OTTO VON GUERICKE
UNIVERSITÄT
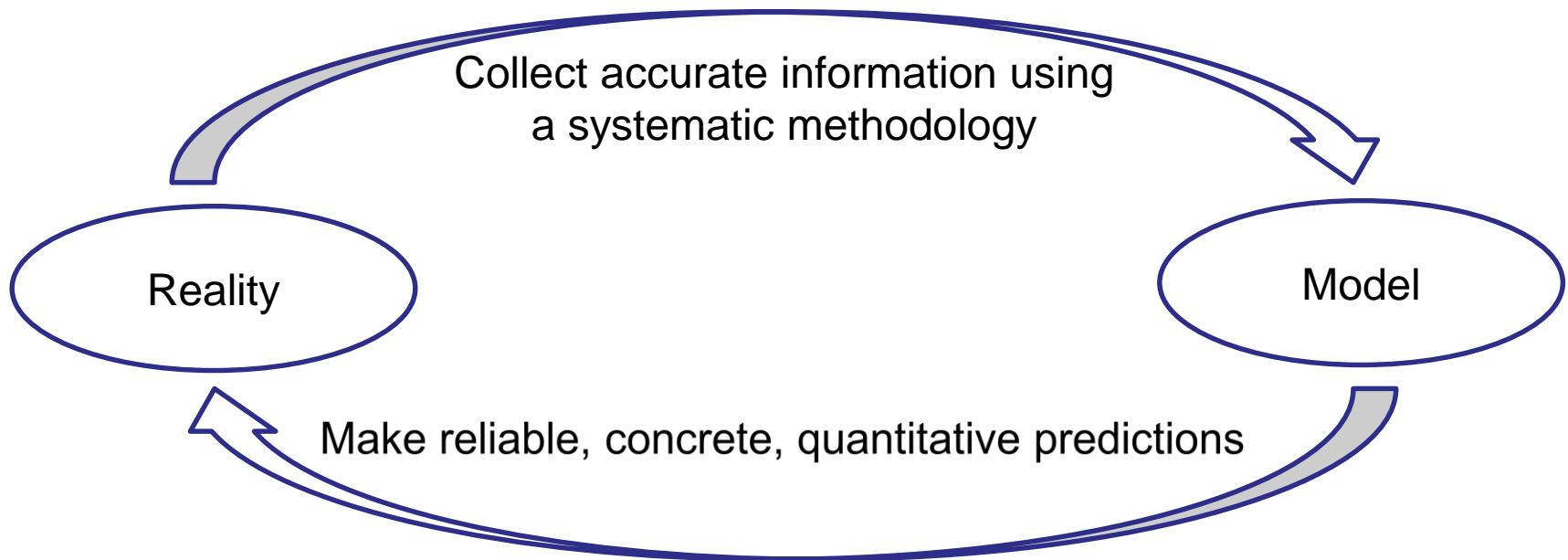MAGDEBURG

INF FAKULTÄT FÜR
INFORMATIK

Scientific Work

Writing a Thesis in the STEM Field

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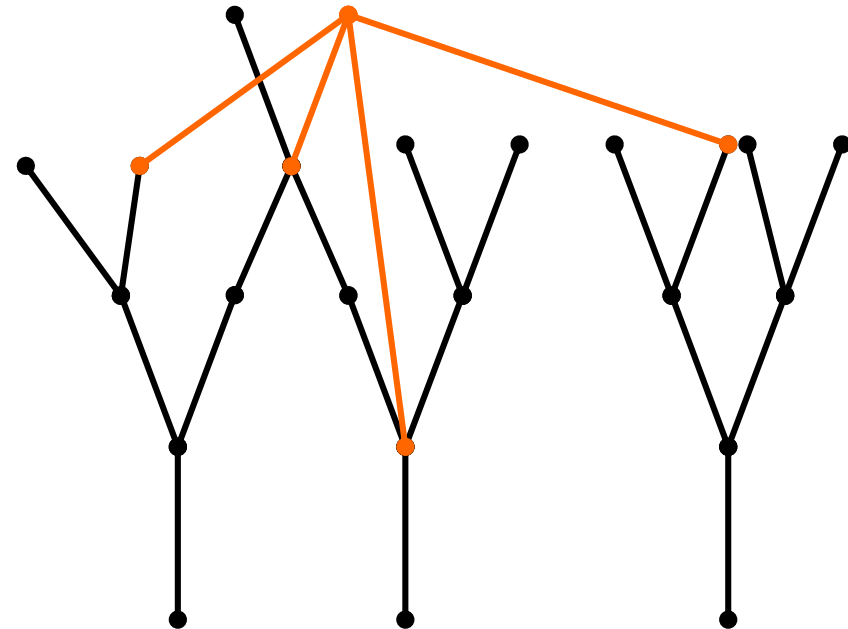
The scientific method

What is science?

