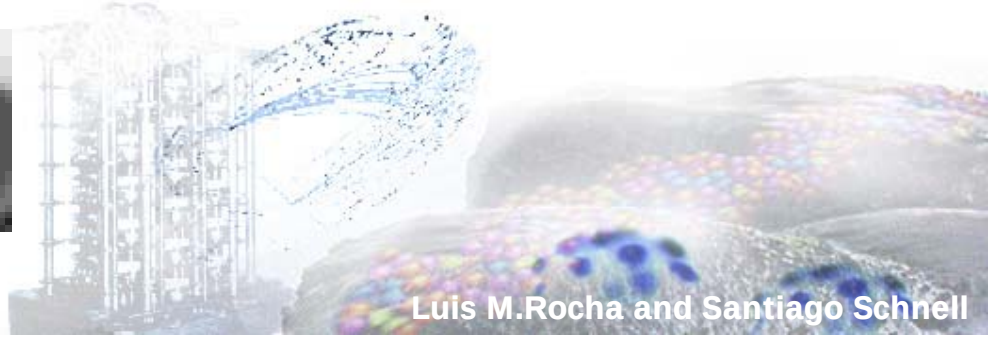
Introduction to Informatics

Lecture 23:

Modelling the World : Algorithms

Individual Assignment (Installment 3) Results



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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*
    - *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

