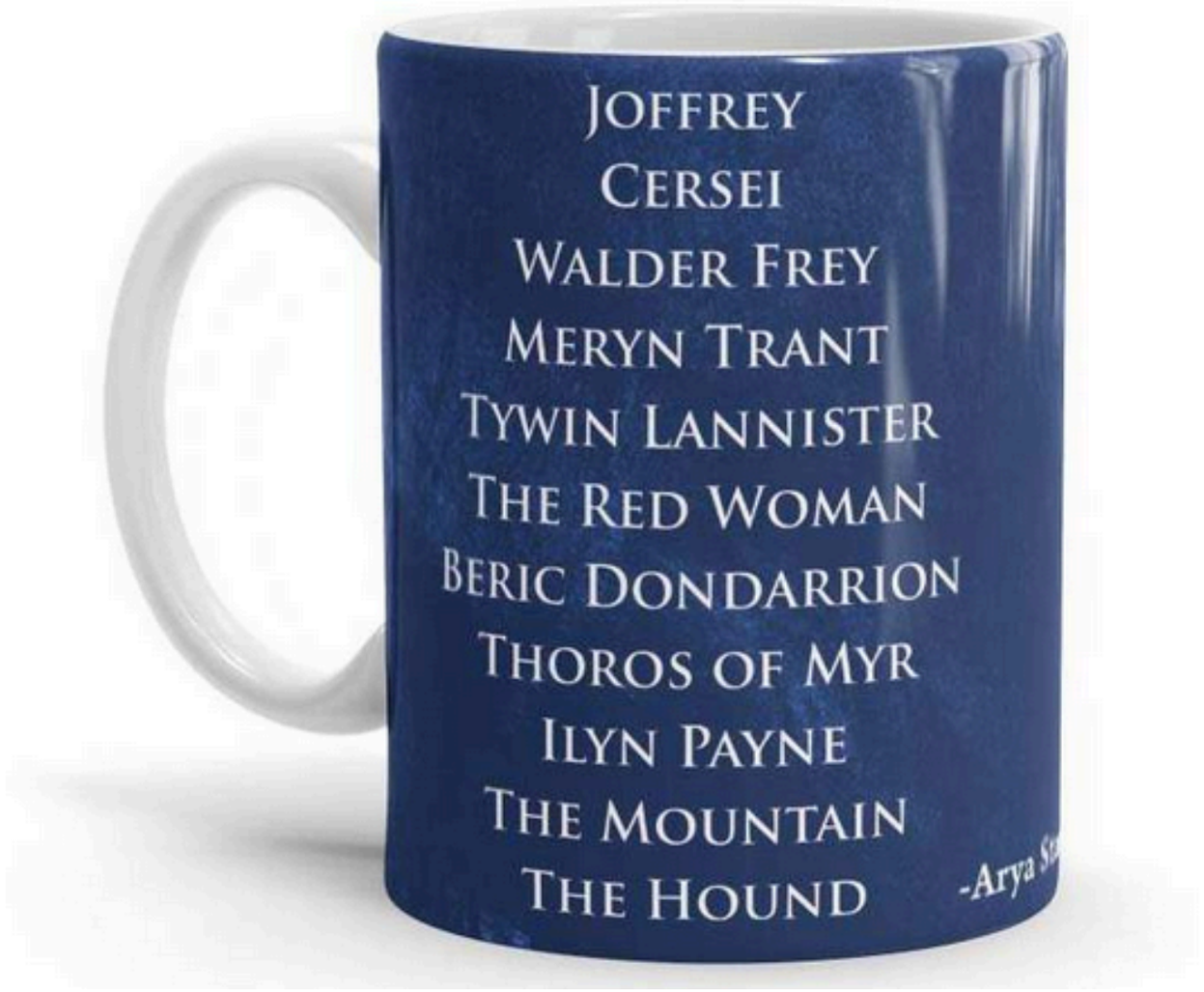

CSCI 141

Lecture 20
Lists
Mutability
Variables are References

Announcements

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- A4 is in! (tonight, if you're using all 3 slip days)

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- I have office hours 2-3 today.

Announcements

- A4 is in! (tonight, if you're using all 3 slip days)
- I have office hours 2-3 today.
- A5 out tomorrow or Wednesday, due Friday 5/31

CS Stories: What's it like to be a female professor?

Who: Dr. Sharmin, Dr. Liu, Dr. Islam, AWC professional guests from industry, alumni, friends, YOU!

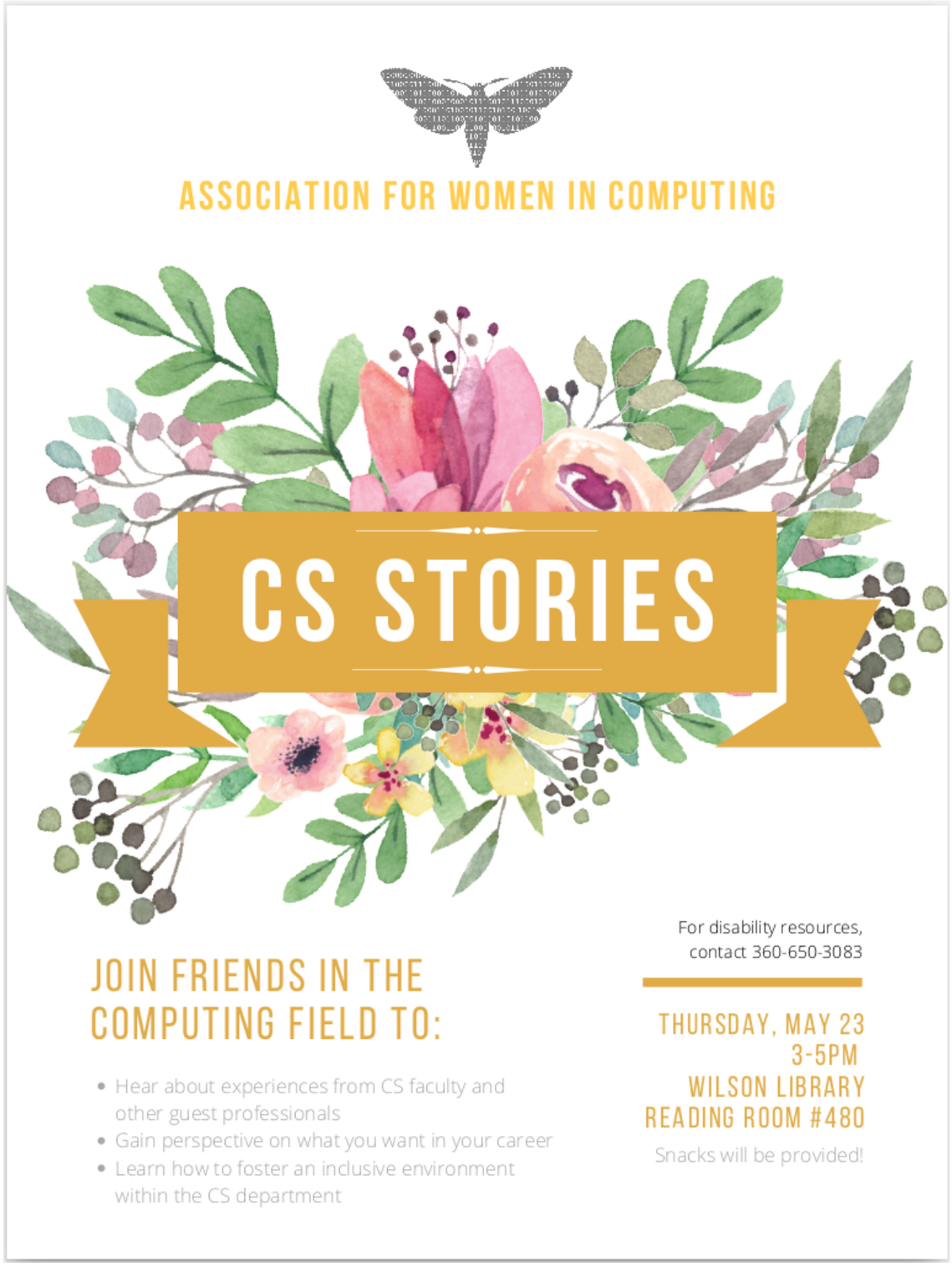
What: Creating the space to open about experiences as students in education with various career goals in addition to equipping our friends to be allies for underrepresented friends.

