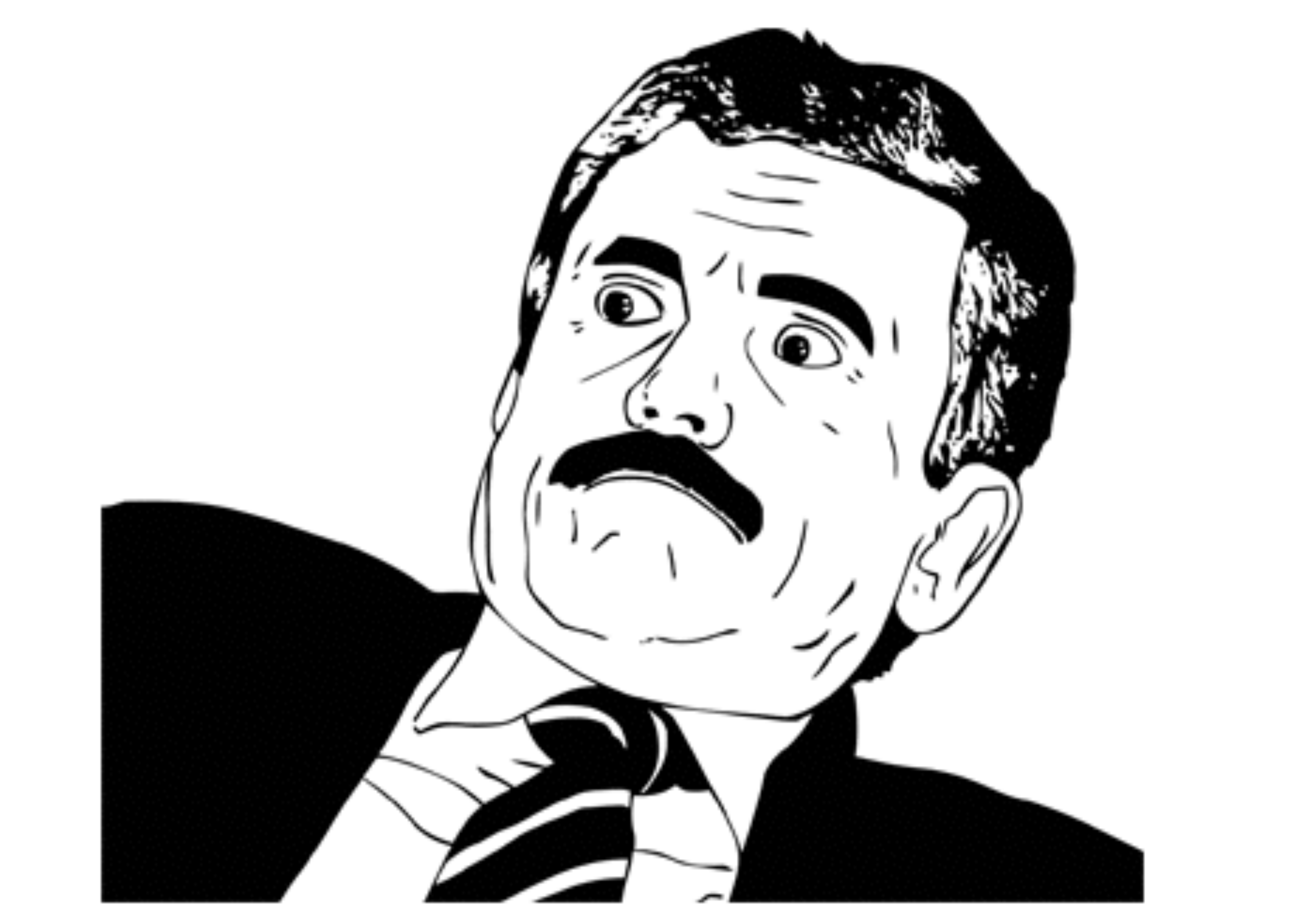
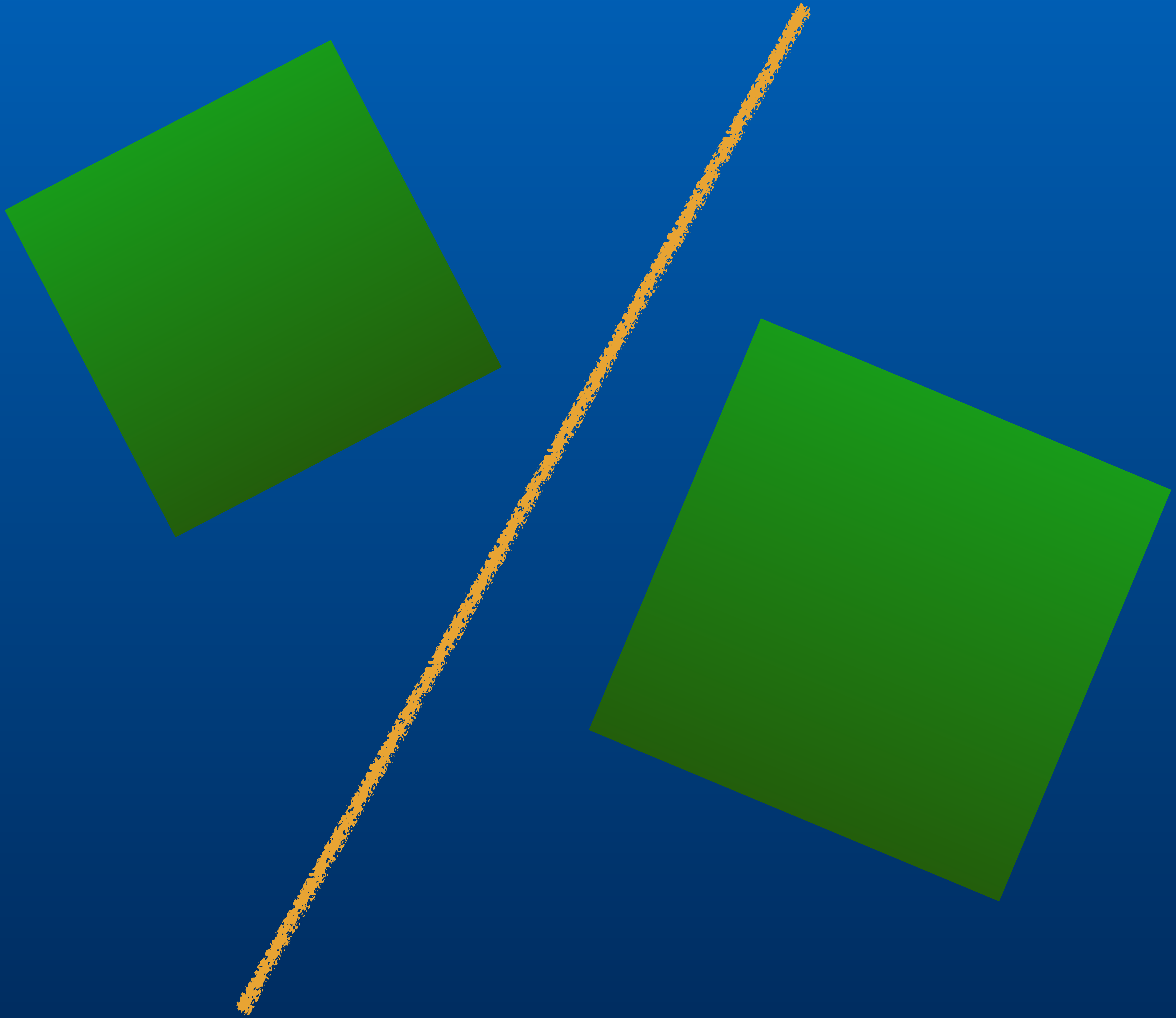
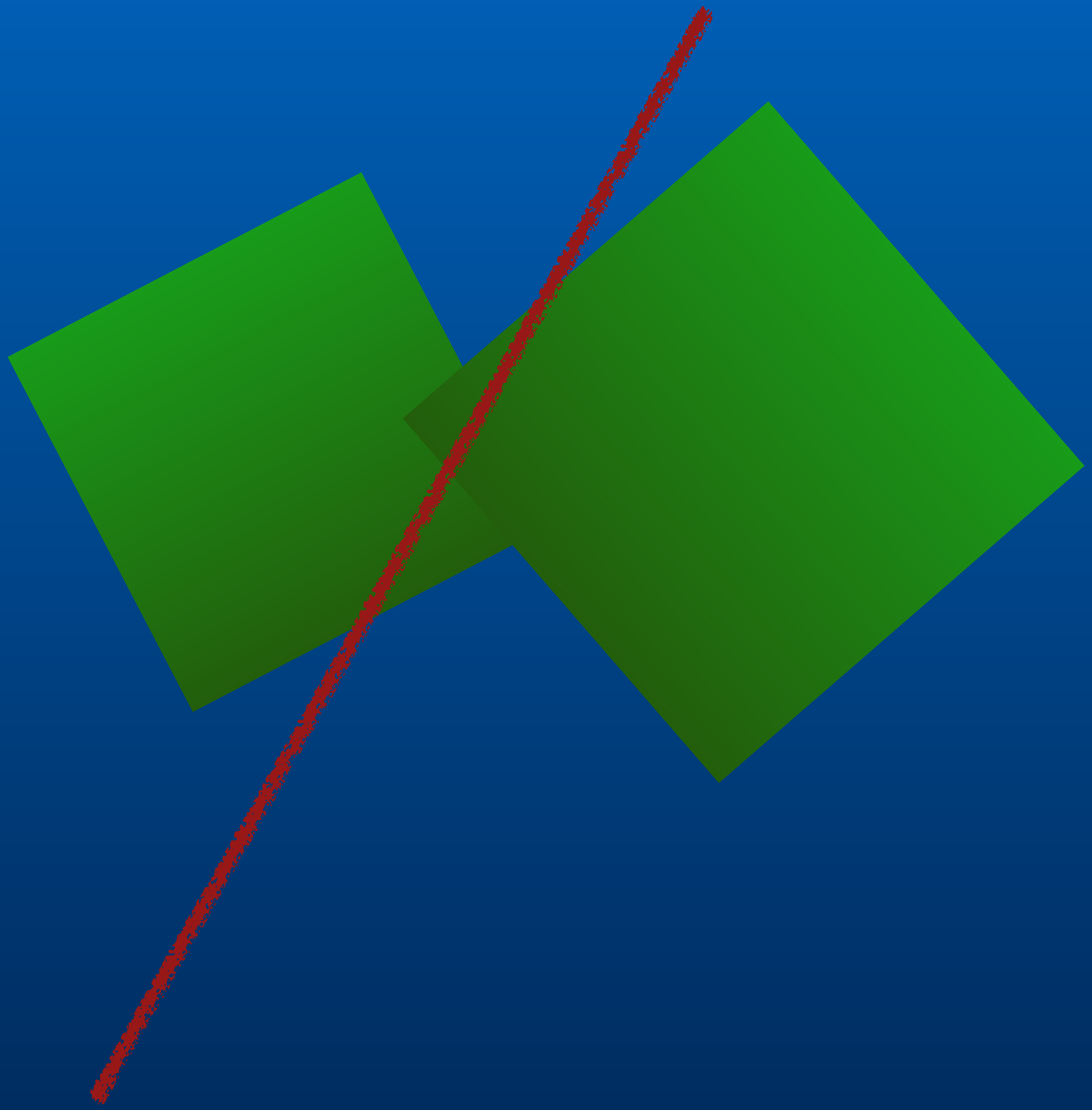
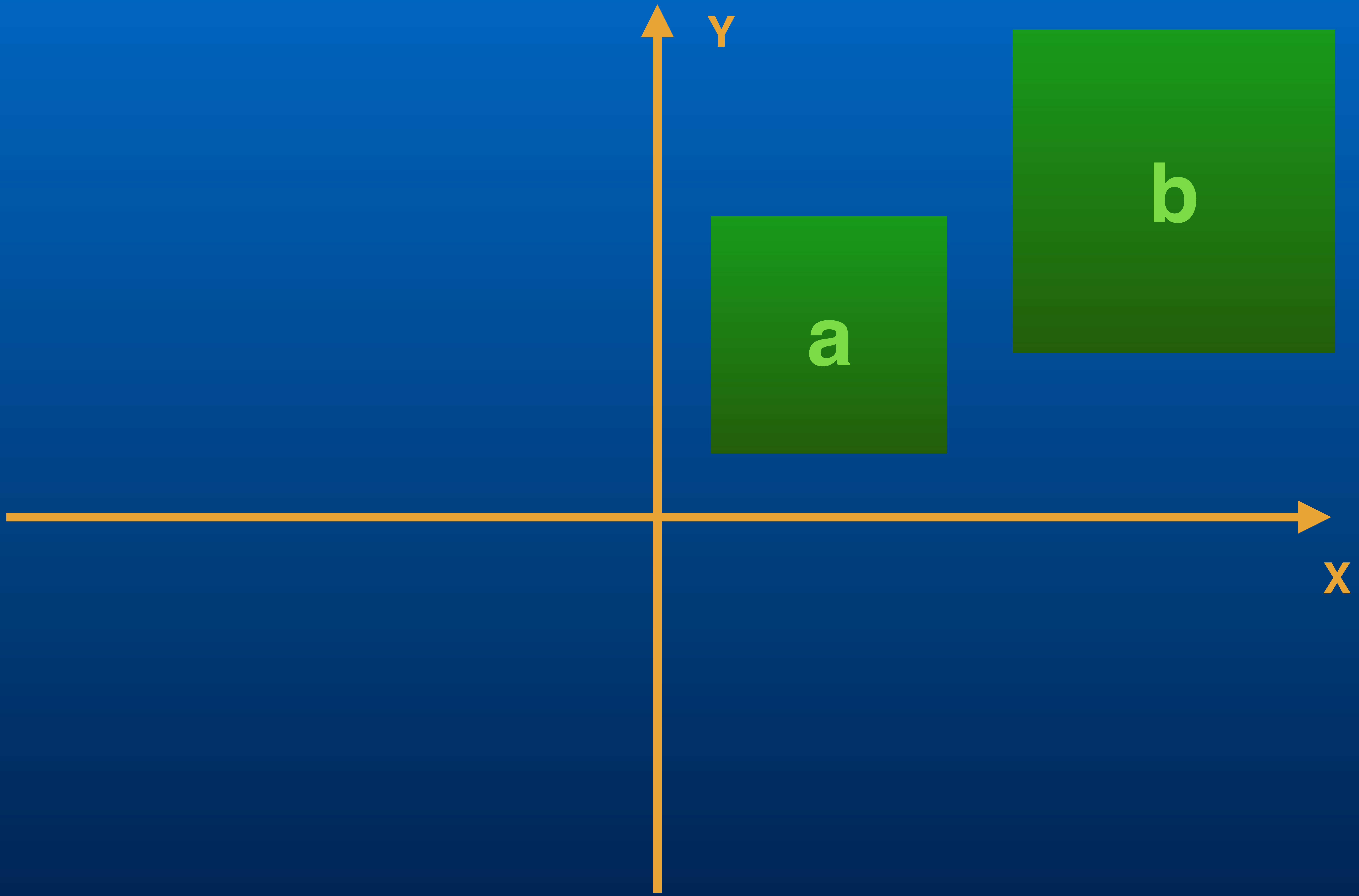
Advanced 2D collision detection.



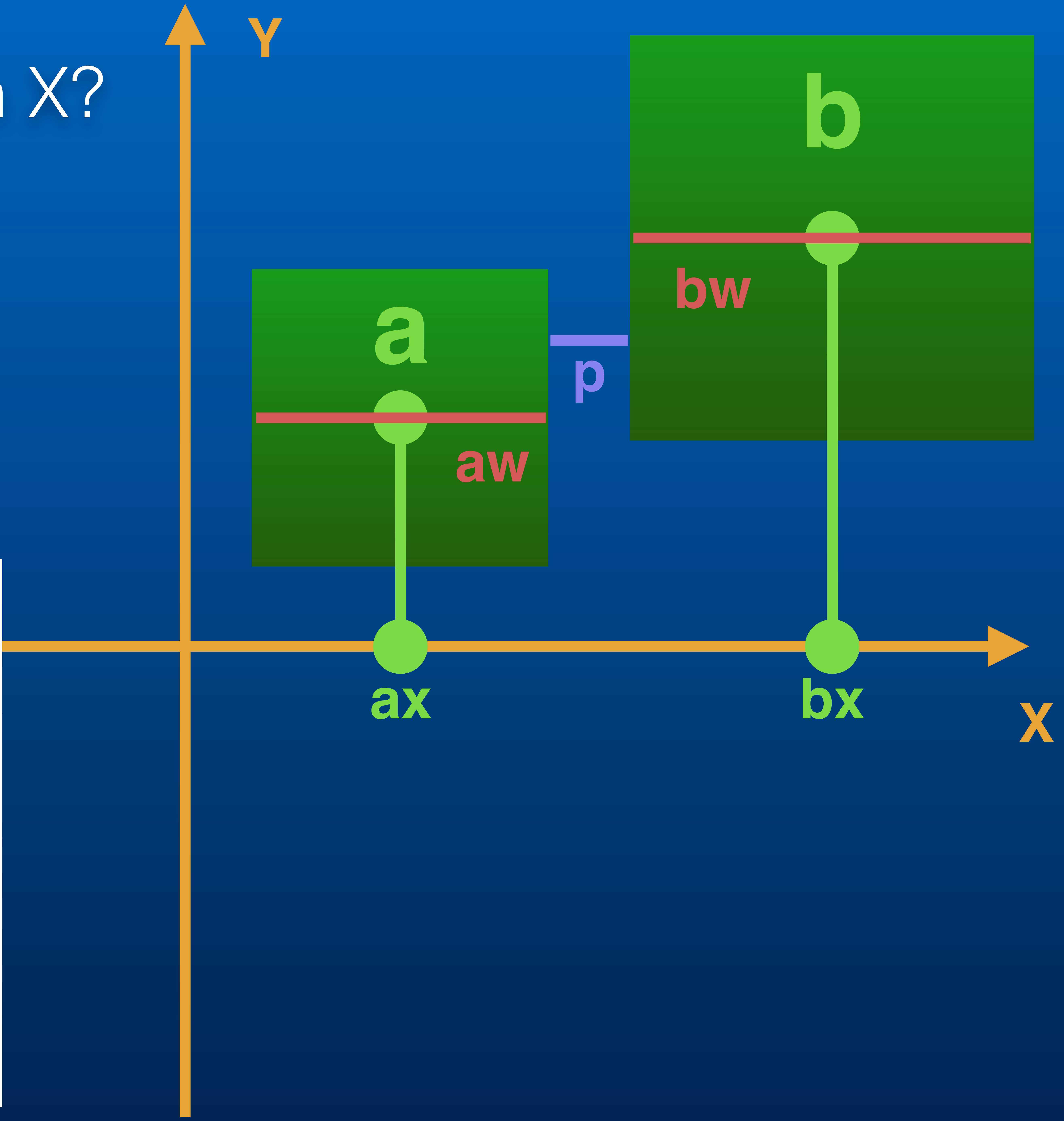
Separating axis theorem (again).





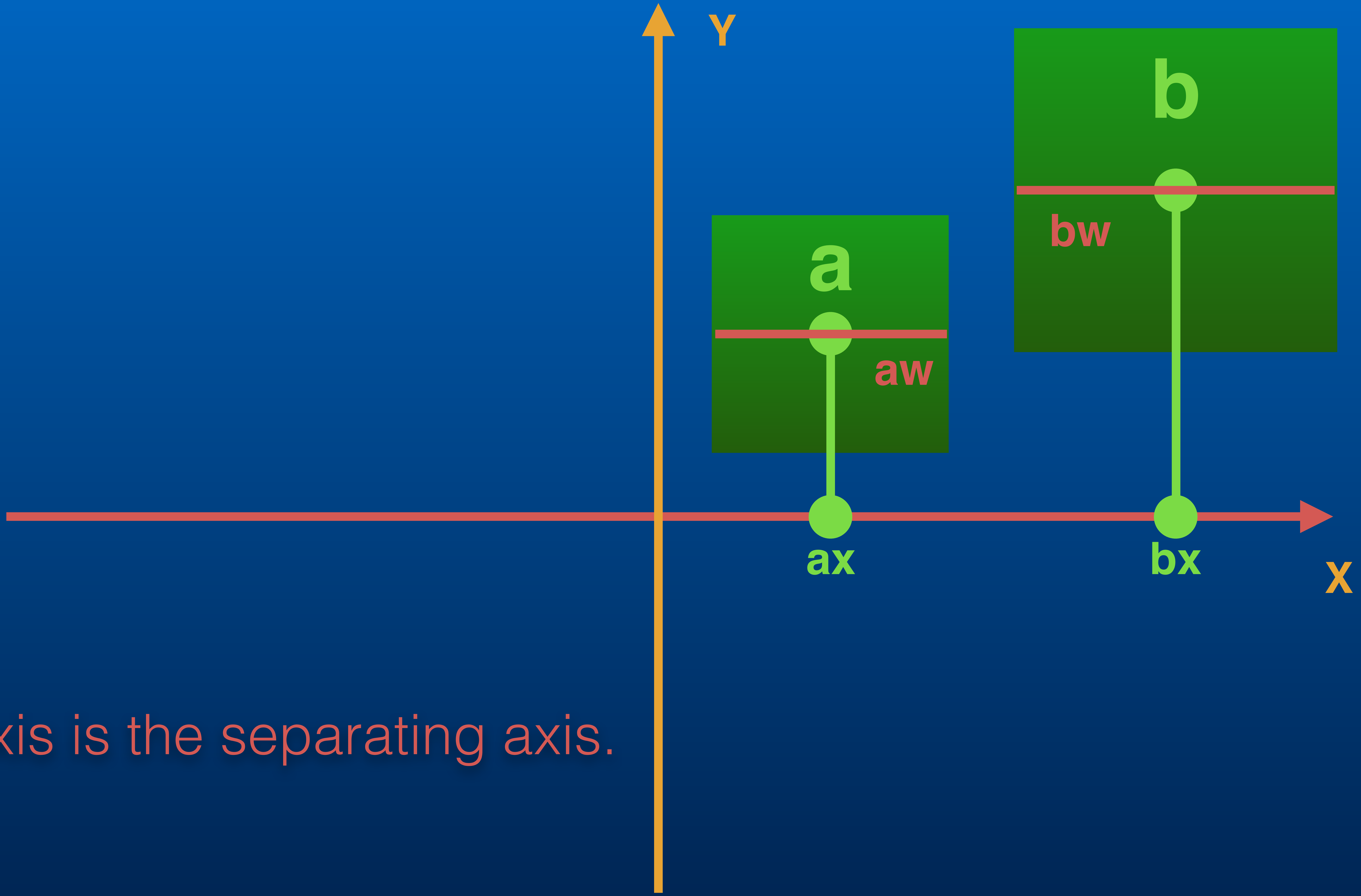

Y
b
a
X

How far away are they on X?



$$p = |x_1 - x_2| - \frac{w_1 + w_2}{2}$$

if p >= 0, we are not colliding!

