Writing a Language Server in OCaml for Emacs, Fun, and Profit

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Outline

Who am I

- Software engineer @ Semgrep
- I work on our editor integrations
- I love working on programming languages, editors, cryptography

What is Semgrep

- Semgrep's core product is a SAST tool
- Can think of it as a security linter
- Supports 30+ languages
- Lots of customers, all using different IDEs

SAST

Static Application Security Testing

Demo

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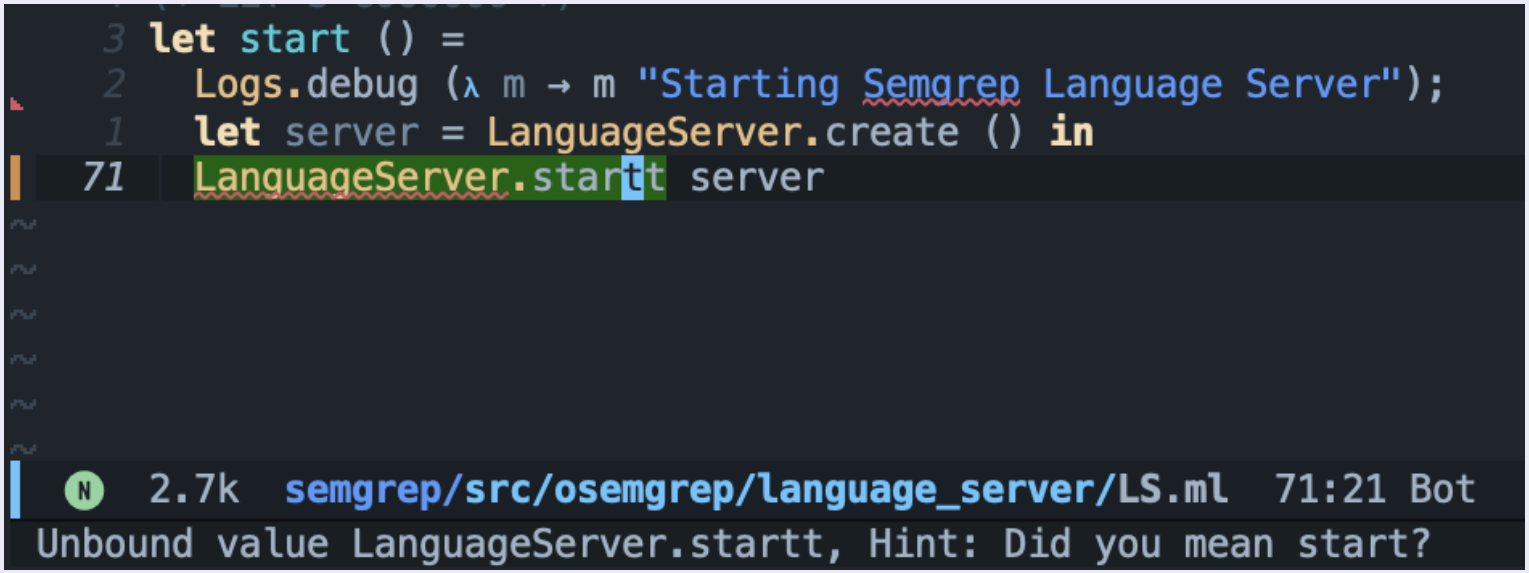
Product Purpose

Show security bugs as early as possible in the development cycle

How do we show security bugs early?

In the editor!