When: Thursday May 23rd from 3-5pm. Doors open @2:45pm

Where: Wilson Library Reading Room #480 (yes the Harry Potter Reading Room)

Contact: awc.wwu@gmail.com for more info or questions!

See you there!



Goals

- Know how to create, index, slice, and check for membership in lists.
- Understand the behavior of the `+, *, in, not in,` operators on lists.
- Know how to use the assignment operator on list elements and slices
- Know how to use the list methods `append`, and `extend`
- Know the definition of mutability, and which sequence types are mutable (lists) and immutable (strings, tuples)
- Understand that Python variables actually hold references to objects
  - Understand the implications of mutability when multiple variables reference the same mutable object.

Last time

Understand the behavior of the following operators on strings:

- `<`, `>`, `==`, `!=`, `in`, and `not in`
- Understand how Python orders strings using lexicographic ordering:

Example: `"Bellingham" > "Bellevue"`

`"Bellingham"`

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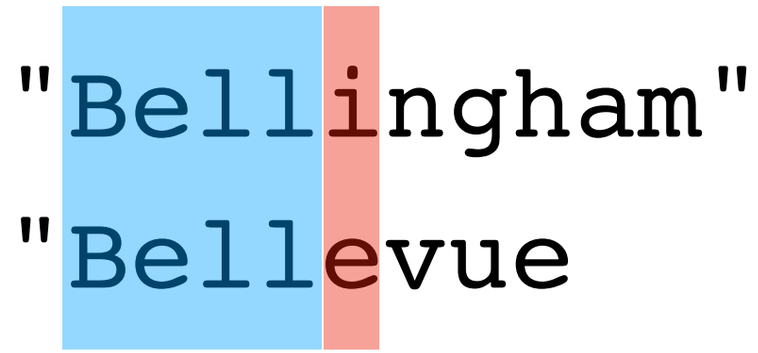

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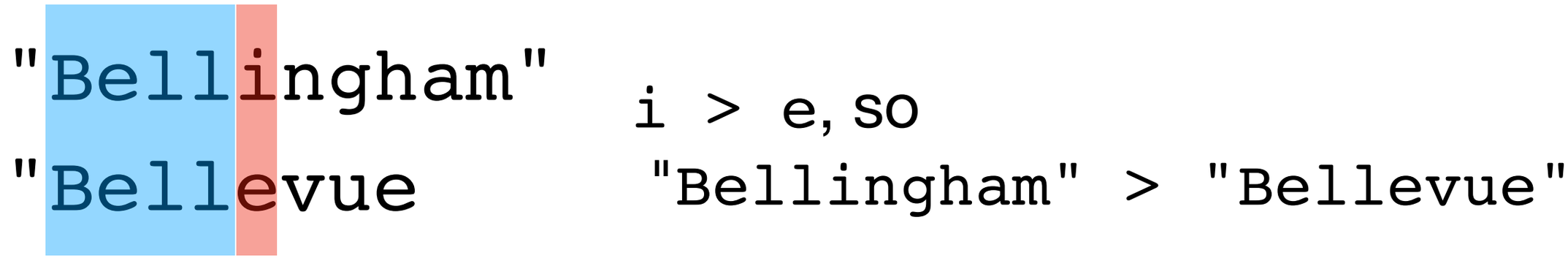

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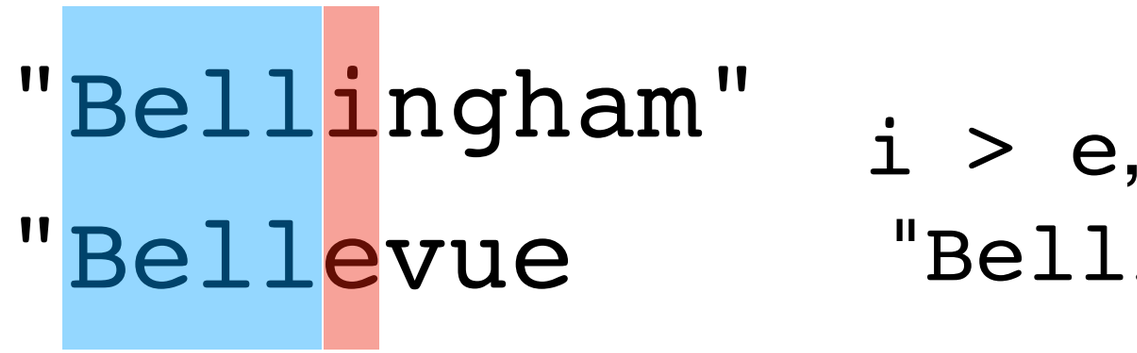

Reminder: character ordering is based on `ord` function:

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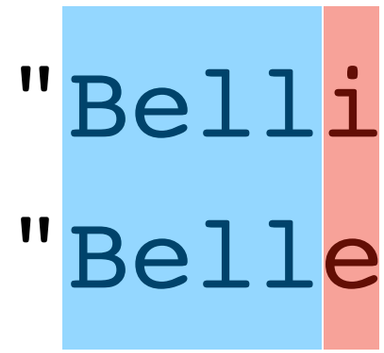

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`ord("a") => 97, ord("b") => 98, ...`

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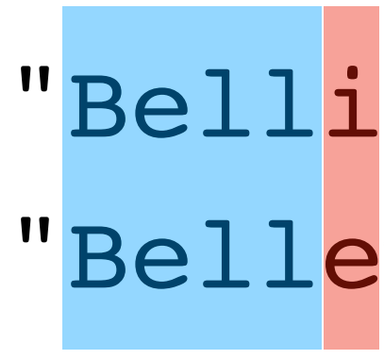

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ord("a") => 97, ord("b") => 98, ...
ord("A") => 65, ord("B") => 66, ...
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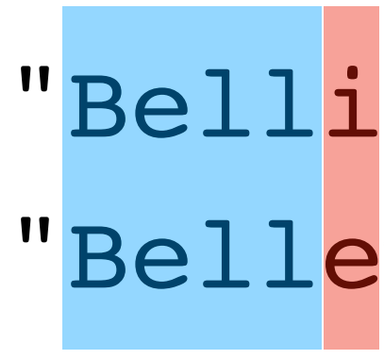

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```
"Bellingham"
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Reminder: character ordering is based on `ord` function:

```
ord("a") => 97, ord("b") => 98, ...
ord("A") => 65, ord("B") => 66, ...
```

All upper-case letters come **before** all lower-case letters.

