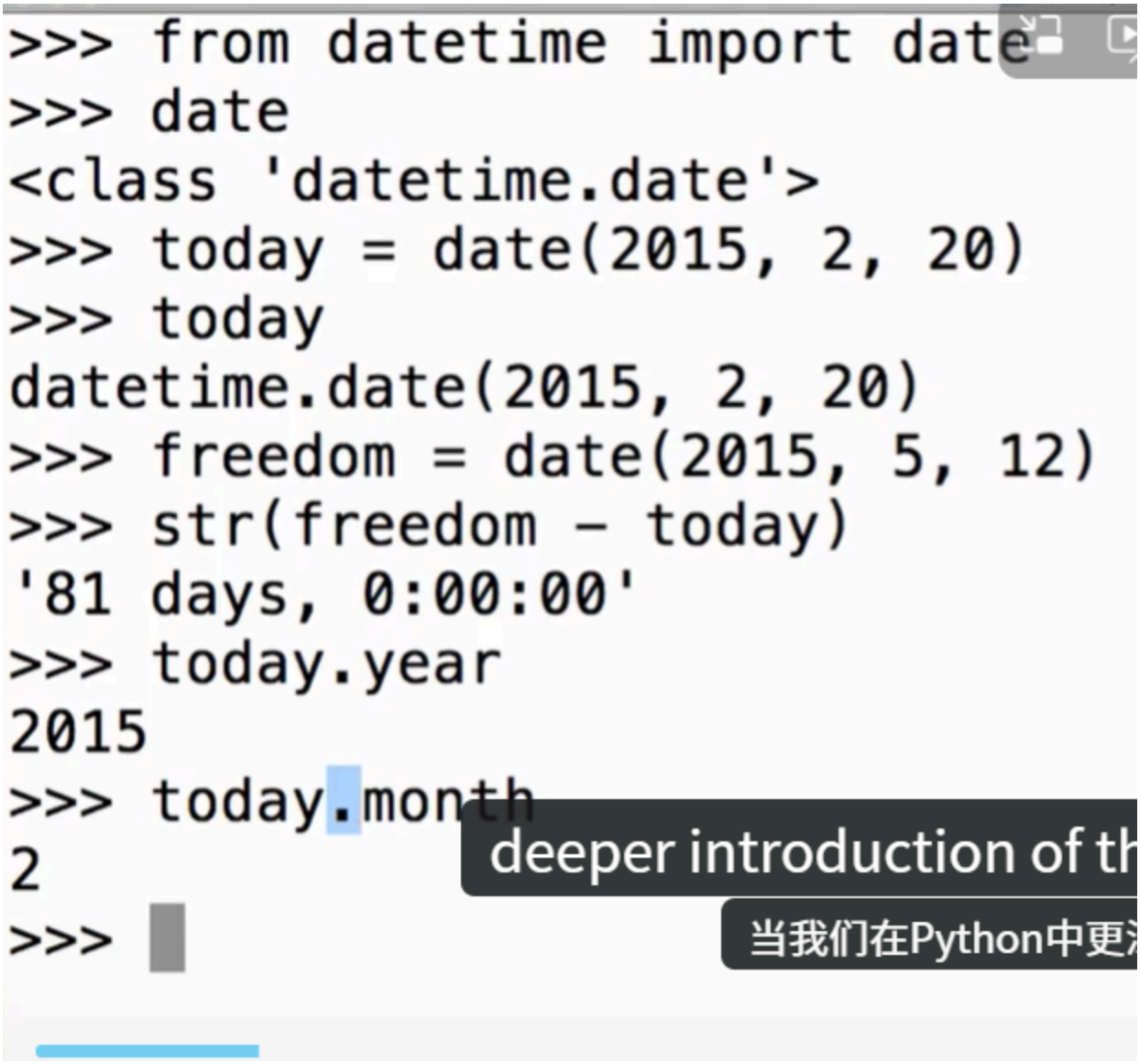
Lecture 15.Mutable values

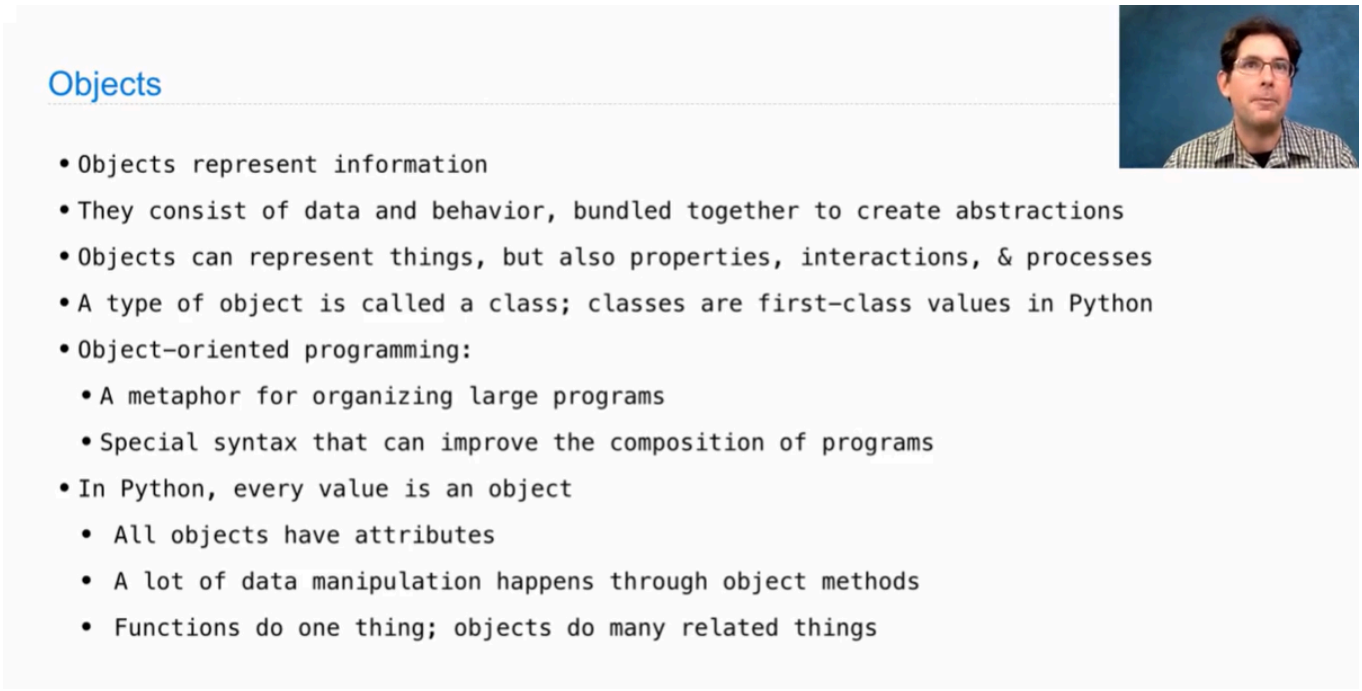
Objects

```
an object is suppose to behave like the values it has.
```

