

Beginner's Python Cheat Sheet

Lists (cont.)

List comprehensions

```
squares = [x**2 for x in range(1, 11)]
```

Slicing a list

```
finishers = ['sam', 'bob', 'ada', 'bea']  
first_two = finishers[:2]
```

Copying a list

```
copy_of_bikes = bikes[:]
```

Tuples

Tuples are similar to lists, but the items in a tuple can't be modified.

Making a tuple

```
dimensions = (1920, 1080)
```

Concatenation (combining strings)

```
first_name = 'albert'  
last_name = 'einstein'  
full_name = first_name + ' ' + last_name  
print(full_name)
```

Lists

A list stores a series of items in a particular order. You access items using an index, or within a loop.

Make a list

```
bikes = ['trek', 'redline', 'giant']
```

Get the first item in a list

```
first_bike = bikes[0]
```

Get the last item in a list

```
last_bike = bikes[-1]
```

Looping through a list

```
for bike in bikes:  
    print(bike)
```

Adding items to a list

```
bikes = []  
bikes.append('trek')  
bikes.append('redline')  
bikes.append('giant')
```

Making numerical lists

```
squares = []  
for x in range(1, 11):  
    squares.append(x**2)
```

Dictionaries

Dictionaries store connections between pieces of information. Each item in a dictionary is a key-value pair.

A simple dictionary

```
alien = {'color': 'green', 'points': 5}
```

Accessing a value

```
print("The alien's color is " + alien['color'])  
Adding a new key-value pair  
alien['x_position'] = 0
```

Looping through all key-value pairs

```
fav_numbers = {'eric': 17, 'ever': 4}  
for name, number in fav_numbers.items():  
    print(name + ' loves ' + str(number))
```

Looping through all keys

```
fav_numbers = {'eric': 17, 'ever': 4}  
for name in fav_numbers.keys():  
    print(name + ' loves a number')
```

Looping through all the values

```
fav_numbers = {'eric': 17, 'ever': 4}  
for number in fav_numbers.values():  
    print(str(number) + ' is a favorite')
```

User input

Your programs can prompt the user for input. All input is stored as a string.

Prompting for a value

```
name = input("What's your name? ")  
print("Hello, " + name + "!")
```

Prompting for numerical input

```
age = input("How old are you? ")  
age = int(age)
```

```
pi = input("What's the value of pi? ")  
pi = float(pi)
```

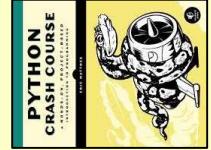
If-elif-else statements

```
if age < 4:  
    ticket_price = 0  
elif age < 18:  
    ticket_price = 10  
else:  
    ticket_price = 15
```

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While loops

A *while loop* repeats a *block* of code as long as a certain condition is true.

A simple while loop

```
current_value = 1
while current_value <= 5:
    print(current_value)
    current_value += 1
```

Letting the user choose when to quit

```
msg = ''
while msg != 'quit':
    msg = input("What's your message? ")
    print(msg)
```

Functions

Functions are named blocks of code, designed to do one specific job. Information passed to a function is called an argument, and information received by a function is called a parameter.

A simple function

```
def greet_user():
    """Display a simple greeting."""
    print("Hello!")
```

greet_user()

```
def greet_user(username):
    """Display a personalized greeting."""
    print("Hello, " + username + "!")
```

greet_user('jesse')

Default values for parameters

```
def make_pizza(topping='bacon'):
    """Make a single-topping pizza."""
    print("Have a " + topping + " pizza!")

make_pizza()
make_pizza('pepperoni')
```

Returning a value

```
def add_numbers(x, y):
    """Add two numbers and return the sum."""
    return x + y

sum = add_numbers(3, 5)
print(sum)
```

Classes

A class defines the behavior of an object and the kind of information an object can store. The information in a class is stored in attributes, and functions that belong to a class are called methods. A child class inherits the attributes and methods from its parent class.

Creating a dog class

```
class Dog():
    """Represent a dog."""

    def __init__(self, name):
        """Initialize dog object."""
        self.name = name

    def sit(self):
        """Simulate sitting."""
        print(self.name + " is sitting.")

my_dog = Dog('Peso')
print(my_dog.name + " is a great dog!")
my_dog.sit()
```

Functions are named blocks of code, designed to do one specific job. Information passed to a function is called an argument, and information received by a function is called a parameter.

Inheritance

```
class SARDog(Dog):
    """Represent a search dog."""

    def __init__(self, name):
        """Initialize the sardog."""
        super().__init__(name)

    def search(self):
        """Simulate searching."""
        print(self.name + " is searching.")

my_dog = SARDog('Willie')
print(my_dog.name + " is a search dog.")
```

```
try:
    num_tickets = int(num_tickets)
except ValueError:
    print("Please try again.")
else:
    print("Your tickets are printing.")
```

Infinite Skills

If you had infinite programming skills, what would you build?

As you're learning to program, it's helpful to think about the real-world projects you'd like to create. It's a good habit to keep an "ideas" notebook that you can refer to whenever you want to start a new project. If you haven't done so already, take a few minutes and describe three projects you'd like to create.

Working with files

Your programs can read from files and write to files. Files are opened in read mode ('r') by default, but can also be opened in write mode ('w') and append mode ('a').

Reading a file and storing its lines

```
filename = 'siddhartha.txt'
with open(filename) as file_object:
    lines = file_object.readlines()

for line in lines:
    print(line)
```

Writing to a file

```
filename = 'journal.txt'
with open(filename, 'w') as file_object:
    file_object.write("I love programming.")
```

Appending to a file

```
filename = 'journal.txt'
with open(filename, 'a') as file_object:
    file_object.write("\nI love making games.")
```

Exceptions

Exceptions help you respond appropriately to errors that are likely to occur. You place code that might cause an error in the try block. Code that should run in response to an error goes in the except block. Code that should run only if the try block was successful goes in the else block.

Catching an exception

```
prompt = "How many tickets do you need? "
num_tickets = input(prompt)

try:
    num_tickets = int(num_tickets)
except ValueError:
    print("Please try again.")
else:
    print("Your tickets are printing.")
```

Zen of Python

Simple is better than complex

If you have a choice between a simple and a complex solution, and both work, use the simple solution. Your code will be easier to maintain, and it will be easier for you and others to build on that code later on.

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet - Lists

Adding elements

You can add elements to the end of a list, or you can insert them wherever you like in a list.

Adding an element to the end of the list

```
users.append('amy')
```

What are lists?

A list stores a series of items in a particular order. Lists allow you to store sets of information in one place, whether you have just a few items or millions of items. Lists are one of Python's most powerful features readily accessible to new programmers, and they tie together many important concepts in programming.

Defining a list

Use square brackets to define a list, and use commas to separate individual items in the list. Use plural names for lists, to make your code easier to read.

Making a list

```
users = ['val', 'bob', 'mia', 'ron', 'ned']
```

Accessing elements

Individual elements in a list are accessed according to their position, called the index. The index of the first element is 0, the index of the second element is 1, and so forth. Negative indices refer to items at the end of the list. To get a particular element, write the name of the list and then the index of the element in square brackets.

Getting the first element

```
first_user = users[0]
```

Getting the second element

```
second_user = users[1]
```

Getting the last element

```
newest_user = users[-1]
```

Modifying individual items

Once you've defined a list, you can change individual elements in the list. You do this by referring to the index of the item you want to modify.

Changing an element

```
users[0] = 'valerie'  
users[-2] = 'ronald'
```

Sorting a list

The `sort()` method changes the order of a list permanently. The `sorted()` function returns a copy of the list, leaving the original list unchanged. You can sort the items in a list in alphabetical order, or reverse alphabetical order. You can also reverse the original order of the list. Keep in mind that lowercase and uppercase letters may affect the sort order.

Sorting a list permanently

```
users.sort()
```

Sorting a list permanently in reverse alphabetical order

```
users.sort(reverse=True)
```

Sorting a list temporarily

```
users.sort(reverse=True)
```

Sorting a list temporarily

```
print(sorted(users))  
print(sorted(users, reverse=True))
```

Reversing the order of a list

```
users.reverse()
```

Looping through a list

Lists can contain millions of items, so Python provides an efficient way to loop through all the items in a list. When you set up a loop, Python pulls each item from the list one at a time and stores it in a temporary variable, which you provide a name for. This name should be the singular version of the list name. The indented block of code makes up the body of the loop, where you can work with each individual item. Any lines that are not indented run after the loop is completed.

Printing all items in a list

```
for user in users:  
    print(user)
```

Printing a message for each item, and a separate message afterwards

```
for user in users:  
    print("Welcome, " + user + "!")  
  
print("Welcome, we're glad to see you all!")
```

List length

The `len()` function returns the number of items in a list.

Find the length of a list

```
num_users = len(users)  
print("We have " + str(num_users) + " users.")
```

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The range() function

You can use the `range()` function to work with a set of numbers efficiently. The `range()` function starts at 0 by default, and stops one number below the number passed to it. You can use the `list()` function to efficiently generate a large list of numbers.

Printing the numbers 0 to 1000

```
for number in range(1001):  
    print(number)
```

Printing the numbers 1 to 1000

```
for number in range(1, 1001):  
    print(number)
```

Making a list of numbers from 1 to a million

```
numbers = list(range(1, 10000001))
```

Simple statistics

There are a number of simple statistics you can run on a list containing numerical data.

Finding the minimum value in a list

```
ages = [93, 99, 66, 17, 85, 1, 35, 82, 2, 77]  
youngest = min(ages)
```

Finding the maximum value

```
ages = [93, 99, 66, 17, 85, 1, 35, 82, 2, 77]  
oldest = max(ages)
```

Finding the sum of all values

```
ages = [93, 99, 66, 17, 85, 1, 35, 82, 2, 77]  
total_years = sum(ages)
```

Slicing a list

You can work with any set of elements from a list. A portion of a list is called a slice. To slice a list start with the index of the first item you want, then add a colon and the index after the last item you want. Leave off the first index to start at the beginning of the list, and leave off the last index to slice through the end of the list.

Getting the first three items

```
finishers = ['kai', 'abe', 'ada', 'gus', 'zoe']  
first_three = finishers[:3]
```

Getting the middle three items

```
middle_three = finishers[1:4]
```

Getting the last three items

```
last_three = finishers[-3:]
```

Copying a list

To copy a list make a slice that starts at the first item and ends at the last item. If you try to copy a list without using this approach, whatever you do to the copied list will affect the original list as well.

Making a copy of a list

```
finishers = ['kai', 'abe', 'ada', 'gus', 'zoe']  
copy_of_finishers = finishers[:]
```

List comprehensions

You can use a loop to generate a list based on a range of numbers or on another list. This is a common operation, so Python offers a more efficient way to do it. List comprehensions may look complicated at first; if so, use the for loop approach until you're ready to start using comprehensions.

To write a comprehension, define an expression for the values you want to store in the list. Then write a for loop to generate input values needed to make the list.

