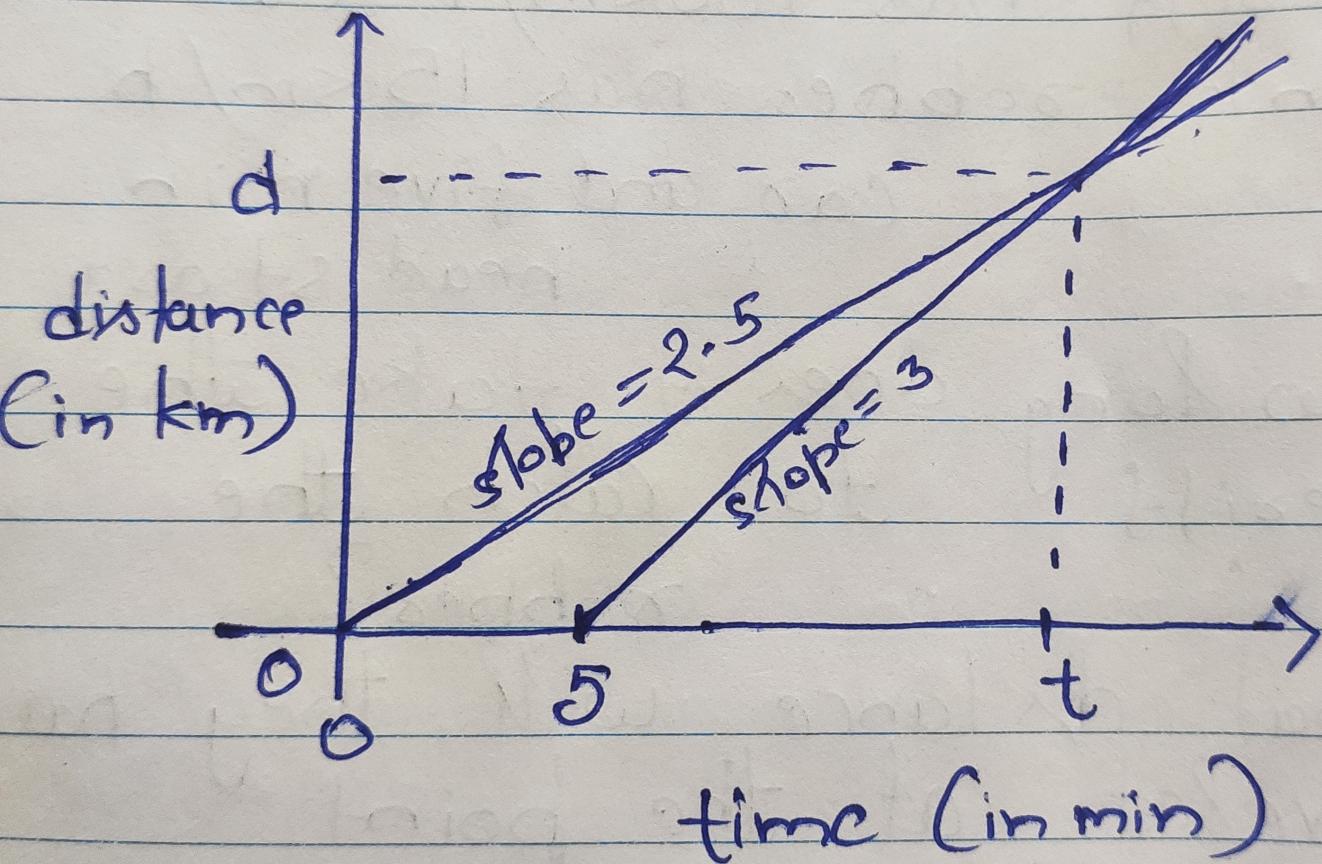


Contemporary applications

- Solving for unknowns in ML algos, including deep learning.
- Reducing dimensionality [e.g. principal component analysis]
- Ranking results [e.g. with eigenvectors]
- Recommenders [e.g., Singular value decomposition, SVD]
- Natural Language processing [e.g., SVD, matrix factorization]
- Topic modeling
- Semantic analysis

Problem could be solved graphically with a plot.

