

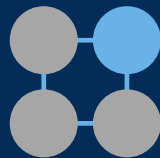


Core Ideas for Teaching Hypothesis Testing Structure, Concepts and Validation

Presentation at the IASE Satellite Conference 2025

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02.10.2025 Universität Münster, Münster



Didaktik der
Mathematik
Sekundarstufen

R
TU
P

Rheinland-Pfälzische
Technische Universität
Kaiserslautern
Landau



Overview

Relevance & Motivation

- **Critically examine data, information, statistics and their messages** in social contexts

(Ben-Zvi & Garfield 2004 , Franklin et al. 2005 ,Gal 2002)

- **Scientific research processes**

(Ben-Zvi & Garfield 2004 , Gal 2002)

- **Misconceptions** about significance and p-values

(Haller & Krauss 2002, Burns-Childers et al. 2017, Krishnan & Idris 2015, Sotos et al. 2007, Gigerenzer & Krauss 2001)

- **one** method of inferential statistics

(Gomez-Blancarte & Tobias Lara 2023, Gigerenzer et al. 2004)

- **Empirical** research

(Burns-Childers et al. 2017, Gigerenzer et al. 2004)

- **Controversial** discussions

(Lane-Getaz 2017 , Wasserstein et al. 2019, Amrhein et al. 2019, Gigerenzer & Krauss 2001)

- **Propaedeutics**

(Weber 2020, AK Stochastik 2003)

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**enlightenment and
opportunity for critical
reflection are necessary**

(Wasserstein et al. 2019)

- Key competence: **Statistical literacy**

(Krüger et al. 2015, Gal 2002)

- **Dealing with variability
& inferential statistical reasoning**

(Garfield et al. 2008, Makar & Rubin 2009, AK Stochastik 2003, KMK 2012, Watson 2006)

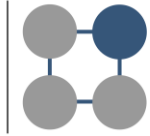
- **Instruction: often more about computational
procedures than interpretative reasoning**

(Krüger et al. 2015; Hauer-Typelt 2010)

- **Structural breaks**

(Hauer-Typelt 2022, Watson 2006)





Informal Inferential Reasoning (IIR)

"Precursor forms" for the (early)
promotion of statistical reasoning:

a) Generalization

b) From Data

c) Probabilistic

(Makar & Rubin 2009, Zieffler et al. 2008,
Wild et al. 2011, Meletiou-Mavrotheris & Paparistodemou 2014,
Pratt et al. 2008, Podworny 2019)

FOCUS

**Hypothesis testing as a central and
exemplary procedure in inferential
statistics**

GOAL

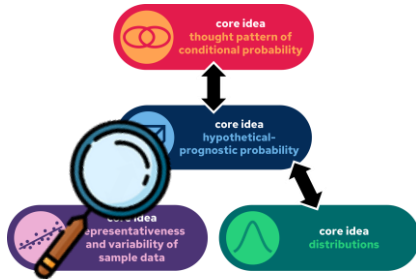
- **Refinement of the IIR concept** for hypothesis testing through ...
- ... the **development and theoretical foundation** of core ideas on the one hand, and ...
- ...the **collection of expert feedback for the validation and modification** of the core ideas and the concept on the other.



Validation of core ideas?

PROCESS

Identification



Expert survey validation



Modification



Research Question 1

Which core ideas are appropriate for fostering students' informal understanding of hypothesis testing and structuring instruction in this area?

Research Question 2

Does orientation towards the core ideas support a conceptual understanding of hypothesis testing?

