Introduction to AI, ML and Deep Learning

PG Level AP in AI&MLOps Cohort 3

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Let's meet a Virtual Assistant

INDIAN INSTITUTE OF SCIENCE
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- "Hey Siri. Show me a good breakfast restaurant near me."
- How does Siri process this query?
  1. Convert speech to text
  2. Understand the semantics of the question (e.g., understand keywords like breakfast, restaurant) and formulate a structured query (place type = "restaurant", good for="breakfast", rating 3-5, distance < 3 km)
     - It also needs your current location!
  3. Search for restaurants, filter by the structure above and rank based on ratings (or other metrics)
     - For rating, the system could use the star rating and the sentiments/points in the written review – another NLP task
  4. At the restaurant, it might translate the menu card from Kannada to English

Department of Computational and Data Sciences

AI System for Almond Processing Plant

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The Learning Process

1
- AI/ML Fundamentals
- Ops Fundamentals
- Programming

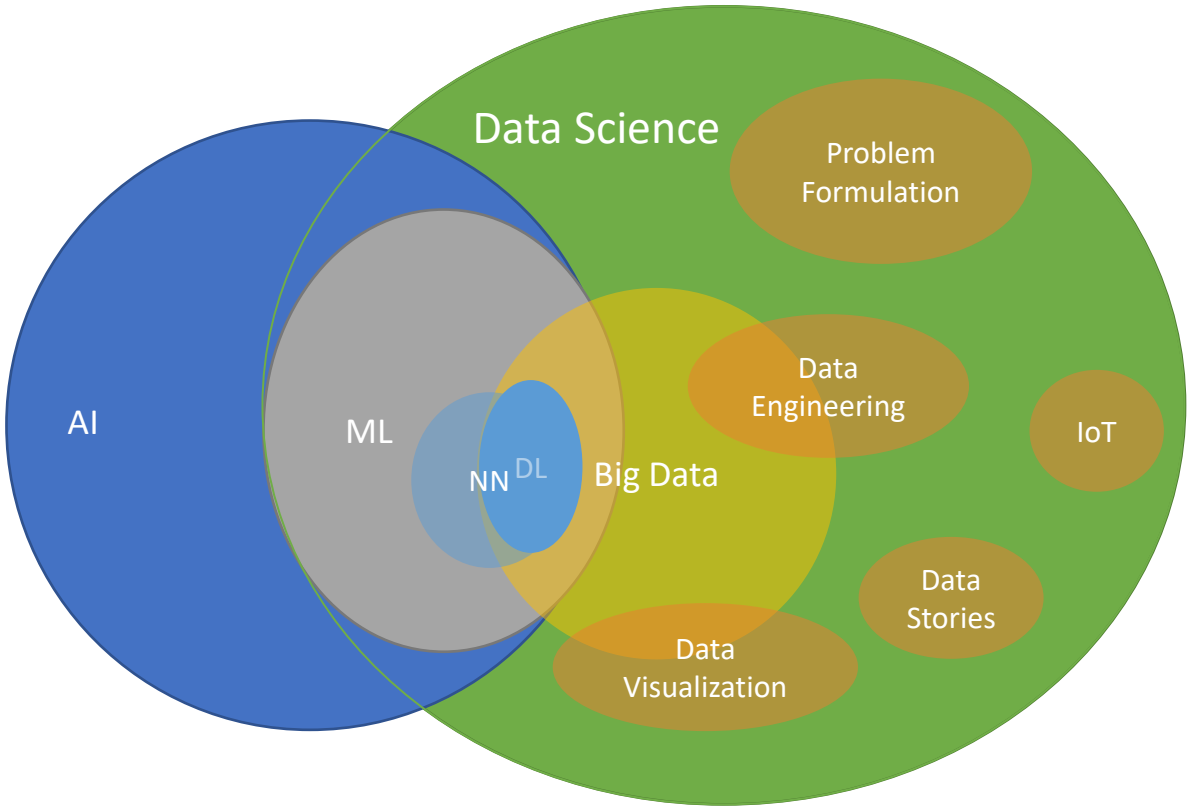
3
- Learning Tools
- Using Tools

Image Courtesy: 123rf

2
- ML Algorithms
- DL Algorithms
- Cloud MLOps
- MLOps at Scale

4
- Projects
- Portfolio

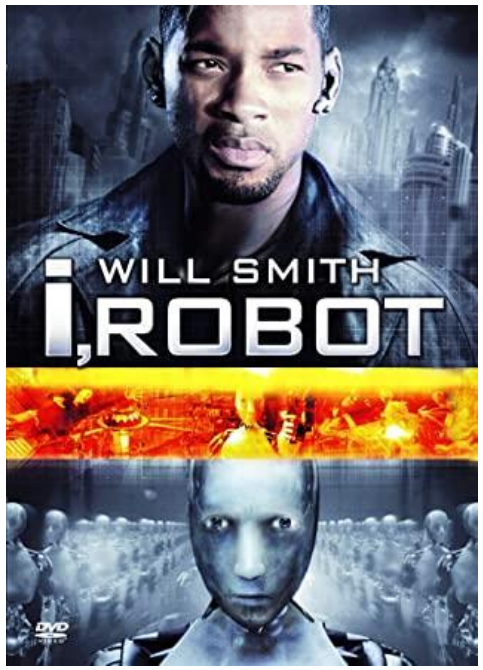
Data Science: ML/AI/DL – What is it?

