
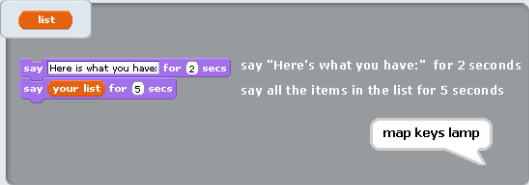


Example List in Scratch


- 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?



Click the checkbox (next to the block) to show the monitor on the stage:



The **list** block reports all the items in a list.
For individual items, use this block: **item** of list

Lists: How to Look at the Contents?

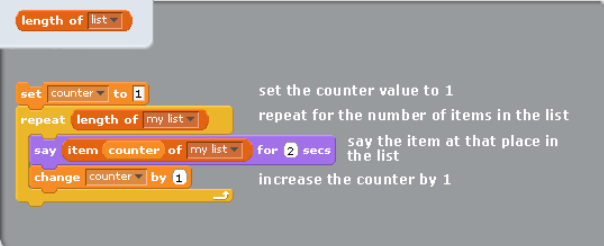


The item block reports the value of the item at the specified place on a list.




You can fit an item block into other blocks, for example: say, switch to costume, play sound, or broadcast.

Lists: How to Look at the Contents?



This block reports how many items are currently in a list.



The number is the same as the length shown at the bottom of the list monitor.

Lists: How to Change the Contents?

add [] to list name []

add **rock** to my list [] add "rock" to the list
 add **paper** to my list [] add "paper" to the list
 add **scissors** to my list [] add "scissors" to the list

my list
 1 rock
 2 paper
 3 scissors
 + length: 3

say **item any** of my list [] for 2 secs say one of the items in the list

Use this block if you want to add an item to the end of a list.
add your words or number here to your list []

Can't find the list blocks? You need to first to make a list: [Make a list](#)

Lists: How to Change the Contents?

insert thing at [] of list []

when lamp clicked
insert lamp at 1 of my list [] when the lamp sprite is clicked
 insert the item "lamp" at the first place in the list

Before:
my list
 1 compass
 + length: 1

After:
my list
 1 lamp
 2 compass
 + length: 2

You can indicate where in the list you want to add an item.
insert score at 2 of scoreboard [] inserts item at the specified place in the list
insert Hello, world! at any of greetings [] inserts item at a random place in the list

Lists: How to Change the Contents?

replace item [] of list [] with []

replace item 1 of scoreboard [] with score replaces item 1 in the list with the current score

Before:
scoreboard
 1 5
 2 8
 + length: 2

After:
scoreboard
 1 10
 2 8
 + length: 2

You can choose where in a list to put an item. For example:
replace item 2 of race times [] with timer replaces item 2 in the list
replace item last of questions [] with How are you? replaces last item in the list

Lists: How to Remove Items?

delete [] of list []

say **item 1** of supplies [] for 2 secs says the first item from the list
delete 1 of supplies [] deletes the first item in the list

Before:
supplies
 1 water
 2 piece of fruit
 3 biscuits
 + length: 3

After:
supplies
 1 piece of fruit
 2 biscuits
 + length: 2

Lists: How to Remove Items?

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

delete 2 of my list deletes item 2 from the list

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

delete last of my list

You can also choose to delete everything in the list:

delete all of my list

Lists: How to Delete Entire List?

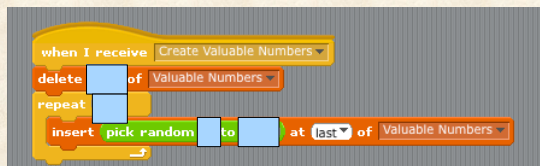


Note: When a list is deleted, any of its blocks used in scripts will remain, but the scripts will not function properly.

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)

```

when I receive Find Key
set index to 1
set Key Index to 0
repeat
if item index of Valuable Numbers = Key
set Key Index to index
stop script
change index by 1
    
```

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!

```

when clicked
broadcast Create Valuable Numbers and wait
ask What number should I search for? and wait
set Key to answer
broadcast Find Key and wait
if not Key Index = 0
say join join The key Key join is located at index Key Index for 2 secs
say join The matching name is item Key Index of Names
else
say join join The key Key was not found!

when I receive Find Key
set index to 1
set Key Index to 0
repeat length of Valuable Numbers
if item index of Valuable Numbers = Key
set Key Index to index
stop script
change index by 1
    
```

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

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	

Similar Code Structure

Find Key

```

when I receive Find Key
  set index to 1
  set Key Index to 0
  repeat length of Valuable Numbers
    if item index of Valuable Numbers = Key
      set Key Index to index
      stop script
  change index by 1
  
```

Find Max

```

when I receive Find Max
  set Max to 0
  set index to 1
  set Max Index to 0
  repeat length of Valuable Numbers
    if item index of Valuable Numbers > Max
      set Max to item index of Valuable Numbers
      set Max Index to index
  change index by 1
  
```

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

```

when I receive Find Max
  set Max to 0
  set index to 1
  set Max Index to 0
  repeat length of Valuable Numbers
    if item index of Valuable Numbers > Max
      set Max to item index of Valuable Numbers
      set Max Index to index
  change index by 1
  
```

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?

```

when I receive Create Valuable Numbers
  delete all of Valuable Numbers
  delete all of Names
  repeat 100
    add pick random 1 to 1000 to Valuable Numbers
    set One Name to 1
    repeat 5
      set One Name to join letter pick random 1 to 26 of abcdefghijklmnopqrstuvwxyz One Name
    add One Name to Names
  
```

What does this code do?

```

when I receive Create Valuable Numbers
  delete all of Valuable Numbers
  delete all of Names
  repeat 100
    add pick random 1 to 1000 to Valuable Numbers
    set One Name to 1
    repeat 5
      set One Name to join letter pick random 1 to 26 of abcdefghijklmnopqrstuvwxyz One Name
    add One Name to Names
  
```

Names	
1	qpjap
2	ultnu
3	rmeto
4	zpkdz
5	vpsfk
6	rrdwr
7	wvmzw
8	lxwtz
9	yubki
10	lbeod
11	swvli
12	qfrss
13	azxer
14	ekauu
15	khnxp

length: 100

Output:

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