

## **T<sub>E</sub>X in the GLAMP world: On-demand creation of documents online**

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### **Abstract**

The acronym GLAMP is used to denote a combination of GNU/Linux, Apache, MySQL and Perl, Python or PHP, which now is one of the most common technologies for the creation of dynamic web pages. In this paper we describe the use of this technology for automatic creation of medical pedigrees.

To make drawing pedigrees easy for medical professionals, we put T<sub>E</sub>X and PostScript processing of their input on a Web site (<http://pedigree.varphi.com>). Here we cover both technical aspects of this (integration of T<sub>E</sub>X with GLAMP) and the preliminary results of using this site in an educational environment.

### **1 Introduction**

One of the most popular Web packages today is the combination of GNU/Linux operating system, Apache HTTP server, MySQL database and Perl, Python or PHP scripting language [15]. Michael Kunze coined the acronym LAMP for such a combination [6]. Following the advice of Richard Stallman [8] we prefer to use the term GNU/Linux instead of Linux, so we use the acronym GLAMP instead. However, the letter G here is silent, like in ‘GNU’, so both versions of the word sound the same.

When a web site needs to perform on-demand typesetting, T<sub>E</sub>X seems to be a good choice for the back-end typesetting engine. Fortunately, it can be easily integrated in the GLAMP system (see, for example [14]). In this paper we describe yet another GLAMP/T<sub>E</sub>X solution, where we use T<sub>E</sub>X for the on-demand typesetting of graphical material.

The problem we addressed here is the problem of automatic creation of pedigree charts for genetic researchers and medical professionals [1, 2, 7]. Earlier we proposed a T<sub>E</sub>X/PSTricks-based program for pedigree creation [10, 12, 13]. Its spreadsheet-like interface turned out to be quite successful for non-technical users. However, there remained a problem of cross-platform installation and technical support of a complex program on many different architectures. At TUG’09 Karl Berry suggested we circumvent this problem by creating a web-based pedigree drawing tool. We followed his advice, and created such tool at <http://www.pedigree.varphi.com>. This paper describes the lessons learned from making this tool and the preliminary user survey.

### **2 Some challenges**

One of the challenges for using T<sub>E</sub>X on the web is the power of this program. Powerful programs are potential security risks. Even when T<sub>E</sub>X is restricted from calling system programs (by disabling the `write18` mechanism), its ability to write files may be dangerous [4]. There are ways to deal with this problem: T<sub>E</sub>X can be limited to the current directory (this is the default in the T<sub>E</sub>X Live distribution [3]), and `chroot` may be used to additionally enforce this restriction. We decided to circumvent the challenge altogether: we do not allow the user to run arbitrary T<sub>E</sub>X files on the server. Instead we create the file from sanitized user input.

Another challenge is caused by the fact that medical pedigrees are used for, well, medical purposes. Laws in the USA and other countries enforce rather strict rules for safeguarding the privacy of medical records. Again, we chose not to implement the infrastructure for storing users’ credentials and compartmentalizing the sensitive data. Instead we require the user to anonymize the patients’ names and agree with the following statement:

I agree to the Terms of Service and certify that my input does not contain individually Identifiable Health Information as defined by HIPAA Privacy Laws in the USA and similar laws of my jurisdiction.

Any attempt to create a pedigree without confirming this statement fails with the gentle reminder to check the box.

### **3 Under the hood: the missing M and the not so silent G**

The setup of the server is very simple. The user input is collected with a spreadsheet-like interface (see <http://www.pedigree.varphi.com/cgi-bin/pedigree.cgi>). The result is fed to the Perl program which uses our library [11] to create a T<sub>E</sub>X file, which is processed by T<sub>E</sub>X/PSTricks program [9].

At this point an astute reader may have realized that a part of the GLAMP system is missing: we do not use MySQL or any other database. This is true: while the program [11] was created with an SQL interface in mind, we do not need it for the pedigrees created with this online tool. However, the letter M still plays a role in our solution.