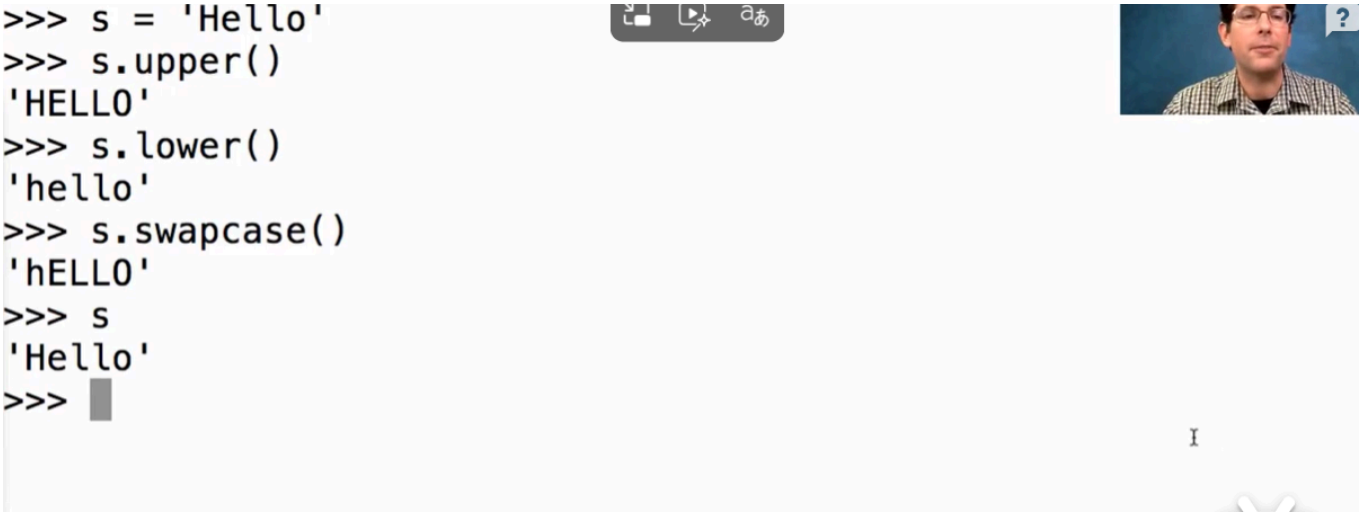


in addition to values bounded to the objects, there are also functions bounded to the objects, which are called method.

