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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) $c_1 \mathbf{v}_1 + \dots + c_n \mathbf{v}_n = \mathbf{0}$.

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

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

Row and Column Rank (Optional)

0 points possible (ungraded)

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



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

The columns of the matrix, $\begin{pmatrix} 1 \\ 2 \end{pmatrix}$ and $\begin{pmatrix} 3 \\ 6 \end{pmatrix}$ span a subspace of dimension



. This is the **column rank** of \mathbf{A} .

We will be using these ideas when studying **Linear Regression**, where we will work with 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 common rank of a matrix.

What is the largest possible rank of a 2×2 matrix?

☐ None of the above



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Examples of Rank (Optional)

0 points possible (ungraded)

What is the rank of $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$?

1



What is the rank of $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$?

2



What is the rank of $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \\ 10 & 11 & 12 \end{bmatrix}$?

0



What is the rank of $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 13 & 14 & 15 & 16 \end{bmatrix}$?

2



What is the rank of $\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 6 & 7 & 8 & 9 & 10 \\ 11 & 12 & 13 & 14 & 15 \\ 16 & 17 & 18 & 19 & 20 \\ 21 & 22 & 23 & 24 & 25 \end{bmatrix}$?

3



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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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