Introduction to Informatics

Lecture 8: Modeling the World (part II)

Luis M.Rocha and Santiago Schnell

Readings until now

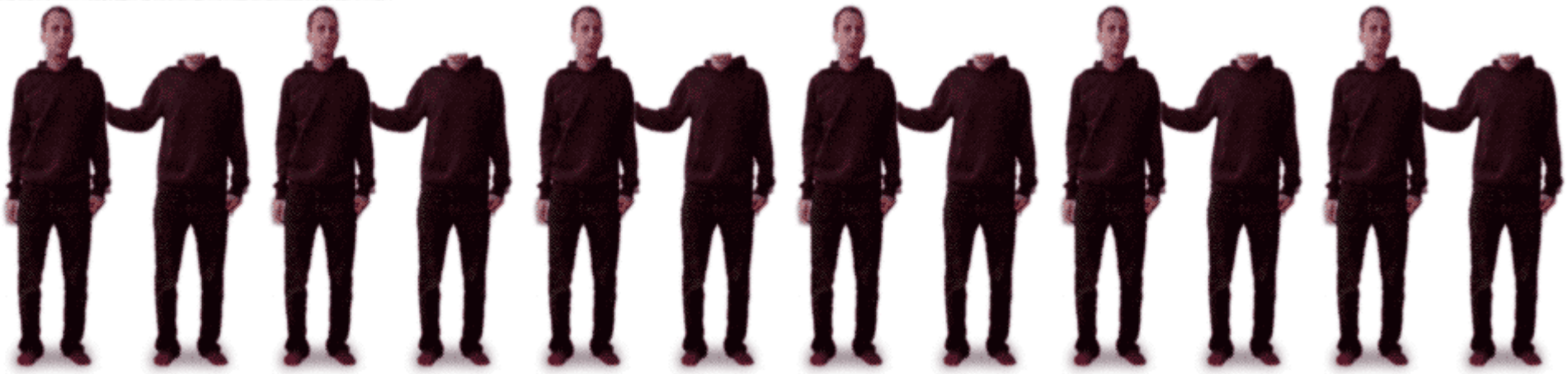
- Lecture notes
  - Posted online @ http://informatics.indiana.edu/rocha/i101
    - *The Nature of Information*
    - *Technology*
    - *Modeling the World*
  - @ *infoport* and web
- From course package
  - Von Baeyer, H.C. [2004]. *Information: The New Language of Science*. Harvard University Press.
    - 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): Grades Posted
    - Lab 3: Advanced HTML: Cascading Style Sheets
      - Closed (Due Friday, February 2)
    - Lab 4: More HTML and CSS
      - Due Friday, February 9
  - Next: Lab 5
    - Introduction to Operating Systems: Unix
      - Due Friday, February 16
- Assignments
  - Individual
    - First installment
      - Due: February 9
  - Group Project
    - First installment
      - Presented: February 20, Due: March 9th
- Midterm Exam
  - March 1st (Thursday)

