Getting Started With Python Programming: Part 2

- Getting information from the user (input)
- How information is stored, converting between different types
- Formatting text output

Input

- The computer program getting *string information* from the user.
- Strings cannot be used for calculations (information for getting numeric input will provided shortly).

- **Format:**

```
<variable name> = input()
        OR
<variable name> = input("<Prompting message>")
```

- **Name of the full example:** `8input.py`

```
print("What is your name: ")
name = input()
        OR
name = input("What is your name: ")
        OR
print("What is your name: ", end="")
name = input()
```

Avoid alignment issues such as this

```
What is your name:
foo

What is your name: foo

What is your name: foo
```

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Variables: Storing Information (If There Is Time)

- On the computer all information is stored in binary (2 states)
  - Example: RAM/memory stores information in a series of on-off combinations
  - A single off/off combination is referred to as a 'bit'

Bit  on OR off 

Byte

•8 bits 

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Variables: Storing Information (If There Is Time)

- Information must be converted into binary to be stored on a computer.

User enters 13 ⟶ Can be stored as 

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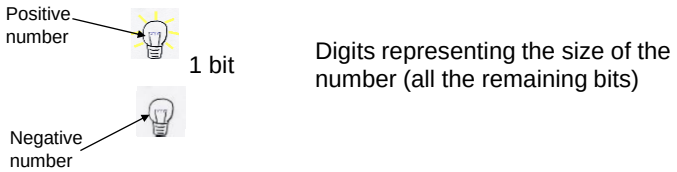
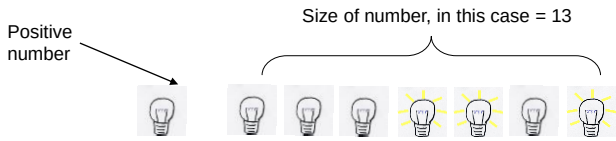
Storing Integer Information (If There Is Time)

- 1 bit is used to represent the sign, the rest is used to store the size of the number
  - Sign bit: 1/on = negative, 0/off = positive
- **Format:**



- **Previous example**



slide 5

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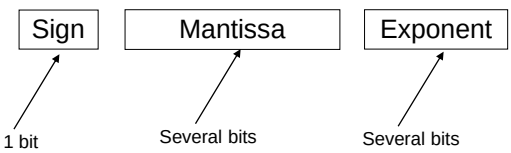
Storing Real Numbers In The Form Of Floating Point (If There Is Time)



  - Mantissa: digits of the number being stored
  - Exponent: the direction (negative = left, positive=right) and the number of places the decimal point must move ('float') when storing the real number as a floating point value.
- Examples with 5 digits used to represent the mantissa:
  - e.g. One: 123.45 is represented as $12345 * 10^{-2}$
  - e.g. Two: 0.12 is represented as $12000 * 10^{-5}$
  - e.g. Three: 123456 is represented as $12345 * 10^{1}$
- Remember: Using floating point numbers may result in a loss of accuracy (the float is an approximation of the real value to be stored).

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Storing Character Information (If There Is Time)

- Typically characters are encoded using ASCII
- Each character is mapped to a numeric value
  - E.g., 'A' = 65, 'B' = 66, 'a' = 97, '2' = 50
- These numeric values are stored in the computer using binary

Character	ASCII numeric code	Binary code
'A'	65	01000001
'B'	66	01000010
'a'	97	01100001
'2'	50	00110010

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Storing Information: **Bottom Line**

- Why it important to know that different types of information is stored differently?
  - One motivation: sometimes students don't why it's significant that "123" is not the same as the number 123.
  - Certain operations only apply to certain types of information and can produce errors or unexpected results when applied to other types of information.
- **Example**

```
num = input("Enter a number")
numHalved = num / 2
```

Use something like this at first
aStr1 = "12"
aNum1 = 12
aNum1 = aNum1 * 2
aStr1 = aStr1 * 2
print(aNum1)
print(aStr1)

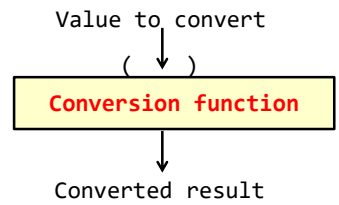
Converting Between Different Types Of Information

