[301] Copying

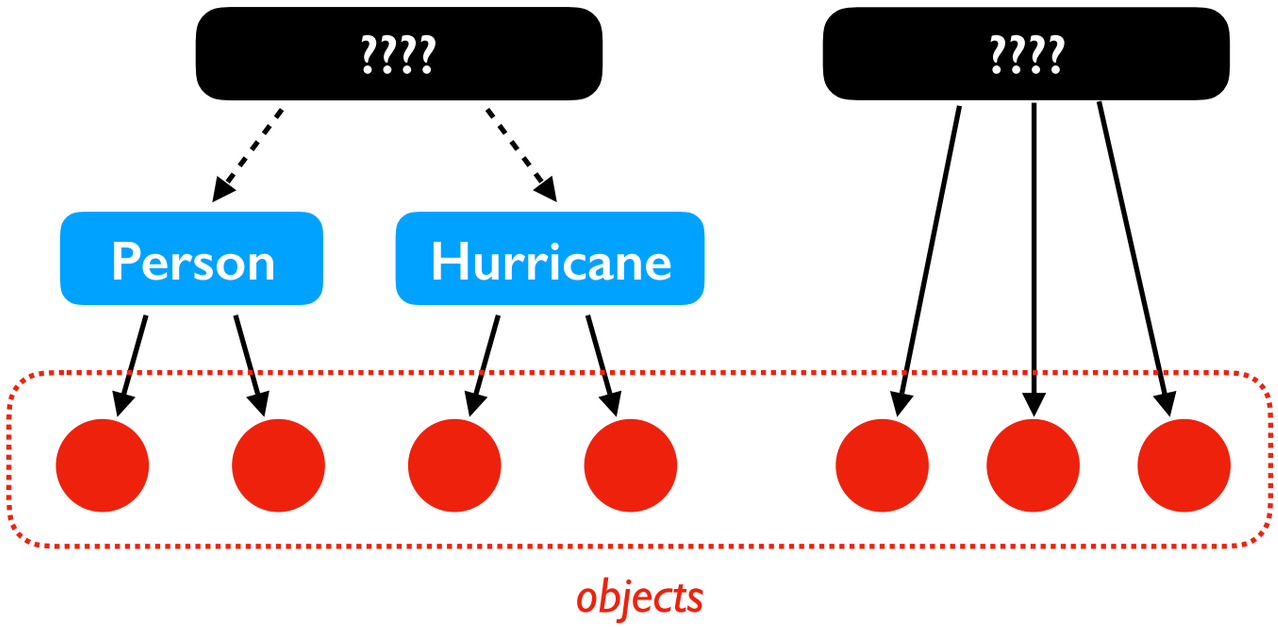
Tyler Caraza-Harter

Test yourself!

A what do variables contain?

1. objects
2. references to objects

B how should we label the blanks in the hierarchy?



1. namedtuple, tuple
2. tuple, namedtuple

C which of the following live inside frames?

1. objects
2. variables

Learning Objectives Today

Practice objects/references!

Levels of copying

- Making a new reference
- Shallow copy
- Deep copy

https://www.copymachinesdirect.com/copier-leasing.php

Read:

- ✦ Sweigart Ch 4 ("References" to the end)
  https://automatetheboringstuff.com/chapter4/

Today's Outline

Review

More references

Copying

- reference
- shallow
- deep

Worksheet

Worksheet Problem 1

What does assignment ACTUALLY do?

```
x = ["A","B","C"]
y = x
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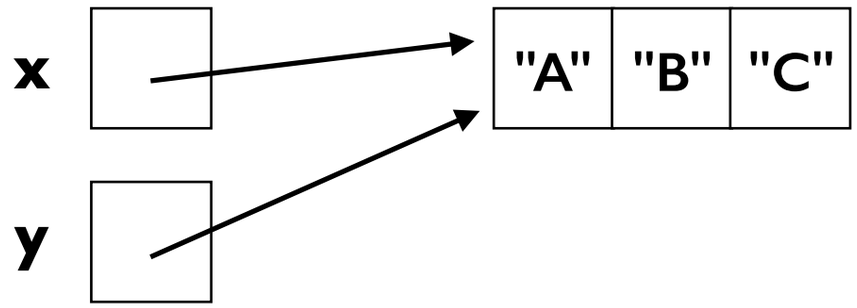

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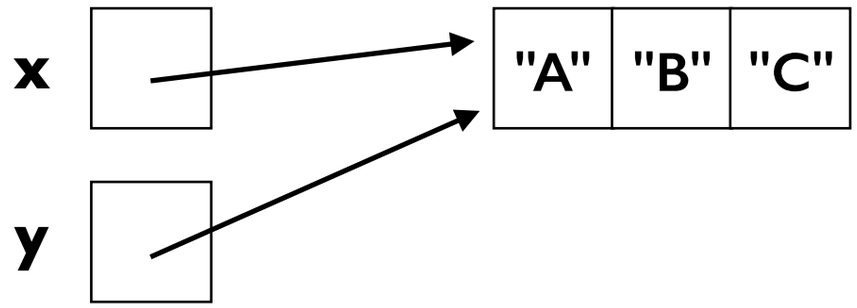

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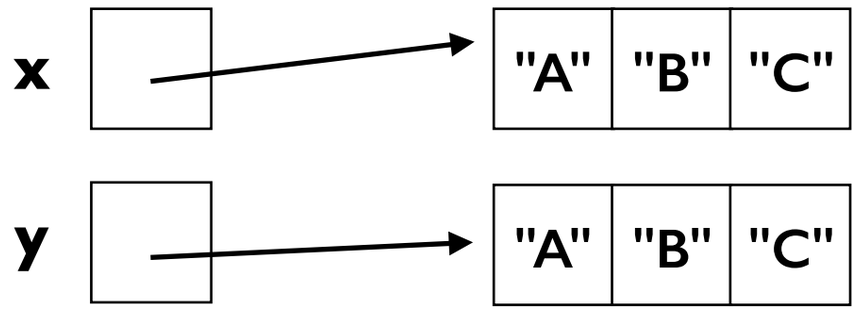
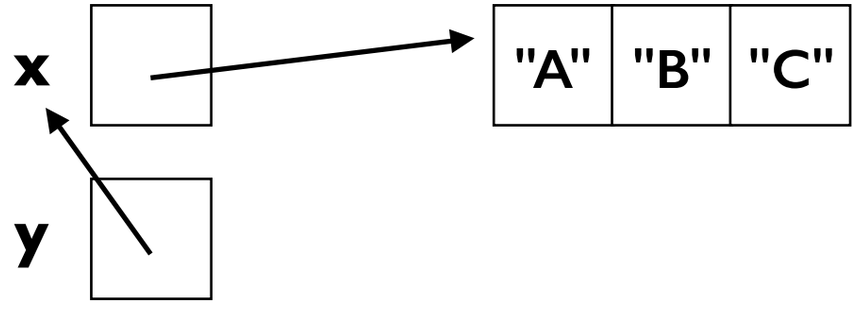
NO



different code would be needed to do this

NO



no code could ever make this happen

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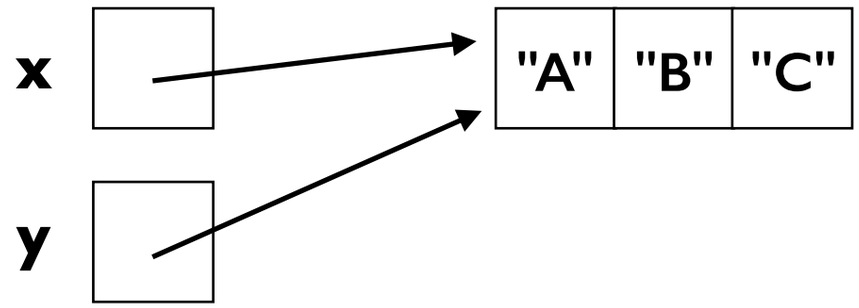

What does assignment ACTUALLY do?

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x = ["A","B","C"]
y = x

def f(y):
    pass

x = ["A", "B", "C"]
f(x)
```

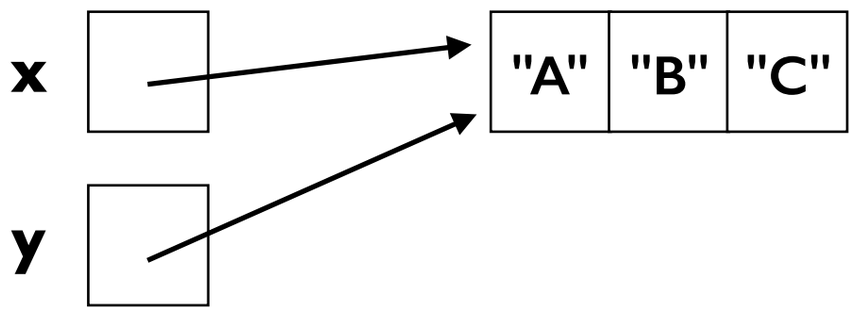

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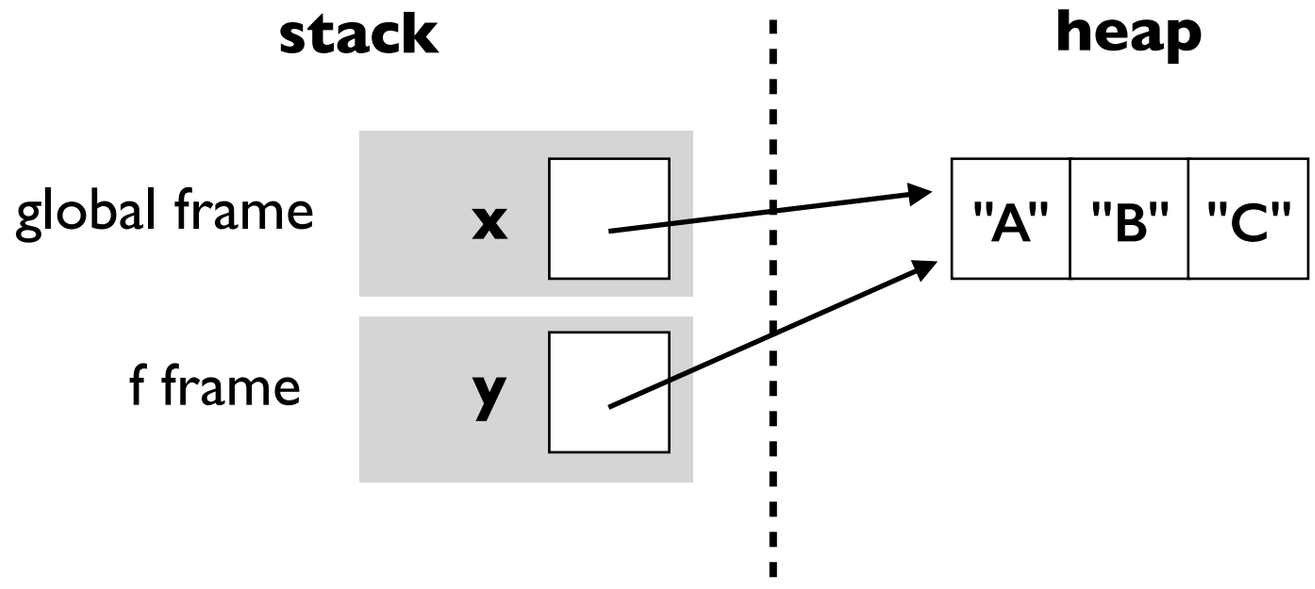
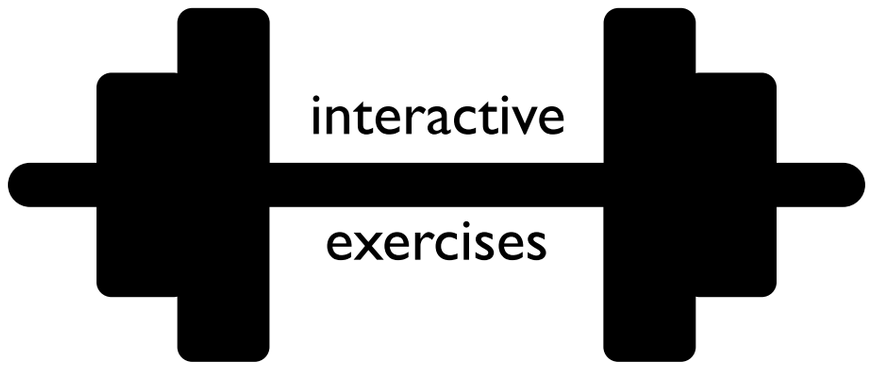


