Science Without Laws
A Book Review
by
Ronald Giere

A Presentation by
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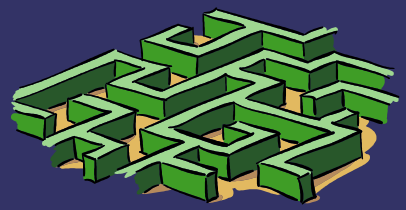
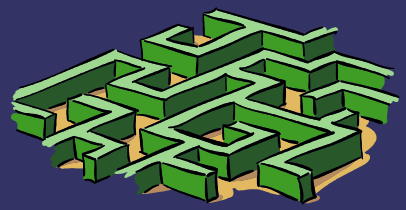
January 20, 2010



Ronald Giere

- Emeritus Professor of Philosophy & Former Director, Center for Philosophy of Science, University of Minnesota
- Fellow of American Association for the Advancement of Science
- Long-time member of the editorial board of the journal Philosophy of Science
- Past President of the Philosophy of Science Association



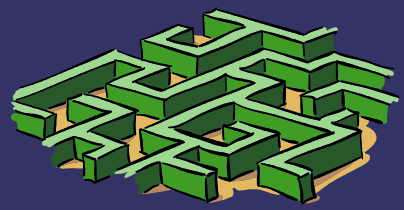
Works of Ronald Giere

Philosopher of Science

- *Understanding Scientific Reasoning* (5th ed 2006)
- *Explaining Science: A Cognitive Approach* (1988)
- *Science Without Laws* (1999)
- *Scientific Perspectivism* (2006).
- Edited volumes of papers in the philosophy of science, including, most recently, *Cognitive Models of Science* (1992) and *Origins of Logical Empiricism*1996).

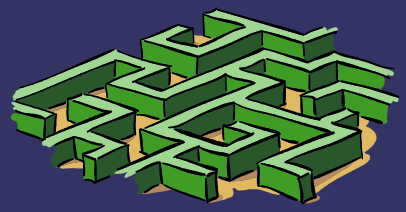
Current Research

- Agent-based accounts of models and scientific representation
- Connections between naturalism and secularism.



Central Idea of the Book

Science without laws locates science in the context of natural, social and cognitive domains, thus offering a more real view of understanding scientific assertions.



Overview of the Book

Part I: Perspectives on Science Studies

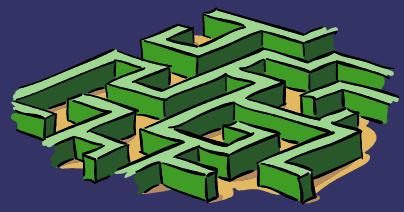
1. Viewing Science
2. Explaining Scientific Revolutions
3. Science and Technology Studies

Part II: Perspectives on Science

4. Naturalism and Realism
5. Science without laws of Nature
6. The Cognitive Structure of Scientific theories
7. Visual Models and Scientific Judgment

Part III: Perspectives on the Philosophy of Science

8. Philosophy of Science Naturalized
9. Constructive Realism
10. The Feminism question in POS
11. From Wissenchaftliche *Philossophie* to POS

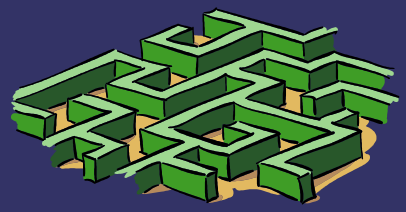


Context of the Book- Science Wars

Growing influence of science and technology and their indispensability for human life – contested

Struggle between

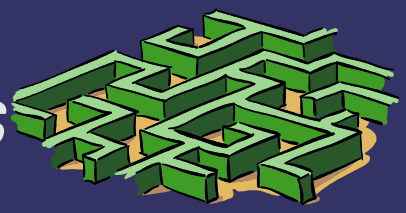
- Humanists and Scientists
- Reductionists or Essentialist's and Relativists or Post-modernists
- Statement and Non statement view theorists
- Logical Positivism and Kuhn
- Science: Objective or Normative



Core Ideas proposed by Giere

- **To offer a Naturalistic Account**
  Rejecting science as something metaphysical and *apriori,* refusal to rely on non empirical ways of doing science

