

Introduction to Evolutionary Multi- objective Optimisation

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- Basic Concepts
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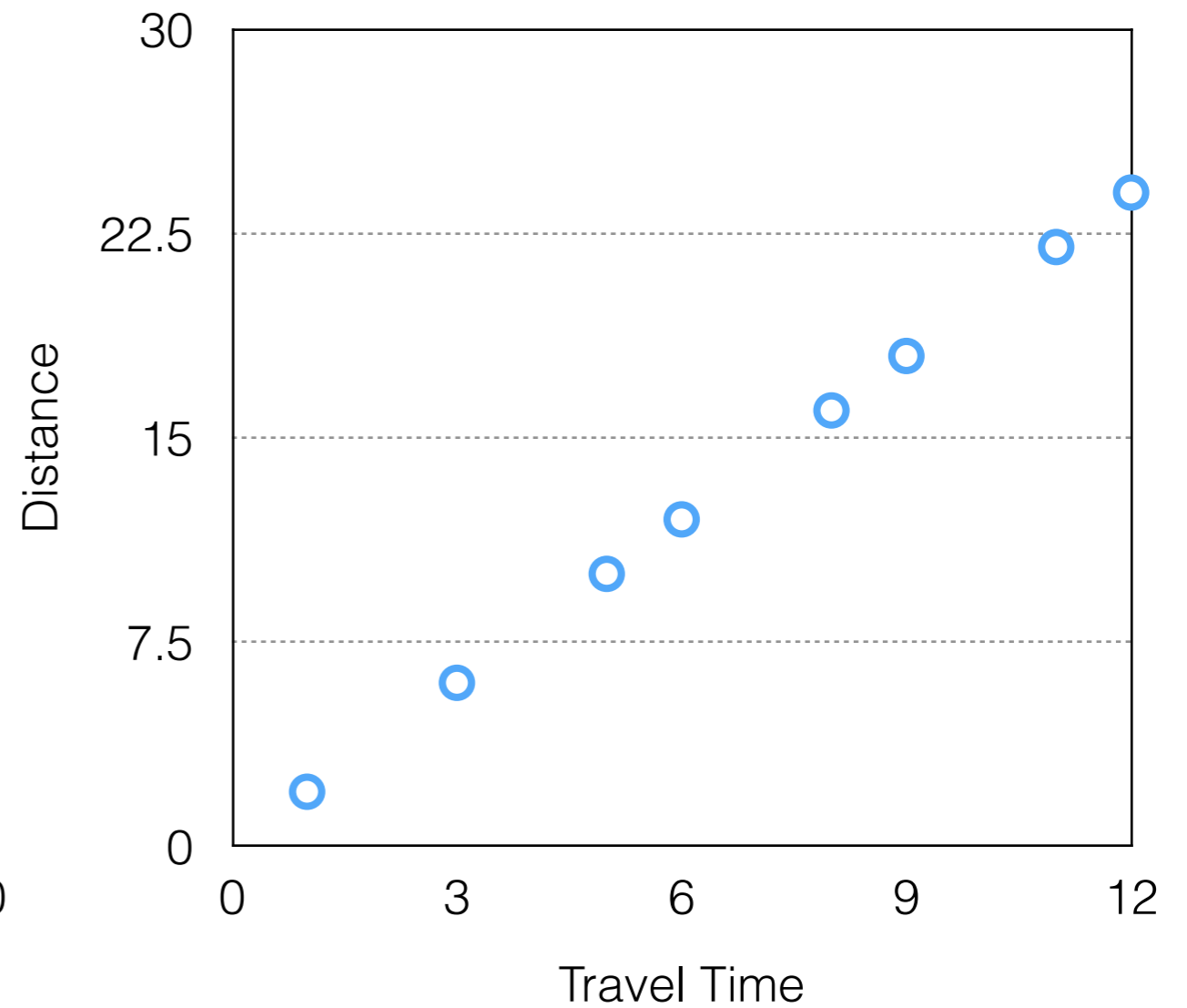
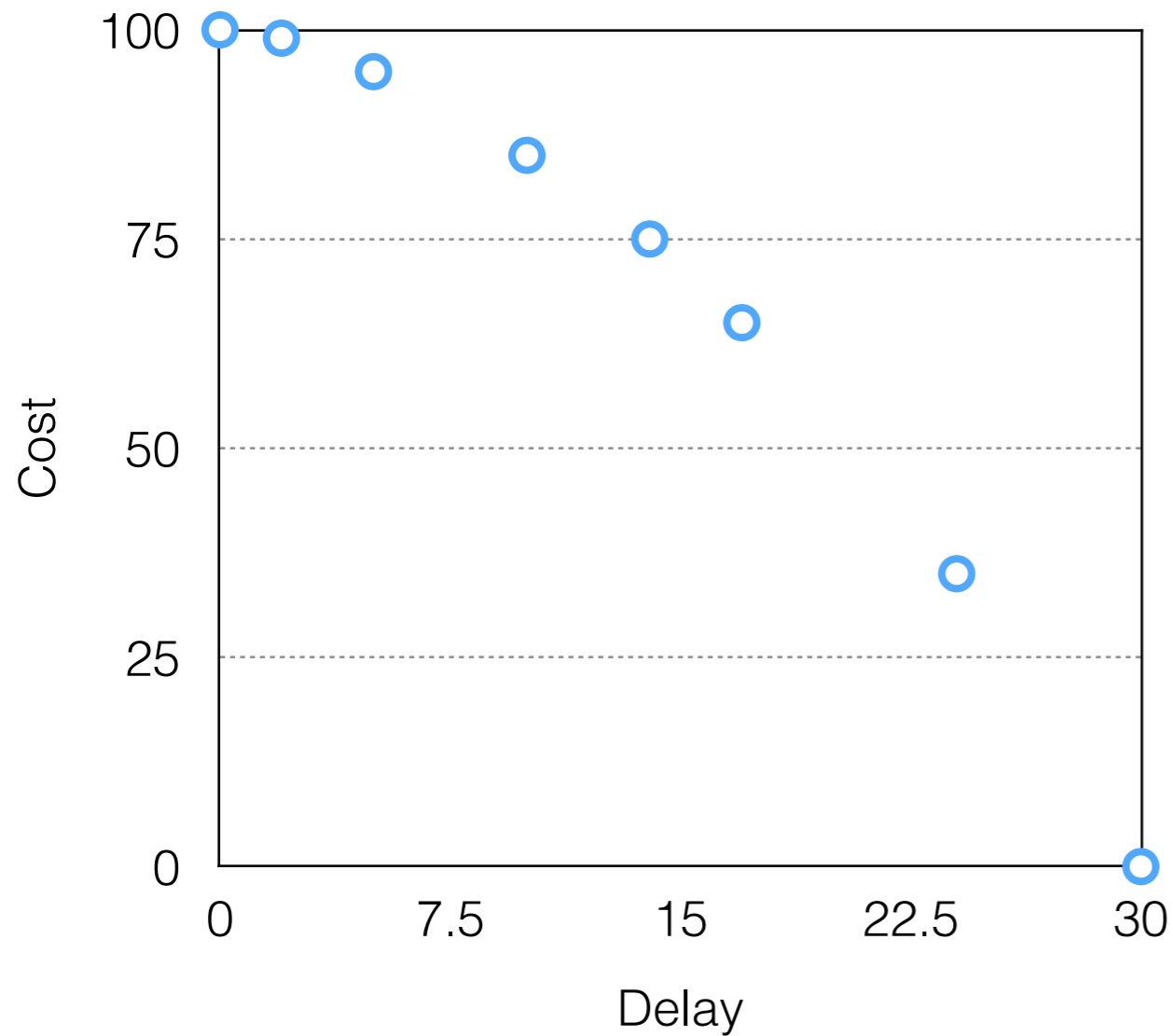
Multi-Objective Optimisation

