TPA

Termination Proved Automatically

http://www.win.tue.nl/tpa

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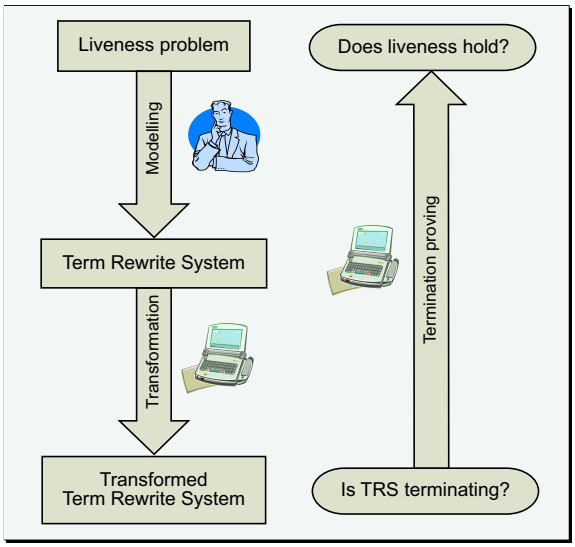
Introduction

TPA is a tool designed to prove termination of term rewriting systems (TRSs) fully automatically. Moreover it is capable of **proving liveness properties** by transforming them to termination problems.

One of the prime concerns for TPA is verification of correctness of the results by collaboration with the CoLoR project (http://color.loria.fr) that aims at certification of proofs found by termination tools.

Verification

Certain class of liveness properties can be verified by transformation to problems of termination of term rewriting systems.



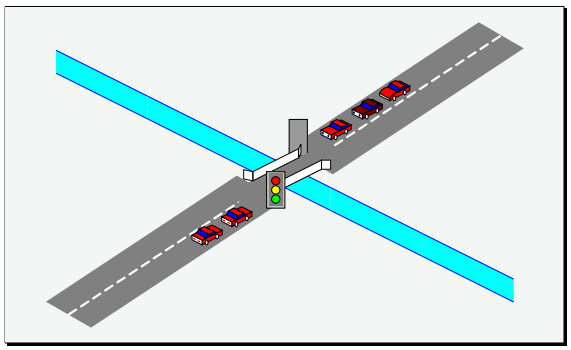
The only human activity is to model the system.

TPA overview

- Proving termination of TRSs fully automatically.
- Proving liveness properties automatically.
- 3rd place in the international termination competitions in 2005 and 2006.

Example

There is a road with a bridge permitting only one single lane of traffic, controlled by traffic lights.
Liveness property: every car will eventually be able to cross the bridge.



Model

We model *fairness* by distinguishing progress steps ($\rightarrow$) and non-progress steps ($\overset{=}{\rightarrow}$).

$$
\begin{array}{lrcl}
(1) & \mathsf{top}(\mathsf{left}(\mathsf{car}(x,y),z)) & \rightarrow & \mathsf{top}(\mathsf{right}(y,z)) \\
(2) & \mathsf{top}(\mathsf{right}(x,\mathsf{car}(y,z))) & \rightarrow & \mathsf{top}(\mathsf{left}(x,z)) \\
(3) & \mathsf{top}(\mathsf{left}(\mathsf{bot},x)) & \rightarrow & \mathsf{top}(\mathsf{right}(\mathsf{bot},x)) \\
(4) & \mathsf{top}(\mathsf{right}(x,\mathsf{bot})) & \rightarrow & \mathsf{top}(\mathsf{left}(x,\mathsf{bot})) \\
(5) & \mathsf{top}(\mathsf{left}(\mathsf{car}(x,y),z)) & \overset{=}{\rightarrow} & \mathsf{top}(\mathsf{left}(y,z)) \\
(6) & \mathsf{top}(\mathsf{right}(x,\mathsf{car}(y,z))) & \overset{=}{\rightarrow} & \mathsf{top}(\mathsf{right}(x,z)) \\
(7) & \mathsf{bot} & \overset{=}{\rightarrow} & \mathsf{car}(\mathsf{new},\mathsf{bot})
\end{array}
$$

(1), (2)	Car crosses the bridge, light changes.
(3), (4)	Nobody is waiting - light changes.
(5), (6)	Car crosses the bridge, light remains the same.
(7)	New car arrives and is waiting to cross the bridge.

TPA can automatically prove the liveness property stating that every car will eventually cross the bridge.