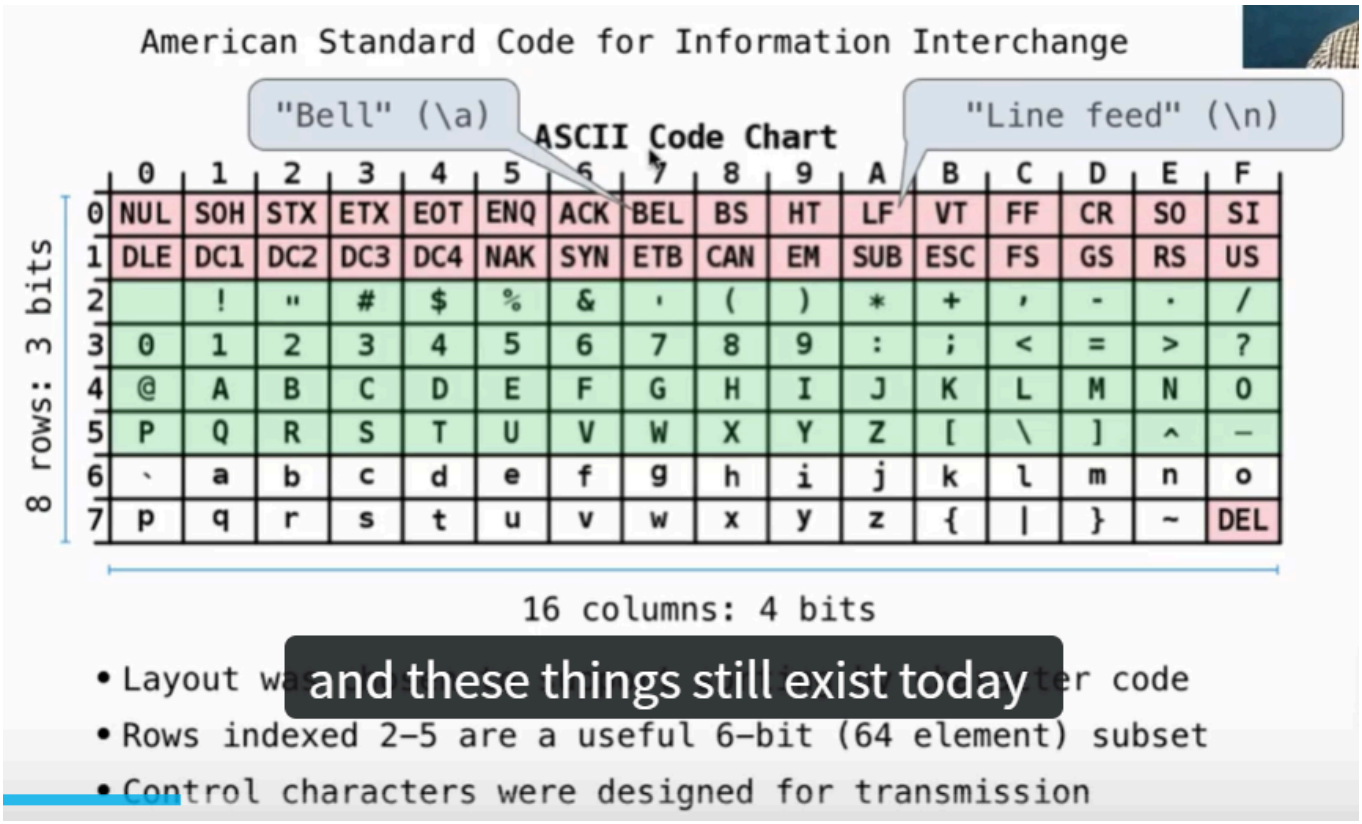
```
today.strftime('%A %B %d')
```



String

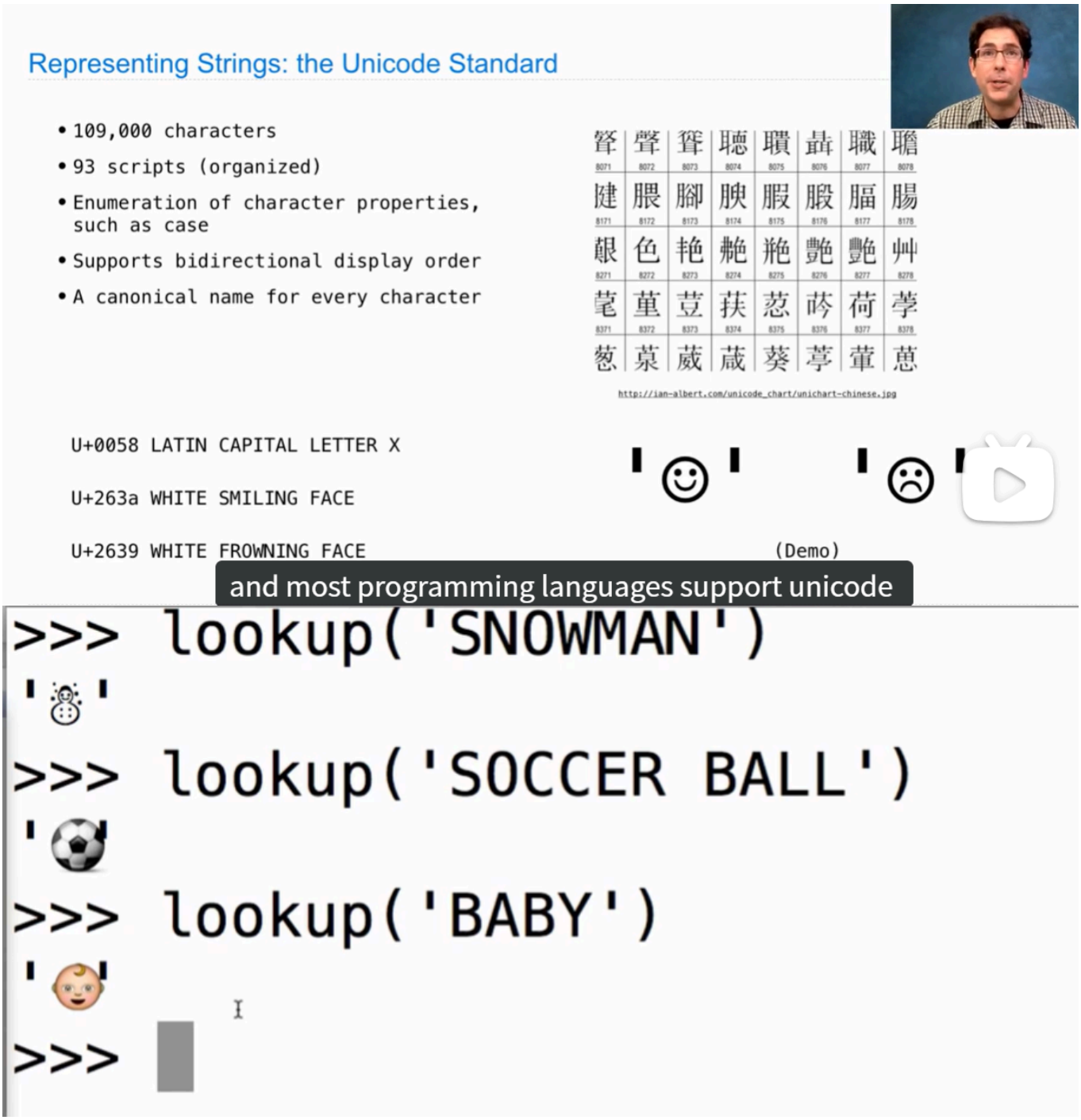


Representing Strings: the ASCII Standard



