Universal Language Server Protocol and Debugger Adapter Protocol for Modular Language Workbenches

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Cyclus 40th

Problem Statement
Programming Language Implementation

Problem Statement
LSP & DAP
In a Nutshell
The Reductions of Combinations
An Achievement
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Scientific Contribution
Type System Components
Checking and Inference
Modularization
Conclusions

The implementation of a programming language is a complex task that involves several implementation aspects, such as:

- Syntax and semantics definition
- Type system definition
- Code generation
- Error handling
- IDE support
- Documentation

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It is usually done in a monolithic way with a top-down approach, where all the aspects are tightly coupled.

This makes the maintainability, extensibility and reusability of the implementation difficult.

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In 2016, Microsoft in collaboration with Red Hat introduced the Language Server Protocol (LSP) and the Debugger Adapter Protocol (DAP).

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The LSP and DAP are JSON-RPC based protocols that allow the communication between a Language Server and an IDE.

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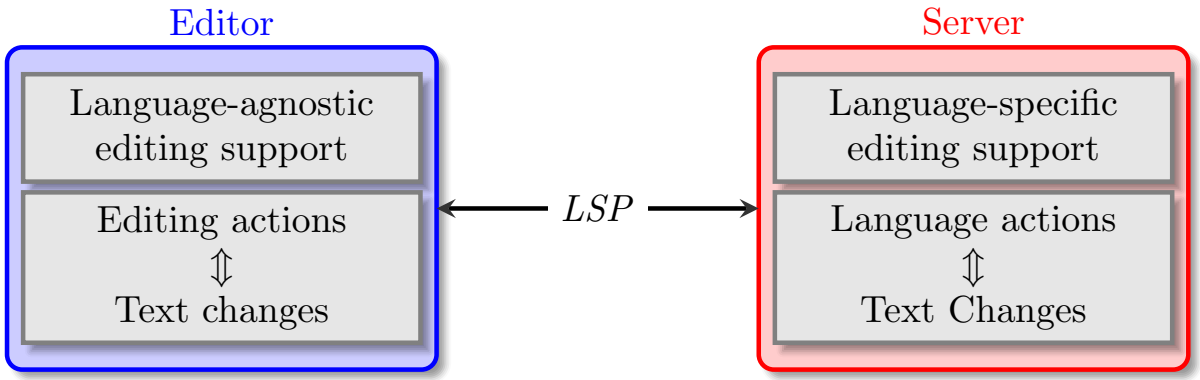

Intrinsic properties:

- Language-agnostic
- IDE-agnostic
- Asynchronous
- Text-based

Features:

- Diagnostics
- Hover
- Go to definition
- Find references

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Initially implemented for Visual Studio Code, the LSP and DAP have been adopted by several IDEs and programming languages.

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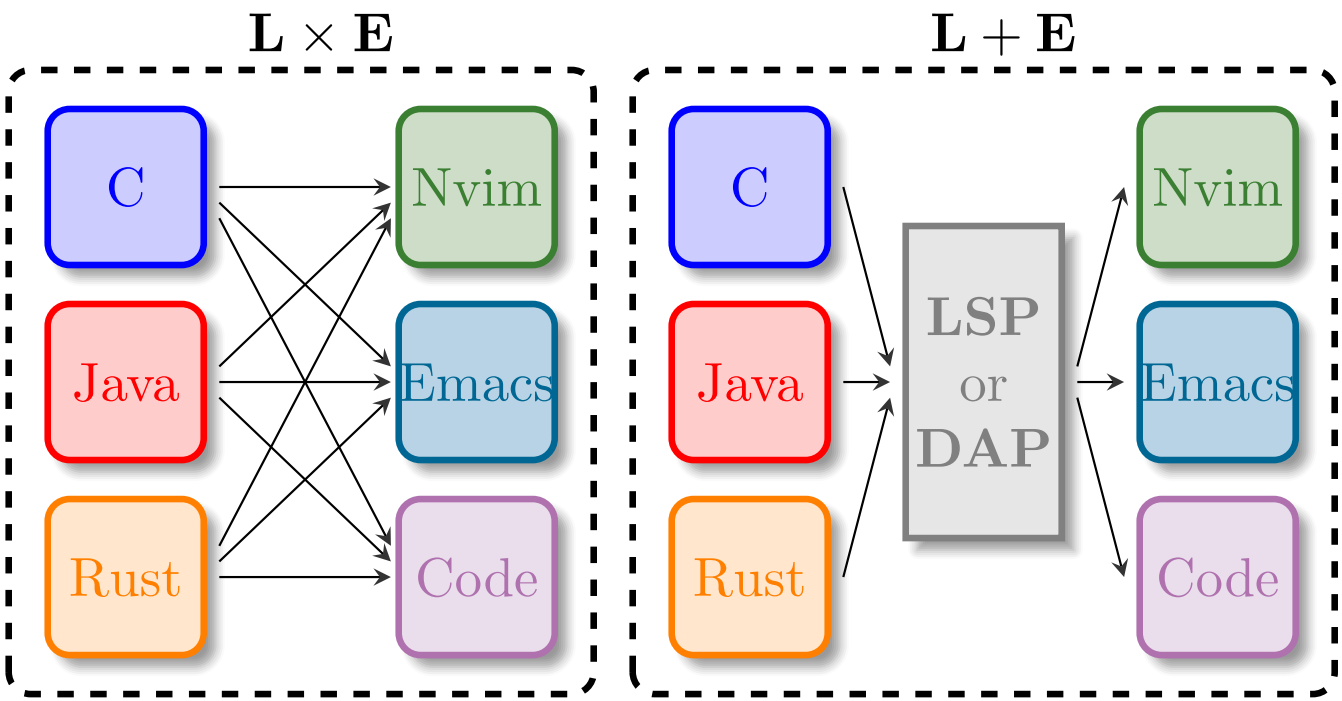

LSP and DAP
What would be an important achievement?

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Reducing the number of combinations between Language Servers and IDEs.

LSP and DAP

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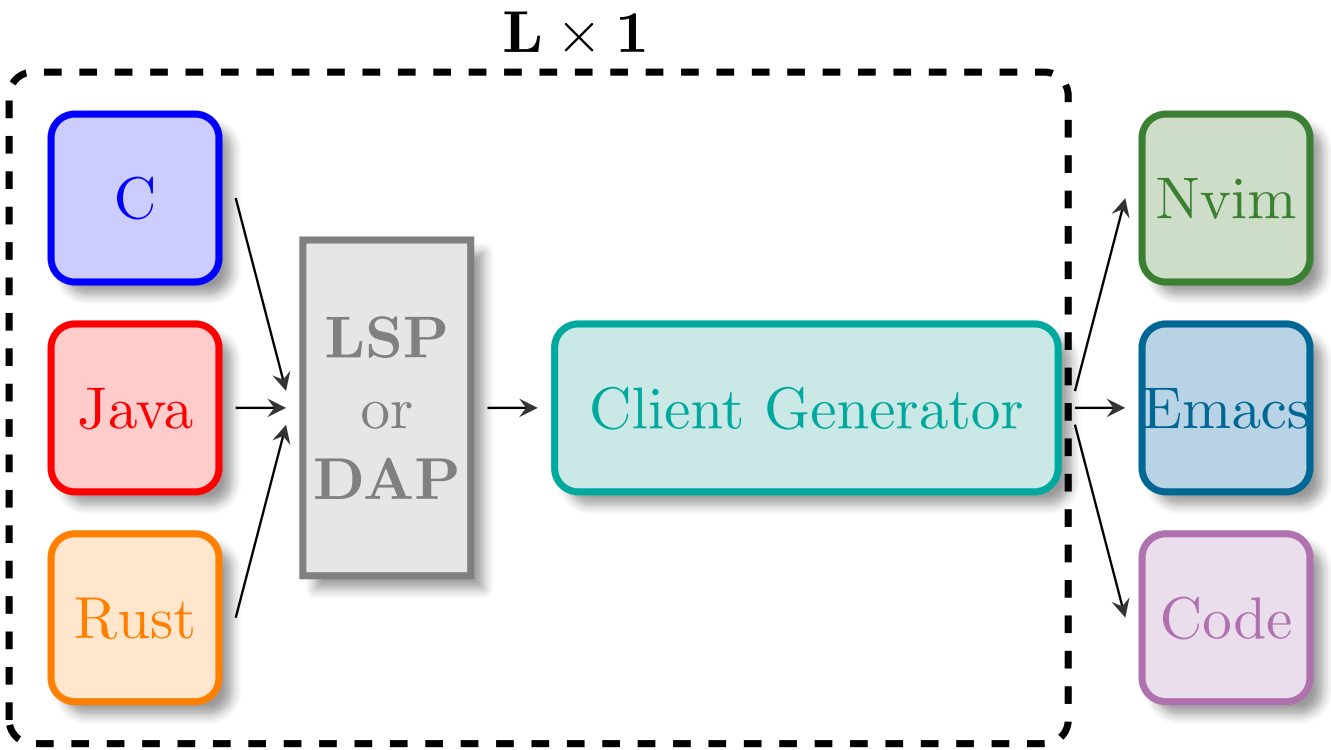

