Lecture 8: Containers & Sequences

CS 61A - Summer 2024
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Sequences

A **sequence** is an ordered collection of values.

Examples:

```
"hello world"
"abcdefghijkl"
```

Strings

Sequence of characters

```
[1, 2, 3, 4, 5]
[True, "hi", 0]
```

Lists

Sequence of values of any data type

Lists

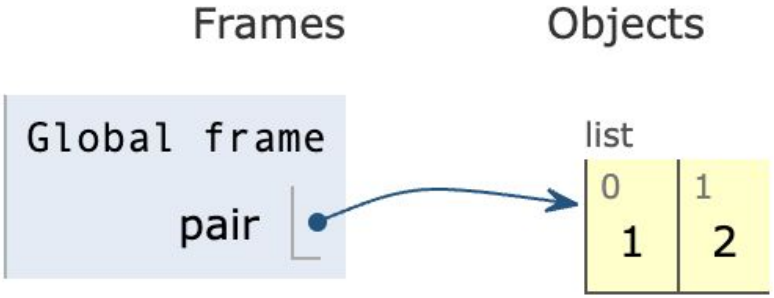
Lists

- A list is an **ordered sequence** of elements
- Some operations we can perform on lists:
  - Access an element at a certain position
  - Get the number of elements in a list
  - Concatenate two lists together into one
  - Determine if an element exists inside the list
  - … and much more
- Lists can contain more than one datatype as elements
  - Including other lists!

Demo: Working with Lists

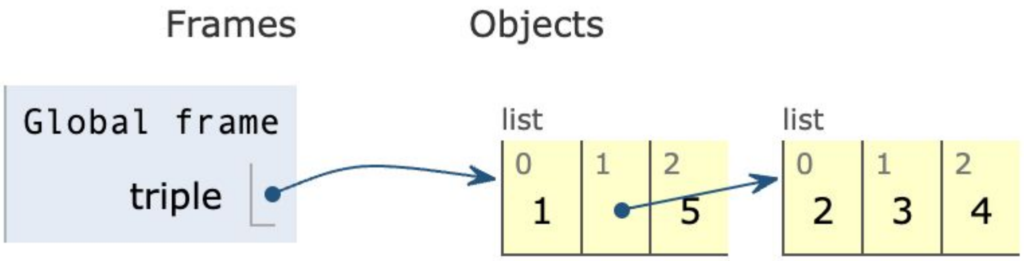
Box and Pointer Notation

- Environment diagrams allow us to visualize the contents of a list
- Each box contains either a primitive value, or points to a compound value
    - Ex: pair = [1, 2]



Box and Pointer Notation

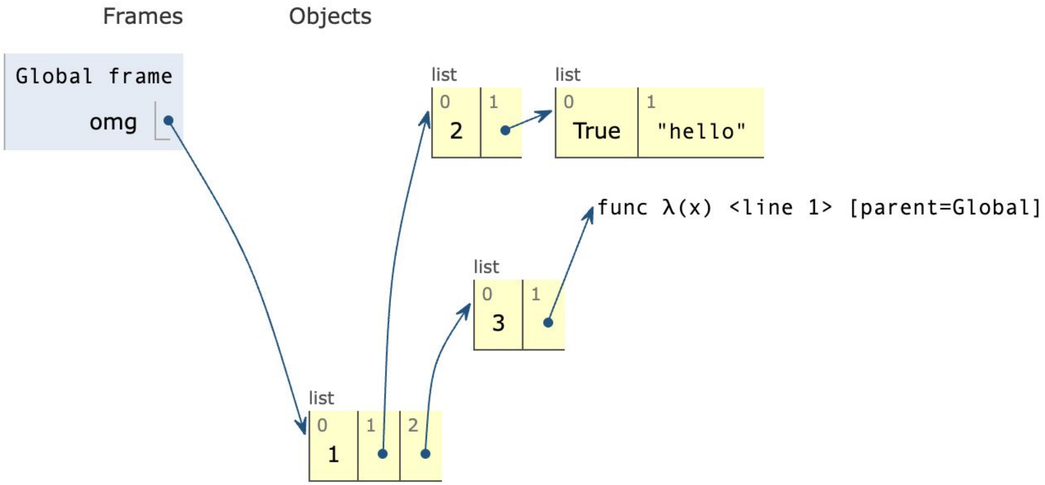
- Environment diagrams allow us to visualize the contents of a list
- Each box contains either a primitive value, or points to a compound value
  - Ex: triple = [1, [2, 3, 4], 5]



