Py ch11: Dictionaries

12 Nov 2008
CMPT14x
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Addendum on class variables

- Two kinds of attributes of an object:
  - Class attributes: shared by all instances

```
class Fraction:
    numer = 0
    denom = 1
```

  - Instance attributes: specific to this instance

```
class Fraction:
    def __init__(self, n=0, d=1):
        self.numer = n
        self.denom = d
```

- For records, it's actually better to use instance attributes, not class attributes

What's on for today (Py ch10)

- Dictionaries
  - Keys and values
  - Basic dictionary methods:
    - .keys(), .values(), .items()
  - Iterating through dictionaries
  - Other dictionary methods:
    - len(), del, in, .get(), .copy()
  - Application: hinting
    - Fibonacci example

Python type hierarchy (partial)

- Atomic types
  - Numbers
    - Integers (int, long, bool): 5, 500000L, True
    - Reals (float) (only double-precision): 5.0
    - Complex numbers (complex): 5+2j
- Container (aggregate) types
  - Immutable sequences
    - Strings (str): "Hello"
    - Tuples (tuple): (2, 5.0, "hi")
  - Mutable sequences
    - Lists (list): [2, 5.0, "hi"]
  - Mappings
    - Dictionaries (dict): {"apple": 5, "orange": 8}

Dictionaries

- Python dictionaries are mutable, unsorted containers holding associative key-value pairs
- Create a dictionary with curly braces {}:
  - **appleInv = {'Fuji': 10, 'Gala': 5, 'Spartan': 7}**
- Index a dictionary using a key:
  - **appleInv['Fuji']   # returns 10**
- Values can be any object; need not be same type:
  - **appleInv['Rome'] = range(3)**
- Keys can be any immutable type:
  - **appleInv[('BC', 'Red Delicious')] = 12**

Dictionaries: keys() and values()

- All dictionaries have the following methods:
  - keys(): returns a list of all the keys
    - appleInv.keys()

    ['Fuji', 'Spartan', 'Rome', 'Gala', ('BC', 'Red Delicious')]
  - values(): returns a list of all the values
    - appleInv.values()

    [10, 7, [0, 1, 2], 5, 12]
- Dictionaries are unsorted!
  - The order of keys() and values() will correspond if the dictionary isn't modified

Iterating through dictionaries

- To print our apple inventory:
  - **for appleType in appleInv.keys():**
    - **print "We have", appleInv[appleType], **
      - **appleType, "apples."**
- Output:
  - We have 10 Fuji apples.
  - We have 7 Spartan apples.
  - We have [0, 1, 2] Rome apples.
  - We have 5 Gala apples.
  - We have 12 ('BC', 'Red Delicious') apples.

Other dictionary methods

- `len(appleInv)`
- `del appleInv['Fuji']`
- `'Fuji' in appleInv`
- `appleInv.get('Braeburn', 0)`
  - Return default value if key is not in dictionary
- `appleInv.items()`
  - Returns a copy of the dictionary as a list of (key, value) tuples
- `appleInv.copy()`
  - Shallow copy

Dictionary application: hinting

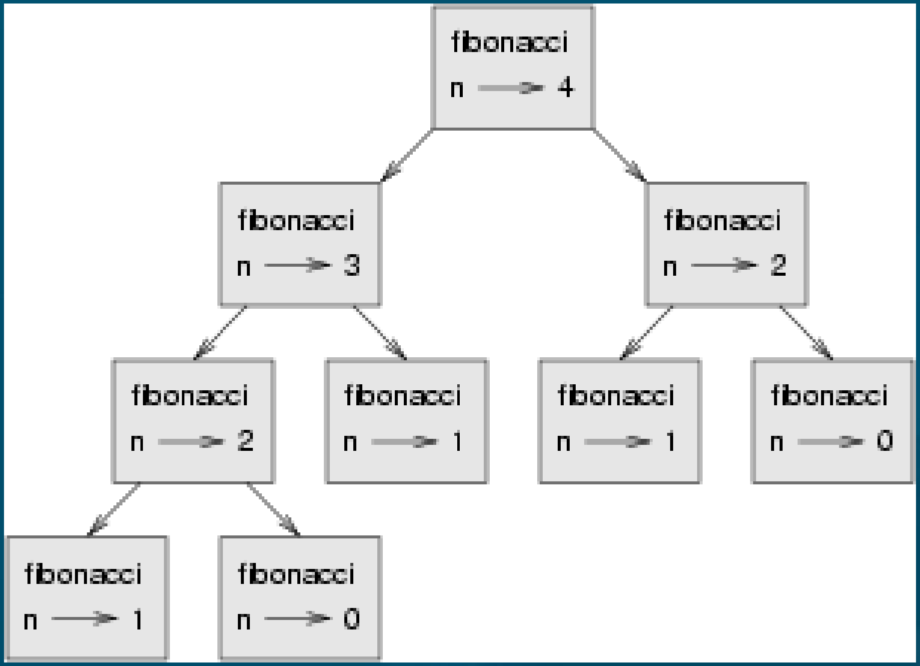
- Py ch10 illustrates a cool use of dictionaries:
- Hinting: save (cache) previously-calculated values for future use
- Fibonacci example:

```
def fib(n):
    if n == 0 or n == 1:
        return 1
    return fib(n-1) + fib(n-2)
```

- But this is very slow and inefficient!
  - Try fib(28), fib(29), fib(30), ...
- Fibonacci numbers get very big very fast

Fibonacci revisited

- The call-graph for fib() shows that, e.g, fib(2) gets recalculated many times:



$O(n^2)$ calls in the graph

- If we save the value of fib(2) the first time it's calculated, we can reuse that hint

Hinting Fibonacci

- Use a dictionary to store the precalculated hints:
  - Key is n; value is fib(n)
  - When we calculate a fib(), add it to the dict
  - Before calculating a fib(), check to see if it's already in the dictionary of hints

```
fibHints = {0:1, 1:1}
def hFib(n):
    if n in fibHints.keys():
        return fibHints[n]
    fibHints[n] = hFib(n-2) + hFib(n-1)
    return fibHints[n]
```

Iterative Fibonacci

- Actually, we don't need recursion to solve Fibonacci:

```
def iFib(n):
    current = 1
    parent = 1
    grandparent = 0
    for i in range( int(n) ):
        current = grandparent + parent
        grandparent = parent
        parent = current
    return current
```

- We show hFib() just to illustrate the concept of hinting

Review of today (Py ch10)

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  - Application: hinting
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