

# Academic / Technical Writing

in Computer Science

## Part II, Topic 5:

# Writing a Master Thesis



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M.Sci Programme in CS - DS



# Final Questions and Answers

- If you find anything:
  - **Not covered** in lectures
  - **Being of interest** to you and your mates
- **Note** these questions
- **Final Q&A Session**
  - End of Topic 8

# Plan

- What is a Master Thesis?
  - How does your Thesis relate to your Master Project?
- What has to be there, in terms of its structure and content?
- When to write your thesis?
- How to plan and structure a thesis?
- What are the most typical flaws in the genre?
- You did your Bachelors, is it all the same?
- Master Thesis Proposal (Exposé)

# Credits

- To **my mentors**, who taught me feel responsible
- To **all** the **colleagues**, whose theses I read and reviewed
- To **my students**, who taught me what is NOT a thesis

**What is  
a (Master)  
Thesis?**

# What is a Master Project?

- A **research** project?
  - Yes
  - What is **research**?
  - Learning what was not known before
  - ...
- A **development** project?
  - No way
  - Focus on research output
  - Software is NOT a result
- A **networking** project?
  - No. Not primarily
  - Using networking is strongly recommended
  - Why?
- A **learning** project?
  - Yes
  - What do you learn in it?
- Research **method**
  - Methodology of Science
  - Part I, Topic II ...
- You **contribute**:
  - Statement, Method, measure
  - Algorithm
  - Proof of being correct, efficient, and effective
- A network is a valuable **resource**
  - Ideas
  - 3d-party solutions
  - Cross-evaluation
- You **learn**:
  - To do and present research
  - To evaluate results
  - To be useful to the society

# What Goes to Your Thesis?

- A **research** project?
  - Yes
  - What is **research**?
  - Learning what was not known before ...
- A **development** project?
  - No way
  - Focus on research output
  - Software is NOT a result
- A **networking** project?
  - No. Not primarily
  - Using networking is strongly recommended
  - **Why?**
- A **learning** project?
  - Yes
  - **What do you learn** in it?

- Research **method**
  - Methodology of Science
  - Part I, Topic II ...

- You **contribute**:
  - Statement, Method, measure
  - Algorithm
  - Proof of being correct, efficient, and effective
- A network is a valuable **resource**
  - Related Work
  - Ideas
  - 3d-party solutions
  - Cross-evaluation
- You **learn**:
  - To do and present research
  - To evaluate results
  - To be useful to the society

# What is a Master Thesis?

- A **Master Thesis** is a manuscript
  - Written using a **research monograph** style
- Methodologically, **could be regarded** as
  - A final (M.Sci) **project report**
    - Extended to document the project in **full detail**
  - A potential **research monograph**
    - If properly framed and fully refurbished
    - Unlikely for M.Sci projects
    - Yes, if the results were **excellent**
      - And, potentially, may have **impact**
  - How to **check?**



# Reqs to M.Sci Theses in CS

- To be written in **partial fulfillment** of your M.Sci program
- To report on your M.Sci **project (research)**
  - Why this topic in terms of **novelty, impact**, etc.
- To present **all** your M.Sci project **results**:
  - In fully **sufficient detail**
  - Following the **research method** used in the project
  - Ready for **immediate re-use**
  - To clearly and explicitly demonstrate that the **goal** of the project has been **reached**

# How to Plan Your Master Project?

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **When:** both for the **project** and **thesis**
  - **Writing** a thesis is a **support activity** – in parallel
    - Do not underestimate **presenting** to your research group
    - **Regularly**
  - At **kick-start**: Develop a **schedule** – detail as much as possible
    - Plan **milestones**
    - Landmark by **Technical Reports** (intermediate)
  - **In the process:** (doing **research** and **writing**)
    - **Refine**: add missing details
    - **Revise**: improve the schedule
    - **Iterate**
    - Observe **Milestones** and **Deadlines**

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **What:**
  - **Introduction** and **Motivation**
  - Your assessment of:
    - The **novelty** and societal **impact** of your results
    - **Practical value** of your results
    - **Potential use** – who are the envisioned early adopters

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **What:**
  - Your **Advance** in the **State-of-the-Art**
    - What is the **related work**?
      - **Research landscape**
    - Which **problems** in the field are **not solved**?
      - **Research context**
    - Which **problem** is **chosen** in your project and **why**?
      - **Research questions**
    - Does your **solution solve** the **problem**?
      - **Research hypotheses**
    - **Who** will presumably **be happy** about that and **why**?
      - **Potential output**

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **What, using what:**
  - Your **Solution**
    - What is the **background** knowledge?
    - What is your **solution idea**?
    - How do you **approach** the solution (**workflow**)?
    - What is your (planned) **foreground** knowledge (**solution**)?
  - Your **Evaluation**
    - How do you **evaluate** your solution? **Using what**?  
What were the **results** of evaluation?
    - What are the **boundaries** for using your **solution**?

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **Using what:**
  - Your **Methodology, Data, Tools, and Materialized Solution**
    - What is the research **methodology**? Why this?
      - How is your workflow **supported** by the **methodology**?
    - What are the **data** to be used in your research? Why these?
      - Do you have **sufficient data** to cover all the needed cases?
    - What are the **3<sup>d</sup> party** (software) **tools** that you plan to use? Why these?
      - Do these **cover** your research workflow? In which **part**? What are the **gaps** to be filled?
    - What are the **tools** you **implement** for the solution?
      - What are your **design** and **development choices**?
  - Do you need to use any **other resources** for your project?
    - **E.g. ...?**

# Planning Your M.Sci Project

- **To recall:** “what”, “using what”, “when”, and “how much” need to be thought about
- **How much:**
  - Does your solution **answer all** your research **questions**? Positively? To which extent?
  - Are **all** your **hypotheses tested**? To which extent?
  - Are the chosen research **methodology, tools**, and available **data** fully **sufficient** your work? To which extent?
  - Does the **plan** of your **evaluation** cover all your **hypotheses**, use **cases**?
  - Do your **evaluation** experiments give a clear picture of the **advantages** and **flaws** of your solution? Compared to what? Are **more experiments** needed? Using what?



# How to Structure Your Thesis?

# Structuring Your Thesis

Myself, I recommend, to my students:

- **Chapter I. Introduction and Motivation**
  - to be concluded with:
    - An outline of the problem
    - The presentation of the structure of the thesis
- **Chapter II. The review of the State-of-the-Art** – to be concluded with:
  - A **concise analytical summary**
  - A comparative **illustration** of the planned **progress**
- **Chapter III. The Approach and Solution**
  - ...