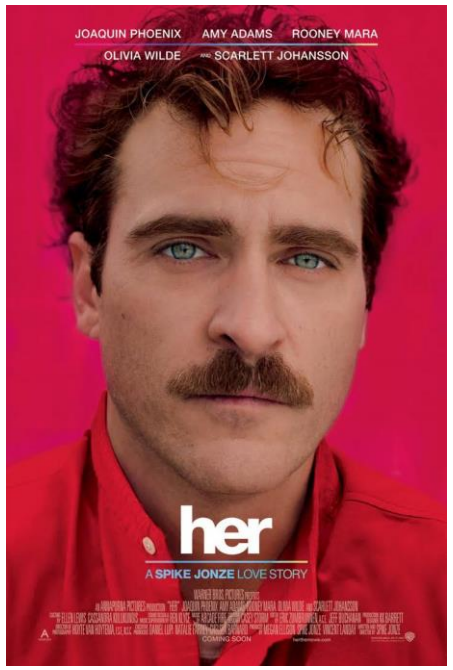


- Data Science is an umbrella term
- It is the full building that we showed
- It has foundation, pillars, floors, walls, interiors, maintenance
- One can focus on a part of the building and develop deep expertise
- But should know the breadth as well

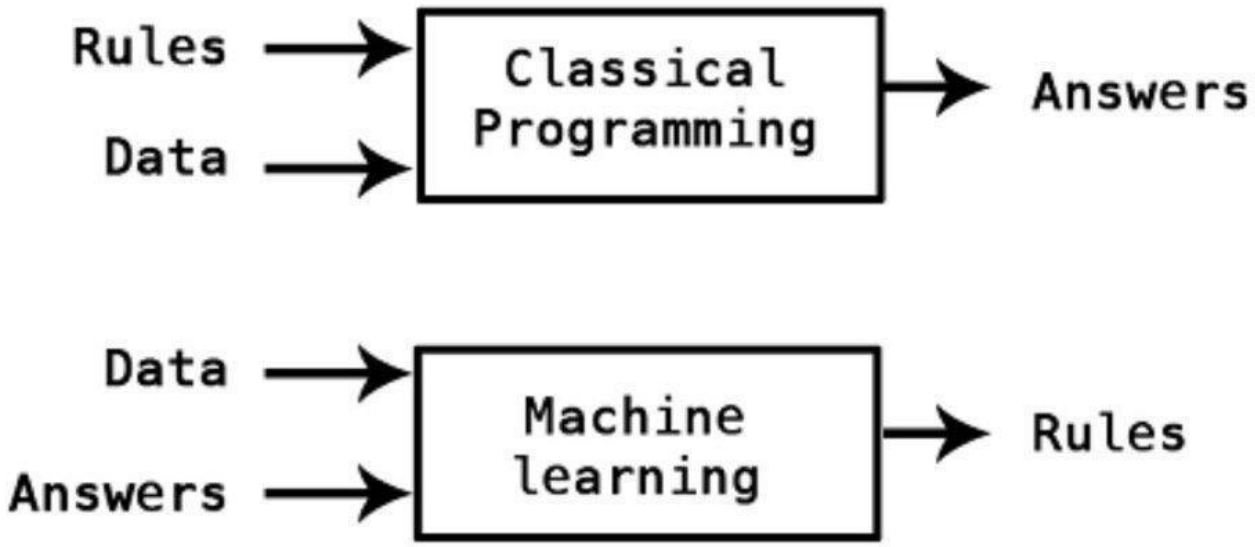
Artificial Intelligence

- AI: The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.
- Can be data-driven or model-driven (rule-based)
- Artificial General Intelligence is the ultimate goal in AI research





