WeBWorK: Open Source On-line Homework for Mathematics

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Outline

- A brief and incomplete history of web homework systems, 1992–present.
- Some similarities and differences between current systems.
- Capabilities and characteristics of WeBWorK and (some) other systems.
- WeBWorK demonstration, including student and instructor views.
- Some details of WeBWorK
  - Features,
  - Philosophy, and
  - Neat and Technical Stuff.
- Conclusions, such as they are.

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$pans1 = Compute( $p );
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$pans1rule = $pans1->ans_rule();

# first set up some probabilities that work
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@pvals = ();
push( @pvals, Compute( "1 - 2*$p" ) );
for ( my $i=1; $i<$n; $i++ ) {
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The Past Decade

- 2009 : The AMS undertook a survey of US mathematics departments to assess use of and experiences with on-line homework (contacted 1230 departments; responses from 467, including 57 statistics departments).
  - About half of doctoral mathematics departments were using on-line homework.
  - MyMathLab had the largest overall user base (110 departments, 230,000 students annually).
  - WebAssign (80 users, 100,000 students) and WeBWorK (55 users, 100,000 students) were the next most popular.

n.b.: the survey predated Cengage's acquisition of WebAssign.

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- Publisher systems dominate standalone web homework:
  - MyMathLab (Pearson) boasts *over 11 million students* annually.
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  - WileyPlus (Wiley); ALEKS (McGraw Hill). . .
- Independent systems have a smaller user base
  - WeBWorK *(over 1,300 institutions)*
  - Maple T.A., rebranded Möbius (spun off to DigitalEd)
  - . . . and IMathAS ("Internet Mathematics Assessment System"), which powers MyOpenMath and LumenOHM, Ximera (Ohio State—an "interactive textbook platform"), local systems (Kansas State,. . .), . . .

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- LMS Interoperability

Advanced	Basic	None
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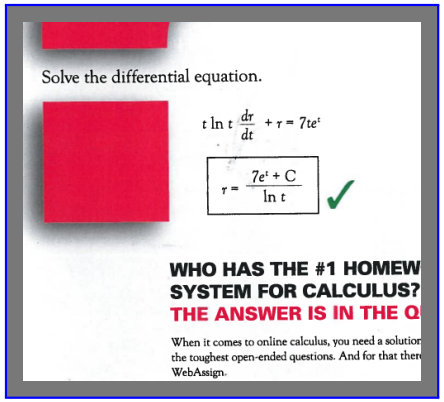
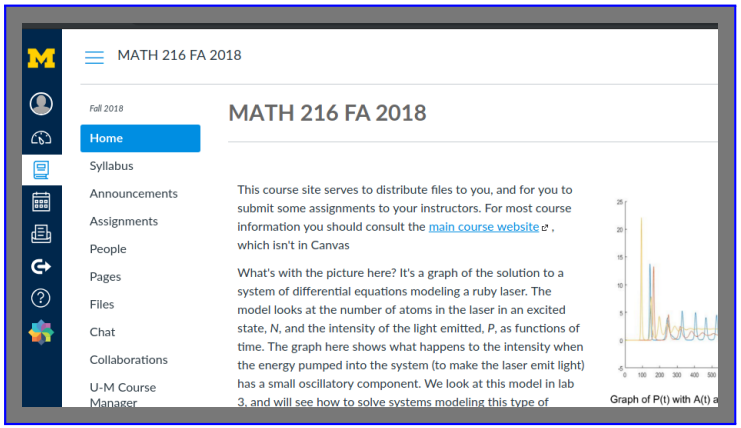
Common Capabilities/Features

- Similarities between WeBWorK and Publisher Systems
  - Robust and varied answer checking.
    - *CAS integration vs. programmatic and MathObjects answer checking, Sage. . .*.
  - Significant problem libraries.
    (WeBWorK's OPL currently has 35,000 problems)
    - *Some direct textbook problem tagging*.
  - LTI Support (that is, connections to any modern LMS).