Outlook

Preliminary core ideas for teaching hypothesis testing

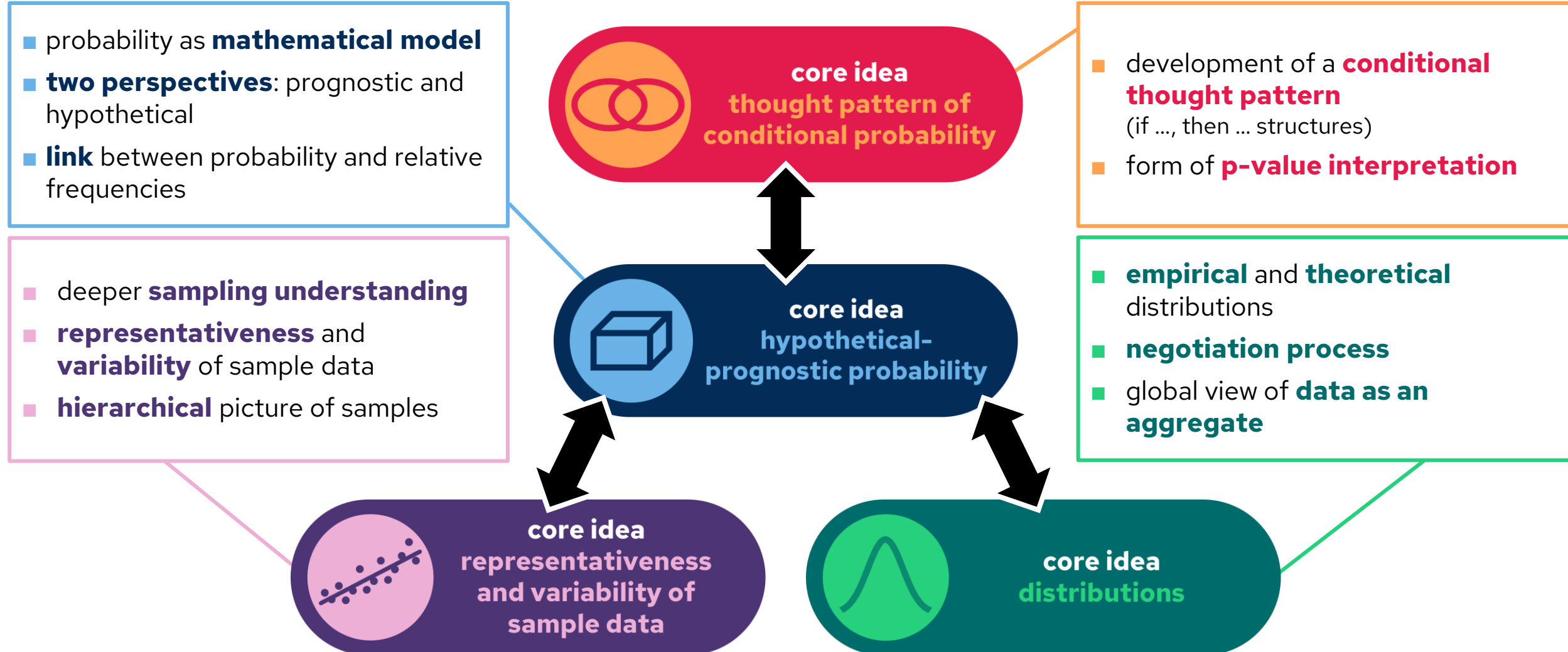
Identification

- probability as **mathematical model**
- **two perspectives**: prognostic and hypothetical
- **link** between probability and relative frequencies

- deeper **sampling understanding**
- **representativeness** and **variability** of sample data
- **hierarchical** picture of samples

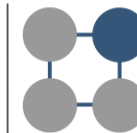
Expert survey validation

Modification





Expert survey validation & analysis



Identification

Expert survey validation

Modification

AIMS

- 1 Assess relevance & potential of core ideas**
(didactic and subject specific)
- 2 Identify ambiguities and refine & expand ideas**
- 3 Determine necessary modifications**
- 4 Add further ideas** if required

STEP 1

**Video-based
questionnaire**



STEP 2

**In-depth stimulated
recall interview**



ANALYSIS



Qualitative content analysis with multiple analysis steps



Preliminary step
Forming units of meaning
*if necessary: explicit and
summarising content analysis*

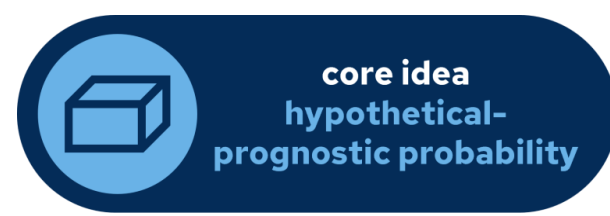


Context-Coding
(deductive codes)
Structure of the questionnaire
Structure of the interview



