SMU SINGAPORE MANAGEMENT UNIVERSITY

AY 2020-21 Term 1 Examination

IS111 Intro to programming

INSTRUCTIONS

Please read this page only. Do not open the paper until instructed.

1. This is a **closed-book** examination. Please remove everything from your workspace except for pens, pencils, erasers, wipe outs and stapler before you begin. No use of calculators is allowed.

2. The time allowed for this examination paper is **TWO** hours.

3. This paper comprises **36** pages including the cover page and **FOUR** blank pages (at the end).

4. This examination consists of 2 sections.
   a. **Section A** consists of 10 multiple choice questions (MCQ). Each MCQ is worth 2 marks. For each question, select the **BEST** choice and put a ✓ inside the box. For example:
      ☑ A. Coding is AWESOME!
   b. **Section B** consists of 7 short answer questions.

5. You are required to write all answers (both sections **A** and **B**) on this examination paper.

6. You can use the blank pages to write your answers if you need extra space. Label your question numbers accordingly.

7. You must **return** all parts of this examination paper to the invigilators. Missing examination paper or parts thereof will be considered cheating.

	Marks	Awarded
Section A (MCQ):	20	
Question 1	9	
Question 2	9	
Question 3	8	
Question 4	7	
Question 5	7	
Question 6	5	
Question 7	5	
TOTAL	70	

Section A

1. **[Difficulty: *]** Which one of the following is a valid variable name (i.e., the name will not cause an error)?

□ A. `True`

□ B. `A-Name`

□ C. `7_dwarfs`

□ D. `$money`

☑ E. `GST_RATE`

2. **[Difficulty: *]** What is the output when you run the following program?

```
count = 10
for i in range(0, 6):
    count = count - 1
print(count)
```

0,1,2,3,4,5

□ A. `0`

☑ B. `4`

□ C. `5`

□ D. `6`

□ E. `10`

3. **[Difficulty: *]** What is the output when you run the following program?

```
my_str = '0123456789'
if 0 in [ my_str ]:        ✗
    print(0, end='')

if '1' in my_str:            ✓
    print('1', end='')

if '24' in my_str:
    print('24', end='')        ✗
```

□ A. `0`

☑ B. `1`

□ C. `01`

□ D. `0124`

□ E. `124`

4. **[Difficulty: *]** What is the output when you run the following program?

```
my_list = [10, 9, 8, 7, 6]

print(my_list[len(my_list) - 1])
print(my_list[0:2])
print(my_list[:1])
```

6
10, 9
10

☑ A.
```
6
[10, 9]
[10]
```

□ B.
```
[6]
[10, 9]
[10]
```

□ C.
```
[6]
[10, 9]
10
```

□ D.
```
6
10, 9
10
```

□ E.
```
6
[10, 9]
10
```

5. **[Difficulty: *]** Given the following code:

```
1  def test(number, string):
2      number = string
3      result = number + string
4
5  n = 1
6  s = 'X'
7  answer = test((n, s))
8  print(n, s, answer)
```

Which statement below is correct?

□ A. Line 2 has an error because we cannot assign a string to a number.

□ B. Line 3 has an error because we cannot add a number and a string.

☑ C. Line 7 has an error because the function `test` needs 2 parameters, but only one is sent in.

□ D. Line 7 has an error because the function `test` does not return any value.

□ E. There is no error in the code.

6. **[Difficulty: **]** What is the output when you run the following program?

```
num = 9

if str(num) == '9':        ✓
    print("Gryffindor")

if num == int('3' + '6'):  ✗
    print("Hufflepuff")

if str(num / 3) == str(3): ✓
    print("Ravenclaw")
else:
    print("Slytherin")
```

□ A.
```
Gryffindor
Hufflepuff
Ravenclaw
```

□ B.
```
Gryffindor
Ravenclaw
```

□ C.
```
Hufflepuff
Ravenclaw
```

□ D.
```
Gryffindor
Hufflepuff
Slytherin
```

☑ E.
```
Gryffindor
Slytherin
```

7. **[Difficulty: **]** Given the following code:

```
def modify_1(my_list):
    my_list = []

def modify_2(my_list):
    my_list[0] = 'Zeus'

def modify_3(my_list):
    your_list = my_list
    your_list.append(['Hades'])

def modify_4(my_list):
    my_value = my_list[0]
    my_value = my_value + '2'

a_list = ['Apollo']
modify_1(a_list)
print(a_list)

a_list = ['Apollo']
modify_2(a_list)
print(a_list)

a_list = ['Apollo']
modify_3(a_list)
print(a_list)

a_list = ['Apollo']
modify_4(a_list)
print(a_list)
```

? [ ]

['zeus']

[Apollo, [Hades]]

[apollo]

What will be the output?

