Objectives

- Defining our own classes

Review: Dictionaries

- What is a dictionary in Python?
  - What is it helpful for representing?
- What is the syntax for creating a new dictionary?
- How do we access a key's value from a dictionary? (2 ways)
  - What happens if there is no mapping for that key?
- How do we create a key → value mapping in a dictionary?
- How do we iterate through a dictionary?

- What does this code do?

```
if key not in dictionary :
    dictionary[key] = 1
else:
    count = dictionary[key] + 1
    dictionary[key] = count
```

- Using objects
  - How do we know what we can do to objects?
  - How do we create objects?
  - How do we perform operations on an object?

ABSTRACTIONS

Abstractions

- Provide ways to think about program and its data
  - Get the jist without the details
- Examples we've seen
  - Functions and methods

```
encryptFile(filename, key)
```

    - Perform some operation but we don't need to know how they're implemented
  - Dictionaries
    - Know they map keys to values
    - Don't need to know how the keys are organized/stored in the computer's memory
  - Just about everything we do in this class…

Classes and Objects

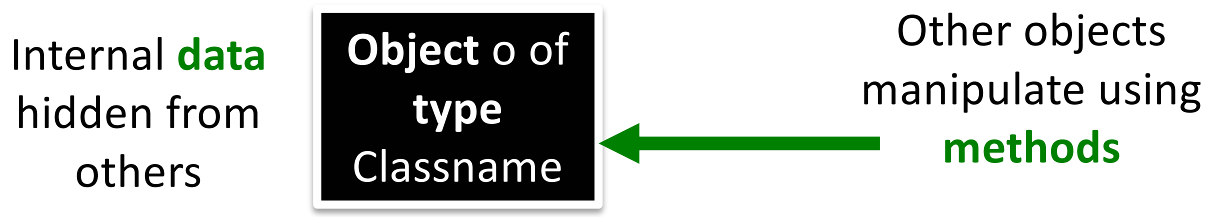
- Provide an abstraction for how to organize and reason about data
- Example: `GraphWin` class
  - Had ***attributes*** (i.e., data or state) background color, width, height, and title
  - Each `GraphWin` object has these attributes
    - Each `GraphWin` object has its own values for these attributes
  - Used methods (API) to modify the object's state, get information about attributes

Defining Our Own Classes

- Often, we want to represent data or information that we do ***not*** have a way to represent using *built-in types* or *libraries*
- Classes provide a way to *organize* and *manipulate* data
  - Organize: data structures used
    - E.g., ints, lists, dictionaries, other objects, etc.
  - Manipulate: methods

What is a Class?

- Defines a new ***data type***
- Defines the class's ***attributes*** (i.e., data or state) and ***methods***
  - Methods are like **functions *within*** a class and are the class's **API**


Internal **data** hidden from others
Object o of **type** Classname
Other objects manipulate using **methods**

Object o is an *instance* of Classname

Defining a Card Class

- Create a class that represents a playing card
  - How can we represent a playing card?
  - What information do we need to represent a playing card?

Representing a Card object

- Every card has two attributes:
  - Suit (one of “hearts”, “diamonds”, “clubs”, “spades”)
  - Rank
    - 2-10: numbered cards
    - 11: Jack
    - 12: Queen
    - 13: King
    - 14: Ace

Pattern of Presentation Today

How We Define It

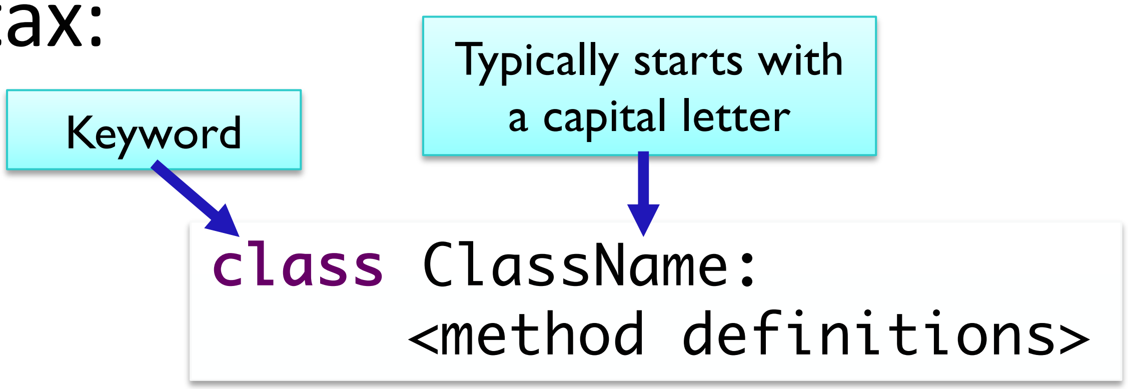
- The code we write so that someone else can use this code

How Someone Calls/Uses It

- How someone uses/leverages our code

Defining a New Class

- Syntax:



```
class ClassName:
      <method definitions>
```

Card Class (Incomplete)

