Multi Objective Algorithms for Automated Generation of Combinatorial Test Cases with the Classification Tree Method

Multi Objective Algorithms

- Algorithms in Multi Objective Problems (MOP)
  - optimize >2 conflicting constraints
  - do not usually have a single solution
  - Pareto optimal solutions
- Pareto front and Pareto optimal set

Pareto Optimality Set
$(P_\star)$ is the set of all Pareto optimal solutions.

Subset of Evolutionary Algorithms, Multi Objective Evolutionary Algorithms (MOEA) suited for MOPs

- Advantages over hill climbers or a single objective Genetic Algorithms

Two well known algorithms

- 
- NSGA-II: Non-dominated Sorting Genetic Algorithm
- SPEA2: Strength Pareto Evolutionary Algorithm

No details needed on day #3 of SSBSE
Combinatorial Test Cases

Combinatorial Interaction Testing (CIT) is a black box system testing technique that samples inputs, configurations and parameters and combines them in a systematic fashion.

Creating functional tests derived from software's specifications

Coverage Criterion: Minimum, Maximum, Pairwise, N-Wise
Pairwise NP Complete
Yu Lei, Kuo-Chung Tai. In-parameter-order: a test generation strategy for pairwise testing, 1998

N-wise NP Complete
Alan W. Williams and Robert L. Probert. A measure for component interaction test coverage, 2001

Constraints
Myra B. Cohen, Matthew B. Dwyer, and Jiangfan Shi. Interaction testing of highly-configurable systems in the presence of constraints, 2007

Classification Tree Method

Classification Tree Method
Matthias Grochtmann and Klaus Grimm. Classification trees for partition testing, 1993

Classification Tree Editor
Eckard Lehmann and Joachim Wegener. Test case design by means of the CTE XL, 2000

Prioritized Test Case Generation using CTE
Peter M. Kruse and Magdalena Luniak. Automated test case generation using classification trees, 2010
Proposal

Use of Multi-Objective Algorithms for Automated …

• … Conventional Generation

• … Prioritized Generation

• … Test Sequence Generation

Conventional Generation

• Old CTE XL 1.x
  • Non-deterministic Approach inspired by AETG

• CTE XL Pro 2.x
  • Deterministic Approach using BDDs

• Seeding, Constraints, Mixed-Strength, Parameter Hierarchies

• Optimization Target:
  • Constraints
  • Coverage
  • Minimization of test suite size

• Benchmarks / Related work
  Yu Lei, Kuo-Chung Tai. In-parameter-order: a test generation strategy for pairwise testing, 1998
  Jazek Czerwonka. Pairwise testing in real world, practical extensions to test case generators, 2006
  James D. McCaffrey. Generation of pairwise test sets using a simulated bee colony algorithm, 2009
Conventional Generation

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Benchmarks / Related work

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Table 3: Comparing CTD results with known CTD algorithms on standard test spaces

Conventional Generation

- Old CTE XL 1.x
  - Non-deterministic Approach inspired by AETG
- CTE XL Pro 2.x
  - Deterministic Approach using BDDs

Seeding, Constraints, Mixed-Strength, Parameter Hierarchies

Optimization Target:
- Constraints
- Coverage
- Minimization of test suite size

Benchmarks / Related work

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James D. McCaffrey. Generation of pairwise test sets using a simulated bee colony algorithm, 2009
Brady J. Garvin, Myra B. Cohen, and Matthew B. Dwyer. An improved meta-heuristic search for constrained interaction testing, SSBSE, 2009

Table 3: Benchmark examples
Prioritized Generation

- Old CTE XL 1.x
  - Not Available
- CTE XL Pro 2.x
  - Deterministic Approach, Greedy Algorithm
- Prioritization vs. Weight
- Constraints
- Optimization Target:
  - Constraints
  - Coverage
  - Prioritization of test suite (by importance of test cases)
  - Minimization of test suite size
- Benchmarks / Related work

  Sebastian Elbaum, Alexey G. Malishevsky, and Gregg Rothermel. Test case prioritization: A family of empirical studies, 2002
  Renée C. Bryce and Charles J. Colbourn: Prioritized interaction testing for pair-wise coverage with seeding and constraints, 2006

Test Sequence Generation

- Old CTE XL 1.x
  - Not Available
- CTE XL Pro 2.x
  - Internal Prototype Implementation
- Constraints
  - Dynamic Constraints
- Optimization Target:
  - Constraints
  - Coverage
  - Minimization of test suite size
- Benchmarks / Related work

  Hasan Ural. Formal methods for test sequence generation, 1992
  Lefticaru et al., Windisch/Lindlar, Zhan and Clark, …
Test Sequence Generation

- Old CTE XL 1.x
  - Not Available
- CTE XL Pro 2.x
  - Internal Prototype Implementation
- Constraints
  - Dynamic Constraints
- Optimization Target:
  - Constraints
  - Coverage
  - Minimization of test suite size
- Benchmarks / Related work
  - Leticaru et al., Windisch/Lindlar, Zhan and Clark, …

Hierarchical Concurrent Chinese Postman Problem, anyone?

Summery

We plan to use Multi-Objective Algorithms for Automated …

- … Conventional Generation
- … Prioritized Generation
- … Test Sequence Generation

- Stay tuned for benchmark results …