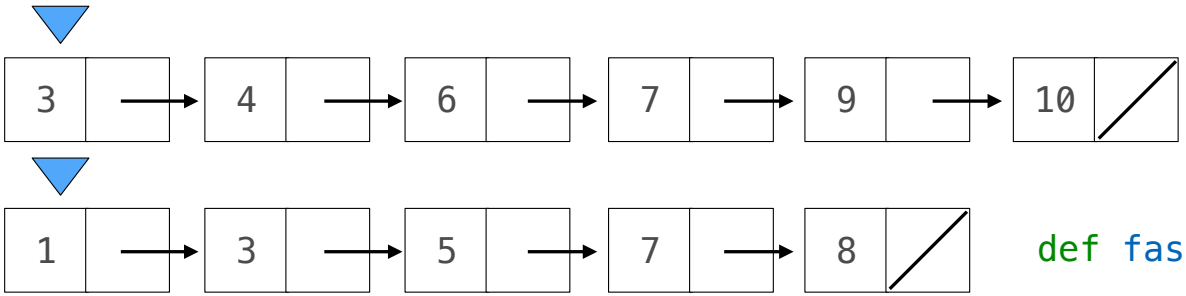
Data Examples

Announcements

Discussion 8

Linear-Time Intersection of Sorted Linked Lists

Given two sorted **linked lists** with no repeats, return the number of elements that appear in both.




```
def fast_overlap(s, t):
    if s is Link.empty or t is Link.empty:
        return 0
    if s.first == t.first:
        return 1 + fast_overlap(s.rest, t.rest)
    elif s.first < t.first:
        return fast_overlap(s.rest, t)
    elif s.first > t.first:
        return fast_overlap(s, t.rest)
```

```
def fast_overlap(s, t):
    k = 0
    while s and t:
        if s.first == t.first:
            k, s, t, = k + 1, s.rest, t.rest
        elif s.first < t.first:
            s = s.rest
        elif s.first > t.first:
            t = t.rest
    return k
```

Slow Overlap

```
def count_if(f, s):
    if s is Link.empty:
        return 0
    else:
        if f(s.first):
            return 1+count_if(f, s.rest)
        else:
            return count_if(f, s.rest)

def contained_in(s):
    def f(s, x):
        if s is Link.empty:
            return False
        else:
            return s.first == x or f(s.rest, x)
    return lambda x: f(s, x)

def overlap(s, t):
    "For s and t with no repeats, count the numbers that appear in both."
   return count_if(contained_in(t), s)
```

Exponential growth. E.g., recursive fib

Incrementing *n* multiplies *time* by a constant

Quadratic growth.

Incrementing *n* increases *time* by *n* times a constant

Linear growth.

