For Loops
or count controlled repetition

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adapted from slides for CSCI-UA.002 by D. Engle, C. Kapp and J. Versoza

let's start with an example

Write a program that prints numbers from 0 to 9, each on a new line.

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print("0")
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print("2")
print("3")
print("4")
print("5")
print("6")
print("7")
print("8")
print("9")
```

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```python
for i in range(0,10,1):
    print(i)
```

let's start with an example

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```

```
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    print(i)
```

- which of the two programs do you prefer?
- which of them is easier to write?
- would your answer be the same if you needed to write a program that printed values from 0 to 1000?

`for` loop statement

examples of `for` loops

```python
for num in [1,2,3,4,5]:
    print ("This will print 5 times")
```

Output:

```
This will print 5 times
This will print 5 times
This will print 5 times
This will print 5 times
This will print 5 times
```

examples of `for` loops

```
for num in [1,2,3,4,5]:
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Output:

```
This will print 5 times
This will print 5 times
This will print 5 times
This will print 5 times
This will print 5 times
```

```
primes = [2,3,5,7,11,13,17,19,23,29]
num = 4
for prime in primes:
    print (num, "*", prime,
                    "=", num*prime)
```

Output:

```
4 * 2 = 8
4 * 3 = 12
4 * 5 = 20
4 * 7 = 28
4 * 11 = 44
4 * 13 = 52
4 * 17 = 68
4 * 19 = 76
4 * 23 = 92
4 * 29 = 116
```

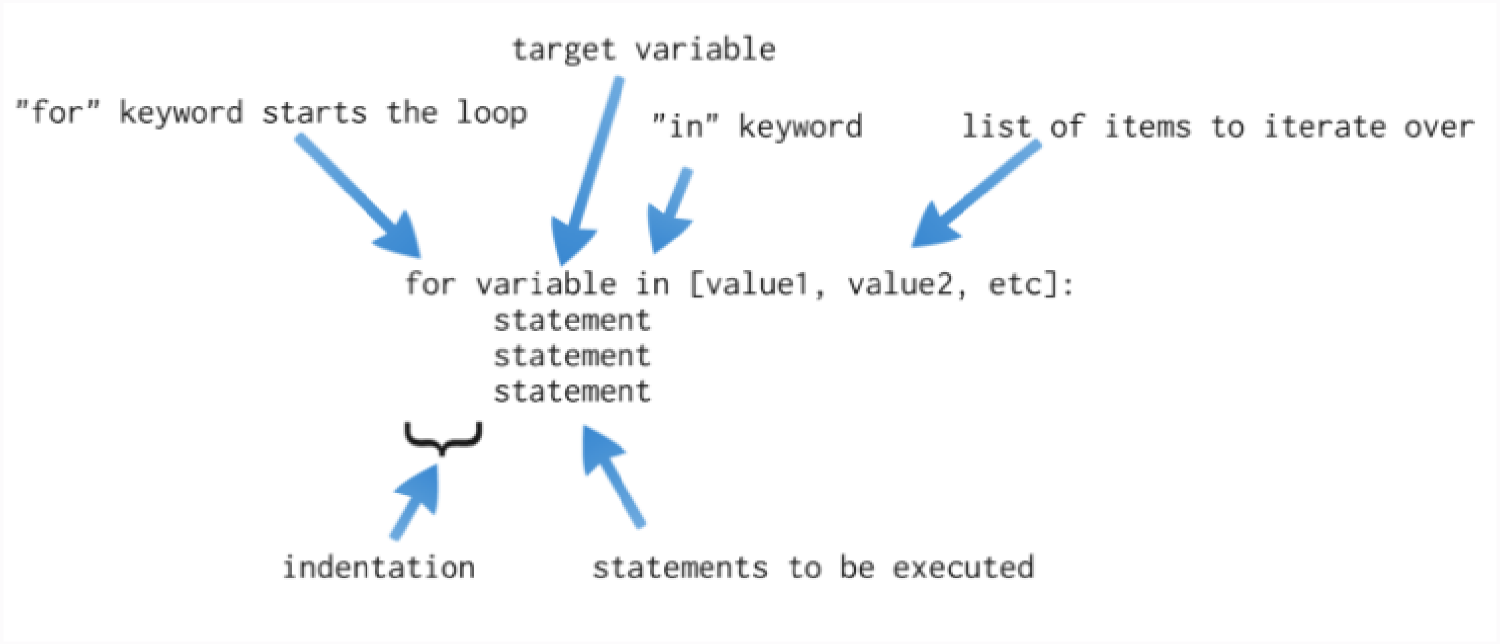
examples of for loops

```python
available_toppings = ['mushrooms', 'olives', 'green peppers',
        'pepperoni', 'pinapple', 'extra cheese']

requested_toppings = ['mushrooms', 'sausage', 'Olives']

for topping in requested_toppings:
    if topping in available_toppings :
        print ('Adding', topping, '.')
    else:
        print ("Sorry, we don't have", topping, ".")

print("\nFinished making your pizza.\nEnjoy!")
```

Output:

```
Adding mushrooms .
Sorry, we don't have sausage .
Sorry, we don't have Olives .

