An Implementation of ACT ONE in MPS

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Agenda

- Background
- Objective
- Functional Requirements
- ACT ONE
- Term Rewriting Logic
- IDE
- Discussion
- Conclusion

Background

- DAT233-G - Concepts of Programming Languages
- Specification Language ACT ONE
- No dedicated tools
- We need a tool

Objective:

*Implement the **specification language ACT ONE** in **MPS**, fitted with features inline with the course **DAT233**.*

1. Our own implementation of the language **ACT ONE**.
2. A **term rewriting system** for it.
3. A corresponding **Integrated Development Environment (IDE)**.

Functional Requirements

Title	Must	Description
Implement Prefix Operations	YES	Allow ACT ONE to work with Prefix Operations.
Implement Infix Operations	NO	Allow ACT ONE to work with Infix Operations.
Let-notation	NO	Allow users to declare let-declarations.
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Exhaustive Reduction	YES	Allow users to initiate Exhaustive-Reduction.
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Tuple Reduction	NO	Allow users to initiate double parameterised Reductions, e.g. Breadth-First 6-Step-Reduction.
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ACT ONE

Specification

*"An act of **identifying something precisely** or of stating a **precise requirement**."*

-Oxford Dictionary

Example: Stack

- Abstract Data Type
- LIFO

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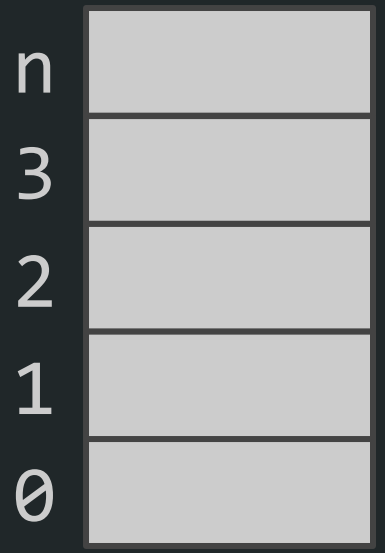

Init

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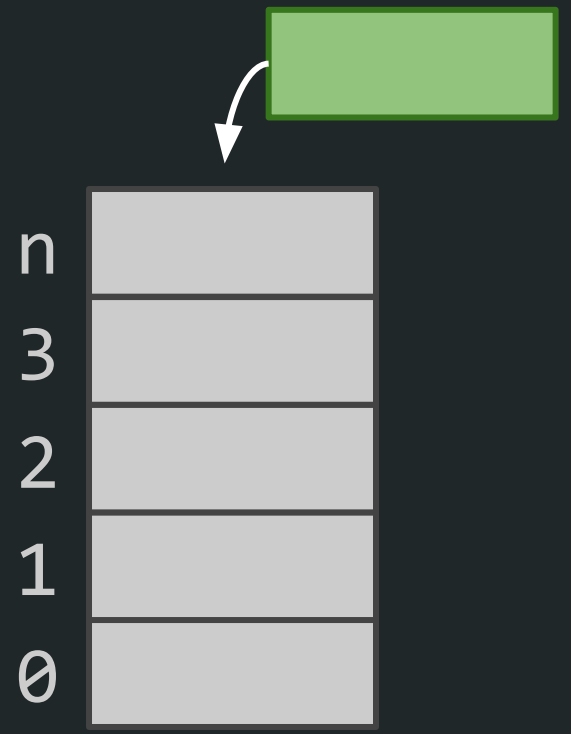

Push

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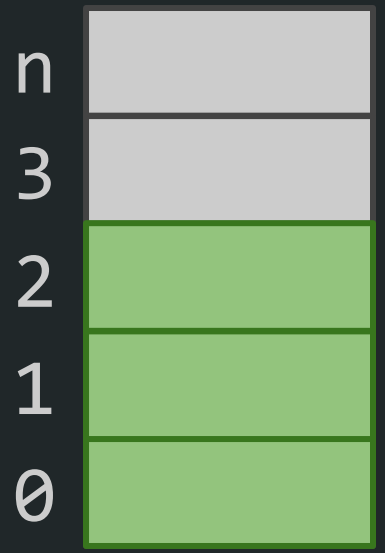