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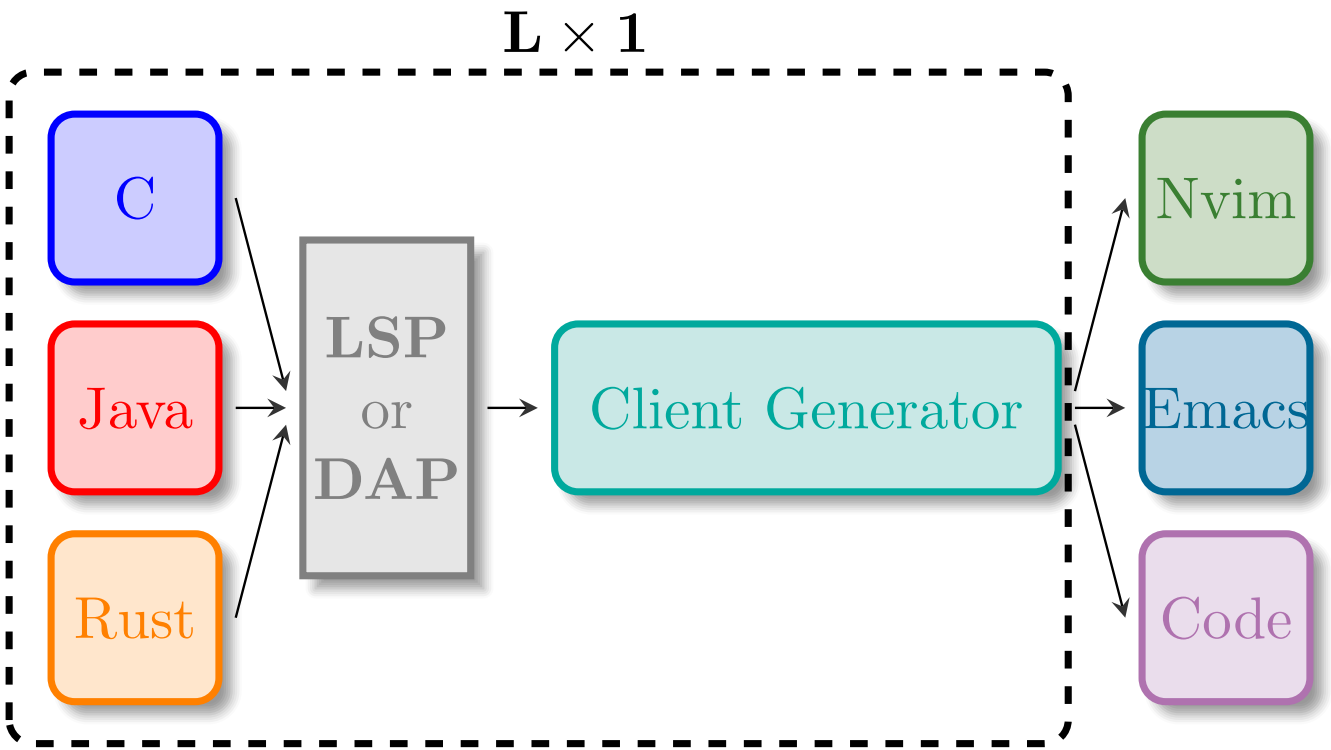

Spoiler: It should be possible! and maybe we can do better.

Feature-Oriented Programming

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Feature-Oriented Programming (FOP) is a programming paradigm that allows the development of software product lines (SPLs).

Feature-Oriented Programming

Feature-Oriented Programming (FOP) is a programming paradigm that allows the development of software product lines (SPLs).

- Feature is a unit of functionality that satisfies a requirement.
- Feature Model is a model that represents the variability of the SPL.
- Feature Configuration is a set of features that compose a product.

Language Workbenches

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Language Workbenches (LWs) are tools that allow the development of programming languages, both GPLs and DSLs.

Language Workbench	Modularization Supp.	Precompiled Feature Supp.	Native IDE gen.	LSP & DAP Gen.	LSP & DAP Mod.
JustAdd	◐	○	○	○	○
Melange	⍓	○	3rd p.	☆	☆
MontiCore	◐	◐	●	○	○
MPS	⍓	○	●	☆	☆
Rascal	○	○	●	○	○
Spoofax	⍓	◐	●	☆	☆
Xtext	○	◐	●	●	○
Neverlang	⍒	●	○	★	★

● Full support

○ No support

◐ Limited support

⍒ Fine-grained mod.

⍓ Coarse-grained mod.

★ My expected contribution

☆ Extended contribution

3rd p. Third-party

Scientific Contribution

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- Methodology for whole LWs that support at least component modularization.
- Type System, LSP and DAP Modularization.
- DSL for Type System definition.
- LSP and DAP generation for Neverlang languages.
- Clients and Syntax Highlighting generation reducing the number of combinations.
- Implementation of a Java Library for Neverlang to support the type system, LSP and DAP for every language developed with Neverlang.
- 3 use cases to show the effectiveness of the methodology.

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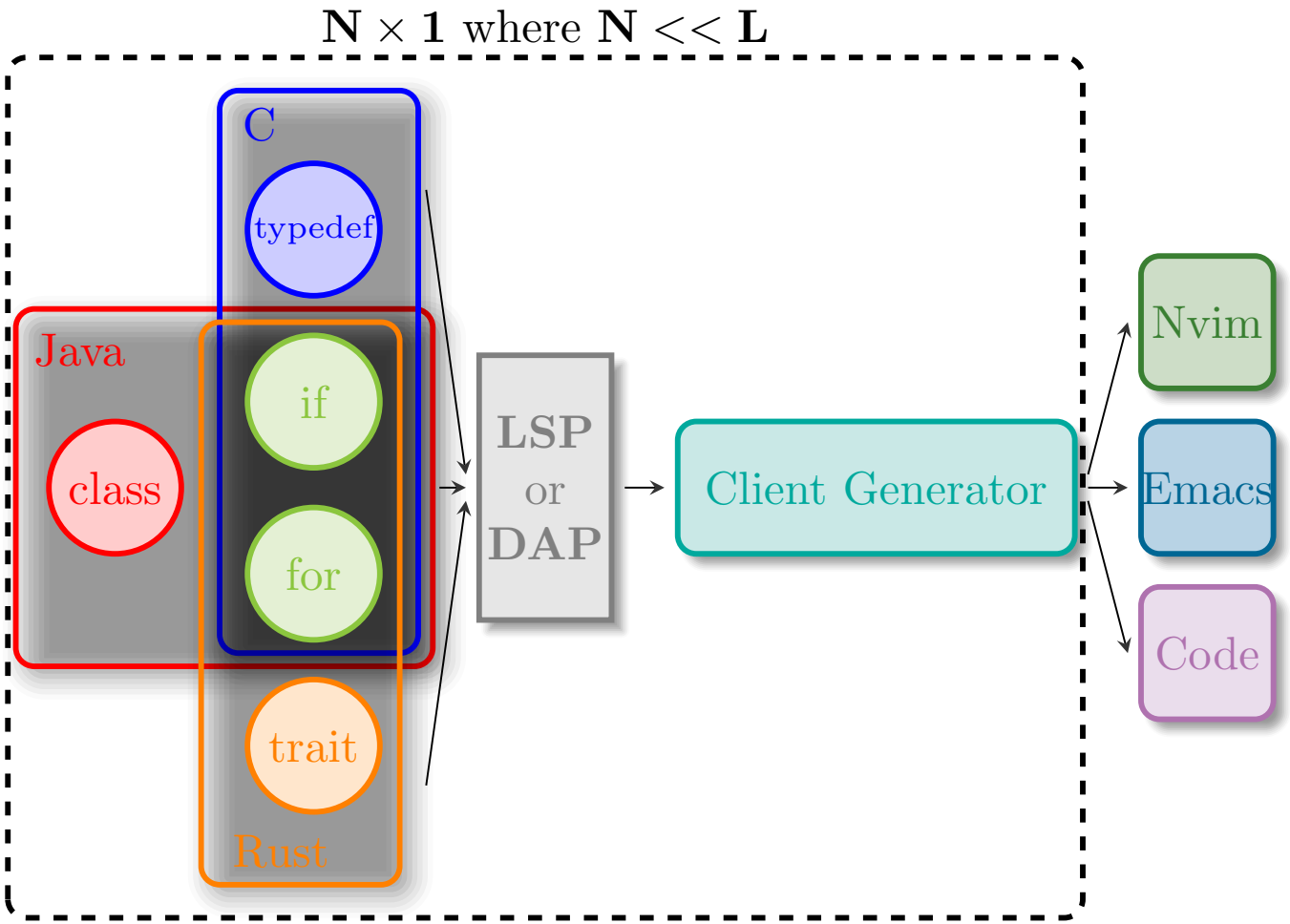