- Optimize multiple objectives

$$\mathbf{f} = (f_1, \dots, f_m)$$

- The objectives **MUST** be conflicting!

Conflicting and Non-conflicting Objectives



Conflicting and Non-conflicting Objectives

- Multiple objectives do **NOT** necessarily lead to multi-objective optimisation
- Make sure the objectives are **conflicting!**
- There is no single global optimum

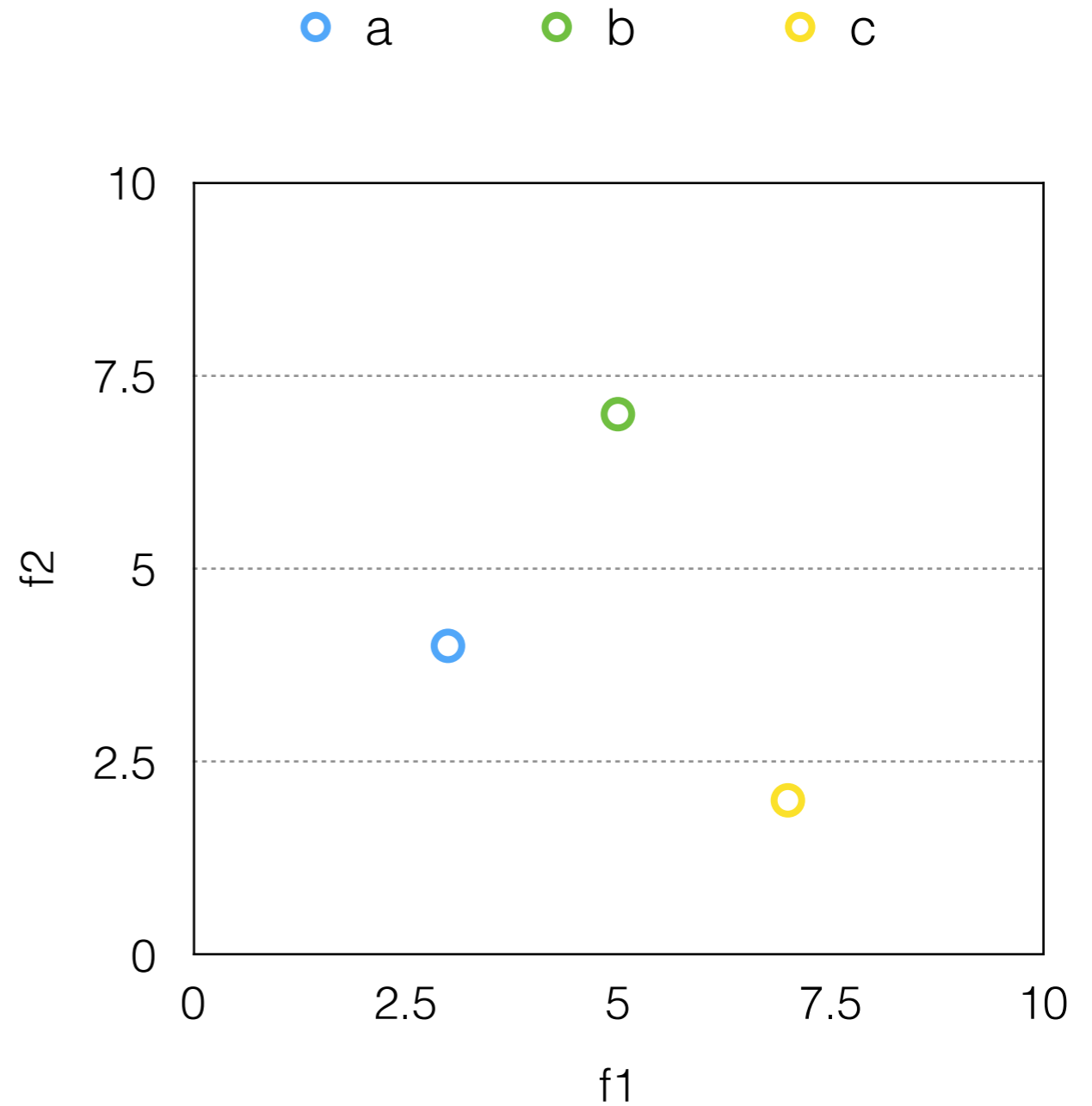
Multi-objective Optimisation

◉ **Dominance Relation**

- ★ x is said to **dominate** y if
 - ▶ x is no worse than y in all the objectives
 - ▶ x is better than y in at least one objective
- ★ x and y are **non-dominated** to each other, if neither x dominates y , nor y dominates x

Dominance Relation

- **a** dominates **b**
- **a** and **c** are non-dominated
- **b** and **c** are non-dominated



