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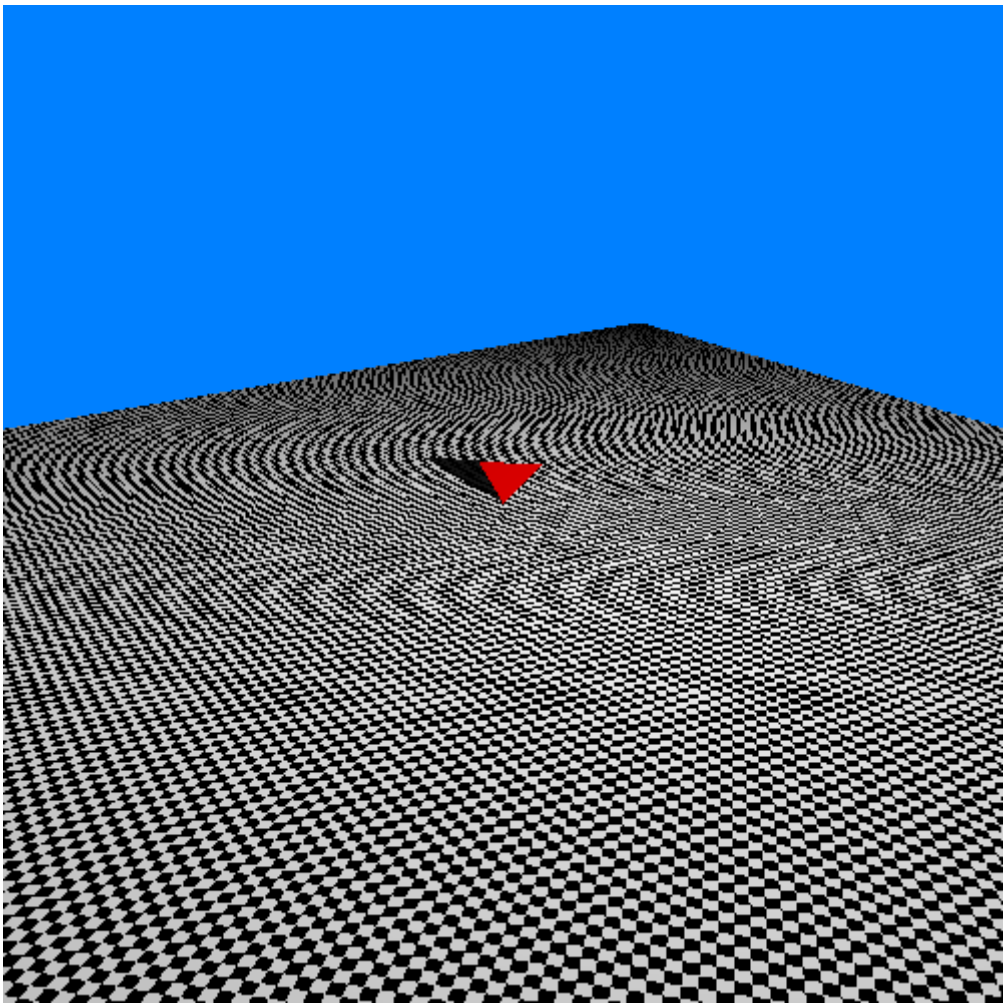
Advanced Graphics Practical 2:

Anti-Aliasing Experiments

Boxfilter

No Anti-Aliasing



In this image there are plenty of aliasing artifacts to be observed.

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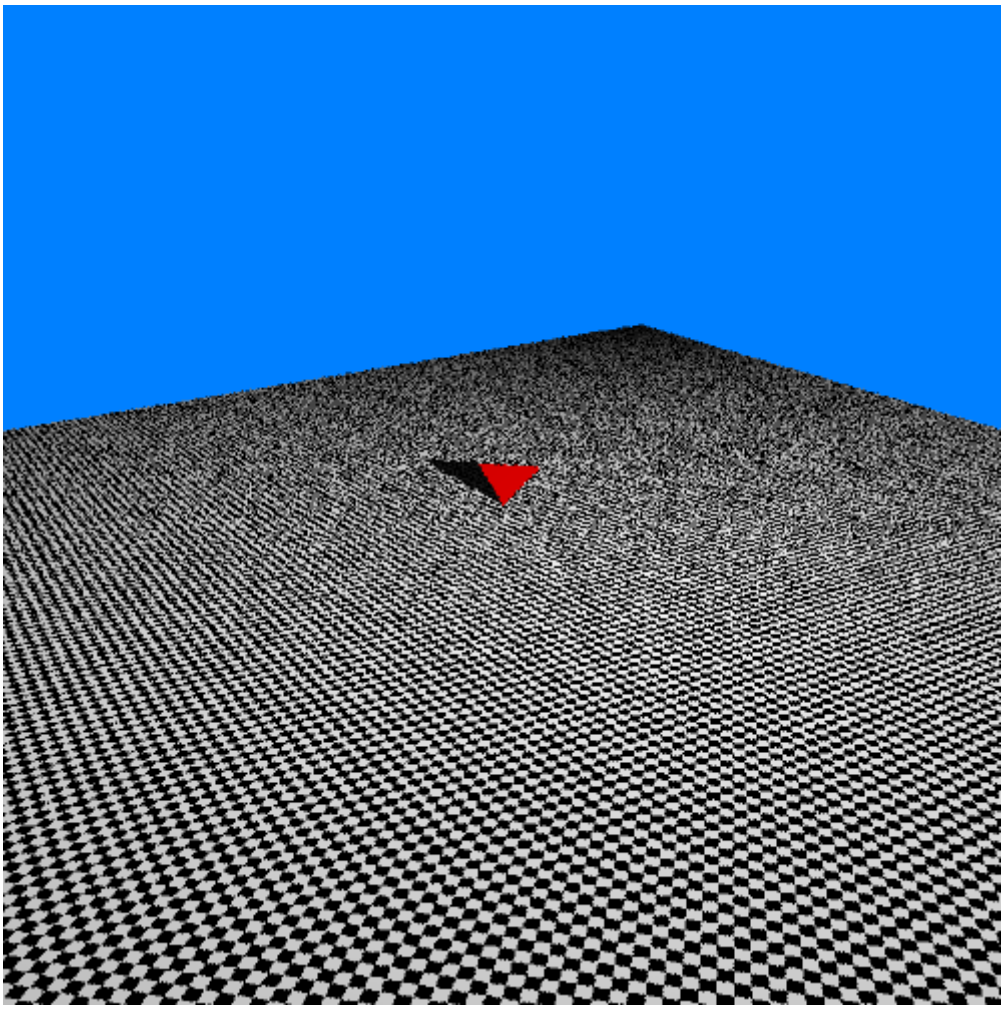
Boxfilter Anti-Aliasing 2 samples



After having augmented our raytracer to shoot multiple rays we generated this image. The raytracer samples each pixel twice and averages the results. We can see that the artifacts are immediately far less pronounced and the checkboard pattern looks much better.

