

[301] Strings

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Learning Objectives Today

String Basics

- Comparison
- Common functions

Chapter 8+9 of Think Python

Sequences (a string is an example of a sequence)

- indexing
- len
- slicing

for loops

- over a sequence
- with range

Today's Outline

Comparison

String Methods

Sequences

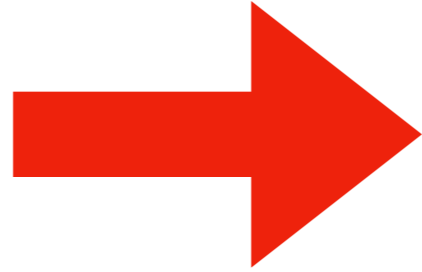
Slicing

for loop over sequence

for loop over range

Comparison

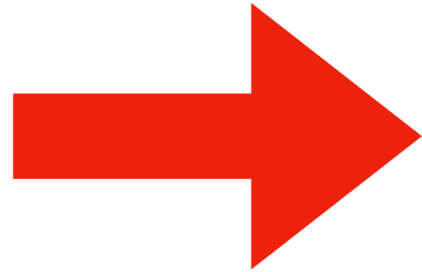
1 < 2



True

(because 1 is before 2)

200 < 100

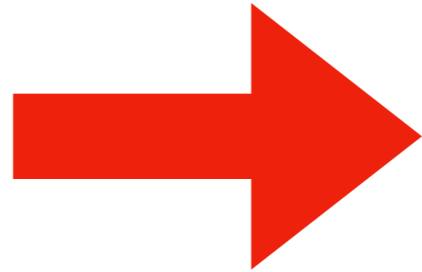


False

(because 200 is NOT before 100)

Comparison

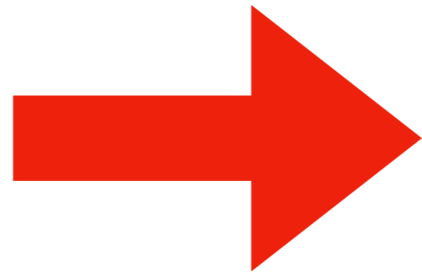
1 < 2



True

(because 1 is before 2)

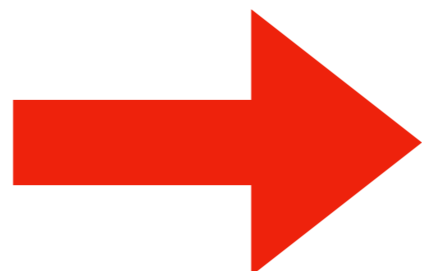
200 < 100



False

(because 200 is NOT before 100)

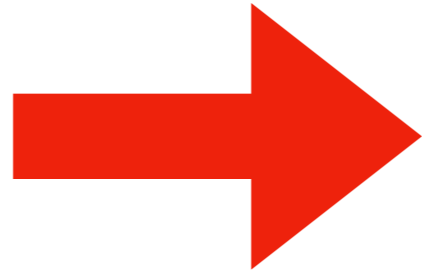
“cat” < “dog”



Python can also compare strings

Comparison

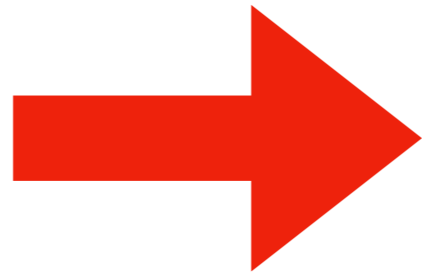
1 < 2



True

(because 1 is before 2)

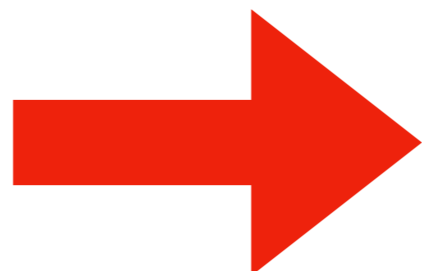
200 < 100



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.

Case is tricky, though...

“A” < “B” < “C” < “D” < ... < “X” < “Y” < “Z”

makes sense

“a” < “b” < “c” < “d” < ... < “x” < “y” < “y”

makes sense

Case is tricky, though...

“A” < “B” < “C” < “D” < ... < “X” < “Y” < “Z”

makes sense

“a” < “b” < “c” < “d” < ... < “x” < “y” < “y”

makes sense

“C” < “b”

Case is tricky, though...

