[220 / 319] Copying

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University of Wisconsin-Madison

Readings:
Parts of Chapter 4 of Sweigart book

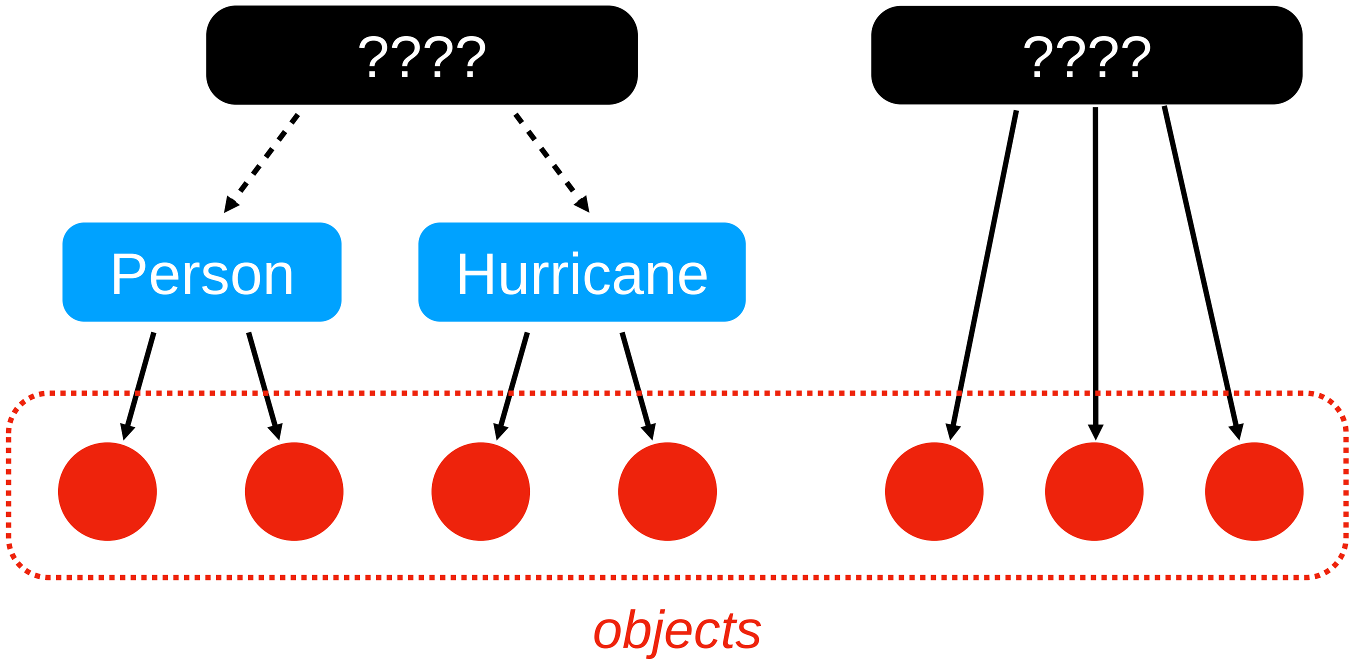
Test yourself!

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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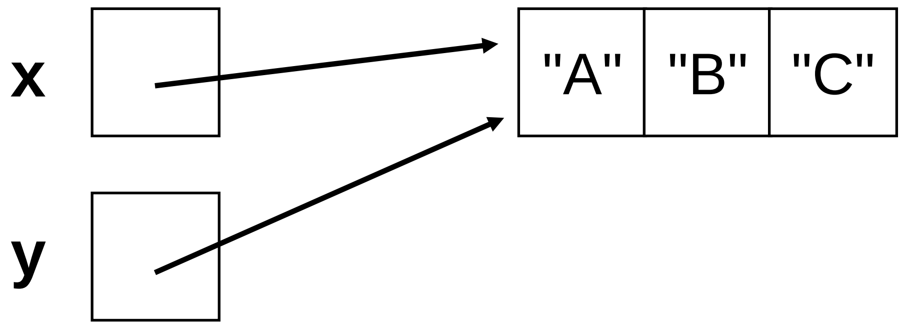
YES



y should reference
whatever x references

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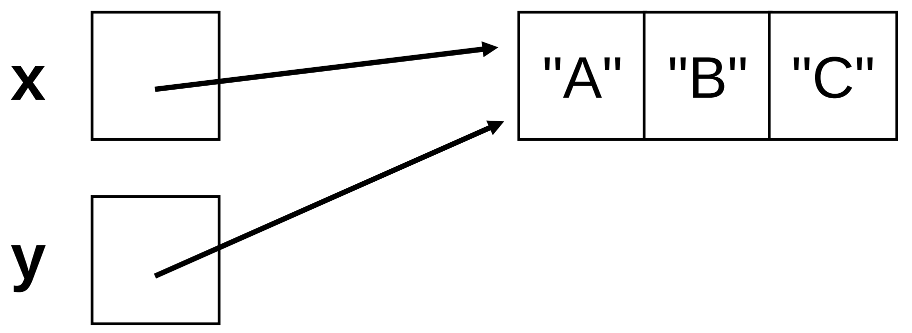
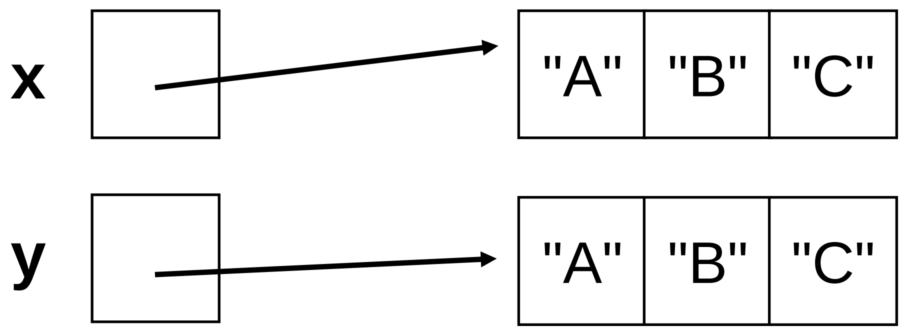


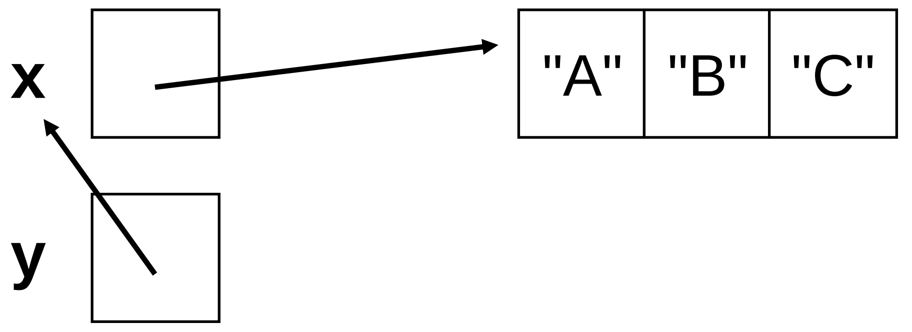
y should reference whatever x references

NO



different code would be needed to do this

NO



no code could ever make this happen

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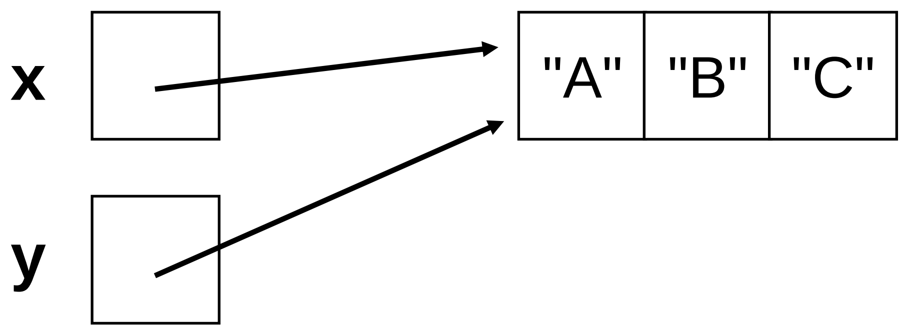


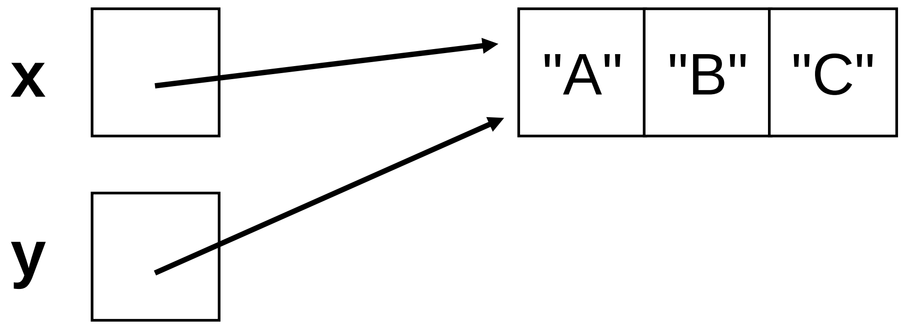
What does assignment ACTUALLY do?

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

~~y = x~~

```
def f(y):
    pass

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



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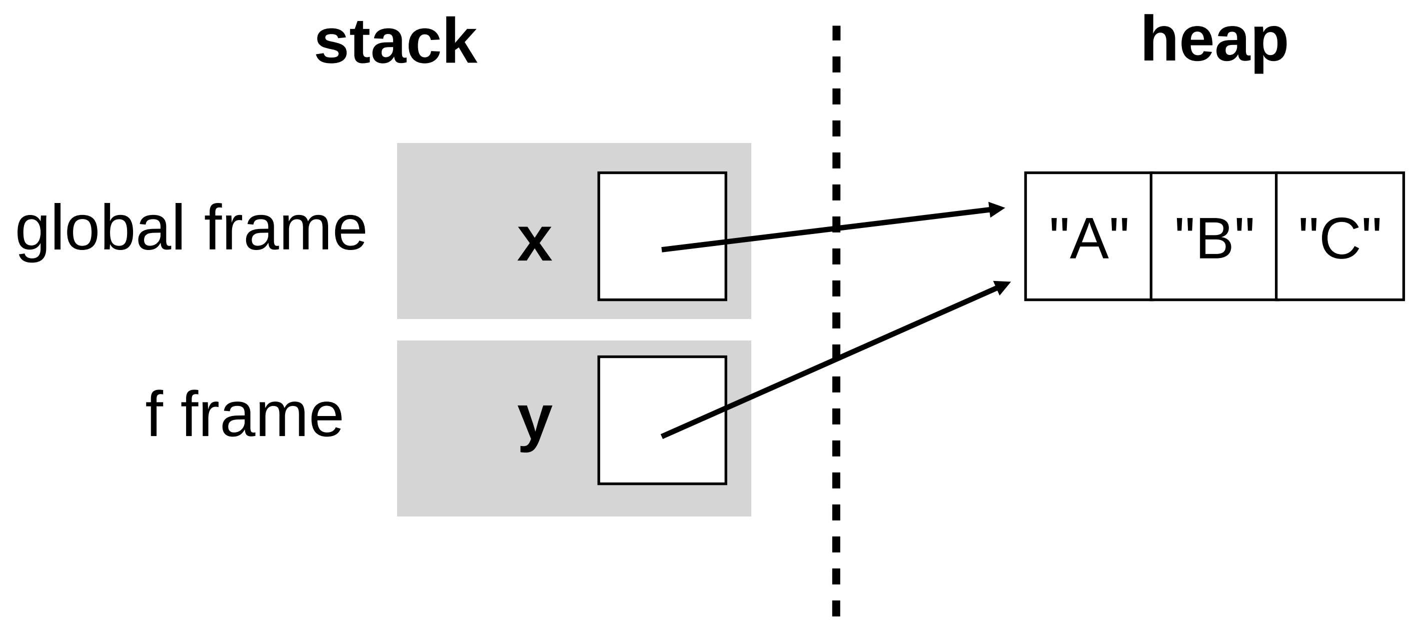

Example 1

