Mutable Values

Mutation Operations

Mutation Can Happen Within a Function Call

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```
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>>> four = [1, 2, 3, 4]
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```
def mystery(s):
    s.pop()
    s.pop()
```


pythontutor.com/composingprograms.html#code=def%20mystery%28s%29%3A%0A%20%20%20%20s.pop%28%29%0A%20%20%20%20s.pop%28%29%0A%0Afour%20%3D%20[1,%202,%203,%204]%0Amystery%28four%29&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=0

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Tuples

(Demo)

Tuples are Immutable Sequences

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Immutable values are protected from mutation

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>>> turtle = (1, 2, 3)
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An immutable sequence may still change if it *contains* a mutable value as an element

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>>> s = ([1, 2], 3)
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```

```
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>>> s[0][0] = 4
>>> s
([4, 2], 3)
```

Mutation

Sameness and Change

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```
>>> a = [10]
```

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>>> a = [10]
>>> b = a
```

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```
>>> a = [10]
>>> b = a
>>> a == b
True
```

Sameness and Change

- As long as we never modify objects, a compound object is just the totality of its pieces
- A rational number is just its numerator and denominator
- This view is no longer valid in the presence of change
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(Demo)

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>>> f()
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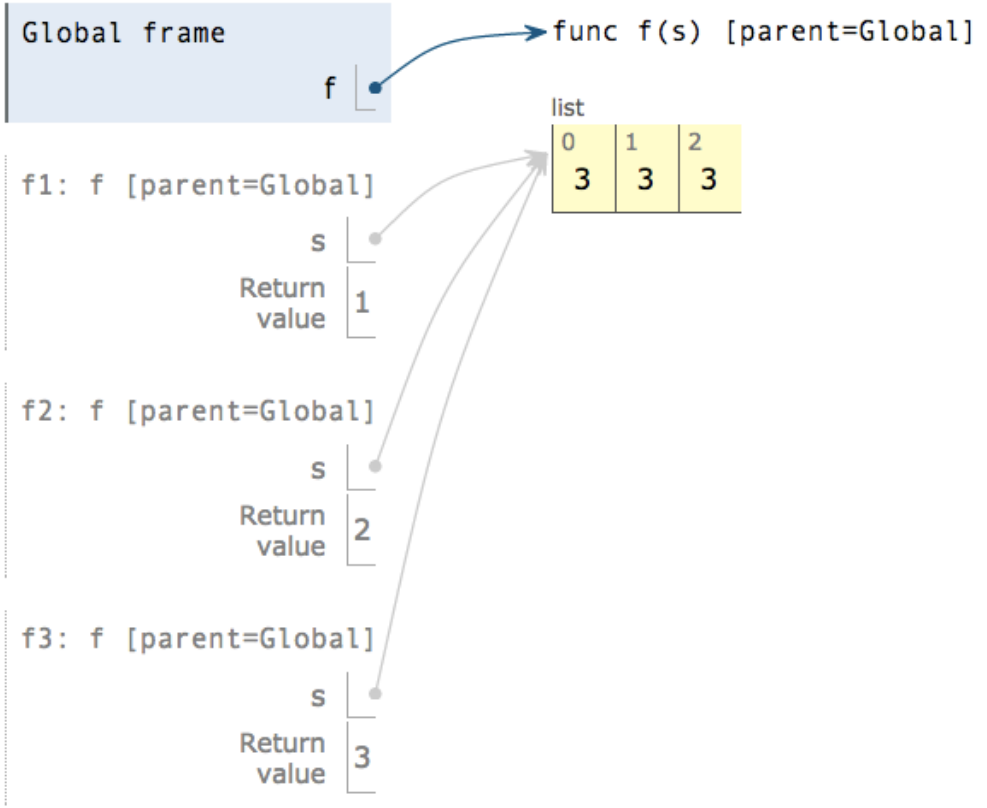

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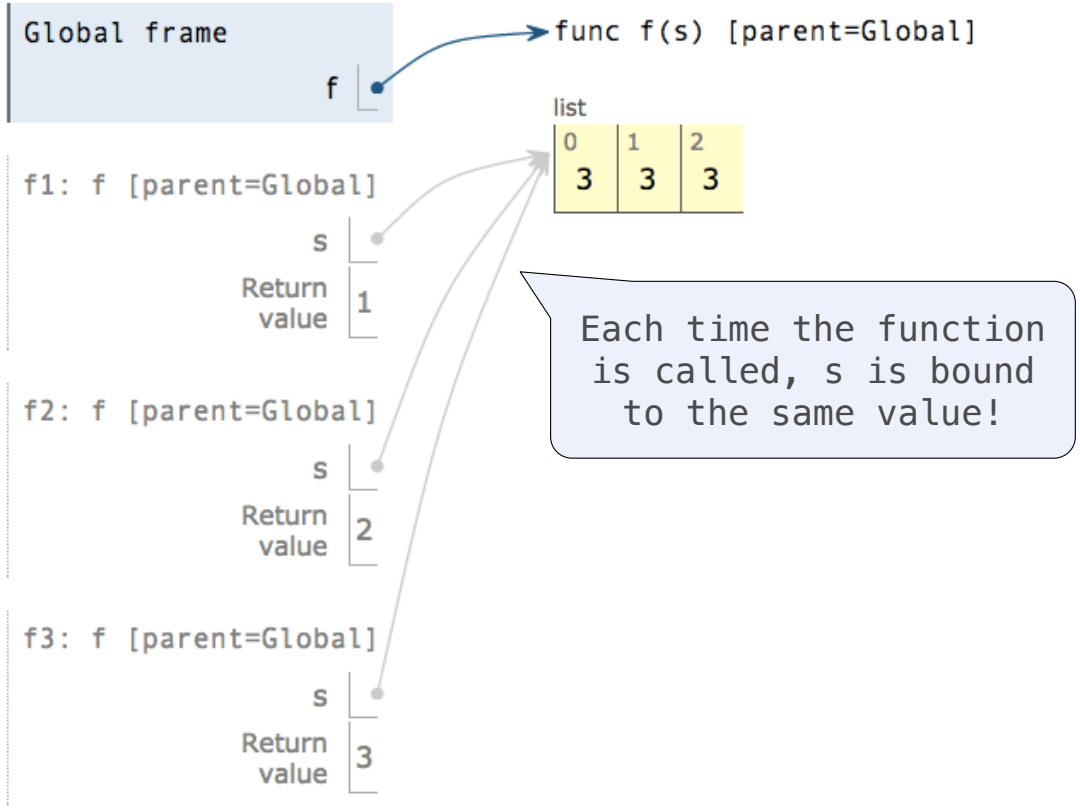

pythontutor.com/composingprograms.html#code=def%20f%28s%3D[]%29%3A%0A%20%20%20%20s.append%283%29%0A%20%20%20%20return%20len%28s%29%0A%20%20%20%20%0Af%28%29%0Af%28%29%0Af%28%29&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=0

Lists

Lists in Environment Diagrams

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append adds one element to a list		

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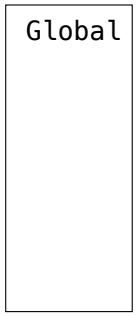

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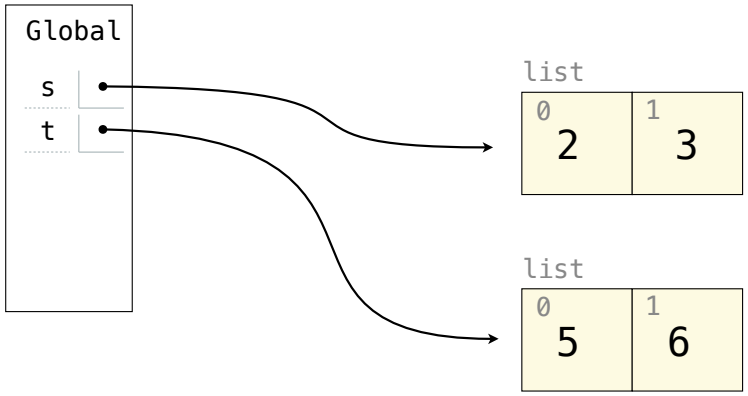

