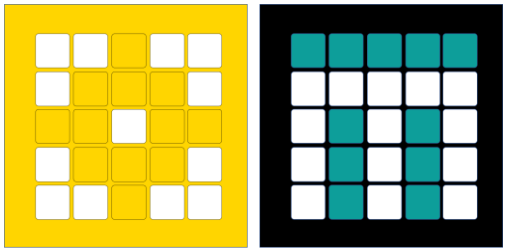
PRIME LESSONS

By the Makers of EV3Lessons



# LISTS AND TUPLES

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# LESSON OBJECTIVES

- Learn to create and use 1D lists
- Learn to create and use tuples
- Learn to create and use 2D lists

# BASICS

- Lists and Tuples store a set of data
- Comma separated lists
  - Lists inside brackets
  - Tuples inside parentheses
- Each entry in a list or tuple is assigned an index, starting at 0
  - L=[index 0, index 1, index 2…..]
- You can read data at an index (for lists, tuples, and strings) by calling
  - L[index]

```
# List:
L = [1, 2, 3]
M = ["Hello", "bye"]
N = [1, True, "Hello"]
L[0] == 1 # True

# Tuple:
a = (1, 2, 3)
b = ("Hello", "bye")
c = (1, True, "Hello")
```

# LIST METHODS

- All list methods edit the original list and do not return anything (except pop() which returns the removed data)

| Method | Description |
|---|---|
| append(data) | Adds an element at the end of the list |
| count(data) | Returns the number of elements with the specified value |
| extend(L) | Add the elements of a list (or any iterable), to the end of the current list |
| index(data) | Returns the index of the first element with the specified value |
| insert(i, data) | Adds an element at the specified position |
| pop(i) | Removes the element at the specified position |
| remove(data) | Removes the first item with the specified value |
| reverse() | Reverses the order of the list |
| sort() | Sorts the list |

# MUTABILITY

- Lists are a mutable data type
  - Tuples, strings, etc. are not
- This means that when you edit a list, it edits that same memory (RAM) object instead of creating a new one
- You can edit a List by assigning an index's data to a new piece of data (see yellow)
  - This is not true for strings or tuples

```
>>> s = "abc"
>>> s[0] = "b"
TypeError: 'str' object does not support item assignment
>>> t = (1,2,3)
>>> t[1] = 0
TypeError: 'tuple' object does not support item assignment
>>> L = [1,2,3]
>>> L[0] = 4
>>> L
[4, 2, 3]
>>>
```

# COPYING A LIST

- You must use the copy function from the copy module
- Unlike strings, tuples, etc., the memory object must be copied; other types will be "copied" simply by "changing" the value
  - I.e. you cannot do a=b to copy a list, but you can for other types → see this in action in the right (green)
- You can copy a list (see yellow)
  - M = L.copy()
  - Edits do not affect the original list

```
>>> L = [1,2,3]
>>> M=L
>>> print(M, L)
[1, 2, 3] [1, 2, 3]
>>> L.append(5)
>>> print(M, L)
[1, 2, 3, 5] [1, 2,
3, 5]
>>> N = L.copy()
>>> N.append(4)
>>> print(M, L, N)
[1, 2, 3, 5] [1, 2,
3, 5] [1, 2, 3, 5, 4]
```

# MORE ABOUT LISTS

- You can….
- Get slices (sections)
- Length of list
- Sum of list
- Append, etc. (see list methods)
- Sort a list using .sort() (numerically, alphabetically, etc.) method
- Reverse a list using .reverse() method

```
L = [1, 2, 3, 4, 5]

# Slices
L[1:3] == [2, 3]
L[1:5:2] == [2, 4]
# L[START:END:INTERVAL]

# Length (of list/tuple)
len(L) == 5

# Sum (of all items in the list/tuple)
sum(L) == 15

# Add to list
L.append(6)
print(L) # [1, 2, 3, 4, 5, 6]
```

# FOR LOOPS WITH LISTS

- You can iterate (i.e. sequentially go through) through a list or tuple using a "for" loop

- The loop variable ("item" in the example) is assigned the value of the next item in the list each time through the loop

- The loop ends when there are no more items

```
L = [1, 2, 8, "hello"]
for item in L:
    print(item)
```

*Output:*

```
1
2
8
hello
```

# STRINGS TO LISTS

- You can use the list() function to split each character into an entry

- You can also use the split() method to convert the string into a list, splitting at the desired item

- You can undo the conversion with "".join(L)

```
>>> L = list("abcd")
>>> print(L)
['a', 'b', 'c', 'd']
>>> s = "a,b,c,de"

>>> M = s.split(",")
>>> print(M)
['a', 'b', 'c', 'de']
```

# CHALLENGE

- Given a list of numbers, sum the squares of the numbers and return the answer. Then print the answer to the light matrix

- You will need to use 1D lists, for loops, and optionally functions

# CHALLENGE SOLUTION

```
from spike import PrimeHub, LightMatrix
from spike.control import wait_for_seconds, wait_until, Timer
from math import *
import time

hub = PrimeHub()

def sumSquares(L):
    sum = 0
    for num in L:
        sum += num**2
    return sum


hub.light_matrix.write(sumSquares([1, 3, 9]))
```

