Assignment 7: Supersampling and Antialiasing

1 代码实现

1.1 Sampler类

```
class Sampler
{
public:
    Sampler(int n) :n(n) {}

    virtual Vec2f getSamplePosition(int i) = 0;


protected:
    int n;
};
```

RandomSampler

```
class RandomSampler :public Sampler
{
public:
    RandomSampler(int i):Sampler(n)
    {
        srand((unsigned int)(time(NULL)));
    }
    virtual Vec2f getSamplePosition(int i)
    {
        return Vec2f((float)rand() / (float)RAND_MAX, (float)rand() /
(float)RAND_MAX);
    }


};
```

UniformSampler

```
class UniformSampler : public Sampler
{
public:

    UniformSampler(int n) :Sampler(n)
    {
        axisN = sqrtf(n);
        step = 1.0 / (float)axisN;
        offset = step / 2.0;
    }
    virtual Vec2f getSamplePosition(int i)
    {
        assert(i < n);
        int x = i % axisN;
        int y = i / axisN;
        return Vec2f(offset + x * step, offset + y * step);
    }


private:
    int axisN;
    float step;
    float offset;
};
```

JitteredSampler

```
class JitteredSampler: public Sampler
{

public:

    JitteredSampler(int n) :Sampler(n)
    {
        srand((unsigned int)(time(NULL)));
        axisN = sqrtf(n);
        step = 1.0 / (float)axisN;
        offset = step / 2;
    }
    virtual Vec2f getSamplePosition(int i)
    {
        assert(i < n);
        int x = i % axisN;
        int y = i / axisN;
        Vec2f center(x * step, y * step);
        Vec2f random((float)rand() / (float)RAND_MAX * step, (float)rand() /
(float)RAND_MAX * step);
        return Vec2f(center.x()+random.x(),center.y()+random.y());
    }

private:
    int axisN;
    float step;
    float offset;
};
```

1.2 Filter类

注意边界时采样不能越界

```
class Filter
{

public:
    Filter(){}

    Vec3f getColor(int x, int y, Film* film)
    {
        int supportRadius=getSupportRadius();
        int numSamples = film->getNumSamples();
        int width = film->getWidth();
        int height = film->getHeight();
        float totalWeight = 0;
        Vec3f color;
        for (int i = x - supportRadius; i<= x + supportRadius; i++)
        {
            if (i < 0)
            {
                continue;
            }
            else if (i >= width)
            {
                break;
            }
            for (int j = y - supportRadius; j <= y + supportRadius; j++)
            {
                if (j < 0)
                {
                    continue;
                }
                else if(j>=height)
                {
                    break;
                }
                for (int k = 0; k < numSamples; k++)
                {
                    Sample sample=film->getSample(i, j, k);
                    Vec2f samplePosition(i+
sample.getPosition().x(),j+sample.getPosition().y());
                    float xoffset = samplePosition.x() - x - 0.5;
                    float yoffset = samplePosition.y() - y - 0.5;
                    float weight = getWeight(xoffset, yoffset);
                    color+=sample.getColor() * weight;
                    totalWeight += weight;
                }
            }
        }

        return color*(1.0/totalWeight);
    }


    virtual float getWeight(float x, float y) = 0;
    virtual int getSupportRadius() = 0;

private:
};
```

BoxFilter

```
class BoxFilter : public Filter
{
public:
    BoxFilter(float radius) :radius(radius)
    {

    }

    virtual float getWeight(float x, float y)
    {
        if (fabs(x) > radius || fabs(y) > radius)
        {
            return 0;
        }
        else
        {
            return 1;
        }
    }
    virtual int getSupportRadius()
    {
        return ceil(radius-0.5);
    }

private:
    float radius;
};

class TentFilter : public Filter
{

public:
    TentFilter(float radius) :radius(radius)
    {

    }
    virtual float getWeight(float x, float y)
    {
        Vec2f vec(fabs(x),fabs(y));
        return fmax(0 , 1.0 -vec.Length() / radius);
    }
    virtual int getSupportRadius()
    {
        return ceil(radius - 0.5);
    }


private:
    float radius;

};
```

GaussianFilter

```
class GaussianFilter :public Filter
{

public:
    GaussianFilter(float sigma) :sigma(sigma)
    {
    }
    virtual float getWeight(float x, float y)
    {
        Vec2f vec(fabs(x), fabs(y));
        float d = vec.Length();

        return exp(-powf(d, 2) / (2 * powf(sigma, 2)));
    }
    virtual int getSupportRadius()
    {
        return ceil(2*sigma - 0.5);
    }

private:
    float sigma;
};
```

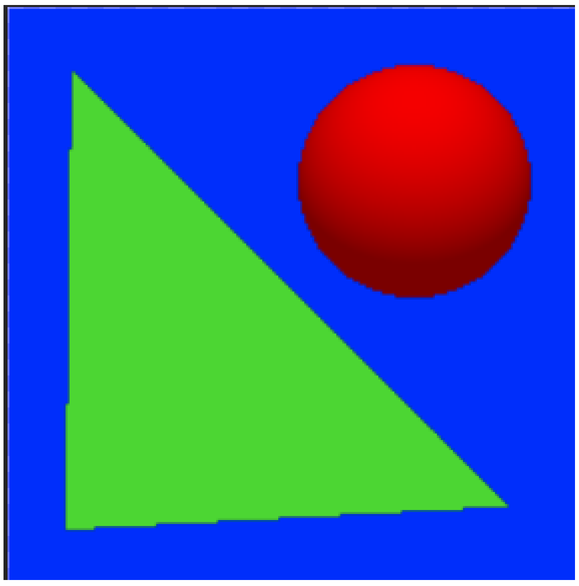
1.3 修改RayTracer

修改RayCast流程以使用Sampler和Filter

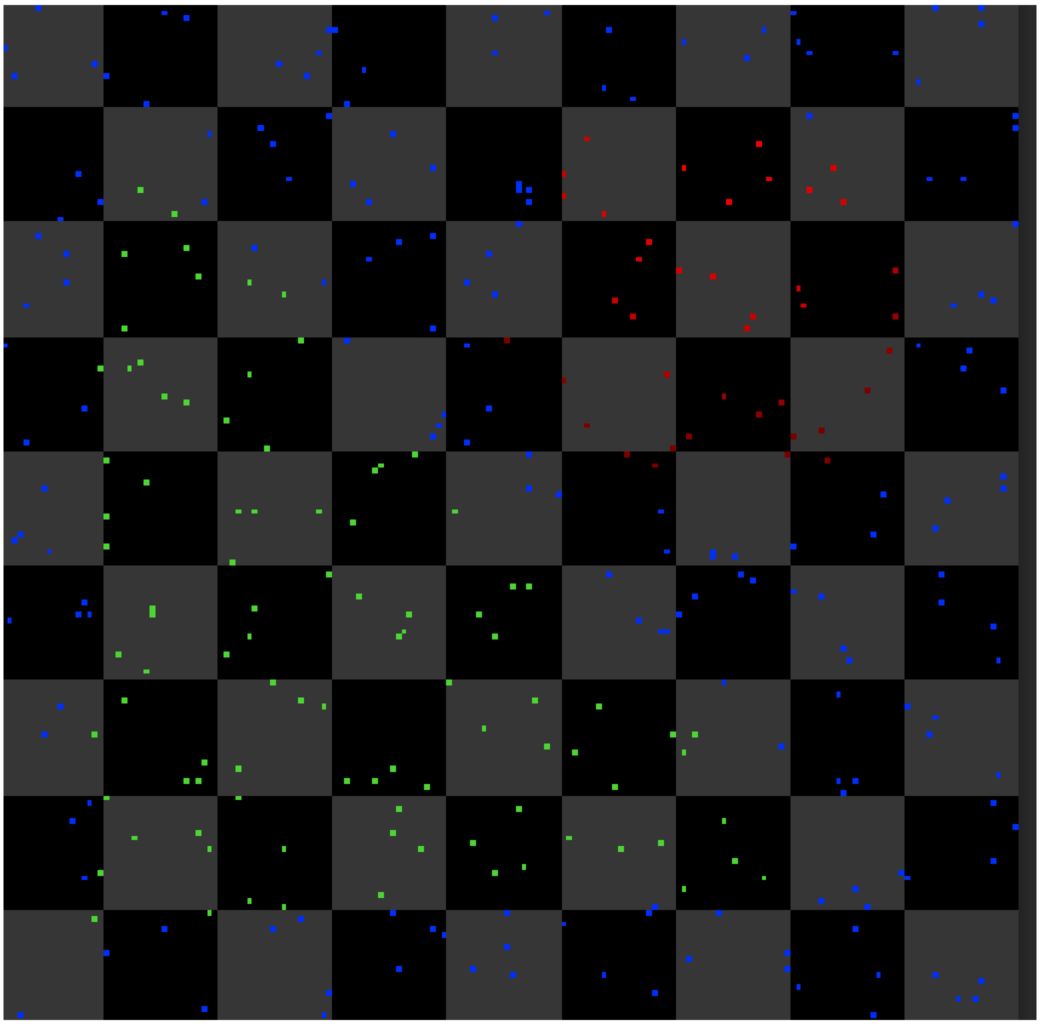
```
    //Assignment7
    void RayCastSample(char* outputFile)
    {
        Image outputImage(width, height);
        int xoffset = 0;
        int yoffset = 0;

        //deal with width!=height
        yoffset =max( 0, (squareLength - height) / 2);
        xoffset =max(0, (squareLength - width) / 2);
        for (int i = 0; i < width * height; i++)
        {
            int x = i % width;
            int y = i / width;
            int xrayIndex = x + xoffset;
            int yrayIndex = y + yoffset;

            //sampling
            for (int s = 0; s < numSamples; s++)
            {
                Vec2f sampleOffset=sampler->getSamplePosition(s);

                Hit hit;
                Ray ray = generateRayAtIndexWithOffset(xrayIndex, yrayIndex, 
sampleOffset);

                Vec3f color = (this->*tracerayFunction)(ray, scene->getCamera()-
>getTMin(), 0, 1, VACUUM_REFRACTION_INDEX, hit);
                //cout << "color: " << color<<endl;
                film->setSample(x, y, s, sampleOffset, color);
            }
        }

        for (int i = 0; i < width * height; i++)
        {
            int x = i % width;
            int y = i / width;
            outputImage.SetPixel(x,y,filter->getColor(x, y, film));
        }
        if(outputFile!=NULL)
            outputImage.SaveTGA(outputFile);
    }
```

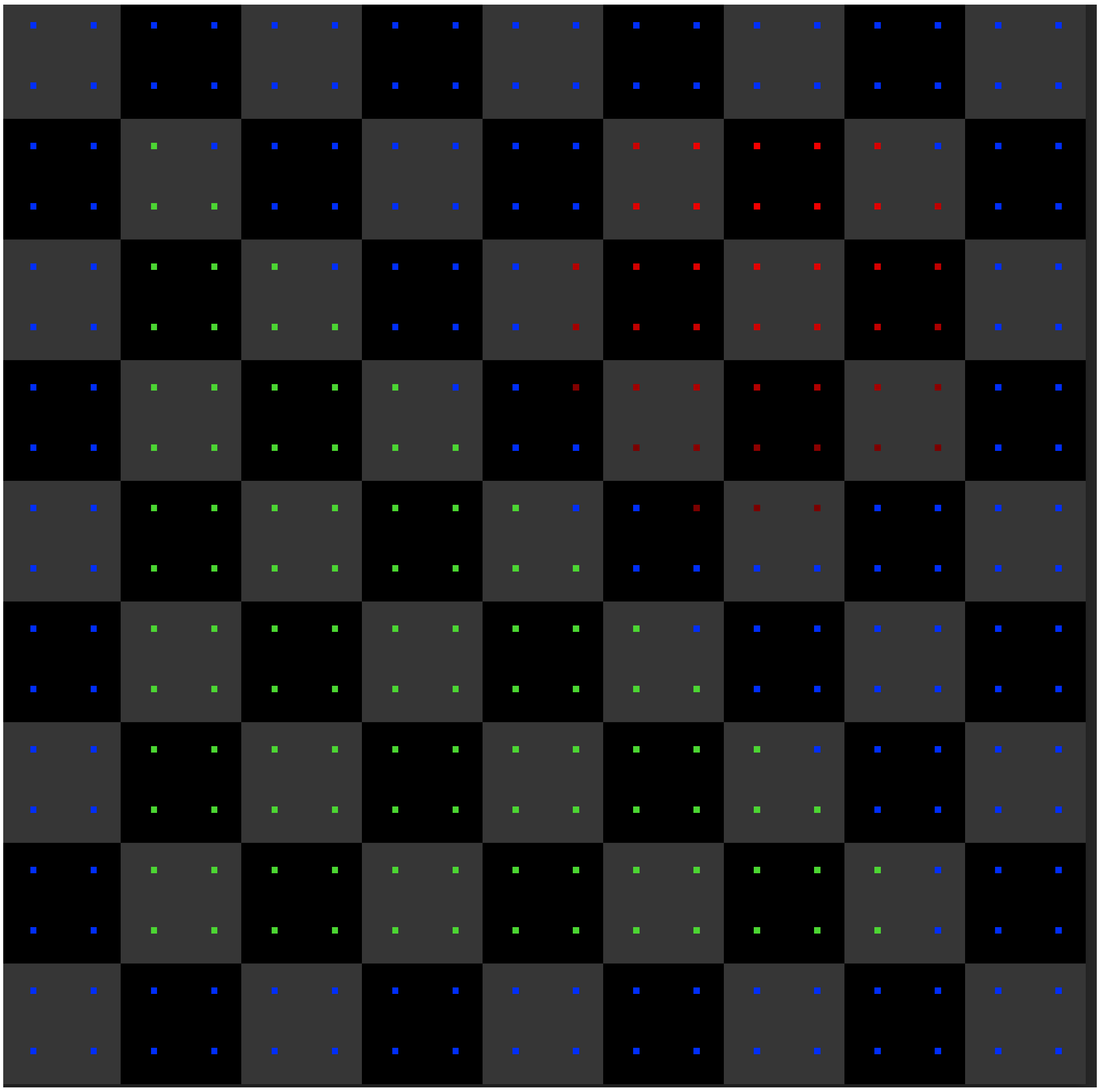
2 实验结果

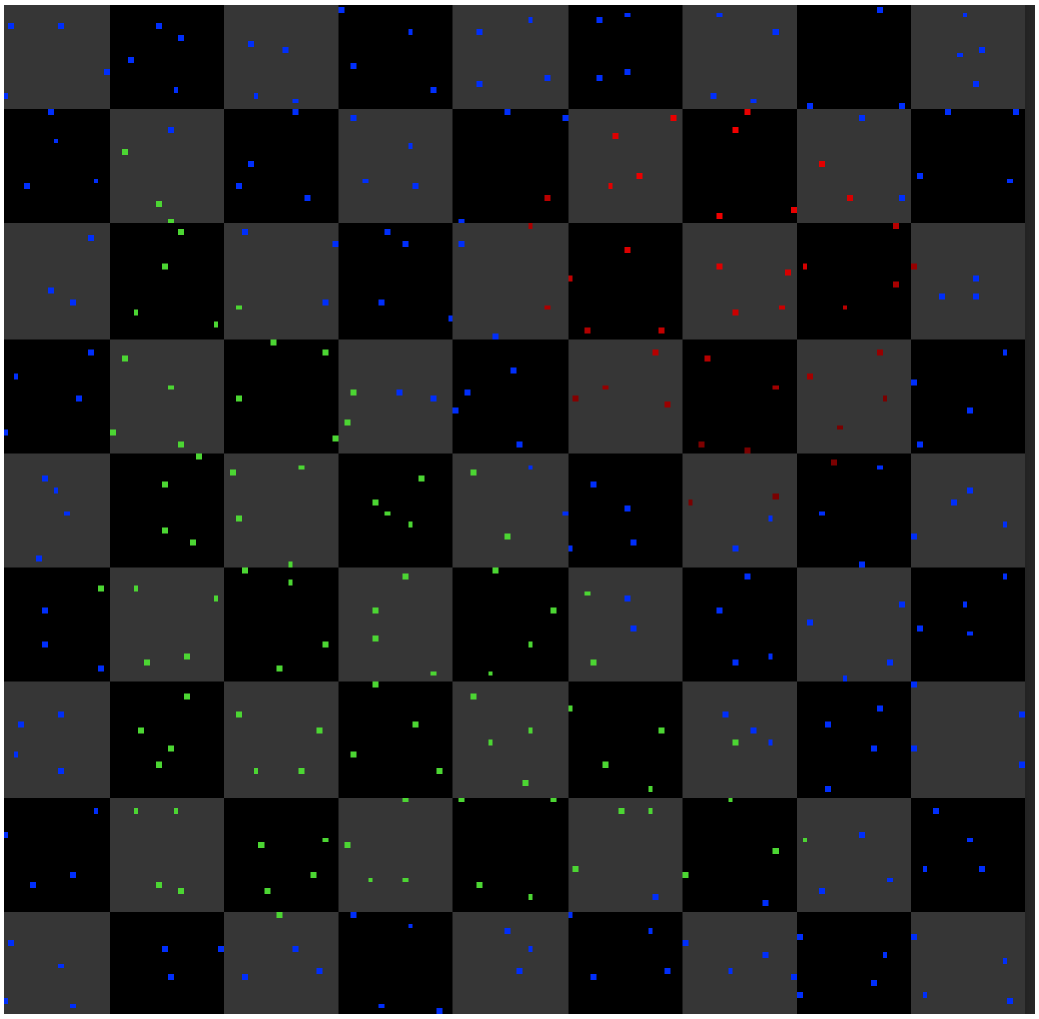
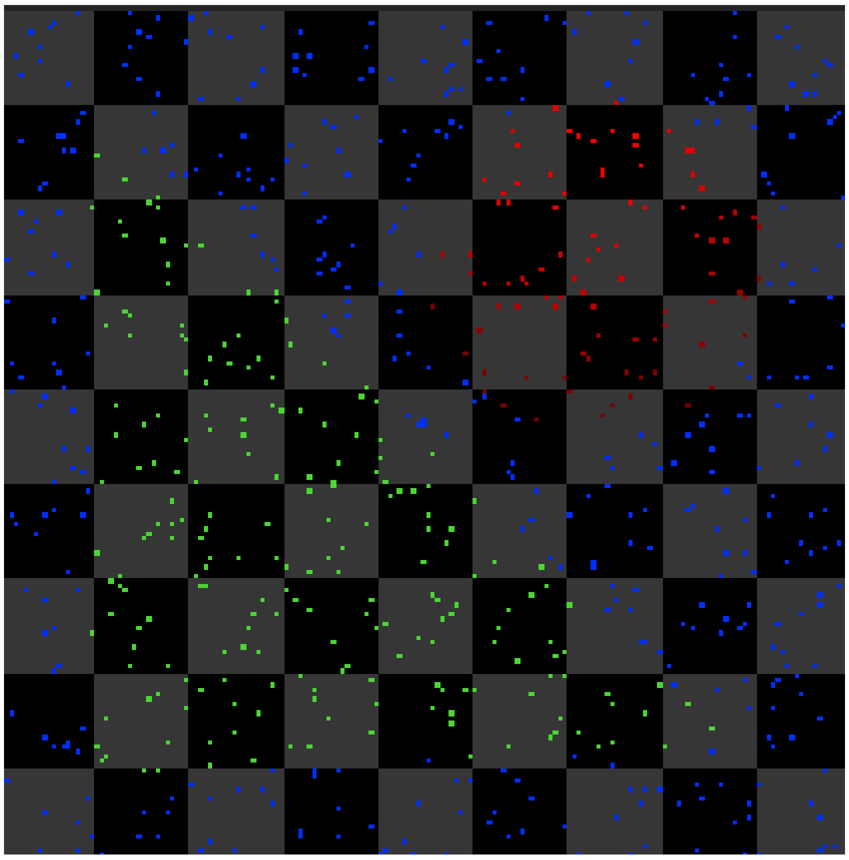
```
raytracer -input scene7_01_sphere_triangle.txt -size 180 180 -output 
output7_01.tga
```

