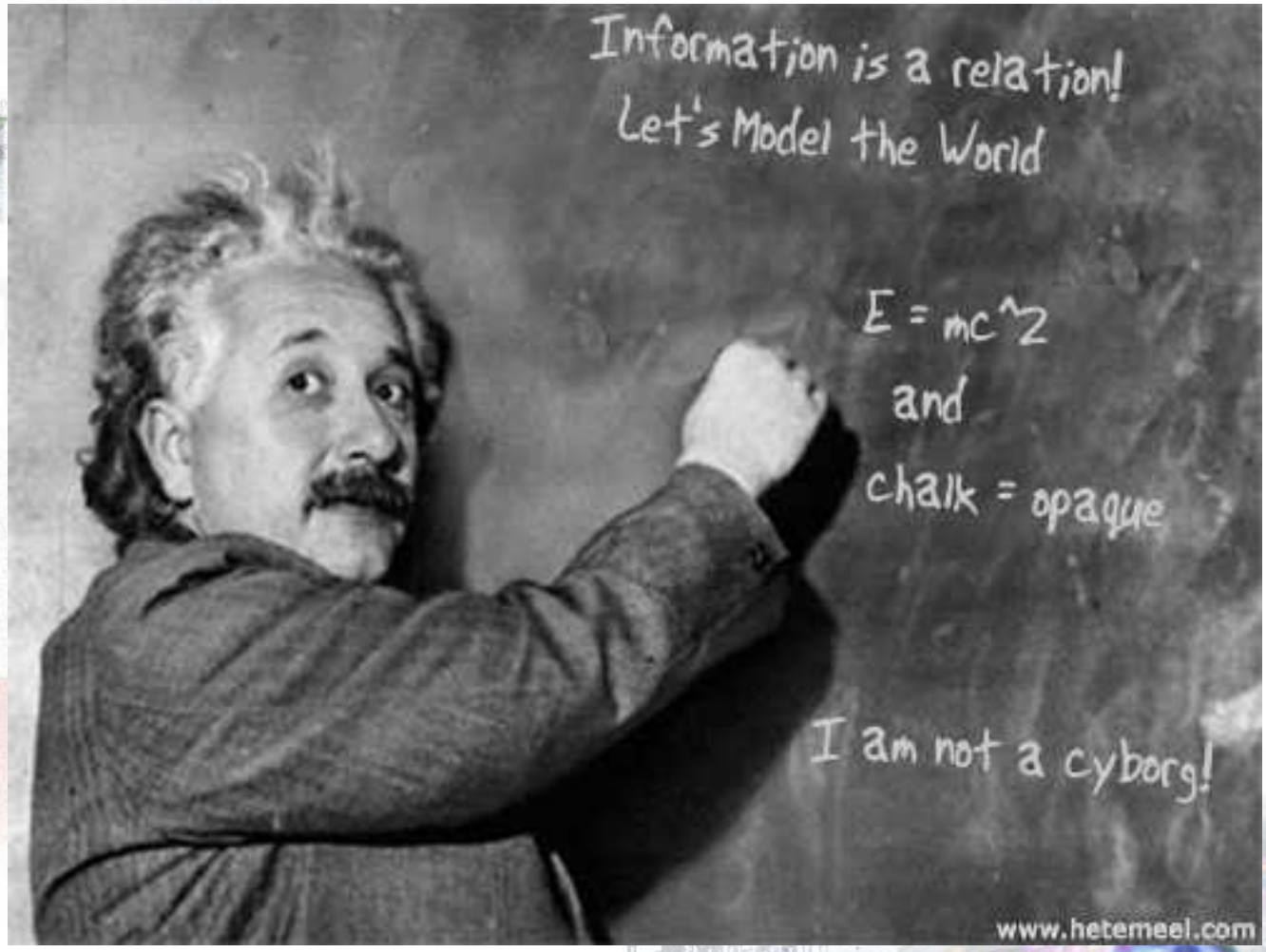
Introduction to Informatics

Lecture 7: Modeling the World



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Readings until now

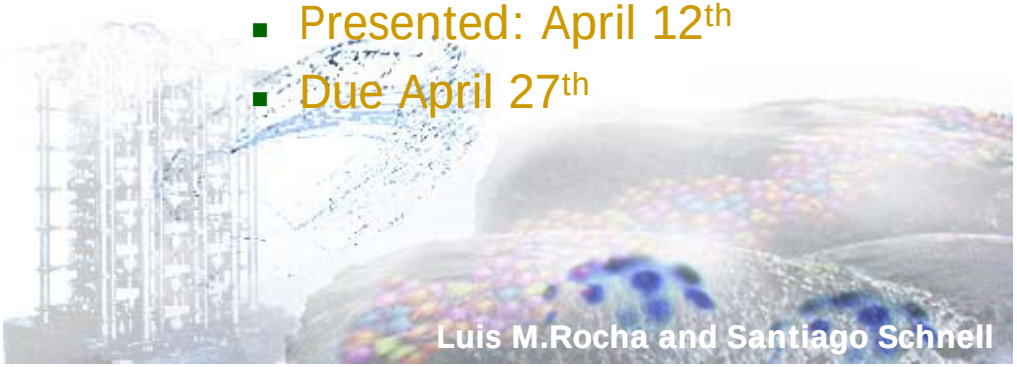
- Lecture notes
  - Posted online @ http://informatics.indiana.edu/rocha/i101
    - *The Nature of Information*
    - *Technology*
    - *Modeling the World*
  - @ *infoport* and web
- From course package
  - Von Baeyer, H.C. [2004]. *Information: The New Language of Science*. Harvard University Press.
    - Chapters 1, 4 (pages 1-12)
  - From Andy Clark's book "*Natural-Born Cyborgs*"
    - Chapters 2 and 6 (pages 19 - 67)