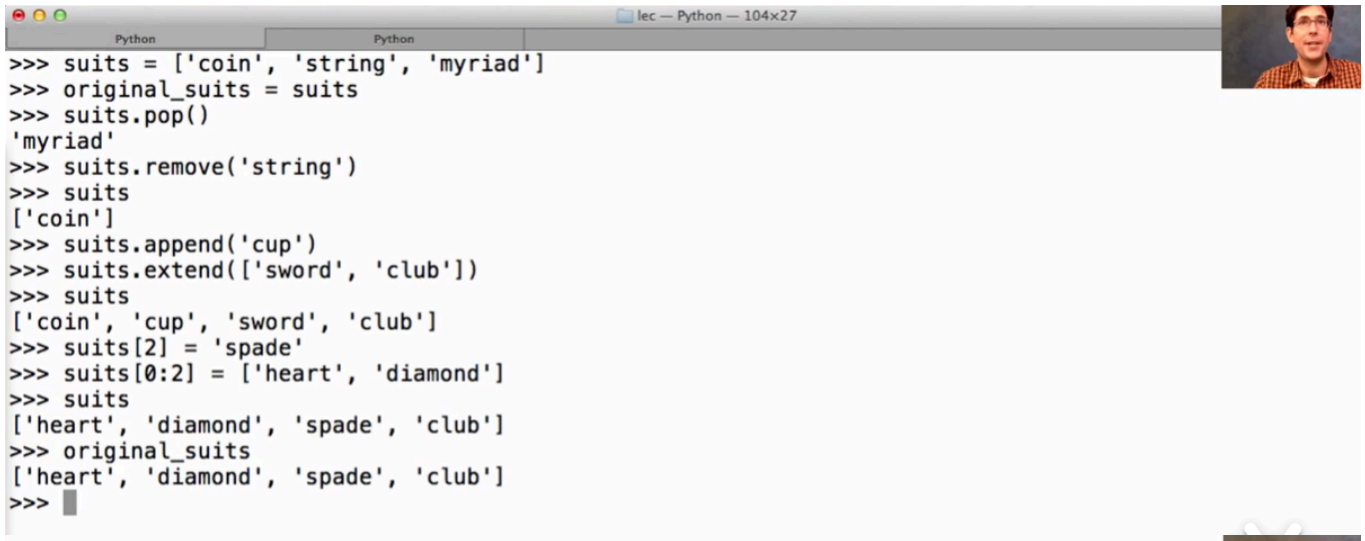
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f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

