

A high-angle photograph of a modern university atrium. A large, white, triangular structural element dominates the center, creating a sense of depth and architectural interest. The atrium has multiple levels with glass railings. Large windows on the right side provide ample natural light. In the lower level, several people are sitting at round tables on a green patterned rug, engaged in study or discussion. A staircase is visible in the bottom left corner.

Advanced Research Methods Syllabus 2018-2019

General information

Title	Advanced Research Methods
Acronym	ARM
Course code	INFOARM
Period	2018-2019 - 2
Time slot	C
Study program	Master in Business Informatics
Level	Master first year
ECTS Credits	7.5
Course type	Mandatory for the Master in Business Informatics
Department	Department of Information and Computing Sciences, Utrecht University
Osiris	https://osiris.uu.nl/osiris_student_uuprd/OnderwijsCatalogusSelect.do?selectie=cursus&collegejaar=2018&cursus=INFOARM
Blackboard	https://uu.blackboard.com/webapps/blackboard/content/listContentEditable.jsp?content_id=2909610_1&course_id=117431_1&mode=reset
Educational page	http://www.cs.uu.nl/education/vak.php?stijl=2&vak=INFOARM&jaar=2018
Language	English
Author	Marcela Ruiz (m.ruiz@uu.nl)
Builds on	Bachelor course INFOWO (INKU UU)
Notification	All information in this Course Syllabus as well as on the Blackboard overrules and supersedes less updated information from other sources, especially course information on Osiris and educational page.



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1 Introduction

Research is curiosity-driven; it is about studying phenomena while becoming the creator of novel inventions. The advanced research methods course provides an initial research experience in the framework of the Master in Business Informatics program. The research methods prevalent in the field of information science (quantitative, qualitative, and design science) are taught. Based on the knowledge in this course and related courses, students can make a well-founded choice for their graduation research, and professional career.

During your studies and professional career, you will come across research in its various manifestations. To learn about how to properly conduct a research project, you need to read about it, and practice by means of exercises and assignments. In the advanced research methods course you will follow systematic protocols for designing and executing a research project. In the context of this course, students will design a comparative-based experiment to validate an artefact in context. This course consists of a combination of lectures, lab sessions, coaching sessions with the teachers, one research assignment, one world café session, and one exam.

2 Contents: Themes of the course

The ARM course provides students with knowledge in the field of empirical research methods and statistics. The course is interdisciplinary, since students have the opportunity to investigate information or computer science artefacts in real contexts. The research focus of the assignment is aligned with the [three research pillars](#) of the MBI program: Complex Software Systems, Data Science Systems, and Learning and Persuasive Technologies. Enrolled students must have completed the course scientific research methods (Wetenschappelijke onderzoeksmethoden - INFOWO) or an equivalent course in order to appreciate the research methods and statistical tests studied in this course

The course contents cover the following themes:

Theme 1. Design Science

Design Science is the design and investigation of artefacts in context. Design Science describes a research method for in information systems and software engineering. It provides guidelines for how to structure research goals and analyse research problems into design goals and knowledge questions. For the ARM course, the students dive into the design or engineering and empirical cycles.

The contents for this theme are:

- A framework for Design Science
- The Design Cycle
- The Empirical Cycle

Theme 2. Empirical research methods

For the ARM course, the students discuss a set of empirical research methods to support treatment validation tasks. The main focus of this theme is on sample-based experiments. In addition, the students are instructed on the main aspects of scientific integrity and research presentation.



The contents for this theme are:

- Ethics in research
- A road map of research methods: Experiments (sample-based and case-based), technical and canonical action research, observational case study research, Systematic Literature Review (SLR).
- Presentation and package

Theme 3. Advanced statistics

For this theme, the students are instructed with advanced inferential statistics for the data analysis. The contents for this theme are:

- Statistics fundamentals
- Data analysis and the empirical cycle
- Advanced statistical tests

3 Practical information

3.1 Dedication

The ARM course is 7.5 ECTs or 200 hours per person. The successful student can earn 7.5 ECTs after a sufficient completion of the course. Average students dedicates 20 hours per week studying the modules of the course. Table 1 presents an estimation of students' dedication per week in the different activities of the course.

Table 1. Average students' dedication in terms of hours per week

Week number	Activities of the course	Dedication (hours)
46	Lectures	4
	Prepare assignment A1	6
	Self-study	10
47	Lectures	4
	Self-study	10
	Prepare assignment A1	6
48	Coaching	2
	Lectures	4
	Lab session	2
	Self-study	12
49	Coaching	2
	Lectures	4
	Lab session	2
	Self-study – Prepare for assignment A2	12
50	Coaching	2
	Lectures	4
	Lab session	2
	Self-study – Prepare for assignment A2	12
51	Coaching	2
	Lectures	4
	Lab session	2
	Self-study – Prepare for assignment A2	12



52	N/A (Christmas week)	
1	N/A (New Year week)	
2	Coaching	2
	Lectures	4
	Lab session	2
	Self-study – Prepare for assignment A2	12
3	Coaching	2
	Lectures	4
	Lab session	2
	Self-study – Prepare for RMP and SP exam, assignment A3, assignment A4 and A5	12
4	Lectures	2
	World cafe	4
	Self-study – Prepare for RMP and SP exam, assignment A5, Assignment A5	14
5	Self-study- RMP and SP exam, assignment A5	20
Total amount of hours: 210		

Please note that the time for self-study and preparation for the exams seems to be a lot. For this course, it is necessary to practice, practice, and practice during the entire period. Students are required to understand the concepts and do exercises to master the contents of the course. Experience from previous courses shows that students who spend enough time on all tasks (lectures, lab sessions, coaching, and self-study), have enough practice to finalise the course successfully.

3.2 Course format

The course consists of a combination of lectures, lab and coaching sessions. These activities take place on Tuesdays and Thursdays from week 46 to week 5, and are intended to support the achievement of the learning outcomes of the ARM course (see section 4.1). Being a researcher is an active and practical endeavour. For that reason, the students are encouraged to participate in the activities of the course. Below you can find a short overview of the parts of the course. Section 5 presents a detailed description of the course activities per week.

Lectures

The lectures introduce the main topics to be studied each week of the course. Students are encouraged to read the self-study material before the lectures. Lectures are designed to promote the active participation of students by means of in-class discussions and activities. Students are encouraged to participate in the lectures and be active when discussing or solving small challenges. A detailed description of lectures and self-study material can be found in sections 5.

Lab sessions

The lab sessions are designed to promote a professional space for practicing the knowledge acquired during self-study sessions and lectures. Lab sessions are guided and supervised by the teaching assistants of the course.

The lab sessions are great preparation for the research assignment and the exam. During the lab sessions you follow different activities that contribute to your research paper. The lab sessions ARE NOT mandatory but prerequisite for the retake (please check section 4.2 for further details). Students'



attendance will be monitored. Students who attend the lab sessions and show great motivation and commitment will be granted with feedback, and the opportunity to participate in the coaching sessions.

