Rendering algorithms

Raghavendra G S

Rendering

Rendering

Figure out which portion of the object corresponds to which pixel on the screen.

Rendering

Two broad ways

1. Rasterization
2. Ray tracing

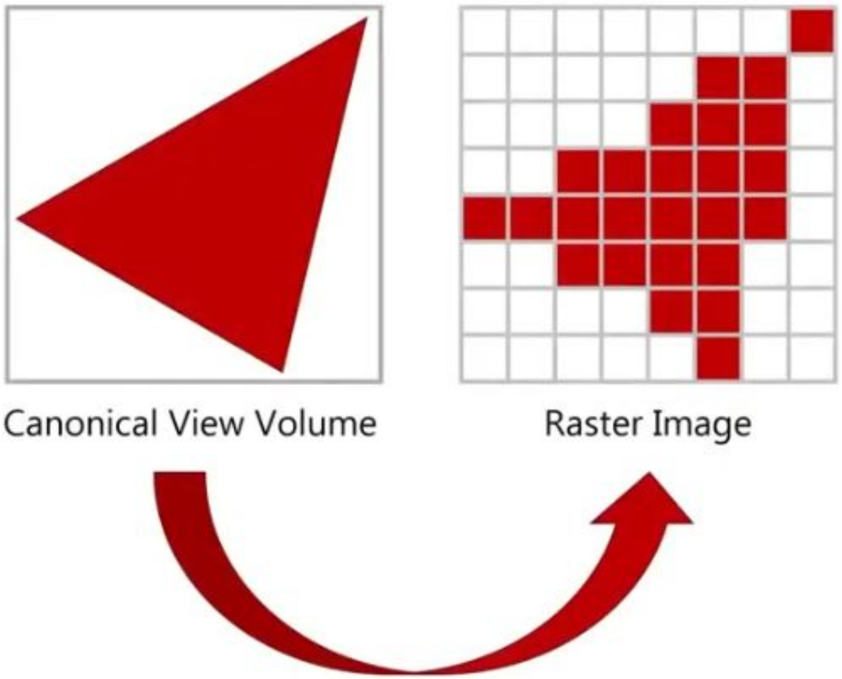
Rendering

Two broad ways

1. Rasterization
   1.1. Painter’s algorithm
   1.2. Z-buffer
   1.3. A-Buffer
   1.4. REYES
2. Ray tracing
   2.1. Ray casting
   2.2. Path tracing
   2.3. …

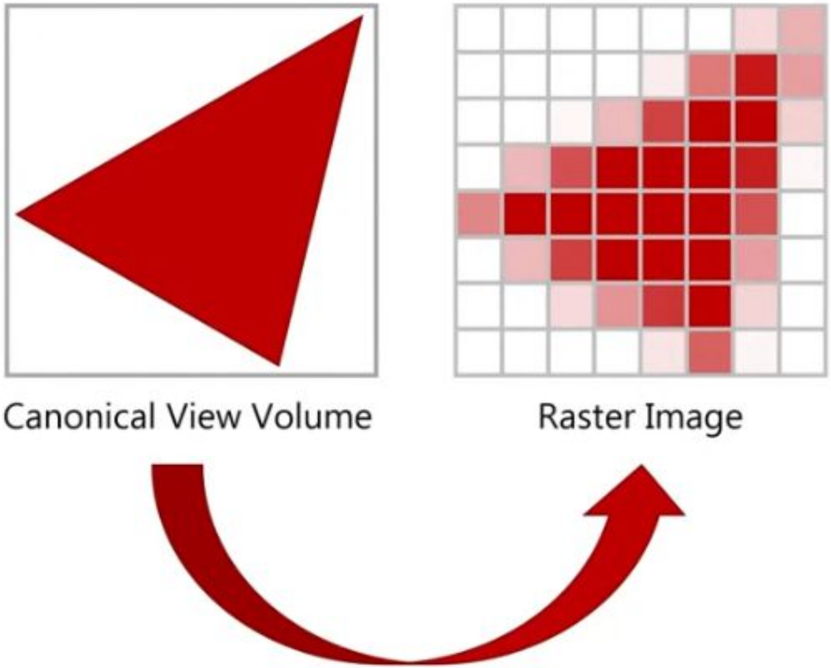
Rasterization

The process



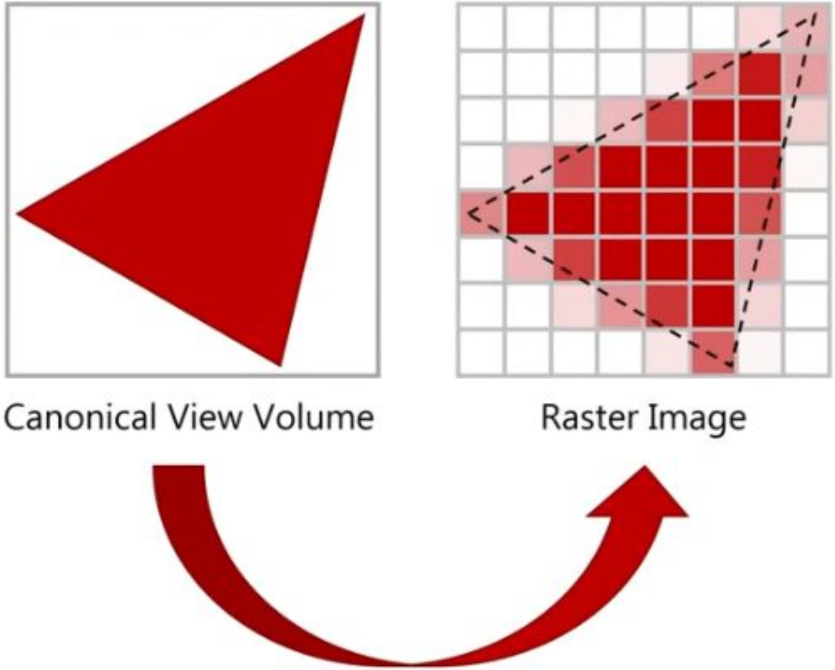
Rasterization

Artifacts?



