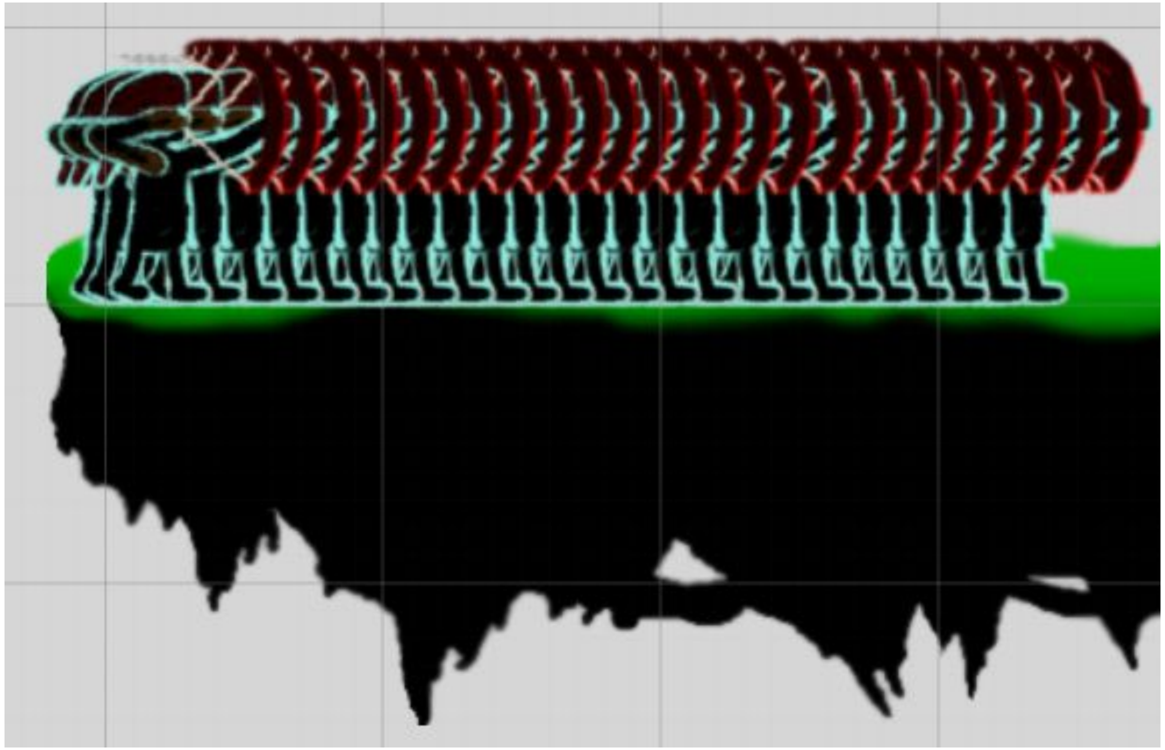
Rendering a Large Amount of Units

Silver Kirotar

Contents

Rendering a large amount of units…?



Overdraw I - Definition

A pixel on the screen is being redrawn in a single frame.
When 3D rendering:

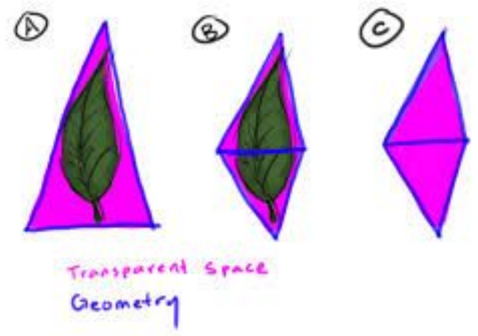
- A pixel is replaced by a closer one.
- Distance is determined by Z coordinates towards the camera.

What are the problems?

