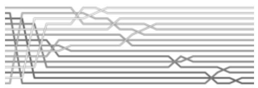
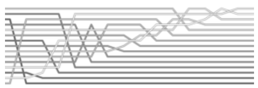
CS 42 Today

Today:

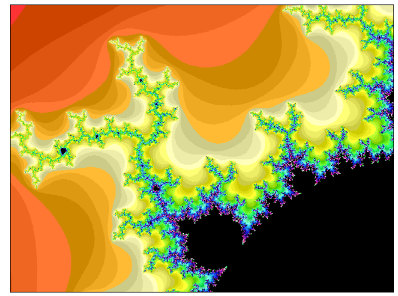
More sorting

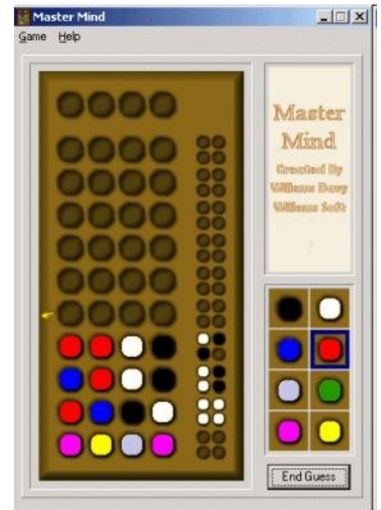




files

HW7 *PREVIEW*





'Cause somethin' like he left knee and a harp," said he had to the whole school? The shouting and then some strange and Mrs. "Well, I know Hagrid; they spotted handkerchief and get him get rid of course, had a gigantic beet with her," he knew what to all he's

All the sky with the sun in the sun in the church where you're gone Lucy in my eyes. There beneath the girl with an hourglass And then the banker never wears a lot to hold your hand. Can't buy me tight, tight Owww! Love is love I can't hide,

Who is the author? What is the work? What is going on?

This is but ourselves. No, faith, My uncle! O royal bed of confession Of your rue for leave to nature; to this time I should weep for thy life is rotten before he is. have sworn 't. Or my blood. I have closely sent for nine; and unprofitable,

The Senators and the date of a written declaration that Purpose, they shall consist of nine States, shall not, when he shall have such Vacancies. The President pro tempore, in the Desire of a Qualification to the Speaker of the Senate. Article 6. When vacancies by the office upon probable

Sorting Algorithms

the *fruit flies* of complexity theory...

Slow:

1 1 1
1 1 2
1 1 3
1 2 1
1 2 2
1 2 3
1 3 1
1 3 2
1 3 3
2 1 1
2 1 2
2 1 3
2 2 1
2 2 2
2 2 3
2 3 1
2 3 2
2 3 3
3 1 1
3 1 2
3 1 3

Checksort

check permutations until sorted

List of length n

c	a	b

Check:

3 1 2
3 2 1
1 2 3
1 3 2
2 1 3
2 3 1

"bogosort"

SlowSort !

pull # s from a hat
with replacement…

List of length n

c	a	b

Sorting Algorithms: Can we do better?

Yes!

Fun for all ages

Sorting Algorithms

The fruit flies of complexity theory...

Minsort
choose the min each iteration

7	4	3	2	1	5	0	6

An algorithm of a similar sort...

Insertion Sort
insert elements in order to the left

7	4	3	2	1	5	0	6

vs. minsort ?

better than $O(N^2)$?

$< N^2$ run times… ?

1959

Shell Sort
sort column-sublists of increasing size

7	4	3	2	1	5	0	6	1

$<O(N^2)$ via 2d sorting!

Shell Sort
sort column-sublists of increasing size

7	4	3	2	1	5	0	6	1

7	4	3	2	1
5	0	6	1	

↓

5	0	3	1	1
7	4	6	2	

2 elements per column

$<O(N^2)$ via 2d sorting!