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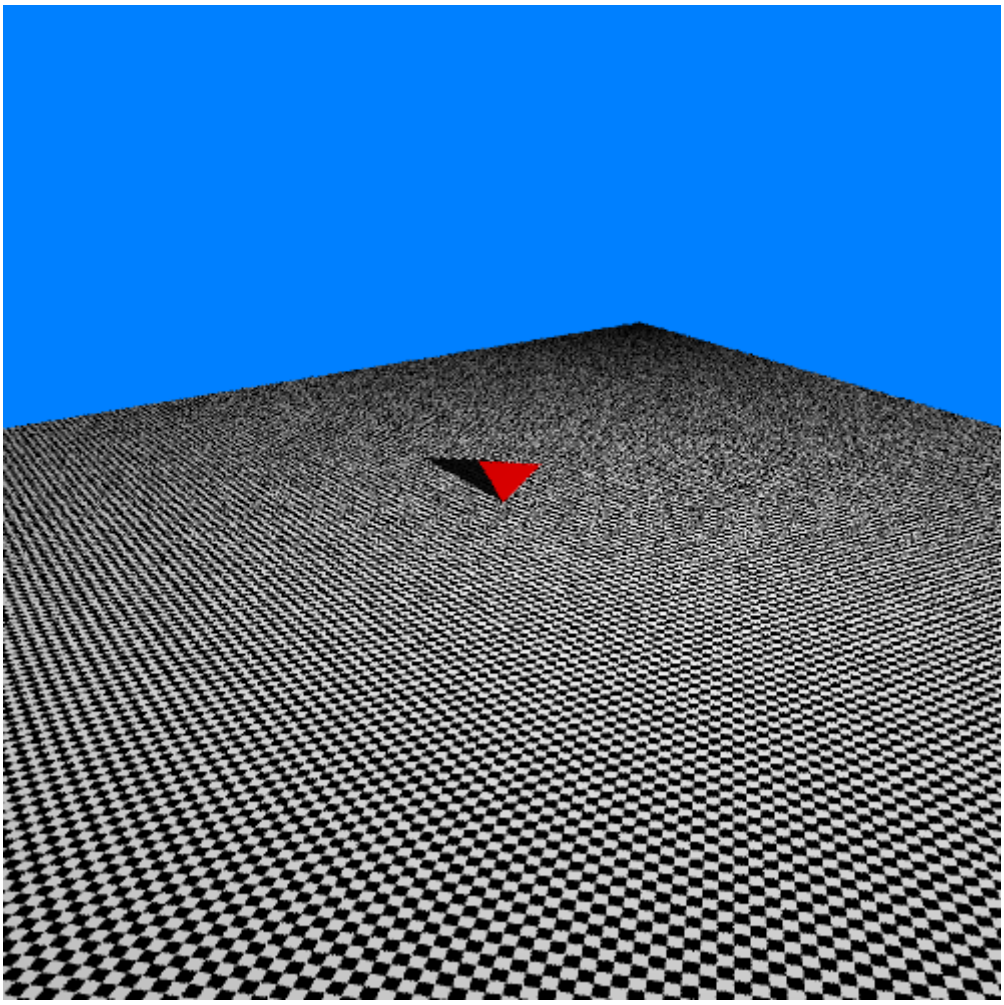
Boxfilter Anti-Aliasing 4 samples



In this image the raytracer samples each pixel 4 times and averages the result. With the increased amount of samples the aliasing artifacts are reduced even further and the image is more accurate than before. The checkerboard pattern is distinguishable for a much larger area then before.

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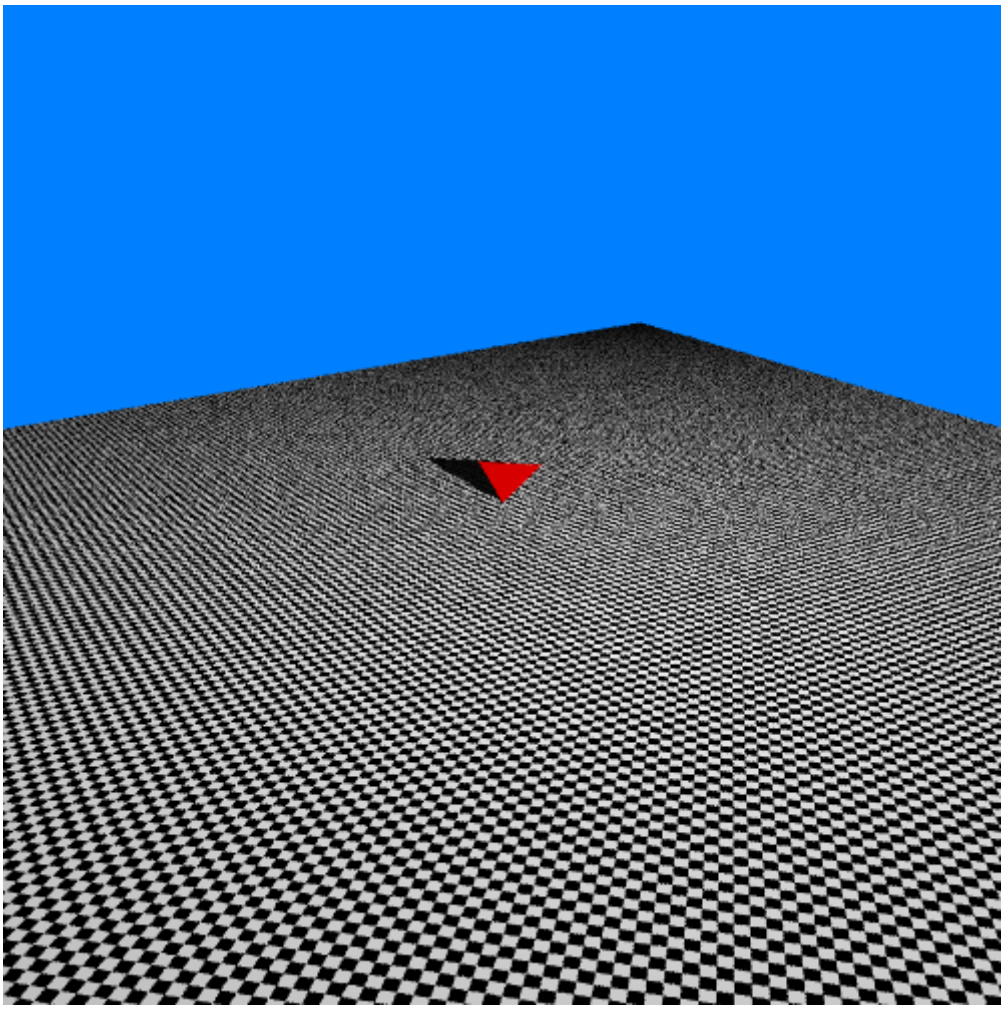
Boxfilter Anti-Aliasing 8 samples



After bumping the number of samples up to 8 per pixel the checkerboard pattern looks good in most places. The aliasing artifacts are difficult to spot, but they definitely still exist. Especially the curves in the checkerboard pattern are still noticeable. The computation time has, as expected, increased significantly.

