Mutability

Announcements

Objects

(Demo)

Objects

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  - All **objects** have **attributes**
  - A lot of data manipulation happens through object **methods**
  - Functions do one thing; objects do many related things

Example: Strings

(Demo)

Representing Strings: the ASCII Standard

American Standard Code for Information Interchange

ASCII Code Chart

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

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2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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0 1 0	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0 1 1	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
1 0 0	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1 0 1	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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0 1 1	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
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0 1 0	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0 1 1	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
1 0 0	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1 0 1	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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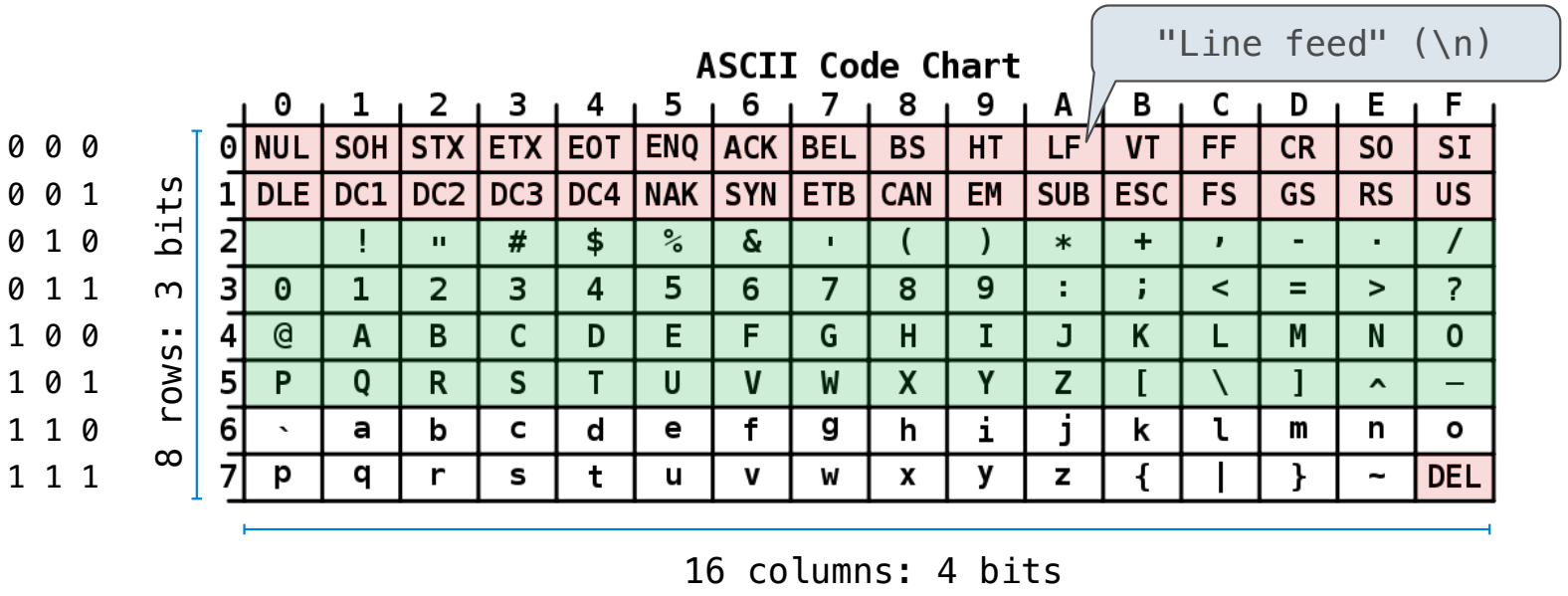

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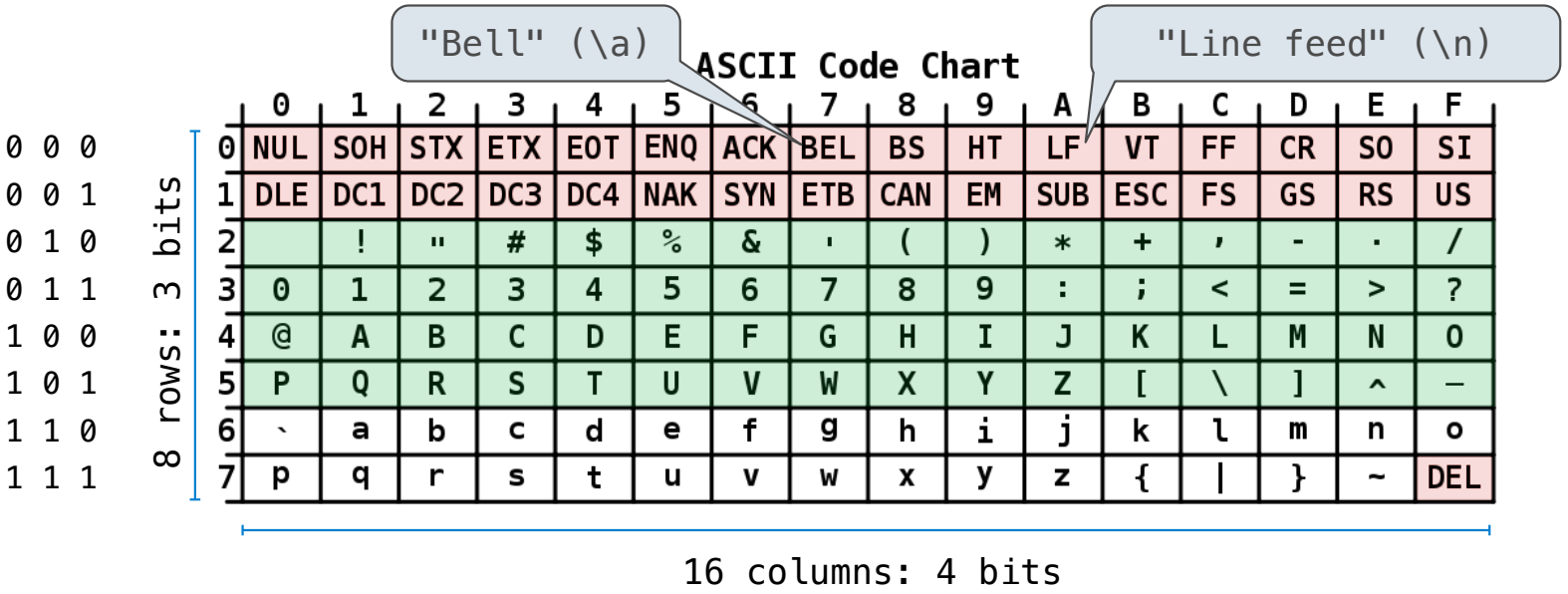

