THE UNIVERSITY OF WESTERN AUSTRALIA

Lecture 3
Writing code in Python

Revision: Getting Started with Python

Start with single statements

```
>>> 2+3
5
>>> 22/7
3.142857142857143
>>> 3**2
9
>>> print(“Hello world”)
Hello world
>>> print(“2+3=“, 2+3)
2+3=5
```

Revision: Temperature Converter program

```
""" convert.py
 A program to convert Celsius temps to Fahrenheit
 by: Someone Programmer """

celsius = float(input("What is the Celsius temperature? "))
fahrenheit = (9/5) * celsius + 32
print("The temperature is ", fahrenheit, " degrees Fahrenheit.")
```

- Note the multiline comment at the start. It is important as it tells the maintainer:
  - What the program does
  - Statement of authorship

Revision: Testing the Program

The next step is to test the program (Press Run or green button on Thonny)

```
>>>
What is the Celsius temperature? 0
The temperature is  32.0  degrees Fahrenheit.
>>>
What is the Celsius temperature? 100
The temperature is  212.0  degrees Fahrenheit.
>>>
What is the Celsius temperature? -40
The temperature is  -40.0  degrees Fahrenheit.
>>>
```

Revision: Identifiers

- Names
  - *Names are given to:*
    - variables (e.g. celsius, fahrenheit)
    - functions (e.g. main)
    - modules (e.g. temp_converter, chaos)

    etc.
  - *These names are called identifiers*
  - *Every identifier must begin with a letter or underscore ("_"), followed by any sequence of letters, digits, or underscores.*
  - *Identifiers are case sensitive.*

Revision: Identifiers examples

- These are all different, valid names
  - *X*
  - *Spam*
  - *spam*
  - *spAm*
  - *Spam_and_Eggs*
  - *Spam_And_Eggs*
  - *_x*
  - *C3P0*

Revision: Reserved words

- Some identifiers are part of Python itself.

- These identifiers are known as *reserved words*. They are not available for you to use as a name for a variable, etc. in your program.

- `and, def, for, is, raise, assert, elif, in, print,` *etc*.

- For a complete list, see the link for more! https://www.w3schools.com/python/python_ref_keywords.asp

Revision: Expressions

- The fragments of code that produce or calculate new data values are called *expressions*.

```
(9/5) * celsius + 32
```

- Expressions are composed of literals, variables and operators
- *Literals* are used to represent a specific value, e.g. `3.9`, `-1`, `1.0`, `3.0e8`, `“Fred”`
- Two expressions can be combined with an operator to make another expression

Revision: Statement

- A standalone unit of execution that can be of one or several lines of code is called *statement*

```
fahrenheit =(9/5) * celsius + 32
```

```
print("The temperature is ",fahrenheit," degrees Fahrenheit.")
```

- Statements can include expressions

Revision: Elements of Program

```
>>> x = 5
>>> x          # This only works on interactive interpreter
5
>>> print(x)   # This works both interactive and from file
5
>>> print(spam)
Traceback (most recent call last):
  File "<pyshell#15>", line 1, in -toplevel-
    print spam
NameError: name 'spam' is not defined
>>>
```

- `NameError` is the error when you try to use a variable without first having a value having been assigned to it.

Revision: Mathematical operators

- Simpler expressions can be combined using *operators*.

- `+,   -,   *,   /, //, **`

- Spaces are irrelevant within an expression
  - *But readability!!*

- The normal mathematical precedence applies.

- `((x1 - x2) / 2*n) + (spam / k**3)` same as
  `(x1 - x2) / 2*n + spam / k**3`

Revision: Input Information

- The `input` function prints text and expects a value (actually a string typed by the user)

```
z = input('type a value ')
```

- The `int` function converts a string of digits to an integer; it will throw an exception (error) if the user did not type an integer

```
z = int(input('type a value '))
```

- The `float` function works the same way, but expects a floating (decimal) point number

Revision: Output

- Output Statements
  - *A* `print` *function can print any number of expressions (separated by commas).*
  - *Successive print statements will display on separate lines.*
  - *A bare print will print a blank line.*

Revision: *print()* function

Expression	Produces
`print(3+4)`	`7`
`print(3, 4, 3+4)`	`3 4 7`
`print()`	
`print(3 + 4)`	`7`
`print("The answer is", 3+4)`	`The answer is 7`

Functions Group Multiple Statements

- To solve a problem, we generally need to execute more than one statements.