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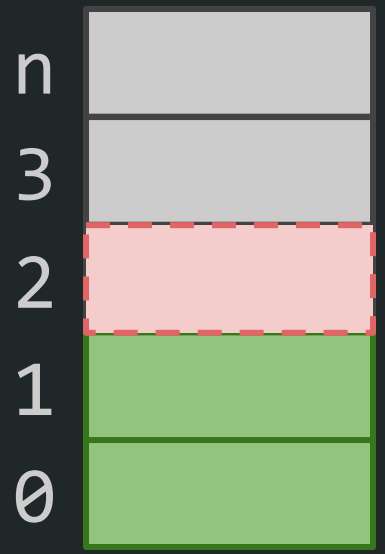

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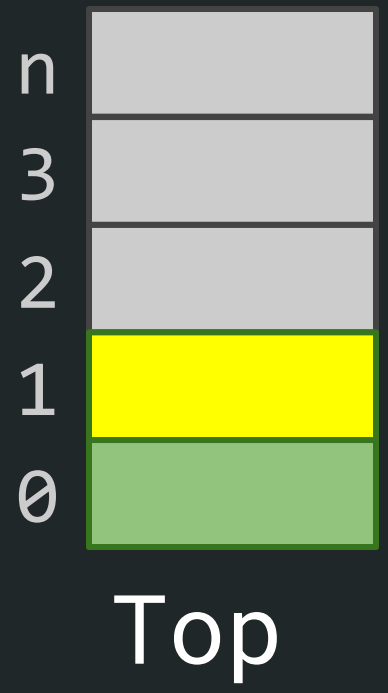

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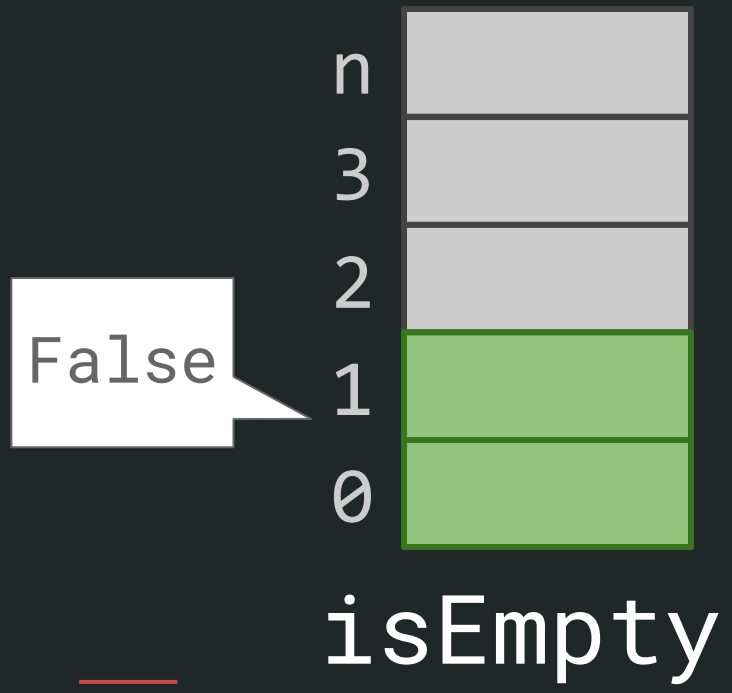

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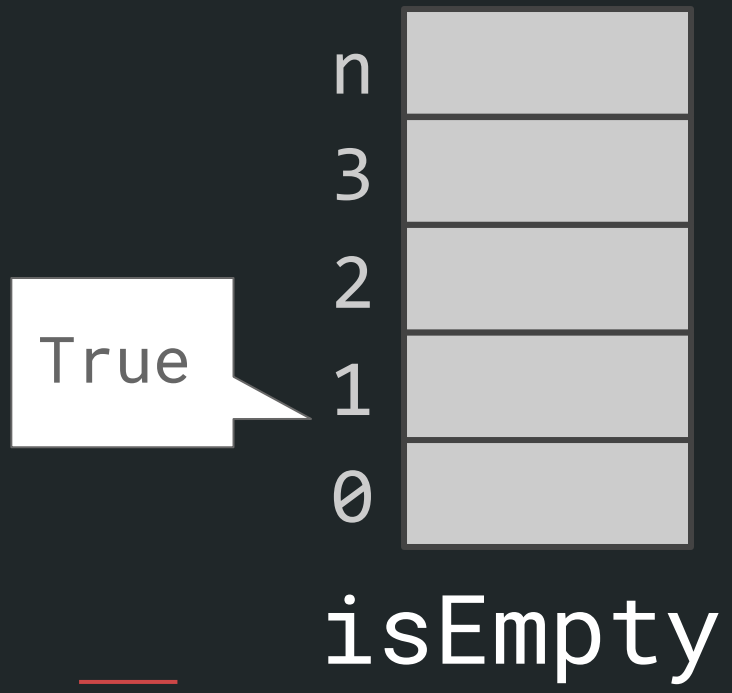