Shell Sort

sort column-sublists of increasing size

7	4	3	2	1	5	0	6	1

7	4	3	2	1
5	0	6	1	

5	0	3	1	1
7	4	6	2	

2 elements per column

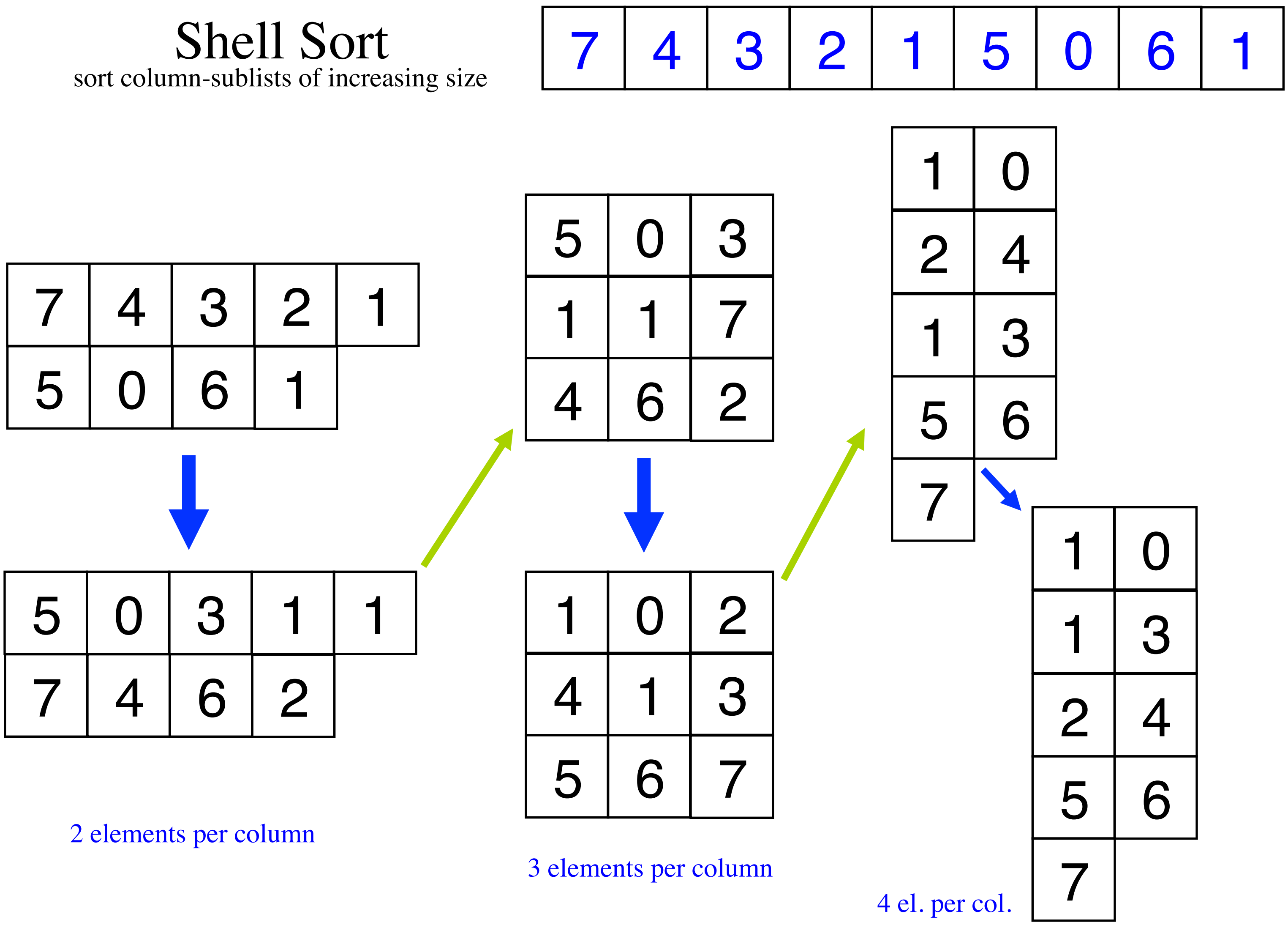
5	0	3
1	1	7
4	6	2

1	0	2
4	1	3
5	6	7

3 elements per column

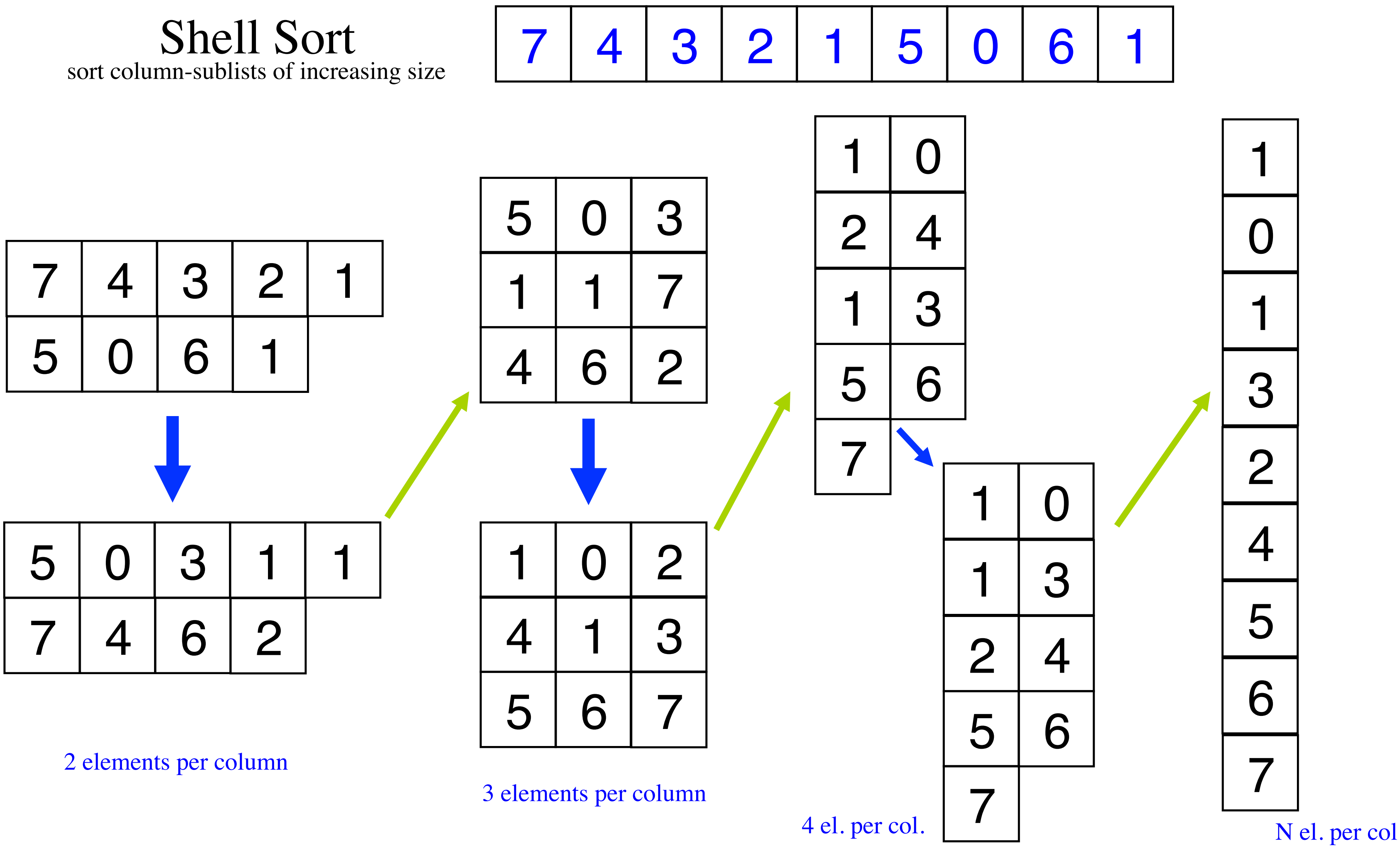
$<O(N^2)$ via 2d sorting!

Shell Sort
sort column-sublists of increasing size



$O(N^{3/2})$ or better
depending on the skip sequence

Shell Sort
sort column-sublists of increasing size



Divide and Conquer

Mergesort
merge sorted lists together

7	4	3	2	1	5	0	6

Running Time: `Loop counting`

How many steps are needed? (usually in the worst case...)

T(N) = running time as a function of problem size, N

MM algorithm:

The problem size is the list length, N.
Each comparison (< or >) will count as 1 step

```
for ( i=1 ; i < N ; ++i )
{
  if  (L[i] > E) E = L[i];
  if  (L[i] < e) e = L[i];
}
```

Running Times:

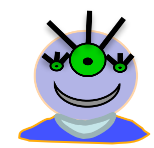
T(N) =

nested loops?
big-O?

Running Time: `Loop counting`

Nested loops will produce a series …

```
for ( int i=0 ; i<N ; ++i )
{
  for ( int j=0 ; j<(i*i) ; ++j )
  {
    1 time step of work here…
  }
}
```



but not always $O(N^2)$!

Algorithms and Impatience

hubris
laziness

Problem: Search through an array to find max *and* min

E e

Divide-and-conquer!

L	5	2	3	8	4	1	6	7

N=8
N is the problem size

better or worse than looping?
in absolute terms? / big-O terms?