Using a loop to generate a list of square numbers

```
squares = []  
for x in range(1, 11):  
    square = x**2  
    squares.append(square)
```

Using a comprehension to generate a list of square numbers

```
squares = [x**2 for x in range(1, 11)]
```

Using a loop to convert a list of names to upper case

```
names = ['kai', 'abe', 'ada', 'gus', 'zoe']
```

Using a comprehension to convert a list of names to upper case

```
upper_names = []  
for name in names:  
    upper_names.append(name.upper())
```

Using a comprehension to convert a list of names to upper case

```
names = ['kai', 'abe', 'ada', 'gus', 'zoe']  
upper_names = [name.upper() for name in names]
```

Tuples

A tuple is like a list, except you can't change the values in a tuple once it's defined. Tuples are good for storing information that shouldn't be changed throughout the life of a program. Tuples are designated by parentheses instead of square brackets. (You can overwrite an entire tuple, but you can't change the individual elements in a tuple.)

Defining a tuple

```
dimensions = (800, 600)
```

Looping through a tuple

```
for dimension in dimensions:  
    print(dimension)
```

Overwriting a tuple

```
dimensions = (800, 600)  
print(dimensions)
```

```
dimensions = (1200, 900)
```

Visualizing your code

When you're first learning about data structures such as lists, it helps to visualize how Python is working with the information in your program. pythontutor.com is a great tool for seeing how Python keeps track of the information in a list. Try running the following code on pythontutor.com, and then run your own code.

Build a list and print the items in the list

```
dogs = []  
dogs.append('willie')  
dogs.append('hootz')  
dogs.append('peso')  
dogs.append('goblin')
```

```
for dog in dogs:  
    print("Hello " + dog + "!")  
print("I love these dogs!")
```

```
print("\nThese were my first two dogs:")  
old_dogs = dogs[:2]  
for old_dog in old_dogs:  
    print(old_dog)
```

```
del dogs[0]  
dogs.remove('peso')  
print(dogs)
```

- Use four spaces per indentation level.
- Keep your lines to 79 characters or fewer.
- Use single blank lines to group parts of your program visually.

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — Dictionaries

Adding new key-value pairs

You can store as many key-value pairs as you want in a dictionary, until your computer runs out of memory. To add a new key-value pair to an existing dictionary give the name of the dictionary and the new key in square brackets, and set it equal to the new value.

This also allows you to start with an empty dictionary and add key-value pairs as they become relevant.

Adding a key-value pair

```
alien_0 = {'color': 'green', 'points': 5}

alien_0['x'] = 0
alien_0['y'] = 25
alien_0['speed'] = 1.5
```

Adding to an empty dictionary

```
alien_0 = {}
alien_0['color'] = 'green'
alien_0['points'] = 5
```

Looping through a dictionary

You can loop through a dictionary in three ways: you can loop through all the key-value pairs, all the keys, or all the values.

A dictionary only tracks the connections between keys and values; it doesn't track the order of items in the dictionary. If you want to process the information in order, you can sort the keys in your loop.

Looping through all key-value pairs

```
# Store people's favorite languages.
fav_languages = {
    'jen': 'python',
    'sarah': 'c',
    'edward': 'ruby',
    'phil': 'python',
}
```

```
# Show each person's favorite language.
for name in fav_languages.items():
    print(name + ": " + language)
```

Looping through all the keys

```
# Show everyone who's taken the survey.
for name in fav_languages.keys():
    print(name)
```

Looping through all the values

```
# Show all the languages that have been chosen.
for language in fav_languages.values():
    print(language)
```

Looping through all the keys in order

```
# Show each person's favorite language,
# in order by the person's name.
for name in sorted(fav_languages.keys()):
    print(name + ": " + language)
```

Dictionary length

You can find the number of key-value pairs in a dictionary.

```
num_responses = len(fav_languages)
```

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Modifying values

You can modify the value associated with any key in a dictionary. To do so give the name of the dictionary and enclose the key in square brackets, then provide the new value for that key.

Modifying values in a dictionary

```
alien_0 = {'color': 'green', 'points': 5}
print(alien_0)

# Change the alien's color and point value.
alien_0['color'] = 'yellow'
alien_0['points'] = 10
print(alien_0)
```

Removing key-value pairs

You can remove any key-value pair you want from a dictionary. To do so use the `del` keyword and the dictionary name, followed by the key in square brackets. This will delete the key and its associated value.

```
alien_0 = {'color': 'green', 'points': 5}
print(alien_0)

del alien_0['color']
print(alien_0)
```

```
del alien_0['points']
print(alien_0)
```

Accessing values

To access the value associated with an individual key give the name of the dictionary and then place the key in a set of square brackets. If the key you're asking for is not in the dictionary, an error will occur.

You can also use the `get()` method, which returns `None` instead of an error if the key doesn't exist. You can also specify a default value to use if the key is not in the dictionary.

Getting the value associated with a key

```
alien_0 = {'color': 'green', 'points': 5}
print(alien_0['color'])
print(alien_0['points'])
```

```
alien_0 = {'color': 'green'}
print(alien_0.get('color'))
```

```
alien_color = alien_0.get('color')
alien_points = alien_0.get('points', 0)
print(alien_color)
print(alien_points)
```

Getting the value with get()

Visualizing dictionaries

Try running some of these examples on pythontutor.com.

Nesting — A list of dictionaries

It's sometimes useful to store a set of dictionaries in a list; this is called nesting.

Storing dictionaries in a list

```
# Start with an empty list.  
users = []  
  
# Make a new user, and add them to the list.  
new_user = {  
    'last': 'fermi',  
    'first': 'enrico',  
    'username': 'efermi',  
}  
  
users.append(new_user)  
  
# Make another new user, and add them as well.  
new_user = {  
    'last': 'curie',  
    'first': 'marie',  
    'username': 'mcurie',  
}  
users.append(new_user)
```

```
# Show all information about each user.  
for user_dict in users:  
    for k, v in user_dict.items():  
        print(k + ":" + v)  
    print("\n")
```

You can also define a list of dictionaries directly, without using append():

```
# Define a list of users, where each user  
# is represented by a dictionary.  
users = [  
    {'last': 'fermi',  
     'first': 'enrico',  
     'username': 'efermi',  
    },  
    {'last': 'curie',  
     'first': 'marie',  
     'username': 'mcurie',  
    },  
]
```

```
# Show all information about each user.  
for user_dict in users:  
    for k, v in user_dict.items():  
        print(k + ":" + v)  
    print("\n")
```

Nesting — Lists in a dictionary

Storing a list inside a dictionary allows you to associate more than one value with each key.

Storing lists in a dictionary

```
# Store multiple languages for each person.  
fav_languages = {  
    'jen': ['python', 'ruby'],  
    'sarah': ['c'],  
    'edward': ['ruby', 'go'],  
    'phil': ['python', 'haskell'],  
}  
  
# Show all responses for each person.  
for name, langs in fav_languages.items():  
    print(name + ":")  
    for lang in langs:  
        print("- " + lang)
```

Nesting — A dictionary of dictionaries

You can store a dictionary inside another dictionary. In this case each value associated with a key is itself a dictionary.

Storing dictionaries in a dictionary

```
users = {  
    'einstein': {  
        'first': 'albert',  
        'last': 'einstein',  
        'location': 'princeton',  
    },  
    'mcurie': {  
        'first': 'marie',  
        'last': 'curie',  
        'location': 'paris',  
    },  
}
```

```
for username, user_dict in users.items():  
    print("\nusername: " + username)  
    full_name = user_dict['first'] + " "  
    full_name += user_dict['last']  
    location = user_dict['location']  
  
    print("\tFull name: " + full_name.title())  
    print("\tLocation: " + location.title())
```

```
# Define a list of users, where each user  
# is represented by a dictionary.  
users = [  
    {'last': 'fermi',  
     'first': 'enrico',  
     'username': 'efermi',  
    },  
    {'last': 'curie',  
     'first': 'marie',  
     'username': 'mcurie',  
    },  
]
```

```
# Show all information about each user.  
for user_dict in users:  
    for k, v in user_dict.items():  
        print(k + ":" + v)  
    print("\n")
```

Using an OrderedDict

Standard Python dictionaries don't keep track of the order in which keys and values are added; they only preserve the association between each key and its value. If you want to preserve the order in which keys and values are added, use an OrderedDict.

Preserving the order of keys and values

```
# Store each person's languages, keeping  
# track of who responded first.  
fav_languages = OrderedDict()  
  
fav_languages['jen'] = ['python', 'ruby']  
fav_languages['sarah'] = ['c']  
fav_languages['edward'] = ['ruby', 'go']  
fav_languages['phil'] = ['python', 'haskell']  
  
# Display the results, in the same order they  
# were entered.  
for name, langs in fav_languages.items():  
    print(name + ":")  
    for lang in langs:  
        print("- " + lang)
```

Generating a million dictionaries

You can use a loop to generate a large number of dictionaries efficiently, if all the dictionaries start out with similar data.

A million aliens

```
aliens = []  
  
# Make a million green aliens, worth 5 points  
# each. Have them all start in one row.  
for alien_num in range(1000000):  
    new_alien = {}  
    new_alien['color'] = 'green'  
    new_alien['points'] = 5  
    new_alien['x'] = 20 * alien_num  
    new_alien['y'] = 0  
    aliens.append(new_alien)
```

```
# Prove the list contains a million aliens.  
num_aliens = len(aliens)
```

Levels of nesting

Nesting is extremely useful in certain situations. However, be aware of making your code overly complex. If you're nesting items much deeper than what you see here there are probably simpler ways of managing your data, such as using classes.

```
print("Number of aliens created:")  
print(num_aliens)
```

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Beginner's Python Cheat Sheet — If Statements and While Loops

Numerical comparisons

Testing numerical values is similar to testing string values.

```
>>> age = 18  
>>> age == 18  
True  
>>> age != 18  
False
```

Comparison operators

```
>>> age = 19  
>>> age < 21  
True  
>>> age <= 21  
True  
>>> age > 21  
False  
>>> age >= 21  
False
```

What are if statements? What are while loops?

If statements allow you to examine the current state of a program and respond appropriately to that state. You can write a simple if statement that checks one condition, or you can create a complex series of if statements that identify the exact conditions you're looking for.

While loops run as long as certain conditions remain true. You can use while loops to let your programs run as long as your users want them to.

Conditional Tests

A conditional test is an expression that can be evaluated as True or False. Python uses the values True and False to decide whether the code in an if statement should be executed.

Checking for equality

A single equal sign assigns a value to a variable. A double equal sign (==) checks whether two values are equal.

```
>>> car = 'bmw'  
>>> car == 'bmw'  
True  
>>> car = 'audi'  
>>> car == 'bmw'  
False
```

Ignoring case when making a comparison

```
>>> car = 'Audi'  
>>> car.lower() == 'audi'  
True
```

Checking for inequality

```
>>> topping = 'mushrooms'  
>>> topping != 'anchovies'  
True
```

If statements

Several kinds of if statements exist. Your choice of which to use depends on the number of conditions you need to test. You can have as many elif blocks as you need, and the else block is always optional.