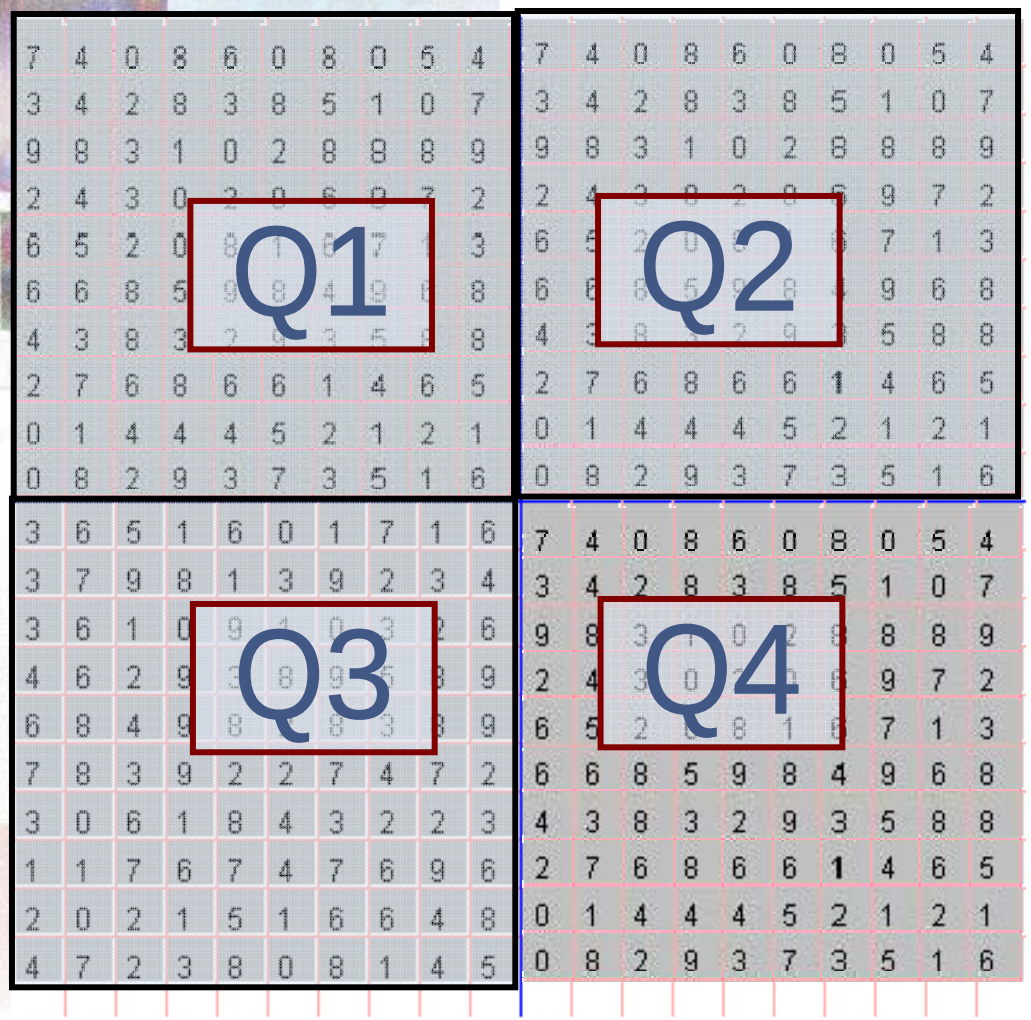
Assignment Situation

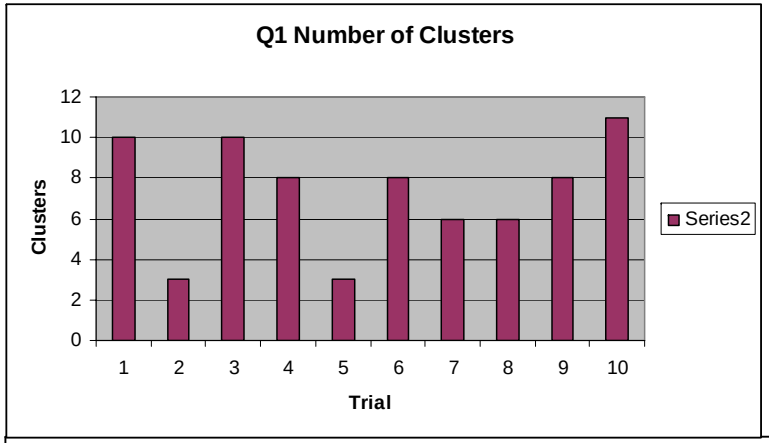
- Labs
  - Past
    - Lab 1: Blogs
      - Closed (Friday, January 19): Grades Posted
    - Lab 2: Basic HTML
      - Closed (Wednesday, January 31): Grades Posted
    - Lab 3: Advanced HTML: Cascading Style Sheets
      - Closed (Friday, February 2): Grades Posted
    - Lab 4: More HTML and CSS
      - 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

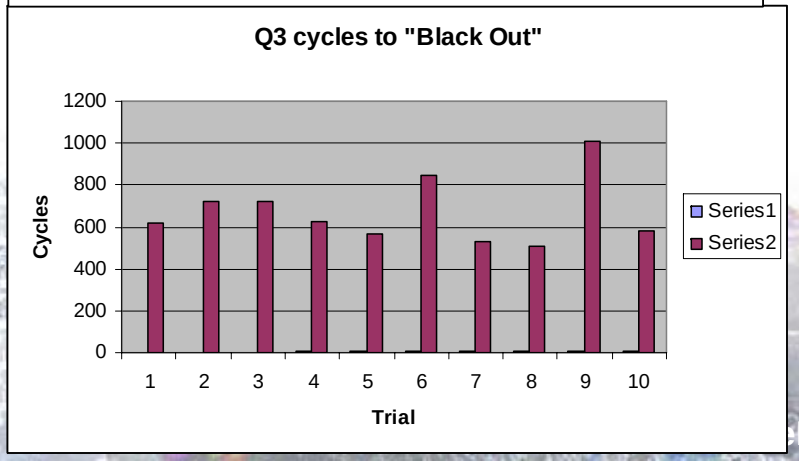
- Assignments
  - Individual
    - First installment
      - Closed: February 9: Grades Posted
    - Second Installment
      - Past: March 2: Grades Posted
    - Third installment
      - Past: Grades Posted
    - Fourth Installment
      - Presented April 10th, Due April 20th
  - Group
    - First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

Individual Assignment – Part III

- Step by step analysis of “dying” squares
  - 3rd Installment
    - Presented: March 8th
    - Due: March 30th
- Student Results
  - Andrew Philbrick
    - In Q3 plotted the number of cycles it took to ‘black out’

