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Advanced Optimization: Techniques and Industrial Applications

Module 2: Heuristics and Metaheuristics

Universidade do Minho

POLITECHNIKA CZĘSTOCHOWSKA

THAMMASAT UNIVERSITY

Prince of Songkla University

ASIAN INSTITUTE OF TECHNOLOGY 1959

POLITEHNICA UNIVERSITATEA DIN BUCUREȘTI 1818

Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

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Session 2.1:

Concept of Heuristics and Metaheuristics

Universidade do Minho

Curriculum Development
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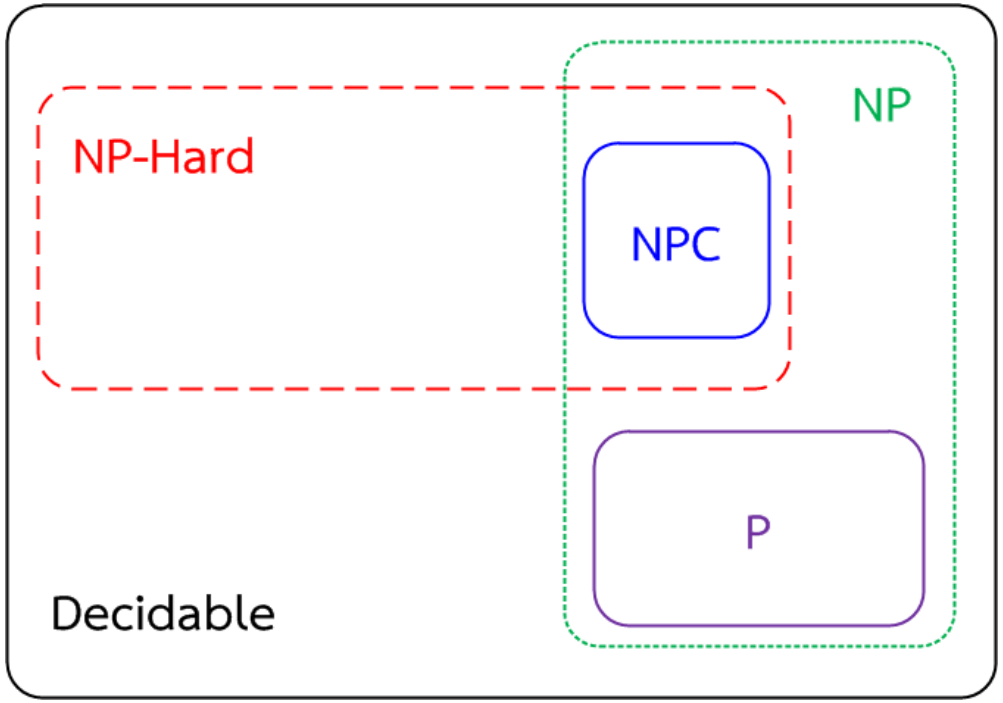
Industrial Engineering for Thailand Sustainable Smart Industry

