1. **Transformation matrices.** Given the following matrix:

$$M = \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix}$$

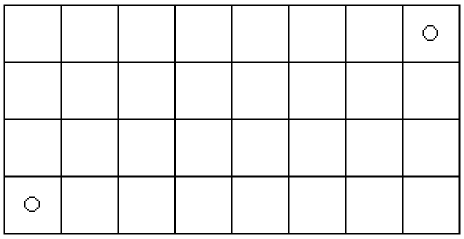
(a) If M is a pure rotation matrix, what is the determinant $|M|$ and the inverse matrix M^{-1}?

(b) If M is pure translation matrix, what is the determinant $|M|$ and the inverse M^{-1}?

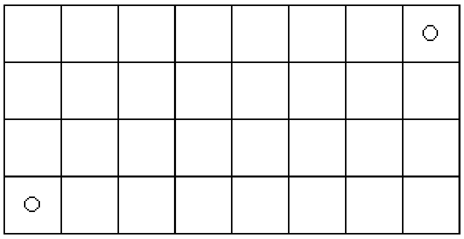
(c) If M is a pure scaling matrix, what is the determinant $|M|$ and the inverse M^{-1}?

(d) If M is a pure shear matrix along the xy-plane, what is the determinant $|M|$ and the inverse M^{-1}?

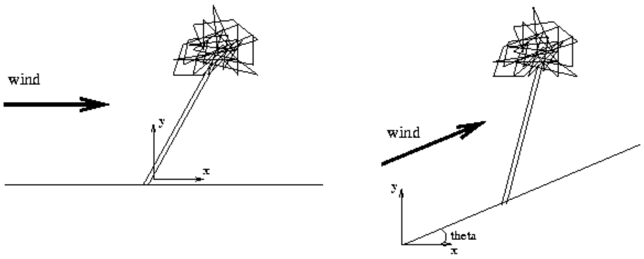
2. **Line Drawing.**
   (a) Given the 2 points below, mark down which points would be generated by the Bresenham line drawing algorithm? Explain why those points would be selected.



   (b) Given the 2 points below, mark down which points would be generated by the digital differential analyzer (DDA) line drawing algorithm? Explain why those points would be selected.



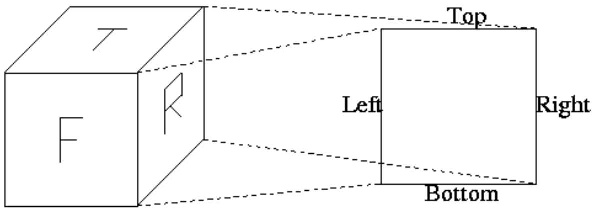
3. **2D Shearing.**



(a) In the top illustration, wind blowing in the horizontal direction will cause the tree to sway and shear to the right. Draw and label the coordinate system containing this situation and write down the corresponding shearing transformation matrix.

(b) In the bottom illustration, the tree is growing on the slopes of a hill. Pretend you have a strong sea breeze that blows uphill, parallel to the slope. What is the composite transformation matrix that can be applied to the tree? You don't need to multiply the individual matrices out, but do fill the elements of each matrix.

4. **Window to viewport mapping.** Suppose you want to display the right side orthographic view of your object defined within the bounding volume $(x_{min}, y_{min}, z_{min})$ to $(x_{max}, y_{max}, z_{max})$. If the viewport to display the right side view is: $(x_{right_{min}}, y_{right_{min}})$ to $(x_{right_{max}}, y_{right_{max}})$ see illustration below. What is the corresponding matrix M_{right}?



5. **Plane equations.** Find the equation of the plane that is perpendicular to the xy-plane and contains the two points (1,2,3) and (4,0,4).

6. **Modeling transforms.** Construct the composite transformation matrix that will **rotate** the point $(\sqrt{3}, 0, 0, 1)$ to its new position $(1, 1, 1, 1)$ in homogeneous coordinates.

7. **Viewing transforms.**
   (a) What is the projection of the vector from (1,2,3) to (4,0,4) on the xy-plane?

   (b) Assume that the projected vector from (a) is the VPN (looking down its positive z-axis), and the vector from (1,2,3) to (4,0,4) represents the UP vector. What is the x-axis of the viewing coordinate system V_x?

   (c) What is V_y?