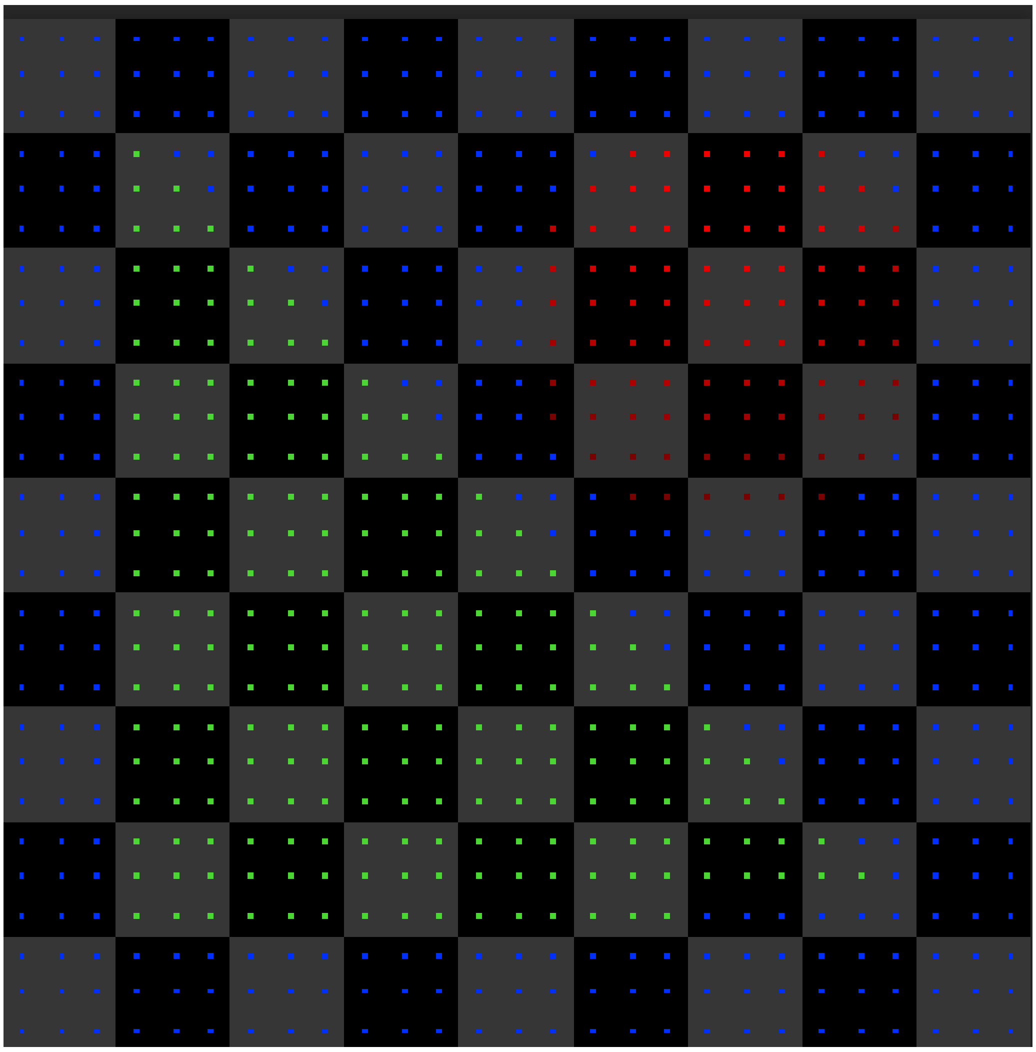


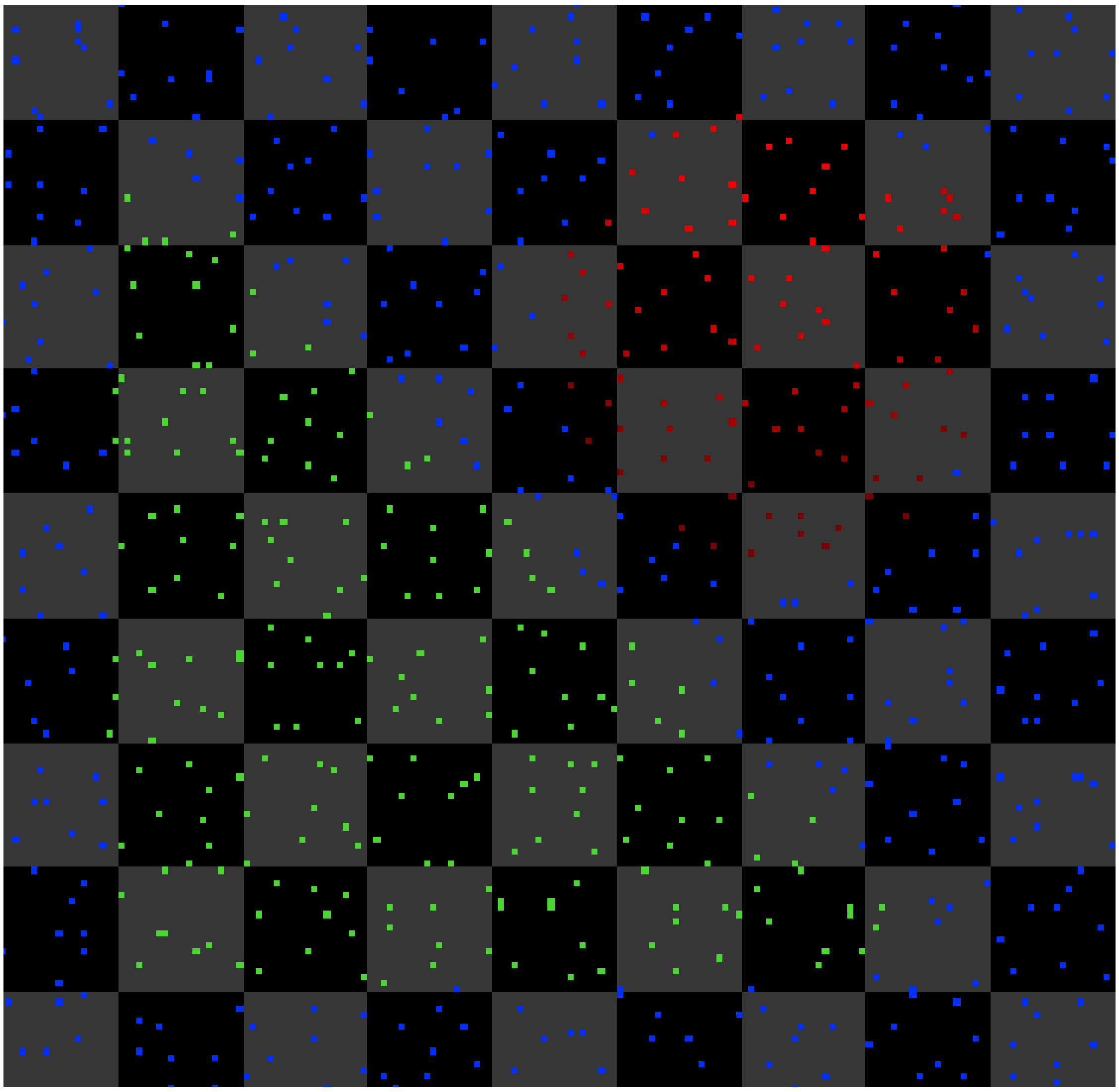
```
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01a.tga 20 -random_samples 4
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01b.tga 20 -uniform_samples 4
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01c.tga 20 -jittered_samples 4
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01d.tga 20 -random_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01e.tga 20 -uniform_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01f.tga 20 -jittered_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01g.tga 20 -random_samples 36
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01h.tga 20 -uniform_samples 36
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_samples
samples7_01i.tga 20 -jittered_samples 36
```

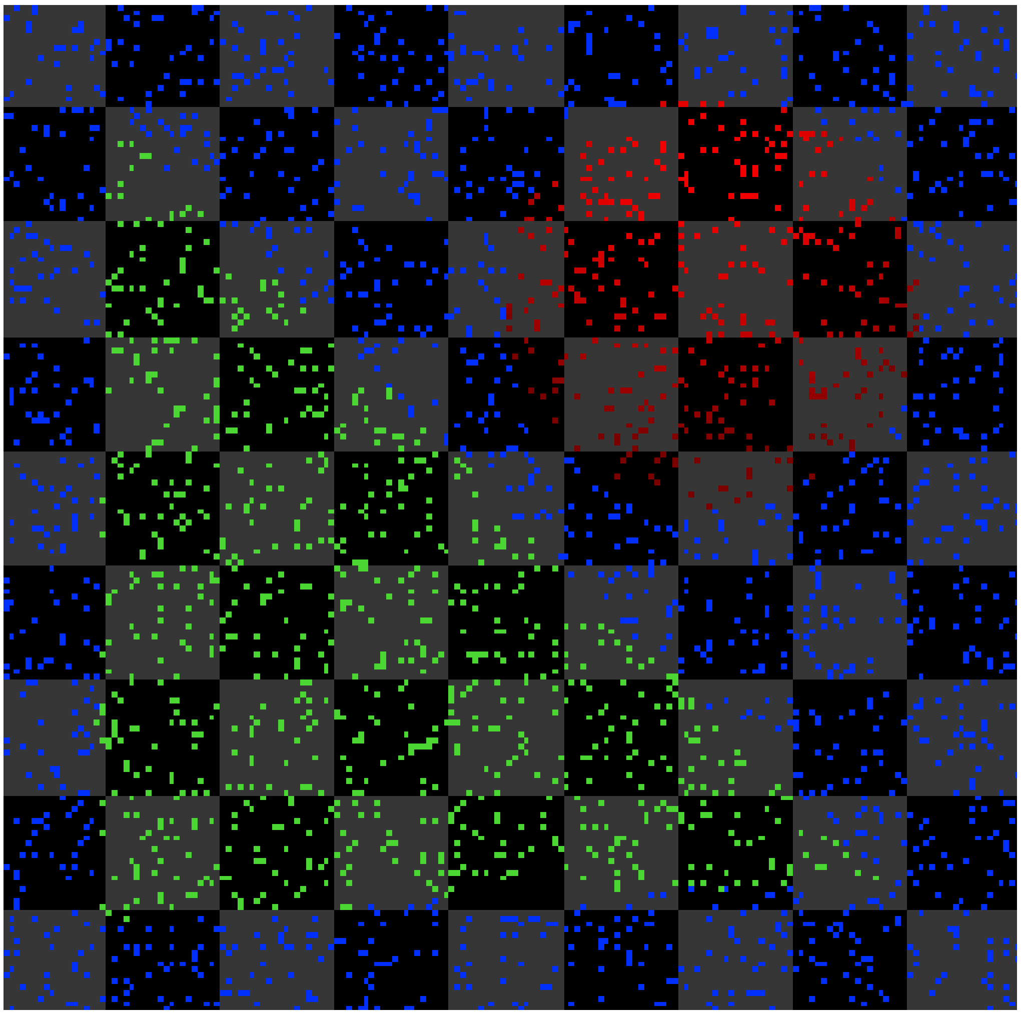
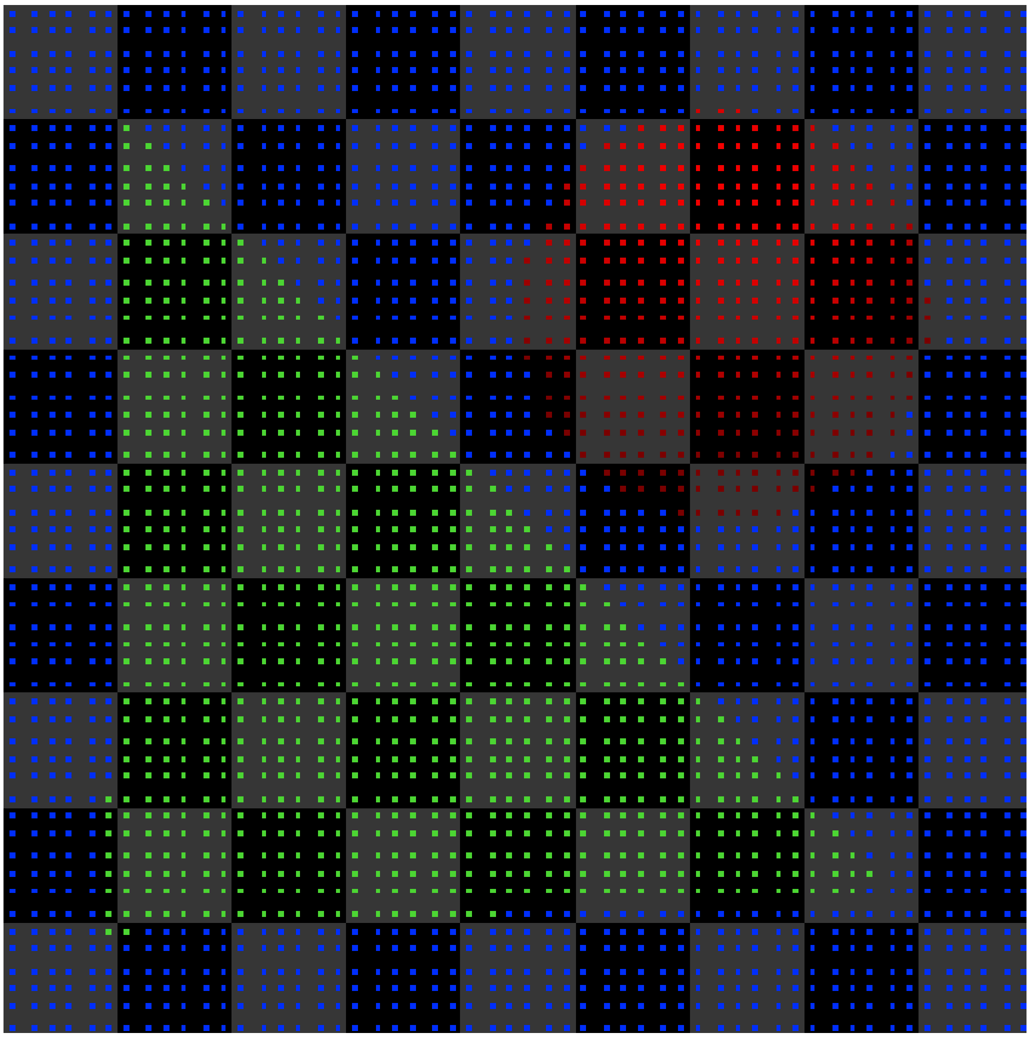


