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ARTICLE

Wikis in Teaching: An Experiment with WikiHaskell and StatMediaWiki

Manuel Palomo Duarte
manuel.palomo@uca.es

Inmaculada Medina Bulo
inmaculada.medina@uca.es

Emilio José Rodríguez Posada
emiliojose.rodriguez@uca.es

Francisco Palomo Lozano
francisco.palomo@uca.es

Department of Computer Languages and Systems, University of Cadiz

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Abstract

This article presents WikiHaskell, a project based on wiki technologies developed on the Computer Engineering degree course at the University of Cadiz. WikiHaskell is a wiki for which students, organised into groups of three, create complementary materials on Haskell programming language libraries. The main objective of this project is to introduce open knowledge creation into the classroom, thus turning the students into the true protagonists of the course subject. To assess the wiki and, therefore, the work done by the students, StatMediaWiki was developed. This is a statistical analysis system for MediaWiki wikis that allows such assessments to be performed both easily and

transparently. StatMediaWiki generates an overall report of the wiki and individual analyses of the work done by user, by page and by category. In the experiment described, StatMediaWiki's analysis of the time distribution of the students' contributions allowed a range of user profiles to be identified. Likewise, by-category analysis allowed certain situations within a group to be detected, such as the identification of the lead students or the less active ones. Both the wiki content and the StatMediaWiki code are open source and publicly accessible.

Keywords
computer-assisted collaborative learning, wikis, e-learning assessment, open-source software

Wikis en docencia: una experiencia con WikiHaskell y StatMediaWiki

Resumen
En este artículo se presenta WikiHaskell, un proyecto basado en tecnologías wiki que se ha desarrollado en la titulación de Ingeniero en Informática de la Universidad de Cádiz. WikiHaskell es un wiki en el que los alumnos, organizados en grupos de tres, crean material complementario sobre bibliotecas del lenguaje de programación Haskell. El principal objetivo de este proyecto es incorporar al aula la creación de conocimiento libre, de manera que se consiga que los alumnos se conviertan en los verdaderos protagonistas de la asignatura. Para evaluar el wiki y, por tanto, el trabajo realizado por el alumnado se ha desarrollado StatMediaWiki, un sistema de análisis estadístico para wikis MediaWiki que permite hacerlo de manera sencilla y transparente. StatMediaWiki genera un informe general del wiki y análisis individuales del trabajo desarrollado por cada usuario, por cada página y por cada categoría. Gracias al análisis de contribuciones de esta herramienta se han podido identificar varios perfiles de usuario según su distribución temporal en el curso. Del mismo modo, el análisis por categorías facilita la detección de determinadas situaciones dentro de un grupo, como por ejemplo, la ubicación de los alumnos líderes o la de los menos activos. Tanto el contenido del wiki como el código de StatMediaWiki son libres y accesibles públicamente.

Palabras clave
aprendizaje colaborativo asistido por computador, wikis, medición en aprendizaje electrónico, software libre

1. Introduction

Just a few years ago, there was a clear, insurmountable divide between information creators and information consumers. However, Web 2.0 technologies have revolutionised that scheme of things. Among them is the MediaWiki technology (Wikimedia Foundation, 2010), which allows knowledge to be created collaboratively and more simply than ever before: just by pressing a key, it is possible to go from being a straightforward consumer of information to an author of content with a vast potential audience. An excellent example of this is Wikipedia, a project developed by volunteers that has recently led to Microsoft abandoning the commercialisation of its pay-to-use encyclopaedia *Encarta* (20 Minutos, 2010).

On the Computer Engineering degree courses at the University of Cadiz (UCA), several education projects using wiki technologies are being developed (Palomo et al., 2009). Other similar initiatives also exist, such as the one described by Chao et al. (2007), though their level of automation is still somewhat limited (Dodero et al., 2009). This article focuses on WikiHaskell, a wiki developed by the students taking Functional Programming, an optional subject in the fourth/fifth year of the Computer Engineering degree course at the UCA. This project is publicly accessible under an open-source licence (OSLUCA, 2010b) and is supported by the UCA's Open-Source Software and Open Knowledge Office (the Spanish acronym of which is OSLUCA) (OSLUCA, 2010a).

In the context of this project, the students documented Haskell programming language libraries as class work. To assess the wiki and, therefore, the work done by the students, StatMediaWiki was developed. This is statistical analysis software for wikis that is available under an open-source licence (Rodríguez et al., 2010). Version 1.05 of this program offers an overall analysis of the wiki and individual analyses of the work done by user, by page and by category.

The rest of this article is structured as follows: the second section expounds the objectives of the experiment carried out. The third section presents StatMediaWiki, the statistical analysis system developed to assess MediaWiki wikis. The fourth section gives a detailed account of the experiment carried out with WikiHaskell. The final section gives the conclusions drawn from our experiment and lists the reference works used.

2. Objectives

The main objective of this project was to introduce open knowledge creation into the classroom, so that the students could become active participants in the course subject, both inside and outside class (Ebner et al., 2008). To that end, and in randomly selected groups of three, the students created materials that complemented those provided in class for Functional Programming, an optional subject in the fourth/fifth year of the Computer Engineering degree course at the UCA.

This subject introduces functional programming, a paradigm that is new to students, who will have previously studied imperative and object-oriented programming. It involves learning about a new way of approaching and solving problems, which generates general, elegant and easy-to-verify solutions. We believe that the activities contained in the project presented in this article facilitated the acquisition of that new way of approaching and solving problems.

In our experience, this approach fosters the acquisition of certain competencies, such as written expression, self-directed learning, group work and critical analysis, while boosting motivation, which is something that other authors have also found (Wheeler et al., 2008; Cole, 2009). Students get a better understanding of the difficulties involved in writing high-quality technical documentation and lecturers have a valuable tool at their disposal to observe the students' progress and, in particular, to ascertain which course subjects the students find hardest and where any uncertainties or gaps occur in the concepts and techniques that they should be able to master.

Among the competencies developed in this project are:

- **Adaptation to change.** The use of the latest generation technology.
- **Learning.** The students' use of new tools and the assessment of such use.
- **Innovation.** Publication of the knowledge generated. This means that the students' work is not just a class practical. Instead, it is something that can be reviewed and used by their fellow students.
- **Teamwork.** To do their work, the students must reach agreement on what to include in the wiki. In addition, they know that this work may be reviewed by their peers (their fellow students).

