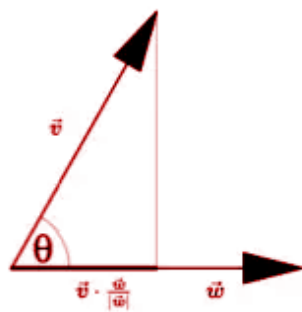


Introduction

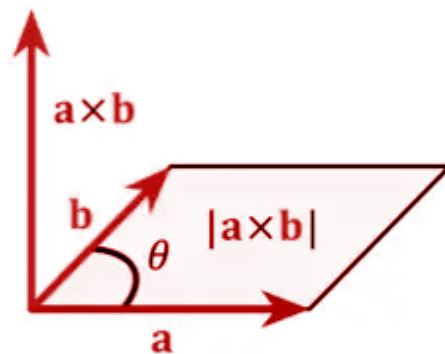
In this chapter we will study about the various applications of geometry in solving computer science problems. We will assume a basic knowledge of geometry and will build on the concepts of points, lines and vectors. We assume the following struct definitions of a point and a line throughout this chapter.

```
struct Point {  
    int x, y;  
}  
  
struct line {  
    Point p1, p2;  
}
```

Let us first define the Dot and Cross products which will help us build the other algorithms on top of it.



dot product



cross product

- **Dot Product**

The **dot product** of two 2-D vectors is $(x_1 * x_2 + y_1 * y_2)$.

- The dot product is a quantity which is the length of one vector times the length of the amount of another vector parallel to that vector.
- Given two vectors u and v , the dot product of the two vectors would be: $|u| |v| \cos(\theta)$. θ is the angle between the two vectors u and v .
- $|u|$ is called the **norm** of the vector, and in a 2-D geometry problem is simply the length of the vector, $\sqrt{x^2 + y^2}$.
- From this, one can see that if two vectors are perpendicular (here, $\theta = 90$ degrees), the dot product would be 0.

```
float dot(point a, point b) {  
    return a.x * b.x + a.y * b.y;  
}
```

- **Cross Product:**

The **cross product** of two 2-D vectors is $x_1*y_2 - y_1*x_2$.

- The cross product takes two vectors and produces a vector that is perpendicular to both vectors.
- Like the dot product, $A \times B = |A| |B| \sin(\theta)$. θ is the angle between the two vectors, but θ is negative or positive based on the right-hand rule (we point our right hand fingers in the direction of A and curl it towards B. The direction of the thumb gives the direction of the resultant). It means that if A is less than 180 degrees clockwise from B, the value is positive. It also means that the cross-product of two parallel vectors is zero. The cross product is also **NOT** commutative: $U \times V = -V \times U$.
- Fun fact: Absolute value of $|A| |B| \sin(\theta)$ is equal to the area of the parallelogram with two of its sides formed by A and B.

```
float cross(point a, point b) {  
    return a.x * b.y - a.y * b.x;  
}
```