

OBJECTIVE: The present study investigates the effect of heuristic sets on the performance of several selection hyper-heuristics.

METHODOLOGY: To achieve this, a number of heuristic sets was generated for the patient admission scheduling problem by setting the parameters of a set of parametric heuristics with specific values.

RESULT: The experimental results indicated that different hyper-heuristics perform superiorly on distinct heuristic sets.

Selection Hyper-heuristics

Selection hyper-heuristics have been studied to effectively manage multiple algorithms, with the motivation behind their employment being to use the heuristics' strengths and eliminating their weaknesses, resulting in a better performance.

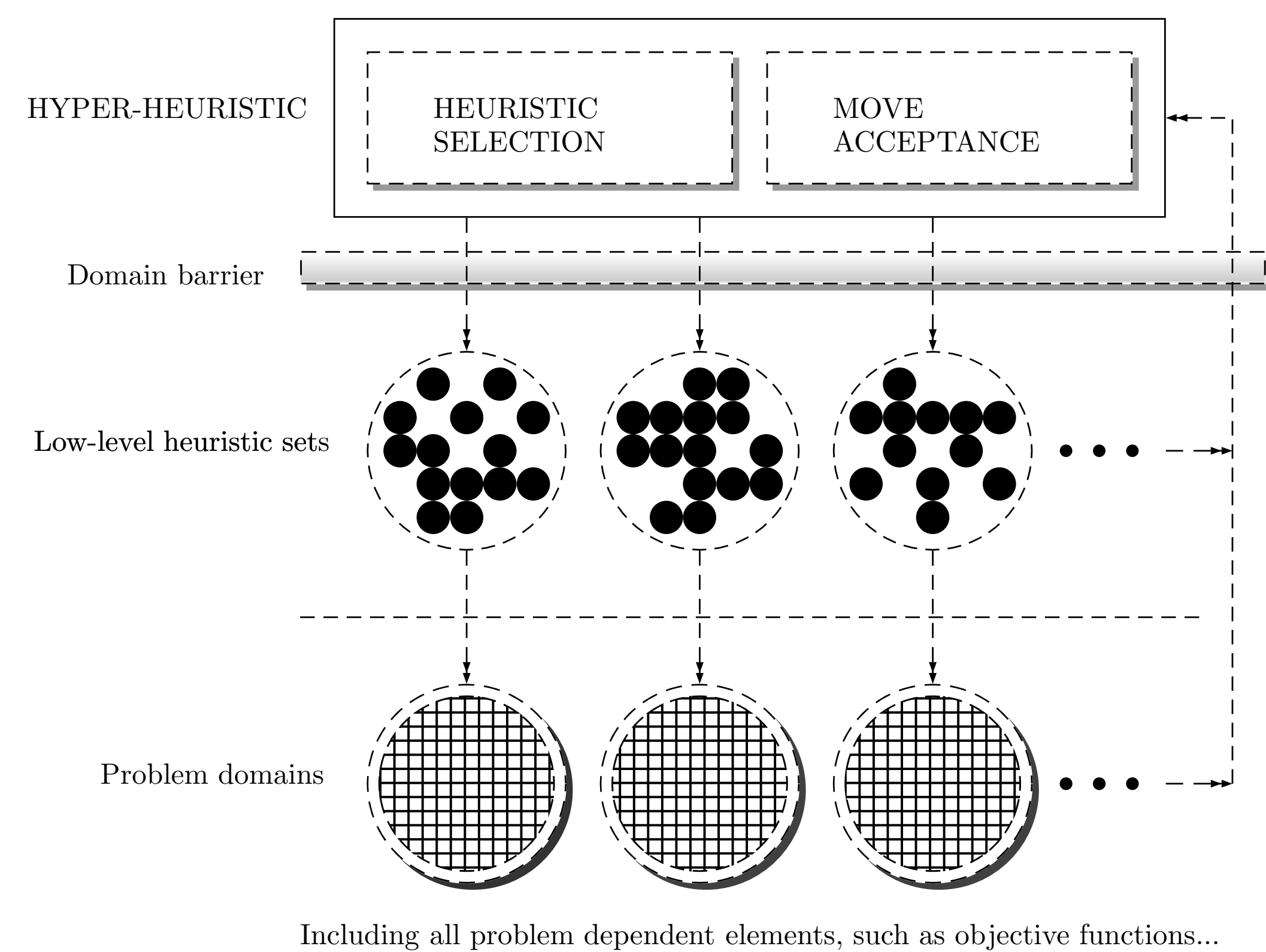


Figure: The traditional selection hyper-heuristic framework

Heuristic Sets

Nine heuristic sets under three group headings were derived based on the 11 parametric heuristics depicted in Table.

