Problem 1: Multiple Choice – circle the correct answer [3 marks]

i. What educational background is required to write algorithms?

a. BSc in computer science or engineering

b. MSc in computer science or computer engineering

c. A high school diploma

d. No educational background is required

ii. If the Internet consisted of four computers, there would be six possible connections. If it consisted of five computers, there would be ten possible connections. How many connections are possible with 10 computers?

a. 10

b. 30

c. 45

d. Infinite

iii. How many algorithms can solve one specific problem?

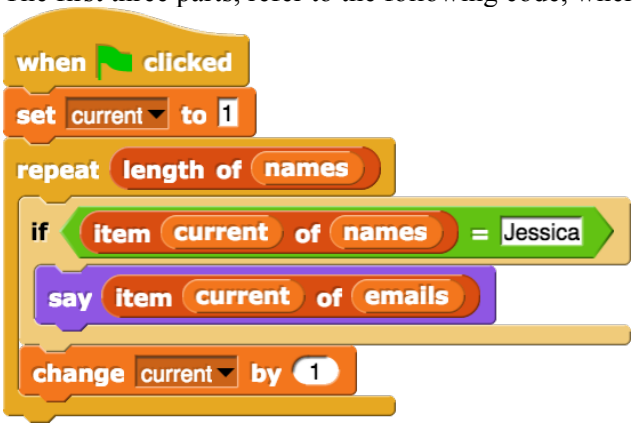
a. Only one

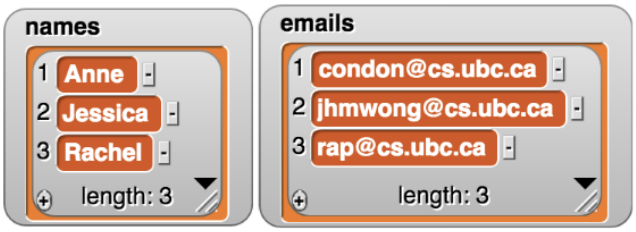
b. Many

c. It depends on the type of algorithm

Problem 2: Programming with Snap! Lists [5 marks]

The first three parts, refer to the following code, where **names** and **emails** are the following lists:





a. [1 mark] How many different variables are used in this code? Circle your answer. 1 2 3 4
(If a variable is used more than once, count it only once.)

b. [1 mark] What will the value of **current** be when the code has finished executing: 1 2 3 4

c. [1 mark] What will the sprite say when the code is executed?

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d. [1 mark] Next, suppose that we execute the instruction:

What will the **names** list look like when we are done? Circle your answer.

(i)

(ii)

(iii)

e. [1 mark] Finally, suppose that we execute the instructions:

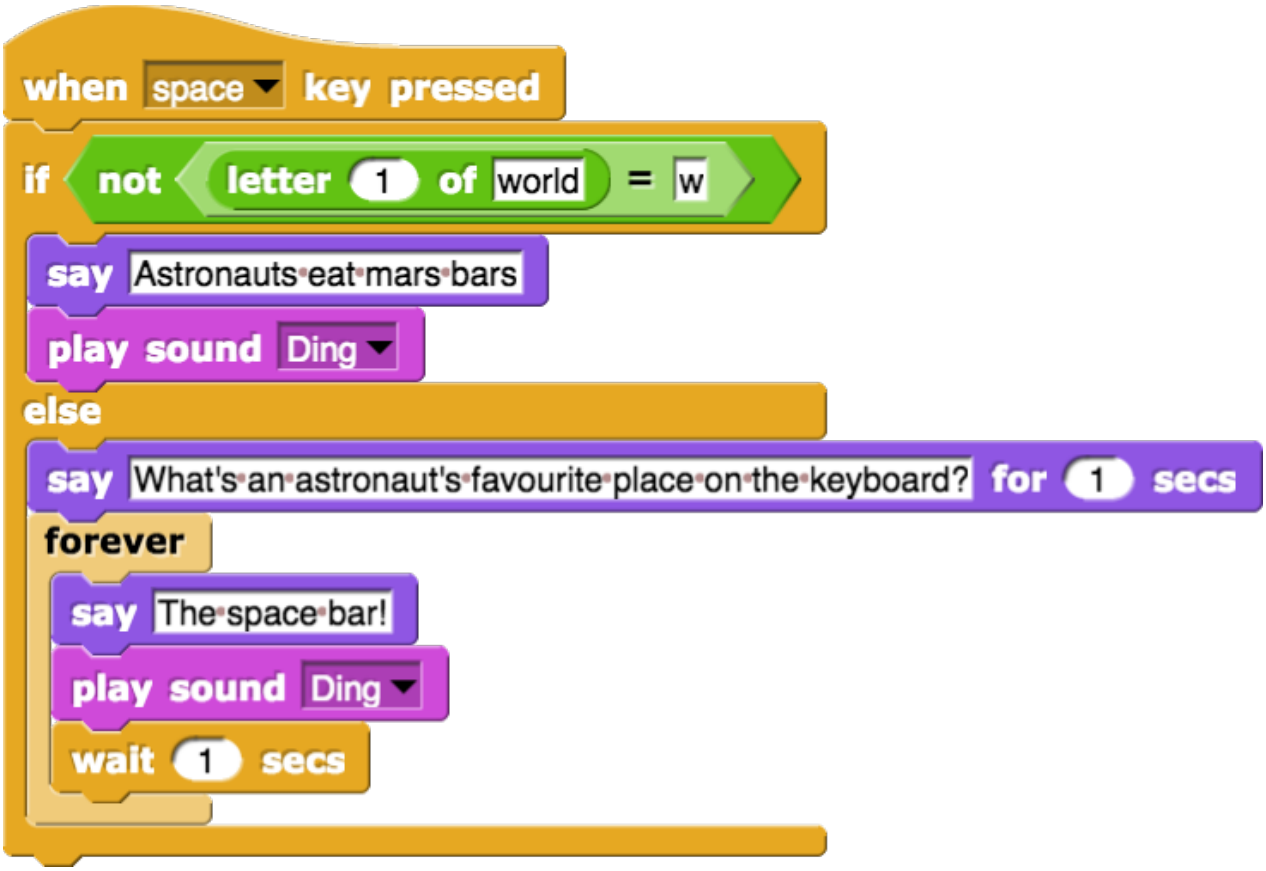
What will the **emails** list look like when we are done? Circle your answer.

(i)

(ii)

(iii)

Problem 3: Zoom, zoom, zoom [2 marks]



If we run this program, will we ever find out what an astronaut's favourite place on the keyboard is?

a) Yes

b) No

The first letter of "world" IS = "w". Therefore, the else case runs which results in outputting "What's an astronaut's favourite place on the keyboard?", followed by the "The space bar!" and the "Ding!" noise playing forever.

Problem 4: Get your swap on [5 marks]

In class we discussed that to swap two items in two slots, one extra slot is needed to temporarily hold one of the items. Consider the case where you have to swap THREE items:

Input:

Slot	Initial Value
1	Card A
2	Card B
3	Card C

Output:

Slot	Desired Value
1	Card B
2	Card C
3	Card A

a. [1 mark] What is the minimum number of additional slots needed to do this?

One

b. [3 marks] Describe your algorithm that does it in your minimum number of additional slots. Your algorithm should include steps like:
1. Move card X to slot Y

1. Move card A from slot 1 to the swap space
2. Move card B from slot 2 to slot 1
3. Move card C from slot 3 to slot 2
4. Move card A from swap space to slot 3

Grading:
0 if blank or totally wrong.
1 point if major error or more than one minor error.
2 points if only one minor error.
3 points if totally correct.

Note: there were several correct variations of this algorithm.

c. [1 mark] What is the minimum number of swaps that are needed to perform this operation, regardless of the number of swap spaces?

There were two different interpretations of this problem, and we gave credit for either interpretation, as long as the answer.

One interpretation was to count the number of "Move" operations, which is four.

Another interpretation was to count the number of "pairwise swaps". An algorithm might swap the contents of slots 1 and 2 (using a pairwise swap involving one additional slot and three moves), and then swap the contents of slots 2 and 3 similarly. This uses two pairwise swaps, so we accepted the answer "two".

Problem 5: Internet [5 marks]

a. [1 mark] The British Broadcasting Corporation (BBC) offers a Chinese language version of its website. The enterprising Business Broadcast of China also offers a news site. Which of the following domain names do you think is that of the British Broadcasting Corporation? Circle your answer.