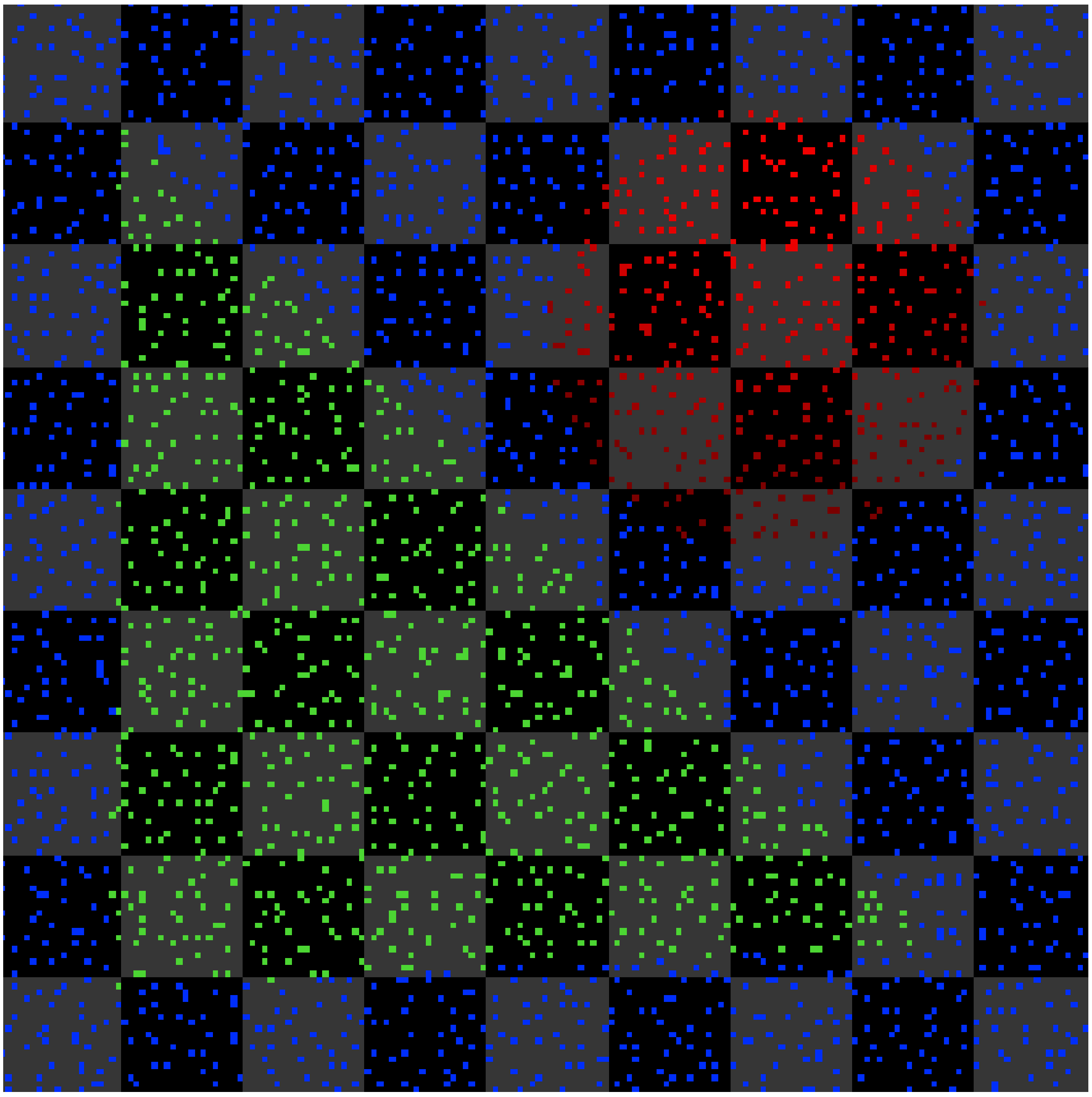


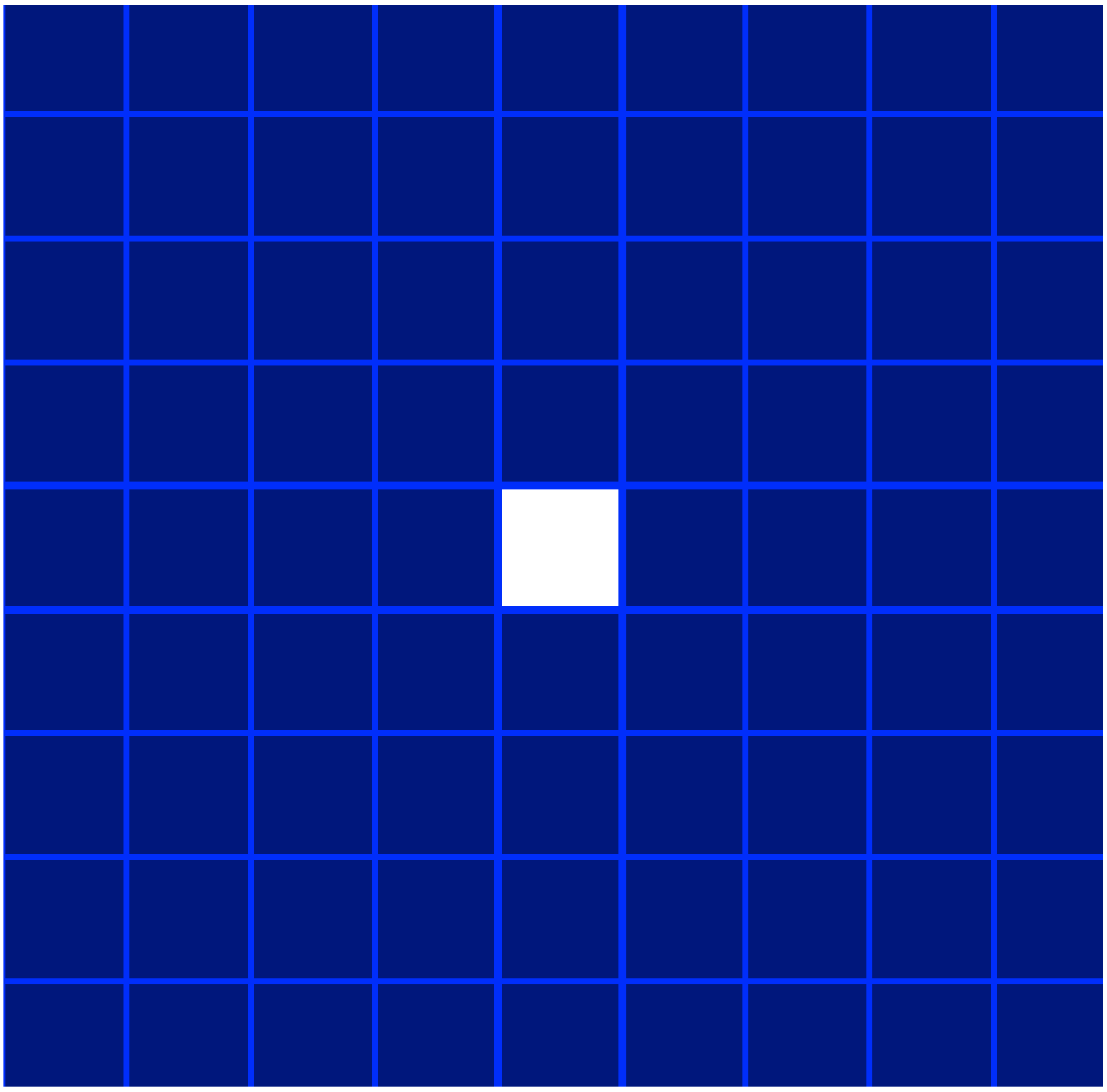
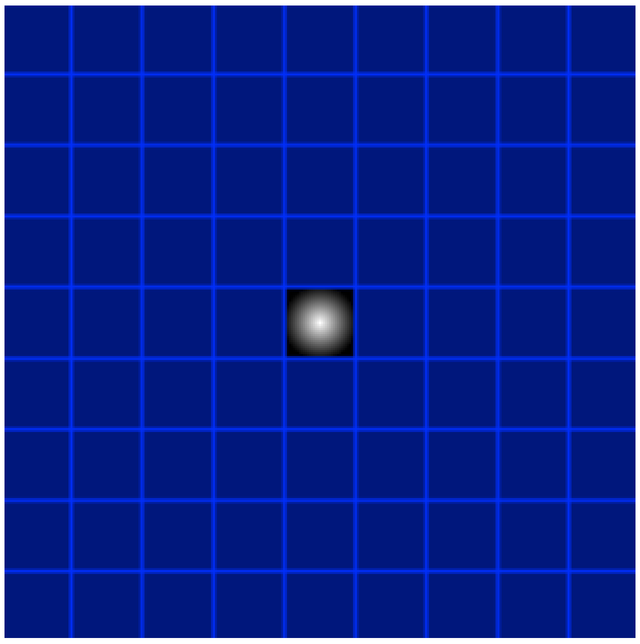


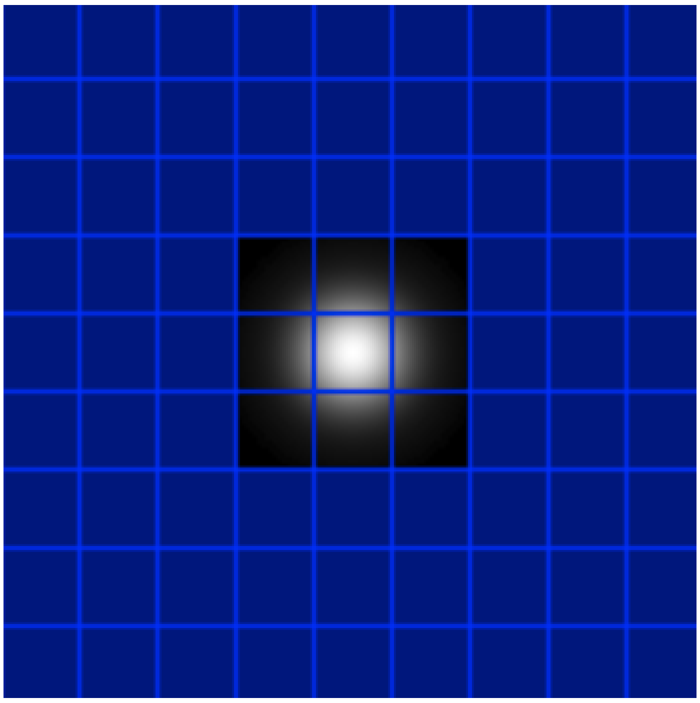


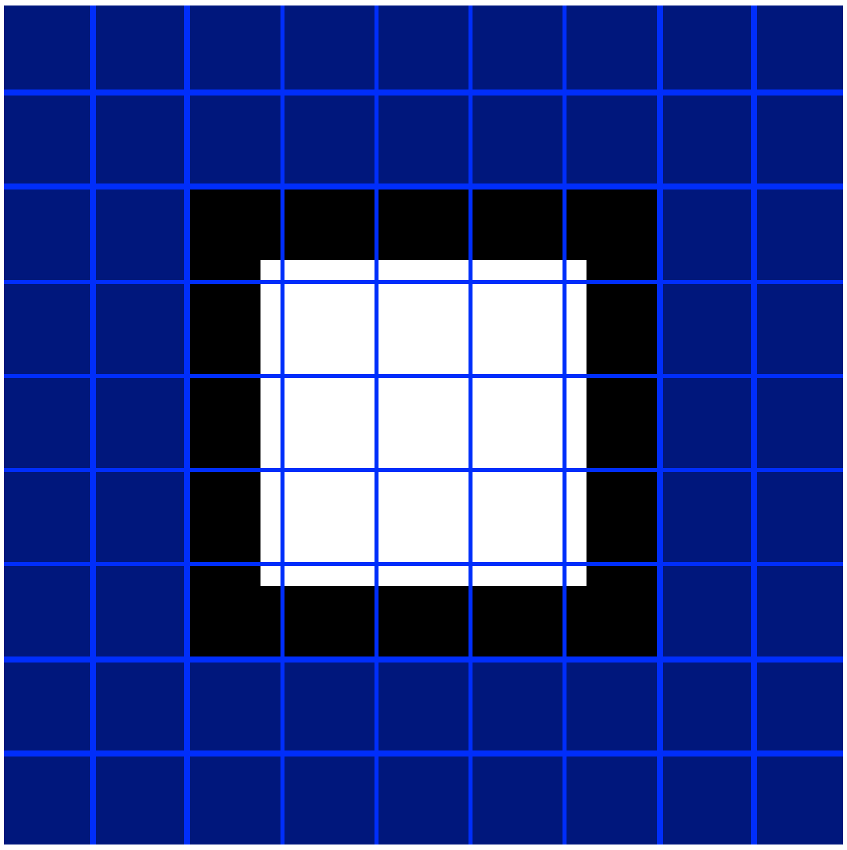



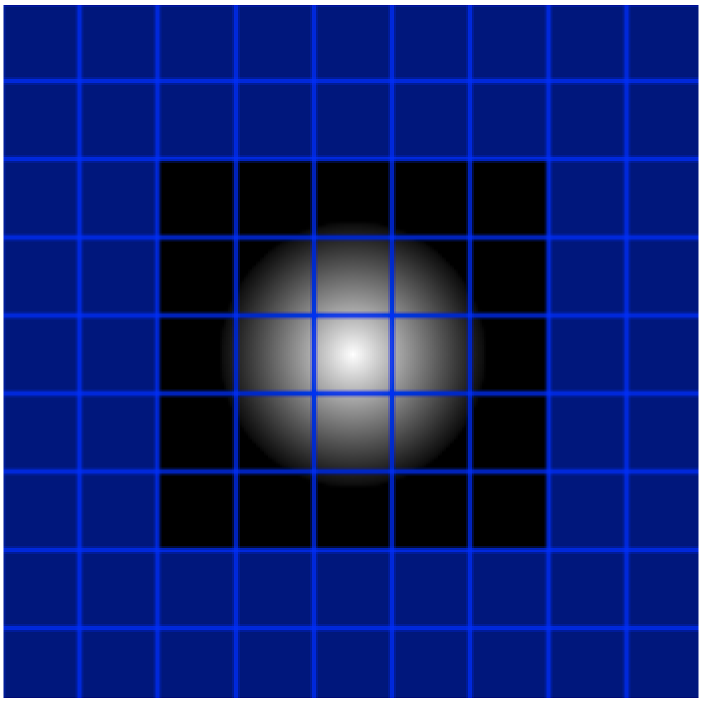


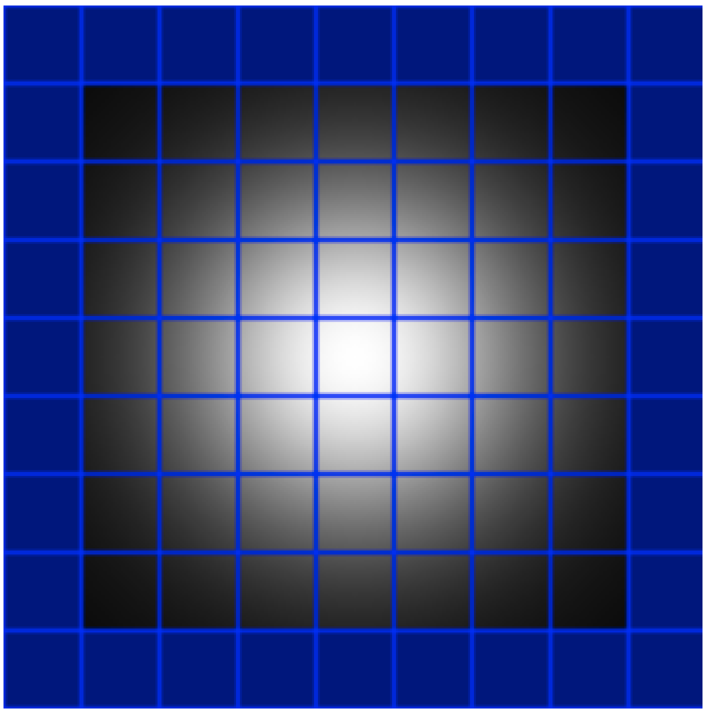
```
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01a.tga 20 -box_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01b.tga 20 -tent_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01c.tga 20 -gaussian_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01d.tga 20 -box_filter 1.7
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01e.tga 20 -tent_filter 1.7
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01f.tga 20 -gaussian_filter 1.7
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01g.tga 20 -box_filter 2.3
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01h.tga 20 -tent_filter 2.3
raytracer -input scene7_01_sphere_triangle.txt -size 9 9 -render_filter
filter7_01i.tga 20 -gaussian_filter 2.3
```

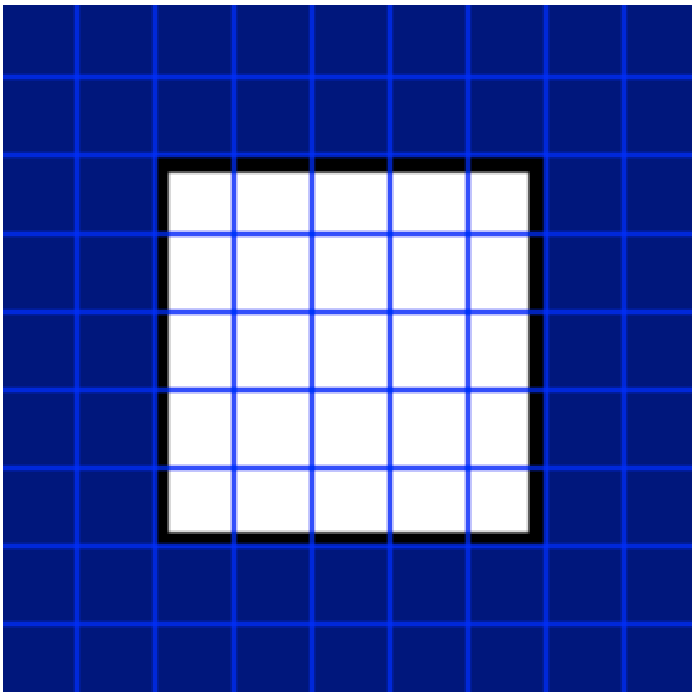
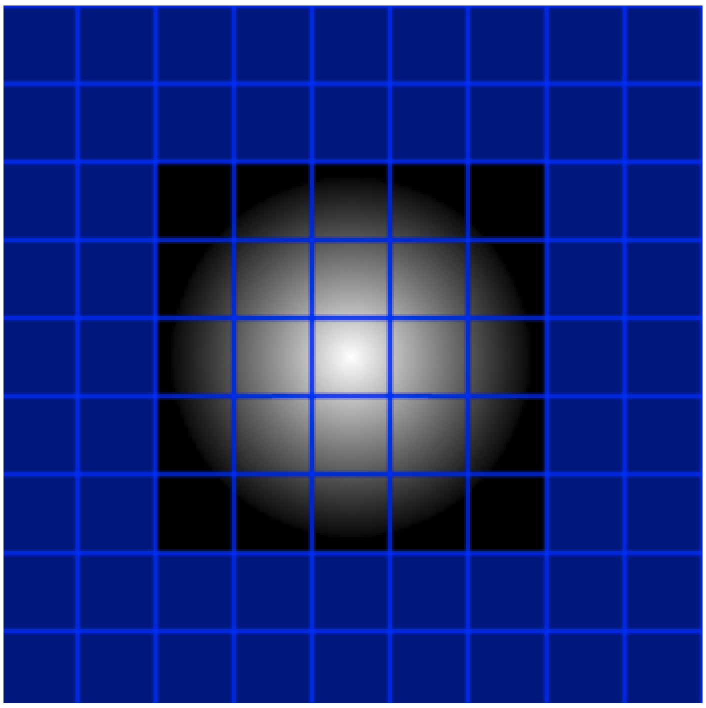
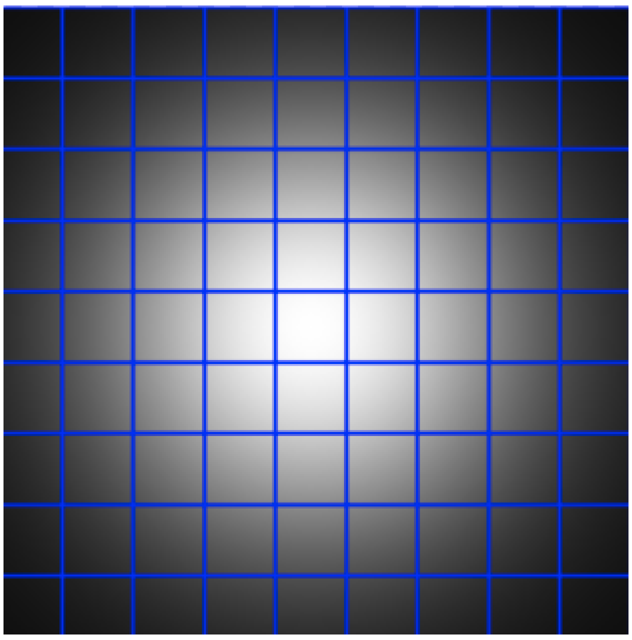





