KBCV 2.0 – Automatic Completion Experiments
IWC 2013

Thomas Sternagel
Computational Logic
Institute of Computer Science
University of Innsbruck

June 28, 2013
• Basic facts
• Features
• Completion Refresher
• Optimization
• Experiments
Basic facts

- [http://cl-informatik.uibk.ac.at/software/kbcv/](http://cl-informatik.uibk.ac.at/software/kbcv/)
- Programmed in Scala
- CLI & GUI & hybrid & web-interface
- Based on Bachmair and Dershowitz’ inference system
  - External termination checker: TTT$_2$
  - Derivation history
- For students
  - Huet’s algorithm
  - Freely apply inference rules
- Undo/Redo
Features

- KBCV

Interactive
Automatic
LPO
TTT2
History
Equational Logic Proofs
MiniSMT
TPDB
TPDB-7
TPTP
CPF
Features

KBCV

Completion

Interactive LPO Automatic

TTT2
Features

KBCV

Completion
Interactive
Automatic

Equational Logic Proofs

MiniSMT

TPDB
TPDB-7
TPTP

TT\textsubscript{T2}

TPDB
TPDB-7
CPF
Completion Procedure

$E_0 \rightarrow$ Completion Procedure
Completion Procedure

\[ \mathcal{E}_0 \rightarrow [>] \]

Completion Procedure
Completion Refresher

\[ \mathcal{E}_0 \xrightarrow{[>]\quad \text{Completion Procedure}} \mathcal{E}_1 \xrightarrow{\quad \text{Completion Procedure}} \mathcal{E}_2 \xrightarrow{\quad \text{Completion Procedure}} \mathcal{E}_3 \xrightarrow{\quad \text{Completion Procedure}} \cdots \]

\((\mathcal{E}_0, \emptyset) \vdash (\mathcal{E}_1, \mathcal{R}_1) \vdash (\mathcal{E}_2, \mathcal{R}_2) \vdash (\mathcal{E}_3, \mathcal{R}_3) \vdash \cdots\)
Completion Procedure

\[(E_0, \emptyset) \vdash (E_1, R_1) \vdash (E_2, R_2) \vdash \cdots \vdash (\emptyset, R_n)\]
Completion Procedure

\[(E_0, \emptyset) \vdash (E_1, R_1) \vdash (E_2, R_2) \vdash \ldots \vdash (\emptyset, R_n)\]

- deduce
- orient
- simplify
- delete
- compose
- collapse
Motivation

Initial Experiments on Deriving a Complete HOL Simplification Set

Cezary Kaliszyk and Thomas Sternagel

Motivation

KBCV

3,500 Equations

term-size 3,400

300,000 CPs

Initial Experiments on Deriving a Complete HOL Simplification Set

Cezary Kaliszyk and Thomas Sternagel

3,500 Equations

KBCV
Motivation

3,500 Equations

term-size 3,400

KBCV

Initial Experiments on Deriving a Complete HOL Simplification Set
Cezary Kaliszyk and Thomas Sternagel
Initial Experiments on Deriving a Complete HOL Simplification Set

Cezary Kaliszyk and Thomas Sternagel

Initial Experiments on Deriving a Complete HOL Simplification Set
Cezary Kaliszyk and Thomas Sternagel
*PxTP 2013, EPiC Series, 2013.*
Optimization

- simplify to NF
- delete
- complete
- orient
- choose $s \approx t$
- TTT2
- compose to NF
- new CPs
- deduce
- collapse
Optimization

- **simplify** to NF
- **delete**
- **choose** $s \approx t$
- **YES**
- **compose** to NF
- **new CPs**
- **deduce**
- **collapse**
- **T_{TT_2}**
- **to NF**
- **YES**
- **choose** $s \approx t$
- **←**
- **new CPs**
- **simplify** to NF
- **delete**
- **complete**
- **T_{TT_2}**
- **to NF**
- **compose**
Optimization

- **Optimization**
  - Caching
  - Parallelization
  - Term-Indexing

\[ \mathcal{E} = \emptyset \]

