SICP-Spring2018

January 9, 2019

0.1 [U+5927] [U+4F6C] [U+9547] [U+697C]

###

[U+7B80] [U+4ECB] [U+4F2F] [U+514B] [U+5229] [U+5927] [U+5B66] CS61 [U+7CFB] [U+5217] [U+7B2C] [U+4E00] [U+FF0C] SICP [U+7684] Python [U+7248] [U+672C] [U+3002]

```
In [ ]: ### 1.3 control
        - 1 python -i [U+4E86][U+89E3][U+4E00][U+4E0B] interactive
        - 2 pyton -m [U+4E86][U+89E3][U+4E00][U+4E0B] -m -i
        - 3 python -v
        A statement is:
        False in Python[U+FF1A]False 0 '' None
        env is a sequence of frames

In [3]: from operator import mod,truediv,floordiv
        mod(2013,5)

Out[3]: 3

In [5]: # Quotient

Out[5]: 1.0
```

0.1.1 1.4 Higher-order function

cs98 addtional Fibobacci seq [U+4E0E] [U+8D1D] [U+58F3] [U+FF1F]
[U+6240] [U+6709] [U+9012] [U+5F52] [U+5747] [U+53EF] [U+4EE5] [U+7528] [U+975E] [U+9012] [U+5F52] [U+65B9
[U+81EA] [U+4E0A] [U+800C] [U+4E0B] [U+81EA] [U+4E0B] [U+800C] [U+4E0A] [U+7684] [U+5907] [U+5FD8] [U+5F5

function's domain [U+8FB9] [U+754C] [U+503C] function's range [U+9608] [U+503C] function's behavior one job DRY repeat generally **shared implention** [U+FF1A] **area solution**
[U+51FD] [U+6570] [U+4F5C] [U+4E3A] [U+4ECE] [U+53C2] [U+6570] [U+4F20] [U+8F93] [U+8FDB] [U+53BB] [U+8FD
[U+8FDB] [U+884C] generally 8/(4k-1)(4k-3) = pi Function are first class:func can be manipulated as a value in program language Higher Order funtion:A function taht takes a function as an arg value or ret a func as a ret value

Lambda expression vs def: [U+690D] [U+7269] [U+5927] [U+6218] [U+50F5] [U+5C38]
[U+62C9] [U+59C6] [U+8FBE]

```
In [9]: assert 3 < 2 ,' Falee'
```

```
        ---------------------------------------------------------------------------

        AssertionError                            Traceback (most recent call last)

        <ipython-input-9-2baa5041699e> in <module>()
    ----> 1 assert 3 < 2 ,' Falee'


        AssertionError:  Falee
```

```
In [11]: def make_adder(n):
             def adder(k):
                 return k+n
             return adder
```

```
In [13]: make_adder(1)(10)
```

```
Out[13]: 11
```

```
In [15]: square = lambda x:x*x
```

0.1.2 1.5 Environment for H_O function

[U+7C7B] [U+4F3C] [U+4E8E] Python [U+7684] [U+88C5] [U+9970] [U+5668] [U+FF1F] [U+FF1F]
[U+73AF] [U+5883] [U+7C7B] [U+4F3C] [U+4E8E] Linux fork() [U+51FD] [U+6570]
frame [U+7684] [U+6982] [U+5FF5] [U+5F88] [U+91CD] [U+8981] [U+5173] [U+4E8E] [U+51FD] [U+6570] [U+7684] [

0.1.3 1.6 Interation

fibnacci seq kth dif = kth+dif,kth

A call staments is: switch back env fx has a value only one ret [U+FF1A] fork()?? self references

WAV Files

```
In [1]: def print_sum(x):
            print(x)
            def next_sum(y):
                return print_sum(x+y)
            return next_sum
        print_sum(1)(3)(5)
```

```
1
4
9
```

```
Out[1]: <function __main__.print_sum.<locals>.next_sum(y)>
```

0.1.4 1.7 recursive function

call himself directly or not different frames keep diff argument in each call can be tricky:**Iteration is a special case of recursion!** Idea:figure out what state must be cantaintend by the iterative funtion converting iter to recursion: The state can be passed as arguments [U+9012][U+5F52][U+7ED3][U+675F][U+6761][U+4EF6][U+FF1A][U+81EA][U+8EAB][U+6EE1][U+8DB3][U+6761][U+4EF6][U+7ED3][U+675F] Mutual recursion Luhn sum recursion and iteration

```
In [2]: def split(n):
            return n//10,n%10
        def sum_digits(n):
            if n < 10:
                return n
            else:
                all_but_last, last = split(n)
                return sum_digits(all_but_last) + last
        def luhn_sum():
            pass
```

```
In [3]: sum_digits(2013)
```

```
Out[3]: 6
```

0.1.5 1.8 Tree recursion

[U+9012][U+5F52][U+7684][U+91CD][U+590D][U+8BA1][U+7B97][U+592A][U+591A][U+5F88][U+5[U+5230]35[U+5DF2][U+7ECF][U+6302][U+4E86] by rembering results #### [U+89E3][U+51B3][U+597D]base case[U+95EE][U+9898][U+5176][U+4ED6][U+4EA4][U+7ED9][U+9012][U+5F52] [U+FF08][U+611F][U+89C9][U+5F88][U+7C7B][U+4F3