Furthermore, we believe that this experiment has several interesting features and certain aspects that have a very positive effect on the dissemination of the actions developed:

- **Knowledge construction.** With wiki technologies, notes in Spanish are created on libraries available in Haskell, thus filling a gap in Spanish-language open resources in this area. In fact, one of the main objectives is that these notes should serve as a complement to the Spanish-language wiki now available on Haskell, which hardly has any content connected with the handling of the many existing libraries that can be used with that programming language.
- **Visibility.** Systems that can be accessed via the Internet are used. This allows the knowledge generated to extend beyond the classroom environment, since it is available anytime to the whole community interested in it (mainly computer engineers in our case).
- **Student collaboration.** After a short period of learning how to use the tools, these technologies allow the students to collaborate in an asynchronous, distributed manner. Every student can work wherever and whenever they want (something that students value highly).

In addition, when working with open-source technologies, it is easy to keep up with the latest advances and results of the project by using specific tools specially designed for that purpose. For this experiment, MediaWiki open-source wiki software and the StatMediaWiki analysis system were used.

3. Analysing wikis with StatMediaWiki

MediaWiki open-source technology is the one currently used by the majority of open-source wikis. It is based on PHP and allows connections to be made with MySQL and PostgreSQL databases. Among the wikis that use MediaWiki are Wikipedia and its sister products (such as Wiktionary, Wikibooks, Wikisource, etc.), for which it was originally designed. This technology was created by Lee Daniel Crocker (Bo & Ward, 2001) and is currently maintained by Wikimedia Foundation employees and some volunteers. Given the dissemination of this project, the interface is totally or partially translated into more than 200 languages (Various authors, 2010a). In addition, as the use of the software becomes more widespread, there are more and more extensions that add new functions to the system, such as Semantic Web features, user access management, etc. (Various authors, 2010b).

Moreover, the open philosophy and the community that develop around the use of this technology have given rise to many studies and to the development of new tools. For example, in his doctoral thesis *Wikipedia: A quantitative analysis* (Ortega, 2009), Felipe Ortega presents an analysis of the 10 biggest versions of Wikipedia. Tools that revert vandalism on MediaWiki also exist (Potthast et al., 2010), such as AVBOT (Rodríguez, 2010), an anti-vandalism system for the Spanish version of Wikipedia that won the "Best Community Project" award at the 3rd Open-Source Software University Competition held in Spain (Various authors, 2010c).

To facilitate the monitoring and assessment of the students' work on WikiHaskell, a statistical analysis tool was developed for MediaWiki-based wikis: StatMediaWiki. This system is available for download free of charge under an open-source licence (Rodríguez et al., 2010). Similar to applications like StatSVN and CVSAnalY (Robles et al., 2004), though adapted to wikis, it allows user activity and generated content progress to be monitored. Likewise, it facilitates the design of metrics to ascertain who contributes to the wiki and to what extent. The use of wikis for assessment and the design of such wikis have been dealt with in recent works (Judd et al., 2010; Wang, 2009), although the approaches taken by De Pedro (2007) and Trentin (2008) are also worthy of note.

The analysis generated by StatMediaWiki 1.05 first of all shows an overall summary of the number of pages, total edits and the number of users and uploaded files. Then it provides detailed information about the wiki's evolution over time, with charts showing the number of bytes added (Fig. 1) and the general activity by time of day and day of the week.

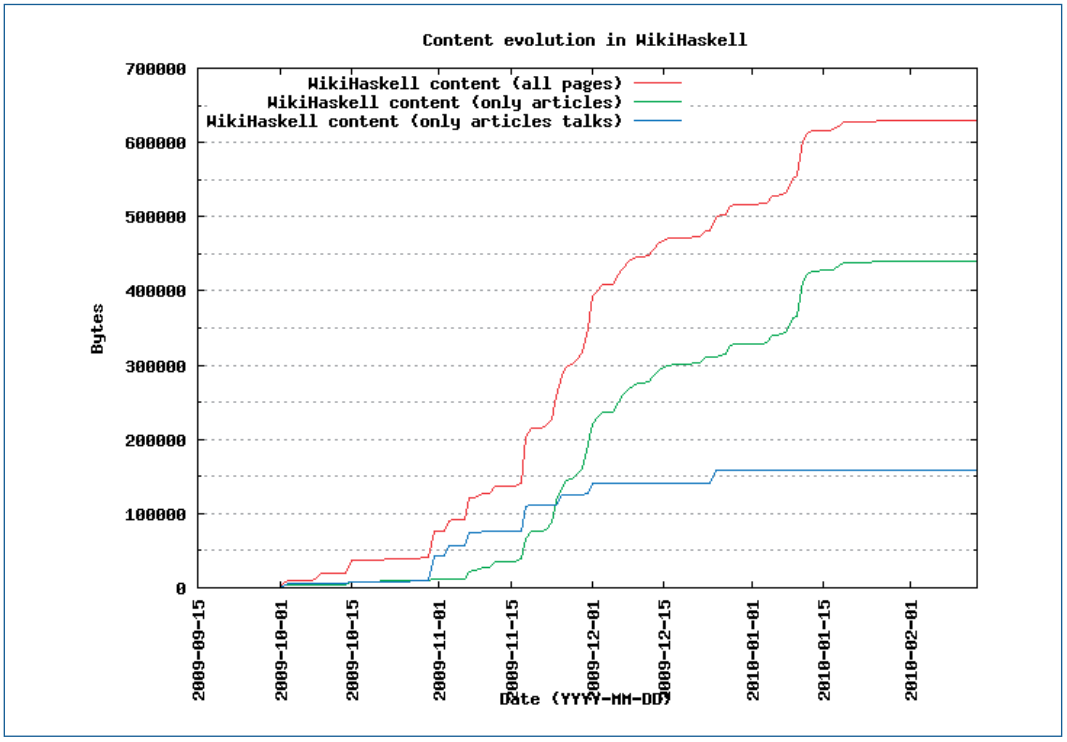

Chart 1. Evolution of WikiHaskell size.

After that, several tables provide a list of users that have worked on the wiki, ordered by changes made, by number of bytes added and by number of files uploaded. A ranking of the most heavily edited pages shows the content that has undergone the most changes and revisions (Table 1). It also shows the number of keywords that have been used most during wiki editing sessions (tag clouds).

