For data to solve problems, what do we need to do?

Capture
- Collect or obtain

Store
- Where? what if it gets lost?

Share
- Who should have access? Anonymize for privacy

Organize
- Sort it? put in categories?

Process it
- Search through it, analyze it, mine it for correlations

Visualize it
- What is useful for humans to look at?

Use results to inform our decision

Lists

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 (+email, id, grades)
- List of account balances at bank (+ account id)
- List of questions to ask in trivia game (+ answers)

Many items in List

Name the List as a whole
- Index into List to access individual items, elements
- Individual elements are named by their number (or index) in the list
Example List in Scratch

• Name: Valuable Numbers

• List of N elements: Element1, Element2, ..., ElementN
  - Don’t need to know the size of N ahead of time
  - N can change...

• N=100 for Valuable Numbers
  - What value is at index 17 index 107?
  - At what location (or index) is value 73?

Lists in Scratch: How to Create?

- Create a list called my list
- Insert a value at a specific index
- Remove an item from a list
- Report the size of a list
- Report the value of an item
- Report the number of items in a list
- Report whether the list is empty

Lists: How to Look at Contents?

- Use the list block to see all items
- Use the length block to see the number of items
- Use the index block to see the index of an item

Lists: How to Change the Contents?

- Add items to the list
- Remove items from the list
- Replace items in the list
- Add an item to the end of the list

Use this block if you want to add an item to the end of a list.
Lists:
How to Change the Contents?

- When lamp clicked:
  insert "lamp" at first place in list

Lists:
How to Remove Items?

- Delete "all": says first item from list
- Delete "one" says first item in list
- Delete "by position" says first item in list

You can indicate where in the list you want to add an item:
- "at beginning" inserts item at the beginning
- "at end" inserts item at the end
- "at random" inserts item at a random place in the list

You can choose where in a list to put an item. For example:
- Replace item 1 of list with "new item"
- Replace item 2 of list with "new item"
- Replace last item in list with "new item"
Lists:
How to Look at the Contents?

1) Make a List called “Names”

Insert 10 names into a list called “Names”

- Could modify list by hand...
- Better to write a script “Make Names” that does this
- Make sure it behaves correctly if run multiple times!
2) Say All Names

Make a script named “Say All Names”
• Sprite should “say” each item in Name List one at a time (in order!)
• Side note: Sprite can “say” entire Name List at once
• Challenge: Script should work for any list called Name (of any length, not just 10!)
• Hint: Need a new variable “index”

3) Make a List called Ages

Make a script called “Make Ages”
• Insert 10 ages into the list
• All ages should be randomly generated between 17 and 23

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

4) Does Age List contain 20?

Check to see if list contains the age “20”
• Hint: Can do this with one instruction!
5) Where does Age 20 Appear?

Where in list does age appear??????
What name corresponds to that age?

“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

How can you find value in list?

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

5) Where does Age 20 Appear?

Where in list does age appear??????

• Use Variable “Key” to hold age you are searching for (i.e., set Key to 20)
• Use Variable “Key Index” to hold answer (location of key)
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
- • 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

6) 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!

Check-Up

How many items can you put in a list?

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

What is the difference:

What is the difference:

For the given list, what would this code do?
What will these scripts do?

Stage scripts

Initializes two lists:
Pen Color and Pen Shade

How long is each List?

Result of Running Scripts

Symmetric picture along both x and y axis (4 quarters)
Ten different color/shade combinations

2: What will these scripts do?

Plot Values in List

How are x, y varied?
How many pen points for each x,y?
What is relationship of two Lists?
What is purpose of c?

Result of Running Scripts

Symmetric picture along both x and y axis (4 quarters)
Ten different color/shade combinations
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

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!

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
- 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?

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