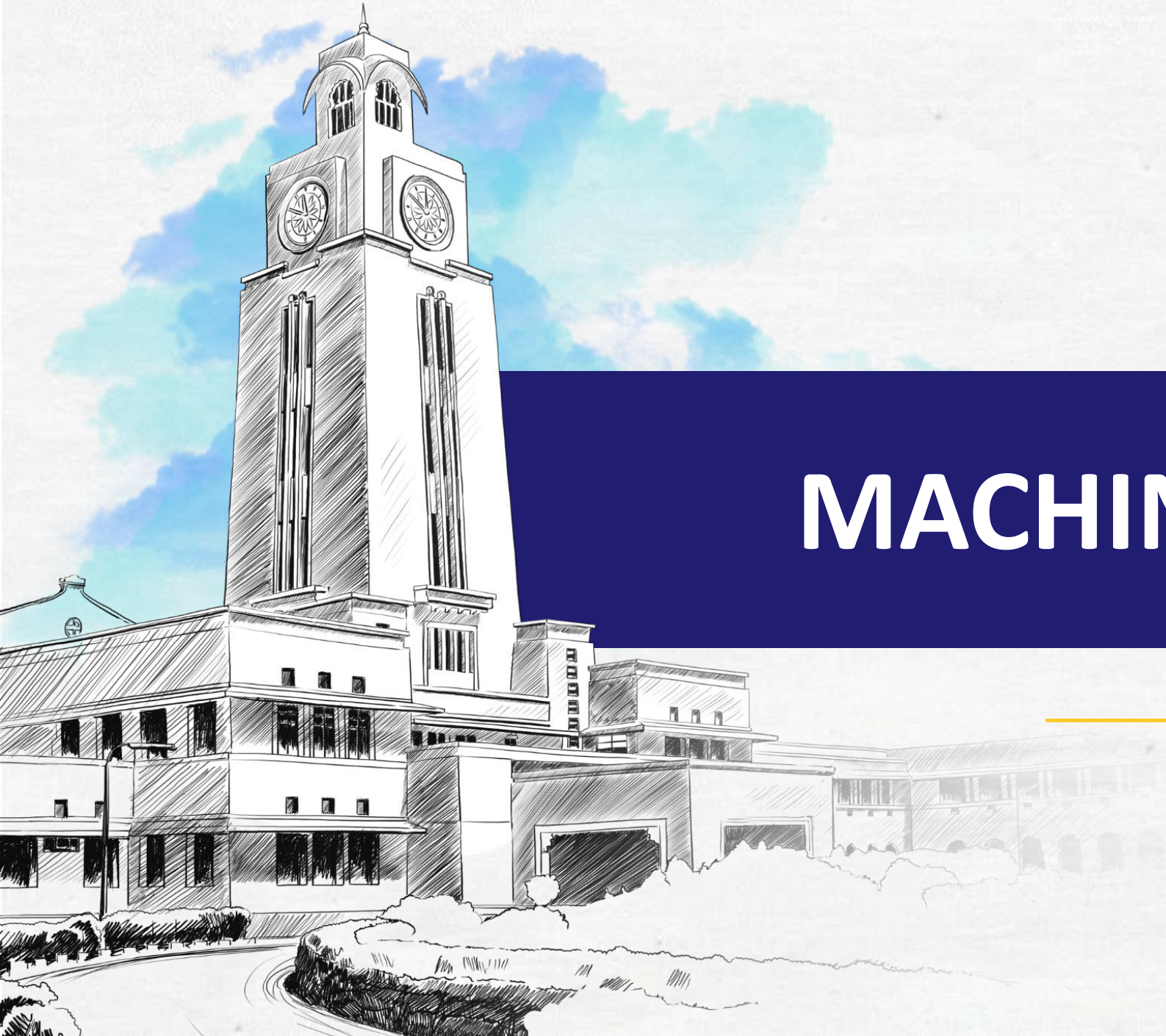

BITS Pilani
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MACHINE LEARNING

Presented by
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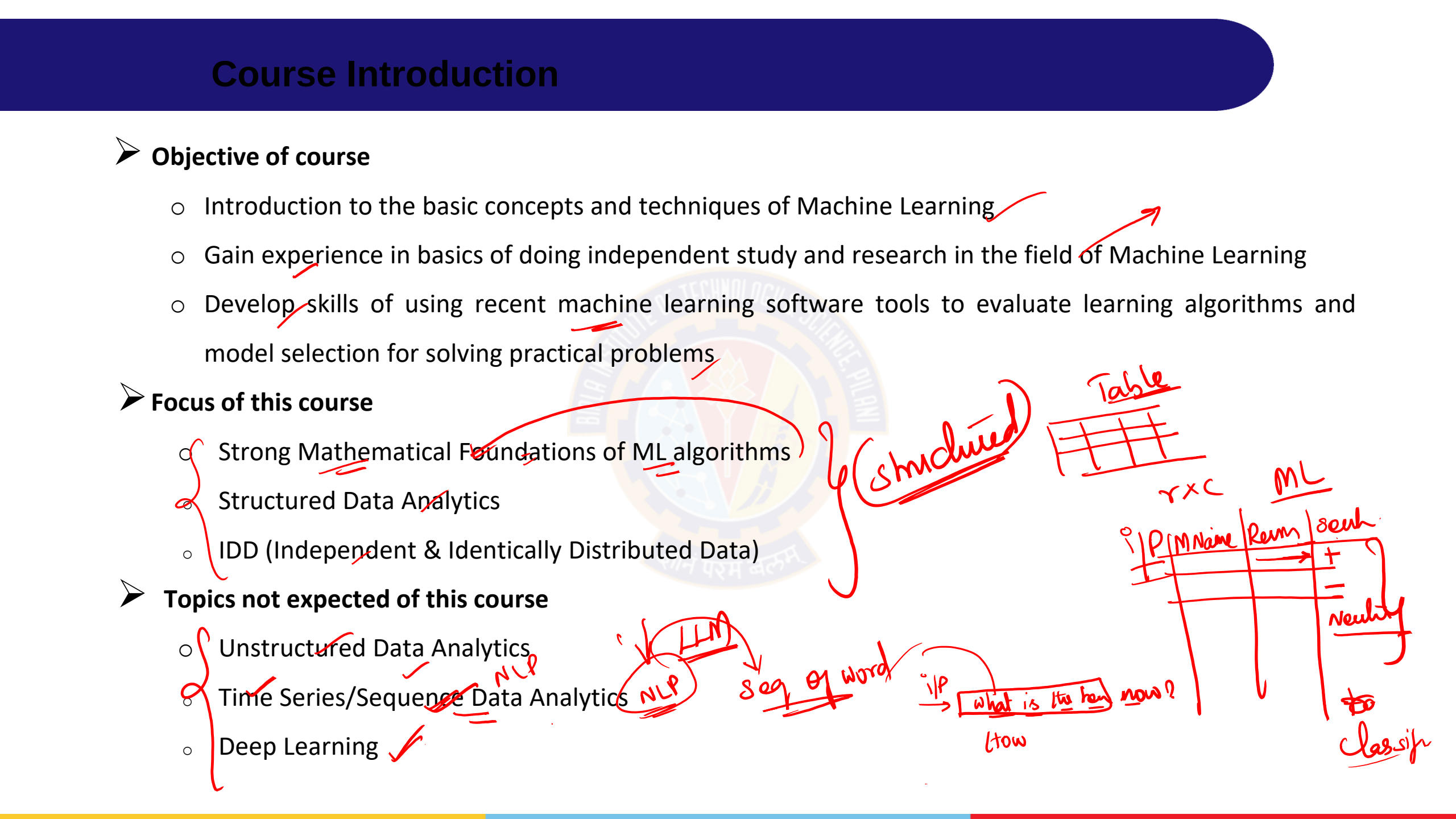
Session 1
(18th January 2026)

