# PRACTICE-FIRST APPROACH: FROM BIOLOGICAL CASES TO PHILOSOPHICAL ISSUES

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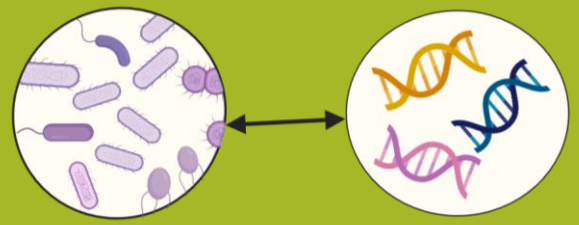
# PRACTICE-FIRST APPROACH: FROM BIOLOGICAL CASES TO PHILOSOPHICAL ISSUES



Microbiology
Metabarcoding =
Amplicon Sequencing (AS)

1. Data vs. Samples

2. Measurement

# DATA AND DIVERSITY MEASUREMENT IN MICROBIOLOGY

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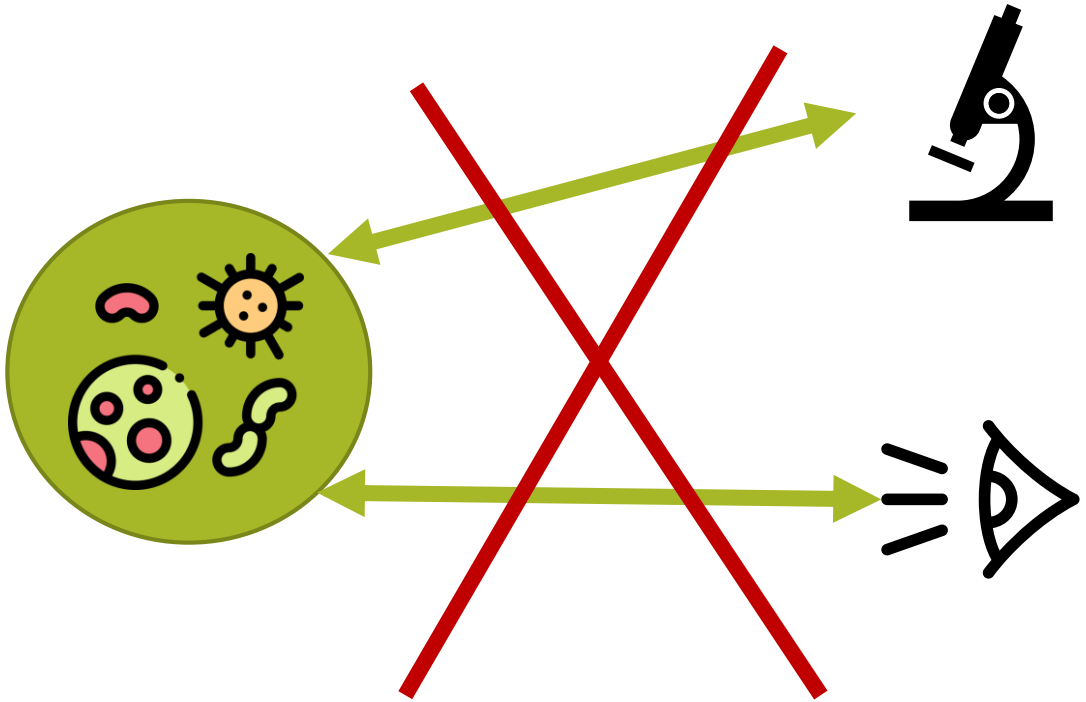
# INTRODUCTION

# Microbiology

# Scientific Issue



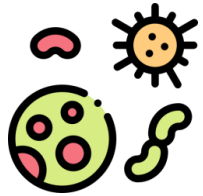
⇒**New method: Metabarcoding or Amplicon Sequencing**