- **Semantic or Model based view of Scientific Study**
  Using Models to represent scientific knowledge- 'abstract objects, imaginary entities whose structure might/ might not be similar to the aspects of the objects and processes in the real world' - discuss the *fit* of models- diagrammatic representations, physical scale models or *theoretical models*



Science Without Laws

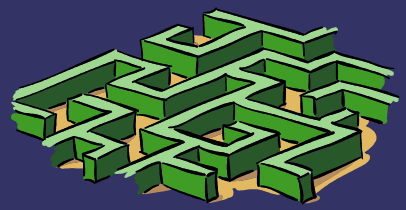
Enlightenment Science

- Responsibility to pose true statements-
- Science to reveal Universal Truths about natural phenomena based on 'rational' principles
- Godly status to science

Arguments by Giere

- Science offers models– varying degree of scope and accuracy
- Laws are interpretations
- There are no universal truths
- Science tries to provide models to represent reality- limited scope and accuracy

Arguments for doing Science without laws....

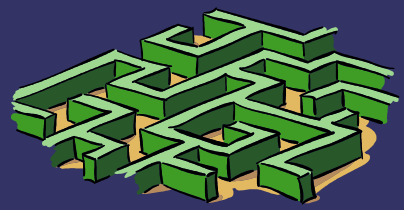


1. Historical Influence

Characteristics of laws in Science

- they are true statements
- they have a universal form
- they are necessary to the study of science
- they are objective
- God's Prescriptions Descartes,Boyle, Galileo

"if there be an universal life and all space be the sensorium of a thinking being who by immediate presence perceives all things in it, the laws of motion arising from life or will may be of universal extent" (Newton, p.87)

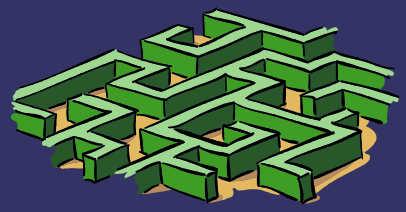


2. Status of Laws

- purported laws of nature - proved false
- 'real' laws or 'near' laws
- statements as laws should be clear and definite., while all the uncertainty should be shifted to the other practices of science like mapping.

Difficulty in Universal status of laws: Newton's Laws

- Which two bodies to choose
- Alone in the universe, with no body whose gravitational force would affect them
- Or a perfectly uniform gravitational field.
- Perfectly spherical bodies- wobble
- No net charge else electrostatic forces
- Free space, with no atmosphere



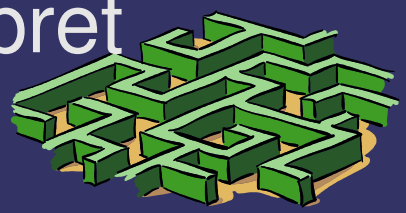
3. Role of Models and Restricted Generalizations

Model-based understanding

- No relation to truth
- Representations of Real world
- Apply to real world with limited accuracy
- Not isomorphic to real world but represent selective parts
- Abstract non- linguistic representations- not true or false
- Questioned their 'fit with the real world '

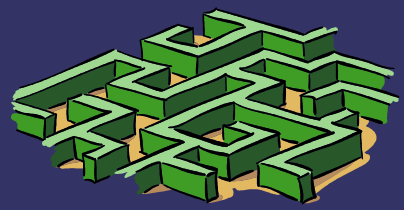
Restricted Generalizations

- Model in 'perspective'
- Generalizations are not universal statements with proviso
- M = a x b
  F = m x a (restrictive)
- Helps to interpret



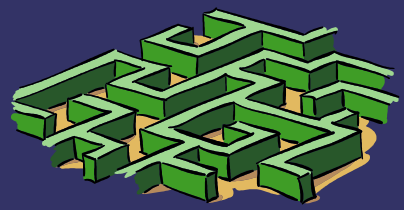
4. Laws vs. Principles

- Replace 'laws' with 'principles'
- Principles- rules defined by humans to be used to build models to represent specific aspects of the world
- Universal character- not needed, their ability to define certain aspects of a system clearly is a substantial proof of their applicability