Thematic-Coding
(inductive-deductive codes)
formed on the material

Preliminary results of the in-depth stimulated recall interview



Identification

Expert survey validation

Modification

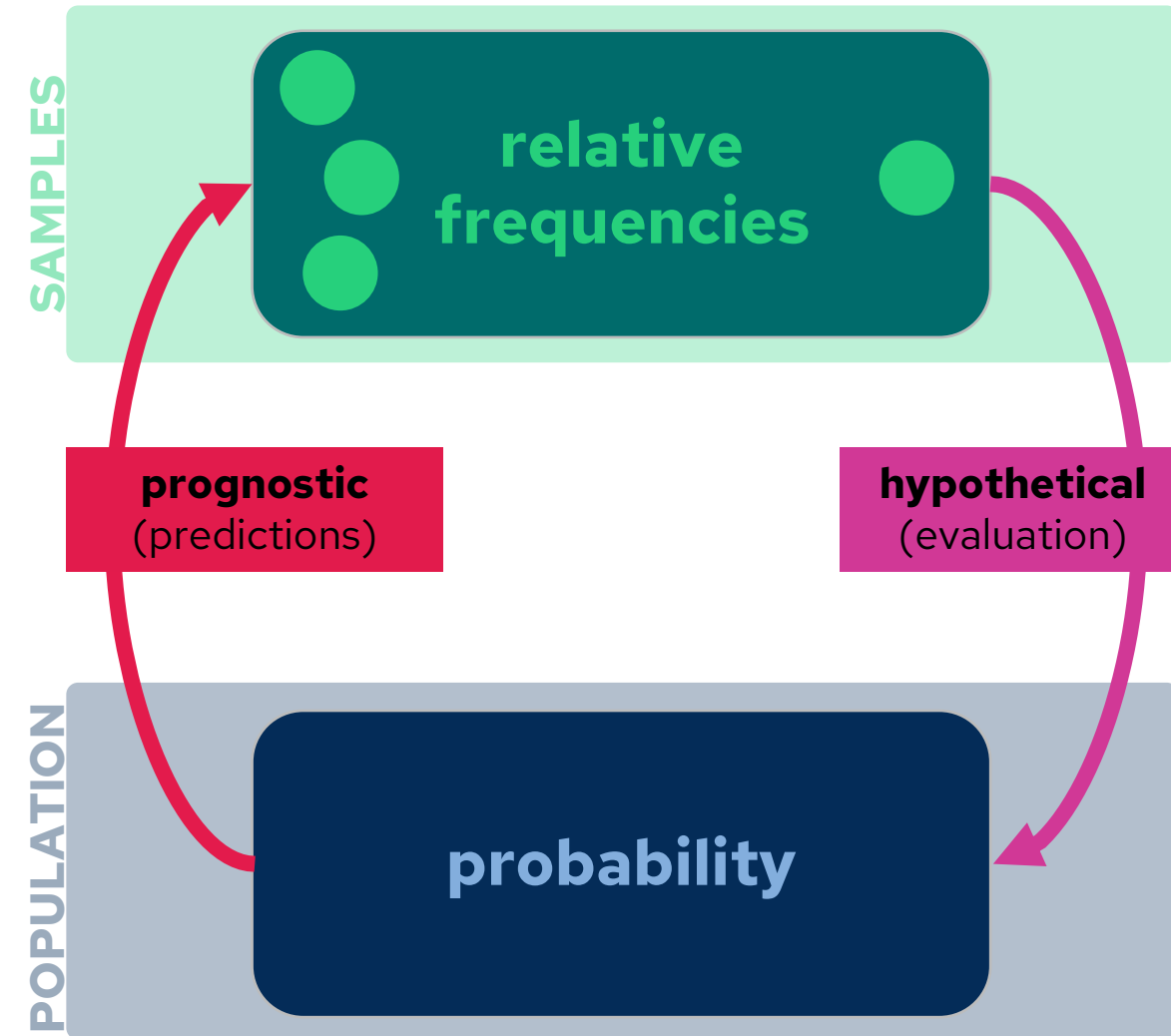
- ✓ Understanding **probability as models**
- ✓ **Hypothetical-prognostic** character
- ✓ **'Forward direction'** (prognostic)

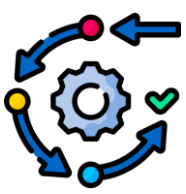
Implemented modifications

- 🕒 **'Reverse direction'** (hypothetical)
- 🕒 Connection between the **different probability concepts**
- 🕒 **central weighting (in hypothesis testing)?**

