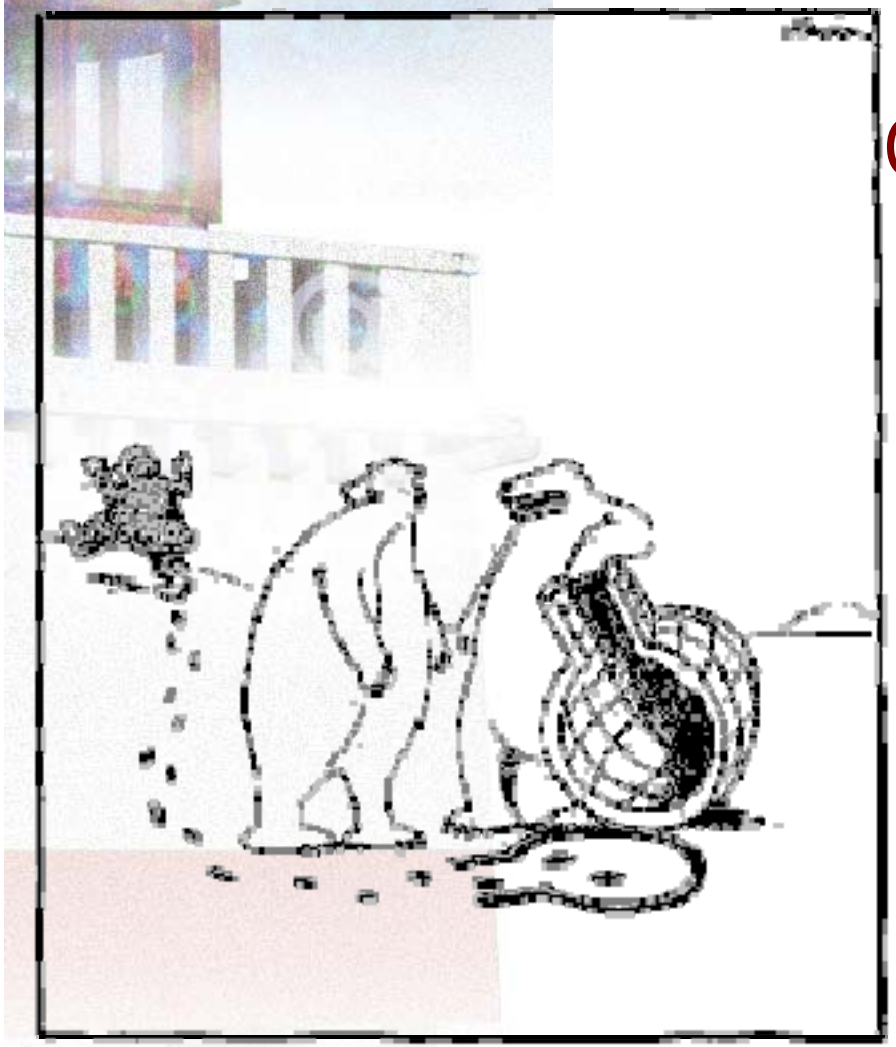
Introduction to Informatics

Lecture 24:

Computing Models – More on Algorithms



"If life, you grab, ... Was that concept just a little too complex, Carl?"

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*
    - *http://infoport.blogspot.com*
  - From course package
    - Von Baeyer, H.C. [2004]. *Information: The New Language of Science*. Harvard University Press.
      - Chapters 1, 4 (pages 1-12)
      - Chapter 10 (pages 13-17)
    - From Andy Clark's book "*Natural-Born Cyborgs*"
      - Chapters 2 and 6 (pages 19 - 67)
    - From Irv Englander's book "*The Architecture of Computer Hardware and Systems Software*"
      - Chapter 3: Data Formats (pp. 70-86)
    - Klir, J.G., U. St. Clair, and B.Yuan [1997]. Fuzzy Set Theory: foundations and Applications. Prentice Hall
      - Chapter 2: Classical Logic (pp. 87-97)
      - Chapter 3: Classical Set Theory (pp. 98-103)
    - Norman, G.R. and D.L. Streinrt [2000]. *Biostatistics: The Bare Essentials*.
      - Chapters 1-3 (pages 105-129)
      - OPTIONAL: Chapter 4 (pages 131-136)
      - Chapter 13 (pages 147-155)
      - Chapter 5 (pages 141-144)
    - Igor Aleksander, "Understanding Information Bit by Bit"
      - Pages 157-166
    - Ellen Ullman, "Dining with Robots"
      - Pages 167-172

