Evolutionary Algorithms
Software

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Outline

1. Evolving Objects: Evolutionary Computation Framework

2. JGap: Java Genetic Algorithms Package

3. ECJ - Evolutionary Computation Java

4. EASEA

5. EvA2
Überblick
[Keijzer et al., 2002]

- Template-based C++ - Library
- very large kit of modules for EAs
- unrestricted combination of modules
- easy to expand
Overview
[Keijzer et al., 2002]
Representation of individuals

Many predefined representations of individuals:

- binary-Strings
- permutations
- vectors
- lists
- ...

Moreover, very easy to adapt on user-defined data structures
Paradigms to develop

Referring to the lecture, there are many paradigms implemented:

• Evolutionary Strategies
• Genetic Algorithms
• Particle Swarm Optimization
• …
Methods on selection

Implemented methods for selection:

- Rank based
- Deterministic or stochastic Tournaments
- Roulette
- Elitism
- ...
Genetic Operators

Ready-to-use Operators:

- Uniform Initializer ($0 \to n$)
- Gaussian Mutation ($1 \to 1$)
- Subtree-Crossover ($2 \to 2$)
- ...
- arbitrary $n \to m$ operators realizable
Summary

• very fast and flexible library
• can be easily adapted to user demands
• 2001 first publication, since then continuous development
• Plattform-independent

• [http://eodev.sourceforge.net](http://eodev.sourceforge.net)
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JGap
Java Genetic Algorithms Package [Meffert, ]

- Java-library for genetic algorithms and genetic programming
- some predefined operators
- many examples
- Tutorials and JavaDoc
Scientific background

- JGap is heavily used in university/scientific context

- Dissertations
- Diploma thesis
- Conference paper
- ...
Genetic Programming

- specialisation on genetic programming
- creates Java-class
- based on JUnit-Tests

- **RobocodeJGAP**: GP-Project with focus in robot programming
Summary

- Java-library with scientific background
- many examples

- **Demo:** Monalisa-Painting-App (tries to paint the Mona Lisa with simple triangles)

- [http://jgap.sourceforge.net](http://jgap.sourceforge.net)
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A Java-based Evolutionary Computation Research System

- Java-based Framework for evolutionary algorithms and genetic programming
- many predefined functions and operators
- specialization on genetic programming
- written in Java - plattform independent
Features

- embedded GUI (unfortunately not easy to use)
- Hierarchical parameter files where important configurations of the EA can be made
- Multithreading
- distribution of computations over several computing machines (with exchange of individuals via Island Model)
Paradigms

- Genetic Algorithms
- Genetic Programming
- Evolutionary strategies $(\mu, \lambda)$ und $(\mu + \lambda)$
- Differential Evolution
- Particle Swarm Optimization
Operators

Große Auswahl an:

- Initializing factors
- Selection methods (with or without elitism)
- preimplemented mutation and crossover operators
Genetic Programming

- Preference on genetic programming
- primarily tree representation but predefined grammar can be used, too
- rather functional programs (Composition of mathematical functions) than linear programs (Scripts, Loops, Branch operations)
- can handle strong typed functions but also automatical defined functions and macros
Summary

- very powerful and popular framework
- Java-Base
- huge community


- Further links to other frameworks on the website.
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EASEA - EAsy Specification of Evolutionary Algorithms

- Plattform for Evolutionary Algorithms
- Evolutionary algorithm can be defined in a special language
- special compiler transfers EA in a set of C++ files
- special optimizations for Multicore-, Distributed systems and computations on graphic cards/accelerators
Parallelising over $n$ GPGPU cards

Parallelizing over $n$ machines
• many elements of the EA are already implemented
• user-defined adaptations and operators can be realized easily
• compiled C++ files can be embedded in a larger, user project
• many parameter of the EA can be set easily via several configuration files

• http://easea.unistra.fr/easea
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EvA2

- Java-based framework for Evolutionary Algorithms
- GUI to specify all the parameters of the EA
- Own classes can be loaded into GUI (development via special API)
- Many opportunities to evaluate and compare between different algorithms
- Developed in university context (Uni Tübingen), strong application in scientific context (usage in at least 40 publications)
### TSP Example

Given a finite number of cities along with the distance between each pair of them, find the cheapest way of visiting all the cities and returning to your starting point.

<table>
<thead>
<tr>
<th>EAindividual</th>
<th>OEGA Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSPInstance</td>
<td>eil102</td>
</tr>
<tr>
<td>doLocalSearch</td>
<td></td>
</tr>
</tbody>
</table>

**EvA2 workbench**

- **Optimization parameters**
- **Statistics**

**Info**

- Select the optimization parameters

**Instance Name**

- eil101

**Comment**

- 101-city problem (Christofides/Eilon)

**Metric**

- Euclidian

**Best found**

- 6537186257520664

**Cutout**

- showed Colors
- showed nodes
- showed edges
- zoom in
- zoom out

**Polygonal view**
Paradigms

- (Multi Start) Hill Climbing, Simulated Annealing
- Evolutionary strategies
- Genetic Algorithms
- Differential Evolution
- Particle Swarm Optimization
- Niche-based approaches
- ...
Application - Examples

- university context, teaching
- **Daimler AG**: automatical transmission optimizations
- **The Bosch Group**: Optimizations of Job-Shop-Scheduling problems
- further companies

- Systems Biology Toolbox for MATLAB
- JCell (Intra-cellular process simulation)
Summary

- Java Framework with own GUI
- widely used in university context
- supports analysis and experiments of different algorithms

- [http://www.ra.cs.uni-tuebingen.de/software/JavaEvA](http://www.ra.cs.uni-tuebingen.de/software/JavaEvA)
Further reading I

Evolving objects: A general purpose evolutionary computation library.

Meffert, K.
Jgap - java genetic algorithms and genetic programming package.
http://jgap.sf.net.