TDDD89 - Scientific Method

Lecture 1 Introduction

Christoph Kessler



Part I: General Information

- Course format
- Activities
- Examination

Part II: Towards a great thesis

(tomorrow afternoon)

- What is a *good* thesis project?
- Overall thesis structure Continued in first part of Lecture 2
- Thesis project types



Part I: General Information



Learning Goals

- Compare and evaluate **scientific and engineering methods** in the topic area selected by each student.
- Find, summarize and reference **related work** and **background literature**. ۰
- Critically **evaluate** scientific works. ۰
- Learn about requirements, structure, format of a master thesis
 - By reading *guidelines* and *best-practices papers*.
 - By reading a sample master thesis.
 - By writing an *extended thesis project plan* for a real or fictitious master thesis project.
- Formulate a **scientific text** using generally accepted standards ۲
- COURSE CONTENTS/LITERATURE IS SPECIFIC TO COMPUTER SCIENCE AND ENGINEERING – Write, and critically review, a **project plan** for an academic study, including method, tasks, time plan, risk analysis.
 - Practice writing, and critically reviewing, text for thesis sections on Introduction (research questions), Background and Related work.
 - Learn about proper use of **academic English**.
- Assess and manage **ethical issues** and **societal aspects** of science and engineering in their topic area. ۲
- Insight into **different forms, fields and career paths** for **professional work in computer science and engineering** related areas, especially in **research and development** in an **international** context, in both industry, research organizations and academic institutions.

Organization

- Practice scientific work, writing, and project planning *before* starting the master's thesis project
 - If you happen to already know your *real* master thesis project, you *can* work with it in the course,
 - otherwise, find *some* thesis topic of interest to work with during the *course*.
 - Seminar group work is mostly topic-area specific
- Focus on formulating research questions, literature review and survey of background and related work, and an initial description of a research method.
- 6 lectures
 - Thesis structure; Topic selection and career paths in R&D; Literature search and analysis; Academic English; Research methods; English feedback, Thesis process, Outlook
- 6 seminars
 - Mandatory presence
 - Guiding questions with hand-in preparation before each seminar
 - Group work, with feedback by group peers and by group leader
- Hybrid course: All seminars (on Thursdays 08:15) and some lectures **on distance**!
 - 2020, 2021, 2022, 2023: zoom breakout rooms worked better for the document-centric group work than the noisy on-campus seminar rooms

Course format and staff

- 6 x 2h **lectures**
- 6 x 2h seminars
 - theme-specific groups
 - Group leaders:
 - Christoph Kessler (Group A)
 - Zeeshan Afzal (Group B)
 - Navya Sivaraman (Group C)
 - August Ernstsson (Group D)
 - John Tinnerholm (Group E)
 - Szilvia Varro-Gyapay (Group F)
 - Jose Antonio Hernandez-Lopez (Group G)
 - Willem Meijer (Group H)



- Feedback seminar on research questions, by group leaders
- Feedback lecture on Academic English and Stylistic Issues, with Shelley Torgnyson and C.K.



Lectures

- 1. Introduction (Christoph Kessler)
- 2. Introduction (cont.): (C.K. and guest speakers) Common thesis types. Panel: Outlook to working and career paths in academic and industry R&D (and what the thesis topic selection may have to do with it...)
- 3. Literature search and evaluation (C.K.)
- 4. Introduction to academic writing in English (Shelley Torgnyson Mikael Svensson)
- 5. Scientific methods (C.K.)
- 6. Feedback on academic English (Shelley Torgnyson); Outlook to the master thesis process (C.K.)



Course web page

https://www.ida.liu.se/~TDDD89/



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Search	Search IDA.LiU.se	~	Search
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Swedish web site

LiU ► IDA ► Undergraduate ► Courses ► TDDD89

TDDD89 (Fall 2023)

