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Hyper-Heuristic Algorithm

超启发式算法

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Outline

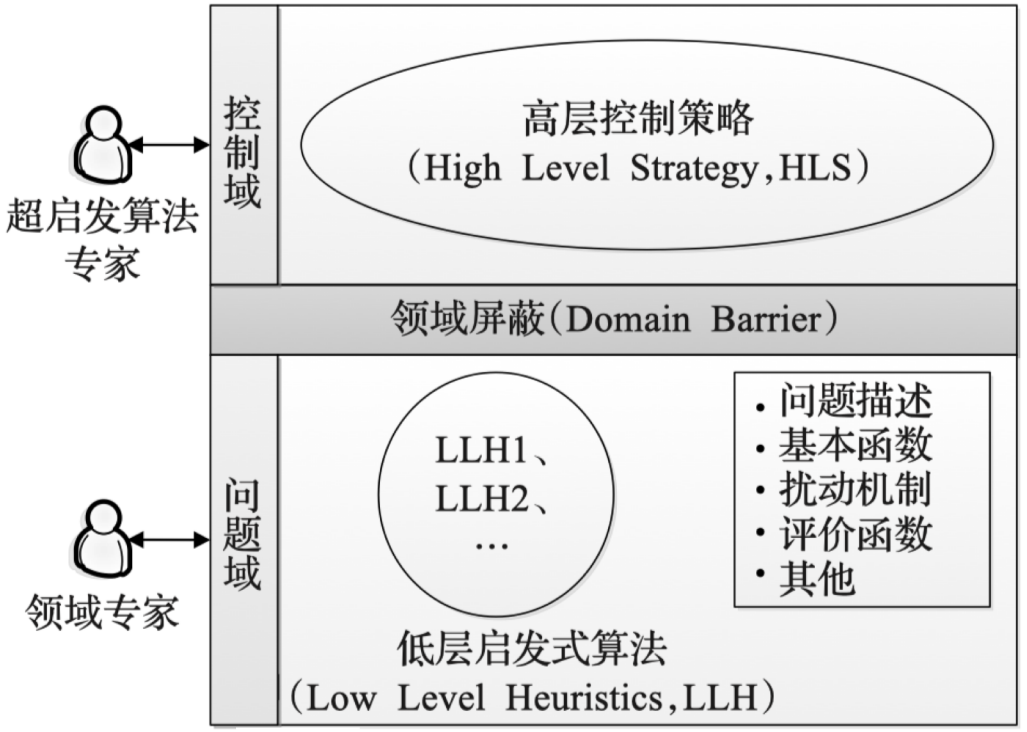
- Introduction
- Classifications of Hyper-Heuristic Algorithms
- Heuristic Selection Methodologies
- Heuristic Generation Methodologies

Introduction

- Exact Algorithm
- Heuristic Algorithm
- Meta-Heuristic Algorithm
- **Hyper-Heuristic Algorithm**
  - Definition: The hyper-heuristic algorithm provides a high-level heuristic method for solving various combinatorial optimization problems by managing or manipulating a series of low-level heuristic(LLH) algorithms.

Introduction

- **Hyper-Heuristic Algorithm**
  1. Control Domain: HLS
  2. Problem Domain: Problem Definition, Basic Function, Evaluation Function, LLH