Coaching sessions

During the coaching sessions, students can receive feedback on the progress of the research paper. The coaching sessions are not mandatory, since they are intended to be a space for lecturers and students to work together on solving research challenges. Students are required to demonstrate an active participation in the lectures and lab sessions to be able to participate in the coaching sessions. For this, the students should attend the lab sessions and lectures, and bring the results of the labs to the coaching sessions.

Research assignment

For the research assignment, the students write a research paper describing the application of the experimental protocol. In addition, students are required to participate in a peer review activity and a world café session. Highly motivated students are encouraged to go beyond the minimum requirements for the course (see section 7). Further details about the research assignment can be found in section 6.

Exams

There will be one exam for the ARM course with two parts: research methods part (RMP) and the statistics part (SP). For each part you will receive a grade. Please refer to section 4.2 for further details about grading.

Content to study

- The exam will contain all content discussed in the weeks 46 – 5: the books, lectures, papers, slides, self-study, modules, lab sessions, and exercises. Please refer to section 5 and Blackboard for further details about the topics and material to study.

Practical guidelines during the exam

- The exam will be a digital test, consisting of about 30-60 multiple choice (and related format) questions. Open questions could be part of the exam. In the case of open questions, you should provide your answers in English.
- Every question has all information needed to answer it.
- Calculators are not needed for this exam (the Remindo system has an integrated calculator), refrain from bringing electronic devices to the exam.
- The exam is closed book, it is not allowed to bring notes or talk during the exam.
- The lecturer is required to verify your identification, so present your student ID card on your table ready for inspection.

When you enter and leave the exam room, please be silent to facilitate your fellow students. All the best!

Grading

$$\text{RMP grade} = (\text{your points}/\text{max points}) * 10$$

$$\text{SP grade} = (\text{your points}/\text{max points}) * 10$$



3.3 Literature

Concerning the literature, you can find below the texts for the course (two of them can be downloaded from Utrecht University Library). All necessary knowledge is delivered either by attending the lectures, conducting the projects, and studying the papers that are associated with the various lectures. The list of papers and book chapters -- all available through the UU library -- will be updated as the course unfolds.

Books

1. **Wieringa, R.J.** Design Science Methodology for Information Systems and Software Engineering. Springer 2014. An electronic version of the book can be downloaded from Utrecht University library (UU library access needed).
2. **Wohlin, Claes.** Et al. Experimentation in Software Engineering. Springer 2012. An electronic version of the book can be downloaded from Utrecht University library (UU library access needed).
3. **Field, A.** Discovering Statistics Using IBM SPSS Statistics (London, UK, SAGE edge, 4th edition). This book has also available a version for R: Andy Field, Discovering Statistics Using R (London, UK, SAGE edge). Students are free to decide which book to use for the course. Both books describe the same theory related to statistics, but the tool support is different (R or SPSS). During the lectures, the examples will be presented using R, but during the lab sessions the support for SPSS and R is offered. For the exam, some tables will be presented based on the output from SPSS or R.
4. **I. Scott MacKenzie:** Human-Computer Interaction, Chapters 5 and 6
5. **Kasper Hornbæk.** 2013. Some Whys and Hows of Experiments in Human-Computer Interaction. Found. Trends Hum.-Comput. Interact. 5, 4 (June 2013), 299-373
6. **More papers** will be delivered during lectures, lab sessions and tutorials. References are available on Blackboard.

3.4 Teachers and teaching assistants

The teachers responsible of the ARM course are: Marcela Ruiz and Pawel Wozniak. Marcela Ruiz coordinates the research methods contents (themes 1 and 2) and gives the lectures, labs, and coaching in weeks 46 – 51. Pawel Wozniak coordinates the statistics contents (theme 3) and gives the lectures, labs, and coaching in weeks 2 – 4.

The teaching assistants Thomas Alflen (t.alflen@uu.nl) and Lars van den Bos (l.vandenbos@uu.nl) provide support and guidance during lab sessions. The students should **contact the teaching assistants first for questions about the content, exercises, assignments, etc.** These questions should be addressed during the lab sessions. If needed, the teaching assistants could forward complex questions to the lecturers of the course.

3.5 Course website, communication, and Blackboard

The website of the ARM course will be hosted on Blackboard. All course documents are provided on Blackboard (except the books).

Course information, course documents and assignments for in-class discussion will be posted on Blackboard prior to the class meeting. Also, lecture slides will be made available in blackboard **only**



after a lecture and not before. Blackboard will serve as the main communication tool for this course. Students are expected to check regularly the announcements and other information posted on Blackboard by the course coordinator.

- There will be announcements through Blackboard, so be sure that your e-mail address is correct and that you check your email frequently.
- If you send e-mails to your instructor regarding group work, please be sure to include your groupmates in the cc, so that every team member has the same information. Alternatively, you can also use the Blackboard group interface and email from there.
- You are always welcome to ask for appointments to discuss your questions and ideas about the course with the course coordinator and teaching assistants. Please make use of the coaching sessions and office hours when provided by the lecturers.

3.6 Research assignment and PeerGrade

The research assignment of the course should be submitted via PeerGrade: <https://app.peergrade.io>. The students of the courses will receive an invitation to access the assignments of the course in week 47. In case you are in doubt, please contact the student assistants or lecturer.

4 Competences and indicators

4.1 Intended learning outcomes

The Intended Learning Outcomes (ILOs) are as follows: “At the end of the course, the successful student is able to”:

ILO1: Discuss prevalent (qualitative and quantitative) research methods in the field of information science, recognise its benefits and drawbacks, and identify ethical constraints.

ILO2: Write and present research papers describing interesting phenomena, providing the design of a comparative experiment to evaluate such phenomena in practice, and presenting the systematic application of design science and research protocols.

ILO3: Criticize and evaluate scientific papers for the improvement of related research

ILO4: Analyse interesting phenomena and provide strong founded evidence on that phenomena by making use of advanced statistical analysis

4.2 Performance evaluation criteria and grading schema

The students’ performance is evaluated by means of the assessment components presented in Table 2.

Table 2. Examination and contribution to final grade

Component	Team work	Individual work
Research assignment: Assignment A1 Assignment A2 Assignment A3 Assignment A4	Sufficient/Insufficient Sufficient/Insufficient Sufficient/Insufficient	Sufficient/Insufficient



Assignment A5	30%	
Ethics Quiz		Sufficient/Insufficient
Exam (Week 5): Research Methods part Advanced statistics part		30% 40%
Total	30%	70%

The current format of the course makes the students responsible for their success or failures. The research assignments A1, A2, A3, A4 and A5, and ethics quiz are intended to prepare the students and help them to achieve the ILOs. Lab and coaching sessions are not evaluated, but also help students to have a successful learning process. The students have to demonstrate hard work by attending the lab sessions, coaching sessions, and accomplishing the deadlines.