# An Approach and Solution

To **include**:

- **Background**
- **Method** and **process** to approach ...
  - A way to transform the **Background** to **Foreground**
- **Foreground**
  - Proven **statement(s)**, a.k.a. theorem(s)
  - Elaborated **method(s)** **Algorithm(s)**
- Potential **advantages** and **flaws**
- Usability **boundaries**

To **exclude**:

- **Software**
- Used **tools** and **data**
- Evaluation **plan**
- Experimental **results**
- **Analysis** and **recommendations**

# Structuring Your Thesis

Myself, I recommend, to my students:

- ...
- **Chapter IV. Implementation and Evaluation**
  - Implementation **requirements, design** and **development choices**
  - Materialized parts of the solution, links to **software**
  - Experimental **evaluation objectives** and **plan**
  - Evaluation **environment** (hardware + software)
  - Evaluation **results** and **discussion**
  - **Technology transfer**: if already done or in process
  - **Summary**: what do your evaluation **results** prove?

# Structuring Your Thesis

Myself, I recommend, to my students:

- ...
- **Chapter V. Conclusive Remarks**
  - **Summary:**
    - What has been **done**?
    - What is the **foreground**, why is it **novel**, compared to the **background**?
    - Does the **foreground** meet your **goal** and **objectives**?
    - What is the (potential) **impact** and **areal of use**?
  - **Recommendation:**
    - Based on the **foreground**, what could be **recommended** to the professional community?
  - **Future Work:**
    - What is **planned to be done** to **improve** the solution / result?

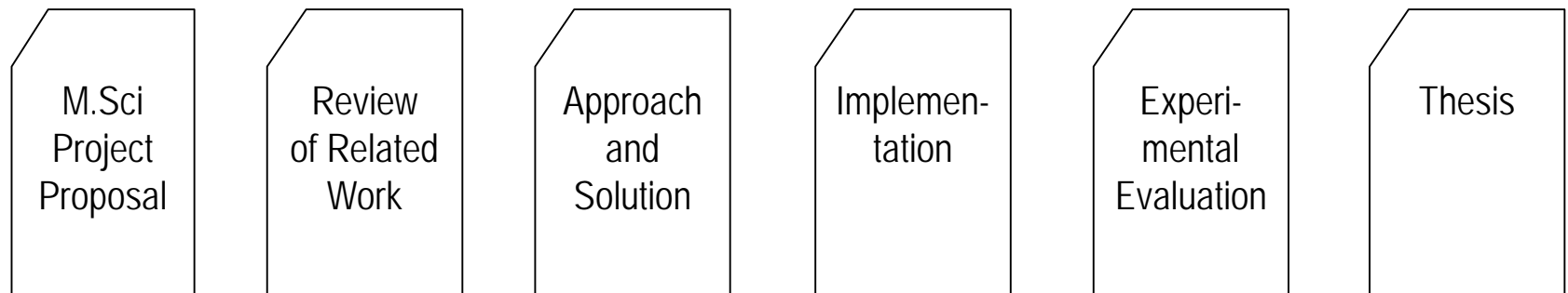
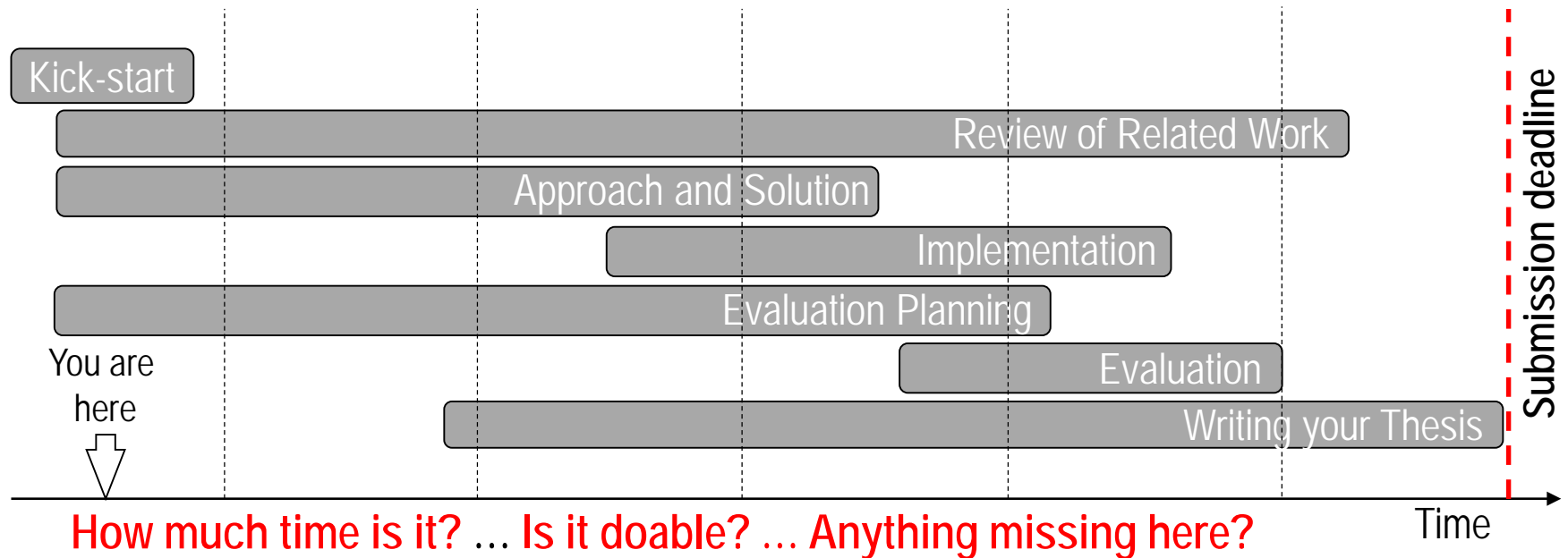
# Structuring Your Thesis

Myself, I recommend, to my students:

- **Chapter I. Introduction and Motivation**
- **Chapter II. The review of the State-of-the-Art**
- **Chapter III. The Solution**
- **Chapter IV. Implementation and Evaluation**
- **Chapter V. Conclusive Remarks**
- Your **supervisors** may have **different views**
  - Talk to them
  - Also listen
- Check **external recommendations**
  - E.g., How to Write an M.Sc. Thesis. U Regina, Canada
    - [http://www.cs.uregina.ca/GraduateProgram/theses/write\\_thesis.html](http://www.cs.uregina.ca/GraduateProgram/theses/write_thesis.html)

# Milestones and Reports

# Project Phases ⇔ Outputs





# Kick Start

- **Objective(s)?**

- **Estimate your chance** to have a successful M.Sci Project
- **Convince** your (potential) supervisor (mentor)
- **Sell** your project to your Master Program

- **Approach?**

- Get an Idea ... Analyze Gaps ... Formulate the Problem ... Read ... Plan ... Talk to a Mentor ... Come out with a Vision ... Sketch out your Approach ... Estimate Impact ...
- Present ... Analyze Feedback ...