Example 1

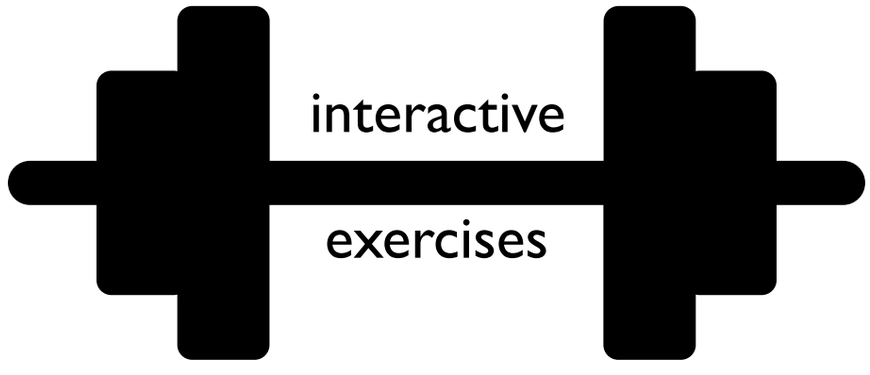
```
x = {}

y = x
y["WI"] = "Madison"
print(x["WI"])
```



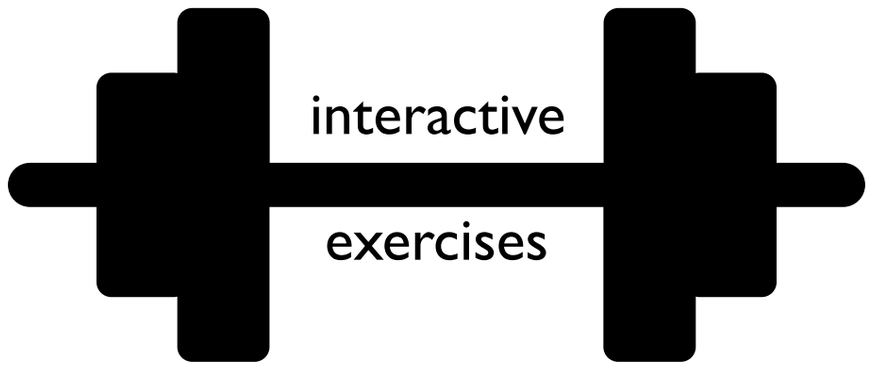
Example 2

```
def foo(nums):
    nums.append(3)
    print(nums)
items = [1,2]
numbers = items
foo(numbers)
print(items)
print(numbers)
```



Example 3

```
x = ["aaa", "bbb"]
y = x[:]
x.pop(0)
print(len(y))
```



Worksheet Problems 2-6

Today's Outline

Review

More references

Copying

- reference
- shallow
- deep

Worksheet

```
from recordclass import recordclass

Person = recordclass("Person", ["name", "score", "age"])

alice = Person(name="Alice", score=10, age=30)
bob = Person(name="Bob", score=8, age=25)
team = [alice, bob]
players = {"A": alice, "B": bob}
```

State:

references *objects*

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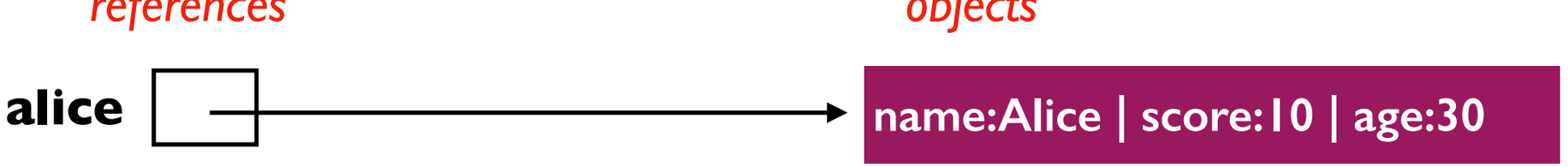

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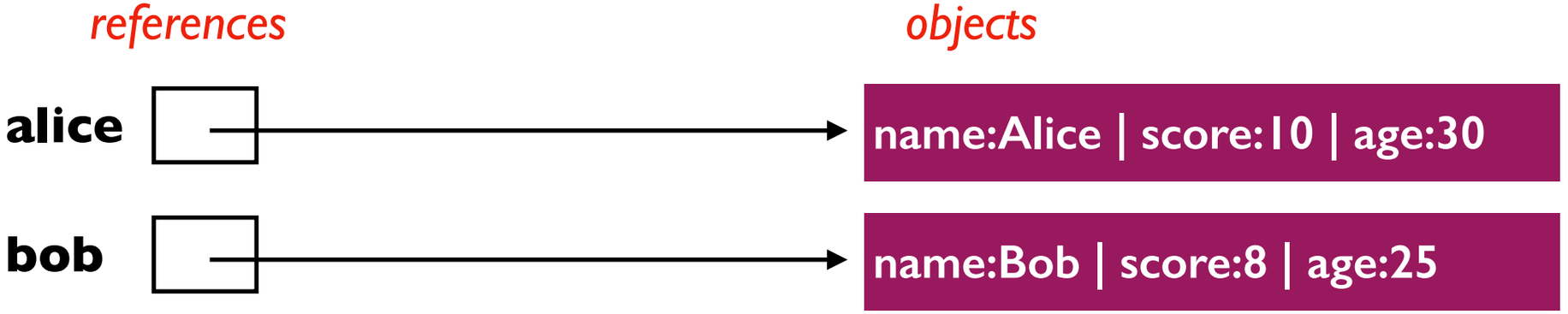

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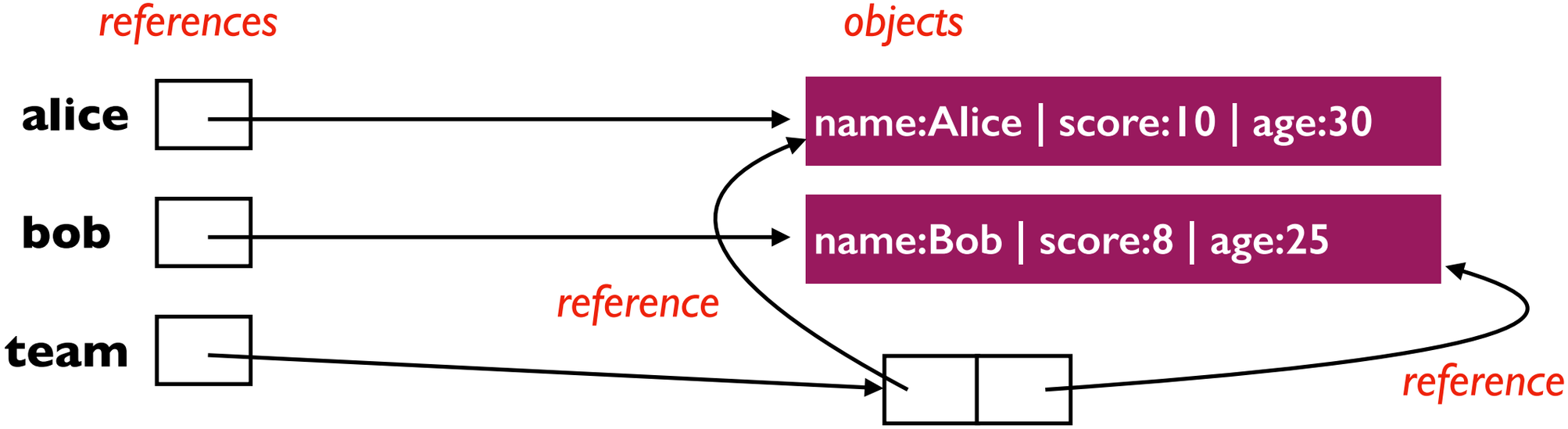

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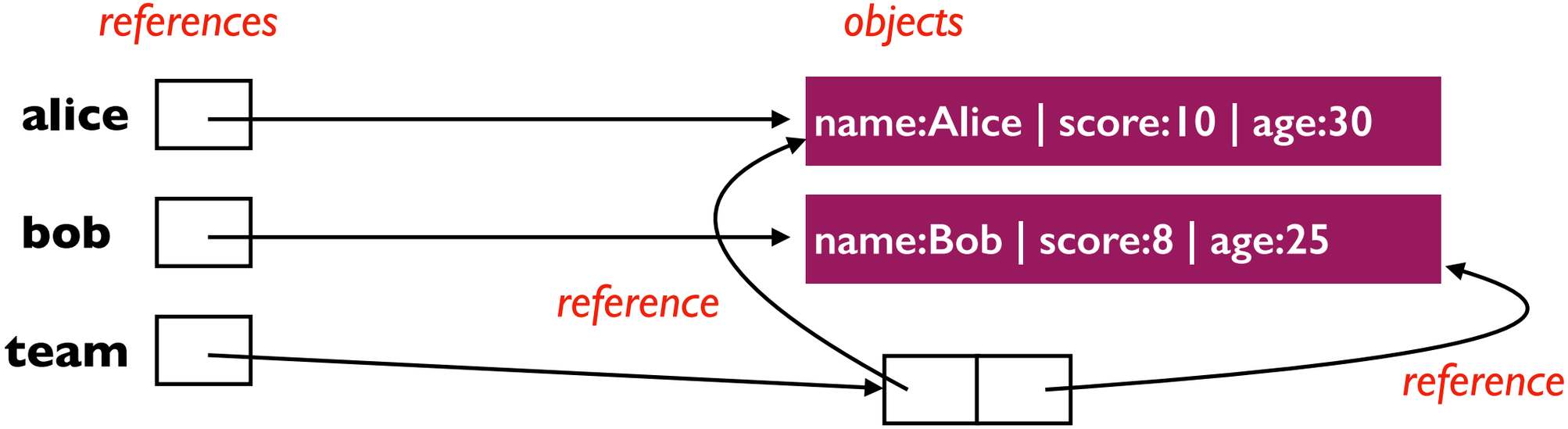

what DID NOT happen: `team` contains the `alice` and `bob` variables

what DID happen: `team` contains references to the objects referenced by `bob` and `alice`

