Let $\mathbf{u_1} = \begin{bmatrix} -1 \\ -3 \\ -2 \end{bmatrix}$, $\mathbf{u_2} = \begin{bmatrix} -2 \\ 0 \\ 1 \end{bmatrix}$, $\mathbf{u_3} = \begin{bmatrix} 3 \\ -5 \\ 6 \end{bmatrix}$, and $\mathbf{y} = \begin{bmatrix} 9 \\ -8 \\ 4 \end{bmatrix}$.

1. Verify that $\{\mathbf{u_1}, \mathbf{u_2}, \mathbf{u_3}\}$ is an orthogonal basis for $\mathbb{R}^3$.
2. Find $\hat{\mathbf{y}}_1$, the orthogonal projection of $\mathbf{y}$ onto $\mathbf{u_1}$
   $\hat{\mathbf{y}}_2$, the orthogonal projection of $\mathbf{y}$ onto $\mathbf{u_2}$.
   $\hat{\mathbf{y}}_3$, the orthogonal projection of $\mathbf{y}$ onto $\mathbf{u_3}$.
3. Find scalars c_1, c_2, and c_3 such that $\mathbf{y} = c_1\mathbf{u_1} + c_2\mathbf{u_2} + c_3\mathbf{u_3}$
4. Form the matrix $A = \begin{bmatrix} \mathbf{u_1} & \mathbf{u_2} & \mathbf{u_3} \end{bmatrix}$, and calculate $A^T A$.