Building and Solving Linear Equations

In this lesson, you will learn how to build and solve a system of linear equations in Python.

WE'LL COVER THE FOLLOWING

- Building linear equations
- Solving the equations

The linear algebra module of NumPy, `linalg`, provides a number of functionalities, including the ability to solve systems of linear equations. This is done using the matrix method.

Suppose we have the following system of linear equations:

$$2x + 3y + z = 17$$

$$3x + 4y + 2z = 25$$

$$x + y - z = 6$$

We need to convert these to the form $AX = b$ and solve the equation for X.

$$\begin{bmatrix} 2 & 3 & 1 \\ 3 & 4 & 2 \\ 1 & 1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 17 \\ 25 \\ 6 \end{bmatrix}$$

Building linear equations

Before we can solve the system of linear equations, it is important to build these equations in a format that Python understands, by using any one of the array creation methods. Let's see an example of this:

```
import numpy as np

A = np.array([[2, 3, 1], [3, 4, 2], [1, 1, 1]]) # building a 2-D array
```

```
b = np.array([17, 25, 6])   # building a 1-D array

print(A)
print(b)
```

Solving the equations

The system may be solved with the `solve` method, which is part of the `linalg` subpackage of `numpy`. The `solve` method takes, as input, a two-dimensional array (the matrix) and a one-dimensional array (the right-hand side) and returns the solution.

```
import numpy as np

A = np.array([[2, 3, 1], [3, 4, 2], [1, 1, -1]])
b = np.array([17, 25, 6])

x = np.linalg.solve(A, b)
print(x)
```

To check whether the solution is correct, we need to multiply the matrix stored in the array `A` with the solution we are checking, which is `x`. We can use the `np.dot()` method to perform matrix multiplication on its input arguments. The order of input arguments does not matter as long as the matrices are compatible.

```
import numpy as np

A = np.array([[2, 3, 1], [3, 4, 2], [1, 1, -1]])
b = np.array([17, 25, 6])

x = np.linalg.solve(A, b)
print(np.dot(A, x))
```

Since the result equals matrix `b`, the solution is correct

The next lesson discusses how to find eigenvectors and eigenvalues of a matrix.