Last time

- Know how to create, index, slice, and check for membership in lists.
- Understand the behavior of the `+`, `*`, `in`, `not in`, operators on lists.

more on this today

Today’s Quiz

- 3 minutes

Today's Quiz

- 3 minutes
- Working with a neighbor: do your answers agree? (2 minutes)

Lists: Yet Another Sequence Type

A list is an object that contains a sequence of values.

We've seen them before.

Values can be of any type(s)!

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for value in [1, 16, 4]:
    print(value)
```

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Syntax:

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[val0, val1, val2, val3]
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comma-separated list of values

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```

comma-separated list of values

surrounded by square brackets

Values can be of any type(s)!

What can we do with Lists?

A lot of this should look familiar.

These things work analogously to strings:

- Indexing
- Slicing
- The len function
- in and not in operators
- + and * operators

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```
a_list = ["Scott", 34, 27.7]
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Demo

A lot of this should look familiar.

make 'em

index 'em

index 'em

slice 'em

Demo

A lot of this should look familiar.

```
a_list = ["Scott", 34, 27.7]
```
make 'em

```
a_list[0]
```
index 'em

```
a_list[-1]
```
index 'em

```
a_list[1:]
```
slice 'em

Demo

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Demo

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```
a_list = ["Scott", 34, 27.7]

len(a_list)

len(["abc"])

len([])

34 in a_list

"34" not in a_list

a_list + ["Wehrwein", "WWU"]

["na"] * 16 + ["Batman"]
```

Demo

Lists can contain any type: lists, tuples, turtles, ...

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```
a_list = ["Scott", [34, 27.7, (39, 70)]]

a_list[0]

a_list[1]

a_list[1][2]

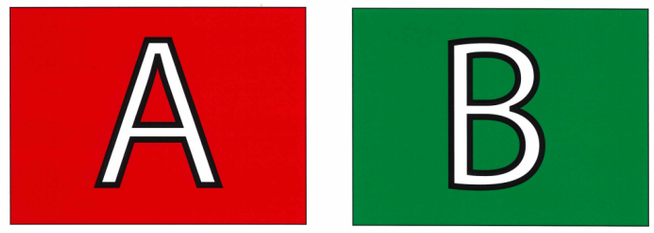
a_list[1][2][0]
```

What can go in lists?

- Like tuples, *any* value can go in a list.
  - tuples, lists, Turtles, ... *anything*

Lists: Yet Another Sequence Type

False **True**

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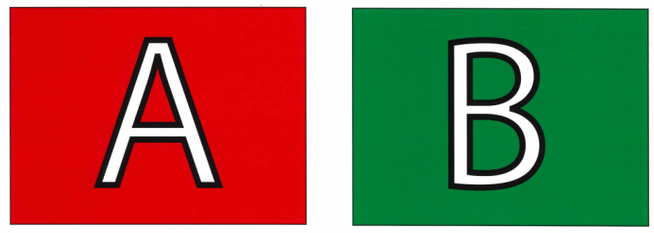


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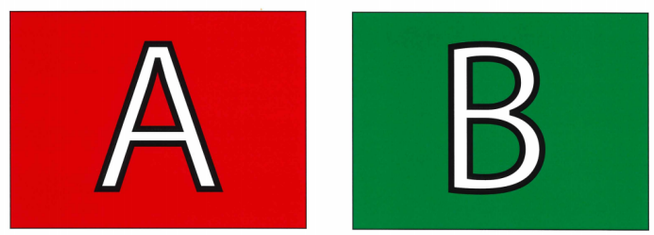


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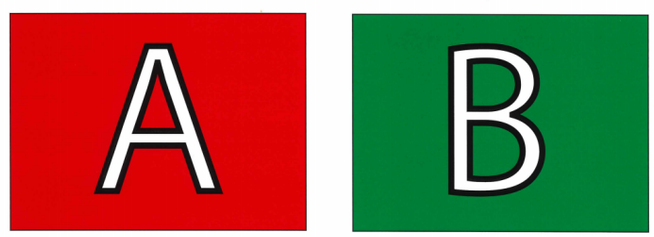


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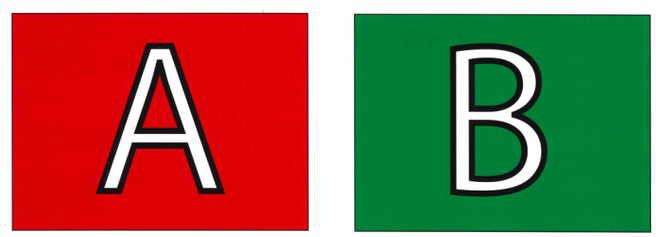


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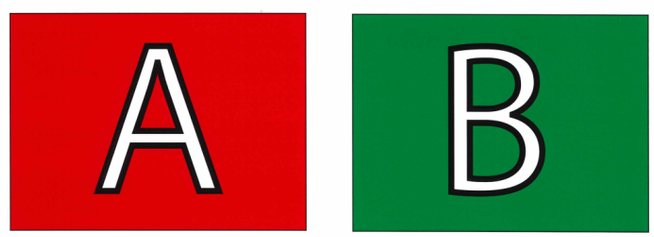


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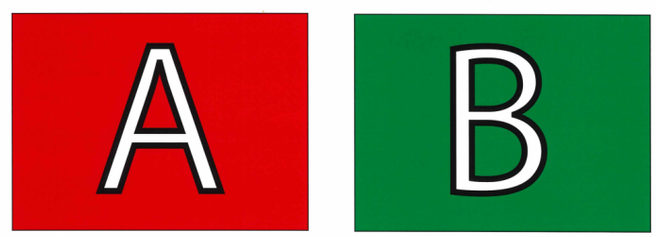


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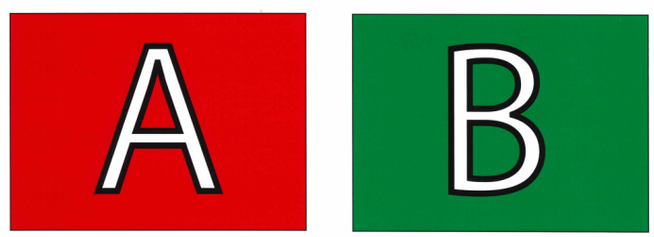


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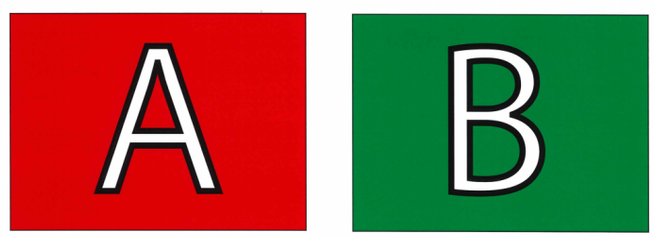


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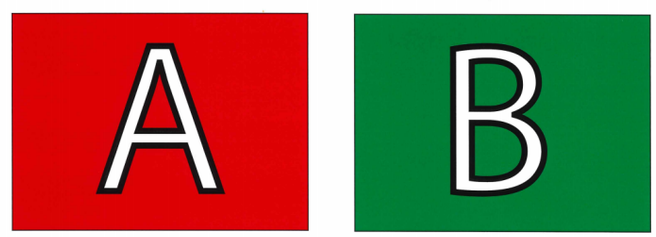


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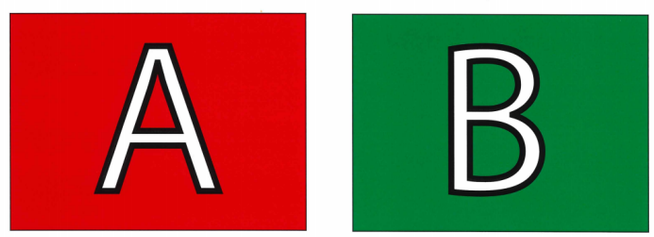


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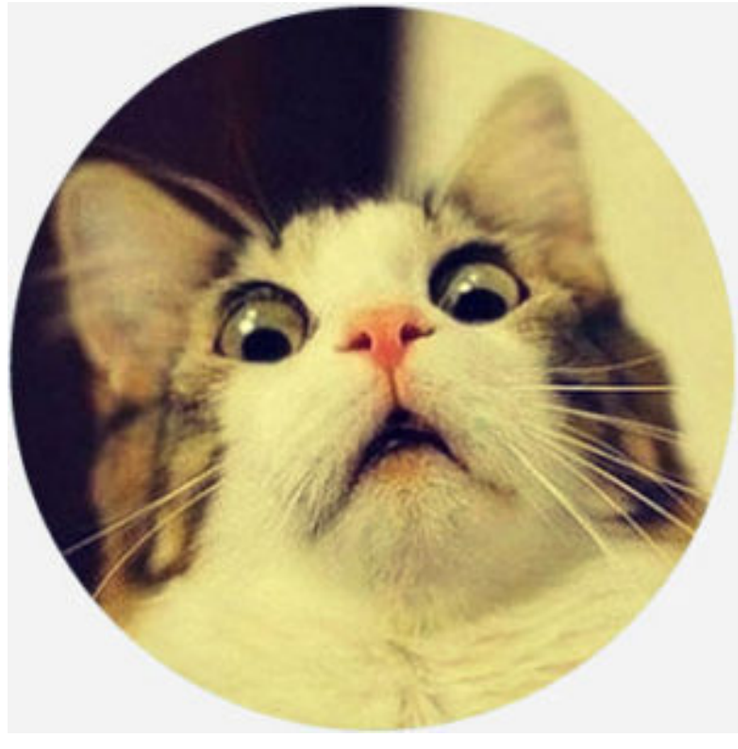

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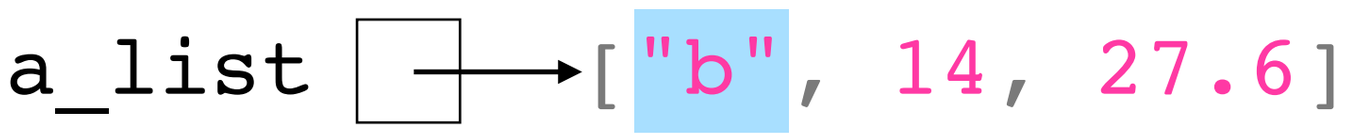
Lists are mutable