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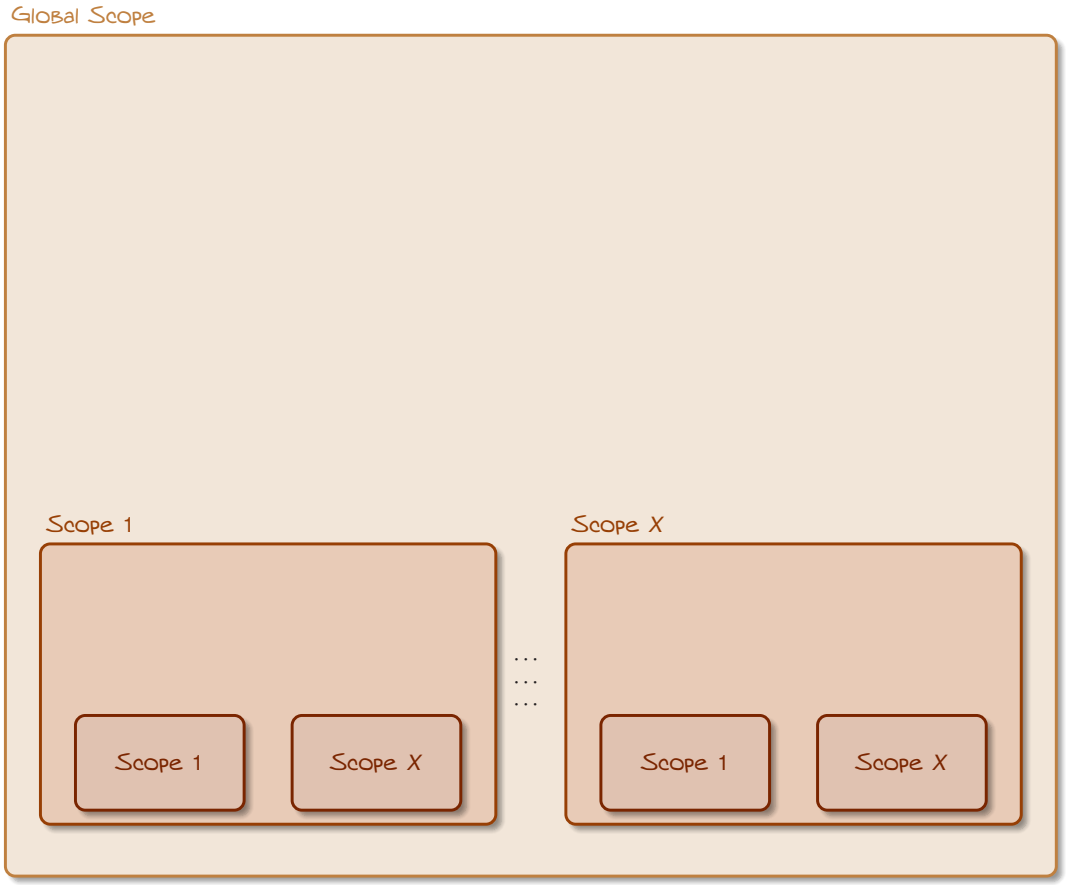

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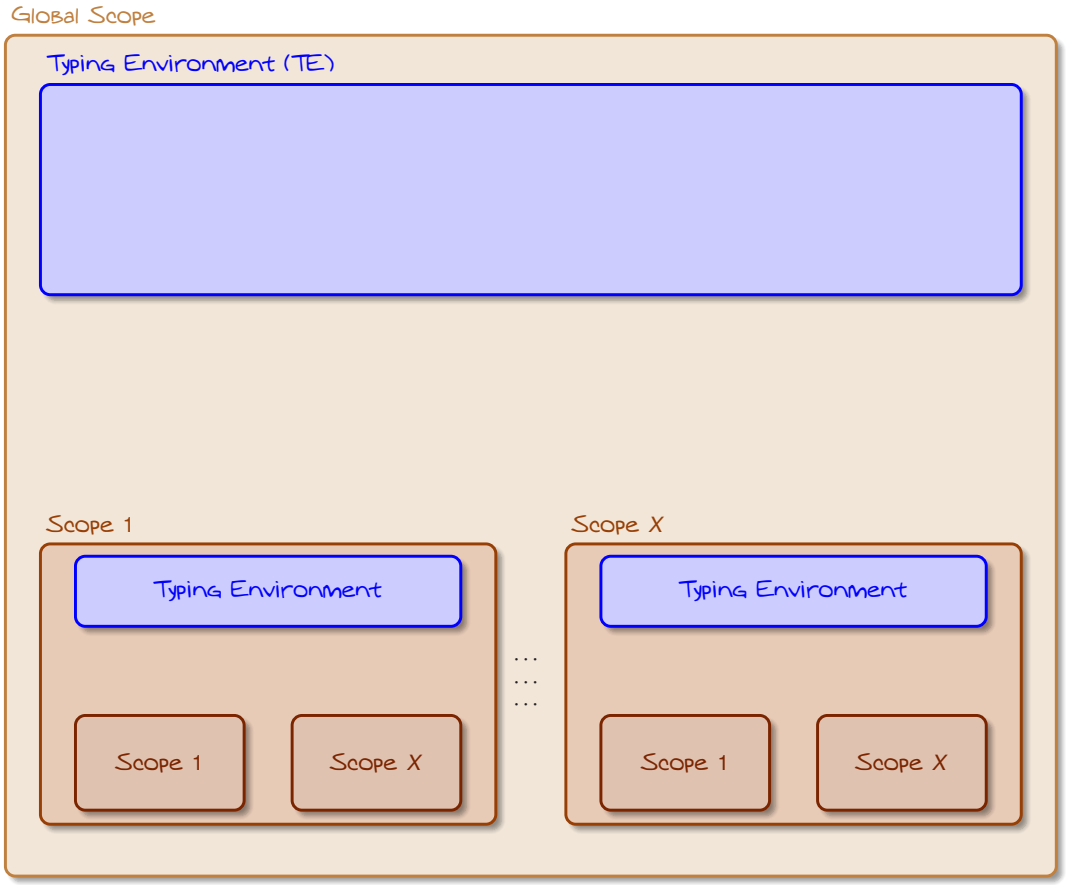

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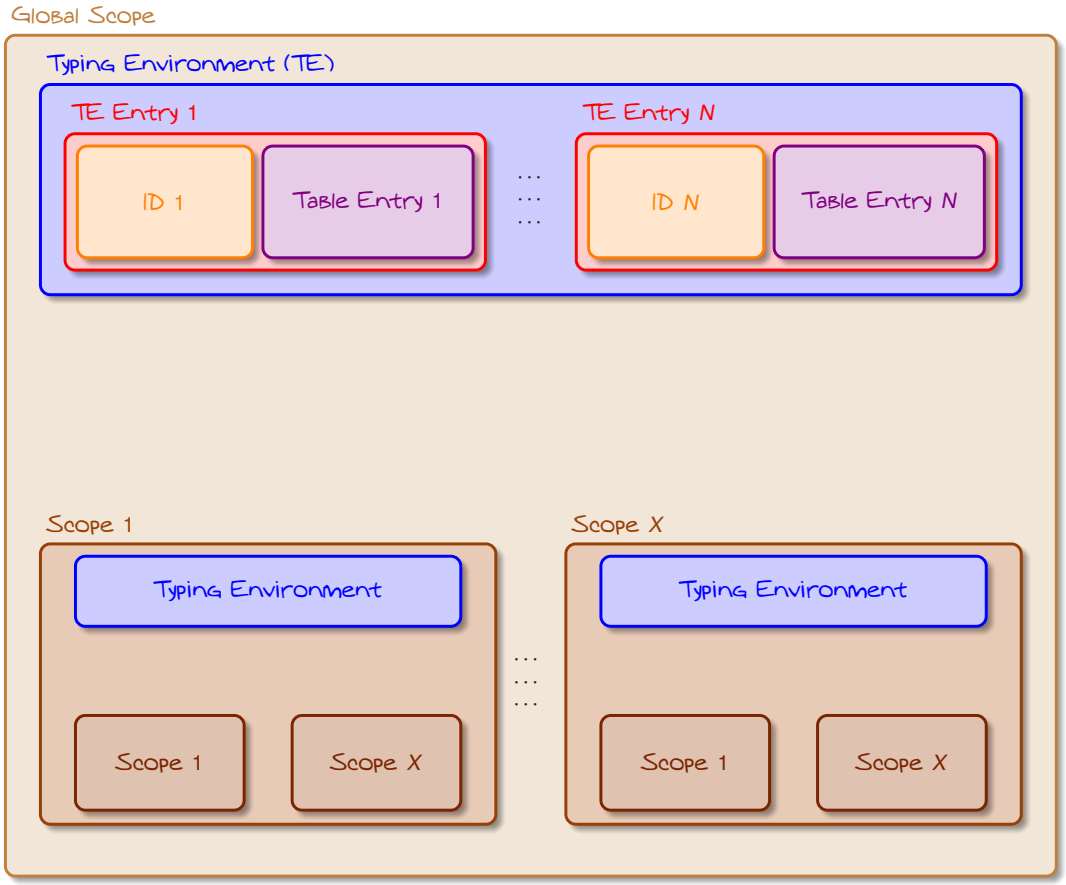

