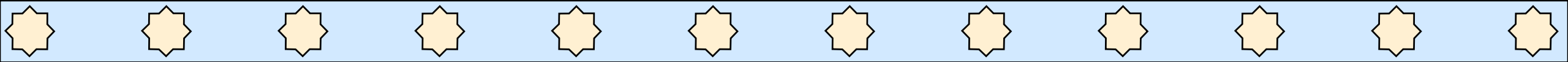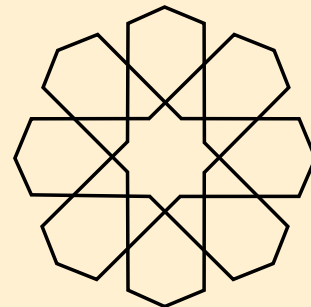# Scientific Method for Wikimedians

The Scientific Method
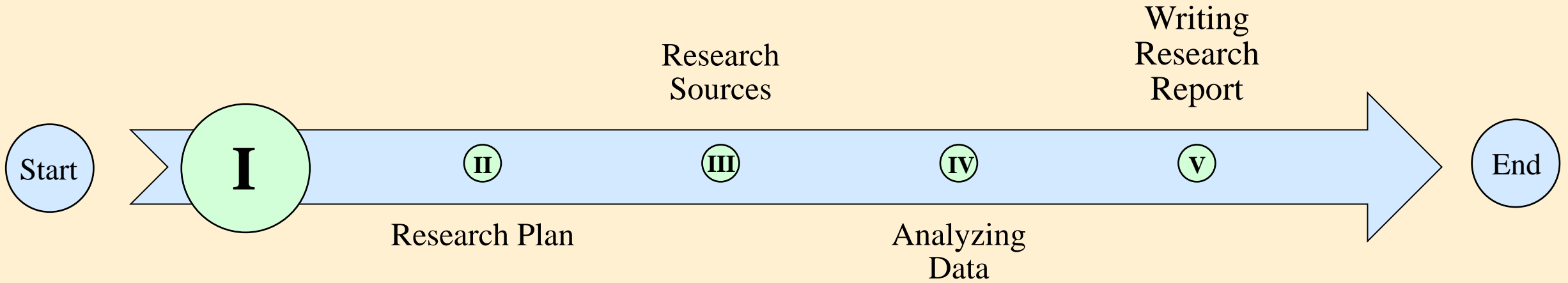
Michel BAKNI

2023

Course Structure

Part I: Knowledge & Scientific Method

Chapter 1: Knowledge & its Types   **Chapter 3:** Research Methodology

Chapter 2: Scientific Facts   **Chapter 4:** Scientific Methods

Chapter 5: Research Question

Outlines

✳ **Reminder: science & method**

✳ **Definition of the scientific method**

✳ **Structure of the scientific method**

✳ **Properties of the scientific method**

✳ **Notes on the scientific method**

I Reminder: Science & Method

✷ Science definition

> " Science, to put its warrant as concisely as possible, is the organized, <u>systemic</u> enterprise that gathers knowledge about the world and condenses the knowledge into <u>testable</u> laws and principles. "

p. 53
Consilience : the unity of knowledge
Wilson, Edward O
ISBN: 978-0-679-76867-8

✷ Example

How many seats are there?
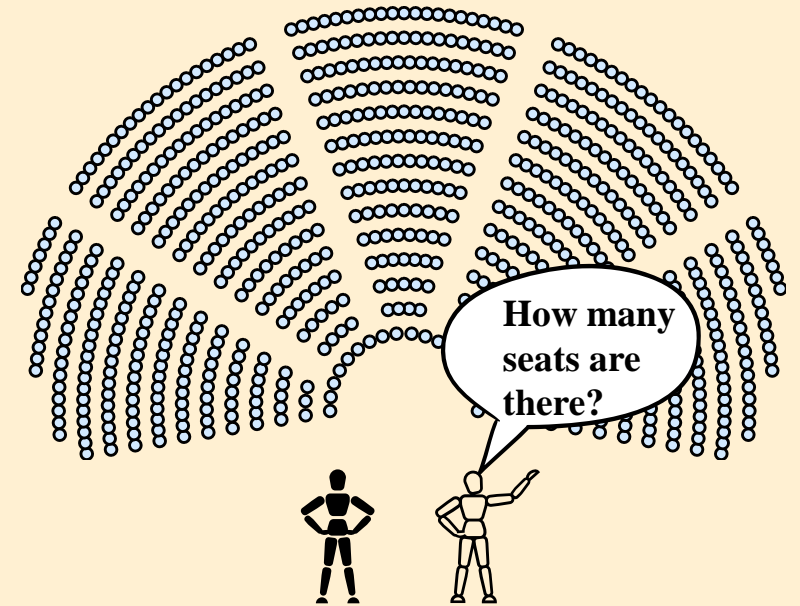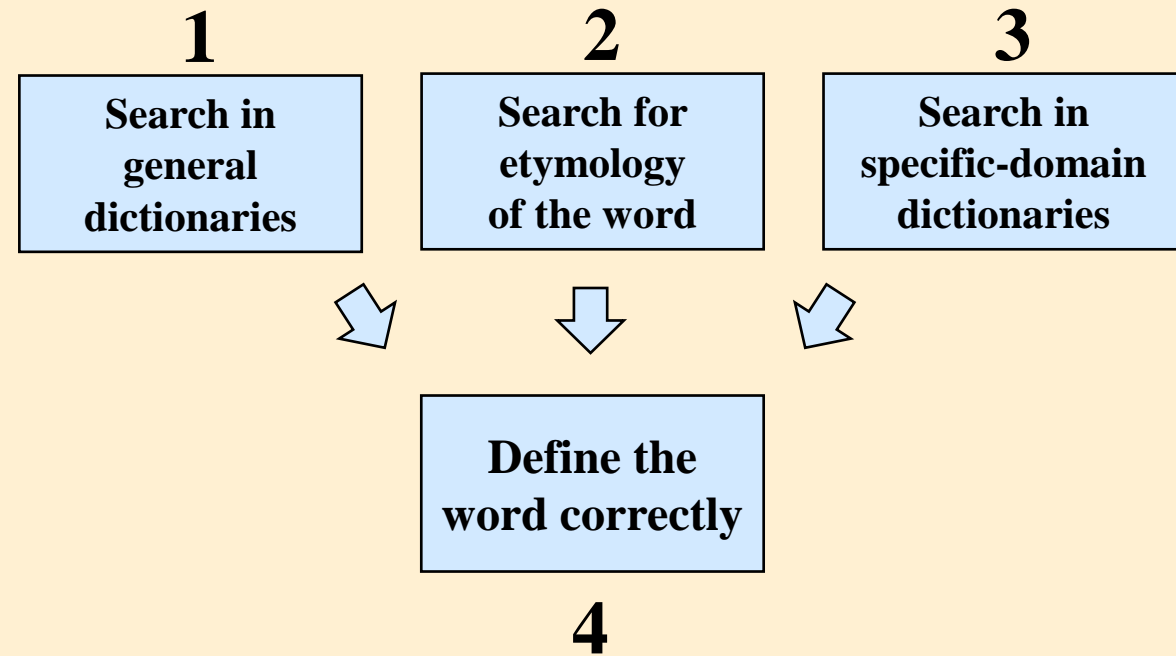
☑ **Systematic**
☑ **Testable**

