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“Whatever works best for you” a new method for *a priori* and *progressive* multi-objective optimization

The 7th International Conference for Evolutionary Multi-Criterion Optimization

Rui Wang, Robin C. Purshouse and Peter J. Fleming

**The University of Sheffield
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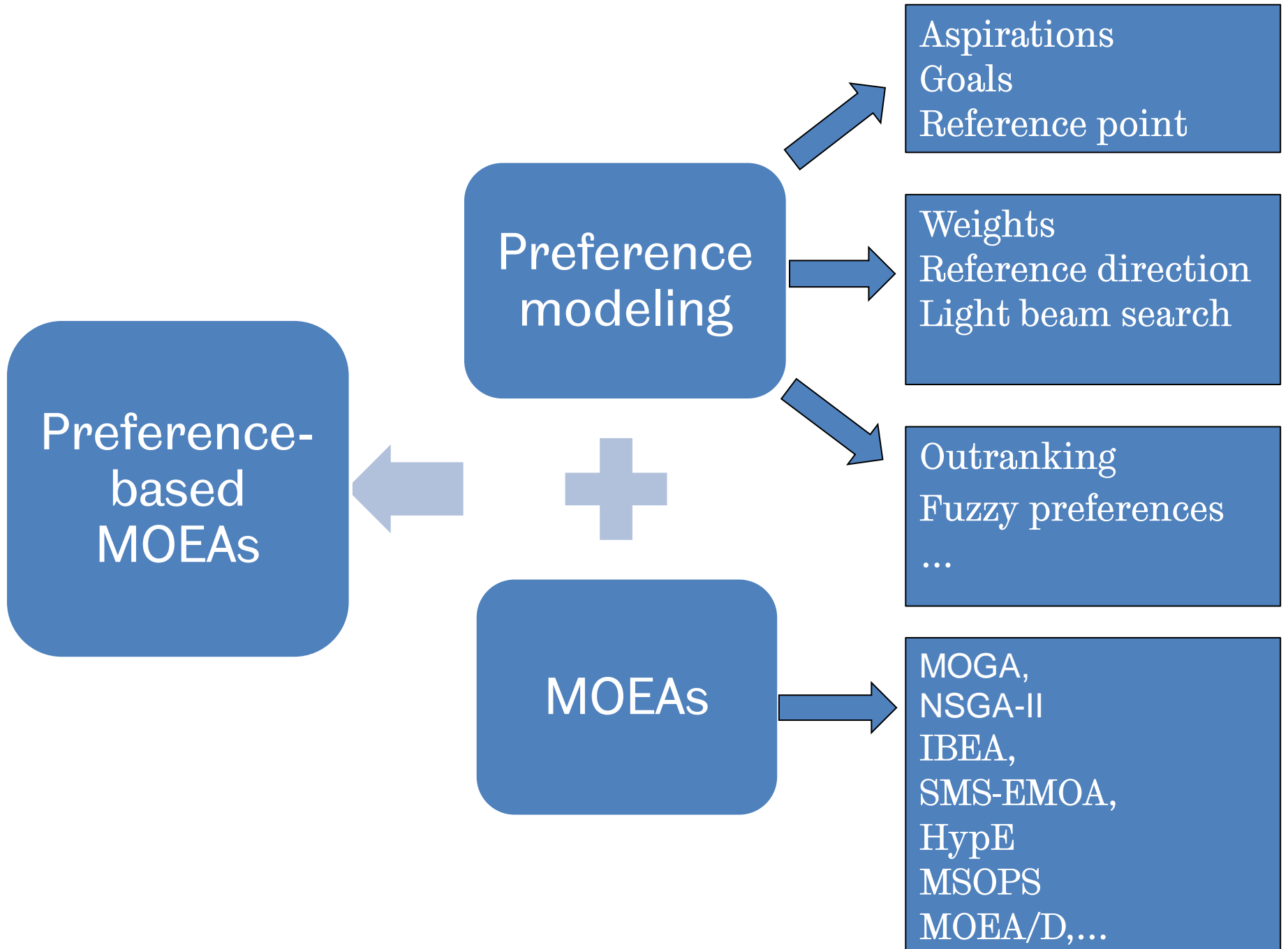
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Outline

- Introduction
- A unified approach
- A new preference-based MOEA

Solve a multi-objective problem

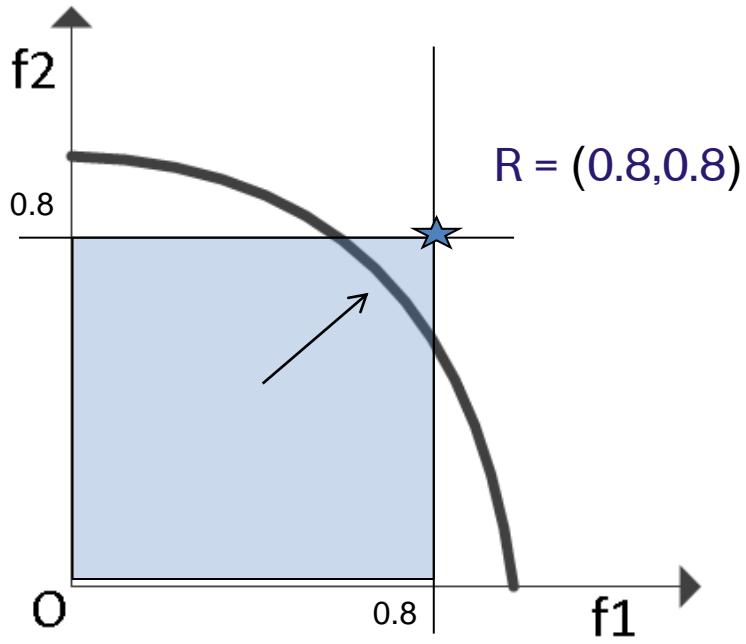
-
- A *posterior* decision is **difficult** (many-objective optimization)
 - Approximation of the entire Pareto front
 - Select one solution from the approximation
 - A *priori* / *interactive* decision-making (an alternative preference-based method)
 - Decision maker → region of interest



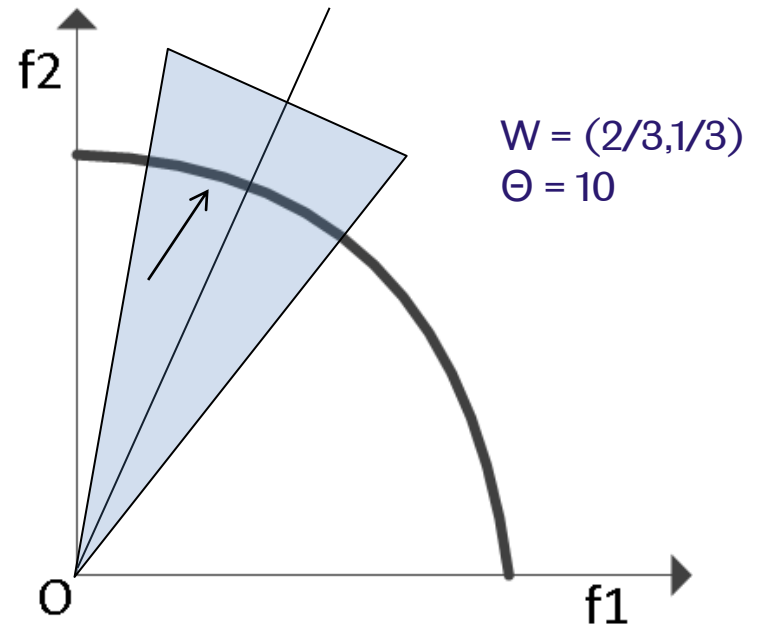
Preference-based MOEAs

- The existing approaches
 - A single preference model, e.g. aspirations, weights,...
- However
 - Decision maker dependent
- Therefore
 - A unified approach is required
 - Aspirations, weights, etc.

