Textures – Magnification and Minification

Lecture 30

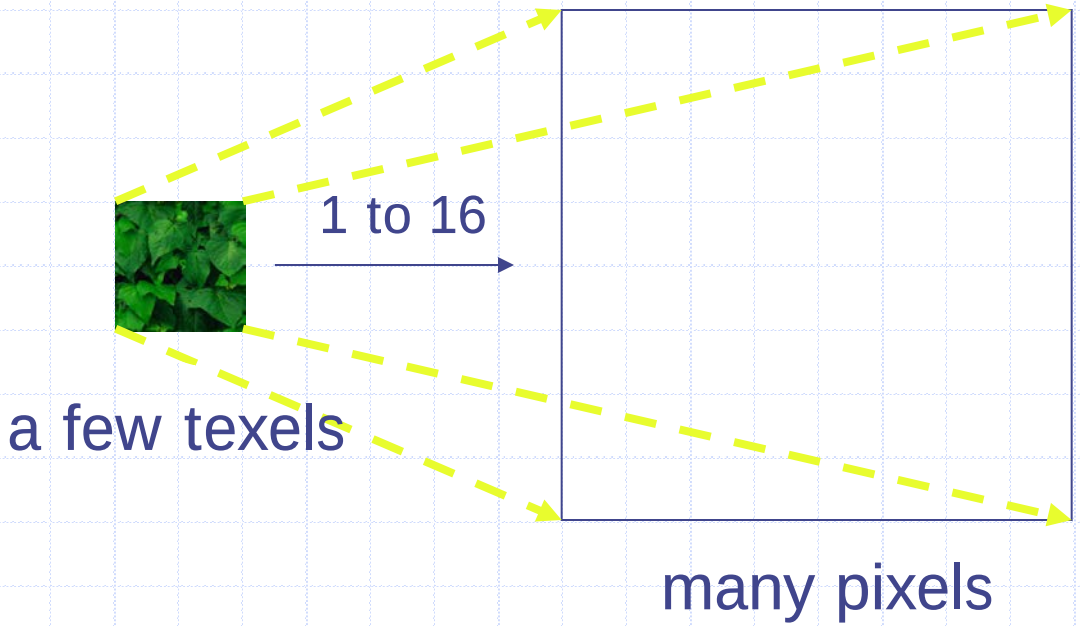
Mon, Nov 17, 2003

Magnification and Minification

- Ideally, the mapping of texels to pixels would be one-to-one.
- Here we run into two problems.
  - A small region of texels may be mapped to a large region of pixels (magnification).
  - A large region of texels may be mapped to a small region of pixels (minification).

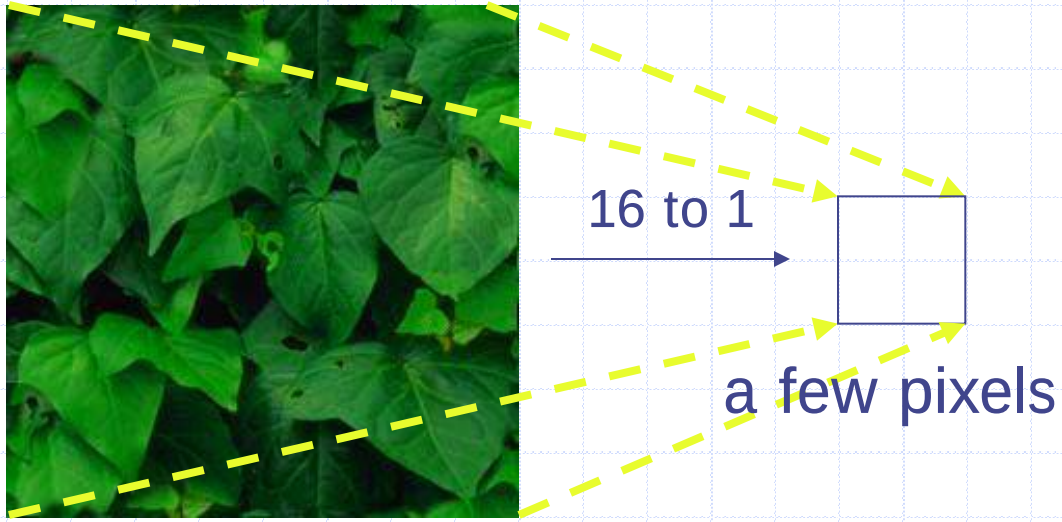
Magnification

- In magnification, one texel is mapped to many pixels.



