Enhancing the problem authoring capabilities of WeBWorK

organized by
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Workshop Summary

Our workshop drew together WeBWorK users with various levels of involvement and expertise, with the goals of (1) face-to-face collaboration to improve the power and flexibility of the PG language used to author the WeBWorK problems and (2) extending the range of examples and documentation available for mathematics instructors learning to write homework exercises for WeBWorK. In five days, we were able to take substantial steps in accomplishing several specific aspects of these goals.

0.1 MathObjects and GraphObjects

On the first and second days, all participants learned about Davide Cervone's "MathObjects" programming paradigm and participated in exercises to become familiar with the new dialect of the PG language. Many of the examples generated through the rest of the conference relied on MathObjects, and nearly everyone was using them by the end. A group formed to expand on Davide's examples and explanations, developed a framework for the documentation for MathObjects, and began to fill in that outline. A second subgroup formed to specify a compatible syntax for presenting on-the-fly graphics, static images, and so forth (now called GraphicsObjects). This functionality has been available in the PG language but with diverse syntax for accessing the various components. Progress was made toward specifying a syntax with a single uniform style that works with the both kinds of objects, and is both flexible and easy to remember. A limited proof-of-concept prototype was developed by the group.

0.2 Flash Applets

A presentation by Doug Ensley and Barbara Kaskosz, the organizers of the PREP MAA workshop "Flash at the Beach: Creating Mathlets with Adobe Flash," described their efforts in harnessing Flash to produce useful education applets. A group formed to write the programming glue that would allow these applets to communicate with WeBWorK and succeeded with developing a functional prototype that works with most browsers (unfortunately not yet Internet Explorer). Further refinements in features, and especially in robustness, will be forthcoming during the academic year.

0.3 Accessibility

Several working groups formed spontaneously, notably a group on accessibility that created a database of references to the issues of making on-line, and especially graphically-based, education programs accessible to those with low vision, hearing loss, or motion restrictions.

While we don't currently have the resources to address all concerns immediately, it is important to be aware of the issues during the design phases and to alleviate or avoid the problems as much as possible. (see `https://webwork.maa.org`: the Accessibility section)

0.4 Sequential problems, precalculus problems, and linear algebra problems

A shared interest in creating "sequential" or "adaptive" problems that can guide a student through a difficult concept step by step, possibly altering the process according to the student's answers, prompted another subgroup, aided by Davide, to come up with macros that facilitate the writing of such problems, and a list of desired properties for additional macros. Linear algebra examples were among those questions developed using these techniques. The prototype macros will be refined, documented and added to the PG language. In a similar vein, Robin Cruz led efforts to come up with problems suitable for pre-calculus level courses in which the syntactic presentation of the answer is as important as the semantic content. (For example, the answer must be in factored form.) This is a harder challenge than analyzing calculus functions for which WeBWorK has simply evaluated the function at a number of points to verify that it coincides with the correct answer. Checking syntax requires parsing of the student's answer; fortunately Davide's parser has a powerful customization feature (Contexts) that allows one to specify precisely the syntactical constructs a student's answer is allowed to have. Several new contexts were developed in direct response to Robin's specifications, including one for currency values, one for scientific notation, and one for inequalities. Robin also was able to construct a prototype flash applet that would be useful for precalculus problems using the macros developed by the Flash group.

0.5 Simplified entry, ease of use, problem library and video documentation

There were several issues brought up in addition to accessibility that were not directly addressed during the workshop but will form the basis for further development.

Robert Molzon presented a method he has used which simplifies the process of writing straightforward calculus and precalculus problems of the type found in textbooks. Davide Cervone also has recently developed a markdown language version of the PG language which addresses the same issue. During the conference, several participants worked on a design for an editing framework for WeBWorK problems. The goal is to make the process of writing straightforward problems easier and less error prone, particularly for those unfamiliar with programming. All three of these approaches will require more development in order to make them more widely usable.

Arnie Pizer led a group that collected case examples in which the ease-of-use for instructors is not optimal along with suggestions for improvement. John Jones led a session that collected similar suggestions for improving the Problem Library interface and, in particular, for creating mechanisms whereby instructors using WeBWorK can easily submit new problems to the library or suggest corrections or improvements to existing Library problems. These recommendations will be evaluated and implemented during this year, including suggestions for automated testing of the Library problems to insure that they will not produce software error warnings.

Jason Aubrey described his interest and experience in developing video tutorials — tutorials for using WeBWorK (intended for instructors) as well as tutorials in solving certain calculus problems (that could be linked to the relevant WeBWorK homework questions).

This is very intriguing, and we'll explore further how to make these videos more widely available and to make the techniques for producing them more widely known.

0.6 The WeBWorK site and on-going working groups

All of the forum comments and wiki documentation created during the AIM-WeBWorK workshop are now available in frozen form in the AIM WeBWorK section of `https://webwork.maa.org`. This fall, the most relevant conclusions and summaries will be transferred to a version of mediaWiki where they can continue to be updated and augmented. (During the workshop, we found some of the limitations of moodle's internal wiki to be a hinderance; fortunately the site at MAA will soon be installing for us a copy of mediaWiki, used by Wikipedia and by the Moodle development group itself for information and documentation. This should be better suited for long term collection of information, manuals, tutorials and hints.)

There are twelve on-going working groups organized during the workshop: MathObject documentation, led by Jason Aubrey and Sam Koski; Flash Object integration, led by Doug Ensley and Barbara Kaskosz; Accessibility, led by Lila Roberts and Vicki Roth; Ease-of-use modifications, led by Arnie Pizer; Linear Algebra problems, led by Tom Hagedorn; Sequential (or progressive or adaptive) problems, led by Karen Clark; Graph Object documentation, led by Darwyn Cook; Simplified entry implementation, Robert Molzon; Precalculus problems, Robin Cruz; Problem Library enhancements, John Jones; automated problem testing, Ted Ashton; and Computer Science programming problems, Christelle Scharff. The facilities of the MAA site, including forums, wiki's, databases and so forth are available to these groups for intra-group communication and for disseminating conclusions.

0.7 Summary

The biggest accomplishment of the workshop was the dramatic increase in the core number of mathematicians who are now familiar with the internals of WeBWorK, experienced with MathObjects and writing problems, and able to make improvements to WeBWorK code and macros and to help answer the questions that come up on our site bulletin board. Those who have worked on WeBWorK for a long time also experienced a noticeable boost in enthusiasm and energy as the newcomers came on board. Direct evidence of this can be found in terms of the activity and the number of active people on the forums at the MAA WeBWorK site (`https://webwork.maa.org`).

The on-going groups developing documentation, tutorials and examples to be posted on the MAA-WeBWorK site will continue to increase the usability, reach, and power of WeBWorK for instructional mathematics in our universities, colleges and high schools.