University of Potsdam Department of Computer Science

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Porsdam

to the Prof. Dr. Data Science Master's Program Tobias Scheffer

Overview

- Introduction.
- Program overview.
- Faculty and course overview.
- HOWTO: study Data Science, by Md Zeeshan Mazhar.
- Introduction of program coordinator, student representatives.
- Tour of the building.

Keep in Touch

- The students of the Data Science Program coordinate via this Slack channel.
- Study materials are shared on the Moodle pages of individual courses, accessible through your UP account.
- If you do not yet have an UP account, please ask your fellow students to access materials for you (for instance, via the Slack channel).
- Please read the information on <u>Institute of</u> <u>Computer Science / Education / For students</u> <u>/ Master Program Data Science</u>.

Keep in Touch



Overview	COVID - 19 Regulations	
For Students	Please find all Uni Potsdam related information regarding the new restrictions <u>here: Corona</u> C.	
Course Catalogue		
Study Regulations and Consultation	Study Regulation	
Examination Issues	The most important document you should know, including an overview of modules and their respective ECTS can be found here:	
FAQ (german)	Discipline-Specific Admission Regulations for the Master's Program in Data Science at the University of Potsdam.	
Forms	Be aware that there has been an untranslated change to the study regulation on July 03, 2019 where the phrase under \$5 "The student must	
Studying Abroad	select either the "A" or "B" version of a module, not both." was removed. That means you can now take also both versions of a module in case you want to specialize in a certain field.	
Study Programs	Quick start for international students C ^a	
Master Program Data Science	Recommended Study Plans	
For Prospective Students		

Course Catalogue

Lehramt Informatik

Alumni

Each semester this document is created but unfortunately not provided in English language. Nevertheless, you can find an overview of courses in this PDF:

Course Catalogue Data Science PDF

If you feel more comfortable to browse through the PULS Webpage please find the current course overview here:

Course Catalog Data Science PULS

Also it might be worth exploring the course offer of the <u>Digital Engineering Faculty</u> 🕑 .







University of Potsdam Faculty of Science



Figures – University of Potsdam

Total Number of Students (Winter 2017/18)	29.000
Doctoral students	1.700
Female students	17.000
International students	2.800
Staff (2016)	
Academic staff	1.940
Professors	240
Jointly appointed professors	70
Other academic staff (full-time and part-time, incl. externally funded)	1.700
Non-academic staff	750



Figures – University of Potsdam

6 Faculties (winter term 2017/18)

Law Faculty

Faculty of Arts

Faculty of Human Sciences

Faculty of Economics & Social Sciences

Faculty of Science

Digital Engineering Faculty

4.500 BSc-/MSc-/Law-students 8.000 BSc-/MSc-students 4.500 BSc-/MSc-students 4.200 BSc-/MSc-students 5.000 BSc-/MSc-students



Total Number of Students (Winter 2017/18)	6.000
Doctoral students	900
Female students	2.800
International students	650
Staff (2016)	
Academic staff	662
Professors	87
Other academic staff (full-time and part-time, incl. externally funded)	575
Non-academic staff	183



Faculty of Science – Institutes

Faculty of Science

- 1. Biochemistry and Biology
- 2. Chemistry
- 3. Nutritional Science
- 4. Geography
- 5. Earth and Environmental Science
- 6. Computer Science
- 7. Mathematics
- 8. Physics and Astronomy







Faculty of Science – Research

Faculty of Science

- Collaboration with i.a.
 - Institutes of the Max Planck Society
 - Institutes of the Fraunhofer Society
 - Helmholtz Centres (e.g. German Research Centre for Geosciences (GFZ))
 - Leibniz Association (e.g. Potsdam Institute for Climate Impact Research (PIK))
 - Hasso Plattner Institute for IT-Systems Engineering
- 3 of the University's 4 research focuses





Complete list

Overview

Operating Systems and Distributed Systems

Didactics of Computer Science

Complex Multimedia Application Systems

Machine Learning

Software Engineering

Theoretical Computer Science

Knowledge Processing and Information Systems

Dependable and Energy Efficient Sensor Networks

Design and Test Methodology

Embedded Systems Architectures for Signal Processing

Research Group Fault-tolerant Computing







Dept. of Mathematics



Sie befinden sich hier: Home > Research

PROFESSORS AT THE INSTITUTE

The Institute of Mathematics. Learn more about us.