```
x = {}

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

interactive

exercises

Example 2

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

interactive

exercises

Example 3

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

interactive exercises

Worksheet Problems 2-6

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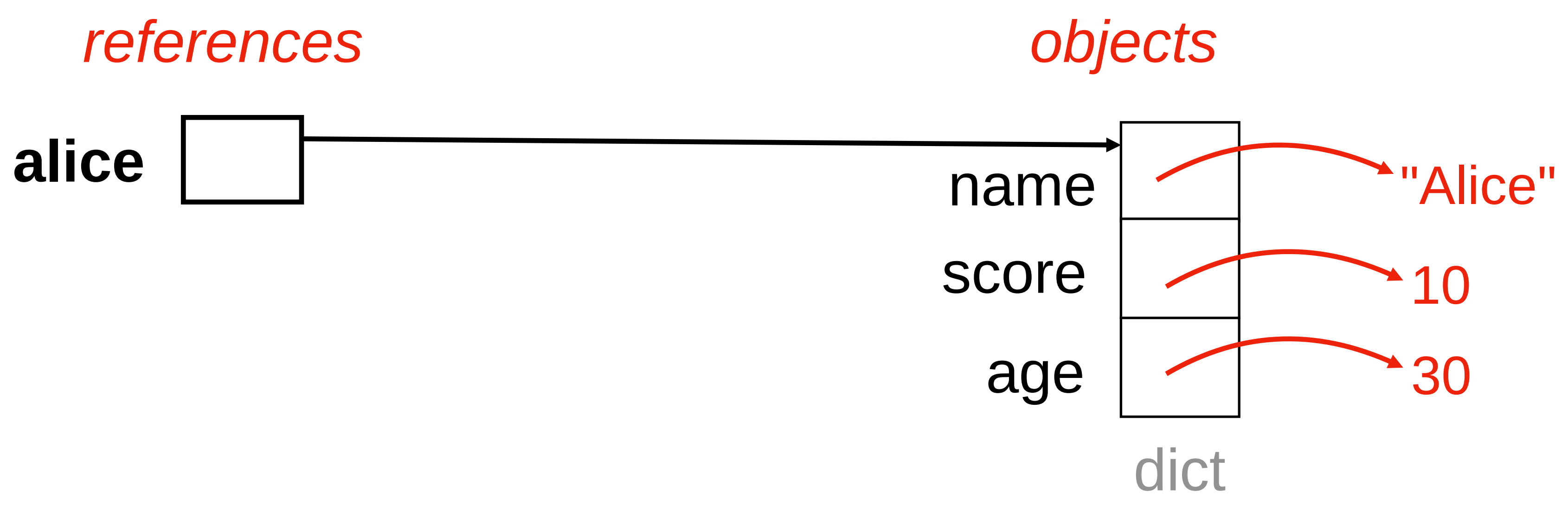
Worksheet

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

State:



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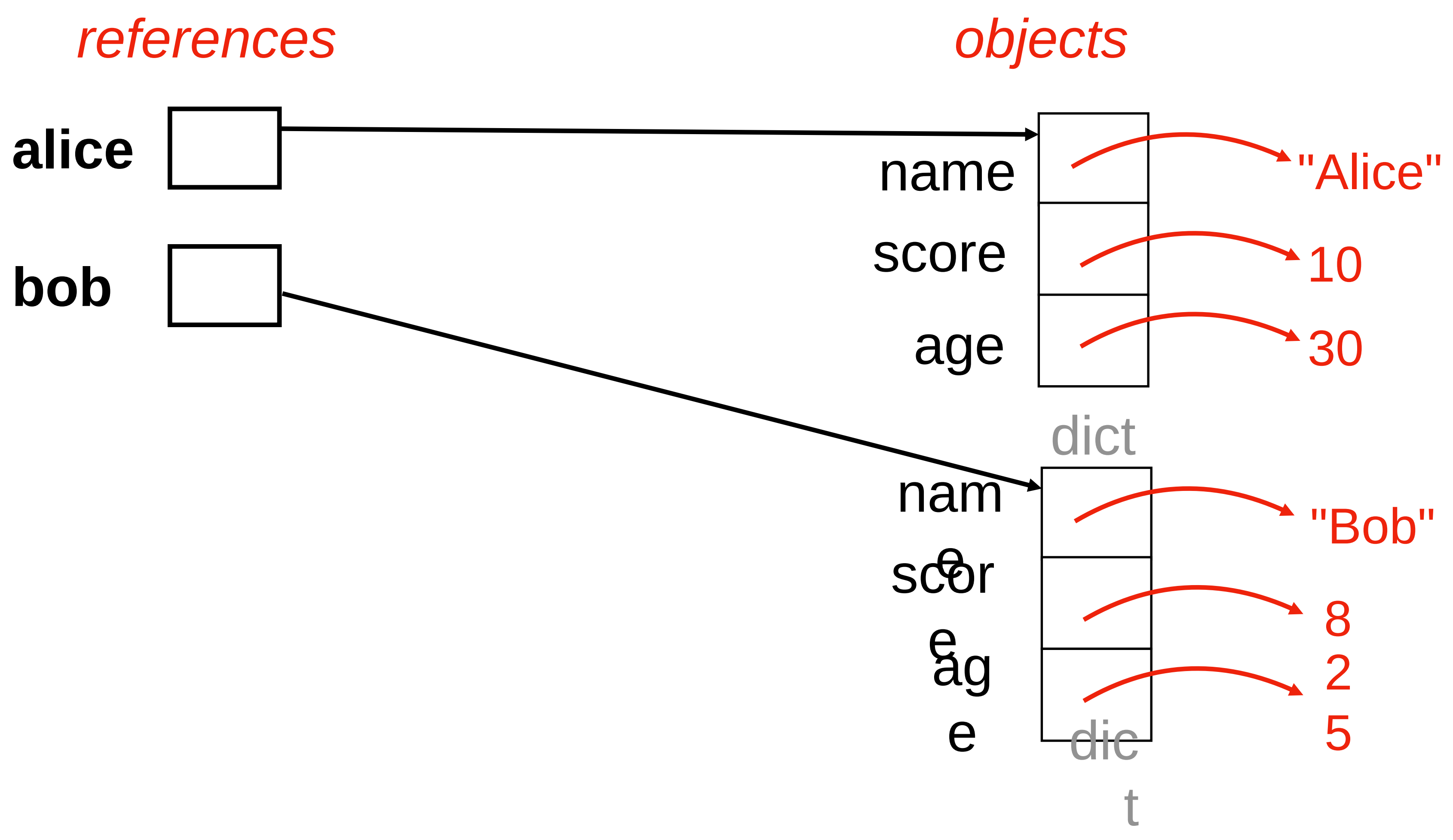

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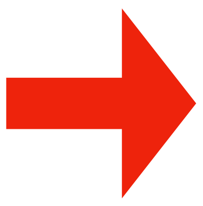
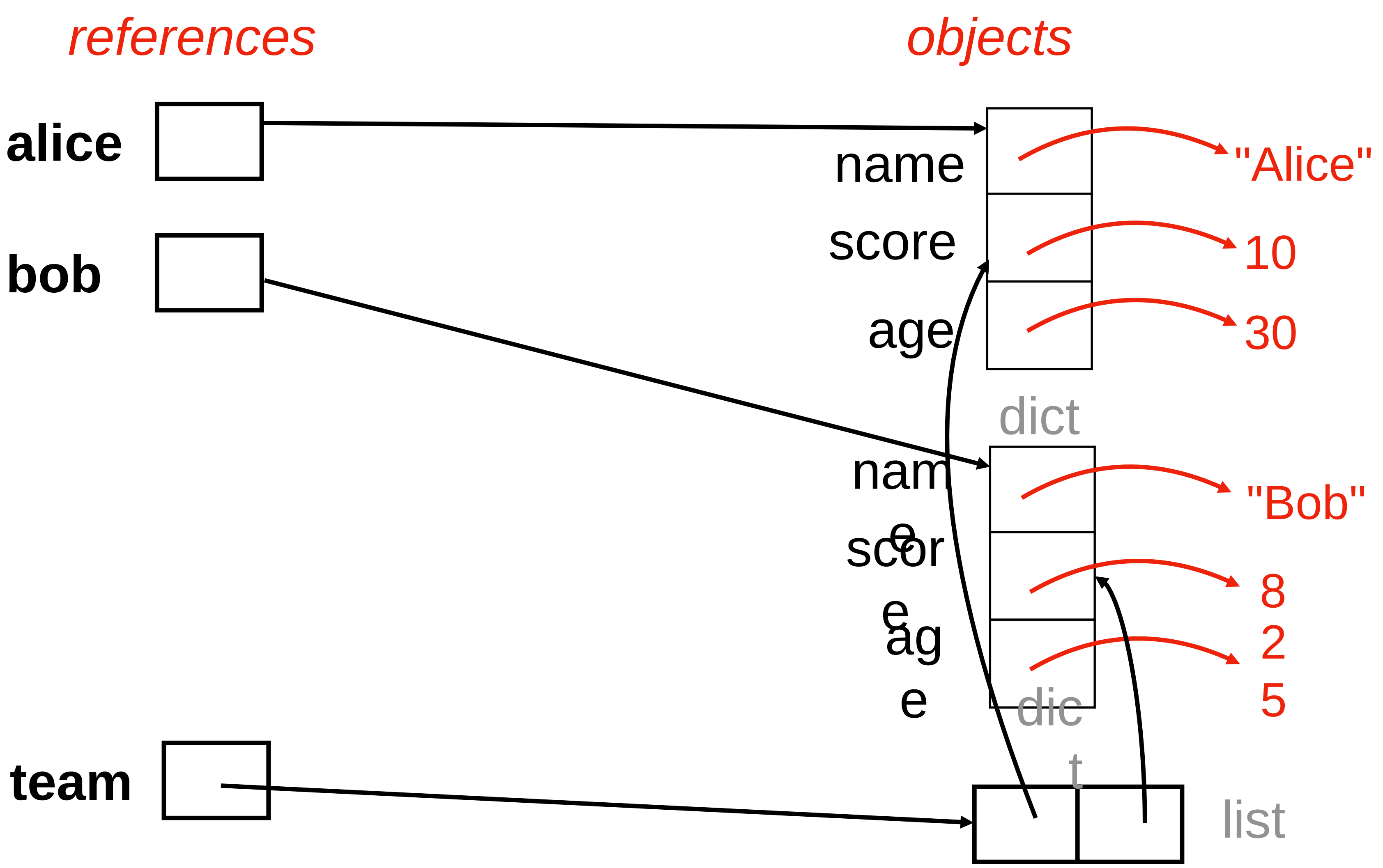


State:



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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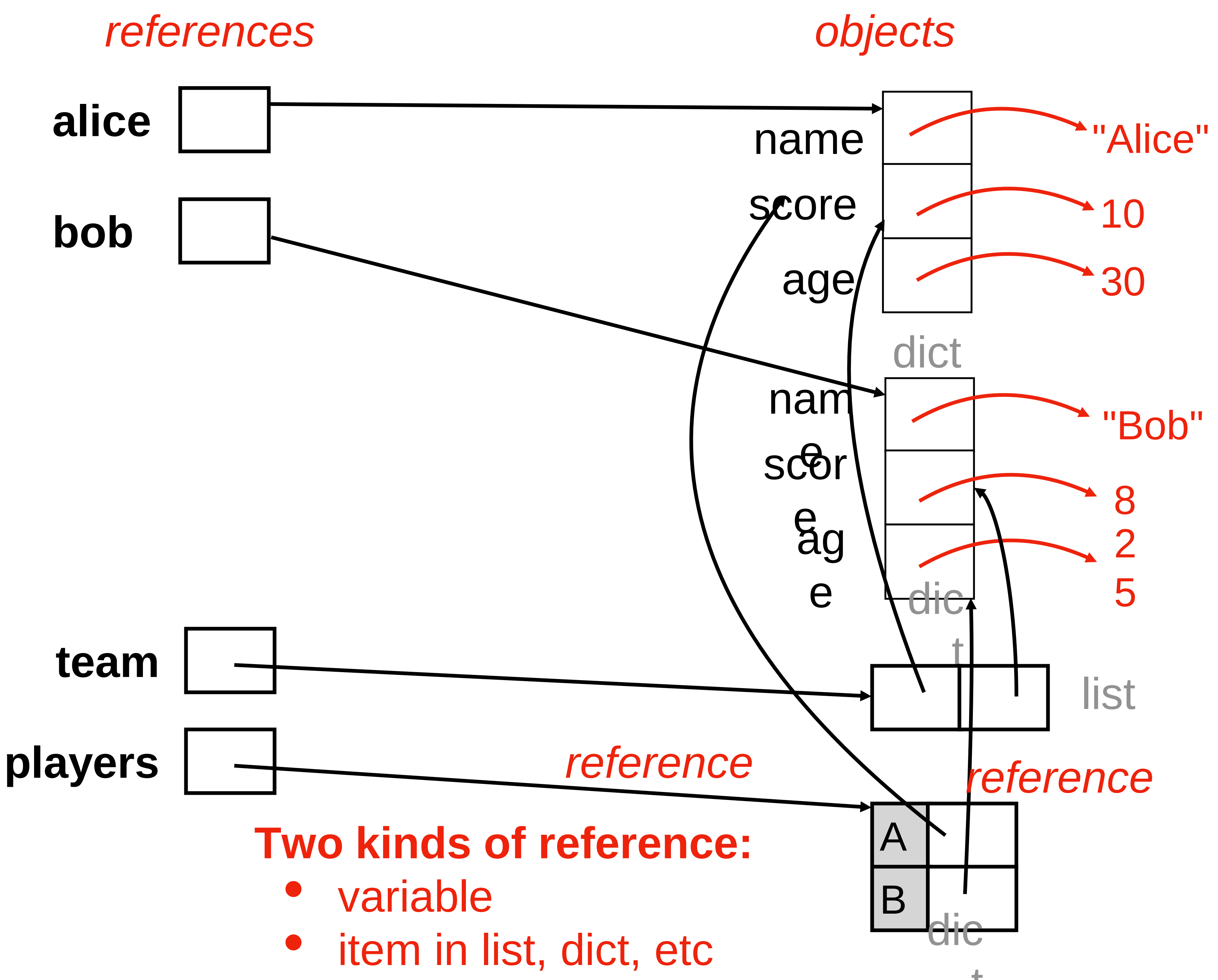
bob = {"name":"Bob", "score":8, "age":25}
team = [alice, bob]
players = {"A": alice, "B": bob}
```

State:



Two kinds of reference:
- variable
- item in list, dict, etc

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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]

Shallow copy of depth level 2

interactive exercises

Using shallow copy to copy other depth levels

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

y = copy.copy(x)

for idx in range(len(x)):
    y[idx] = copy.copy(x[idx])
```