“A” < “B” < “C” < “D” < ... < “X” < “Y” < “Z” **makes sense**

“a” < “b” < “c” < “d” < ... < “x” < “y” < “y” **makes sense**

“C” < “b”

“Z” < “a”

(any upper case letter) < (any lower case letter)

counterintuitive, but this is almost always the default behavior, across many programming languages (not just Python)

Watch numbers too!

“0” < “1” makes sense

“8” < “9” makes sense

“11” < “2”
“100” < “15”

less intuitive

Watch numbers too!

“0” < “1” makes sense

“8” < “9” makes sense

“11” < “2”
“100” < “15”

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

Watch numbers too!

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“8” < “9” makes sense

“11” < “2”
“100” < “15”

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

Prefixes come before longer strings

String 1: abcd

String 2: abcdef

Prefixes come before longer strings

String 1: abcd□

String 2: abcdef

Prefixes come before longer strings

String 1: abcd□

String 2: abcdef

“” < “e”, so String 1 is first:

“abcd” < “abcdef”

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,
like we've been using.

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()  
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

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Comparison

String Methods

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Sequences

In Python, data is often organized in sequences. A sequence is a series of **items**, in order

strings are the first example of a sequence we'll consider

- a string is a sequence of **characters** (strings of length 1)

Sequences

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There are a few handy things we can do with all sequences (strings or otherwise)

- grab an item (e.g., a character) from the middle
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- grab an item (e.g., a character) from the middle ← **indexing**
- grab a range of items (e.g., a substring) ← **slicing**
- use a fancy loop to iterate over every item ← **for loops**

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- a string is a sequence of **characters** (strings of length 1)

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- **grab an item (e.g., a character) from the middle** ← **indexing [demos]**
- **grab a range of items (e.g., a substring)** ← **slicing**
- **use a fancy loop to iterate over every item** ← **for loops**

Do problem 3

Sequences

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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"

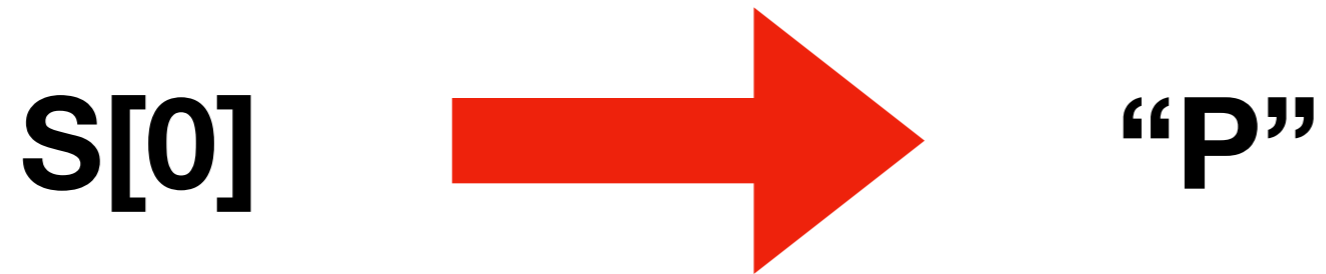
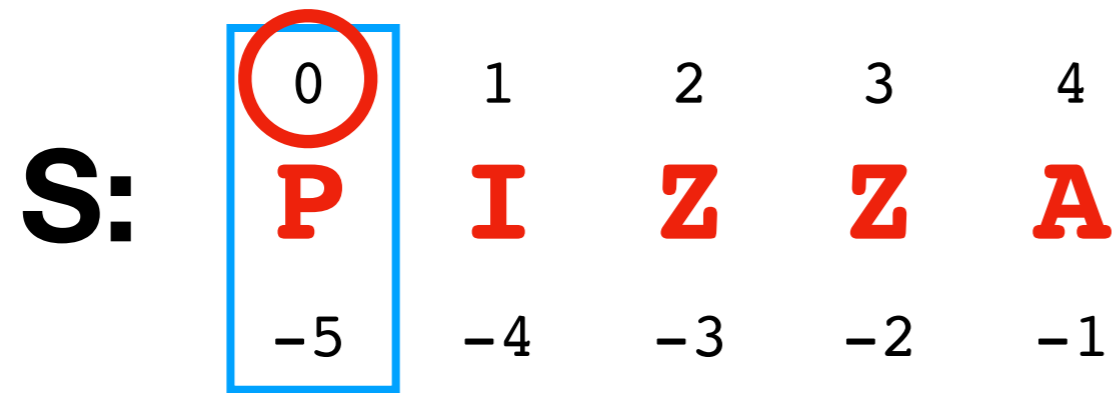
Slicing