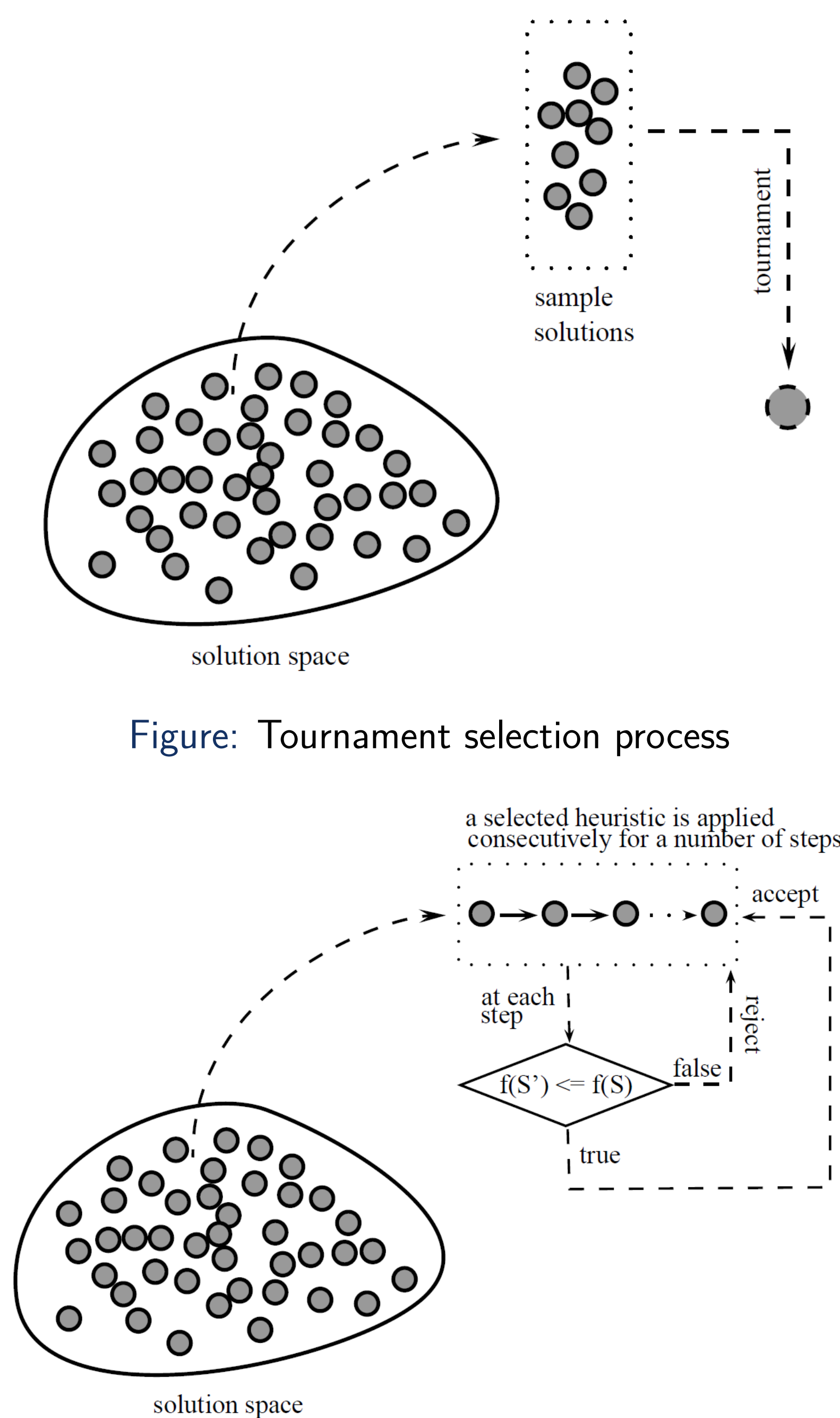


Figure: Tournament selection process

Figure: Hillclimbing process

Table: Heuristic sets used for the experiments

	Set size	Sampl. factor	Selection type
HS_1	11	4	BEST
HS_2	11	4	FIRST_IMPROVING
HS_3	11	4	HILL_CLIMBER
HS_4	22	4, 1000	BEST
HS_5	22	4, 1000	FIRST_IMPROVING
HS_6	22	4, 1000	HILL_CLIMBER
HS_7	44	1,4,8,16	BEST
HS_8	44	1,4,8,16	FIRST_IMPROVING
HS_9	44	1,4,8,16	HILL_CLIMBER

