INF FAKULTÄT FÜR INFORMATIK

Evolutionary Algorithms

Software

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Outline

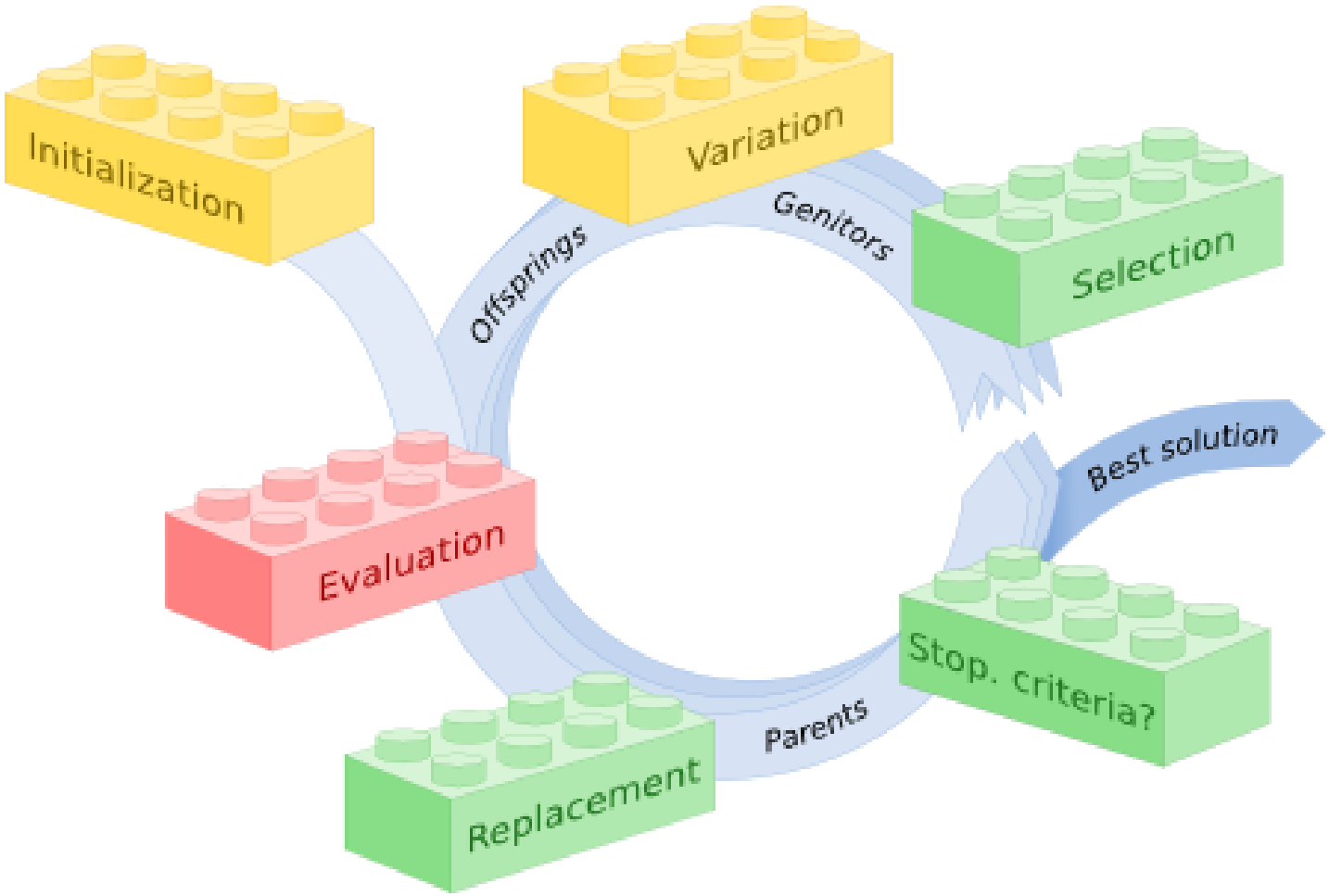
Überblick

[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 ($0 \rightarrow n$)
- Gaussian Mutation ($1 \rightarrow 1$)
- Subtree-Crossover ($2 \rightarrow 2$)
- ...
- arbitrary $n \rightarrow m$ operators realizable

Summary

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

- `http://eodev.sourceforge.net`

Outline

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 universary/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`

Outline

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 (μ, λ) 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

- `http://www.cs.gmu.edu/~eclab/projects/ecj/`

- Further links to other frameworks on the website.