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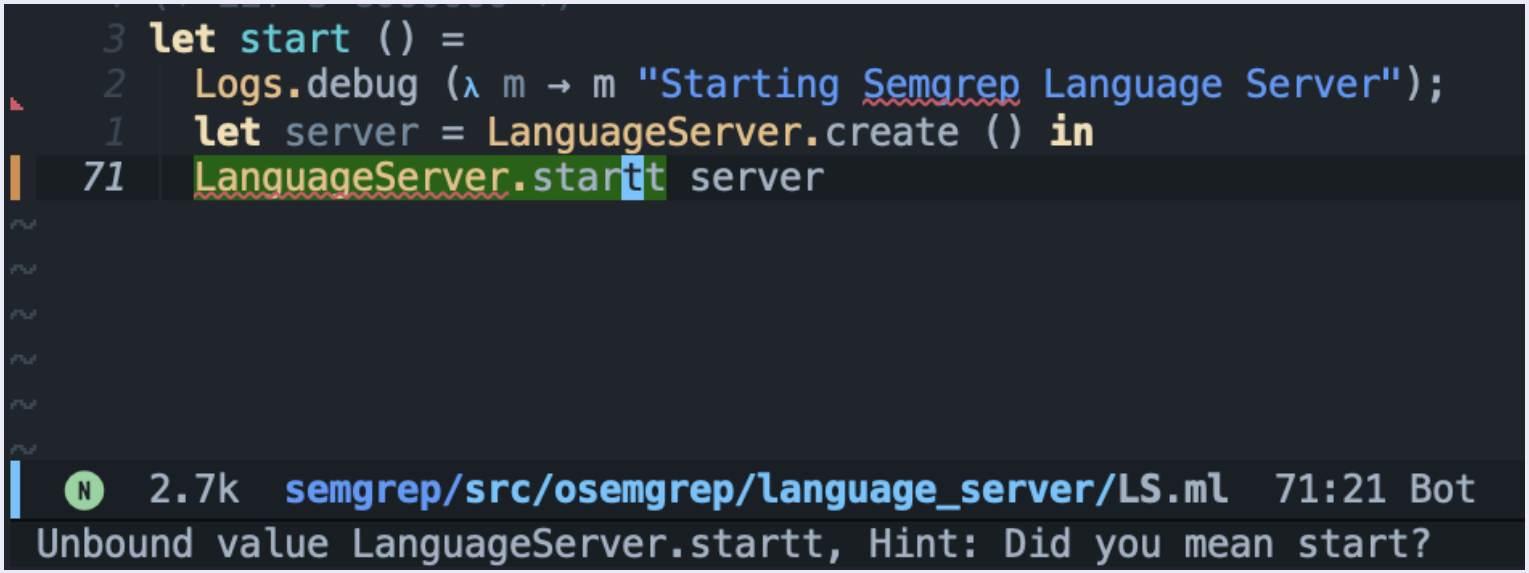
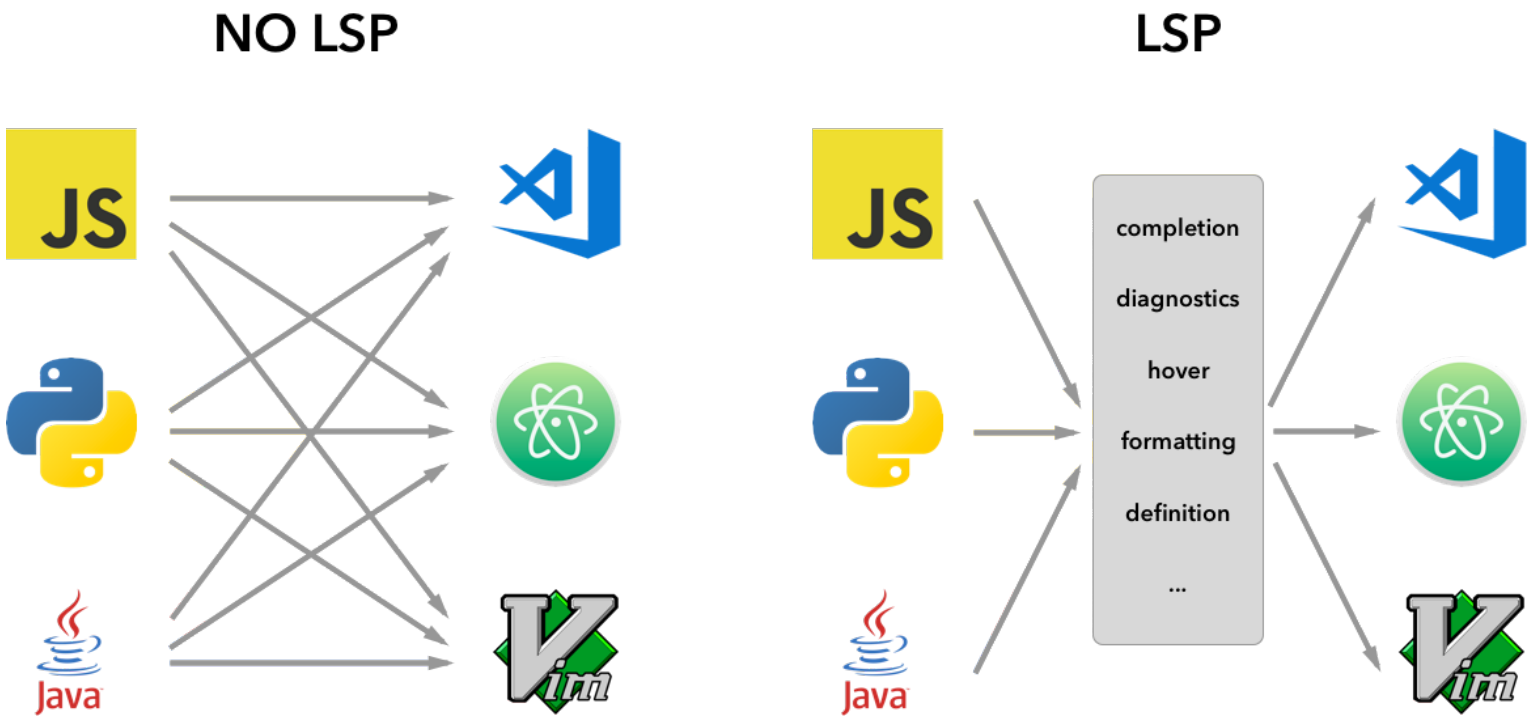