Class Doc String

```
class Card:
    """ A class to represent a standard playing card.
    The ranks are ints: 2-10 for numbered cards, 11=Jack,
    12=Queen, 13=King, 14=Ace.
    The suits are strings: 'clubs', 'spades', 'hearts’,
    'diamonds’."""

    def __init__(self, rank, suit):
        """Constructor for class Card takes int rank and
             string suit."""
        self._rank = rank
        self._suit = suit

    def getRank(self):
        "Returns the card’s rank."
        return self._rank

    def getSuit(self):
        "Returns the card’s suit."
        return self._suit
```

Method Doc String

Methods

card.py

Card Class (Incomplete)

Class Doc String

```
class Card:
    """ A class to represent a standard playing card.
    The ranks are ints: 2-10 for numbered cards, 11=Jack,
    12=Queen, 13=King, 14=Ace.
    The suits are strings: 'clubs', 'spades', 'hearts',
    'diamonds'."""

    def __init__(self, rank, suit):
        """Constructor for class Card takes int rank and
             string suit."""
        self._rank = rank
        self._suit = suit

    def getRank(self):
        "Returns the card's rank."
        return self._rank

    def getSuit(self):
        "Returns the card's suit."
        return self._suit
```

Method Doc String

Methods

Methods are like *functions* defined in a *class*

card.py

Defining the Constructor: `__init__`

- `__init__` method is like the ***constructor***
- In constructor, define ***instance variables***
  - **Instance variables:** the data contained in every object
  - Also called **attributes** or **fields**
- Constructor **never *returns*** anything

First parameter of *every* method is `self`
- reference to the object that method acts on

Instance variables

```python
def __init__(self, rank, suit):
    """Constructor for class Card takes int rank
       and string suit."""
    self._rank = rank
    self._suit = suit
```

Convention: named with _

Review

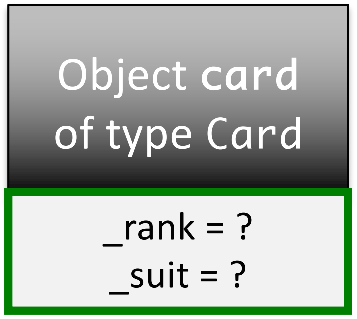
- How do we call/use the constructor for a class?

Using the Constructor

Method Signature

```
def __init__(self, rank, suit):
```

- As defined above, constructor is called using `Card(<rank>,<suit>)`
    - Do not *pass* anything for the `self` parameter
    - Python *automatically* passes the `self` parameter for us

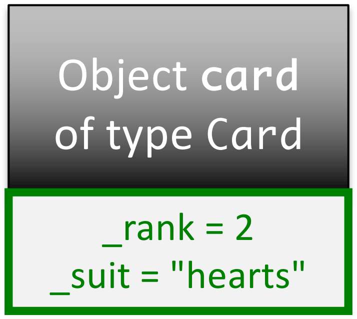


Using the Constructor

```
def __init__(self, rank, suit):
```

Method Signature

- As defined, constructor is called using `Card(<rank>,<suit>)`
  - Do ***not*** *pass* anything for the `self` parameter
  - Python *automatically* passes the `self` parameter for us
- Example:
  - `card = Card(2, "hearts")`
  - Creates a 2 of Hearts card
  - Python passes `card` as `self` for us
  - `card` is an instance of the `Card` class



Review

- How do we call a method on an object?

Accessor Methods

- To get information about the object

> - Must take `self` parameter
> - Return data/information

```
def getRank(self):
   "Returns the card's rank."
   return self._rank

def getSuit(self):
   "Returns the card's suit."
   return self._suit
```

- Scenario: previously created object using `card = Card(…, …)` these methods would get called as `card.getRank()` and `card.getSuit()`
  - ➢ Python plugs `card` in for `self`
- Methods can access the instance variables (even though not defined in these methods) through `self`

Testing Accessor Methods

1. Create an object
2. Call the accessor method and confirm it returns what is expected

```
c1 = Card(14, "spades")

# test the getSuit() method and constructor
test.testEqual(c1.getSuit(), "spades")

# test the getRank() method and constructor
test.testEqual(c1.getRank(), 14)
```

Another Special Method: `__str__`

- Returns a *string* that describes the object
- Whenever you **`print`** an object, Python checks if the object's **`__str__`** method is defined
  - Prints result of calling `__str__` method
- `str(<object>)` also calls **`__str__`** method
- Python provides a default **`__str__`** method
  - We are *overriding* that method

```
def __str__(self):
    """Returns a string
    representing the card as
    'rank of suit'."""
    result = ""
    if self._rank == 11:
        result += "Jack"
    elif self._rank == 12:
        result += "Queen"
    elif self._rank == 13:
        result += "King"
    elif self._rank == 14:
        result += "Ace"
    else:
        result += str(self._rank)
    result += " of " + self._suit
    return result
```