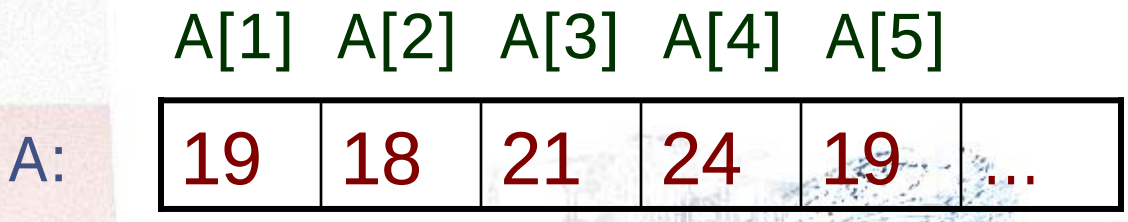
Assignment Situation

- 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 (Friday, February 2): Grades Posted
    - Lab 4: More HTML and CSS
      - Closed (Friday, February 9): Grades Posted
    - Lab 5: Introduction to Operating Systems: Unix
      - Closed (Friday, February 16): Grades Posted
    - Lab 6: More Unix and FTP
      - Closed (Friday, February 23): Grades Posted
    - Lab 7: Logic Gates
      - Closed (Friday, March 9): Grades Posted
    - Lab 8: Intro to Statistical Analysis using Excel
      - Closed (Friday, March 30): being graded
    - Lab 9: Data analysis with Excel (linear regression)
      - Closed (Friday, April 6): Being Graded
  - Next: Lab 10
    - Lab 10: Simple programming in Excel and Measuring Uncertainty
      - April 12 and 13, Due April 20

- Assignments
  - Individual
    - First installment
      - Closed: February 9: Grades Posted
    - Second Installment
      - Past: March 2: Grades Posted
    - Third installment
      - Past: Grades Posted
    - Fourth Installment
      - Presented April 10th, Due April 20th
  - Group
    - First Installment
      - Past: March 9th, graded
    - Second Installment
      - Past: April 6th Being graded
    - Third Installment
      - Presented Thursday, April 12; Due Friday, April 27

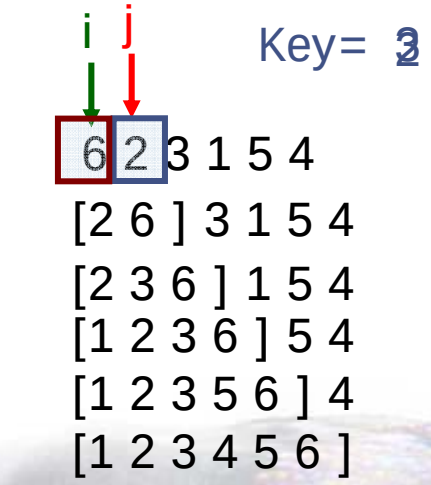
Array of Integers

- A data structure to store series or lists or data
  - Example: age of students in I101
    - 19, 18, 21, 24, 19, 20, 19, 22, 18, 19
  - Index: stores the location of data element in the series
    - i: 1,2,3,4,5,6,7,8,9,....., 100,....
  - Array: stores data elements organized by index
    - A[i]: A[1]=19, A[2]=18, A[3]=21, A[4]=24,....