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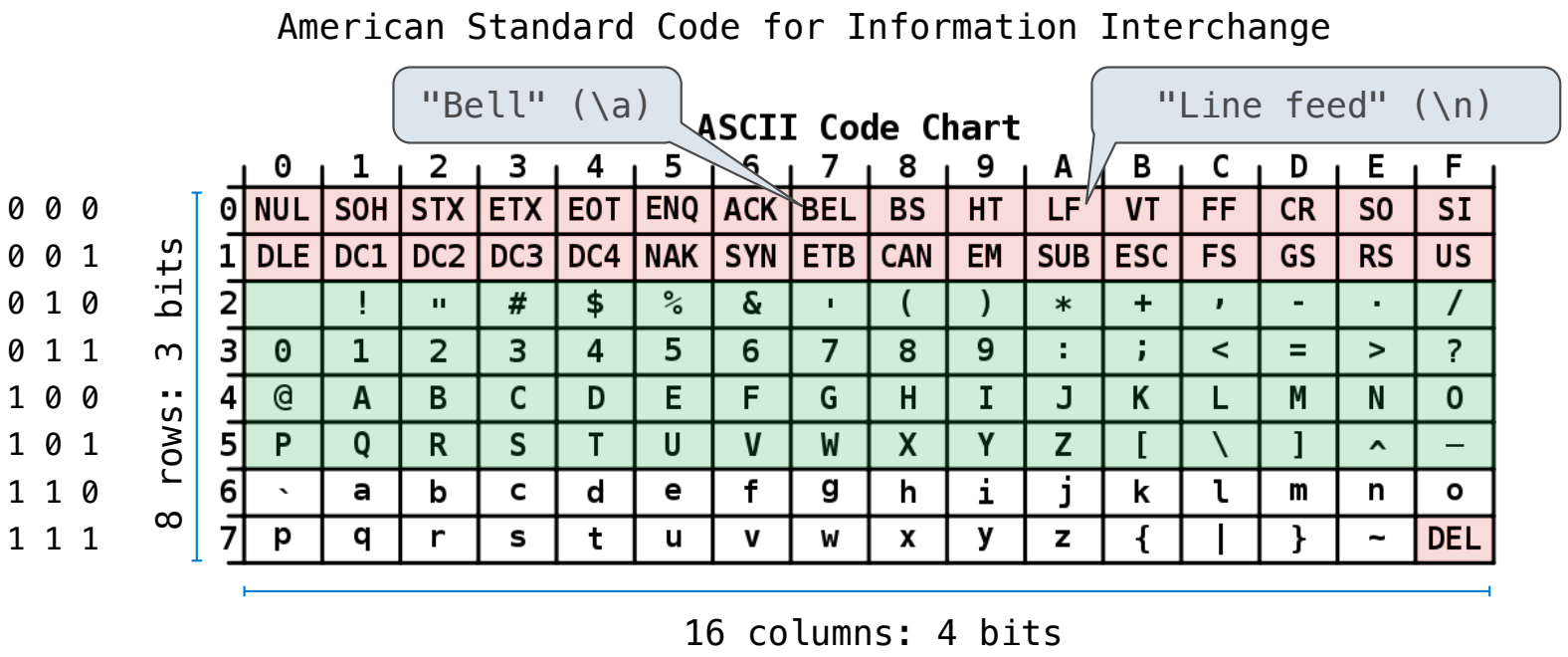

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(Demo)

Representing Strings: the Unicode Standard

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http://ian-albert.com/unicode_chart/unichart-chinese.jpg

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LATIN CAPITAL LETTER A

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LATIN CAPITAL LETTER A

DIE FACE-6

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EIGHTH NOTE
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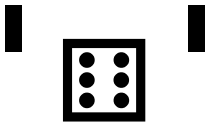
EIGHTH NOTE



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EIGHTH NOTE

(Demo)

Mutation Operations

Some Objects Can Change

[Demo]

Some Objects Can Change

[Demo]

First example in the course of an object changing state

Some Objects Can Change

[Demo]

First example in the course of an object changing state

The same object can change in value throughout the course of computation

Some Objects Can Change

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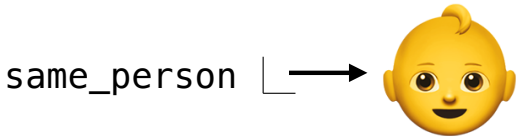

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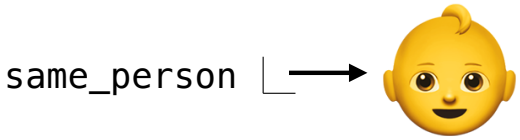

BABY

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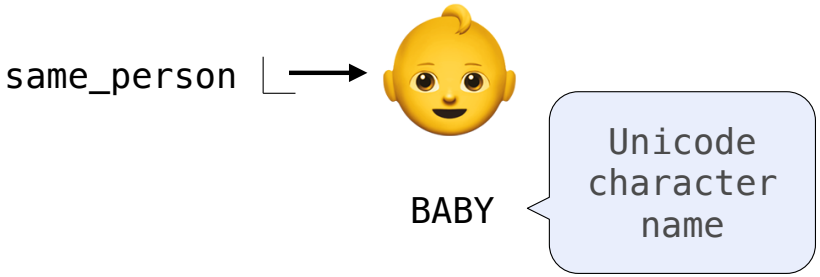

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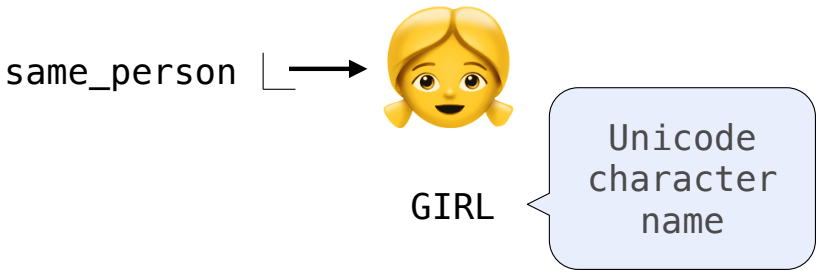

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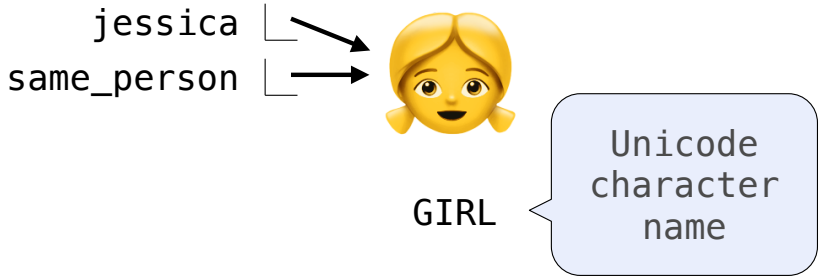