- One way to do this is to use a *file*
- Another way to do this is to use a function

```
>>> def hello():
         print("Hello")
         print("Computers are Fun")

>>>
```

Defining Functions in Python

```
>>> def hello():
        print("Hello")
        print("Computers are Fun")

>>>
```

- The first line tells Python we are defining a new function called “hello”.
- The following lines are indented to show that they are part of the hello function. Indent must be uniform
- The blank line (hit enter/return twice) on shell lets Python know the definition is finished.

Executing, or Invoking, a Function

```
>>> def hello():
        print("Hello")
        print("Computers are Fun")

>>>
```

- Notice that nothing has happened yet! We defined the function, but we haven’t told Python to execute the function!
- A function is invoked or executed by typing its name.

```
>>> hello()
Hello
Computers are Fun
>>>
```

Brackets are important!

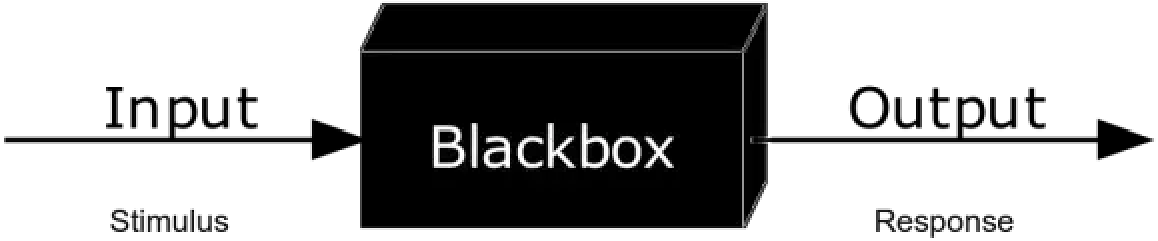
Problems with scripts (files without functions)

- In the scripts we have seen, the entire script consists of just one "block" of statements, executed in order – but this can become unmanageable when your script is thousands of lines long, contained in just one file.
- You may want to use previously written code in other programs. But cutting and pasting bits of code can create inadvertent variable name clashes.
- Scripts are not as flexible as we would like.
- How to address this?

A general problem solving technique is to break down complex problems into smaller, more manageable tasks: *divide and conquer*

Functions help us to avoid those problems

Functions as black box



Input

Blackbox

Output

Stimulus

Response

Functions can take Inputs (Parameters)

- Functions can have changeable parts called parameters that are placed between the brackets.
- The function “hello” did not need any parameters.
- Here is another function that has one parameter.

```
>>> def greet(person):
      print("Hello", person)
      print ("How are you?")

>>>
```

Invoking a Function that has parameter(s)

- A function that has parameters requires arguments
- If we try to execute the function `greet()`

```
>>> greet()
Traceback (most recent call last):
  File "<pyshell#74>", line 1, in <module>
    greet()
TypeError: greet() takes exactly 1 argument (0 given)
```

- It gives us an error because we did not specify a value for the parameter “person”

Passing Parameters to Functions

```
>>> greet("Terry")
Hello Terry
How are you?
>>> greet("Paula")
Hello Paula
How are you?
>>>
```

- When we use parameters, we can customize the output of a function.

Why You need to Use Functions

- Define once, use many times
  - *Replace repeated code sections with a parameterized function*
- Aids problem decomposition
  - *Even if code is used just once, helps break problem into smaller, manageable pieces*
  - *Like sections and paragraphs in a paper, or chapters and paragraphs in a story*
- Defining code as functions allows independent testing/validation of code

Functions in a file

- When we exit the Python interpreter, all functions that we defined will cease to exist.
- How about writing them in a file and saving it.
  - *Saves a **LOT** of retyping*
- A *programming environment* is designed to help programmers write programs and usually include automatic indenting, highlighting, etc.