(i) http://www.bbc.com/zhongwen/simp (ii) http://www.businessnews.cn

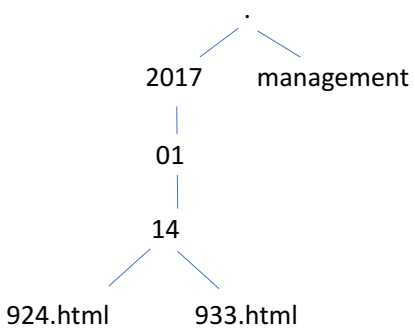
b. [2 marks] How can knowledge of domain name structure help you detect phishing?

[One reasonable answer: Links from bona fide business typically end in ".com". A link from a purported business that ends in a country code is more likely to be an instance of phishing.]

c. [2 marks] Diagram the hierarchical relationships among the **folders and files** that can be inferred from the following URLs. (You should not show the relationships among the domain names.)

www.businessnews.cn
www.businessnews.cn/management
www.businessnews.cn/2017/01/14/924.html
www.businessnews.cn/2017/01/14/933.html

[Some students included domain names, which is not technically correct, but we gave credit if the part of the diagram showing the relationships under "2017" are correct, with "management" being separate. It's not correct to have a direct link between "management" and 2017.]



Problem 6: Algorithms and fairness [5 marks]

"Sometimes, in order to be fair, it is important to make use of sensitive information... This may be a little counterintuitive: The instinct might be to hide information that could be the basis of discrimination."
- Cynthia Dwork

a. [1 mark] Give one example of a *classification task*.

[Possible examples: 1. Given a digitial image, determine whether or not it is a cat. 2. Given an individual's loan application, determine whether to approve or deny it.

b. [2 marks] Briefly describe one reason why algorithmic classifiers might introduce bias in decision-making.

[Possible reasons: (i) the classifiers might be trained on biased data, e.g., historical data; (ii) human programmers might introduce bias; (iii) the decision-making criteria used by classifiers are often learned by computers, and so (despite the best intentions of programmers) the underlying logic may be opaque and introduce bias; (iv) classifiers might ignore sensitive features of data, even though use of those features could ameliorate bias.]

c. [2 marks] Cynthia Dwork has argued that "Sometimes, in order to be fair, it is important to make use of sensitive information". Describe one example that illustrates her point.

[2 points. In the loan application example described in class, making use of potentially sensitive data, namely the colour of applicants (blue or orange) was necessary, both in order to maximize the bank's profit or to ensure that the same fraction of worthy applicants from both groups are granted loans.]

Problem 7: Reasoning about algorithms [5 marks]

Amelia and Jennifer are playing a game where they have to guess a number Charmaine is thinking. The number Charmaine is thinking is between 1 and 50.

Amelia decides to guess every even number between 1 and 50 starting from 2. After each guess, Charmaine will tell Amelia if she guessed the right number. If Amelia guesses all the even numbers without finding the number Charmaine is thinking of, she starts guessing the odd numbers found in 1 to 50 starting from 1.

Jennifer decides to guess the median number (the middle number found in a range of numbers when the numbers are arranged in numerical order) each time. She asks Charmaine if the median number is greater than or less than the number Charmaine is thinking of, or whether she has guessed the correct number. After Charmaine replies, Jennifer adjusts her next guess accordingly. For example, Jennifer first guesses 25 and if Charmaine tells her that the secret number is less than 25, Jennifer then guesses the median number from 1 to 25 (i.e., 13). Jennifer will continue until she guesses the correct number.

a. [1 mark] Assuming Charmaine never lies to Amelia and Jennifer, who has the better algorithm?

   1. Amelia and Jennifer's algorithms are both equally good
   2. Amelia's algorithm is better as it finds the answer faster
   3. Jennifer's algorithm is better as it finds the answer faster
   4. Both Amelia and Jennifer's algorithms are bad

   [Note: which algorithm is faster does depend on which number Charmaine is thinking of, but it's not hard to see that Jennifer's algorithm will be faster if you take the average over all the possibilities.]

b. [1 mark] List the worst number(s) Charmaine could choose in terms of maximizing the number of guesses Amelia has to make?

   49

c. [1 mark] What is the maximum number of guesses Amelia has to make in order to find the secret number? Just give a number- we don't need an explanation.

   50

d. [1 mark] List the worst number(s) Charmaine could choose in terms of maximizing the number of guesses Jennifer has to make?

   1, 2 OR 49, 50

e. [1 mark] What is the maximum number of guesses Jennifer has to make in order to find the secret number? Just give a number- we don't need an explanation.
   7.

   We also gave credit for 6, since some students assumed that the last guess of the secret number need not be counted.