



# WeBWorK

An open-source  
on-line homework system  
for mathematics

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<http://webwork.maa.org>

- What is WeBWorK?
- Who is using WeBWorK?
- WeBWorK Community: <http://webwork.maa.org>
- Timeline
- Special Features
- Summary and future activities

# Overview



- WeBWorK is a web-based homework checker. (WebAssign and WeBWorK are similar)
- WeBWorK makes homework more effective in calculus and physics courses.
- The overwhelming majority of students complete all of their homework correctly -- (sometimes after several attempts).
- It is particularly adept at handling mathematics and physics problems.
- The homework is corrected and graded efficiently and completely.

# Goal:

Make homework more effective and efficient.

- It increases the effectiveness of traditional homework as a learning tool by:
  - Providing students with **immediate feedback** on the validity of their answers and giving students the opportunity to correct mistakes while they are still thinking about the problem. As one student said, *“I can fix my mistakes while [the] problem is fresh in my mind.”*
  - Providing students with **individualized versions** of problems which means that instructors can encourage students to work together; yet each student must develop an answer to his or her own version of the problem.

# Screenshots

# interval example

Entered	Answer Preview
$(-3,7)$	$(-3, \frac{35}{5})$

The answer above is correct.

(1 pt)

The interval described in set notation by the inequality  $|5x - 10| < 25$  has interval notation:

$(-3, 35/5)$

---

## Sample responses to incorrect answers

Entered	Answer Preview	Messages
$(-3,7]$	$(-3, 7]$	The type of interval is incorrect

Entered	Answer Preview	Messages
$(-3, 35/5)$		Missing operand before '!

# Code



```
"MathObjects.pl",
"PGcourse.pl" # should always be imported last
);

TEXT(beginproblem());
$showPartialCorrectAnswers = 0;

#####
#
# Setup

Context("Interval");

$a = random(2,5,1);
$b = $a*random(-5,5,1);
$c = $a*random(3,10,1);

$answer = Compute("( -($b)/$a-$c/$a,-($b)/$a+$c/$a)");

#####
#
# Text

Context()->texStrings;

BEGIN_TEXT
The interval described in set notation by the inequality$BR
\(|$a x + $b| < $c\) has interval notation: $BR $BR
\{ans_rule(20)\}
$BR
END_TEXT

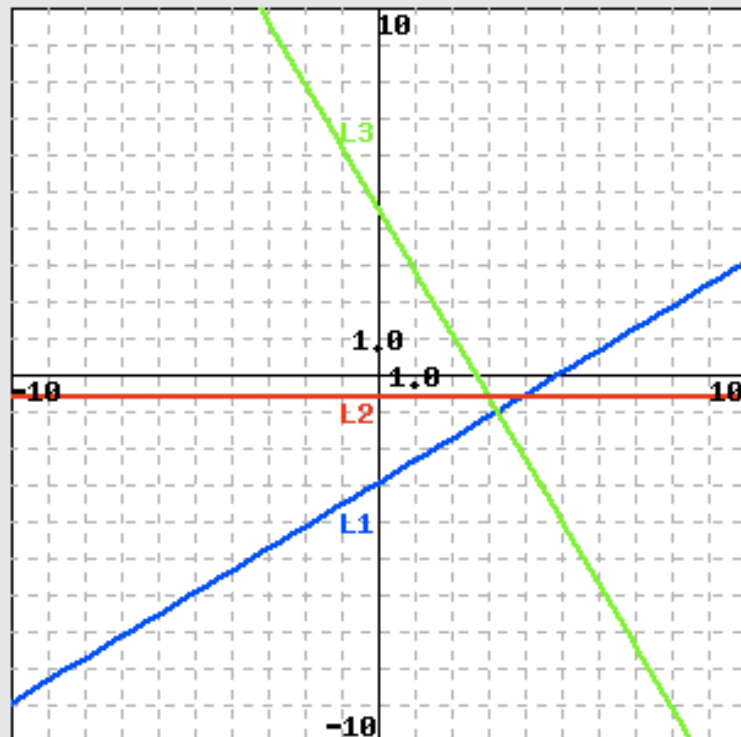
Context()->normalStrings;

#####
#
# Answers

ANS($answer->cmp);

ENDDOCUMENT();          # This should be the last executable lin
```

