Visualization of Evolutionary Algorithms
Real-World Application of Standard Techniques and Multidimensional Visualization

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Overview

- Motivation
- Result visualization
- Multidimensional scaling
- Real world application
- Summary

Motivation

Introduction

Evolutionary Algorithms

→ work with simple algorithms

→ produce vast amount of data

Problem:

extraction of useful information to provide insight into

→ state of the population,

→ progress of the Evolutionary Algorithm

Visualization of data

Goals:

→ set of standard methods for different data types

→ advanced method for multidimensional data

→ use of standard visualization methods and tools (MATLAB)

Data types in Evolutionary Algorithms

- individuals (solution vector)
  - → variables and objective value(s)
- (sub) population
  - → individuals (variables/objective values of best/all individuals)
  - → distance between individuals
  - → ranking / order and size of subpopulations
- different time frame
  - → one generation ➡ state of EA
  - → multiple / all generations ➡ course of EA
  - → multiple runs ➡ comparison of EA
- problem-specific visualization
- properties of objective function

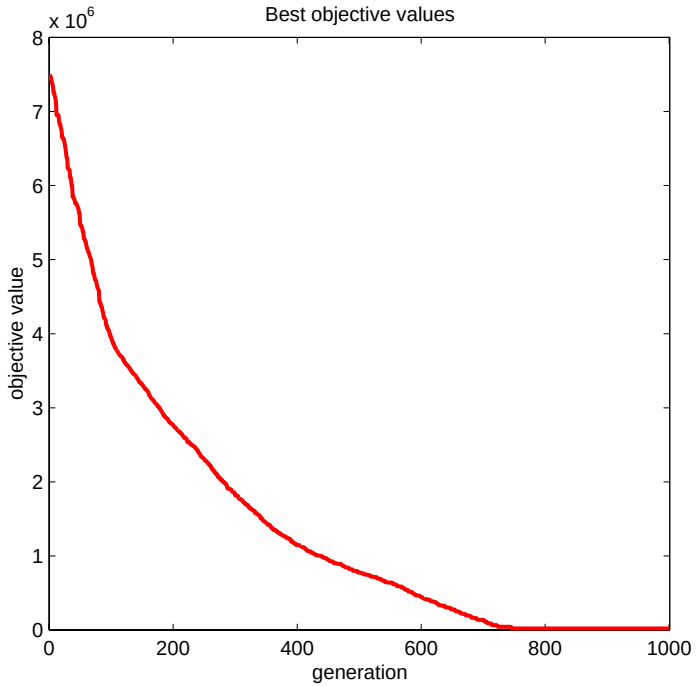
Result visualization

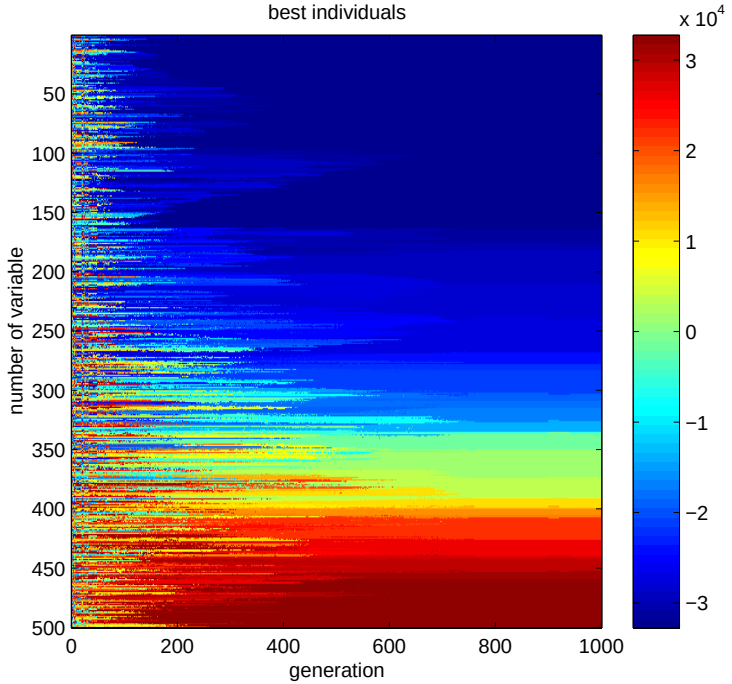
Standard results

Standard result visualization (course of optimization)

