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

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Cyclus 40th

Problem Statement
Programming Language Implementation

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

LSP and DAP
In a Nutshell

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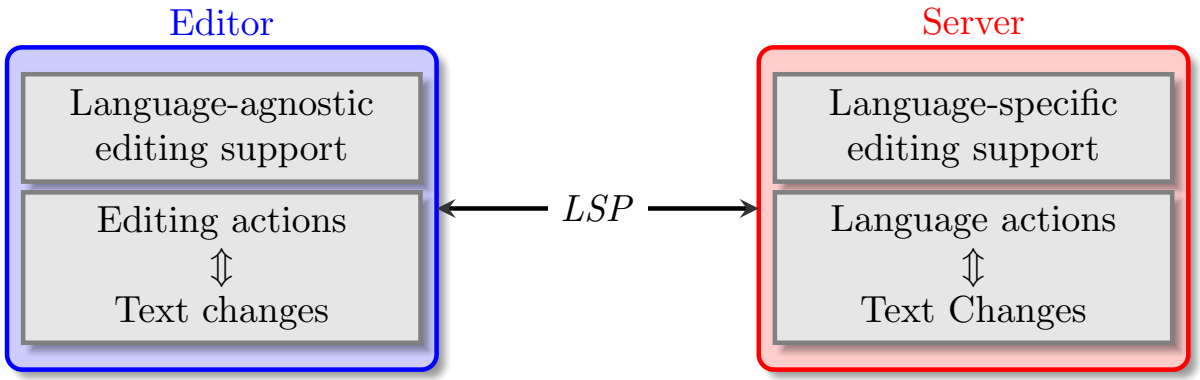

Intrinsic properties:

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

Features:

- Diagnostics
- Hover
- Go to definition
- Find references

LSP and DAP
The Reduction of Combinations

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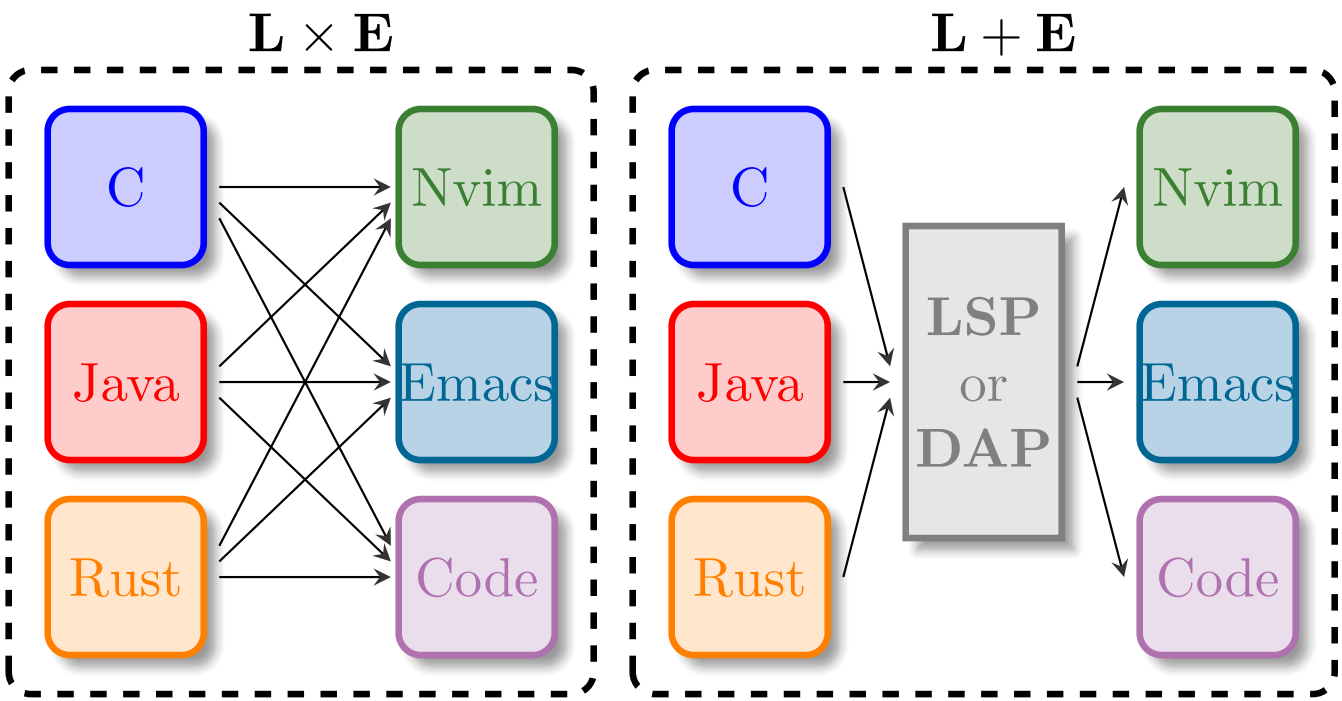

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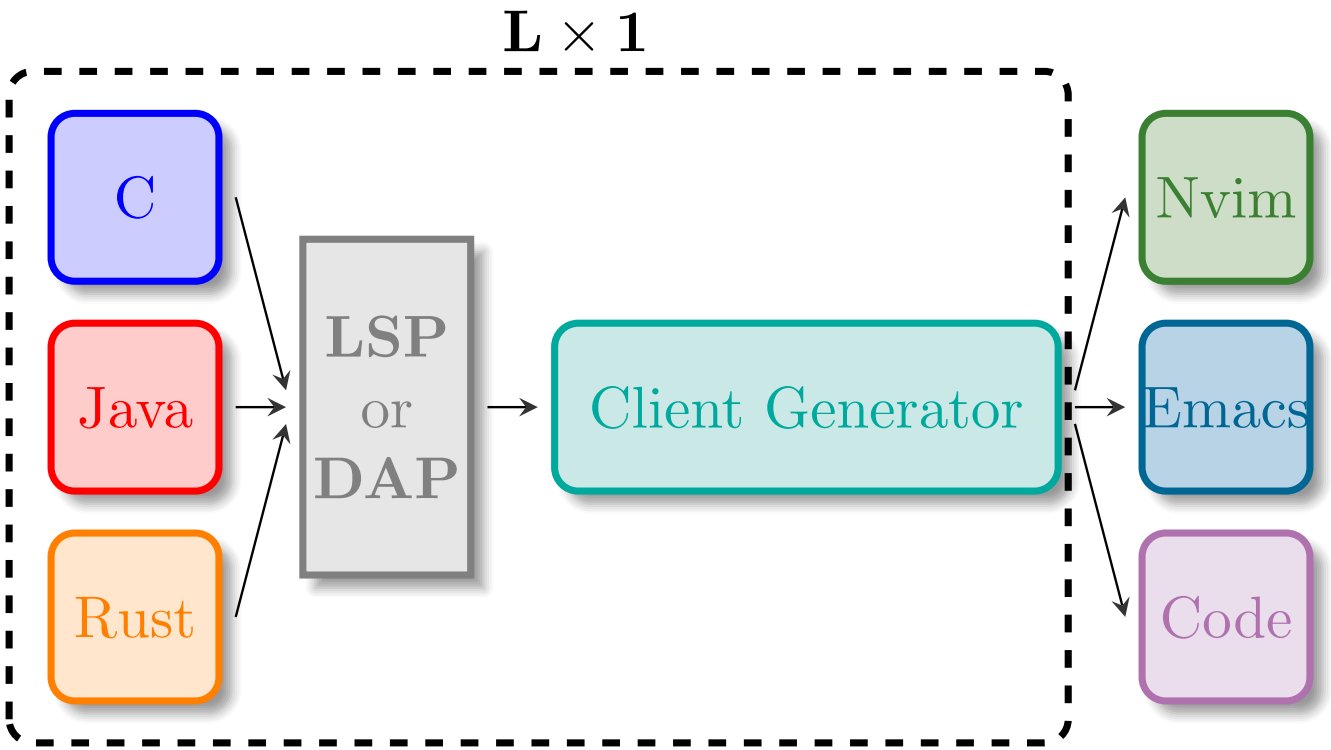

RO 3: Reduce to **L × 1** the number of combinations to support **L** languages

Feature-Oriented Programming

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

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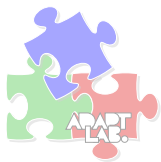
- Feature is a unit of functionality that satisfies a requirement.
- Feature Model is a model that represents the variability of the SPL.
- Feature Configuration is a set of features that compose a product.

