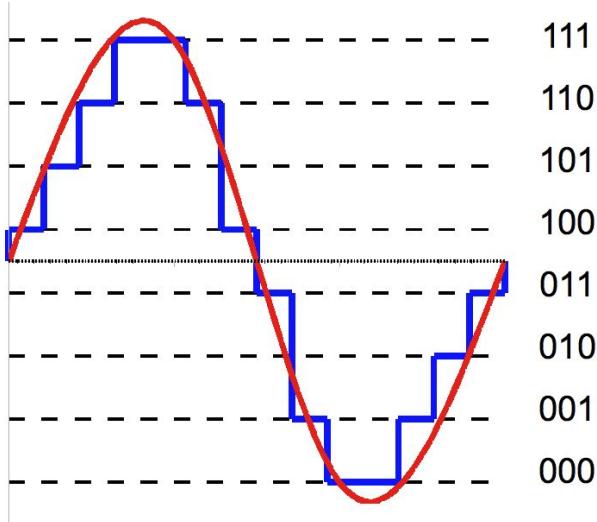


Chapter 3: Computing with Numbers Part 1

Jan 14, 2020



Today's Outline

- Review simple programs:
 - functions
 - simultaneous variable assignments
 - for loops
- Review for Quiz
- Numeric Data Types (int and float)
- Math library

Functions

- Use to run to another piece of code that is not part of the main program
- Built-in functions:
 - `print ("Hello world ")`
 - `username = input ("Please enter your first name: ")`

Functions

- Custom functions:

```
#Custom Function to convert a temperature
```

```
def tempConvert (celsius):  
    fahrenheit = celsius*9/5 + 32  
    return fahrenheit
```

Simultaneous Variable Assignments

- Use to swap variables

```
num_eggs, num_toast = num_toast, num_eggs
```

```
num_toast, num_eggs = eval(input("Enter # of slices of toast followed by # of eggs: "))
```

For loops

- Use to repeat part of a program a specified number of times

```
for i in range(10):  
    print(i)
```

```
for fruits in ["strawberry", "cherry", "grape"]:  
    print (fruits)
```

```
for i in range (0, 10, 2):  
    print(i)
```

Temperature Program

Create a program that computes and prints a table of Celsius temperatures and the Fahrenheit equivalents every 10 degrees from 0° C to 100°C.



Temperature Program

Create a program that computes and prints a table of Celsius temperatures and the Fahrenheit equivalents every 10 degrees from 0° C to 100°C.

Ideas:

function - can use a function to convert celsius to fahrenheit

for loop - to repeat the conversion many times

Fibonacci Program

Develop a function that can print the first n elements of the Fibonacci sequence.

Example:

```
print_fibonacci (10)
```

Computer will output to the screen:

```
0 1 1 2 3 5 8 13 21 34
```



Fibonacci

0 1 1 2 3 5 8 13 21 34

f1 f2 f3 =
f1 + f2

Fibonacci

0 1 1 2 3 5 8 13 21 34

f1 f2 $f_3 =$ $f_4 =$
 $f_1 + f_2$ $f_2 + f_3$

Fibonacci

0 1 1 2 3 5 8 13 21 34

f1 f2 $f_3 = f_1 + f_2$ $f_4 = f_2 + f_3$ $f_5 = f_3 + f_4$

Fibonacci

0 1 1 2 3 5 8 13 21 34

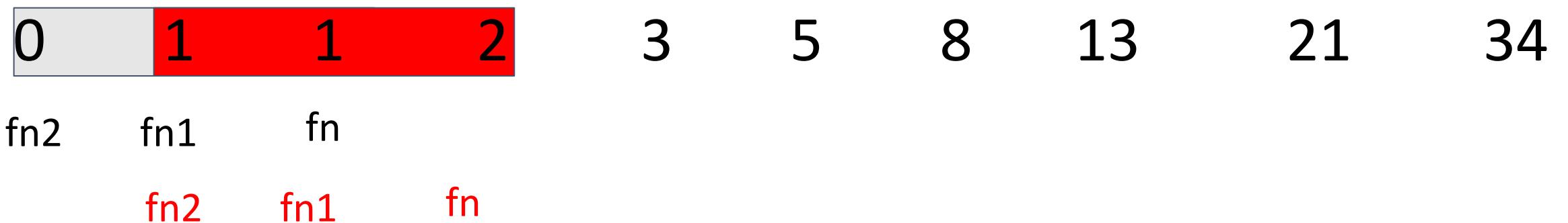
f1 f2 $f_3 = f_1 + f_2$ $f_4 = f_2 + f_3$ $f_5 = f_3 + f_4$