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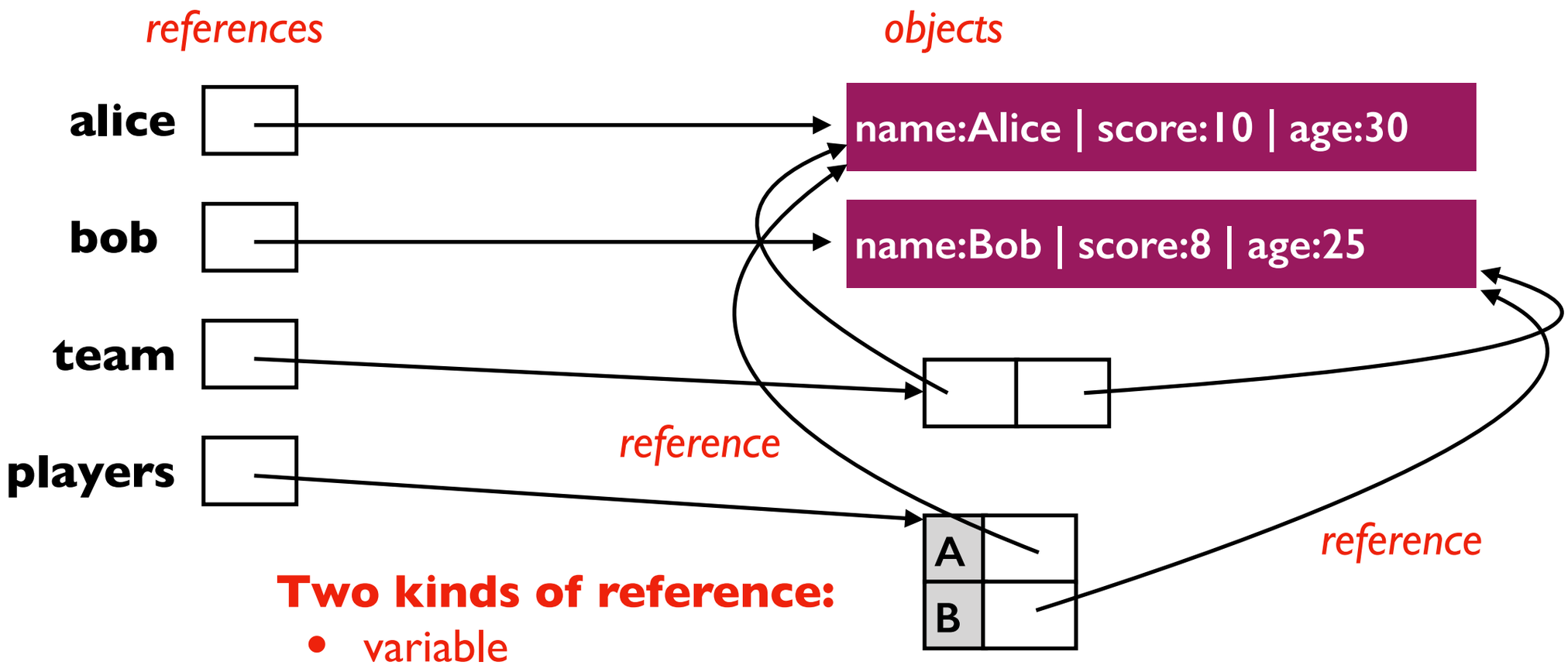


Two kinds of reference:

- variable
- item in list, dict, etc

Today's Outline

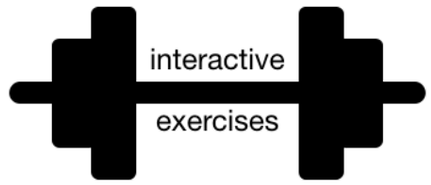
Review

More references

Copying
- reference
- shallow
- deep

Worksheet

Three Levels of Copy



When should we use which one?

```
import copy
x = [
   {"name":"A", "score":88},
   {"name":"B", "score":111},
   {"name":"C", "score":100}
]

# uncomment one of these
#y = x
#y = copy.copy(x)
#y = copy.deepcopy(x)
```

reference copy [fastest, most dangerous]

shallow copy

deep copy [slowest, safest]

Example: Player Scores

```
players = [
   {"name":"A", "score":88},
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]
```
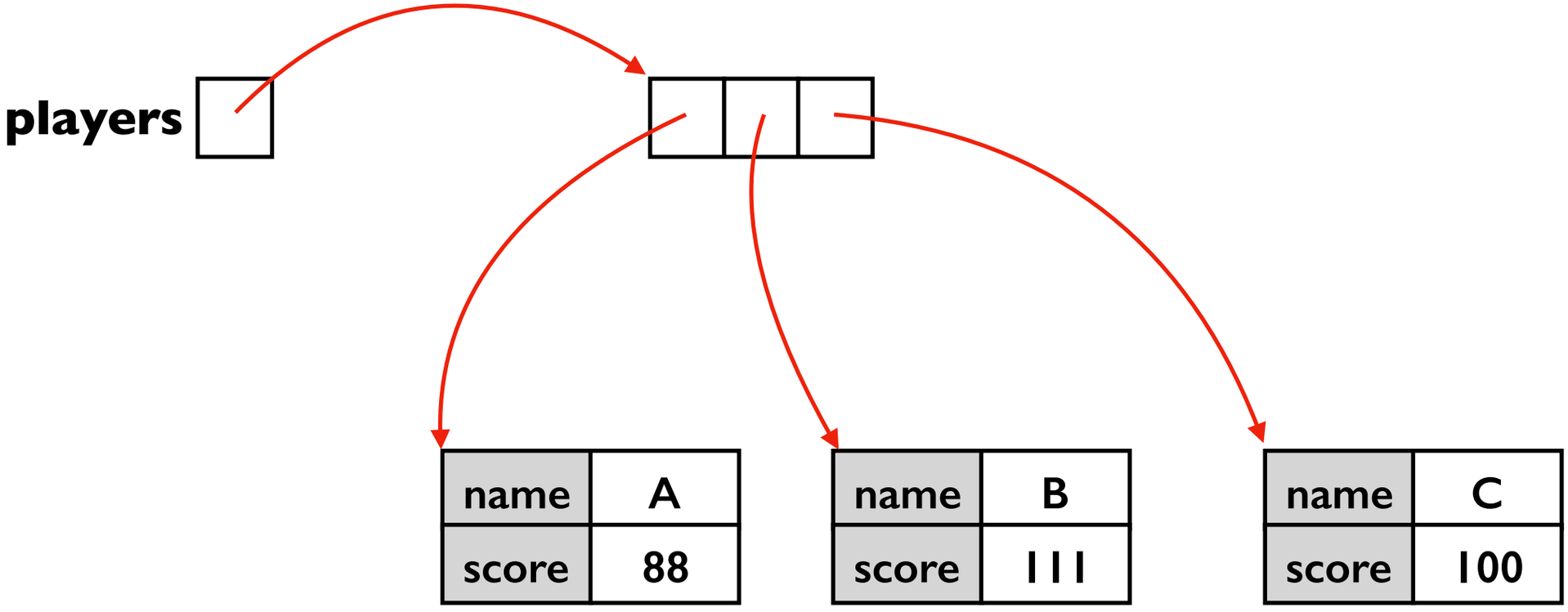

Depending on the use case,
there are **three ways** we might
"copy" the player's data



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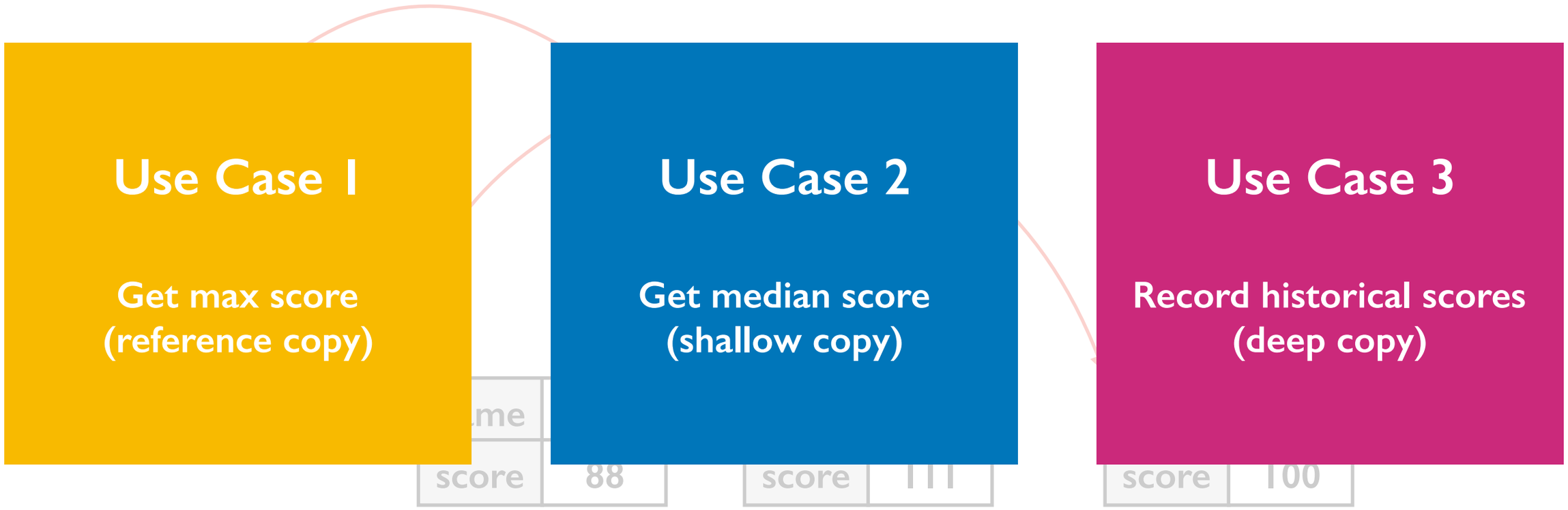

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Use Case 1

Get max score
(reference copy)

Use Case 2

Get median score
(shallow copy)

