

Intensive Programmes in Functional Programming

- Extended abstract -

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In this paper we present the advantages and experiences of the Central European Functional Programming summer school series. The two weeks intensive programmes offers courses on specific topics of functional programming. The summer school series provided several benefits for the participants. Here we describe the structure of the intensive programme, the challenges, experiences, advantages of the school series. We also provide the teaching methodology applied, tutorial topics, case studies of interesting functional programming lab exercises.

1 Introduction

Nowadays the information society needs reliable, maintainable, manageable software. Functional programming languages represent modern tools for designing and implementing software which meet the high requirements.

In 2005 we introduced the intensive programmes called Central European Functional Programming School (CEFP). CEFP is an advanced summer school series in selected topics of functional programming, it is the Central European counterpart of the Advanced Functional Programming schools. CEFP has as additional goal to stimulate students from Central Europe to attend by choosing a location accordingly. The school was organized every two years.

The goals of the CEFP summer school are defined as:

- Bringing together computer scientists, in particular young researchers (PhD students), and make them familiar with the latest functional programming techniques.
- Show the use of advanced functional programming techniques in real world applications.
- Bridge the gap between recent results presented at programming conferences and material from introductory textbooks on functional programming.

The main approaches taken to achieve these goals in the schools are also defined:

- In depth lectures about a selected number of advanced functional programming techniques that emerged or established recently. The lectures are taught by experts in the field that actively contribute to research and application of the techniques.
- Lectures are accompanied by practical exercises to be solved by the students at the school. These exercises guide the students' learning to a great extent.
- Group work is stimulated, such that the students can also learn from each other.

There are several advantages for the lecturers too. It is very stimulating to give a lecture for an international community of interested PhD students. There are a reasonable amount of pages available

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for your lecture notes (max 80 pages) such that the lecturer have a unique opportunity to explain their research topic in all details. The draft version of the lecture notes should be available two weeks before the start of the summer school and it is used as course material. The final version is committed after the event and it is reviewed to ensure that the quality meets international standards. The revised lecture notes are published by Springer after the school.

The first and the third Central European Functional Programming School was organized as Erasmus Intensive Programme, therefore no participation fee was applied for students. The Erasmus IP covered most of the travel, accommodation and subsistence costs of the participants and lecturers arriving from partner institutions listed in the application. Also CEEPUS supported the CEFPP series, with many participants from the university network formed in the framework of the CEEPUS exchange programme of universities. The CEEPUS network supporting these schools was the winner of the CEEPUS Minister's Prize of Excellence in 2004 and in 2007.

The CEFPP school series were sponsored by software companies too, which need skilled, highly qualified software engineers. Top experts of industrial partners were involved as invited lecturers. Researchers of Microsoft Research, Ericsson, Erlang Solutions, Intellifactory, Quvick A.B., Morgen Stanley have presented state-of-the-art software technologies.

The selected revised lectures of the summer schools were published by Springer in LNCS series (see the volumes' details in [1, 2, 3, 4]).

More than 200 Central European students completed these summer schools successfully. The web-pages related to the schools can be found at:

- CEFPP 2005, Budapest (Hungary): <http://plc.inf.elte.hu/cefp/cefp2005/>
- CEFPP 2007, Cluj-Napoca (Romania): <http://cs.ubbcluj.ro/cefp2007/>
- CEFPP 2009, Budapest and Komárno (Slovakia): http://www.inf.elte.hu/english/conf/TFP_cefp_2009/Lapok/index.aspx
- CEFPP 2011, Budapest (Hungary): <http://plc.inf.elte.hu/cefp/>

2 The structure of the summer schools

The intensive programme consists of two weeks activities, daily with eight lecture hours. Every day there is a four hours lecture session and a four hours lab session. Additionally, we included warm-up tutorials and a PhD workshop providing a forum for the participating PhD students. Students can present their ideas and get feed-back and expertise from the researchers and professors. Postgraduate students prepare extended abstracts about their current research work. The ratio of teaching staff (including pre-, post-doctorates and assistants) to Bachelor and Master students is 1:4.

The whole summer school consist of 80 contact hours plus 40 hours independent study. This corresponds to 4 ECTS credits. Since we are using ECTS, students can have their studies recognized at their home universities. A website which serves as a background of the summer school is built.

The summer schools are focusing on specific topics of functional programming with lectures on specialized fields of the functional programming paradigm covering new, state-of-the-art knowledge not existing in the curricula of the participating institutions. The school offers a different course material from the regular university curricula by providing directly applicable teaching materials, while there is a high demand from industrial side too.

Teaching and training materials are produced for each topic. The materials are created by the invited professors and top experts. The tutorial for each course contains about 150 slides. A booklet of approxi-

mately 50 pages long is provided for each lecture with additional lab exercises. Based on these materials we also created interactive web-based exercises. The exercises and the slides of the presentations are freely available on the web page of the summer school for everyone interested in the tutorials of the school.