# Graph examples

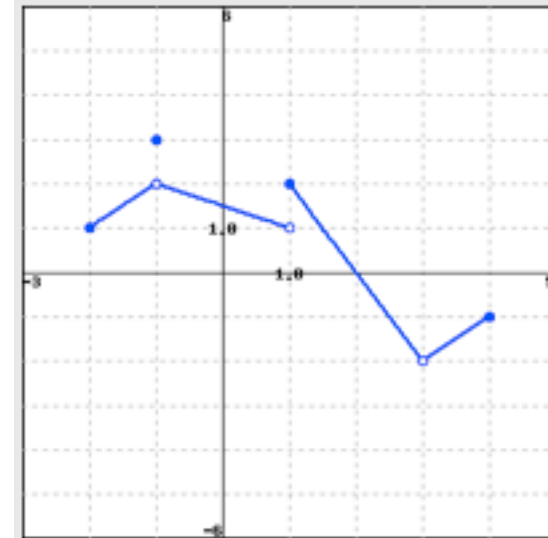


Match the Lines L1 (blue), L2 (red) and L3 (green) with the slope each set listed below:

- 1. The slope of line  $L1$
- 2. The slope of line  $L3$
- 3. The slope of line  $L2$

- A.  $m = -1.7$
- B.  $m = 0.6$
- C.  $m = 0$

Let  $F$  be the function below.



Evaluate each of the following expressions.

Note: Enter 'DNE' if the limit does not exist

a)  $\lim_{x \rightarrow -1^-} F(x) = \text{[ ]}$

b)  $\lim_{x \rightarrow -1^+} F(x) = \text{[ ]}$

c)  $\lim_{x \rightarrow -1} F(x) = \text{[ ]}$



# Goal:



Make homework more effective and efficient.

- It increases the efficiency of traditional homework by:
  - Providing automatic grading of assignments.
  - Providing information on the performance of individual students and the course (or section or recitation) as a whole.
- Key Features:
  - Using WeBWork, instructors can ask most questions typically found in mathematics and other scientific textbooks as well as more advanced interactive questions.
  - Students **persist** with WeBWork. At Rochester we find almost all students complete each homework set until most problems are correct.

- from students:

- When asked on anonymous surveys: Does the immediate feedback provided by the WeBWoRK system enhance the educational value of solving homework problems? Please provide a number between 1 and 5 where 1 means strongly disagree while 5 means strongly agree. Most students responded with a 5 and made comments such as:
  - *"Yes. It was very helpful to know if I was wrong and be able to work the problem through until I knew and understood how to get it right."*
  - *"I understand the problems better when given the ability to correct them."*
  - *"I think it's a better way to learn."*
  - *"I really like finding out right away and being able to rework a problem I got wrong."*
  - *"I loved it. It helped me develop on my skills."*
  - *"Significant increase in motivation [thus] giving students more confidence"*
  - *"It definitely does. I think this is the strongest point of W.W."*
  - *"It was helpful in learning from mistakes & seeing mistakes."*
  - *"Very much so. I don't have to wait for lecture to see if I'm doing it right."*
  - *"Yes. It makes you want to redo it; after finding an answer, you feel accomplished, immediate feedback makes sure you have accomplished something."*

- from instructors:
  - *“...Without instant grading of math homework, even if students do math homework assignments, they do not know if they have done them correctly– unless the answer is in the back of the book (in which case it is tempting to copy the answer and work backward from it). Being told immediately that their answer is wrong is a strong motivation for students to keep working on a problem. Engaging students to stick with a problem until they get it right is an extremely powerful strategy for good learning...”*
  - *“WebWork combines the best features of these other programs in a very usable package. WebWork is the ONLY system that allows 1) Individualized (dynamic) Problems 2) Web Delivery 3) Grade and User Management 4) Extensive and useful problem sets and 5) User ability to create additional problems.”*

