

Improving Engagement of Students in Software Engineering

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<https://impress-project.eu/>



ERASMUS+

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IMPRESS

- A recently started EU-funded project aiming at improving students' engagement in Software Engineering courses through gamification.



- Sept. 2017 – Aug. 2020

Teaching software engineering

- waterfall, iterative, agile
- 14 UML diagram types
- 23 design patterns
- over 80 refactorings
- ...



IMPRESS case study: quality assurance

- Developers need to **test** the modules they build.
- and invest in **formalizing** the modules' specification

```
public static void getMax_spec1(int[] a) {  
    // preconditions  
    pre(a != null);  
    pre(a.length > 0);  
  
    // call the actual function implementation  
    int retval = getMax(a);  
  
    // postconditions  
    post(exists(a, i -> a[i] == retval)); // A  
    post(forall(a, i -> a[i] <= retval)); // B  
}
```


A lesson in writing formal specifications

- We can write **simple expressions**:
 - constants like 1,2,3
 - identifiers like x,y,Students
 - properties, e.g. x.age, y.goal
 - $e_1 \otimes e_2$ where \otimes is + , - , * , = , > , \geq , < , \leq , \in
- A **simple formula** is a simple expression of type Boolean

A lesson in writing formal specifications

- A **formula** is either:
 - a simple formula
 - $\forall \text{identifier} \in \text{simple-expression} \bullet \text{formula}$
 - $\exists \text{identifier} \in \text{simple-expression} \bullet \text{formula}$)
- For example:
 - $\forall x \in \text{Students} \bullet x.\text{age} \geq 16$
 - $\exists x \in \text{Students} \bullet x.\text{age} = 16$

A lesson in writing formal specifications







IMPRESS

- Can gamification improve the engagement in SE courses?
- Different gamification level:
 - Gamified class room SE quizzes
 - “Serious” education game
 - “Playful” education games
- AI for story build up
- Integrated analytics

Example of SE education games



My Duels▼ | Settings▼ | Sign In

Coding Duel
for fun

Random Puzzle | Learn | APCS | New 1,858,343 clicked 'Ask Pex!' | C# | Visual Basic | F#

This puzzle is an interactive Coding Duel. Can you write code that matches a secret implementation? Other people have already won this Duel 10419 times! [Help](#)

```
using System;

public class Program {
    // Can you fill the puzzle method to match the secret arithmetic
    // operation?
    public static int Puzzle(int x, int y) {
        if (x == 0 && y == 0) return 0;
        if (x == 0 && y == 1) return 1;
        if (x == 1 && y == 0) return 1;
        return 0;
    }
}
```

Ask Pex!


Done. 4 interesting inputs found. [How does Pex work?](#)

Permalink


Pex found 1 difference between your puzzle method and the secret implementation. Improve your code, so that it matches the other implementation, and 'Ask Pex!' again.


You are not signed in. [Sign In](#) to rate duels and track your achievements. [Help](#)

	x	y	your result	secret implementation result	Output/Exception	Error Message
✓	0	0	0	0		
✓	0	1	1	1		
✗	0	2	0	2	Mismatch	Your puzzle method produced the wrong result.
✓	1	0	1	1		



Pex and Moles

 Like Page 4.8K likes

 Tweet

Pex (Microsoft)

Example of SE education games

Game ID	Score	Round	Mutants Alive	Status
2997	ATK (vladbala): 1 DEF (you): 0	2 of 3	1	Waiting

Class Under Test

```
--
17  * @throws ClassCastException if list elements are
18  * @throws IllegalArgumentException if list is empty
19  */
20  public static <T extends Comparable<? super T>> T :
21  {
22      if (list.size() == 0)
23      {
24          throw new IllegalArgumentException ("Min.min
25      }
26
27      Iterator<? extends T> itr = list.iterator();
28      T result = itr.next();
29
30      if (result == null) throw new NullPointerException
31
32      while (itr.hasNext())
33      { // throws NPE, CCE as needed
34          T comp = itr.next();
35          if (comp.compareTo (result) < 0)
36          {
37              result = comp;
38          }
39      }
40  }
```

Write a new JUnit test here

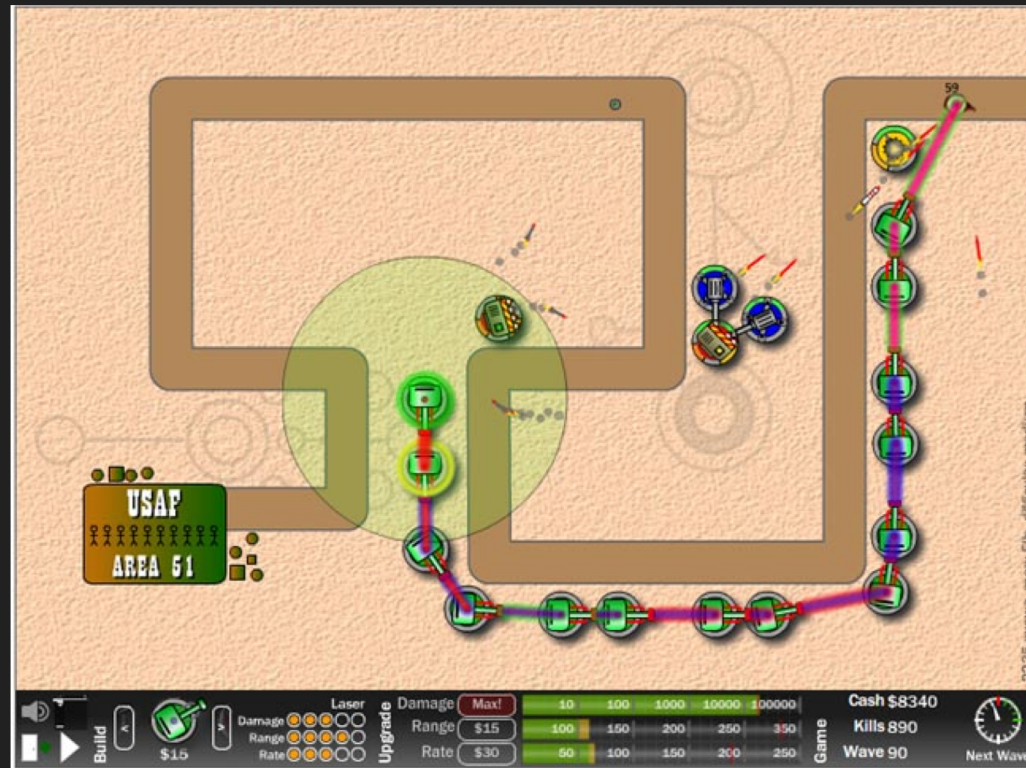
```
1  /* no package name */
2
3  import org.junit.*;
4  import static org.junit.Assert.*;
5
6  public class TestMin {
7      @Test(timeout = 4000)
8      public void test() throws Throwable {
9          // test here!
10     }
11 }
```

