

[301] Strings

Tyler Caraza-Harter

Learning Objectives Today

String Basics

- Comparison
- Common functions



Method Syntax

Sequences (a string is an example of a sequence)

- len
- indexing
- slicing
- for loop

Chapter 8+9 of
Think Python

what we've learned
about strings so far

what we'll learn today



Today's Outline

Comparison

String Methods

Sequences

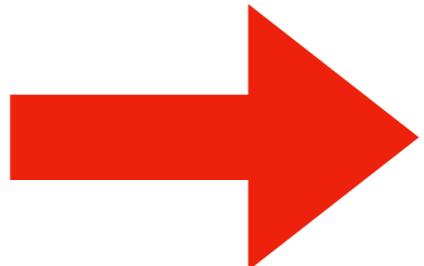
Slicing

for loop over sequence

for loop over range

Comparison

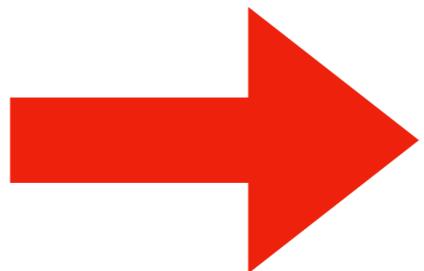
$1 < 2$



True

(because 1 is before 2)

$200 < 100$

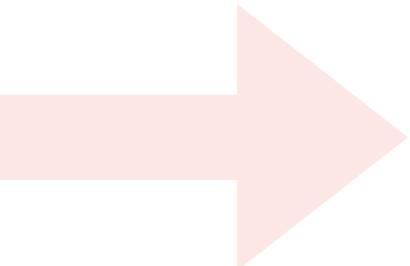


False

(because 200 is NOT before 100)

Comparison

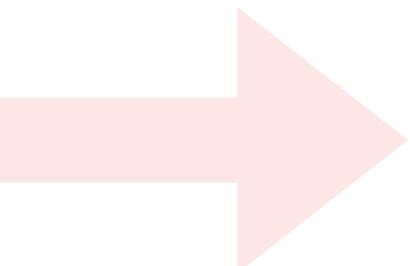
$1 < 2$



True

(because 1 is before 2)

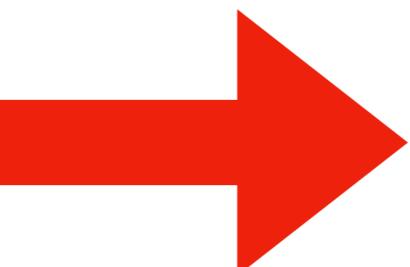
$200 < 100$



False

(because 200 is NOT before 100)

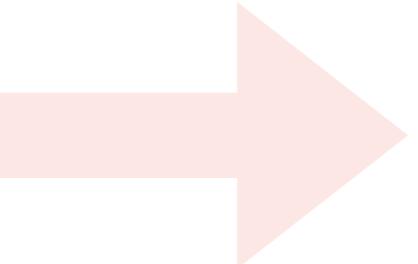
“cat” < “dog”



Python can also compare strings

Comparison

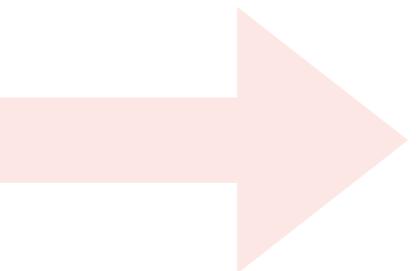
$1 < 2$



True

(because 1 is before 2)

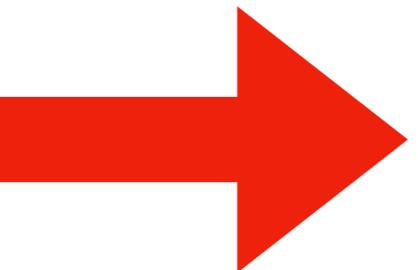
$200 < 100$



False

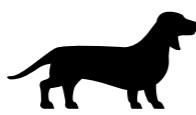
(because 200 is NOT before 100)

“cat” < “dog”



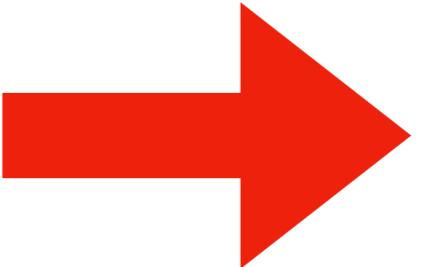
True

(because “cat” is before “dog” in the dictionary)



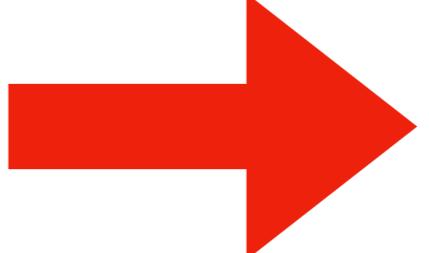
Python can also compare strings

Comparison

“dog” < “doo doo”  ???

What about strings that start with the same letter?

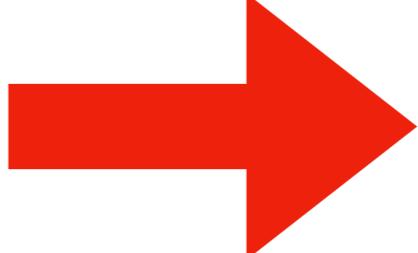
Comparison

“dog” < “doo doo”  ???

What about strings that start with the same letter?

Look for the first letter that's different, and compare those.

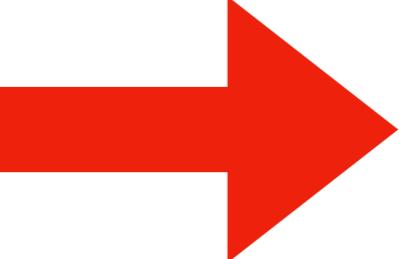
Comparison

“dog” < “doo doo”  True

What about strings that start with the same letter?

Look for the first letter that's different, and compare those.

