ERTH 401 / GEOP 501
Computational Methods for Geoscientists

– Lecture 04: Functions –

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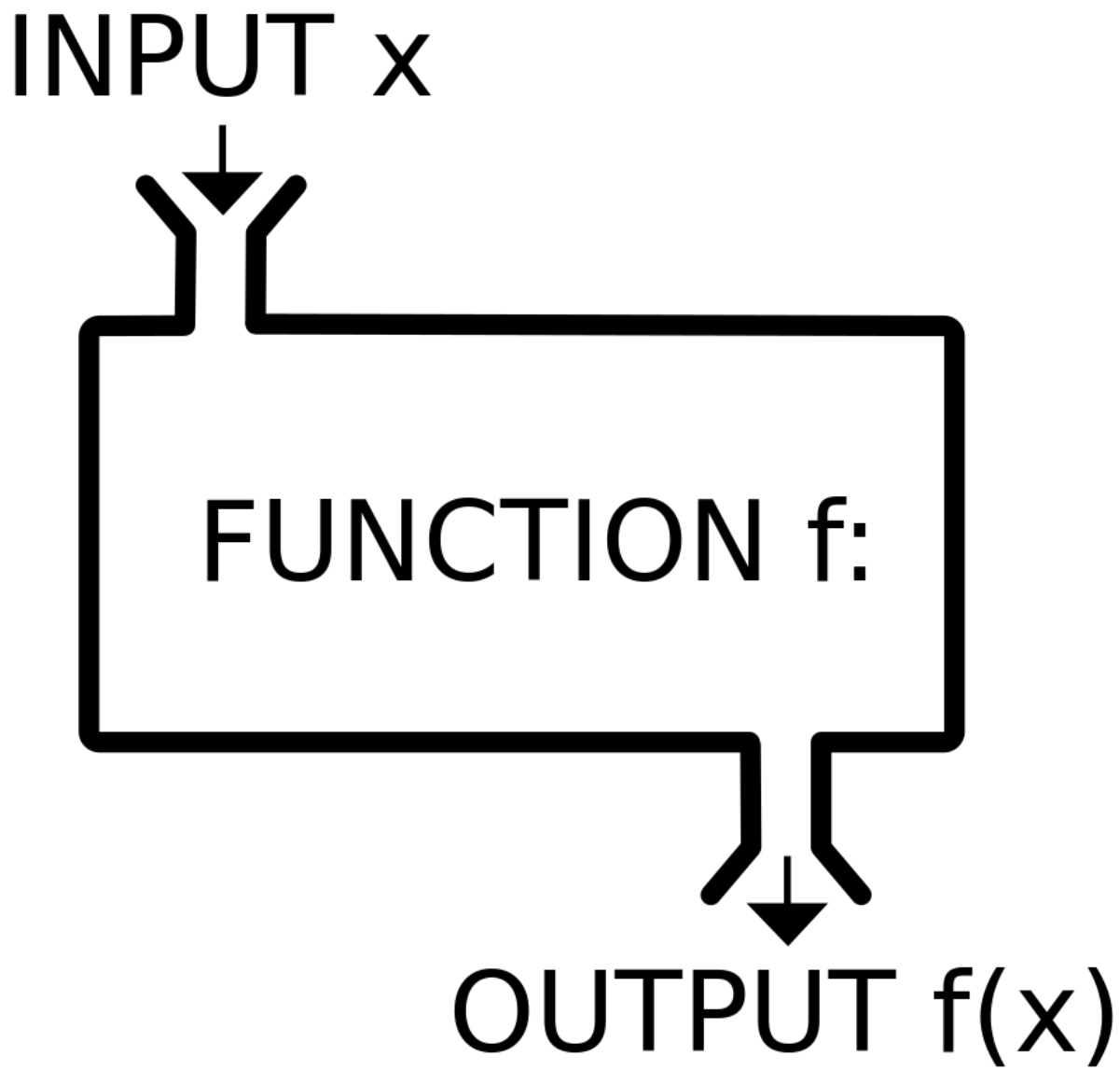
