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Implementing Activity-Based Models - Accelerating the Replanning Process of Agents Using an Evolution Strategy

D. Charypar, K.W. Axhausen and K. Nagel

IVT ETH Zurich
VSP TU Berlin

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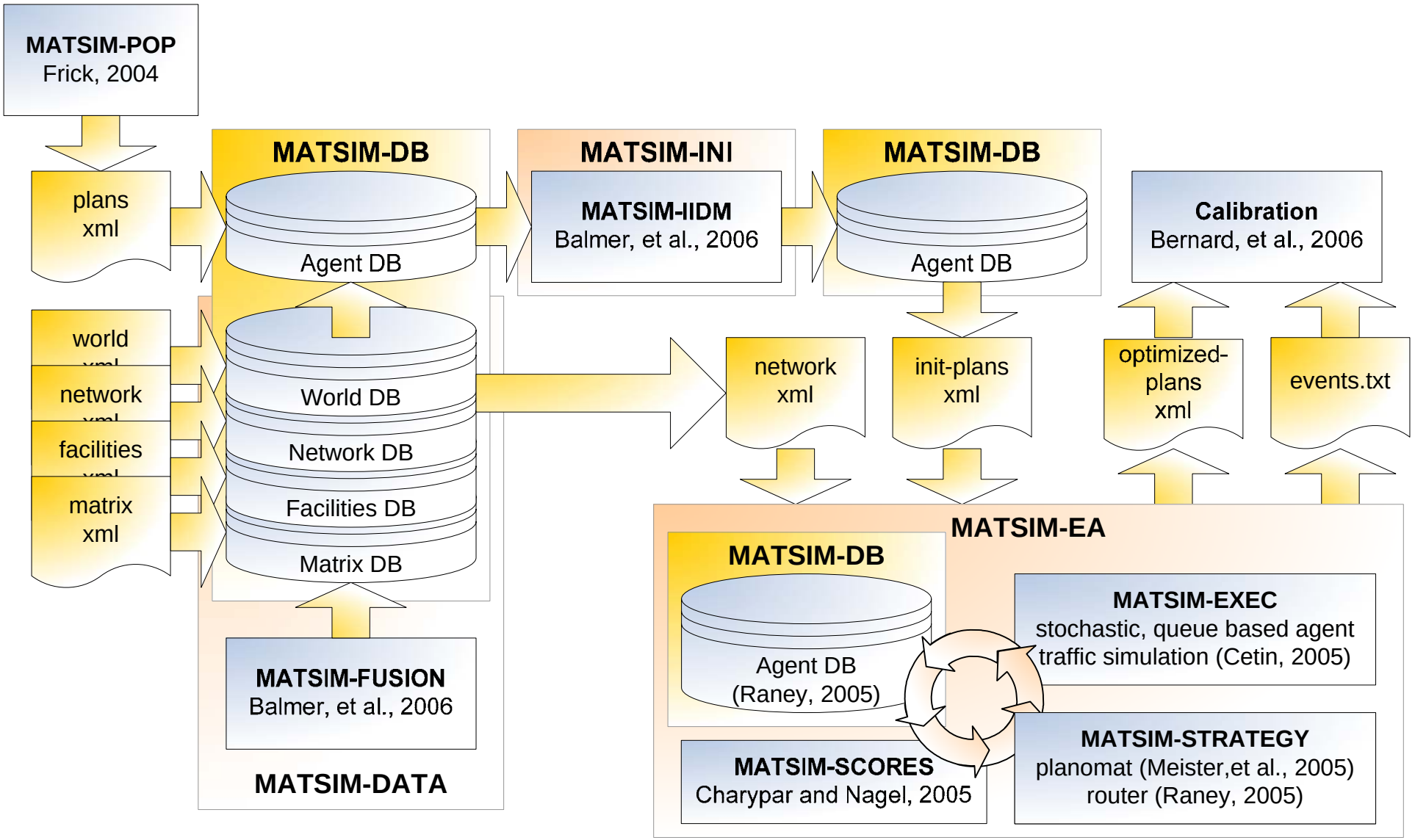
Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Overview

- MATSIM-T
- Goal
- Planomat
- Covariance Matrix Adaptation Evolution Strategy
- Learning performance
- Findings
- Further Work