Assignment Situation

- Labs
  - Past
    - Lab 1: Blogs
      - Closed (Friday, January 19): Grades Posted
    - Lab 2: Basic HTML
      - Closed (Wednesday, January 31)
    - Lab 3: Advanced HTML: Cascading Style Sheets
      - Due Friday, February 2
  - Next: Lab 4
    - More HTML and CSS
      - Due Friday, February 9
- Assignments
  - Individual
    - First installment
      - Lecture 7: Thursday, February 1
- Midterm Exam
  - March 1st (Thursday)

Assignment Schedule

- Individual Project
  - 1st installment
    - Presented: February 1st
    - Due: February 9th
  - 2nd Installment
    - Presented: February 13th
    - Due: March: 2nd
  - 3rd Installment
    - Presented: March 8th
    - Due: March 30th
  - 4th Installment
    - Presented: April 5th
    - Due: April 20th
- Group Project
  - 1st installment
    - Presented: February 20th
    - Due: March 9th
  - 2nd installment
    - Presented: March 22nd
    - Due: April 6h
  - 3rd installment
    - Presented: April 12th
    - Due April 27th

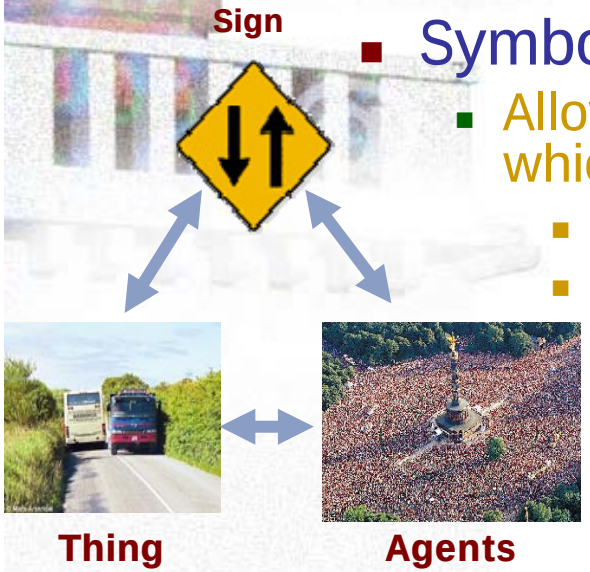


Exam Schedule

- 17707 (T/Th Class)
  - Midterm
    - March 1st (Thursday)
      - Regular Class time
  - Final Exam
    - May 3rd (Thursday)
      - 7:15-9:15 p.m.

Symbols and The World

- The Information Relation
  - Symbols are abstractions of the World
    - Easier to communicate, store, manipulate
  - Symbolic abstractions of the World
    - Allow us to manipulate the symbols to create new ones which may have never observed but can understand
      - We can think about realities we have not actually observed
      - Some are correct and some are not



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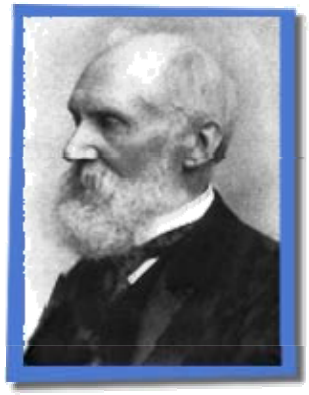
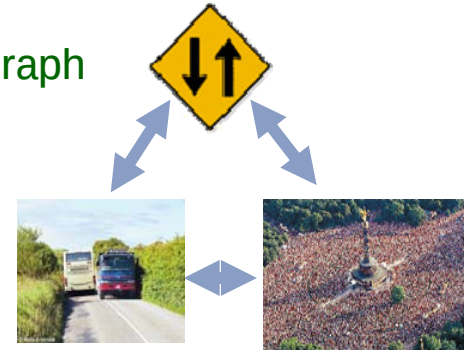
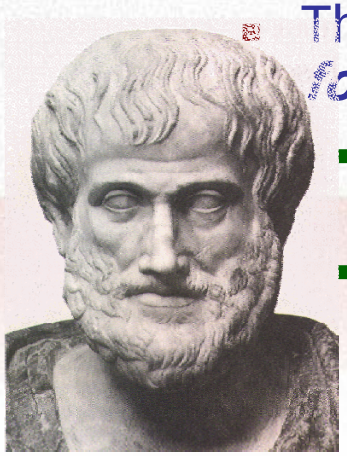
Formalizing Knowledge



- Lord Kelvin's dictum
  - "When you can measure what you are speaking of and express it in numbers you know that on which you are discoursing. But if you cannot measure it and express it in numbers. your knowledge is of a very meagre and unsatisfactory kind."
    - 1824-1907
      - Absolute scale of temperature, underwater telegraph cables, thermodynamics



- Physics
  - The first science to construct precise, rigorous ***formal*** theories of the world.
    - relating the operation of rules upon symbols to the law-like behavior of the World.
    - ***Aristotle*** (384-322 BC) was first to relate symbols more explicitly to the external world and to successively clarify the nature of the symbol-world relation.



