The Vienna PhD School of Informatics

Design, Implementation and Experiences

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Abstract. Doctoral education is one of the main contributors to scientific development through the training of new generations of scientists. In this context the traditional European individual doctoral study program is questioned as being appropriate to meet the challenges of research training in a competitive market. As a consequence one can observe a tendency towards structured programs with doctoral candidates grouped in doctoral schools. This paper presents the Vienna PhD School of Informatics, following such a structured approach and with a clear focus on scientific research. The paper also provides a short overview about different approaches applied world-wide, and presents an evaluation framework together with first evaluation results.

1. Introduction

Doctoral education can be considered as a cornerstone of a University's scientific research. This is also recognized by the different national and international organizations such as the European University Association (EUA). EUA even considers doctoral training as one of the most crucial activities to reach the ambitious Lisbon objectives. However, EUA questions the traditional individual doctoral study programs as being appropriate to meet the new multiple challenges of research training for careers in a competitive market [1].

This paper presents the Vienna PhD School of Informatics, a doctoral initiative with a structured curriculum and a clear focus on scientific research. After discussing related initiatives in the next section, we give an overview of the design and implementation of our doctoral school in section 3. The following two sections show our approach to evaluate our program and some first experiences.

2. PhD Education Worldwide – An Overview

In this section we give a short overview of the different doctoral approaches in Computer Science (CS) worldwide. More detailed information can be found in our report on PhD programs [2], based on 17 doctoral initiatives around the world. One lesson to be drawn is that there does not exist a PhD education per se, the programs differ between and within countries, and even within Universities, sometimes operating different forms at the same time. While this is true for the structure and organization, it can also be said with respect to the focus of the doctoral training (scientific vs. industry applied), the duration (from 3 to 6 years) or funding.

2.1. Europe

The European doctoral landscape is quite diverse. Most European universities follow the so-called Master-apprentice model. It is a single-supervised approach based on a rather close relationship between supervisor and PhD candidate. However, in the last years one can observe a tendency towards structured programs with doctoral candidates grouped in doctoral schools. Their formats resemble the Anglo-American doctorate [3]. Such doctoral colleges set clear rules for the application and selection of new candidates, and have structured curricula with general and subject-related courses and milestones, all under continuous supervision [4]. They, however, do not follow only one organizational model. They are run either at institutional level as mono-disciplinary or multidisciplinary graduate schools, or closely connected to departments, research groups, and other research milieus.

2.2. United States

Doctoral education in American universities is generally provided by dedicated institutional structures, called graduate schools. These are mainly decentralized units in the departments of doctoral-granting universities. Their Implementation of the Anglo-American model has a minimum duration of 4 years. The curriculum includes courses in the major and minor areas and has a strong emphasis on the acquisition of transferable skills and teaching experience. Their milestone process includes a preliminary exam and the Qualifying Exam, which respectively assess technical background and research capability. The process finishes with a dissertation defense.

2.3. Asia

Asia is very diverse in terms of socioeconomic, cultural and political contexts, which is reflected in the development of doctoral education. Singapore, Japan and China are examples of countries, where doctoral education programs are developed through large public investments in research and development.

Singaporean universities have partnered with prestigious foreign universities for the establishment of local campuses increasing their research productivity and setting their universities in a competitive position. Their doctoral programs resemble the ones offered in U.S.

Japanese academic institutions collaborate intensely with public and private non-academic institutions, using doctoral program as a means for such a co-operation. Japanese doctoral programs' curricula are not structured nor include a milestone process. Candidates are only required to complete a number of courses and pass the thesis evaluation.

China, the world's second biggest provider of doctoral education after U.S, concentrates almost a third of its doctorate programs in engineering and technology. The doctoral model at top Chinese universities consists of a structured curriculum that includes soft-skills and doctoral courses in different research areas. Students undergo a qualifying exam to assess their understanding of the state-of-the-art as well as their ability to conduct research. Internships are also offered to provide students with an extensive industrial exposure and to satisfy the demand for a competent workforce in China's economic growth.