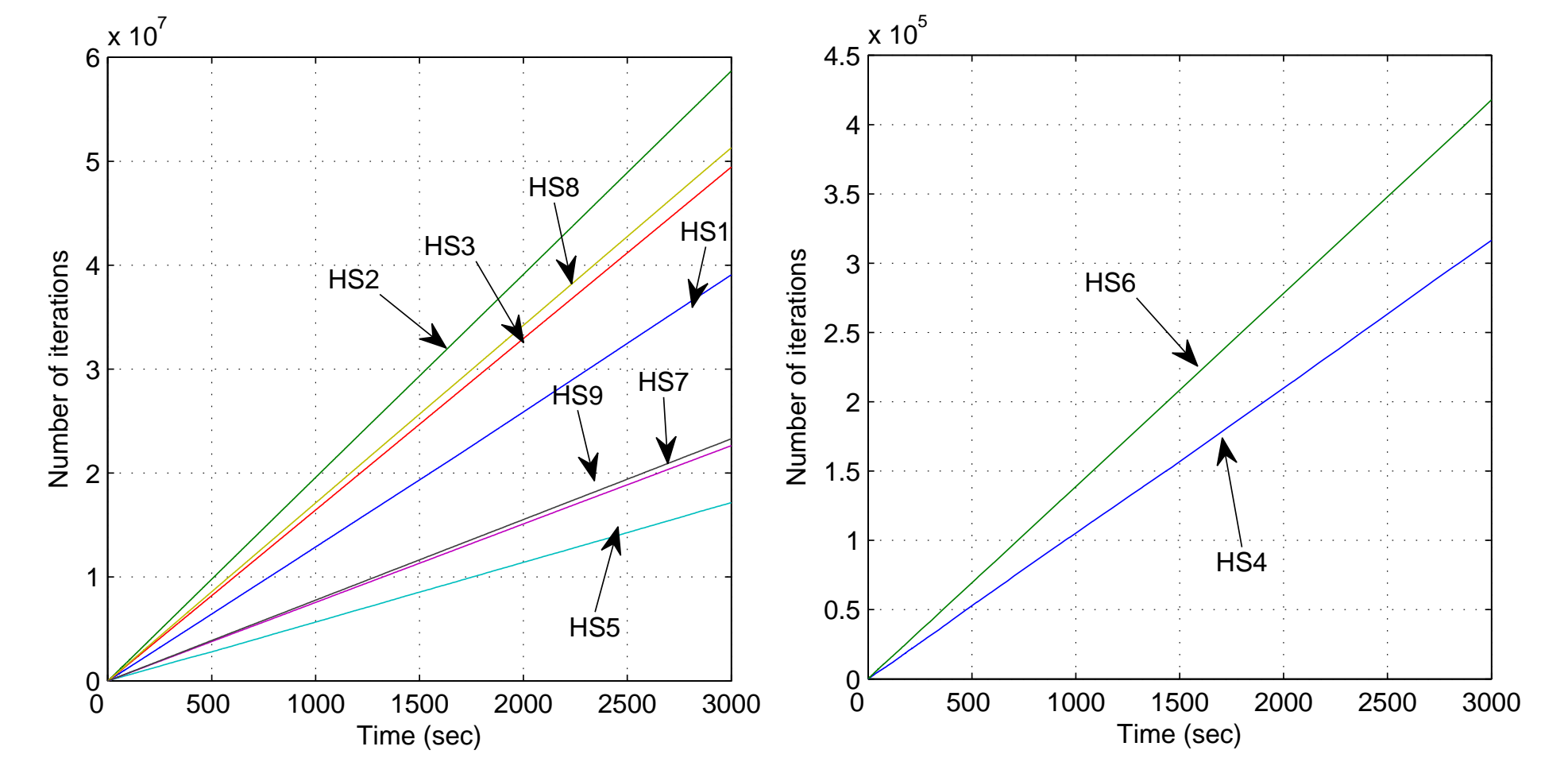


Figure: Number of iterations spent over time when heuristics are randomly selected

Computational Results

14 Hyper-heuristics

- Heuristic selection: ADHS, SR
- Move acceptance: AILLA, GD, SA, LATE, IE, OI, AM

For 10 minute experiments, AILLA and LATE usually perform better, yet there is no general statistically significant performance difference. For 50 minute experiments, the hyper-heuristics with GD perform best together with different hyper-heuristics on different heuristic sets. This can be considered an effect of the execution time limit increase, from 10 minutes to 50 minutes.

