Intro to Python 🐍

CS @ Illinois SAIL 2018

Objectives

- Learn Python's syntax.
- Code a game of Hangman.

About me

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Before we start...

- Install Python 3.6
- Download the zip file: **http://bit.ly/2GPZmAf**

Python crash course

Basic Concepts

Documentation

It is good practice to document code that you write.

```python
"""Here is the documentation for the module."""

def my_add_func(a, b):
    """Add two numbers together."""
    return a + b

def get_random_number():
    """Get a random number chosen by a dice roll. Guaranteed to be random.

    Source: https://xkcd.com/221/
    """
    return 4
```

String interpolation

An alternative to concatenating strings is to use string interpolation.

Python provides the `str.format` method to do so.

```
name1 = 'Daniel'
name2 = 'Sam'

# Using string concatenation
geah = 'I am ' + name1 + ', I am ' + name2 + ', ' + name2 + ' I am.'

# Using string interpolation
geah = 'I am {0}, I am {1}, {1} I am.'.format(name1, name2)
```

`Lists vs. sets`

- Both lists and sets can contain an arbitrary number of elements.
- The elements in a list are ordered, and a list can have duplicate elements.
- The elements in a set are **not** ordered, and a set **cannot** have duplicate elements.

```python
my_list = []
my_set = set()

my_list.append('a')
my_set.add('a')
print(my_list)  # Output: ['a']
print(my_set)  # Output: {'a'}

my_list.append('b')
my_set.add('b')
print(my_list)  # Output: ['a', 'b']
print(my_set)  # Output: {'b', 'a'}

my_list.append('a')
my_set.add('a')
print(my_list)  # Output: ['a', 'b', 'a']
print(my_set)  # Output: {'b', 'a'}
```

Why use sets?

Suppose I have a collection of one billion unique strings. I want to determine whether the string `"UIUC"` is in that collection.

- **List**: Python has to search through the entire list and compare `"UIUC"` with each string.
- **Set**: Python can *hash* each string. Comparing hashes is **much quicker** than comparing strings.

List comprehension

Concise syntax for creating lists from existing lists.

```python
# Goal: Add one to each number
my_list = [1, 3, 3, 7]

# Using for loop
my_list_plus_one = []
for num in my_list:
    my_list_plus_one.append(num + 1)
print(my_list_plus_one)  # Output: [2, 4, 4, 8]

# Raises TypeError: can only concatenate list (not "int") to list
my_list_plus_one = my_list + 1

# Using list comprehension
my_list_plus_one = [num + 1 for num in my_list]
print(my_list_plus_one)  # Output: [2, 4, 4, 8]
```

```python
my_list = [1, 3, 3, 7]

# Add one to each number
my_list_plus_one = [num + 1 for num in my_list]
print(my_list_plus_one)  # Output: [2, 4, 4, 8]

# Filter out numbers below 5, then add 1 to remaining numbers
filtered_out_low_nums = [num + 1 for num in my_list if num >= 5]
print(filtered_out_low_nums)  # Output: [8]

# For each number
# If number ≥ 5, set it to 5
# Otherwise, add 1 to the number
all_high_nums = [num + 1 if num >= 5 else 5 for num in my_list]
print(all_high_nums)  # Output: [5, 5, 5, 8]
```

The `enumerate` function

When iterating through a list, you can keep track of both the index and element.

```
words = ['all', 'your', 'base']
for idx, word in enumerate(words):
    print(idx, word)
print(list(enumerate(words)))

# Output:
# 0 all
# 1 your
# 2 base
# [(0, 'all'), (1, 'your'), (2, 'base')]
```

Before we begin...

What should a game of Hangman have?

