



ARTIFICIAL INTELLIGENCE LAB 01 - INTRODUCTION

Al Course Team

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- Teaching Assistant Al Department | Faculty of Computers and Artificial Intelligence BU
- Specialized in Artificial Intelligence and Machine Learning (ML Computer Vision Optimization Speech)
- Specialized in Data Science (Data Modeling Databases Data analytics Data Orchestration Big Data)
- AWS Academy Graduate Data Engineering
- Soon to be Huawei associate certified in HCIA Big Data (Huawei Certified ICT Associate)
- Head member of training and job guidance unit in BFCAL

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GUIDELINES

You don't need to memorize what will be mentioned. Instead, try to understand

Each PowerPoint Presentation will be available as PDF file on Google Drive Folder of the Course

Any miscellaneous for the course (i.e. Software, packages, libraries ... etc) will be available

The grade system will be out of (100 Points) to guarantee a fair grading for each student

There are <u>(5) points</u> based on **Attendance**, as there will be approximately **10 labs**

There are <u>(5) points</u> based on **Activity work** during classes, so keep up

There are (18) points based on **Tasks**, as there will be 6 tasks along the semester

There are (22) points based on Quizzes, as there will be 4 quizzes along the semester

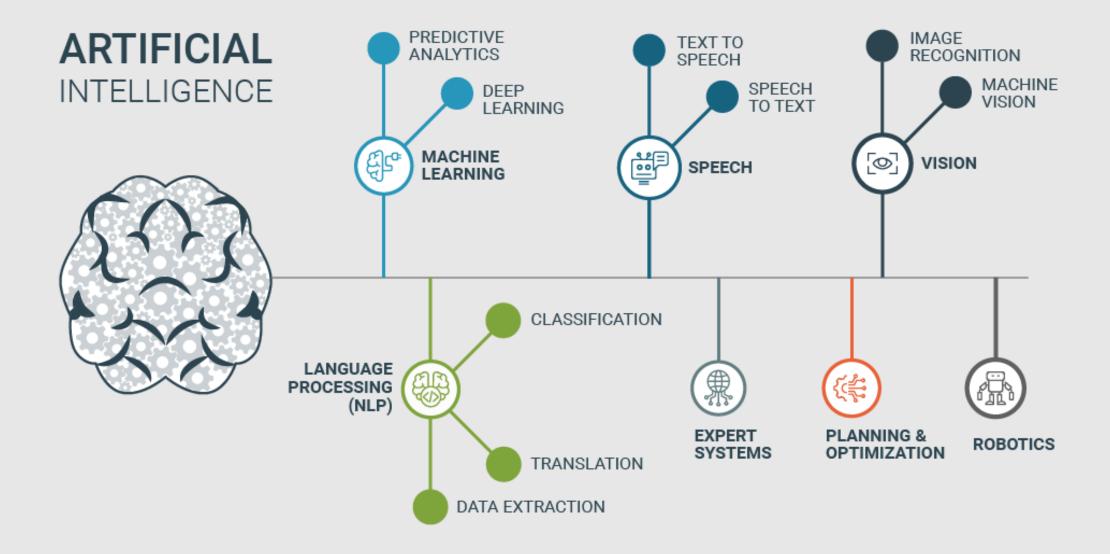
There are (50) points based on **Projects and Practical**, as there will be a project and practical exam along the semester

WHAT IS "ARTIFICIAL INTELLIGENCE"?

The simulation of human intelligence in machines that are programmed to perform tasks that typically require human cognition.

These tasks include learning, reasoning, problem-solving, understanding natural language, perception, and decision-making.

Al systems can range from simple, rule-based algorithms to complex machine learning models that adapt and improve over time.



WHICH BRANCH OF "AI" WE WILL STUDY?

Agent Environment

CATEGORIES OF ENVIRONMENTS

	Observability	Fully Observable Partially Observable
	Determinism	Deterministic Stochastic
o	Dynamics	Static Dynamic
	Episodic Nature	Episodic Sequential
~	Dimensionality	Discrete Continues
2	Agent Interaction	Single-Agent Multi-Agent
S	Realism	Simulated Real-world
Ö	Reward Structure	Sparse Reward Dense Reward

Aspect	Fully Observable Environment	Partially Observable Environment
Definition	The agent has complete and direct access to all information about the environment at all times.	The agent has limited or incomplete information about the environment; some information is hidden.
Observability	The entire state of the environment is visible to the agent.	Only a portion of the environment's state is visible; the rest is unknown or uncertain.
Agent Knowledge	The agent knows everything it needs to make optimal decisions.	The agent must infer or predict missing information to make decisions.
Complexity	Generally simpler to model and solve.	More complex due to uncertainty and the need for inference or memory.
Examples	Chess, tic-tac-toe, a fully mapped grid world.	Poker, real-world navigation (e.g., self-driving cars), most real-world scenarios.
Decision-Making	Decisions are based on complete information, making them more straightforward.	Decisions require reasoning under uncertainty, often using probabilistic models or memory.
Al Techniques Used	Rule-based systems, search algorithms (e.g., minimax, A*).	Probabilistic models (e.g., Bayesian networks), reinforcement learning with memory (e.g., POMDPs).