	TDDD89 Scientific Method (6 ECTS)							
Syllabus								
Course Information	HT2 2023							
Timetable and Deadlines								
Resources	l gtest News							
Lectures								
Grading Rubric	2023-10-17 Find a team mate for the seminars A shared spreadsheet for finding a team mate for the seminars has been set up in the Lisam cooperative area for the							
Examination	course (login required). Information will be given in the first lecture.							
All Messages	2023-10-10 Course HT2023 given in hybrid mode / Course web page being updated for HT2/2023							
Contact	As listed in the course syllabus, the mandatory-attendance seminars and two of the lectures will be given entirely on							
	distance (zoom) also in HT2/2023, due to more convenient group work on text documents via screen sharing in zoom and due to chapters of scores that would be suitable for the cominant.							
SEMINARS (UPG2)	Lectures and seminars will be given live and will <i>not</i> be recorded.							
General Information + rules	We started updating the course web pages for the coming instance of TDDD89 HT2/2023.							
Getting started	By and large, the 2023 course will follow the same structure as 2022.							
Mandatory attendance	All course information and instructions will be given here on the course web page. We use Lisam only for group cooperation in the seminars and for submission, and for non-nublic documents (e.g., zoom session links).							
Seminar Topic Groups								
Thesis topic outline (2/11)								

Seminar

Thesis to

Seminar 1

Seminar 2

Feedback Seminar

Seminar 3

Seminar 4

Seminar 5

FINAL SUBMISSION (UPG1)

Final thesis plan submission



LISAM (REPO/SUBM ONLY) Main LISAM page (group

work area, UPG2)

Subm. for feedback on Introduction (17/11)

Final submissions (UPG1)

Page responsible: Christoph Kessler Last updated: 2023-10-17

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LISAM - Shared workspace and document submission

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	Schedule			- 2	Zoom-links				A few seco	onds ago	Christoph Kessler	1.0			
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Resources



IDA - Department of Computer and Information Science

LIU
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Courses
TDDD89
Info
Resources

Syllabus

Resources Lectures

Contact

Seminar 1

Seminar 2

Seminar 3

Seminar 4

Seminar 5

TDDD89 (Fall 2024) TDDD89 Scientific Method Resources Course Information Timetable and Deadlines Degree projects (Master theses 30hp) at IDA (valid since 15/8/2024, new page on Liunet, requires LiU login) Instructions for students regarding thesis works (30hp) at IDA (PDF, requires LiU login) Grading Rubric Degree projects at ISY exjobb.liu.se, new exjobb-project database at LiU Examination For further currently open internal thesis projects, check also open thesis projects at IDA (forthcoming on LiUnet) as well All Messages thesis projects announced on the personal web pages of IDA researchers and research labs/divisions, and on the ISY exjo web page. You can also talk to the teachers in relevant advanced-level courses that you are taking. Template for an IDA thesis project specification Such a project specification (including self-assessment of project-specific prerequisites and availability of resources) is SEMINARS (UPG2) required for the IDA wexupp registration, deadline 15 working days before the beginning of the lecturing period containing the desired project start date. You can possibly reuse text from the TDDD89 ETP (UPG1) if it was for the same project. General information + rules Template for an IDA master thesis project plan Getting started The (real) thesis project plan is due 2 weeks after project start. This is the generic structure for IDA, i.e., minimum Mandatory attendance requirements; your thesis examinator might have further requirements. You can possibly reuse text from the TDDD89 ET (UPG1) if it was for the same project. Seminar Topic Groups Checklist for degree project at the second cycle (Master's) level Thesis topic outline (7/11) J. Åberg: Introduction to scientific methods (in Swedish) ACM Code of Ethics and Professional Conduct (see also the PDF poster). IEEE Code of Ethics Writing a thesis Feedback Seminar J. Åberg (2015). Instructions for final thesis reports. (English, Swedish). C. Kessler: Stylistic advice to my students for writing a thesis N. Ramsey: Learning Technical Writing Using The Engineering Method, Tufts University, 2016. LiU Academic English Support (AES) (no web page available any more - see guest lecture by Shelley Torgnyson for references)

IEEE Editorial Style Manual, official manual by the Institute of Electrical and Electronics Engineers, used by engineers in Computer Science and Electrical Engineering (adf)

[<u>=</u>]

Search

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Search IDA.LiU.se 🚿



Working in pairs - Find a partner

Seminar work such as extended thesis plan writing is done in pairs.

Exception for those who already have their "real" final project and know they will do it alone.

No partner for the course yet?