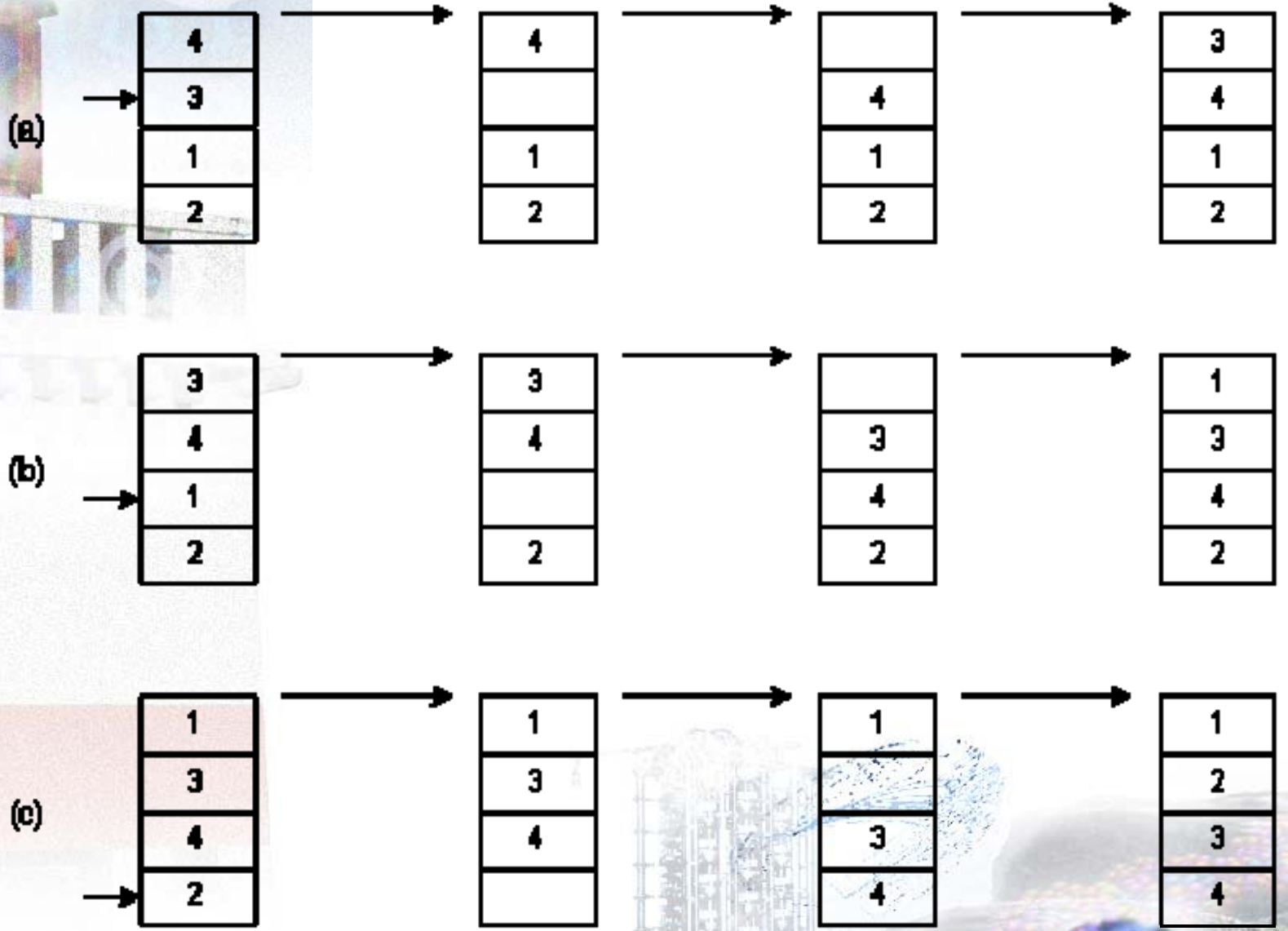


Example: Sorting Algorithm

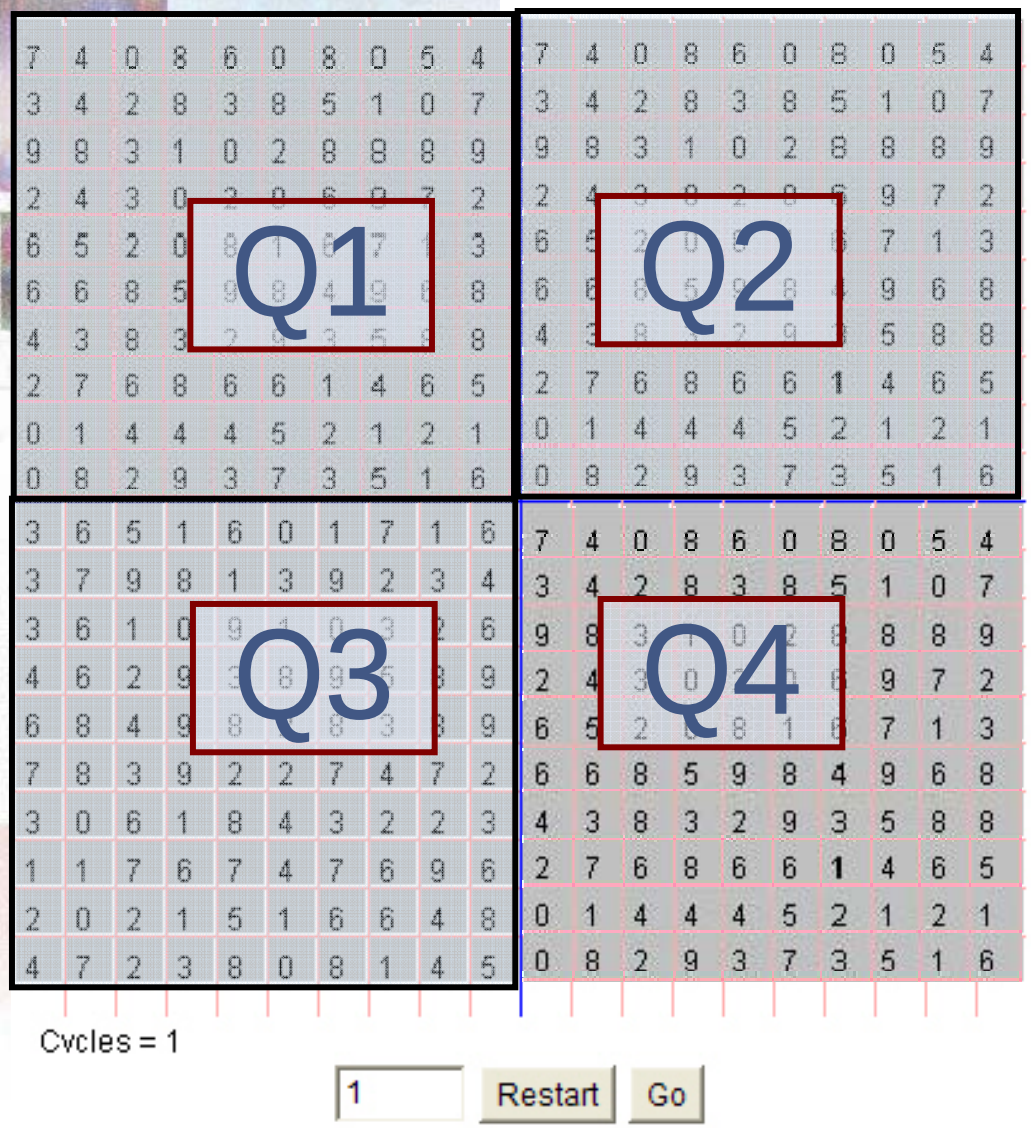
- Insertion Sort
  - Given a random sequence of numbers, sort them in increasing order
  - Input
    - $S = <a_1, a_2, ..., a_n>$
  - Output
    - A permutation or reordering of S: $S' = <a'_1, a'_2, ..., a'_n>$, such that $a_1 \leq a_2 \leq ... \leq a_n$
  - Works the way many people sort a card hand
  - For j ←2 to length S do
    - Key ← A[j]
    - i ← j-1
    - While ((i>0) and (A[i]>key)) do
      - A[i+1]=A[i]
      - i ← i-1
    - endWhile
    - A[i+1] ← key
  - Endfor