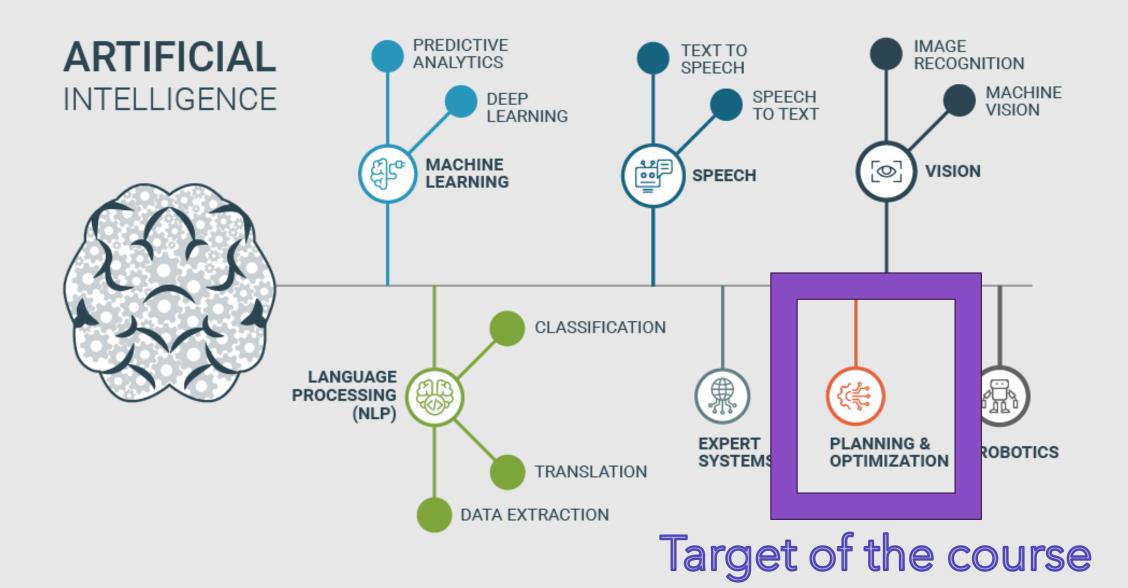
Aspect	Deterministic Environment	Stochastic Environment
Definition	The outcome of an action is predictable and certain.	The outcome of an action is uncertain and involves randomness or probability.
Predictability	Highly predictable; the same action in the same state always produces the same outcome.	Unpredictable; the same action in the same state may produce different outcomes.
Uncertainty	No uncertainty; the environment is fully known and deterministic.	High uncertainty; the environment includes random or probabilistic elements.
Examples	Chess, tic-tac-toe, a robot moving in a controlled grid.	Weather prediction, stock market, rolling a dice, real-world navigation (e.g., self-driving cars).
Decision-Making	Decisions are straightforward, as outcomes are certain.	Decisions require handling uncertainty, often using probabilistic models or risk analysis.
Al Techniques Used	Search algorithms (e.g., A*, Dijkstra), rule-based systems, planning algorithms.	Probabilistic models (e.g., Markov Decision Processes, Bayesian networks), reinforcement learning.

Aspect	Static Environment	Dynamic Environment
Definition	The environment does not change while the agent is deciding or acting.	The environment changes while the agent is deciding or acting.
Change Over Time	No changes occur during the agent's decision-making process.	Changes occur independently of the agent's actions or as a result of them.
Predictability	Highly predictable, as the environment remains constant during the task.	Less predictable, as the environment can change unexpectedly.
Examples	Solving a crossword puzzle, playing a turn-based game like chess.	Driving a car in traffic, managing a stock portfolio, playing a real-time video game.
Decision-Making	Decisions are based on a fixed state of the environment.	Decisions must account for the evolving state of the environment.
Al Techniques Used	Search algorithms (e.g., A*, Dijkstra), rule-based systems, planning algorithms.	Real-time decision-making systems, adaptive algorithms, reinforcement learning.

Aspect	Episodic Environment	Sequential Environment
Definition	The agent's experience is divided into independent episodes with no connection between them.	The agent's actions have long-term consequences, and decisions affect future states.
Temporal Dependency	No dependency between episodes; each episode is self-contained.	Strong dependency between actions and states over time.
Decision-Making	Decisions in one episode do not affect future episodes.	Decisions in one step influence future states and outcomes.
Examples	Playing individual games of tic-tac-toe, classifying individual images.	Playing a game of chess, managing a supply chain, navigating a maze.
Memory Requirement	No need for memory of past episodes, as each episode is independent.	Requires memory or history of past actions and states to make informed decisions.
Al Techniques Used	Supervised learning, classification, simple reinforcement learning.	Reinforcement learning, planning algorithms (e.g., MDPs, POMDPs), recurrent neural networks (RNNs).