- objective value of best individual (convergence plot)
- variables of best individual

(optimization of extreme execution time of bubble sort module)





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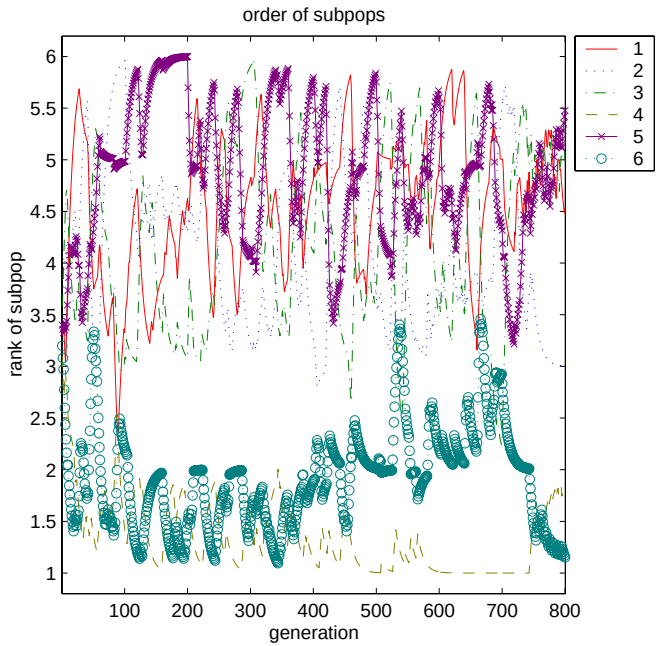
Result visualization

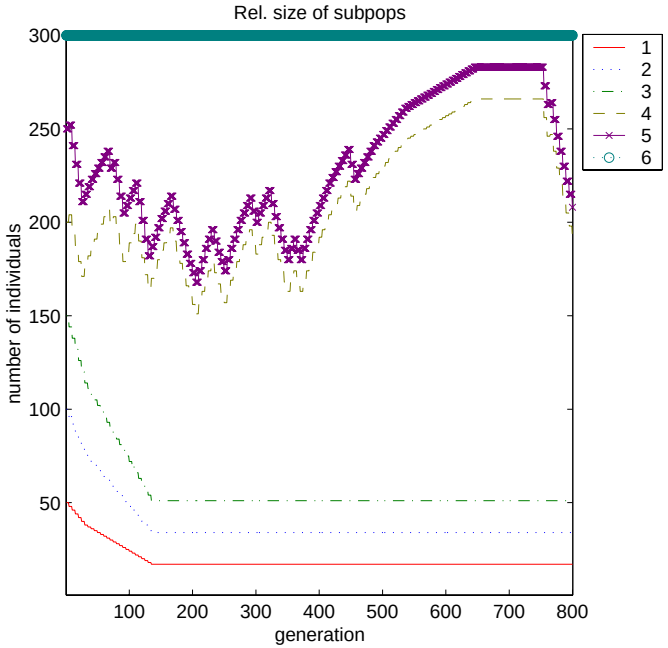
Strategy selection

Selection of successful strategies

- each subpopulation employs a different strategy (different operators and/or parameters)
- When is which strategy successful?
- next run(s) with selected strategies
  $\Rightarrow$ 140.000 instead of 200.000 objective function calls

(optimization of extreme execution time of bubble sort module)





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Advanced visualization

Comparing two runs

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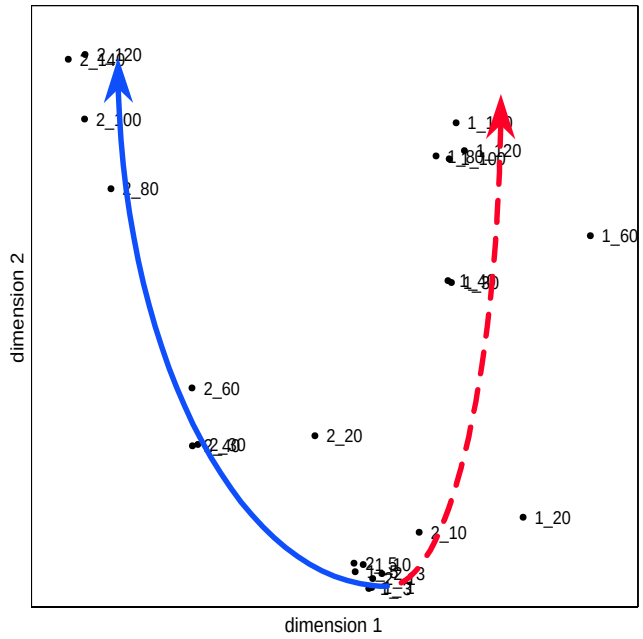
Multidimensional scaling

