CSE-457

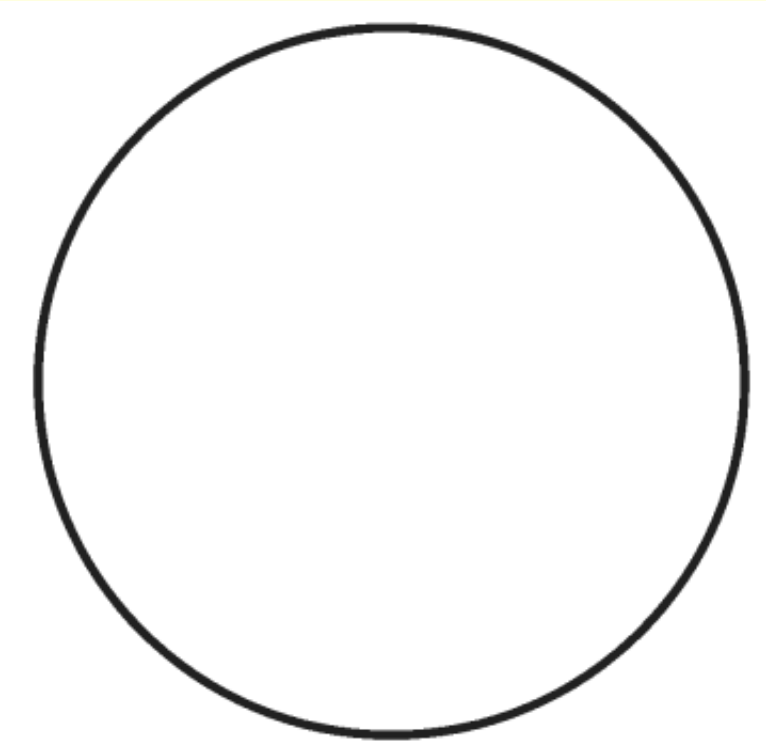
Aliasing and Anti-Aliasing Techniques

Aliasing and Anti-Aliasing Techniques

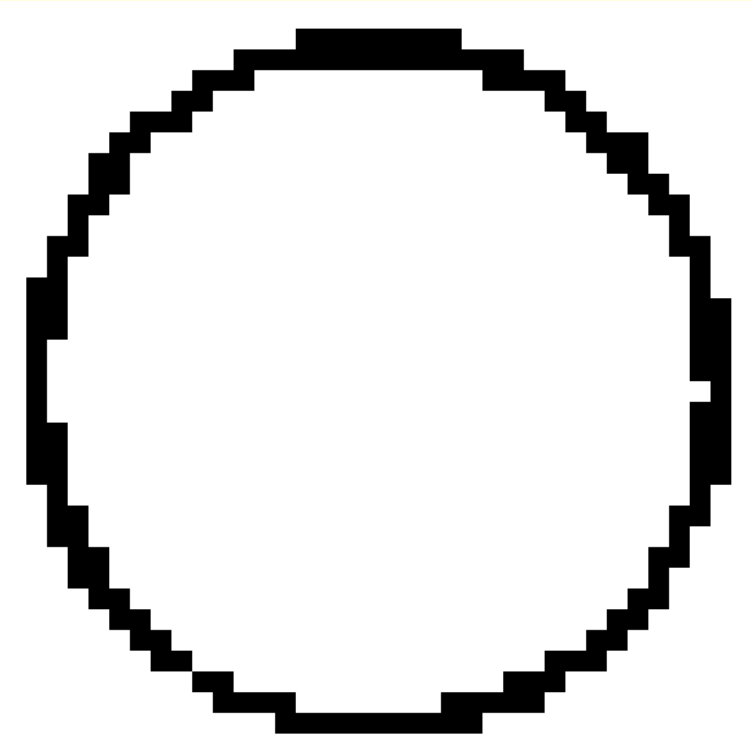
- What is Aliasing?
- Effects of Aliasing
- Avoiding Aliasing
- Anti-Aliasing Techniques
  - Unweighted Filtering
  - Weighted Filtering
  - Supersampling

Effects of Aliasing in Graphics

- Jagged effect in rasterised graphics:



Vector representation of a circle



Jagged edges due to aliasing during the rasterisation process

Effects of Aliasing in Graphics

- Poor representation of fine detail:

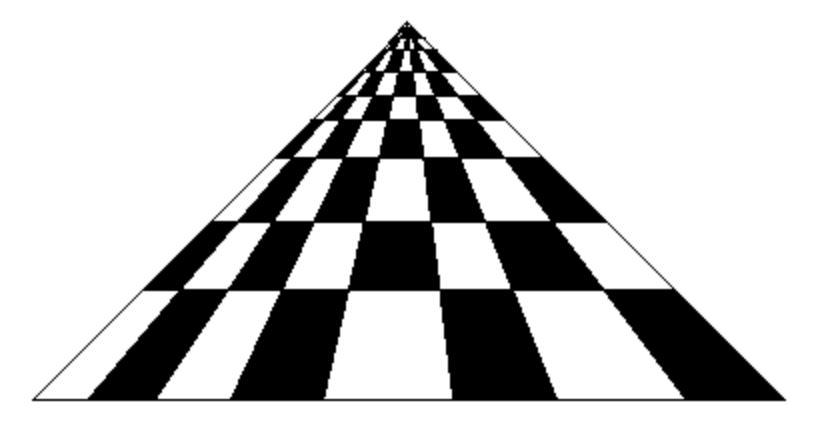
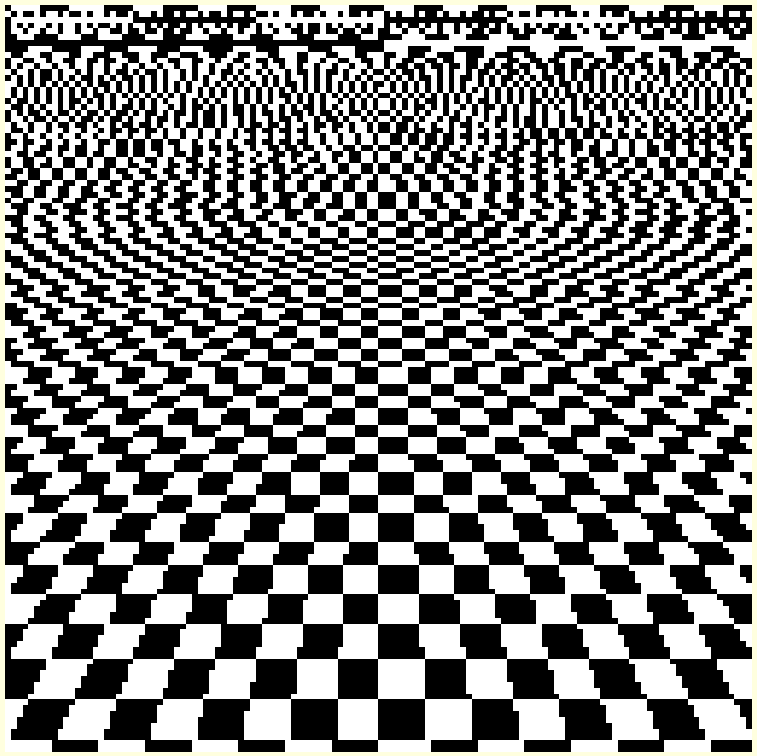


Image representing a chessboard in 3D

Closeup of most distant squares

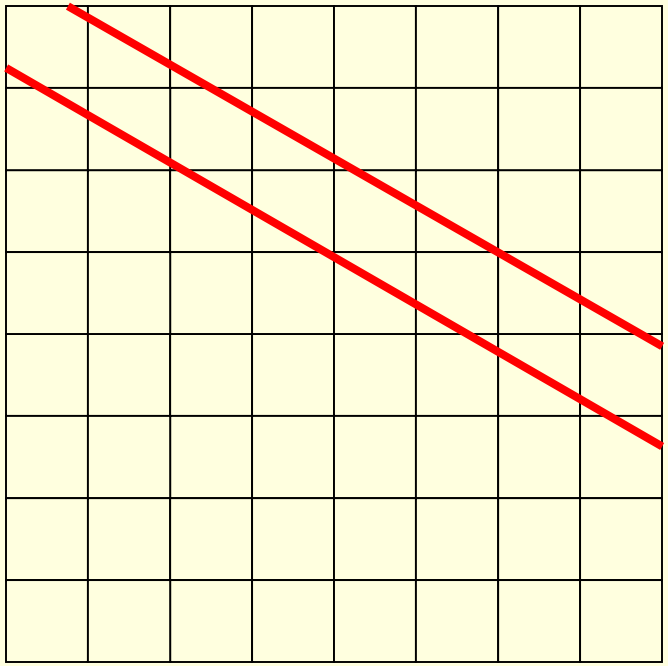
Aliasing in Graphics

- A graphics example:



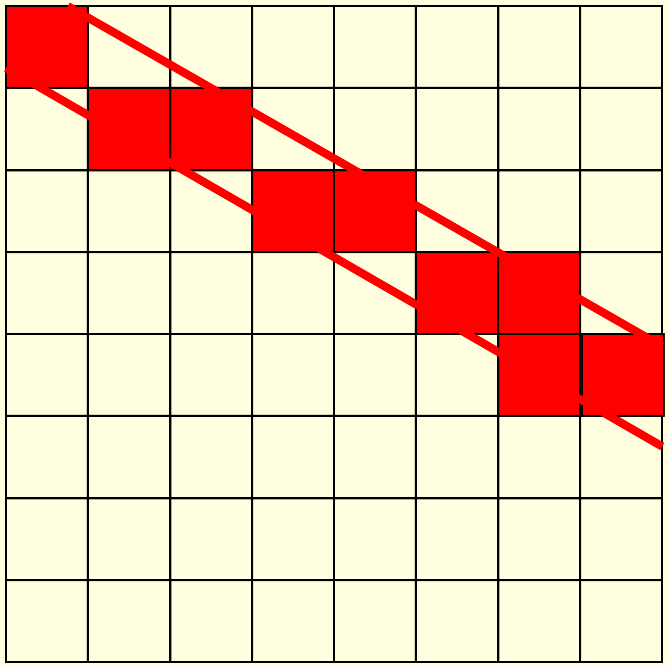
Anti-Aliasing Techniques

- Consider a diagonal line to be represented as a raster graphic…



Anti-Aliasing Techniques

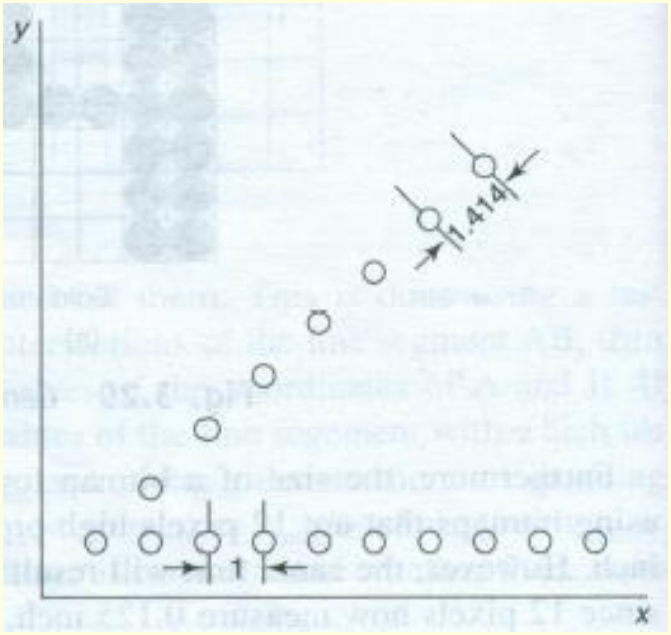
- The simplest way to rasterise would be to fill only those pixels with >50% coverage.



Anti-Aliasing Techniques

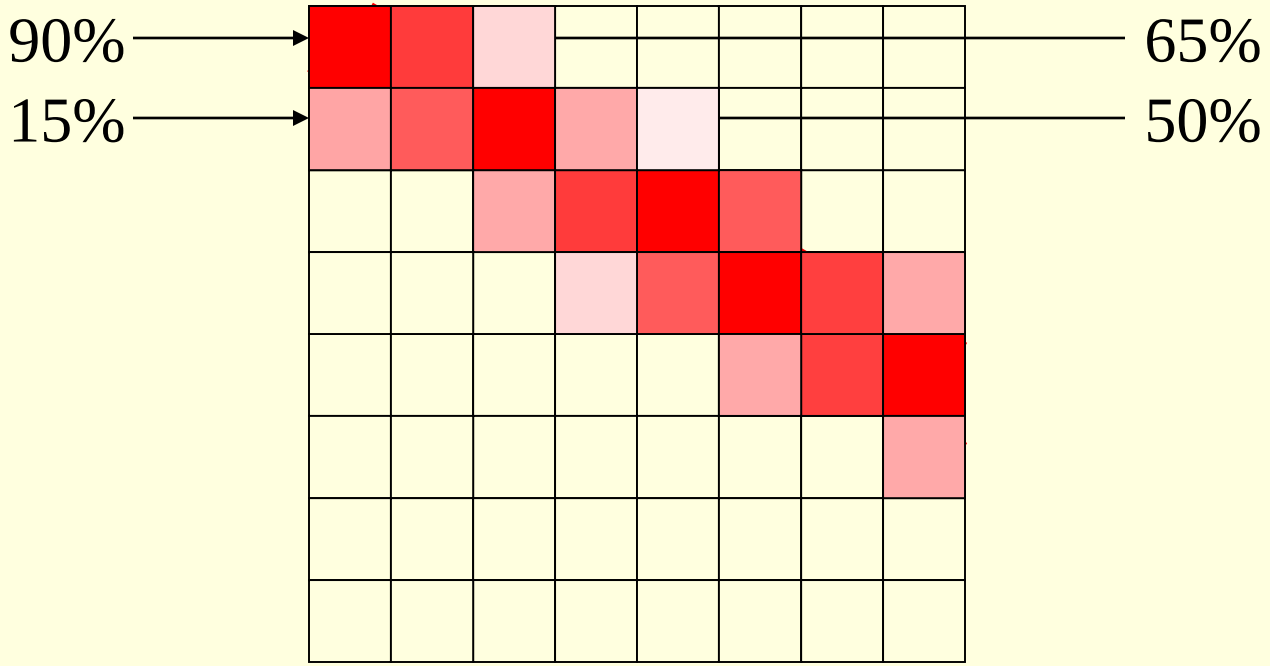
- This is not a particularly good representation of the original line.
- Aliasing artefacts create a jagged, ‘stepped’ appearance.
- The aliasing also makes lines appear to have different intensities depending on their angle.

Unequal Brightness



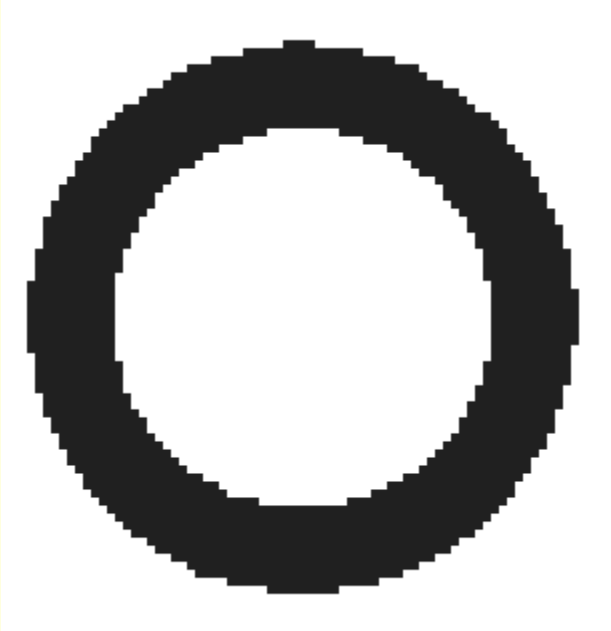
Anti-Aliasing Techniques

- A better method would be to determine the strength of the colour used to fill each individual pixel according to the percentage covered by the line.



Anti-Aliasing Techniques

- This technique (known as *pre-filtering*) creates a much smoother appearance.