Box and Pointer Notation

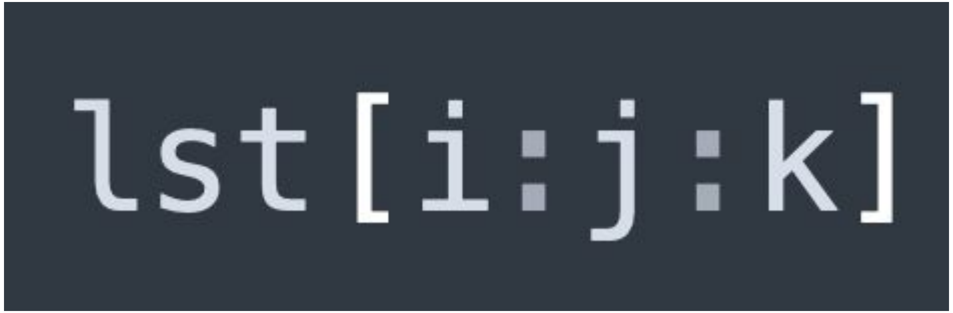
- Environment diagrams allow us to visualize the contents of a list
- Each box contains either a primitive value, or points to a compound value
    - Ex: omg = [1, [2, [True, ‘hello’]], [3, lambda x : 2 * x]]

```
>>> omg[2][1](4)
8
```



List Slicing

- List slicing returns a specified “chunk” of a list
- Syntax:



```
lst[i:j:k]
```

`i`: Starting Index (**inclusive**)

`j`: Ending Index (**exclusive**)

`k` (optional): Step size (default set to 1)

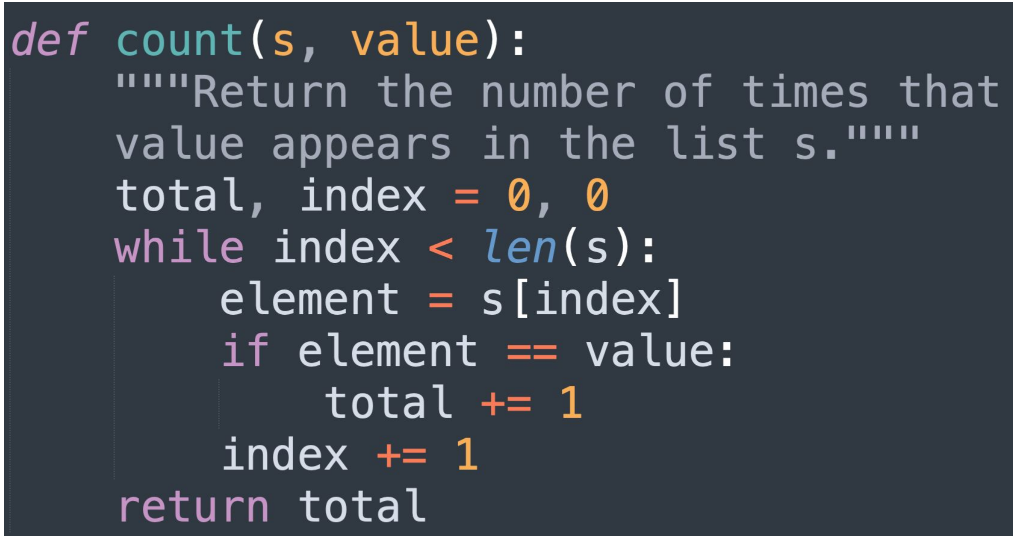
Demo: List Slicing

For Statements

Example: count

- Problem: We want to come up with a function that takes two arguments - `s` and `value`. The goal is to return the number of times the integer `value` appears in the list `s`.