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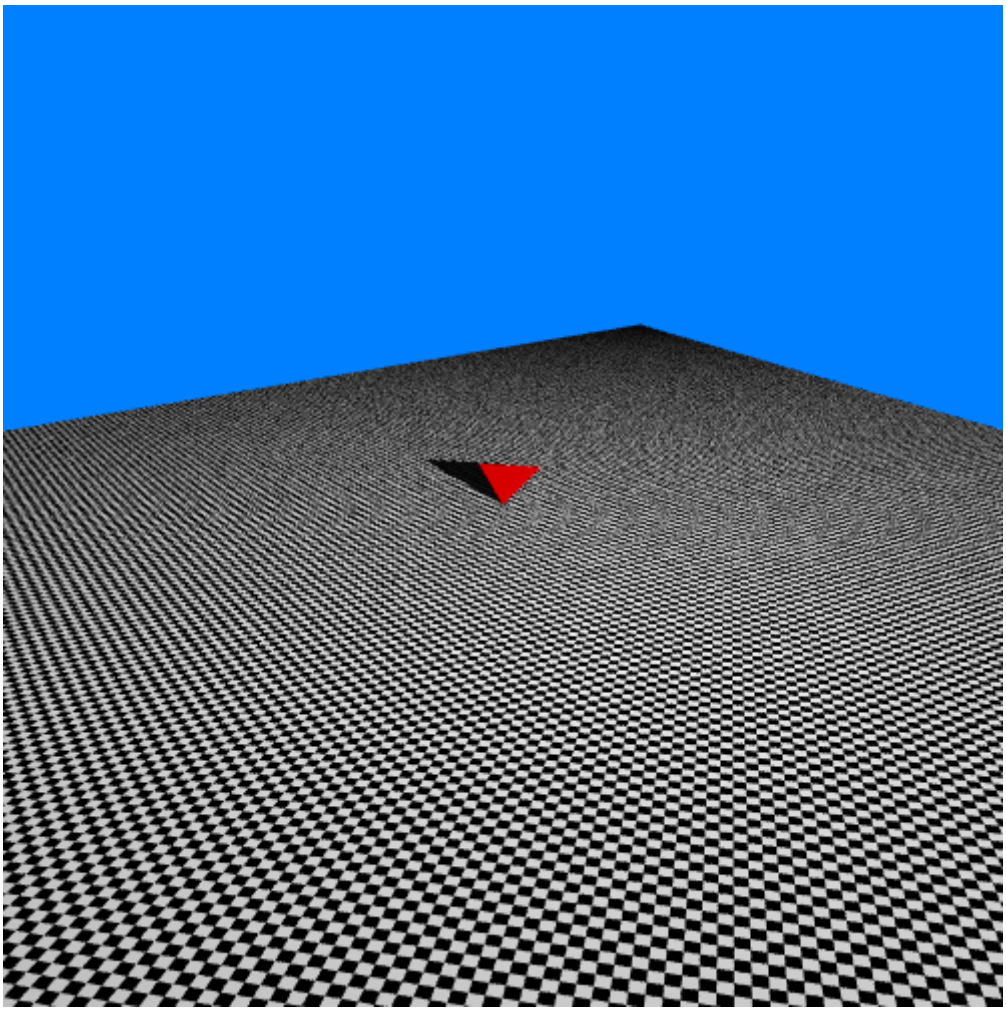
Boxfilter Anti-Aliasing 16 samples



The differences between this image with 16 samples per pixel and the previous 8 samples per pixel are difficult to spot. Most of the checkerboard pattern is once again distinguishable and the sharpness of the image has increased. The aliasing artefacts that we could find in the previous image (curvature of the checkerboard pattern) are still present though, and the computation time is now very long.

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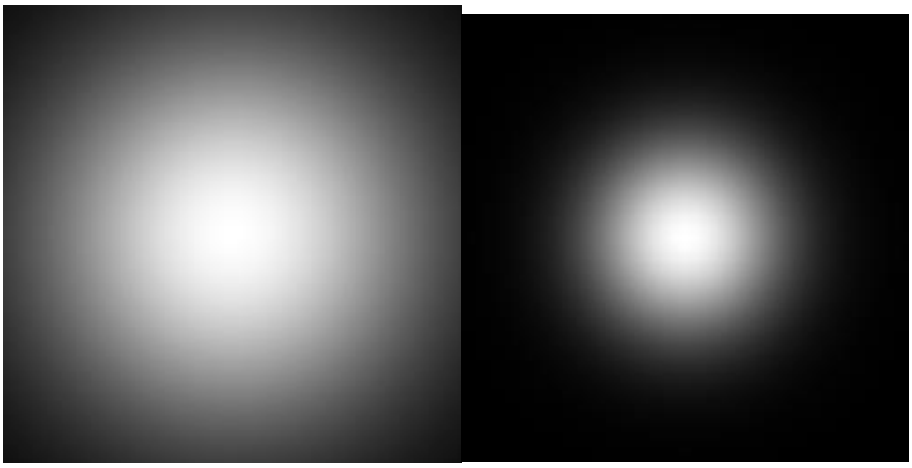
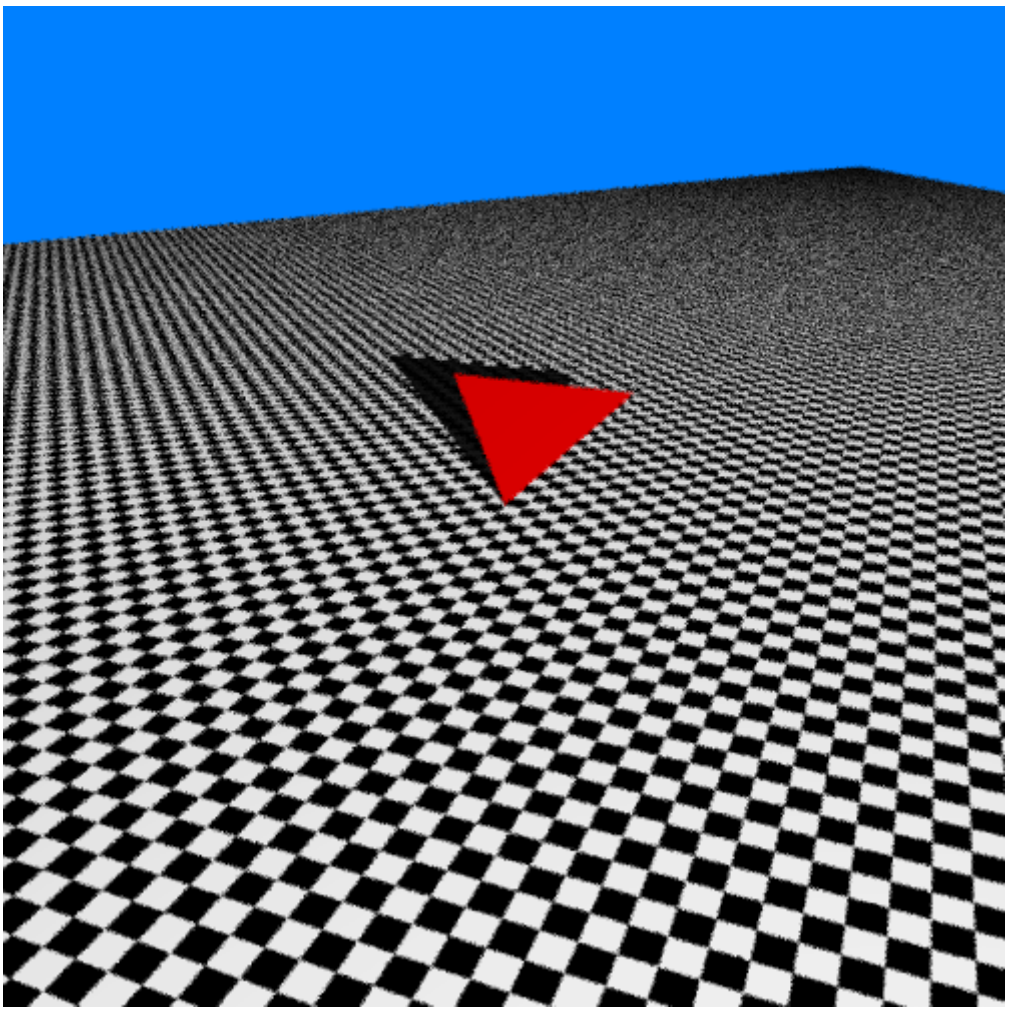
Gaussian Weighting

After some experimentation with the value for σ we settled on two Gaussians with a σ of 0.3 and 0.1 respectively. We found that these gave the best looking results as a smaller value did not reduce the artefacts to an acceptable level and a larger value caused too much blur, making the checkerboard pattern difficult to distinguish.



