Getting a PhD in Software Engineering in Germany and especially at the University of Rostock

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Abstract. The paper gives an overview of possible ways to get a PhD in software engineering in Germany. Additionally, it discusses the different support activities at the University of Rostock. Conventional individual decorates and structured doctoral programmes are distinguished in Germany. Graduate schools are a very good organizational form of cooperative research of several PhD students. The graduate school MuSAMA and their results are presented as an example. Finally, some ideas for a PhD programme are provided.

Keywords: PhD programme, Software engineering, Graduate school.

1   Introduction

A University in Germany consists of several faculties like Medicine, Natural Sciences, Philosophy, Business Administration, and so on. Those faculties consist of institutes. This organizational structure is the same for all universities. However, the size and the name of the faculties vary. Computer Science is sometimes an own faculty, sometimes Mathematics and Computer Science form a faculty, and sometimes Computer Science is part of Natural Sciences

Traditionally, in Rostock there was a Faculty of Engineering that consisted of Mechanical Engineering, Electrical Engineering, Civil Engineering and Computer Science. However, Civil Engineering was closed after unification of Germany. Mechanical Engineering founded an own Faculty and a Faculty of Computer Science and Electrical Engineering was founded as well..

Graduation is the most important task of faculties. Therefore, the PhD degree is offered by a Faculty. In our case the degree is Dr.-Ing. It is given to all PhD-theses in the domain of Computer Science and Electrical Engineering. A PhD grade for Software Engineering does not exist. However, the domain of a PhD can be Software Engineering.

2 Doctoral Programmes

Currently, there exist two different approaches that are called "conventional individual doctorate" and "structured doctoral programme".

2.1 Conventional Individual Doctorate

A conventional individual doctorate consists of a Thesis that has to be accepted by three reviewers. One of the reviewers is the supervisor. The other two should be from other universities. However, nowadays reviewers from the own university are accepted as well.

It is assumed that a Thesis is accompanied with a series of international publications. In general the Thesis is a summary of the research results in form of a monography. However, it is possible to organize publications in such a way that they can be used as chapters of the Thesis. In this case only an introduction and a summary have to be written. Only five percent of PhD-Theses are organized in such a way. They need a strategic approach from a very early stage of the research.

The defence of the Thesis is organised in very different ways at universities. At some universities even the talk is not open for the public. However, most universities allow public audience. At our university in Rostock even the discussion is public and at the end everybody is allowed to ask questions. However, first question rounds only allow questions from the reviewers. After, reviewers are satisfied members of the graduation commission are allowed to ask questions.

At other universities the whole part with questions is private.

Finally, at all universities a decision is made whether the faculty council is advised to accept or not to accept the PhD-Thesis

2.2 Structured Doctoral Programme

A structured doctoral programme is currently most of the time related to a graduate school that is funded by the German Research Fund (DFG). However, graduate programmes exist as well in other domains. They do not exist for Software Engineering.

2.2.1 Graduate School
"Graduate Schools play a key role not only in developing internationally competitive centres of top-level research and scientific excellence in Germany but also in increasing their recognition and prestige. They serve as an instrument of quality assurance in promoting young researchers and are based on the principle of training outstanding doctoral students within an excellent research environment.

Graduate Schools thus offer ideal conditions for doctoral students within a broad scientific area and, as integrative institutions with international visibility, they encourage students to be active members of their academic and social communities. As a result, graduate schools will extend far beyond DFG Research Training Groups and differ from them substantially." [1]

In a graduate school several professors supervise PhD students. The whole research has a common theme. Students are offered special courses and invited talks.

A typical graduate school consists of 12 to 15 PhD students supervised by six professors. Scholarships are provided for three years for one generation of students. The German Research Foundation supports three generations of students. Students are encouraged to publish papers with their fellow students. However, the Thesis has to be written by each student alone. There is not much different to the procedure of the classical individual doctorate.

2.2.2 Graduate Academy.

At several universities there exist "Graduate Academies". The website of Graduate Academy in Rostock can be found via address provided by [2].