MATSIM-T Process Steps

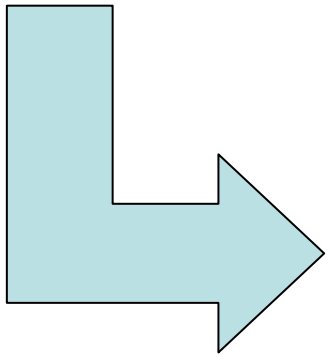


How to Get Final Daily Plans Faster

- More intelligent replanning
- Faster replanning

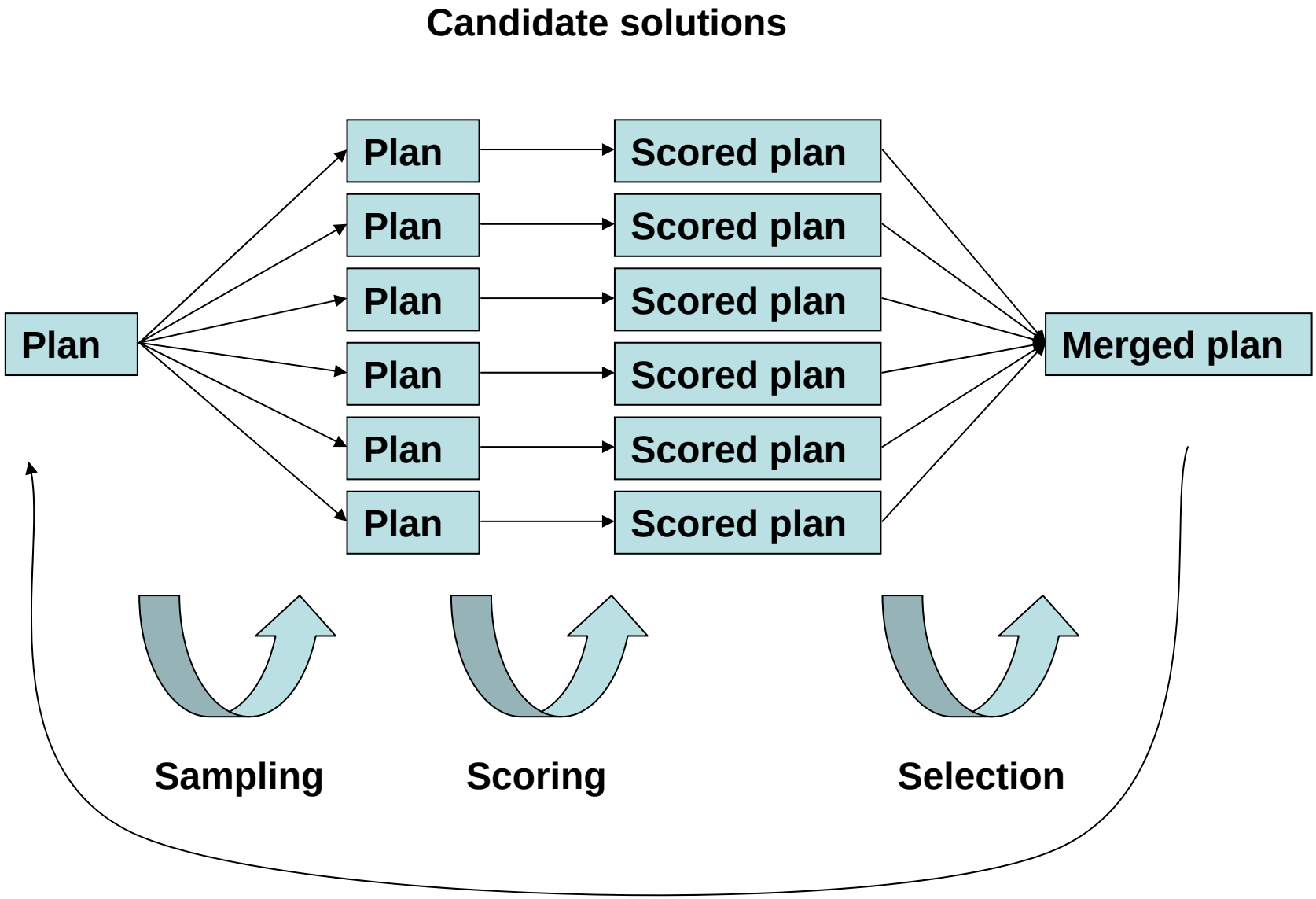
Approach

Use sophisticated algorithm to modify / adapt plans



- Higher quality of resulting plans
- Less evaluations of scoring function needed