RO 2: Facilitate LSP and DAP Modularization



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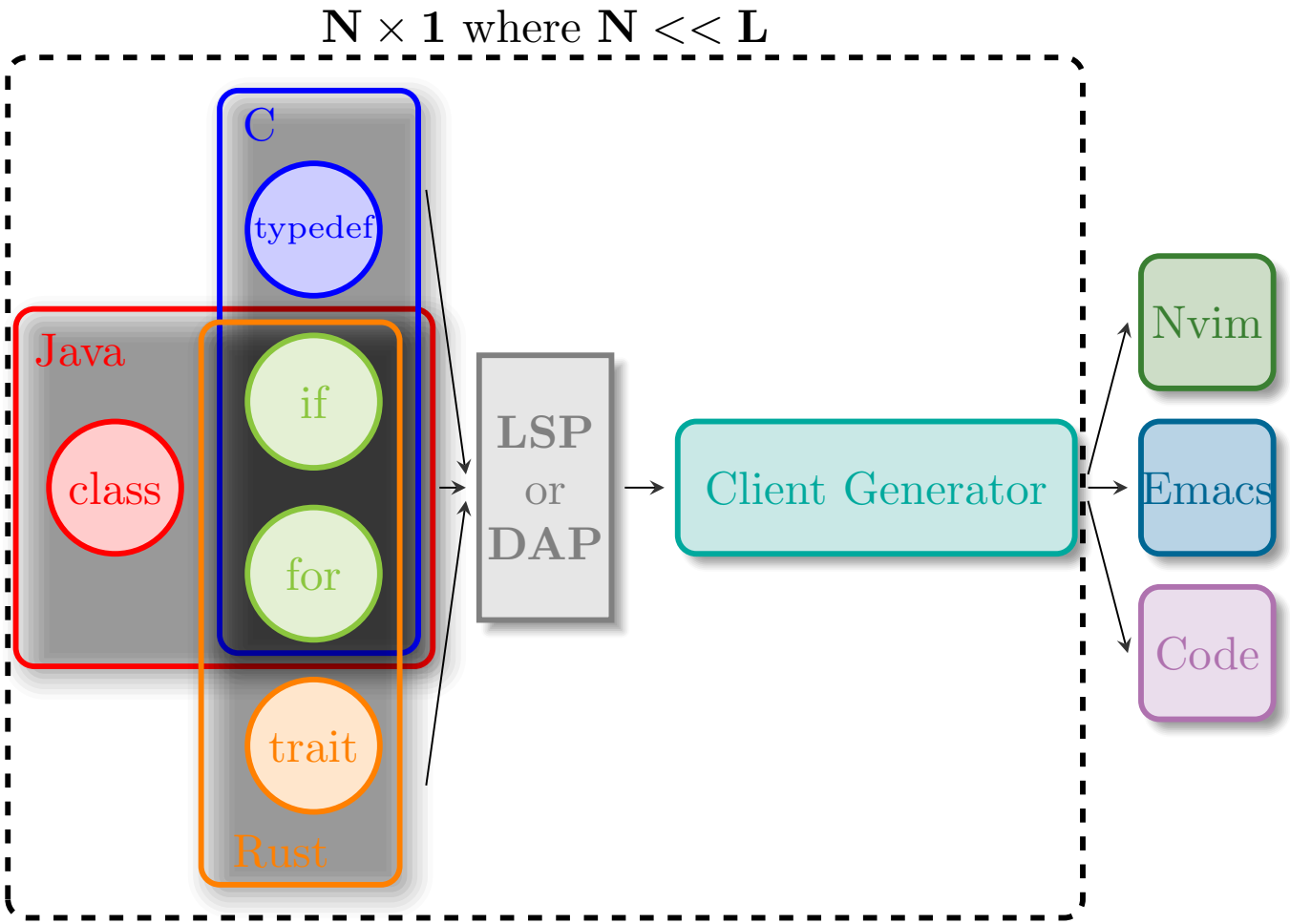


Language Workbenches

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

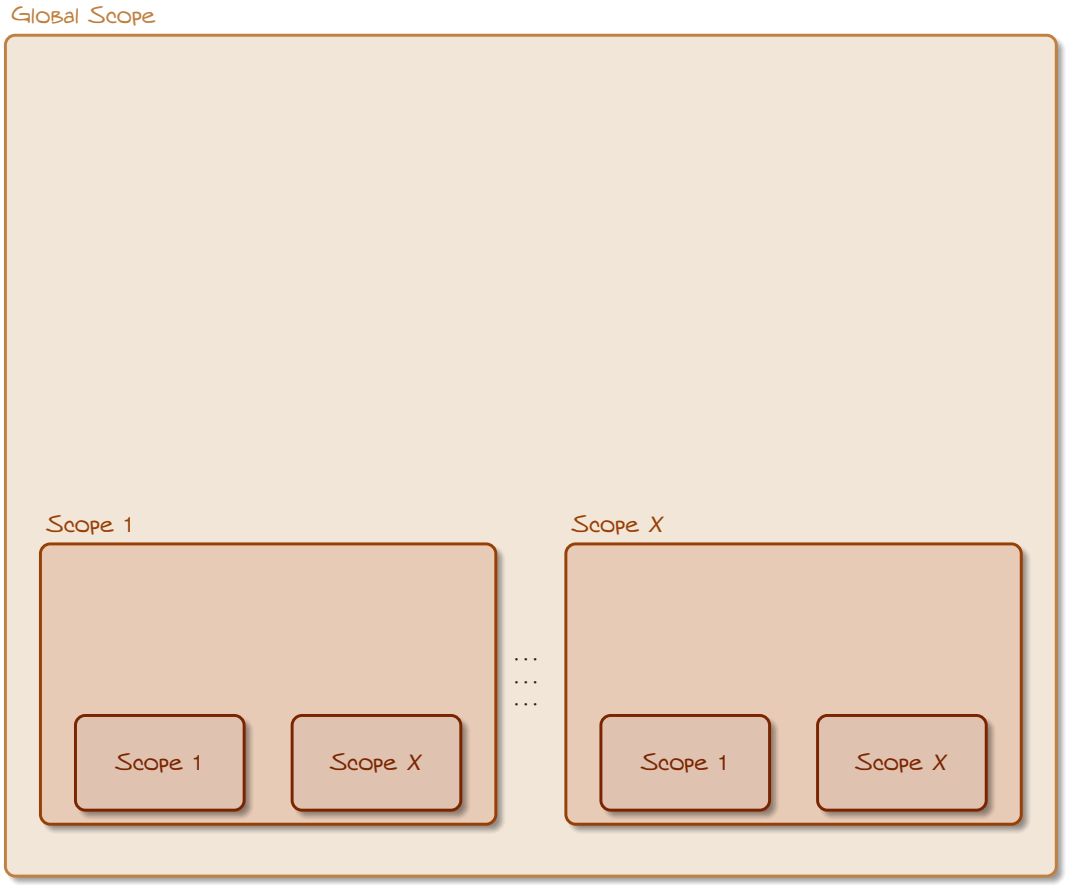
RO 1: Improve IDE and LSP Generation

Scientific Contribution

- 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.

RO 4: Leverage Neverlang for LSP and DAP in LPL Development

Scientific Contribution
Type System Components



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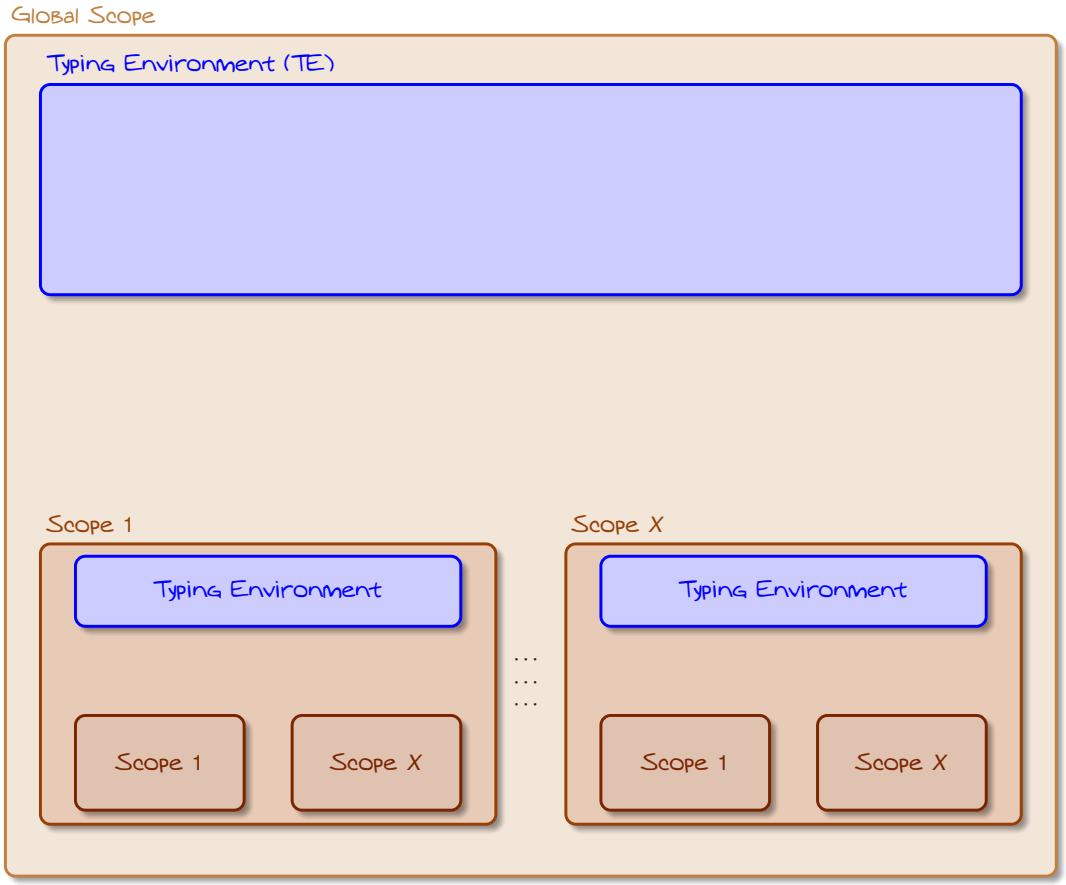

