

CS 354

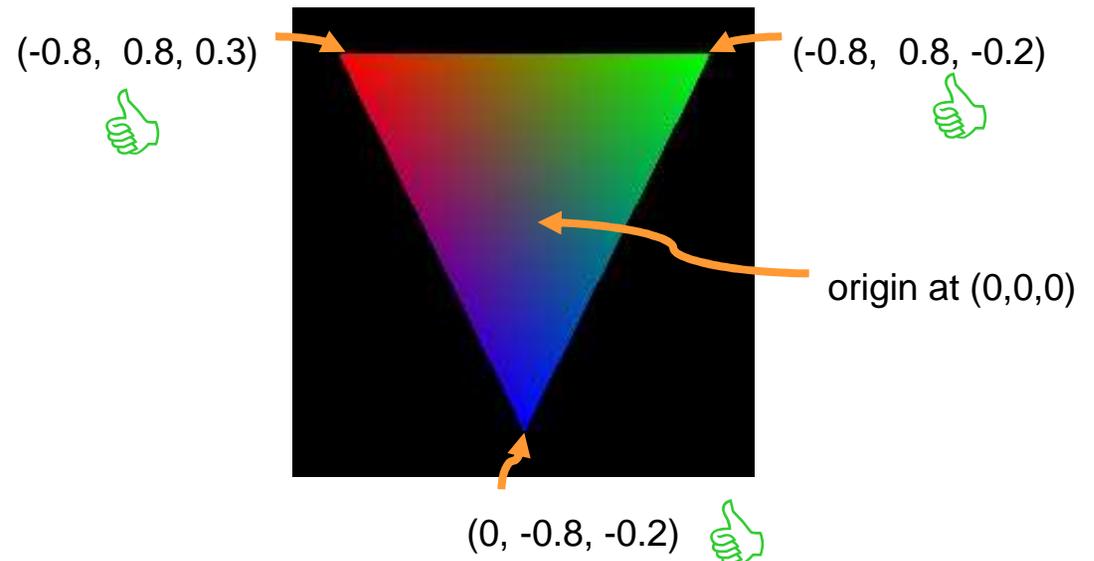
Viewing Stuff

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What about clipping?

