Intro to MATLAB

MATLAB is a programming language and a computing environment. MATLAB is short for **Matrix Laboratory** and is especially useful for vector and matrix computations. Octave Online uses the MATLAB language in a web-based environment. We'll look at some basic MATLAB commands and practice them in Octave Online.

Octave Online can be found at:
https://octave-online.net

Example 1: Creating a row vector.
This command creates a row vector. The semicolon suppresses any output.

```
>> v = [1 2 3];
```

To view any object type its name:

```
>> v
```

We could have typed the following to create and view the row vector.

```
>> v = [1 2 3]
```

Example 2: Creating a column vector.

```
>> u = [1; 2; 3]
```

Example 3: Calculating the length of a vector.

```
>> a = [1 2 3];
>> norm(a)
ans = 3.7417
```

Example 4: Calculating the dot product.

```
>> a = [1 2 3];
>> b = [3 2 1];
>> dot(a,b)
ans = 10
```

Example 5: The arccosine function.
>> acos(0.5)
ans = 1.0472
>> acosd(0.5)
ans = 60
Notice that the command acos(0.5) returns the angle in radians whereas acosd(0.5) returns the angle in degrees.

Example 6: Multiplying, Exponentiating and Dividing Real Numbers.
>> 237 * 143
ans = 33891
>> 123 ∧ 2
ans = 15129
>> 237/143
ans = 1.6573

Example 7: Handling Fractions and Decimal Places.
format rat gives output as simplified fractions.
format short gives output to a few significant figures (typically five).
format long gives output to many significant figures (typically 16).
>> format rat
>> 65536/24
ans = 8192/3

>> format short
>> 65536/24
ans = 2730.7

>> 3456 * 5678
ans = 1.9623e+07
Meaning 1.9623×10^7

>> format long
>> 65536/24
ans = 2730.666666666667

Example 8: Let's put together some of the previous concepts. Calculate the angle between $\mathbf{u} = [9, 8, 7]$ and $\mathbf{v} = [1, -3, 4]$. Give your answer in radians.

Recall that the formula for the angle is $\theta = \arccos(\frac{\mathbf{u} \cdot \mathbf{v}}{||\mathbf{u}|| \; ||\mathbf{v}||})$.

```
>> format short
>> u = [9 8 7];
>> v = [1 -3 4];
>> acos( dot(u,v) / ( norm(u) * norm(v) ) )
ans = 1.3867
```

Example 9: Calculating the cross product.

```
>> a = [1 2 3];
>> b = [3 2 1];
>> cross(a,b)
ans = -4 8 -4
```

Meaning the cross product is the vector [-4, 8, -4].

Example 10: Creating a matrix.

We use semicolons to end each row, except the last row.

```
>> A = [1 2 3; 4 5 6; 7 8 9]
```

To suppress the output we would type:

```
>> A = [1 2 3; 4 5 6; 7 8 9];
```

Example 11: Matrix Operations.

Suppose we have the following two matrices:

```
>> A = [3 9; 1 6];
>> B = [8 2; -1 5];
```

Let's compute: $2A,\ \frac{1}{3}A,\ A + B,\ A - B,\ AB,\ A^2,\ A^T$.

Note that the command for A^T is A'.

```
>> 2*A
>> A/3
>> A+B
>> A-B
>> A*B
>> A ∧ 2
>> A'
```

Example 12: Vector operations.
Vector operations are special cases of matrix operations.
Suppose we have the following vectors:

```
>> u = [7 8 9];
>> v = [3 -4 5];
```

Let's compute $2\mathbf{u},\ \frac{1}{3}\mathbf{u},\ \mathbf{u}+\mathbf{v},\ \mathbf{u}-\mathbf{v}, \mathbf{u}^T$.

```
>> 2*u
>> u/3
>> u+v
>> u-v
>> u'
```

Example 13: Consider the plane passing through A = (2, 1, 0), B = (1, 2, 3), and C = (4, 5, 6). Find a normal vector to the plane.

Recall that $\mathbf{n} = \vec{AB} \times \vec{AC}$.

```
>> a = [2 1 0];
>> b = [1 2 3];
>> c = [4 5 6];
>> ab = b-a;
>> ac = c-a;
>> cross(ab, ac)
ans = -6 12 -6
```

Meaning a normal vector is [-6, 12, -6].

Example 14: Calculating determinants.

```
>> A = [1 7 -3; 4 6 1; 2 5 6];
>> det(A)
ans = -147
```

Example 15: Calculating the inverse of A (provided det $A \neq 0$).

```
>> A = [1 7 -3; 4 6 1; 2 5 6];
>> inv(A)
```

Example 16: Solve the following system using A^{-1}.

$$\begin{aligned} 9x + 2y &= 48 \\ 3x - 8y &= -36 \end{aligned}$$

We'll use the formula $\mathbf{x} = A^{-1}\mathbf{b}$.

```
>> A= [9 2; 3 -8];
>> b = [48; -36];
>> inv(A)*b
```

The output is:
4
6
Meaning the solution is $x = 4, y = 6$.

Example 17: RREF of a Matrix.

```
>> A= [1 2 3; 3 2 1; 1 1 1];
>> rref(A)
```

Example 18: Solve the system by finding the RREF:

$$\begin{aligned} 9x + 2y &= 48 \\ 3x - 8y &= -36 \end{aligned}$$

We build an augmented matrix with the constants in the last column.

```
>> A= [9 2 48; 3 -8 -36];
>> rref(A)
```

The output is the following augmented matrix. Note that MATLAB does not draw the vertical bar before the last column.
1 0 4
0 1 6
Meaning the solution is $x = 4, y = 6$.

Example 19: Solve the system by finding the RREF:

$$\begin{aligned} 3x + 6y &= 24 \\ 2x + 7y &= 25 \\ 4x + \ y &= 26 \end{aligned}$$

We build an augmented matrix with the constants in the last column.
>> A= [3 6 24; 2 7 25; 4 1 26];
>> rref(A)
The output is the following augmented matrix. Note that MATLAB does not draw the vertical bar before the last column.
1 0 0
0 1 0
0 0 1
The last equation reads $0x + 0y = 1$.
The system has no solution.