We output the pedigrees in the format selected by the user: T<sub>E</sub>X, DVI, EPS, PDF, GIF or PNG. However, to lower the load on the server, we decided to create only the files requested by the user. This means that we need to decide which ones to

```

PSTOIMG = pstoimg -density 300 -antialias \
-aaliastext -transparent
%.dvi: %.tex
      latex $<
%.ps: %.dvi
      dvips -T"WIDTH cm, HEIGHT cm" -o $@ $<
%.pdf: %.ps
      ps2pdf $<
%.png: %.ps
      $(PSTOIMG) -type png $<
%.gif: %.ps
      $(PSTOIMG) -type gif $<
.SECONDARY: chart.ps chart.dvi

```

**Figure 1:** Makefile for pedigree creation

generate—or regenerate if the input has been updated. The trusted Unix `make` utility is the best tool for this purpose (and it starts with M!). So our program creates a special `Makefile` in the working directory (Figure 1). Note the special markers `WIDTH` and `HEIGHT`: since `PSTricks` has trouble communicating with `TEX` to tell it the dimensions of the chart, we calculate them separately and give them as options to `dvips`. In this way we can create charts exceeding “standard” paper dimensions.

The `Makefile` in Figure 1 uses the program `pstoimg`. This is actually a wrapper around `Ghostscript`; it is distributed as a part of the `latex2html` package [5]. Therefore the letter G in our version of GLAMP may not be silent after all.

#### 4 Preliminary user survey

To test our program, we used the site <http://www.pedigree.varphi.com> during the classes at Bashkir State Medical University, Russia. There were 33 participants: 20 Russian-speaking fourth year students, 6 English-speaking fourth year students, 7 English-speaking first year students. The first year students were taking a Genetics course, and the fourth year students were taking a Clinical Neurology course. For the first year students this was the first introduction to medical pedigrees, while the fourth year students had some experience with manual creation of pedigrees in earlier courses. All students were asked to create their own pedigrees with our online tool. Additionally, the fourth year students used the tool to create pedigrees of their patients to be included in the patients’ medical chart. The plotting of a patient’s pedigree for the academic medical chart is a standard part of the curriculum for clinical classes. Usually this chart is created manually.

The students were asked to fill a questionnaire about their experiences. Some of their answers are shown in Table 1.

Question	Yes	No	Not Sure
1. Did you manage to create your first pedigree yourself?	83.9%	16.1%	—
2. Do you plan to use this program in your studies?	93.9%	6.1%	—
3. Do you plan to use this program in your future work?	75.8%	3.0%	21.2%
4. Do you like the chart you drew with the program?	100%	—	—

**Table 1:** Questionnaire answers

Class	Number of responses
Biology	27
Genetics	24
Neurology	19
Internal diseases	4
Oncology	3
Obstetrics	3
Psychiatry	2
All clinical subjects	1

**Table 2:** Students’ responses about the classes that can benefit from the use of the pedigree drawing program

The ease of use of the program was assessed by question 1 in Table 1 and by some specific questions. We asked the students how much time it took to create their first pedigree chart. The answers varied from 2 minutes to 40 minutes with the average of 19 minutes. We also asked the students to rate the ease of use of the software on a scale from 0 (impossible) to 10 (no problem at all). The answers varied from 5 to 10 with the average of 8.9.

Those participants who answered affirmatively to question 2 in Table 1 (“Do you plan to use this program in your studies?”) were asked to specify for which disciplines they would like to use the software. It was an open-ended question: the students wrote in the answers. Their responses are summarized in Table 2.

The students were asked the traditional question, what they liked and disliked the most about the software (open-ended questions). Their answers are shown in Table 3. Some of the problems found by the students are corrected in the recent version of the program. For example, it is now possible to save the results and return to the pedigree later.

Feature	Number of responses
<b>What did you like most?</b>	
Easy to use	26
Fast	13
Functionality	12
Free	7
Beautiful results	6
Exact	5
Many output formats	1
Helps in genetic studies	1
<b>What did you dislike most?</b>	
English only	12
Sometimes freezes	3
Cramped text	2
Online only	2
Only genetic relatives are plotted	2
Cannot save the input	2

**Table 3:** Features of the software most liked or disliked by the students

We asked the students to rate their general impression from the software on the scale from 0 (miserable) to 10 (outstanding). The answers varied from 7 to 10 with the average being 8.9.

Some pedigrees created by the students participated in the study are shown in Figure 2.

