

5. Given the system of linear equations  $Ax=b$ , where  $A \in \mathbb{R}^{n \times n}$  is an invertible matrix &  $b \in \mathbb{R}^n$ . Also,  $A$  is orthogonal.

Since the matrix  $A$  is orthogonal, it implies that the columns of  $A$  are linearly independent and also, more importantly, ~~the column~~ we have  $n$  linearly independent vectors in  $\mathbb{R}^n$ , hence they can be said to form a basis of  $\mathbb{R}^n$ .

Thus, we can say that  $b \in \text{colspace}(A)$  always.

Since  $A$  is invertible, we have a solution

$$x = A^{-1}b.$$

But as  $A$  is orthogonal,

$$AA^T = A^T A = I,$$

hence,  $A^{-1} = A^T$

So, the solution will be  $\boxed{x = A^T b}$ .

Thus, the advantages that we get from  $A$  being orthogonal are that there is always guarantee to be a solution  $x$  to  $Ax=b$ , and more importantly, we are saved from the burden of calculating the inverse, as the inverse of an orthogonal matrix is simply its transpose.