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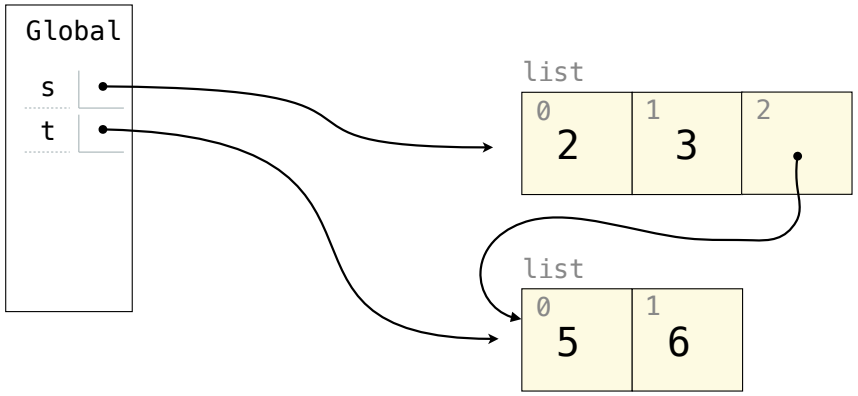

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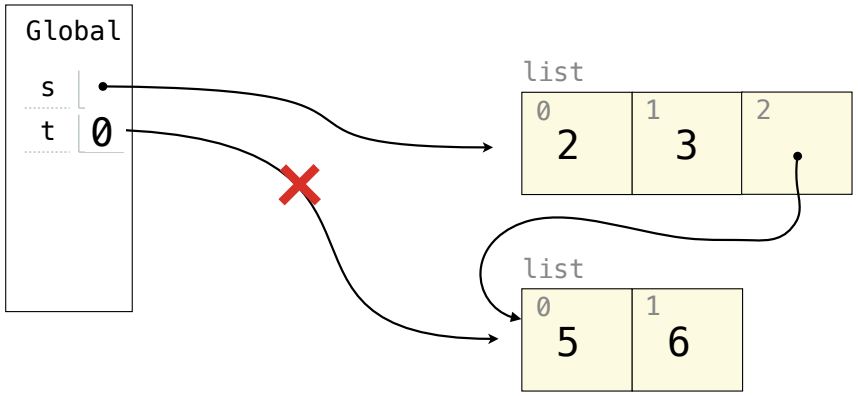

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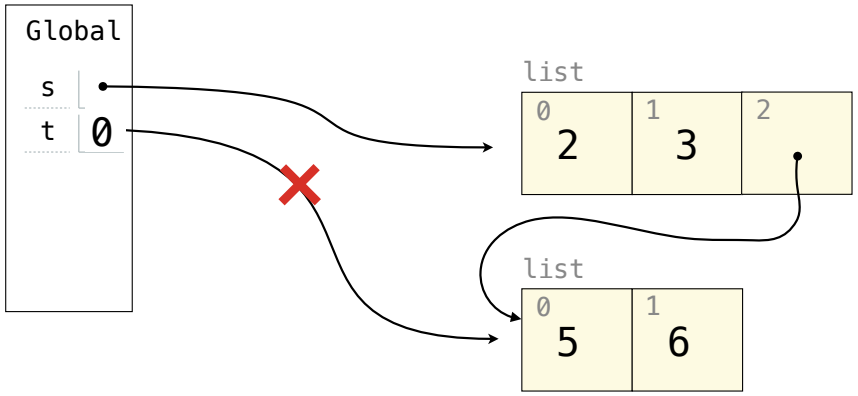

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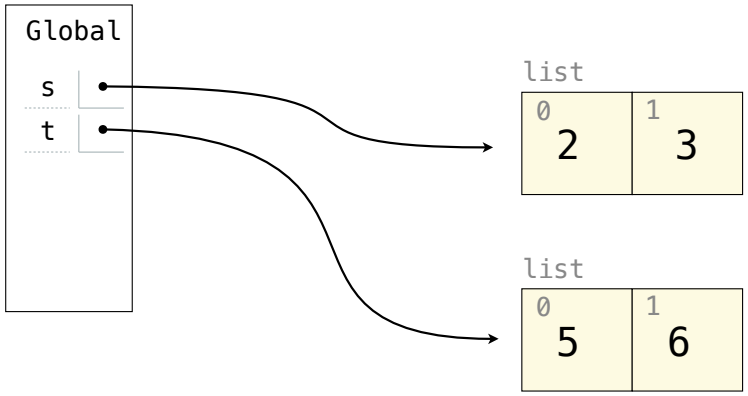

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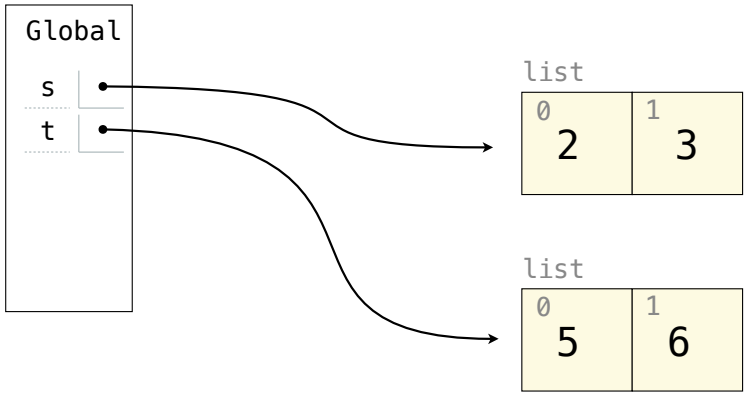

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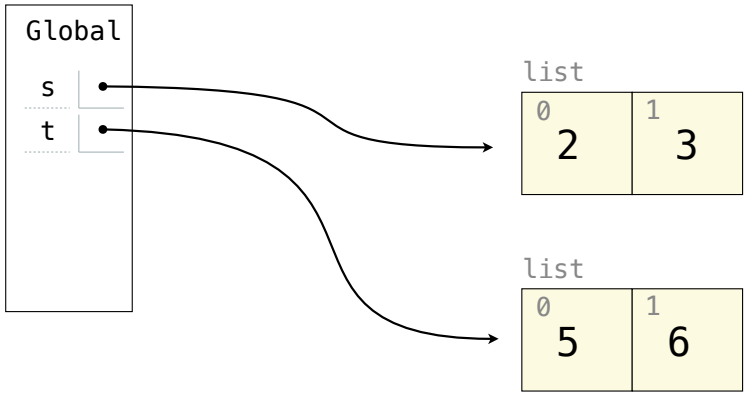

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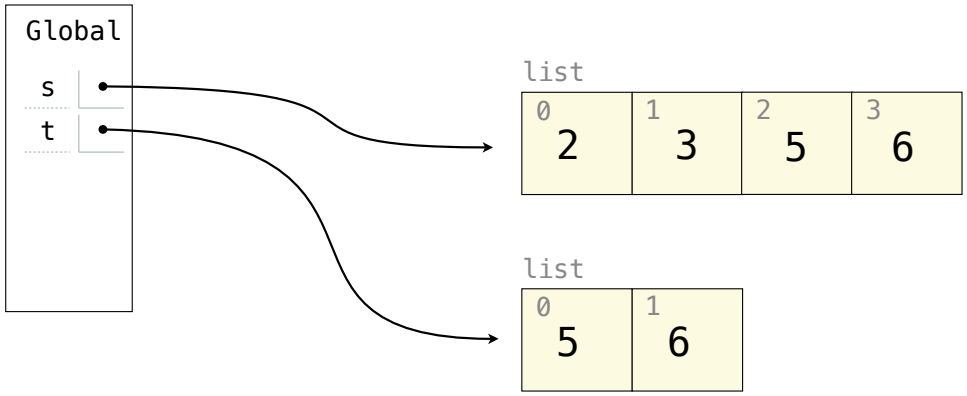