The research assignment

The first weeks of the ARM course run as a project, and students work on different deliverables. The project has the shape of a research assignment and contains the following deliverables:

- Assignment A1: Select a research artefact (Sufficient/Insufficient)
- Assignment A2: Draft paper (Sufficient/Insufficient)
- Assignment A3: Peer review of research paper (Sufficient/Insufficient)
- Assignment A4: Poster session (Sufficient/Insufficient). Students could get a bonus point for the final version of the research paper (Assignment A5). Bonus point 0.5 (very good), and 1.0 (excellent).
- Assignment A5: Final version of research paper (30%)

The assignments are mandatory. The deadlines of the assignments are strict. Assignments A1, A2, A3, and A4 are graded with a sufficient or insufficient. Assignment A5 is graded in a scale from 0 to 10. Failing to meet a deadline will result in the deduction of one point from your final paper grade each time (Assignment A5). For each subsequent day one additional point will be subtracted, until the assignment has been submitted (this is the repair opportunity). Assignments A1, A2, A3, and A4 are graded with a sufficient or insufficient grade. However, failing to obtain a sufficient grade in any of the assignments will result in no mark for the course.

The ethics quiz

The ethics quiz will take place in week 47 during the lectures on ethics (please see section 5 for an overview of the planning). The ethics quiz will be graded with a sufficient or insufficient. A sufficient grade can be obtained with a minimum of 50% correct answers. In the case of an insufficient grade (because you did not managed to get at least a 50%, or you missed the ethics quiz), you have to contact the lecturer to ask for a repair assignment. Failing to obtain a sufficient grade in the ethics quiz will result in no mark for the course.

Research methods and statistics exam

In addition, there is one exam with two parts: the **Research methods part** and the **Statistics part**.

Requirements for passing the course



The three parts that contribute to your final grade are:

- RA: Research assignment grade (Ethics quiz, Assignments A1, A2, A3, A4, and A5). 30%
- RMP: Research methods part. 30%
- SP: Statistics part. 40%

Assignments A1, A2, A3, A4, and ethics quiz should be sufficient. They do not contribute to the calculation of the final grade, but are prerequisite to pass the course.

To calculate your grade, use the following formula:

$\text{Final grade} = 0.3 (\text{RA}) + 0.3 (\text{RMP}) + 0.4 (\text{SP})$

In order to pass the course your final grade should be 5.5 or higher (5.49 is not enough!). Furthermore, we use the following constraints:

- The research assignments grade should be 4.5 or higher (4.49 is not enough); **AND**
- The research methods part should be 4.5 or higher (4.49 is not enough); **AND**
- The statistics part should be 4.5 or higher (4.49 is not enough).

In case one of these conditions is not met, your final grade is the lowest of the three grades.

Repair tests

The repair tests are meant for the students who do not meet the requirements for passing the course. It is not possible to access the repair tests to improve the grade (please check the OER).

There will be one repair exam. It is possible to repair **one** of the three main parts of the final grade (Research assignment, research methods part, or statistics part) if the final grade is at least 4.0. The regulations for the repair tests are:

- **Research assignment.** It is possible to repair the research assignment up to 5.5, but only if $4.0 \leq \text{research assignment grade} < 5.5$. You are admitted to repair the research assignment if:
 - Grade of the research methods exam at least 5.5; **AND**
 - Grade of the statistics exams is at least 5.5; **AND**
 - Participated in at least 4 lab sessions.

The repair assignment is an individual project.

- **Research methods part.** It is possible to repair the research methods part up to 5.5, but only if $4.0 \leq \text{research methods part grade} < 5.5$. You are admitted to repair the research methods part if:
 - Grade of the research assignment is at least 5.5, **AND**
 - Grade of the statistics part is at least 5.5.
- **Statistics exam.** It is possible to repair the statistics part up to 5.5, but only if $4.0 \leq \text{statistics part grade} < 5.5$. You are admitted to repair the statistics part if:
 - Grade of the research assignment is at least 5.5; **AND**
 - Grade of the research methods part is at least 5.5.

Final grades for students with access to the repair tests



The final grade (FG) for students with access to the repair tests (FGadd) is as follows:

$FG_{add} = \min(5, FG) = 5$. Code in osiris = AANV

The final grade for students that fail the course (FGfail) without option to repair is as follows:

$FG_{fail} = \min(3, FG) = 3$. Code in osiris = NVD

The final grade for students who did not participate in any assignment (FGnd) is as follows:

$FG_{nd} = \min(0, FG) = 0$. Code in Osiris = ND

4.2.1 Contribution of lectures, lab sessions, coaching and assessment methods to the ILOs

The main activities of the course (lectures, lab assignments, and coaching sessions) are intended to support students in their task to achieve the ILOs of the course. Table 3 presents the contribution of lectures, lab assignments, and coaching sessions to the ILOs.

Table 3. Matrix of ILOs, lectures, lab and coaching sessions.

ILO code	Lectures	Lab assignment	Coaching session
I1	Lecture 1- 6, 9-11	Lab 1	Coach 1
I2	Lecture 7, 8, 12	Lab 1- 4	Coach 2-4
I3	Lecture 9	Lab 4	Coach 4
I4	Lecture 13-17	Lab 5 – 7	Coach 5-6

To evaluate the degree of achievement of the main ILOs, students are encouraged to participate in the assessment activities: exam, research assignment, and ethics quiz. Table 4 presents the matrix of ILOs and assessment methods.

Table 4. Matrix of ILOs and assessment methods

ILO code	Research assignment					Ethics quiz	Exam		Total
	A1	A2	A3	A4	A5		Methods part	Statistics part	
I1	*	*	0%	*	30%	*	70%	0%	100%
I2	*	*	*	*	100%	0%	0%	0%	100%
I3	0%	0%	100%	0%	0%	0%	0%	0%	100%
I4	0%	0%	0%	0%	0%	0%	0%	100%	100%

* These assignments are not graded but they contribute to the ILOs assessment. They should be sufficient and submitted timely.

In case of doubt, please contact the teaching assistants and lecturers.

5 Planning and deadlines

Please find below the planning and deadlines for the ARM course.