5. Keeping the Necessity of science without laws

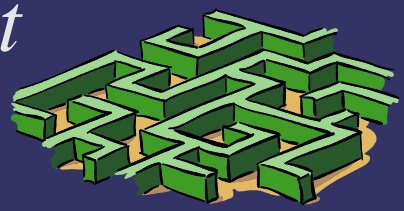
- Possible to deny the 'universal' character of laws without questioning their causal necessity
- Relationship between length of a pendulum and time taken – motion of harmonically driven pendulum – can it explain a real life clock



Realism without truth

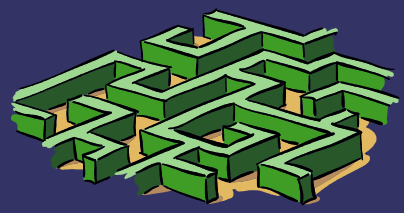
"science is all about is understanding how these humanly created concepts enable us to connect in such exquisite ways with the real world" (Giere, p.2)

- In actual practice- no laws with universal applicability
- Replace 'laws' by 'principles'
- Laws- not statements but general rules to form 'models'
- Question for models: not true or false but how better do they represent part of real world
- Models will always be *partial* and *imperfect* to represent parts of real world

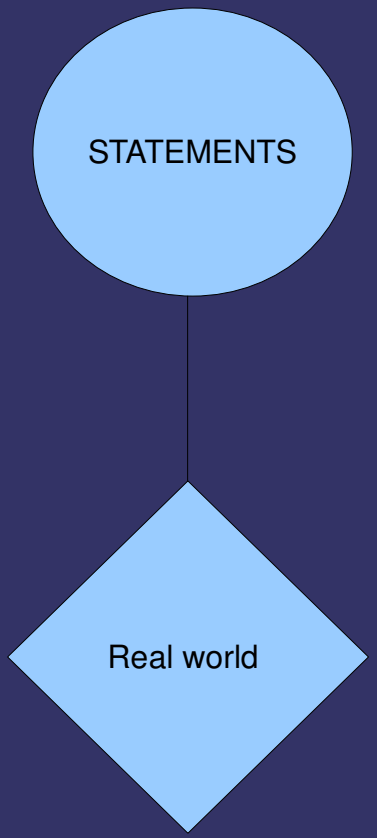


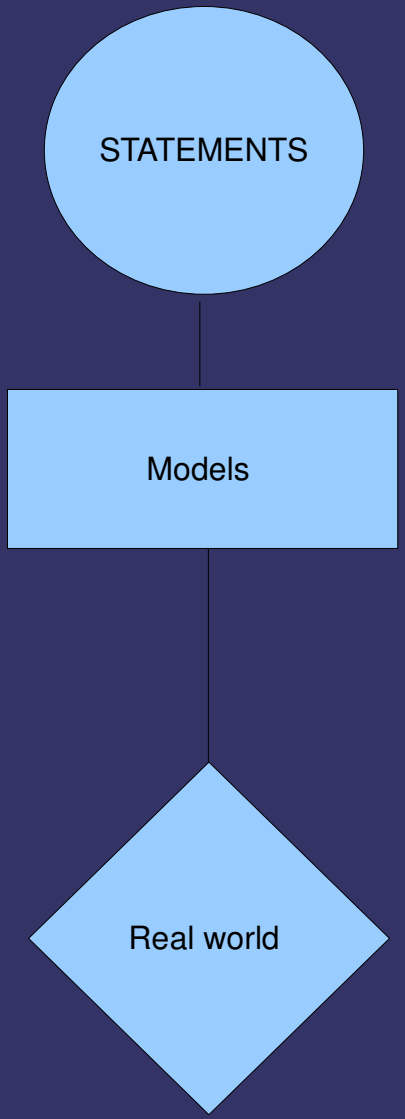
Naturalism and Realism - A mid way

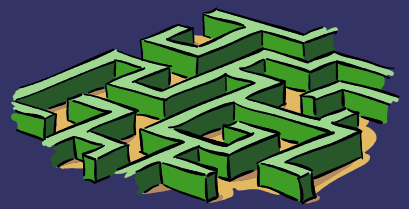
- Proposes Naturalism as a program not just for POS but for life
- Darwinian theory which first talked about the *fit* between the functional anatomy of animals with their natural environment and their ways of adaptation- A naturalistic explanation
- Common Criticism - since the methods of science provide a normative basis for claims to knowledge, how can it be naturalistic?
- Come out from the notion of 'reference' and 'truth'
- Introduce the intermediate representational categories- models



Changing Model to represent Scientific Knowledge







Perspectival Realism

- Can have several models to explain different possible for a better fit between the model and real world
- Models have evolved historically but the 'truths' are unchanging
- Notion of 'truth' – changing Models to explain real world
- Let different sciences emerge to explain the real world models
- Reality is understood in 'perspective' so define this perspective instead of claiming to have a model for all

Perspectives...

