Anti-aliasing

Lecture notes provided by

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What is going on here?

… and here?


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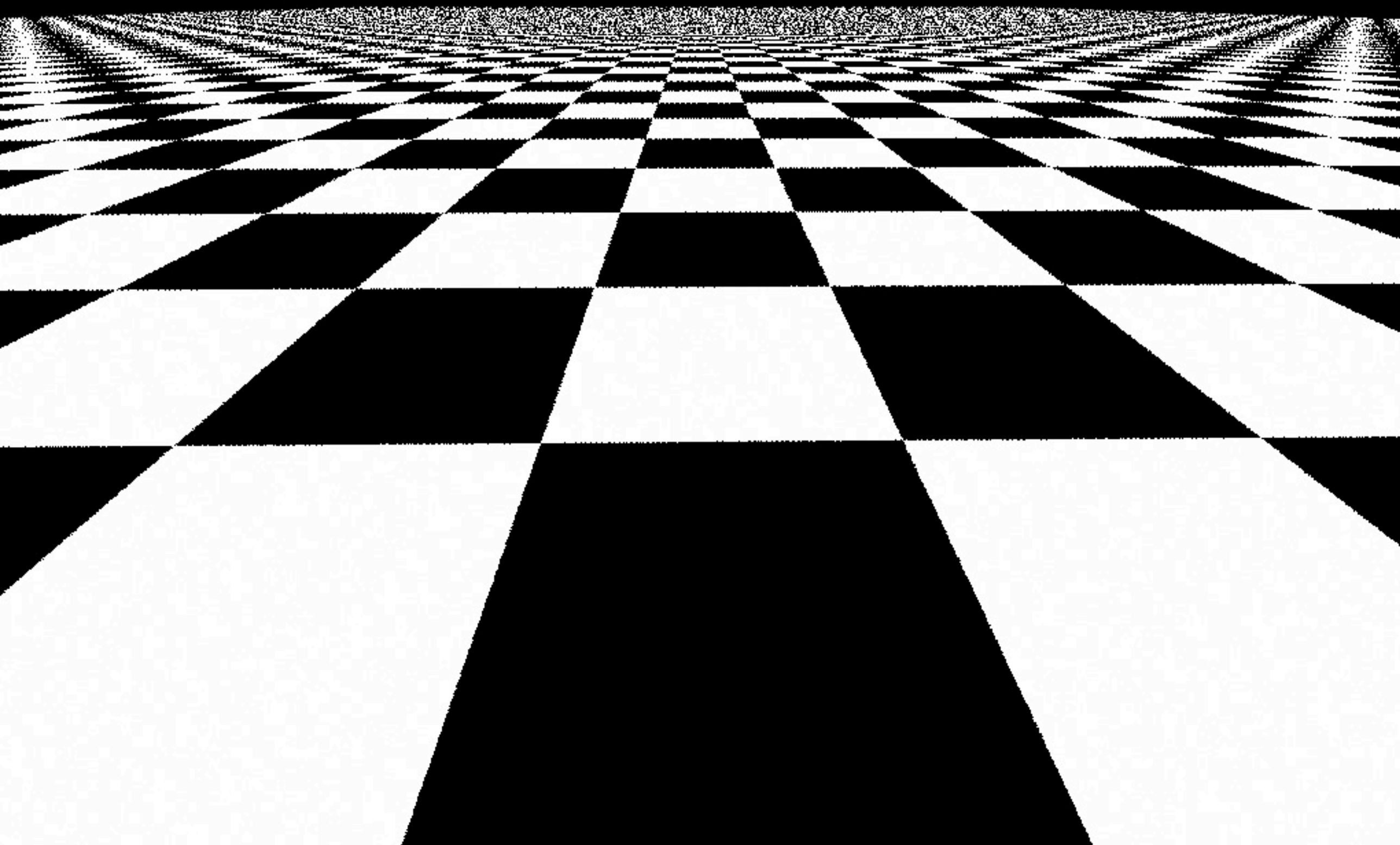
JPEG