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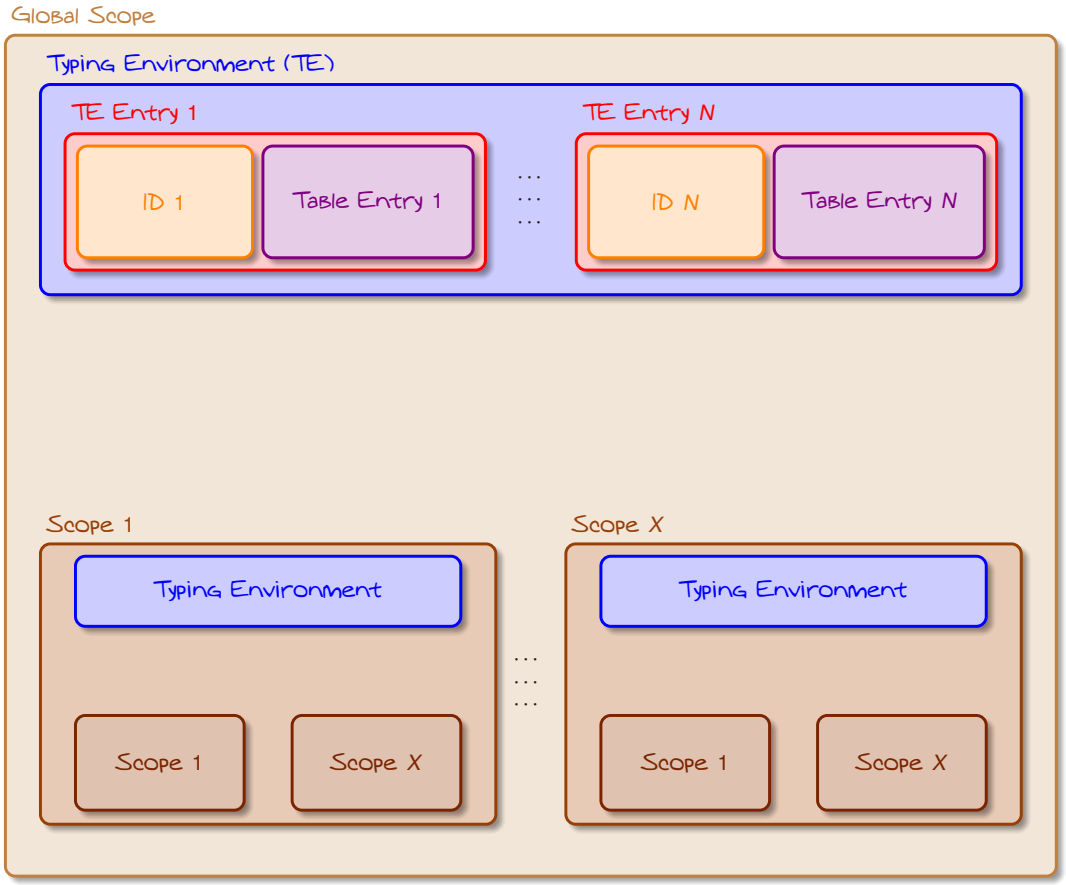

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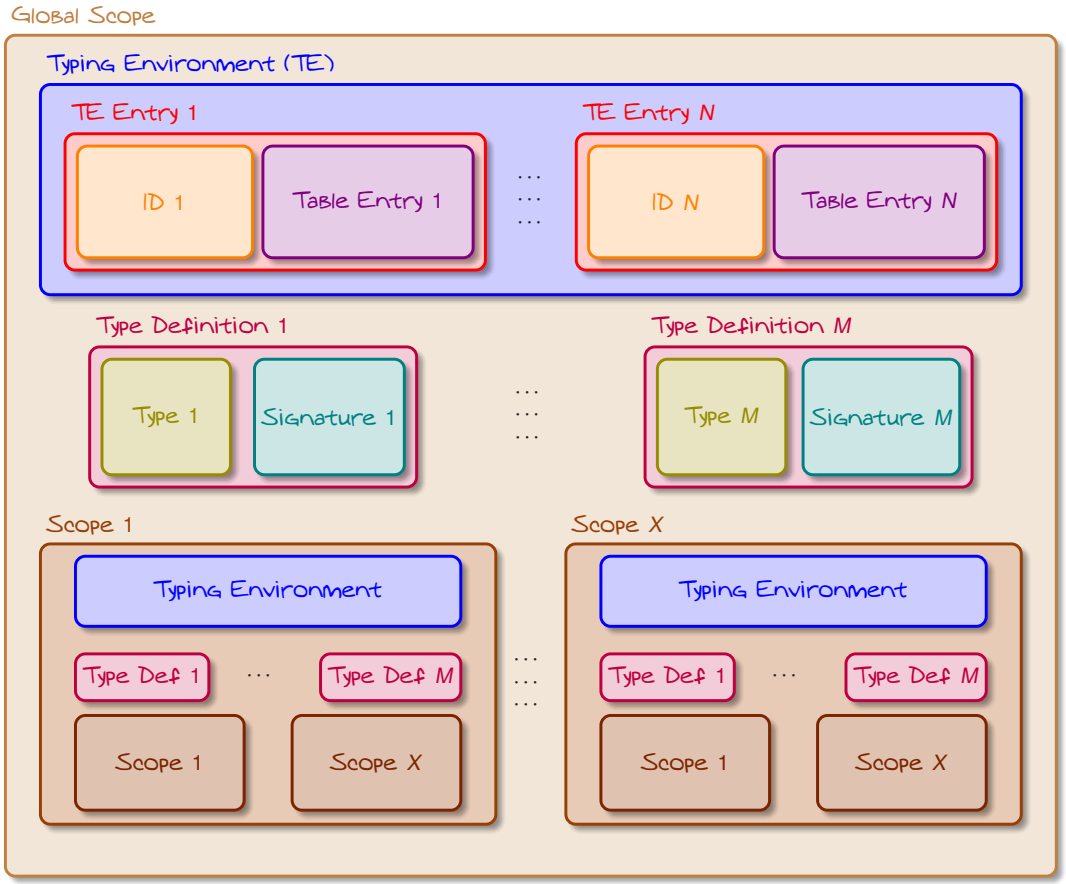