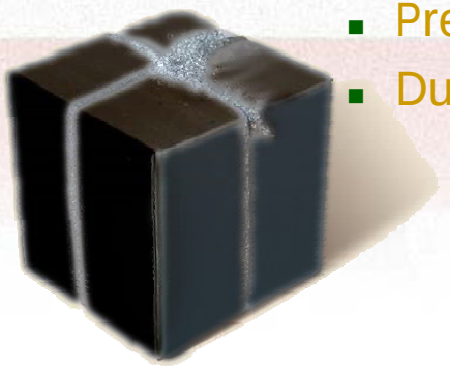
Exam Schedule

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



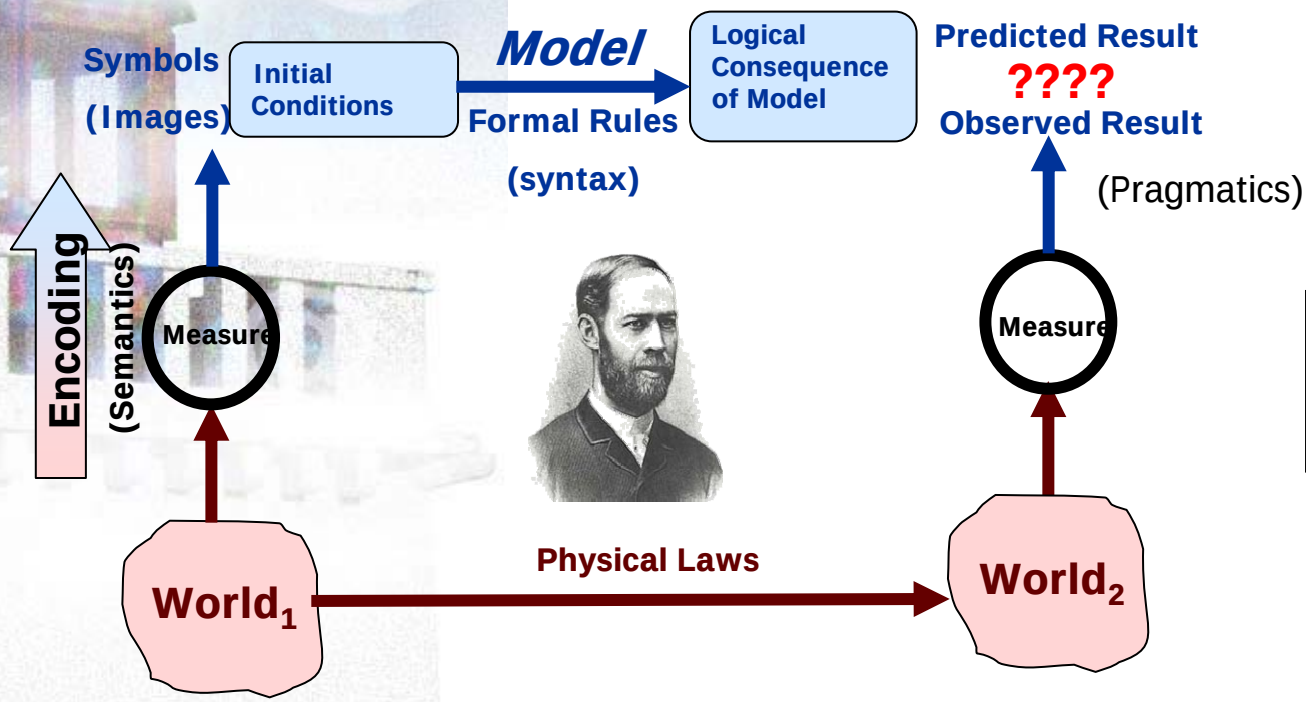
Individual assignment

- 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



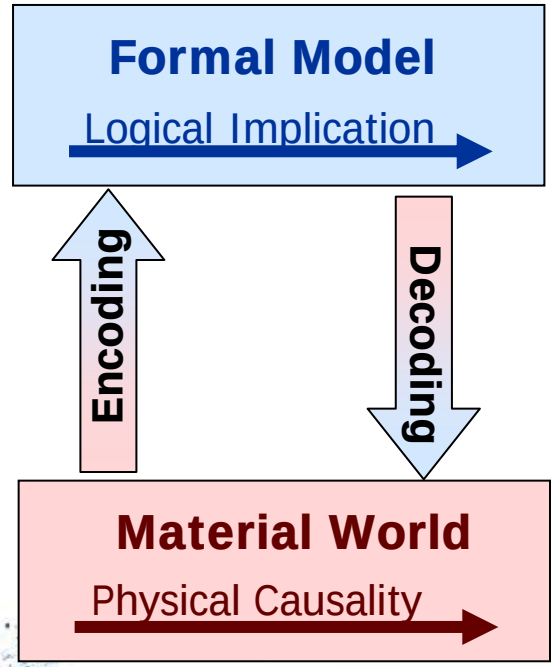
The Black Box

The Modeling Relation



Hertz' Modeling Paradigm

Rosen's Modeling Relation



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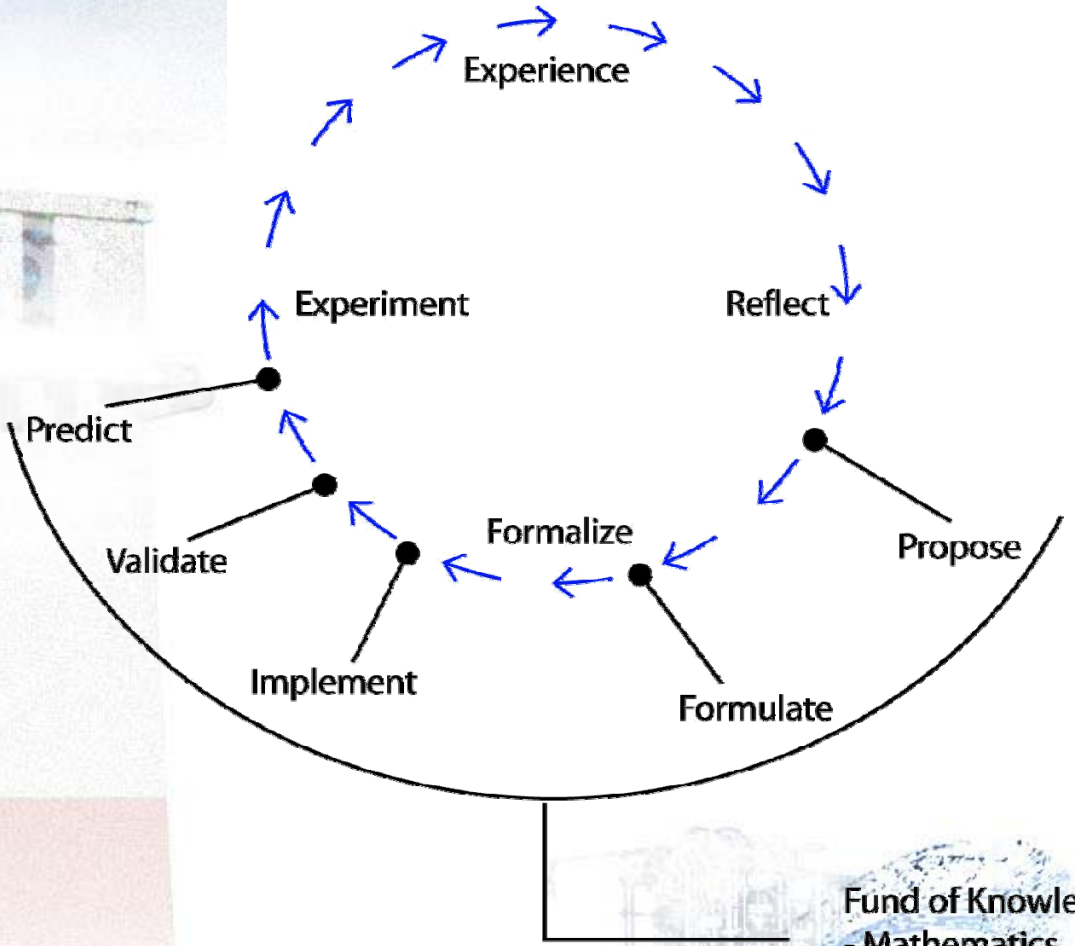
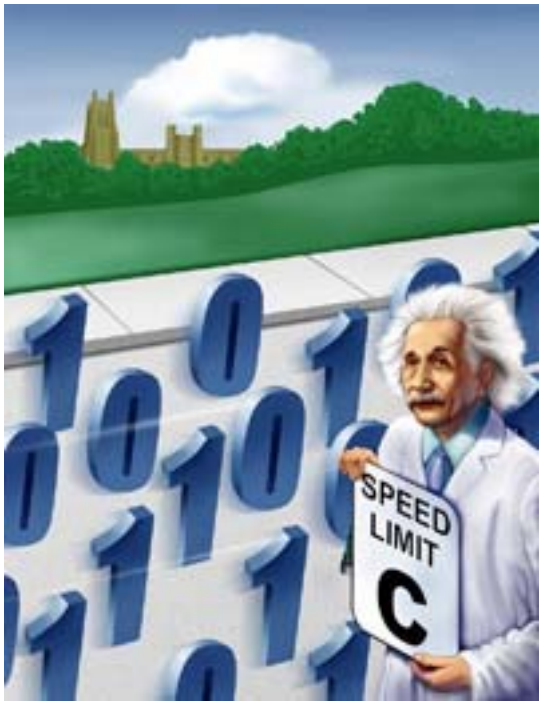
The process of modeling



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

