Experiences from New Accreditation Cycle of the Information Engineering Study Program at Faculty of Technical Sciences

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DAAD Workshop 2019

Agenda

- Information Engineering Curriculum
- Collected Experiences
- Reengineered Program Structure
- Conclusion

Information Engineering Curriculum

- **Goals**
  - Having a curriculum to cover a body of knowledge
  - **of Data Science and Information Engineering**
  - Necessary to support **information management in organization systems** (business), as well as **scientific computations**
    - Applicable in a wide variety of organizations (of any type) or research institutions
    - Covering wide range of aspects of information management
      - typically required by many stakeholders
    - That will nurture both **interdisciplinary** and **formal** approaches
      - typically expected formality: at the level of mathematical rigor, whenever is possible
  - The first selected application domain
    - **Financial Engineering**

Information Engineering Curriculum

- **Body of Knowledge - Requirements**
  - a not necessarily complete list of required knowledge
  - **Computer Science, Informatics, and Software Engineering**
    - all core CSI&SE disciplines, including Algorithms, Formal Methods, Computational Intelligence and Machine Learning, HCI, Software Engineering, Information Systems
  - **Applied mathematics**
    - Calculus, Discrete Mathematics, Algebra, Graph Theory, Combinatorics, Logic, Probability and Statistics, Operational Research, Optimization Methods, Data Series Processing
  - **Economics, Communicology, and Management**
    - Basics of: Communicology, Finances / Financial Engineering, Business Intelligence, Decision Theory, Quantitative Methods, Risk Management, Entrepreneurship in IT sector

Information Engineering Curriculum

- **B.Sc. in Information Engineering (240 ECTS, 4 years)**
  - Elective courses and two modules in 3rd and 4th years:
    - **Analytics Engineering** – more towards CSI&SE and Data Science
    - **Applied Information Engineering** – more towards Management and applied disciplines
- **M.Sc. in Information Engineering (60 ECTS, 1 year)** and
- **M.Sc. in Inf. and Analytics Engineering (90 ECTS, 1,5 year)**
  - A pool of more than 50 elective courses
  - Covering **Data Science, HPC, Information and Financial Engineering**
  - **Specific courses, created for DS, HPC, IE and FE**
  - courses referenced from other study programs
    - **Computing and Control, Software Engineering and Information Technologies**
    - **Mathematics in Engineering**
    - **Power Systems, Electronics and Telecommunications**
    - **Engineering Management**

Information Engineering Curriculum

- **2015**
  - The three new study programs in Data Science were accredited
  - Officially accredited in the category of **interdisciplinary and multidisciplinary** programs, in the two main areas:
    - **Electrical Engineering and Computing**
    - **Engineering Management**
  - In practice, a completely new combination of courses predominantly coming from
    - **Computer Science, Informatics, and Software Engineering**
    - **Mathematics**
    - **Telecommunications and Signals**
    - **Finances, and Engineering Management**

Information Engineering Curriculum

- **2017**
  - First execution of the two programs
    - B.Sc. in Information Engineering, and
    - M.Sc. in Information Engineering
  - Two active generations of students in the B.Sc. program
    - 60 students / year
  - Two generations of M.Sc. students
    - 8 students / year
    - where the first students have already completed their studies
  - First experiences with these generations of students are quite positive
  - Preparing for the new accreditation cycle, announced for 2017 year
    - Finally, resulted in performing minor changes to the existing study program structures

Information Engineering Curriculum

- **2019**
  - The new 7-year accreditation cycle is initiated in Serbia
  - All the study programs are submitted for accreditation (June 2019)
- Two main goals
  - Embed the best practices of already running students' generations in these study programs
  - Face with some new or improved regulations set by the National Accreditation Body of Republic of Serbia, in January of 2019
    - The most important, new metrics introduced for interdisciplinary programs only
      - At least 50% of courses and lecturers from the first main discipline
        - » **Electrical Engineering and Computing**
      - At least 25% participation of courses and lecturers from the second main discipline
        - » **Engineering Management**
      - NOTE: a weighted participation in terms of No. of ECTSs and course disciplines

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Collected Experiences

- **B.Sc. in Information Engineering**
  - Quota: 60 students, No. of applicants:

Year	Option I	Options II and III	Total	Over Quota	Entrance Max. Points	Entrance Min. Points
2017	46 ↑	131 ↑	177 ↑	117 ↑	100.00↓	69.02 ↑
2018	65 ↑	215 ↑	280 ↑	220 ↑	91.00 ↓	70.42 ↑
2019	67 ~	210 ~	277 ~	217 ~	98.24 ↑	72.54 ↑

  - Still, not clear recognition of study program potentials and values
    - Many questions about the notion of data science and expected outcomes
    - Not clear distinction from other programs, like Information Systems Engineering
    - Sometimes, not awareness about a high degree of Mathematics inside
  - A study program mostly recognized by students as an Option II or III
    - Possibly, due to lot of formal disciplines and Mathematics included

Collected Experiences

- **B.Sc. in Information Engineering**
  - Year 2017: **polarization ½ : ½** of very good over relatively bad students
    - Almost no middle layer exists
    - 55 of 60 enrolled Year II, some of them with serious troubles, not completed courses
  - Year 2018: much better middle layer, **app. ¾ : ¼** for good students
  - Strong **polarization in programming courses**
    - For beginners, programming courses are declared as very difficult
    - For experienced students, programming courses are declared as easy to normal
  - Strong **troubles with Algebra** of low half of population in Year I
    - Declared as too abstract, while Calculus 1 is seen as much easier
  - Regularly put question: “Why we need Mechanics in our program?”
  - Regular comment: “We are happy as we do not have Electrical Engineering courses inside”

Collected Experiences

- **M.Sc. in Information Engineering**
  - Implemented program structure

Year I – M.Sc.	Sem.	Class / Week
Datawarehouse Systems	1	3+3
Business Process Modeling	1	3+3
Data Mining	1	3+3
Introduction to Interactive Theorem Provers	1	2+2
Quantitative Methods in Risk Management	1	2+2
Cryptography	1	2+2
Statistics in Information Engineering	2	3+3
Domain Specific Modeling and Languages	2	3+3
Professional Practice / Internship	2	0+3
Master Thesis	2	8+5

Collected Experiences

- **M.Sc. in Information Engineering**
  - Strong interest of differently profiled students form B.Sc. level, with programs completed in:
    - Computing and Control
    - Applied Mathematics / Mathematics
    - Business Informatics
    - Electronics, Telecommunications and Power Systems
  - Wide selection of companies searching for such profiled students
    - Even offered attractive scholarship schemes
    - To support initiating of such study program
  - Students clearly recognize potentials and values of such profiled study program

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Reengineered Program Structure

Year I – B.Sc.	Sem.	Class / Week
Algebra	1	4+4
Fundamentals of Programming and Programming Languages	1	4+4
Introduction to Information and Financial Engineering	1	2+2
Communicology	1	2+2
Mechanics	1	2+2
Elective Foreign Language 1 / English	1	2+0
Calculus 1	2	4+4
Computer Architecture	2	4+4
Theory of Algorithms	2	3+3
Fundamentals of Financial Engineering 1	2	3+3
Elective Foreign Language 2 / English	2	2+0

Reengineered Program Structure

Year II – B.Sc.	Sem.	Class / Week
Calculus 2	3	3+3
Fundamentals of Graph Theory and Combinatorics	3	3+3
Advanced Programming and Programming Languages	3	4+4
Logic Design of Computer Systems 1	3	3+3
English for Information Engineering	3	2+0
Probability and Stochastic Processes	4	2+2
Mathematical Logic	4	3+2
Operating Systems	4	4+4
Web Programming	4	3+3
Fundamentals of Financial Engineering 2	4	3+2

Reengineered Program Structure

Year III – B.Sc.	Sem.	Class / Week
Optimization Algorithms and Nonlinear Programming	5	4+4
Numerical Algorithms and Numerical Software	5	2+2
Databases 1	5	4+4
Time Series Processing	5	3+2
Compilers	5	3+2
Parallel Computing	6	2+2
Practicum in Statistics	6	2+1

Reengineered Program Structure

Year III – B.Sc. (Continued . . .)	Sem.	Class / Week
Elective Course II31	6	4+4
- Methods and Techniques in Data Science		
- Logic Design of Computer Systems 2		
Elective Course III32	6	2+2
- Human Computer Interaction		
- Biomechanics		
- Business Process Modeling and Analysis		
- Fundamentals of LEAN Production		
- Reliability of Engineering Systems		