Running Time: Recurrences

T(N) = running time as a function of problem size, N

Recursive algorithms lead to ***recurrence relationships:***

base case: **MMRec(L):**

```
if L == [x,y] and x > y then
return [x,y] else return [y,x];
```

recursion: **MMRec(L):**

```
[E1,e1] = MMRec( half1(L) ),     first half of L
[E2,e2] = MMRec( half2(L) ),     second half of L
if E1 > E2 then E=E1 else E=E2,
if e1 < e2 then e=e1 else e=e2,
return [E,e];
```

Running Time:

as a Recurrence Relation

$T(2) = 1$

$T(N) =$

Recurrences

Recurrence relation from the recursive max/min finding program...

$$T(2) = 1$$

$$T(N) = 2\,T\left(\frac{N}{2}\right) + 2$$

what is T(N/2) ?

recursive vs. looping?
big-O?

Mergesort

Mergesort
merges sorted lists together

7	4	3	2	1	5	0	6

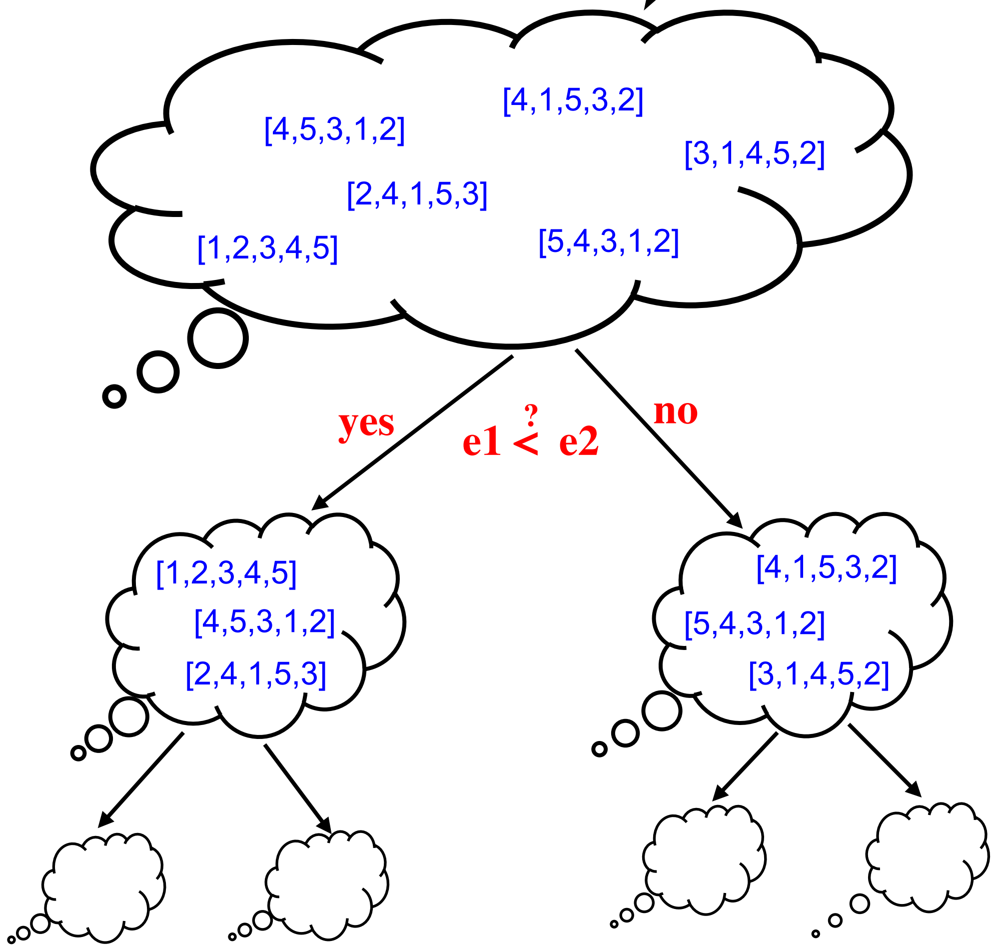
Recurrence relation for mergesort:

Big-O running time:

Any *Comparison Sort* is at best O(n•log(n))

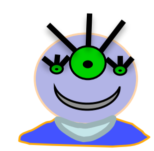
Start with all of the permutations of an n-element list.
$[e_1, e_2, e_3, \ldots, e_n]$

Sorting is equivalent to determining ***which*** of the permutations we started with…



The Adversary

"Adversary Argument"