Considerations

- How can let the player specify the game’s difficulty?
- How can I verify that the player has inputted a valid letter?
- How can I display a word with the unguessed letters censored?
- How can I keep track of already guessed letters?
- How can I detect whether the player has won or lost the game?

```
Ask for number of attempts, make sure it is between 1 and 25, inclusive
Ask for minimum word length, make sure it is between 4 and 16, inclusive [I will explain this later.]
Open the word list file & select a random word
Create a set of remaining letters and initialize it to contain the 26 ASCII lowercase character

While there are attempts remaining OR there are unguessed letters in the word remaining
    Print the word with the unguessed letters censored
    Ask for the next letter and make it lowercase
    If the "letter" has multiple characters
        Notify the player that the "letter" has multiple characters
    Else if the letter is not an ASCII lowercase character
        Notify the player that the letter is not an ASCII lowercase character
    Else if the letter is not in the remaining letter set (i.e. has been guessed before)
        Notify the player that the letter has been guessed before
    Else
        If letter is in the word
            Notify the player that the letter is in the word
        Else
            Decrement attempt counter
            Notify the player that the letter is not in the word
        Remove guessed letter from the remaining letter set

Reveal the word
If the word is solved
    Notify the player of victory
Else
    Notify the player of defeat

Give the player the option to try again
```

Part 1 of 5

Selecting a word uniformly at random

words.py

Check to see that you have the `wordlist.txt` file. Create a file called `words.py`

```
"""Function to fetch words."""

import random

WORDLIST = 'wordlist.txt'

def get_random_word(min_word_length):
    """Get a random word from the wordlist using no extra memory."""
    pass
```

Implement `get_random_word`

Simple approach: Gather all of the words into a list, and do `random.choice` to select a word uniformly at random.

```python
def get_random_word(min_word_length):
    """Get a random word from the wordlist using no extra memory."""
    words = []
    with open(WORDLIST, 'r') as f:
        for word in f:
            if '(' or ')' in word:
                continue  # Skip the word because it contains parentheses.
            word = word.strip().lower()
            if len(word) < min_word_length:
                continue  # Skip the word because it is too short.
            words.append(word)
    return random.choice(words)
```

Part 2 of 5

Game difficulty

hangman.py

We'll need the two imports later.