Scientific progress

- Is a network of individual works
- Everyone builds on their precursor

What is happening?

- Extensions
- Corrections
- Syntheses
- Comparisons
- Improvements
- …

Creating knowledge

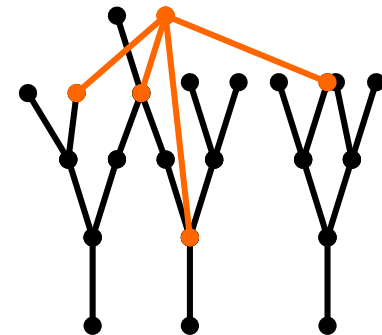## „Wissenschaft = Wissen schaffen"

- A scientist is someone who creates knowledge

The goal of scientific research is to gain new insights

- Scientific research is related to questions

A scientific work answers a question

- The question must be new
- The answer must provide a new insight

How to proceed …

A Typical Research Study

A scientific study (in natural sciences) has four phases

Hypothesis:

- An assumption, how something works

Prognosis:

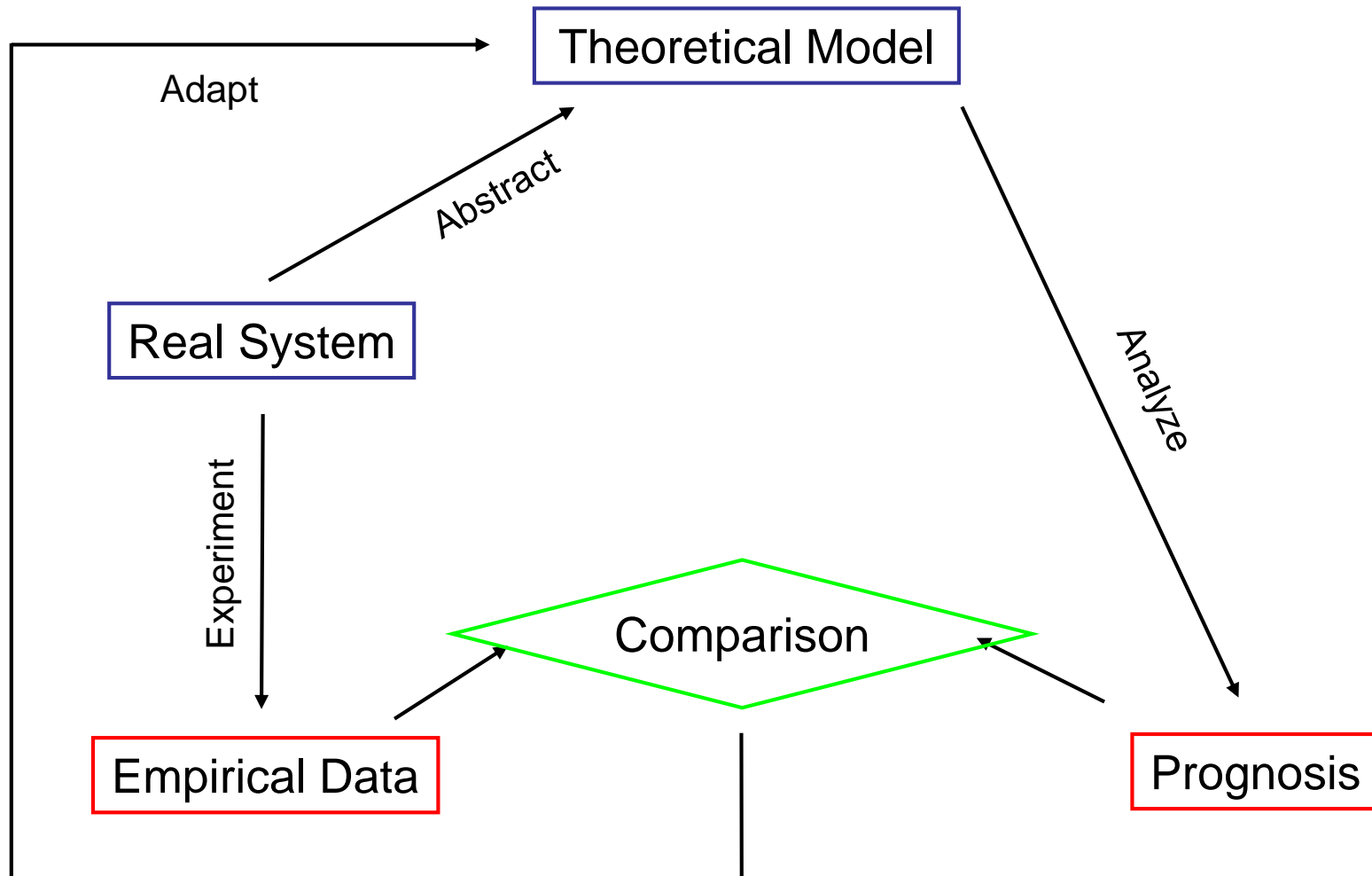- How something should behave according to the hypothesis