I Reminder: Science & Method

✴ **Research method**

❝
Research methods are the strategies, processes or techniques utilized in the collection of data or evidence for analysis in order to uncover new information or create better understanding of a topic.
❞

Research guide
University of Newcastle*

✴ Example

1
| Search in general dictionaries |

2
| Search for etymology of the word |

3
| Search in specific-domain dictionaries |

| Define the word correctly |

4

☑ **Set of steps**

☑ **Well-defined**

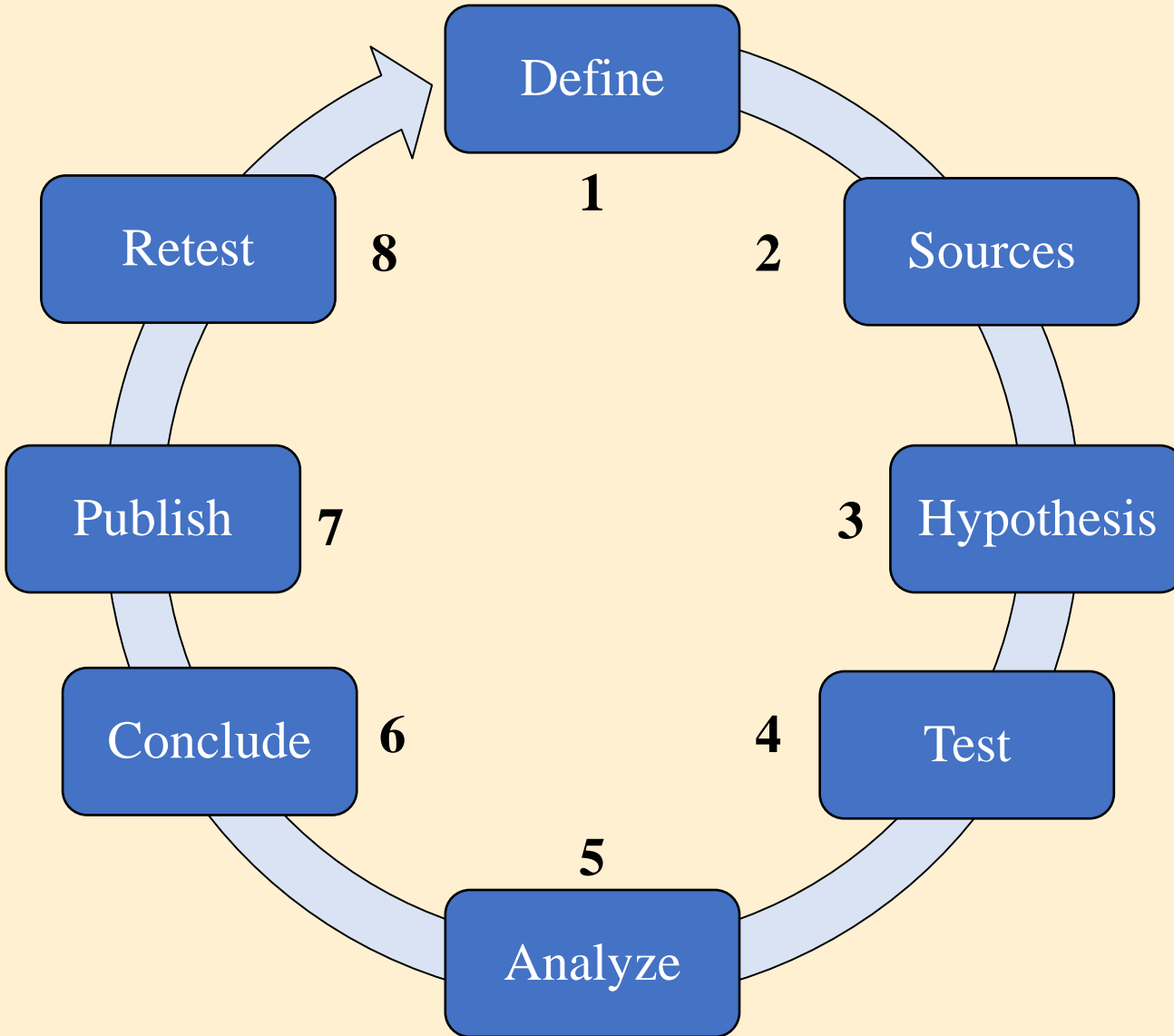# II · Scientific method: Definition

✸ What do we know so far?

- ✦ A way | not doctrine nor ideology

- ✦ Create new knowledge

- ✦ Set of well-defined steps

- ✦ Can be tasted

- ✦ Same results

✸ What to consider a science?