# 2D LISTS: LISTS WITHIN LISTS

- In Python, a 2D list is just a list of lists (i.e. each element of the list is another list)
- You can have 3D, 4D, etc.
- 2D list sometimes called a matrix

```
L = [[ 2, 3, 5 ],
     [ 1, 4, 7 ]]
```

# GETTING AN ELEMENT

- Similar to 1D lists
- You get an element of a list within an element of the "parent" list
- Address an element by calling
  - L[row][column]

```
L = [[ 2, 3, 5 ],
     [ 1, 4, 7 ]]

L[0][1] == 3
L[1][2] == 7
```

# LOOPING ON A 2D LIST

- Use nested loops
- Iterate on the parent list then the child list
- Loop over rows then columns

```
L = [[ 2, 3, 5 ],
     [ 1, 4, 7 ]]

for row in L:
    for col in row:
        print(col)

Output:
2
3
5
1
4
7
```

# COPYING A 2D LIST

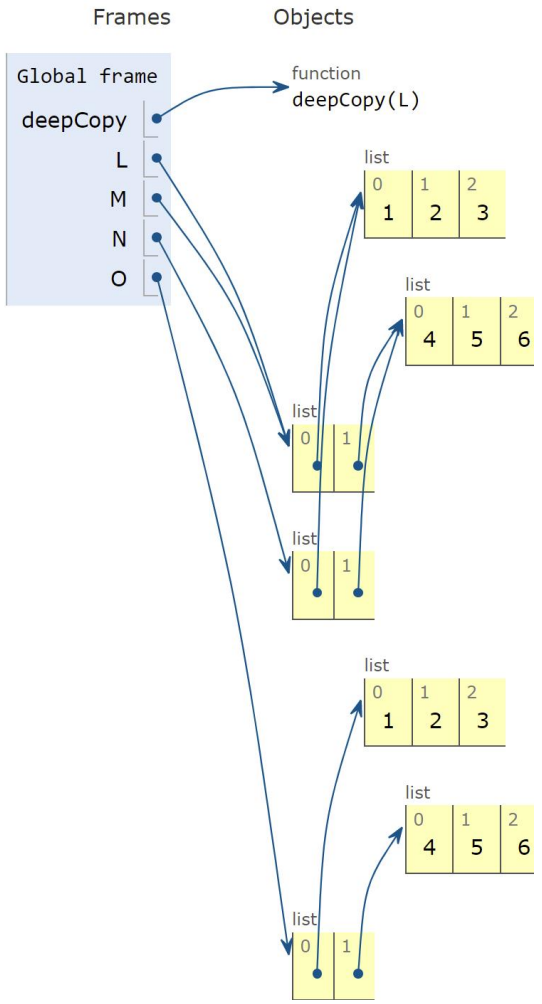
- Similar mutability issues to 1D lists but even more
- Each "child" list has its own memory reference
- We need to do a "deepcopy"
- Unfortunately, micropython does not natively implement the copy library so we need to create our own deepcopy
- The function below uses recursion (which will be taught in a later lesson) to create a simple copy of list elements without using the original list
- Use this function on any list - i.e., `M=deepCopy(L)`

```
def deepCopy(L):
    if (type(L)==list):
        return [deepCopy(e) for e in L]
    else: return L
```

# 2D LIST COPYING ANALYSIS

- Let's take a look at the memory structure of the following code:

```
def deepCopy(L):
    if (type(L)==list):
        return [deepCopy(e) for e in L]
    else: return L
L = [ [ 1, 2, 3 ] , [ 4, 5, 6 ] ]
M = L
N = L.copy()
O = deepCopy(L)
```




- Notice in the object diagram (right), M and L point to the same list, showing that it is really the same object
- While N has its own list, its elements point to the same lists as L, showing that they were not copied when using the normal copy method
- O, however, has all of its children independent of L, showing that it is copied correctly using deepcopy
- Basically, if you are working with 2D lists, use deepcopy.

# LIGHT MATRIX PIXEL CONTROL

- Each pixel on the light matrix is represented by a `x,y` value and a brightness value
- The method to control the matrix pixel is `set_pixel(x, y, brightness)`.
  - The x value is the pixel position counting from the left (range 1-5)
  - The y value is the pixel position counting from the top (range 1-5)
  - The brightness value ranges from 0-100

For example:

```
hub.light_matrix.set_pixel(1, 4, brightness=100)
```

# CHALLENGE

- Given a 2D list of coordinates, in a loop, turn on, wait one second, and turn off each pixel sequentially
- The list will look like:

```
L=[[1, 1],
   [2, 4],
   [3, 5]]
```

- Each child list is an [x, y] coordinate

# CHALLENGE SOLUTION

```
from spike import PrimeHub, LightMatrix
from spike.control import wait_for_seconds, wait_until, Timer
from math import *
import time

hub = PrimeHub()

L=[[1, 1],
   [2, 4],
   [3, 5]]

for coord in L:
    x = coord[0]
    y = coord[1]
    # Note that the previous three lines can be replaced with a single 'for (x,y) in L:' instead
    hub.light_matrix.set_pixel(x, y, brightness=100)
    time.sleep(1)
    hub.light_matrix.set_pixel(x, y, brightness=0)
```

# CREDITS

- This lesson was created by Sanjay and Arvind Seshan for Prime Lessons
- More lessons are available at www.primelessons.org