$$f_n = f_{n-1} + f_{n-2}$$

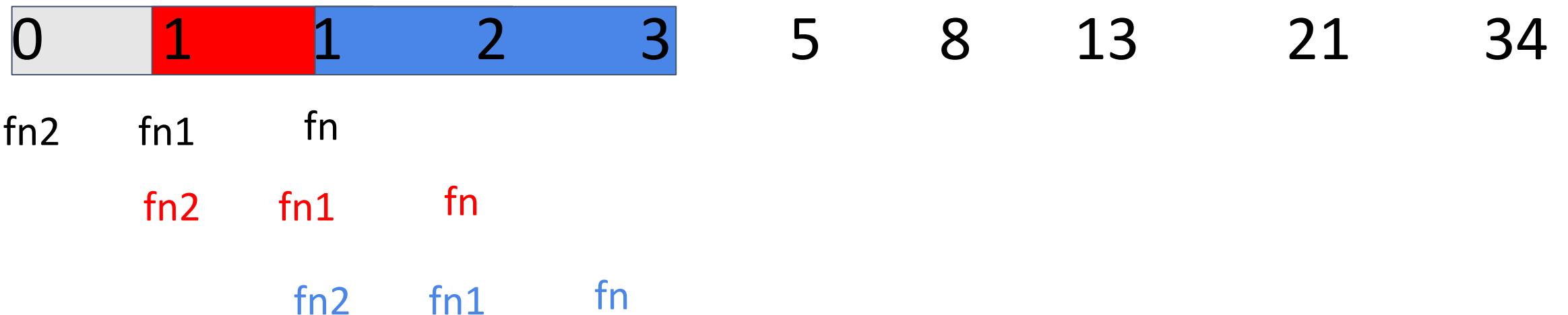
Fibonacci

0	1	1	2	3	5	8	13	21	34
fn2	fn1	fn							

Fibonacci Update



Fibonacci Update



Lab 1: Friday Jan 17

Programming assignment based on Chapter 1 and Chapter 2 lectures.

Tutorial time: Friday Jan 17, 8:35-11:35am MacOdrum Library 153

Posted: Thursday

Deadline: next Friday (Jan 24) 9:00am

Quiz

Quizzable topics:

Mostly will be focusing on **theory** from Chapter 1 and 2 Lectures.

Format: 10 Multiple Choice, Matching or Short Answer questions

Posted: Wednesday

Deadline: Sunday (Jan 19) at 11:55pm

Quiz Review

Go to:

PollEv.com/itec5920w

Quiz Review 1

The Python print function:

- a) causes your printer to print out a page of paper
- b) causes text to be printed on the screen
- c) saves data to a file on your disk
- d) none of the above

Quiz Review 2

The Python input function:

- a) only allows someone using your program to enter a value from the keyboard
- b) only displays text on the screen
- c) both displays text on the screen and allows someone using your program to enter value from the keyboard
- d) none of the above

Quiz Review 3

A computer's CPU executes instructions that are written in

- a) Python
- b) source code
- c) a subset of the English language
- d) the CPU only executes 0s and 1s

Quiz Review 4

Why don't we program computers using a common human language such as English?

- a) To make it more challenging for programmers.
- b) So programmers can make more money.
- c) Human languages are complex and often ambiguous or imprecise.
- d) all of the above

Quiz Review 5

An algorithm is

- a) a mathematical function that is the opposite of a logarithm function
- b) a step-by-step process that may or may not solve a problem
- c) a step-by-step process for solving a problem that is guaranteed to complete within an hour on a computer
- d) a step-by-step process that will eventually solve a problem

Quiz Review 6

Which of the following is a legal identifier (variable name)?

