Informatics Doctorate in Europe: Models and Equivalence

Manfred Nagl
RWTH Aachen University, nagl@cs.rwth-aachen.de

ECSS 2018, Chalmers U./ U. of Gothenburg,
October 8, 2018
Motivation

• Different structures for research universities: private elite university USA, collegiate university UK, grandes écoles F, Humboldt model, …

• Different cultures in different disciplines
  preciseness: from math to art
  constructiveness: from liberal arts to engineering

• Doctorates determine a big part of the scientific outcome

Not too different in a discipline?

• Investigation for Informatics Europe 2012 „What makes a good PhD?“
  Looking for Informatics doctorates in Europe „How different?“

• Study/ conferences about doctorates in Engg. and Informatics in
  Germany/ Europe for 4ING, Acatech, TU9, conferences 2008, 2009

• Ombudsman for Doctoral Students in a Faculty of 120 professors
Contents

- The investigation and its simple method
- Characterization of the process
  - Formal parameters (duration, …)
  - Organization of the doctoral process
- Outcome: Dissertation and Ph.D.s’ profiles
  - Thesis / publications / qualifications
  - Profiles and the “Doctoral Environment”
- Models
  - Character of Informatics research (very short)
  - Variety of Doctoral Models
  - The Central European Model
- Conclusions
  - What is similar / different
  - The essential difference comes from outside
The investigation and its simple method

- Questionaire by JvL,UH,MN
- Was sent to 2-5 colleagues p.c.
- Experienced colleagues: their university and their country
- 70 answers, ratio ≈ 80%
- European countries covered
- Evaluation
- 2 folder
- Excel sheet
- Report after ECSS 2012 conf.
Characterization of the process (1)

Formal parameters

- Duration
- Age
- Females
- Foreigners
- How many go for PhD? \( \approx 15\%, \) from 5 to 30
Characterization of the process (2)

Organization of the doctoral process

- Entrance
- Working
- Finalisation

All these steps can be more or less formalized

Entrance level
Ma or Ba+Ma courses + language

PhD title in different names
Organization of the doctoral process

How to get new students?
Who is hiring?
Is this done regularly or at a few dates?
How much competition?
Multilevel selection
Formal exam?

Mostly own students
Characterization of the process (2)

Organization of the doctoral process

- Entrance
  - Recruiting
  - Getting started
- Working
- Finalisation
  - Defence

Lectures/seminars: general/specific (10-90 ECTS)
Reading literature
First idea after 1 year
Go NoGo Decision

Transfer/
Upgrade in UK
Characterization of the process (2)

Organization of the doctoral process

Entrance → Working → Finalisation

- Recruiting
- On solid ground
- Defence

After 2 or 3 years
Topic of thesis clear
Outline of how to approach
Might include approval

Candidate Licentiate in Sweden
Characterization of the process (2)

Organization of the doctoral process

Entrance → Working → Finalisation

Recruiting

Doing research
Working out thesis
Characterization of the process and its results (2)

Organization of the doctoral process

- Entrance
- Working
- Finalisation

After thesis submission
Reference organisation
In 1 or 2 steps
Reviewers or opponents
Formal decision (on predefence)
Defence/exam: talk, discussion, questions
from 1 to 6 hours
Passed/failed or up to n grades
Afterwards approvement/certification

Informatics Doctorate in Europe: Models and Equivalence
Doctoral process: General aspects

**PhD plan**
- Res./teaching/further topics dev. in group
- Approved by comm.
- Formally accepted
- Incl. budget

**execution**

**monitoring**
Characterization of the process (2)

Doctoral process: General aspects

- Entrance
- Recruiting
- person/institution handling
- most active supervision
- milestone evaluation/reporting
- drop-out quote
- Working
- Finalisation
- Defence
- process
## Outcome (1)