Use (today!) this matchmaking spreadsheet linked from the course web page:

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	3 If you already know yo	ur final thesis topic and/or	have a partner to do 1	רDDD89 group work ו	vith, you can ignore this and proceed to elabora	ting your topic submission.	
	4 See the course web	page (https://www.ida.liu.s	e/~TDDD89) and first	lecture for instructi	ons.		
	5 Otherwise, you could	use this spreadsheet for fin	ding a team mate for	doing the TDDD89 p	piert together. (It is not used for topic submission		
	6 If you have a favorite	topic or area (see the cour	se web page for group	work topics for sug	estions) to work with during the course, put you	ir name and other information in an emr	ty row below
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	9 H you hind someone	in this list with an interestin	ig topic/area, contact	that person. After yo	agreed to team up, remove both your entries i	fom this document.	
	10 All teams need be form	ned by thursday 7 Novemb	per at the latest, which	n is the deadline for t	ppic-outline submissions (Lisam folder "Thesis-	topic-outlines Deadline-7 Nov 2024")	. Further informatio
	10 we especially recomm	end the second lecture on 5	5/11.				
	11 NB If you do not subr	nit a topic submission by 7	November, we assume	e that you will not tak	e the course in this year.		
_	12 This shared document	is only for matchmaking (n	ot for team registratio	n) and will be delete	after 7 November.		
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G S	LiU-ID	First name	Last name	Study program	iopic(s) rain interested in for the course	Topic area(s) I am interested in for th	e course work
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Selecting some thesis topic to work with in this course

SharePoint	Ø Search across sites					\leftrightarrow \Rightarrow G	i www.isy.liu.se/edu/xj	iobb/											
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 There should be an authorized ex <u>examiners</u>. IDA can help you to fin and routines for the degree project 	aminer from IDA and a superisor from IDA. <u>List of authorized</u> d a supervisor and/or examiner in certain cases, see Rules rt at the advanced level (below).		 16hp 30hp 	Master Thesis - Information Theoretic Security Proofs and Methods	Liu Isy Icg	Tillämpad matematik	2025-01-01	2 examinator our Erri-Handiduare 2 examinatorer av TGZ-kurser											
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ECTS) Most of the degree projects at the basic level that IDA administrates are from the bachelor program in Computer Engineering and the bachelor program in programming. Degree projects within these programs are organized as separate courses with own rules and routines. Please check the links to the right if you want to learn more about the degree projects at these programmes. Students from the other programmes are assumed to follow the routines for the advanced level degree projects. With the following adjustments: • Two auscultations are required instead of three • Half time check is not required.			You can find some extern the differen IDA and ISY	further opp al thesis pro t researche , e.g. <u>https</u>	ojects rs and ://www	on the wel research w.ida.liu.se	b pages of – groups at e/~pelab	 Datorseende Datorteknik Elektroniska kretsar och system Informationskodning Fordonssystem 											
Rules and routines for t	he degree p Deadline	fo	r topic su	bmissio	n (li	ke lab i	registrat	ion): Thursday 7/11/2024											

New Instructions 30 ECTS projects

Uunet

level (30 ECTS)

Sample theses - define the group topic areas

IDA - Department of Computer and Information Science

LiU > IDA > Undergraduate > Courses > TDDD89 > Seminars > Seminar Topic Groups and Sample Master Theses

TDDD89 (Fall 2022)

Syllabus

Course Information

Timetable and Deadlines

Resources

Lectures

Grading Rubric

Examination

All Messages

Contact

SEMINARS (UPG2)

General information + rules

Getting started

Mandatory attendance

Seminar Topic Groups

Thesis topic outline (3/11)

Seminar 1

Seminar 2

Feedback Seminar

Seminar 3

TDDD89 Scientific Method

Seminar Topic Groups and Sample Master Theses

Seminar Topic/Method Groups and Sample Master Theses

The following selected Masters' theses pertain to the different groups' topics and/or research method types. Each thesis has a number of keywords describing it by topic area and method type, and seminar groups are formed based on the similarity of the thesis topic outlines submitted by students in the first week.