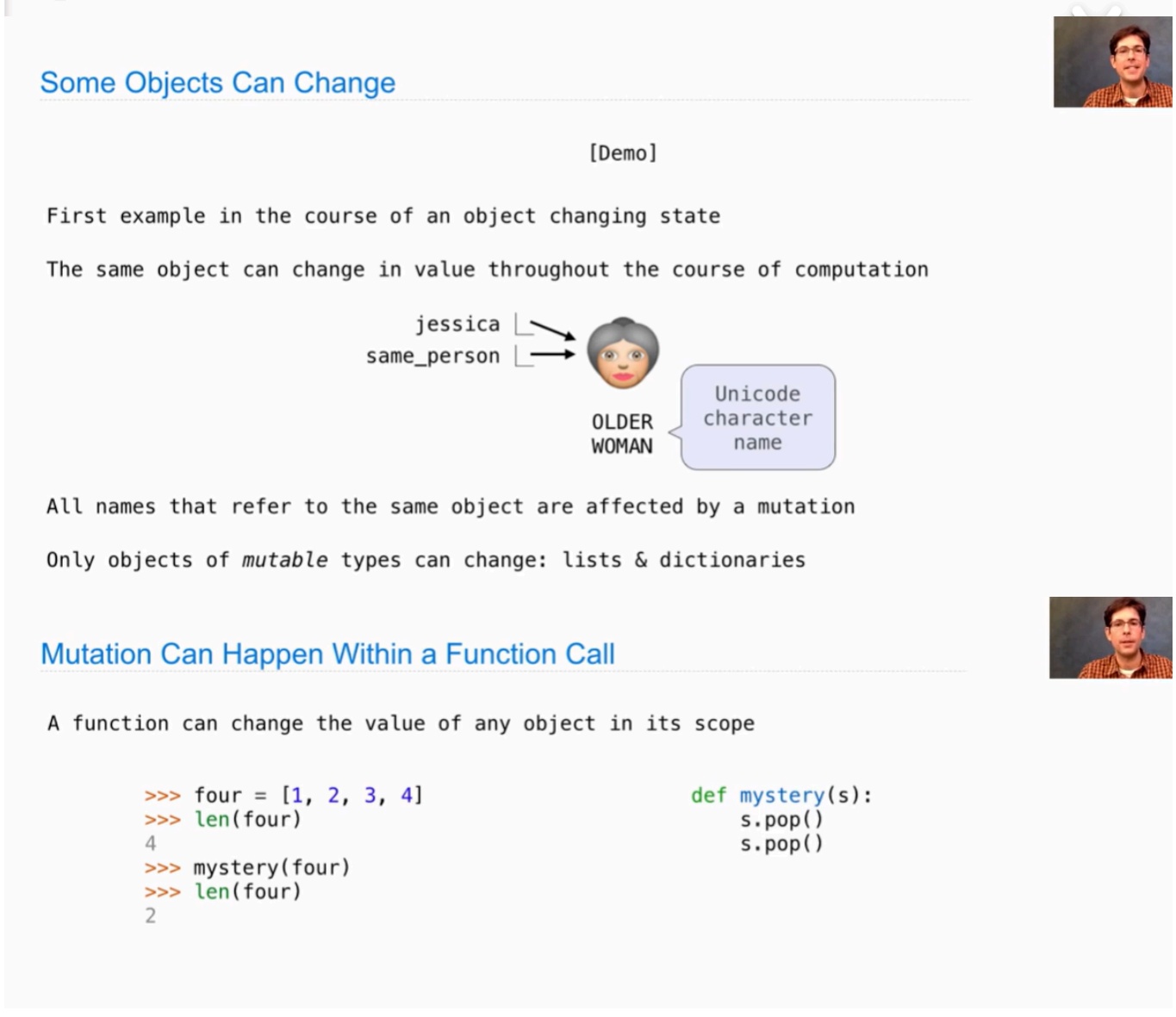
Representing Strings: the Unicode Standard