3. Design and Implementation of the Vienna PhD School of Informatics

The Vienna PhD School of Informatics has a clear focus on scientific research and pursues the following objectives: i) to increase both the quality and the quantity of excellent young researchers in the field of informatics; and ii) to position the Faculty of Computer Science of the Vienna University of Technology at a high level of excellence. The PhD School runs parallel to the traditional doctoral program at our university and coexists with other structured doctoral programs that, unlike the Vienna PhD School of Informatics, are topic-specific (so called doctoral colleges). The program is designed for three full-time years, with a scientific research focus, in contrast to an industrial PhD. The curriculum, entirely in English, consists of a total of 204 ECTS credits, with 42 ECTS credits assigned to the fulfillment of courses and 162 to the thesis (see *fig. 1*). The curriculum has 28 ECTS course credits more than the traditional doctorate at our faculty. Its content is structured along the five major research areas of the faculty, covering the research of the entire faculty:

- Business Informatics
- Computational Intelligence
- Computer Engineering
- Distributed and Parallel Computing
- Media Informatics and Computer Graphics

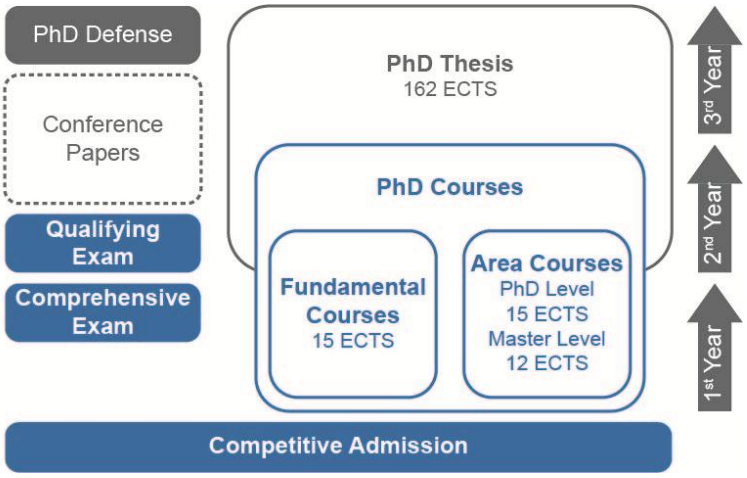

Figure 1: The Vienna PhD School of Informatics' curriculum structure.

Compared to the traditional doctorate, the curriculum of the PhD School is more extensive, more structured, although personalized to each student. The curriculum contains dedicated PhD courses and Master courses (see *Table 1*). The PhD level courses include subject-related and so-called fundamental courses.

Category	Number	ECTS	Objective
Area Course (internal)	2	6	Overview of research area topics and methods; in-depth course in primary area
Area Course (visiting professor)	2	6	Further courses specific to primary area and research topic
Master Course	3	12	Reinforcement of specific strengths
Secondary Area Course	1	3	Overview of a secondary area
Fundamental Course	5	15	Fundamental research skills

Table 1: Course load. Numbers refer to the number of courses to be taken from each course category. ECTS is the total of credits to be taken from each course category.

These different courses have several objectives:

i) to lead students into an in-depth and state-of-the-art knowledge in their research areas, area-specific and visiting professor courses are offered;

ii) to foster interdisciplinarity and extend the body of knowledge to other research area, a secondary area course has to be completed;

iii) to socialize students to scholarship and research, as well as to develop transferable skills a set of five multidisciplinary fundamental courses is mandatory.

Yearly, an international competitive admission process selects approximately 15 students, which are entitled to a scholarship and budget for travel expenses, funded by internal and external sources. As no PhD proposal is necessary for admission, students decide on their primary area and supervisor during the first semester. The matching student-supervisor is personal, left to the student and the potential supervisor. A milestone process begins at the beginning of the second semester with the Comprehensive Exam, which assesses the knowledge level in their research area. In the first year supervisor and primary area can be changed in order to align them better with the student's research topic. In case of conflict, a mediation process between the student and the supervisor is managed by the director of the program. After the Comprehensive Exam students are integrated into the faculty research groups. The process continues with the Qualifying Exam that takes place at the end of the second semester, and has the form of the student's PhD proposal. At the end of their studies, students defend their thesis, previously evaluated by two external reviewers.

4. Evaluation Framework

In order to analyze the achievement of our objectives, and to compare our performance with that of other institutions, we need a multidimensional framework that takes into consideration different stakeholders, evaluation areas and benchmarking criteria. We have designed such an evaluation framework taking these different views into consideration (see *Fig. 2*). The framework needs to be applied on a regular basis and can also be used to benchmark our program with those of other institutions.

