

11. The ADED Research Process - From the Idea to the Text of a Paper or Thesis

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Exzellenz aus
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- ▶ **Hubert Österle, Boris Otto.** A Method For Consortial Research. Report No. BE HSG/ CC CDQ/ 6, University of St. Gallen
 - http://works.bepress.com/hubert_oesterle/196/
- ▶ **Helga Esselborn-Krumbiegel.** Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben: 3. überarbeitete Auflage, 2008. <http://schreibzentrum-koeln.de/>
- ▶ **Joseph Novak.** The Theory Underlying Concept Maps and How To Construct Them. IHMC, Techreport, 2002.
 - <http://cmap.ihmc.us/docs/theory-of-concept-maps>
- ▶ **Alan Bundy.** How to Write an Informatics Paper. Web page:
 - <http://homepages.inf.ed.ac.uk/bundy/how-tos/writingGuide.html>
- ▶ **Matti Tedre.** Know your discipline: Teaching the philosophy of computer science. Journal of Information Technology Education (JITE), 6:105-122, 2007.
- ▶ **Prof. Mary Shaw** from CMU has a lot of good material on Software Engineering Research. <http://spoke.compose.cs.cmu.edu/ser04/>



Goals of this Chapter

- ▶ Give you an overview of the research process, e.g., of research paper or a Bachelor, Master's thesis, or PhD thesis
- ▶ Illustrate the process with some example methods.



11.1. The ADED Research Processes

Inspired from [Österle/Otto] and [Esselborn-Krummbiegel]



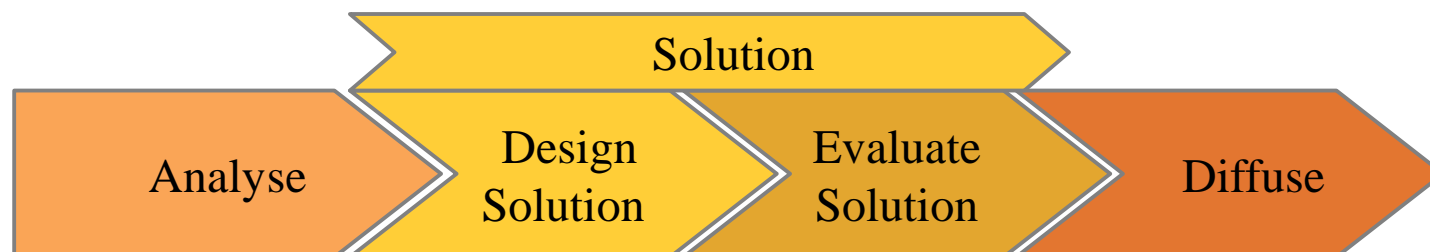
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Standard Research Process ADED [Österle/Otto]

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Academic Skills in Computer Science (ASICS)

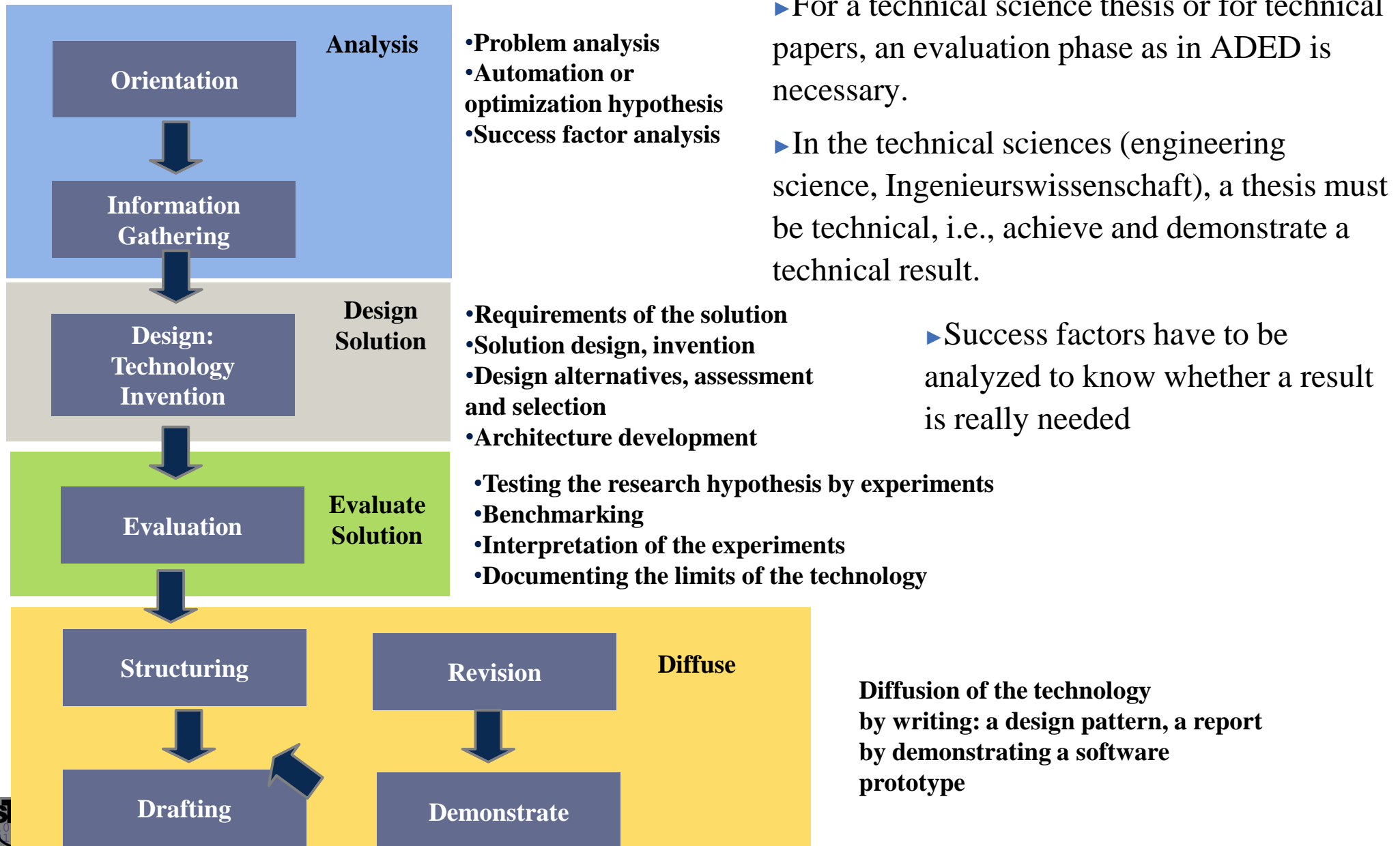
- ▶ [Hubert Österle, Boris Otto. A Method For Consortial Research. Report No. BE HSG/ CC CDQ/ 6, University of St. Gallen http://works.bepress.com/hubert_oesterle/196/]
- ▶ **Analyse** existing technologies, literature, background, problems
- ▶ **Design** new technologies (new solution)
 - Think, brainstorm, generate ideas
 - Research and develop
- ▶ **Evaluate** technologies (new solution)
 - Show why the new technology is superior; use success criteria
- ▶ **Diffuse (publish and demonstrate)**
 - Demonstration for creating vision
 - Popularize (position) your research results
 - „visible scientist“



The ADED Research Process for Technical Science Thesis

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Academic Skills in Computer Science (ASICS)



► For a technical science thesis or for technical papers, an evaluation phase as in ADED is necessary.