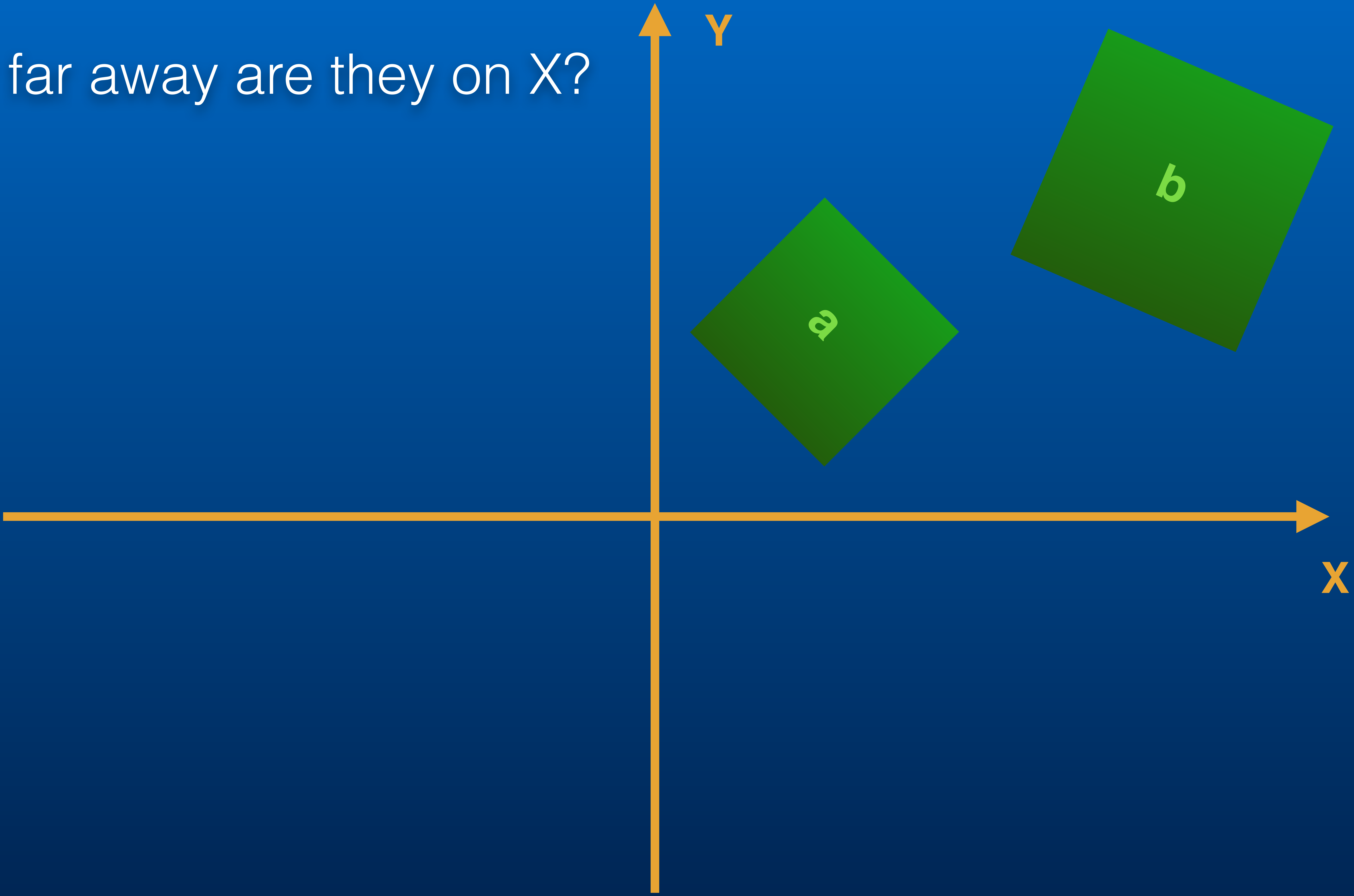


X axis is the separating axis.

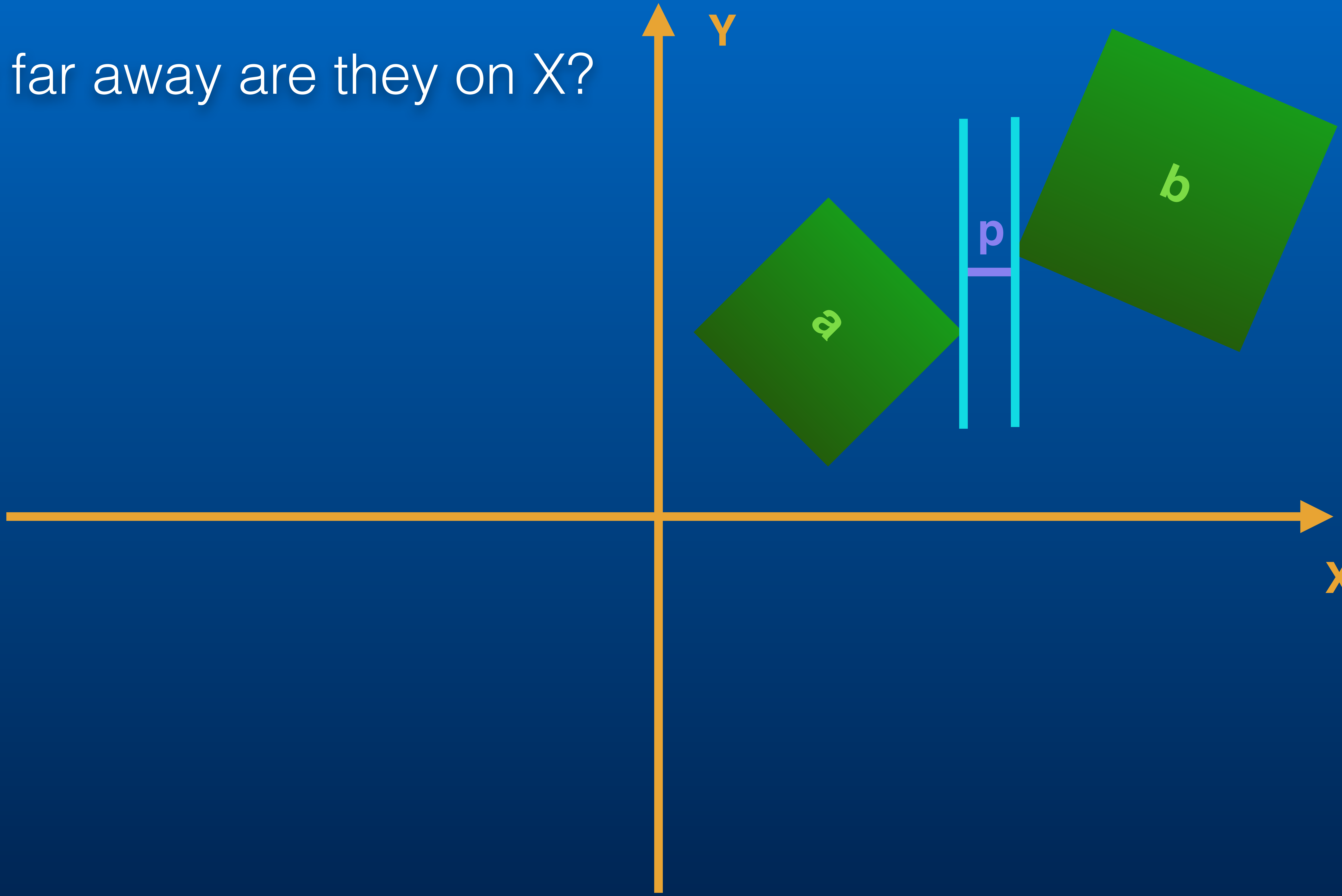
Do the same o the Y-axis with box heights if X is not separating.

If neither axis is separating, we have a collision!

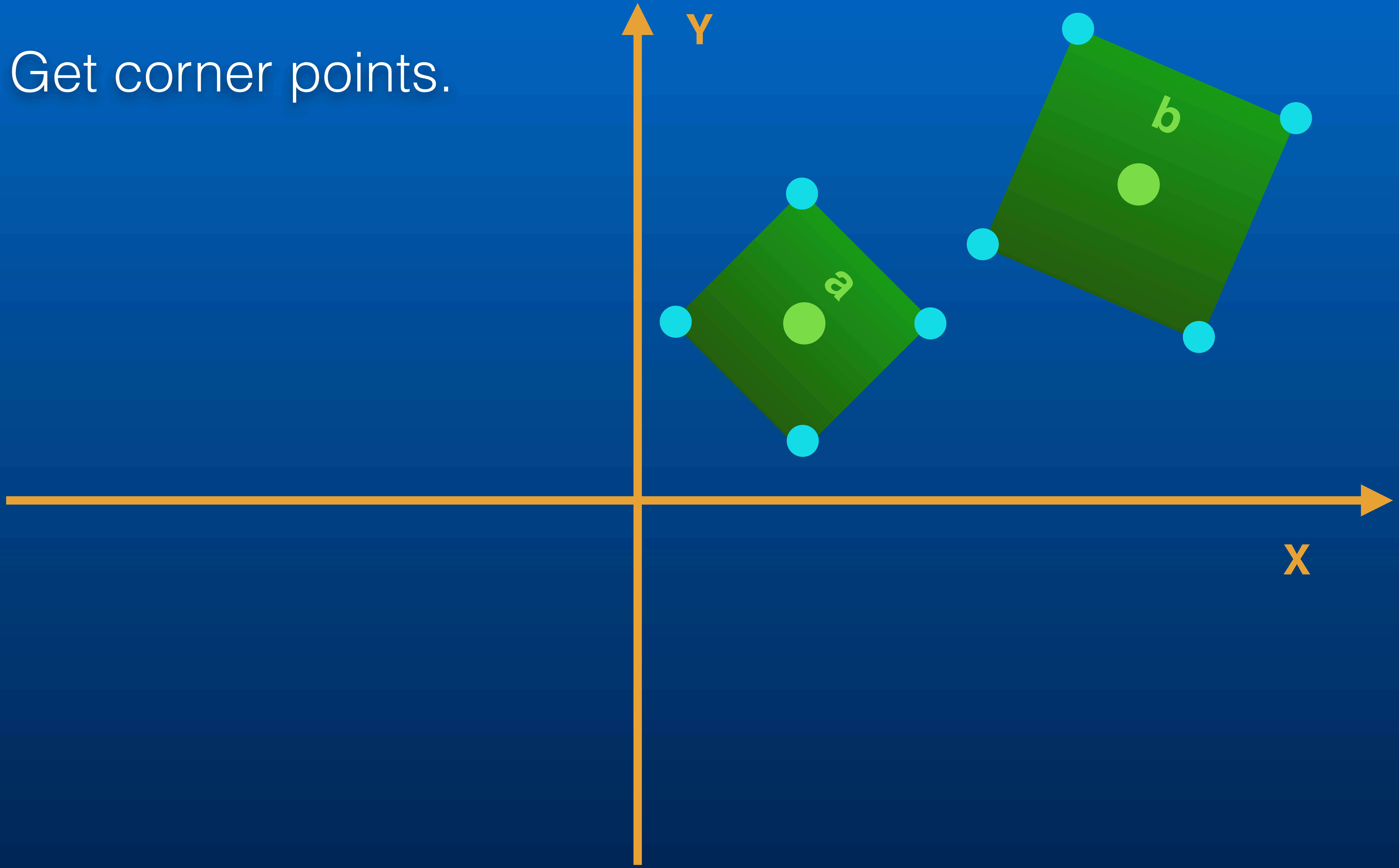
How far away are they on X?



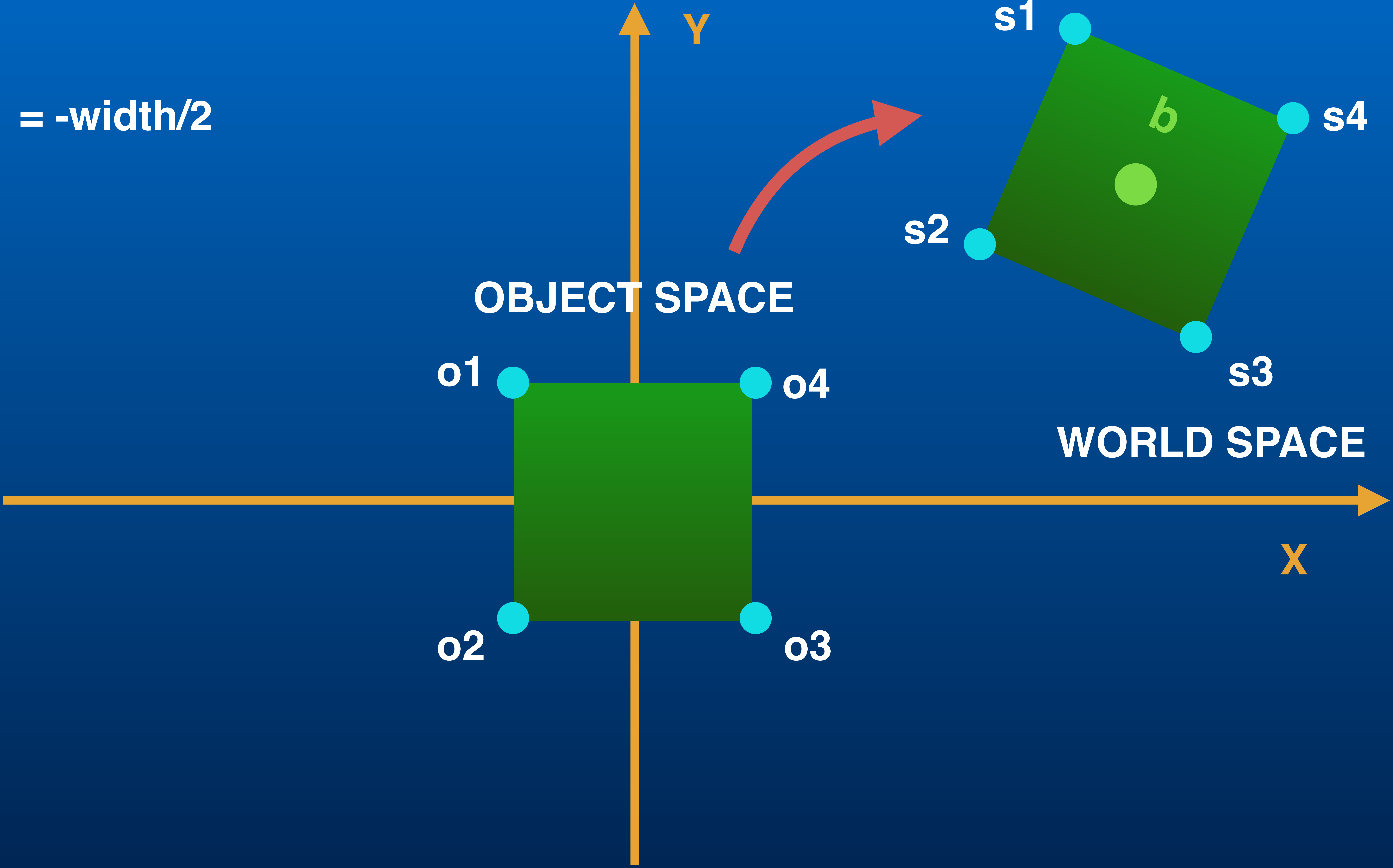
How far away are they on X?



Get corner points.