# BIOLOGICAL CASE

Amplicon Sequencing

# Amplicon Sequencing

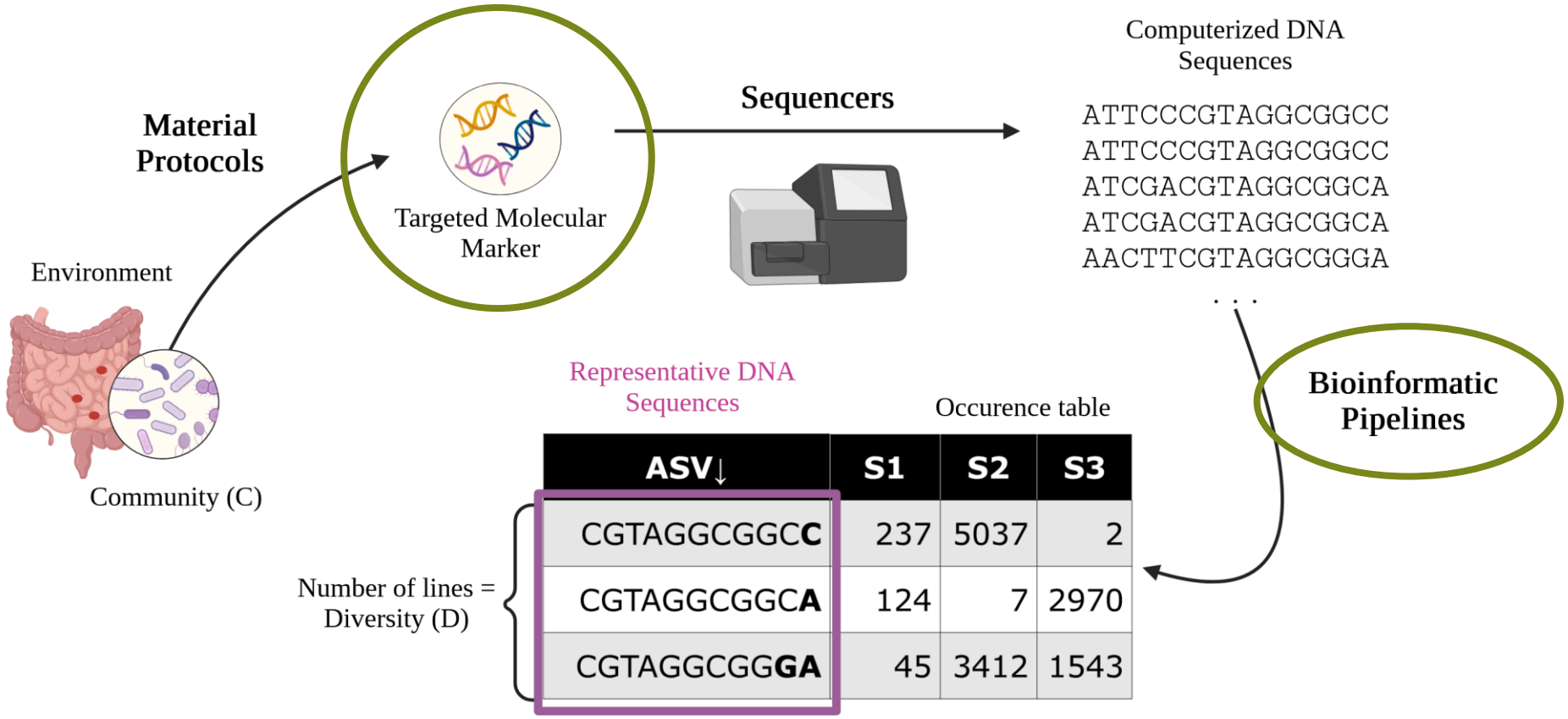
- Amplicon Sequencing  is a methodological **substitution to microbial observation**, which **disrupt the link between microorganism and their DNA**.



**Object:** Microbial community

- By generating **millions of DNA sequences**, AS is expected to **"reveal" the underlying characteristics of the microbial community in general.**

# Amplicon Sequencing




| ASV↓ | S1 | S2 | S3 |
|---|---|---|---|
| CGTAGGCGGC**C** | 237 | 5037 | 2 |
| CGTAGGCGGC**A** | 124 | 7 | 2970 |
| CGTAGGCGG**GA** | 45 | 3412 | 1543 |