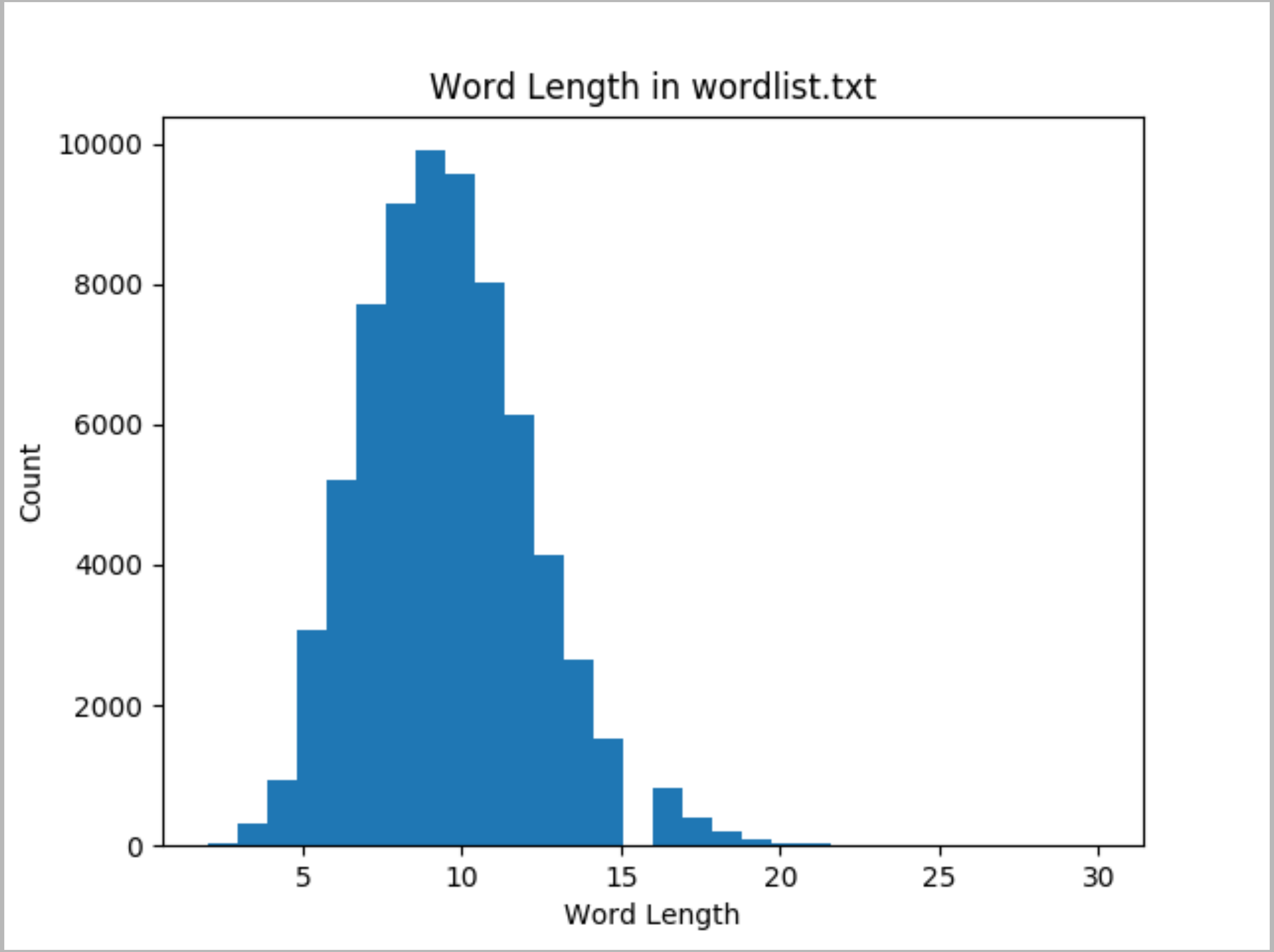
```
"""Main hangman game.

Use Python 3.
"""


from string import ascii_lowercase
from words import get_random_word
```

How can we adjust game difficulty?

1. By specifying the number of incorrect attempts he/she is allowed. The less attempts there are, the harder the difficulty. Cannot be more than 25 incorrect attempts.
2. By specifying the minimum word length. The longer the minimum word length is, the harder the difficulty. We'll set minimum word length bounds to 4 and 16.


Word Length in wordlist.txt
Count
10000
8000
6000
4000
2000
0
5
10
15
20
25
30
Word Length

Implement get_num_attempts

```python
def get_num_attempts():
    """Get user-inputted number of incorrect attempts for the game."""
    while True:
        num_attempts = input(
            'How many incorrect attempts do you want? [1-25] ')
        try:
            num_attempts = int(num_attempts)
            if 1 <= num_attempts <= 25:
                return num_attempts
            else:
                print('{0} is not between 1 and 25'.format(num_attempts))
        except ValueError:
            print('{0} is not an integer between 1 and 25'.format(
                num_attempts))
```

Implement get_min_word_length

```python
def get_min_word_length():
    """Get user-inputted minimum word length for the game."""
    while True:
        min_word_length = input(
            'What minimum word length do you want? [4-16] ')
        try:
            min_word_length = int(min_word_length)
            if 4 <= min_word_length <= 16:
                return min_word_length
            else:
                print('{0} is not between 4 and 16'.format(min_word_length))
        except ValueError:
            print('{0} is not an integer between 4 and 16'.format(
                min_word_length))
```

A note about infinite loops

Usually, coding an infinite loop (`while True`) is bad practice.

But we can make an exception because we have a clear and straightforward way of `break`ing out of the loop.