o1 = -width/2

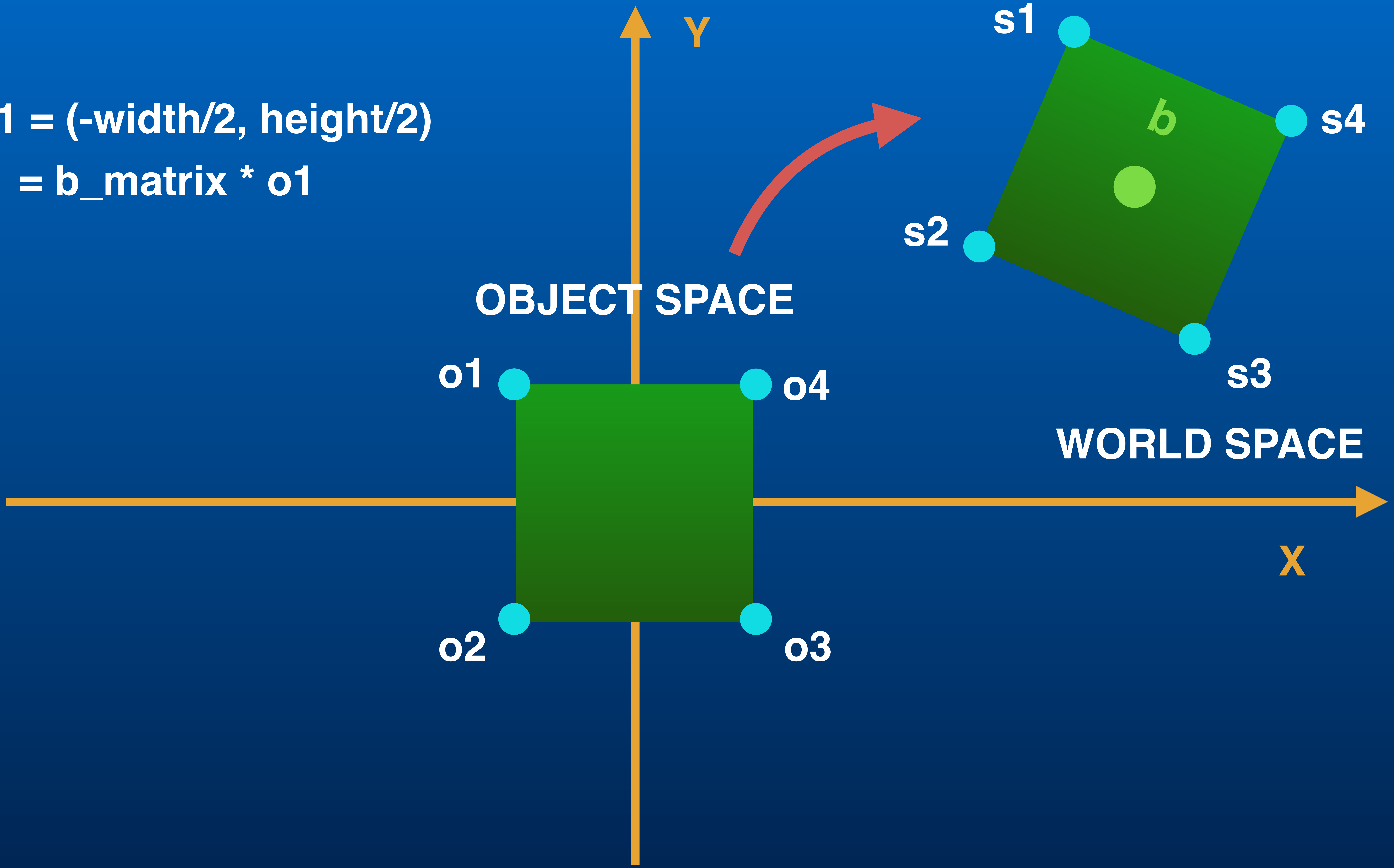


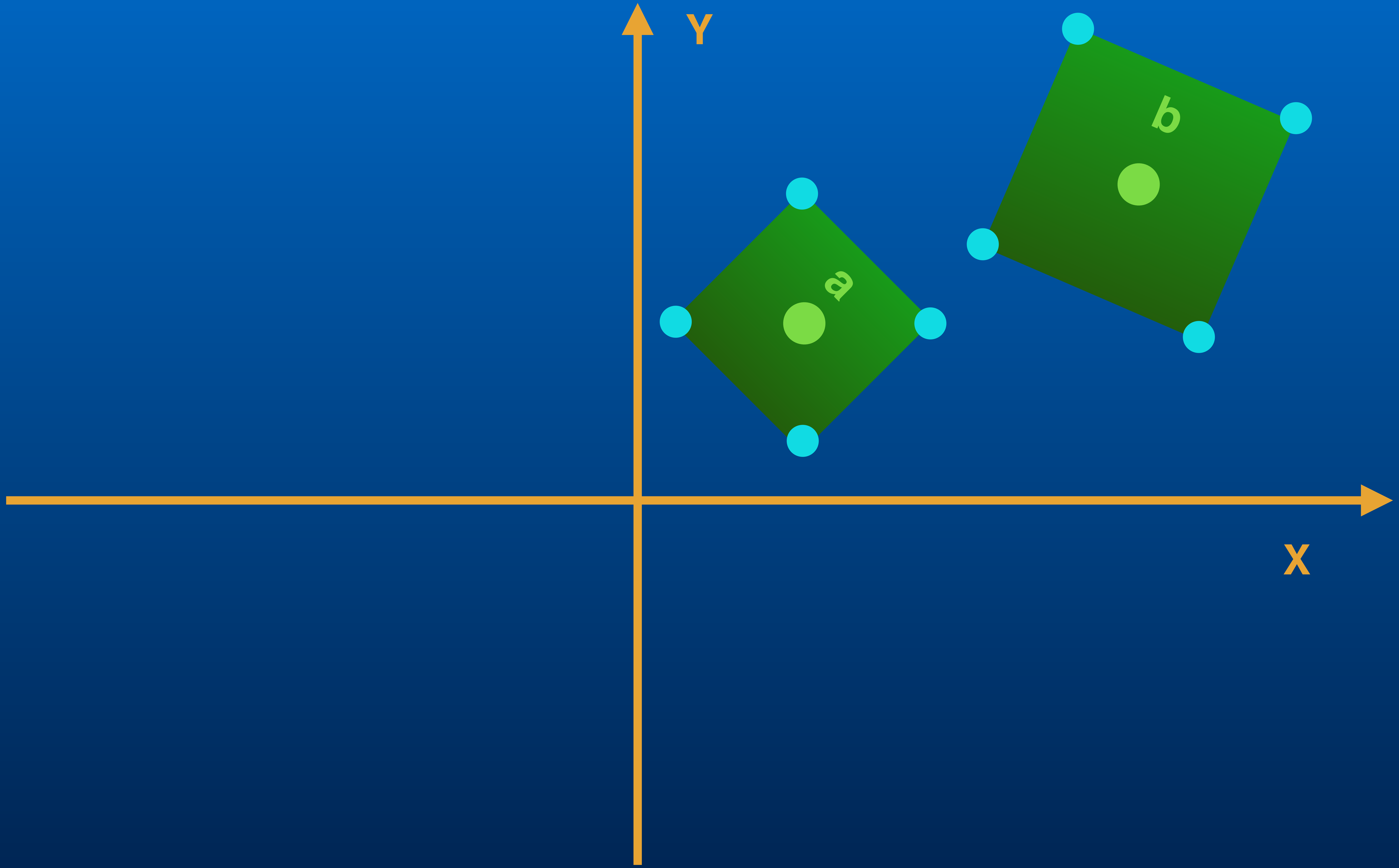
OBJECT SPACE

WORLD SPACE

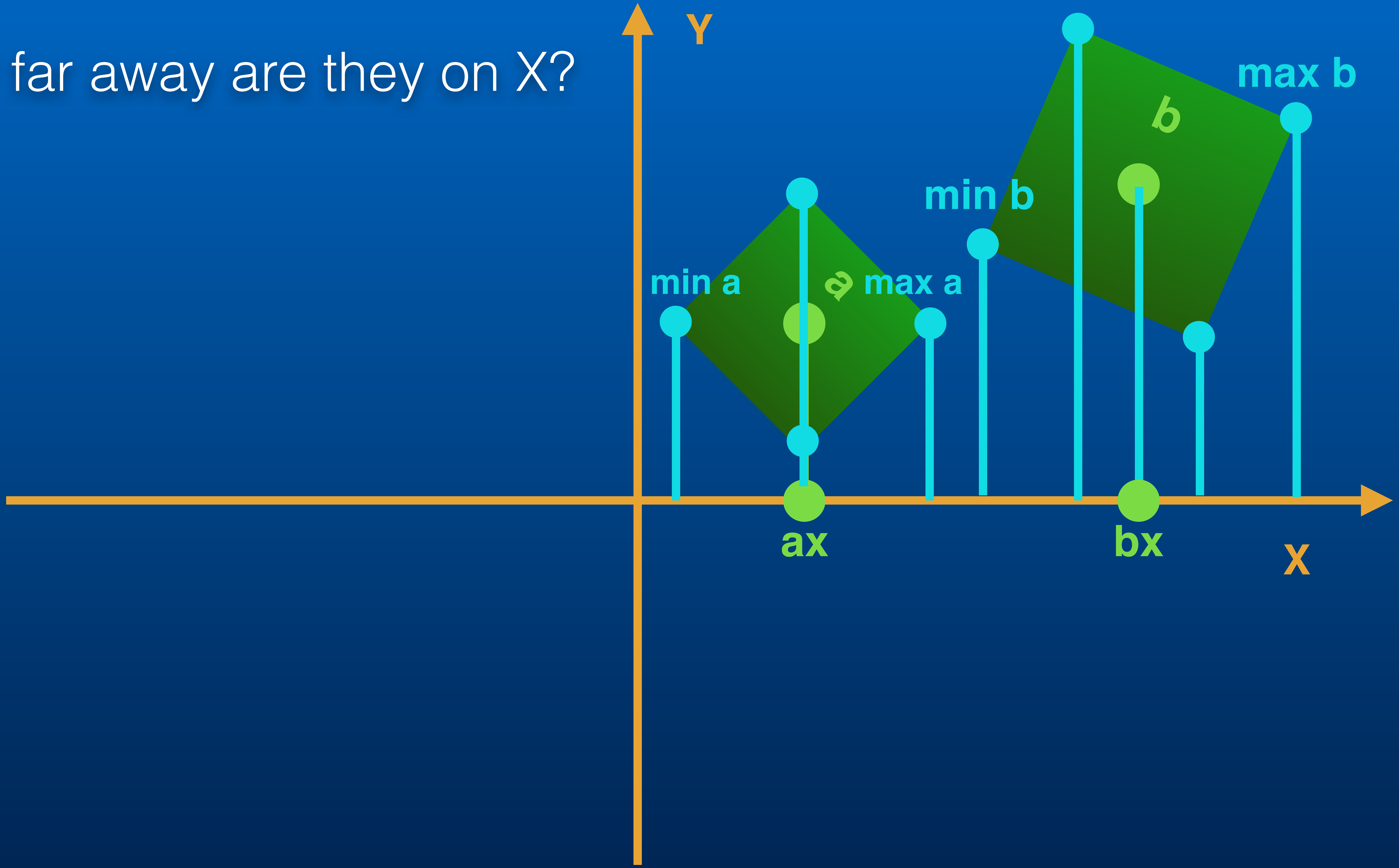
o1 = (-width/2, height/2)

s1 = b_matrix * o1

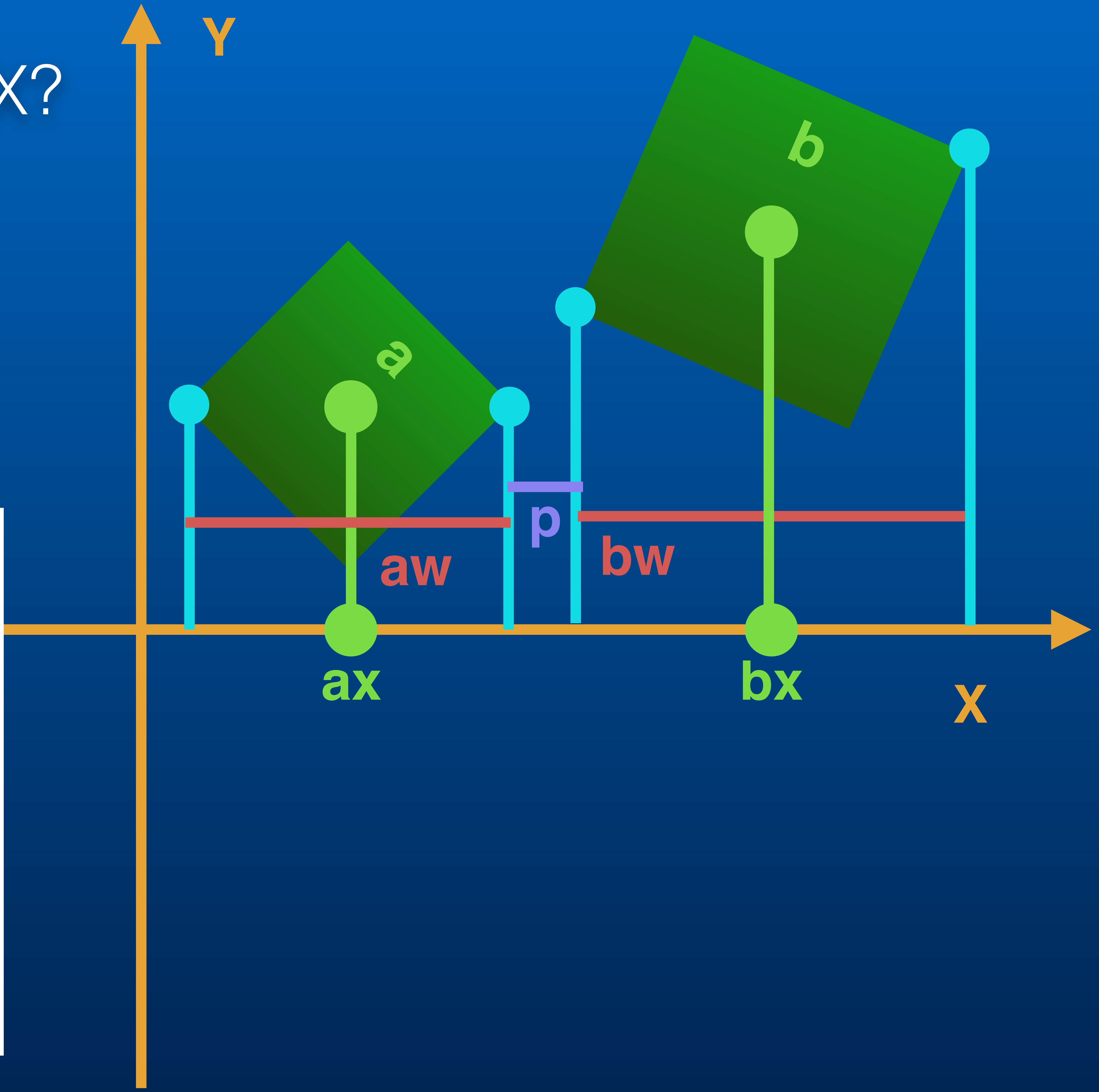



Y
X
a
b

How far away are they on X?



How far away are they on X?



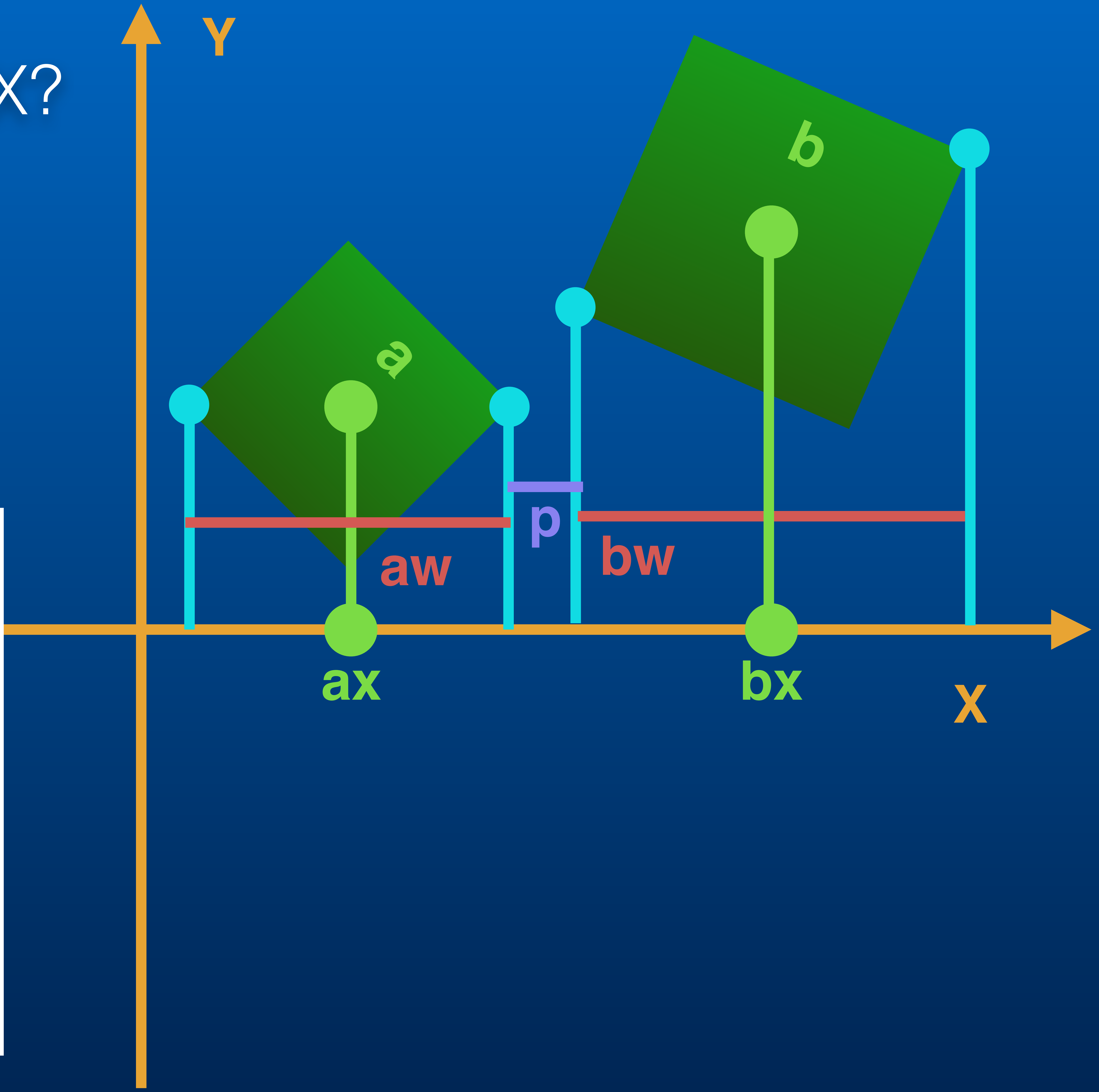
$$p = |x_1 - x_2| - \frac{w_1 + w_2}{2}$$

if p >= 0, we are not colliding!

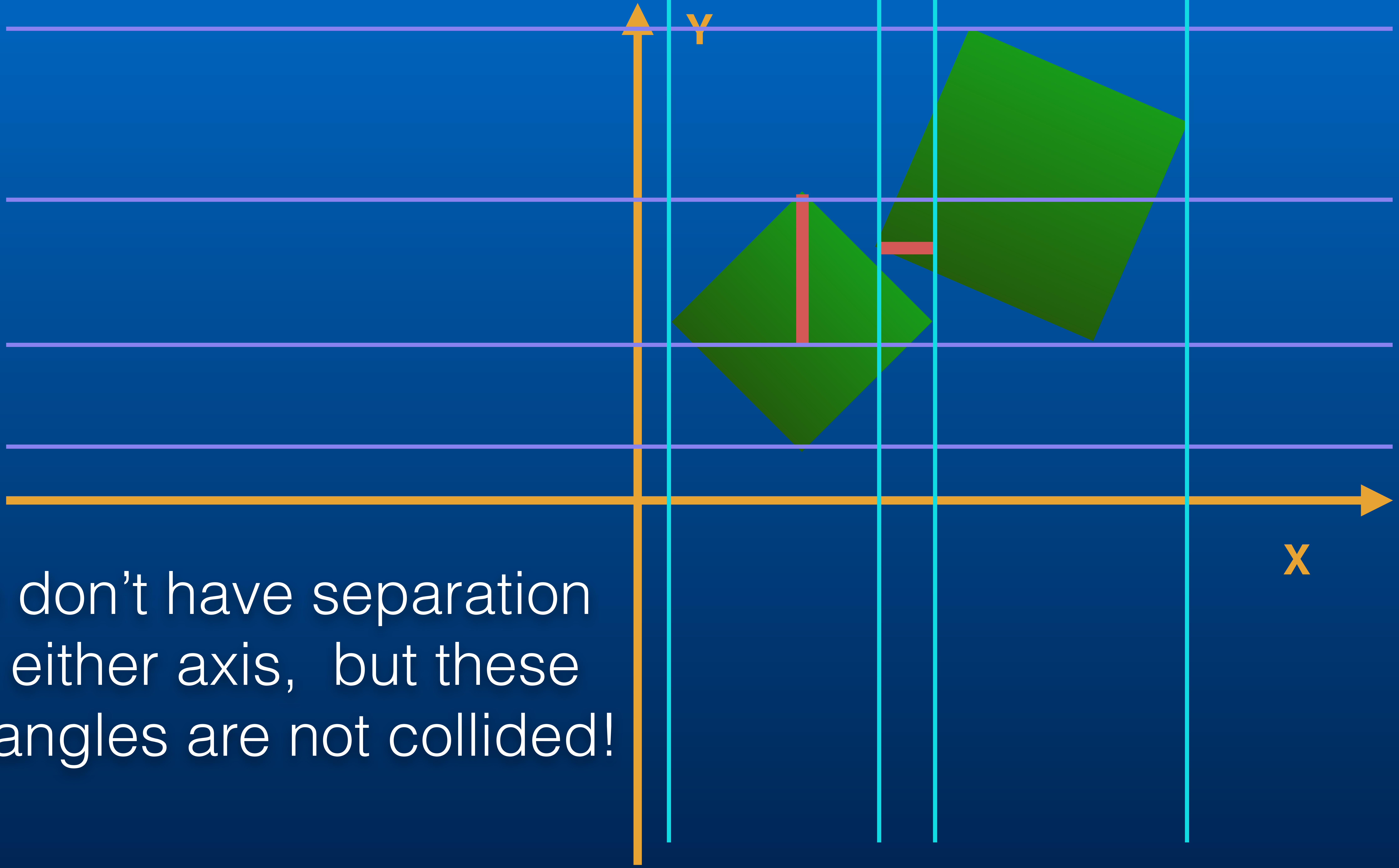
How far away are they on X?

$$p = |x_1 - x_2| - \frac{w_1 + w_2}{2}$$

if p >= 0, we are not colliding!

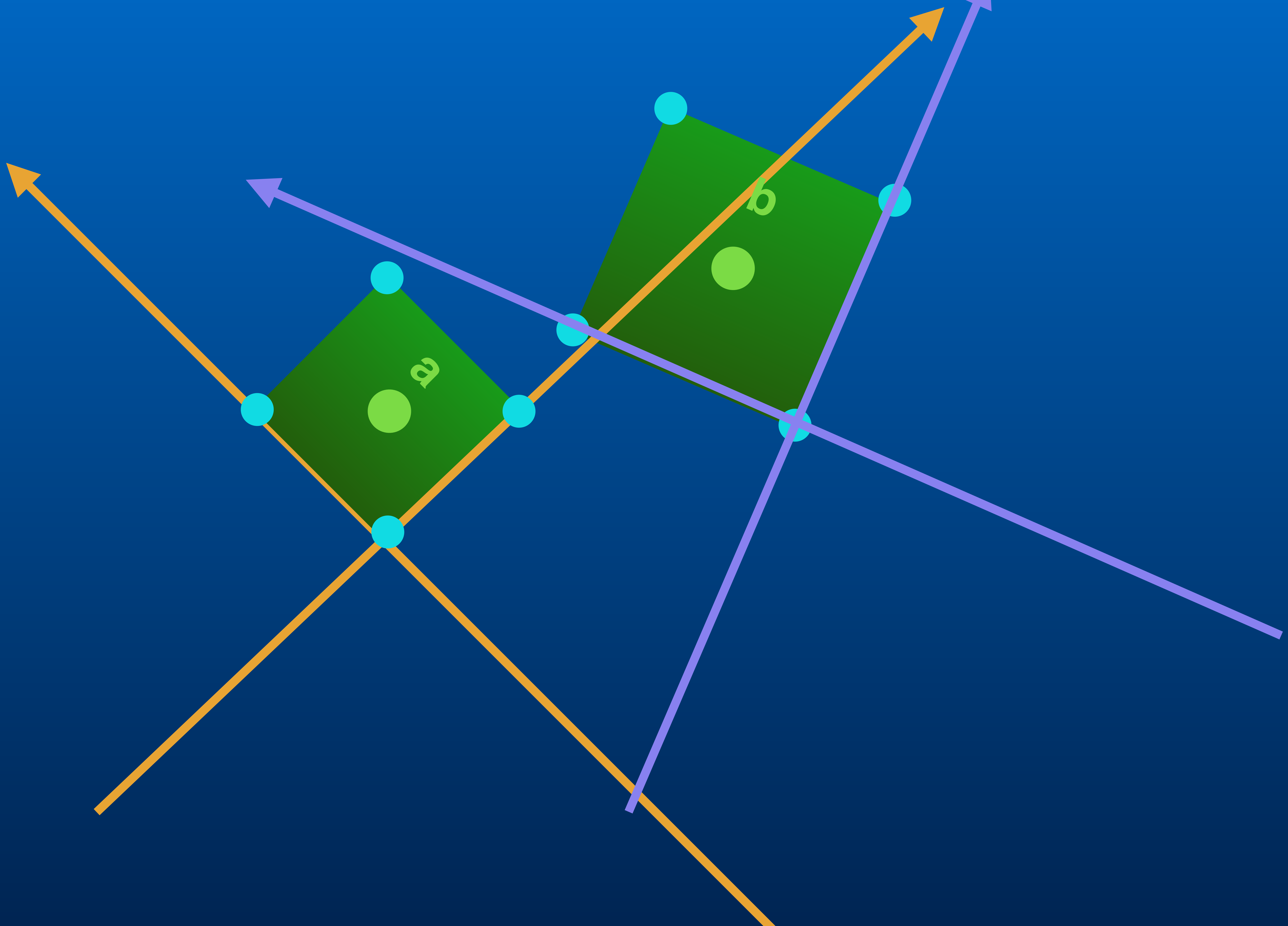


We cannot check rotated separation on X and Y axes!



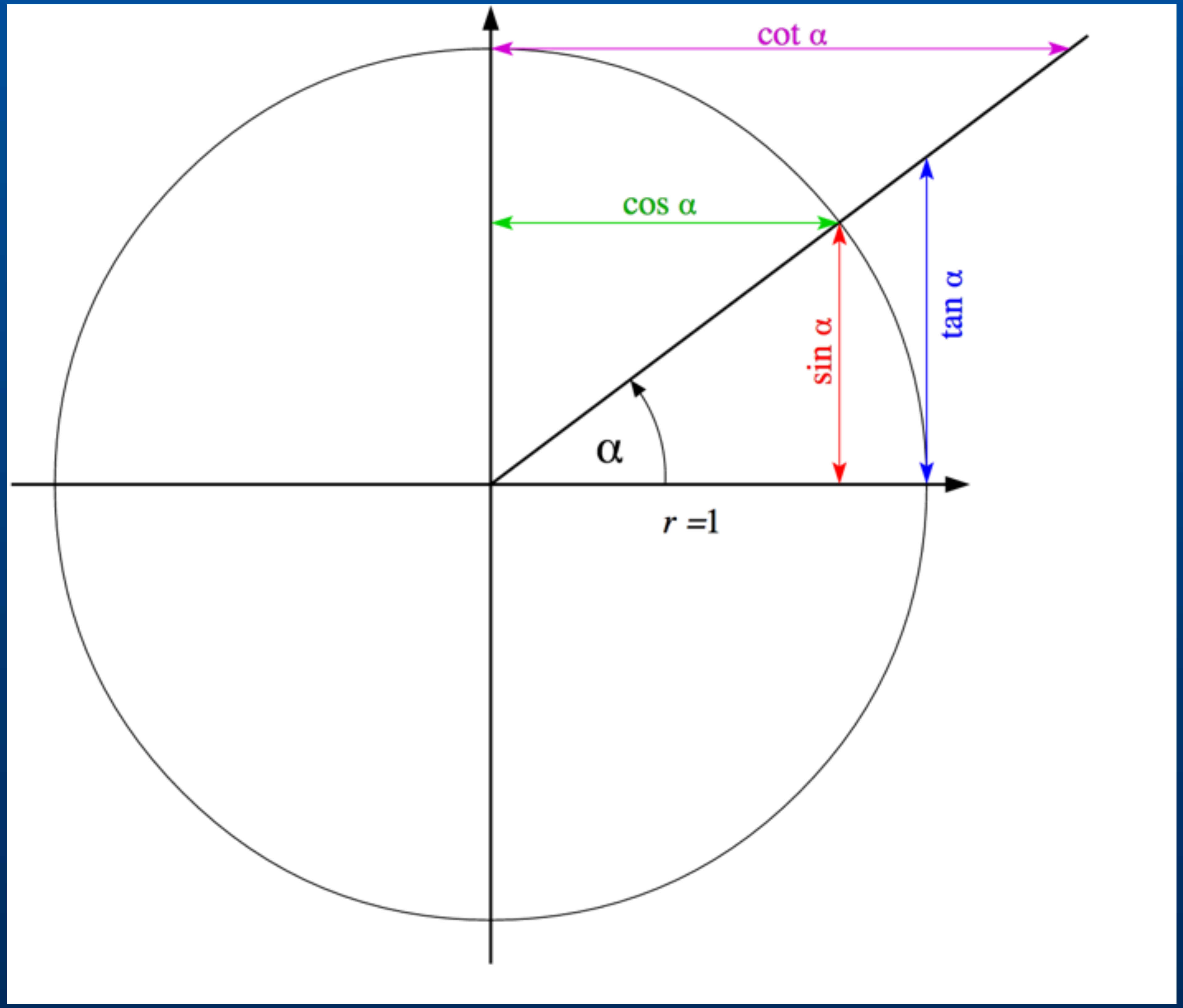
We don’t have separation on either axis, but these rectangles are not collided!

