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

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)
Motivation

Data types

• 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

Visualization of EA
real-world application

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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)
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
  ⇒ 140.000 instead of 200.000 objective function calls
    (optimization of extreme execution time of bubble sort module)

Visualization of EA real-world application

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Advanced visualization

Comparing two runs

Visualization of EA real-world application

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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

- 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)

### Visualization of EA real-world application

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**Requirements for real world application**

- Best obj. vals per subpop
- Variations of best ind. (scaled)
- Obj. vals of all gen. (85% best)
- Variables of all ind. (scaled) [Gen: 50]
- Input / Visualization
- Gopt(62) = 111111;
- Gopt(63) = 564613;
Real world application

Graphical user interface

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

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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

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