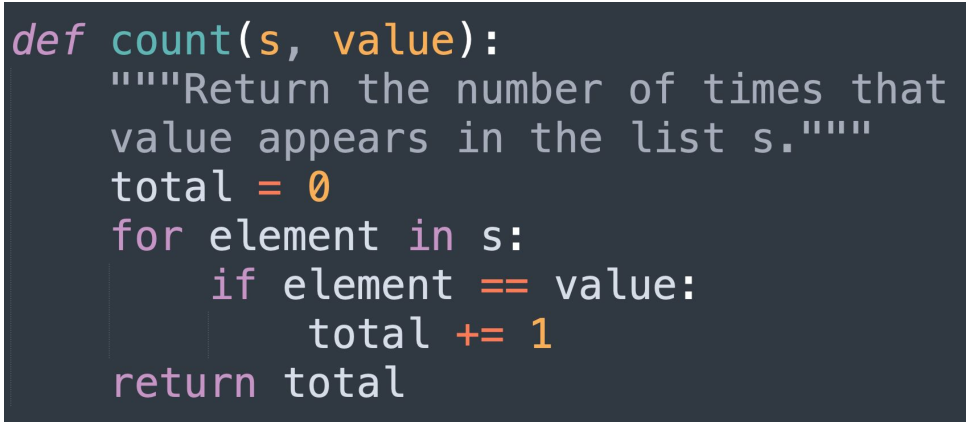
count: while loop



```python
def count(s, value):
    """Return the number of times that
    value appears in the list s."""
    total, index = 0, 0
    while index < len(s):
        element = s[index]
        if element == value:
            total += 1
        index += 1
    return total
```

Is there a way we can make this implementation shorter?

count: for statement



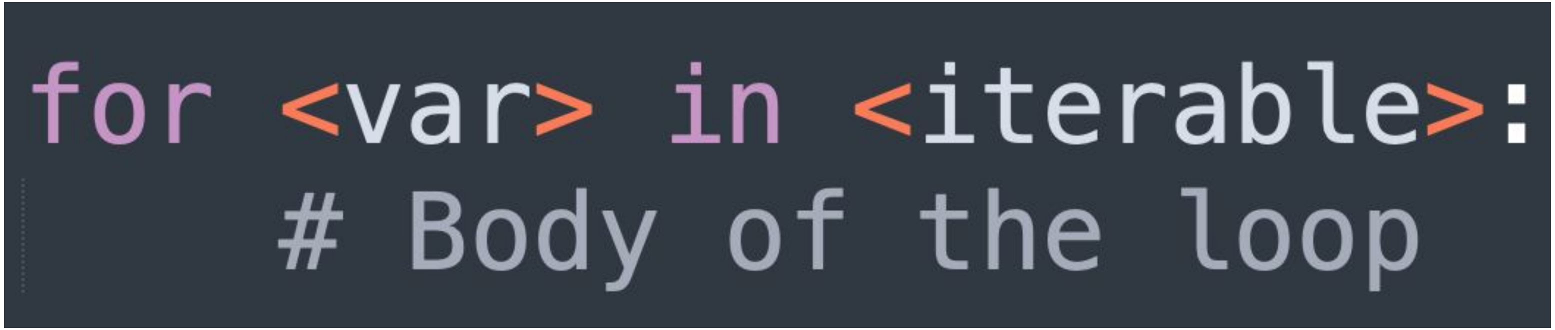
```
def count(s, value):
    """Return the number of times that
    value appears in the list s."""
    total = 0
    for element in s:
        if element == value:
            total += 1
    return total
```

The for statement automatically:

- Binds the current element in the list to a variable
- Removes the need to keep track of an index, as the variable bound to the current element will automatically rebind to the next element

For Statements

- A `for` statement is a way of iterating over sequences
- General syntax:



```
for <var> in <iterable>:
    # Body of the loop
```

  - `var` is bound to the current value in the iterable
  - `iterable` is the object we're iterating over (ex: list, but we'll talk about many more iterables later)

Range Objects

- A range object returns a sequence of values created by calling the range function
- Default values are set for a range depending on how many arguments we pass in
  - If one argument is passed in, this represents the end value (exclusive), starting from 0
  - If two arguments are passed in, this represents the start value (inclusive) and end value (exclusive)
  - If three arguments are passed in, this represents the start value (inclusive), the end value (exclusive), and the step size

