Functions and Modules Revisited

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A function in math, often denoted $f : X \rightarrow Y$, associates with $x$ in $X$ a unique value $f(x)$ in $Y$.

**Examples:**

(a) $f(x) = x^2$. Here $x$ can be any real number and $f(x)$ is a non-negative real number.

$$f(3) = 9, \quad f(-1.1) = 1.21, \quad f(15) = 225,$$

etc.

(b) $f(x) = \sqrt{x}$. Here $x$ can be any *positive* real number and $f(x)$ is a *positive* real number.

$$f(25) = 5, \quad f(100) = 10, \quad f(20) = 4.47213,$$

etc.

$x$ is called the *argument* to the function $f$.

We are also taught to sometimes view $f : X \rightarrow Y$ as a “black box” to which you provide an $x$ as input and out comes $f(x)$.
Functions in Python

- Most programming languages provide ways of defining the *computational* equivalent of this.
- For example, the *math* module contains the definition of a function called `sqrt`.
- This is a piece of Python code that, when given the value of an *argument*, computes and returns the square root of that argument.
- This allows us to write code such as:

```python
factorBound = math.sqrt(n)
```
One way to categorize functions in Python is:

1. **Built-in functions**: these functions are pre-defined and are always available.

2. **Functions defined in modules**: these functions are pre-defined in particular modules and can only be used when the corresponding module is imported.

3. **User defined functions**: these are defined by the programmer.
Built-in Functions

- Python documentation lists 80 built-in functions at: [http://docs.python.org/library/functions.html](http://docs.python.org/library/functions.html)

- Math functions: `abs(x)`, `round(x, n)`
- Type conversion functions: `bool(x)`, `float(x)`, `int(x)`, `long(x)`, `str(x)`
- Input functions: `raw_input(x)`, `input(x)`
- Miscellaneous: `len(x)`, `type(x)`
What is `input()`?

- The function `input(prompt)` treats what the user types as input as a Python expression and returns the evaluated value.
- I prefer `raw_input(prompt)` to `input(prompt)` in general because it gives the programmer more control on how to interpret the input.
- `input(prompt)` is okay when all you are expecting is simple numeric input.
- In Python version 3, `raw_input(prompt)` has been renamed as `input(prompt)`.
The modules we have used so far are: `sys`, `math`, `time`

There are 100s of “standard” modules in Python:
- Generation of random numbers and probability distributions
- Accessing files and directories
- Web development
- Network programming
- Graphics, etc.

A module is simply a file (just like the files that you have been creating your programs in) that contains related Python statements and function definitions.

Programmers can define their own modules. There are 1000s of third-party modules available for Python.
Importing from modules

- We have used statements of the form
  \[\text{import math}\]
  
  to import from modules.

- When we import a module $X$ in this manner, we need to use $X$.name to refer to an item called name that is defined in the module $X$.

- **Examples:** \[\text{math.sqrt(25)}\] or \[\text{math.pi}\]

- There are some other ways of importing from modules as well.
Another way of importing from modules

- You can also use
  ```python
  from X import f
  ```
  Here X is a module name and f is the name of a function defined in X.
  In this case, you can directly refer to f, without using the “X.” prefix.

- Try
  ```python
  from math import sqrt
  ```
  You can use `sqrt(35)` without the “math.” prefix.

- You can also use
  ```python
  from math import *
  ```
  In this case all items in the math module can be used without the “math.” prefix.

- Beware of
  - new items (variables, functions, etc.) that you don’t know about, coming into existence
  - and new items overriding items you have defined