Comparison

“dog” < “doo doo”  True

There are three gotchas:

- 1 case (upper vs. lower)
- 2 digits
- 3 prefixes

1. Case rules

“A” < “B” < ... < “Y” < “Z”

makes sense

“a” < “b” < ... < “y” < “y”

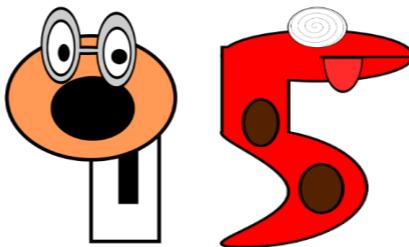
makes sense

“C” < “b”
“Z” < “a”

upper case is
before lower

less intuitive

2. Pesky digits



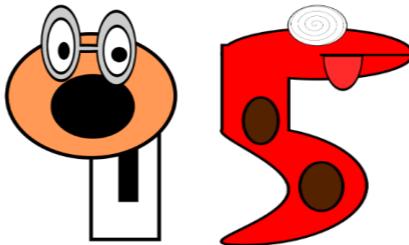
“0” < “1” makes sense

“8” < “9” makes sense

“11” < “2”
“100” < “15”

less intuitive

2. Pesky digits



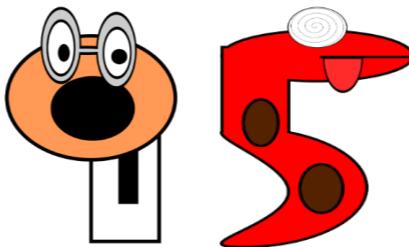
“0” < “1” makes sense

“8” < “9” makes sense

“11” < “2”
“100” < “15”

remember to find the FIRST difference,
and base everything on that

2. Pesky digits



“0” < “1” makes sense

“8” < “9” makes sense

“11” < “2”
“100” < “15”

remember to find the FIRST difference,
and base everything on that

3. Prefixes

String 1: bat

String 2: batman



3. Prefixes

String 1: bat

String 2: batman



3. Prefixes

String 1: bat□

String 2: bat□man



“” < “m”, so String 1 is first:

“bat” < “batman”

Do problem 1

Today's Outline

Comparison

String Methods

Sequences

Slicing

for loop over sequence

for loop over range

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>>
```

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)
```



len is a normal function,
it returns number
of characters in string.

It returns the number of
characters in a string

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>>
```

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>> msg.isdigit()
```



isdigit is a special function,
called a method, that operates
on the string in msg.

It returns a bool, whether the
string is all digits

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>> msg.isdigit()
```

str.isdigit(msg)

equivalent

isdigit is a special function,
called a method, that operates
on the string in msg.

It returns a bool, whether the
string is all digits

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>> msg.isdigit()
```

equivalent

type of msg

method in str
(similar to mod)

str.isdigit(msg)

is digit is a special function,
called a method, that operates
on the string in msg.

It returns a bool, whether the
string is all digits

What is a method?

A special function associated variable/value

```
>>> msg = "hello"
>>> len(msg)
5
>>> msg.isdigit()
False
>>>
```

What is a method?

A special function associated variable/value

```
>>> msg = "hello"
>>> len(msg)
5
>>> msg.isdigit()
False
>>>
```

Both the regular function (`len`) and method (`isdigit`) are answering a question about the string in `msg`, but we call them slightly differently

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>> msg.isdigit()  
False  
>>> msg.upper()
```



is upper a regular function or a method?

What is a method?

A special function associated variable/value

```
>>> msg = "hello"
>>> len(msg)
5
>>> msg.isdigit()
False
>>> msg.upper()
'HELLO'
```

What is a method?

A special function associated variable/value

```
>>> msg = "hello"  
>>> len(msg)  
5  
>>> msg.isdigit()  
False  
>>> msg.upper()  
'HELLO'
```

methods can be called with literal values as well as with values in variables

What is a method?

A special function associated variable/value

```
>>> msg = "hello"
>>> len(msg)
5
>>> msg.isdigit()
False
>>> msg.upper()
'HELLO'
```

methods can be called with literal values as well as with values in variables

What is a method?

A special function associated variable/value

```
>>> msg = "hello"
>>> len("301")
3
>>> "301".isdigit()
True
>>> "Hello World".upper()
'HELLO WORLD'
```

methods can be called with literal values as well as with values in variables

String Method	Purpose
s.upper()	change string to all upper case
s.lower()	opposite of upper()
s.strip()	remove whitespace (space, tab, etc) before and after
s.lstrip()	remove whitespace from left side
s.rstrip()	remove whitespace from right side
s.format(args...)	replace instances of "{}" in string with args
s.find(needle)	find index of needle in s
s.startswith(prefix)	does s begin with the given prefix?
s.endswith(suffix)	does s end with the given suffix?
s.replace(a, b)	replace all instances of a in s with b

Quick demos in interactive mode...

Do problem 2

Today's Outline

Comparison

String Methods

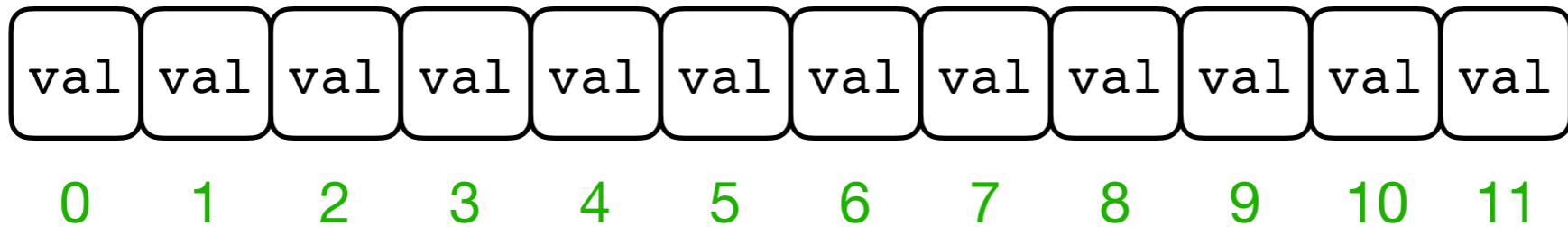
Sequences

Slicing

for loop over sequence

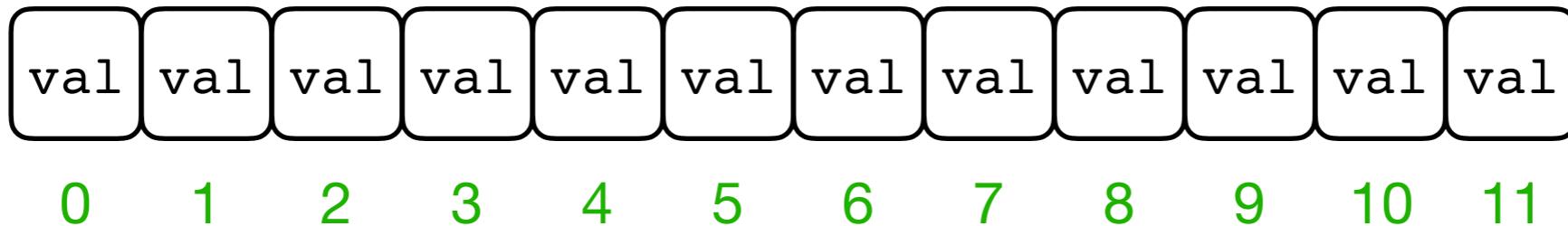
for loop over range

Python Sequences

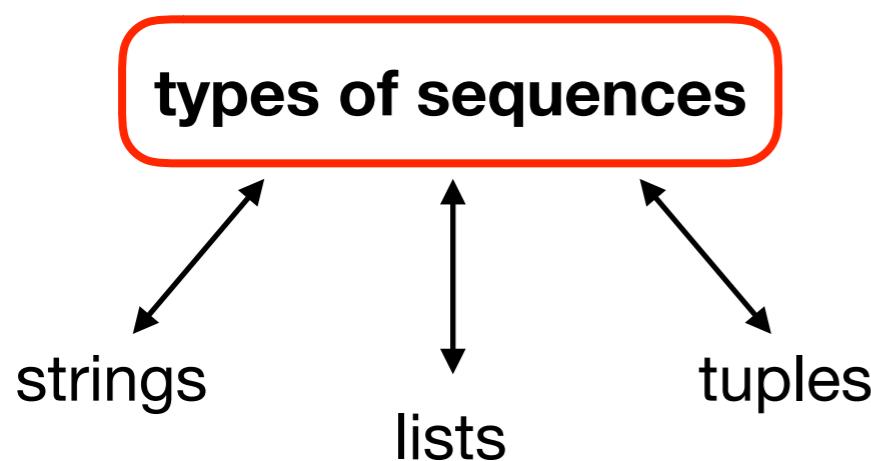


Definition: a *sequence* is a collection of numbered/ordered values

Python Sequences



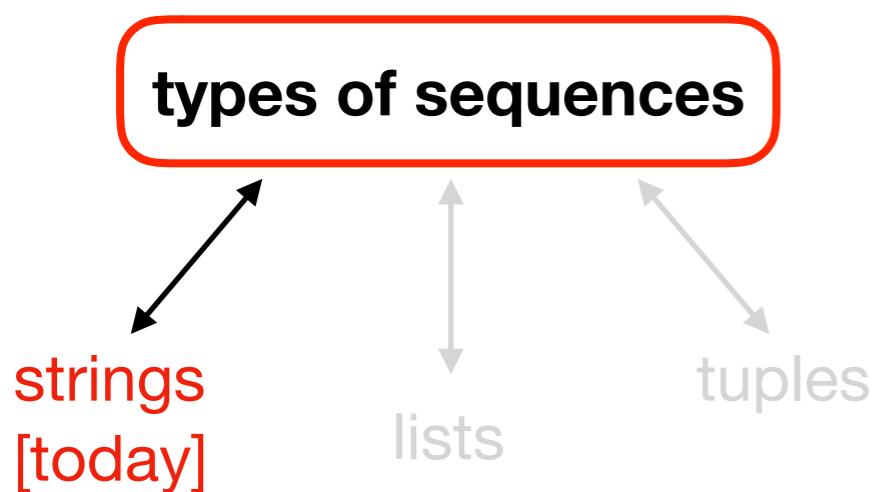
Definition: a sequence is a collection of numbered/ordered values



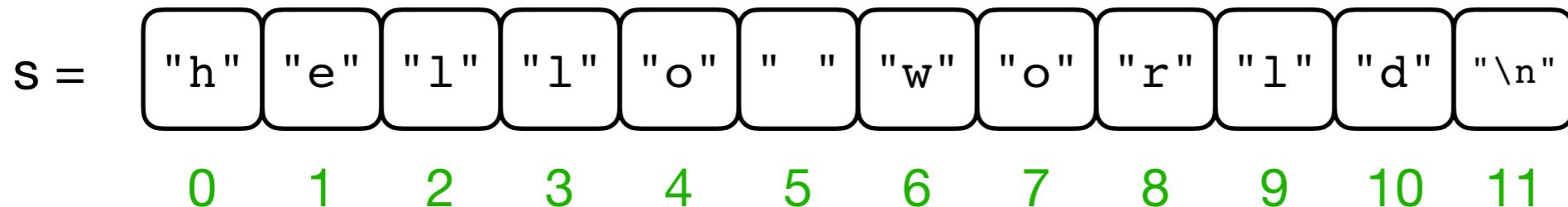
Python Sequences

