Final Exam CS10 Summer 2017

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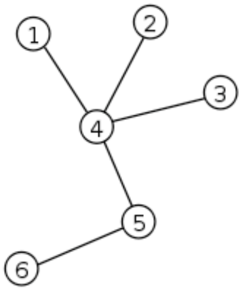
Q1: Graph Terminology



Which of the following terms could describe the graph to the right? (select all that apply)

□ Tree
□ Disconnected

□ Acyclic
□ Directed

Q2: Quantum Computers (Week 8 Reading)

Which of the following is true about quantum computers, according to the article "Here's why we should be really excited about quantum computers"? (select all that apply)

□ A quantum bit can exist as a 1, or a 0, or both at the same time.
□ Quantum computers could revolutionize entire industries.
□ Quantum computers are better than normal computers at performing calculations with many numbers.
□ Quantum computers can be programmed to act similarly to human brains.

Q3: P vs. NP (Week 8 Reading)

According to the video "P vs. NP and the Computational Complexity Zoo", which of the following best describes the P and NP classes of problems? (pick one)

○ P problems' solutions can be verified quickly; NP problems can be solved quickly.
○ P problems can be solved quickly; NP problems cannot be solved quickly.
○ P problems can be solved quickly; NP problems' solutions can be verified quickly.
○ P problems' solutions can be verified quickly; NP problems' solutions cannot be verified quickly.

Q4: What is Information Theory? (Week 8 Reading)

What do a song, a telegraph, an email, and a drawing have in common, according to the video? (pick one)

○ They are made of bits.
○ They are universal forms of communication.
○ They can carry the same amount of information.
○ They have the same information density.

Q5: UI and Design

Which of the following steps describe the iterative design cycle in order? (pick one)

○ Design, Test & Evaluate, Prototype, Repeat
○ Prototype, Design, Test & Evaluate, Repeat
○ Prototype, Simplify, Test & Evaluate, Repeat
○ Design, Simplify, Test & Evaluate, Repeat
○ Design, Prototype, Test & Evaluate, Repeat

Q6: Internet & IP Addresses

Which of the following are true statements about IP addresses? (select all that apply)

□ Everything that connects to the internet needs an IP address
□ We ran out of unique IPv4 addresses
□ DNS translates domain names like "facebook.com" to IP addresses
□ We will probably run out of IPv6 addresses in the next five years

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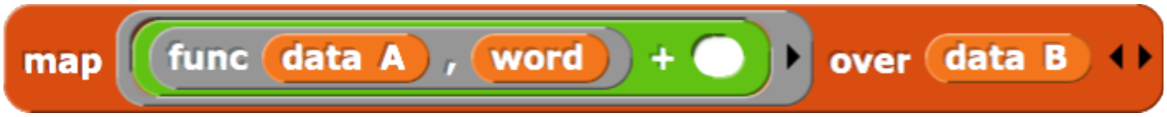
Q7: Runtime the Jewels

You will determine the runtime of the following expression in terms of the size (length) of each input separately. func ☰ , ▭ takes linear time in terms of the length of its list input, and constant time in terms of the length of its text input.



```
map (( func (data A) , (word) ) + ( ) ) over (data B) ◂▸
```

What is the runtime complexity of the expression in terms of the length of data A ?

constant	logarithmic	linear	quadratic	exponential	something else
○	○	○	○	○	○

What is the runtime complexity of the expression in terms of the length of the word word ?

constant	logarithmic	linear	quadratic	exponential	something else
○	○	○	○	○	○

What is the runtime complexity of the expression in terms of the length of data B ?

constant	logarithmic	linear	quadratic	exponential	something else
○	○	○	○	○	○

Replace data B with a second instance of data A . What is the runtime complexity in terms of data A ?

constant	logarithmic	linear	quadratic	exponential	something else
○	○	○	○	○	○

Q8: A Game of San Francisco vs. Oakland

A man and a woman are planning a trip. They can each choose to go to either San Francisco or Oakland. Their utilities for every outcome are shown below. Which outcome is an equilibrium? (pick one)

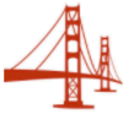
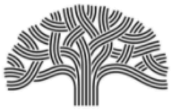
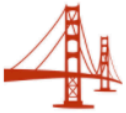
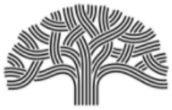
Hint: It might help to first consider the man's optimal strategy.