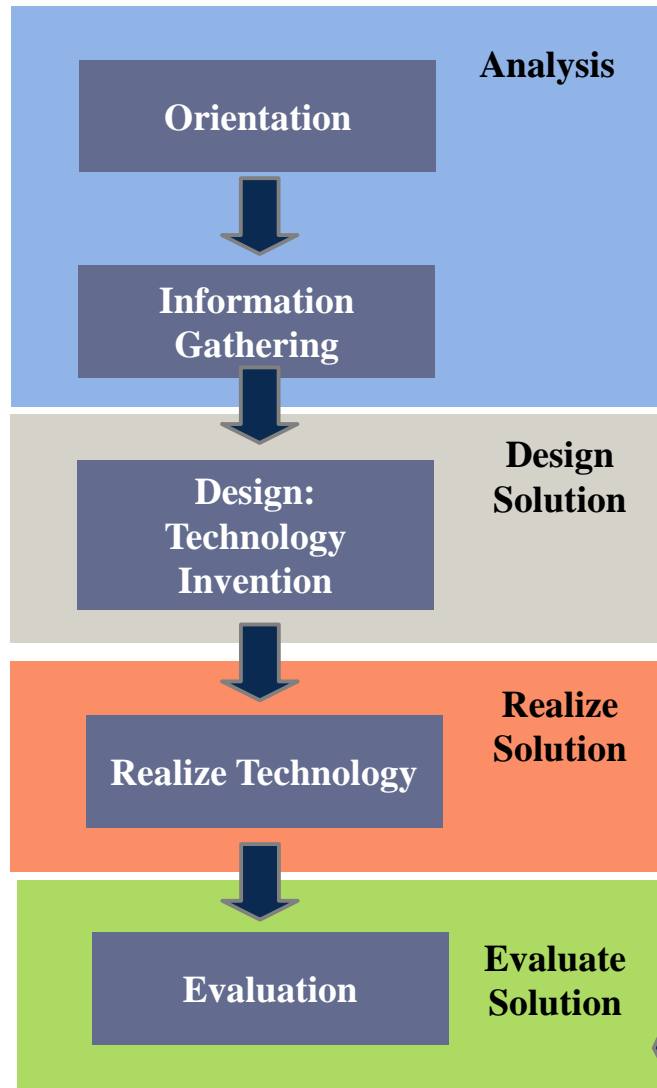
► In the technical sciences (engineering science, Ingenieurwissenschaft), a thesis must be technical, i.e., achieve and demonstrate a technical result.

► Success factors have to be analyzed to know whether a result is really needed

The AD-R-ED Research Process for Technical Science Thesis

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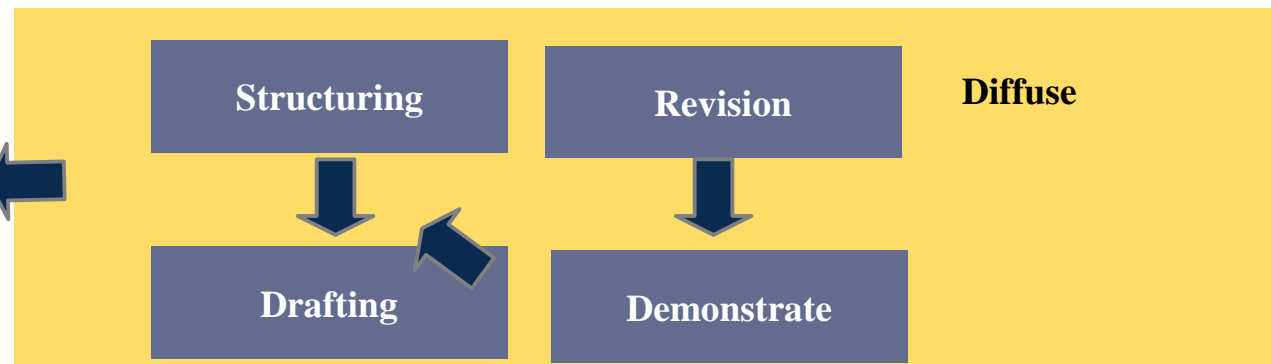
Academic Skills in Computer Science (ASICS)



► For technical science, in particular software engineering, a *realization phase* is required so that evaluation can take place

- Requirements of the solution
- Solution design, invention
- Design alternatives, assessment and selection
- Architecture development

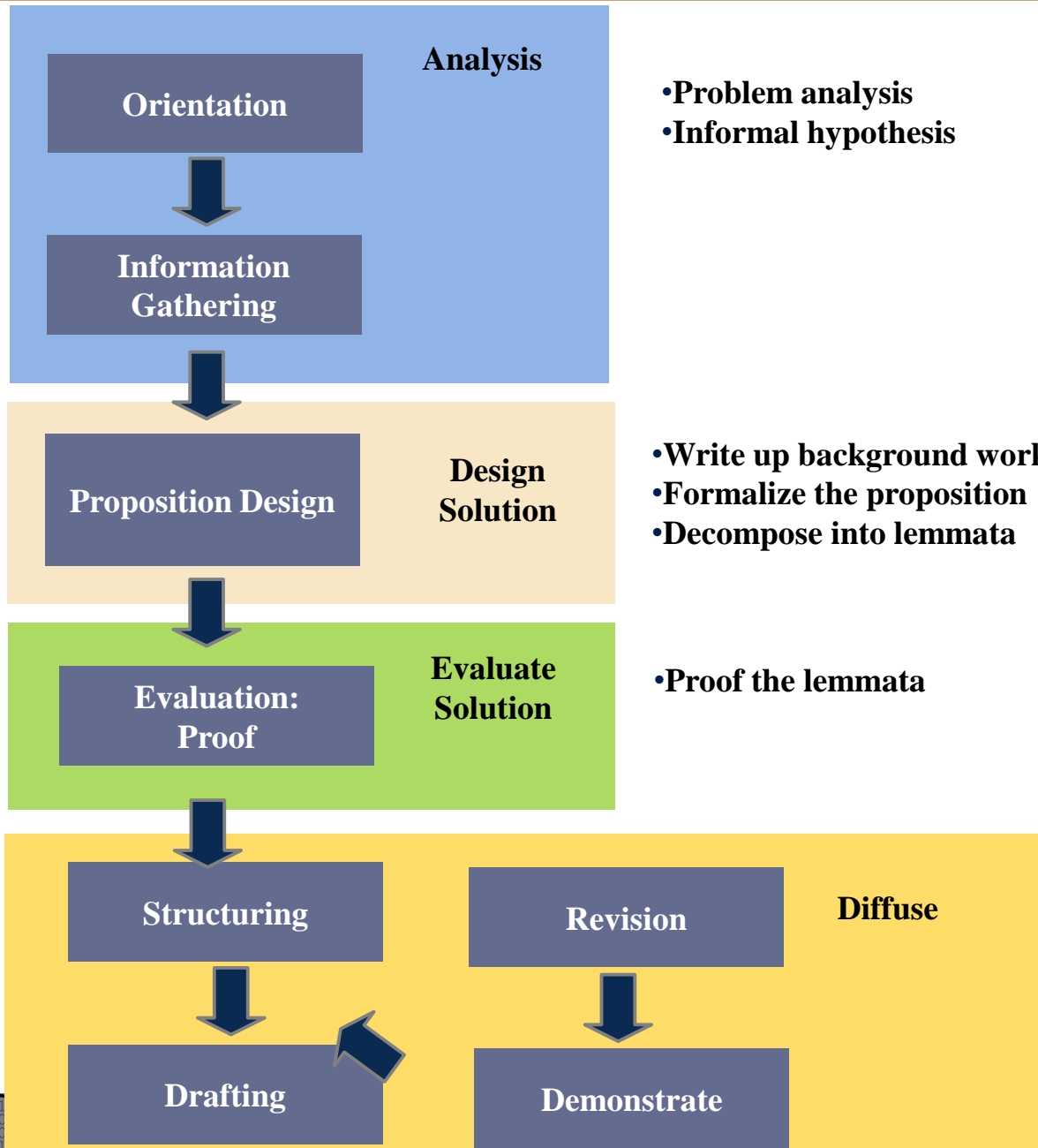
- Realize the architecture (implement components)
- Tune the system
- Stabilize the system for better quality (non-functional requirements)