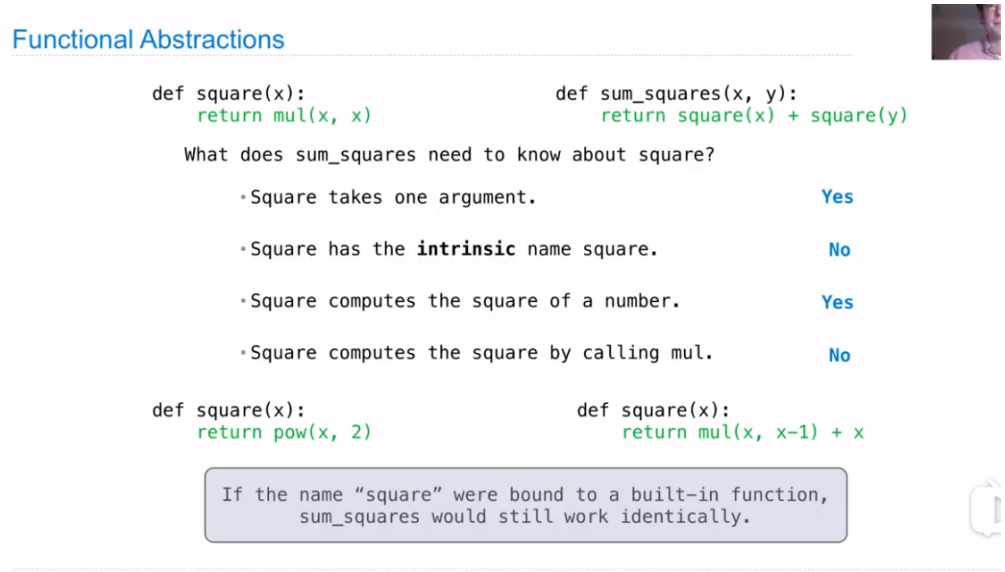
In [13]:
```
from ucb import trace
@trace
def cascade(n):
    if n < 10:
        pass
        #print(n)  ## base case  return None
    else:
        #print(n)
        cascade(n//10)
        #print(n)
def cascade_inverse():
    pass

@trace
def fib(n):
    if n<=1:
        return n
    else:
        return fib(n-1) + fib(n-2)
```

In [15]:
```
#cascade(12345)
#fib(10)
```

In [19]:
```
## countingh partions
## description : [U+628A][U+4E00][U+4E2A][U+6570][U+5206]n[U+4E3A][U+51E0][U+4E2A][U+6
def count_partion(n,m):
    if n == 0:
        return 1
    elif n < 0:
        return 0
    elif m == 0 :
        return 0
    else:
        with_m = count_partion(n-m,m)
        without_m = count_partion(n,m-1)
    return with_m + without_m
count_partion(6,4)
```

Out[19]: 9

0.1.6 1.9 Function Examples



./image/\begingroup \let \relax \relax \endgroup [Please in

[U+51FD] [U+6570] [U+547D] [U+540D] [U+53D8] [U+91CF] [U+547D] [U+540D]

./image/\begingroup \let \relax \relax \endgroup [Please insert \PrerenderUnicode{\unichar{21464

- 1 repeated - 2 names can be long to help depument your code #### Test Driven Development python -m doctest ex.py #### function currying

Decorators

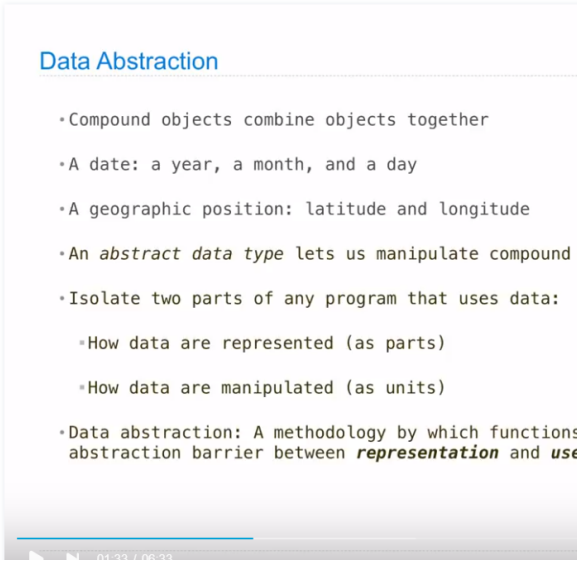
Enclosing scope

```
In [20]: def gcd(m,n):
             '''Return the K largest
             k , m, n are all pso
             >>> gcd(12,8)
             4
             >>> gcd(16,12)
             4
             '''
             if m == n:
                 return m
             elif m < n:
                 return gcd(n,m)
```

```
            else:
                return gcd(m-n,n)
```

In [23]:
```
gcd(4,3)
```

0.1.7 1.10 Data Abstraction



[U+6570] [U+636E] [U+62BD] [U+8C61] [U+7684] [U+610F] [U+4E49] #### Pairs #### Abstration Barriers #### Dat a presention

In [28]:
```
from operator import getitem
pair = [1,2]
x, y = pair
getitem(pair,0)
```

Out[28]:
```
1
```

0.1.8 1.11 Containers

- List for in [U+7D22] [U+5F15] [U+7684] [U+5DE6] [U+95ED] [U+53F3] [U+5F00] [U+533A] [U+95F4] [-2,2) length: [U+53F3] [U+51CF] [U+5DE6] [U+4EE5] [U+504F] [U+79FB] [U+91CF] [U+4F5C] [U+4E3A] [U+89D2]
- List Comprehensions [U+63A8] [U+5BFC]
- sring [U+7684] [U+5143] [U+7D20] [U+4ECD] [U+4E3A] string
- Dict limitation [U+FF1A] key [U+4E0D] [U+80FD] [U+4E3A] [U+53EF] [U+53D8] [U+7684] [U+7684] [U+6570] [U+mutable

In [29]:
```
[2,7] + [1,2,3] * 2
```

Out[29]:
```
[2, 7, 1, 2, 3, 1, 2, 3]
```

In [36]:
```
pairs = [[1,2],[3,4],[5,6],[7,8]]
for x,y in pairs:
    print(x,y)
range(-2,2)
y = [1,2,3,4,5]
[x for x in y if x%2 == 0]
```

```
1 2
3 4
5 6
7 8


Out[36]: [2, 4]

In [37]: {x:x**x for x in range(10)}

Out[37]: {0: 1,
          1: 1,
          2: 4,
          3: 27,
          4: 256,
          5: 3125,
          6: 46656,
          7: 823543,
          8: 16777216,
          9: 387420489}
```

