



# Strings

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## **Introduction to Programming and Problem Solving**

Erdogan Dogdu

Computer Science Department / Angelo State University



# String Data Type

- A **string** is a sequence of characters
- A string literal uses **quotes**  
'Hello' or "Hello"
- For strings, **+** means "**concatenate**"
- When a string contains numbers, it is still a string
- We can **convert** numbers in a string into a number using **int()**

```
>>> str1 = "Hello"
>>> str2 = 'there'
>>> bob = str1 + str2
>>> print(bob)
Hellothere
>>> str3 = '123'
>>> str3 = str3 + 1
Traceback (most recent call
last):  File "<stdin>", line 1,
in <module>
TypeError: cannot concatenate
'str' and 'int' objects
>>> x = int(str3) + 1
>>> print(x)
124
>>>
```

# Reading and Converting

- Python reads data in using **strings** and then we parse and **convert** the data as we need
- This gives us more control over error situations and/or bad user input
- Input **numbers** must be **converted** from strings using **int()** or **float()**

```
>>> name = input('Enter:')
Enter:Chuck
>>> print(name)
Chuck
>>> apple = input('Enter:')
Enter:100
>>> x = apple - 10
Traceback (most recent call
last):  File "<stdin>", line 1,
in <module>
TypeError: unsupported operand
type(s) for -: 'str' and 'int'
>>> x = int(apple) - 10
>>> print(x)
90
```

# Looking Inside Strings

b	a	n	a	n	a
0	1	2	3	4	5

- We can get at any single character in a string using an **index** specified in **square brackets**
- The **index** value must be an integer and **starts at zero**
- The index value can be an **expression** that is computed

```
>>> fruit = 'banana'
>>> letter = fruit[1]
>>> print(letter)
a
>>> x = 3
>>> w = fruit[x - 1]
>>> print(w)
n
```

# A character too far

- You will get a **python error** if you attempt to **index beyond the end of a string**
- So be careful when constructing index values and slices

```
>>> zot = 'abc'
>>> print(zot[5])
Traceback (most recent
call last):  File
"<stdin>", line 1, in
<module>
IndexError: string index
out of range
>>>
```

# Strings have length

- The built-in function `len()` gives us the `length` of a string

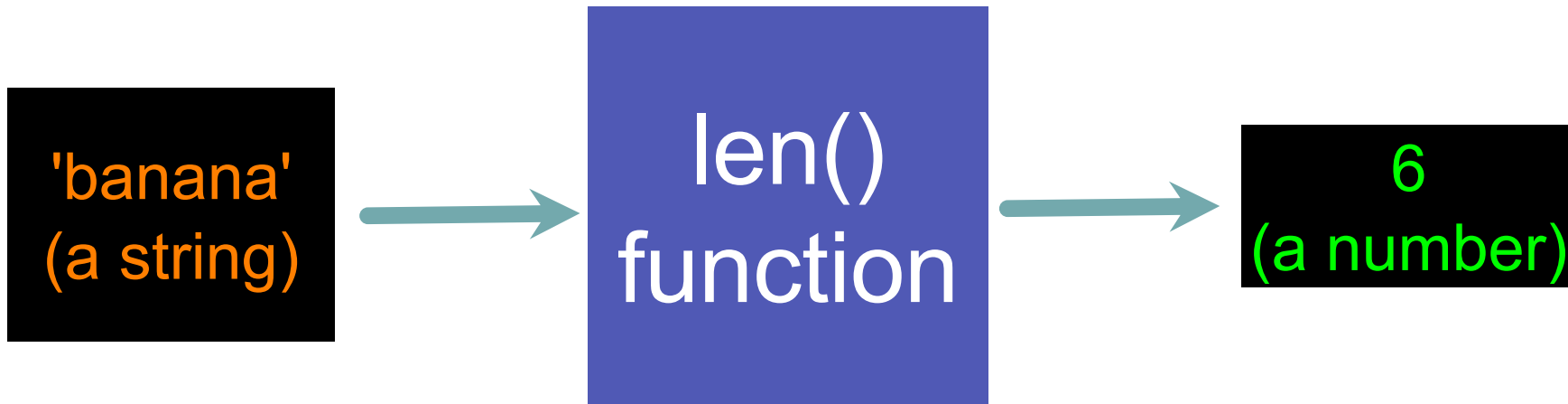
b	a	n	a	n	a
0	1	2	3	4	5

```
>>> fruit = 'banana'
>>> print(len(fruit))
6
```