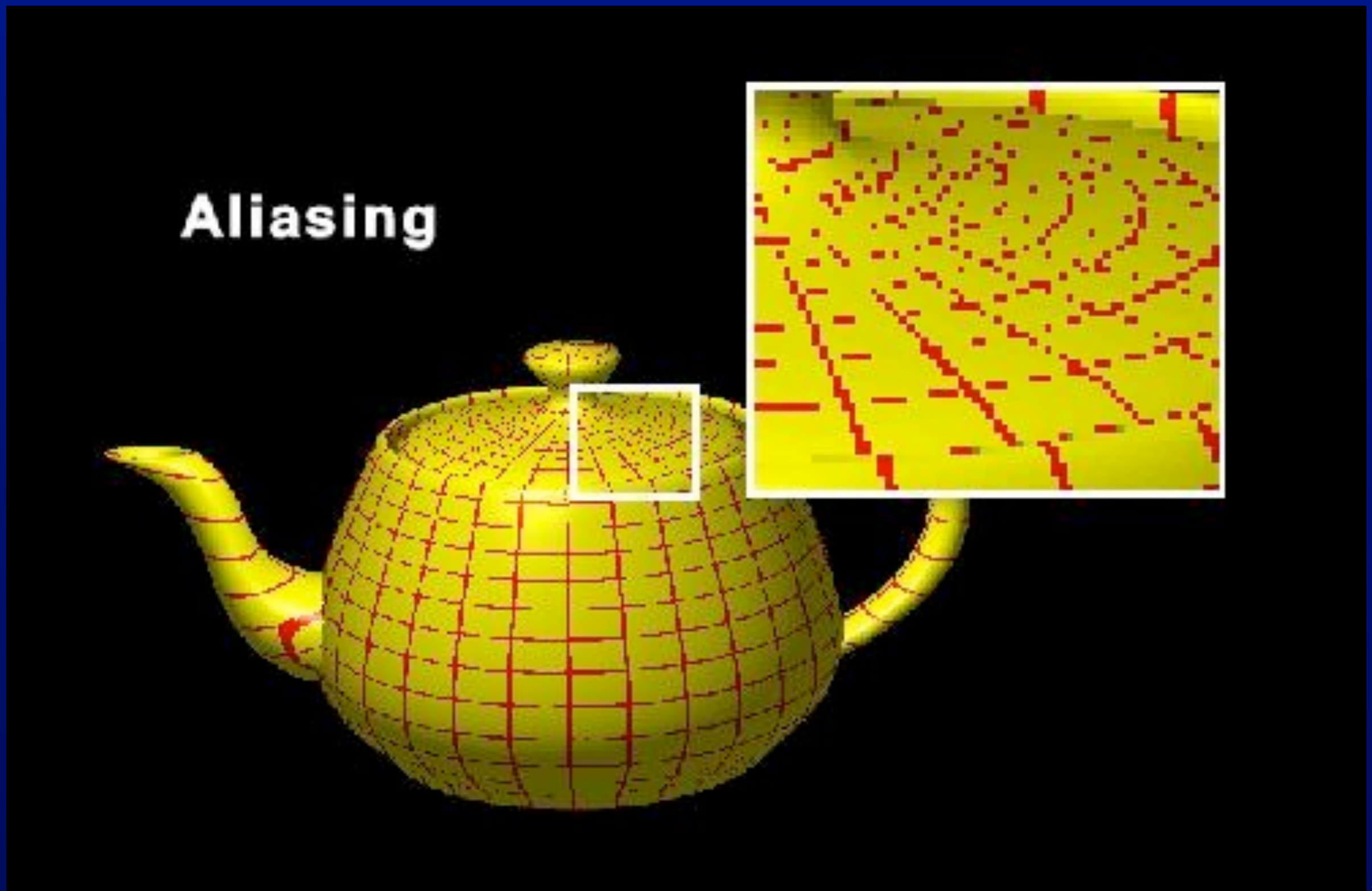
- Lossy compression format.
- What do we mean by ‘lossy’?
- Lose detail, i.e. high spatial frequencies.
- What do we mean by ‘high spatial frequencies’.

What is happening

Remember this?



and this?



Aliasing

- Ray tracing gives a colour for every pixel in the image, but …
- … a pixel contains an infinite number of points.
- These points may not all map to the same colour in the scene.

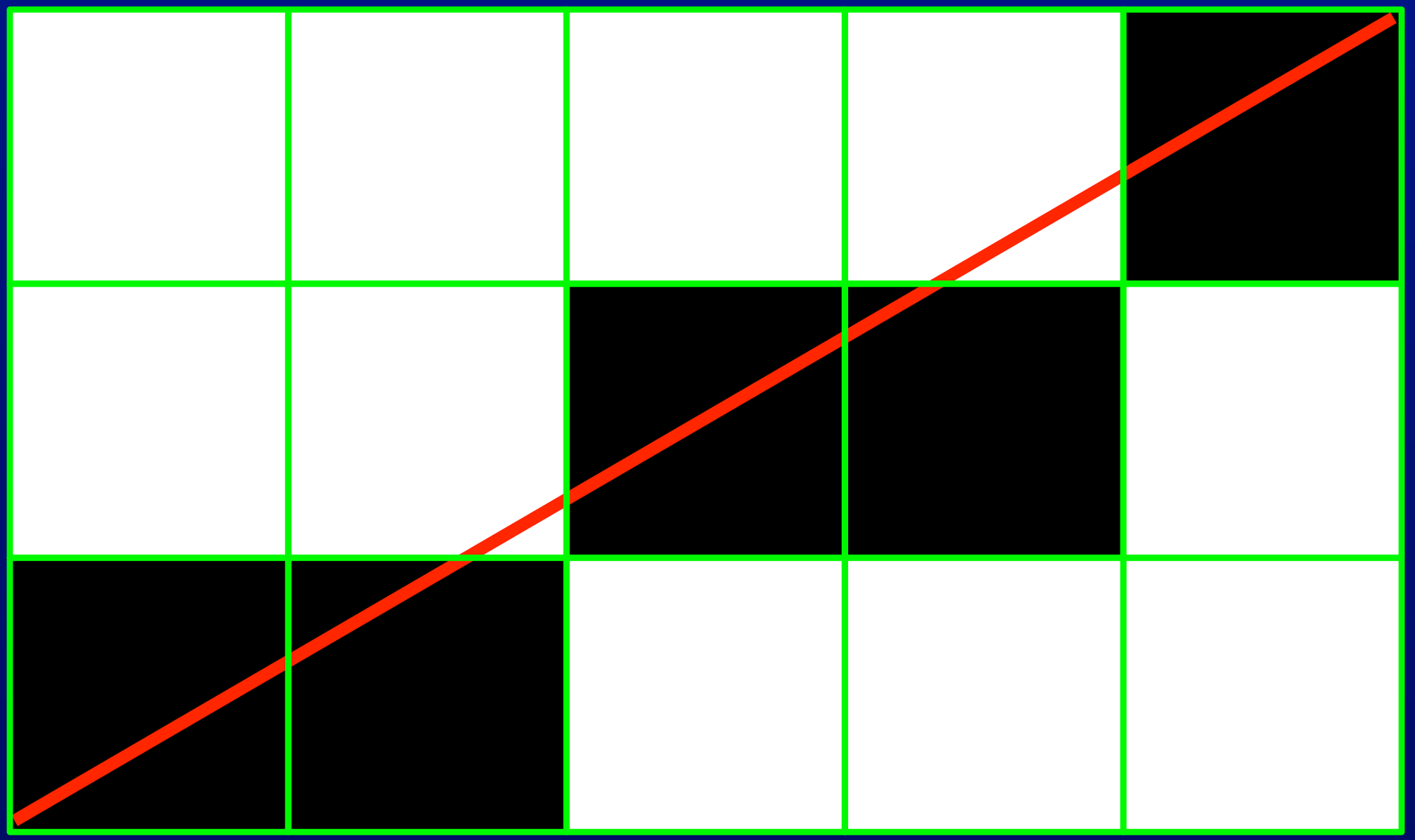
So what is Aliasing?

