## coe808 Lab 5: Python Scrabble

## Objectives

- Learn how to use python.
- Duration: two weeks.


## Scrabble basics

Letters are dealt to players, who then construct one or more words out of their letters. Each valid word receives a score, based on the length of the word and the letters in that word.
The rules of the game are as follows:

## Dealing

A player is dealt a hand of n letters chosen at random (assume $\mathrm{n}=7$ for now).
The player arranges the hand into a set of words using each letter at most once.
Some letters may remain unused (these won't be scored).

## Scoring

The score for the hand is the sum of the score for the words.
The score for a word is the sum of the points for letters in the word, plus 50 points if all n letters are used on the first go.
Letters are scored as in Scrabble; A is worth 1, B is worth 3, C is worth 3, D is worth 2, E is worth 1, and so on. We have defined the dictionary: SCRABBLE_LETTER_VALUES that maps each lowercase letter to its Scrabble letter value.

For example, 'weed' would be worth 8 points $(4+1+1+2=8)$, as long as the hand actually has 1 ' w ', 2 'e's, and 1 ' d '.

As another example, if $\mathrm{n}=7$ and you get 'waybill' on the first go, it would be worth 65 points $(4+1+4+3+1+1+1=15,+50$ for the 'bingo' bonus of using all seven letters).

## Getting Started

1. Download and save

- game.py: the skeleton you'll fill in for Problems 1-5 game.py
- test_game.py: Unit tests for some of your code (more on this later) test game.py
- words.txt: the list of valid words (all words acceptable in North American Scrabble up to 10 letters long) words.txt

Make sure to put all of the files in the same directory!
2. Run the code

Run game.py, without making any modifications to it, in order to ensure that everything is set up correctly. The code we have given you loads a list of valid words from a file and then calls the play_game function. You will implement the functions it needs in order to work.
If everything is okay, after a small delay, you should see the following printed out:

```
Loading word list from file...
83667 words loaded.
play_game not implemented.
play_hand not implemented.
```

If you see an IOError instead (e.g., No such file or directory), you should change the value of the WORDLIST_FILENAME constant (defined near the top of the file) to the complete pathname for the file words. txt (This will vary based on where you saved the file).

## Provided code

The file game.py has a number of already implemented functions you can use while writing up your solution. You can ignore the code between the following comments, though you should read and understand everything else:

```
# -------------------------------------
# Helper code
# (you don't need to understand this helper code)
...
# (end of helper code)
# -_-----------------------------------
```


## Unit testing

This problem set is structured so that you will write a number of modular functions and then glue them together to form the complete word playing game. Instead of waiting until the entire game is ready, you should test each function you write, individually, before moving on. This approach is known as unit testing, and it will help you debug your code.
We have provided several test functions to get you started. As you make progress on the problem set, run test_game.py as you go.

If your code passes the unit tests you will see a SUCCESS message; otherwise you will see a FAILURE message. These tests aren't exhaustive. You may want to test your code in other ways too.
If you run test_game.py using the provided game.py skeleton, you should see that all the tests fail. These are the provided test functions:

```
test_get_word_score()
```

Test the get_word_score() implementation.
test_update_hand()
Test the update_hand() implementation.
test_is_valid_word()
Test the is_valid_word() implementation.

## I. Word scores

The first step is to implement some code that allows us to calculate the score for a single word.

## Problem \#1

The function get_word_score should accept a string of lowercase letters as input (a word) and return the integer score for that word, using the game's scoring rules.

Fill in the code for get_word_score in game.py:

```
def get_word_score(word, n):
Returns the score for a word. Assumes the word is a valid word.
The score for a word is the sum of the points for letters
in the word, plus }50\mathrm{ points if all n letters are used on
the first go.
Letters are scored as in Scrabble; A is worth 1, B is
worth 3, C is worth 3, D is worth 2, E is worth 1, and so on.
word: string (lowercase letters)
n: integer (maximum hand size; i.e., hand size required for
additional
points)
returns: int >= 0
" " "
\# то DO ...
```

You may assume that the input word is always either a string of lowercase letters, or the empty string "". You will want to use the SCRABBLE_LETTER_VALUES dictionary defined at the top ofgame.py. You should not change its value.

Do not assume that there are always 7 letters in a hand! The parameter n is the number ofletters required for a bonus score (the maximum number of letters in the hand).

## Testing:

If this function is implemented properly, and you run test_game.py, you should see that the test_get_word_score() tests pass. Also test your implementation of get_word_score, usingsome reasonable English words.