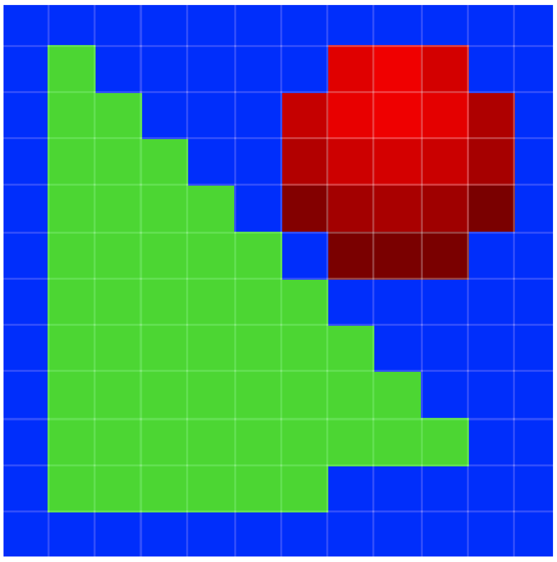


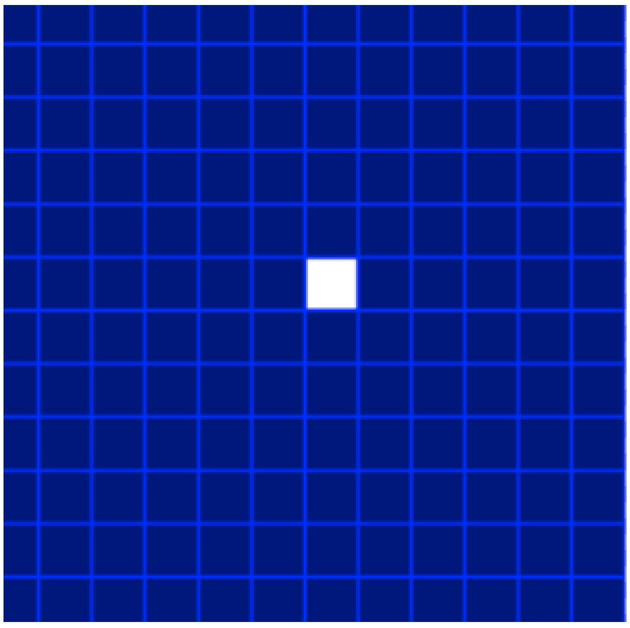
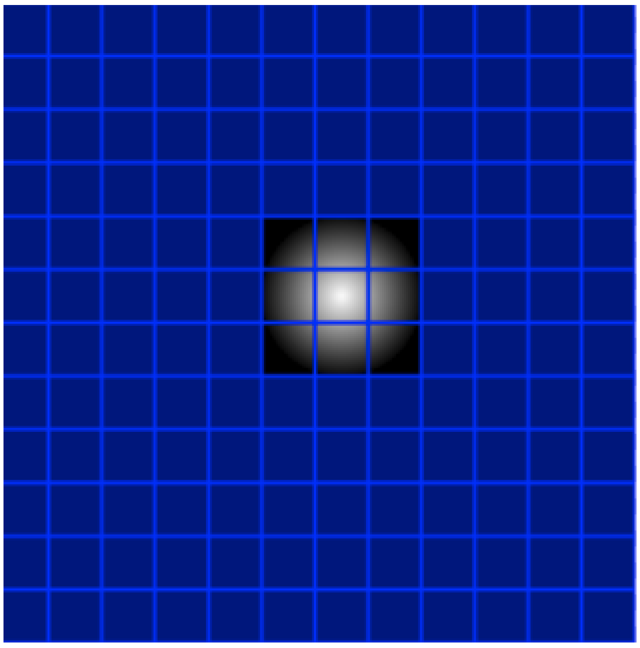
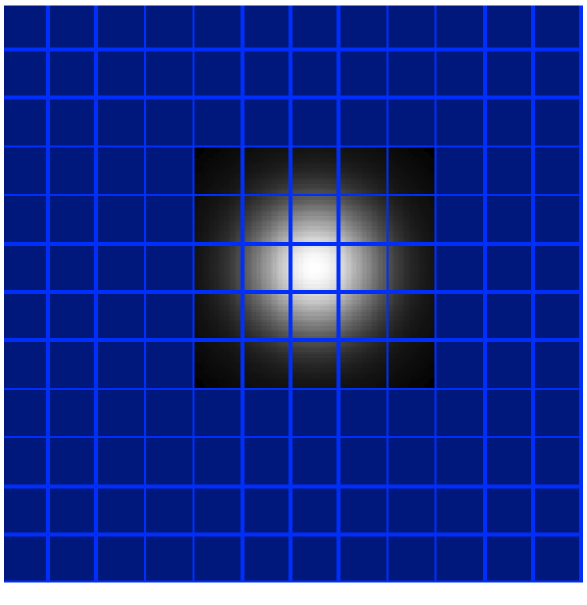


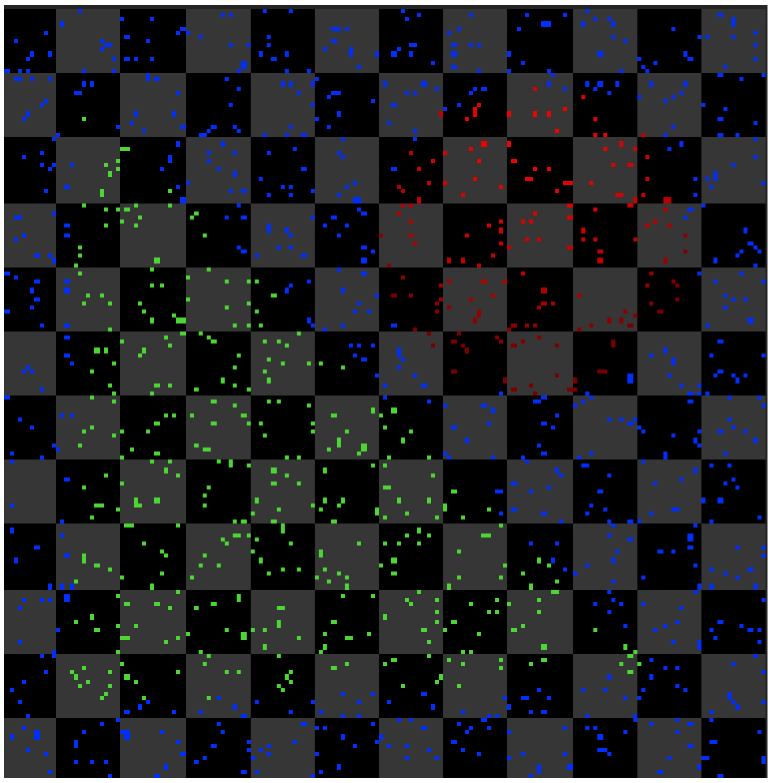
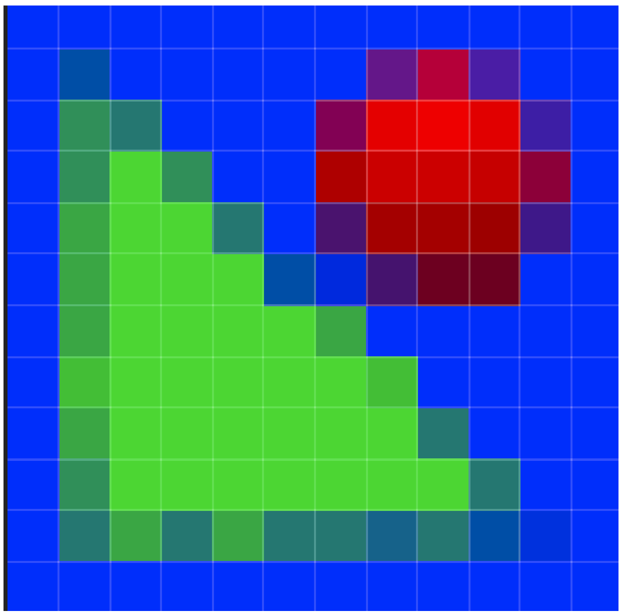
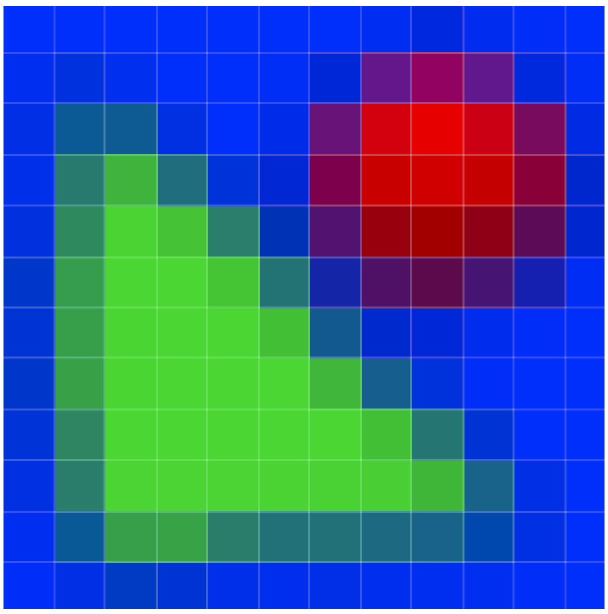


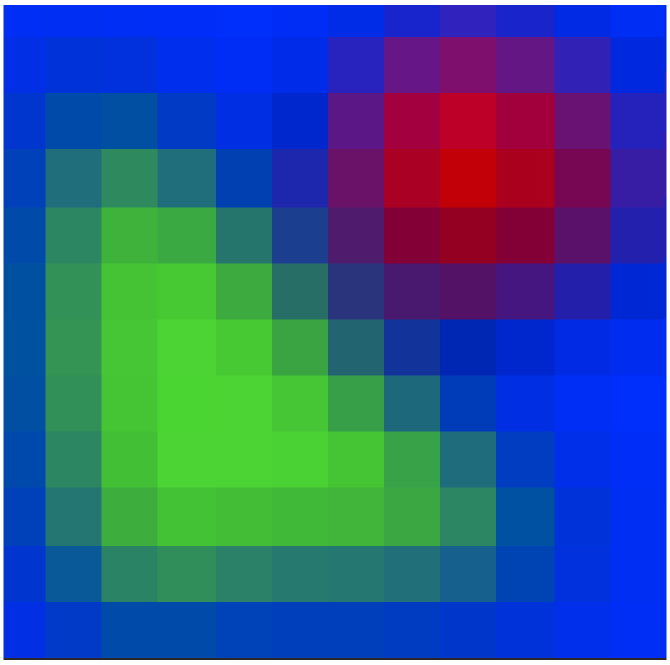




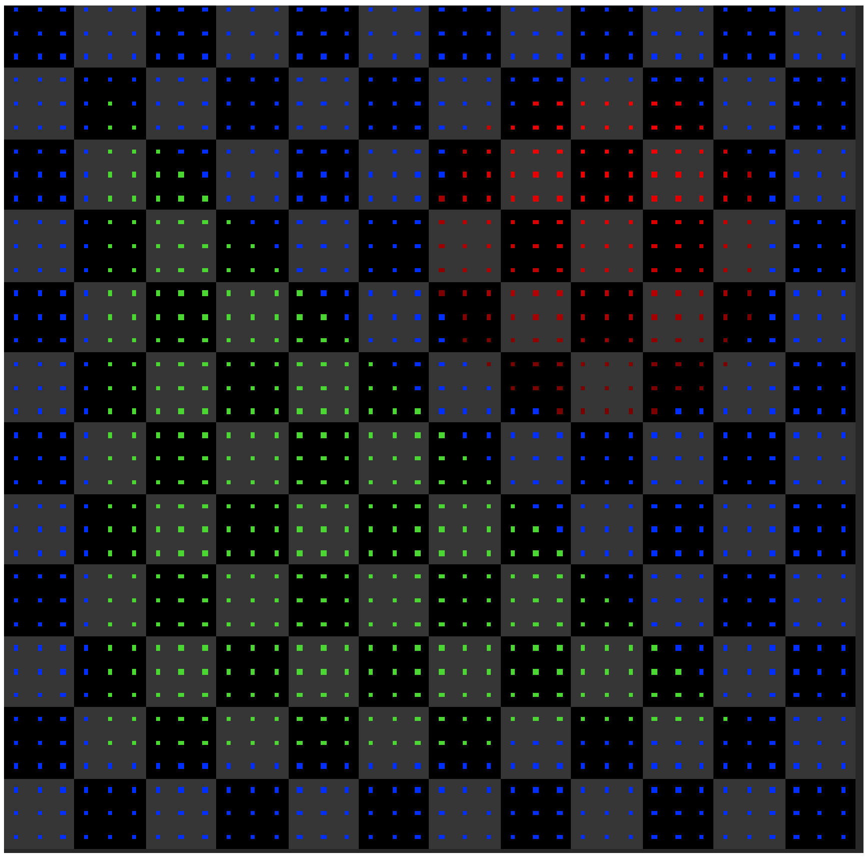
```
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01_low_res.tga
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_samples
samples7_01a_low_res.tga 15 -random_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_samples
samples7_01b_low_res.tga 15 -uniform_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_samples
samples7_01c_low_res.tga 15 -jittered_samples 9
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_filter
filter7_01a_low_res.tga 15 -box_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_filter
filter7_01b_low_res.tga 15 -tent_filter 1.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -render_filter
filter7_01c_low_res.tga 15 -gaussian_filter 1.0
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01a_low_res.tga -random_samples 9 -box_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01b_low_res.tga -random_samples 9 -tent_filter 1.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01c_low_res.tga -random_samples 9 -gaussian_filter 1.0
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01d_low_res.tga -uniform_samples 9 -box_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01e_low_res.tga -uniform_samples 9 -tent_filter 1.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01f_low_res.tga -uniform_samples 9 -gaussian_filter 1.0
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01g_low_res.tga -jittered_samples 9 -box_filter 0.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01h_low_res.tga -jittered_samples 9 -tent_filter 1.5
raytracer -input scene7_01_sphere_triangle.txt -size 12 12 -output
output7_01i_low_res.tga -jittered_samples 9 -gaussian_filter 1.0
```

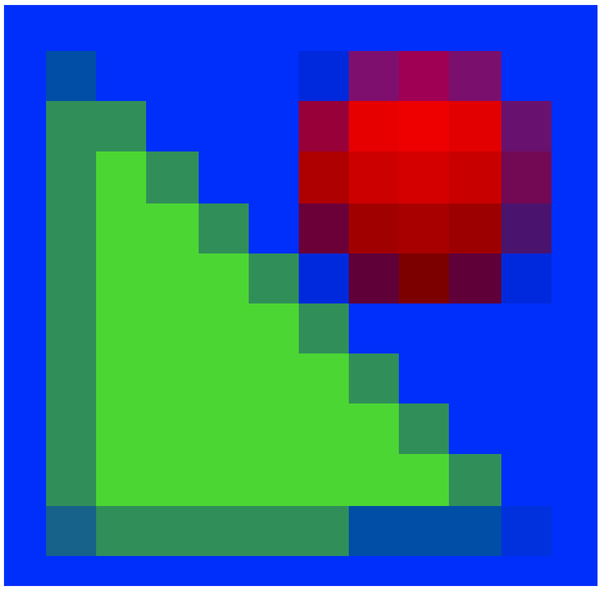
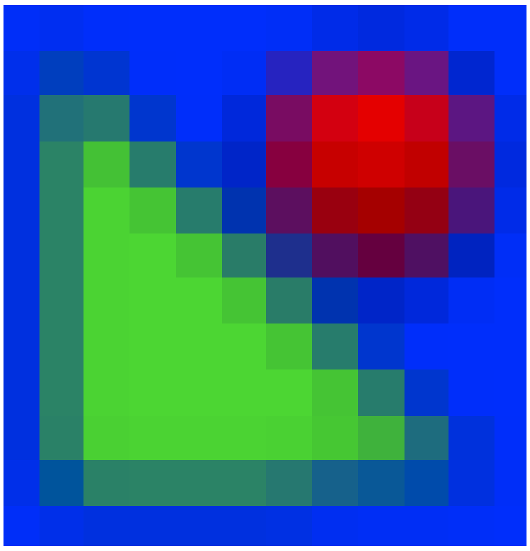
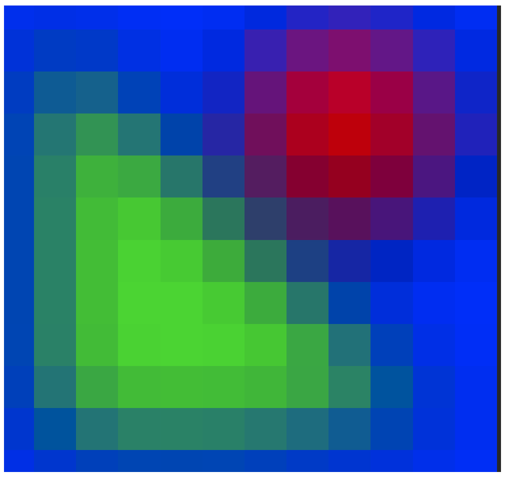


