Matlab

- Variables are 2D arrays (matrices). Vectors/1D arrays are matrices/2D arrays with a single row or column
- `a = [1 2 3]` will assign vector/1D array `[1 2 3]` to variable `a` and print the result
- End command with a semicolon e.g. `a = [1 2 3];` to avoid printing result

Colon generates number sequence:
- `11:14` generates 11 12 13 14
- `-1:1` generates -1 0 1
- `3:0` generates Empty matrix

Specify step size with second colon:
- `1:3:12` generates 1 4 7 10
- `4:-1:1` generates 4 3 2 1
- `3:-0.5:2` generates 3.0 2.5 2.0
Variables

- $a = [1:3]$ same as $a = [1 2 3]$
- Access element 3 of vector $a$ using $a(3)$ e.g. $a(3) = 4$ produces $a = [1 2 4]$
- `end` is the highest index value e.g. $a(end)$ is 4
- Using just ":" is equivalent to $1:end$

Select rows, columns of $a$:

- $a = [1 2 3]$;
- $a(1,:)$ is 1st row 1 2 3
- $a(:,1)$ is 1st column 1

Access multiple elements of $a$:

- $a = [1 2 3]$;
- $a(1:2)$ is 1 2
- $a([1 3])$ is 1 3
Use [ ] to build new arrays:
- \( a = [1 \ 2 \ 3] \);
- \( [a \ 4 \ 5] \) is 1 2 3 4 5

Use ";" to add rows:
- \( a = [1 \ 2 \ 3] \);
- \( [a; \ 4 \ 5 \ 6] \) is matrix/2D array:
  1 2 3
  4 5 6

Using conditions:
- \( a = [1 \ 2 \ 3] \);
- \( a > 2 \) is binary vector 0 0 1
- \( \text{find}(a>2) \) returns index 3
Operations

Operations + add, - subtract, * multiply, / divide work on vectors/matrices:

- \(a=[1 \ 2 \ 3]; \ b=[4 \ 5 \ 6];\)
- \(a+b\) is \(5 \ 7 \ 9\)
- \(a-b\) is \(-3 \ -3 \ -3\)
- \(a*2\) is \(2 \ 4 \ 6\)
- \(a*b\) gives an error since its a vector multiply
- Use "." to make multiply and divide apply element by element i.e. \(.*\) and \(./\)
- \(a.*b\) is \(4 \ 10 \ 18\)
- \(a./b\) is \(0.25 \ 0.40 \ 0.50\)
- \(a.^2\) raises the elements of \(a\) to the power 2 giving \(1 \ 4 \ 9\)
Operations

Functions $\sin()$, $\cos()$, $\exp()$ etc work on vectors/matrices:

- $a=[1 \ 2 \ 3]$;
- $\sin(a)$ is $0.8415 \ 0.9093 \ 0.1411$
- $\exp(a)$ is $2.7183 \ 7.3891 \ 20.0855$

Use $\text{rand()}$ to generate random numbers uniformly distributed between 0 and 1

- E.g. $\text{rand}$ might return $0.8147$ on first call and $0.1270$ on second call
- $\text{rand}(1,n)$ returns a vector of $n$ random numbers
- E.g. $\text{rand}(1,5)$ might return $0.9134 \ 0.6324 \ 0.0975 \ 0.2785 \ 0.5469$
x=[0:0.1:6]; plot(x,sin(x))

x=rand(1,10000); hist(x)

- hist(x) calculates the number of times values occur in vector \( x \) and plots as histogram.
- Defaults to using 10 “bins”, but can change this to use \( y \) by hist(x,y).
Useful Functions

- `help <command>`
- Comparisons: `==, =, >, <, >=, <=`
- Sizes of vectors/matrices: `length, size`
- `zeros, ones` all zeros and all ones vectors
- `xlim, ylim` plot axes ranges
- `xlabel, ylabel, title` plot labels
- `figure` open new figure

- `sum` sum up elements of a vector
- `mean, var` mean and variance of elements of a vector
- `find` find indices
- `nchoosek` return number of ways in which `k` objects can be drawn from a set of `n` objects
- `load, save` load and save data from file
Conditions and Loops

**Conditions:**
if <condition>
   <statement>
else
   <statement>
end

```
a=1; b=2
if a>b
   disp(a)
else
   disp(b)
end
```

**Loops:**
for <variable> = <vector>
   <statement>
end

```
for i=1:10
   disp(i)
end
```
Exercises

1. Generate $n = 10$ random numbers using `rand` function and calculate their sum.
2. Repeat above to calculate random sum 100 times (it will change each time since it's random) and plot a histogram of the values of the sum.
3. Now generate $n = 1000$ random numbers using `rand` function and calculate their sum. Repeat 100 times and plot a histogram of the values of the sum. How has it changed?
4. Rather than plotting histogram of sums, plot histogram of sums divided by $n$ (so divided by 10 in first case and by 1000 in second case). How do they differ?
Exercises (extra)

1. Write a matlab program to enumerate all the different ways we can arrange the letters in the word “abc”.