□ A.
```
[]
['Zeus']
['Apollo']
['Apollo']
```

□ B.
```
[]
['Zeus', 'Apollo']
['Apollo', 'Hades']
['Apollo2']
```

□ C.
```
['Apollo']
['Zeus']
['Apollo', 'Hades']
['Apollo']
```

□ D. ✓
```
[]
['Zeus']
['Apollo', ['Hades']]
['Apollo2']
```

☑ E. ✓
```
['Apollo']
['Zeus']
['Apollo', ['Hades']]
['Apollo']
```

8. **[Difficulty: **]** What is the output when you run the following program?

```
def do_magic(x):
    return x[0] + x[1]

list_1 = [1, 3, 5]              4
print(do_magic(list_1))

list_2 = [[1], [3], [5]]        [1,3]
print(do_magic(list_2))

my_str = '135'                  13
print(do_magic(my_str))
```

☑ A.
```
4
[1, 3]
13
```

□ B.
```
[1, 3]
[[1], [3]]
13
```

□ C.
```
[1, 3]
[[1], [3]]
4
```

□ D.
```
4
[[1], [3]]
13
```

□ E. There is an execution error.

9. **[Difficulty: ***]** Given the following code:

```
def is_valid(my_str):
    digits = '0123456789'
    letters = 'abcdefghijklmnopqrstuvwxyz' # A string containing all 26 letters.
    count_1 = 0
    for d in digits:
        count_2 = 0
        for ch in my_str:
            if ch == d:
                count_2 += 1
        if count_2 >= 2:
            count_1 += 1

    if count_1 < 5:
        return False

    for l in letters:
        for ch in my_str:
            if ch == l:
                return True

    return False
```

l = l

Which of the following print() statement will print True?

□ A. print(is_valid('01234567890abcdefghijklmnopqrstuvwxyz')) ✗

□ B. print(is_valid('012345xyz')) ✗

☑ C. print(is_valid('a-12345-54321'))

□ D. print(is_valid('00,11,22,33,44'))

□ E. None of the above.

10. **[Difficulty: ***]** A function named `check_numbers()` takes in a list of integers as its only parameter. The function returns `True` if each number in the list is either a divisor or a multiple of another number in the list. Otherwise it returns `False`. If the list is empty, the function returns `True`.

You can assume that the given list does not contain any duplicate numbers. You can also assume that none of the integers in the list is 0.

For example, here are some calls to the function and their expected results:

- `check_numbers([4, 8, 12])` returns `True`
  - 4 is a divisor of 8 and 12; 8 is a multiple of 4; 12 is a multiple of 4.
- `check_numbers([3, 1, 2])` returns `True`
  - 3 is a multiple of 1; 1 is a divisor of 3 and 2; 2 is a multiple of 1.
- `check_numbers([4, 2, 6, 7])` returns `False`
  - 7 is not a divisor or a multiple of any other number in the list.
- `check_numbers([2])` returns `False`
  - Because 2 is the only number in the list, it is not a divisor or a multiple of any other number in the list.
- `check_numbers([])` returns `True`
  - If the list is empty, the function always returns `True`.

Which of the implementation(s) below of `check_numbers()` is(are) CORRECT?

I.

```
def check_numbers(my_list):
    for n in my_list:
        for m in my_list:
            if n != m:
                if n % m != 0 or m % n != 0:
                    return False
    return True
```

✓

II.

```
def check_numbers(num_list):
    count = 0
    found = False
    for n in num_list:
        for m in num_list:
            if n != m and not found:
                if n % m == 0 or m % n == 0:
                    found = True
                    count += 1

    if count == len(num_list):
        return True
    else:
        return False
```

III.
```
def check_numbers(num_list):
    for i in range(len(num_list)):
        is_valid = False
        for j in range(len(num_list)):
            if j != i:
                if num_list[i] % num_list[j] == 0 or num_list[j] % num_list[i] == 0:
                    is_valid = True

        if not is_valid:
            return False

    return True
```

☑ A. I only

□ B. II only

□ C. III only

□ D. I, II and III are all correct

□ E. None of I, II or III is correct

Section B

Question 1 [9 marks, Difficulty: *]

In q1.py, write a function called print_digits() that takes in a parameter called text of type str.