In addition, the analysis that the tool provides offers not only an overall view, but also a by-user report where information is broken down by user progress over time, by content added, by the times and days of the week when most work was done, by pages to which changes have been made and by images added to the wiki (in the form of a gallery).

Finally, regarding by-page analysis, a by-page report is shown, similar to the by-user report, where information is broken down by page progress over time, by content added, by the times and days of the week when most work was done, by users that have made the most changes and, finally, the tag cloud. The information shown by pages grouped by category is identical to the latter, though with a ranking of pages belonging to it.

No	User	Total edits	Edits in articles	Bytes added	Bytes added to articles	Files
1	Student 1	175 (11.78%)	87 (7.75%)	209,882 (30.31%)	26,017 (5.51%)	0
2	Student 2	129 (8.68%)	54 (4.81%)	12,668 (1.83%)	8,390 (1.78%)	0
3	Student 3	75 (5.05%)	49 (4.37%)	39,309 (5.68%)	32,997 (6.99%)	1
4	Student 4	63 (4.24%)	54 (4.81%)	28,478 (4.11%)	27,219 (5.76%)	2
5	Student 5	62 (4.17%)	61 (5.44%)	15,185 (2.19%)	14,851 (3.14%)	0
6	Student 6	54 (3.63%)	27 (2.41%)	31,382 (4.53%)	26,789 (5.67%)	0
7	Student 7	51 (3.43%)	41 (3.65%)	19,058 (2.75%)	18,683 (3.96%)	9
8	Student 8	50 (3.36%)	49 (4.37%)	23,145 (3.34%)	23,109 (4.89%)	0
9	Student 9	49 (3.30%)	47 (4.19%)	5,614 (0.81%)	5,525 (1.17%)	0
10	Student 10	38 (2.56%)	37 (3.30%)	11,854 (1.71%)	11,292 (2.39%)	0
	Subtotal	746 (50.20%)	506 (45.10%)	396,575 (57.27%)	194,872 (41.27%)	12

Table 1. WikiHaskell user ranking.

StatMediaWiki was used for the WikiHaskell analysis, as a support for the students' assessments. Fairly good results were obtained and these are detailed in the next section. Given the good results obtained from the application of StatMediaWiki to WikiHaskell, we also believe that it would be interesting to extend its use to other fields, such as the analysis of public wikis or the assessment of competencies (Dodero et al., 2009).

4. WikiHaskell

The WikiHaskell project was developed as part of the university education innovation project for teaching and research staff called "Using Web 2.0 Collaborative Technologies to Foster Student Teamwork" at the UCA (Universidad de Cádiz, 2009).

4.1. Method and development

While the course subject was being taken, the students were subject to continuous assessment in relation to doing and successfully completing the following compulsory tasks and activities:

1. Individual written tests (face-to-face). These accounted for 30% of the final assessment grade.
2. Exercise solving: development of functions (programming exercises, on computers and on paper). These accounted for 25% of the final assessment grade.
3. Doing assignments: developing materials that complement those provided in class on WikiHaskell, and producing critiques and summaries of articles and lectures. Together, these accounted for 35% of the final assessment grade (25% for the development of complementary materials on WikiHaskell).
4. Generating frequently asked questions (FAQs). These FAQs were also for WikiHaskell and accounted for 10% of the final assessment grade.

In order to develop WikiHaskell, the students were divided into randomly selected groups of three to simulate, within our constraints, what would normally happen in real-life work situations: it is necessary to work in groups formed by people with whom an individual cannot normally choose to work.

From the libraries available in Haskell, each group selected one to use for the generation of complementary materials. While taking the course subject, the students generated documentation for the GHC6-Network, the Gtk2Hs chart library, the astar library, HOMMAGE, the IO library, the libSDL library, the gnuplot package, the Cabal packaging library, Haskell unit testing, the HPDF library, the HDBC library, the C Math library and RSA-Haskell.

In addition, each group had to give regular presentations in class to inform the groups about the current status of their work on WikiHaskell, as well as their latest advances and the problems encountered. This allowed each group to find out about the students' opinions on the work techniques used and about their progress on the project. For a positive assessment, it was essential for the members of each group to take turns, thus allowing a different member to give a periodical update.

The following were also essential requirements:

- Systematic attendance at WikiHaskell sessions.
- Individual and group work. Each student had to make individual and group contributions to WikiHaskell, in relation to both the FAQs and the complementary materials.

- Continuous and planned monitoring. Contributions made continuously to WikiHaskell were assessed positively. The aim of this was to encourage students to work continuously and not to leave everything to the last minute.
- Peer review. The students were asked to monitor and review the work done by their fellow students.
- Doing and delivering activities within the deadlines.

Regarding the assessment criteria, account was taken of the following:

- Suitability to the principles of the functional programming paradigm.
- Suitability to standards and specifications.
- Efficiency in the execution of the programs made.
- Organisation, clarity, elegance and accuracy of the solutions presented.
- Participation and engagement.
- Spelling and grammatical accuracy..

4.2. Analysis of WikiHaskell data

In the research carried out, the following analysis was performed on WikiHaskell data:

- User activity: who contributed to the wiki and to what extent, by the changes they made, by the bytes they added and by the number of files they uploaded over time.
- Progress on wiki content: the most heavily edited pages, showing what content underwent the most changes and revisions, the total number of pages generated, edits and uploaded files and images.
- General activity on the wiki by time of day and day of the week.
- The keywords that were used most during wiki editing sessions (tag clouds).

The whole analysis was performed using StatMediaWiki, which automatically provided the results presented in the next section. The data used were those obtained from October 2009 to February 2010, which was the period when the Functional Programming subject was imparted.

StatMediaWiki was used while the subject was being taken, and not just to obtain the final results at the end of the course. These data are presented further below. This allowed the progress of the wiki and of the students to be monitored in some detail, and corrective actions to be taken to ensure that both the course subject and the experiment ran smoothly.

4.3 Results

This project was developed in the first semester of the 2009/2010 academic year. The results were very positive. Despite the significant number of students (46 to be precise, of whom 40 became involved in the project), all of them performed at a fairly high level, especially in relation to their work on WikiHaskell. In fact, of the initial 46 students, the 40 who became involved in the project passed (four did not attend and two failed).

By applying StatMediaWiki, the charts obtained show a total of 1,486 changes (a total of 695,745 bytes), 1,122 of which were made on 44 pages (the rest were mainly on Haskell library discussion pages). The percentages indicate that each student made a mean of just over 32 contributions to the wiki (a total of 15,124 bytes per student). It is interesting to note that the 10 most active students (just over 20% of the total students in the class) together made around 50% of the total contributions to the wiki, which shows that, in general terms, participation was fairly well distributed (StatMediaWiki, 2009).