- Topic 1: Software development processes, software quality Case study:
 "Vertically Scaling Agile: A Multiple-Case Study" by Nicklas Östman and Rasmus Lindström, Linköping University 2017.
- Topic 2: Programming framework, parallel systems, compilers, metaprogramming, performance Design, Prototype implementation: "SkePU 2: Language Embedding and Compiler Support for Flexible and Type-Safe Skeleton Programming", by August Ernstsson, Linköping University 2016.
- Topic 3: Business software, services, software contracts Usability study, iterative development: "Usability of a Business Software Solution for Financial Follow-up Information of Service Contracts" by Therese Borg, Link
- University 2018.
- Topic 4: Machine learning, data mining, image processing Experimentation:
 "3D reconstruction from satellite imagery using deep learning" by Tim Yngesjö, Linköping University 2021.
- Topic 5: Security Evaluation:
 - "Certificate Transparency in Theory and Practice" by Josef Gustafsson, Linköping University 2016.
 - Topic 6: Algorithms, scheduling, embedded realtime systems, metaheuristics Improvement, optimization, analysis: "Performance Optimizing Priority Assignment in Embedded Soft Real-time Applications" by Fredrik Bergstrand and Tobias Edqvist, Linköping University 2018.

Absolutely no idea for a topic? Take one of these – as a last resort, so you have something to work with during the course.

Topic groups and seminar groups will be assigned based on the submitted thesis topic outlines.

Choosing a closest thesis topic area / method type¹⁴ from the list of sample master's theses

- 1. Software development processes, software quality / Case study
- 2. Programming framework, parallel systems, performance /

Design, prototype implementation

3. Business software, services, software contracts /

Usability study, iterative development

- 4. Machine learning, data mining, image processing / Experimentation
- 5. Security / Evaluation
- 6. Algorithms, scheduling, embedded / realtime systems, metaheuristics / Improvement, optimization, analysis



Getting started: An early deadline

- By Thursday (!):
 - Find a partner to work with
 - Find a topic to work with
 - Find the closest topic area (1-6)
 - Find the closest method type (1-6)
 - Submit a *thesis topic outline* (max. 1 page)
 - File (.pdf), e.g. "liuid001_liuid002_topic.pdf"
 - Put it in LISAM collaborative workspace folder "Thesis-topic-outlines_Deadline_7_Nov_2024"
- By next monday, you will be divided into seminar groups based on your selected topics / research method types.
 - We will then sign you up in a webreg group (A-H, see schedule) for UPG2.

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Start

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SM Scientific N	lethod (TDE	DB9 2024H	T KA)			
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Course plan						
Course documents	Collaborat	ive workspace	\mathbb{I}/\mathcal{I}			
Collaborative workspace	D	Name \vee		Modified	~	Modified By
Members and groups		Thesis-topic-outline	es_Deadline-7_Nov_2024	4 October 21		Christoph Kessl
Schedule	-	Zoom-links		A few secor	nds ago	Christoph Kessk
Quiz		Find_a_team_mate_	for_TDDD89.xlsx	October 21		Christoph Kessk
Submissions						

Up to 28 Seminar topic groups: {A,...,H} x {1,...,4} (mapping to be announced early on Monday 6/11)



Seminars

Seminar	Read in sample thesis	Write extended thesis plan	
1	Introduction, Background+Related work / Theory		
2		Introduction incl. research questions → ca. 2 pages + references	Submission of introductions 22/11 for feedback
FB	Feedback session semir	nar on research questions	(1) from Shelley and
3		Introduction incl. res. questions, Background, Related work → ca. 5 pages + references	academic English (2) from your group supervisor on the
4	Method, Results, Discussion, Conclusion		research questions
5		Introduction incl. res. questions, Background, Related work, project plan → ca. 8 pages + references	then revise for

Seminars 1 and 4: Reading the sample thesis

"Are the research questions in the published thesis easy to find, clear and with a reasonable scope, as required by the *instructions for final thesis reports* ?" ...



ILU UNCERE Scientif	ic Method	
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Seminars 2, 3, 5: Writing an extended thesis plan + feedback

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TDDD89 Scientific Method Examination

- UPG2 (2hp): Preparation and participation in *seminars* during the course (weekly deadlines)
 partly individually, partly per team
- UPG1 (4hp): *Extended thesis plan*, to be finished at the end of the course (deadline 11 January)
 per team (pair) of students





Seminars





Avoid distractions.

Have your solution ready in Lisam. Use screensharing.

Take notes!

