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 $\rightarrow$ value mapping in a dictionary?
- How do we iterate through a dictionary?
- Compare lists and dictionaries
  - What are their structures and properties? How are they similar, different? When would you use one or the other?

Discussion: Comparing Lists and Dictionaries

- What are their structures? Properties?
- How are they similar?
- How are they different?
- When do you use one or the other?

Lists vs. Dictionaries

Lists	Dictionaries
integer positions (0, …) to any type of value	Map immutable keys (int, float, string) to any type of value
Ordered	Unordered
Slower to find a value (`in` or `find`)	Fast to find a value (use key)
Fast to print in order	Slower to print in order (by key)
Only as big as you make it	Takes up a lot of space (so can add elements in the middle)

Review: What do these solutions do?

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

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

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Review: Equivalent Solutions
A Dictionary of Accumulators

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

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

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ABSTRACTIONS

Abstractions

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

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

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 had these attributes
    - Each `GraphWin` object had its own values for these attributes
  - Used methods (API) to modify the object's state, get information about attributes

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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 way to *organize* and *manipulate* data
  - Organize: data structures used
    - E.g., ints, lists, dictionaries, other objects, etc.
  - Manipulate: methods

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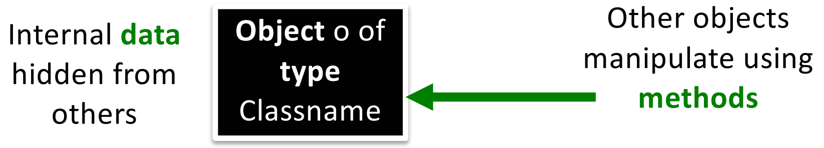
What is a Class?

- 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

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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?

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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

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Defining a New Class

- Syntax:

Keyword

Typically starts with a capital letter

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

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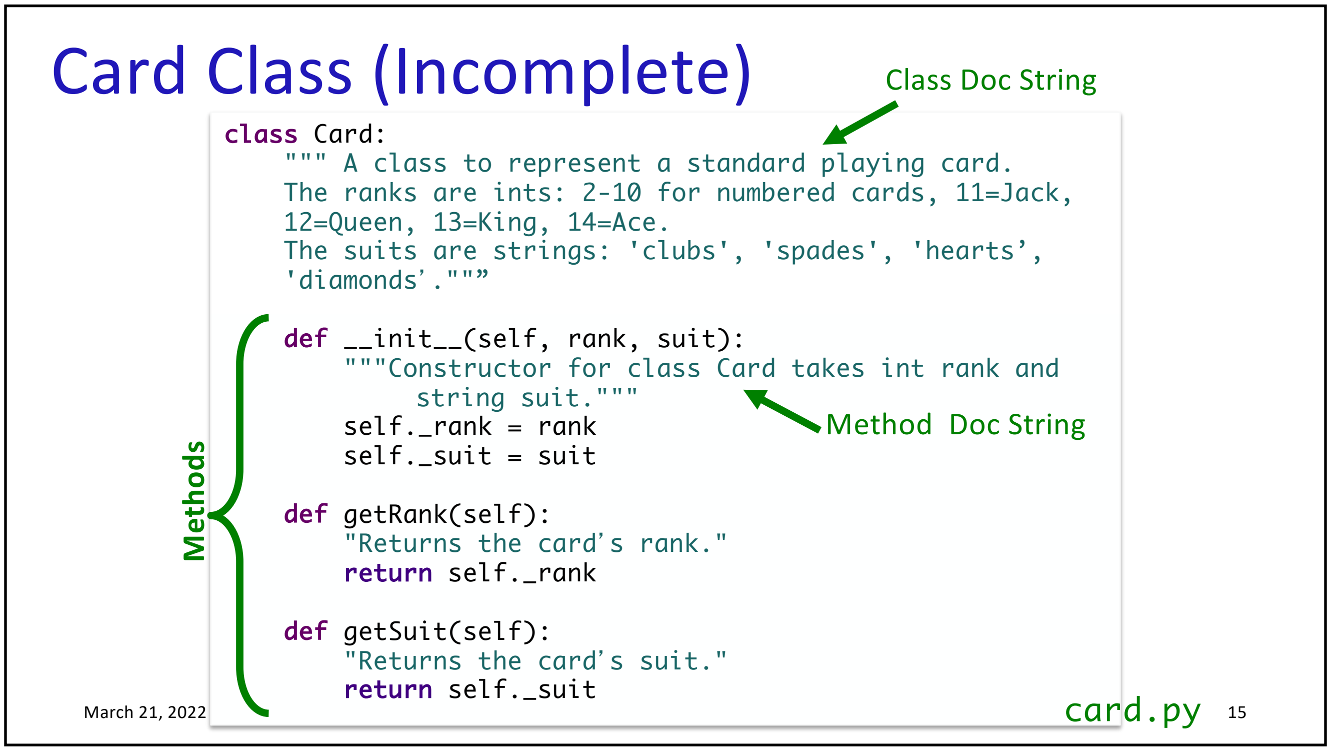