In addition, the charts generated by StatMediaWiki allowed five student profiles to be identified:

- *Continuous* profile: we consider this to be the optimum profile. The student makes continuous contributions throughout the course of the work. Only three students matched this profile (the student in Chart 2 for example).
- *Stepped* profile: this profile is also good. The student makes continuous contributions, albeit intermittently. Sixteen students matched this profile (the student in Chart 3 for example).
- *Early peak* profile: this is the abandonment profile. Students made contributions at the beginning but then abandoned the work and gave up the subject. Only four students matched this profile (the student in Chart 4 for example).
- *Middle peak* profile: similar to the stepped profile in terms of numbers. Seventeen students – the highest number – matched this profile. In this case, most of the work is done halfway through (the student in Chart 5 for example).
- *Late peak* profile: this is the profile of the student who leaves everything to the last minute. Only six students matched this profile.

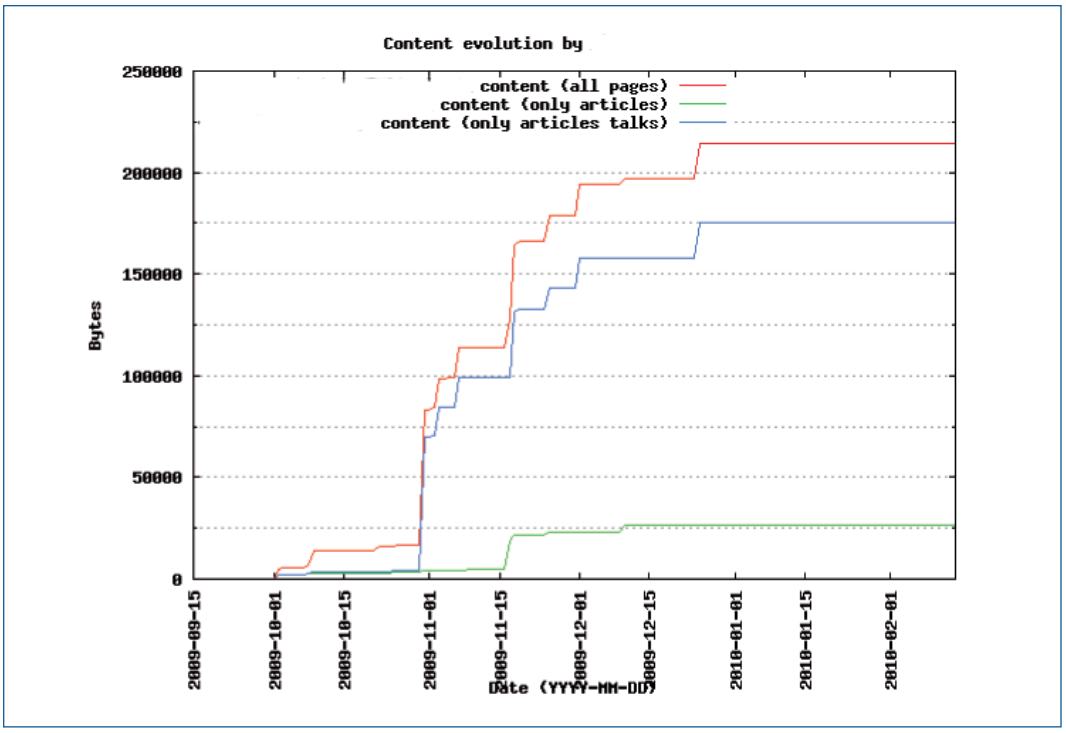

Chart 2. Example of a continuous profile.

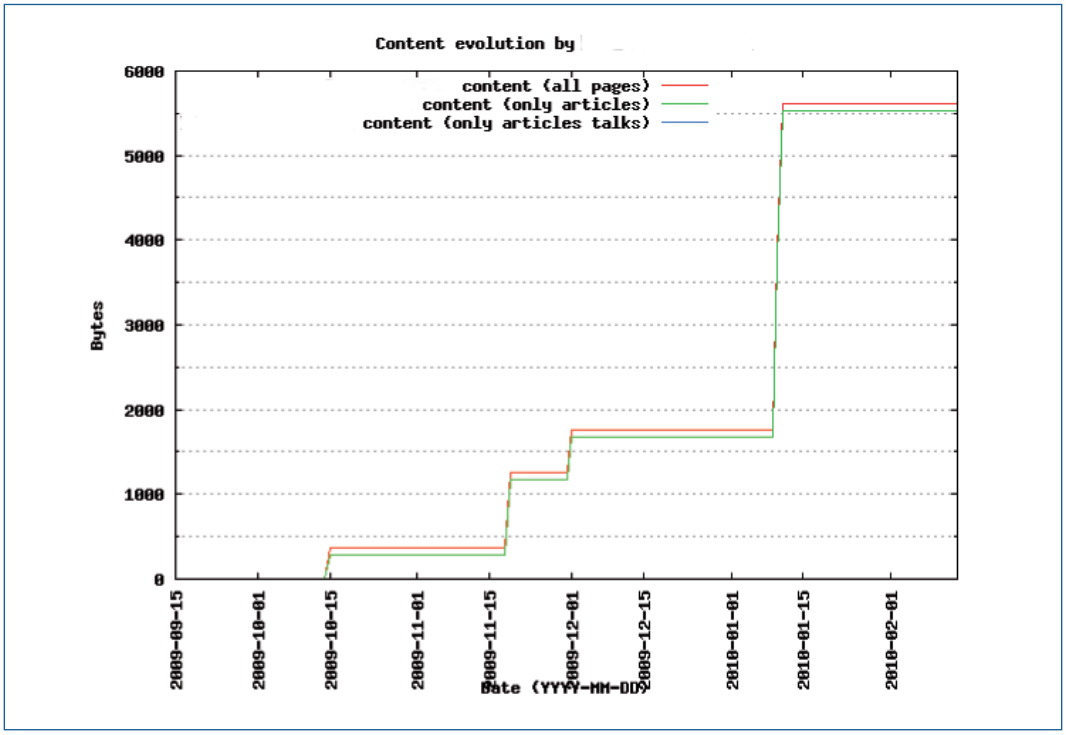

Chart 3. Example of a stepped profile.