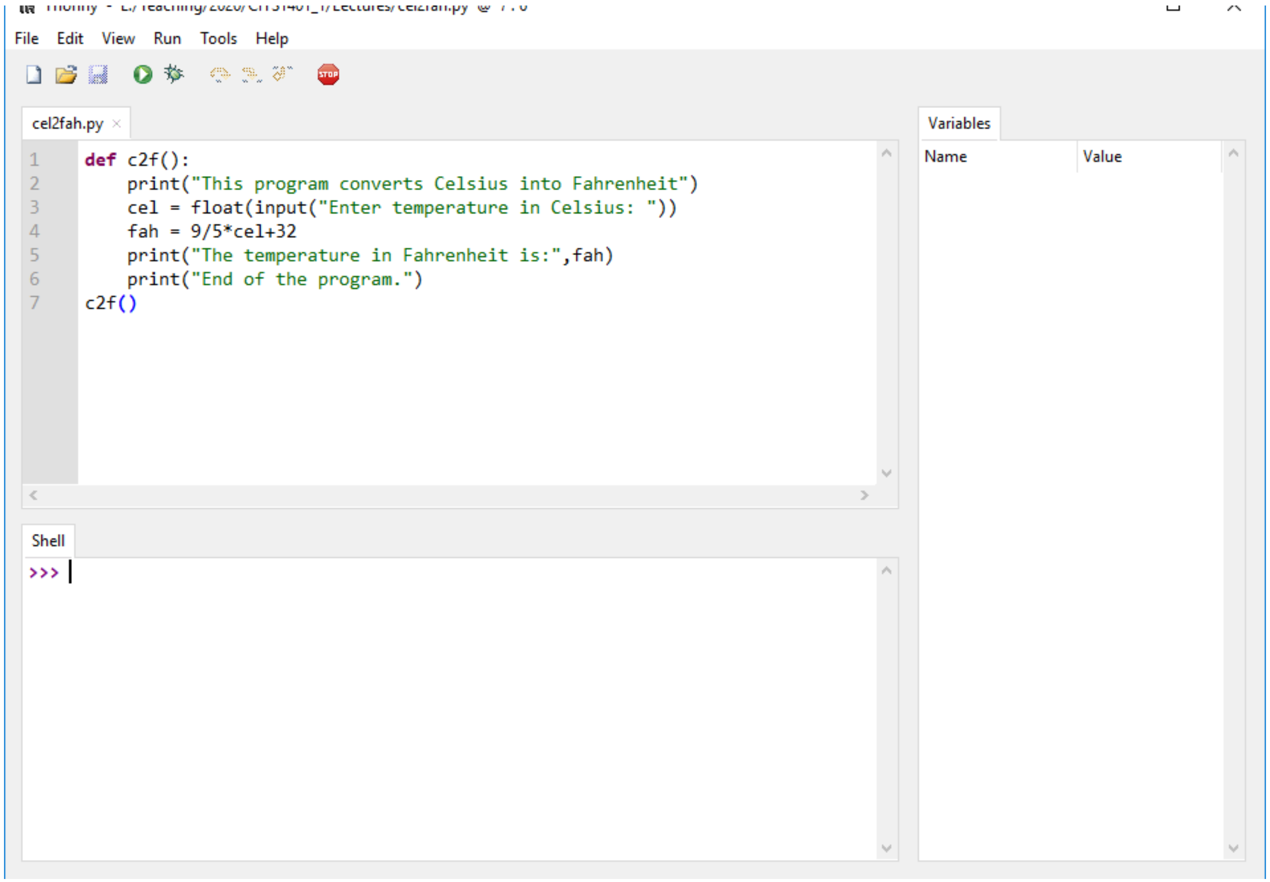
Creating a Module File

```
# File: cel2fah.py
# A simple program is illustrating Celsius to Fahrenheit conversion

def c2f():
    print("This program converts Celsius into Fahrenheit")
    cel = float(input("Enter temperature in Celsius: "))
    fah = 9/5*cel+32
    print("The temperature in Fahrenheit is:",fah)
    print("End of the program.")
c2f()
```

- We use a filename ending in .py when we save our work to indicate it's a Python program.
- Click green button (run) on Thonny to run the program.