Pareto Optimality

- A solution x is **Pareto-optimal**, if there is no solution in the solution space that can dominate x .
- **Pareto front**: The set of all the Pareto-optimal solutions.
- GOAL: find the Pareto front

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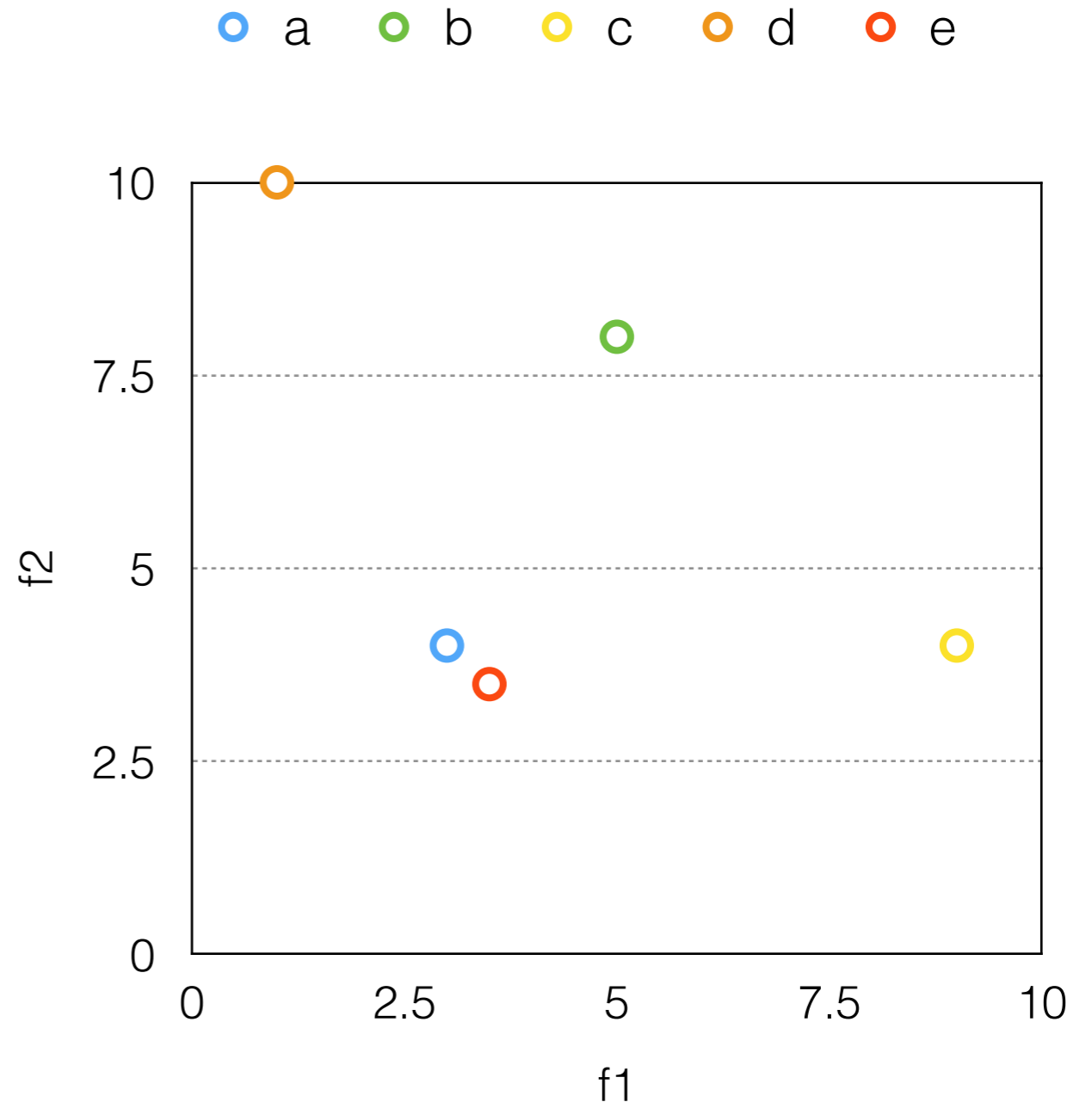
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Challenging Issues

- Fitness Assignment
- Diversity Preservation
- Elitism

Fitness Assignment

- Which one is better?
- **d** seems to be good
- **a** and **e** are too close
- **c** has potential to explore new area
- **b** is poor
- What if only **two** can survive?