HINT: To iterate through all the characters in a string, try something like this loop, which prints each letter in word:

```
for letter in word:
    print letter
```


## II. Dealing with hands

## Representing hands

A hand is the set of letters held by a player during the game. The player is initially dealt a set of random letters. For example, the player could start out with the following hand:
a, $\mathrm{q}, \mathrm{l}, \mathrm{m}, \mathrm{u}, \mathrm{i}, \mathrm{l}$
A straightforward way to represent a hand in Python is as a list:
hand $=\left[{ }^{\prime} a^{\prime}, ~ ' q ', ~ ' l ', ~ ' m ', ~ ' u ', ~ ' i ', ~ ' l '\right] ~$
However, we'll represent the hand in a different way, because it simplifies the code we'll need in the update_hand and is_valid_word functions. (In general, there are many ways to represent, in code, various concepts -- some are better suited to certain operations than others).

In our program, a hand will be represented as a dictionary: the keys are (lowercase) letters and the values are the number of times the particular letter is repeated in that hand. For example, the above hand would be represented as:

```
hand = {'a':1, 'q':1, 'l':2, 'm':1, 'u':1, 'i':1}
```

Notice how the repeated letter 'l' is represented.
Notice that with a dictionary representation, the usual way to access a value is hand['a'], where 'a'is the key we want to find. However, this only works if the key is in the dictionary; otherwise, we get an error. To avoid this, we can call hand.get('a', 0 ). This is the "safe" way to access a value if we are not sure the key is in the dictionary. It returns the value found if the key is in the dictionary, and 0 otherwise.

## Converting words into dictionary representation

One useful function we've defined for you is get_frequency_dict, defined near the top of game.py. When given a string of letters as an input, it returns a dictionary where the keys are letters and the values are the number of times that letter is represented in the input string. For example:

```
>> get_frequency_dict("hello")
{'h': 1, 'e': 1, 'l': 2, 'o': 1}
```

As you can see, this is the same kind of dictionary we use to represent hands.

## Displaying a hand

Given a hand represented as a dictionary, we want to display it in a user-friendly way.
We have provided the implementation for this in the the display_hand function. Make sure you read through this carefully and understand what it does and how it works.

```
"""" display_hand(hand):
Displays the letters currently in the hand.
For example:
display_hand({'a':1, 'x':2, 'l':3, 'e':1})
Should print out something like:
a x x l l l e
The order of the letters is unimportant.
hand: dictionary (string -> int)
for letter in hand.keys():
    for j in range(hand[letter]):
```

```
print letter, # the comma ensures everything in the for loop
    #prints on the same line
print # this just prints an empty line
```


## Generating a random hand

The hand a player is dealt is a set of letters chosen at random. We now need a function that generates this random hand. We have to be careful when randomly picking a hand. We need to ensure that there are enough VOWELS in the hand to allow the player to spell some words.
In our implementation, we use the randrange function from the random module to generate random numbers. Note that we import random at the top of game.py, and use the syntax random.randrange() to call randrange from inside module random. Make sure you read through our implementation of deal_hand carefully, and understand what it does and how it works.

```
import random
def deal_hand(n):
Returns a random hand containing n lowercase letters.
At least n/3 of the letters in the hand should be VOWELS.
Hands are represented as dictionaries. The keys are
letters and the values are the number of times the
particular letter is repeated in that hand.
n: int >= 0
returns: dictionary (string -> int)
"""
hand={ }
num_vowels = n / 3
for i in range(num_vowels):
x = VOWELS[random.randrange(0,len(VOWELS))]
hand[x] = hand.get(x, 0) + 1
for i in range(num_vowels, n):
x = CONSONANTS[random.randrange(0,len(CONSANANTS))]
hand[x] = hand.get(x, 0) + 1
return hand
```

Notice the access of values using hand.get $(x, 0)$ because we do not know if the key x is in the dictionary, as discussed in the Representing hands section.

## Removing letters from a hand

The player starts with a hand, a set of letters. As the player spells out words, letters from this set areused up. For example, the player could start out with the following hand:
a, q, l, m, u, i, 1
The player could choose to spell the word quail. This would leave the following letters in the player's hand:

1, m
You will now write a function that takes a hand and a word as inputs, uses letters from that hand to spell the word, and returns the remaining letters in the hand.

For example:

```
>> hand = {'a':1, 'q':1, 'l':2, 'm':1, 'u':1, 'i':1}
>> display_hand(hand)
a q l l m u i
>> hand = update_hand(hand, 'quail')
>> hand
{'l': 1, 'm': 1}
>> display_hand(hand)
l m
```

(NOTE: alternatively, in the above example, after the call to update_hand the value of hand could be the dictionary $\left\{\mathrm{a}^{\prime}: 0\right.$, 'q': 0 , 'l': $\left.1, ~ ' m ': 1, ~ ' u ': 0, ~ ' i ': 0\right\} . ~ T h e ~ e x a c t ~ v a l u e ~ d e p e n d s ~ o n ~ y o u r ~ i m p l e m e n t a t i o n ; ~ b u t ~$ the output of display_hand() should be the same in either case.)