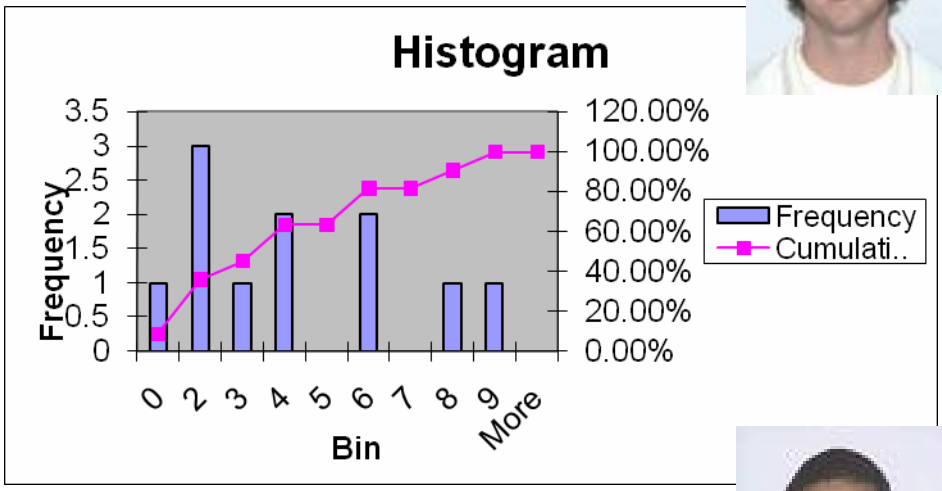


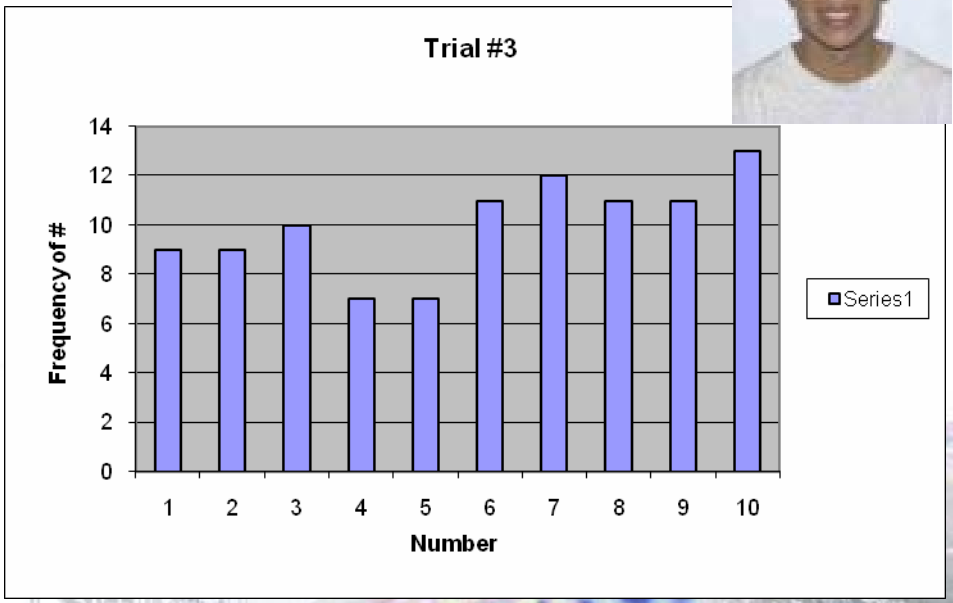




Student Results

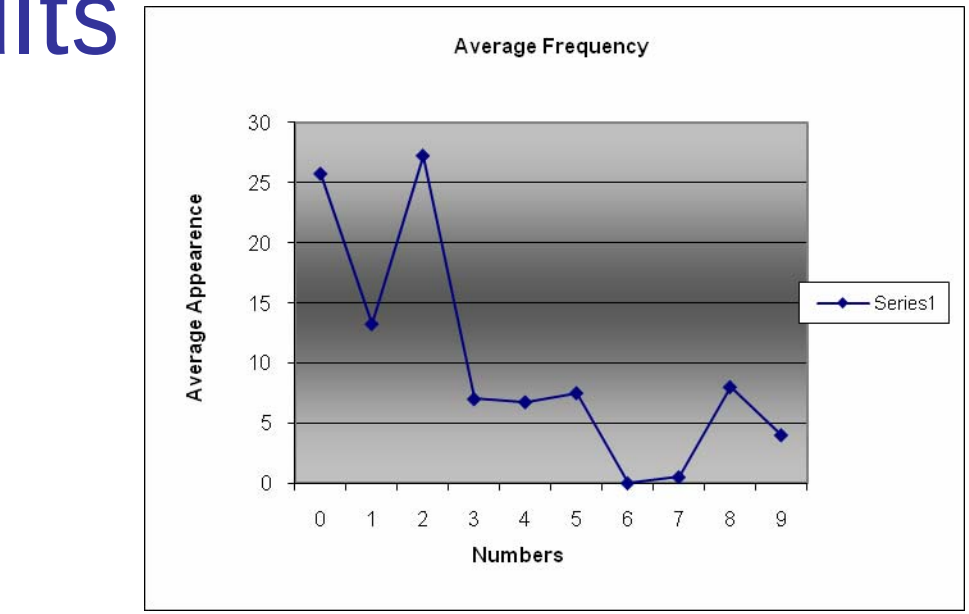
- John Oglesby
  - Recorded changes in top left corner cell of Q1
- Steven Tran
  - Collected digit frequencies in Q4
    - After 1500 cycles nothing emerges
  - Chris Kremser,Donald Peek
    - Also put much effort on Q4
  - Q4 can be ignored for now as pointed out before
    - Random behavior