Disclaimer and Acknowledgement

- The content for these slides has been obtained from books and various other source on the Internet
- I hereby acknowledge all the contributors for their material and inputs.
- I have provided source information wherever necessary
- I have added and modified the content flow to suit the requirements of the course and for ease of class presentation
- Students are requested to refer to the textbook and detailed content of this presentation deck over canvas

Course Introduction

- **Objective of course**
  - Introduction to the basic concepts and techniques of Machine Learning
  - Gain experience in basics of doing independent study and research in the field of Machine Learning
  - Develop skills of using recent machine learning software tools to evaluate learning algorithms and model selection for solving practical problems
- **Focus of this course**
  - Strong Mathematical Foundations of ML algorithms
  - Structured Data Analytics
  - IDD (Independent & Identically Distributed Data)
- **Topics not expected of this course**
  - Unstructured Data Analytics
  - Time Series/Sequence Data Analytics
  - Deep Learning



Course Plan

M1	Introduction
M2	Machine learning Workflow
M3	Linear Models for Regression
M4	Linear Models for Classification
M5	Decision Tree
M6	Instance Based Learning
M7	Support Vector Machine
M8	Bayesian Learning
M9	Ensemble Learning
M10	Unsupervised Learning
M11	Machine Learning Model Evaluation/Comparison

Text books and Reference book(s)

T1 Tom M. Mitchell: Machine Learning, The McGraw-Hill Companies

R1 Christopher M. Bishop: Pattern Recognition & Machine Learning, Springer

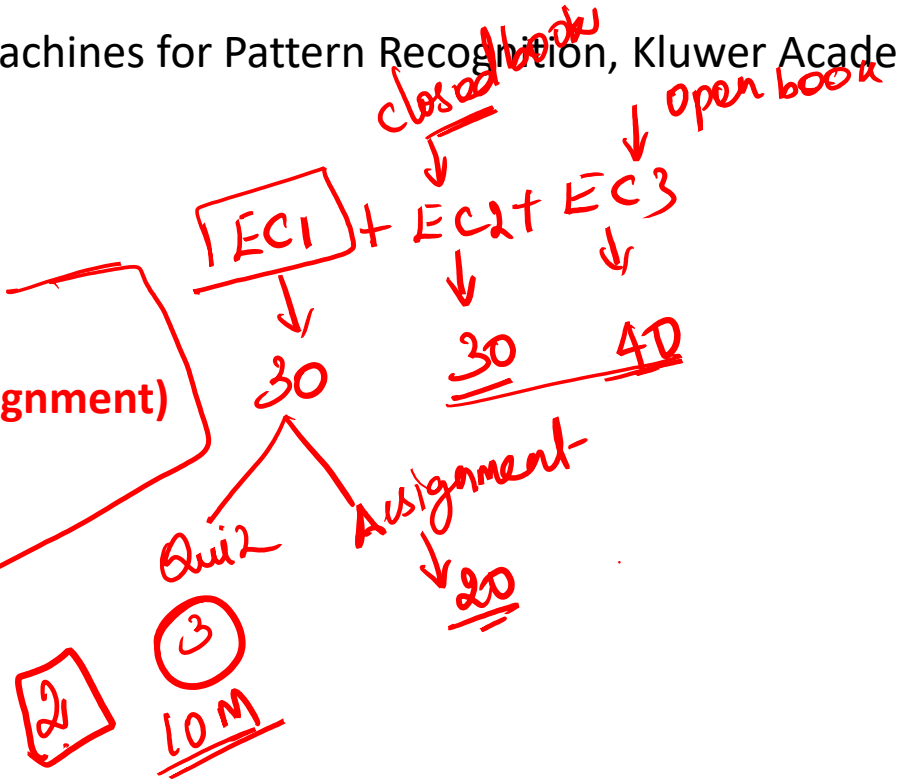
P. Tan, et al. Introduction to Data Mining, Pearson

R2 C.J.C. BURGES: A Tutorial on Support Vector Machines for Pattern Recognition, Kluwer Academic

R3 Publishers, Boston.

Evaluation scheme

- **Quiz (10% - Best 2 of 3 quizzes)**
- **Assignment (20% - 1 Progressive Assignment)**
- **Mid-semester exam (30%)**
- **Comprehensive exam (40%)**



Pre-requisites

- Linear algebra: vector/matrix manipulations, properties
- Calculus: partial derivatives
- Probability: common distributions; Bayes Rule
- Statistics: mean/median/mode; maximum likelihood

Lab Plan

Lab No.	Lab Objective
1	End to End Machine Learning
2	Linear Regression and Gradient Descent Algorithm
3	Logistic Regression Classifier
4	Decision Tree
5	Naïve Bayes Classifier
6	Random Forest