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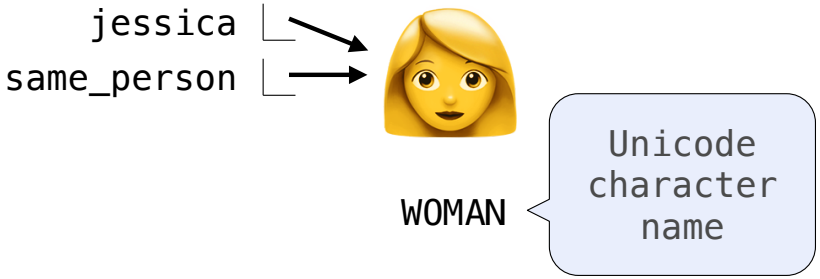

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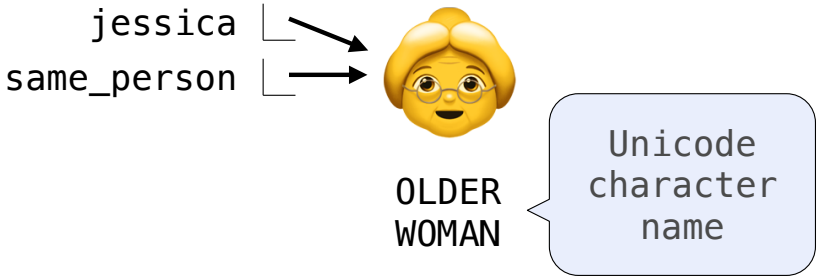

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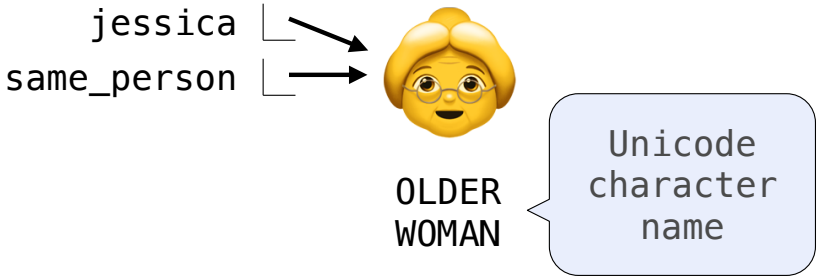

All names that refer to the same object are affected by a mutation

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First example in the course of an object changing state

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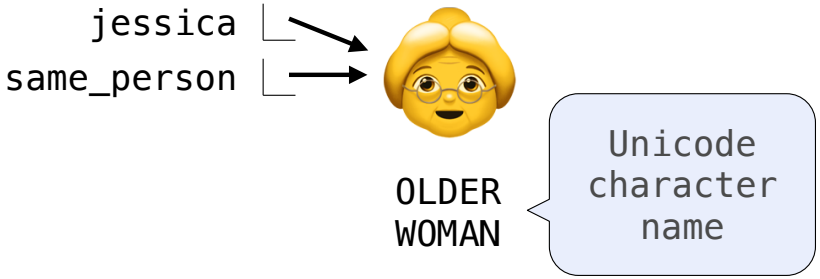

All names that refer to the same object are affected by a mutation

Only objects of *mutable* types can change: lists & dictionaries

Some Objects Can Change

[Demo]

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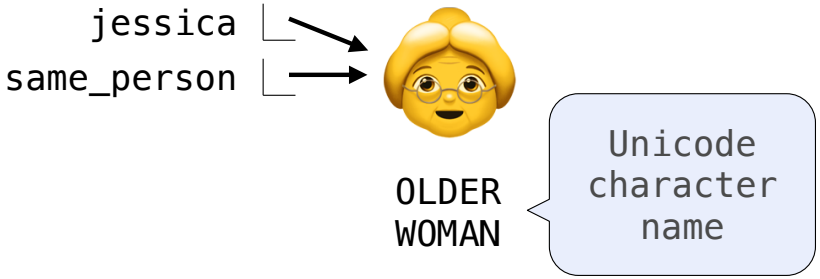

All names that refer to the same object are affected by a mutation

Only objects of *mutable* types can change: lists & dictionaries

{Demo}

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
```

Mutation Can Happen Within a Function Call

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```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
```

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
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>>> mystery(four)
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>>> four = [1, 2, 3, 4]
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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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```
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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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['Anything could be inside!']
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Name change:

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```

The value of an expression can change because of changes in names or objects

```
>>> x + x
```

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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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>>> s = ([1, 2], 3)
>>> s[0] = 4
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>>> s[0] = 4
ERROR
```

```
>>> s = ([1, 2], 3)
>>> s[0][0] = 4
>>> s
([4, 2], 3)
```

Mutation

Sameness and Change

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- As long as we never modify objects, a compound object is just the totality of its pieces

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

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

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Sameness and Change

- As long as we never modify objects, a compound object is just the totality of its pieces
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evaluates to True if both <exp0> and <exp1> evaluate to the same object

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(Demo)

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```
A default argument value is part of a function value, not generated by a call
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>>> def f(s=[]):
...     s.append(3)
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...
```

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>>> def f(s=[]):
...     s.append(3)
...     return len(s)
...
>>> f()
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```

