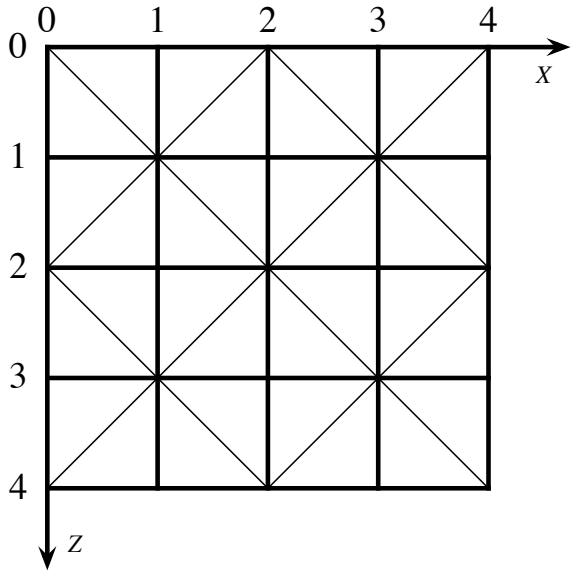
CMSC 23700	**Introduction to Computer Graphics**	**Homework 5**
Autumn 2015		**Due December 3**

For this homework, please read Handout 2.

1. Consider a height-field mesh H with $(n+1) \times (n+1)$ posts that are distance w apart (*i.e.*, the size of the height field in world coordinates is $nw \times nw$). Also assume that the mesh is triangulated as in the following illustration, with the world-space origin coinciding with the north-west corner of the height field.

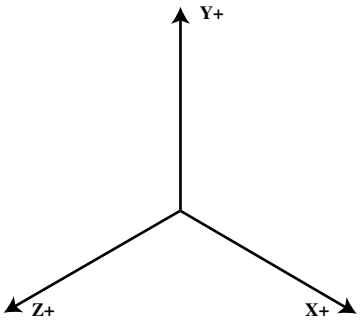


   (a) Give pseudo code for a function that maps an $\langle x, z \rangle$ world-space coordinate onto the surface of the mesh and returns both the surface position $\mathbf{p} = \langle x, y, z \rangle$ and the surface normal at $\mathbf{p}$. (To simplify your answer, you may ignore the case where $\mathbf{p}$ lies on the edge of a mesh triangle).

   (b) Give pseudo code for a function that takes two points $\mathbf{p}$ and $\mathbf{q}$ in world space, and returns true if the line segment from $\mathbf{p}$ to $\mathbf{q}$ intersects the height field mesh. You may assume that both $\mathbf{p}$ and $\mathbf{q}$ are above the surface of the mesh and that they project to different points on the XZ plane.

2. How many edges does a *closed manifold triangle mesh* of N faces have? Justify your answer.

3. An *isometric projection* is a parallel projection in which the angles between the projected axes are equal (*i.e.*, 120°) as shown in the following picture.



Let f be the distance to the far plane and n the distance to the near plane. Assume that $r = 1$, $l = -1$, $t = 1$, and $b = -1$. Define an isometric projection matrix that maps the world-space axes as shown in the picture, with the world-space origin being projected to $x = 0$ and $y = 0$.