WeBWorK in Computer Science around the Globe

Presented by: Dr. Olly Gotel
Pace University, New York, USA

WeBWorK in CS Team:
Drs. Christelle Scharff, Olly Gotel and Richard Kline
Pace University, New York, USA
Dr. Andrew Wildenberg
Cornell College, Iowa, USA
Online Assessment Systems for Computer Science and Mathematics

URL: http://www.csis.pace.edu/~scharff/webworknyc2008
When: Friday, May 2nd, 2008
Where: Pace University, 163 William Street, 15th Floor, New York City

Keynote:
Dr. Michael Gage
University of Rochester
Designer and Developer of WeBWorK

Organizers:
Drs. Christelle Scharff, Olly Gotel, Richard Kline
Pace University, New York
Dr. Andrew Wildenberg
Cornell College, Iowa

Email: webworknyc2008@gmail.com
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Outline

• The Problem with CS and Teaching Programming … A Personal Perspective …
• Systems for Automated Assessment of Programming Assignments
• WeBWorK and WeBWorK-JAG
• A Global Experiment
• Conclusions and Future Work
WeBWorK in CS

Systems for Automated Assessment of Programming Assignments

• Web-based systems to encourage practice (with feedback), and improve and reinforce students’ understanding of concepts

• Types of questions
  – True / false, short answer, multiple-choice, programming

• Grading programs
  – Correctness + quality + authenticity
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Existing Systems

- Boss  www.dcs.warwick.ac.uk/boss
- CodeLab  www.turingscraft.com
- CourseMarker  www.cs.nott.ac.uk/CourseMarker
- DevSquare  www.devsquare.com
- Gradiance  www.gradiance.com
- JavaBat  www.javabat.net
- MyCodeMate  www.mycodemate.com
- OWL  owl.course.com
- Viope  www.viope.com

Not an exhaustive list!
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WeBWorK

- `webwork.rochester.edu`
- Project funded by NSF
- Free, open-source and web-based
- Automated problem delivery and grading
- Initial development and applications in the fields of mathematics and physics
- Currently in use at more than 50 colleges and universities
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WeBWorK

• Problems are written in the Problem Generating macro language (PG)
  – Text, HTML, Latex, Perl
• Underlying engine dedicated to dealing with mathematical formulae
  – \( x+1 = (x^2-1)/(x-1) = x+\sin(x)^2+\cos(x)^2 \)
• Individualized and parameterized versions of problems
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WeBWorK for Programming Fundamentals

• atlantis.seidenberg.pace.edu/webwork2/demo

• True / false, short answer and multiple choice problems for Java, Python, C and SML

• Extension of WeBWorK for use in programming fundamentals

• Evaluation of Java program fragments by interfacing WeBWorK with JUnit [www.junit.org] - WeBWorK-JAG = WeBWorK +

JUnit
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A Global Experiment (Share!)

• Global Perceptions on the Use of WeBWorK as an Online Tutor for Computer Science
• A 5 Country Experiment
• Java and C Problem Sets
• Student and Professor Questionnaires

Collaborating Profs:
• Olly Gotel, Christelle Scharff, Andrew Wildenberg (US)
• Chim Bunthoeurn, Phal Des, (Cambodia)
• Vidya Kulkarni (India)
• Mamadou Bousso, Cheikh Sarr (Senegal)
• Srisupa Palakvangsa Na Ayudhya, Thanwadee Sunetnanta (Thailand)
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Problem Sets
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Problems
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Multiple-Choice Questions
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Fill-in-the-Blanks Questions

Javaset: Problem 3

This set is visible to students.

(1 pt)

For Loop

How many times does the following for loop execute?
We consider that there are no errors in the code.

```
for(int i = 1; i < 9; i = i+1) {
    statements
}
```

Edit this problem

Show correct answers
Preview Answers Check Answers

You have attempted this problem 0 times.
This homework set is closed.

Show Past Answers
Email instructor

This set is visible to students.
You Can Build up Interesting / Typical Questions
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Randomize / Parameterize
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JAG - For Open Coding

Java Programming - Fibonacci

The Fibonacci sequence is the list of numbers (0, 1, 1, 2, 3, 5, ...) such that each number of the sequence is the sum of the previous two.