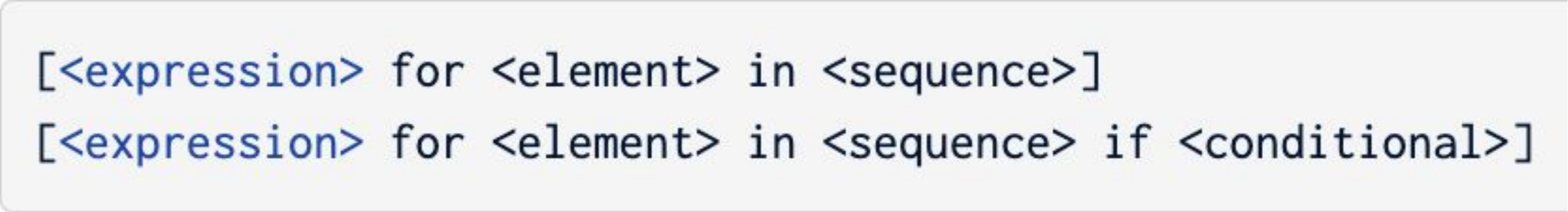
Demo: Range Objects

For statements using range objects

- In many different problems we’ll encounter, we’ll need not only the element of a list, but also the *index* in which that element is stored
  - Ex: Printing out the indices of a list that store a given value, x
- It’s common to iterate over a range object where the argument to range is the length of the list
  - This allows you to iterate over a set of all indices belonging to that list
  - Syntax: for i in range(len(s))

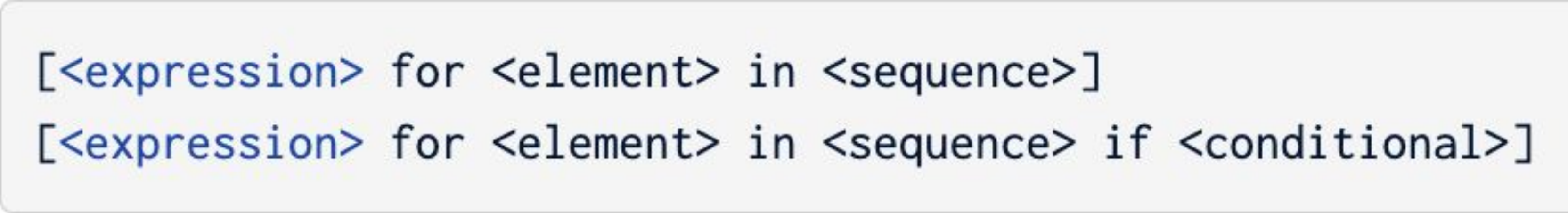
List comprehensions

- List comprehensions allow us to initialize a **list** based on another **iterable** in a single line
- Syntax:



```
[<expression> for <element> in <sequence>]
[<expression> for <element> in <sequence> if <conditional>]
```

List comprehensions



```
[<expression> for <element> in <sequence>]
[<expression> for <element> in <sequence> if <conditional>]
```