Use Case 3

Record historical scores
(deep copy)

```
def max_score(people):
  highest = None
  for p in people:
    if highest == None or p["score"] > highest:
      highest = p["score"]
  return highest


players = …
m = max_score(players)
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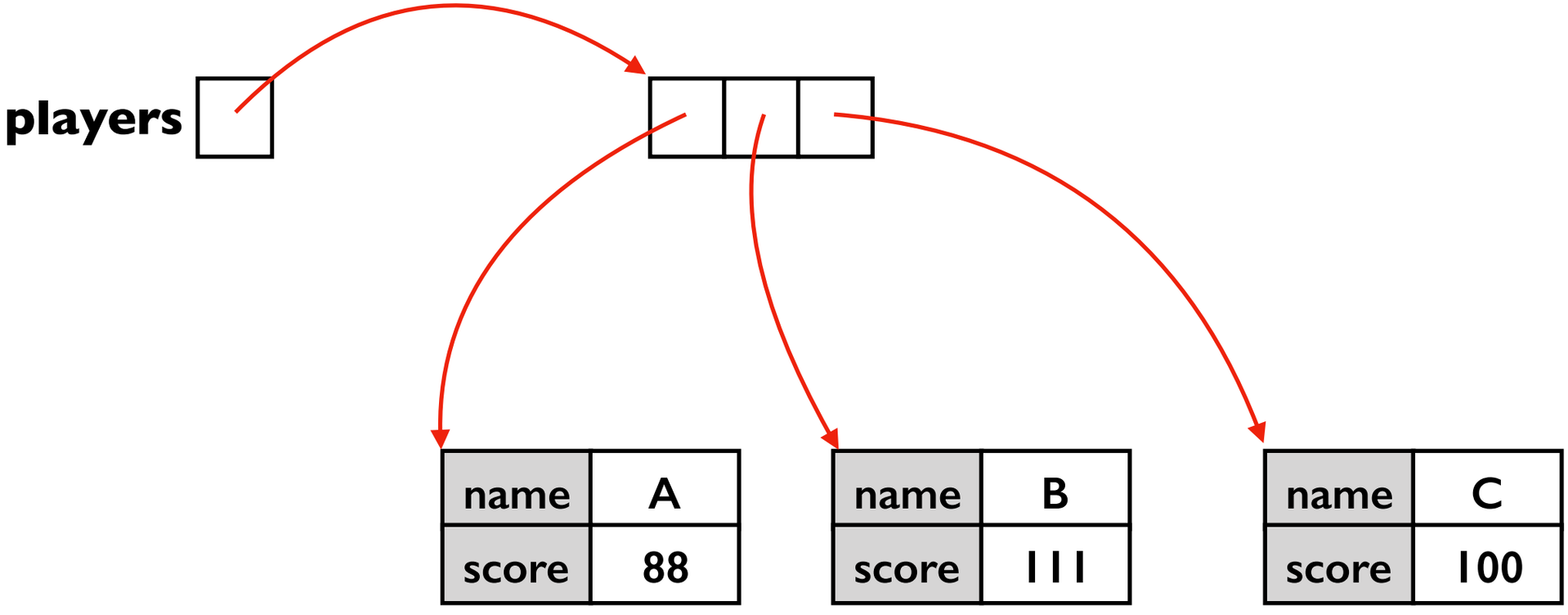

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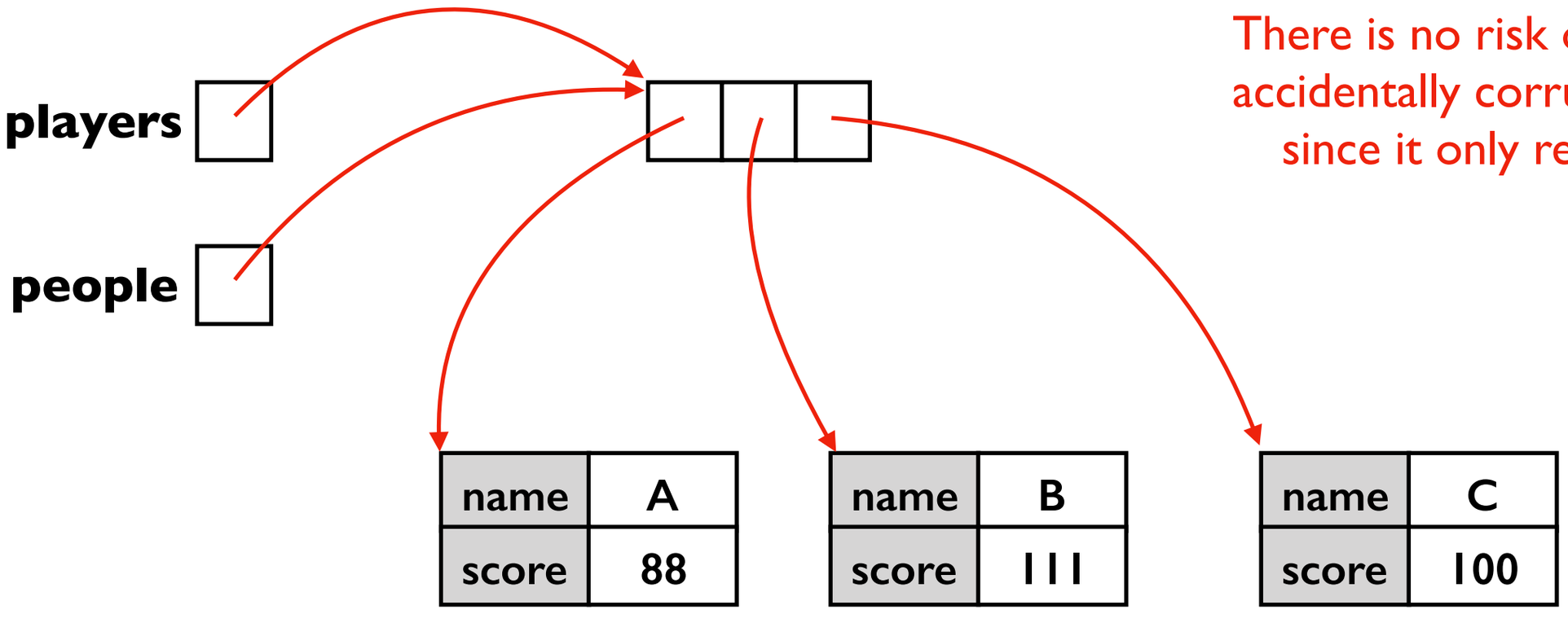

There is no risk of max_score accidentally corrupting players since it only reads people