Webcam on during seminar group work

Recording is not permitted



General rules for group work – Group Contract

- Participation is documented by zoom login with LiU-ID.
- Webcam is on for everyone. No recording.
- All material needs to be available during discussions (in group folder on Lisam). Use screen sharing in zoom. The group chairperson is responsible for the screen-sharing.
- Use English, at least if a non-Swedish speaking participant or seminar leader is present.
- All need to actively participate.
 - Aim for equal participation.
 - The group chairperson keeps track of the time.
 - Shuffle the role of the group chairperson over the seminars.
- Give clear and constructive feedback to your group peers.
 Be polite. Criticize the draft / answer given, not the person(s) behind.
- Take notes!
- If anything is unclear: collect these issues and ask the seminar leader when visiting your room.
- Individually, submit 4-5 lines of discussion outcome to your seminar leader at the end (email).

Final submissions





Workload distribution

160h total:

Plan your time, look ahead and read the course description document thoroughly

Seminar	Work %
1	20
2	15
3	20
4	20
5	15
Final submission	10



Recent changes based on course evaluation feedback

- Widely appreciated and kept: the **hybrid** format (see syllabus)
 - Seminars in zoom breakout rooms
 - Was perceived by many as BETTER than physical seminars (screensharing is convenient, less background noise, no need to move tables around)
 - provided that one can *see* each other during discussions and microphones are working properly.
 - Some *lectures* remain virtual, too
 - helps to reduce schedule conflicts as LiU does not have enough large lecture halls
- The *panel discussion* was appreciated and kept in its early position (Lecture 2) to possibly help with the course topic selection before the deadline 7/11
- Compensation assignment for missed seminars and late preparation hand-in has been updated/clarified
- Reading *Method* chapter of the sample thesis moved since 2021 from Seminar 1 to Seminar 4
 - to reduce time pressure before Seminar 1 deadline
- Seminars moved from Tuesdays to Thursdays / submission deadlines moved from Sundays to Tuesdays
 - Less stressful, kept also for this year
- We admit singleton groups if you already know your *real* thesis topic and that you will do it alone.



Part 2: Getting Started

Towards a Great Thesis



What is a great thesis?

Thesis = project results + written presentation

Example:

- A working, interesting application with proven and general value
 - A well-described *application*
 - of general *interest*
 - and with a clear description of "proven" and "value"



What is a great thesis?

Thesis = project results + written presentation

- Includes an **evaluation** with
 - general and
 - interesting results
 - that others can use
 - that others will **believe**



What is a great thesis?

Thesis = project results + written presentation

• An authoritative report

with a good focus (→ research questions!)
and results that answer the questions
through a transparent, thorough description of the process



Getting started: Elaborate the requirements → find the research problem / research questions





Precise requirement -

Relevance vs. Rigor



Thesis outline

Why should I even read this thesis?

What have you studied here?

What does this relate to?

Can I trust you?

What is built?

What have you found?

How can we explain the results?

How can I use these results in my work?

Hourglass model for technical reports: Usually, most specific in the middle (details, technicalities)





Thesis outline



Hourglass model for technical reports: Usually, most specific in the middle (details, technicalities)





Thesis outline

Remark: This very generic thesis structure, which we use in this course, is not necessarily the best choice for the *chapter* structure and -titles of your thesis. For your final thesis, you might find a more specific chapter structure and titles, but make sure to duly cover all these *aspects* somewhere.

Abstract

Research Questions

Background, Related Work / Theory

Method

Implementation

Results

Discussion

Conclusion

What is a good research question in Computer Science?

Question type Example question

Type of answer

Different research questions in Software Engineering, adapted from: Mary Shaw: Writing Good Software Engineering Research Papers: Minitutorial. Proc. 25th International Conference on Software Engineering, ICSE '03, pages 726-736, 2003. IEEE Computer Society.

What is a good research question in Computer Science?

Question type	Example question	Type of answer
Means of development	What is the most efficient software testing method for a small team developing a mobile application?	Procedure
General method for analysis	How can one verify conformance to real-time constraints in a multi-threaded embedded system?	Analysis method
Specific evaluation of systems	When is PhoneGap more economical to use than NativeGoo for cross-platform mobile development?	Empirical predictive model based on data
Generalization or characterisation	Given recent results in tuning deep neural networks, which meta-heuristics should be used for exploring the parameter space?	Classification, taxonomy
Feasibility study	Can one automate a car?	Specific implementation, empirical observations

Different research questions in Software Engineering, adapted from: Mary Shaw: Writing Good Software Engineering Research Papers: Minitutorial. Proc. 25th International Conference on Software Engineering, ICSE '03, pages 726-736, 2003. IEEE Computer Society.

