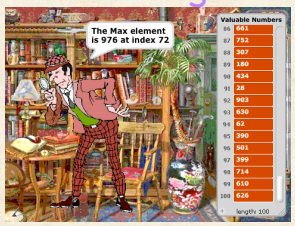
UNIVERSITY of WISCONSIN-MADISON
Computer Sciences Department

CS 202
Introduction to Computation

Professor Andrea Arpaci-Dusseau
Fall 2010

Lecture 19: How can computation... find what you are looking for?



"Search" has many meanings

- Look up "name" in online phonebook
- 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

What is a List?

Lists are common data structure

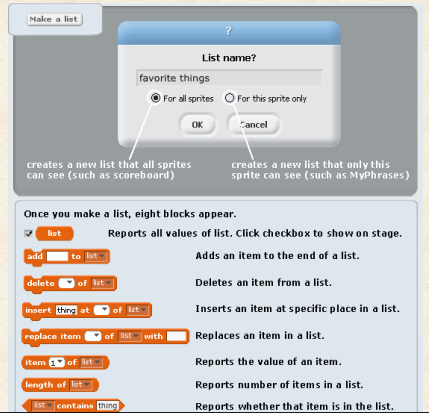
- List of items to buy at grocery store
- List of high scores for game
- List of student names in class
- List of account balances at bank
- List of cities in Wisconsin

Name the List as a whole

- Index into List to access individual items, elements

<Insert Demo Here: Find Key>

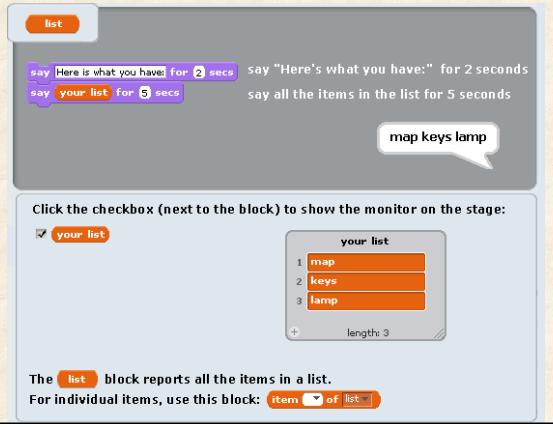
Lists in Scratch: How to Create?



Example List in Scratch

- Name: Valuable Numbers
- List of N elements: Element1, Element2, …, ElementN
- N=100 for Valuable Numbers
  - What value is at element 1? element 10?
  - At what location (or index) is value 73?

Lists: How to Look at Contents?



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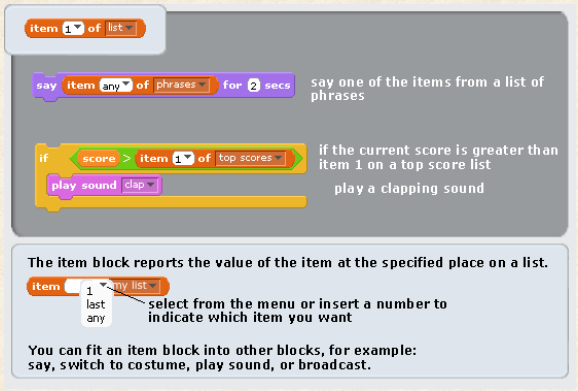

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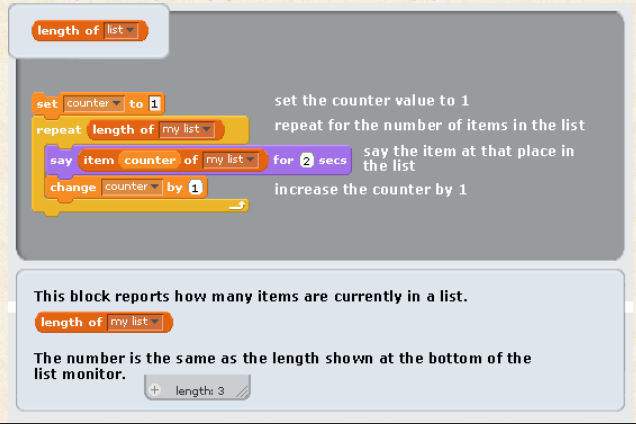

Lists: How to Change the Contents?

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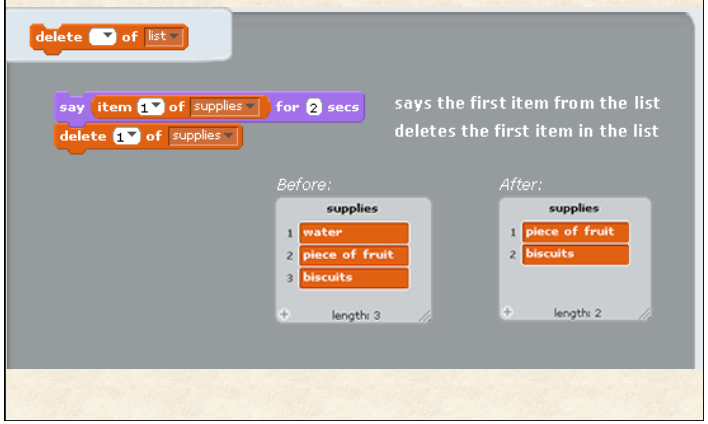
Lists: How to Change the Contents?

Lists: How to Remove Items?



Lists: How to Remove Items?