Simple if statement

```
age = 19
```

```
if age >= 18:  
    print("You're old enough to vote!")
```

If-else statements

```
age = 17
```

```
if age >= 18:  
    print("You're old enough to vote!")  
else:  
    print("You can't vote yet.")
```

The if-elif-else chain

```
age = 12
```

```
if age < 4:  
    price = 0  
elif age < 18:  
    price = 5  
else:  
    price = 10
```

Conditional tests with lists

You can easily test whether a certain value is in a list. You can also test whether a list is empty before trying to loop through the list.

Testing if a value is in a list

```
>>> players = ['al', 'bea', 'cyn', 'dale']  
>>> 'al' in players  
True  
>>> 'eric' in players  
False
```

Boolean values

A boolean value is either True or False. Variables with boolean values are often used to keep track of certain conditions within a program.

Simple boolean values

```
game_active = True  
can_edit = False
```

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Conditional tests with lists (cont.)

Testing if a value is not in a list

```
banned_users = ['ann', 'chad', 'dee']
user = 'erin'

if user not in banned_users:
    print("You can play!")
```

Checking if a list is empty

```
players = []
```

if players:

```
for player in players:
    print("Player: " + player.title())
```

```
else:
    print("We have no players yet!")
```

Accepting input

You can allow your users to enter input using the `input()` statement. In Python 3, all input is stored as a string.

Simple input

```
name = input("What's your name? ")
print("Hello, " + name + ".")
```

Accepting numerical input

```
age = input("How old are you? ")
age = int(age)
```

```
if age >= 18:
    print("\nYou can vote!")
```

```
else:
    print("\nYou can't vote yet.")
```

Accepting input in Python 2.7

Use `raw_input()` in Python 2.7. This function interprets all input as a string, just as `input()` does in Python 3.

```
name = raw_input("What's your name? ")
print("Hello, " + name + ".")
```

While loops

A while loop repeats a block of code as long as a condition is True.

Counting to 5

```
current_number = 1

while current_number <= 5:
    print(current_number)
    current_number += 1
```

While loops (cont.)

Letting the user choose when to quit

```
prompt = "\nTell me something, and I'll "
prompt += "repeat it back to you."
prompt += "\nEnter 'quit' to end the program.

message = ""
while message != 'quit':
    message = input(prompt)

    if message != 'quit':
        print(message)
```

Using a flag

```
prompt = "\nTell me something, and I'll "
prompt += "repeat it back to you."
prompt += "\nEnter 'quit' to end the program.

active = True
while active:
    message = input(prompt)

    if message == 'quit':
        active = False
    else:
        print(message)
```

Using break to exit a loop

```
prompt = "\nWhat cities have you visited?"
prompt += "\nEnter 'quit' when you're done.

while True:
    city = input(prompt)

    if city == 'quit':
        break
    else:
        print("I've been to " + city + "!")
```

Accepting input with Sublime Text

Sublime Text doesn't run programs that prompt the user for input. You can use Sublime Text to write programs that prompt for input, but you'll need to run these programs from a terminal.

Breaking out of loops

You can use the `break` statement and the `continue` statement with any of Python's loops. For example you can use `break` to quit a for loop that's working through a list or a dictionary. You can use `continue` to skip over certain items when looping through a list or dictionary as well.

Using continue in a loop

```
banned_users = ['eve', 'fred', 'gary', 'helen']
prompt = "\nEnter 'quit' when you're done.

players = []
while True:
    player = input(prompt)
    if player == 'quit':
        break
    elif player in banned_users:
        print(player + " is banned!")
    else:
        print(player)
        players.append(player)
```

Avoiding infinite loops

Every while loop needs a way to stop running so it won't continue to run forever. If there's no way for the condition to become False, the loop will never stop running.

An infinite loop

```
while True:
    name = input("\nWho are you? ")
    print("Nice to meet you, " + name + "!")
```

Removing all instances of a value from a list

The `remove()` method removes a specific value from a list, but it only removes the first instance of the value you provide. You can use a while loop to remove all instances of a particular value.

Removing all cats from a list of pets

```
pets = ['dog', 'cat', 'dog', 'fish', 'cat',
        'rabbit', 'cat']

print(pets)

while 'cat' in pets:
    pets.remove('cat')

print(pets)
```

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — Functions

Positional and keyword arguments

The two main kinds of arguments are *positional* and *keyword arguments*. When you use *positional arguments* Python matches the first argument in the function call with the first parameter in the function definition, and so forth. With *keyword arguments*, you specify which parameter each argument should be assigned to in the function call. When you use *keyword arguments*, the order of the arguments doesn't matter.

What are functions?

Functions are named blocks of code designed to do one specific job. Functions allow you to write code once that can then be run whenever you need to accomplish the same task. Functions can take in the information they need, and return the information they generate. Using functions effectively makes your programs easier to write, read, test, and fix.

Defining a function

The *first line of a function is its definition, marked by the keyword def*. The *name of the function is followed by a set of parentheses and a colon*. A *docstring, in triple quotes, describes what the function does*. The *body of a function is indented one level*. To call a function, give the name of the function followed by a set of parentheses.

Making a function

```
def greet_user():
    """Display a simple greeting."""
    print("Hello!")
```

greet_user()

Passing information to a function

Information that's passed to a function is called an *argument; information that's received by a function is called a parameter*. Arguments are included in parentheses after the function's name, and parameters are listed in parentheses in the function's definition.

Passing a single argument

```
def greet_user(username):
    """Display a simple greeting."""
    print("Hello, " + username + "!")
```

```
greet_user('jesse')
greet_user('diana')
greet_user('brandon')
```

Return values

A function can return a value or a set of values. When a function returns a value, the calling line must provide a variable in which to store the return value. A function stops running when it reaches a *return statement*.

Returning a single value

```
def get_full_name(first, last):
    """Return a neatly formatted full name."""
    full_name = first + ' ' + last
    return full_name.title()
```

```
musician = get_full_name('jimi', 'hendrix')
print(musician)
```

Returning a dictionary

```
def build_person(first, last):
    """Return a dictionary of information about a person."""
    person = {'first': first, 'last': last}
    return person
```

```
musician = build_person('jimi', 'hendrix')
print(musician)
```

```
person = {'first': 'first', 'last': 'last'}
```

Returning a dictionary with optional values

```
def build_person(first, last, age=None):
    """Return a dictionary of information about a person."""
    person = {'first': first, 'last': last}
    if age:
        person['age'] = age
    return person
```

```
musician = build_person('jimi', 'hendrix', 27)
print(musician)
```

Visualizing functions
Try running some of these examples on pythontutor.com.

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Passing a list to a function

You can pass a `list` as an argument to a function, and the function can work with the values in the list. Any changes the function makes to the `list` will affect the original `list`. You can prevent a function from modifying a `list` by passing a copy of the `list` as an argument.

Passing a list as an argument

```
def greet_users(names):
    """Print a simple greeting to everyone."""
    for name in names:
        msg = "Hello, " + name + "!"
        print(msg)

usernames = ['hannah', 'ty', 'margot']
greet_users(usernames)
```

Allowing a function to modify a list

The following example sends a `list` of `models` to a function for printing. The original `list` is emptied, and the second `list` is filled.

```
def print_models(unprinted, printed):
    """3d print a set of models."""
    while unprinted:
        current_model = unprinted.pop()
        print("Printing " + current_model)
        printed.append(current_model)

    # Store some unprinted designs,
    # and print each of them.
    unprinted = ['phone case', 'pendant', 'ring']
    printed = []
    print_models(unprinted, printed)

print("\nUnprinted:", unprinted)
print("Printed:", printed)
```

Preventing a function from modifying a list

The following example is the same as the previous one, except the original `list` is unchanged after calling `print_models()`.

```
def print_models(unprinted, printed):
    """3d print a set of models."""
    while unprinted:
        current_model = unprinted.pop()
        print("Printing " + current_model)
        printed.append(current_model)

# Store some unprinted designs,
# and print each of them.
original = ['phone case', 'pendant', 'ring']
printed = []

print_models(original[:], printed)
print("\nOriginal:", original)
print("Printed:", printed)
```

Passing an arbitrary number of arguments

Sometimes you won't know how many arguments a function will need to accept. Python allows you to collect an arbitrary number of arguments into one parameter using the `*` operator. A parameter that accepts an arbitrary number of arguments must come last in the function definition. The `**` operator allows a parameter to collect an arbitrary number of keyword arguments.

Collecting an arbitrary number of arguments

```
def make_pizza(size, *toppings):
    """Make a pizza."""
    print("\nMaking a " + size + " pizza.")
    print("Toppings:")
    for topping in toppings:
        print("- " + topping)
```

Allowing three pizzas with different toppings.

```
make_pizza('small', 'pepperoni')
make_pizza('large', 'bacon bits', 'pineapple')
make_pizza('medium', 'mushrooms', 'peppers',
           'onions', 'extra cheese')
```

Collecting an arbitrary number of keyword arguments

```
def build_profile(first, last, **user_info):
    """Build a user's profile dictionary."""
    # Build a dict with the required keys.
    profile = {'first': first, 'last': last}
    # Add any other keys and values.
    for key, value in user_info.items():
        profile[key] = value

    return profile
```

Creating two users with different kinds

```
# of information.
user_0 = build_profile('albert', 'einstein',
                       location='princeton')
user_1 = build_profile('marie', 'curie',
                       location='paris', field='chemistry')

print(user_0)
print(user_1)
```

Importing all functions from a module

Don't do this, but recognize it when you see it in others' code. It can result in naming conflicts, which can cause errors.

```
from pizza import *
make_pizza('medium', 'pepperoni')
make_pizza('small', 'bacon', 'pineapple')
```

What's the best way to structure a function?

As you can see there are many ways to write and call a function. When you're starting out, aim for something that simply works. As you gain experience you'll develop an understanding of the more subtle advantages of different structures such as positional and keyword arguments, and the various approaches to importing functions. For now if your functions do what you need them to, you're doing well.

Modules

You can store your functions in a separate file called a `module`, and then import the functions you need into the file containing your main program. This allows for cleaner program files. (Make sure your module is stored in the same directory as your main program.)

Storing a function in a module

`File: pizza.py`

```
def make_pizza(size, *toppings):
    """Make a pizza."""
    print("\nMaking a " + size + " pizza.")
    print("Toppings:")
    for topping in toppings:
        print("- " + topping)
```

Importing an entire module

`File: making_pizzas.py`
Every function in the module is available in the program file.

```
import pizza
pizza.make_pizza('medium', 'pepperoni')
pizza.make_pizza('small', 'bacon', 'pineapple')
```

Importing a specific function

Only the imported functions are available in the program file.

```
from pizza import make_pizza
make_pizza('medium', 'pepperoni')
make_pizza('small', 'bacon', 'pineapple')
```

Giving a module an alias

```
from pizza as p
p.make_pizza('medium', 'pepperoni')
p.make_pizza('small', 'bacon', 'pineapple')
```

Importing all functions from a module

Don't do this, but recognize it when you see it in others' code. It can result in naming conflicts, which can cause errors.

