CS 132 – Geometric Algorithms
Notes on Linear Algebra in Python

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Floating Point. This is just a reminder, that, as already discussed, real numbers are approximated in the computer using "floating point" format, which is in general a number that is close but not necessarily exactly equal to the real number of interest. So, for example, it is not always true that `a - (b * (a/b))))` will be equal to zero when computed in Python.

Linear Algebra in Python. The linear algebra package we will use is `numpy`. Always import it as

```
import numpy as np
```

Matrices will always be represented as *numpy* arrays. Some important functions:

```
np.array
np.shape
np.readtxt
np.savetxt
```

Read the documentation on these before starting. Later there will be more functions from numpy that we will use. Get used to consulting the documentation!

A vector in `python` is a 1-D `numpy` array. For example, here the vector `x` has been constructed from a list of floats:

```
x = np.array([1.0, 2.0, 3.0])
```

A matrix in `python` is a 2-D `numpy` array. It behaves like a list of lists that correspond to rows. So you can construct a matrix like this:

```
A = np.array([[1.0, 2.0],[3.0, 4.0]])
```

Thus `A[0][0]` (or `A[0,0]`) is a single element of the array `A` (the element in the upper left corner), while `A[0]` is the first row of `A`. You can also use a colon (`:`) to mean "all indices." So another way to get the first row of `A` is `A[0,:]`, and to get the first column of `A`, you would use `A[:,0]`.

Numpy array types. Numpy assigns a type to each matrix – for example, `float` or `int`. If you enter a matrix by hand into the python interpreter, and all of the entries are integers, then numpy will auto-detect this as an integer matrix. When you assign values to an integer matrix they will be rounded to the nearest integer. This is **not** what you want. So you do **not** want to work with integer matrices in general.

So it is a good idea to make sure that the inputs your your functions are floating point matrices. To convert an integer matrix to a floating point matrix you can simply use:

```
A = A.astype(float)
```

Parameter Passing. Remember that parameter passing in `python` is by reference. Thus if you pass an array into a subroutine, and modify the array in the subroutine, the modifications will still be in effect after the subroutine exits (i.e., modifying an array creates side-effects).

For similar reasons, if A is an array, the code `B = A` does not create a new array B, but rather results in both A and B pointing to the same array. If you want to make an actual copy of an array or any object, use its `.copy()` method; i.e., write `B = A.copy()`.