```
s = ["h", "e", "l", "l", "o", " ", "w", "o", "r", "l", "d", "\n"]  
     0   1   2   3   4   5   6   7   8   9   10  11
```

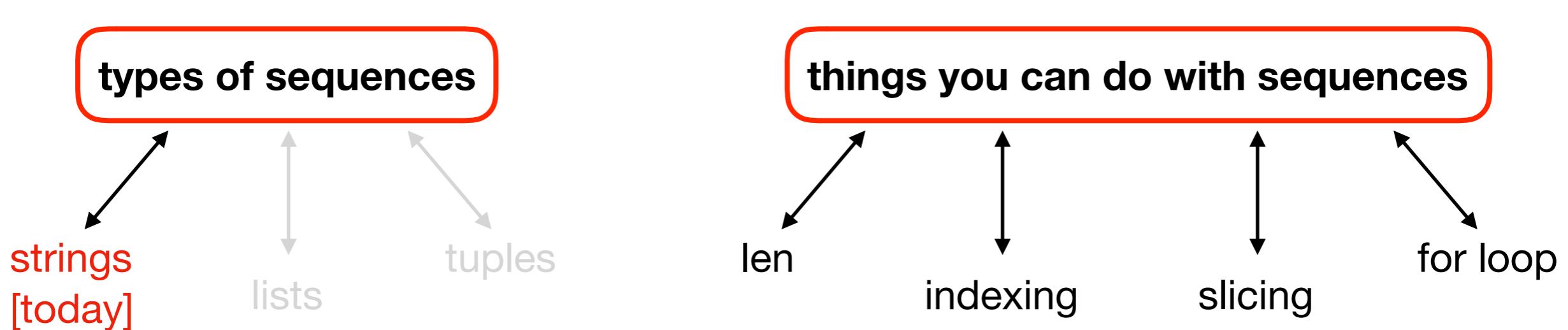
Definition: a *string* is a sequence of one-character strings



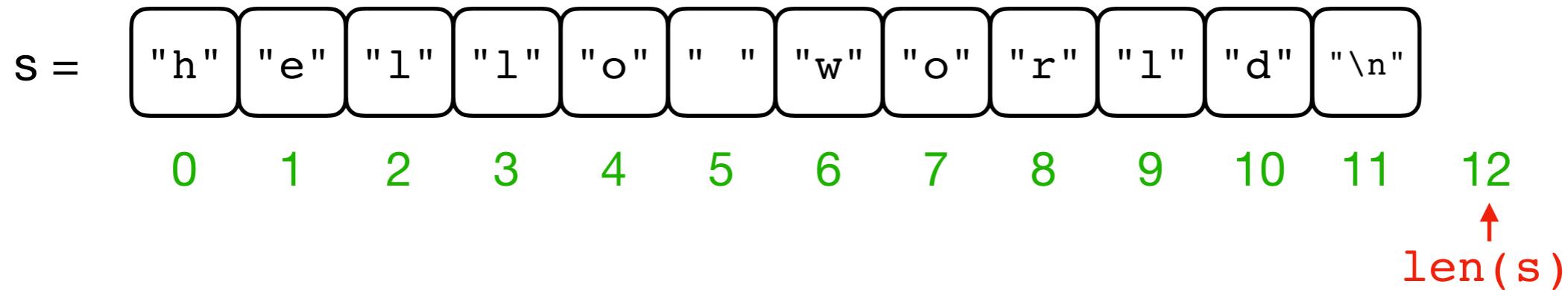
Python Sequences



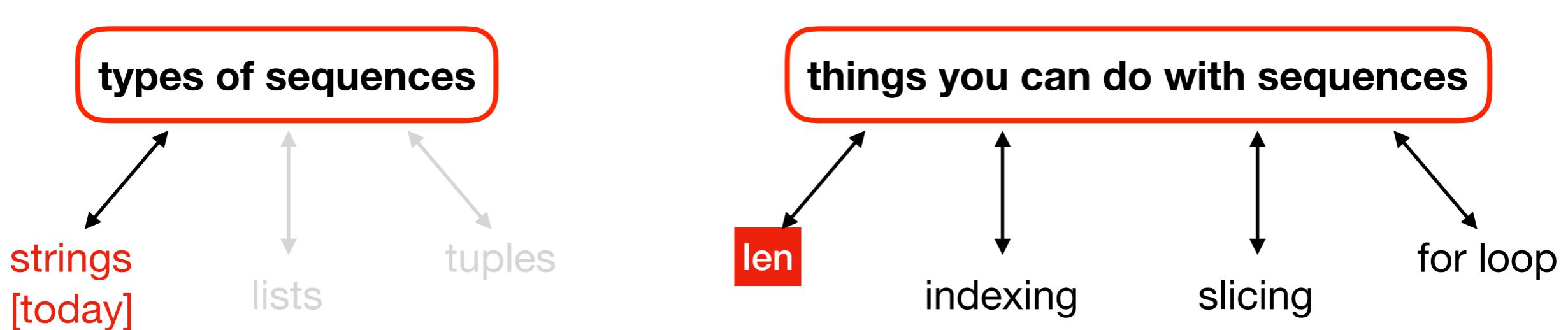
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Python Sequences

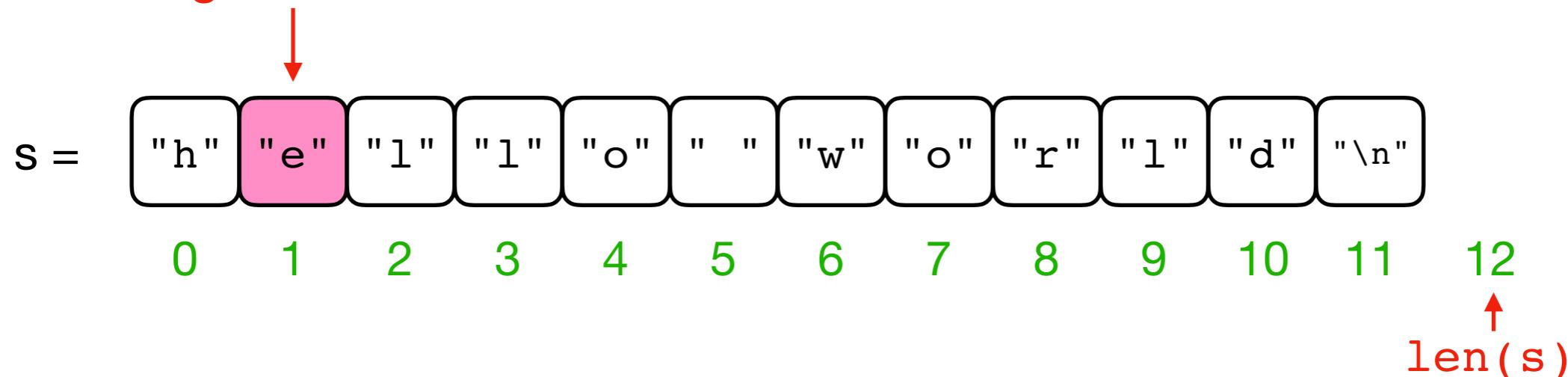


Definition: a *string* is a sequence of one-character strings

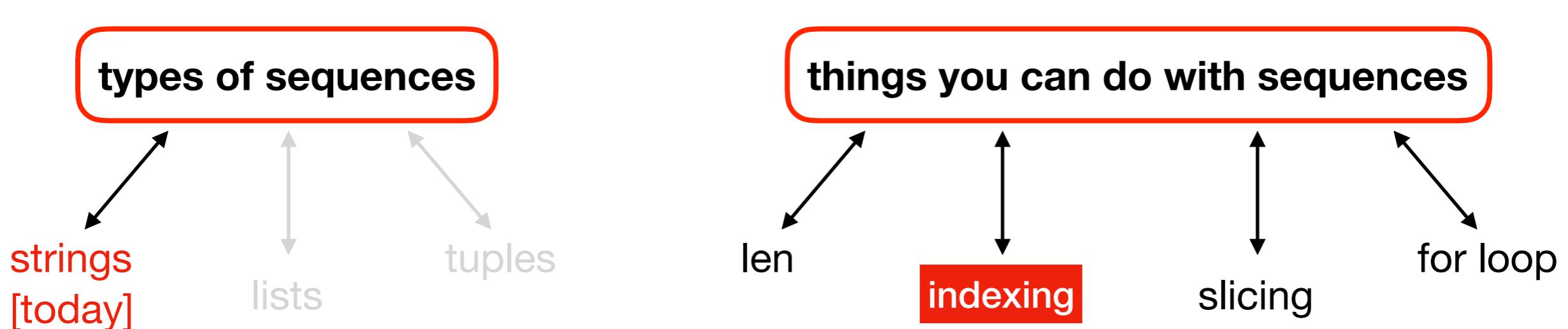


Python Sequences

indexing: access one value

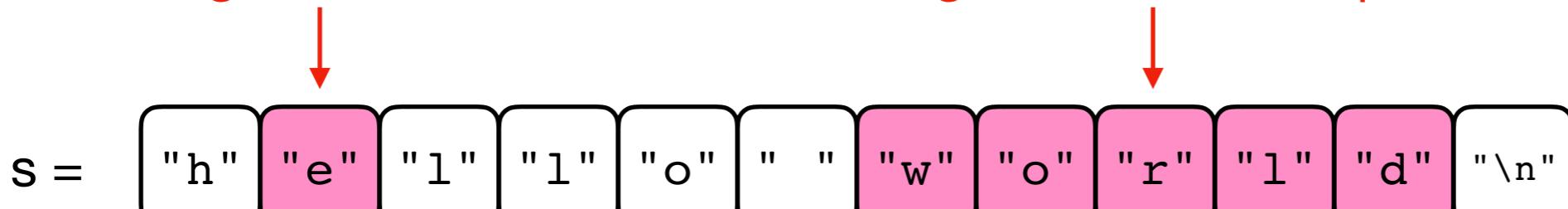


Definition: a *string* is a sequence of one-character strings

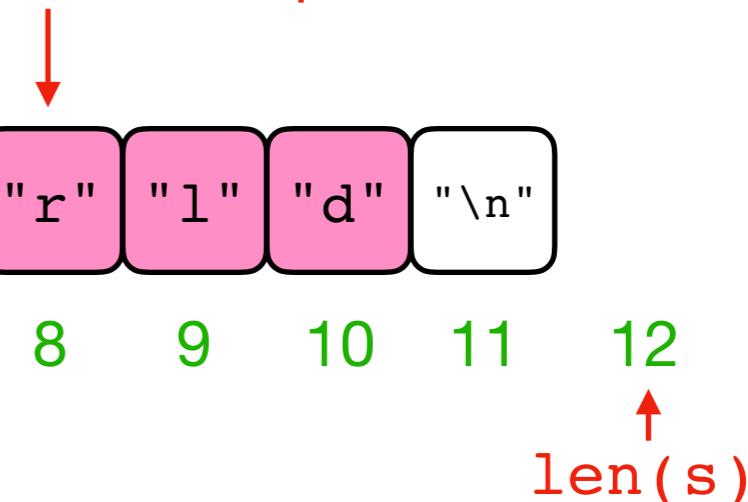


Python Sequences

indexing: access one value



slicing: extract sub-sequence

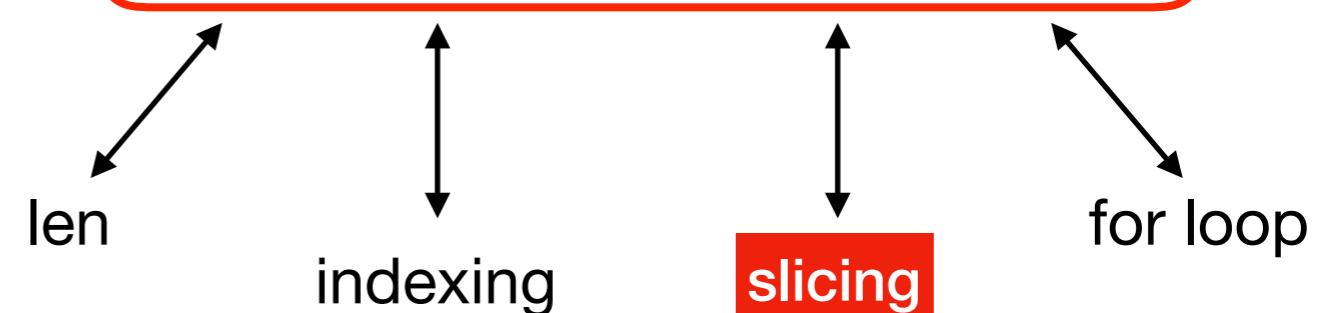


Definition: a *string* is a sequence of one-character strings

types of sequences