Understanding Nature with Symbols

- ***Aristotle*** (384-322 BC)
  - First to relate symbols more explicitly to the external world and to successively clarify the nature of the symbol-world relation.
    - Student of Plato, educated Alexander the Great
    - first to consider specific ***observable*** factors which determine *motion*.
  - In ***Physics***
    - he recognized (mathematical) ***rules*** which could describe the ***relation*** between an object's weight, the medium's density and the consequent rate of motion (fall):
      - (1) for freely falling or freely rising bodies, speed is proportional to the density of the medium.
      - (2) in forced motion, speed is proportional to the force applied and inversely proportional to the mass of the body moved
    - first time that ***observable*** quantities had been expressed in symbolic (numerical) form allowing the results of observations to be used in calculations
      - The nature of ***causation***
      - http://classics.mit.edu/Aristotle/physics.html

Raphael's "*Plato and Aristotle*"

Modeling!

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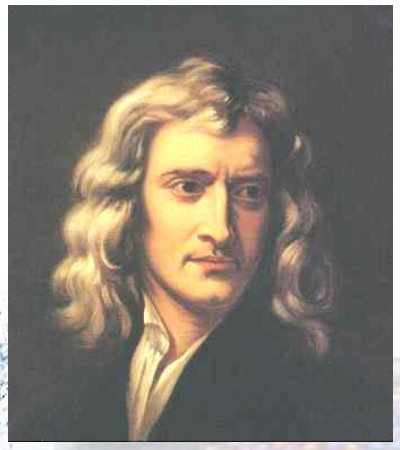
Abstracting Relations

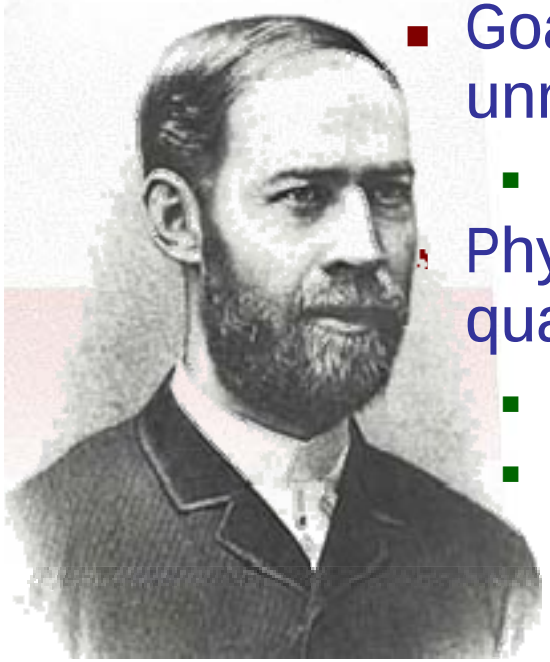
- Galileo (1564-1642)
  - Progressive dissociation of the symbols from objects
    - The interrelationships among signs themselves studied quite apart from the relations among the objects they represent
      - Previously, symbols were still generally regarded as inherent properties of the referent objects themselves
      - Aristotle's *Physics* postulated certain primary qualities/elements such as "Fire". Galileo regards "primary" properties as only those that can be mathematically quantified, such as size, shape and motion.

- Newton (1643-1727)
  - Extends process of abstraction
    - Distinguishes between symbols
      - Arising from *observation*
        - represent initial conditions
      - Arising from *symbol relations*
        - representing laws which govern the subsequent motion.



