

2. Modules, Scripts, and I/O

Topics:

- Script Mode
- Modules
- The `print` and `input` statements
- Formatting
- First look at importing stuff from other modules

The Windchill Calculation

Let's compute the windchill temperature given that the air temperature is $T = 32\text{F}$ and the wind is $W = 20\text{mph}$.

Here is the formula courtesy of the National Weather Service:

$$W_{chill} = (35.74 + 0.6215 * T) + (-35.75 + 0.4275 * T) * W^{.16}$$

The formula only applies if $T < 50\text{F}$ and $W \geq 3\text{mph}$.

Use Python in Interactive Mode

```
>>> Temp = 32
>>> Wind = 20
>>> A = 35.74
>>> B = .6215
>>> C = -35.75
>>> D = .4275
>>> e = .16
>>> WC = (A+B*Temp) + (C+D*Temp) * Wind**e
>>> print WC
19.9855841878
```

The `print` statement is used for displaying values in variables.

Quick Note on `print`

The line

```
>>> print WC
```

results in the display of the value currently housed in the variable `WC`

More on the `print` statement later.

Motivating "Script Mode"

What is the new windchill if the wind is increased from 20mph to 30mph?

Looks like we have to type in the same sequence of statements. Tedious.

Wouldn't it be nice if we could store the sequence of statements in a file and then have Python "run the file" after we changed `Wind = 20` to `Wind = 30` ?

Script Mode

Instead of running Python in **interactive mode**, we run Python in **script mode**.

The code to be run (called a **script**) is entered into a file (called a **module**).

We then ask Python to "run the script".

What is a Module?

A **module** is a **.py** file that contains Python code.

In CS 1110, these are created using Komodo Edit.

The Module `windChill.py`

```
WindChill.py
Temp = 32
Wind = 20
A = 35.74
B = .6215
C = -35.74
D = .4275
e = .16
WC = (A+B*Temp) + (C+D*Temp) *Wind**e
print WC
```

Produced using Komodo Edit. This is our first draft.

Running the Module

Here are the steps to follow in the command shell:

1. Navigate the file system so that you are "in" the same directory that houses `WindChill.py`
2. Type: `python WindChill.py`

Details

Suppose I have a directory on my desktop called **TODAY** where I keep all my python files for today's lecture.

I navigate the file system until I get this prompt:

```
C:\Users\cv\Desktop\TODAY>
```

Asking Python to Run the Code in `WindChill.py`

```
C:\Users\cv\Desktop\TODAY> Python WindChill.py
19.6975841877955
```

To save space in subsequent slides, we will refer to `C:\Users\cv\Desktop\TODAY>` as `Blah\Blah>`

Multiple Statements on a Line

Can put multiple statements on a line. Separate the statements with semicolons.

```
WindChill.py
Temp = 32
Wind = 20
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
WC = (A+B*Temp) + (C+D*Temp) *Wind**e
print WC
```

For lecture slides we will sometimes do this to save space. But in general, it makes for "dense reading" and should be avoided.

Module Readability: Comments

Comments begin with a "#"

```
WindChill.py
Temp = 32
Wind = 20
# Model Parameters
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
# Compute and display the windchill
WC = (A+B*Temp)+(C+D*Temp)*Wind**e
print WC
```

Comments: Guidelines

Comments can also appear on the same line as a statement:

```
Wind = 20 # wind speed in miles-per-hour
```

Everything to the right of the "#" is part of the comment and not part of the program.

Comments and Readability

Start each program (script) with a **concise** description of what it does.

Define each important variable/constant.

A chunk of code with a specific task should be generally be prefaced with a **concise** comment.

Module Readability: docstrings

A special comment at the top of the module.

```
WindChill.py
"""Computes windchill as a function of
wind(mph) and temp (Fahrenheit)."""
Temp = 32
Wind = 20
# Model Parameters
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
# Compute and display the windchill
WC = (A+B*Temp)+(C+D*Temp)*Wind**e
print WC
```

Docstrings: Guidelines

Docstrings are multiline comments that are delimited by triple quotes: """

They are strategically located at the beginning of "important" code sections.

Their goal is to succinctly describe what the code section is about.

One example of an "important" code section is a module.

Trying Different Inputs

```
WindChill.py
"""Computes windchill as a function of
wind(mph) and temp (Fahrenheit)."""
Temp = 32
Wind = 20
# Model Parameters
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
# Compute and display the windchill
WC = (A+B*Temp)+(C+D*Temp)*Wind**e
print WC
```

Can we be more flexible here?

Handy Input

If we want to explore windchill as a function of windspeed and temperature, then it is awkward to proceed by editing the module `WindChill.py` every time we want to check out a new wind/temp combination.

The `input` statement addresses this issue.

The input Statement

The `input` statement is used to solicit values via the keyboard:

```
input( < string that serves as a prompt > )
```

Later we will learn how to input data from a file.

Temp and Wind via input

```
WindChill.py
"""Computes windchill as a function of
wind(mph) and temp (Fahrenheit)."""

Temp = input('Enter temp (Fahrenheit):')
Wind = input('Enter wind speed (mph):')

# Model Parameters
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
# Compute and display the windchill
WC = (A+B*Temp)+(C+D*Temp)*Wind**e
print WC
```

A Sample Run

The prompt is displayed...

```
> Enter temp (Fahrenheit) :
```

And you respond...

```
> Enter temp (Fahrenheit) : 15
```

A Sample Run

The next prompt is displayed...

```
> Enter wind speed (mph) :
```

And you respond again...

```
> Enter wind speed (mph) : 50
```

A Sample Overall "Dialog"

```
BlahBlah> python WindChill.py
Enter temp (Fahrenheit) : 15
Enter wind speed (mph) : 50
-9.79781580448
```

For more on Keyboard Input

Practice with the demo file
ShowInput.py

There is an alternative to input called
raw_input

It is handier in certain situations. Practice with

ShowRawInput.py

More Readable Output

The print statement can be used to format output in a way that facilitates the communication of results.

