Containers

Announcements

List Comprehension Example: Promoted

First in Line

Implement **promoted**, which takes a sequence **s** and a one-argument function **f.** It returns a list with the same elements as **s,** but with all elements **e** for which **f(e)** is a true value ordered first. Among those placed first and those placed after, the order stays the same.

```
def promoted(s, f):
    """Return a list with the same elements as s, but with all
    elements e for which f(e) is a true value placed first.

    >>> promoted(range(10), odd)  # odds in front
    [1, 3, 5, 7, 9, 0, 2, 4, 6, 8]
    """
    return [e for e in s if f(e)] + [e for e in s if not f(e)]
```

Strings

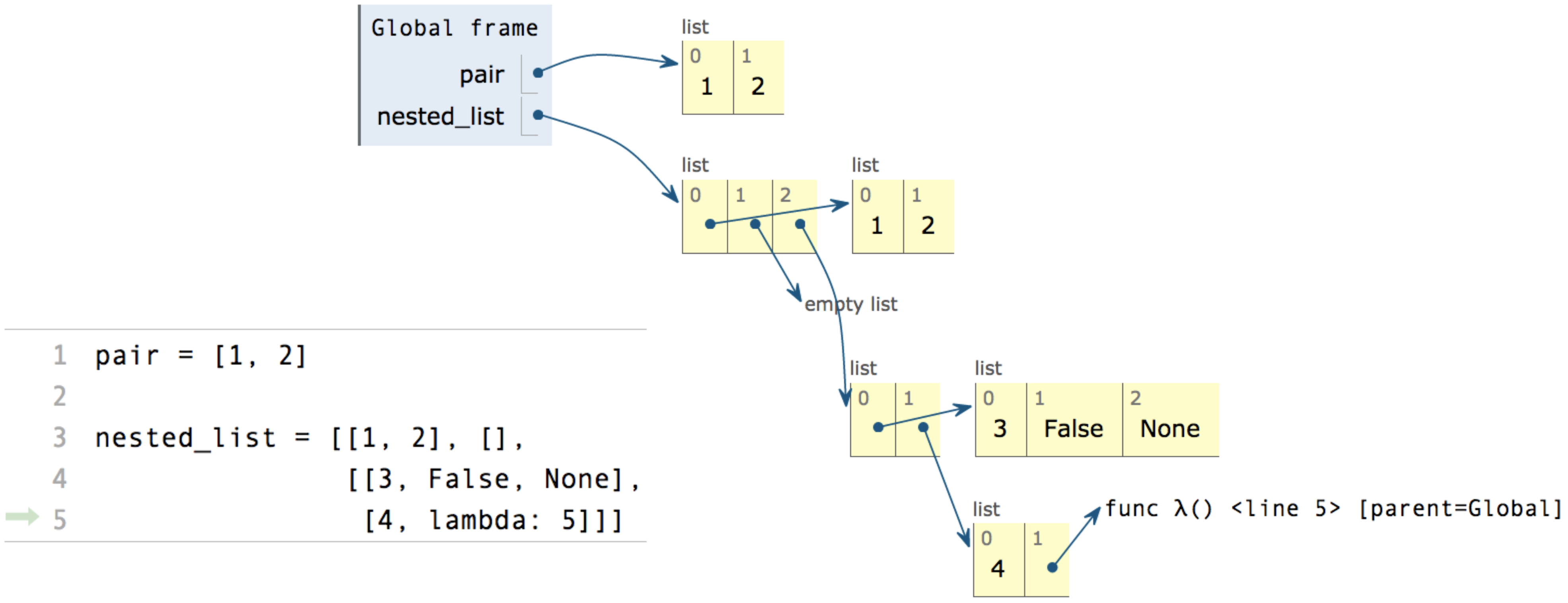
```
'Demo'
```

Box-and-Pointer Notation

Box-and-Pointer Notation in Environment Diagrams

Lists are represented as a row of index-labeled adjacent boxes, one per element

Each box either contains a primitive value or points to a compound value



```python
pair = [1, 2]

nested_list = [[1, 2], [],
                  [[3, False, None],
                   [4, lambda: 5]]]
```

pythontutor.com/composingprograms.html#code=pair%20%3D%20[1,%202]%0A%0Anested_list%20%3D%20[[1,%202],%20[],%0A%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20[[3,%20False,%20None],
%0A%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20[4,%20lambda%3A%205]]]&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=4

Discussion Question

What's the environment diagram? What gets printed?

```
def f(s):
    x = s[0]
    return [x]

t = [3, [2+2, 5]]
u = [f(t[1]), t]
print(u)
```

https://pythontutor.com/cp/composingprograms.html#code=def%20f%28s%29%3A%0A%20%20%20%20x%20%3D%20s%5B0%5D%0A%20%20%20%20return%20%5Bx%5D%0A%0At%20%3D%20%5B3,%20%5B2%2B2,%205%5D%5D%0Au%20%3D%20%5Bf%28t%5B1%5D%29,%20t%5D%0Aprint%28u%29&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