Finished making your pizza.
Enjoy!
```

syntax


target variable
"for" keyword starts the loop
"in" keyword
list of items to iterate over
indentation
statements to be executed

```
for variable in [value1, value2, etc]:
    statement
    statement
    statement
```

- the statements in the loop run multiple times
- each time the `variable` takes on a different value from the list `[value1, value2, etc]`
    - on the first iteration `variable` is equal to `value1`
    - on the second iteration `variable` is equal to `value1`
    - on the third iteration `variable` is equal to `etc`

lists in Python

Lists in Python are defined by the square bracket characters `[` and `]`. Items in a list are separated by a comma.

There are several ways of creating a **list** in Python.

- enumeration: simply enumerate values for the list inside square brackets; the values are separated by commans
    - `grades = ['a', 'b', 'c', 'd', 'f']`
    - `primes = [2,3,5,7,11,13,17,19,23,29]`
    - `friends = ['Alice', 'John', 'Mary']`
    - `random_things = [3.14, 'quiz3', 45, 'long weekend', 6.7]`

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- return value from a function: many functions return a list when called; one such example is the `range()` function
    - `range(0,10,1)` returns `[0, 1, 2, 3, 4, 5, 6, 7, 8, 8]`
    - `range(0,20,2)` returns `[0, 2, 4, 6, 8]`
    - `range(10)` returns `[0, 1, 2, 3, 4, 5, 6, 7, 8, 8]`
    - `range(-10, 11, 5)` returns `[-10, -5, 0, 5, 10]`

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What do you think the rules for this `range()` function are?

`range()` function

- the **`range()`** function lets you dynamically generate lists based on criteria that you define
    - well, technically `range()` function returns an iterable not a list
    - the `for` loop does not care which of the two it uses
    - in any other context, you can create the list out of an iterable using the `list()` function, for example `list(range(1,10,1))`

`range()` function

- when **called with one argument `range( n )`** it returns a list that contains all the numbers starting from `0` up to (but not including) `n`
  - `range(5)` returns `[0, 1, 2, 3, 4]`
  - `range(-5)` returns `[]` - an empty list

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- when **called with two argumets `range( n1, n2 )`** it returns a list that contains all the numbers starting from `n1` up to (but not including) `n2`
    - `range(2,7)` returns `[2, 3, 4, 5, 6]`
    - `range(-99, -95)` returns `[-99, -98, -97, -96]`

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- when **called with three arguments `range(n1, n2, diff)`** it returns a list that contains all the numbers starting from `n1` up to (but not including) `n2` in increments of `diff`
  - `range(-10, 11, 5)` returns `[-10, -5, 0, 5, 10]`
  - `range(0, 10, 3)` returns `[0, 3, 6, 9]`
  - `range(1,1000,100)` returns `[1, 101, 201, 301, 401, 501, 601, 701, 801, 901]`
  - `range(0, -10, -2)` returns `[0, -2, -4, -6, -8]`

`range()` function

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    - `range(-10, 11, 5)` returns `[-10, -5, 0, 5, 10]`
    - `range(0, 10, 3)` returns `[0, 3, 6, 9]`
    - `range(1,1000,100)` returns `[1, 101, 201, 301, 401, 501, 601, 701, 801, 901]`
    - `range(0, -10, -2)` returns `[0, -2, -4, -6, -8]`
- when **called with four arguments** ...
    - it produces an error message:
      `TypeError: range expected at most 3 arguments, got 4`

try it yourself

- write a program that calculates the squares of the numbers between 1 and 10
- the output of this program should be

```
num     num^2
=============
1        1
2        4
3        9
4        16
5        25
6        36
7        49
8        64
9        81
10       100
```

- write a program that calculates the cubes of the even numbers starting at 20 and going down to 0
- the output of this program should be

```
num     num^3
=============
20        8000
18        5832
16        4096
14        2744
12        1728
10        1000
8         512
6         216
4         64
2         8
0         0
```

mixing loops and conditionals

```
for num in range(1,11,1):
    if num % 2 == 0 :
        print (num, "is even")
    else :
        print (num, "is odd")
```

- what will the above program produce?

mixing loops and conditionals

```python
for num in range(1,11,1):
    if num % 2 == 0 :
        print (num, "is even")
    else :
        print (num, "is odd")
```

- what will the above program produce?