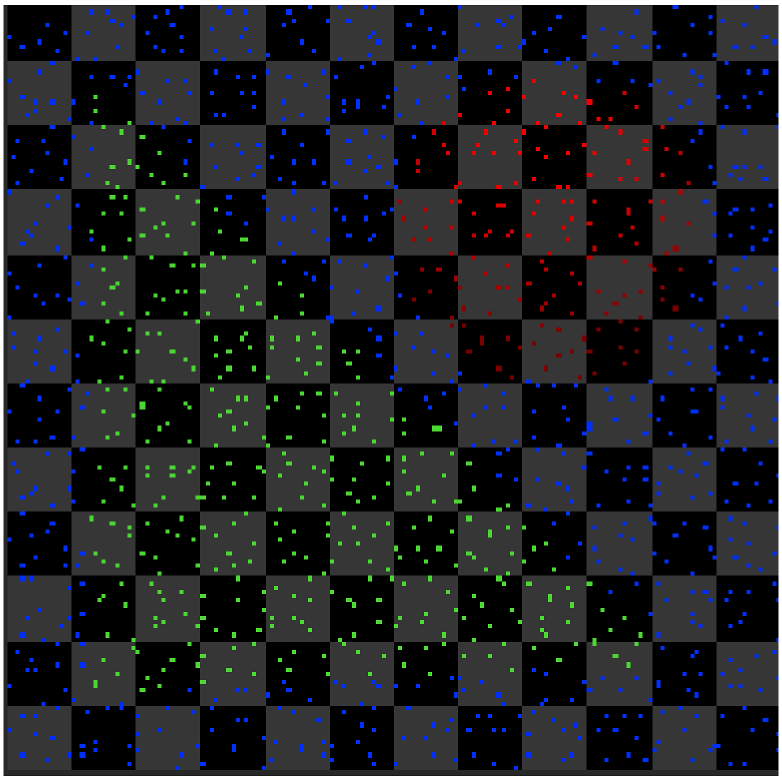
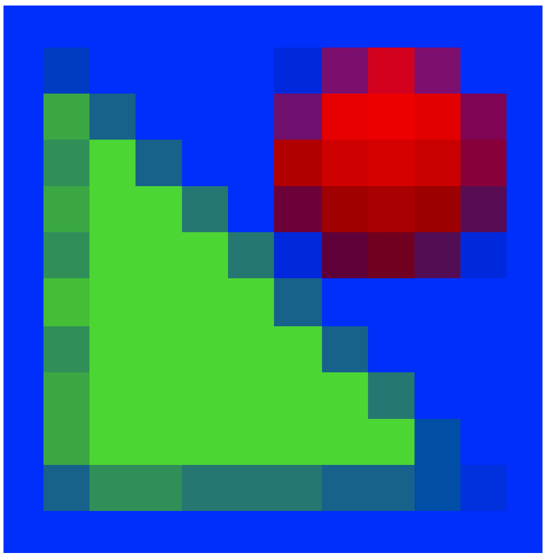
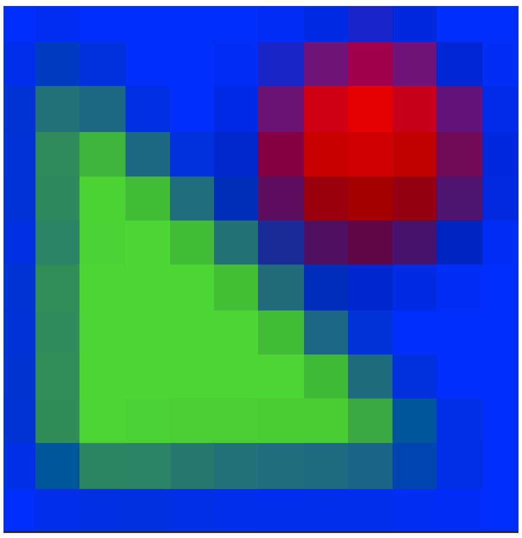




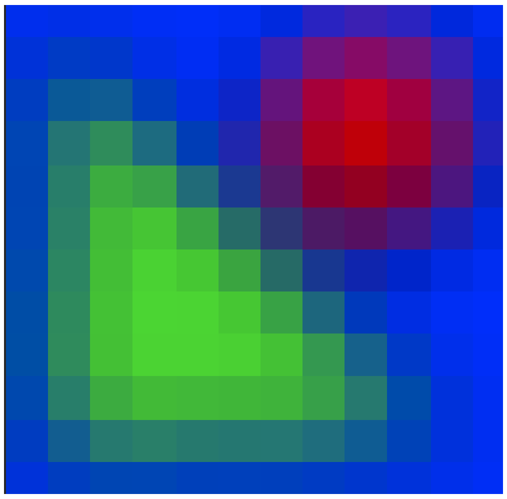






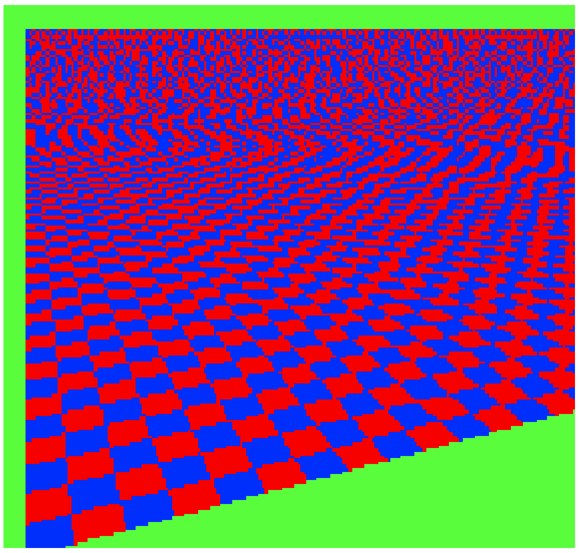
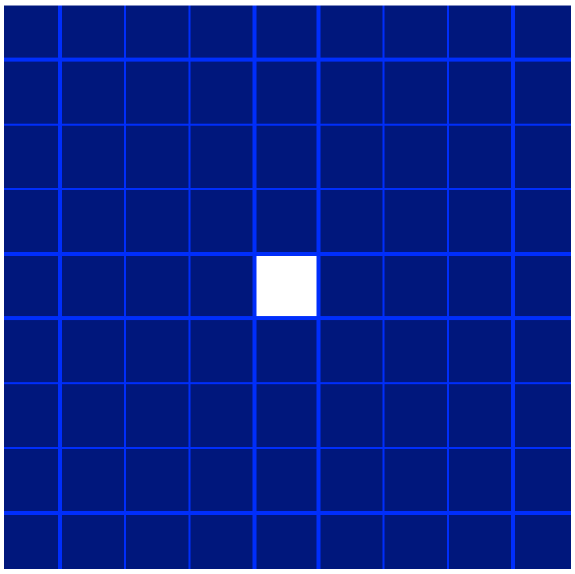
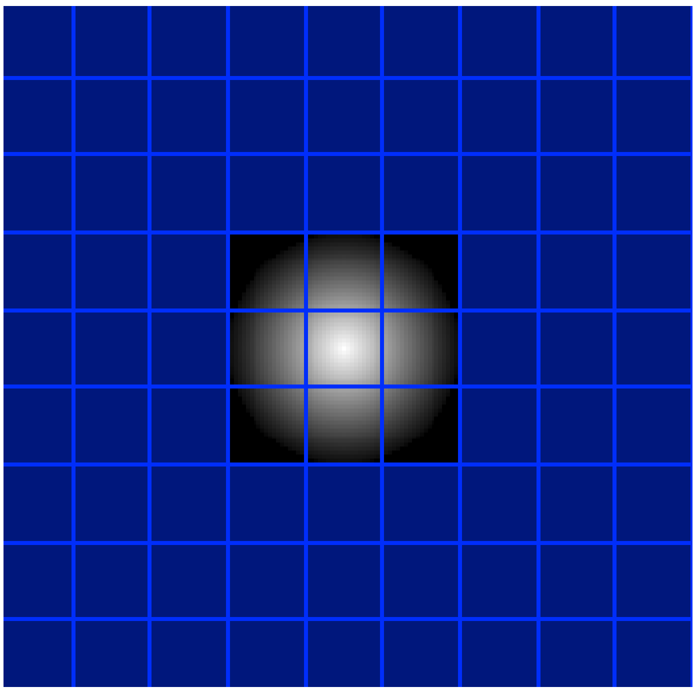


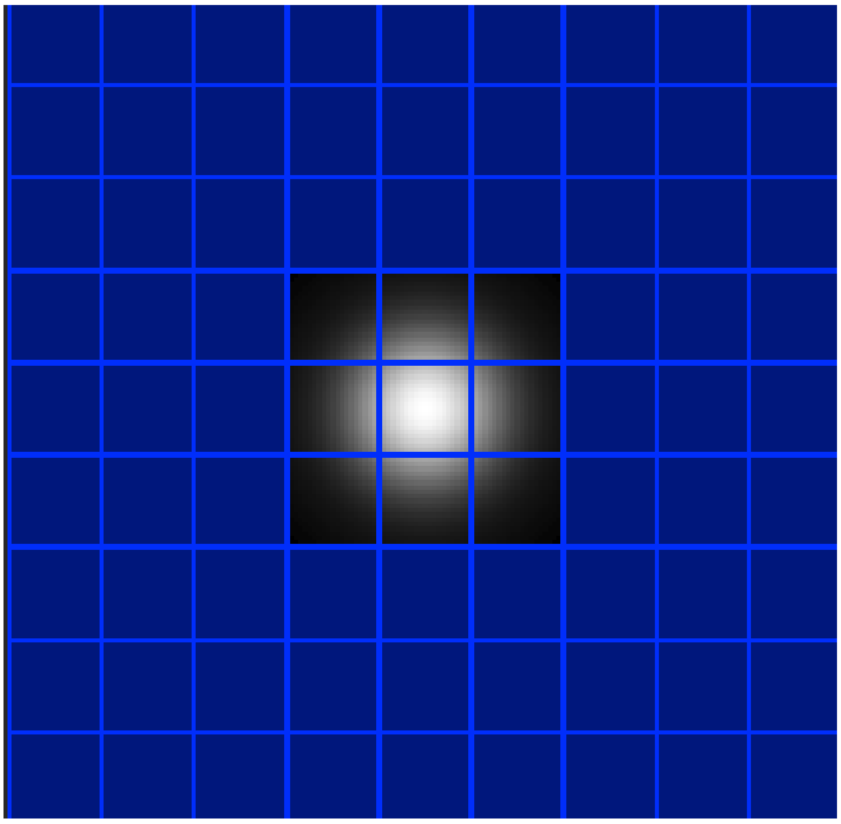
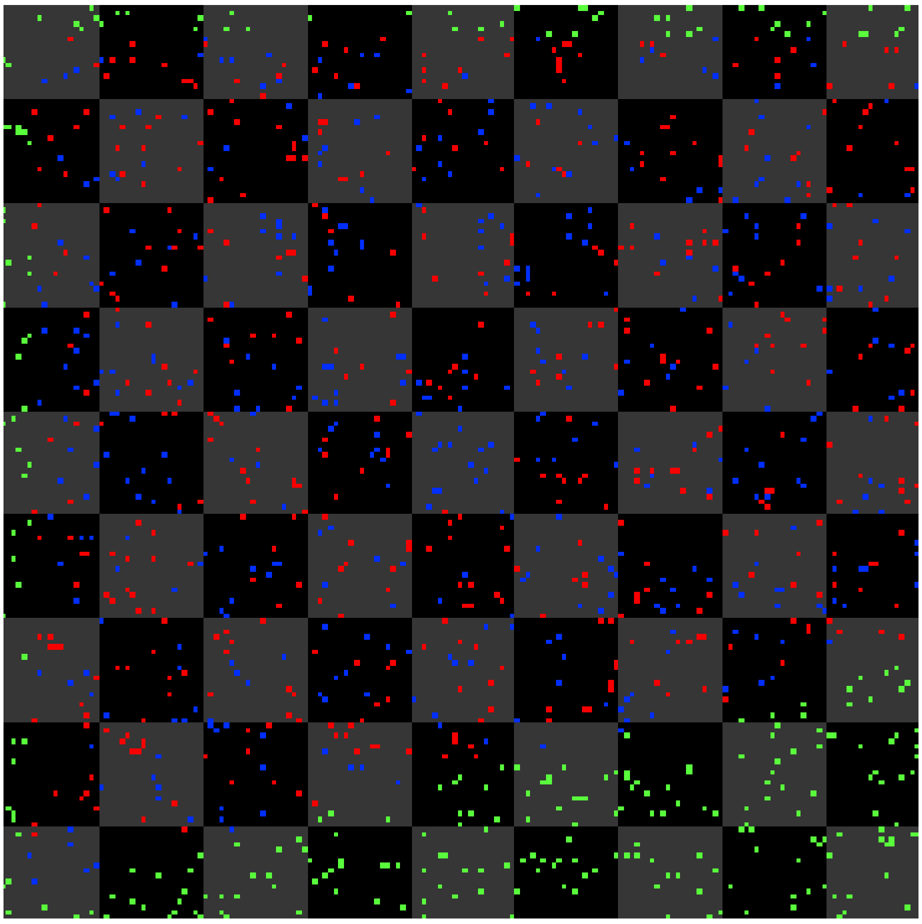




