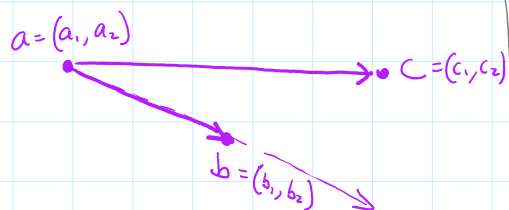


DOWNSIDES of using slope in calculations

- slope is not defined for vertical lines
- numerical (in) stability
- speed (?)

LEFT OF QUERIES

Decide whether point c is left of a directed segment ab .



Recall: cross product $\vec{v} \times \vec{w}$ gives the (signed) area of a parallelogram

A 3D coordinate system with \vec{i} , \vec{j} , and \vec{k} axes. Two vectors \vec{v} and \vec{w} are shown in the xy -plane, forming a shaded parallelogram. The cross product vector $\vec{v} \times \vec{w}$ is shown pointing along the positive z -axis.

Vectors in the plane

$$\vec{ab} = \langle b_1 - a_1, b_2 - a_2, 0 \rangle$$

$$\vec{ac} = \langle c_1 - a_1, c_2 - a_2, 0 \rangle$$

Cross product:
$$\vec{ab} \times \vec{ac} = \langle b_1 - a_1, b_2 - a_2, 0 \rangle \times \langle c_1 - a_1, c_2 - a_2, 0 \rangle =$$

$$= \langle 0, 0, \underbrace{(b_1 - a_1)(c_2 - a_2) - (b_2 - a_2)(c_1 - a_1)} \rangle$$

$$\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ b_1 - a_1 & b_2 - a_2 & 0 \\ c_1 - a_1 & c_2 - a_2 & 0 \end{vmatrix}$$

Signed area of parallelogram

- + if c is left of \vec{ab}
- if c is right of \vec{ab}
- 0 if c is collinear with \vec{ab}