- Example motivation: you may want numerical information to be stored as a string (for built in string functions e.g., check if a string consists only of numbers) but also you want to perform calculations).
- Some of the conversion mechanisms (functions) available in Python:

Format:

```
int(<value to convert>)
float(<value to convert>)
str(<value to convert>)
```

Digits right of decimal are removed (truncation - no rounding)



Examples:

Name of the full example: 9convert.py

```
var1 = 10.9
var2 = int(var1)
print(var1,var2)
```

```
10.9 10
```

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Overloaded Operators

- The same symbol can have different results depending upon the context.
- Example: the 'plus' operator +
  - Previously this symbol represented mathematical addition because the values left and right of the symbol (operands) were numeric e.g.,

    ```
    num1 = 2 + 2
    ```
  - If the operands are strings then the symbol represents the string operation concatenation e.g.,

    ```
    str1 = "2" + "2"
    ```

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Overloaded Operators (2)

- **Name of the full example:** 10overloaded_operator.py

```
num1 = 2 + 2
str1 = "2" + "2"
print("Addition:", num1)
print("Concatenation:", str1)

#Error cannot perform a concatenation on a number
str2 = "2" + 2
```

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Converting Between Different Types Of Information (2)

Examples:

Name of the full example: 11convert.py

```
var1 = "100"
var2 = "-10.5"
print(var1 + var2)
print(int(var1) + float(var2))
```

```
100-10.5
89.5
```

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Converting Types: Extra Practice For Students

- Determine the output of the following program:

```
print(12+33)
print("12"+"33")
x = 12
y = 21
print(x+y)
print(str(x)+str(y))
```

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Converting Between Different Types Of Information: Getting Numeric Input

- The '`input()`' function only returns a string so the value returned must be converted to the appropriate type as needed.
  - **Name of the full example:** `12convert.py`

```
# No conversion performed: problem!
HUMAN_CAT_AGE_RATIO = 7
age = input("What is your age in years: ")
catAge = age * HUMAN_CAT_AGE_RATIO
print ("Age in cat years: ", catAge)
```

- 'Age' refers to a string not a number.
- The '*' is not mathematical multiplication

```
What is your age in years: 12
Age in cat years:  12121212121212
```

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Converting Between Different Types Of Information: Getting Numeric Input (2)

```
# Input converted: Problem solved!
HUMAN_CAT_AGE_RATIO = 7
ageString = input("What is your age in years: ")
ageNum = int(ageString)
catAge = ageNum * HUMAN_CAT_AGE_RATIO
print("Age in cat years: ", catAge)
```

- 'Age' converted to an integer.
- The '*' now multiplies a numeric value.

```
print("Alternative: combines 2 steps into 1")
age = int(input("What is your age in years: "))
catAge = age * HUMAN_CAT_AGE_RATIO
print("Age in cat years: ", catAge)
```

```
What is your age in years: 12
Age in cat years:  84
```

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Section Summary: Input, Representations

- How to get user input in Python
- How do the different types of variables store/represent information (optional/extra for now)
- How/why to convert between different types

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By Default Output Is Unformatted

- Example:

```
num = 1/3
print("num=",num)
```

```
num= 0.3333333333333333
```

Sometimes you get extra spaces (or blank lines)

The number of places of precision is determined by the language not the programmer

- There may be other issues e.g., you want to display output in columns of fixed width, or right/left aligned output
- There may be times that specific precision is needed in the displaying of floating point values

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Formatting Output

- Output can be formatted in Python through the use of **format specifiers** and **escape codes**

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Format Specifiers

- **Format**:

```
print ("%<placeholder for type of info to display/code>"
  %<source of the info to display>)
```

- **Example (starting with simple cases)**:
  - **Name of the full example:** `13formatting.py`

Doesn't literally display this: It's a placeholder (for information to be displayed)

```
num = 123
st = "cpsc 231"
print("num=%d"        %num)
print("course: %s"    %st)
num = 12.5
print("%f %d" %(num,num))
```

```
num=123
course: cpsc 231
12.500000 12
```

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Types Of Information That Can Be Formatted Via Format Specifiers (Placeholders)

