On the Structure of a Global Knowledge Space

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Nihil sine ratione

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Overview

1. Introduction
2. Space Characteristics
3. Knowledge Modules
4. Global Knowledge Space
5. Conclusion

1. Introduction

What is the idea for a knowledge space?

How to unify two theories?

Theories are „hard cores"

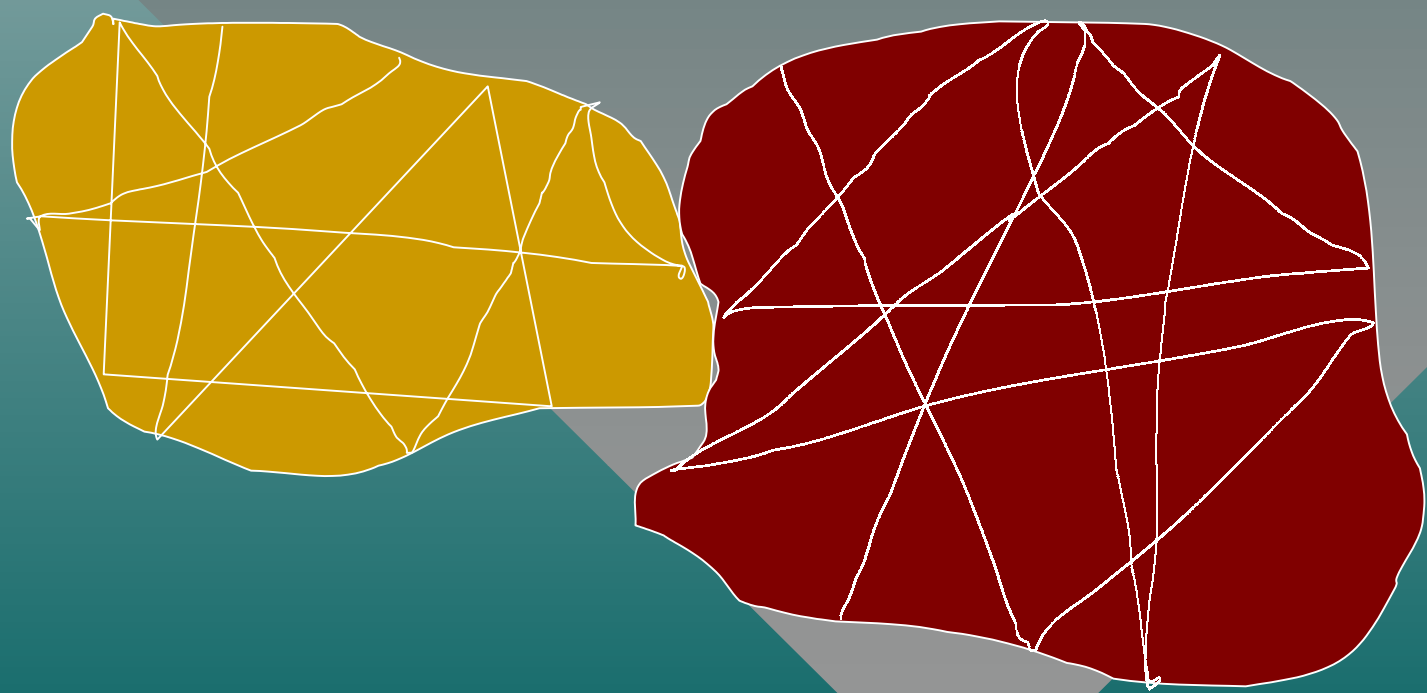
Theory 1

Theory 2

?