Still outstanding modifications

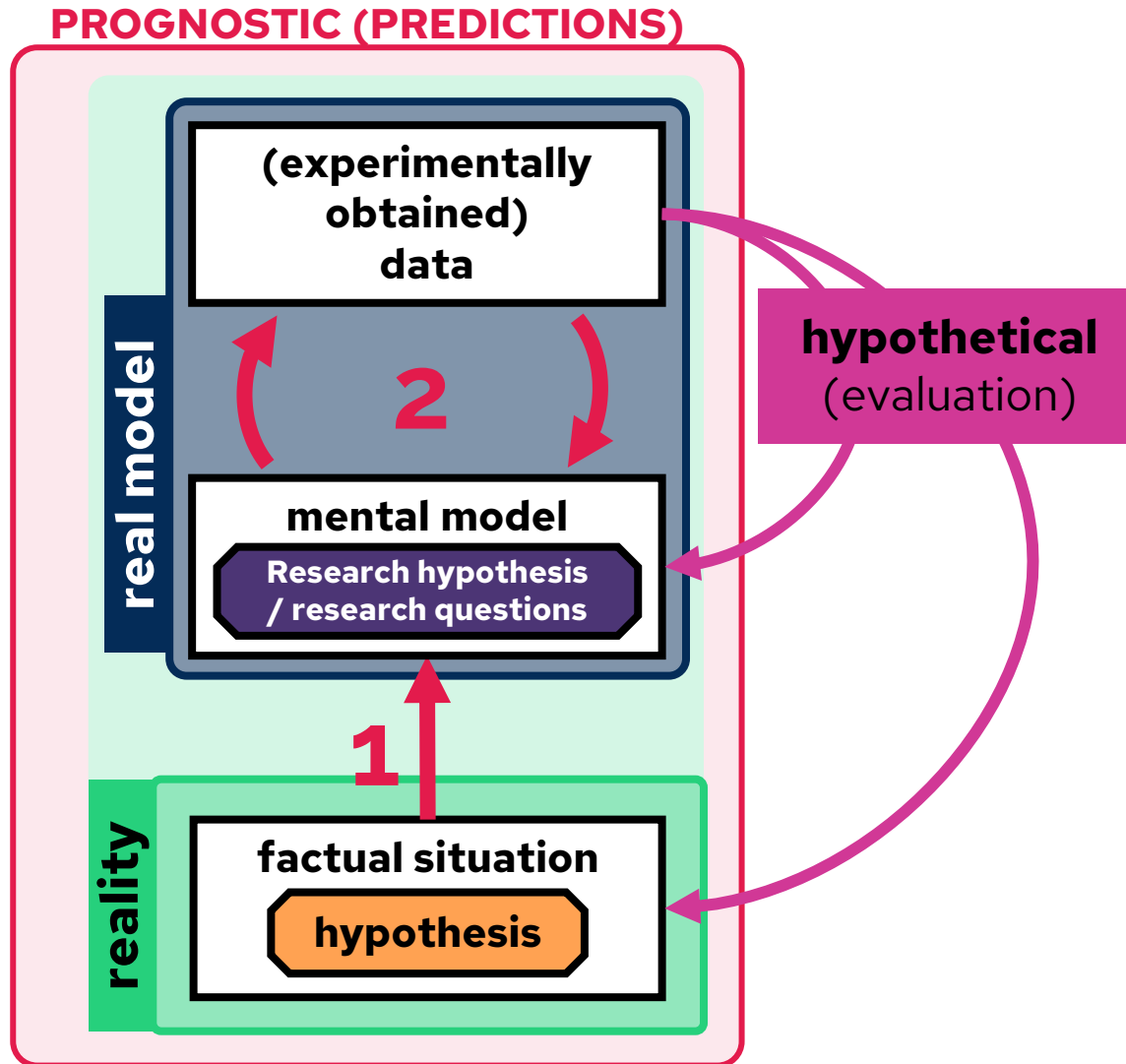
- ✂ Strong **school perspective**
- ✂ Applicability to **various hypothesis tests?**
- ✂ Integration of the **static-contrast-view**