Towards A Great Thesis



I - The Problem

Start from a problem that people may be interested in (at least a few more than those who gave you your task)

 → Motivation and Aims
 → Formulate explicit research questions





Evaluating a research question

- "How can one construct a web application?"
- "Is it possible to construct a mobile application for functionality X?"
- "How can one create a usable website?"

Is the answer any of the following?

By writing what has already been written many times before

Yes, there is no reason to believe it could not be done. By adhering to published design guideline Y

Then come up with a better question...



Arriving at interesting research questions

- Start exploring a field:
 - "How can fuzz testing be used to find bugs in concurrent embedded software?"
- Then, use existing technical approaches and theoretical models:
 - "Combining with dynamic and static analysis of schedulability of embedded real-time systems"
 - "What is the efficiency of AFL at finding timing-related errors in concurrent software?"



The journey to a better question

Question	Approach	Objection
How can we automate testing?	Applying automatic generation of test cases	We end up with 10 ⁷ test cases, only some of which are necessary

The journey to a better question

Question	Approach	Objection
How can we automate testing?	Applying automatic generation of test cases	We end up with 10 ⁷ test cases, only some of which are necessary
How can we select <i>relevant</i> test cases?	Applying statistical/ML clustering techniques	Black-box solution with no known accuracy, we need traceability
How can we <i>automatically</i> <i>prioritize</i> test cases?	Optimize based on historical records to maximize <i>a</i> verage <i>p</i> ercentage <i>f</i> aults <i>d</i> etected (APFD)	No weight given to critical functionality
What do we really want to <i>optimize</i> ?	Listen, observe, collect data	Requires an open mindset

2 - the Theory

"Theory":

Rooting your work in your subject area's scientific body of knowledge

 \rightarrow create *trust* in your work

- Background
- Formalization/Modeling
- Related Work



"In God We Trust – All Others Must Bring Data!"

--- W. Edwards Deming



Convince the reader!

- In many cases, you will produce some code as part of your thesis project. This is not enough for your thesis work, though.
 - Is this a *relevant* problem?
 - Is this work based on the *state-of-the-art techniques* in the field?
 - Does it *improve* or *generalize* over previous work? And how?
 - Are all claims made *proven* in the thesis, or based on *trustworthy sources*?
- You need to convince your (critical) audience that you have done a great job! They do not know you ...
 - ... nor your supervisor
 - ... nor your company
 - so better be convincing!
- By anchoring your work in the scientific body of knowledge of your field

Theory

Compare these two claims:

"There are seven dimensions of usability"

"NP-hard problems are at least as hard as the hardest NP problems"

Theory: Characterization of knowledge, accumulated through scientific studies, published in peer-reviewed journals and conferences

Criteria:			
Validation			
Does it describe			
the world?			

Is it proven?



Modeling / Formalization

- Isolate and abstract the core problem
- Models = abstractions
 - Distill and formally describe the main relevant properties of a complex real system
 - Example: Models of computation, CPU performance / energy models
 - Formalization: Key parameters, set theory, equations, constraints, graphs, abstract data types, formal logic reasoning, ...
- Empirical observations are based on expectations, informed by theoretical frameworks (models):
 - When reading **power consumption** values of a modern CPU, we expect that it depends on the CPU's different **power states** (e.g., voltage/frequency level)
- Based on observations, you can **test claims** made by your theory
- → **Generalizability** of your result beyond the concrete problem instance



"There is Nothing so Practical as a Good Theory"

--- Kurt Lewin, 1890-1947, social psychologist



How to convince the reader (aka. a Method)

In industry as well as in academia, well-presented working solutions based on widely trusted state-of-the-art techniques are the best means of convincing the reader.

In the scientific community, we also require claims about solutions to be **sound**, so others can rely on them in their work.



