UNIVERSITY of WISCONSIN–MADISON
Computer Sciences Department

CS 202: Introduction to Computation   Professor Andrea Arpaci-Dusseau

How can computation...
find what you are looking for?

How to Make List with 100 Random Numbers?

Script: Create Valuable Numbers
- Puts result in List: Valuable Numbers
  - Contains 100 elements
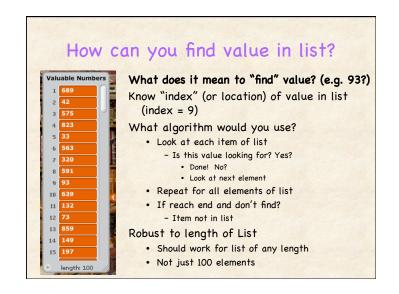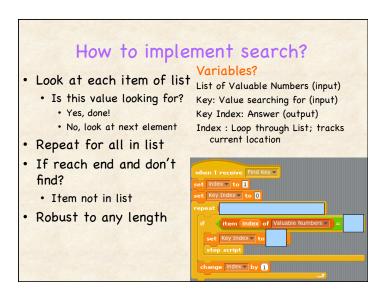 - Each element: Integer between 1 and 1000

How to plot contents of List?

How to plot contents of List?

Same approach as
    drawing function for y

Just grab next value of
    y from list instead

Check-Up

How many items can you put in a list?

How do you find the number of items in a list?

`length of Random Numbers`

What is the difference:

`add thing to Random Numbers`

`insert thing at 1 of Random Numbers`

What is the difference:

`delete all of Random Numbers`   `Delete a list`

For the given list, what would this code do?

```
if  Random Numbers contains 149
  play sound Bird until done
else
  play sound Cricket until done
```

Valuable Numbers

1	689
2	42
3	575
4	823
5	33
6	563
7	320
8	591
9	93
10	639
11	132
12	73
13	859
14	149
15	197

length: 100

"Search" has many meanings

- Look up "name" in phonebook (get number)
- Find "credit-worthy" consumers in database
- Find web pages relevant to "computer music"
- Identify suspicious cell phone conversations originating in Country X
- Find the meaning of life

- Today: Very straight-forward
  - Find specified KEY in a LIST
  - Find maximum element in a LIST

Search Demo

The Max element is 976 at index 72

Valuable Numbers

86	661
87	752
88	307
89	180
90	434
91	28
92	903
93	630
94	62
95	390
96	501
97	399
98	714
99	610
100	626

length: 100

How can you find value in list?

Valuable Numbers

1	689
2	42
3	575
4	823
5	33
6	563
7	320
8	591
9	93
10	639
11	132
12	73
13	859
14	149
15	197

length: 100

What does it mean to "find" value? (e.g. 93?)

Know "index" (or location) of value in list (index = 9)

What algorithm would you use?
- Look at each item of list
  - Is this value looking for? Yes?
    - Done! No?
    - Look at next element
- Repeat for all elements of list
- If reach end and don't find?
  - Item not in list

Robust to length of List
- Should work for list of any length
- Not just 100 elements

How to implement search?

- Look at each item of list
  - Is this value looking for?
    - Yes, done!
    - No, look at next element
- Repeat for all in list
- If reach end and don't find?
  - Item not in list
- Robust to any length

Variables?

List of Valuable Numbers (input)
Key: Value searching for (input)
Key Index: Answer (output)
Index : Loop through List; tracks current location

How to display matching Name?

Have corresponding Names list

Use Key Index to "index" into Name list

Take care to use broadcast and wait
- (and not just broadcast)
- Find Key script must finish to guarantee it has set value of "Key Index" variable

How do we know if Key not found?
- Key index is 0!

How can you find Max value in list?

How is this different than finding specified key?
- Don't know max value before start

How do you know found maximum?
- Greater than (or equal to) all others in list

Approach to finding maximum?
- Remember the largest seen so far
- If current key > current max, remember current key as new max

Similar Code Structure

Find Key   **Find Max**

Similarities?
    Loop through List using "index" which starts at 1, increments by 1, thru length
    Key Index or Max Index set to index where element is located
Differences?
    Find Max: Uses Max to record current max (initialize to 0...)
    Find Max: Must look through every element of list (don't stop early)

Demo "Find Max"

Linear Search

Summary: Examine all of the elements of list looking for a match; examine elements in order

Inefficient algorithm; why?

Efficiency (performance) really matters when millions or billions of elements!
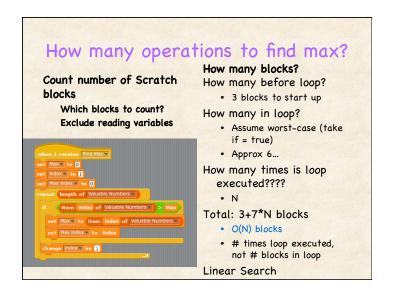
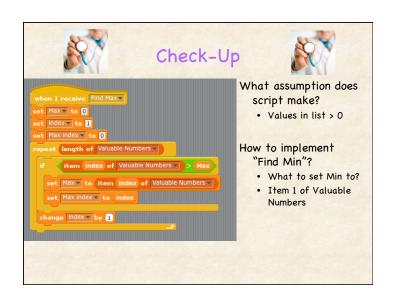## How efficient is an algorithm?
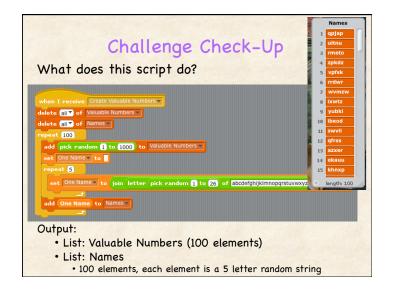
Option 1: Could run and measure how it takes
- Disadvantage: Depends on hardware
- Disadvantage: Don't know efficiency on different lists

Option 2: Can analyze code
- Count number of operations performed
- Advantage: Understand how behavior depends upon size of input
- Use N for number of elements in input (List)

How many operations to find max?

Count number of Scratch blocks
- Which blocks to count?
- Exclude reading variables

How many blocks?
How many before loop?
- 3 blocks to start up

How many in loop?
- Assume worst-case (take if = true)
- Approx 6…

How many times is loop executed????
- N

Total: 3+7*N blocks
- O(N) blocks
- # times loop executed, not # blocks in loop

Linear Search

Check-Up

What assumption does script make?
- Values in list > 0

How to implement "Find Min"?
- What to set Min to?
- Item 1 of Valuable Numbers

Challenge Check-Up

What does this script do?

Output:
- List: Valuable Numbers (100 elements)
- List: Names
  - 100 elements, each element is a 5 letter random string

Announcements

Today's Topic: How to search (find value in List)
- Basic approach: Loop thru list using index variable, inc index by 1 til end
- How many ops to find element in List: O(N) with Linear Search

Announcements
- Exam 1 returned (Ave 90)
- Homework 5: Due Friday at 5pm
  - Compose Random Music (Save values to replay song in list!)
  - Visualization