- comparing optimization runs
  - → variables of best individuals ("path through search space")
  - → multi criteria objective values ("path through solution space")

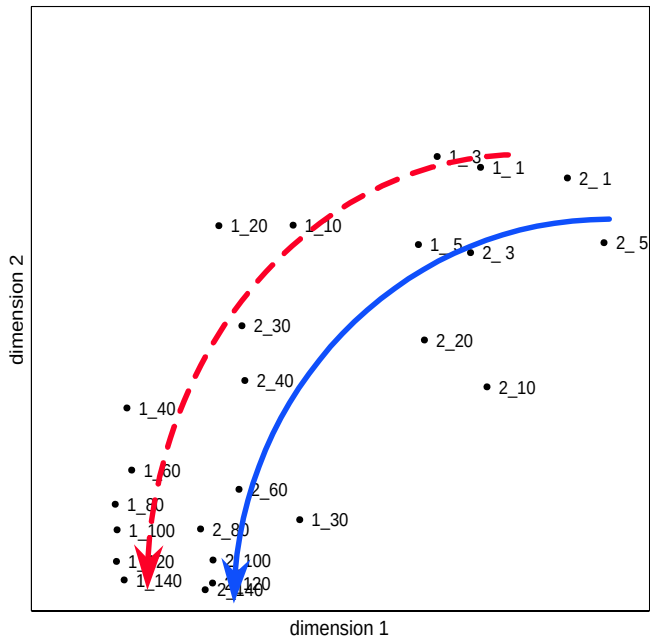
  1. run: red paths 2. run: blue paths

optimization of CHOPPER system (controller of DC-line converter)

Sammon−Mapping: comparison variables of best individuals Chopper (Nr. 54 and 55)



Sammon−Mapping: comparison best objective values Chopper (Nr. 54 und 55)

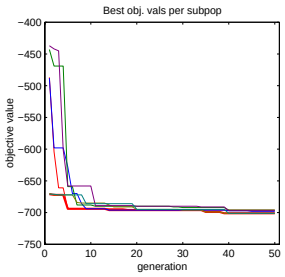


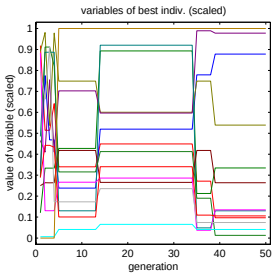
Real world application

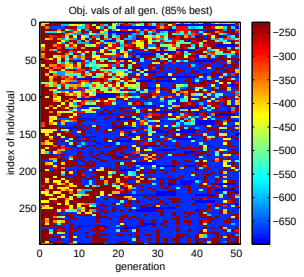
Requirements

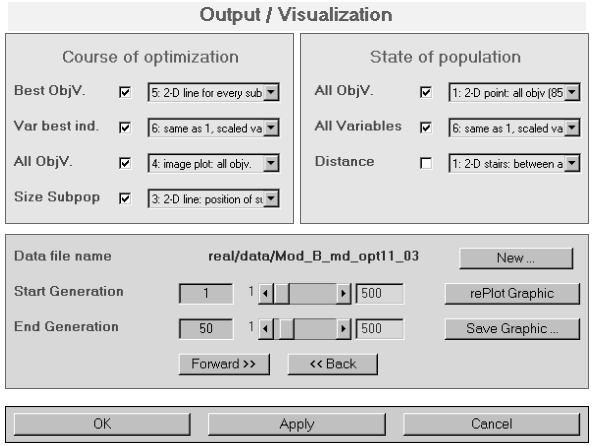
Requirements for real world application

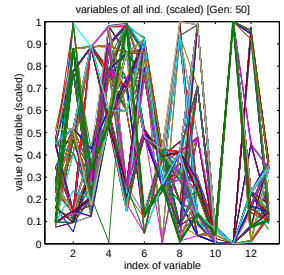
- What do we need?
  - → powerful optimization tool including operators and methods for a broad range of problems
  - → multiple access possibilities (script and GUI interface)
  - → integration of visualization methods (on-line and off-line use)