Aspect	Discrete Environment	Continuous Environment
Definition	The environment has a finite or countable number of states and actions.	The environment has an infinite or uncountable number of states and actions.
State Space	States are distinct and separate (e.g., grid cells, chess positions).	States are represented by real-valued variables (e.g., position, velocity).
Action Space	Actions are distinct and finite (e.g., move left, right, up, down).	Actions are represented by continuous values (e.g., steering angle, throttle intensity).
Examples	Chess, tic-tac-toe, a grid world with discrete cells.	Self-driving cars, drone control, robotic arm manipulation.
Decision-Making	Decisions are based on selecting from a finite set of options.	Decisions involve choosing values from a continuous range.
Al Techniques Used	Search algorithms (e.g., A*, minimax), tabular reinforcement learning.	Function approximation (e.g., neural networks), continuous control algorithms (e.g., PID, RL with policy gradients).

Aspect	Single-Agent Environment	Multi-Agent Environment
Definition	Only one agent operates in the environment.	Multiple agents operate in the same environment, interacting with each other.
Agent Interaction	No interaction with other agents; the environment is static or changes independently.	Agents interact with each other, either cooperatively, competitively, or in a mixed manner.
Complexity	Simpler, as the agent only needs to consider its own actions and the environment.	More complex, as agents must account for the actions and strategies of other agents.
Examples	A robot navigating a maze, a single- player video game.	Multiplayer games (e.g., soccer, poker), traffic systems, collaborative robotics.
Decision-Making	Decisions are based solely on the agent's own goals and the environment.	Decisions must consider the behavior, goals, and strategies of other agents.
Al Techniques Used	Reinforcement learning, search algorithms, planning algorithms.	Game theory, multi-agent reinforcement learning, cooperative/competitive algorithms.



WHAT IS "PLANNING & OPTIMIZATION"?

They are applied in various fields, such as business, project management, urban development, education, and personal life, to ensure efficient resource allocation, time management, and decision-making.





The efficient utilization means that we need to make THE BEST benefit of something!

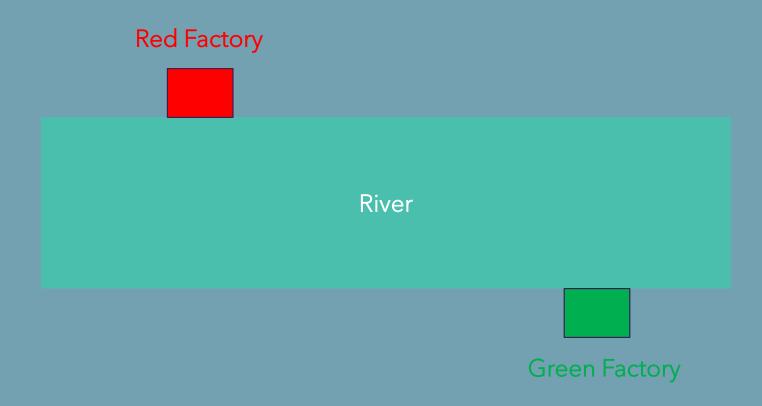
- "THE BEST" in scientific manner is Searching/Optimization process, which is a systematic approach to get benefit of something
- Optimization is found in all life aspects, even in your study, in the making of the semester schedule, EVERYTHING NEEDS SEARCHING





