

The Termination Competition

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Short history

- WST'03, Valencia: initiated by Albert Rubio
 - Termination Problems Data Base
 - Competition/Exhibition of termination tools
- Since 2004: 'automatic' competition
 - tools run fully automatically
 - results available 'live' on a web page
- Goals of such a competition:
 - stimulate research on termination techniques
 - put emphasis on automation
 - provide a standard to compare termination techniques

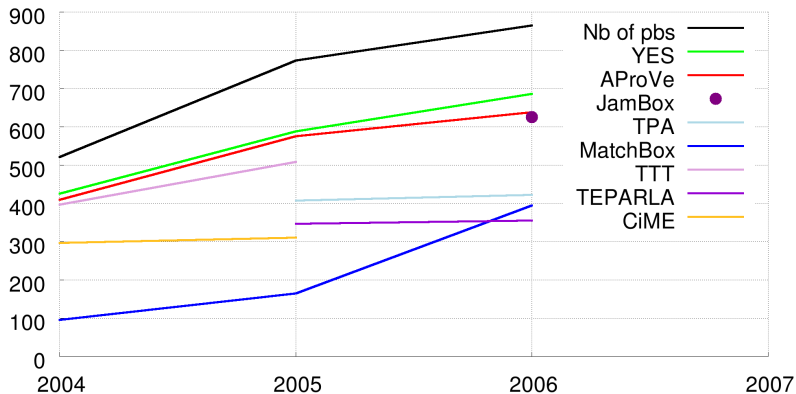
The TPDB

- Problems of the TPDB: 3 syntax
 - String Rewriting System (SRS)
 - Term Rewriting System (TRS)
 - Logic Program (LP)
- SRS sub-category: relative termination
- TRS sub-categories:
 - modulo theory (only AC in current TPBD)
 - reduction strategies: innermost, outermost, context-sensitive
 - relative termination

The rules

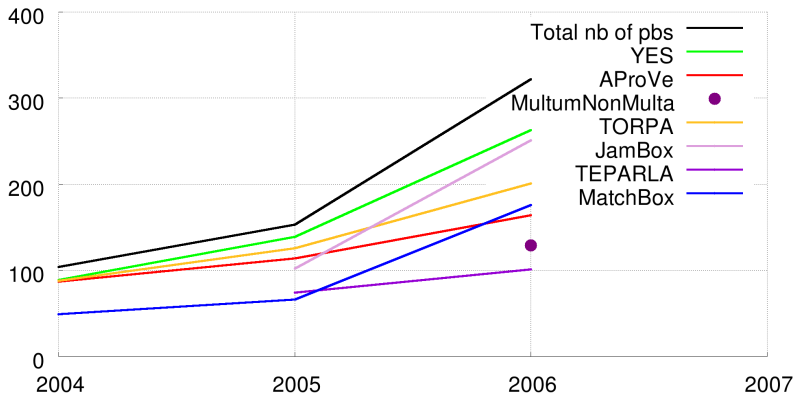
- Tools run on all problems of the TPDB they support, on the same computer
- Running time is limited (1 minute)
- Required output:
 - “YES”, followed by the text of a termination proof, or
 - “NO”, followed by the text of a non-termination proof, or
 - anything else, including time limit reached, is interpreted as “DON'T KNOW”
- Score: 1 point for each problem solved

TRS category



(not shown: Mu-Term, TTTbox)

SRS category



(not shown: CiME, TPA, TTTbox)

A success story

- SRS `Zantema/z086`:

$aa \rightarrow bc$ $bb \rightarrow ac$ $cc \rightarrow ab$

- Unsolved by any tool in 2004 and 2005
- Became RTA open problem #104
- First solved 'by hand': [[Hofbauer, Waldmann, IPL 06](#)]
- Brought up idea of Matrix interpretations
- Solved by Jambox tool in 2006 (clear winner of SRS category)
- Matrix interpretations on terms [[Endrullis, IJCAR 06](#)]
- Jambox got second (628) just behind AProVe (638) in TRS category

Other evidences of success

- Usefulness of back-end SAT solvers for finding solutions to orderings constraints
- “AProVe couldn't remain winner each year without several major improvements”:
 - applicative TRSs [Giesl et al., FroCos 05]
 - polynomials with negative coefs [Hirokawa, Middeldorp, AISC 04]
 - subterm criterion [Hirokawa, Middeldorp, RTA 04]
 - match-bounds for term rewriting [Geser et al. IC 07]
 - etc.

Longstanding open problems

- Past open problems, now solved, e.g.:
 - AC-TRSs for integer arithmetic [Contejean et al., RTA 97]
for sequent calculus modulo [Deplagne, 00], solved in 2004 by CiME
 - TRSs for explicit substitutions: [Bonelli] (solved in 2005 by TEPARLA) and $\text{TRS}/\text{Zantema-z10}$ (solved by TPA)
- Remain open:
 - Hercules & Hydra battle, only unsolved pb of famous collection “33 problems of termination” [Dershowitz, 1995]
 - Cohen-Watson [RTA 91] system for arithmetic [RTA LOOP #65]

Other challenges

- Emphasized right after the end of the 2006 edition:

$aaa \rightarrow bab$ $bbb \rightarrow aaa$

- Semantic decreasing argument:
 - encodings of ‘while loops’
 - automatic translations from CS-TRSs, Maude or OBJ programs
- SRS challenge: (SRS/Zantema-z079)

$caa \rightarrow ac$ $acb \rightarrow adb$
 $ad \rightarrow daaa$ $bd \rightarrow bc$

(essentially rewrites 2^n to 3^n)

Non-termination challenges

- No tool able to discover non-looping non-termination
- e.g. TRS TRS/HofWald-6:

$$f(f(a, x), y) \rightarrow f(f(x, f(a, y)), a)$$

- or SRS SRS/Zantema-z073:

$$\begin{array}{ll} al \rightarrow la & ra \rightarrow ar \\ bl \rightarrow bar & rb \rightarrow lb \end{array}$$

Perspectives

- Certified proofs of termination
 - termination tools are complex softwares, hence intrinsically buggy. . .
 - proof assistants (e.g. Coq, Isabelle) can help for double-checking proofs
- Handling programs in 'real' languages:
 - functional: lazy (Haskell), strict (ML)
 - imperative: C, Java, etc.
- Handling numerical computations
 - built-in integers

The 2007 edition

- New category: *Haskell programs*
- New 'option': *certified proofs* of termination

What happened?

- **Some challenges solved!**
- For details:

Johannes Waldmann's talk on Friday
WST workshop 15:15