61A Lecture 16

Announcements

String Representations

String Representations

An object value should behave like the kind of data it is meant to represent

For instance, by producing a string representation of itself

Strings are important: they represent language and programs

In Python, all objects produce two string representations:

- The **str** is legible to humans
- The **repr** is legible to the Python interpreter

The **str** and **repr** strings are often the same, but not always

The repr String for an Object

The **repr** function returns a Python expression (a string) that evaluates to an equal object

```
repr(object) -> string

Return the canonical string representation of the object.
For most object types, eval(repr(object)) == object.
```

The result of calling **repr** on a value is what Python prints in an interactive session

```
>>> 12e12
12000000000000.0
>>> print(repr(12e12))
12000000000000.0
```

Some objects do not have a simple Python-readable string

```
>>> repr(min)
'<built-in function min>'
```

The str String for an Object

Human interpretable strings are useful as well:

```
>>> from fractions import Fraction
>>> half = Fraction(1, 2)
>>> repr(half)
'Fraction(1, 2)'
>>> str(half)
'1/2'
```

The result of calling **str** on the value of an expression is what Python prints using the **print** function:

```
>>> print(half)
1/2
```

(Demo)

```
>>> s = "Hello, World"
>>> s
'Hello, World'
>>> print(repr(s))
'Hello, World'
>>> print(s)
Hello, World
>>> print(str(s))
Hello, World
>>> str(s)
'Hello, World'
>>> repr(s)
"'Hello, World'"
>>> eval(repr(s))
'Hello, World'
>>> repr(repr(repr(s)))
'\'"\\\'Hello, World\\\'"\''
>>> eval(eval(eval(repr(repr(repr(s))))))
'Hello, World'
>>> eval(s)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "<string>", line 1, in <module>
NameError: name 'Hello' is not defined
>>> eval(repr(s))
'Hello, World'
```

Polymorphic Functions

Polymorphic Functions

Polymorphic function: A function that applies to many (poly) different forms (morph) of data

str and **repr** are both polymorphic; they apply to any object

repr invokes a zero-argument method __repr__ on its argument

a function that asks the argument what to do

```
>>> half.__repr__()
'Fraction(1, 2)'
```

str invokes a zero-argument method __str__ on its argument

```
>>> half.__str__()
'1/2'
```

Implementing repr and str

The behavior of **repr** is slightly more complicated than invoking __repr__ on its argument:

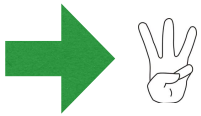
- An instance attribute called __repr__ is ignored! Only class attributes are found
- *Question*: How would we implement this behavior?

```
def repr(x):
    return x.__repr__(x)
```

The behavior of **str** is also complicated:

- An instance attribute called __str__ is ignored
- If no __str__ attribute is found, uses **repr** string
- (By the way, **str** is a class, not a function)
- *Question*: How would we implement this behavior?

```
def repr(x):
    return x.__repr__()
```



```
def repr(x):
    return type(x).__repr__(x)
```

```
def repr(x):
    return type(x).__repr__()
```

(Demo)

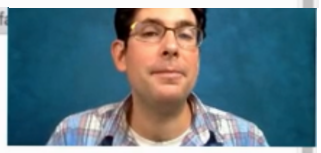
```
def repr(x):
    return super(x).__repr__()
```

```
~/lec$ python3 ex.py
Bear()
Bear()
Bear()
Bear()
Bear()
~/lec$
```

```
class Bear:
    """A Bear."""

    def __repr__(self):
        return 'Bear()'

oski = Bear()
print(oski)
print(str(oski))
print(repr(oski))
print(oski.__str__())
print(oski.__repr__())
```

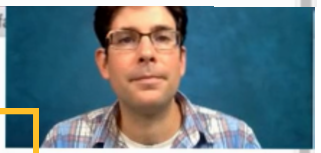
```
~/lec$ python3 ex.py
Bear()
Bear()
Bear()
Bear()
Bear()
~/lec$ python3 ex.py
a bear
a bear
Bear()
a bear
Bear()
~/lec$
```

```
class Bear:
    """A Bear."""

    def __repr__(self):
        return 'Bear()'

    def __str__(self):
        return 'a bear'

oski = Bear()
print(oski)
print(str(oski))
print(repr(oski))
print(oski.__str__())
print(oski.__repr__())
```