```
1 is odd
2 is even
3 is odd
4 is even
5 is odd
6 is even
7 is odd
8 is even
9 is odd
10 is even
```

nesting loops

nested loops are loop that are inside other loops

```
for num1 in range(1,11,1):
    for num2 in range (1,11,1):
        print (num1*num2,end="\t")
    print()
```

- what will the above program produce?

nesting loops

nested loops are loop that are inside other loops

```
for num1 in range(1,11,1):
    for num2 in range (1,11,1):
        print (num1*num2,end="\t")
    print()
```

- what will the above program produce?

Output

```
1       2       3       4       5       6       7       8       9       10
2       4       6       8       10      12      14      16      18      20
3       6       9       12      15      18      21      24      27      30
4       8       12      16      20      24      28      32      36      40
5       10      15      20      25      30      35      40      45      50
6       12      18      24      30      36      42      48      54      60
7       14      21      28      35      42      49      56      63      70
8       16      24      32      40      48      56      64      72      80
9       18      27      36      45      54      63      72      81      90
10      20      30      40      50      60      70      80      90      100
```

- it's a multiplication table (although the labels for rows and columns are missing)
- **challenge:** modify the program to add labels to each row and column

using loops to *accumulate* values

What do you think this program does?

```
sum = 0

for num in range(1,101):
    sum = sum + num

print (sum )
```

using loops to *accumulate* values

What do you think this program does?

```
sum = 0

for num in range(1,101):
    sum = sum + num

print (sum )
```

Output

```
5050
```

- The program computes the sum of all the numbers from 1 to 100.
- We will often talk about variable like `sum` as an *accumulator* because we *accumulate* all the values from 1 to 100 in `sum`

user provided number of repeats

- the user can determine the number of times some task is repeated

```
height = int(input('How tall do you want this ladder to be?'))

for i in range(height):
    print('========\n|      |')
```

Interaction 1:

```
How tall do you want this ladder to be? 3
========
|      |
========
|      |
========
|      |
```

Interaction 2:

```
How tall do you want this ladder to be?5
========
|      |
========
|      |
========
|      |
========
|      |
========
|      |
```

- the loop is repeated a different number of time dending on the user's response

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========
|      |
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========
|      |
```

Interaction 2:

```
How tall do you want this ladder to be?5
========
|      |
========
|      |
========
|      |
========
|      |
========
|      |
```

- the loop is repeated a different number of time dending on the user's response
- Can you think of a program that performs the same task without using a loop?

programming challenges

prime numbers?

Write a program that prompts the user for a positive number. The program should determine if the number is a prime.

Prime numbers are the numbers that are divisible only by 1 and itself. For example 7 is prime since the only numbers that divide it (without a remainder) are 1 and 7:

```
7 / 1 = 7.0             <===  no remainder
7 / 2 = 3.5
7 / 3 = 2.33333333333
7 / 4 = 1.75
7 / 5 = 1.4
7 / 6 = 1.16666666666
7 / 7 = 1.0             <===  no remainder
```

average scores

Write a program that allows you to calculate average of your quiz grades. The program should prompt the user for 5 grades and then compute their average (add all grades together and divide by 5). Assume that the scores are always between 0 and 10.

Version 2: add verification of the user input, i.e., check if the user entered a score between zero and 10, and if not, print an error message

stair steps

- Write a program that prints out the following pattern of characters:

```
++
++++
++++++
++++++++
++++++++++
++++++++++++
```

- Write a program that prints out the following pattern of characters:

```
          ++
        ++++
      ++++++
    ++++++++
  ++++++++++
++++++++++++
```

- Rewrite the above programs to take the number of rows in the pattern from the user.

divisibility testing

Write a program that asks the user to enter in an integer.

The program should then find all numbers between 1 and 10,000 that are evenly divisible by that number.

fizz buzz

Write a program that prints out numbers 1 to 100 with the following exceptions:

- for multiples of three, print out "Fizz" instead of the number
- for multiples of five, print out "Buzz" instead of the number
- for multiples of both three and five print “FizzBuzz”

Example output on the next slide.

fizz buzz - output

```
1
2
Fizz
4
Buzz
Fizz
7
8
Fizz
Buzz
11
Fizz
13
14
FizzBuzz
16
...
88
89
FizzBuzz
91
92
Fizz
94
Buzz
Fizz
97
98
Fizz
Buzz
```