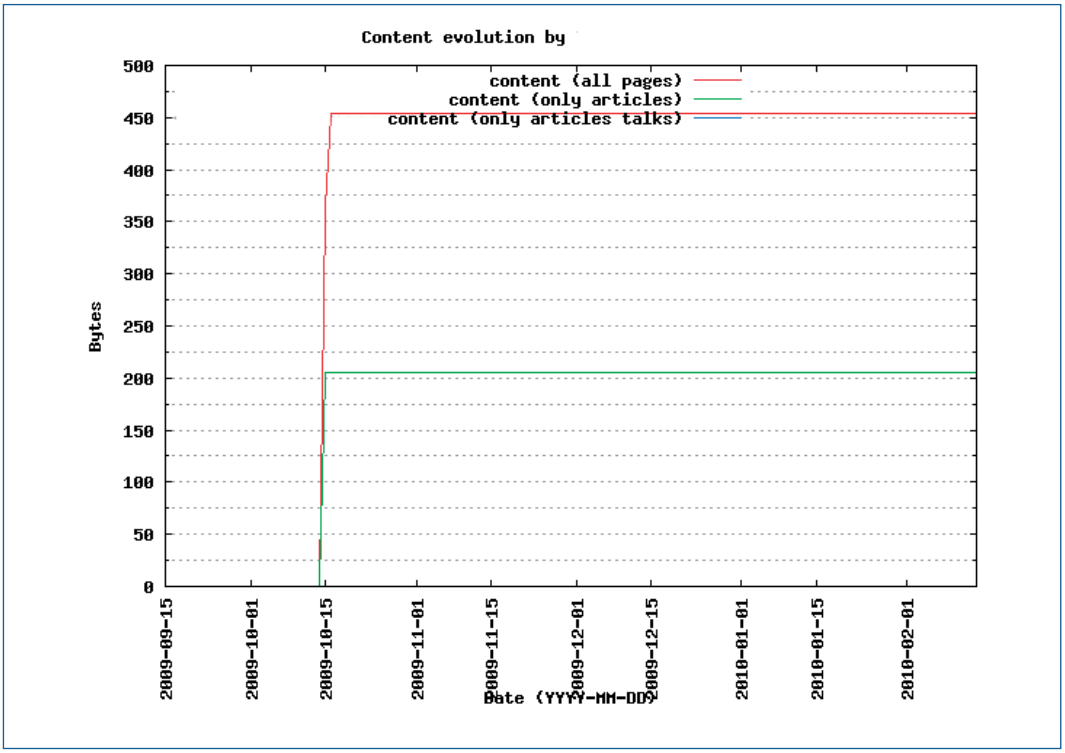

Chart 4. Example of an early peak profile.

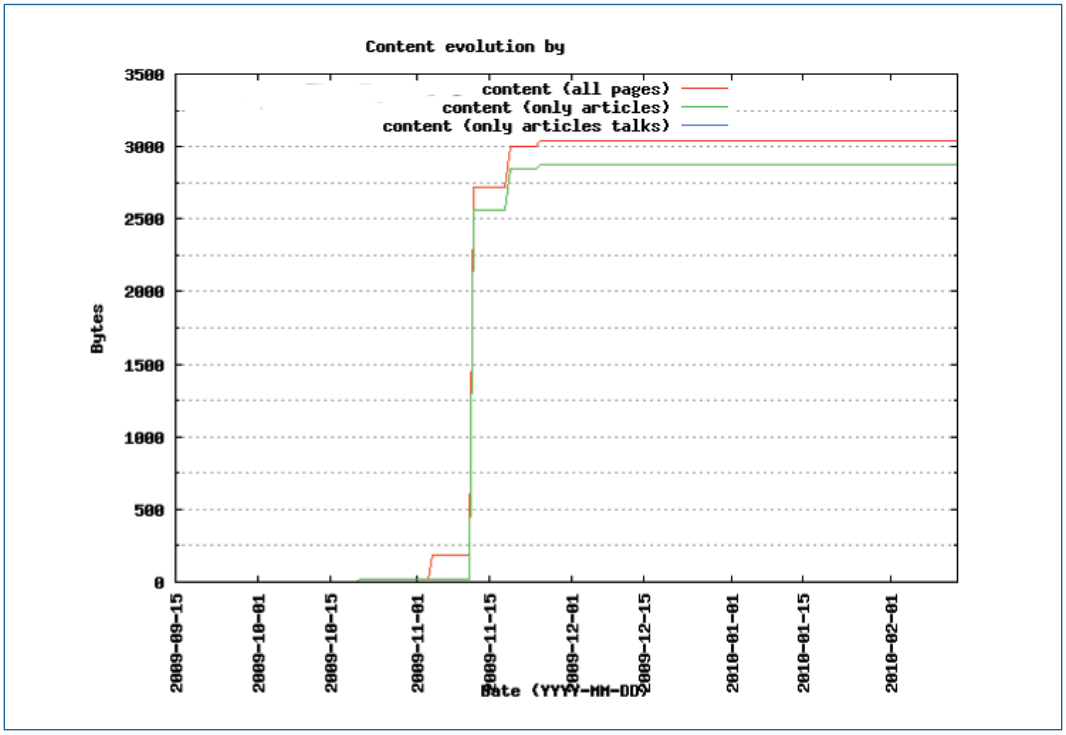

Chart 5. Example of a middle peak profile.

In addition, data were obtained for the times and days of the week when most work was done. Generally speaking, the students worked most midweek, with hardly any contributions at weekends. The times when students worked varied considerably, though they usually worked in the morning (obviously, because their face-to-face lectures were in the afternoon).

Given that this activity was assessed in class and that it counted towards the final grade, the wiki only allowed students taking this course subject to make changes. However, the content was publicly accessible in Medina.

An anonymous survey of the students was carried out on completion of the course subject. Twenty-four students responded and the following results were obtained (Table 2). The scale used was from 0 (Low) to 5 (High):

Question	*Mean*
Opinion on the use of the publicly accessible open-source wiki in teaching	4.5
Method and development of work on the wiki (groups of three students, organisation and revisions, etc.)	3.83
Difficulty using the wiki	2.54
Weight of work on the wiki in the final grade for the course subject	3.67
Overall assessment of the course subject	4.13

Table 2. End-of-course survey.