- **Resources?**

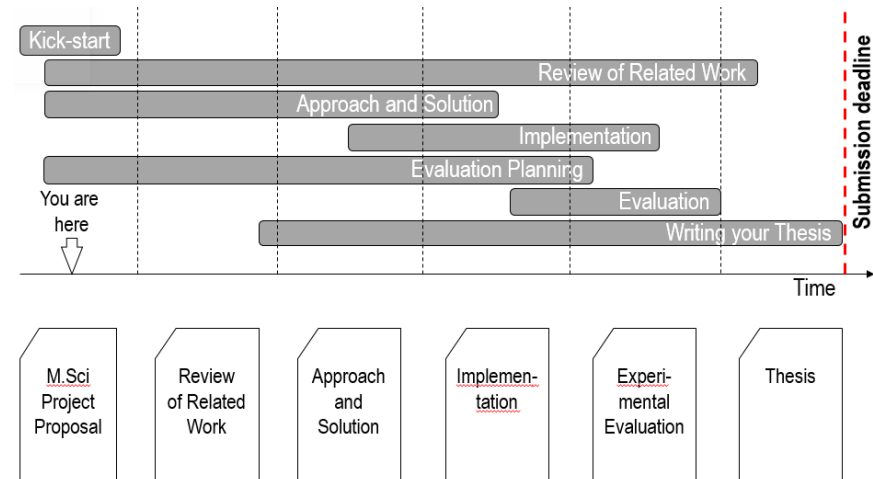
- Brain ... Experience ... Curiosity ... Mentor's advise ...
- Research **environment**, **network**, and **infrastructure**

- **Output?**

- M.Sci Project **Proposal** (Exposé)
- Together with your mentor
- Could be submitted as a **position** paper

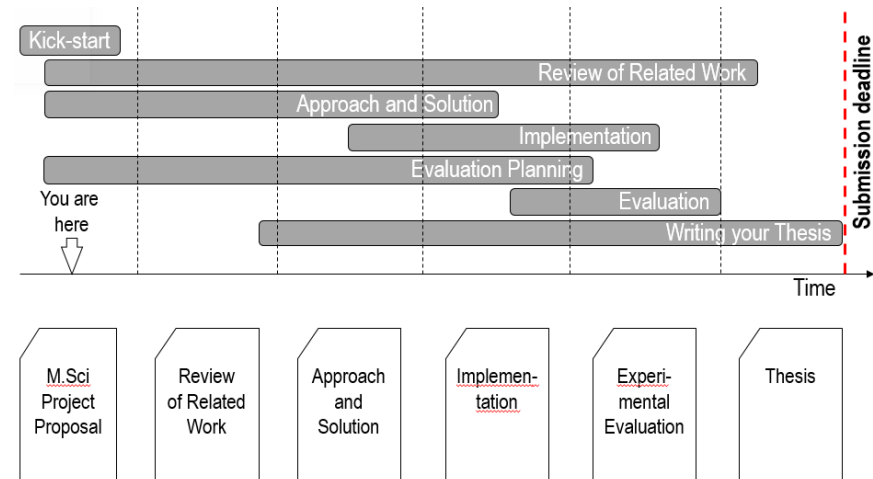
# Review of Related Work

- This course
  - Part I; Topic III
- **Output(s)?**
  - Research gaps fully identified
  - Project objectives specified
  - Intermediate Tech. Report
- **To whom to present?**
  - Your mentor, peers ...
  - To be posted to social media ...
  - Could be a **review paper**. Discuss with your mentor
- Be ready to come back and iterate ... till the end
  - **Why?**



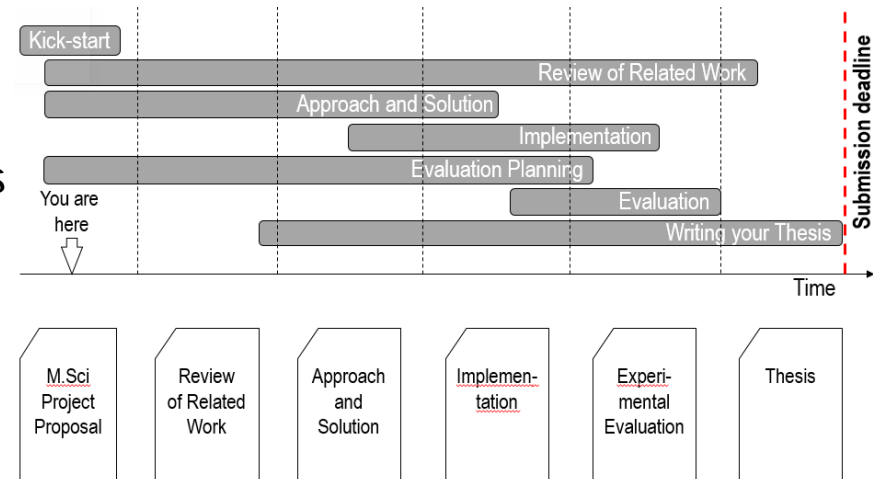
# Approach and Solution

- **Objective(s)?**
  - Given the **background**:
    - What is your **goal state** (foreground)?
    - What is your **path** to the goal state? **Why** this?
- **Approach to present the Approach and Solution?**
  - Scientific Method
- **Output(s)?**
  - **Approach**: to reflect the **evolution** of the objectives, hypotheses, and solution
  - **Solution**: to present the **limitations** and potential **impact**
  - Intermediate Tech. Report
- **To whom to present?**
  - Your mentor, peers, potential early adopters ...
  - To be posted to social media ...
  - Could become a **position paper**. Talk to your mentor



