1. The Assignment Statement and Types

Topics:
- Python's Interactive Mode
- Variables
- Expressions
- Assignment
- Strings, Ints, and Floats

The Python Interactive Shell

Python can be used in a way that reminds you of a calculator. In the `` command shell of your system simply type

```
python
```

and you will be met with a prompt…

```
>>>
```

Let's Compute the Area of a Circle Using Python

```
>>> r = 10
>>> A = 3.14*r*r
>>> print A
314.0
```

Programming vs Math

```
>>> r = 10
>>> A = 3.14*r*r
>>> print A
314.0
```

Notation is different.

In Python, you can't say A = 3.14xrxr

Programming vs Math

```
>>> r = 10
>>> A = 3.14*r**2
>>> print A
314.0
```

Notation is different.

In Python you indicate exponentiation with **

Programming vs Math

```
>>> r = 10
>>> A = 3.14*r**2
>>> print A
314.0
```

`r` and `A` are variables. In algebra, we have the notion of a variable too. But there are some big differences.

Variables

```
>>> r = 10
>>> A = 3.14*r**2
```

r -> 10 A -> 314.0

A variable is a named memory location. Think of a variable as a box.
It contains a value. Think of the value as the contents of the box.

" The value of r is 10. The value of A is 314.0."

The Assignment Statement

```
>>> r = 10
```

r -> 10

The "=" symbol indicates assignment.
The assignment statement r = 10 creates the variable r and assigns to it the value of 10.

Formal: " r is assigned the value of 10" Informal: "r gets 10"

The Assignment Statement

```
>>> r = 10
>>> A = 3.14*r**2
```

r -> 10 A -> 314.0

A variable can be used in an expression like 3.14*r**2.
The expression is evaluated and then stored.

Assignment Statement: WHERE TO PUT IT = RECIPE FOR A VALUE

Order is Important

```
>>> A = 3.14*r**2
>>> r = 10
NameError: name 'r' is not defined
```

Math is less fussy:

A = 3.14*r**2 where r = 10

Assignment vs. "Is Equal to"

```
>>> r = 10
>>> 3.14*r**2 = A
SyntaxError: can't assign to an
operator
```

In Math "=" is used to say what is on the left equals what is on the right.

In Python, "=" prescribes an action, "evaluate the expression on the right and assign its value to the variable named on the left."

The Assignment Statement

```
>>> r = 10
>>> A = 3.14*r**2
>>> S = A/2
```

r -> 10
A -> 314.0
S -> 157.0

Here we are assigning to S the area of a semicircle that has radius 10.

Assignment Statement: WHERE TO PUT IT = RECIPE FOR A VALUE

The Assignment Statement

```
>>> r = 10
>>> A = 3.14*r**2
>>> A = A/2
```

r -> 10

A -> 157.0

Here we are assigning to A the area of a semicircle that has radius 10.

No new rules in the third assignment. The "recipe" is A/2. The target of the assignment is A.

"A has been overwritten by A/2"

Tracking Updates

```
>>> y = 100
```

Before:

Tracking Updates

```
>>> y = 100
```

After:

y -> 100

Tracking Updates

```
>>> y = 100
>>> t = 10
```

Before:

y -> 100

Tracking Updates

```
>>> y = 100
>>> t = 10
```

After:

y -> 100

t -> 10

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
```

Before:

y -> 100

t -> 10

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
```

After:

y -> 110

t -> 10

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
```

Before:

y -> 110

t -> 10

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
```

After:

y -> 110

t -> 20

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10;
>>> y = y+t
```

Before:

y -> 110

t -> 20

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10;
>>> y = y+t
```

After:

y -> 130

t -> 20

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
>>> y = y+t
>>> t = t+10
```

Before:

y -> 130

t -> 20

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
>>> y = y+t
>>> t = t+10
```

After:

y -> 130

t -> 30

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
>>> y = y+t
>>> t = t+10
>>> y = y+t
```

Before:

y -> 130

t -> 30

Tracking Updates

```
>>> y = 100
>>> t = 10
>>> y = y+t
>>> t = t+10
>>> y = y+t
>>> t = t+10
>>> y = y+t
```

After:

y -> 160

t -> 30

Assignment vs Equations

In algebra,

t = t +10

doesn't make sense unless you believe

0 =t-t = 10

In Python,

`t = t + 10`

means add 10 to the value of t and store the result in t.

The Key 2-Step Action Behind Every Assignment Statement

< *variable name* > = < *expression* >

1. Evaluate the expression on the right hand side.
2. Store the result in the variable named on the left hand side.

Naming Variables