### Dissertation, publications, qualifications

<table>
<thead>
<tr>
<th>Formal Degree</th>
<th>Length</th>
<th>Language</th>
<th>Publication</th>
<th>Format</th>
<th>Professional Doctorate</th>
<th>Public. before</th>
<th>#Public.</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>≈200pp. (50-400)</td>
<td>≈70% English (0-100) Dramatic change</td>
<td>Internal rep book ISBN ePub. very often Only an abstract is published</td>
<td>Mostly monograph Cummulative thesis</td>
<td>Not one Some saying not in our dept. or some other univ</td>
<td>Social must Some require minimum (or 80% has to be publ.) (or with score in cit.)</td>
<td>≈5-10 Conf./journal papers Nearly all in English</td>
<td>Mostly group papers</td>
</tr>
</tbody>
</table>
## Outcome (2)

### Candidates’ Profiles and Environments

<table>
<thead>
<tr>
<th>Formal position</th>
<th>Research/other duties</th>
<th>Scientific achievements / soft skills</th>
<th>Independence</th>
<th>International experience</th>
<th>Competences</th>
<th>Career perspectives</th>
<th>Relevance for industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students/employees of which sort salary in relation to Ma salary</td>
<td>Research plus some duty (research +) Administration, management</td>
<td>Study Compare Create ideas Present Discuss Defend Soft skills depend on the project, esp. on the employee status</td>
<td>Student being guided for independence Young scientists developing</td>
<td>Conferences Visiting/ staying in other groups</td>
<td>Scientific competences And others</td>
<td>Only academic position Industry</td>
<td>Industry not interested Relevance increases Industry appreciates (but importance decreases)</td>
</tr>
</tbody>
</table>
## Character of Informatics Research

<table>
<thead>
<tr>
<th>Theory/Pr Appl</th>
<th>Core Inf./Appl.</th>
<th>Appl. and methods</th>
<th>Depth/Breadth</th>
</tr>
</thead>
<tbody>
<tr>
<td>≈ 30:70</td>
<td>≈ 60% core</td>
<td>Engg. BA</td>
<td>≈ 40:60?</td>
</tr>
<tr>
<td>or</td>
<td>or</td>
<td>Bio/Neuro/Med/LifeSci.</td>
<td>Some depth</td>
</tr>
<tr>
<td>variety</td>
<td>variety</td>
<td>Nat.Sci.</td>
<td>required</td>
</tr>
</tbody>
</table>

Some depth required.
Models (2)

Variety of Models

Classification Dimensions:
- Handling of the process,
- Curriculum,
- Status,
- Role of supervisor,
- Responsibility,
- Financial support,
- Dissertation Format,
- Reviewer / Opponent
- Examination Form,
- Title,
- Grades

Three Models and many in between:
- Anglo-American Model
- Central European Model
- North European Model
The Central European Model

Dissertation Project

- Coacher
- Leader
- Group of students
- 60% third party money

Eng./Inf. Doctorate

- Select. 20%
- 85% Master in the same field
- Full payment

Ph.D. candidate

Other Projects

Qualification

- Sci. research
- presentation
- Discuss.
- Publ./ Mon.

Sci. Qual.

Soft Skills

- Teaching
- Admin.
- Org.
- Group..Fac.
- Getting Money/Money cons.
- Rel. to Comp./Transfer

Future Career

- Payment as ...
- 85% go to Industry
- 45% have a lead. pos.
- Clear Career perspective

Other Projects

Future Career

Sci. Qual.

- Discuss.
- Publ./ Mon.

Soft Skills

- Teaching
- Admin.
- Org.
- Group..Fac.
- Getting Money/Money cons.
- Rel. to Comp./Transfer

Future Career

Ph.D. candidate

Engr./Info. Doctorate

Dissertation Project

- Coacher
- Leader
- Group of students
- 60% third party money

Other Projects

Qualification

- Sci. research
- presentation
- Discuss.
- Publ./ Mon.

Sci. Qual.

Soft Skills

- Teaching
- Admin.
- Org.
- Group..Fac.
- Getting Money/Money cons.
- Rel. to Comp./Transfer
Conclusions (1)

What is similar / different?

• **Similar:**
  Process/ cand.: age, duration, structure, how many for a PhD, drop-out rate, females, foreigners
  Thesis: length, English, publications, monograph

• **Difference of formals:** details vary and their degree of formality

• **Main differences come from the environment**
  Appl. , …, theory
  Role, importance, estimation

  not from the scientific process/ product.
Conclusions (2)

Is there a necessity for coherence / unification?