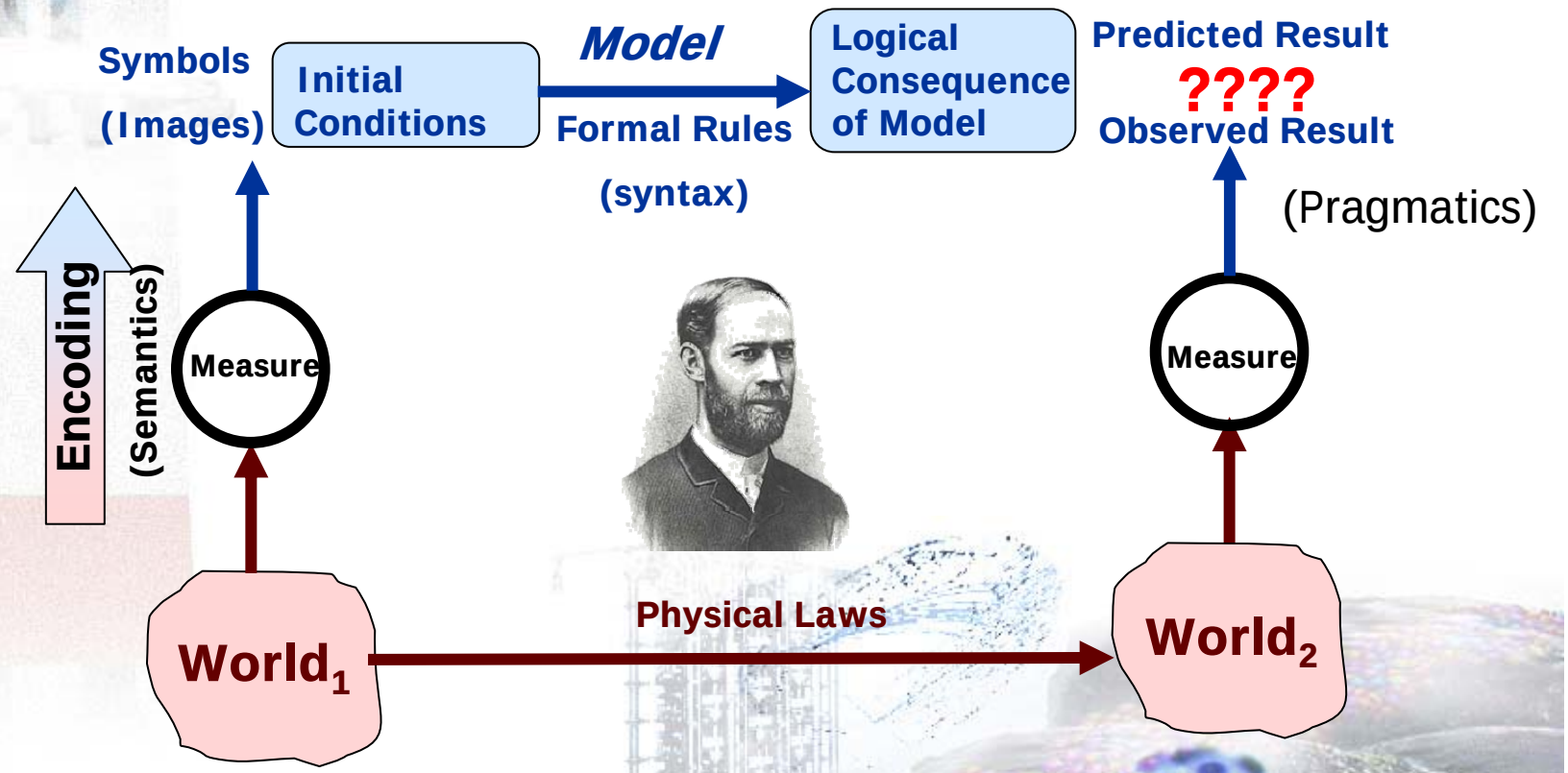
Heinrich Hertz (1857-1894)

- Some facts about Hertz
  - First to broadcast and receive radio waves
  - Established that light is a form of electromagnetic radiation.
  - His name is associated with the SI unit for frequency
- *Principles of Mechanics* (1894)
  - Goal was to purge physics of mystical, undefined, unmeasured entities
    - such as force (which one can infer but not measure)
  - Physical theories to be based only on measurable quantities
    - the results of *measurements* are symbols.
    - Physical theory becomes about building *relationships* among observationally-derived symbols: ***models***
      - what Hertz called "images."



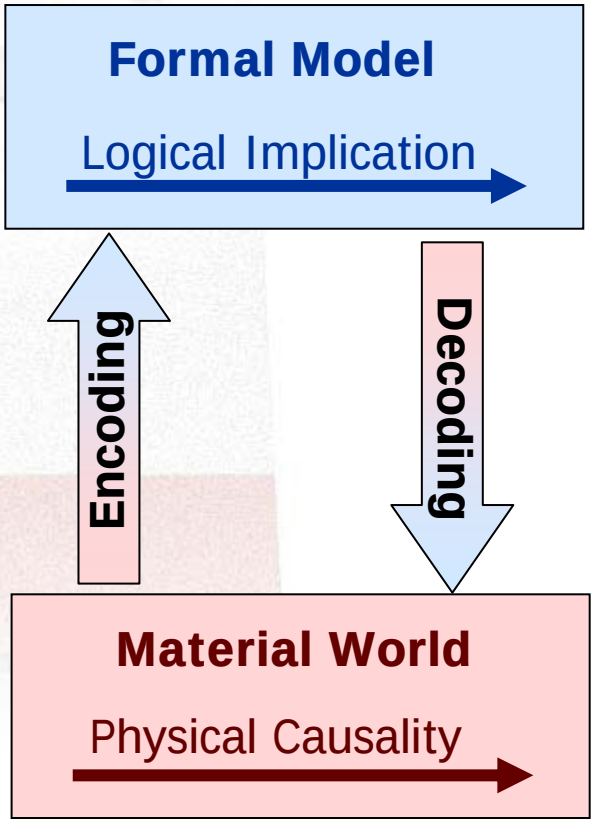
The Hertzian Modeling Paradigm

"The most direct and in a sense the most important problem which our conscious knowledge of nature should enable us to solve is the ***anticipation of future events***, so that we may arrange our present affairs in accordance with such anticipation". (Hertz, 1894)