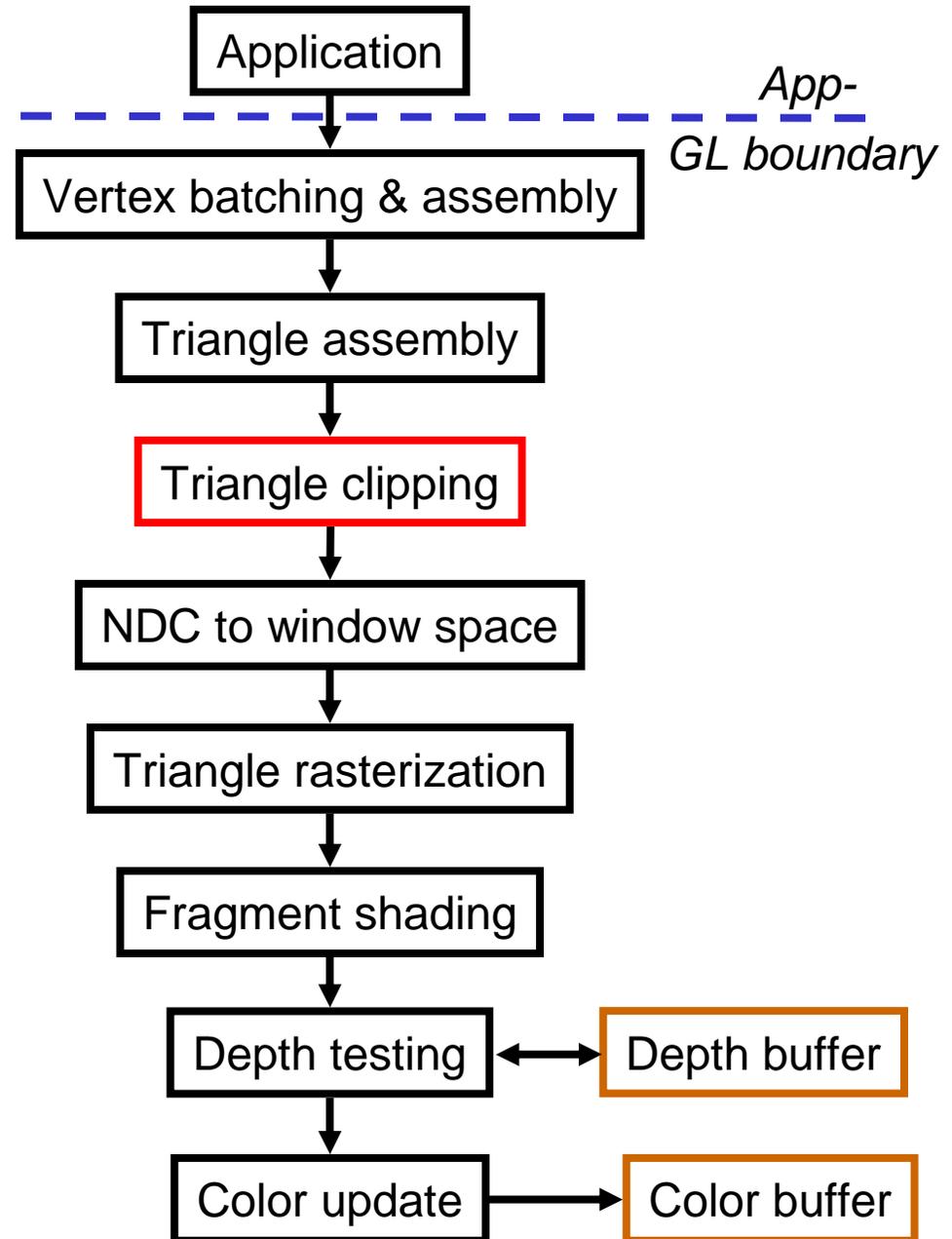
- What if any portion of our triangle extended beyond the NDC range of the $[-1,+1]^3$ cube?
 - Only regions of the triangle $[-1,+1]^3$ cube should be rasterized!
- No clipping for our simple triangle 😊
 - This situation is known as “trivial accept”
 - Because all 3 vertices in the $[-1,+1]^3$ cube

Vertexes of a triangle are extrema points defining an exact convex hull so entire triangle must also be in the cube if the vertexes are