0.1.9 1.12 mutable values

unicode standard

- 109000 charters
- 93 scripts enumeration of charter properties

mutation change dict.pop(key) #### tuples are sequence but they are not mutable sequence tuple [U+4E0D] [U+80FD] [U+88AB] [U+6539] [U+53D8] [U+7528] [U+6237] [U+4FDD] [U+62A4] [U+6570] [U+636E] [U+7C7B] [U+4F3C] [U+4E8E] c const [U+FF1F] [U+FF1F] **tuple** [U+4E0D] [U+80FD] [U+6539] [U+53D8] [U+4F46] [U+662F] [U+5143] [U+7D20] [U+53EF] [U+4EE5] [U+6539] [U+53D8] [U+FF01] [U+FF01]

'is' and '=='

- is evaluate to Ture if both a and b evaluates the same object
- == evaluate to True if both a and b evaluates the same value identical object are always the same value #### mutable values as default arg are dangerous

```
In [6]: from datetime import date
        print('\a\a\a') #bell
        a = 'A'
        print(ord(a),hex(65))


65 0x41
```

```
In [10]: from unicodedata import lookup
         lookup('BABY')
         a = ([1,2,3],4,5)

         print(a)
```

```
([1, 2, 3], 4, 5)
```

```
In [14]: a[0][1] = 6
         print(a)
```

```
([1, 6, 3], 4, 5)
```

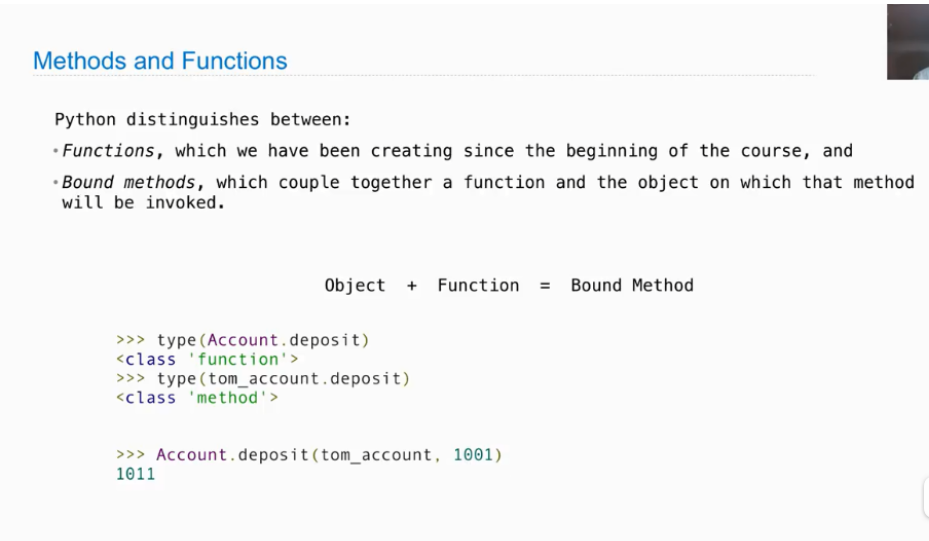
```
In [19]: def f(s = []):
             s.append(1)
             return len(s)
         for i in  range(5):
             print(f()) really dangerous
```

```
1
2
3
4
5
```