Circle with aliasing

Pre-filtering applied

Anti-Aliasing Techniques

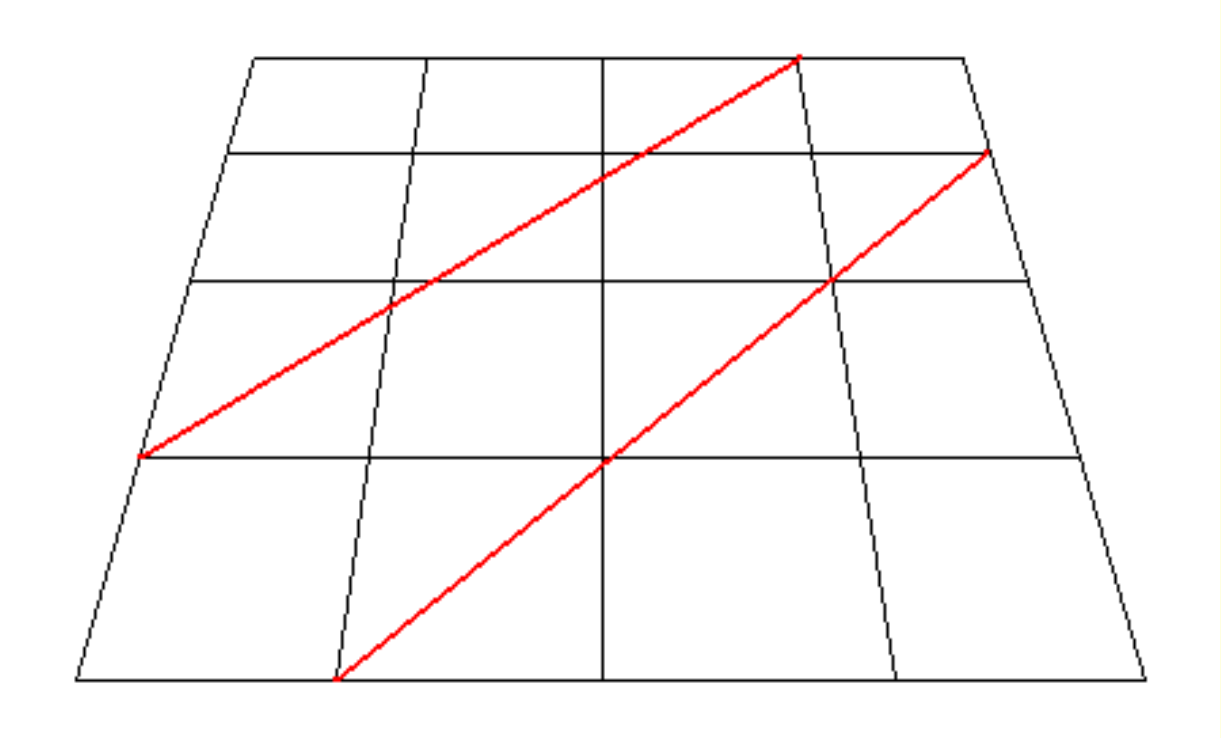
- In the method seen on the previous slides, the amount of coverage given to each pixel is determined irrespective of the distance from the center of the line.

- It is therefore known as *Un-weighted* filtering.

- The filter used to calculate the % coverage of each pixel in this method can be thought of as a cube covering an area of 1x1 pixels, as explained in the following slides…

