Teaching programming and algorithm design with Pythia, a web-based learning platform

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Context

- **Programming and algorithm design**

    - No or few courses at secondary schools (12–18 years old)

    - No or few opportunities to encourage pupils to learn it

    - No or few teachers able to teach it

- Missing a place where pupils can learn and train their skills

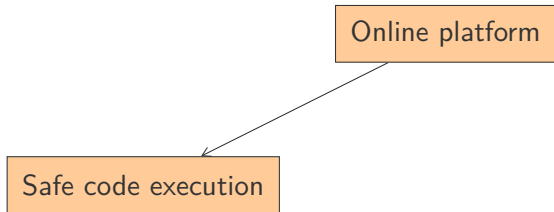- Missing a tool that can support teachers to teach programming

Existing solutions

- Contests like be-OI

- Computer science festival

- Online learning
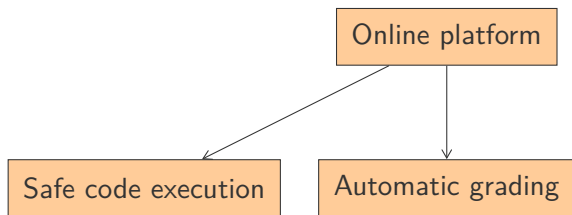   - Rubymonk, Try ruby, Try python...
    - Codecademy
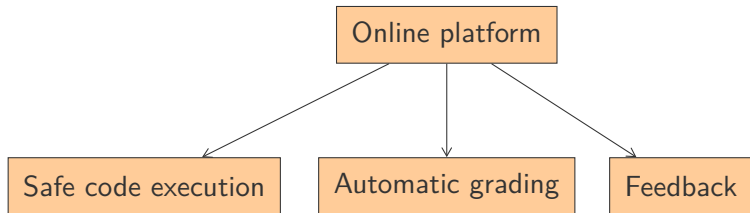   - Coursera

Proposed solution
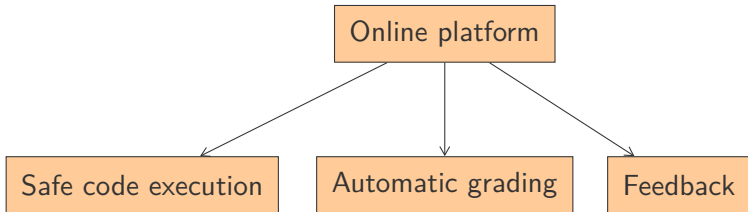
Online platform

Proposed solution

Proposed solution

Proposed solution

Proposed solution

- Should be language-agnostic
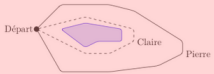- Should ease the creation of new problems

Problems

Context and concrete situation

Problems

Screenshot of the CSITEd Learning Centre web application titled "Allons courir autour du lac !" with context text in French, a diagram, and a Python programming question. Overlaid in red: "Simple instances solvable by hand"

5

Problems

Larger instances to solve with an algorithm

Peter and Clara decided that they are going to go running around the lake. There are several possible paths around the lake. Peter and Clara both have their favourite paths. The two paths have the same starting point and Peter and Clara both arrive at the same point after having run.
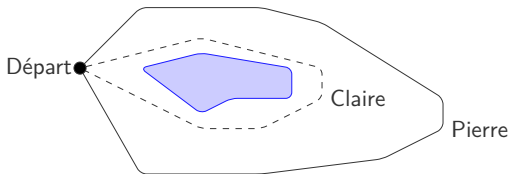
Let's go for a tour around the lake II

1. Let's suppose that Peter's path is **five** kilometres long and that Clara's one is only **three kilometres** long. If they start at the same time and if they are running at exactly the same speed, after **how many rounds** will Clara cross Peter **for the first time**?

2. Write a function that **takes two parameters** A and B which are **non-zero natural numbers** corresponding to the lengths of the paths of Peter and Clara. The function **returns a pair of natural numbers** containing the minimal number of rounds after which Peter and Clara (in that order) will cross each other at the starting point.

Course

- Sequences of problems to help students directly practice

- *"Learning by doing" motto*

- System of progression with trophies, following serious games

Feedback I

```
                    ┌──────────────┐
                    │   Feedback   │
                    └──────────────┘
                   ↙                ↘
Grades for the teacher          Information for student
```

For the student:

- Very important for motivation

- Help student to find his issues

- Summarize the newly learned knowledge

Feedback II

- Example of a more rich feedback

Le graphe suivant montre la répartition des nombres pseudo-alétoires générés par votre code. Un bon générateur devrait couvrir au maximum l'espace des valeurs possibles.

Plot of random numbers
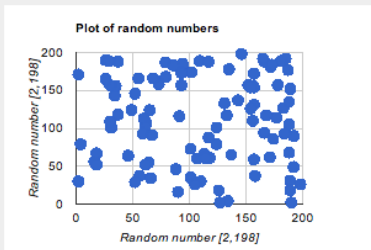
Assumptions

- Not interested in real-time correction

- Delayed execution is acceptable (best-time)

- High-performance is not crucial

Pythia framework

Sandbox architecture
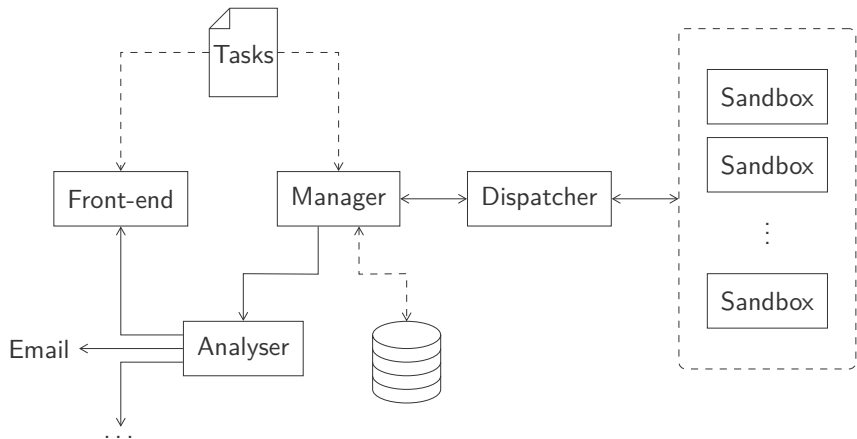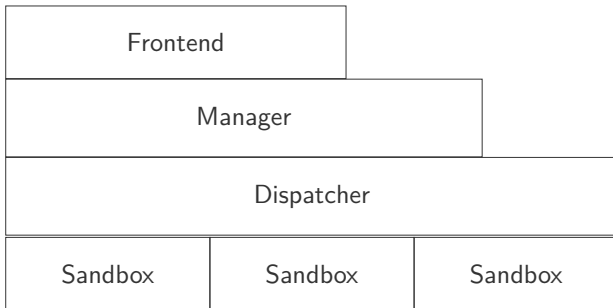
- Virtualisation

- User-Mode Linux (UML)

- Multiple rootfs for supported languages

- Rootfs easily assembled from Debian packages

- Startup overhead less than one second

Pythia framework architecture

- A modular and adaptable architecture

Pythia library

- Language-specific blocks to ease writing of tasks

    1. Datatest generator
    2. Student's code execution
    3. Analysing student's results

Conclusion and perspectives

- Course and problem to be used by secondary schools teachers
- Automatic correction and feedback generation
- A first prototype has been implemented and tested

- Strengthening the platform to be robust to errors
- Working on the teacher's side platform
- Integrating more analysis tools
- The tool will be open-sourced soon!