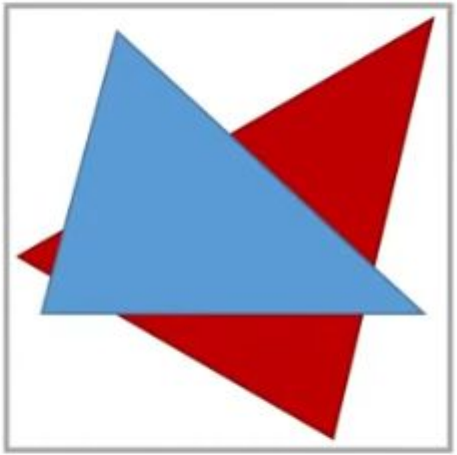
Rasterization

Antialiasing

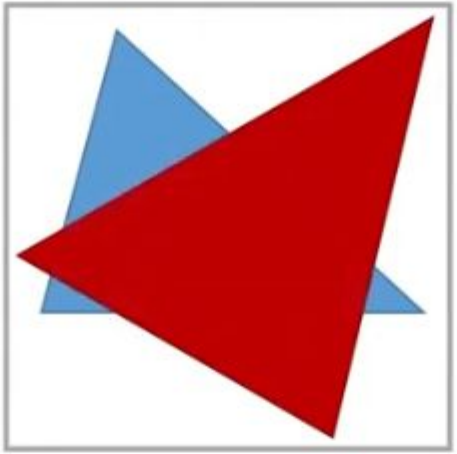


The fundamental problem

Visible surface detection or ***Hidden surface removal***



Canonical View Volume



Canonical View Volume

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

Painter’s algorithm

Draw farther objects followed by nearer objects

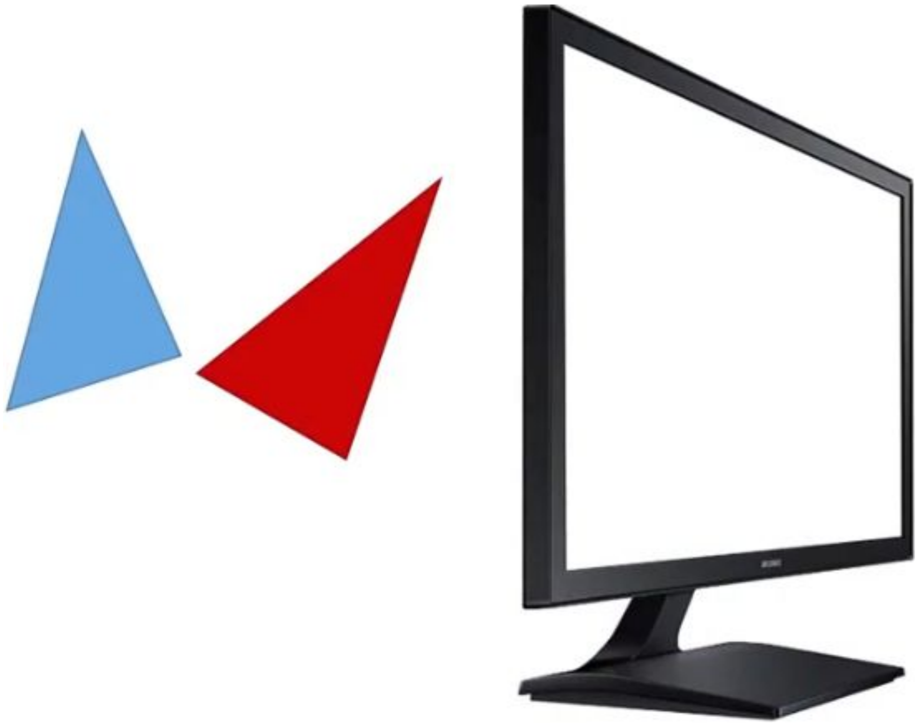
Painter’s algorithm