Specification: STACK

- **Init** : returns a new, empty stack
- **Push** : pushes an element to a given stack
- **Pop** : returns the given stack with the top-most element removed
- **Top** : returns the top-most element
- **isEmpty** : returns true if list is empty, false otherwise

Can we do better?

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In ACT ONE

```
type STACK is
    sorts
        Stack
        Int

    constructors
        init:            -> Stack;
        push: Int, Stack -> Stack;

    functions
        vars
            s    : Stack;
            d, e : Int;

    func top: Stack -> Int;
        top(push(d,s)) = d;

    func pop: Stack -> Stack;
        pop(push(d,s)) = s;

    func isempty: Stack(D) -> Bool;
        isempty(init) = true;
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endtype
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Our version of ACT ONE

```
Type STACK is
Imports
  ref: BOOLEAN
  ref: INTEGER
Sorts
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Operators
  ctor: init : -> Stack
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  oper: top : Stack -> Int
  oper: pop : Stack -> Stack
  oper: isEmpty : Stack -> Bool
Variables
  var s : Stack
  var d : Int
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Axioms
  axiom: top(push(:d, :s)) = :d
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What are these?

```
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  ref: INTEGER
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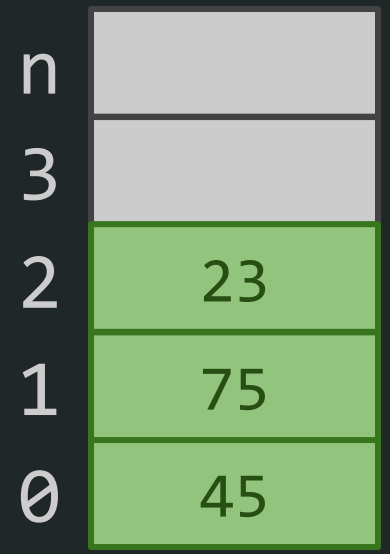
Example: Stack

This is Stack S



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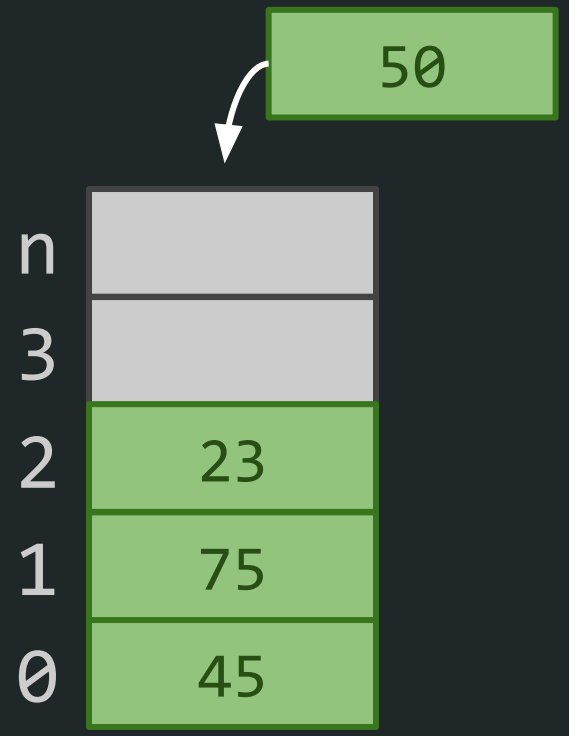
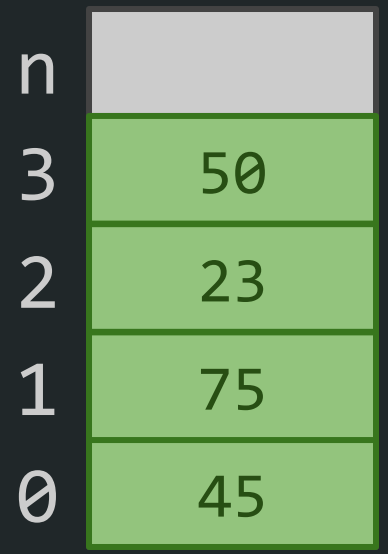


Push

Example: Stack



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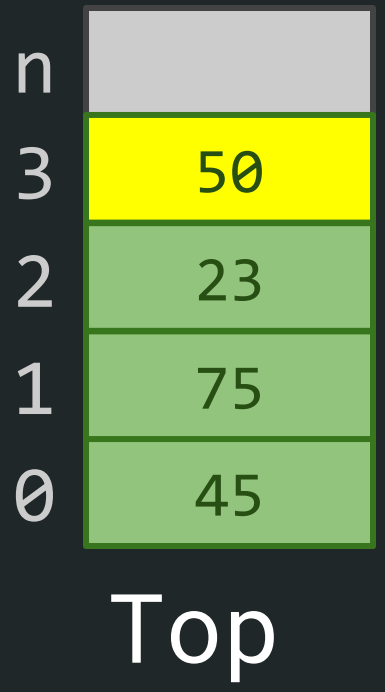

Axioms