Week	Self-study (check additional papers published in blackboard)	Lectures (TUE) Ruppert A	Lectures (THU) Ruppert A	Lab sessions (TUE) Group1: Ruppert C Group 2: Ruppert B	Coaching session (THU) Ruppert 134	Deadlines
46	Wieringa: Ch 1 and 2,	Lecture 1: Introduction to the course Advanced Research Methods	Lecture 2: Intro to design science	No lab	Coach Intro: Selection of research artefact	
47	Wohlin Ch 2. VSNU Ethics report	Lecture 3: Ethics in research part I. By Sjaak Brinkkemper Ethics Quiz	Lecture 4: Ethics in research part II. By Sjaak Brinkkemper Ethics Quiz	No lab	No coaching	- A1: Register team and select a research artefact to investigate. Nov 23 @ 18h00 - Ethics Quiz during lecture 3 or 4
48	Wieringa: Ch 3, 4, 5, 6, 7, 10, and 16	Lecture 5: The design and engineering cycle.	Lecture 6: The empirical cycle	Lab 1: Analysing experiments	Coach 1: Design science	
49	Wohlin: Ch 7, 8.1 – 8.5. Ch 8.6 – 8.9, 9.	Lecture 7: Sample-based experiments.	Lecture 8: Validity evaluation	Lab 2: Experimental design I	Coach 2: Experimentation I	
50	Wohlin: Ch 4 Wieringa: Ch 19	Lecture 9: SLR and peer review	Lecture 10: Observational methods I	Lab 3: Experimental design II	Coach 3: Experimentation II	
51	Wohlin Ch , 5, 11 Wieringa: Ch 17	Lecture 11: Observational methods II	Lecture 12: Presentation and Package	Lab 4: Building experimental objects	Coach 4: Presenting research	
52	Christmas week: no activities					
1	New year week: no activities					
2	MacKenzie, Hornbæk, and Field	Lecture 13: Stats intro	Lecture 14: Stats and research	Lab 5: Intro	Coach 5: Intro	- A2: Draft paper. Jan 11 @ 18h00
3	MacKenzie, Hornbæk, and Field	Lecture 15: Selecting statistical tests for research I	Lecture 16: Selecting statistical tests for research II	Lab 6: Qualitative experiments I	Coach 6: Advanced statistical tests	- A3: Peer review of draft paper. Jan 18 @ 18h00
4	MacKenzie, Hornbæk, and Field	Lecture 17: Advanced statistical tests	- A4: World café Group1. Attendance is mandatory	Lab 7: Qualitative experiments II	- A4: World café Group2. Attendance is mandatory	- A4: Poster. Jan 23 @ 18h00
5	Exam (contents weeks 46-5)					- A5: Final version of research paper. Feb 1 @ 18h00

Retake date to be confirmed

6 Instructions for the research assignment

The main objective of this assignment is to get acquainted with research methods techniques by investigating a certain phenomenon in information or computer sciences.

For this assignment you will write a research paper describing the design of a comparative experiment to investigate the implementation of a research artefact. The research assignment has five assignments (A1, A2, A3, A4 and A5), which are mandatory. For the research assignment you are required to work in teams of three people. To register your team, please follow the link provided in the introductory lecture.

Please review carefully the section 8, it contains common mistakes found in submissions of the previous year. Please read carefully the instructions of the assignments presented below.

6.1 Assignment A1: Select a research artefact to investigate

For this assignment you will write a document with your motivation to do research about your technique, method, or framework. For this, you have to select one of the following topics first. Next to the topics, you can find links to websites that can be used as a source of inspiration:

List of topics: Techniques, methods, guidelines, frameworks, or algorithms for:

- Traceability engineering: <https://www.springer.com/gp/book/9781447122388>
- High quality software development:
<https://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1810366>
- Alignment for large-scale heterogeneous systems:
<https://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000691>
- Crowd-based software and systems evolution:
<https://link.springer.com/conference/caise>
- Requirements engineering: <https://link.springer.com/conference/refsq>
- Software architecture:
<https://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000680>
- Clinical and Genomic Information Systems
- Business process modelling automation: <https://link.springer.com/conference/bpm>
- Applied data science
- Software ecosystems
- IoT modelling: <https://link.springer.com/article/10.1186/s40294-017-0043-1>
- Flexible modelling:
<http://www.ifi.uzh.ch/en/rrg/research/flexiblemodeling/flexisketch.html>
- Special topics suggested by honour and highly motivated students. The topics must be sent to the lecturer for approval in before November 21, 18h00. Please send an email to m.ruiz@uu.nl with your request.

After selecting a topic, choose one research artefact (i.e., technique, method, framework, etc) within the topic you have selected. The artefact you select should fulfil the following requirements:

1. It is possible to compare the selected artefact with similar artefacts



2. There are scientific publications with a clear presentation of the design of the technique, method, or framework within the topic that you have selected
3. There are publications presenting examples of the application of the technique, method, or framework. If there are no examples available, they should be derivable.
4. There is a clear need to do research in the topic you have selected. There is related work or similar designs to the technique, method, or framework you have selected.
5. There is a clear need for conducting empirical evaluations for the technique, method, or framework you have selected. There is a clear need to investigate the selected technique, method, or framework in a certain context.

The motivation document consists of the following parts (1 to 2 pages)

1. Student names and numbers
2. Selected topic
3. One to two paragraphs with the motivation. Why are you interested to do research about the selected artefact/topic? Can you identify a possible technological impact?
4. What kind of variables could be validated? Please identify qualitative and quantitative variables.
5. One to two paragraphs with the expectations of the team. What do you expect to learn when designing this research project? Which grade do you want to get for the research assignment? What is your plan to maximise the chances to receive the desired grade? What do you need to achieve your goal?

Create a PDF document with the parts presented above and submit your assignment in PeerGrade. In case you are in doubt, please contact the student assistant or lecturer.

Before the deadline you have to submit the assignment in PeerGrade. Failing to finalize Assignment A1 on time will result in the deduction of one point per day from your own final paper grade (assignment A5), starting on the date of the deadline. You can find further details about the deadlines in Section 5.

6.2 Assignment A2: Draft paper

This is the first major deliverable for which you receive feedback. In this assignment you create the draft of your research paper. This draft paper consists of the work you have done in the previous lab sessions and tutorials (lab 1- 3 and tutorial 1-3). The draft of the research paper must include the parts described in Table 5.

Table 5. Structure for the research paper

Section	Content
Title, authorship	<ul style="list-style-type: none">• Give a catchy title to your paper.• Indicate the authors in alphabetical order, or in order of who worked the hardest.
Structured abstract Keywords	Summarise the paper under headings of background or context, objectives or aims, method, results, and conclusions.