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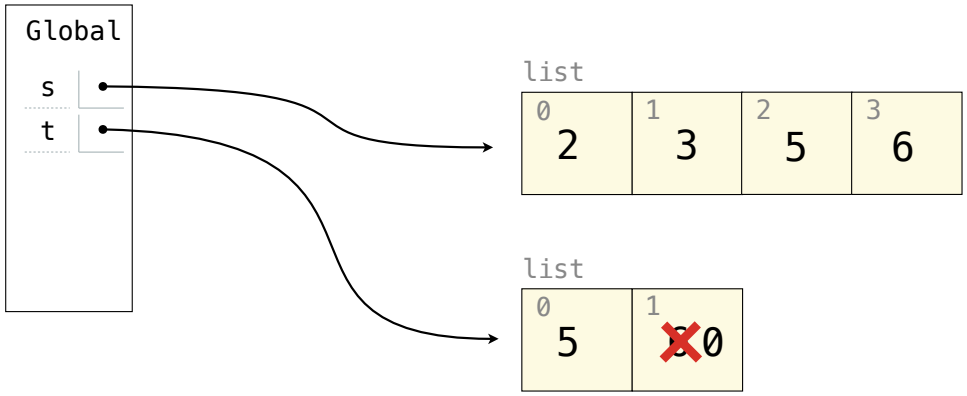

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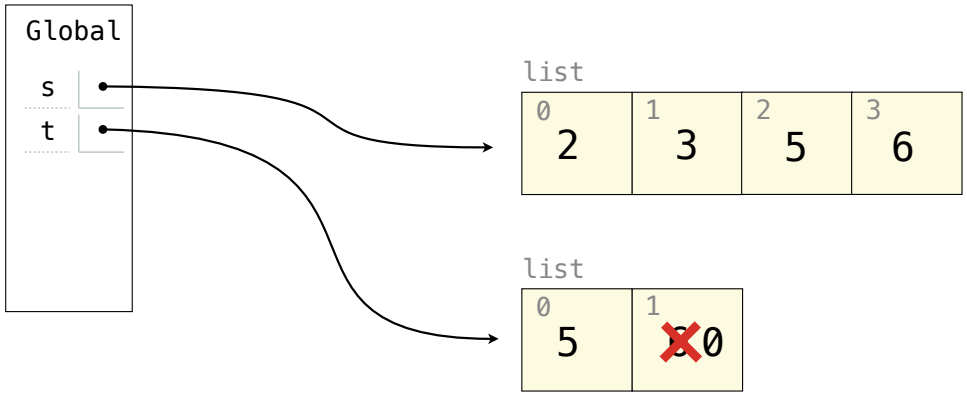

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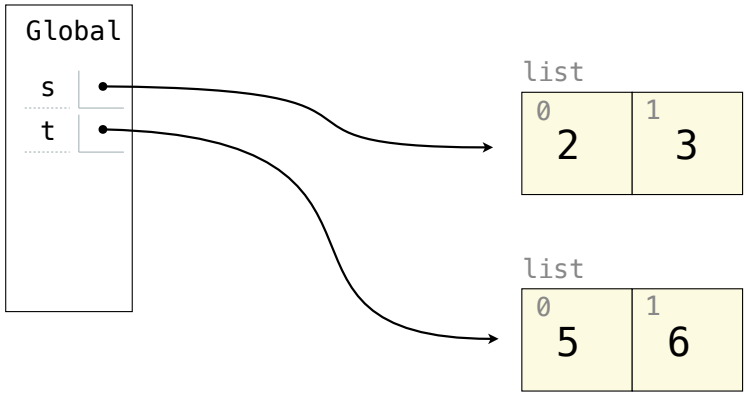

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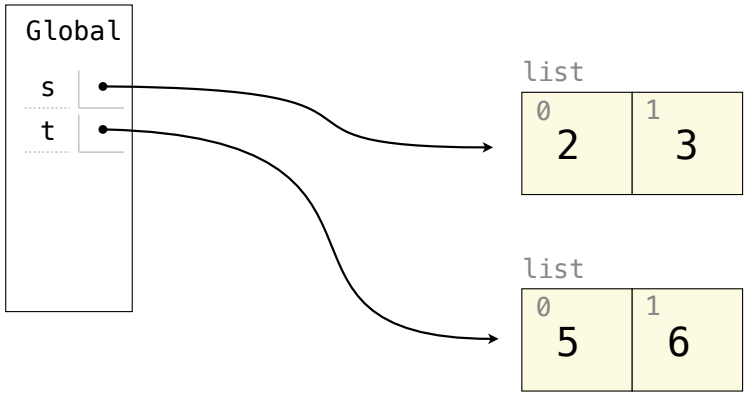

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	`b = a[1:]`
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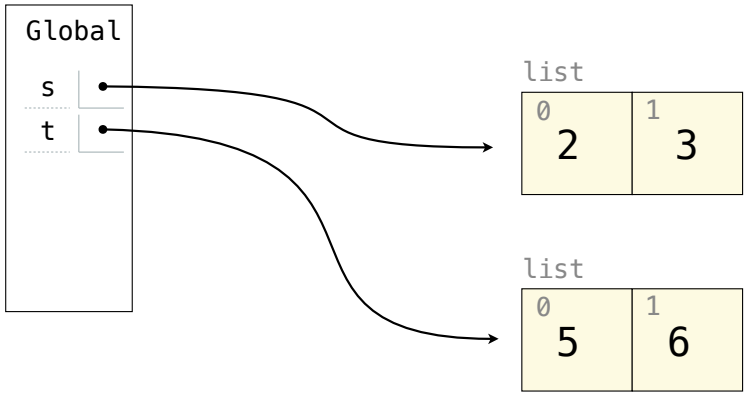

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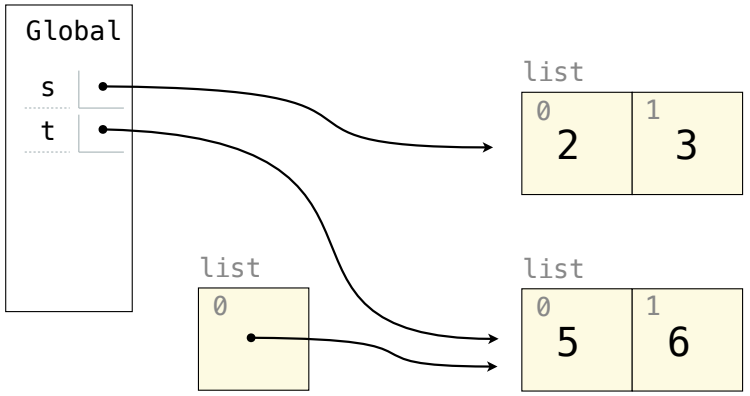