`from pizza import *`

```
make_pizza('medium', 'pepperoni')
make_pizza('small', 'bacon', 'pineapple')
```

*More cheat sheets available at
ehmatthes.github.io/pcc/*

Beginner's Python Cheat Sheet - Classes

Creating and using a class (cont.)

Creating an object from a class

```
my_car = Car('audi', 'a4', 2016)
```

Accessing attribute values

```
print(my_car.make)  
print(my_car.model)  
print(my_car.year)
```

What are classes?

Classes are the foundation of object-oriented programming. Classes represent real-world things you want to model in your programs: for example dogs, cars, and robots. You use a class to make objects, which are specific instances of dogs, cars, and robots. A class defines the general behavior that a whole category of objects can have, and the information that can be associated with those objects. Classes can inherit from each other – you can write a class that extends the functionality of an existing class. This allows you to code efficiently for a wide variety of situations.

Creating and using a class

Consider how we might model a car. What information would we associate with a car, and what behavior would it have? The information is stored in variables called attributes, and the behavior is represented by functions. Functions that are part of a class are called methods.

The Car class

```
class Car():  
    """A simple attempt to model a car."""  
  
    def __init__(self, make, model, year):  
        """Initialize car attributes."""  
        self.make = make  
        self.model = model  
        self.year = year  
  
    # Fuel capacity and level in gallons.  
    self.fuel_capacity = 15  
    self.fuel_level = 0  
  
    def fill_tank(self):  
        """Fill gas tank to capacity."""  
        self.fuel_level = self.fuel_capacity  
        print("Fuel tank is full.")
```

Naming conventions
In Python class names are written in CamelCase and object names are written in lowercase with underscores. Modules that contain classes should still be named in lowercase with underscores.

Class inheritance

If the class you're writing is a specialized version of another class, you can use *inheritance*. When one class inherits from another, it automatically takes on all the attributes and methods of the parent class. The child class is free to introduce new attributes and methods, and override attributes and methods of the parent class.

To inherit from another class include the name of the parent class in parentheses when defining the new class.

The `__init__()` method for a child class

```
class ElectricCar(Car):  
    """A simple model of an electric car."""  
  
    def __init__(self, make, model, year):  
        """Initialize an electric car."""  
        super().__init__(make, model, year)  
  
        # Attributes specific to electric cars.  
        # Battery capacity in kWh.  
        self.battery_size = 70  
        # Charge level in %.  
        self.charge_level = 0
```

Adding new methods to the child class

```
class ElectricCar(Car):  
    """Snip--  
    def charge(self):  
        """Fully charge the vehicle."""  
        self.charge_level = 100  
        print("The vehicle is fully charged.")
```

Using child methods and parent methods

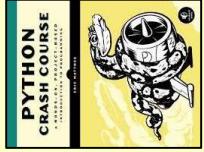
```
my_ecar = ElectricCar('tesla', 'model s', 2016)  
  
my_ecar.charge()  
my_ecar.drive()
```

Finding your workflow

There are many ways to model real world objects and situations in code, and sometimes that variety can feel overwhelming. Pick an approach and try it – if your first attempt doesn't work, try a different approach.

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Class inheritance (cont.)

Overriding parent methods

```
class ElectricCar(Car):
    --snip--
    def fill_tank(self):
        """Display an error message."""
        print("This car has no fuel tank!")
```

Instances as attributes

A class can have objects as attributes. This allows classes to work together to model complex situations.

A Battery class

```
class Battery():
    """A battery for an electric car."""
    def __init__(self, size=70):
        """Initialize battery attributes."""
        # Capacity in kWh, charge level in %.
        self.size = size
        self.charge_level = 0

    def get_range(self):
        """Return the battery's range."""
        if self.size == 70:
            return 240
        elif self.size == 85:
            return 270
        else:
            return 300
```

Using an instance as an attribute

```
class ElectricCar(Car):
    --snip--

    def __init__(self, make, model, year):
        """Initialize an electric car."""
        super().__init__(make, model, year)

        # Attribute specific to electric cars.
        self.battery = Battery()
```

Using the instance

```
my_ecar = ElectricCar('tesla', 'model x', 2016)

my_ecar.charge()
print(my_ecar.battery.get_range())
my_ecar.drive()
```

Importing classes

Class files can get long as you add detailed information and functionality. To help keep your program files uncluttered, you can store your classes in modules and import the classes you need into your main program.

Storing classes in a file car.py

```
"""Represent gas and electric cars."""

class Car():
    """A simple attempt to model a car."""
    --snip--
```

```
class Battery():
    """A battery for an electric car."""
    --snip--
```

```
class ElectricCar(Car):
    --snip--
    def __init__(self, make, model, year):
        super(ElectricCar, self).__init__(
            make, model, year)
```

Importing individual classes from a module my_cars.py

```
from car import Car, ElectricCar
```

```
my_beetle = Car('volkswagen', 'beetle', 2016)
my_beetle.fill_tank()
my_beetle.drive()
```

```
my_tesla = ElectricCar('tesla', 'model s', 2016)
my_tesla.charge()
my_tesla.drive()
```

Importing an entire module

```
import car

my_beetle = car.Car('volkswagen', 'beetle', 2016)
my_beetle.fill_tank()
my_beetle.drive()

my_tesla = car.ElectricCar(
    'tesla', 'model s', 2016)
my_tesla.charge()
my_tesla.drive()
```

```
def charge(self):
    """Fully charge the vehicle."""
    self.battery.charge_level = 100
    print("The vehicle is fully charged.")
```

Importing all classes from a module

(Don't do this, but recognize it when you see it.)

```
from car import *

my_beetle = Car('volkswagen', 'beetle', 2016)
```

Classes in Python 2.7

Classes should inherit from object

```
class ClassName(object):
```

The Car class in Python 2.7

```
class Car(object):
    Child class __init__() method is different
```

```
class ChildClassName(ParentClass):
```

```
    def __init__(self):
        super(ClassName, self).__init__()
```

The ElectricCar class in Python 2.7

```
class ElectricCar(Car):
    def __init__(self, make, model, year):
        super(ElectricCar, self).__init__(
            make, model, year)
```

Storing objects in a list

A list can hold as many items as you want, so you can make a large number of objects from a class and store them in a list.
Here's an example showing how to make a fleet of rental cars, and make sure all the cars are ready to drive.

A fleet of rental cars

```
from car import Car, ElectricCar
# Make lists to hold a fleet of cars.
gas_fleet = []
electric_fleet = []

# Make 500 gas cars and 250 electric cars.
for _ in range(500):
    car = Car('ford', 'focus', 2016)
    gas_fleet.append(car)
for _ in range(250):
    ecar = ElectricCar('nissan', 'leaf', 2016)
    electric_fleet.append(ecar)
```

```
# Fill the gas cars, and charge electric cars.
for car in gas_fleet:
    car.fill_tank()
for ecar in electric_fleet:
    ecar.charge()

print("Gas cars:", len(gas_fleet))
print("Electric cars:", len(electric_fleet))
```

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Beginner's Python Cheat Sheet — Files and Exceptions

Reading from a file (cont.)

Storing the lines in a list

```
filename = 'siddhartha.txt'  
with open(filename) as f_obj:  
    lines = f_obj.readlines()  
  
for line in lines:  
    print(line.rstrip())
```

What are files? What are exceptions?

Your programs can read information in from files, and they can write data to files. Reading from files allows you to work with a wide variety of information; writing to files allows users to pick up where they left off the next time they run your program. You can write text to files, and you can store Python structures such as lists in data files.

Exceptions are special objects that help your programs respond to errors in appropriate ways. For example if your program tries to open a file that doesn't exist, you can use exceptions to display an informative error message instead of having the program crash.

Reading from a file

To read from a file your program needs to open the file and then read the contents of the file. You can read the entire contents of the file at once, or read the file line by line. The with statement makes sure the file is closed properly when the program has finished accessing the file.

Reading an entire file at once

```
filename = 'siddhartha.txt'  
  
with open(filename) as f_obj:  
    contents = f_obj.read()  
  
print(contents)
```

Each line that's read from the file has a newline character at the end of the line, and the print function adds its own newline character. The `rstrip()` method gets rid of the extra blank lines this would result in when printing to the terminal.

```
filename = 'siddhartha.txt'  
  
with open(filename) as f_obj:  
    for line in f_obj:  
        print(line.rstrip())
```

File paths (cont.)

Opening a file using an absolute path

```
f_path = "/home/ehmatthes/books/alice.txt"  
  
with open(f_path) as f_obj:  
    lines = f_obj.readlines()
```

Opening a file on Windows

Windows will sometimes interpret forward slashes incorrectly. If you run into this, use backslashes in your file paths.

```
f_path = "C:/Users/ehmatthes/books/alice.txt"  
  
with open(f_path) as f_obj:  
    lines = f_obj.readlines()
```

The try-except block

When you think an error may occur, you can write a try-except block to handle the exception that might be raised. The try block tells Python to try running some code, and the except block tells Python what to do if the code results in a particular kind of error.

Handling the ZeroDivisionError exception

```
try:  
    print(5/0)  
except ZeroDivisionError:  
    print("You can't divide by zero!")
```

Handling the FileNotFoundError exception

```
f_name = 'siddhartha.txt'  
  
try:  
    with open(f_name) as f_obj:  
        lines = f_obj.readlines()  
except FileNotFoundError:  
    msg = "Can't find file {}".format(f_name)  
    print(msg)
```

Knowing which exception to handle

It can be hard to know what kind of exception to handle when writing code. Try writing your code without a try block, and make it generate an error. The traceback will tell you what kind of exception your program needs to handle.

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The else block

The try block should only contain code that may cause an error. Any code that depends on the try block running successfully should be placed in the else block.

Using an else block

```
print("Enter two numbers. I'll divide them.")

x = input("First number: ")
y = input("Second number: ")

try:
    result = int(x) / int(y)
except ZeroDivisionError:
    print("You can't divide by zero!")
else:
    print(result)
```

Preventing crashes from user input

Without the except block in the following example, the program would crash if the user tries to divide by zero. As written, it will handle the error gracefully and keep running.

```
"""A simple calculator for division only."""

print("Enter two numbers. I'll divide them.")
print("Enter 'q' to quit.")

while True:
    x = input("\nFirst number: ")
    if x == 'q':
        break
    y = input("Second number: ")
    if y == 'q':
        break
    try:
        result = int(x) / int(y)
    except ZeroDivisionError:
        print("You can't divide by zero!")
    else:
        print(result)
```

Failing silently

Sometimes you want your program to just continue running when it encounters an error, without reporting the error to the user. Using the pass statement in an else block allows you to do this.

