New Initialisation Techniques for Multi-Objective Local Search
Application to the Bi-Objective Permutation Flowshop

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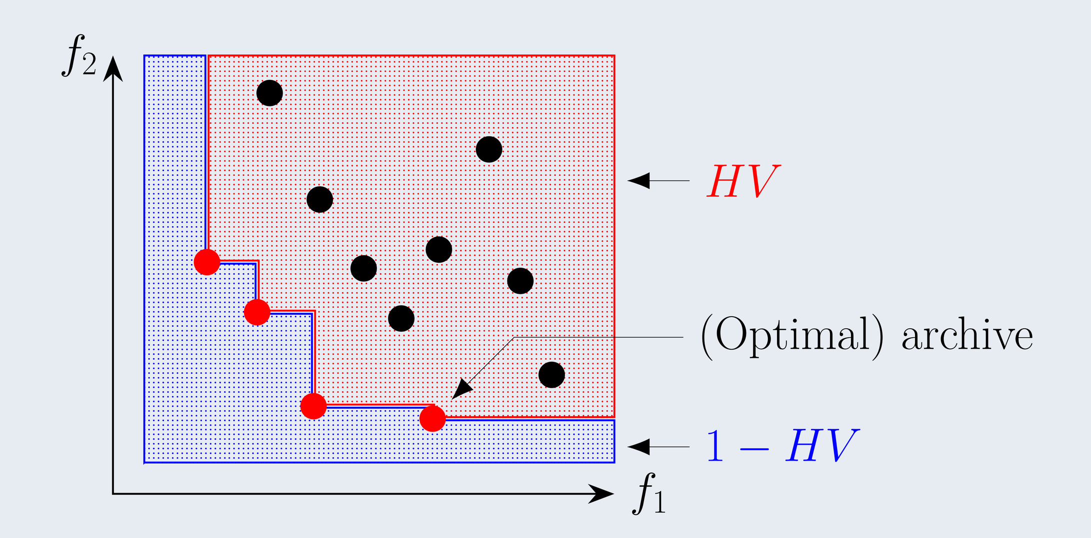
Multi-Objective Optimisation



Multi-Objective Local Search

Taxonomy

SBLS: scalarisation-based local search
- ▶ Aggregate the criteria to a single one
- ▶ Use a single-objective local search

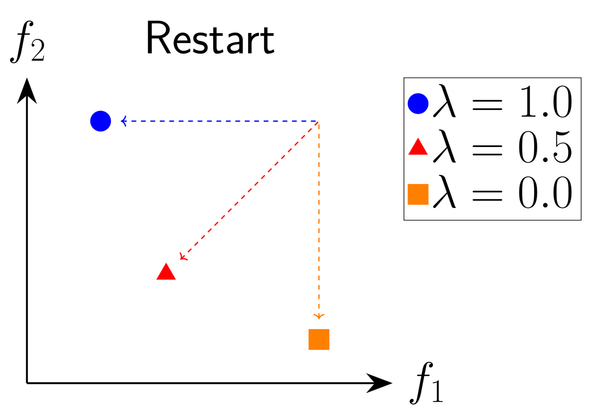
DBLS: dominance-based local search
- ▶ Use Pareto dominance