The website provides the following statement:

"The promotion of junior scientists is one crucial factor for success in international scientific competition. The Graduate Academy seeks to create an optimum surrounding to support young doctoral candidates, postdocs and scientists successfully at our University. As the central service and coordinating office for junior scientists, the Graduate Academy contributes to improving and developing the conditions for doctoral candidates at our University."

The academy provides a qualification program that supports PhD students in their scientific activities.

"The aim of the Graduate Academy's qualification program is to support your work on your research projects and to provide useful information on career possibilities. Unless otherwise specified, the courses are open for both, doctoral candidates and postdocs."

Such courses provide support for skills like reading, academic writing, presenting at conferences, analyzing data, etc. Such skills are necessary for a PhD. However, the courses are not mandatory. They are a service that is provided by the University that can be used but can also be neglected.

The PhD in Germany is really individual research work only. There is no need for further courses.

In the following paragraph, we would like to present some details about a specific graduate school that was finished last year in Rostock. The school was called MuSAMA [3] (Multimodal Smart Appliance Ensembles for Mobile Applications)

2.2.3 Graduate School MuSAMA.

"MuSAMA is based on the hypothesis that ubiquitous machine intelligence, envisioned for our future everyday environments, will be provided by dynamic ensembles: Local agglomerations of smart appliances, whose composition is prone to frequent, unforeseeable, and substantial changes. Members of such ensembles need to be able to cooperate spontaneously and without human guidance in order to achieve their joint goal of assisting the user. The resultant concept of autonomous cooperative as-

sistance poses new challenges for the research on ubiquitous and ambient information technology.

Work in MuSAMA therefore concentrates on the investigation of models and algorithms that allow dynamic, ad-hoc ensembles to deliver the assistive power of Smart Environments independently of external or global knowledge. Globally coherent ensemble behavior with respect to a user's need emerges from local interaction of individual appliances. The application scenario for MuSAMA are instrumented rooms that support teams in knowledge exploration and knowledge integration based on distributed display facilities."

The graduate school MuSAMA was funded from 2006 to 2015. However, some students were supported till the end of 2016 because of extension options.

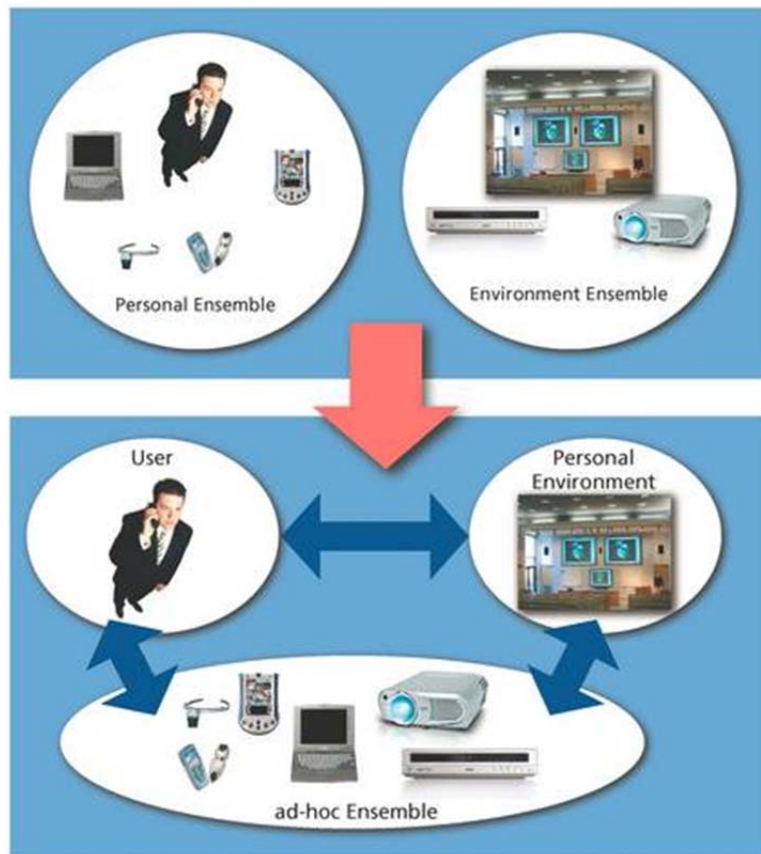**Fig. 1** gives a visual representation of the MuSAMA domain.