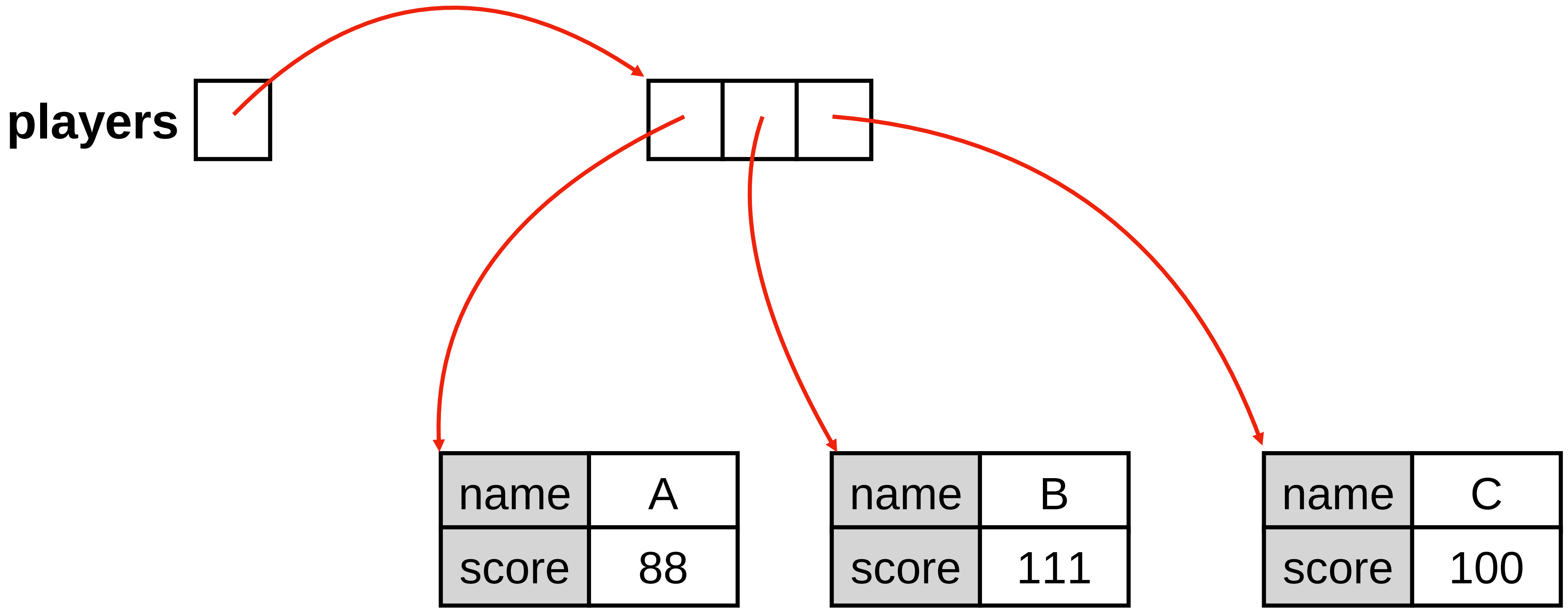
shallow copy

shallow copy of depth level 2

Example: Player Scores

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

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



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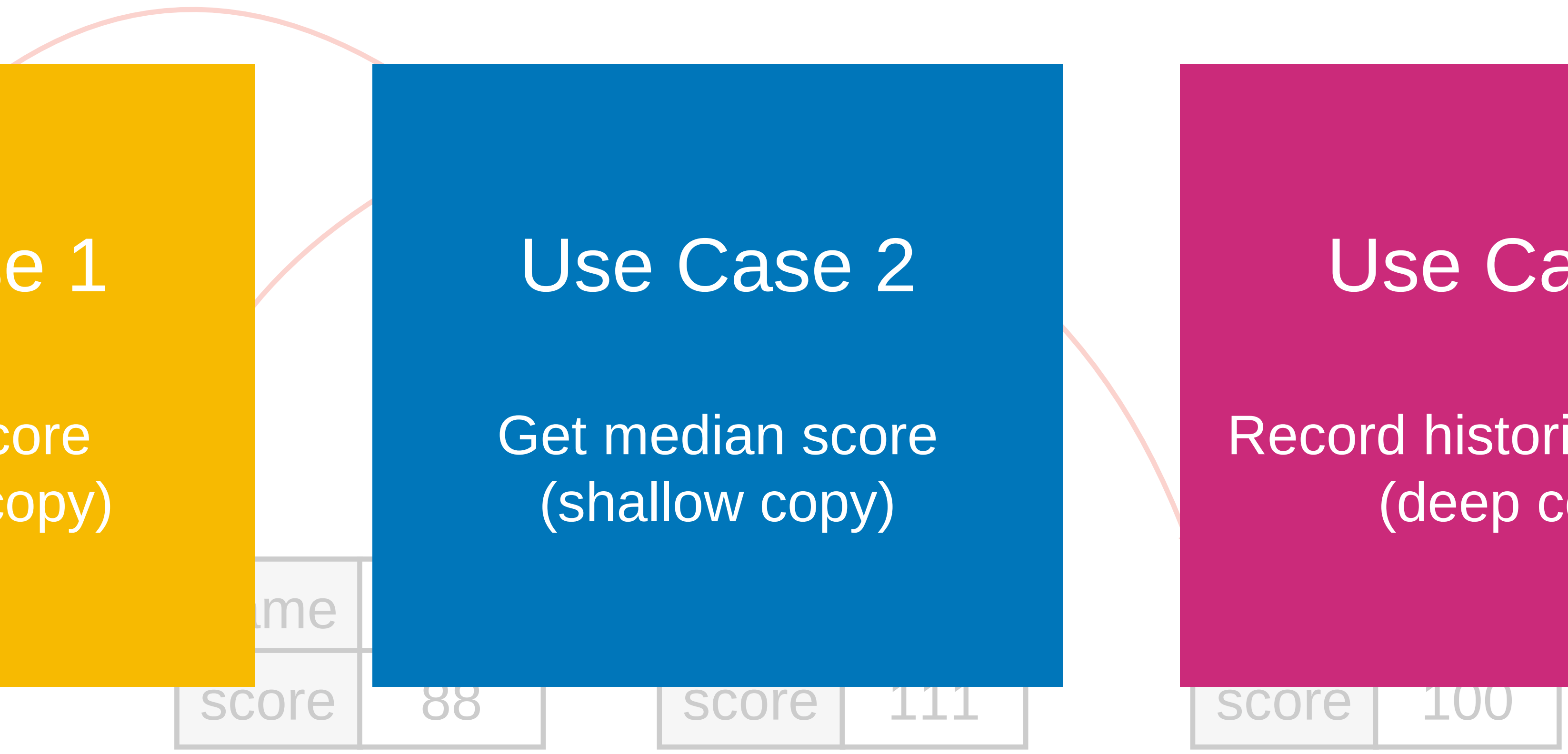

Use Case 1

Get max score
(reference copy)

Use Case 2

Get median score
(shallow copy)

Use Case 3

Record historical scores
(deep copy)

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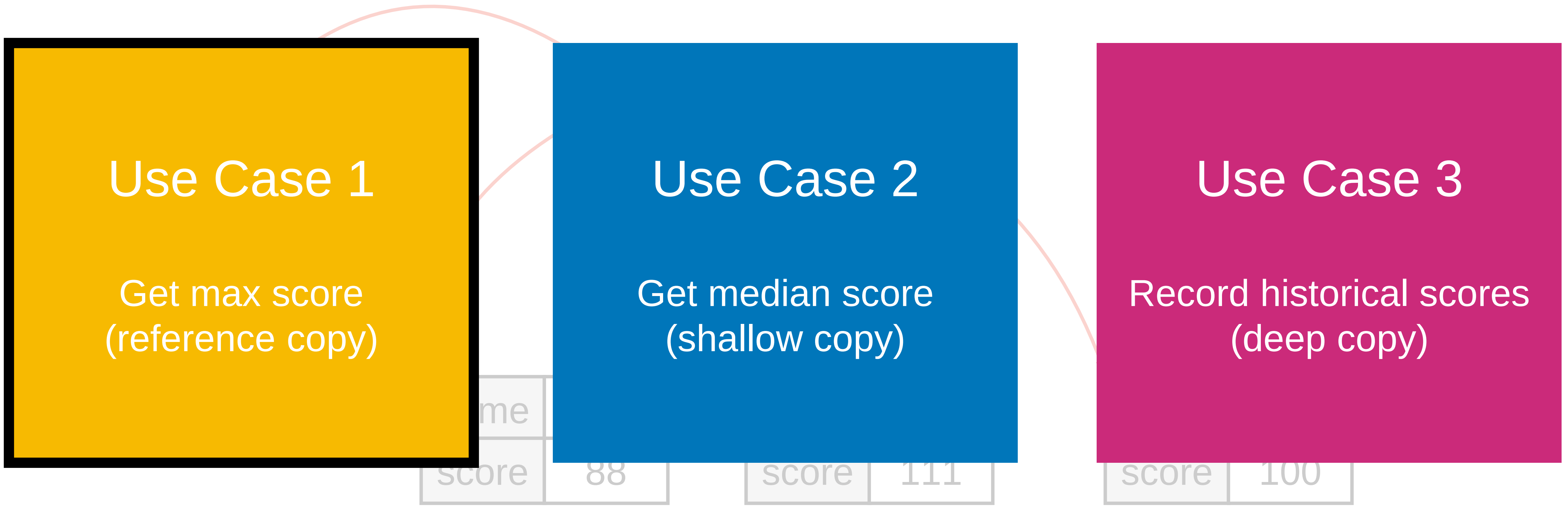