The Variant A-PP-ED Research Process for Mathematical/Structural Science Thesis

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Academic Skills in Computer Science (ASICS)



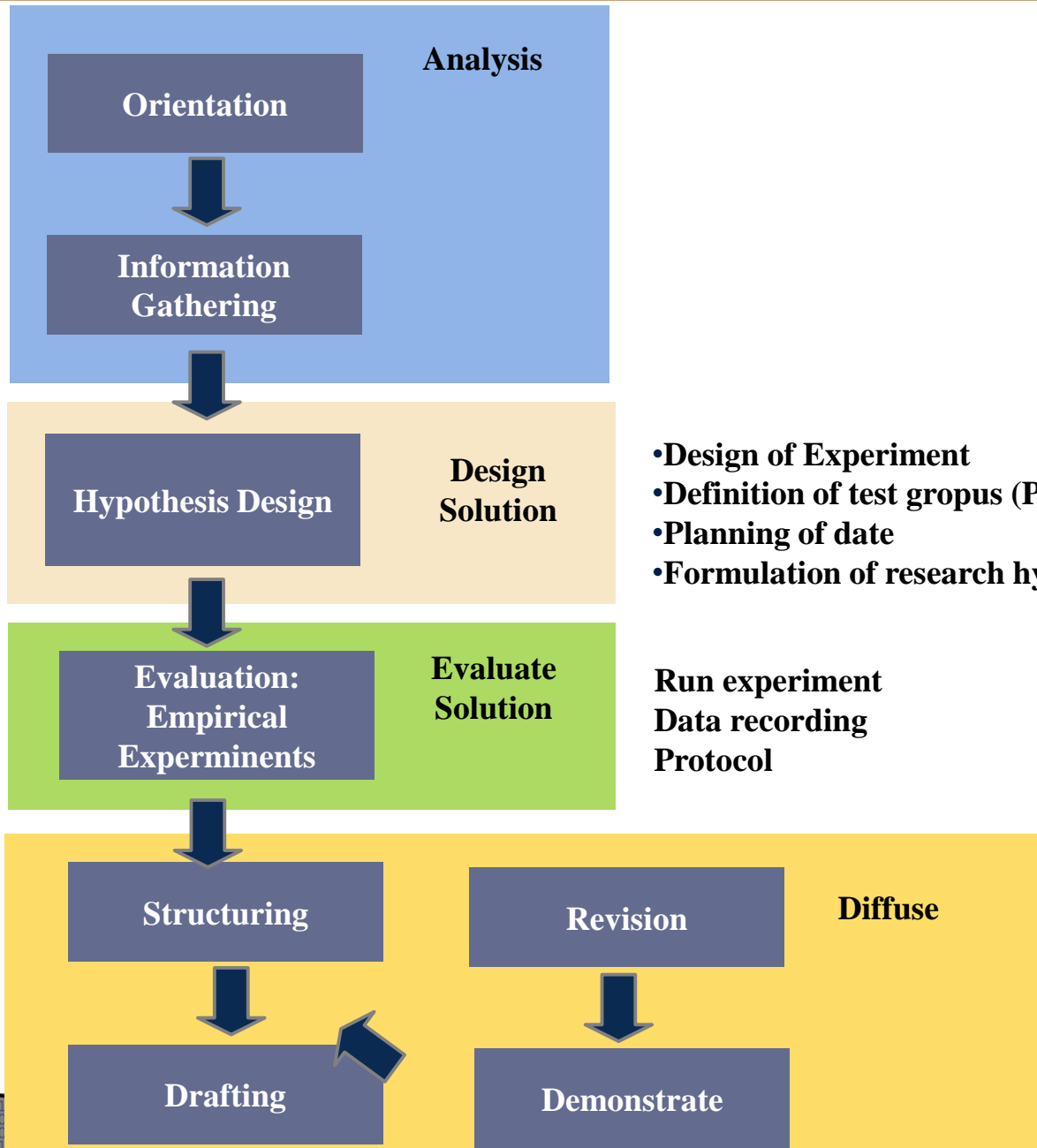
Phases of scientific text production, e.g., for mathematical papers or papers in theoretical computer science.

In the structural sciences (mathematics, theoretical computer science), a thesis must prove a **proposition** (thesis), i.e., demonstrate a result in mathematical language and logic.

The Variant A-HE-D Research Process for Empirical Science Thesis

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Academic Skills in Computer Science (ASICS)



Phases of scientific text production for empirical papers, e.g., in usability engineering.

- **Design of Experiment**
- **Definition of test groups (Probanden)**
- **Planning of date**
- **Formulation of research hypotheses**

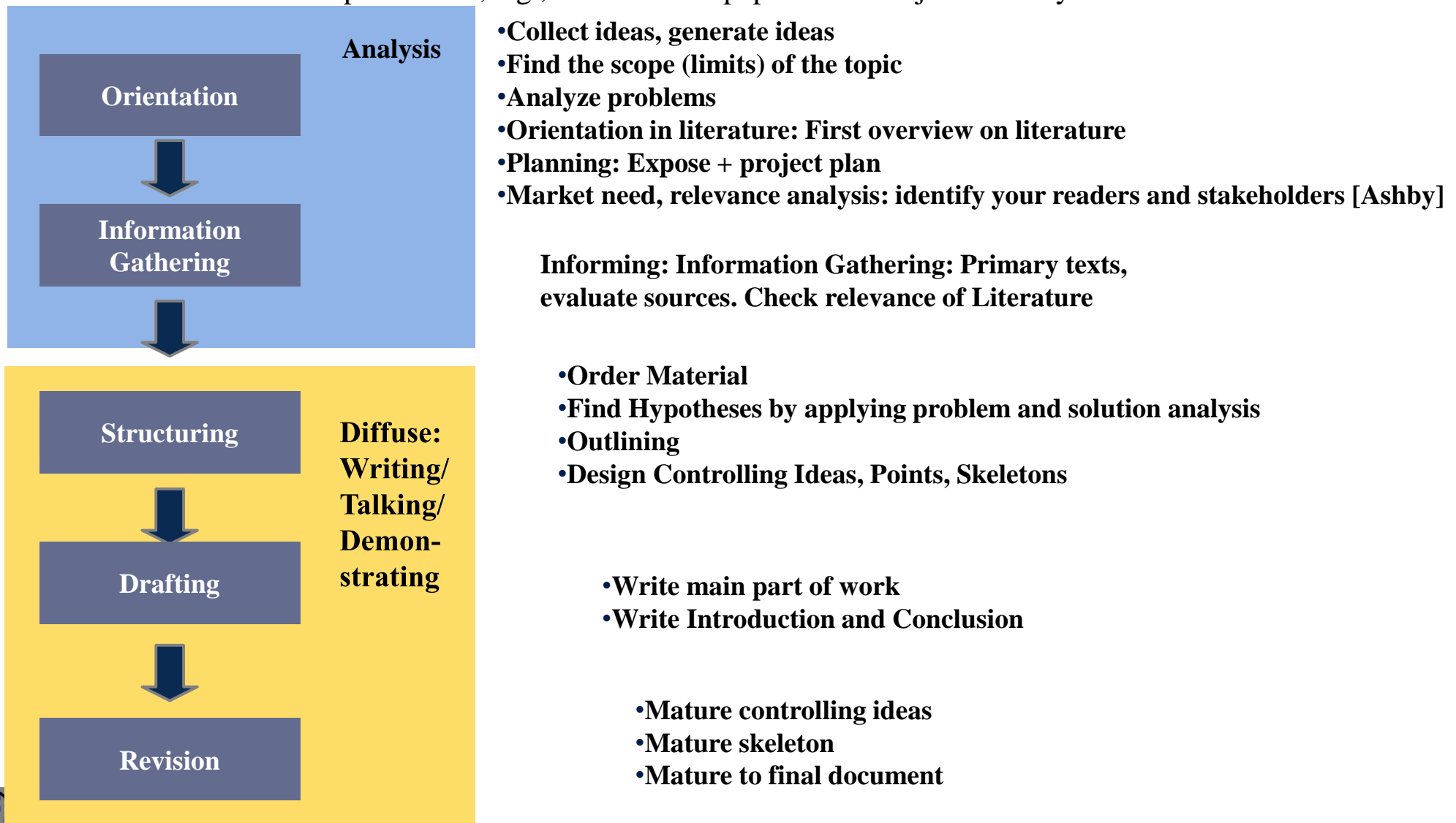
Run experiment
Data recording
Protocol



The A-D Process for General Scientific Topics and Overviews (without Solution Design and Evaluation)

Here, we look at a simple variant of ADED, OI-SDR [Esselborn-Krummbiegel].