The Institute of Mathematics is one of eight institutes in the Faculty of Science. This faculty is the largest at the University of Potsdam. There are currently 13 professors at the Institute of Mathematics in Potsdam. Their research groups represent a wide range of teaching and modern research topics in Mathematics.

The following professors work at the Institute:

- » Algebra and Number Theory | Prof. Dr. Gräter
- » Analysis | Prof. Dr. Paycha & apl. Prof. Dr. Tarkhanov
- » Applied Mathematics | Prof. Dr. Holschneider & apl. Prof. Dr. Zöller
- » Didactics of Mathematics | Prof. Dr. Kortenkamp
- » Geomagnetism | Prof. Dr. Stolle
- » Geometry | Prof. Dr. Bär & apl. Prof. Dr. Andersson
- » Graph Theorie | Prof. Dr. Keller
- » Mathematical Modelling and System Biology | Prof. Dr. Huisinga
- » Mathematical Physics | Prof. Dr. Klein
- » Mathematical Statistics | Prof. Dr. Blanchard & apl. Prof. Dr. Liero
- » Numerical Mathematics | Prof. Dr. Reich & apl. Prof. Dr. Böckmann
- » Partial Differential Equations | Prof. Dr. Metzger
- » Probability Theory | Prof. Dr. Roelly
- » Emeriti and Former Research Groups

UPCOMING EVENTS

10.10.2018, 10:15 - Haus 9, Raum 2.22 Forschungsseminar Wahrscheinlichkeitstheorie

Gibbsian representation for point processes via hyperedge potentials

Benedikt Jahnel (WIAS) » mehr erfahren

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Integrated approaches to investigate reactive transport processes in soil and groundwater

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Boundary Value Problems on Manifolds with Singularities

Sara Ali Ahmad Khalil

Dept. of Mathematics



Data Science

Is a young science.



- Love child of computer science, statistics, mathematics.
- Understanding and analyzing actual phenomena using data.

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Data Science

Data Science is trending.



Data Science

Data Science is trending.



However, for reference:



Foundations

- Computer Science: algorithms, complexity, parallel computing, computer architectures.
- Statistics, numerics, functional analysis.



THE HALTING PROBLEM IS UNDECIDABLE

Now we are ready to prove Theorem 4.11, the undecidability of the language

 $A_{\mathsf{TM}} = \{ \langle M, w \rangle | \ M \text{ is a TM and } M \text{ accepts } w \}.$

PROOF We assume that A_{TM} is decidable and obtain a contradiction. Suppose that H is a decider for A_{TM} . On input $\langle M, w \rangle$, where M is a TM and w is a string, H halts and accepts if M accepts w. Furthermore, H halts and rejects if M fails to accept w. In other words, we assume that H is a TM, where

 $H(\langle M, w \rangle) = \begin{cases} accept & \text{if } M \text{ accepts } w \\ reject & \text{if } M \text{ does not accept } w. \end{cases}$

Now we construct a new Turing machine D with H as a subroutine. This new TM calls H to determine what M does when the input to M is its own description $\langle M \rangle$. Once D has determined this information, it does the opposite. That is, it rejects if M accepts and accepts if M does not accept. The following is a description of D.

D = "On input $\langle M \rangle$, where M is a TM:

- Run H on input (M, (M)).
- Output the opposite of what H outputs; that is, if H accepts, reject and if H rejects, accept."

Don't be confused by the idea of running a machine on its own description! That is similar to running a program with itself as input, something that does occasionally occur in practice. For example, a compiler is a program that translates other programs. A compiler for the language Pascal may itself be written in Pascal, so running that program on itself would make sense. In summary,

$$D(\langle M \rangle) = \begin{cases} accept & \text{if } M \text{ does not accept } \langle M \rangle \\ reject & \text{if } M \text{ accepts } \langle M \rangle. \end{cases}$$

What happens when we run D with its own description $\langle D\rangle$ as input? In that case we get

$$D(\langle D \rangle) = \begin{cases} accept & \text{if } D \text{ does not accept } \langle D \rangle \\ reject & \text{if } D \text{ accepts } \langle D \rangle. \end{cases}$$

No matter what D does, it is forced to do the opposite, which is obviously a contradiction. Thus neither TM D nor TM H can exist.

Data Science

- In any application field:
 - when enough data becomes available that can be analyzed,
 - Eventually machine learning outperform the traditional engineering methods of this field.
- This has happened in many application fields.
 - Speech recognition.
 - Machine translation.
 - Computer vision.
 - Computational finance.





