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## Introduction to Programming I

Lecture #04 –Control Flow, Functions

HACETTEPE UNIVERSITY

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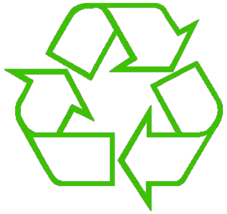
# Last time... **Control Flow, Functions**



Repeating yourself

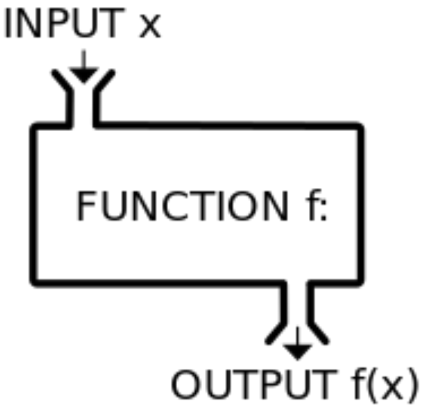
```
for f in [30,40,50]:
    print(f,(f-32)/9.0*5)
```

```
counter = 1
while counter <= n:
    s = s + counter
    counter += 1
```

Making decisions

```
if val < 0:
    result = - val
else:
    result = val
```

```
if height > 100:
  print("space")
elif height > 50:
  print("mesosphere")
elif height > 20:
  print("stratosphere")
else:
  print("troposphere")
```



Functions

```
def dbl_plus(x):
    return 2*x + 1
```

# Lecture Overview

- Collections
  - Lists
  - Sets
  - Tuples
  - Dictionaries
- File I/O

**Disclaimer:** Much of the material and slides for this lecture were borrowed from
—Ruth Anderson, Michael Ernst and Bill Howe’s  CSE 140 class

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# Data Structures

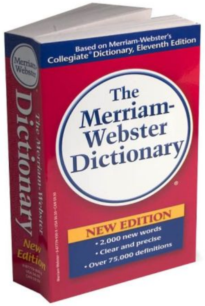
- A *data structure* is way of organizing data
  - Each data structure makes certain operations convenient or efficient
  - Each data structure makes certain operations inconvenient or inefficient

- Example: What operations are efficient with:
  - a file cabinet sorted by date?
  - a shoe box?

# A Collection Groups Similar Things

- List: ordered
- Set: unordered, no duplicates
- Tuple: unmodifiable list
- Dictionary:  maps from values to values

  Example: word → definition



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# What is a List?

- A list is an ordered sequence of values, where each value is identified by an index.

- What operations should a list support efficiently and conveniently?
  - Creation
  - Querying
  - Modification

# List Creation

```
a = [ 3, 1, 2*2, 1, 10/2, 10-1 ]

b = [ 5, 3, 'hi' ]

c = [ 4, 'a', a ]

a = [3, 4, 5]
```

- Use square brackets to specify a list.
- Separate each element with a comma.
- The empty list is written as [].

# List Example - 1

```
L = ['I did it all', 4, 'love']

for i in range(len(L)):
   print(L[i])
```

```
>> I did it all
>> 4
>> love
```

# List Example - 2

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

print('Univs =', Univs)
print('Univs1 =', Univs1)
print(Univs == Univs1)
```

```
>> Univs = [['MIT','Caltech'],['Harvard','Yale','Brown']]
>> Univs1 = [['MIT','Caltech'],['Harvard','Yale','Brown']]
>> True
```

# List Querying

- Extracting part of the list:
  - Single element: **`mylist[index]`**
  - Sublist (“slicing”): **`mylist[startidx : endidx]`**

- Find/lookup in a list
  - **`elt in mylist`**
    - Evaluates to a boolean value

  - **`mylist.index(x)`**
    - Return the int index in the list of the first item whose value is x. It is an error if there is no such item.

  - **`list.count(x)`**
    - Return the number of times x appears in the list.

# List Mutation

- Insertion
- Removal
- Replacement
- Rearrangement

# List Insertion

- **`mylist.append(x)`**
  - Extend the list by inserting x at the end

- **`mylist.extend(L)`**
  - Extend the list by appending all the items in the argument list

- **`mylist.insert(i, x)`**
  - Insert an item before the a given position.
  - a.insert(0, x) inserts at the front of the list
  - a.insert(len(a), x) is equivalent to a.append(x)

# List Removal

- **`list.remove(x)`**
  - Remove the first item from the list whose value is x
  - It is an error if there is no such item

- **`list.pop([i])`**
  - Remove the item at the given position in the list, and return it.
  - If no index is specified, a.pop() removes and returns the last item in the list.

Notation from the Python Library Reference:
The square brackets around the parameter, “[i]”, means the argument is *optional*.
It does *not* mean you should type square brackets at that position.

# List Replacement

- **`mylist[index] = newvalue`**

- **`mylist[start : end] = newsublist`**
  - – Can change the length of the list
  - – mylist[ start : end ] = []  # removes multiple elements
  - – a[len(a):] = L      # is equivalent to a.extend(L)

# List Rearrangement

- **`list.sort()`**
  - Sort the items of the list, in place.
  - “in place” means by modifying the original list, not by creating a new list.

- **`list.reverse()`**
  - Reverse the elements of the list, in place.

# How to Evaluate a List Expression

There are two new forms of expression:

- **`[a, b, c, d]`** list creation
  - To evaluate:
    - evaluate each element to a value, from left to right
    - make a list of the values
  - The elements can be arbitrary values, including lists
    - ["a", 3, 3.14*r*r, fahr_to_cent(-40), [3+4, 5*6]]

Same tokens "**`[]`**" with two *distinct* meanings

List expression

- **`a[b]`** list indexing or dereferencing
  - To evaluate:
    - evaluate the list expression to a value
    - evaluate the index expression to a value
    - if the list value is not a list, execution terminates with an error
    - if the element is not in range (not a valid index), execution terminates with an error
    - the value is the given element of the list value (counting from zero)

Index expression

# List Expression Examples

What does this mean (or is it an error)?