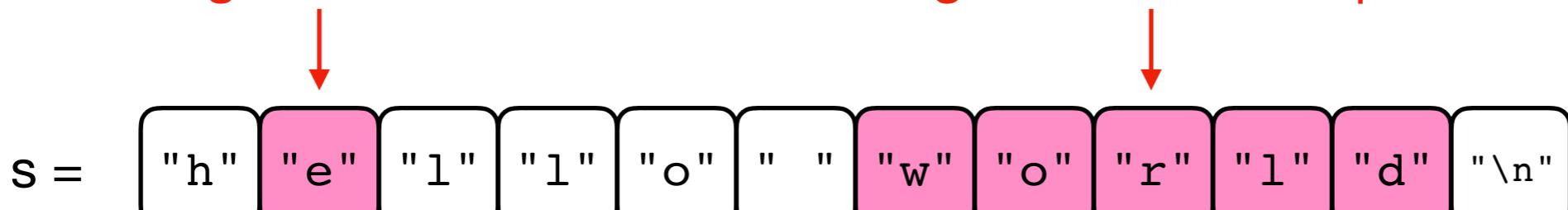


things you can do with sequences

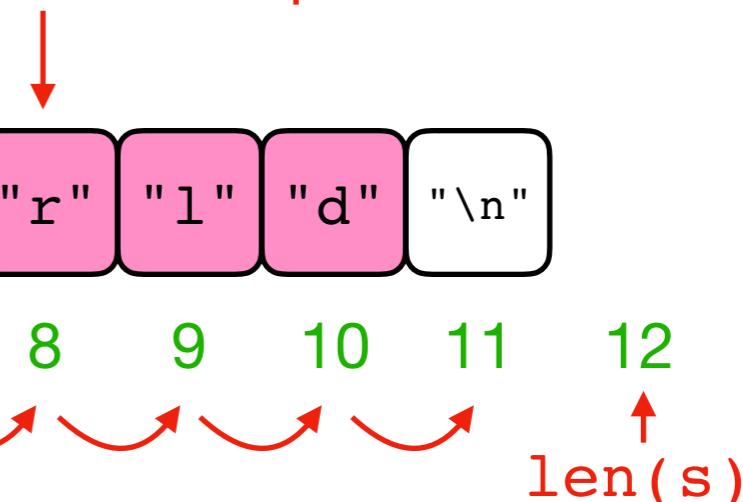


Python Sequences

indexing: access one value



slicing: extract sub-sequence



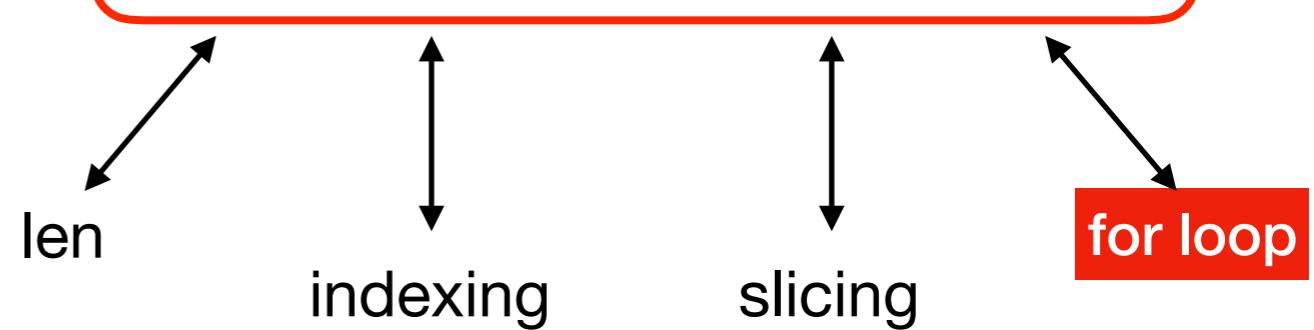
for loop: execute for each value

Definition: a *string* is a sequence of one-character strings

types of sequences

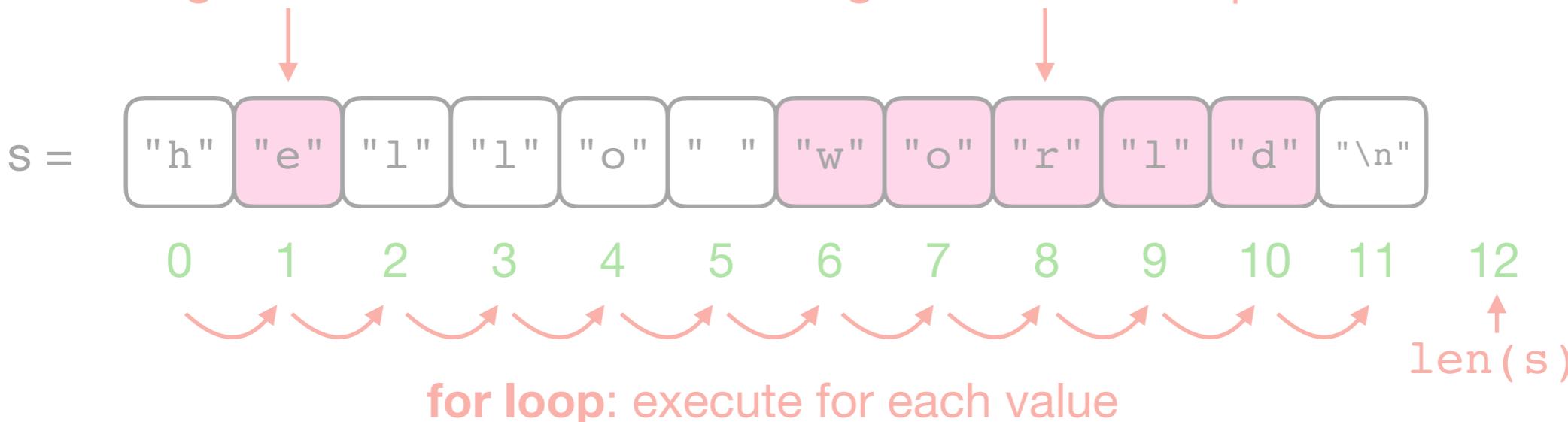


things you can do with sequences



Python Sequences

indexing: access one value



slicing: extract sub-sequence

Definition: a *string* is a sequence of one-character strings

types of sequences

strings
[today]

lists

tuples

things you can do with sequences

len

indexing

slicing

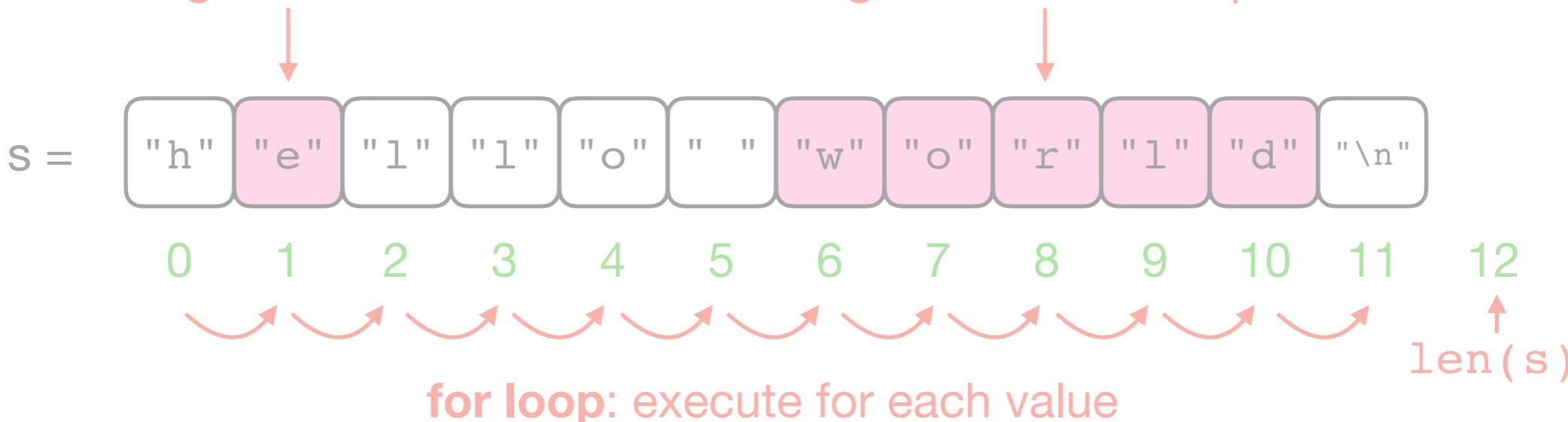
for loop

demos in interactive mode

Do problem 3

Python Sequences

indexing: access one value



slicing: extract sub-sequence

Definition: a *string* is a sequence of one-character strings

types of sequences