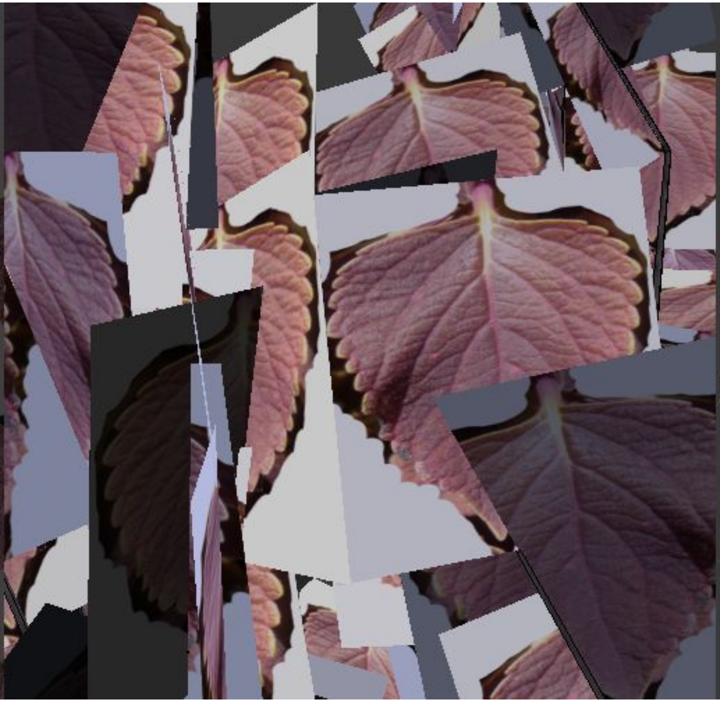
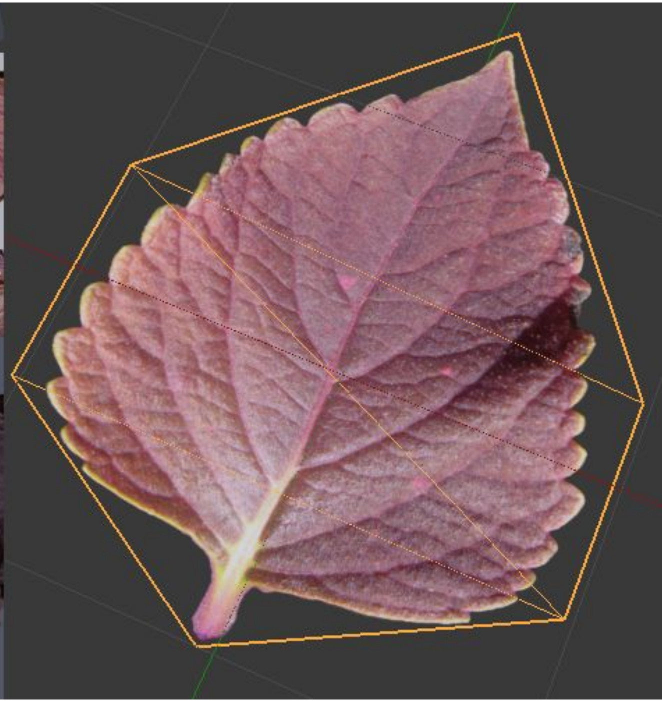
- Rendering “empty” pixels/polygons == Wasting time.
- Redrawing non-transparent pixels.

Overdraw II - Minimizing (3D)

- Reducing transparent areas in meshes.
- Why? Triangles vs Big Unused Transparent Areas?
  - Triangles are cheaper

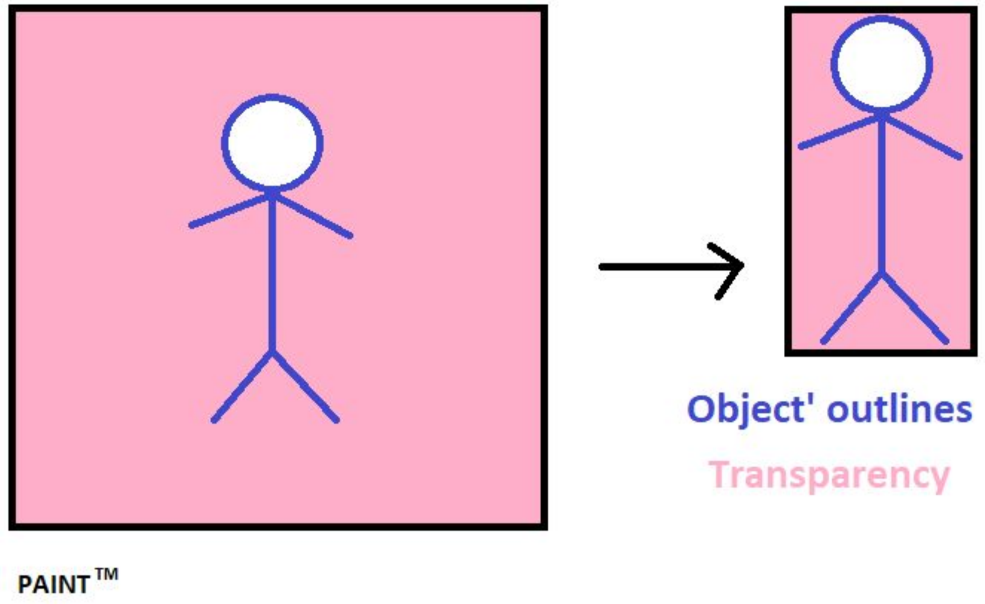


Overdraw III - Example (3D)

