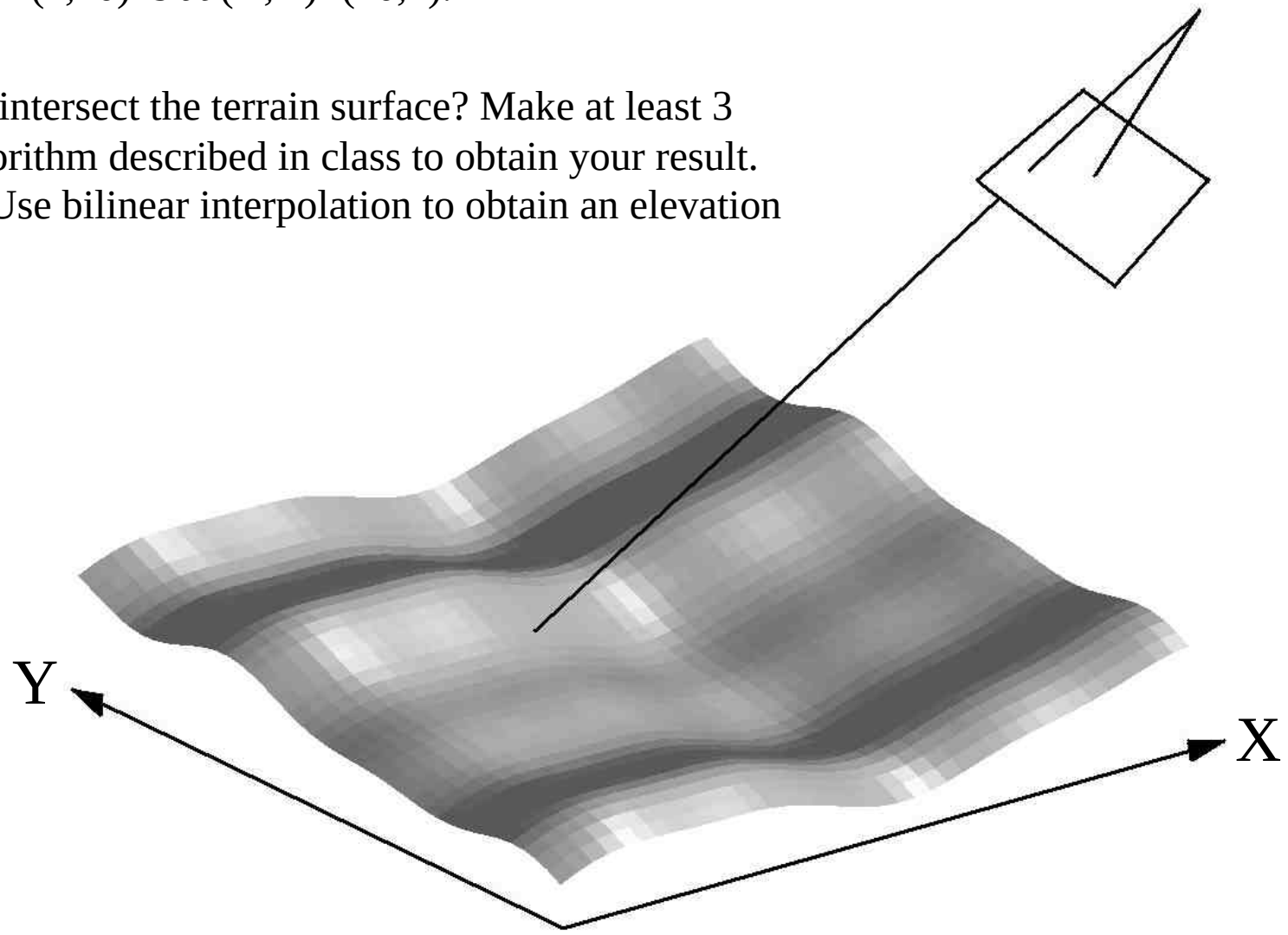
A frame photograph has exterior orientation (X_L, Y_L, Z_L) = (25.0,-5.0,45.0), and (omega, phi, kappa) = (20, 5, 5) degrees. The inner orientation is (x_0, y_0, f) = (0,0,50.0). A point is observed at (x,y) = (-5,15). The terrain is represented by a DEM with 40x40 samples, in file terrain.mat. Use the matlab command "load terrain" to import it. Terrain(1,1) is at (X,Y)=(1,1). Terrain(40,1) is at (X,Y)=(1,40). Terrain(1,40) is at (X,Y)=(40,1).

Where does the ray intersect the terrain surface? Make at least 3 iterations of the algorithm described in class to obtain your result. Does it converge? Use bilinear interpolation to obtain an elevation within a grid cell.



Recall,

$$\mathbf{M} = \mathbf{M}_k \mathbf{M}_f \mathbf{M}_w$$

$$\mathbf{M}_w = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos w & \sin w \\ 0 & -\sin w & \cos w \end{bmatrix}$$

$$\mathbf{M}_f = \begin{bmatrix} \cos f & 0 & -\sin f \\ 0 & 1 & 0 \\ \sin f & 0 & \cos f \end{bmatrix}$$

$$\mathbf{M}_k = \begin{bmatrix} \cos k & \sin k & 0 \\ -\sin k & \cos k & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Remember, MATLAB needs angles in radians.

Intersect ray with plane at Z

$$\begin{bmatrix} x - x_0 \\ y - y_0 \\ -f \end{bmatrix} = l\,\mathbf{M} \begin{bmatrix} X - X_L \\ Y - Y_L \\ Z - Z_L \end{bmatrix}$$

$$\frac{1}{l}\mathbf{M}^{\mathbf{T}} \begin{bmatrix} x - x_0 \\ y - y_0 \\ -f \end{bmatrix} = \begin{bmatrix} X - X_L \\ Y - Y_L \\ Z - Z_L \end{bmatrix}$$

$$\frac{1}{l} \begin{bmatrix} u \\ v \\ w \end{bmatrix} = \begin{bmatrix} X - X_L \\ Y - Y_L \\ Z - Z_L \end{bmatrix}$$

rearranging, with known Z

$$X = X_L + (Z - Z_L)\left(\frac{u}{w}\right)$$

$$Y = Y_L + (Z - Z_L)\left(\frac{v}{w}\right)$$