Characteristics of Perspectives

- All perspectives are partial or relative to the object they represent.
- Each perspective is a perspective of some-thing.
- Perspective is a form of realism prima facie and not relativism or constructivism.

Example of Perspective-Colour Perception

- Different species of the world experience the world from different perspectives

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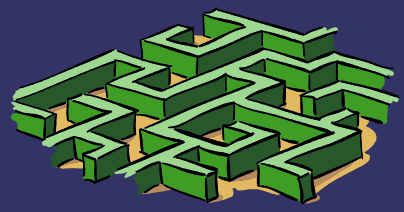
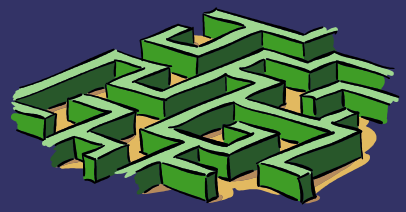
- Even among humans there are different perspectives due to genetic or physical differences.



Supporting Claims from Cognitive Psychology

- Naturalistic account and model based frame-work to understand scientific knowledge-supplemented by psychology
- In consonance with the studies on concepts and categories
- Fundamental connection between 'theories' and 'categories' pointing to families of models



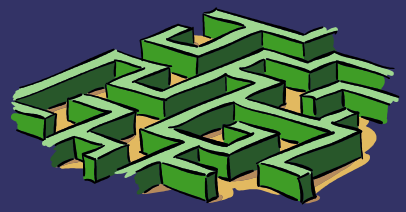
Basic and Higher Level Categories

Basic Level

1. Close to intuitive judgments
2. Members of this category appear visually similar
3. First step in the learning ladder
4. Concrete and part of our everyday experience
5. Applicable
6. Central Categories
7. Novice way of learning
8. Spring, Pendulum, Inclined plane, free fall etc