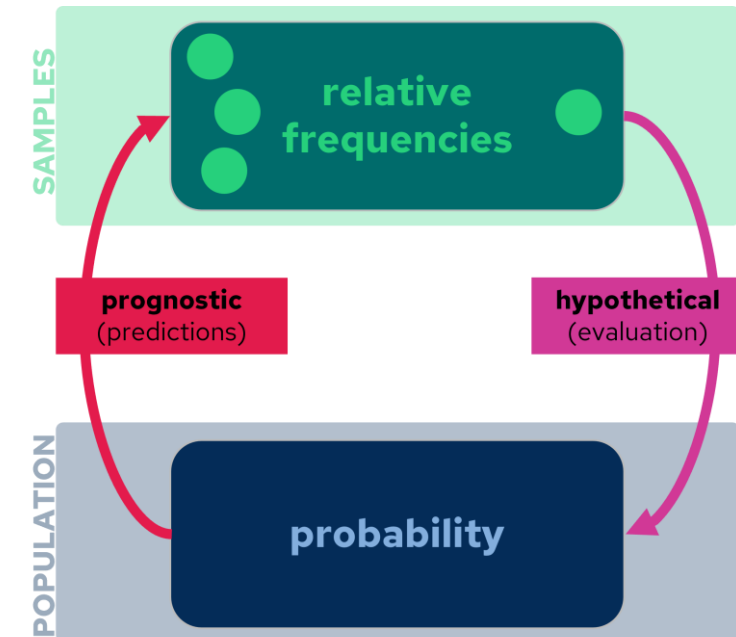


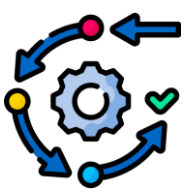
Modelling cycle in hypothesis testing

Prognostic perspective
(predictions)



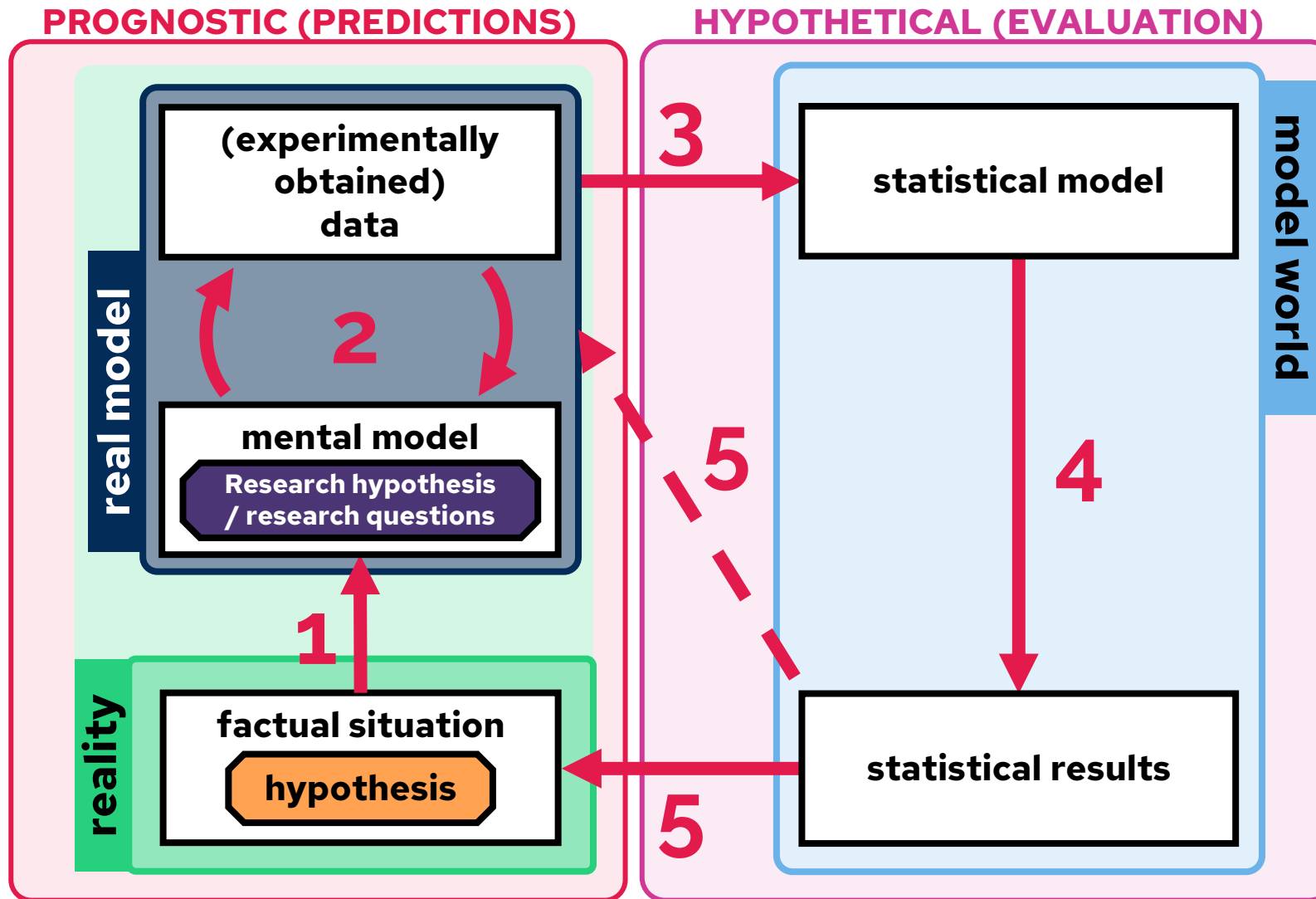
- 1 Structure, simplify, clarify
- 2 Data collection (method of data acquisition)