Experiments:

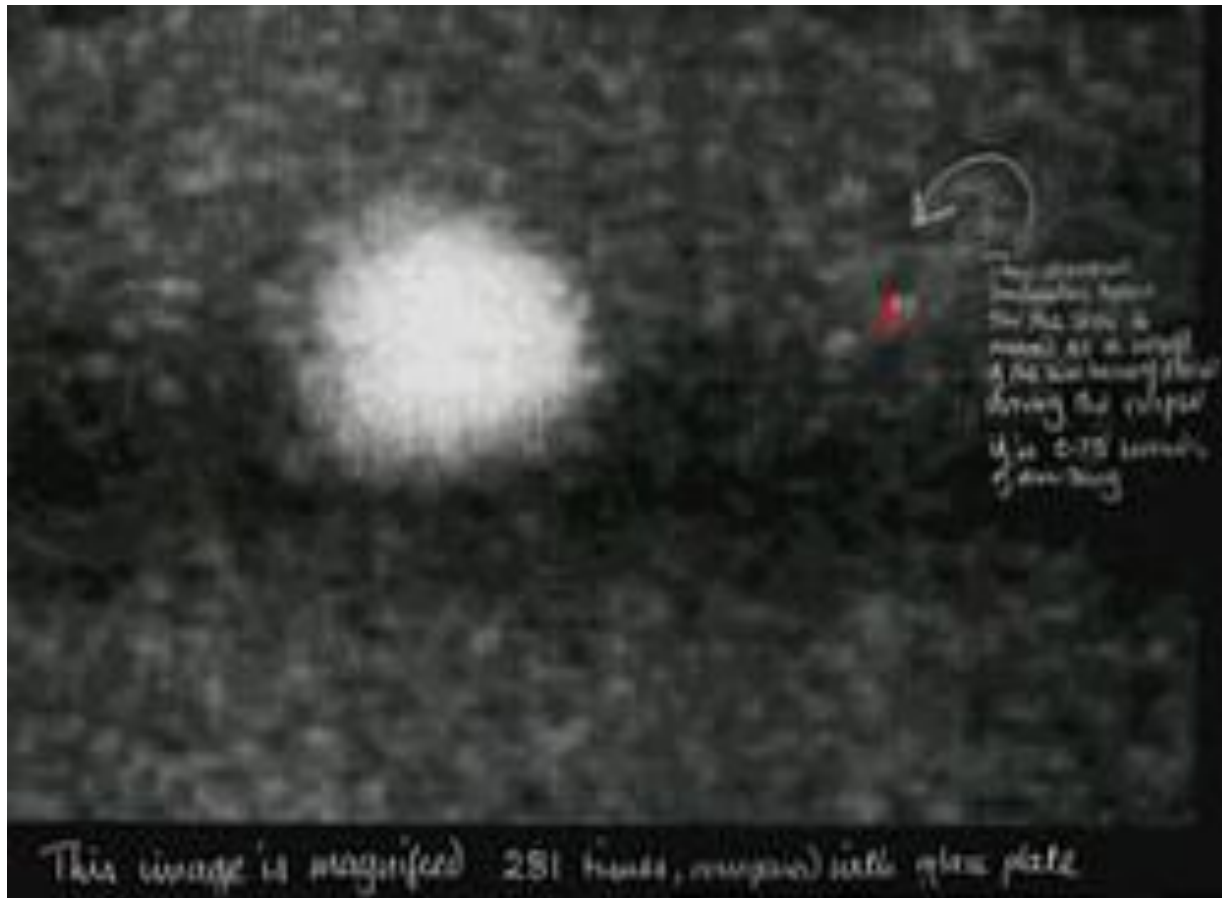- Selective observations of reality

Interpretation:

- Do these observations support the hypothesis?
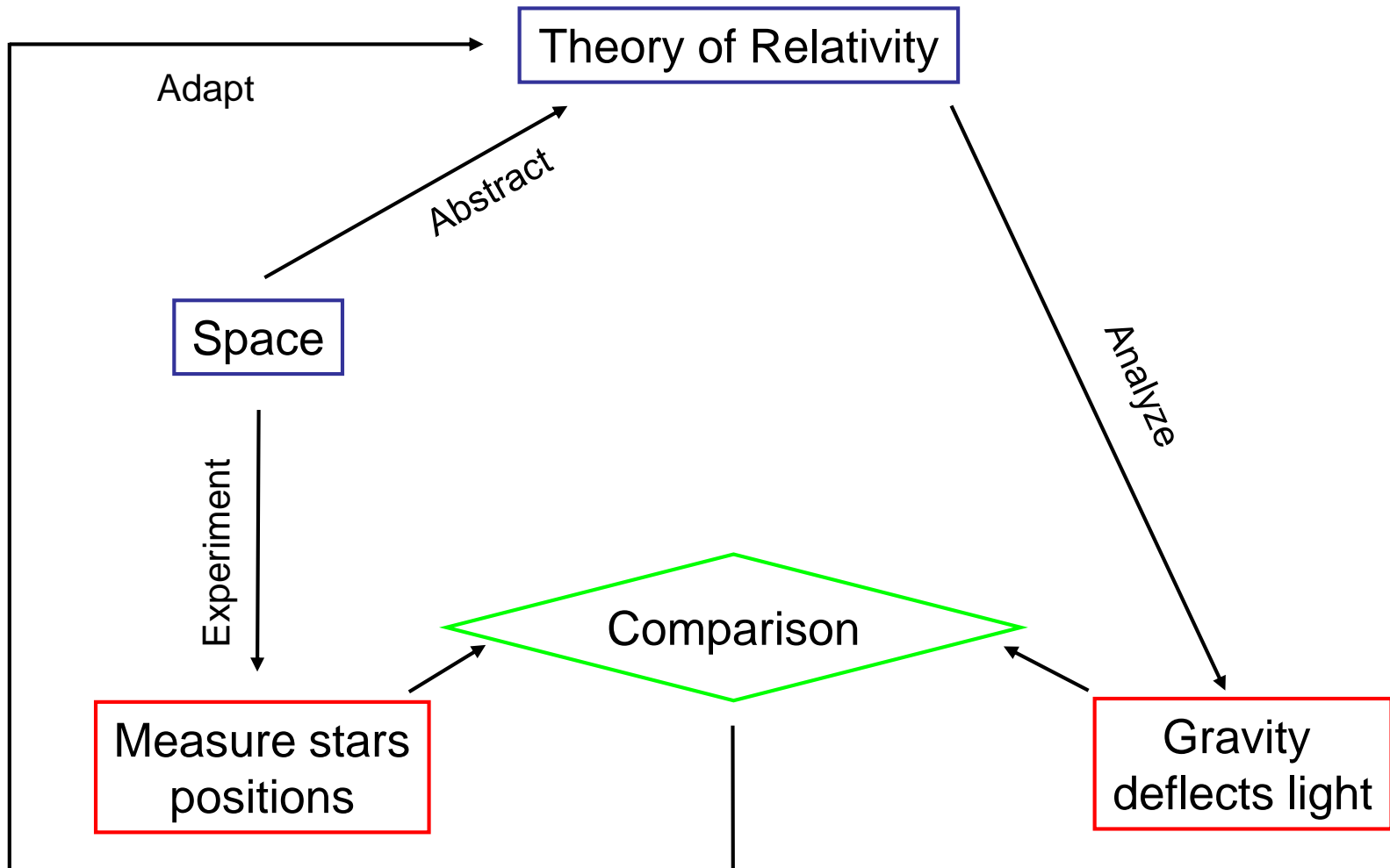
Theory and Experiment

Example: Relativity

Example (Einstein 1915 / Eddington 1919):

Example: Relativity

Possible Publication Structure

General structure of a publication:

1. Theory X says, that […]
2. This results in the prognosis, that […]
3. We conducted the following experiment: […]
4. The result of the experiment was, […]
5. We therefore conclude, that theory X […]

Engineering science

What is engineering science?

Definition of American Engineers' Council for Professional Development:

- *The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, […]*
- *or to forecast their behavior under specific operating conditions;*
- *all as respects an intended function, economics of operation and safety to life and property.*

A typical engineering study

Engineering science questions often concern …

- Functionality
- Efficiency

Typical questions can therefore be:

- *How efficient is method <X>?*
- *Is procedure <X> suitable for problem <Y>?*
- *How efficient is technology <X>?*
- *What can a solution for problem <X> look like?*

A typical engineering study

This means that one has to determine, …

- What is "efficient"?
- What is „suitable"?
- What should the method be able to accomplish?
- What should be measured and why?
- What are the important performance parameters?
- What are possible failure points?