```
>>> radius = 10
>>> Area = 3.14*radius**2
```

radius -> 10 Area -> 314.0

Rule 1. Name must be comprised of digits, upper case letters, lower case letters, and the underscore character "_"

Rule 2. Must begin with a letter or underscore

A good name for a variable is short but suggestive of its role: `Circle_Area`

Precedence

Q. In an arithmetic expression, what is the order of evaluation?

A. Exponentiation & negation comes before multiplication & division which in turn come before addition & subtraction.

This:	Is the same as:
`A + B*C`	`A + (B*C)`
`-A**2/4`	`-(A**2)/4`
`A*B/C*D`	`((A*B)/C)*D`

It is a good habit to use parentheses if there is the slightest ambiguity.

Revisit Circle Area

```
>>> r = 10
>>> A = (22/7)*r**2
>>> print A
300.0
```

It seems that Python evaluates (22/7) as 3 instead of 3.142… WHY?

A different kind of arithmetic. We have a related experience here. 11+3 = 2 in "clock arithmetic"

Integers and Decimals

In math we distinguish between integer numbers and decimal numbers.

Integer Numbers:

100, 0, -89, 1234567

Decimal Numbers:

-2.1, 100.01, 100.0, 12.345

Integers and Decimals

There are different kinds of division.

Integer Division:

30/8 is 3 with a remainder of 6

Decimal Division:

30/8 is 3.75

`int` vs `float`

In Python, a number has a type.

The `int` type represents numbers as integers.

The `float` type represents numbers as decimals.

Important to understand the differences and the interactions

`int` Arithmetic

```
>>> x = 30
>>> y = 8
>>> q = x/y
>>> print q
3
>>> r = x%y
>>> print r
6
```

To get the remainder, use %. Python "knows" that the values stored in x and y have type int because there are no decimal points in those assignments.

`float` Arithmetic

```
>>> x = 30.
>>> y = 8.
>>> q = x/y
>>> print q
3.75
```

Python "knows" that the values stored in x and y have type float because there are decimal points in those assignments.

Mixing `float` and `int`

```
>>> x = 30.
>>> y = 8
>>> q = x/y
>>> print q
3.75
```

In Python if one operand has type float and the other has type int, then the type int value is converted to float and the evaluation proceeds.

Explicit Type Conversion

```
>>> x = 30.0
>>> y = 8.0
>>> q = int(x)/int(y)
>>> print q
3
```

`int(` *-expression-* `)` converts the value of the expression to `int` value

Explicit Type Conversion

```
>>> x = 30
>>> y = 8
>>> q = float(x)/float(y)
>>> print q
3.75
```

`float(` *-expression-* `)` converts the value of the expression to a `float`

An Important Distinction

Integer arithmetic is exact.
Float arithmetic is (usually) not exact.

```
>>> x = 1.0/3.0
>>> print x
.333333333333
```

Strings

So far we have discussed computation with numbers.

Now we discuss computation with text.

We use strings to represent text.

You are a "string processor" when you realize 7/4 means July 4 and not 1.75!

Strings

Strings are quoted characters. Here are three examples:

```
>>> s1 = 'abc'
>>> s2 = 'ABC'
>>> s3 = ' A B C '
```

`s1`, `s2`, and `s3` are variables with string value.

Strings

Strings are quoted characters. Here are three examples:

```
>>> s1 = 'abc'
>>> s2 = 'ABC'
>>> s3 = ' A B C '
```

The values in `s1`,`s2`,and `s3` are all different. Upper and lower case matters. Blanks matter

Strings

Nothing special about letters…

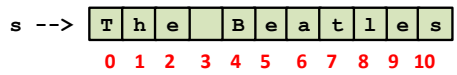
```
>>> Digits = '1234567890'
>>> Punctuation = '!:;.?'
>>> Special = @#$%^&*()_-+='
```

Basically any keystroke but there are some exceptions and special rules. More later.

Here is one: `'Sophie"'"s Choice'` i.e., Sophie's Choice

Strings are Indexed