Phases of scientific text production, e.g., for overview papers on a subject or essays

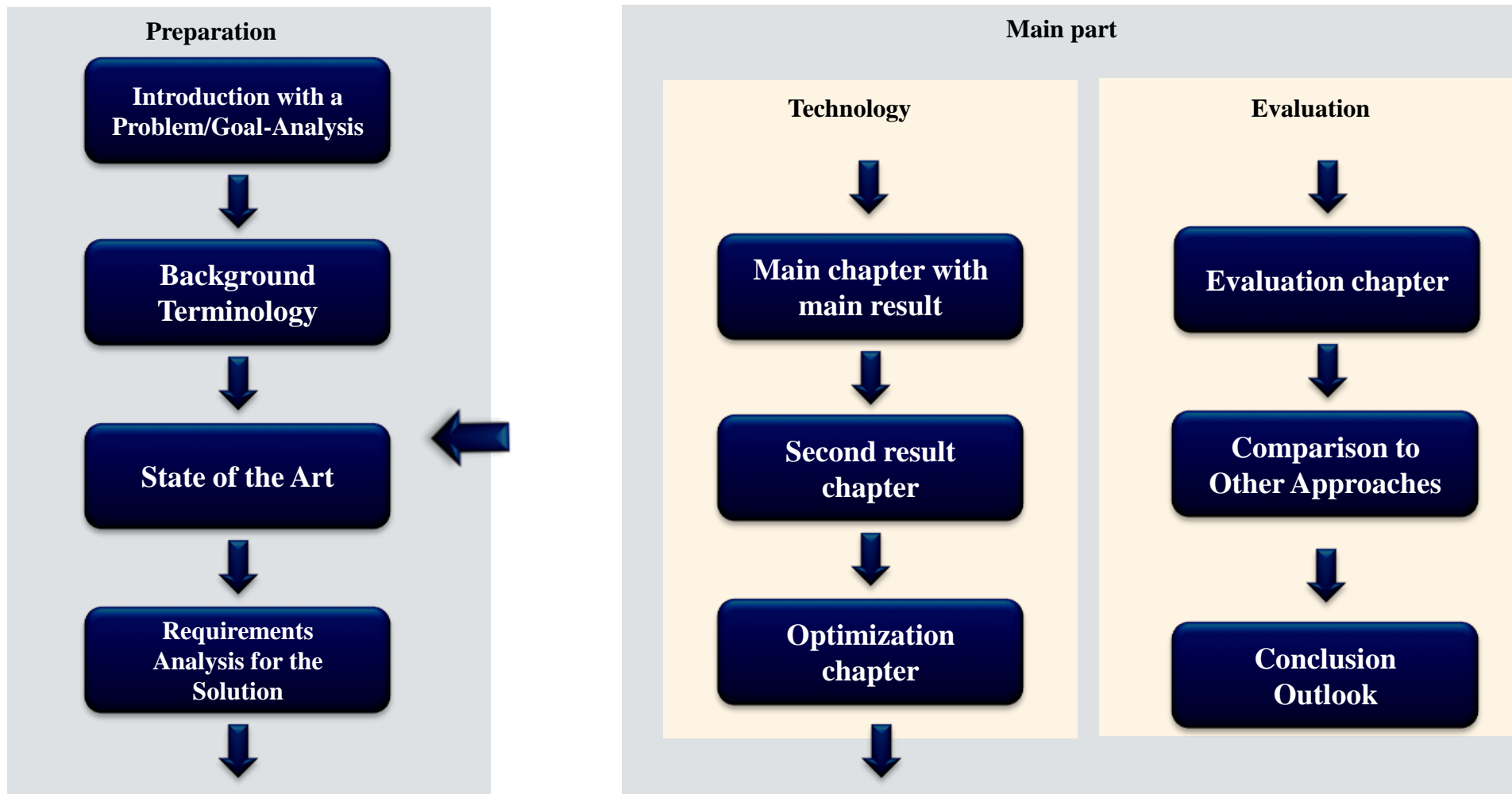


Standard Structure of a Technical Science Thesis

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Academic Skills in Computer Science (ASICS)

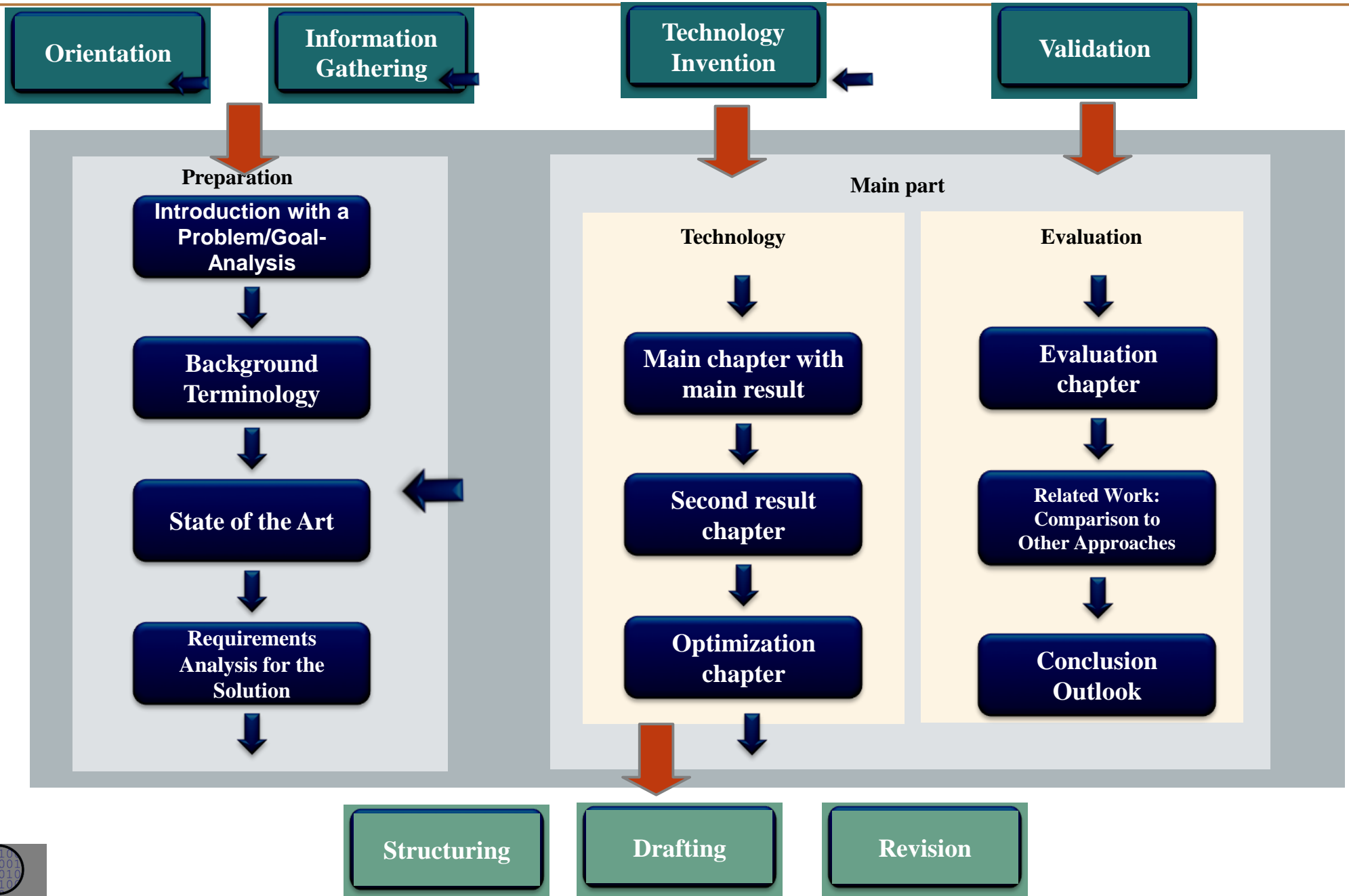
- ▶ A scientific thesis work should clear demarcate the part that is from you from the part that is not from you (background).
- ▶ The main part is divided in technology and evaluation part.
 - Some chapters can be folded or distributed.