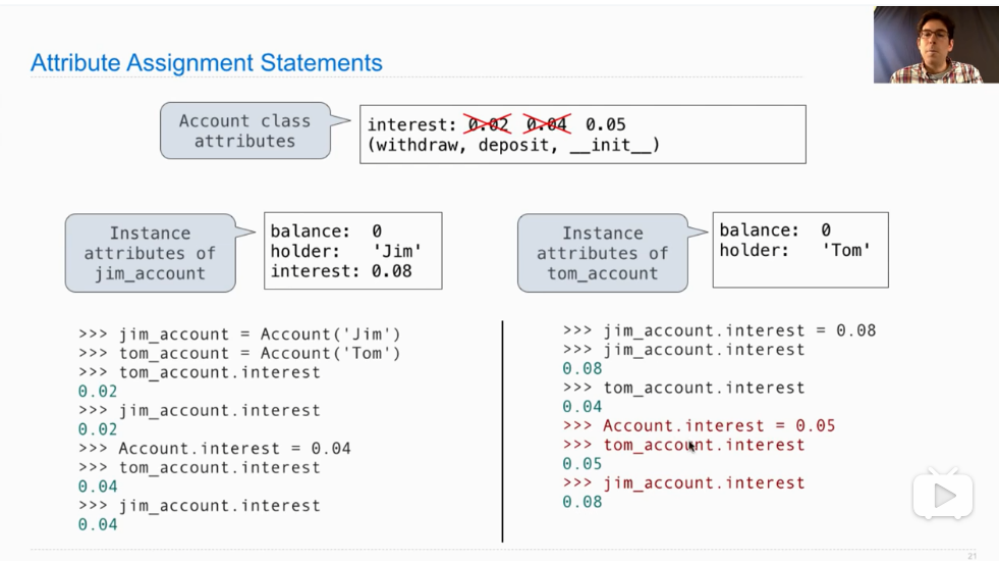
0.1.10 1.14 mutable functions

nonlocal statement

0.1.11 1.15 oriented-object programming

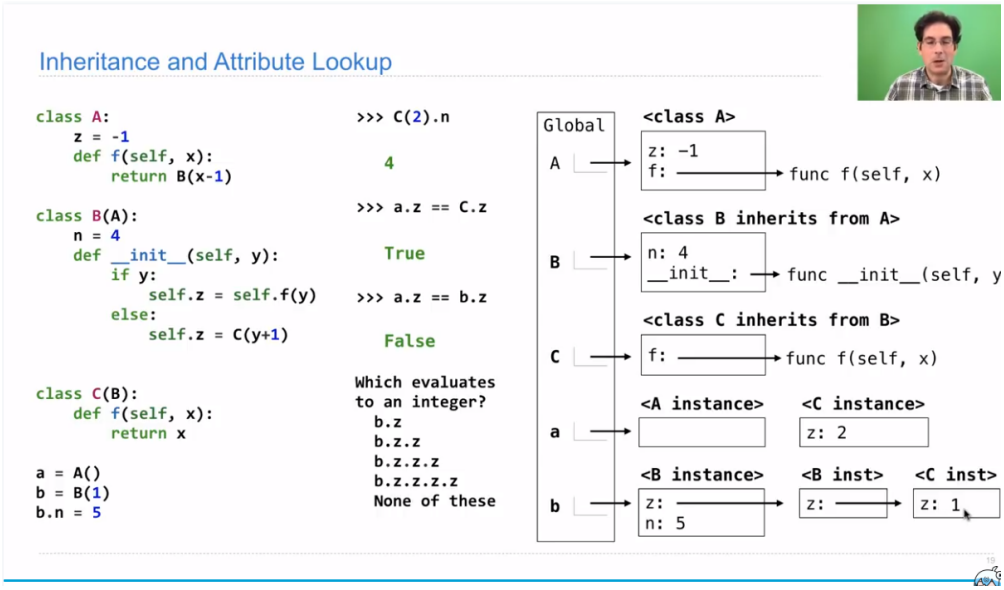


invoking methods function and method attribute [U+5F88] [U+5947] [U+602A] [U+4E3A] [U+4EC0] [U+4E48] [U+53EF] [U+4EE5] [U+4FDD] [U+5B58] [U+4E0



0.1.12 1.6 inheriate

base class [U+7684]attribute [U+4E0D] [U+4F1A] [U+62F7] [U+8D1D] [U+5230]subclass - attribute



lookup - complicated ingeritance

0.1.13 1.7 Represention

str and repr

polymorphic functions [U+591A] [U+6001] [U+51FD] [U+6570]

- how implement this behavior #### interface #### special method names
- always with two underscores
- **add str booler float**
- [U+7C7B] [U+4F3C] [U+4E8E] [U+5B9E] [U+73B0] [U+591A] [U+6001] [U+6216] [U+8005] [U+91CD] [U+8F7D]

```
In [1]: >>> from fractions import Fraction
        >>> half = Fraction(1,2)
        >>> repr(half)
        'Fraction(1, 2)'
        >>> eval(repr(half))
        Fraction(1, 2)

Out[1]: Fraction(1, 2)
```

0.1.14 1.18 Growth

measuring efficency

idea: remeber the result has been computed

- [U+88C5] [U+9970] [U+5668] [U+592A] [U+723D] [U+5427] [U+597D] [U+597D] [U+770B] [U+4E00] [U+4E0B]
- The consumption of Tine
- [U+6C42] [U+4E00] [U+4E2A] [U+6570] [U+7684] [U+56E0] [U+6570] [U+6570] [U+76EE] [U+3002] [U+91C7] [U
- Order of Growth
- constant does not affect
- The base of logarithm does not affetx log2[U+7B49] [U+6548]log10 O($b^{n)}$ $^{O(n}$2) O(n) O(nˆ0.5) O(logn) O(1)
- Exponentiation

bˆn [U+6309] [U+7167]n[U+7684] [U+5947] [U+6570] [U+5076] [U+6570] [U+6765] [U+5206]

```
In [21]: ### [U+597D] [U+597D] [U+7406] [U+89E3] [U+4E00] [U+4E0B] [U+4E0B] [U+9762] [U+4EE3] [U+7801]
         def fib(n):
             if n <= 1:
                 return n
             else:
                 return fib(n-1) + fib(n-2)
         def count(f):
             def counted(n):
                 counted.call_count += 1
                 return f(n)
             counted.call_count = 0
             return counted
         def memo(f):
             cache = {}
             def memoized(n):
                 if n not in cache:
                     cache[n] = f(n)
                 return cache[n]
             return memoized
         print(fib(10))
         fib = count(fib)
         print(fib(10),fib.call_count)
         counted_fib = fib
```

```
        fib = memo(fib)
        fib = count(fib)
        print(fib(10),fib.call_count,counted_fib.call_count)
```

```
55
55 177
55 19 188
```

```
In [25]: from ucb import trace

        @trace
        def exp(b,n):
            if n == 0:
                return 1
            else:
                return b * exp(b,n-1)

        @trace
        def fast_exp(b,n):
            if n == 0:
                return 1
            elif n % 2 == 0:
                return square(fast_exp(b,n//2))
            else:
                return b * fast_exp(b,n-1)
```

```
In [26]: exp(10,5)
```

```
exp(10, 5):
    exp(10, 4):
        exp(10, 3):
            exp(10, 2):
                exp(10, 1):
                    exp(10, 0):
                    exp(10, 0) -> 1
                exp(10, 1) -> 10
            exp(10, 2) -> 100
        exp(10, 3) -> 1000
    exp(10, 4) -> 10000
exp(10, 5) -> 100000
```

```
Out[26]: 100000
```