```
a_list = ["a", 14, 27.6]
```

Lists are mutable

```
a_list = ["a", 14, 27.6]

a_list[0] = "b"
```



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```
a_list = ["a", 14, 27.6]

a_list[0] = "b"

a_list.append(19)
```

Lists are mutable

```
a_list = ["a", 14, 27.6]

a_list[0] = "b"

a_list.append(19)

a_list.append(["12", 2])
```

Lists are mutable

```
a_list = ["a", 14, 27.6]

a_list[0] = "b"

a_list.append(19)

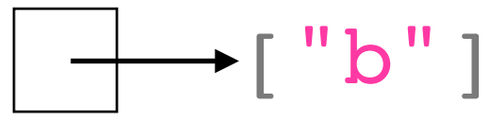
a_list.append(["12", 2])

a_list.extend([22, 33])
```

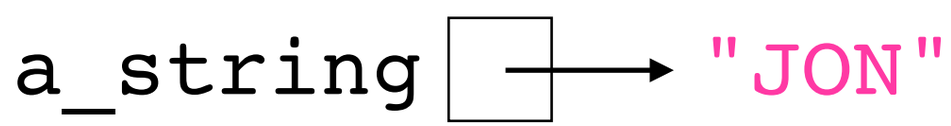
Lists are mutable

Notice the difference between string methods and list methods:

```
a_list.append(19)
```




```
new_string = a_string.lower()
```



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- **modifies** the list in-place
- has **no** return value

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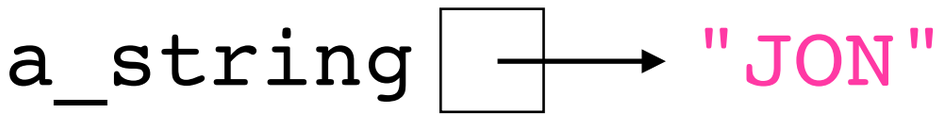

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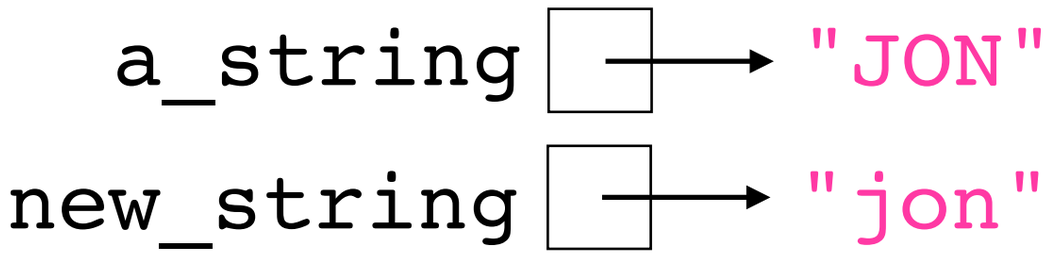
```
new_string = a_string.lower()
```

- **does not modify** a_string
- **returns** a lower-case copy



Demo: a *bale* of turtles

- bale.py

Objects and Variables: Digging a little deeper

When we talked about variables...