The Standard Structure of a Master Thesis in Technical Science is Related to the ADED Research Process

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Academic Skills in Computer Science (ASICS)



Chapters and Process

- ▶ Because the structure of a scientific thesis is related to the chapters, write chapter by chapter
 - Start with (a draft of) the “background” and “literature/state of the art” chapters from the orientation phase
 - Then develop the technical solution and write it up in a main technical contribution chapter
 - Validate with an evaluation (experimental, proof, empiric) in parallel.
 - Draft, revise, revise,...
- ▶ If you clearly put your technical contributions into 3-4 main chapters, your main slide at your defense will be:

Scientific Results / Contributions:

- 1. Result of Main Chapter 1**
- 2. Result of Main Chapter 2**
- 3. Result of Main Chapter 3**

- ▶ And this will also form yo



Practical Hints

- ▶ Meet your supervisor biweekly or weekly.
 - Produce protocols of the meetings
- ▶ Write up everything in scratchpads. Material can be used in the end, and you don't forget important discussions or decisions
 - Starting to write after 2/3 of the time is a fatal error (start early)
- ▶ Reserve 1/3 of your time for writing
 - 3 months Bachelor → 1 month writing
 - 6 months Masters → 8 weeks, at least 7 weeks, writing
 - 4 years PhD thesis → 1 year writing PhD thesis, 0.5 year writing papers
- ▶ Your thesis may be written in English or German.
 - English gets a broader, world-wide audience.



11.2. Analysis – From the Problem to the Research Question

- ▶ When I don't know what to do yet (Overview)
- ▶ This orientation process is from [Esselborn-Krummbiegel]



11.2.1 Orientation

Analysis and Idea Generation with Semantic Nets, Concept Maps, Clusters, Mindmaps, Row Hierarchies, Honest Serving Men, and other Techniques

- ▶ Concept maps by [Novak]
- ▶ Clustering was invented by [Rico] [Esselborn-Krummbiegel]
- ▶ Mindmaps by [Buzan]

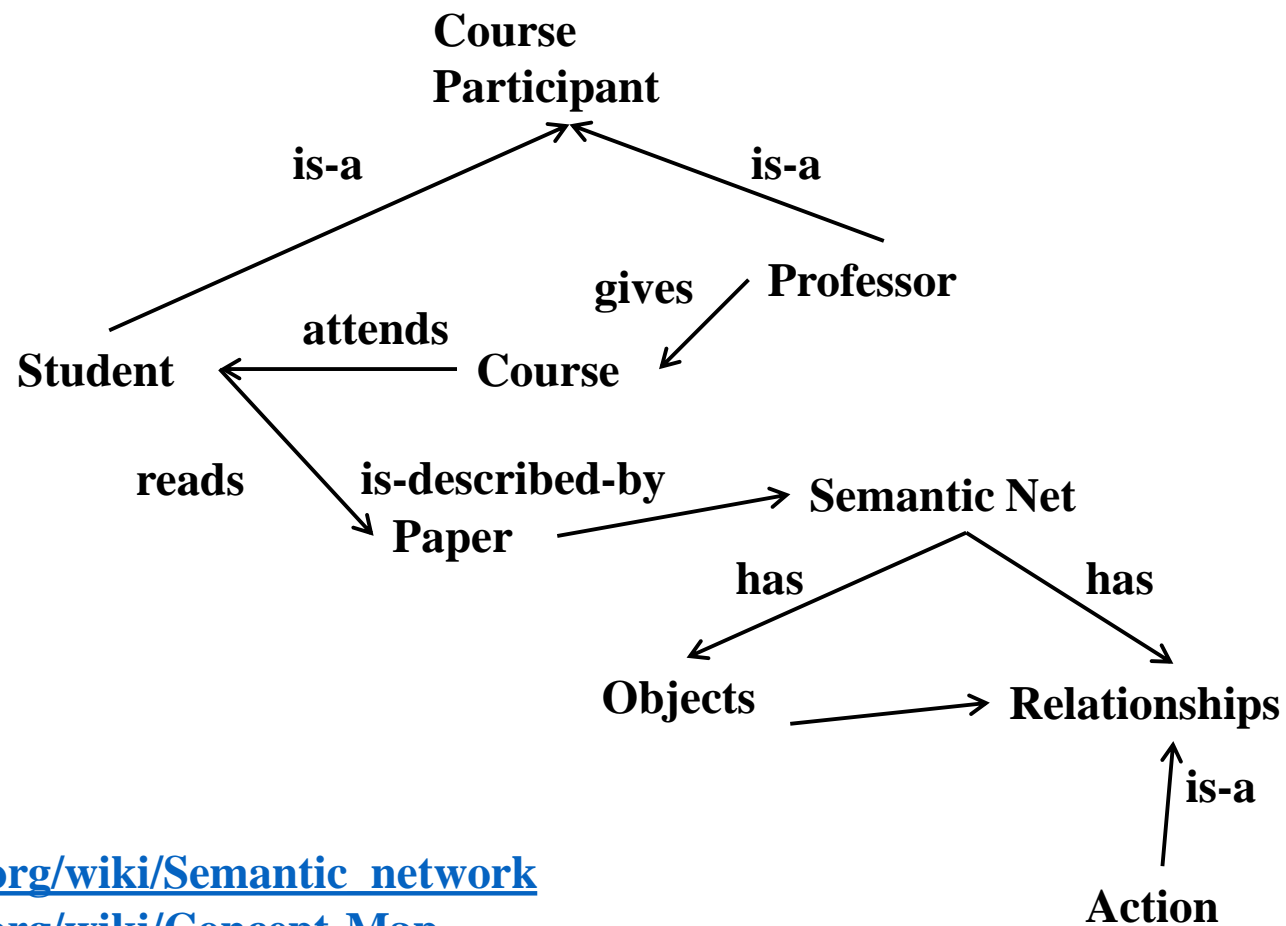


Semantic Nets (Simple Concept Maps)

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Academic Skills in Computer Science (ASICS)

- ▶ To record what you understand, draw a **semantic net (simple concept map)** while reading
- ▶ A **semantic net** draws objects and their relationships and actions into a graph
 - Distinguished relationships: is-a, has-a, owns-a, ...