	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

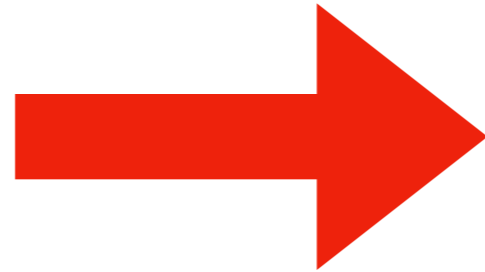
Slicing



Slicing

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

S[1]



“I”

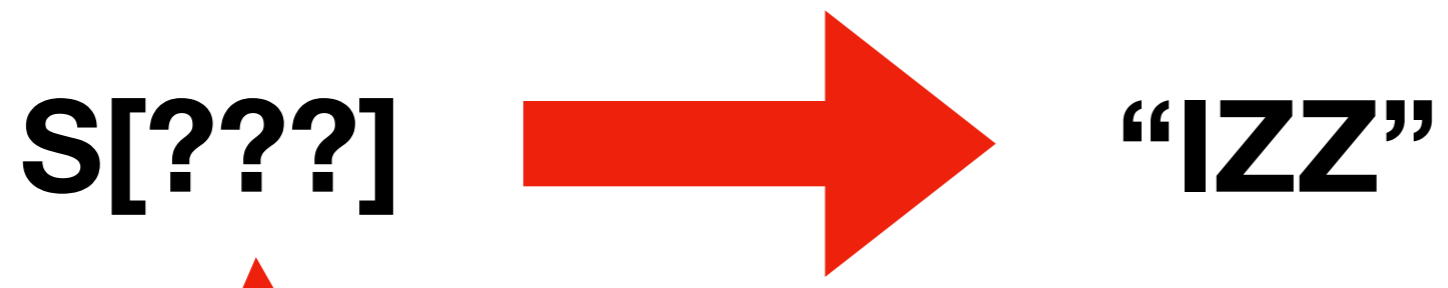
Slicing

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



Slicing

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



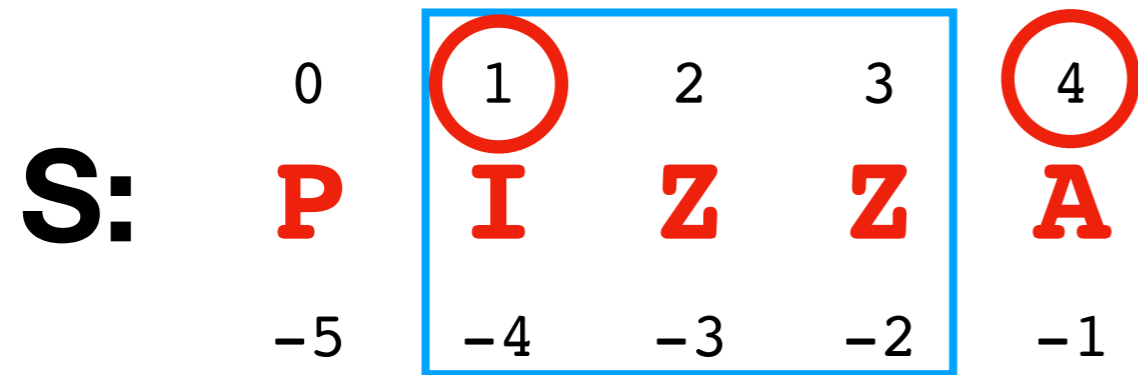
 what to put if we want multiple letters,
like “IZZ”?