Introduction

Combinatorial optimization problem: COP



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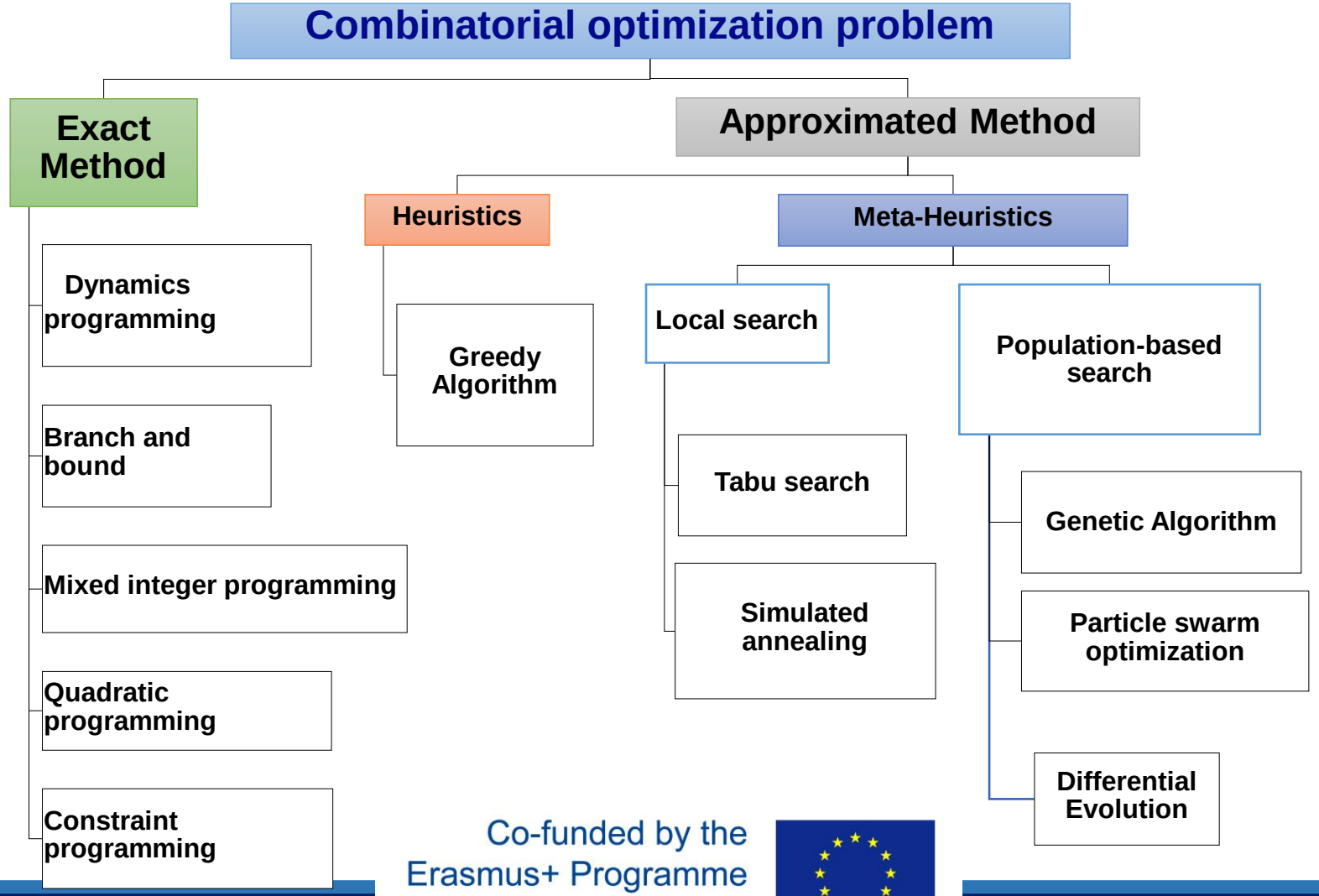
Approaches for discrete combinatorial optimization problem