As shown, the students' satisfaction with the use of the publicly accessible open-source wiki in teaching was very high (4.5 on a scale from 0 to 5). In fact, they remained motivated and engaged in the project throughout the course of the experiment. In terms of the method and development of work on the wiki, the students were also satisfied, though at times they felt the additional workload was excessive. Using the wiki did not present any difficulties for most of the students, though a small group of them did have problems to begin with due to a lack of familiarity with this technology. Regarding the weight of work on the wiki in the final grade for the course subject, most of the students agreed with it. Finally, the overall assessment of the course subject was very positive (4.13 on a scale from 0 to 5).

In addition, in the satisfaction survey carried out by the UCA's quality unit, the course subject obtained a score of 4.2 on a scale from 0 to 5, positioning it above the mean obtained for the department's course subjects, for the degree course and for the university.

4.4. By-category analysis

Since the experiment, StatMediaWiki has been extended to include by-category analysis, a feature that users of version 1.05 desired (Rodríguez et al., 2010). Analysis by page groups is therefore facilitated. Such pages groups will form part of the student group's projects next year.

In MediaWiki, a category is a group of related articles on the same topic. An article can form part of as many categories as is considered appropriate. For example, an entry in Wikipedia on "primary education" can be included in the *child education* and *Spanish education system* categories. Likewise, a category can form part of other categories, thus becoming one of their subcategories. Continuing with the same example, *Spanish education system* can become a subcategory of *European education systems*.

By-category reports allow the work done by a user group on a set of the wiki's pages to be followed in accordance with the interrelated nature of the information. In particular, these reports begin with various statistics on the category: number of pages, number of edits, number of users taking part in them, number of bytes, etc. Then the same content and activity evolution charts as those in a normal page report are included, but this time aggregating information from all of the category's pages. Finally, lists appear for the most active users and for the most visited pages, as well as the tag cloud.

In WikiHaskell, each student group had to work on a specific topic of functional programming. Consequently, they were able to divide their work into different pages of the wiki, all of which belonged to the same category. Their work can therefore be analysed more easily by using StatMediaWiki by-category charts. Specifically, five of the 14 groups divided their work into more than one page.

Among other things, the use of StatMediaWiki's by-category analysis helps to identify the leaders of each group. For example, this is shown clearly in the content evolution charts for the various students of the *libSDL* category (Chart 6). Chart 7 shows the evolution of content generated by its leader. When compared with the other two members of the group (Charts 8 and 9), it is possible to see that the leader started working before the other two. On the vertical axis of the charts (or on the classification of users in the category), what is noticeable is that the total amount of bytes of the leader's contributions is greater than the other contributors'.

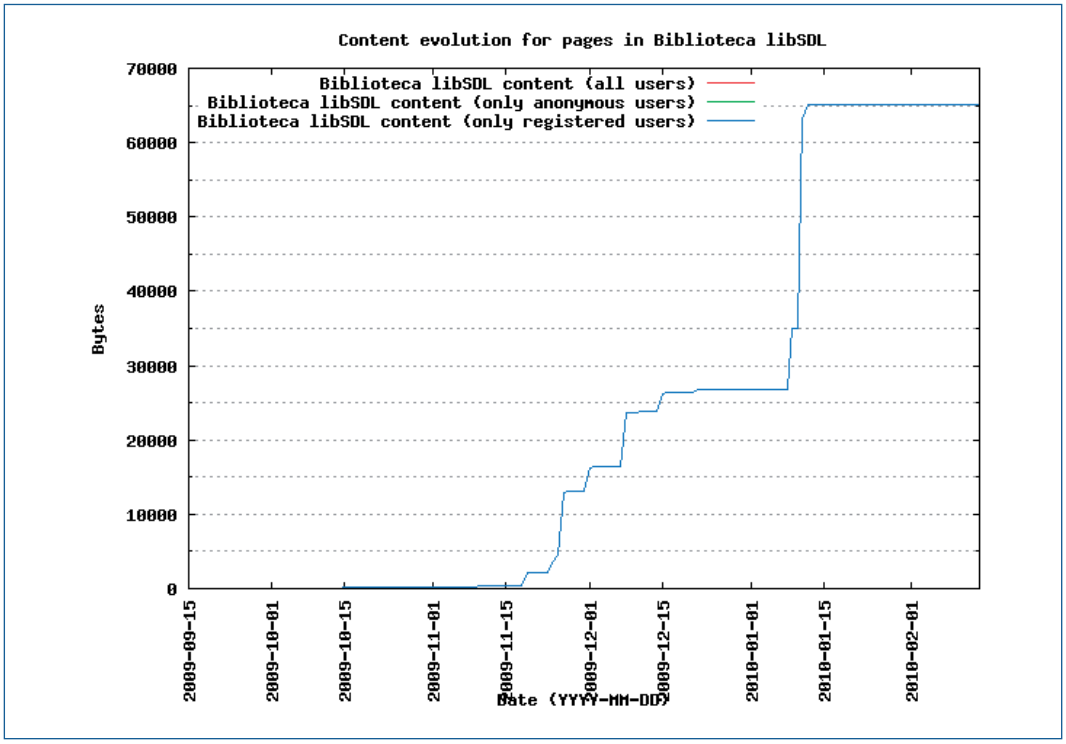

Chart 6. Content evolution of the libSDL category.