## Problem \#2

Implement the update_hand function. Make sure this function has no side effects; i.e., it cannot mutate the hand passed in.

```
def update_hand(hand, word):
Assumes that 'hand' has all the letters in word.
In other words, assumes that however many times
a letter appears in 'word', 'hand' has at least as
many instances of that letter in it.
Updates the hand: uses up the letters in the given word
and returns the new hand, without those letters in it.
Has no side effects: does not modify hand.
word: string
hand: dictionary (string -> int)
returns: dictionary (string -> int)
"""
# TO DO ...
```


## Testing:

Make sure the test_update_hand() tests pass. You may also want to test your implementation of update_hand with some reasonable inputs.

## III. Valid words

At this point, we have written code to generate a random hand and display that hand to the user. We can also ask the user for a word (Python's raw_input) and score the word (using your get_word_score). However, at this point we have not written any code to verify that a word given bya player obeys the rules of the game.

A valid word is: in the word list; and it is composed entirely of letters from the current hand.

## Problem \#3

Implement the is_valid_word function.

```
def is_valid_word(word, hand, word_list):
Returns True if word is in the word_list and is entirely
composed of letters in the hand. Otherwise, returns False.
Does not mutate hand or word_list.
word: string
hand: dictionary (string -> int)
word_list: list of strings
# TO DO ...
```


## Testing:

Make sure the test_is_valid_word tests pass. In particular, you may want to test your implementation by calling it multiple times on the same hand - what should the correct behavior be?

## IV. Playing a hand

We are now ready to begin writing the code that interacts with the player.

## Problem \#4

Implement the play_hand function. This function allows the user to play out a single hand.

```
def" play_hand(hand, word_list):
Allows the user to play the given hand, as follows:
* The hand is displayed.
* The user may input a word. Alternatively, the user may end the
game by entering a period (.).
* An invalid word is rejected, and a message is displayed asking
the user to choose another word.
* When a valid word is entered, it uses up letters from the hand.
* After every valid word: the score for that word and the total
score so far are displayed, the remaining letters in the hand
are displayed, and the user is asked to input another word.
* The sum of the word scores is displayed when the hand finishes.
```

```
* The hand finishes when there are no more unused letters.
The user may choose to end the hand at any time by inputting
a single period (the string '.') instead of a word.
* The final score is displayed.
hand: dictionary (string -> int)
word_list: list of strings
"""
\# TO DO ...
Testing:
```

Try out your implementation as if you were playing the game.
Note: Do not assume that there will always be 7 letters in a hand! The global variable HAND_SIZE represents this value.
Here is some example output of play_hand (your output may differ, depending on what messages you print out):
Current Hand: a ci h m m z
Enter word, or a . to indicate that you are finished: him him earned 8 points. Total: 8 points
Current Hand: a c m z
Enter word, or a . to indicate that you are finished: cam
cam earned 7 points. Total: 15 points
Current Hand: $z$
Enter word, or a . to indicate that you are finished: .
Total score: 15 points.
V. Playing a game

A game consists of playing multiple hands. We need to implement one final function to complete our word-game program.

## Problem \#5

Uncomment the code that implements the play_game function. You should remove the code that is currently uncommented in the play_game body. Read through and make sure you understand what this code does and how it works.

There is no coding for this question - the only "work" you have to do here is actually just uncommenting some lines and deleting some other lines of code.

For the game, you should use the HAND_SIZE constant to determine the number of cards in a hand. If you like, you can try out different values for HAND_SIZE with your program.

```
"""" play_game(word_list):
```

Allow the user to play an arbitrary number of hands.

* Asks the user to input 'n' or 'r' or 'e'.
* If the user inputs 'n', let the user play a new (random) hand. When done playing the hand, ask the 'n' or 'e' question again. * If the user inputs 'r', let the user play the last hand again. * If the user inputs 'e', exit the game.

```
* If the user inputs anything else, ask them again.
```

" " "
\# TO DO ...
Testing:
Try out this implementation as if you were playing the game.

## Finally: Submit your lab

1. Create a zip file of the folder where your project resides and email it as an attachment named lab5.zip to your lab instructor (ysaber@ryerson.ca) with a copy to kclowes@ee.ryerson.ca. The email must be sent before your next lab.