Classical Programming vs ML

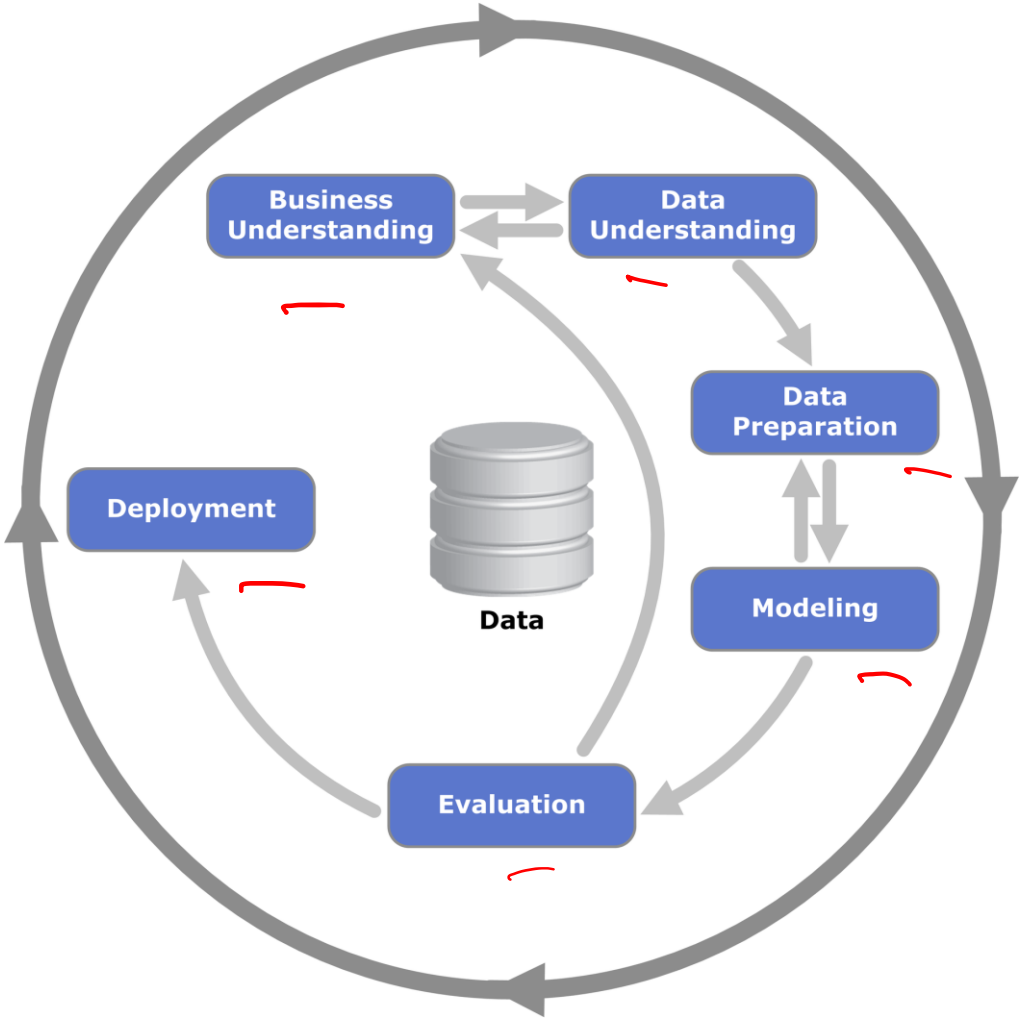


The AI/ML Workflow

1. Frame the AI problem by looking at the business need
   a. Identify subproblems (One/more of the 5 tasks a computer can do)
   b. Establish a current baseline (What is currently done?)
   c. Define success
2. Gather the data and do Data Munging/Wrangling + Baselines
   a. Explore the data
   b. Clean data and prepare for the downstream ML models
   c. Establish a data, domain and SoTA baseline
3. Explore different models, improve them through Cross Validation and perhaps new model design
4. Form an ensemble of multiple models and solutions
5. Present your solution
   a. Say a story with the data
6. Deploy

CRISP-DM

- Cross Industry Standard Process for Data Mining
- Initiative in the mid 90s by European Strategic Programme on Research in Information Technology (ESPRIT)
- The key ideas are in our 6-step process as well



Types of Data

- Tabular Data
  - Most common form
  - Arises in almost all business use cases
  - Usually number of data points x features
- Timeseries Data
  - Tabular but at different times (a logical ordering in time)
- Image Data
  - Increasing in recent years
  - Usually number of data points x height x width x sensor channels
  - Time series of image data is video data
  - Vision Tasks
- Text Data
  - Language tasks
  - Usually text corpus – Needs to be converted to number – How?
- Speech Data
  - Language tasks
  - Usually recording corpus – Signal Processing

Continuous vs Categorical Data

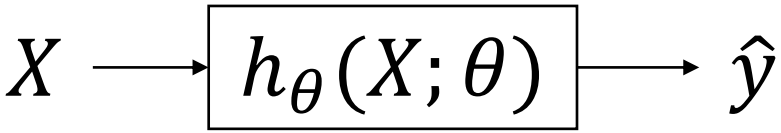
- Continuous Data – mm of rainfall tomorrow
- Categorical data – Will it rain or no?
- How to reason about categories?
- We will use the language of probability and statistics to answer these questions

ML: Mental Model

Data that can be collected

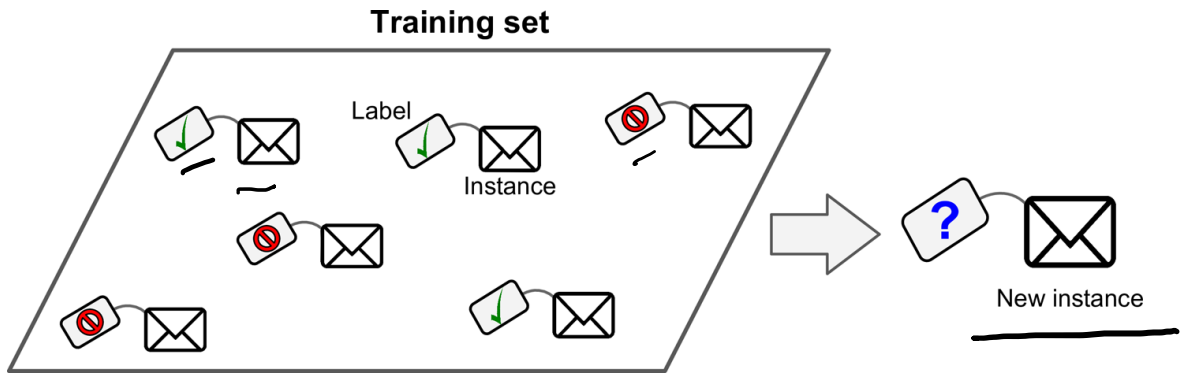
Quantity that must be predicted to make money