All variables store **references** to **objects.**
Objects can be any type
(that's why a variable can have any type):

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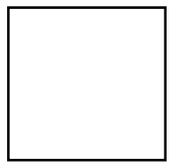
what's actually happening: `number` 

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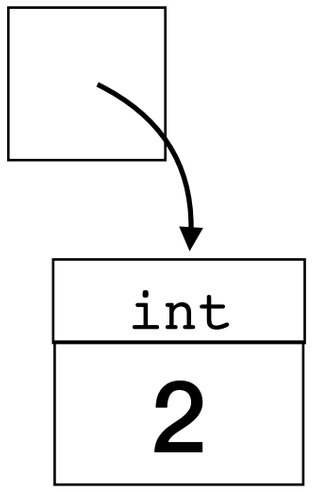

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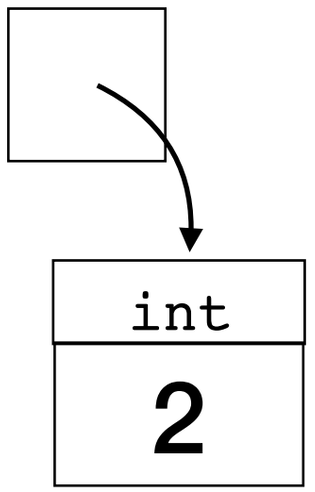

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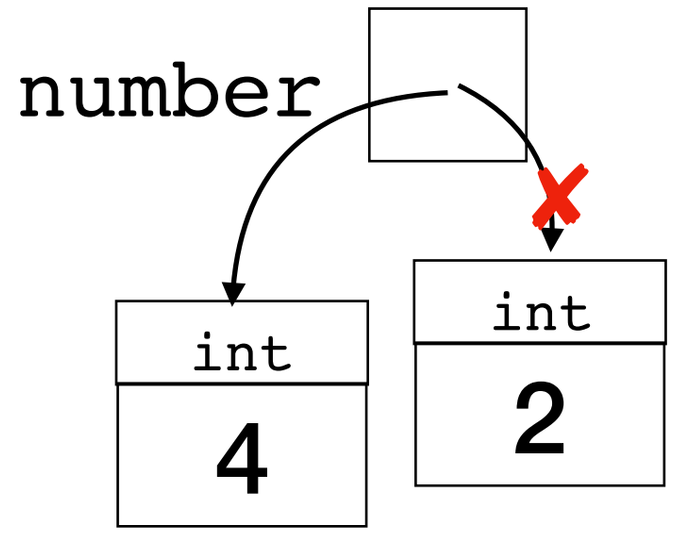

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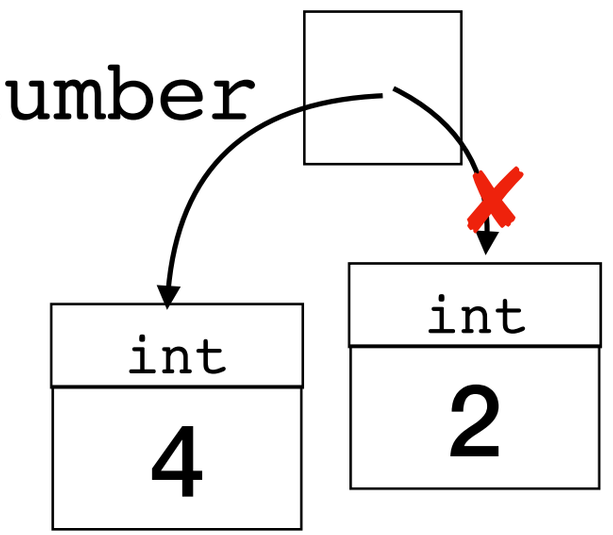

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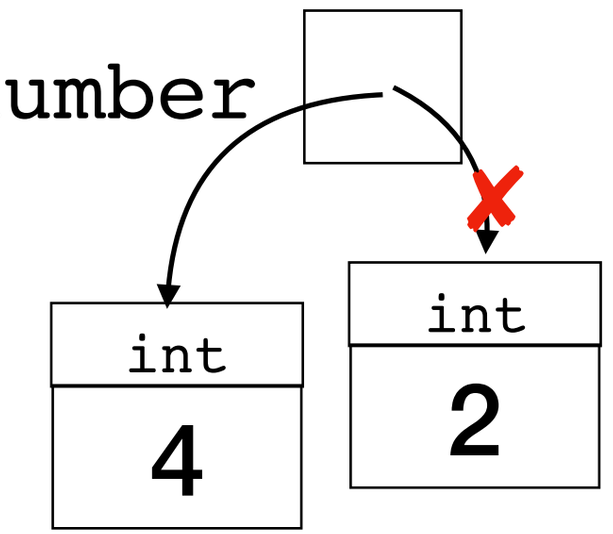

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After `number = 4` is executed,

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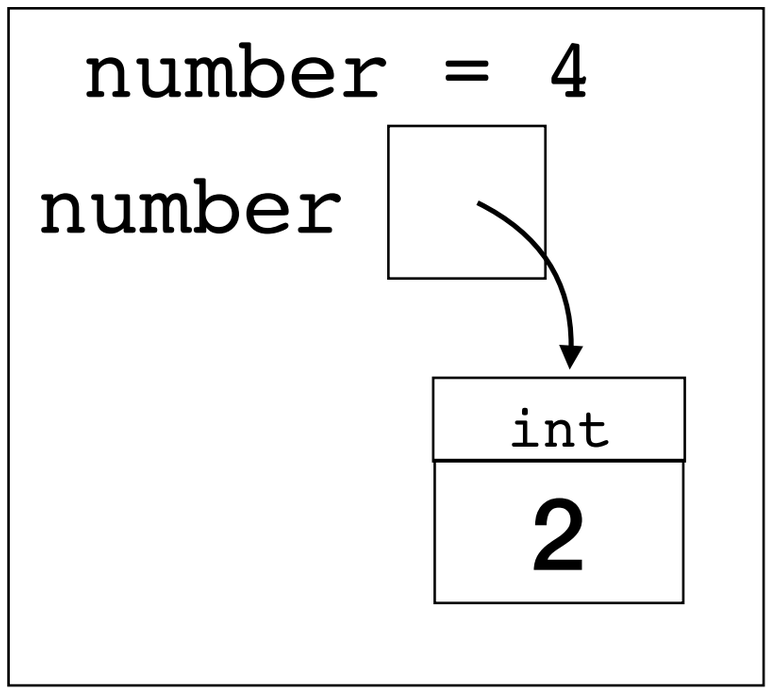
For immutable objects, we don't have to think about this much.

Objects and Variables: Digging a little deeper

On paper exercise (not collected)
Execute the following, drawing and updating the memory diagram for each variable and object involved.

```
number = 2
number = 4
another_number = number
another_number += 1
```



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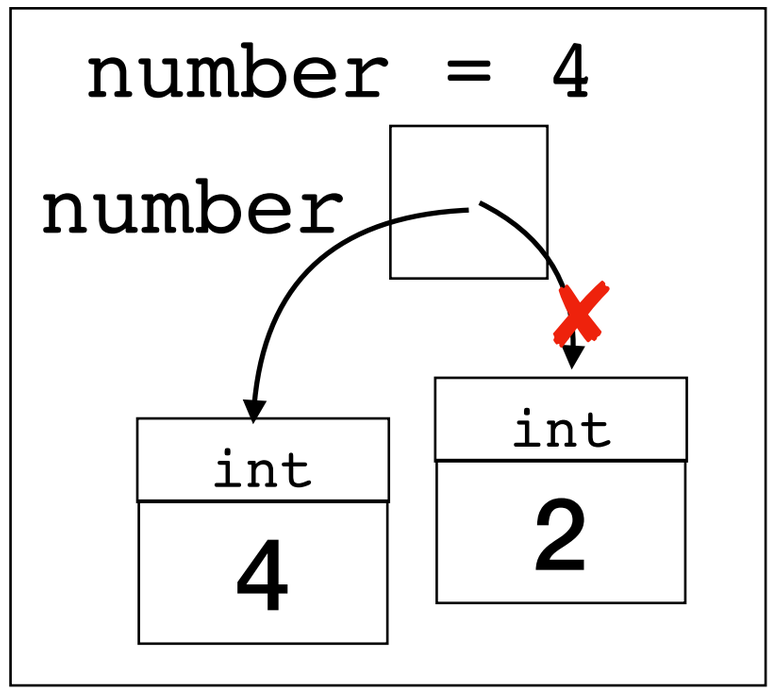