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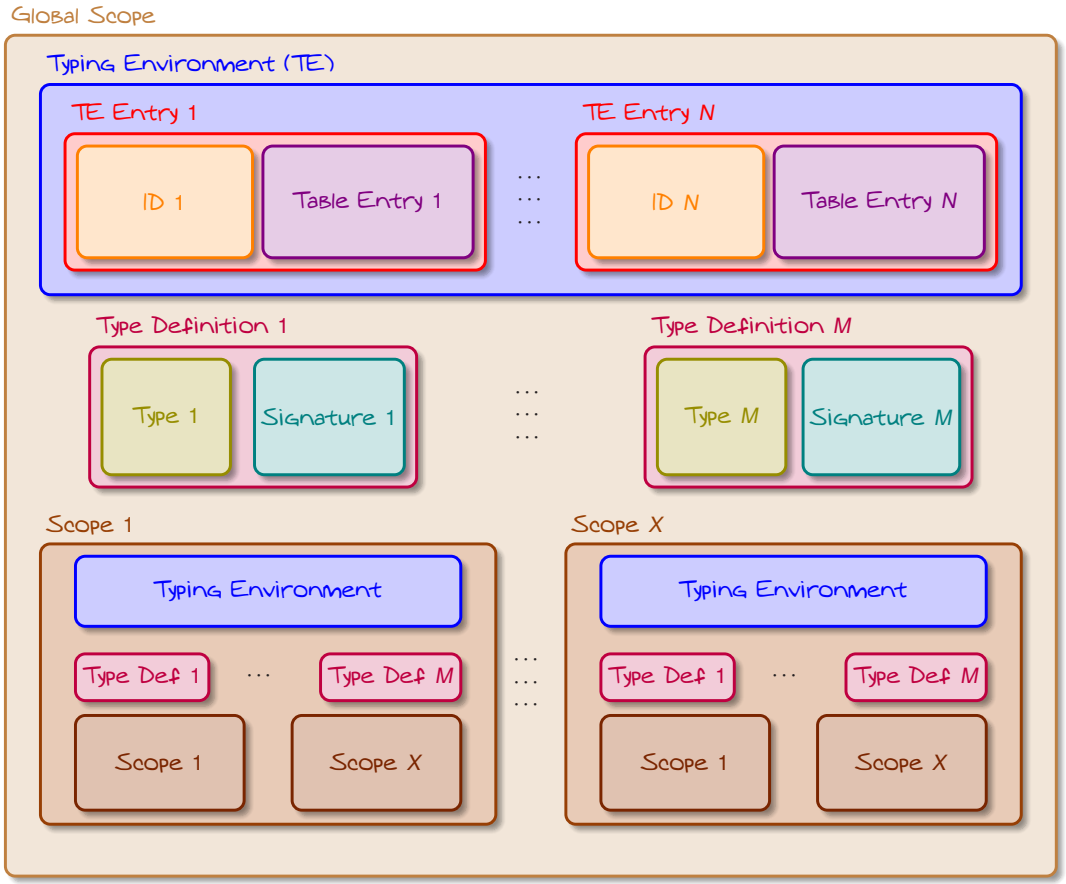

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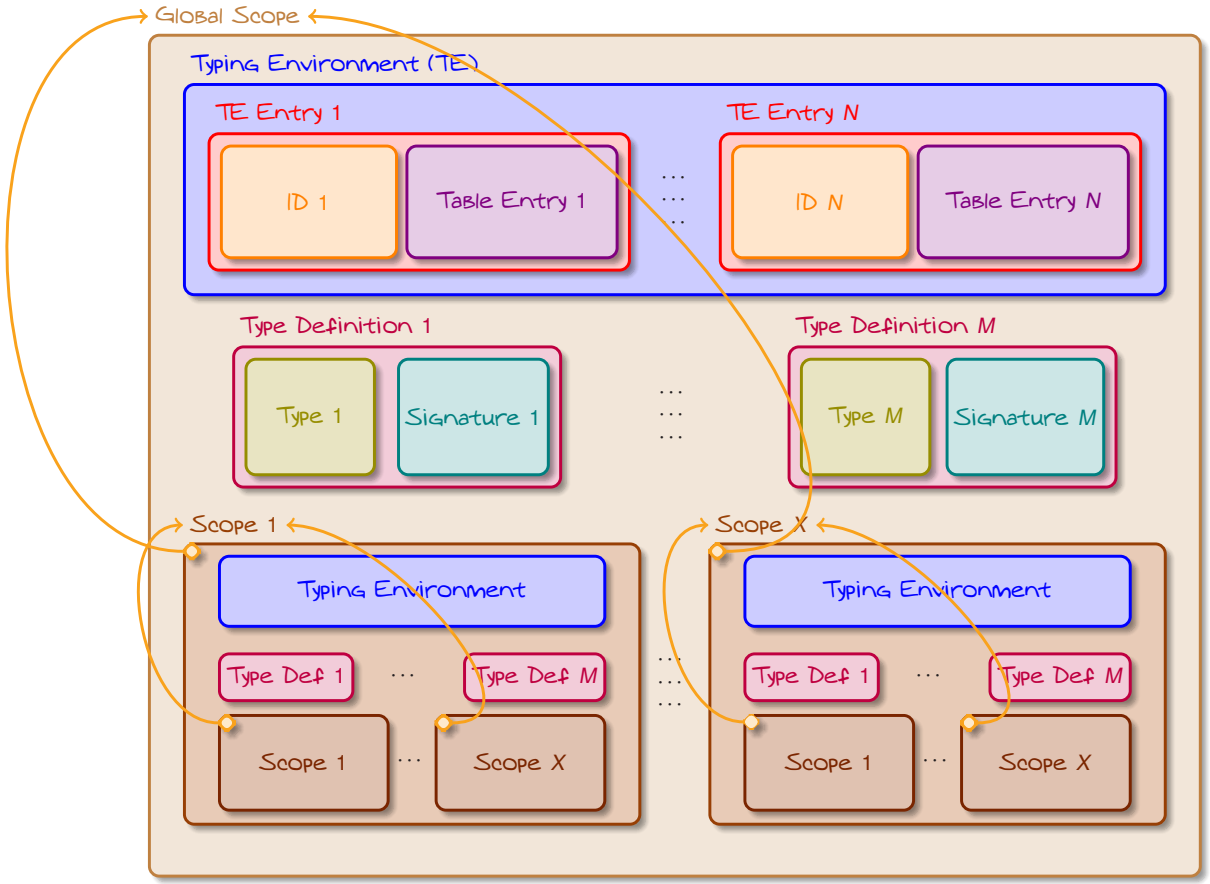

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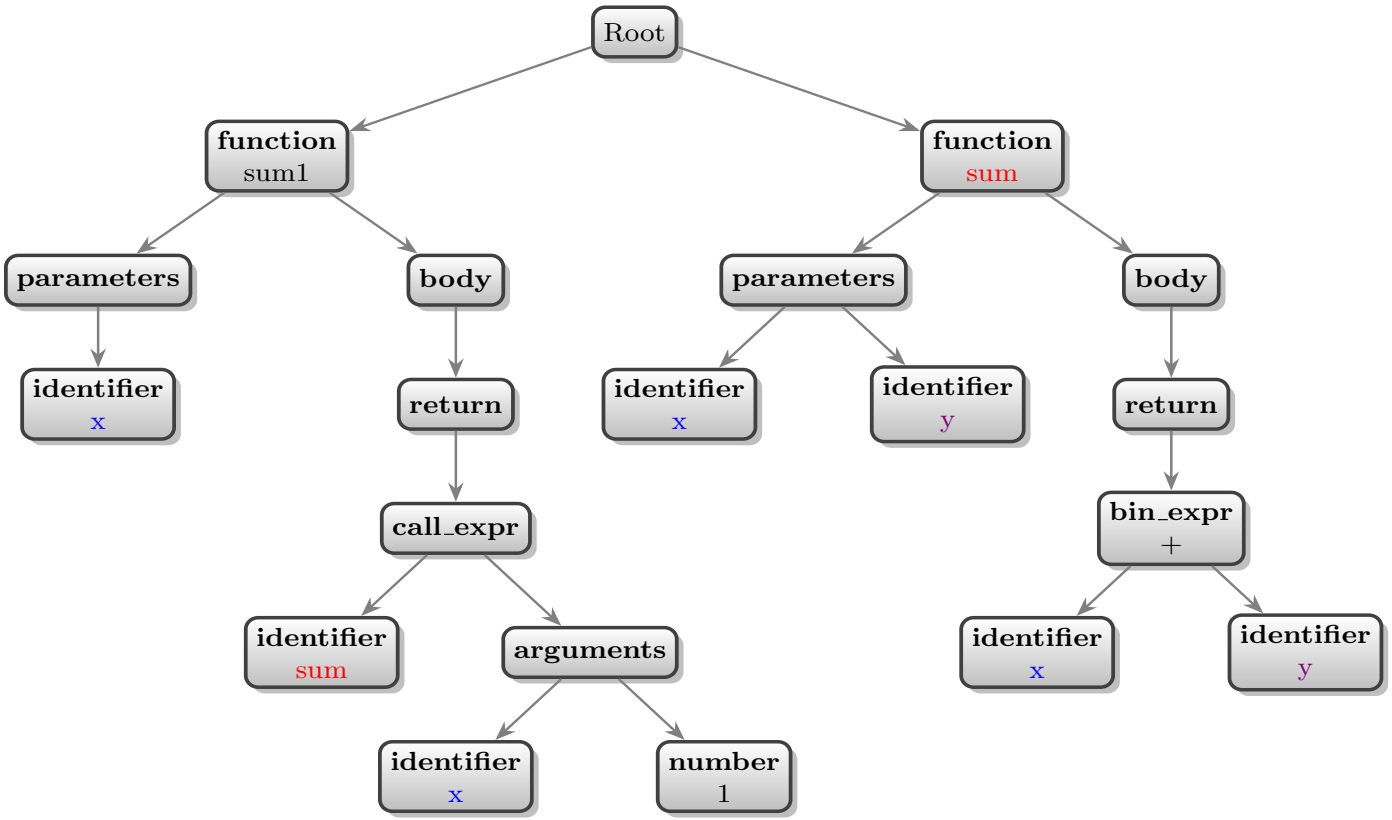
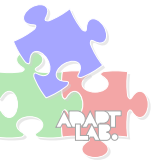
Type Checking and Type Inference


```
1  function sum1(x) {
2      return sum(x, 1);
3  }
5  function sum(x, y) {
6      return x + y;
7  }
```