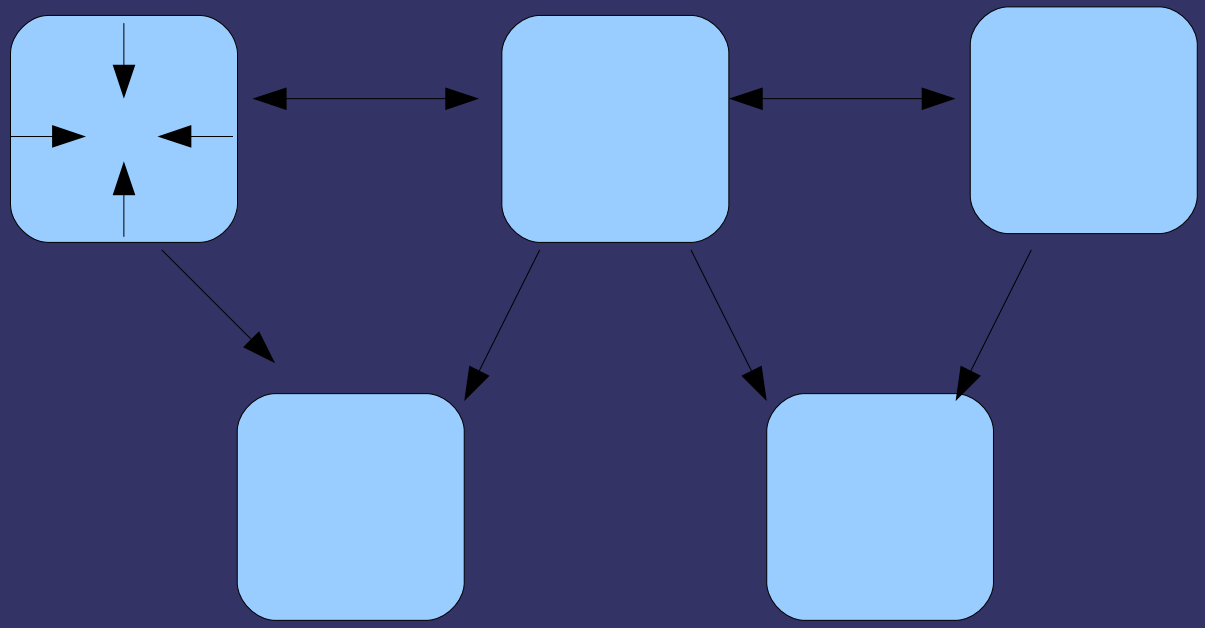
Higher Level

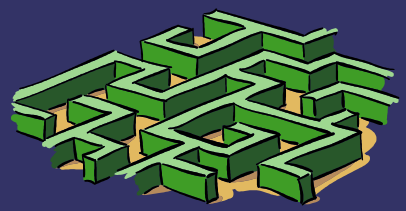
1. Complicated, do not appeal naturally
2. Distinct and non obvious connections
3. Abstract, do not relate to the real world
4. least applicability
5. Peripheral Models
6. Expert understanding-connections
7. Conservative and non-conservative models



Insights from concepts and categorization

Family of models can be interpreted using vertical, horizontal and radial relationships

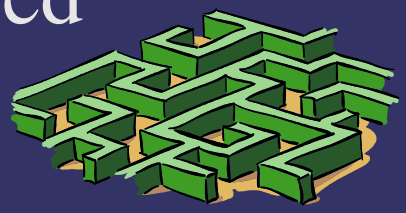




Changing Frame of Science

Logical Positivists View

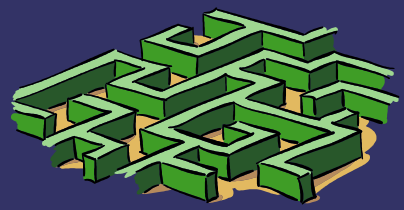
1. Scientific knowledge is encapsulated in scientific theories
2. Primary mode of representation in science is *linguistic*
3. Genuine knowledge in any theory comes from logical reasoning
4. No significant role of diagrams or other non- linguistic components in science or in the way scientists think or learn about particular theories unless reduced to linguistic forms



Kuhn's Arguments

In "*Structure of Scientific Revolutions*" (1962)

1. General statements organized into axiomatic systems play little role in actual practice of science
2. The relative evaluation of rival paradigms can not be reduced to any sort of logic but depends upon the consensus in scientific community.
3. Science is a puzzle solving activity, where different scientists are making efforts to solve these puzzles- a source of revolutions in science.