[Note that : $150 \text{ km/h} = 2.5 \text{ km/min}$
 $(180 \text{ km/h} = 3 \text{ km/min})$



Alternatively, problem can be solved algebraically

$$\text{Equation 1: } d = 2.5t$$

$$\text{Equation 2: } d = 3(t-5)$$

$$2.5t = 3(t-5)$$

$$2.5t = 3t - 15$$

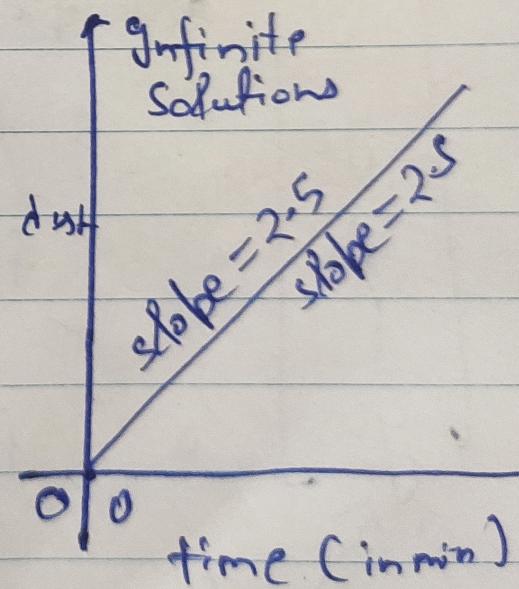
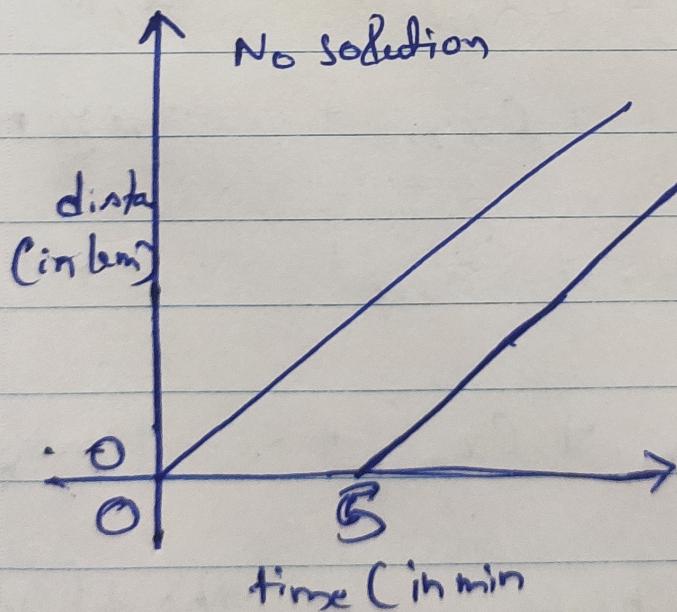
$$2.5t - 3t = -15$$

$$-0.5t = -15$$

$$t = -15 / -0.5 = 30 \text{ min}$$

No Solution: if sheriff car is same speed as bank robber's

Infinite solutions: if same speed and same starting time



There are the only three options in linear algebra

three options:
one & no,
or infinite
solutions.

In a given system of equations.

- Could be many equations
 - Could be many unknowns

in each equation

$$y = a + f x_1 + c x_2 + \dots + m x_n$$

These can be many features

$$y = a + bx_1 + cx_2 + \dots + mx_m$$

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} a + f x_{1,1} + c x_{1,2} + \dots + m x_{1,m} \\ a + f x_{2,1} + c x_{2,2} + \dots + m x_{2,m} \\ \vdots \\ a + f x_{n,1} + c x_{n,2} + \dots + m x_{n,m} \end{bmatrix}$$

For any house i in the dataset
 y_i = price and $x_{i1}, x_{i2}, \dots, x_{im}$ are its features
 we solve for parameters a, b, c to

Solving for unknowns within System of linear eq

Consider the following example:

- Sheriff has 180km/h car.
- Bank robber has 15km/h car and five min head start
- How long does it take the sheriff to catch the robber?
- What distance will they have traveled at the point
- [For simplicity, lets ignore acc, + traffic) etc

What is Linear Algebra. I.e.
Algebra is arithmetic that
includes non-numerical
entities like x

$$2x + 5 = 25$$

$$2x + 5 - 5 = 25 - 5$$

$$2x = 20$$

$$2x/2 = 20/2$$

$$x = 10$$

We have determined x must
equal 10 because $2(10) + 5$
 $= 25$

If it has an exponential term
it isn't linear algebra, e.g:

$$2x^2 + 5 = 25$$

$$2\sqrt{x} + 5 = 25$$

Linear Algebra

- 1) Data Structures & Algebra
- 2) Common Tensor Operations
- 3) Matrix Properties

- What is Linear Algebra is
- Brief History of Algebra
 - Tensors
 - Scalars
 - Vectors and Vector Transposition
 - Norms and Unit Vectors
 - Basis, Orthogonal, and Ortho-normal Vectors
- Arrays in Numpy
- Matrices
- Tensors in TensorFlow and PyTorch