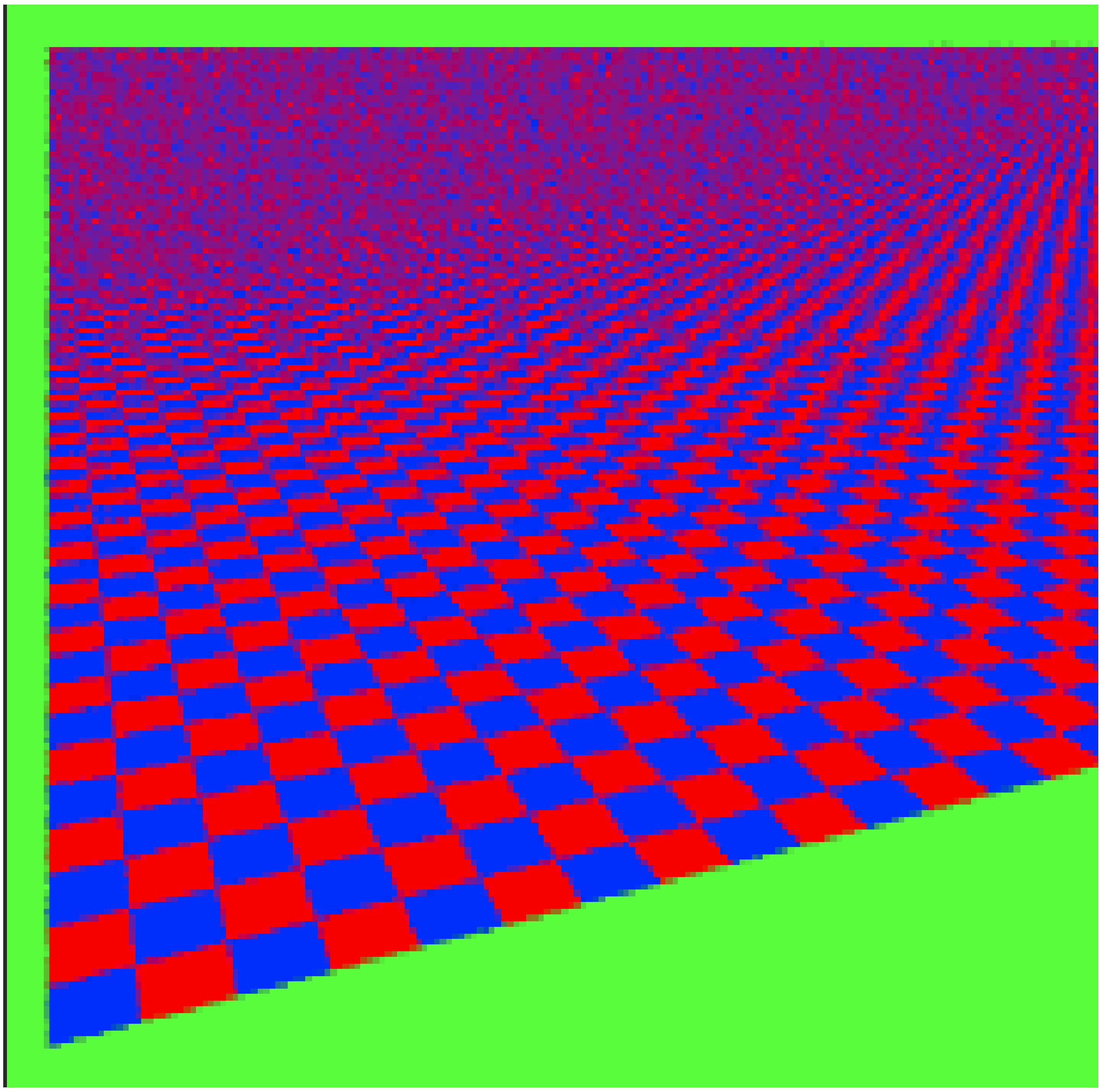




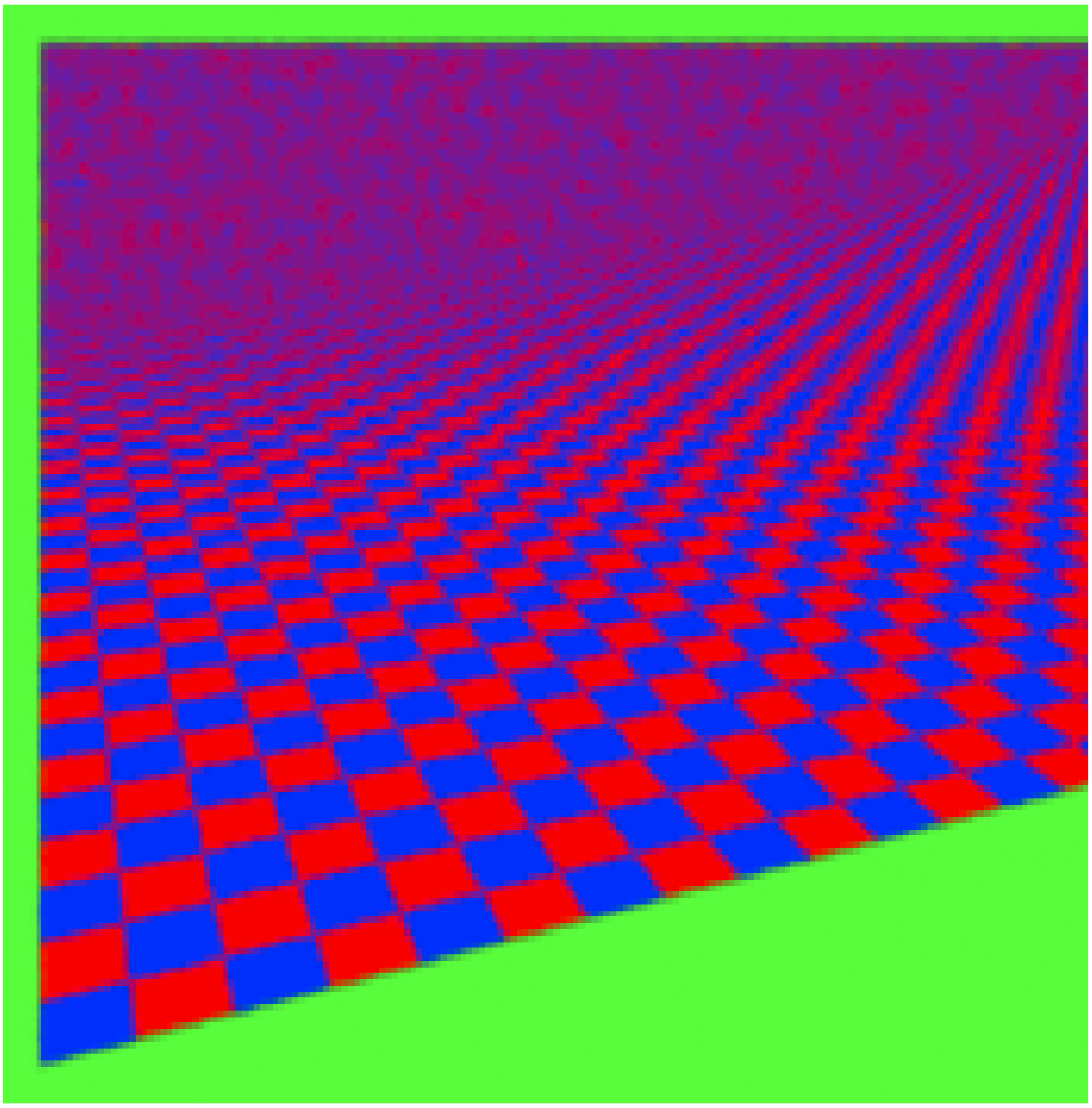


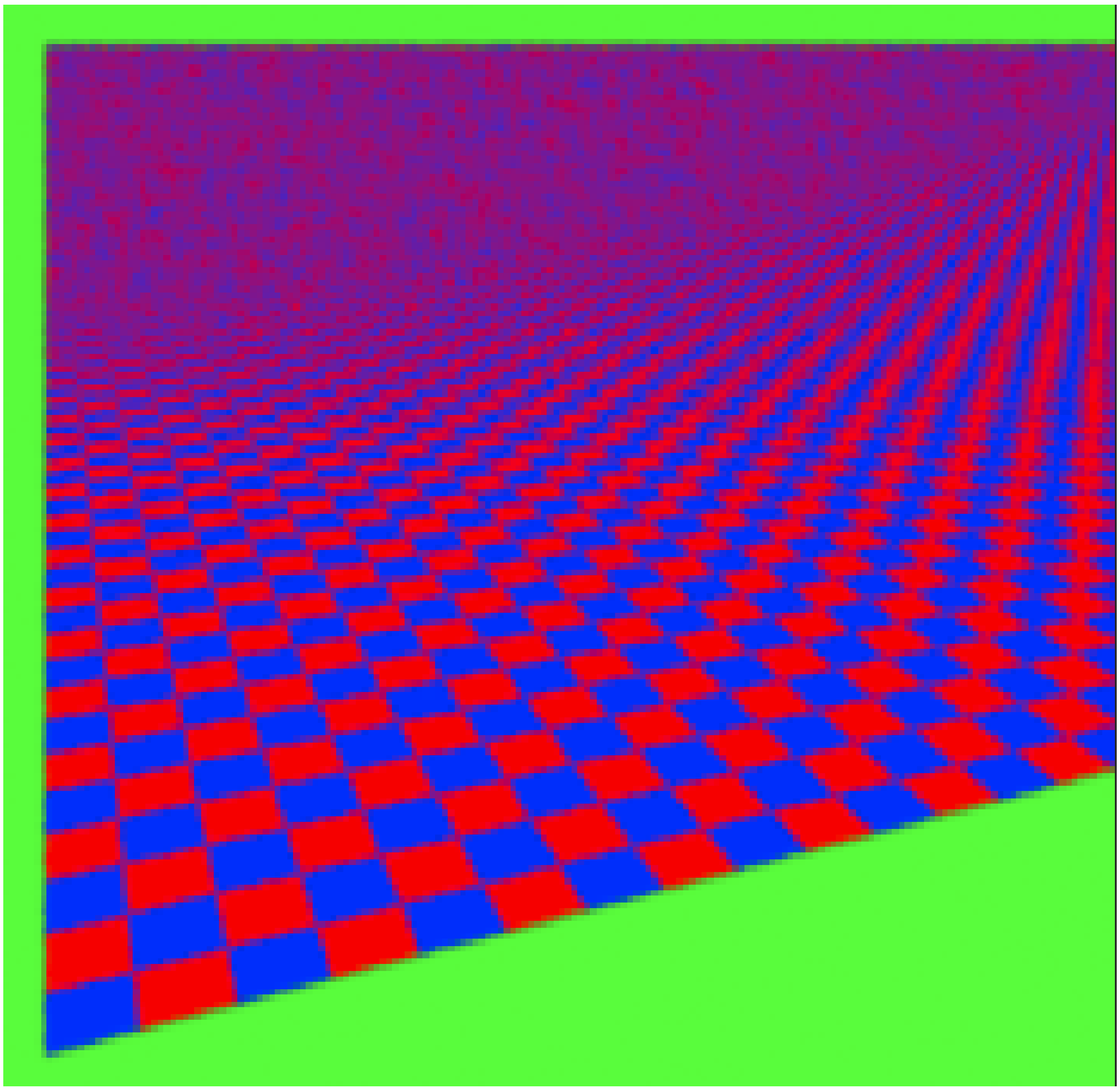
```
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output output7_02.tga
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_samples
samples7_02a.tga 20 -random_samples 16
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_samples
samples7_02b.tga 20 -uniform_samples 16
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_samples
samples7_02c.tga 20 -jittered_samples 16
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_filter
filter7_02a.tga 20 -box_filter 0.5
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_filter
filter7_02b.tga 20 -tent_filter 1.5
raytracer -input scene7_02_checkerboard.txt -size 9 9 -render_filter
filter7_02c.tga 20 -gaussian_filter 0.6
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02a.tga -random_samples 16 -box_filter 0.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02b.tga -random_samples 16 -tent_filter 1.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02c.tga -random_samples 16 -gaussian_filter 0.6
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02d.tga -uniform_samples 16 -box_filter 0.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02e.tga -uniform_samples 16 -tent_filter 1.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02f.tga -uniform_samples 16 -gaussian_filter 0.6
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02g.tga -jittered_samples 16 -box_filter 0.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02h.tga -jittered_samples 16 -tent_filter 1.5
raytracer -input scene7_02_checkerboard.txt -size 180 180 -output
output7_02i.tga -jittered_samples 16 -gaussian_filter 0.6
```