Draw farther objects followed by nearer objects

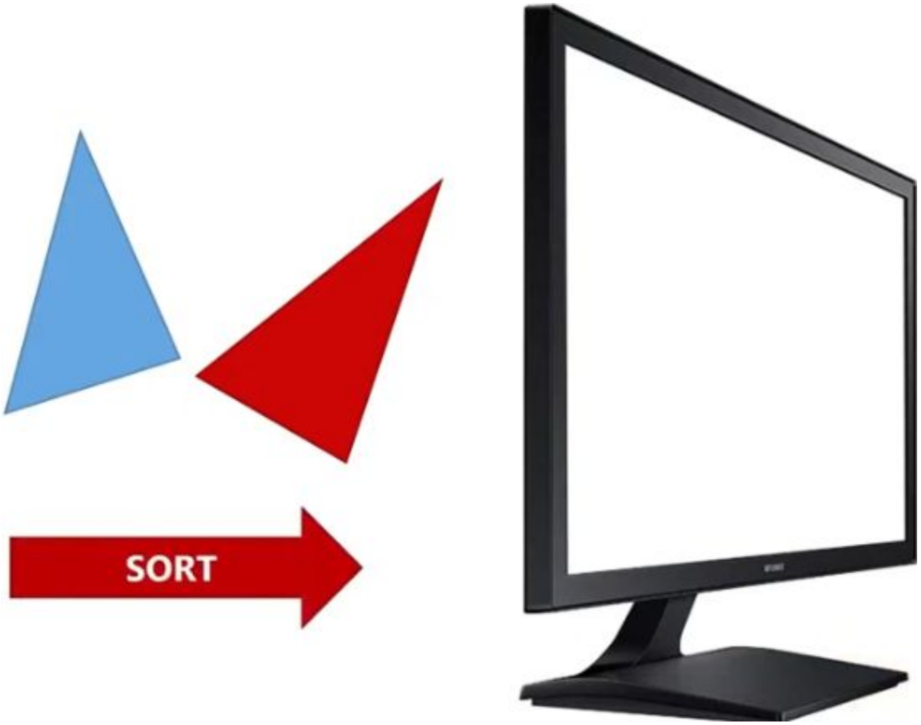
Painter’s algorithm

Draw farther objects followed by nearer objects

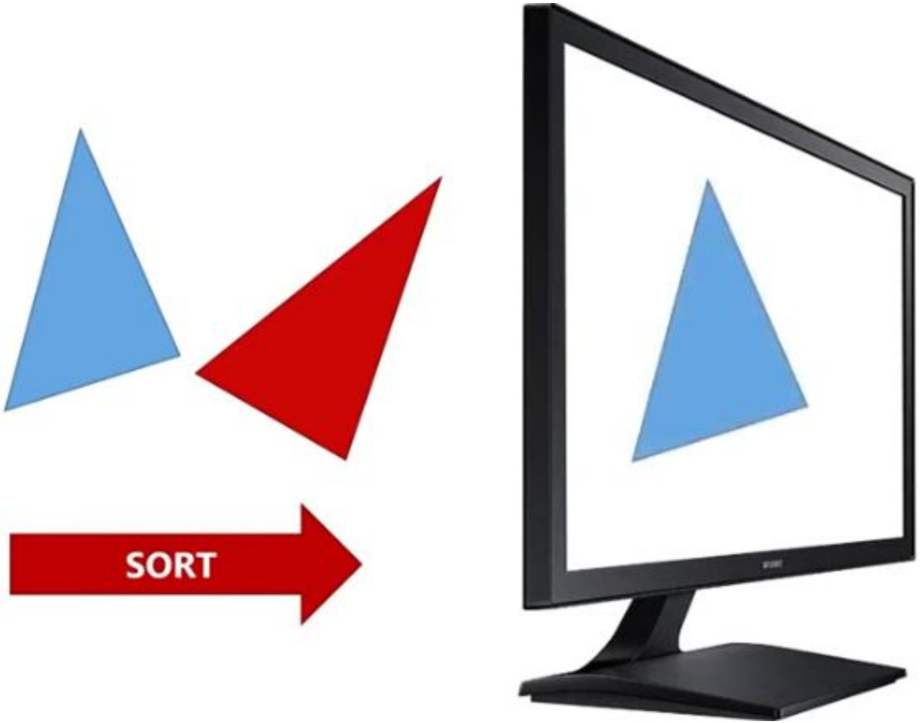
On a computer



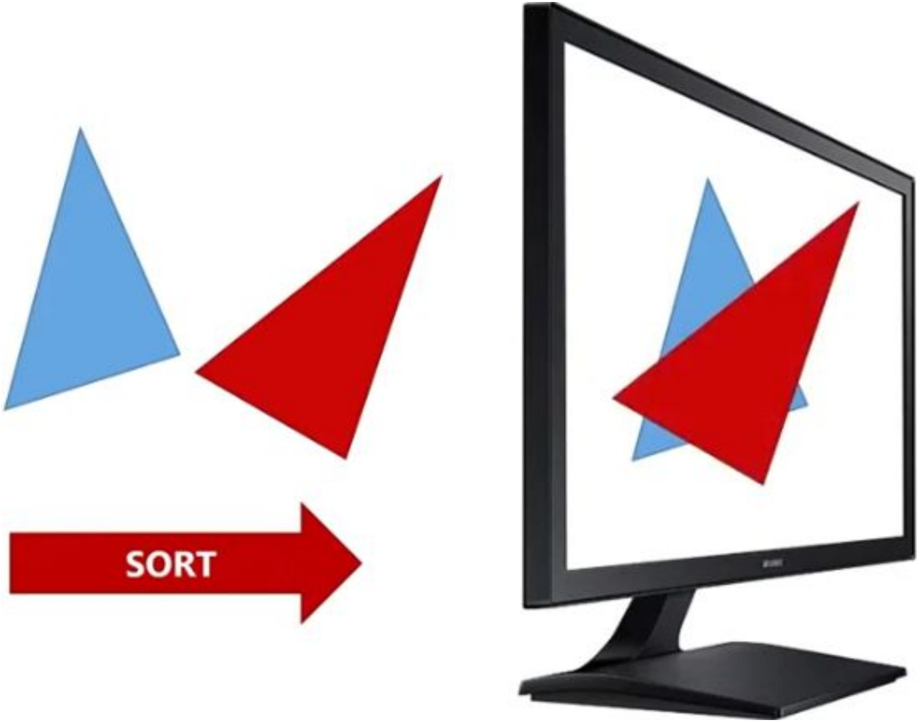
On a computer



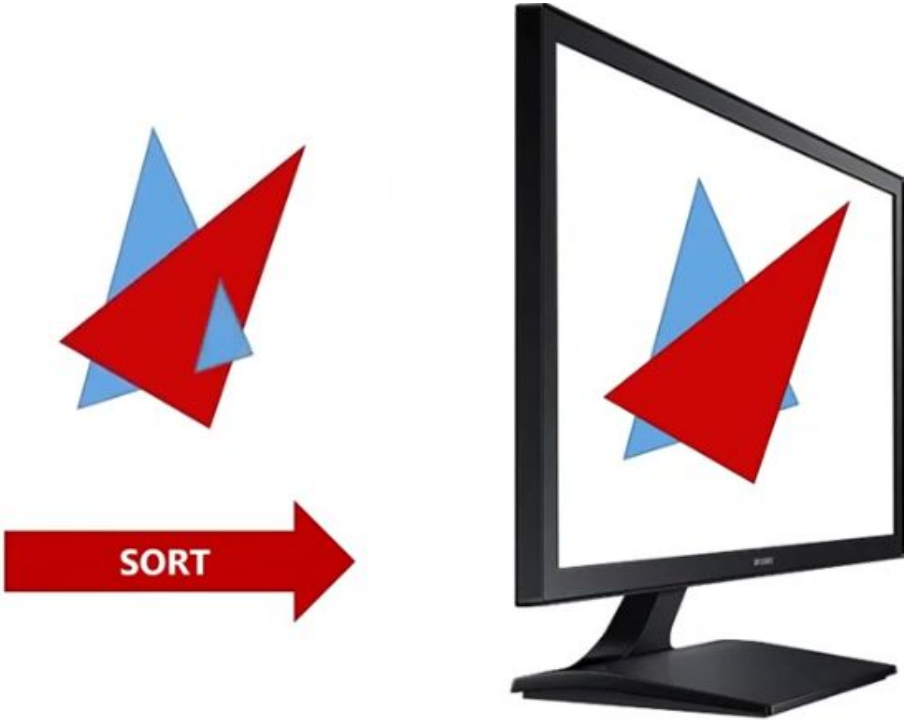
On a computer



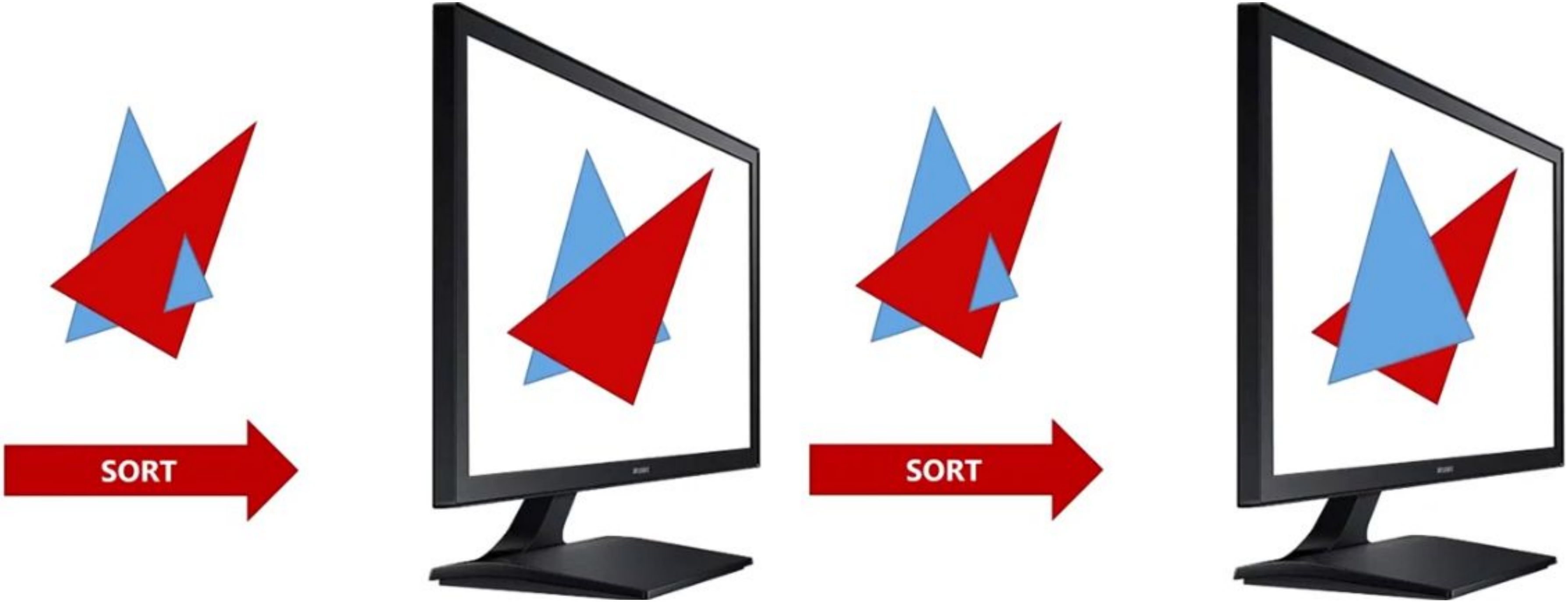
On a computer



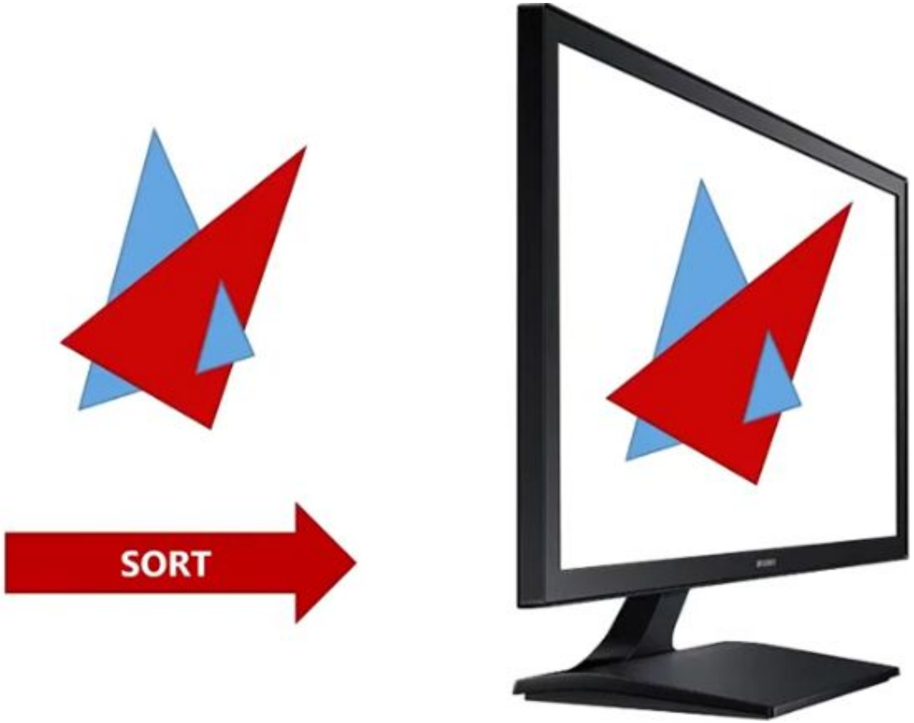
Problem/s?