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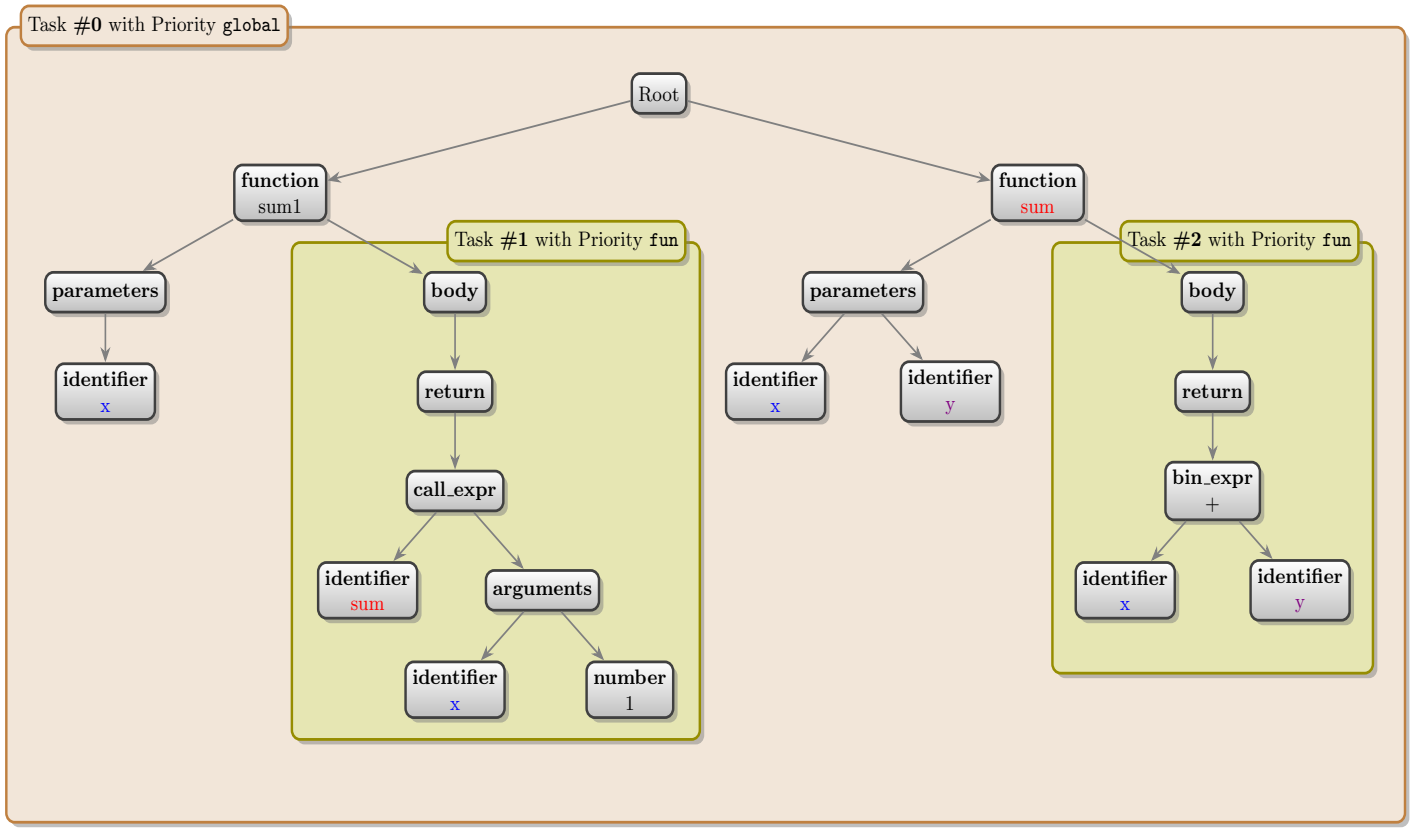
- Compilation Unit
- Compilation Unit Task
- Compilation Helper



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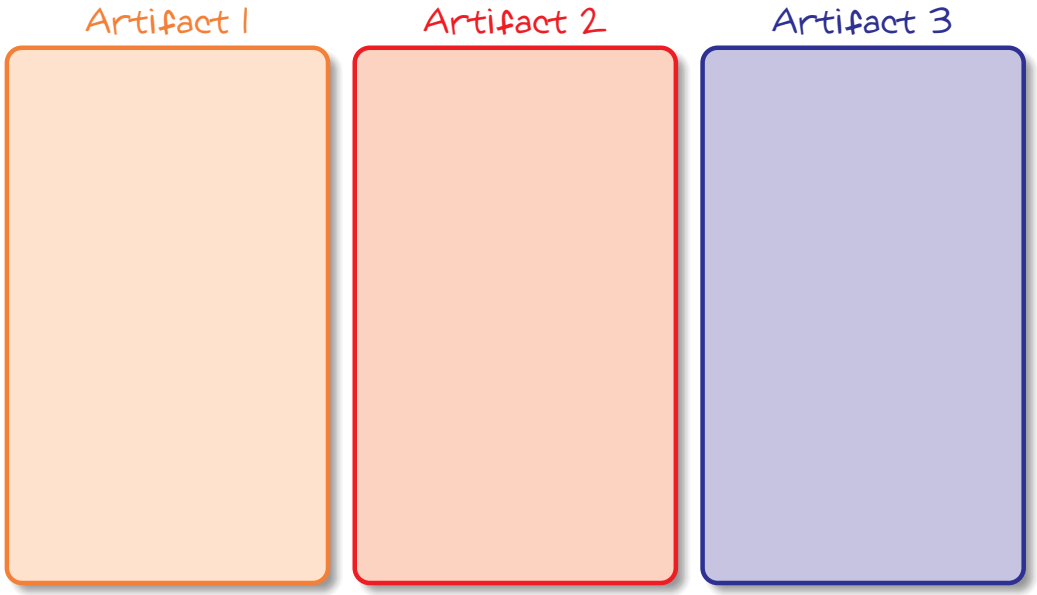

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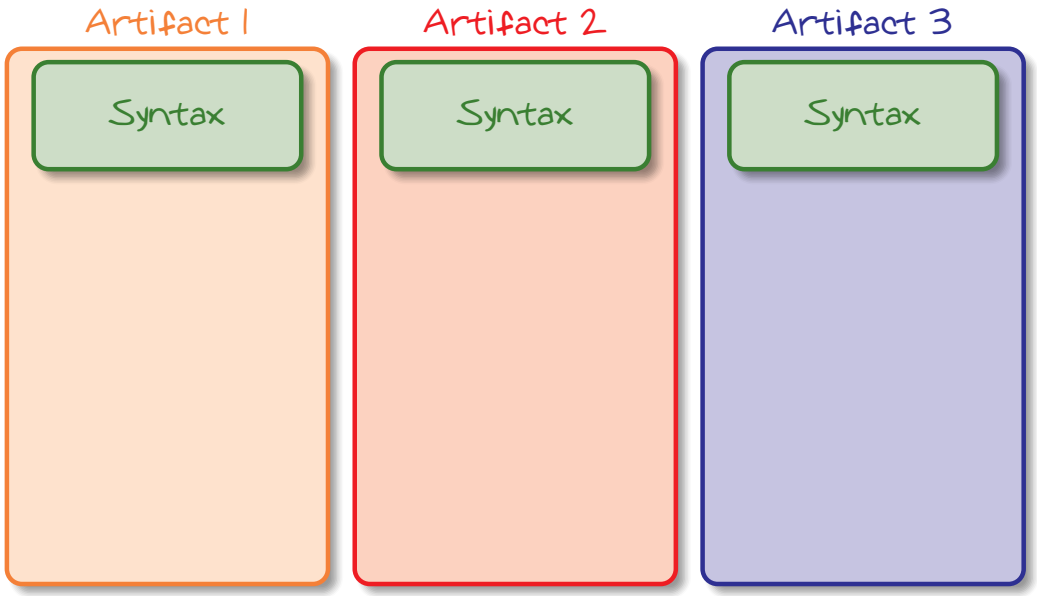

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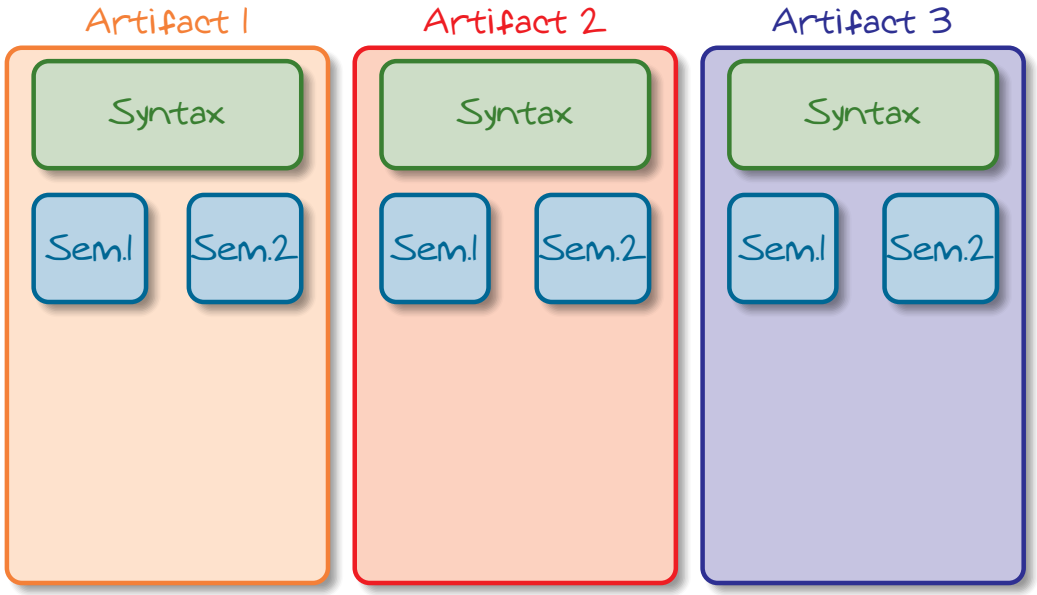