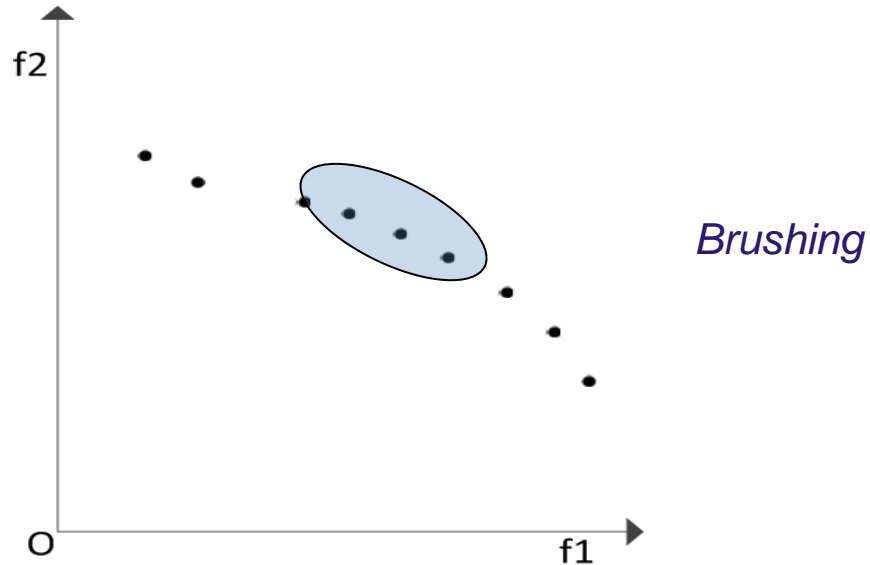
Different preference expressions



Aspirations



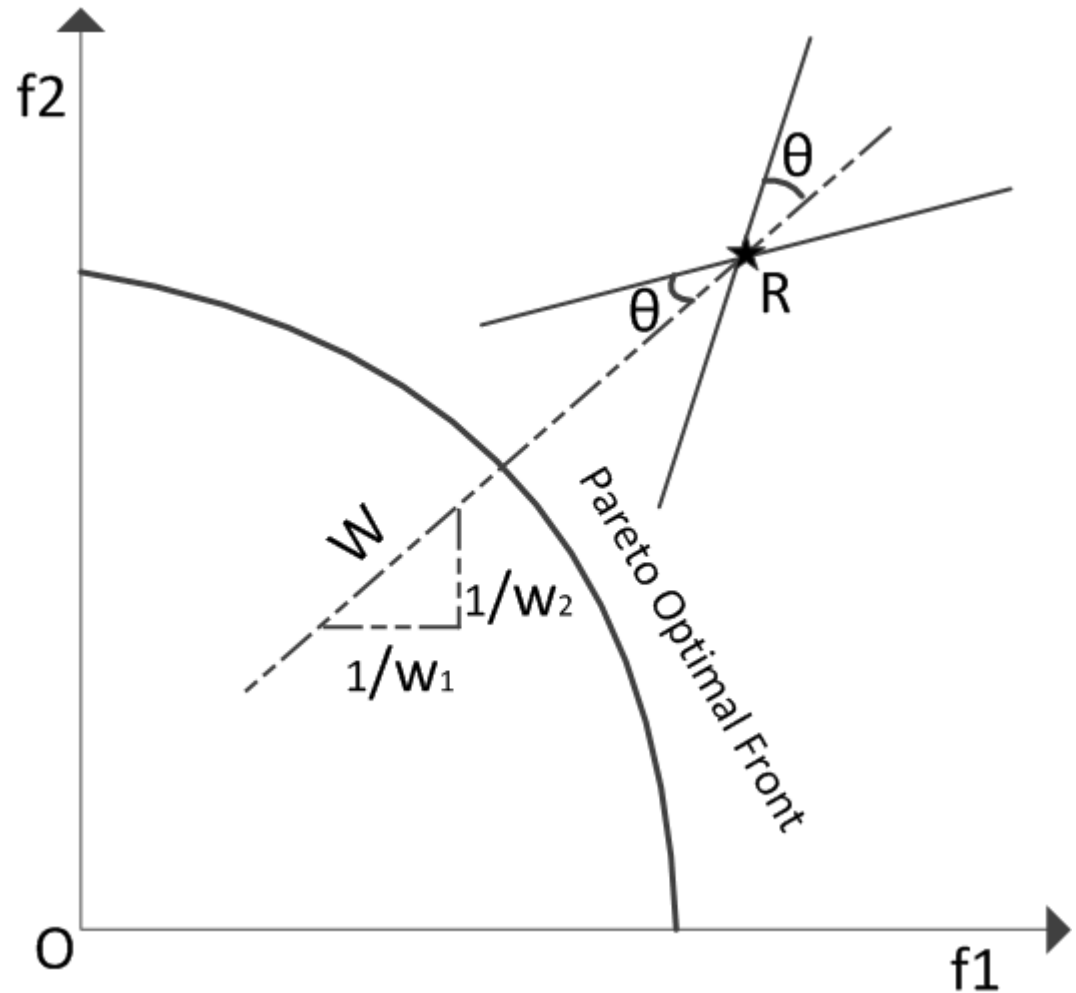
Weights



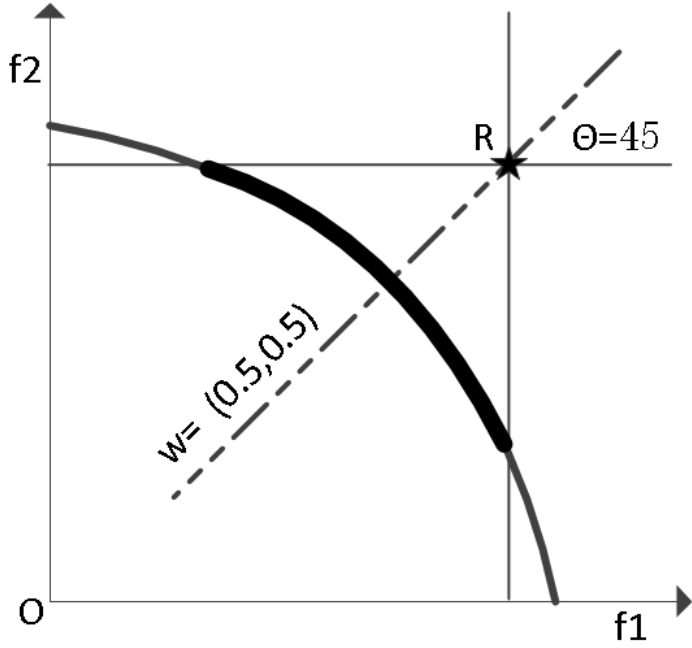
Brushing

A unified approach

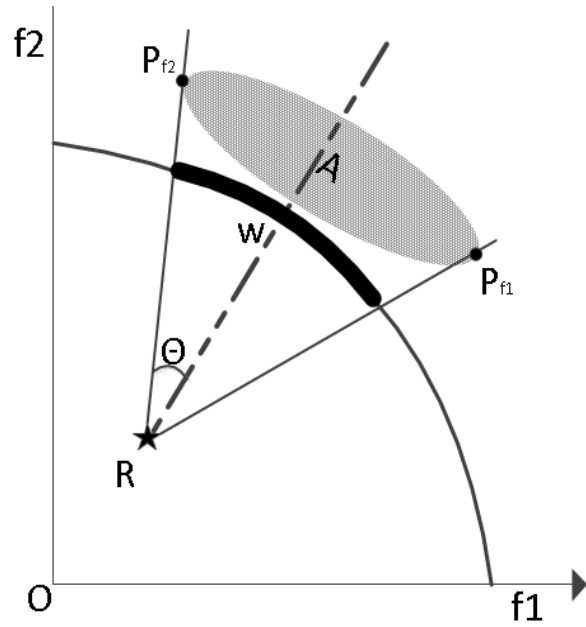
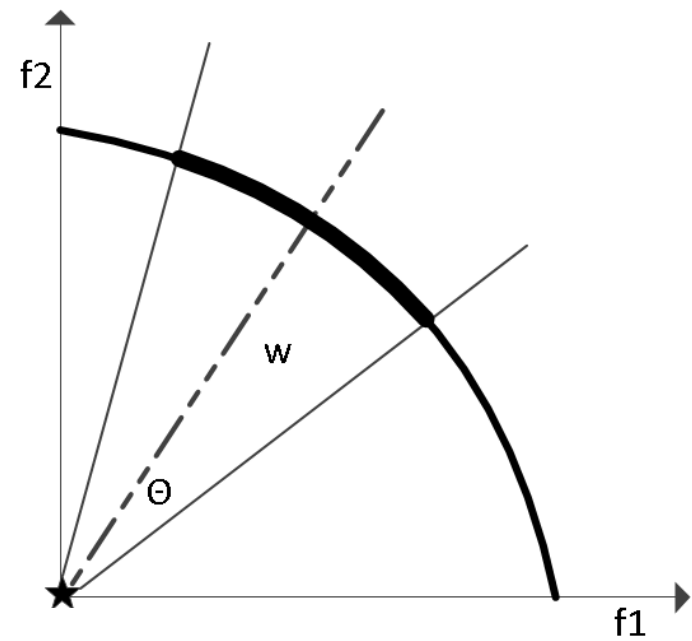
reference point (\mathbf{R}),
search direction (\mathbf{w})
search range (θ).