The function does the following:

a. For every digit character ('0' – '9') in text, it prints out the digit character as it is.
b. For every non-digit character (e.g., 'a' or '$') in text, it prints out a hex/hash character (i.e.,'#').

For example, given the following script (q1_test.py):

```
import q1

print('--')
q1.print_digits('12a4eu$')
q1.print_digits('')
q1.print_digits('#90=')
print('--')
```

Running the script gives the following output:

```
C:\exam>python q1_test.py
--
12#4###

#90#
--
```

Write your answer in the box below.

```
# q1.py
def print_digits(string):
    numbers = '0123456789'
    new_str = ''
    for i in string:
        if i in numbers:
            new_str += i
        else:
            new_str += '#'
    return new_str
```

Question 2 [9 marks, Difficulty: *]

In q2.py, write a function called count_decimal_places() that takes in a parameter called num_value of type str. num_value is a string that contains a valid whole number (e.g., num_value is "3" or "-10") or a valid decimal number (e.g., num_value is "-5.14" or "9.64").

The function returns the number of decimal places in num_value (i.e., the number of digits to the right of the decimal point). In the case when num_value contains a whole number, the function returns 0.

For example, given the following script (q2_test.py):

```
import q2

print(q2.count_decimal_places('100'))
print(q2.count_decimal_places('11.1234'))
print(q2.count_decimal_places('3.0'))
print(q2.count_decimal_places('3.12345678908'))
print(q2.count_decimal_places('3.'))
```

Running the script gives the following output:

```
C:\exam>python q2_test.py
0
4
1
11
0
```

Write your answer in the box below.

```
# q2.py
def count_decimal_place (num_value):
    dot = 'x'
    for i in range(len(num_value)):
        if num_value[i] == '.':
            dot = i
    if dot == 'x':
        return 0
    else:
        return len(num_value[dot+1:])
```

Question 3 [8 marks]

Part A [Difficulty: *]

Implement a function called `fraction_compare()`. The function takes in two parameters:

- `fraction_1` (type: `tuple`) : A tuple in the form of `(a, b)` where `a` is the numerator and `b` is the denominator.
- `fraction_2` (type: `tuple`) : A tuple in the form of `(c, d)` where `c` is the numerator and `d` is the denominator.

For example,

- the fraction $\frac{3}{4}$ can be represented by `(-3, -4)`, `(6, 8)`, `(-6, -8)`, etc.
- the fraction $-\frac{3}{4}$ can be represented by `(-3, 4)`, `(-6, 8)`, `(6, -8)`, etc.

You can assume that `a`, `b`, `c` and `d` are all integers, and `b` and `d` are not 0.

The function returns an `int` value of `1`, `-1` or `0` based on the result value below:

$$\text{result} = \frac{a}{b} - \frac{c}{d} = \frac{ad - bc}{bd}$$

- If result > 0, then the function returns `1` (type: `int`).
- If result < 0, then the function returns `-1` (type: `int`).
- If result is zero, then the function returns `0` (type: `int`).

Note:

- Your code is **NOT** allowed to create any float values. E.g., if you compute a/b, it is a float, and this is not allowed. Similarly, if you compute (a * d – b * c) / (b * d), it is also a float and is not allowed.
- You are **NOT** allowed to use the `fractions` library.

For example, given the following script (`q3a_test.py`):

```
import q3

print(q3.fraction_compare((3, 4), (1, 2))) # 3/4 > 1/2
print(q3.fraction_compare((1, 4), (6, 7))) # 1/4 < 6/7
print(q3.fraction_compare((1, 6), (1, 6))) # same value
print(q3.fraction_compare((-3, 4), (-1, 2))) # -3/4 < -1/2
print(q3.fraction_compare((1, -2), (-9, 4))) # -1/2 > -9/4
```

Running the script gives the following output:

```
C:\exam>python q3a_test.py
1
-1
0
-1
1
```

Write your answer in the box below:

```
# q3.py
def fraction_compare(f1,f2):
    num = f1[0]*f2[1] - f1[1]*f2[0]
    deno = f1[1]*f2[1]

    if num==0:
        return 0
    elif (num<0 and deno<0) or (num>0 and deno>0):
        return 1

    else:
        return -1
```

Part B [Difficulty: **]

Implement a function called `get_largest_fraction()`. The function takes in a single parameter:

- `fractions` (type: `list`) : It contains a list of tuples. Each tuple is in the form of `(a, b)` where
  - a is the numerator, and
  - b is the denominator.