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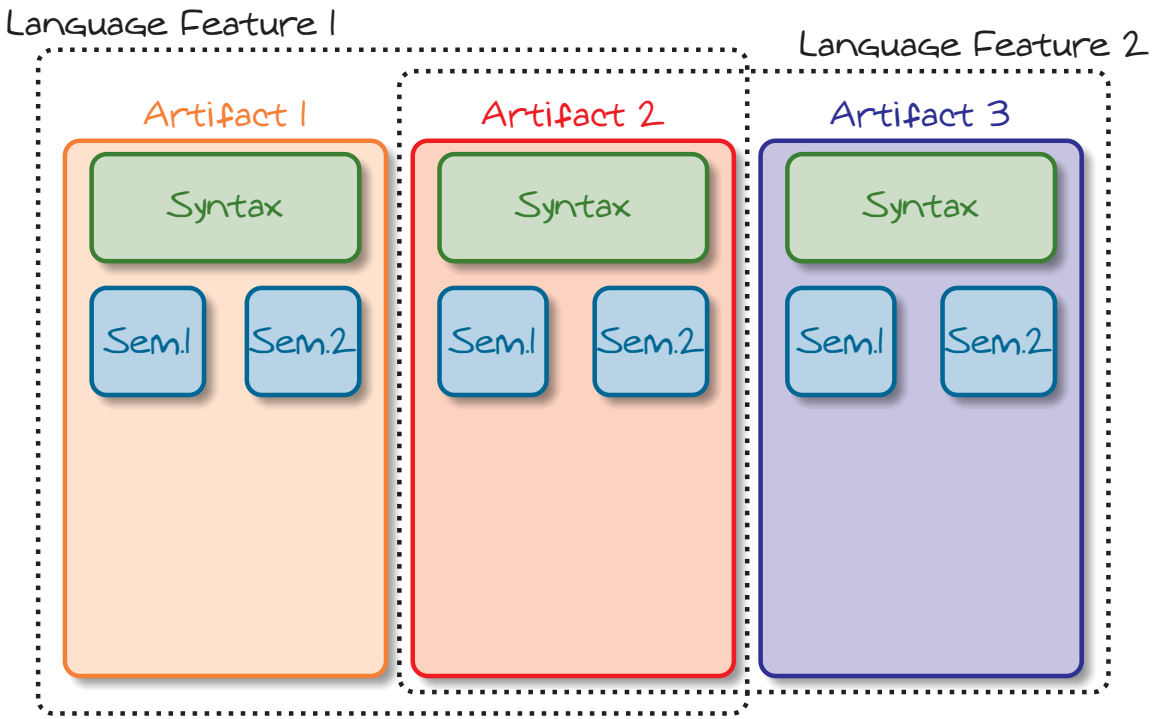

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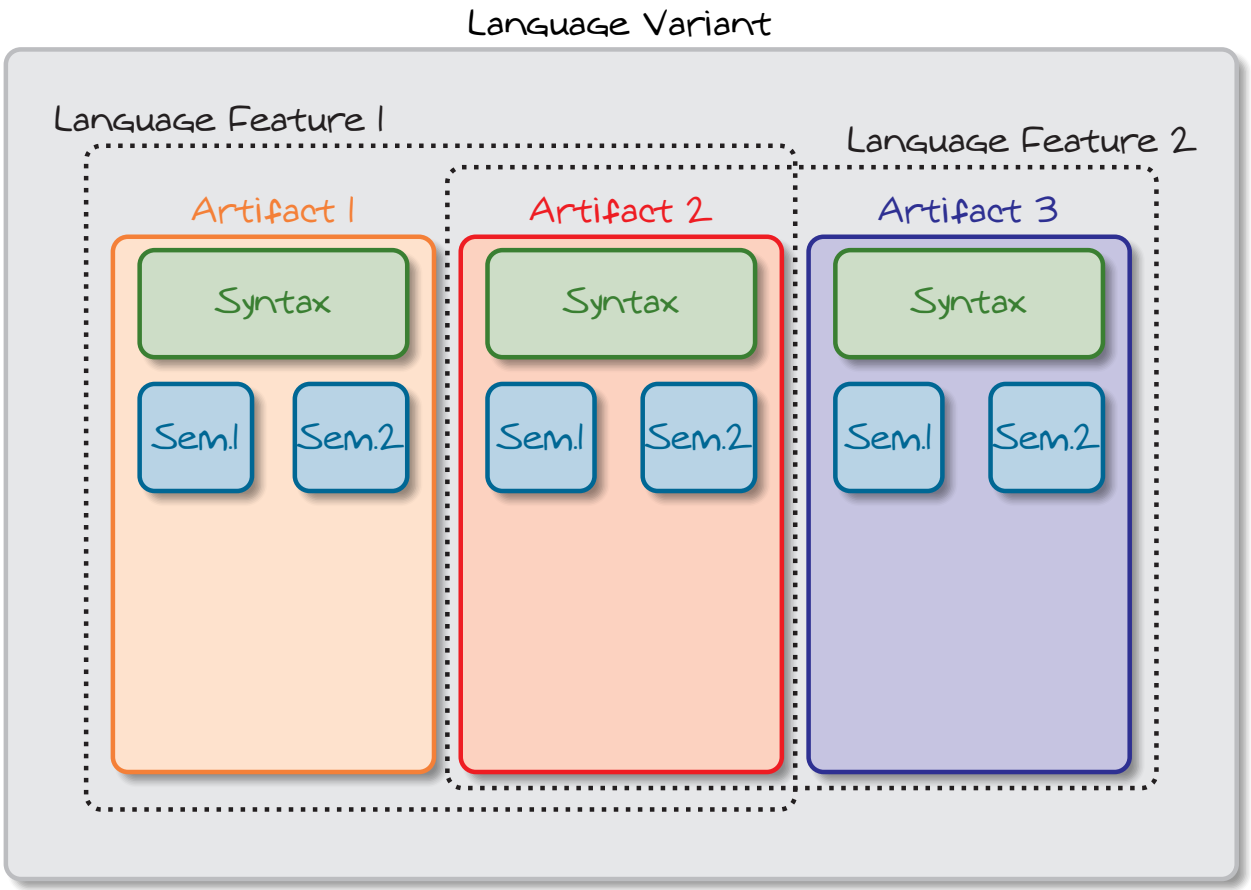

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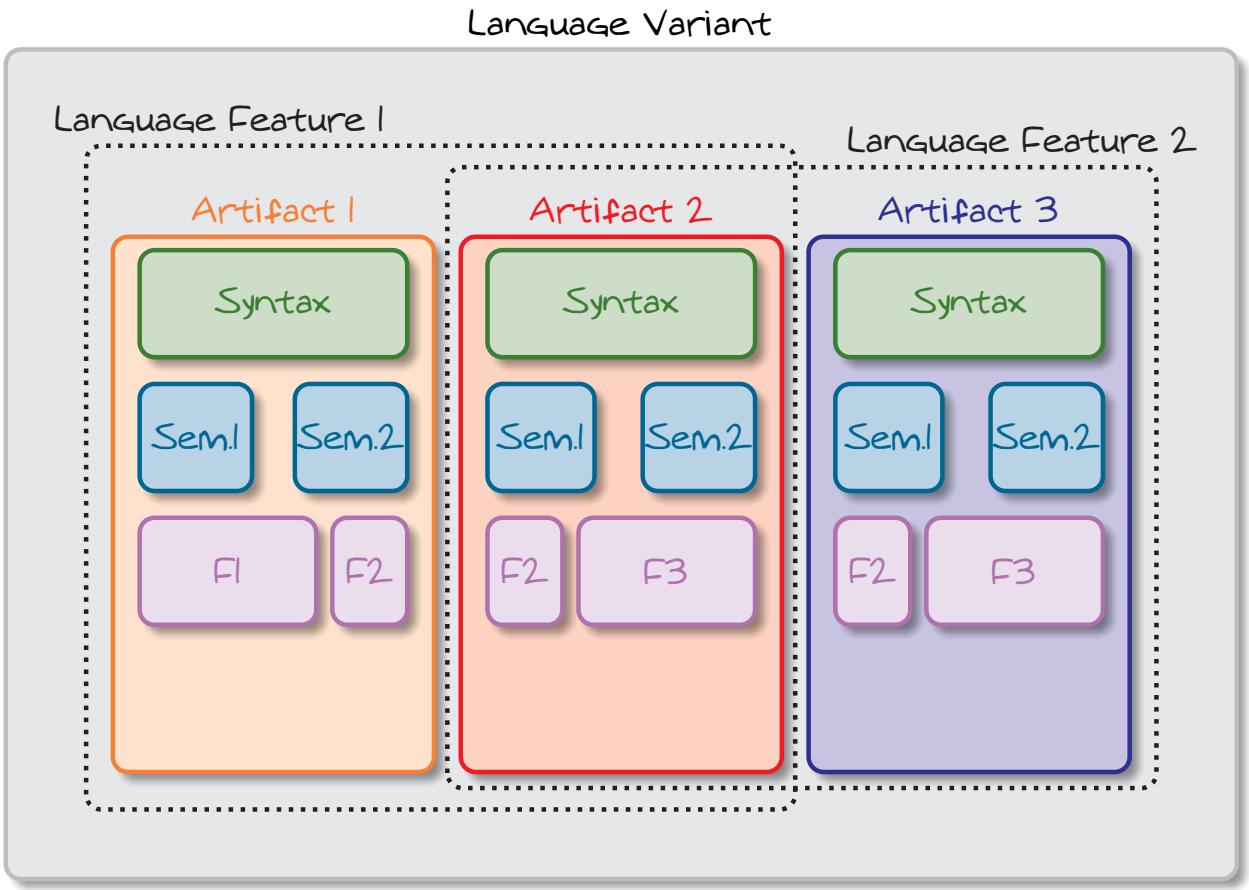