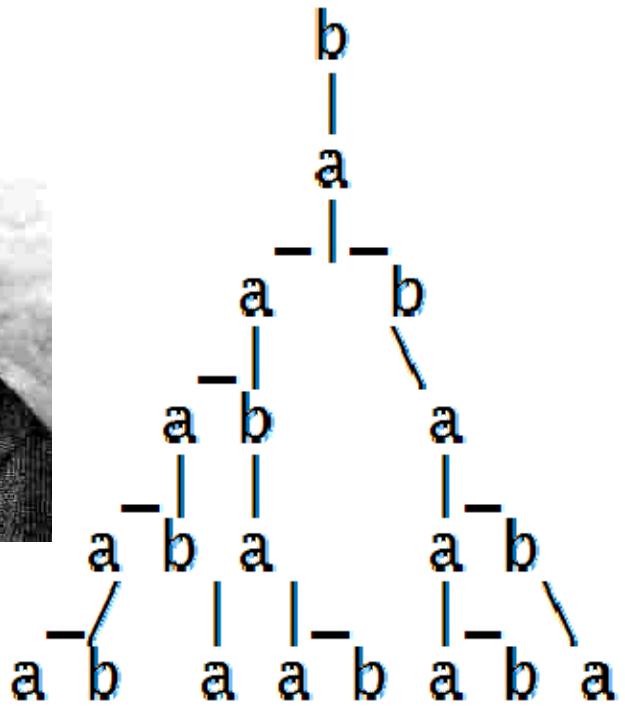
What is a model?

- The term ***model*** is used for any complete and consistent set of verbal arguments, mathematical equations or computational rules which are thought to ***correspond*** to some observable entity in the World
  - Often known as its ***prototype***.
- Understanding of the world in scientific terms is to build a model, to reduce apparent complexity to a set of simpler rules.
  - These rules constitute a ***theory***!
  - "Only theory can tell us what to measure and how to interpret" – Albert Einstein.

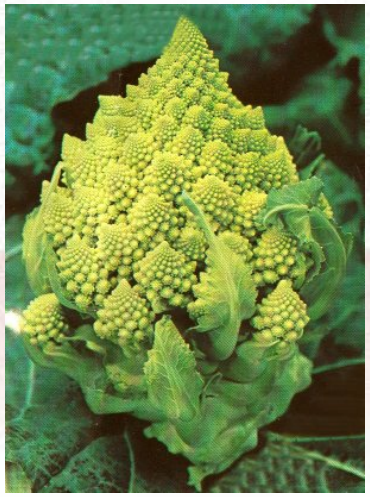


Fibonacci Numbers!