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>>> f()
2
```

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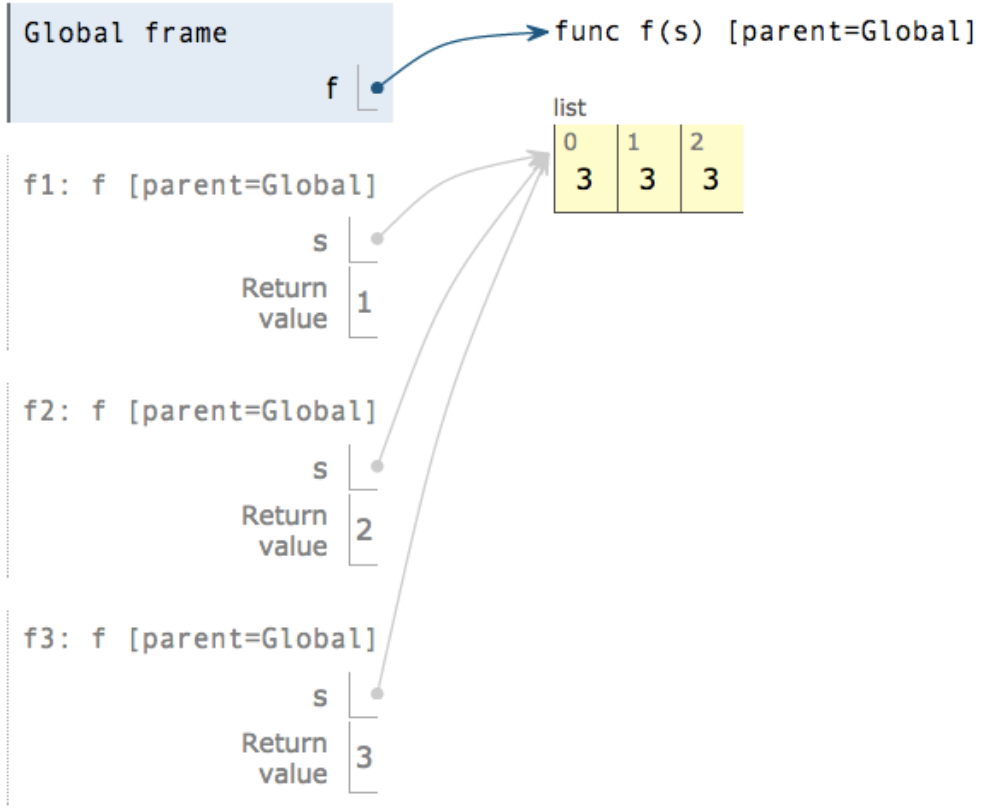

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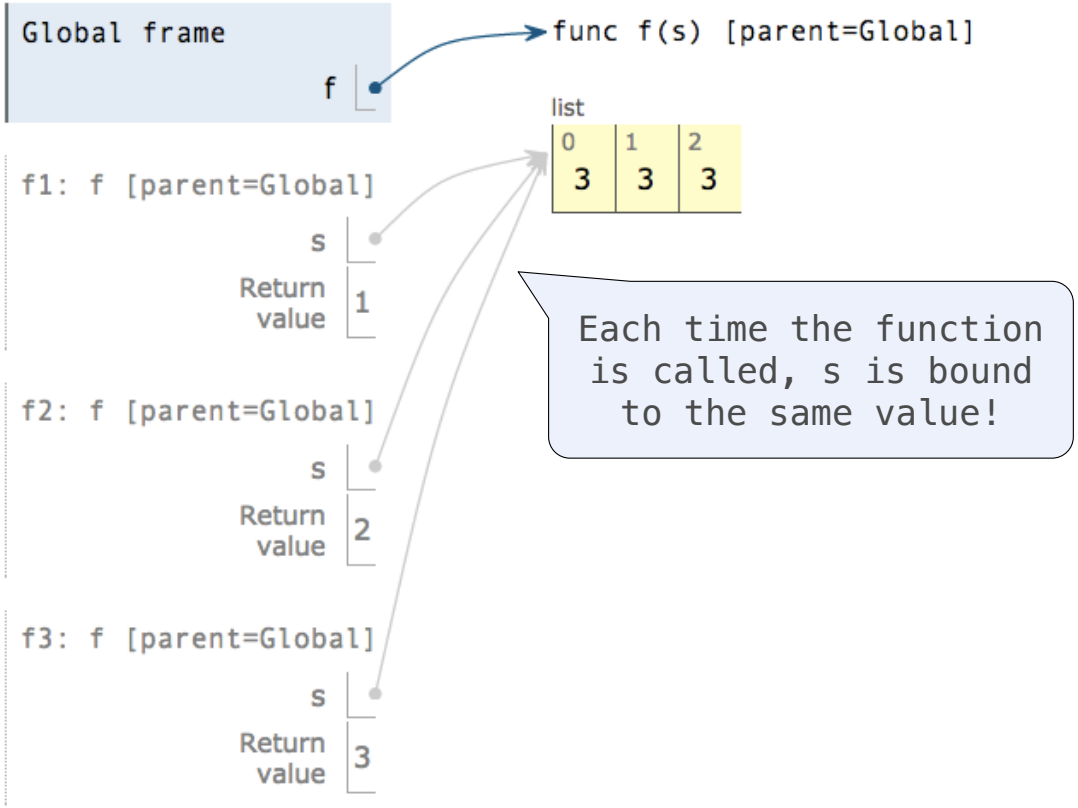

Mutable Functions

A Function with Behavior That Varies Over Time

Let's model a bank account that has a balance of $100

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```
>>> withdraw(25)
```

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```
>>> withdraw(25)
75
```

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```
>>> withdraw(25)
75
```

Argument:
amount to withdraw

A Function with Behavior That Varies Over Time

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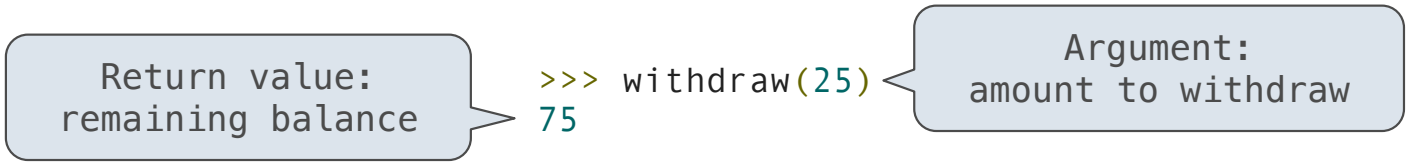

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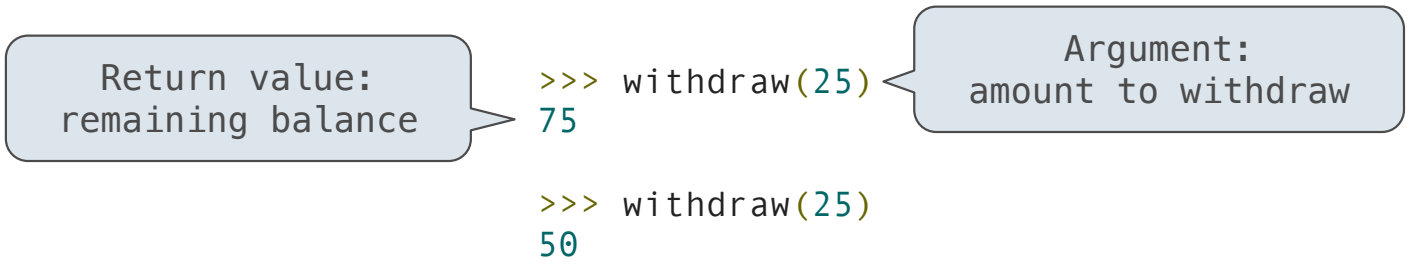