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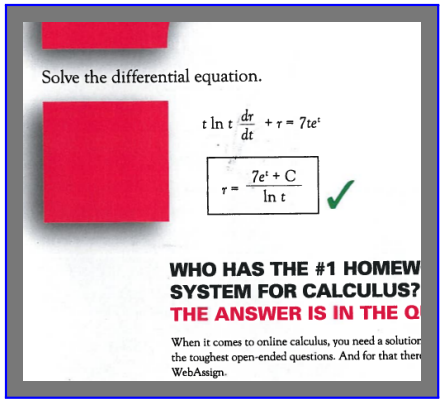

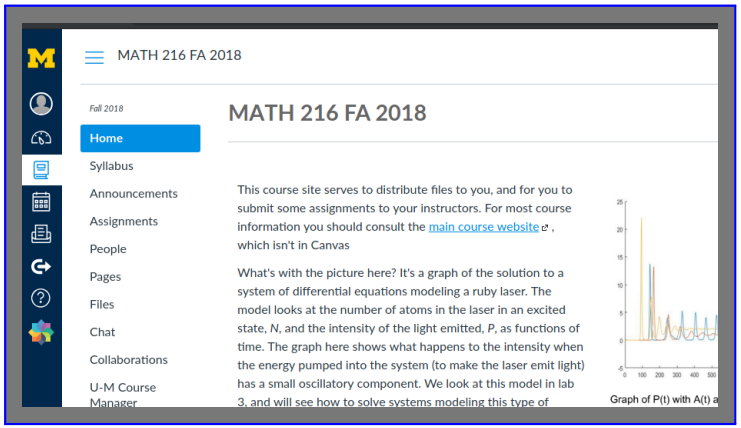

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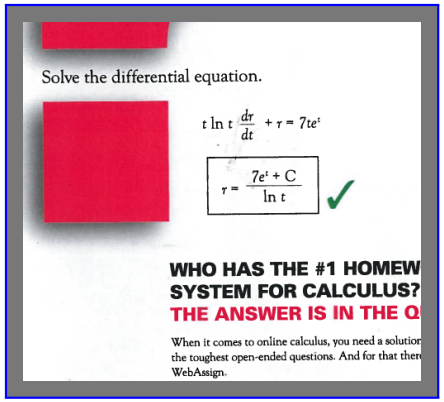
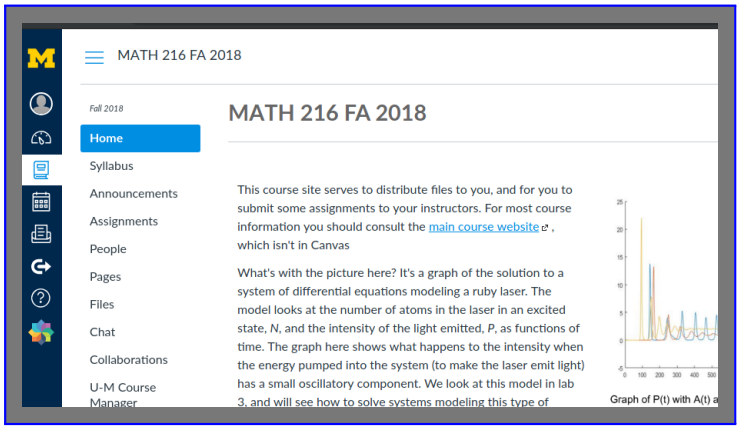
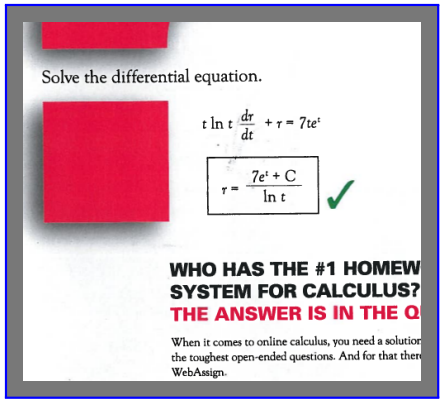
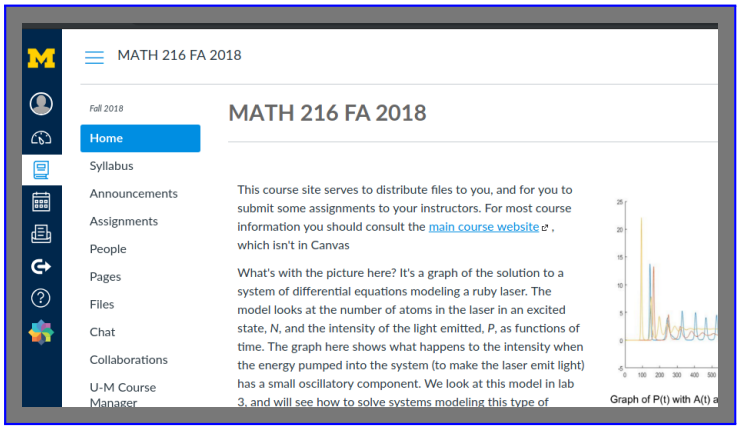