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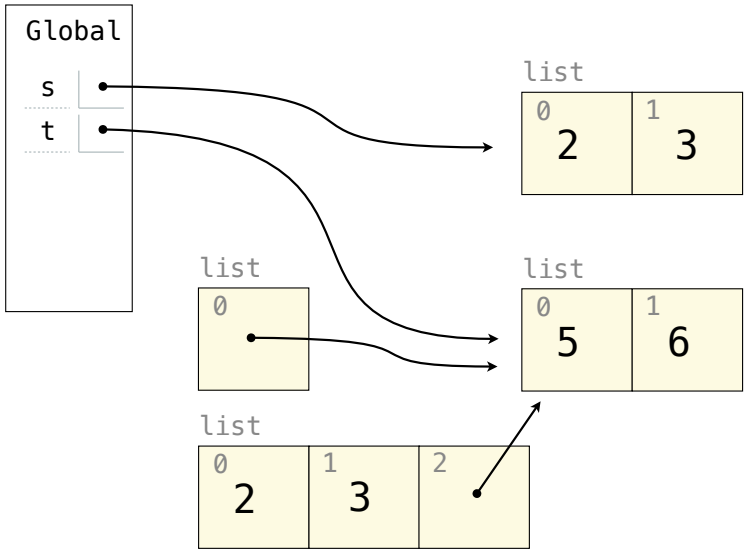

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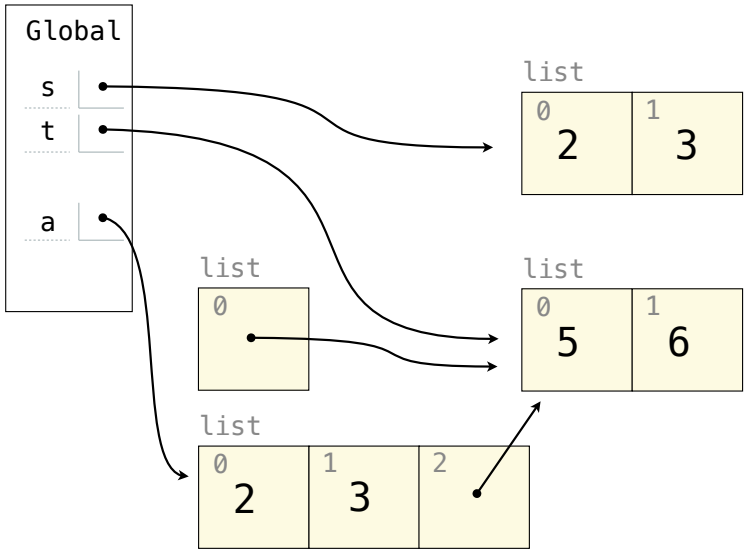

Lists in Environment Diagrams

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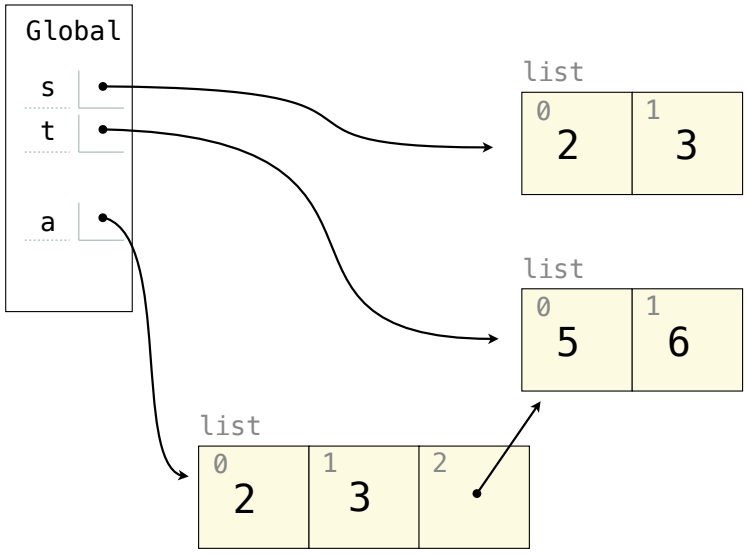

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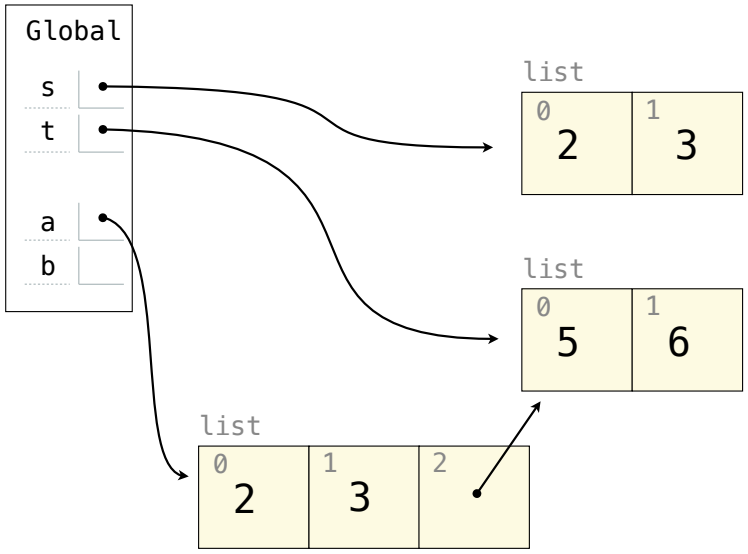

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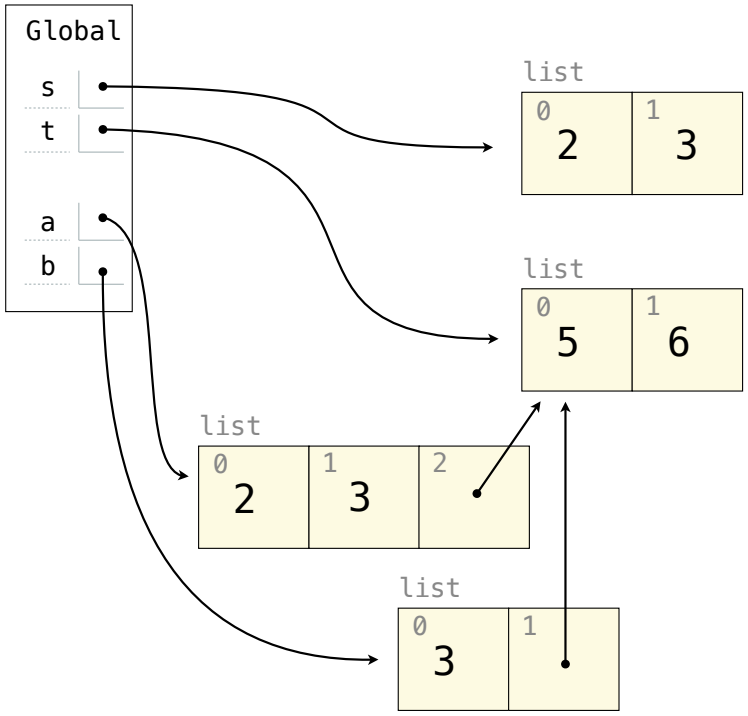

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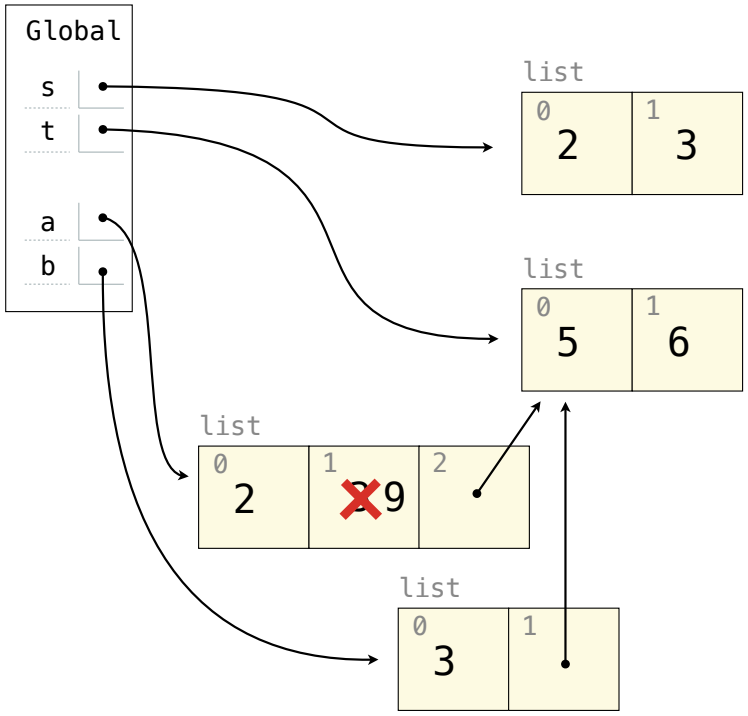