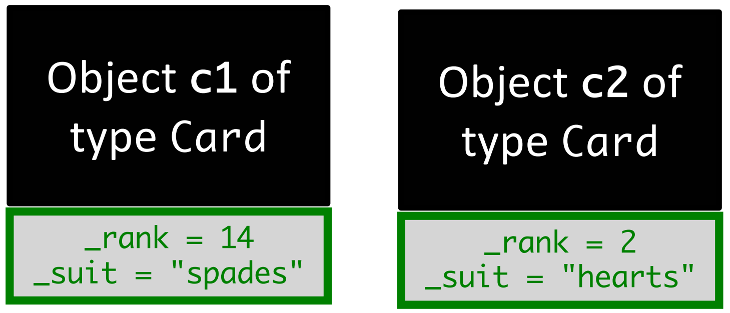
Using the Card Class

Invokes the `__str__` method

```
def main():
    c1 = Card(14, "spades")
    print(c1)
    c2 = Card(2, "hearts")
    print(c2)
```

Displays:

```
Ace of spades
2 of hearts
```



Testing Methods

1. Create an object
2. Call a method and confirm it returns what is expected

```
    c1 = Card(14, "spades")

    test.testEqual( str(c1), "Ace of spades" )
```

Recall: `str(…)` automatically calls `__str__` method

Local Variables vs Instance Variables

- `result` is a *local* variable. Its scope is the __str__ method.
- `rank` or `self._rank` is an *instance* variable. It can be seen in any method within the class (that takes self as a parameter)

```python
def __str__(self):
    """Returns a string
    representing the card as
    'rank of suit'."""
    result = ""
    if self._rank == 11:
        result += "Jack"
    elif self._rank == 12:
        result += "Queen"
    elif self._rank == 13:
        result += "King"
    elif self._rank == 14:
        result += "Ace"
    else:
        result += str(self._rank)
    result += " of " + self._suit
    return result
```

Example: Card Color

- Problem: Add a method to the `Card` class called `getCardColor` that returns the card's suit's color ("red" or "black")
- (Partial) **procedure** for defining a method (similar to functions)
  - What is the input to the method?
  - What is the output from the method?
  - (Wait on defining the body of the method)
- How do we call the method?
- How can we test the method using `test.testEqual` function?
  - Provide some test cases

`card2.py`

Example: Card Color

- Problem: Add a method to the `Card` class called `getCardColor` that returns the card's suit's color ("red" or "black")

- Procedure for defining a method (similar to functions)
  - What is the input to the method?
  - What is the output from the method?
  - What is the method signature/header?
  - What does the method do?

`card2.py`

Example: Rummy Value

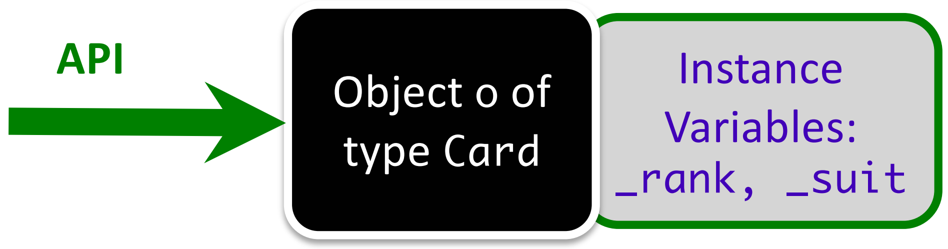
- Problem: Add a method to the `Card` class called `getRummyValue` that returns the value of the card in the game of Rummy
- Procedure for defining a method (similar to functions)
  - What is the input to the method?
  - What is the output from the method?
  - What is the method signature/header?
  - What does the method do?
- How do we call the method?
- How can we test the method?
  - Formulate test cases

`card2.py`

Card API

- Based on what we've seen/done so far, what is the Card class's API?
  - (Review: What is an API?)

Card API



Implementation of methods is hidden

- `Card(<rank>, <suit>)`
- `getRank()`
- `getSuit()`
- `getRummyValue()`
- `__str__()` or `str(card)`

Using the Card class

- Having the `Card` class means that we can represent a `Card` in code

Now that we have the `Card` class, how can we **use** it?

Using the Card class

Now that we have the `Card` class,
how can we **use** it?

- Let's write a simplified version of the game of War
  - Basically just part of a round

- What are the rules of a round of War?

`war.py`

Review

```python
from graphics import *

win = GraphWin("Picture")
win.setBackground("black")
```

```python
from card import *

c = Card(7, "diamonds")
print(c.getRank())
```

- Same programming as before
- Just defining our own classes

Algorithm for Creating Classes

1. Identify need for a class
2. Identify state or attributes of a class/an object in that class
   - Write the constructor (`__init__`) and `__str__` methods
3. Identify methods the class should provide
   - How will a user call those methods (parameters, return values)?
     - Develop API
   - Implement methods, test

Looking Ahead

- Prelab 9 for tomorrow
  - Engage in the object-oriented reading
- Lab 9 due Friday
- Exam Friday
  - Defining classes will *not* be on exam
  - Review tomorrow