Objects and Variables: Digging a little deeper

Now let's talk about lists:

- each element is like its own variable

```
weather = [63, "light rain", 8, "SSW", 29.75]
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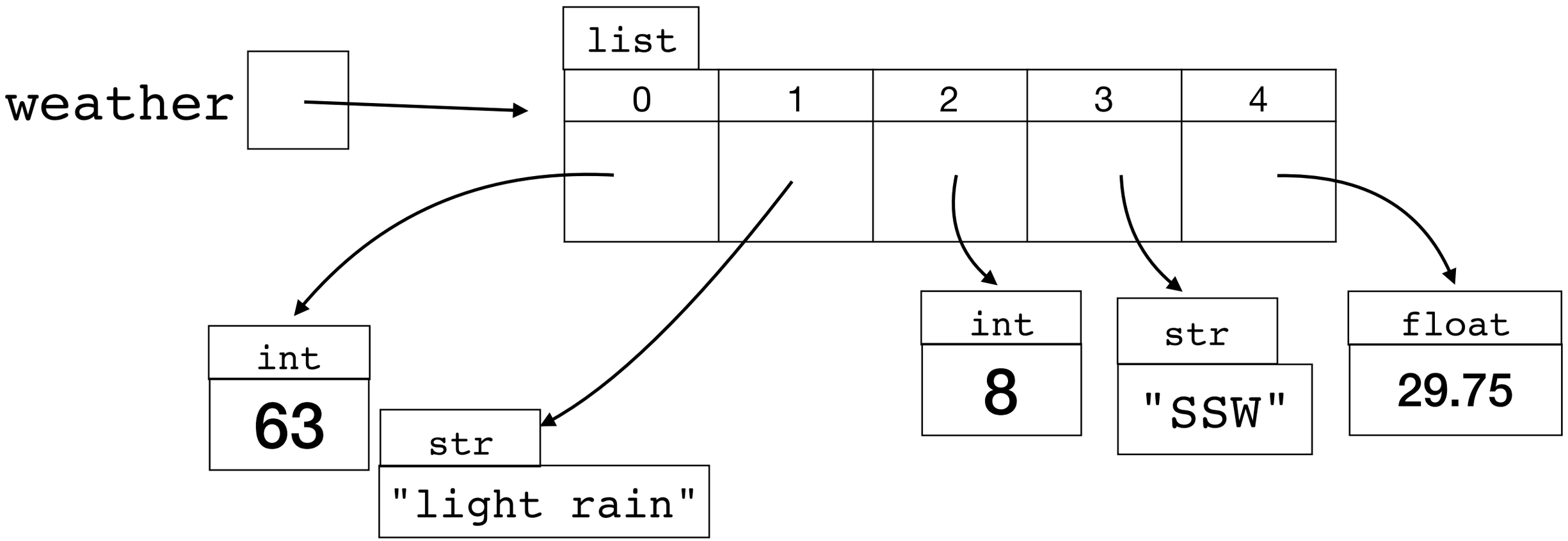

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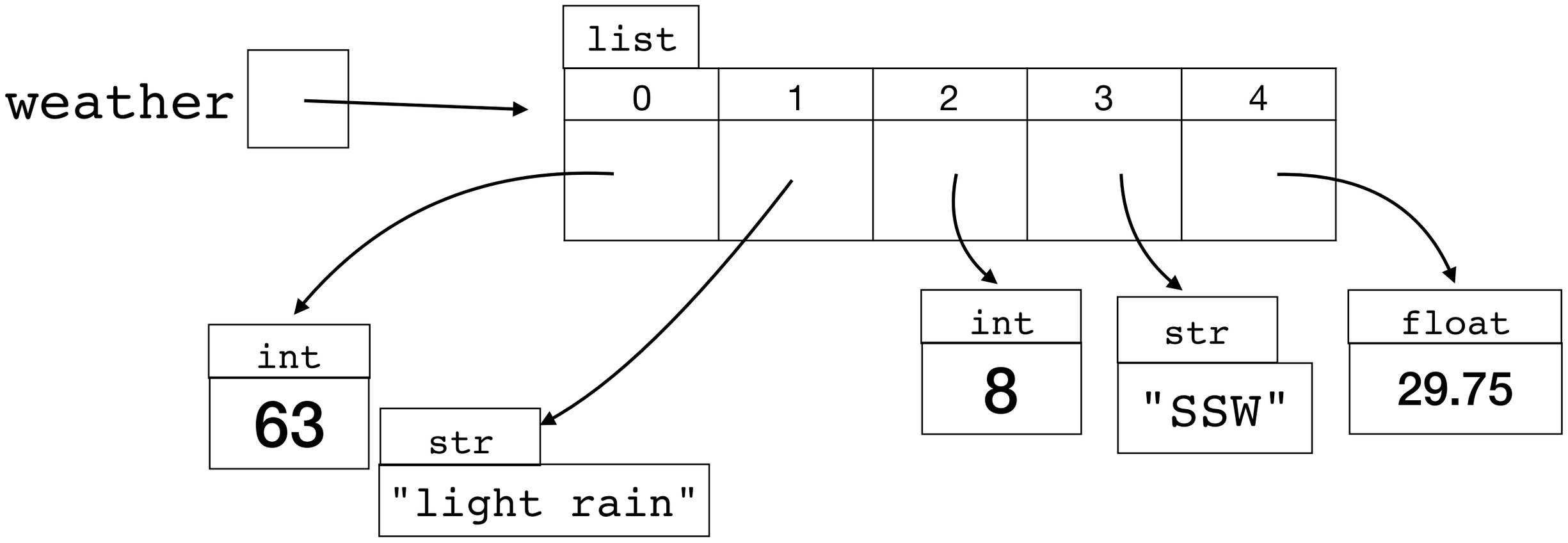