```
["four", "score", "and", "seven", "years"][2]

["four", "score", "and", "seven", "years"][0,2,3]

["four", "score", "and", "seven", "years"][[0,2,3]]

["four", "score", "and", "seven", "years"][[0,2,3][1]]
```

# Exercise: List Lookup

```
def index(somelist, value):
   """Return the position of the first occurrence of
      the element value in the list somelist.
      Return None if value does not appear in
      somelist."""

  i = 0
  for c in somelist:
    if c == value:
      return i
    i = i + 1
  return None
```

# Exercise: List Lookup

```
def index(somelist, value):
   """Return the position of the first occurrence of
      the element value in the list somelist.
      Return None if value does not appear in
      somelist."""
```

Examples:

```
gettysburg = ["four", "score", "and",
"seven", "years", "ago"]
```

`index(gettysburg, "and")` => 2

`index(gettysburg, "years")` => 4

Fact: `mylist[index(mylist, x)] == x`

# List Slicing

**`mylist[startindex : endindex]`** evaluates to a sublist of the original list

- **`mylist[index]`** evaluates to an element of the original list

- Arguments are like those to the **`range`** function
  - **`mylist[start : end : step]`**
  - start index is inclusive, end index is exclusive
  - *All* 3 indices are *optional*

- Can assign to a slice: **`mylist[s : e] = yourlist`**

# List Slicing Examples

```
test_list = ['e0', 'e1', 'e2', 'e3', 'e4', 'e5', 'e6']
```

| | |
|---|---|
| From e2 to the end of the list: | `test_list[2:]` |
| From beginning up to (but not including) e5: | `test_list[:5]` |
| Last element: | `test_list[-1]` |
| Last four elements: | `test_list[-4:]` |
| Everything except last three elements: | `test_list[:-3]` |
| Reverse the list: | `test_list[::-1]` |
| Get a copy of the whole list: | `test_list[:]` |

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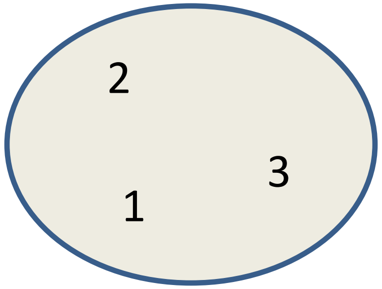
# Sets

- Mathematical set: a collection of values, without duplicates or order

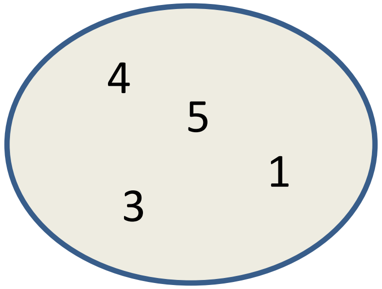
- Order does not matter

  { 1, 2, 3 } == { 3, 2, 1 }



- No duplicates

  { 3, 1, 4, 1, 5 } == { 5, 4, 3, 1 }



- For every data structure, ask:
  - How to create
  - How to query (look up) and perform other operations
    - (Can result in a new set, or in some other datatype)
  - How to modify

  Answer: [http://docs.python.org/3/library/stdtypes.html#set](http://docs.python.org/3/library/stdtypes.html#set)

# Creating a Set

- Construct from a **list:**