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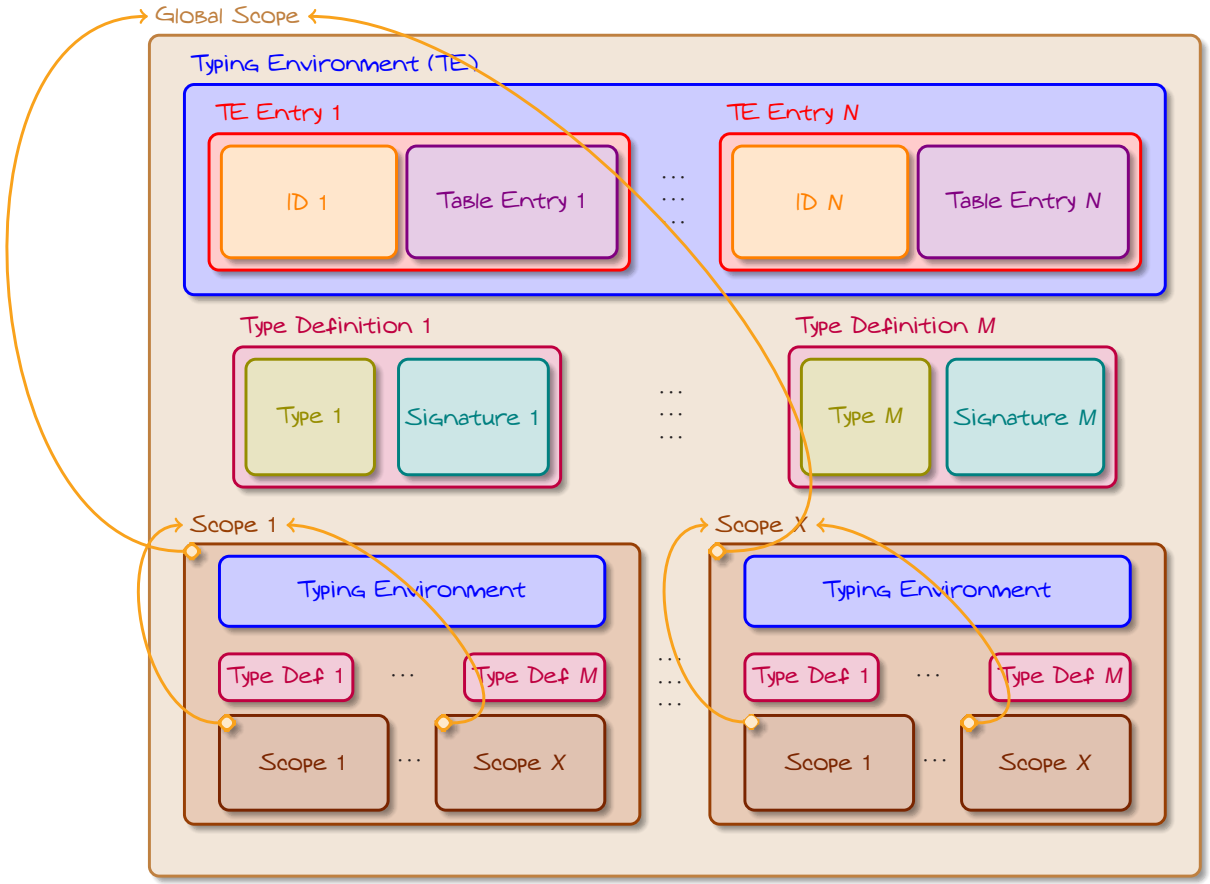
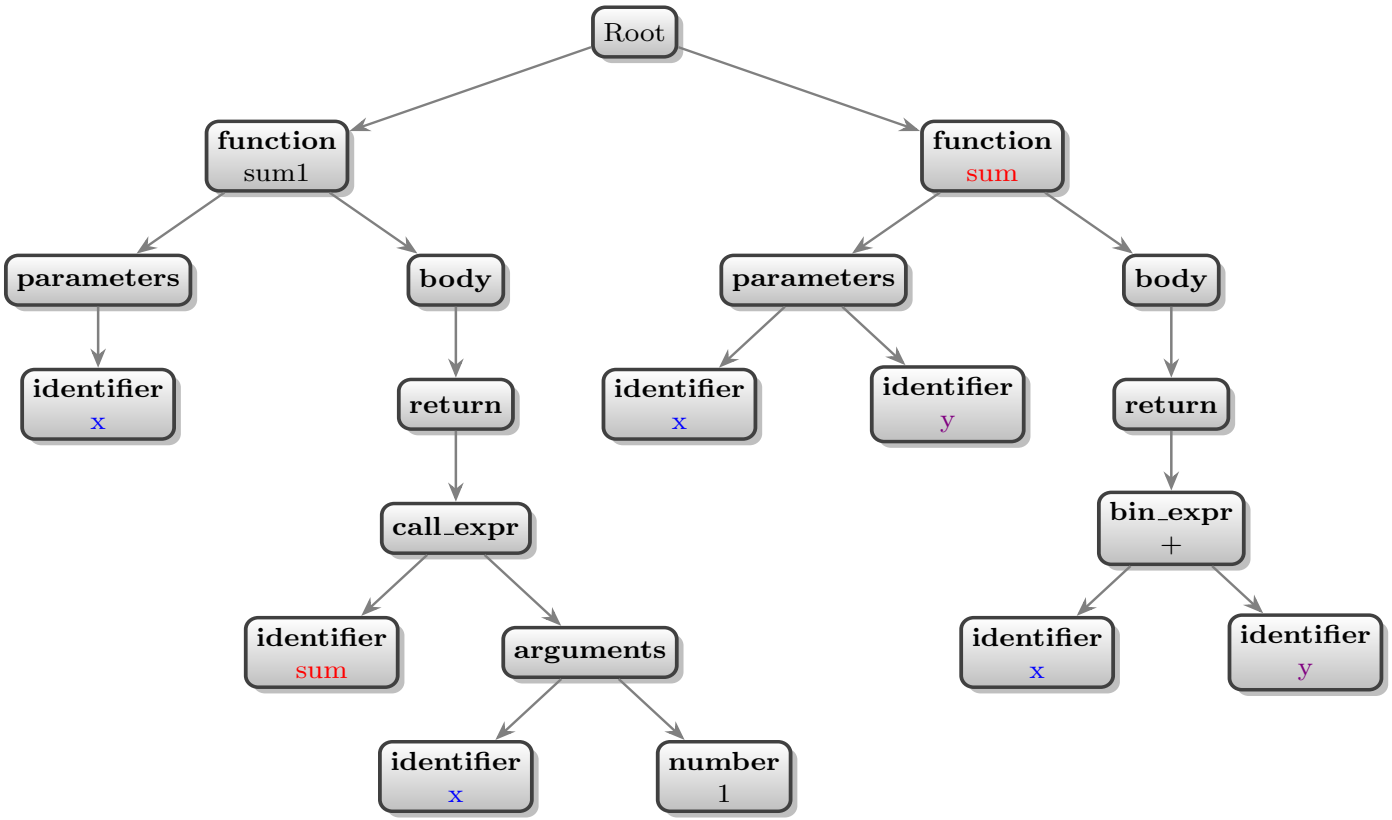
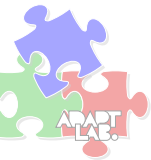


Scientific Contribution
Type Checking and Type Inference


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





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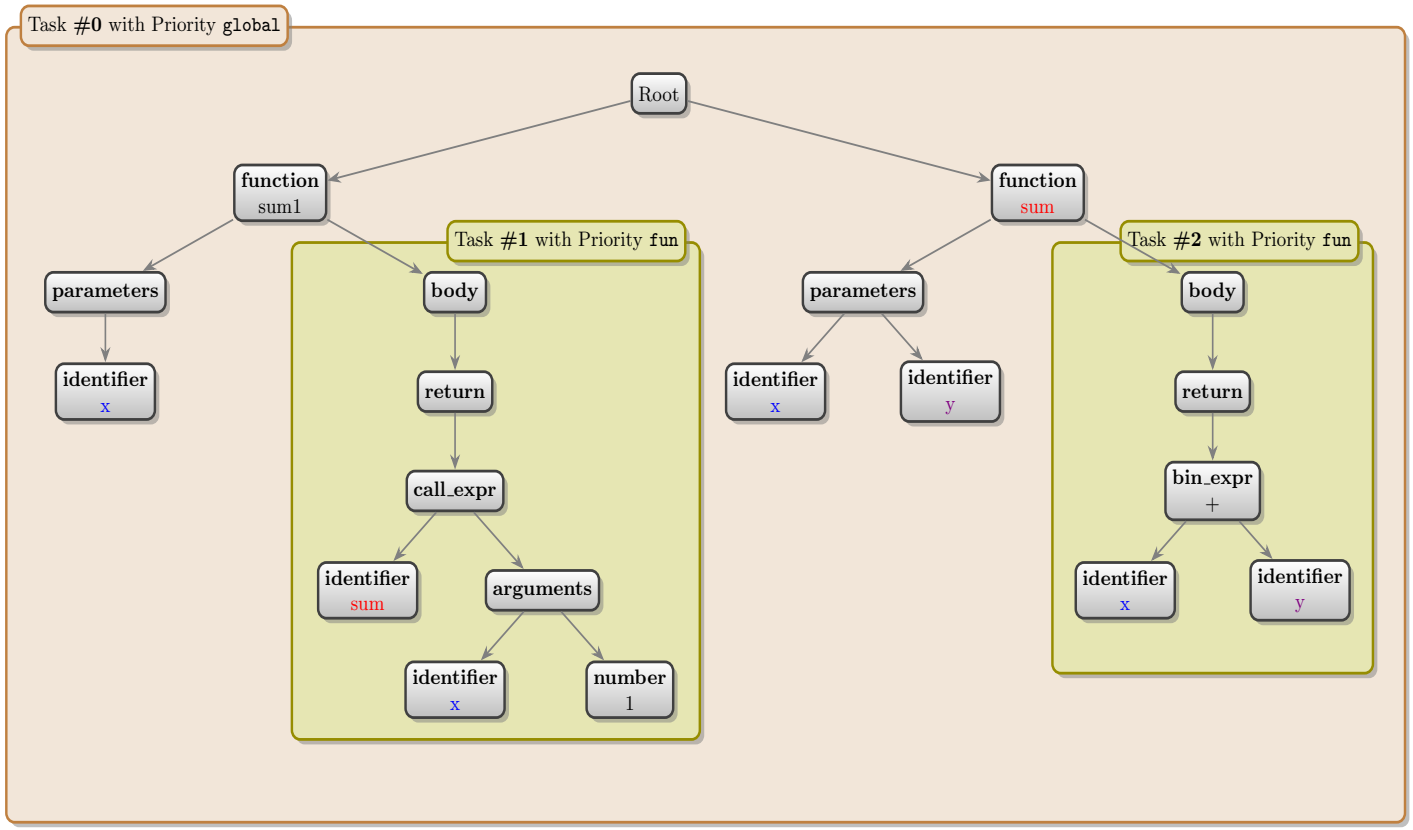
- Compilation Unit
- Compilation Unit Task
- Compilation Helper