State of the art
- ▶ SBLS as initialisation procedure
- ▶ DBLS as main algorithm

Known SBLS Strategies

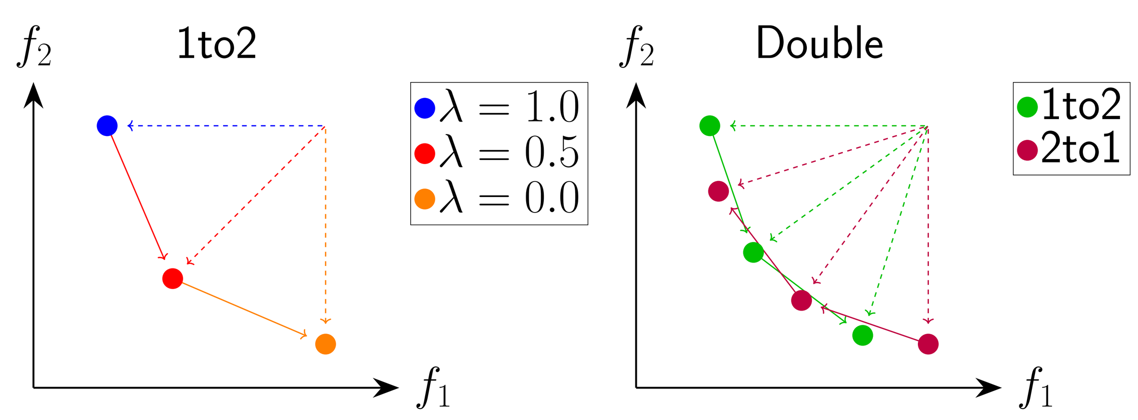
Restart

Divide the search in independent scalar problems



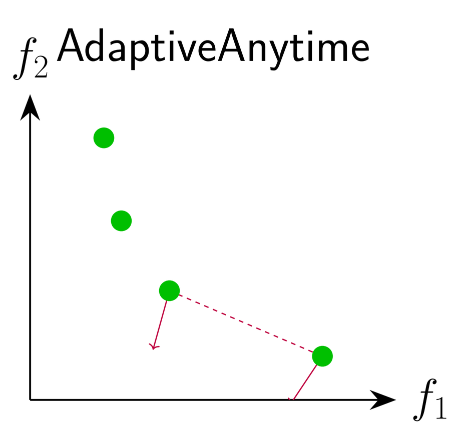
1to2, 2to1, Double

Re-use final solutions as initial solutions



AdaptiveAnytime [1]

Adapt the scalarisations during the search
Target the biggest gap in the archive



This Poster in a Nutshell

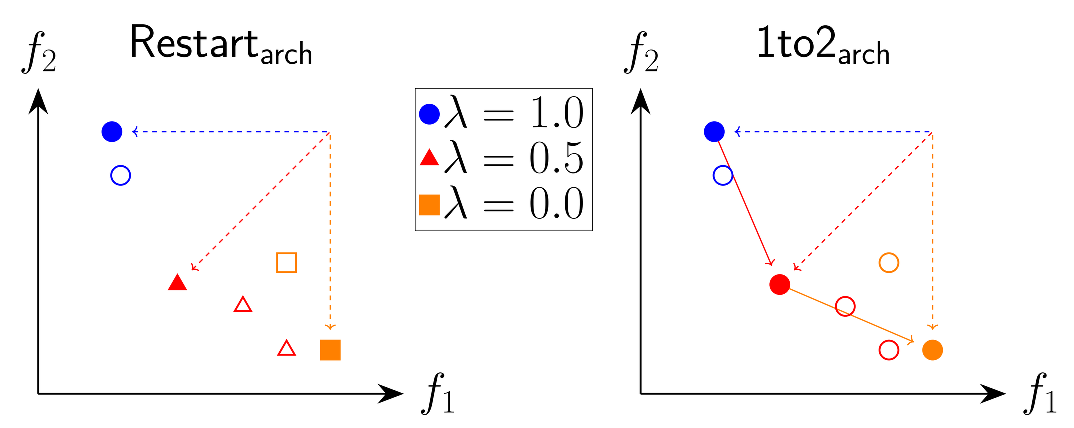
Observation
- ▶ SBLS benefit from multi-objective knowledge

Aims
- ▶ Augment SBLS with archives
- ▶ Propose new SBLS strategies
- ▶ Overall, improve SBLS+DBLS results

