

Benchmarks for Verification of Autonomous Vehicles

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Abstract

To do...

1 Introduction

- Need for AV verification
- Why it is hard
- Contributions/Benchmarks
 - Scenario 1: Obstacle avoidance on a sharp curve
 - * No longer have clear invariant cut
 - Scenario 2: T-Junction
 - * Variant: Traffic light
 - * Variant: Pedestrian
 - Scenario 3: Obstructed T-Junction
 - * Map provides knowledge of obstruction and automatically adjusts behavior

2 State of the Art

- Types of Autonomy
- Levels of Abstraction
- Verification Methods and Tools
 - Industry Perspective: Testing and Simulation
 - Control Perspective: Lyapunov Functions
 - Software Perspective: Model Checking
 - Logic Perspective: Theorem Proving

3 Models

Key new idea: Examine continuous evolution of ego-vehicle, but only discrete evolution of environment. Give environment grid-based abstraction. We don’t know the control inputs for the environment anyway

Re-examine grid based timed automaton: Can’t really capture accelerations and nuance?

Vehicle

- Vehicle Dynamics: Bicycle Model
- Planning

- Perception
- Computation and Scheduling
- Traffic Participants

Traffic Control

- Stop Sign
- Speed Limit
- Yield
- Traffic Light

Pedestrians

- Dynamics
- Grid based abstraction
- Non determinism

4 Scenarios

5 Verification Engines

6 Results

7 Conclusions

References

- [1] David Carlisle. `graphicx`: Enhanced support for graphics. <http://www.ctan.org/tex-archive/help/Catalogue/entries/graphicx.html>, last viewed April 2010, 1995–1999.

A Formatting Information

1. The default paper size is US letter. It can be explicitly set to A4 (`a4paper`) or letter (`letterpaper`) paper in the document class entry, e.g.:
`\documentclass[a4paper]{easychair}`
2. The print area for both letter and A4 paper sizes is 145x224 mm. This size has been selected to allow for inexpensive printing using our current print-on-demand publisher.
3. The base font is Computer Modern. The base font size is 10pt. If you use any other font size, there is no guarantee that the produced document will look nice or fit into our standard page size.
4. The references list is condensed. The default bibliography styles, such as `plain`, `abbrv`, and `alpha`, are suggested.
5. PNG, JPG, and PDF images are supported, i.e., those that are supported by the standard `graphicx` package [1], and render nicely in online versions of PDF documents. This document shows some examples of JPG and PDF images, for example in Figure ???. If the papers are designed for publishing in print, the images should be at least 300dpi in resolution.

ATP System	LTB	Avg	Prfs	SOTA	μ	CYC	MZR	SMO
Vampire-LTB 11.0	69	24.5	69	0.37	28.1	23	22	24
iProver-SInE 0.7	67	76.5	0	0.36	8.8	28	14	25

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Figure 1: Original table and tables with `tabcolsep` set to 5pt, 3pt, and 1pt

A.1 Tables

Many page overflows happen because of large tables. In many case these overflows can be easily removed by slightly reducing padding added by \LaTeX to every column. It is controlled by the \LaTeX command `\tabcolsep` whose value by default is 6pt. Even small changes in the value of this command may give drastic reductions in the width of tables. This is illustrated in Figure 1 on page 3. Note though that there is no free lunch: smaller values for this command may result in lower readability.


A.2 Images

Images included using `\includegraphics` are easy to resize since one can specify the size of the result explicitly. For example, Figure ?? shows three copies of the same image having different sizes obtained using the following commands:


```
\includegraphics[width=0.5\textwidth]{throneEC.jpg}
\includegraphics[width=0.3\textwidth]{throneEC.jpg}
\includegraphics[width=0.15\textwidth]{throneEC.jpg}
```

A.3 A Universal Recipe


\LaTeX has a very powerful weapon for reducing the size of almost anything. More precisely, it can reduce anything producing what \LaTeX considers a box. This weapon is called `\scalebox`. Consider an example (check the source of this file to see how it was produced).

year	users	
2007	47,753	
2008	114,494	
2009	207,506	
2010	371,054	
The number of users of EasyChair and one of its logos, scaled to the number of users in 2010		

This is what happens when we put (almost) the same L^AT_EX code in `\scalebox{0.55923}{...}` to scale it down to the number of users in 2009:

year	users	
2007	47,753	
2008	114,494	
2009	207,506	
2010	371,054	
The number of users of EasyChair and one of its logos, scaled to the number of users in 2009		

We can scale it down even further to the 2008 figure using `\scalebox{0.30856}{...}`:

year	users	
2007	47,753	
2008	114,494	
2009	207,506	
2010	371,054	
The number of users of EasyChair and one of its logos, scaled to the number of users in 2008		

or further down to 2007:

year	users	
2007	47,753	
2008	114,494	
2009	207,506	
2010	371,054	
The number of users of EasyChair and one of its logos, scaled to the number of users in 2007		

This size reduction technique is very efficient: using the right scale you may post your whole article on Twitter in a single tweet. However, it may also may parts of your text virtually unreadable with an unfortunate side effect of annoying reviewers.