Lists

- Look a lot like tuples
  - Ordered sequence of values, each identified by an index
  - Use [1, 2, 3] rather than (1, 2, 3)
  - Singletons are now just [4] rather than (4,)
- **BIG DIFFERENCE**
  - Lists are mutable!!
  - While tuple, int, float, str are immutable
  - So lists can be modified after they are created!

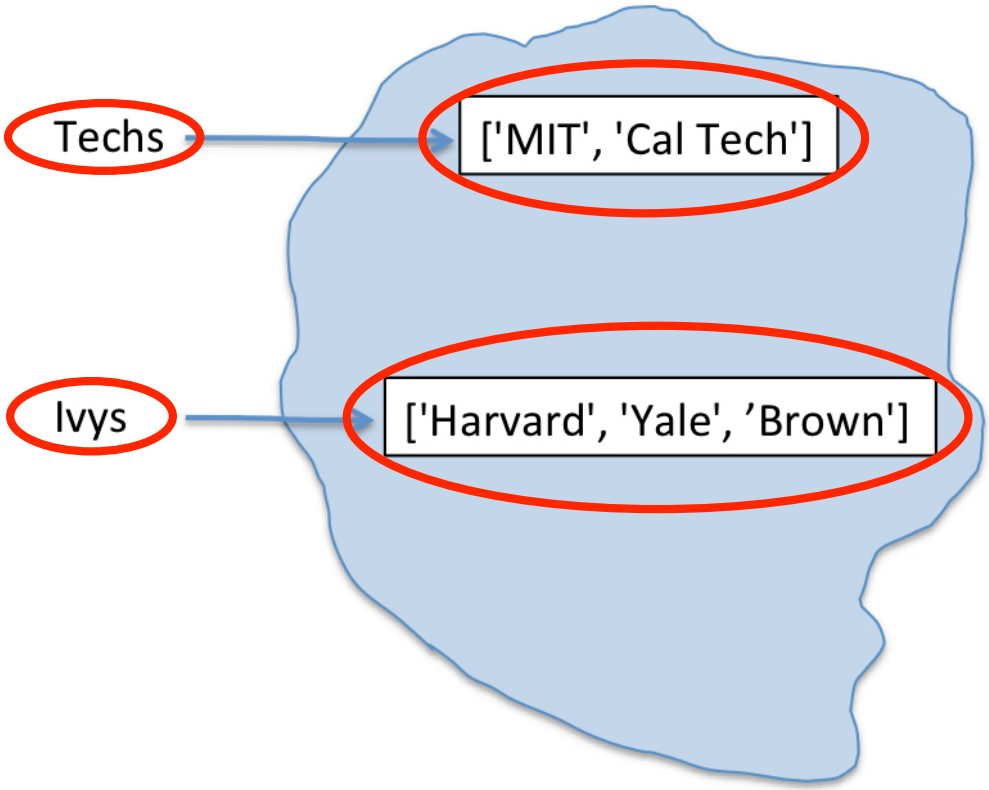
Why should this matter?

- Some data objects we want to treat as fixed
  - Can create new versions of them
  - Can bind variable names to them
  - But don't want to change them
  - Generally valuable when these data objects will be referenced frequently but elements don't change
- Some data objects may want to support modifications to elements, either for efficiency or because elements are prone to change
- Mutable structures are more prone to bugs in use, but provide great flexibility

Visualizing lists

```
Techs = [‘MIT’,
  ‘Cal Tech’]
Ivys = [‘Harvard’,
  ‘Yale’, ‘Brown’]

>>>Ivys[1]
‘Yale’
```



Structures of lists

- Consider

```
Univs = [Techs, Ivys]
Univs1 = [['MIT', 'Cal Tech'],
          ['Harvard', 'Yale', 'Brown']]
```

- Are these the same thing?
  - They print the same thing
  - But let's try adding something to one of these