Incrementing *n* increases *time* by a constant

Lists

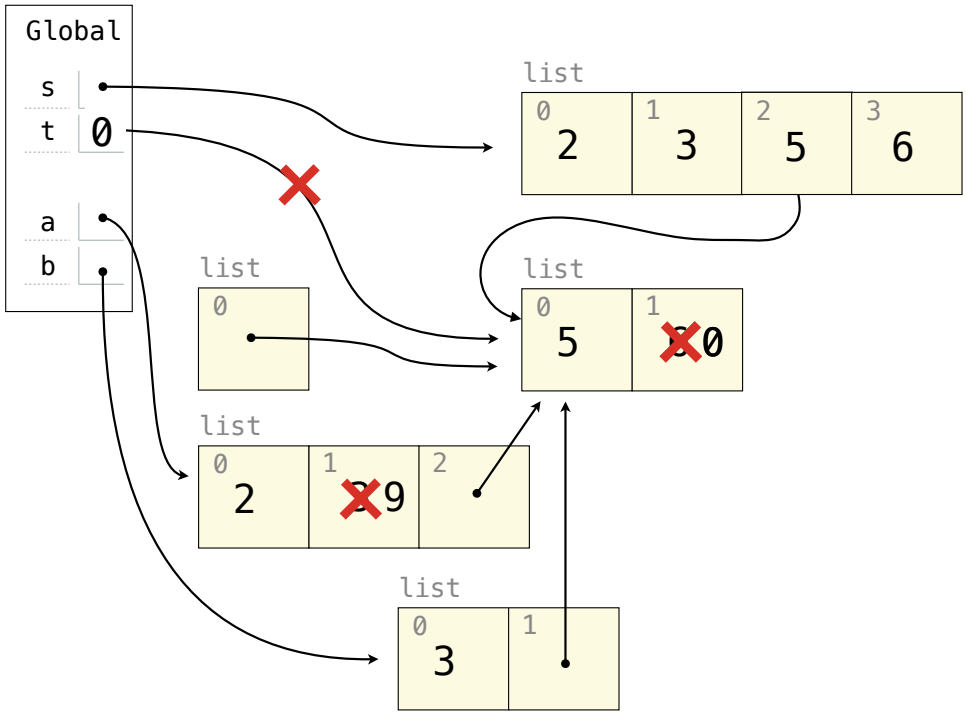
Lists in Environment Diagrams

Assume that before each example below we execute:

```
s = [2, 3]
t = [5, 6]
```

Operation	Example	Result
append adds one element to a list	`s.append(t)` `t = 0`	`s → [2, 3, [5, 6]]` `t → 0`
extend adds all elements in one list to another list	`s.extend(t)` `t[1] = 0`	`s → [2, 3, 5, 6]` `t → [5, 0]`

addition & **slicing** create new lists containing existing elements	`a = s + [t]`
	`b = a[1:]`
	`a[1] = 9`
	`b[1][1] = 0`
		`s → [2, 3]`
		`t → [5, 0]`
		`a → [2, 9, [5, 0]]`
		`b → [3, [5, 0]]`



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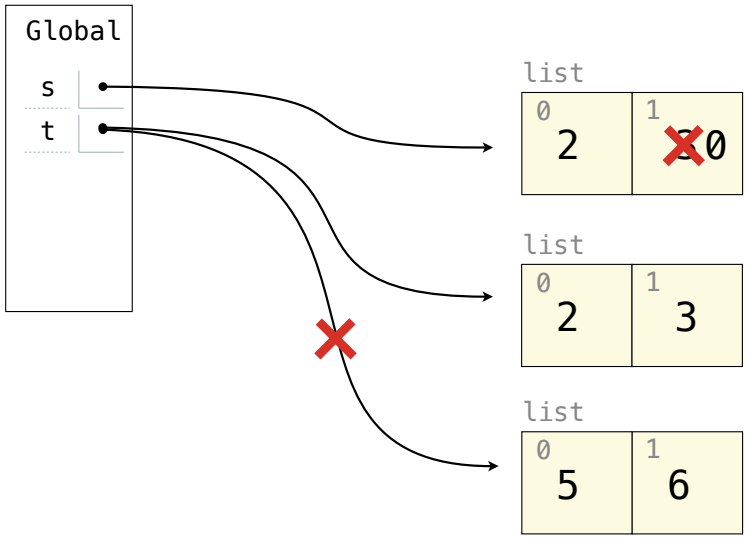
		`s → [2, 3]`
		`t → [5, 0]`
		`a → [2, 9, [5, 0]]`
		`b → [3, [5, 0]]`

The **list** function also creates a new list containing existing elements	`t = list(s)` `s[1] = 0`	`s → [2, 0]` `t → [2, 3]`



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	`a[1] = 9`
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		`s → [2, 3]`
		`t → [5, 0]`
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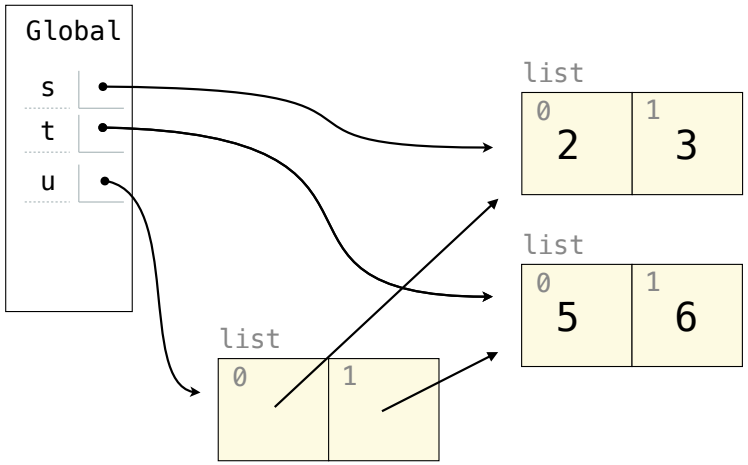
The **list** function also creates a new list containing existing elements	`t = list(s)` `s[1] = 0`	`s → [2, 0]` `t → [2, 3]`