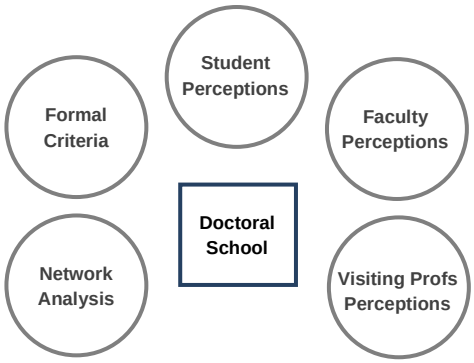

Figure 2: Evaluation framework of the Vienna PhD School of Informatics.

Given the complexity of the concept under evaluation, we see the need to include different angles of analysis that require qualitative and quantitative approaches:

- Characterization of the organizational environment, such as information about university structures and activities supporting structured doctoral programs.
- Students, faculty members and visiting professors' perceptions, which will enable the study the different processes, interactions and effects between the organizational context and the research environment. Primary data are obtained through questionnaires and interviews.
- Quantitative data encompasses the measurement of a selection of formal indicators that should not be limited to research results, but also include resource allocation, innovation and community engagement, such as the ones proposed in [5].
- Network analysis is included in the evaluation framework due to the strong dependence of scientists on a social network to share knowledge and to collaborate. We are considering how to model scientific relations and their evolution within the entire faculty, combining them with more informal interactions that take place at doctoral schools.

5. First assessments

The Vienna PhD of School of Informatics has just started its fourth year, receiving over 600 applications in the last application call (see *Fig. 3*) and having up to now a total of 44 PhD candidates and 1 alumni (see *Fig. 8*).

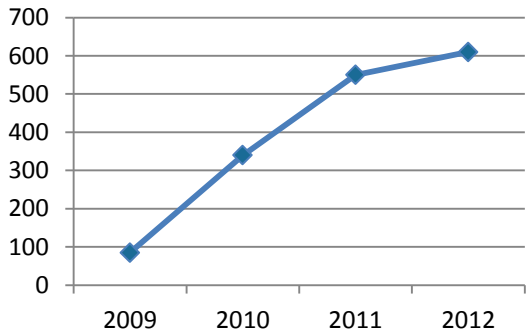

Figure 3: Application received in the last years.

In the following we present some evaluation results based on the guidelines of *Informatics Europe* [5], and a qualitative study of our students' experiences at different stages of their PhD study.

5.1. Evaluation According to Informatics Europe's Guidelines

This evaluation should be understood in the context of the PhD School, taking into account its nature and the fact that an evaluation of the entire faculty is out of scope. Therefore, some of the criteria of are not applicable. In the following we provide a selection of criteria.

Quality and scientific relevance of the research – Publications

PhD School students have authored a total of 92 publications. Students' average number of publications per PhD year is illustrated in *Fig. 4*.

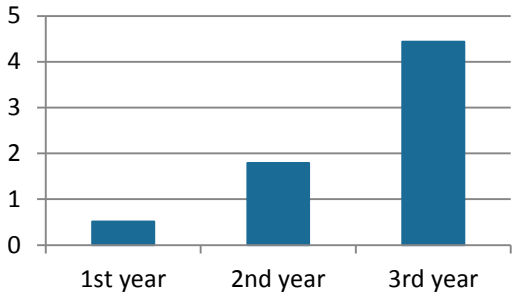

Figure 4: Average number of publications per study year.

Doctoral training - Attrition

During the last three years a total of 13 candidates left the program – 9 males and 4 females (see *Fig* 5). The reasons were personal ones in 8 cases, the acceptance of another PhD position in 2 cases, and the low performance in the Comprehensive/Qualifying Exam in 3 cases (see *Fig. 6*).

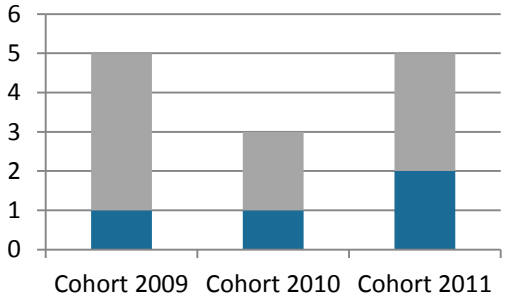

Figure 5: Attrition per cohort and gender.