Fitness Assignment

- Simple weighted sum cannot work well
- Fitness relies more on **relative** quality (e.g. dominance relation)

Diversity Preservation

- In single-objective optimisation, diversity is needed mainly to **prevent being stuck in local optima**.
- In multi-objective optimisation, diversity is needed not only to **prevent being stuck in local optima**, but also to **cover the whole Pareto front**.
- Different convergence-diversity balance from single-objective optimisation

Elitism

- Which should be in the next generation?

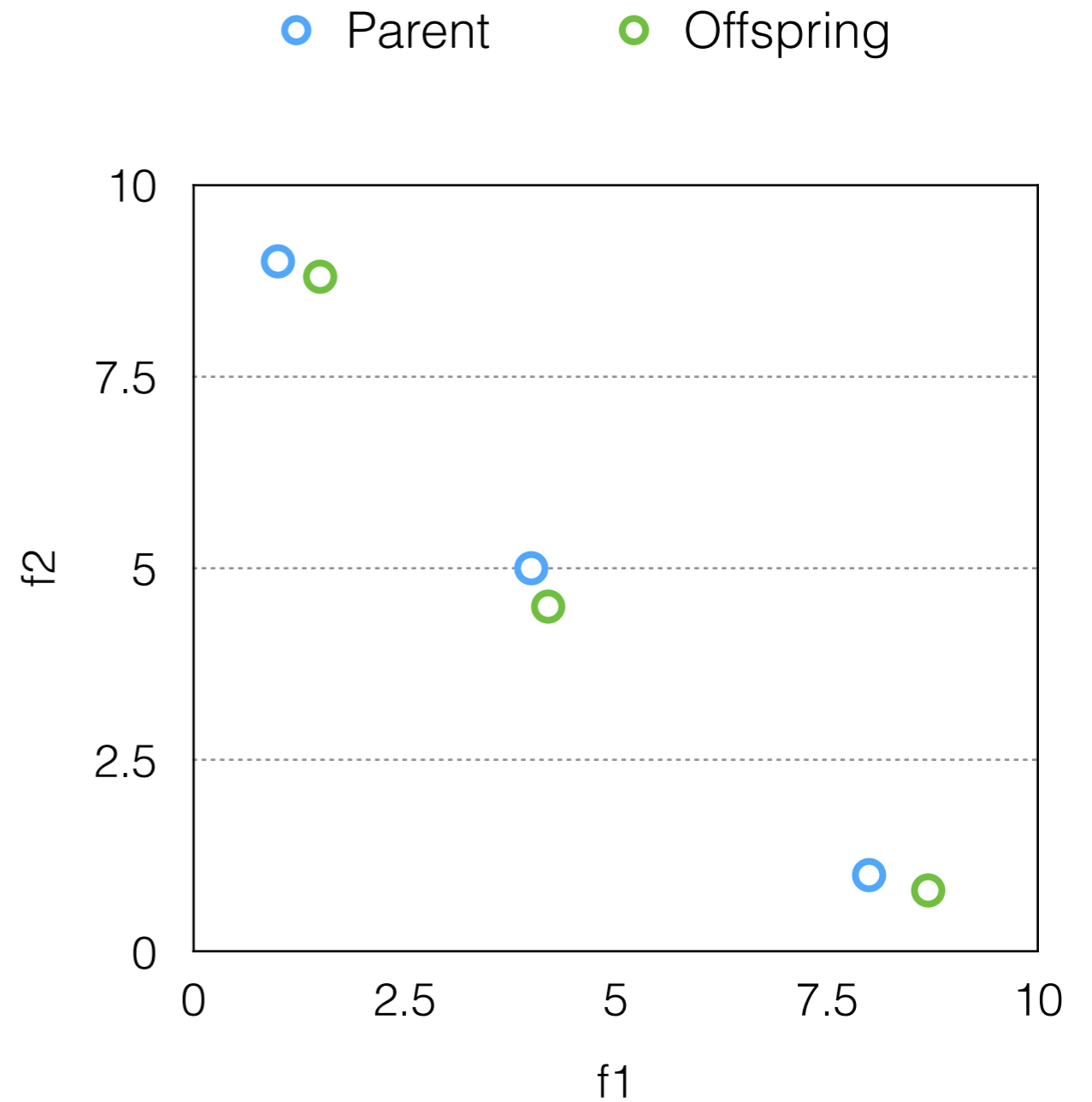


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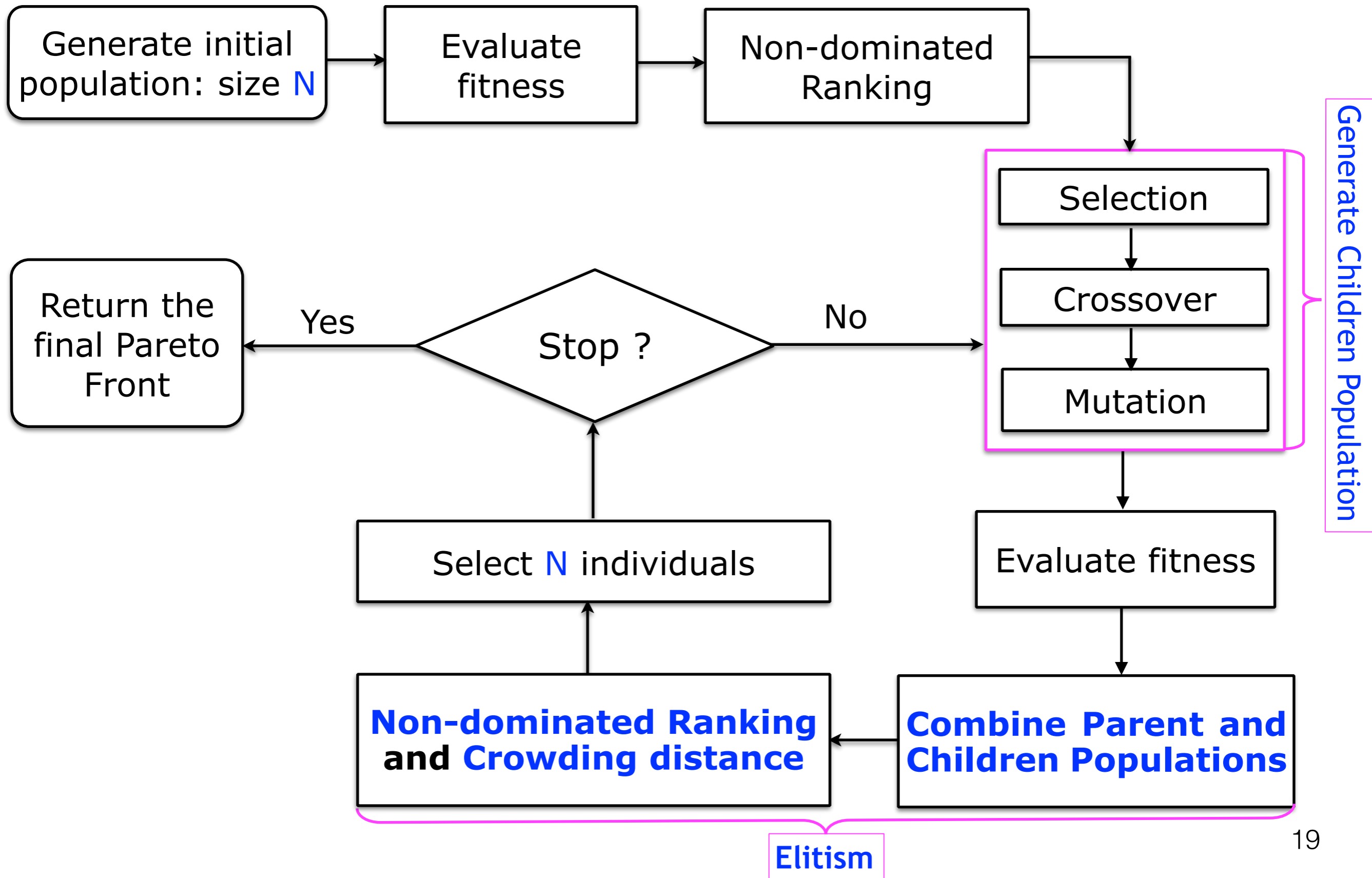