Card Class (Incomplete)

Class Doc String

```python
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

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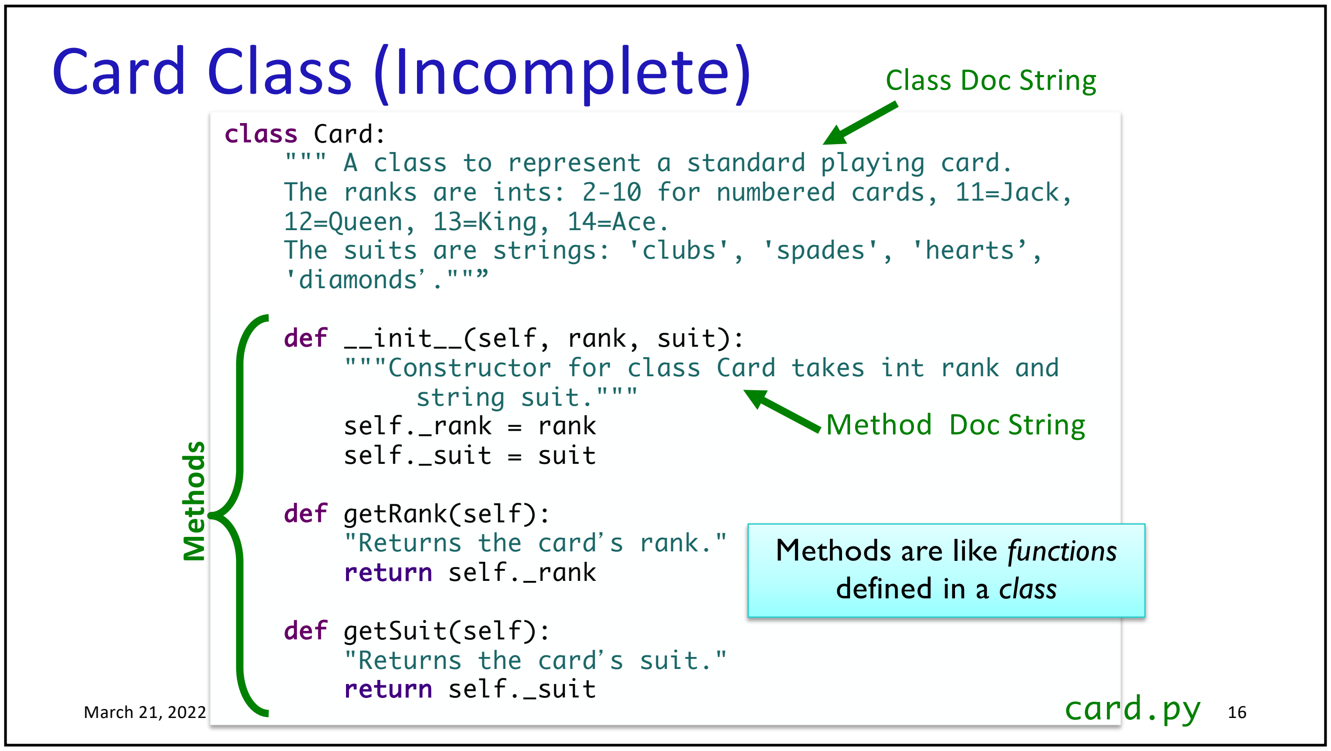

Card Class (Incomplete)

Class Doc String

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        """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*

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Defining the Constructor: `__init__`

- `__init__` method is like the ***constructor***
- In constructor, define ***instance variables***
  - **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

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

Instance variables

Convention: named with _

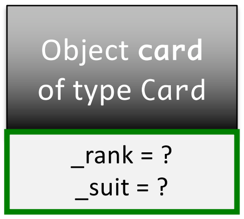
Review