SEARCHING/OPTIMIZATION

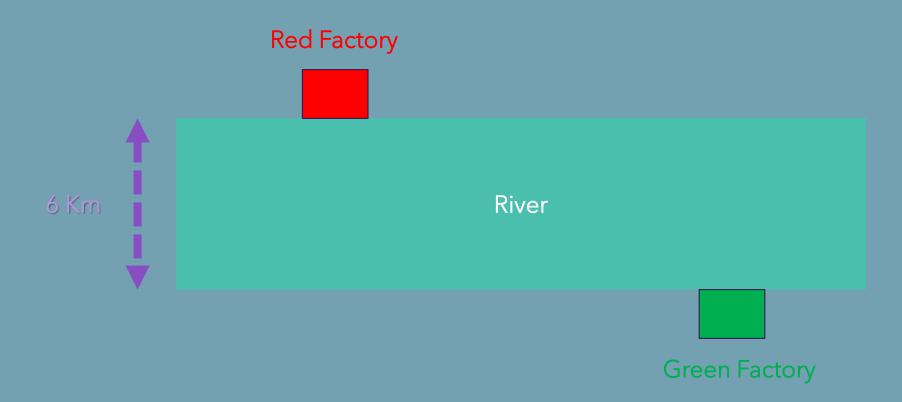
REAL-LIFE EXAMPLE

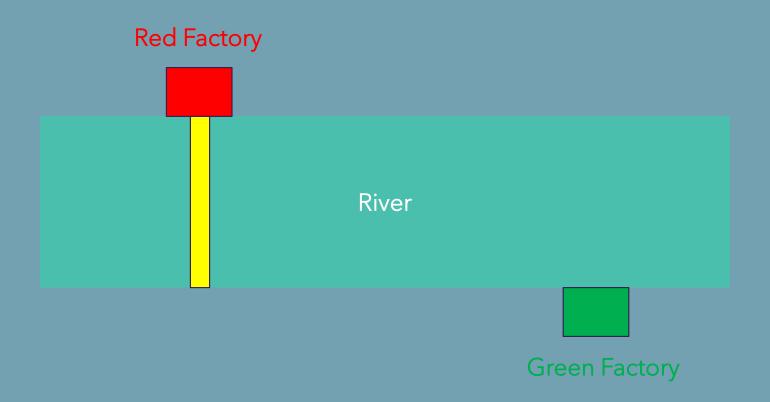


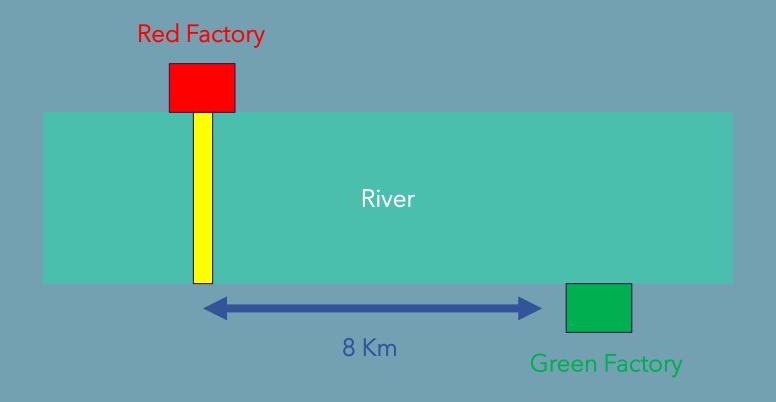
I need to get some stuff from Red factory to my green factory