[...] creates a new list	`u = [s, t]`	`s → [2, 3]`
		`t → [5, 6]`
		`u → [[2, 3], [5, 6]]`



Lists in Environment Diagrams

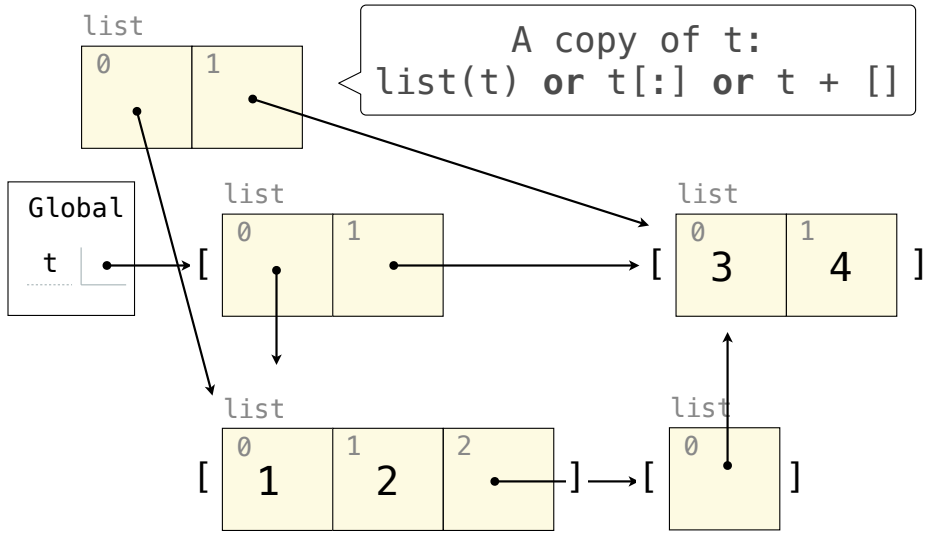
Assume that before each example below we execute:

```
s = [2, 3]
t = [5, 6]
```

Operation	Example	Result
pop removes & returns the last element	`t = s.pop()`	`s → [2]` `t → 3`
remove removes the first element equal to the argument	`t.extend(t)` `t.remove(5)`	`s → [2, 3]` `t → [6, 5, 6]`

Lists in Lists in Lists in Environment Diagrams

```
t = [[1, 2], [3, 4]]
list(t)
t[0].append(t[1:2])
print(t)
```




```
[[1, 2, [[3, 4]]], [3, 4]]
```

