WeBWorK

Automated Homework

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Outline

Introduction

WeBWorK

- Developed at University of Rochester - Pizer and Gage
- Supported by MAA
  - Website - **webwork.maa.org**
- Open source
- PG language - Perl/LaTeX
- Local control
- Public Library with more than 20,000 problems

WeBWorK at San Diego State University

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- Numerous courses
  - Calculus for Life Sciences
  - Calculus (some main sections)
  - College Algebra
  - Discrete Math
  - Some PDE and Numerical Analysis

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  - Calculus for Life Sciences
  - Calculus (some main sections)
  - College Algebra
  - Discrete Math
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- Local Administration
  - Set courses
  - Update WeBWorK
  - Instructors control individual classes

Calculus for the Life Sciences

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- Classes with 100-250 students

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- Homework
  - Random numbers - slightly different problems
  - Students discuss methods - answer individually
  - Instant feedback
  - Multiple attempts - work harder for CORRECT answer
  - Accepts answers in numerous forms - preview available

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- Created own problems

WeBWorK Program

WeBWorK Program

- Homework Problems
  - Create Assignment from Libraries (new or existing)
  - Assign weight and number of attempts
  - Give a due time/date
  - Can generate PDF hardcopy

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  - Information on specific problems

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- Score homework to Excel spreadsheet (.csv)

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  - Information on specific problems
- Score homework to Excel spreadsheet (.csv)
- Email between students and instructor

WeBWorK Problems

WeBWorK Problem Types

Good templates and help available

webwork.maa.org/wiki/Category:Authors

- Multiple choice and Matching

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- Functions - default 5 point evaluation for $x \in [0, 1]$ with 0.1% rel tol (easily modified)

WeBWorK Problems

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- Multiple choice and Matching
- Numerical - default 0.1% relative tolerance (easily modified)
- Functions - default 5 point evaluation for $x \in [0, 1]$ with 0.1% rel tol (easily modified)
- Graphing on the fly

WeBWorK Examples

Three Examples Available

webwork.sdsu.edu/webwork2/math-121-mahaffy/

Login: GUEST1
Password: mcast1

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Examples

- Hormone - **PG file**
- Kaplan - gene/neural net - **PG file**
- Beetle Lab - **PG file**

WeBWorK Example 1

Start with Headers for Library Searches

```
## DBsubject('Calculus for Biology')
## DBchapter('Differentiation and Applications')
## DBsection('The Derivative of e^x and ln(x)')
## KEYWORDS('derivative', 'hormone', 'exponential', 'drug', 'maximum')
## TitleText1('Calculus: A Modeling Approach for the Life Sciences')
## EditionText1('2e')
## AuthorText1('Mahaffy and Chavez-Ross')
## Section1('The Derivative of e^x and ln(x)')
## Problem1('Problem 9')
## Author('Joseph M. Mahaffy')
## Institution('San Diego State University')
```

WeBWorK Example

Load PG Macros - Start Problem - Let students know partial answers

```
DOCUMENT();
loadMacros("PGbasicmacros.pl",
           "PGchoicemacros.pl",
           "PGanswermacros.pl",
           "PGauxiliaryFunctions.pl"
);

TEXT(&beginproblem);
$showPartialCorrectAnswers = 1;
```

WeBWorK Example

Define Variables - Randomize

```
#define the variables

$a = random(20,70,10);
$b = random(0.002,0.007,0.001);
$c = random(0.1,0.3,0.01);
```

WeBWorK Example 4

Text for Problem

```
BEGIN_TEXT

Some hormones have a strong effect on mood, so finding a delivery
device that delivers a hormone at a more constant level over a longer
period of time is important for hormone therapy. Suppose that a drug
company finds a polymer that can be implanted to deliver a  hormone,
\( h(t), \) which is experimentally found to satisfy $BR
\[ h(t) = $a \left(e^{-$b t} - e^{-$c t}\right), \] $BR
where \( h \) is in nanograms per deciliter of blood (ng/dl) and \( t \)
is in days. $BR
Find the derivative of the function: $BR
\( h'(t) = \) \{ans_rule(35) \}  $BR
Find the maximum concentration of this hormone in the body
and when this occurs. $BR
\( t_{max} = \) \{ans_rule(15) \} days. $BR
\( h(t_{max}) = \) \{ans_rule(15) \} ng/dl.  $BR
Evaluate \( h(0) = \) \{ans_rule(10) \} ng/dl. $BR
Find the horizontal asymptote by evaluating, $BR
\( \lim_{t\to\infty}h(t) = \) \{ans_rule(10) \} ng/dl. $BR
You should make a sketch of this graph with the information that
you have found above on a piece of paper. $BR

$PAR
END_TEXT
```

