More Lists

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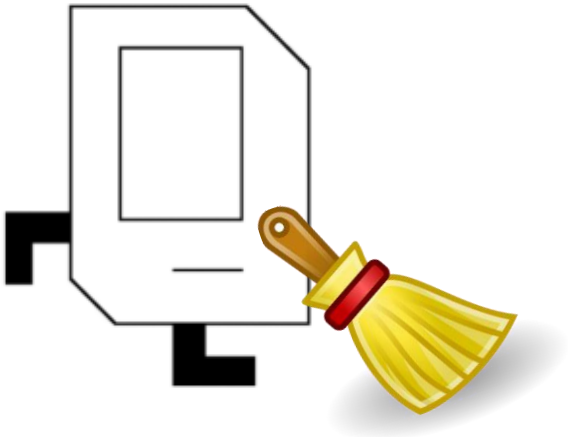
Housekeeping



- Diagnostic assessments will be graded this weekend
  - Please don't talk to others about it until they are returned
- We'll talk more about what scores on the assessment mean after it's returned
  - Important to focus on what the diagnostic is telling you about learning and understanding, not just the grade

Swapping Elements in a List - Sad

```
def swap_elements_buggy(elem1, elem2):
    temp = elem1
    elem1 = elem2
    elem2 = temp


def main():
    my_list = [10, 20, 30]
    swap_elements_buggy(my_list[0], my_list[1])
    print(my_list)
```

Output: `[10, 20, 30]`

Swapping Elements in a List - Happy

```
def swap_elements_working(alist, index1, index2):
    temp = alist[index1]
    alist[index1] = alist[index2]
    alist[index2] = temp


def main():
    my_list = [10, 20, 30]
    swap_elements_working(my_list, 0, 1)
    print(my_list)
```

Output: `[20, 10, 30]`

Learning Goals

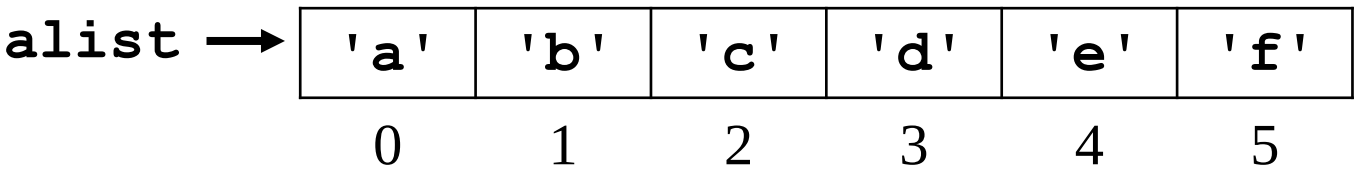
1. Learning about slices
2. Working with 2-dimensional lists

Slices

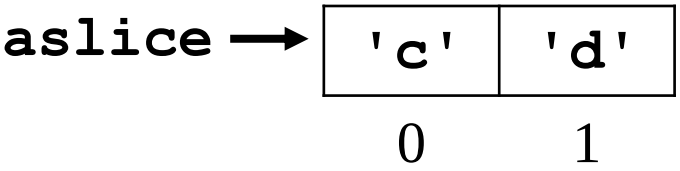
What are Slices?

- Can cut up lists into "slices"
  - Slices are just sub-portions of lists
  - Slices are also lists themselves
  - Slicing creates a **new** list
- Example:

```
alist = ['a', 'b', 'c', 'd', 'e', 'f']
```




```
aslice = alist[2:4]
```



What are Slices?

- Can cut up lists into "slices"
  - Slices are just sub-portions of lists
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  - Slicing creates a **new** list
- Example:

```
alist = ['a', 'b', 'c', 'd', 'e', 'f']
```

alist →

'a'	'b'	'c'	'd'	'e'	'f'
0	1	2	3	4	5

```
aslice = alist[2:4]
```

aslice →

'x'	'd'
0	1

```
aslice[0] = 'x'
```

General Form of Slice

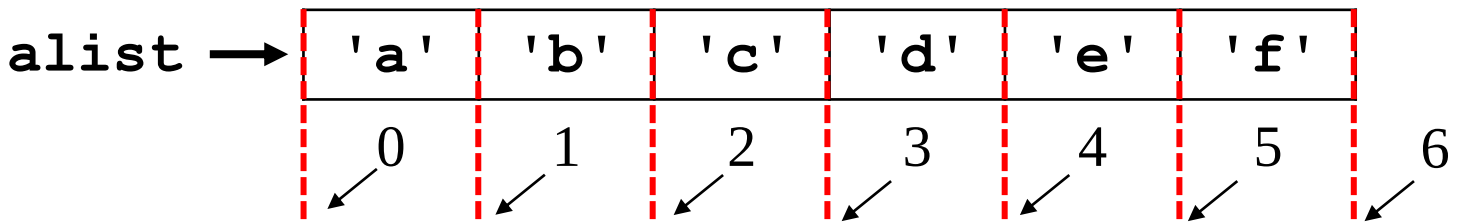
- General form to get a slice

  list **[** ***start*** **:** ***end*** **]**

  – Produces a new list with elements from ***list*** starting at index ***start*** up to (but not including) index ***end***