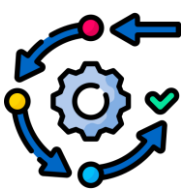


Modelling cycle in hypothesis testing

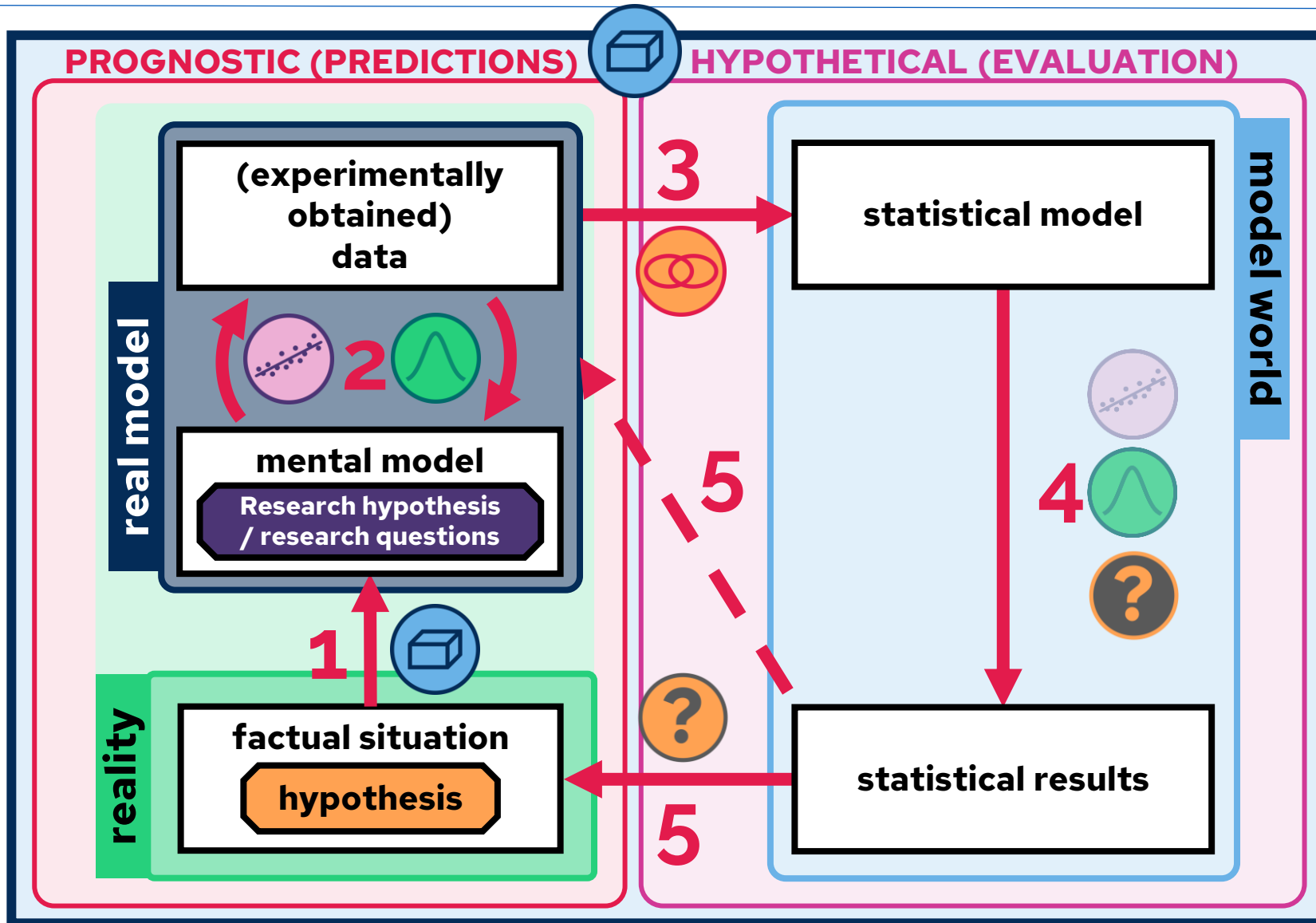
Hypothetical perspective (evaluation)