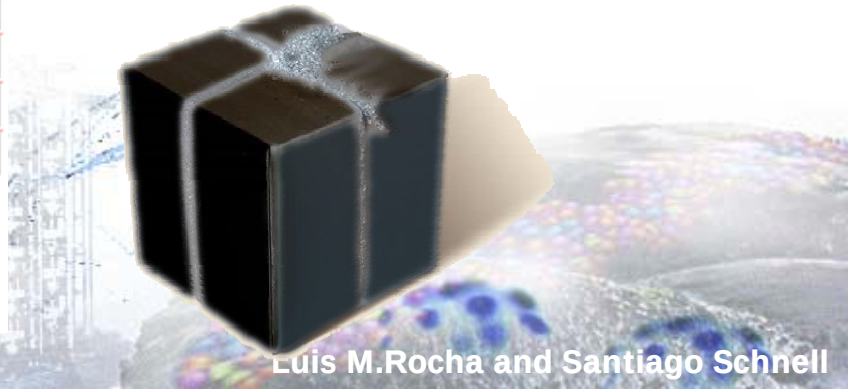
Insertion Sort Example



Individual Assignment – Part IV

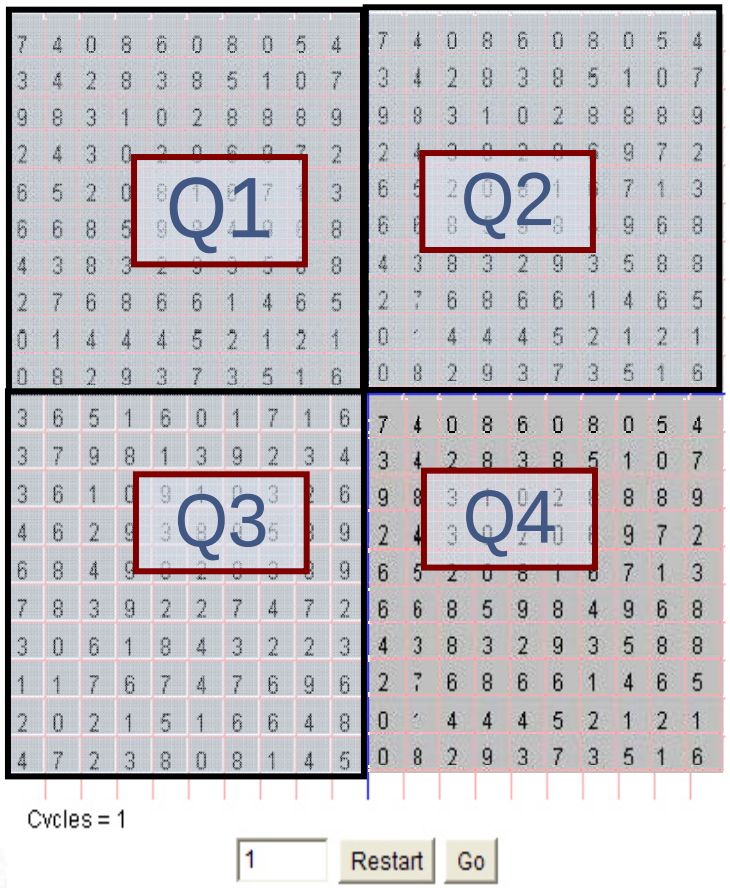


- Step by step analysis of “dying” squares
  - 4th Installment
    - Presented: April 10th
    - Due: April 20th
- Use inductive and deductive reasoning
  - To uncover the algorithm in each quadrant
    - Build from inductive knowledge accumulated so far



Summary of Black Box

- Quadrant 1
  - At the random initial state
    - All numbers have equal probability of being initially present
    - But the probability of changes are different
- In Any State
  - Any number changes depending on its neighbors
  - It ‘gravitates’ towards the smallest number that it ‘sees’ most often.
  - Odd and Even numbers do not show different behavior
- What is the Algorithm?