strings
[today]

lists

tuples

things you can do with sequences

len

indexing

slicing

for loop

Today's Outline

Comparison

String Methods

Sequences

Slicing

for loop over sequence

for loop over range

Slicing

S: **P** **I** **Z** **Z** **A**

Code:
S = “PIZZA”

Slicing

0 1 2 3 4
S: **P** **I** **Z** **Z** **A**

Slicing

	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

Slicing

S:

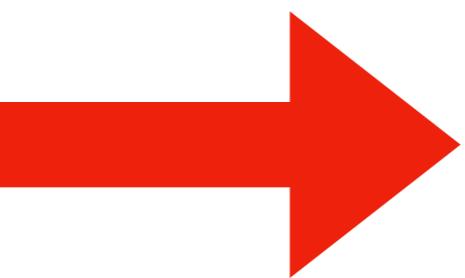
0	1	2	3	4
P	I	Z	Z	A
-5	-4	-3	-2	-1

s[0] → “P”

Slicing

S: P I Z Z A

	0	1	2	3	4
	P	I	Z	Z	A
	-5	-4	-3	-2	-1

S[1]  “I”

Slicing

	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

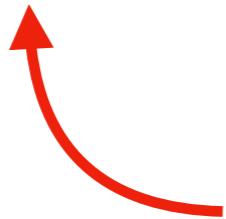
S[-1] → “A”

Slicing

S: **P I Z Z A**

0	1	2	3	4
P	I	Z	Z	A
-5	-4	-3	-2	-1

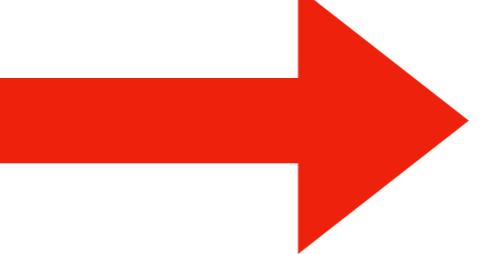
S[???] → “IZZ”



what to put if we want multiple letters,
like “IZZ”?

Slicing

	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

S[1:4]  “IZZ”