You can specify the number of the item you want to delete. For example:

deletes item 2 from the list

To delete the last item in the list, choose "last" from the pull-down menu:

You can also choose to delete everything in the list:

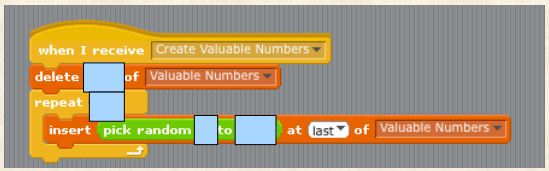
Lists: How to Delete Entire List?

Note: When a list is deleted, any of its blocks used in scripts will remain, but the scripts will not function properly.

How to Make List with 100 Random Numbers?

New script: Create Valuable Numbers

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



How can you find specific element in list?

What does it mean to "find" element?
Know the "index" (or location) of that value in the list

Algorithm you would use?

- Look at one element of list; Ask?
  - 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 can you find value in list?

- Look at each element 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

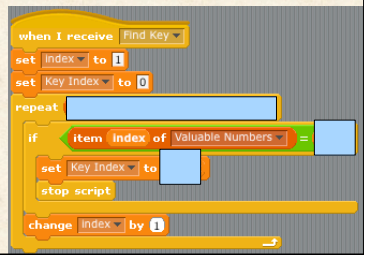
Variables?

List of Valuable Numbers (input)

Key: Value searching for (input)

Key Index: Answer (output)

Index : Loop through List; tracks current location (private)



How to display matching Name?

Have corresponding Name list

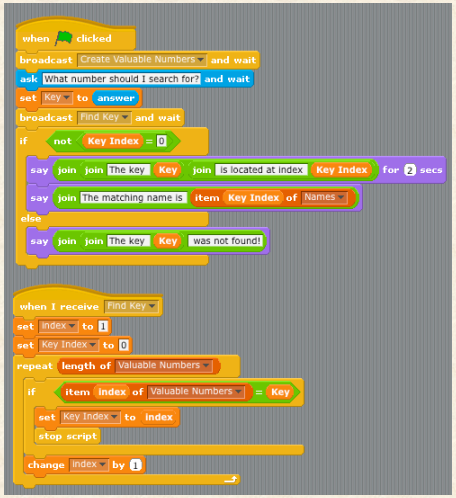
Use Key Index to "index" into Name list

Take care to use broadcast and wait

- (and not just broadcast)
- Find Key scripts must finish before caller knows it has set value of 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?

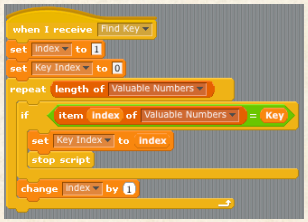
- Greater than (or equal to) all others in list

Approach to finding maximum?

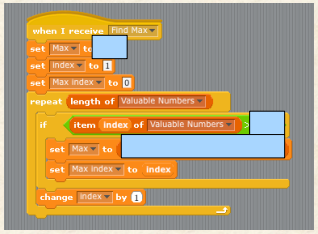
- Remember the largest seen so far
- If current key > current max, remember current key as new max

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)

How efficient is an algorithm?

Option 1: Could run and measure how it takes

- Disadvantage: Depends on hardware

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)

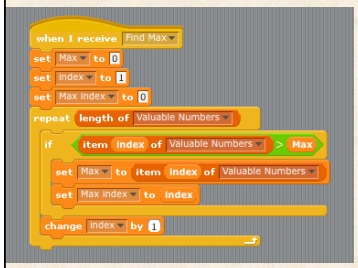
Efficiency (performance) really matters when millions or billions of elements!

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 7…

How many times is loop executed????

Total: 3+7*N blocks

- O(N) blocks
- # times loop executed, not # blocks in loop

Today's Summary

How to search; how to find elements in a List

- List is basic data structure
- Loop through list using index variable, inc by 1 til end
- Max: Remember largest seen thus far
- How many ops to find max element of List: O(N)

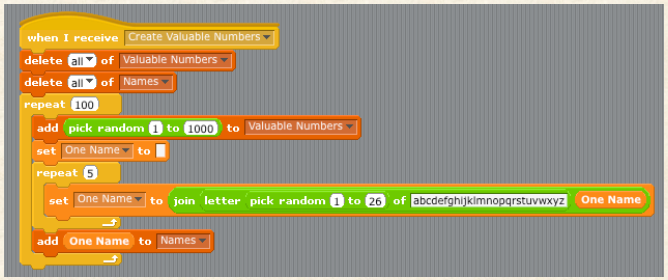
Reading:

- Invitation pp 55-66 and 80-88 (Searching and complexity)

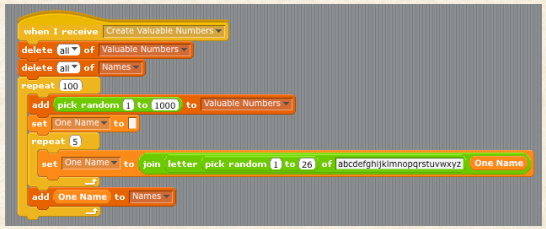
Announcements

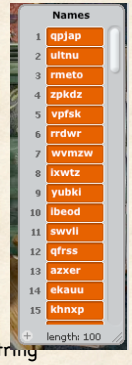
- Exam 1 being graded
- Project 1: Draft uploaded to Scratch website by Friday at 5:00
- No other homework this week

Challenge:
What does this script do?



What does this code do?





Output:

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