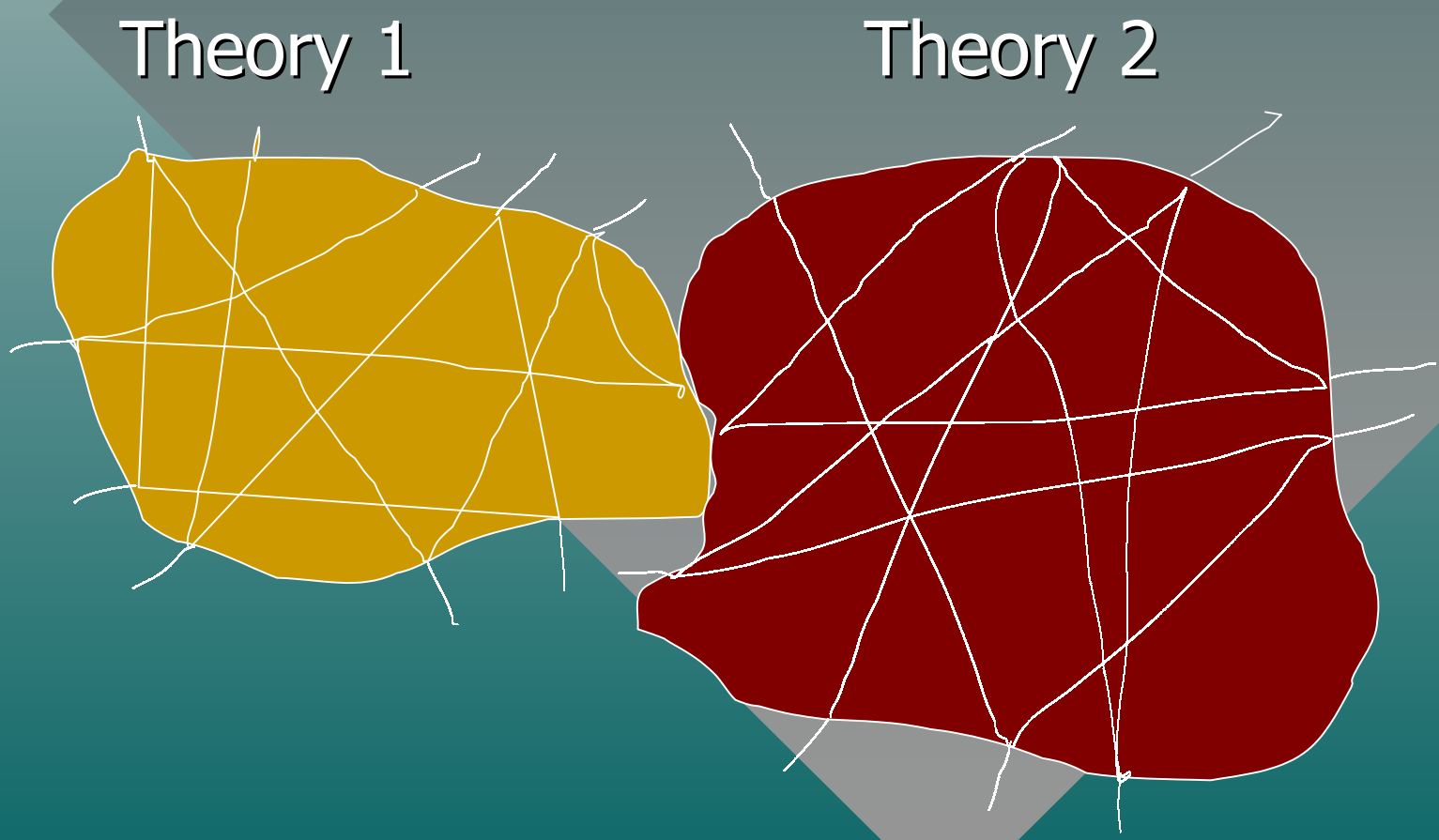
However, theories are no monolithic blocks:

They consist of a variety of single elements



Basic Idea (1):