超启发算法逻辑结构

Introduction

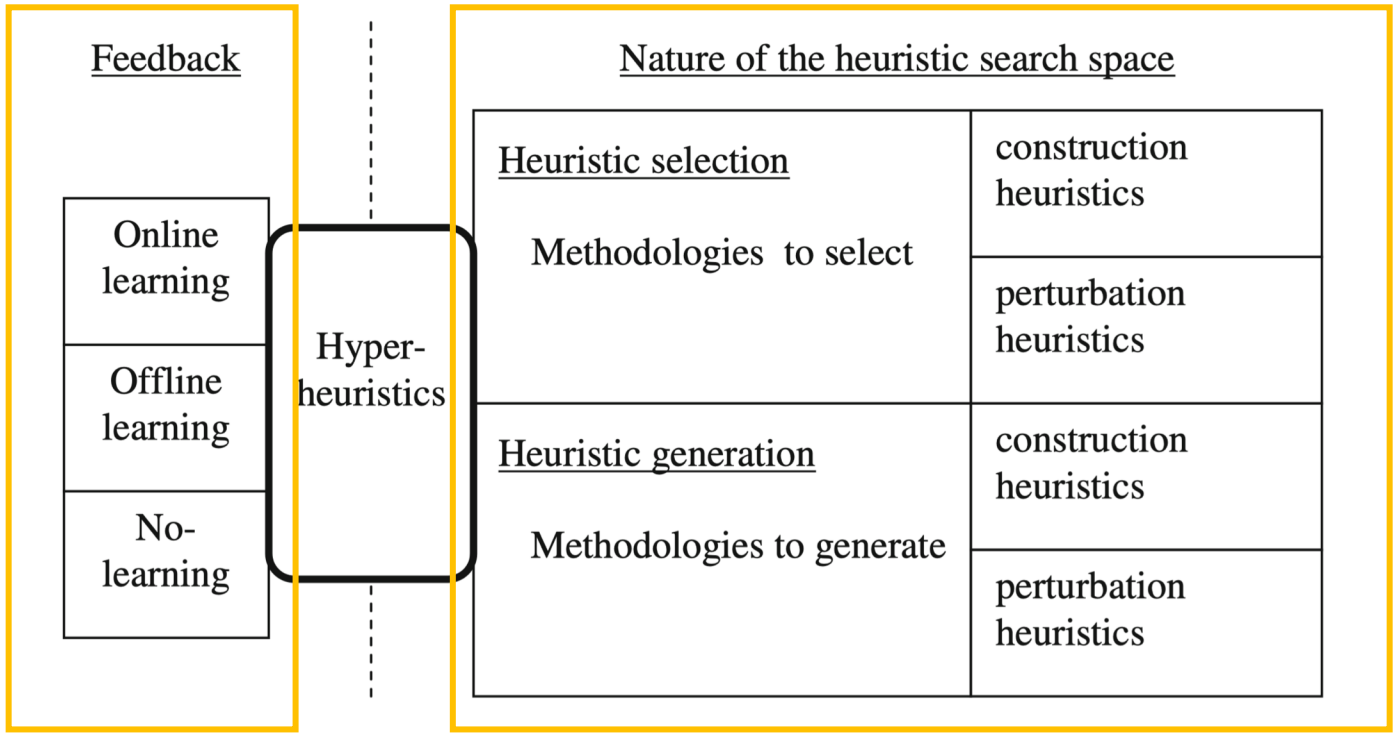
- **Hyper-Heuristics vs. Heuristics**

超启发算法与传统启发式算法异同

	传统启发式算法	超启发算法
搜索空间	问题解空间	低层启发式算法集合
专业知识	设计人员需要同时具备智能计算知识和问题领域知识	控制域设计人员较少或不需要具备问题领域知识
通用性	面对新问题，一般需要重新设计	高层控制策略可以应用于不同的问题领域

Classifications of Hyper-Heuristic Algorithms

- **Classification:**
  - A classification of hyper-heuristic approaches, according to two dimensions:
    - The nature of the heuristic search space.
    - The source of feedback during learning.



Classifications of Hyper-Heuristic Algorithms

- With respect to the source of feedback during learning:
  - **Online learning hyper-heuristics:** Learn whilst solving a given instance of a problem.
  - **Offline learning hyper-heuristics:** Learn, from a set of training instances, a method that would generalise to unseen instances.
  - **No-learning hyper-heuristics:** Do not use feedback from the search process.

Classifications of Hyper-Heuristic Algorithms

- With respect to the nature of the heuristic search space:
  - **Heuristic selection methodologies**: Produce combinations of pre-existing
    – Construction heuristics
    – Perturbation heuristics
  - **Heuristic generation methodologies:** Generate new heuristic methods using basic components (building blocks) of
    – Construction heuristics
    – Perturbation heuristics

Heuristic Selection Methodologies

- **Approaches Based on Construction Low-Level Heuristics**

  - Starting with an empty solution, the goal is to intelligently select and use construction heuristics to gradually build a complete solution.

  - Provided with a set of preexisting (generally problem specific) construction heuristics and the challenge is to select the heuristic that is somehow the most suitable for the current problem state.

  - This process continues until the final state is obtained.

Heuristic Selection Methodologies

- **Approaches Based on Perturbation Low-Level Heuristics**

  - Start with a complete solution, generated either randomly or using simple construction heuristics, and thereafter try to iteratively improve the current solution.

  - Provided with a set of neighborhood structures and/or simple local searchers and the goal is to iteratively select and apply them to the current complete solution.

  - This process continues until a stopping condition has been met.

Heuristic Generation Methodologies

- **Heuristic Generation Methodologies**

  - These approaches uses existing components to generate a new heuristic algorithm instead of a pre-defined completed heuristic algorithm.

  - Many of the approaches in the literature to generate heuristics use genetic programming.

  - The principle is to express some rules as a tree structure or a string with crossover and mutation functions, and then use these rules and heuristic algorithm components to generate a new heuristic algorithm to solve.

Thank You !