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

Using the Constructor

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

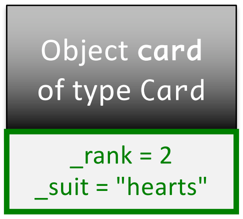
- As defined above, constructor is called using **Card(<rank>,<suit>)**
  - Do not *pass* anything for the `self` parameter
  - Python *automatically* passes the `self` parameter for us



Using the Constructor

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

- 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`

Testing Accessor Methods

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

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

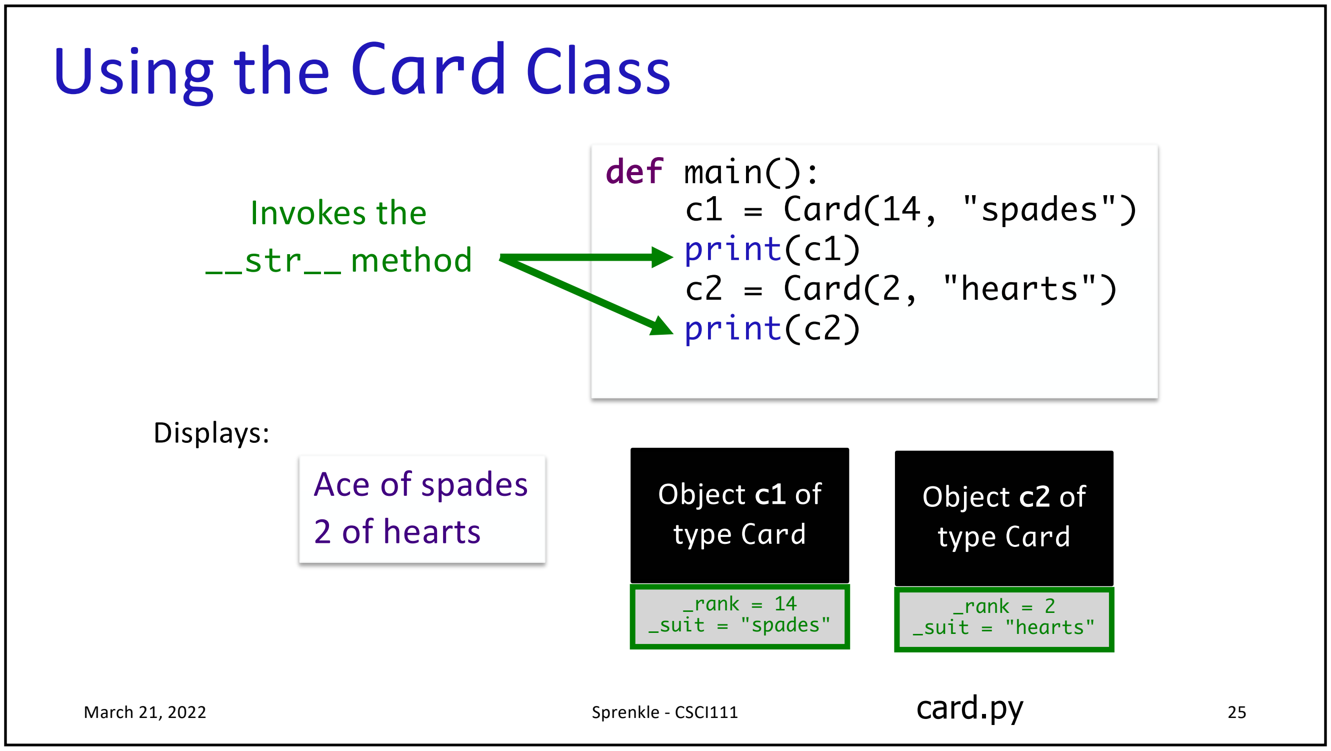
# test the getSuit() method and constructor
test.testEqual(c1.getSuit(), "spades")

# 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