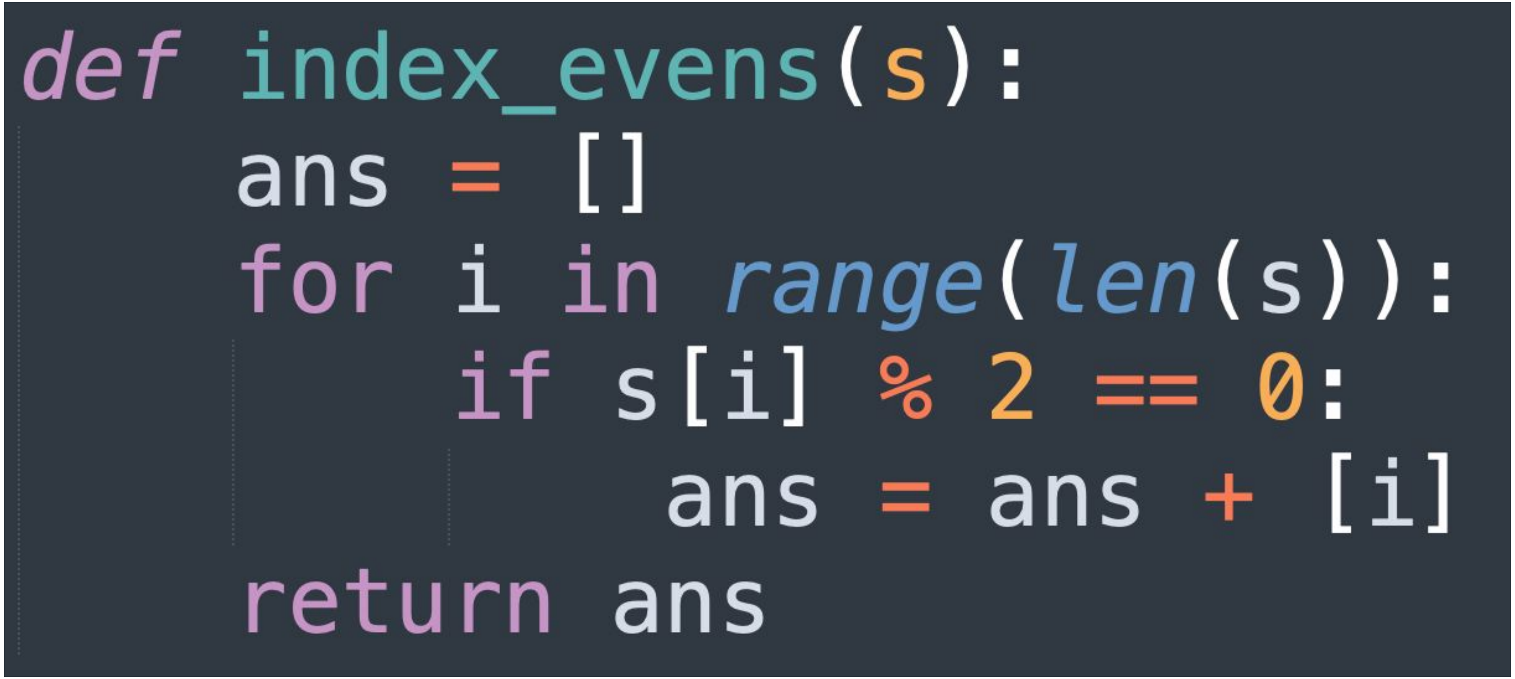
- expression - The expression we want to include in the final list
- element - The variable bound to where we currently are in the sequence
- sequence - The iterable we are basing the list comprehension on
- conditional (optional) - Only include expression if this conditional is true

Break

Example: Index evens

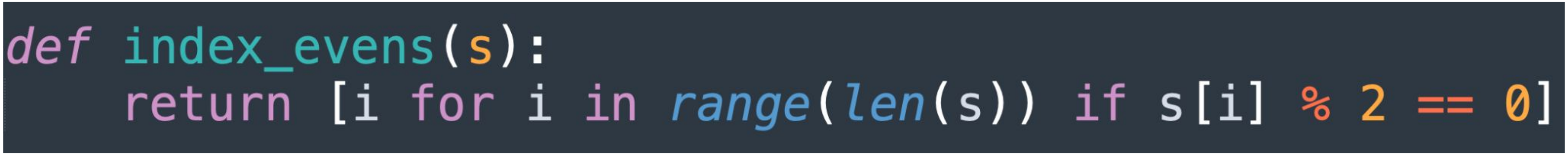
- Write a function that takes in a list s, and returns a list of all the indices of the elements in the list for which the element is an even number.
- Try doing it with a traditional for loop, and then with a list comprehension!

index evens - Traditional For Loop



```python
def index_evens(s):
    ans = []
    for i in range(len(s)):
        if s[i] % 2 == 0:
            ans = ans + [i]
    return ans
```

index evens - List Comprehension



```python
def index_evens(s):
    return [i for i in range(len(s)) if s[i] % 2 == 0]
```

Strings

Strings are an Abstraction

Representing Data:

‘False’, ‘Everyday’, ‘2500’

Representing Language:

‘Entschuldigung , wie bitte’ , ‘Nos vemos’ , ‘你好’

Representing Programs:

‘curry = lambda f: lambda x: lambda y: f(x,y)’

Three Forms of Strings

Single quotes strings and double quotes strings are equivalent

‘Hello there’ , “General Kenobi”

Multi-line strings automatically insert new lines

“””Shall I compare thee to a summer’s day?