  You can assume that both a and b are integers and b is not 0.

The function returns the largest fraction in the `fractions` list. If the list is empty, the function returns an empty list.

Note: You **MUST** use the function that you have defined in Part (A) to help you solve this problem.

For example, given the following script (`q3b_test.py`):

```
import q3

print(q3.get_largest_fraction([(1, 4), (1, 2), (7, 8), (3, 4)]))
print(q3.get_largest_fraction([(1, 4)]))
print(q3.get_largest_fraction([]))
```

Running the script gives the following output:

```
C:\exam>python q3b_test.py
(7, 8)
(1, 4)
[]
```

Write your answer in the box below:

```
# q3.py
# Assume fraction_compare is implemented and in the same file.

def get_largest_fraction(fractions):
    frac= fractions[:]
    while len(frac) > 1 :
        if fraction_compare(frac[0] ,frac[1])>=0
            frac = frac[0] + frac[2:]

        else:
            frac = frac[1] + frac[2:]
    if fraction_compare(frac[0] ,frac[1])>=0
        frac = frac[0]

    else:
        frac = frac[1]

    return frac
```

Question 4 [7 marks, Difficulty: **]

Part (A)

Define a function called `is_compatible()`. The function takes in the following parameters:

- `donor` (type: `str`): The blood type of the person donating blood.). You can assume a valid blood type (e.g. `'A+'`) is used.
- `recipient` (type: `str`): The blood type of the person receiving the blood donation. You can assume a valid blood type is used.

The function returns `True` if the donor’s blood type is compatible with the recipient’s. Otherwise, it returns `False`. The compatibility table is listed below:

		Donor’s blood type							
		O-	O+	B-	B+	A-	A+	AB-	AB+
Recipient’ s blood type	AB+	✓	✓	✓	✓	✓	✓	✓	✓
	AB-	✓		✓		✓		✓	
	A+	✓	✓			✓	✓		
	A-	✓				✓			
	B+	✓	✓	✓	✓				
	B-	✓		✓					
	O+	✓	✓						
	O-	✓							

For example,

- `is_compatible('A+', 'AB+')` should return `True`
- `is_compatible('A+', 'A+')` should return `True`
- `is_compatible('A+', 'AB-')` should return `False`

Note: To be awarded any marks, you

1. **MUST** use the dictionary data type
2. **MUST NOT** use any form of conditionals (e.g. if-else, if-elif, if-elif-else)
3. **MUST NOT** use list comprehension (e.g., `[(a – 1) for a in num_list]`)

```
# q4.py
def is_compatible(donor, recipient):
    blood = {'O-': ['AB+', 'AB-', 'A+', 'A-', 'B+', 'B-', 'O+', 'O-'],
             'O+': ['AB+', 'A+', 'B+', 'O+'],
             'B-': ['AB+', 'AB-', 'B+', 'B-'],
             'B+': ['AB+', 'B+'],
             'A-': ['AB+', 'AB-', 'A+', 'A-'],
             'A+': ['AB+', 'A+'],
              'AB-': ['AB+', 'AB-'],
              'AB+': ['AB+'] }
    if recipient in blood[donor]:
          return True
    else:
          return False
```

Part (B)

Define a function called `get_donors()`. The function takes in two parameters:

a. `willing_donors` (type: `list`): A list of tuples. Each tuple represents a person who is willing to donate blood. The tuple is in the form of `(donor_name, donor_blood_type)`. You can assume a valid blood type (e.g. `'A+'`) is used.

b. `recipient` (type: `str`): The blood type of the person receiving the blood donation. You can assume a valid blood type is used.

The function returns a list consisting of willing donors whose blood types are compatible with the recipient's blood type.

Note: You **MUST** use the function that you have defined in Part (A) to help you solve this problem.

For example, given the following script (`q4b_test.py`):

```
import q4

donor_list = [('apple','A+'), ('orange', 'O+'), ('pear', 'AB-')]
print(q4.get_donors(donor_list, 'A+'))
print('----')

donor_list = [('apple','A+'), ('orange', 'A-'), ('pear', 'AB-')]
print(q4.get_donors(donor_list, 'O+'))
print('----')

print(q4.get_donors([], 'A+'))
```

Running the script gives the following output:

```
C:\exam>python q4b_test.py
[('apple', 'A+'), ('orange', 'O+')]
----
[]
----
[]
```

Write your answer in the box below:

```
# q4.py
# Assume is_compatible is implemented and in the same file.
def get_donors (donor-list, recipient):
    final=[]
    for donor in donor_list:
        if is_compatible(donor[1], recipient):
            final.append (donor)
    return final
```

Question 5 [7 marks, Difficulty: **]

Examine the following program and list the output when it runs.