○ A

○ B

○ C

○ D

Woman's choice Man's choice		
	A. 👩 2 👦 0	B. 👩 0 👦 0
	C. 👩 0 👦 1	D. 👩 1 👦 1

Q9: Distributed Computing

According to Alex Mckinney's lecture on distributed computing, which of the following is a reason why *idempotence* is important in a distributed program? (pick one)

○ Machines in datacenters may fail unexpectedly, so you must have multiple copies of the same data.

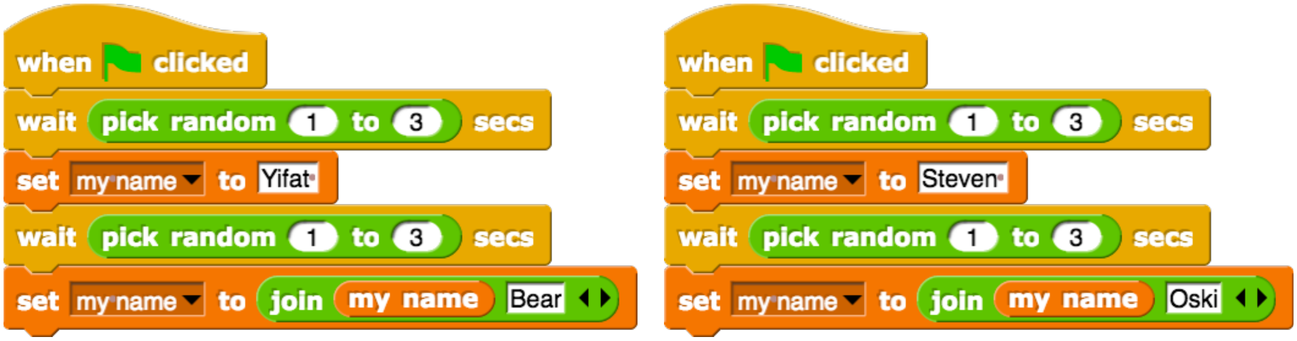
○ Malicious users could take advantage of your system by sending many requests at the same time, so you must make sure only one request actually gets executed.

○ Having internet connection 99.99% of the time is not guaranteed, so you must make a program that continues running when the network is down.

○ Distributed programs send user requests to datacenters around the world, so you must make sure your code runs correctly independent of the machine it's run on.

Q10: Con-What Cur-Is Ren-My Cy-Name

Which of the following could be the value of global variable `my_name` when the green flag is clicked and after both scripts below finish executing? (select all that apply)



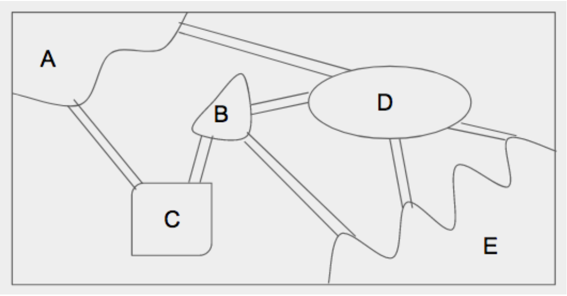
```
when ⚑ clicked
wait (pick random 1 to 3) secs
set my name to Yifat
wait (pick random 1 to 3) secs
set my name to (join (my name) Bear)
```

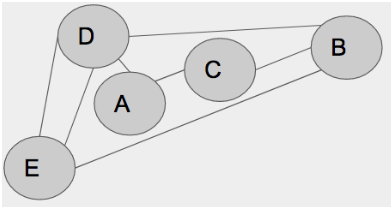
```
when ⚑ clicked
wait (pick random 1 to 3) secs
set my name to Steven
wait (pick random 1 to 3) secs
set my name to (join (my name) Oski)
```

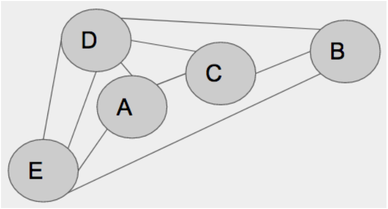
Yifat	Steven	Yifat Bear	Steven Oski	Yifat BearOski	Steven Yifat	Oski	Yifat OskiBear
□	□	□	□	□	□	□	□

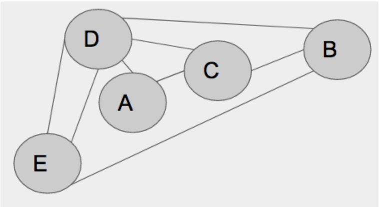
Q11: Graph Abstraction

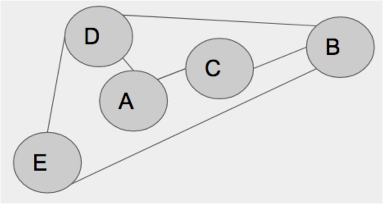
Which of the following undirected graphs correctly abstracts the following map of islands and bridges? (pick one)