Slicing

S: P I Z Z A

0	1	2	3	4
-5	I	Z	Z	A
	-4	-3	-2	-1

S[1:4] → “IZZ”

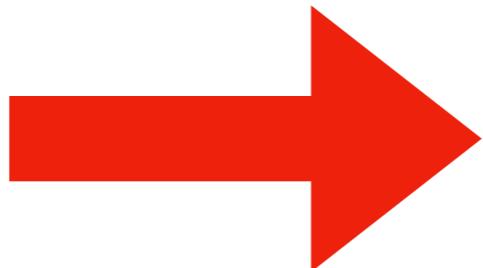
Slicing

S:

	0	1	2	3	
P	I	Z	Z	A	
	-5	-4	-3	-2	-1

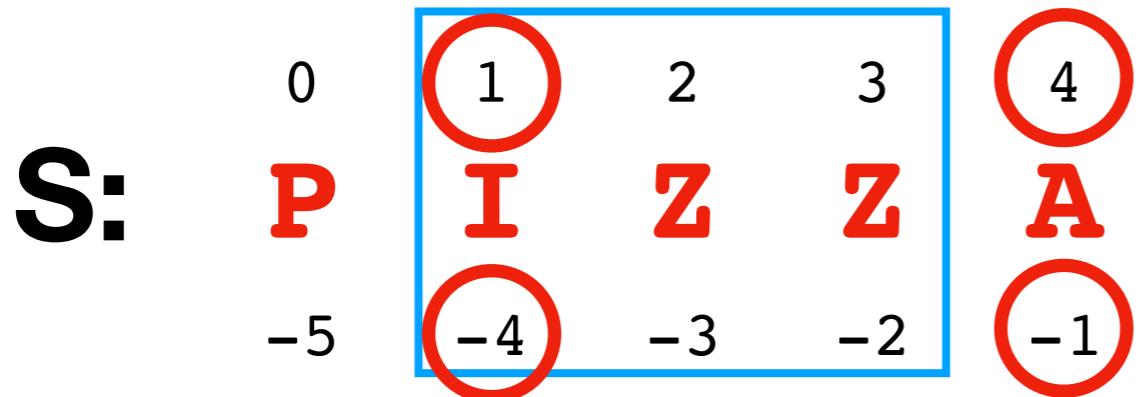
start is “inclusive”
end is “exclusive”

S[1:4]



“IZZ”

Slicing



S[1:4] → “IZZ”

Many different slices give the same result:
 $S[1:4] == S[1:-1] == S[-4:4] == S[-4:-1]$

Slicing

S: **P I Z Z A**

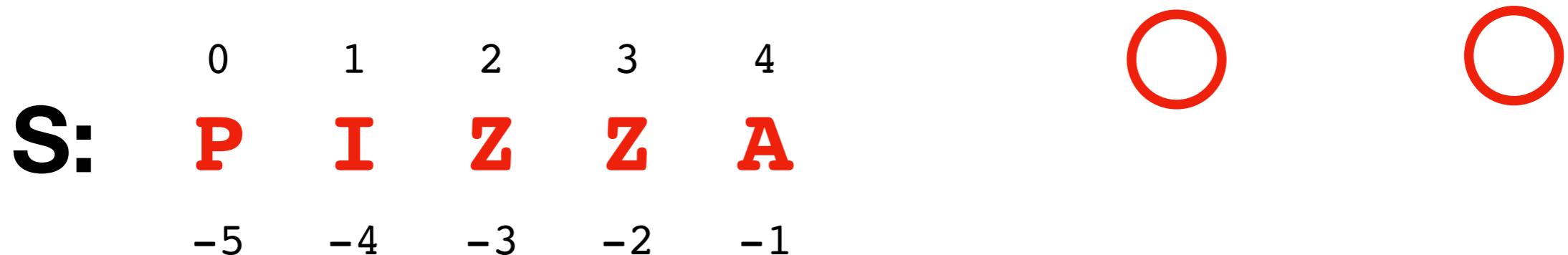
0	1	2	3	4
-5	I	Z	Z	A
	-4	-3	-2	-1

Red circles highlight index 1 and the character 'I'.

S[1:100] → “IZZA”

Slices don't complain about out-of-range numbers.
You just don't get data for that part

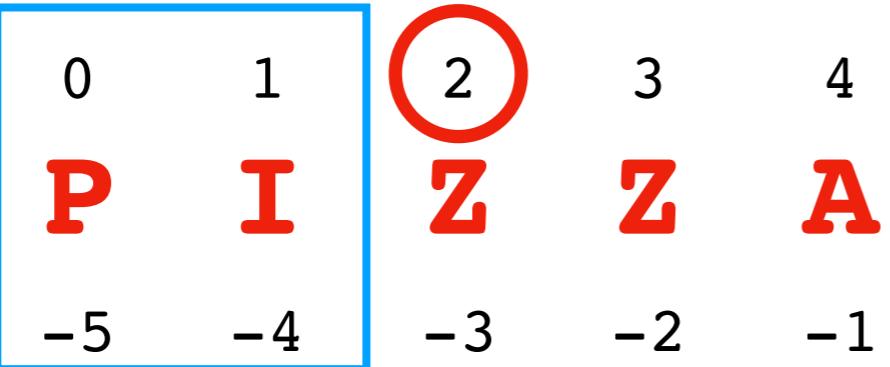
Slicing



S[50:100] → “”

Slices don't complain about out-of-range numbers.
You just don't get data for that part

Slicing

S: 
0 1 2 3 4
P I Z Z A
-5 -4 -3 -2 -1

S[: 2] → “PI”

Feel free to leave out one of the numbers in the slice

Slicing