Aspirations



Weights

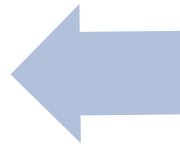


Brushing

The unified approach

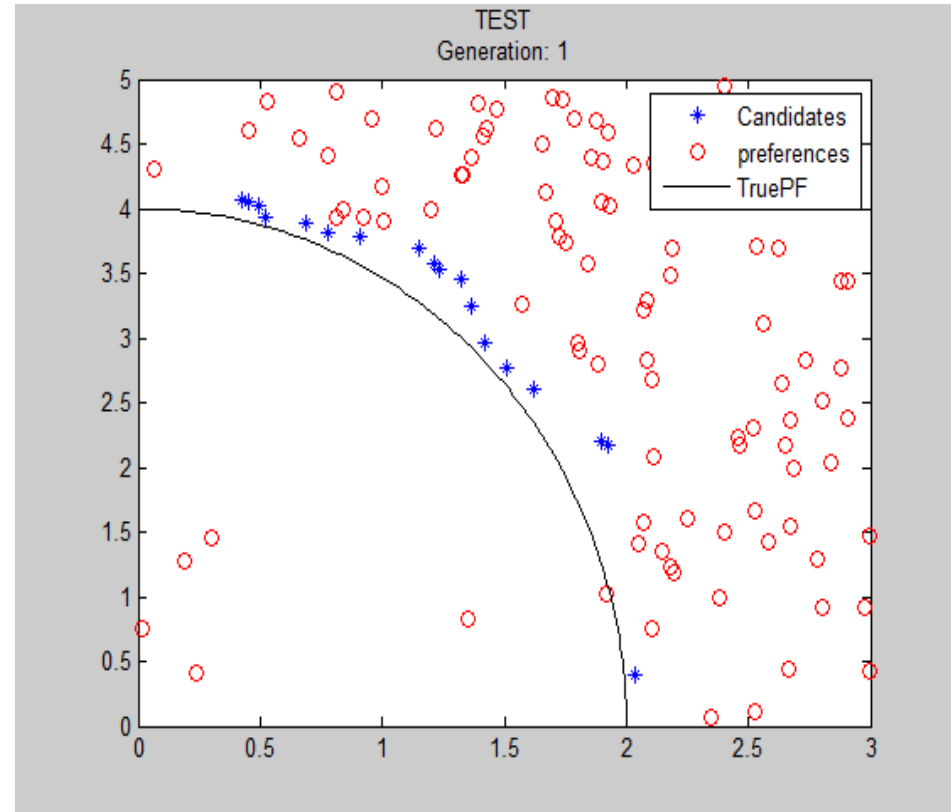
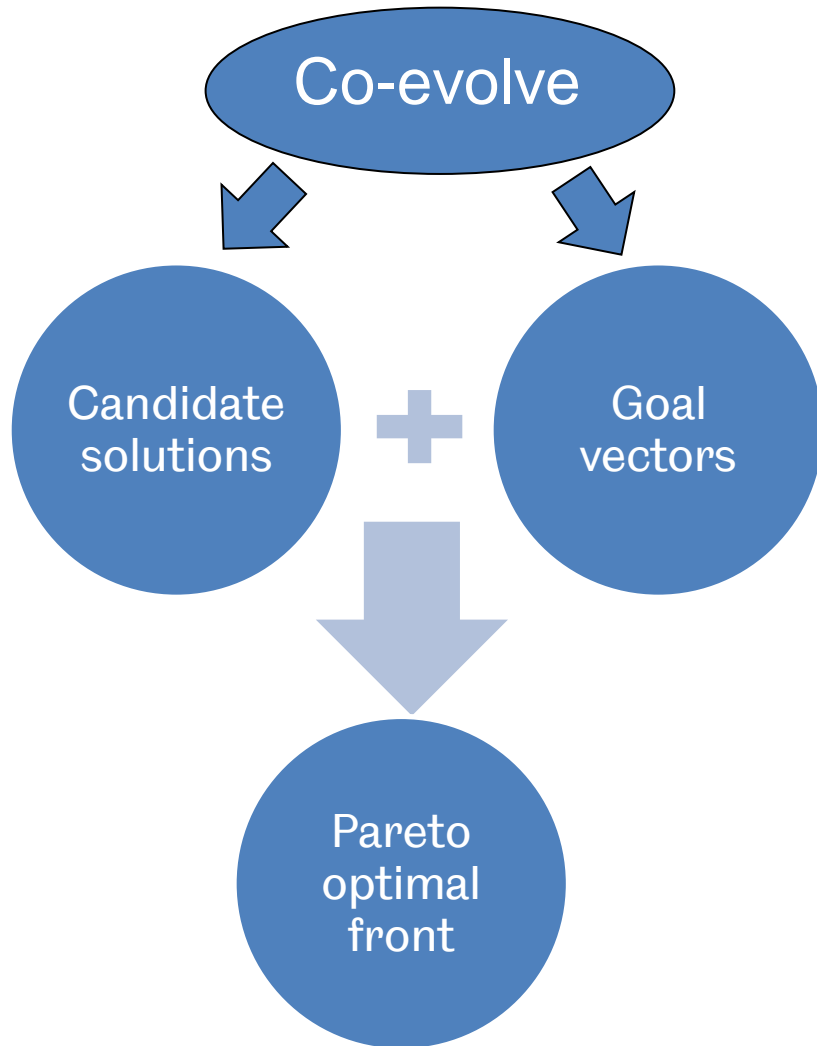


PICEA-g



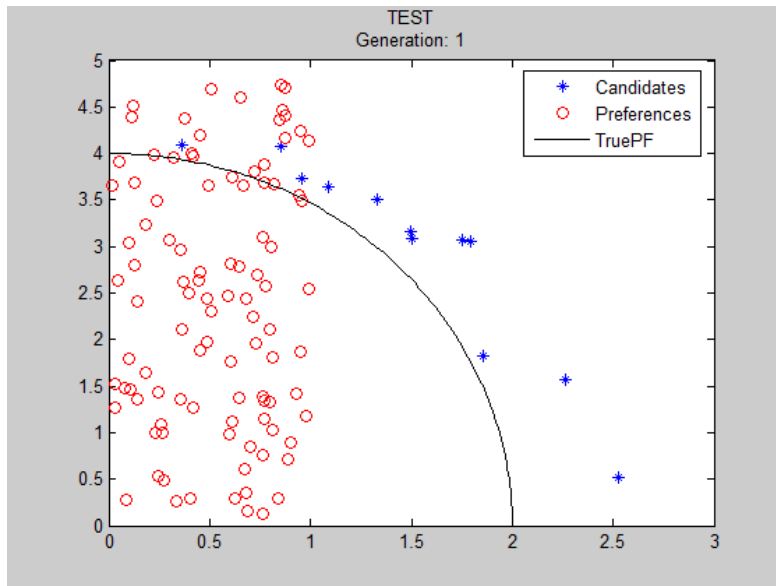
A new preference-based MOEA

Preference-inspired co-evolutionary algorithm using goal vectors (PICEA-g)