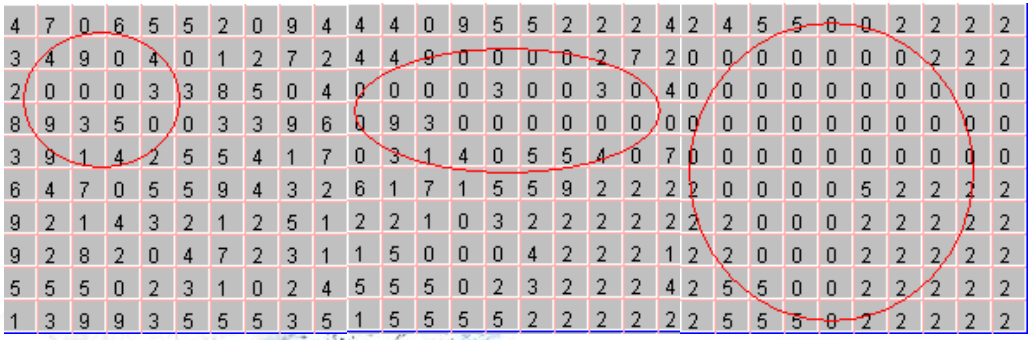




Student Results

- David Tharp
  - Observed Q1 after 1500 cycles and counted digit frequencies
    - Averaged them over 4 trials
  - Observations
    - Most common numbers are 2,0 and 1
    - Their average frequencies are 27.25,25.75 and 13.25
    - There is ‘grouping’ or ‘flocking’ behavior like boids
- Also to observe the above behavior were:
  - Anna Wong, J.T. Waugh, Marcus Bigbee, Kael Kanczuzewski, Andrew Kim





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Student Results

- Christopher Kremser
  - Q1
    - whenever 3 of the same number or color group together, they become a region that can not die.
  - For quadrants 3 & 4
    - Observed transitions of each digit with cycles
  - Observations (Q3)
    - This box is similar to the fourth quadrant. Its special parameter is whenever a black box occurs, it dies.
    - Each cycle seems to be fairly random, and it keeps cycling until it becomes a black box.
    - The only way the randomization stops is when it becomes black.
    - Generally it only cycles through a few different numbers.

30	Starting at 1				
31	Cycles	1	40	80	120
32	Value	1	1	7 then 5	0
33	Cycles	1	40	80	120
34	Value	1	1	9 then 5	0
35	Cycles	1	40	80	120
36	Value	1	1	1	6 then 8
37	Cycles	1	40	80	120
38	Value	1	1	6	4
39	Cycles	1	40	80	120
40	Value	1	4	4	4
41					
42	Starting at 2				
43	Cycles	1	40	80	120

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Student Results

- Sarah Kepa
  - Looked at a small box of 4 numbers at bottom right of Q1
    - Generally, the numbers that are originally clustered in groups of more than 4 are the numbers that end up remaining as the ones that are permanent

Original Numbers→changes(in order)→permanent number

3 0 → 3 3

3 1 → 3 3

1 4 → 3 4 → 3 4 → 1 4 → 1 1

0 6 → 0 1 → 1 1 → 1 1 → 1 1

6 2 → 6 1 → 6 1 → 6 1 → 1 1 → 1 1 → 2 1 → 2 2

6 8 → 6 8 → 6 0 → 0 0 → 0 0 → 2 0 → 2 2 → 2 2

8 9 → 8 9 → 8 8 → 3 8 → 3 3

7 9 → 3 9 → 3 9 → 3 3 → 3 3

- Marcus Bigbee

(Number started with)		(Number that it changed to(red) and how many times)
0	→	2x2, 3x1, 1x6, 6x1
1		0x5, 3x2, 5x1, 7x1, 2x1
2		0x4, 1x4, 8x2
3		2x2, 7x1, 0x5, 1x1, 6x1
4		2x2, 1x2, 0x3, 8x1, 3x1, 6x1
5		0x3, 2x2, 3x3, 8x1, 9x1
6		8x1, 5x1, 1x1, 3x3, 0x1, 4x2, 2x1
7		1x5, 2x2, 5x1, 0x1, 4x1
8		0x3, 1x2, 3x4, 4x1
9		1x3, 2x3, 7x1, 5x2, 8x1