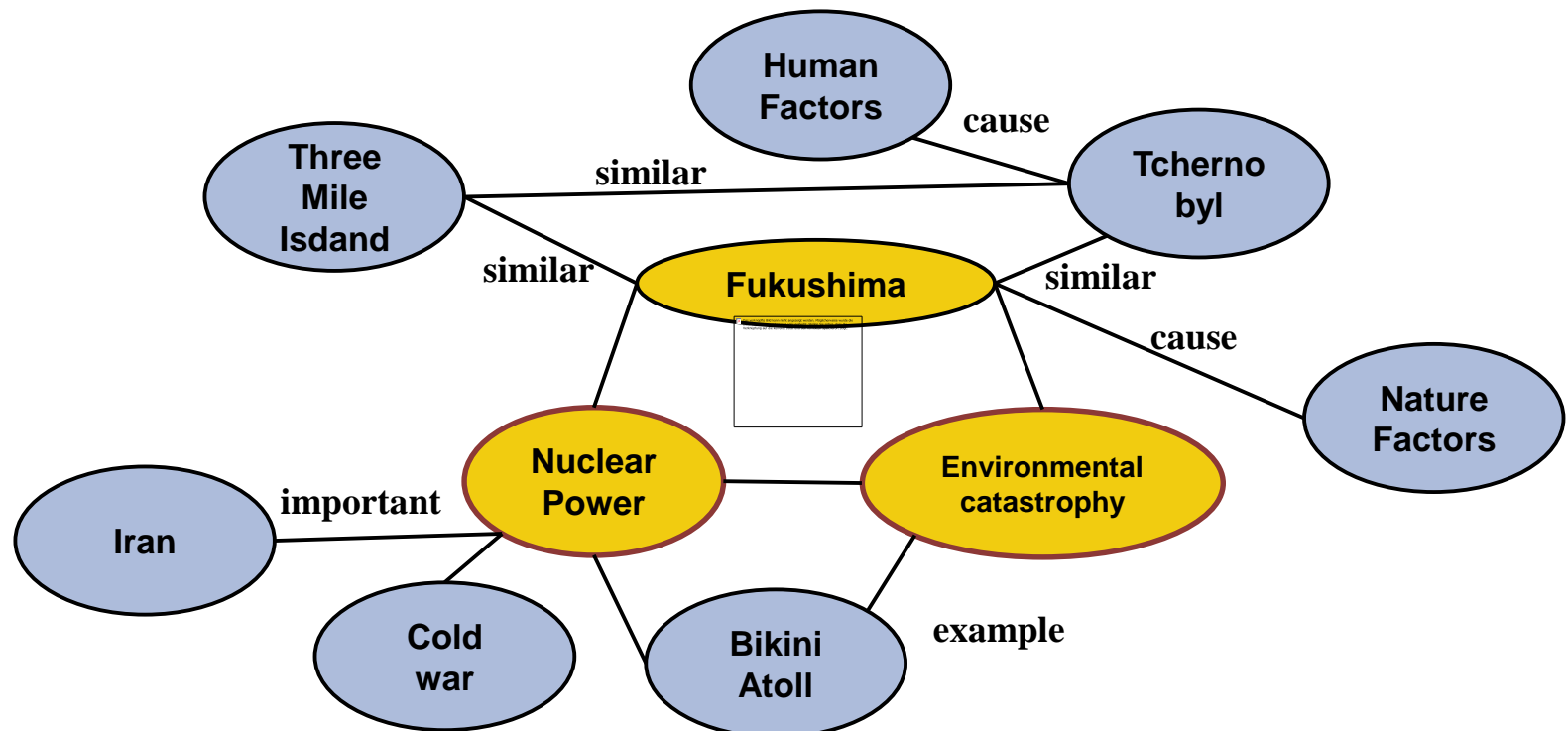
http://en.wikipedia.org/wiki/Semantic_network

<http://de.wikipedia.org/wiki/Concept-Map>



Concept Maps

- ▶ <http://de.wikipedia.org/wiki/Concept-Map>
- ▶ A **concept map (Begriffslandkarte)** shows several concepts and their relations
 - usually, one starts with several central concepts in the middle of a page and collects associations
- ▶ Concept mapping is a method for analysis, idea generation and structuring.
 - Other forms: Clustering, Mindmapping [Buzan], Structure Trees, Cause-Effect diagrams
- ▶ Depending on the purpose, a concept map is a **model** of problems, knowledge, goals, solution ideas



Concept Maps (Strukturbilder, Textbilder)

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Academic Skills in Computer Science (ASICS)

- ▶ The **concept map** enriches a Semantic Net with pictures and figures (Strukturbilder) [Novak]
 - http://www.teachsam.de/arb/visua/visua_3_2_6.htm
- Development
 - Always start the development with a focus question
 - Use a discriminating question to decompose (e.g., the Honest Men)
 - Grouping is important: group into phases, layers, regions, skeleton trees
 - Specific relations such as <implies>, <causes>, <abstracts>
- ▶ Concept maps are the basis of paper writing and book reading
- ▶ Software: <http://cmap.ihmc.us/documentation-support/>
- ▶ Alberto J. Canas, Greg Hill, James Lott. Support for Constructing Knowledge Models in CmapTools. Introduction. Technical Report IHMC CmapTools 93-02. Institute for Human and Machine Cognition (IHMC)
- ▶ <http://cmap.ihmc.us/Publications/WhitePapers/Support%20for%20Constructing%20Knowledge%20Models%20in%20CmapTools.pdf>



Clustering Helps to Develop Hierarchic, Logical Structures of Your Work

- ▶ A **Cluster** is a node-labeled concept map with *one* root in the middle of the page
 - If the cluster is a tree, it is called a *mindmap*
 - [http://de.wikipedia.org/wiki/Cluster_\(Kreatives_Schreiben\)](http://de.wikipedia.org/wiki/Cluster_(Kreatives_Schreiben))
- ▶ Clustering finds associations to one central term:
 - Develop, structure, find ideas by association
 - Start from a central term, concept, or idea (a spider-map)
 - Use the blackboard's space to find association
 - Use landscape to get a broader view and more space in breadth
- ▶ Develop: Note the **central concept** in the middle
 - Start to note associated terms or relations
 - Note relations or discriminators on the edges (optional)
 - Iterate
- ▶ Restructure: Redraw on new sheet
 - Find relations between the branches; Group

