

Universal LSP and DAP for Modular LWs

Eederico Bruzzone

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

#### Federico Bruzzone

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> 22/07/2024 Cyclus 40th





### Problem Statement Programming Language Implementation

Universal LSP and DAP for Modular LWs

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Problem Statement

Statemen

In a Nutshell

The Reductions of Combination

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Condusions

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.





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

- Syntax and semantics definition
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- Documentation

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.





#### LSP and DAP In a Nutshell

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





#### LSP and DAP In a Nutshell

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In a Nutshell

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

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





### LSP and DAP In a Nutshell

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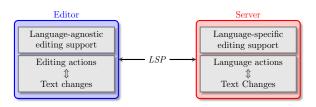
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Conclusion

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

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



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





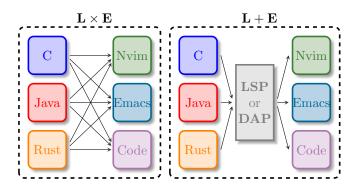
#### LSP and DAP The Reduction of Combinations

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The Reductions of Combinations

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







### LSP and DAP What would be an important achievement?

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Reducing the number of combinations between Language Servers and  $\ensuremath{\mathsf{IDEs}}$ .





### LSP and DAP

What would be an important achievement?

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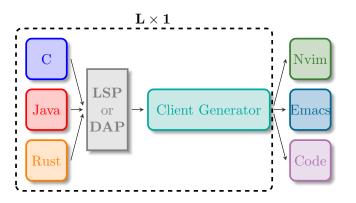
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### LSP and DAP

What would be an important achievement?

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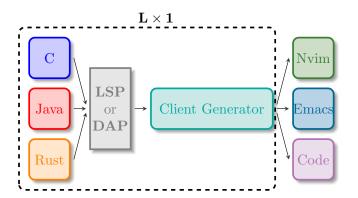
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Conclusion

Reducing the number of combinations between Language Servers and IDEs.



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



### Feature-Oriented Programming

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Conclusions

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





### Feature-Oriented Programming

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Conclusions

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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Conclusions

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	•	0	0	0	0
Melange	0	0	3rd p.	₹	☆
MontiCore	•	•	•	0	0
MPS	0	0	•	☆	À
Rascal	0	0	•	0	0
Spoofax	0	•	•	☆	À
Ytext	0	•	•	•	0
Neverlang	<b>Ø</b>	•	0	☆	☆

- Full support
- No support
- Limited support

- O Coarse-Grained mod.
- ★ My expected contribution
- ☆ Extended contribution

3rd p. Third-party





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Conclusions

- 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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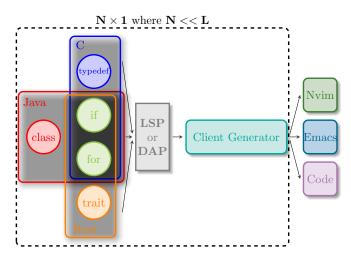
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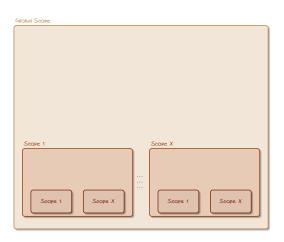
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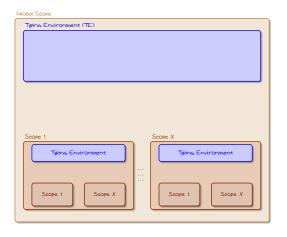
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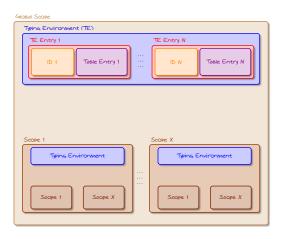
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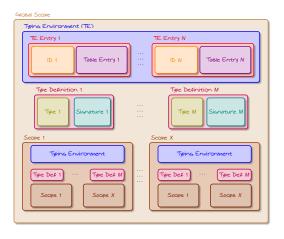
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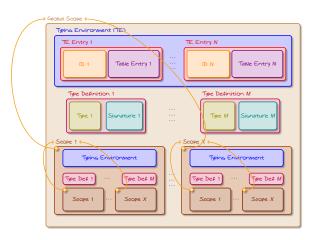
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Conclusions