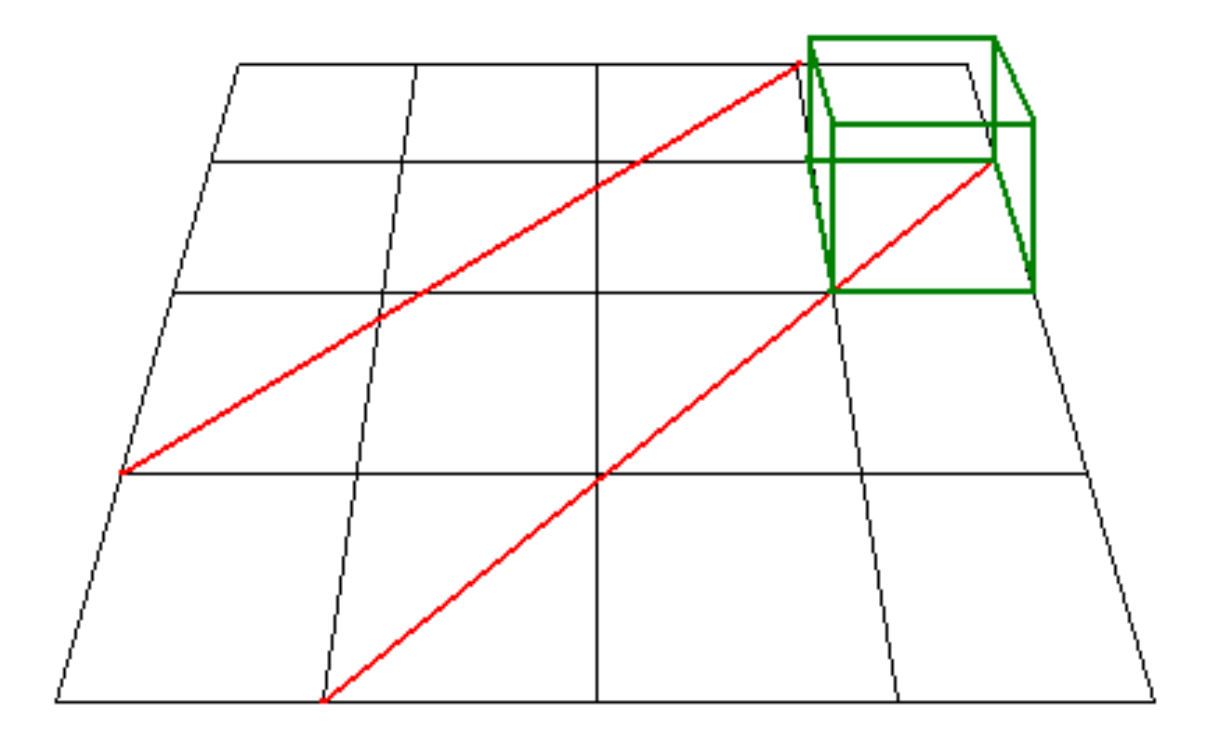
Unweighted Filtering

- Consider the line on a plane surface in a 3D space…



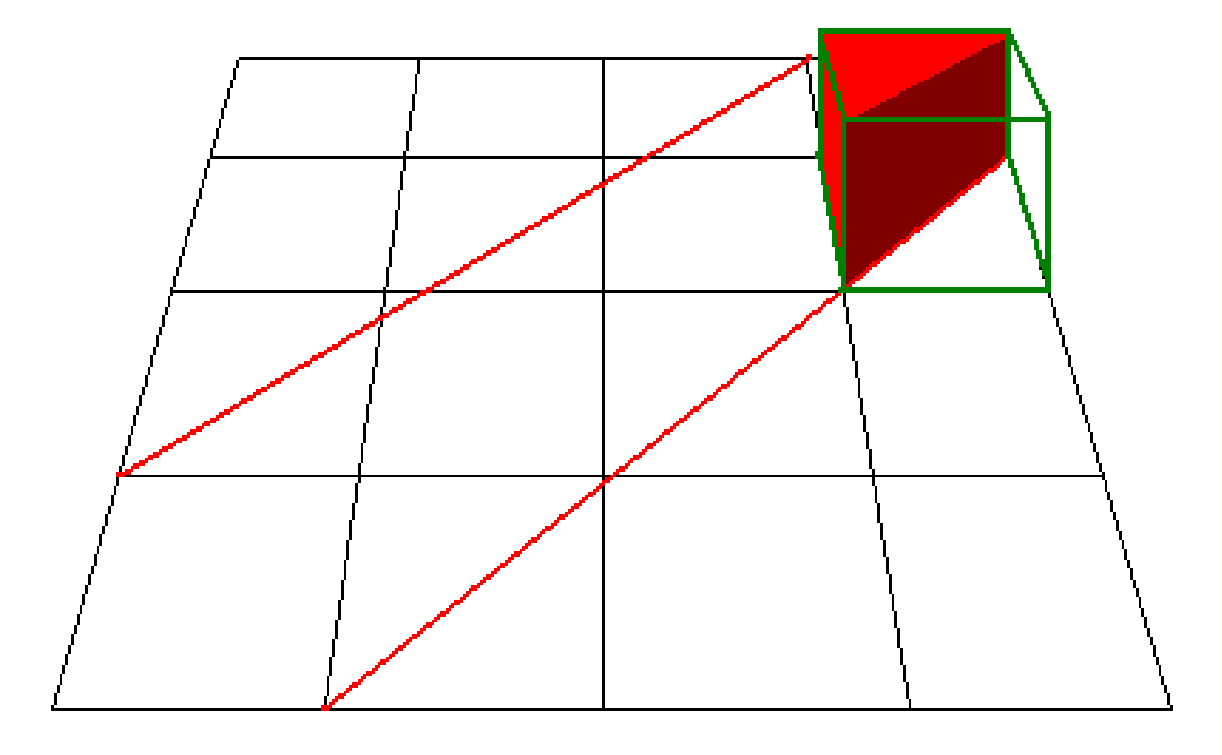
Unweighted Filtering

- A cube is extrapolated up from the plane for each pixel that the line intersects…