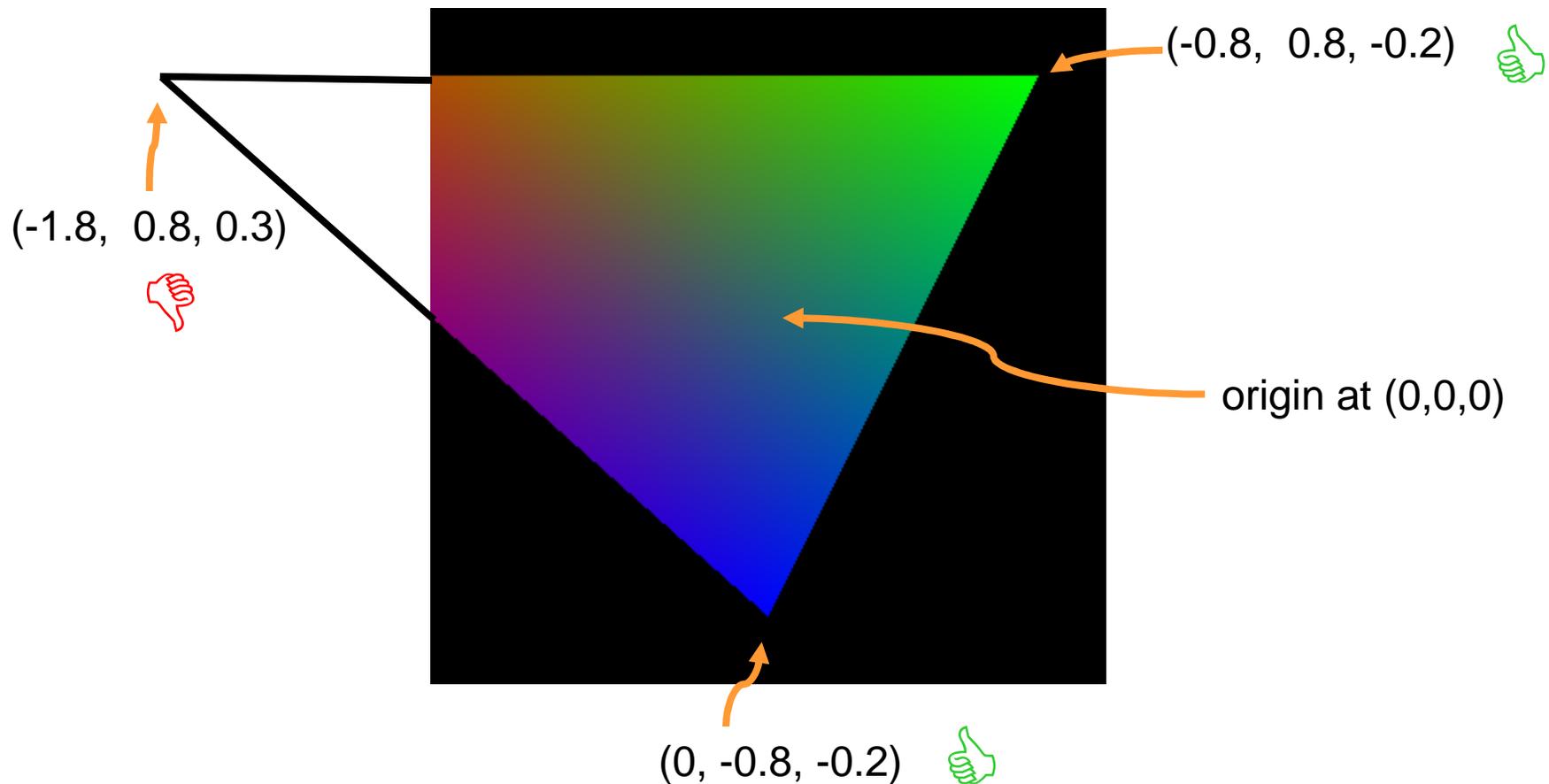
Triangle Clipping

- Triangles can straddle the NDC cube
 - Could happen with lines too
- In this case, we must “clip” the triangle to the NDC cube
 - This is an involved process but one that must be done