```
Top(Push(50,s)) = 50
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```
Top(Push(x,s)) = x
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Term Rewriting Logic

Terms

Examples:

- Top(Push(50,Init()))
- Init()
- isEmpty(Push(50,Init()))

Rewriting

```
Top(Push(50,Push(40,Init())))
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Rewriting

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`Top(Push(50,Push(40,Init()))) = 50`

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Rewriting - BFS & DFS

2 ways to evaluate terms:

- Inside-out = DFS
- Outside-in = BFS

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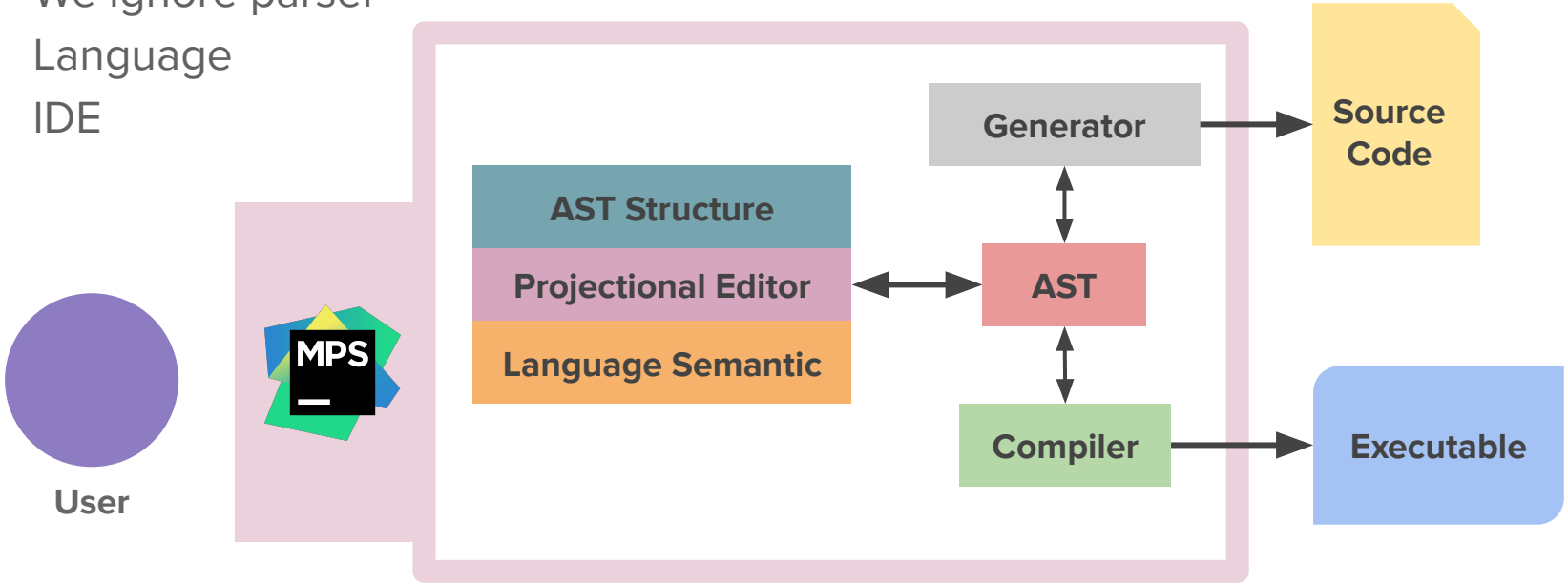
IDE

MPS - Meta-Programming System

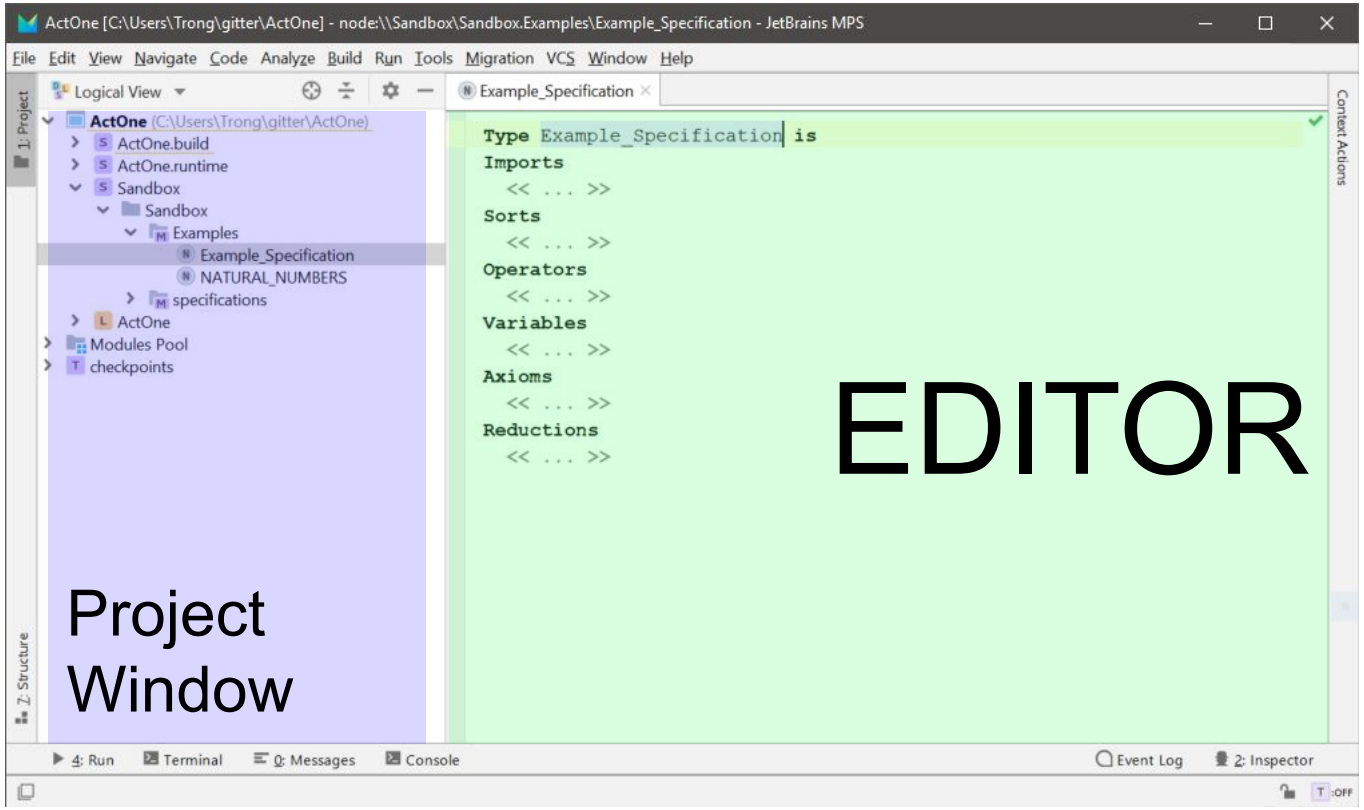
- JetBrains
- Language workbench
- Domain Specific Languages

How MPS works

- We ignore parser
- Language
- IDE



Our result


ActOne [C:\Users\Trong\gitter\ActOne] - node:\\Sandbox\Sandbox.Examples\Example_Specification - JetBrains MPS
File Edit View Navigate Code Analyze Build Run Tools Migration VCS Window Help
Logical View
Example_Specification
ActOne (C:\Users\Trong\gitter\ActOne)