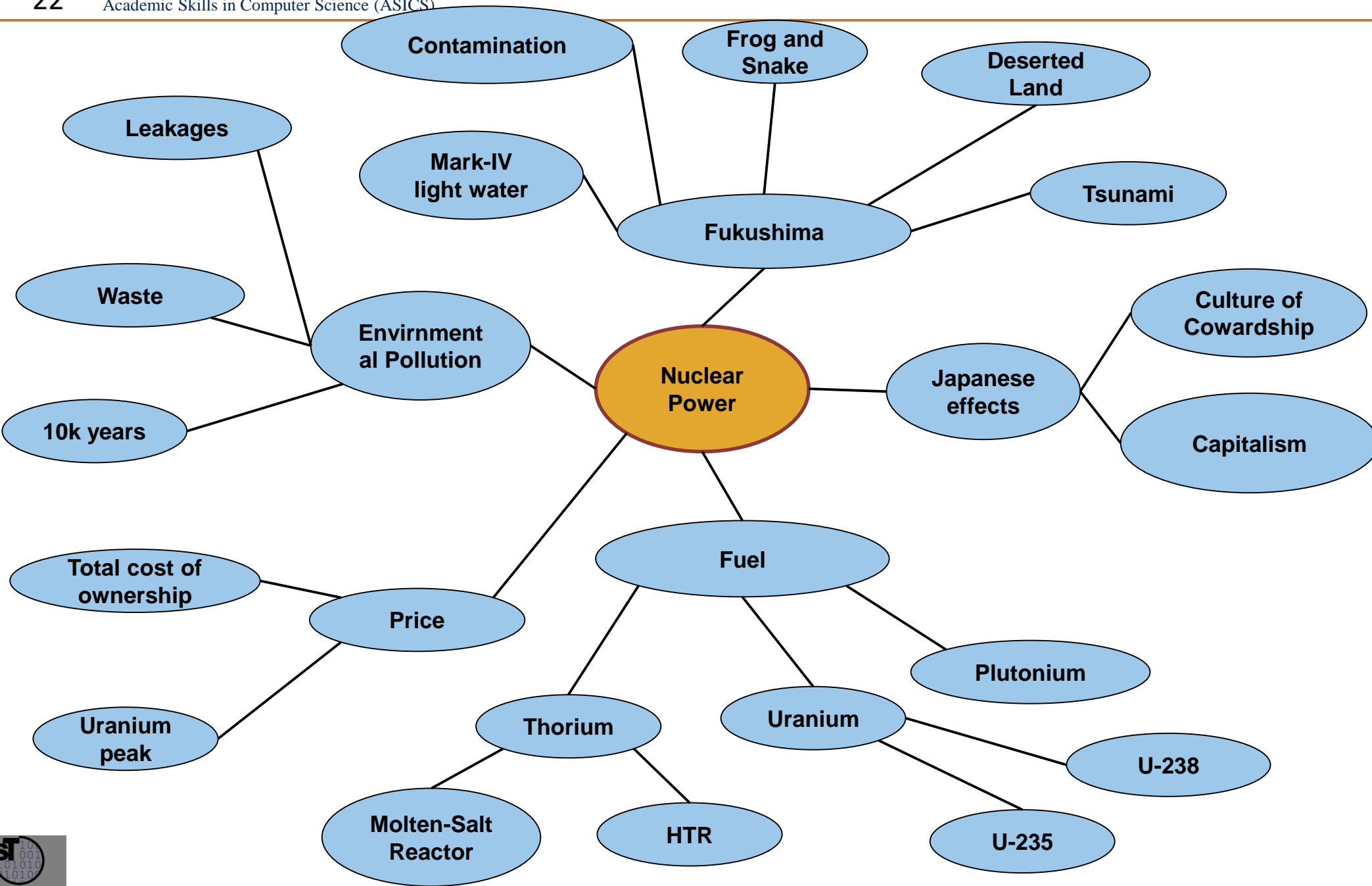


11.2.1.1 Mindmaps

- ▶ Mindmaps are similar to structure trees
- ▶ A **Mindmap** is an node- or edge-labeled association tree

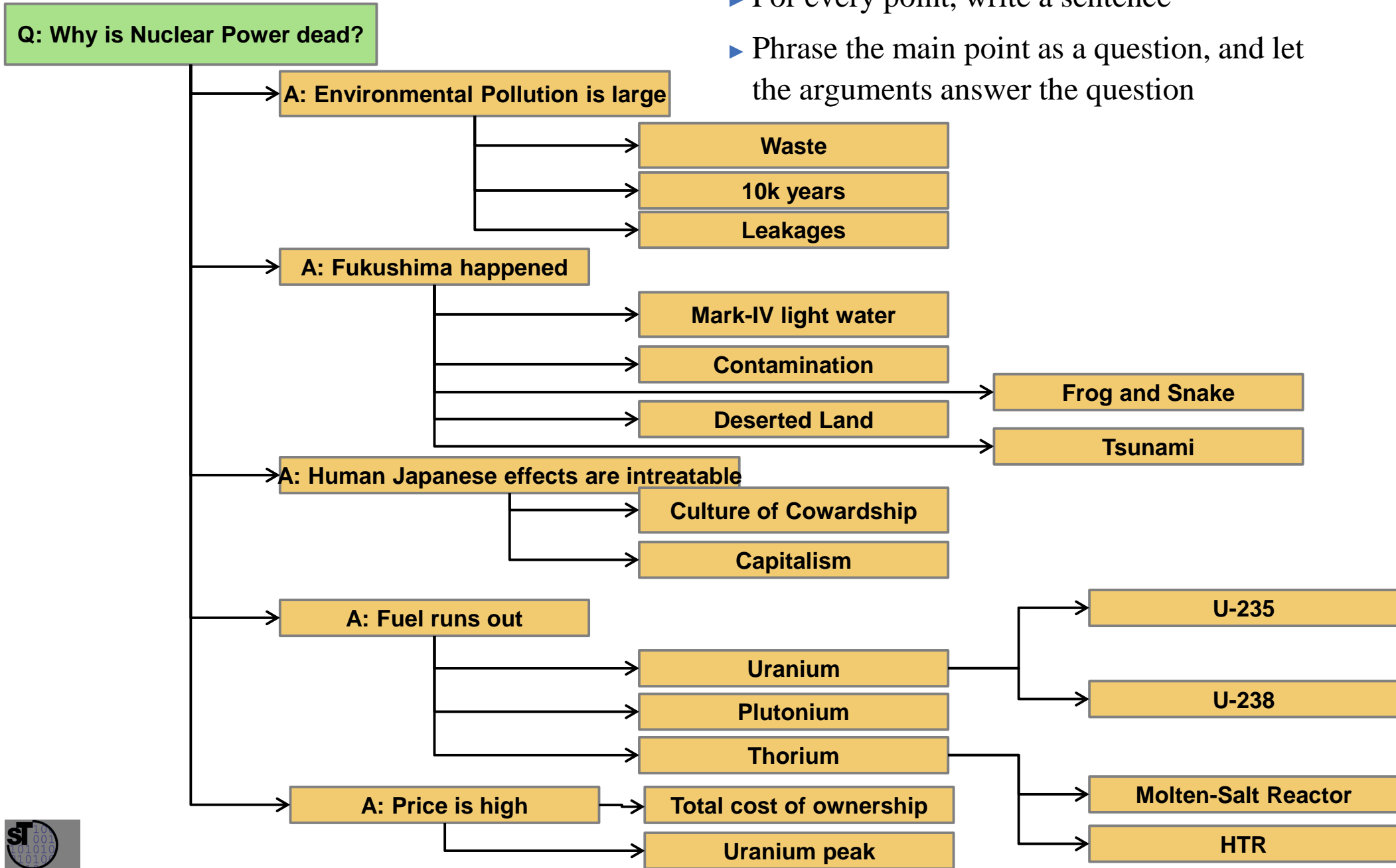


Node-Labelled Mindmap of Associations to “Nuclear Power”