How Planomat works



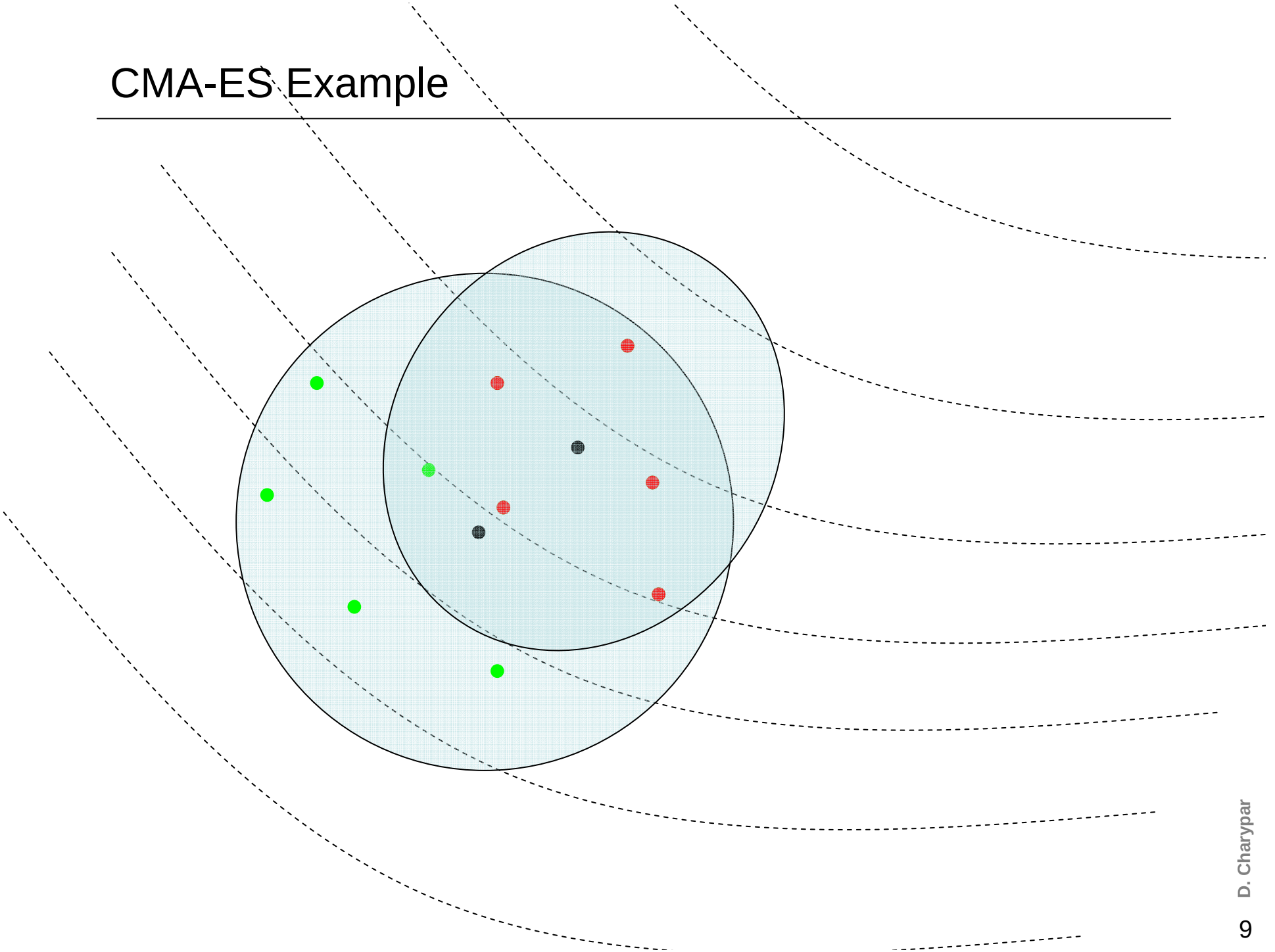
New optimization algorithm in planomat

- **C**ovariance **M**atrix **A**daptation **E**volution **S**trategy (CMA-ES)

- Estimates multivariate normal distribution around current search point to maximize evolution progress

- Step-size adaptation based on object space path length and estimated length of a random walk