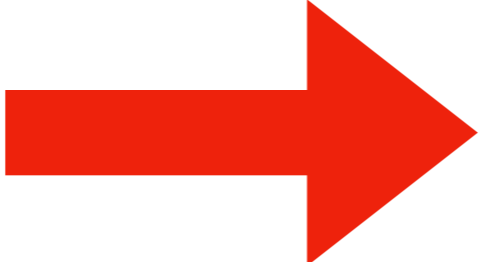
Slicing

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

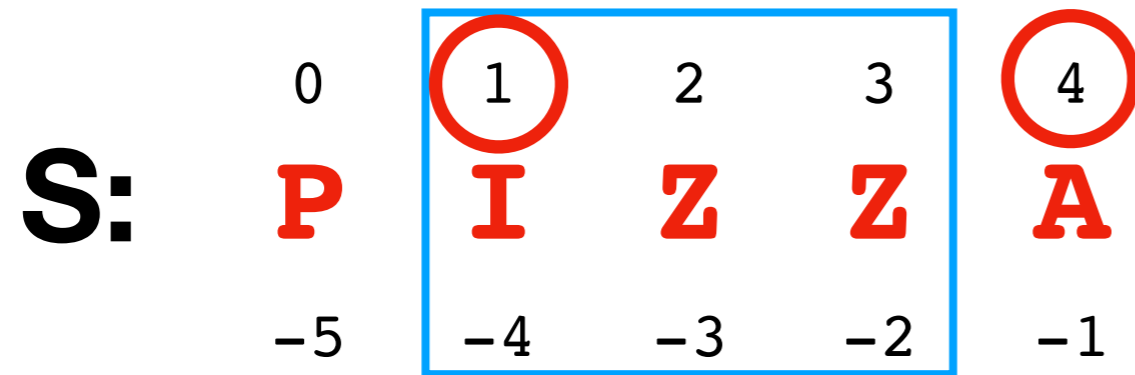
S[1:4]  **“IZZ”**

Slicing



S[1:4]  **“IZZ”**

Slicing



start is “inclusive”
end is “exclusive”

S[1:4]  **“IZZ”**

Slicing

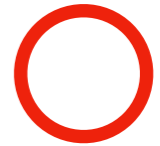
	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

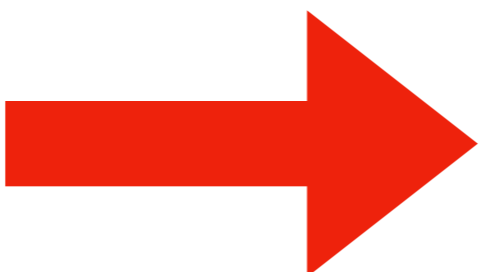
S[1:4]  **“IZZ”**

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

Slicing

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

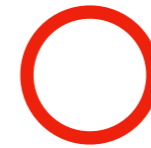


S[1:100]  **“IZZA”**

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

Slicing

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



S[50:100]  **“”**

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

Slicing

S:

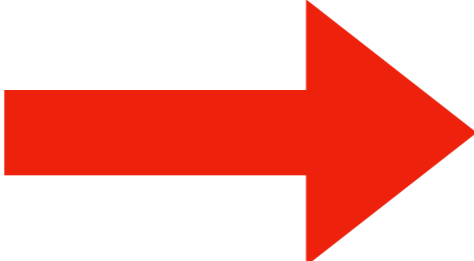
0	1	2	3	4
P	I	Z	Z	A
-5	-4	-3	-2	-1

S[:2]  **“PI”**

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

Slicing

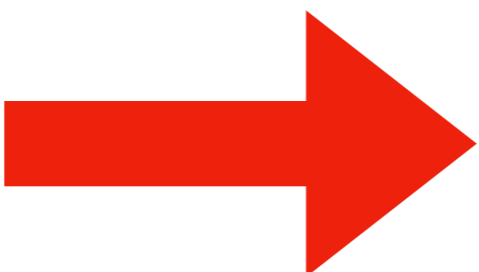
	0	1	2	3	4
S:	P	I	Z	Z	A
	-5	-4	-3	-2	-1

S[2 :]  **“ZZA”**

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

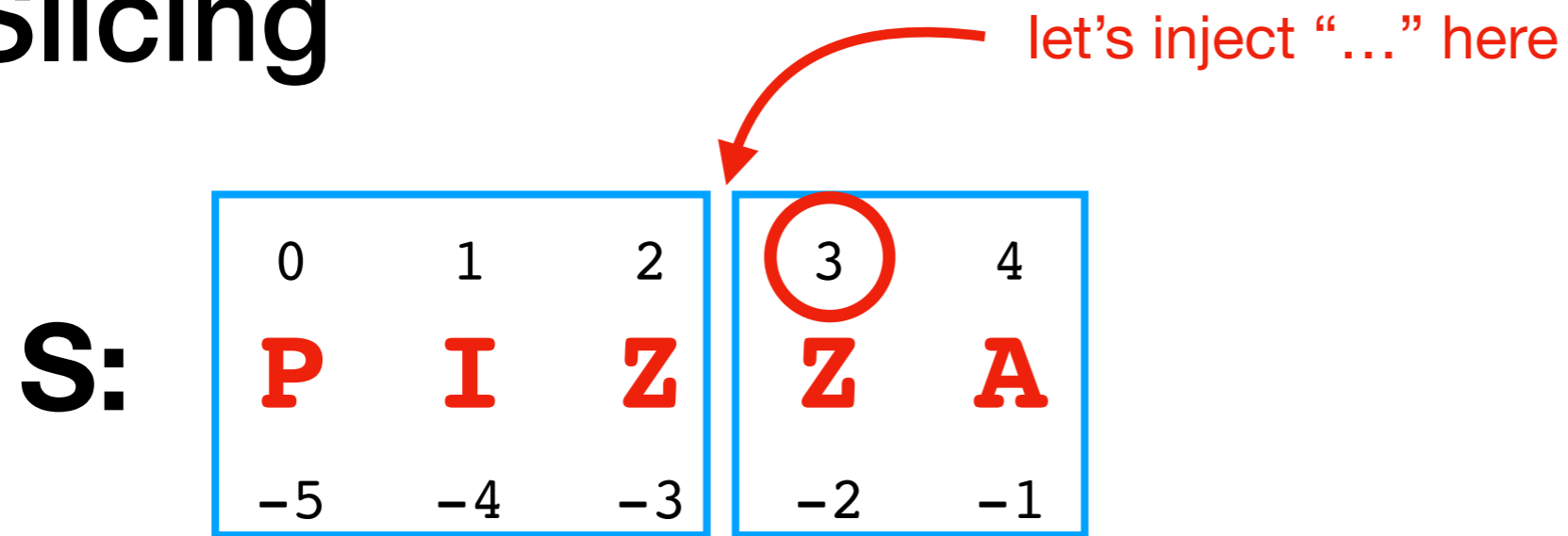
Slicing

	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



mid = 3

S[:3] + "...” + S[3:]  **“PIZ...ZA”**

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

Do problem 4

Sequences

In Python, data is often organized in sequences. A sequence is a series of items, in order

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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

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

the sequence (e.g., “hello”)

**for
loop**

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

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

for syntax

do PythonTutor example

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

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

for
loop

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

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

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for loop over sequence

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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



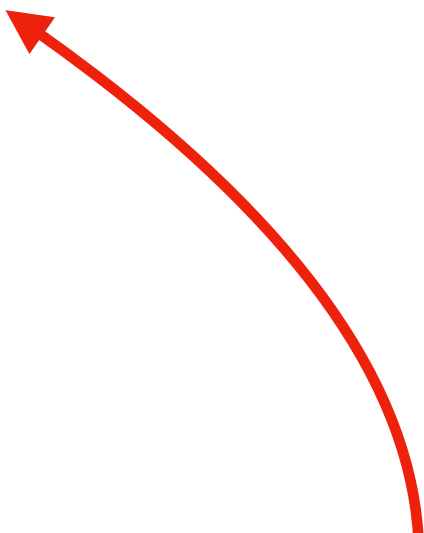
what if we want to iterate over the integers
0 to 4 (instead of string digits "0" to "4")?

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

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

```
N = project.getNumRecords()
```

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

```
N = project.getNumRecords()
```

```
for i in range(N):  
    print(i)
```

Output:

0

1

2

...

527

528

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

```
N = project.getNumRecords()
```

```
for i in range(N):  
    name = project.getName(i)  
    print(name)
```

Output:
HEIDI
OLAF
TINA
...
GAIL
KENNETH

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

```
target = "OLAF"
```

```
N = project.getNumRecords()
```

```
for i in range(N):  
    name = project.getName(i)  
    print(name)
```

Output:
HEIDI
OLAF
TINA
...
GAIL
KENNETH

Example

Hypothetically... Let's say somebody gave you a bunch of hurricanes that are each given an index, and you're searching one with a given name.

```
target = "OLAF"  
N = project.getNumRecords()  
  
for i in range(N):  
    name = project.getName(i)  
    if name == target:  
        print("found " + name)
```

Output:
found OLAF

Do problem 6