○ 

○ 

○ 

○ 

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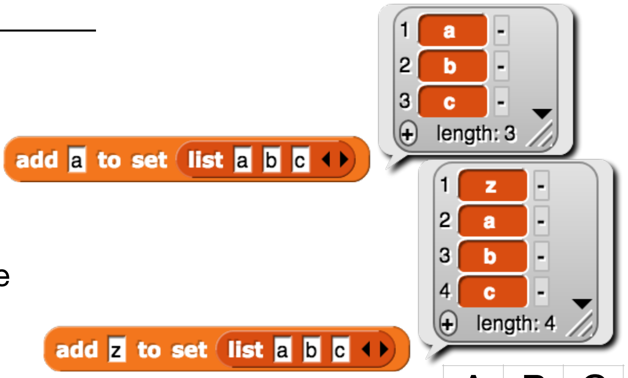
Q12 a): Setting You Up For Success

A set is similar to a list, with one major difference: it cannot contain duplicate values. If you try to add a value to a set that already contains that value, no value should be added. Furthermore, sets are *unordered*, so we do not care about the positions of values in a set. **empty_set** reports an empty set.

First, we'll write the block add_value_to_set. Some example inputs and outputs are shown to the right (the output appears like a list, but we will treat it as a set).



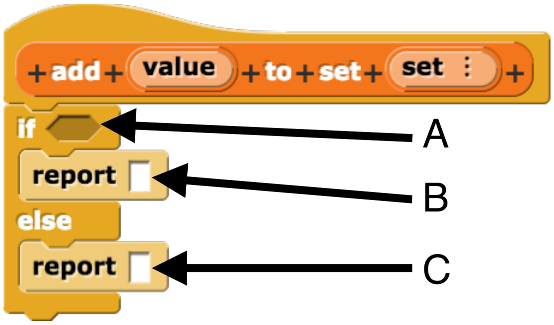
```
add a to set list a b c
```

```
1 a
2 b
3 c
length: 3
```

```
add z to set list a b c
```

```
1 z
2 a
3 b
4 c
length: 4
```

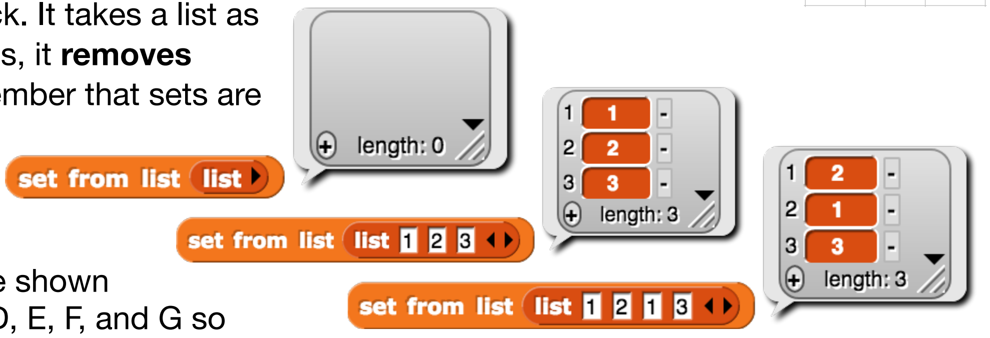
Complete code using the blanks for A, B, and C.



```
+add+(value)+to+set+(set :)+
if < >
  report [ ]
else
  report [ ]
```

	A	B	C
item (1) of (set)	○	○	○
(set) contains (value)	○	○	○
set	○	○	○
(value) in front of (set)	○	○	○
item (1) of (set) = (value)	○	○	○
empty set	○	○	○
empty? (set)	○	○	○

Next, we'll write the set_from_list block. It takes a list as input, and reports a set. In other words, it **removes duplicate values from the list**. Remember that sets are *unordered*, so we don't care if the order of the values change when we run operations.



```
set from list (list)
```

```
length: 0
```

```
set from list list 1 2 3
```

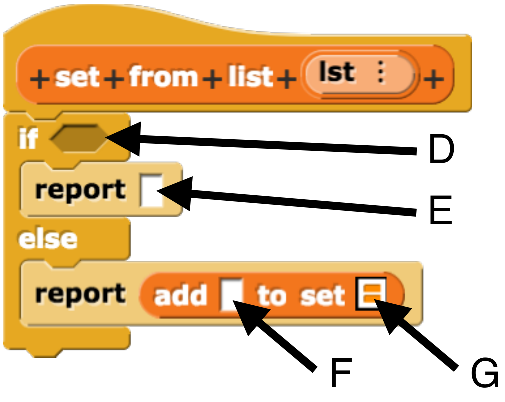
```
1 1
2 2
3 3
length: 3
```

```
set from list list 1 2 1 3
```

```
1 2
2 1
3 3
length: 3
```

Some example inputs and outputs are shown to the right. Complete the blanks for D, E, F, and G so that the block works as described.