- Example:

```
alist = ['a', 'b', 'c', 'd', 'e', 'f']
```



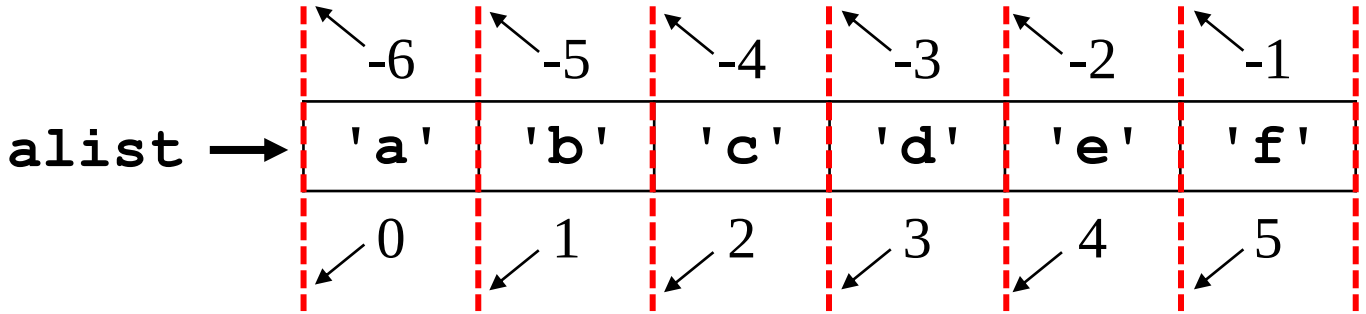

```
alist[2:4]   →   ['c', 'd']
alist[1:6]   →   ['b', 'c', 'd', 'e', 'f']
alist[0:3]   →   ['a', 'b', 'c']
```

I'll Take Another Slice!

- General form to get a slice

  list **[** ***start*** **:** ***end*** **]**

  - If ***start*** is missing, default to use 0 in its place
  - If ***end*** is missing, default to use **`len`** **(** ***list*** **)** in its place
  - Can also use negative indexes for ***start/end***




```
alist[2:-2]   →  ['c', 'd']
alist[-2:]    →  ['e', 'f']
alist[:-1]    →  ['a', 'b', 'c', 'd', 'e']
alist[:]      →  ['a', 'b', 'c', 'd', 'e', 'f']
```

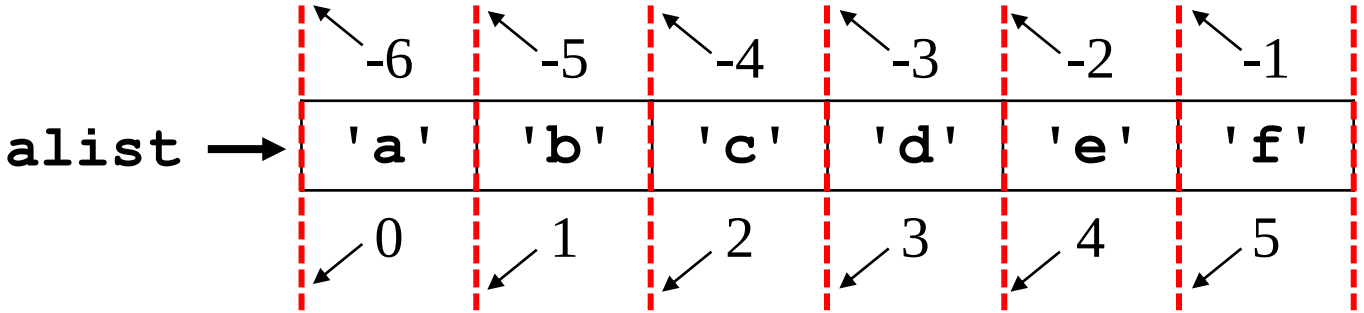
Advanced Slices

- General form to get a slice, with a step

  ***list*[*start*:*end*:*step*]**

  – Take slice from ***start*** to ***end***, progressing by ***step***

  – ***step*** can be negative (go backwards, so ***start*/*end*** are flipped)




```
alist[1:5:2]  →  ['b', 'd']
alist[::2]    →  ['a', 'c', 'e']
alist[4:1:-1] →  ['e', 'd', 'c']  # note start
alist[1:4:-1] →  []
alist[::-1]   →  ['f', 'e', 'd', 'c', 'b', 'a']
```