- 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

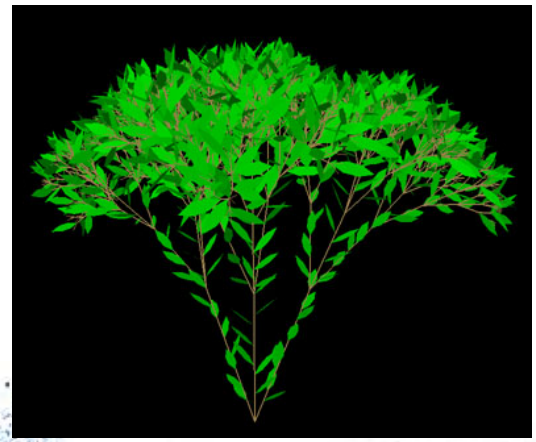


  - The length of the string is the Fibonacci Sequence
    - 1 1 2 3 5 8 13 21 34 55 89 ...
  - Fibonacci numbers in Nature
    - http://ccins.camosun.bc.ca/~jbritton/fibslide/jbfibslide.htm
    - Romanesco: http://alt.venus.co.uk/weed/fractals/romanesco.htm



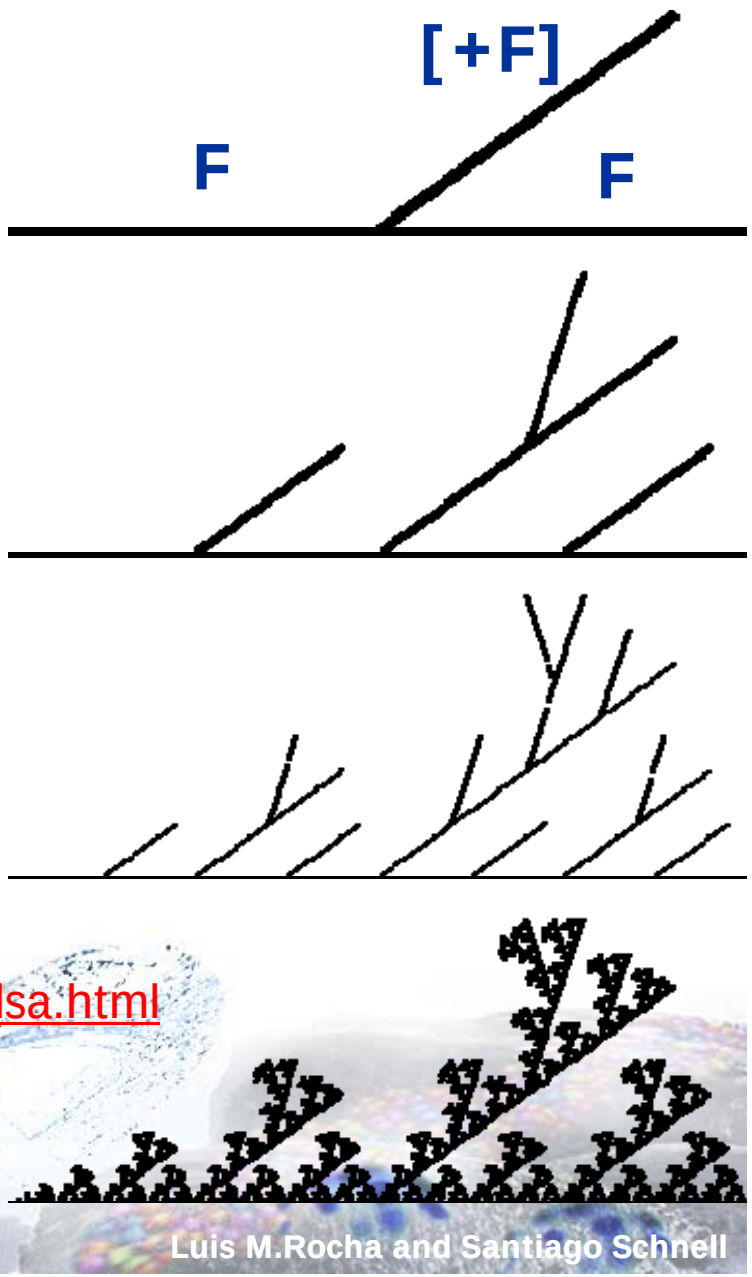
L-Systems

- Mathematical formalism proposed by the biologist Aristid Lindenmayer in 1968 to study biological development.
  - applications in computer graphics
    - Generation of fractals and realistic modeling of plants
  - Grammar for rewriting Symbols
    - Production Grammar
    - Defined complex objects by successively replacing parts of a simple object using a set of recursive, rewriting rules or productions.
      - Parallel ***recursion***
      - Access to computers



Branching L-Systems

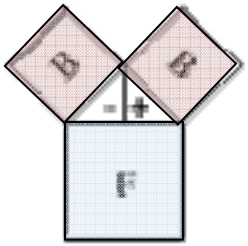
- Add branching symbols [ ]
  - simple example
    - Main trunk shoots off one side branch
  - Angle 45
  - Axiom F
  - F=F[+F]F