Problem/s?



Problem/s?



Problem/s?

Needs sorting

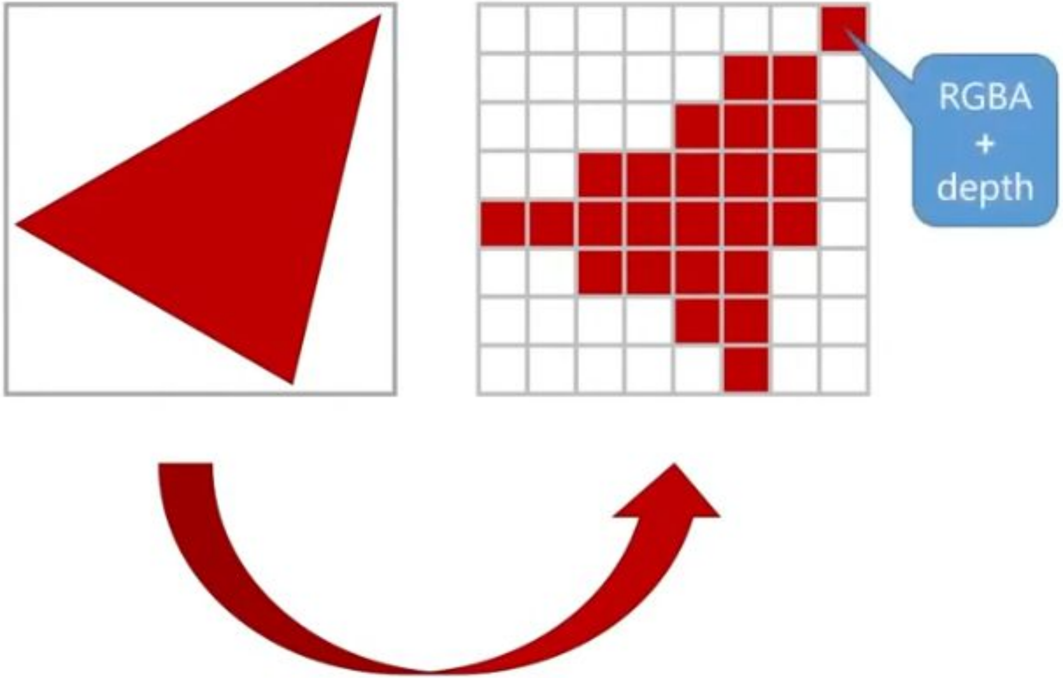
Can’t handle intersecting primitives

Z-buffer

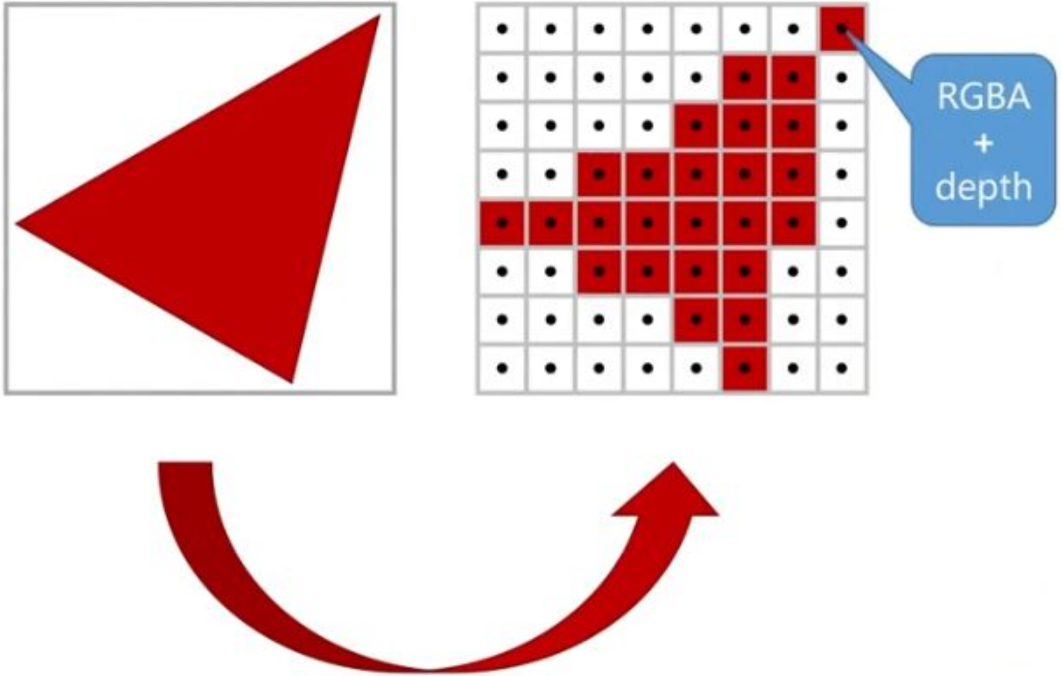
The default algorithm used in almost all the graphic pipelines