# len() function

```
>>> fruit = 'banana'
>>> x = len(fruit)
>>> print(x)
6
```

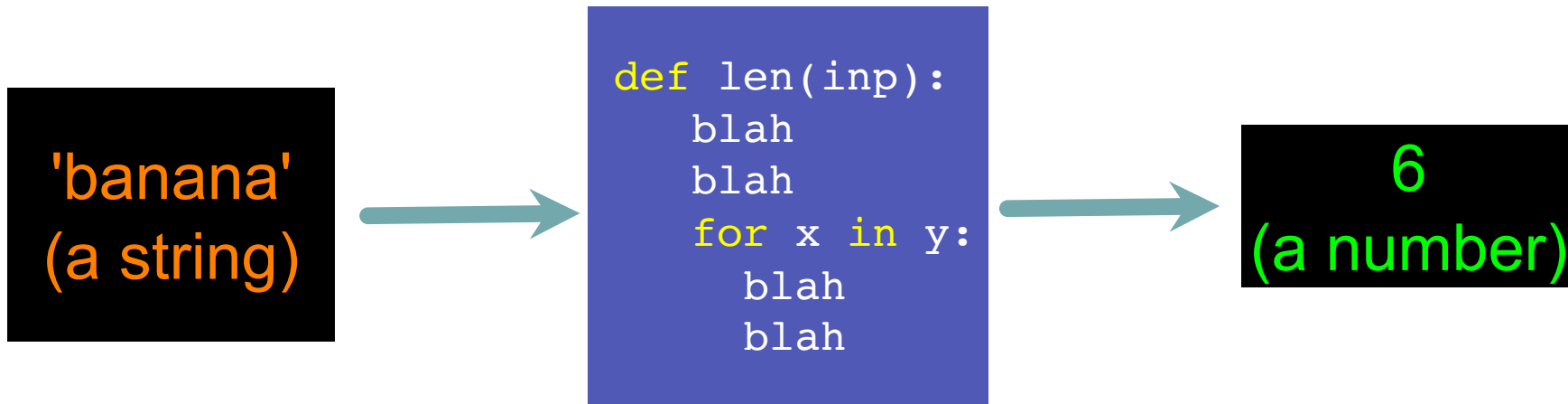
A function is some stored code that we use. A function takes some input and produces an output.



# len() function

```
>>> fruit = 'banana'
>>> x = len(fruit)
>>> print(x)
6
```

A function is some stored code that we use. A function takes some input and produces an output.





# Looping through string characters

- Using a while statement, an **iteration variable**, and the **len** function, we can construct a loop to look at each of the letters in a string individually

```
fruit = 'banana'
index = 0
while index < len(fruit):
    letter = fruit[index]
    print(index, letter)
    index = index + 1
```

```
0 b
1 a
2 n
3 a
4 n
5 a
```

# Looping through string characters (2)

- A **definite loop** using a **for** statement is much more elegant
- The **iteration variable** is completely taken care of by the for loop

```
fruit = 'banana'  
for letter in fruit:  
    print(letter)
```