1. Clearly defined terminology

2. Quantifiability

3. Highly controlled experimental conditions

4. Reproducibility
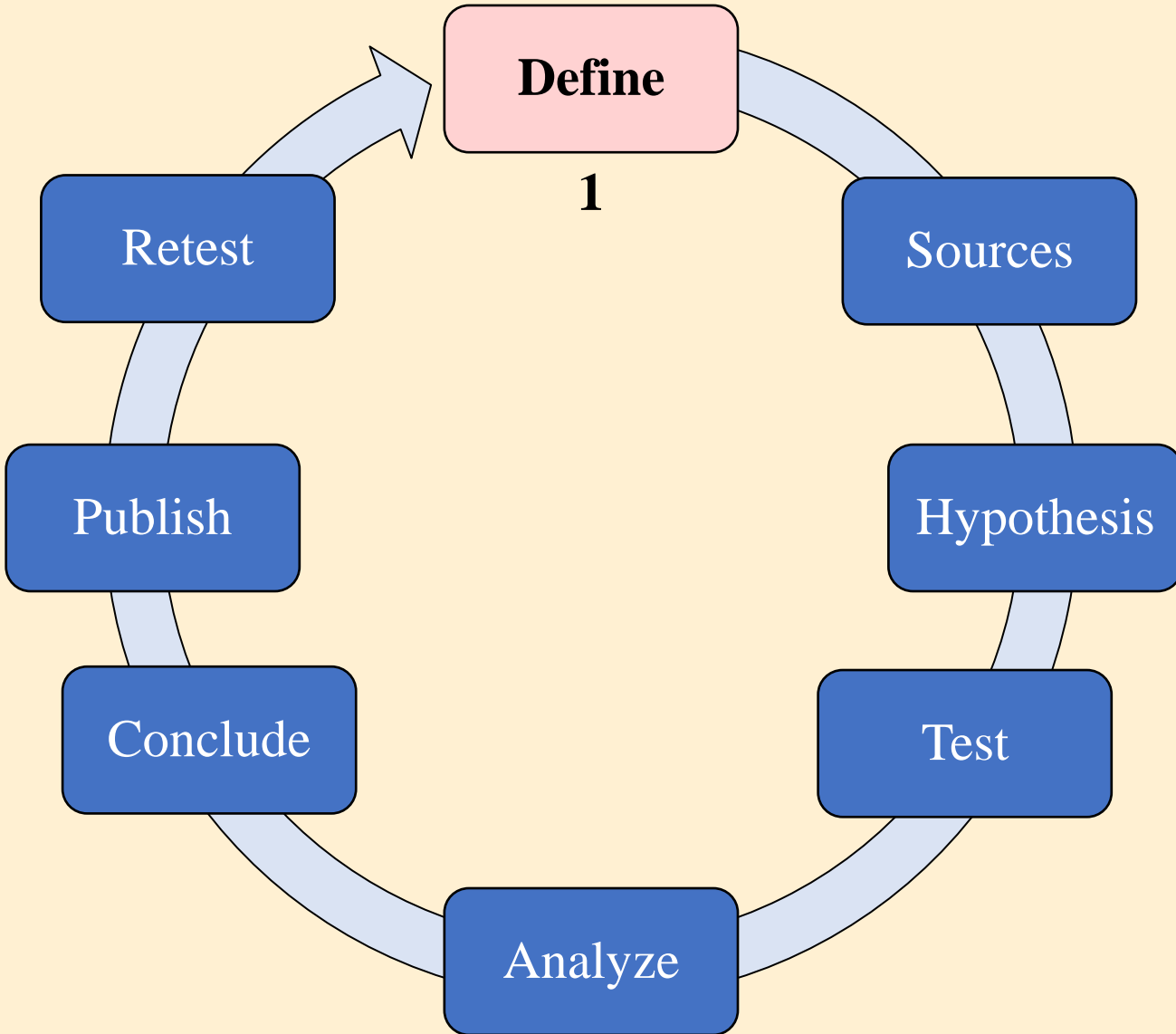
5. Predictability

6. Testability

Jogalekar, A. "Is psychology a "real" science? Does it really matter." *Scientific American* (2013).

Scientific method: Definition

1. **Define problem**
2. **State-of-the-art**
3. **Form hypothesis**
4. **Test hypothesis**
5. **Analyze data**
6. **Interpret data & draw conclusions**
7. **Publish results**
8. **Retest**

Cycle diagram: Define (1) → Sources → Hypothesis → Test → Analyze → Conclude → Publish → Retest → Define