Thou art more lovely and more temperate”””

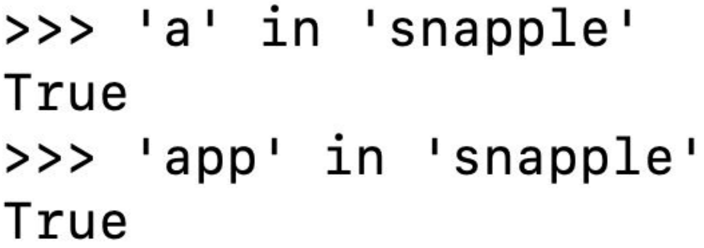
The **\n** is an escape sequence signifying a line feed

“””Shall I compare thee to a summer’s day?\nThou art more lovely and more temperate”””

Multi-line strings are often used in docstrings as they usually span multiple lines

Strings are Sequences

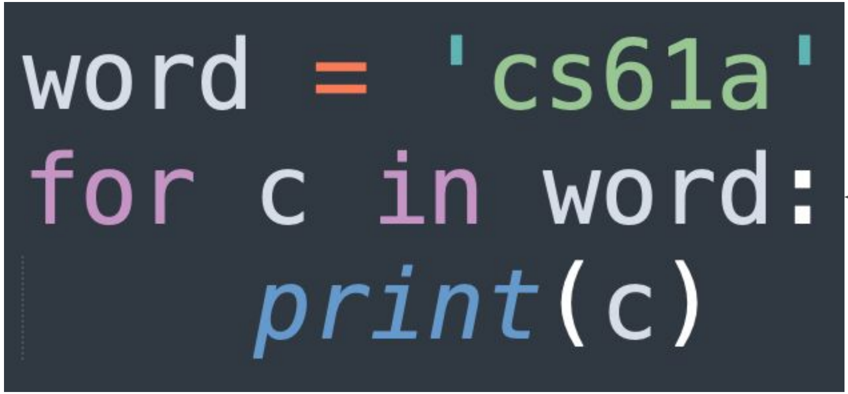
- A String can be thought of as a sequence of characters
  - We can get the number of elements in the sequence by using `len`
  - We can index into a String to get an individual character
    - Note: An element of a String is itself a String, just a single element
    - This is different from a list, where if we have a list of numbers, indexing into that list would return a number
- However, the `in` and `not in` operators can match substrings, rather than only individual elements in the sequence



```
>>> 'a' in 'snapple'
True
>>> 'app' in 'snapple'
True
```

Strings are Sequences

- Can use a `for` statement to iterate over the characters of a String



```
word = 'cs61a'
for c in word:
    print(c)
```

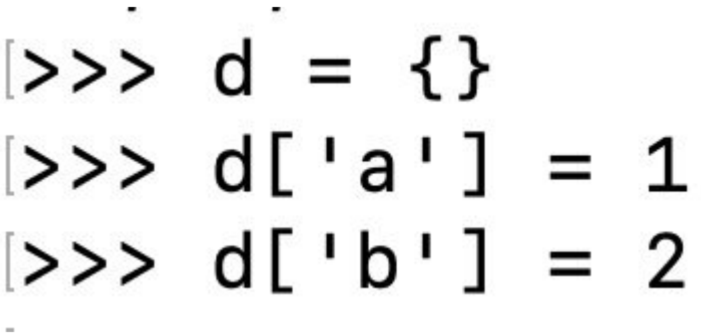
This would print out the individual characters of ‘cs61a’