```
>>> s = 'The Beatles'
```

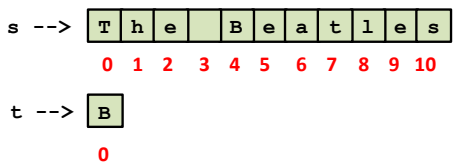


The characters in a string can be referenced through their indices. Called "subscripting".

Subcripting from zero creates a disconnect: 'T' is not the first character.

Strings are Indexed

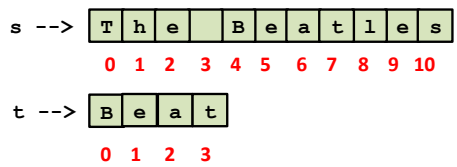
```
>>> s ='The Beatles'
>>> t = s[4]
```



The square bracket notation is used. Note, a single character is a string.

String Slicing

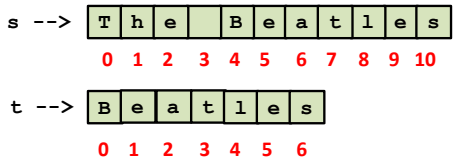
```
>>> s ='The Beatles'
>>> t = s[4:8]
```



We say that "t is a slice of s".

String Slicing

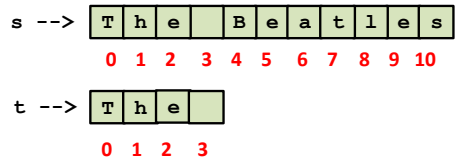
```
>>> s ='The Beatles'
>>> t = s[4:]
```



Same as `s[4:11]`. Handy notation when you want an "ending slice."

String Slicing

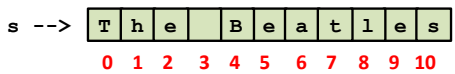
```
>>> s ='The Beatles'
>>> t = s[:4]
```



Same as `s[0:4]`. Handy notation when you want a "beginning slice".

String Slicing

```
>>> s ='The Beatles'
>>> t = s[11]
IndexError: string index out of
range
```

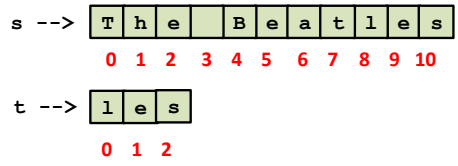


The is no s[11]. An illegal to access.

Subscripting errors are EXTREMELY common.

String Slicing

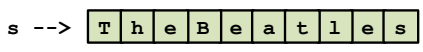
```
>>> s ='The Beatles'
>>> t = s[8:20]
```



It is "OK" to shoot beyond the end of the source string.

Strings Can Be Combined

```
>>> s1 = 'The'
>>> s2 = 'Beatles'
>>> s = s1+s2
```

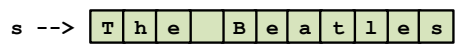


This is called concatenation.

Concatenation is the string analog of addition except

Concatenation

```
>>> s1 = 'The'
>>> s2 = 'Beatles'
>>> s = s1 + ' ' + s2
```



We "added" in a blank.

No limit to the number of input strings: `s = s2+s2+s2+s2+s2`

Types

Strings are a type: `str`

So at this point we introduced 3 types:

`int`	for integers, e.g., `-12`
`float`	for decimals, e.g., `9.12`, `-12.0`
`str`	for strings, e.g., `'abc'`, `'12.0'`

Python has other built-in types. And we will learn to make up our own types.

A Type is a Set of Values and Operations on Them

Values…

`int`	`123, -123, 0`
`float`	`1.0, -.00123, -12.3e-5`
`str`	`'abcde', '123.0'`

These are called "literals"

The "e" notation (a power-of-10 notation) is handy for very large or very small

A Type is a Set of Values and Operations on Them

Operations…

`int`	`+ - * / unary- ** %`
`float`	`+ - * / unary- **`
`str`	`+`

concatenation

Type Conversion

```
>>> s = '123.45'
>>> x = 2*float(s)
>>> print x
246.90
```

A string that encodes a decimal value can be represented as a `float`.

Type Conversion

```
>>> s = '-123'
>>> x = 2*int(s)
>>> print x
-246
```

A string that encodes an integer value can be represented as an `int`.

Type Conversion

```
>>> x = -123.45
>>> s = str(x)
>>> print s
'-123.45'
```

Shows how to get a string encoding of a float value.

Automatic Type Conversion

```
>>> x = 1/2.0
>>> y = 2*x
```

An operation between a `float` and an `int` results in a `float`. So `x` is a `float`.

Thus, `y` is also a `float` even though its value happens to be an integer.

Python is a Dynamically Typed Language

A variable can hold different types of values at different times.

```
>>> x = 'abcde'
>>> x = 1.0
>>> x = 32
```

In other languages the type of a variable is fixed.

Summary

1. Variables house values that can be accessed.
2. Assignment statements assign values to variables.
3. Numerical data can be represented using the `int` and `float` types.
4. Text data can be represented using the `str` type.