Goals

- Provide a similar user experience to normal language checking
- Abstract away editing and language features for editors to one code base

What is the Language Server Protocol



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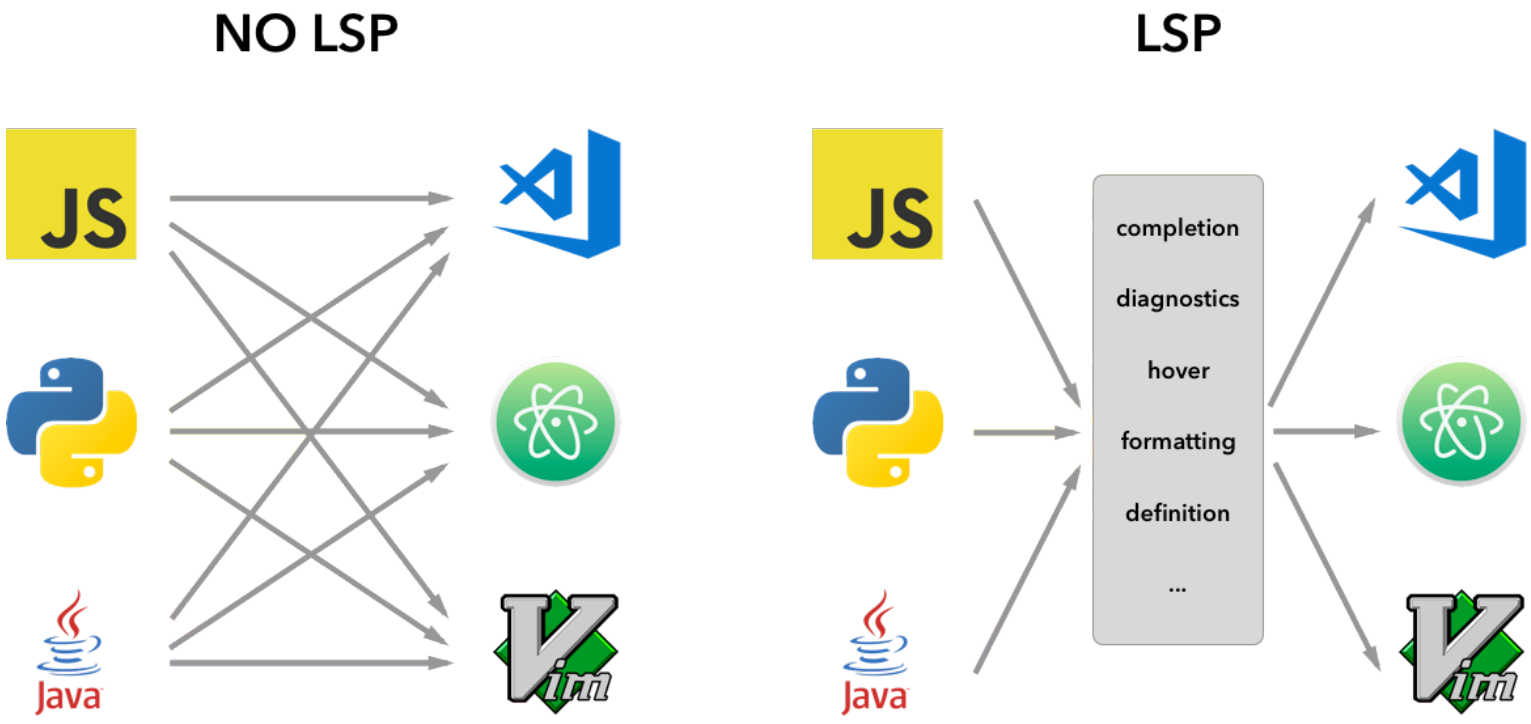

