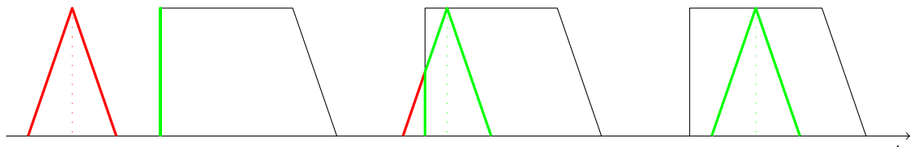
MULTIOBJECTIVE FUZZY APPROACH TO THE VEHICLE ROUTING PROBLEM WITH TIME WINDOWS

Przemysław Wesołek Marek Kubiak

Poznan University of Technology, Poznań, Poland

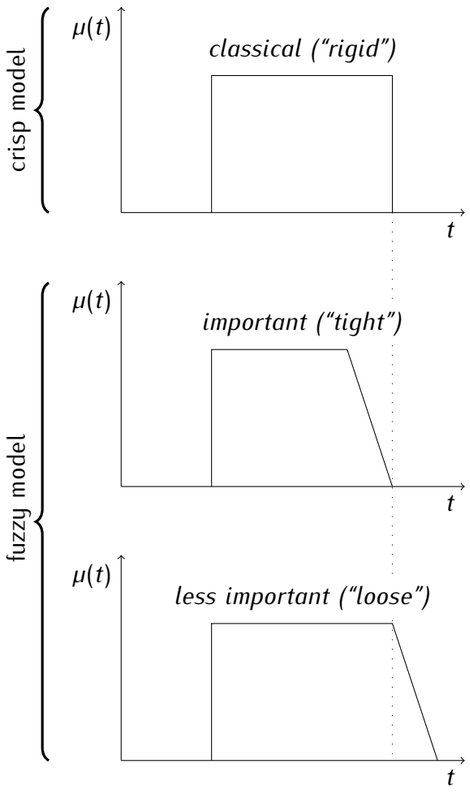
Fuzzy VRPTW

Service start times

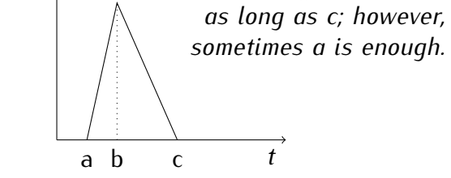


- arrival before time window
- service starts at the beginning of time window
- arrival during allowed time window
- service start is "clipped" by the start of time window
- arrival during allowed time window
- service start = arrival time

Models of customer time window



Intuitive uncertain travel times



The travel is most likely to take b, although it can last as long as c; however, sometimes a is enough.

The problem contains two objectives:

- maximization of satisfaction
- minimization of cost

Motivation

No diversity → no choice

- no option for a DM: only one solution (the best one?)
- the best solution is the magic one (w.r.t. one objective)

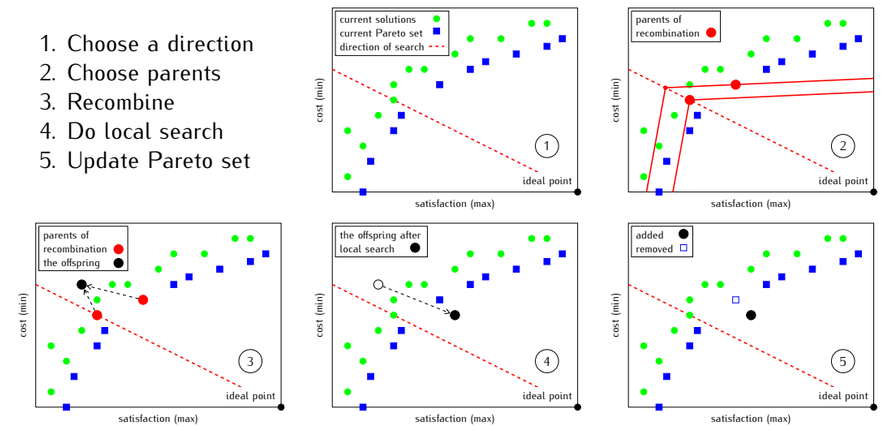
Unrealistic assumptions

- deterministic parameters, e.g. travel times, are unrealistic
- stochastic models contain too strong assumptions