The fast heuristics with well balanced intensification-diversification behaviour resulted in better performance on the tested problem instances.

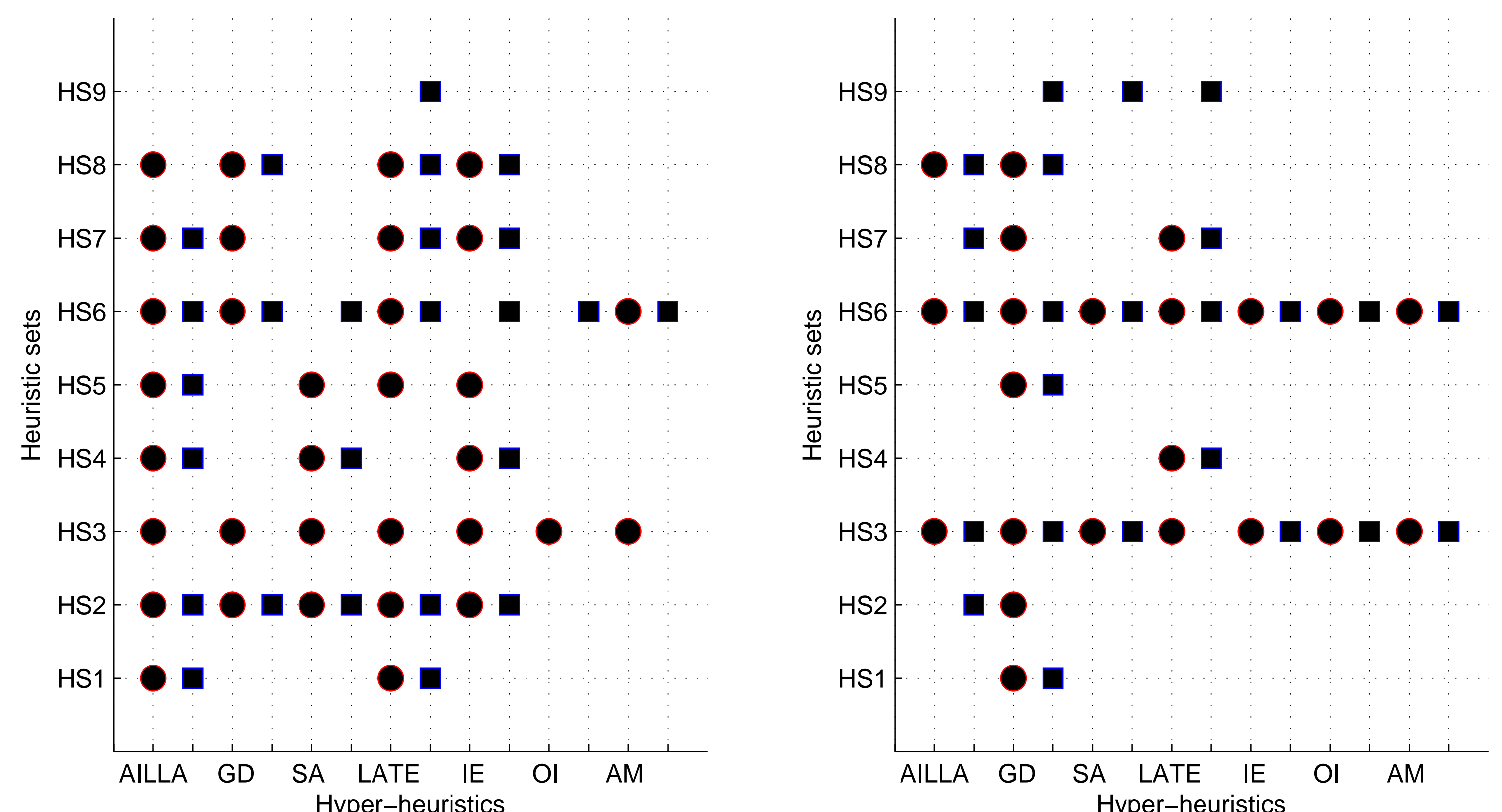


Figure: The significantly best hyper-heuristics on each heuristic set after 10 minutes (left) and 50 minutes (right) (Circles refer to the hyper-heuristics with ADHS and squares refer to the hyper-heuristics with SR) [based on the Wilcoxon test with a 95% confidence interval]

10-minute rankings

ADHS performs better than SR in the majority of the cases.