	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

S[2 :] → “ZZA”

Feel free to leave out one of the numbers in the slice

Slicing

	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

S[2 :] → “ZZA”

Inclusive start and exclusive end makes it easier to split and inject things

Slicing

S:

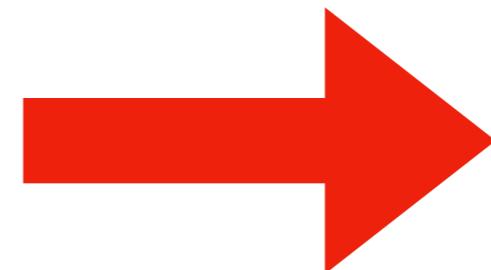
0	1	2
P	I	Z
-5	-4	-3

3	4
Z	A
-2	-1

let's inject “...” here

mid = 3

S[:3] + “...” + S[3:]



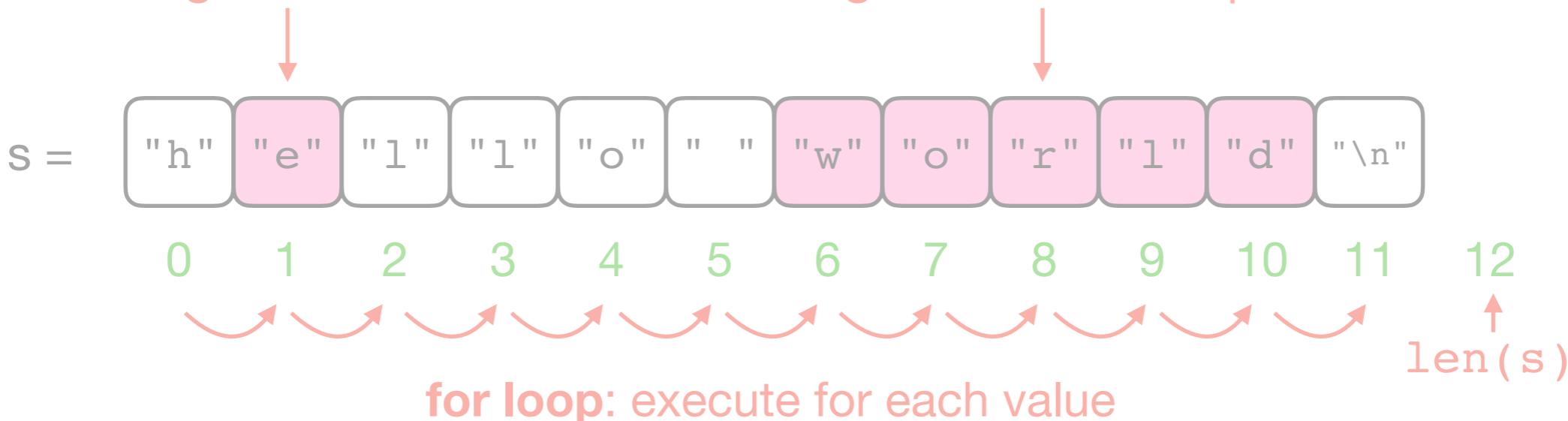
“PIZ...ZA”

Inclusive start and exclusive end makes it easier to split and inject things

Do problem 4

Python Sequences

indexing: access one value



slicing: extract sub-sequence

Definition: a *string* is a sequence of one-character strings

types of sequences

strings
[today]

lists

tuples

things you can do with sequences

len

indexing

slicing

for loop

Today's Outline

Comparison

String Methods

Sequences

Slicing

for loop over sequence

for loop over range

Motivation