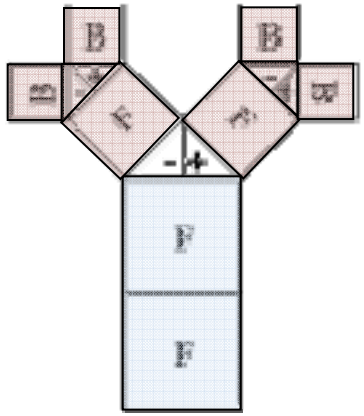


http://www.info.univ-angers.fr/pub/gh/vitrine/lsysa/lsa.html

L-system with 2 cell types

- Axiom
  - B
- Cell Types
  - B,F
- Rules
  - $B \rightarrow F[-B]+B$
  - $F \rightarrow FF$

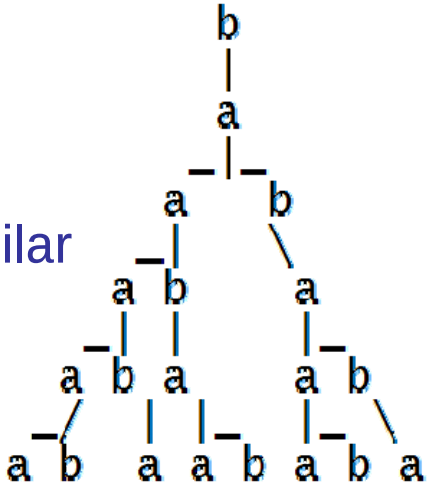


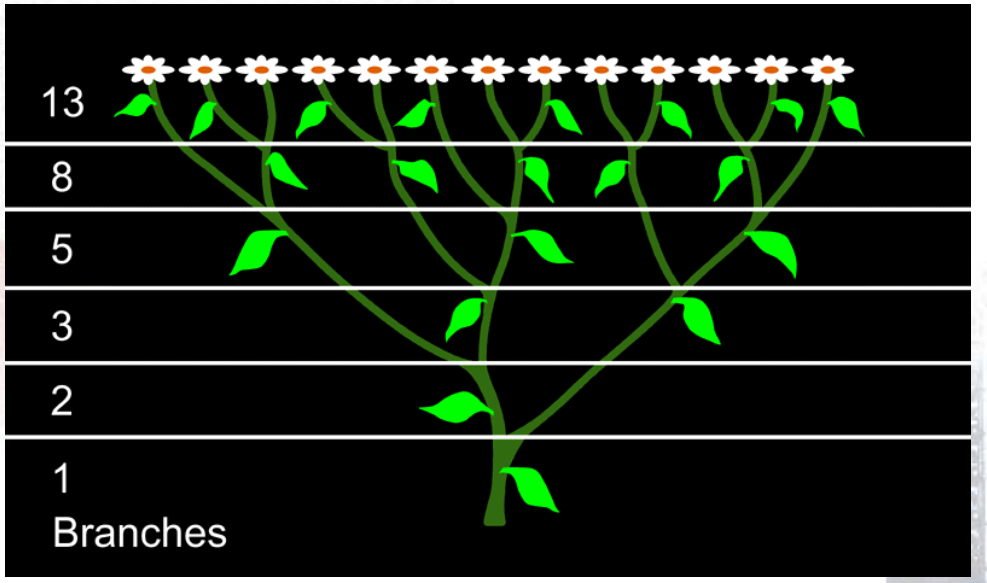


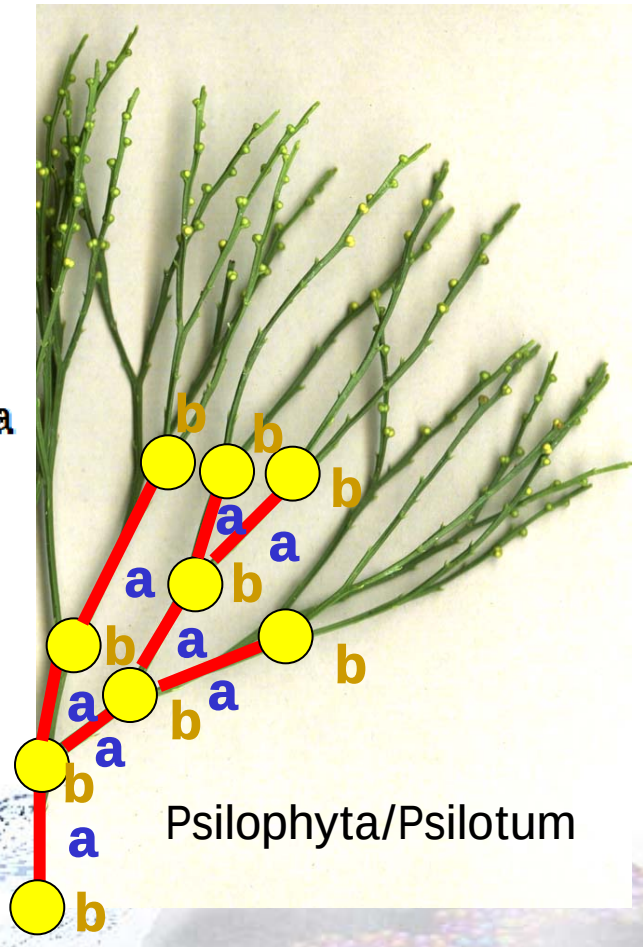
Depth	Resulting String
0	B
1	F[-B]+B
2	FF[-F[-B]+B]+F[-B]+B
3	FFFF[-FF[-F[-B]+B]+FF[-B]+B]+F[-F[-B]+B]+F[-B]+B

What about our plant?

