Objectives

- Designing our own classes
  - Representing attributes/data
  - What functionality to provide
- Using our defined classes

Where We Are

- With what you now know (OO programming)
  - Opens up the possibilities for what you kinds of programs you can write
  - Just about anything computational is possible

- Example: Car
  - Data to model for a Car?
  - API for a Car?

Review: Classes and Objects

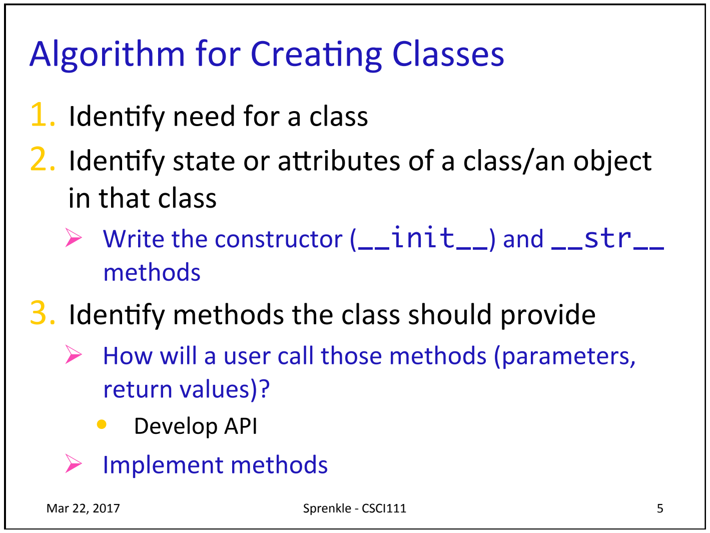
- Car class
- Each car has these **attributes**:
  - Make
  - Model
  - Year
  - Transmission
  - Exterior color
- Methods
  - getYear()
  - setGear()
  - …

Cars all have these attributes, different values for the attributes

Each car is an **instance of** the Car class

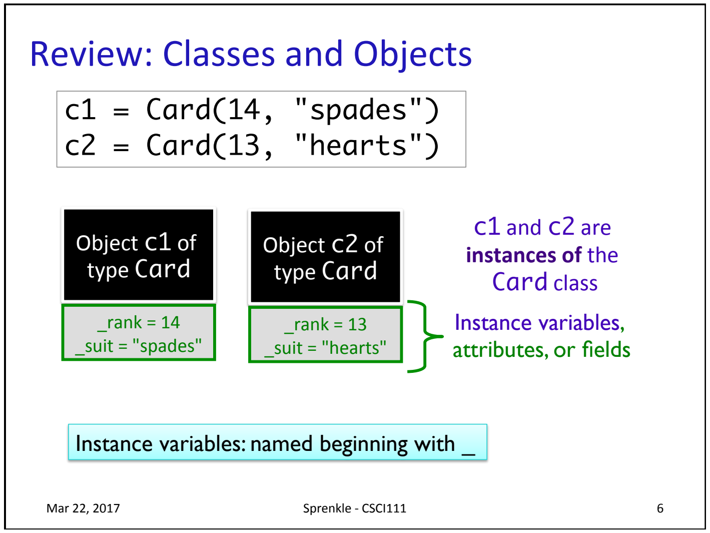
Review: Object-Oriented Programming

- Why do we want to define classes/new data types?
- What is the keyword to create a new class?
- How do you define a method?
  - What parameter is needed in every method?
- How do you create a new object of a given class?
  - What method does this call?
- How do we access instance variables in other methods?