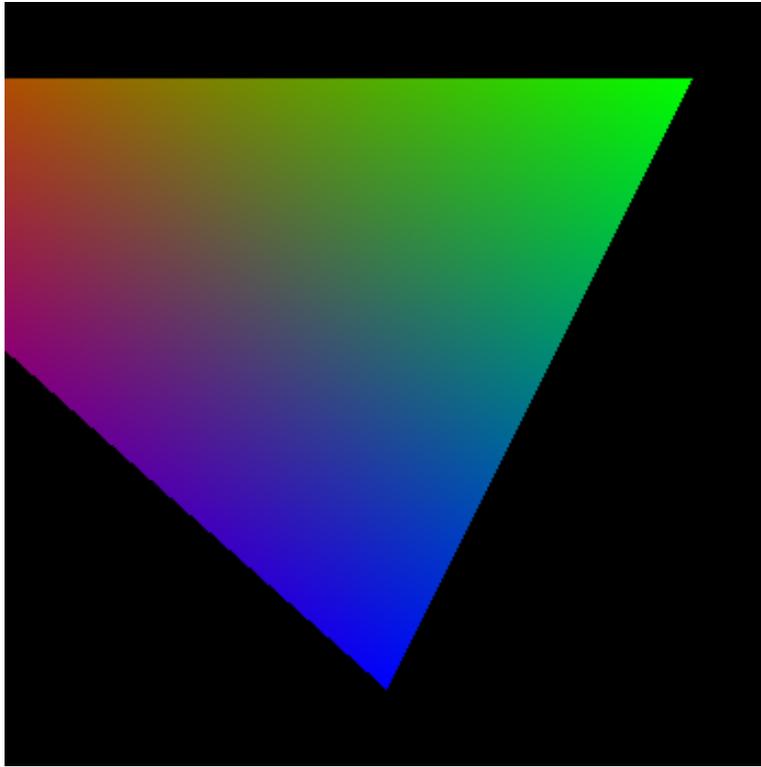


Consider a Different Triangle

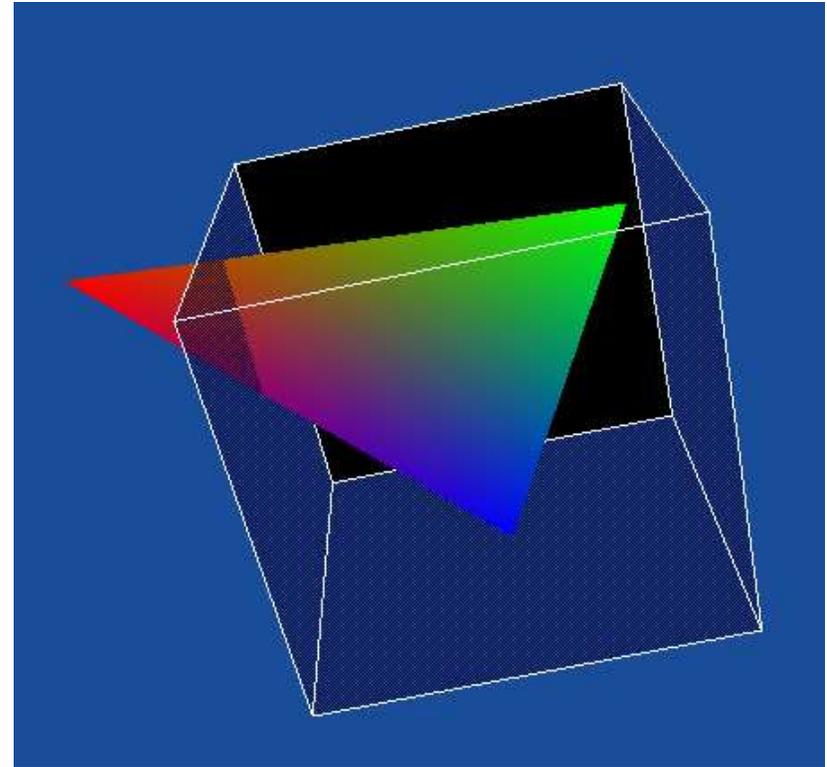
- Move left vertex so it's $X = -1.8$
 - Result is a clipped triangle