- a) 3_points
- b) fieldGoal%
- c) three points
- d) three_points

Quiz Review 7

Which of the following is used in Python to execute statements multiple times?

- a) def
- b) for
- c) print
- d) input

Quiz Review 8

When you want to have the user of your program enter a number, which of the following should you use?

- a) `input()`
- b) `eval(input())`
- c) `print()`
- d) `input(eval())`

Quiz Review 9

Most simple computer programs follow the basic pattern defined by the acronym IPO.

What does IPO mean with regards to programming?

- a) I programmed output.
- b) Initial public offering.
- c) Input, process, output.
- d) Input, program, output.

Quiz Review 10

Which of the following is not a correct Python statement?

- a) `x, y = 3`
- b) `x = 3 + 4`
- c) `x, y = 3, 3`
- d) `x = x + 1`

Chapter Three: Computing with Numbers

Numeric Data Types in Python

1. INT: Integers (whole numbers)

-2, -1, 0, 1, 2 etc.

2. FLOAT: Floating point (fractional numbers)

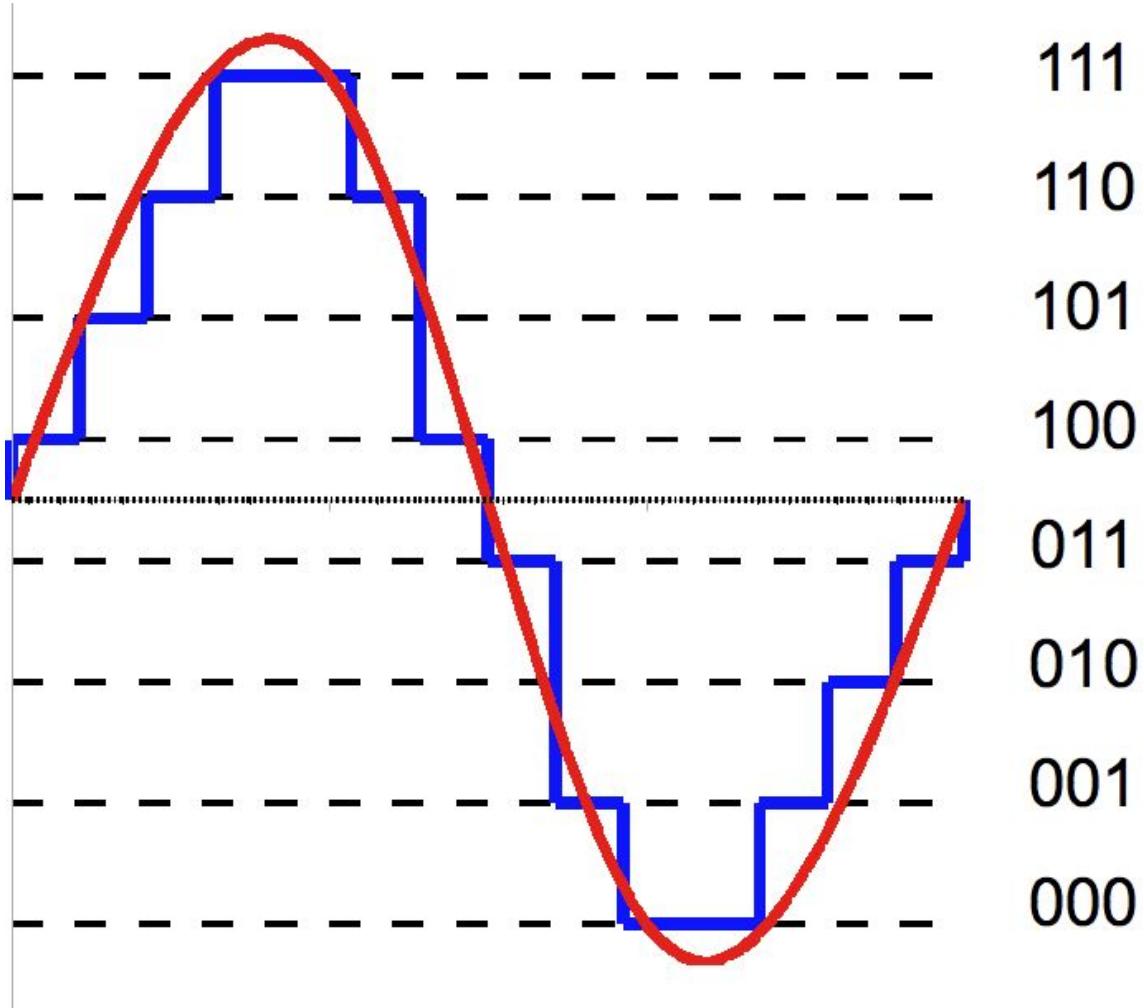
0.5, 0.23425, 30.2, -3.235 ... etc.