Points for this problem do not rely on correctness of the previous block.



```
+set+from+list+(lst :)+
if < >
  report [ ]
else
  report (add [ ] to set [ ])
```

	D	E	F	G
item (1) of (lst)	○	○	○	○
length of (lst) = length of (set from list (lst))	○	○	○	○
set from list (item (1) of (lst))	○	○	○	○
all but first of (lst)	○	○	○	○
empty? (lst)	○	○	○	○
empty set	○	○	○	○
set from list (all but first of (lst))	○	○	○	○

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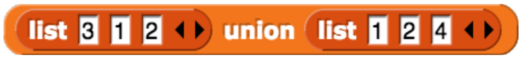
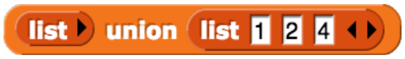
The *union* of two sets, A and B, is a new set that contains items found in just A, just B, or both A and B. Here are two examples of union:

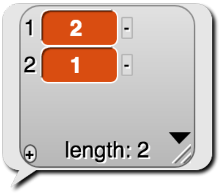

list 3 1 2 union list 1 2 4

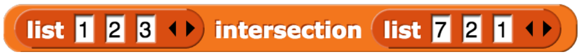
=> [3, 1, 2, 4]


list union list 1 2 4

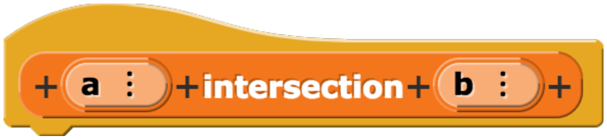
=> [1, 2, 4]

b) The *intersection* of two sets, A and B, is a new set that contains only items found in *both* A and B. Please fill in the block definition to achieve this operation. You may use previous whatever Snap*!* blocks you'd like, including those introduced in problem 12. You may not need all of the lines.

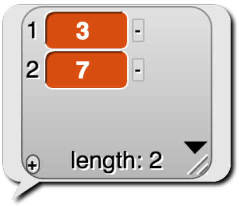

1 2
2 1
length: 2

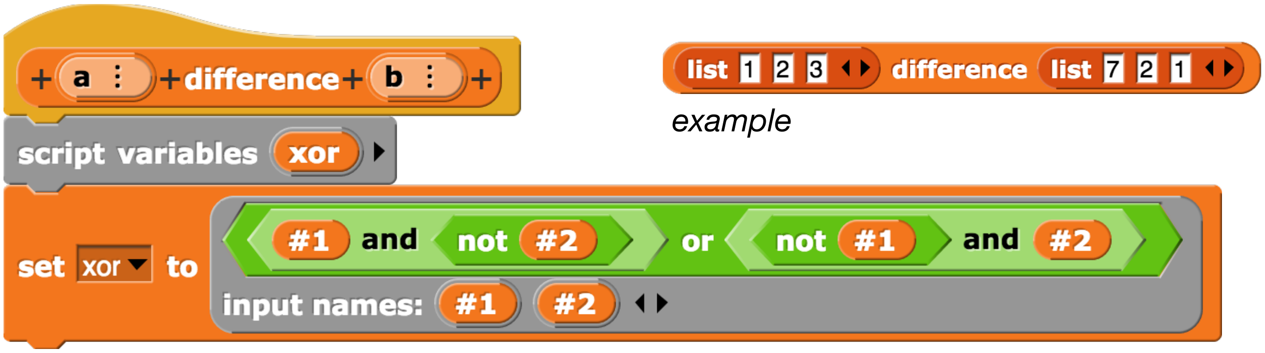

list 1 2 3 intersection list 7 2 1

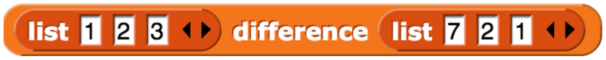
example


+ a ⋮ +intersection+ b ⋮ +

c) The *difference* of two sets, A and B, is a new set that contains only items found in just A or just B. If an item is in both A and B, it is not included. Please fill in the block definition to achieve this operation. You may use previous whatever Snap*!* blocks you'd like, including those introduced in problem 12. You may not need the xor variable.