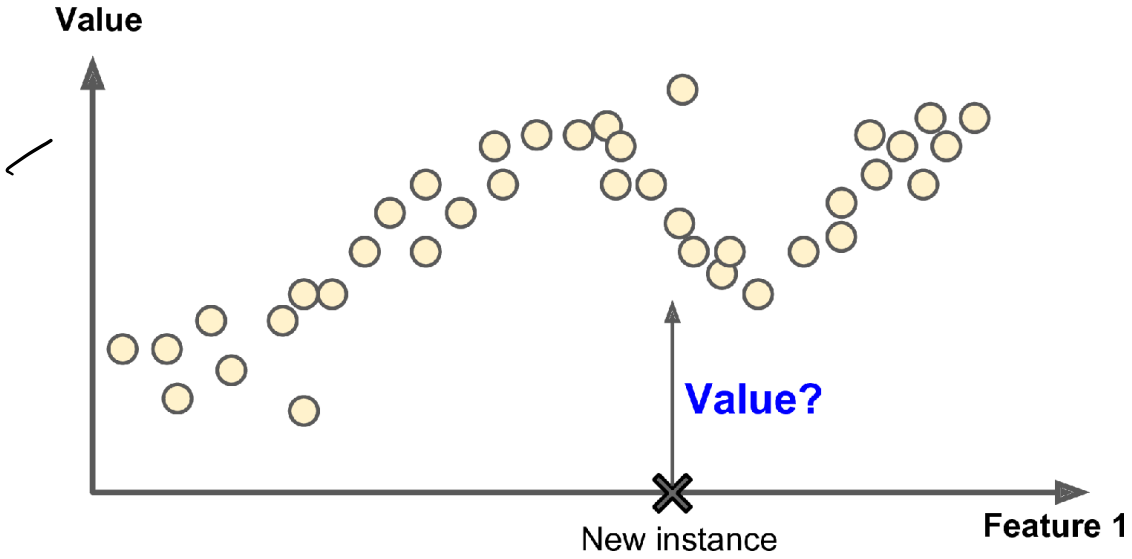
Data that can be collected

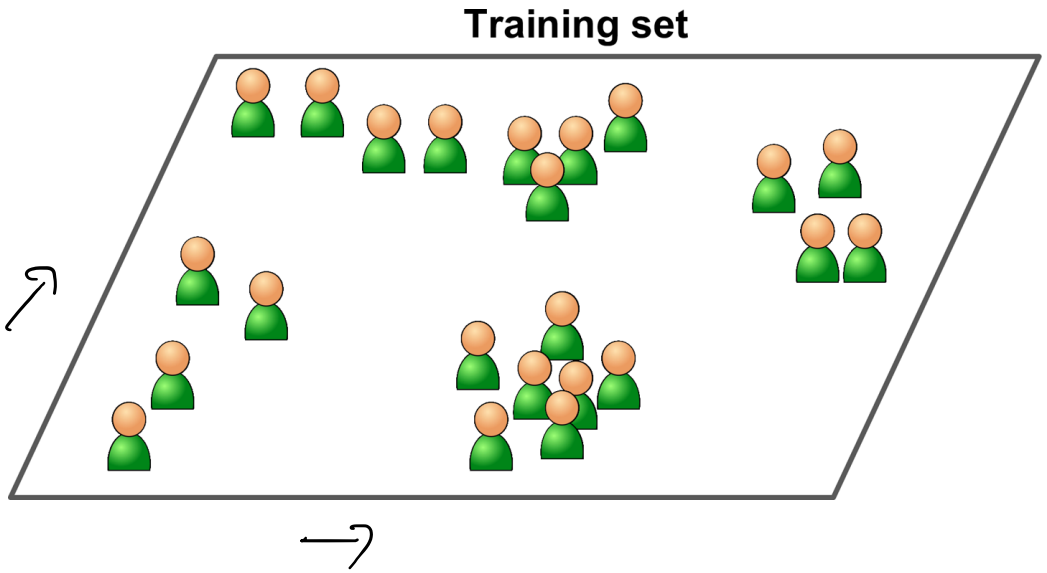


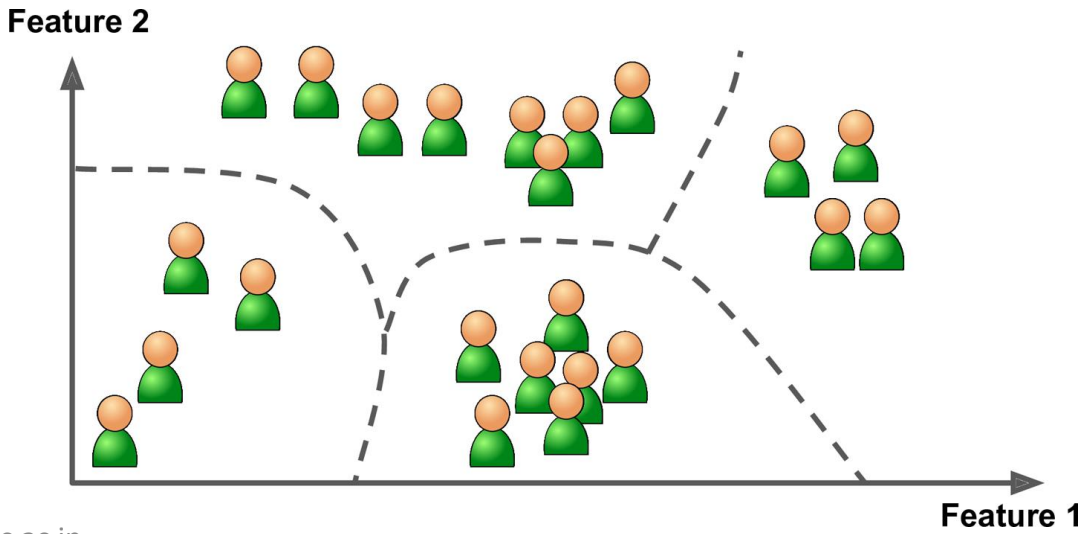
Machine's Prediction

Tasks in ML/DS/AI: Visual Introduction