Mutation Operations

Some objects can change





Immutable values

Tuples

Tuples are Immutable Sequences

Immutable values are protected from mutation

```
>>> turtle = (1, 2, 3)
>>> ooze()
>>> turtle
(1, 2, 3)
```

Next lecture: ooze can change turtle's binding

```
>>> turtle = [1, 2, 3]
>>> ooze()
>>> turtle
['Anything could be inside!']
```

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

Name change:

```
>>> x = 2
>>> x + x
4
>>> x = 3
>>> x + x
6
```

Object mutation:

```
>>> x = [1, 2]
>>> x + x
[1, 2, 1, 2]
>>> x.append(3)
>>> x + x
[1, 2, 3, 1, 2, 3]
```

An immutable sequence may still change if it *contains* a mutable value as an element

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

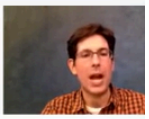
Mutations

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
- A compound data object has an "identity" in addition to the pieces of which it is composed
- A list is still "the same" list even if we change its contents
- Conversely, we could have two lists that happen to have the same contents, but are different

```
>>> a = [10]
>>> b = a
>>> a == b
True
>>> a.append(20)
>>> a == b
True
>>> a
[10, 20]
>>> b
[10, 20]
```

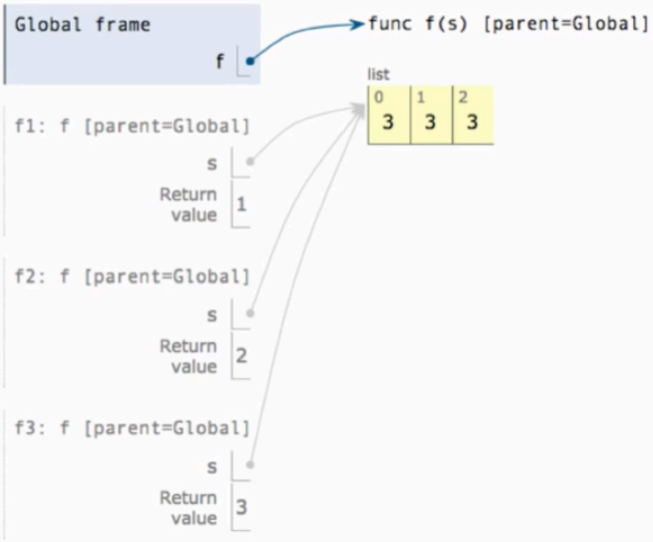
```
>>> a = [10]
>>> b = [10]
>>> a == b
True
>>> b.append(20)
>>> a
[10]
>>> b
[10, 20]
>>> a == b
False
```



Mutable Default Arguments are Dangerous

A default argument value is part of a function value, not generated by a call

```
>>> def f(s=[]):
...     s.append(5)
...     return len(s)
...
>>> f()
1
>>> f()
2
>>> f()
3
```



Interactive Diagram

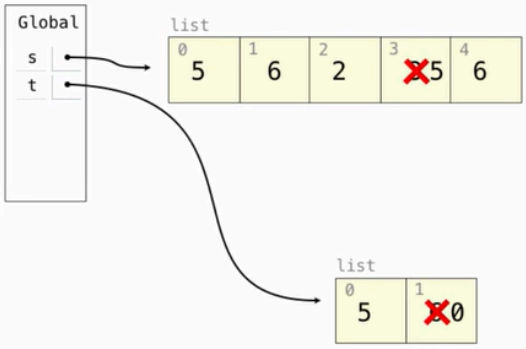
> 简单的来说，在python中，tuple，int这些immutable value在赋值的时候只能整体赋值，当重新赋值的时候，事实上他们是指向不同的值（name bound to values）而不是相同的地址。而mutable values，比如list，在创建的时候，比如[]，就已经给定了这一个位置，name bound的是位置，而不是值。