- An Accurate Model
  - Requires
    - Varying angles
    - Varying stem lengths
  - The Fibonacci Model is similar
    - Initial State: b
    - b -> a
    - a -> b[a]
  - *sneezewort*







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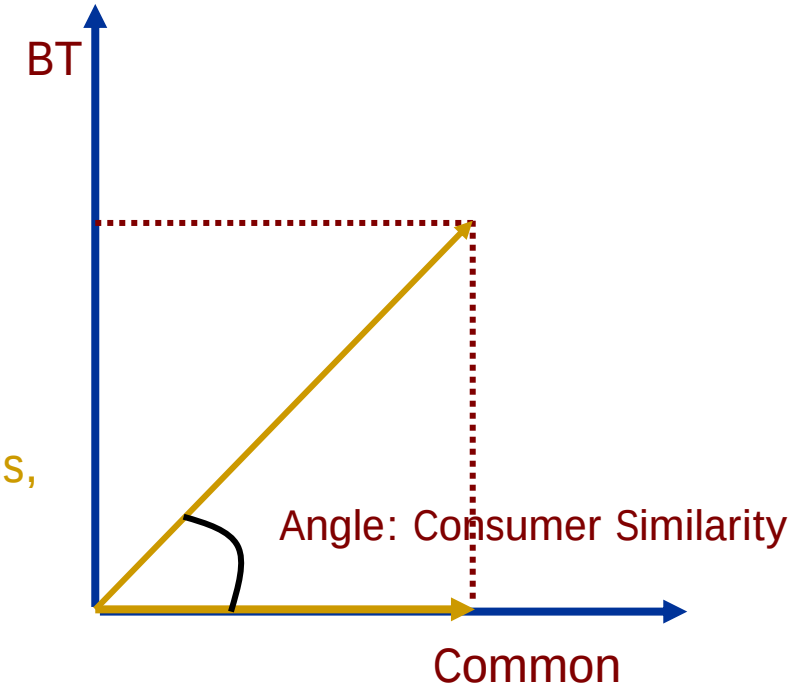
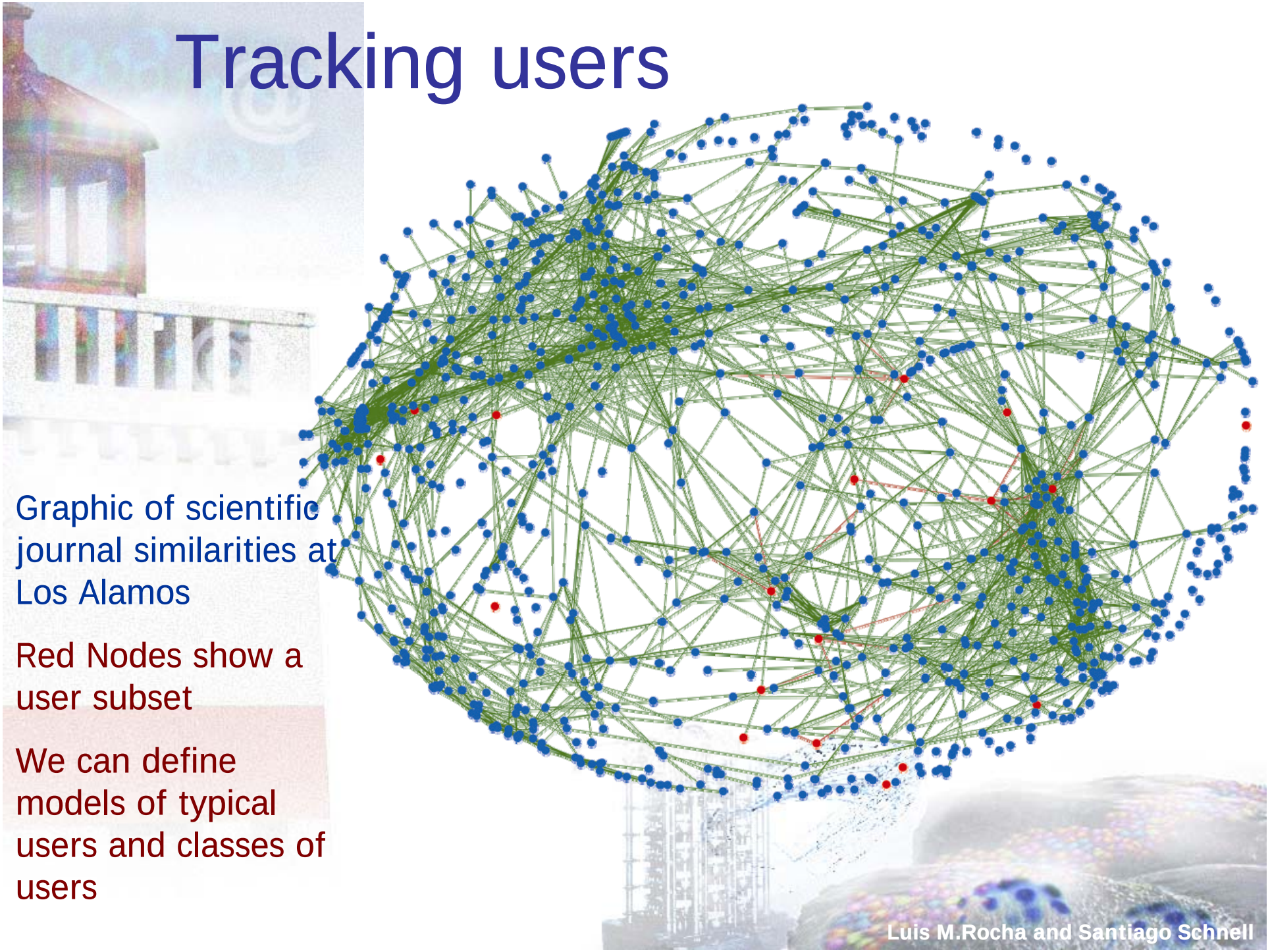
Tracking Consumer Data