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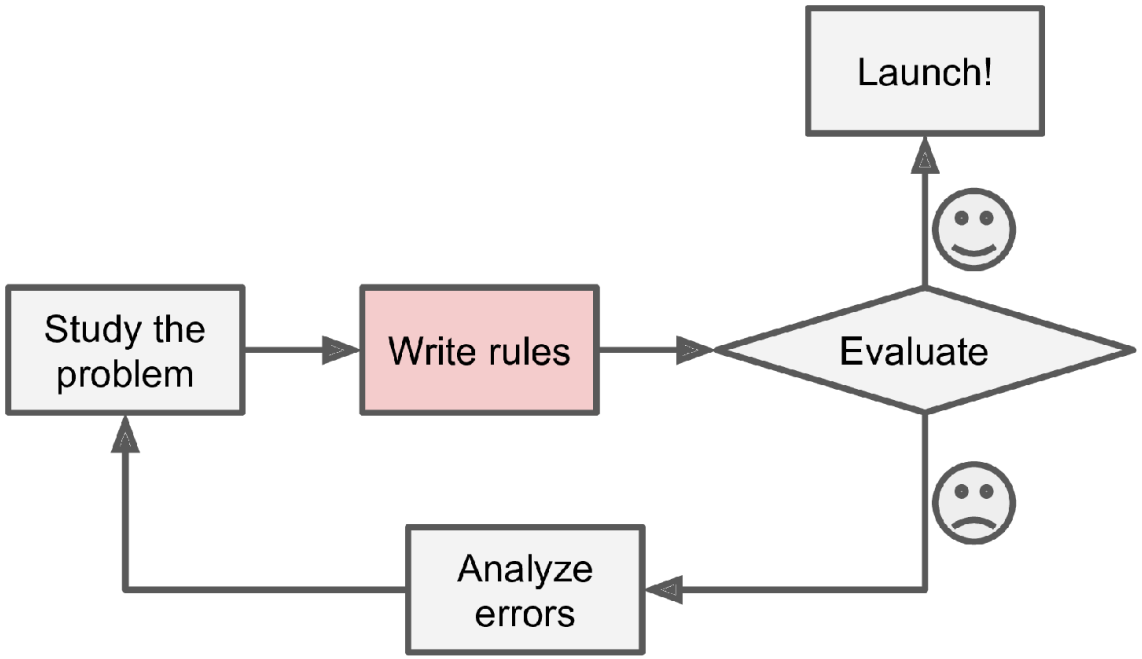
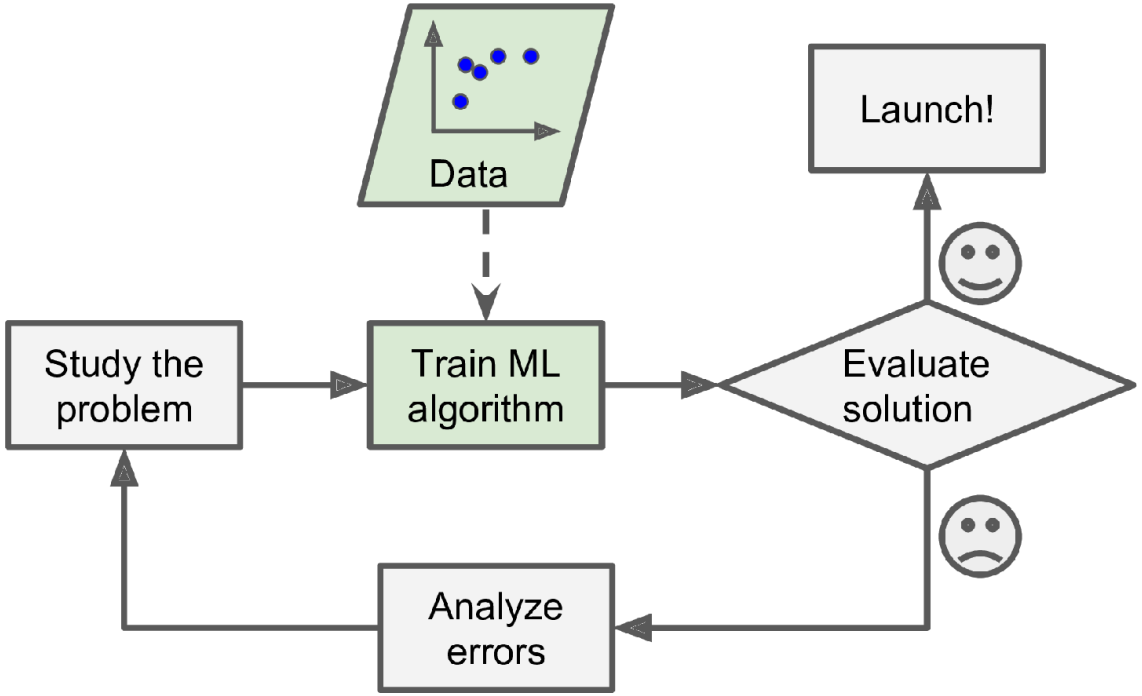
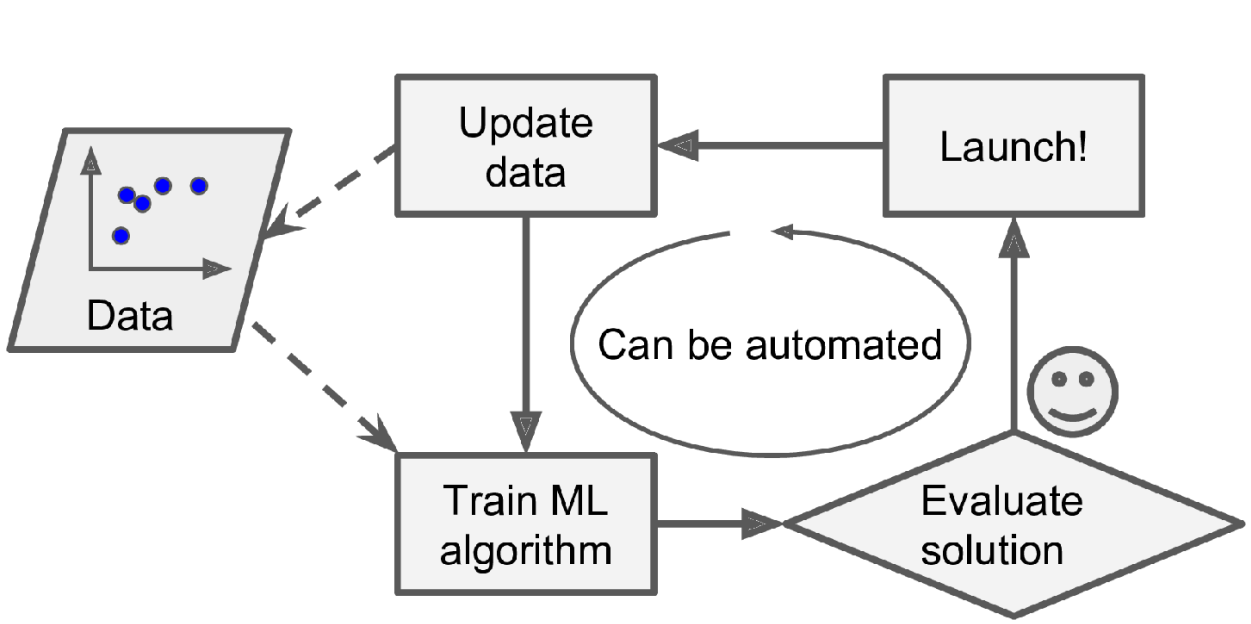
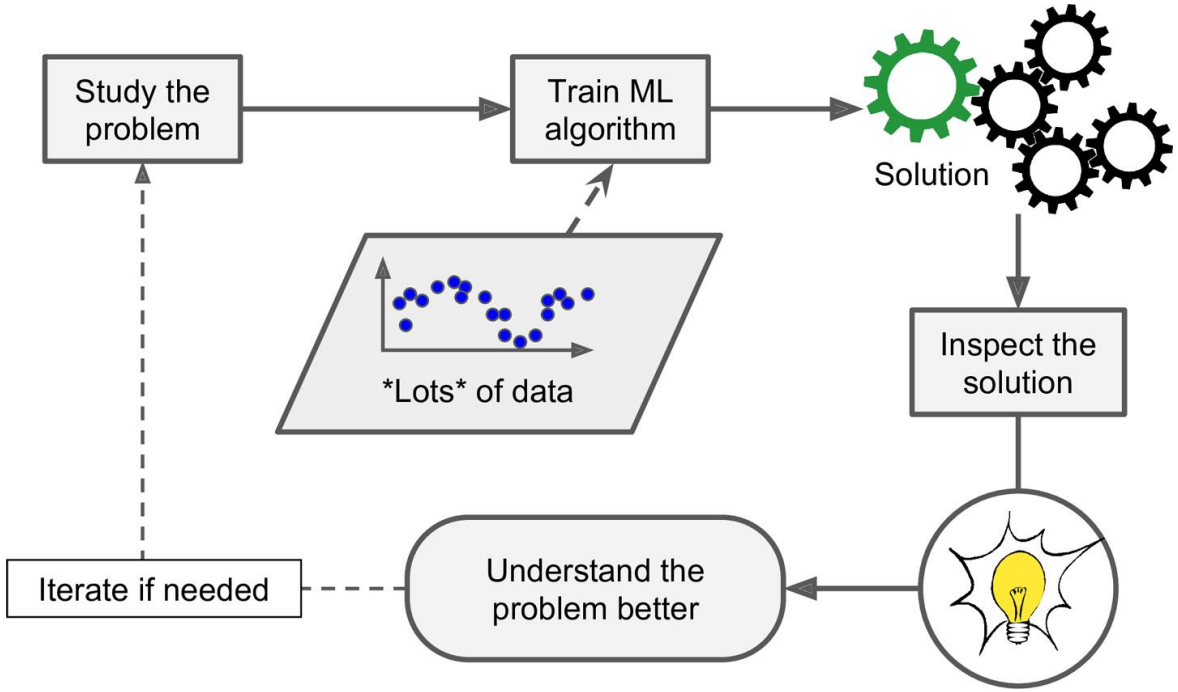
Traditional Approach vs ML