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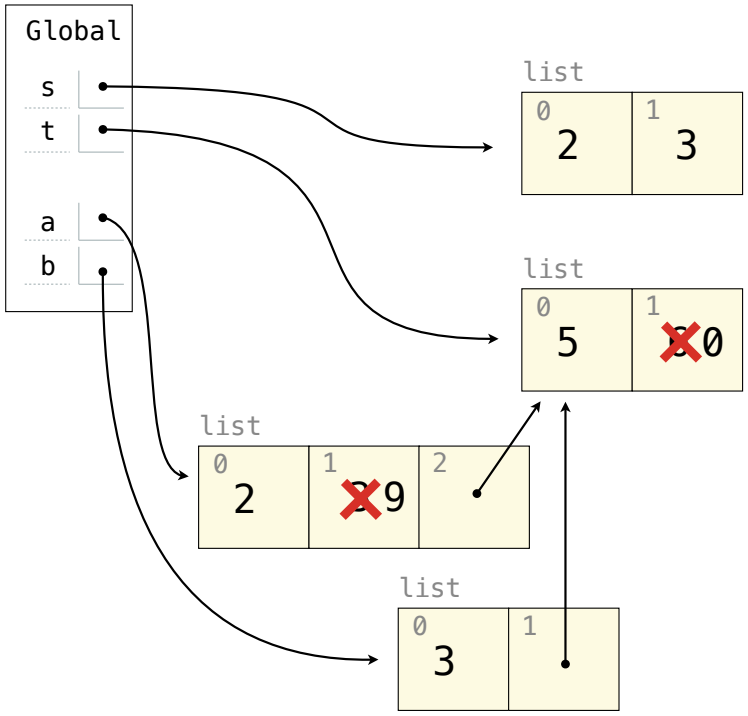

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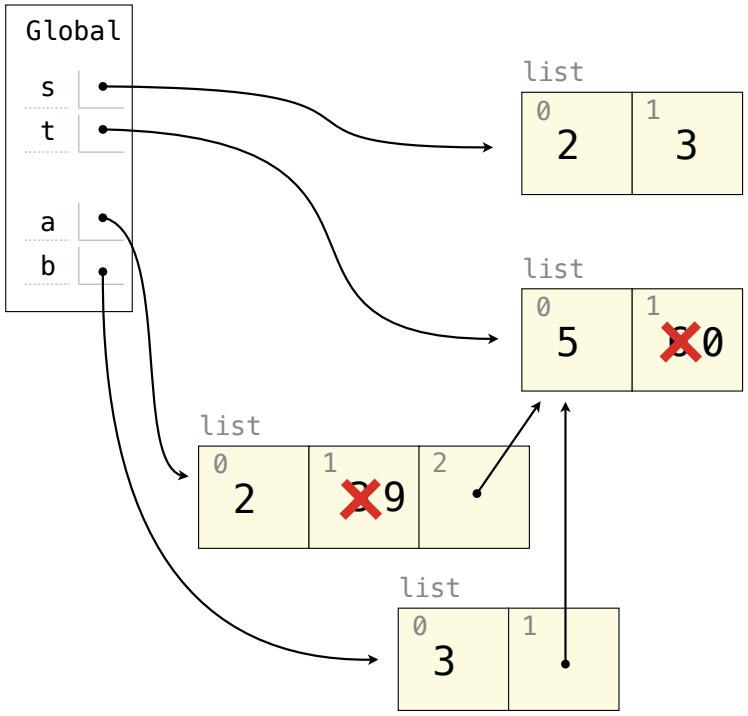

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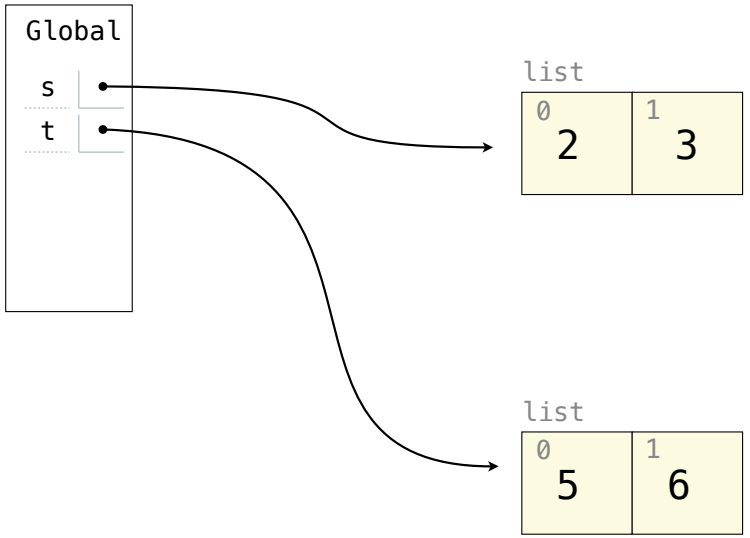

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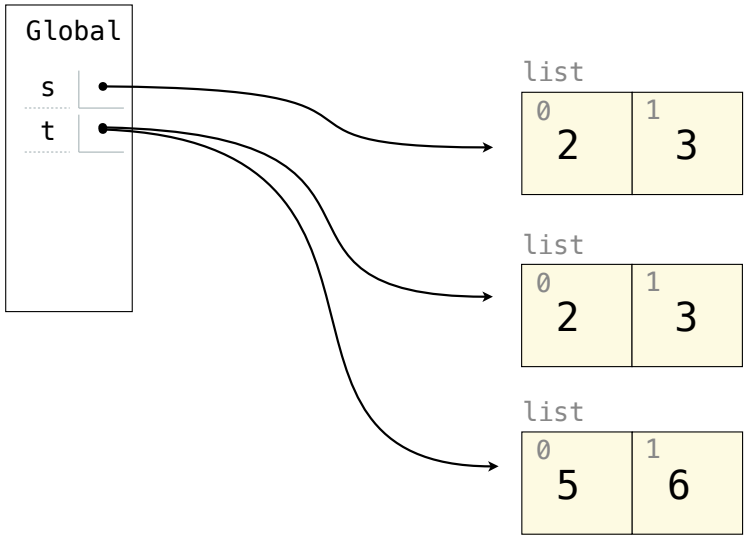

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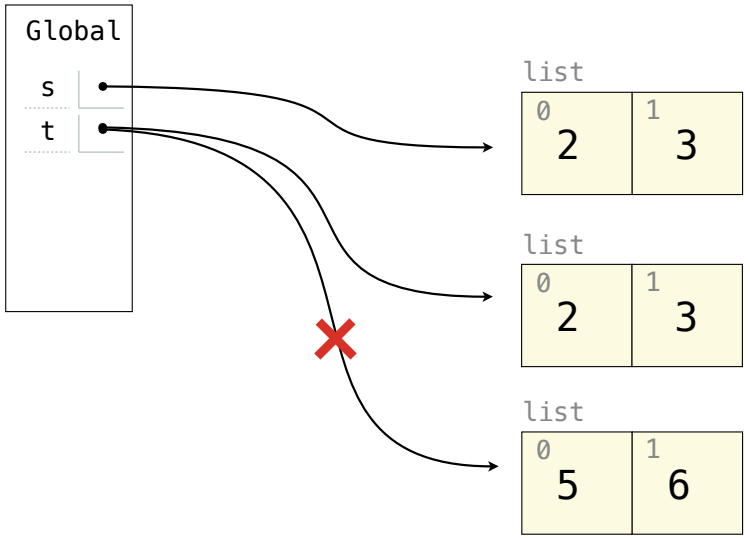