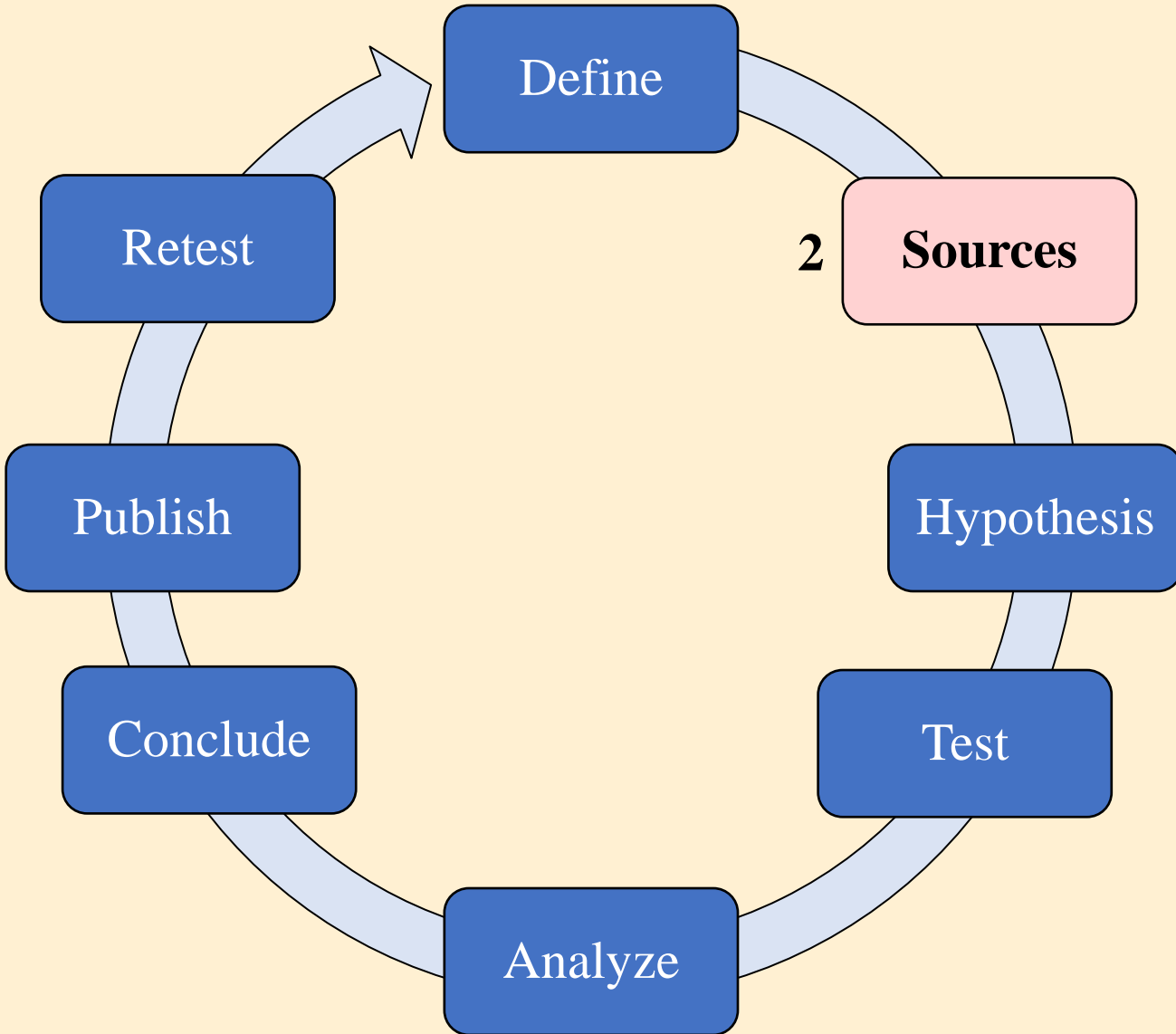✸ **Define research question**

❧ Detailed & clear problem

❧ Open & close end

❧ Must be based on others' work

❧ Hardest step & large impact
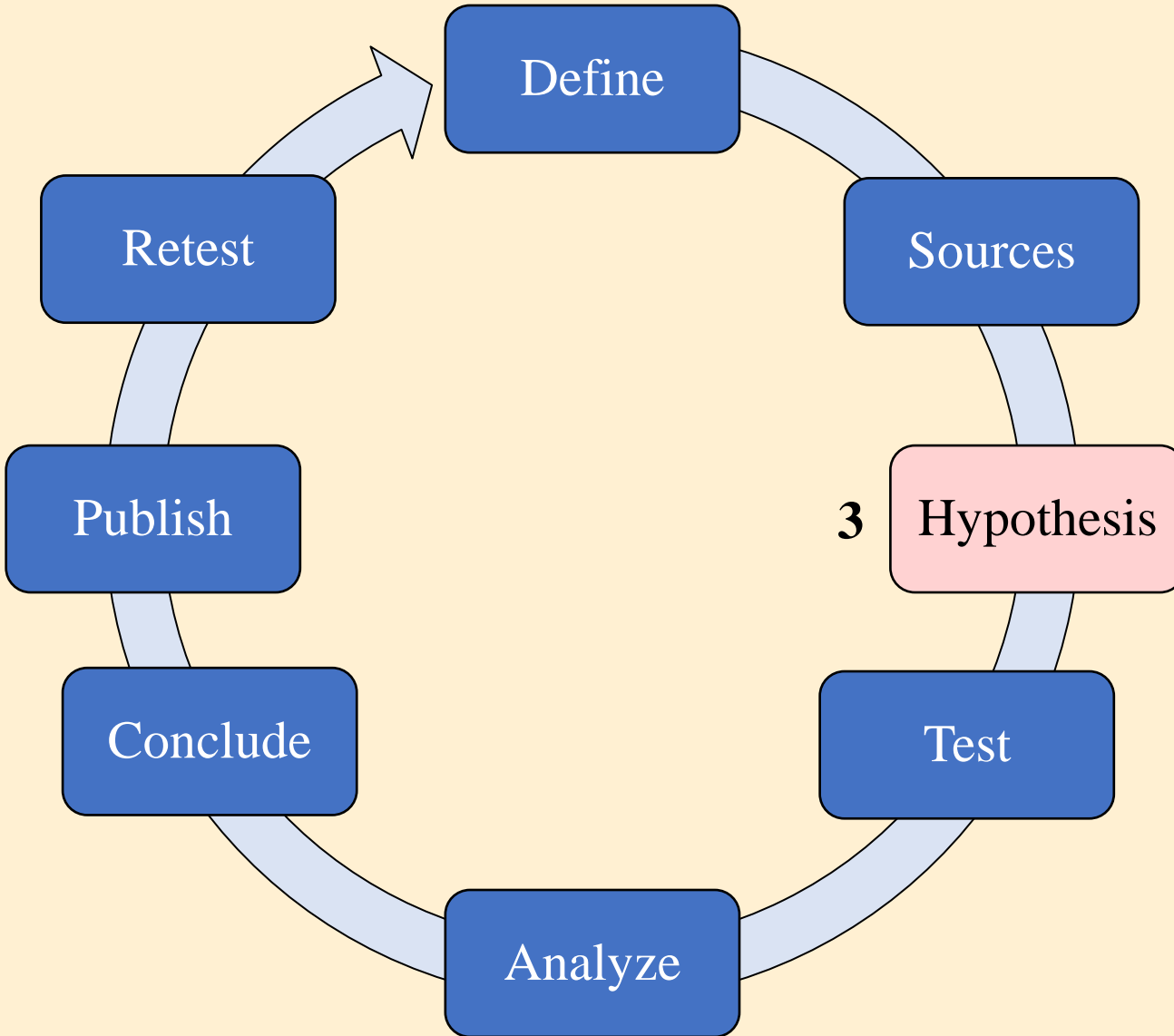
❧ 5W1H help formulating question