Specifier	Type of Information to display
%s	String
%d	Integer
%f	Floating point

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Format Specifiers: Precision & Field Width

- **Precision**:
  - The number of digits to the right of the decimal point.
    - E.g. 3.14 has 2 places of precision
  - Alternate ways of specifying this term as: number of places of precision, number of fractional digits
- **Field width**:
  - Think of it as "the width of a column" (the column created for each format specifier/placeholder).
    - E.g. 1: Four column width %4s
    - E.g. 2: Ten column width %10d
  - When the column is too narrow to display the data then the column width is automatically expanded.
  - When the column is wider than the width of the data then extra spaces will be added before or after the data.
    - Space before the first "ab" and a space after the second "ab" `abab`
    - Space after the first "ab" and a space before the second "ab" `ab ab`

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Formatting Effects Using Format Specifiers

- **Format**:

  %<*field width*>[1].<*precision*>[2]<*type of information*>

- **Examples (format specifiers to format output)**:
  - **Name of the full example**: `14formatting.p`

```
num1 = 12.55
num2 = 12
str1 = "hi"
print ("%s" %str1)
print ("%3.1f" %num1)
print ("%6.1f" %num1)
print("%-5s" %num2)
print ("%3s%-3s" %("ab", "ab"))
print ("%-3s%3s" %("ab", "ab"))
```

`hi`
`12.6` (1 2 . 6)
`12.6` (<SP><SP> 1 2 . 6)
`12` (1 2 <SP><SP><SP>)
`abab` (<SP> a b a b <SP>)
`ab ab` (a b <SP> <SP> a b)

- 1 A positive integer will add leading spaces before the information to display (right align), negatives will add trailing spaces (left align). Excluding a value will set the field width to a value large enough to display the output
- 2 For numeric variables only.

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Displaying The Percent Sign[1] (If There Is Time)

- If no format specifiers are used then simply enclose the '%' within the quotes of a `print()` statement

  `print("12%")` → `12%`
- If format specifiers are used within a call to `print()` then use one percent sign to act as an escape code for another percent sign to follow

  `print("%f%%" %(100))` → `100.000000%`

1 Since the question inevitably comes up each term I'm answering it here

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One Application Of Format Specifiers

- It can be used to align columns of text.
- Example (movie credits, tabular or financial information)

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Section Summary: Formatting Output

- How to use format specifiers (field width, precision) to format output

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Escape Codes/Characters

- The back-slash character enclosed within quotes won't be displayed but instead indicates that a formatting (escape) code will follow the slash:

Escape sequence	Description
\a	Alarm: Causes the program to beep.
\n	Newline: Moves the cursor to beginning of the next line.
\t	Tab: Moves the cursor forward one tab stop.
\'	Single quote: Prints a single quote.
\"	Double quote: Prints a double quote.
\\	Backslash: Prints one backslash.

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Escape Codes (2)

- **Program name:** `15formatting.py`

print ("\a*Beep!*") → `*Beep!* (may not work through text-or`

print ("hi\nthere") →
```
hi
there
```

print ('it\'s') →
```
it's
```

print ("he\\y \"you\"") → `he\y "you"`

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Escape Codes: Application

- It can be used to nicely format text output (alignment output, provide separators within and between lines)
- **Program example**: `16formatting.py`

```
firstName = "James"
lastName = "Tam"
mobile = "123-4567"
print("Last name:\t", lastName)
print("First name:\t", firstName)
print("Contact:\t", mobile)
```

```
Last name:      Tam
First name:     James
Contact:        123-4567
```

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Section Summary: Escape Codes

- How to use escape codes to format output

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Extra Practice

- Traces:
  - Modify the examples (output using format specifiers and escape codes) so that they are still valid Python statements.
    - Alternatively you can try finding some simple ones online or from a textbook.
  - Hand trace the code (execute on paper) without running the program.
  - Then run the program and compare the actual vs. expected result.
- Program writing:
  - Write a program the will right-align text into 3 columns of data.
  - Write a program the will left-align text into 3 columns of data.

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After This Section You Should Now Know

- How to format output through:
  - The use of format specifiers
  - Escape codes

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