- Technically, it is any one of several different effects that arise when we under-sample a signal.
- Easiest example (and known to all of you) is the ‘staircase’ effect of a line on a pixelised display.
- Commonly referred to as the *jaggies*.

Antialiasing

- Antialiasing is the name given to a group of techniques which attempt to remove or mitigate the jagged effect of aliasing.
- Techniques include supersampling, area sampling and various filtering techniques.

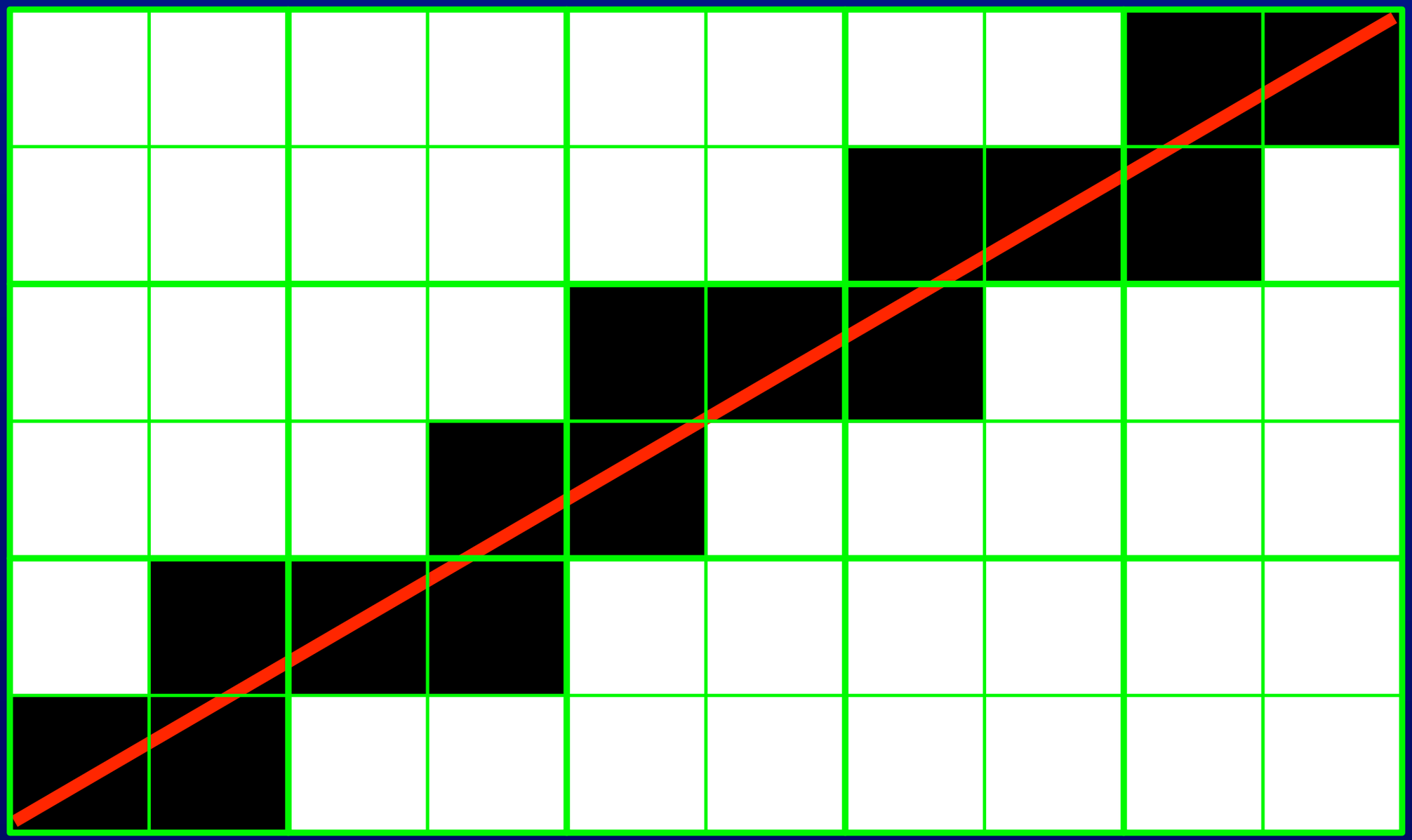
Jaggies



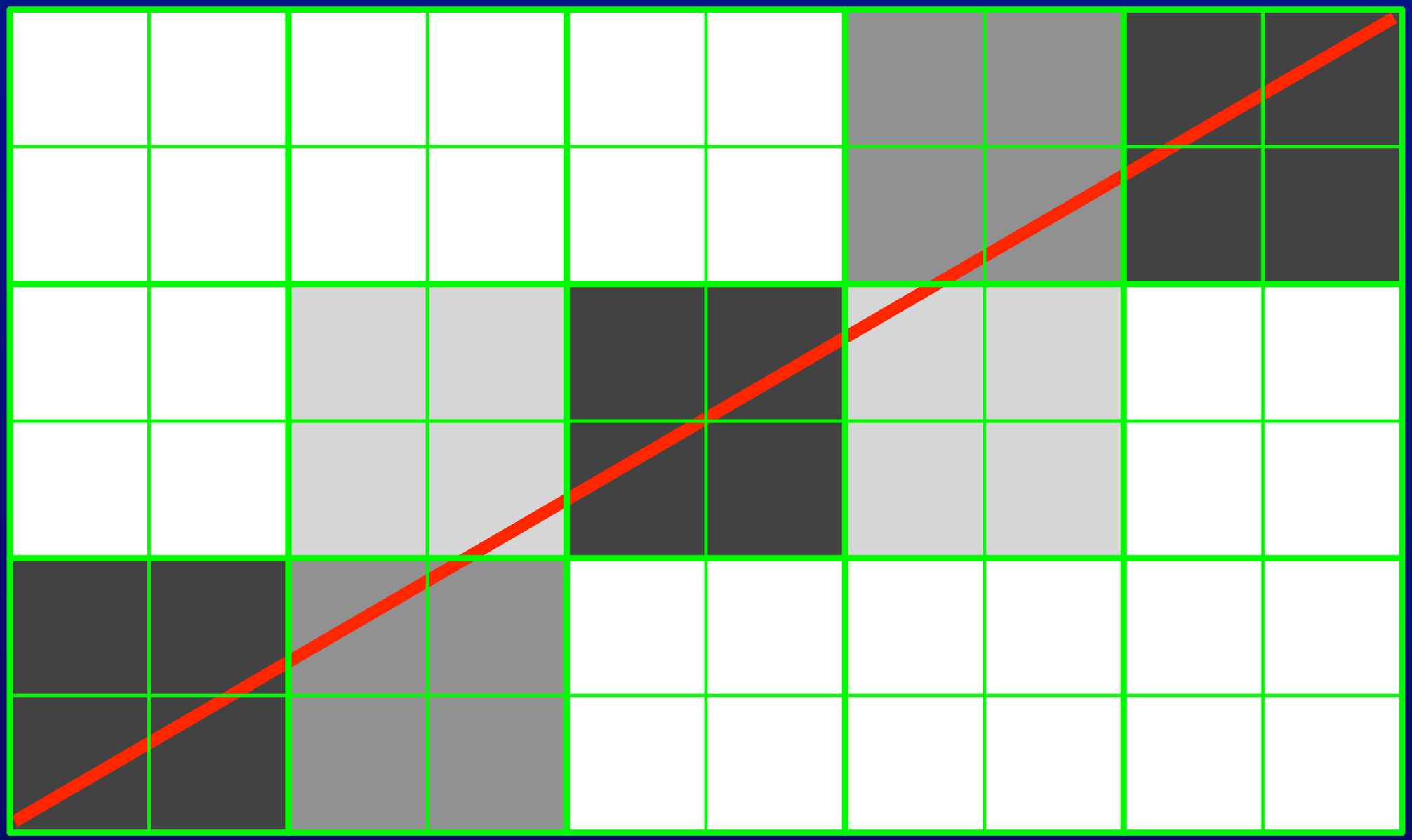
Supersampling

- Divide each pixel into a number of smaller (subpixel) elements.
- Determine the colour and/or intensity of each subpixel and sum to determine the resulting colour/intensity.
- Has the effect of increasing screen resolution.