In general:

- What are the success criteria?

A typical engineering study

Task:

- A task to be solved and criteria of a good solution

Solution approach:
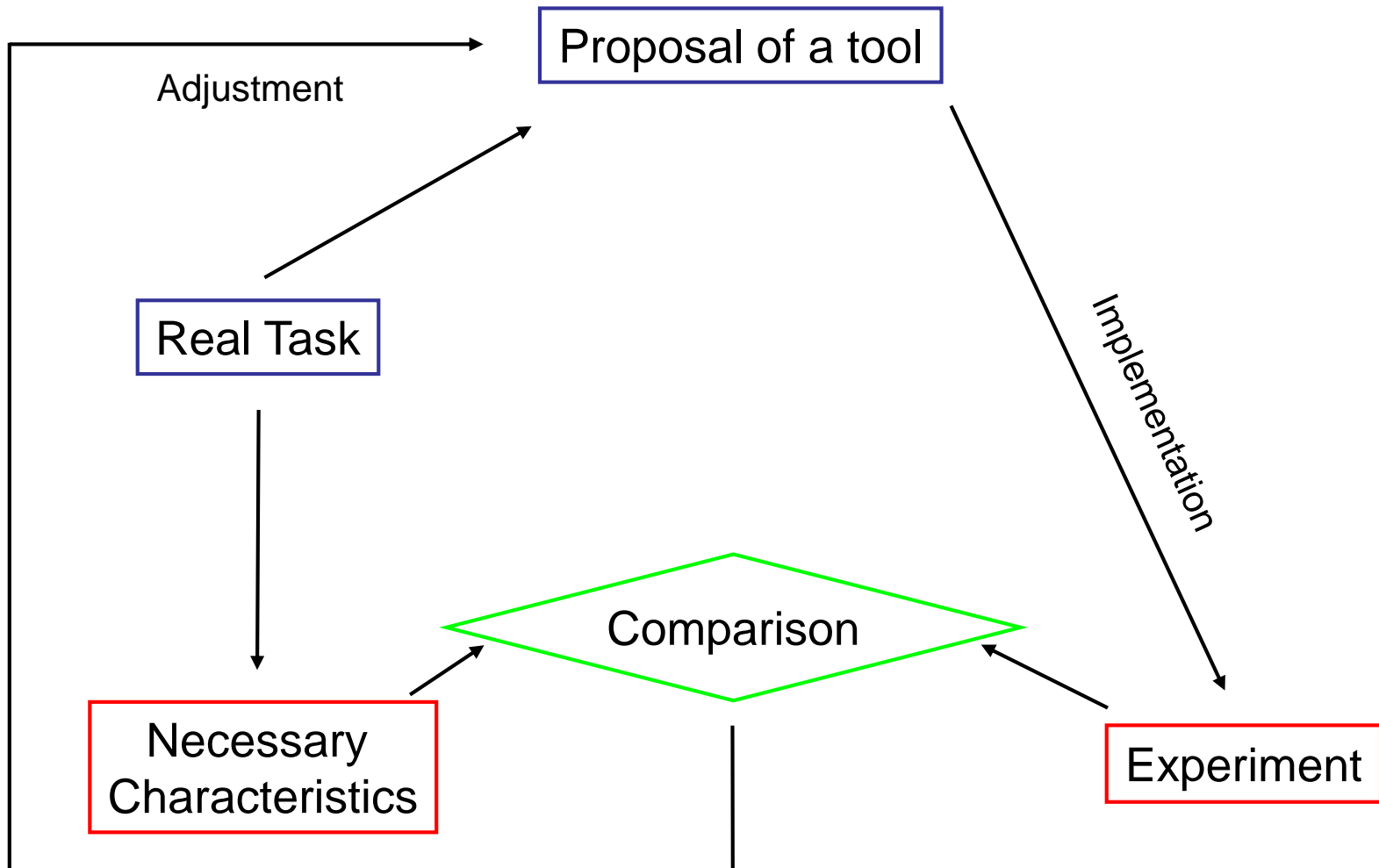
- A proposal how to solve the task

Implementation and experiments:

- Implementation and testing of the proposal

Conclusion:

- Is the proposal a suitable solution of the task?