Archive-aware Variants

Restart$_{arch}$, 1to2$_{arch}$, 2to1$_{arch}$, Double$_{arch}$

Final archives are merged; trajectories are conserved



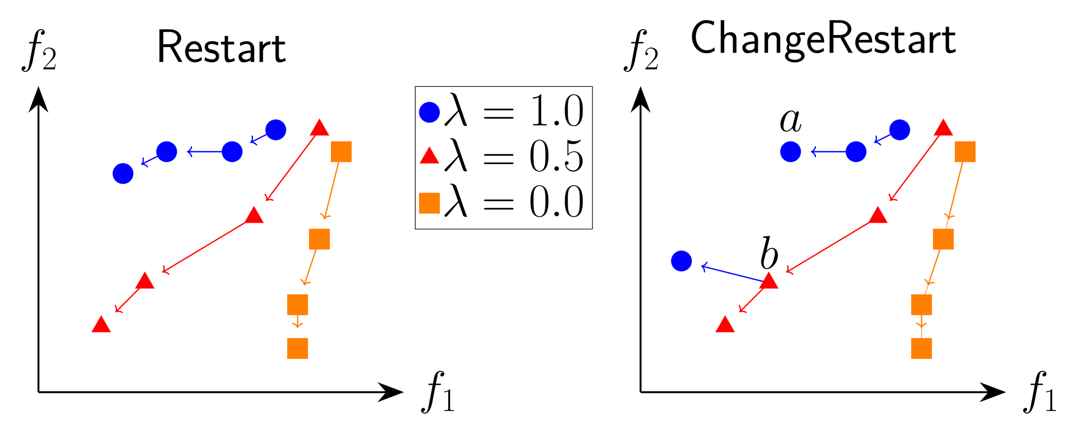
AdaptiveAnytime$_{arch}$

Archives are merged every time: trajectories are affected

New SBLS Strategies

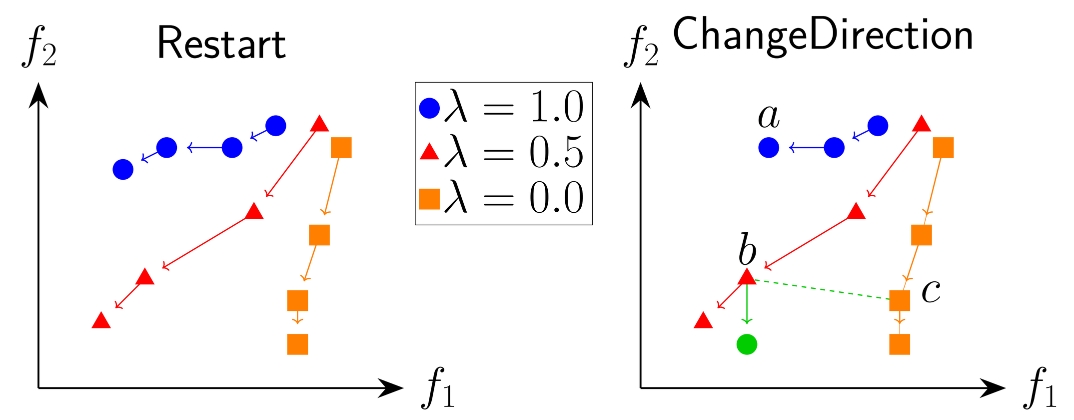
ChangeRestart

Based on Restart
Break the search into smaller chunks
Stop dominated directions



ChangeDirection

Based on ChangeRestart
Continue based on the biggest gap (AdaptiveAnytime)



ChangeRestart$_{arch}$, ChangeDirection$_{arch}$

Intermediary archives are merged: trajectories are affected

Experimental Setup

Problem

Bi-objective permutation flowshop scheduling problem
- ▶ makespan
- ▶ total flowtime

8 classes of Taillard PFSP instances [2]
- ▶ 20, 50, 100, 200 jobs
- ▶ 10, 20 machines

Algorithm
- ▶ 25% initialisation (NEH+IG [3])
- ▶ 75% multi-objective local search (iterated PLS [1, 4])

