

IMPERIAL COLLEGE LONDON

DEPARTMENT OF COMPUTING

Background Report

Author:
Nikolai Merritt

Supervisors:
Bob Kowalski, Jacinto
Quintero, Galileo Sartor

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Introduction

Language Extensions for code editors are a crucial tool in writing code quickly and without errors. In this project we create a Syntax Highlighter and Language Server for the logical and declarative programming language Logical English. We will allow the Language Server to auto-generate “boilerplate” template code from rules. We also aim to allow the Language Server to identify type mismatch errors occurring between rules and templates.

Literature Review

Language Servers have proven to be a powerful tool in creating cross-editor support for a wide variety of programming languages. As noted by Rask et al [5], the Language Server Protocol, which language servers use to communicate with code editors, "changed the field of IDEs" since one language server can communicate with any IDE that supports the protocol. In surveying the effectiveness of language servers when building a language server for OCaml, Bour et al [3] note that "adding support for a new editor to a language server requires no language-specific logic". This allows people who are not yet familiar with a given language to link a language server to their IDE of choice and begin programming.

Bour et al [3] and the Visual Studio Code Language Server Extension documentation [1] also describe two main challenges that Language Servers face, "incrementality and partiality":

- Due to efficiency constraints, the IDE only being able to send the portions of the document to the language server
- The language server having to parse incomplete portions of code that the user is writing

In building their language server for OCaml, Bour et al solved these two issues by additionally building their own parser, generated using an enhanced version of Menhir, that could handle incrementality and partiality. This was needed because OCaml has a complex, recursive grammar, which made parsing incomplete portions of code a highly complex task. Logical English, however, has a very simple, non-recursive grammar, and our language server only concerns itself with parsing certain aspects of the language. Thus it is reasonable for our language server to parse the document itself.

Wang et al [6] created a powerful compilation agent that auto-generates Java boilerplate code from more succinct, annotated Java. The boilerplate code is generated at the Abstract Syntax Tree (AST) level: the code generator starts with the AST representing the annotated code and, using the Lombok compilation agent, produces an AST corresponding to non-annotated, boilerplate Java. Since neither templates nor heads of rules are recursive, we will likely find that a less complex representation can be favoured over AST.

Project Specification

The project will consist of developing two tools for Logical English: a Syntax Highlighter and a Language Server. These two tools are cross-editor, meaning that they can be used with many of the most popular programming editors with minimal configuration.

Syntax Highlighter

The Syntax Highlighter will identify both micro-features of Logical English such as keywords and variable names, and macro-features such as section headers. It will identify these features using TextMate grammar. This way, the default themes of many popular code editors will recognise and style them.

Language Server

The Language Server will allow the user to generate new templates from rules. If a set of rules do not match any existing templates, the Language Server will communicate this to the user. It will allow the user to, at the click of a button, generate a template that matches the rules.

If there is time, we will give the Language Server the feature to alert the user of certain type mismatch errors. The user will be notified of errors where a rule is supplied in the knowledge base with a type that conflicts with the corresponding type in the rule's template. To determine whether the one type conflicts with the other, the Language Server would consider type inheritance as supported by Logical English.

The language server will communicate with potential language clients using the Language Server Protocol. This way, many popular code editors will be able to communicate with the language server.

Project Implementation Plan

The Syntax Highlighter will be implemented using TextMate grammar, since this has the widest range of editor support. The Language Server will be implemented in TypeScript using the `vscode-languageserver` NPM package, since this package has clear, thorough documentation and describes multiple example language servers. In testing, both the language server and syntax highlighter will be run through a Visual Studio Code language client. This choice is made due to Visual Studio Code's powerful debugging features for language plugins.

Project Timeline

The timeline for developing and testing these two tools is below. This plan has us completing both the template generation and type error detection features of the

Language Server. However, if any large problems arise, we will prioritise solving these over working on type error detection.

6th June - 10th June	Learn Regular Expressions. Write a TextMate grammar for Logical English.
13th June - 17th June	Using the Visual Studio Code documentation [2], create a proof-of-concept language server with dummy error highlighting, warning highlighting, and code generation.
20th June - 25th June	Convert Logical English templates to a suitable TypeScript representation. Using this representation, determine whether a Logical English rule conforms to a template.
27th June - 8th July	Create a template from first two, then arbitrarily many, rules.
11th July - 23rd July	Create a Logical English Type representation in TypeScript. Use this type representation in giving types to the arguments of templates. Use this type representation to consider types in determining whether a rule conforms to a template.

Technical Achievements

Before fully beginning on this project, we have built and tested a rudimentary syntax highlighter and language server.

We have written a syntax highlighter, using TextMate, for a small subset of the Logical English grammar ¹. This highlighter successfully detected the micro-features `if` and `then` as keywords. It also detects the macro-features `The templates are:` and `The knowledge base subset includes:` as headers for the template and knowledge base sections, respectively. Once detected, these features were highlighted by the default light and dark theme of Visual Studio Code.

We also followed Jeremy Greer's language server tutorial[4] to create a basic language server. This language server "blacklists" certain words by marking their usages as errors. ² This language server was tested both by manually writing language server requests through standard console input, and by connecting with the language client taken from the same tutorial. In both tests the server behaved as expected (that is, as described in Greer's tutorial) when ran on Windows Subsystem for Linux.

The purposes of these trial runs were twofold. Firstly, completing these projects allowed us to familiarise ourselves with the tools and languages that we will be working with. Secondly, we have confirmed that a syntax highlighter and language server will run as intended using our choice of platform, tools and testing environment.

¹The syntax highlighter can be found at <https://github.com/nikolaimerritt/LogicalEnglish/tree/main/language-server/logical-english>

²The server can be found at <https://github.com/nikolaimerritt/LogicalEnglish/tree/main/language-server/blacklist-server>. However, the code is entirely taken from the tutorial.

Bibliography

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