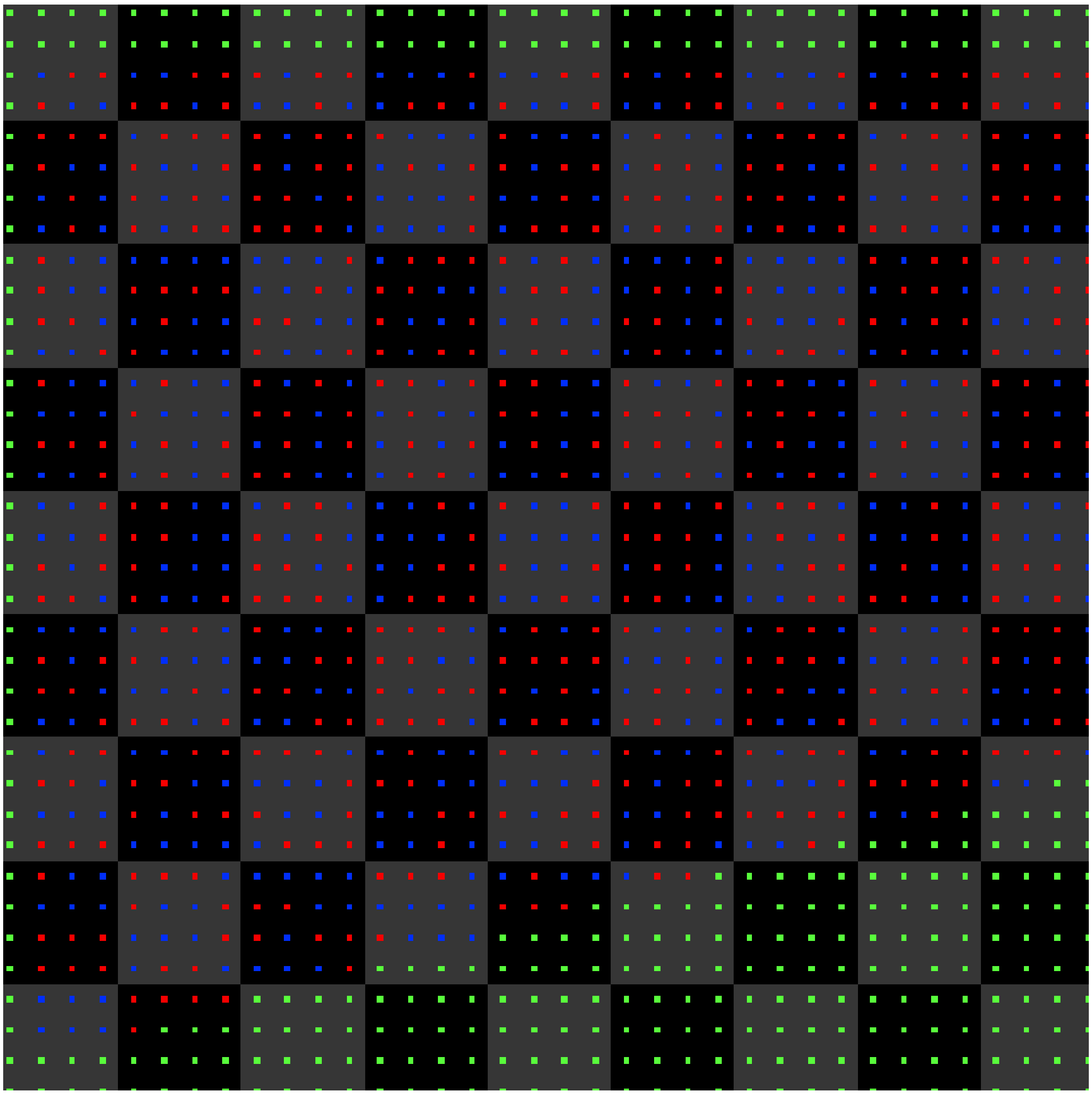




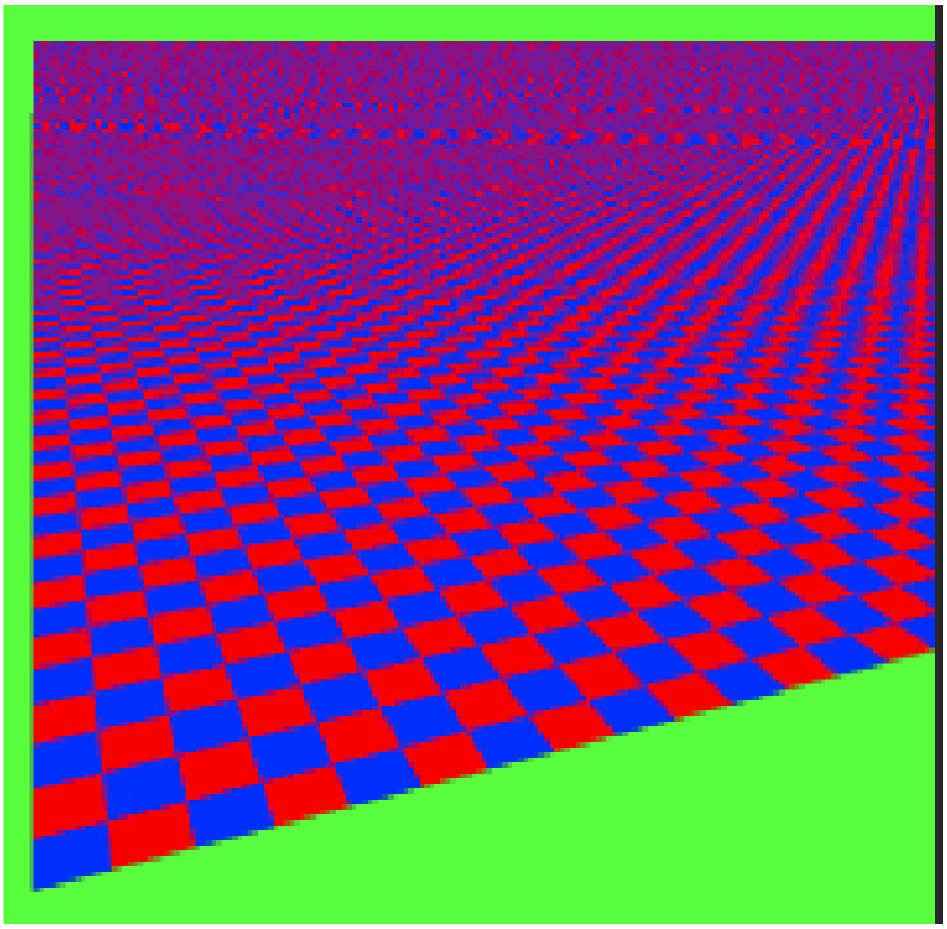



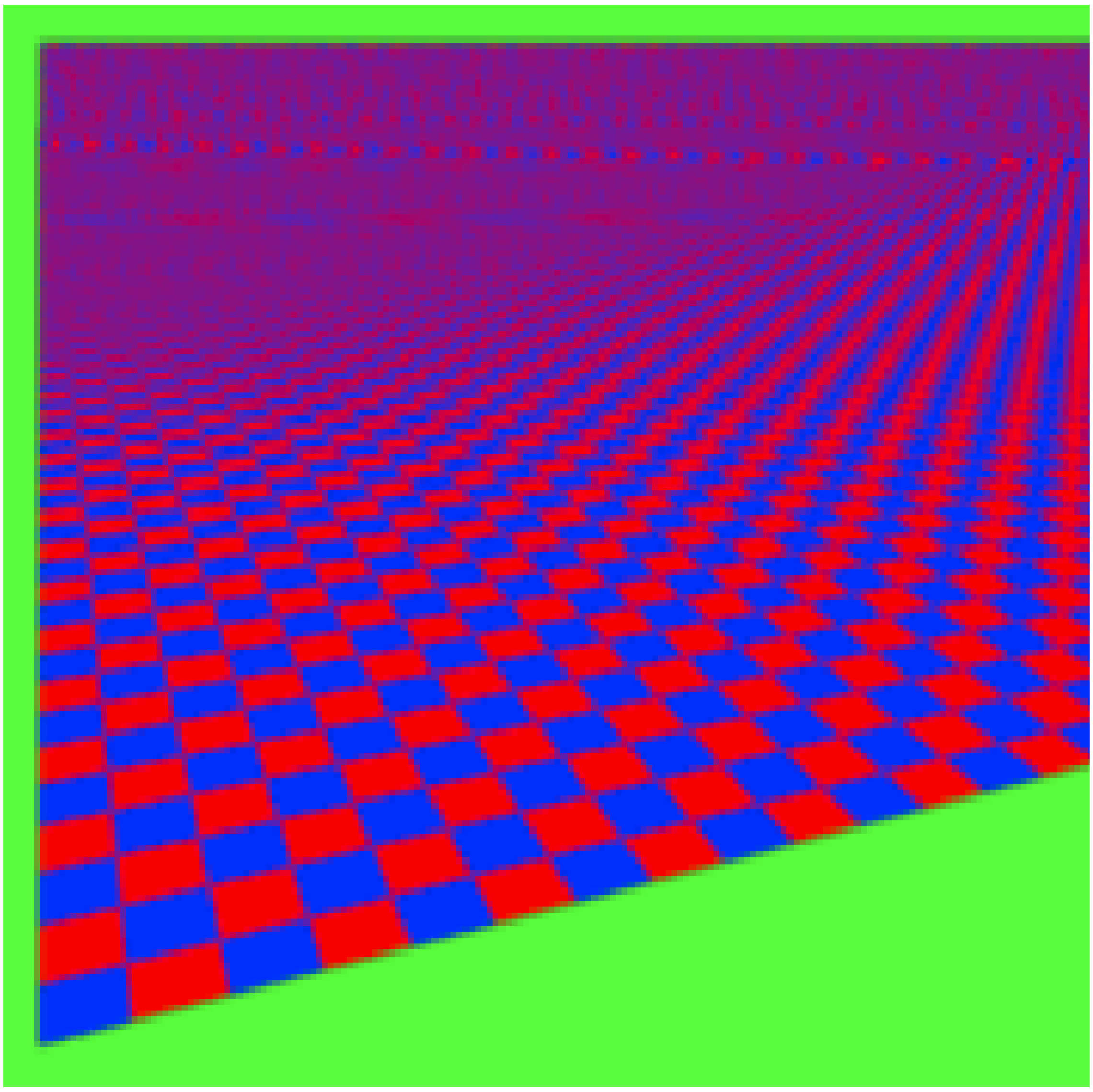


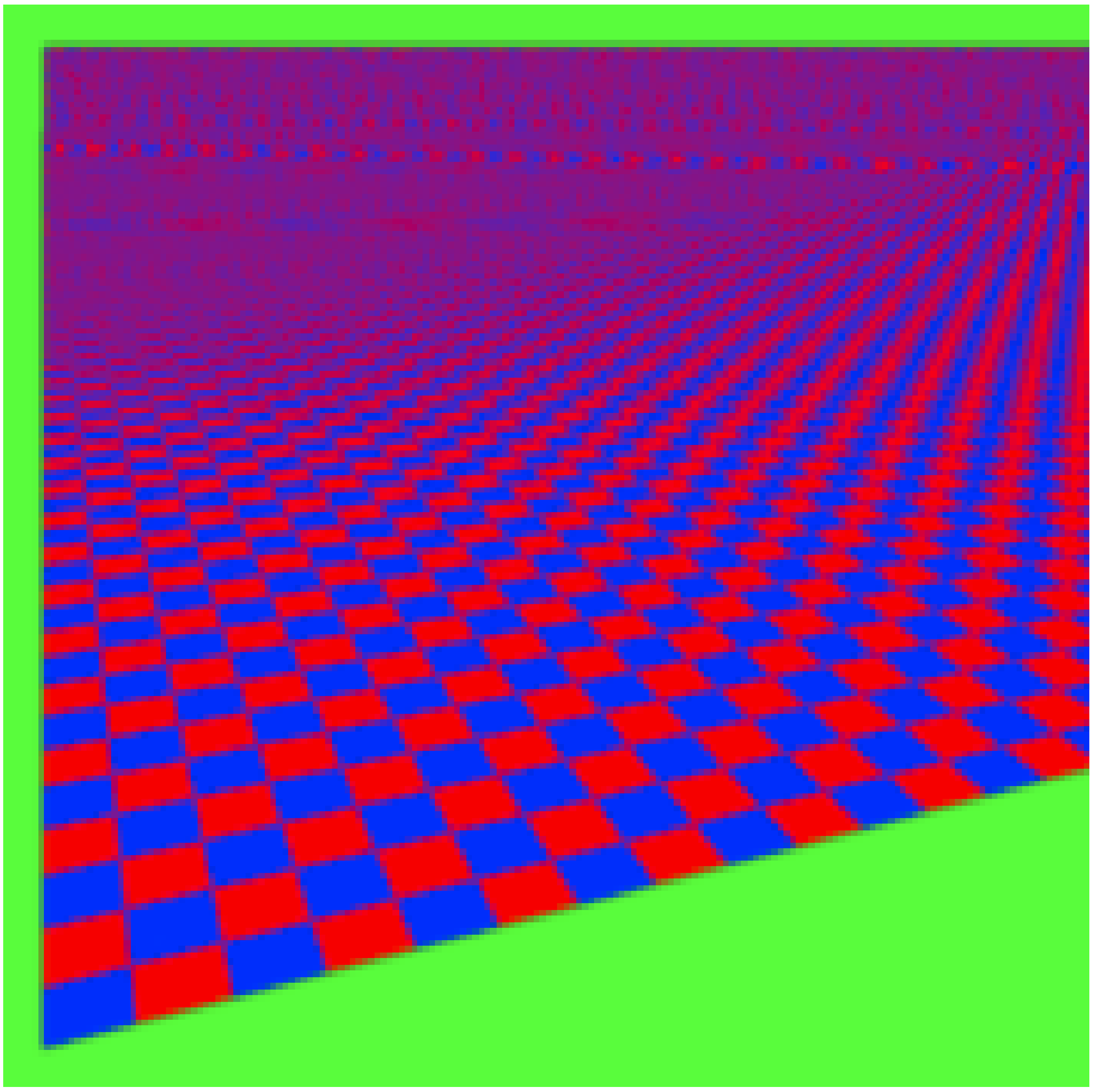


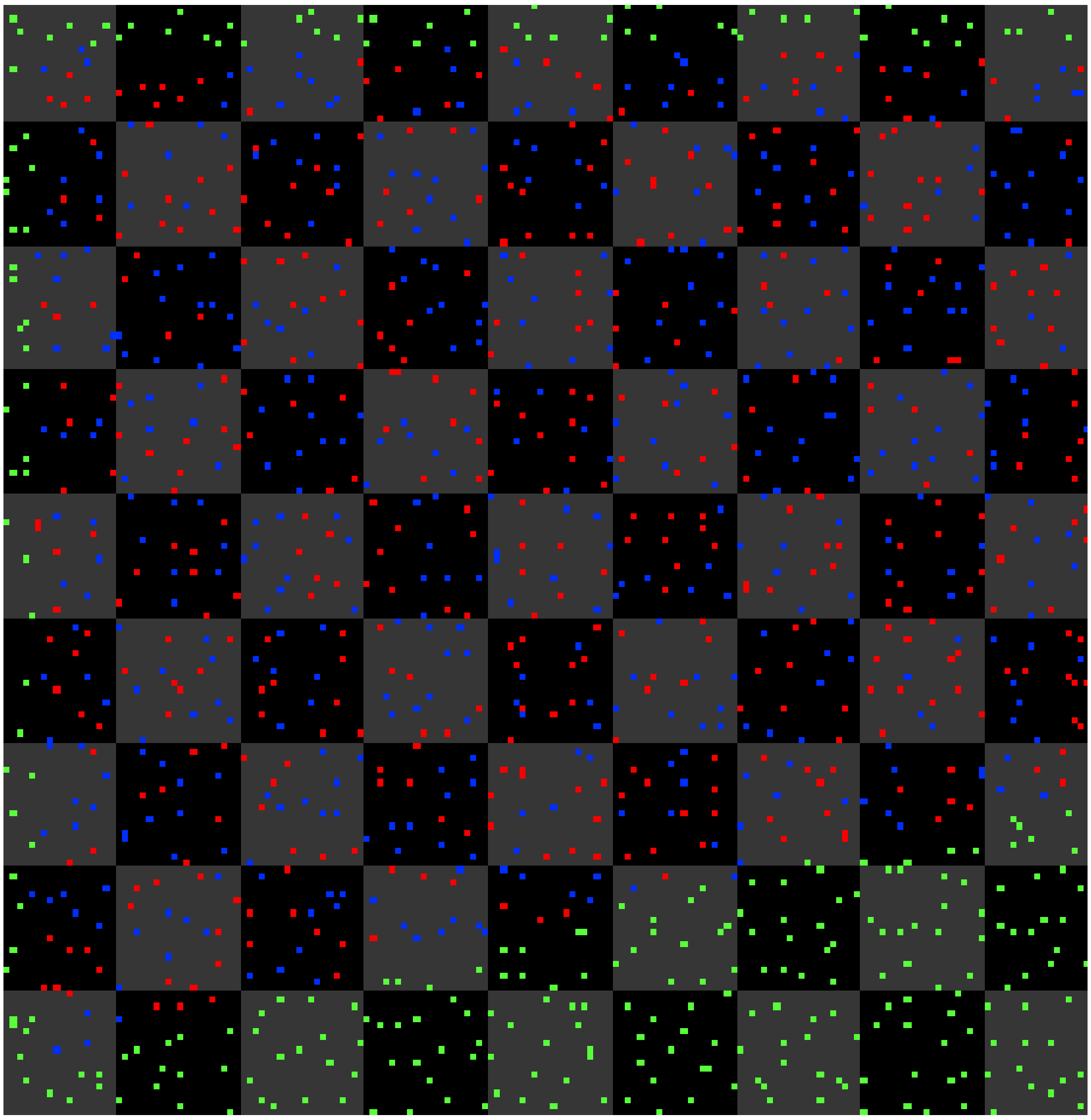


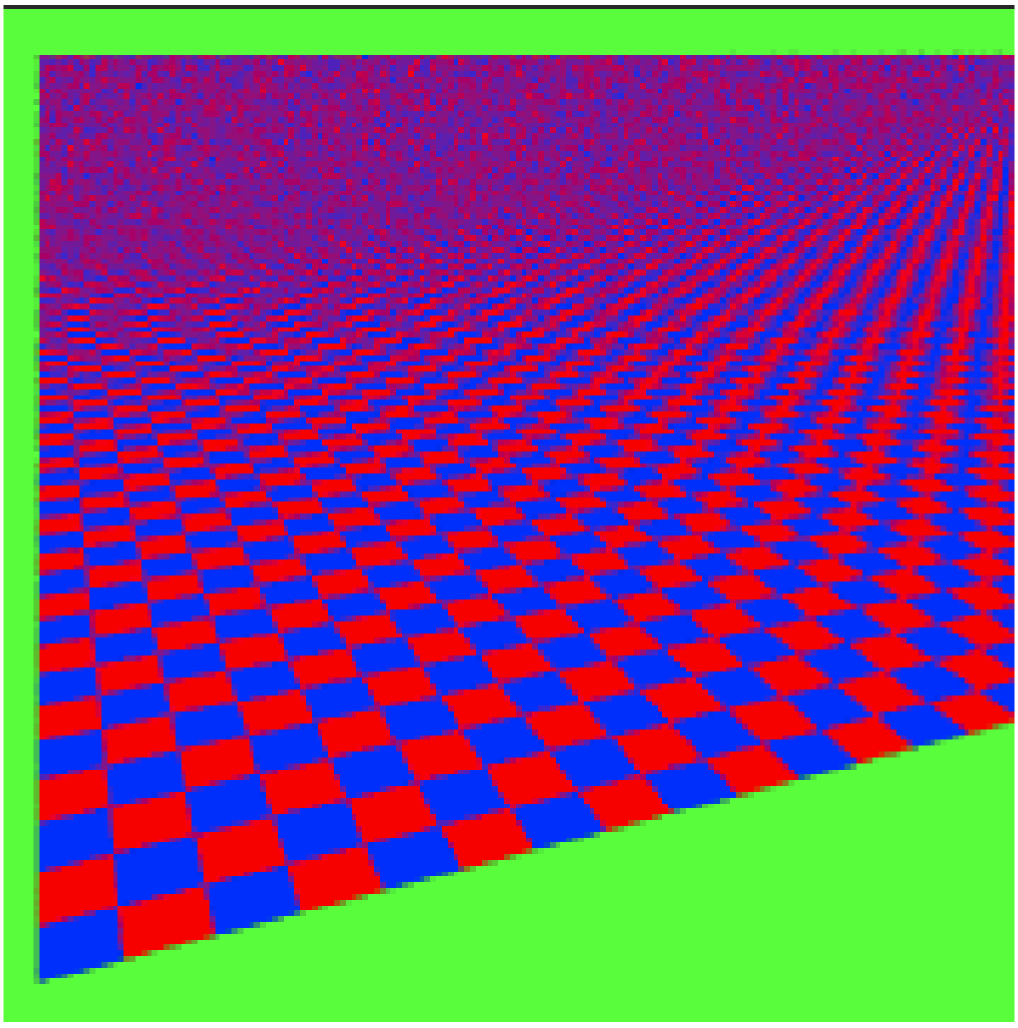


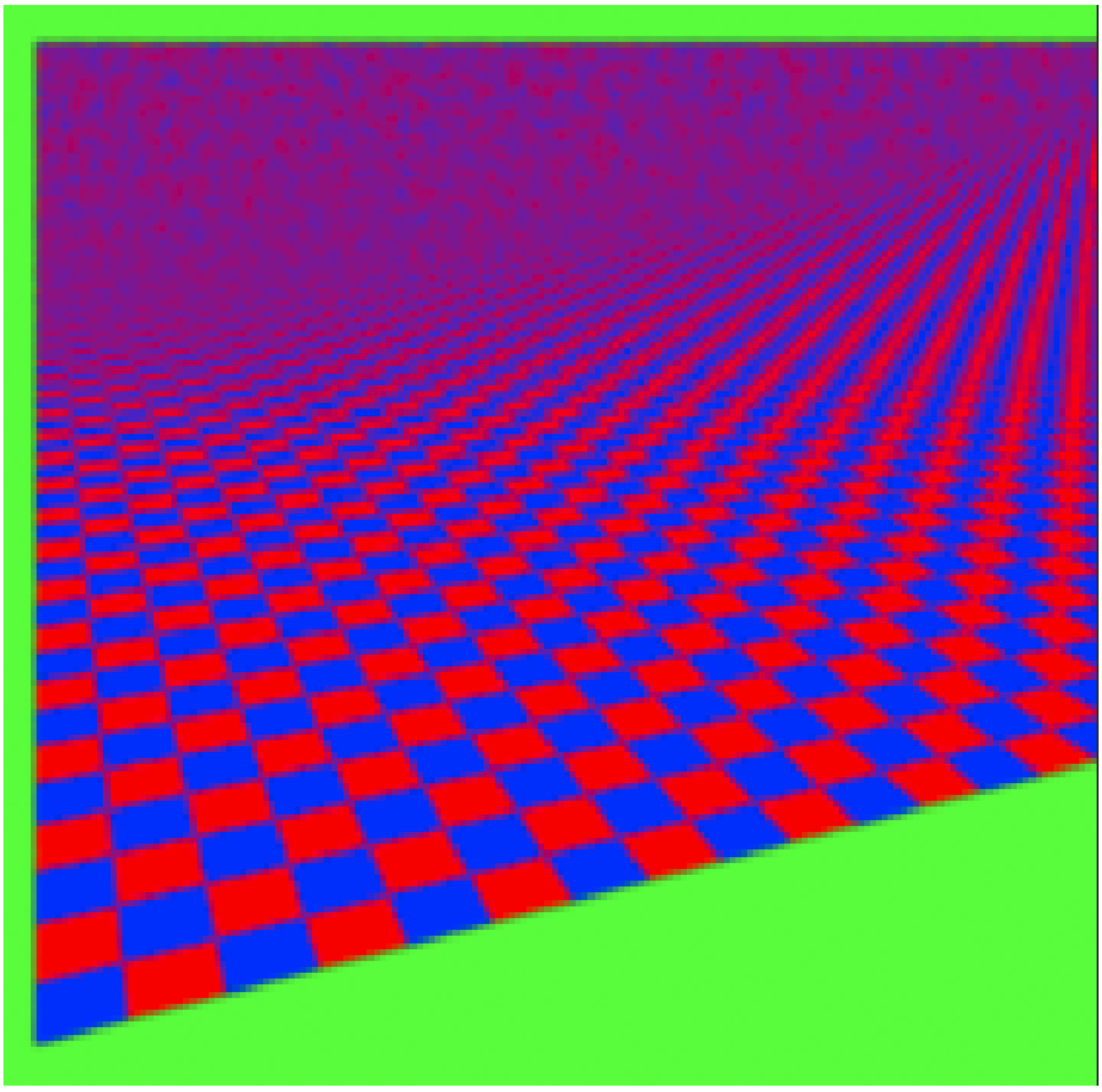


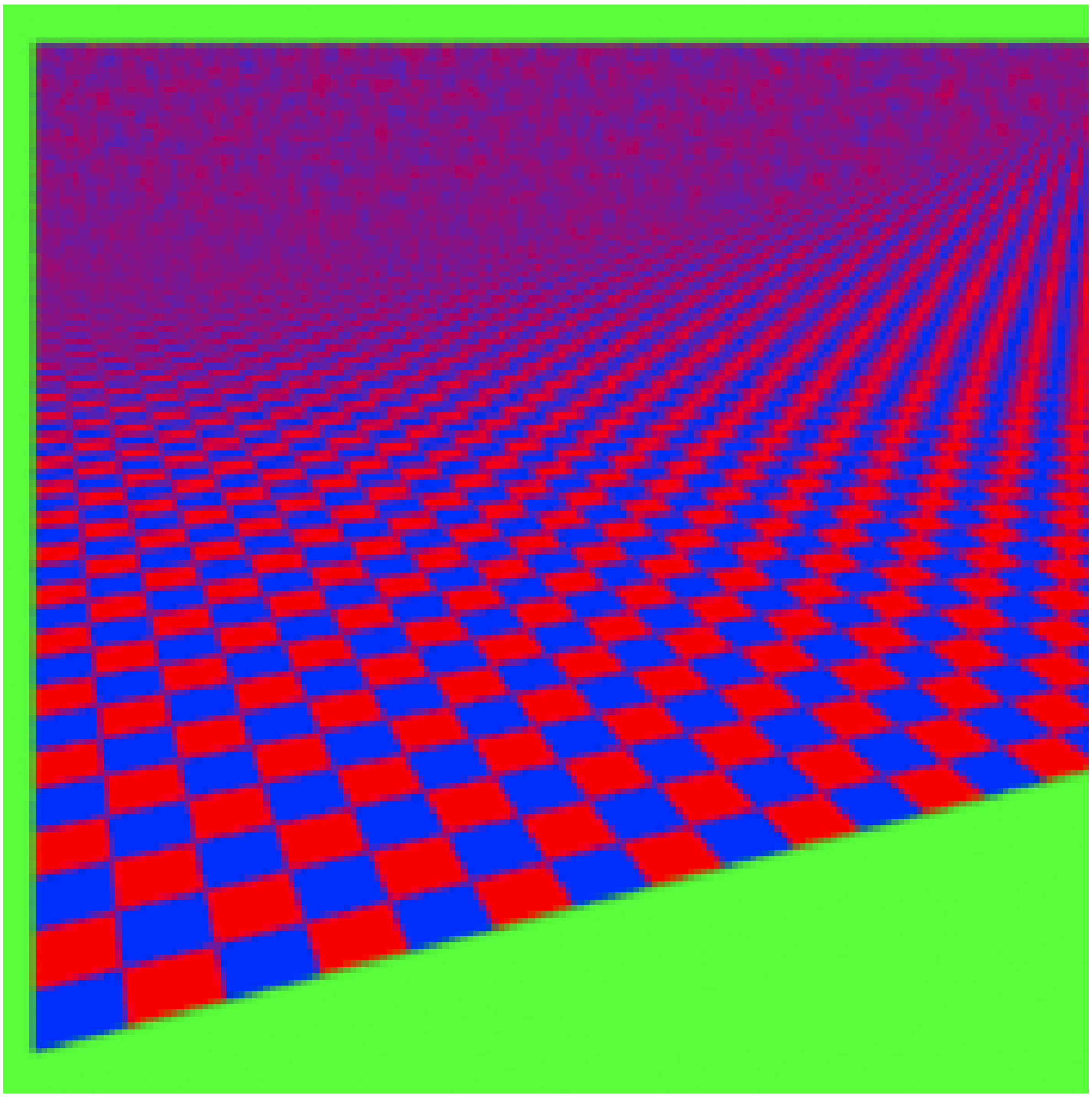




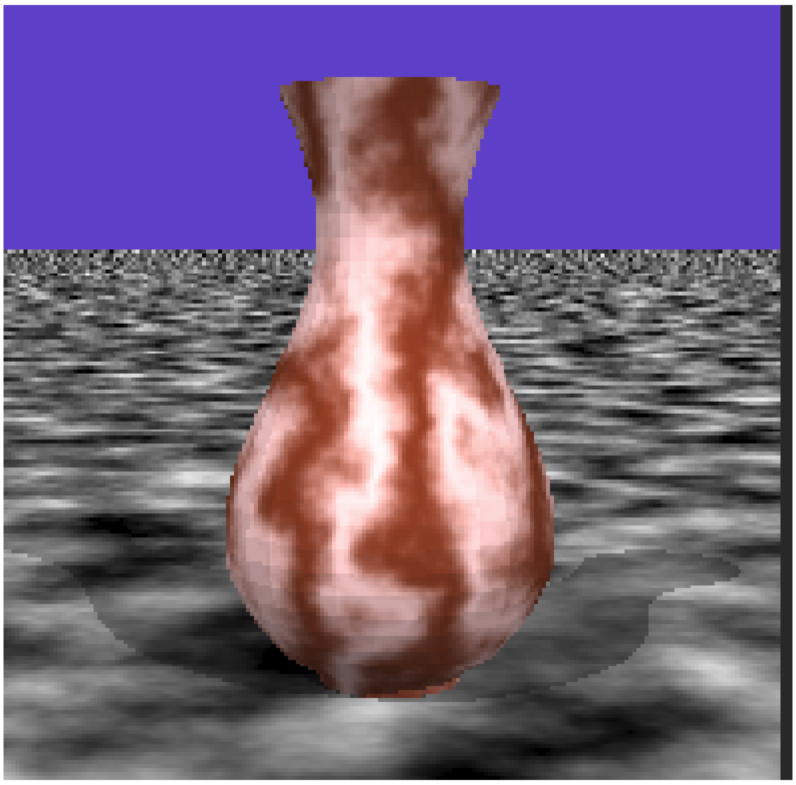
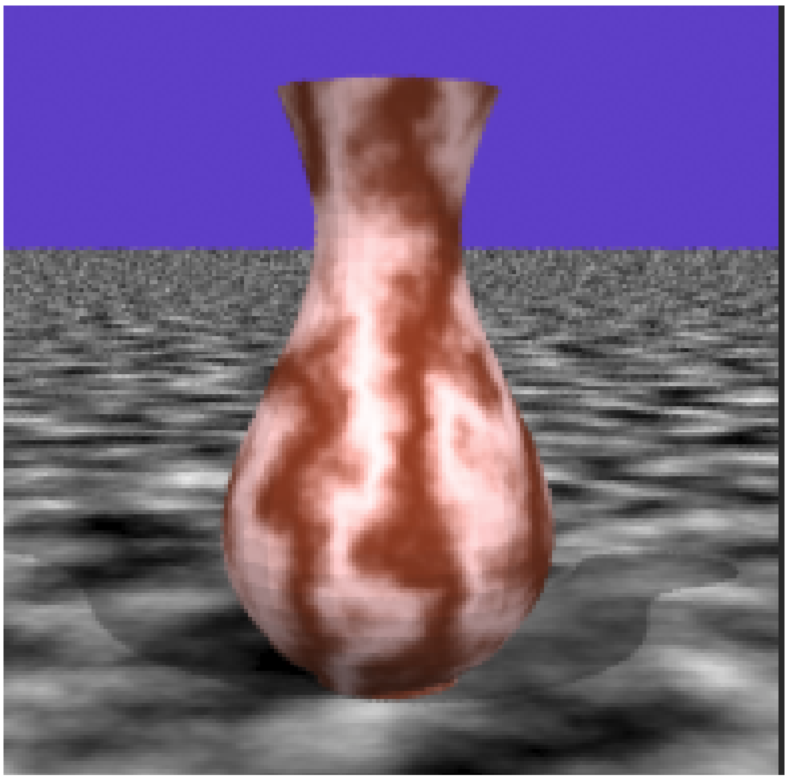


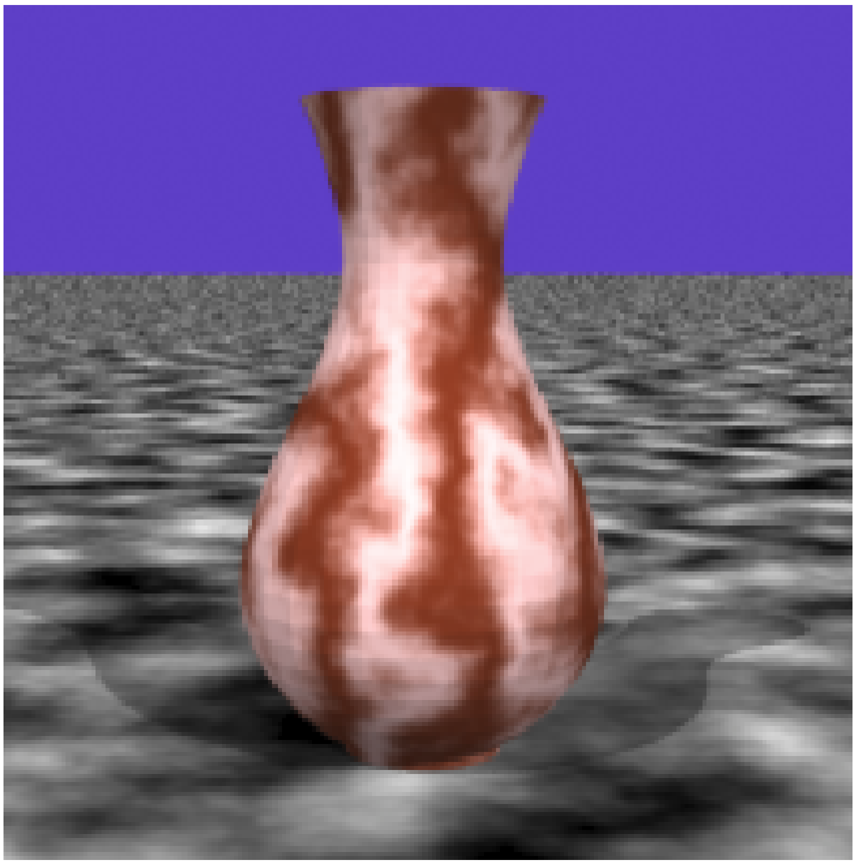


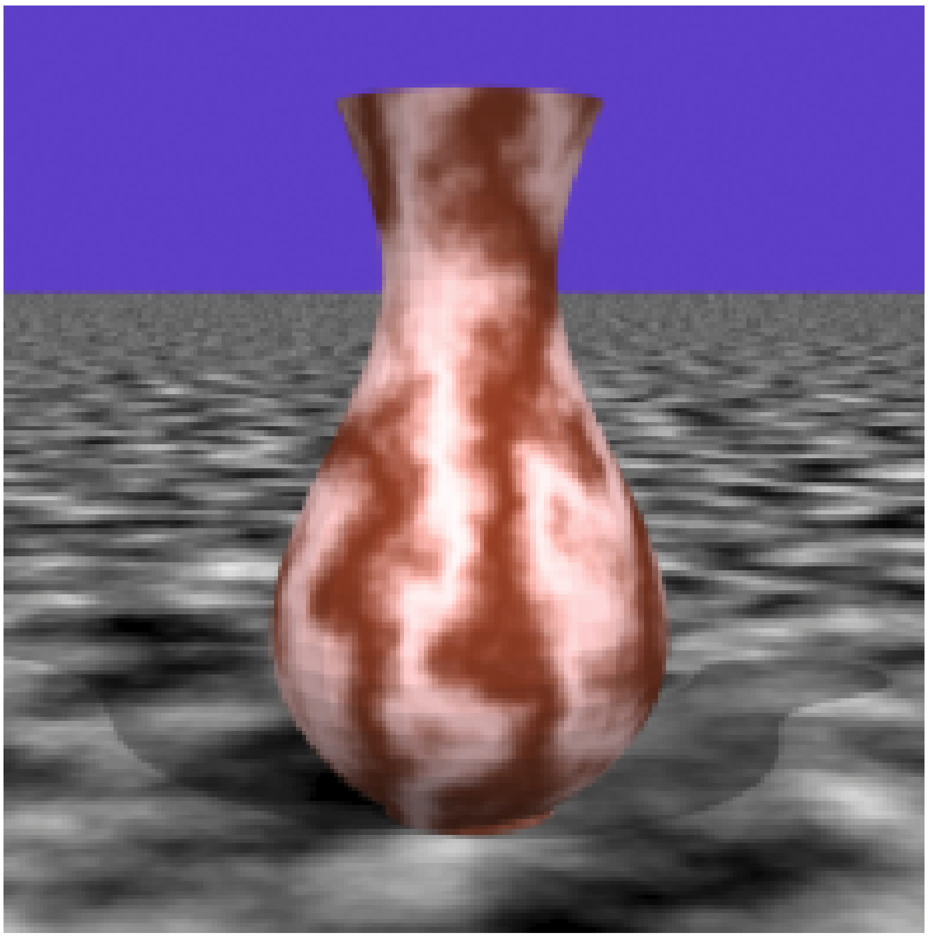




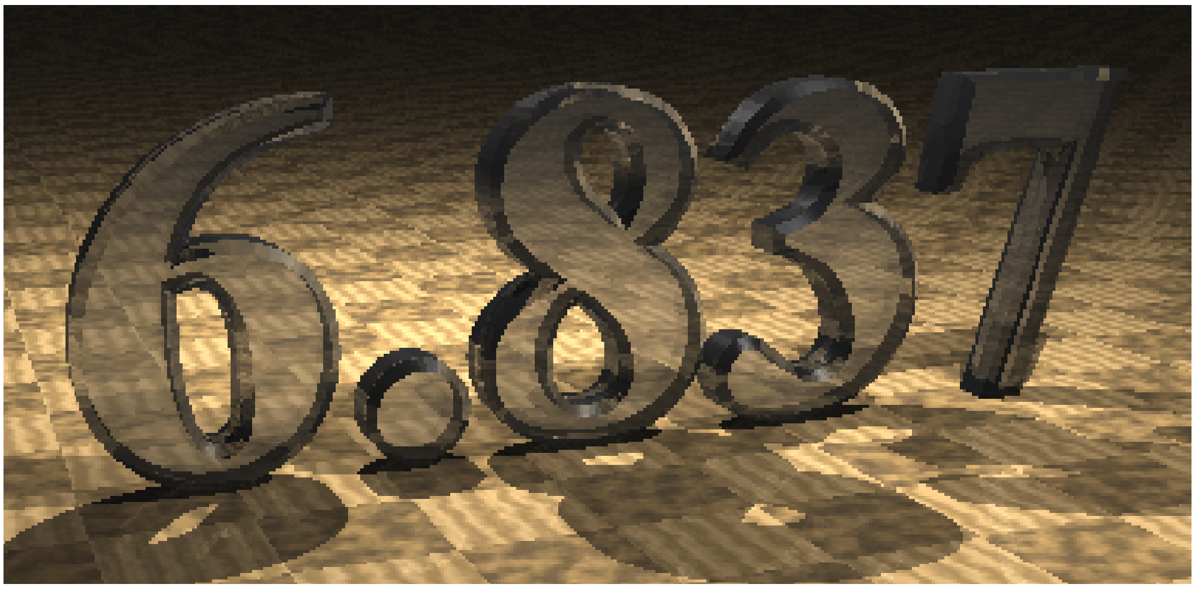
```
raytracer -input scene7_03_marble_vase.txt  -size 200 200 -output