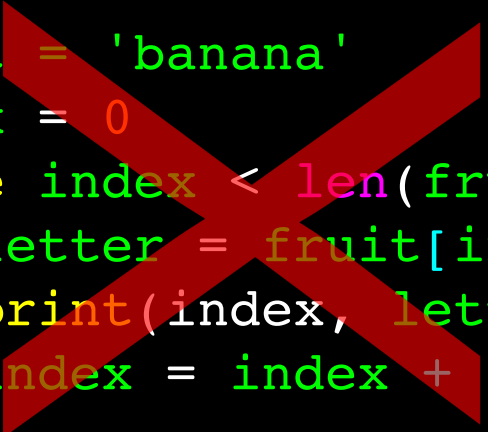
b  
a  
n  
a  
n  
a

# Looping through string characters (2)

- A **definite loop** using a **for** statement is much more **elegant**
- The **iteration variable** is completely taken care of by the for loop

```
fruit = 'banana'
for letter in fruit:
    print(letter)
```

```
fruit = 'banana'
index = 0
while index < len(fruit):
    letter = fruit[index]
    print(index, letter)
    index = index + 1
```



b  
a  
n  
a  
n  
a

# Looping and counting

- This is a simple loop that loops through each letter in a string and counts the number of times the loop encounters the 'a' character

```
word = 'banana'
count = 0
for letter in word :
    if letter == 'a' :
        count = count + 1
print(count)
```