GPUs are designed to run Z-buffer

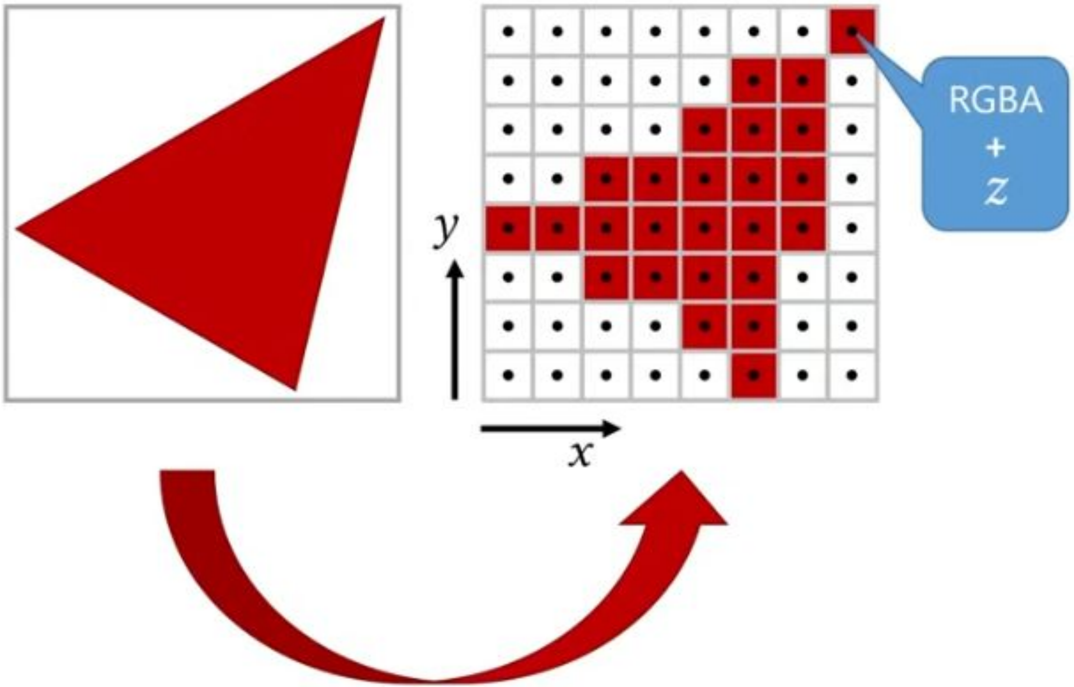
Z-buffer



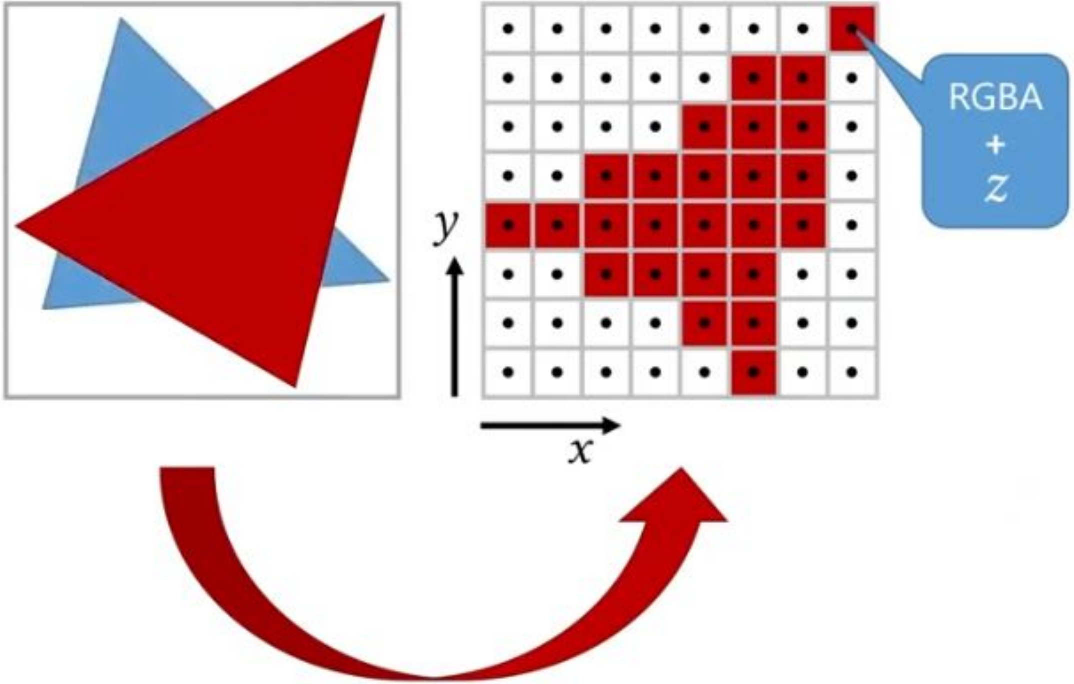
Z-buffer



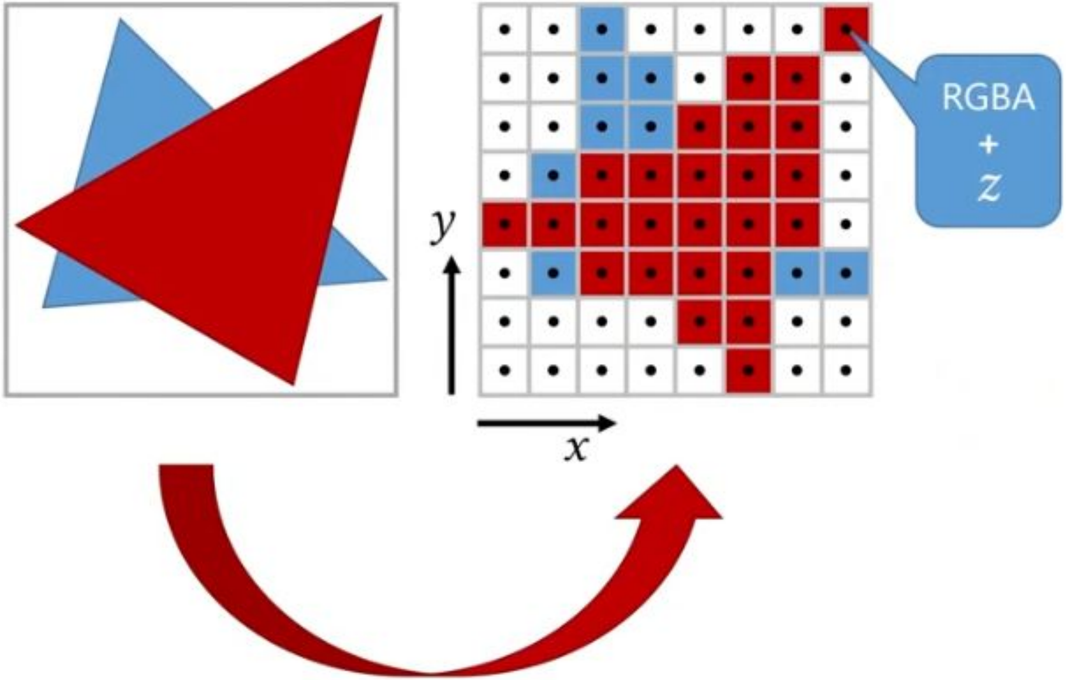
Z-buffer



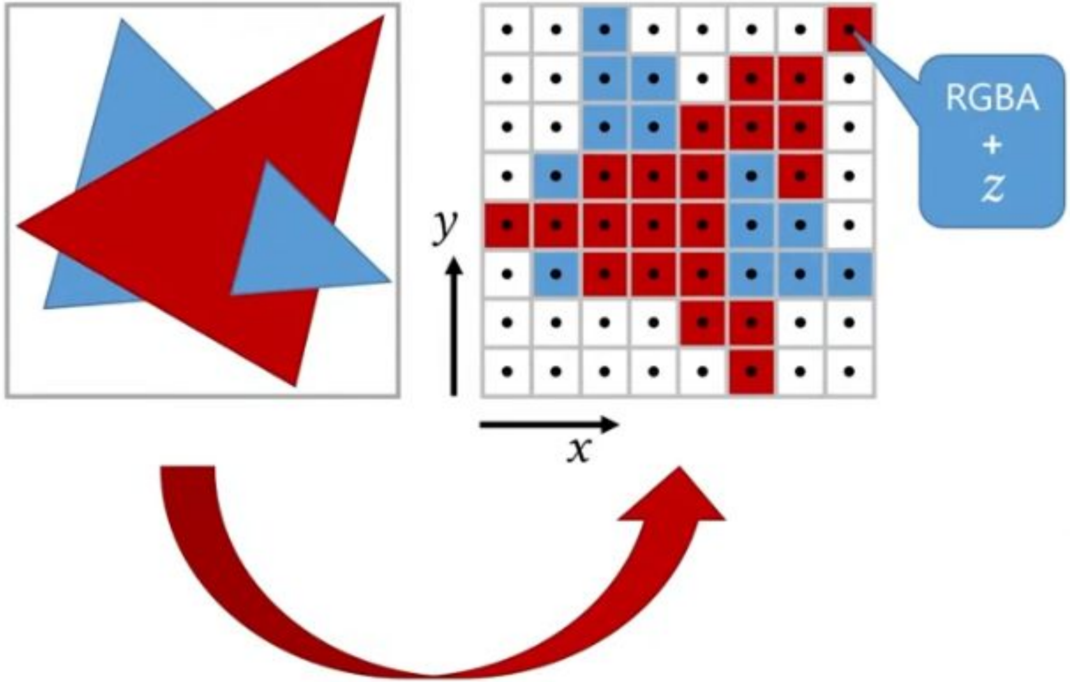