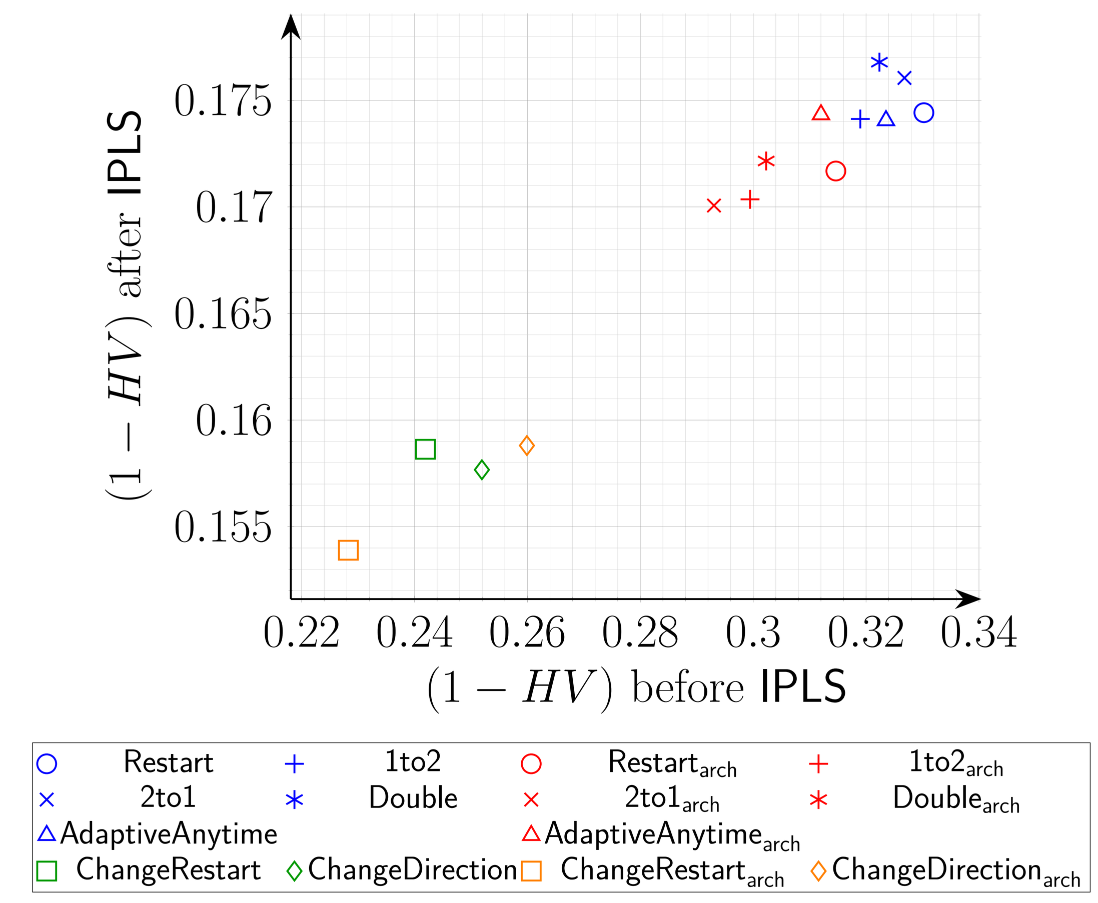
Protocol
- ▶ 12 SBLS strategies
- ▶ 50 runs per PFSP instance class (400 runs)

Table 1: SBLS parameter values

	N^{scalar}	N^{steps}	T^{first}	θ
Restart	12			
1to2	12		1.5	
2to1	12		1.5	
Double	12		1.5	
AdaptiveAnytime	12		1.5	0.25
ChangeRestart	12	20	1.5	
ChangeDirection	12	20	1.5	0.25

Results

Performance Assessment
- ▶ Before IPLS: to compare SLBS strategies
- ▶ After IPLS: to validate final results



Statistical Analysis after IPLS

Wilcoxon test ("✓" means rank 1)

	Restart	1to2	2to1	Double	AdaptiveAnytime	Restart$_{arch}$	1to2$_{arch}$	2to1$_{arch}$	Double$_{arch}$	AdaptiveAnytime$_{arch}$	ChangeRestart	ChangeRestart$_{arch}$	ChangeDirection	ChangeDirection$_{arch}$
20×10						✓	✓		✓	✓		✓	✓	✓
20×20						✓	✓	✓	✓	✓		✓	✓	✓
50×10		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
50×20	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
100×10											✓	✓	✓	✓
100×20		✓			✓		✓				✓	✓	✓	✓
200×10											✓	✓	✓	✓
200×20											✓	✓	✓	

Summary

Results
- ▶ Archive-aware SBLS perform better
- ▶ New SBLS are almost never outperformed

Conclusions
- ▶ Single-objective sub-problems benefit from multi-objective knowledge
- ▶ Intermediary solutions should not be discarded

Future Work
- ▶ In-depth study of parameter interactions
- ▶ Archive-aware SBLS validation on other problems

References

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[2] Éric D. Taillard. Benchmarks for basic scheduling problems. *European Journal of Operational Research*, 64(2):278–285, 1993.

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[4] Aymeric Blot, Laetitia Jourdan, and Marie-Éléonore Kessaci. Automatic design of multi-objective local search algorithms: case study on a bi-objective permutation flowshop scheduling problem. In *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO 2017*, pages 227–234. ACM Press, 2017.

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