# Course 1: Linear Algebra for Machine Learning & Data Science
# Overview

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# 1 System of linear equations: 2 variables

## 1.1 System of sentences

### 1.1.1 What is a system of sentences?

- A system of sentences is just a group of sentences
- Example 1: A system of 2 sentences

| System 1 | System 2 | System 3 |
|---|---|---|
| The dog is **Black** | The dog is **Black** | The dog is **Black** |
| The cat is **Orange** | The dog is **Black** | The dog is **White** |

- Example 2: A system of 3 sentences

| System 1 | System 2 | System 3 | System 4 |
|---|---|---|---|
| The dog is **Black** | The dog is **Black** | The dog is **Black** | The dog is **Black** |
| The cat is **Orange** | The dog is **Black** | The dog is **Black** | The dog is **White** |
| The bird is **Red** | The bird is **Red** | The dog is **Black** | The bird is **Red** |

### 1.1.2 New concepts

1. Complete, Redundant, Contradictory
   - **Complete:** when *number of pieces of information = number of sentences*
     Example: Ex1 - System 1, Ex2 - System 1
   - **Redundant:** when there are same sentences
     Example: Ex1 - System 2, Ex2 - System 2, Ex2 - System 3
   - **Contradictory:** when there are sentences contradict each other
     Example: Ex1 - System 3, Ex2 - System 4
2. Singular & non-Singular
   - **Singular**: when the system is Complete
   - **non-Singular**: when the system is not Complete

## 1.2 System of equations

### 1.2.1 From sentences to equations

| **Sentences** | **Sentences with numbers** | **Equations** |
|---|---|---|
| The dog is black | The price of an apple and a banana is \$10 | $a + b = 10$ |

### 1.2.2 Systems of equations

| **System 1** | **System 2** | **System 3** |
|---|---|---|
| $a + b = 10$<br>$a + 2b = 12$ | $a + b = 10$<br>$2a + 2b = 20$ | $a + b = 10$<br>$2a + 2b = 24$ |
| **Unique Solution** | **Infinite solutions** | **No solution** |
| $a = 8$<br>$b = 2$ | $a = 8, 7, 6, ...$<br>$b = 2, 3, 4, ...$ | |
| **Complete** | **Redundant** | **Contradictory** |
| *Non-singular* | *Singular* | *Singular* |

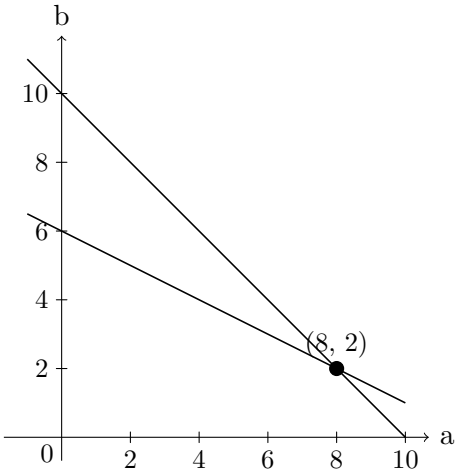
### 1.2.3 What is a linear equation?

| Linear | non-Linear |
|---|---|
| $a + b = 10$ | $a^2 + b^2 = 20$ |
| $3.4a - 48.99b + 2c = 122.5$ | $ab^2 + \frac{b}{a} - \frac{3}{b} - \log c = 4^a$ |

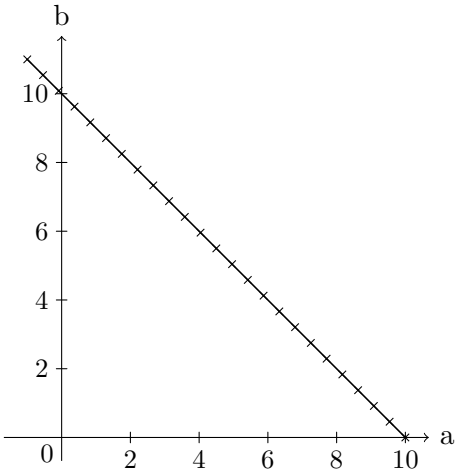
**→ Linear Algebra is the study of Linear equations**

## 1.3 System of equations as lines

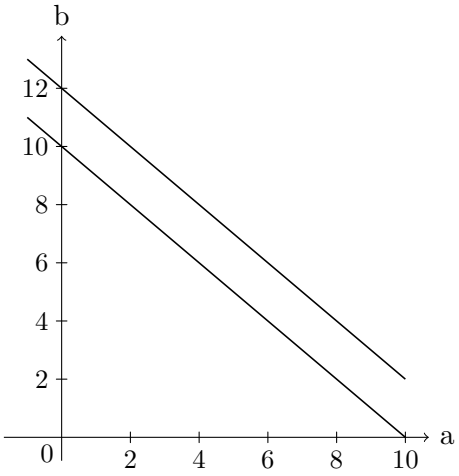
| System 1 | System 2 | System 3 |
|---|---|---|
| $a + b = 10$<br>$a + 2b = 12$ | $a + b = 10$<br>$2a + 2b = 20$ | $a + b = 10$<br>$2a + 2b = 24$ |
| **Unique Solution** | **Infinite solutions** | **No solution** |
| $a = 8$<br>$b = 2$ | $a = 8, 7, 6, ...$<br>$b = 2, 3, 4, ...$ | |
| **Complete** | **Redundant** | **Contradictory** |
| *Non-singular* | *Singular* | *Singular* |




**Hình 1:** System 1




**Hình 2:** System 2




**Hình 3:** System 3

# 2 System of linear equations: 3 variables