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



Review: Classes and Objects

```
c1 = Card(14, "spades")
c2 = Card(13, "hearts")
```

Object `c1` of type `Card`

_rank = 14
_suit = "spades"

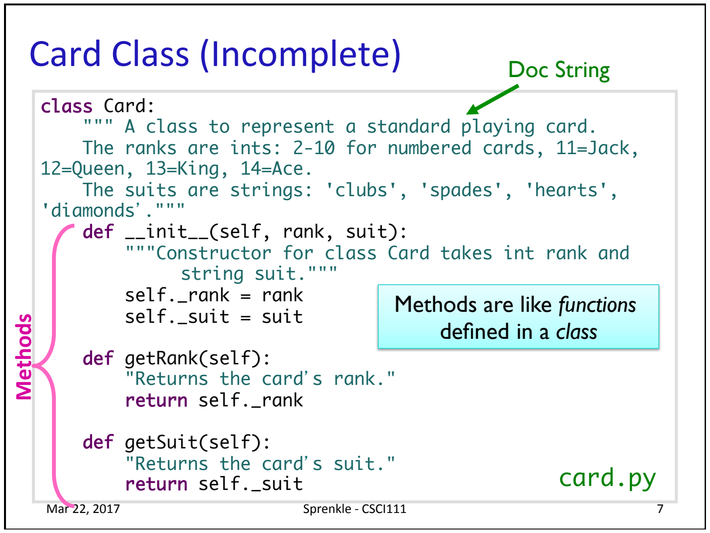
Object `c2` of type `Card`

_rank = 13
_suit = "hearts"

`c1` and `c2` are **instances of** the `Card` class

Instance variables, attributes, or fields

Instance variables: named beginning with _



Card Class (Incomplete)

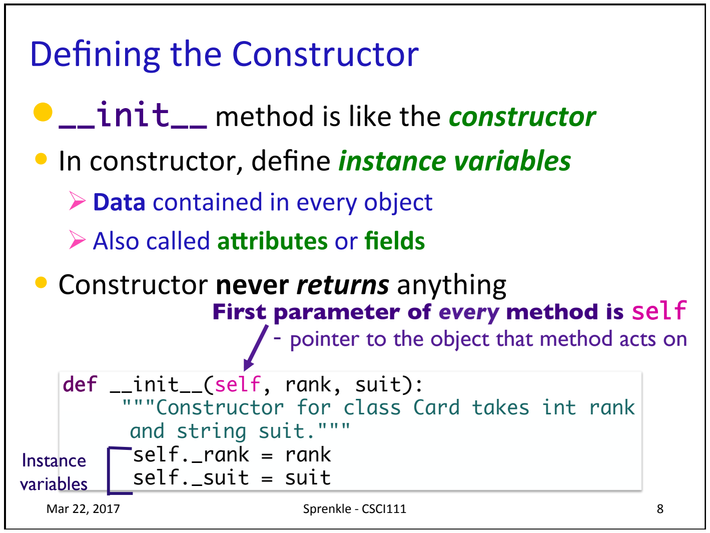
Doc String

```
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
```

Methods

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

card.py



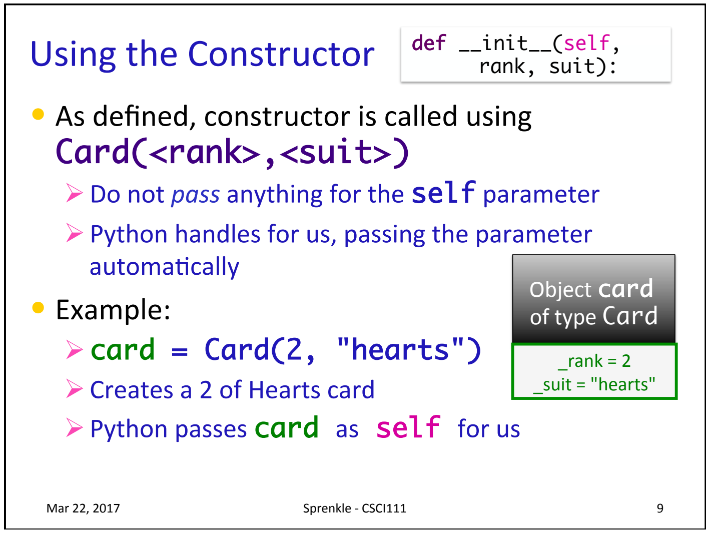
Defining the Constructor

- `__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` - pointer 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