# Who is using WeBWorK?



- More than 100 universities serving WeBWorK homework from their own servers.
- More than 150 courses hosted at the University of Rochester for other small colleges and high schools and first timers.
- The WeBWorK server is free and open source (GPL)
- A partial list: [WeBWorK servers](#) and [map](#)

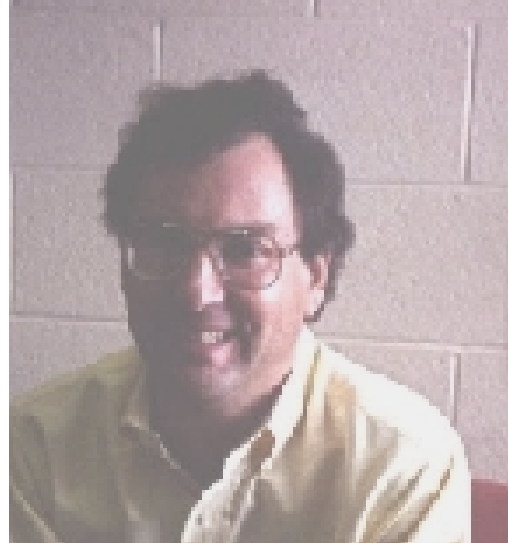
# WeBWork sites



# Community



## Co-PIs



Mike Gage

Arnie Pizer

Vicki Roth

Michael Pearson

University of Rochester

MAA

# Community

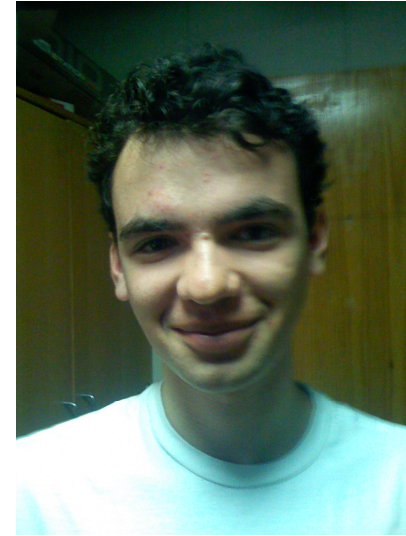
some developers:



Sam Hathaway  
Gavin LaRose



Davide Cervone  
John Jones



Matt Leventi  
Jason Aubrey



# Community



more developers



American Institute of Mathematics (AIM)

WeBWorK Workshop

August 2007

and



100's of instructors writing questions

(more than 12,000 collected in the national library)



# Timeline



- Fall 1996 - WeBWorK first used in classes at U of R
- Spring 1999 - NSF support for WeBWorK at U of R NSF 
- Fall 1999 - WeBWorK received ICTCM award for Excellence and Innovation with the Use of Technology in Collegiate Mathematics  
ICTCM 
- Spring 2003 - WeBWorK2 is first released
- Summer 2004 - MSRI sponsors WeBWorK programming workshop
- August 2007 - American Institute of Mathematics sponsors workshop on WeBWorK development and outreach
- 2009 -- WeBWorK 2.4.7 released
  - Moodle interoperability
  - flash, java and geogebra API's in beta
- Sept 2009 -- 5 year NSF dissemination grant to MAA for WeBWorK

# Ongoing group activities



- Wednesday video conferences - Jason Aubrey
  - Alternate Wednesdays at (5pm EST)
  - see Wiki at <http://webwork.maa.org>
- One day mini-conferences at Mathfest -- recruiting, training and supporting WeBWorK consultants
- Adding and organizing documentation on the wiki.
- Creating and organizing new material for the NationalProblemLibrary