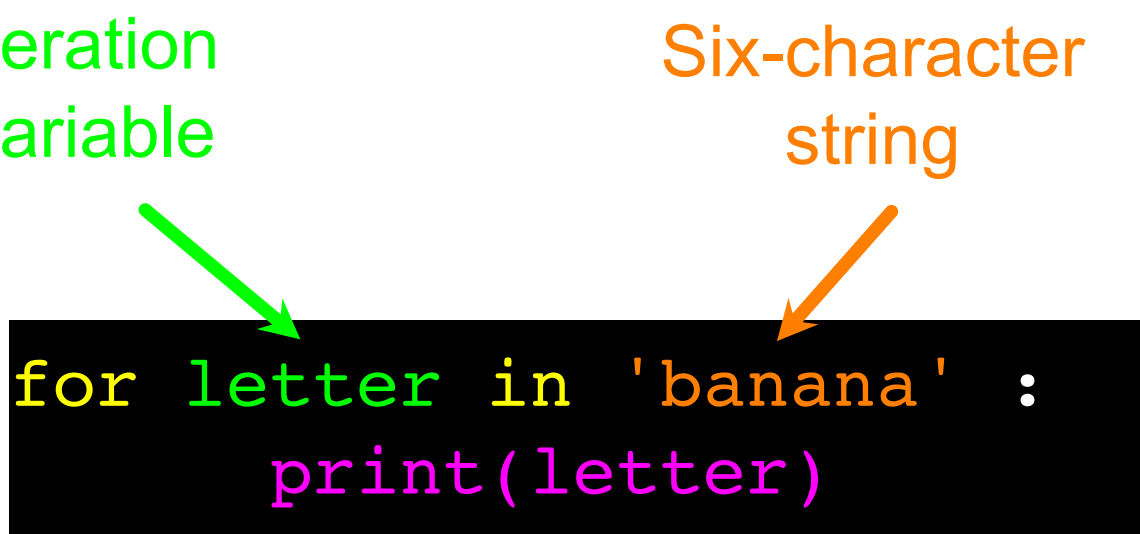
3

# Looking deeper into in

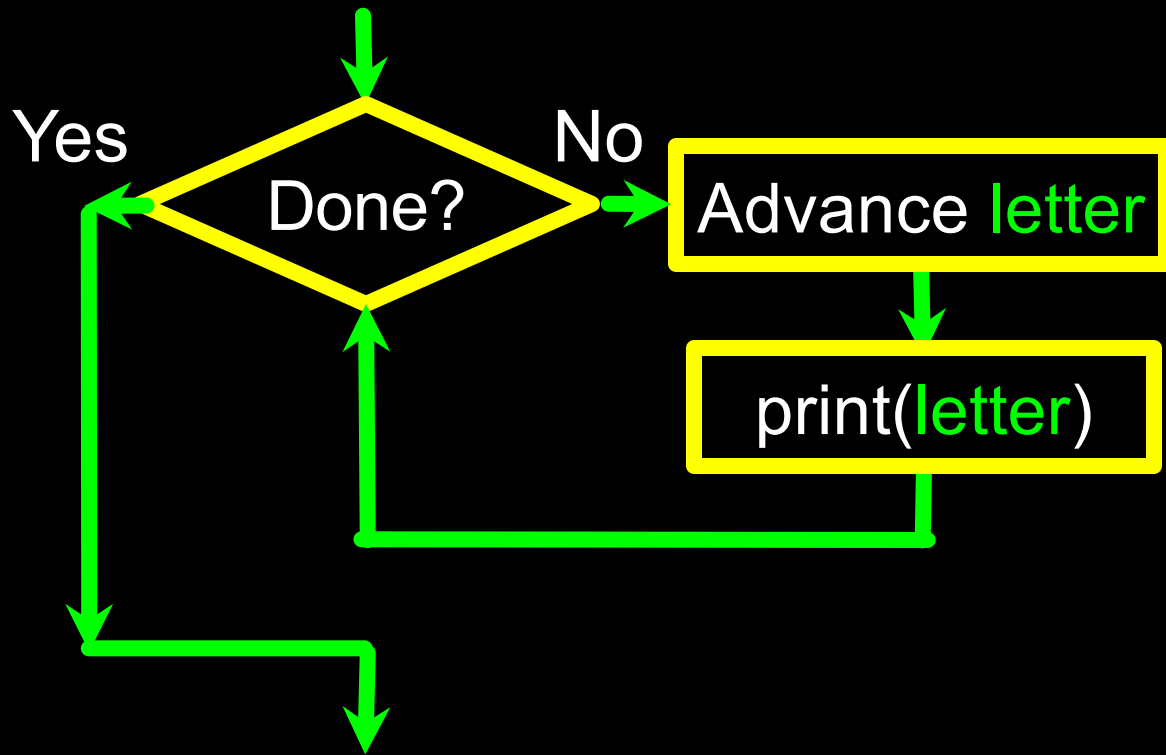
- The **iteration variable** “iterates” through the sequence (ordered set)
- The **block (body) of code** is executed once for each value in the **sequence**
- The **iteration variable** moves through all of the values in the **sequence**

Iteration  
variable

Six-character  
string



```
for letter in 'banana' :  
    print(letter)
```



b	a	n	a	n	a
---	---	---	---	---	---

```
for letter in 'banana' :  
    print(letter)
```

The **iteration variable** “iterates” through the **string** and the **block (body)** of code is executed once for each value **in** the **sequence**

# More string operations

# Slicing strings

M	o	n	t	y		P	y	t	h	o	n
0	1	2	3	4	5	6	7	8	9	10	11

- We can also look at any continuous section of a string using a **colon operator**
- The second number is one beyond the end of the slice - "**up to but not including**"
- If the second number is beyond the end of the string, it stops at the end

```
>>> s = 'Monty Python'
>>> print(s[0:4])
Mont
>>> print(s[6:7])
P
>>> print(s[6:20])
Python
```



## Slicing strings (2)

M	o	n	t	y		P	y	t	h	o	n
0	1	2	3	4	5	6	7	8	9	10	11

- If we leave off the first number or the last number of the slice, it is assumed to be the beginning or end of the string respectively

```
>>> s = 'Monty Python'
>>> print(s[:2])
Mo
>>> print(s[8:])
thon
>>> print(s[:])
Monty Python
```

# String concatenation

- When the `+` operator is applied to strings, it means "concatenation"

```
>>> a = 'Hello'
>>> b = a + 'There'
>>> print(b)
HelloThere
>>> c = a + ' ' + 'There'
>>> print(c)
Hello There
>>>
```

# Using `in` as a logical operator

- The `in` keyword can also be used to check to see if **one string is "in" another string**
- The `in` expression is a logical expression that returns **True** or **False** and **can be used in an if statement**

```
>>> fruit = 'banana'
>>> 'n' in fruit
True
>>> 'm' in fruit
False
>>> 'nan' in fruit
True
>>> if 'a' in fruit :
...     print('Found it!')
...
Found it!
>>>
```

# String comparison

```
if word == 'banana':  
    print('All right, bananas.')  
if word < 'banana':  
    print('Your word,' + word + ', comes before banana.')elif word > 'banana':  
    print('Your word,' + word + ', comes after banana.')else:  
    print('All right, bananas.')
```