**Is the value 1.0 an INT or a FLOAT?

Why do we need two data types for numbers?

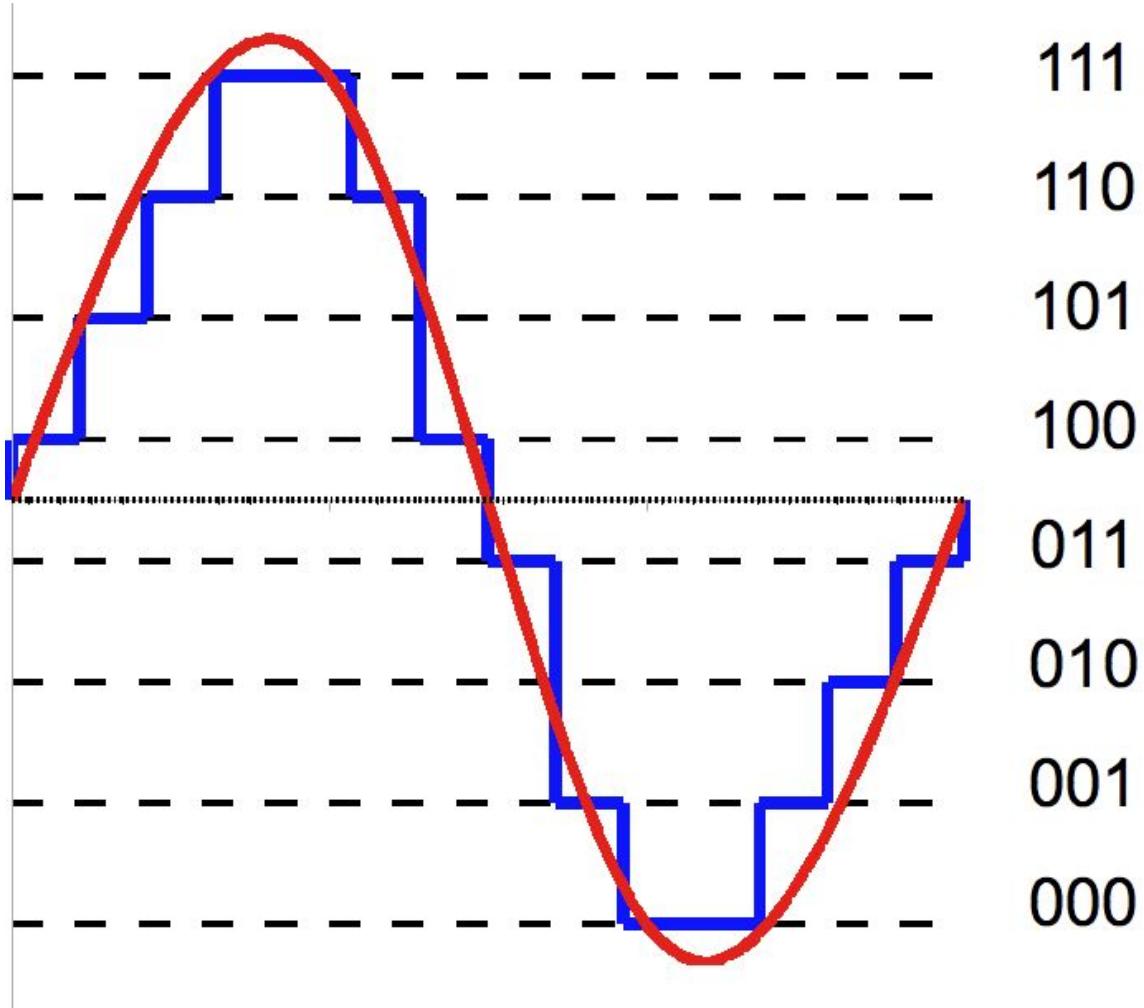
- Many algorithms are much more efficient with integers
 - **Quantizing** values can greatly reduce the time and memory requirements for complex processes without impacting the efficacy of the solution