	<ul style="list-style-type: none"> • Write a structure abstract. Tip: check the guidelines for structured abstracts presented in the lectures and the book. • Present at least 8 keywords.
1. Introduction	<p>Set the scope of the work and encourages readers to read the rest of the paper:</p> <ul style="list-style-type: none"> • Research context in a nutshell. Write a summary of the research field you are investigating, methods, artefacts, languages, etc. that you are evaluating. • Report what the problem is; where it occurs, and who observes it. • Indicate the main contribution of your research to the state of the art. Remember, you are evaluating, you are not building a new artefact. • Research method. Use the design science method to describe all the steps and tasks of your research
2. Related work	<p>How current study relates to other research.</p> <ul style="list-style-type: none"> • Write down a related work section. Present at least 15 references to related research. These references are intended to support your arguments in the introduction, measurement model, and research design and analysis sections. A list of references with a short summary related to each reference is not enough. Create clusters of papers, and reflect about the evidence and research presented in the selected papers. <p>Tip: Read the related work sections of research papers of your interest.</p>
3. Experimental design	<p>Describe the outcome of the experimental planning stage:</p> <ul style="list-style-type: none"> • Goals, hypotheses and variables. Describe the experiment using the formalized style used in GQM. Presents the refined research objectives. Present the main goal, knowledge goals, variables, and hypotheses. <ul style="list-style-type: none"> ○ The design should include at least 1 independent variable and 5 dependent variables (2-3 for qualitative analysis and 2-3 for quantitative analysis). • Design. Describe the type of experimental design • Subjects. Describe the methods for subject sampling and group allocation. Describe the sample characteristics and subjects background • Context. Report environmental factors such as settings and locations • Objects. Describe the experimental objects or cases for data collection. <ul style="list-style-type: none"> ○ A full description of the experimental objects should be included in the appendix. • Instrumentation for experimental tasks. Describe the measurement instruments to collect data (exercises, questionnaires, cases, etc.). Describe the experimental tasks with the full set of guidelines to be used for experimentation. Include the instructions for the experimental subjects. The instrumentation should be ready for execution and involve the experimental objects. <ul style="list-style-type: none"> ○ <u>Attach the material for the experimental tasks as an appendix to your paper.</u> Since this is a comparative

	<p>experiment, it is expected to find the instruments to measure the variables for each artefact.</p> <ul style="list-style-type: none"> • Data collection procedure. Describe the experimental schedule, timing and data collection procedures (how the data should be collected)
4. Analysis and execution	<p>Describe the data analysis phase</p> <ul style="list-style-type: none"> • Describe the type of descriptive statistics that should be used to summarise the data • Describe the different types of statistical tests that can be applied to analyse the data after the execution of the experimental tasks. • Explain why the tests are adequate for the data analysis of your experiment. • Provide a trade-off analysis that could help for the selecting the best test.
5. Interpretation	<p>Interprets the findings from the previous sections</p> <ul style="list-style-type: none"> • Limitations of study. Discuss threats to validity. Identify main limitations of approach i.e. circumstances when the expected benefits will not be delivered • Inferences. Explain if the findings could be generalised. Take into account the limitations of the study. Can you apply this experimental design to similar artefacts? • Lessons learnt. Descriptions of what went well and what did not during the phase of the experimental design.
6. Conclusions and future work	<p>Presents a summary of the design of the experiment</p> <ul style="list-style-type: none"> • Summary of the design of the experiment. Present a short summary of the design of the experiment. Indicate the main contribution of your research to the state of the art. • Relation to existing evidence. Describe the contribution of the experimental design in the context of earlier (or related) experiments • Future work. Suggest other experiments to further investigate the selected artefact. Describe potential design cycles to be conducted after the execution of this empirical cycle. Identify the most important findings in relation to the research field. Describe the impact of your study
Acknowledgements	<p>Add a short text to acknowledge any contributors who do not fulfil authorship criteria (i.e., subjects, colleagues, etc.)</p>
References	<p>Include all cited literature</p>
Appendices	<ul style="list-style-type: none"> • Include the experimental tasks for each of the artefacts to be compared during (instruments and experimental objects) • Include tables, raw data and/or detailed analyses which might help others to use the results • Attach a table with the project dedication of each team member in terms of hours. In addition, indicate the percentage of participation of each team member in the project.

Requirements for assignment A2

- **The style** of the research paper must follow the LNCS Springer template (you can download the template for MS Word or LaTeX from this [link](#)).



- **The document format** should be PDF. Always submit PDF files.
- **The page limit** for the research papers is 15. Appendices do not account towards this total, for example, you can submit a paper of 15 pages and 5 additional pages for appendices.

Please note that this assignment is mandatory and the deadline is strict. Failing to finalise this assignment on time will result in the deduction of one point per day from your own final paper grade (Assignment A5), starting on the date of the deadline. Please check section 5 and take note of the deadlines. Furthermore, late submissions may not be included in the peer review process.

Please try to hand in your papers as complete as possible so you can get useful feedback from your fellow students and staff. In case you are in doubt, please contact the student assistant or lecturer.

6.3 Assignment A3: Peer review

In this assignment, you have to review one draft paper that is randomly assigned to you in PeerGrade. The reviews do not have a consequence, it is only an indication of the quality of your paper. Please follow these steps:

1. Check if the paper assigned to you is in a state to be reviewed. If this is not the case, you have to mark this paper as “**PROBLEMATIC**”. Typical characteristics of problematic papers are:
 - It does not contain any valuable content to be reviewed.
 - The introduction is far from complete
 - No literature review has been done.
 - There is no experimental design and execution sections.

If you mark a paper as problematic, PeerGrade will assign you a new paper to review. You have to ensure that you can provide a valuable review, in this way you could proof and train your peer reviewing skills. A “problematic” paper would not let you do so. Please note that marking a paper as problematic do not have a consequence. If you are required to mark a paper as problematic, please give an explanation.

2. When you have obtained a proper paper to review, you need to provide textual feedback (i.e., remarks and suggestions for improvement) based on the rubrics provided in PeerGrade (the reviewing criteria is also available in section 6.6). Read the rubrics carefully to understand the specifics of where to pay attention to when reviewing.

Finalize your reviews in PeerGrade before the deadline. Please note that this deadline is strict. Failing to upload your work in time will result in the deduction of one point per day from your own final paper grade (Assignment A5), starting on the date of the deadline. Failing to deliver a serious peer review will result in the deduction of one point from your own final paper grade. Please check section 5 and take note of the deadlines.

How to access your feedback

As soon as the deadline for providing feedback has passed, you will be able to access your feedback on PeerGrade. Since more than one reviewer (student or TA) provides feedback to your paper, you need to react to each reviewer’s feedback in order to access all the feedback forms.



6.4 Assignment A4: World café

To share what you have learnt with us and your fellow students, we will have a poster presentation meeting. The poster should read like an infographic. Provide a good overview of your research project, focus on 1 or 2 variables that you find particularly interesting, and present future steps for your research project.

With the poster, you have to be clear about what the intended audience of your presentation is. Remember, this is a poster that describes a research process, so, your intended audience are academic people. The poster does not have to show your full experimental design, be creative!

Posters can be in A0 or A1 size (there's plenty of print shops where you can go for this), and colour print gives the best result. We will show all posters in a typical poster presentation setting, where lecturers and students walk around and view each other's posters.

During the poster session, the groups of students elaborate on their work with the visual aid of an academic poster. During the poster session, students present to one another their work.