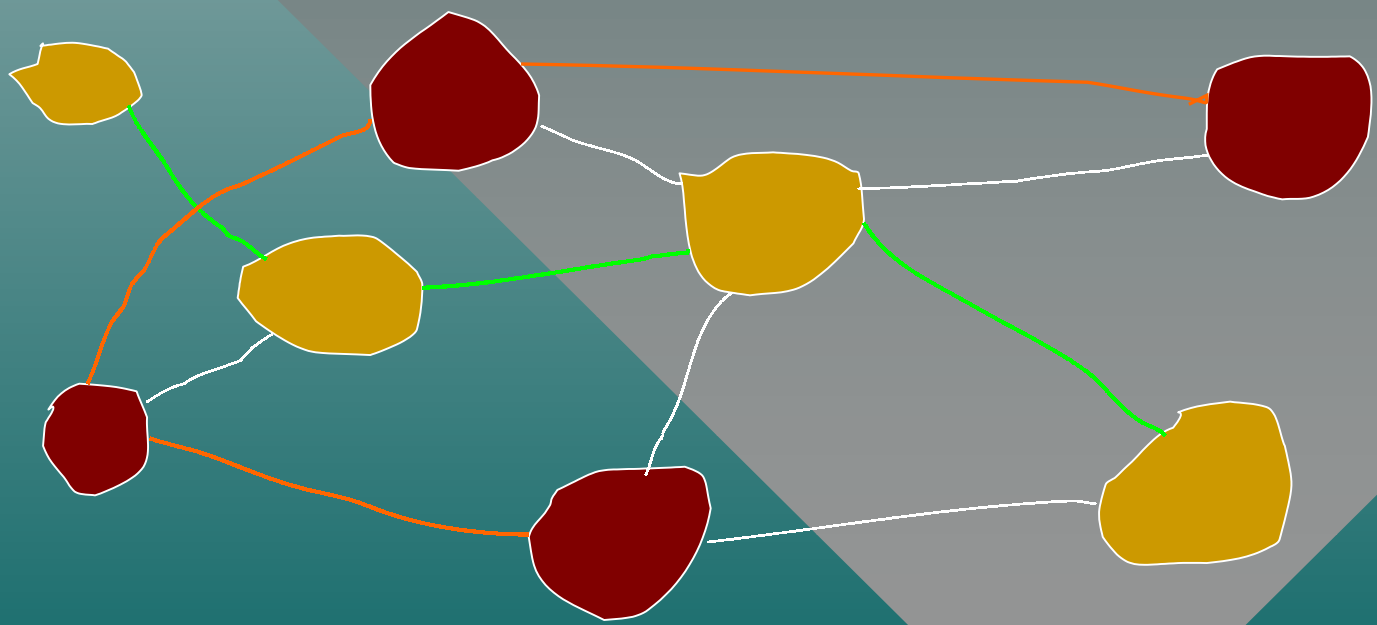
Split the theories into their elements



Basic Idea (2):

Try to „unify“ the elements

Theory 1 $\cup$ Theory 2



Basic Concepts

The elements of a scientific theory are called ‚knowledge modules‘

The „unified“ knowledge modules form a knowledge space

2. Space Characteristics

Representation Formalism

- Semantic Networks (preferred)
  - no restriction [?]
- Topic Maps (alternatively)
  - possibly with a restricted functionality with respect to reasoning and consistency checks

Semantic Network

The basic unit in the space is the two-valued fact

which means that A is linked with B by means of the relation R

3. Knowledge Modules

3.1. Rules for Identifying Knowledge Modules

3.2. Characterization of Knowledge Modules

3.1. Rules for Identifying Knowledge Modules

- It must be possible to reconstruct scientific theories by means of knowledge modules and only by means of them
- Each knowledge module must have a uniquely defined function
- Knowledge modules must be elementary units, i.e., their function must not be achievable by another module, or by a combination of other modules

3.2. Characterization of Knowledge Modules

There are three “abstraction levels”

- module schema
- module species
- real knowledge modules

3.2.1. Module Schema

The schema includes general features common for all modules

There are generic features common for all species

There are specific features common for all knowledge modules of the same species

Module Scheme

- Name of the Module Species
- Semantic Relationship
- Role
- Quality Criterion
- [Concatenation Operation(s)]
- Name of the Type of a Module Species
- Name of the Knowledge Module
- Module Core

3.2.2. Module Species

Examples:

abbreviation, phenomenological definition, method, proposition, metaphor, ...