Data Science

- Data Science will revolutionize many of its application areas.
- As a data scientist, you can be part of that.



"Big Data"

- Web sites we browse (targeted advertising).
- Products we buy (recommendation).
- Astronomy data, physical experiments.
- Genetics and health data.
- Meteorologic data.
- Satellite optical and sensor data.
- Housing prices.

"Small Data"

- In many application areas, data will always be scarce.
 - Pharmacology, medicine: every data point may be a patient in a drug trial.
 - Pharmacokinetics: drug trials on children are impossible. Still have to recommend dosage.
 - Credit default risk: every positive example is a failed loan; old data points are less useful.
- For small-data applications more background knowledge has to go into the model.

- Genomics, metagenomics.
 - Common ancestors? Place in phylogenetic tree?
 - Connection between genome and phenotype?



Recommendation.



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- Autonomous driving:
 - Analysis of traffic scenes.
 - Predicting actions of other participants.
 - Driver state.



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Application Areas

- Precision medicine: Which drug for this particular
 - Mutation of a virus?
 - Cancer cell line?
 - Patient genotype?



- Earth sciences:
 - Safe to build nuclear power plant right here?

Geo

ch Network for Geosciences in Berlin and Potsdam

- Risk of flash flood in 15 minutes?
- Will my sattelite get roasted by a solar flare?



Robotics: The AIs will take away ALL of our jobs.



Dystopic Application Areas

- Predictive policing:
 - Who will commit new crime during parole?
 - Where and when will crimes occur?
 - Who has likely committed a crime?



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Dystopic Application Areas

- Targeted advertising:
 - Who will click on a particular advertisement?
 - Who fits a particular target demographic?
 - Whose behavior can be influenced towards a desired outcome by a particular message?



Data Science Jobs

 Probably the single most highly sought qualification right now.



Data Science Jobs

- Great starting point for academic carreer.
- Plenty of PhD opportunities—for instance in the CRC Data Assimilation.

Data Assimilation

The mathematics of data assimilation is an emerging field that lays the foundation for the seamless integration of large date sets into computational models of evolutionary processes.



Data Science Jobs

Berlin is a hotspot for data science startups.



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Without bridge modules.



With bridge module computer science.



With bridge module stochastics.



These modules are specific courses.



- All other modules are placeholders.
- They can be filled with suitable courses.



- Modules are linked to some courses in PULS.
- You can find a suitable course yourself and have the link created.



Internship:

- Find a company / institute / organization who will let you work on an interesting project.
- Make an appointment with a faculty member who will advise and grade you.



- Research module / thesis:
 - Make an appointment with a faculty member whose courses you enjoyed.
 - Discuss project

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Machine Learning – Prof. Tobias Scheffer



- Research: Machine learning; current topics in clude machine learning for biometric identification, precision medicine, computer security, and model-building in the sciences.
- Lectures Machine Learning I and II.
- Research modules, seminars, internships.

Data Science in Agricuture – Prof. Claire-Marie Höhne



- Research: Explainable AI and domain adaptation, applications of machine learning in agricultural engineering.
- Lectures and research modules on explainable AI and deep learning.

Knowledge Processing and Information Systems – Prof. Torsten Schaub

- Research: Logic-based knowledge representation and knowledge processing; processing of dynamic, incomplete, and inconsistent information.
- Lecture Artificial Intelligence.
- Lecture Advanced Problem Solving Techniques.
- Lecture Declarative Problem Solving and Optimization.
- Research Module Intelligent Logistics Technology.



Embedded Systems Architectures for Signalprocessing – Prof. Benno Stabernack

- Research: Image- and Videoprocessing, Hardware Architectures and HW/SW Co-Design Methodologies.
- Seminar Computer Graphics and Computer Vision.
- Lecture Multi-Media Signal Processing.
- Lecture Parallel Computing.



Design and Test Methodology – Prof. Milos Krstic

- Research: Computer engineering, design methods of fault tolerant computing systems.
- Lecture Computer Architectures for AI Applications.
- Lecture Reliability and Fault Tolerance.
- Lecture Introduction to Hardware Description Languages.