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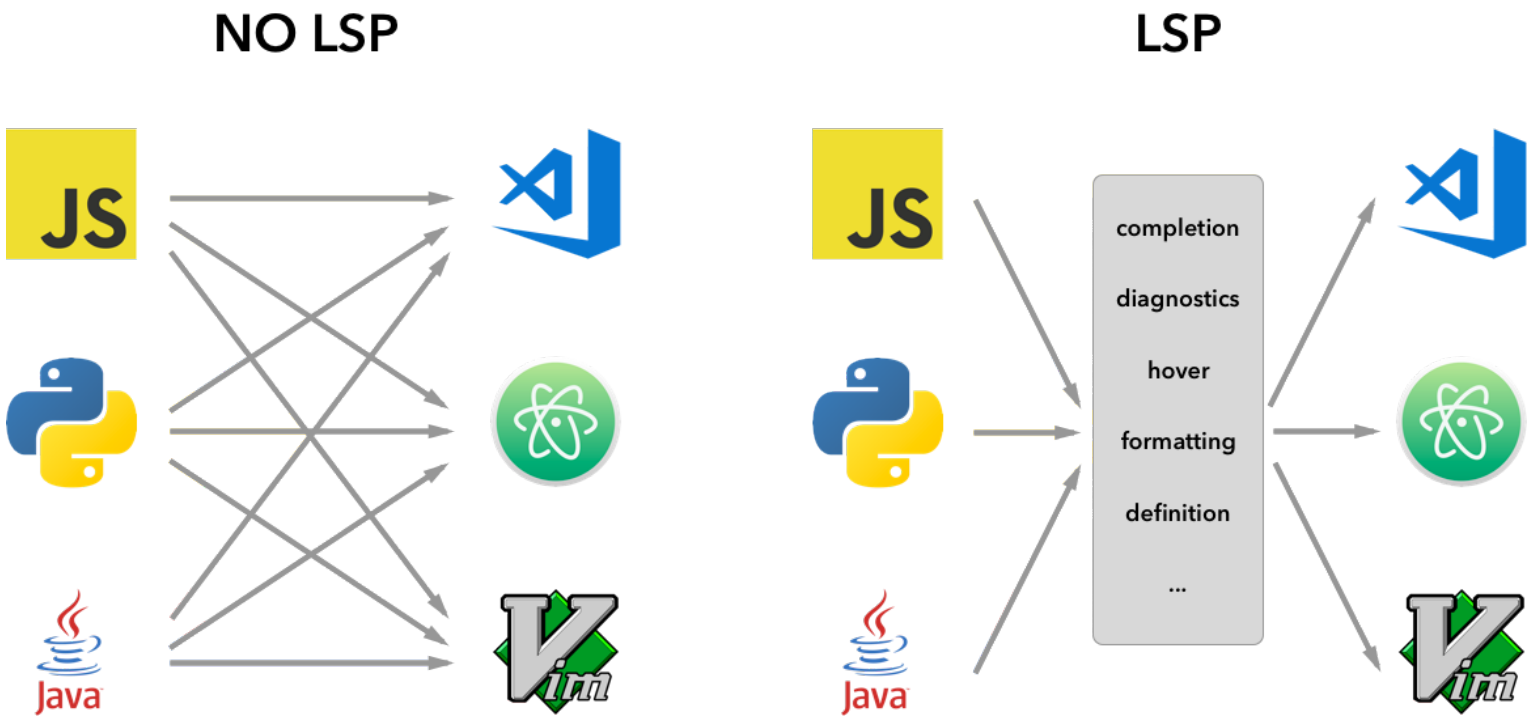

Language Server Protocol (LSP) Defines all the ways an editor can interact with a LS

Language Server (LS) Program that provides language tooling (syntax errors, completion, refactoring etc.)