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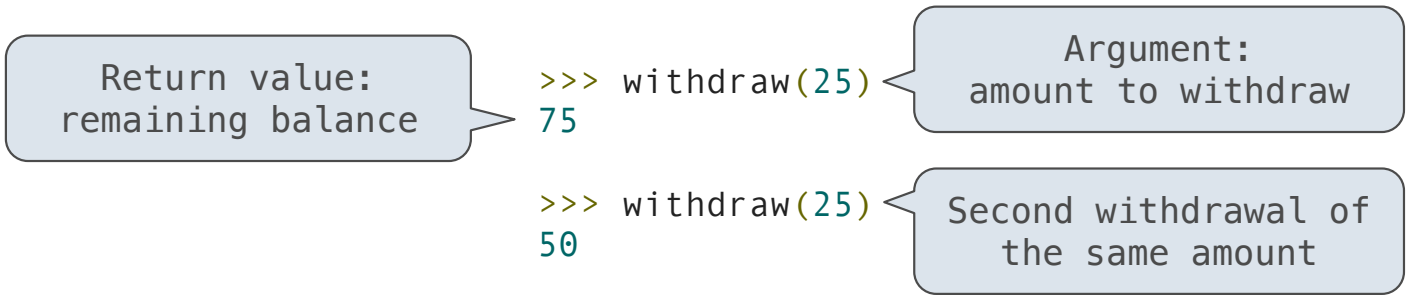

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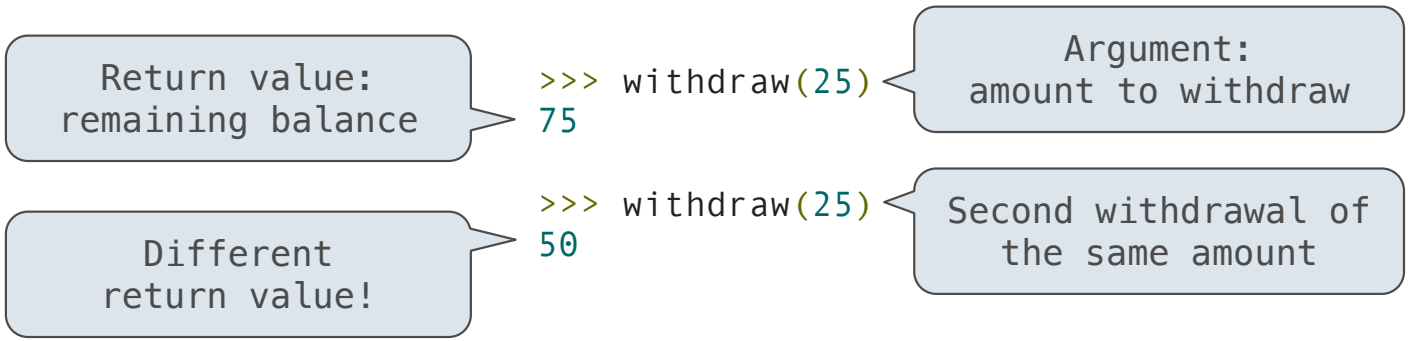

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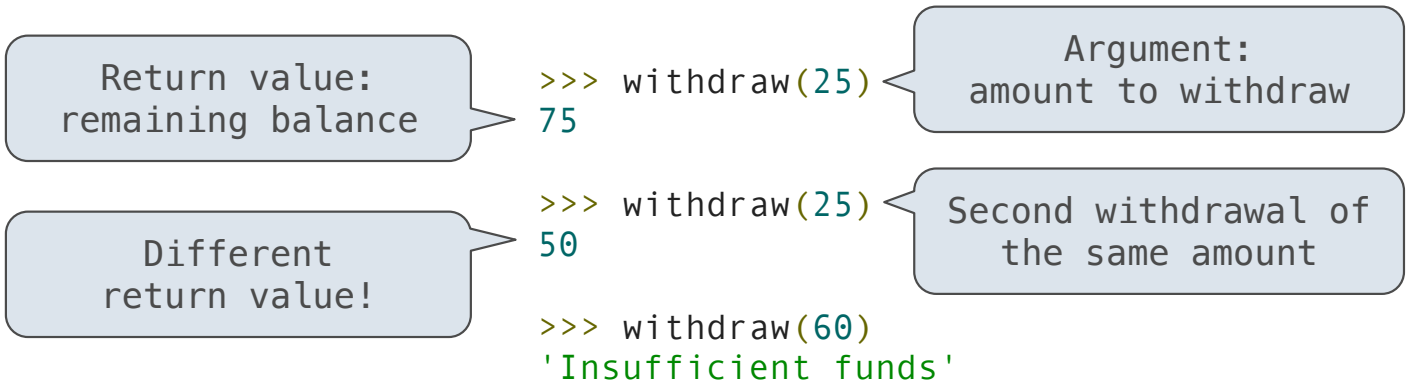

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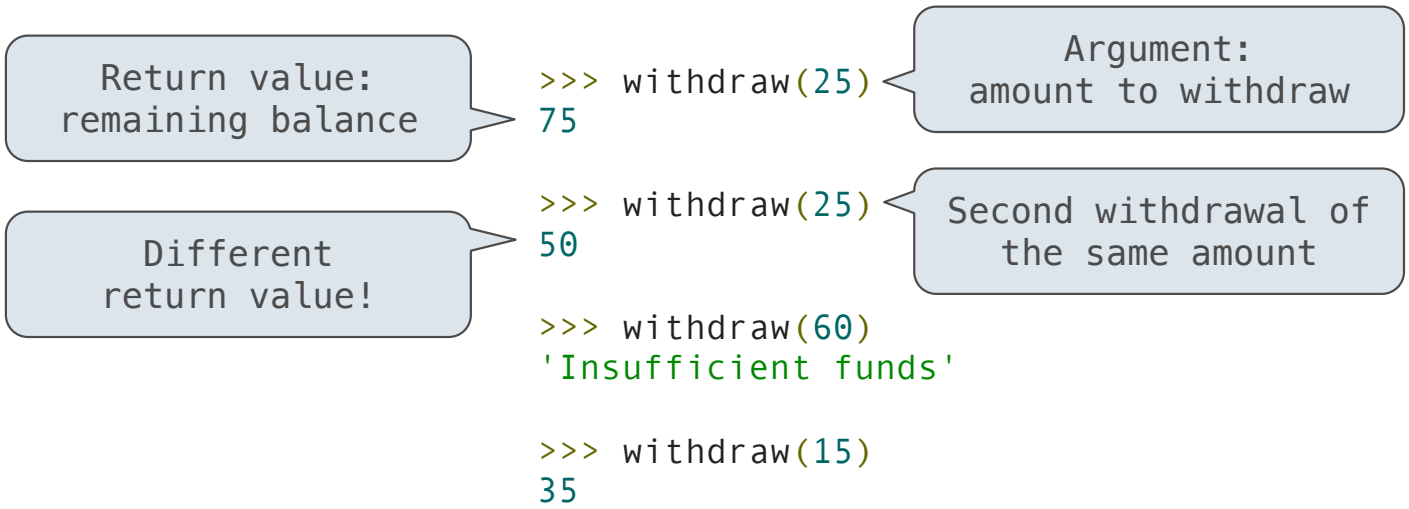


```
>>> withdraw(25)
75

>>> withdraw(25)
50

>>> withdraw(60)
'Insufficient funds'

>>> withdraw(15)
35
```