Example: An engineering tool

Example: Engineering Tool

A possible publication structure:

1. The following task should be solved: […]
2. A good solution has the following characteristics […]
3. We propose the following tool: […]
4. We built the tool as follows: […]
5. Experiments with the tool showed, that […]
6. We therefore conclude, that […]
7. The consequences are […]

Many Masters Thesis in Computer Science look like this

- (or should look like this ☺)

What should be avoided …

Top Ten Planing Mistakes

Our "Top Ten-List" of mistakes when planing a thesis:

1. Don't plan
2. Don't agree on goals
3. Don't specify milestones
4. No buffer for failures and mishaps
5. Underestimate the time needed for bugfixing
6. Underestimate the time needed for literature research
7. Insuficient communication with your supervisor
8. Be done with implementation too late
9. Underestimate the effort when test subjects are involved
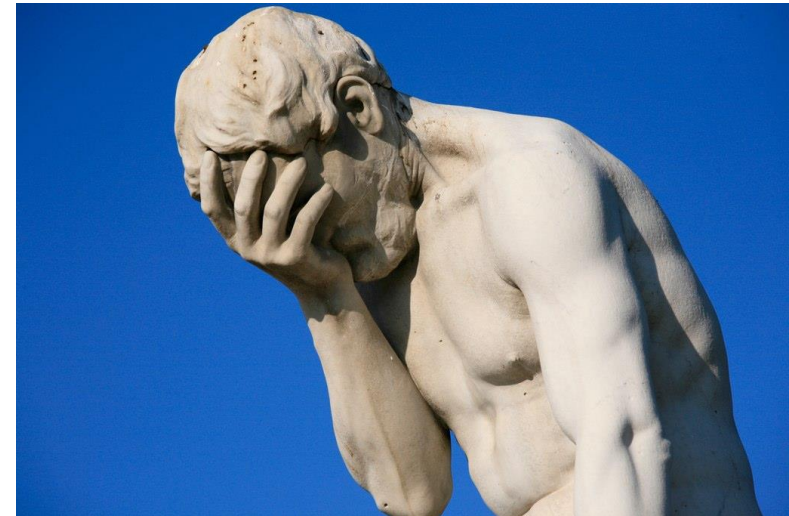10. Expecting the copy shop to be open on Sunday ;-)

Writing Mistake #1

Writing mistake #1 in Masters and Bachelors theses:

- They don't answer a question.
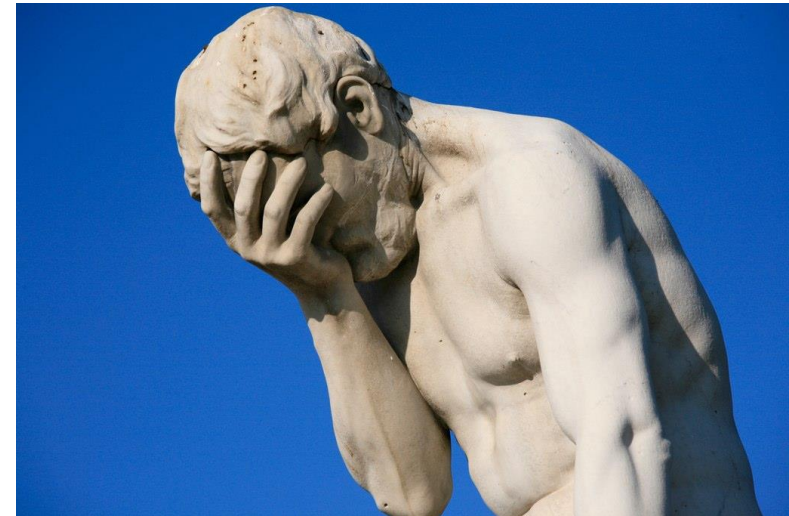
A scientific thesis is <u>not</u> …

- just a project report!

Writing Mistake #2

Writing mistake #2 in Masters and Bachelors theses :

- They do not define (or motivate) success criteria.

Writing Mistake #3

Writing mistake #3 in Masters and Bachelors theses:

- They see what has been build as goal, not as means to an end.

(This leads to mistake #2.)
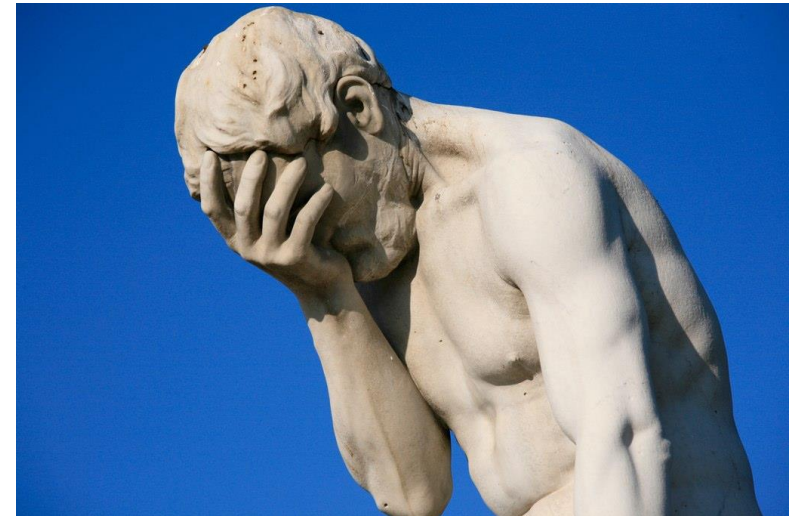
Typical Deficits