The poster session presentation:

- Must be accompanied by at least one of the authors (advice: take turns for the poster presentation, but make sure everyone is present when the presentation is given for the teaching staff.)
 - Last approximately 5-7 minutes per team.
 - Allows for questions and comments from the teaching staff and fellow students.
 - Is presented not exclusively at the teaching staff, but also (mostly) at fellow classmates.
 - The contents of the poster should include:
 - A catchy title (it doesn't need to be the one used in the paper!)
 - The names of the authors
 - An overview of the research
 - Main motivation to conduct your research
 - The research method (Figure of the experimental process)
 - Future lines of work and novel ideas motivated by your research outcome
 - Acknowledgements
- ❖ To promote a nice environment, the teams are encouraged to bring something small to share with the attendees. The lecturer and teaching assistants will prepare something as well ☺.

Students should prepare an elevator pitch of 2 minutes. The logistics for the world café are published on blackboard.

Create a PDF version of your poster and submit it via PeerGrade before the deadline. Please note that this assignment and attendance is mandatory. Failing to finalise this assignment on time will result in the deduction of one point per day from your own final paper grade (Assignment A5), starting on the date of the deadline. Please check section 5 and take note of the deadlines.

6.5 Assignment A5: Final version of research paper

This is the fifth major deliverable for which you receive a grade. Complete the draft paper and take the comments of the peer reviewers and your student assistant into account. Your paper should include the parts described in Table 5. Finally, if you really want to go for the 10, provide a good



alignment between the literature review and the design of your comparative experiment. Present a clear research design that is aligned to your main goal. Execute your experiment and describe your findings. Please check the rubrics and analyse how this assignment will be graded. Contact the lecturer for additional guidance if you want to go for the highest grade.

Requirements for assignment A5

- **The style** of the research paper must follow the LNCS Springer template (you can download the template for MS Word or LaTeX from this [link](#)).
- **The document format** should be PDF. Always submit PDF files.
- **The page limit** for the research papers is 15. Appendices do not account towards this total, for example, you can submit a paper of 15 pages and 5 additional pages for appendices.

Please note that these requirements are mandatory. Papers not submitted in the LNCS style, or exceeding the page limit, or not PDF file, will not be reviewed and automatically failed with a grade of 1.0.

Submit your final paper in PeerGrade before the deadline. Please note that this deadline is strict. Failing to finalize Assignment A5a on time will result in the deduction of one point per day from your own final paper grade, starting on the date of the deadline. Please check section 5 and take note of the deadlines.

6.6 Rubrics

Please find below the rubrics to evaluate the assignments A1, A2, A3, A4, and A5. Full details on the rubrics are available on PeerGrade.

6.6.1 Assignment A1: Select a research artefact

Motivation and action plan

- Did the students provide additional findings to support the motivation?
- Did the students provide an adequate plan to achieve their desired grade?
- Did the students provide a topic from list of topics?

Overall

- Are the basic parts adequate? If not, what is missing? Please indicate if the students have chosen a suitable artefact for the research project. The artefact should be validated by means of a comparative experiment. It should be possible to find suitable variables and hypotheses that can be tested.
- Based on the answers from the previous questions, did the students submit a sufficient assignment?

6.6.2 Assignment A2 and A3: Draft paper and peer review

Most people find peer reviews useful; a good peer review can suggest different perspectives and provides valuable feedback on what is compelling and what is problematic. Good peer reviews, however, do not write themselves (unfortunately), and it can be a challenge to learn. An important aspect of a review is that it should be constructive and provide guidance to the authors on how to improve their report. The goals of the peer review are 1) to help improve your classmate's paper by pointing out strengths and weaknesses that may not be apparent to the authors, and 2) to improve



your own reviewing skills. As we do not have external reviewers each student needs to review the papers of another teams. Based on the feedback, teams can improve the draft papers before to submit the final version, which is graded.

To understand what a good peer review should cover, we need to understand what a good paper should cover. After all, if you cannot tell a good paper from a bad paper, how will you ever write a good review? A good review consists of roughly 1 to 2 standard pages of constructive feedback (the exact amount depends on the quality of the paper of course). Make use of the following reviewing criteria to write a review for a draft paper:

Overall

- Completeness: Are all sections that are part of the assignment in the paper?
- Presentation: Is the style and grammar of the text OK? Is the layout and presentation of the figures and tables OK?
- Check if the research is really suited for a comparative experiment: e.g. two different artefacts that can satisfy the same goals can be compared.
- Is the title suited for the research topic? Is it catchy? Do you feel attracted to read this paper?
- Are the authors of the paper properly listed?
- Does the abstract contain the parts of the structured abstract? Is it a good summary of the research paper?
- Is the paper easy to read?
- Is the appendices section complete?
- Did the student use the springer template? Is it applied in the correct way? Does it has less than 15 pages?

Introduction

- Does it include a description of the research problem and the research questions, plus an overview and discussion of the relevant literature?
- Does it present the scope of the work?
- Does it include the description of an empirical cycle of Design Science?

Literature review, related work and references

- Did the student deliver a proper text describing the literature review? Remember that students shouldn't deliver a summary of 15 papers, they should bring a single text describing their findings
- Were the references properly listed at the end of the document?
- Does it highlight the main gap in the current state of the art?

Experimental design

- Feasibility and explanations of the research: Does the research design make sense? Is it explained well in the text accompanying the figures?
- Research design: Does it describes the research protocol as it is expected for the type of paper?



- As a rule of thumb students should aim at no more than six dependent variables and two independent variables for this research.
- Is the GQM complete enough (at least 4 research questions)? Does it have a proper presentation of Goal, Research Questions and Variables?
- When checking the submitted experiment, pay attention to:
 - Clarity: are the questions clearly formulated, unambiguous?
 - Do they include units of measure?
 - Please check the experimental objects and tasks in the appendix. Is it clear how they can contribute to the measurement of the variables? Do they measure every variable of the GQM? Is the instrumentation clearly presented and detailed? The instrumentation should be ready for execution.
- Does it describe the type of experimental design?
- Does it present the context in which this research is conducted?
- The cases or objects for experimentation are clearly introduced in the paper. The full explanation of the cases is usually presented in the instrumentation.
- The data collection procedure is detailed

Analysis and execution

- The descriptive statistics make sense to the type of research.
- Different types of statistical tests than can be used are listed. In addition, the authors present an explanation of the reasoning behind the selection of each test.
- The trade-off analysis is provided.

Interpretation, conclusions and appendices

- The paper presents a discussion on the threats to the validity of the experiment.
- Main conclusions regarding generalisation are presented.
- Does it includes lessons learnt about the phase of experimental design?
- Does it include future work in terms of further design and empirical cycles?
- Are the experimental tasks included in the appendix?
- Project dedication of each team member is included. The workload of the team members is well balanced.

Overall recommendation

In addition to providing the feedback scoring some of the aspects mentioned above, you will have to provide an overall recommendation of the report.