- Write 'error' if you think the code will crash (i.e., raise an error) during execution. You should still list the output up to the point of the execution error.
- Write 'nothing' if you think the code will not produce any output.

```
def do_something(my_list):
    print(my_list[len(my_list) // 2])
    my_list[len(my_list) - 1] = 'golden'
    if len(my_list) > 4:
        return True
    return False


my_list = ['blue', 'white', 'red']
index = 1
while my_list[index] != 'golden':
    if index < 3:
        print(my_list[0])
        my_list = my_list[index:]
        my_list.append('cyan')
        my_list.append('pink')
    elif do_something(my_list):
        print(my_list[1])
    else:
        my_list = my_list + ['yellow', 'orange']
        print(my_list[index + 1])
    index += 1
print(index)
```

[white, red], cyan, pink]

index 2

cyan pink cyan pink

index 3

4//2 = 2

~~cyan pink~~

cyan pink cyan goldn

False

cyan pink cyan gol y gol

0 1 2 3 4 5

index 4

3

index 5

Output when the program is executed (what you see on the console window only)

```
blue
white
cyan
yellow
golden
pink
5
```

Question 6 [5 marks, Difficulty: ***]

Implement a function called `get_social_people(meetups, m, n)`. This function takes in the following parameter:

- `meetups` (type: `list`): This is a list of tuples, where each tuple contains `(person1, person2, date)`, representing a meetup between `person1` and `person2` on a given `date`. Here, `person1` and `person2` are both strings. `date` is a **negative integer** representing the date of the meetup relative to the current date. E.g., if `date` is -3 and today is Nov 20, it means `person1` and `person2` met up on Nov 17.
- `m`: This is a positive integer.
- n: This is another positive integer.

The function returns the list of people who have met at least `m` **different** people in the past `n` days relative to the current date (i.e., the meetup date is `-1`, `-2`, …, or `-n`).

Note the following assumptions about the tuples in the list `meetups`:

- Each tuple contains two different names. I.e., you will not have anything like `('eric', 'eric', -3)`.
- The order of the two people in a tuple does not matter. E.g., `('joe', 'eric', -1)` is the same as `('eric', 'joe', -1)`.
- The same pair of people may have met more than once on different days and therefore appear more than once in the list. E.g., you might see both `('jack', 'eric', -4)` and `('eric', 'jack', -3)` appearing in the list.
- The same pair of people may also have met more than once on the same day and therefore appear more than once in the list. E.g., you might see `('jack', 'eric', -4)` appearing twice in the list, or both `('jack', 'eric', -4)` and `('eric', 'jack', -4)` appearing in the list.
- The tuples in the list are **NOT** sorted in any chronological order.

For example, if the list is `[('joe','eric',-1), ('joe', 'eric', -2), ('tim','eric',-2), ('eric','jack',-3), ('jack','george',-7), ('jack','cindy',-2), ('jack','eric',-4)], this means:`

1. Joe and Eric met up both 1 day ago and 2 days ago.
2. Tim and Eric met up 2 days ago.
3. Eric and Jack met up 3 days ago.
4. Jack and George met up 7 days ago.
5. Jack and Cindy met up 2 days ago.
6. Jack and Eric also met up 4 days ago.

Example 1: If the function is invoked like this:

```
get_social_people([('joe','eric',-1), ('joe', 'eric', -2), ('tim','eric',-2),
('eric','jack',-3), ('jack','george',-7), ('jack','cindy',-2), ('jack','eric',-4)], 2,
3)
```

The function returns either `['eric', 'jack']` or `['jack', 'eric']`. This is because only Eric and Jack each met up with at least 2 different friends in the past 3 days. (Eric met up with Joe, Tim and Jack in the past 3 days, while Jack met up with Eric and Cindy in the past 3 days.) Note that although Joe met up with Eric *twice* in the past 3 days, it's the same friend that Joe met up with, and therefore it's counted as Joe only meeting up with 1 friend.