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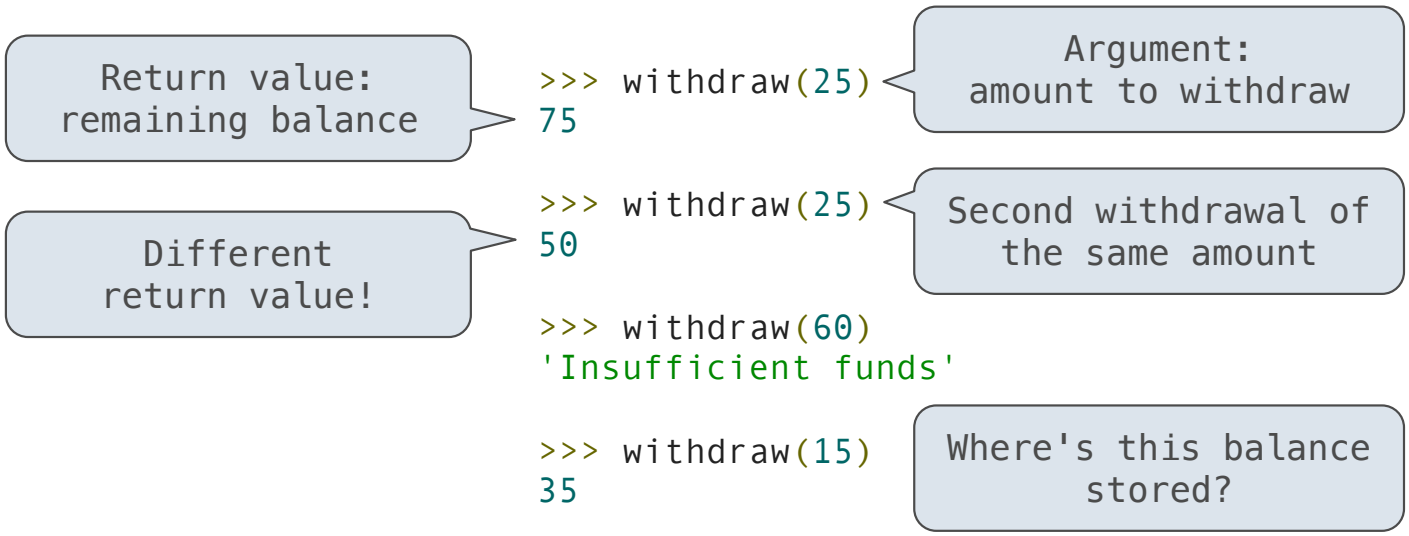

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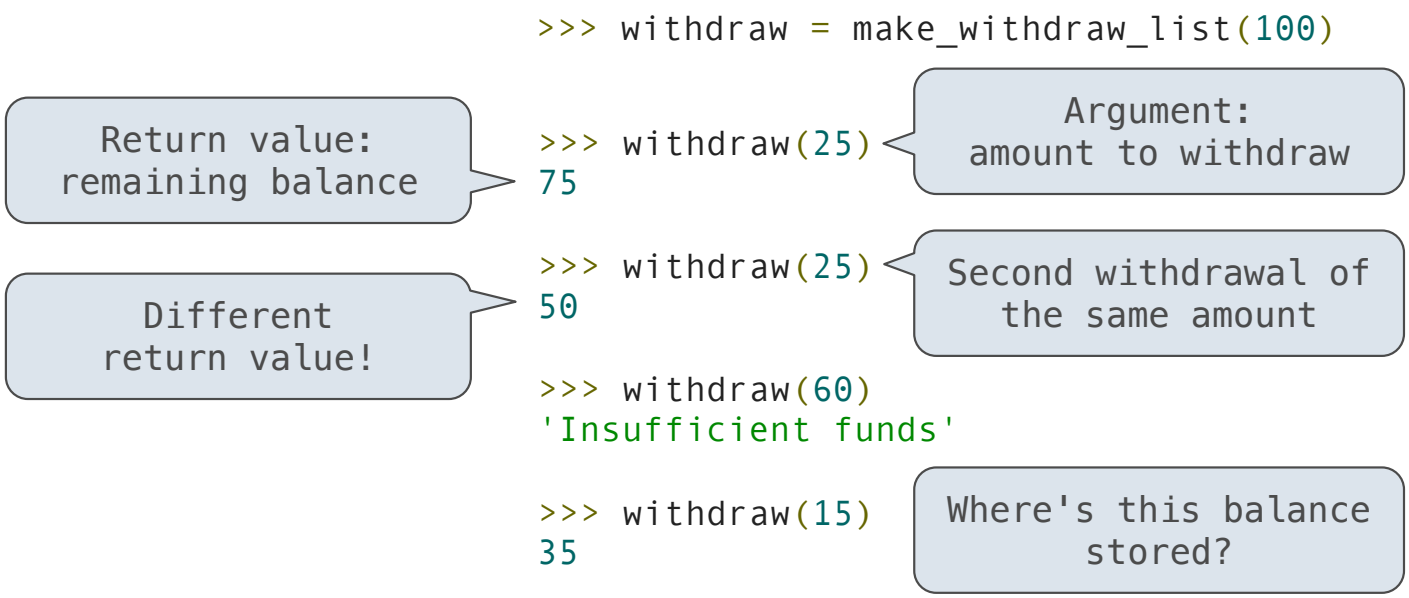


A Function with Behavior That Varies Over Time

Let's model a bank account that has a balance of $100

```
>>> withdraw = make_withdraw_list(100)

>>> withdraw(25)
75

>>> withdraw(25)
50

>>> withdraw(60)
'Insufficient funds'

>>> withdraw(15)
35
```

In a (mutable) list referenced in the parent frame of the function

Argument: amount to withdraw

Return value: remaining balance

Second withdrawal of the same amount

Different return value!

Where's this balance stored?