- strong accept: No changes needed
- accept: Some changes are required
- borderline paper: Arguments for accept as well as reject
- reject: Paper is not sufficient for handing in due to bad presentation or content, the paper should be significantly extended/improved
- strong reject: Paper is bad in presentation and content and we do not see that this can be fixed on short notice. Lots of work still needs to be done



These recommendation can go from accept to reject (as indicated above), but these recommendation do not have a consequence. It is only an indication of the quality of the paper.

6.6.3 Assignment A4: World café session

The assignment A4 will be graded based on the following criteria:

All the team members should participate in the poster session. Below you can find the grading schema for the posters.

Negative aspects	Positive aspects
<ul style="list-style-type: none">· Pixellated images· Arrows flowing through the text· No clear audience in mind· Reloaded poster, too many text and info· A4/A3 taped together, this is unprofessional· Boring poster· Unreadable, Small figures and text· The poster does not fulfil the requirements· Copy and paste from the paper <p>When presenting the poster</p> <ul style="list-style-type: none">· Lack of motivation· Vague content· No energy when talking· Reading from a paper	<ul style="list-style-type: none">· Good story to tell· Enthusiastic presentation· Sharply dressed· Poster nice and colourful· Original poster· Clear target audience· Professionalism· The poster fulfil the requirements· Good presentation of the poster· Open minded authors <p>When presenting the poster</p> <ul style="list-style-type: none">· High motivation about the topic of the pitch· Good introduction to catch the audience· Good conclusion· Good examples of real world cases

Good and excellent posters can receive bonus points, please refer to section 4.2 for further details about the grading and bonus points for the world café session.

6.6.4 Assignment A5: Final version of research paper

The assignment A5 will be graded based on the following points:

Section	Points
Title, authorship, Structured abstract, Keywords	10
1. Introduction	15 points
2. Related work	15 points
3. Experimental design	20 points
4. Analysis and execution	10 points
5. Interpretation	10 points
6. Conclusions and future work, Acknowledgements, References, Appendices	20 points
Total	100 points



The dedication per student in terms of hours should be included as an appendix to the paper. The dedication in terms of hours should have a good balance. And the percentage of dedication should be evenly distributed among the team members. For example, 33% of dedication associated to each team member.

Papers not submitted in the LNCS style, or exceeding the page limit, or not PDF file, will not be reviewed and automatically failed with a grade of 1.0.

The grade for the assignment AA (RA) will be calculated as follows:

$RA = (\text{your points}/100) \times 10$. The dedication per student to the project could affect the calculation of the RA grade.

Below you can see textual equivalents for numerical grades:

Excellent (10)	Can be submitted to a conference. The paper is crystal clear. The work went beyond the assignment requirements. The paper presents the execution of the research project and data analysis sections. Pilot of the experiment. All the ideas flow logically. Excellent team collaboration. The instruments are ready for execution.
Very good (9)	The paper is sophisticated. Excellent transitions from point to point. The evidence provided is solid and supports the main goal, research questions, hypotheses and research design. The paper presents the execution of the research. The instruments are ready for execution.
Good (8)	Very good paper. The alignment between main goal, research questions and hypothesis is easily identifiable. The instruments are well presented and ready for execution.
More than sufficient (7)	Promising paper, but it is lacking insight and originality. The structure of the paper is generally clear and appropriate. It may have few unclear transitions. The argument of paper is clear, usually flows logically and makes sense. The instrumentation is not ready for execution.
Sufficient (6)	All the section of the paper are present and there is a clear alignment between research goal, research questions, hypothesis, and study of related research. Points often lack supporting evidence, or evidence used where inappropriate. There is a lack of originality. The experimental instruments are not documented.
Mediocre (5)	Difficult to identify the main goal of the research project. There is not clear alignment between goal, research questions, and hypothesis. Weak analysis of related research. Incomplete paper.
Unsatisfactory (4)	Shows obviously minimal lack of effort or comprehension of the assignment. Very difficult to understand owing major problems with the establishment of the main goal and research questions of the paper. The hypothesis are not aligned with the research goal and questions. There is not a clear motivation.
Very unsatisfactory (3)	Missing sections and lack of consistency. Ideas do not flow.
Poor (2)	There is not identifiable research problem investigation. The paper does not present a clear motivation and study of the related literature.
Very poor (1)	The requirements for the assignment are not satisfied. Shows obviously minimal lack of effort.

The requirements for Assignment A5 and the research assignment in general apply. The final grade for the research assignment is calculated according to the rules presented in section 4.2.

7 Instructions for cum laude and honour students

Students that are following the honours track or are highly motivated to obtain a high grade for this course, are advised to contact the lecturers for guidance. These group of students are especially encouraged to design and execute the research project of this course. It means that they would conduct a complete empirical cycle from the problem investigation to the data analysis. The selected topic should be consulted with the lecturer of the course to evaluate the viability of the project and potential opportunities. In addition, *capita selecta* projects can derive as a result of the research project of this course.

Appendices

8 Common mistakes in papers from previous years

Section	Tips for improvement
Title, authorship	<p>Catchy title. Authors in alphabetical order or in order of who worked the hardest.</p> <ul style="list-style-type: none"> We noticed that some of you forgot to include credentials, such as the University at which we study, and/or e-mail addresses. Please also make sure that you use the right format for these, so that it is in accordance with the template.
Structured abstract Keywords	<p>Summarizes the paper under headings of background or context, objectives or aims, method, results, and conclusions. Present at least 5 keywords.</p> <ul style="list-style-type: none"> check the guidelines for structured abstracts presented in the lectures and make sure all parts are there. make sure your abstract contains no more than 300 words, and that every sentence in the abstract is worthy of being there. regarding the keywords, be specific. Put yourself in the shoes of a researcher that is looking for your paper. Some of you use keywords such as “perception”, “completeness”, try to avoid those as they are very general and don’t relate to the contents of this paper necessarily.
Introduction	Sets the scope of the work and encourages readers to read the rest of the paper.
Research context in a nutshell	Present a summary of the research field you are investigating, methods, artefacts, languages, etc. that you are evaluating. Reports what the problem is; where it occurs, and who observes it.
Research method	Use the design science method to describe all the steps and tasks of your research. Use the book of Wieringa to describe the steps which are made in the Design Science process.
Related work	<p>How current study relates to other research. It should present at least 10 references to related research. These references are intended to support your arguments in the introduction, measurement model, and research design and analysis sections.</p> <ul style="list-style-type: none"> all literature should be closely related to the subject (either in favour of the hypothesis, or posing an argument against it). whenever you refer to a source, don’t forget to cite it (properly). don’t make specific claims you can not back up with literature. do not just throw in citations here, but make sure you actually discuss the articles and elaborate on some of the main conclusions, and how these could impact your study. make sure you clearly describe which gap exists in your researched literature.
Experimental design	Describes the outcome of the experimental planning stage
Goals, hypotheses and variables	<p>Defines the experiment using the formalized style used in GQM (include a GQM-model in the paper → Wohlin 2.9.4). Present the refined research objectives. Present the main goal, knowledge goals, variables, and hypotheses.</p> <ul style="list-style-type: none"> the variables should include an explanation how they are measured (which factors/calculation is used). for the hypotheses, the null hypotheses and the alternative hypotheses should be described.

