

Formalization and Runtime Verification of Invariants for Robotic Systems[★]

Ricardo Cordeiro¹, Alcides Fonseca¹, and Christopher Timperley²

¹ Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal

² Carnegie Mellon University, Pittsburgh, PA

Abstract. Robotics has a big influence in today's society, so much that a potential failure in a robot may have extraordinary costs, not only financial, but can also cost lives. Current practices in robot testing are vast and involve such methods as simulations, log checking, or field tests. The frequent common denominator between these practices is the need for human visualization to determine the correctness of a given behavior. Automating this analysis could not only relieve this burden from a high-skilled engineer, but also allow for massive parallel executions of tests, that could potentially detect behavioral faults in the robots that would otherwise not be found due to human error or lack of time. We have developed a domain-specific language to specify properties of robotic systems in ROS. Specifications written by developers in this language can be compiled to a monitor ROS module, that will detect violations of those properties. We have used this language to express the temporal and positional properties of robots, and we have automated the monitoring of some behavioral violations of robots in relation to their state or events during a simulation.

Keywords: Robotics · Domain-specific language · Runtime Monitoring · Error detection · Automation.

1 First Section

1.1 A Subsection Sample

Please note that the first paragraph of a section or subsection is not indented. The first paragraph that follows a table, figure, equation etc. does not need an indent, either.

Subsequent paragraphs, however, are indented.

Sample Heading (Third Level) Only two levels of headings should be numbered. Lower level headings remain unnumbered; they are formatted as run-in headings.

Table 1. Table captions should be placed above the tables.

Heading level	Example	Font size and style
Title (centered)	Lecture Notes	14 point, bold
1st-level heading	1 Introduction	12 point, bold
2nd-level heading	2.1 Printing Area	10 point, bold
3rd-level heading	Run-in Heading in Bold. Text follows	10 point, bold
4th-level heading	<i>Lowest Level Heading.</i> Text follows	10 point, italic

Sample Heading (Fourth Level) The contribution should contain no more than four levels of headings. Table 1 gives a summary of all heading levels. Displayed equations are centered and set on a separate line.

$$x + y = z$$

(1)

Please try to avoid rasterized images for line-art diagrams and schemas. Whenever possible, use vector graphics instead (see Fig. 1).

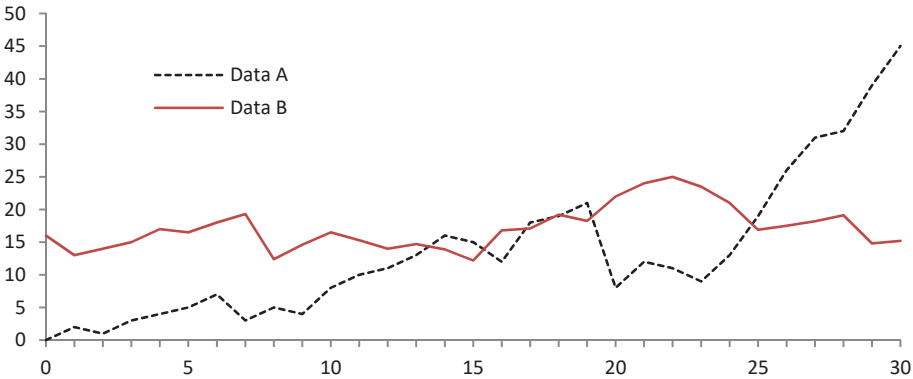


Fig. 1. A figure caption is always placed below the illustration. Please note that short captions are centered, while long ones are justified by the macro package automatically.

Theorem 1. *This is a sample theorem. The run-in heading is set in bold, while the following text appears in italics. Definitions, lemmas, propositions, and corollaries are styled the same way.*

Proof. Proofs, examples, and remarks have the initial word in italics, while the following text appears in normal font.

For citations of references, we prefer the use of square brackets and consecutive numbers. Citations using labels or the author/year convention are also acceptable. The following bibliography provides a sample reference list with entries

* Supported by organization x.

for journal articles [1], an LNCS chapter [2], a book [3], proceedings without editors [4], and a homepage [5]. Multiple citations are grouped [1–3], [1, 3–5].

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