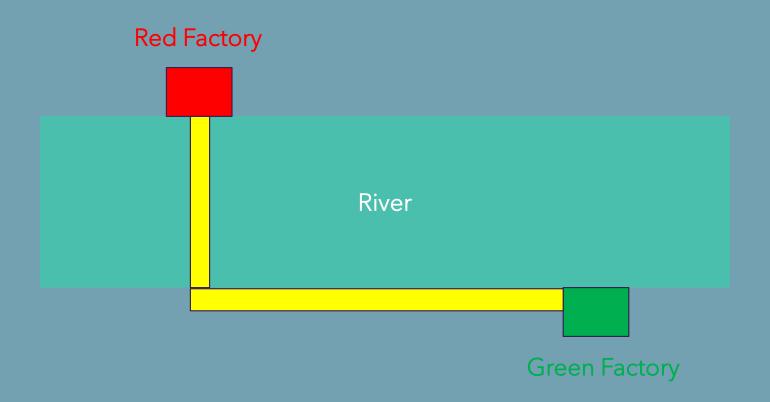


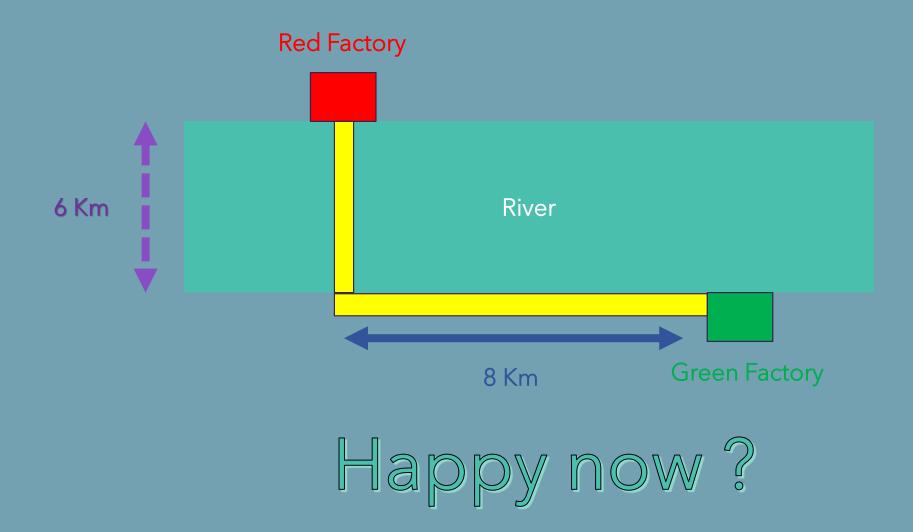
REAL-LIFE EXAMPLE



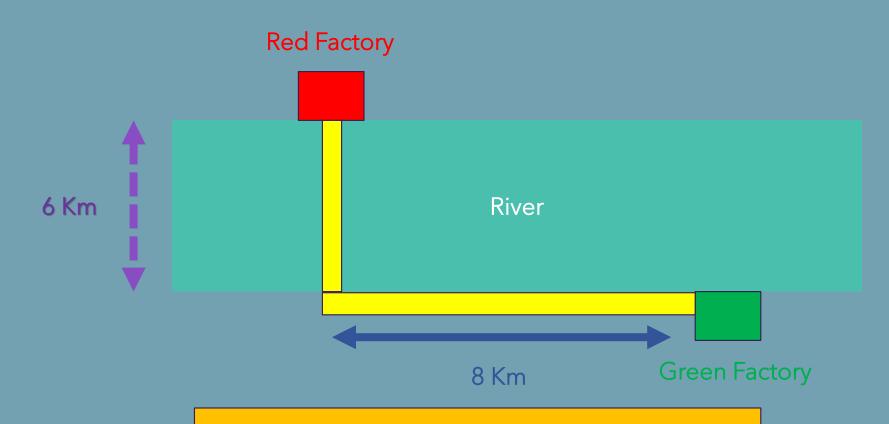








SURE NOT THE COST OF THE BRIDGE IS \$40,000 PER KM THE COST OF THE ROAD IS \$20,000 PER KM

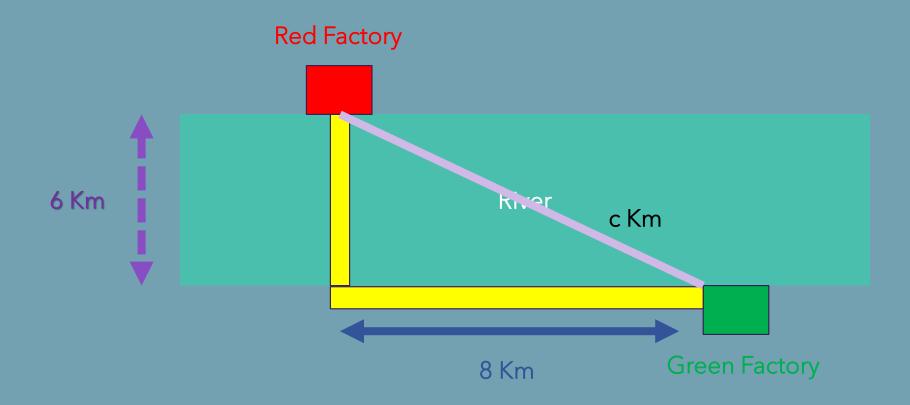


Bridge cost = 6 Km x \$40,000 = \$240,000Road cost = 8 Km x \$20,000 = \$160,000Total = \$240,000 + \$160,000 = \$400,000



ANOTHER SOLUTION?

ANOTHER SOLUTION

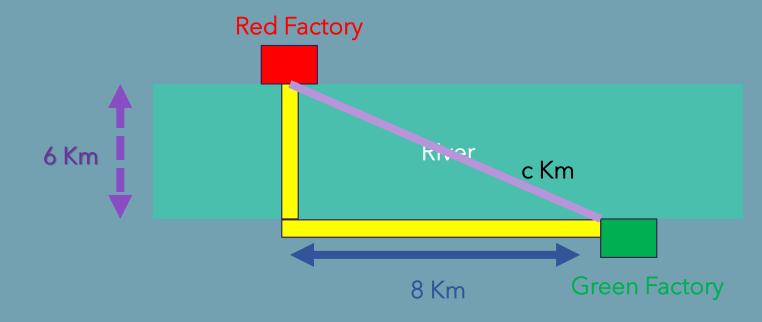


Pythagorean Theorem



PYTHAGOREAN THEOREM

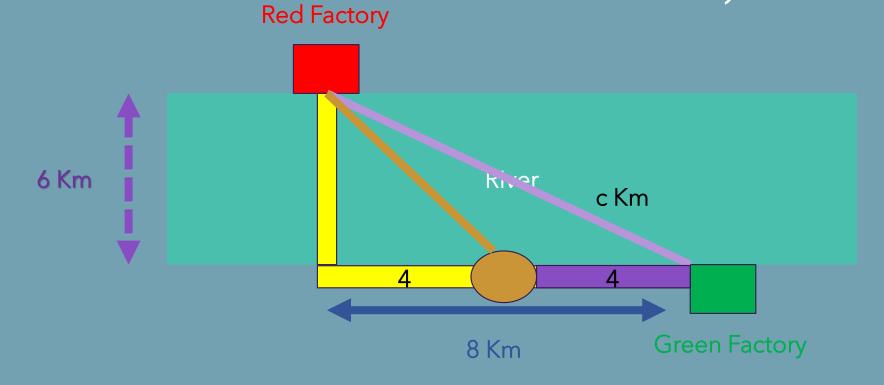
$$c^{2} = a^{2} + b^{2}$$
 $c^{2} = 6^{2} + 8^{2}$
 $c^{2} = 100$
 $c = 10$



Bridge cost = 10 Km x \$40,000 = \$400,000

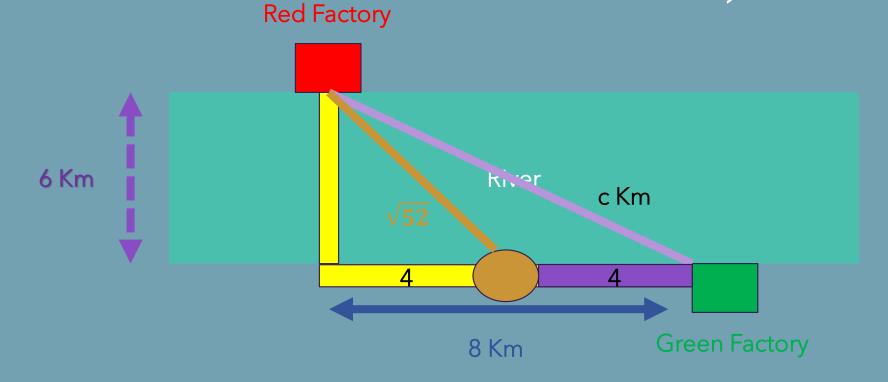


SOLUTION 3 (BALANCE BETWEEN BRIDGE & ROAD -MIDDLE POINT LOCATION-)