III Scientific method: Structure

✸ State-of-the-art

- ❦ = Cutting edge or leading edge

- ❦ Latest achievement in domain

- ❦ Based on reliable sources

- ❦ Organizing & analyzing

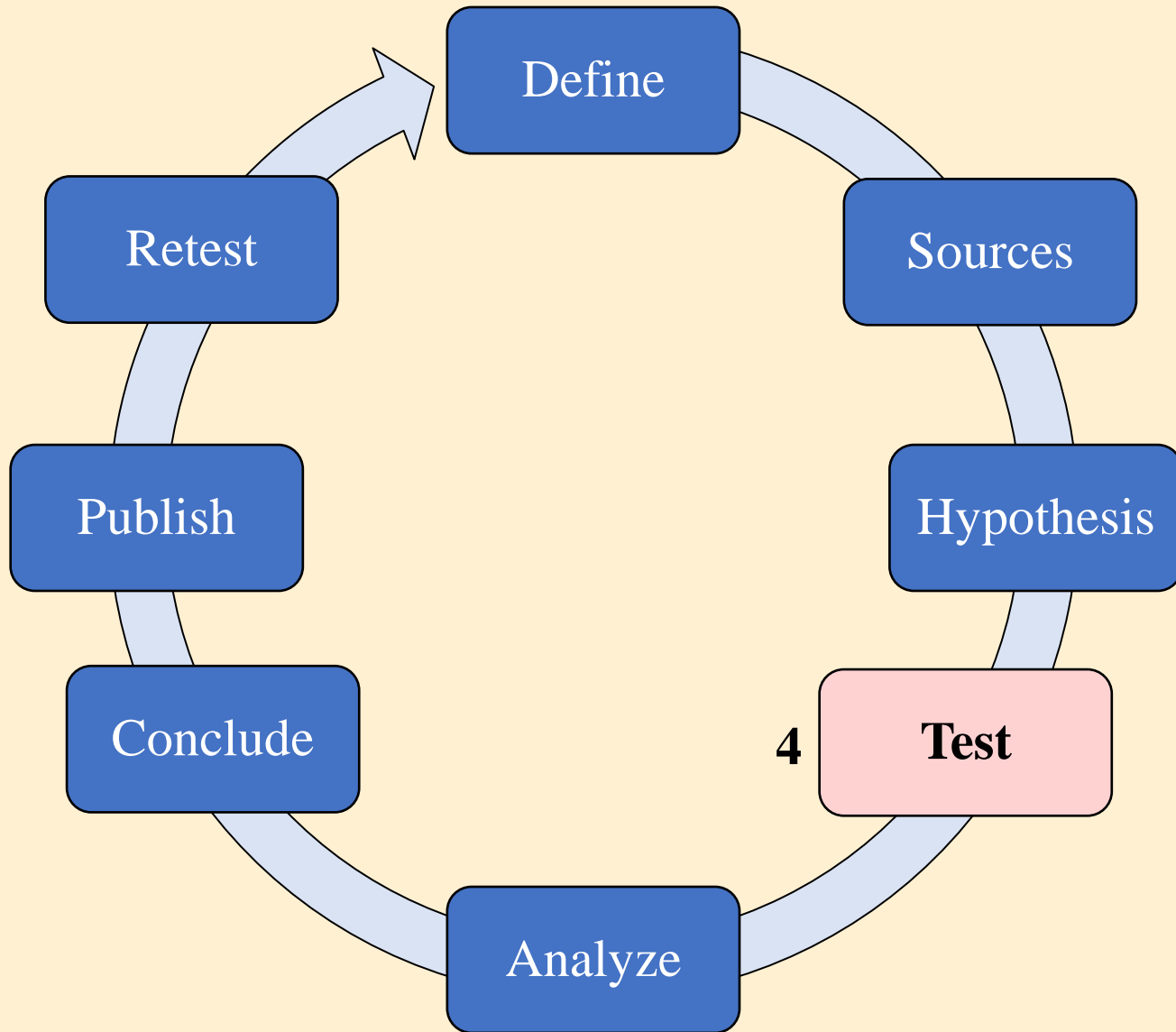- ❦ Cover always 1st part or chapter

- ❦ End with research question

Scientific method: Structure

✴ Form a hypothesis

- ❧ A conjecture to be tasted

- ❧ Not random | possible answer

- ❧ Close to physical

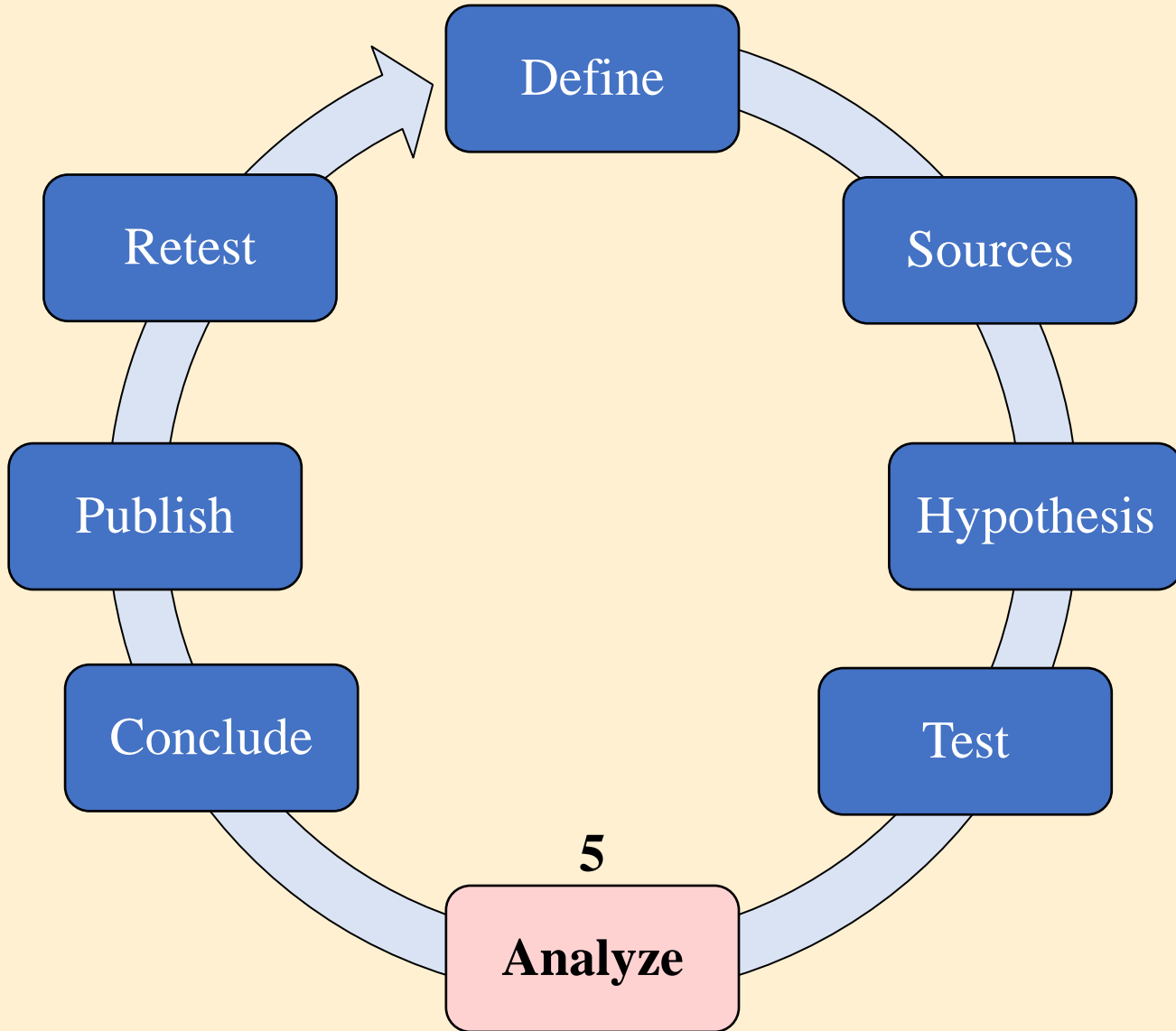- ❧ Test using experiments & theories

Scientific method: Structure

✳ Test the hypothesis

  ❋ Build a test or query!

  ❋ Select what to record & expected values

  ❋ Results against theories

  ❋ If invalid, repeat form sources!