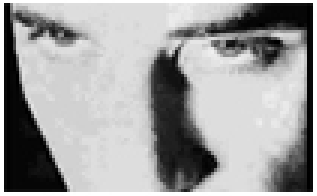
Robert Rosen (1934-1998)

"We must also believe that this causal order relating events in the external world, can be brought into congruence with a logical or implicative order in some appropriate logical, ***symbolic world of propositions*** describing these events. When such a congruence is established. ***implications*** in the logical system become ***predictions*** about the causal order". (Rosen. 1985).



Mathematics

Language



3.

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4811174502 8410270193 8521105559
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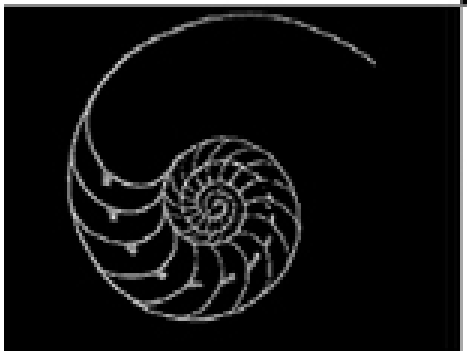
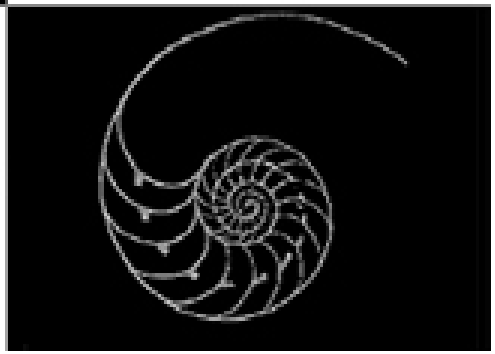
Is The