Using the pass statement in an else block

```
f_names = ['alice.txt', 'siddhartha.txt',
           'moby_dick.txt', 'little_women.txt']

for f_name in f_names:
    # Report the length of each file found.
    try:
        with open(f_name) as f_obj:
            lines = f_obj.readlines()
    except FileNotFoundError:
        # Just move on to the next file.
        pass
    else:
        num_lines = len(lines)
        msg = "{0} has {1} lines.".format(
            f_name, num_lines)
        print(msg)
```

Deciding which errors to report

Well-written, properly tested code is not very prone to internal errors such as syntax or logical errors. But every time your program depends on something external such as user input or the existence of a file, there's a possibility of an exception being raised.

```
try:
    result = int(x) / int(y)
except ZeroDivisionError:
    print("You can't divide by zero!")
else:
    print(result)
```

Using exceptions instead

```
try:
    # Do something
    except:
        pass
```

Printing the exception

```
try:
    # Do something
    except Exception as e:
        print(e, type(e))
```

Storing data with json

The json module allows you to dump simple Python data structures into a file, and load the data from that file the next time the program runs. The JSON data format is not specific to Python, so you can share this kind of data with people who work in other languages as well.

Knowing how to manage exceptions is important when working with stored data. You'll usually want to make sure the data you're trying to load exists before working with it.

Using json.dump() to store data

```
"""Store some numbers."""

import json

numbers = [2, 3, 5, 7, 11, 13]

filename = 'numbers.json'
with open(filename, 'w') as f_obj:
    json.dump(numbers, f_obj)

Using json.load() to read data
```

"""Load some previously stored numbers."""

import json

numbers = json.load(open('numbers.json'))

Making sure the stored data exists

```
try:
    f_name = 'numbers.json'
    with open(f_name) as f_obj:
        numbers = json.load(f_obj)
except FileNotFoundError:
    msg = "Can't find {0}.".format(f_name)
    print(msg)
else:
    print(numbers)
```

Practice with exceptions
Take a program you've already written that prompts for user input, and add some error-handling code to the program.

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — Testing Your Code

Testing a function (cont.)

Building a testcase with one unit test
To build a test case, make a class that inherits from unittest.TestCase and write methods that begin with `test_`. Save this as `test_full_names.py`

```
import unittest  
from full_names import get_full_name  
  
class NamesTestCase(unittest.TestCase):  
    """Tests for names.py."""  
  
    def test_first_last(self):  
        """Test names like Janis Joplin."""  
        full_name = get_full_name('janis',  
                                 'joplin')  
        self.assertEqual(full_name,  
                        'Janis Joplin')  
  
    def test_main(self):  
        unittest.main()  
  
if __name__ == '__main__':  
    unittest.main()
```

A unit test verifies that one specific aspect of your code works as it's supposed to. A test case is a collection of unit tests which verify your code's behavior in a wide variety of situations.

Testing a function: A passing test

Python's `unittest` module provides tools for testing your code. To try it out, we'll create a function that returns a *full name*. We'll use the function in a regular program, and then build a test case for the function.

A function to test
Save this as `full_names.py`

```
def get_full_name(first, last):  
    """Return a full name."""  
    full_name = "{0} {1}".format(first, last)  
    return full_name.title()
```

Using the function
Save this as `names.py`

```
from full_names import get_full_name  
  
janis = get_full_name('janis', 'joplin')  
print(janis)  
  
bob = get_full_name('bob', 'dylan')  
print(bob)
```

A failing test (cont.)

Running the test
When you change your code, it's important to run your existing tests. This will tell you whether the changes you made affected existing behavior.

```
E  
=====  
ERROR: test_first_last (main_.NamesTestCase)  
Test names like Janis Joplin.  
  
Traceback (most recent call last):  
  File "test_full_names.py", line 10,  
    in test_first_last  
      'joplin')  
TypeError: get_full_name() missing 1 required  
positional argument: 'last'  
  
Ran 1 test in 0.001s  
  
FAILED (errors=1)
```

Fixing the code
When a test fails, the code needs to be modified until the test passes again. (Don't make the mistake of rewriting your tests to fit your new code.) Here we can make the middle name optional.

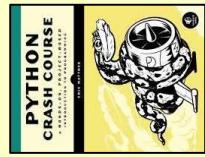
```
def get_full_name(first, last, middle=''): #  
    """Return a full name.  
    :param first: str  
    :param last: str  
    :param middle: str, optional  
    :return: str  
    """  
    full_name = "{0} {1} {2}".format(first,  
                                    middle, last)  
  
    else:  
        full_name = "{0} {1} ".format(first,  
                                    last)  
  
    return full_name.title()
```

Running the test
Now the test should pass again, which means our original functionality is still intact.

```
Ran 1 test in 0.000s  
OK
```

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Adding new tests

You can add as many unit tests to a test case as you need.
To write a new test, add a new method to your test case class.

Testing a class

Testing a class is similar to testing a function, since you'll mostly be testing your methods.

A class to test

Save as `accountant.py`

```
Testing middle names
We shown that get_full_name() works for first and last
names. Let's test that it works for middle names as well.

import unittest
from full_names import get_full_name

class NamesTestCase(unittest.TestCase):
    """Tests for names.py."""

    def test_middle_names_like_Janis_Joplin(self):
        """Test names like Janis Joplin."""
        full_name = get_full_name('janis',
                                  'joplin')
        self.assertEqual(full_name,
                        'Janis Joplin')

    def test_first_last(self):
        """Test names like David Lee Roth."""
        full_name = get_full_name('david',
                                  'roth', 'lee')
        self.assertEqual(full_name,
                        'David Lee Roth')

    def test_main(self):
        """Test the two dots represent two passing tests.
        The two dots represent two passing tests.

        ...
        Ran 2 tests in 0.000s
        OK
```

Running the tests
The two dots represent two passing tests.

...

Ran 2 tests in 0.000s

OK

A variety of assert methods

Python provides a number of assert methods you can use to test your code.

Verify that a==b, or a != b	assertEqual(a, b)	assertNotEqual(a, b)
Verify that x is True, or x is False	assertTrue(x)	assertFalse(x)
Verify an item is in a list, or not in a list	assertIn(item, list)	assertNotIn(item, list)

The setUp() method

When testing a class, you usually have to make an instance of the class. The `setUp()` method is run before every test. Any instances you make in `setUp()` are available in every test you write.

Using `setUp()` to support multiple tests
The instance `self.acc` can be used in each new test.

```
import unittest
from accountant import Accountant

class TestAccountant(unittest.TestCase):
    """Tests for the class Accountant."""

    def setUp(self):
        self.acc = Accountant()

    def test_initial_balance(self):
        # Default balance should be 0.
        self.assertEqual(self.acc.balance, 0)

    # Test non-default balance.
    acc = Accountant(100)
    self.assertEqual(acc.balance, 100)

    def test_deposit(self):
        # Test single deposit.
        self.acc.deposit(100)
        self.assertEqual(self.acc.balance, 100)

    # Test multiple deposits.
    self.acc.deposit(100)
    self.acc.deposit(100)
    self.assertEqual(self.acc.balance, 300)

    def test_withdrawal(self):
        # Test single withdrawal.
        self.acc.withdraw(100)
        self.assertEqual(self.acc.balance, 900)

    unittest.main()
```

Running the tests
...

Ran 3 tests in 0.001s
OK

When is it okay to modify tests?

In general you shouldn't modify a test once it's written. When a test fails it usually means new code you've written has broken existing functionality, and you need to modify the new code until all existing tests pass.
If your original requirements have changed, it may be appropriate to modify some tests. This usually happens in the early stages of a project when desired behavior is still being sorted out.

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet - Pygame

Starting a game
The following code sets up an empty game window, and starts an event loop and a loop that continually refreshes the screen.

An empty game window

```
import sys
import pygame as pg

def run_game():
    # Initialize and set up screen.
    pg.init()
    screen = pg.display.set_mode((1200, 800))
    pg.display.set_caption("Alien Invasion")

    # Start main loop.
    while True:
        # Start event loop.
        for event in pg.event.get():
            if event.type == pg.QUIT:
                sys.exit()

        # Refresh screen.
        pg.display.flip()

run_game()
```

What is Pygame?

Pygame is a framework for making games using Python. Making games is fun, and it's a great way to expand your programming skills and knowledge. Pygame takes care of many of the lower-level tasks in building games, which lets you focus on the aspects of your game that make it interesting.

Installing Pygame

Pygame runs on all systems, but setup is slightly different on each OS. The instructions here assume you're using Python 3, and provide a minimal installation of Pygame. If these instructions don't work for your system, see the more detailed notes at <http://ehmatthes.github.io/pcc/>.

Pygame on Linux

```
$ sudo apt-get install python3-dev mercurial
libSDL-image1.2-dev libSDL2-dev
libSDL-ttf2.0-dev
$ pip install -user
hg+http://bitbucket.org/pygame/pygame
```

Pygame on OS X

This assumes you've used Homebrew to install Python 3.

```
$ brew install hg sdl_image sdl_ttf
$ pip install -user
hg+http://bitbucket.org/pygame/pygame
```

Pygame on Windows

Find an installer at <https://bitbucket.org/pygame/pygame/downloads/> or <http://www.ifd.uci.edu/~goilkre/pythonlibs/#pygame> that matches your version of Python. Run the installer file if it's a .exe or .msi file. If it's a .whl file, use pip to install Pygame:

```
> python -m pip install --user
pygame-1.9.2a0-cp35-none-win32.whl
```

Testing your installation

To test your installation, open a terminal session and try to import Pygame. If you don't get any error messages, your installation was successful.

```
$ python
>>> import pygame
>>>
```

Pygame rect objects (cont.)

Useful rect attributes

Once you have a rect object, there are a number of attributes that are useful when positioning objects and detecting relative positions of objects. (You can find more attributes in the Pygame documentation.)

```
# Individual x and y values:
screen_rect.left, screen_rect.right
screen_rect.top, screen_rect.bottom
screen_rect.centerx, screen_rect.centery
screen_rect.width, screen_rect.height

# Tuples
screen_rect.center
screen_rect.size
```

Creating a rect object

You can create a rect object from scratch. For example a small rect object that's filled in can represent a bullet in a game. The Rect() class takes the coordinates of the upper left corner, and the width and height of the rect. The draw_rect() function takes a screen object, a color, and a rect. This function fills the given rect with the given color.

```
bullet_rect = pg.Rect(100, 100, 3, 15)
color = (100, 100, 100)
pg.draw.rect(screen, color, bullet_rect)
```

Working with images

Many objects in a game are images that are moved around the screen. It's easiest to use bitmap (.bmp) image files, but you can also configure your system to work with jpg, png, and gif files as well.