# Implementation

- The **development part** in the project
  - Goes to the **Appendixes** in the thesis
- **Objective(s)?**
  - Get your contribution **materialized**
- **Approach to present?**
  - Serve as ready for (re)use, including concise instructions
    - Create a public repository (e.g. @GitHub), upload, mind version tracking
    - Refer to the repo from your text, provide also data
      - E.g. This algorithm has been implemented as a Python module (<https://.../>)
- **Output(s)?**
  - Could be an Intermediate Tech. Report
  - Better to combine with **Evaluation** report
- **To whom to present?**
  - Your mentor, peers, potential early adopters ...
- Be ready to come back and iterate ... almost till the end
  - **Why?**



# Evaluation

- **Objective(s)?**

- **Check and prove:** correctness, efficiency, effectiveness, user acceptance, potential impact
- **Given:** the problem, context, claimed limitations

- **Approach?**

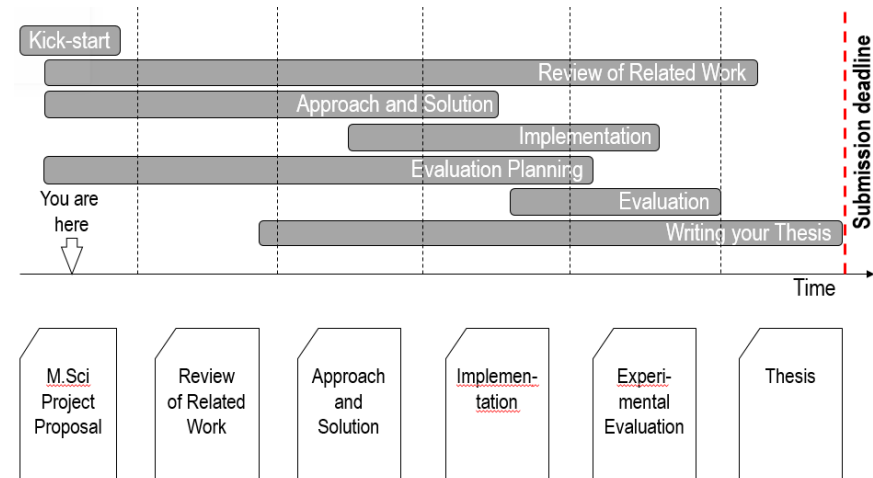
- Formal proof, experimental, or both
- Scientific Method

- **Output(s)?**

- **Plan:** evaluation objectives, methodology, data, instruments (software), workflow, measures
  - The rationale for the choices to be presented
- **Results:** Experiment outcomes, discussion and analysis
- Intermediate Tech. Report

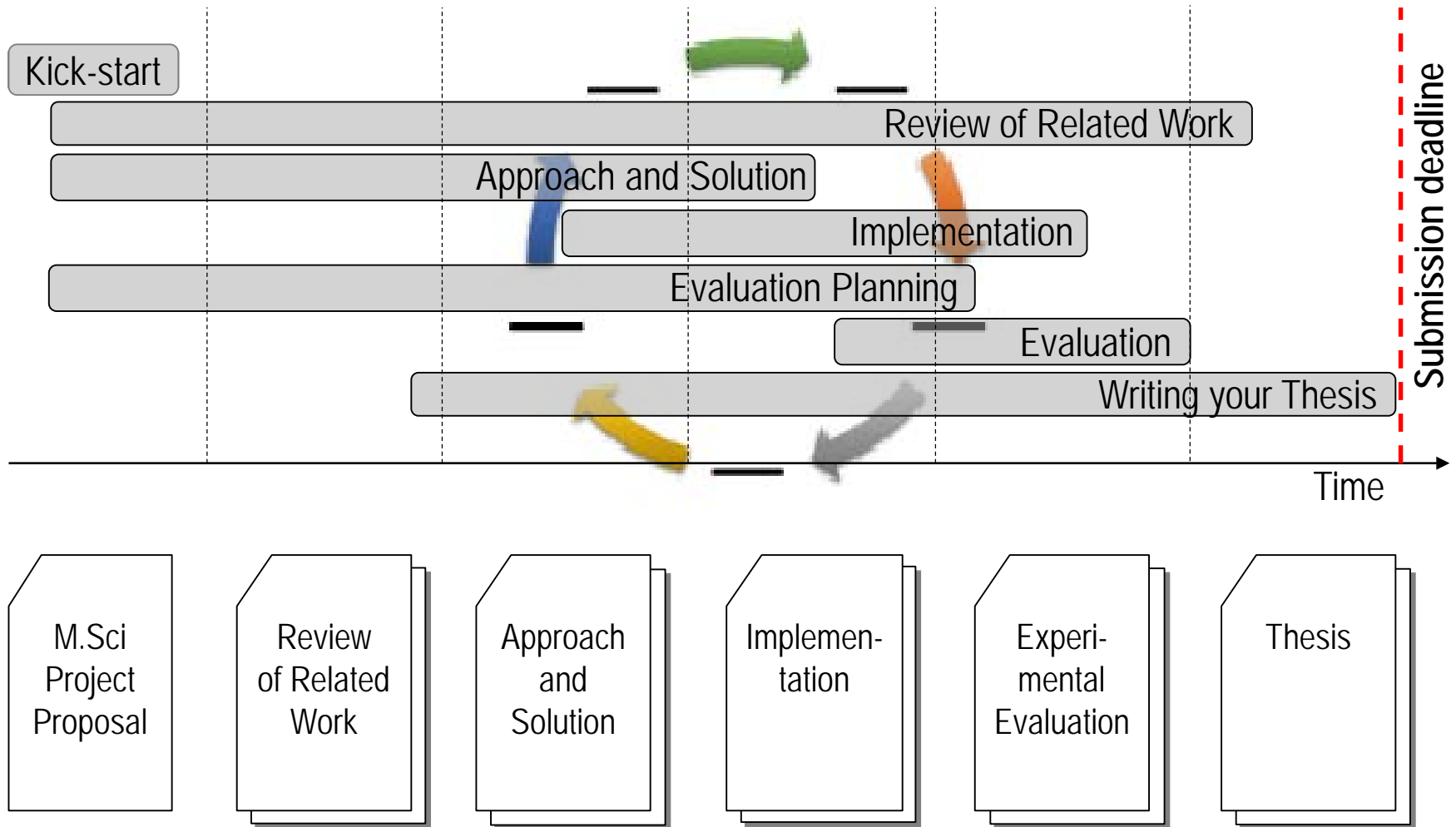
- **To whom to present?**

- Your mentor, peers, potential early adopters ...
- To be posted to social media ...
- Could become a part of a **regular research paper**. Talk to your mentor



