Consider the 1-parameter family of vectors $v(t)$ given by

$$v(t) = \begin{bmatrix} x(t) \\ y(t) \\ z(t) \end{bmatrix} = \begin{bmatrix} \sin(t) \cos(t) \\ (1 - t \cos(t)) \sin(t) \\ 2 \sin(t) + \sin(t) \cos(t)(3 - 2t) \end{bmatrix}, \quad t \in \mathbb{R}.$$ 

Observe that $v(0) = (0, 0, 0)$. We will obtain numerical evidence for the fact that the family of vectors $\{v(t)\}_{t \in \mathbb{R}}$ lie on a plane.

Pick two distinct values of $t$, $t_1$ and $t_2$, and find the vectors $u = v(t_1)$ and $w = v(t_2)$. Be sure that for the $t_1$ and $t_2$ you pick the vectors are independent (that is, such that $w$ and $u$ are not a scalar multiple of one another—and so are not parallel).

**Exercise 1:** For another value of $t$, verify that $v(t)$ is perpendicular to the cross product $w \times u$.

**Exercise 2:** Generate a list of vectors from the family $v(t)$ by evaluating $v$ or its components on a range of values of $t$. Because operators and functions in MATLAB are vector aware, you can do this by creating a list of $t$-values (see the : operator) and then defining the list of vectors $v$ by evaluating on that list. Note that we will need use the .* command here so that the multiplication is element-by-element, rather than matrix multiplication.

**Exercise 3:** Verify that each of the vectors in your list $v$ is orthogonal to $w \times u$. Because the dot function in MATLAB is also vector aware, you can do this by evaluating it with your list of vectors and a list of the same length each element of which is the cross product.

**Exercise 4:** Bonus! Make a plot with plot3 of your list of vectors to see that they do look as if they are planar!