LearnLib Tutorial

@ ASE 2013

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www.learnlib.de
Tutorial Resources

- http://www.learnlib.de
- https://github.com/LearnLib/learnlib
- https://github.com/LearnLib/learnlib-ase2013-tutorial
LearnLib

- Library for Active Automa Learning Algorithms
- **Framework for Application in Practice**

- 10+ years of experience and development (from c++ to Java, from closed source to open source)

- Open Source
- LGPLv3

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Brief Recap

Static interface of SUL

```
login(u:int, p:int)
signup(u:int, p:int)
```

Dynamic interface of SUL

```
login(1, 2) signup(1, 2)
```

OK!

No: counterexample! equivalent??

YES: done!

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Equivalence Tests

Finding Counterexamples vs. Conformance Testing

Model-based Testing

- Randomized DFS (Randon Walk)
- Random Test Cases (Random Words)

- Exhaustive BFS (Depth k)
- Conformance (W-Method)

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Practical Challenges

interfacing real systems:
- alphabet generation
- abstraction
- data

equivalence queries

membership queries

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LearnLib: structure & components

Algorithms (LearnLib)
• Learning algorithms
• Counterexample analysis
• Equivalence Tests

AutomataLib
• (Small) automata library
• Statistics
• Logging
• Import/export (dot, ppt, xml etc.)
• Simulation environments

Case studies
• Test-driver tools
• Data mappers
• Abstraction

LearnLib Studio
• Visual composition of learning experiments

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Experimental Setup
LearnLib Components (I)

• **Learning algorithms**
  – Angluin’s L*
  – Rivest and Schapire’s “Reduced Observation Table”
  – Non-uniform observation table
  – DHC

• **Handling Counterexamples**
  – Maler and Pnueli
  – Shahabaz and Groz
  – Rivest and Schapire

• **Equivalence queries**
  – Chow’s “W-Method”
  – Random walks
  – Hopcroft and Karp’s almost linear time explicit equivalence test
  – Evolving hypothesis

  All algorithms work for DFA + Mealy machines

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LearnLib Components (II)

- **Filters**
  - Cache
  - Prefix Closure
  - System State Reuse
  - POR
  - Symmetry

- **Test Drivers**
  - Reflection
  - Web Services
  - Web Applications
  - Processes (StdIn / StdOut)
Mappers

\[ L^* \leftarrow (\Sigma^L)^* \rightarrow Mappers \]

\[ \gamma : (\Sigma^L)^* \rightarrow (\Sigma^S)^* \]

\[ \alpha : (\Omega^S)^* \rightarrow (\Omega^L)^* \]

\[ SUL \rightarrow (\Sigma^S)^* \leftarrow (\Omega^S)^* \]
LearnLib

Test Drivers

Membership
Oracle

Test Driver

Data Mapper

abcab

a(d₁)b(d₂)... b(d₅)

xyzxx

x(d₆)y(d₇)z ... x(d₈)

reset

a(10)/x(20)

b(20)/y(10)

b(20)/x(10)

d₁=10
d₂=20
d₃=“test”...

“a” means "call method a(p)" and use d₁ for p

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