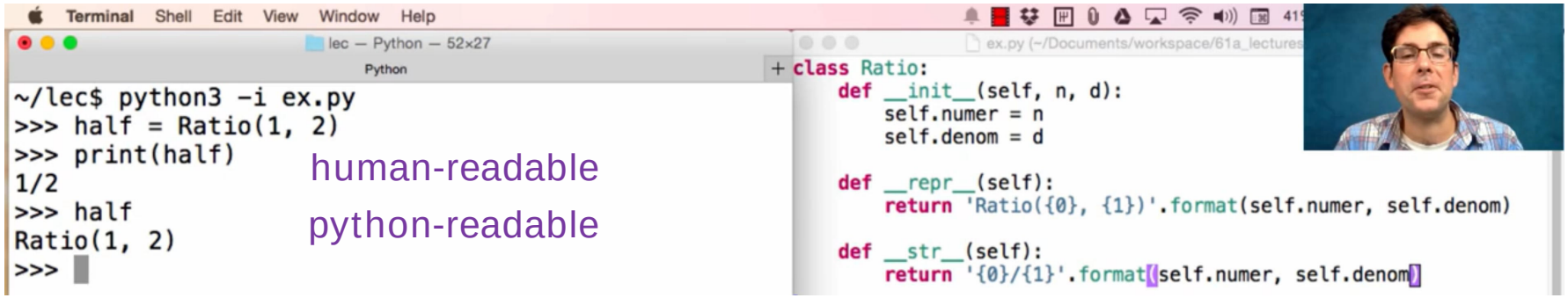


```
~/lec$ python3 ex.py
Bear()
Bear()
Bear()
Bear()
Bear()
~/lec$ python3 ex.py
a bear
a bear
Bear()
a bear
Bear()
~/lec$ python3 ex.py
a bear
a bear
Bear()
this bear
oski
```

```
class Bear:
    """A Bear."""

    def __init__(self):
        self.__repr__ = lambda: 'oski'
        self.__str__ = lambda: 'this bear'

    def __repr__(self):
        return 'Bear()'

    def __str__(self):
        return 'a bear'

oski = Bear()
print(oski)
print(str(oski))
print(repr(oski))
print(oski.__str__())
print(oski.__repr__())
```



Interfaces



Message passing: Objects interact by looking up attributes on each other (passing messages)

The attribute look-up rules allow different data types to respond to the same message

A **shared message** (attribute name) that elicits similar behavior from different object classes is a powerful method of abstraction

An interface is a set of shared messages, along with a specification of what they mean

Example:

Classes that implement `__repr__` and `__str__` methods that return Python-interpretable and human-readable strings implement an interface for producing string representations

(Demo)

Special Method Names

Special Method Names in Python

Certain names are special because they have built-in behavior

These names always start and end with two underscores

`__init__`	Method invoked automatically when an object is constructed
`__repr__`	Method invoked to display an object as a Python expression
`__add__`	Method invoked to add one object to another
`__bool__`	Method invoked to convert an object to True or False
`__float__`	Method invoked to convert an object to a float (real number)

```
>>> zero, one, two = 0, 1, 2
>>> one + two
3
>>> bool(zero), bool(one)
(False, True)
```

Same behavior using methods

```
>>> zero, one, two = 0, 1, 2
>>> one.__add__(two)
3
>>> zero.__bool__(), one.__bool__()
(False, True)
```

Special Methods

Adding instances of user-defined classes invokes either the __add__ or __radd__ method

add in the opposing direction
(from right to left)

```
>>> Ratio(1, 3) + Ratio(1, 6)
Ratio(1, 2)

>>> Ratio(1, 3).__add__(Ratio(1, 6))
Ratio(1, 2)

>>> Ratio(1, 6).__radd__(Ratio(1, 3))
Ratio(1, 2)
```

http://getpython3.com/diveintopython3/special-method-names.html

http://docs.python.org/py3k/reference/datamodel.html#special-method-names

(Demo)

ex.py (~/Documents/workspace/61a_lectures/fa15) -

```
class Ratio:
    def __init__(self, n, d):
        self.numer = n
        self.denom = d

    def __repr__(self):
        return 'Ratio({0}, {1})'.format(self.numer, self.denom)

    def __str__(self):
        return '{0}/{1}'.format(self.numer, self.denom)

    def __add__(self, other):
        if isinstance(other, int):
            n = self.numer + self.denom * other
            d = self.denom
        elif isinstance(other, Ratio):
            n = self.numer * other.denom + self.denom * other.numer
            d = self.denom * other.denom
        elif isinstance(other, float):
            return float(self) + other
        g = gcd(n, d)
        return Ratio(n//g, d//g)

    __radd__ = __add__

    def __float__(self):
        return self.numer/self.denom

def gcd(n, d):
    while n != d:
        n, d = min(n, d), abs(n-d)
    return n
```

type dispatching

type coersion

Generic Functions

A polymorphic function might take two or more arguments of different types

Type Dispatching: Inspect the type of an argument in order to select behavior

Type Coercion: Convert one value to match the type of another

```
>>> Ratio(1, 3) + 1
Ratio(4, 3)

>>> 1 + Ratio(1, 3)
Ratio(4, 3)

>>> from math import pi
>>> Ratio(1, 3) + pi
3.4749259869231266
```

(Demo)