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def max_score(people):
    highest = None
    for p in people:
        if highest == None or p["score"] > highest:
            highest = p["score"]
    return highest

players = …
m = max_score(players)
```

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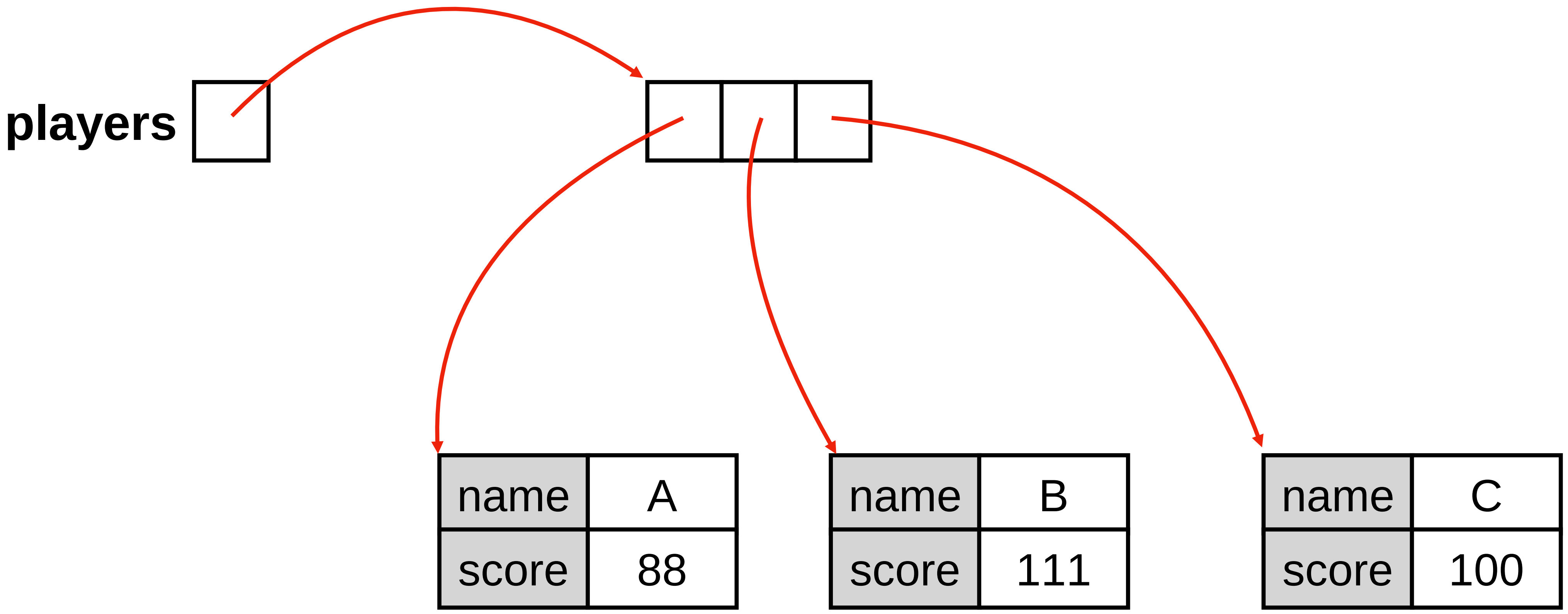

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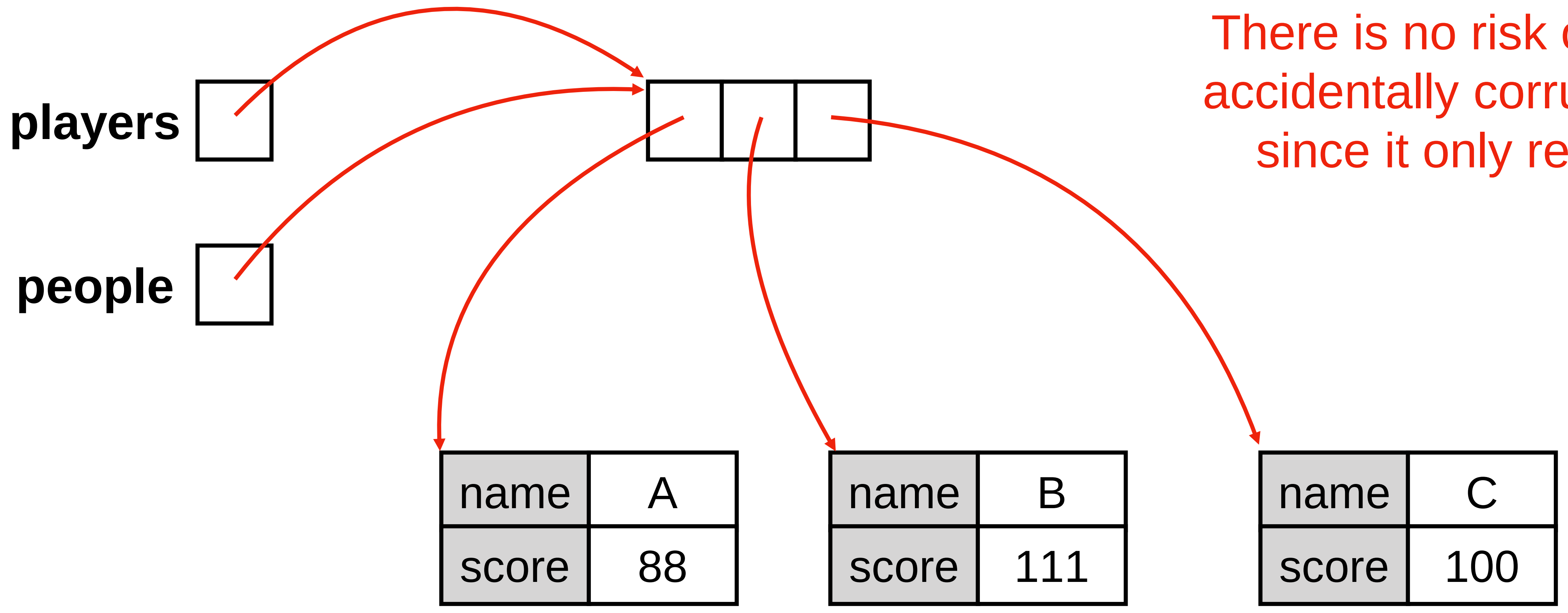

There is no risk of max_score accidentally corrupting players since it only reads people