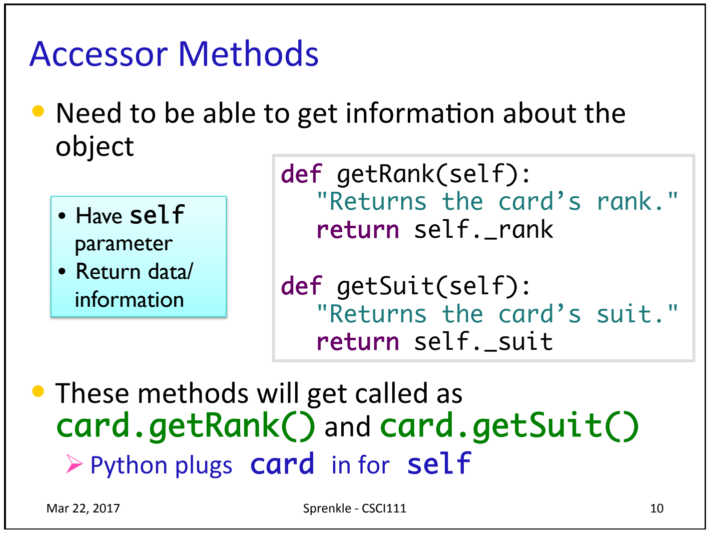
Using the Constructor

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

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

Object `card` of type `Card`

_rank = 2
_suit = "hearts"



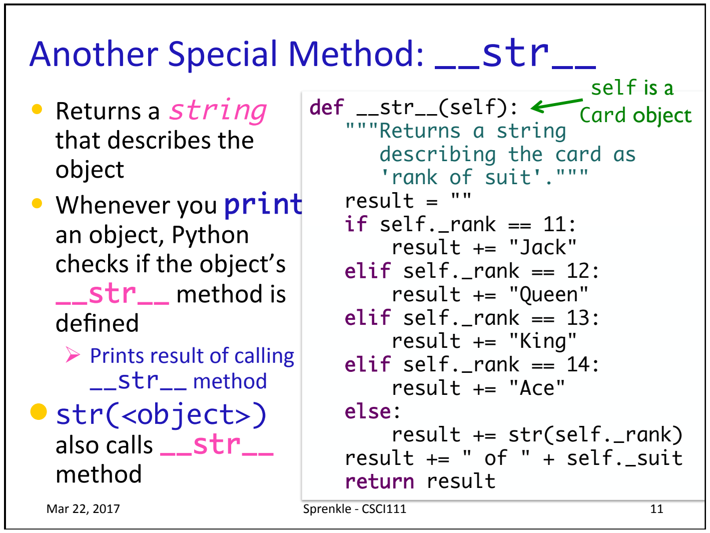
Accessor Methods

- Need to be able to get information about the object

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

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

- Have `self` parameter
- Return data/ information

- These methods will get called as `card.getRank()` and `card.getSuit()`
  - Python plugs `card` in for `self`

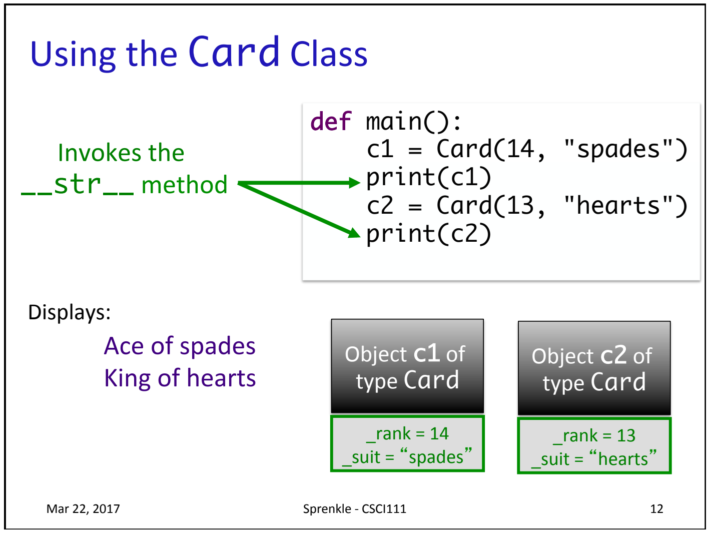


Another Special Method: `__str__`

- 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

self is a Card object

```
def __str__(self):
    """Returns a string
       describing 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(13, "hearts")
    print(c2)
```