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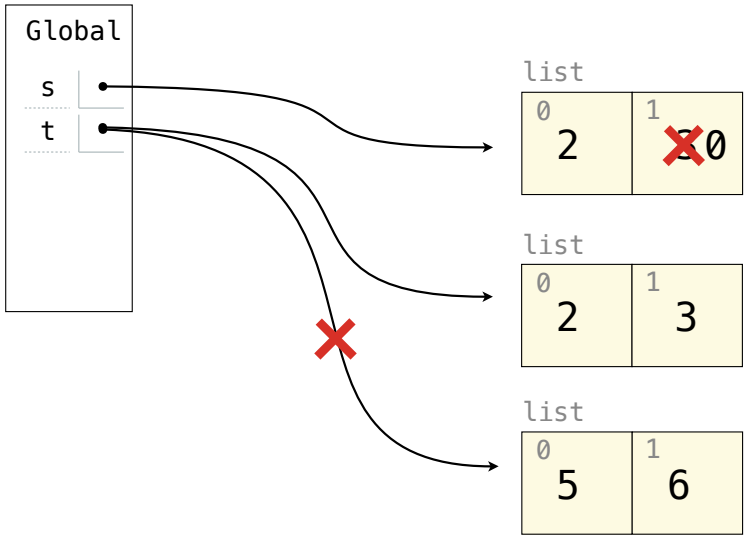

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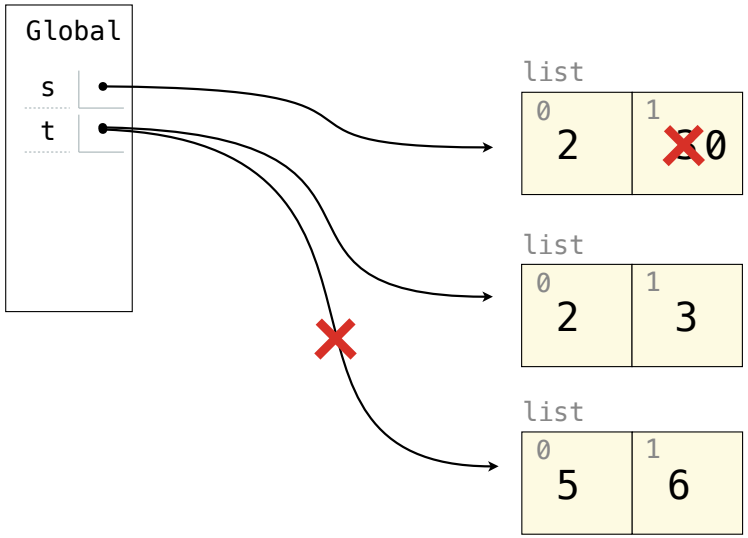

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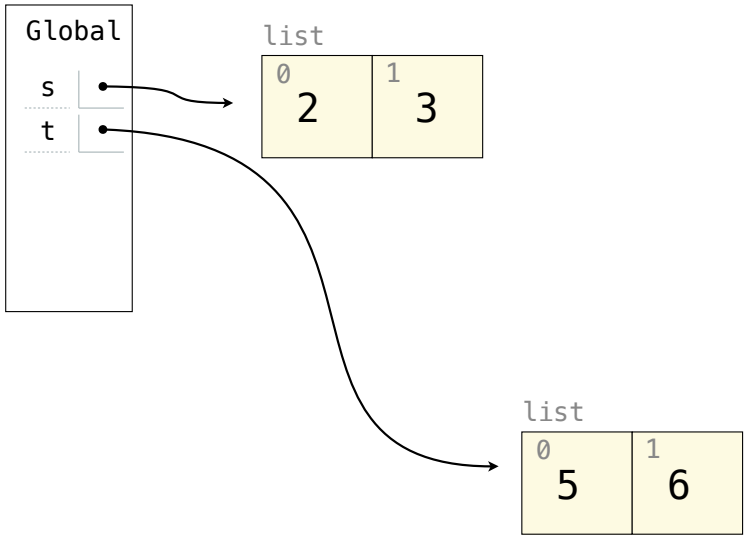

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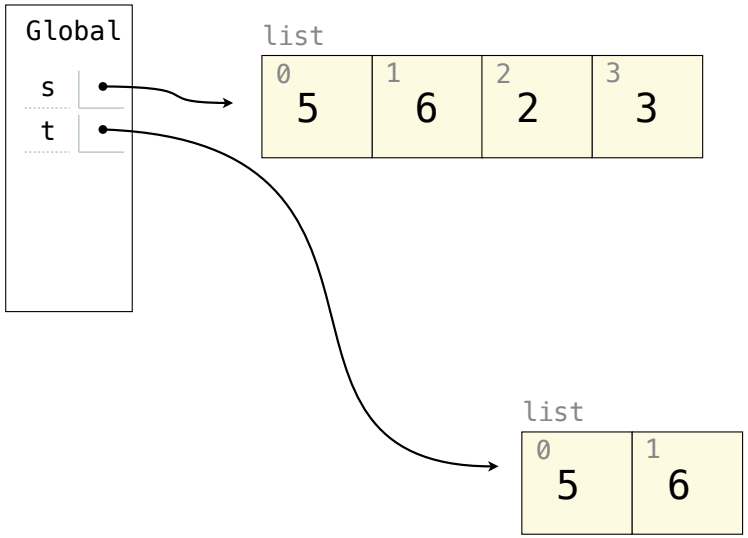

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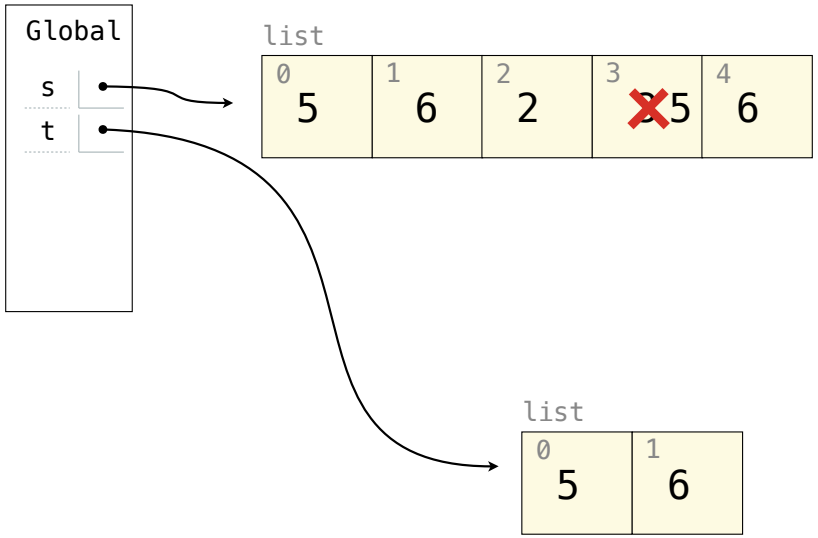