We need to check on both axes of each rectangle.

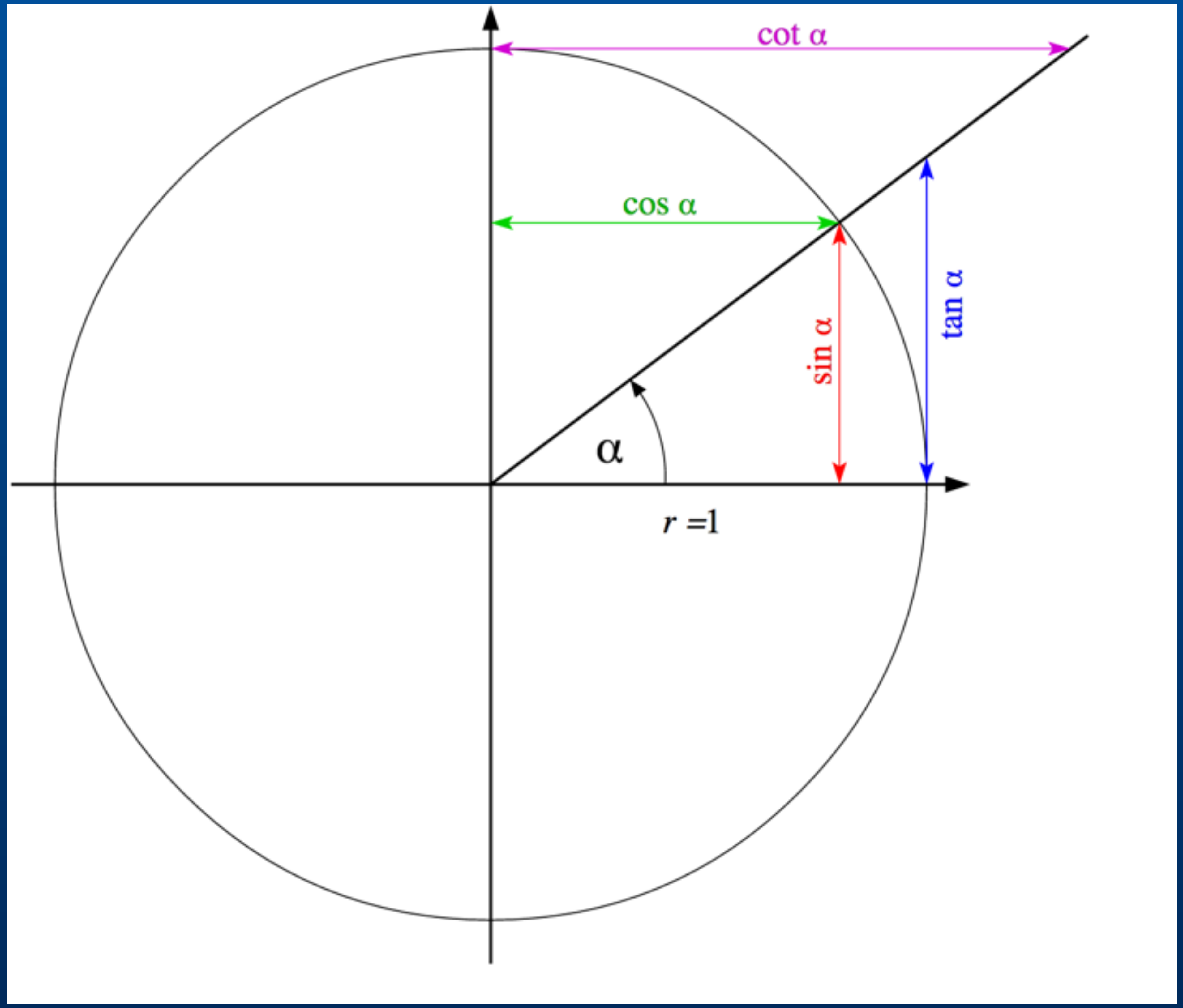

a
b

What is an axis?

An axis is just a unit vector representing a direction.



An axis is just a unit vector representing a direction.



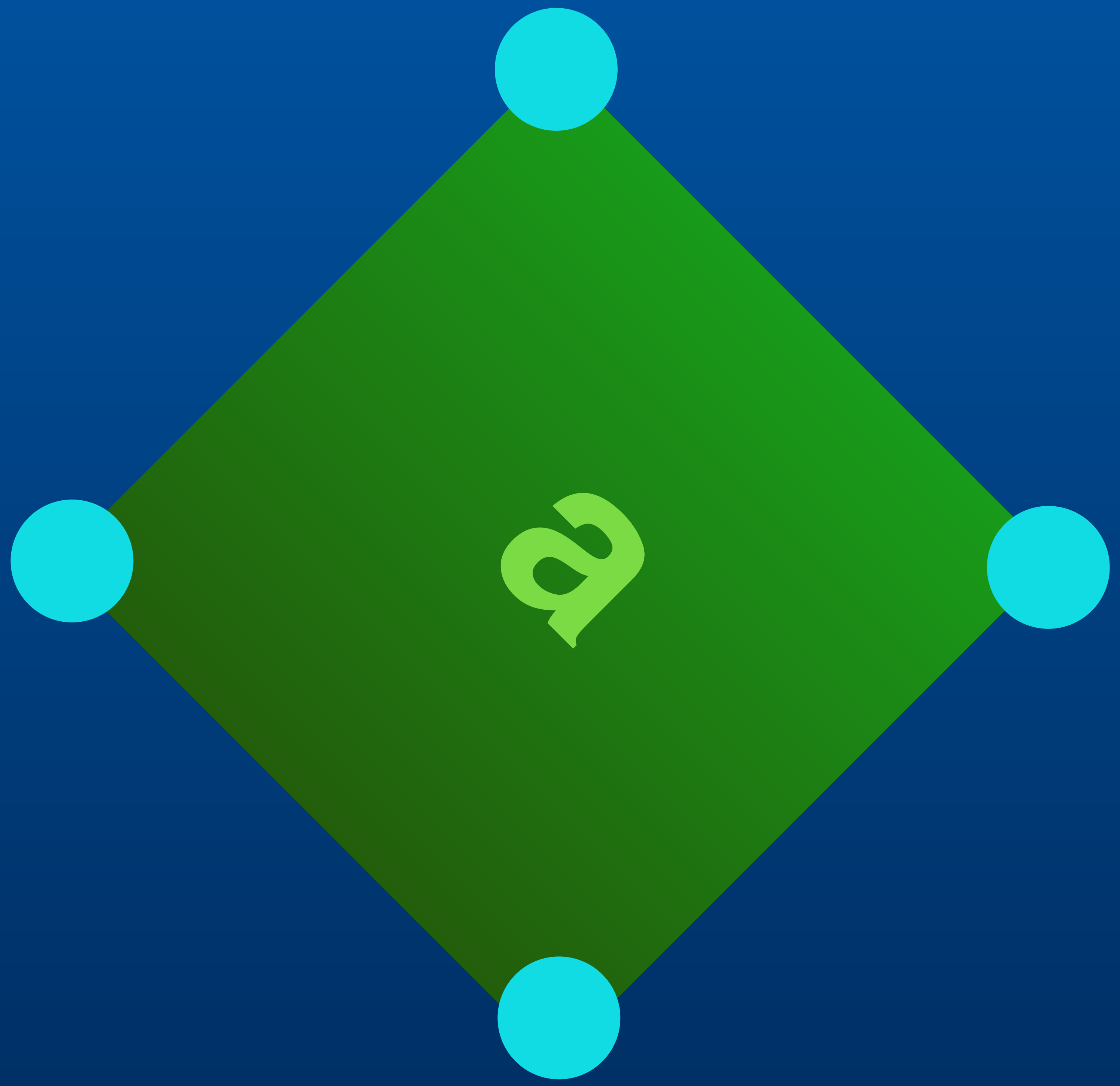
Our usual X axis is (1.0, 0.0) and Y is (0.0, 1.0).

An axis that's at a 45 degree angle (PI/4) can be represented by (cos(PI/4), sin(PI/4)).

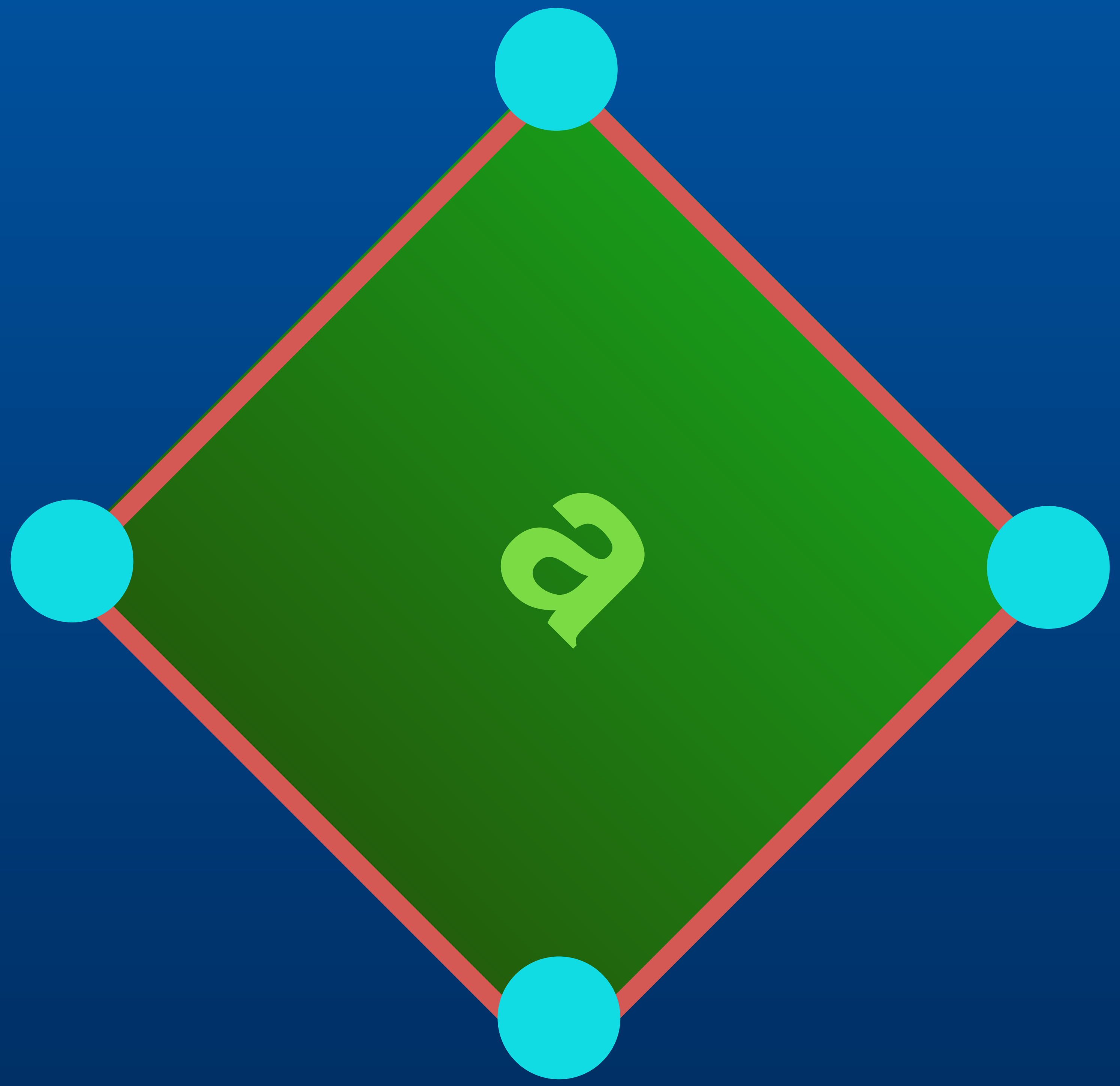
How do we figure out our rectangle axes?

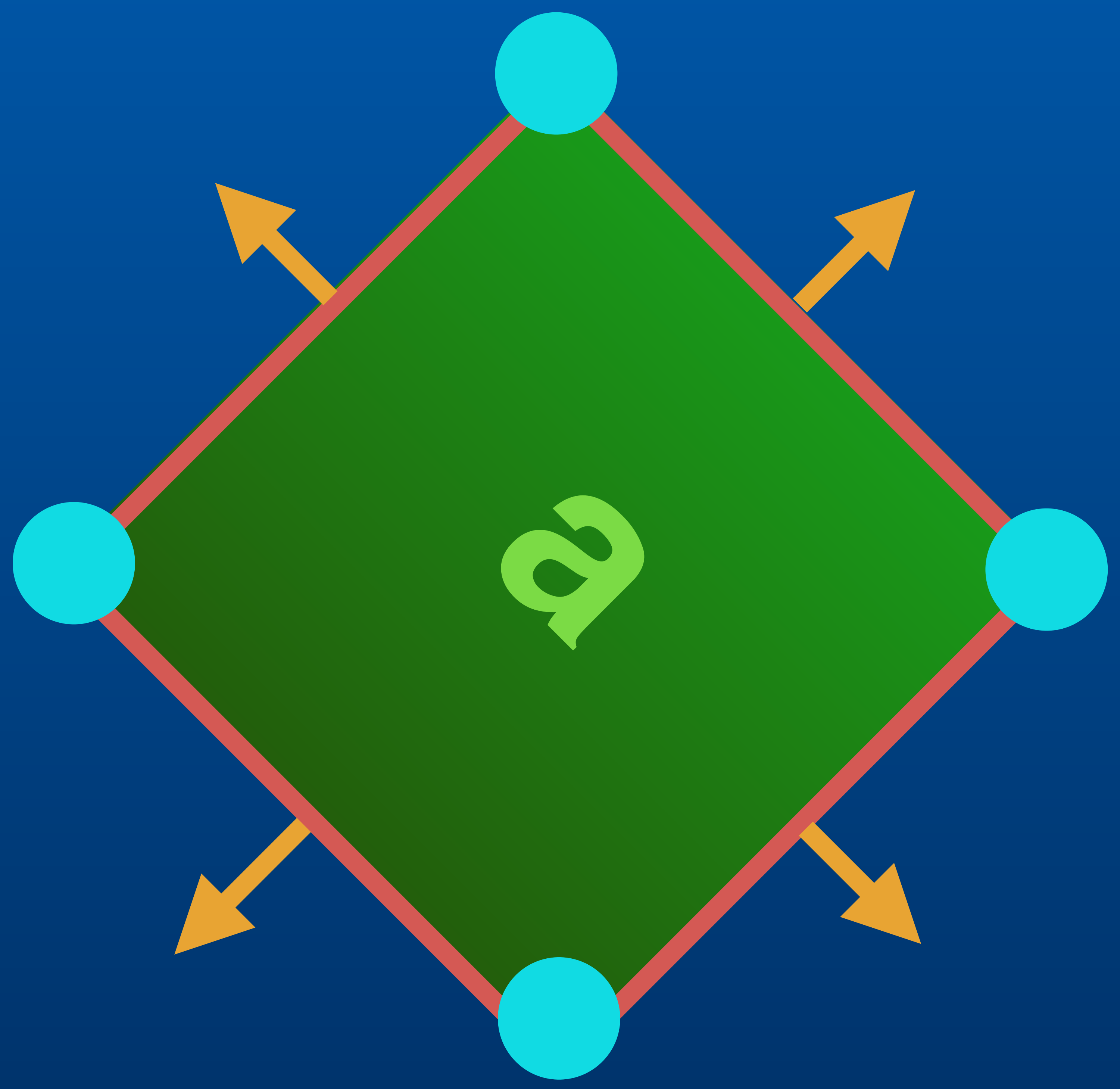
Normals.

Polygon



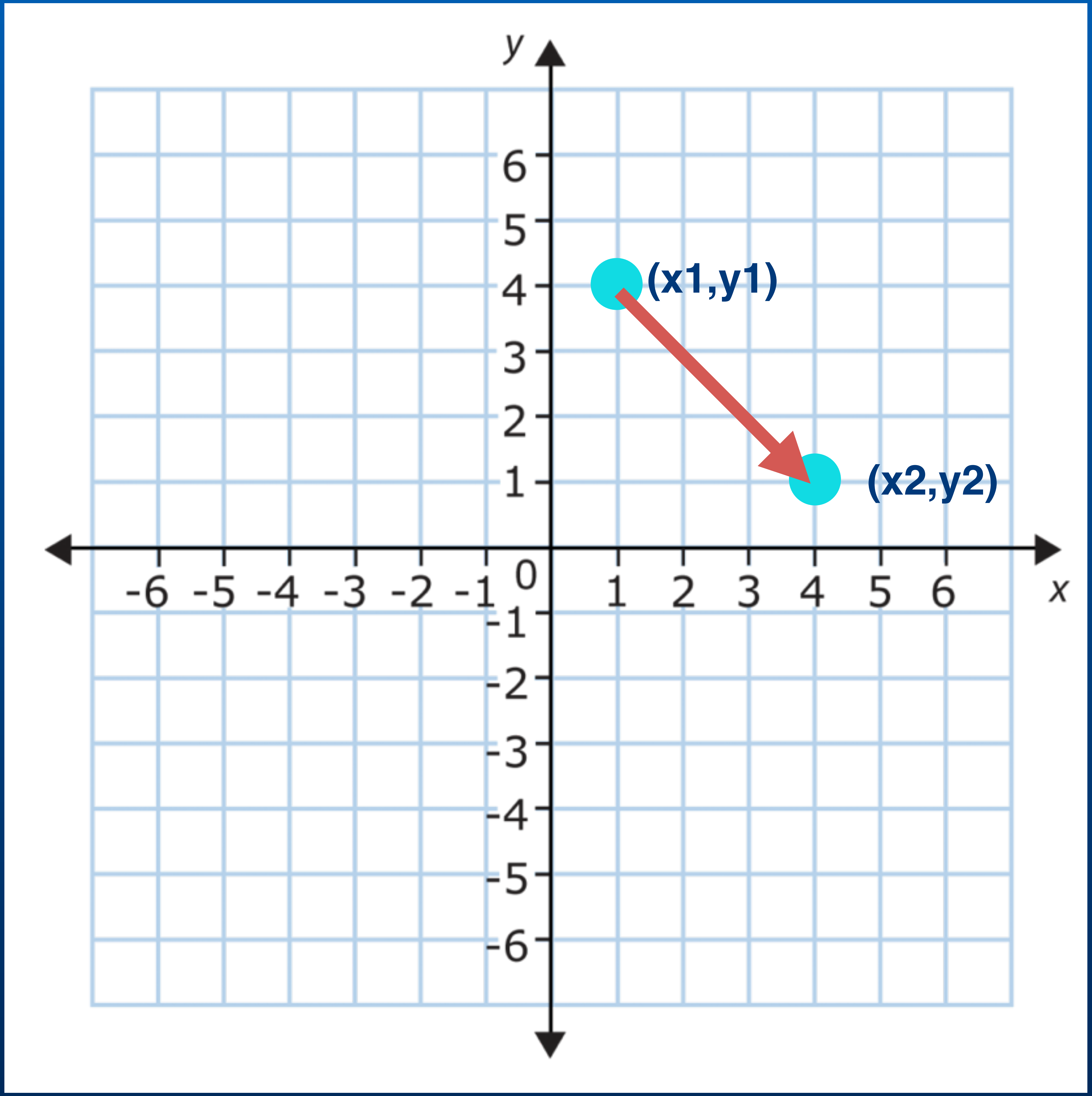
Polygon edges or sides.





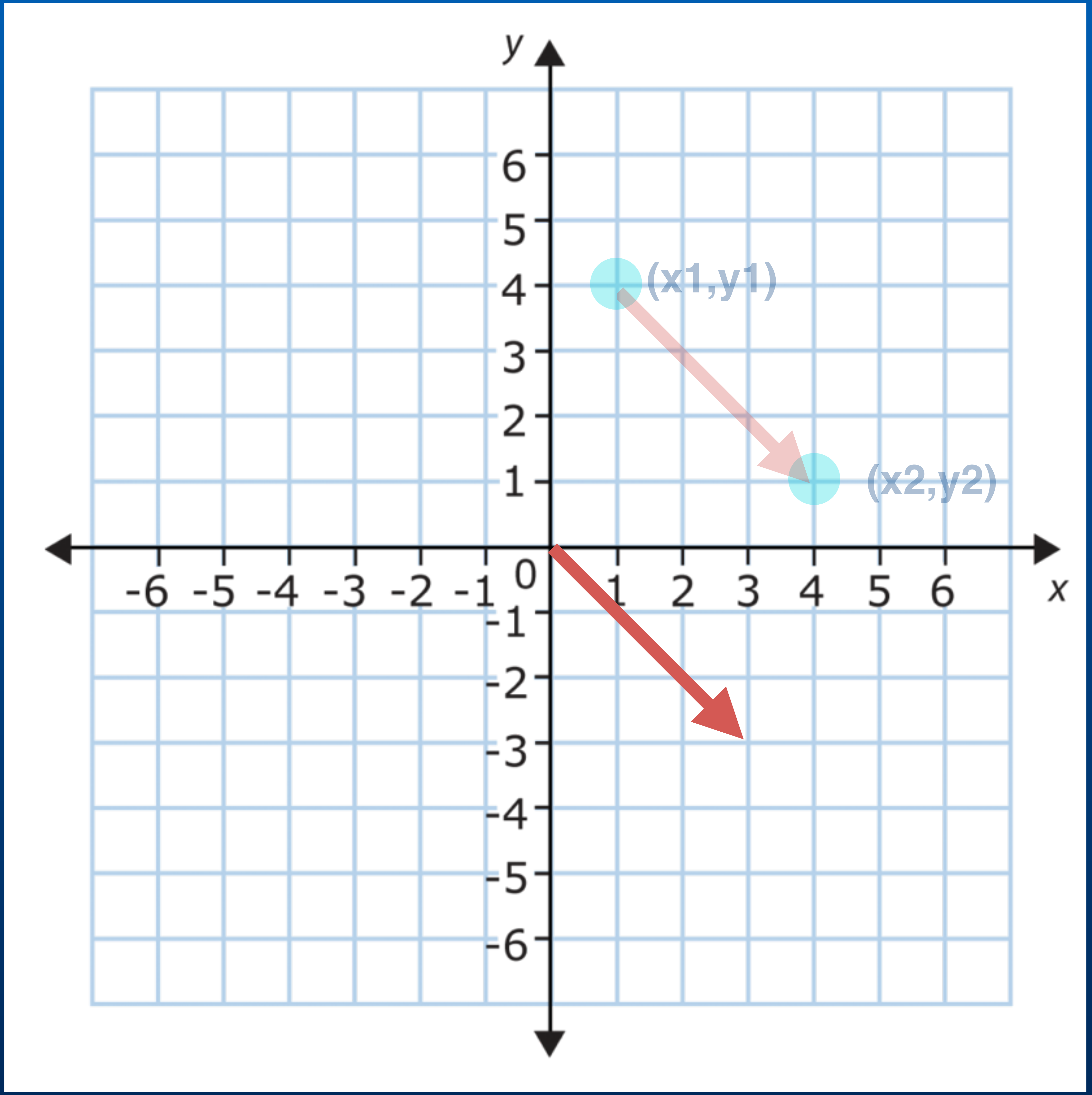
Edge normals.