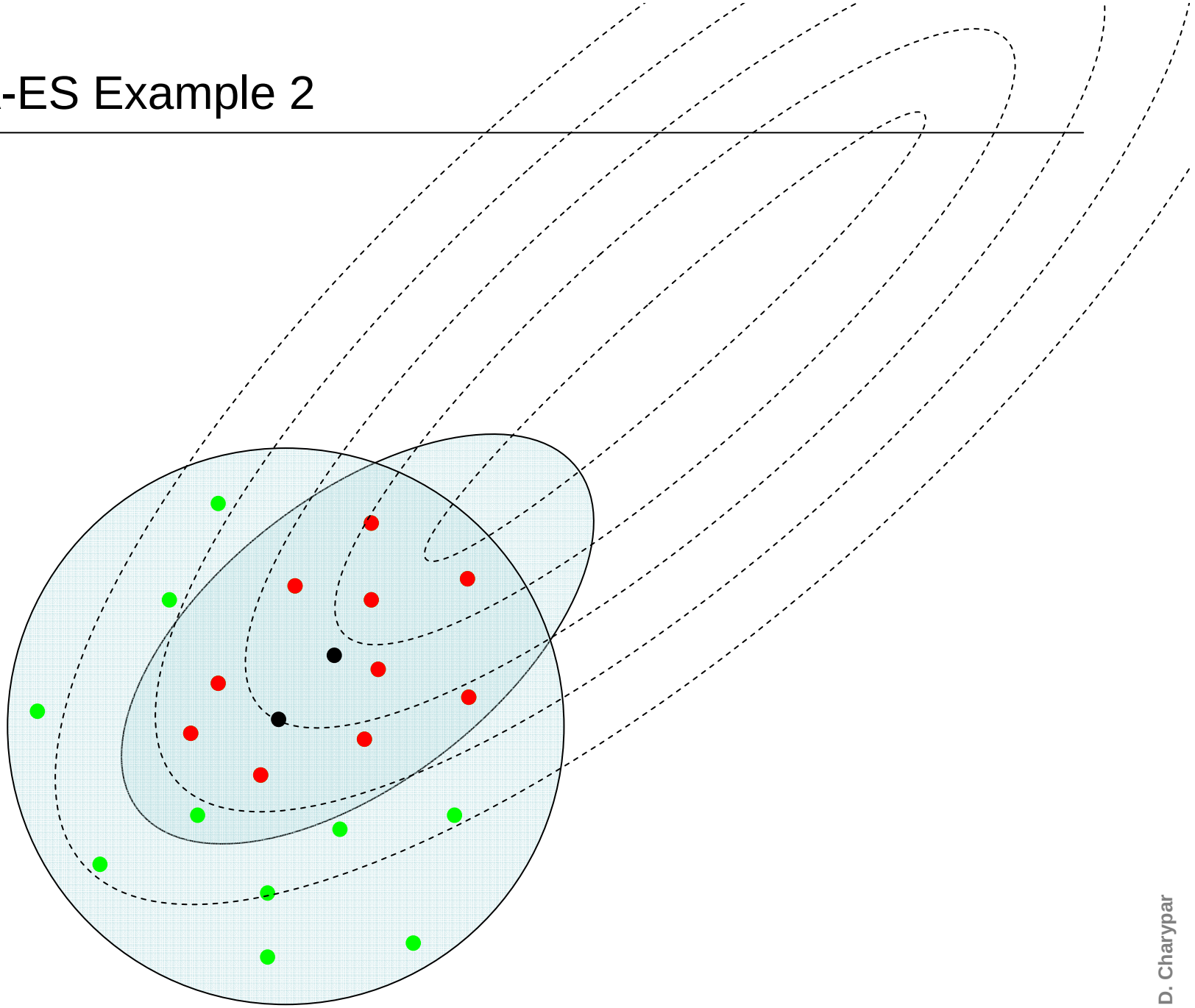
CMA-ES Example



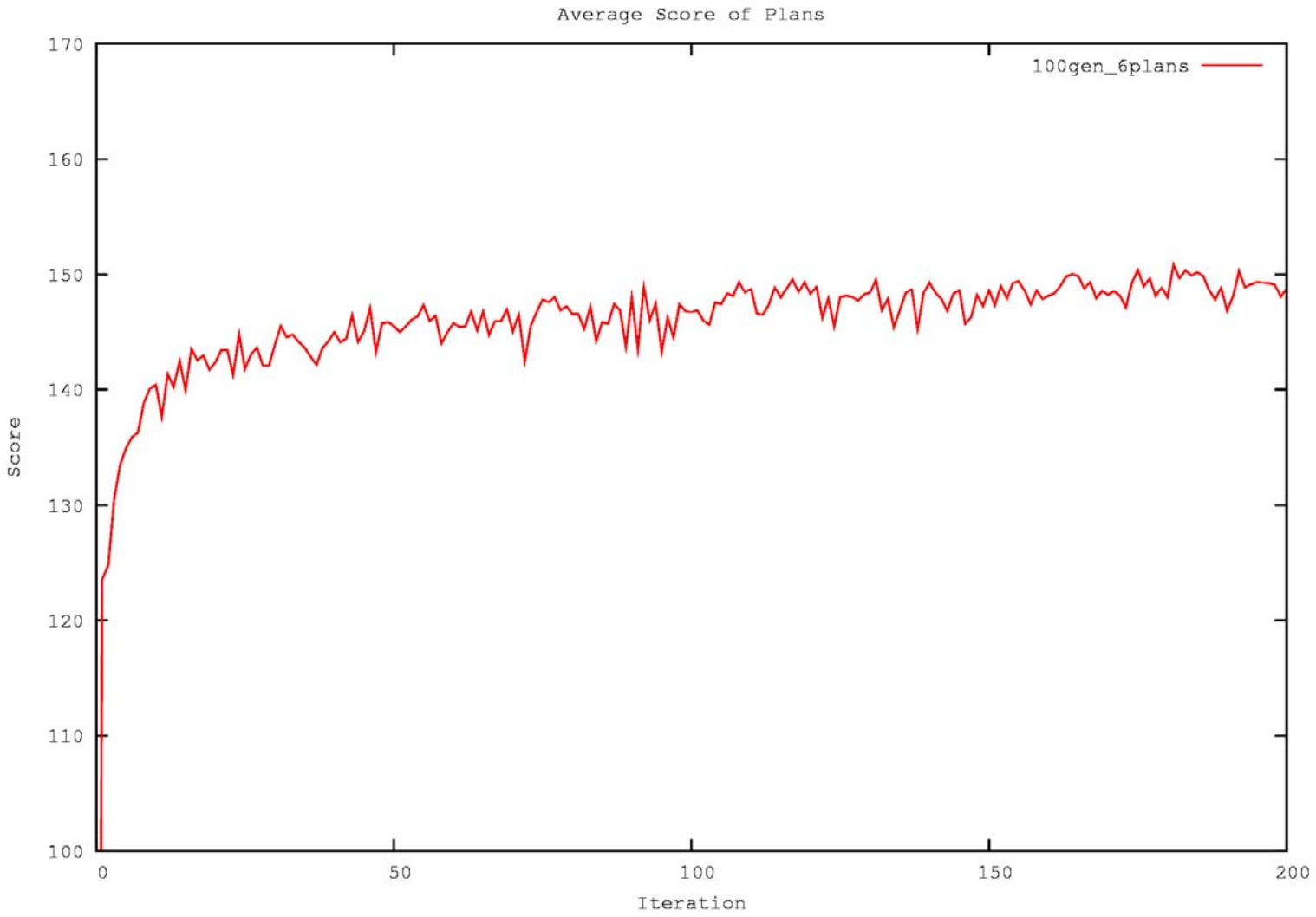
Properties of CMA-ES Optimizer

- Suited for non-linear, non-convex search problems
- Invariant to order preserving mappings of the objective function
- Can handle discontinuous, noisy search landscapes
- Able to cope with local optima
- Adapts to ill-conditioned search spaces
- Performs well on certain non-separable objective functions.
- Insensitive to any linear transformation of search space

