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

Sébastien Combéfis    Vianney le Clément de Saint-Marcq

Université catholique de Louvain
Department of Computer Science Engineering (INGI)

September 26, 2012

[IOI 2012, Montichiari, Italy]
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

- Safe code execution
- Automatic grading
- Feedback

Should be language-agnostic

Should ease the creation of new problems
Proposed solution

Online platform

Safe code execution

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

Automatic grading
Feedback
Proposed solution

Online platform

Safe code execution

Automatic grading

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

- Online platform
  - Safe code execution
  - Automatic grading
  - Feedback

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

- Online platform
  - Safe code execution
  - Automatic grading
  - Feedback

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

Context and concrete situation

Allons courir autour du lac !

Contexte

Départ Claire Pierre

Question
Question 1
Supposons que le parcours de Pierre fasse cinq kilomètres et que celui de Claire n’en fasse que trois. S’ils partent tous les deux en même temps du point de départ, et qu’ils courent exactement à la même vitesse, après combien de tours Claire va-t-elle recroiser Pierre pour la première fois ?

Question 2
Ecrivez une fonction qui reçoit en paramètre deux naturels non-nuls A et B correspondant respectivement aux distances des parcours de Pierre et de Claire. La fonction renvoie une paire de naturels contenant le nombre minimal de tours après lequel respectivement Pierre et Claire vont se recroiser au point de départ.

def tourNumber(A, B):
  # Your code here
  return 1
Problems

Simple instances solvable by hand
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.
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

For the student:

- Very important for motivation
- Help student to find his issues
- Summarize the newly learned knowledge
Example of a more rich feedback

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

- Not interested in real-time correction
- Delayed execution is acceptable (best-time)
- High-performance is not crucial
Pythia framework

- Front-end
- Manager
- Dispatcher
- Sandbox
- Sandbox
- Sandbox

Tasks

Email

...
Sandbox architecture

- Virtualisation
- User-Mode Linux (UML)
- Multiple rootfs for supported languages
- Rootfs easily assembled from Debian packages
- Startup overhead less than one second
- **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!