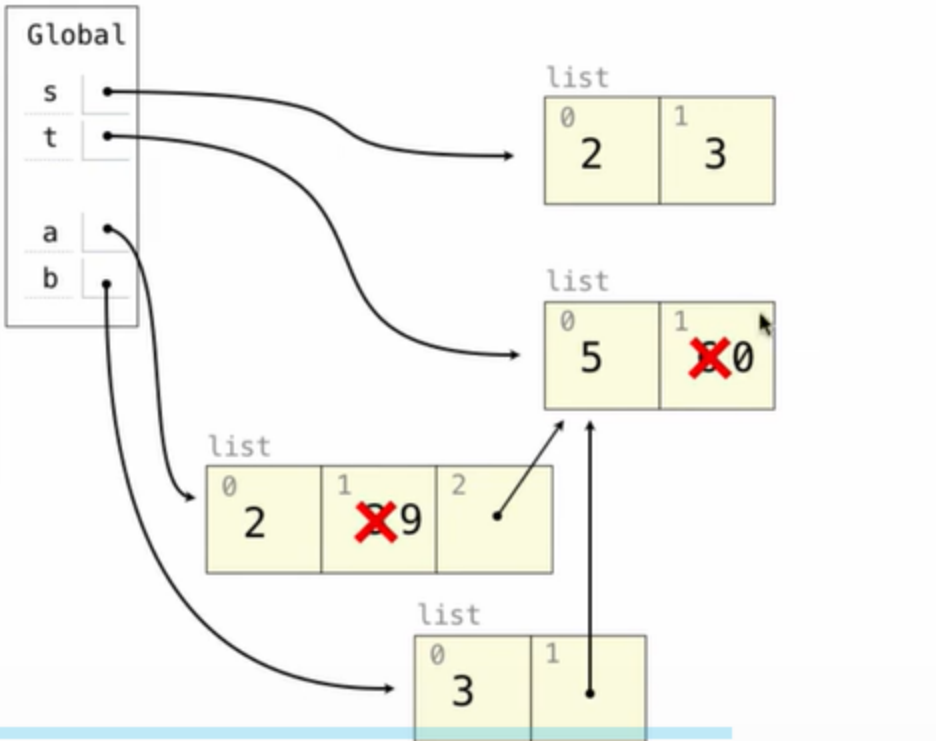
Lists in Environment Diagrams

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]]
The **list** function also creates a new list containing existing elements	t = list(s) s[1] = 0	s → [2, 0] t → [2, 3]
slice assignment replaces a slice with new values	s[0:0] = t s[3:] = t t[1] = 0	s → [5, 6, 2, 5, 6] t → [5, 0]

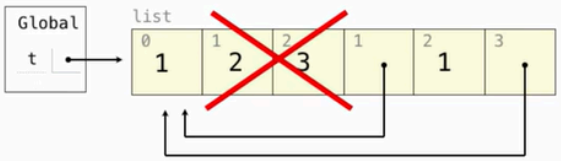




Operation	Example	Result
pop removes & returns the last element	`t = s.pop()`	`s → [2]` `t → 3`
remove removes the first element equal to the argument	`t.extend(t)` `t.remove(5)`	`s → [2, 3]` `t → [6, 5, 6]`
slice assignment can remove elements from a list by assigning [] to a slice.	`s[:1] = []` `t[0:2] = []`	`s → [3]` `t → []`

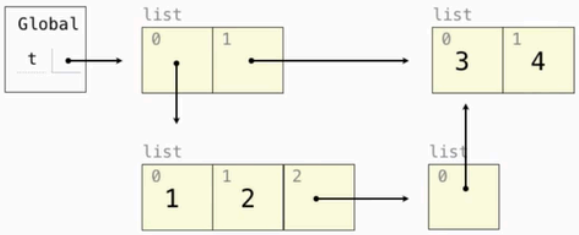
Lists in Lists in Lists in Environment Diagrams

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



`[1, [...], 1, [...]]`

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



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