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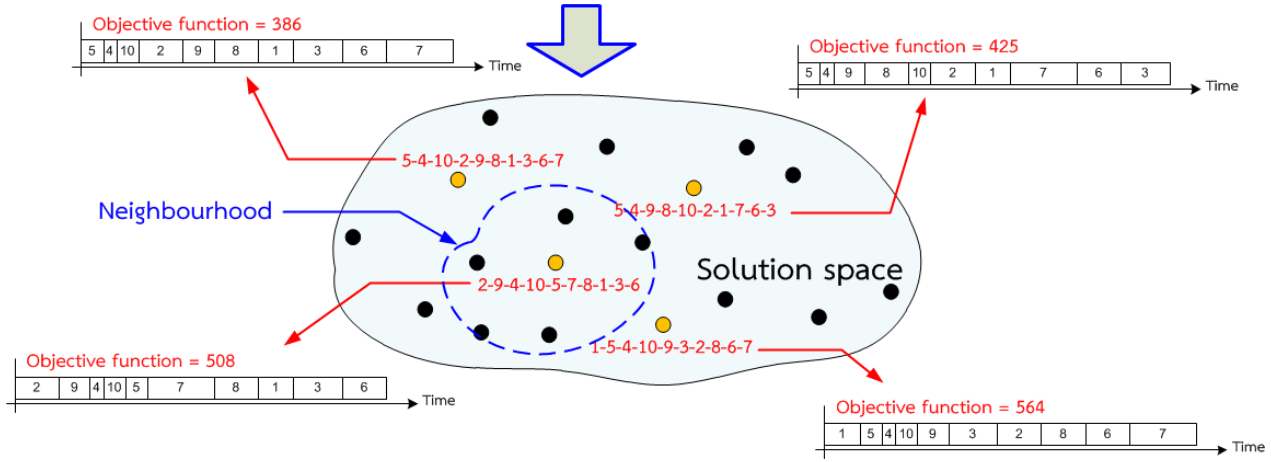
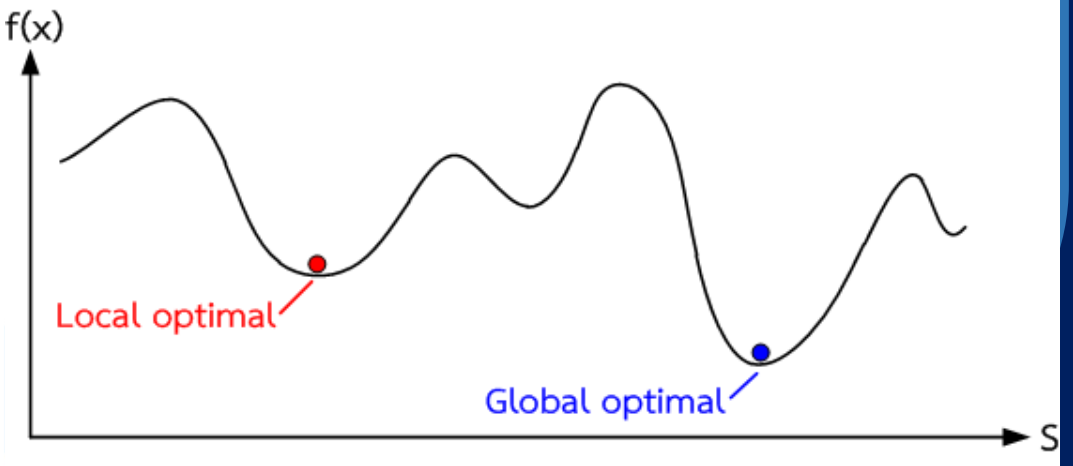
Solution space of discrete combinatorial optimization problem

Single Machine Scheduling Problem

Job	1	2	3	4	5	6	7	8	9	10
p_j	8	10	11	3	5	10	15	10	7	5
d_j	18	5	27	10	2	30	40	21	12	35
w_j	2	4	2	5	3	1	3	4	3	5



Optimal solution ?



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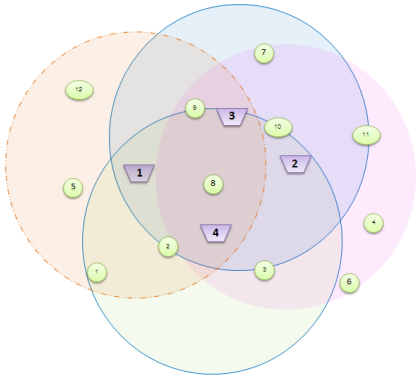
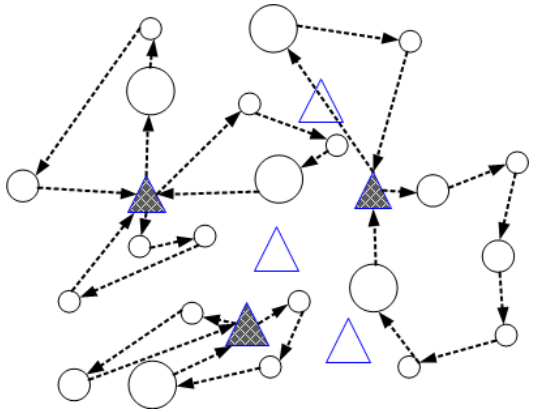
Solution space of discrete combinatorial optimization problem