Minification

- In minification, many texels are mapped to one pixel.



Calculating the Texel

- Suppose the polygon (rectangle) goes from (xmin, ymin) in the lower left to (xmax, ymax) in the upper right.
- Then pixel coordinates (x, y) correspond to texture coordinates
  - s = (x – xmin)/(xmax – xmin).
  - t = (y – ymni)/(ymax – ymin).

Calculating the Texel

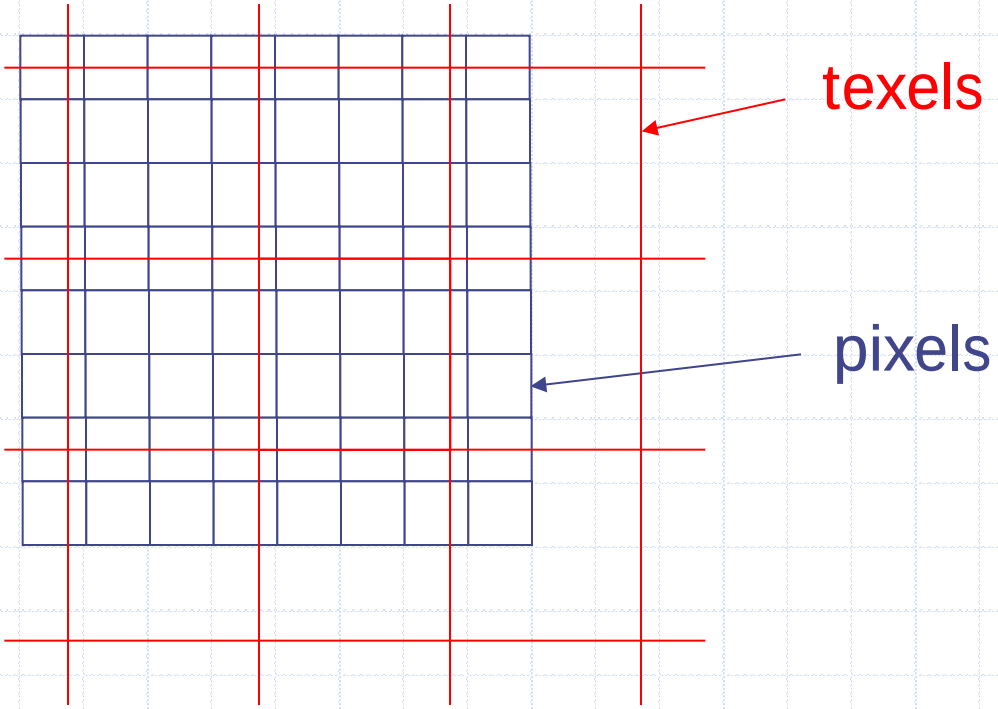
- Then multiply s and t by the dimensions of the texture, e.g., 64×64.
- Typically, the results are not integers.
- So we have a choice.
  - Round them to the nearest integers and use that single texel.
  - Use the fractional values to interpolate among the nearest 2×2 array of texels.

Magnification and Minification

- Run Nate Robin's tutorial by shrinking the texture region down to a small rectangle.
- Then expand the texture region and shrink the pixel region down to a small rectangle.
- Tutors