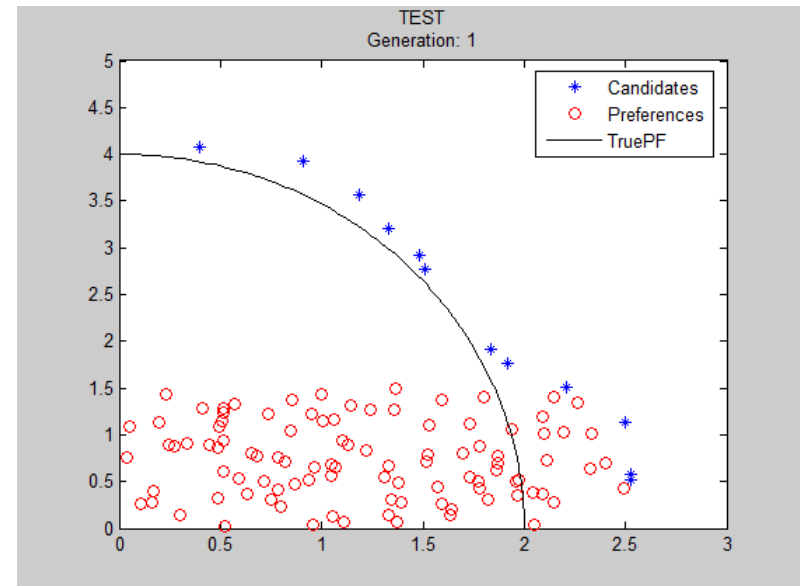


Co-evolving different goal vectors

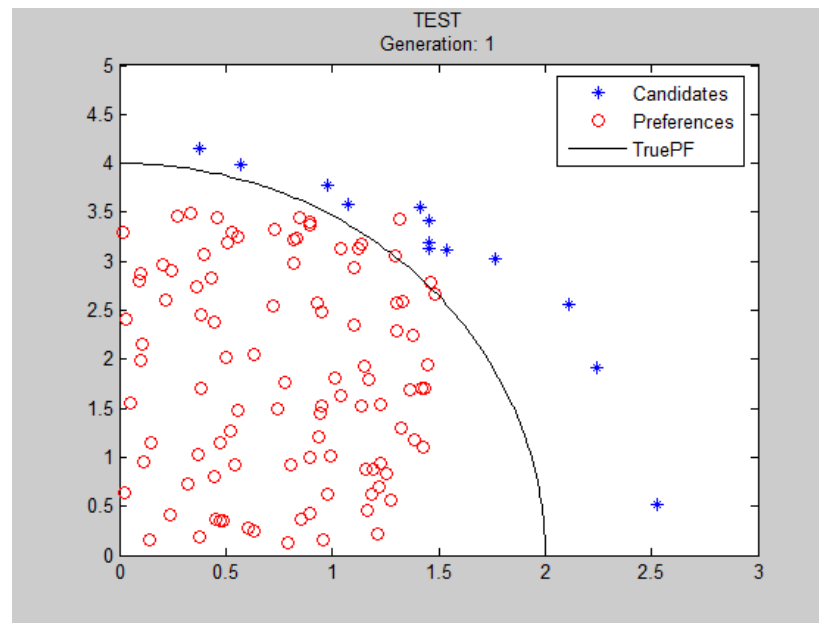
A



B



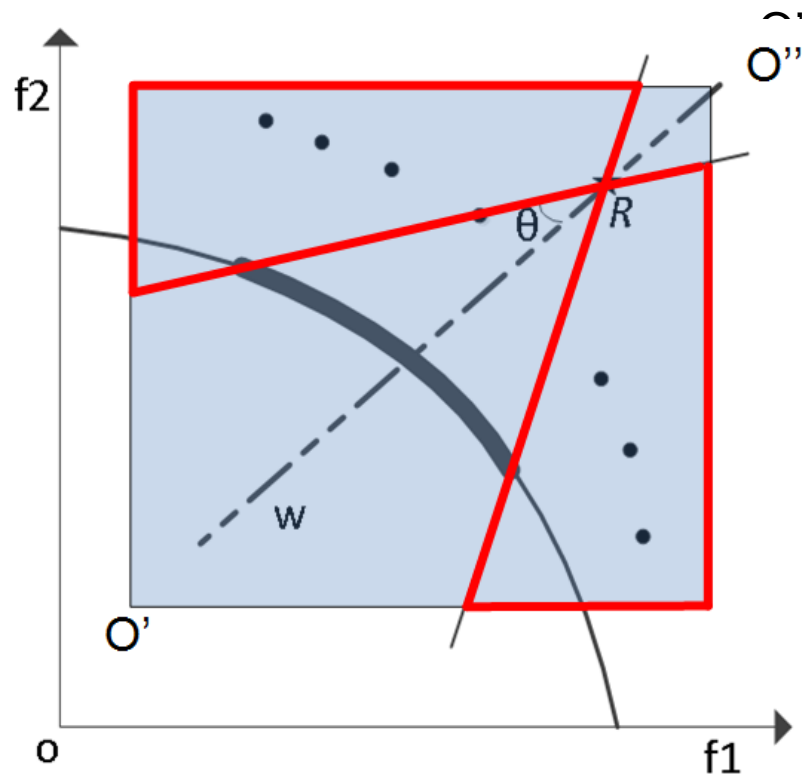
C



iPICEA-g = unified approach + PICEA-g

Idea:

candidate solutions + *'special'* goal vectors (determined by the unified approach)



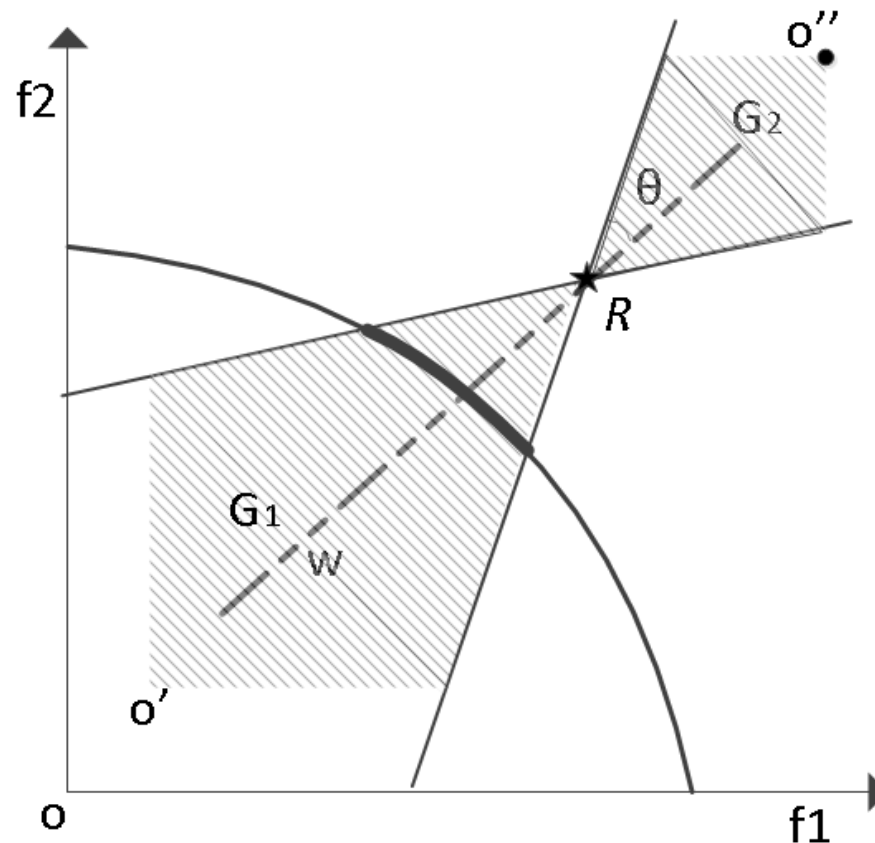
$$O' = \alpha \times \min (R_i \uplus f_i(S^*)), i = 1, 2, \dots, M, 0 < \alpha < 1$$

$$O'' = \beta \times \max (R_i \uplus f_i(S^*)), i = 1, 2, \dots, M, \beta > 1$$

iPICEA-g = unified approach + PICEA-g

Idea:

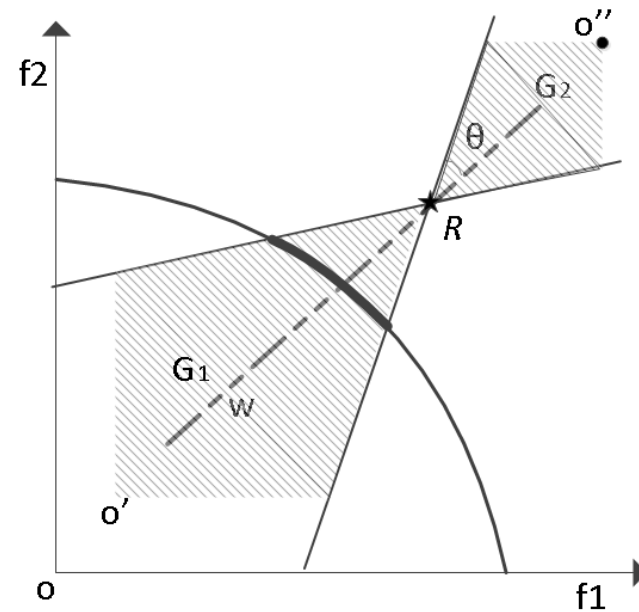
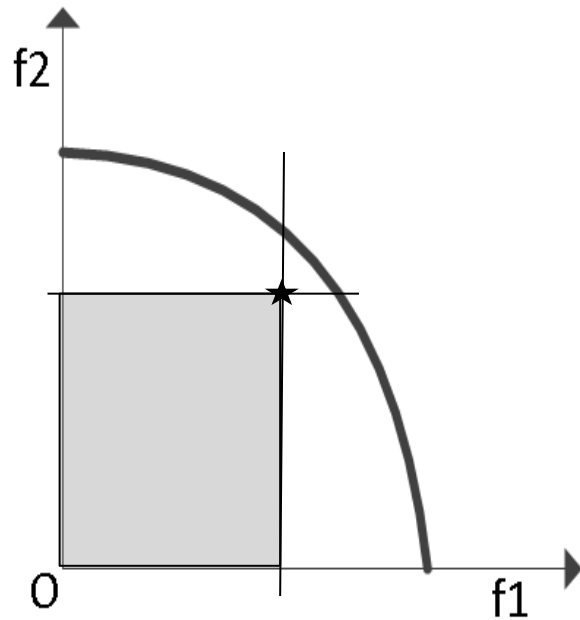
candidate solutions + *'special'* goal vectors (determined by the unified approach)



iPICEA-g = unified approach + PICEA-g

- Infeasible R

→ both G_1 and G_2



- Multiple regions of interest → goals in different regions

Search with aspirations

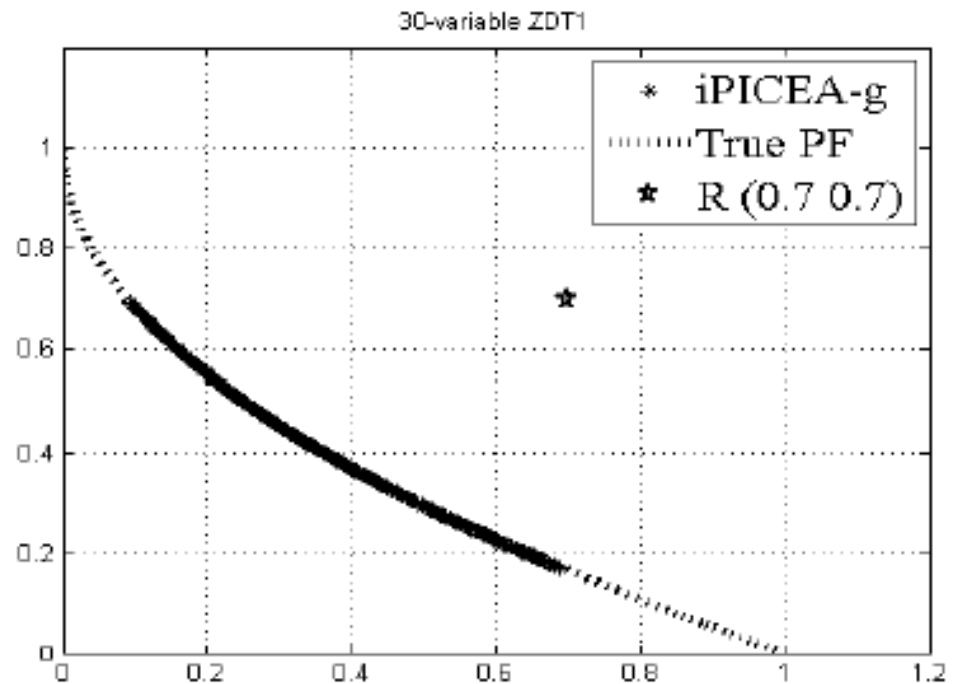
- **f1 and f2 are better (smaller) than 0.7.**



$R = (0.7, 0.7)$

$w = (0.5, 0.5)$

$\Theta = 45;$



Search with weights

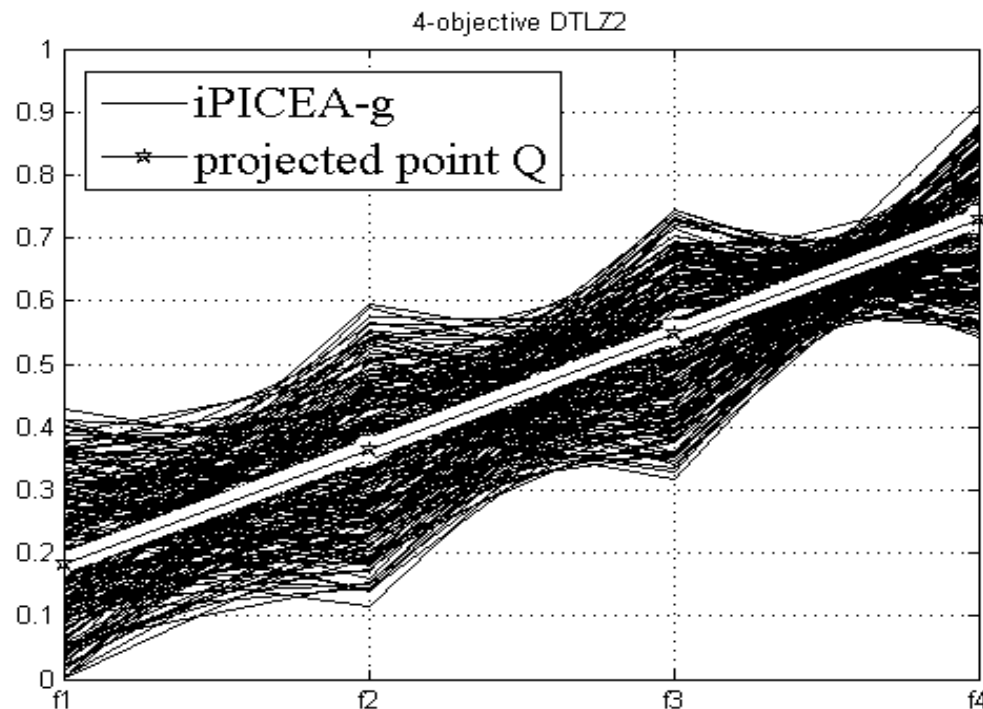
- **f1 4 times as important as f4;**
- **f2 3 times as important as f4;**
- **f3 2 times as important as f4;**