Language Client The development tool/editor etc. handles documents, user interaction etc. (i.e. Emacs)

Case study: Rust Analyzer

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- Type signatures
- Auto imports
- View dependency graph
- Run code/tests
- Refactoring
- Much much more

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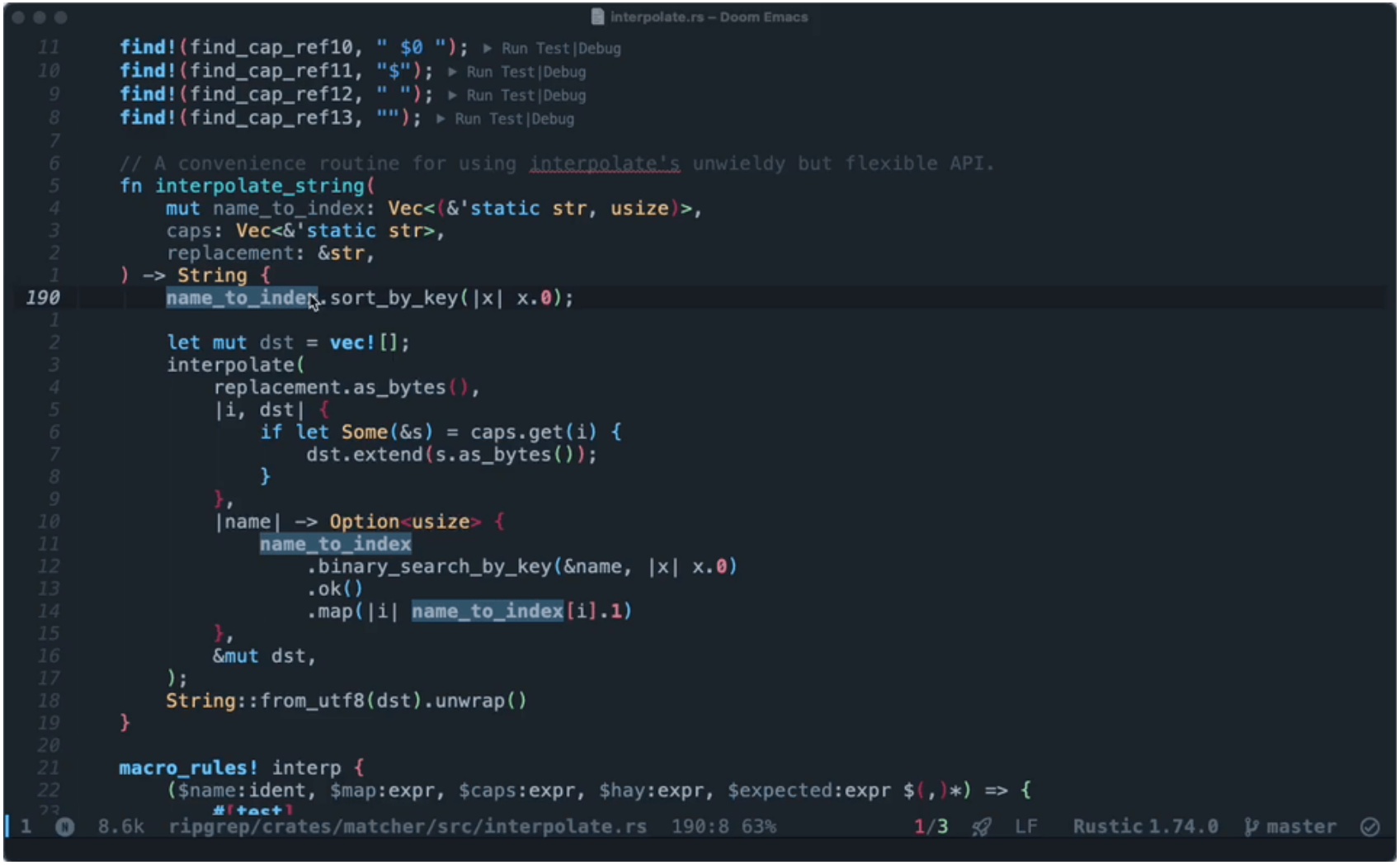
TL;DR

Developing Rust with Rust Analyzer is a pleasure, and makes dealing with advanced language features significantly easier

Rust Analyzer in action



Why is this useful?

