[220 / 319] Functions as Objects

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Radical Claim:

Functions are Objects

implications:

- variables can reference functions
- lists/dicts can reference functions
- we can pass function references to other functions
- we can pass lists of function references to other functions
- ...

```
l1 = [1, 2, 3]
l2 = l1

def f(l):
    return l[-1]

g = f

num = f(l2)
```

which line of code is most novel for us?

```
l1 = [1, 2, 3]
l2 = l1

def f(l):
    return l[-1]

g = f

num = f(l2)
```

Explanation: l1 should reference a new list object

Explanation: l2 should reference whatever l1 references

Explanation: f should reference a new function object

Explanation: g should reference whatever f references

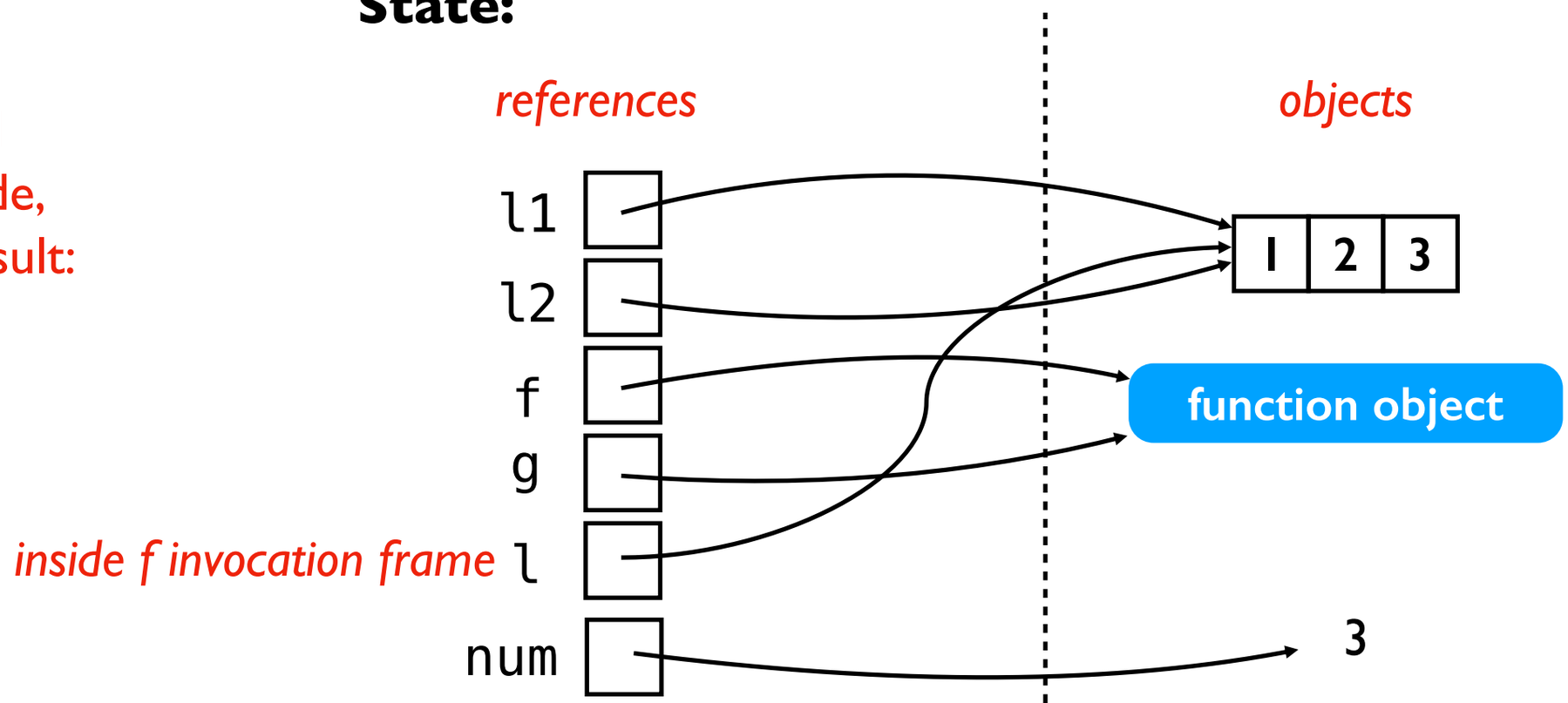
Explanation: l should reference whatever l2 references