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Student Results

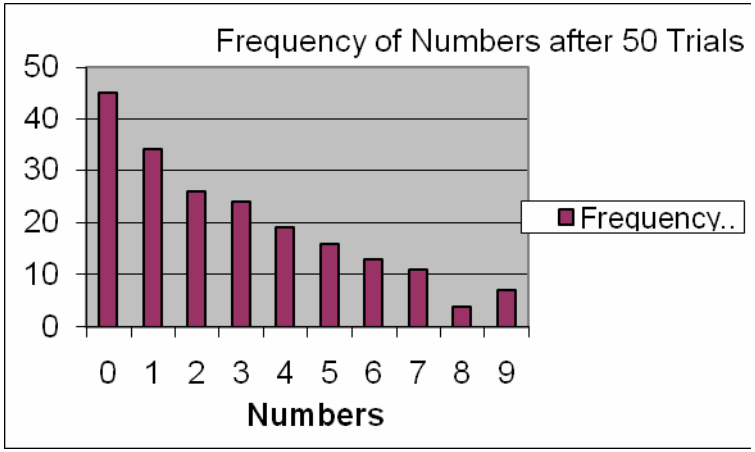
- Kael Kanczuzewski
  - For Q1 first ran 3 trials
    - Jumping by 10 until 150 and then jumping by 100 until the quadrant froze
    - The numbers are more likely to go from a higher number to a lower number
      - though did observe jumps to higher numbers
    - I theorize that the numbers do not run in a pattern exclusively, they depend on the numbers around them.
      - The earlier numbers appear to be the strongest numbers which dominate the screen (quadrant 1) at the end (around 2000 cycles). So I tested this by running 2000 cycles 50 separate times and recorded the remaining numbers

Recorded Data Changes

Trial1	Trial2	Trial3
5-3	0-1	3-8
4-1	2-7	4-7
6-1	9-7	9-5
8-0	7-1	6-5
9-1	3-1	8-7
3-0	4-1	6-1
1-0	6-1	2-1
1-0	8-5	
7-1	5-1	
2-1		
3-1		
1-0		

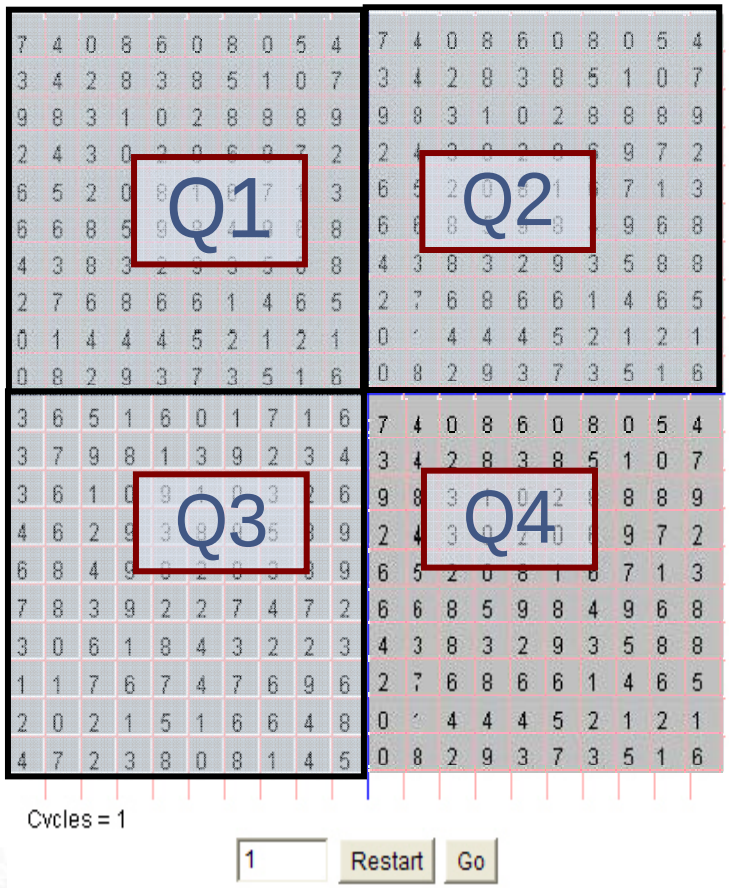
Student Results

- Kael Kanczuzewski
  - What remains at cycle 2000 (50 measurements)
    - The numbers were almost perfectly aligned 0 being the most common and 9 (almost being the least).
      - The correlation is nearly perfectly linear
      - Linear regression
        - The r^2 is .92
    - Hypothesis:
      - The lower the number the stronger it is, and can conquer the surrounding numbers based on the strength.
      - The entire thing is first based on the (assumed) random numbers that appear at the reset.
      - The groupings of numbers that first appear have the best chance of taking over the rest of the board, but if low numbers (0-3) have groupings in the beginning they begin expanding and taking over the higher numbers. This confirms Donald Peek's theory with more conclusive results.
    - Tested by guessing future states
      - If 0's had any sort of grouping or connection at the beginning they would begin to spread to the rest of the board, and 9's would only survive until the end if they had a strong grouping in the beginning.