1 3
2 7
length: 2


```
+ a ⋮ +difference+ b ⋮ +
script variables xor
set xor to (#1 and not #2) or (not #1 and #2)
    input names: #1 #2
```


list 1 2 3 difference list 7 2 1

example

Q13: Debugging in Python

We have attempted to write a function, `index(item, lst)`, that returns the index of `item` in the list `lst`. Here are a few examples of how the function should work:

```
>>> my_list = [2, 3, 4, 5, 6]
>>> index(2, my_list)         # 2 is in the beginning of the list
0
>>> index(5, my_list)         # 5 is in the middle of the list
3
>>> index(7, my_list)         # 7 is not in the list
-1
```

We begin by writing the function using iteration, but there seems to be a bug.

```
def index(item, lst):
     for i in range(0, len(lst)):
          if lst[i] == item:
               return i
          else:
               return -1
```

a) What will the buggy code above output for the following call? (pick one)

```
>>> index(2, [1, 2, 3])
```

○ -1 ○ 0 ○ 1 ○ Error

b) Briefly describe the bug in the code above. ____

____.

We decide to rewrite the function using a different form of iteration, but unfortunately there's another bug.

```
def index(item, lst):
     i = 0
     current = lst[i]
     while current != item:
          i = i + 1
          current = lst[i]
     if current == item:
          return i
     else:
          return -1
```

c) What will the buggy code above output for the following call? (pick one)

```
>>> index(4, [1, 2, 3])
```

○ -1 ○ 0 ○ 1 ○ Error

d) Briefly describe the bug in the code above. ____

____.

Yet again, we decide to rewrite the function. This time we use recursion. Unfortunately there's another bug.

```
def index(item, lst):
     if lst[0] == item:
          return 0
     else:
          return 1 + index(item, lst[1:])
```

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e) Fill in the blanks below with an example of inputs to the function that would illustrate the bug in the buggy code above. Then explain why those inputs illustrate the bug.

`index(________________, ________________________________)` would illustrate the bug because

____

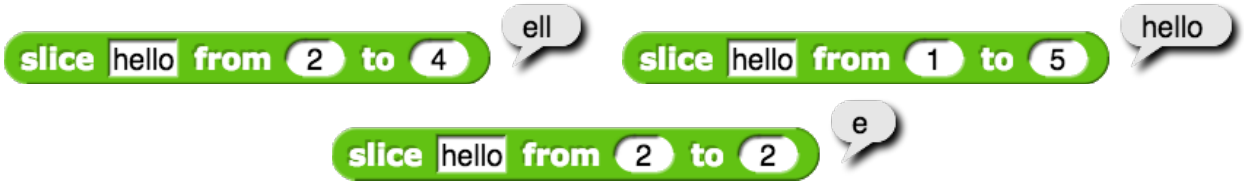
____.

f) On the line below, implement `index` using only a Python list comprehension. Unlike before, the `index` function should return a list of all of the indices at which `item` appears in `lst`. If `item` is not in `lst`, the function should return an empty list.

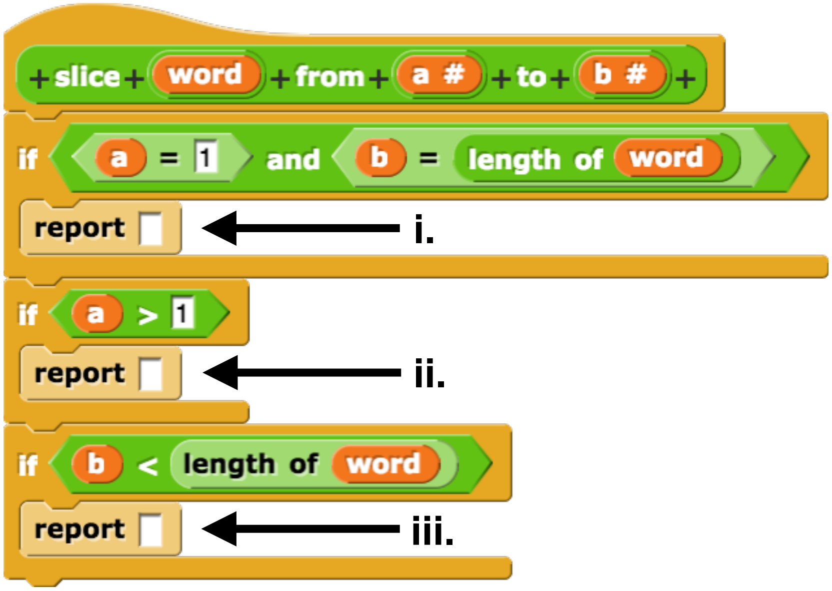
```
        def index(item, lst):

            return ______________________________________________
```