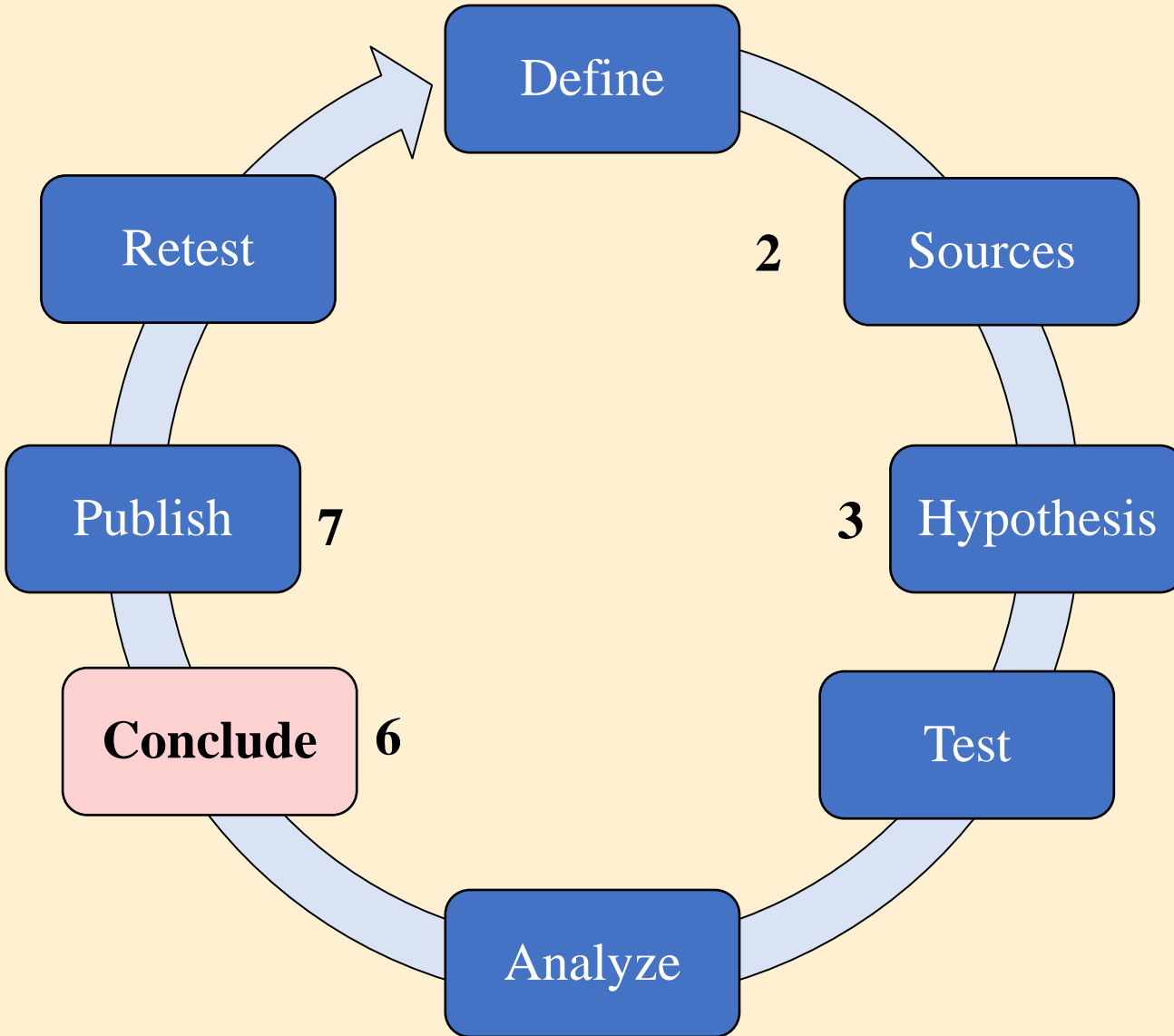 ❋ Analyze & conclude first

  ❋ Publish fails too!

III Scientific method: Structure

✳ **Analyze data**

- ♣ Classify & sort
- ♣ Quantitative or Qualitative?
- ♣ Not bias & neutral point of view
- ♣ Expected value? If not, why?
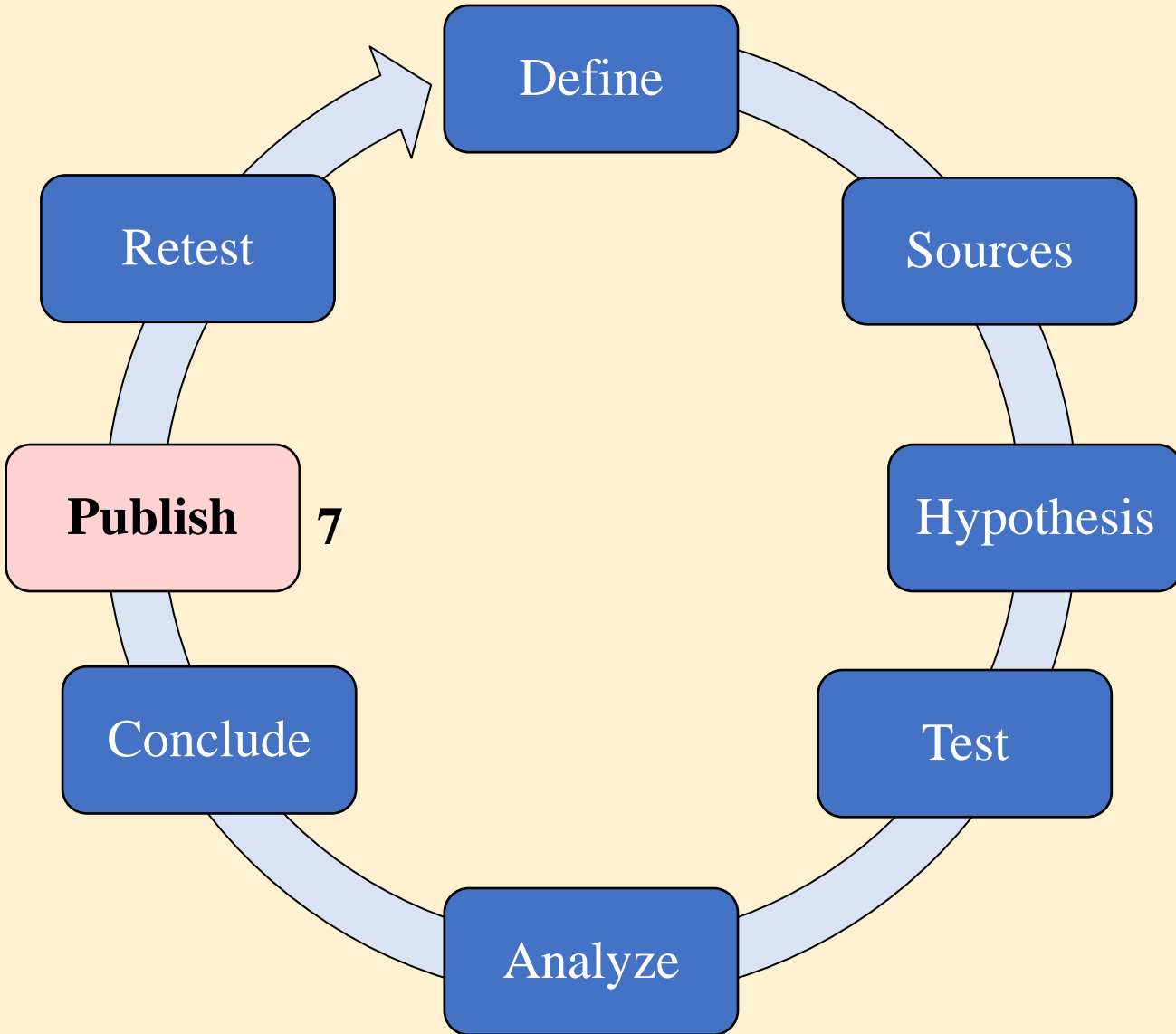- ♣ Do not jump to results
- ♣ Build inductively