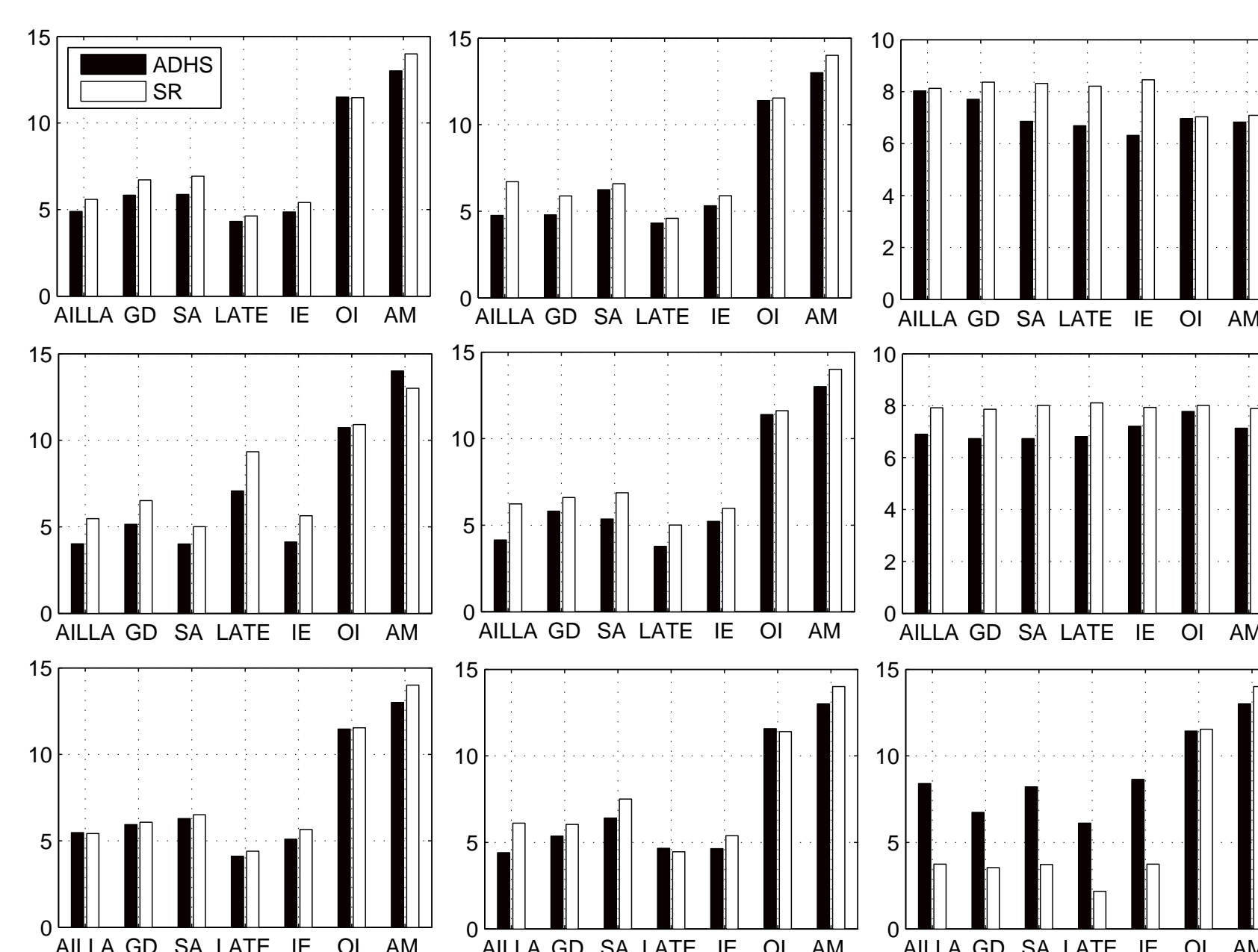


Figure: Average ranking of the hyper-heuristics after 10 minutes (Each graph represents the results obtained on a heuristic set. They are ordered from left to right, top to bottom: $HS_1 \rightarrow HS_9$)

50-minute rankings

Choosing wrong heuristics is not as influential when compared with the 10 minute execution time experiments.