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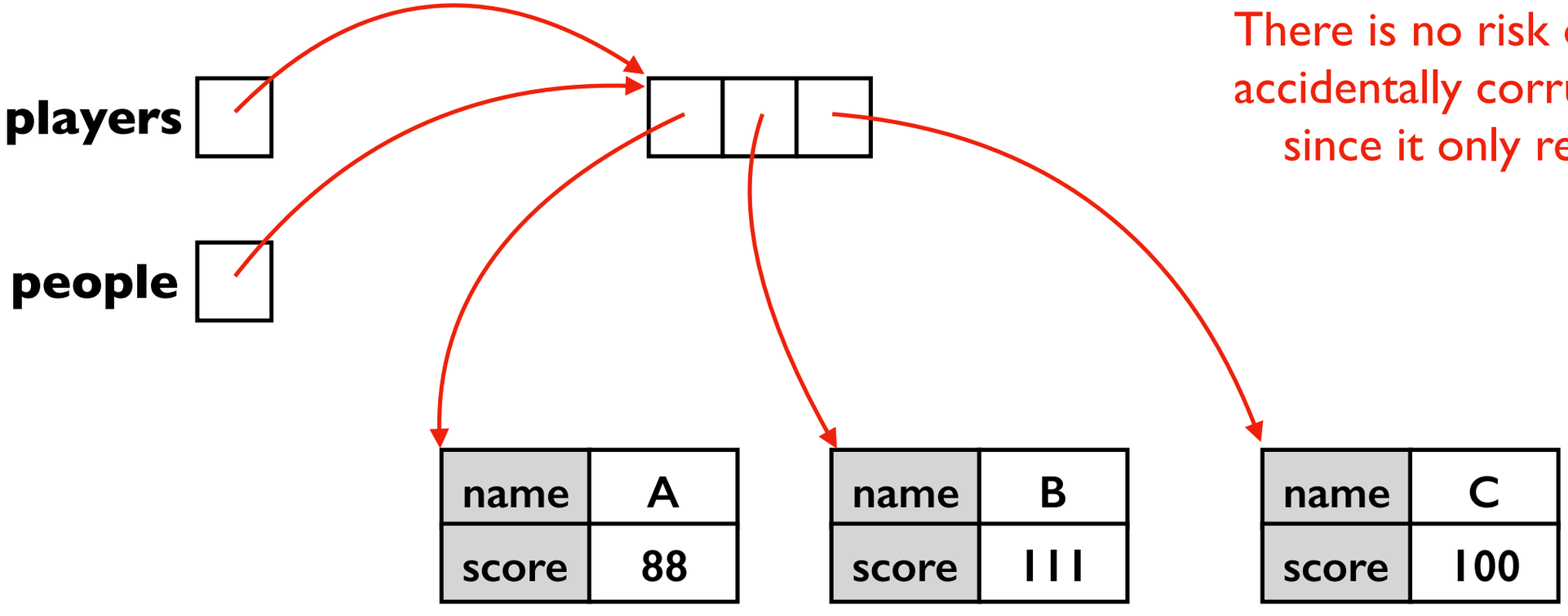

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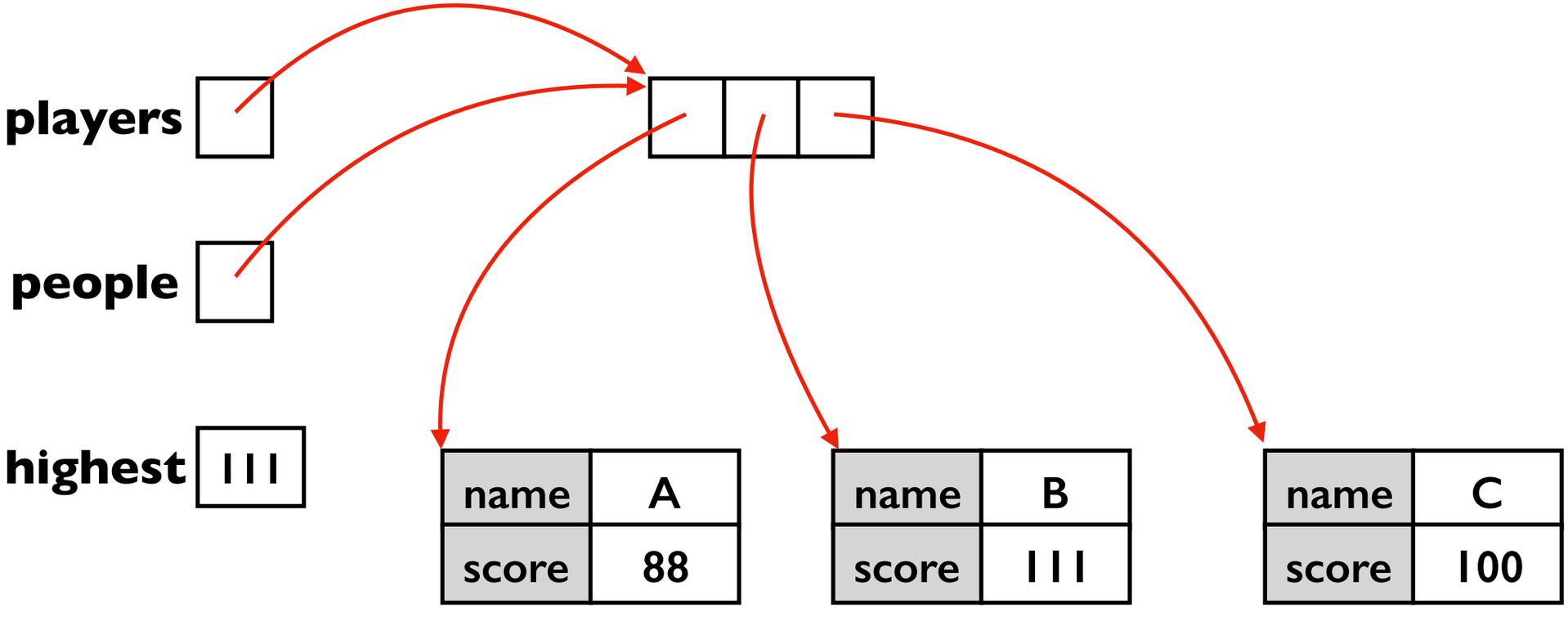

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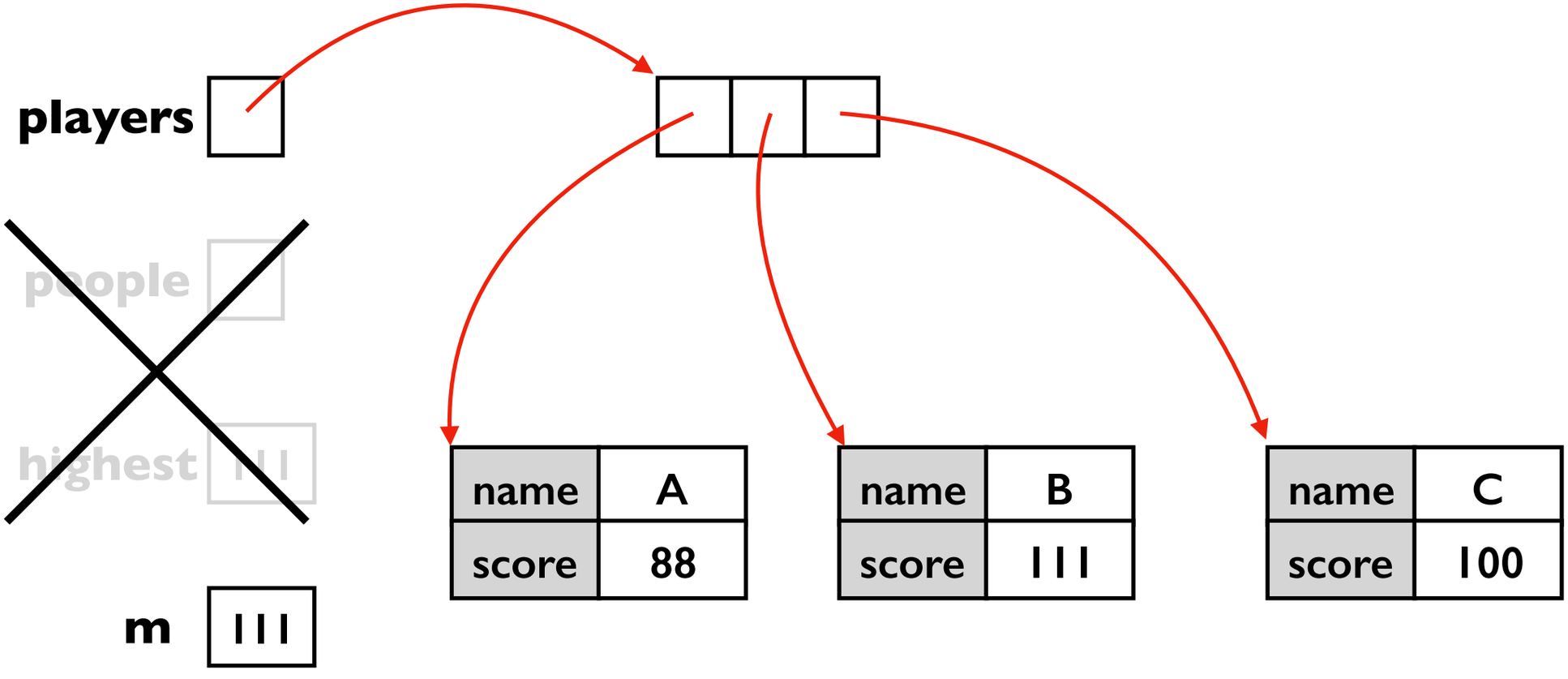

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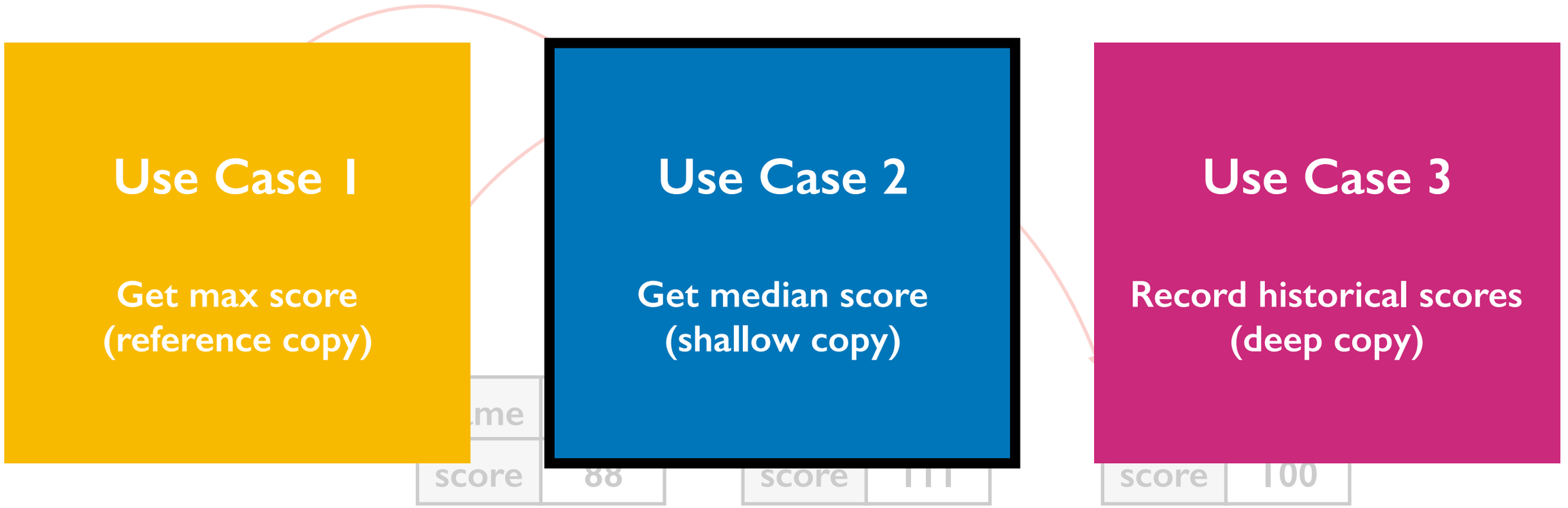

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  people = copy.copy(people)
