EECS 16A Designing Information Devices and Systems I
Spring 2020 Discussion 1B

1. Linear or Nonlinear

Determine whether the following functions (f: $\mathbb{R}^2 \to \mathbb{R}$) are linear or nonlinear.

(a)
$$f(x_1, x_2) = 3x_1 + 4x_2$$

(b)
$$f(x_1, x_2) = e^{x_2} + x_1^2$$

(c)
$$f(x_1, x_2) = x_2 - x_1 + 3$$

2. Solving Systems of Equations

(a) Systems of linear equations can either have one solution, an infinite number of solutions, or no solution at all. For the following systems of equations, state whether there is a unique solution, no solution, or an infinite number of solutions. If there are an infinite number of solutions give one possible solution.

i. $\begin{cases} 49x + 7y = 49 \\ 42x + 6y = 42 \end{cases}$

ii. $\begin{cases} 5x + 3y = -21 \\ 2x + y = -9 \end{cases}$

iii. $\begin{cases} 49x + 7y = 60 \\ 42x + 6y = 30 \end{cases}$

iv. $\begin{cases} 2x + 2y + 4z = -1 \\ y + z = -2 \\ x + 2y + 3z = 2 \end{cases}$

v. $\begin{cases} 2x + 2y + 4z = 6 \\ y + z = 1 \\ x + 2y + 3z = 4 \end{cases}$

vi. $\begin{cases} x + y + z = 4 \\ 3z = 6 \\ y + z = 3 \end{cases}$

(b) Systems of equations can also be interpreted graphically. We will try to build a graphical intuition for the results you found in the previous part. Follow along as your TA walks through `dis1B.ipynb`.

3. Vectors Introduction to vectors and vector addition.

Definitions:
Vector: An ordered list of elements - for example:

$$\vec{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} \in \mathbb{R}^n$$

$\mathbb{R}$ or $\mathbb{R}^1$: The set of all real numbers (i.e. the real line)
$\mathbb{R}^2$: The set of all two-element vectors with real numbered entries (i.e. plane of 2×1 vectors) - for example:

$$\vec{v} = \begin{bmatrix} 2 \\ 5 \end{bmatrix} \in \mathbb{R}^2$$

$\mathbb{R}^3$: The set of all three-element vectors with real numbered entries (i.e. 3-space of 3×1 vectors) - for example:

$$\vec{v} = \begin{bmatrix} 3 \\ 1 \\ 4 \end{bmatrix} \in \mathbb{R}^3$$

$\mathbb{R}^n$: The set of all n-element vectors with real numbered entries (i.e. n-space of $n \times 1$ vectors)

(a) Are the following vectors in $\mathbb{R}^2$?

i. $\begin{bmatrix} 3 \\ 6 \end{bmatrix}$

ii. $\begin{bmatrix} 5 \\ 0 \\ 3 \end{bmatrix}$

(b) Graphically show the vectors:

i. $\begin{bmatrix} 2 \\ 5 \end{bmatrix}$

ii. $\begin{bmatrix} 5 \\ 2 \end{bmatrix}$

(c) Graphically show the vector sum and check your answer algebraically:

$$\begin{bmatrix} 1 \\ 2 \end{bmatrix} + \begin{bmatrix} 4 \\ 3 \end{bmatrix}$$