HUST

ĐẠI HỌC BÁCH KHOA HÀ NỘI

HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

ONE LOVE. ONE FUTURE.

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PLANNING OPTIMIZATION

Introduction

ONE LOVE. ONE FUTURE.

INTRODUCTION TO OPTIMIZATION PROBLEMS

- Maximize or minimize some function relative to some set (range of choices)
- The function represents the quality of the choice, indicating which is the “best”
- Example
  - A shipper need to find the shortest route to deliver packages to customers 1, 2, …, N

0	3	1	6
3	0	2	4
1	2	0	5
6	4	5	0

0	3	4	2	5	6	8	7
3	0	3	6	7	2	1	6
4	3	0	4	7	1	1	9
2	6	4	0	2	8	3	4
5	7	7	2	0	6	5	1
6	8	1	8	6	0	9	3
8	1	1	3	5	9	0	2
7	6	9	4	1	3	2	0

INTRODUCTION TO OPTIMIZATION PROBLEMS

- $x \in R^n$: vector of decision variables x_j, for $j = 1, 2, ..., n$
- $f : R^n \rightarrow R$ is the objective function
- $g_i : R^n \rightarrow R$ is the constraint function defining restriction on x, $i = 1, 2, ..., m$

minimize $f(x)$ over $x = (x_1, x_2, ..., x_n) \in X \subset R^n$ satisfying a property P:

$$g_i(x) \leq b_i,\ i = 1, 2, ..., s$$
$$g_i(x) = d_i,\ i = s + 1, 2, ..., m$$

INTRODUCTION TO OPTIMIZATION PROBLEMS

- Example

$$\min f(x) = 3x_1 - 5x_2 + 10x_3$$
$$x_1 + x_2 + x_3 \le 10$$
$$2x_1 + 4x_2 - 5x_3 = 9 \qquad \text{(Linear Program)}$$
$$x_1, x_2 \in R^+, x_3 \in Z$$

$$\min f(x) = 4x_1^2 + 3x_2^2 - 7x_1 x_3$$
$$x_1 + x_2^3 + 4x_3 \le 10$$
$$2x_1^2 + 4x_2 - 5x_3 = 7 \qquad \text{(Nonlinear Program)}$$
$$x_1, x_2 \in R^+, x_3 \in Z$$

INTRODUCTION TO OPTIMIZATION PROBLEMS

- General optimization problems
  - Very difficult to solve
- Some special cases
  - Linear programming
  - Least square problem
  - Some shortest path problems on networks
  - Etc.

INTRODUCTION TO OPTIMIZATION PROBLEMS

- Classification
  - Linear Programming (LP): f and g_i are linear
  - Nonlinear Programming (NLP): some function f, g_i are nonlinear
  - Continuous optimization: f and g_i are continuous on an open set containing X, X is closed and convex
  - Integer Programming (IP): $X \subseteq \{0,1\}^n$ or $X \subseteq Z^n$
  - Constrained optimization: $m > 0$, $X \subset R^n$
  - Unconstrained optimization: $m = 0$, $X = R^n$

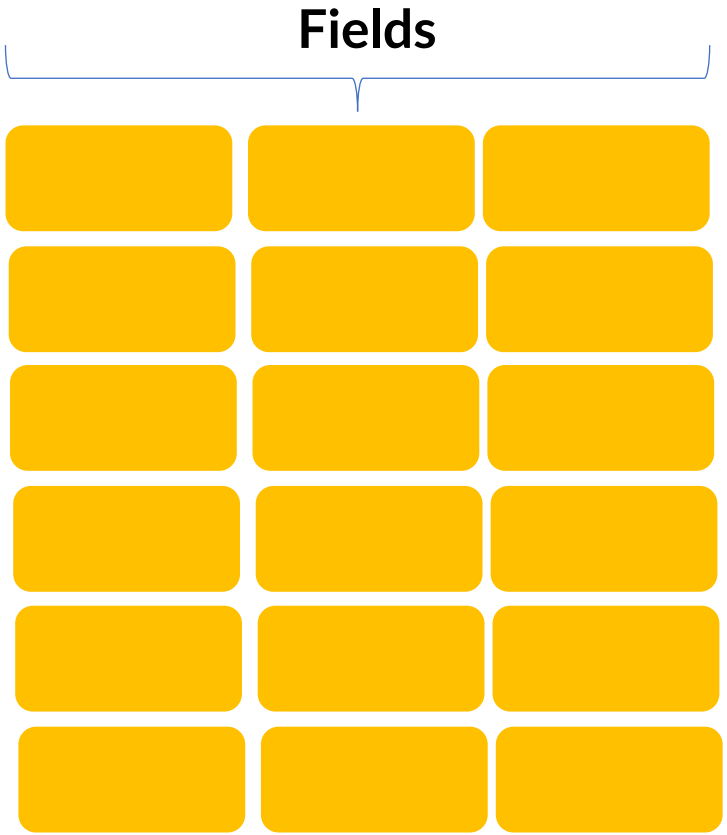
INTRODUCTION TO OPTIMIZATION PROBLEMS

- Applications
  - Production Planning
  - Routing in transportation
  - Scheduling
  - Assignment
  - Packing
  - Time Tabling
  - Network designs
  - Machine learning
  - . . .