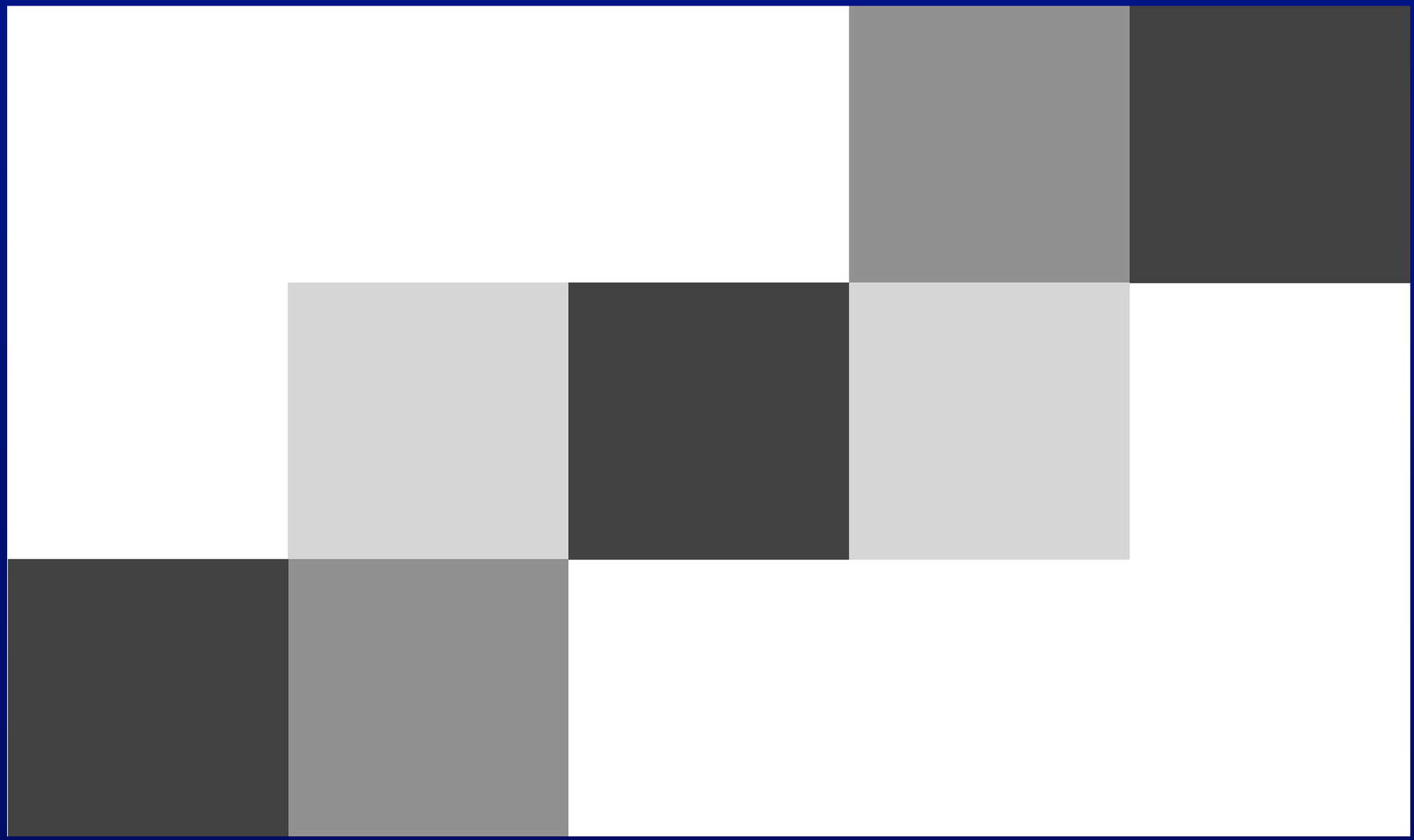
Supersampling



Supersampling



Supersampling

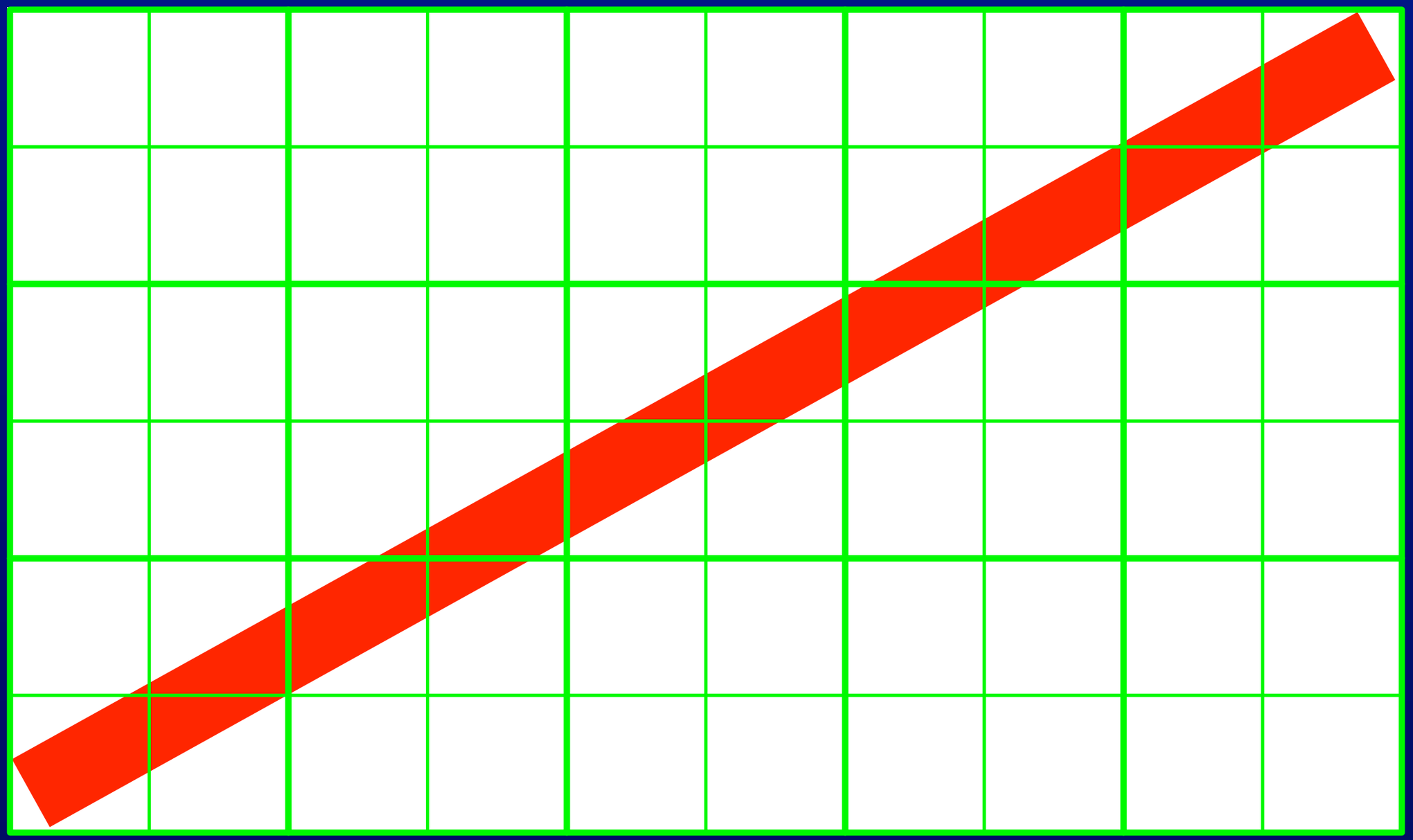


Supersampling with finite width