Example 2: If the function is invoked like this:

```
get_social_people([('joe','eric',-1), ('joe', 'eric', -2), ('tim','eric',-2),
('eric','joe',-1), ('eric','jack',-3), ('jack','george',-7), ('jack','cindy',-2),
('jack','eric',-4)], 3, 5)
```

The function returns `['eric']` because only Eric met up with at least 3 different friends (i.e., Joe, Tim and Jack) in the past 5 days.

Example 3: If the function is invoked like this:

```
get_social_people([('joe','eric',-1), ('joe', 'eric', -2), ('tim','eric',-2),
('eric','joe',-1), ('eric','jack',-3), ('jack','george',-7), ('jack','cindy',-2),
('jack','eric',-4)], 3, 1)
```

The function returns [ ] because nobody met up with at least 3 different friends in the past 1 day.

Write your answer in the box below:

```
# q6.py
def get_social_people(meetups, m, n):
    final = {}
    n *= -1
    for meet in meetups:
        if meet[2] >= n:
            if meet[0] not in final:
                final[meet[0]] = [meet[1]]
            else:
                final[meet[0]].append(meet[1])

            if meet[1] not in final:
                final[meet[1]] = [meet[0]]
            else:
                final[meet[1]].append(meet[0])
    proxy = []
    for key in final:
        for value in final[key]:
            if final[key].count(value) > 1:
                final[key].remove(value)
        if len(final[key]) >= m:
            proxy.append(key)

    return proxy
```

Question 7 [5 marks, Difficulty: ***]

q7.py (on Page 29) is a buggy implementation of the last question from Lab Test 1. Identify and correct **ALL** execution and logic errors (i.e., errors that cause the program to behave incorrectly when executed). An error has been identified for you on page 29.

Note: 1 mark will be deducted for every incorrect error that you have identified. The minimum score for this question is 0 mark.

The description of the question is as follows:

Implement a function `trace_contacts_2()` that works as follows:

- The function takes in 4 parameters:
    - o `patient` (type: `str`): the name of a person who just starts to develop symptoms on the current day.
    - o `history` (type: `list`): a list of tuples that stores the meeting history of people in the community. Specifically, each tuple contains three elements:
        - ▪ `p1` (type: `str`): a person’s name
        - ▪ `p2` (type: `str`): another person’s name (which is always different from `p1`)
        - ▪ `day` (type: `int`): a *negative* integer indicating the day of the meeting relative to the current day (i.e., the day when `patient` develops symptoms)

      For example, the tuple `("Jason", "Gideon", -3)` means Jason met Gideon three days ago. (I.e., if the current date is September 23, 2030, which is the date when `patient` develops symptoms, then Jason and Gideon met on September 20, 2030.)
    - o `m` (type: `int`): a positive integer indicating how many days a person is infectious but asymptomatic.
    - o `n` (type: `int`): a positive integer indicating how many days it takes for a person to develop symptoms from the day when he catches the virus. You can assume that `n>m`.

catches the virus	non-infectious period			infectious period				develops symptoms and stops meeting people
$-n$ (n days before Day 0)	$-(n-1)$	...	$-(m+1)$	$-m$ (m days before Day 0)	$-(m-1)$	...	-1	Day 0

- The function returns a list of strings, which are the names of those people who have caught the virus either directly or indirectly from `patient`. This returned list should not contain any duplicate elements.

Note:

- The same pair of people could meet each other on different dates, e.g., `('A', 'B', -3)` and `('A', 'B', -2)` may both appear in `history`.
- All dates in `history` (i.e., the negative integers) are with respect to the original `patient`’s Day 0.
- The original `patient` could appear anywhere in the meeting history (not necessarily in the first tuple).
- The tuples in `history` are not necessarily chronologically ordered.

For example,

- Suppose the variable `history` stores the following list:

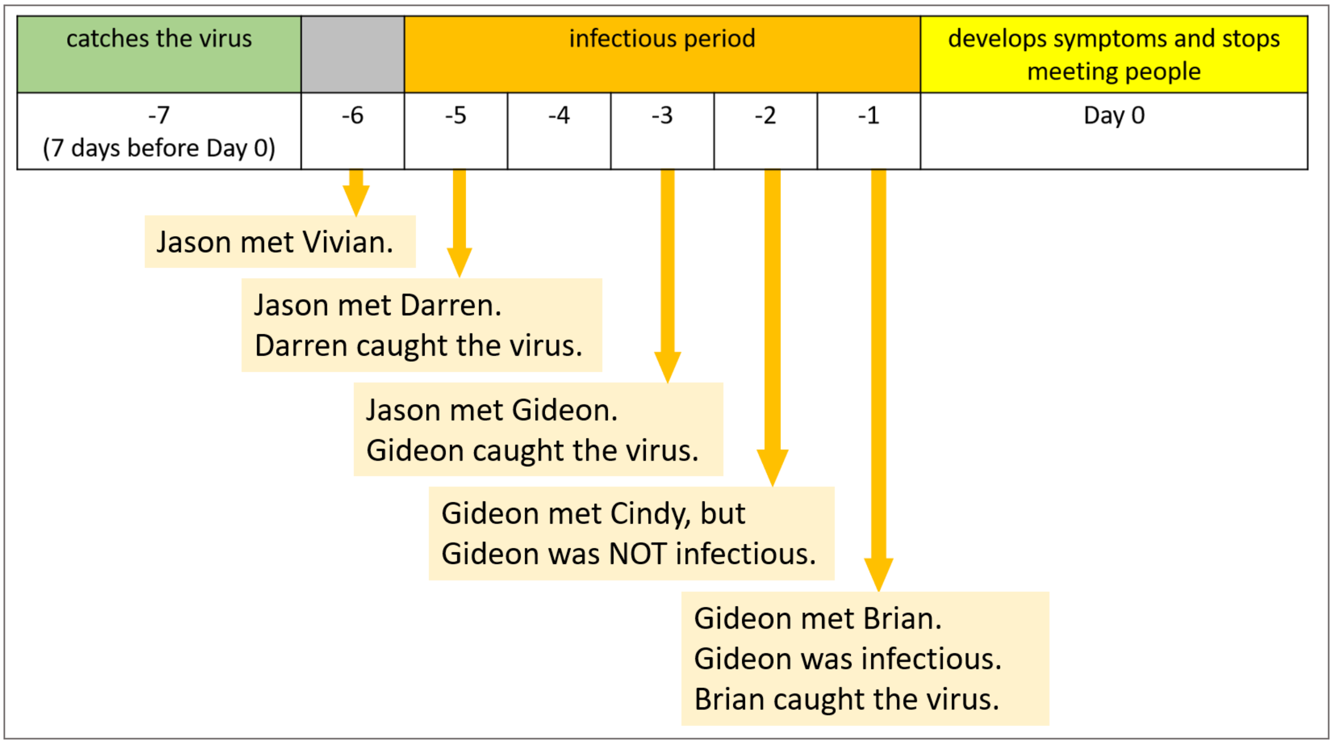
```
history = [("Jason", "Gideon", -3),
           ("Zac", "Yacob", -3),
           ("Gideon", "Brian", -1),
           ("Cindy", "Gideon", -2),
           ("Darren", "Jason", -5),
           ("Jason", "Vivian", -6)]
```

  Suppose `m` is `5` and `n` is `7`.

  Then `trace_contacts_2("Jason", history, 5, 7)` should return

  `["Gideon", "Brian", "Darren"]` (or a list with these three elements in any order)

  This is because Gideon and Darren both met Jason during Jason's infectious period (which is between 5 days ago and 1 day ago), and Brian met Gideon during Gideon's infectious period (which started 1 day ago), given that Gideon has already caught the virus. This is illustrated in the following diagram:



catches the virus		infectious period					develops symptoms and stops meeting people
-7 (7 days before Day 0)	-6	-5	-4	-3	-2	-1	Day 0

Jason met Vivian.

Jason met Darren.
Darren caught the virus.

Jason met Gideon.
Gideon caught the virus.

Gideon met Cindy, but
Gideon was NOT infectious.

Gideon met Brian.
Gideon was infectious.
Brian caught the virus.

- Suppose the variable history stores the following list:

```
history = [("B", "A", -5),
         ("C", "A", -1),
         ("B", "C", -2)]
```