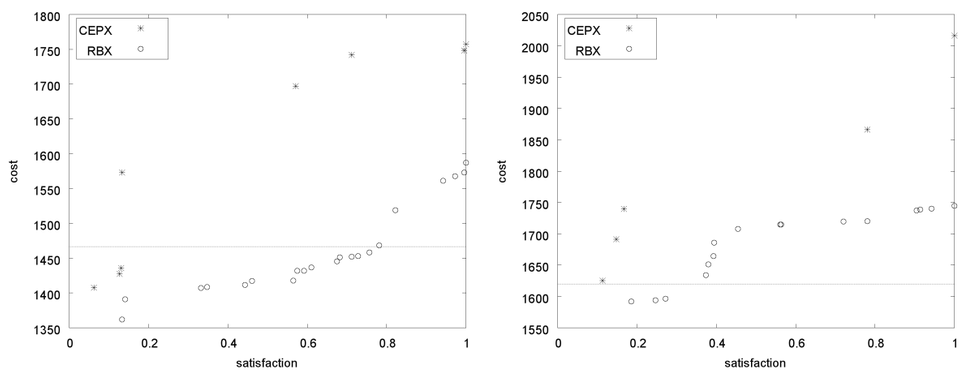
Pareto Memetic Algorithm

Main loop of the multiobjective evolutionary algorithm

1. Choose a direction
2. Choose parents
3. Recombine
4. Do local search
5. Update Pareto set



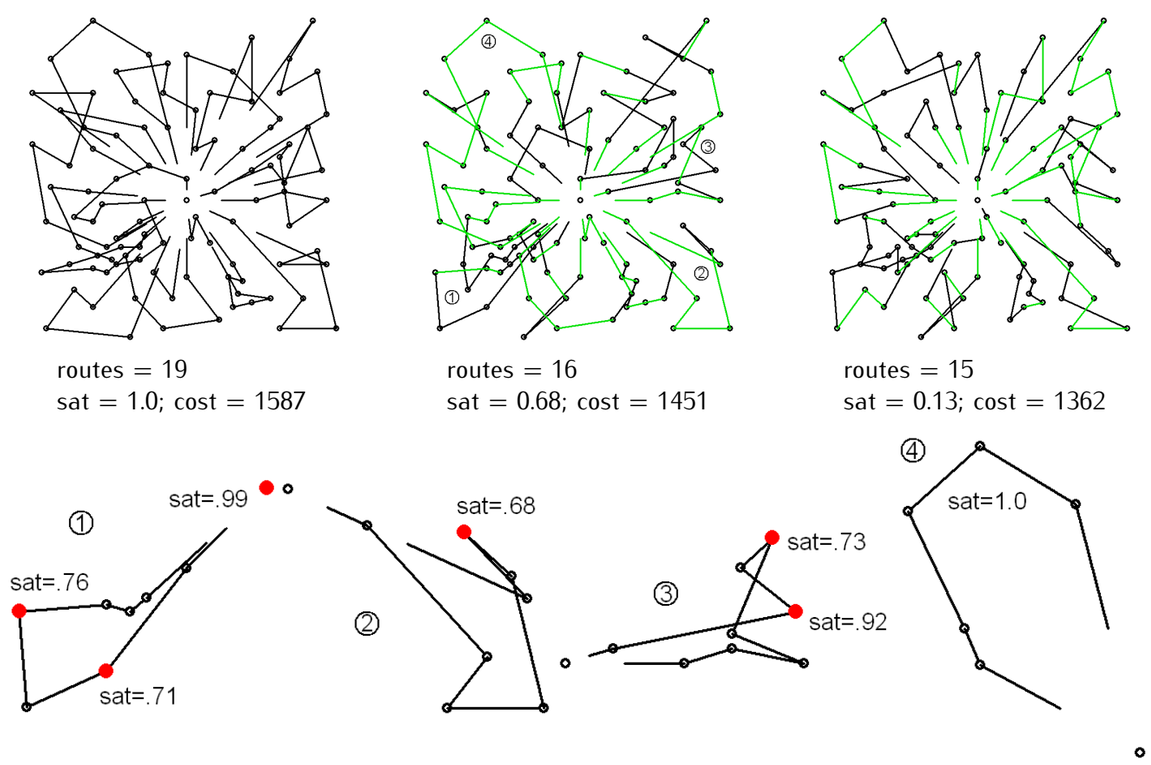
Main results



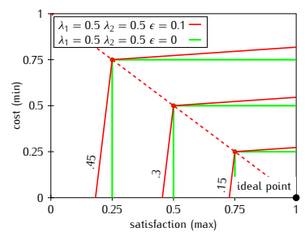
Advantages

- diversified solutions
- lower cost and satisfaction vs. high cost and satisfaction
- possibility of choice of a solution
- possibility of renegotiation of time windows