Uses of ML


Update data
Launch!
Data
Can be automated
Train ML algorithm
Evaluate solution


Study the problem
Train ML algorithm
Solution
Lots of data
Inspect the solution
Iterate if needed
Understand the problem better

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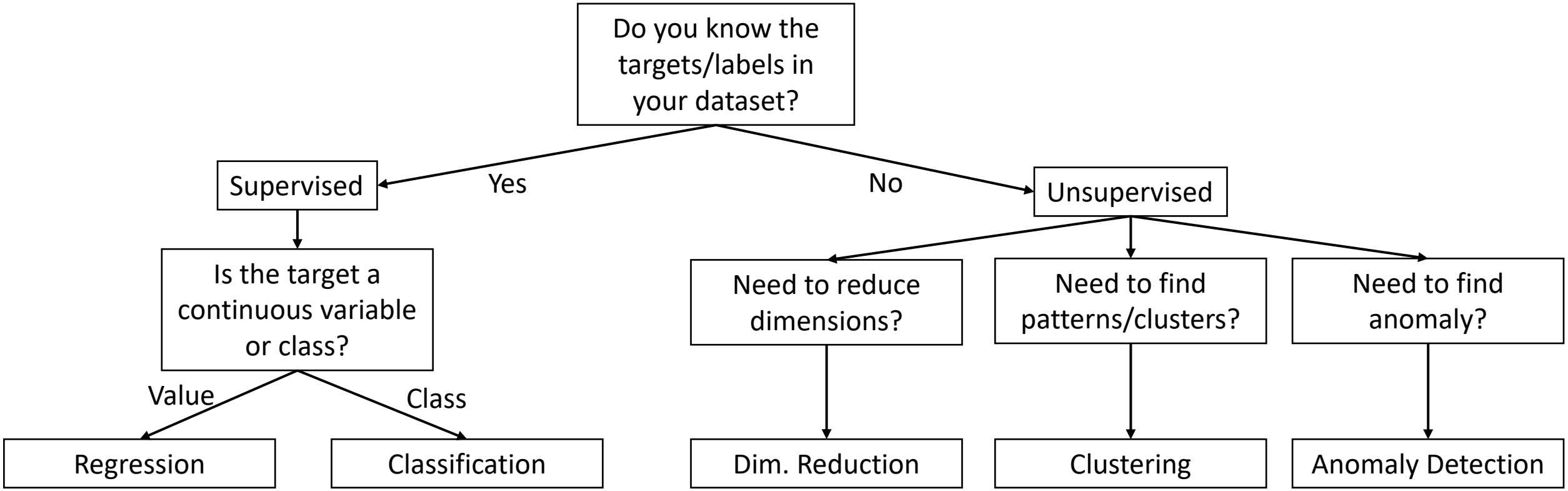
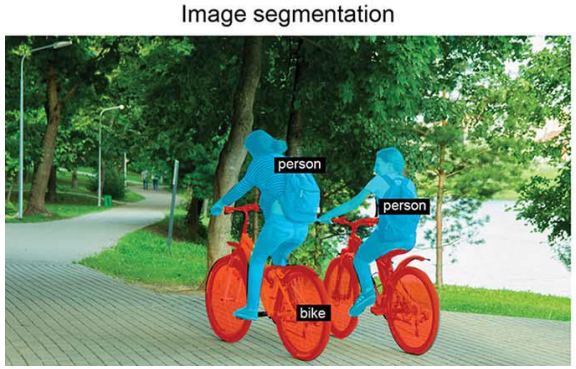
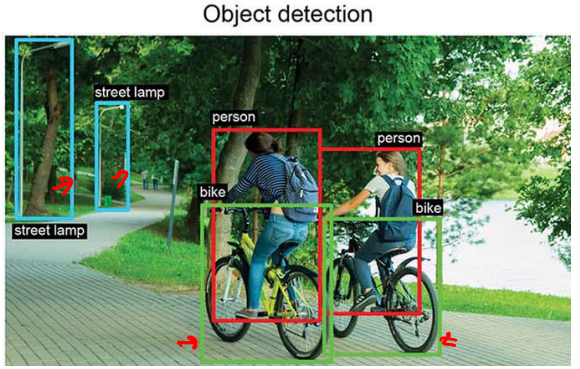
Summary of ML