```
odd = set([1, 3, 5])
prime = set([2, 3, 5])
empty = set([])
```

Python always **prints** using this syntax above

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# Set Operations

```
odd = set([ 1, 3, 5 ])
prime = set([ 2, 3, 5 ])
```

- membership ∈ Python: **`in`** **`4 in prime`** ⇒ False
- union ∪ Python: **`|`** **`odd | prime`** ⇒ { 1, 2, 3, 5 }
- intersection ∩ Python: **`&`** **`odd & prime`** ⇒ { 3, 5 }
- difference \ or - Python: **`-`** **`odd – prime`** ⇒ { 1 }

Think in terms of **set operations**,
*not* in terms of iteration and element operations

– Shorter, clearer, less error-prone, faster

Although we can do iteration over sets:

```
    # iterates over items in arbitrary order
    for item in myset:
       …
```

But we *cannot* index into a set to access a specific element.

# Modifying a Set

- **Add** one element to a set:

```
myset.add(newelt)
myset = myset | set([newelt])
```

- **Remove** one element from a set:

```
myset.remove(elt)     # elt must be in myset or raises err
myset.discard(elt)    # never errs
```

What would this do?

```
myset = myset – set([newelt])
```

- Choose and remove some element from a set:

```
myset.pop()
```

# Practice with Sets

```
z = set([5,6,7,8])
y = set([1,2,3,"foo",1,5])
k = z & y
j = z | y
m = y - z
z.add(9)
```

```
z: {8, 9, 5, 6, 7}
y: {1, 2, 3, 5, 'foo'}
k: {5}
j: {1, 2, 3, 5, 6, 7, 8, 'foo'}
m: {1, 2, 3, 'foo'}
```

# List vs. Set Operations (1)

Find the common elements **in both** list1 and list2:

```
out1 = []
for i in list2:
    if i in list1:
        out1 .append(i)
```

or

```
out1 = [i for i in list2 if i in list1]
```

Find the common elements in both set1 and set2:

```
set1 & set2
```

Much shorter, clearer, easier to write!

# List vs. Set Operations (2)

Find the elements in **either** list1 or list2 (**or both**) (without duplicates):

```
out2 = list(list1)      # make a copy
for i in list2:
    if i not in list1:  # don’t append elements
   out2.append(i)       # already in out2
```

or

```
out2 = list1+list2
for i in out1:       # out1 (from previous example),
   out2.remove(i)    # common elements in both lists
                     # Remove common elements
```

Find the elements in either set1 or set2 (or both):

```
set1 | set2
```

# List vs. Set Operations (3)

Find the elements in **either list but not in both**:

```
out3 = []
for i in list1+list2:
    if i not in list1 or i not in list2:
        out3.append(i)
```

Find the elements in either set but not in both:

```
set1 ^ set2      # symmetric difference
```

# Set Elements

- Set elements must be immutable values
  - int, float, bool, string, *tuple*
  - *not*: list, set, dictionary

- Goal: only set operations change the set
  - after "**`myset.add(x)`**", **`x in myset`** ⇒ True
  - **`y in myset`** always evaluates to the same value

  Both conditions should hold until **`myset`** itself is changed

# Set Elements

- Mutable elements can violate these goals

```
list1 = ["a", "b"]
list2 = list1
list3 = ["a", "b"]
myset = { list1 }              ⇐ Hypothetical; actually illegal in Python
list1 in myset                 ⇒ True
list3 in myset                 ⇒ True
list2.append("c")              ⇐ modifying myset  “indirectly” would
                                 lead to different results

list1 in myset                  ⇒ ???
list3 in myset                  ⇒ ???
```

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# Tuples

- Like strings, **tuples** are ordered sequences of elements.
- The individual elements can be of any type, and need not be of the same type as each other.
- Literals of type tuple are written by enclosing a comma-separated list of elements within parentheses.
- Tuples differ from lists in one hugely important way:
  - Lists are mutable. In contrast, tuples are immutable.

-
  ```
  t1 = ()
  t2 = (1, 'two', 3)
  print(t1)
  print(t2)

  >> ()
  >> (1, 'two', 3)
  ```

# Tuples

- Like strings, tuples can be concatenated, indexed, and sliced.