## 5 Conclusions

T<sub>E</sub>X is a natural typesetting engine in the GLAMP world. Our experience shows that it can be used not only for creating texts, but also for creating graphical materials with charts like those for medical pedigrees. Our web site <http://www.pedigree.varphi.com> demonstrates this point. We were successful in using it for teaching medical students. Our preliminary user survey demonstrates the potential of the online tool for teaching, research, genetic consulting and medical care.

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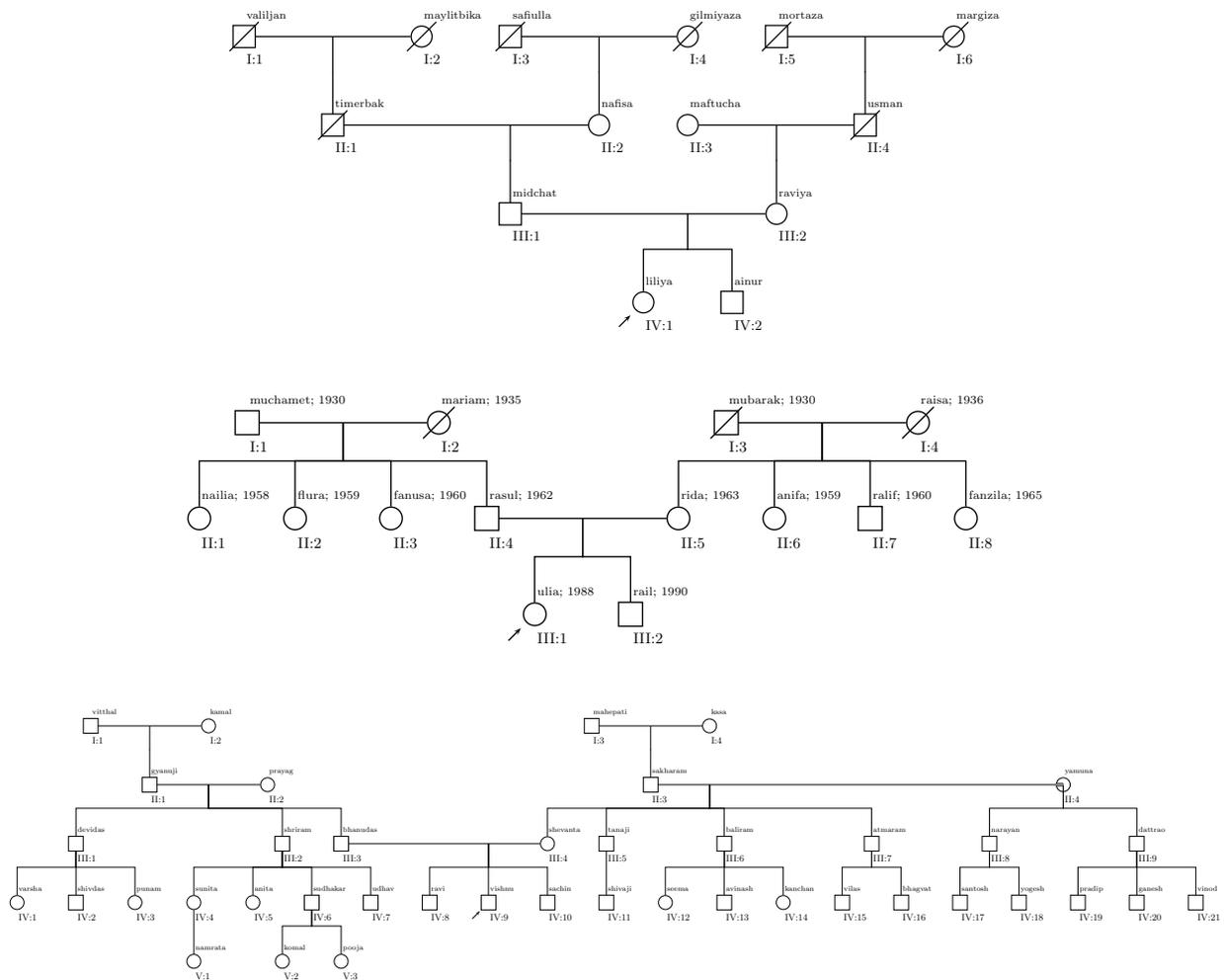


Figure 2: Pedigrees created by students; used with permission

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