  Then `trace_contacts_2("A", history, 5, 7)` should return `["B", "C"]` or `["C", "B"]`.
Note that here C is listed only once in the returned list, although C met both B during B's infectious period and A during A's infectious period.

```
# q7.py
# spot your errors from this point onwards
def generate_timeline(history, n)  # mistake 1
~~define generate_timeline(history, n):~~
    '''
    This function generates a timeline of all the meetups.

    Parameters:
        history (type: list):
                A list of tuples that stores the meeting history.
                Each tuple contains three elements:
                1. p1 (type: str): a person’s name
                2. p2 (type: str): another person’s name (always different from p1)
                3. day (type: int): a negative integer indicating the
                        day of the meeting relative to the current day
                        (which is the day when the patient develops symptoms)

        n (type: int): A positive integer indicating how many days it takes for a person
                to develop symptoms from the day when he catches the virus.



    Returns:
        A new list of lists that stores the meeting history in chronological order
        from the day when the patient catches the virus (which is n days before the
        current day) to 1 day before the current day.

        For example, if history contains
            [
                ("Z", "X", -4),
                ("D", "F", -1),
                ("C", "D", -3),
                ("A", "C", -5),
                ("B", "A", -5),
                ("A", "X", -4),
                ("E", "D", -2),
                ("X", "A", -6),
                ("Y", "A", -6)
            ]

        and n is 7, this function returns the following list:

            [   [],                        # day on which patient got infected (n days ago).
                [('X', 'A'), ('Y', 'A')],  # 1 day after patient got infected (n-1 days ago).
                [('A', 'C'), ('B', 'A')],  # 2 day after patient got infected.
                [('Z', 'X'), ('A', 'X')],  # 3 day after patient got infected.
                [('C', 'D')],              # 4 day after patient got infected.
                [('E', 'D')],              # 5 day after patient got infected.
                [('D', 'F')]               # 6 day after patient got infected.
            ]

    '''


    timeline = []    # the list to be returned


    one_day = []


    for i in range(n):


        timeline.append(one_day)


    for meetup in history:


        p1 = meetup[0]
        p2 = meetup[1]
        index = meetup[2]


        if index >= -n:

                  index+n
            timeline[~~index~~] += (p1, p2)


    return timeline



def get_infected_people(timeline, target, start_day, inactive_interval):
    '''
    This function returns the list of people who are directly
    infected by target (who is an infectious person).

    Parameters:
        timeline (type: list):
                A list of lists that stores the meeting history in chronological order
                from the day when the original patient catches the virus to 1 day before
                the current date. It is the list returned by the function
                generate_timeline().

        target (type: str): The name of a person who has been infected (who may or may not
                be the original patient).

        start_day (type: int): The first infectious day of target, relative to the day when
                the original patient got infected.

        inactive_interval (type: int): How many days the virus will be dormant before
                it becomes infectious.

    Returns:
        A new list of tuples that stores people directly infected by target, and the
        first infectious days of these people.

        For example, if timeline contains
            [   [],                         # day on which patient got infected.
                [('X', 'A'), ('Y', 'A')],   # 1 day after patient got infected.
                [('A', 'C'), ('B', 'A')],   # 2 day after patient got infected. 2+3=5
                [('Z', 'X'), ('A', 'X')],   # 3 day after patient got infected. 3+3=6
                [('C', 'D')],               # 4 day after patient got infected.
                [('E', 'D')],               # 5 day after patient got infected.
                [('D', 'F')]                # 6 day after patient got infected.
            ]

        and if target is 'A',
        start day is 2 (meaning that 'A' becomes infectious 2 days after the original
        patient got infected),
        inactive_interval is 3,
        then this function will return:
             [('C', 5), ('B', 5), ('X', 6)]

        For example, ('C', 5) is in the returned list because 'C' met up with 'A' when
        'A' is infectious, and 'C' will start to be infectious 3 days after 'C' met 'A',
        which is 5 days after the original patient got infected.

    '''

    result = []


    for day in range(start_day, len(timeline)):


        meetups = timeline[day]


        for a_meetup in meetups:


            p1 = a_meetup[0]
            p2 = a_meetup[1]


            if p1 == target:

                result.append((p2, day ~~-~~+ inactive_interval))


            elif p2 == target:

                result.append((p1, day ~~-~~+ inactive_interval))



    return result
```

```
def trace_contacts_2(patient, history, m, n):

    timeline = generate_timeline(history, n)

    # the number of days where the virus remains dormant
    inactive_interval = n - m

    to_contact_list = ~~[(patient, inactive_interval)]~~
                      get_infected_people(generate_timeline(history,n),
                                         patient, 0, inactive interval)
    result = []

    for one_contact in to_contact_list:

        name = one_contact[0]

        start_day = one_contact[1]

        if name not in result:

            result.append(name)

                          +=                     generate_timeline(history,n)
            to_contact_list ~~=~~ get_infected_people(~~timeline~~, name, start_day,
                    inactive_interval)



    return result
```

END OF PAPER.
ENJOY YOUR HOLIDAY!

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