  people.sort(...)
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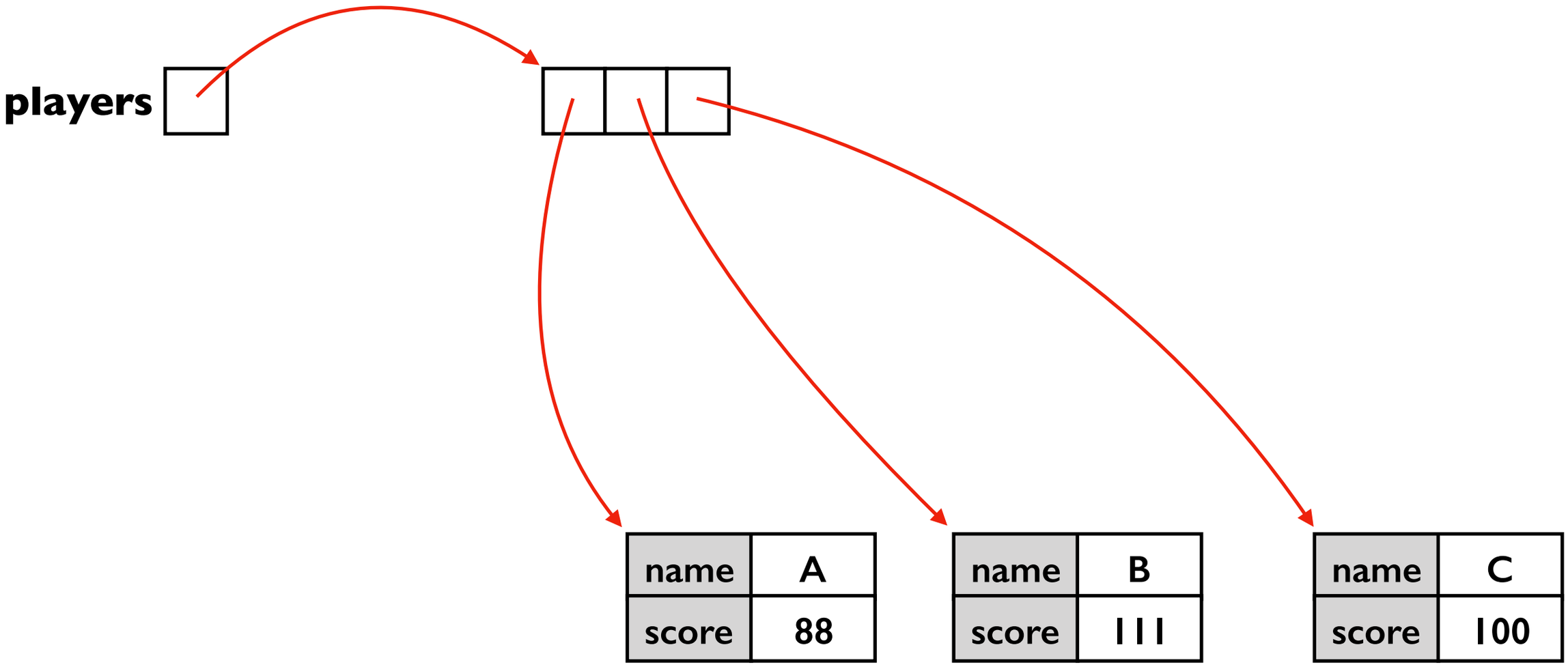

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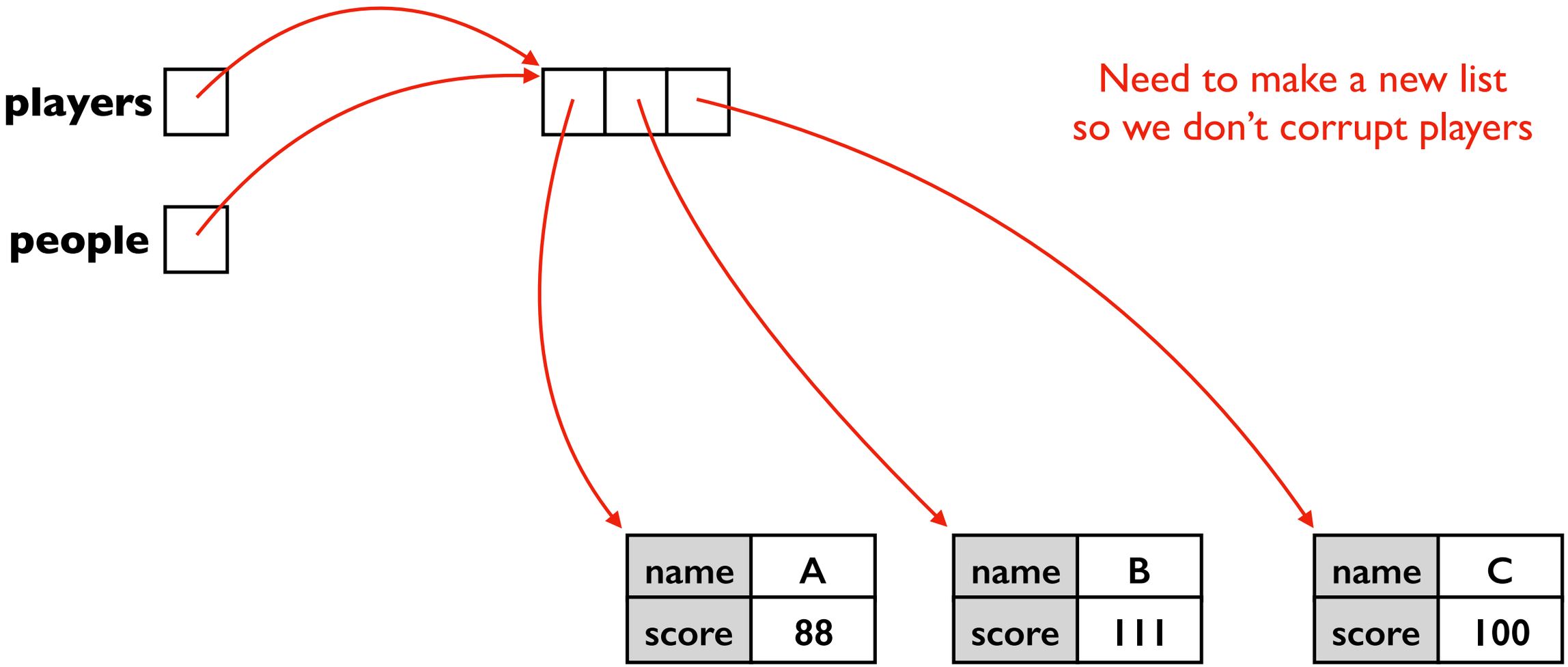

Need to make a new list
so we don't corrupt players

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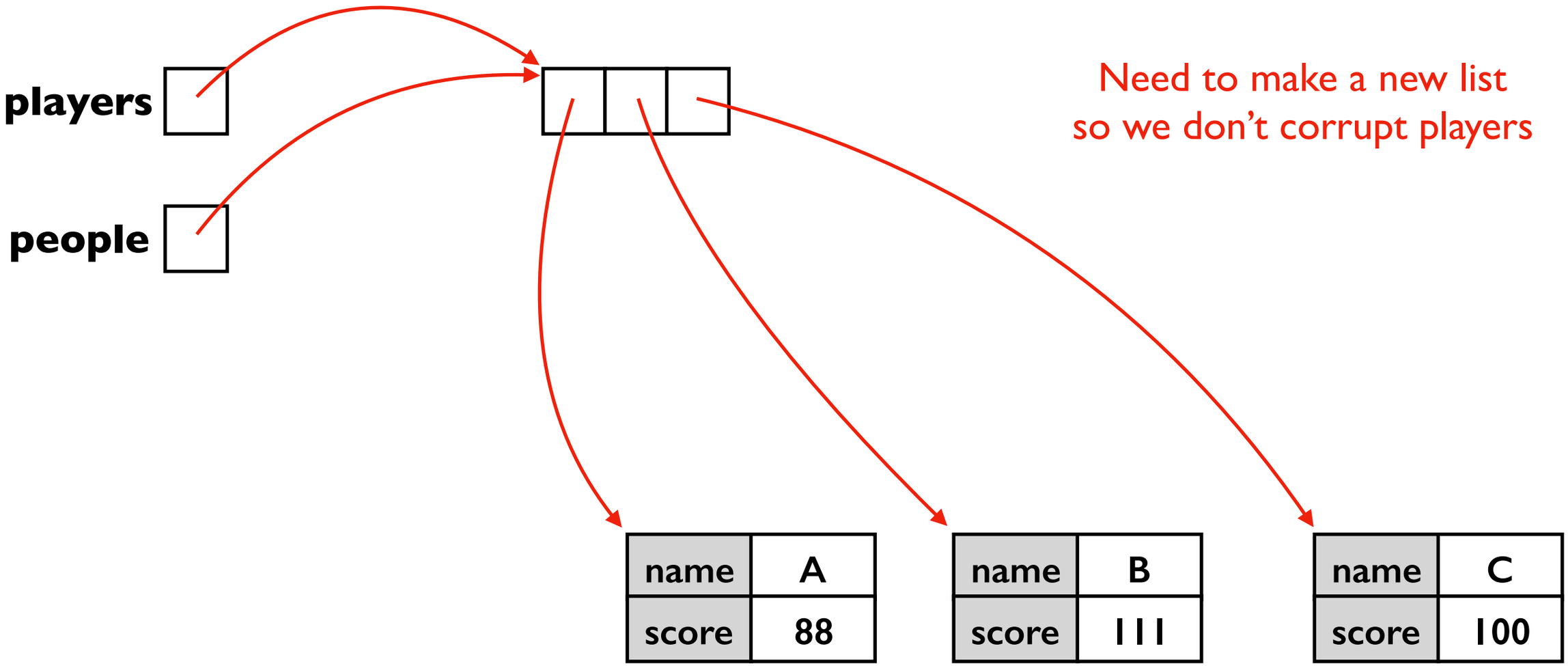

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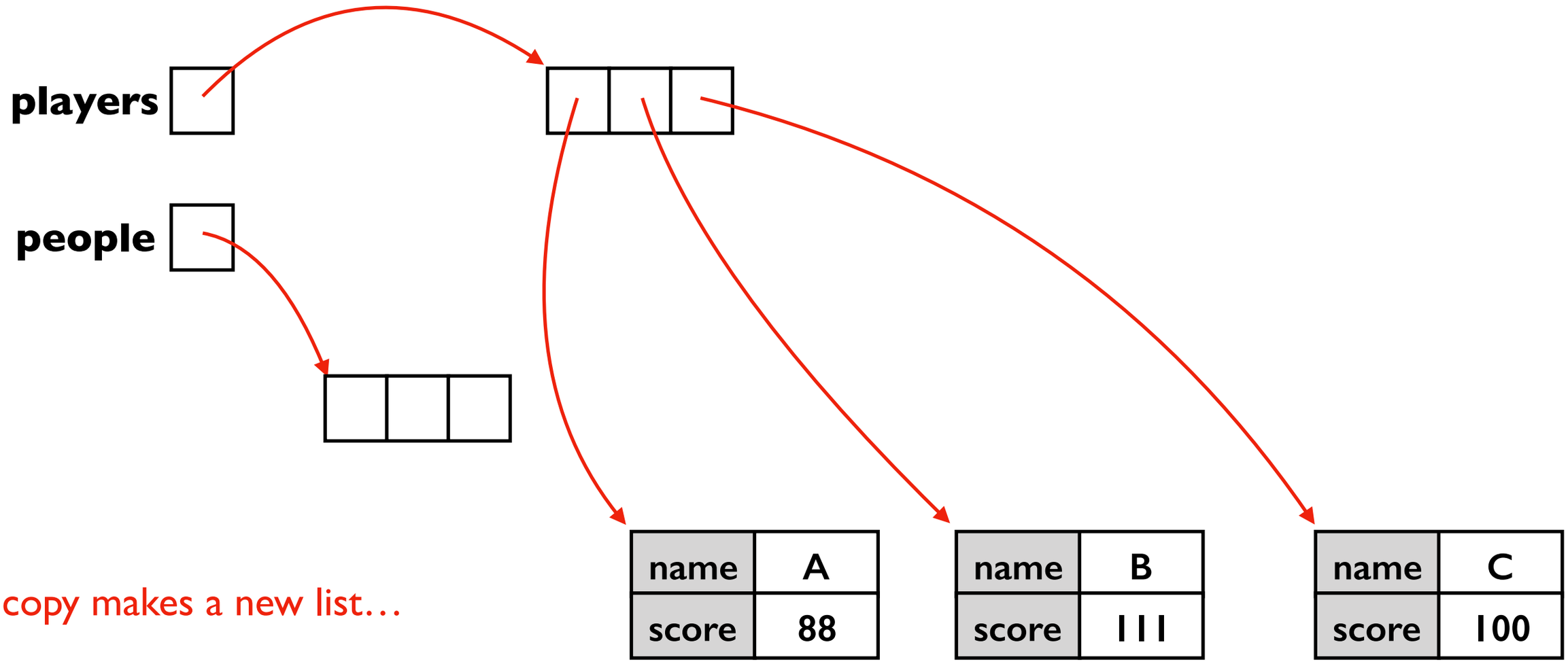

