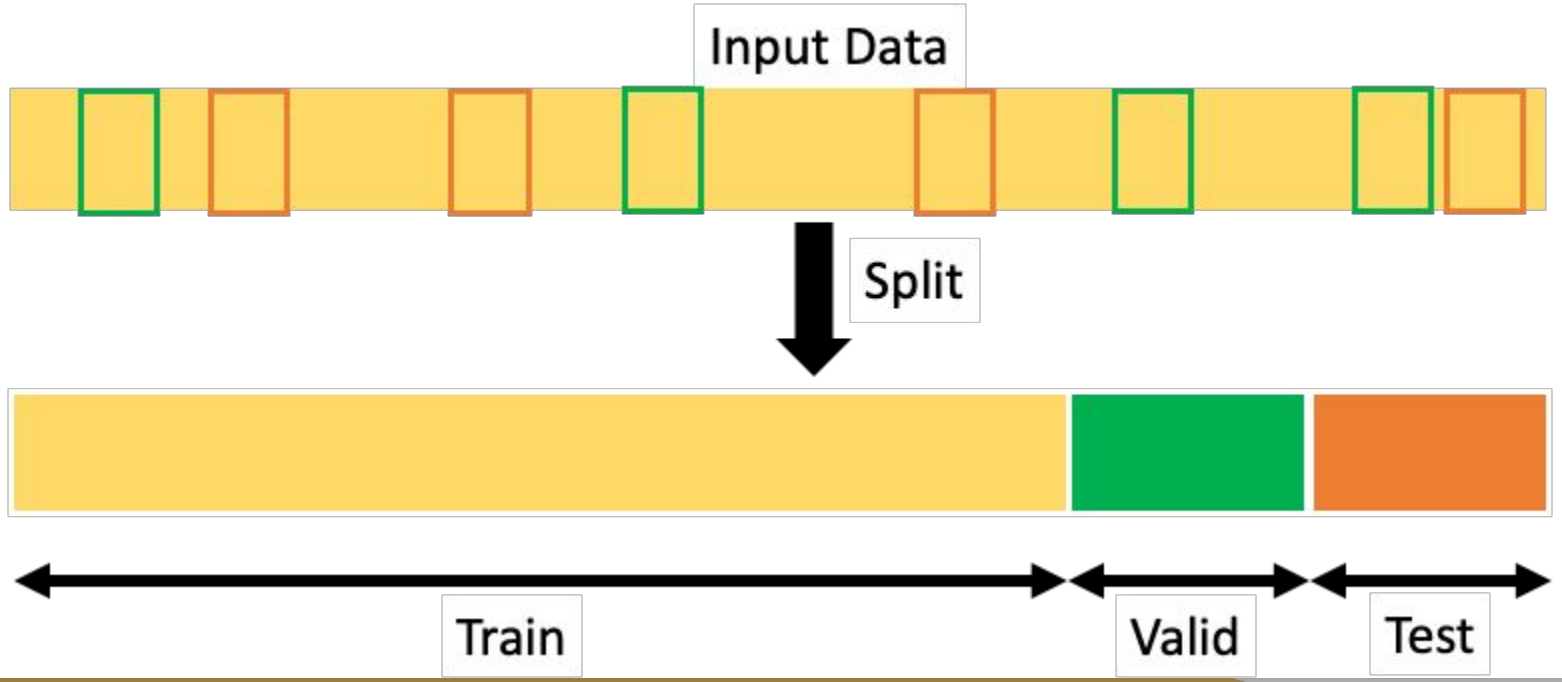
Underfitting vs. Overfitting

	Underfitting	Just right	Overfitting
Symptoms	• High training error • Training error close to test error • High bias	• Training error slightly lower than test error	• Very low training error • Training error much lower than test error • High variance
Regression illustration			
Classification illustration			