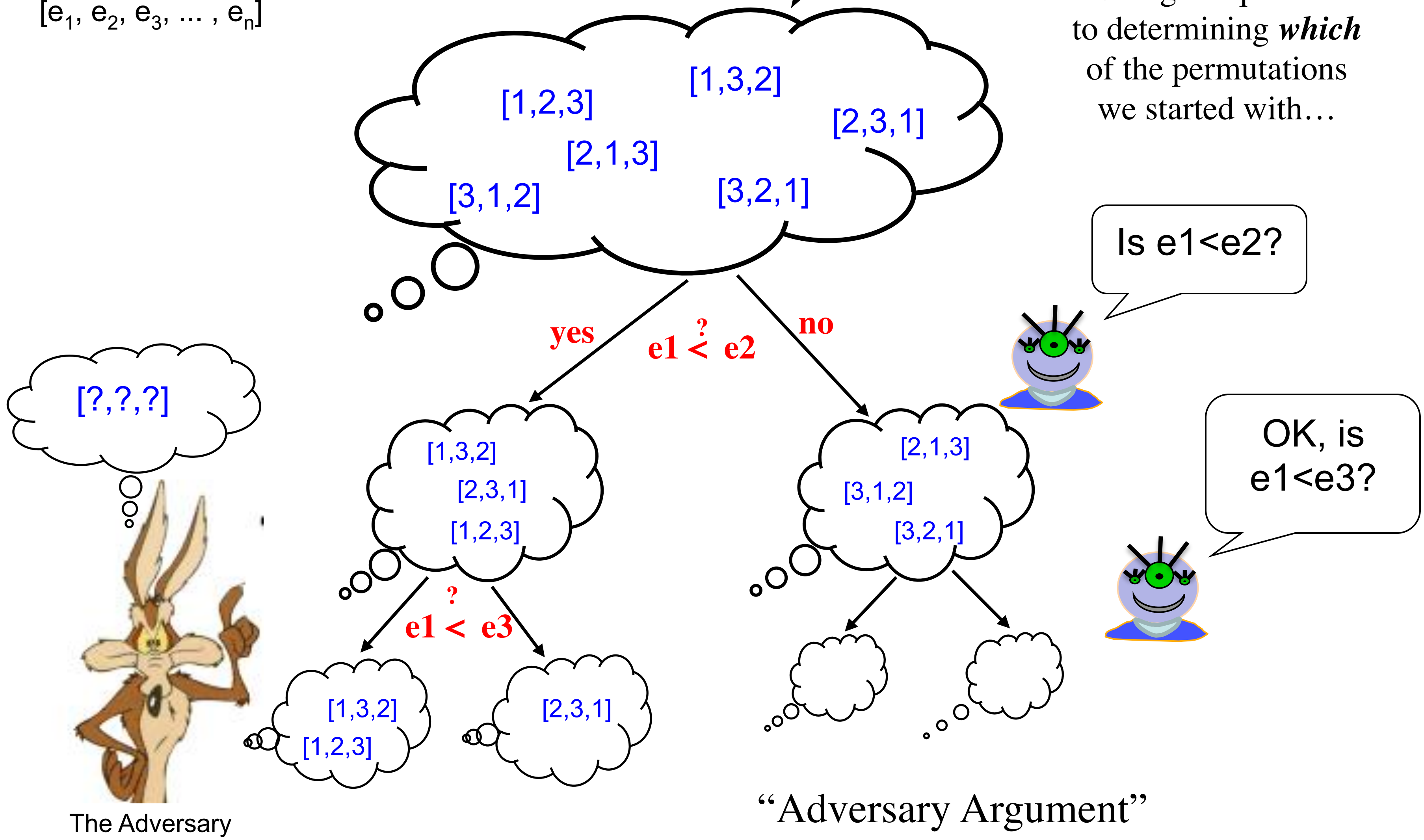


The "adversary" doesn't seem to do all that much…

Any *Comparison Sort* is at best O(n•log(n))

Start with all of the permutations of an n-element list.
[e_1, e_2, e_3, ... , e_n]

Sorting is equivalent to determining ***which*** of the permutations we started with…



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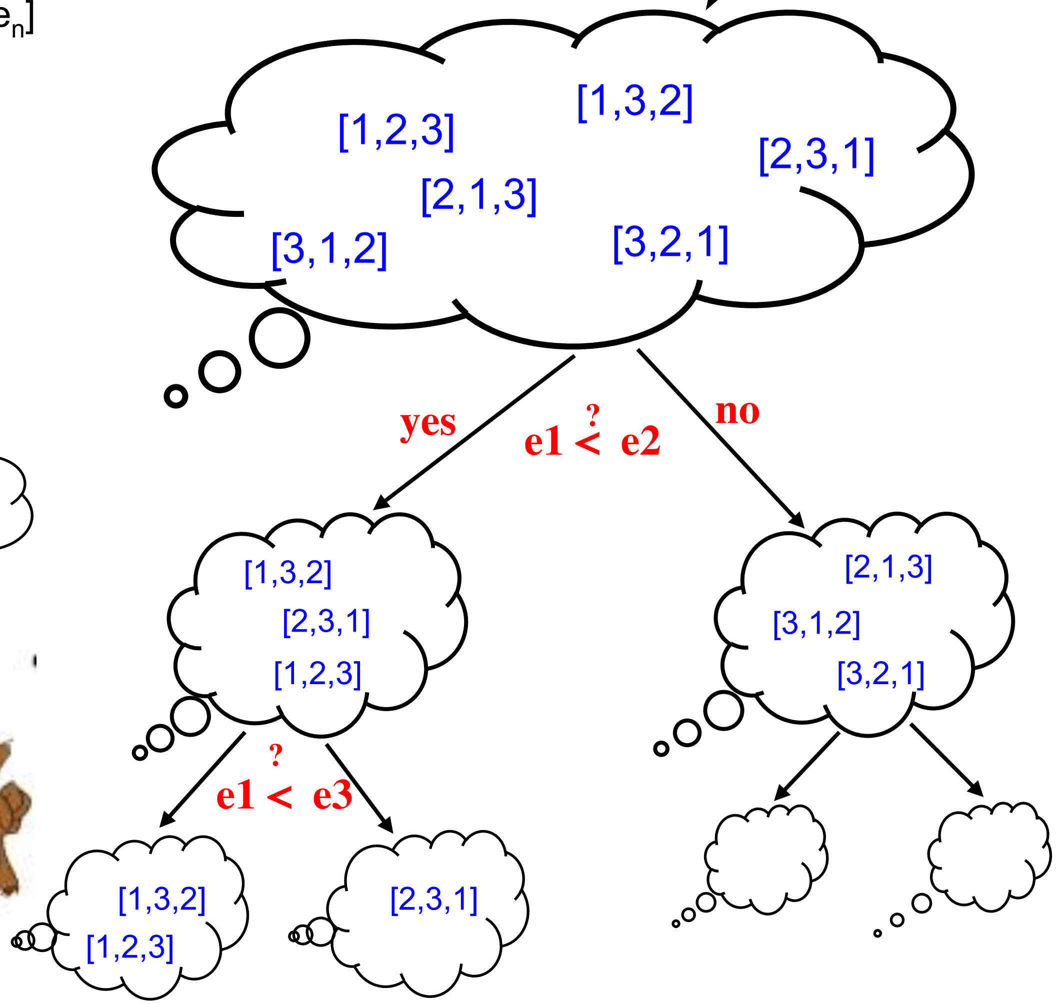

