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### **Machine Learning with Python-From Linear Models to Deep Learning**

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## 12. Linear Independence, Subspaces and Dimension (Optional)

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Vectors  $\mathbf{v}_1, \dots, \mathbf{v}_n$  are said to be **linearly dependent** if there exist scalars  $c_1, \dots, c_n$  are zero and (2)  $c_1 \mathbf{v}_1 + \dots + c_n \mathbf{v}_n = 0$ .

Otherwise, they are said to be **linearly independent**: the only scalars  $c_1, \ldots, c_n$  that  $c_1 \mathbf{v}_1 + \cdots + c_n \mathbf{v}_n = 0$  are  $c_1 = \cdots = c_n = 0$ .

The collection of non-zero vectors  $\mathbf{v}_1,\ldots,\mathbf{v}_n\in\mathbb{R}^m$  determines a **subspace** of  $\mathbb{R}^m$ , linear combinations  $c_1\mathbf{v}_1+\cdots+c_n\mathbf{v}_n$  over different choices of  $c_1,\ldots,c_n\in\mathbb{R}$ . The subspace is the size of the **largest possible**, **linearly independent** sub-collection of the  $\mathbf{v}_1,\ldots,\mathbf{v}_n$ .

## Row and Column Rank (Optional)

0 points possible (ungraded)

Suppose  ${f A}=egin{pmatrix}1&3\\2&6\end{pmatrix}$  . The rows of the matrix, (1,3) and (2,6) , span a subspace of

1  $\checkmark$  . This is the **row rank** of  $\mathbf{A}$ .

The columns of the matrix,  $inom{1}{2}$  and  $inom{3}{6}$  span a subspace of dimension

1 ✓ . This is the **column rank** of **A**.

We will be using these ideas when studying **Linear Regression**, where we will work wit rectangular matrices.

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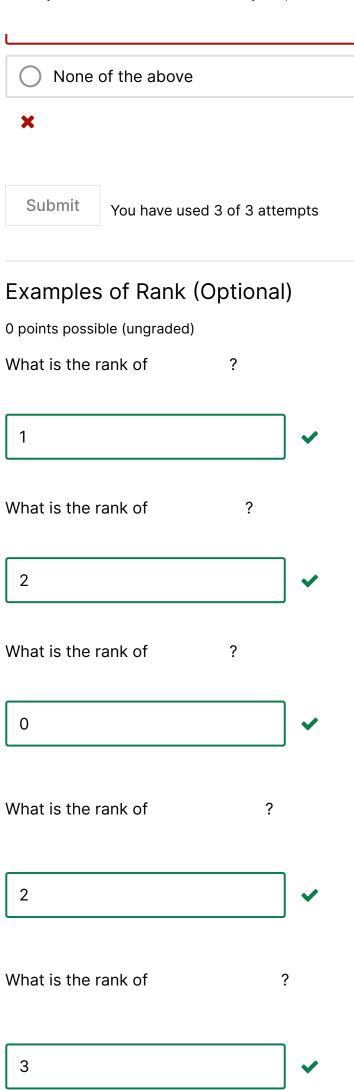
You have used 2 of 3 attempts

#### Rank of a matrix (Optional)

0 points possible (ungraded)

In general, row rank is always equal to the column rank, so we simply refer to this comra matrix.

What is the largest possible rank of a  $2 \times 2$  matrix?



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You have used 1 of 3 attempts

## Invertibility of a matrix (Optional)

0 points possible (ungraded)

An matrix is invertible if and only if has full rank, i.e.

Which of the following matrices are invertible? Choose all that apply.

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