```
msg = "hello"
```

```
# let's say we want to print  
# each letter on its own line
```

Motivation

```
msg = "hello"
```

```
i = ???  
while i < ???:  
    ???  
    i += ???
```

Motivation

```
msg = "hello"  
i = 0  
while i < ???:  
    ???  
    i += ???
```

indexing starts at 0, so msg[0] is 'h',
so we want to start i at 0



Motivation

```
msg = "hello"
```

```
i = 0
```

```
while i < ???:
```

```
    ???
```

```
    i += 1
```

indexing starts at 0, so msg[0] is 'h',
so we want to start i at 0

we don't want to skip any letters

Motivation

```
msg = "hello"  
i = 0  
while i < len(msg):  
    ???  
    i += 1
```

indexing starts at 0, so msg[0] is 'h',
so we want to start i at 0

last letter (o) has index 4,
or len(msg)-1

we don't want to skip any letters

Motivation

```
msg = "hello"
```

```
i = 0
while i < len(msg):
    ???
    i += 1
```

Motivation

```
msg = "hello"
```

```
i = 0
while i < len(msg):
    letter = msg[i]
    ???
    i += 1
```



get the letter for the current index

Motivation

```
msg = "hello"
```

```
i = 0
while i < len(msg):
    letter = msg[i]
    print(letter)
    i += 1
```

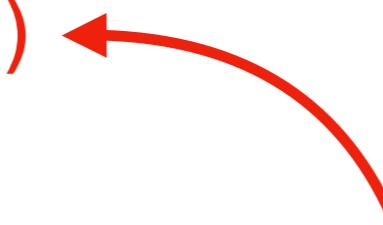


this is the only interesting part
(we just want to print each letter!)

Motivation

```
msg = "hello"
```

```
i = 0
while i < len(msg):
    letter = msg[i]
    print(letter)
    i += 1
```



this is the only interesting part
(we just want to print each letter!)

Code like this for sequences is so common
that Python provides an easier way, with the **for loop**

while vs. for

**while
loop**

```
msg = "hello"  
  
i = 0  
while i < len(msg):  
    letter = msg[i]  
    print(letter)  
    i += 1
```

while vs. for

**while
loop**

```
msg = "hello"  
  
i = 0  
while i < len(msg):  
    letter = msg[i]  
    print(letter)  
    i += 1
```

**for
loop**

```
for letter in msg:  
    print(letter)
```

they do the same thing!

for syntax

**for
loop**

```
for letter in msg:  
    print(letter)
```

basic syntax always used

for syntax

for loop

```
for letter in msg:  
    print(letter)
```

automatically initialized to a
different item on each iteration
("h" on 1st, "e" on 2nd, etc)

the sequence
(e.g., "hello")

specify a variable name to use inside the loop,
and the sequence you want to loop over

for syntax

do PythonTutor example

for
loop

```
for letter in msg:  
    print(letter)
```

automatically initialized to a
different item on each iteration
("h" on 1st, "e" on 2nd, etc)

the sequence
(e.g., "hello")

specify a variable name to use inside the loop,
and the sequence you want to loop over

Do problem 5

Today's Outline

Comparison

String Methods

Sequences

Slicing

for loop over sequence

for loop over range

for with range

```
msg = "01234"  
  
for item in msg:  
    print(item * 3)
```

Output:
000
111
222
333
444

for with range

```
msg = "01234"
```

```
for item in msg:  
    print(item * 3)
```

Output:

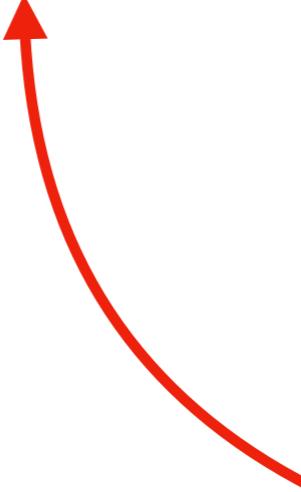
000

111

222

333

444



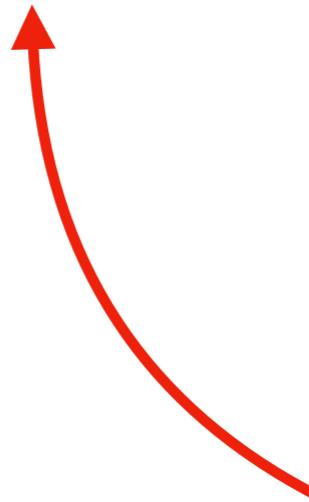
what if we want to iterate over the integers
0 to 4 (instead of string digits “0” to “4”)?

for with range

```
msg = "01234"
```

Output:

```
for item in msg:  
    print(item * 3)
```



what if we want to iterate over the integers
0 to 4 (instead of string digits “0” to “4”)?

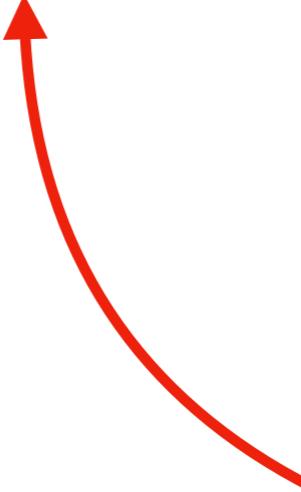
for with range

```
for item in range(5):  
    print(item * 3)
```

Output:

0
3
6
9
12

what if we want to iterate over the integers
0 to 4 (instead of string digits “0” to “4”)?



for with range

```
for item in range(5):  
    print(item * 3)
```

Output:

0
3
6
9
12

using range(N) with a for loop will iterate with these values for item:

0, 1, 2, ..., $N-2$, $N-1$

Do problem 6