

Verifying imperative programs with Dafny

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Abstract

The goal of this work is to show how to formally reason about imperative programming constructs such as assignments, loops, arrays and especially about dynamically allocated objects. To be able to achieve that, basic Dafny constructs will be shown, such as variables, functions and methods. The discussion thereafter will move towards recursion and termination as well as inductive datatypes. Having learned from those chapters, loop invariants and their usage will be explored. Because analyzing objects in the heap is more challenging, searching and modifying arrays will be covered. The final chapter will include a detailed discussion about Dafny's dynamic frames and their significance.

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1 Introduction

When software engineers encounter the field of formal methods and verification, this usually happens in an academic setting, where proof techniques are learned and done by hand. Moreover, actually taking advantage of those methods in practice involves a steep learning curve and lots of time. This unfortunately leads to less acceptance of verification techniques in an industry where fast time to market is essential. Dafny promises to solve those problems. As a programming language designed to support specifications and proofs, it comes with an automated verifier that integrates seamlessly into most modern IDEs enabling software engineers to write bug free, formally verifiable code at a surprisingly high pace.

2 Formal Methods

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3 Section about quotations

In this section, an example for a literal quotation is given.

“A persona is a rich picture of an imaginary person who represents your core user group.” (?)

Sometimes you might want to make use of the authors name within the text. Before, we used the command `citep{}`, which creates the brackets around author name and year. You can also use the `cite` command like this:

? defined the concept of persona as follows:

“A persona is a rich picture of an imaginary person who represents your core user group.” (?)

You may notice, that this increases the readability of the text.

According to APA format¹ there are some rules, when and how to include page numbers, when referring to literature.

¹American Psychological Association (APA)

“Include page numbers for any citations in the text of your paper that include direct quotations or refer to a specific part of the work you are referencing. Direct quotations must include a page number as part of the citation. The quoted material should be followed by a citation in parentheses that gives the author’s name, the year in which the work was published, and the page number from which the quoted material appears.” (?)

Check out the example and recommendations of ? on http://www.ehow.com/how_5689799_cite-numbers-apa-format.html. In L^AT_EX you can include the pages very easy. For example:

?, p. 86 stated:

“We hope that our preliminary attempts to begin answering the question will convince the reader, not necessarily that our views are correct, but that the question was and is well worth asking” (?, p. 86)

Note that in the first reference, we used `citet[]{}` in order to have brackets just around year and page number; later we used `citep[]{}` .

4 Section about references within the document

If you want to refer to you own chapters, figures, tables or the like, you can make use of the `ref{}` command, for example:

- section 3 on page 3

4.1 Subsection within Foundations

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4.2 Another subsection within Foundations

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5 Methodology

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6 Results

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua (?, p. 48). At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

7 Conclusion

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References