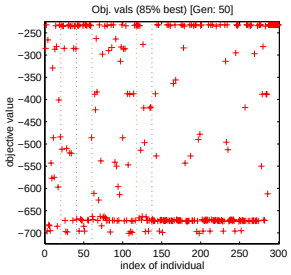


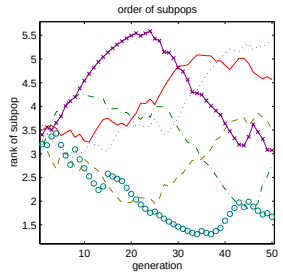












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Gopt(63) =564613;

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Real world application

Graphical user interface

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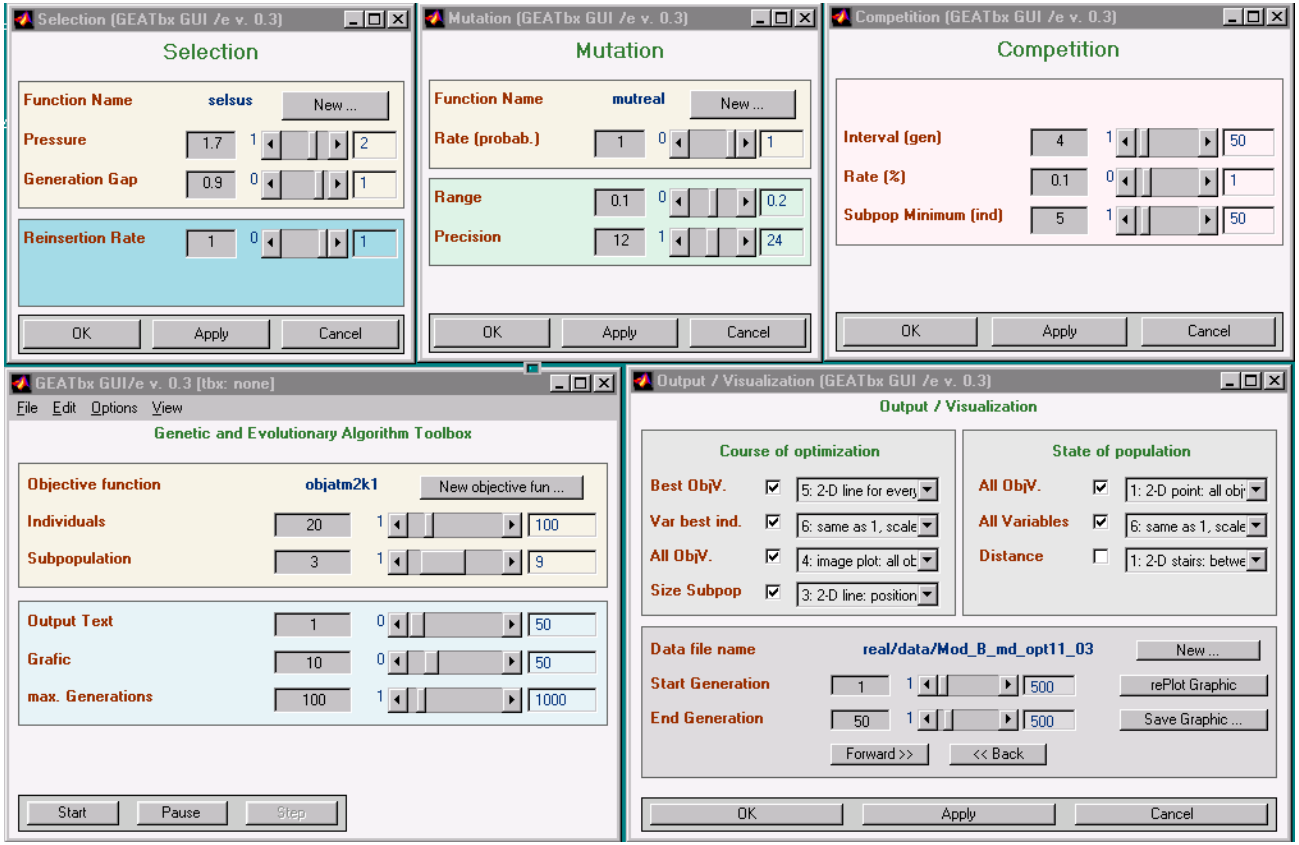
Graphical User Interface (GEATbx)