Road cost = 4 Km x \$20,000 = \$80,000

SOLUTION 3 (BALANCE BETWEEN BRIDGE & ROAD -MIDDLE POINT LOCATION-)



$$c^{2} = a^{2} + b^{2}$$

 $c^{2} = 6^{2} + 4^{2}$
 $c^{2} = 52$
 $c = \sqrt{52}$

Bridge cost = $\sqrt{52}$ Km x \$40,000 = \$288,444.10

SOLUTION 3 (BALANCE BETWEEN BRIDGE & ROAD -MIDDLE POINT LOCATION-) Red Factory

6 Km

V52

C Km

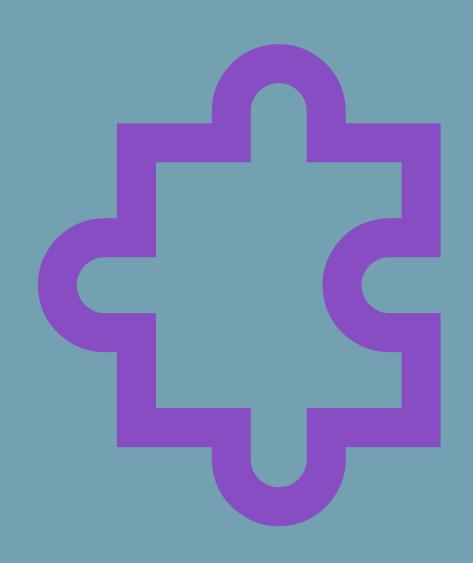
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Green Factory

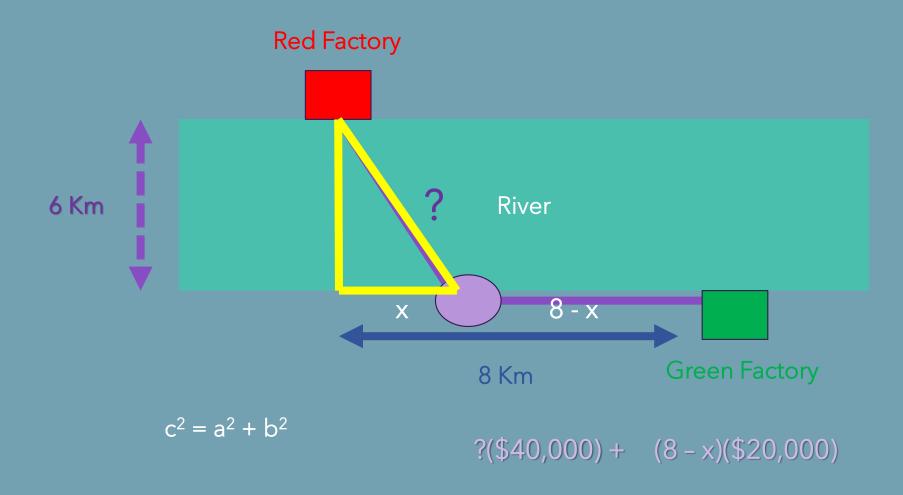
Road cost = 4 Km x \$20,000 = \$80,000Bridge cost = $\sqrt{52} \text{ Km x } \$40,000 = \$288,444.10$ Total = \$240,000 + \$160,000 = \$368,444.10



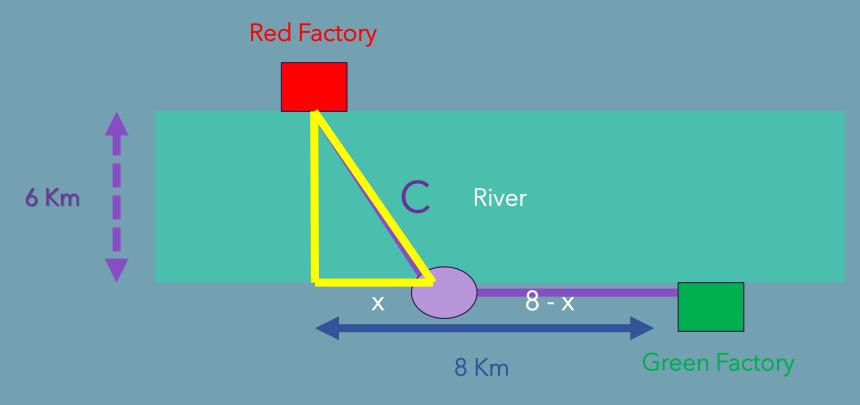


BETTER SOLUTION?