Overdraw IV - Example (2D)

- Reducing transparent areas in images.
- Not many options…



“Culling”

Selects objects for rendering operations

- in a defined region of interest.

Makes rendering quicker and more efficient.

What I mean:

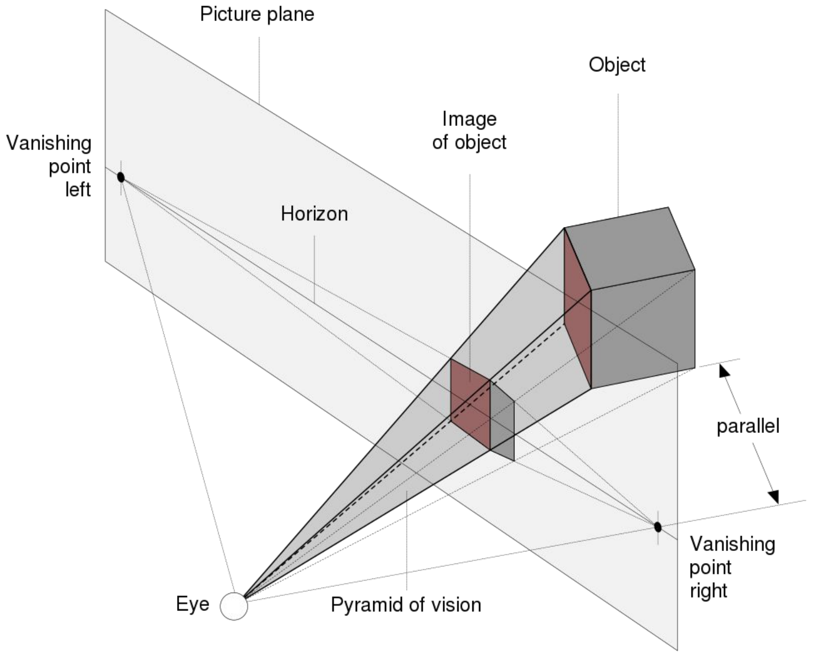
- Frustum culling
- Back-face culling
- Occlusion culling

Frustum culling

View frustum - volume in space from a given viewpoint.

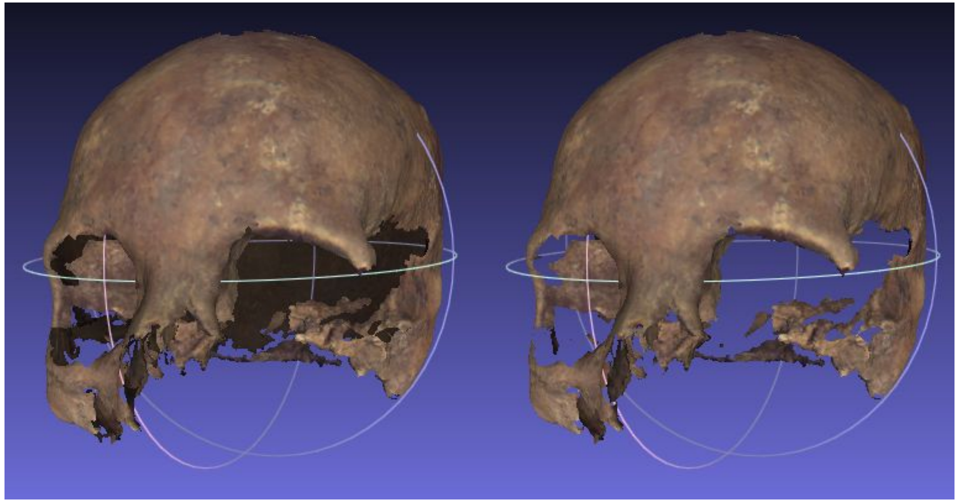
Only objects in view frustum are sent for rendering.