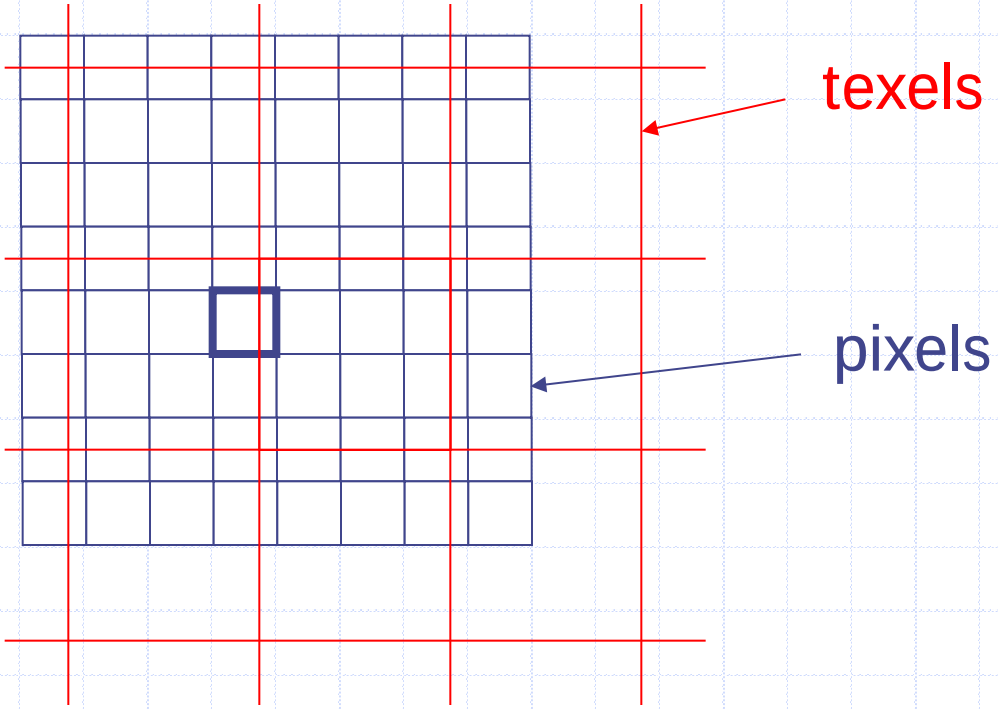
Magnification

- The alignment is probably not exact.



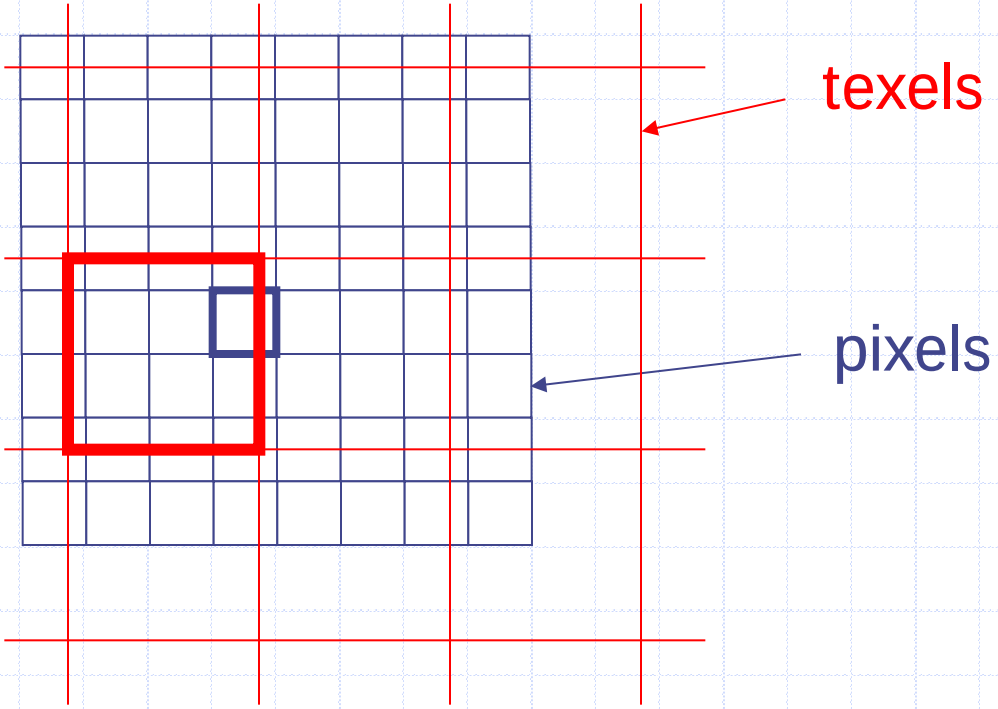
Nearest Texel

- Find the nearest texel.



Nearest Texel

- Find the nearest texel.