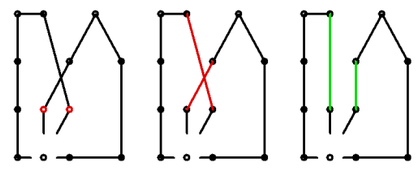
Examples of solutions from a Pareto set



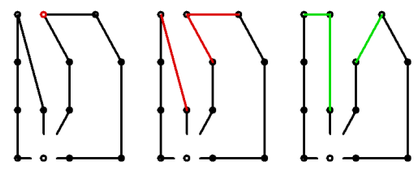
Achievement scalarizing functions



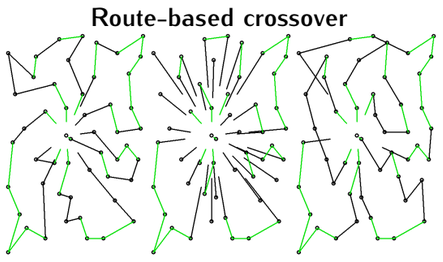
Local search: exchange of two customers



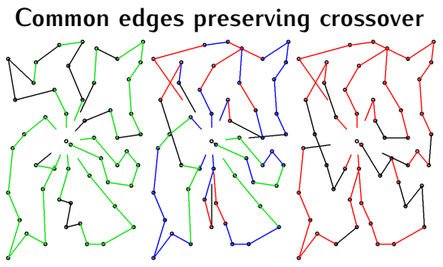
Local search: relocation of a customer



Route-based crossover

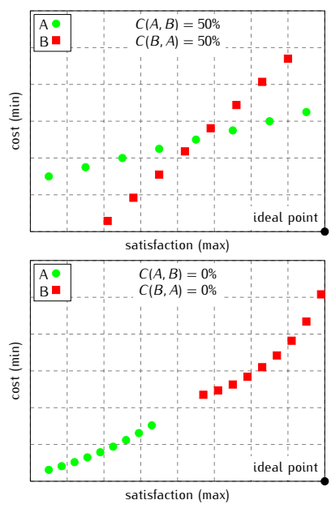


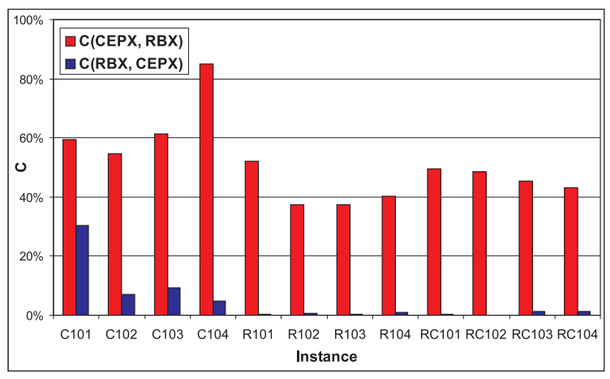
Common edges preserving crossover



Additional conclusions

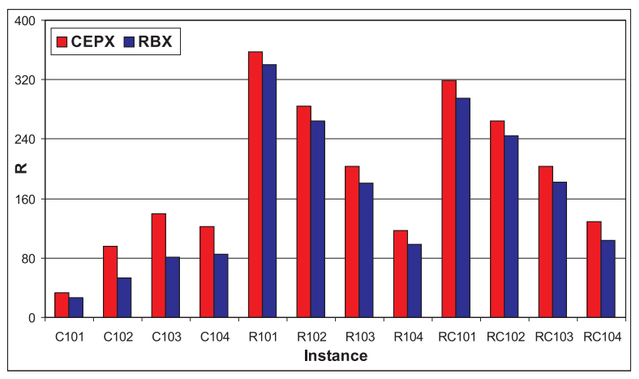
Comparison of approximations: coverage C





Comparison of instances:

- clustered instances are easier than random ones
- wide time window → easier random instances
- wide time window → harder clustered instances



Comparison of crossovers:

- RBX is random, CEPX is deterministic
- RBX is usually better than CEPX
- randomness in RBX is useful

Comparison of approximations: R measure