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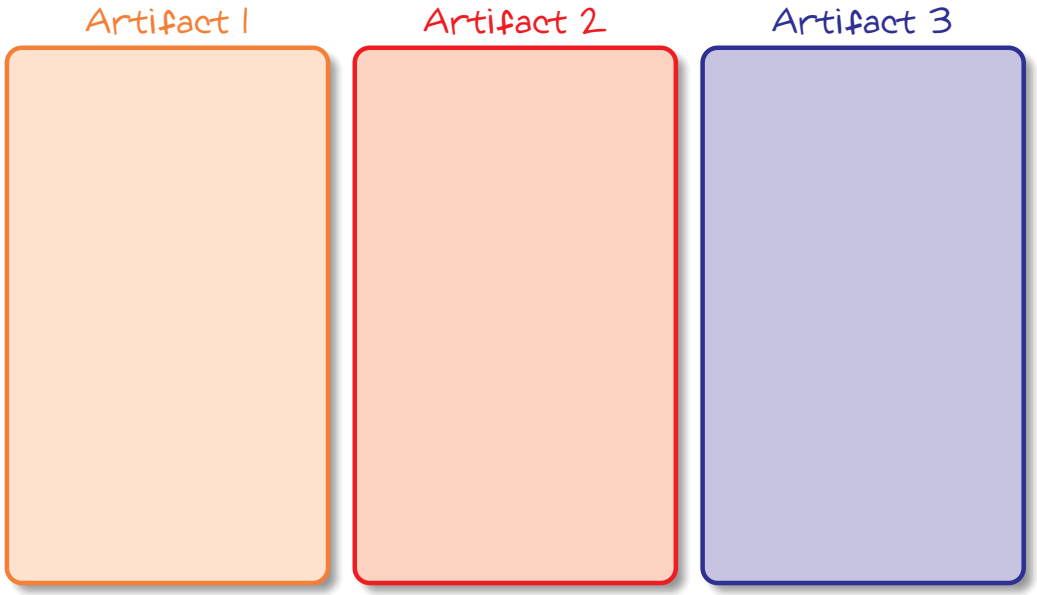
TSs, LSP and DAP Modularization



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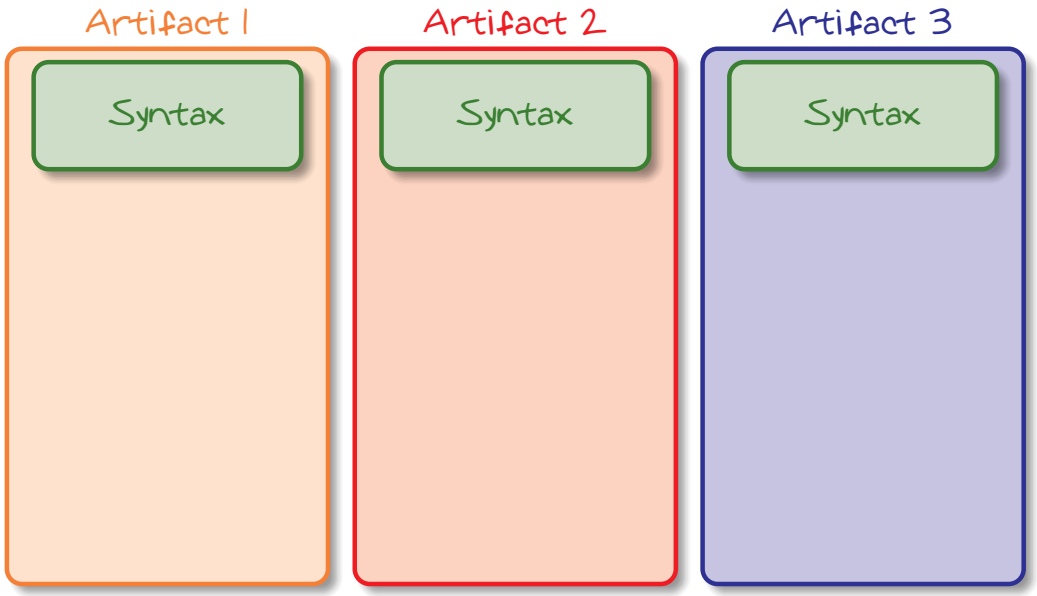

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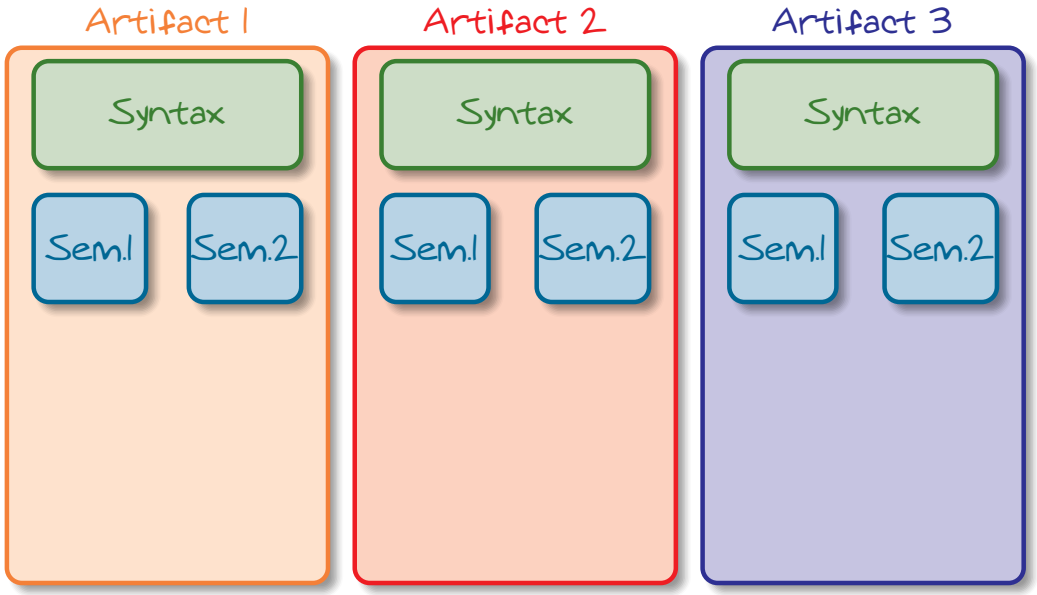

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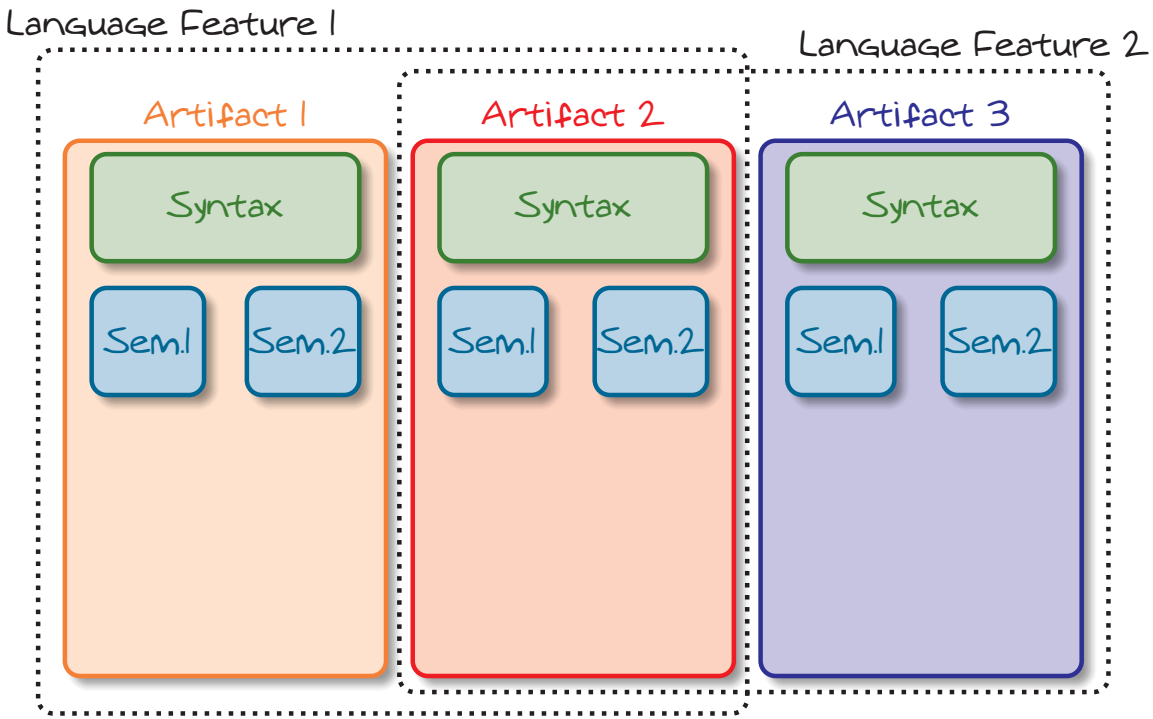