BETTER SOLUTION (RANDOM POINT LOCATION)



BETTER SOLUTION (RANDOM POINT LOCATION)

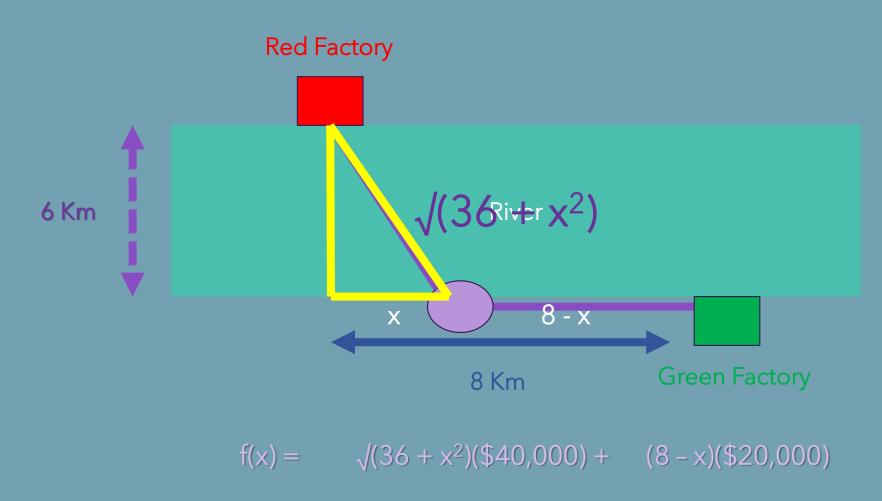


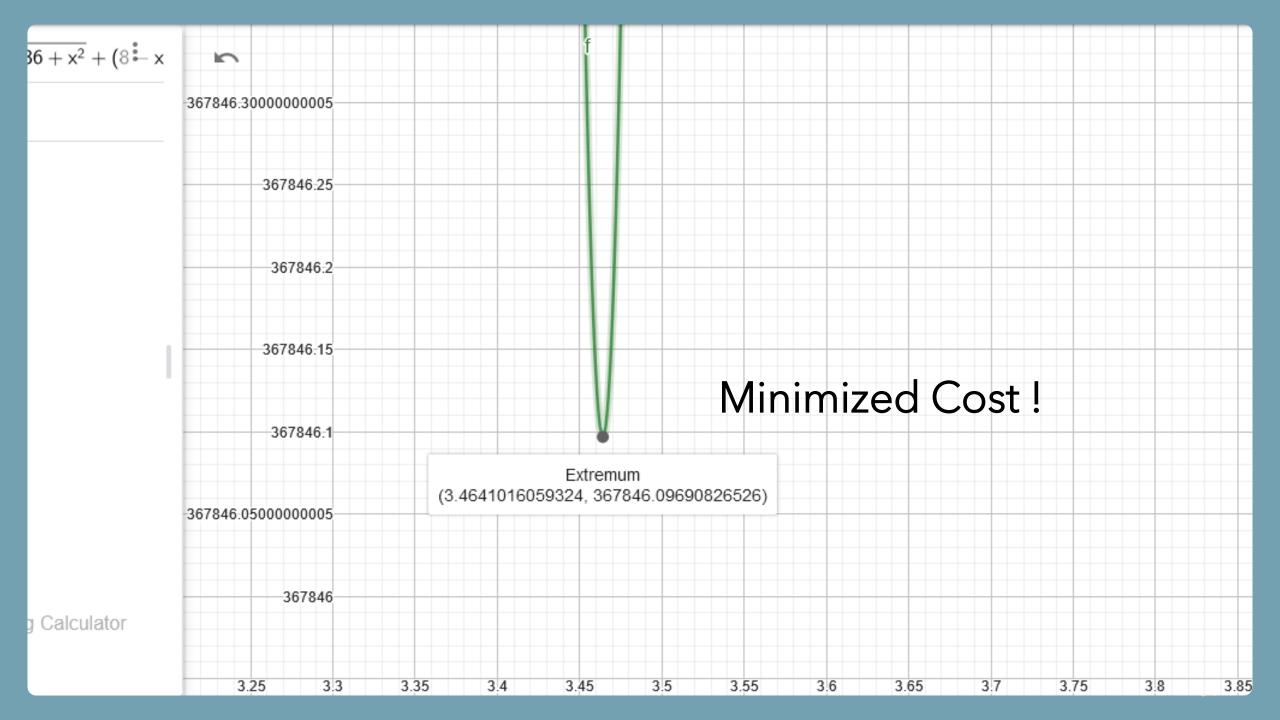
$$c^{2} = a^{2} + b^{2}$$

 $c^{2} = 6^{2} + b^{2}$
 $c^{2} = 6^{2} + x^{2}$
 $c = \sqrt{36 + x^{2}}$

$$c(\$40,000) + (8 - x)(\$20,000)$$

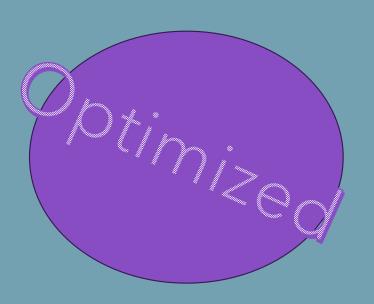
BETTER SOLUTION (RANDOM POINT LOCATION)