σ=0.3 σ=0.1

No Anti-Aliasing



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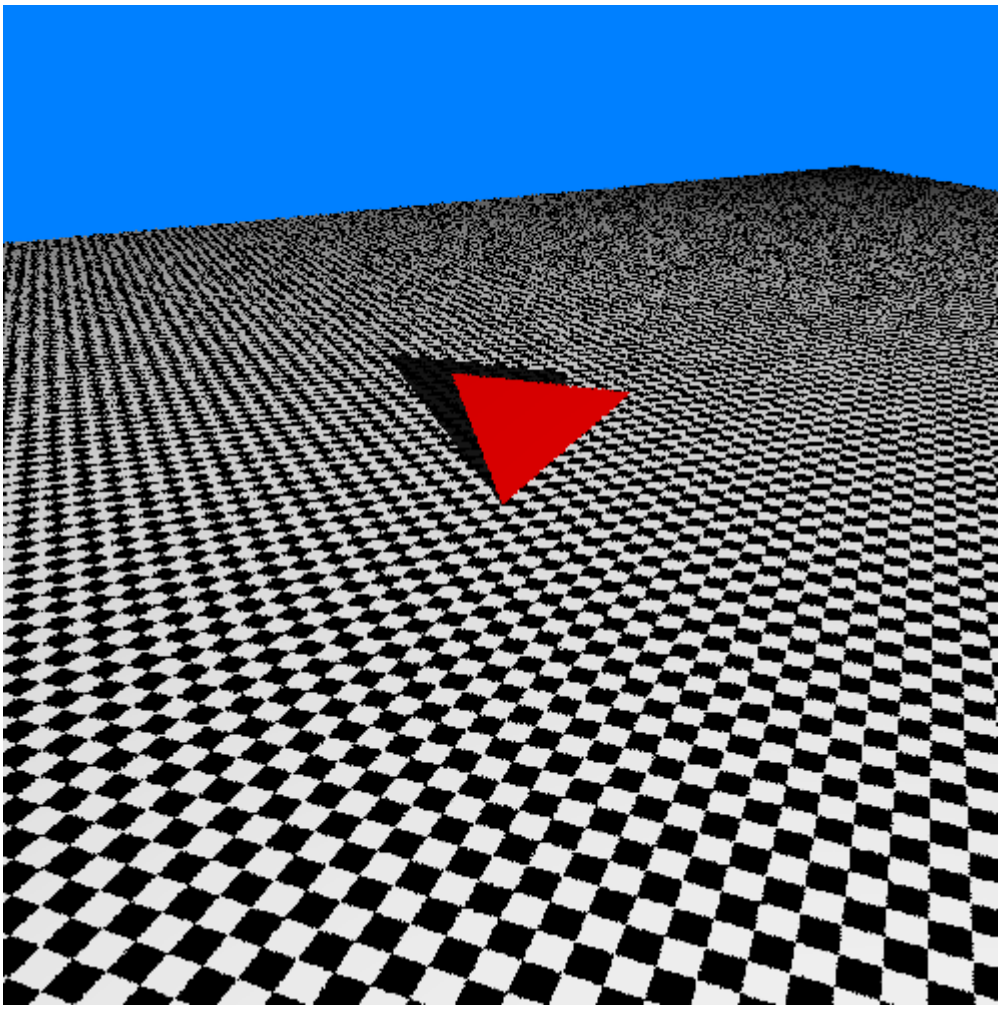
Gaussian Weighting, σ=0.1, 8 samples



In this image the σ is set to 0.1 and the each pixel area is sampled 8 times. It does a good job at removing the aliasing artefacts and the checkerboard pattern is no longer regularly distorted by curves, as it remained with the box filter even when the sampling density was greatly increased, however there are still some small curves visible. The image sharpness also suffers due to the blur effect that is caused by the Gaussian, making the image seem of lower quality.

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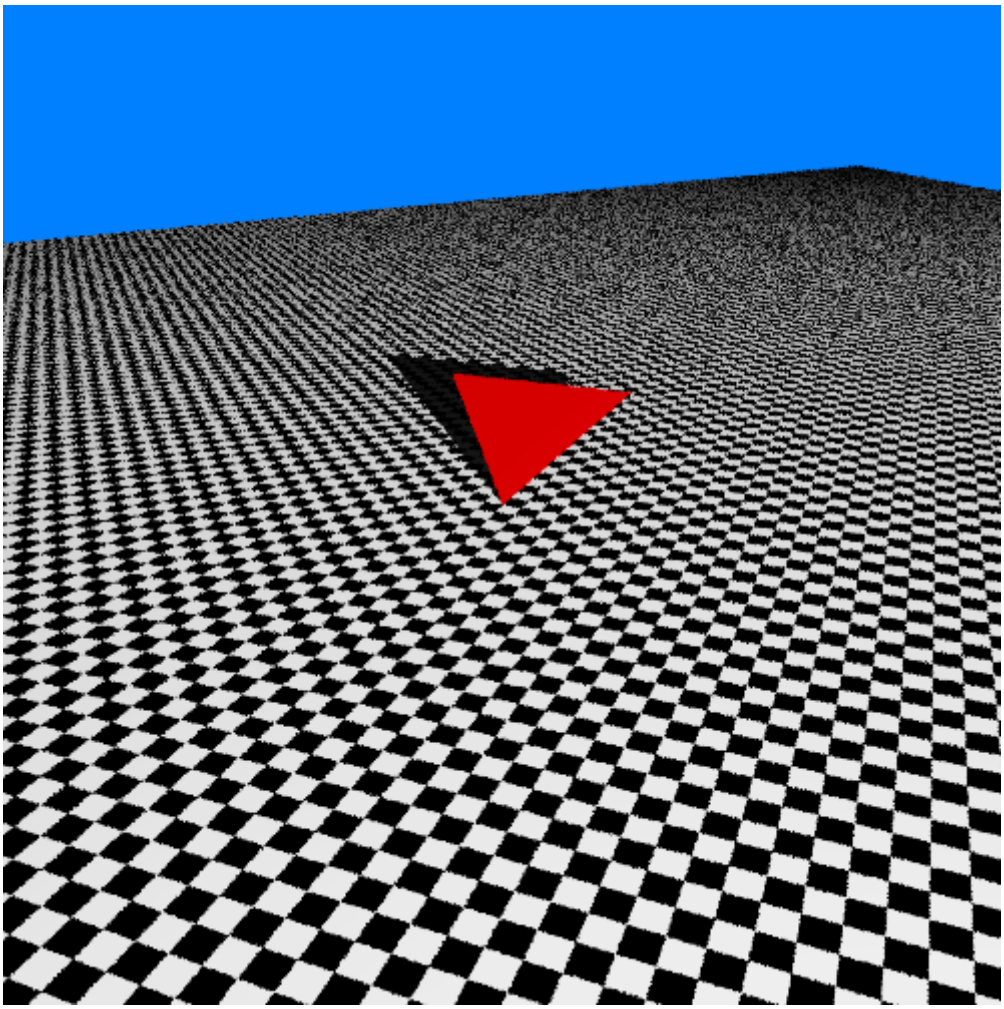
Gaussian Weighting, σ=0.3, 8 samples



In this image the σ value has been increased to 0.3 which does a better job at removing the aliasing artefacts and they are rather difficult to spot. The image sharpness still suffers but overall this image is an improvement over the previous one.