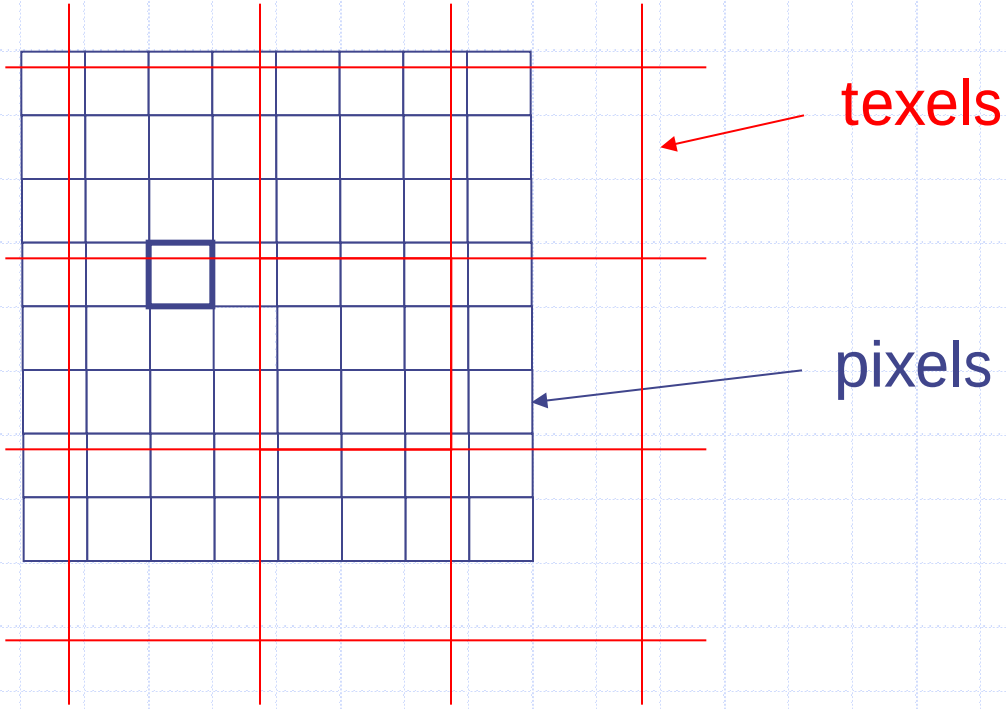


Linear Interpolation

- OpenGL may also interpolate the colors of the nearest four texels.

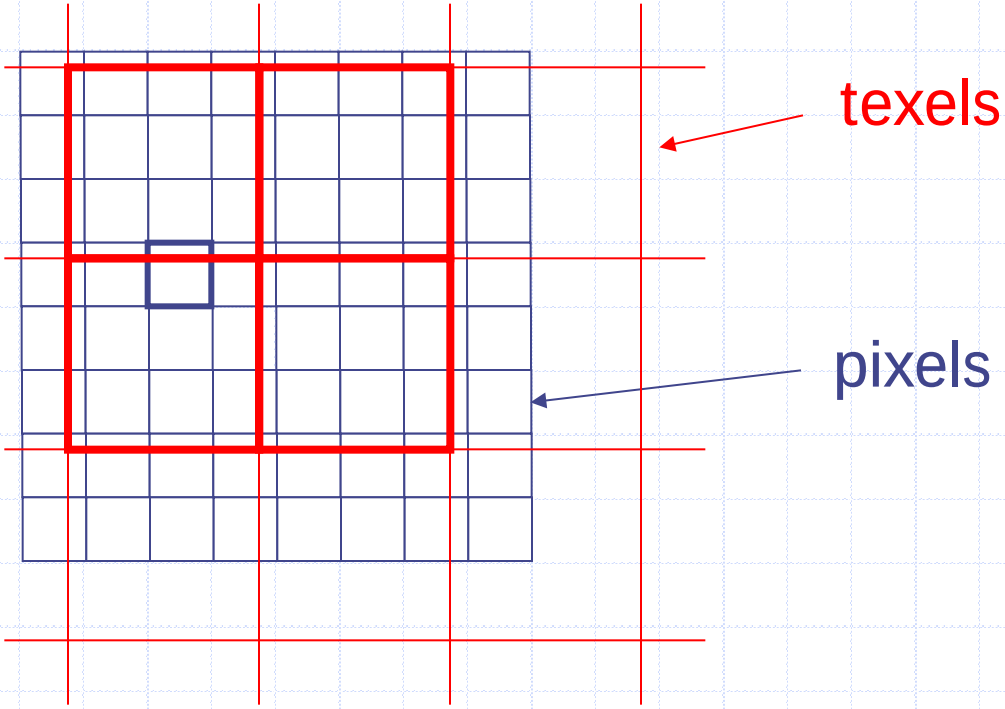
Linear Interpolation

- Find the nearest four texels.