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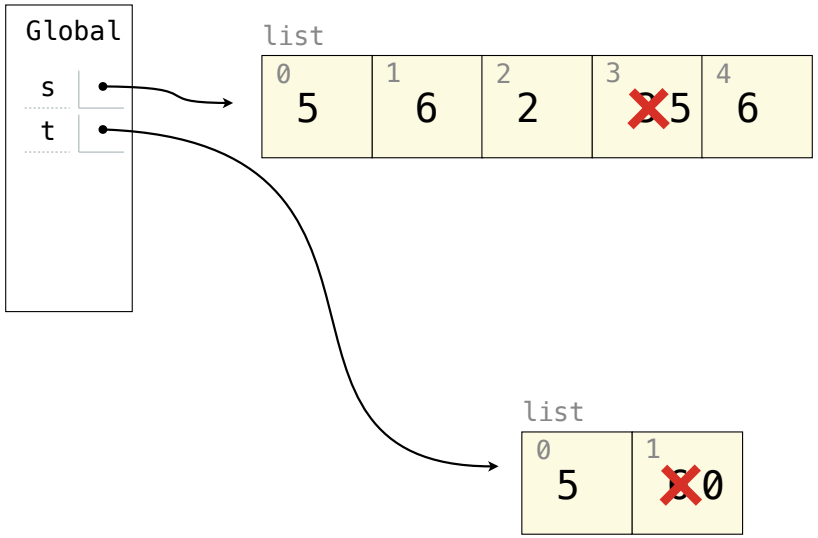

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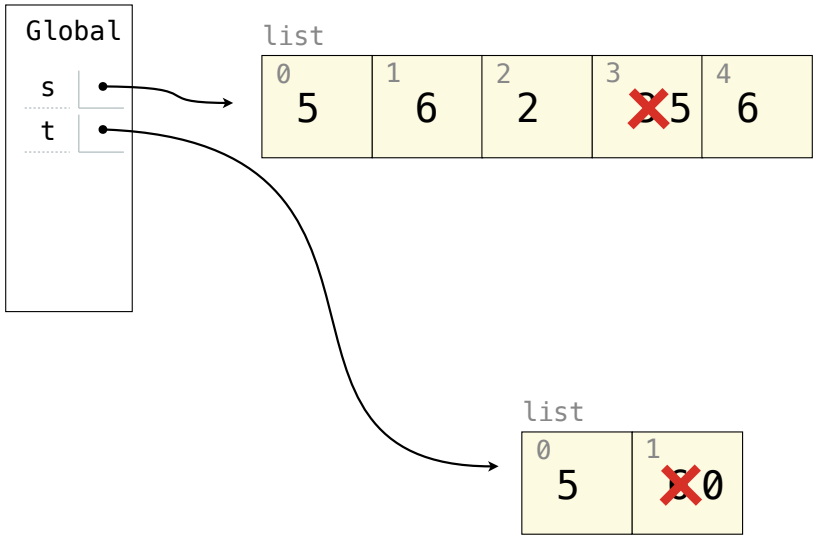
		`s → [5, 6, 2, 5, 6]`
		`t → [5, 0]`



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Operation	Example	Result

Lists in Environment Diagrams

Assume that before each example below we execute:

```
s = [2, 3]
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```

Operation	Example	Result
pop removes & returns the last element		

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()	

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

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		

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)`	

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]`

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Operation	Example	Result
pop removes & returns the last element	`t = s.pop()`	`s → [2]` `t → 3`
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slice assignment can remove elements from a list by assigning [] to a slice.		

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Assume that before each example below we execute:

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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]`
slice assignment can remove elements from a list by assigning [] to a slice.	`s[:1] = []` `t[0:2] = []`	

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slice assignment can remove elements from a list by assigning [] to a slice.	`s[:1] = []` `t[0:2] = []`	`s → [3]` `t → []`

Lists in Lists in Lists in Environment Diagrams