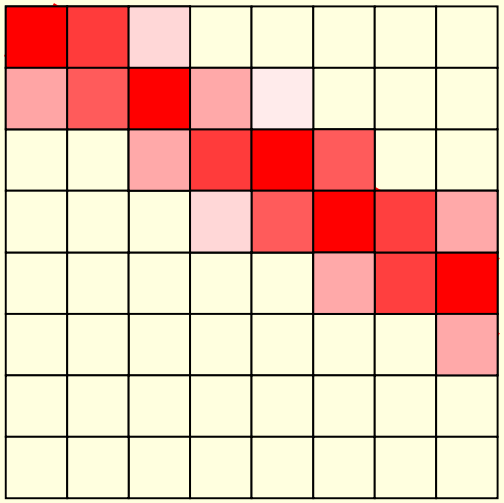
Unweighted Filtering

- The line is then extrapolated to fill a portion of this cube…



Unweighted Filtering

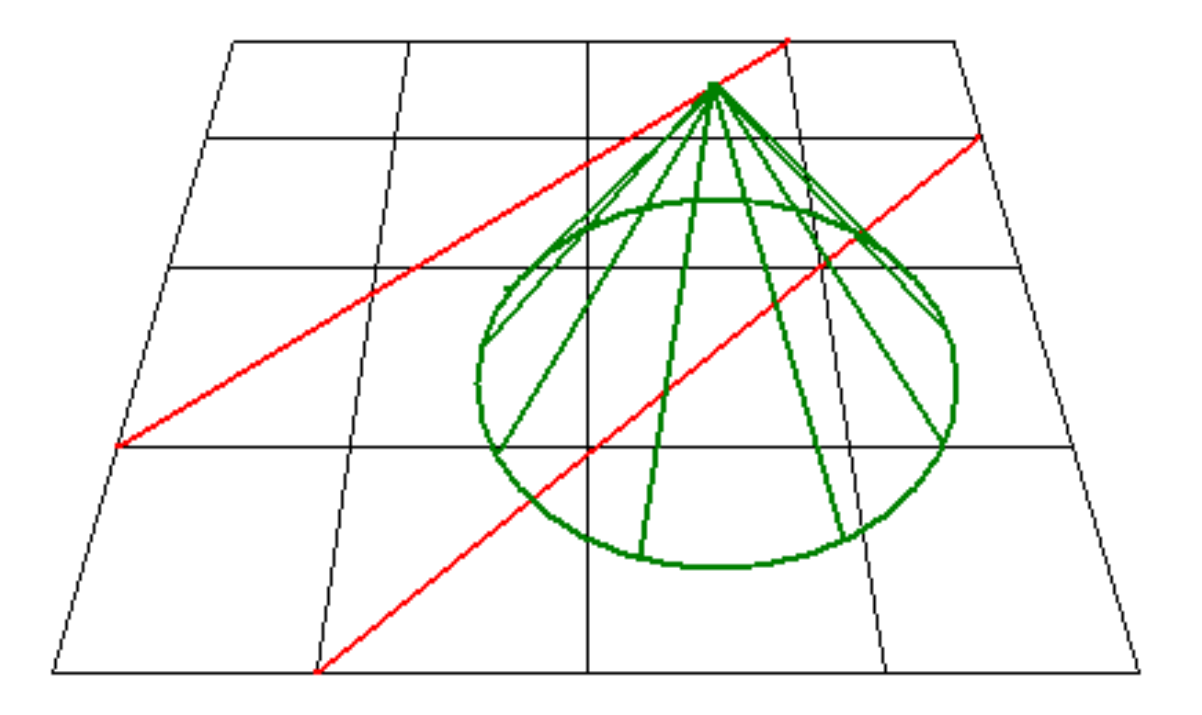
- The percentage of the cube filled by the line can now be calculated and used to shade this pixel.



- *Unweighted* filtering is computationally simple, but better results can be achieved by using a *weighted* filter.

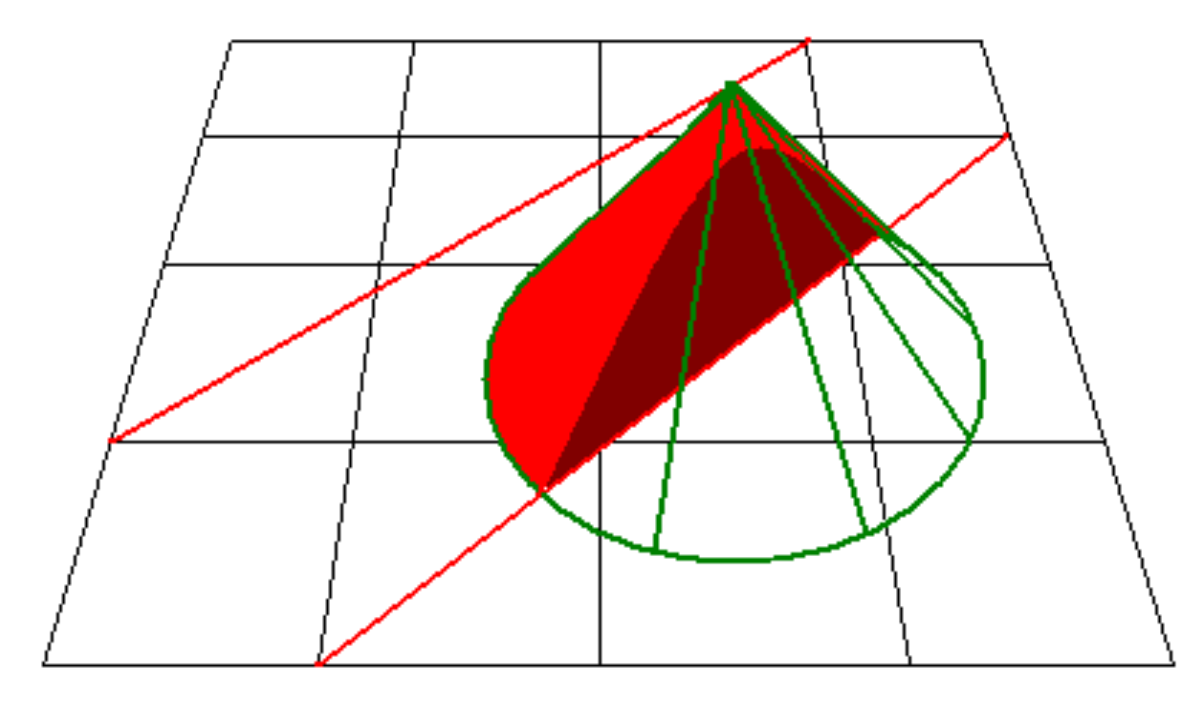
Weighted Filtering

- In weighted filtering, a cone is used in place of the cube.