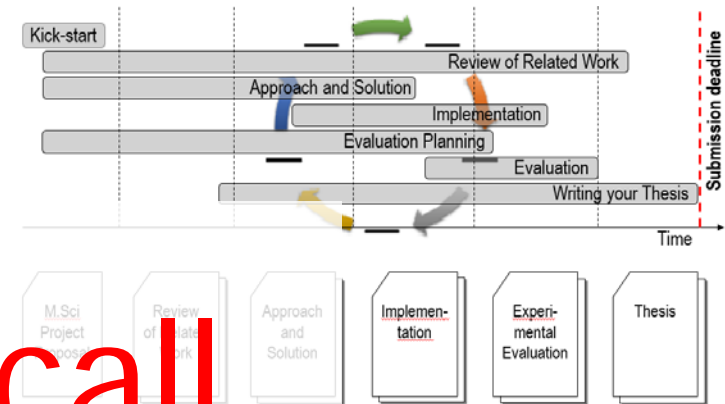
**What  
to Put in?**

# Lifecycle and Evolution



# What to Put in Your Thesis?

- Thesis:
  - A **FINAL** report
  - A **FULL-DETAIL** report
- All project phases to be presented
  - Use the **FINAL** versions of the Tech Reports
- **Approach to Solution**
  - Present the **evolution** of what you thought and did – through the versions
- Thesis:
  - Start writing **early!** **Why?**
    - Plan B, just in case
    - Take care about the text balance and volume



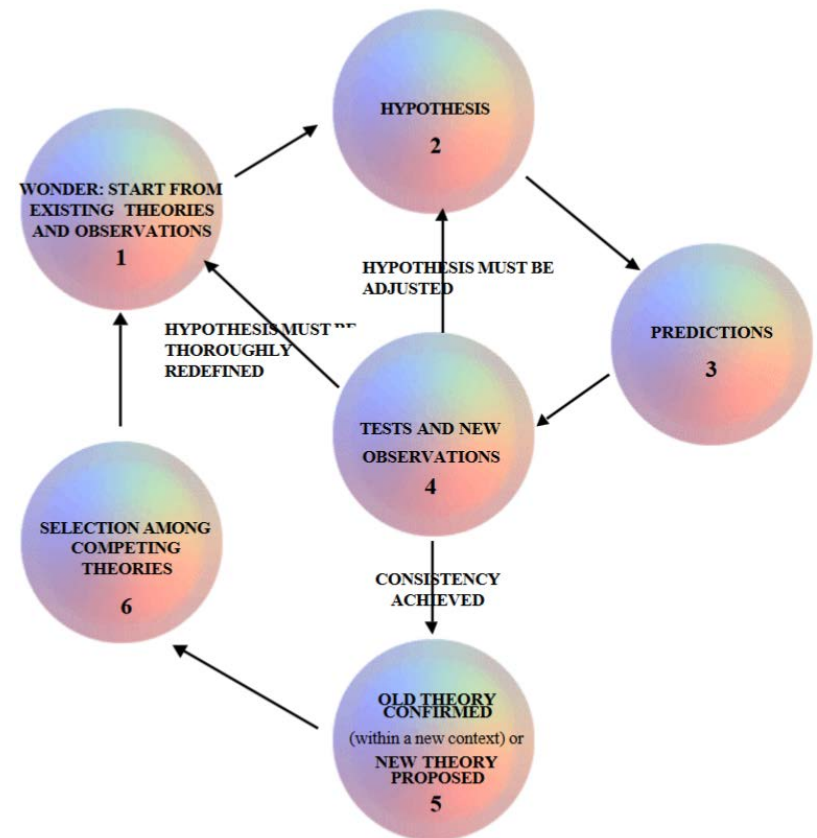
Does it recall  
**ANYTHING?**



# The Scientific Method

An **outline\***:

- Very **similar** in different sciences / branches
  - Philosophy ... CS ... Medicine
- **Iterative**
  - Question (1)
  - Hypothesis (2)
  - Prediction (3)
  - Test (4)
  - Revision / Refinement (5)
  - Benchmarking (6)
- Part I, Topic II: **Methodology of Science**



\* **Dodig-Crnkovic, G.:** Scientific Methods in Computer Science. Proc Conf for the Promotion of Research in IT at New Universities and at University Colleges in Sweden (2002)

# Illustrations ...

- What is an **illustration**?
  - A **figure** (chart, picture, etc.)
  - But also: a **table**; an **example**; a **fact**; a **link**
  - A piece that **supports** your **story/statement**
- Which **types** of illustrations are **appropriate**?
  - **All** those above, that help you
    - **Save space** (a look is worth a thousand words)
    - Make your **explanation simple** and **clear**
- Make sure that
  - Use **permissions** are **granted**
  - **Sources** are **mentioned**:
    - Like the above: [https://en.wikipedia.org/wiki/A\\_picture\\_is\\_worth\\_a\\_thousand\\_words](https://en.wikipedia.org/wiki/A_picture_is_worth_a_thousand_words)



1913 newspaper advertisement

# How Many?

- ... a typical question to be asked by a student ...
  - Also about the no of pages ...
  - The **more** – the **better**, more **convincing**?
- How much money you need to feel completely happy?
- Is having 10 beers vs 5 is a more productive October Fest for you?
- ... Just **enough** ... there are better places to party in Muenchen
- To keep it **simple** ...