Of Nature



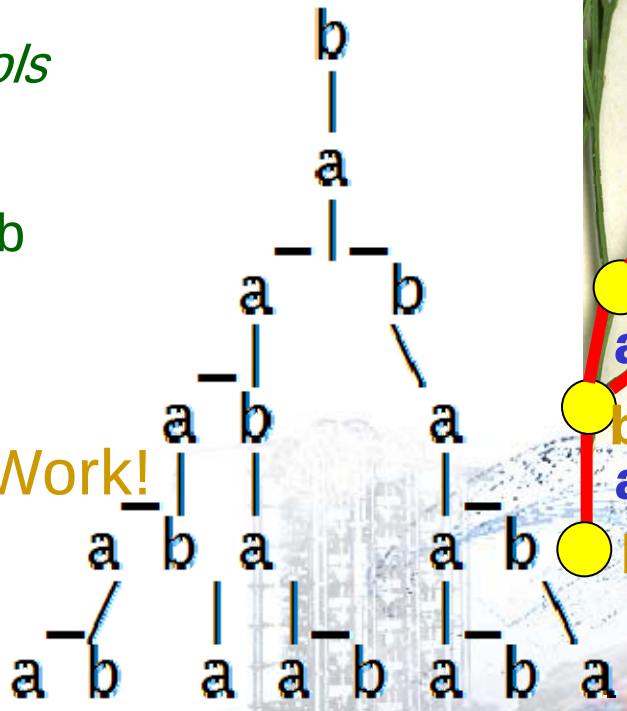
http://pithemovie.com

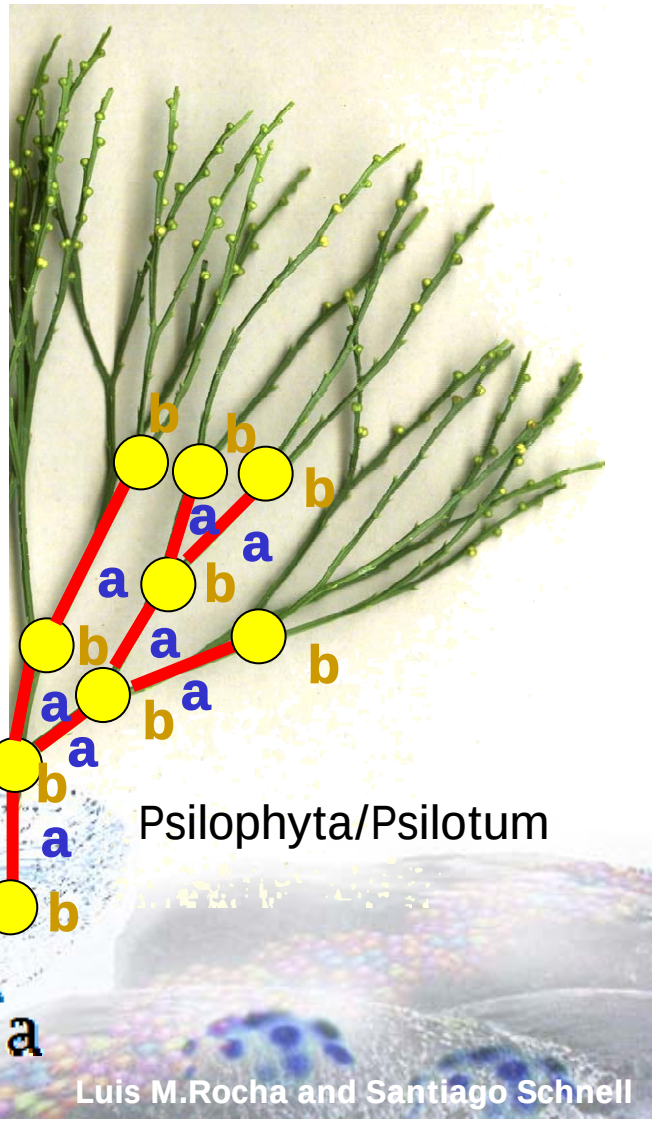
When I was a kid my mother told me
never to stare into the centre of the sun.
So once, when I was 6,
I did



Let's Observe Nature!

- What do you see?
  - Plants typically branch out
  - How Can we model that?
    - Observe the distinct parts
      - Color them
      - Assign *symbols*
    - Build Model
      - Initial State: b
      - b -> a
      - a -> ab
    - Doesn't quite Work!





Polya Method: How To Solve It

1. Understanding The Problem
   - **First**. You have to understand the problem.
   - What is the thing you want to find to answer the problem (the unknown)?
   - Explain the question to other people
   - What are the data? What is the condition?
   - Draw a figure. Introduce suitable notation.
2. Devising A Plan (A ***Model***)
   - **Second**. Find the connection between the data and the unknown. You may need to consider auxiliary problems
   - Have you seen it before? Do you know a related or analogous problem?
   - Could you restate the problem? Could you solve a part of the problem?
   - Could you derive something useful from the data?
3. Carrying Out The Plan
   - **Third**. Calculate the model using all data and conditions.
   - Do all the calculations, and check them as they go along.
   - Ask: "Can I see it is right?" and then, "Can I prove it is right?"
4. Looking Back
   - **Fourth**. Examine the solution obtained.
   - Can you check the result?
   - Can you derive the solution differently?

If you can't solve a problem, then there is an easier problem you can solve: find it.

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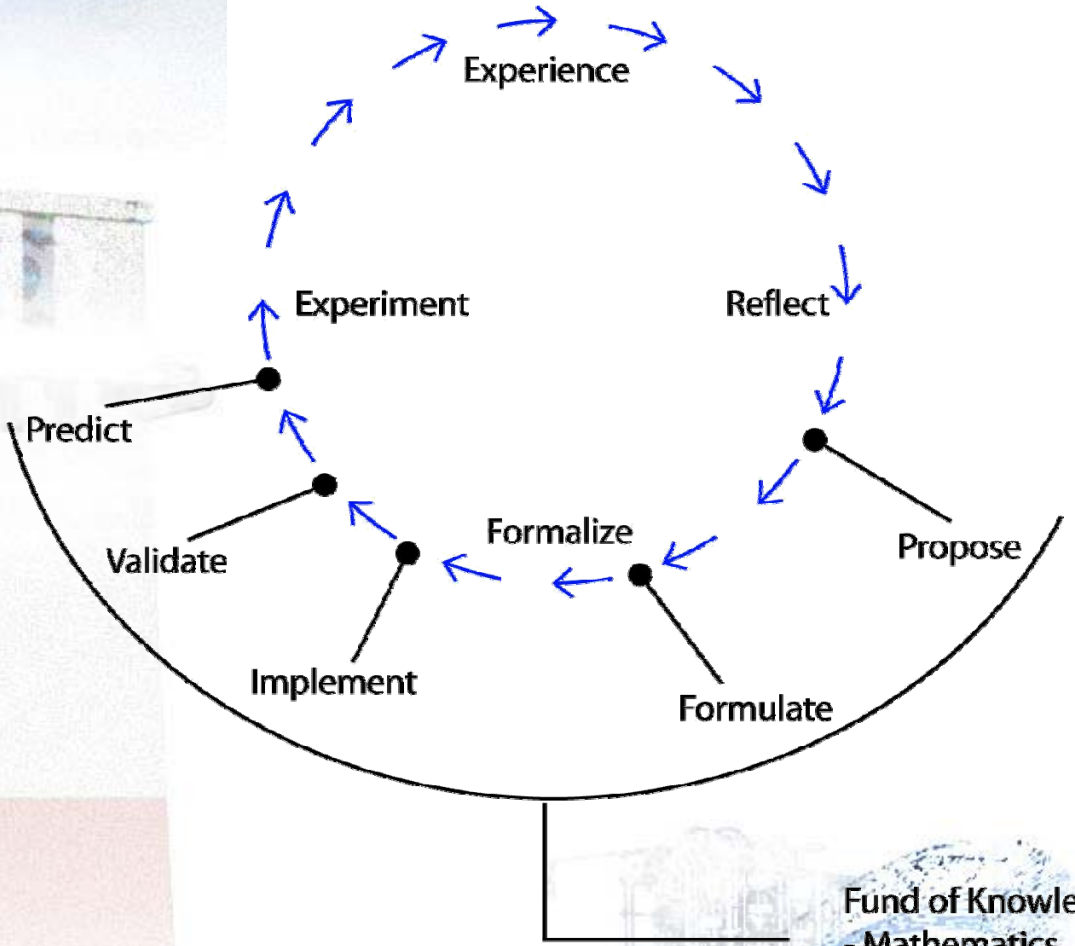
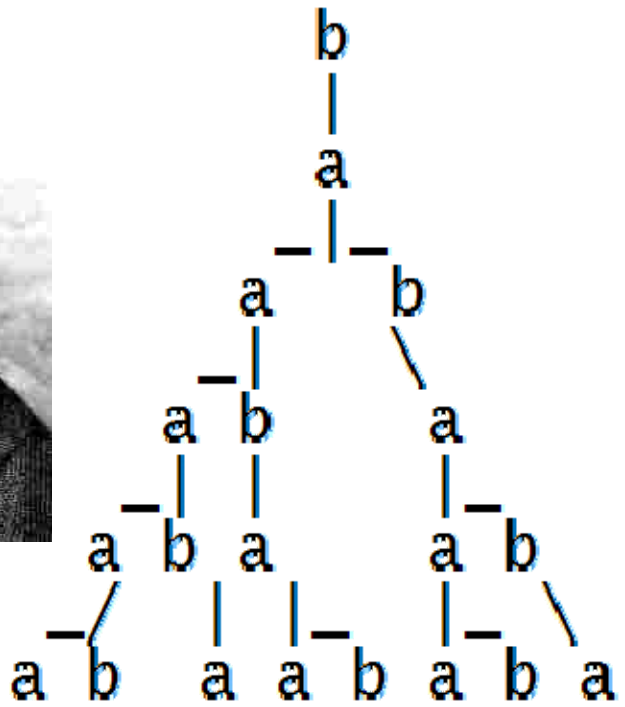
The process of modeling