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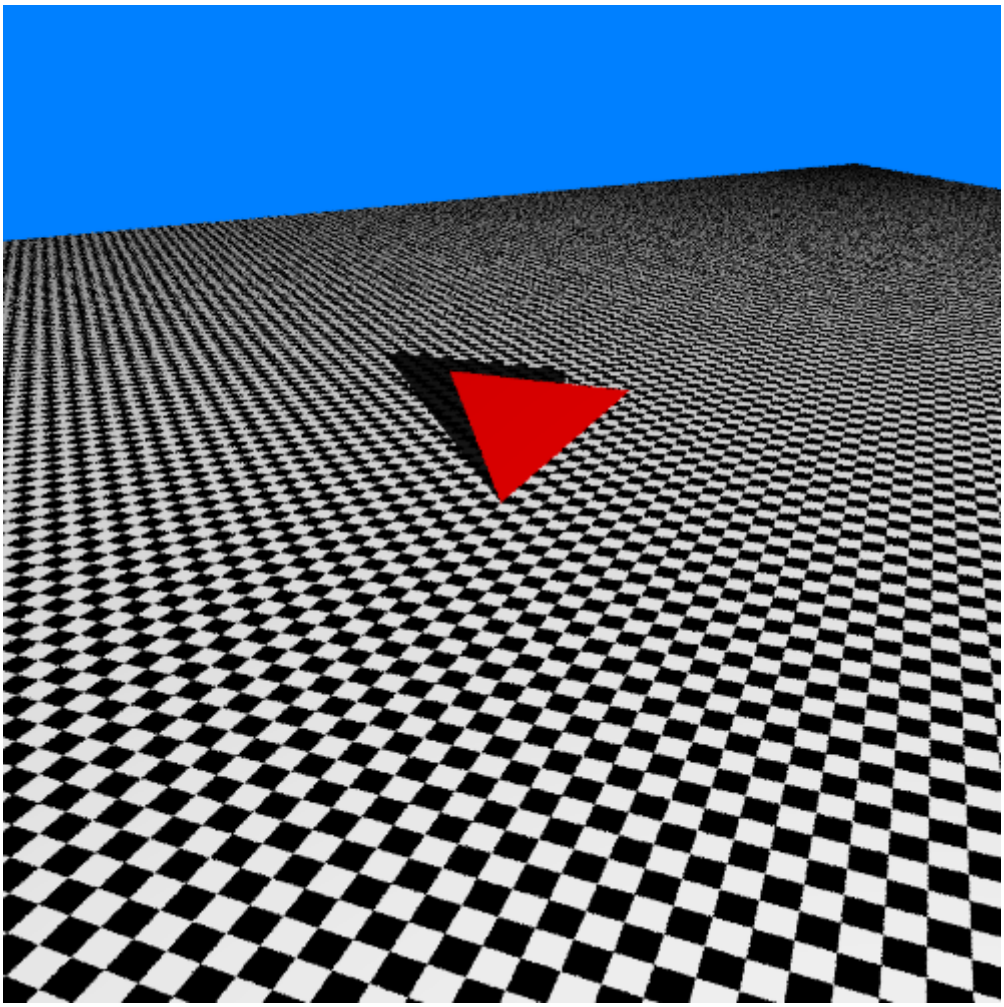
Gaussian Weighting, σ=0.3, 16 samples



The image utilizes the same σ value of 0.3 but has 16 samples are taken per pixel. This image, similarly to the boxfilter 16 samples per pixel image, had a greatly increased computation time. The benefits of the increased samples are noticeable this time around as this image maintains much more sharpness while still containing very few artifacts.

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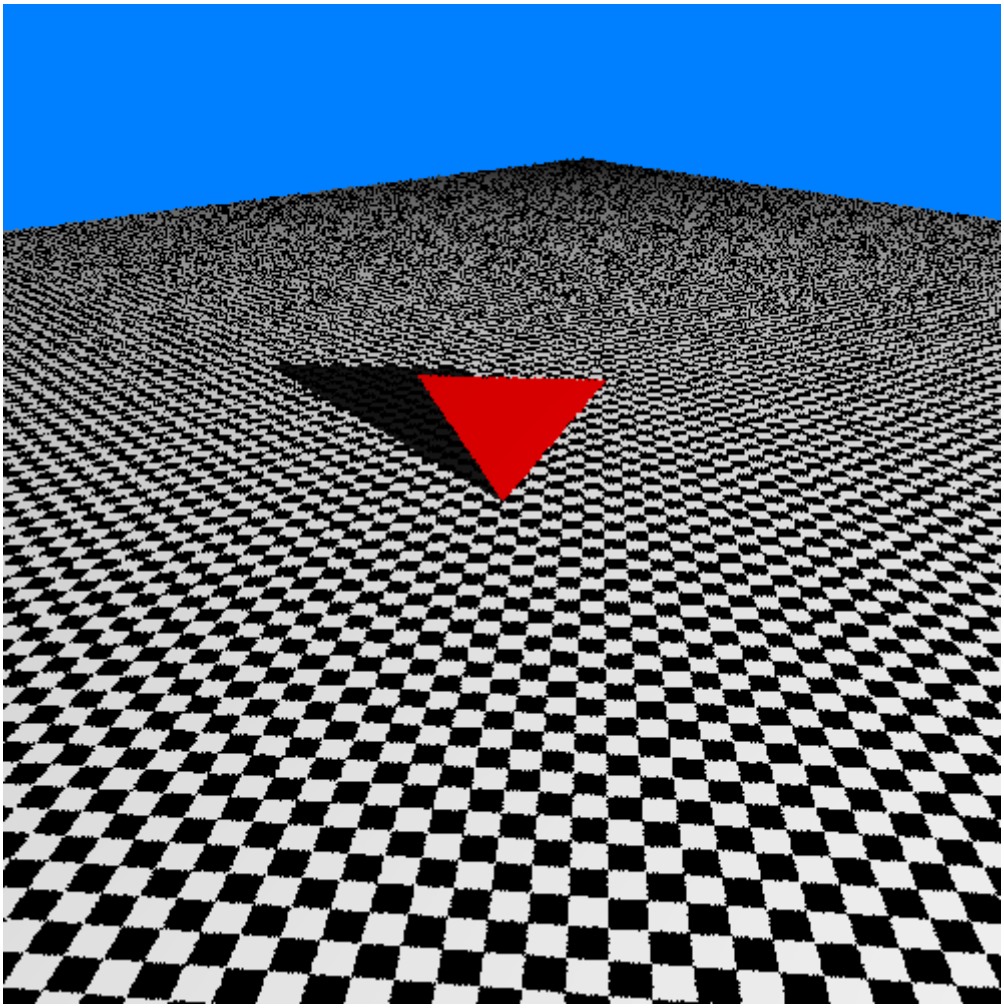
Stratification (Jittered Grid)

As expected the increase in grid size increases the quality of the image and makes the checkerboard pattern more distinguishable for more of the covered area.