We don't need to show wind chill to the 12th decimal!

More Readable Output

WindChill.py

```
"""Computes windchill as a function of
wind(mph) and temp (Fahrenheit)."""
```

```
Temp = input('Enter temp (Fahrenheit):')
Wind = input('Enter wind speed (mph):')
```

```
# Model Parameters
```

```
A=35.74;B=.6215;C=-35.74;D=.4275;e=.16
```

```
# Compute and display the windchill
```

```
WC = (A+B*Temp)+(C+D*Temp)*Wind**e
print '      Windchill :%4.0f' % WC
```

The "Dialog" With Formatting

```
BlahBlah> WindChill
Enter temp (Fahrenheit) : 15
Enter wind speed (mph) : 50
-9.79781580448
```

print
without
formatting

```
BlahBlah> WindChill
Enter temp (Fahrenheit) : 15
Enter wind speed (mph) : 50
      Windchill : -10
```

print
with
formatting

The print Statement

The print statement tries to intelligently format the results that it is asked to display.

print with formatting puts you in control.

print w/o Formatting

Script:

```
x = 2./5.
print x
x = 1./3.
print x
x = 1234.5678901234
print x
```

Output:

```
0.4
0.3333333333333333
1234.56789012
```

Later we will learn how to direct output to a file

For float values, print (by itself) displays up to 12 significant digits

print w/o Formatting

Script:

```
x = 1234
y = 12345678
print x,y
```

Output:

```
1234 12345678
```

To display more than one value on a line, separate the references with commas.
A single blank is placed in between the displayed values.

print with the %f Format

```
x = 1234.123456789
print 'x = %16.3f' %x
print 'x = %16.6f' %x
print 'x = %16.9f' %x
```

```
x =          1234.123
x =          1234.123457
x =          1234.123456789
```

Formatted print statements are developed by "trial and error."
It not a topic for memorization and it does not show up on exams.

print with the %e Format

```
x = 1234.123456789
print 'x = %16.3e' %x
print 'x = %16.6e' %x
print 'x = %16.9e' %x
```

```
x =          1.234e+03
x =          1.234123e+03
x =          1.234123456e+03
```

Formatted print statements are developed by "trial and error."
It not a topic for memorization and it does not show up on exams.

print with the %d Format

```
x = 1234
print 'x = %4d' %x
print 'x = %7d' %x
print 'x = %10d' %x
```

```
x = 1234
x =    1234
x =      1234
```

Formatted print statements are developed by "trial and error."
It not a topic for memorization and it does not show up on exams.

print with the %s Format

Script:

```
Band = 'The Beatles'
print '%s in 1964' % Band
```

Output: `The Beatles in 1964`

Strings can be printed too

Formatted Print With More than 1 Source Value

Script:

```
y1 = 1964
y2 = 1971
Band = 'The Beatles'
print '%s in %4d and %4d' % (Band,y1,y2)
```

Need parentheses here.

Output:

```
The Beatles in 1964 and 1971
```

print with Formatting

`print < string with formats > %(< list-of-variables >)`

A string that includes things like
%10.3f, %3d,
%8.2e, etc

Comma-separated, e.g., x,y,z. One variable for each format marker in the string. The Parentheses are Required if more than one variable.

Practice with the demo file `ShowFormat.py`

Why Program Readability and Style is Important

How we "do business" in commercial, scientific, and engineering settings increasingly relies on software.

Lack of attention to style and substandard documentation promotes error and makes it hard to build on one another's software.

Another Detail

All modules that are submitted for grading should begin with three comments.

`WindChill.py`

```
# WindChill.py
# Xavier Zanzibar (xz3)
# January 1, 1903

etc
```

Name of module
Your name and netid
Date

A Final Example

Write a script that solicits the area of a circle and prints out the radius.

Preliminary Solution

`Radius.py`

```
A = input('Enter the circle area: ')
r = sqrt(A/3.14)
print r
```

The Math: solve $A = \pi r^2$ for r .

We Get an Error

```
A = input('Enter the circle area: ')
r = sqrt(A/3.14)
print 'The radius is %6.3f' % r
```

```
r = sqrt(A/3.14)
NameError: name 'sqrt' is not defined
```

`sqrt` is NOT a built-in function

Final Solution

```
Radius.py
from math import sqrt
A = input('Enter the circle area: ')
r = sqrt(A/3.14)
print 'The radius is %6.3f' % r
```

We are importing the function `sqrt` from the `math` module.

The Math: solve $A = \pi r^2$ for r .

The Idea Behind `import`

People write useful code and place it in modules that can be accessed by others.

The `import` statement makes this possible.

One thing in the `math` module is the square root function `sqrt`.

If you want to use it in your module just say

```
from math import sqrt
```

Better Final Solution

```
Radius.py
from math import sqrt, pi
A = input('Enter the circle area: ')
r = sqrt(A/pi)
print 'The radius is %6.3f' % r
```

We are importing the function `sqrt` and the constant `pi` from the `math` module.

Can import more than one thing from a module. Much more on import later.

Sample Run

```
C:\Users\cv\Desktop\TODAY> Python Radius.py
Enter the circle area: 10
The radius is 1.785
```

For more insights, check out the lecture script `SurfaceArea.py`.