-
  ```
  t1 = (1, 'two', 3)
  t2 = (t1, 3.25)
  print(t2)
  print((t1 + t2))
  print((t1 + t2)[3])
  print((t1 + t2)[2:5])
  ```

  ```
  >> ((1, 'two', 3), 3.25)
  >> (1, 'two', 3, (1, 'two', 3), 3.25)
  >> (1, 'two', 3)
  >> (3, (1, 'two', 3), 3.25)
  ```

# Tuples

- A for statement can be used to iterate over the elements of a tuple.
- The following code prints the common divisors of 20 and 100 and then the sum of all the divisors.
-

```
def findDivisors (n1, n2):
    """Assumes n1 and n2 are positive ints
       Returns a tuple containing all common divisors
       of n1 & n2"""
    divisors = () #the empty tuple
    for i in range(1, min (n1, n2) + 1):
       if n1%i == 0 and n2%i == 0:
          divisors = divisors + (i,)
    return divisors

divisors = findDivisors(20, 100)
print(divisors)
total = 0
for d in divisors:
    total += d
print(total)
```

```
>> (1, 2, 4, 5, 10, 20)
>> 42
```

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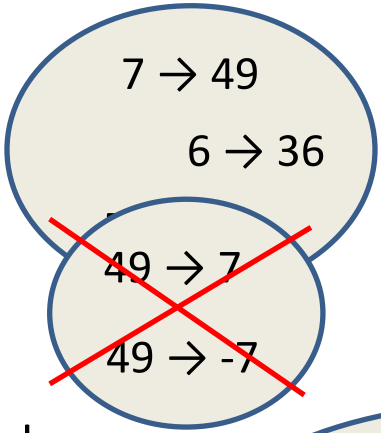
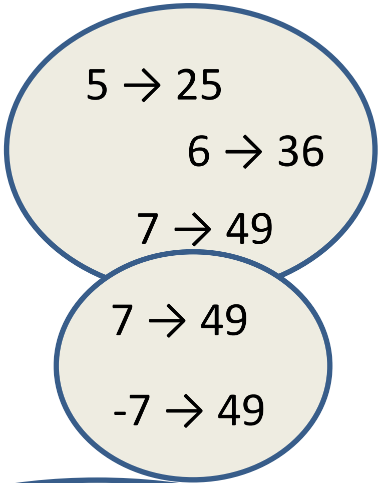
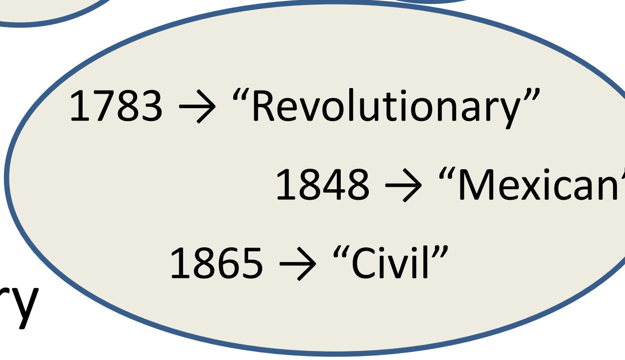
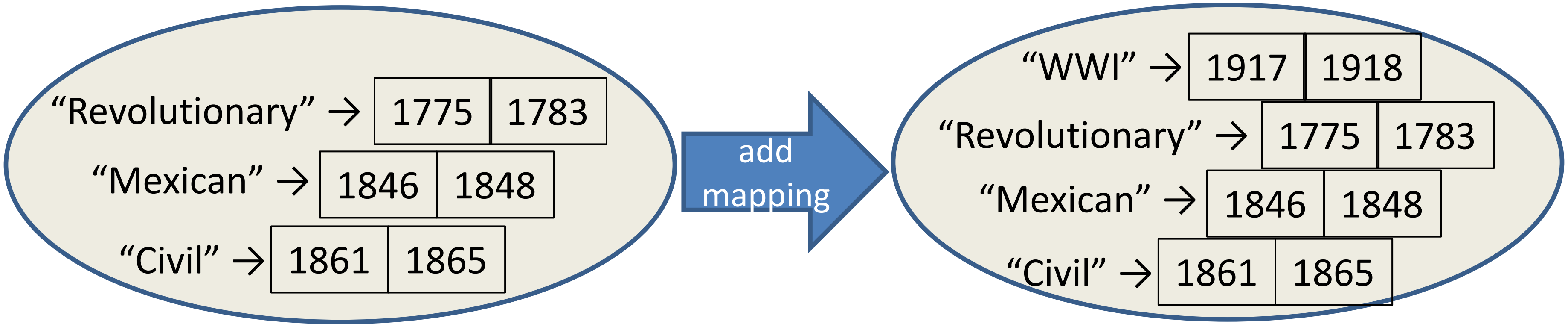
# Dictionaries or Mappings

- A dictionary maps each *key* to a *value*
- Order does not matter
- Given a key, can look up a value
  - Given a value, cannot look up its key
- **No duplicate keys**
  - Two or more keys may map to the same value
- *Keys* and *values* are Python values
  - Keys must be **immutable** (not a list, set, or dict)
- Can add *key* → *value* mappings to a dictionary
  - Can also remove (less common)







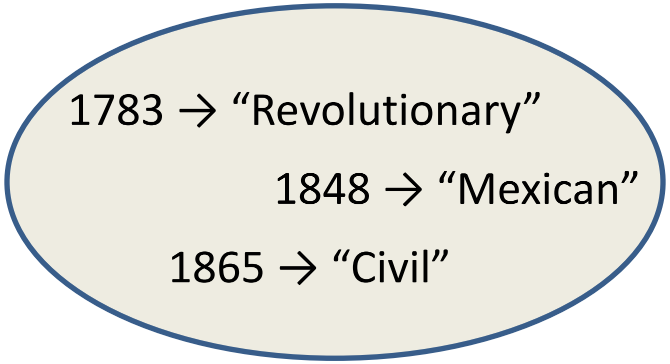


# Dictionary Syntax in Python