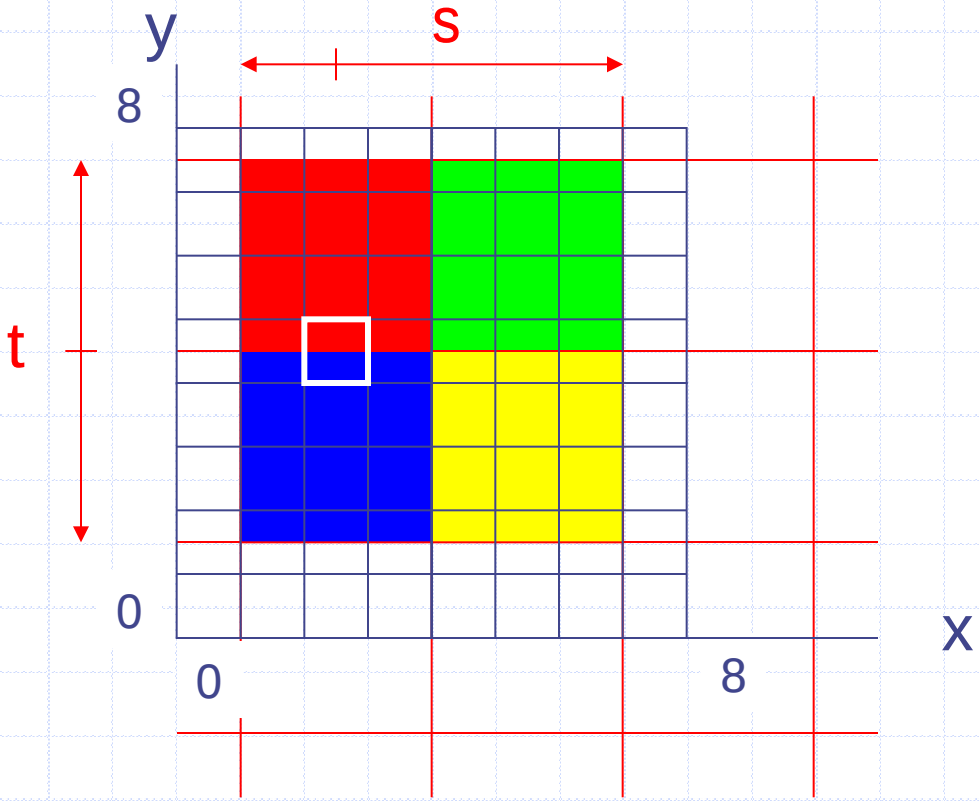
Linear Interpolation

- Find the nearest four texels.



Example: Interpolation

- Using the nearest texel, color the pixels.



Example: Interpolation

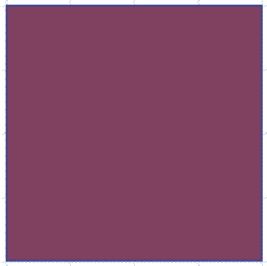
- Compute the color of the pixel (2, 4).
- Assume the texture is 2×2.
- The center of the pixel is
  - 25% of the way across the group of texels.
  - Therefore, s = 0.25.
  - 50% of the way up the group of texels.
  - Therefore, t = 0.50.

Example: Interpolation

- Interpolate horizontally.
- Top edge:
  - 0.75(1, 0, 0) + 0.25(0, 1, 0) = (0.75, 0.25, 0).
- Bottom edge:
  - 0.75(0, 0, 1) + 0.25(1, 1, 0) = (0.25, 0.25, 0.75).

Example: Interpolation

- Now interpolate those values vertically:
  - 0.5(0.75, 0.25, 0) + 0.5(0.25, 0.25, 0.75)
    = (0.5, 0.25, 0.375).