- “Potentially visible” objects.



Back-face culling

- Determines if a polygon is visible.
- Reduces the number of polygons to be drawn.



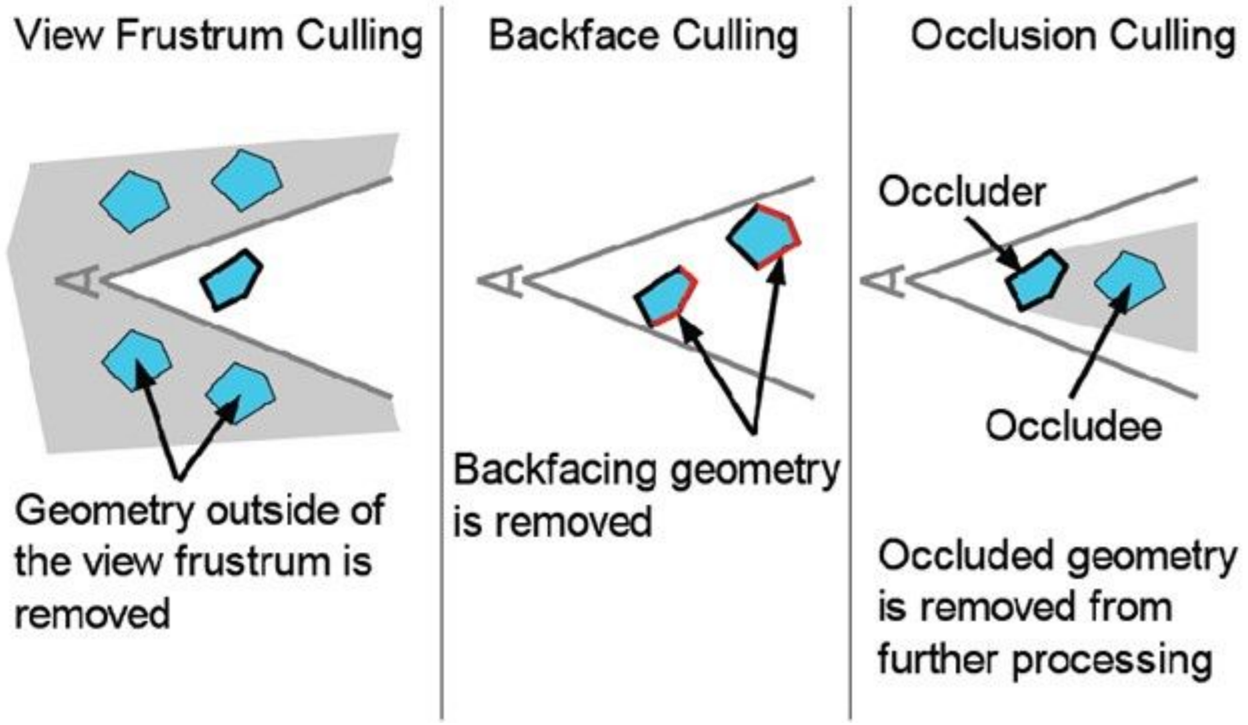
Occlusion Culling

Also

- **Hidden surface determination**
- **hidden surface removal** (**HSR**)
- **visible surface determination** (**VSD**)

Determines surfaces and parts of surfaces that are not visible from a certain viewpoint.

Culling illustrations



View Frustrum Culling
Geometry outside of the view frustrum is removed
Backface Culling
Backfacing geometry is removed
Occlusion Culling
Occluder
Occludee
Occluded geometry is removed from further processing

Draw calls I - Definition

- A number of materials drawn.
- For all objects.
    - Some objects have multiple materials.