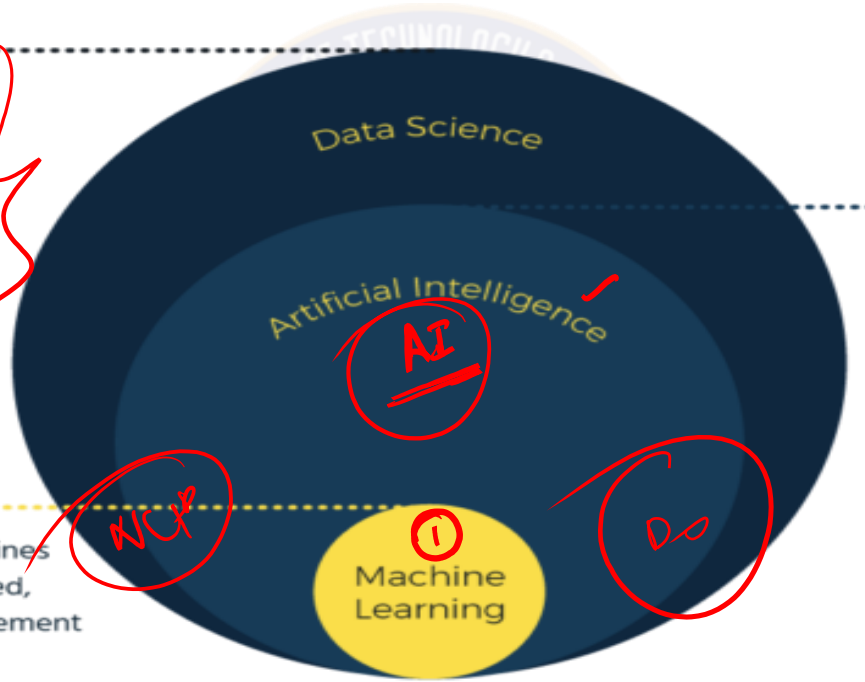
Agenda

- What is Machine Learning?
- Why Machine Learning is important?
- Types of Machine Learning
- Application Areas
- Issues in Machine Learning
- Demo Case study

AI vs. Data Science vs. Machine Learning

Data Science

- Collection, preparation, and analysis of data
- Leverages AI/ML, research, industry expertise, and statistics to make business decisions



Artificial Intelligence

- Technology for machines to understand/interpret, learn, and make 'intelligent' decisions
- Includes Machine Learning among many other fields

Machine Learning

- Algorithms that help machines improve through supervised, unsupervised, and reinforcement learning
- Subset of AI and Data Science tool

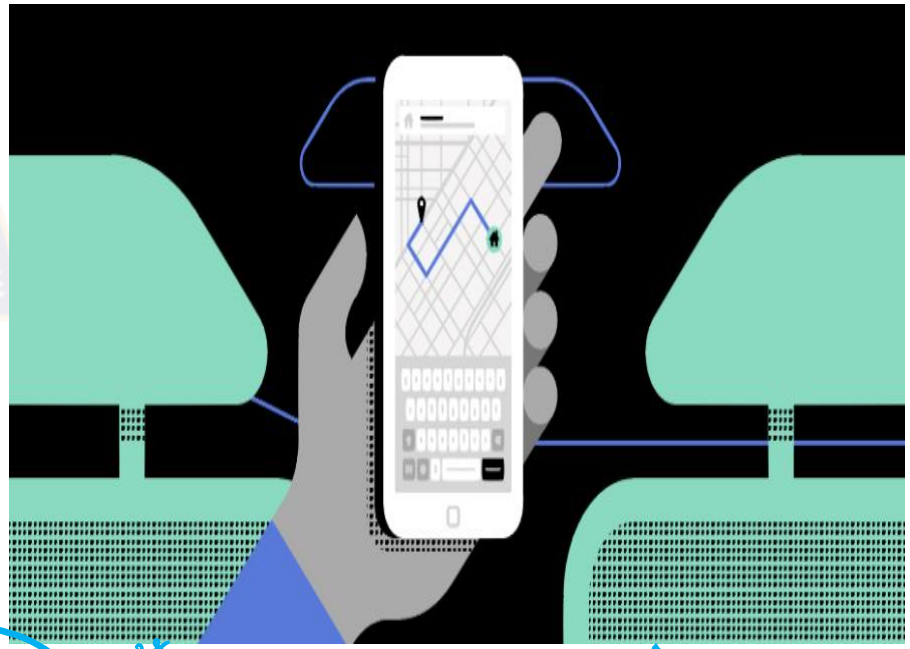
Introduction to Machine Learning

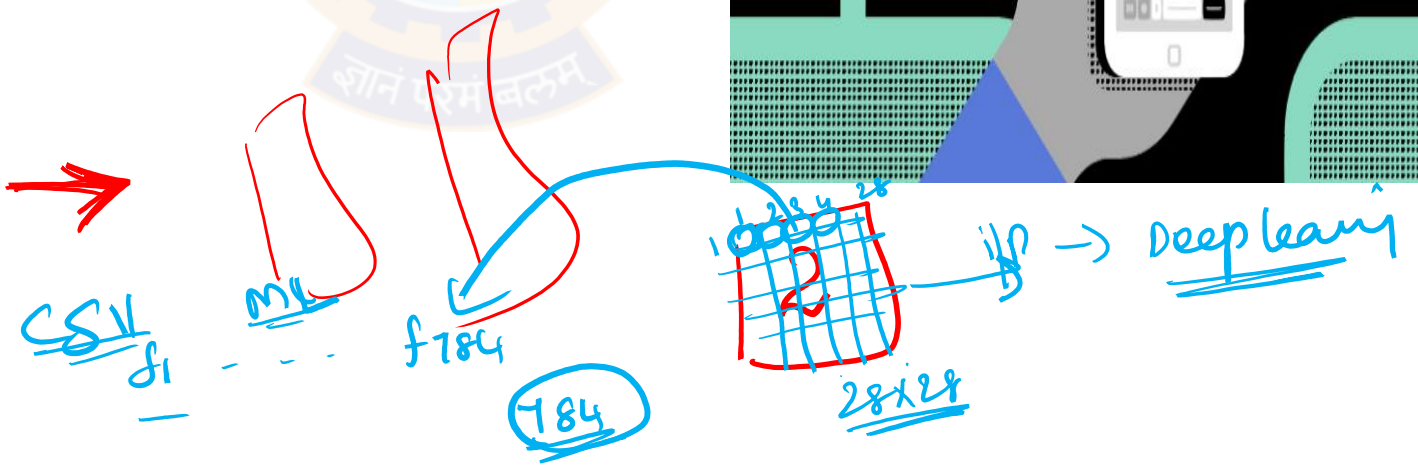
Common Use cases - Security & Transaction Domain

- Self Driving Cars
- Fraud Detection in Banking
- Email Filtering
- Dynamic Pricing in Travel

Derived Applications:

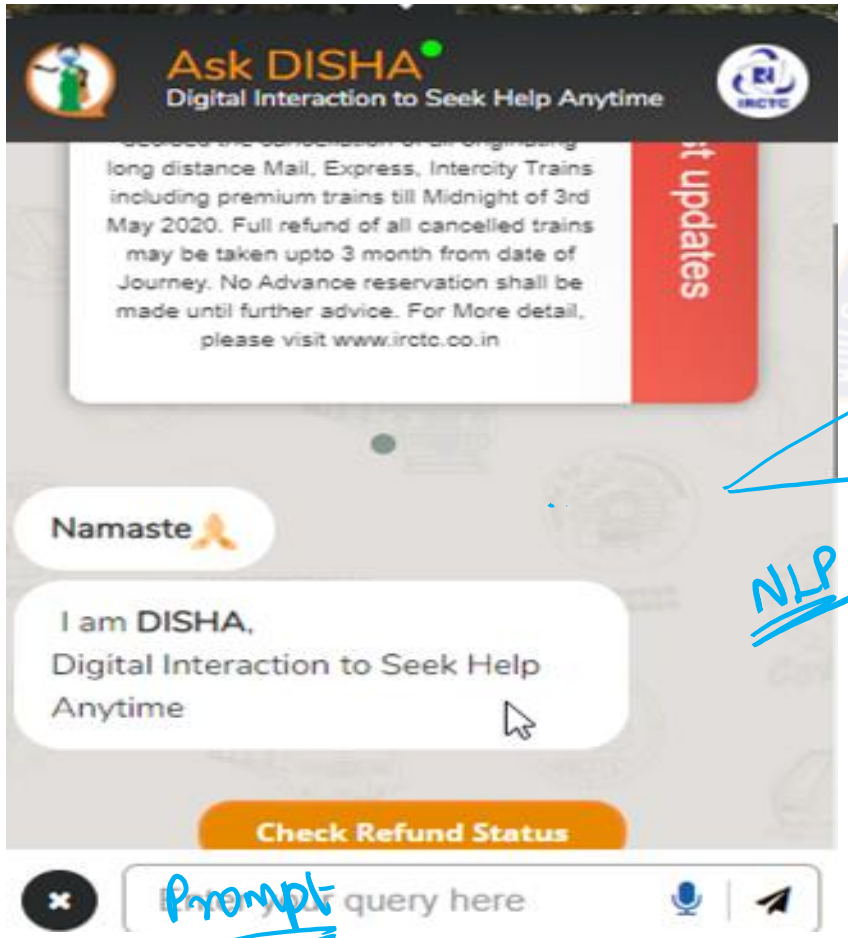
- Cyber Security
- Video Surveillance
- Object Detection

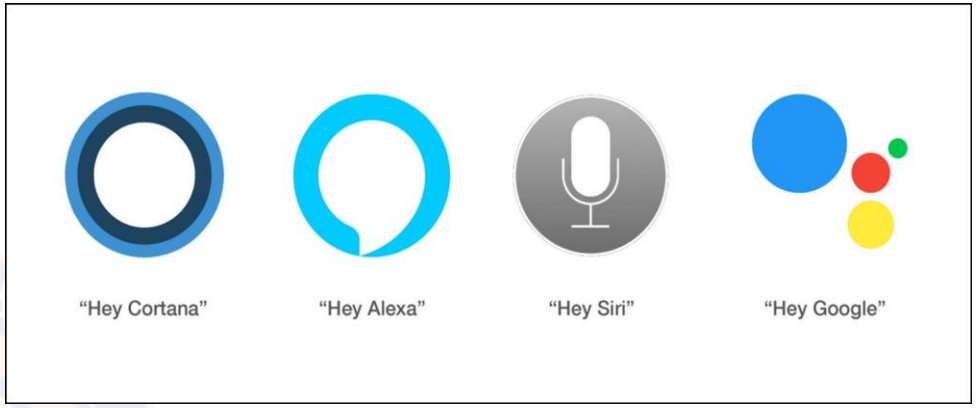




Introduction to Machine Learning

Common Use cases - Customer Support Systems





- Apple's Siri
- Google Assistant
- Amazon's Alexa
- Google Duplex
- Microsoft's Cortana
- Samsung's Bixby

Derived Applications:

> Customer Support Query (Voice vs Text)

> Chatbots

Introduction to Machine Learning

Common Use cases - Recommendation Engines

- E-commerce sites like Amazon and Flipkart
- Book sites like Goodreads
- Movie services like IMDb and Netflix
- Hospitality sites like MakeMyTrip, Booking.com, etc.
- Retail services like StitchFix
- Food aggregators like Zomato and Uber Eats

Derived Applications:

> Personalized Marketing

> Personalized Banking

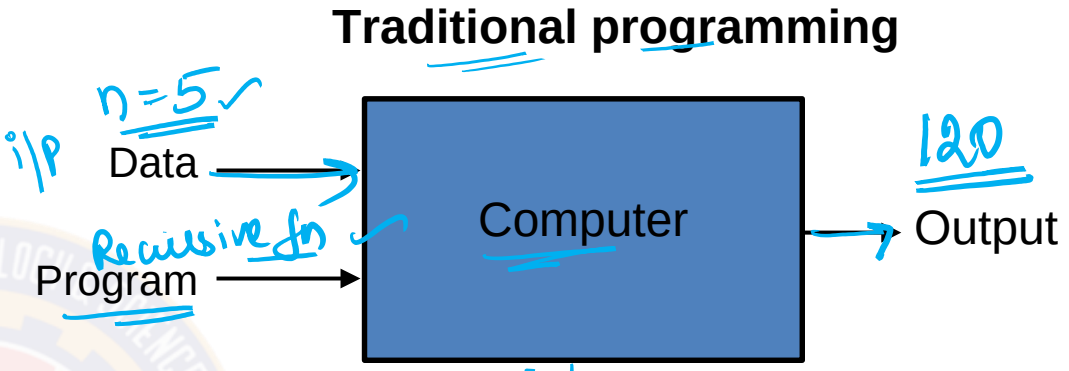
ML – What, When, Where ?

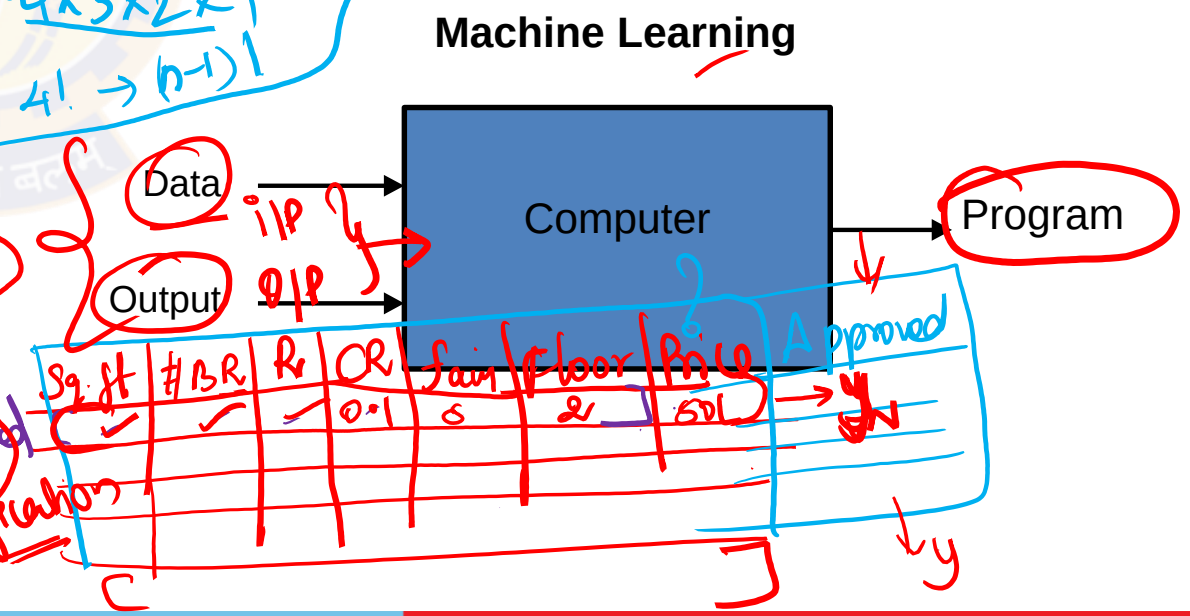
What is Machine Learning (ML)?