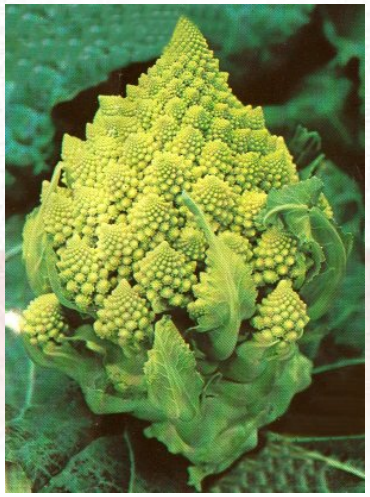
Fund of Knowledge
- Mathematics
- Physics
- Numerical Methods
- etc., etc., etc.

Fibonacci Numbers!

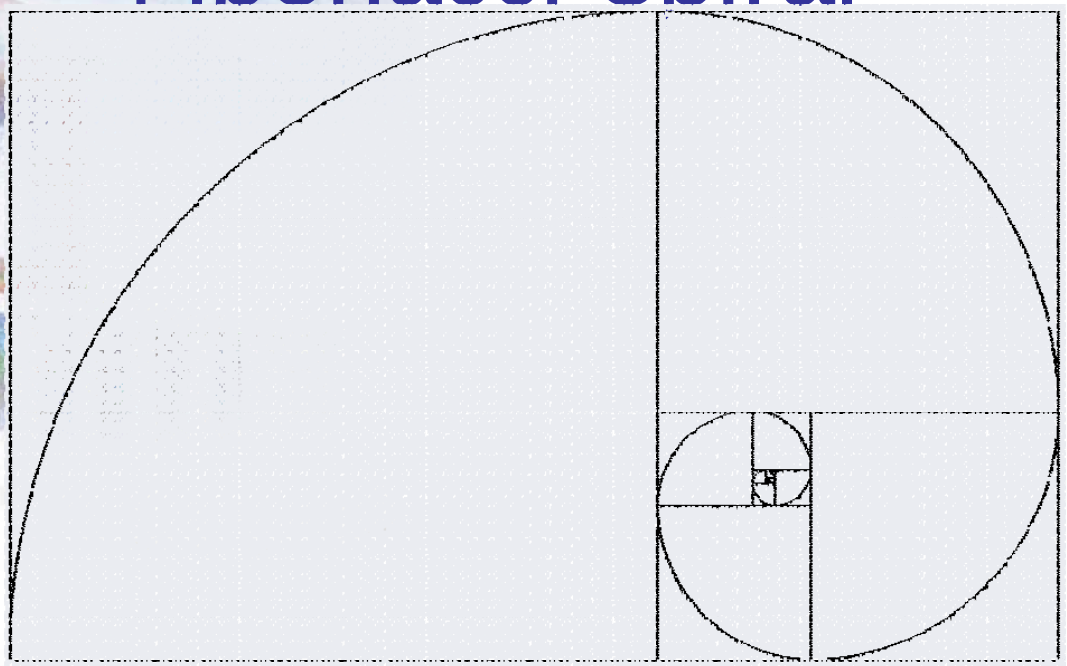
- Our First Model
  - Initial State: B
  - B -> A
  - A -> BA
    - n=0 : B
    - n=1 : A
    - n=2 : BA
    - n=3 : ABA
    - n=4 : BAABA
    - n=5 : ABABAABA
    - n=6 : BAABAABABAABA
    - n=7 : ABABAABABAABAABABAABA