Quantization



- Convert a continuous values of inputs (red) to a finite number of possible inputs (blue)

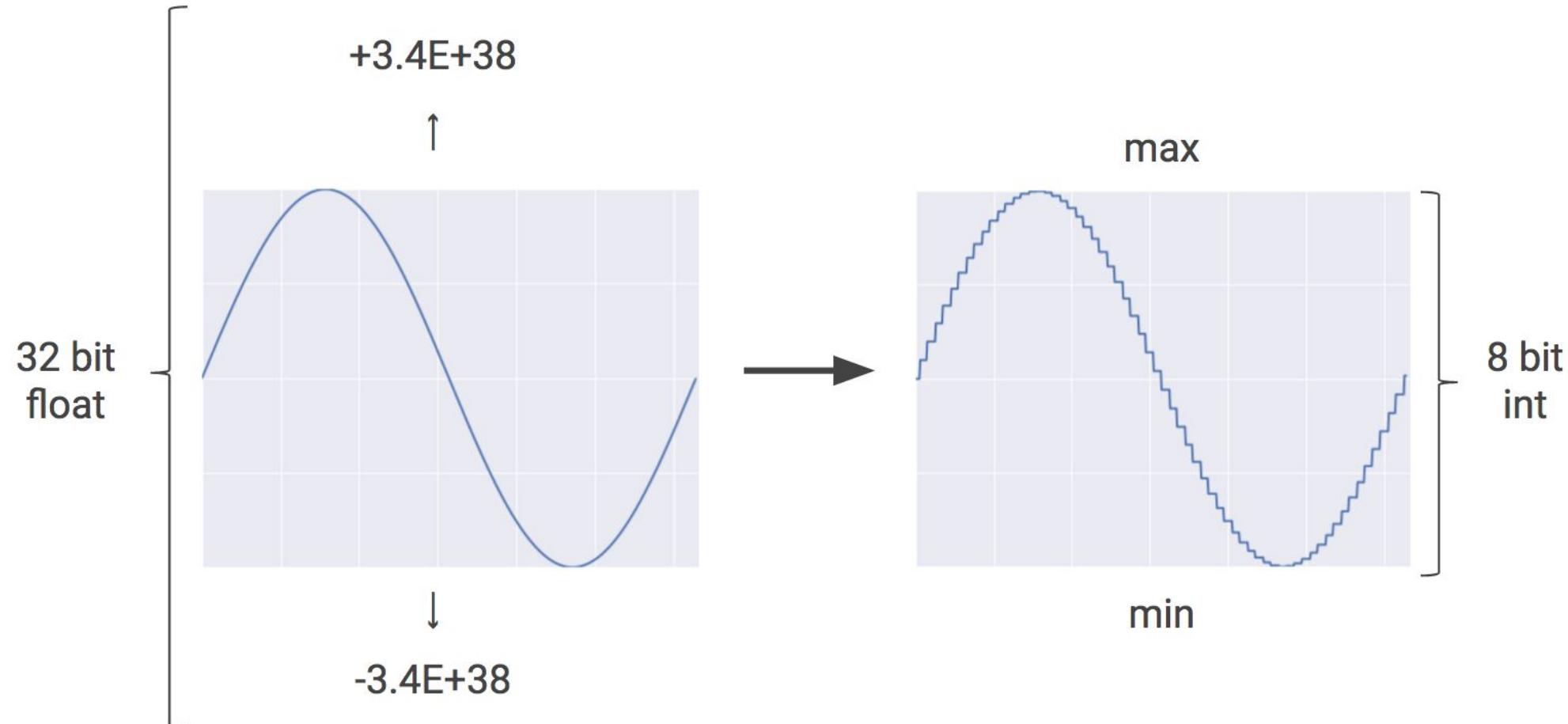
Quantization



- Convert a continuous values of inputs (red) to a finite number of possible inputs (blue)