$$R = (0, 0, 0, 0)$$

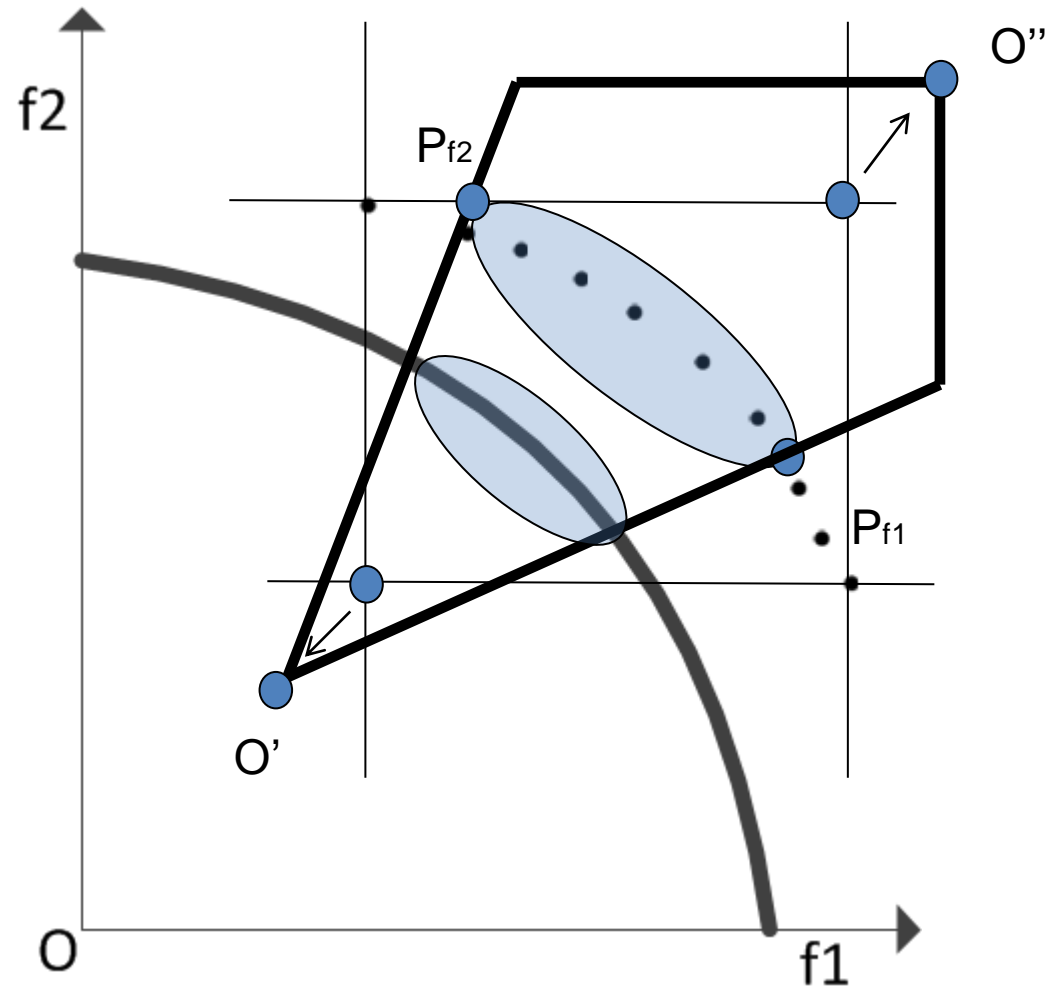
$$W = (0.4, 0.3, 0.2, 0.1) ;$$

$$\Theta = 15$$

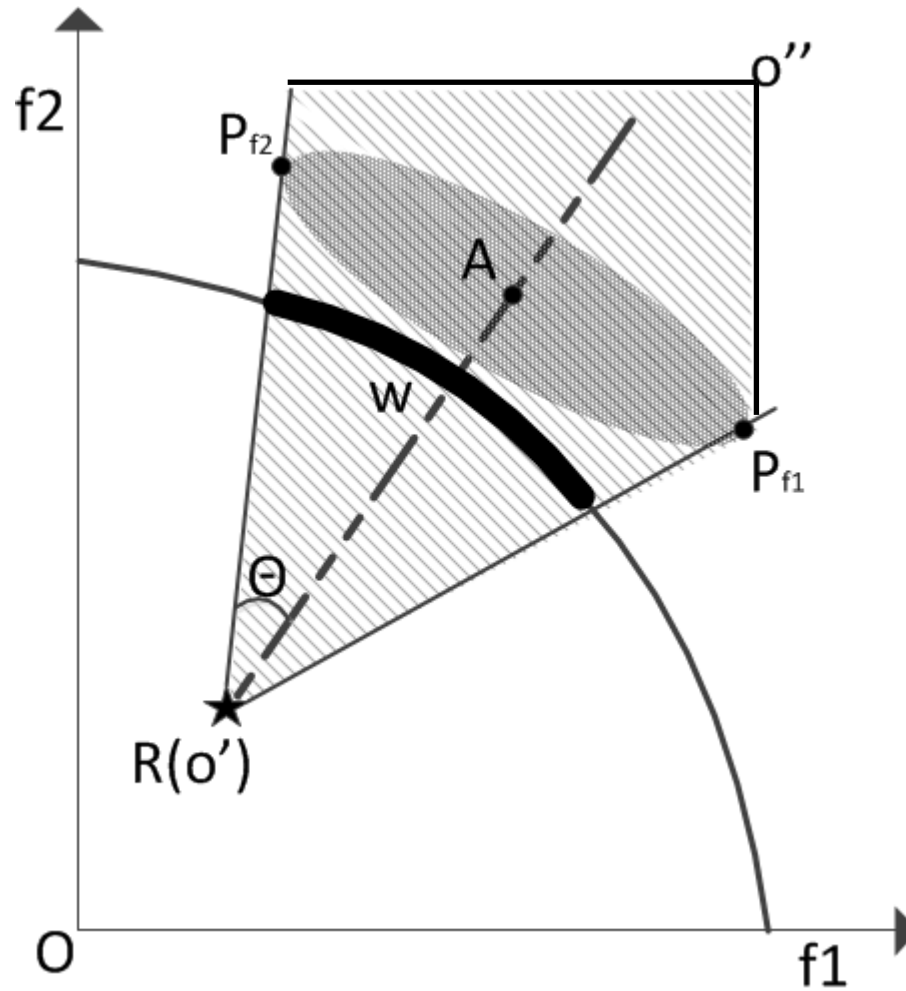


Q is the Pareto optimal solution along the direction of **w**