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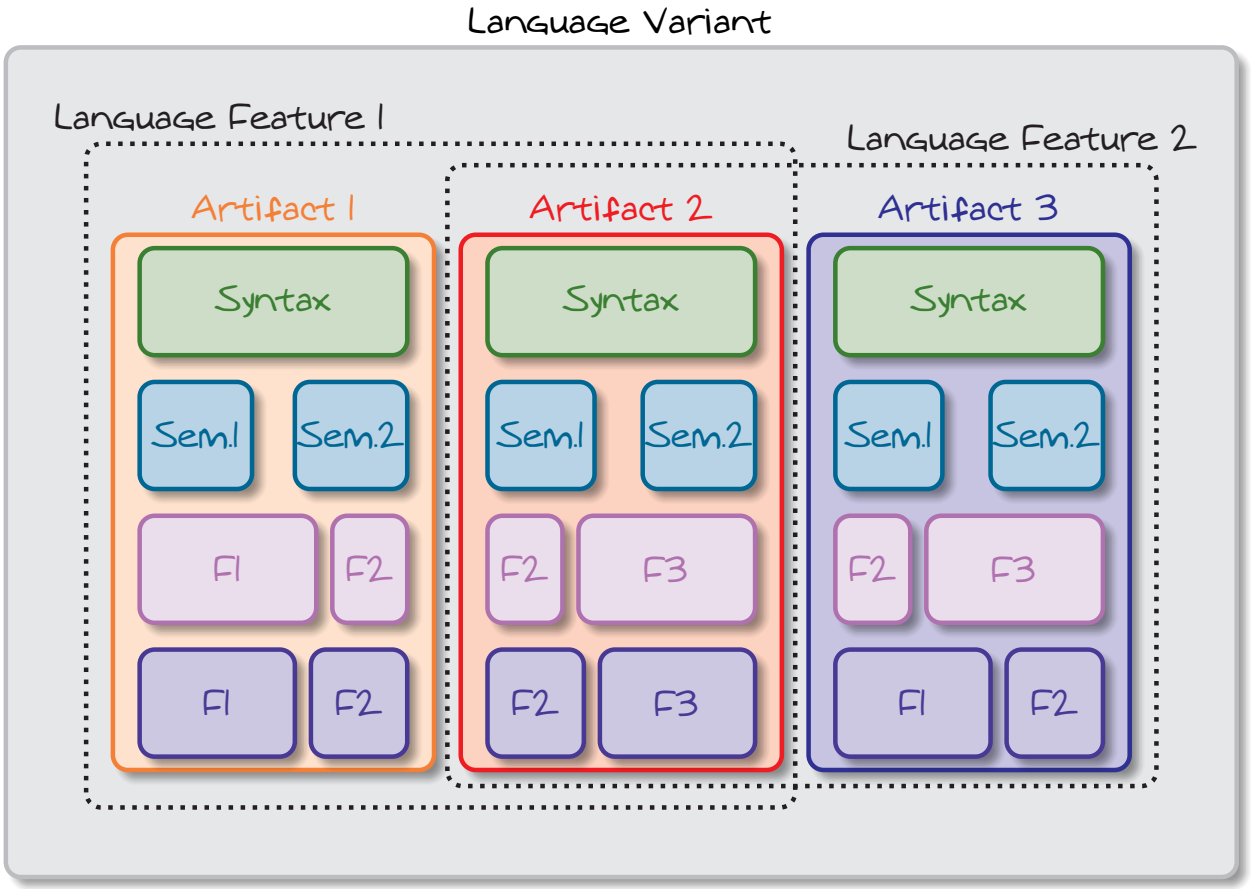

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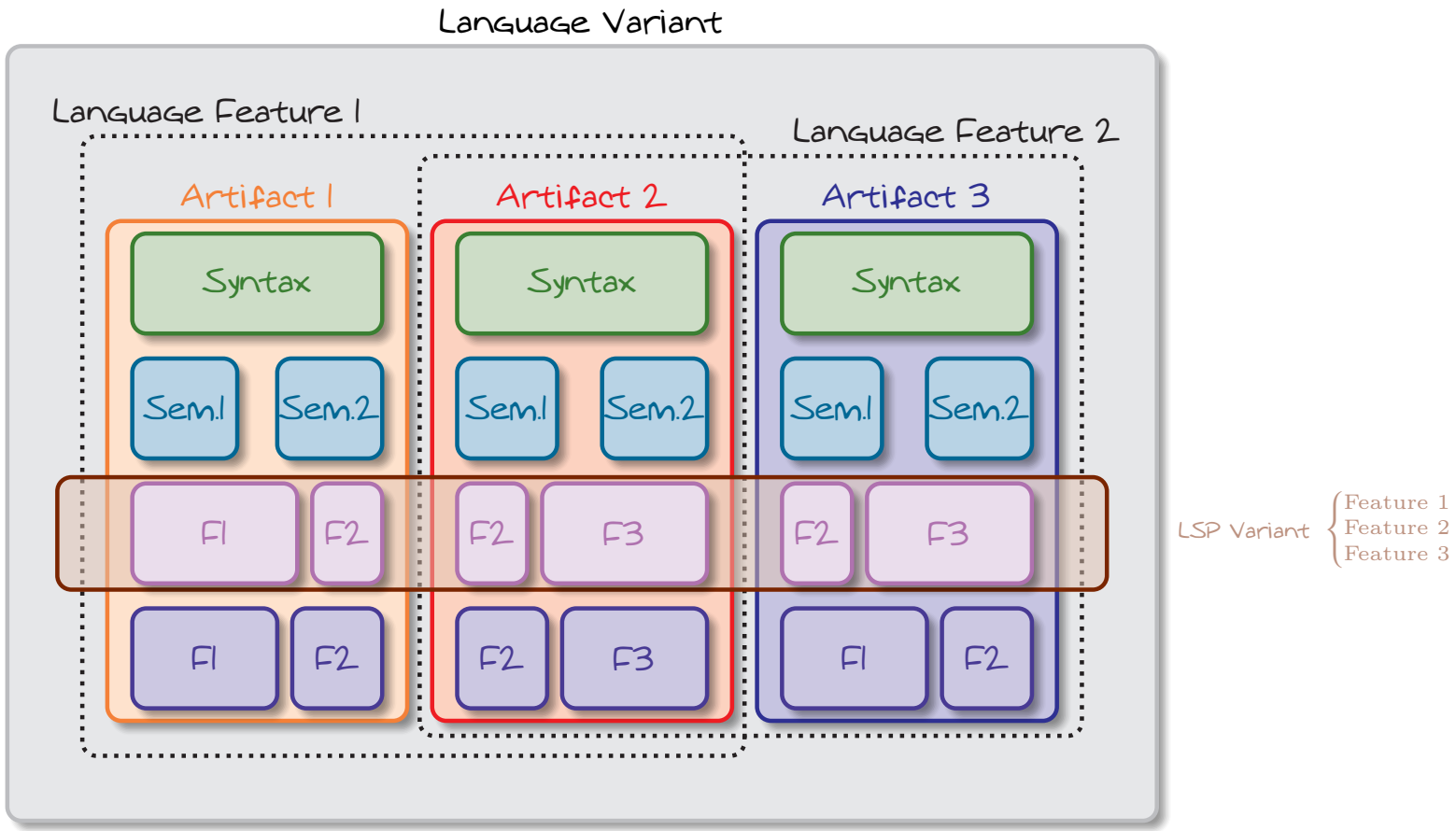