ActOne.build
ActOne.runtime
Sandbox
Sandbox
Examples
Example_Specification
NATURAL_NUMBERS
specifications
ActOne
Modules Pool
checkpoints
Type Example_Specification is
Imports
<< ... >>
Sorts
<< ... >>
Operators
<< ... >>
Variables
<< ... >>
Axioms
<< ... >>
Reductions
<< ... >>
EDITOR
Project Window
4: Run
Terminal
0: Messages
Console
Event Log
2: Inspector
Context Actions
1: Project
7: Structure

Example Usage

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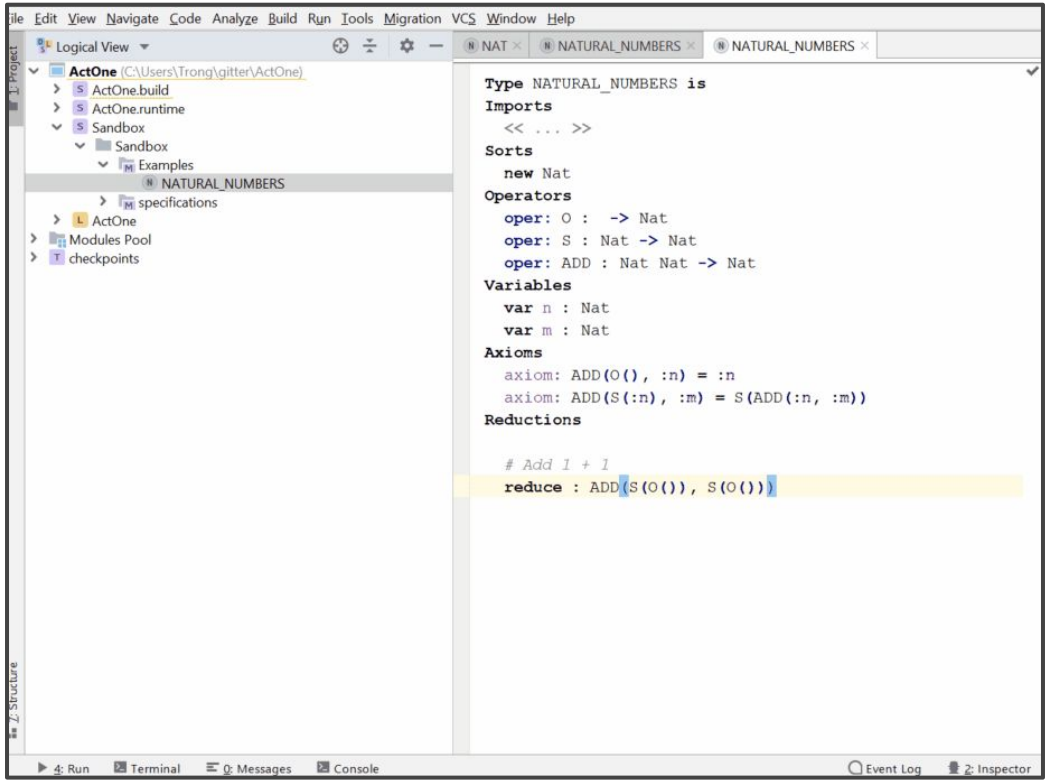
Feature: Execution



Feature: Vertical Formatting