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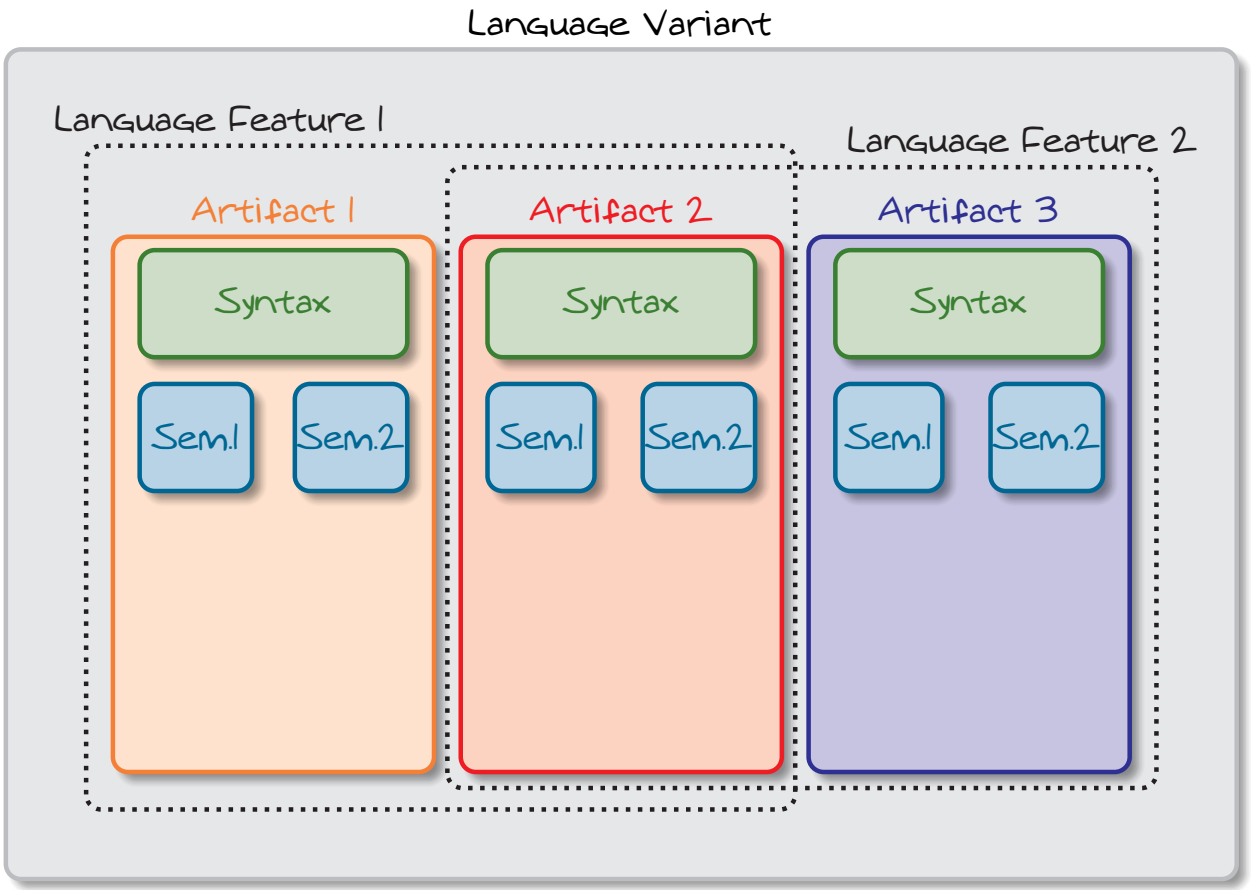

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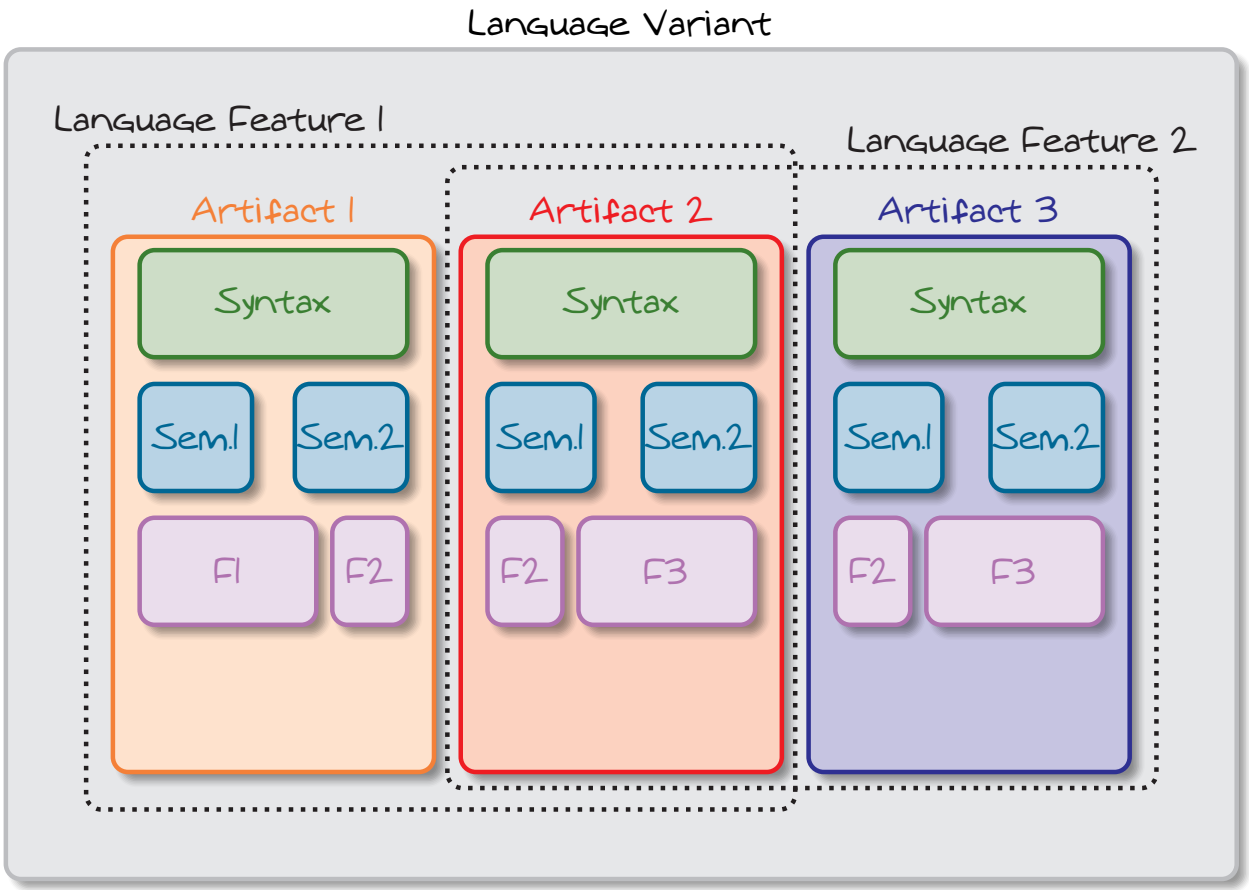