Common Capabilities/Features

- Similarities between WeBWorK and Publisher Systems
  - Robust and varied answer checking.
    - *CAS integration vs. programmatic and MathObjects answer checking, Sage. . .*.
  - Significant problem libraries.
    (WeBWorK's OPL currently has 35,000 problems)
    - *Some direct textbook problem tagging*.
  - LTI Support (that is, connections to any modern LMS).





Differences in Capabilities/Features

- Differences between WeBWorK and Publisher Systems
  - Incomplete text problems
    - *But: textbook problems tend to be similar. . .*
  - No links back to textbooks
  - No "plug and play."
    - *But: LMS Interoperability*
- Other Thoughts
  - SSO support exists in WeBWorK, and maybe other systems.
  - Features generally exceed *used* features.
  - Paying usually buys something
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WeBWorK Demonstration

- Student view
  - Setup
  - Homework assignments
  - (Gateway) Tests
  - Settings & Grades
- Administrator view
  - Web interface—Add/edit courses, manage locations.
- Instructor view
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- Traditional workflow
  1. WeBWorK Administrator creates course(s).
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- LTI workflow
  1. WeBWorK Administrator creates course(s), and configures it (them) to use LTI.
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Underpinnings and Further Use Cases

- What is WeBWorK?
  - A *Perl Apache module* that is loaded into an apache server process,
  - with most data in a *MySQL database*.
  - Additional data (problem source code, macro files, classlist import files, set definition import files. . .) are stored in *small text files* on the webserver.
- Where does it live for a given University?
  - Locally, or
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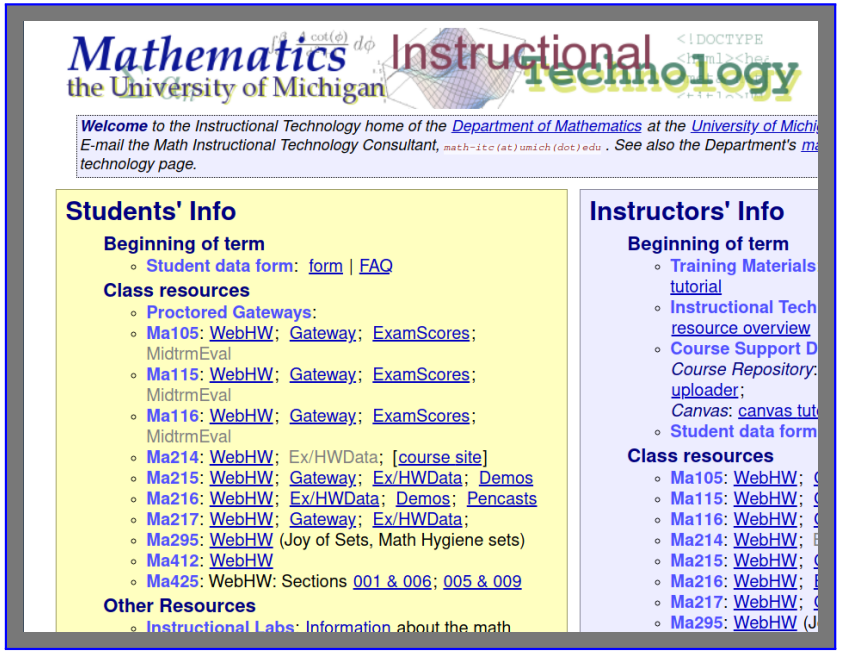
WeBWorK at Michigan