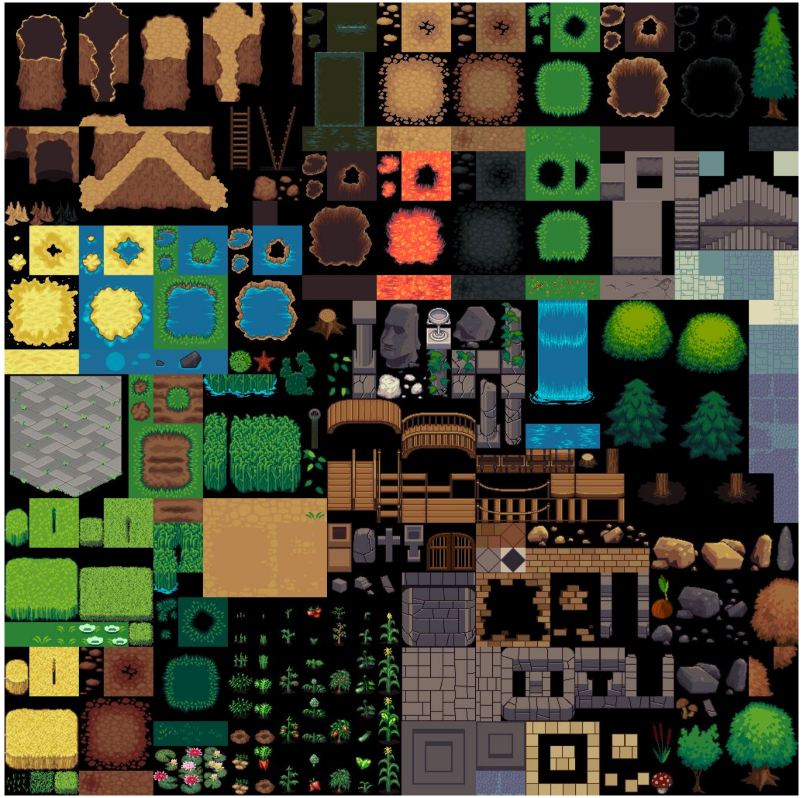
(Also takes in count dynamic lighting)

Draw calls II - Minimizing

Shared material

- Create texture atlases.
- Single big vs several smaller textures.

- Separate textures which
  - use alpha values.
  - do not use alpha.

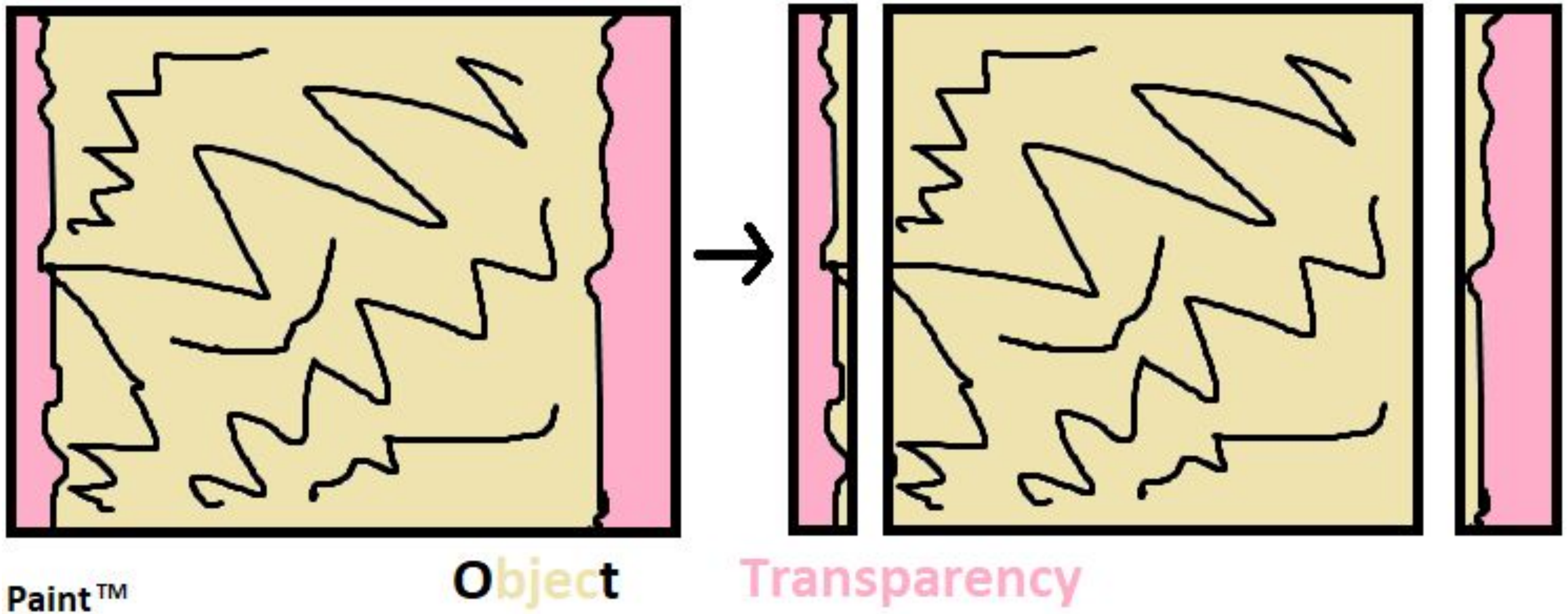


Draw calls III - Large objects

Large images with small amount of transparency.