Part 3 of 5

Displaying the word

Problem

- The displayed word has to be censored to avoid spoilers.
- We shouldn't modify the chosen word.
- We shouldn't needlessly copy the word just to censor some letters. Remember that strings are immutable.

```python
my_string = 'ABC124'

# Raises TypeError: 'str' object does not support item assignment
my_string[5] = '3'
```

`Solution`

- Represent censored letters as a list of booleans.
- `True`: corresponding letter should be displayed
- `False`: corresponding letter should be censored and replaced with an asterisk

If the word is `"hangman"` and the boolean list is
`[False, True, True, False, True, True, True]`
We should display `*an*man`

Implement get_display_word

```python
def get_display_word(word, idxs):
    """Get the word suitable for display."""
    if len(word) != len(idxs):
        raise ValueError('Word length and indices length are not the same')
    displayed_word = ''.join(
        [letter if idxs[i] else '*' for i, letter in enumerate(word)])
    return displayed_word.strip()
```

Part 4 of 5

Asking the player to input the next letter

On each turn, the player inputs a string.

Which conditions must this input satisfy?

Conditions

1. The input string must consist of a single character.
2. The input letter must be an ASCII lowercase or uppercase character. We can ensure the letter is lowercase by using `str.lower`
3. The input letter cannot have been guessed before.

Implement get_next_letter

```python
def get_next_letter(remaining_letters):
    """Get the user-inputted next letter."""
    if len(remaining_letters) == 0:
        raise ValueError('There are no remaining letters')
    while True:
        next_letter = input('Choose the next letter: ').lower()
        if len(next_letter) != 1:
            print('{0} is not a single character'.format(next_letter))
        elif next_letter not in ascii_lowercase:
            print('{0} is not a letter'.format(next_letter))
        elif next_letter not in remaining_letters:
            print('{0} has been guessed before'.format(next_letter))
        else:
            remaining_letters.remove(next_letter)
            return next_letter
```

Part 5 of 5

Stitching it all together

Implement play_hangman

```python
def play_hangman():
    """Play a game of hangman.

    At the end of the game, returns if the player wants to retry.
    """
    # Let player specify difficulty
    print('Starting a game of Hangman...')
    attempts_remaining = get_num_attempts()
    min_word_length = get_min_word_length()

    # Randomly select a word
    print('Selecting a word...')
    word = get_random_word(min_word_length)
    print()
```

Initialize game state variables

Continue coding in `play_hangman`...

```
idxs = [letter not in ascii_lowercase for letter in word]
remaining_letters = set(ascii_lowercase)
wrong_letters = []
word_solved = False
```

`Main game loop`

Continue coding in `play_hangman`...

```python
while attempts_remaining > 0 and not word_solved:
    # Print current game state
    print('Word: {0}'.format(get_display_word(word, idxs)))
    print('Attempts Remaining: {0}'.format(attempts_remaining))
    print('Previous Guesses: {0}'.format(' '.join(wrong_letters)))

    # Get player's next letter guess
    next_letter = get_next_letter(remaining_letters)

    # Check if letter guess is in word
    if next_letter in word:
        # Guessed correctly
        print('{0} is in the word!'.format(next_letter))

        # Reveal matching letters
        for i in range(len(word)):
            if word[i] == next_letter:
                idxs[i] = True
    else:
        # Guessed incorrectly
        print('{0} is NOT in the word!'.format(next_letter))

        # Decrement num of attempts left and append guess to wrong guesses
        attempts_remaining -= 1
        wrong_letters.append(next_letter)

    # Check if word is completely solved
    if False not in idxs:
        word_solved = True
    print()
```

When the game is over

Continue coding in `play_hangman`...

```
# The game is over: reveal the word
print('The word is {0}'.format(word))

# Notify player of victory or defeat
if word_solved:
    print('Congratulations! You won!')
else:
    print('Try again next time!')

# Ask player if he/she wants to try again
try_again = input('Would you like to try again? [y/Y] ')
return try_again.lower() == 'y'
```

The finishing touch

At the end of `hangman.py`, we write the "main" function.

```
if __name__ == '__main__':
    while play_hangman():
        print()
```

In the terminal, run

```
python3 hangman.py
```