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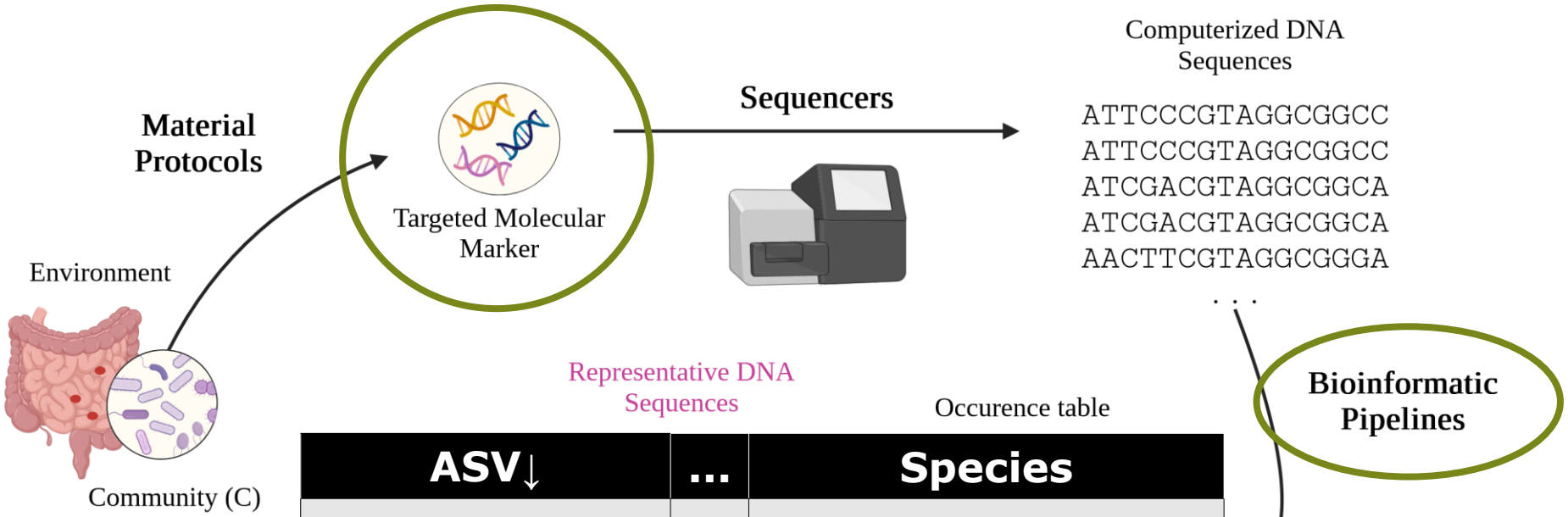
# Amplicon Sequencing




| ASV↓ | ... | Species |
|---|---|---|
| CGTAGGCGGC**C** | | *Escherichia coli* |
| CGTAGGCGGC**A** | | *Phocaeicola vulgatus* |
| CGTAGGCGG**GA** | | *Blautia faecis* |

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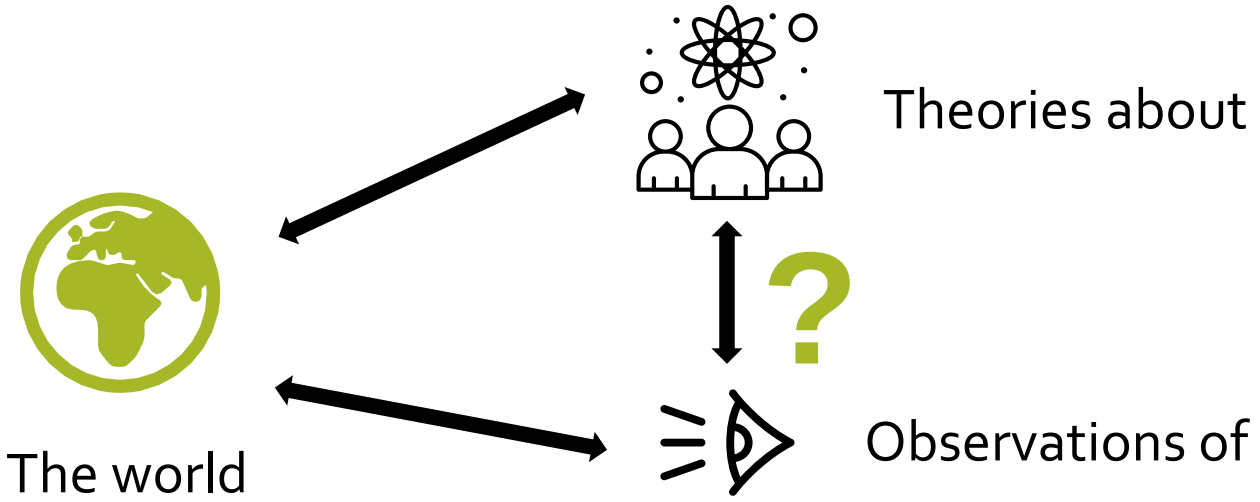
# PHILOSOPHICAL ISSUES

1. Data vs. Samples
2. Measurement

# Data in Philosophy

- Dichotomy:




⇒There is a tension between **what data are** and **what data do** in the scientific inquiry.