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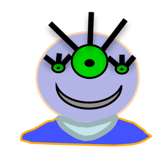
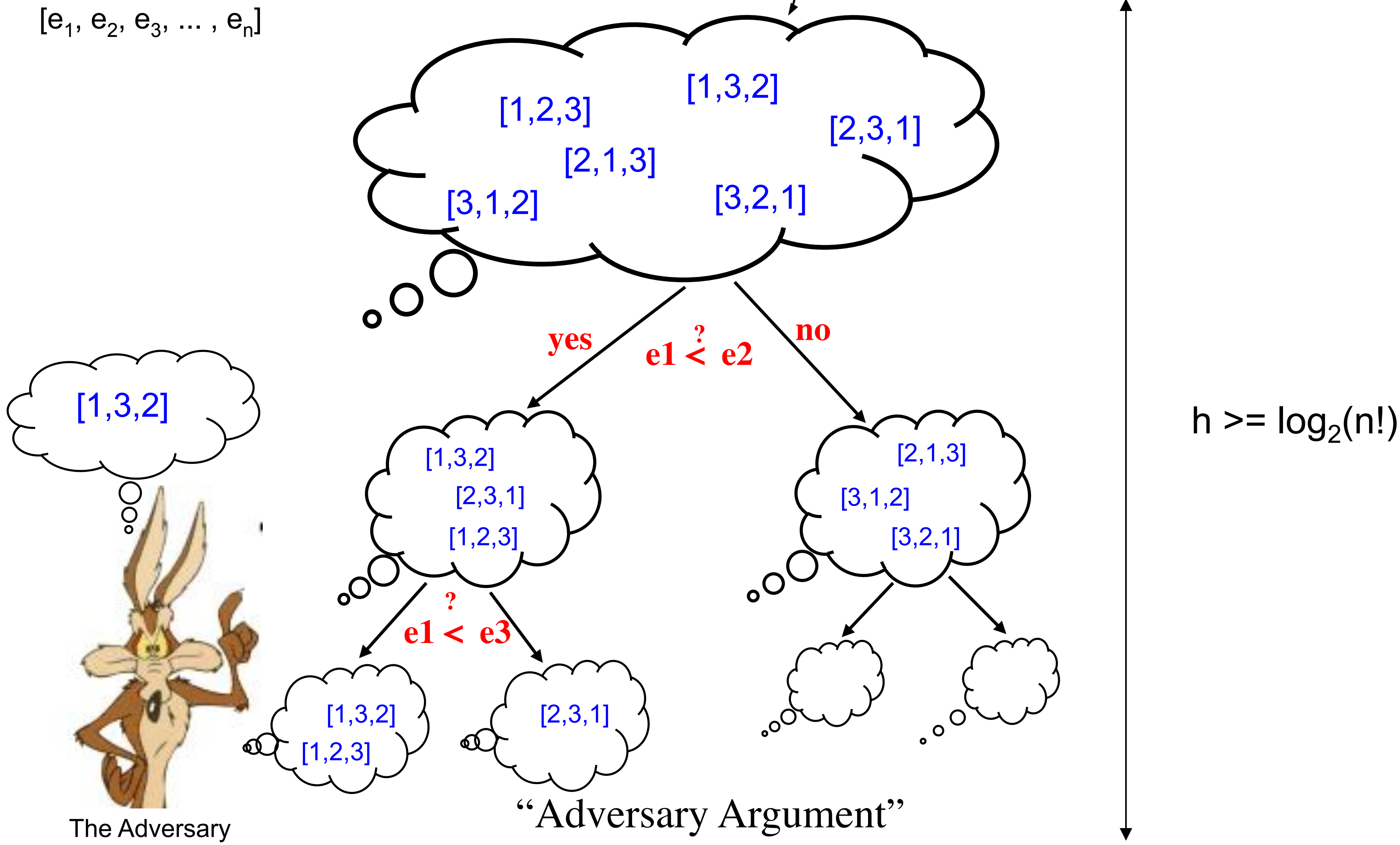
“Adversary Argument”



Ah, this adversary is tricky after all!

Any *Comparison Sort* is at best O(n•log(n))

Start with all of the permutations of an n-element list.
$[e_1, e_2, e_3, \ldots, e_n]$



"Adversary Argument"

Fun with Logs and Big-Omega

$$\left(\frac{n}{2}\right)^{\frac{n}{2}} < n!$$

$$\log\left(\frac{n}{2}\right)^{\frac{n}{2}} < \log n! \leq h$$

$$\frac{1}{2}n\log\left(\frac{n}{2}\right) < \log n! \leq h$$

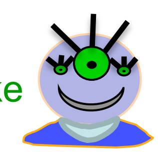
$$\frac{1}{2}n(\log n - \log 2) < \log n! \leq h$$

$$\frac{1}{2}(n\log n - n\log 2) < \log n! \leq h$$

$$h > \frac{1}{2}(n\log n - n\log 2)$$

$$\boxed{h \text{ is } \Omega(n\log n)}$$

So I guess omega is sort of like an upside-down O.



HW7: Loops, loops and more loops!

`for`

definite iteration

For a **known** number of iterations

`while`

indefinite iteration

For an **unknown** number of iterations

Problem 1: the Mandelbrot Set

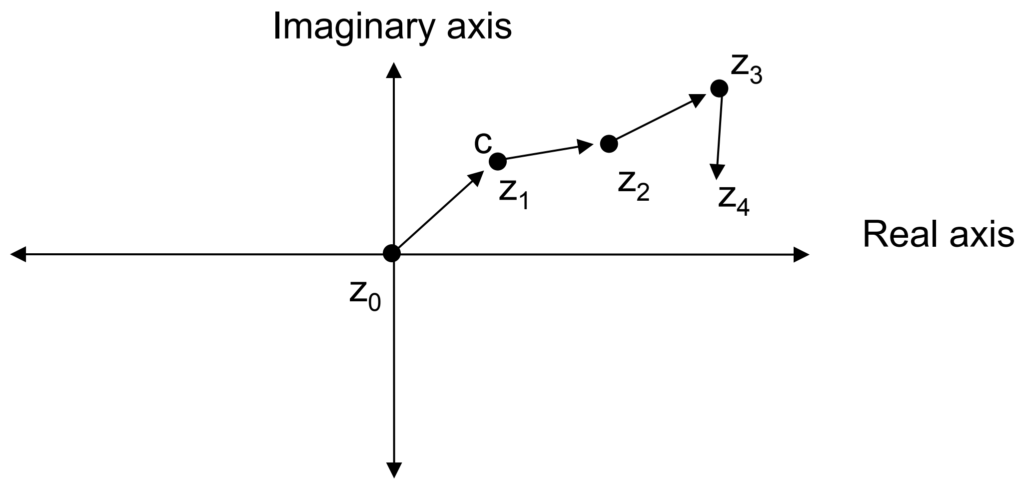
Consider the following update rule for all complex numbers c:

Benoit M.

$z_0 = 0$

$z_{n+1} = z_n^2 + c$

If z does *not* diverge, then c is in the M. Set.