- Locally hosted, large installation.
  - ≈230 WeBWorK courses for fall 2018.
  - ≈50 hosted for UM Dearborn, using LTI to integrate with Canvas.
  - UM AA courses run through SSO.



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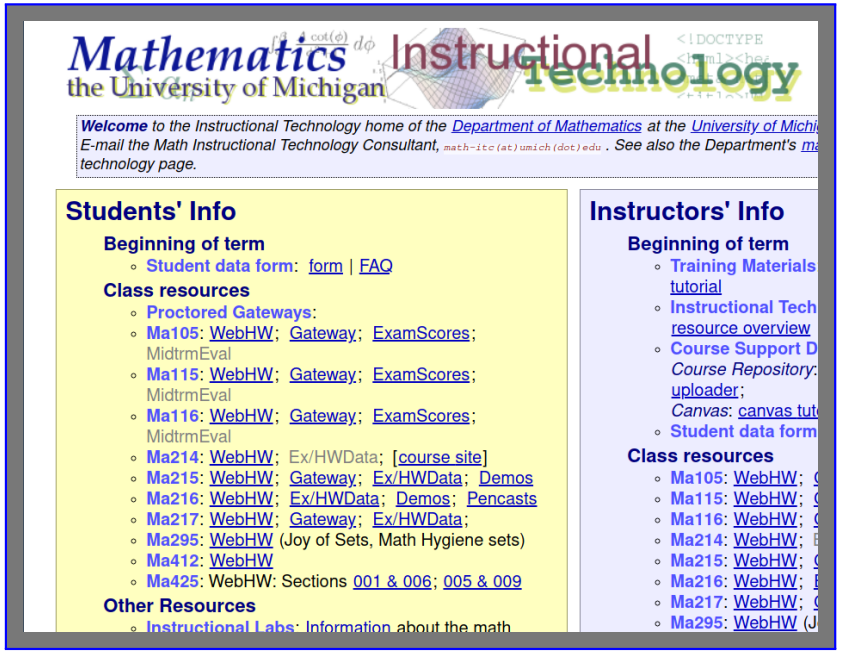

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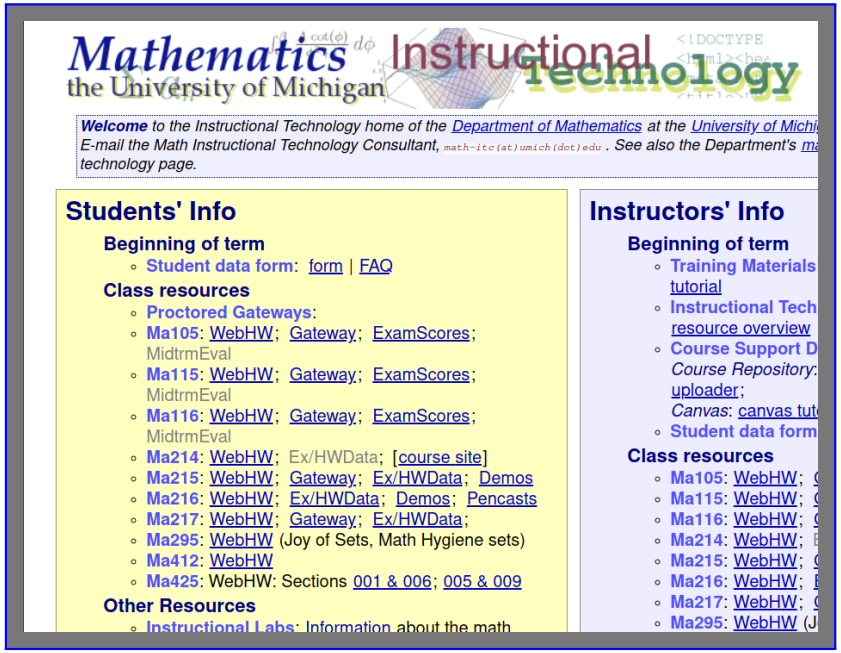