User perspective

- Same experience across editors
- Can easily setup and use LS' made for other editors, if developers don't support a certain editor
- Performance is not dependent on editor
- Bug fixes, updates, etc. all come out at the same time

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Developer perspective

- Adding new editors is quick and easy
- Only need one mental model
- Write tests for the LS, not for the editor

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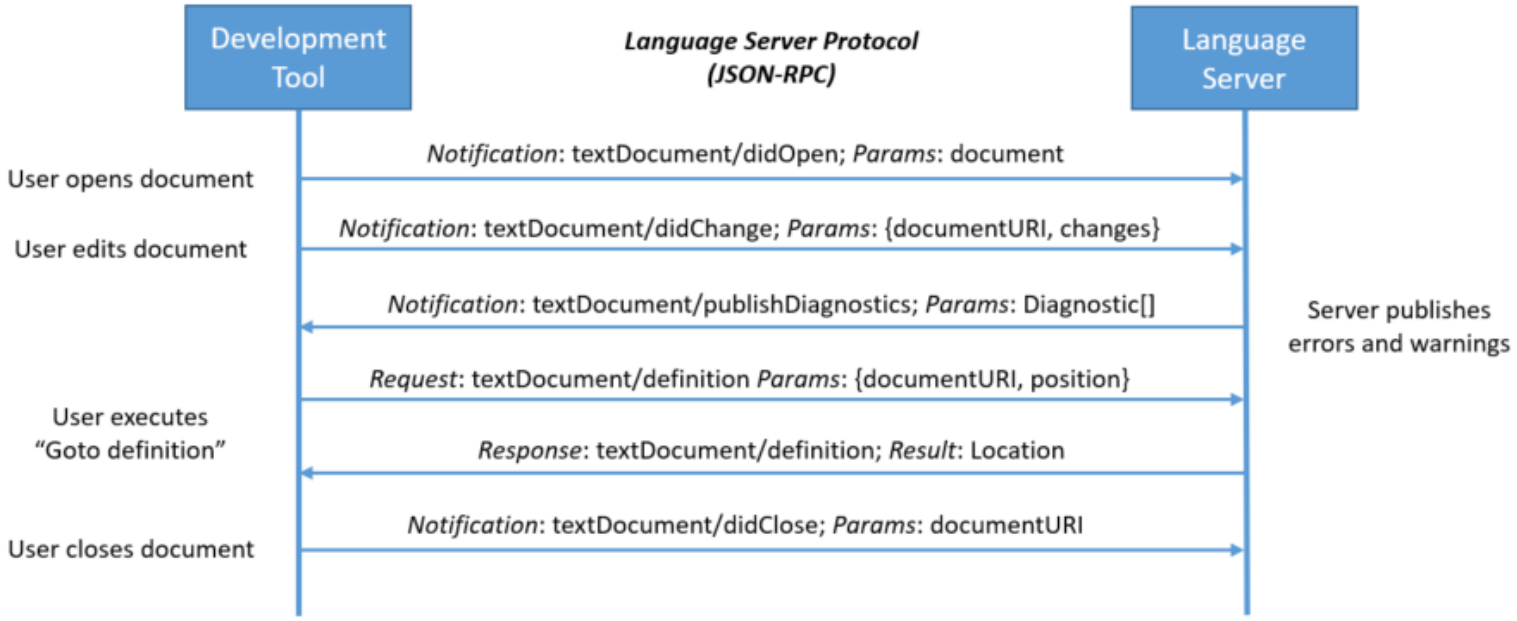
Some supported languages

C/C++/C#, Python, Rust, Type/Javascript, Dockerfile, Elixir, D, Java, Haskell, Ruff, Semgrep, and more

Brief communication overview



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- A way for two programs to communicate
- Transport platform agnostic (can be stdin/out, sockets etc.)