0.1.15 1.19 composition

- Linked list

- property methods
- Tree class
- Tree Mutation

```
In [28]: assert 1 is 1
```

0.1.16 1.20 set

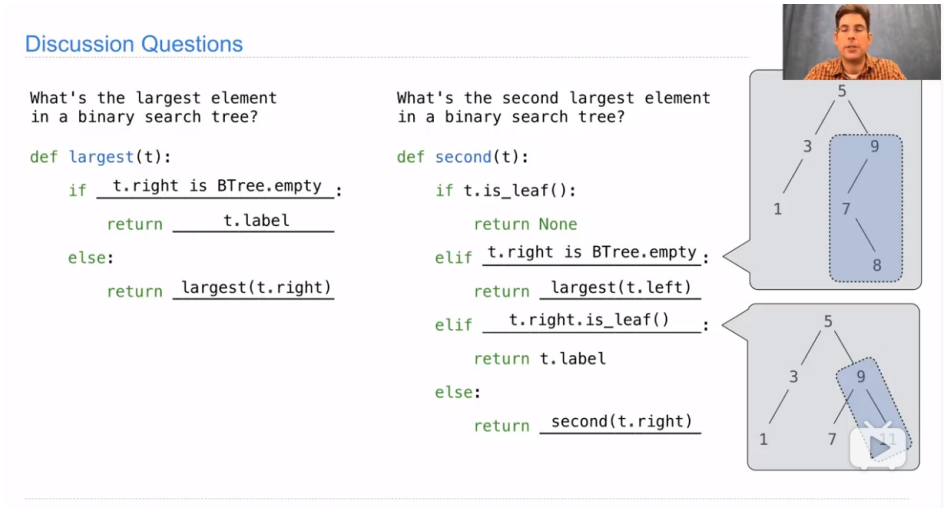
s.union s.intersection s.add() #### implementing sets #### sets as linked liked list - searching an ordered list - set operations def intersect(set1,set2) - set mutation

0.1.17 1.21 Binary Tree

Binary search [U+FF1A]check the middle and eliminate half

Bnary search Trees:

- The biggest element in bst :[U+6700] [U+53F3]

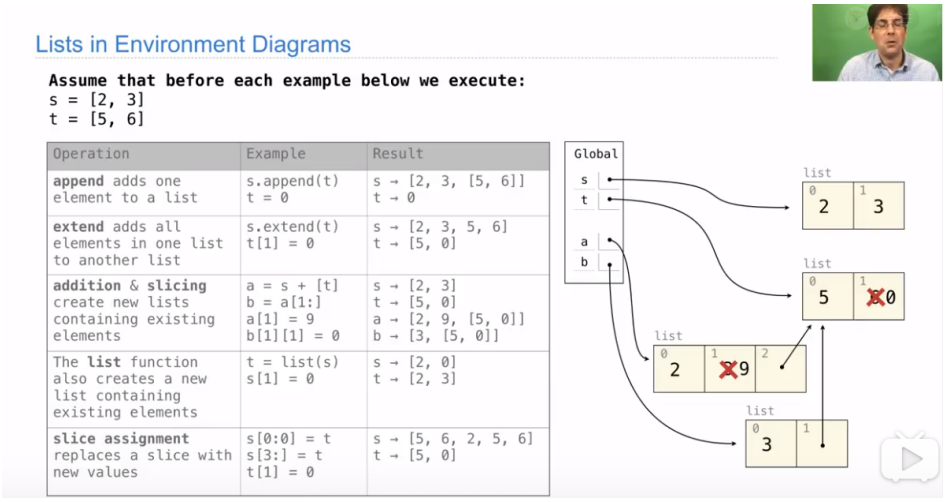


- The second biggest Tree #### membership in BST [U+6BCF] [U+6B21] [U+6298] [U+534A] [U+65F6] [U+95F4] [U+590D] [U+6742] [U+5EA6] [U+4E3A]logn

```
In [29]: from random  import shuffle
```

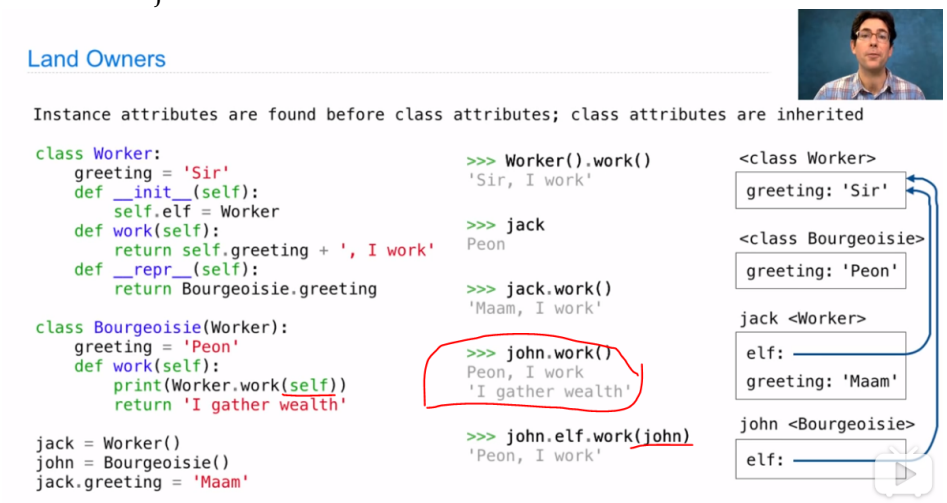
0.1.18 1.22 Data Examples

- List
- append extend addation %slicing



- list in list #### environment diagram

- frame
- parent frame #### objects



- instance #### recursive link

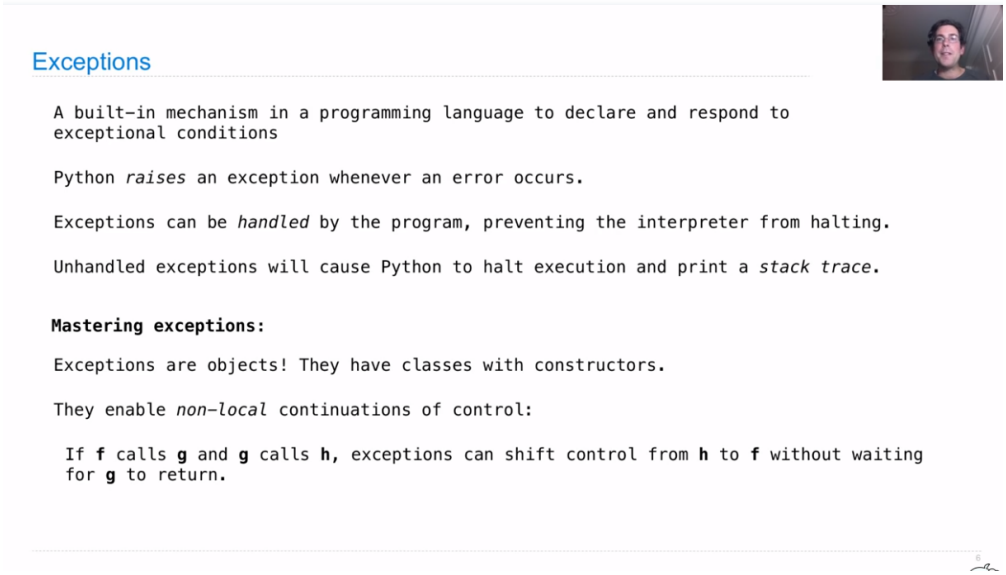
morse code

```
In [36]: t = [1,2,3]
         t[1:3] = [t]
         t.extend(t)
         print(t,len(t[1]))

[1, [...], 1, [...]] 4


In [ ]: def Worker:
            g
```