Bad theses are often similar

They exhaustively answer the questions
- What did I do?
- How did I do it?

They do not answer the questions
- Why did I do that?
- What is it good for?

Remember:
- Science is about answering questions!

How can I avoid that …

Goals

Every project must have a goal
- The goal tells you when the project is complete

The goal of scientific research is to gain new insights
- Scientific research is related to questions

Very important!:
- First determine the goal of the thesis!

NOT:
- *Just start to work – something useful will come up.*

Goals

Example from Simulation Project

- Task from the Magdeburg city planning office

An inappropriate project goal:

- *Our goal is to develop a program to simulate the crossroad*

A better project goal:

- *Our goal is to determine, how to improve the safety for bicyclists at the crossroad.*

Goal Agreement

We suggest that as a first stept for our students.

- (To check whether they understand what lies ahead.)

Content

- Preliminary title
- Motivation (What is it about and why?)
- Goals (What shall be accomplished?)
- Boundary conditions (What has to be considered?)
- Success criteria (How to determine, whether the thesis was successful?)
- Benefit (How can the result be useful?)
- Schedule (Registration → Draft Version → Preliminary Version → Submission)
- Signatures

The Draft Version

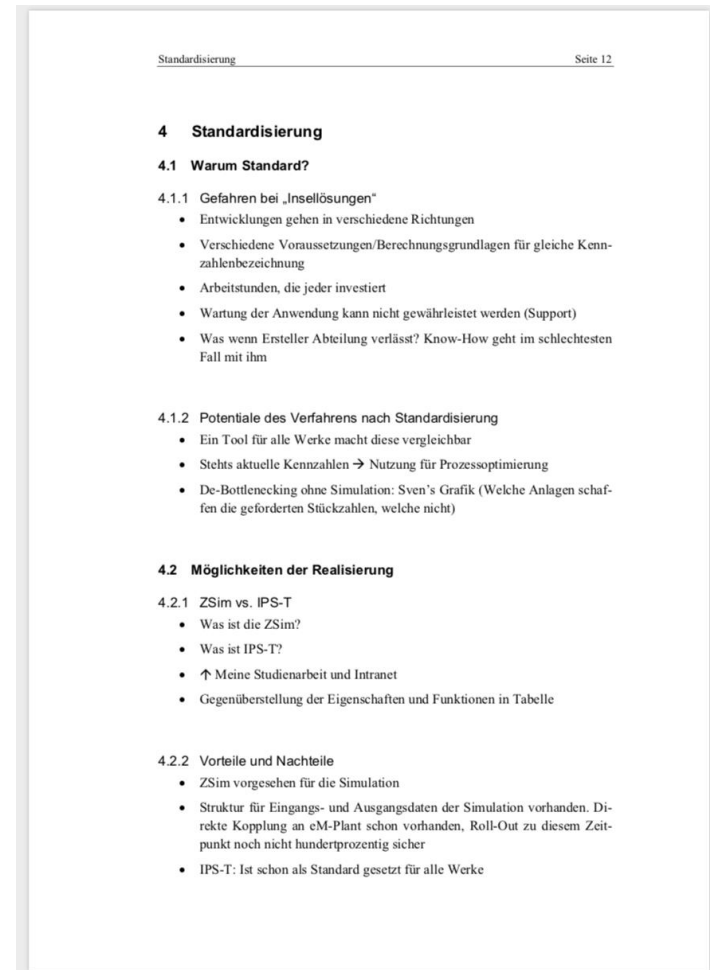## What is meant by a Draft Version?
- More than just the thesis structure

Contains all planned statements
- BUT only as phrases and bullets
- Not including all diagrams and pictures

Advantages:
- Forces to collect all thoughts
- Good basis for meeting with supervisor
- Not a lot of effort needed yet