Normalized (unit) vectors perpendicular to the edge.



An edge is a vector from one vertex to another.

edge_x = x2-x1
edge_y = y2-y1
edge = (edge_x, edge_y)



An edge is a vector from one vertex to another.

edge_x = x2-x1
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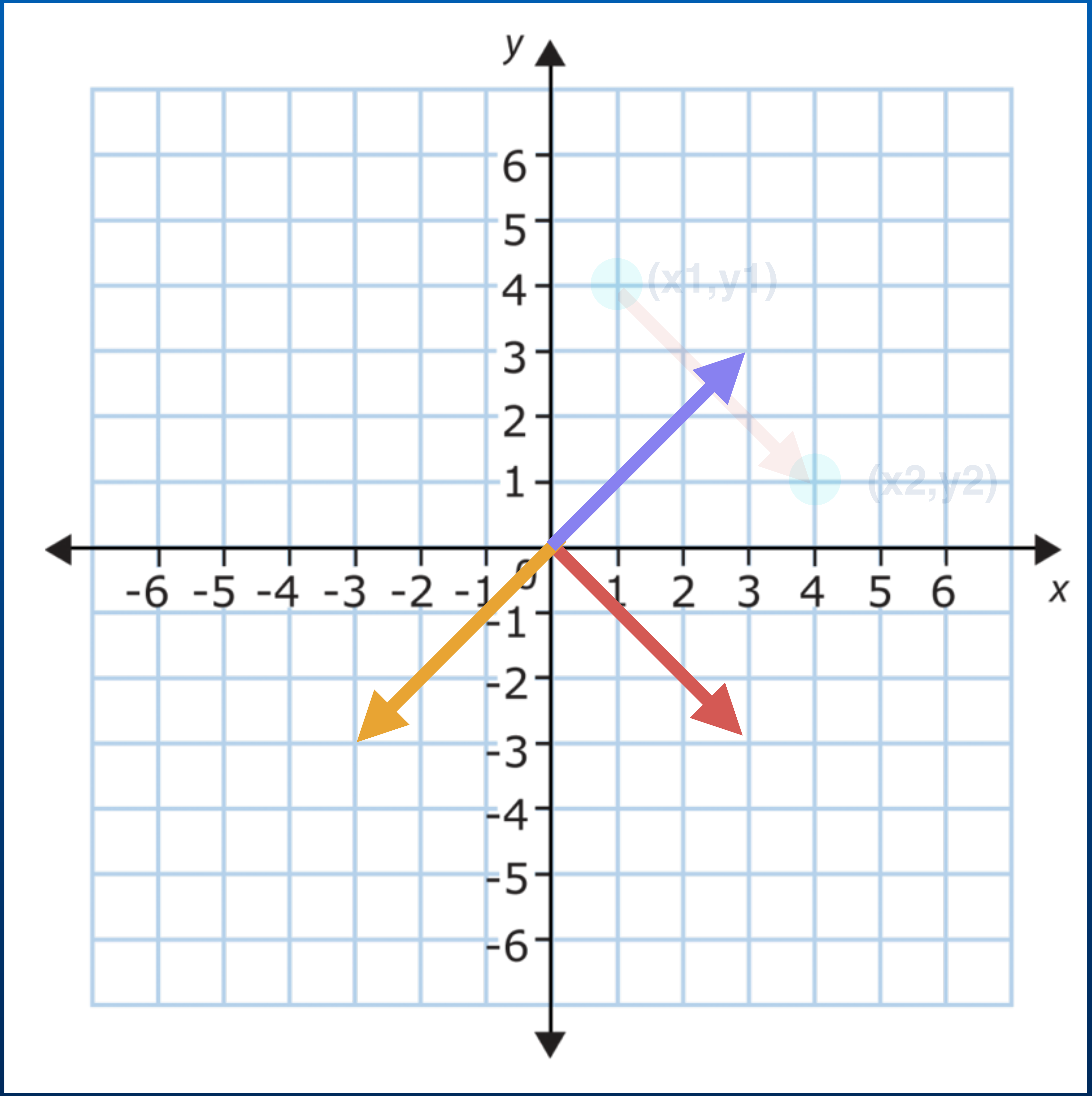


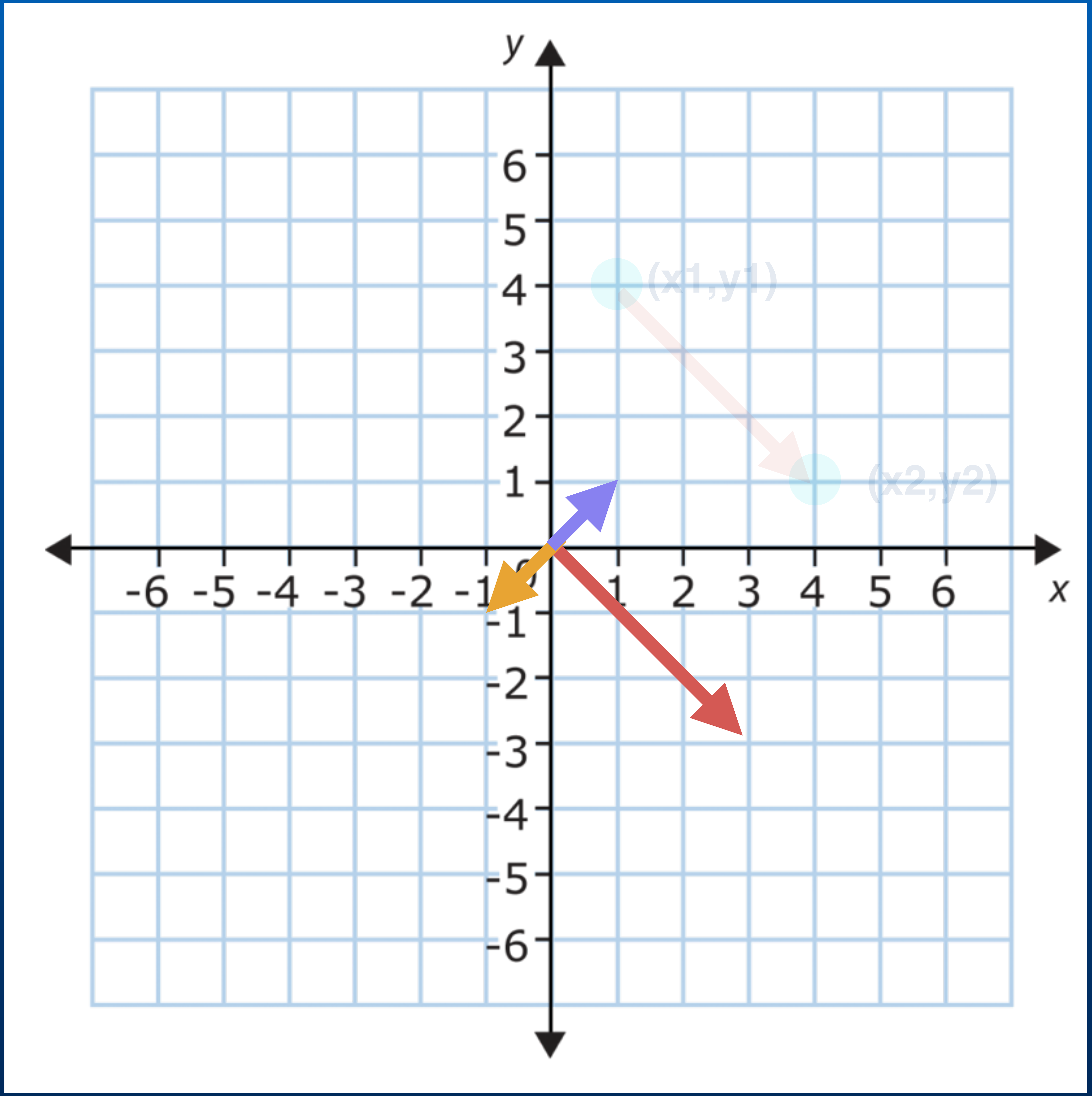
An edge is a vector from one vertex to another.

edge_x = x2-x1
edge_y = y2-y1
edge = (edge_x, edge_y)

Its normals are the vectors perpendicular to that vector.
normal1 = (edge_y, -edge_x)

and

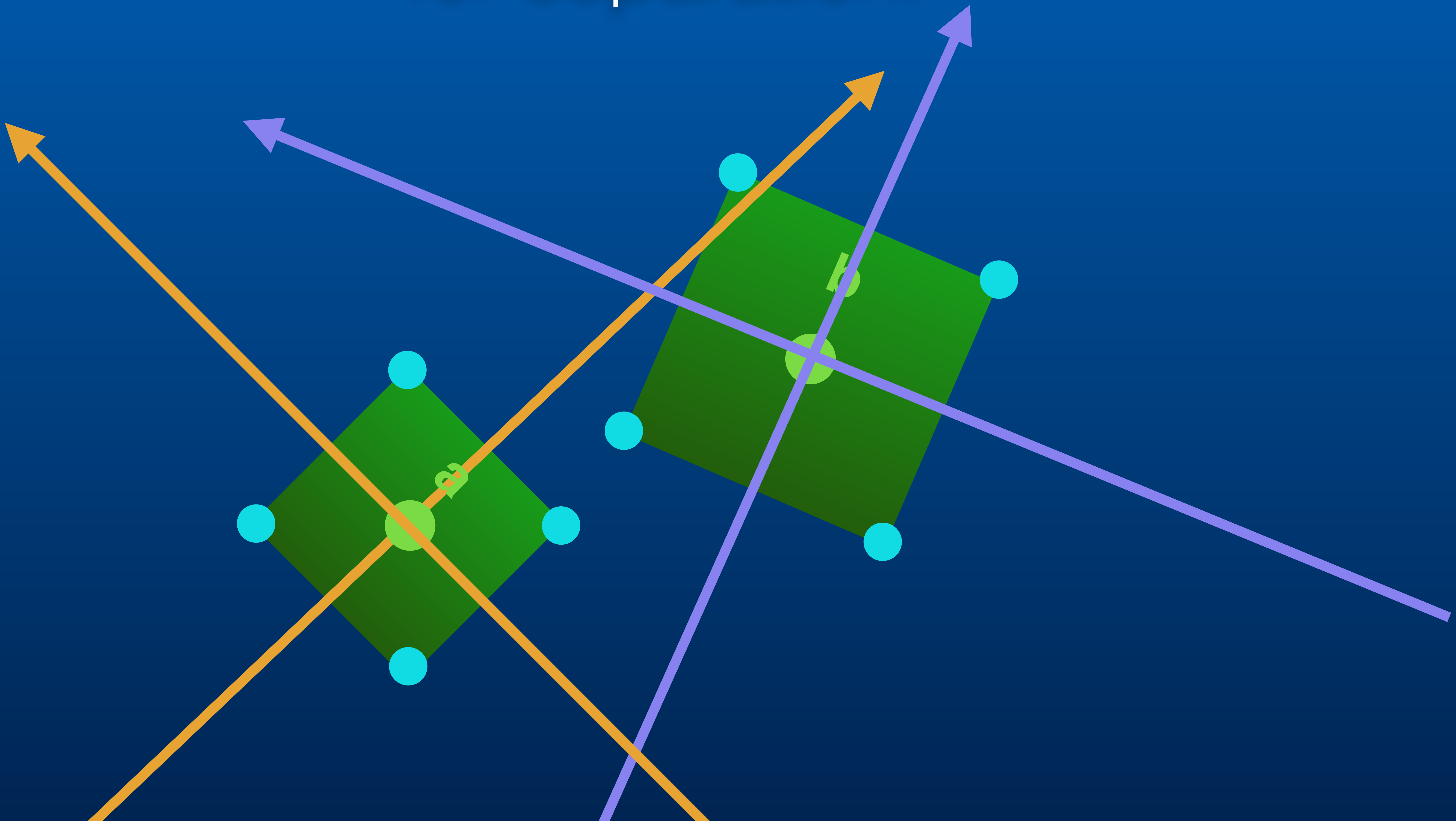
normal2 = (-edge_y, edge_x)



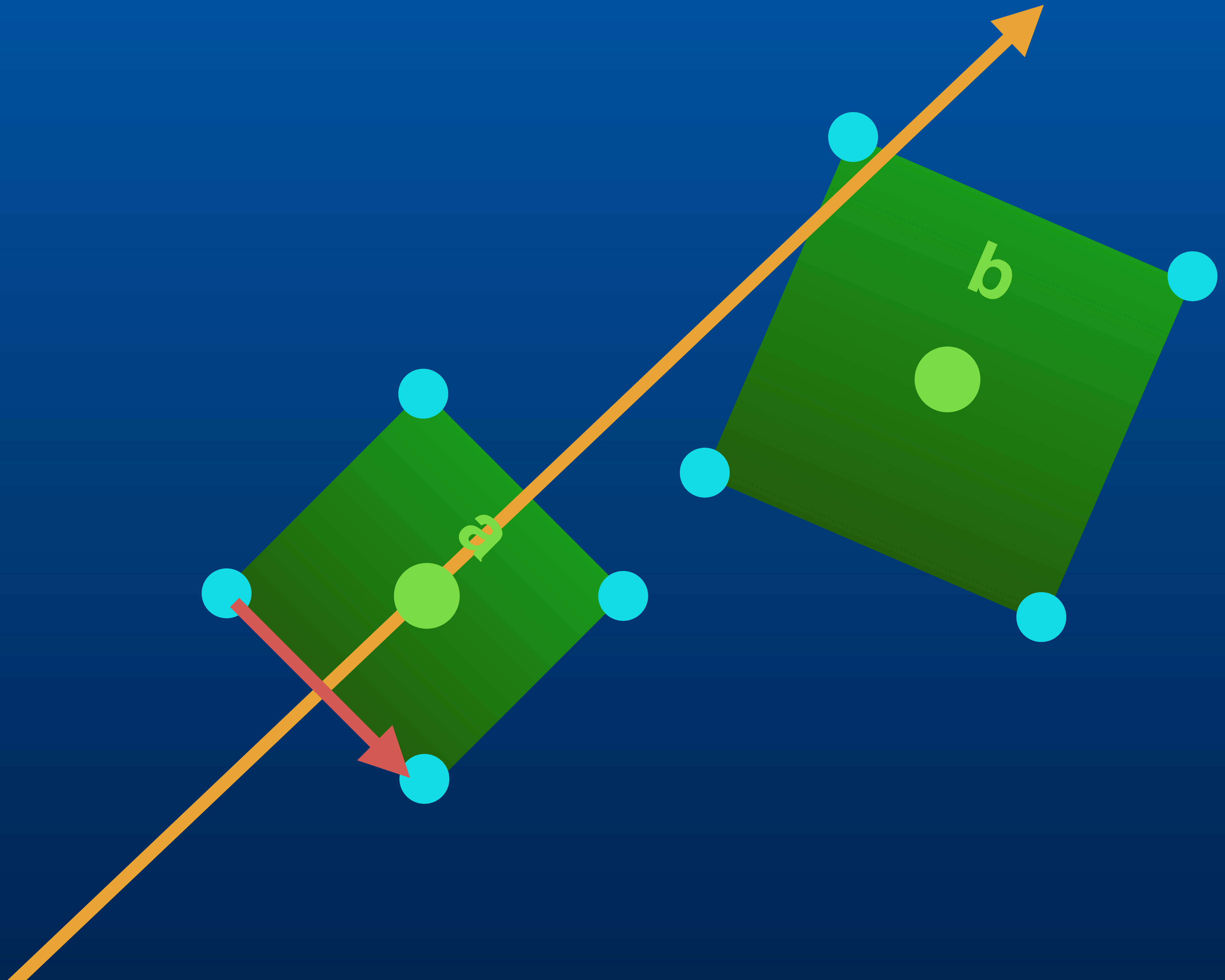
Now, normalize the normals.

```
length = sqrt(x*x + y*y)
x /= length
y /= length
```

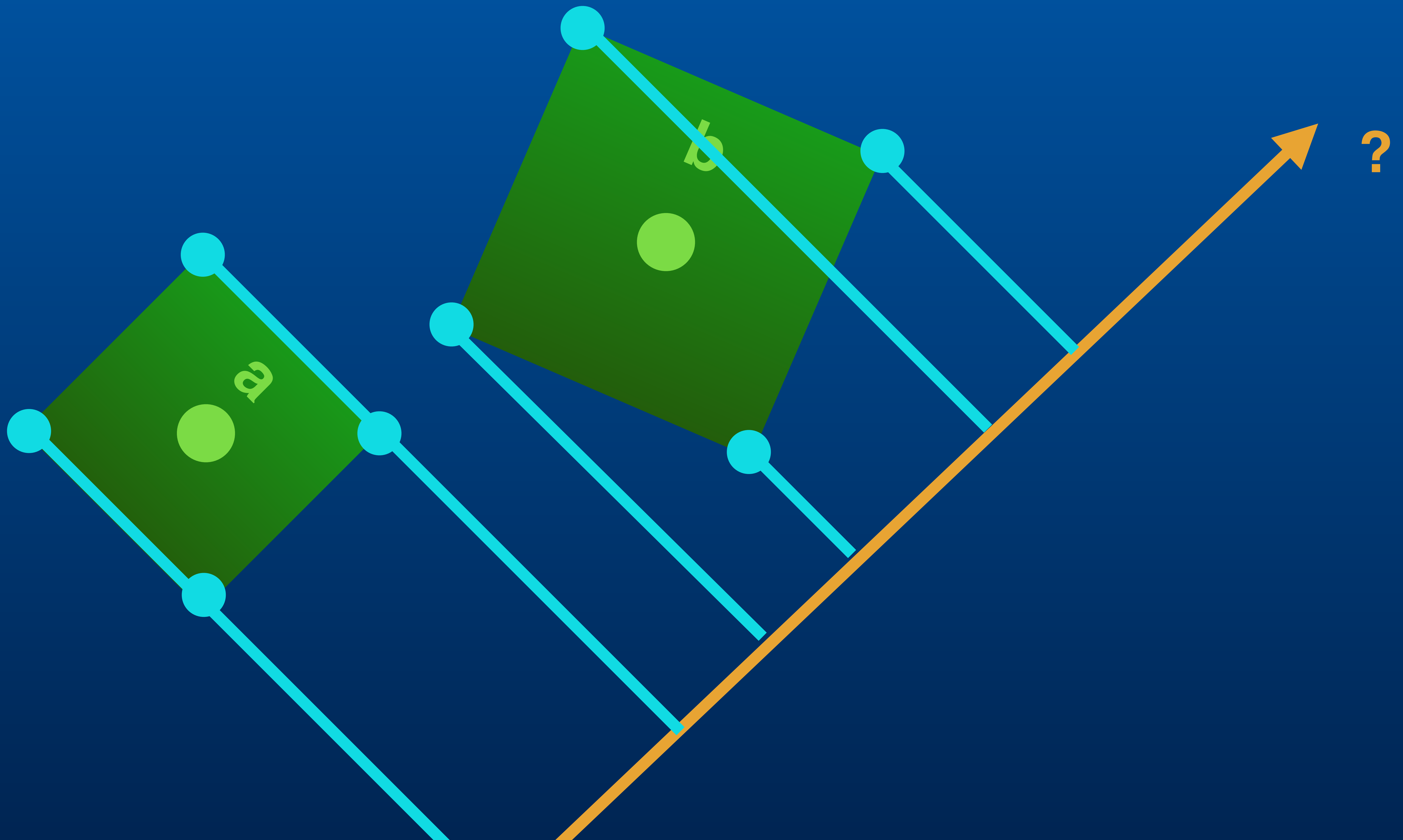
Our normals are the axes on which we check for separation.



For each edge find the normal.