Defining a species means

- instance the generic features
- constitute the general form of species

Abbreviation is the name of module species

Meaning(short form)=Meaning(long form) is the semantic relationship

Shortening the length of text is the role

Length(short form) < Length(long form) is the Quality criterion

The terms 'short form' and 'long form' must be unique in the space

[no concatenation operation]

$Term_1$ is a name of the abbreviation type

$Term_2$ is a name of the knowledge module

Short form is a Term

$=_{abb}$ is an Equivalence relation

Long form is a Text

3.2.3. Knowledge Modules

A knowledge module is the instantiation of the species-specific features

- Name of the Type of a Module Species
- Name of the Knowledge Module
- Module Core

The module core varies from species to species

Example ‘Abbreviation QPSK’

Acronym	is the	name of the abbreviation type
Abbreviation QPSK	is the	name of the knowledge module
QPSK	is the	short form
$=_{abb}$	is an	Equivalence relation
Quaternary Pulse Shape Keying	is the	long form

Method is the name of module species

Correct execution → goal is the semantic relationship

To reach a well-defined goal is the role

It must be proved that - if used correctly - the method leads to the wanted goal. The method requirements must be known is the Quality criterion

Serialization is the concatenation operation

$Term_1$ is a name of the method type

$Term_2$ is a name of the knowledge module

$Text_1$ is a Problem Description

$Text_2$ is a Requirement

$Text_3$ is an Approach

Example 'Regula Falsi'

Algorithm is the name of the method type

Regula Falsi is the name of the knowledge module

Computation of a null of a real function f is the problem description

There exists $x_0 \neq x_1$ so that $f(x_0)\, f(x_1) < 0$ is the requirement

$x_{m+1} = x_m - f(x_m)/s_m$

where $s_m = [f(x_m) - f(x_{m-1})]/(x_m - x_{m-1})$ is the approach

Phenomenological definition is the name of module species

Meaning(concept)=Meaning(phenomenon) is the semantic relationship

To fix preliminary a concept by experience is the role

The experience must generally be known, is the
or it must be verifiable empirically Quality criterion
[no concatenation operation]

$Term_1$	is a	name of the phenomenological definition
$Term_2$	is a	name of the knowledge module
$Text_1$	is an	experience
$Text_2$	is a	conclusion
$Term_3$	is a	concept to be defined
$=_{pdf}$	is an	equivalence relation
$Text_3$	is a	phenomenological characteristic

Example Phenomenological Definition 'Force'

Empirical definition	is the	name of the phenomenological definition type
Classical Force	is the	name of the knowledge module
Our muscles provide us the qualitative impression that they can be tensed with different intensities	is the	experience
It must be a property in which these different efforts are embodied	is the	conclusion
Force	is the	concept to be defined
$=_{pdf}$	is an	equivalence relation
property characterized by the fact that muscles can be tensed by different strains	is the	phenomenological characteristic

4. Global Knowledge Space

4.1. Cross-Connections

4.2. Consistency Constraints

4.1. Cross-Connections

Cross-connections in the space are realized by

- the generic/specific terms in the "questionnaires"
- interlocking a module with other modules via module names located in the module core (and elsewhere)
- the properties of the mathematical entities like the equivalence relation
- additional relations, e.g., to order the modules in a path which represents a theory
- obligatory relations like 'acronym is an abbreviation type'
- relations representing management information

4.2. Consistency Constraints

- The space should be tested whether there are:
- cross-connections which violates space topology
- uncompleted modules or open problems
- modules which can be derived from other modules
- contradiction between modules

5. Conclusion

5.1. Impacts

5.2. Status

5.1. Impacts

Because of its semantic roots, the global knowledge space has strong impacts to scientific conceptions

- Theories are represented in the knowledge space as paths having interconnection to other paths (theories)
- The space provides tools for identifying weak-points: it can be used as a research tool

5.2. Status

- About 20 knowledge species have been identified as yet in analyzing a physical, a technical and a psychological theory
- The consistency constraints are quite unclear as yet
- For realization the topic maps seem to be the best choice
- However: for constraint-based validation, an extension of the ISO standard will be needed

5.3. Outlook

- With the knowledge space the value of statements can be tested
- Possibly more reason will enter into the discussions by excluding statements which proved be nonsense with respect to the knowledge space

The totality of all sciences can be compared with the ocean which is continuous and without disruption or partition everywhere, even if the humans conceive partitions and give them names according to their convenience (Leibniz)