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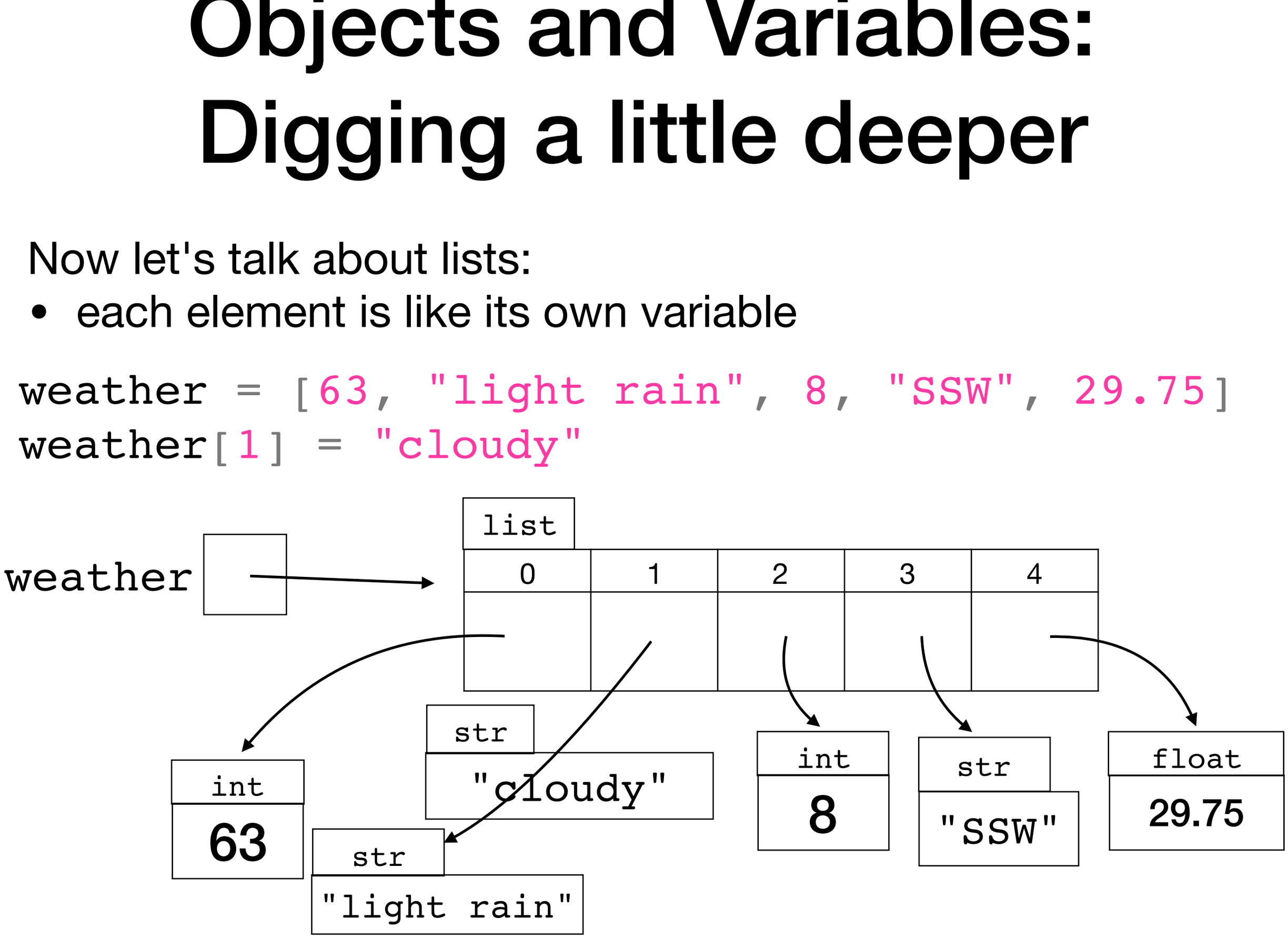

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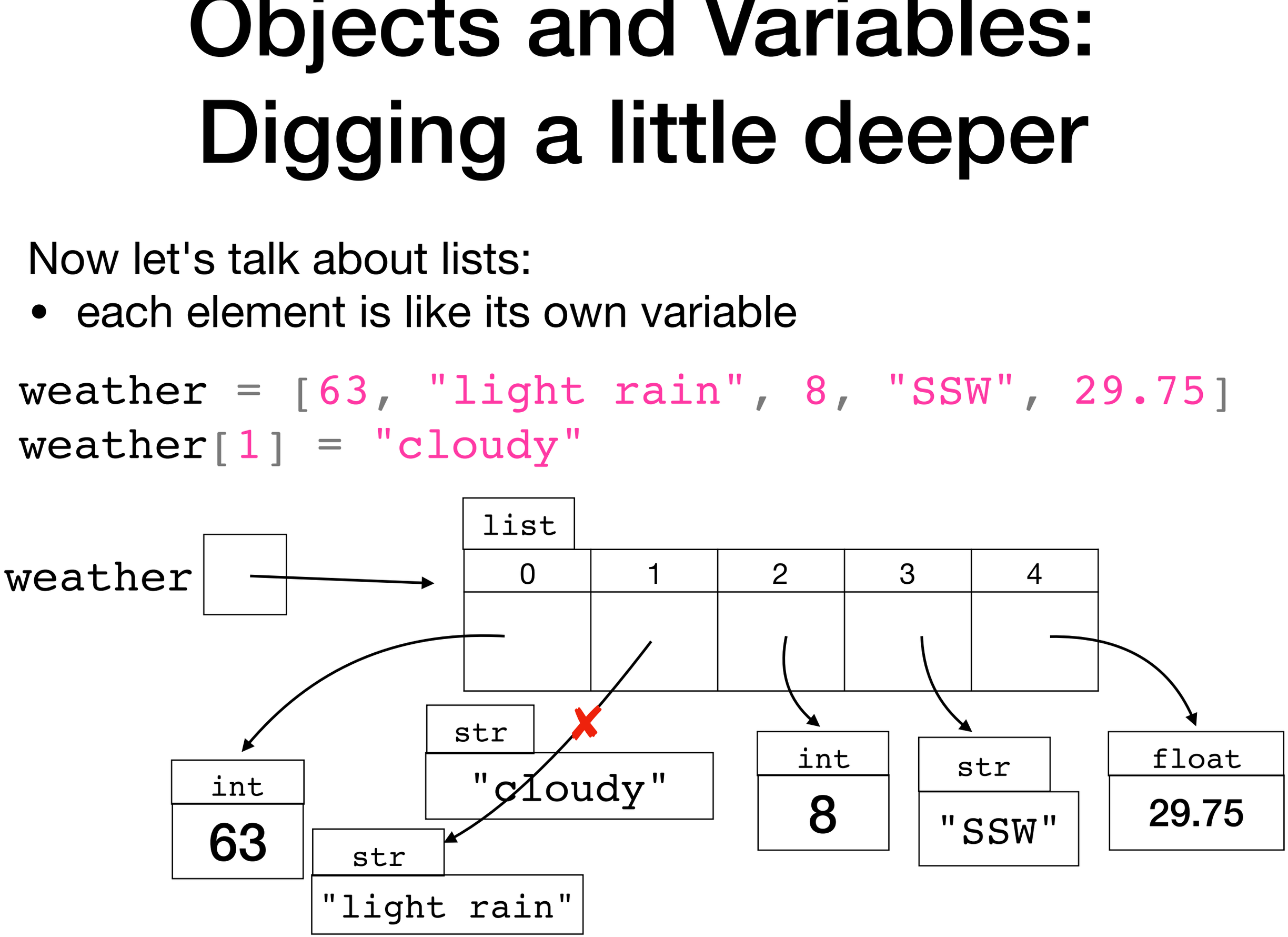

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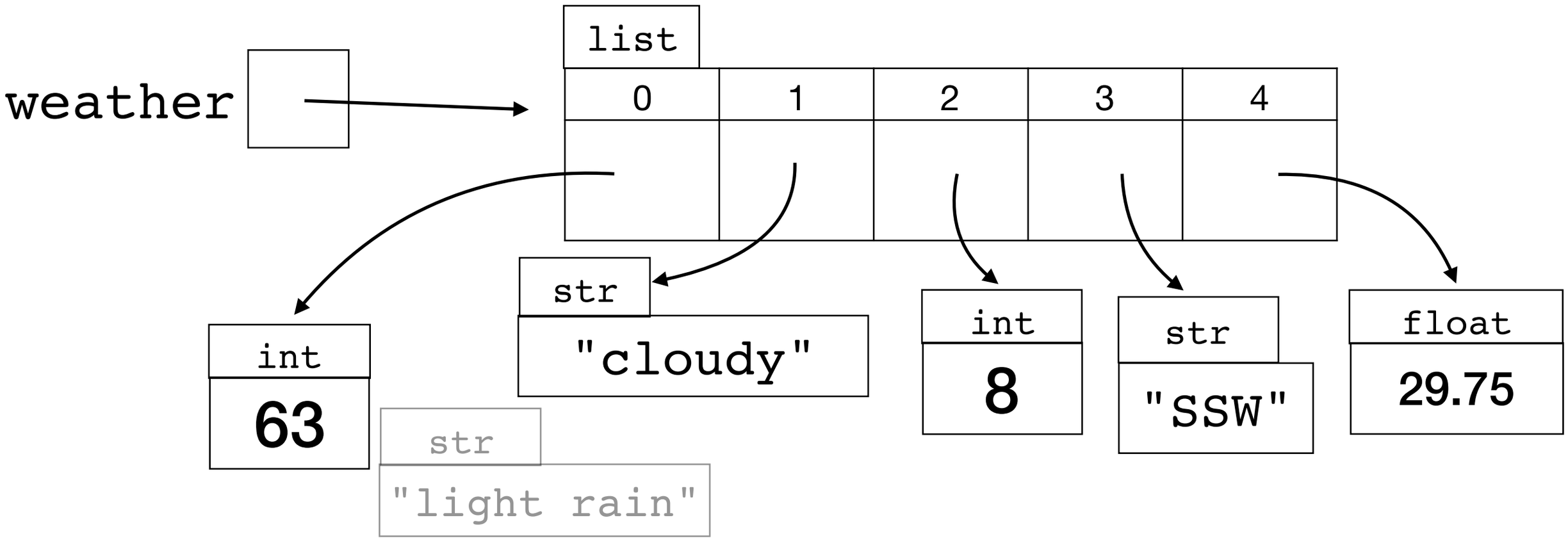
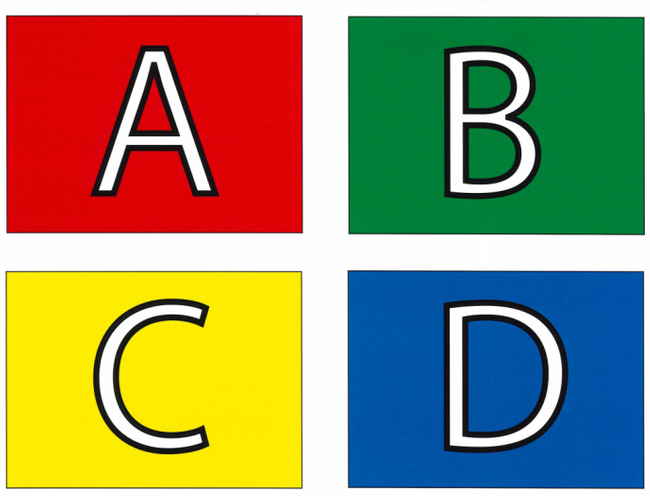


Implications of Mutability