⇒What **about samples**?

# The Relational Framework of Data

- Developed in a "practice-oriented" philosophy – looking at biology
- Objects are not data based on what they are but on what they do in the scientific inquiry, on which relationships they stand with the investigators and the situation of the inquiry.
- Two features are necessary in the relational view for an(y) object to be data. An object must have:
  1. The **potential to serve as evidence for sustaining knowledge** claims and
  2. The **potential to travel between different situations** of scientific inquiry
- **NB**: Situationism is a kind of **contextualism** BUT a situation gathers only those elements (whatever they are, events, objects, etc.) of the context that are **RELEVANT for the agent's current inquiry.**

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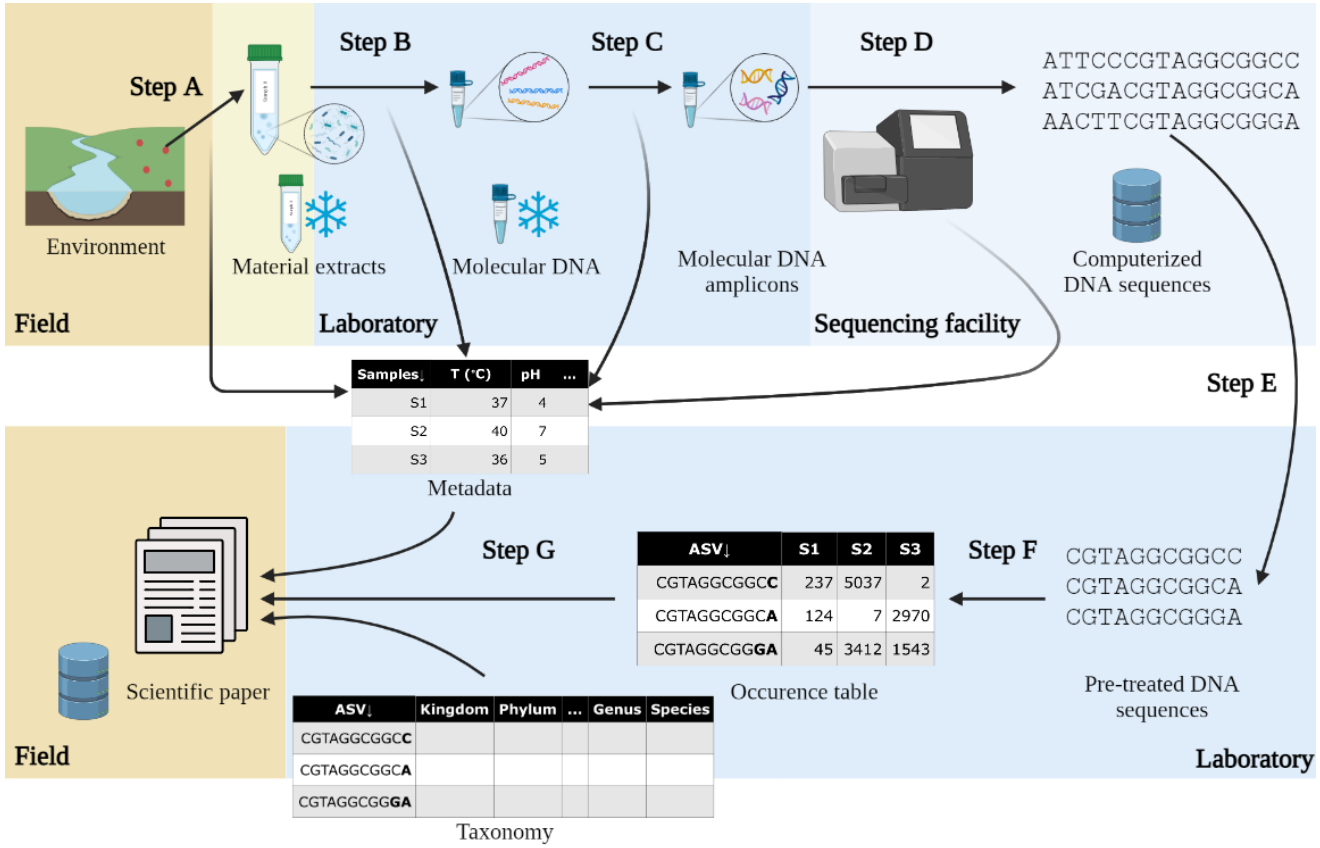
# Issues with AS