0.1.19 1.24

scheme

0.1.20 1.25 Exceptions



exceptions #### rasing exception - assert , assert python -0 ex.py

TypeErr KeyErr NameErr RuntimeErr([U+9012] [U+5F52] [U+8FC7] [U+6DF1] [U+7B49]**)**

Try statement

WWPD

Reduce [U+FF1A]

- reduce a sequence to a value #### Sierpinski's triangle
-

```
In [38]: raise TypeError("Bad")
         def f():
             f()


        ---------------------------------------------------------------------------

        TypeError                                 Traceback (most recent call last)

        <ipython-input-38-3b635fc5af21> in <module>()
    ----> 1 raise TypeError("Bad")
          2 def f():
```

```
      3     f()


    TypeError: Bad
```

```
In [41]: from operator import add
         reduce(add,[1,2,3],4)
```

```
    ---------------------------------------------------------------------------

    NameError                                 Traceback (most recent call last)

    <ipython-input-41-6e8e7f9b87a9> in <module>()
      1 from operator import add
----> 2 reduce(add,[1,2,3],4)


    NameError: name 'reduce' is not defined
```

0.1.21 1.26 calculator

Interpreters

parsing

0.1.22 1.27 Interpreters

Base cases: - scheme evaluation - logical special forms - Quotation

0.1.23 1.28 Tail calls

Dynamic scope

lexical scope

tail recursion

functional programming

[U+5C3E][U+8C03][U+7528] **linear recursive can always be re-write as tail call**

0.1.24 Map and Reduce Google [U+8BBA][U+6587][U+5927][U+4F5C]

An analogy: programs specific machine

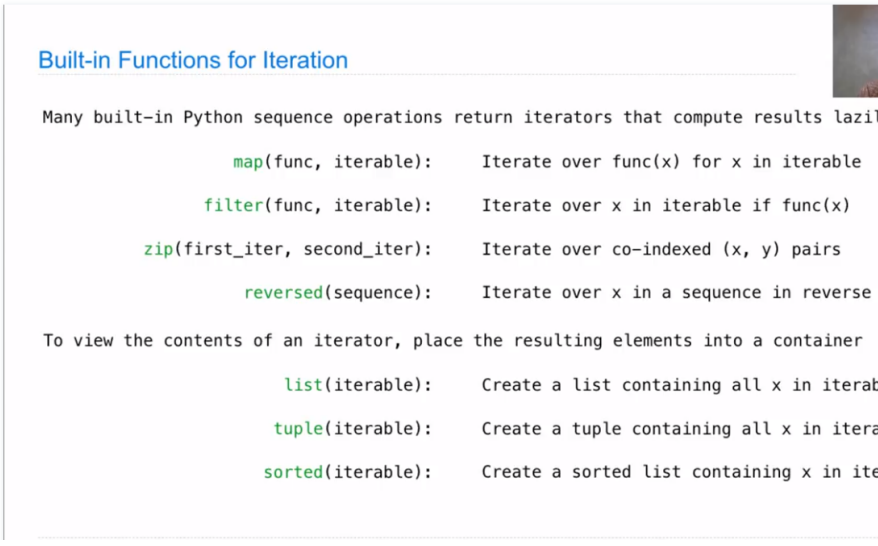
```
In [45]: list(map(abs,[1,2,3,-4]))
         reduce()

Out[45]: [1, 2, 3, 4]
```

0.1.25 1.29 Macros

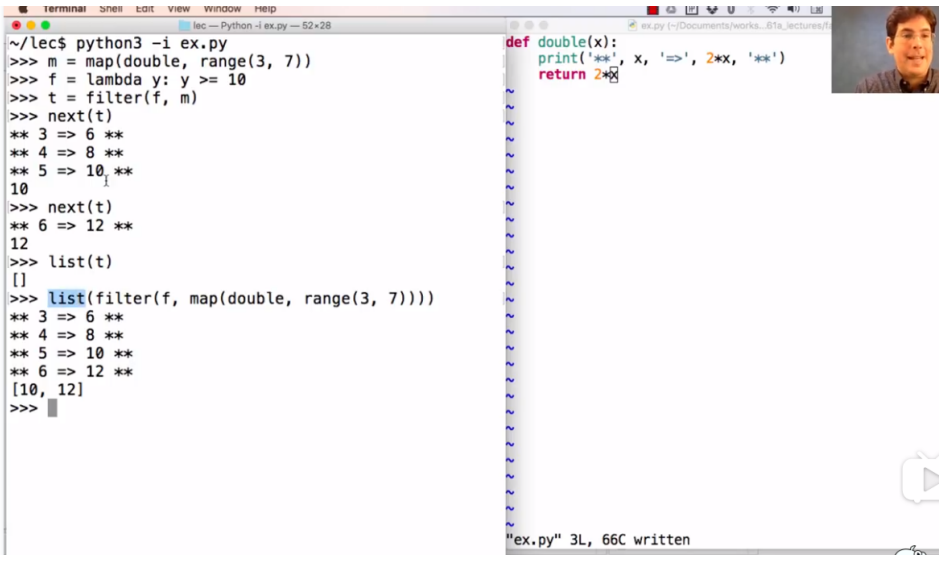
0.1.26 1.30 Iterators

Data processing

- process squeential data
- sequence interface
- has a finite known lengrh
- allows element selection
- big data processing
- Distributed and parallel computing #### Iterators
- iter return an iterator
- next return the next element in an iterator #### For statements
- when exe for statements ,iter returns an iterator and next provides each item
- A StopIteration exception is raised when next is called on empty iterator #### bulit-in iterator fnctions [U+6CE8][U+610F][U+554A] iterable



