61A Lecture 12

Monday, September 26

Implementing Dice

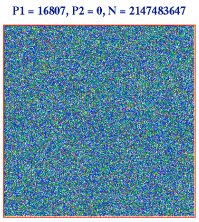
Random numbers are useful for experimentation

They also appear in lots of algorithms, e.g.,

- Primality tests
- Machine learning techniques

```
def make_dice(sides=6):
    seed = 1
    def dice():
        nonlocal seed
        seed = (16807 * seed) % 2147483647
        return seed % sides + 1
    return dice
```

$2^{31} - 1$



http://www.math.utah.edu/~pa/Random/Random.html

S.K. Park and K.W. Miller, " Random Number Generators: Good Ones Are Hard To Find", Communications of the ACM, October 1988, pp. 1192-1201.

Referential Transparency, Lost

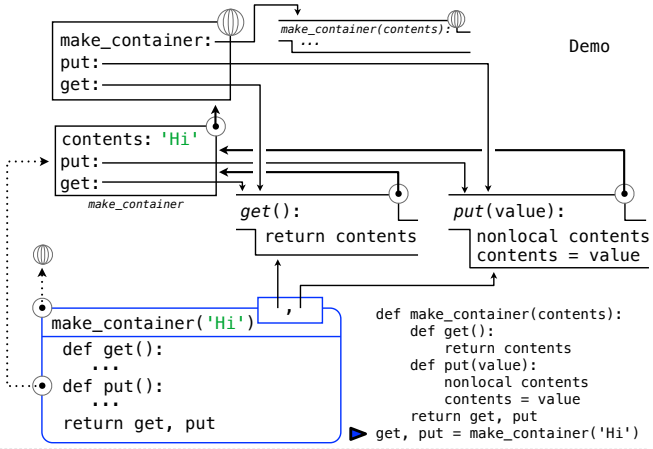
- Expressions are **referentially transparent** if substituting an expression with its value does not change the meaning of a program.

```
mul(add(2, mul(4, 6)), add(3, 5))
mul(add(2,    24    ), add(3, 5))
mul(       26        , add(3, 5))
```

- Re-binding operations violate the condition of referential transparency because they let us define functions that do more than just return a value; **we can change the environment**, causing values to mutate.

Demo

Implementing a Mutable Container Object

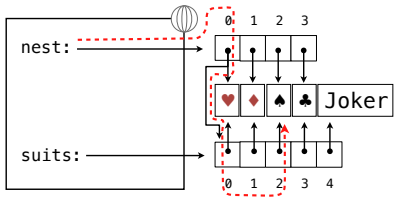


Python Lists

```
['Demo']
```

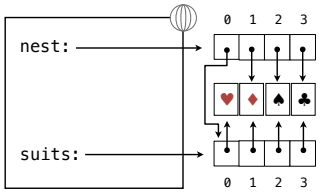
http://docs.python.org/py3k/library/stdtypes.html#mutable-sequence-types

Sharing and Identity with Lists




```
suits = ['♥', '♦', '♠', '♣']
nest = list(suits)
nest[0] = suits
nest[0][2]
suits.append('Joker')
nest[0].pop()
```

Testing for Identity




```
>>> suits is nest[0]
True
>>> suits is ['♥', '♦', '♠', '♣']
False
>>> suits == ['♥', '♦', '♠', '♣']
True
```


List Comprehensions

```
[<map exp> for <name> in <iter exp> if <filter exp>]
```

Short version: `[<map exp> for <name> in <iter exp>]`

Unlike generator expressions, the map expression is evaluated when the list comprehension is evaluated.

```
>>> suits = ['heart', 'diamond', 'spade', 'club']
>>> from unicodedata import lookup
>>> [lookup('WHITE ' + s.upper() + ' SUIT') for s in suits]
['♡', '♢', '♤', '♧']
```


Dispatch Functions

A technique for packing multiple behaviors into one function

```
def make_pair(x, y):
    """Return a function that behaves like a pair."""
    def dispatch(m):
        if m == 0:
            return x
        elif m == 1:
            return y
    return dispatch
```

Message argument can be anything, but strings are most common

The body of a dispatch function is always the same:

- One conditional statement with several clauses
- Headers perform equality tests on the message

A Mutable Container That Uses Message Passing

```
def make_container_dispatch(contents):
    def dispatch(message, value=None):
        nonlocal contents
        if message == 'get':
            return contents
        if message == 'put':
            contents = value
    return dispatch
```

```
def make_container(contents):
    def get():
        return contents
    def put(value):
        nonlocal contents
        contents = value
    return get, put
```

Demo

Implementing Mutable Recursive Lists

```
def make_mutable_rlist():
    contents = empty_rlist
    def dispatch(message, value=None):
        nonlocal contents
        if message == 'len':
            return len_rlist(contents)
        elif message == 'getitem':
            return getitem_rlist(contents, value)
        elif message == 'push_first':
            contents = make_rlist(value, contents)
        elif message == 'pop_first':
            f = first(contents)
            contents = rest(contents)
            return f
        elif message == 'str':
            return str(contents)
    return dispatch
```

Recursive List Refresher Demo

Demo