Interpolation

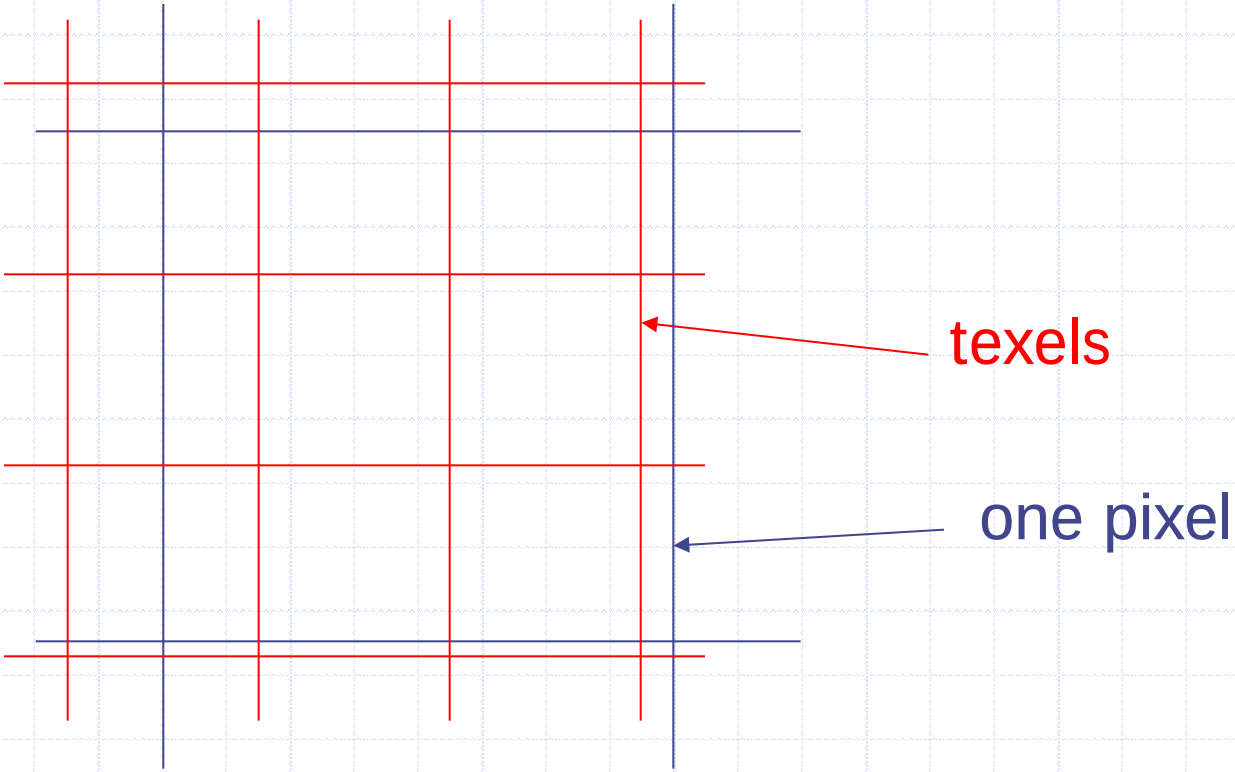
- This is very similar to the interpolation used to shade a triangle except that
  - The triangle used barycentric coordinates.
  - The texture uses *bilinear* interpolation in rectangular coordinates.

Example

- TextureDemo.cpp.
- RgbImage.cpp.
- Press ‘N’ to toggle between GL_NEAREST and GL_LINEAR.