- map() filter(f,iterable) zip() reversed()



Generator and generator func

- yield #### generator and iterator
- genor can Yield from iterator
- yield from [U+8BED] [U+6CD5]

```
In [46]: s =[11,2,3]
         t = iter(s)

In [49]: next(t)
         list(t)   ##  [U+7ED3] [U+675F] [U+8FED] [U+4EE3]


         ---------------------------------------------------------------------------

         StopIteration                             Traceback (most recent call last)

         <ipython-input-49-1376cbf80061> in <module>()
     ----> 1 next(t)
           2 list(t)


         StopIteration:


In [51]: d = {'1':2,'2':'two'}
         k = iter(d)

In [52]: next(k)

Out[52]: '1'

In [53]: d.pop('2')
```

```
Out[53]: 'two'
```

```
In [66]: ### attention
         t = [1,2,3,2,1]
         print(t == reversed(t),t == list(reversed(t)))

         d = {'1':'one','2':'two'}
         items = zip(d.keys(),d.values())
         print(list(items))


         ## generator
         def evens(start,end):
             even = start + (start % 2)
             while even < end:
                 yield even
                 even += 2
         g = evens(2,10)
         print(list(g))

         def cntdown(k):
             if k > 0:
                 yield k
                 yield from cntdown(k-1)
         for k in cntdown(3):
             print(k)
         print(list(cntdown(10)))
```

```
False True
[('1', 'one'), ('2', 'two')]
[2, 4, 6, 8]
3
2
1
[10, 9, 8, 7, 6, 5, 4, 3, 2, 1]
```

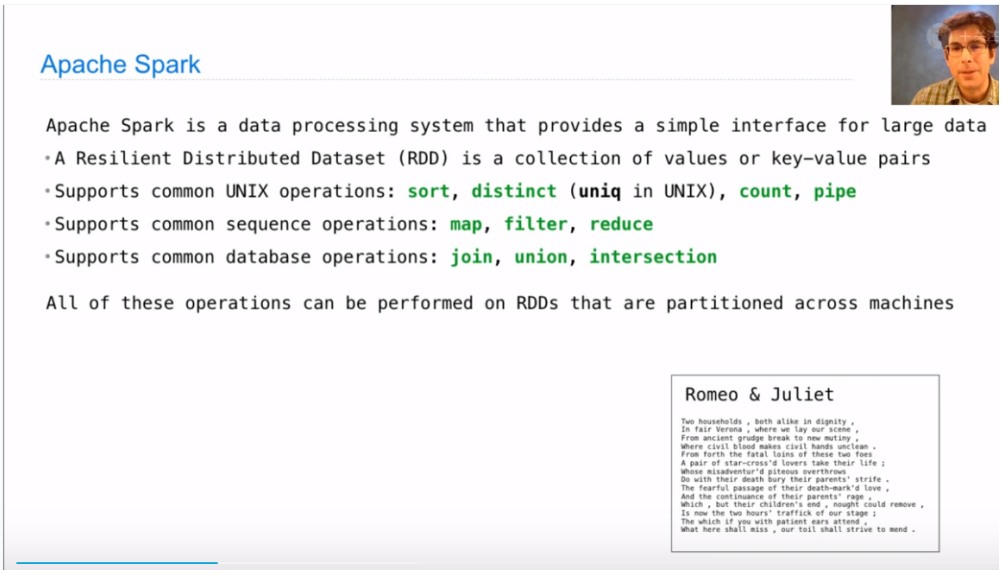
0.1.27 1.31 streams

efficent sequence operations

all() [U+51FD] [U+6570] [U+600E] [U+4E48] [U+64CD] [U+4F5C] [U+7684]

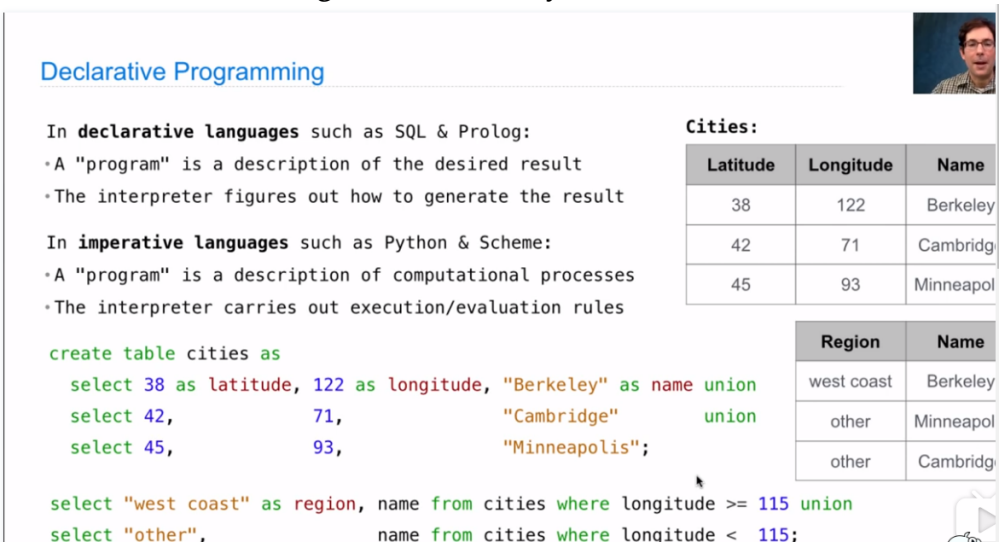
```
In [4]: all(map(lambda y: 1 % y,range(1,6)))
```

```
Out[4]: False
```