Dictionaries

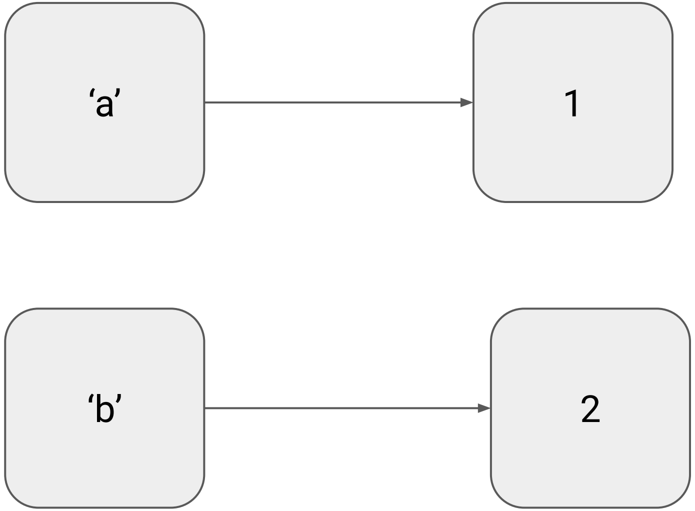
Dictionaries

- Dictionaries are an example of a key-value data structure
    - Each data entry consists of a (key, value) pair
- Incredibly efficient to retrieve data as it utilizes a concept known as **hashing** (out of scope)

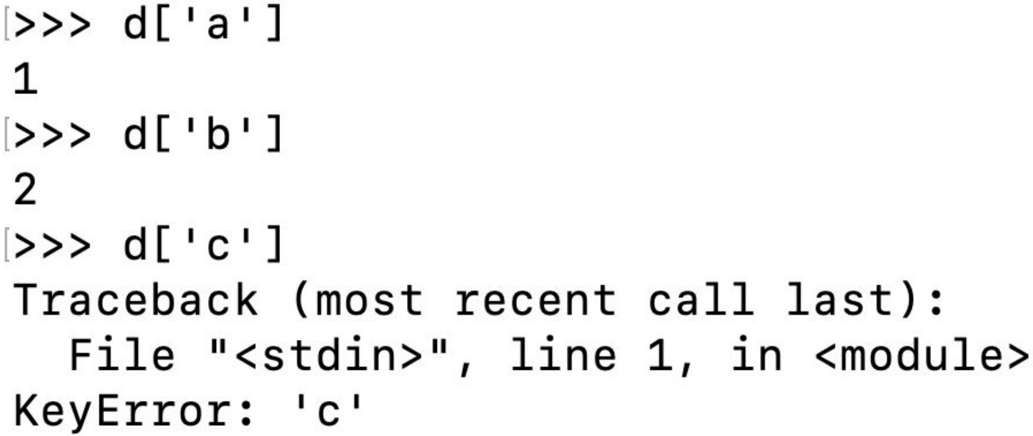
Dictionaries - Example



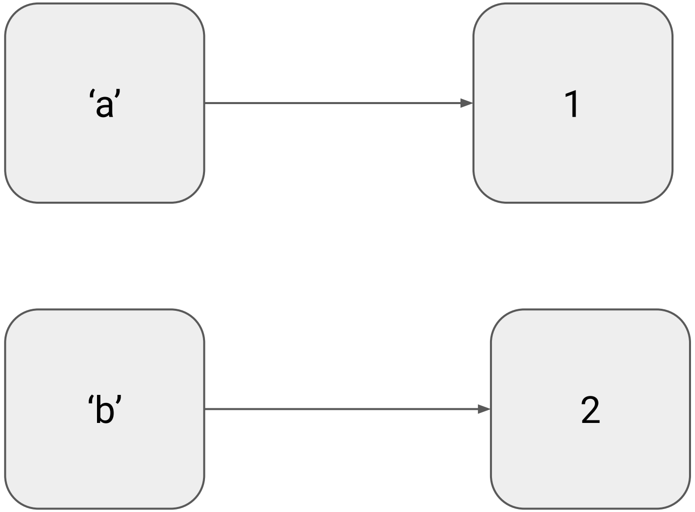
```
>>> d = {}
>>> d['a'] = 1
>>> d['b'] = 2
```