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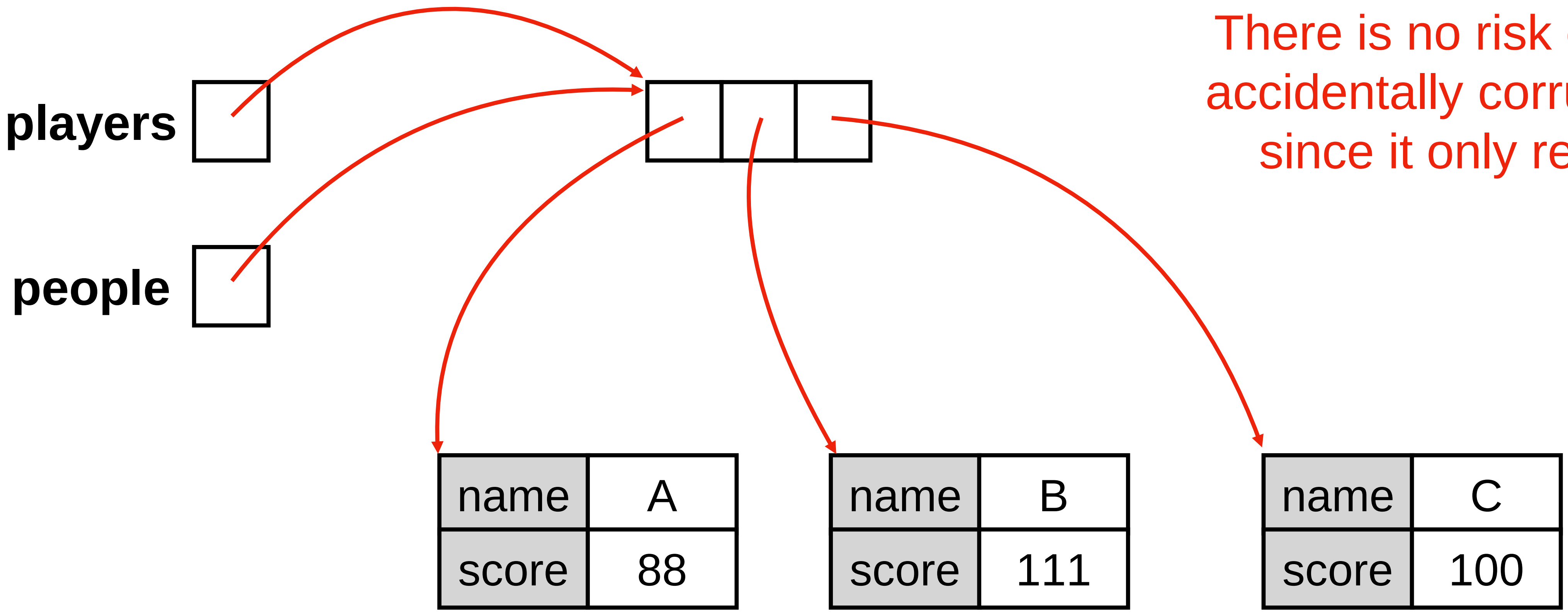

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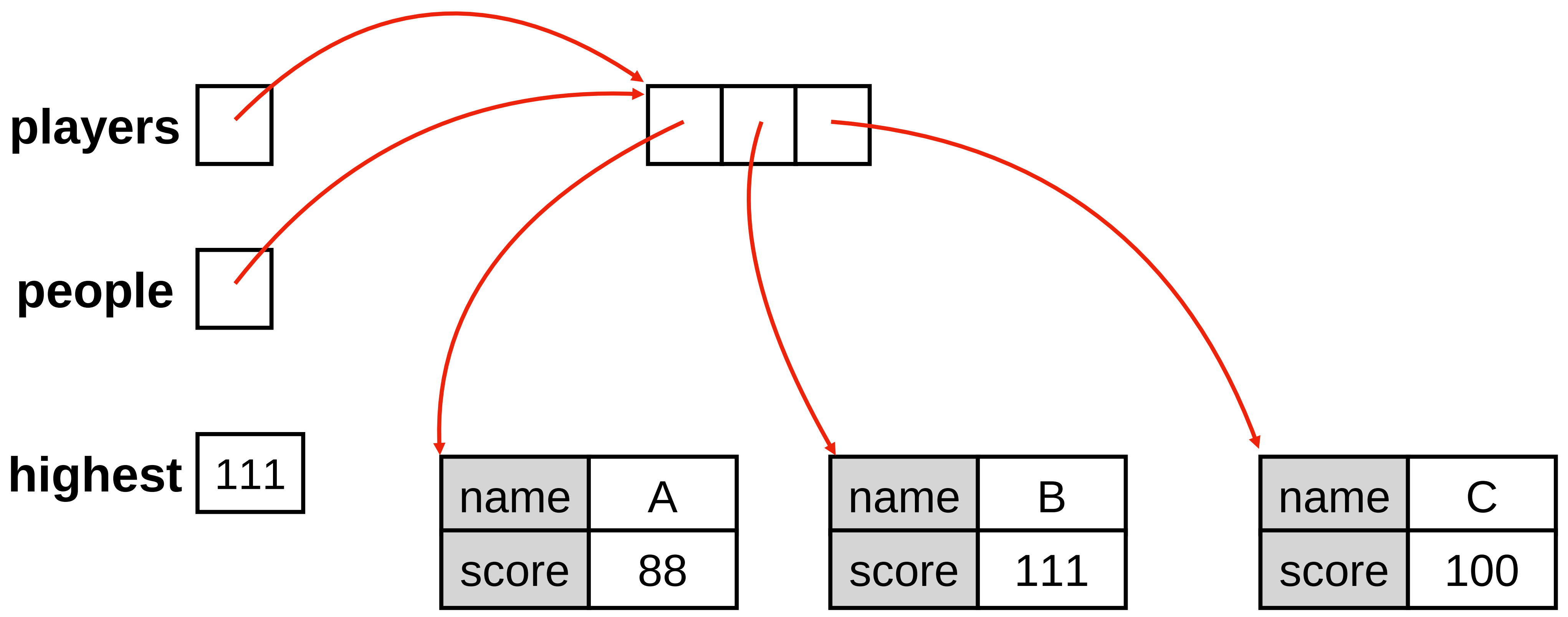

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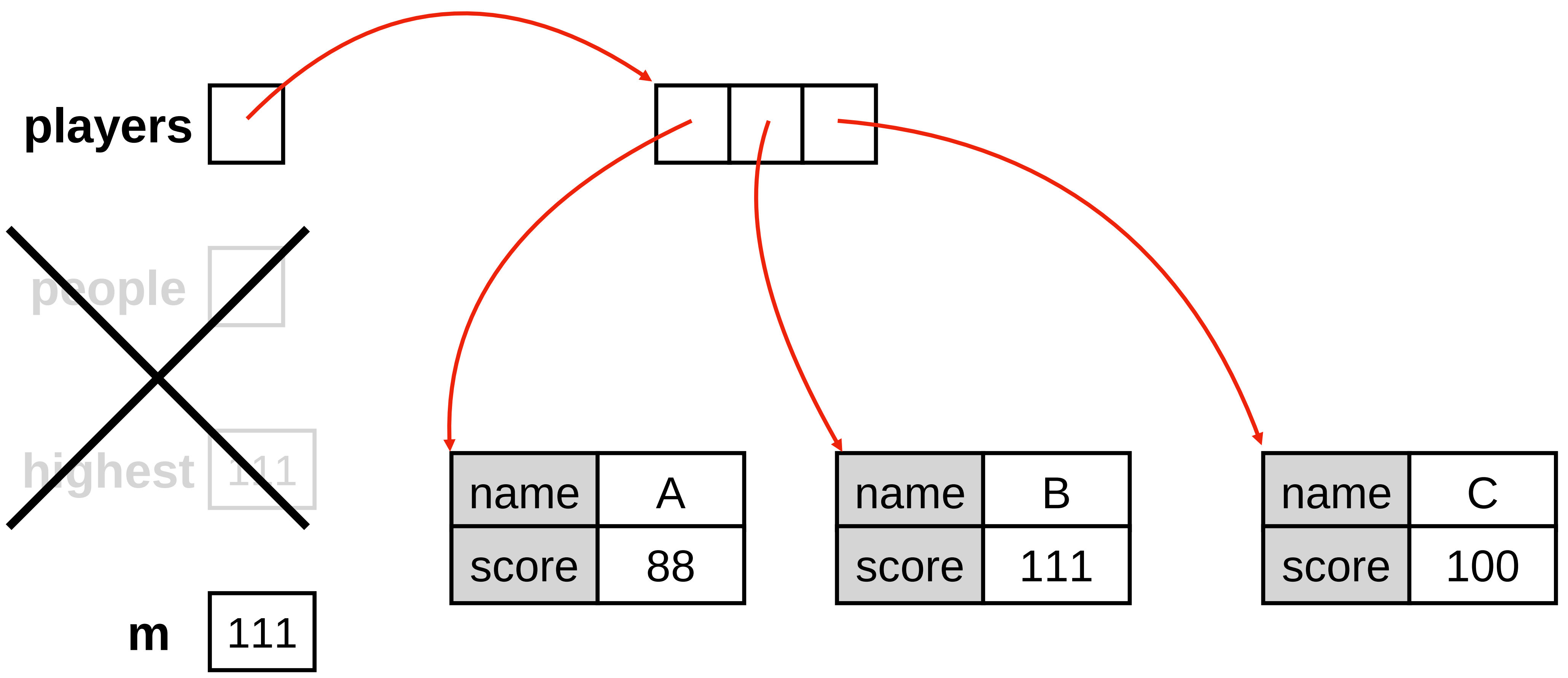

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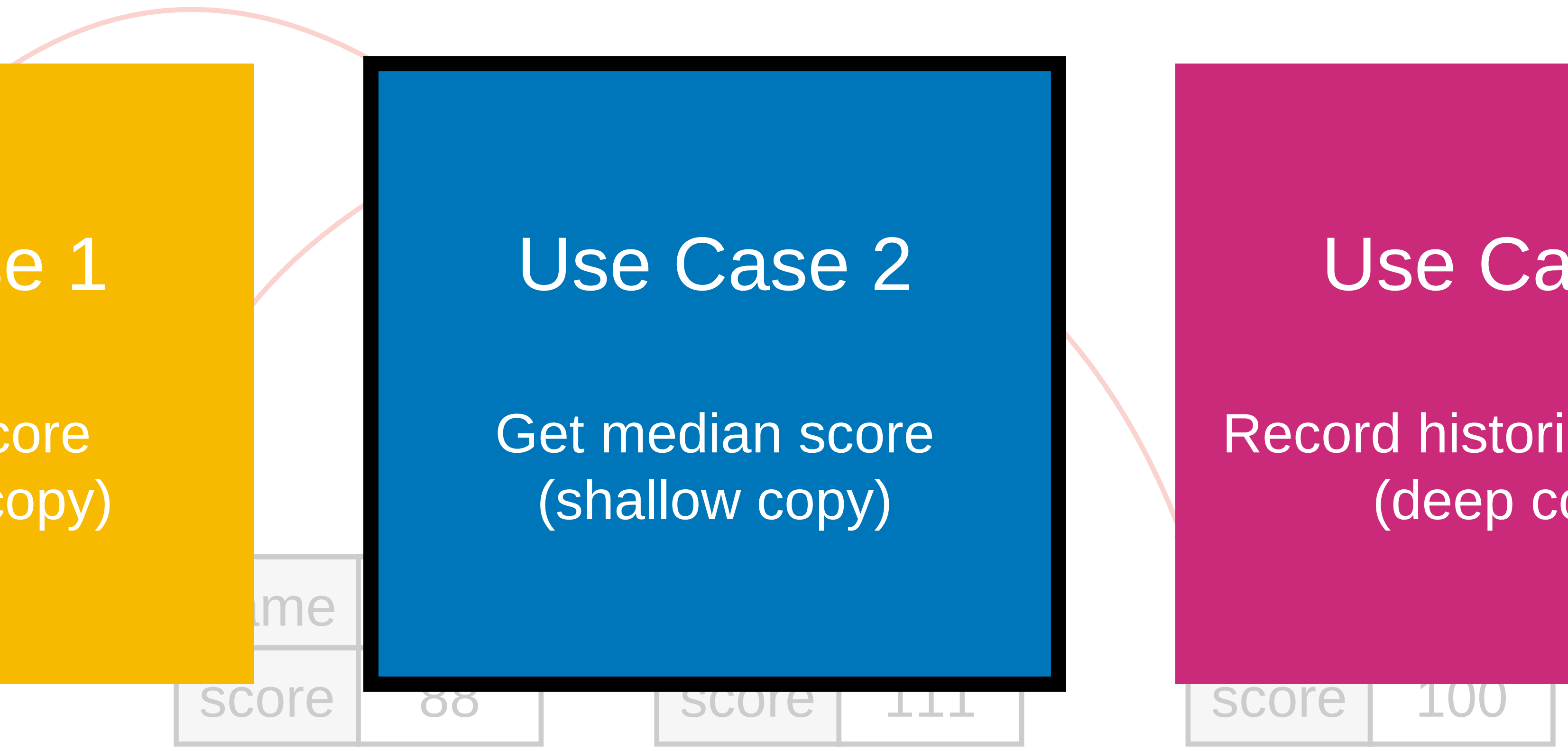

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def median_score(people):
  people = copy.copy(people)
  people.sort(...)