Clipped Triangle Visualized



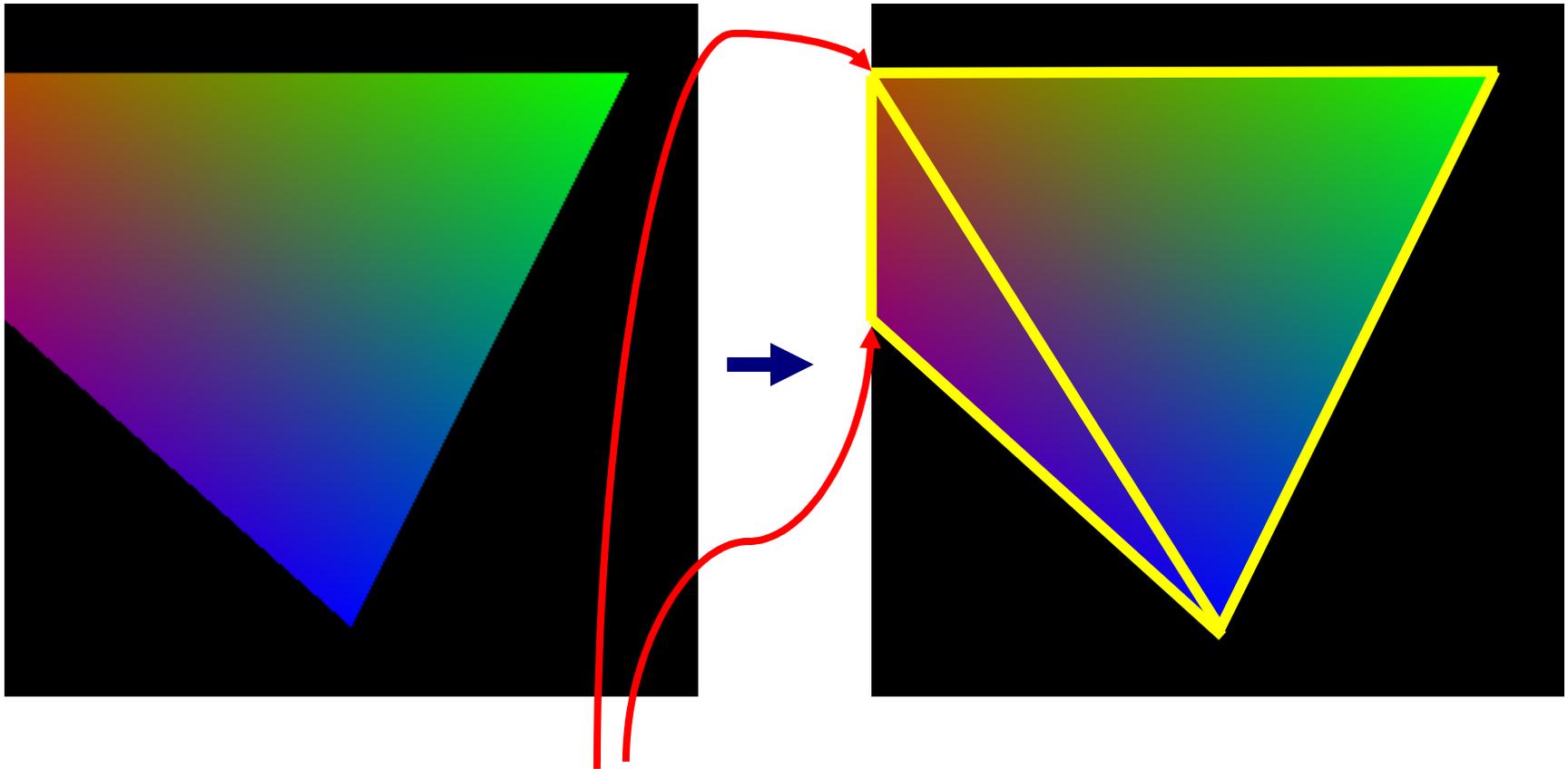
Clipped and Rasterized Normally



Visualization of NDC space

*Notice triangle is “poking out” of the cube;
this is the reason that should be clipped*

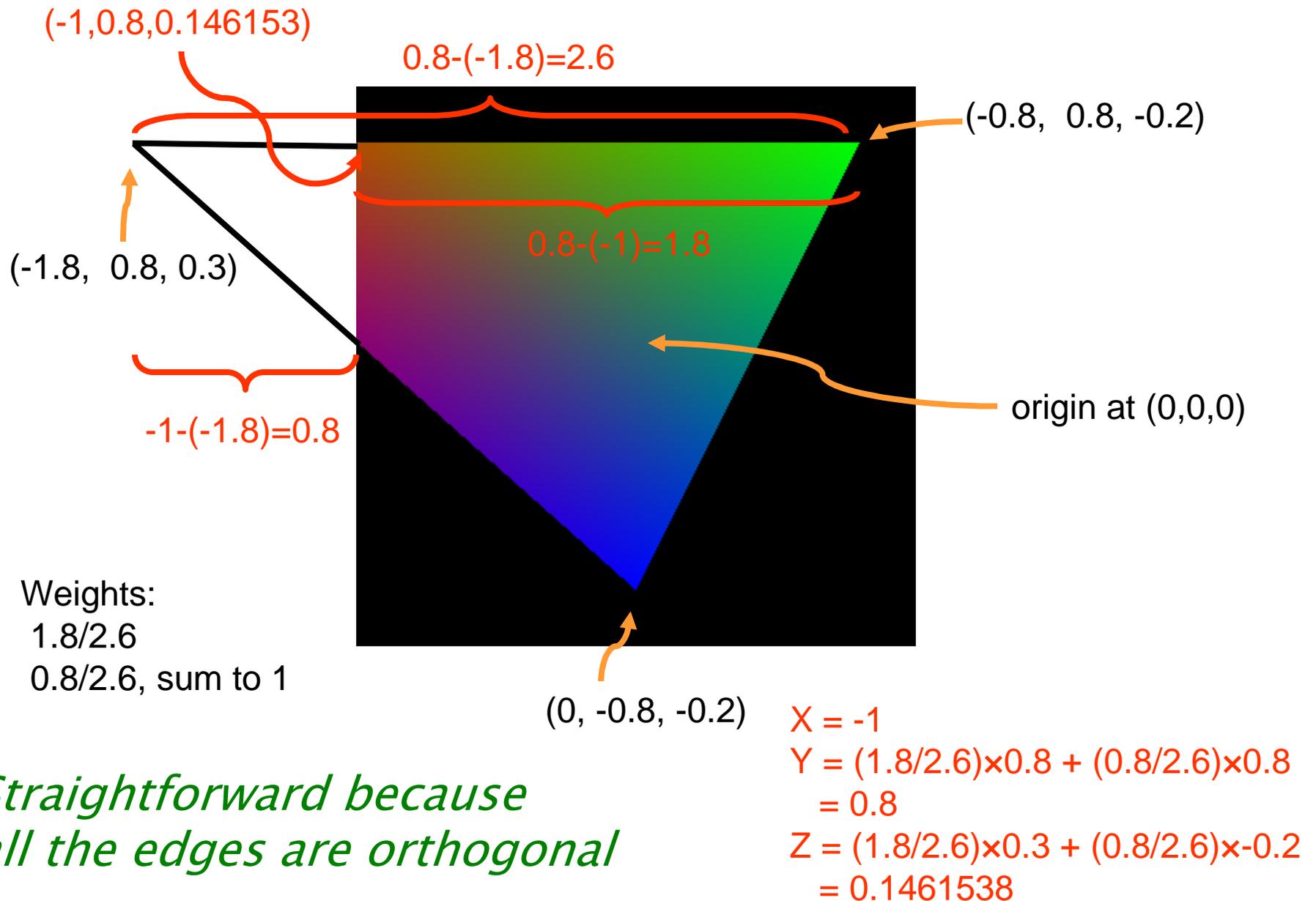
Break Clipped Triangle into Two Triangles