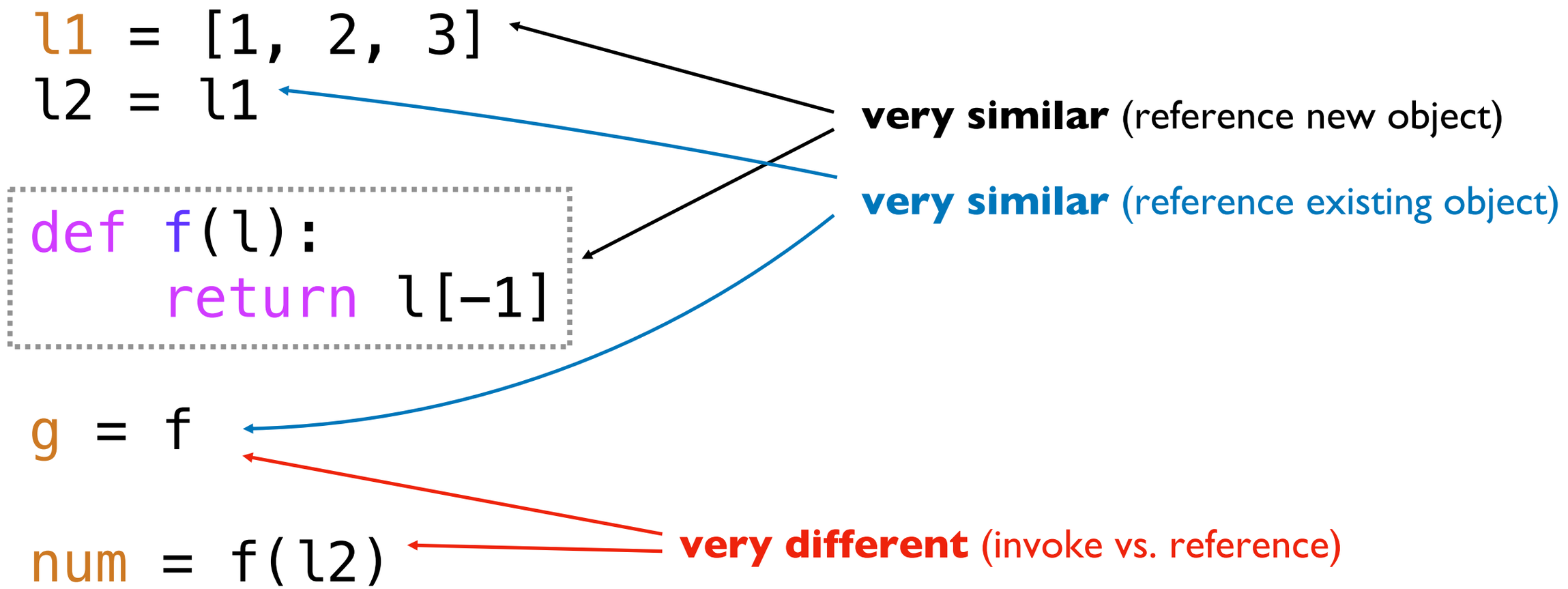
Explanation: num should reference whatever f returns

both these calls would have run the same code, returning the same result:

- `num = f(l1)`
- `num = g(l2)`

State:




l1 = [1, 2, 3]
l2 = l1
def f(l):
return l[-1]
g = f
num = f(l2)
very similar (reference new object)
very similar (reference existing object)
very different (invoke vs. reference)

CODING DEMOS

[Python Tutor]

Function References (Part 1)

Outline

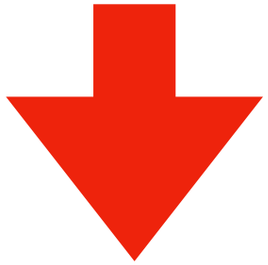
- functions as objects
- sort
- lambda

Example: Sorting Names

List of tuples:

```
names = [
      (“Catherine”, “Baker”),
      (“Alice”, “Clark”),
      (“Bob”, “Adams”),
]
```

Catherine	Baker
Bob	Adams
Alice	Clark



```
names.sort()
```

sorting tuples is done on first element
(ties go to 2nd element)

Alice	Clark
Bob	Adams
Catherine	Baker

Example: Sorting Names

List of tuples:

```
names = [
     (“Catherine”, “Baker”),
     (“Alice”, “Clark”),
     (“Bob”, “Adams”),
]
```

Catherine	Baker
Bob	Adams
Alice	Clark

```
names.sort()
```

what if we want to sort by the last name?

or by the length of the name?