```
d = { }
d = dict()
```

Two different ways to create an empty dictionary

```
us_wars_by_end = {
   1783: "Revolutionary",
   1848: "Mexican",
   1865: "Civil" }
```

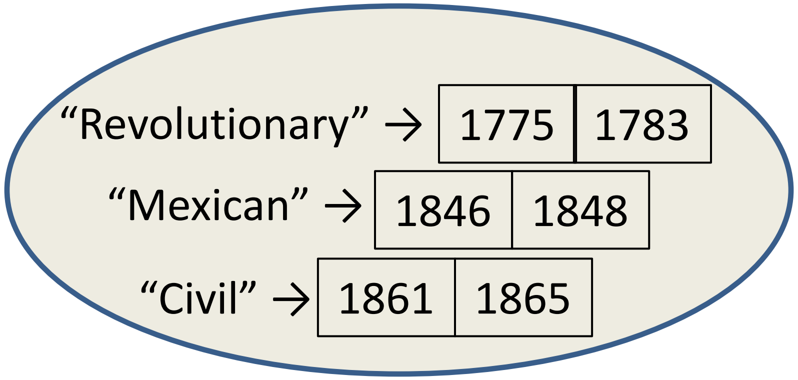


1783 → “Revolutionary”

1848 → “Mexican”

1865 → “Civil”

```
us_wars_by_name = {
   "Civil" : [1861, 1865],
   "Mexican" : [1846, 1848],
   "Revolutionary" : [1775, 1783]
}
```



“Revolutionary” → 1775 | 1783

“Mexican” → 1846 | 1848

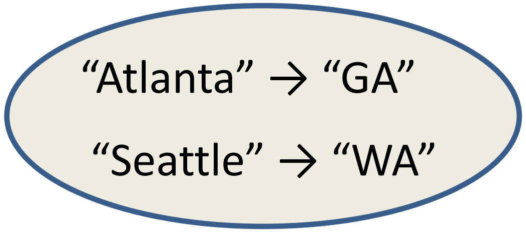
“Civil” → 1861 | 1865

Syntax just like arrays, for accessing and setting:

```
us_wars_by_end[1783]    ⇒
us_wars_by_end[1783][1:10]    ⇒
us_wars_by_name["WWI"] = [1917, 1918]
```

# Creating a Dictionary

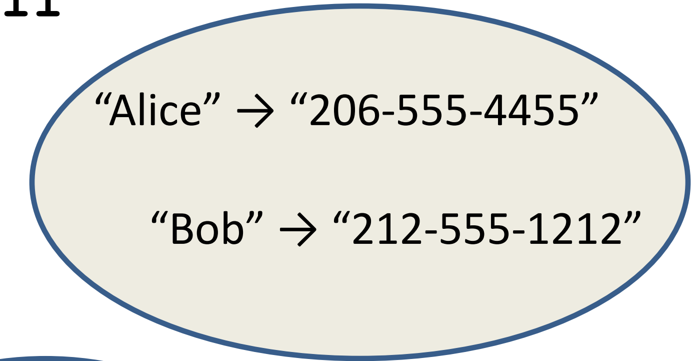
```
>>> state = {"Atlanta" : "GA", "Seattle" : "WA"}
```



“Atlanta” → “GA”

“Seattle” → “WA”

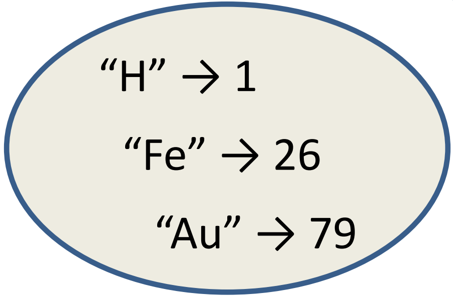
```
>>> phonebook = dict()
>>> phonebook["Alice"] = "206-555-4455"
>>> phonebook["Bob"] = "212-555-2211"
```



“Alice” → “206-555-4455”

“Bob” → “212-555-1212”