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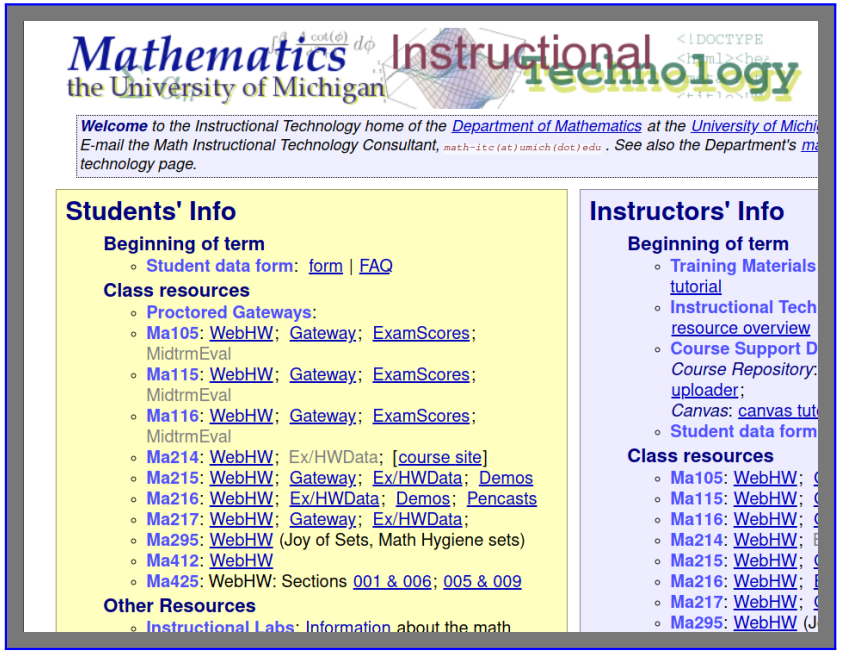

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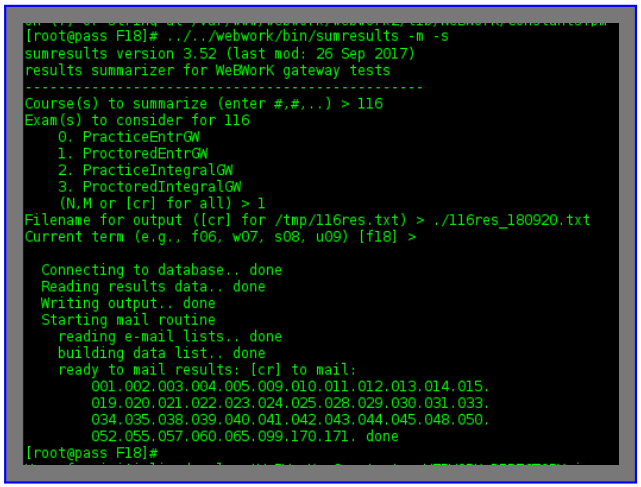