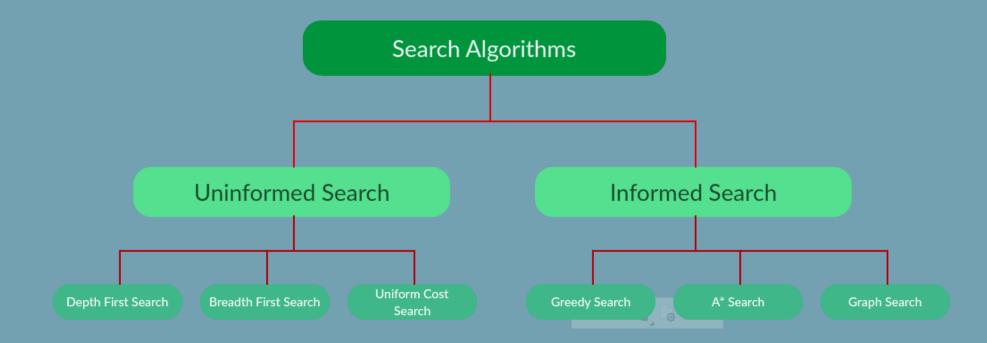


WHEN X = 3.464the total cost = \$367,846.09



"ARTIFICIAL INTELLIGENCE" COURSE

• As mentioned, optimization and searching are two faces of the same coin



Are these only the searching algorithms?

BASED ON TYPE OF THE PROBLEM

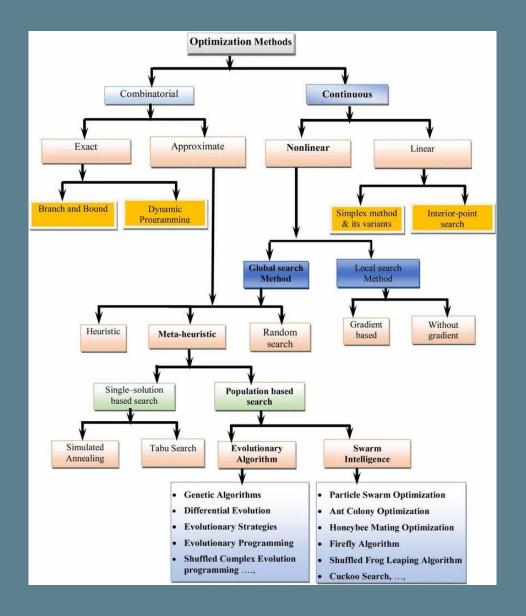
Along our course, we will analyze each problem we are facing through



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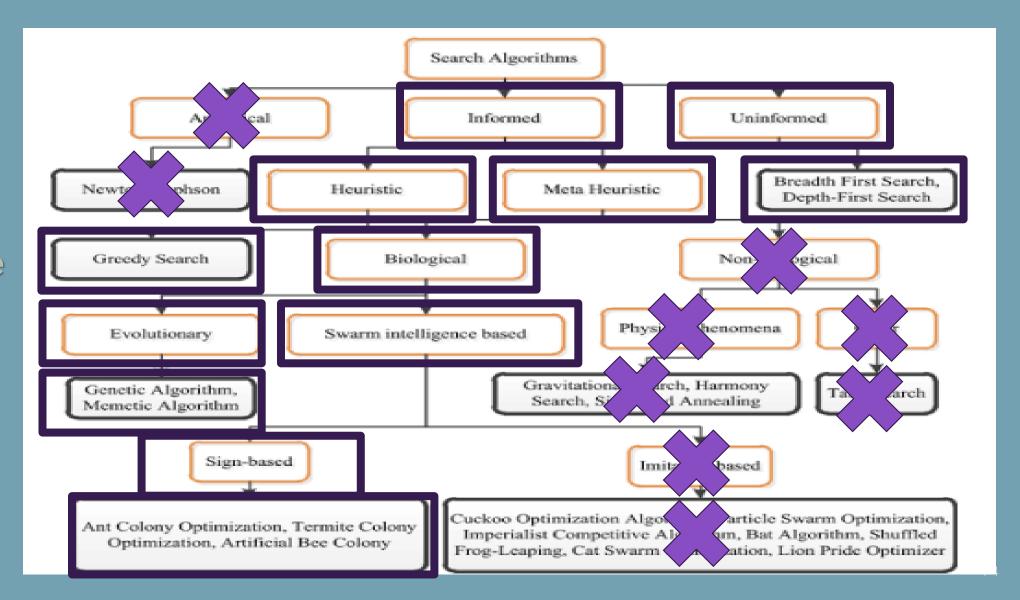
SEARCHING/OPTIMIZATION ALGORITHMS





THE CLASSIFICATION OF SEARCHING ALGORITHMS

This is the target of the course





NEXT LAB:
PYTHON
FUNDAMENTALS

Thank you