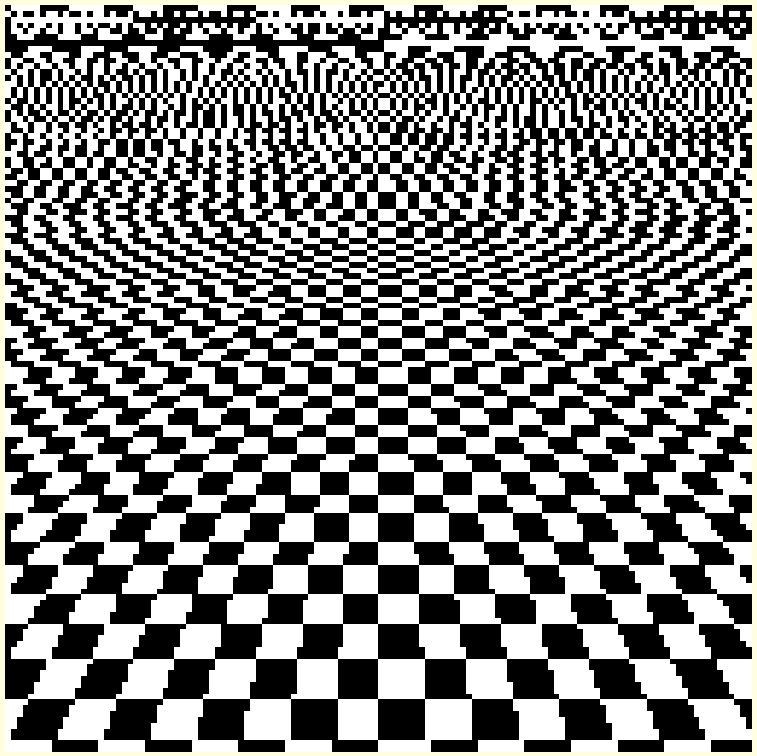
Weighted Filtering

- The line is extrapolated into the cone and the percentage of the cone filled is calculated.



Aliasing in Graphics

- A graphics example:



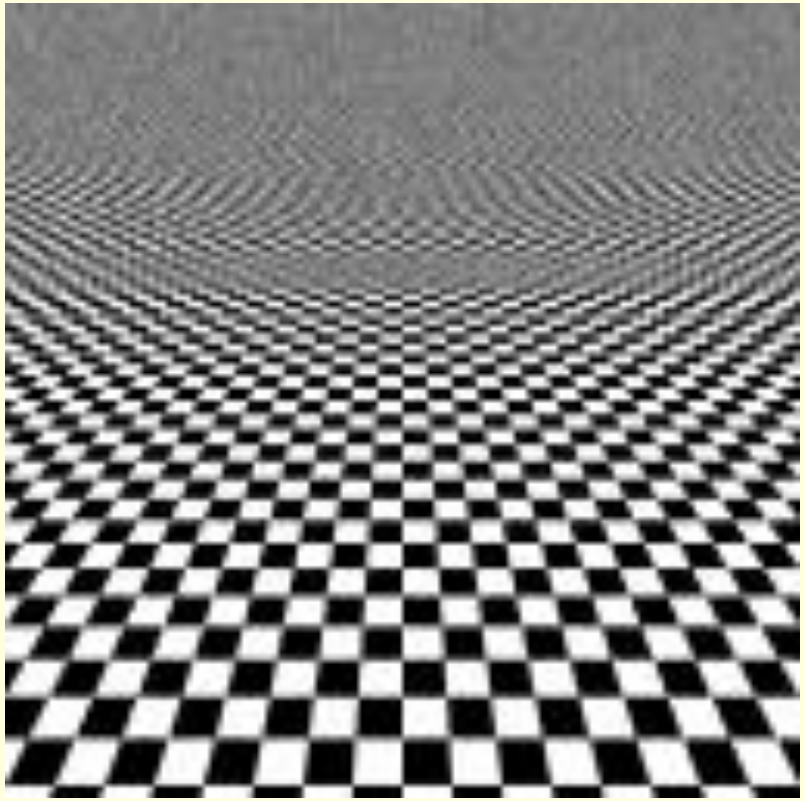
Weighted Filtering

- This *weighted filtering* gives a more accurate result by taking into account the pixels around the one currently being investigated.

- The use of a cone means that priority is given to line coverage closest to the center of the pixel in question.

- It is possible to give different priorities to the outlying pixels by adjusting the height therefore of the cone - a steeper slope will give more priority to the pixel at the center.

The Results



Supersampling

- These filtering methods have so far been applied just once per pixel in the rasterised image.
- This is referred to as *"**1x**"* anti-aliasing.
- Greater accuracy and more graphically impressive results can be obtained by a technique known as *supersampling*.

Supersampling

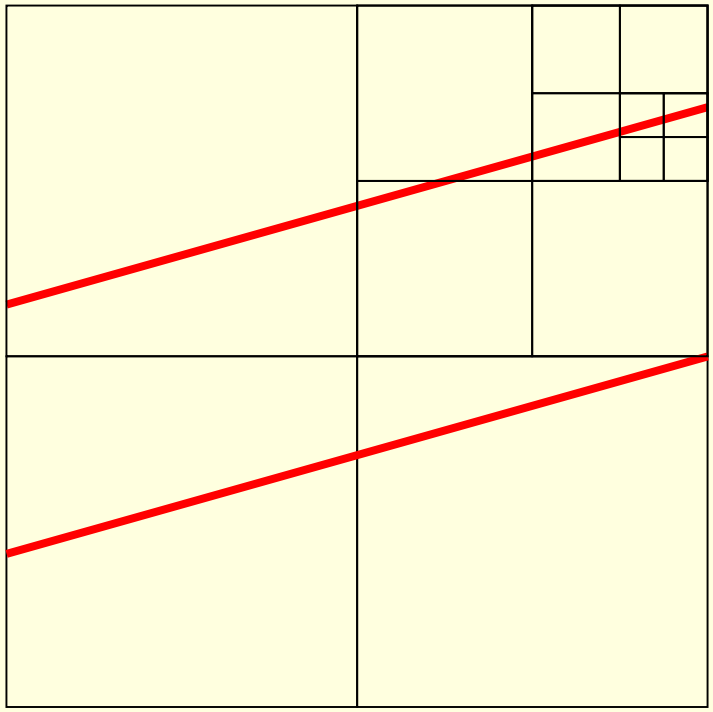
- Supersampling performs calculations on a virtual image '***n***' times the resolution of the desired output.