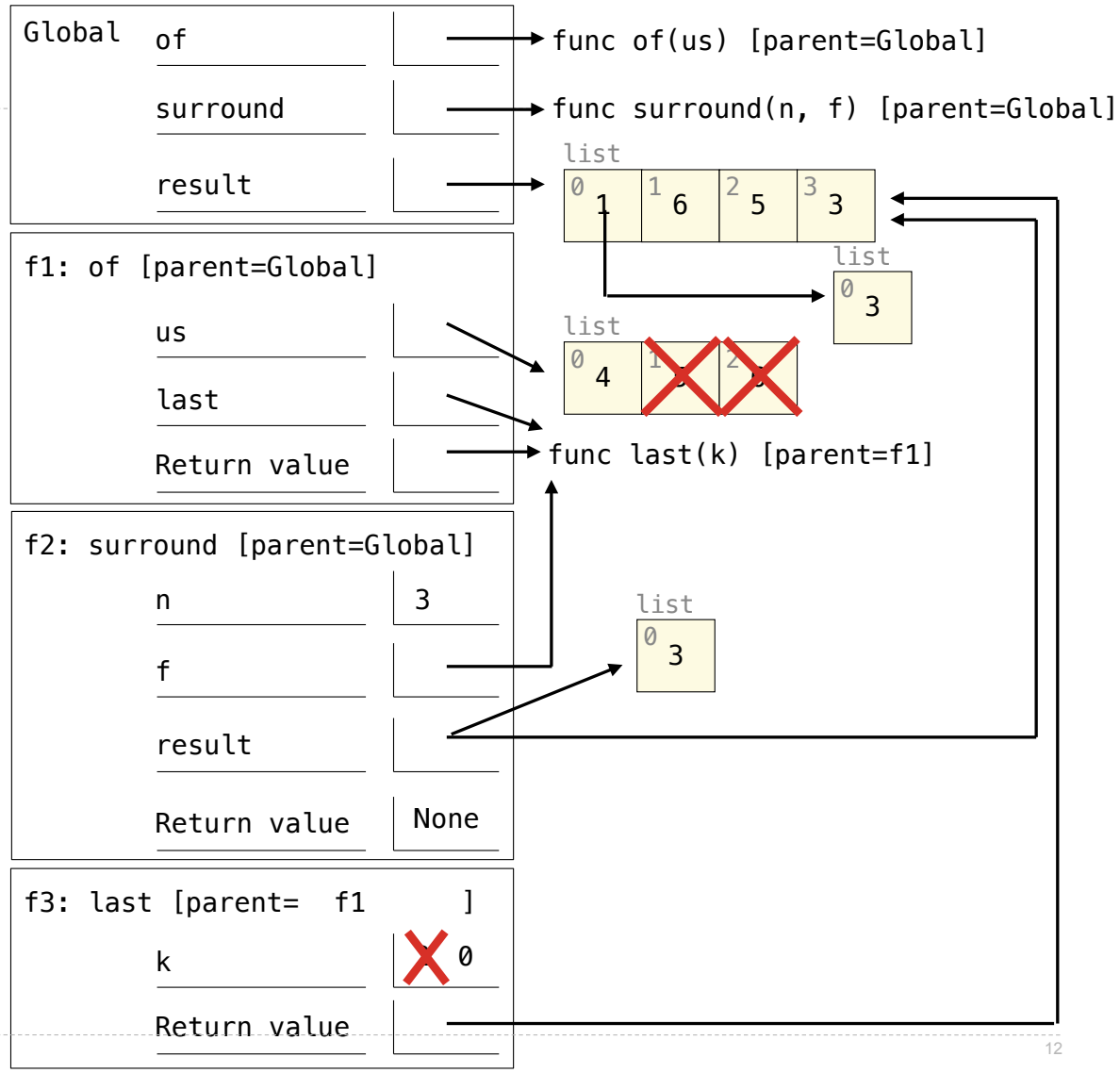
Fall 2022 Midterm 2 Question 2

```
def of(us):
    def last(k):
        "The last k items of us"
        while k > 0:
            result.append(us.pop())
            k = k - 1
        return result
    return last

def surround(n, f):
    "n is the first and last item of f(2)"
    result = [n]
    result = f(2)
    result[0] = [n]
    return result.append(n)

result = [1]
surround(3, of([4, 5, 6]))
print(result)
```

```
[[3], 6, 5, 3]
```



Trees

Heracles, Iolaus and the Hydra, Paestan black-figure hydra C6th B.C., The J. Paul Getty Museum

Fall 2022 Midterm 2 Question 4(b)

A *hydra* is a Tree with a special structure. Each node has 0 or 2 children. All leaves are heads labeled 1. Each non-leaf body node is labeled with the number of leaves among its descendants.

Implement **chop_head(hydra, n)**, which takes a hydra and a positive integer n. It mutates hydra by chopping off the nth head from the left, which adds two new adjacent heads in its place. Update all ancestor labels.

```
def chop_head(hydra,  n):
    assert n > 0 and n <= hydra.label
    if hydra.is_leaf():
        hydra.label = 2
        hydra.branches = [Tree(1),  Tree(1)]
    else:
        hydra.label += 1
        left, right = hydra.branches
        if n > left.label :
            chop_head(right, n - left.label )
        else:
            chop_head(left, n)
```