  # TODO: return score for middle of people

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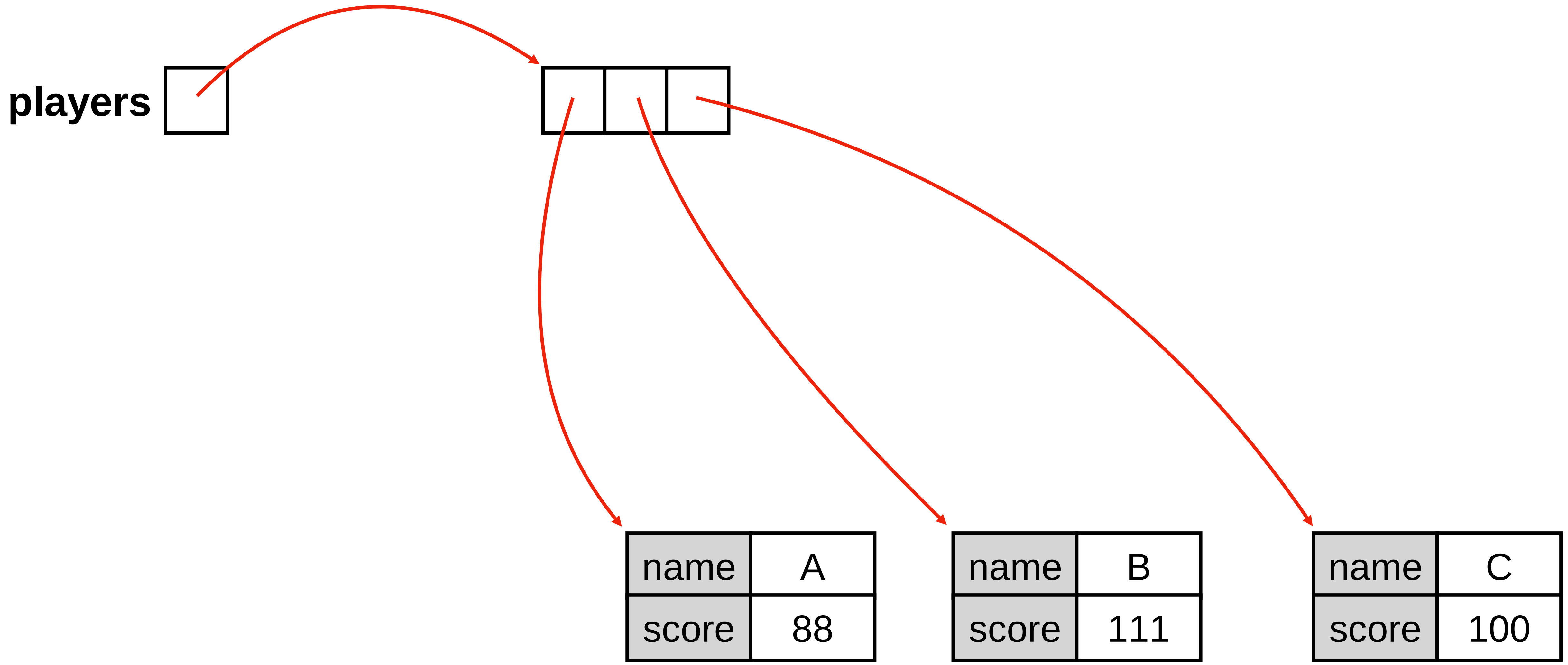

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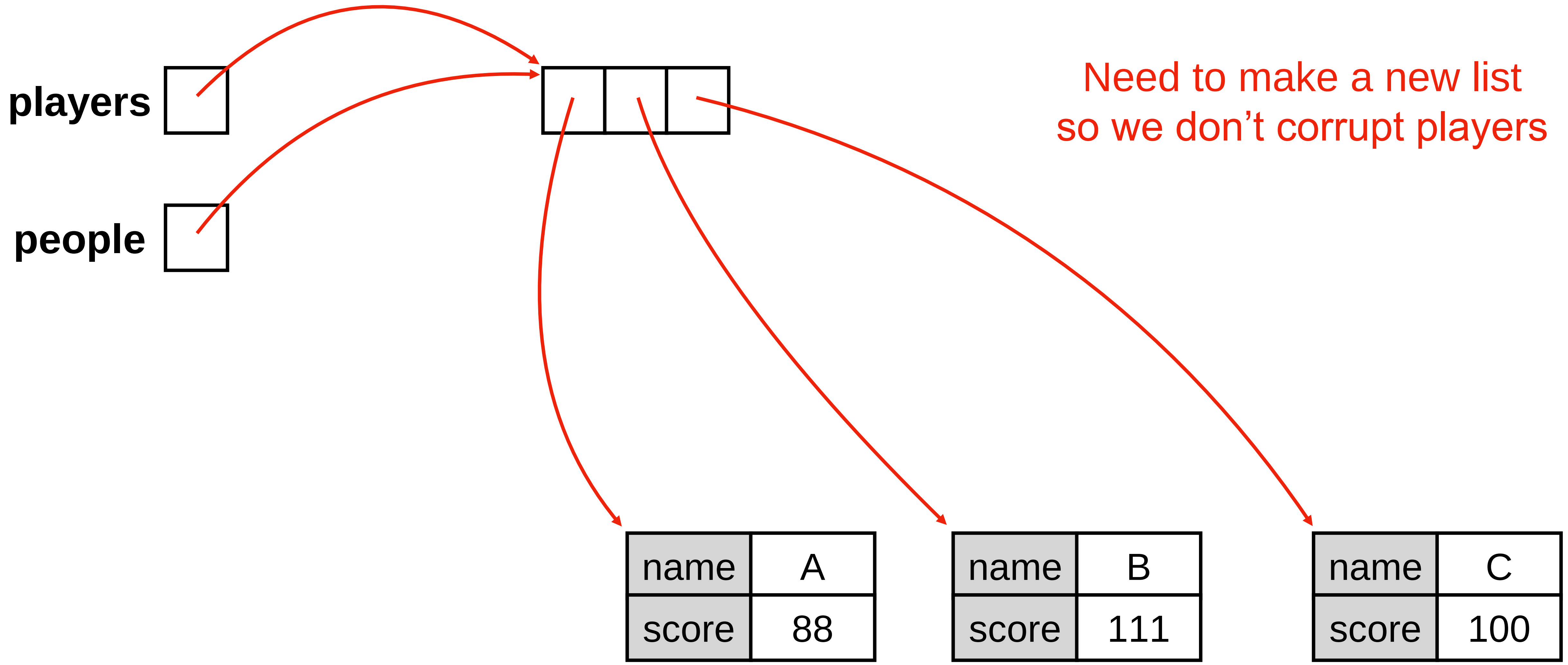

Need to make a new list
so we don’t corrupt players

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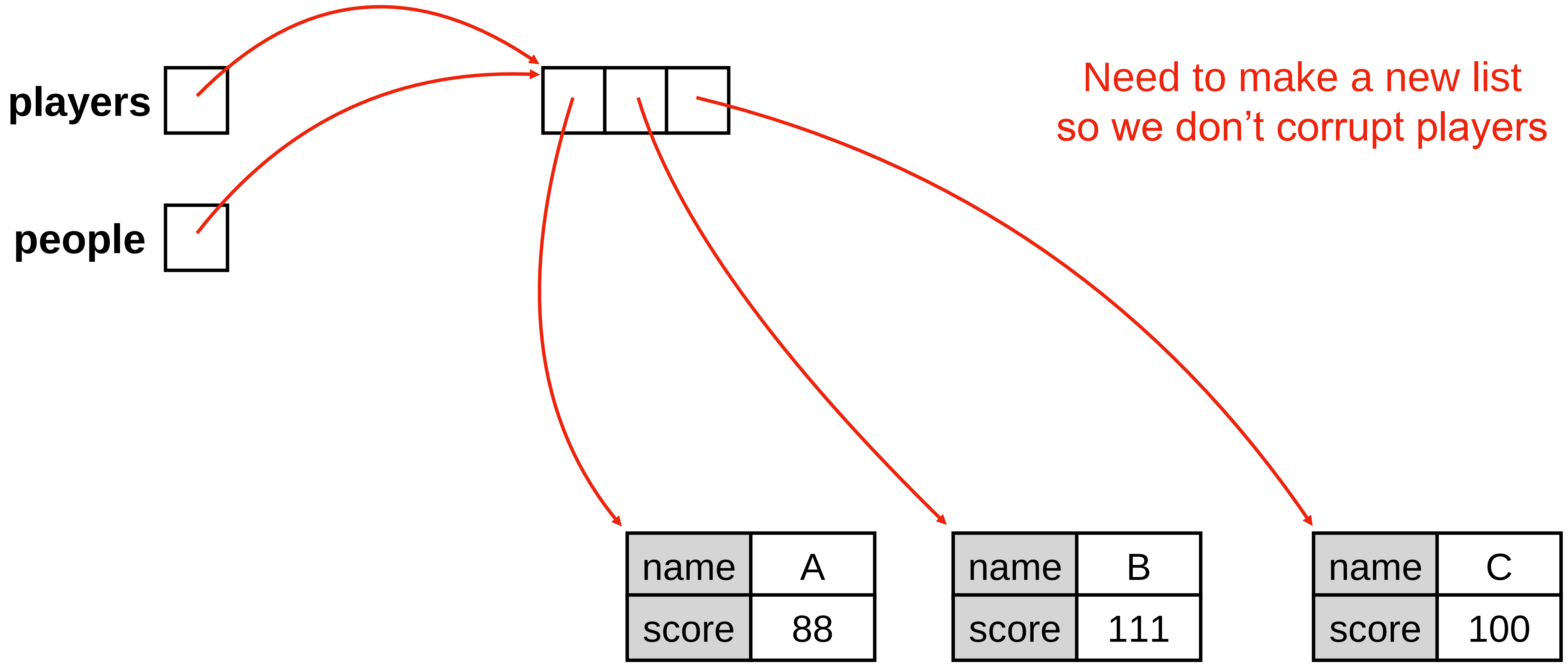

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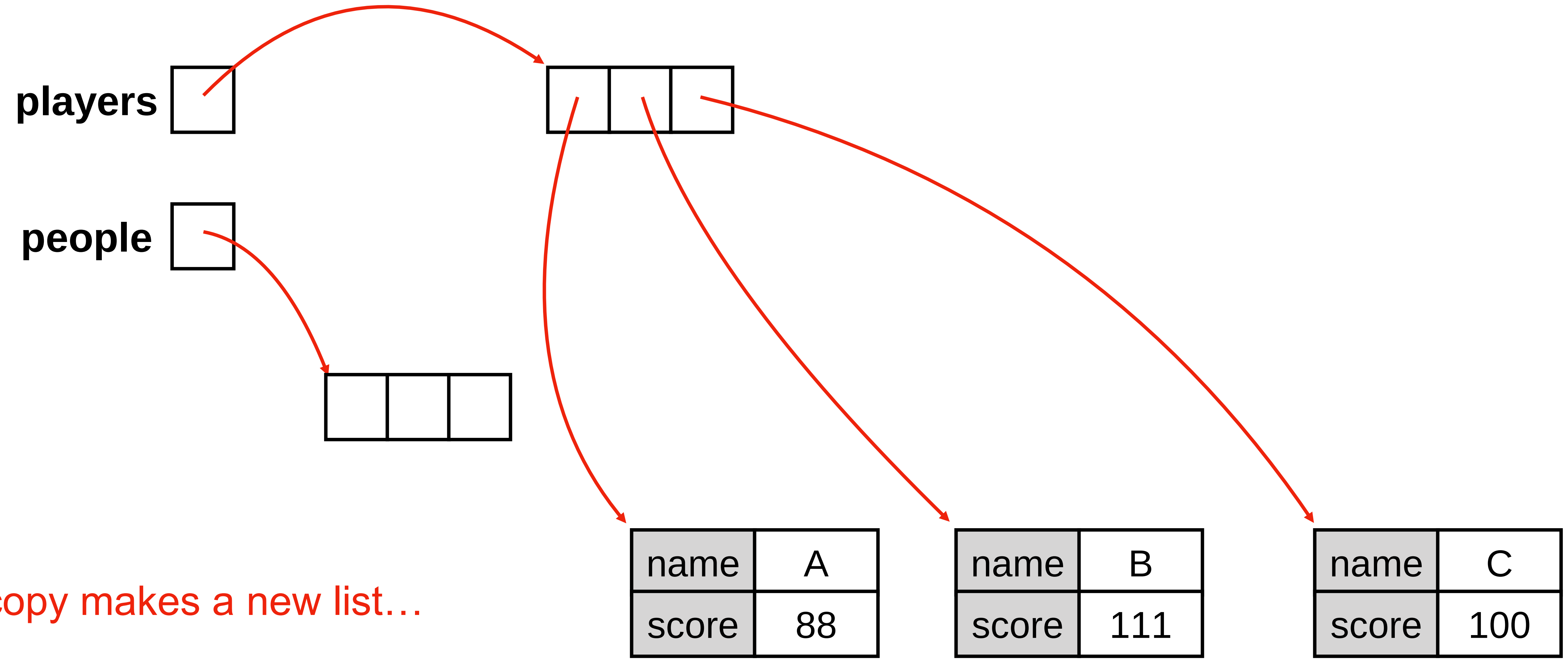

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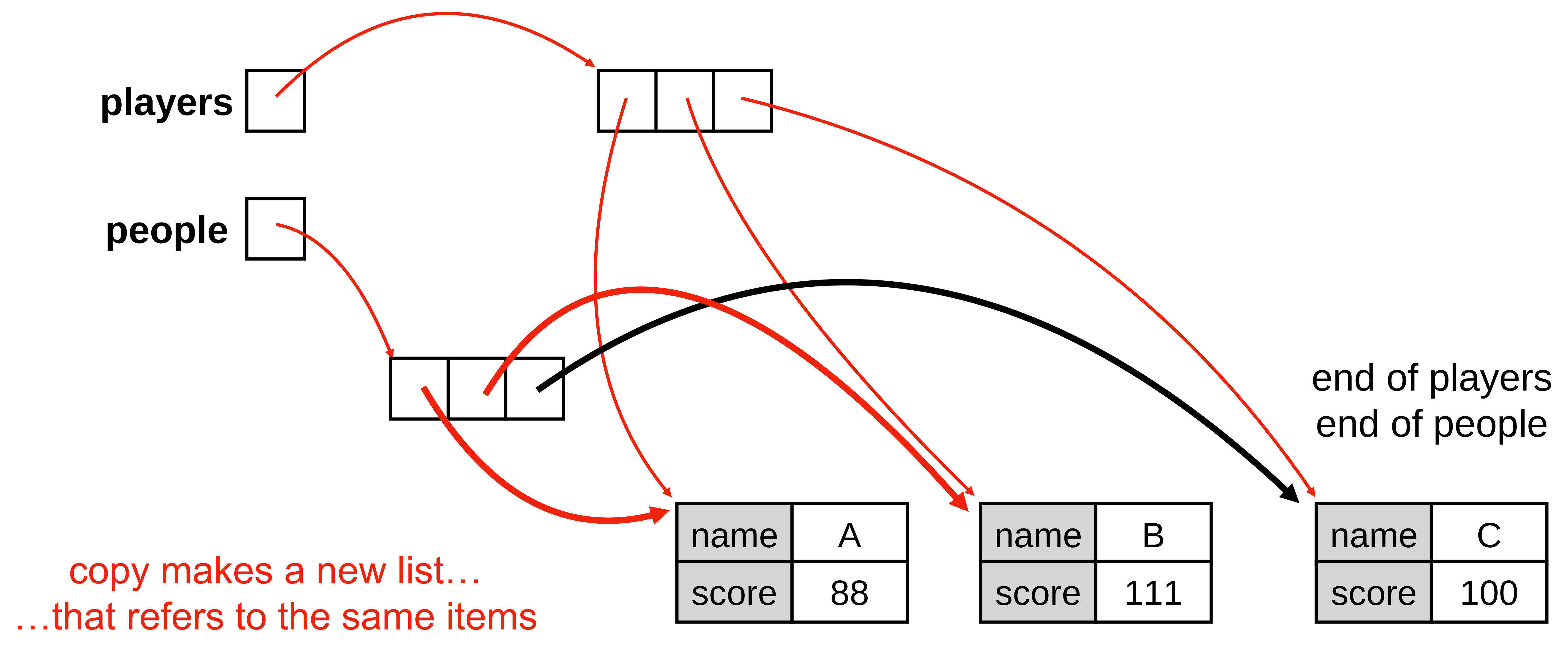