A lab session is held for each tutorial containing 5 or 6 exercises related to the topic of the lecture. At the end of the school the achievements of the participants are evaluated according to what they accomplished at the lab sessions. The students' assessment is determined according to the number of exercises solved.

We developed new methods for checking solutions of the lab exercises, programming codes. A web server is testing automatically the solutions uploaded by the attendants of the warm-up sessions. The exercises of the lab sessions are checked by the tutor students. We disseminate the innovative teaching practices and we apply them at regular courses too. The materials are used later for curriculum developments at graduate and postgraduate levels and for the renewal of some existing courses.

The revised text of the lectures are published as a volume of the Lecture Notes in Computer Science at Springer. The abstracts of the PhD presentations are also available on the web. The quality of the output materials are assured by peer reviewing.

The schools encouraged PhD students in their research by giving possibility to present their work and get feed-back from researchers/professors. The practical courses enable to experience the newly acquired state-of-the art knowledge. The intensive programmes offer a good opportunity to exchange ideas, to discuss solutions to the programming problems, to sparkle new research problems.

3 Challenges and experiences

The knowledge level and the skills of the participants are very different. Therefore is a high challenge to build the courses and related materials in a way that every participant should be involved actively in the sessions. The lectures that give brief and relevant introduction of specific notions, describe in details the main topics and provide differentiate exercises with instructions for individual learning and practising proved to be the most popular courses.

The specialized topics of the tutorials of the summer school can be attractive on very different levels for subgroups of PhD students, depending on their actual research work, studying motivation. However, this aspect can be also a positive approach for the knowledge base enlargement and commitment for further deeper research questions.

A good topic selection for the summer school highly depends on the state-of-the-art of the researches carried out by the functional programming communities at international level. It also depends on the demands of the software industry. For example, in 2011 the multicore functional programming was the most intensively researched field, so it was straightforward to choose the main topic of the summer school.

The lecture and lab session alteration was proved to be an adequate methodology for presenting a topic. A good tutorial, with topics of potential interest to the advanced functional programming school attendees, always needed a lab session too for practicing. The system of local PhD students tutors at labs assisting the lecturer in directing the students (in average 60 participating students) has been worked dynamically and successfully during the schools.

The motivation of students for studying several specific topics during a two weeks period is also very variable. The exercises always need to add small programming tricks to involve as many students as possible.

The statistics of correctly solved exercises offers a good measurement of problems' adequacy. A good presentation of key elements of a topic has been proved to be more important than the students' knowledge background at the beginning of the school (for example, minimalist skeletons used in distributed programming were more useful in testing high level coordination primitives).

The revised lecture notes preparation is also challenging for presenters. However, the discussions and interactions during the school highly improve the original draft lecture notes. According to Springer statistics, since its online publication on Jan 04, 2011, Central European Functional Programming School has received a total of 554 chapter download requests. Over the last year(s) the download figures have been as follows: 2011-453, 2010-101. The electronic version offers a broader readership for the revised notes.

4 Advantages and continuations

The aims of this summer school series is to continue to propagate functional programming paradigm in education, in high-quality software development, and to acquire the newest specific topics in this field.

The summer school inspires more students to apply for mobility grants to visit university and industrial partners (e.g. joint Master and PhD programmes, research projects, internships at industrial partners).

Cooperation between the partner institutions is developed since the series started. The increased number of participating institutes and the wide spectrum of specific fields of functional programming contributed to curricula development by creating teaching materials in recently researched fields of informatics.

Based on the lectures of the summer school, new courses are started in co-operation with the invited lecturers. Several new PhD and Master Thesis topics can be offered to the students with joint supervision of them. Students participants at schools are joining research activities and publishing thesis at student conferences.

There is an increasing demand on education and industrial application of specific programming languages and paradigms. Due to rapid technological changes, new curricula development and industrial cooperations are inevitable in this domain.

The school series encourages the discussion for common projects too. Based on the successful cooperation in organizing the intensive programme, Ericsson Hungary, Morgan Stanley Hungary and Ericsson Software Research started innovative R&D projects related to industrial application of the schools' materials. These projects are integrated into the curricula as master courses involving about 30 master and PhD students - including Erasmus and CEEPUS exchange students.

The direct learning outcomes of the project are highly qualified skills gained by the PhD and graduate students, and by university lecturers in the field of functional programming. Graduate students are able to develop high-quality software, while the software industry gets skilled engineers.

5 Conclusions and further work

We have presented the advantages and experiences of the Central European Functional Programming summer school series. The summer school series has several benefits for students and lecturers. Here we described the structure of the intensive programmes, the challenges encountered, the advantages for participants, the applied teaching methodology. In the final paper we also intend to describe the tutorials' topics, some case studies of interesting functional programming lab exercises.

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