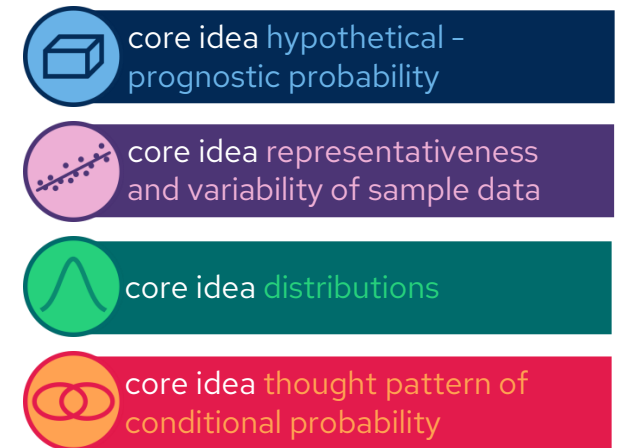
- 1** Structure, simplify, clarify
- 2** Data collection (method of data acquisition)
- 3** Mathematisation, selection of a suitable statistical method
- 4** Utilise statistical skills, process data, generate results
- 5** Interpreting/validating results

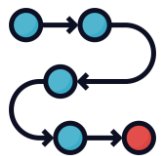


Modelling cycle in hypothesis testing



- 1 Structure, simplify, clarify
- 2 Data collection (method of data acquisition)
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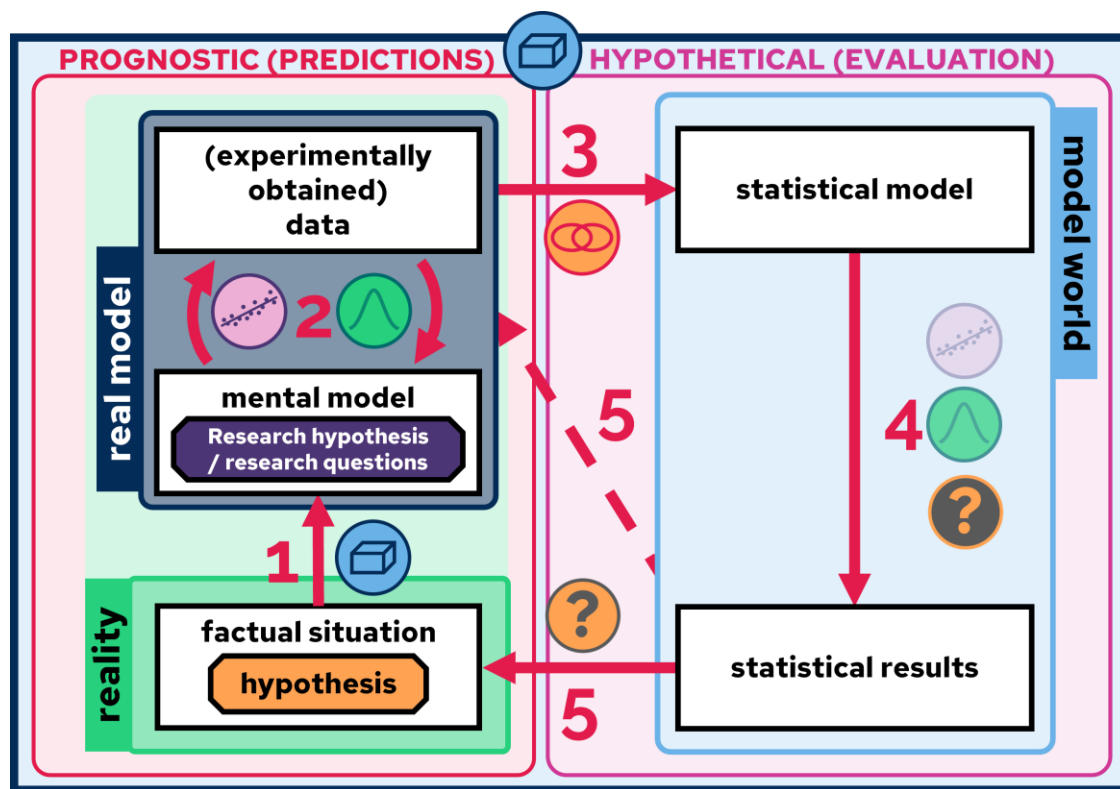
Next steps