Displays:

Ace of spades
King of hearts

Object `c1` of type `Card`

_rank = 14
_suit = “spades”

Object `c2` of type `Card`

_rank = 13
_suit = “hearts”

Creating a Deck Class (Partial)

- List of Card objects

```
from card import *

class Deck:
    def __init__(self):
        self._listOfCards = []
        for suit in ["clubs","hearts","diamonds","spades"]:
            for rank in range(2,15):
                self._listOfCards.append(Card(rank, suit))

    def __str__(self):
        deckRep= ""
        for c in self._listOfCards:
            deckRep += str(c) + "\n"
        return deckRep
```

Initialize instance variable, `self._listOfCards`

Creates and returns a string

Represents cards on separate lines

Actual code should have doc strings

Deck Class

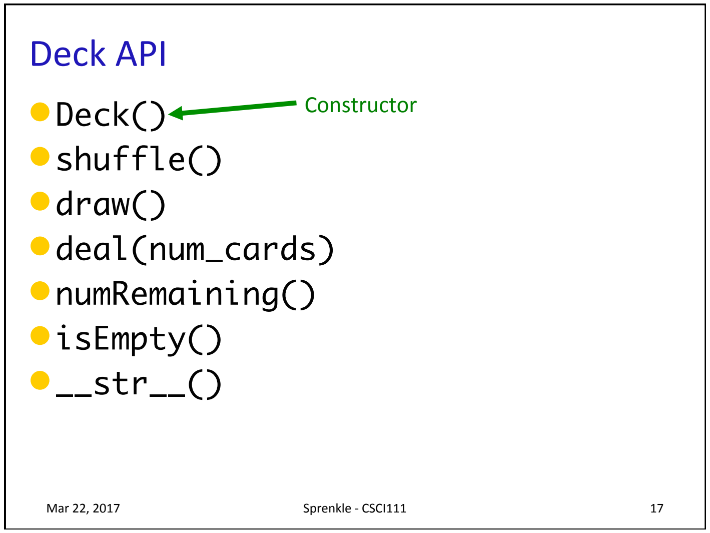
- What does the Deck API look like so far?

Deck API

- `Deck()` Constructor
- `__str__()`

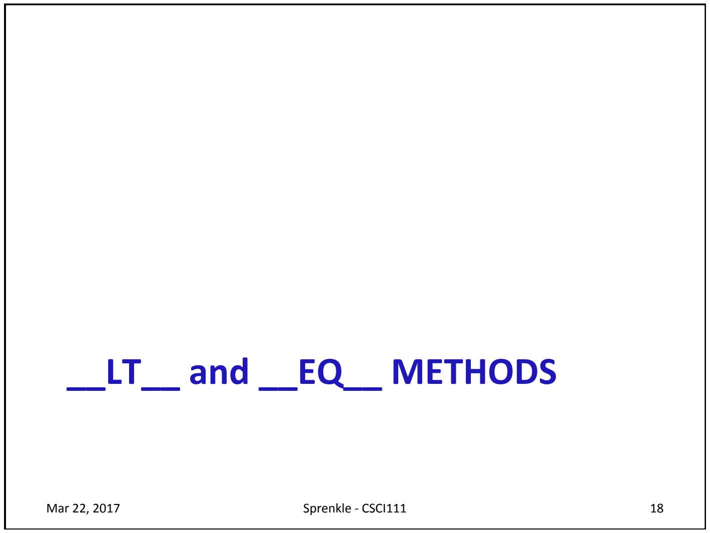
Deck API

- What additional methods should our Deck class provide?
- What do the method headers look like?
  - Deck's API
- What should they return?
- How do we implement them?