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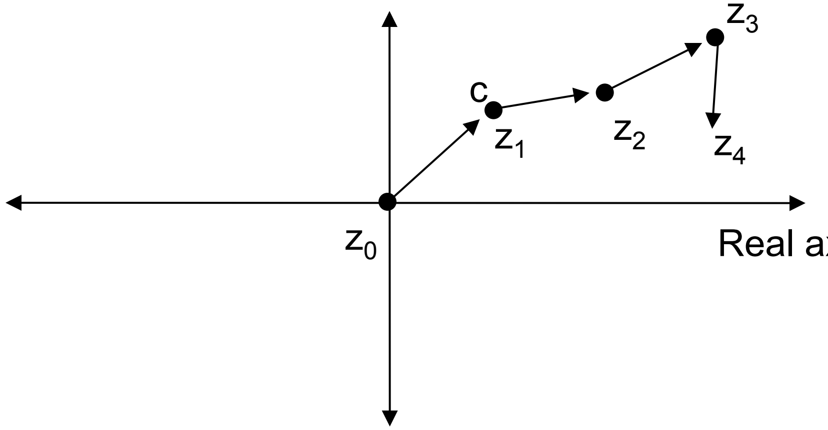

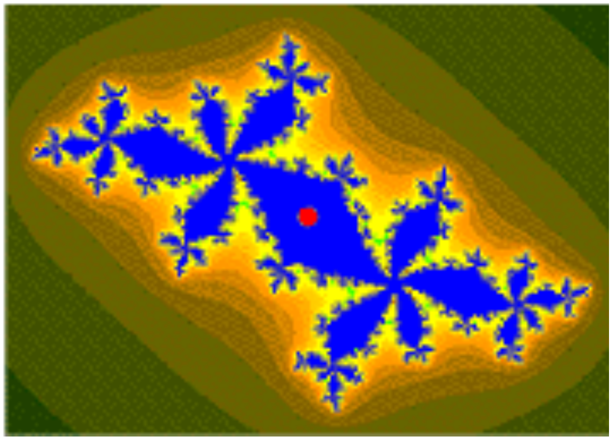

example of a non-diverging cycle

Problem 1: the Mandelbrot Set

Consider the following update rule for all complex numbers c:

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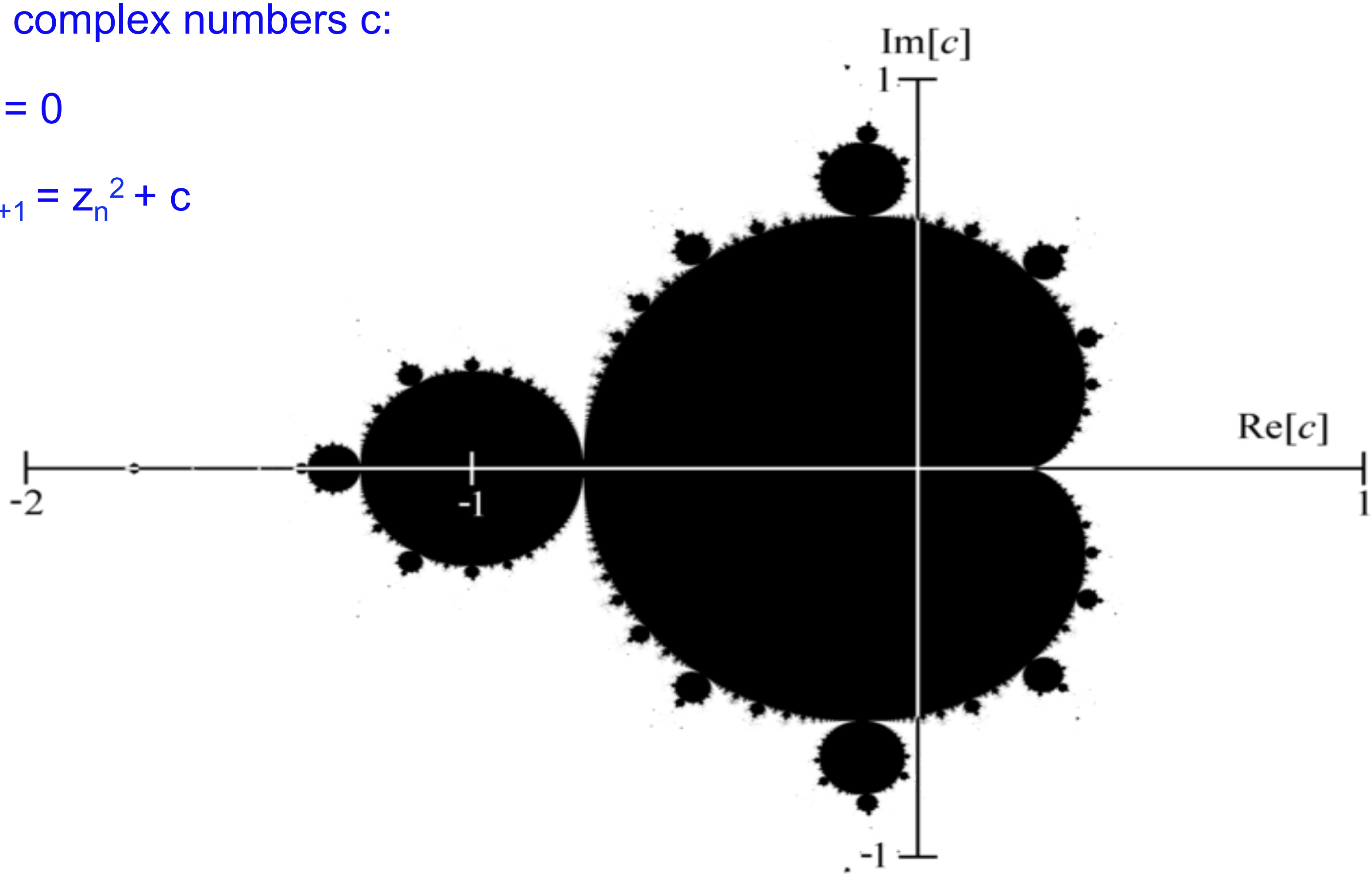
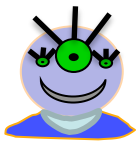


The shaded area are points that do not diverge.

Python and images

```
from bmp import *
```

for creating and saving images




```
image = BitMap( 300, 200, Color.GREEN )
```

creates a bitmap ***object***

and names it **`image`**

Python and images and ***objects***

```
from bmp import *

image = BitMap( 300, 200, Color.GREEN )
```

here, a bitmap ***object*** *named* **`image`**

is calling an internal method named **`saveFile`**

```
image.saveFile( "test.bmp" )
```

Python and images and ***objects***

```
from bmp import *

image = BitMap( 300, 200, Color.GREEN )


  image.setPenColor( Color.Red )

  image.plotPixel( 150, 100 )


image.saveFile( "test.bmp" )
```

two more internal methods

objects are variables that can contain their own functions, often called ***methods***

Imagining Images

```
from bmp import *

def test():
    """ image demonstration """
    width = 200
    height = 200
    image = BitMap( width, height )

    # a 2d loop over each pixel
    for col in range(width):


        for row in range(height):

            if col == row:

                image.plotPoint( col, row )



    image.saveFile( "test.bmp" )
```

upper triangle?

thicker diagonal?

reverse?

both?