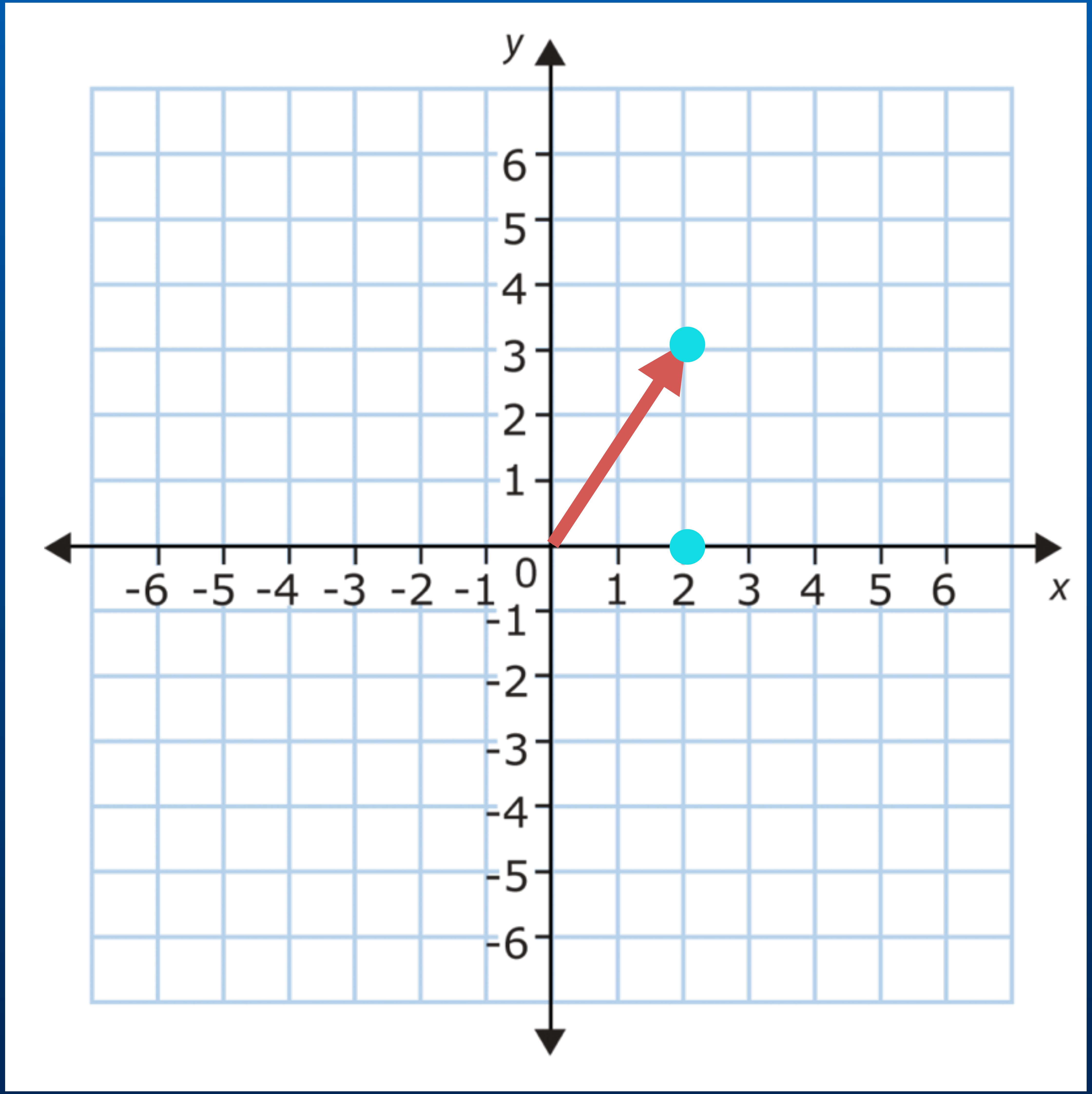
Projecting onto an arbitrary axis.



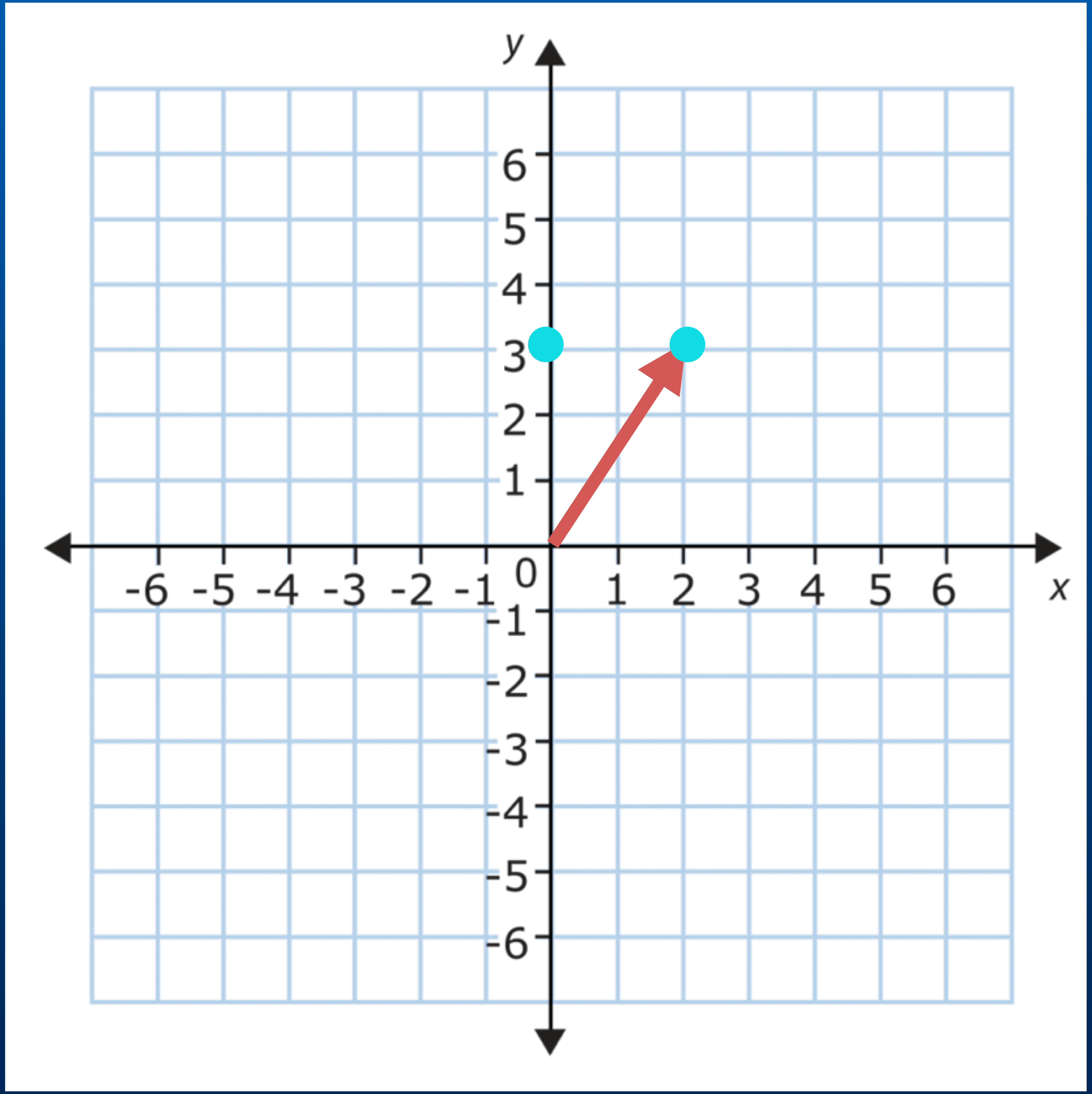
The dot product.

$$(x1*x2) + (y1*y2)$$

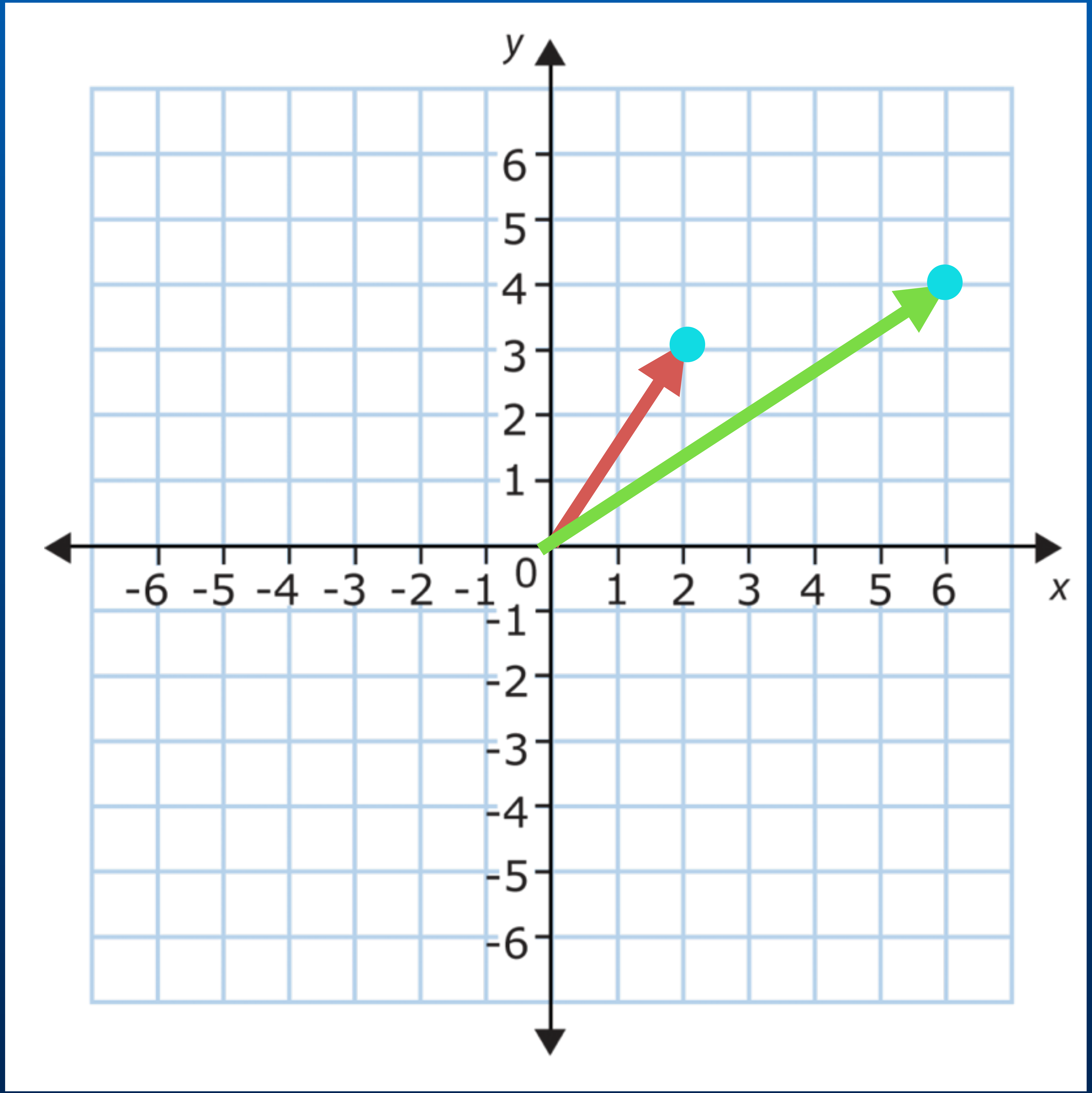
Applies one vector to another.



$$(2,3) \cdot (1,0) = (2*1) + (3 * 0) = 2$$



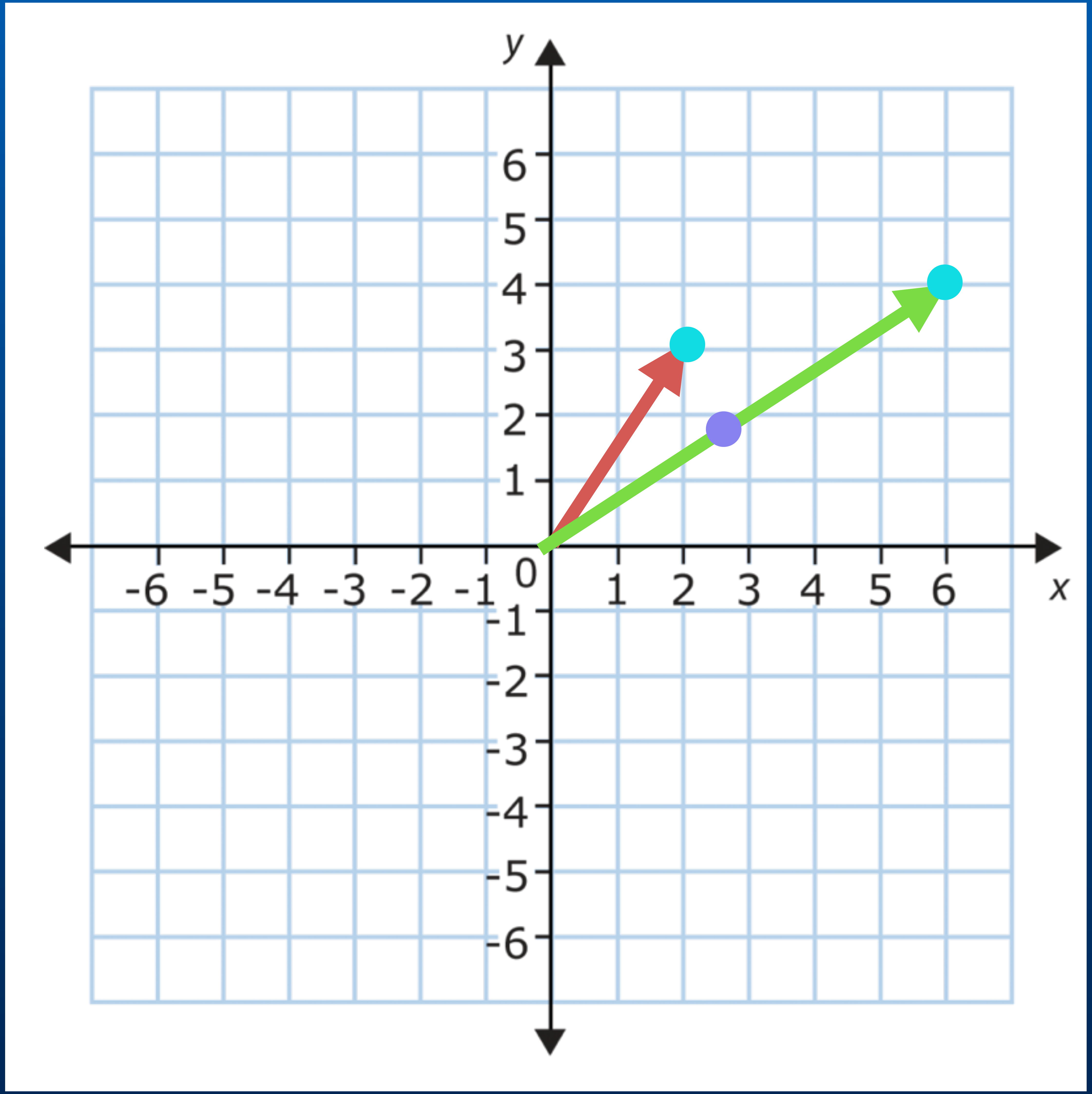
(2,3) · (0,1) = (2*0) + (3 * 1) = 3



Normalize (6,4):

length = sqrt(6*6 + 4*4) = 7.2111
x = 6 / 7.2111 = 0.832
y = 4 / 7.2111 = 0.5547

(2,3) · (0.832,0.555) = (2*0.832) + (3 * 0.555)
= 1.664 + 1.665 = **3.329**



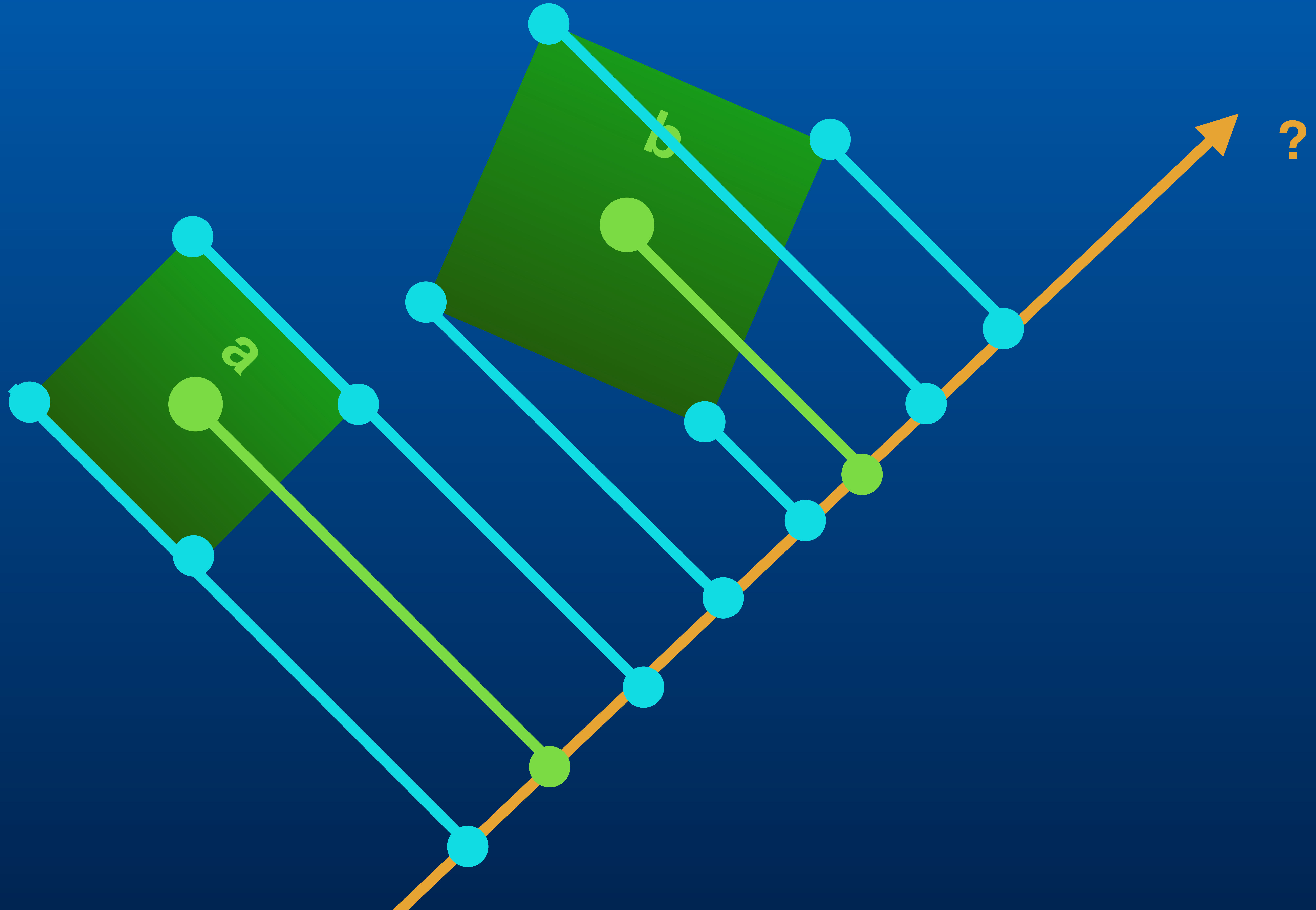
Normalize (6,4):

length = sqrt(6*6 + 4*4) = 7.2111
x = 6 / 7.2111 = 0.832
y = 4 / 7.2111 = 0.5547

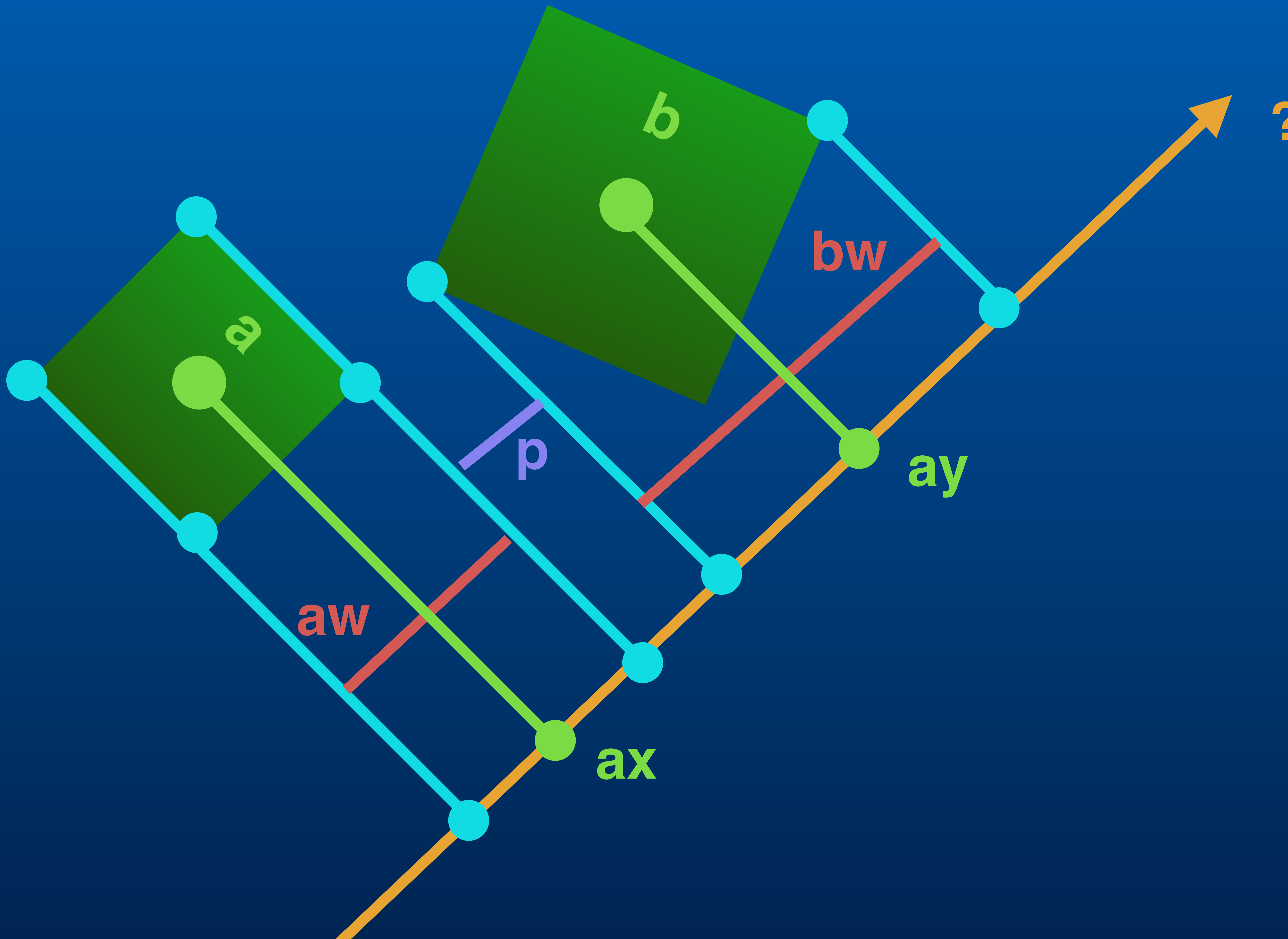
(2,3) · (0.832,0.555) = (2*0.832) + (3 * 0.555)
= 1.664 + 1.665 = **3.329**

(0.832,0.555) * 3.329 = (2.769, 1.847)

Find dot product of each corner with the normalized axis vector.



How far away are they on this axis?