Summary of Black Box

- Quadrant 3
  - At the random initial state
    - All numbers have equal probability of being initially present
    - But the probability of changes are different
- In Any State
  - 0 can only change to 0
  - 5 can only change to 5 or 0
  - Even digits always change to even digits
  - Odd digits could change to any other digit
- What is the Algorithm?

	n(i)	p(i)
0	27	0.27
1	4	0.04
2	12	0.12
3	4	0.04
4	12	0.12
5	9	0.09
6	12	0.12
7	4	0.04
8	12	0.12
9	4	0.04

1. $0 \rightarrow 0$
2. $\{5\} \rightarrow \{0, 5\}$
3. $\{2, 4, 6, 8\} \rightarrow \{0, 2, 4, 6, 8\}$
4. $\{1, 3, 7, 9\} \rightarrow$ $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

Summary of Black Box

- Quadrant 2
  - At the random initial state
    - All numbers have equal probability of being initially present
    - But the probability of changes are different
- In Any State
  - 0 can only change to 0
  - 5 can only change to 5 or 0
  - Even digits always change to even digits
  - Odd digits could change to any other digit
- What is the Algorithm?

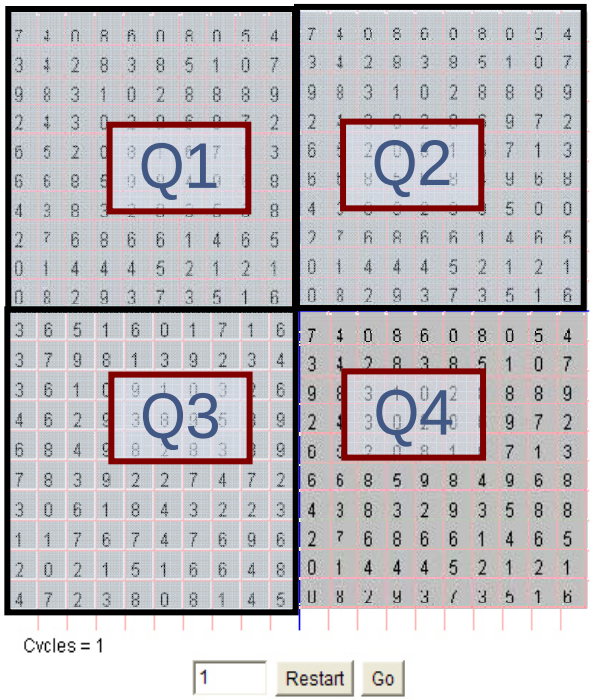
1. $0 \rightarrow 0$
2. $\{5\} \rightarrow \{0, 5\}$
3. $\{2, 4, 6, 8\} \rightarrow \{0, 2, 4, 6, 8\}$
4. $\{1, 3, 7, 9\} \rightarrow$ $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

Possible Operations Q2 and Q3

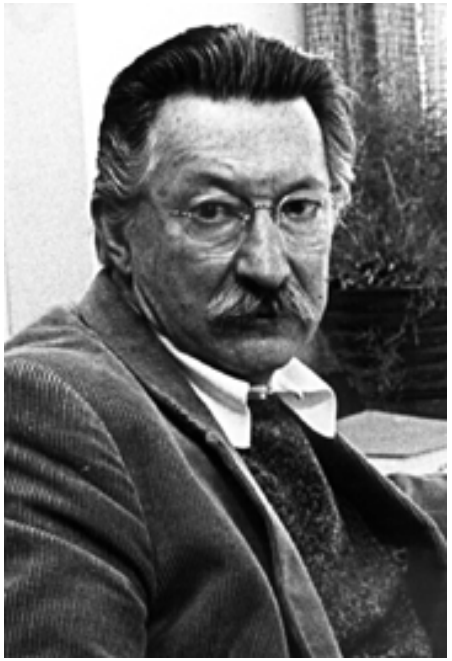
Operator	Meaning	Excel	Example
()	Brackets, grouping	()	y = (a + b) * (c + d)
*	Multiplication	*	i=j*k
+	Add	+	i = i+1
-	Subtract	-	i=j-3.2
/	Real division	/	i=8/5 = 1.6
div	Integer division	Quotient (a,b)	i=8/5 = 1
Mod, %	remainder	Mod (a, b)	i=8 mod 5 = 3
ROUND	Rounds	ROUND (a, d)	i=ROUND(3.67,0) = 4
INT	Integer Part	INT	i=INT(3.67) = 3
rand	Random number	Rand() RandBetween(a,b)	i=rand(n)