Identifikation

Expertenbefragung

Modifikation



Further revision of core ideas and concept and clarification of new core ideas

Hierarchy of core ideas
IIR → FIR?

Connections to signal and noise as an overarching framework?

Finalisation of interviews & intercoder reliability check



Summary, Outlook & Discussion

PROCESS



Further outlook

- Proving the core ideas in
 - assessment tests
 - learning environments

Discussion

- Connection to the modeling cycle?
- Connection to the signal and noise concept?

Thank you very much for your attention.



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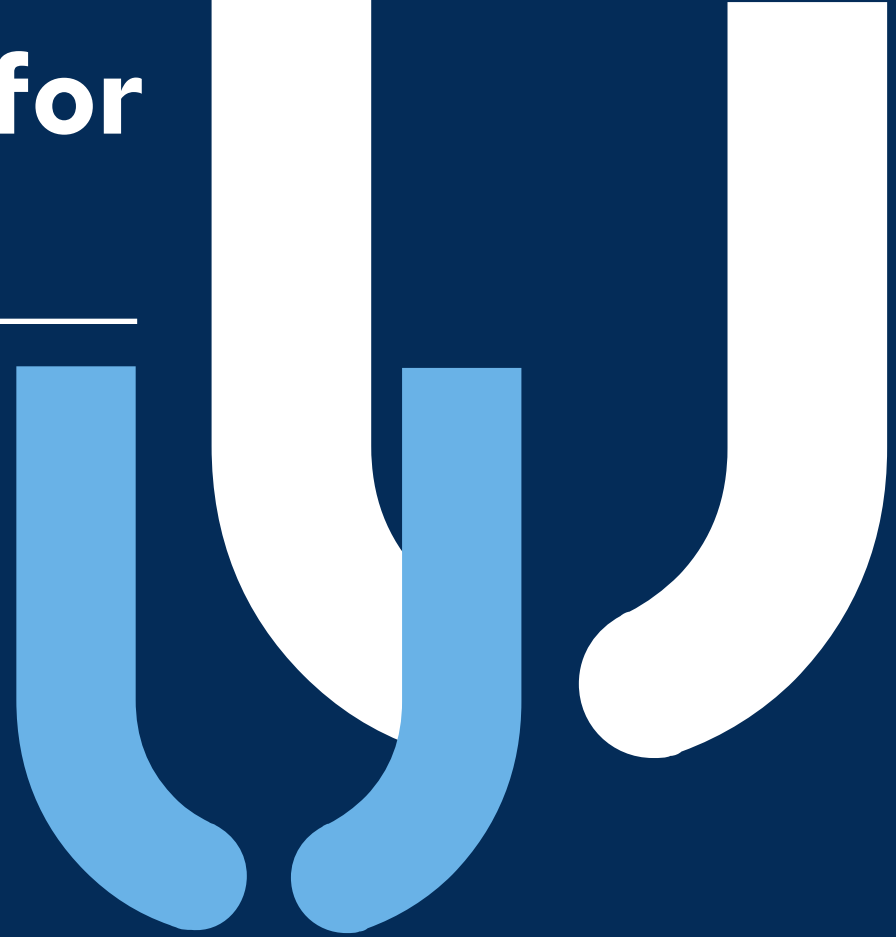
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RPTU



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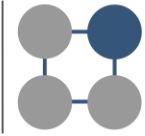
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