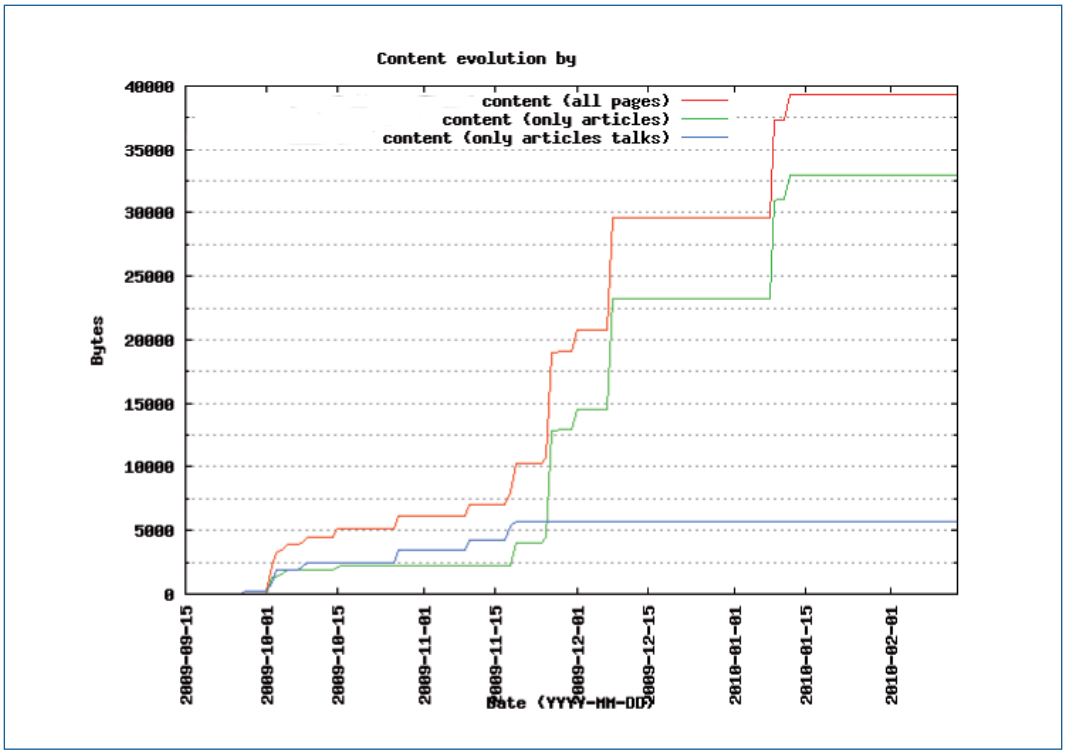

Chart 7. Evolution of content generated by the leader.

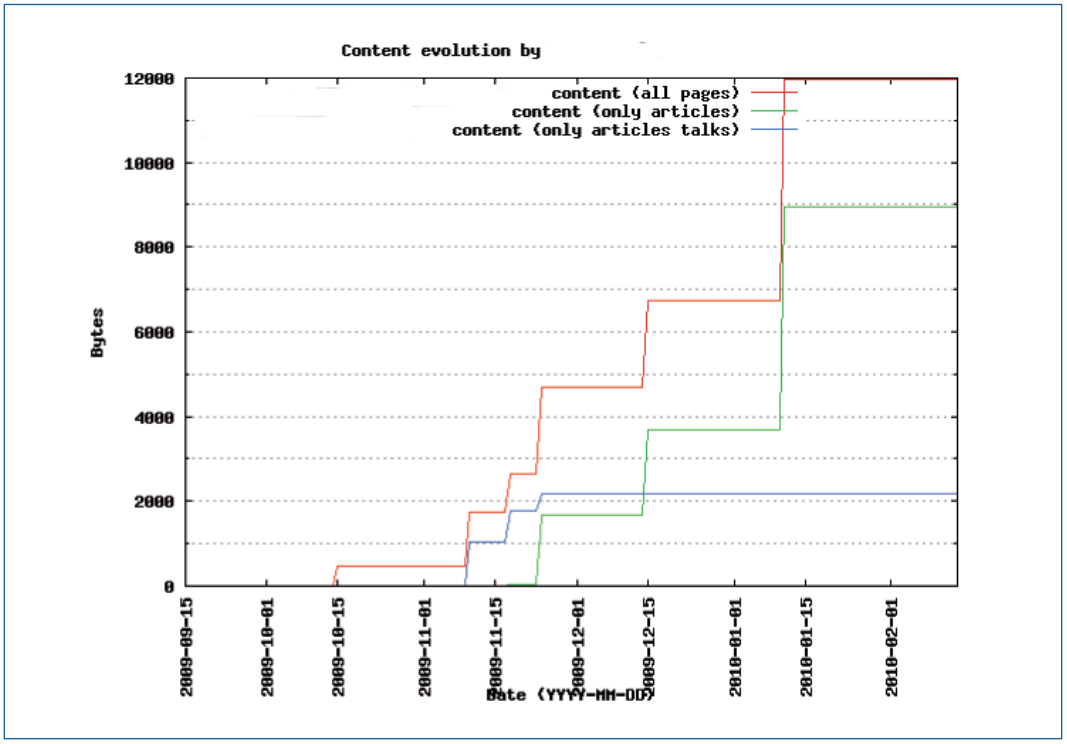

Chart 8. Evolution of content generated by user 1.

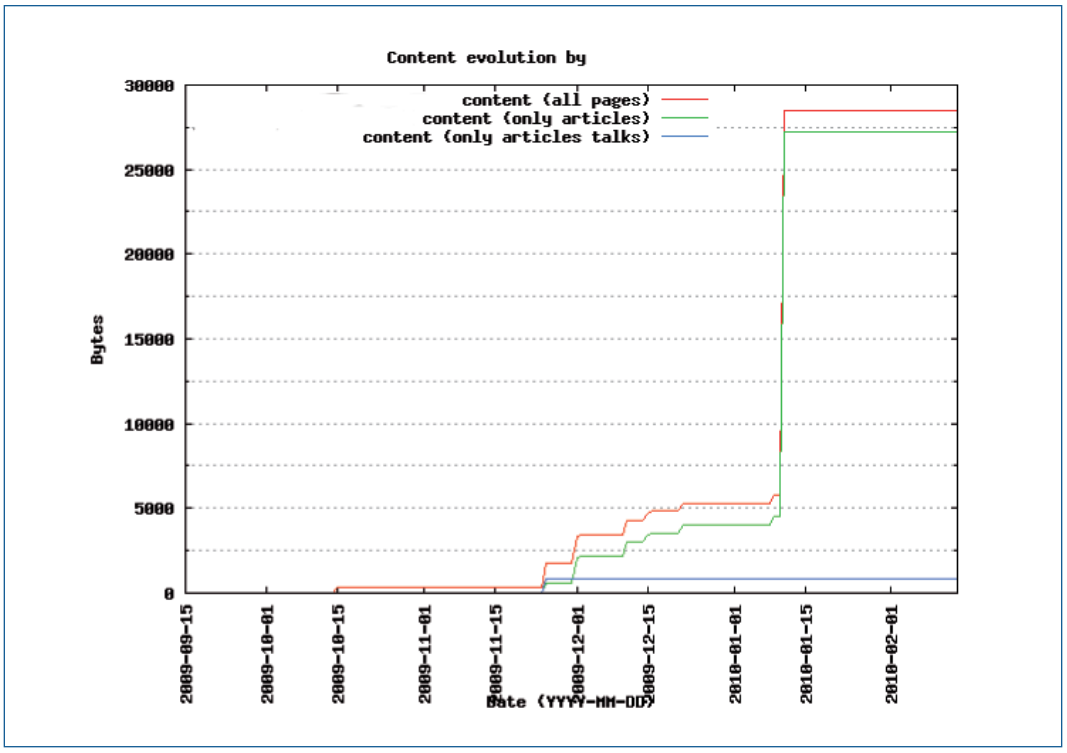

Chart 9. Evolution of content generated by user 2.