- Records stored as vectors
  - CD Purchases
    - [BT, Pi Soundtrack, Common, Electric 6, 4 Hero, Carl Craig, LCD Soundsystem, Fujiya & Miyagi, ...]
  - Pages you read
    - [Information, Library of Babel, Blogs, Technology, Cyborgs, Turntablism, TB303, ...]
  - Vector is a representation of consumer
  - Grouping consumers according to similarity is a model of users
    - Clustering
    - Used for all sorts of models!



[BT, Common, Electric 6, 4 hero,...]
Buyer 1 [1, 1, 0, 0, 0,...]
Buyer 2 [1, 0, 0, 0, 0,...]

Tracking users



Graphic of scientific journal similarities at Los Alamos

Red Nodes show a user subset

We can define models of typical users and classes of users

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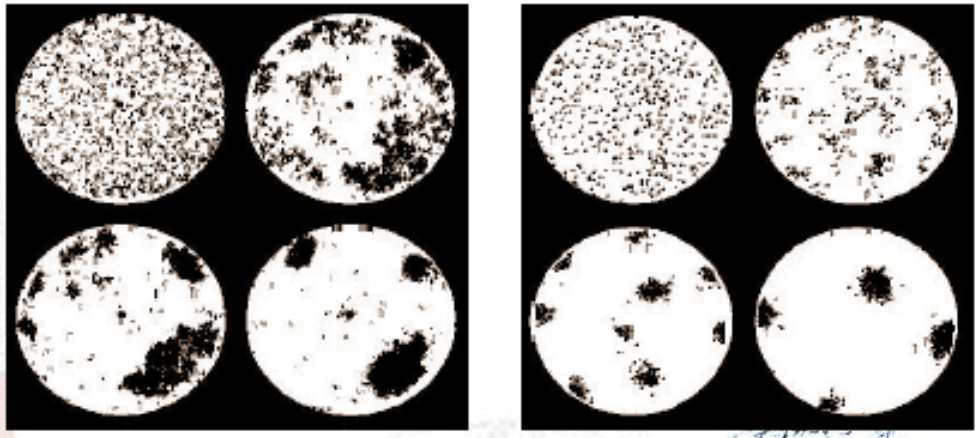
Probabilistic cleaning

- Very simple rules for colony clean up
  - ***Pick dead ant.*** if a dead ant is found pick it up (with probability inversely proportional to the quantity of dead ants in vicinity) and wander.
    - ***Drop dead ant***. If dead ants are found, drop ant (with probability proportional to the quantity of dead ants in vicinity) and wander.

Real and Simulated Ants Clustering



Real ants *Messor sanota* build clusters starting from randomly located corpses

Simulated ants build clusters starting from randomly located items

Figure by Marco Dorigo in *Real ants inspire ant algorithms*

ant-inspired robots

Clustering by collective robots

- Becker et al Rules
  - **Move**: with no sensor activated move in straight line
  - **Obstacle avoidance**: if obstacle is found, turn with a random angle to avoid it and **move**.
  - **Pick up and drop**: Robots can pick up a number of objects (up to 3)
    - If shovel contains 3 or more objects, sensor is activated and objects are dropped. Robot backs up, chooses and angle and **moves**.
- Results in clustering
  - The probability of dropping items increases with quantity of items in vicinity