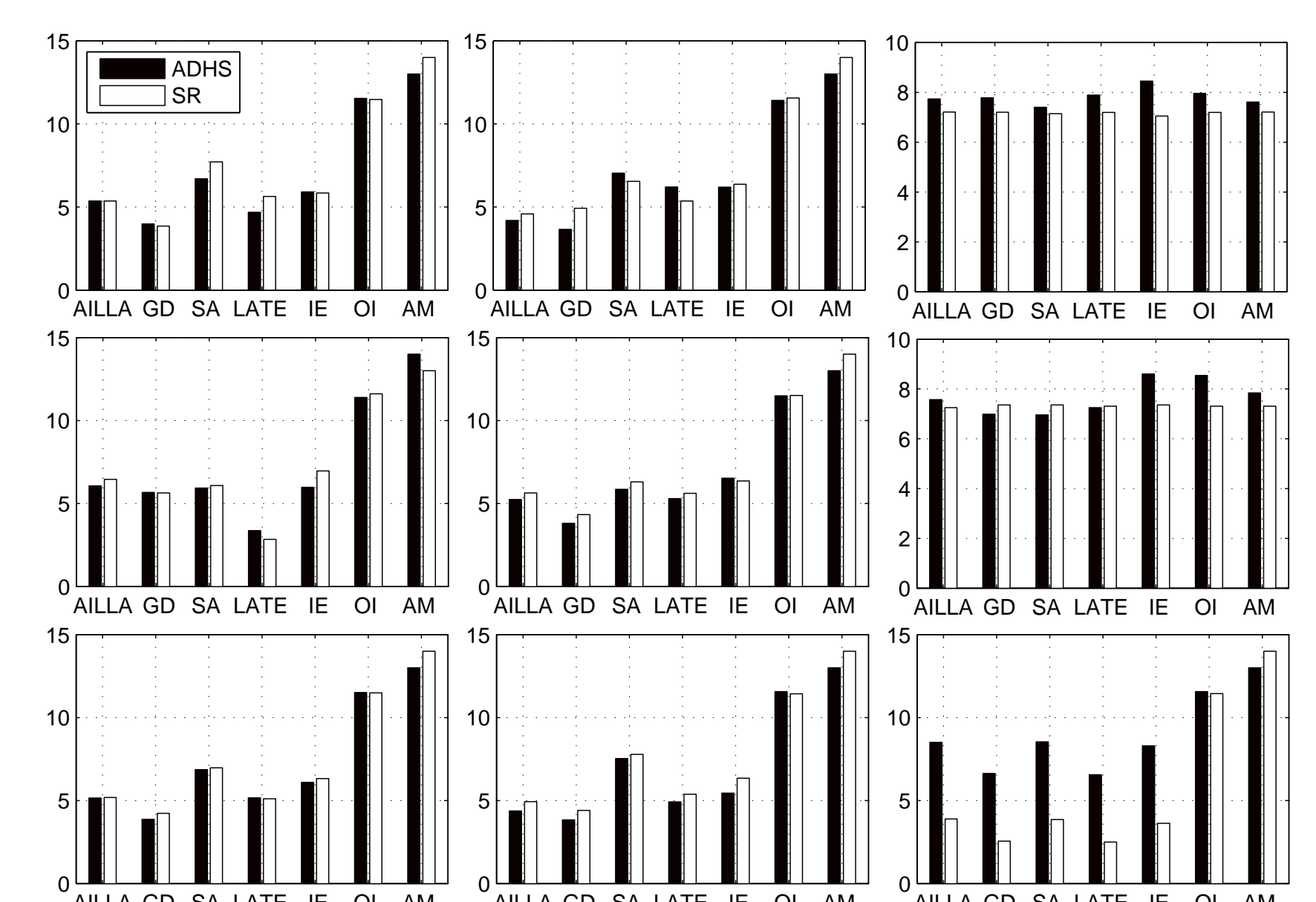


Figure: Average ranking of the hyper-heuristics after 50 minutes (Each graph represents the results obtained on a heuristic set. They are ordered from left to right, top to bottom: $HS_1 \rightarrow HS_9$)