11.2.1.2 Line / Row Hierarchy (Q-A-Hierarchy)

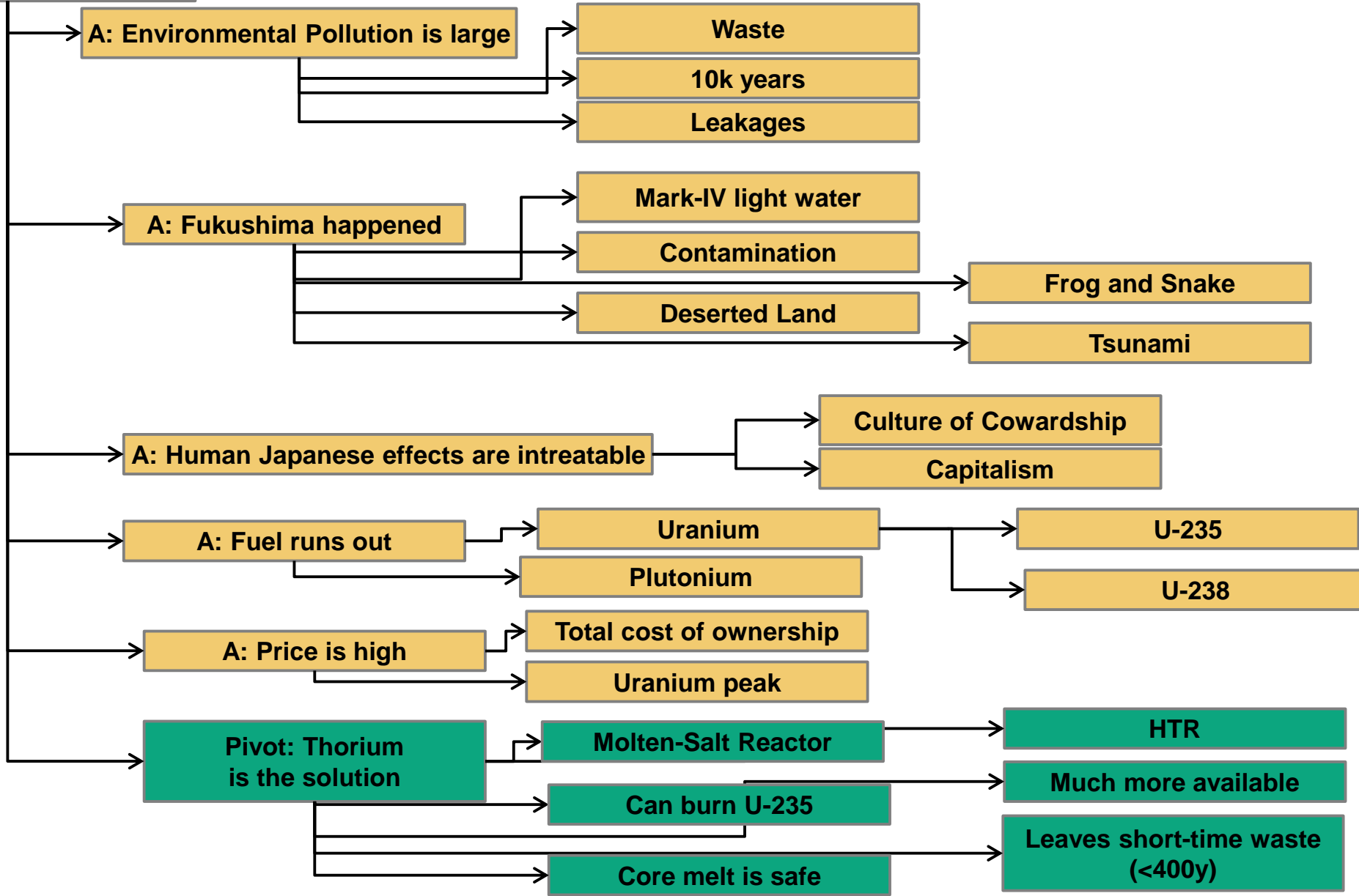
- ▶ From a mindmap or structure tree, a row hierarchy can be formed with main thesis and arguments
- ▶ For every point, write a sentence
- ▶ Phrase the main point as a question, and let the arguments answer the question



Alternative Row Hierarchy

- ▶ Also alternative row hierarchies can be built, with other messages.
- ▶ Then, the solution must answer all counterarguments

Q: What is the last exit of Nuclear Power?




11.2.1.3 Canvases

- ▶ A Canvas is a structured **collaborative** form, to be printed on a BIG poster
 - It has a **fill order**, in which the fields should be filled
 - Every field has standardized questions
 - Fields are filled by sticky notes
- ▶ Canvases are very structured – Mindmaps and Concept Maps are unstructured
- ▶ Canvases are **mind maps with normalized discriminators**



Open Project Management Canvas

<https://www.openpm.info/display/openPM/Canvas>





Projekt: _____

Projekt ID: _____

Projektleitung: _____

Versionierung: _____

Vision & Ziel	Nutzen <ul style="list-style-type: none"> • Welchen Nutzen hat das Projekt für die Zielgruppe? • Welchen Nutzen erwarten sich die Stakeholder? • Besteht Klarheit was die Zielgruppe das Projekt mit dem Ergebnis des Projektes erreichen will? 	Scope/Projektgegenstand <ul style="list-style-type: none"> • Was ist konkret zu tun? • Besteht Klarheit bzgl. Auftragsklärung & Zielvorgabe? • Was ist in Scope/Out of Scope? • Wie wird mit Änderungen umgegangen? 	Kosten <ul style="list-style-type: none"> • Wie sind die Kosten des Projekts? • Welche Folgekosten oder mögliche Schäden drohen? • Sind Projekt und Projektergebnisse nachhaltig?
Setup	Team <ul style="list-style-type: none"> • Welche Kriterien mit welchen Qualifikationen sind im Projektteam? • Wie sind die Aufgaben- und Rollenverteilung im Team auf? • Gibt es einen Reforan für Selbstverantwortung? • Wie sieht es um die Motivation im Team? 	Ressourcen <ul style="list-style-type: none"> • Welche Ressourcen werden für das Projekt benötigt? • Welche erforderlichen Ressourcen stehen nicht zur Verfügung? • Welche Schlüsselressourcen sind unverzichtbar? 	Stakeholder <ul style="list-style-type: none"> • Welche Stakeholdergruppen gibt es? • Wie sind die Stakeholder eingebunden? • Haben Stakeholder eine "Hidden agenda"?
Vorgehen	Prozesse & Werkzeuge <ul style="list-style-type: none"> • Welche Vorgehensmodelle ist für das Projekt geeignet? • Gibt es geeignete Standards/Methoden/Werkzeuge? 	Kommunikation & Transparenz <ul style="list-style-type: none"> • Wie erfolgt Statusberichterstattung und Berichterstattung? • Welche Kommunikationswege sind im Einsatz? • Wie ist die Kommunikationskultur im Projekt? • Wie ist der Auftritt des Projekts nach innen und außen? • Wie wird das Projekt in der Organisation wahrgenommen? 	Risiken & Qualität <ul style="list-style-type: none"> • Welche wesentlichen Risiken bestehen? • Wie wird mit Risiken/Uncertainty umgegangen? • Ist das Projekt machbar? • Gibt es Qualitätsrisiken & Maßnahmen zur Qualitätssicherung?
Zeithorizont			



Die openPM Canvas steht unter einer [Creative Commons Namensnennung 3.0 Deutschland Lizenz](https://creativecommons.org/licenses/by/3.0/).

V. 1.0



11.2.2 Problem Analysis with Questions

Problem Analysis asks the questions:

- ▶ Why?
- ▶ To which end?



The Honest Serving Men

7 Basic Questions (7 W-Fragen)

The 6 honest serving men (R. Kipling, Just So Stories)

I keep six honest serving-men:
 (They taught me all I knew)
Their names are What and Where and When
 And How and Why and Who.
I send them over land and sea,
 I send them east and west;
But after they have worked for me,
 I give them all a rest.

I let them rest from nine till five.
 For I am busy then,
As well as breakfast, lunch, and tea,
 For they are hungry men:
But different folk have different views:
 I know a person small--
She keeps ten million serving-men,
 Who get no rest at all!
She sends 'em abroad on her own affairs,
 From the second she opens her eyes--
One million Hows, two million Wheres,
 And seven million Whys!



The 7 Basic Questions (7 W-Fragen) used for Topical Questions

- ▶ For finding topics of research, a text or talk, the 6 honest men (7-W-Questions) should be attempted to expand into a checklist.
- ▶ This checklist can be used to create alternatives for the topic (idea generation for topic).

	Ideas for Topic; Limits and Implications	Aspects
Who?	Who is interested in the topic? Who benefits?	
What?	What do I want to find out? What may change in my topic, problem or question? What is fix?	Results, Solutions
How?	How similar is my topic to another work? How different is it? What is its research advance? research contribution?	Implementation, Realization
Where?	Where is my research located in the research landscape?	
When?	When did somebody else research on something similar?	
Why?	causal; Why do we need the topic?	Motivation; Problem
For what? To which end?	final; What will happen if we don't solve the problem?	Goal



Problem Analysis

- ▶ Most idea generation techniques (concept maps, clusters, mindmaps, Honest Men) can be used to analyze problems
 - Ask the questions “why” and “to which end”?
- ▶ But they can also be used to generate solution ideas
 - Ask the question “how to achieve”?
- ▶ and to structure the available knowledge and literature:
 - Ask the question “What do we know?”