Three Essential Tasks in Computer Vision

- Image Classification
  - Single Label
    - Binary
    - Multiclass
  - Multi Label
- Image Segmentation
  - Pixel wise identify the class
  - Example: Zoom background replacement
- Object Detection
  - Bounding box around objects
  - Self-driving cars, face detection in cameras





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NLP: Major Tasks

- Modern NLP – Goal is not to understand language, but to ingest a piece of language as input and return useful quantities
- A collection of fundamental tasks repeatedly come in NLP
- Natural Language Understanding
  - "What is the topic of this text?" – Topic Modelling
  - "Is this text inappropriate?" – Content Filtering
  - "Is this text, positive, neutral or negative?" – Sentiment Analysis
  - Named Entity Recognition, Part of Speech Tagging
  - Information retrieval (Keyword based)
- Natural Language Generation
  - "What is the next word or character?" – Language Modeling, Sentence Completion
  - "What is "AI" in tamil?" – Machine Translation
  - "What is the crux of this paragraph?" – Text Summarization
  - Answer to "Where is the nearest hair salon?" – Question Answering

Generative AI

- Text to Text
- Text to Image/Video
- Image/Video to Text
- Image/Video to Image/Video
- Text to Speech
- Speech to Text

- Input is the “Prompt”; Model is a Large Language/Vision Model; Output is Image/Video/Text/Speech

Explain your work to stakeholders and set expectations

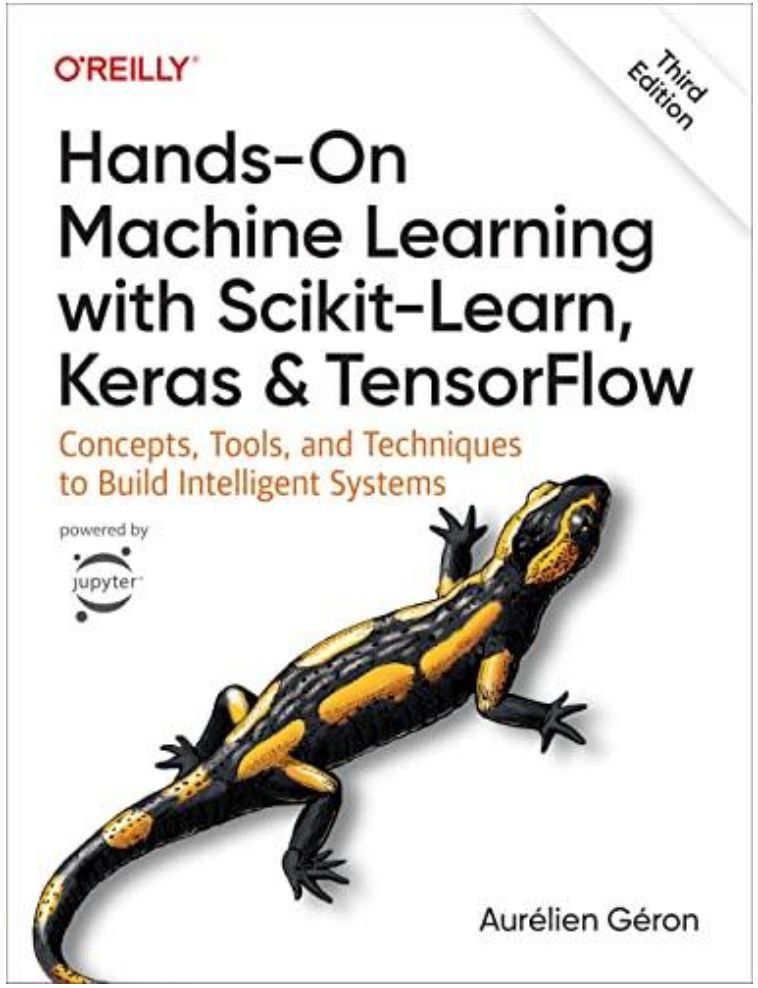
- Success and customer trust are about consistently meeting or exceeding expectations
- The actual model is only half the picture; the level of expectation about system performance matters a lot
- Non-specialists expect AI to punch above its weight
  - They expect the system to “understand” and meet or exceed capability of a human doing the task
- Clearly setting the expectation is important
- Some guidelines
  - Don’t talk in easily mis-understood terminology – Accuracy is 98%
  - Show examples of what misclassification looks like
  - Understand if customer cares about False Positive or False Negative more
  - Discuss key parameters – the probability above which a fraud has to be detected
  - Explain how many cases on average we expect the system to be falsely labelled as positive [False Positive, False Negative, Explain in simple language]