Z-buffer



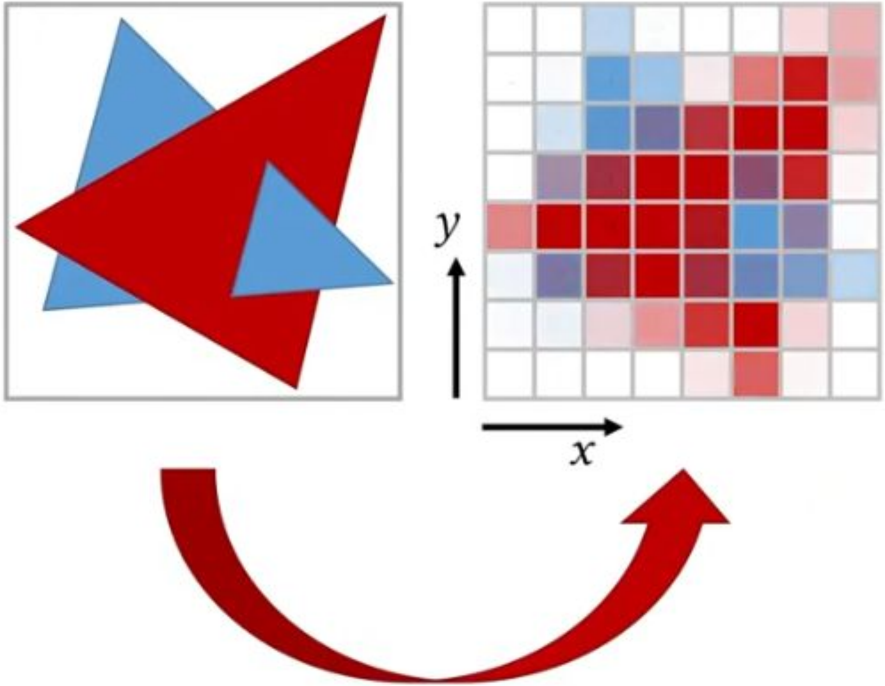
Z-buffer



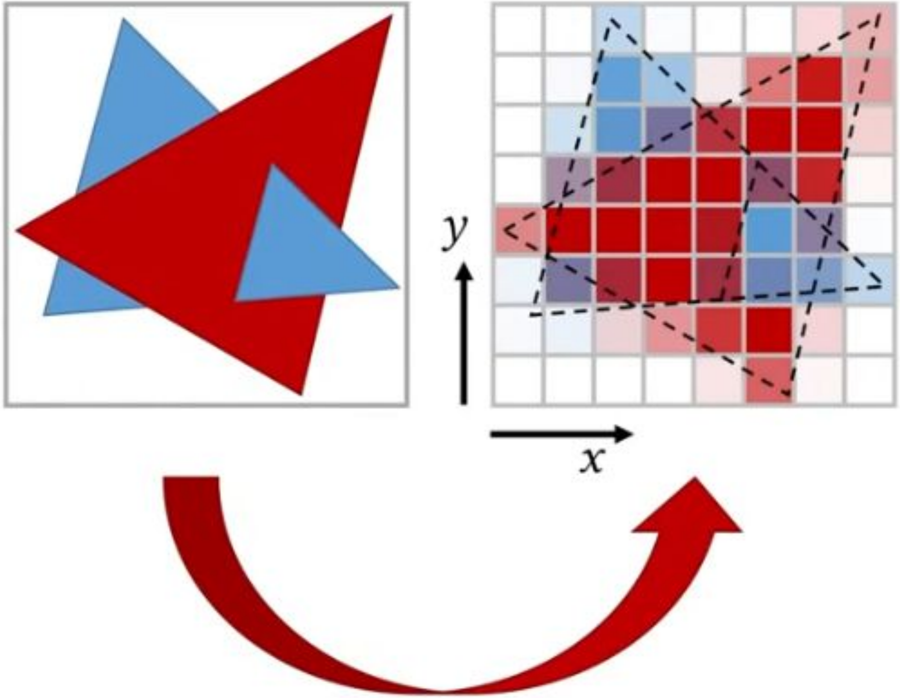
Z-buffer



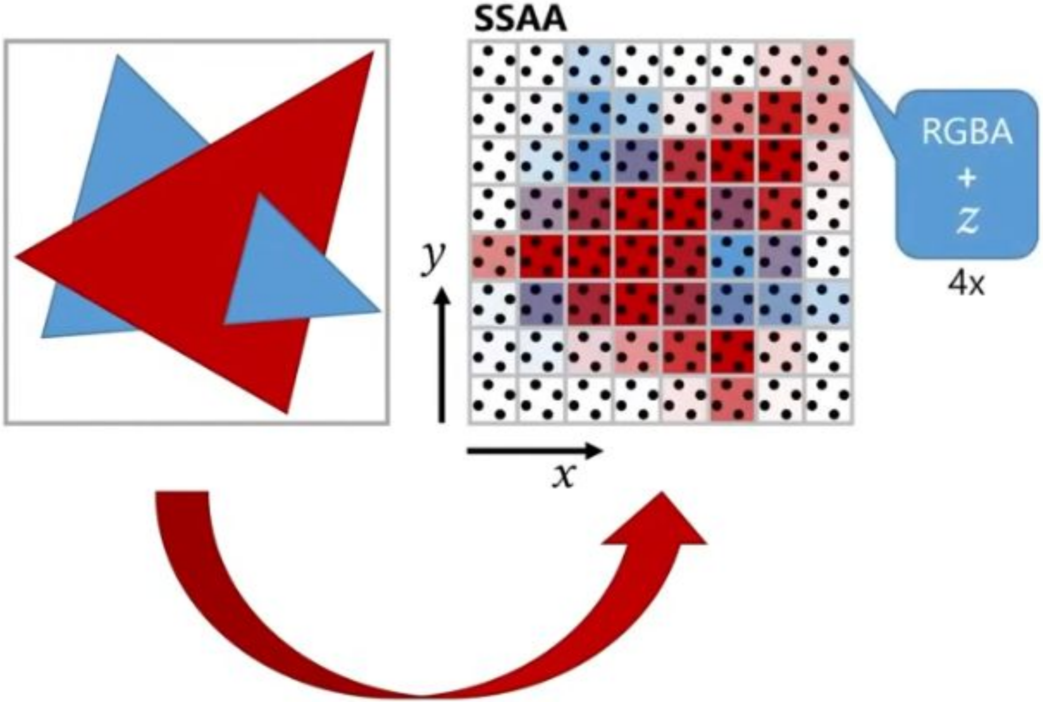
Z-buffer



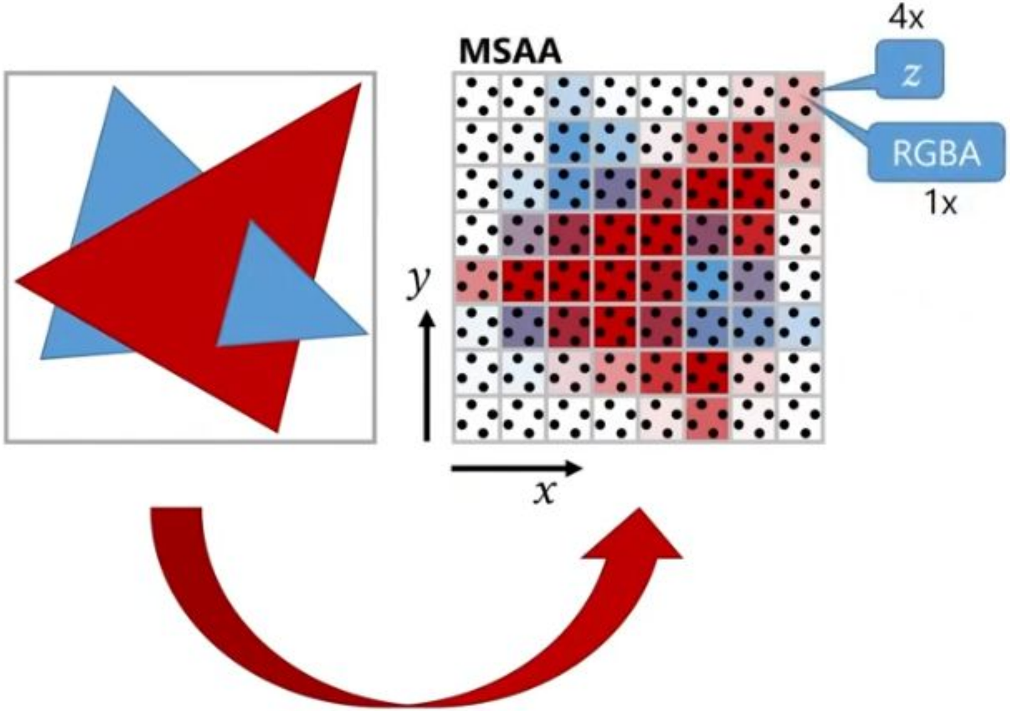
Z-buffer



Z-buffer antialiasing