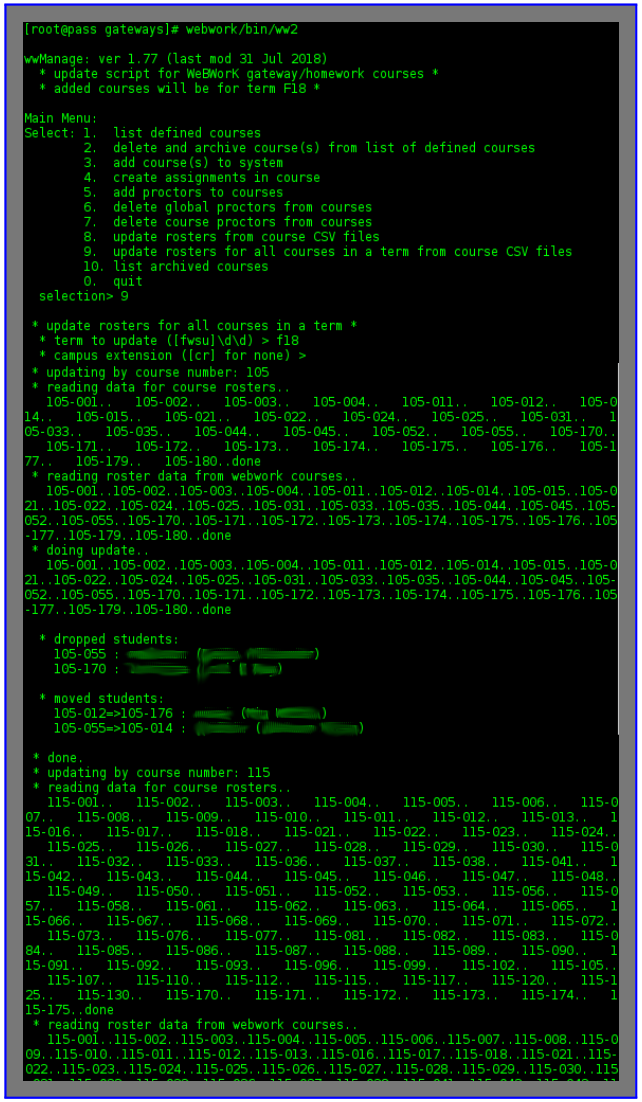

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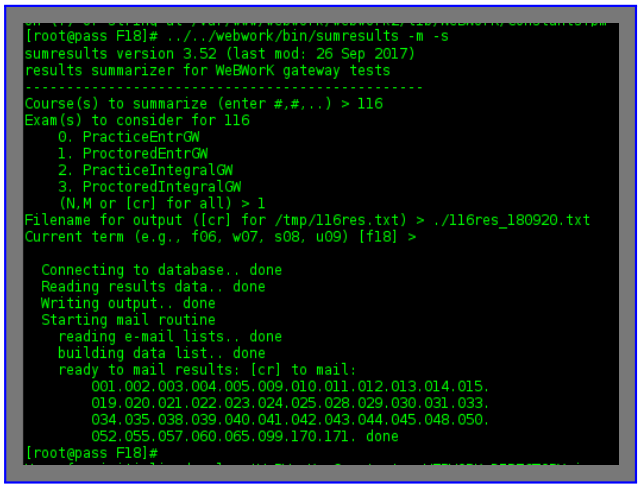