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Operating Systems and Distributed Systems – Prof. Bettina Schnor



- Research: distributed and parallel systems with special focus on high-performance communication and security.
- Lecture Architectures and Middleware for Scientific Computing.
- Seminar Intrusion Detection.
- Research Seinar Cluster Computing.
- Seminar Secure Communication Networks.

Complex Multi-Medial Application Architextures – Prof. Ulrike Lucke



- Research: interoperability of heterogeneous IT landscapes, architectures, and interfaces.
- Lecture Research Data Management.
- Seminar on Law and Ethics.

Software Engineering – Prof. Anna-Lena Lamprecht



- Research: research software and research software engineering; software quality in science, FAIR (findable, accessible, interoperable, reusable) software, the role of software in open science, computational workflows and their automated construction
- Lectures Software Engineering I and II.
- Quality in Software Engineering.

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Boundary Value Problems on Manifolds with Singularities

Sara Ali Ahmad Khalil

Mathematical Statistics and Machine Learning – Prof. Alexandra Carpentier



- Research: high dimensional inference and sequential learning; sequential and adaptive sampling problems related to bandit problems.
- Lecture Mathematics of Machine Learning.
- Lecture Foundations of Stochastics.
- Seminar Statistics, Machine Learning, and Probability.

Data Assimilation – Prof. Melina Freitag



- Research: Numerical linear algebra, iterative methods for eigenvalue problems and linear systems; data assimilation and inverse problems.
- Lecture Numerical Optimization.
- Seminar Matrix Methods in Data Science.
- Research Seminar Numerical Analysis.

Numerical Mathematics – Prof. Sebastian Reich

- Research: Data analysis, modeling, simulation, and data assimilation.
- Lecture Bayesian Inference and Data Assimilation.
- Lecture Interdisciplinary Applied Mathematics.
- Seminar Data Assimilation.



Uncertainty Quantification – Prof. Han Cheng Li



- Research: Bayesian inference, numerical methods for approxiation of diffusion processes.
- Lecture Gaussian Processes.
- Lecture Foundations of Stochastics.

Mathematical Modeling and Systems Biology – Prof. Wilhelm Huisinga

- Research: Systems biology; pharmacokinetics, drug discovery.
- Lecture Statistics.
- Lecture Introduction to Theoretical Systems Biology.
- Seminar Data Analysis and Statistics in Drug Discovery and Development.
- Seminar Systems Biology in Drug Discovery and Development.

Probability Theory – Prof. Sylvie Roelly

- Research: Stochastic processes and applications biology and statistical mechanics.
- Lecture Stochastics.
- Lecture Advanced Probability Theory.
- Research Seminar Probability.



Department of Linguistics \rightarrow Foundations of Computational Linguistics – Prof. David Schlangen

- Research: Computational linguistics, multimodal dialogue, human-computer interaction.
- Lecture Advanced Natural Language Processing.
- Seminar Language, Vision, and Understanding.



Business Information Systems → Social Media and Data Science – Prof. Hanna Krasnova

- Research: social, individual and enterprise value of the emerging social media applications.
- Lecture Data Science and Business Analytics.
- Social Media Research Project.

Department of Biochemistry and Biology \rightarrow Bioinformatics – Prof. Zoran Nikoloski

- Research: cellular markers characterizing biological processes such as which gene products respond most significantly to external stimuli.
- Lecture Algorithmic and Mathematical Bioinformatiks.
- Lecture Data Integration in Cellular Networks.
- Seminar Advanced Methods for Analysis of Biochemical Networks.



Digital Engineering Faculty



Artificial Intelligence and Intelligent Systems – Prof. Gerard de Melo



- Research: Natural language processing, deep learning, knowledge graphs, multimodality and data integration.
- Leture Natural Languaga Processing.
- Research Module Knowledge Graphs for Explainable AI.

Artificial Intelligence and Sustainability – Prof. Ralf Herbrich

- Research: Energy and artificial intelligence.
- Letures TBD.

Data Analytics and Computational Statistics – Prof. Bernhard Renard



- Research: statistical and IT methods to automatically evaluate large amounts of data, filter out relevant signals, and integrate pertinent prior knowledge.
- Lecture Applied Probabilistic Machine Learning.
- Lecture Computational Statistics.

Digital Health and Machine Learning – Prof. Christoph Lippert



- Research: Machine Learning and Artificial Intelligence algorithms and novel applications in medicine; detection of disease patterns in images and molecular data
- Lecture Deep Learnin.
- Lecture Mathematics for Machine Learning.

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