Mutability of lists

- Let's evaluate

```
Techs.append('RPI')
```

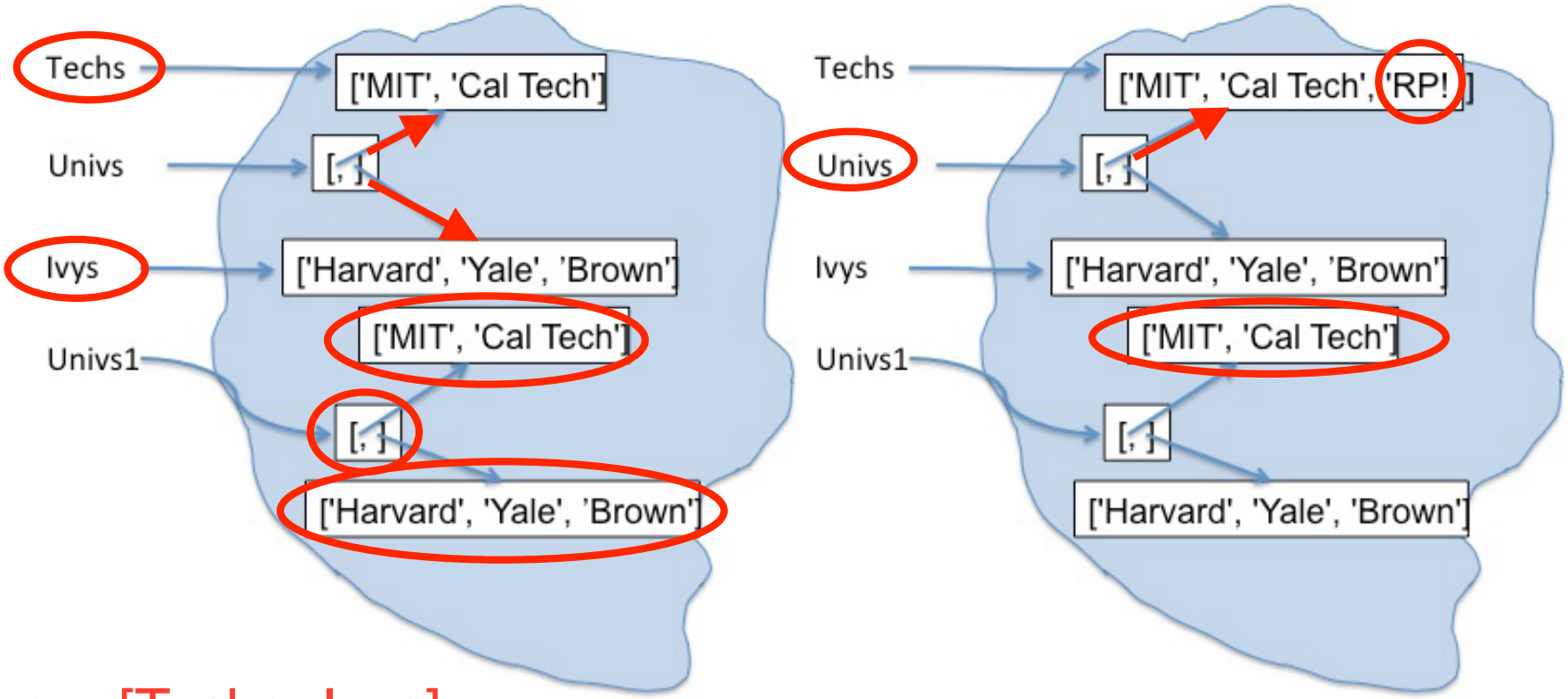
- Append is a method (hence the .) that has a **side effect**
  - It doesn't create a new list, it mutates the existing one to add a new element to the end
- So if we print Univs and Univs1 we get different things

```
print(Univs)
Univs = [['MIT', 'Cal Tech',
  'RPI'], ['Harvard', 'Yale',
  'Brown']]

Print(Univs1)
Univs1 = [['MIT', 'Cal Tech'],
  ['Harvard', 'Yale', 'Brown']]
```

Why?

- Bindings before append
- Bindings after append



Univs = [Techs, Ivys]
Univs1 = [['MIT', 'Cal Tech'], ['Harvaard', 'Yale', 'Brown']]

Observations

- Elements of `Univs` are not copies of the lists to which `Techs` and `Ivys` are bound, but are the lists themselves!
- This effect is called **aliasing**:
  - There are two distinct paths to a data object
    - One through the variable `Techs`
    - A second through the first element of list object to which `Univs` is bound
  - Can mutate object through either path, but effect will be visible through both
  - Convenient but **treacherous**

We can directly change elements

```
>>> Techs
['MIT', 'Cal Tech', 'RPI']

>>> Techs[2] = 'WPI'
```

Cannot do this with tuples!

```
>>> Techs
['MIT', 'Cal Tech', 'WPI']
```