cel2fah.py using Thonny IDE

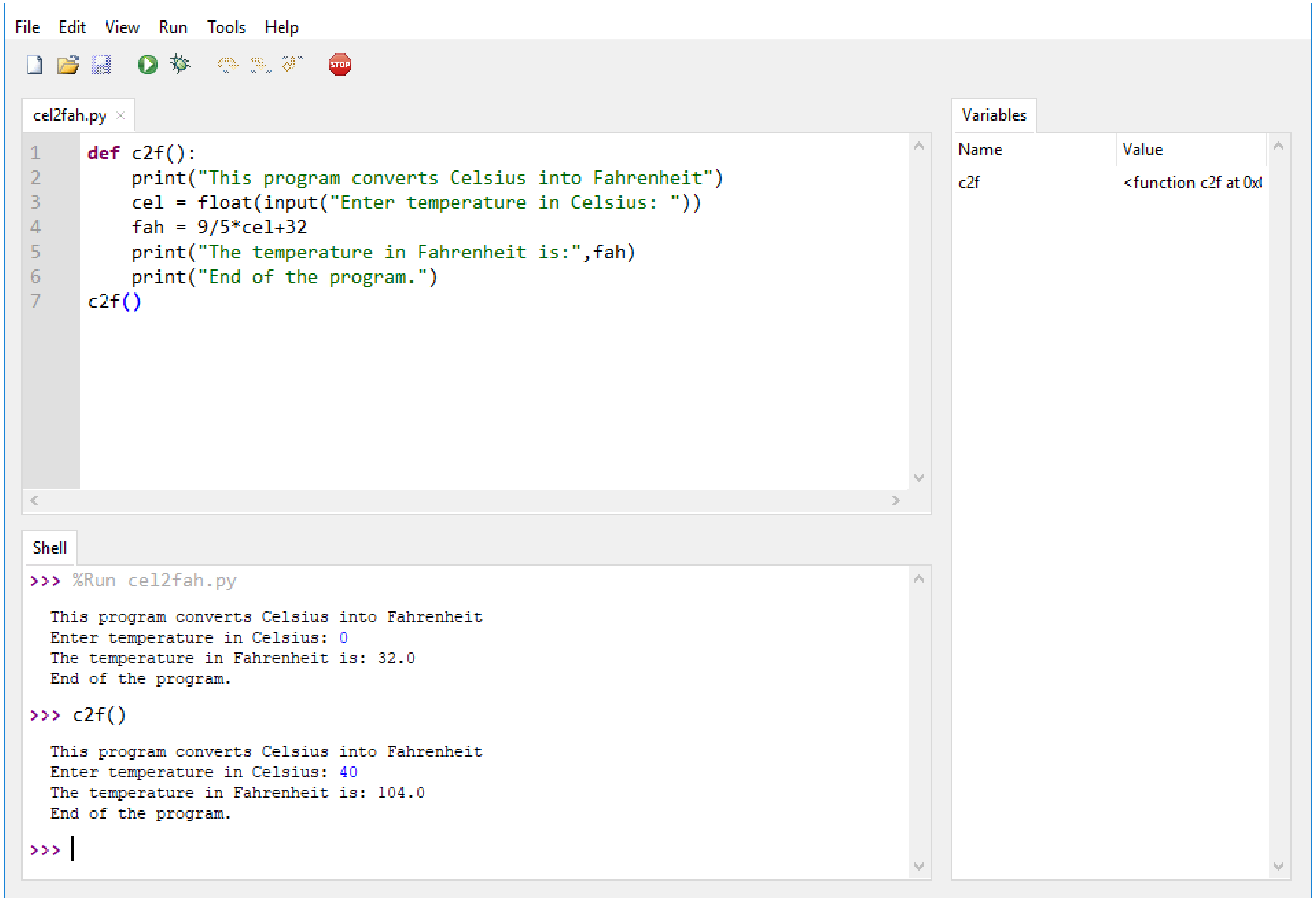


```
def c2f():
    print("This program converts Celsius into Fahrenheit")
    cel = float(input("Enter temperature in Celsius: "))
    fah = 9/5*cel+32
    print("The temperature in Fahrenheit is:",fah)
    print("End of the program.")
c2f()
```

```
>>> 
```

▶ Is the Run button, or choose from main menu

Running cel2fah.py using Thonny



```python
def c2f():
    print("This program converts Celsius into Fahrenheit")
    cel = float(input("Enter temperature in Celsius: "))
    fah = 9/5*cel+32
    print("The temperature in Fahrenheit is:",fah)
    print("End of the program.")
c2f()
```