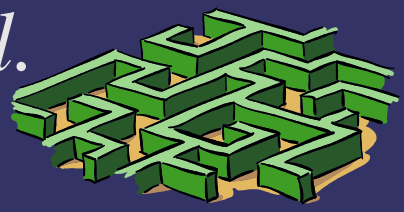


Giere's Arguments

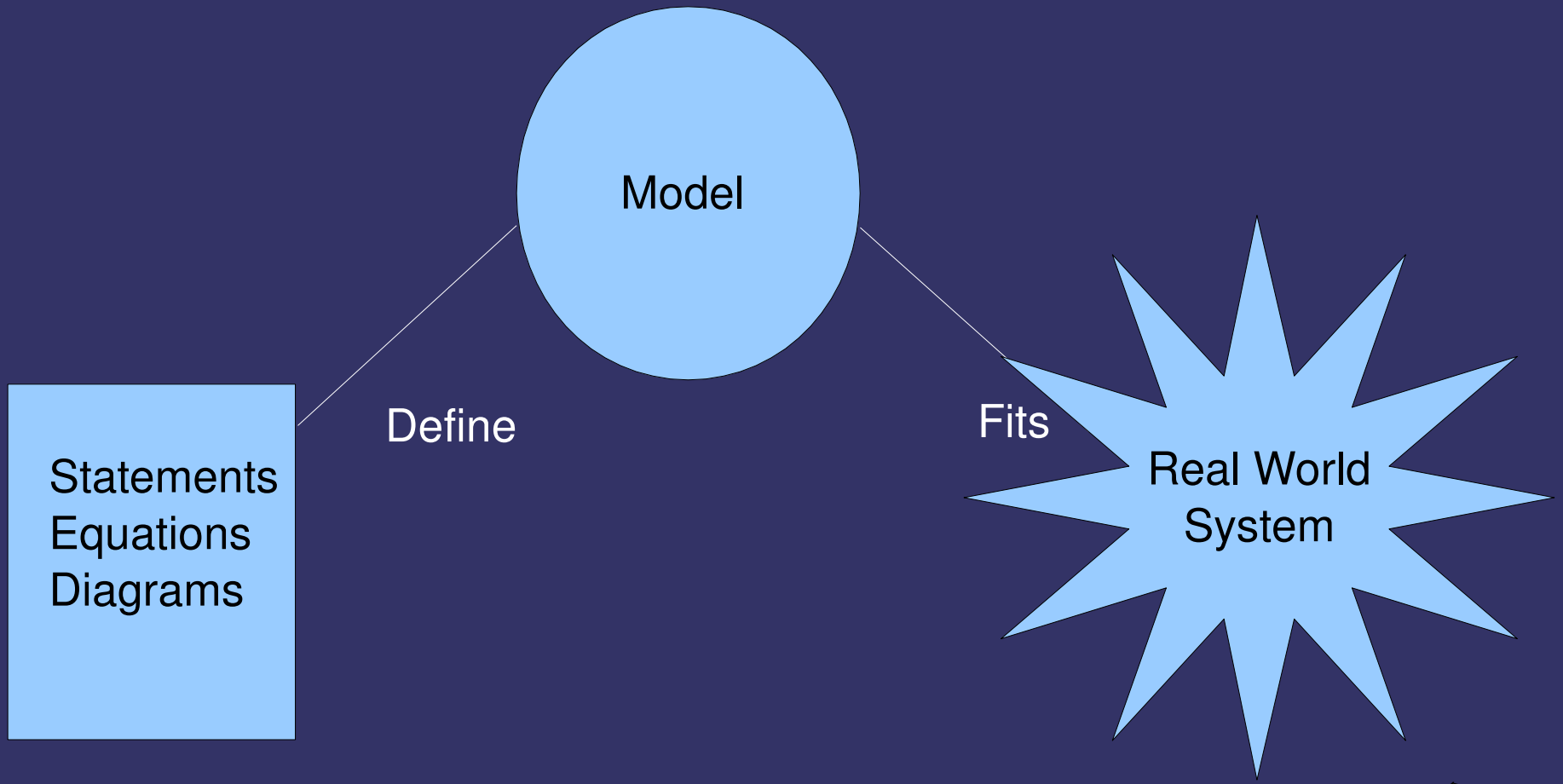
Introducing visual models- pictures, diagrams and other non propositional forms- relativist sociologists of science.

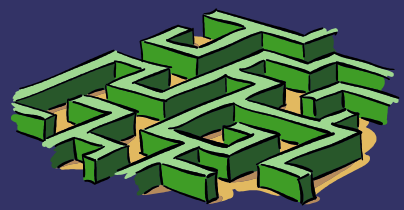
The significance of visual modes of representation is important as:

1. Images- neither true nor false, role of representations
2. Various images and non propositional devices can be used to represent the real world- accuracy, scope and purpose
3. Model- based- diagrammatic presentations and scale models at par with the *theoretical model*. core of any theory.



Model- A Connector

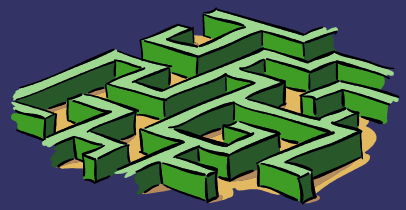




Syntactic & Semantic view of Scientific study

1.Elimination of theoretical constructs from science
2. Scientific theories are abbreviations or collection of basic statements
3. theories are expressions, reformed due to pragmatic reasons
4. facts are basic observation statements
5. laws are universal statements

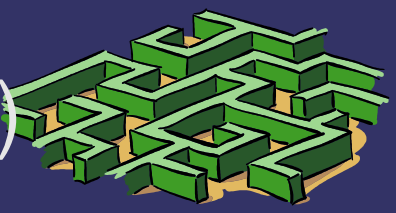
1. science tries to describe world in indirect ways
2. scientists strive to explain some part of the whole phenomena by selecting parts which can be represented- abstraction