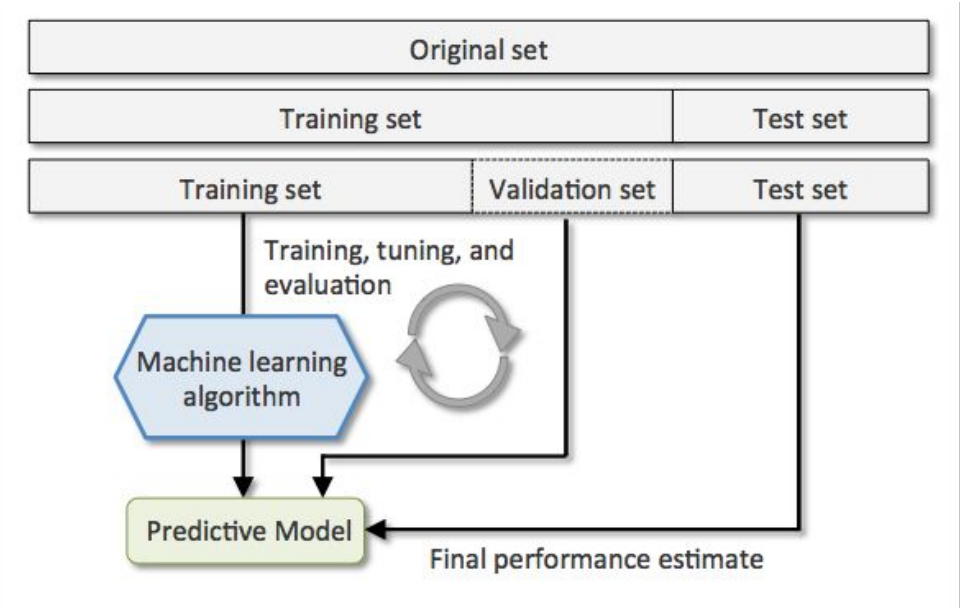
How to infer under- or over-fitting?

Holding out a subset of the training dataset.

How to infer under- or over-fitting?



Using the dataset splits

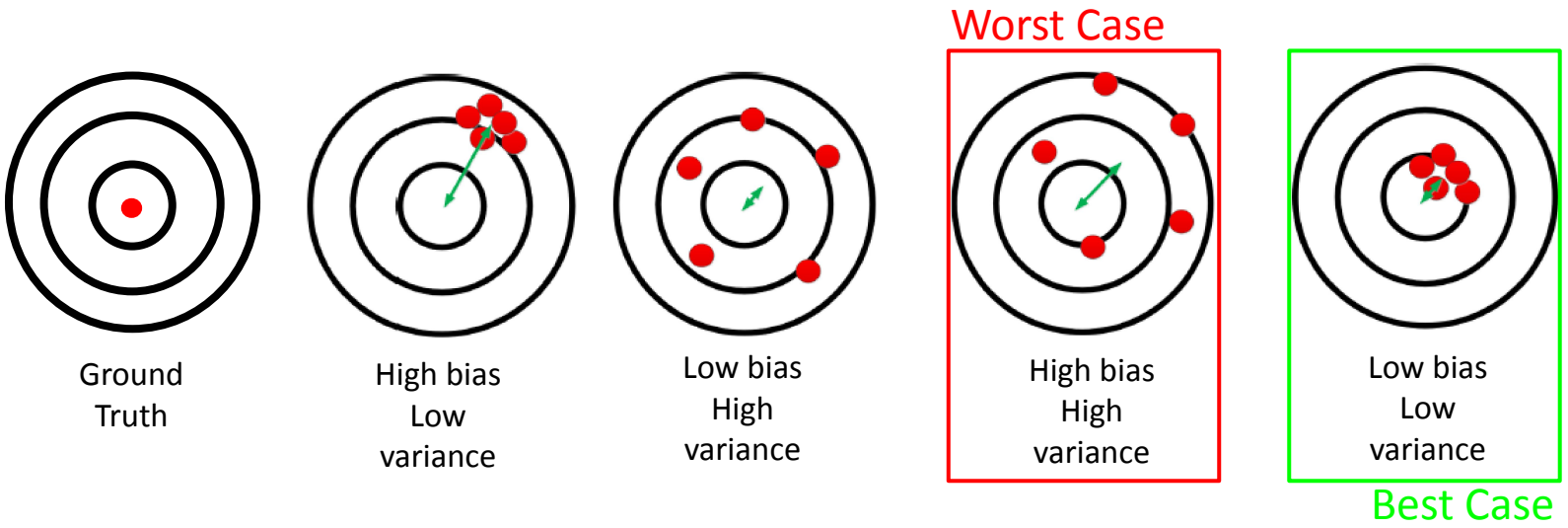


Test dataset is never exposed during the training of the model. Instead, we use validation dataset for hyperparameter tuning.

How to prevent overfitting?

- Try getting **more training examples**
- Try a **smaller or larger set of features**
- Try **changing the features**
- Run gradient descent for **more iterations**
- Use a different value for **regularization parameter λ**
- Try using a **different model** (e.g., SVM)

Bias and Variance of a Random Variable



Hands-On Session

https://tinyurl.com/intro-to-ml-iiitd