- The science (and art) of programming computers so they can *learn from data*
- More general definition

  Field of study that gives computers the ability to learn without being explicitly programmed
- Engineering-oriented definition

  Algorithms that improve their performance P at some task T with experience E
  - A well-defined learning task is given by <*P*, *T*, *E*>

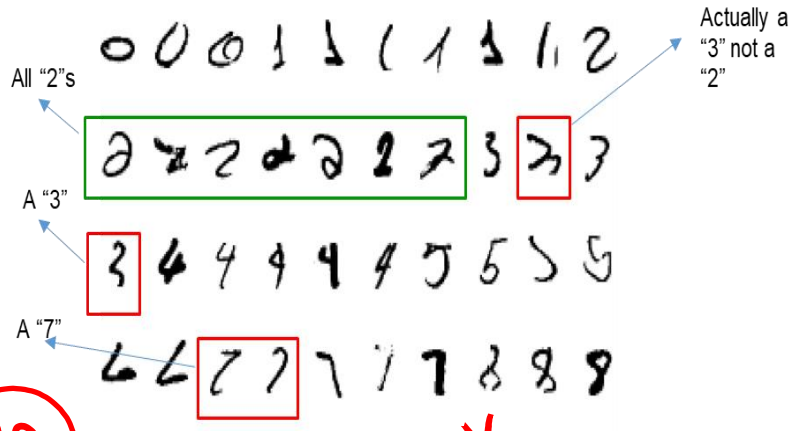


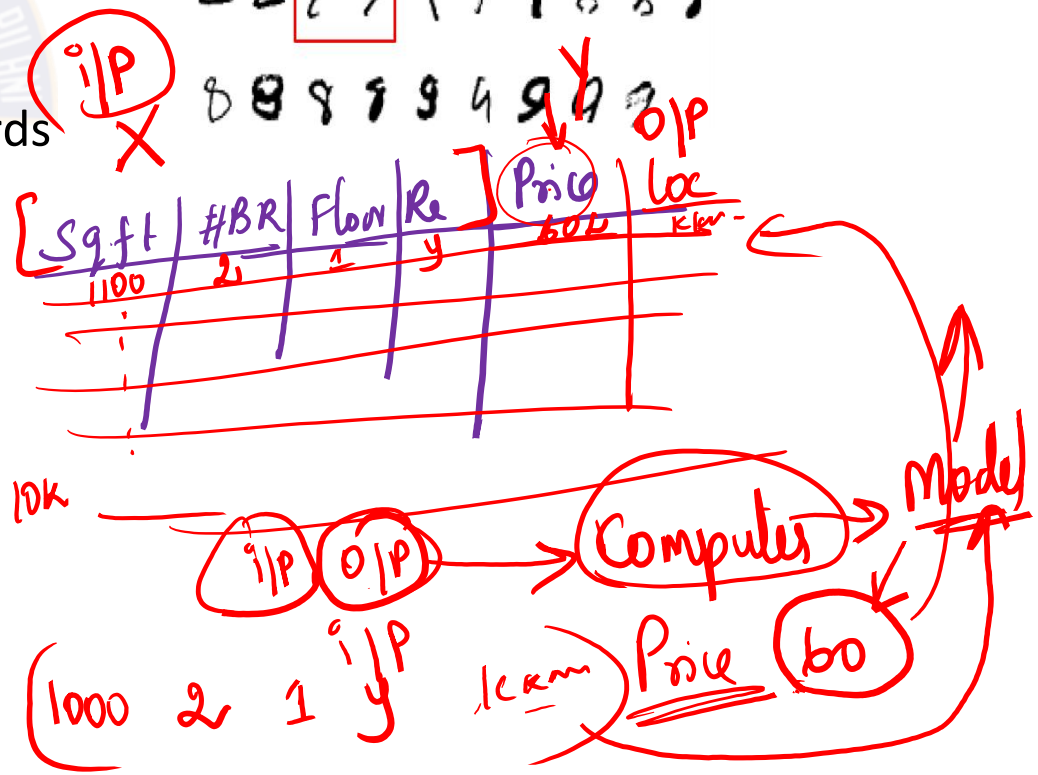


Introduction to Machine Learning

Defining the Learning Tasks

- **Example 1**
  - T: Recognizing hand-written words
  - P: Percentage of words correctly classified
  - E: Database of human labelled images of handwritten words
- **Example 2**
  - T: Categorize email messages as spam or legitimate.
  - P: Percentage of email messages correctly classified.
  - E: Database of emails, some with human-given labels





Introduction to Machine Learning

Defining the Learning Tasks

Improve on task T, with respect to performance metric P, based on experience E

Example 3

T: Playing Checkers

P: Percent of games won against opponents

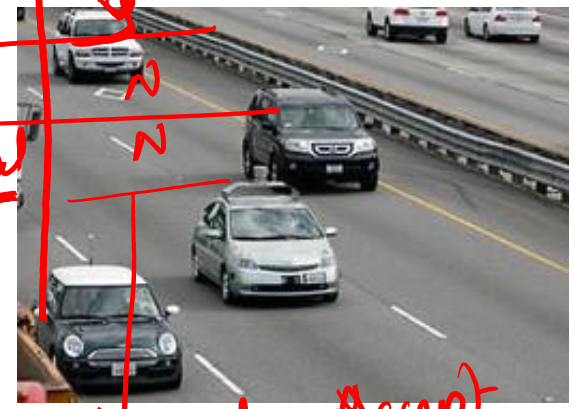
E: Games Played against itself

Example 4

T: Drive on public four-lane highways using vision sensors.

P: Average distance travelled before an error (as judged by human).