The Semantic Approach

1. Scientists describe world in indirect ways
2. They try to study a part of something and not the whole of it
3. Abstraction comes in from the part they choose to represent

When phenomena are described using structured parameters, the *meaning* of the description is not independent of the constructively visualized system or structure and hence its is an *indirect description or observation* (Nagarjuna,1994)

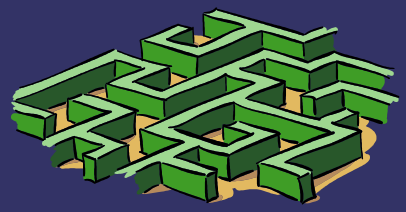


Role of Models

Functions of Models

- Represent the behavior of a certain extent and kind of a physical system
- Understood as mathematical structures whose characteristics are obtained or specified by definition
- Defined with varied levels of complexity
- Derive their identity from how effectively can they be used to explain a scientific assertion (replace laws with scientific assertions)

Model is a predicate of a system as it tries to define the class of physical systems



An Example:

Scientific Assertion
Earth- Sun system is a two body model (of Newton's theory)
Physical System- Earth- Sun system
Model - two body model (of Newton's theory)

The structure S is neither true nor false, for it is not an assertion but a conception. When we apply a structure to a *concrete* situation by making the assertion 'c is S', we obtain a statement which can either be falsified or verified, for only statements are true or false (Nagarjuna, 1994)

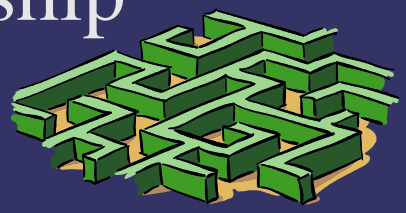
Critique of the book

Giere advocates:

- Naturalistic, Cognitive, Evolutionary account of science
- Weaves science, philosophy of science and sociology of science neatly
- Regards Scientific theories as families of models with cognitive underpinnings
- Differentiates between Theoretical models and statements
- Models are always a partial representation of real world

Critique of the book (contd...)

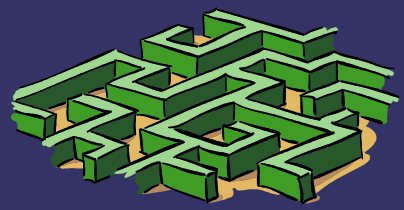
- Validity of a model doe not come from its universality but its degree of applicability
- Less articulated proposition- Models should also tell us to some degree of approximation, what system would do if we change the initial conditions in specified ways
- Which model among rival models should be preferred more – purpose as a criteria needs clarification (Woodward, 2002)
- Replace two place with three place relationship between Model- Real world – Purpose



Implications for Science Education

1. **Science as a discipline**

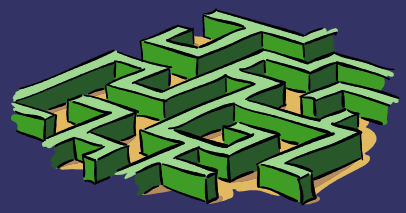
- Defining a realistic goal for science as something less than learning about the world. Claiming to understand specific part of reality and not universal claims with no application
- From a psychological perspective, Understanding science- cognitive processes of scientists involved in doing science
- Philosophy + Sociology of science- integrated
- Naturalistic + Realistic perspective of doing science
- Attempt to understand and explain science and not justify it
- Important decisions about content, pedagogy and a way of looking at science as a subject changes
- breaks off the notion of superior status of science- Objectivity, value neutrality



Implications for Science Education

2. **Teaching and Learning of Science**

a) modeling is a useful idea
b) Models capture the essence of causal structures
c) identifying basic level categories – teaching principle of near to far
d) cognitively appropriate tasks- increasing level of abstraction with models
e) formation of model and using it for purposed
f) understanding is not dogmatic but contextualized through perspectives
f) Empowering the learners with thinking tools (models)



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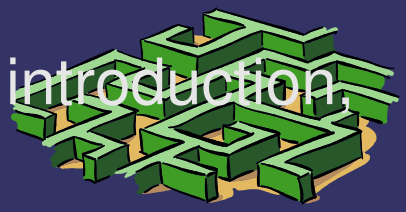

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