Slicing

Double-Eights with a List

```
Implement double_eights,
which takes a list s and returns whether two consecutive items are both 8.
```

```
def double_eights(s):
    """Return whether two consecutive items
    of list s are 8.

    >>> double_eights([1, 2, 8, 8])
    True
    >>> double_eights([8, 8, 0])
    True
    >>> double_eights([5, 3, 8, 8, 3, 5])
    True
    >>> double_eights([2, 8, 4, 6, 8, 2])
    False
    """
    for     i in range(len(s)-1)       :

        if  s[i] == 8 and s[i+1] == 8 :
            return True
    return False
```

```
def double_eights(s):
    """Return whether two consecutive items
    of list s are 8.

    >>> double_eights([1, 2, 8, 8])
    True
    >>> double_eights([8, 8, 0])
    True
    >>> double_eights([5, 3, 8, 8, 3, 5])
    True
    >>> double_eights([2, 8, 4, 6, 8, 2])
    False
    """
    if    s[:2] == [8, 8]   :
        return True
    elif len(s) < 2:
        return False
    else:
        return  double_eights(s[1:])
```

https://pythontutor.com/cp/composingprograms.html#code=def%20double_eights%28s%29%3A%0A%20%20%20%20if%20s%5B%3A2%5D%20%3D%3D%20%5B8,%208%5D%3A%0A%20%20%20%20%20%20%20%20return%20True%0A%20%20%20%20elif%20len%28s%29%20%3C%202%3A%0A%20%20%20%20%20%20%20%20return%20False%0A%20%20%20%20else%3A%0A%20%20%20%20%20%20%20%20return%20double_eights%28s%5B1%3A%5D%29%0A%20%20%20%20%20%20%20%20%0Adouble_eights%28%5B5,%203,%208,%208,%203,%205%5D%29&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

Processing Container Values

Aggregation

Several built-in functions take iterable arguments and aggregate them into a value

- **sum**(iterable[, start]) -> value

  Return the sum of an iterable (not of strings) plus the value
  of parameter 'start' (which defaults to 0). When the iterable is
  empty, return start.

- **max**(iterable[, key=func]) -> value
  max(a, b, c, ...[, key=func]) -> value

  With a single iterable argument, return its largest item.
  With two or more arguments, return the largest argument.

- **all**(iterable) -> bool

  Return True if bool(x) is True for all values x in the iterable.
  If the iterable is empty, return True.

Example: Two Lists

Given these two related lists of the same length:

```
xs = range(-10, 11)
ys = [x*x - 2*x + 1 for x in xs]
```

Write an expression that evaluates to the x for which the corresponding y is smallest:

```
>>> list(xs)
[-10,  -9, -8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4,  5,  6,  7,  8,  9, 10]
>>> ys
[121, 100, 81, 64, 49, 36, 25, 16,  9,  4, 1, 0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
>>> x_corresponding_to_min_y
1
```

Spring 2023 Midterm 2 Question

Definition. A *prefix sum* of a sequence of numbers is the sum of the first `n` elements for some positive length `n`.

(a) (4.0 points)

Implement `prefix`, which takes a list of numbers `s` and returns a list of the prefix sums of `s` in increasing order of the length of the prefix.

```
def prefix(s):
    """Return a list of all prefix sums of list s.

    >>> prefix([1, 2, 3, 0, 4, 5])
    [1, 3, 6, 6, 10, 15]
    >>> prefix([2, 2, 2, 0, -5, 5])
    [2, 4, 6, 6, 1, 6]
    """     sum(s[:k+1])      range(len(s))
    return [_________ for k in _________]
               (a)                (b)
```

ii. (1.0 pt) Fill in blank (b).

- ○ `s`
- ○ `[s]`
- ○ `s[1:]`
- ○ `range(s)`
- ○ `range(len(s))`

Tree Recursion with Strings

Parking

Definition. When parking vehicles in a row, a motorcycle takes up 1 parking spot and a car takes up 2 adjacent parking spots. A string of length n can represent n adjacent parking spots using % for a motorcycle, <> for a car, and . for an empty spot.

For example: '.%%.<><>' (Thanks to the Berkeley Math Circle for introducing this question.)

Implement **park**, which returns a list of all the ways, represented as strings, that vehicles can be parked in n adjacent parking spots for positive integer n. Spots can be empty.

```
def park(n):
    """Return the ways to park cars and motorcycles in n adjacent spots.
    >>> park(1)
    ['%', '.']
    >>> park(2)
    ['%%', '%.', '.%', '..', '<>']
    >>> len(park(4))  # some examples: '<><>', '.%%.', '%<>%', '%.<>'
    29
    """
    if n < 0:
        return []
    elif n == 0:
        return ['']
    else:
        return ['%'+s for s in park(n-1)] + ['.'+s for s in park(n-1)] + ['<>'+s for s in park(n-2)]
```

```
park(3):
   %%%
   %%.
   %.%
   %..
   %<>
   ---
   .%%
   .%.
   ..%
   ...
   .<>
   ---
   <>%
   <>.
```