E: A sequence of images and steering commands recorded while observing a human driver



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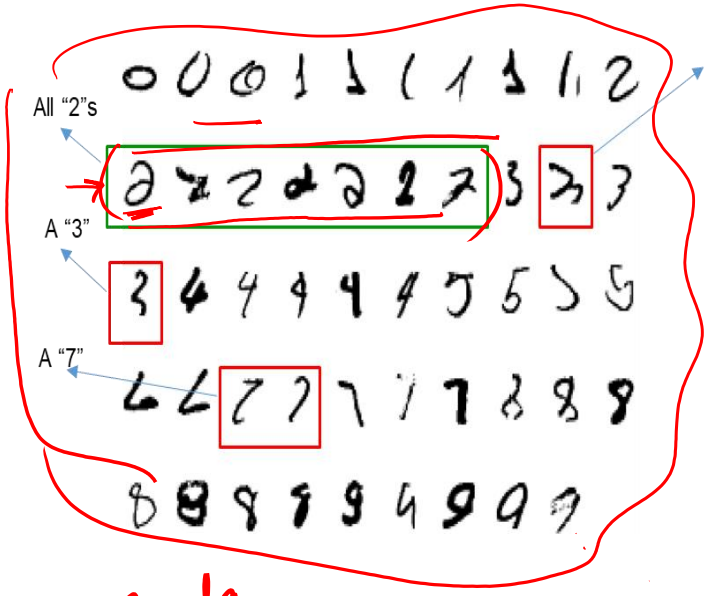

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Introduction to Machine Learning

Traditional Approach - Spam Filtering

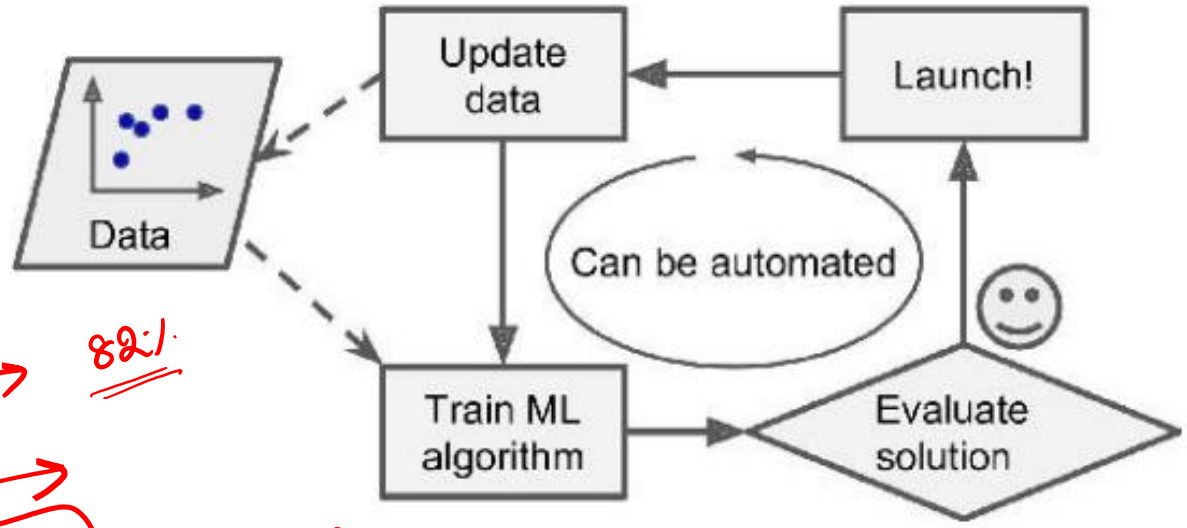
- Spam typically uses words or phrases such as “4U,” “credit card,” “free,” and “amazing”

- **Solution**
  - Write a detection algorithm for frequently appearing patterns in spams
  - Test and update the detection rules until it is good enough.
- **Challenge**
  - Detection algorithm likely
  - to be a long list of complex rules
  - hard to maintain.

Introduction to Machine Learning

ML Approach - Spam Filtering

Automatically learns phrases that are good predictors of spam by detecting unusually frequent patterns of words in spams compared to “ham”s



The program is much shorter, easier to maintain, and most likely more accurate.

Introduction to Machine Learning

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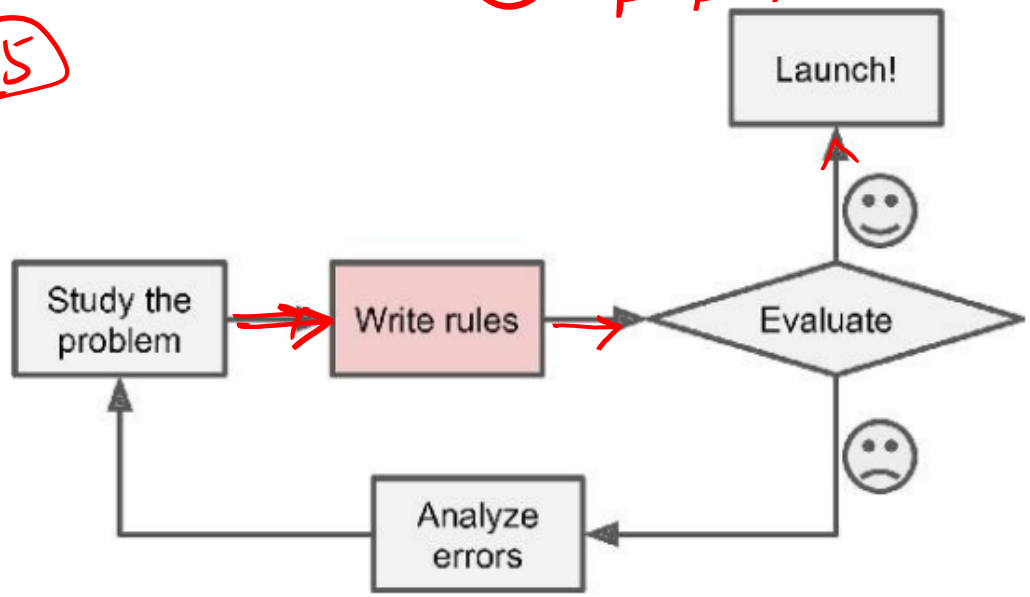