Q14: Slice Slice Baby

In Python, we have the concept of *slicing*, where we can use indices to extract a substring. Let's make our own slicing operation in Snap*!*. Here are some examples of how this operation should behave:



```
slice hello from 2 to 4     → ell
slice hello from 1 to 5     → hello
slice hello from 2 to 2     → e
```

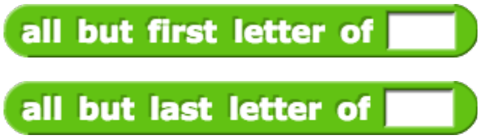


```
+slice+ word +from+ a # +to+ b # +
if < < a = 1 > and < b = length of word > >
    report [ ]   ← i.
if < a > 1 >
    report [ ]   ← ii.
if < b < length of word >
    report [ ]   ← iii.
```

Complete the code so that the slice function works as above. You can assume that the inputs to the block are valid.

Note that the indices are treated as inclusive, and indexing starts at 1 like usual in Snap*!*.

You may find the following two blocks useful. You are free to use other blocks as well.



```
all but first letter of [ ]
all but last letter of [ ]
```

i. ____

ii. ____

iii. ____

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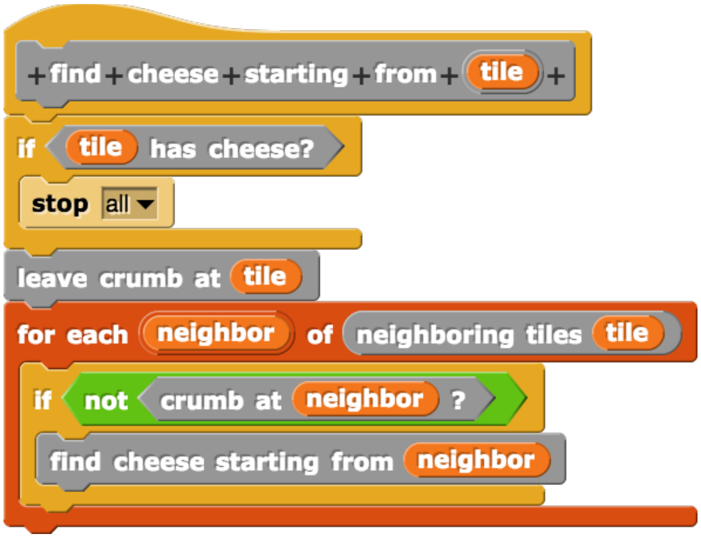
Q15: Say Cheese

A mouse is in a maze, and is searching for the cheese. To find the cheese, the mouse will use a Snap*!* block. The strategy involves leaving crumbs so that it knows where it's been.

□ has cheese?	Reports true if the given tile has cheese on it.
leave crumb at □	Places a crumb on the given tile.
crumb at □ ?	Reports true if the given tile has a crumb on it.
neighboring tiles □	Reports a list of all tiles that are next to the given tile in random order. Squares colored black will not be included.



```
+find+cheese+starting+from+(tile)+
if <(tile) has cheese?>
    stop [all]
leave crumb at (tile)
for each (neighbor) of (neighboring tiles (tile))
    if <not <crumb at (neighbor) ?>>
        find cheese starting from (neighbor)
```

To the right is an potential result of the the algorithm. The mouse starts from the tile marked "**S**", and there is cheese on the tile marked "**C**". Tiles are marked in the order that crumbs were left on them. If a tile does not have a number, no crumb was left on it.

Please mark two *different, unique* potential results of the algorithm in the same fashion. Blank mazes are provided below.

			■	C
	■	5	6	7
	■	4	■	■
■	■	3		
S	1	2	■	

a)

			■	C
	■			
	■		■	■
■	■			
S			■	

b)

			■	C
	■			
	■		■	■
■	■			
S			■	

c) How many ways are there for the mouse to find the cheese using this algorithm in this scenario?

____

d) Which search algorithm does this code best represent?