INTRODUCTION TO OPTIMIZATION PROBLEMS

- Production Planning

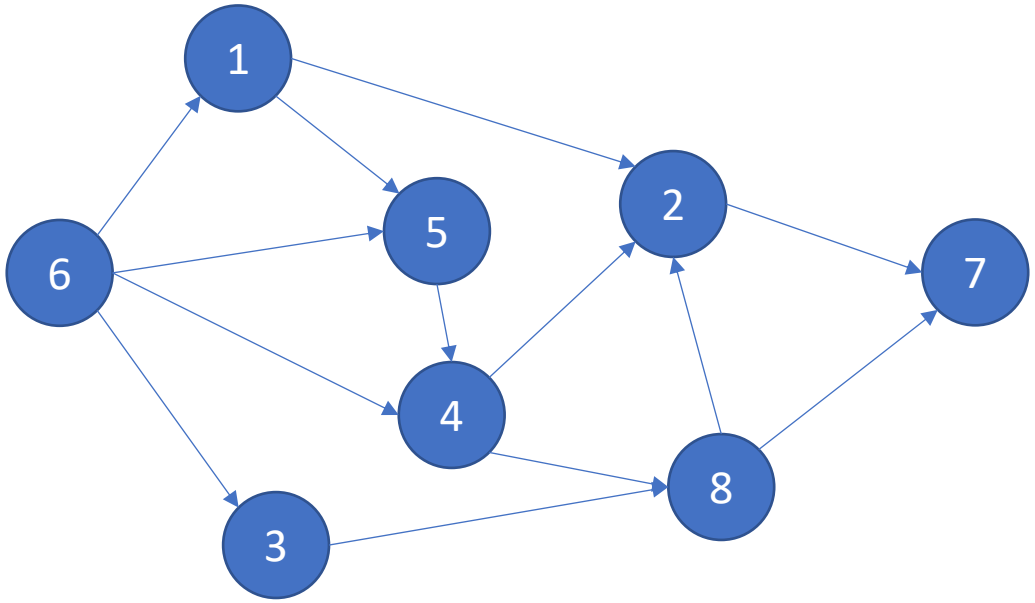
SKU	Chart	Demand
		10000
		25000
		32000
		42500

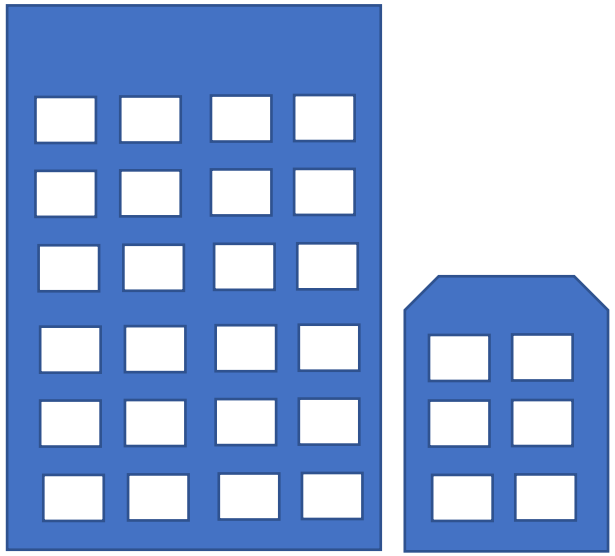


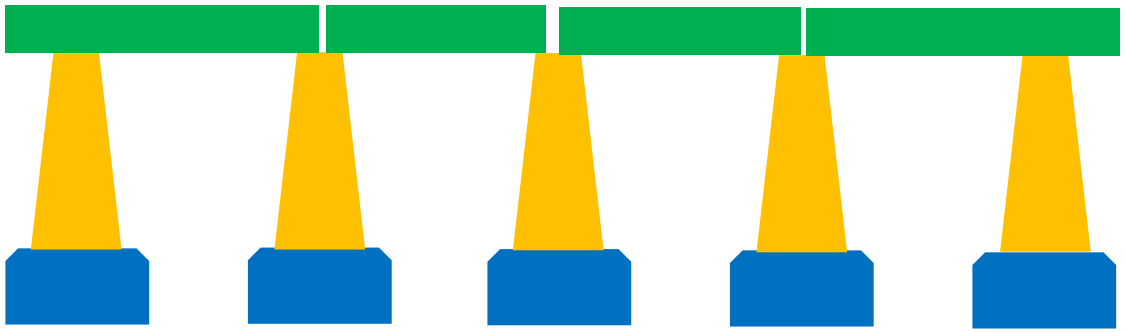
INTRODUCTION TO OPTIMIZATION PROBLEMS

- Construction Planning

Task	Duration	Predecessors
1	30	6
2	20	1,4,8
3	15	6
4	25	5,6
5	20	1,6
6	45	
7	40	2,8
8	30	3,4