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# Issues with AS

| Step. Products of AS inquiry | 1. Considered as potential evidence | 2. Capacity to travel between different situations of inquiry | Relational framework |
|---|---|---|---|
| A. Material extracts | Y | Y | **Data** |
| B. Molecular DNA | Y | Y | |
| C. Molecular DNA amplicons | Y | Y | |
| D. Computerized DNA sequences | Y | Y | |
| E. Pre-treated DNA sequences | Y | Y | |
| F. Occurrence tables | Y | Y | |
| G. Scientific papers | N* | Y | Knowledge claims |

⇒**Everything is data**

# The Sample Category of Data

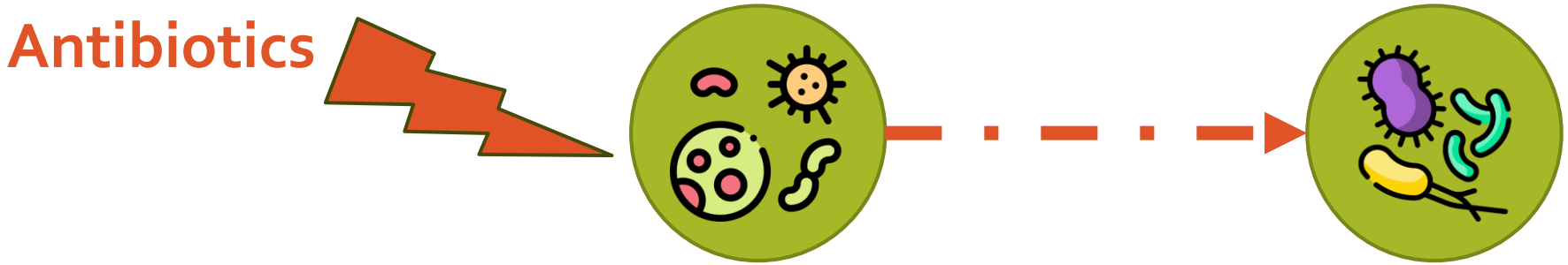
- In AS and within the relational framework, samples
  1. are **necessarily transformed** to be considered evidence,
  2. are portable **in the limit of the situation where they endure this transformation**, and
  3. **act as material/world anchors for claims about a phenomenon**.
- *I will not detailed these points here, if you wish to discuss them, find me at the end of our session*

# PHILOSOPHICAL ISSUES

1. Data vs. Samples
2. Measurement

# Diversity in Biology

- Intuitive idea of diversity: Changes (e.g., take antibiotics) in the community are real and mind-independent.
- Changes (e.g., over time) in the **number and types of individuals in a community**




- **Several information** such as: How many individuals? Of which types? How many per types? How close they are from each other? Which metabolisms are present? Etc.

⇒**Need to measure the parameter diversity**

# Diversity in Philosophy

- The main issue is about the conceptual definition of diversity: Which of the several aspects mentioned before the diversity concept should capture? All of them? None of them?
- I take another perspective: Focus **on the measuring activity in microbiology**
- **Amplicon Sequencing**

⇒**However, measuring diversity is challenging: General Issues and Specific Issues relative to microbiology and AS**

# Measuring Diversity – General Issues

- The concept of diversity is **ambiguous**: taxonomic, genetic, functional, phylogenetic.
- Diversity is a **relative** notion: relative to the spatial area chosen.
- **Several statistical indices** aggregating various information differently exist and are used: richness, evenness, Simpson index, Shannon index, Chao index, etc.
  - General issues of these indices: presupposes the access to individuals, sensitive to the area chosen, sensitive to how taxa are delineated.
  - Additionally, some indices are **composite**: Shannon index is one way of aggregating the richness and evenness information.
  - **None of the indices aggregate all the information contained in the idea of "diversity".**