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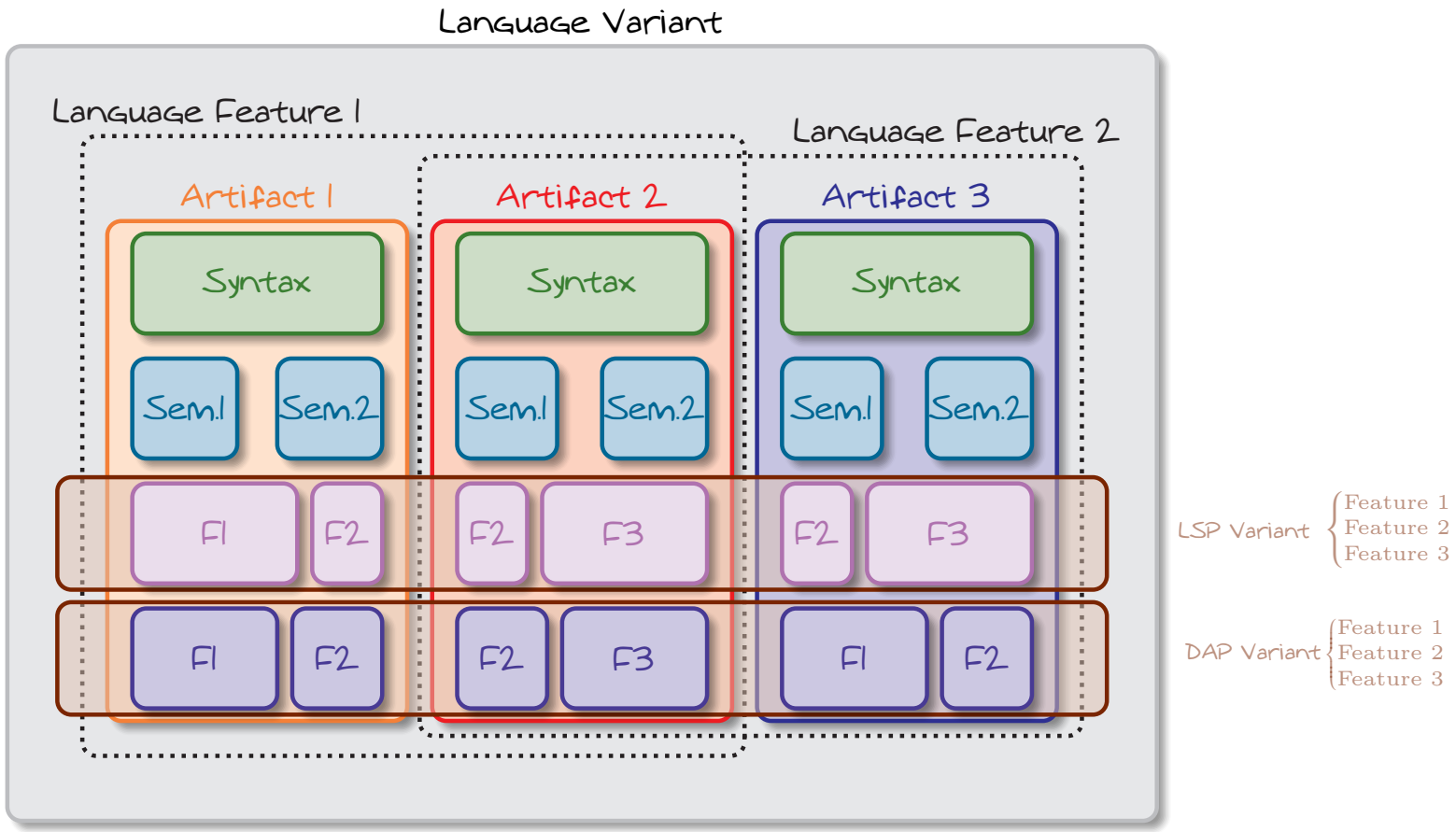

Conclusions
Master's Thesis Results

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Interesting results:

- We are writing an article (Code Less to Code More) to be submitted to JSS.

Interesting twist:

- Recycling the code of the TS to define a new compilation phase inside of Neverlang.

Thanks for your attention!

Software Product Lines

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Since 1990s, researchers have been working on the concept of Software Product Lines (SPLs) to move towards a more modular world.

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Since 1990s, researchers have been working on the concept of Software Product Lines (SPLs) to move towards a more modular world.

- SPLs defines a family of software products.
- SPLs is described by a Feature Model.
- A Feature Model describes the variability of the software.
- SPL variants are generated by selecting a set of features.
- A feature (or artifact) is a first-class entity in SPLs.

Language Product Lines

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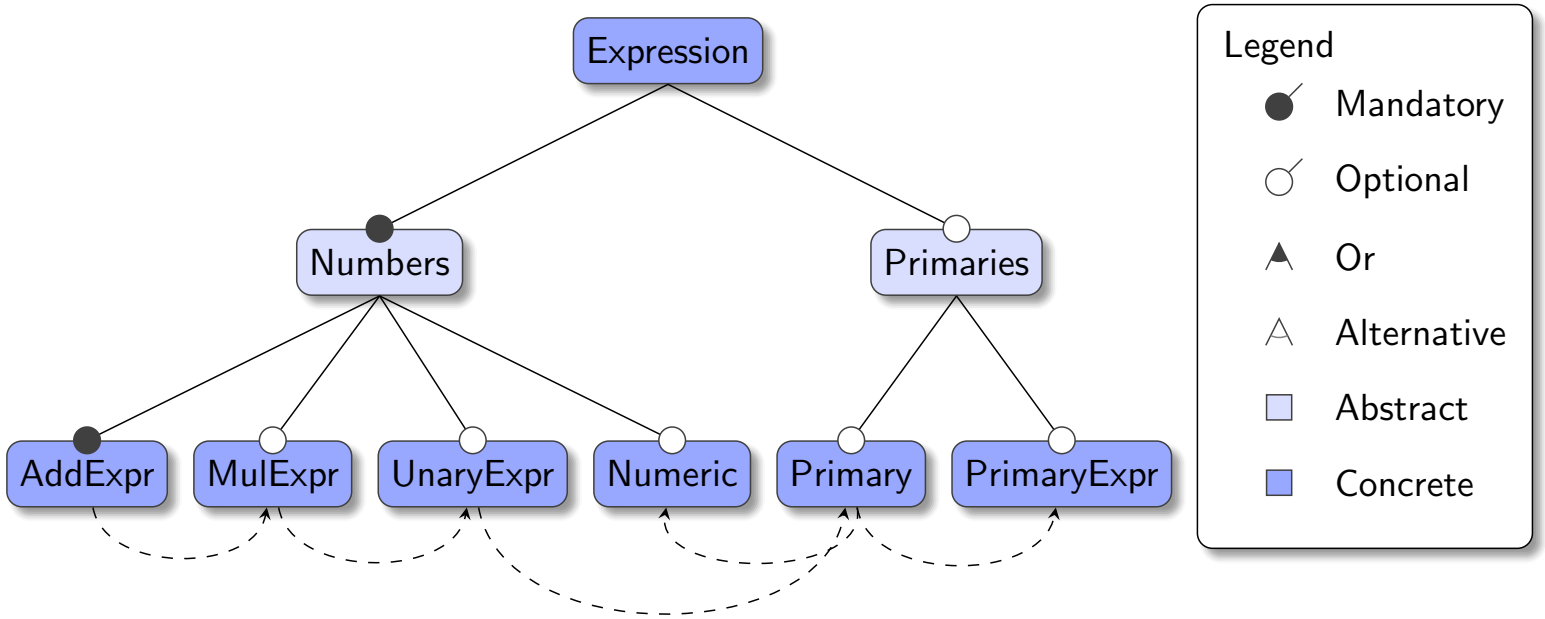
Applying the concept of SPLs to programming languages, we obtain the concept of Language Product Lines (LPLs).



Language Product Lines

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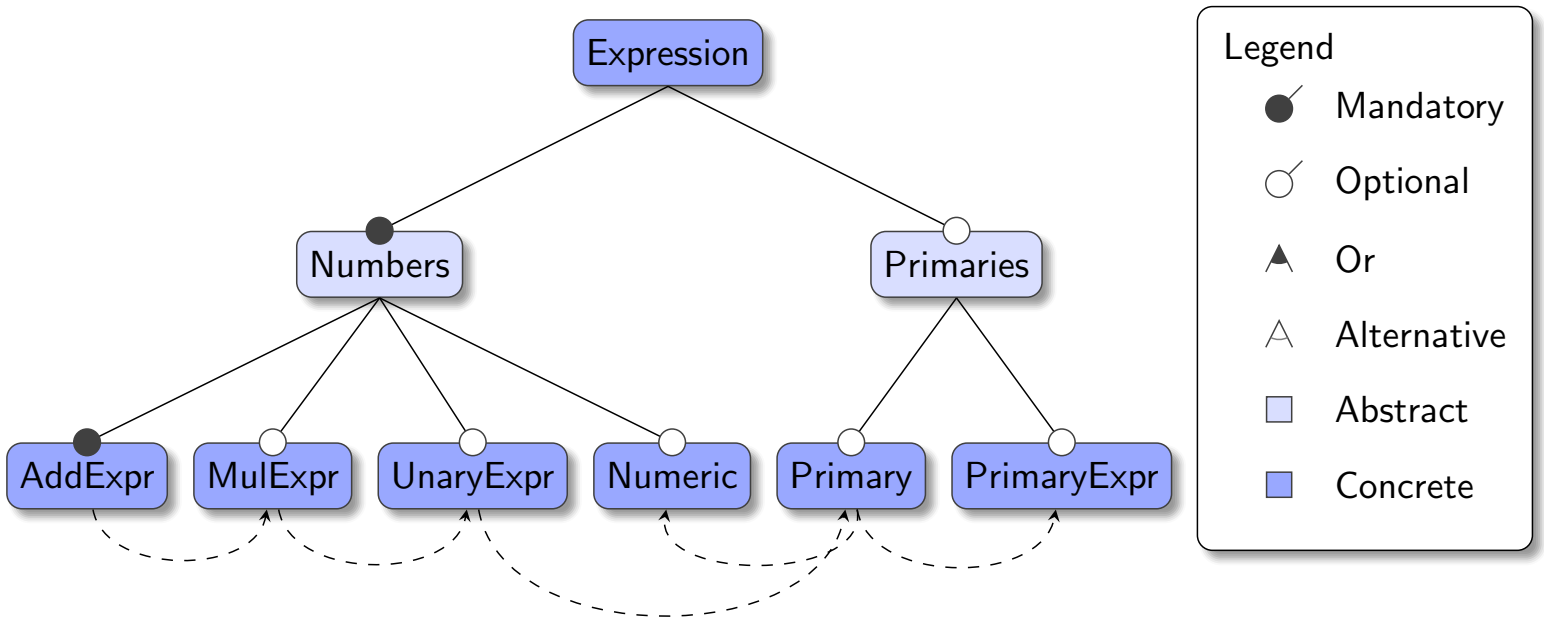

Some achievements:

- Bottom-up approach to language implementation
- Reusability of language artifacts
- Multiple variants of the same language
- Language Workbenches come to the rescue