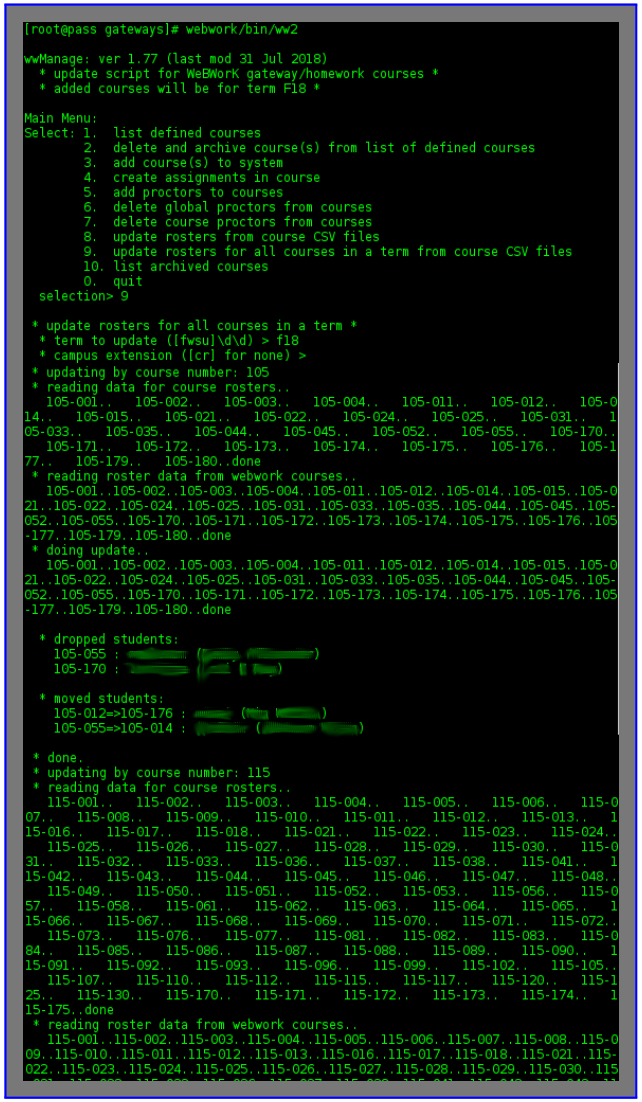

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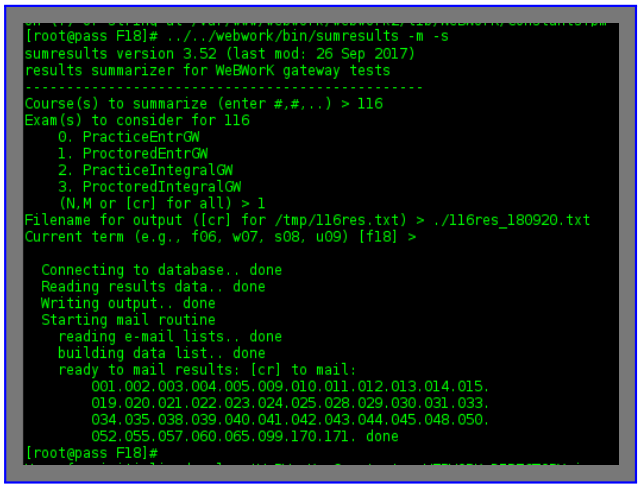

