Enabling Web access to a database of calculus problems using LaTeX, PHP and LaTeX2HTML

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Abstract

In this paper, we present work which we have done to provide the material used in the teaching of calculus to students at Lappeenranta University of Technology. This procedure can be divided into three separate steps: 1) creation of the LaTeX files, 2) conversion of the base LaTeX files to the HTML files, and 3) implementation of these HTML files in the PHP database. So far, we have stored hundreds of exercises with hints and solutions on our Web server, in addition to some theory that we felt is necessary for the students. In this paper we will also discuss the benefits and future of our functioning Web environment [1].

Introduction

At the beginning of 2002, we initiated an investigation to develop possible solutions for providing the material used in the teaching of calculus to students at Lappeenranta University of Technology. In this paper, we present the complete procedure, from creation of the LaTeX files to a functioning Web environment [1].

We decided to write the pages in question in the LaTeX language. We also wanted to use database and network solutions for the final version of these pages. We chose to use a network solution because the material, once available on the Internet:

1. is easy to reuse, transform and combine with other materials,

2. can be easily accessed, at least with fast connections,

3. is accessible 24 hours a day,

4. can be accessed by many users at once, for performing searches on the calculus information.

The students can then study the material that they feel is the most interesting and then hopefully begin to carry out their own research and form a view of mathematics. Therefore we have taken a constructivist approach to the learning process.

The LaTeX files, which are entered into a database with all the necessary keywords, form the core of the solution. Based on the keywords, the database includes information on where each file is located, the specific area of mathematics, and whether the file is an exercise, solution, hint or general information. The database alters the user's view of its contents by using the keywords that are included in the above-mentioned base LaTeX files.

Any of our lecturers can contribute new material to the database by using a very simple interface and LaTeX. Lecturers can also easily construct weekly tutorials and even whole examinations from the contents of the database. So far, we have stored hundreds of exercises with hints and solutions on our Web server, in addition to some theory that we felt is necessary for the students.

Our lecturers have found that this new interface saves a significant amount of time and is also flexible enough for their needs. Student satisfaction with this new material is also apparent, since the material is now always available, information is easy to find, and the material is clear.

Converting LaTeX files to a functioning Web environment

All of our LaTeX files are articles or exercises which are executed by a cover file. Article files include theory, exercise files include tutorials of different kinds, and cover files (`kuori.tex`) are files which call the previously mentioned document files. Cover files use `math.sty`, which includes macro definitions of mathematical formulas and all other necessary definitions. DVI files are generated by execution of a cover file. All of these LaTeX files were originally created by a lecturer, Simo Kivelä, from Helsinki University of Technology (HUT).

Creating LaTeX files Base LaTeX files, articles and exercises include categorization which defines the final destination of the file in our Web environment. Categorization is done as follows:

- At the beginning there is `\begin{Artikkeli}` or `\begin{Tehtava}`, which defines if the file is an article or an exercise.
- `\tunniste{}`: The name of the file, for example `\tunniste{lta179}`. (The value comes from the words Liisa, Torikka, article and the number of the article.)
- `\alue{}`: The highest categorization in our content dictionary; for example `\alue{tavdy}`, meaning ordinary differential equation.
- `\luku{}`: The next categorization area, a section; for example `\luku{2kdy}`, meaning second order differential equations.
- `\kappale{}`: The lowest categorization area, a chapter; for example `\kappale {vali}`, meaning constant linear coefficient.
- `\otsikko{}`: The title of the document, e.g. `\otsikko{2ODYvaki lineaariset DY:t}`, meaning second order constant linear coefficient ODE.
- `\luonne[]{}`: Two arguments which characterize the file, for example `\luonne[Matlab] {teoria}`. Here, the first argument, 'Matlab', specifies that you need a computer program called Matlab to run the issued theory part; the second argument, 'teoria', means theory.
- `\kuvaus{}`: A short description of what the file includes.
- `\tekija{}`: The name of person who typed the file, for example `\tekija{Liisa Torikka}`.
- `\pvm{}`: The date, e.g. `\pvm{29.8.2002}`.
- `\kieli{}`: The language, with Finnish as the default.
- `\lahde{}`: The original source, for example `\lahde {LTKK/Pekka Jauhon moniste, kevät 2002}`.
- `\kayttooikeus{}`: Copyrights.
- `\lahdekoodi{}`: Source code, for example `\lahdekoodi{LaTeX}`.
- `\laitos[]{}`: The level of the material is the first argument, and the institution name is the second; for example, `\laitos[hard]{LUT}`.
- Then come keys to help database searches, for example `\avain[Calculus] {course}`; normally we use many keys to make files easy to find from our database.
- After these definitions comes the actual article or exercise.

Figure 1: A view of the add file page.

Figure 2: A view of the starting page of calculus.

All of these files which are written are then included in the previously mentioned cover file, executed and tested.

Conversion After we have a functioning LaTeX file, let us say `abc.tex`, we will run a script that uses the LaTeX2HTML translator to install this file into our Web database. The script is written in Perl and it transfers the original LaTeX file into the package called `abc.tar.gz`, which includes the original file `abc.tex` along with pieces of converted HTML files.

Adding a file into the database After this, the package, here named `abc.tar.gz`, is ready to be sent into our server using a very simple form; see figure 1. Once a person pushes a button called Send a PHP-script does the following things for the file:

- it will be unpacked,
- the contents will be checked,
- the information will be added into the database and
- HTML-pages will be sent to the right directory.

All this is done based on the information included in original LaTeX file.

Finalization After all this is done we have our file in our Web page, where the starting page looks like figure 2.

A user can perform different searches in our Web environment. A file which was added can be found from the categorization, from its place, or by a text search on a word included in the file categorization. For example, if we pretend that our file which we added had something to do with Euler, we could try to find it by entering the word 'Euler'

Figure 3: Searching for the word 'Euler'.

Figure 4: Result of the search for 'Euler'.

into the search engine as in figure 3 and the outcome of the search looks like figure 4. This works well, as long as one can think of an appropriate term for which to search.

The result from a successful search might look like figure 5.

Conclusions and future

We have received many positive and very few negative comments from these pages that we have created. Our pages have been used in our normal basic courses and both lecturers and students have taken them as their own. We have also done both qualitative and quantitative usability testing for these pages and the results have been very promising.

In the future, we plan to automate the way in which text will be captured in the pages of, for example, examinations. This will make our pages more usable in the context of distance education, among others. We will also continue developing these pages with animations and other features.

References

[1] Kalle Saastamoinen, Jaakko Ketola, Tuukka Kurppa and Liisa Torikka (2002). "Calculus Web pages", `http://www.it.lut.fi/mat/virtuaali/matb`

Figure 5: Example result document.