Write a method that fills up with the Fibonacci sequence numbers.

The method will be called fibonacci and must:

- Be public and static;
- Take an array of int as parameters that will be filled up with the Fibonacci sequence numbers; and
- Return void.

```java
public static void fibonacci(int[] array) {
    // Implementation
}
```
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Typical Feedback - Correct

```
public static int sumEven(int n) { int res = 0; for (int i = 0; i <= n; i++) { if (i % 2 == 0) res = res + i; } return res; } throw new IllegalArgumentException("Argument \+ n \+ not in range");
```

The above answer is correct.

SUM OF EVEN NUMBERS

Write a method that computes the sum of the even numbers from 0 to a given limit (included).

The method will be called sumEven and must:
- Be declared public and static;
- Take one parameter of type int representing the limit;
- Return an int containing the sum, and
- Throw an IllegalArgumentException for an argument strictly smaller than 0.

```
public static int sumEven(int n) {
    if (n >= 0) {
        int res = 0;
        for (int i = 0; i <= n; i++) {
            if (i % 2 == 0) 
                res = res + i;
        }
        return res;
    }
```
Typical Feedback - Incorrect

A screenshot of a WeBWorK problem showing a student's attempted solution for a method that computes the sum of even numbers. The student's code is incorrect, and the feedback indicates the solution is not completely correct. The problem statement is as follows:

**Problem Statement**

Write a method that computes the sum of the even numbers from 0 to a given limit (inclusive). The method will be called `sumEven` and must:

- Be declared public and static;
- Take one parameter of type `int` representing the limit;
- Return an `int` containing the sum;
- Throw an `IllegalArgumentException` for an argument strictly smaller than 0.

```java
public static int sumEven(int n) {
    int res = 0;
    ...
    return res;
}
```
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How Did They Do?

Student Progress for CambodiaJavaExp student student3

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WebWork is an open-source project and is available on GitHub and other platforms. For more information, visit the WeBWorK Project page: [WeBWorK Project](http://webwork.maa.org).
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... & With Respect to the Others?
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PG Code (and more) Behind the Scenes
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Student Perceptions

• “WebWorK is good but needs the user to have the Internet. So if we don't have internet we can't do it.” [Cambodia.]
• “Though it was my first experience at WeBWorK, I found it quite simple to use and really encouraging to remind me about Java, as I haven't did any java practice for the last 3-4 months. Its interface was nice.” [India.]
• “I liked the concept of WeBWorK. It is a useful tool for testing students’ level at programming.” [Senegal.]
• “WeBWorK make it convenient to do the test by automatically checking the answer and responding back to the user.” [Thai.]
• “It was a fun experience to go through the questions and find the answers. I enjoyed reviewing, and verifying that I know how to write code.” [US.]

Implications? For uptake and future work?
Professor Perceptions

• “I think the problem should be clear - should [be] basic Java and OOP concept in Java. Internet was too slow to have all students complete the exercises.” [Cambodia.]

• “I will be happy to see how it will test a large programming assignment with multiple classes.” [India.]

• “Internet use which expands collaborations.” [Senegal.]

• “...limited programming library; expand problem library...” [US.]

Implications? For uptake and future work?
Conclusions and Future Work

• Supports an overloaded professor and can tide students over inbetween classes

• These systems open up opportunities for professors and students around the globe to transfer and share knowledge, and extend practice, but some local adaptations are necessary (Intranet, question formulation, integration)

• Development of a novel pedagogy, encouraging students to contribute their own questions to the WeBWorK library, introducing them to crucial practices of software engineering

• Aim to create a community of contributors to monitor quality, share work and extend the WeBWorK library
Come to our May workshop and find out more!

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  – Sophal Chiv (input of problems and help desk)
  – Eileen Crupi, Tabitha Estrellado (input of problems)
  – Allyson Ortiz, Veronica Portas (existing systems)
  – Yue Ma (user acceptance testing)