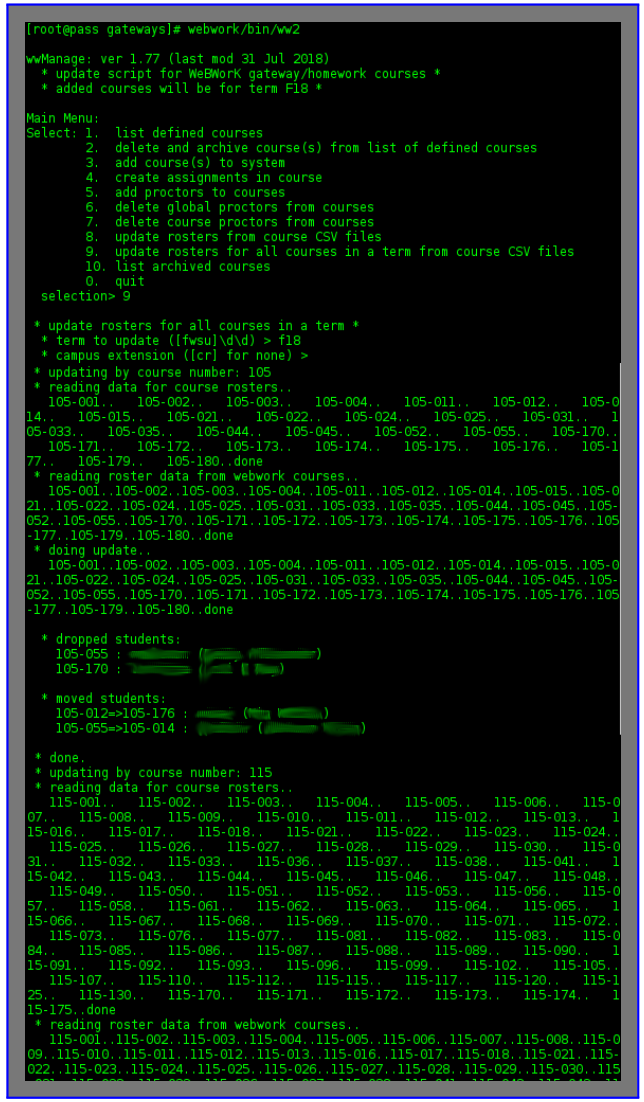

The Philosophy of WeBWorK

- Why WeBWorK?
  think: LaTeX
- What should it do?
  - *Let you do what you want*.
    Implication: Not necessarily to make it easy to code problems.

    But: one thing we want to do is write problems in LaTeX.

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## EditionText1('7')
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## Section1('8.2')
## Problem1('1')

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Context("Numeric");
$m  = random(2,4,1); $x0 = random(1,3,1); $b  = $m*$x0;

TEXT(beginproblem());
BEGIN_PGML
The region bounded by the line [` y = [$b] - [$m] x `] between [`x = 0`]
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of this solid of revolution, we would evaluate the integral
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- Note: WeBWorK problems are small Perl programs.
  - Thus: it's possible to check any answer for which one can write an algorithmic test.
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    - ```
      $f = Formula('sin(x^2 + 3)');
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      $tanline = $f->eval(x=>$x0) +
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  - . . . and more: determine relationships between student answers, disallow use of functions or operations. . .

Neat Tricks

- Note: WeBWorK problems are small Perl programs.
  - Thus: it's possible to check any answer for which one can write an algorithmic test.
  - But *it's better than that!* They are Perl programs with added macros that allow mathematical operations:
    - ```
      $f = Formula('sin(x^2 + 3)');
      $f_deriv = $f->D();
      $tanline = $f->eval(x=>$x0) +
          $f_deriv->eval(x=>$x0)*(x - $x0);
      ```
    - ```
      $v2 = Compute("<-3,1>");
      ANS( $v2->cmp( checker=>sub {
          my ($correct, $student, $ansHash) = @_;
          return $correct->isParallel($student);
          }, showCoordinateHints => 0 ) );
      ```
  - . . . and more: determine relationships between student answers, disallow use of functions or operations. . .

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- What about installation?
  - Needed: a server; WeBWorK installs with git, from github, and requires LaTeX, Perl, apache, MySQL (or MariaDB);
  - configuration is in apache's **`httpd.conf`** file, and text configuration files for WeBWorK.
  - Which usually works perfectly fine. . .
    once all the required Perl modules are installed.
  - Documentation is pretty good, though it needs freshening.
- And this works fine on cloud services (*e.g.,* AWS).
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Conclusions

- WeBWorK vs. Publisher Systems
  - Both can provide good homework sets
  - and can be (relatively) easy to use.
  - Both have costs to use.
- We pick a system based on our situation
  - University policy.
  - Available resources (monetary, staff).
  - Philosophy and interest.
- WeBWorK is open source, robust, powerful, and has an active developer community.
  - *it's been around for 20-odd years, and there's a concerted effort to ensure it will continue.*

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