# Features



- Download a typeset copy of the entire homework set
- Use gateway quiz or homework set mode
- Each student's homework set is different
- 'Email instructor' button aids communication
- Create homework sets from library with more than 12,000 problems.
- Precalculus, calculus I and II, multivariable calculus
- Linear algebra, differential equations, statistics, classical physics

# More features



- A partial list of answer types that can be checked with current response evaluators.
  - Real and complex numbers - to specified accuracy
  - Functions - of one or more variables: (  $x^3+5x-4+\sin x$  )
  - Numbers or functions with units (  $500\text{ cm}$  or  $5\text{ m}$  )
  - Antiderivatives -- up to a constant
  - True-False, multiple choice, short answer
  - Solutions to non-homogeneous ODE up to a solution of the homogeneous ODE
  - Eigenvectors, parallel vectors, vectors lying in a given span
  - Independence of a set of vectors

# More features



- Material for all lower level courses and textbooks
- WeBWorK works with others -- can use jsMath, mathML, gif images; java, javaScript, flash applets
- Standard methods for managing homework sets and class lists.
- Integrates as a component of Moodle -- soon Blackboard

# Moodle: model Calculus site



<http://hosted.webwork.rochester.edu/moodle/>

## 15 September - 21 September

Text	Topic	Supplementary Problems	Recitations	WeBWork
1.6	Inverse Functions and Logarithms	1.6 21, 23, 25, 35, 38, 49	App. D, 1.3, 1.5	WeBWork Set 1 due Mon, Sept 22, 6:00 AM
2.1	Tangents, Velocity, Limits	2.1 3, 5		
2.2	The Limit of a Function	2.2 1, 3, 5, 9, 15, 25, 27		

[Set 1](#)

## 22 September - 28 September

Text	Topic	Supplementary Problems	Recitations	WeBWork
2.3	Limit Laws	2.3 1, 5, 7, 10, 11 - 23 (odd), 35, 37, 57	1.6, 2.1, 2.2	WeBWork Set 2 due Tue, Sept 29, 6:00 AM
2.5	Continuity	2.5 3, 17, 20, 39, 45, 47, 60		
2.6	Limits at Infinity, Horizontal Asymptotes	2.6 3, 5, 13 - 31 (odd)		

[Set 2](#)

## MTH201 Probability (Fall 2009)

You are logged in as [Michael Gage](#) (Logout)







mathmoodle ▶ math201-fa09

Switch role to... Turn editing on

### People

 [Participants](#)












### Activities

-  [Assignments](#)
-  [Choices](#)
-  [Forums](#)
-  [Resources](#)
-  [WeBWoRK Problem Sets](#)
-  [Wikis](#)

### Search Forums

[Advanced search](#)


### Administration

-  [Turn editing on](#)
-  [Settings](#)
-  [Assign roles](#)
-  [Grades](#)
-  [Groups](#)
-  [Backup](#)
-  [Restore](#)
-  [Import](#)
-  [Reset](#)
-  [Reports](#)
-  [Questions](#)

### Weekly outline

MTH201 -Probability - Fall 2009

 [MTH 201 Textbook, Policies, Office hours](#)

 [Class announcements](#)

 [Orientation](#)

You MUST do the Orientation webwork. (You will get free credit for doing it.) We use this to make sure that you are correctly signed up for the course in Moodle and WeBWoRK. Make sure that you click the "enrol me in course" label in the left hand margin of this page.

