

Dot and Cross product

A fast Maple note

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We have been looking at dot products and cross products in class. It seems worthwhile to point out the syntax for doing them with Maple.

(You can then use Maple as another way to check your work.)

First we define a bunch of vectors:

```
> restart;  
> a := <1, 2, 3>; b := <4, 5, 6>;  
v := <v1, v2, v3>; w := <w1, w2, w3>;
```

$$a := \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

$$b := \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$$

$$v := \begin{bmatrix} v1 \\ v2 \\ v3 \end{bmatrix}$$

$$w := \begin{bmatrix} w1 \\ w2 \\ w3 \end{bmatrix}$$

▼ LinearAlgebra Commands

The commands for dot product and cross product are part of the LinearAlgebra package. The syntax is:

```
LinearAlgebra[DotProduct](vector1, vector2);
```

```
LinearAlgebra[CrossProduct](vector1, vector2);
```

```
> LinearAlgebra[DotProduct](a, b);  
LinearAlgebra[CrossProduct](a, b);  
LinearAlgebra[DotProduct](v, w);  
LinearAlgebra[CrossProduct](v, w);
```

$$\begin{aligned} & \begin{bmatrix} -3 \\ 6 \\ -3 \end{bmatrix} \\ & \overline{v_1} w_1 + \overline{v_2} w_2 + \overline{v_3} w_3 \\ & \begin{bmatrix} v_2 w_3 - v_3 w_2 \\ v_3 w_1 - v_1 w_3 \\ v_1 w_2 - v_2 w_1 \end{bmatrix} \end{aligned}$$

An alternative syntax for the dot product is to put a dot (or period) between the two vectors.

```
> a.b;
v.w;
```

$$\overline{v_1} w_1 + \overline{v_2} w_2 + \overline{v_3} w_3$$

```
>
```

Yet another syntax is to use the "with(LinearAlgebra):" command to load the LinearAlgebra package, then use the short form of the command. This way the package only needs to be loaded once in a Maple session.

```
> with(LinearAlgebra);
```

```
[&x, Add, Adjoint, BackwardSubstitute, BandMatrix, Basis, BezoutMatrix,
BidiagonalForm, BilinearForm, CharacteristicMatrix, CharacteristicPolynomial,
Column, ColumnDimension, ColumnOperation, ColumnSpace, CompanionMatrix,
ConditionNumber, ConstantMatrix, ConstantVector, Copy, CreatePermutation,
CrossProduct, DeleteColumn, DeleteRow, Determinant, Diagonal, DiagonalMatrix,
Dimension, Dimensions, DotProduct, EigenConditionNumbers, Eigenvalues,
Eigenvectors, Equal, ForwardSubstitute, FrobeniusForm, GaussianElimination,
GenerateEquations, GenerateMatrix, Generic, GetResultDataType, GetResultShape,
GivensRotationMatrix, GramSchmidt, HankelMatrix, HermiteForm,
HermitianTranspose, HessenbergForm, HilbertMatrix, HouseholderMatrix,
IdentityMatrix, IntersectionBasis, IsDefinite, IsOrthogonal, IsSimilar, IsUnitary,
JordanBlockMatrix, JordanForm, LA_Main, LUdecomposition, LeastSquares,
LinearSolve, Map, Map2, MatrixAdd, MatrixExponential, MatrixFunction,
MatrixInverse, MatrixMatrixMultiply, MatrixNorm, MatrixPower,
MatrixScalarMultiply, MatrixVectorMultiply, MinimalPolynomial, Minor, Modular,
Multiply, NoUserValue, Norm, Normalize, NullSpace, OuterProductMatrix,
Permanent, Pivot, PopovForm, QRdecomposition, RandomMatrix, RandomVector,
Rank, RationalCanonicalForm, ReducedRowEchelonForm, Row, RowDimension,
RowOperation, RowSpace, ScalarMatrix, ScalarMultiply, ScalarVector, SchurForm,
SingularValues, SmithForm, StronglyConnectedBlocks, SubMatrix, SubVector,
SumBasis, SylvesterMatrix, ToeplitzMatrix, Trace, Transpose, TridiagonalForm,
```