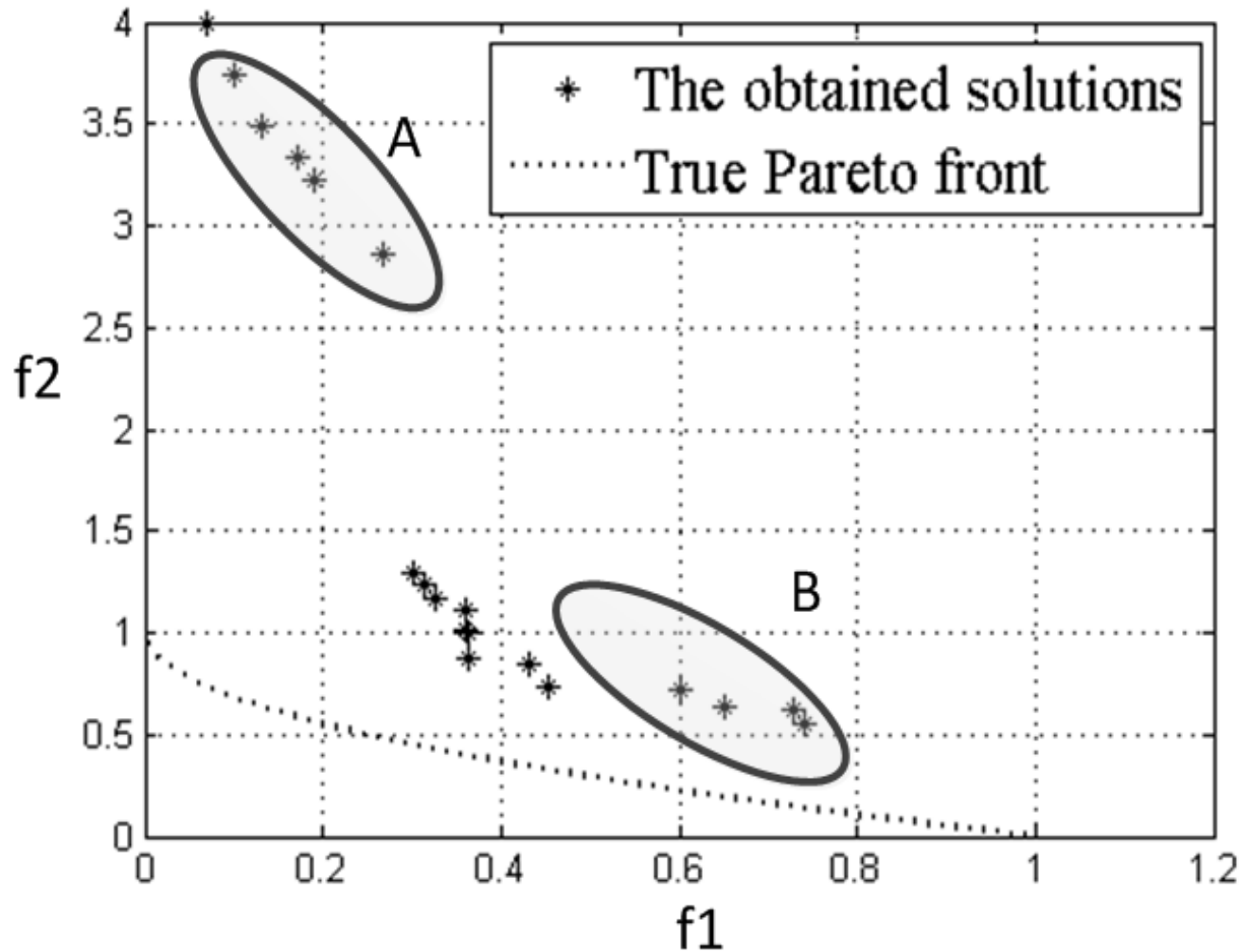
Search with a *brushed* region



Search with a *brushed* region



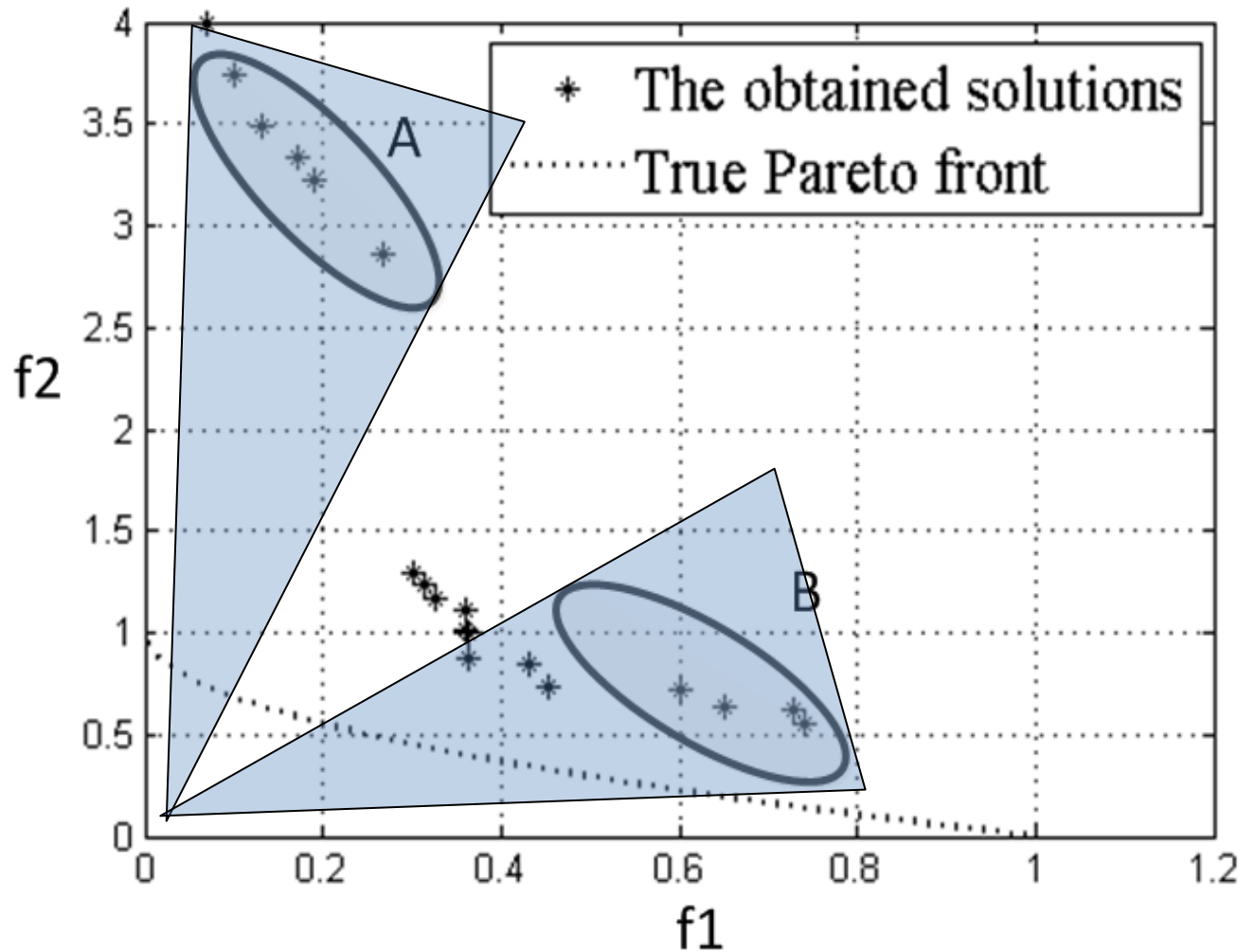
An example



■ Step 1:

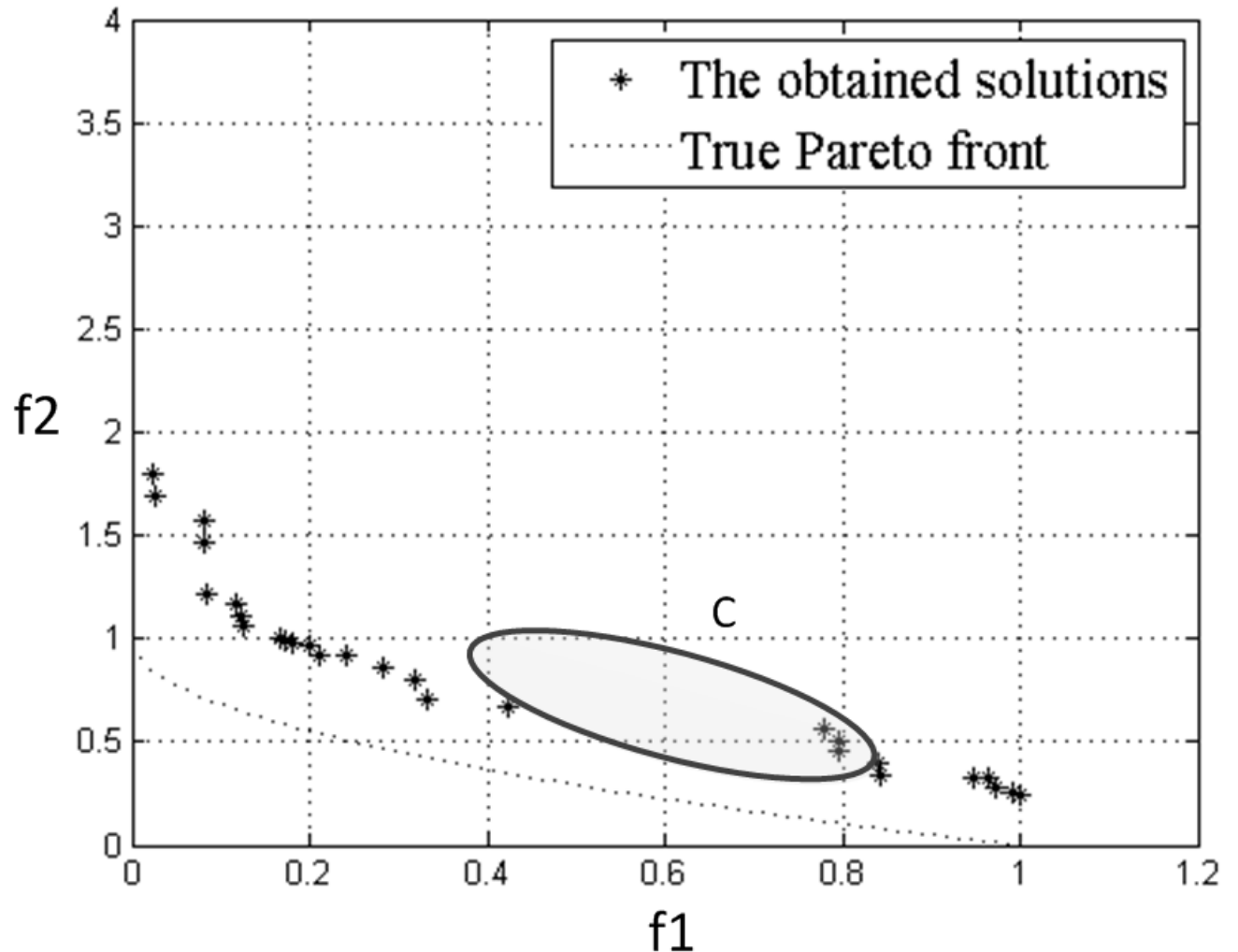
An example

- Step 1:



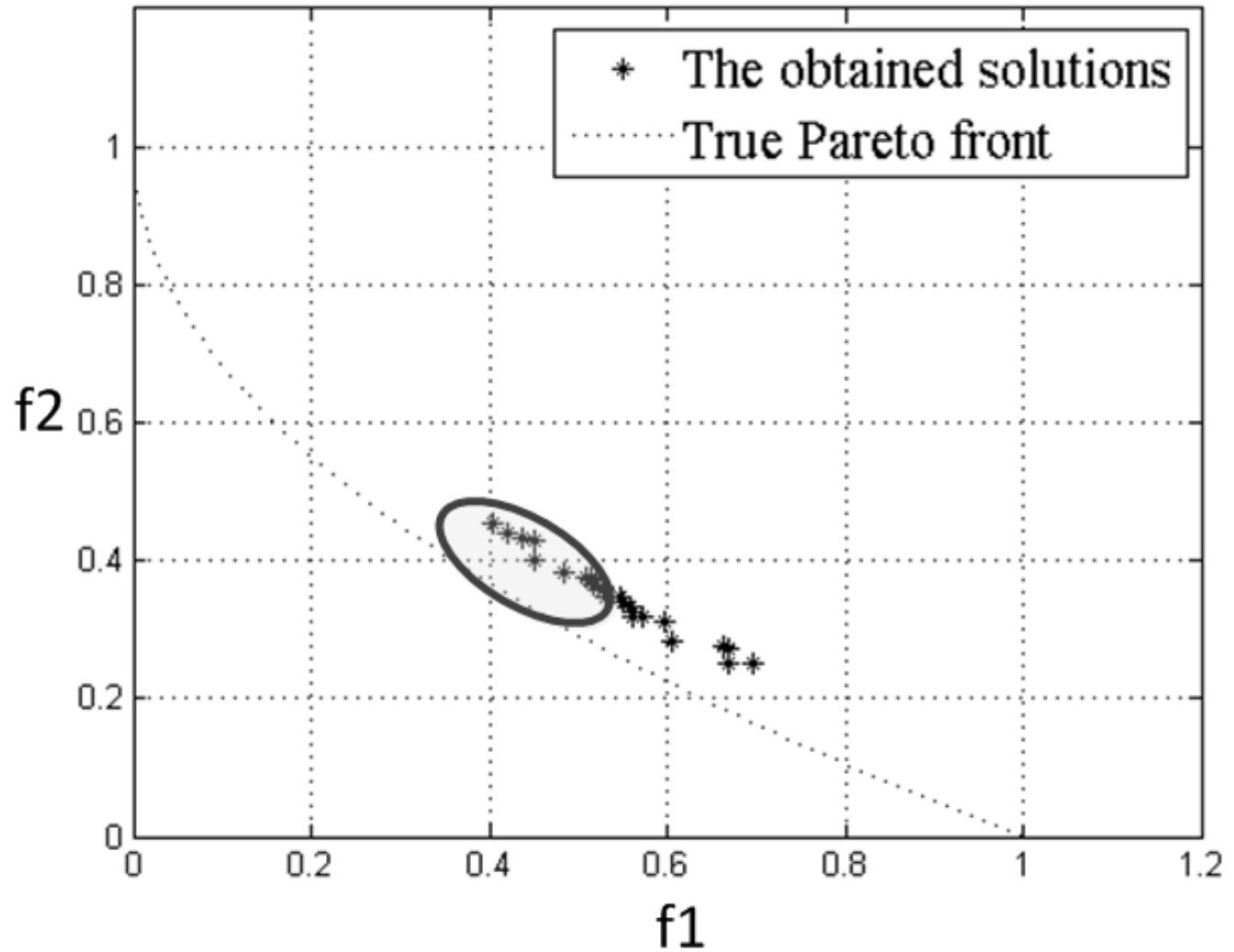
An example

- Step 2:



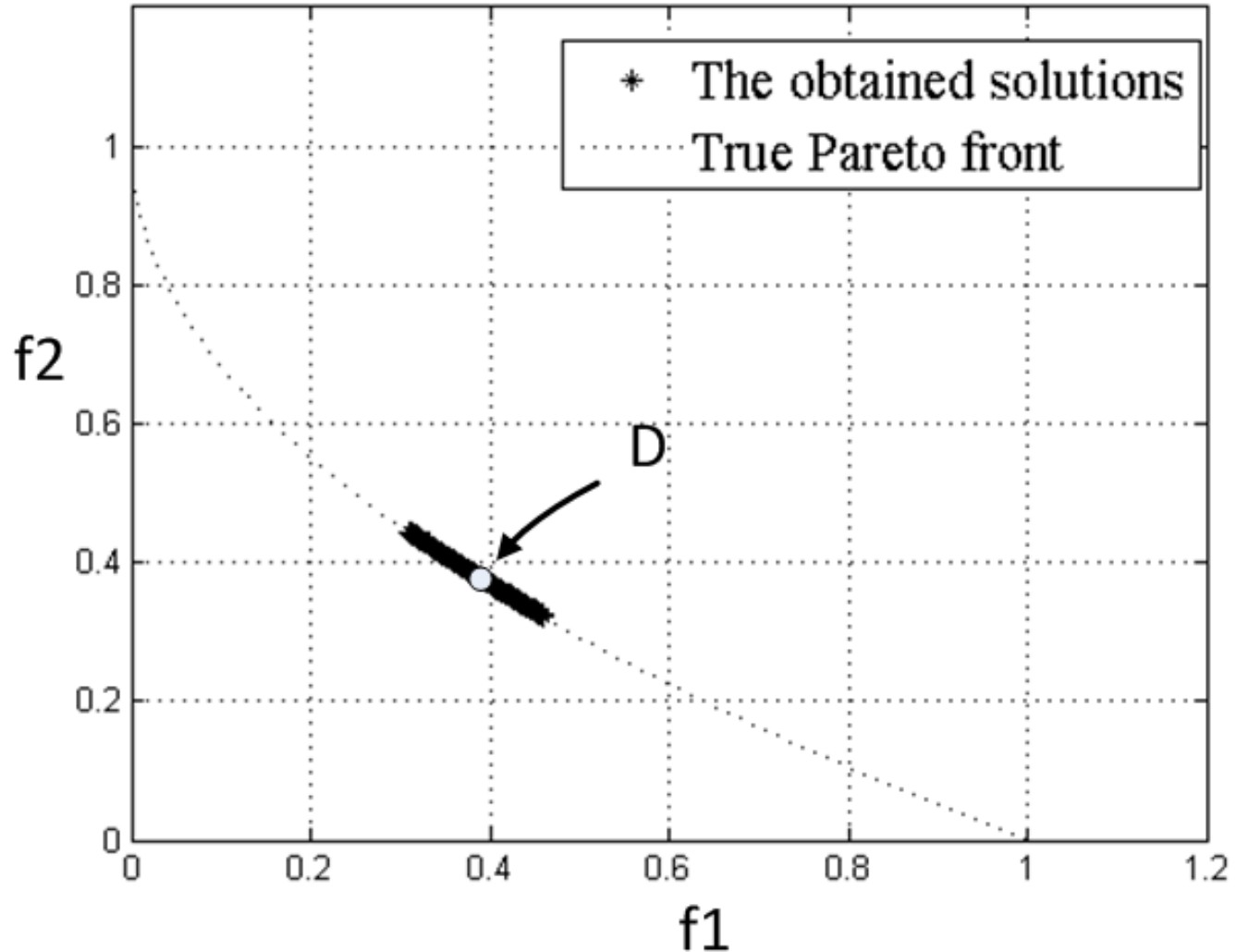
An example

■ Step 3:



An example

- Step 4:



Summary

- What we have done:
 - A unified approach to articulate DM preferences
 - A new preference-based MOEA, i.e. iPICEA-g.
- Future work:
 - Group decision making
 - Fuzzy preference