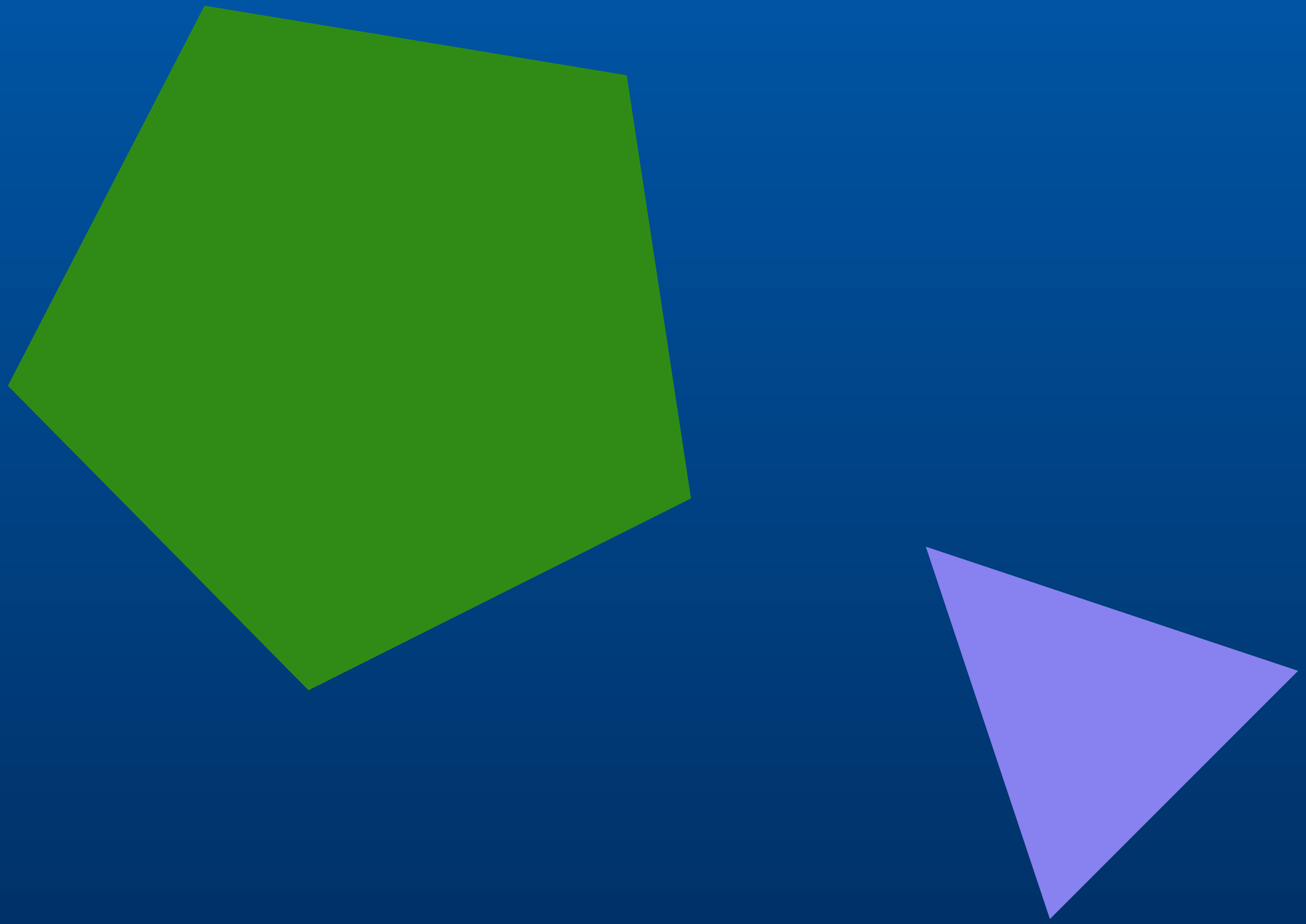
$$p = |x_1 - x_2| - \frac{w_1 + w_2}{2}$$

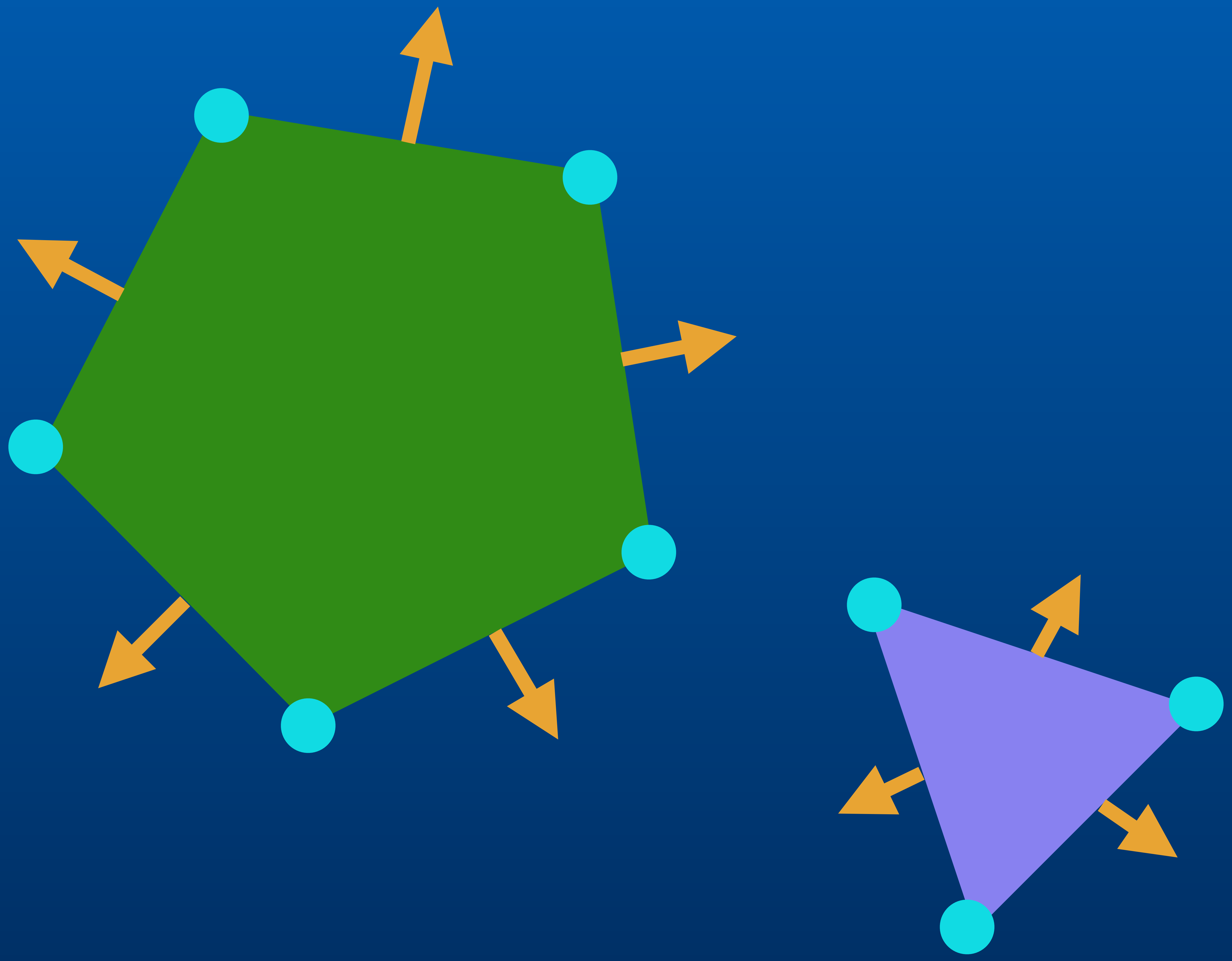
if p >= 0, we are not colliding!

Check the separation on each of the 4 normal axes (we don’t have to check all 8 since 2 sides of each rectangle are parallel.

If on any axis, there is a separation, the collision is not occurring.

Arbitrary polygon collision.



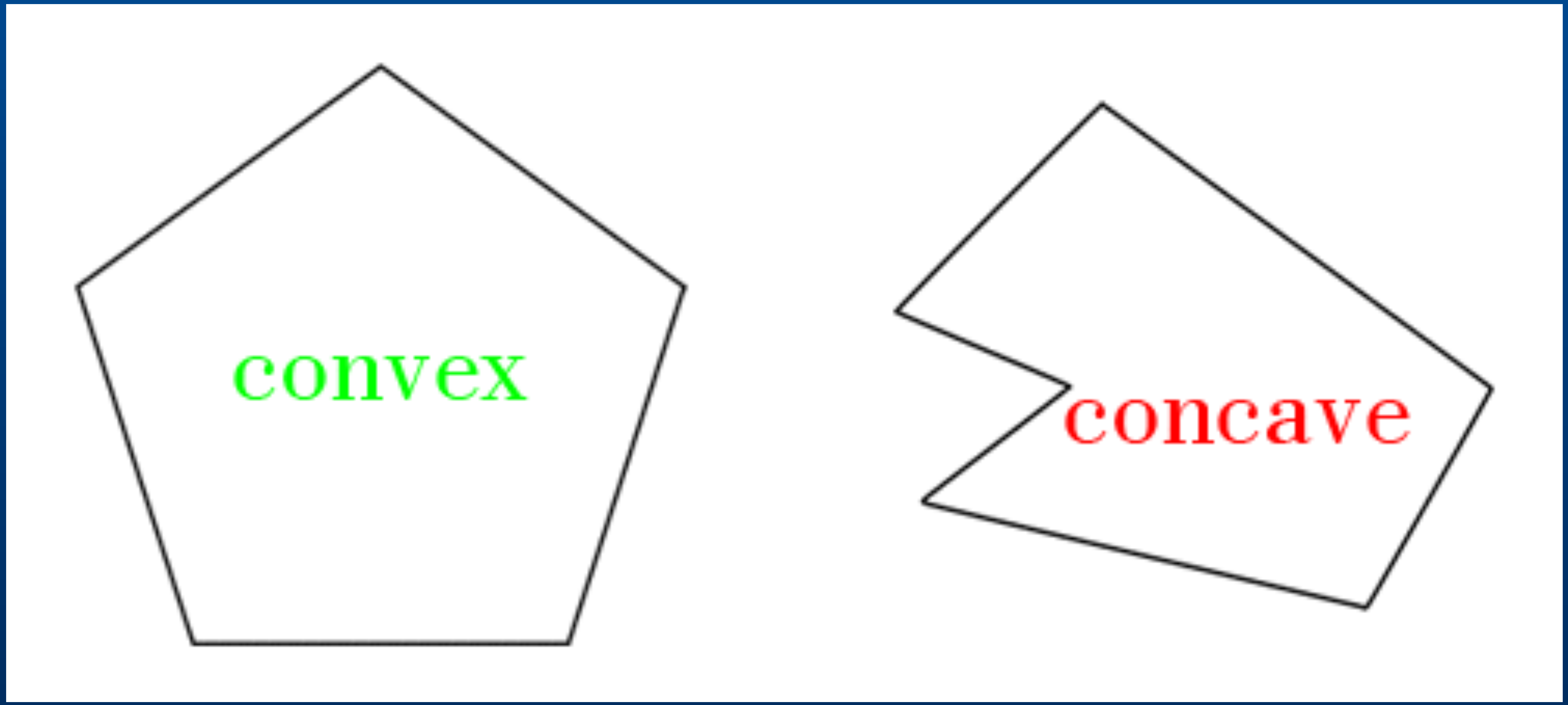


aMin
aMax
bMin
bMax

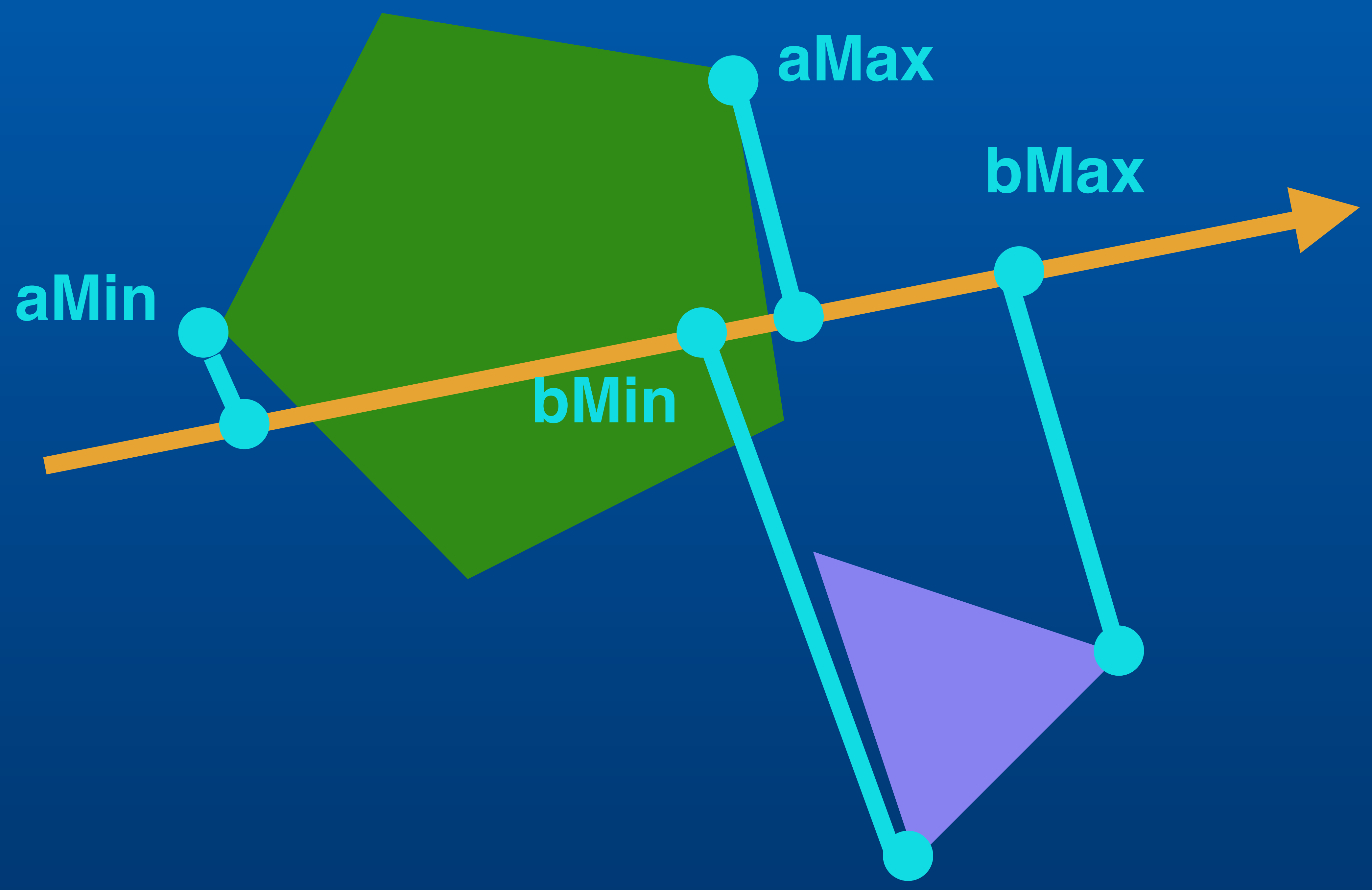
If aMin <= bMax and aMax >= bMin, we have a collision on this axis

Only works with convex polygons!

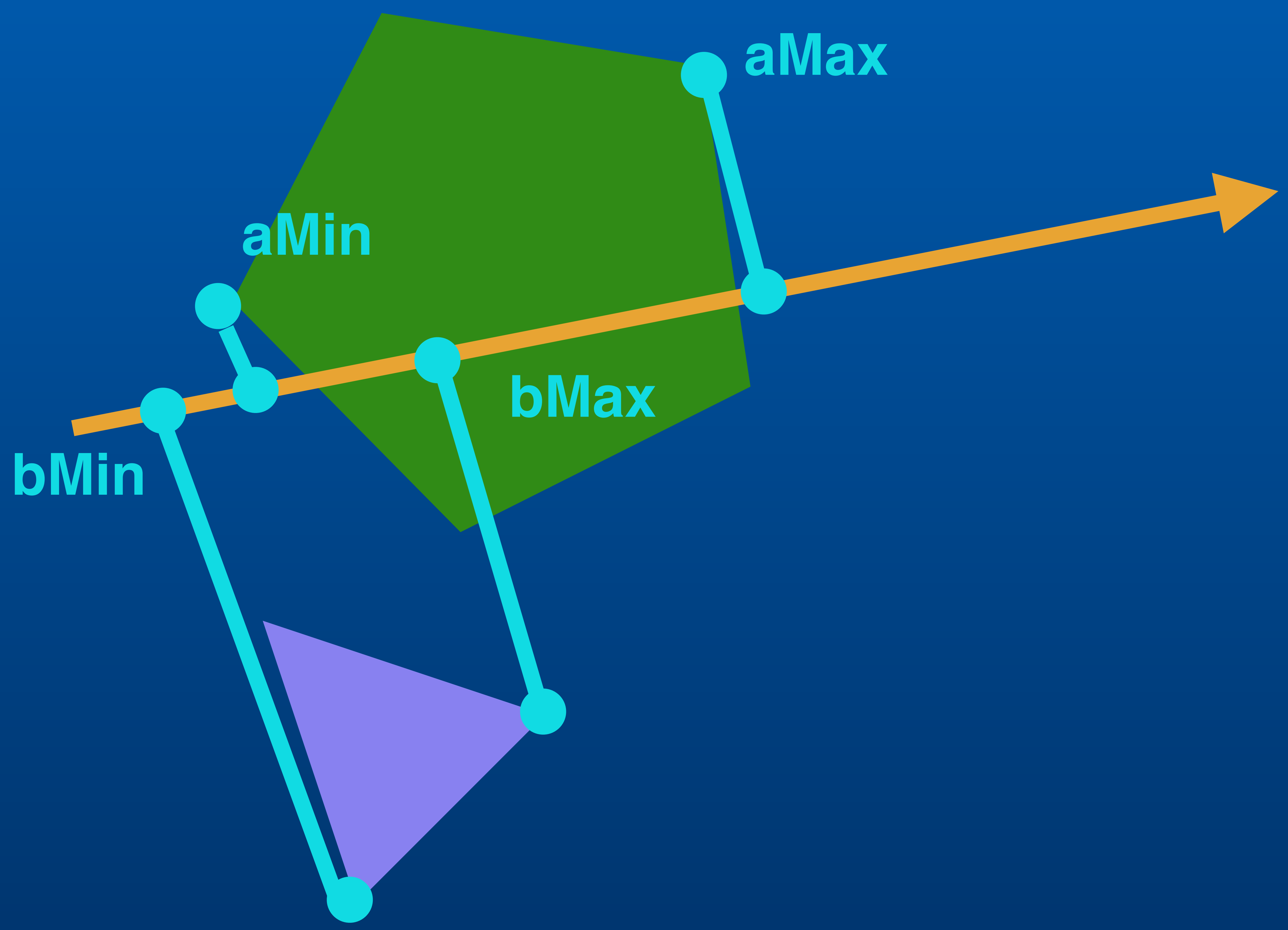
(every internal angle < 180 degrees and it’s not self intersecting)



Responding to collisions.