- This produces several pixels for each pixel in the final output.

- Filtering is applied to each of these virtual pixels and the resultant average value is used to shade the corresponding pixel in the output image.

Supersampling

- Supersampling anti-aliasing is usually referred to in terms of the ***n*** value used:



n = 8

(8x anti-aliasing)

Supersampling

- Supersampling is expensive computationally, but many high-end video cards provide on-board functionality to speed the process up.

- Modern video games strive for smooth, realistic edges and make extensive use of anti-aliasing techniques.

- Many games provide the user with options to select the level of supersampling used (2x, 4x, 8x) to balance the desired graphics level with the computing power available.

Character Display

1. Two methods: Bitmap Font and Outline Font

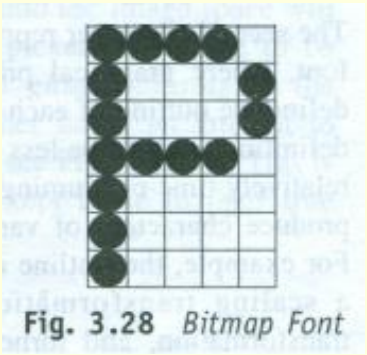


Fig. 3.28 *Bitmap Font*

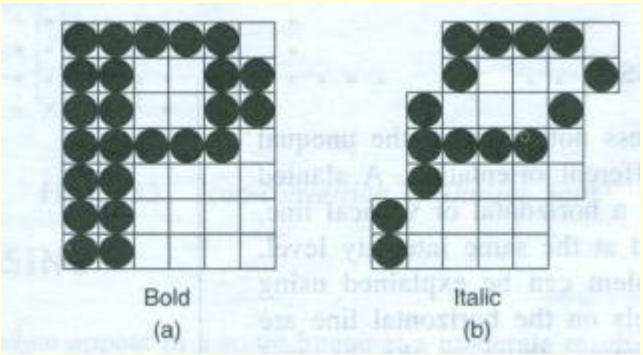


Fig. 3.30 *Outline Font*

Bitmap Font

- Character is represented by the on pixels in a bilevel pixel grid pattern called a bitmap.
- Characters are already scan converted form.
- We may overlay the bitmap onto itself with a horizontal offset of one pixel to produce bold and shift rows of pixels to produce italic.
- Thus variation in appearance and size from one font, the overall results tends to be less than satisfactory.
- Furthermore, the size of a bitmap font is dependent on image resolution.

Outline Font

- The graphical primitives such as lines and arcs are used to define the outline of each character.
- Requires scan conversion operations.
- But it can be used to produce characters of varying size, appearance and even orientation.
- It can be resized through a scaling transformation, made into italic through a shearing transformation and turned around with respect to a reference point through a rotation transformation.

Picket Fence Problem

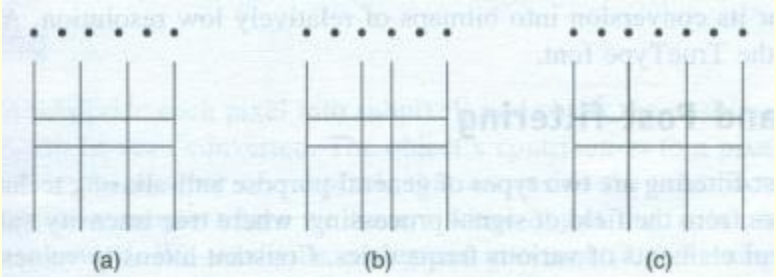


Fig. 3.32 *The Picket Fence Problem*

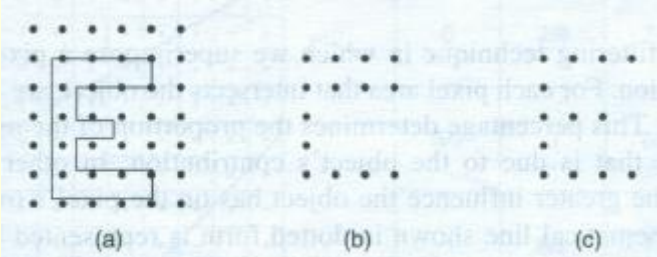


Fig. 3.33 *Scan-converting an Outline Font*

Bibliography

- Anti-Aliasing. *Wikipedia, 2005.*
  - http://en.wikipedia.org/wiki/Anti-aliasing
- Nyquist-Shannon Sampling Theorem. *Wikipedia, 2005.*
  - http://en.wikipedia.org/wiki/Nyquist-Shannon_sampling_theorem
- Antialiasing Techniques. *Kaushik, S. 2005.*
  - http://www.cs.wpi.edu/~matt/courses/cs563/talks/antialiasing/first.html
- Anti-aliasing and Fractals. *Jones, D. 2004.*
  - http://www.fractalus.com/info/antialias.htm
- Aliasing problems and Anti-Aliasing Techniques. *Owen, S. 1999.*
  - http://www.siggraph.org/education/materials/HyperGraph/aliasing/alias0.htm