III Scientific method: Structure

✷ Interpret data & draw conclusions

- ❧ Be honest | not personal

- ❧ Decide what do next

- ❧ Go back to 2 or 3 | if still time

- ❧ Advance to 7
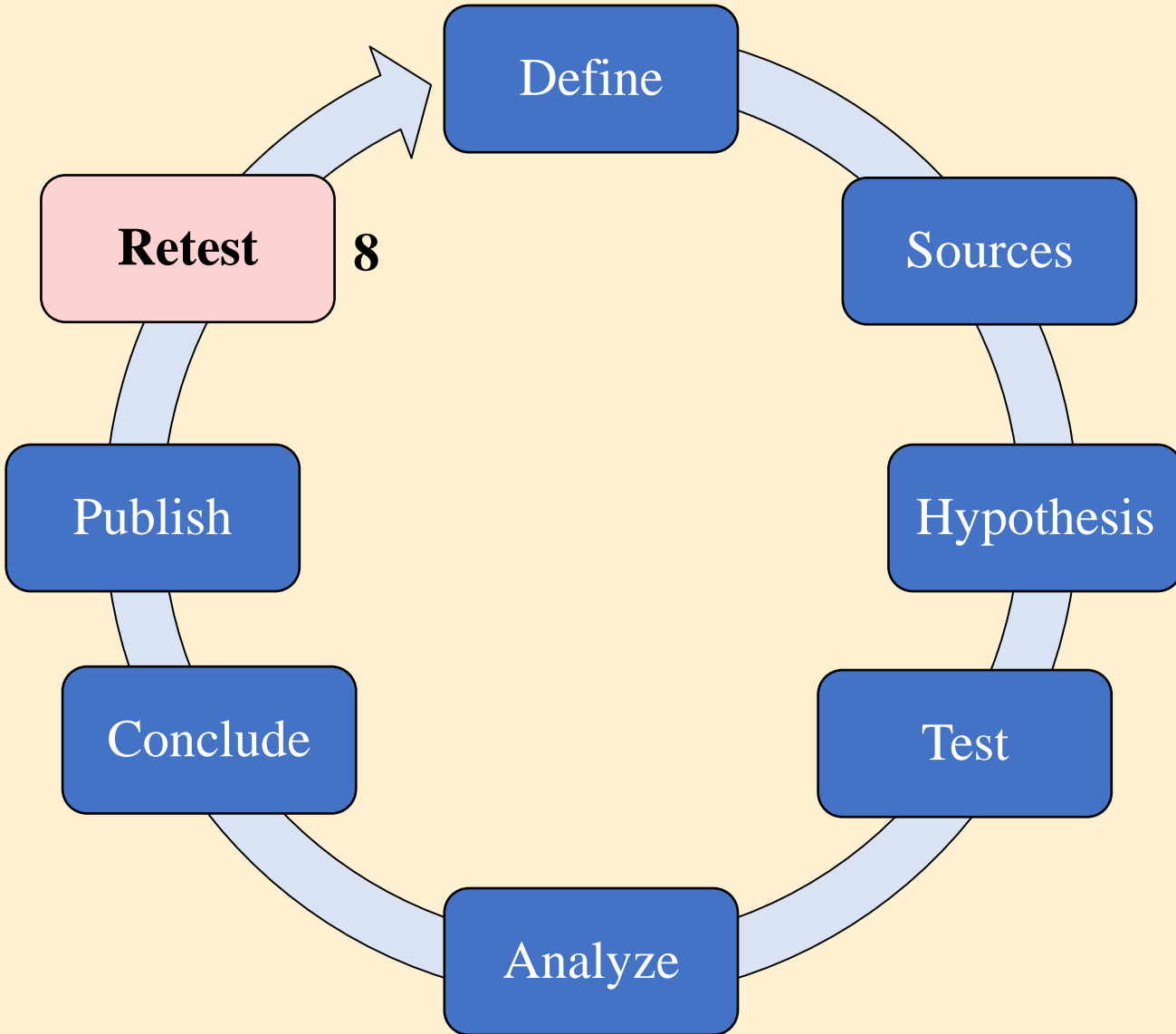
Ⅲ Scientific method: Structure

❋ Publish results

- ♣ Peer review process

- ♣ Can be rejected! Not personal

- ♣ Write down systemically

- ♣ Publication: Workshop? Conference? Journal?

- ♣ Respect style

⬡ III ⬡ **Scientific method: Structure**

- ✳ **Retest**
  - ♣ Done by others to validate
  - ♣ Can be 1st step
  - ♣ Communication!
  - ♣ Keep up to date!

IV Scientific method: Properties

✴ **Reproducibility:** **Consistency of measurements**

✴ **Predictability** **Forecasting based on past & present data**

✴ **Systematicity:** **State of being systematic**

✴ **Skepticism:** **Doubt toward knowledge**

✴ **External review:** **Evaluation by people w/ similar competencies**

IV Scientific method: Properties

✳ Reproducibility

❋ = replicability & repeatability = same result under same circumstances.

Experiment

❋ Subject → Observational study → Results

Statistical analysis

❋ Example: Power posing

[Blythwood CC BY 2.0]

IV Scientific method: Properties

✴ **Predictability**

- ❀ **Future data based on current & past data**

- ❀ <u>Not</u> **astrology nor fortune-telling**

- ❀ **Hypothesis to be tested = testable prediction**

- ❀ **Example: Albert Einstein & black holes**

✳ **Systematicity**

    ❇ **= Methodical: following clear & detailed method = no ambiguity**

    ❇ **Create order & justify every steps and choices**

    ❇ **Based on clear definitions**

    ❇ **Origin of reproducibility & predictability**

    ❇ **Example: Classical impossible**
            Geometry constructions

1. Trisecting an angle
2. Squaring a circle
3. Doubling a cube

IV Scientific method: Properties

✴ **Skepticism (Uncertainty)**

 ❧ **Examination of claims and theories**

 ❧ **"Application of reason to any & all ideas"***

 ❧ **Evaluation: verifiability & falsifiability | <u>not</u> faith nor unreliable evidence**

 ❧ **Example: "Cartesian doubt" :**
    René Descartes (1596–1650)

1. **Accepting <u>only</u> information you know is true**
2. **Breaking down truths => smaller units**
3. **Solving simple problems first**
4. **Making complete lists of further problems**