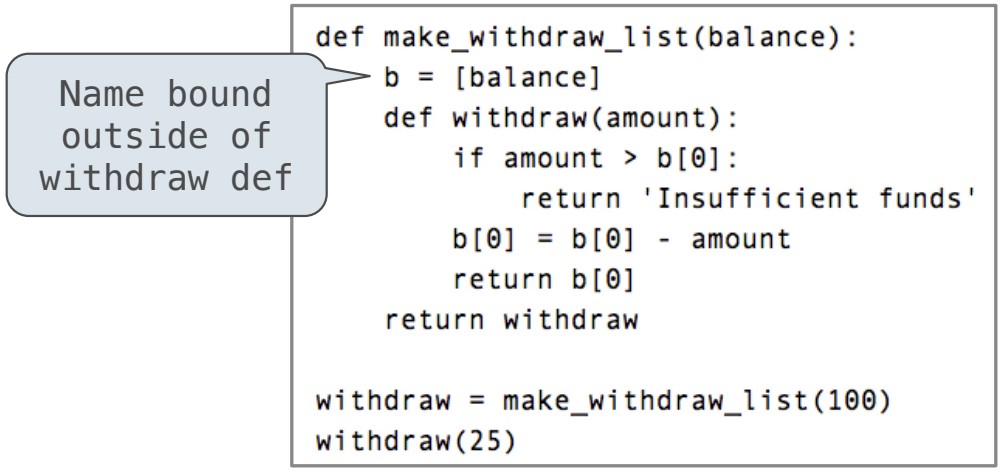
Mutable Values & Persistent Local State

Mutable Values & Persistent Local State

```
def make_withdraw_list(balance):
    b = [balance]
    def withdraw(amount):
        if amount > b[0]:
            return 'Insufficient funds'
        b[0] = b[0] - amount
        return b[0]
    return withdraw

withdraw = make_withdraw_list(100)
withdraw(25)
```

Mutable Values & Persistent Local State



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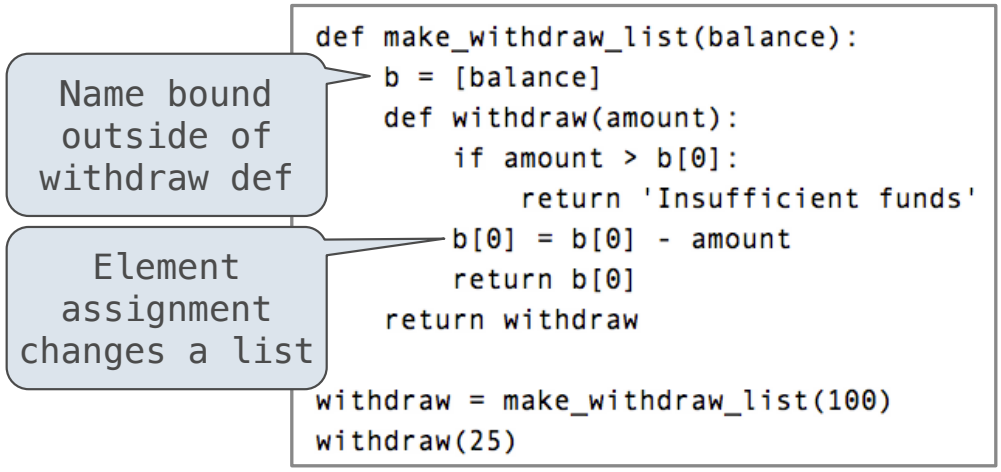

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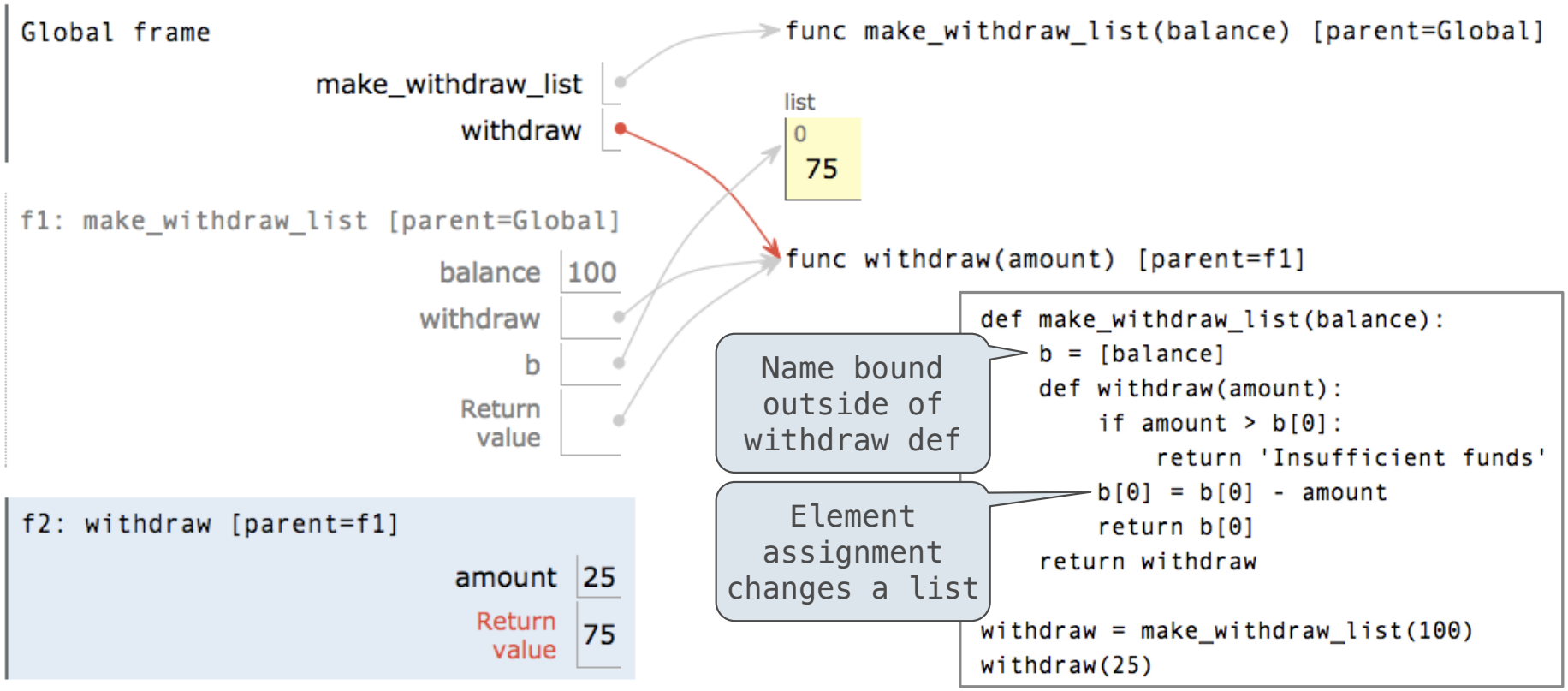