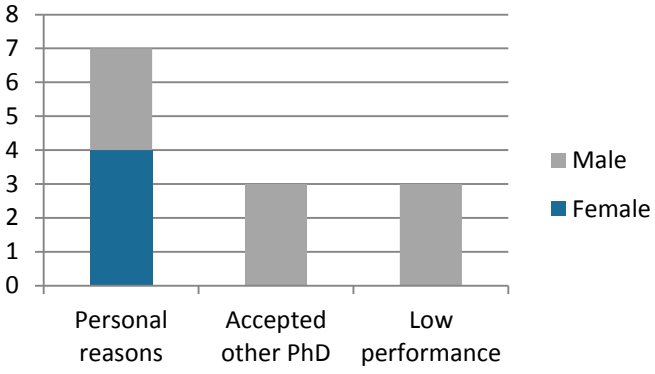

Figure 6: Attrition reasons per gender.

Research infrastructure – Human resources and work facilities

The PhD School is steered by a faculty committee board. The organization of the school is managed by an administrative assistant and a university assistant. The latest is also in charge of the assessment of the program.

Before students are integrated into the research groups, they are offered a fully equipped common room. Latest at the end of the first semester, they are offered a place in their research group, and granted access as members of the research group to all facilities of the resp. institute. These include office material, technological equipment and human resources, such as technicians and administrative staff.

Internal Orientation – Student mobility

The doctoral program welcomes guest students and facilitates stays and visits of its students to other research institutes. Currently, we also host candidates funded by foreign universities. They follow the entire study plan of the School of Informatics.

Diversity

The PhD School students come from 19 countries forming a quite diverse group of students (see *Fig. 7*). Through a careful applicant selection, female applications are thoroughly scrutinized, given that when deciding between applicants of comparable background and experience, female candidates are preferred. The PhD School has 36% of female representation (see *Fig. 8*).

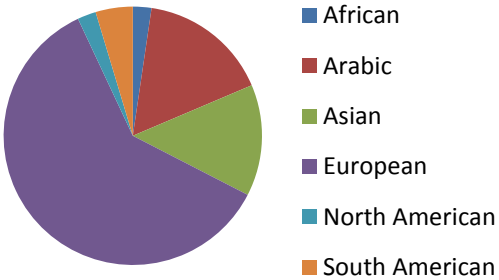

Figure 7: Students' nationalities per geographic area.

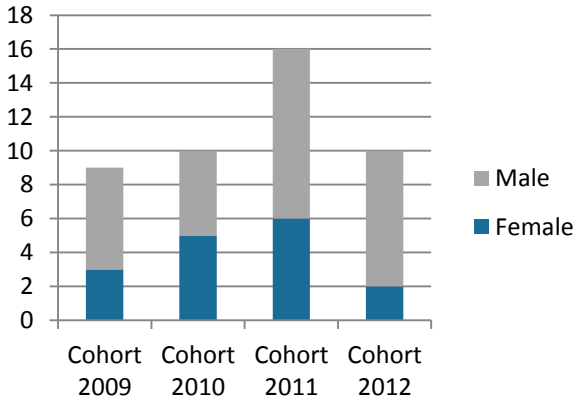

Figure 8: Gender of current candidates of cohorts 2009 to 2012.

5.2. Qualitative Study of Students' Experiences

We conducted a first qualitative study of students' experiences at different stages of their PhD study, to analyze the effects of the organization and structure of the different programs of doctoral education in Computer Science at our University. The study was conducted in three different Computer Science doctoral programs at our faculty that follow different approaches. We used the data of open-ended interviews and organizational information. The sample consisted of 36 male and female PhD

candidates in their first, second and third year. This qualitative research is based on grounded theory [6] to build an explanatory framework based on the interviews, from which we selected critical variables with high discriminating power. And we used a method called qualitative comparative analysis to identify relational patterns [7].

Examples of our findings are: i) the importance of scientific social interaction for students' satisfaction of their scientific work; and ii) the process of getting familiar and active in a research area differs substantially in time and effort for students with different cultural backgrounds. On the basis of these exploratory variables, we will formulate questionnaires to use them on a yearly basis within our longitudinal framework. A similar approach will be used for faculty members and visiting professors.

6. Conclusion

The Vienna PhD of Informatics is now in its fourth year, showing initial positive results. Besides implementing and operating the school, we designed a framework to evaluate our performance against our objectives. Obtaining positive results motivates us to pursue efforts to develop a more advanced and complete evaluation framework suited to the characteristics of doctoral schools. This framework should also be used to benchmark our initiatives with those of other universities.

7. References

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