Reengineered Program Structure

Year III – B.Sc. (Continued . . .)	Sem.	Class / Week
Elective Course III33	6	3+3
- Software Specification and Modeling		
- Computer Communication		
Elective Course III34	6	≤ 3+2
- Internet Networks		2+2
- Design of Communication Systems		3+2
- Investment Management		2+2
- Principles of Economics		2+2

Reengineered Program Structure

Year IV – B.Sc., Analytics Engineering	Sem.	Class / Week
Databases 2	7	2+2
Internet Software Architectures	7	2+2
Operational Research	7	3+3
Elective Course AI41	7	2+2
- Decision Theory		
- Self-Learning and Adaptive Algorithms		
Elective Course AI42	7	≤ 3+3
- Soft Computing		3+3
- Machine Learning 1		3+2
- Introduction to Information Theory		3+3
- Real Time Operating Systems		3+3
- Principles of Engineering Management		3+2
- Management of Work Processes		3+3
Professional Training	7	0+6

Reengineered Program Structure

Year IV – B.Sc., Analytics Engineering (Continued . . .)	Sem.	Class / Week
Elective Course AI43	8	≤ 3+2
- Service Oriented Architectures		2+2
- Algorithms and Computational Complexity		3+2
- Corporative Finances		3+2
- Platforms and Systems for Knowledge Transfer		3+2
Elective Course AI44	8	2+2
- Advanced Information System Architectures		
- Software Quality and Standardization		
- Mobile Application Development		
- Performance Indicators of a Company		

Reengineered Program Structure

Year IV – B.Sc., Analytics Engineering (Continued . . .)	Sem.	Class / Week
Elective Course AI45	8	3+3
- Information System Engineering		
- Knowledge Based Systems		
- Business Informatics		
- Visual Programming of Animation		
- Machine Learning 2		
- Dynamics and Optimization of Engineering Systems		
Elective Course AI46	8	3+3
- Database Systems		
- E-Business Systems Security		
- Software Agents		
- Knowledge Engineering		
B.Sc. Thesis	8	0+7

Reengineered Program Structure

Year IV – B.Sc., Applied Information Engineering	Sem.	Class / Week
Databases 2	7	2+2
Risks in Investment Management	7	2+2
Elective Course PI41	7	2+2
- Decision Theory		
- Self-Learning and Adaptive Algorithms		
- Internet Software Architectures		
Elective Course PI42	7	≤ 3+3
- Machine Learning 1		3+2
- Operational Research		3+3
- Computer Graphics		3+2
- Business Law		3+2
- Service Engineering		3+2

Reengineered Program Structure

Year IV – B.Sc., Applied Information Engineering (Continued. . .)	Sem.	Class / Week
Elective Course PI43	7	3+3
- Introduction to Information Theory		
- Soft Computing		
- Fundamentals of Information Systems and Software Engineering		
- Real Time Operating Systems		
- Principles of Engineering Management		
- Management of Work Processes		
Professional Training	7	0+6

Reengineered Program Structure

Year IV – B.Sc., Applied Information Engineering (Continued. . .)	Sem.	Class / Week
Elective Course PI44	8	≤ 3+2
- Corporative Finances		3+2
- Algorithms and Computational Complexity		3+2
- Service Oriented Architectures		2+2
- Platforms and Systems for Knowledge Transfer		3+2
Elective Course PI45	8	2+2
- Financing of Innovative Enterprises		
- Entrepreneurship in ICT		
- Advanced Information System Architectures		
- Systems for Automatic Identification		
- Performance Indicators of a Company		

Reengineered Program Structure

Year IV – B.Sc., Applied Information Engineering (Continued. . .)	Sem.	Class / Week
Elective Course PI46	8	3+3
- Information System Engineering		
- Knowledge Based Systems		
- Business Informatics		
- Visual Programming of Animation		
- Machine Learning 2		
- Dynamics and Optimization of Engineering Systems		
Elective Course PI47	8	3+3
- Database Systems		
- E-Business Systems Security		
- Software Agents		
- Knowledge Engineering		
B.Sc. Thesis	8	0+7

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Conclusion

- Noticeable motivation of education staff to create a good study program and offer respectable opportunities to students
- Increasing awareness of students about the importance of Data Science in upcoming years, and outcomes of the study program
- Polarization of students' population: one, with clear ideas about their future vs. students with not clear recognition of their future opportunities
- Again, increasing number of students expressing their interest for M.Sc. studies abroad

End of presentation

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