0.1.28 1.32 declarative programming

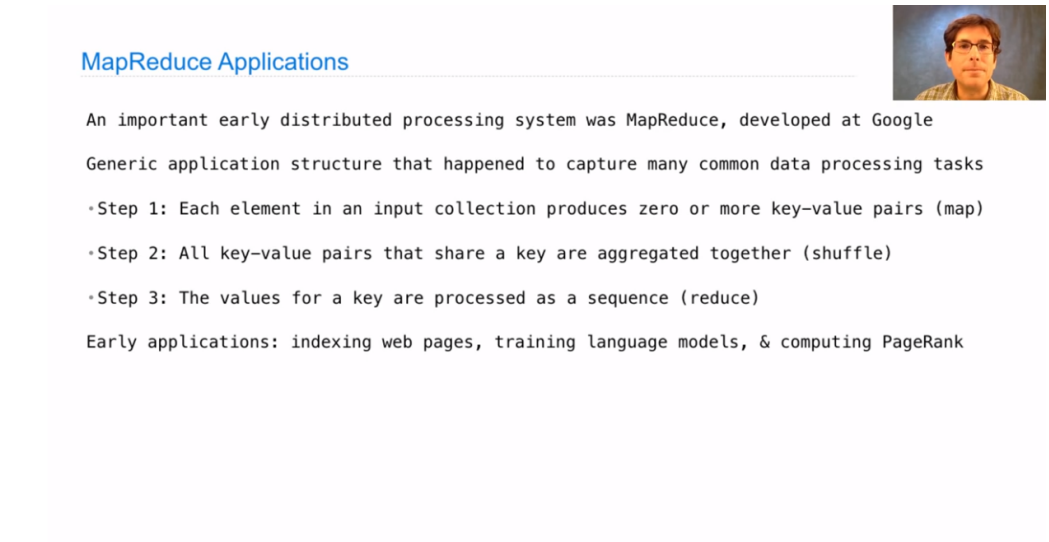
DataBase Management system DBMS declarrative langusge

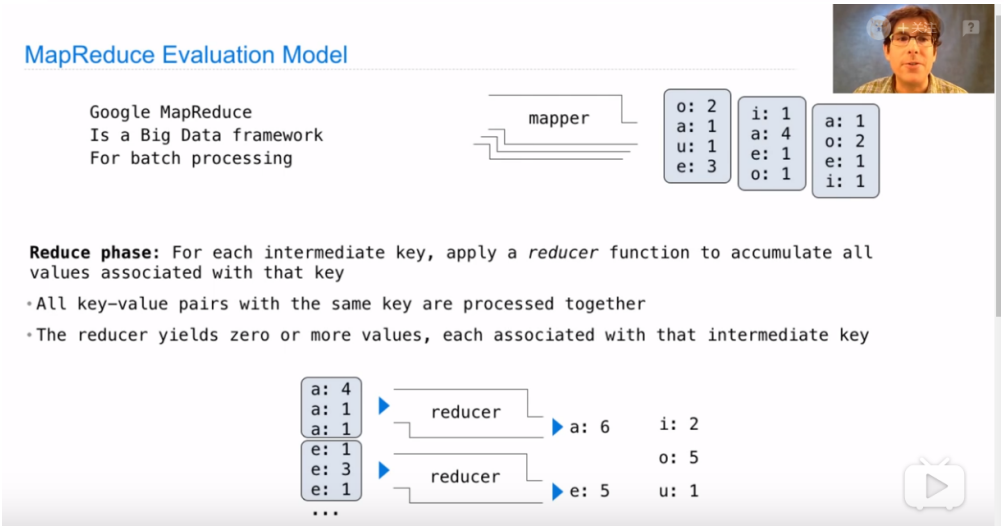


arithmetic ### 1.33 Tables pass ### 1.34 aggregation - SQL [U+4E13] [U+5C5E] - pass #### 1.35 DataBase - pass #### 1.36 Distributed Data - Unix - Computer System - Operate System - Networks - DataBase - Dis sys - Hide complexity but retain flexablity - stdin ----> process -----> stdout | | std err

- sys.stdin sys.std.out
- Big Data
- Apache Spark

- MapReduce
- An important early distributed prossing system developed by google





0.1.29 1.37 Natual language

Ambiguity

- **Programs must be written for people to read!** ---> preface of SICP
- Syntax Trees
- buffalo
- Recursive Tree
- Grammars
- Parsing
- Learning

end

currying rational odd compound civil Comprehensions closure hierarachical polymorphic arbitrary scheme dialate quotient liberally useless spatial lextical analysis tokens tail middlemen macros evaluation Vote cast declarative imperative arithmetic ambiguity intimidate invoke

[U+67EF] [U+91CC] [U+5408] [U+7406] [U+7684] [U+5947] [U+590D] [U+5408] [U+56FD] [U+5185] [U+63A8] [U+5BFC] [U+5173] [U+95ED] hierarachical [U+591A] [U+6001]

[U+968F] [U+610F] [U+65B9] [U+6848] dialate [U+5546] [U+5BBD] [U+677E] [U+65E0] [U+7528] [U+7A7A] [U+95F4] [U+7684] lextical [U+5206] [U+6790] [U+4EE4] [U+724C] [U+5C3E] [U+5DF4] [U+4E2D] [U+95F4] [U+5546] [U+5B8F] [U+8BC4] [U+6D4B] [U+6295] [U+7968] [U+9648] [U+8FF0] [U+52BF] [U+5728] [U+5FC5] [U+884C] [U+7B97] [U+672F] [U+6B67] [U+4E49] [U+5A01] [U+5413] [U+8C03] [U+7528]