Loops and Slices

- Can use for-each loop with slice
  - Slice is just a list, so you can use it just like a list
  - Recall loops with lists:

```
for i in range(len(list)):
    # do something with list[i]


for elem in list:
    # do something with elem
```

Loops and Slices

- Can use for-each loop with slice
  - Slice is just a list, so you can use it just like a list
  - Now, for loops with slices (note: **`step`** is optional)

```
for i in range(start, end, step):
    # do something with list[i]
```

```
for elem in list[start:end:step]:
    # do something with elem
```

- Remember: if **`step`** is negative, then **`start`** should be greater than **`end`**

Deleting with Slices

- You can delete elements in a list with **`del`**
- Example:

```
>>> num_list = [50, 30, 40, 60, 90, 80]
>>> del num_list[1]
>>> num_list
[50, 40, 60, 90, 80]
```

- Can use **`del`** with slice notation:

```
>>> num_list = [50, 30, 40, 60, 90, 80]
>>> del num_list[1:4]
>>> num_list
[50, 90, 80]
```


Changing a List in Place

- Python provides some operations on whole list
  - These functions modify list in place (doesn't create new list)
- Function: ***list*`.reverse()`**
  - Reverses order of elements in the list

```
>>> fun_list = [6, 3, 12, 4]
>>> fun_list.reverse()
>>> fun_list
[4, 12, 3, 6]
```

- Function: ***list*`.sort()`**
  - Sorts the elements of the list in increasing order

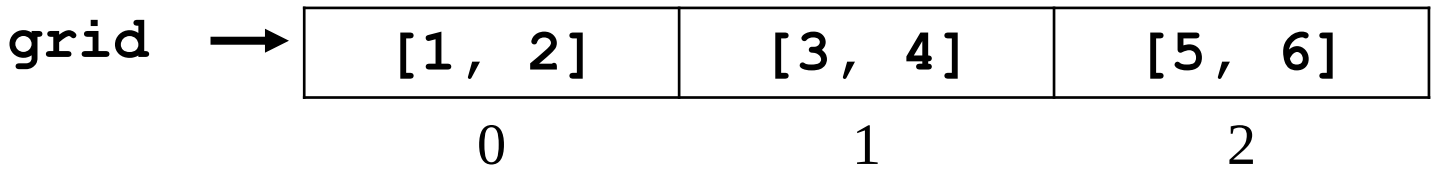
```
>>> fun_list = [6, 3, 12, 4]
>>> fun_list.sort()
>>> fun_list
[3, 4, 6, 12]
```


2-Dimensional Lists

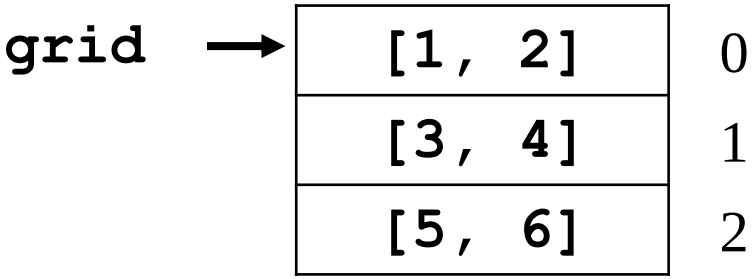
2-Dimensional List

- You can have a list of lists!
  - Each element of "outer" list is just another list
  - Can think of this like a grid
- Example:

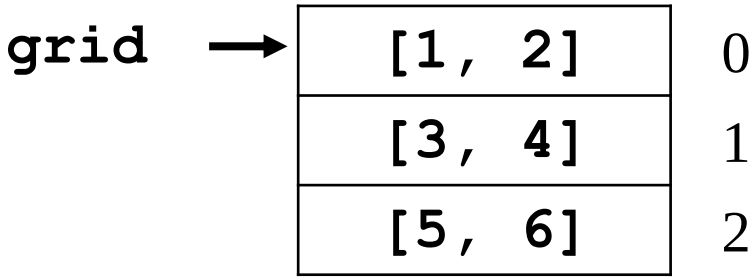
```
grid = [[1, 2], [3, 4], [5, 6]]
```



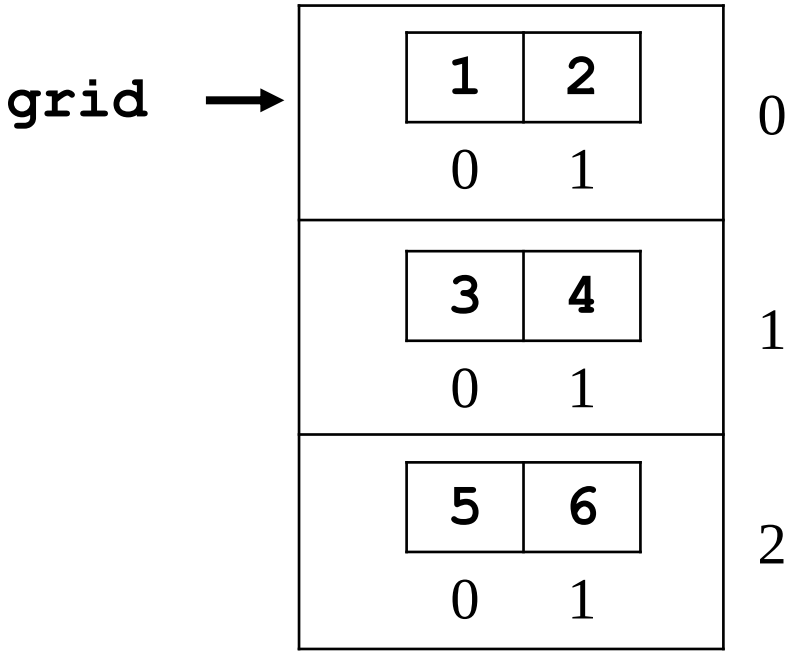
- Can be easier to think of like this:



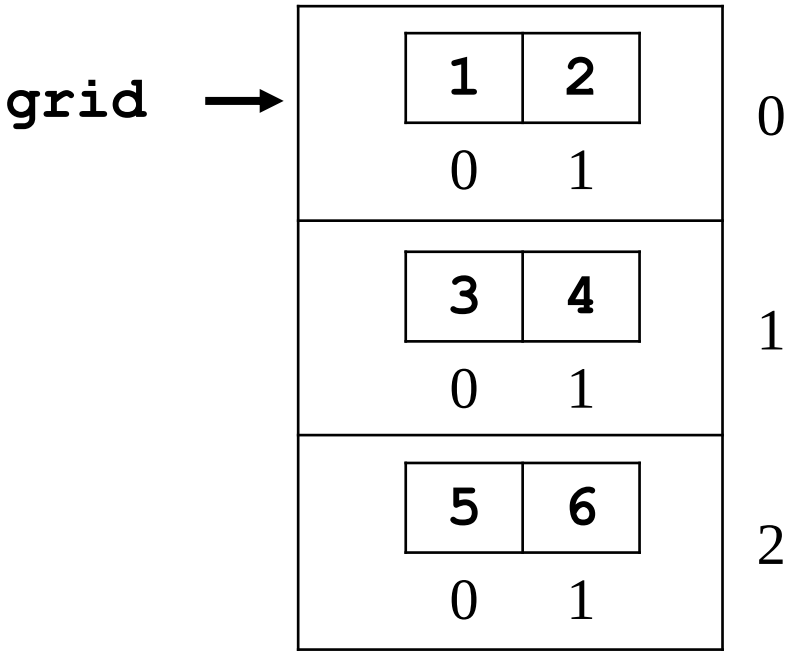
2-Dimensional List



- Um, can you zoom in on that…



2-Dimensional List

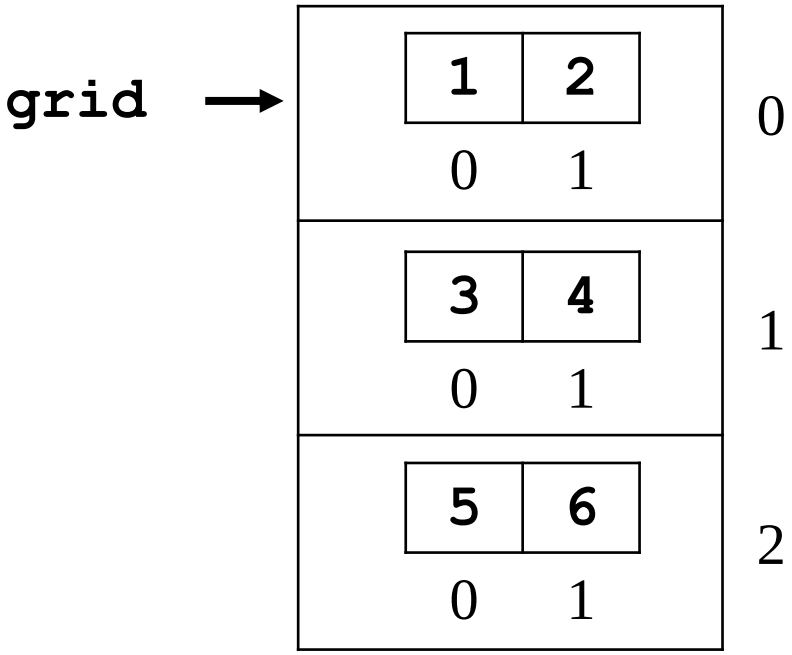


grid[0][0] 1	grid[0][1] 2
grid[1][0] 3	grid[1][1] 4
grid[2][0] 5	grid[2][1] 6

- To access elements, specify index in "outer" list, then index in "inner" list

```
grid[0][0]  →  1
grid[1][0]  →  3
grid[2][1]  →  6
```

2-Dimensional List



- So what if I only specify one index?

```
grid[0]    →  [1, 2]
grid[1]    →  [3, 4]
grid[2]    →  [5, 6]
```

- Remember, **`grid`** is just a list of lists
  - Elements of "outer" list are just lists

Getting Funky With Lists

- Do the inner lists all have to be the same size?
  - No! Just be careful if they are not.

```
jagged = [[1, 2, 3], [4], [5, 6]]
jagged[0]      →  [1, 2, 3]
jagged[1]      →  [4]
jagged[2]      →  [5, 6]
```

- Can I have more than two dimensions?
  - Sure! You can have as many as you like (within reason).

```
cube = [[[1, 2], [3, 4]], [[5, 6], [7, 8]]]
cube[0]        →  [[1, 2], [3, 4]]
cube[0][1]     →  [3, 4]
cube[0][1][0]  →  3
```


Swapping Elements in a Grid

```
def swap(grid, row1, col1, row2, col2):
    temp = grid[row1][col1]
    grid[row1][col1] = grid[row2][col2]
    grid[row2][col2] = temp


def main():
    my_grid = [[10, 20, 30], [40, 50, 60]]
    swap(my_grid, 0, 1, 1, 2)
    print(my_grid)
```

Output: `[[10, 60, 30], [40, 50, 20]]`

Looping Through a List of Lists

```
def main():
    grid = [[10, 20], [40], [70, 80, 100]]
    rows = len(grid)
    for i in range(rows):
        cols = len(grid[i])
        for j in range(cols):
            print("grid[" + str(i) + "][" + str(j)
                  + "] = " + str(grid[i][j]))
```

Output:

```
grid[0][0] = 10
grid[0][1] = 20
grid[1][0] = 40
grid[2][0] = 70
grid[2][1] = 80
grid[2][2] = 100
```


Simplified With a True Grid

```
def main():
    grid = [[1, 2], [10, 11], [20, 21]]
    rows = len(grid)
    cols = len(grid[0])
    for i in range(rows):
        for j in range(cols):
            print("grid[" + str(i) + "][" + str(j)
                  + "] = " + str(grid[i][j]))
```

Output:

```
grid[0][0] = 1
grid[0][1] = 2
grid[1][0] = 10
grid[1][1] = 11
grid[2][0] = 20
grid[2][1] = 21
```


Using For-Each With 2-D List

```
def main():
    grid = [[10, 20], [40], [70, 80, 100]]
    for row in grid:
        for elem in row:
            print(elem)
```

Output:

```
10
20
40
70
80
100
```


Creating a 2-D List

```
def create_grid(rows, cols, value):
    grid = []                       # Create empty grid
    for y in range(rows):           # Make rows one by one
        row = []
        for x in range(cols):       # Build up each row
            row.append(value)       # by appending to list

        grid.append(row)            # Append row (list)
                                    # onto grid
    return grid
```

Console:

```
>>> create_grid(2, 4, 1)
[[1, 1, 1, 1], [1, 1, 1, 1]]
>>> create_grid(3, 2, 5)
[[5, 5], [5, 5], [5, 5]]
```


Putting it all together:
spread.py

(This program give you practice with a lot of concepts!)

Added bonus: example of how computing is used for modeling

Learning Goals

1. Learning about slices
2. Working with 2-dimensional lists