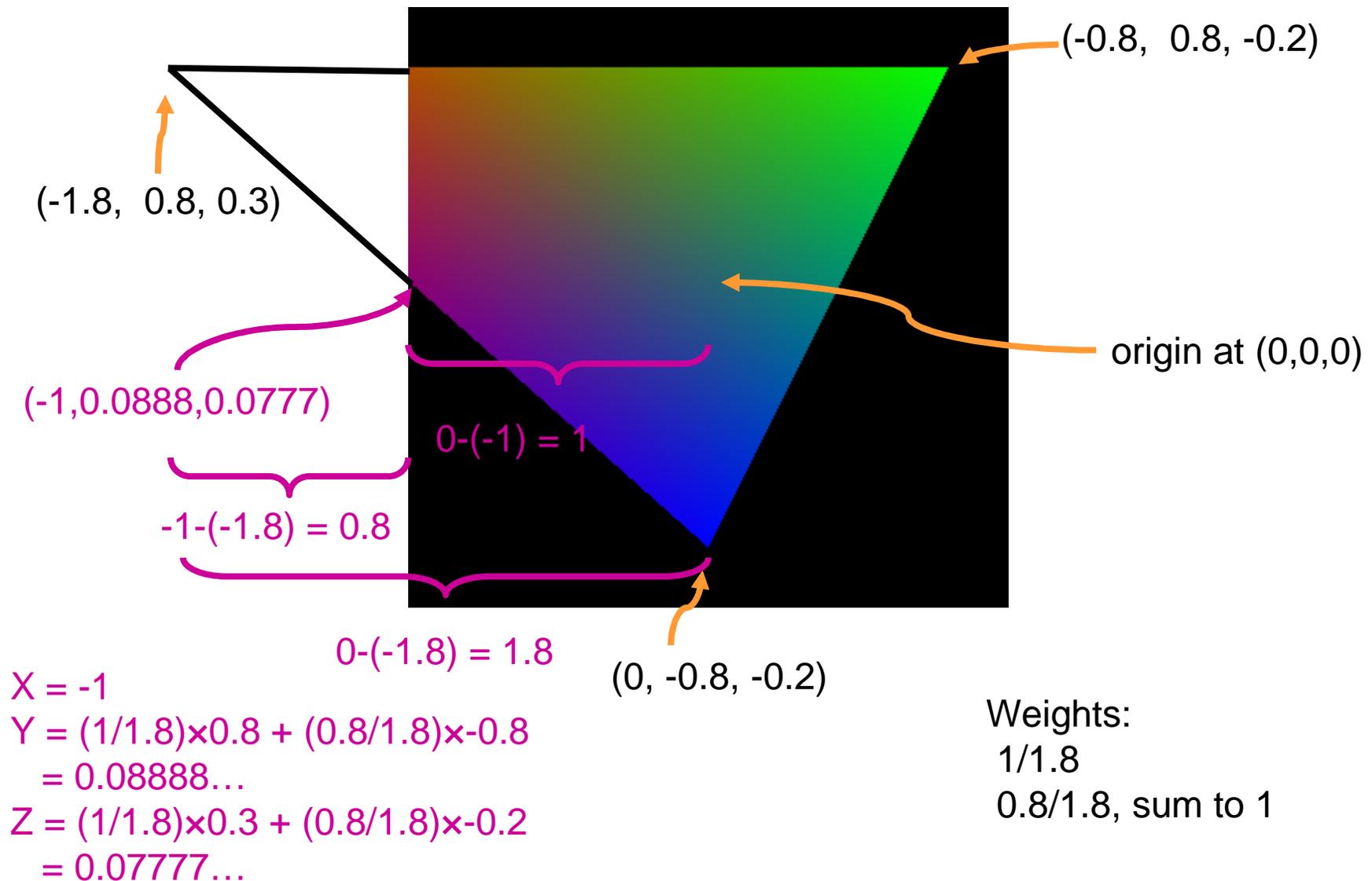
But how do we find these “new” vertices?