Type of Method	Example scenario
used to obtain and	
validate results	

Type of Method used to obtain and validate results	Example scenario
Analysis	I have conducted a formal analysis of my algorithm, and have proved that it solves the TSP in O(N ²), thus proving that P=NP
Evaluation	I have compared code review results with interviews and surveys, and found that if you test software, you are more likely to find faults than if you do not
Experience	I report on experience with aligning software architecture with code based on 20 years of software development for Swedish Social Security and have found that software architectures are essentially useless
Example/Prototype	This tool can recognize location and pose, so when you enter a bathroom it will give you valuable advertisements on Facebook while sitting down.

Method



For theses that involve creating a product / prototype, you need to **assess the external or internal qualities** of what you produce (e.g. usability, correctness, or scalability), using **qualitative** or **quantitative methods**.

Other types of theses that do not involve creating products/prototypes (e.g., systematic literature reviews) have their own established criteria for assessment.

You want to ensure that what you are studying does represent reality. This is called *external validity*.

Reproducible Results

All details about your assessment method need be carefully documented in the thesis

 e.g., test data sets, benchmarks, code, system, experimental setup

Allows others to follow the same setup to obtain the same data

→ Reproducibility increases trust in your work.

Algorithms	Implementations	Number of runs	Hyper-parameters
nearest centroid classifier	NearestCentroid	3	<pre>netric # {*11*;*12*;*cosine*}</pre>
naive Bayes classifier (multinomial distribution)	MultinomialNB	22	alpha€np.linspace(0,1,11) fit_prior∈{True;False}
Linear SVM	LinearSVC	20	<pre>C∈np.logspace(-4, 4, 10) loss∈{"squared_hinge";"hinge"} class_weight="balanced"</pre>
Logistic Regression	LogisticRegression	40	<pre>dual=False C Enp.logspace(-4, 4, 10) class_weight="balanced" solver E {"newton-cg";"sag";"lbfgs"} multi_class="multinomial" dual=True C Enp.logspace(-4, 4, 10) class_weight="balanced" solver="liblinear" multi_class="ovr"</pre>
Perceptron	Perceptron	13	<pre>penalty @["12";"elastionet"] alpha E 10.0**-np.arange(1,7) class_weight = "balanced"</pre>
Stochastic gradient descent	SGDClassifier	120	<pre>"squared_hinge";"perceptron"] penalty E["12";"elasticnet"] alpha © 10.0**-np.arange(1,7) class_weight="balanced" average © {True;False}</pre>

Table 3.8: The different configurations of the experiment 4



More about Research Methods in Lecture 4 ...

Thesis structure and format For theses in mathematics, computer LIST OF TADICS × **Bookmarks** science and engineering Introduction Motivation := I recommend Aim Research Questions using LATEX. Abstract Delimitations . . Thesis Overview Contents List of Figures Background Data Plane Development Kit . . List of Tables Encryption Pay attention to the structure, formatting and typesetting of your thesis, Intr > 🔲 Bac and start to write early. Rela > 🛛 🔤 Few people have accurate estimates of how long it takes to write a thesis. > 🔍 Results 3 Related Work 15Exploiting Integrated GPUs for Network Packet Processing Workloads 15Discussion Processing data streams with hard real-time constraints on heterogeneous systems . 3.216Machine Learning-Based Runtime Scheduler for Mobile Offloading Framework . . . 16 Conclusions and Future Machine learning based online performance prediction for runtime parallelization Work and task scheduling. 17 Bibliography 2.5 Delay Ontimal Computation Task Scheduling for Mobile-Edge Computing Systems . 17B. Le Gal and C. Jego. "High-Throughput LDPC Decoder on Low-Power Embedded Proces-[45] ning Strategy for Task Scheduling of WSNs with Mobile Nodes 17 sors". In: IEEE Communications Letters 19.11 (Nov. 2015), pp. 1861-1864. ISSN: 1089-7798. 1 Packet Classification on FPGA, Multi-core General Purpose

DOI: 10.1109/LCOMM.2015.2477081

Summary so far:

A great thesis:

- An interesting problem
- A convincing theory
- A reliable method
- A working solution
- Established effects
- Great presentation



To be continued in the next lecture ...

- Engineering vs. Science?
- Common thesis types
- Also:

Panel discussion: Outlook to a professional career in industrial or academic R&D (and what the thesis topic selection may have to do with it...)

- Important for answering preparatory questions before Seminar 1
- On zoom, tomorrow Tuesday 15:15 zoom link see Lisam cooperative area



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