Line segment and Ray intersect math

Math here is inspired by content at https://stackoverflow.com/a/4030884

Say the ray is something start at pint P. We want to check its intersection with line segment from $P1$ to $P2$

Define all the vector components

Here we define these vectors:

```
                            ray_direction              P2
                           ^                      ---->
                           |              -------/    >
                           |      -------/          -/ ^
                          -x-----/                 /   |
                  -------/ | intersect            /    |
    P1    -------/         |                    -/     |
     <---/                 |                   /       |
       <                   |                  /        |
     ^  \-                 |                -/ V_a2    |
     |    \                |               /           |
     |     \-              |              /            |
     |       \ V_a1        |            -/             |
     |        \-           |           /               |
     |          \          |         -/                |V_b2
 V_b1|           \         |        /                  |
     |            \-       |       /                   |
     |              \      |     -/                    |
     |               \-    |    /                      |
     |                 \   |   /                       |
     |   V_c1           \- | -/         V_c2           |        Normal to ray
     <------------------- \|---------------------------->---------->
                            P
```

V_{a1} is vector P-P1, V_{c1} is the projection of V_{a1} onto ray's normal direction.

$$V_{c\ proj} = V_{a1} \cdot \hat{P_{norm}}$$

$$V_{b\ proj} = V_{a1} \cdot \hat{V_{ray}}$$

The same apply for the other sets of vectors with $P2$.

note: V_{ray} and P_{norm} are both unit vector

Both V_b and V_c vector itself is not needed since we do the math later with geometry. But their projected length is important. As the sign after dot project is necessary for next step's checking.

Check for intersection

To check for intersection, we compare the direction of V_{c1} and V_{c2} (or the sign of $V_a \cdot P_{norm}$, as dot product gives directional magnitude after projection). This check will also give intersect result if both points are behind the line. Thus we also need to check for that. Could use the same dot product trick $V_a \cdot \hat{V_{ray}}$, negative means it's behind the ray and should be skipped.

However there is an special case where the above conditions are both satisfied but still no intersection.

```
             ^
             |
--\          |
   ---\      |
       ----\
            ----\
                 ---\
                     ---
```

This is a very special case where we can only check after computing the intersect distance.

Finding intersection point

```
                                     ---^
                               -----/   |  b2
                         -----/         |
                    ----/            ---|
              -----/|          -----/   |
        -----/      |     ----/         |
     --/            -----/              |
     ^         ----/|                   |  b2-b1
  b1 |   -----/     | x                 |
     |--/           |                   |
     <--------------|------------------->
           c1                c2
```

```
     ^--\
     |   -----\
     |         -----\
     |              |-----\
     |              |      -----\
   b1|              |            -----\
     |              |                  ---^
```

```
|              |                     |
|              |                     | b2
|       c1     |        c2           |
<--------------|--------------------->
 --\           |                     |
    -----\     | x                   |
          -----\                     | b2-b1
                -----\               |
                      -----\         |
                            -----\   |
                                  ---|
```

The trick here is to move the line segment P1-P2 down to form two triangles. We could use similar triangles to find the segment x, which $x + b_1$ will be the length from P to intersecting point.

Sign of these values are important. For b_1 and b_2, they need to keep their sign from projection. While for c_1 and c_2, they need to be the magnitude (abs value)

$$\frac{x}{b_2 - b_1} = \frac{c_1}{c_1 + c_2}$$

$$x = \frac{c_1(b_2 - b_1)}{(c_1 + c_2)}$$

$$intersect\ length = \frac{c_1(b_2 - b_1)}{(c_1 + c_2)} + b_1$$

This math will work in both case where $b_1 > b_2$ or $b_1 < b_2$. In the second case, x will be negative and subtract from b_1 will effectively "extend" it.

There is a third case not drawn, which is b_1 and b_2 having opposite direction. The same math hold, as long as b is a signed value (negative when it's going in opposite direction of the ray).

Remember to check for negative intersect distance. That will catch the third case of no intersect