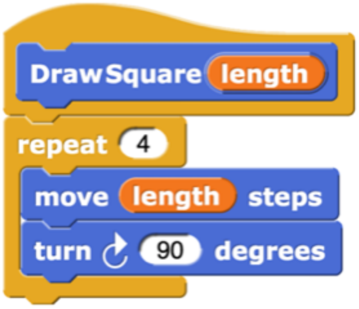
____

Writing *Snap!* code on paper (supplementary)

You will be asked to write *Snap!* code on this exam, so we've developed a technique for writing it on paper. There are a few key things to notice:

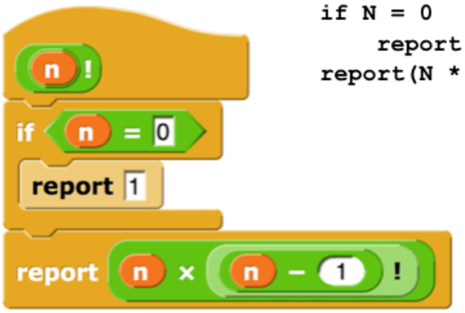
- We often write variables in **`UPPERCASE`**.
- We change spaces between words in block names to dashes (this makes it much easier to read).
- We use indentation just as *Snap!* does, to help us understand what is "inside" the **`if`**, **`else`**, and other Control structures. E.g., here's how you could write the **`DrawSquare`** and **`n!`** blocks:

```
Draw-Square(LENGTH)
   repeat(4)
      move(LENGTH)steps
      turn-right(90)degrees
```



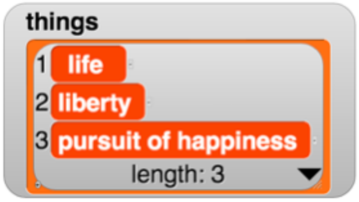
```
DrawSquare length
repeat 4
  move length steps
  turn ↻ 90 degrees
```

```
(N)!
   if N = 0
      report(1)
   report(N * (N - 1)!)
```



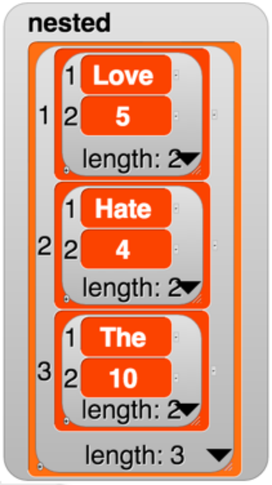
```
n !
if n = 0
  report 1
report n × (n − 1) !
```

- When you want to write a list of things, write them with an open parenthesis, then the first item, second item, etc (separated by spaces) and when you're done, put a closed parenthesis. If any of your items are a sentence, you have to put quotes around the sentence. So, for example, the following list of three things would be written as the equivalent 3-element-list:
  - **`(life liberty "pursuit of happiness")`**.



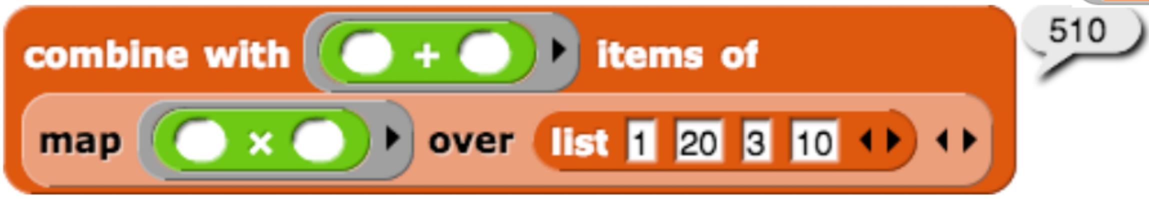
things	
1	life
2	liberty
3	pursuit of happiness
length: 3	

- Similarly, a nested list just shows up as a nested set of parenthesis. So the following would be written as
  - **`((Love 5) (Hate 4) (The 10))`**.