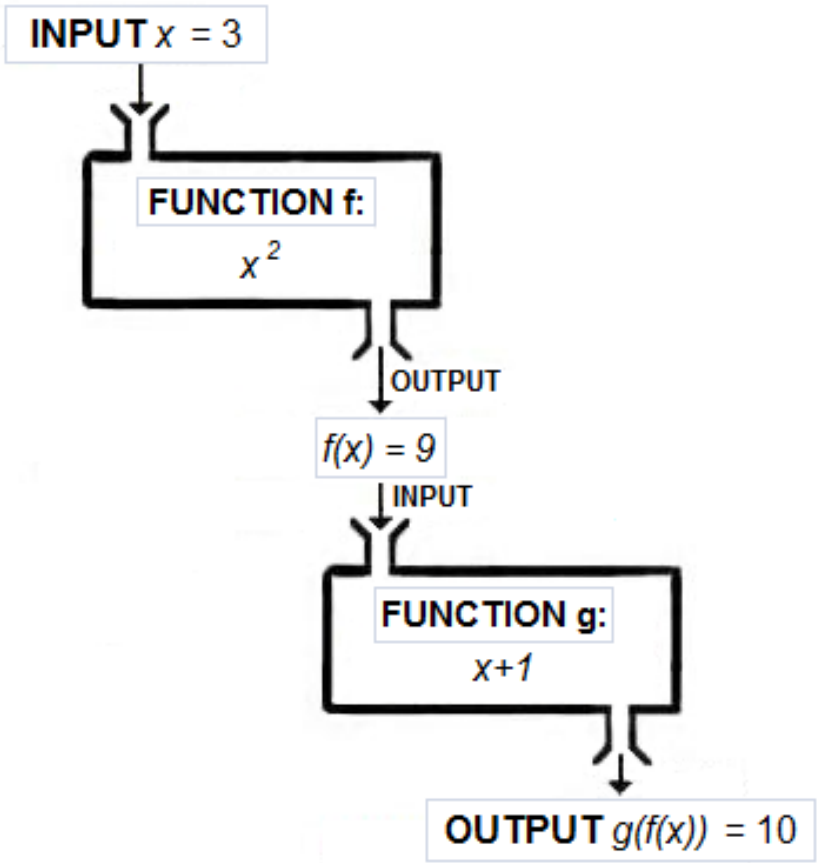
Wouldn’t it be great if we could think up some functionality, write it up, test it, and be able to reuse it at any time in the future?*