```
reduce : validate(mkPuzzle(ships(3, 2, 1, 0, 0, 0), horizontal(3, 0, 1, 3, 2, 1), vertical(2, 0, 2, 3, 1, 2),                    ))
                          mkBoard(mkLine(X(), W(), X(), X(), X(), X()), mkLine(W(), W(), W(), W(), W(), W()),     )
                                      mkLine(X(), W(), X(), X(), X(), X()), mkLine(W(), W(), W(), D(), W(), X()),
                                      mkLine(X(), W(), X(), X(), X(), X()), mkLine(X(), W(), W(), X(), X(), X())
```

Feature: Duplicate Name Check

```
  << ... >>
Sorts
  new Nat
  new Int
Operators
  << ... >>
```

Feature: Intentions

```
Reductions

  # Add 1 + 1
  reduce : ADD(S(O()), S(O()))
```

Feature: Operation Parameter Check

Error: Wrong number of parameters! Expected: 2, Actual: 1

```
reduce : ADD(S(O()))
```

Error: type Bool is not a subtype of Nat

```
reduce : ADD(True(), False())
```

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- Usability
  - Available assets
  - Feel
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- Correctness
  - Term rewriting logic
  - No-large scale testing

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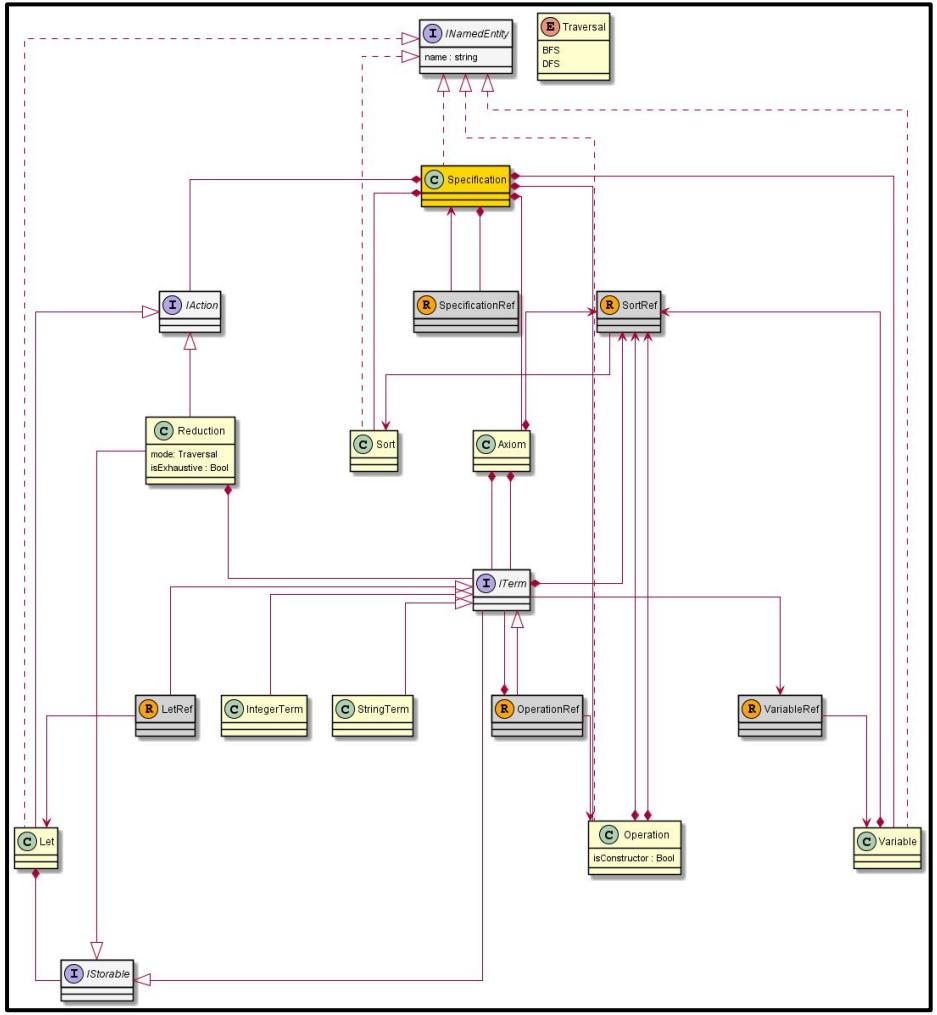
Conclusion

- Sufficient version of ACT ONE
- Working term rewriting system
- Usable IDE
- Befitting for DAT233

Questions?

- Need more elaboration on MPS?
- Want to see the product in action?
- Ask about Battleship!
- What does BFS and DFS stand for?
- Wonder why I chose to do this project?
- Something in the thesis that is unclear?

UML


INamedEntity
name : string
Traversal
BFS
DFS
Specification
IAction
SpecificationRef
SortRef
Reduction
mode: Traversal
isExhaustive : Bool
Sort
Axiom
ITerm
LetRef
IntegerTerm
StringTerm
OperationRef
VariableRef
Let
Operation
isConstructor : Bool
Variable
IStorable