CMA-ES Example 2

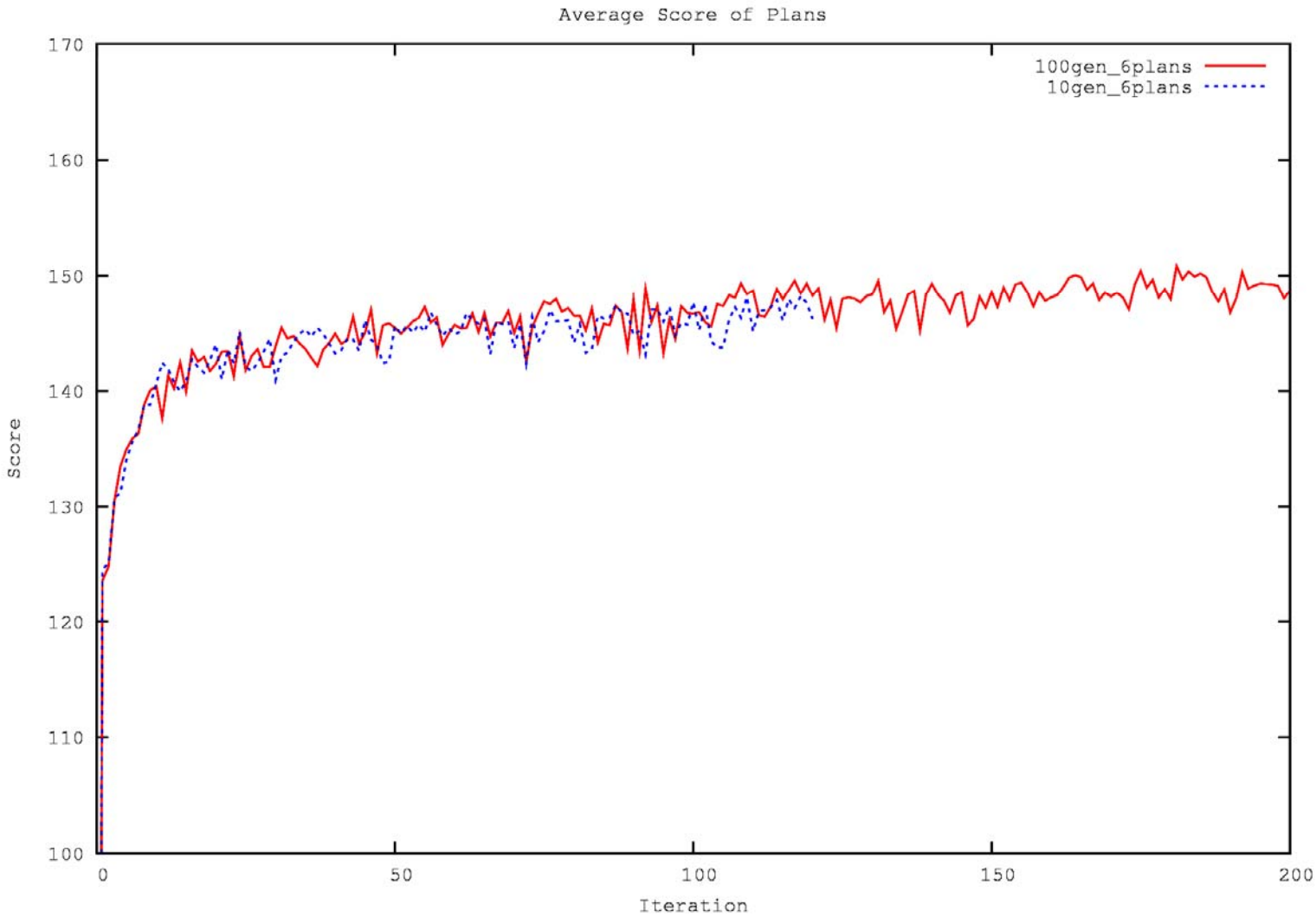


MATSIM-T Performance with Planomat-CMAES



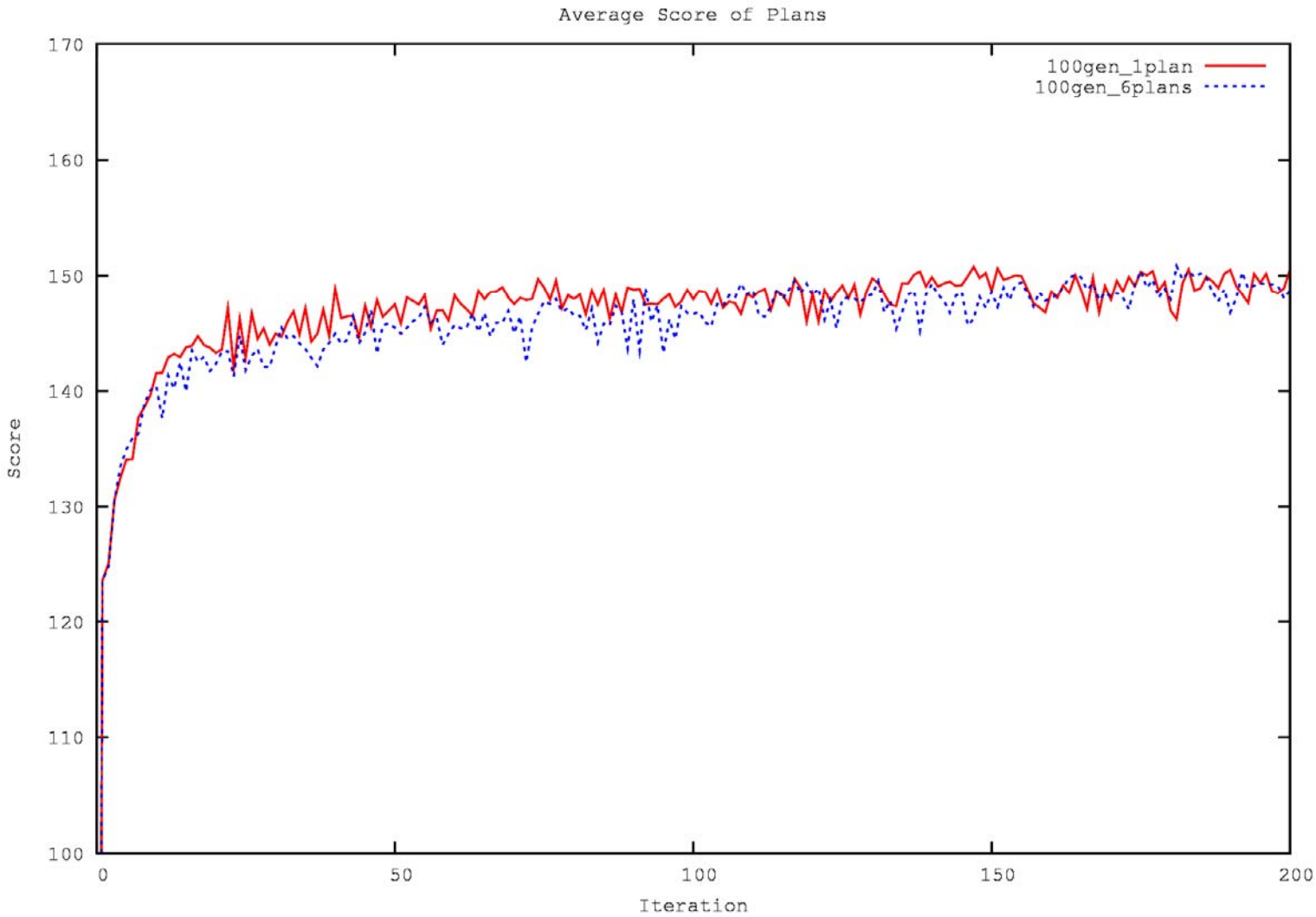
Agent DB with 6 plans per agent, p_{replan}=0.1, $p_{reroute}$=0.1, p_{random}=0.1, 100 CMA-generations