- Google frequently quantizes FLOAT numbers to INT numbers to speed up machine learning computations



Creating an AI can be five times worse for the planet than a car

<https://institutions.newscientist.com/article/2205779-creating-an-ai-can-be-five-times-worse-for-the-planet-than-a-car/>

<https://institutions.newscientist.com/article/mg24031992-100-ais-dirty-secret-energy-guzzling-machines-may-fuel-global-warming/>

AI's dirty secret: Energy-guzzling machines may fuel global warming



<https://www.theverge.com/2019/6/25/18744034/ai-artificial-intelligence-ml-climate-change-fight-tackle>

Creating an AI can be five times worse for the planet than a car

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AI's dirty secret: Energy-guzzling machines may fuel global warming



Why do we need two data types for numbers? (Part 2)

- FLOAT values are always **approximations** of real numbers
 - For example, if we try to assign a FLOAT type with a value of 3, the FLOAT might actually hold the value 3.00000000003
 - If we want to use an integer value, it is best to use the INT type in Python

Chaos Example Code

```
# File: chaos.py

# A simple program illustrating chaotic behavior.

print("This program illustrates a chaotic function")

x = eval(input("Enter a number between 0 and 1: "))

for i in range(10):

    x = 3.9 * x * (1 - x)

    print(x)
```



** what happens if we set: $x = 3.9 * (x - x*x)$?

Type () function

- The `type()` function in python can be called to determine whether a value is an INT or a FLOAT

`x = 3`

`type(x)`

`y = -2.65`

`type(y)`

Numerical Operations

operator	operation
+	addition
-	subtraction
*	multiplication
/	float division
**	exponentiation
abs()	absolute value
//	integer division
%	remainder

Table 3.1: Python built-in numeric operations

/ (float division) vs. // (integer division)

- Dividing an INT by an INT with / produces a FLOAT
- To perform integer division: use //

ex:

$$10//3 = 3$$

`%`: remainder operation

`10 // 3 = 3`

`10 % 3 = 1`

round () function

- The `round()` function will round a float value to a specified number of decimal places.

```
x = 1/3
```

```
round_x = round(x)
```

```
round_x2 = round(x,2)
```

```
round_x_1 = round (x,-1)
```

```
print(round_x, round_x2, round_x_1, sep="\n")
```

int () and float () functions

```
x = int(3.0)
```

```
print(x)
```

```
y = float(5)
```

```
print(y)
```

Using int ()

`int(5.8) = 5`

Using the `int()` function does not round the number, but instead discards the fractional part.

The number is **truncated**, not rounded.

int () function to prevent code injection attacks

Idea: use int () instead of eval () to get whole number inputs

```
x = int(input("Enter a number between 0 and 10: "))
```

Python Libraries

- A library is a module that contains a set of functions.
- In order to use a library, we first have to tell python to import it.

`import library_name`

ex. `import math`

Python Package Index

- The Python Package Index (PyPI) is a repository of third-party modules for Python

Using Libraries in Google Colab

When using Google colab, you can usually type

```
import library_name
```

ex.

```
import math
```

or use:

```
!pip install library_name
```

Libraries with Anaconda/Spyder

If you try to import a library that you don't have installed, you will receive a “module not found error”.

```
ModuleNotFoundError: No module named 'beautifulsoup4'
```