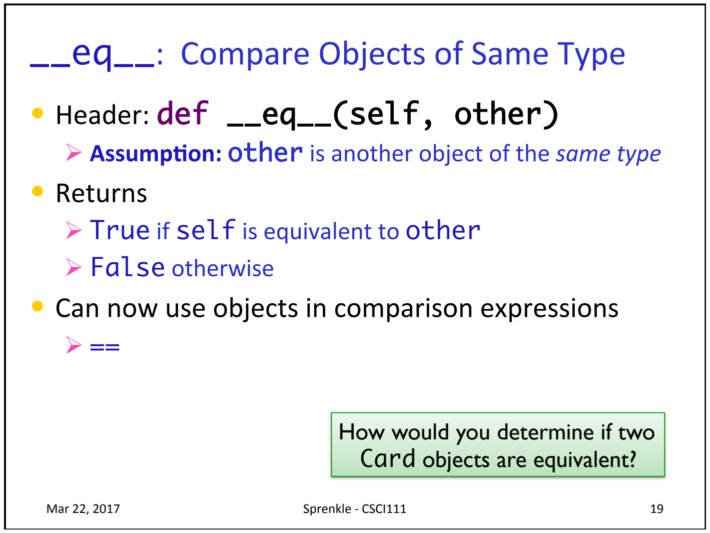


Deck API

- `Deck()` Constructor
- `shuffle()`
- `draw()`
- `deal(num_cards)`
- `numRemaining()`
- `isEmpty()`
- `__str__()`



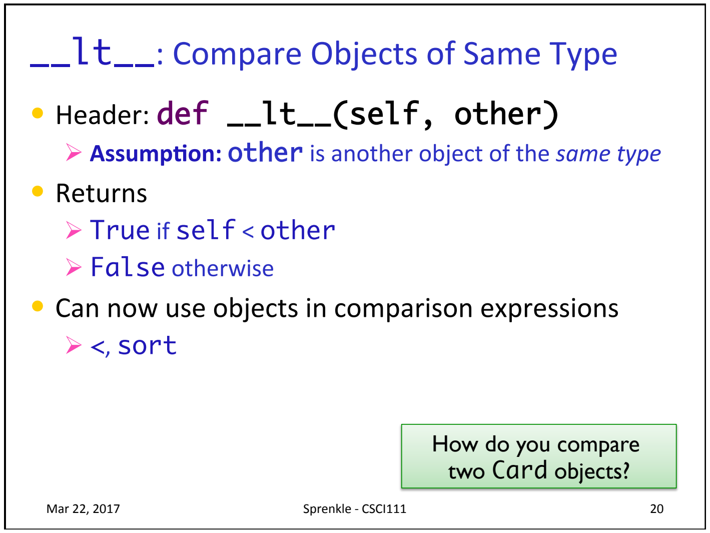
__LT__ and __EQ__ METHODS



`__eq__`: Compare Objects of Same Type

- Header: `def __eq__(self, other)`
  - **Assumption:** `other` is another object of the *same type*
- Returns
  - `True` if `self` is equivalent to `other`
  - `False` otherwise
- Can now use objects in comparison expressions
  - ==

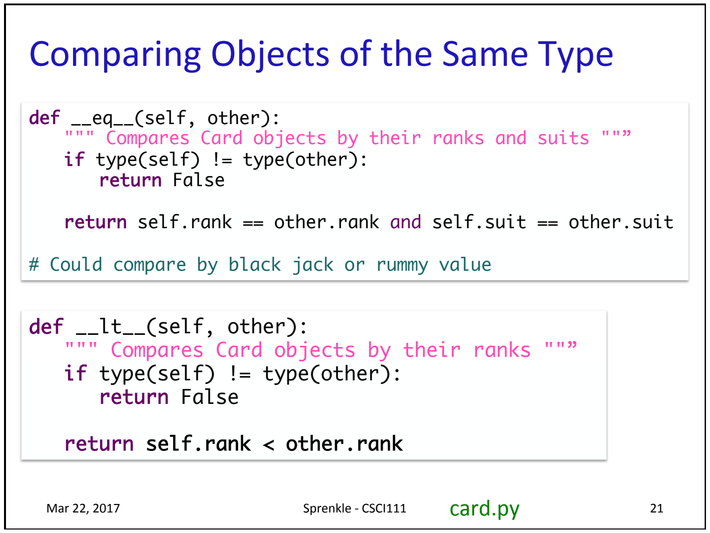
How would you determine if two `Card` objects are equivalent?