WeBWorK Example

Solutions - Answers - End Problem

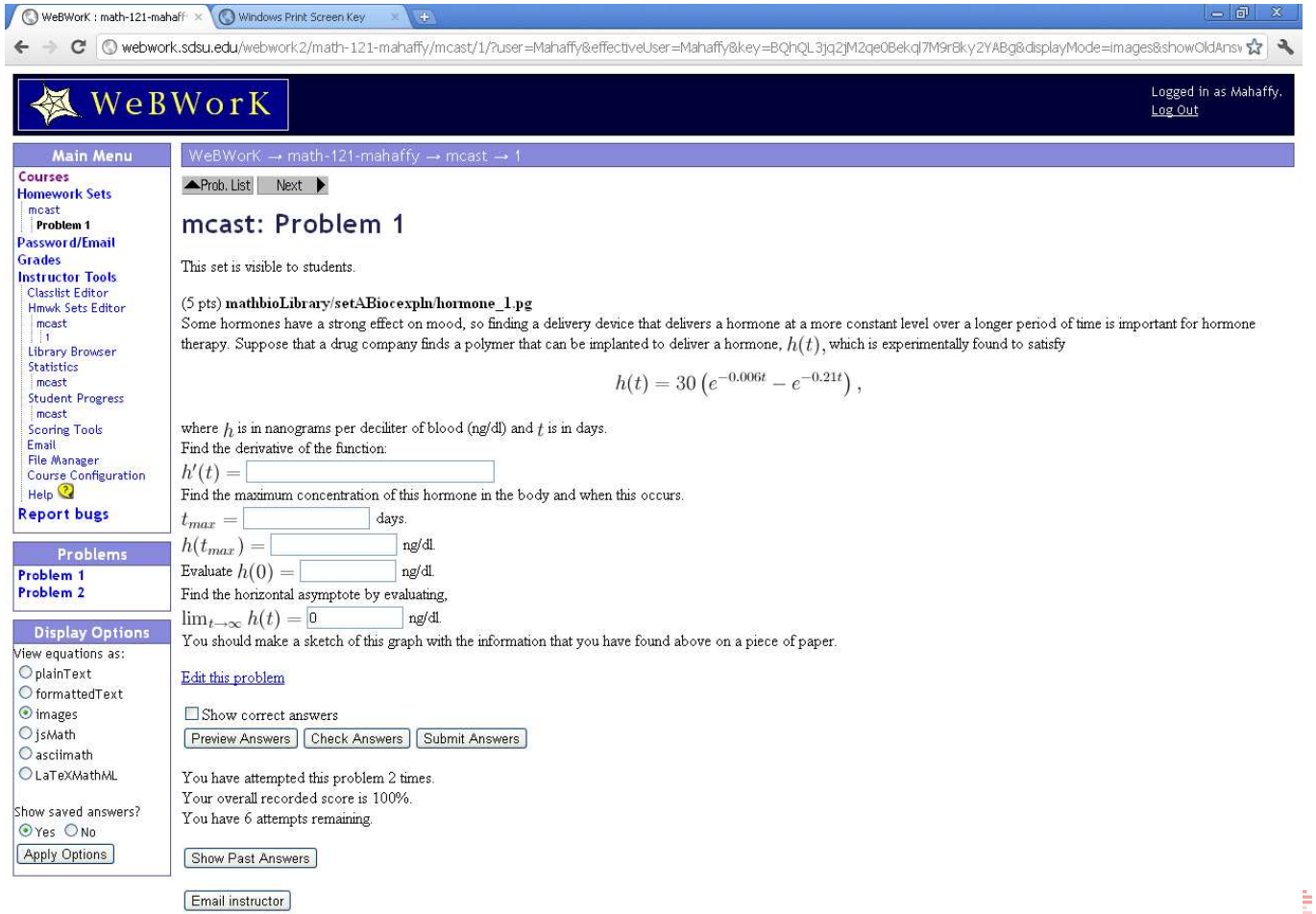
```
$tmax = ln($c/$b)/($c-$b);
$hmax = $a*(exp(-$b*$tmax) - exp(-$c*$tmax));

ANS( fun_cmp( "$a*($c*exp(-$c*t) - $b*exp(-$b*t))", var => 't') );
ANS( num_cmp( $tmax ) );
ANS( num_cmp( $hmax ) );
ANS( num_cmp( 0 ) );
ANS( num_cmp( 0 ) );

##################################################>>>
ENDDOCUMENT();
```

WeBWorK Example

WeBWorK Display



WeBWorK Example - Beetle Lab 1

Outline of Beetle Lab Problem

- Descriptors

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- Usual WeBWorK Macros

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Outline of Beetle Lab Problem

- Descriptors
- Usual WeBWorK Macros
- Randomize data - Based on actual data
- Problem text
  - Find 4 best-fitting updating functions
  - Find derivatives and analyze stability
  - Describe graphs
  - Fit time series with initial population

WeBWorK Example - Beetle Lab 2

Outline of Beetle Lab Problem - cont

- Solutions

WeBWorK Example - Beetle Lab

Outline of Beetle Lab Problem - cont

- Solutions
  - Initialize guesses
  - PERL code for Newton's method (2D)
  - Error answers
  - Line search for initial population

WeBWorK Example - Beetle Lab

Outline of Beetle Lab Problem - cont

- Solutions
  - Initialize guesses
  - PERL code for Newton's method (2D)
  - Error answers
  - Line search for initial population
- WeBWorK answers - appropriate evaluators