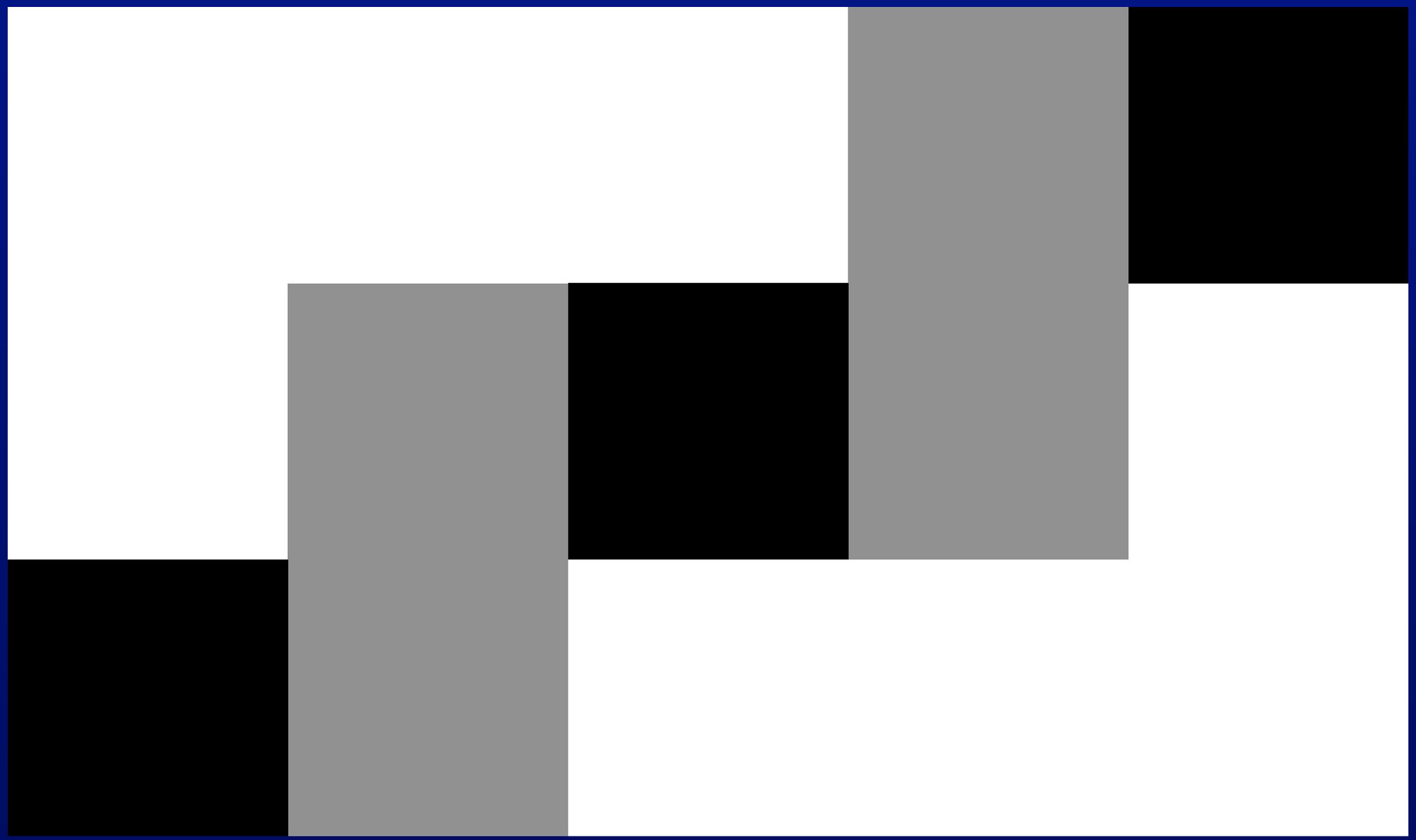
- This presupposes a ‘mathematical’ line, i.e. infinitesimally narrow. However, all lines on the screen must be at least one pixel wide.

