Arrays

Some Inconsistent Terminology

- Vector
  - Mathematically
    - A geometrical object with a magnitude and a length
  - Computer Science and some programming languages (C++, Matlab)
    - A homogenous (all same type) ordered data structure with a variable length
  - Other languages (Fortran, Python)
    - A homogenous (all same type) ordered data structure with a fixed length; a one-dimensional array.

More Terminology

- List
  - Computer Science
    - "List" usually means "linked list." An ordered but *not* indexed list of arbitrary types
  - Some computer languages (e.g. Python)
    - A list is an ordered (indexed), inhomogeneous data structure. Like a "vector" in Matlab but elements need not be the same type.
  - Henceforth we will use the Python terminology for lists/arrays.

Arrays

- Arrays are ordered structures of fixed size. Each element can be referenced by its index.
- Arrays are native in Fortran; in particular, each rank is a *first-class* data type.

Fortran Arrays

- Arrays must be declared by type and either by size or by some indication of the number of dimensions.
  - We will do variable dimensions later

```
REAL, DIMENSION(100) :: A
```

By default the index starts at 1. However, it can start at any integer less than the upper bound:

```
REAL, DIMENSION(-1:101) :: A0
```

- Arrays may have zero size.

Array Elements

- Each element can be addressed by its index
- Fortran

  `A(3)`

  – Remember, starts at 1 by default

Subarrays

- Fortran

```
REAL, DIMENSION(100) :: A
REAL, DIMENSION(12)  :: B
A=0.0
B=A(1:12)
```

Array Operations

- In Fortran and NumPy the mathematical functions are *overloaded* to accept array arguments. They operate on the array(s) *elementwise*. Fortran examples:

```
T=3.0
I=(/1,0,0,0/)
A=3.14159*I
B=sin(A)
C=A/B
```

Important Fact to Remember #1

- FORTRAN IS NOT MATLAB
  - Depending on the compiler and circumstances, loops may be *faster* than array operations
  - There is no dynamic "list" or "vector" unless you create it, or use somebody else's module (I can give you such a module but note: "lists" are always slower than arrays)
  - Operations are elementwise. There are a few functions, specifically matmul and transpose, that operate on the entire array (these require two-dimensional arrays).