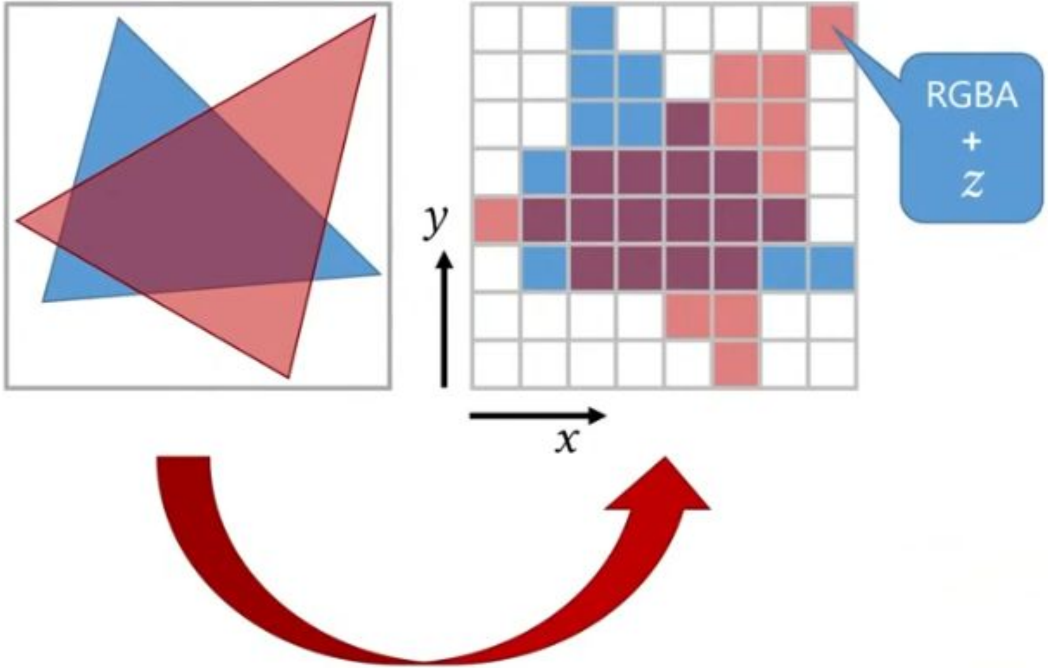


Z-buffer antialiasing



Problem/s?

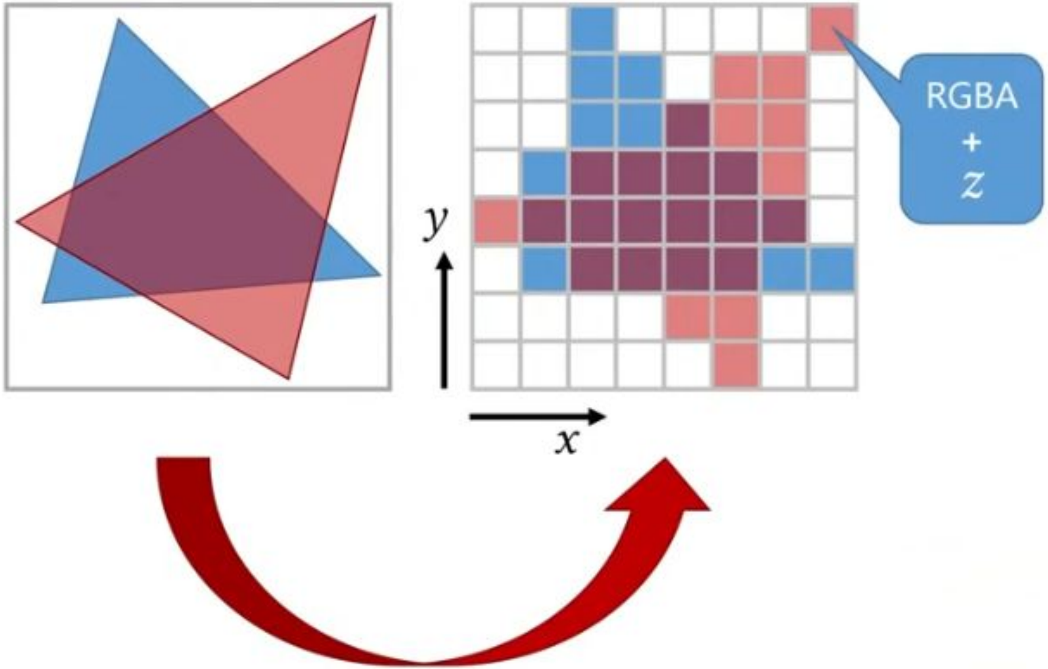
Transparency



Problem/s?

Transparency

Requires order

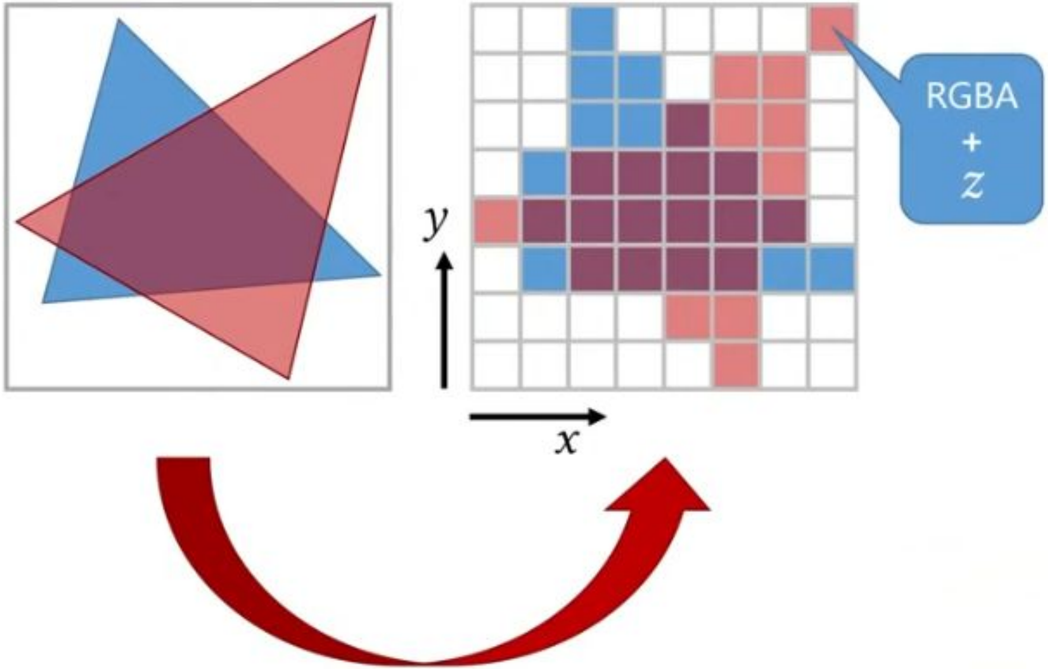


Problem/s?