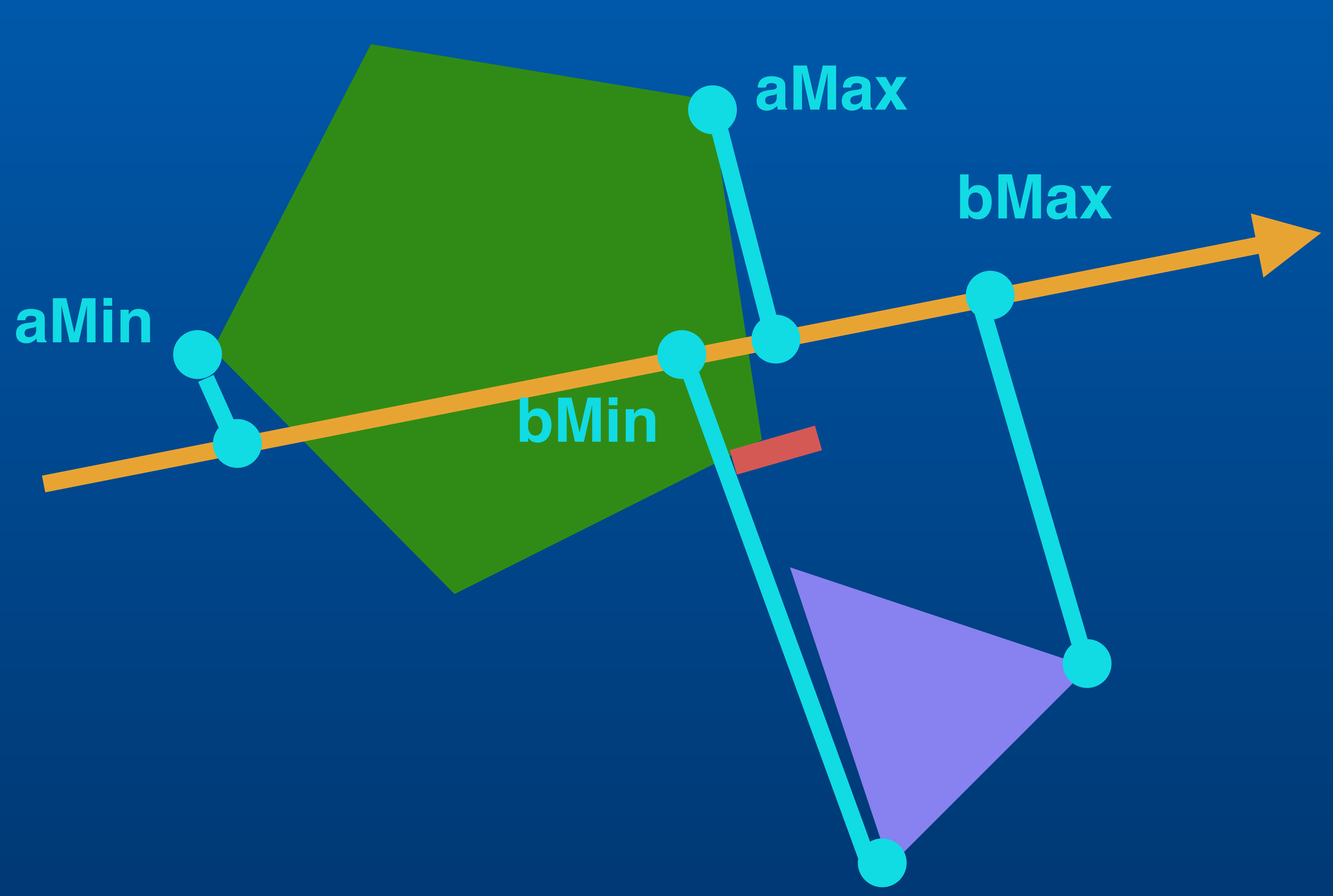


OR

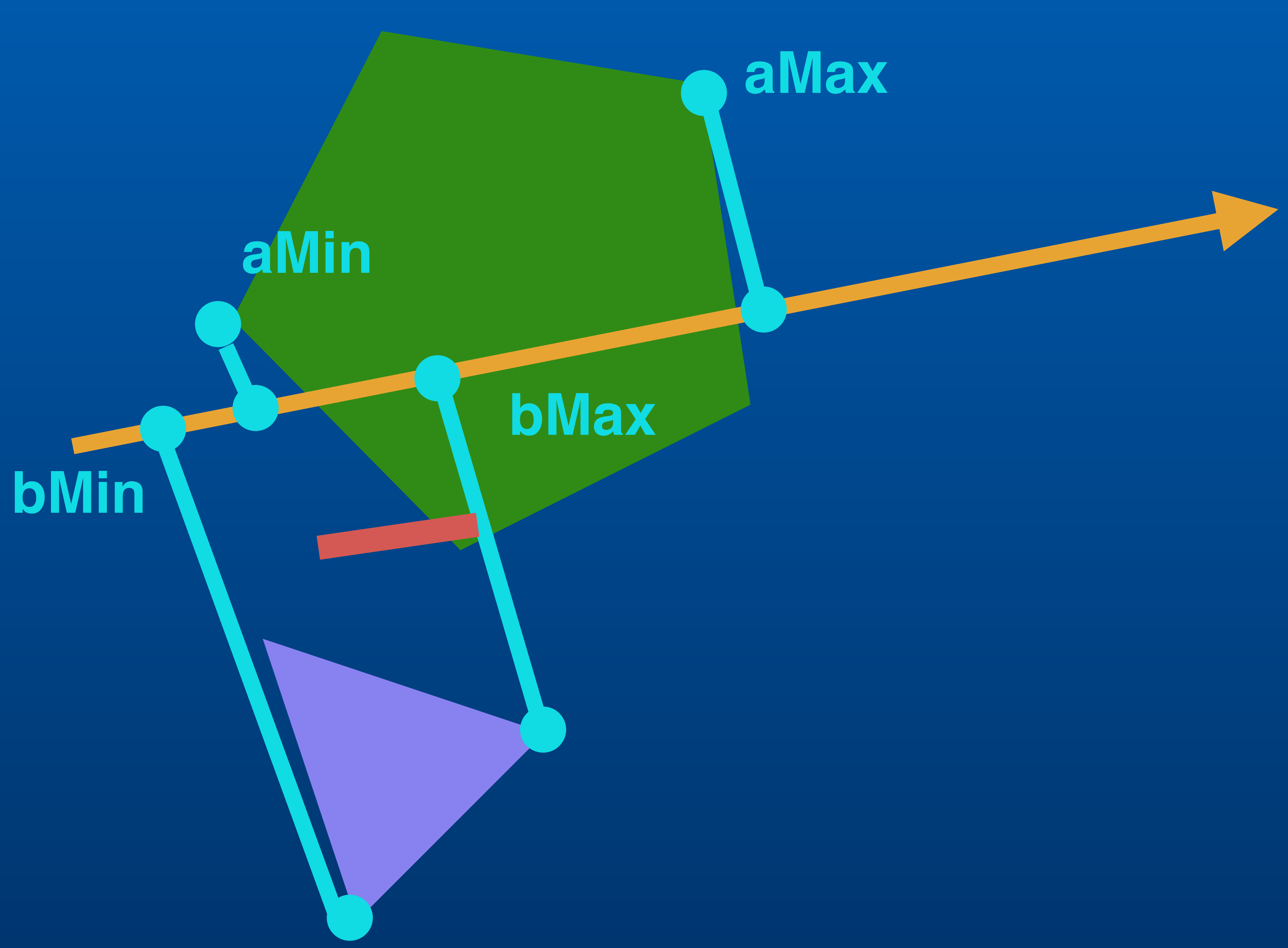


If aMin <= bMax and aMax >= bMin, we have a collision on this axis

FIND THE SMALLER PENETRATION FOR EACH AXIS



OR



aMax - bMin OR bMax - aMin

THEN TRANSLATE IT BACK INTO WORLD SPACE COORDINATES
BY MULTIPLYING BY THE AXIS NORMAL AND SAVE INTO A LIST

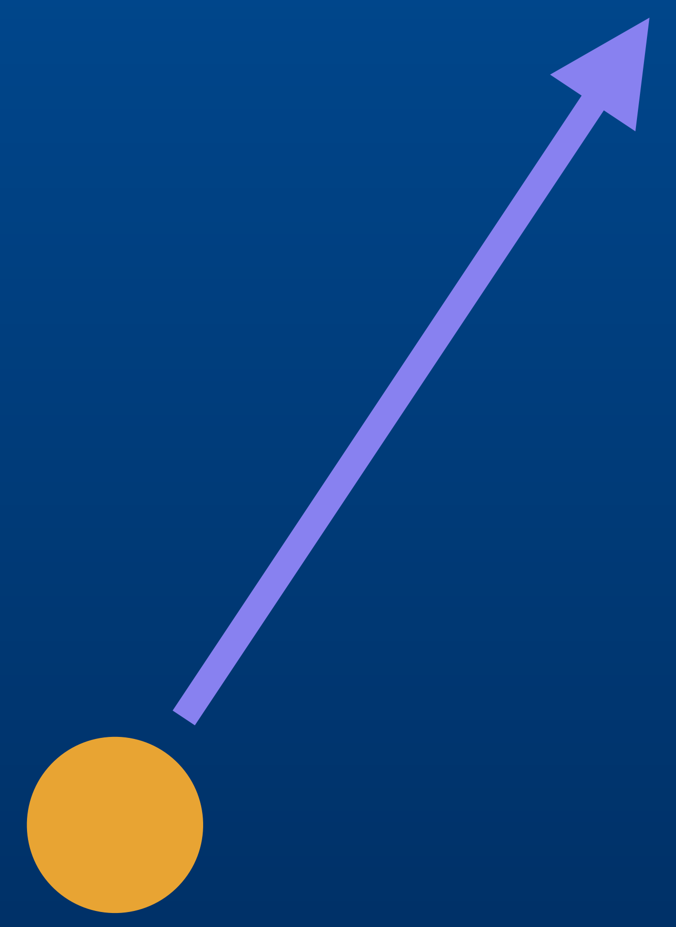
OUR ADJUST VECTOR IS THE SMALLEST PENETRATION VECTOR
FROM ALL THE AXES!

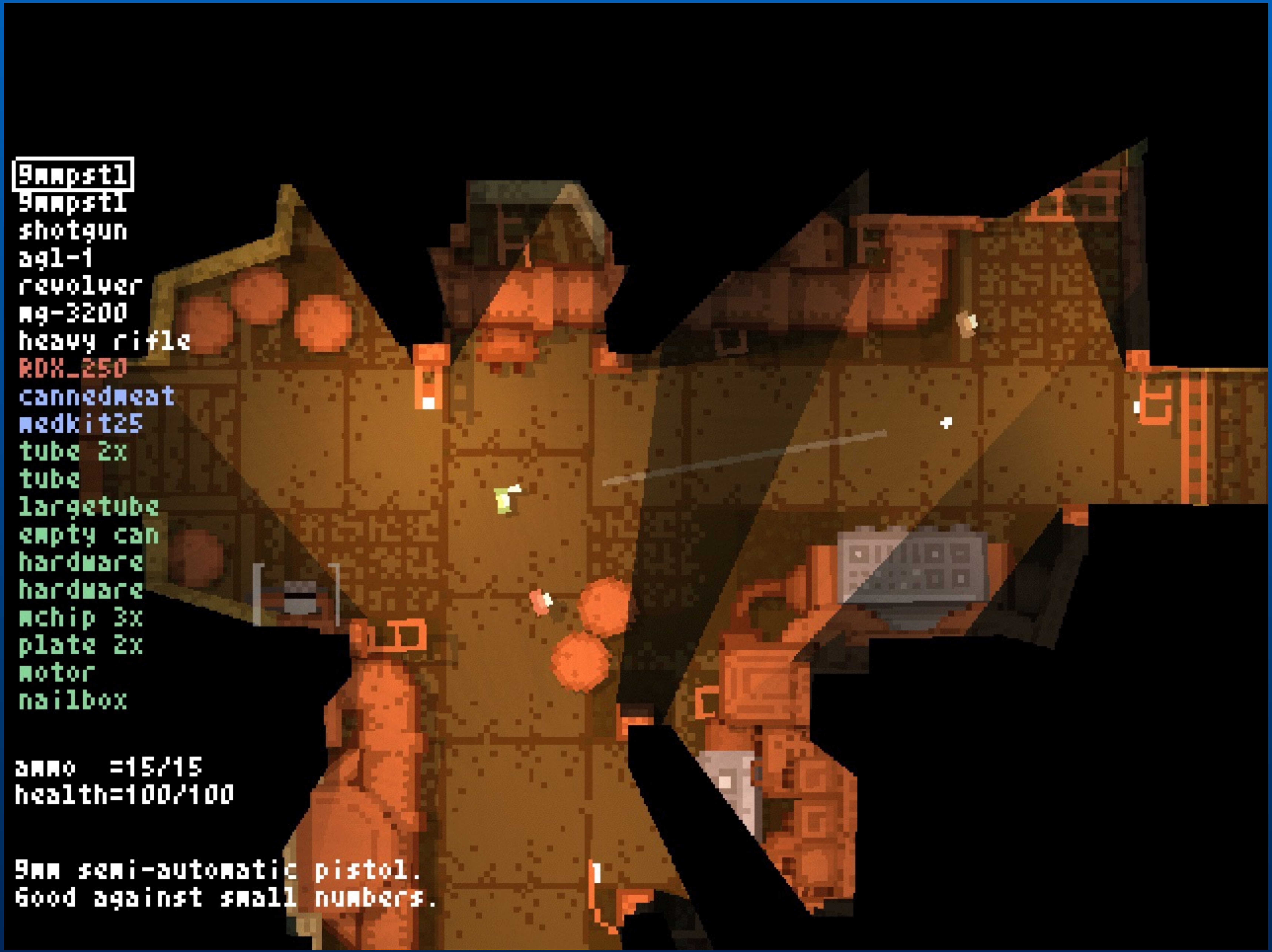
Raycasting.

What is a ray?

A ray has an origin position and a direction.

It can be defined as a two vectors, one defining the position and another (unit!) vector defining the direction.





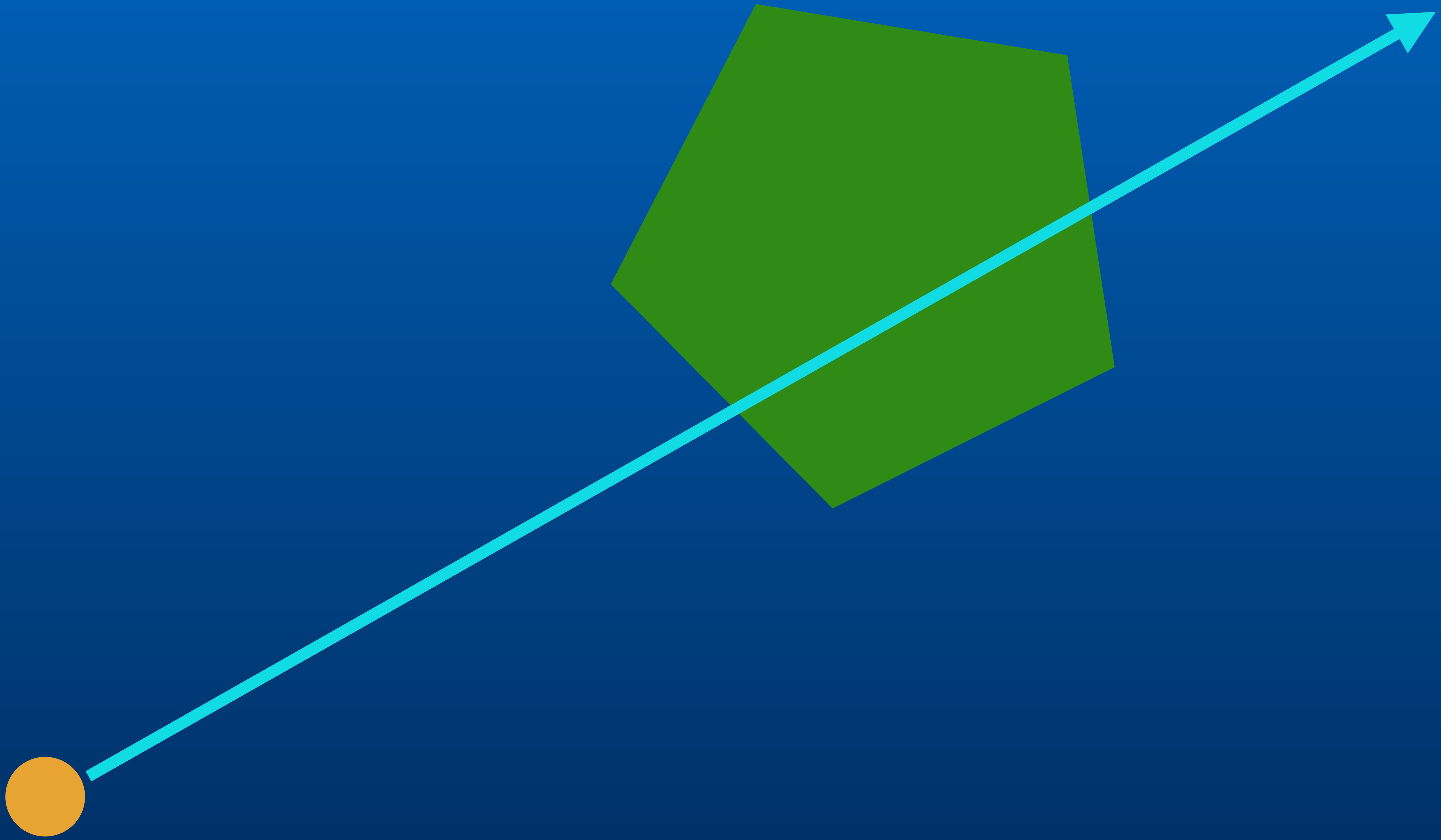
```
ammo  =15/15
health=100/100
```

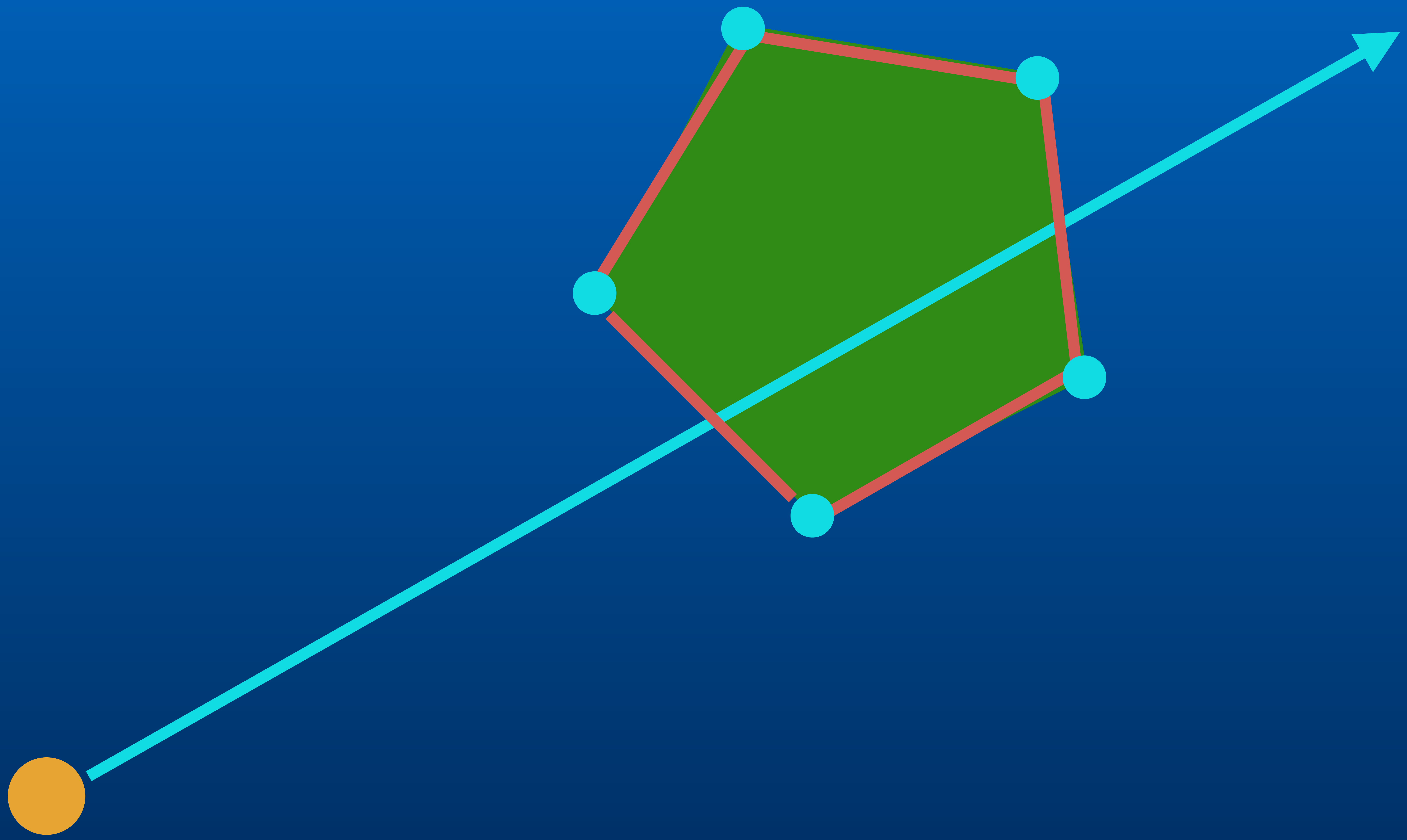
9mm semi-automatic pistol.
Good against small numbers.

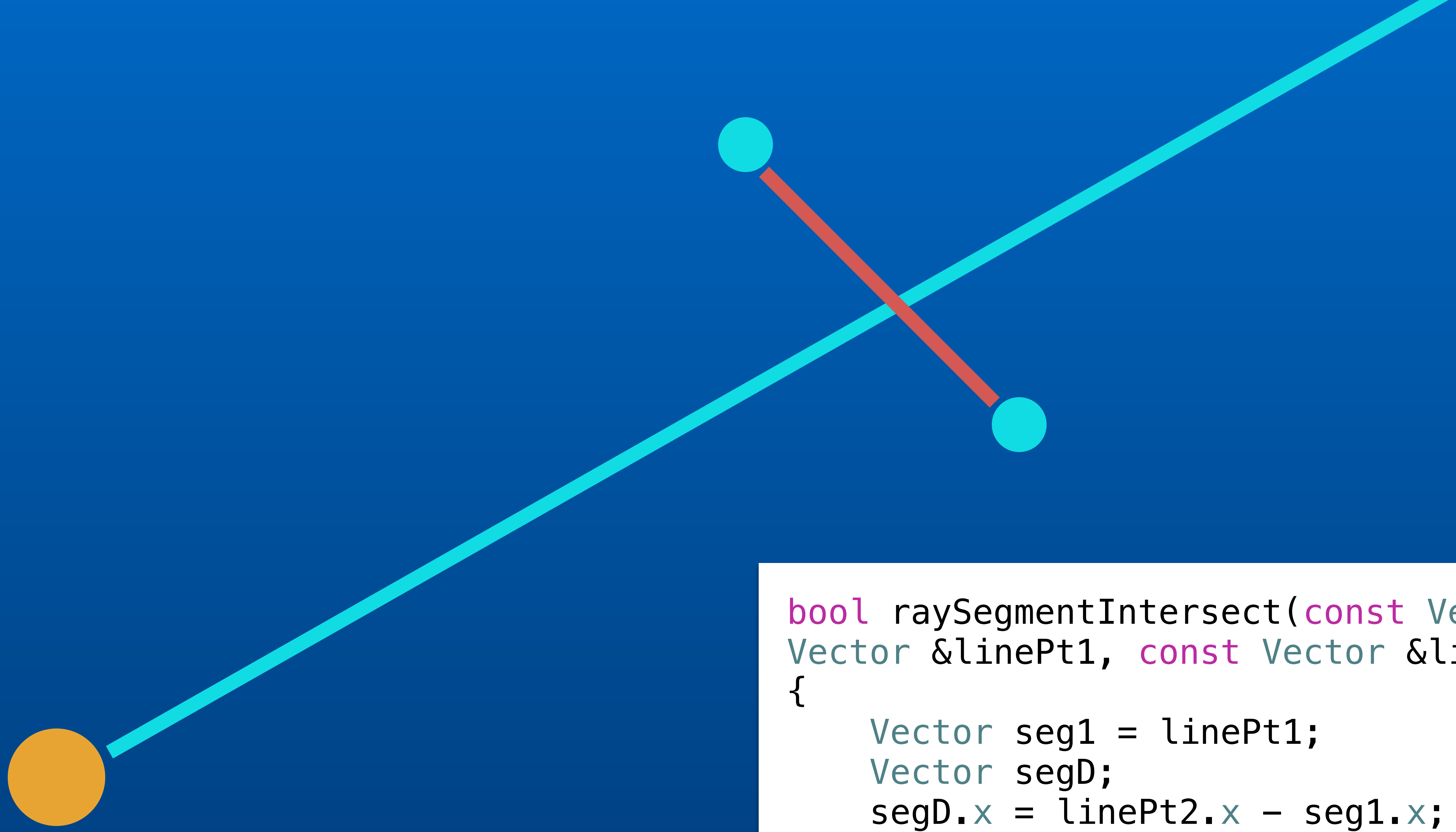
Drop
Y
Drop
B
X
043

ZR
X
Y
29
A
Back
B
00
477

Ray/Polygon intersection test.







```
bool raySegmentIntersect(const Vector &rayOrigin, const Vector &rayDirection, const
Vector &linePt1, const Vector &linePt2, float &dist)
{
    Vector seg1 = linePt1;
    Vector segD;
    segD.x = linePt2.x - seg1.x;
    segD.y = linePt2.y - seg1.y;

    float raySlope = rayDirection.y / rayDirection.x;
    float n  = ((seg1.x - rayOrigin.x)*raySlope + (rayOrigin.y - seg1.y)) / (segD.y -
segD.x*raySlope);

    if (n < 0 || n > 1)
        return false;

    float m = (seg1.x + segD.x * n - rayOrigin.x) / rayDirection.x;
    if (m < 0)
        return false;

    dist = m;
    return true;
}
```

Use closest distance.