```
>>> atomicnumber = {}
>>> atomicnumber["H"] = 1
>>> atomicnumber["Fe"] = 26
>>> atomicnumber["Au"] = 79
```



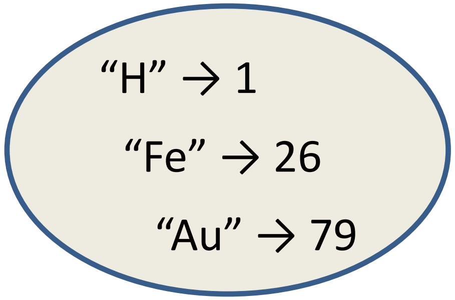
“H” → 1

“Fe” → 26

“Au” → 79

# Accessing a Dictionary

```
>>> atomicnumber = {"H":1, "Fe":26, "Au":79}
>>> atomicnumber["Au"]
79
>>> atomicnumber["B"]
Traceback (most recent call last):
  File "<pyshell#102>", line 1, in <module>
    atomicnumber["B"]
KeyError: 'B'
>>> atomicnumber.has_key("B")
False
>>> atomicnumber.keys()
['H', 'Au', 'Fe']
>>> atomicnumber.values()
[1, 79, 26]
>>> atomicnumber.items()
[('H', 1), ('Au', 79), ('Fe', 26)]
```



“H” → 1

“Fe” → 26

“Au” → 79

Good for iteration (for loops)

```
for key in mymap.keys():
   val = mymap[key]
   … use key and val

for key in mymap:
   val = mymap[key]
   … use key and val

for (key,val) in mymap.items():
   … use key and val
```

# Iterating Through a Dictionary

```
atomicnumber = {"H":1, "Fe":26, "Au":79}

# Print out all the keys:
for element_name in atomicnumber.keys():
    print(element_name)
```

```
H
Fe
Au
```

```
# Another way to print out all the keys:
for element_name in atomicnumber:
    print(element_name)
```

```
H
Fe
Au
```

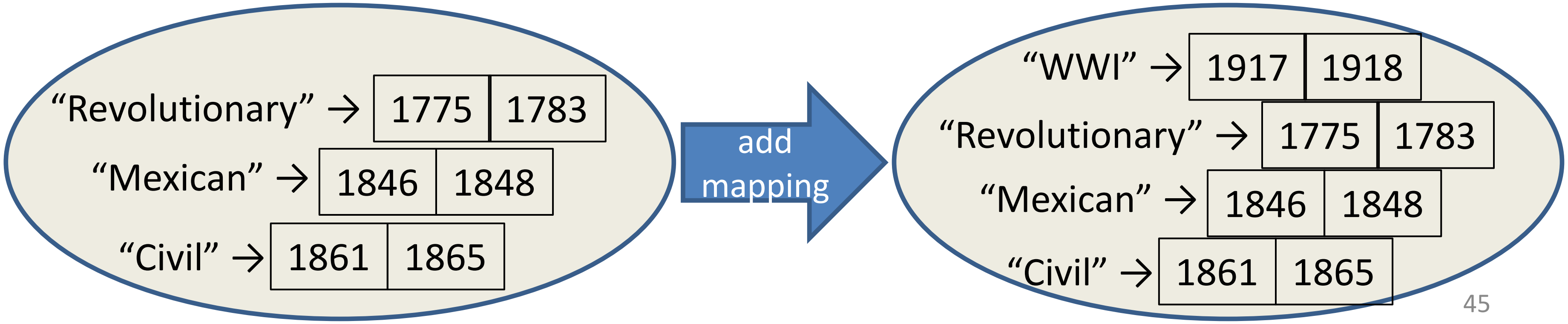
```
# Print out the keys and the values
for (element_name, element_number) in atomicnumber.items():
    print("name:",element_name, "number:",element_number)
```

```
name: H number: 1
name: Fe number: 26
name: Au number: 79
```

# Modifying a Dictionary

```
us_wars1 = {
    "Revolutionary" : [1775, 1783],
    "Mexican" : [1846, 1848],
    "Civil" : [1861, 1865] }

us_wars1["WWI"] = [1917, 1918]    # add mapping
us_wars1.pop("Mexican”)           # remove mapping
```



# Dictionary Exercises

- Convert a list to a dictionary:
  - Given [5, 6, 7], produce {5:25, 6:36, 7:49}
- Reverse key with value in a dictionary:
  - Given {5:25, 6:36, 7:49}, produce {25:5, 36:6, 49:7}
- What does this do?