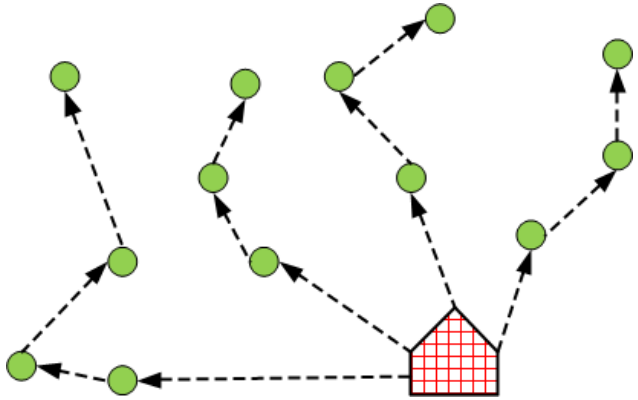
Location & allocation problem: LAP



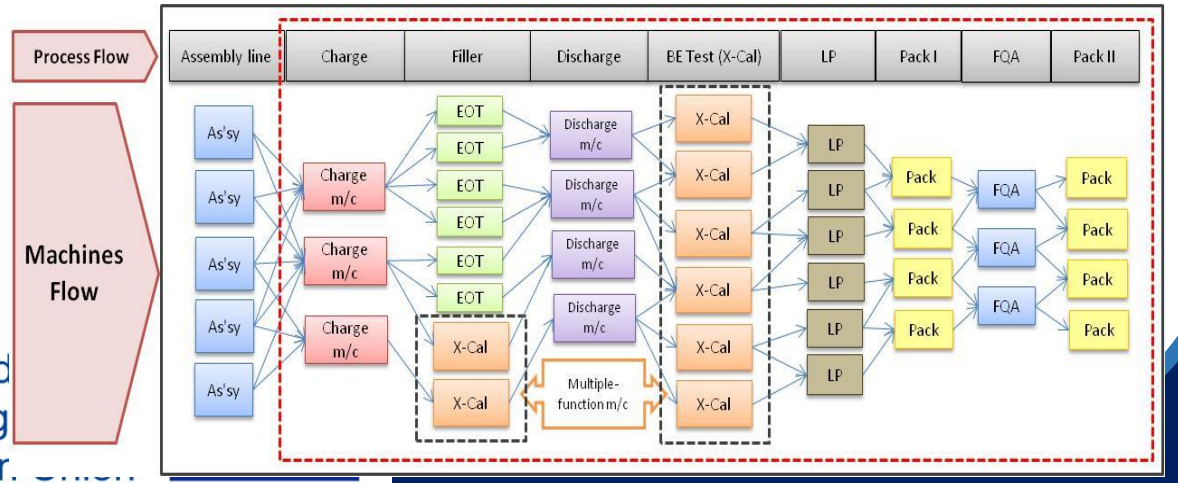
Location and routing problem: LRP



Vehicle routing problem: VRP



Production planning and scheduling



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Heuristic approach

A heuristic technique, often called simply a heuristic, is any approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals. Where finding an optimal solution is impossible or impractical, heuristic methods can be used to speed up the process of finding a satisfactory solution. Heuristics can be mental shortcuts that ease the cognitive load of making a decision.

Example: Artificial Intelligence (AI), Shortest Path Algorithms, Language recognition etc.