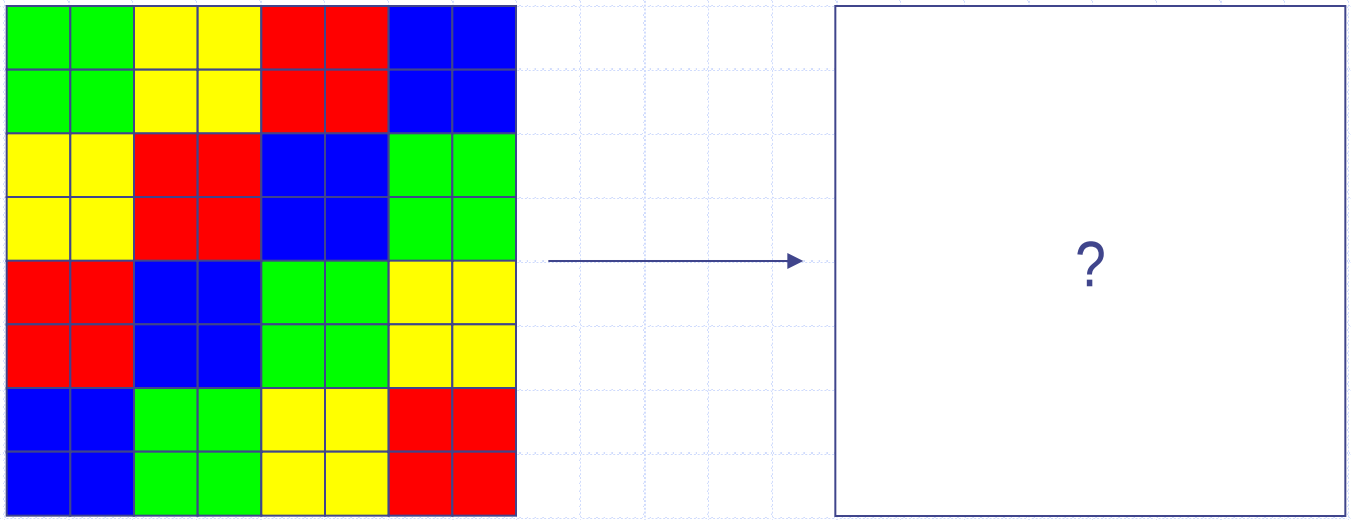
Minification

- Again, the alignment is not exact.



Minification

- If 64 texels all map to the single pixel, what color should the pixel be?



Minification

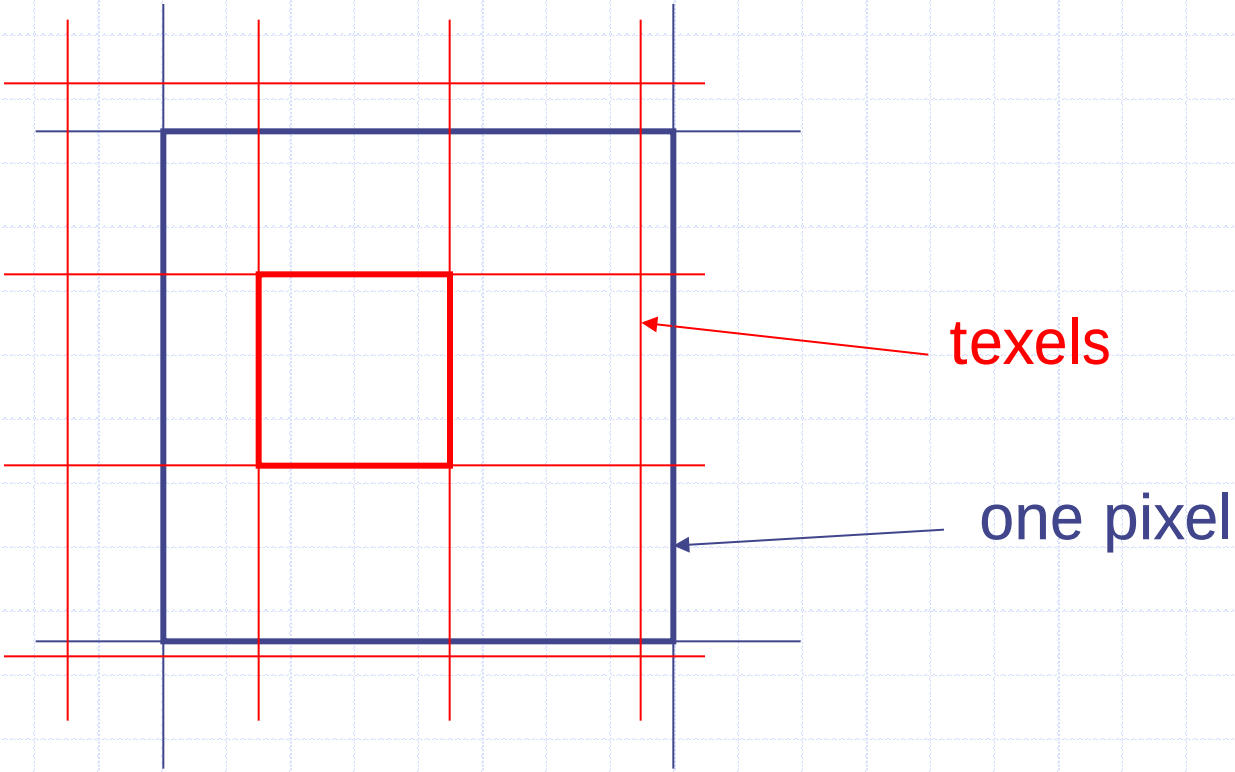
- Again, we may choose between the nearest texel and interpolating among the nearest four texels.