MATSIM-T Performance with Planomat-CMAES



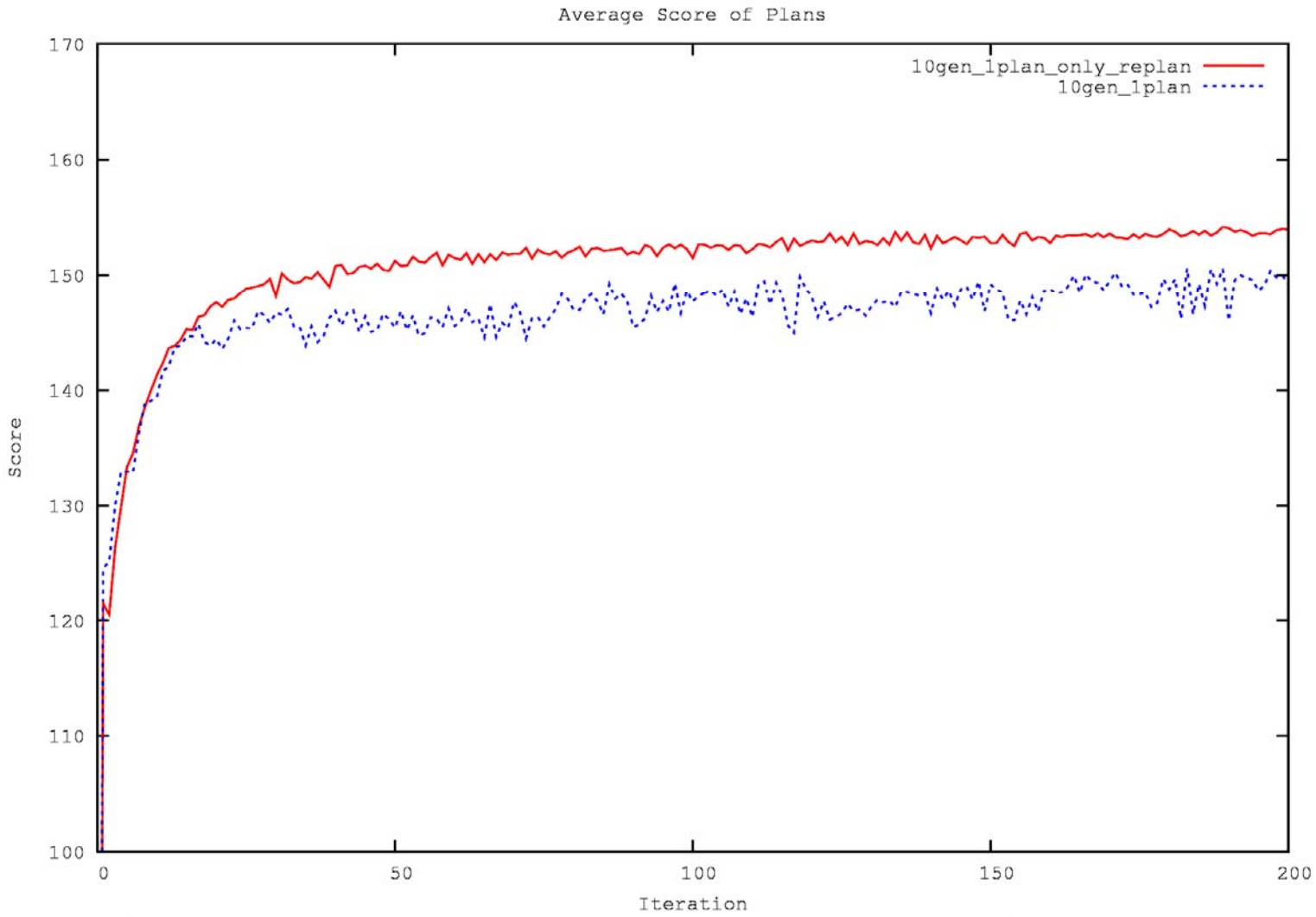
Comparison: Performance with 100 vs. 10 generations of CMA-ES evolution

MATSIM-T Performance with Planomat-CMAES



Comparison: Agent DB with 6 plans per agent vs. Agent DB with only 1 plan per agent

MATSIM-T Performance with Planomat-CMAES



Comparison: only replan vs. replan + reroute + random

Findings

- 10 generations / 100 evaluations of scoring function per agent sufficient
- Separate rerouting seems unnecessary
- Execution of randomly selected plans seems unnecessary
- Performance of learning process using MATSIM-T is not limited by quality of individual optimization of plans

Further Work

- Find optimal way of managing the replanning probability depending on state of the learning process
- Use more available information from MATSIM-EXEC in the planomat (time-dependent travel times)
- Location choice
- Mode choice
- Activity choice
- ...

Literature

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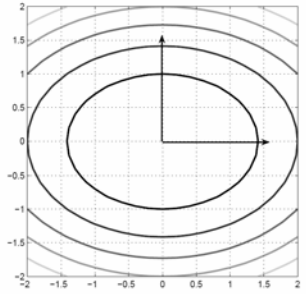
New optimization algorithm in planomat

- **Covariance Matrix Adaptation Evolution Strategy (CMA-ES)**
- **Estimates multivariate normal distribution around current search point to maximize evolution progress**
- **Stepsize adaptation based on estimated drift of a random walk**



Contour plot of $f_{H_1}(x) = \frac{1}{5}(x_1^2 + 2x_2^2)$
typical shape for ill-conditioned problems

CMA deforms the covariance matrix in the direction of good ste