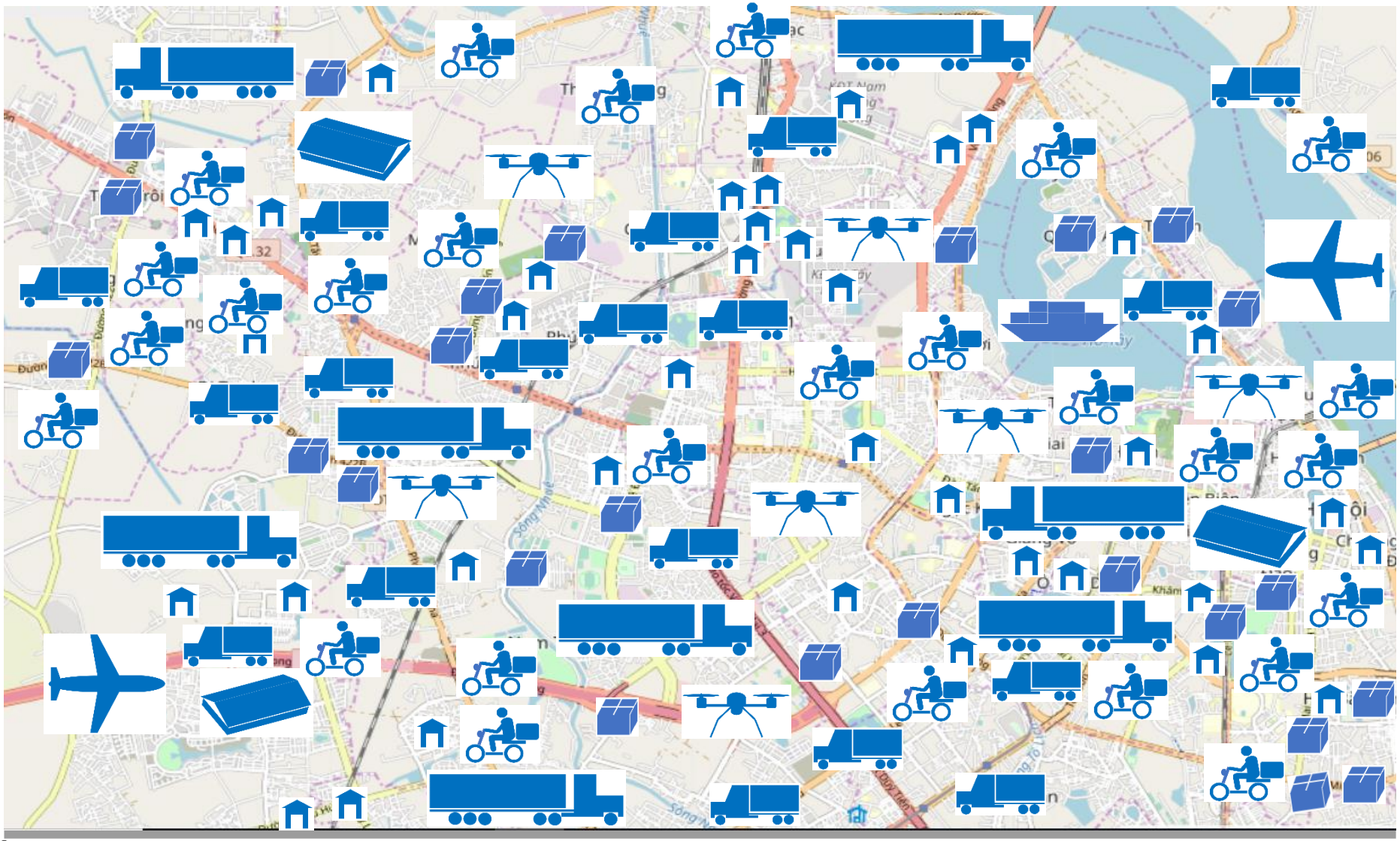






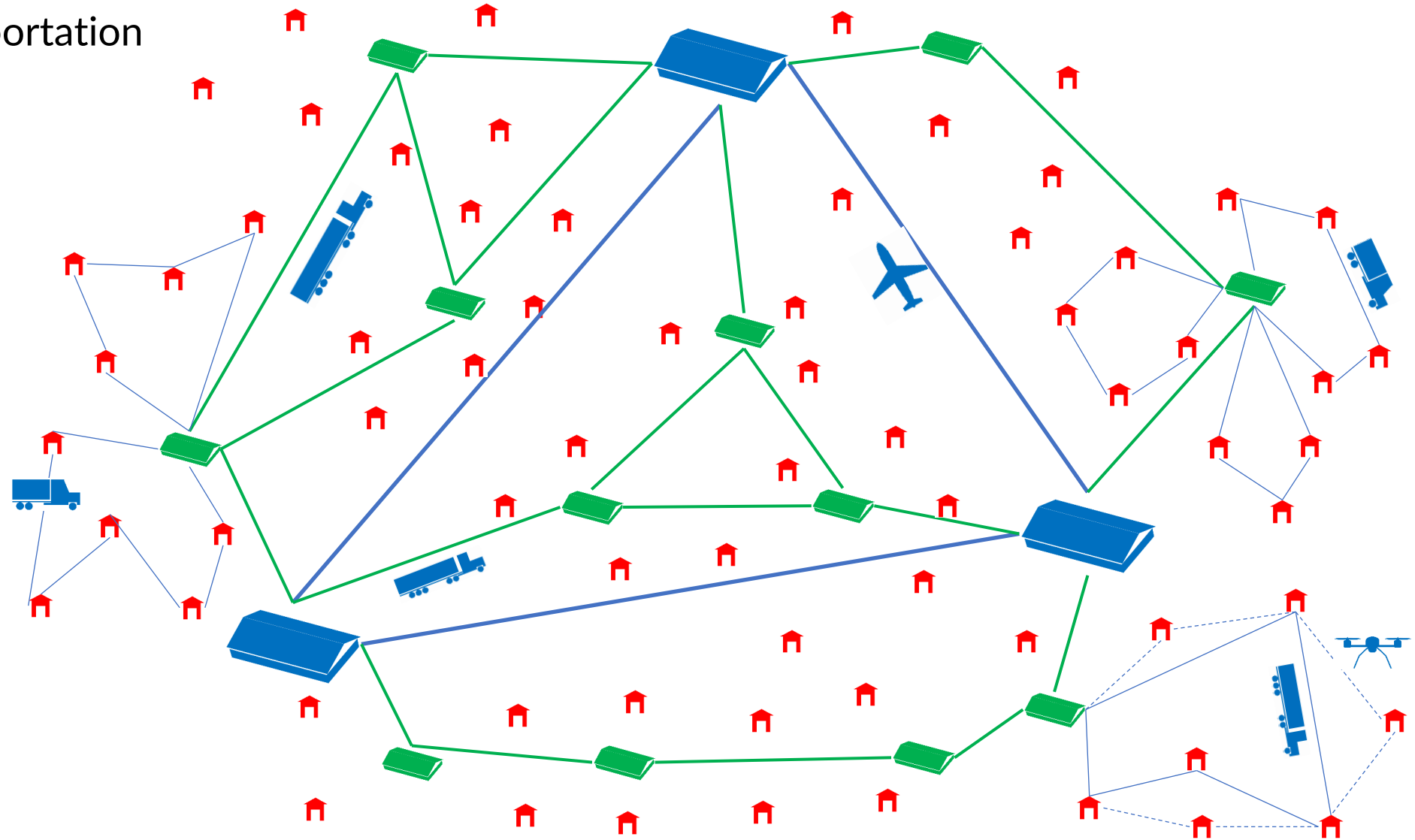
INTRODUCTION TO OPTIMIZATION PROBLEMS

- Routing in transportation & logistics



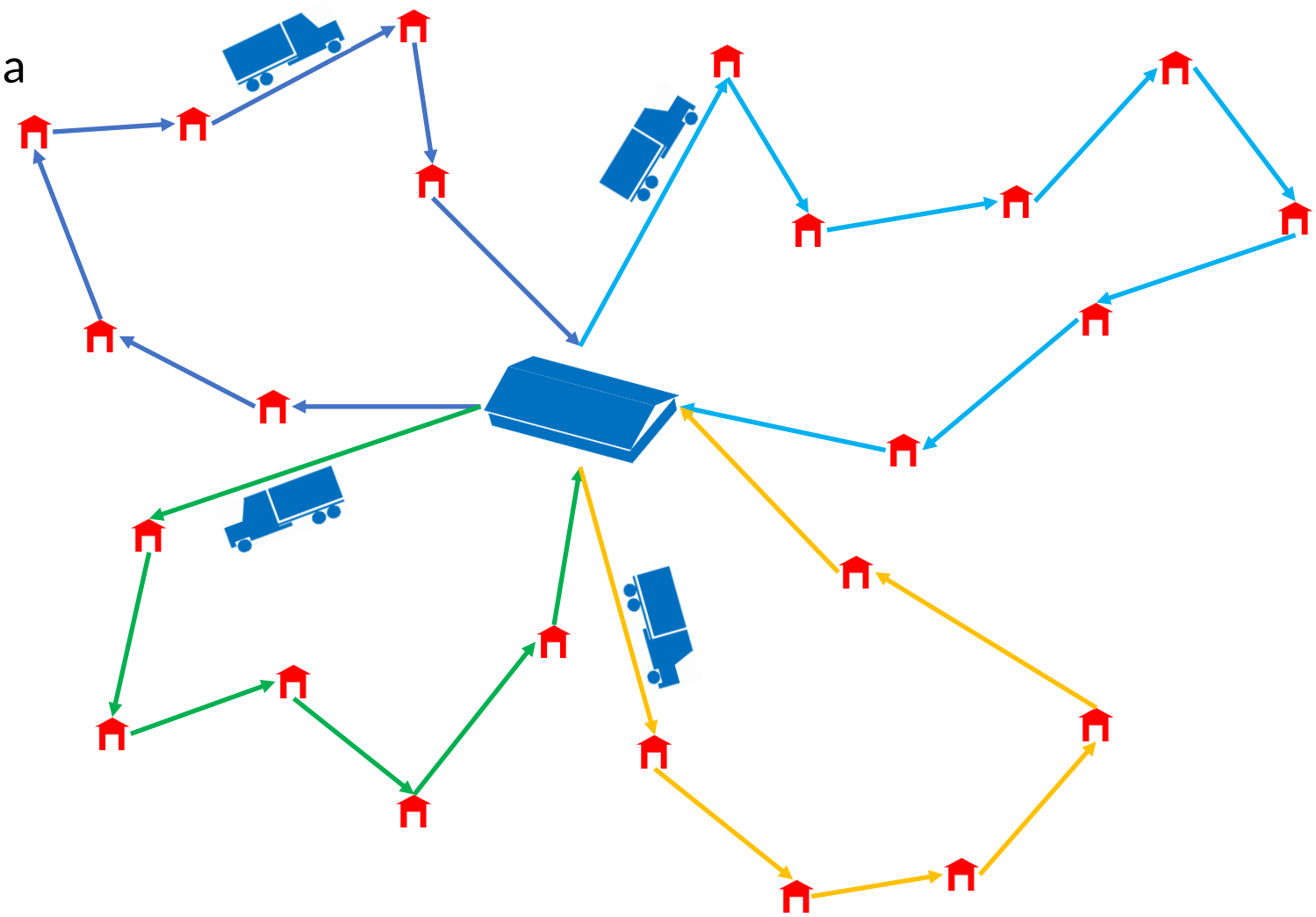
INTRODUCTION TO OPTIMIZATION PROBLEMS

- Routing in transportation & logistics



INTRODUCTION TO OPTIMIZATION PROBLEMS

- Routing in transportation & logistics
  - How to make a route plan for delivering goods to customers from a central depot?