*The edge clipping the triangle is the line at $X = -1$
so we know $X = -1$ at these points—but what about Y ?*

Use Ratios to Interpolate Clipped Positions



Use Ratios to Interpolate Clipped Positions

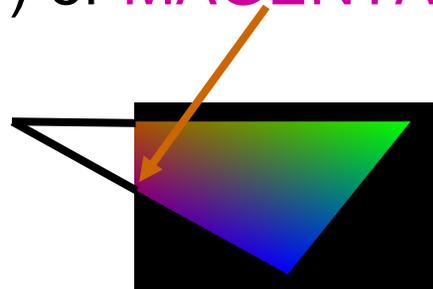


Clipping Complications

- Given primitive may be clipped by multiple cube faces
 - Potentially clipping by all 6 faces!
- Approach
 - Four possibilities
 - Face doesn't actually result in any clipping of a triangle
 - Triangle is unaffected by this plane then
 - Clipping eliminates a triangle completely
 - All 3 vertices on "wrong" side of the face's plane
 - Triangle "tip" clipped away
 - Leaving two triangles
 - Triangle "base" is clipped away
 - Leaving a single triangle
 - **Strategy:** implement recursive clipping process
 - "Two triangle" case means resulting two triangles must be clipped by all remaining planes

Attribute Interpolation too for Clipping

- When splitting triangles for clipping, must also interpolate new attributes
 - For example, color
 - Also texture coordinates
- Back to our example
 - $\text{BLUE} \times 0.8/1.8 + \text{RED} \times 1/1.8$
 - $(0,0,1,1) \times 0.8/1.8 + (1,0,0,1) \times 1/1.8$
 - $(0.444, 0, .555, 1)$ or **MAGENTA**



Weights:

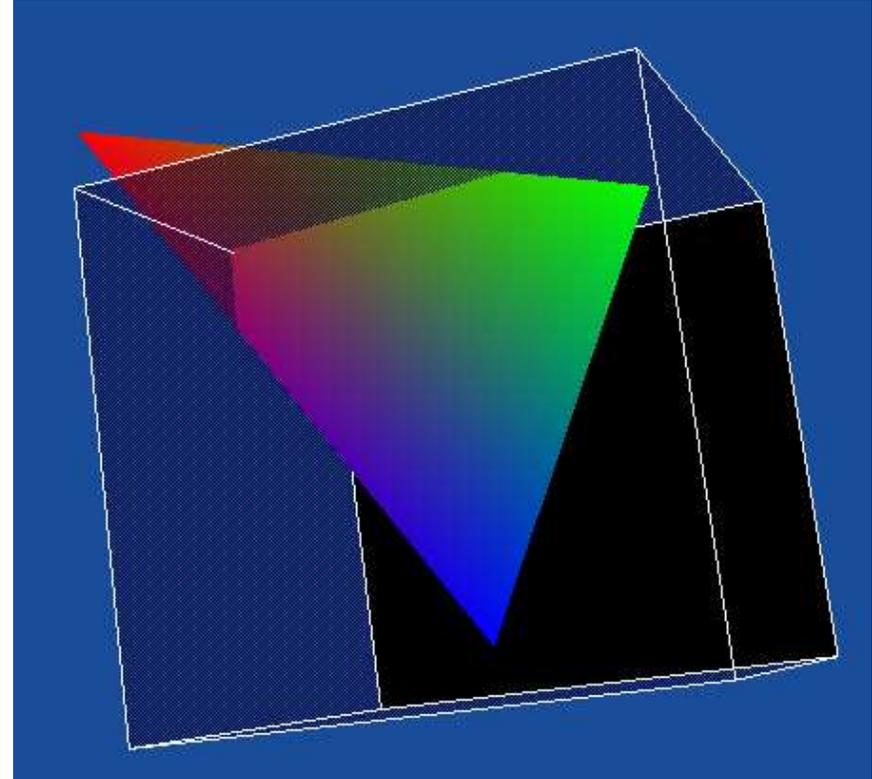
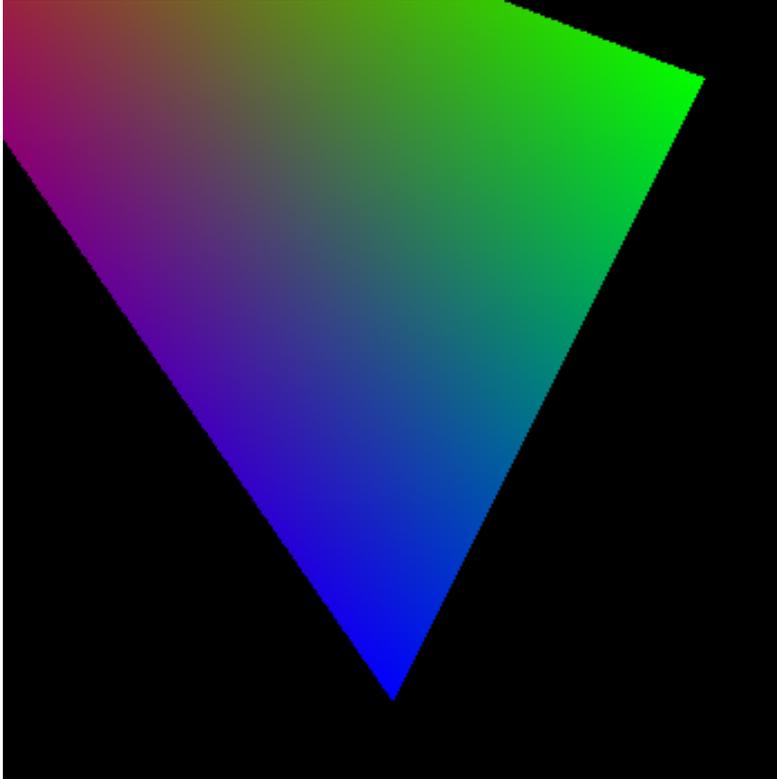
1/1.8

0.8/1.8, sum to 1

What to do about this?

- Several possibilities
 - Require applications to never send primitives that require clipping
 - Wishful thinking
 - And a cop-out—makes clipping their problem
 - Rasterize into larger space than normal and discard pixels outside the NDC cube
 - Increases useless rasterizer work
 - Requires additional math precision in the rasterizer
 - Worse, creates problems when rendering into a projective clip space (needed for perspective)
 - Something for a future lecture
 - Break clipped triangles into smaller triangles that tessellate the clipped region...

Triangle clipped by Two Planes Visualization



*Recursive process can make 4 triangles
And it gets worse with more non-trivial clipping*