# String library

- Python has a number of string **functions** which are in the **string library**
- These functions are already **built into** every string - we invoke them by appending the function to the string variable
- These **functions** do not modify the original string, instead they **return a new string** that has been altered

```
>>> greet = 'Hello Bob'
>>> zap = greet.lower()
>>> print(zap)
hello bob
>>> print(greet)
Hello Bob
>>> print('Hi There'.lower())
hi there
>>>
```

```
>>> stuff = 'Hello world'
>>> type(stuff)
<class 'str'>
>>> dir(stuff)
['capitalize', 'casefold', 'center', 'count', 'encode',
'endswith', 'expandtabs', 'find', 'format', 'format_map',
'index', 'isalnum', 'isalpha', 'isdecimal', 'isdigit',
'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace',
'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip',
'maketrans', 'partition', 'replace', 'rfind', 'rindex', 'rjust',
'rpartmention', 'rsplit', 'rstrip', 'split', 'splitlines',
'startswith', 'strip', 'swapcase', 'title', 'translate', 'upper',
'zfill']
```

<https://docs.python.org/3/library/stdtypes.html#string-methods>

**str.replace(*old*, *new*[, *count*])**

Return a copy of the string with all occurrences of substring *old* replaced by *new*. If the optional argument *count* is given, only the first *count* occurrences are replaced.

**str.rfind(*sub*[, *start*[, *end*]])**

Return the highest index in the string where substring *sub* is found, such that *sub* is contained within `s[start:end]`. Optional arguments *start* and *end* are interpreted as in slice notation. Return `-1` on failure.

**str.rindex(*sub*[, *start*[, *end*]])**

Like `rfind()` but raises `ValueError` when the substring *sub* is not found.

**str.rjust(*width*[, *fillchar*])**

Return the string right justified in a string of length *width*. Padding is done using the specified *fillchar* (default is an ASCII space). The original string is returned if *width* is less than or equal to `len(s)`.

**str.rpartition(*sep*)**

Split the string at the last occurrence of *sep*, and return a 3-tuple containing the part before the separator, the separator itself, and the part after the separator. If the separator is not found, return a 3-tuple containing two empty strings, followed by the string itself.

**str.rsplit(*sep=None*, *maxsplit=-1*)**

Return a list of the words in the string, using *sep* as the delimiter string. If *maxsplit* is given, at most *maxsplit* splits are done, the *rightmost* ones. If *sep* is not specified or `None`, any whitespace string is a separator. Except for splitting from the right, `rsplit()` behaves like `split()` which is described in detail below.

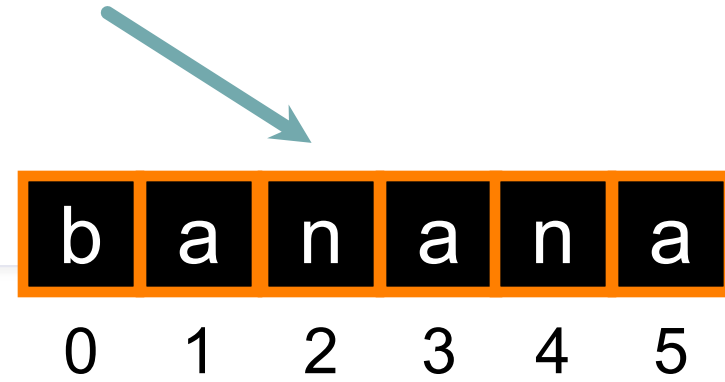
# String library

```
str.capitalize()  
str.title()  
str.center(width[, fillchar])  
str.endswith(suffix[, start[, end]])  
str.find(sub[, start[, end]])  
str.lstrip([chars])
```

```
str.replace(old, new[, count])  
str.lower()  
str.rstrip([chars])  
str.strip([chars])  
str.upper()
```