Nearest Texel

- If we choose to use the nearest texel, then OpenGL uses the color of the texel whose center is nearest to the center of the pixel.
- This can lead to “shimmering” and other effects if adjacent pixels have very different colors, as in the checkerboard example.

Minification

- Choose the nearest texel.

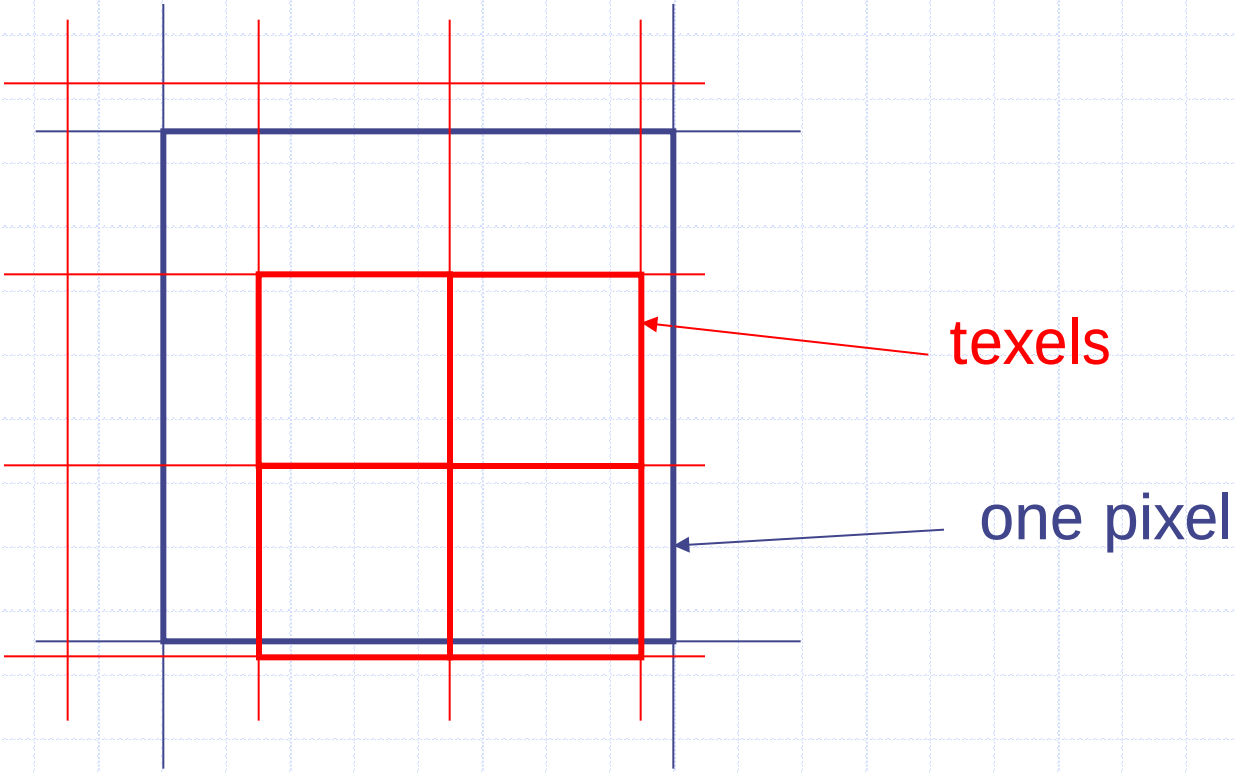


Minification

- If we choose to interpolate, then OpenGL will compute the average of the four texels that whose centers are *nearest* to the center of the pixel.
- This will reduce, but not eliminate, the shimmering and other effects.

Minification

- Choose the four nearest texels.



Minification