31 August - 6 September

 [Make your workshop choice here -- SOON](#)

Lectures:

- Sections 1.1,
- 1.2 Basic principles of counting;
- 1.3 Permutations

 [WeBWoRK1 -- combinatorics](#)

 [If you can't attend any existing workshops leave a note here](#)

7 September - 13 September

Lectures:

- Sec: 1.4, Combinations
- 1.5, Multinomial coefficients
- 1.6 (skim) Integer solutions of equations

 [workshop 1](#)

Print out a copy of workshop 1 and bring it with you to your first workshop this week. It is a good idea to have worked as many problems as possible in

### Latest News

[Add a new topic...](#)

17 Dec, 18:44

Michael Gage  
grade cutoffs -- [more...](#)

17 Dec, 14:17

Michael Gage  
and more grade adjustments .... :-  
) !!!! [more...](#)

17 Dec, 11:57

Michael Gage  
grades are really up? [more...](#)

17 Dec, 10:41

Michael Gage  
Grades are up [more...](#)

16 Dec, 18:33

Michael Gage  
grades will be ready Thursday --  
probably around noon [more...](#)  
[Older topics ...](#)

### Upcoming Events

There are no upcoming events

[Go to calendar...](#)  
[New Event...](#)

# Full Geogebra applet with debugging window



The screenshot shows a Geogebra applet window with a menu bar (File, Edit, View, Options, Tools, Help) and a toolbar with various construction tools. The main workspace displays a coordinate plane with a line passing through points A and B, and a circle passing through points C and D. The coordinates of the points are: A = (-1.77, 5.27), B = (2.4, 3.57), C = (-1.07, 2.3), and D = (-2.67, 3.13). The line is labeled with the equation  $a = 2$ . The circle is labeled with the equation  $c: (x + 1.07)^2 + (y - 2.3)^2 = 3.25$ . The debugging window at the bottom shows the XML output of the applet, including the `<show algebraView="true" spreadsheetView="false" auxiliaryObjects="true" algebraInput="false" cmdList="true"/>` tag. Below the XML output are several buttons for debugging: getXML, setXML, getConfig, setConfig, Hide A, Show A, A red, A blue, Delete A, and Reset. There are also input fields for getting and setting the coordinates of point B.

Free Objects

- A = (-1.77, 5.27)
- B = (2.4, 3.57)
- C = (-1.07, 2.3)
- D = (-2.67, 3.13)

Dependent Objects

- a:  $1.7x + 4.17y = 18.94$
- c:  $(x + 1.07)^2 + (y - 2.3)^2 = 3.25$

Auxiliary Objects

```
<?xml version="1.0" encoding="utf-8"?>
<geogebra format="3.02">
<gui>
  <show algebraView="true" spreadsheetView="false"
  auxiliaryObjects="true" algebraInput="false" cmdList="true"/>
</gui>
```

getXML setXML getConfig setConfig Hide A Show A A red A blue Delete A Reset

get coords of B:

set coords of B:

State is preserved from one viewing to the next!

[local](#)

[internet cloud](#)



# Strengths



- WeBWorK is flexible and easily extensible
  - **Few limits: Ask the questions you *should*, not just the questions you can!**
  - Response evaluators can be written or customized for each problem.
  - A large number of standard response evaluators already exist -- ready to use.
  - WeBWorK's structure imitates TeX and LaTeX: There is an underlying basic and powerful language and an overlying collection of macros that make authorship of problems and response evaluators easier.
  - Math formulas are written using LaTeX. The algorithmic portions are written in PG which is a subset of Perl with customized macros (subroutines).

# Summary



- Immediate feedback on homework is educationally valuable -- big time!
- WeBWorK offers maximum extensibility and flexibility -- **Ask the questions you should, not just the questions you can!**
- **Free** -- open source software - Mathematics community support - share the work. Install your own server
- **or** -- Hosting for moderate size classes can be arranged at the U. of Rochester: email [gage at math.rochester.edu](mailto:gage@math.rochester.edu)
- Central site: <http://webwork.maa.org>

# The End



- Thank you.
- MAA session: Online homework -- innovation and assessment
  - Thursday 1:00pm - 4:15pm Room 2009 Moscone
  - Friday 8:40am - 10:55am Room 3002 Moscone
  - Friday 2:00pm - 4:55pm Room 3002 Moscone
  - Friday 5:30pm “Symposium” at the Thirsty Bear -  
661 Howard St.