***** **skeptic.com (The Skeptics Society)**

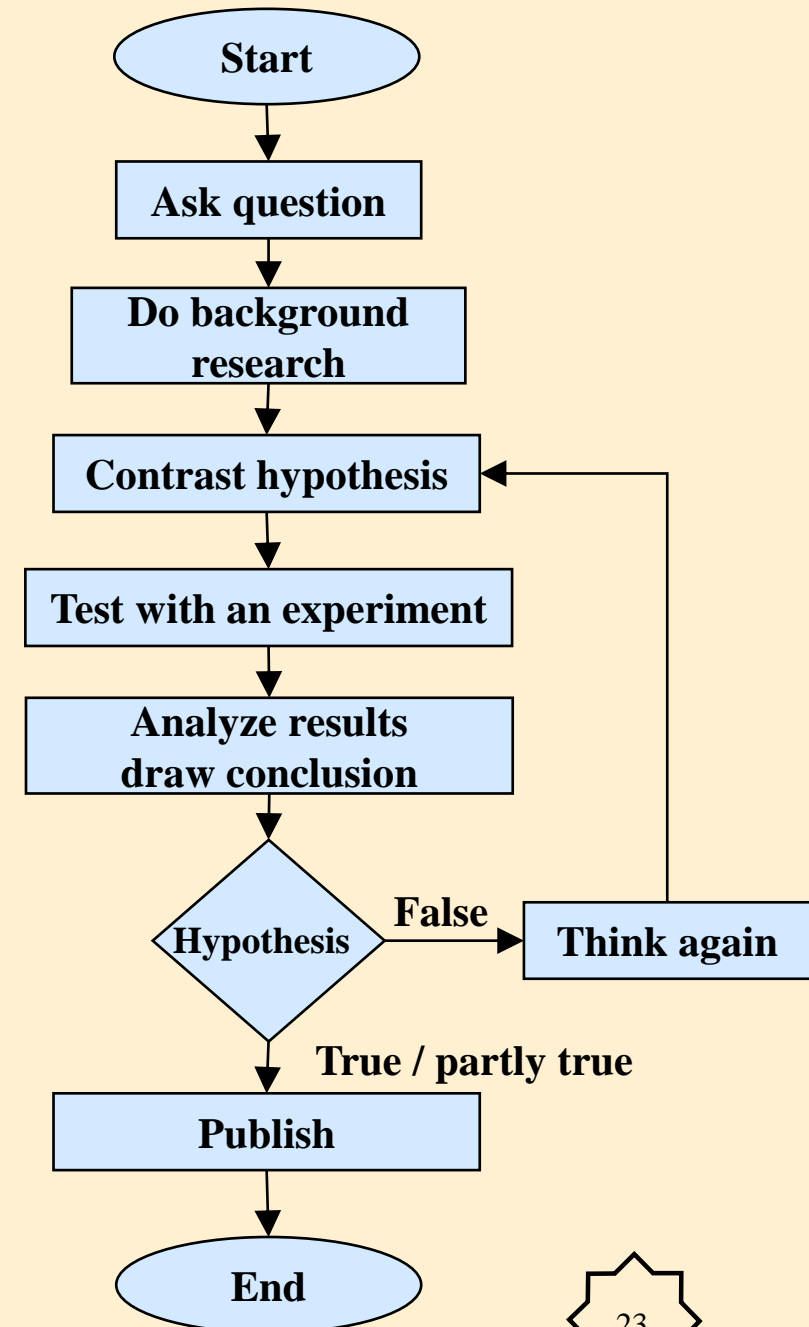# Scientific method: Properties

✴ External review (Peer Review)
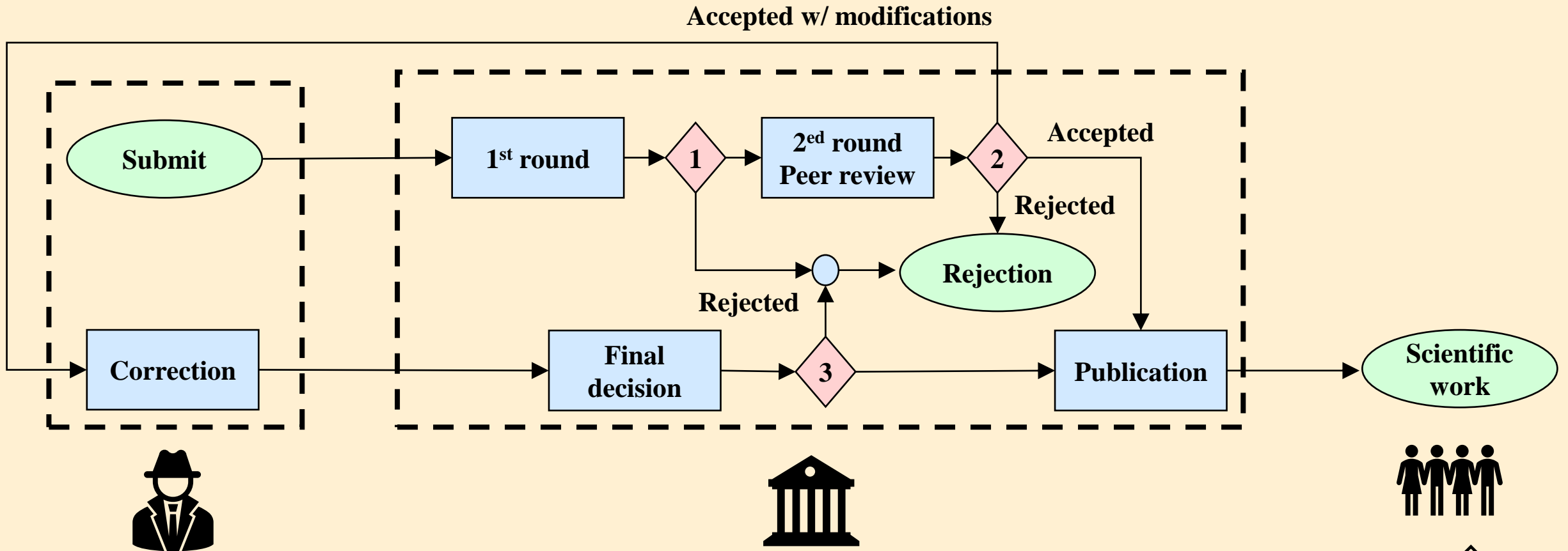
IV Scientific method: Properties

✳ **External review (Peer Review)**

    ❧ **Independent & high skilled party**

    ❧ **Long process: 3-9 months (submit => publication)**

    ❧ **High cost | ?Equal opportunity?**

    ❧ **Example: Predatory journal models**

✦ V Notes on the Scientific Method

✸ **Complex concept & definition**

✸ **Psychology & Economy excluded by definition**

✸ **Scientific method includes 8 steps**

✸ **Peer review process**

```
        Start
          ↓
     Ask question
          ↓
   Do background
      research
          ↓
  Contrast hypothesis  ←──────────┐
          ↓                       │
 Test with an experiment          │
          ↓                       │
   Analyze results                │
   draw conclusion                │
          ↓                       │
      Hypothesis  ──False──→  Think again
          ↓
    True / partly true
          ↓
      Publish
          ↓
        End
```

Course Title: Scientific Method for Wikimedians

Course Creator: Michel BAKNI

Video Title: The Scientific Method

Film Editing : Sandra HANBO

Date: February 2023

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Scientific Method for Wikimedians - The Scientific Method