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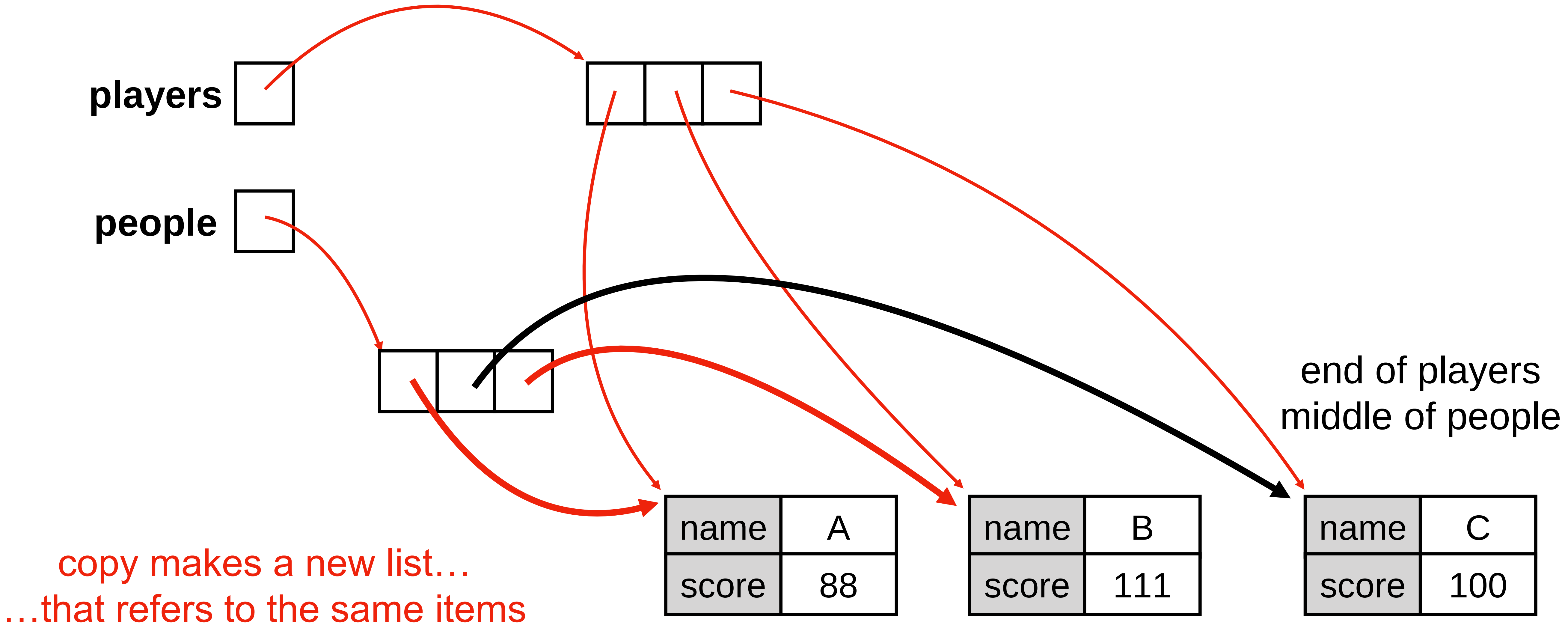

copy makes a new list…
…that refers to the same items

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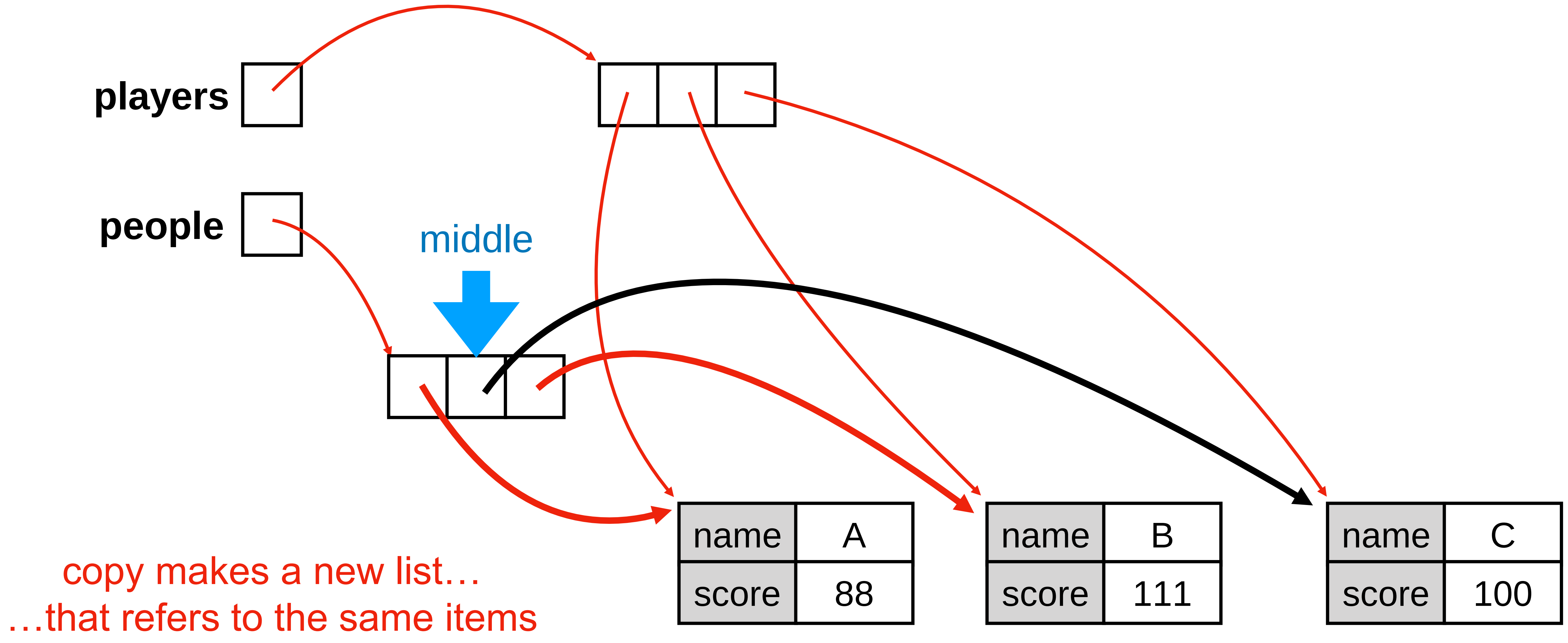

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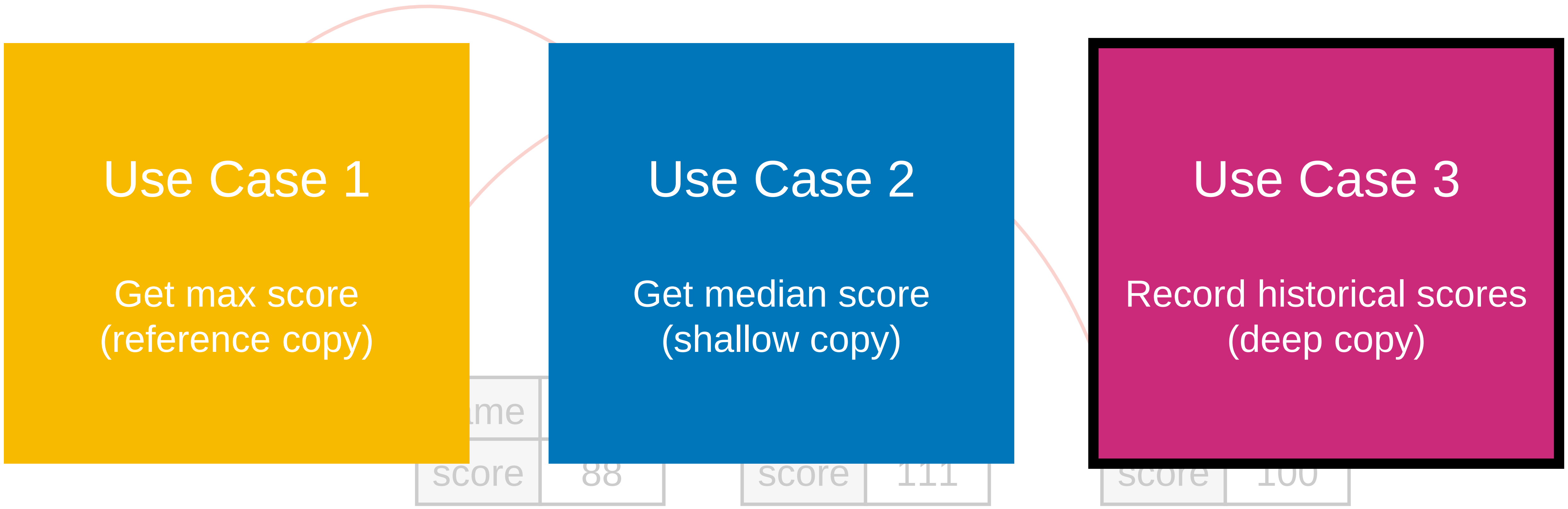

Use Case 1

Get max score
(reference copy)

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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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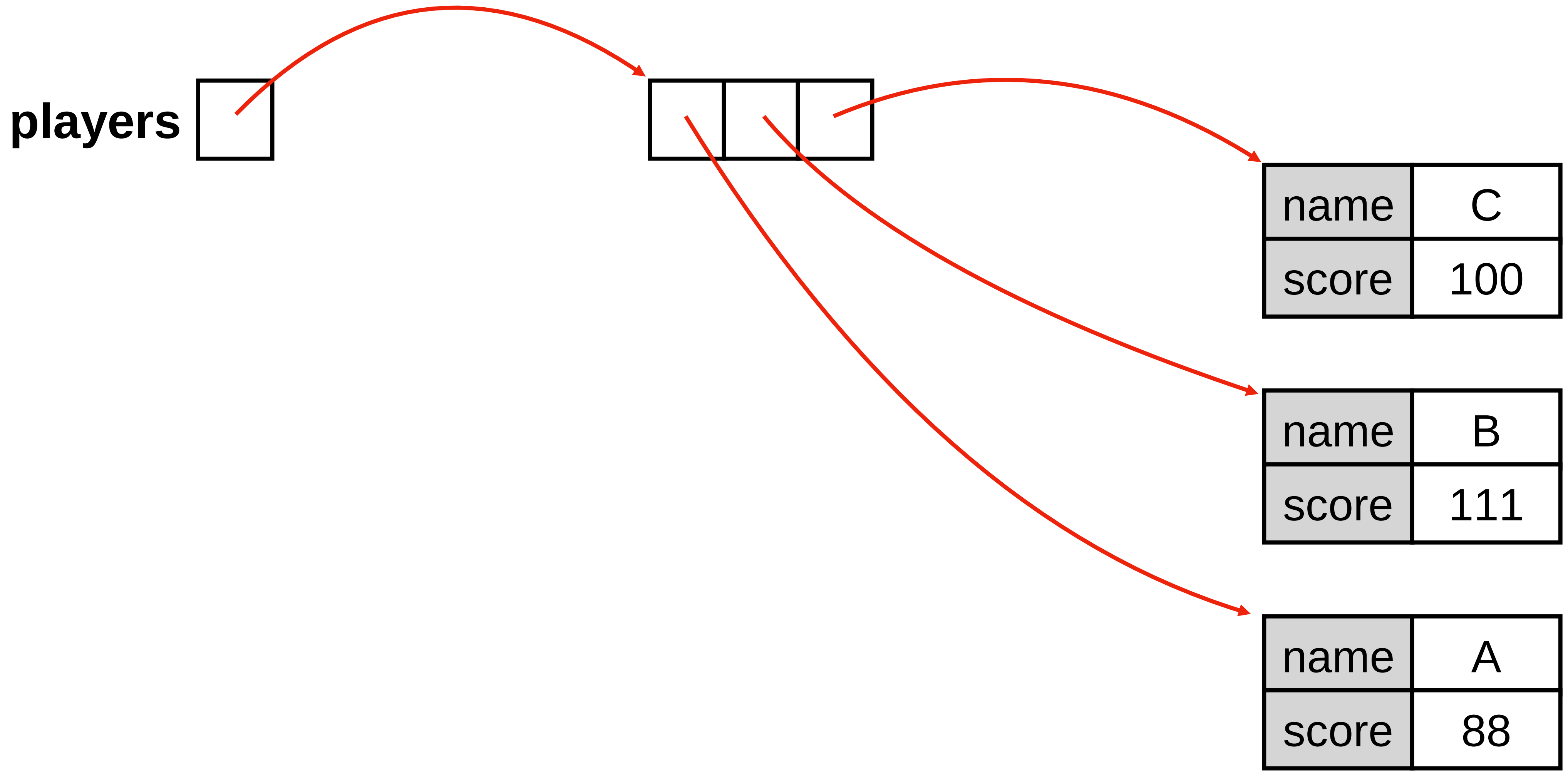