Name	Value
c2f	<function c2f at 0x|

```
>>> %Run cel2fah.py

  This program converts Celsius into Fahrenheit
  Enter temperature in Celsius: 0
  The temperature in Fahrenheit is: 32.0
  End of the program.

>>> c2f()

  This program converts Celsius into Fahrenheit
  Enter temperature in Celsius: 40
  The temperature in Fahrenheit is: 104.0
  End of the program.

>>> 
```

Inside a Python Program

```
# File: cel2fah.py
# A simple program is illustrating Celsius to Fahrenheit conversion
```

- Lines that start with # are called *comments*. Similar to text enclosed in triple quotes as discussed in earlier lecture
  - *Comments can begin in the middle of lines, too*
- Intended for human readers and ignored by Python
  - **Important**, *so you or other maintainers of that code know what you were intending*
  - *Helps maintainability*
- Python skips text from # to end of line

Inside a Python Program

```
def c2f():
```

- Beginning of the definition of a function called *c2f*
  - *Note the* : is important. It separates header from the function body

Inside a Python Program

```
print(" This program converts Celsius into Fahrenheit")
```

- This line causes Python to print a message introducing the program to the user.
  - *The message is sent to Standard Output (usually the computer screen)*
  - *Standard Input is usually the keyboard*

Inside a Python Program

```
cel = float(input("Enter temperature in Celsius: "))
```

- `cel` is an example of a *variable*
- A variable is used to assign a name to a memory location so that a value can be stored there and later retrieved.
- Variables come into existence when first assigned to
- The quoted text is displayed. The user enters a number (which is text, i.e. just numerical letters).
- The function `float` converts the string, e.g. “0.5”, into the number 0.5, which is then stored in `cel`.
- Note function call within function call (inner one called first)

Inside a Python Program

```
fah = 9/5 * cel + 32
```

- This is called an *assignment* statement
- The part on the right-hand side (RHS) of the = is a mathematical expression
- *, + and / are used to indicate multiplication, addition and division respectively
- Once the value on the RHS is computed, it is stored back into (*assigned*) into `fah`

```
print("The temperature in Fahrenheit is:",fah)
```

- Prints the calculated temperature `fah` to standard output

Indenting your Python programs

```
# File: cel2fah.py
#  A simple program is illustrating Celsius to Fahrenheit conversion
def  c2f():
    print("This program converts Celsius into Fahrenheit")
    cel = float(input("Enter temperature in Celsius: "))
    fah = 9/5*cel+32
    print("The temperature in Fahrenheit is:",fah)
    print("End of the program.")
```

- Indentation is used in Python programs to indicate the different blocks of statements. These are executed together, one after the other
- Note the colon highlighted in purple

Inside a Python Program

```
c2f()
```

- The interpreter first creates a function definition
- The last line tells Python to *execute* the code in the function `c2f`
  - *No arguments expected so none supplied*

Executing a Python Program from a File

- You can run a program in a file any time you want using one of the following methods:

1. Using Thonny, the easiest way is to click the green forward arrow or select Run from the Run Module
2. On the command line (windows) or terminal (Mac OS), enter `python ./cel2fah.py` (`./` generally not be need if path variable has been specified)
   - *Paths are where system looks for files and programs*
3. You can also double click the `.py` file in Windows to run it

Importing a module

```
>>> import cel2fah
This program converts Celsius into Fahrenheit
Enter temperature in Celsius: 0
The temperature in Fahrenheit is: 32.0
End of the program.
>>>
```

Note: No `.py` suffix!

- This tells Python interpreter to load the file cel2fah.py into the main memory.
- Since the last statement of cel2fah.py is `c2f()` the function will get executed upon importing the file.
- Importing modules very common (particularly library modules – huge range, performing many useful functions)

Importing a Module

- When Python imports a module, it executes each line.
  - *The* `def` *causes Python to create the function* `c2f:`
  - `c2f()` *call at the end executes the function*
- Upon first import, Python creates a companion file with .pyc extension. This is an intermediate file containing the byte code used by the interpreter.
- Modules need to be imported in a session only once.

Modules and Functions

- You can define multiple functions in a module file
- You can call a function by typing *moduleFileName.functionName(…)*
  - *E.g.* `>>> cel2fah.c2f()`

    ```
    >>> math.sqrt(2)
    ```

Summary

- Python is an interpreted language. We can execute commands directly in a shell or write a Python file.

- A Python program is a sequence of commands (statements) for the interpreter to execute. It can take input from the user, print output to the screen and run a set of statements.