In production: Formal-Z game

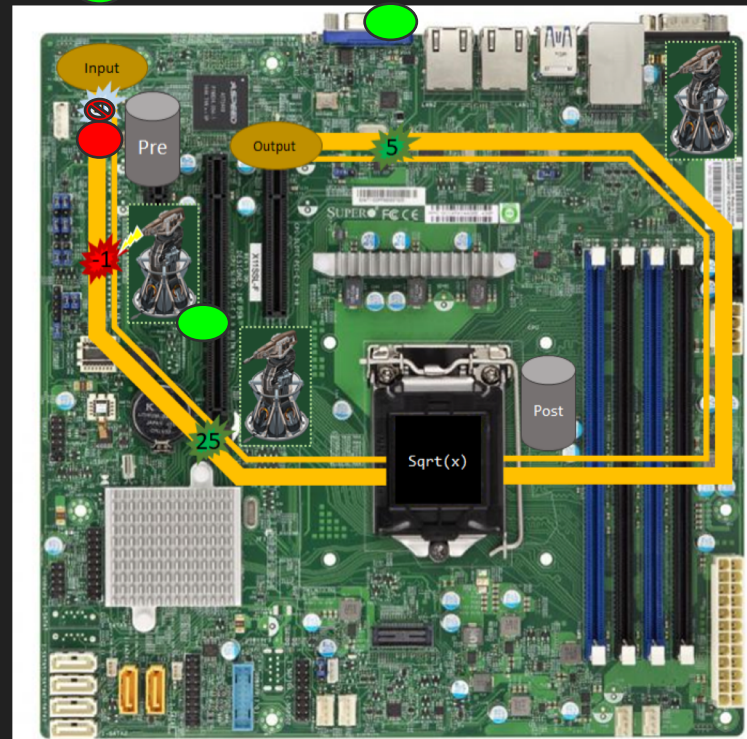
- a game to train student to write formal specifications interpretable in Java
- will lean more towards the “engagement” aspect
- <https://git.science.uu.nl/impresshs/javawlp>

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```


The concept of Fomal-Z

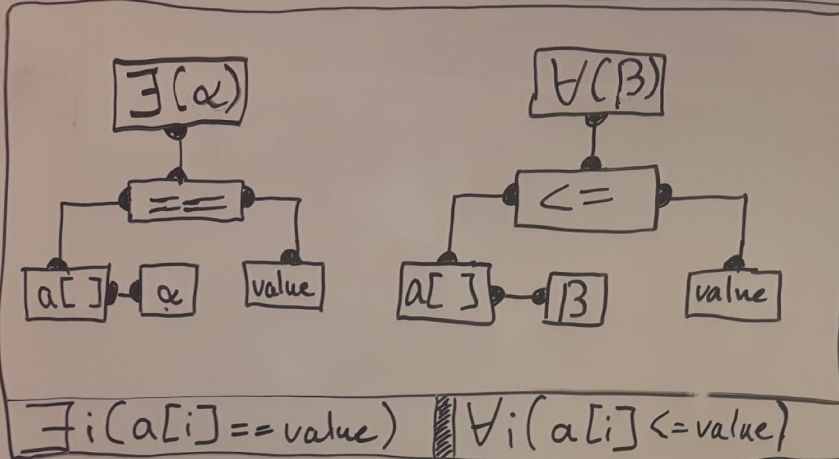


From tower defense to computer defense

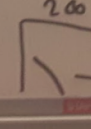
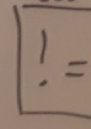
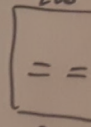
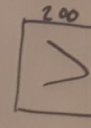
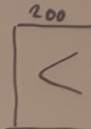
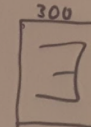
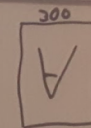
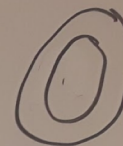


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Life



Get Max
Returns the maximum value of a given array.





IMPRESS future work

- Education quizzes and games for Software Engineering, experimenting with the balance between “seriousness” and “excitement”.
- Data analytics.
- Studying these innovations in actual class rooms.
- If you are interested: Tanja.Vos@ou.nl