* hint: yes!

Function

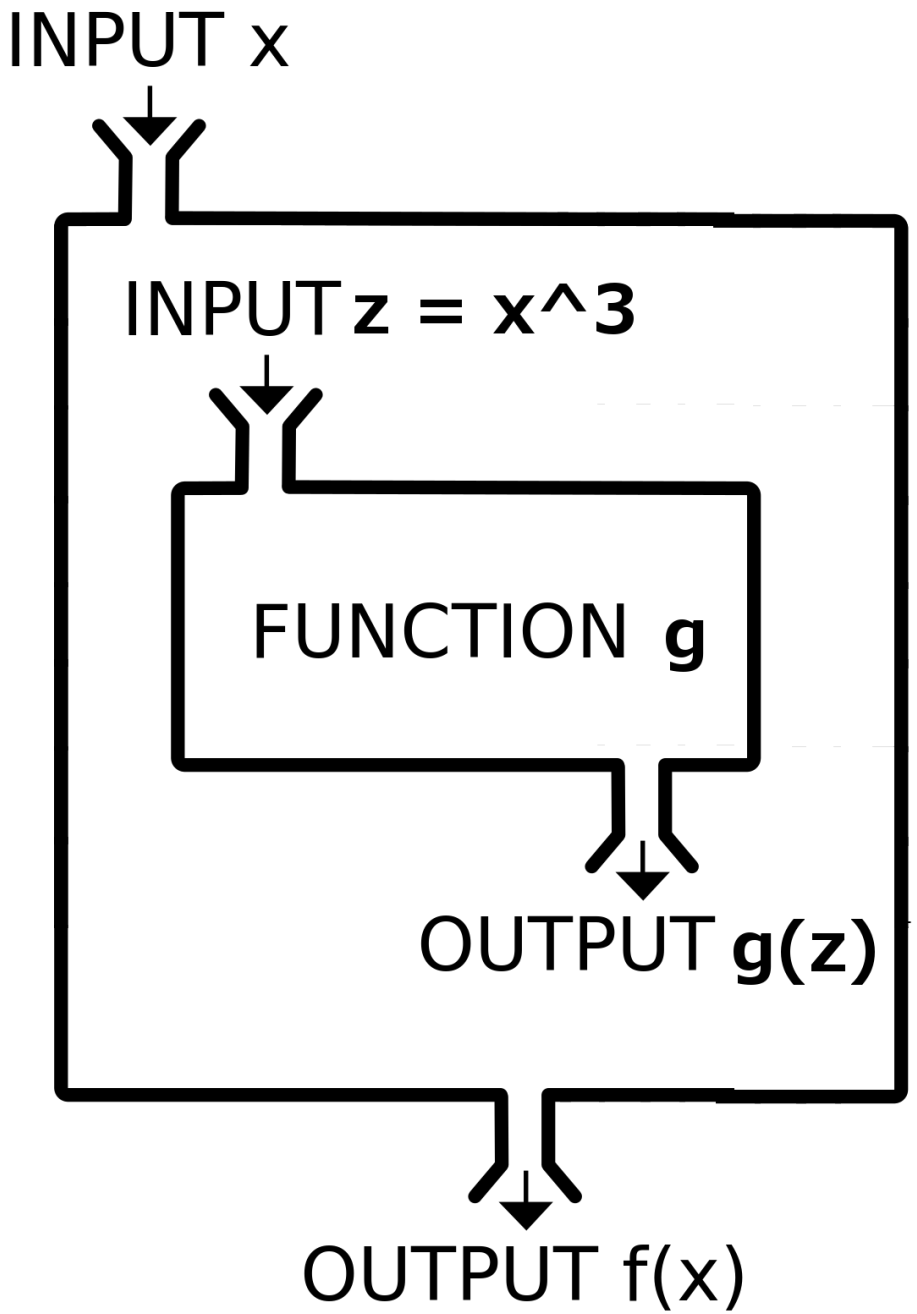


Function & Function



https://en.wikipedia.org

Use a Function in a Function



What Is A Function?

. . . a set of rules that takes input, from which it produces output.

What Is A Function?

- one of the boxes you drew in the flow charts
- one of the most important tools you have to:
  - capture & contain
  - test
  - reuse

  algorithms / behavior of any complexity
- change something in **one** spot instead of all over your source code (don't copy and paste in programming!)

Examples

```
1  #!/usr/bin/env python

3  def letter_grade(percent):
       if   percent > 90:
5          return "A"
       elif percent > 80:
7          return "B"
       elif percent > 70:
9          return "C"
       elif percent > 60:
11         return "D"
       else:
13         return "F"

15 if __name__ == "__main__":
       print letter_grade(85)
```

```
$> ./grades.py
B
```

Examples

```python
#!/usr/bin/env python

def letter_grade(percent):
    if   percent > 90:
        return "A"
    elif percent > 80:
        return "B"
    elif percent > 70:
        return "C"
    elif percent > 60:
        return "D"
    else:
        return "F"

if __name__ == "__main__":
    print letter_grade(85)
```

```bash
#!/bin/bash
function letter_grade(){
  if   [ $1 -gt 90 ]; then
       echo "A"
  elif [ $1 -gt 80 ]; then
       echo "B"
  elif [ $1 -gt 70 ]; then
       echo "C"
  elif [ $1 -gt 60 ]; then
       echo "D"
  else
       echo "F"
  fi
}

letter_grade 85
```

```
$> ./grades.py
B
```

```
$>./letter_grades.bash
B
```

Examples - Interactive Python

import **entire module**

```
>>> import grades
>>> grades.letter_grade(60)
'F'
>>> grades.letter_grade(87)
'B'
>>> g = grades.letter_grade(87)
>>> print g
B
```

Examples - Interactive Python

import **entire module**

```
>>> import grades
>>> grades.letter_grade(60)
'F'
>>> grades.letter_grade(87)
'B'
>>> g = grades.letter_grade(87)
>>> print g
B
```

import **individual function** from a module

```
>>> from grades import letter_grade
>>> letter_grade(60)
'F'
>>> letter_grade(87)
'B'
>>> g = letter_grade(87)
>>> print g
B
```