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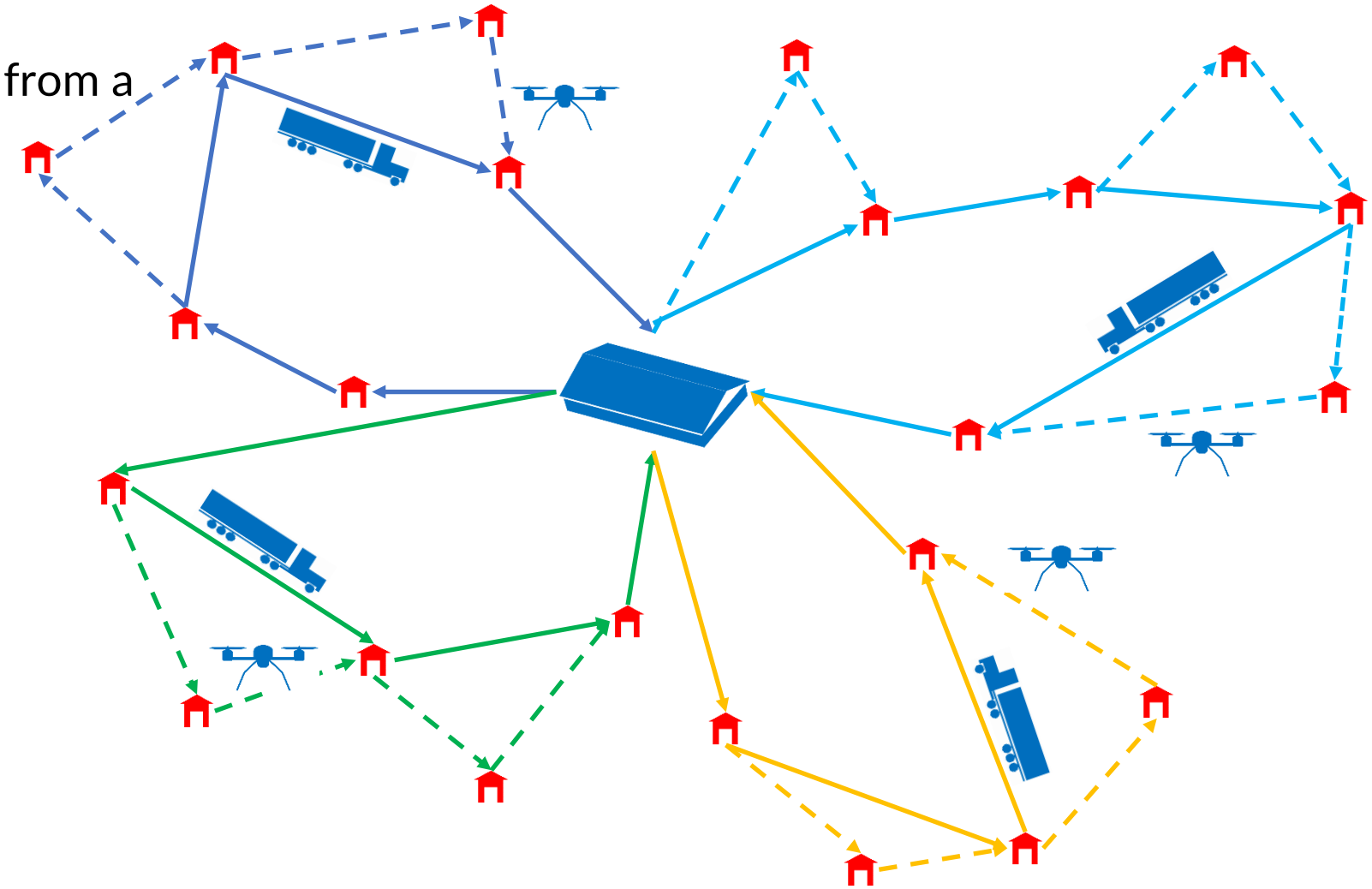
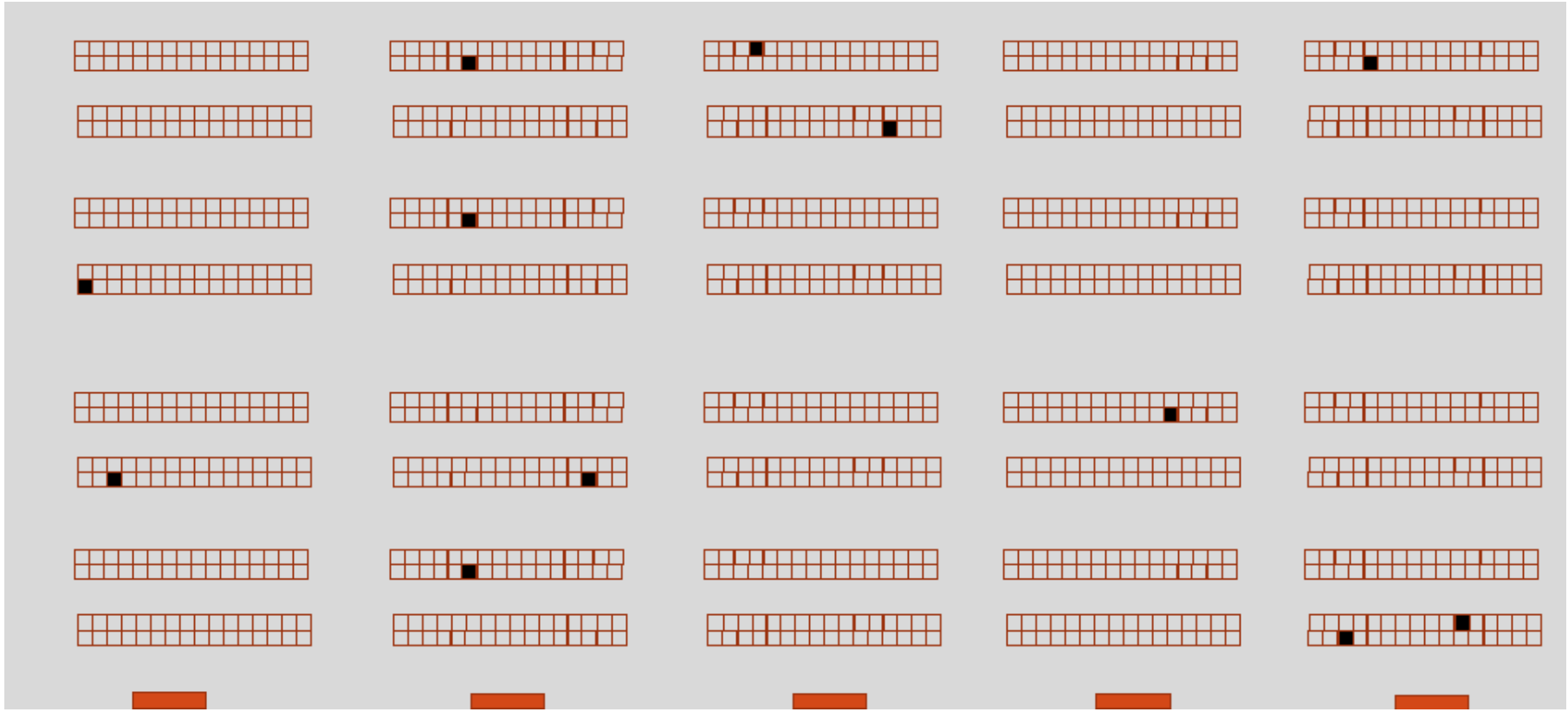