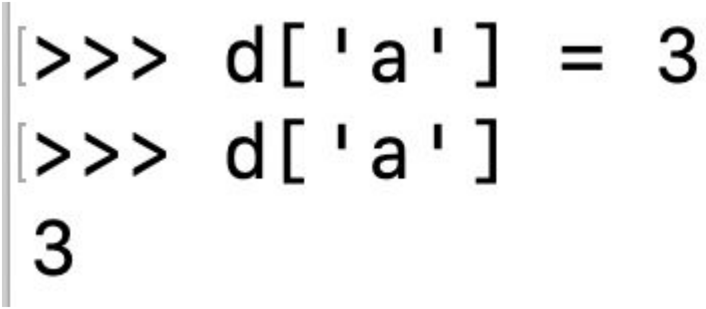
Dictionaries - Example



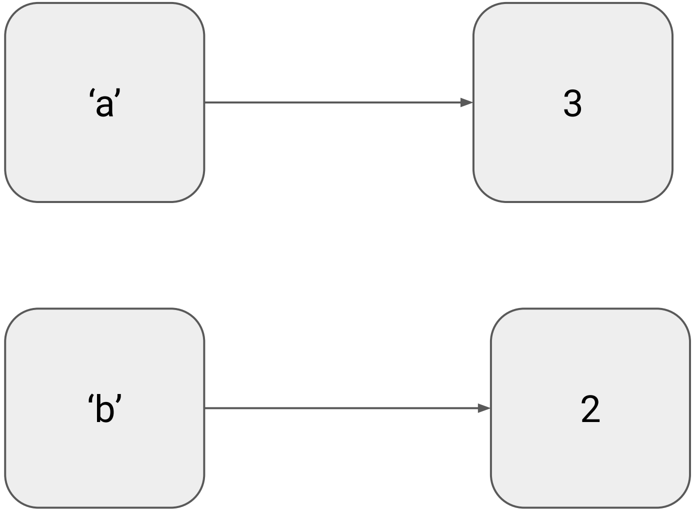
```
[>>> d['a']
1
[>>> d['b']
2
[>>> d['c']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 'c'
```



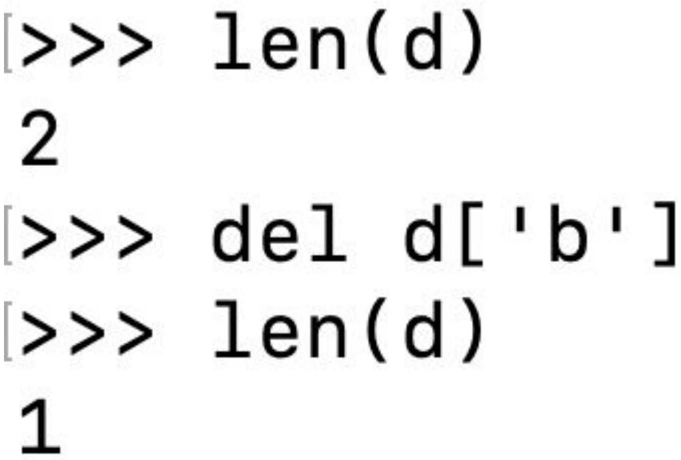
Dictionaries - Example



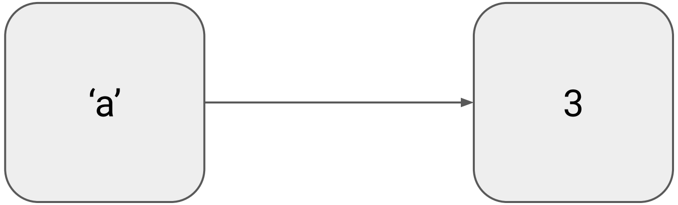
```
[>>> d['a'] = 3
[>>> d['a']
3
```



Dictionaries - Example



```
>>> len(d)
2
>>> del d['b']
>>> len(d)
1
```



Summary

- A sequence is an ordered collection of values
    - Ex: Lists, Strings, ranges, dictionaries
- Box and Pointer Notation is how we represent lists in diagrams
    - Primitive values are stored in the boxes directly, while compound values are represented with an arrow pointer
- For statements are a more direct way of iteration over an iterable
- List comprehensions allow us to create lists in a single line based on another iterable
- Dictionaries are an efficient, key-value store datatype