- Separate areas with transparency.
  - Define subimages as alpha or no alpha.
- If possible, use
  - smaller mipmap levels of images.
  - meshes with smaller level of detail.

Draw calls III+ - Image separation example



Batching

- Multiple meshes are merged together.
- Reduces communication between CPU and GPU.
- Improves performance.

Dynamic batching

- Automatic*, used each frame.
- Reduces draw calls for objects that
  - share the same material.
  - can be moved.

Useful when transforming vertices is cheaper than doing these same draw calls.

Static batching

- Reduces draw calls for geometry that
  - shares the same material.
  - does not move.
- Usually more efficient than dynamic batching.
  - Pre-calculated
- Downside: Uses more memory.
- Bad examples: Trees in a dense forest.

Geometry Instancing

- Copies of mesh in different locations.
- Needs to know the position of each object.

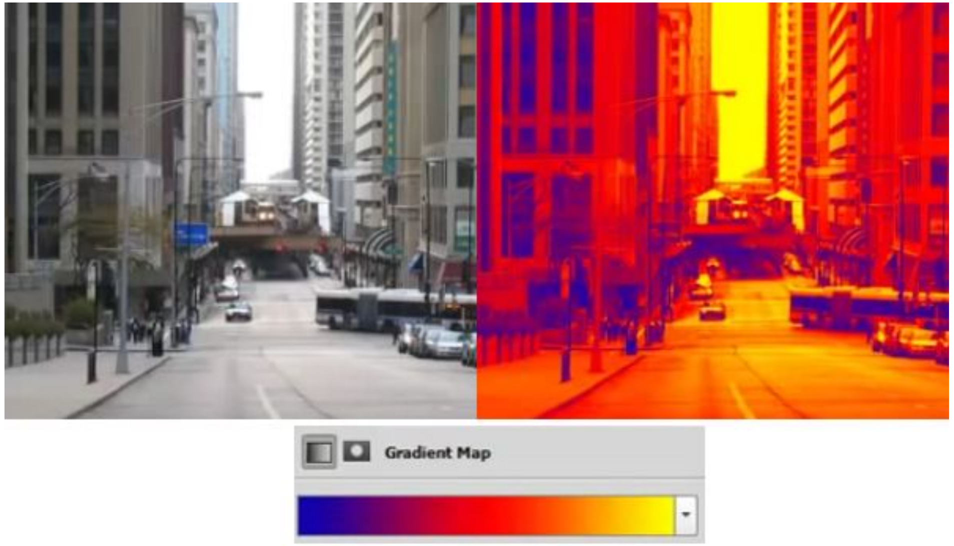
- Especially useful for thousands of meshes.
- Used for repeated geometry, like
  - trees, grass, buildings,
  - Or characters.

20000 GONDOR SOLDIERS vs 10000 SPARTANS - Ultimate Epic Battle Simulator
Team 1 (GondorCaptains): Remaining: 20775 Enemies Killed: 0
Team 2 (Spartans): Remaining: 11647 Enemies Killed: 0
Time: 12 AM
Player Kills: 0
Player Deaths: 0
Press K To Start Battle
6:27 / 16:34

Tips for better performance

- Simplify meshes.
- Use reasonable level of detail.

- Try vertex coloring.
- Try gradient mapping.
- Avoid dynamic lighting.



Thank you for listening!

See also

Overdraw in frontend development:
https://www.youtube.com/watch?v=T52v50r-JfE

Reducing polygon count:
https://blender.stackexchange.com/questions/78499/how-to-decrease-the- polygon-count-on-my-mesh

Optimizing graphics performance:
https://docs.unity3d.com/Manual/OptimizingGraphicsPerformance.html

References

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https://en.wikipedia.org/wiki/Back-face_culling

Images borrowed from...

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https://en.wikipedia.org/wiki/Back-face_culling