Anaconda Navigator

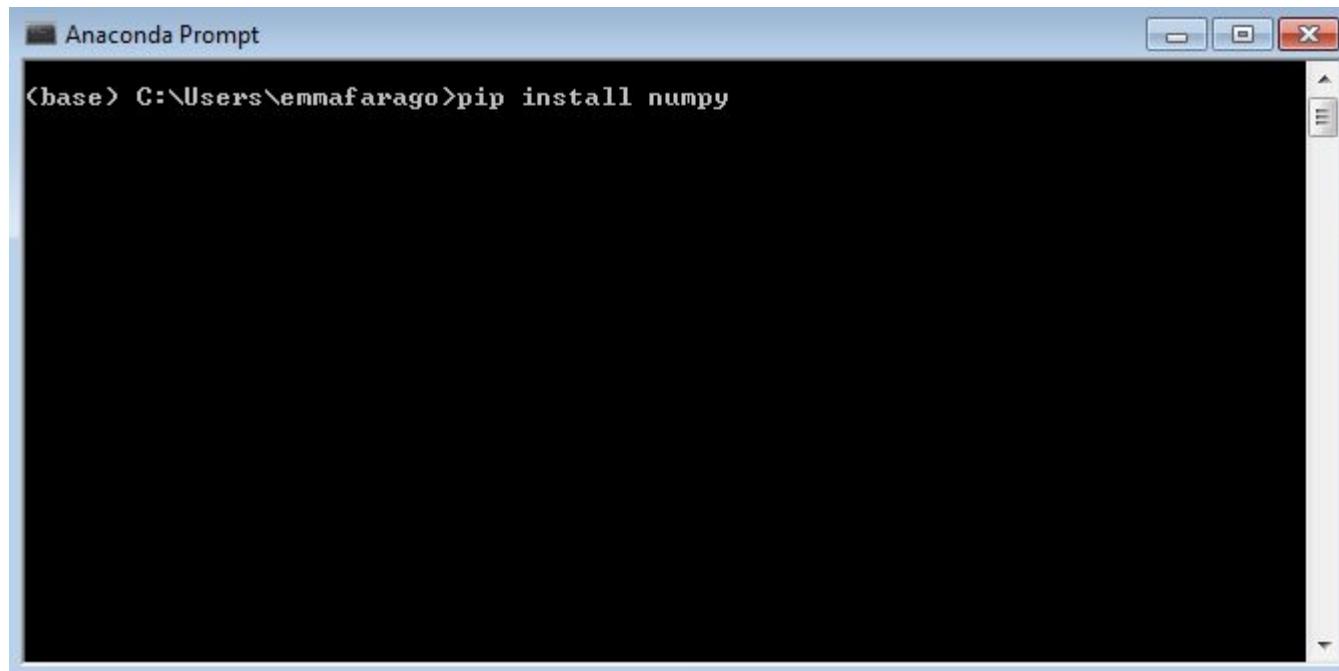
<https://docs.anaconda.com/anaconda/navigator/getting-started/>

The screenshot shows the Anaconda Navigator interface. On the left is a sidebar with icons for Home, Environments, Learning, and Community. The main area has a search bar for environments and another for packages. A dropdown menu shows 'Installed' selected. The central part displays a table of installed packages:

Name	Description	Version
_anaconda_depends		2019.03
_ipyw_jlab_nb_ex...	A configuration metapackage for enabling anaconda-bundled jupyter extensions	0.1.0
alabaster	Configurable, python 2+3 compatible sphinx theme.	0.7.12
anaconda	Simplifies package management and deployment of anaconda	2018.12
anaconda-client	Anaconda.org command line client library	1.7.2
anaconda-project	Tool for encapsulating, running, and reproducing data science projects	0.8.2
asn1crypto	Python asn.1 library with a focus on performance and a pythonic api	0.24.0
astroid	A abstract syntax tree for python with inference support.	2.1.0
astropy	Community-developed python library for astronomy	3.1
atomicwrites	Atomic File writer	1.2.1

PIP Package Manager

pip install library_name



Anaconda Prompt

```
(base) C:\Users\emmafarago>pip install numpy
```

Math Library*

*Should already be installed with Anaconda/Spyder

To use, write the code:

`import math`

at the top of your program.