Fig. 1. Visualization of the domain of the Graduate School MuSAMA [3].

The school was organized by 12 Professors that identified four different research fields. These research fields are:

- Context analysis
- Multimodal interaction and visualization
- Intention analysis and strategy development
- Management of resources und infrastructures.

Research questions were identified and PhD students were hired. For the first three years 15 PhD students a scholarship for two years was offered only. After two years, students had to provide their plan for the third year. This plan has to be supported by the 12 professors. After acceptance students were allowed to proceed with their research. However, in some cases students did not get further support.

Further extensions of the research were provided based on the need and available funds. Statistically, students got scholarships for 36 months + 3 months extensions. 11 PhD students were supported by an additional year because of parenthood.

Additionally to PhD students few postdoc positions were available. Also funds for student assistants were available. These students were intended to support experiments. Finally, so called "associated" PhDs were part of the school. They were financed from other resources but their work was related to the research questions of the school.

The following table will provide some numbers about participants in nearly ten years.

Participants	Status	Number
PhD	financed	45
Postdoc	financed	3
Student Assistant	financed	132
PhD	external	29

Table 1. Different types of students in MuSAMA

The success rate of the research projects was good but not as good as expected.

	1. Generation	2. Generation	3. Generation
Finished	12	10	10
Cancelled	2	7	4

Table 2. Different generation of students and their success in MuSAMA

3   Ideas from other PhD Programmes

The Carnegie Mellon University provides a PhD programme in Software engineering. PhD students have to meet the following requirements:
In order to meet the requirements for ABD/ABS in the Software Engineering PhD program all students must:

1. Meet Star course requirements
2. Meet Elective requirements
3. Complete both (2) practicums
4. TA two courses
5. Speaking requirement approved
6. Writing requirement approved
7. Residency requirement of 4 semesters "[4]

PhD students have to participate in two presentations in a research seminar every week. They have to give two well prepared talks every year. The role of the seminar is described as follows: "The Software Research Seminar (SSSG) at CMU relies on active participation and a supportive community to help students broaden their understanding of software research and hone their presentation skills."[4]

The faculty of Carnegie Mellon University selected a canonical set of papers in the domain of software engineering [**Error! Reference source not found.**] that students have to read in the first semester. It seems to be a good idea to provide papers. However, some papers are very fundamental and should be already known by the students.

Concordia University in Montreal allows even Bachelor alumni for their PhD programme. The University provides very precise requirements for the degree, admission requirement, and the admission process [6].
Additionally, a list of typical offered courses is provided. This list contains the following courses:

o Software engineering development process
o Mining large software system data
o Software re-engineering
o Software comprehension and maintenance
o Software architecture and design
o Software requirements, verification, testing and validation
o Human computer interface design
o Software project management
o Services computing: Foundations, design and implementations

Students with a Master degree have to participate in course work for 12 credits and students with Bachelor degree have to have 28 credits. Additionally, a seminar with 2 credits and doctoral research proposal with 6 credits have to be passed.

4   Summary

In the paper some general ideas of PhD programmes in Germany and especially at the University of Rostock were provided. An example of a graduate school was discussed based on the experience with the school MuSAMA.

There are discussions about structured PhD programmes in Software Engineering in Germany. However, currently there exist only additional services. It is still assumed that the result of a PhD is presented in form of a monographic work. Real PHD programmes do not exist yet.

Good practices from other programmes could help to establish such programmes. A list of papers or books that are expected to be known by PhD candidates could be such an idea. Also the list of courses provided by Carnegie Mellon or Concordia could be helpful.

4   References

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