Outline

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

EASEA


Parallelising over n GPGPU cards
Parallelizing over n machines

EASEA

- 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

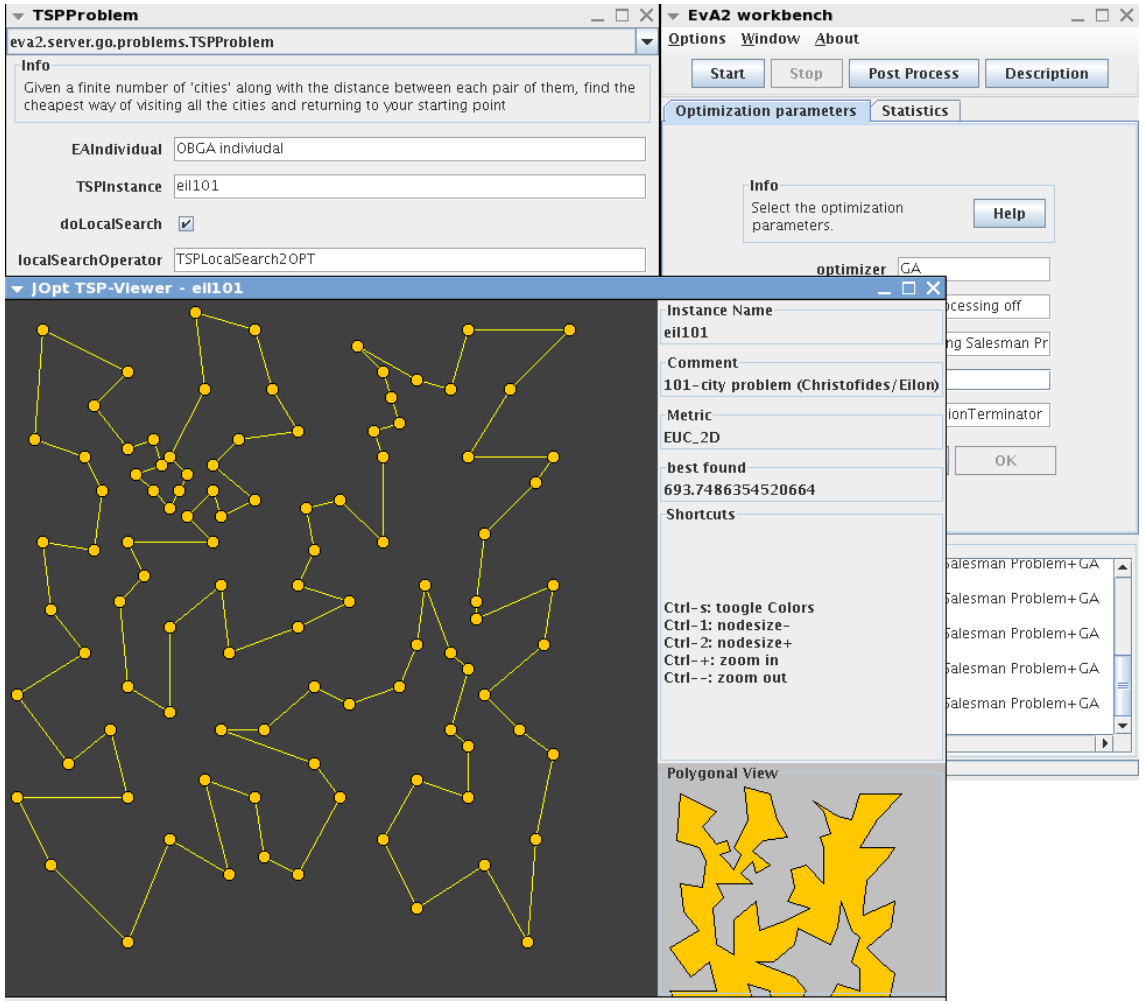
- `http://easea.unistra.fr/easea`

Outline

EvA2

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

EASEA


TSPProblem
eva2.server.go.problems.TSPProblem
Info
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
EAIndividual
OBGA indiviudal
TSPInstance
eil101
doLocalSearch
localSearchOperator
TSPLocalSearch2OPT
EvA2 workbench
Options Window About
Start Stop Post Process Description
Optimization parameters Statistics
Info
Select the optimization parameters.
Help
optimizer
GA
OK
JOpt TSP-Viewer - eil101
Instance Name
eil101
Comment
101-city problem (Christofides/Eilon)
Metric
EUC_2D
best found
693.7486354520664
Shortcuts
Ctrl-s: toogle Colors
Ctrl-1: nodesize-
Ctrl-2: nodesize+
Ctrl-+: zoom in
Ctrl--: zoom out
Polygonal View

Paradigms

- (Multi Start) Hill Climbing, Simulated Annealing
- Evolutionary strategies
- Genetic Algorithms
- Differential Evolution
- Particle Swarm Optimization
- Nieche-based approachs
- ...

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 snd experiments of different algorithms

- `http://www.ra.cs.uni-tuebingen.de/software/JavaEvA`

Further reading I


Keijzer, M., Merelo, J. J., Romero, G., and Schoenauer, M. (2002).
Evolving objects: A general purpose evolutionary computation library.
Artificial Evolution, 2310:829–888.


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