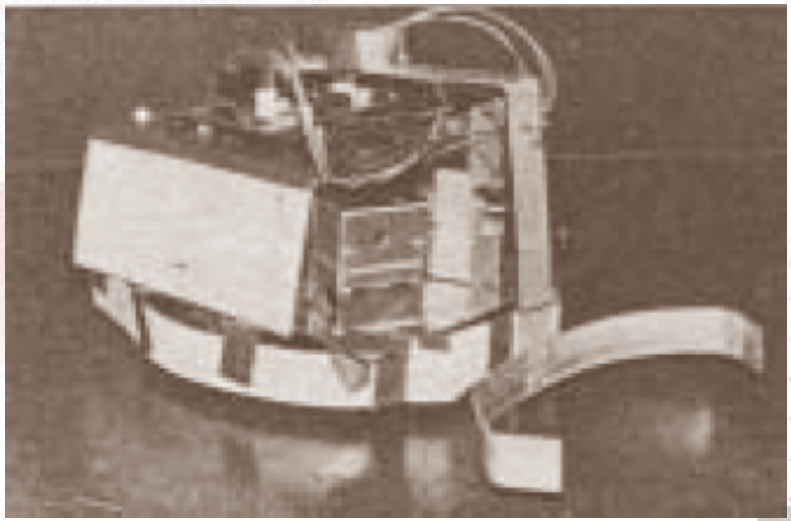
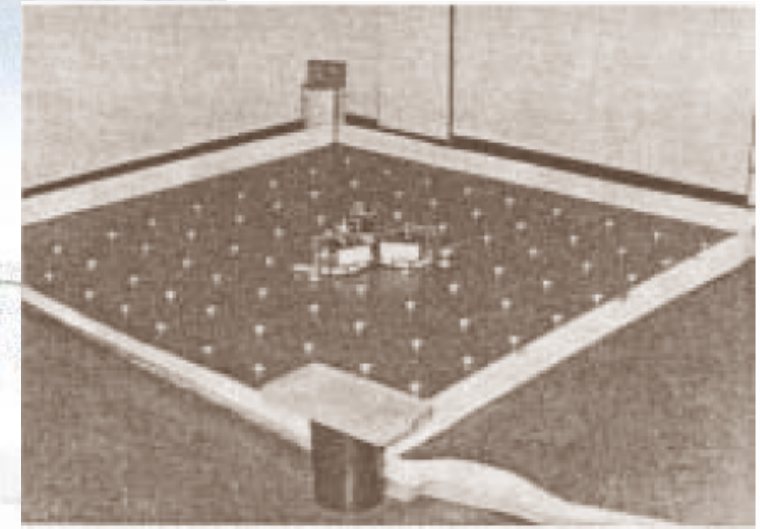
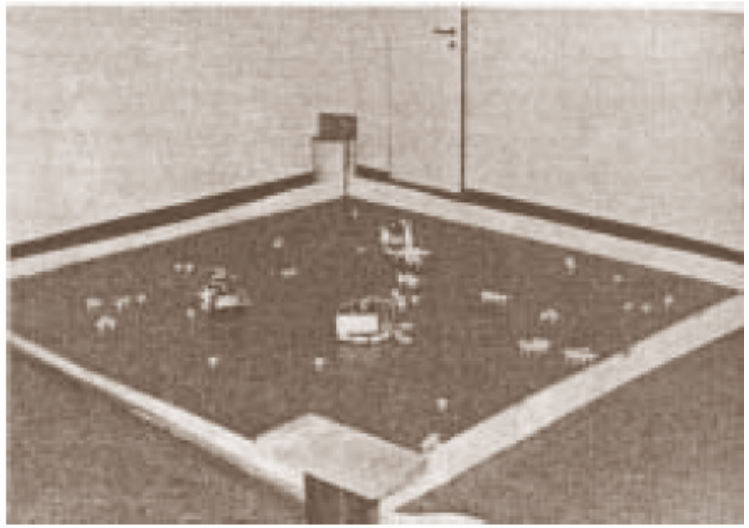
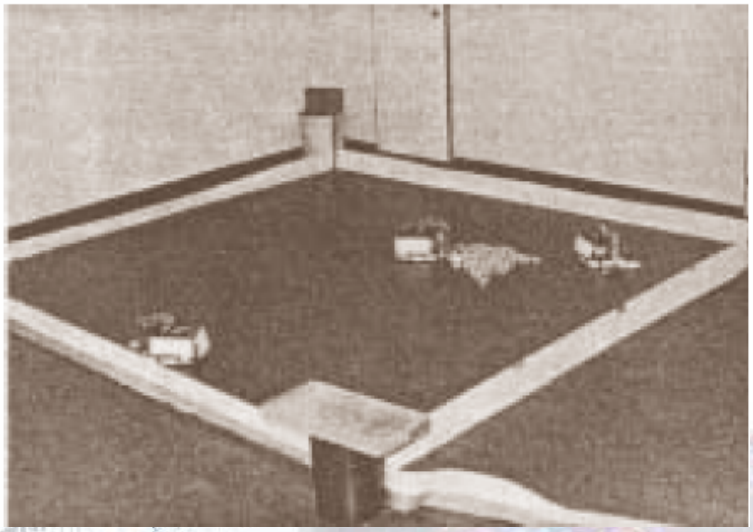


Figure from R Beckers, OE Holland, and JL Deneubourg [1994]. “From local actions to global tasks: Stigmergy and collective robotics”. In *Artificial Life IV*.

becker et al experiments







Next Class!

- Topics
  - Data Representation
- Readings for Next week
  - Lecture notes Posted online @ http://informatics.indiana.edu/rocha/i101
    - *Modeling the World*
  - @ *infoport*
  - From course package
    - From Irv Englander's book "*The Architecture of Computer Hardware and Systems Software*"
      - Chapter 3: Data Formats (pp. 70-86)
- Lab 5
  - Introduction to Operating Systems: Unix