Loading an image

```
ship = pg.image.load('images/ship.bmp')
```

Getting the rect object from an image

```
ship_rect = ship.get_rect()
```

Pygame rect objects

Many objects in a game can be treated as simple rectangles, rather than their actual shape. This simplifies code without noticeably affecting game play. Pygame has a rect object that makes it easy to work with game objects.

Getting the screen rect object

We already have a screen object, we can easily access the rect object associated with the screen.

```
screen_rect = screen.get_rect()
```

Finding the center of the Screen

Rect objects have a center attribute which stores the center point.

```
screen_center = screen_rect.center
```

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Working with images (cont.)

Drawing an image to the screen

Once an image is loaded and positioned, you can draw it to the screen with the `blit()` method. The `blit()` method acts on the screen object, and takes the image object and image rect as arguments.

```
# Draw ship to screen.  
screen.blit(ship, ship_rect)
```

The blitme() method
Game objects such as ships are often written as classes. Then a `blitme()` method is usually defined, which draws the object to the screen.

```
def blitme(self):  
    """Draw ship at current location."""  
    self.screen.blit(self.image, self.rect)
```

Responding to keyboard input

Pygame watches for events such as key presses and mouse actions. You can detect any event you care about in the event loop, and respond with any action that's appropriate for your game.

Responding to key presses

Pygame's main event loop registers a `KEYDOWN` event any time a key is pressed. When this happens, you can check for specific keys.

```
for event in pg.event.get():  
    if event.type == pg.KEYDOWN:  
        if event.key == pg.K_RIGHT:  
            ship_rect.x += 1  
        elif event.key == pg.K_LEFT:  
            ship_rect.x -= 1  
        elif event.key == pg.K_SPACE:  
            ship.fire_bullet()  
        elif event.key == pg.K_q:  
            sys.exit()
```

Responding to released keys

When the user releases a key, a `KEYUP` event is triggered.

```
if event.type == pg.KEYUP:  
    if event.key == pg.K_RIGHT:  
        ship.moving_right = False
```

Pygame documentation

The Pygame documentation is really helpful when building your own games. The home page for the Pygame project is at <http://pygame.org/>, and the home page for the documentation is at <http://pygame.org/docs/>. The most useful part of the documentation are the pages about specific parts of Pygame, such as the `Rect()` class and the `sprite` module. You can find a list of these elements at the top of the help pages.

Responding to mouse events

Pygame's event loop registers an event any time the mouse moves, or a mouse button is pressed or released.

Responding to the mouse button

```
for event in pg.event.get():  
    if event.type == pg.MOUSEBUTTONDOWN:  
        ship.fire_bullet()
```

Finding the mouse position

The mouse position is returned as a tuple.

```
mouse_pos = pg.mouse.get_pos()
```

Clicking a button

You might want to know if the cursor is over an object such as a button. The `rect.collidepoint()` method returns true when a point is inside a rect object.

```
if button_rect.collidepoint(mouse_pos):  
    start_game()
```

Hiding the mouse

```
pg.mouse.set_visible(False)
```

Pygame groups

Pygame has a `Group` class which makes working with a group of similar objects easier. A group is like a list, with some extra functionality that's helpful when building games.

Making and filling a group

An object that will be placed in a group must inherit from `Sprite`.

```
from pygame.sprite import Sprite, Group  
  
def Bullet(Sprite):  
    ...  
    def draw_bullet(self):  
        ...  
    def update(self):  
        ...
```

Looping through the items in a group

```
bullets = Group()  
new_bullet = Bullet()  
bullets.add(new_bullet)
```

The `sprites()` method returns all the members of a group.

```
for bullet in bullets.sprites():  
    bullet.draw_bullet()
```

Calling update() on a group

Calling `update()` on a group automatically calls `update()` on each member of the group.

```
bullets.update()
```

Pygame groups (cont.)

Removing an item from a group
It's important to delete elements that will never appear again in the game, so you don't waste memory and resources.

```
bullets.remove(bullet)
```

Detecting collisions

You can detect when a single object collides with any member of a group. You can also detect when any member of one group collides with a member of another group.

Collisions between a single object and a group

The `spritecollideany()` function takes an object and a group, and returns True if the object overlaps with any member of the group.

```
if pg.sprite.spritecollideany(ship, aliens):  
    ships_left -= 1
```

Collisions between two groups

The `sprite.groupcollide()` function takes two groups, and two booleans. The function returns a dictionary containing information about the members that have collided. The booleans tell Pygame whether to delete the members of either group that have collided.

```
collisions = pg.sprite.spritecollide(  
    bullets, aliens, True, True)
```

Rendering text

You can use text for a variety of purposes in a game. For example you can share information with players, and you can display a score.

Displaying a message

The following code defines a message, then a color for the text and the background color for the message. A font is defined using the default system font, with a font size of 48. The `font.render()` function is used to create an image of the message, and we get the rect object associated with the image. We then center the image on the screen and display it.

```
msg = "Play again?"  
msg_color = (100, 100, 100)  
bg_color = (230, 230, 230)  
  
f = pg.font.SysFont(None, 48)  
msg_image = f.render(msg, True, msg_color,  
    bg_color)  
  
msg_image_rect = msg_image.get_rect()  
msg_image_rect.center = screen_rect.center  
screen.blit(msg_image, msg_image_rect)
```

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — matplotlib

Line graphs and scatter plots (cont.)

Making a scatter plot

The `scatter()` function takes a list of x values and a list of y values, and a variety of optional arguments. The `s=10` argument controls the size of each point.

```
import matplotlib.pyplot as plt
```

```
x_values = list(range(1000))
squares = [x**2 for x in x_values]
plt.scatter(x_values, squares, s=10)
plt.show()
```

Customizing plots

Plots can be customized in a wide variety of ways. Just about any element of a plot can be customized.

Adding titles and labels, and scaling axes

```
import matplotlib.pyplot as plt

x_values = list(range(1000))
squares = [x**2 for x in x_values]
plt.scatter(x_values, squares, s=10)

plt.title("Square Numbers", fontsize=24)
plt.xlabel("Value", fontsize=18)
plt.ylabel("Square of Value", fontsize=18)
plt.tick_params(axis='both', which='major',
                labelsize=14)
plt.axis([0, 1100, 0, 1100000])
plt.show()
```

Installing matplotlib

`matplotlib` runs on all systems, but setup is slightly different depending on your OS. If the minimal instructions here don't work for you, see the more detailed instructions at <http://enmattthes.github.io/pcc/>. You should also consider installing the Anaconda distribution of Python from <https://continuum.io/downloads/>, which includes `matplotlib`.

matplotlib on Linux

```
$ sudo apt-get install python3-matplotlib
```

Start a terminal session and enter `import matplotlib` to see if it's already installed on your system. If not, try this command:

```
$ pip install --user matplotlib
```

matplotlib on Windows

You first need to install Visual Studio, which you can do from <https://dev.windows.com/>. The Community edition is free. Then go to <https://pypi.python.org/pypi/matplotlib/> or <http://www.lfd.uci.edu/~gohlke/pythonlibs/#matplotlib> and download an appropriate installer file.

Line graphs and scatter plots

Making a line graph

```
import matplotlib.pyplot as plt

x_values = [0, 1, 2, 3, 4, 5]
squares = [0, 1, 4, 9, 16, 25]
plt.plot(x_values, squares)
plt.show()
```

Customizing plots (cont.)

Emphasizing points

You can plot as much data as you want on one plot. Here we re-plot the first and last points larger to emphasize them.

```
import matplotlib.pyplot as plt
```

```
x_values = list(range(1000))
squares = [x**2 for x in x_values]
plt.scatter(x_values, squares, c=squares,
            cmap=plt.cm.Blues, edgecolor='none',
            s=10)

plt.scatter(x_values[0], squares[0], c='green',
            edgecolor='none', s=100)
plt.scatter(x_values[-1], squares[-1], c='red',
            edgecolor='none', s=100)

plt.title("Square Numbers", fontsize=24)
--snip--
```

Removing axes

You can customize or remove axes entirely. Here's how to access each axis, and hide it.

```
plt.axes().get_xaxis().set_visible(False)
plt.axes().get_yaxis().set_visible(False)

plt.title("Square Numbers", fontsize=24)
plt.xlabel("Value", fontsize=18)
plt.ylabel("Square of Value", fontsize=18)
plt.tick_params(axis='both', which='major',
                labelsize=14)
plt.axis([0, 1100, 0, 1100000])
plt.show()
```

Setting a custom figure size

You can make your plot as big or small as you want. Before plotting your data, add the following code. The `dpi` argument is optional; if you don't know your system's resolution you can omit the argument and adjust the `figsize` argument accordingly.

```
plt.figure(dpi=128, figsize=(10, 6))
```

Saving a plot

The `matplotlib` viewer has an interactive save button, but you can also save your visualizations programmatically. To do so, replace `plt.show()` with `plt.savefig()`. The `bbox_inches='tight'` argument trims extra whitespace from the plot.

```
plt.savefig('squares.png', bbox_inches='tight')
```

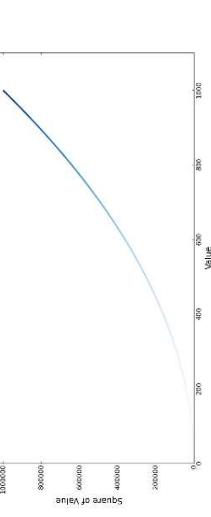
Online resources

The `matplotlib` gallery and documentation are at <http://matplotlib.org/>. Be sure to visit the examples, gallery, and pyplot links.

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Multiple plots

You can make as many plots as you want on one figure.

When you make multiple plots, you can emphasize relationships in the data. For example you can fill the space between two sets of data.

Working with dates and times (cont.)

Datetime formatting arguments

The `strftime()` function generates a formatted string from a `datetime` object, and the `strptime()` function generates a `datetime` object from a string. The following codes let you work with dates exactly as you need to.

Plotting two sets of data
Here we use `plt.scatter()` twice to plot square numbers and cubes on the same figure.

```
x_values = list(range(11))
squares = [x**2 for x in x_values]
cubes = [x**3 for x in x_values]

plt.scatter(x_values, squares, c='blue',
            edgecolor='none', s=20)
plt.scatter(x_values, cubes, c='red',
            edgecolor='none', s=20)

plt.axis([0, 11, 0, 1100])
plt.show()
```

Filling the space between data sets

The `fill_between()` method fills the space between two data sets. It takes a series of x-values and two series of y-values. It also takes a `facecolor` to use for the fill, and an optional `alpha` argument that controls the color's transparency.

```
plt.fill_between(x_values, cubes, squares,
                 facecolor='blue', alpha=0.25)
```

Working with dates and times

Many interesting data sets have a date or time as the x-value. Python's `datetime` module helps you work with this kind of data.