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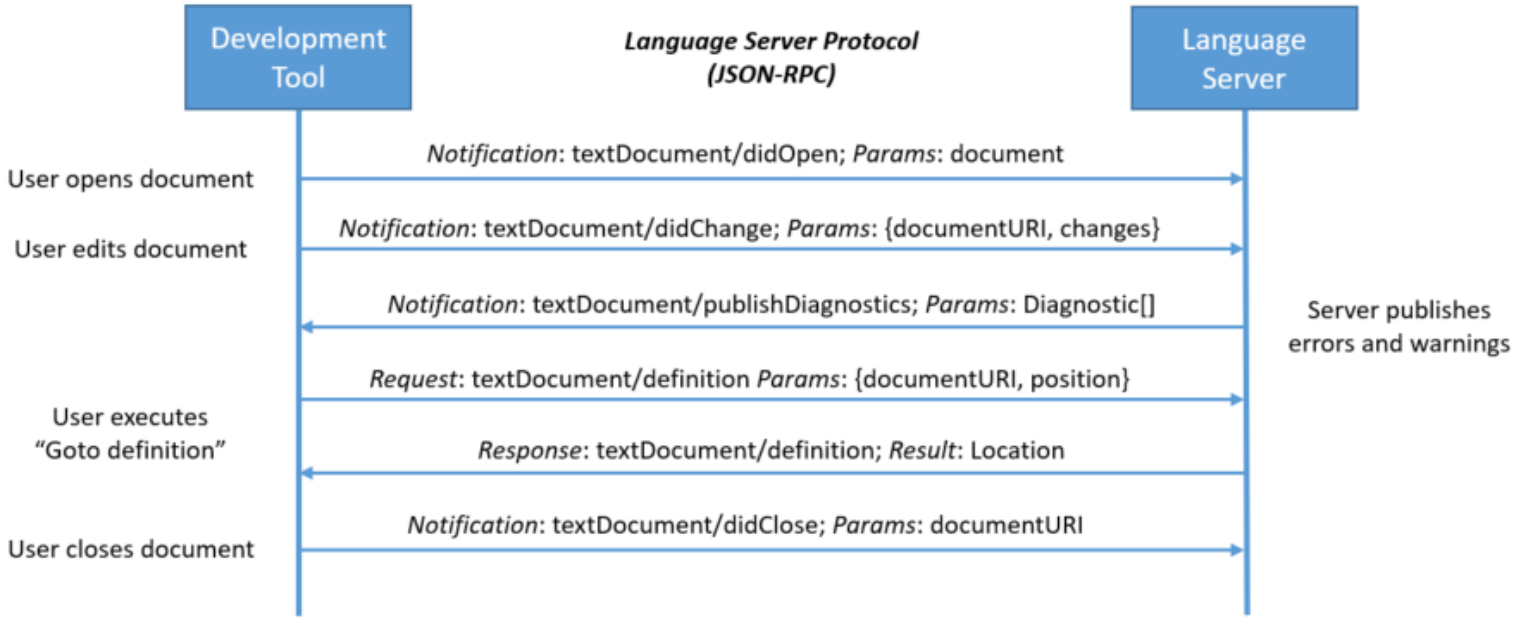

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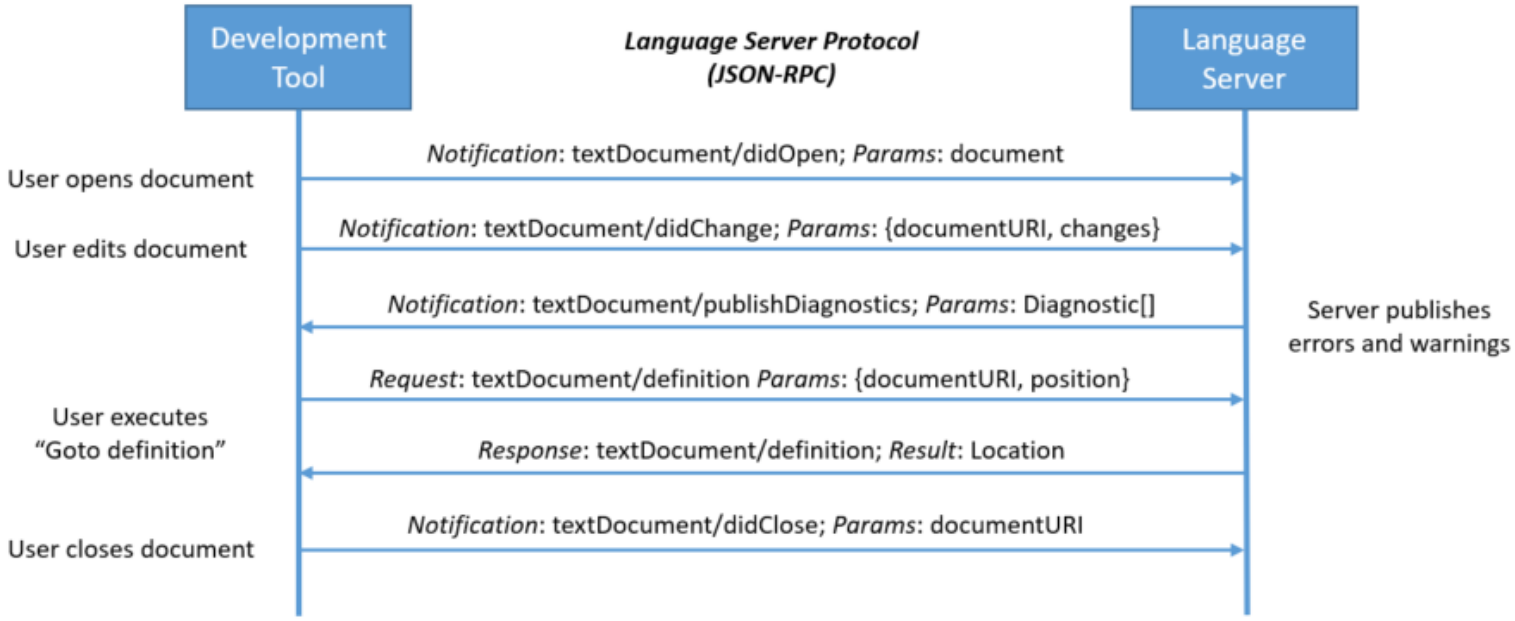