Choose \( s \approx t \)

YES

Complete

\( \mathbf{TTT}_2 \)

Compose

NEW CPs

To NF

Simplify

To NF

Delete

Deduce

Collapse

Complete

Orient
Optimization

- **Caching**
- **Parallelization**
- **Term-Indexing**

- **simplify**
- **delete**
- **E = ∅**
- **complete**
- **orient**
- **TTT2**
- **compose**

- **choose s ≈ t**
- **YES**
- **new CPs**
- **deduce**
- **collapse**
- **to NF**
Optimization

- **Simplify**
- **Delete**
- **Complete**
- **Orient**
- **Compose**

1. $\mathcal{E} = \emptyset$
2. Choose $s \approx t$
3. YES
4. New CPs
5. Deduce
6. Collapse
7. To NF
8. To NF

Term Indexing

- Caching
- Parallelization
Optimization

Caching

Parallelization

delete

\[ \mathcal{E} = \emptyset \]

orient

\[ T_{T^2} \]

collapse

deduce

YES

simplify to NF

new CPs

choose \( s \approx t \)

complete

compose to NF

simplify to NF
Optimization

Caching

Parallelization

Term-Indexing

\[ E = \emptyset \]

YES

orient

choose \( s \approx t \)

\[ TTT_2 \]

compose

to NF

collapse
deduce

to NF

simplify

to NF

delete

Term Index

new CPs
<table>
<thead>
<tr>
<th>C</th>
<th>P</th>
<th>T</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>×</td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table: 48 processors, 115 systems, timeout 10 min.
## Experiments

<table>
<thead>
<tr>
<th>$C$</th>
<th>$P$</th>
<th>$T$</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\times$</td>
<td>85</td>
<td></td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>$\times$</td>
<td>85</td>
<td></td>
<td>$\times$</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>$\times$</td>
<td>85</td>
<td></td>
<td>$\times$</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>$\times$</td>
<td>85</td>
<td></td>
<td>$\times$</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>$\times$</td>
<td>87</td>
<td></td>
<td></td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>$\times$</td>
<td>89</td>
<td></td>
<td></td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>$\times$</td>
<td>90</td>
<td></td>
<td></td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>$\times$</td>
<td>90</td>
<td></td>
<td></td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**Table:** 48 processors, 115 systems, timeout 10 min.
### Experiments

<table>
<thead>
<tr>
<th>C</th>
<th>P</th>
<th>T</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>×</td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table: 48 processors, 115 systems, timeout 10 min.
<table>
<thead>
<tr>
<th>C</th>
<th>P</th>
<th>T</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table: 48 processors, 115 systems, timeout 10 min.
### Experiments

<table>
<thead>
<tr>
<th>C</th>
<th>P</th>
<th>T</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table: 48 processors, 115 systems, timeout 10 min.
### Table 48 processors, 115 systems, timeout 10 min.

<table>
<thead>
<tr>
<th>$C$</th>
<th>$P$</th>
<th>$T$</th>
<th>completed</th>
<th>avg. time</th>
<th>speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>85</td>
<td>×</td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td>×</td>
<td>85</td>
<td>×</td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>×</td>
<td>85</td>
<td>×</td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>×</td>
<td>85</td>
<td>×</td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>87</td>
<td>×</td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td>×</td>
<td>89</td>
<td>×</td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td>×</td>
<td>90</td>
<td>×</td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>×</td>
<td>90</td>
<td>×</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
<tr>
<td>$C$</td>
<td>$P$</td>
<td>$T$</td>
<td>completed</td>
<td>avg. time</td>
<td>speed-up</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>85</td>
<td>13.4</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>85</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td>85</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td>85</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>87</td>
<td>5.9</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>89</td>
<td>13.1</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td>14.7</td>
<td>4.0</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>90</td>
<td>12.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table: 48 processors, 115 systems, timeout 10 min.
3,500 Equations
term-size 3,400

KBCV 2.0
<2h

300,000 CPs
Thank you for your attention! Any questions?