```
weather = [63, "light rain"]
tomorrow_weather = weather
tomorrow_weather[0] = 68
print(weather[0])
```

ABCD: What does the above code print?



A. "light rain"
B. Error
C. 63
D. 68

Implications of Mutability

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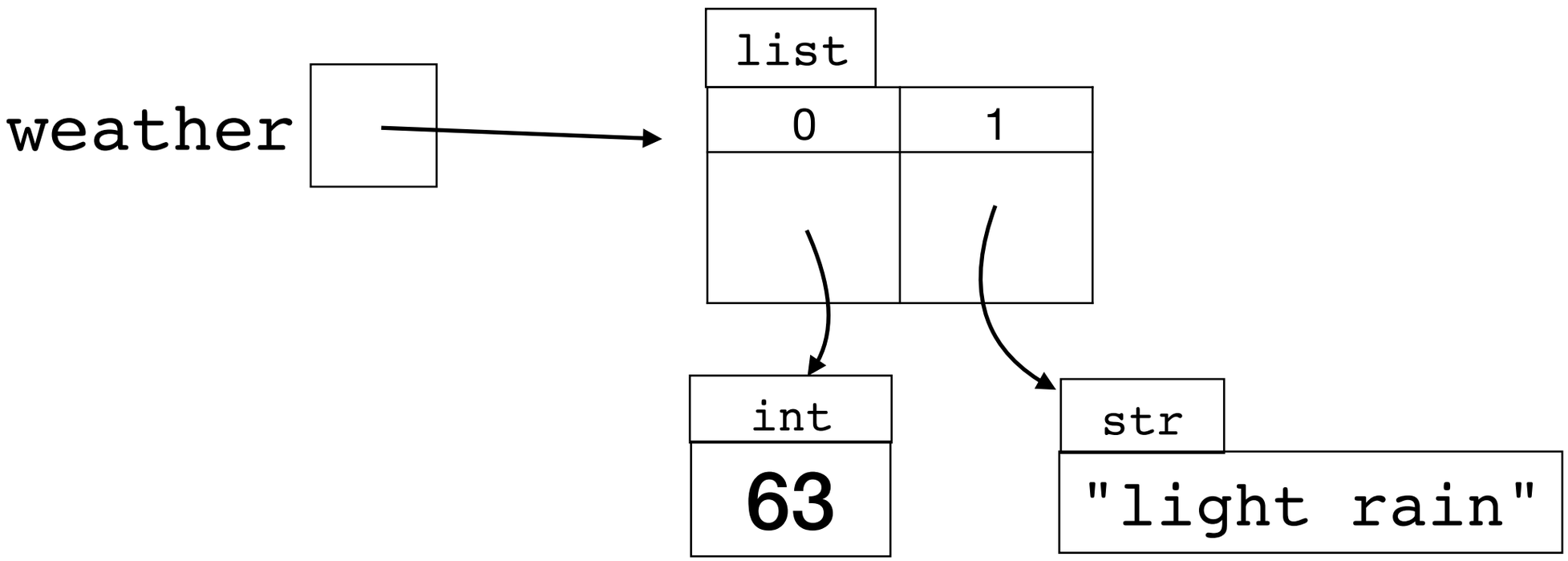

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To create a true copy of a **mutable** object, you can't simply assign a new variable to the object.

Exercise

Write a function that returns a true copy (i.e., a different object that has the same values).

```
def copy_list(in_list):
    """ Return a new list object containing
        the same elements as in_list. """
```

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Hint: one possible approach uses a loop and the `append` method.