- We get a better result if we take the width into account and colour pixels accordingly.

Supersampling with finite width



Supersampling with finite width



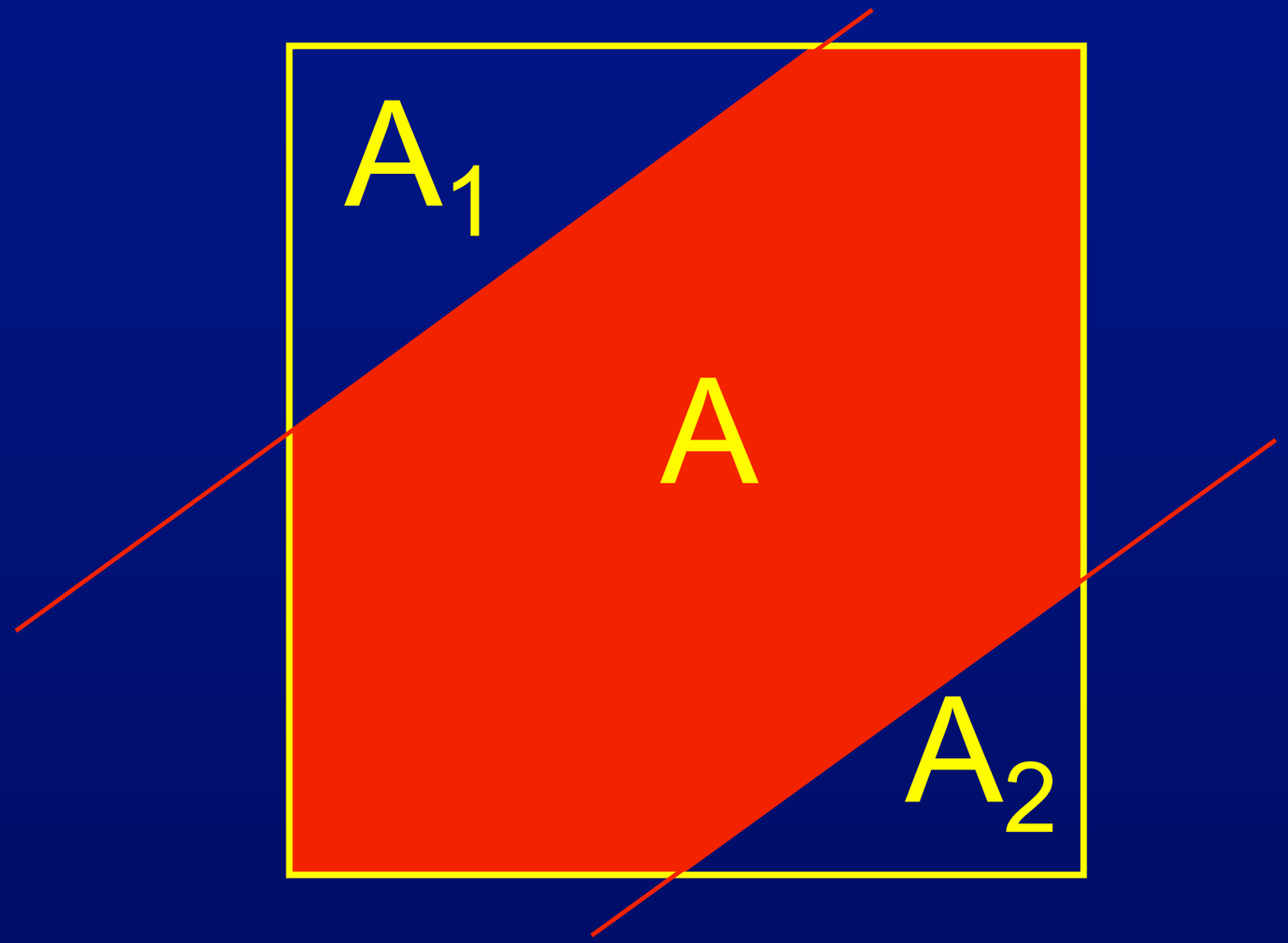
Things to think about

- What do we do if the background is not white and/or the line is not black?
- How do we determine if a subpixel is within the boundary of the line and by how much?

Area Sampling

- Supersampling a line of finite width is really just an approximation to area sampling.
- We can calculate the area of overlap analytically — at the cost of increased complexity.
- This will allow us even more intensity levels which should result in a better line.