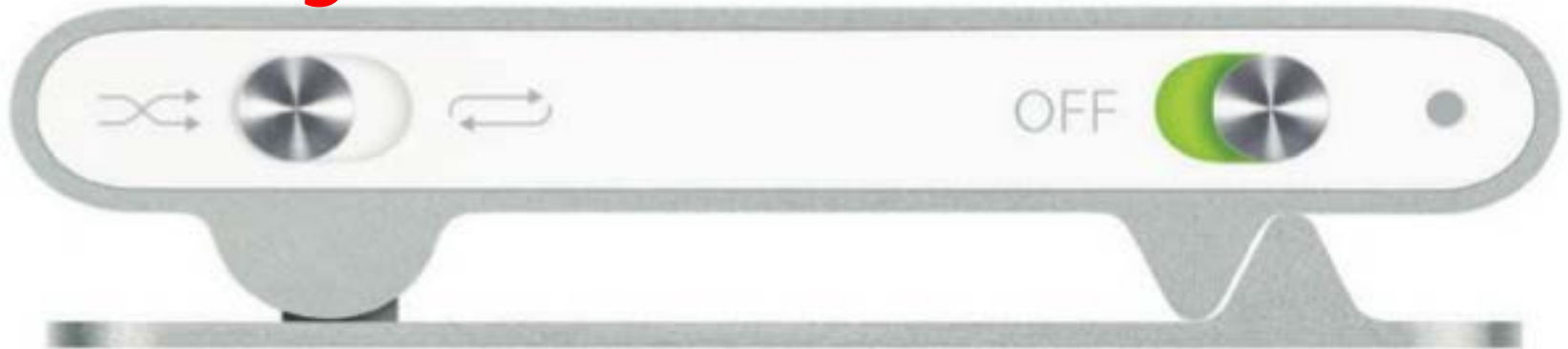


# How to Keep it Simple

**“Simplicity is about subtracting the obvious, and adding the meaningful.”**

— John Maeda

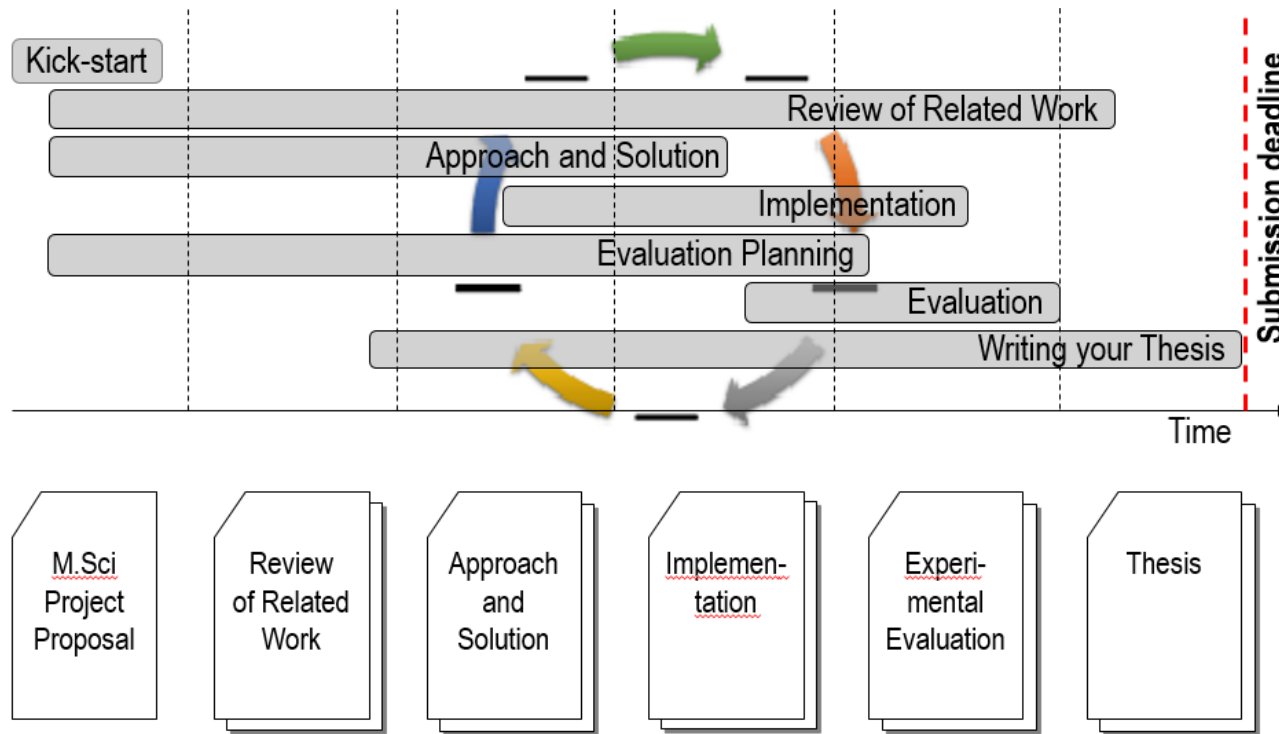
Sorry, that **ABSTRACT**



**Oh, Yeah ...  
What  
to Leave Out?**

# Filter out:

- All **intermediate** versions of your hypothesis, solution, and results
- Except mentioning the **evolution** of your thought in the context of the **Approach to Solution**



# Not to Forget

# Acknowledgements

- Paying your **credits** to those, **who ...**
  - **Fund** your work
  - Are not on the authors list, but **helped** with the reported work
  - Anyone else, whom you do not directly cite, but feel **grateful** to
    - E.g. for a valuable **advise**

## Acknowledgements

The research leading to this publication has been done in part in cooperation with the Ontology Engineering Group of the Universidad Politécnica de Madrid in frame of FP7 Marie Curie IRSES SemData project (<http://www.semdata-project.eu/>), grant agreement No PIRSES-GA-2013-612551. While performing this research, the first author has been a master student on the program on Computer Science and Information Technologies at Zaporizhzhia National University. The second author is funded by a PhD grant provided by Zaporizhzhia National University and the Ministry of Education and Science of Ukraine.



# Citations

- Any **use** without **mentioning** the **source** is ...
- ... **plagiarism**
- Any **mention** of the others **result** has to be
  - **Cited**, by giving a reference
    - E.g. (Allen, 1984), or [42]
  - **Referenced** by putting the paper in the References section. e.g.:
    - Allen, J. (1984): Towards a General Theory of Action and Time. Artificial Intelligence, **23**(2), pp. 123–154
  - Including **indirect** and **direct** mentions
    - **Literal citations** should be **quoted** “...”

# Risk and Responsibility

- Master Project is **your individual** project
  - You are the **only author** mentioned in the title page
- Which **implies ...**
  - You are the **best expert** available for the project
  - All the incurred risks are your **own risks**
  - You **bare sole responsibility** for every bit (mis-)presented in your thesis
- Your **mentor ...**
  - Is not an author
  - Helps you manage the project, also methodologically
  - Suggests things
  - Does not decide
  - Is not punished for the failure

# Typical Flaws

# What Fails Your Thesis?

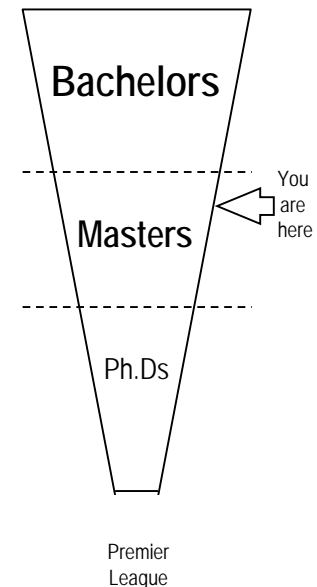
## Suspicious?