Tip for Individual Assignment

- Quadrant Q
  - There are 100 cells in each 10x10 quadrant
    - C = 1...100
  - Each cell can take one of 10 colors
    - V(C)=0..9
      - is the value of the cell
      - This is the state cell C is in
  - Random initialization of quadrant Q at cycle 1
    - For c=1 to 100 do
    - V(C) ← randbetween(0,9) {random number 0 to 9}
    - EndFor
    - Cycle ← 1
  - Run for Number of cycles
    - n ← Input dialog
    - For k=1 to n do
    - Cycle ← cycle+1
    - {Pick random cell}
    - C ← randbetween(1,100)
    - {Update the value of the cell (NOT THE REAL THING)}
    - V(C) ← ((V(C) * randbetween(0,9)) div 2) – 5*x
    - EndFor
  - X may be a hidden variable
    - X ← ???



Eliza



- In 1966 Joseph Weizenbaum developed an algorithm and program that simulates the behavior of a psychotherapist
  - The program seemed to be able to understand anything typed in by the user
  - The program was actually fairly “dumb” in modern AI terms
    - Its “understanding” was the result of programming trickery
  - Its weaknesses were caused by relying almost exclusively on the premise that the syntax of a sentence captured its semantic meaning

Adapted from Bruce R. Maxim

Eliza Algorithm

- set up a language database
  - Words, synonyms, sentences
- begin the conversation (e.g. with a greeting)
- Repeat
  - read user input
  - generate Eliza's response
  - print the response on the screen
- until the conversation ends

Eliza Algorithm – More Details

- set up a language database
  - Words, synonyms, sentences
- begin the conversation (e.g. with a greeting)
- Repeat
  - read user input
    - Keeps track of the two most recent inputs from the user
  - generate Eliza's response
    - preprocess the user input
      - Remove all punctuation from inputs and check for duplicate input
      - Make some synonym replacements from a list of pairs (e.g. big for huge)
      - Change pronouns (e.g. I and me to you)
    - find a matching keyword
    - choose an appropriate response template
      - if a keyword is found
        - extract the part of the user's input following the keyword
        - apply transformations to the extracted input
        - plug the transformed input into the response
      - Else
        - generate a non-committal response
  - print the response on the screen
- until the conversation ends

Actroid

- The Actroid Robot
  - understands naturally spoken words and can carry on a conversation with a guest, answering in a natural voice.
    - Speaks Chinese, Korean, English and Japanese.
    - understands 40,000 phrases
    - 2,000 types of answers
    - Nuanced facial expressions, Natural gestures such eye movement and smiling
- Robot information booth attendant at 2005 World Fair in Aichi
  - Built by Kokoro and Advanced Media
  - And she raps!

Next Class!

- Topics
  - Limits of Computation
  - Databases
- Readings for Next week
  - @ *infoport*
  - From course package
    - Igor Aleksander, "Understanding Information Bit by Bit"
      - Resources tab in onCourse.
    - Ellen Ullman, "Dining with Robots"
      - Resources tab in onCourse.
- There is a lab this week!!!!!!!
  - Lab 10
    - Simple programming in Excel and Measuring Uncertainty
      - April 13, 14; Due April 21