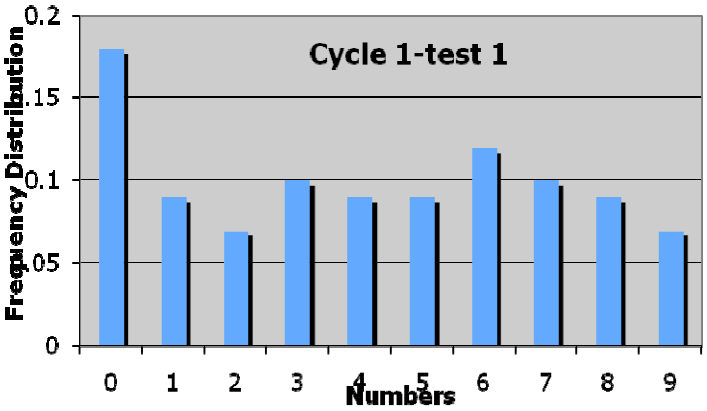
Summary of Black Box

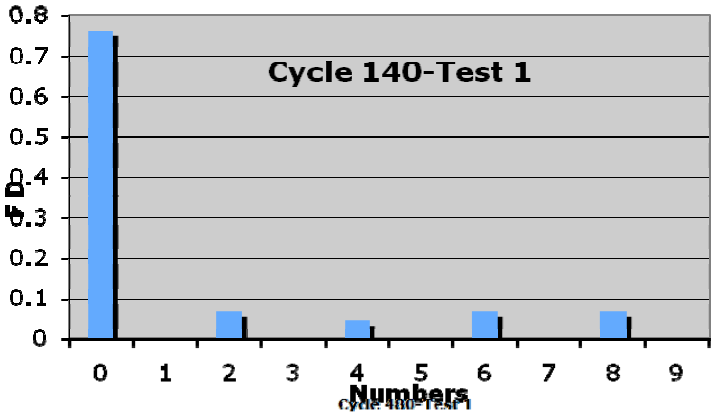
- Quadrant 1
  - At the random initial state
    - All numbers have equal probability of being initially present
    - But the probability of changes are different
- In Any State
  - Any number changes depending on its neighbors
  - It ‘gravitates’ towards the smallest number that it ‘sees’ most often.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

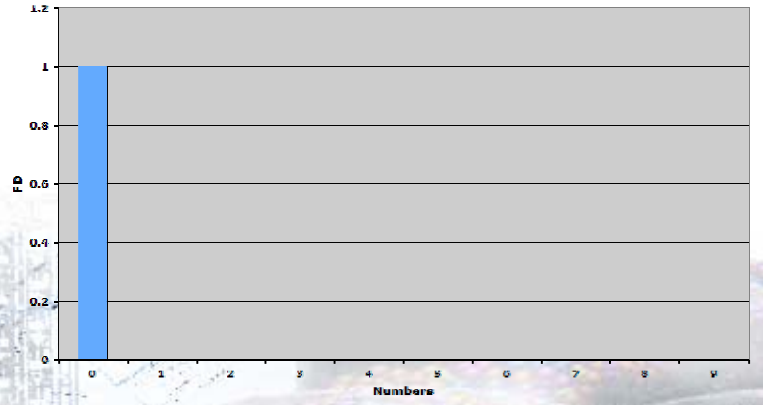


Student Results

- Andrew Dempsey
  - Quadrant 3
    - Plotted frequencies with increasing number of cycles
  - Observations
    - Zeroes steadily increase
    - Even numbers are the last to ‘die’ or change to 0







Quadrant 3

- Maxwell Bryan Cutler
  - Many excellent observations about Q3!!!
    - Individual digit transitions
      - 0's do not change into anything
      - 1 changes to 2,4, 5, 7,
      - 2 changes to 0, 4,
      - 3 changed to 5, 0, 6
      - 4 changes to 6, 8,
      - 5 changes to 0,
      - 6 changed to 0, 2, 4,
      - 7 changes to 6,8,9,
      - 8 changes to 0, 6,
      - 9 resilient????
    - Evens vs. Odds
      - 4, 6, and 8 are somewhat interchangeable, switching between the three until they become a zero
      - odds are weaker
      - Odds more likely to change to 0's or at least to evens