- Things that **fail** your Master Project ...
  - **Blurred focus:**
    - You solve **one** small research **problem**
    - Research **question**, **gaps**, **hypothesis** have to be clearly stated
  - **Development** instead of research:
    - No clear **research contribution**
      - **Novelty** (progress re background)
      - **Impact** (the **value** of your contribution for **target groups**)
  - No clear identification of **related work** and **background**
  - No clear **methodology**
  - No **evaluation**
    - A **correctness test** is not enough
    - **Novelty**, **efficiency**, **impact** need to be proven
    - **Limits** have to be justified

# Is it a B.Sci Thesis?

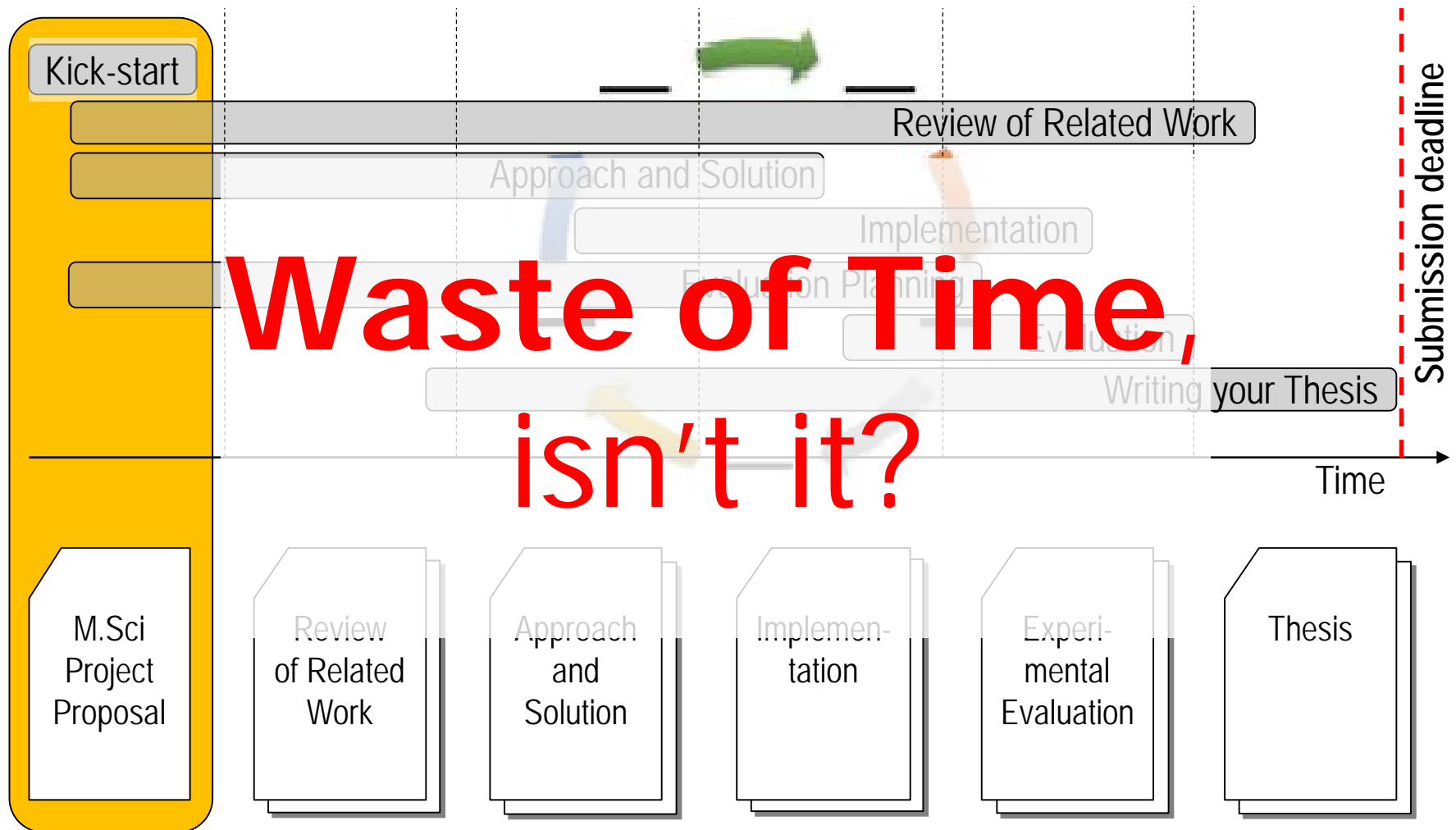
## Opinions?

- Not really ... like in **soccer**
- **Bachelors**: your initial step to profession
  - Doing what your supervisor tells
  - Learning very **basic things** in an R&D context
  - Attending a **soccer school**
- **Masters**: apprenticeship
  - Producing research **foreground**
  - Following your mentor's pattern in research
  - Trying your own idea
  - Allowed to kick a ball in the **first league**
- **Ph.D**: aspiration
  - Respect your mentor, aspire to **outperform**, gain **reputation**
  - You are the best **expert** in your narrow field, not your mentor
  - Being on a bench in the **Premier League**
- **After** (successful) Ph.D: allowed to **choose a Club**



# Your Master Project Proposal

# To Recall ...



# Not Really ... Recall ...

- **Objective(s)?**
  - **Estimate your chance** to have a successful M.Sci Project
  - **Convince** your (potential) supervisor (mentor)
  - **Sell** your project to your Master Program
- **Approach?**
  - Get an Idea ... Analyze Gaps ... Formulate the Problem ... Read ... Plan ... Talk to a Mentor ... Come out with a Vision ... Sketch out your Approach ... Estimate Impact ...
  - Present ... Analyze Feedback ...
- **Resources?**
  - Brain ... Experience ... Curiosity ... Mentor's advise ...
  - Research **environment**, **network**, and **infrastructure**
- **Output?**
  - M.Sci Project **Proposal** (Exposé)
  - Together with your mentor
  - Could be submitted as a **position** paper