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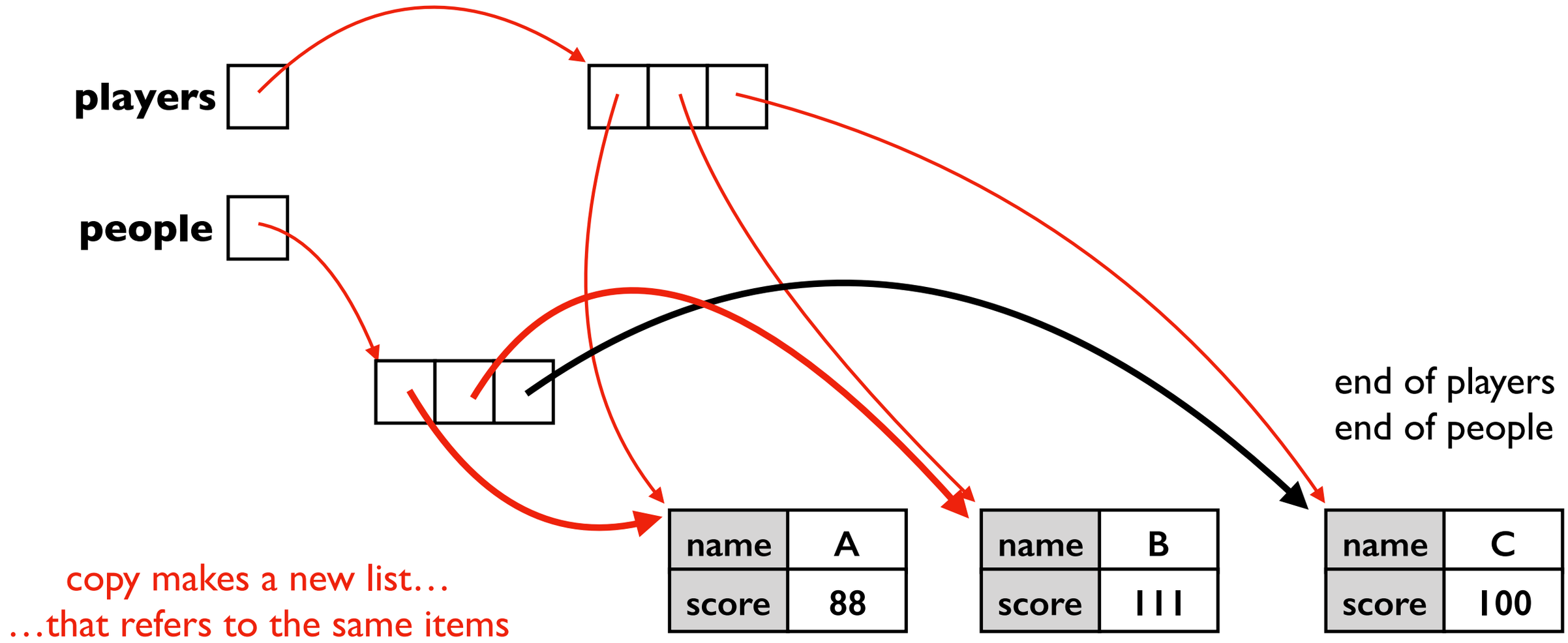

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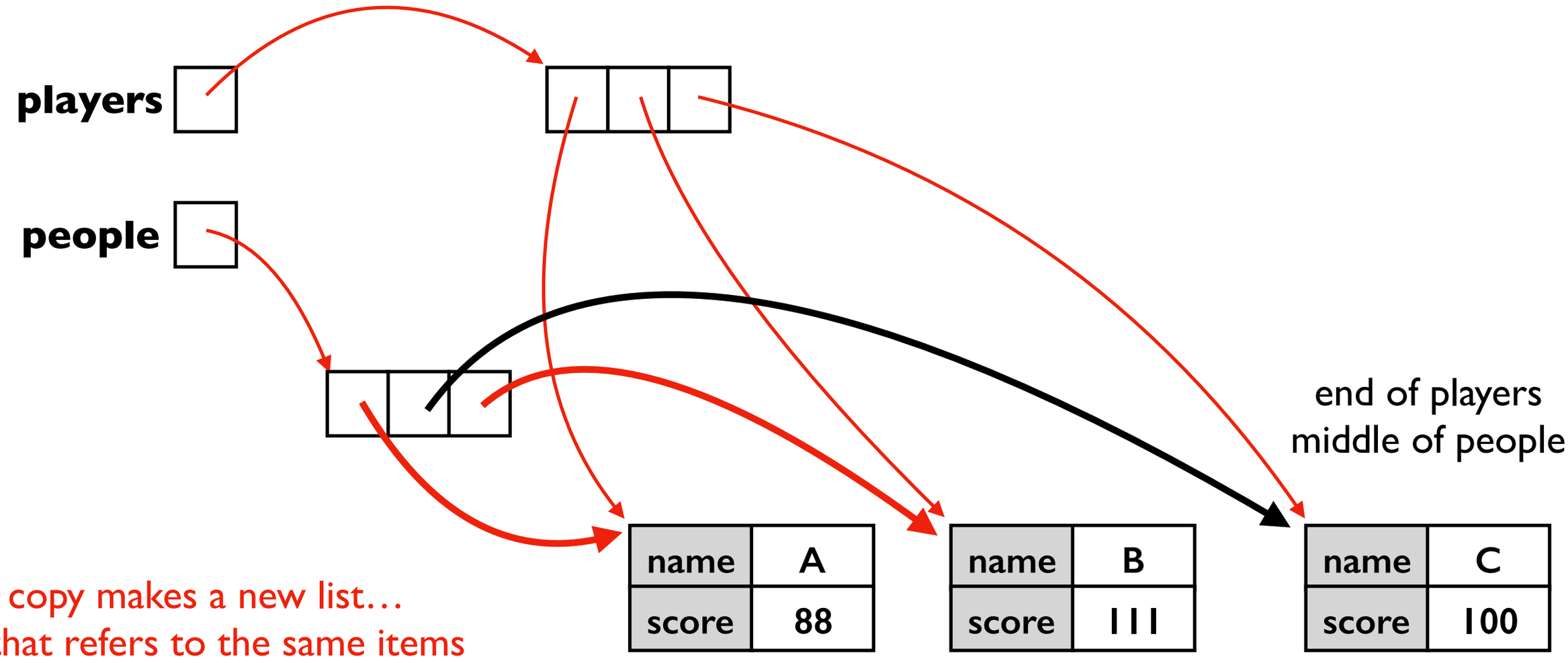

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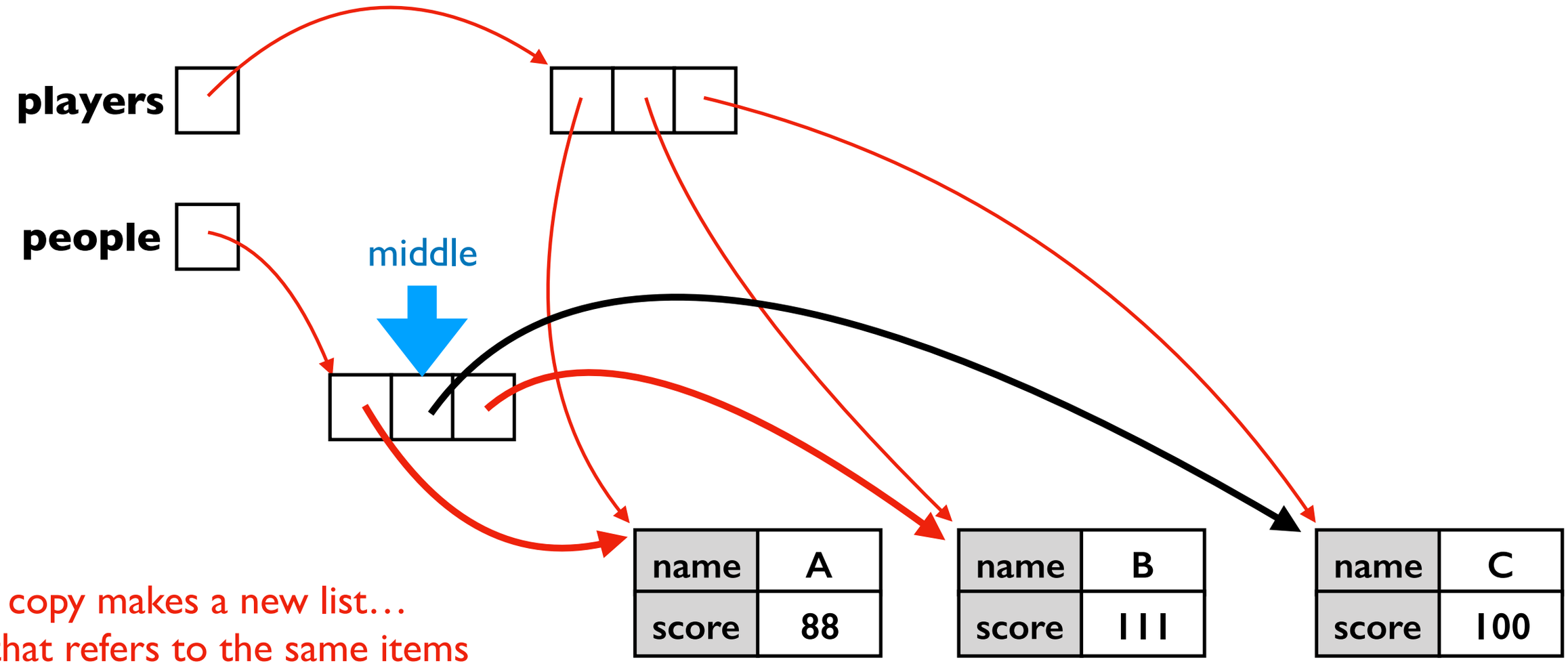

copy makes a new list…
…that refers to the same items

Example: Player Scores

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players = [
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  {"name":"C", "score":100}
]
```