Generating the current date

The `datetime.now()` function returns a `datetime` object representing the current date and time.

```
from datetime import datetime as dt
```

```
today = dt.now()
date_string = dt.strftime(today, '%m/%d/%Y')
print(date_string)
```

Generating a specific date

You can also generate a `datetime` objects for any date and time you want. The positional order of arguments is year, month, and day. The hour, minute, second, and microsecond arguments are optional.

```
from datetime import datetime as dt

new_years = dt(2017, 1, 1)
fall_equinox = dt(year=2016, month=9, day=22)
```

Multiple plots in one figure

You can include as many individual graphs in one figure as you want. This is useful, for example, when comparing related datasets.

Sharing an x-axis

The following code plots a set of squares and a set of cubes on two separate graphs that share a common x-axis. The `plt.subplots()` function returns a figure object and a tuple of axes. Each set of axes corresponds to a separate plot in the figure. The first two arguments control the number of rows and columns generated in the figure.

```
import matplotlib.pyplot as plt

x_vals = list(range(11))
squares = [x**2 for x in x_vals]
cubes = [x**3 for x in x_vals]

fig, axarr = plt.subplots(2, 1, sharex=True)
```

```
axarr[0].scatter(x_vals, squares)
axarr[0].set_title('Squares')

axarr[1].scatter(x_vals, cubes, c='red')
axarr[1].set_title('Cubes')

plt.show()
```

Converting a string to a datetime object

```
new_years = dt.strptime('1/1/2017', '%m/%d/%Y')
```

Converting a datetime object to a string

```
ny_string = dt.strftime(new_years, '%B %d, %Y')
print(ny_string)
```

Plotting high temperatures

The following code creates a list of dates and a corresponding list of high temperatures. It then plots the high temperatures, with the date labels displayed in a specific format.

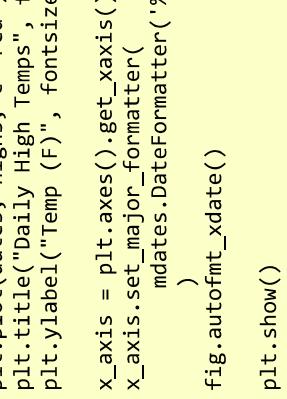
```
from datetime import datetime as dt
```

```
import matplotlib.pyplot as plt
from matplotlib import dates as mdates

dates = [
    dt(2016, 6, 21), dt(2016, 6, 22),
    dt(2016, 6, 23), dt(2016, 6, 24),
]
highs = [57, 68, 64, 59]

fig = plt.figure(dpi=128, figsize=(10, 6))
plt.plot(dates, highs, c='red')
plt.title("Daily High Temps", fontsize=24)
plt.ylabel("Temp (F)", fontsize=16)
```

```
x_axis = plt.axes().get_xaxis()
x_axis.set_major_formatter(
    mdates.DateFormatter('%B %d %Y'))
plt.show()
```



```
new_years = dt(2017, 1, 1)
fall_equinox = dt(year=2016, month=9, day=22)
```

```
fig.autofmt_xdate()
plt.show()
```



More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — Pygal

What is Pygal?

Data visualization involves exploring data through visual representations. Pygal helps you make visually appealing representations of the data you're working with. Pygal is particularly well suited for visualizations that will be presented online, because it supports interactive elements.

Installing Pygal

Pygal can be installed using pip.

Pygal on Linux and OS X

```
$ pip install --user pygal
```

Pygal on Windows

```
> python -m pip install --user pygal
```

Line graphs, scatter plots, and bar graphs

To make a plot with Pygal, you specify the kind of plot and then add the data.

Making a line graph

To view the output, open the file squares.svg in a browser.

```
import pygal
```

```
x_values = [0, 1, 2, 3, 4, 5]
squares = [0, 1, 4, 9, 16, 25]

chart = pygal.Line()
chart.force_uri_protocol = 'http'
chart.add('x^2', squares)
chart.render_to_file('squares.svg')
```

Adding labels and a title

```
--snip--
chart = pygal.Line()
chart.force_uri_protocol = 'http'
chart.title = "Squares"
chart.x_labels = x_values
chart.x_title = "Value"
chart.y_title = "Square of Value"
chart.add('x^2', squares)
chart.render_to_file('squares.svg')
```

Line graphs, scatter plots, and bar graphs (cont.)

Multiple plots

You can add as much data as you want when making a visualization.

Plotting squares and cubes

```
import pygal

x_values = list(range(11))
squares = [x**2 for x in x_values]
cubes = [x**3 for x in x_values]

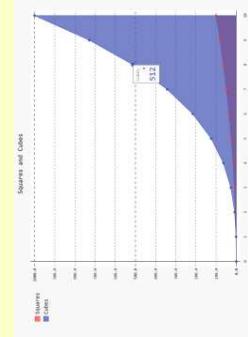
chart = pygal.Line()
chart.force_uri_protocol = 'http'
chart.title = "Squares and Cubes"
chart.x_labels = x_values

chart.add('Squares', squares)
chart.add('Cubes', cubes)
chart.render_to_file('squares_cubes.svg')
```

Filling the area under a data series

Pygal allows you to fill the area under or over each series of data. The default is to fill from the x-axis up, but you can fill from any horizontal line using the zero argument.

```
chart = pygal.Line(fill=True, zero=0)
```



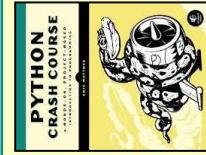
Online resources

The documentation for Pygal is available at <http://www.pygal.org/>.

Enabling interactive features

If you're viewing svg output in a browser, Pygal needs to render the output file in a specific way. The force_uri_protocol attribute for chart objects needs to be set to 'http'.

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Styling plots (cont.)

Pygal lets you customize many elements of a plot. There are some excellent default themes, and many options for styling individual plot elements.

Using built-in styles

To use built-in styles, import the style and make an instance of the style class. Then pass the style object with the style argument when you make the chart object.

```
import pygal
from pygal.style import LightGreenStyle

x_values = list(range(11))
squares = [x**2 for x in x_values]
cubes = [x**3 for x in x_values]

chart_style = LightGreenStyle()
chart = pygal.Line(style=chart_style)
chart.force_uri_protocol = 'http'
chart.title = "Squares and Cubes"
chart.x_labels = x_values

chart.add('Squares', squares)
chart.add('Cubes', cubes)
chart.render_to_file('squares_cubes.svg')
```

Some built-in styles accept a custom color, then generate a theme based on that color.

```
from pygal.style import LightenStyle
--snip--
chart_style = LightenStyle('#336688')
chart = pygal.Line(style=chart_style)
--snip--
```

Customizing individual style properties
Style objects have a number of properties you can set individually.

```
chart_style = LightenStyle('#336688')
chart_style.plot_background = '#CCCCCC'
chart_style.major_label_font_size = 20
chart_style.label_font_size = 16
--snip--
```

Custom style class
You can start with a bare style class, and then set only the properties you care about.

```
chart_style = Style()
chart_style.colors = ['#AAAAAA', '#888888']
chart_style.plot_background = '#EEEEEE'
chart = pygal.Line(style=chart_style)
--snip--
```

Plotting global datasets

Pygal can generate world maps, and you can add any data you want to these maps. Data is indicated by coloring, by labels, and by tooltits that show data when users hover over each country on the map.

Installing the world map module
The world map module is not included by default in Pygal 2.0. It can be installed with pip:

```
$ pip install --user pygal_maps_world
--snip--
```

Making a world map
The following code makes a simple world map showing the countries of North America.

```
from pygal.maps.world import World

wm = World()
wm.force_uri_protocol = 'http'
wm.title = 'North America'
wm.add('North America', ['ca', 'mx', 'us'])

wm.render_to_file('north_america.svg')
```

Showing all the country codes
In order to make maps, you need to know Pygal's country codes. The following example will print an alphabetical list of each country and its code.

```
from pygal.maps.world import COUNTRIES

for code in sorted(COUNTRIES.keys()):
    print(code, COUNTRIES[code])
```

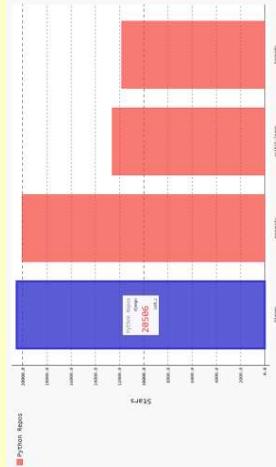
Plotting numerical data on a world map
To plot numerical data on a map, pass a dictionary to add() instead of a list.

```
from pygal.maps.world import World

populations = {
    'ca': 34126000,
    'us': 309349000,
    'mx': 113423000,
}

wm = World()
wm.force_uri_protocol = 'http'
wm.title = 'Population of North America'
wm.populations = populations

wm.render_to_file('na_populations.svg')
```



[More cheat sheets available at ehmatthes.github.io/pcc/](https://ehmatthes.github.io/pcc/)

Beginner's Python Cheat Sheet — Django

Working with models

The data in a Django project is structured as a set of models.

Defining a model

To define the models for your app, modify the file `models.py` that was created in your app's folder. The `__str__()` method tells Django how to represent data objects based on this model.

```
from django.db import models
```

Django is a web framework which helps you build interactive websites using Python. With Django you define the kind of data your site needs to work with, and you define the ways your users can work with that data.

Installing Django

It's usually best to install Django to a virtual environment, where your project can be isolated from your other Python projects. Most commands assume you're working in an active virtual environment.

Create a virtual environment

```
$ python -m venv 11_env
```

Activate the environment (Linux and OS X)

```
$ source 11_env/bin/activate
```

Activate the environment (Windows)

```
> 11_env\Scripts\activate
```

Install Django to the active environment

```
(11_env)$ pip install Django
```

Migrating the database

The database needs to be modified to store the kind of data that the model represents.

```
$ python manage.py makemigrations learning_logs  
$ python manage.py migrate
```

Creating a project

To start a project we'll create a new project, create a database, and start a development server.

Create a new project

```
$ django-admin.py startproject learning_log .
```

Create a database

```
$ python manage.py migrate
```

View the project

After issuing this command, you can view the project at `http://localhost:8000/`.

```
$ python manage.py runserver
```

Create a new app

A Django project is made up of one or more apps.

```
$ python manage.py startapp learning_logs
```

Building a simple home page

Users interact with a project through web pages, and a project's home page can start out as a simple page with no data. A page usually needs a URL, a view, and a template.

Mapping a project's URLs

The project's main `urls.py` file tells Django where to find the `urls.py` files associated with each app in the project.

```
from django.conf.urls import include, url  
from django.contrib import admin
```

```
urlpatterns = [  
    url(r'^admin/', include(admin.site.urls)),  
    url(r'', include('learning_logs.urls'),  
        namespace='learning_logs')),
```

Mapping an app's URLs

An app's `urls.py` file tells Django which view to use for each URL in the app. You'll need to make this file yourself, and save it in the app's folder.

```
from django.conf.urls import admin
```

```
urlpatterns = [  
    url(r'^$', views.index, name='index'),
```

```
from . import views
```

```
urlpatterns = [  
    url(r'^$', views.index, name='index'),
```

```
Writing a simple view
```

A view takes information from a request and sends data to the browser, often through a template. View functions are stored in an app's `views.py` file. This simple view function doesn't pull in any data, but it uses the template `index.html` to render the home page.

```
from django.shortcuts import render
```

```
def index(request):
```

```
    """The home page for Learning Log."""  
    return render(request,  
                 'learning_logs/index.html')
```

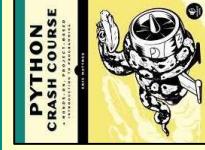
Online resources

The documentation for Django is available at <http://docs.djangoproject.com/>. The Django documentation is thorough and user-friendly, so check it out!