Seeing into the future…

```
def menu():
    choice = 1   # Anything except 9
    while choice != 9:
        print "I see danger in your future..."
        printMenu()
        choice = input("Make your choice ")

    print "The inner eye can see no more"

def printMenu():
    print "What would you like to do?"
    print "\t 0: See another prediction"
    print "\t 9: Quit"
```

"\t" represents a tab

Gimme a `break`

```
def menu():
    while True:
        print "I see danger in your future..."
        printMenu()
        choice = input("Make your choice ")
        if choice == 9:
            break

    print "The inner eye can see no more"

def printMenu():
    print "What would you like to do?"
    print "\t 0: See another prediction"
    print "\t 9: Quit"
```

I'll figure out later how to get out of this loop!

OK - I'll stop the loop now and continue with the code ***after*** the loop

`break` stops the execution of the current loop

Name that author… ?

'Cause somethin' like he left knee and a harp," said he had to the whole school? The shouting and then some strange and Mrs. "Well, I know Hagrid; they spotted handkerchief and get him get rid of course, had a gigantic beet with her," he knew what to all he's

All the sky with the sun in the sun in the church where you're gone Lucy in my eyes. There beneath the girl with an hourglass And then the banker never wears a lot to hold your hand. Can't buy me tight, tight Owww! Love is love I can't hide,

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HW7 Pr 2: Read some text and automatically generate new (reasonable?) text

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Markov Model

Technique for modeling any sequence of natural data

Each item depends ***on <u>only</u> the item immediately before it .***

1st-order Markov Model

The text file:

I like spam. I like toast and spam.
I eat ben and jerry's ice cream too.

For each word, keep track of the words that can follow it (and how often)

The Model:

I: like, like, eat	ben: and
like: spam., toast	jerry's: ice
spam.: I, I	ice: cream
toast: and	cream: too.
eat: ben	too.:
and: spam., jerry's	

- We can repeat words to indicate frequency
- Where to begin??

1st order Generative Markov Model

Technique for modeling any sequence of natural data

Each item depends ***on only the item immediately before it .***

A key benefit is that the model can ***generate*** feasible data!

I like spam. I like spam. I like toast and jerry's ice cream too.

Generating text (1st order):

1) start with the first word in the file. Call it **`w`**

2) choose a word following **`w`**, at random. Call it **`w`**

3) choose a word following **`w`**, at random. And so on…

HW7 Pr 2: Need to be able to…

Read text from a file

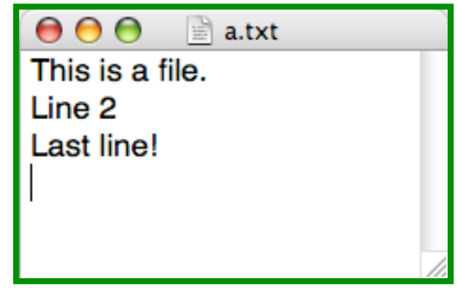
Compute and store the model

Generate the new text

Reading Files

In Python reading files is no problem…

```
>>> f = file( 'a.txt' )
```




```
>>> text = f.read()
```

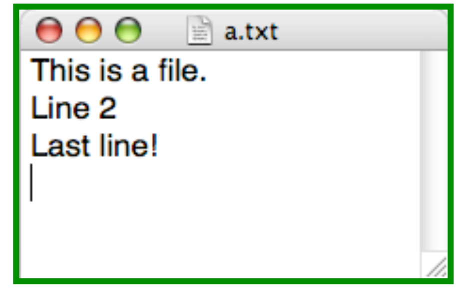
```
>>> text
'This is a file.\nLine 2\nLast line!\n'
```

```
>>> f.close()
```

Files

In Python reading files is no problem…

```
>>> f = file( 'a.txt' )
```



opens the file and calls it **f**

```
>>> text = f.read()
```

reads the whole file and calls it **text**

```
>>> text
'This is a file.\nLine 2\nLast line!\n'
```

```
>>> f.close()
```

`text` is a single string containing all the text in the file

But how to process the text from here…?

closes the file (closing Python does the same)

String Manupulation

```
>>> text
'This is a file.\nLine 2\nLast line!\n'
>>> print text
This is a file.
Line 2
Last line!

>>> text.split()
['This', 'is', 'a', 'file.', 'Line', '2', 'Last', 'line!']
>>> text
'This is a file.\nLine 2\nLast line!\n'
>>> lines = text.split('\n')
>>> lines
['This is a file.', 'Line 2', 'Last line!', '']
```

Returns a list of the words in the string (splitting at spaces, tabs and newlines)

Returns a list of the lines in the string (splitting at newlines)

Objects, objects, everywhere!

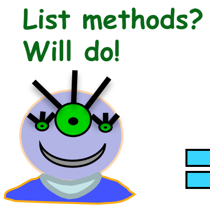
```
>>> L = []         # create a list, L

>>> dir(L)         # see all of L's methods
```

all list methods appear -- lots of them including **append**, **index**, **remove**, and **sort**

```
>>> help(L.sort)      # I wonder…

>>> help(L.index)     # What does this do?
```



List methods

not including list *operators*

```
>>> dir([])
```

append
count
extend
index
insert
pop
remove
reverse
sort

String methods

not including string *operators*

```
>>> dir('')
```

capitalize
center
count
find
index
isalpha
lower
replace
split
strip
title
upper
and ~10 more…

help can help

but there's a fundamental difference… what and why?

Mutable vs. immutable objects

Lists are ***mutable*** objects.

```
>>> L = [2,1,3]
>>> L.sort()
>>> L
[1,2,3]
```

no return value

`L` has changed.

Strings are ***immutable*** objects.