- **Essence of talk:**
  Dissertation) in Informatics devoted to ambitious research, is precise and more or less constructive
  Process is fair to the candidate, supervisor cares about progress of the candidate‘s research
  Faculty giving the framework for process and controls, following good academic practice

- Nevertheless there are differences in academic habits and role of Ph.D.s in society

  **Europe is colourful. Does that upset anybody?**
  **Do we want to learn from each other?**
Character informatics research (2)

Informatics is 55% Engineering, 25% Natural Sciences, 10% Business Administration, 10% Arts and alike

Informatics is aimed at understanding and analyzing the essence of natural and imagined information processing and communication systems. It is different in that it explicitly also includes the study of artifacts (constructed in the field). A vibrant industry is pushing and pulling the field.

Informatics research is getting more and more interdisciplinary

Informatics is mostly constructing something, a system, a nontrivial design, a proof. Informatics should be formal, for practical solutions also experience and intuition pay a role. Theoretical results should discuss applicability, practical results should be formal where possible. Practical solutions should not be only present their technical details. The way to get the solution, what has been learnt, how method, product, process, and domain knowledge has been improved is an essential part. So, Informatics is not building one solution after the other. It is an intellectual discussion about ideas, varieties of solutions, learning, and improvement.
Informatics contains math, engineering, natural science aspects, and nowadays also social or societal. The core is algorithmic thinking and constructive problem solving. A research cycle proceeds in the following iterated steps: Specification and conceptualization of the problem, design and analysis of a solution (algorithm), software implementation, experimental and empirical analysis of the software. That is not all but covers a lot.

Informatics is the continuation of Logic by other means. It is a deeply mathematical discipline with some engineering aspects. It is on the other hand very multi-disciplinary. I feel there is no universally valid formula of how research in informatics might be characterized.

Informatics offers better possibilities to come up with completely new theory and ideas (theory-driven) compared to traditional engineering disciplines. Practice-driven research is sometimes motivated by challenges coming from industrial collaboration.
Character informatics research (2)

Informatics research – even theoretical one – may deeply and directly affect the way people live, work, and get entertained. This short cut between Informatics as a scientific discipline and its large scale effects is what makes Informatics appealing to the most brilliant students. We should underline the unique potential of innovation in Informatics to preserve its appeal.

Informatics is designing and implementing formal models that are executable and work efficiently: Informatics solutions are formal (vs. Engineering) and working efficiently (vs. Mathematics).

Informatics research is somehow success-driven, appropriate proofs, statistical analysis, and math-like development are common. All research forms are goal-driven: There has to be a system, an artifact, an approach that will override the previous existing ideas and artifacts.
Character informatics research (2)

Informatics involves a range of sub-areas (as formal systems, algorithmic thinking, language design etc) like other disciplines but is different in having technological and engineering components at the same time, aimed at mimicking or realizing information processing and communication systems in practice for the benefit of mankind. Informatics spans the entire spectrum from science-oriented to engineering- and use-oriented. This characterizes the field and its research, making it a science and engineering and a management discipline at the same time.

Informatics contains mathematical aspects (rigor, proofs), engineering aspects (realizing concepts in pieces of software or systems), empirical ones (evaluation of implemented concepts by experiments). There are also speculative aspects (how things should be done instead of doing it) or social/societal aspects.

Informatics research has 3 types: (1) to develop new types of software systems, (2) to develop approaches how development processes can be improved, and (3) to solve practical problems by actively using IT potentials.
Character informatics research (2)

Informatics research has different facets: (a) applying mathematical formalisms and developing abstractions (such as meta and meta-meta models), (b) understanding and systematically solving interdisciplinary problems and issues, (c) creating generalized and long-lasting solutions to problems. (d) Interpersonal and communication skills are necessary to cooperate with professionals from other disciplines in large teams. (e) The essence is to understand, model, construct, and integrate complex systems.

Informatics covers a wide range from (i) theoretical research similar to math to (ii) experimental work similar to experimental physics and biology. There is also (iii) a big engineering core, where research focuses on other aspects.