Math library functions

Python	mathematics	English
<code>pi</code>	π	An approximation of pi.
<code>e</code>	e	An approximation of e .
<code>sqrt(x)</code>	\sqrt{x}	The square root of x .
<code>sin(x)</code>	$\sin x$	The sine of x .
<code>cos(x)</code>	$\cos x$	The cosine of x .
<code>tan(x)</code>	$\tan x$	The tangent of x .
<code>asin(x)</code>	$\arcsin x$	The inverse of sine x .
<code>acos(x)</code>	$\arccos x$	The inverse of cosine x .
<code>atan(x)</code>	$\arctan x$	The inverse of tangent x .
<code>log(x)</code>	$\ln x$	The natural (base e) logarithm of x .
<code>log10(x)</code>	$\log_{10} x$	The common (base 10) logarithm of x .
<code>exp(x)</code>	e^x	The exponential of x .
<code>ceil(x)</code>	$[x]$	The smallest whole number $\geq x$.
<code>floor(x)</code>	$[x]$	The largest whole number $\leq x$.

Table 3.2: Some math library functions

Library

Note: to reference a library function, you have to call it as follows:

library_name.function_name ()

```
import math  
print(math.sin(0.5))
```

Math Example 1: Area of a Circle

Update our old area of a circle program to make it better

```
r = eval(input("What is the radius? "))
```

```
Area = 3.14*r*r
```

```
print("The area is: ", Area)
```

Math Example 2:

```
import math

def main():

    a = float (input ("Enter coefficient a: "))

    b = float (input ("Enter coefficient b: "))

    c = float (input ("Enter coefficient c: "))

    discRoot = math.sqrt (b * b - 4 * a * c)

    root1 = (-b + discRoot) / (2 * a)

    root2 = (-b - discRoot) / (2 * a)

    print ("The solutions are: ", root1, root2 )

main ()
```

- a) What does this program do?
- b) How could this program be improved?

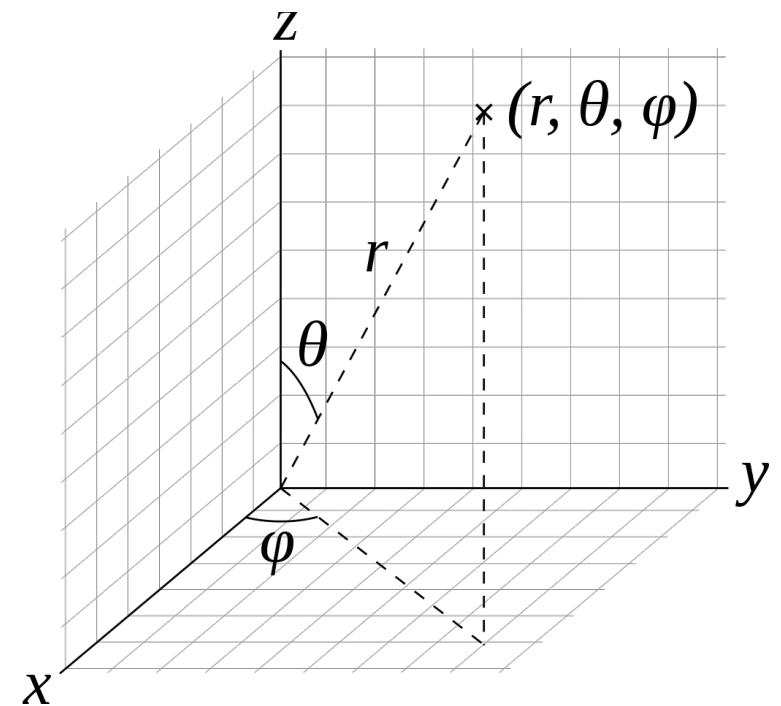
Math Example 3:

Develop a program that converts cartesian coordinates (x, y, z) into spherical coordinates (r, θ, φ) .

$$r = \sqrt{x^2 + y^2 + z^2},$$

$$\varphi = \arctan \frac{y}{x},$$

$$\theta = \arccos \frac{z}{\sqrt{x^2 + y^2 + z^2}}$$



Practice: Calculating Pi

Write a program that approximates the value of pi by summing the terms of this series: $4/1 - 4/3 + 4/5 - 4/7 + 4/9 - 4/11 + \dots$

The program should prompt the user for n, the number of terms to sum, and then output the sum of the first n terms of this series. Have your program subtract the approximation from the value of `math.pi` to see how accurate it is.