	<ul style="list-style-type: none"> • for each hypothesis, describe which variables are used to measure it. Describe also how the variables are used to decide if a hypothesis is true or false • remember: the hypotheses are linked to a knowledge goal, which is related to the main goal of the experiment. • don't describe which types of test are used for the hypothesis testing! This should be included in the analysis part. • be consistent when you write down your variables in italic (or other styling such as quotes) • provide an explanation for the GQM model to help the reader understand it.
Design	Define the type of experimental design. Give an explanation of the type of design which is used for the experiment. The types of designs are described in the book by Wohlin chapter 8.5. Also create a figure which views the design, including an explanation why a specific type of design is used during the experiment.
Subjects	Defines the methods used for subject sampling and group allocation (see Wohlin chapter 8.4). Description of the sample characteristics and subjects background. <ul style="list-style-type: none"> • some students used demographic information here; which is great and I would definitely recommend to do this!
Context	Reports environmental factors such as settings and locations.
Objects	Defines what experimental objects were used. Objects are explained in Wohlin chapter 8.6.
Instrumentation	Defines any guidelines and measurement instruments used (Wohlin chapter 8.6). In this section you should describe all the material which is used during the experiment, but make sure you distinguish the objects, which are elaborated on in the previous section.
Data collection procedure	Defines the experimental schedule, timing and data collection procedures. Define all the steps which are taken during the process of the experiment. Deliver a process model, which describes the process step by step.
Analysis and execution	Summarizes the collected data and describes how it was analysed
Execution	How data collection took place and any deviations from plan.
Descriptive statistics	<p>Presentation of the data using descriptive statistics. Describe which insights you can already get, next to the test of the hypotheses. Examples of descriptive statistics are: distribution male/female, average age, minimums and maximums, valid values, std deviation, mean and normal distribution.</p> <ul style="list-style-type: none"> • I highly recommend using the right types of graphs for your data. Think about what message you are trying to convey and how this is best broadcasted using visual aids. I think Stephen Few offers many useful insights in this short article. • on the topic of graphs, a few more recommendations: don't use fancy colours, don't use MS Office graph designs (stick to SPSS or similar scientific-ish designs), use the same font (style, weight, spacing, etc.) in your graphs as you do in your paper, this makes for a more neat look, also be consistent in the layout of your graphs, and their size on the page. Furthermore, make sure you annotate them with a relevant name and always mention this figure (when you mention a table or figure in text, use a capital letter "T" or "F") and it's annotation in your text. Don't just throw the graphs in there. • also, make sure you only use graphs when you think it helps convey your message, when you can say it in text in not too many words, please do so. This also works the other way around, don't write down every single observation when you can also make it clear by using a graph.

Data set reduction	Describes any reduction of the data set e.g. removal of outliers, different settings etcetera. Explain why the discarded subjects are not taken into account in the experiment.
Hypothesis testing	<p>Describes how the data was evaluated and how the analysis model was validated. Apply statistical tests to answer your hypothesis and support further research ideas.</p> <ul style="list-style-type: none"> for reporting statistical test results, make sure you use the right format, and use it consistently. You can find examples of how to do this on the website of the Illinois State University's website. make sure you use the correct statistical technique for your data! some statistical tests assume normality of the data distribution. Make sure you test this assumption by executing a normality test. A great tutorial can be found on the website of Laerd Statistics.
Interpretation	Interprets the findings from the Analysis section
Evaluation of results and implications	Explain and interpret the results in light of what is already known about the topic. Some of you forgot to write a very complete evaluation, which should explain what the results mean, examine whether the questions of your research were answered, and show how results relate to literature. I recommend you use this part of the discussion to link your results to the introduction/theoretical backgrounds of your paper.
Limitations of study	<p>Here you should discuss the several threats to validity, and how they pose a limit on the generalizability or outcomes of your research. Marcela Ruiz provided you an extensive list and explanation on many of the types of threats to validity (conclusion, internal, construct, and external), which you can find the sheets <i>ARM-04 – Validation Evaluation</i> and can learn more about in the book by Wohlin et al in chapter 8.7, 8.8, and 8.9.</p> <p>Please, be critical, but also prioritize. There's a lot of types of bias affecting your research, and numerous things that could have been done better. This doesn't mean you must mention every single one of them. I recommend you explain a few of them in detail (what has happened, how did this happen, what could we do better in the future to prevent this from influencing our research outcomes?), and not just list a lot of types of influences that affect your research in one way or another.</p> <ul style="list-style-type: none"> besides describing ways to improve the current research for future replication, you can also discuss possibilities for future research that are based on the results of this study.
Inferences	How the results generalize given the findings and limitations
Lesson learned	Descriptions of what went well and what did not during the course of the experiment
Conclusions and future work	<p>Presents a summary of the study. Repeat the knowledge questions and give the answer on it.</p> <ul style="list-style-type: none"> answer each of the research questions separately. many papers did not contain a concrete conclusion (for example → Which method is better?). make sure you don't just sum up a bunch of findings, but categorize these (for instance according to your research questions). use a consistent format for answering your research questions (for instance, what did we hypothesize, what did we find, what does this mean?)
Relation to existing evidence	Describes the contribution of the study in the context of earlier experiments (the gap in the study)
Future work	Suggestions for other experiments to further investigate the research project. Define potential design cycles to be conducted as a result of the findings. Identify the most important findings in relation to the research field. Describe impact and limitations of your study.

	<ul style="list-style-type: none"> • some students neatly related the future work proposals to the limitations of the current study. I highly recommend this.
Acknowledgements	Identifies any contributors who do not fulfil authorship criteria (i.e., subjects, colleagues, etc.). Some of you forgot this section, so make sure it's there!
References lists	<p>List all of the full references from the authors you have cited. Make sure you are consistent, by using a standard format of IEEE for LNCS. To minimize mistakes, I recommend you use Mendeley or the references feature which is built into MS Office Word.</p> <ul style="list-style-type: none"> • check if all used sources are in your references lists (and the other way around). • sort your papers chronologically either alphabetically (A-Z on last name), or on occurrence in your paper (first cited source first in the references list).
Appendices	<p>Includes raw data and/or detailed analyses which might help others to use the results. Only include relevant appendices, which have additional value to the paper.</p> <ul style="list-style-type: none"> • don't add screenshots of data in your appendices. • refer to your appendices in your paper's text. • either place content in the paper, or in the appendix, not in both.
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