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

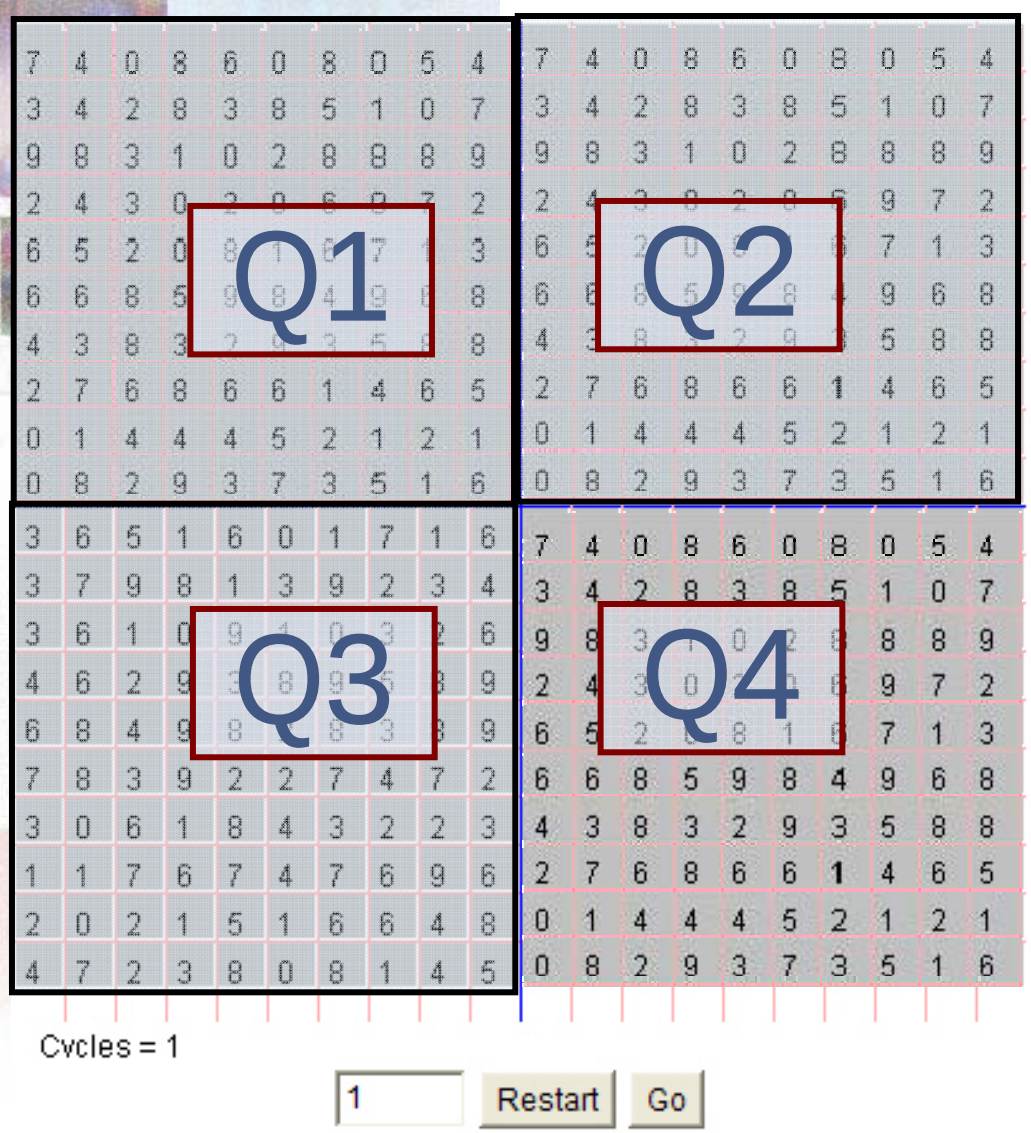
1. $0 \rightarrow 0$
2. $\{5\} \rightarrow \{0, 5\}$
3. $\{2, 4, 6, 8\} \rightarrow \{0, 2, 4, 6, 8\}$
4. $\{1, 3, 7, 9\} \rightarrow$ $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

Summary of Black Box

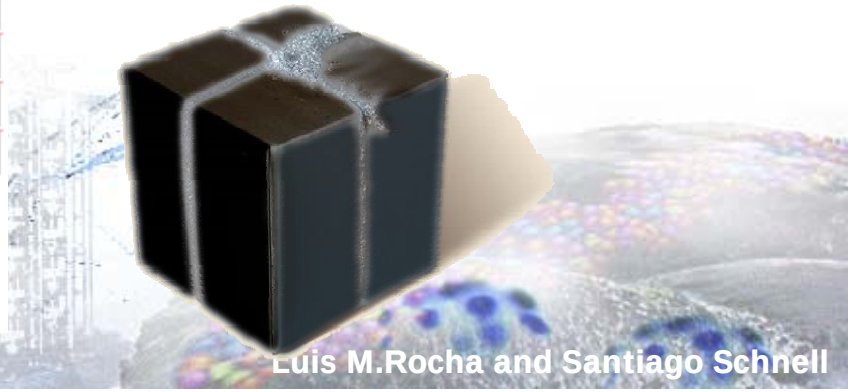
- Quadrant 2
  - At the random initial state
    - All numbers have equal probability of being initially present
    - But the probability of changes are different
- In Any State
  - 0 can only change to 0
  - 5 can only change to 5 or 0
  - Even digits always change to even digits
  - Odd digits could 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. $\{1, 3, 7, 9\} \rightarrow$ $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