From the experimentation with subdividing pixels on a regular grid with and without jitter we noticed that jittering greatly reduces the visibility of the artefacts. We have included an image of the 3x3 and 4x4 grids with and without jitter to demonstrate this.

1x1 Grid with jitter



With a 1x1 jittered grid the image does not look very good.

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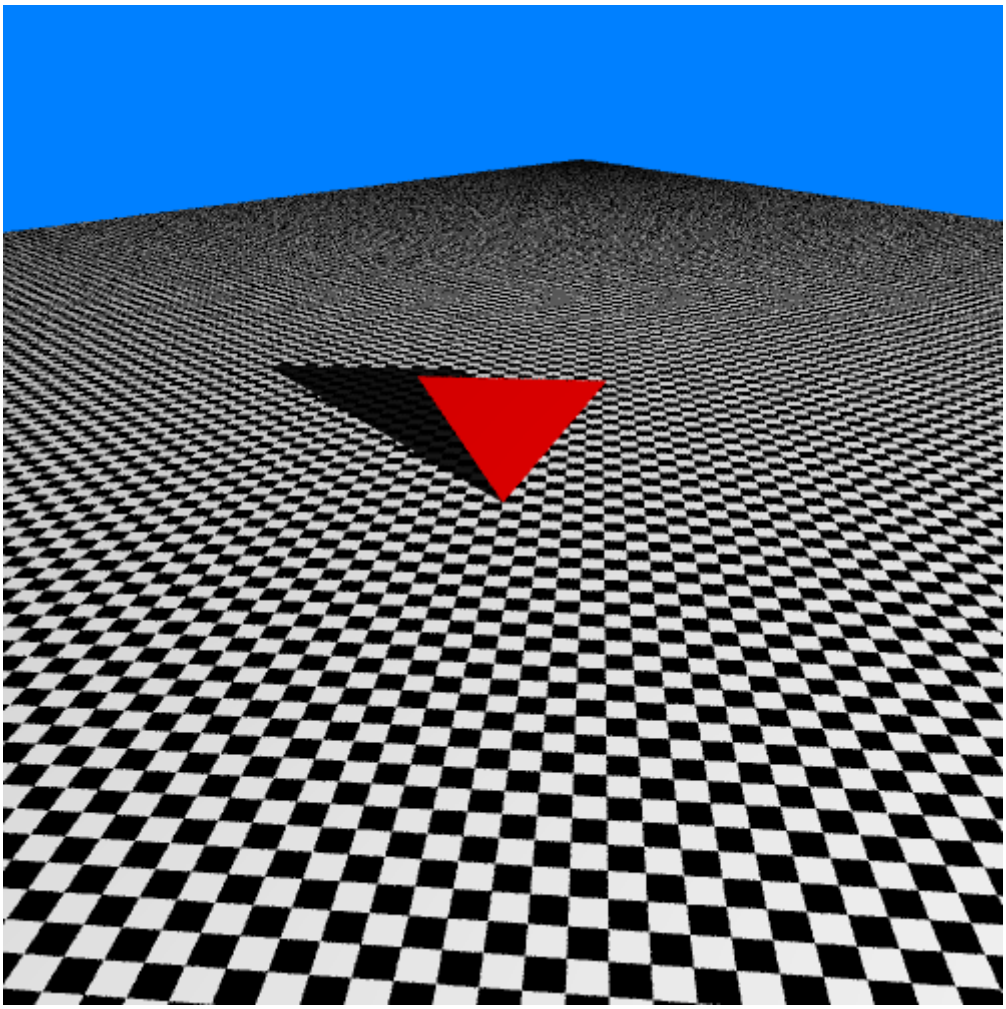
2x2 Grid with jitter



A 2x2 jittered grid is a great improvement. The checkerboard pattern is looking rather good, but there are still plenty of noticeable artifacts.

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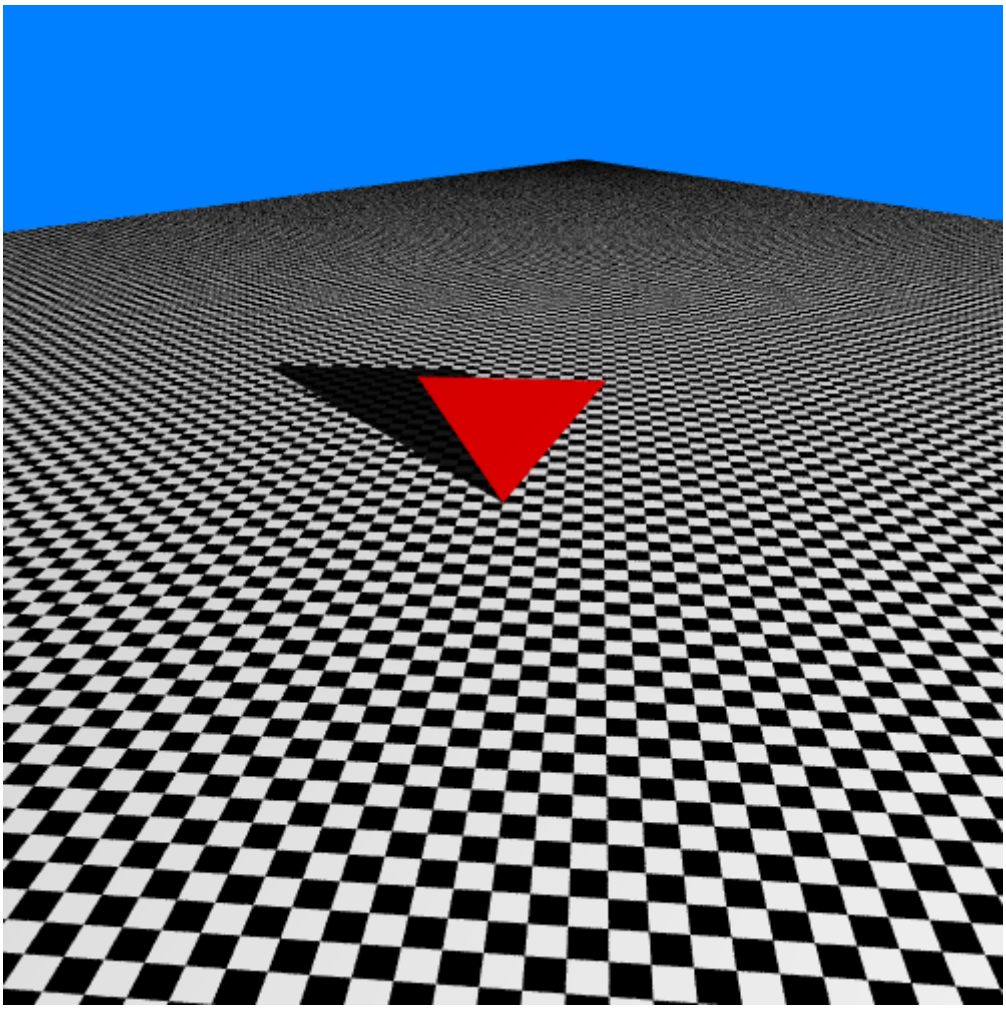
3x3 Grid with jitter



The 3x3 jittered grid looks quite nice and unlike the Gaussian images this one does not lose sharpness, causing the image to seem of higher quality than the Gaussian ones. The image does contain more noticeable artifacts then the Gaussian ones.