Introduction to Machine Learning

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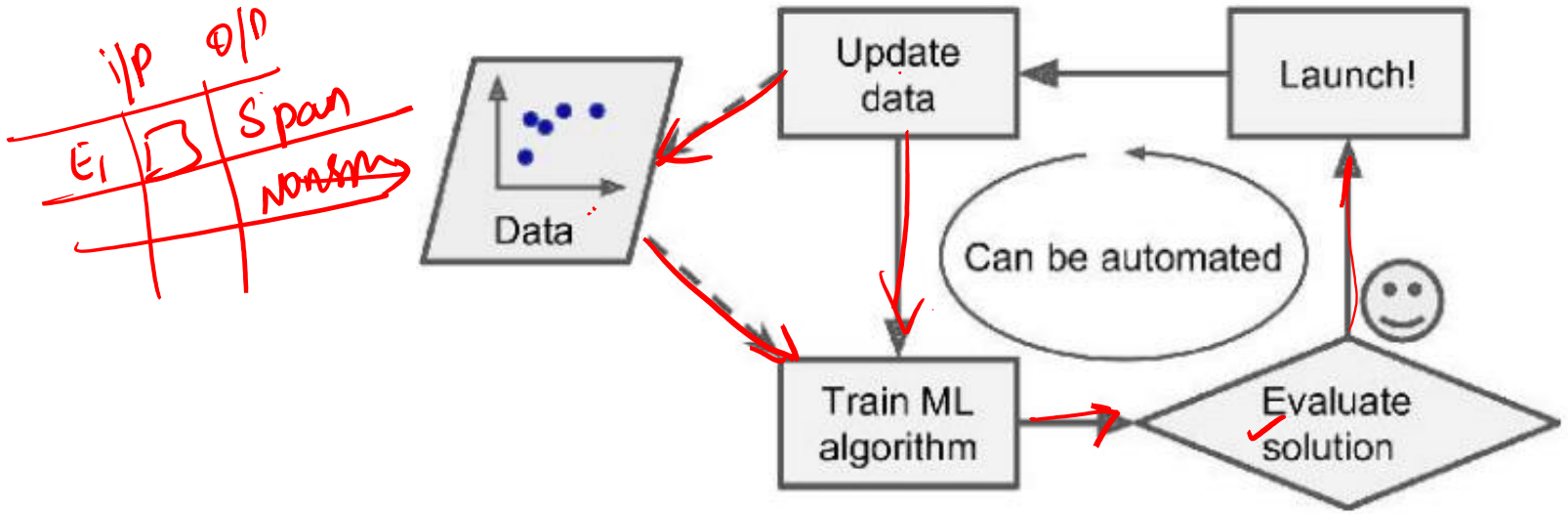

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Introduction to Machine Learning

Applications - Perspectives

Object Categorization

- Medical Diagnosis
- Transaction Analysis
- Recommendation System
- Speech – Text Processing

Sequence Prediction

- Pattern Recognition
- Optimization
- Decision System

Introduction to Machine Learning

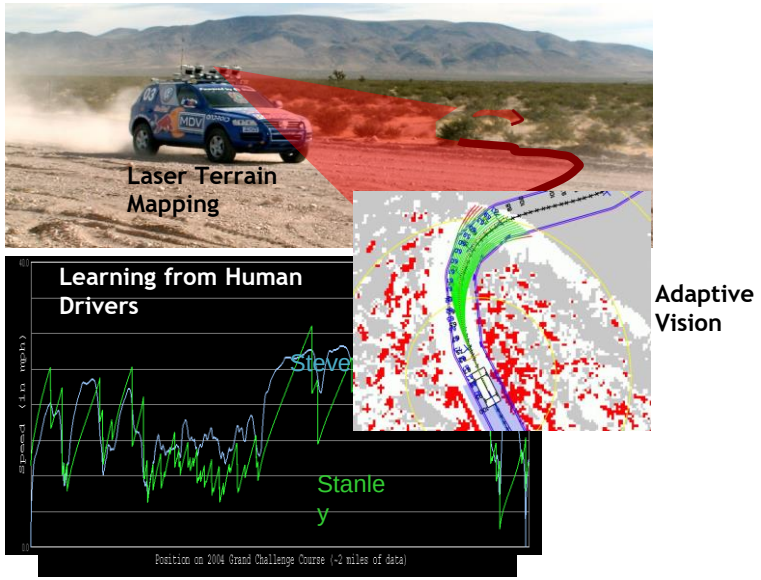
Applications - Perspectives

Planning

- Navigation
- Path Finding
- Gaming
- Controlling

Sequence Prediction

- Pattern Recognition
- Optimization
- Decision System

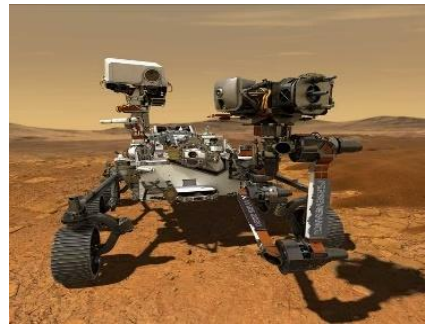


Why ML

When Do We Use Machine Learning?

ML is used when:

- Human expertise does not exist (navigating on Mars)
- Humans can't explain their expertise (Biometrics)
- Models must be customized (personalized medicine)
- Learning isn't always useful:
  - There is no need to "learn" to calculate payroll