```
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
```

Object **c1** of type Card

```
_rank = 14
_suit = "spades"
```

Object **c2** of type Card

```
_rank = 2
_suit = "hearts"
```

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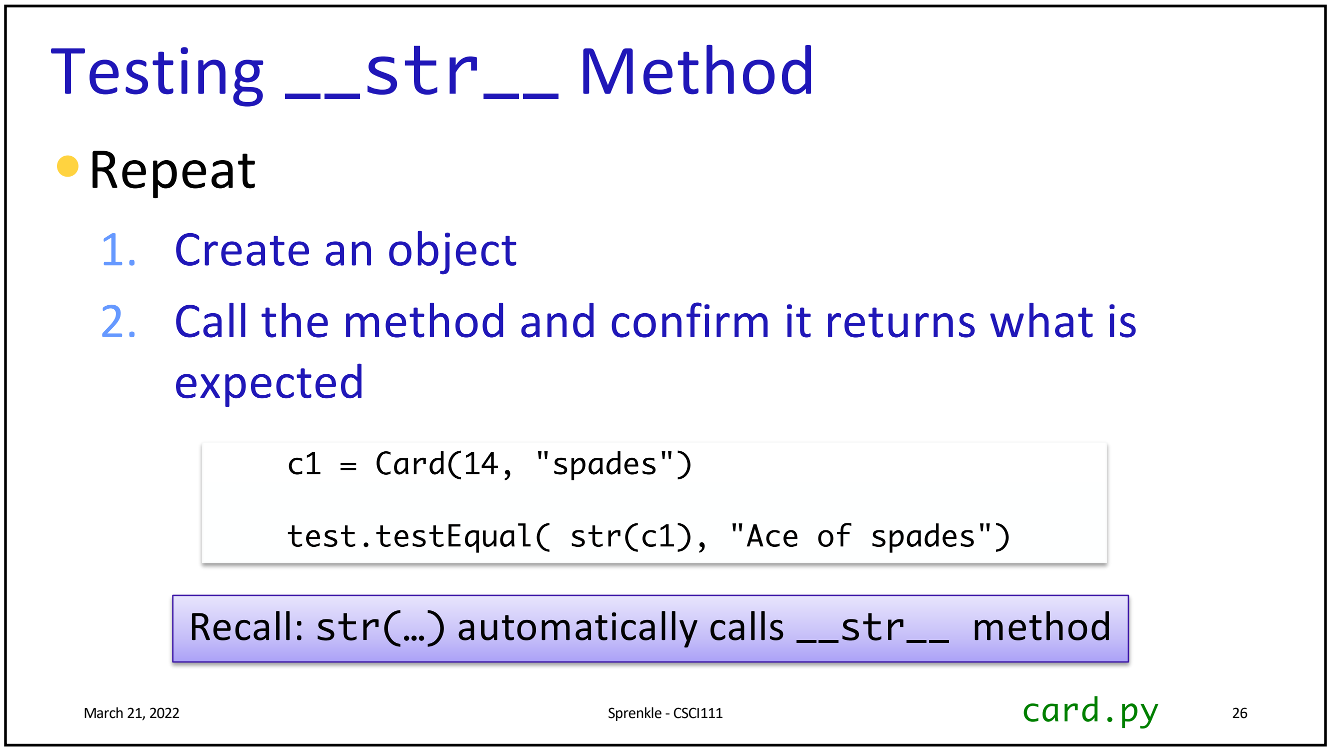

Testing __str__ Method

- Repeat
  1. Create an object
  2. Call the 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

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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`

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
  - Discussion on Wednesday