Examples - bash vs tcsh

```
#!/bin/bash
function letter_grade(){
  if [ $1 -gt 90 ]; then
        echo "A"
  elif [ $1 -gt 80 ]; then
        echo "B"
  elif [ $1 -gt 70 ]; then
        echo "C"
  elif [ $1 -gt 60 ]; then
        echo "D"
  else
        echo "F"
  fi
}

letter_grade $1
```

```
$> ./letter_grades2.bash 85
B
```

Examples - bash vs tcsh

```bash
#!/bin/bash
function letter_grade(){
    if [ $1 -gt 90 ]; then
        echo "A"
    elif [ $1 -gt 80 ]; then
        echo "B"
    elif [ $1 -gt 70 ]; then
        echo "C"
    elif [ $1 -gt 60 ]; then
        echo "D"
    else
        echo "F"
    fi
}

letter_grade $1
```

```tcsh
#!/bin/tcsh

set grade = $1


if    ($grade > 90) then
        echo "A"
else if ($grade > 80) then
        echo "B"
else if ($grade > 70) then
        echo "C"
else if ($grade > 60) then
        echo "D"
else
        echo "F"
endif
```

```
$> ./letter_grades2.bash 85
B
```

```
$> ./letter_grades.tcsh 85
B
```

Overview

- programming languages provide functions differently
- functions in the shell are a bit clunky (bash) or not available (tcsh), but workarounds possible
- think about how to parameterize your function

Syntax

- some languages provide multiple return values:

```
#!/usr/bin/env python

def get_two_values():
    return 23, 42

if __name__ == "__main__":
    val1, val2 = get_two_values()
    print val1
    print val2
```

```
$> ./multi_return.py
23
42
```

Syntax

- some languages provide multiple return values:

```
1 #!/usr/bin/env python

3 def get_two_values():
      return 23, 42
5
  if __name__ == "__main__":
7     val1, val2 = get_two_values()
      print val1
9     print val2
```

```
$> ./multi_return.py
23
42
```

- could always return more complex type with multiple values (arrays, lists, . . .)

Examples - Python: multiple functions

```
1  #!/usr/bin/env python

3  def letter_grade(percent):
       if   percent > 90:
5          return "A"
       elif percent > 80:
7          return "B"
       elif percent > 70:
9          return "C"
       elif percent > 60:
11         return "D"
       else:
13         return "F"

15 def gpa(letter_grades, credits):
       grades={'A': 4.00, 'B': 3.00, 'C':2.00, 'D':1.00, 'F':0.00}
17
       total_points = 0
19
       for i in range(len(letter_grades)):
21         total_points += grades[ letter_grades[i] ] * credits[i]

23     return float(total_points)/float(sum(credits))
```

Examples - Interactive Python

import **entire module**

```
>>> import grades2
>>> print grades2.gpa(['B','A','C','A','B'], [4, 3, 3, 4, 2])
3.25
>>> print grades2.letter_grade(90)
B
```

Examples - Interactive Python

import **entire module**

```
>>> import grades2
>>> print grades2.gpa(['B','A','C','A','B'], [4, 3, 3, 4, 2])
3.25
>>> print grades2.letter_grade(90)
B
```

import **individual functions** from a module

```
>>> from grades2 import gpa, letter_grade
>>> print gpa(['B','A','C','A','B'], [4, 3, 3, 4, 2])
3.25
>>> print letter_grade(90)
B
```

What is this {'A':4.0} Business?

- python provides `dictionary` datatype, associative arrays
- think "Lookup tables"
- you get to assign key value pairs where the key can be string, number, other datatype (list requires the key to be the index of the value)

What is this {'A':4.0} Business?

- python provides `dictionary` datatype, associative arrays
- think "Lookup tables"
- you get to assign key value pairs where the key can be string, number, other datatype (list requires the key to be the index of the value)

```
>>> grades={'A': 4.00, 'B': 3.00, 'C':2.00}
>>> grades['A']
4.0
>>> grades['a']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 'a'
>>> grades['D'] = 2.00
>>> grades['F'] = 0.00
>>> grades['D']
2.0
>>> grades['D'] = 1.00
>>> grades['D']
1.0
>>> grades[4]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 4
```