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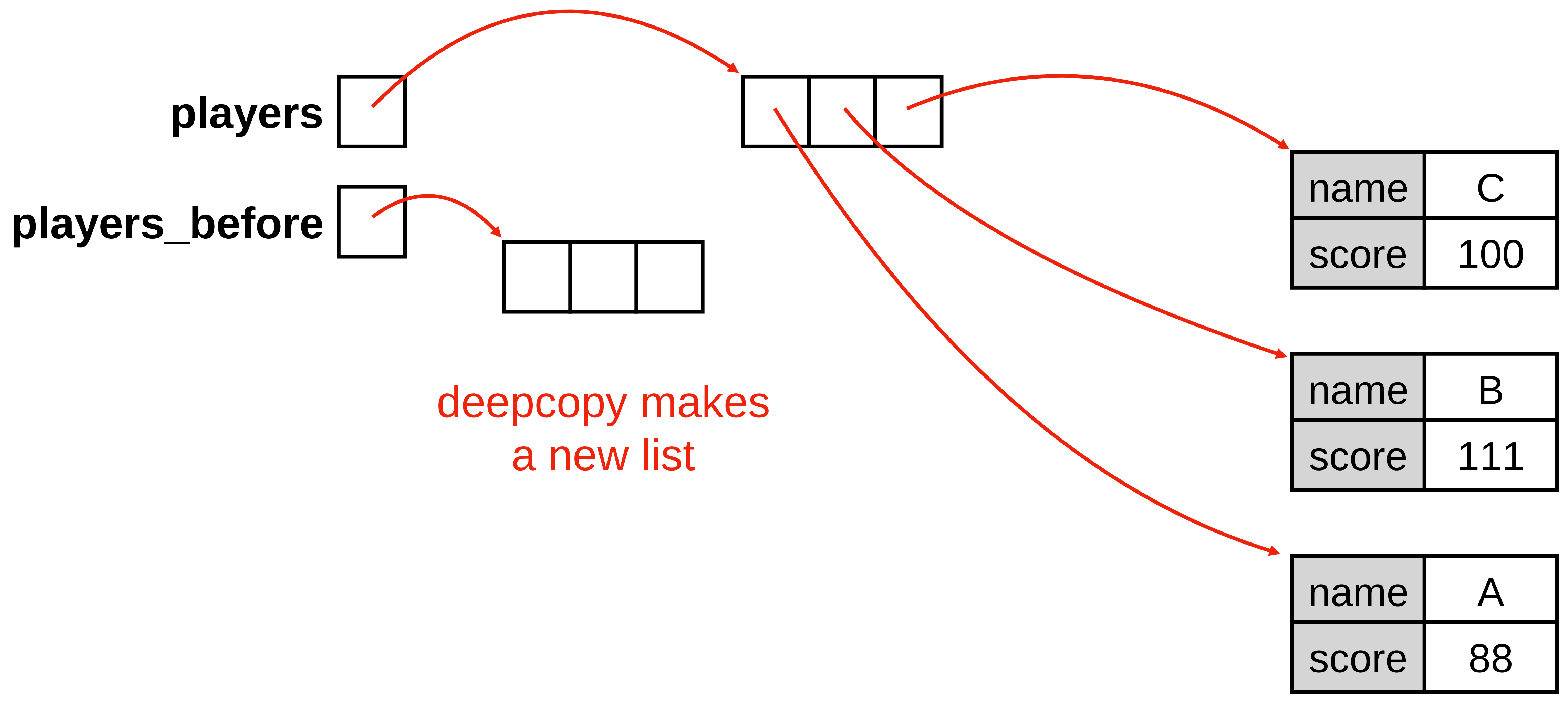

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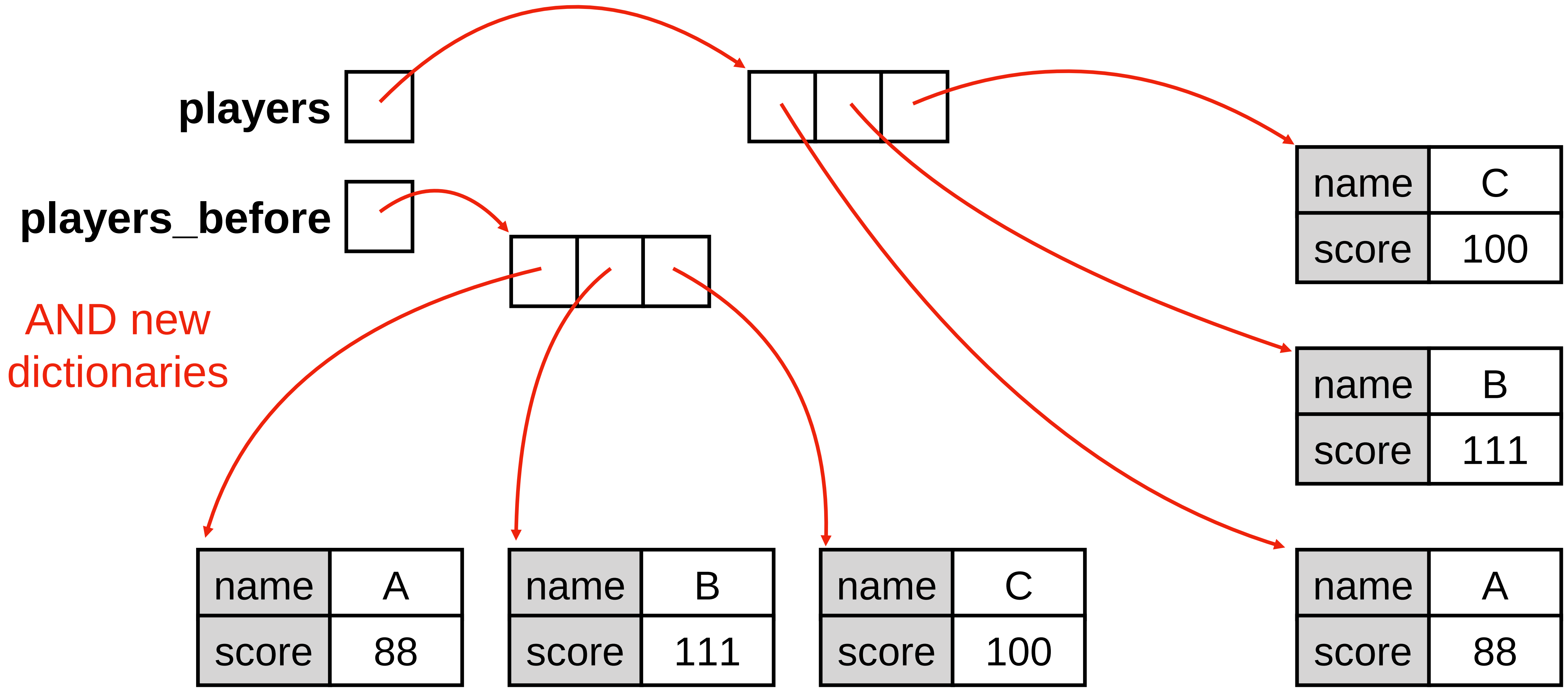

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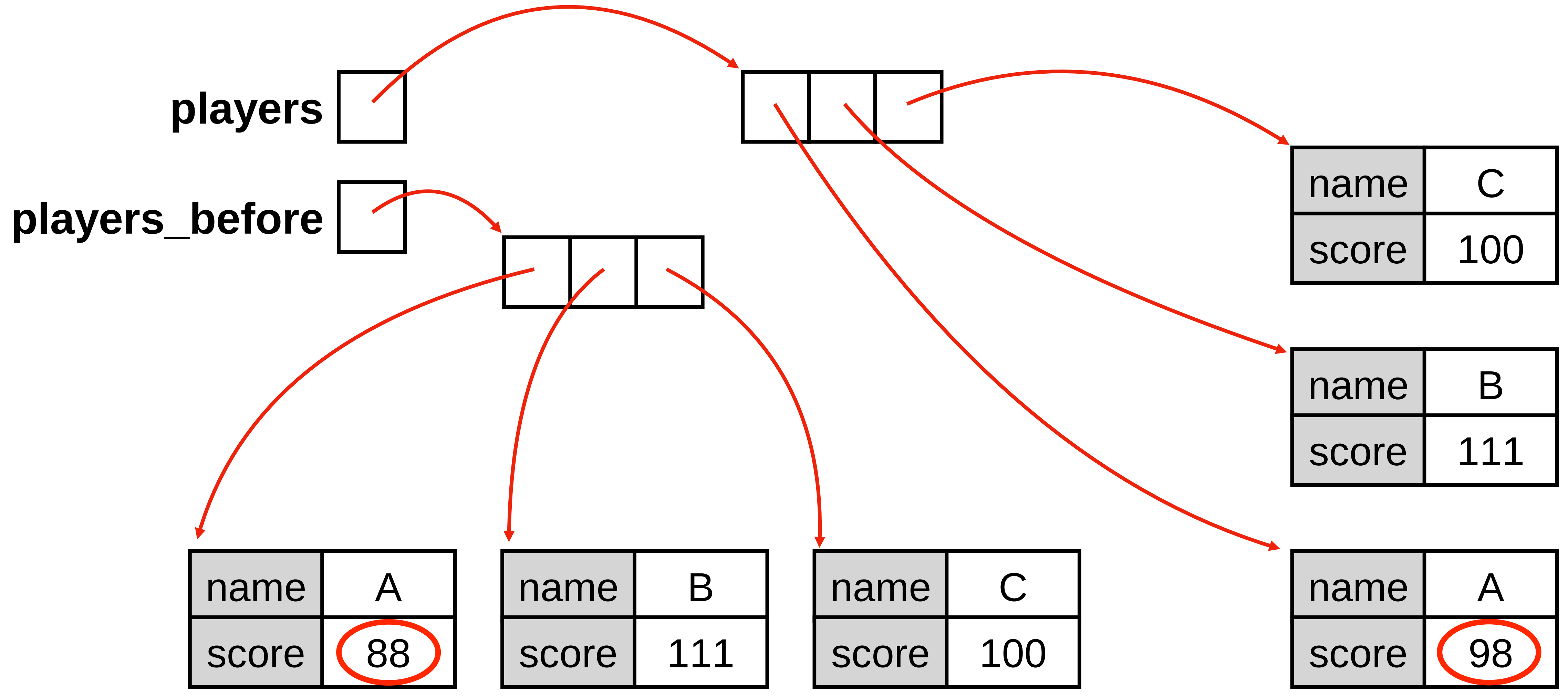

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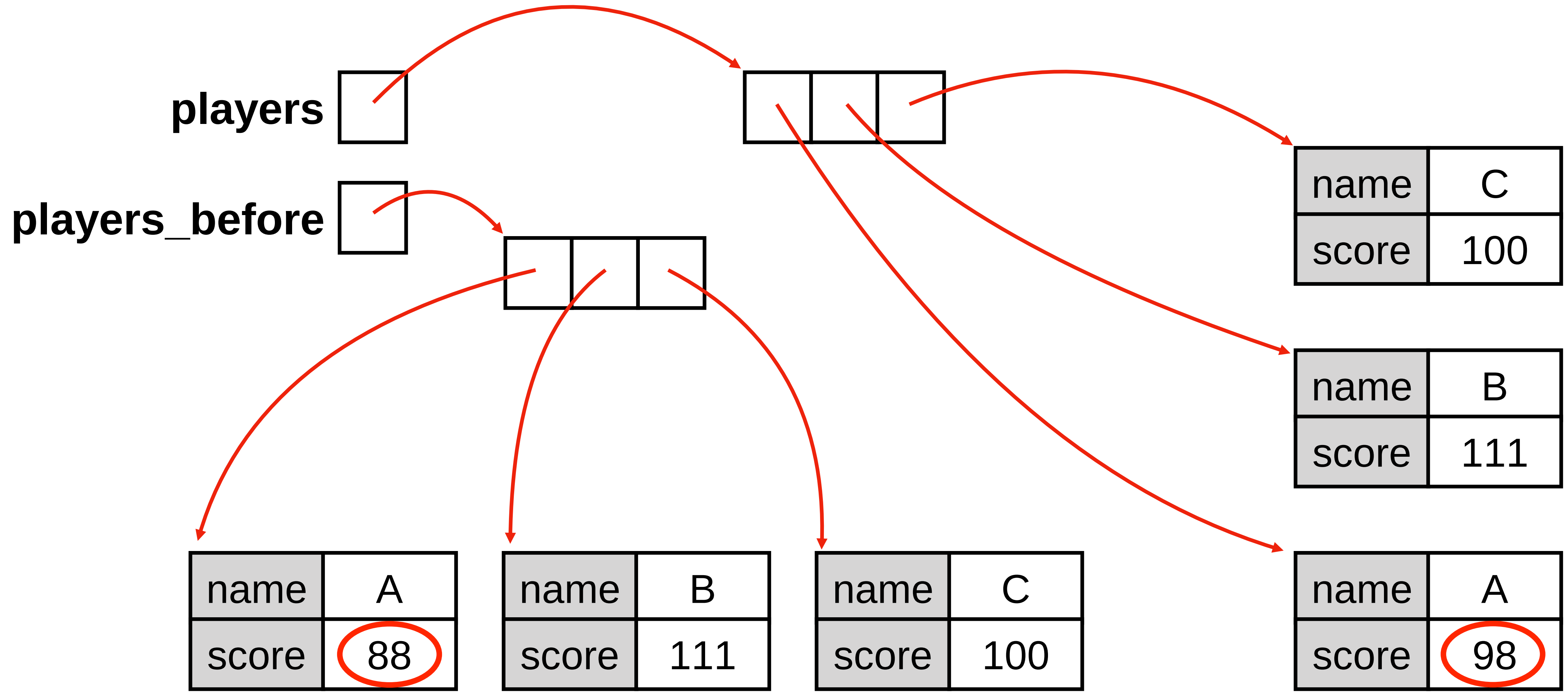
prints 10



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More references

Copying
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Worksheet

Worksheet Problems 7-11