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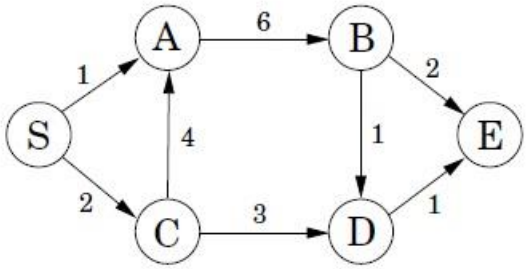
Heuristic approach

Artificial Intelligence (AI)

E.g. When a computer algorithm plays a game of Chess (e.g. Deep Blue) or a game of Go (e.g. AlphaGo), the computer cannot investigate every single move that can be played. Instead it will apply a few rules of thumb to quickly discard some moves while focusing on key moves that are more likely to lead to a victory.



Shortest Path Algorithms

Short Path Algorithms used by GPS systems and self-driving cars also use a heuristic approach to decide on the best route to go from A to Z. This is for instance the case for the A* Search algorithm which takes into consideration the distance as the crow flies between two nodes to decide which paths to explore first and hence more effectively find the shortest path between two nodes.

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Heuristic approach

Advantage	Disadvantage

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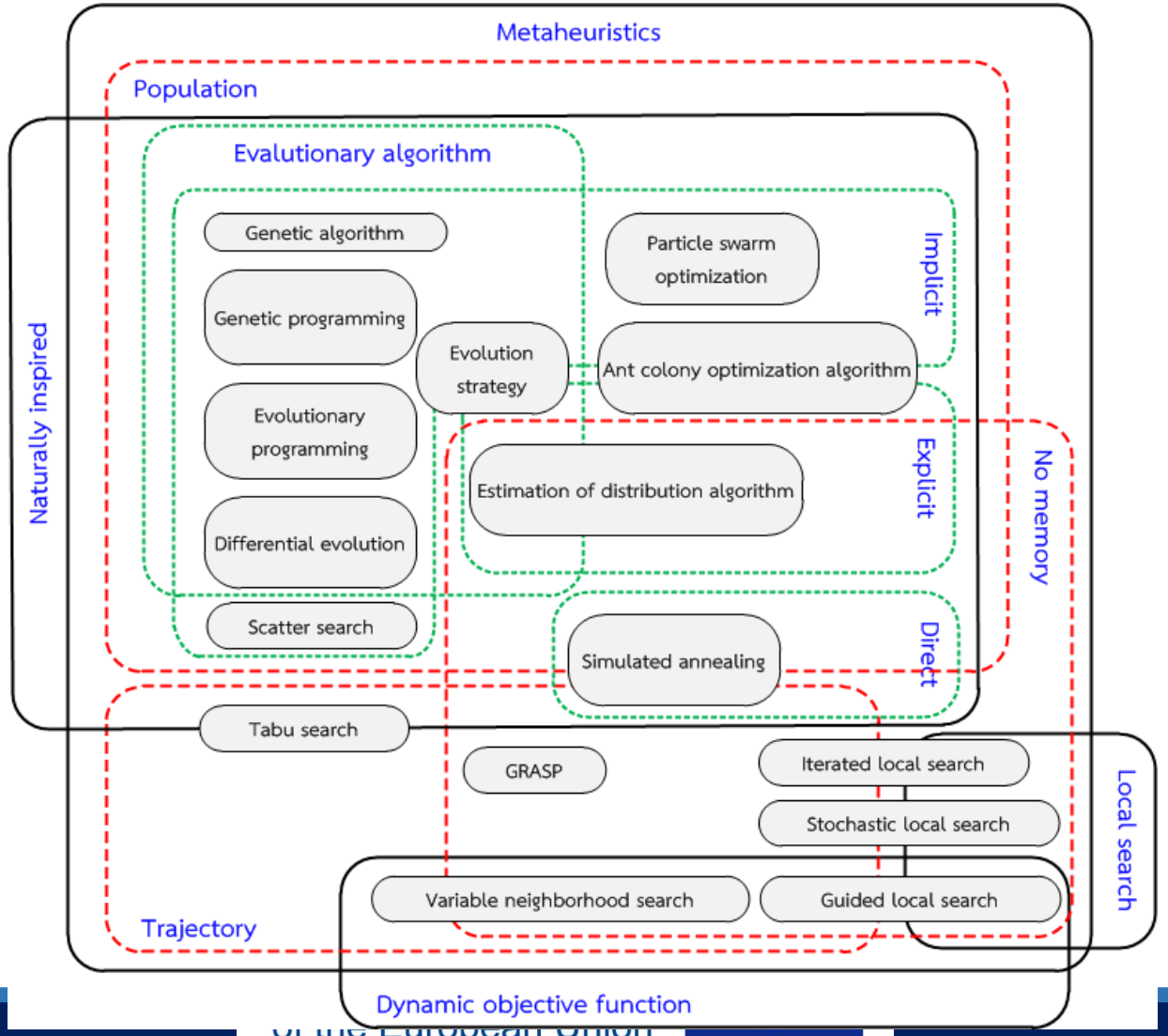
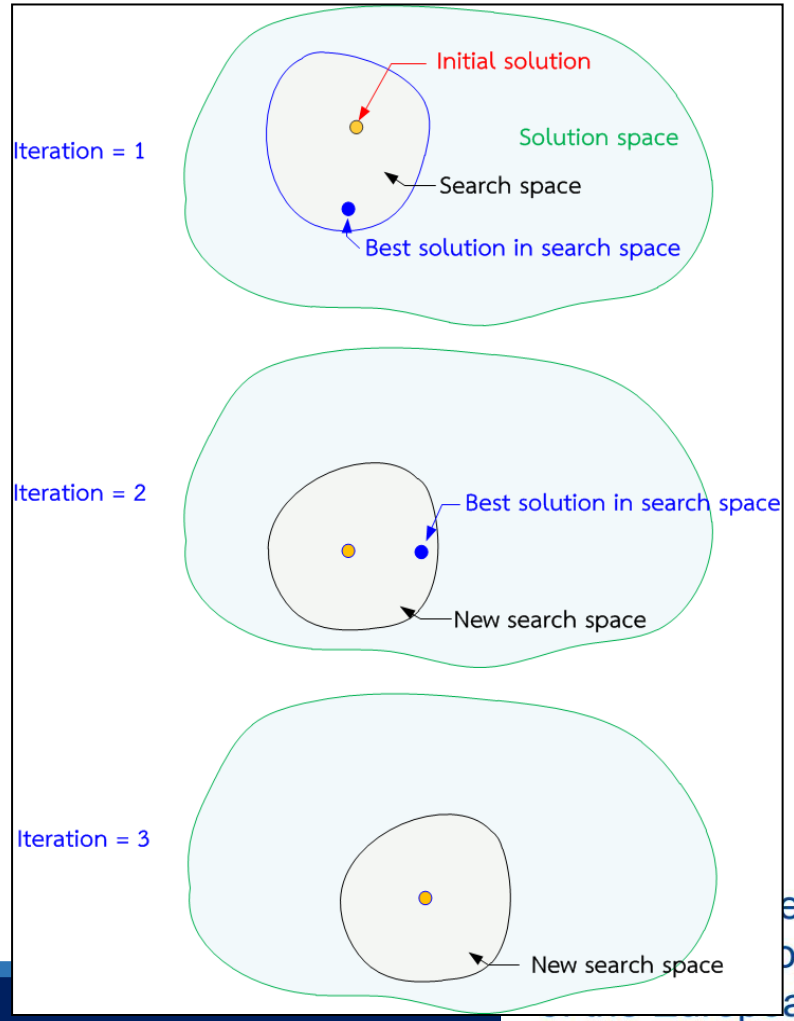
Metaheuristic approach



Metaheuristic approach

Local search



Population-based search