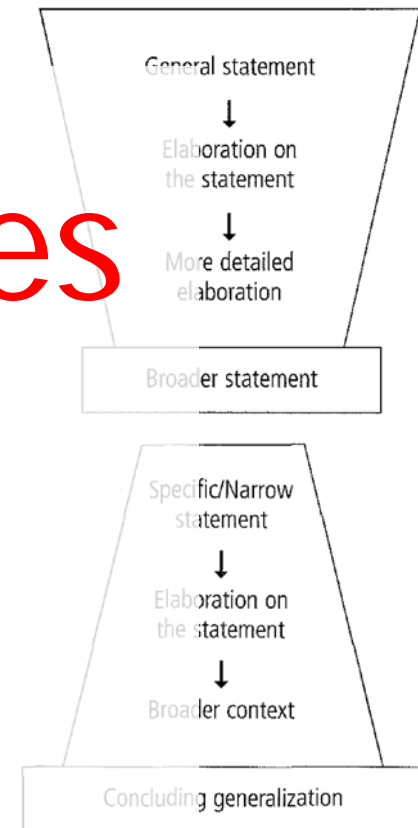
# Motive

- It is in your best **pragmatic interest**
- Helps think out your project **conceptually**
  - Form your **position(s)** and research **offer**
- Helps **plan** your project:
  - From a verified **idea** and identified **research problem**
  - Through identified and justified **research gaps**
  - Following the **path** of the rationally chosen **methodology**
  - To an appropriately **focused solution** to the problem
  - **Evaluated** in a proper way
- If **properly done** ...
  - The rest becomes **manageable** and **predictable**
    - Sort of routine
  - With clearly defined **milestones**
- Hence, your **idea** and **positions** become **credible**

# Suggested Structure

- Introduction and motivation
  - Coming up with a research question
- Review of related work
  - Has your RQ been answered? In which part?
  - What are the research gaps?
- Research hypothesis and problem
  - What is(are) your objective(s)?
  - What is your hypothetical recipe to narrow the gaps?
  - How you shape it out as a problem, formally?
- Envisioned approach to solution
  - Problem solution
  - Hypothesis verification
- Research methodology and plan
  - Including research, development, evaluation, revision/refinement, supporting activity (writing)
- Early results, if any
- Conclusive remarks and outlook

How many pages  
do you need  
to cover that,  
concisely?



# Some Recommendations

- **Recommendations:**

- <https://www.wikihow.com/Draft-a-Thesis-Proposal>
- TU-Muenchen: <https://thesisguide.org/>
- <https://classroom.synonym.com/write-proposal-computer-science-topic-4108.html>
- Duke: <https://nicholas.duke.edu/programs/masters/advising/masters-projects/proposal>
- ETH Zuerich: <https://ethz.ch/content/dam/ethz/special-interest/erdw/departement/dokumente/studium/master/msc-project-proposal-guidelines.pdf>
- TU-Wien: [https://sts.univie.ac.at/fileadmin/user\\_upload/i\\_sts/Studium/Master\\_STS/05\\_Services\\_for\\_current\\_students/Master\\_Thesis/Guidelines\\_for\\_Writing\\_a\\_Master\\_Thesis\\_Expose.pdf](https://sts.univie.ac.at/fileadmin/user_upload/i_sts/Studium/Master_STS/05_Services_for_current_students/Master_Thesis/Guidelines_for_Writing_a_Master_Thesis_Expose.pdf)

- **Samples** of Master Project Proposals:

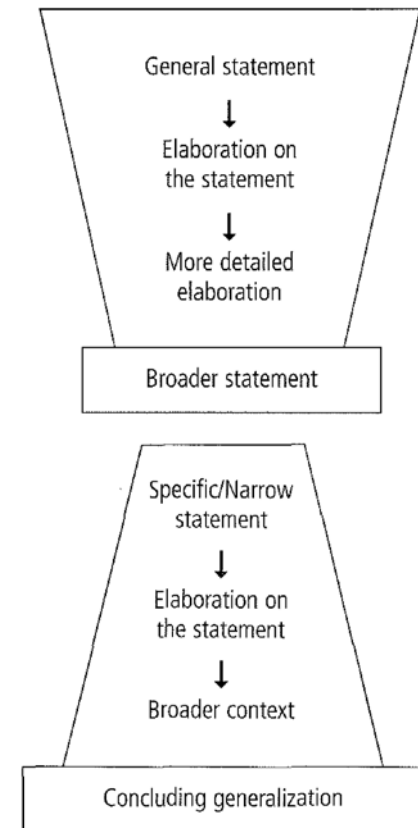
- Texas Tech: <https://pdfs.semanticscholar.org/e887/189e2839c112931dafae8829eec29f5b2db7.pdf>
- HU-Berlin: [https://www.informatik.hu-berlin.de/de/forschung/gebiete/wbi/teaching/studienDiplomArbeiten/finished/2016/expose\\_bleuel.pdf](https://www.informatik.hu-berlin.de/de/forschung/gebiete/wbi/teaching/studienDiplomArbeiten/finished/2016/expose_bleuel.pdf)

# Let Us Do by Example

Does anyone have a topic?

# Suggested Structure

- Introduction and motivation
  - Coming up with a research question
- Review of related work
  - Has your RQ been answered? In which part?
  - What are the research gaps?
- Research hypothesis and problem
  - What is(are) your objective(s)?
  - What is your hypothetical recipe to narrow the gaps?
  - How you shape it out as a problem, formally?
- Envisioned approach to:
  - Problem solution
  - Hypothesis verification
- Research methodology and plan
  - Including research, development, evaluation, revision/refinement, supporting activity (writing)
- Early results, if any
- Conclusive remarks and outlook



# Reading

# Basic Reading

- A book that covers almost all the material in this course:
  - Justin Zobel: Writing for Computer Science. Third Edition. Springer London Heidelberg New York Dordrech (2014)
- A comprehensive course material, covering thesis writing:
  - Wilhelmiina Hämäläinen: Scientific Writing for Computer Science Students. Course material. Department of Computer Science University of Joensuu, Finland (2006)
- Please also learn by:
  - Looking at appropriate examples
  - Trying yourself
  - Suffering

# Additional Reading

- **Scientific method:**
  - **Dodig-Crnkovic, G.:** Scientific Methods in Computer Science. Proc Conf for the Promotion of Research in IT at New Universities and at University Colleges in Sweden (2002)
    - <http://www.mrtc.mdh.se/publications/0446.pdf>
- Several bits mentioned (referenced) in the slides as **recommendations** or **samples**



**Will be happy  
to answer  
your questions ...**

Will be also happy to continue discussions

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