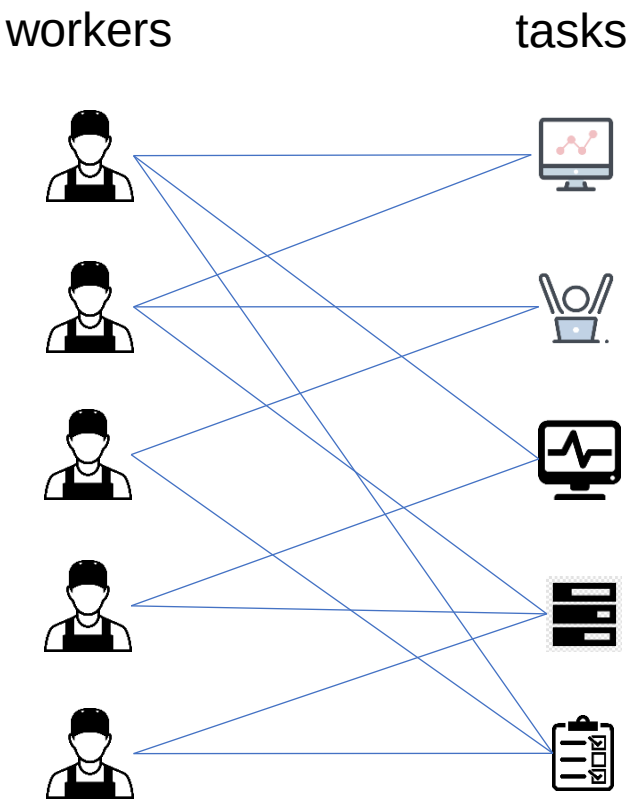
INTRODUCTION TO OPTIMIZATION PROBLEMS

- Routing in transportation & logistics
  - How to make a route plan for picking up items in a very large warehouse?



INTRODUCTION TO OPTIMIZATION PROBLEMS

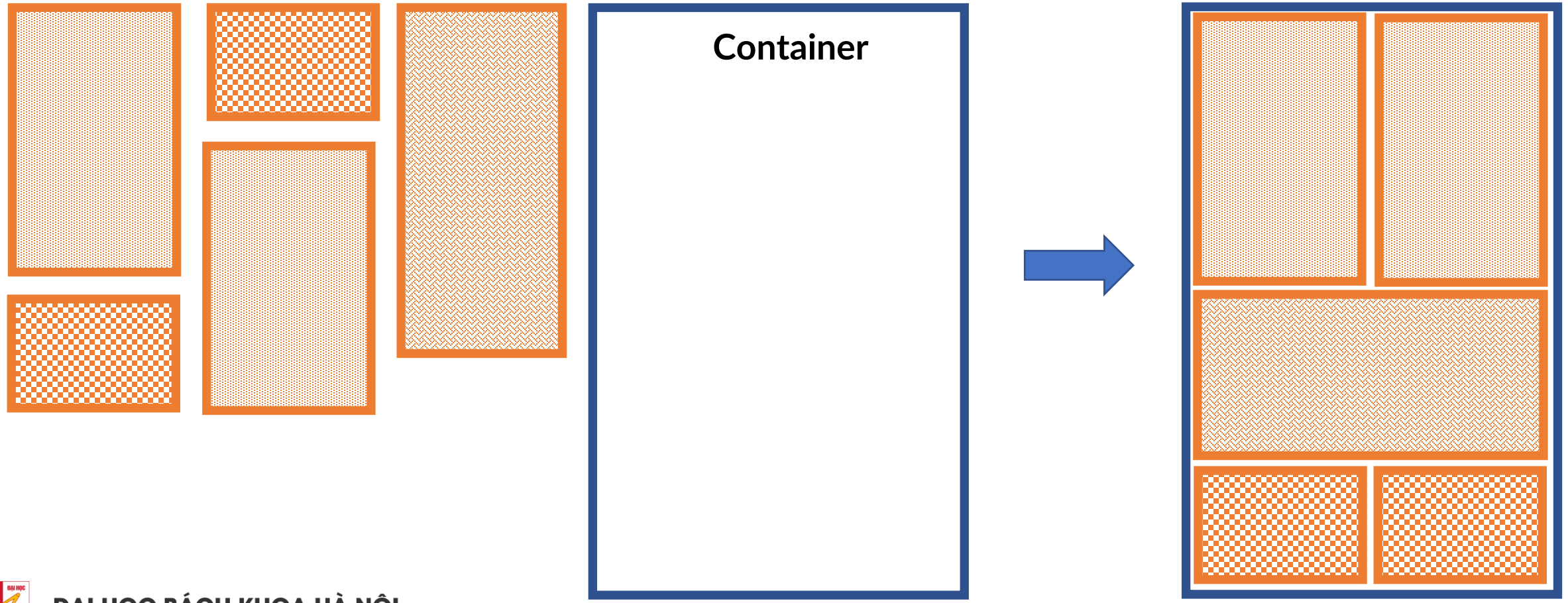
- Assignment
  - How to assign tasks to workers in an optimal way ?



4		6		8
2	6		7	
	5			6
		1	4	
			6	3

INTRODUCTION TO OPTIMIZATION PROBLEMS

- Packing
  - How to arrange items in a container in an optimal ways?