- access to all operators and options (including visualization) before and during an optimization



Real world application

Problem-specific visualization

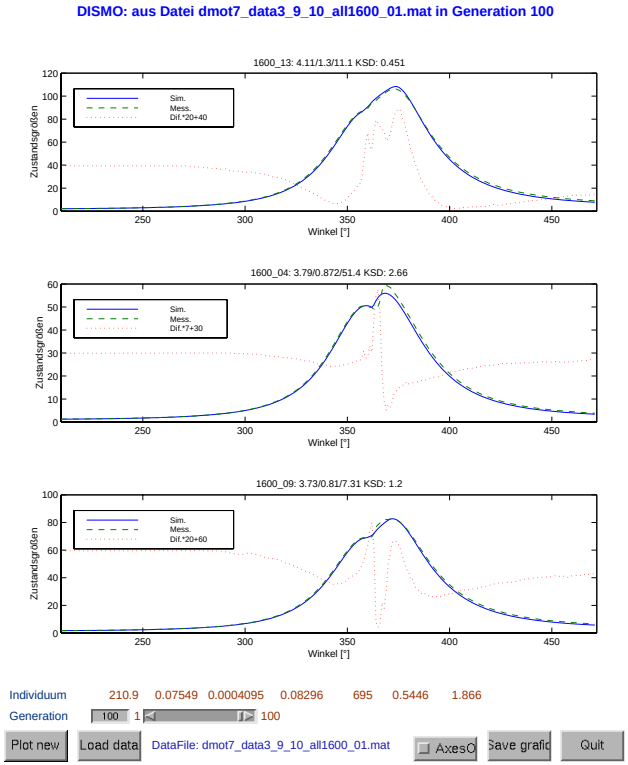
Visualization of problem-specific results

- variables are the smallest unit of the EA

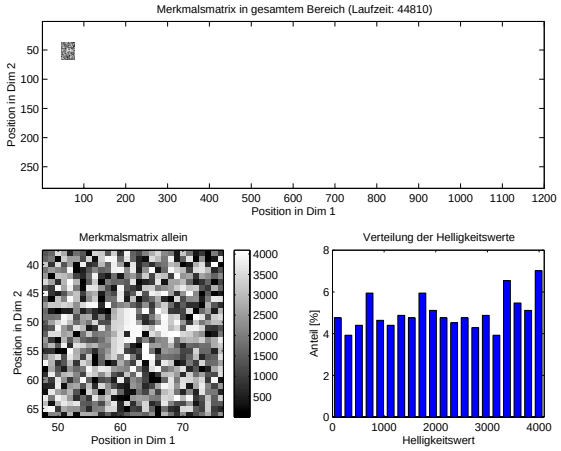
but: complex problem-specific meaning of variables

⇒ tailored visualization methods needed

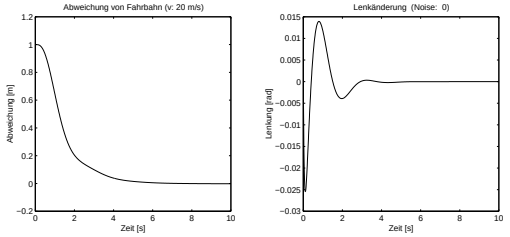
parameter identification of diesel engine model



execution time of feature extraction modul



lateral controller of an autonomous road vehicle



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Summary

Advantages

Visualization methods for Evolutionary Algorithms

Advantages:

- → baseline for understanding the evolutionary process
- → insight into the work of the Evolutionary Algorithm
- → powerful visualization tools to aid the designer and user of Evolutionary Algorithms

Application to real world problems proved successful

- → result visualization
- → selection of successful strategies
- → comparison of highdimensional data
- → problem-specific visualization

example implementation

"Genetic and Evolutionary Algorithm Toolbox for use with Matlab"
http://www.geatbx.com/index.html