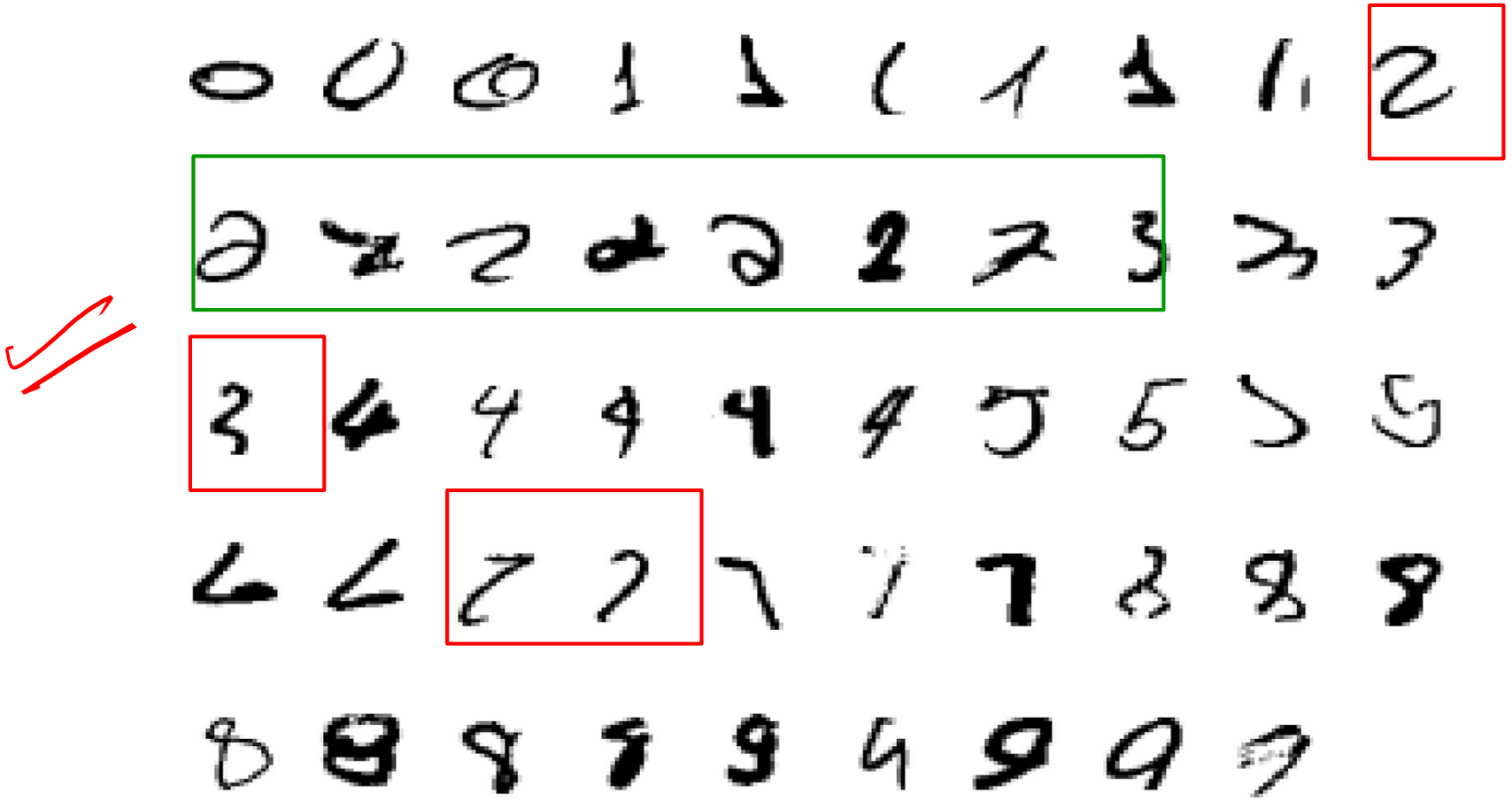


Why only ML?

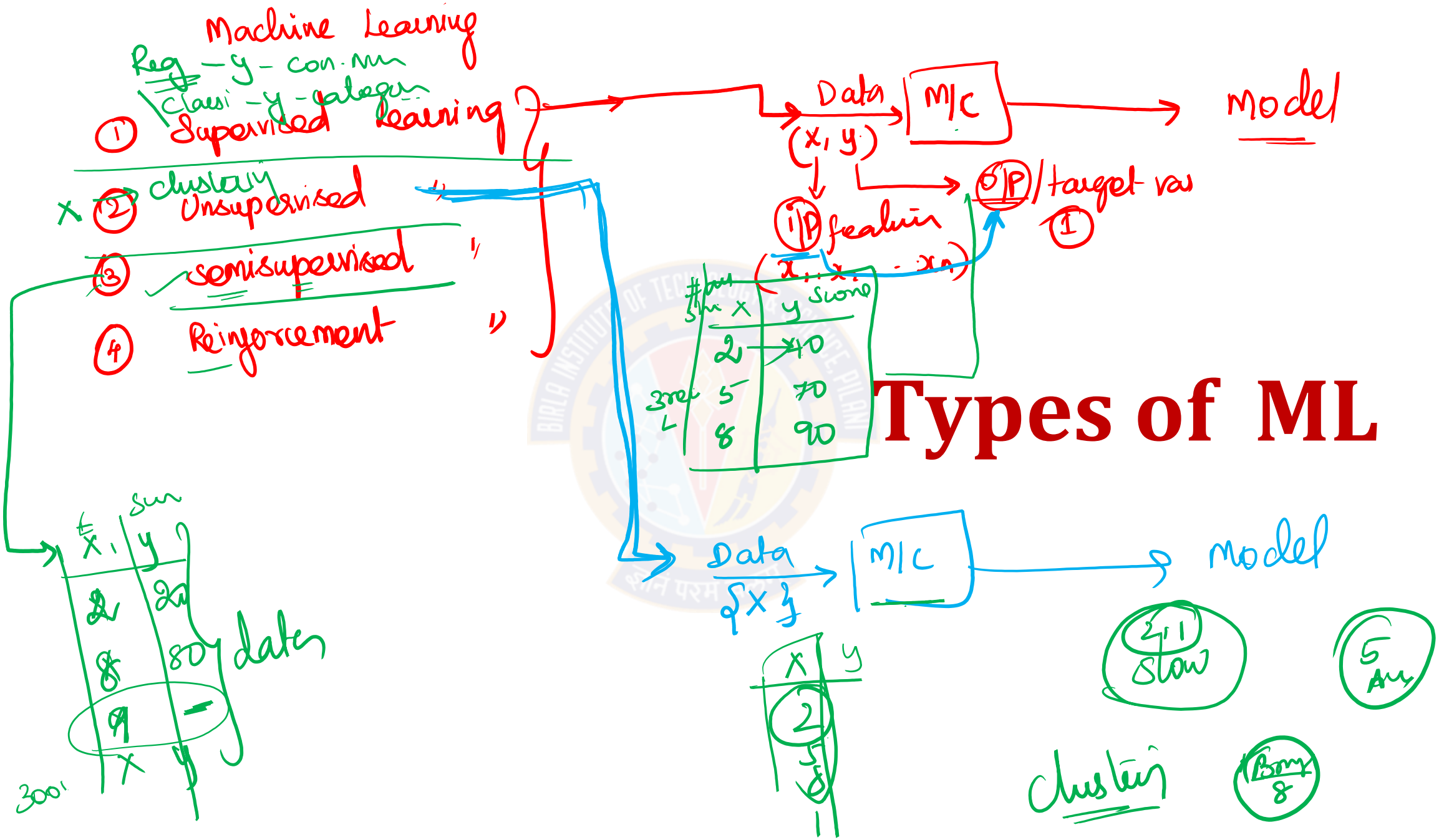
- Some tasks cannot be defined well, except by examples.
  - It is very hard to write programs that solve problems like recognizing a handwritten digit
  - What distinguishes a 2 from a 7?
  - How does our brain do it
- Hidden relationships and correlations in data
- large data makes it difficult for explicit encoding by humans (e.g., medical diagnostic)
- Continuous availability of new knowledge

Pattern recognition

It is very hard to say what makes a 2



Slide credit: Geoffrey Hinton


Machine Learning
Reg - y - con. no
Classi - y - categ
1 Supervised learning
2 clustering Unsupervised
3 semisupervised
4 Reinforcement
Data
(x, y)
M/C
model
i/p features
o/p / target var
Types of ML
Data
{x}
M/C
model
data
cluster

References

Chapter 1 – Machine Learning, Tom Mitchell

Chapter 1, 2 – Introduction to Machine Learning, 2nd edition, Ethem Alpaydin

Chapter 1 - Pattern Recognition & Machine Learning Christopher M. Bhishop

http://www.cs.princeton.edu/courses/archive/spr08/cos511/ [Web]

https://www.softwaretestinghelp.com/machine-learning-tools/

Thank you