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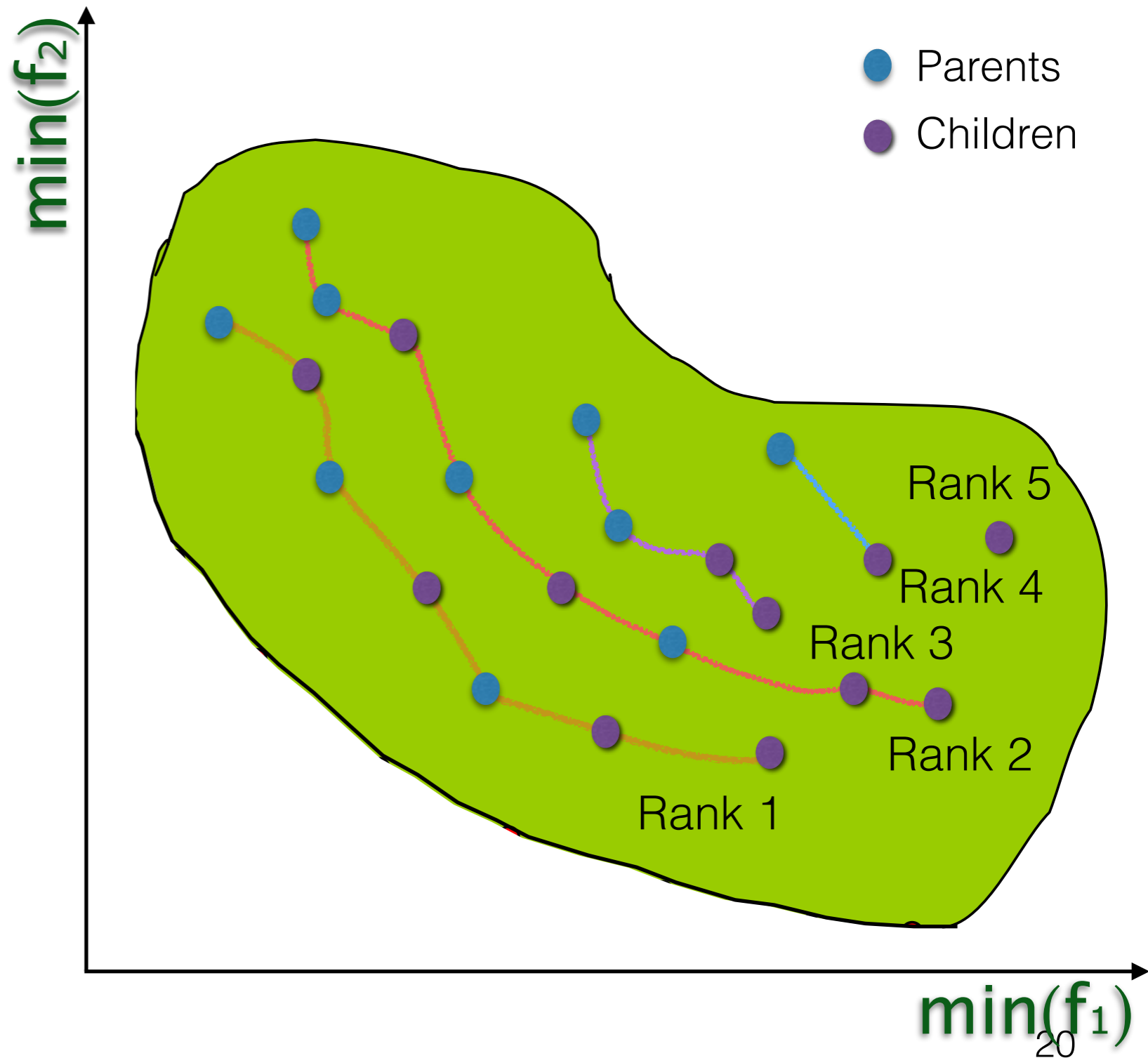
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Flowchart of NSGAI



NSGAI I — Elitism

- Elitism: Keep the best Parent Child individuals from the parent and child population



NSGAI I — Elitism