Use Case 1

Get max score
(reference copy)

Use Case 2

Get median score
(shallow copy)

Use Case 3

Record historical scores
(deep copy)

```
players = …
players_before = copy.deepcopy(players)

# make changes to players
players[0]["score"] += 10


print("score change:",
      players[0]["score"] - players_before[0]["score"])
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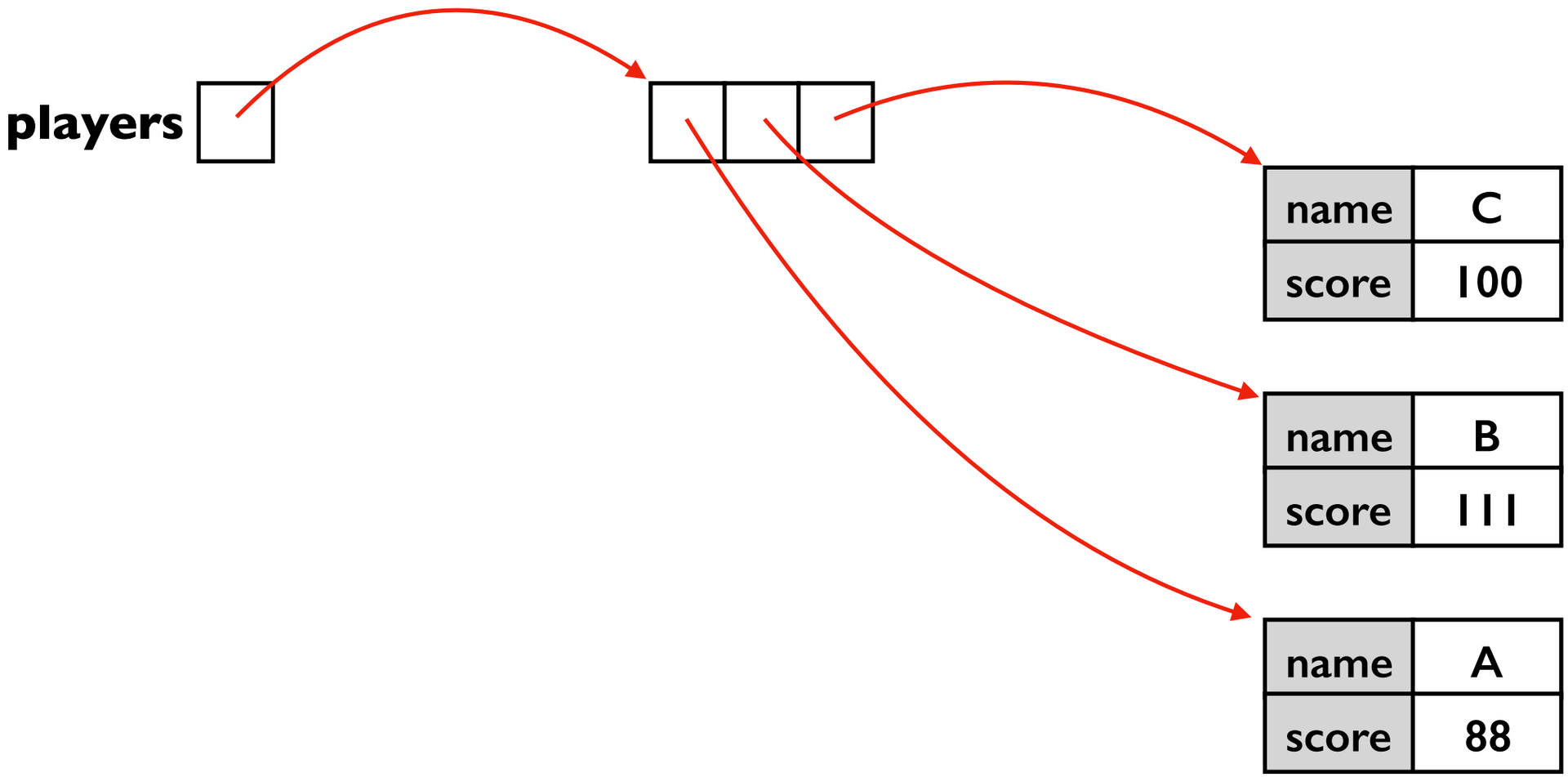

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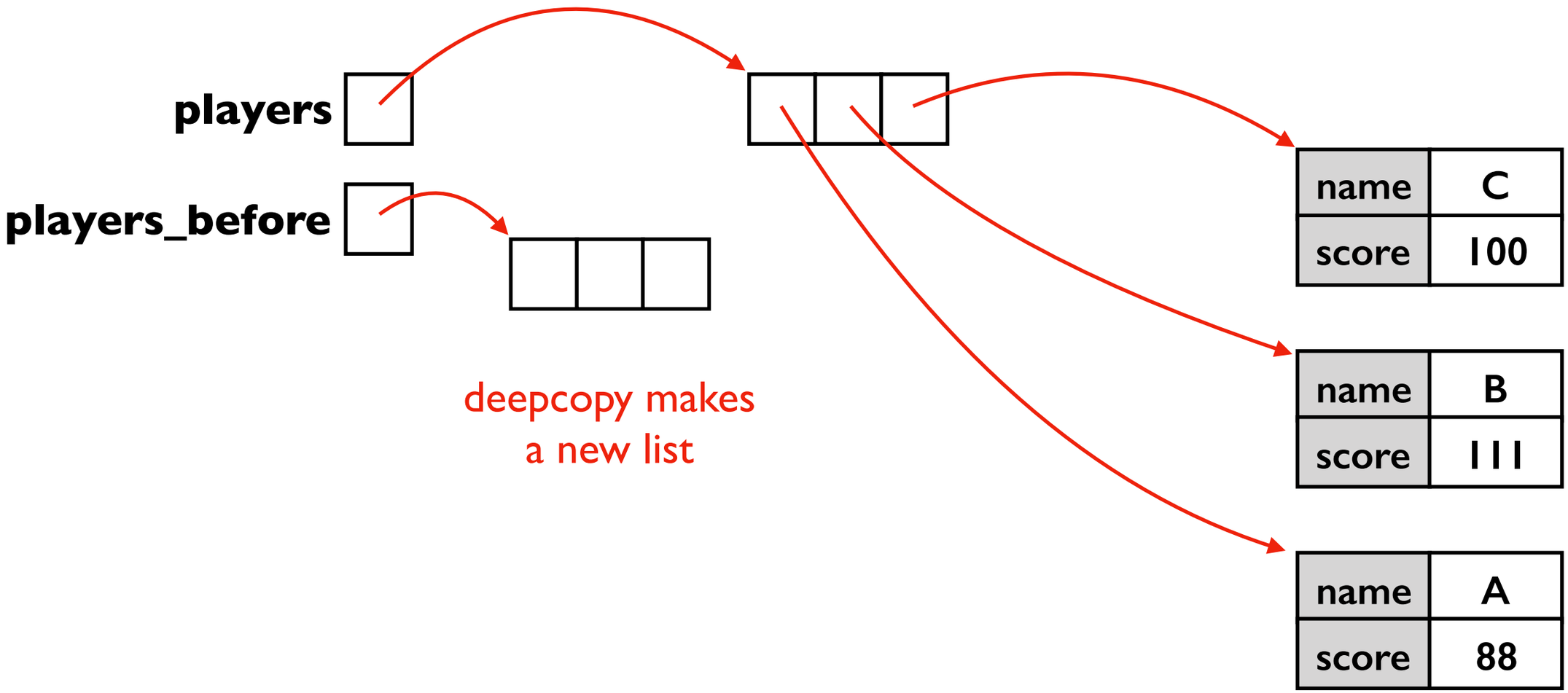

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```
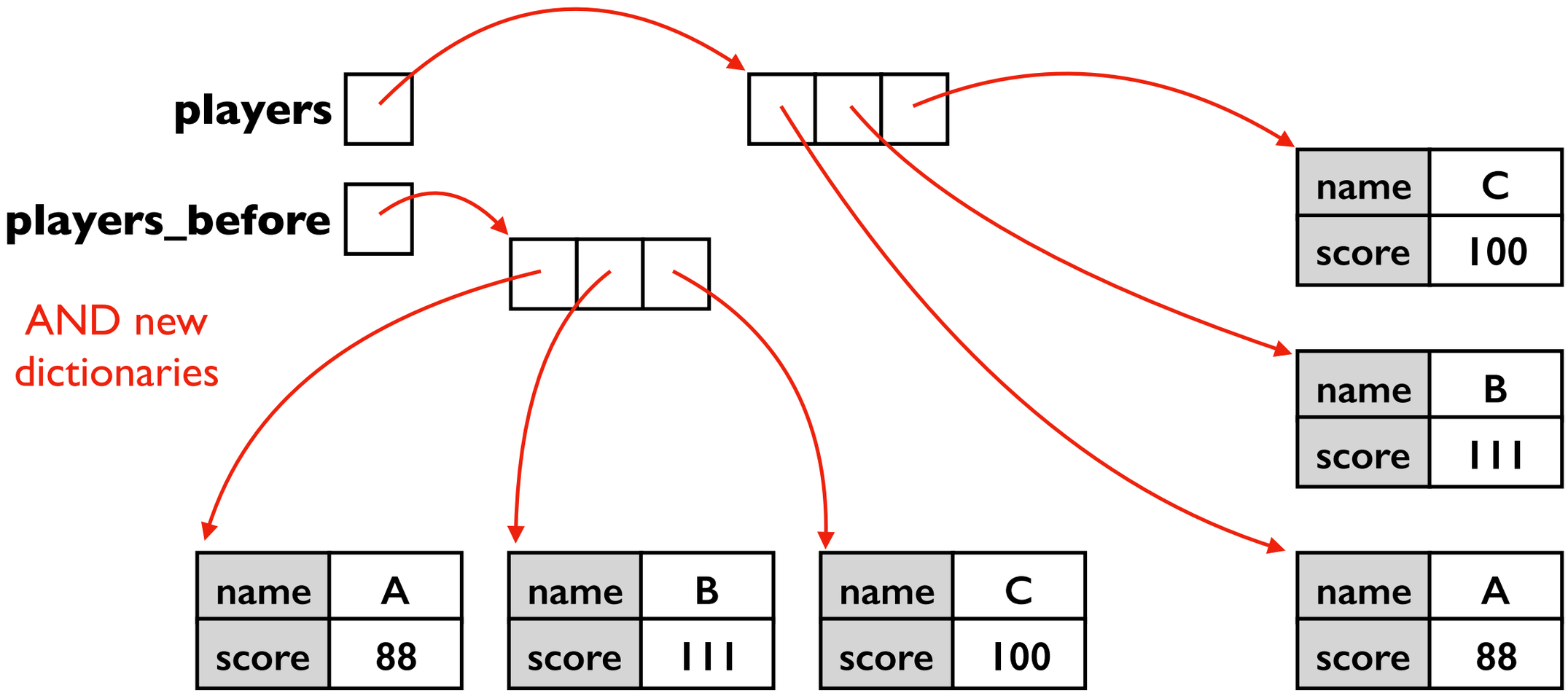
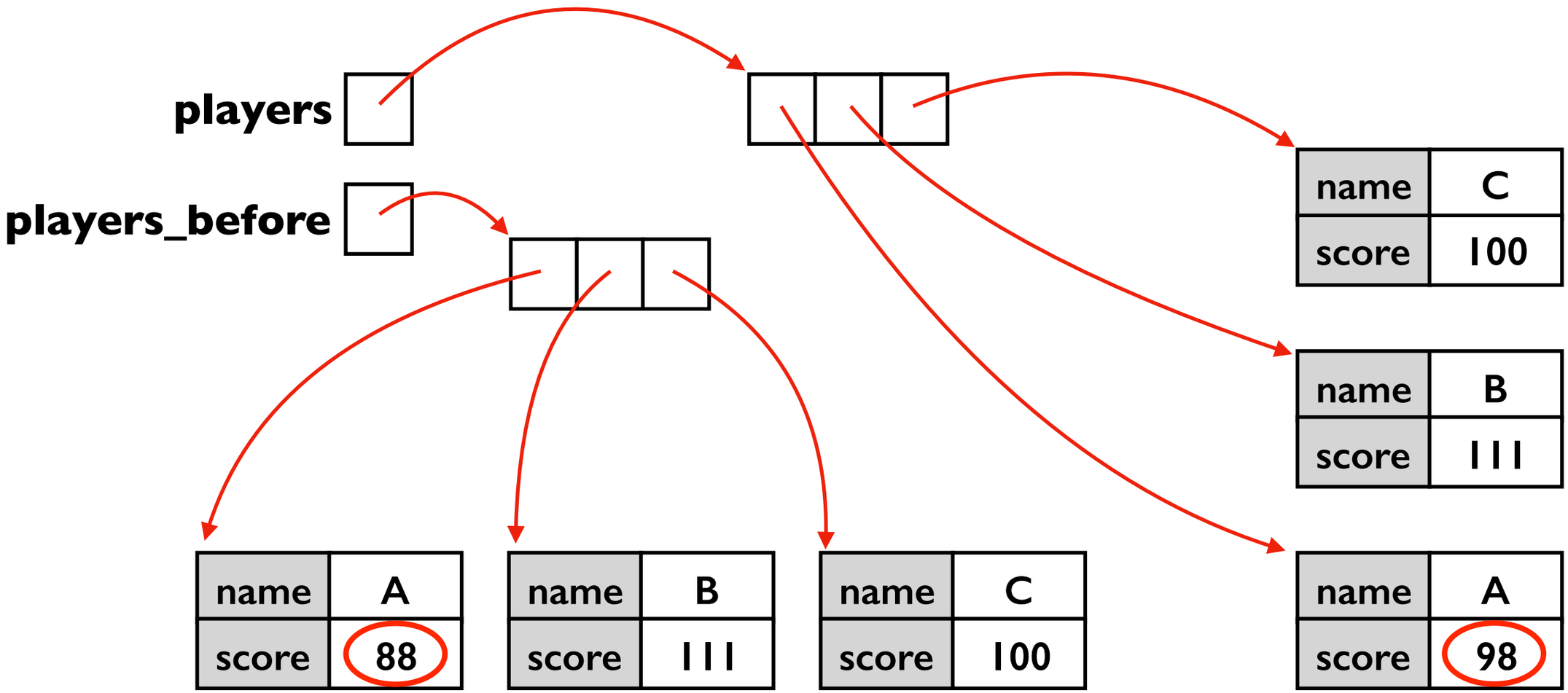



```
players = …
players_before = copy.deepcopy(players)

# make changes to players
players[0]["score"] += 10

print("score change:",
      players[0]["score"] - players_before[0]["score"])
```



```
players = …
players_before = copy.deepcopy(players)

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players[0]["score"] += 10

print("score change:",
      players[0]["score"] - players_before[0]["score"])
```
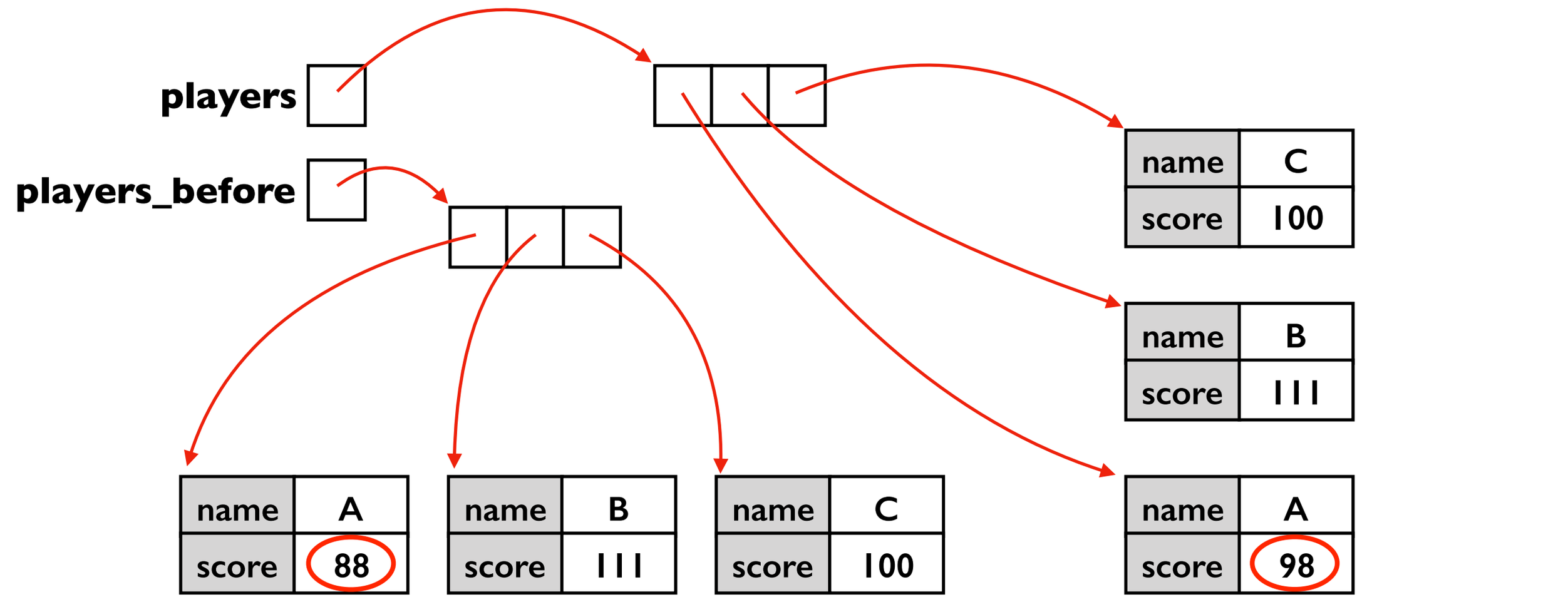

prints 10



Today's Outline

Review

More references

Copying

- reference
- shallow
- deep

Worksheet

Worksheet Problems 7-11