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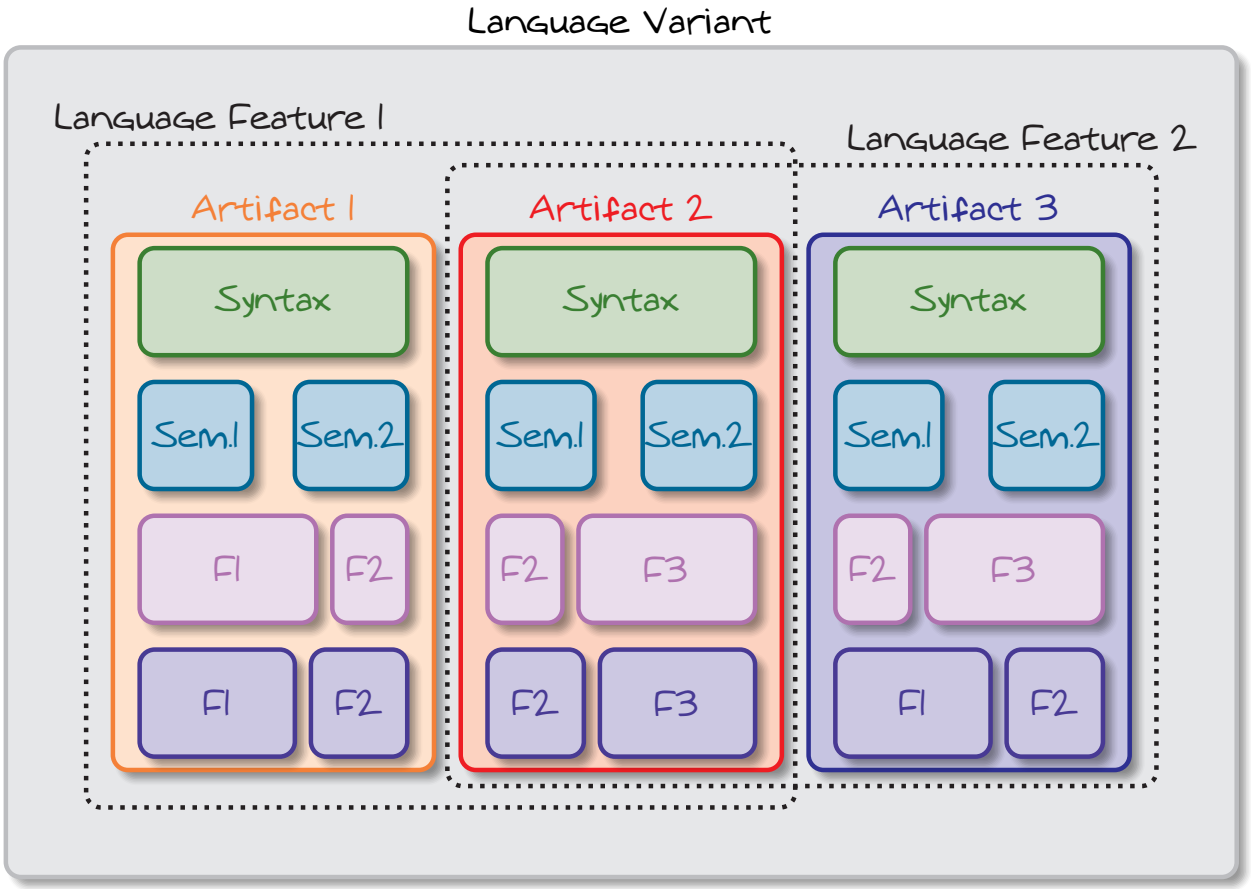

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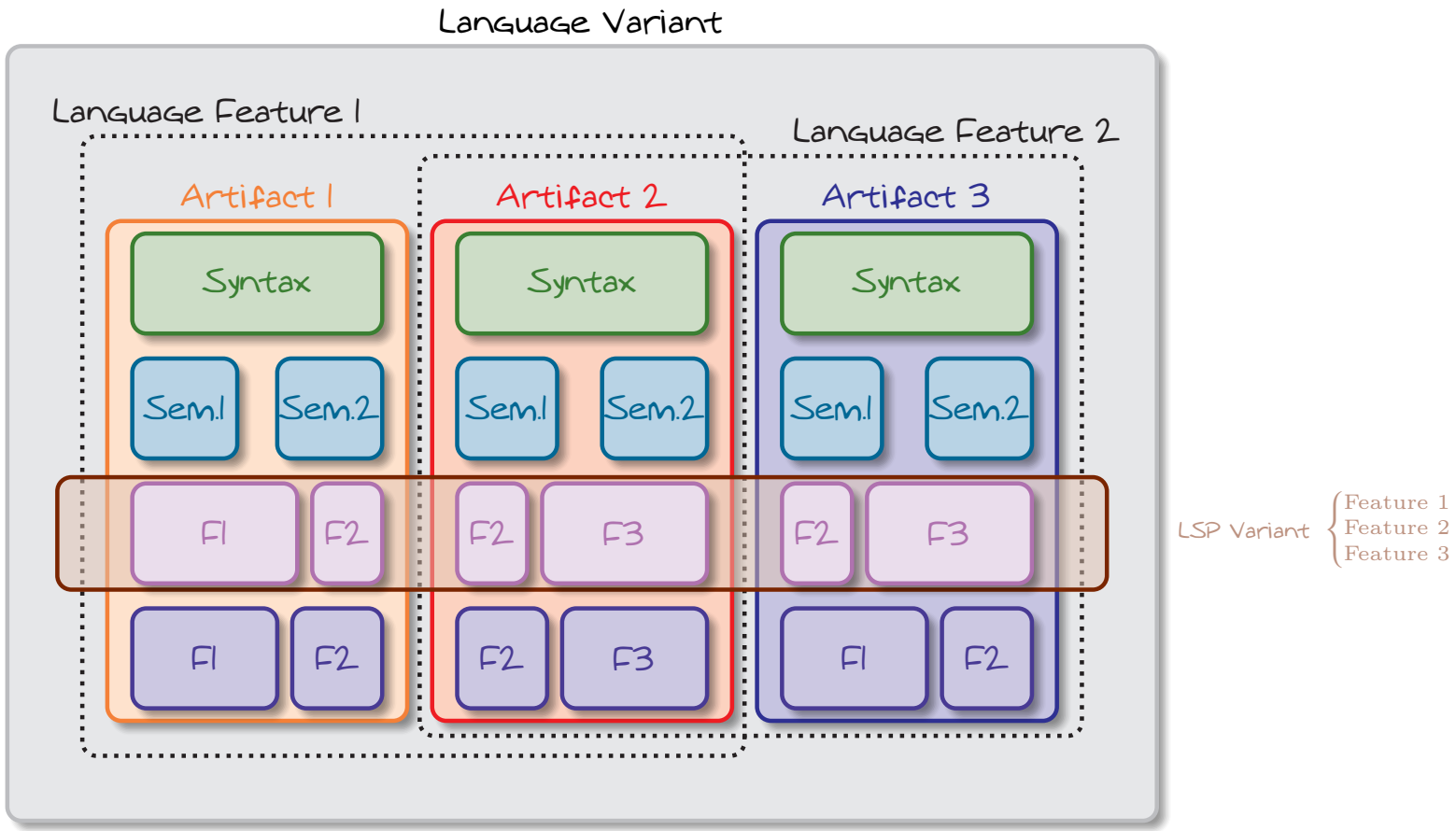

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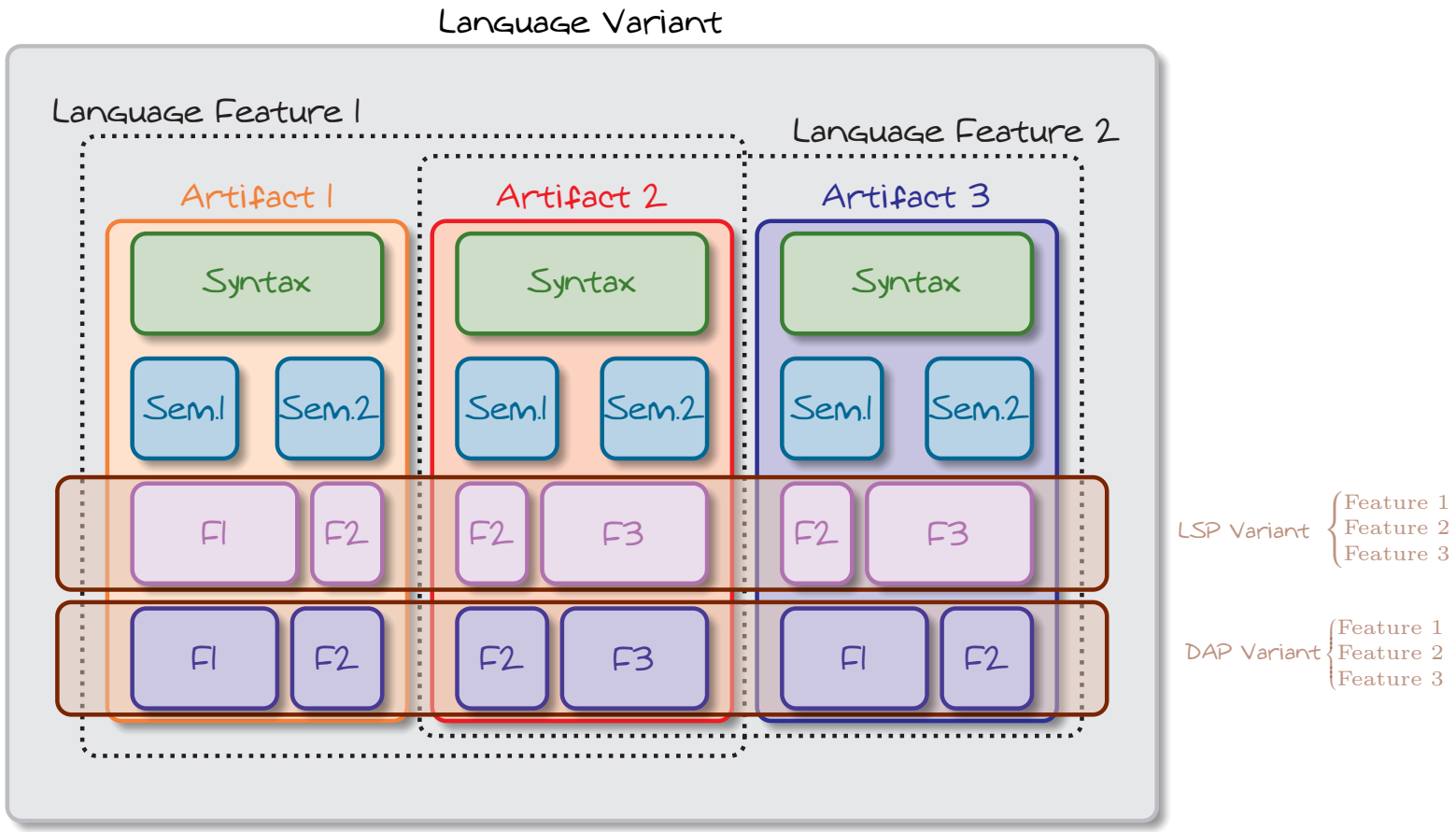