function sum1(x) { 1 2 return sum(x. 1): 3 5 function sum(x, y) { 6 return x + y; 7 Root function function sum1 sum parameters body parameters body identifier identifier identifier return return bin\_expr call\_expr identifier identifier identifier arguments sum identifier number



# Scientific Contribution Type Checking and Type Inference

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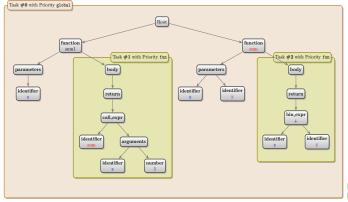
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Conclusions

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

- Compilation Unit
- Compilation Unit Task
- Compilation Helper







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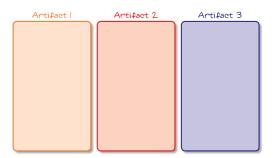
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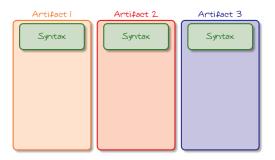
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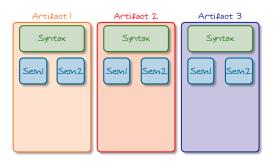
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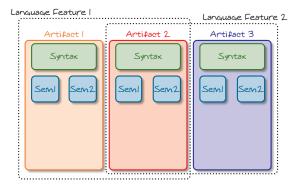




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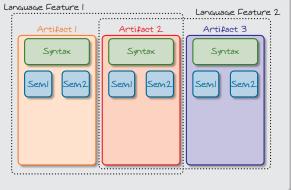




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Language Variant





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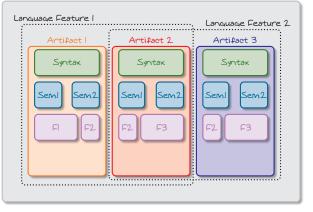
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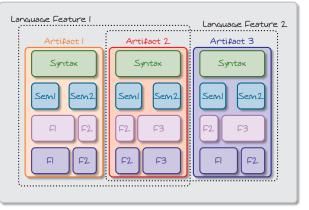
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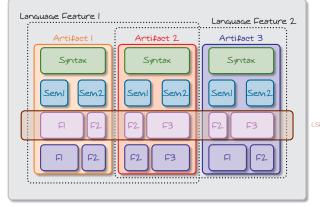
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LSP Variant Feature 2





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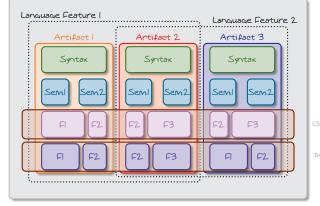
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LSP Variant {Feature 1 Feature 2

DAP Variant Feature 1

Feature 3





### 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.





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### 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.





#### 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.

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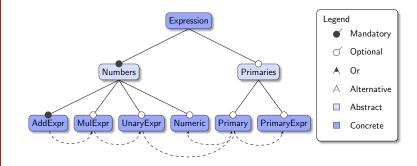
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Applying the concept of SPLs to programming languages, we obtain the concept of Language Product Lines (LPLs).







#### Language Product Lines

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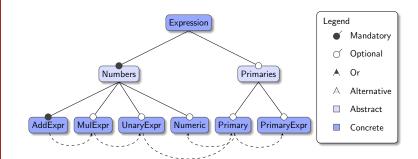
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Applying the concept of SPLs to programming languages, we obtain the concept of Language Product Lines (LPLs).



### Some achievements:

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