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

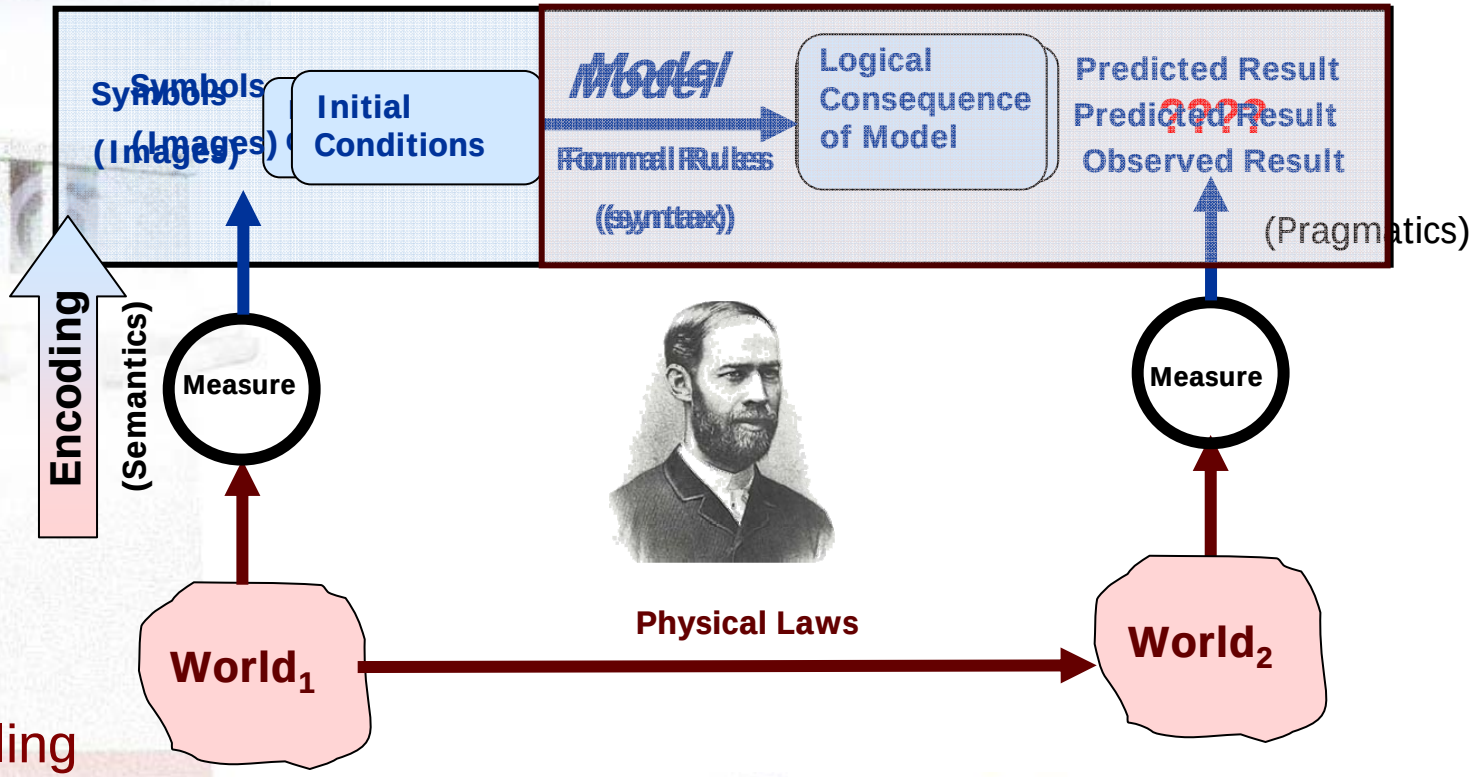


Possible Operations Q2 and Q3

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)

The Modeling Relation

Hertz' Modeling Paradigm



- Modeling
  - Compute hypothesis
- Rules from Inductive and Deductive Analysis
  - From Data analysis
  - Produce Conclusions

Next Class!

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