Area Sampling



Filtering

- Can reduce effects of aliasing.
- Common filters include:
  - –Box (mean) filter, i.e. area sampling,
  - –Subpixel weighted filters, i.e. weighted supersampling,
  - –Weighted function filters.

Subpixel weighted filters

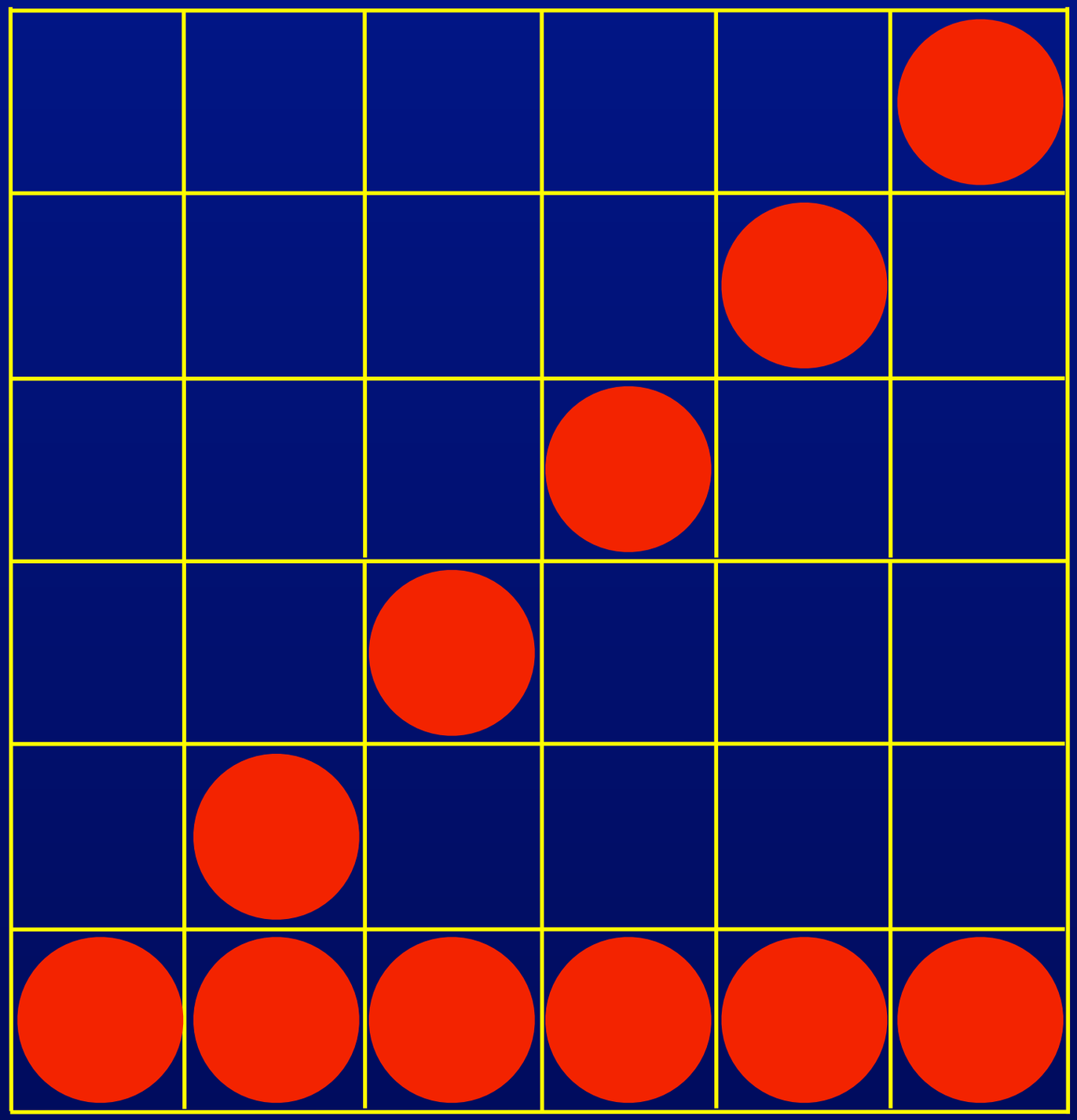
- Each sub-pixel is given a different weight depending on how close it is to the centre of the pixel, e.g.:

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Weighted function filters

- Can think of area sampling (box filter) as using a cube as the function.
- Other functions include the cone, quadratic(?), Gaussian, etc.
- Typically results improve as complexity of the function increases.
- Law of Diminishing Returns.

What do you notice about this picture?



Line Intensity Differences

- The length (and hence the area) of a line depends on its orientation.
- Diagonal lines are 40% ($\sqrt{2} \approx 1.414$) longer than horizontal or vertical lines.
- However they contain the same number of pixels, so they display at a lower intensity.
- Antialiasing automatically adjusts for these intensity differences.

Antialiasing Area Boundaries

- All that we have said for lines applies to area boundaries.
- Supersampling or overlap area estimation works the best.
- Care needs to be taken if polygons are small enough that more than one edge passes through a pixel.

Next Lecture

OpenGL™ and the GL pipeline