(So are numbers.)

```
>>> s = 'string'
>>> s.replace('st','')
'ring'
>>> s
'string'
```

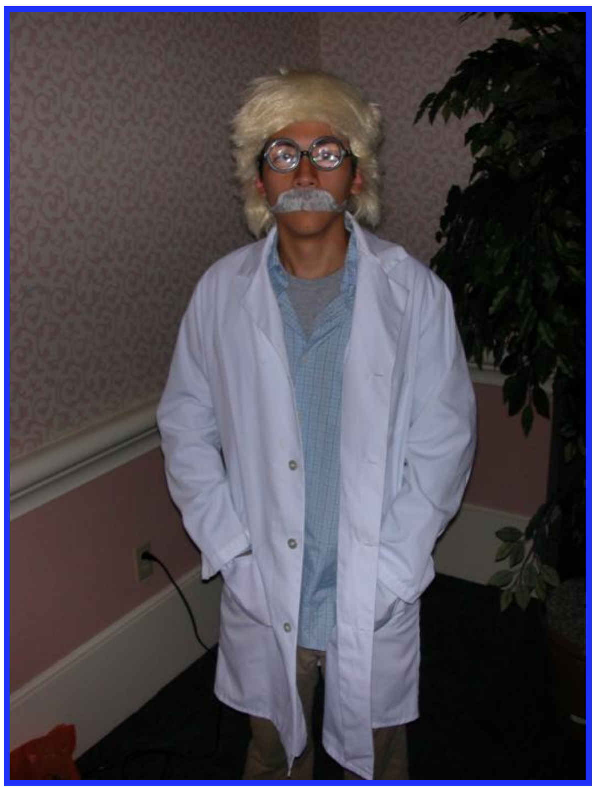
returns a NEW string

`s` has NOT changed

WMSCI 2005

Rooter: A Methodology for the Typical Unification of Access Points and Redundancy

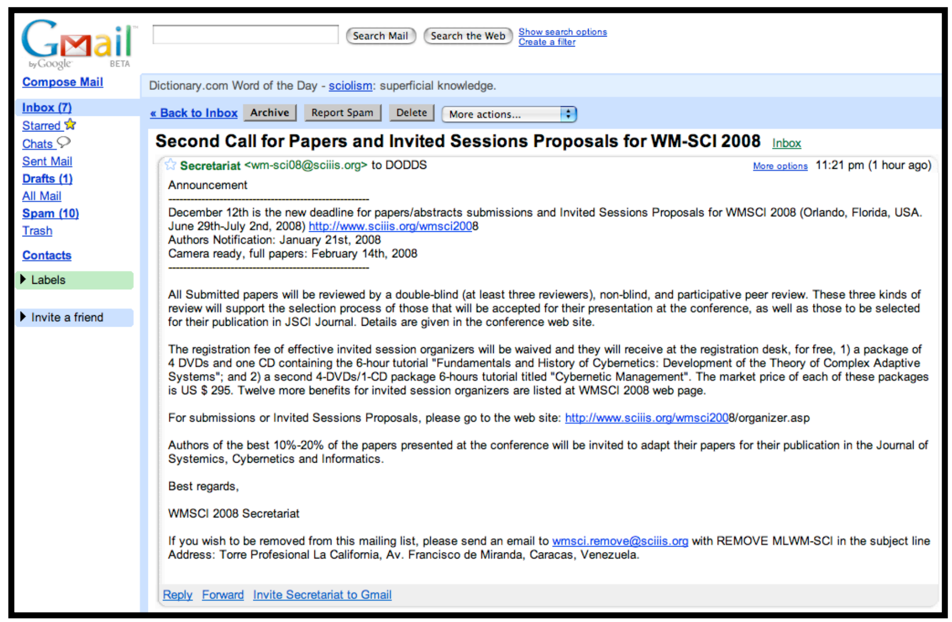
Jeremy Stribling, Daniel Aguayo and Maxwell Krohn



Randomly-generated submission accepted to WMSCI 2005

http://pdos.csail.mit.edu/scigen/

No end to the WMSCI emails…



Gmail by Google BETA

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Compose Mail

Inbox (7)
Starred
Chats
Sent Mail
Drafts (1)
All Mail
Spam (10)
Trash

Contacts

Labels

Invite a friend

Dictionary.com Word of the Day - sciolism: superficial knowledge.

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Second Call for Papers and Invited Sessions Proposals for WM-SCI 2008 Inbox

Secretariat <wm-sci08@sciiis.org> to DODDS — More options 11:21 pm (1 hour ago)

Announcement

December 12th is the new deadline for papers/abstracts submissions and Invited Sessions Proposals for WMSCI 2008 (Orlando, Florida, USA. June 29th-July 2nd, 2008) http://www.sciiis.org/wmsci2008
Authors Notification: January 21st, 2008
Camera ready, full papers: February 14th, 2008

All Submitted papers will be reviewed by a double-blind (at least three reviewers), non-blind, and participative peer review. These three kinds of review will support the selection process of those that will be accepted for their presentation at the conference, as well as those to be selected for their publication in JSCI Journal. Details are given in the conference web site.

The registration fee of effective invited session organizers will be waived and they will receive at the registration desk, for free, 1) a package of 4 DVDs and one CD containing the 6-hour tutorial "Fundamentals and History of Cybernetics: Development of the Theory of Complex Adaptive Systems"; and 2) a second 4-DVDs/1-CD package 6-hours tutorial titled "Cybernetic Management". The market price of each of these packages is US $ 295. Twelve more benefits for invited session organizers are listed at WMSCI 2008 web page.

For submissions or Invited Sessions Proposals, please go to the web site: http://www.sciiis.org/wmsci2008/organizer.asp

Authors of the best 10%-20% of the papers presented at the conference will be invited to adapt their papers for their publication in the Journal of Systemics, Cybernetics and Informatics.

Best regards,

WMSCI 2008 Secretariat

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The Price Is Right!

Goal: Buy from a set of 5 items (as many of each as you want) while spending between $9.25 and $10.00.

Demo

Step 1: Identify Information To Store

- What information does this program need to keep track of?

Step 1: Identify Information To Store

- How much has the user spent?

  `float: money`
- Which items are available?

  `list of strings: items`
- How much does each available item cost?

  `list of floats: prices`
- Which item did the user currently choose?

  `int: choice`
- How many of the currently chosen item does the user want?

  `int: number`

Step 2: Break Down Functionality

- What are the things that this program needs to do?

Step 2: Break Down Functionality

- Control the overall game play
- Prompt the user to enter a choice and number of items
- Calculate the total spent
- Figure out when the game is over
- Figure out win or lose
- Print a welcome message
- Remove the purchased item from the lists

<u>Attempt 1</u>

```
def playTry1():
    print "Welcome to the price is right!"
    print "Your goal is to buy 5 or fewer items (any number of each)"
    print "and spend between $9.25 and $10"

    items = ["bleach","coke","ramen","ice cream","super ball"]
    prices = [1.35, .75, .25, 3.00, 1.75]
    money = 0.0

    while money < 9.25 and len(items) > 0:
        print "You have spent $", money
        printItems( items )
        choice = input( "Which item would you like to buy? ")
        number = input( "How many "+items[choice]+" would you like?")
        print items[choice], "is $", prices[choice]
        money += prices[choice]*number

        prices = prices[0:choice] + prices[choice+1:]
        items = items[0:choice] + items[choice+1:]

    print "You have spent $", money
    if money >= 9.25 and money <= 10.0:
        print "You win!"
    else:
        print "You lose!"
```