⇒Choose an Index relative to the **purpose of the inquiry**

# Measuring Diversity – Specific Issues

- **Taxa Delineation Issue**

*Example*: OTUs/ASVs are **two different ways of delineating phylogenetic similarity**. It does not always correspond to a specific taxa, species or genus.
  - Add another layer at which communities can be compared (species or ASVs?), what is the meaning of this layer?
  - Problem for comparing scientific publications among them

- **Microorganism Isolation Issue**

*Example:* Pooling of the microorganisms and their DNA
  - Difficulties to equate one DNA molecule to one microorganism

- **Unstable Microbial Classification**:

*Example:* Problem to link DNA sequences to a moving classification.
  - Few valid taxon names = few reliable link between DNA sequences and taxon name.
  - Need a lot of background knowledge (databases).

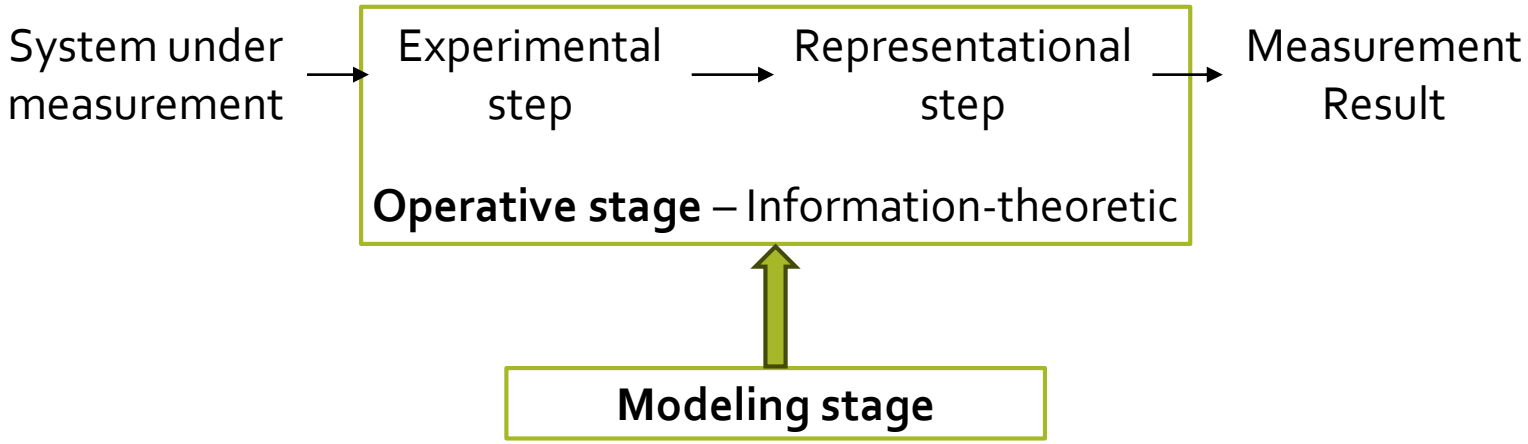
# Philosophical Accounts of Measurement

- "Fundamental problem of measurement"

# Model-Based Account

## Description

- Development of the information-theoretic account.



# Model-Based Account

## Description

- Development of the information-theoretic account.
- Main differences: **Importance of Calibration and of the Goal of the measurement**

## Advantages

- **Goal of the measurement**: help select an index of diversity and a measurement procedure.
- Close to scientific practice of measurement (metrology)
- Can account for complex measurement procedures
- No ontological commitment

# Model-Based Account

- The **measurement goal/purpose** gives the decision criterion between a more accurate and encompassing model of the measurement procedure and the resources that will be needed to obtain such a model.
- The **purpose** is also what should guide the choice of the diversity index to be used in the modeling stage and the choices of the different parameters of the measurement method.

  ⇒**What are the consequences of this account for microbial ecology diversity measuring practices?**

- **Calibration**
- **Purpose of the Measurement**

# Conclusion

- **Science for Philosophers:**
  1. Development of a new category of Data: **Samples**
  2. Successful analysis of the measurement problem using the **Model-Based Account**
- **Philosophy for Scientists:**
  1. Make sense and articulate precisely their intuition that samples are different from other kinds of data; choose sampling methods and transformations that respect the representativity of the samples.
  2. Calibration and purpose

# Thank you!