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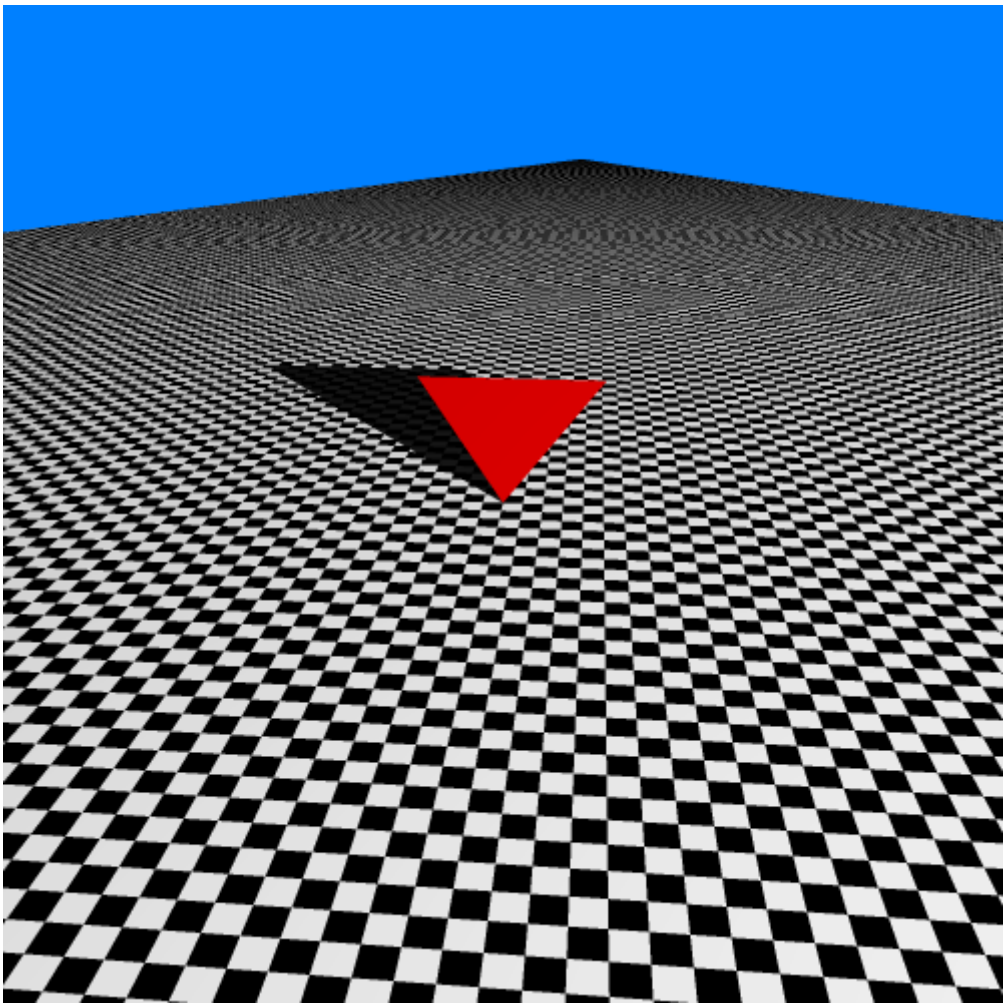
3x3 Grid no jitter



Without the jitter the artifacts are far more pronounced and are difficult to miss.

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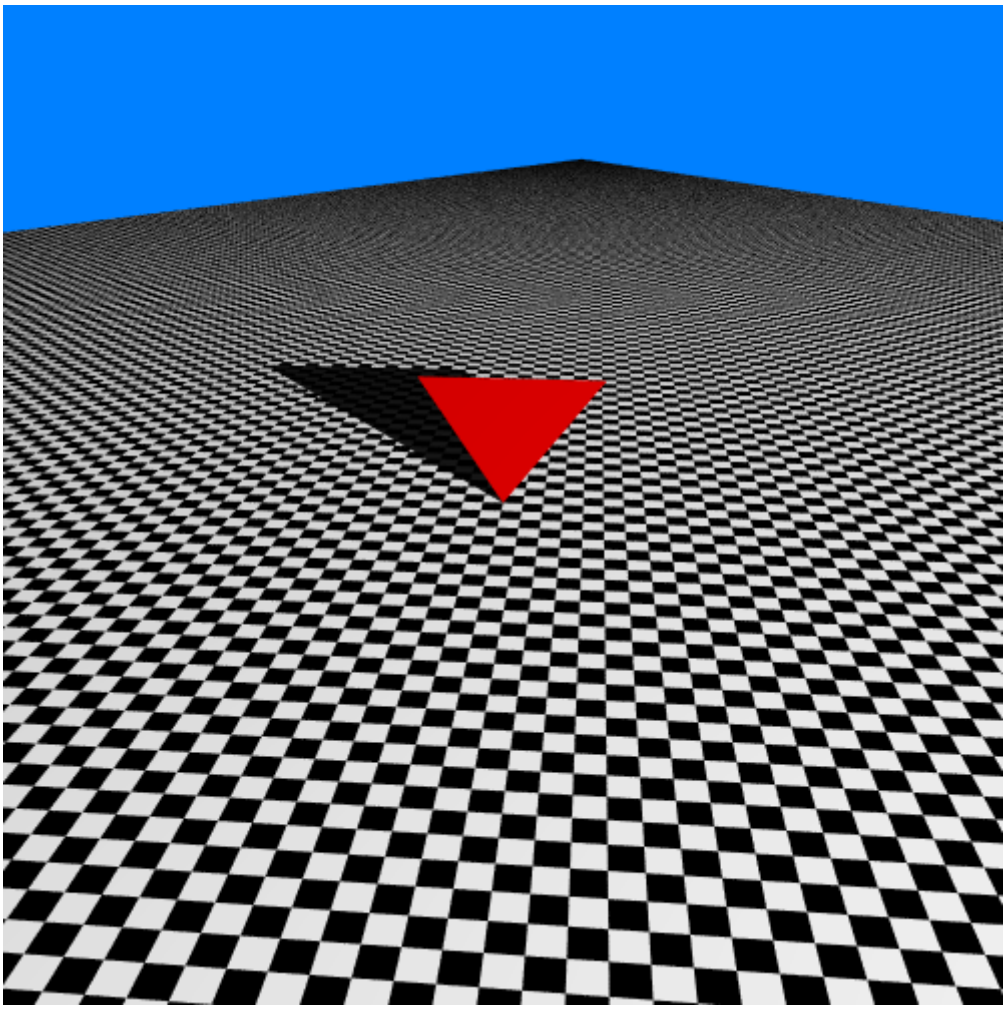
4x4 Grid with jitter



The larger grid size of 4x4 produces a very nice looking image but the artifacts are not reduced by the increase in grid size.