```
squares = { 1:1, 2:4, 3:9, 4:16 }
squares[3] + squares[3]
squares[3 + 3]
squares[2] + squares[2]
squares[2 + 2]
```

# Dictionary Exercise Solutions

- Convert a list to a dictionary:
  - E.g. Given [5, 6, 7], produce {5:25, 6:36, 7:49}

```
d = {}
for i in [5, 6, 7]:  # or range(5, 8)
    d[i] = i * i
```

- Reverse key with value in a dictionary:
  - E.g. Given {5:25, 6:36, 7:49}, produce {25:5, 36:6, 49:7}

```
k ={}
for i in d.keys():
    k[d[i]] = i
```

# A list is like a dictionary

- A list maps an integer to a value
  - The integers must be a continuous range 0..*i*

```
mylist = ['a', 'b', 'c']
mylist[1] ⇒ 'b'
mylist[3] = 'c'     # error!
```

- In what ways is a list more convenient than a dictionary?

- In what ways is a list less convenient than a dictionary?

# Not Every Value is Allowed to be a Key - 1

- Keys must be immutable values
  - int, float, bool, string, *tuple*
  - *not*:  list, set, dictionary

- Goal:  only dictionary operations change the keyset
  - after "**`mydict[x] = y`**", **`mydict[x]`** ⇒ y
  - if **`a == b`**, then **`mydict[a] == mydict[b]`**

  These conditions should hold until **`mydict`** itself is changed

# Not Every Value is Allowed to be a Key - 2

- Mutable keys can violate these goals

```
list1 = ["a", "b"]
list2 = list1
list3 = ["a", "b"]
mydict = {}
mydict[list1] = "z"        ⇐ Hypothetical; actually illegal in Python
mydict[list3]              ⇒ "z"
list2.append("c")
mydict[list1]              ⇒ ???
mydict[list3]              ⇒ ???
```

# Lecture Overview

- Collections
  - Lists
  - Sets
  - Tuples
  - Dictionaries
- File I/O

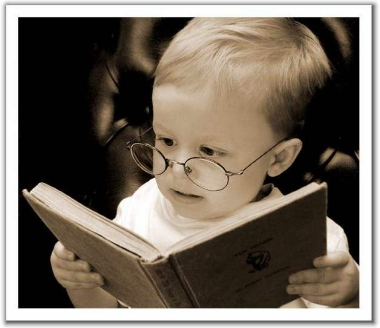
**Disclaimer:** Much of the material and slides for this lecture were borrowed from
—Ruth Anderson, Michael Ernst and Bill Howe's CSE 140 class

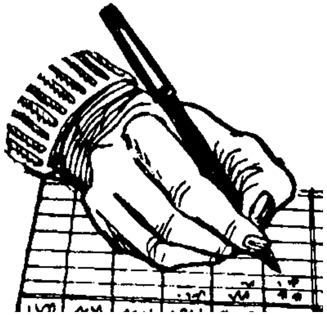
# File Input and Output

- As a programmer, when would one use a file?
- As a programmer, what does one do with a file?

Important operations:

- open a file
- close a file
- read data
- write data





# Files and Filenames

- A file object represents data on your disk drive
  - Can read from it and write to it
- A filename (usually a string) states where to find the data on your disk drive
  - Can be used to find/create a file

- Each operating system comes with its own file system for creating and accessing files:
  - Linux/Mac: `"/home/rea/bbm101/lectures/file_io.pptx"`
  - Windows: `"C:\Users\rea\MyDocuments\cute_dog.jpg"`

# Two Types of Filenames

- An Absolute filename gives a specific location on disk:
  **`"/home/rea/bbm101/14wi/lectures/file_io.pptx"`** or
  **`"C:\Users\rea\MyDocuments\homework3\images\Husky.png"`**
  - Starts with "/" (Unix) or "C:\" (Windows)
  - Warning: code will fail to find the file if you move/rename files or run your program on a different computer

- A Relative filename gives a location relative to the *current working directory*:
  **`"lectures/file_io.pptx"`** or **`" images\Husky.png"`**
  - Warning: code will fail to find the file unless you run your program from a directory that contains the given contents

- *A relative filename is usually a better choice*

# Examples

Linux/Mac: These *could* all refer to the same file:

```
"/home/rea/class/140/homework3/images/Husky.png"
"homework3/images/Husky.png"
"images/Husky.png"
"Husky.png"
```

Windows: These *could* all refer to the same file:

```
"C:\Users\rea\My Documents\class\140\homework3\images\Husky.png"
"homework3\images\Husky.png"
"images\Husky.png"
"Husky.png"
```

# “Current Working Directory” in Python

The directory from which you ran Python

To determine it from a Python program:

```
>>> import os   # "os" stands for "operating system"
>>> os.getcwd()
'/Users/johndoe/Documents'
```

*Can be the source of confusion:  where are my files?*

# Reading a File in Python

```
# Open takes a filename and returns a file.
# This fails if the file cannot be found & opened.
myfile = open("datafile.dat")

# Approach 1:
for line_of_text in myfile:
  … process line_of_text

# Approach 2:
all_data_as_a_big_string = myfile.read()

myfile.close() # close the file when done reading
```

*Assumption: file is a sequence of lines*
*Where does Python expect to find this file (note the relative pathname)?*

# Reading a File Example

```
# Count the number of words in a text file
in_file = "thesis.txt"
myfile = open(in_file)
num_words = 0
for line_of_text in myfile:
    word_list = line_of_text.split()
    num_words += len(word_list)
myfile.close()

print("Total words in file: ", num_words)
```

# Reading a File Multiple Times

You can iterate over a **list** as many times as you like:

```
mylist = [ 3, 1, 4, 1, 5, 9 ]
for elt in mylist:
 … process elt
for elt in mylist:
 … process elt
```

Iterating over a **file** uses it up:

```
myfile = open("datafile.dat")
for line_of_text in myfile:
   … process line_of_text
for line_of_text in myfile:
   … process line_of_text
```

This loop body will never be executed!

## How to read a file multiple times?

**Solution 1:** Read into a list, then iterate over it

```
myfile = open("datafile.dat")
mylines = []
for line_of_text in myfile:
  mylines.append(line_of_text)
… use mylines
```

**Solution 2:** Re-create the file object (slower, but a better choice if the file does not fit in memory)

```
myfile = open("datafile.dat")
for line_of_text in myfile:
  … process line_of_text
myfile = open("datafile.dat")
for line_of_text in myfile:
  … process line_of_text
```

# Writing to a File in Python

```
#  Replaces any existing file of this name
myfile = open("output.dat", "w")
```

open for **W**riting (no argument, or **"r"**, for **R**eading)

```
#  Just like printing output
myfile.write("a bunch of data")
myfile.write("a line of text\n")
```

“\n” means end of line (**N**ewline)

```
myfile.write(4)
```

Wrong; results in:
`TypeError: expected a character buffer object`

```
myfile.write(str(4))
```

Right.  Argument must be a string

```
myfile.close()
```

close when done with all writing

# More Examples - 1

```
nameHandle = open('characters.txt', 'w')
for i in range(2):
    name = input('Enter name: ')
    nameHandle.write(name + '\n')
nameHandle.close()

nameHandle = open('characters.txt', 'r')
for line in nameHandle:
    print(line)
nameHandle.close()
```

- If we had typed in the names Rick and Morty, this will print

  ```
  Rick

  Morty
  ```

- The extra line between Rick and Morty is there because print starts a new line each time it encounters the '\n' at the end of each line in the file.

# More Examples - 2

```
nameHandle = open('characters.txt', 'w')
nameHandle.write('Jerry\n')
nameHandle.write('Beth\n')
nameHandle.close()

nameHandle = open('characters.txt', 'r')
for line in nameHandle:
   print line[:-1]
nameHandle.close()
```

- It will print

  ```
  Jerry
  Beth
  ```

- Notice that
  - we have overwritten the previous contents of the file kids.
  - **`print line[:-1]`** avoids extra newline in the output

# More Examples - 3

```
nameHandle = open('characters.txt', 'a')
nameHandle.write('Rick\n')
nameHandle.write('Morty\n')
nameHandle.close()

nameHandle = open('kids', 'r')
for line in nameHandle:
   print line[:-1]
nameHandle.close()
```

- It will print

  ```
  Jerry
  Beth
  Rick
  Morty
  ```

- Notice that we can open the file for appending (instead of writing) by using the argument 'a'.

# Common functions for accessing files

- **`open(fn, 'w')`** fn is a string representing a file name. Creates a file for writing and returns a file handle.
- **`open(fn, 'r')`** fn is a string representing a file name. Opens an existing file for reading and returns a file handle.
- **`open(fn, 'a')`** fn is a string representing a file name. Opens an existing file for appending and returns a file handle.
- **`fh.close()`** closes the file associated with the file handle fh.

# Common functions for accessing files

- **`fh.read()`** returns a string containing the contents of the file associated with the file handle fh.
- **`fh.readline()`** returns the next line in the file associated with the file handle fh.
- **`fh.readlines()`** returns a list each element of which is one line of the file associated with the file handle fh.
- **`fh.write(s)`** write the string s to the end of the file associated with the file handle fh.
- **`fh.writeLines(S)`** S is a sequence of strings. Writes each element of S to the file associated with the file handle fh.