The Topic-Burger

Every section needs three parts
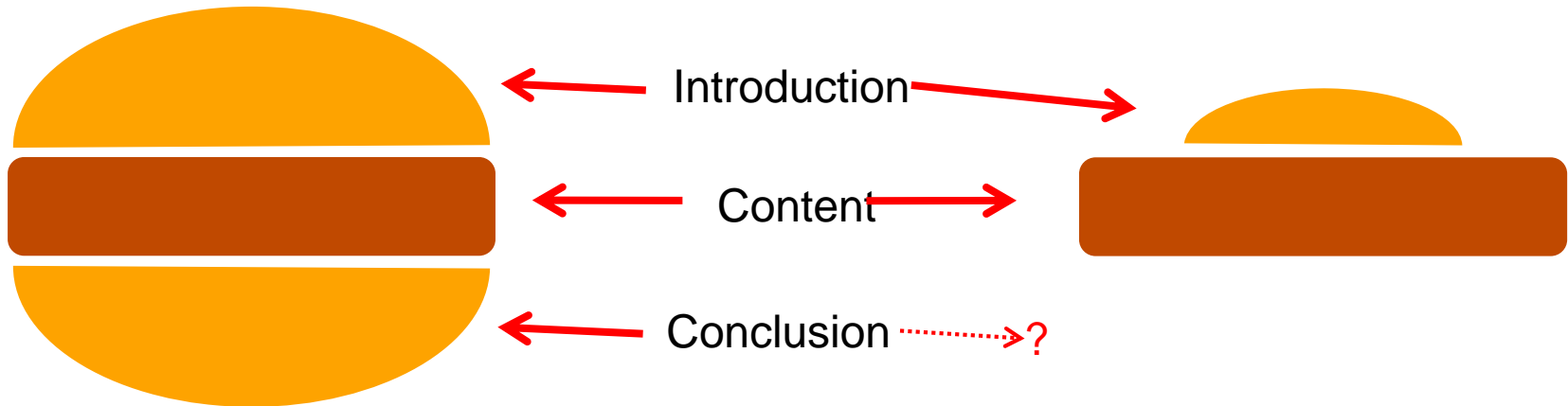
- An introduction
- The actual content
- A conclusion

Introduction:

- What will follow and why?

Conclusion:

- Summary / Meaning/ Assessment

The Topic–Burger

Introduction

Content

Conclusion ⋯⋯> ?

The Topic-Burger

These three elements are needed on all levels

- For the whole work
- In every chapter
- In every section

Badly written theses:

- Are just a concatenation of meet loafs

Consequences:

- Tiring for the reader
- The author misses the oportunity to shine

What if I don't make progress …

Help, I got writer's block!

Writer's block – weak strategies

Trial and error

- Working on phrasing in our head leads to rejecting the same phrases again and again
- Jot down variants and pick one

Insisting on a perfect draft

- A recipe for writer's block!
- It's more efficient to go through several drafts focusing on different goals

Waiting for inspiration

- Sometimes it works. Often you just sit there and get depressed
- Try some of the powerful strategies to get some inspiration

Words looking for an idea

- Be wary of phrases like „due to the fact that" or „it's imperative to say"
- They give an illusion of progress, but it's easier to say something when you know what you want to say

Writer's block – powerful strategies

Make notes as they appear to you

- Use a notebook, piece of paper, blog, editor, …, to jot down your ideas before you forget them

Freewriting

- Use this when you are stuck
- Write for 10mins without pausing
  - When you run out of things to write, feel free to write „bla bla bla"
  - If ideas away from your topic surface, write them down, too

Brainstorming

- Decide on a topic and your goal for that topic
- Jot down ideas without censoring for usefulness or prose style

Writer's block – powerful strategies II

Piecework

- Once you know the rough outline of your work, start writing the section you know most about

What I really mean is (WIRMI)

- Use this phrase and then write down the idea the way you think it is
- Now you know what you need to rephrase

Satisficing (satisfy + suffice)

- Take the first reasonable solution instead of searching for the perfect word or phrase
- You can always revise afterwards

Writer's block – more strategies

Eat the right food

Go for a walk

30 seconds dance party

Take a break

Final thoughts …

Ten (more) Tipps

Ten Tips for Writing a Theses :

1. Choose a supervisor who understands his stuff
2. Choose a topic that you are interested in
3. Know the expectations of your supervisor
4. Agree on and fix a topic, goal, tasks and plan
5. Choose your second reviewer early on
6. Mind: The utility of a plan is in planning
7. Mind: It always takes longer than you think!
8. Other people always cause delays
9. Use a Draft Version
10. Always remember: You want to answer a question!

Caveat

This script contains many suggestions
- These are from our perspective only

Supervisors are …
- often headstrong
- always different

Therefore:
- Do not rely on this script solely
- Always ask the opinion of your reviewer!

Thank you for your attention