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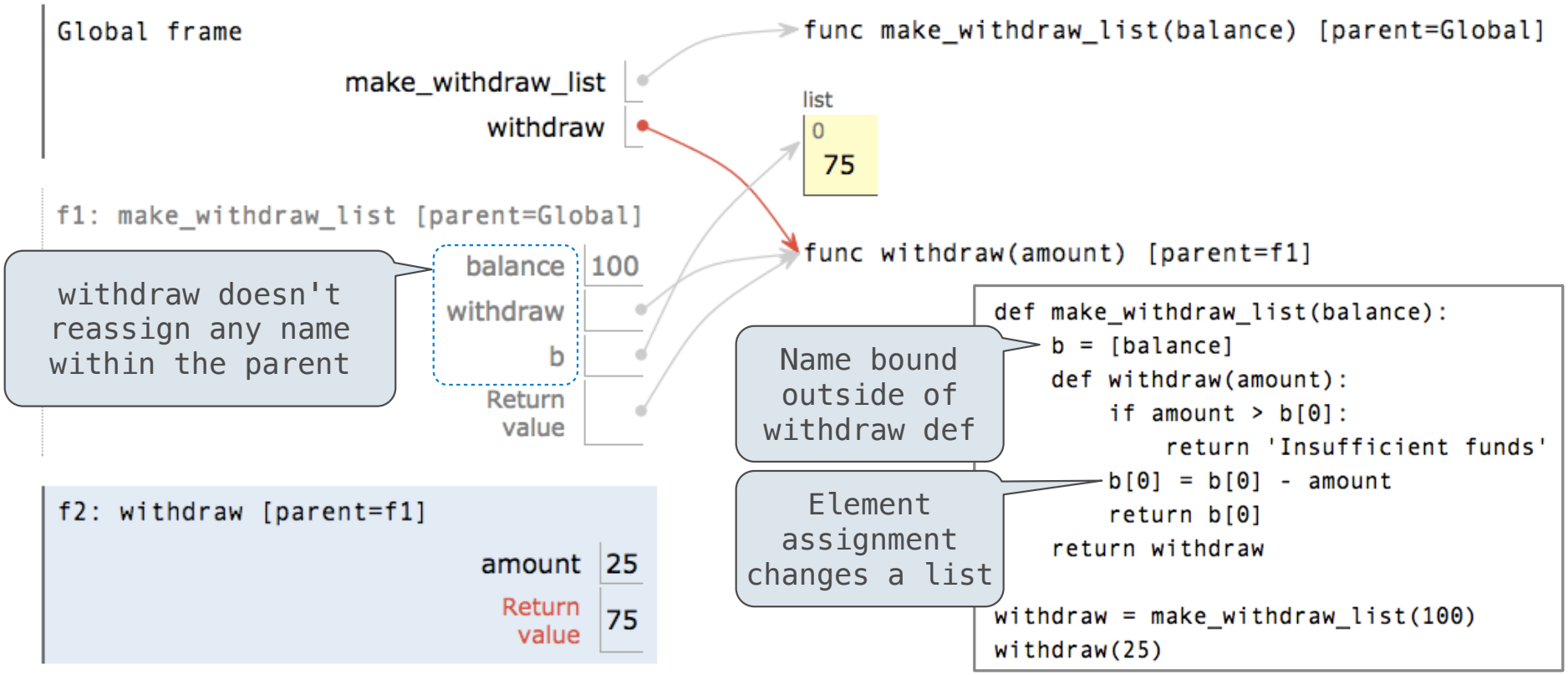
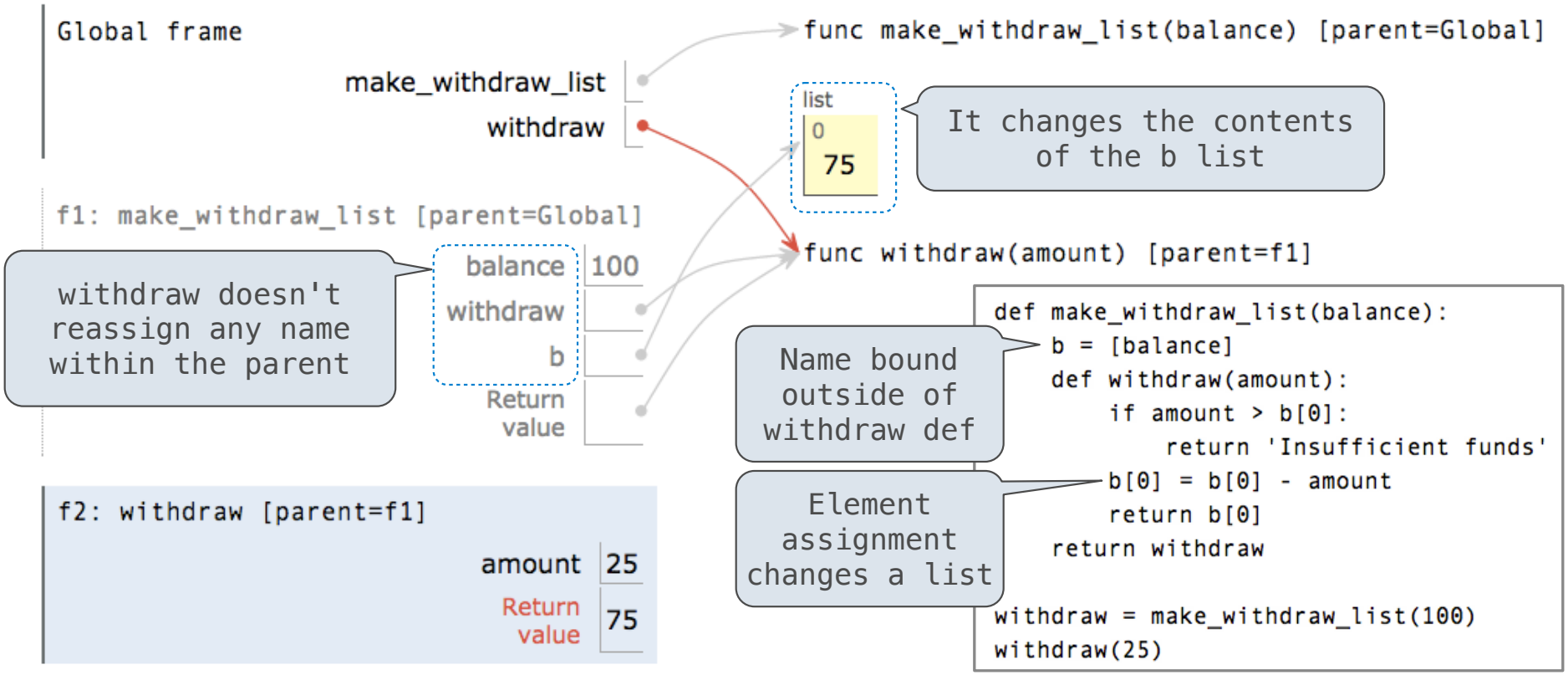
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