# MATLAB Brush Up Course
# Practice Set 3

by Joan Margalef

10.01.2024

## Problem 1: Symbolic Mathematics

1. Differentiating, Integrating, and Evaluating a Symbolic Function:

   - Define a symbolic expression $f(x) = \cos(x) - x^3$.
   - Differentiate $f(x)$ with respect to $x$ and evaluate the derivative at $x = \frac{\pi}{4}$.
   - Integrate $f(x)$ with respect to $x$ over the interval from 0 to $\pi$.
   - Display the results of both the differentiation and integration.

2. Solving Symbolic Equations:

   - Define and solve the equation $x^3 - 3x^2 + 2 = 0$ symbolically.
   - Display the solutions.
   - Define and solve the following system of equations symbolically:

$$\begin{aligned} 2x + 3y - z &= 1, \\ -x + y + z &= 3, \\ x - 2y + 3z &= -1. \end{aligned}$$

   - Display the solutions for $x$, $y$, and $z$.

## Problem 2: Anonymous Functions and Optimization

1. Utility Function Evaluation and Optimization

   Define an anonymous function $U(c) = \sqrt{c}$, where $c$ represents consumption.

   (a) Evaluate this function at $c = 25$.

2. Unconstrained Utility Maximization

   Consider a utility maximization problem for an individual with the utility function $U(x, y) = 2\sqrt{x} + 3\sqrt{y}$, where $x$ and $y$ represent quantities of two goods.

   (a) Define the utility function as an anonymous function in MATLAB.

(b) Use `fminunc` to find the optimal quantities of $x$ and $y$ that maximize utility, starting from an initial guess of $x = 1$ and $y = 1$.

(c) Is something weird happening?

3. Constrained Optimization Problem

   Consider a cost function $C(x_1, x_2, x_3, x_4, x_5) = 2x_1^2 + 3x_2^2 + x_3^2 + 4x_4 + 5x_5$ representing the total cost involving five different inputs. The objective is to minimize this cost function subject to the following constraints:

   (a) Inequality constraints:

   - $x_1 + 2x_2 + x_3 \leq 50$
   - $2x_4 + 3x_5 \leq 40$

   (b) Equality constraint:

   - $x_1 + x_2 + x_3 + x_4 + x_5 = 60$

   (c) Lower bounds: $x_1, x_2, x_3, x_4, x_5 \geq 0$

   (d) Upper bounds: $x_1, x_2, x_3 \leq 20$, $x_4 \leq 15$, $x_5 \leq 10$

## Problem 3: Local Functions

1. Temperature Conversion Function

   - Create a local function named `convertTemperature` that converts temperatures between Fahrenheit and Celsius.
   - The function should take three arguments: the temperature value, the current temperature scale ('F' or 'C'), and the target scale to convert to ('F' or 'C').
   - Test this function by converting 32°F to Celsius and 100°C to Fahrenheit.

2. Present Value Calculation

   - Write a local function named `calculatePresentValue` that calculates the present value of a series of future cash flows.
   - The function should accept three arguments: a vector of cash flows, the interest rate (as a decimal), and the number of periods.
   - The function should return the present value of the cash flows, assuming they occur at the end of each period.
   - Test this function with the following data: Cash flows of \$100, \$200, \$300 over 3 years and an annual interest rate of 5%.