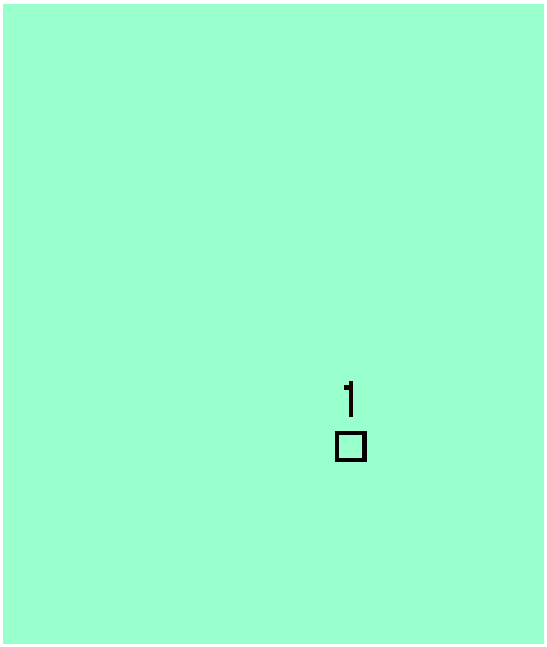


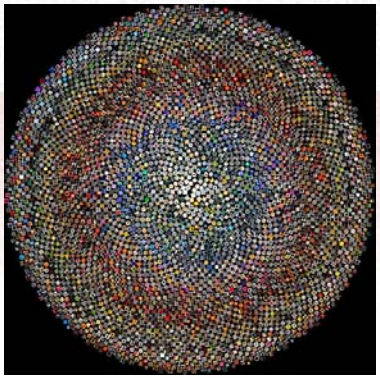
  - The length of the string is the Fibonacci Sequence
    - 1 1 2 3 5 8 13 21 34 55 89 ...
  - Fibonacci numbers in Nature
    - http://ccins.camosun.bc.ca/~jbritton/fibslide/jbfibslide.htm
    - Romanesco: http://alt.venus.co.uk/weed/fractals/romanesco.htm

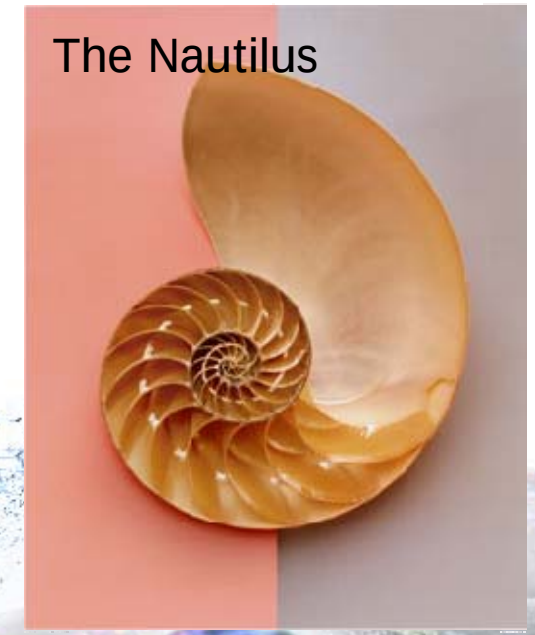


Fibonacci Spiral





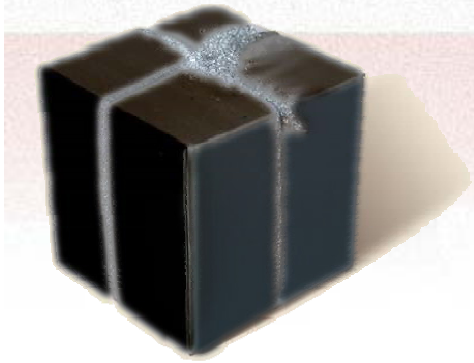




Individual assignment

The Black Box

what is it!!??



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Next Class!

- Topics
  - Modeling the World
  - Individual Assignment
- Readings for Next week
  - Lecture notes Posted online @ http://informatics.indiana.edu/rocha/i101
    - *Modeling the World*
  - @ *infoport*
  - From course package
    - From Andy Clark's book "*Natural-Born Cyborgs*"
      - Chapter 6: Global Swarming (pp. 45-67)
- Lab 4
  - More HTML and CSS