# BL5229: Data Analysis with Matlab
# Lab: Graphing and Programming

With this lab, you will do some programming as well as practice plotting

## Exercise 1: *Checking if a matrix is magic.*

A magic square is a square that produces the same sum, when its elements are added row-wise, column-wise or diagonally (both main diagonal and anti-diagonal). A matrix is magic if it represents a magic square. For example,

$$M = \begin{bmatrix} 16 & 2 & 3 & 13 \\ 5 & 11 & 10 & 8 \\ 9 & 7 & 6 & 12 \\ 4 & 14 & 15 & 1 \end{bmatrix}$$

is a magic matrix with sum = 34.

Write a small program that checks if a matrix of any size is magic.

**Get program checkmagic.m from web page**

## Exercise 2: *Challenge: sum of Fibonacci numbers.*

Remember the Fibonacci sequence from Lab 1. As a reminder, it is defined as follows:

$$F_n = \begin{cases} 1, & n = 1 \\ 1, & n = 2 \\ F_{n-1} + F_{n-2}, & n \geq 3 \end{cases}$$

Write a MATLAB script that computes the sum of the Fibonacci numbers $F_n$, for n between 1 and a given number N, with $F_n$ being a multiple of 2 or 5.

For example, when $N = 5$, only $F_3$ and $F_5$ are multiples of 2 or 5, and the sum is: $S = F_3 + F_5 = 7$.

Check your program for $N = 10$, 15, 20, and 30 (in which cases $S = 104$, 858, 10207, and 1171004).

**Get program Fibosum.m from web page**

## Exercise 3: *Analyzing biological data*

A simple experiment was designed to analyze the effects of noise on gene expression within a cell: a cell has been engineered to contain two genes (which we will label as C and Y) that are supposed to be expressed identically. In the presence of noise however, the expression levels will differ. There are two possible source of noise:

- extrinsic noise: noise related to all external factors that may affect gene expression
- intrinsic noise: noise related to the gene expression machinery itself.

Two different experiments were conducted, each with a different type of cell. In experiment 1, data (i.e. expression levels for C and Y) were collected for 30 cells, while in experiment 2, data were available for 37 cells. The raw data are in the two files available on the web site.

Write a Matlab script for analyzing these data:

1) Generate a plot (scattered plot) of Y as a function of C for each experiment

2) Compute the levels of intrinsic, $h_{int}^2$, extrinsic, $h_{ext}^2$, and total $h_{tot}^2$ noise in each experiment. You will use the formula:

$$\eta_{\text{int}}^2 = \frac{\left\langle (c-y)^2 \right\rangle}{2\langle c\rangle\langle y\rangle}; \quad \eta_{ext}^2 = \frac{\langle cy\rangle - \langle c\rangle\langle y\rangle}{\langle c\rangle\langle y\rangle}; \quad \eta_{tot}^2 = \frac{\left\langle c^2+y^2 \right\rangle - 2\langle c\rangle\langle y\rangle}{2\langle c\rangle\langle y\rangle}$$

```
% Load data
%
load Data_exp1.dat
load Data_exp2.dat
%
% get columns:
%
C1 = Data_exp1(:,1);
Y1 = Data_exp1(:,2);
C2 = Data_exp2(:,1);
Y2 = Data_exp2(:,2);
%
% Plot both curves on the same page
%
figure
subplot(2,2,1)
plot(C1,Y1,'or')
axis([0.5 2.5 0 4]);
xlabel('C')
ylabel('Y')
title('Experiment 1')
subplot(2,2,2)
plot(C2,Y2,'or')
```

```
axis([0.5 2.5 0 4]);
xlabel('C')
ylabel('Y')
title('Experiment 2')
%
% Compute noise levels for each experiment
%
cy_mean1 = mean(C1)*mean(Y1);
num1=mean((C1-Y1).^2);
den1 = 2*cy_mean1;
noise_int1 = num1/den1;
num1 = mean(C1.*Y1)-cy_mean1;
den1 = cy_mean1;
noise_ext1 = num1/den1;
num1=mean(C1.^2 + Y1.^2)-2*cy_mean1;
den1 = 2*cy_mean1;
noise_tot1 = num1/den1;
%
cy_mean2 = mean(C2)*mean(Y2);
num1=mean((C2-Y2).^2);
den1 = 2*cy_mean2;
noise_int2 = num1/den1;
num1 = mean(C2.*Y2)-cy_mean2;
den1 = cy_mean2;
noise_ext2 = num1/den1;
num1=mean(C2.^2 + Y2.^2)-2*cy_mean2;
den1 = 2*cy_mean2;
noise_tot2 = num1/den1;
```