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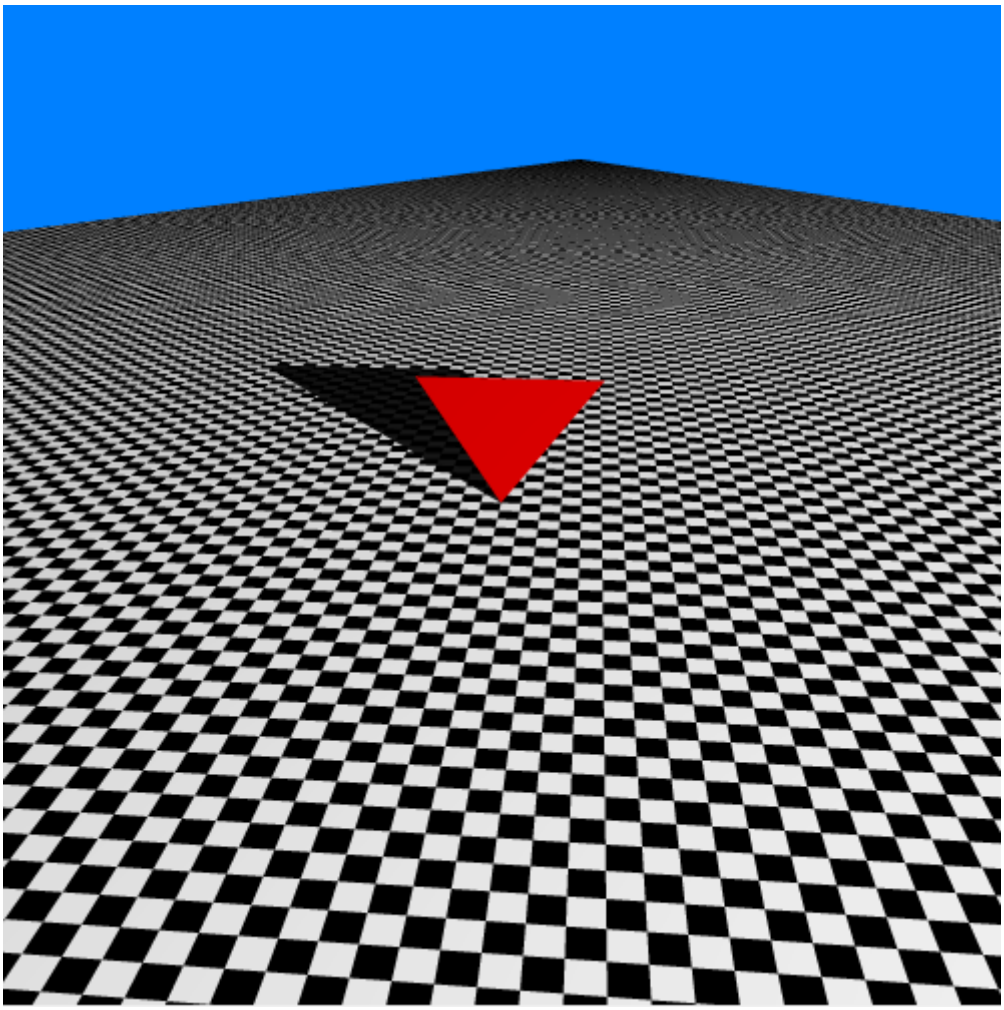
4x4 Grid no jitter



The lack of jitter again makes the artifacts very noticeable.

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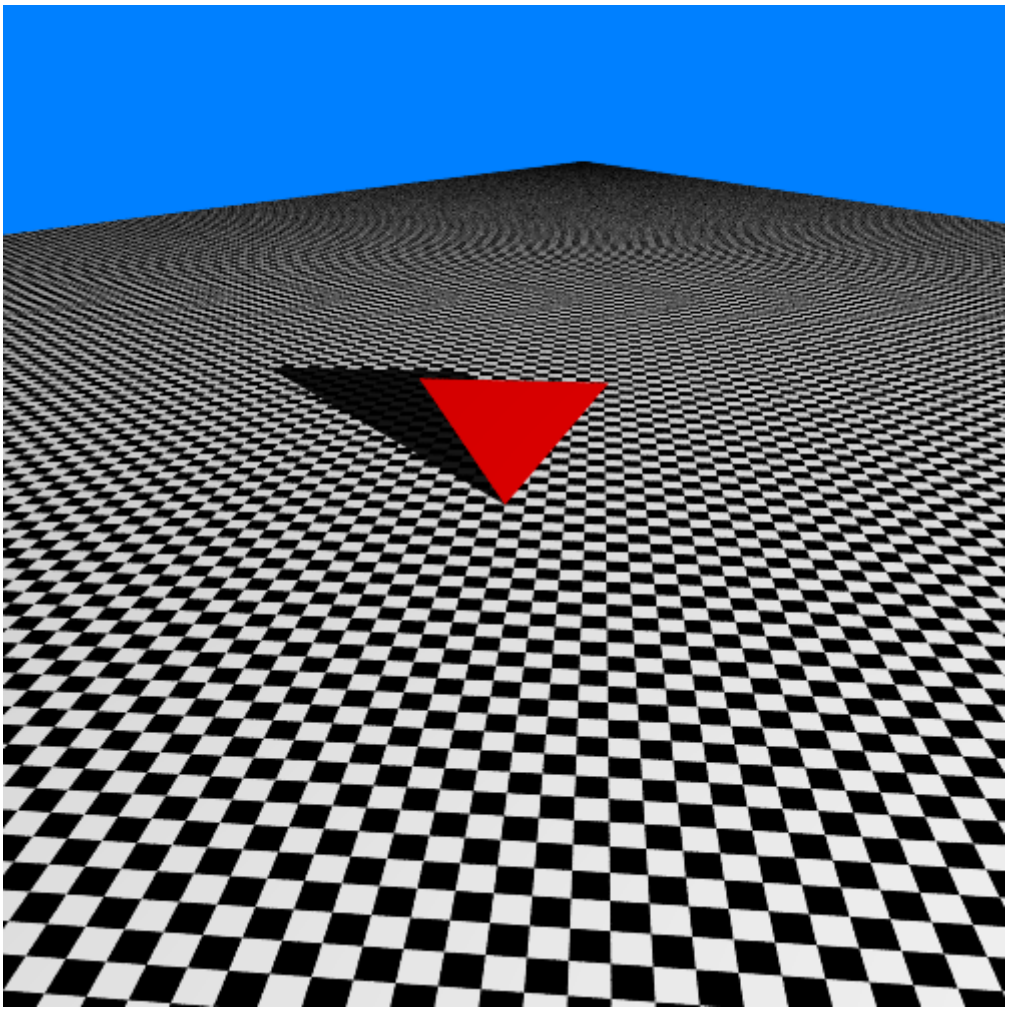
4x4 Grid with jitter and Gaussian



We tried an image where we turned both the jittered grid and the Gaussian weighting on. While the parts of the checkerboard close to the camera look very nice the further away parts show some very interesting looking curvy artefacts.