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Request message that requires a response from the other party

Notification message that does not expect a response

Example Request

```
{
    "jsonrpc": "2.0",
    "id" : 1,
    "method": "textDocument/definition",
    "params": {
        "textDocument": {
            "uri": "file:///p%3A/mseng/VSCode/Playgrounds/cpp/use.cpp"
        },
        "position": {
            "line": 3,
            "character": 12
        }
    }
}
```

Example Response


```
{
    "jsonrpc": "2.0",
    "id": 1,
    "result": {
        "uri": "file:///p%3A/mseng/VSCode/Playgrounds/cpp/provide.cpp",
        "range": {
            "start": {
                "line": 0,
                "character": 4
            },
            "end": {
                "line": 0,
                "character": 11
            }
        }
    }
}
```

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- Almost all of the LSP is opt-in
- Server and client communicate on what parts of the protocol they both support
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- Open/Close file
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- Code Actions
- Completion
- Other actions
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Custom Capabilities

- Example: Rust Analyzer has "Structural Search and Replace" request
- If you choose to go down this route, you must implement this custom capability in every client

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- The hard part is not LSP, but the actual logic
- If you want to do analysis on code, you'll need some sort of parser, a way to get errors etc.
- If you're adapting an existing language tool, this is much easier

Supporting a LS through LSP mode in Emacs

- How to write a client for a Language Server in Emacs
- There's the official `lsp-mode` repository on Github w/ many clients
  - These are available to anyone who installs `lsp-mode`
  - Alternatively, one can create a separate package altogether (but we won't focus on this)
- Steps:
  1. A simple .el file that contains the logic
  2. An entry into the list of clients
  3. Documentation!

Create a client

```
;; lsp-mode/clients/lsp-<client-name>.el
;;
;; Use lsp-mode library
(require 'lsp-mode)

(lsp-register-client
 (make-lsp-client
  :new-connection (lsp-stdio-connection '("<server-executable>"))
  :activation-fn (lsp-activate-on "<language-name>")
  :server-id 'language-server-name))

(lsp-consistency-check 'language-server-name)
(provide 'lsp-client-name)
```

Add to list of client packages

```
;; lsp-mode/lsp-mode.el
;; a bunch of lisp
(defcustom lsp-client-packages
  '(
    ;; A bunch of clients
    lsp-client-name
    ;; more clients
    )
  "List of the clients to be automatically required."
  :group 'lsp-mode
  :type '(repeat symbol))
;; more lisp
```

Add to list of clients

```
// lsp-mode/docs/lsp-clients.json
{
  // other clients...
  "name": "client name",
  "full-name": "full client name",
  "server-name": "language-server-name",
  "server-url": "<url>",
  "installation": "<installation command>",
  "debugger": "Yes or Not available"
}
```

Add documentation!

```
# lsp-mode/mkdocs.yml
# Documentation!
# Other client pages
- Client Name: page/lsp-<client-name>.md
# More client pages
```

Adding commands and custom capabilities

```
;; Custom notification
(defun client-notify-command (params)
 "Documentation"
 (interactive)
 (lsp-notify "method" params))

;; Custom request
(defun client-request-command (params)
 "Documentation"
 (interactive)
 (lsp-request-async "method" params
                    (lambda (result)
                      (do-thing result))))
;; Previous content of lsp-client-name.el
```

Thanks for listening

Resources

- Semgrep: We're hiring!
- LSP Specification
- lsp-mode + docs
- Rust Analyzer
- Long Video Tutorial

Q&A Time