INTRODUCTION TO OPTIMIZATION PROBLEMS

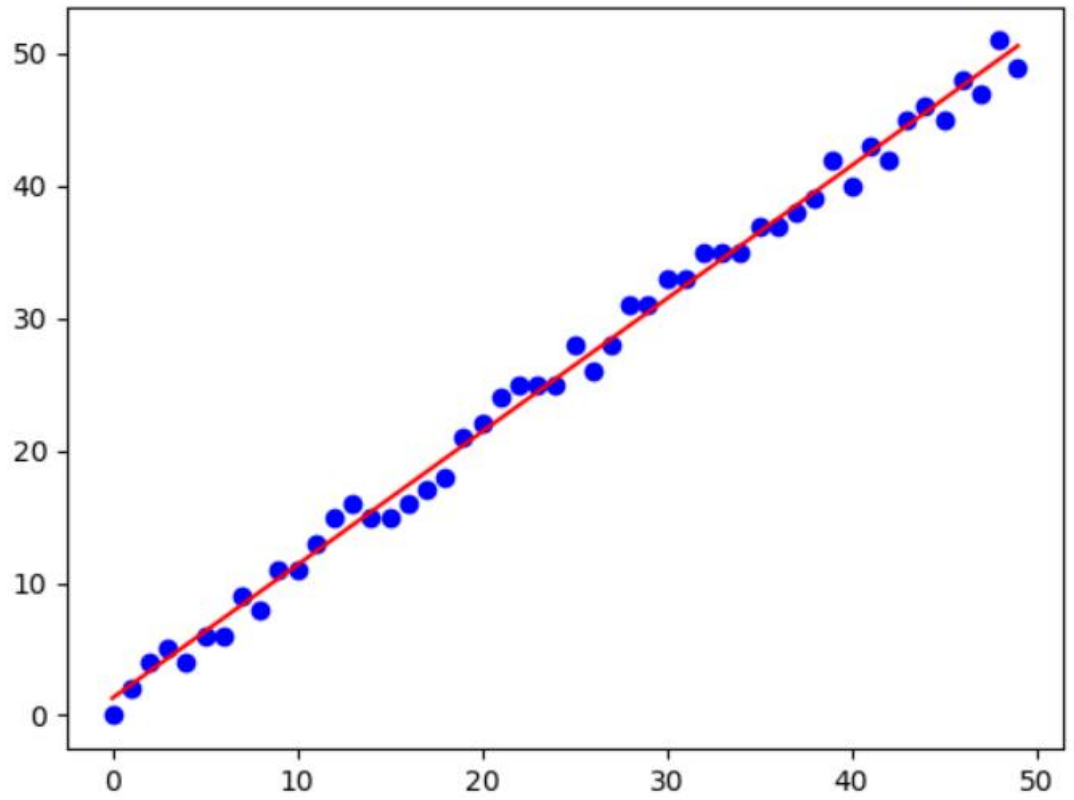
- Time Tabling
  - How to arrange courses into time slots?

Monday	Tuesday	Wednesday	Thursday	Friday
Data structure & Algorithms, TC-305	Python Programming, D9-302	Statistics, B1-203	Technical writing, B1-202	Networkings, B1-404
Fundamental of optimization, B1-402	Machine learning, D6-302		Java advanced, B1-204	Image processing, D6-303
		Software engineering, D5-102	Operating systems, D9-101	

INTRODUCTION TO OPTIMIZATION PROBLEMS

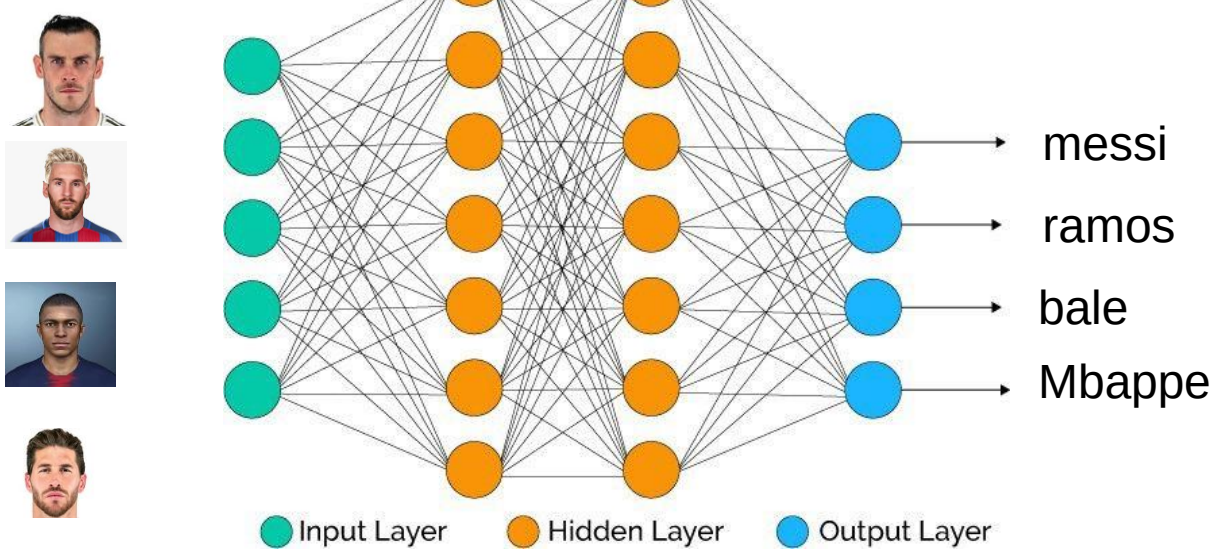
- Machine learning
  - Prediction

X	Y
43	45
44	46
45	45
46	48
47	47
48	51
49	49
50	?



INTRODUCTION TO OPTIMIZATION PROBLEMS

- Machine learning
  - Computer Vision



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THANK YOU !