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Building a simple home page (cont.)

Another model

A new model can use an existing model. The `ForeignKey` attribute establishes a connection between instances of the two related models. Make sure to migrate the database after adding a new model to your app.

```
<p>Learning Log</p>
<p>Learning Log helps you keep track of your learning, for any topic you're learning about.</p>
```

Template inheritance

Many elements of a web page are repeated on every page in the site, or every page in a section of the site. By writing one parent template for the site, and one for each section, you can easily modify the look and feel of your entire site.

The parent template

The parent template defines the elements common to a set of pages, and defines blocks that will be filled by individual pages.

```
<p>
  <a href="{% url 'learning_logs:index' %}">
    Learning Log
  </a>
</p>
{% block content %}{% endblock content %}
```

The child template

The child template uses the `{% extends %}` template tag to pull in the structure of the parent template. It then defines the content for any blocks defined in the parent template.

```
{% extends 'learning_logs/base.html' %}

{% block content %}
  <p>Learning Log helps you keep track of your learning, for any topic you're learning about.
  </p>
  {% endblock content %}
```

Template indentation

Python code is usually indented by four spaces. In templates you'll often see two spaces used for indentation, because elements tend to be nested more deeply in templates.

Building a page with data (cont.)

Using data in a template

The data in the view function's context dictionary is available within the template. This data is accessed using template variables, which are indicated by doubled curly braces.

The vertical line after a template variable indicates a filter. In this case a filter called `date` formats date objects, and the filter `linebreaks` renders paragraphs properly on a web page.

```
{% extends 'learning_logs/base.html' %}

{% block content %}
  <p>Topic: {{ topic }}</p>

  <p>Entries:</p>
  <ul>
    {% for entry in entries %}
      <li>
        <p>{{ entry.date_added|date:'M d, Y H:i' }}</p>
        <p>{{ entry.text|linebreaks }}</p>
      </li>
    {% empty %}
  <li>There are no entries yet.</li>
  {% endfor %}
  </ul>
  {% endblock content %}
```

The Django shell

You can explore the data in your project from the command line. This is helpful for developing queries and testing code snippets.

```
Start a shell session
$ python manage.py shell

Access data from the project
>>> from learning_logs.models import Topic
>>> Topic.objects.all()
[<Topic: Chess>, <Topic: Rock Climbing>]
>>> topic = Topic.objects.get(id=1)
>>> topic.text
'Chess'
```

Restarting the development server

If you make a change to your project and the change doesn't seem to have any effect, try restarting the server:

```
$ python manage.py runserver
```

More cheat sheets available at
ehmatthes.github.io/pcc/

Beginner's Python Cheat Sheet — Django, Part 2

User accounts (cont.)

Defining the URLs

Users will need to be able to log in, log out, and register. Make a new `urls.py` file in the users app folder. The login view is a default view provided by Django.

```
from django.conf.urls import url
from django.contrib.auth.views import login
from . import views

urlpatterns = [
    url(r'^login/$', login,
        {'template_name': 'users/login.html'},
        name='login'),
    url(r'^logout/$', views.logout_view,
        {'name': 'logout'},),
    url(r'^register/$', views.register,
        {'name': 'register'},),
]
```

Users and forms

Most web applications need to let users create accounts. This lets users create and work with their own data. Some of this data may be private, and some may be public. Django's forms allow users to enter and modify their data.

User accounts

User accounts are handled by a dedicated app called `users`. Users need to be able to register, log in, and log out. Django automates much of this work for you.

Making a users app

After making the app, be sure to add 'users' to INSTALLED_APPS in the project's `settings.py` file.

```
$ python manage.py startapp users
```

Including URLs for the users app

Add a line to the project's `urls.py` file so the users app's URLs are included in the project.

```
urlpatterns = [
    url(r'^admin/', include(admin.site.urls)),
    url(r'^users/', include('users.urls',
                           namespace='users')),
    url(r'', include('learning_logs.urls',
                     namespace='learning_logs')),
```

Using forms in Django

There are a number of ways to create forms and work with them. You can use Django's defaults, or completely customize your forms. For a simple way to let users enter data based on your models, use a ModelForm. This creates a form that allows users to enter data that will populate the fields on a model. The register view on the back of this sheet shows a simple approach to form processing. If the view doesn't receive data from a form, it responds with a blank form. If it receives POST data from a form, it validates the data and then saves it to the database.

User accounts (cont.)

Showing the current login status

You can modify the `base.html` template to show whether the user is currently logged in, and to provide a link to the login and logout pages. Django makes a user object available to every template, and this template takes advantage of this object.

The user `is_authenticated` tag allows you to serve specific content to users depending on whether they have logged in or not. The `{% user.username %}` property allows you to greet users who have logged in. Users who haven't logged in see links to register or log in.

```
<p>
    <a href="{% url 'learning_logs:index' %}">
        Learning Log
    </a>
    {% if user.is_authenticated %}
        Hello, {{ user.username }}.
        <a href="{% url 'users:logout' %}">
            log out
        </a>
    {% else %}
        <a href="{% url 'users:register' %}">
            register
        </a> -
        <a href="{% url 'users:login' %}">
            log in
        </a>
    {% endif %}
</p>
```

The login template

The login view is provided by default, but you need to provide your own login template. The template shown here displays a simple login form, and provides basic error messages. Make a templates folder in the users folder, and then make a users folder in the templates folder. Save this file as `login.html`. The tag `{% csrf_token %}` helps prevent a common type of attack with forms. The `{% form.as_p %}` element displays the default login form in paragraph format. The `<input>` element named next redirects the user to the home page after a successful login.

```
{% extends "learning_logs/base.html" %}

{% block content %}
    {% if form.errors %}
        <p>
            Your username and password didn't match.
            Please try again.
        </p>
    {% endif %}

    <form method="post" action="{% url 'users:login' %}">
        {% csrf_token %}
        {{ form.as_p }}
        <button name="submit">log in</button>
        <input type="hidden" name="next" value="{% url 'learning_logs:index' %}">
    </form>
    {% endblock content %}
```

The logout view

The logout view function uses Django's `logout()` function and then redirects the user back to the home page. Since there is no logout page, there is no logout template. Make sure to write this code in the `views.py` file that's stored in the users app folder.

```
from django.http import HttpResponseRedirect
from django.core.urlresolvers import reverse
from django.contrib.auth import logout

def logout_view(request):
    """Log the user out."""
    logout(request)
    return HttpResponseRedirect(reverse('learning_logs:index'))
```

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User accounts (cont.)

User accounts (cont.)

The register view
The register view needs to display a blank registration form when the page is first requested, and then process completed registration forms. A successful registration logs the user in and redirects to the home page.

```
from django.contrib.auth import login
from django.contrib.auth import authenticate
from django.contrib.auth.forms import UserCreationForm

def register(request):
    """Register a new user."""
    if request.method != 'POST':
        # Show blank registration form.
        form = UserCreationForm()
    else:
        # Process completed form.
        form = UserCreationForm(
            data=request.POST)

    if form.is_valid():
        new_user = form.save()
        # Log in, redirect to home page.
        pw = request.POST['password1']
        authenticated_user = authenticate(
            username=new_user.username,
            password=pw)
        login(request, authenticated_user)
        return HttpResponseRedirect(reverse('learning_logs:index'))

    context = {'form': form}
    return render(request,
                  'users/register.html', context)
```

Connecting data to users

The register template displays the registration form in paragraph formats.

```
{% extends 'learning_logs/base.html' %}

{% block content %}

<form method='post' action="{% url 'users:register' %}">

    {% csrf_token %}
    {{ form.as_p }}

    <button name='submit'>register</button>
    <input type='hidden' name='next' value="{% url 'learning_logs:index' %}" />
</form>

{% endblock content %}
```

Connecting data to users

Users will have data that belongs to them. Any model that should be connected directly to a user needs a field connecting instances of the model to a specific user.

```
class Topic(models.Model):
    """A topic the user is learning about."""
    text = models.CharField(max_length=200)
    date_added = models.DateTimeField(
        auto_now_add=True)
    owner = models.ForeignKey(User)
```

```
def __str__(self):
    return self.text
```

Restricting access to logged-in users

Some pages are only relevant to registered users. The views for these pages can be protected by the @login_required decorator. Any view with this decorator will automatically redirect non-logged in users to an appropriate page. Here's an example views.py file.

```
from django.contrib.auth.decorators import login_required
--snip--
```

```
@login_required
def topic(request, topic_id):
    """Show a topic and all its entries."""
    --snip--
```

Setting the redirect URL

The @login_required decorator sends unauthorized users to the login page. Add the following line to your project's settings.py file so Django will know how to find your login page.

```
LOGIN_URL = '/users/login/'
```

Preventing inadvertent access

Some pages serve data based on a parameter in the URL. You can check that the current user owns the requested data, and return a 404 error if they don't. Here's an example view.

```
from django.http import Http404
--snip--
def topic(request, topic_id):
    """Show a topic and all its entries."""
    topic = Topics.objects.get(id=topic_id)
    if topic.owner != request.user:
        raise Http404
    --snip--
```

Using a form to edit data

If you provide some initial data, Django generates a form with the user's existing data. Users can then modify and save their data.

Creating a form with initial data
The instance parameter allows you to specify initial data for a form.

```
form = EntryForm(instance=entry)
```

Modifying data before saving
The argument commit=False allows you to make changes before writing data to the database.

```
new_topic = form.save(commit=False)
new_topic.owner = request.user
new_topic.save()
```

More cheat sheets available at
ehmatthes.github.io/pcc/

Connecting data to users (cont.)

Querying data for the current user

In a view, the request object has a user attribute. You can use this attribute to query for the user's data. The filter() function then pulls the data that belongs to the current user.

```
topics = Topic.objects.filter(
    owner=request.user)
```

Styling your project

The django-bootstrap3 app allows you to use the Bootstrap library to make your project look visually appealing. The app provides tags that you can use in your templates to style individual elements on a page. Learn more at <http://django-bootstrap3.readthedocs.io/>.

Deploying your project

Heroku lets you push your project to a live server, making it available to anyone with an internet connection. Heroku offers a free service level, which lets you learn the deployment process without any commitment. You'll need to install a set of heroku tools, and use git to track the state of your project. See <http://devcenter.heroku.com/>, and click on the Python link.