Lecture 19

An introduction to Matlab

What is Matlab?

• MATLAB, short for “matrix laboratory”, refers to both the numerical computing environment and to its core programming language.
• MATLAB allows one to easily manipulate matrices, plot functions and data, implement algorithms, create user interfaces, and interface with programs in other languages.
• It is used by more than one million people in industry and academia and runs on most modern operating systems, including Windows, Mac OS, Linux and Unix.

How does it work?

• It is an interactive language, interpreted on the fly.
  – (There is a compiler, but that isn’t the normal use)
• It is, at its heart, a matrix manipulation tool.
  – It has a gob of built in functions to do everything from multiply matrices to reading Microsoft excel files.
  – It is outstanding at generating plots and graphs.
• It supports many of the features we’ve been working with
  – Loops, if statements, structures, etc.
  – But they are often significantly different in actual use.

ex0.m: Array generation

```matlab
a=2;
b=[1 3 5];
x=(1:4);
y=[a b x]
x=(5:-2:-4)
bob=(x)'
linda=bob(2)
```
Basic array construction

• \([x_1, x_2, \ldots, x_n]\)
  – Concatenates the elements as columns
    • Any of the \(x\)'s can be arrays, but if so, they must all have the same number of rows.

• \((x:y)\)
  – Make an array of values (with 1 row)
    • So \((1:4)\) is \([1 \ 2 \ 3 \ 4]\)

• \((z:a:y)\)
  – As above, but count by \(a\).
    • So \((1:2:6)\) is \([1 \ 3 \ 5]\)

More arrays

• \((x)'\) is the transpose of \(x\).
  – So rows become columns
  – (This is actually the complex transpose!)

• \([1;2;3;4]\)
  – This is the transpose of \([1 \ 2 \ 3 \ 4]\)

ex1.m: Array manipulation

```matlab
base = rand(1, 4);
real = base * 6;
d6 = ceil(real);
roll = sum(d6) - min(d6)
```

building

• rand() is a built in “matrix builder” function. Others include:
  – ones() – all ones
  – zeros() – all zeros
  – randn() – random numbers with zero mean and unit variance
  – eye() – identity matrix
Matrix-scalar

- Matrix scalar operations in general involve the operation being applied to each element.
  - So if A=[1 2; 3 4] and b=3
  - A+b = [4 5; 6 7]
- Some functions, like ceil(), are scalar operations that apply to each element.
- `sum()` and `min()` are functions that work on one dimension of an array
  - In general they work on columns. But if there is only one row, will operate on rows.

Scalar-scalar

- Just like C++.
  - `sum(d6)−min(d6)`
  - Both are scalars.

ex2.m: more array manipulation

```matlab
base=rand(4,100000);  
real=base*6;          
d6=ceil(real);        
roll=sum(d6)−min(d6); 
bins=(3:18);          
hist(roll,bins)      
rr=(roll);            
mean(rr)              
median(rr)
```

- `base=rand(4,100000);`
  - Big array (and a good time not to forget the “;”)
  - Changed so 4 rows, 100,000 columns instead of 1 row, 4 columns.
- Did this so `sum()` and `min()` would work as they “prefer” to operate on columns
- Notice the next 3 lines are unchanged!
• Next, want to graph it.
  – Each graphing function is a bit different.
  – hist(x,y) graphs a histogram of data in x using bins in the array y.

• Finally, compute mean and median.
  – Note, using rows now as only 1 row!

```matlab
biglist=xlsread('exam1scores.xls');
section=biglist(:,1);
scores=biglist(:,7);
one=(101:109);
two=(201:209);
both=[one two];
i=0;
for x=both
  i=i+1;
  idx=find(section==x);
  list=scores(idx);
  a(i)=mean(list);
end
```