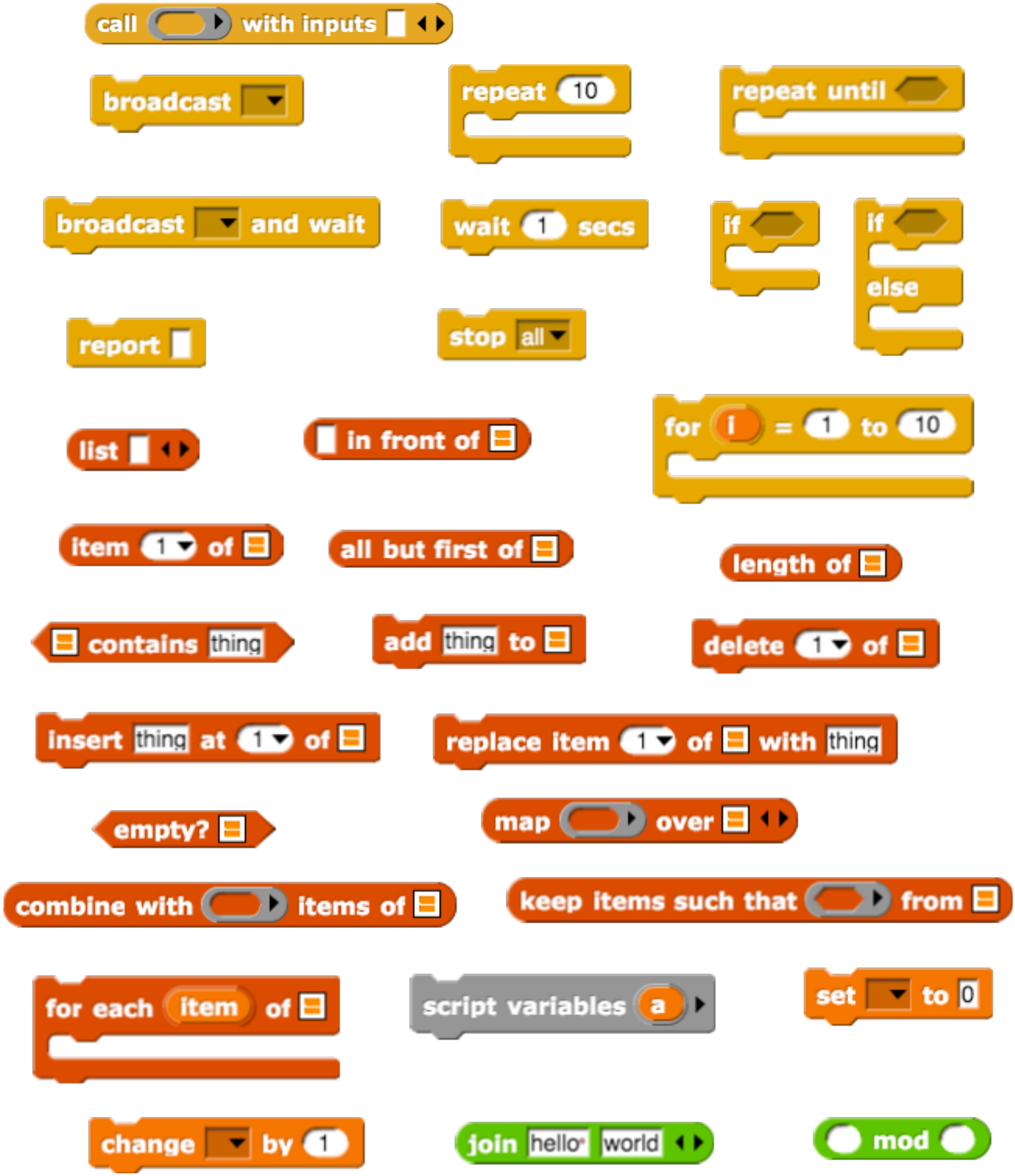
nested		
1	1	Love
	2	5
	length: 2	
2	1	Hate
	2	4
	length: 2	
3	1	The
	2	10
	length: 2	
length: 3		

- If you want to pass in a function as argument, you know the function must be surrounded by a grey-border. Here are three new conventions:
  - The grey border is written as *square brackets*: **`[ ]`**
  - Blanks are written as parenthesis with underscore _ in the middle, but common blocks that are passed in to HOFs can be simplified by just their name (and not the parens and underscores)
  - Return values are written as ➔ **`value`**
- So the following would be written as:
  - **`Combine[(_)+(_)]items-of(Map[(_)x(_)]over( (1 20 3 10) ))`**
- or, in a more simplified (and preferred) format, also showing return value:
  - **`Combine[ + ]items-of(Map[ x ]over( (1 20 3 10) ) ➔ 51`**



```
combine with ( ○ + ○ ) items of
  map ( ○ × ○ ) over list 1 20 3 10
```

A bunch of Snap blocks are shown below as a reference. For coding problems on this exam, unless the problem says otherwise, you may use any Snap! block, not just the ones below (we've omitted lots of them, like +, -, split, etc.)



```
call ( ) with inputs [ ] ◂▸
broadcast [ ▾]
repeat (10)
repeat until < >
broadcast [ ▾] and wait
wait (1) secs
if < >
if < >
else
report [ ]
stop [all ▾]
list [ ] ◂▸
[ ] in front of ☰
for (i) = (1) to (10)
item (1 ▾) of ☰
all but first of ☰
length of ☰
☰ contains [thing]
add [thing] to ☰
delete (1 ▾) of ☰
insert [thing] at (1 ▾) of ☰
replace item (1 ▾) of ☰ with [thing]
empty? ☰
map ( ) over ☰ ◂▸
combine with ( ) items of ☰
keep items such that < > from ☰
for each (item) of ☰
script variables (a) ▸
set [ ▾] to [0]
change [ ▾] by (1)
join [hello ] [world] ◂▸
( ) mod ( )
```