Transparency

Requires order

Back to front



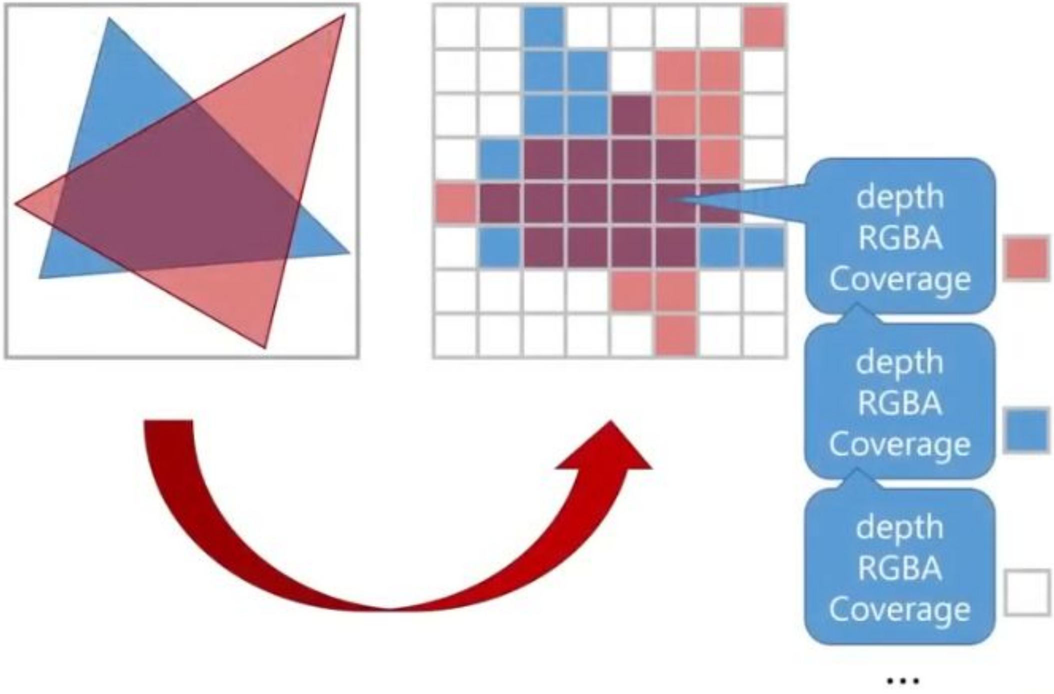
A-buffer

Handles intersection

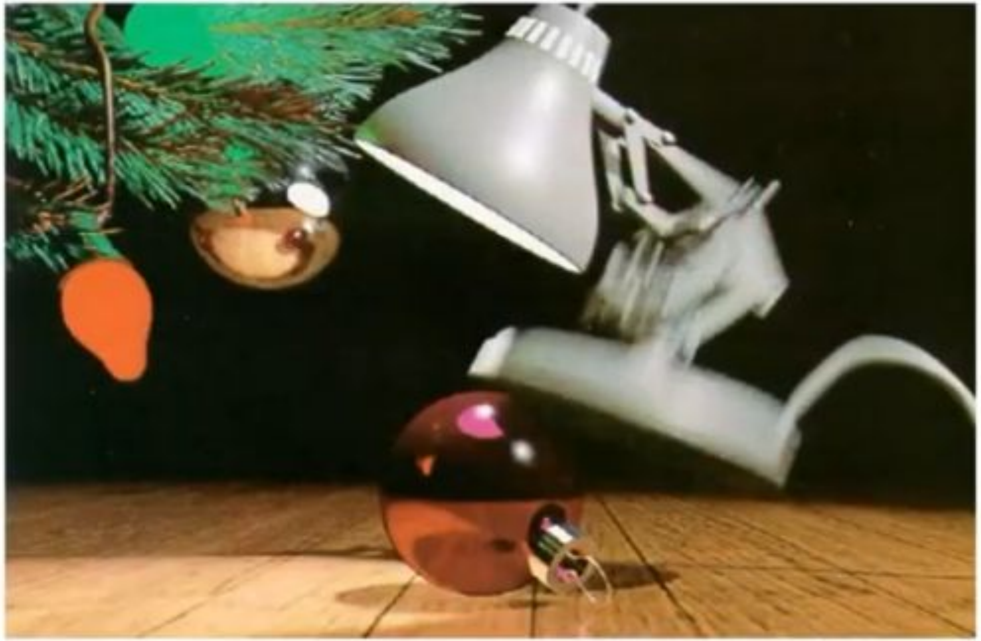
Handles transparency irrespective of the ordering

But needs dynamic memory allocation (on GPU)

A-buffer


depth
RGBA
Coverage
depth
RGBA
Coverage
depth
RGBA
Coverage
...

Render **E**verything **Y**ou **E**ver **S**aw



1986 Pixar Christmas Card by John Lasseter and Eben Ostby

Render **E**verything **Y**ou **E**ver **S**aw

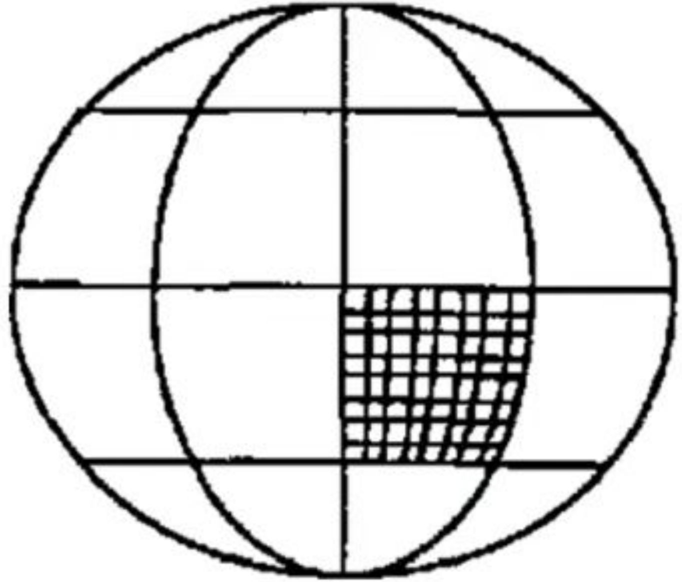
Use micropolygons

Data stored using bezier patches

Subdivide to small micropolygons.

Aggressive subdivision

Polygons become subpixel



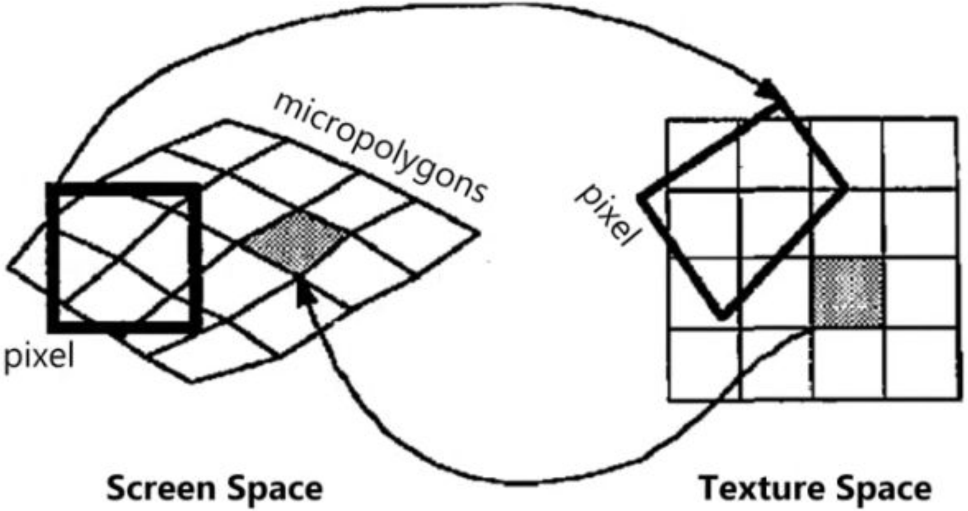
Render **E**verything **Y**ou **E**ver **S**aw

Use micropolygons

Extremely costly

Still used by Pixar, Lucas films etc

But in conjunction with Ray tracing



Rasterization vs Ray tracing

For each primitive

Find the pixel which it maps to

For each pixel

Find all the primitive which contributes to that pixel

If objects are opaque, find the closest primitive