`__lt__`: Compare Objects of Same Type

- Header: `def __lt__(self, other)`
  - **Assumption:** `other` is another object of the *same type*
- Returns
  - `True` if `self` < `other`
  - `False` otherwise
- Can now use objects in comparison expressions
  - <, `sort`

How do you compare two `Card` objects?

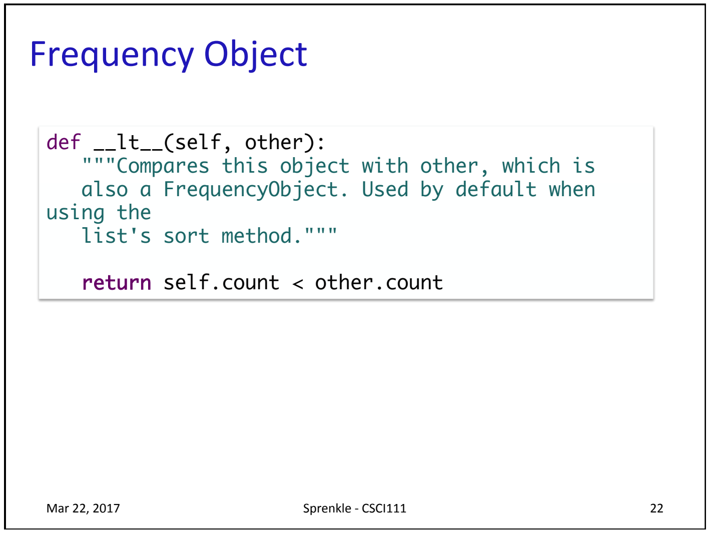


Comparing Objects of the Same Type

```
def __eq__(self, other):
   """ Compares Card objects by their ranks and suits ""”
   if type(self) != type(other):
      return False

   return self.rank == other.rank and self.suit == other.suit

# Could compare by black jack or rummy value
```

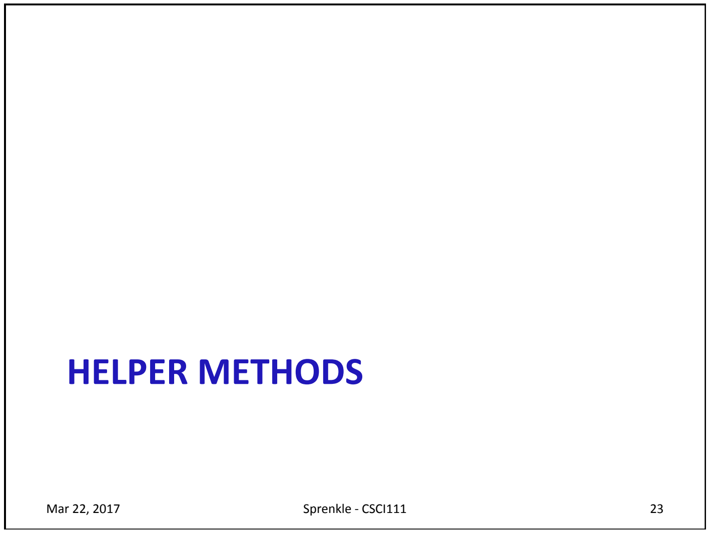
```
def __lt__(self, other):
   """ Compares Card objects by their ranks ""”
   if type(self) != type(other):
      return False

   return self.rank < other.rank
```