```
t = [1, 2, 3]
t[1:3] = [t]
t.extend(t)
```

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

Lists in Lists in Lists in Environment Diagrams

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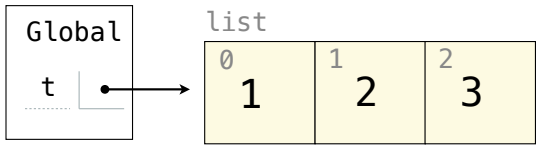

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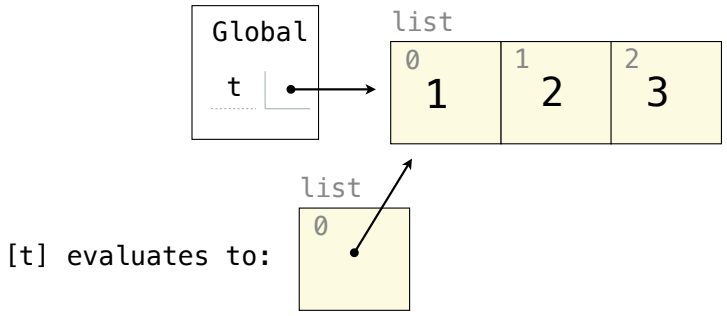

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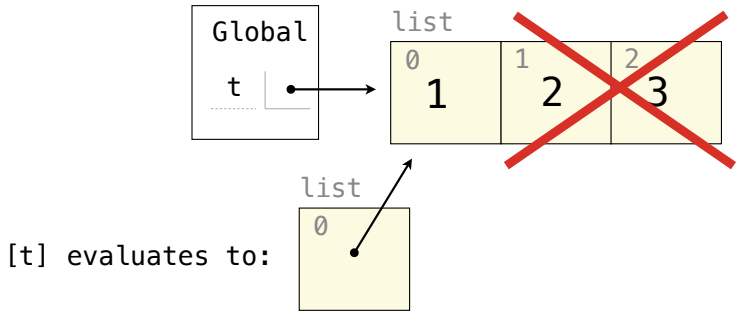

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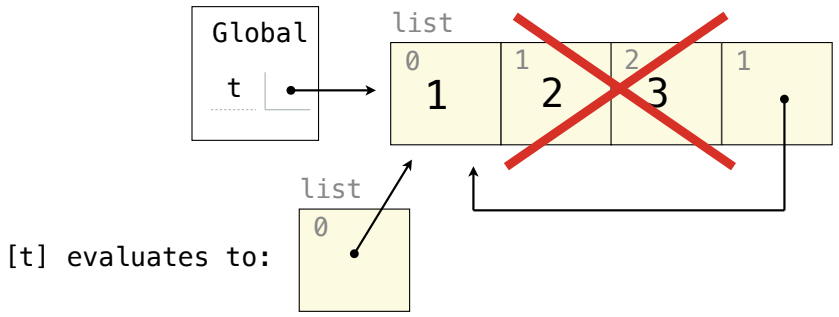

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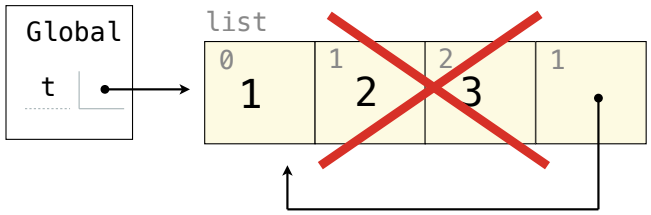

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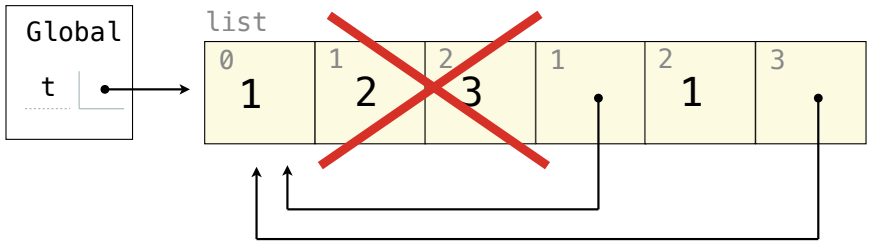

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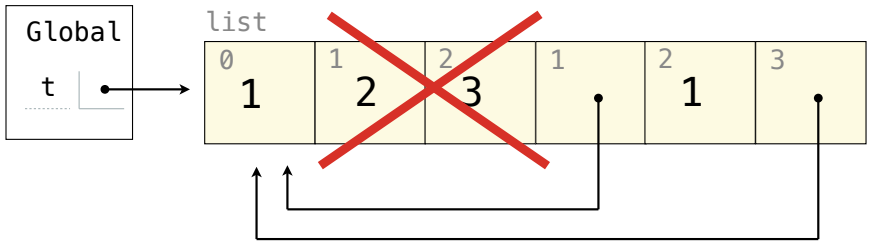


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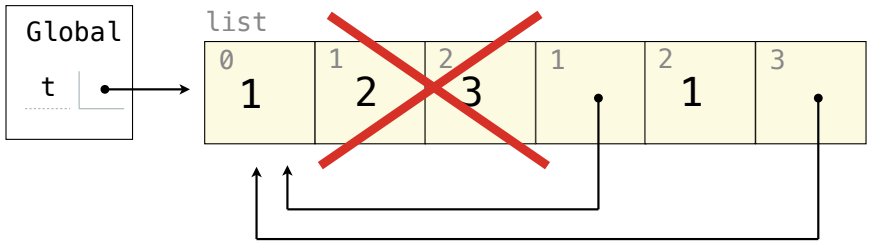


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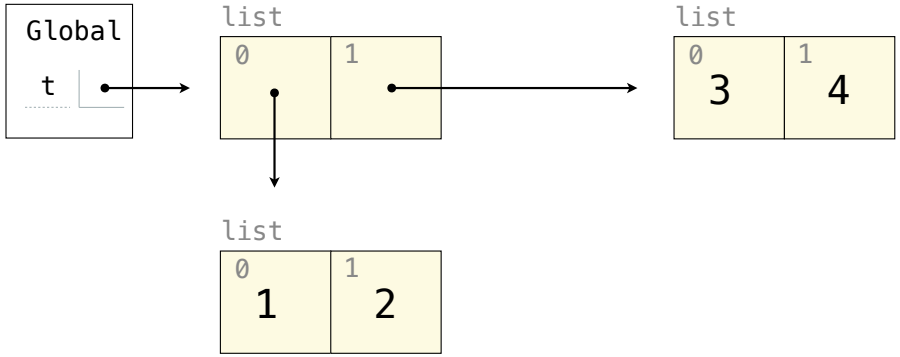

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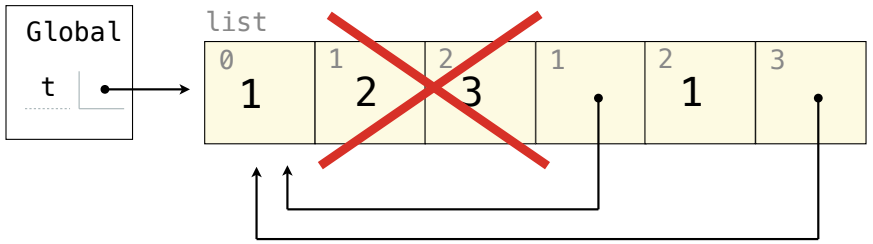


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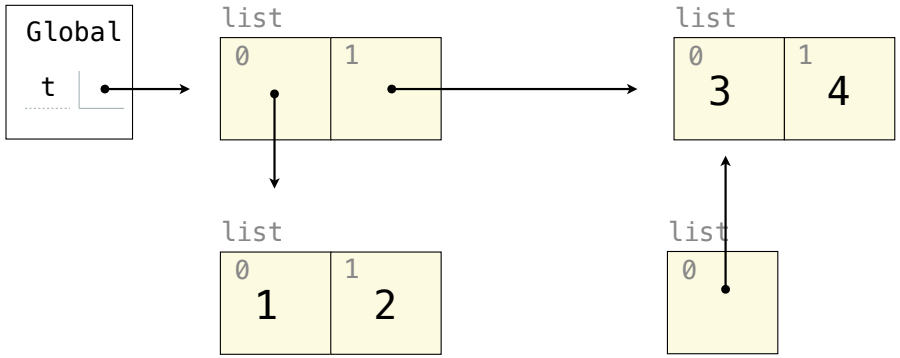

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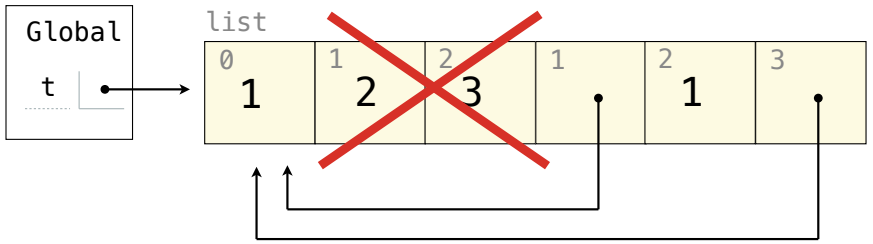


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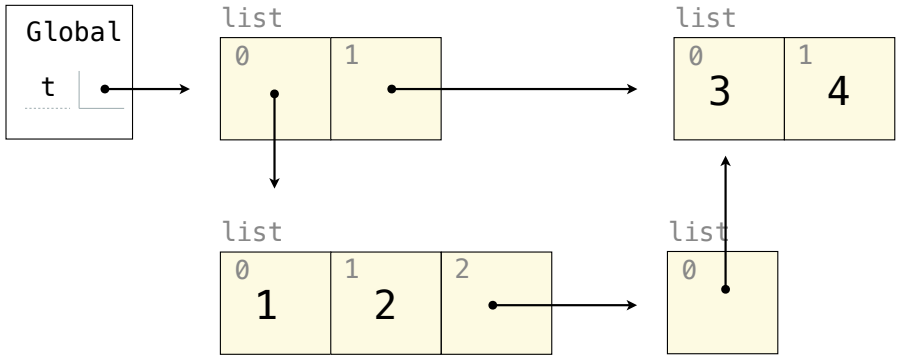

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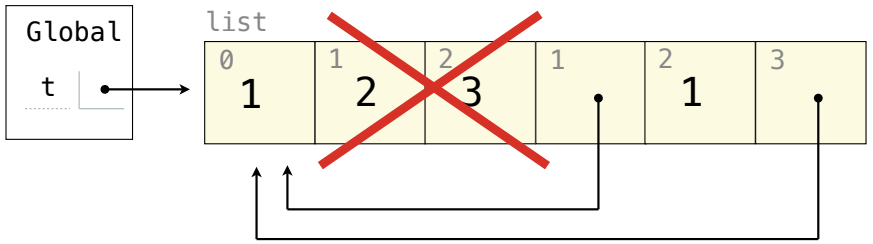


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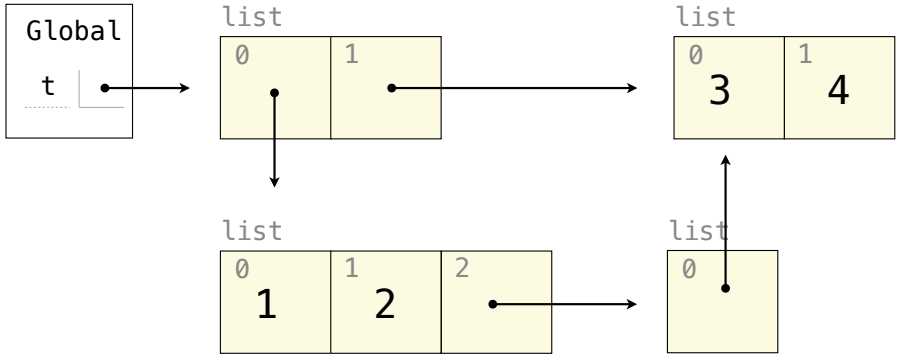


```
[[1, 2, [[3, 4]]], [3, 4]]
```