Given that MediaWiki software does not store the pages that have belonged to a category over time, the report is generated with the pages currently belonging to each category. This may lead one to think that a student could falsify the data for a group's effort by adding pages to its category. However, while it is true that the size of a category's content significantly increases if an average-sized page is added to that category, it is also true that the authors' contributions to the bigger category proportionately decrease as a percentage. That said, it should be pointed out that such a situation did not occur during this experiment.

5. Conclusions and future work

This article has presented WikiHaskell, a project based on wiki technologies and developed in the Functional programming subject on the Computer Engineering degree course at the UCA. Although the experiment focused on computer engineering, we believe that the initiative could be adapted to other branches of knowledge, as discussed at the 2009 Open Knowledge and Web 2.0 Conference organised by OSLUCA at the Cadiz Engineering School (OSLUCA, 2009).

Our experiment showed that these technologies help to identify problems in the students' learning, in group work, etc. Thanks to the use of an automatic tool like StatMediaWiki, many repetitive tasks are avoided while light is thrown on the work done by the students, thus allowing them to be assessed both easily and transparently. By using it, we were able to identify several student profiles related to the work they did while taking the course subject. By cross-matching this information with data on their academic performance, in upcoming academic years we will be able to identify which students are prone to giving up the course subject, thus allowing us to focus our efforts on them. Similarly, other interesting data are obtained, such as the times and days of the week that students work most, the distribution of work by student or by page (individual or aggregated by category), etc.

In general, students are very happy to participate in initiatives of this type, where they are the protagonists (Álvarez et al., 2009; Recio-Quijano et al., 2010). By using straightforward, convenient technologies and establishing a work system that is flexible yet forces students to be accountable, we believe that their engagement, satisfaction and academic performance can be very high.

On the Computer Engineering degree courses at the UCA, several education projects using wiki technologies are being developed (Palomo et al., 2010). The use of wikis for assessment and the design of such wikis have been dealt with in earlier works (De Pedro, 2007; Trentin, 2008). However, while other similar initiatives exist (Judd et al., 2010; Wang, 2009), and not just in technical teaching (Chao et al., 2007; Various authors, 2009a; Various authors, 2009b), their level of automation is still somewhat limited (Dodero et al., 2009). The Wikimedia Foundation itself is developing (2010/2011) a programme to get university students in the United States to improve Wikipedia articles in English as part of the curriculum, though it is still too early to draw any conclusions from the preliminary results (Various authors, 2011).

Finally, we would underscore the importance of this type of initiative in terms of making high-quality documentation in Spanish freely available to the Spanish-speaking WikiHaskell community.

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About the Authors

Manuel Palomo Duarte
manuel.palomo@uca.es
Department of Computer Languages and Systems, University of Cadiz

Manuel Palomo Duarte holds a qualification as a Computer Engineer awarded by the University of Seville. He currently works as a lecturer in the Department of Computer Languages and Systems at the University of Cadiz (UCA). His teaching focuses on subjects related to operating systems and video game design. As a member of several education innovation projects, his particular interest is the use of collaborative technologies and video games for educational purposes, especially in the field of Computer Engineering. He is the director of the Open-Source Software and Open Knowledge Office at the UCA. His objectives include studying and fostering the implementation of open-source solutions in higher education in particular and in society in general. He is a member of the "Improving the Software Process and Formal Methods" research group, in which he did his doctoral thesis on web service composition testing with WS-BPEL using invariants.

http://neptuno.uca.es/~mpalomo

Inmaculada Medina Bulo
inmaculada.medina@uca.es
Department of Computer Languages and Systems, University of Cadiz

Inmaculada Medina Bulo is the holder of a doctorate in Computer Science awarded by the University of Seville. She currently works as a lecturer in the Department of Computer Languages and Systems at the University of Cadiz (UCA). Her teaching focuses on subjects related to programming and algorithm design and analysis. As a member of several education innovation projects, her particular interest is the use of collaborative technologies for educational purposes, especially in the field of Computer Engineering. She is the coordinator of the Computer Engineering degree course at the UCA. Her objectives include studying and fostering the implementation of open-source solutions in higher education in particular and in society in general. She is a member of the UCASE Software Engineering research group. Her main lines of research are software verification and validation, model-driven methodologies and service-oriented architectures. She has supervised and is supervising doctoral theses on web service composition testing with WS-BPEL using dynamic invariant generation and mutation testing.

http://neptuno.uca.es/~imedina

Emilio José Rodríguez Posada
emiliojose.rodriguez@uca.es
Department of Computer Languages and Systems, University of Cadiz

Emilio José Rodríguez Posada holds a qualification as a Technical Engineer in Computer Systems awarded by the University of Cadiz (UCA), where he is currently taking Computer Engineering and is a collaborating student. He was a grantholder in the Open-Source Software Office and has collaborated on the organisation of various open-source software conferences held at the UCA. His work focuses on open culture, and he has participated as an editor in various wiki projects, such as Wikipedia, and developed tools for them, such as the AVBOT anti-vandalism bot, which won the "Best Community Project" award at the 3rd Open-Source Software University Competition held in Spain. He is now collaborating as a developer of StatMediaWiki, a statistical analysis tool for wikis.

http://osl.uca.es

Francisco Palomo Lozano
francisco.palomo@uca.es
Department of Computer Languages and Systems, University of Cadiz

Francisco Palomo Lozano holds a degree in Computer Science awarded by the University of Seville and is a lecturer in Computer Engineering in the Department of Computer Languages and Systems at the University of Cadiz (UCA). His teaching focuses on subjects related to algorithm engineering and logical reasoning automation. As a participant in several education innovation projects, his particular interest is the improvement of learning techniques in Computer Engineering. His research interests include automated reasoning and software verification.

http://neptuno.uca.es/~palomo/

Universidad de Cádiz
Escuela Superior de Ingeniería
C/ Chile, n.º 1.
11002 Cádiz
Spain

UOC
Universitat Oberta de Catalunya