# Searching a string



- We use the `find()` function to search for a substring within another string
- `find()` finds the first occurrence of the substring
- If the substring is **not found**, `find()` returns `-1`
- Remember that string position starts at zero (0)

```
>>> fruit = 'banana'
>>> pos = fruit.find('na')
>>> print(pos)
2
>>> aa = fruit.find('z')
>>> print(aa)
-1
```

# Making everything UPPER CASE

- You can make a copy of a string in **lower case** or **upper case**
- Often when we are searching for a string using **find()** we first convert the string to **lower case** so we can search a string regardless of case

```
>>> greet = 'Hello Bob'
>>> nnn = greet.upper()
>>> print(nnn)
HELLO BOB
>>> www = greet.lower()
>>> print(www)
hello bob
>>>
```

# Search and replace

- The `replace()` function is like a “search and replace” operation in a word processor
- It **replaces all occurrences** of the search string with the replacement string

```
>>> greet = 'Hello Bob'
>>> nstr = greet.replace('Bob', 'Jane')
>>> print(nstr)
Hello Jane
>>> nstr = greet.replace('o', 'x')
>>> print(nstr)
HellX Bxb
>>>
```

# Stripping whitespace

- Sometimes we want to take a string and **remove whitespace at the beginning and/or end**
- **lstrip()** and **rstrip()** remove whitespace at the left or right
- **strip()** removes both beginning and ending whitespace

```
>>> greet = '    Hello Bob    '
>>> greet.lstrip()
'Hello Bob    '
>>> greet.rstrip()
'    Hello Bob'
>>> greet.strip()
'Hello Bob'
>>>
```

# Prefixes

```
>>> line = 'Please have a nice day'
>>> line.startswith('Please')
True
>>> line.startswith('p')
False
```

# Parsing and extracting

18

29

From erdogan.dogdu@angelo.edu Sat Jan 5 09:14:16 2008

```
>>> data = 'From erdogan.dogdu@angelo.edu Sat Jan 5 09:14:16 2008'
>>> atpos = data.find('@')
>>> print(atpos)
18
>>> sppos = data.find(' ', atpos)
>>> print(sppos)
29
>>> host = data[atpos+1 : sppos]
>>> print(host)
angelo.edu
```

# Two kinds of strings

Python 2.7.10

```
>>> x = '이광춘'
>>> type(x)
<type 'str'>
>>> x = u'이광춘'
>>> type(x)
<type 'unicode'>
>>>
```

Python 3.5.1

```
>>> x = '이광춘'
>>> type(x)
<class 'str'>
>>> x = u'이광춘'
>>> type(x)
<class 'str'>
>>>
```

In Python 3, all strings are Unicode

# Summary

- String type
- Read/Convert
- Indexing strings []
- Slicing strings [2:4]
- Looping through strings with for and while
- Concatenating strings with +
- String operations
- String library
- String comparisons
- Searching in strings
- Replacing text
- Stripping white space



# Problems

- Write the following functions:
  - **countWords**: counts the words in a string
  - **printCol**: given a string and column size, prints the string as a column of characters in the given column size
  - **rightJust**: given a string and a width, returns the string right-justified for the given width
    - Same as rjust built-in function, but do not use rjust to implement 😊

# Problem

Following code reads all of Shakespeare's works in text:

```
import urllib.request
```

```
req = urllib.request.Request('http://www.gutenberg.org/files/100/100-0.txt')
```

```
with urllib.request.urlopen(req) as response:
```

```
    the_page = response.read().decode("utf-8")
```

- Count how many times the word 'love' is used (any case)?
  - Answer: 2752
- How many words start with 'love' (any case):
  - Answer: 5695

# Hints

```
>>> str = 'One Fish, Two Fish, Red Fish, Blue Fish.'
>>> str = str.lower()
>>> str
'one fish, two fish, red fish, blue fish.'
>>> list = str.split()
>>> list
['one', 'fish,', 'two', 'fish,', 'red', 'fish,', 'blue', 'fish.']
>>> len(list)
8
```

```
>>> list[3]
'fish,'
>>> list[3].startswith('fi')
True
```

# Acknowledgements / Contributions



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- Initial Development: Charles Severance, University of Michigan School of Information
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