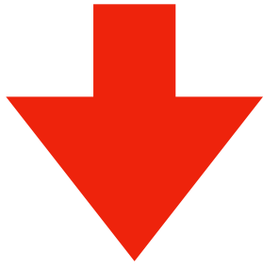
Alice	Clark
Bob	Adams
Catherine	Baker

Example: Sorting Names

List of tuples:

```
names = [
     (“Catherine”, “Baker”),
     (“Alice”, “Clark”),
     (“Bob”, “Adams”),
]
```

Catherine	Baker
Bob	Adams
Alice	Clark



```
def extract(name_tuple):
     return name_tuple[1]

names.sort(key=extract)
```

Example: Sorting Names

List of tuples:

```
names = [
     (“Catherine”, “Baker”),
     (“Alice”, “Clark”),
     (“Bob”, “Adams”),
]
```

```
def extract(name_tuple):
     return name_tuple[1]

names.sort(key=extract)
```

Catherine	Baker
Bob	Adams
Alice	Clark

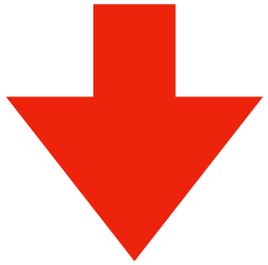
Bob	Adams
Catherine	Baker
Alice	Clark

Example: Sorting Names

List of tuples:

```
names = [
     (“Catherine”, “Baker”),
     (“Alice”, “Clark”),
     (“Bob”, “Adams”),
]
```

Catherine	Baker
Bob	Adams
Alice	Clark



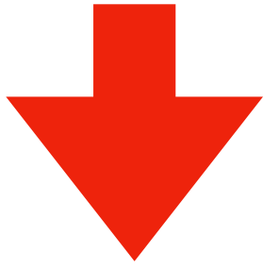
```
def extract(name_tuple):
     return len(name_tuple[0])

names.sort(key=extract)
```

Example: Sorting Names

List of tuples:

```
names = [
     (“Catherine”, “Baker”),
     (“Alice”, “Clark”),
     (“Bob”, “Adams”),
]
```

Catherine	Baker
Bob	Adams
Alice	Clark



```
def extract(name_tuple):
     return len(name_tuple[0])

names.sort(key=extract)
```

Bob	Adams
Alice	Clark
Catherine	Baker

CODING DEMOS

[Jupyter notebook]

Function References (Part 1)

Outline

- functions as objects
- sort
- lambda

Example: Sorting Dictionary by keys using lambdas

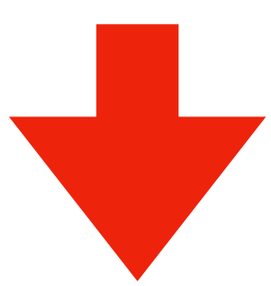
- lambda functions are a way to abstract a function reference
- multiple possible parameters and single expression as function body

***lambda* parameters: expression**

Dictionary:

```
players = {"bob": 20, "alice": 8,
"alex": 9}

dict(sorted(players.items(), key
= lambda item: item[0]))
```

bob	20
alice	8
alex	9



alex	9
alice	8
bob	20

Example: Sorting Dictionary by values using lambdas

- lambda functions are a way to abstract a function reference
- multiple possible parameters and single expression as function body

lambda **parameters:**
expression

Dictionary:

```
players = {"bob": 20, "alice": 8,
"alex": 9}

dict(sorted(players.items(), key
= lambda item: item[1]))
```

bob	20
alice	8
alex	9

alice	8
alex	9
bob	20