Sources of ML Data

- There are several open data repositories for learning ML/DL
- UCI Repository - https://archive.ics.uci.edu/ml/index.php
- Google Dataset Search - https://datasetsearch.research.google.com/

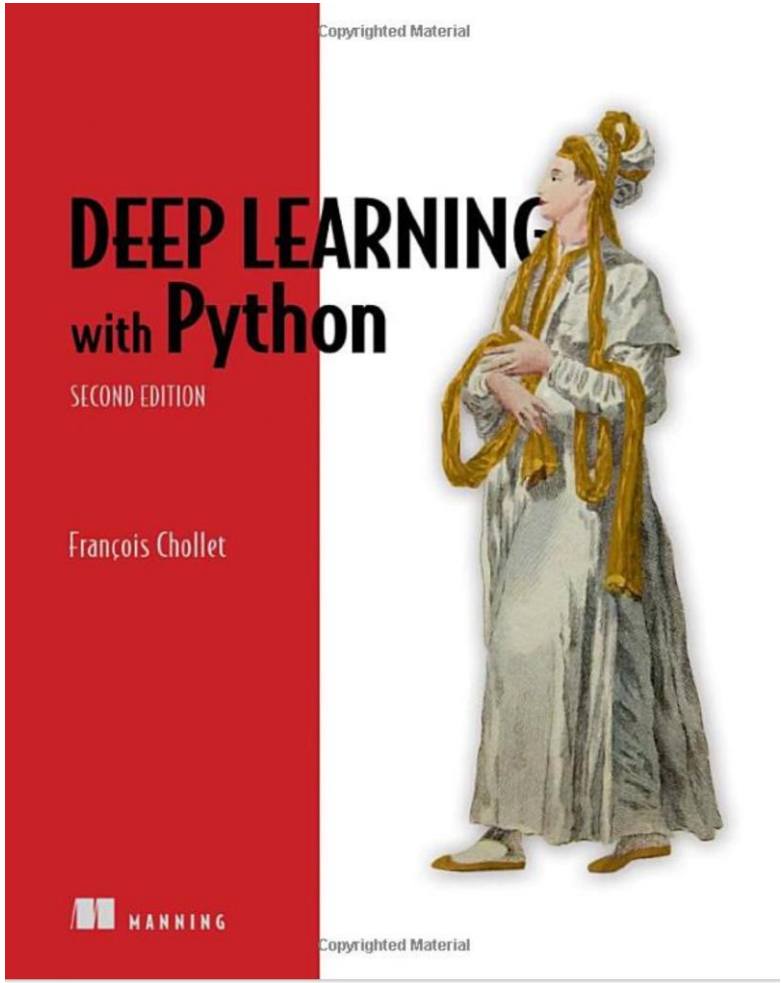
- For our illustration and as a first case study, we will use the California Housing Prices dataset from Geron Textbook Chapter 2

Text Book 1



https://www.amazon.in/Hands-Machine-Learning-Scikit-Learn-TensorFlow-ebook/dp/B0BHCFNY9Q/

Text Book 2



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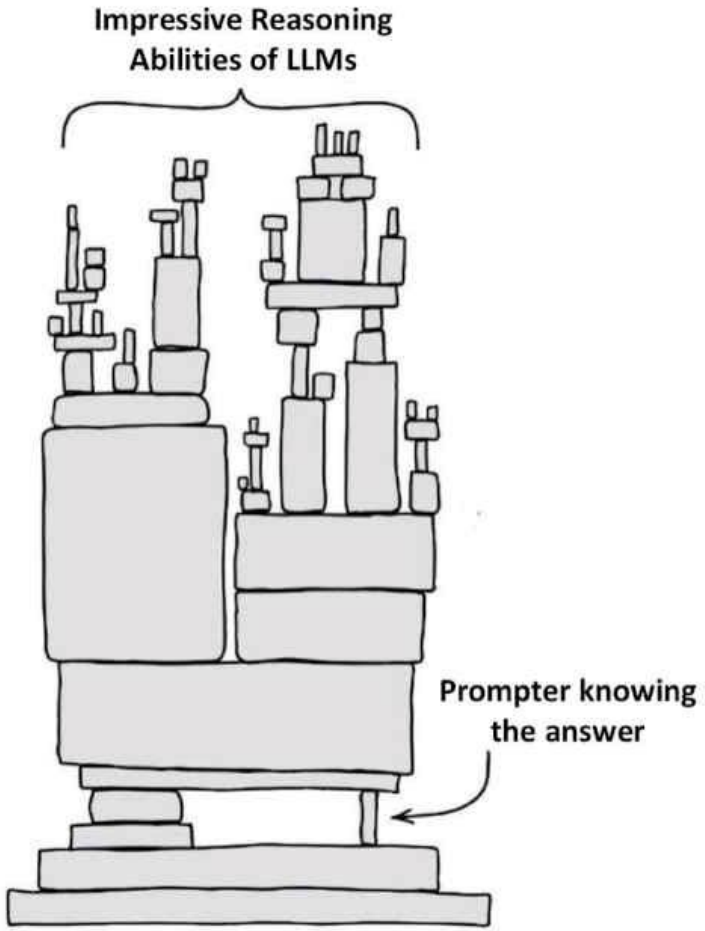
Impressive Reasoning
Abilities of LLMs
Prompter knowing
the answer