Conclusions
Master's Thesis Results

Interesting results:

- We are writing an article (Code Less to Code More) to be submitted to JSS.
- Propose a feasibility study for the methodology.
- We prototyped the reduction of combinations.
- We prototyped the modularization of the type system.

Thanks for your attention!

Software Product Lines

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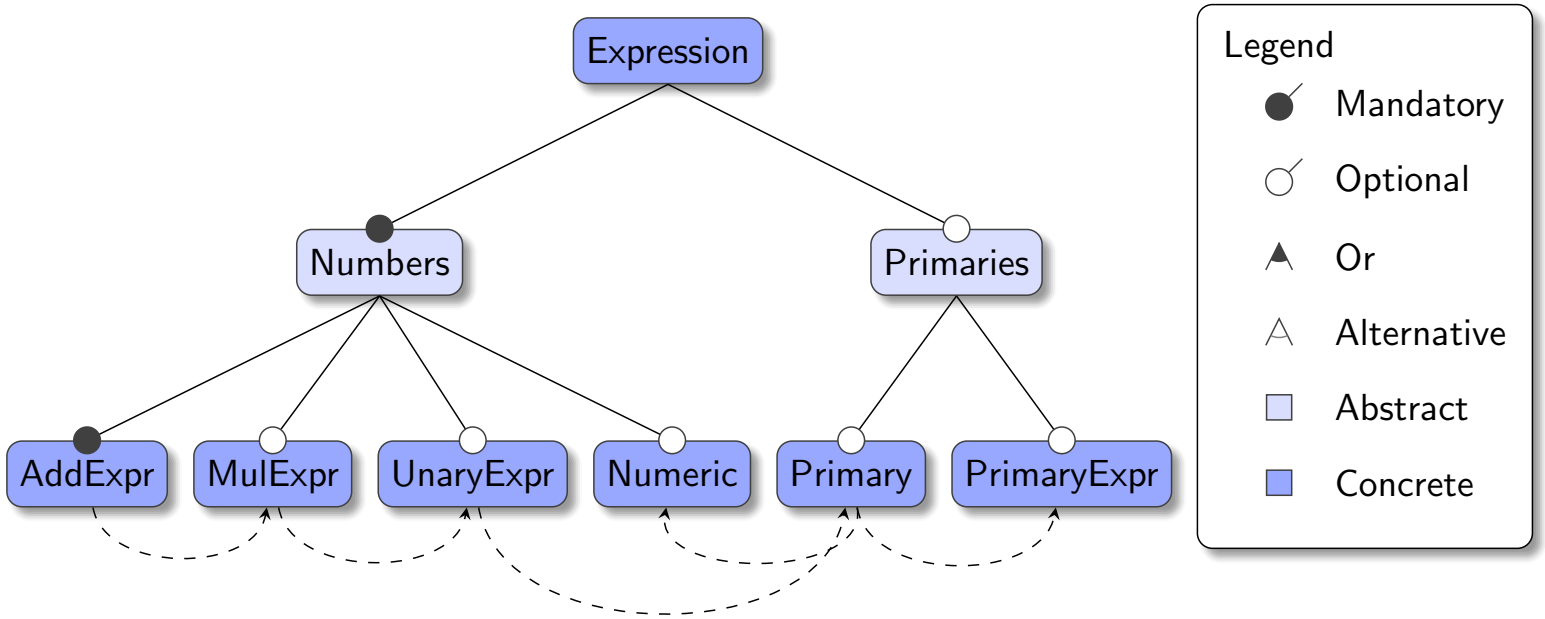
- SPLs defines a family of software products.
- SPLs is described by a Feature Model.
- A Feature Model describes the variability of the software.
- SPL variants are generated by selecting a set of features.
- A feature (or artifact) is a first-class entity in SPLs.

Language Product Lines

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



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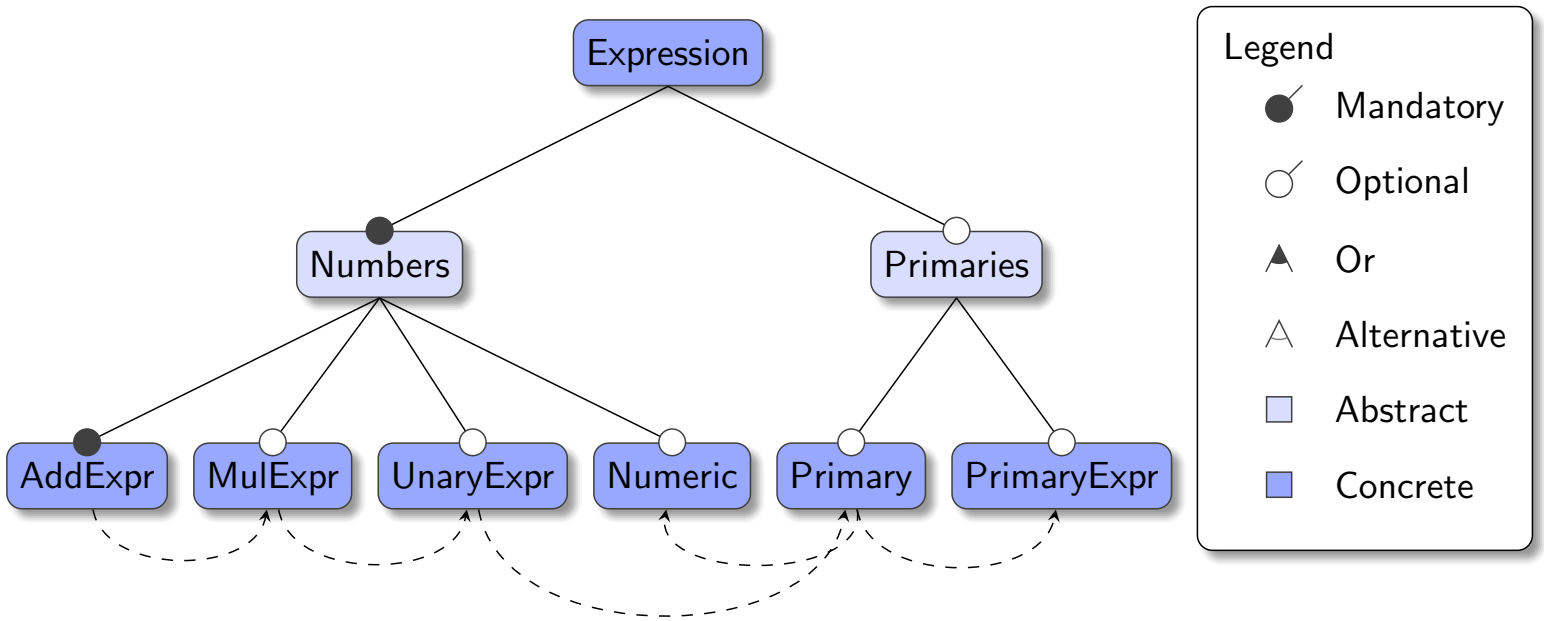

Some achievements:

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