card.py

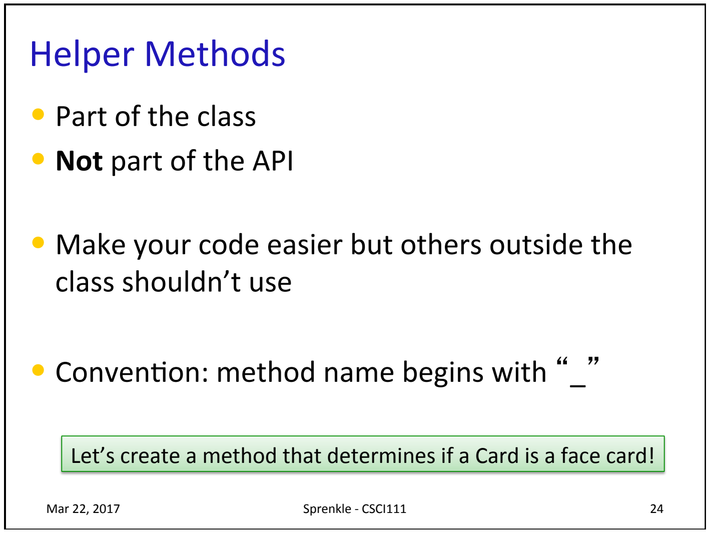


Frequency Object

```
def __lt__(self, other):
   """Compares this object with other, which is
   also a FrequencyObject. Used by default when
using the
   list's sort method."""

   return self.count < other.count
```



HELPER METHODS



Helper Methods

- Part of the class
- **Not** part of the API
- Make your code easier but others outside the class shouldn’t use
- Convention: method name begins with “_”

Let’s create a method that determines if a Card is a face card!

Example Helper Methods

- Only *loosely* enforces that other can't use
  - Doesn't show up in `help`
  - Does show up in `dir`

Helper Method:

```
def _isFaceCard(self):
   if self._rank > 10 and self._rank < 14:
      return True
   return False
```

In use:

```
def rummyValue(self):
   if self._isFaceCard():
      return 10
   elif self._rank == 10:
      return 10
   elif self._rank == 14:
      return 15
   else:
      return 5
```

card2.py

Summary: Designing Classes

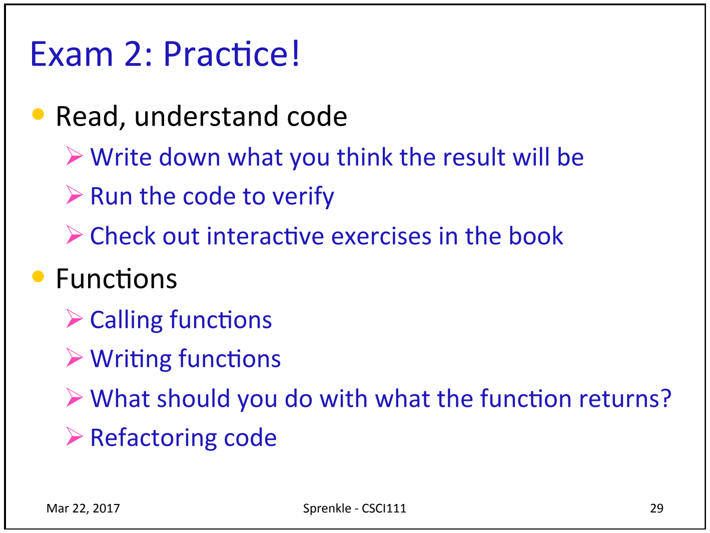
- What does the object/class represent?
- How to model/represent the class's *data*?
  - Instance variable
  - Data type
- What *functionality* should objects of the class have?
  - How will others want to use the class?
  - Put into methods for others to call (API)

Looking Ahead

- Lab 9: Analysis of student names at W&L
  - Staggered extension
  - MUST complete first two questions by Friday at class
    - Run turnin script to get credit that you turned in the first two questions.
  - All due Monday before class
  - Keep in mind: no students assistants or office hours over the weekend
- Exam 2

Exam 2

- Cumulative
- Focused on things after first exam (see prep document)



Exam 2: Practice!

- Read, understand code
  - Write down what you think the result will be
  - Run the code to verify
  - Check out interactive exercises in the book
- Functions
  - Calling functions
  - Writing functions
  - What should you do with what the function returns?
  - Refactoring code