UnitVector, VandermondeMatrix, VectorAdd, VectorAngle, VectorMatrixMultiply, VectorNorm, VectorScalarMultiply, ZeroMatrix, ZeroVector, Zip]

```
> DotProduct(a, b);
CrossProduct(a, b);
DotProduct(v, w);
CrossProduct(v, w);;
```

$$\begin{aligned}
 & 32 \\
 & \begin{bmatrix} -3 \\ 6 \\ -3 \end{bmatrix} \\
 & \overline{v_1} w_1 + \overline{v_2} w_2 + \overline{v_3} w_3 \\
 & \begin{bmatrix} v_2 w_3 - v_3 w_2 \\ v_3 w_1 - v_1 w_3 \\ v_1 w_2 - v_2 w_1 \end{bmatrix}
 \end{aligned}$$

Once the LinearAlgebra package has been loaded the cross product can also be called with the &x operator.

```
> a &x b;
v &x w;
```

$$\begin{aligned}
 & \begin{bmatrix} -3 \\ 6 \\ -3 \end{bmatrix} \\
 & \begin{bmatrix} v_2 w_3 - v_3 w_2 \\ v_3 w_1 - v_1 w_3 \\ v_1 w_2 - v_2 w_1 \end{bmatrix}
 \end{aligned}$$

```
>
```

▼ Other packages with dot and cross product

The dot and cross product are in a couple of other packages we may use. In particular they are in both the VectorCalculus and the Student[VectorCalculus] packages. As with LinearAlgebra, these commands can be loaded with the package or called with the long format.

```
> VectorCalculus[DotProduct](a, b);
VectorCalculus[DotProduct](v, w);
VectorCalculus[CrossProduct](a, b);
VectorCalculus[CrossProduct](v, w);
```

$$\begin{aligned}
 & 32 \\
 & v_1 w_1 + v_2 w_2 + v_3 w_3 \\
 & -3e_x + 6e_y - 3e_z \\
 & (v_2 w_3 - v_3 w_2)e_x + (v_3 w_1 - v_1 w_3)e_y + (v_1 w_2 - v_2 w_1)e_z
 \end{aligned}
 \tag{2.1}$$

```
> Student[VectorCalculus][DotProduct](a, b);
Student[VectorCalculus][DotProduct](v, w);
Student[VectorCalculus][CrossProduct](a, b);
```

```
Student[VectorCalculus][CrossProduct](v,w);
```

32

$$v_1 w_1 + v_2 w_2 + v_3 w_3$$

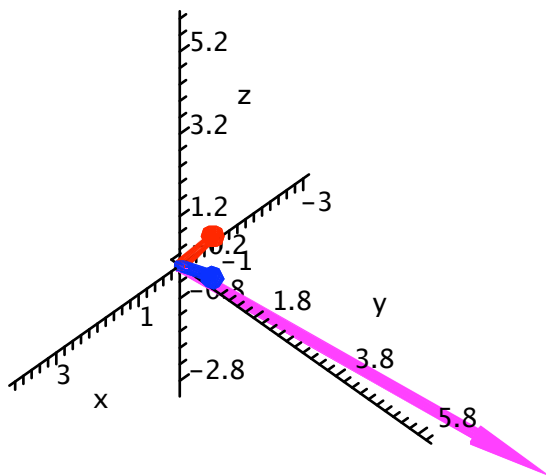
$$-3e_x + 6e_y - 3e_z$$

$$(v_2 w_3 - v_3 w_2)e_x + (v_3 w_1 - v_1 w_3)e_y + (v_1 w_2 - v_2 w_1)e_z \quad (2.2)$$

The Student[LinearAlgebra] package also has a command to visualize the cross product of two vectors.

```
> Student[LinearAlgebra][CrossProductPlot](a,b);
```

The Cross Product of 2 Vectors



```
>  
>
```