output7_03a.tga -grid 15 30 15 -shadows
raytracer -input scene7_03_marble_vase.txt  -size 200 200 -output
output7_03b.tga -grid 15 30 15 -shadows -jittered_samples 4 -gaussian_filter 0.4
raytracer -input scene7_03_marble_vase.txt  -size 200 200 -output
output7_03c.tga -grid 15 30 15 -shadows -jittered_samples 9 -gaussian_filter 0.4
raytracer -input scene7_03_marble_vase.txt  -size 200 200 -output
output7_03d.tga -grid 15 30 15 -shadows -jittered_samples 36 -gaussian_filter
0.4
```

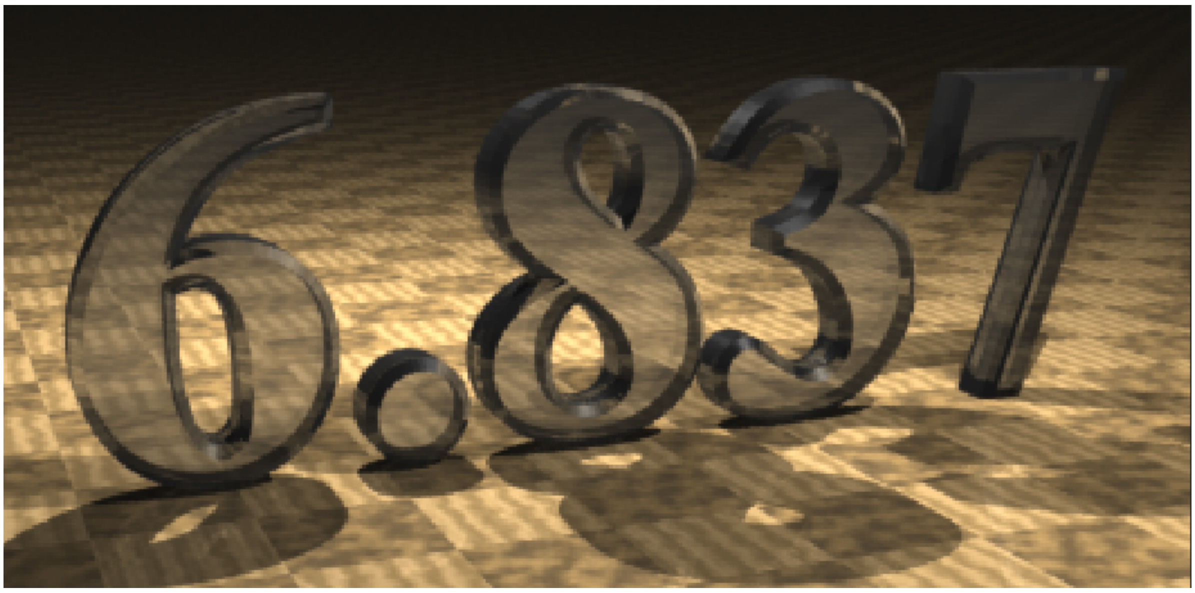





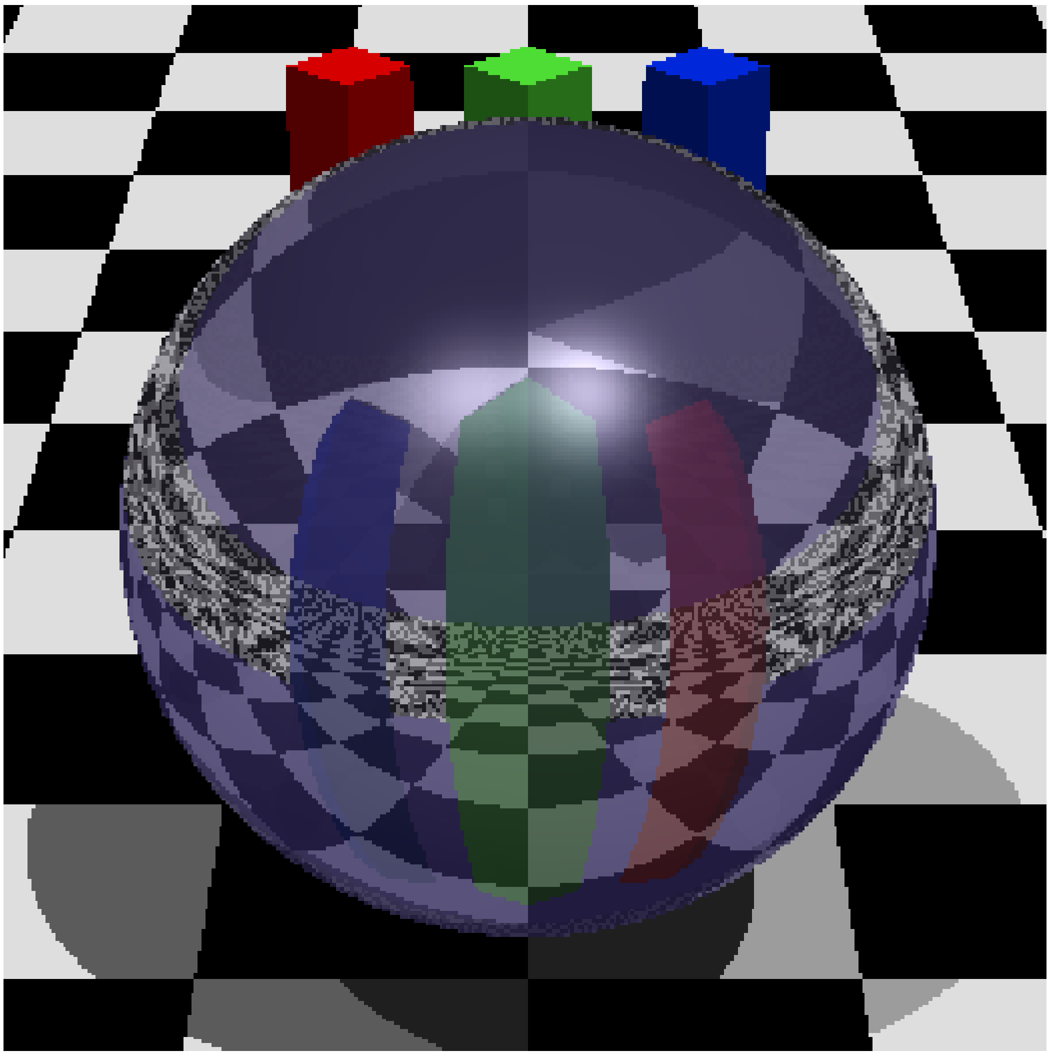


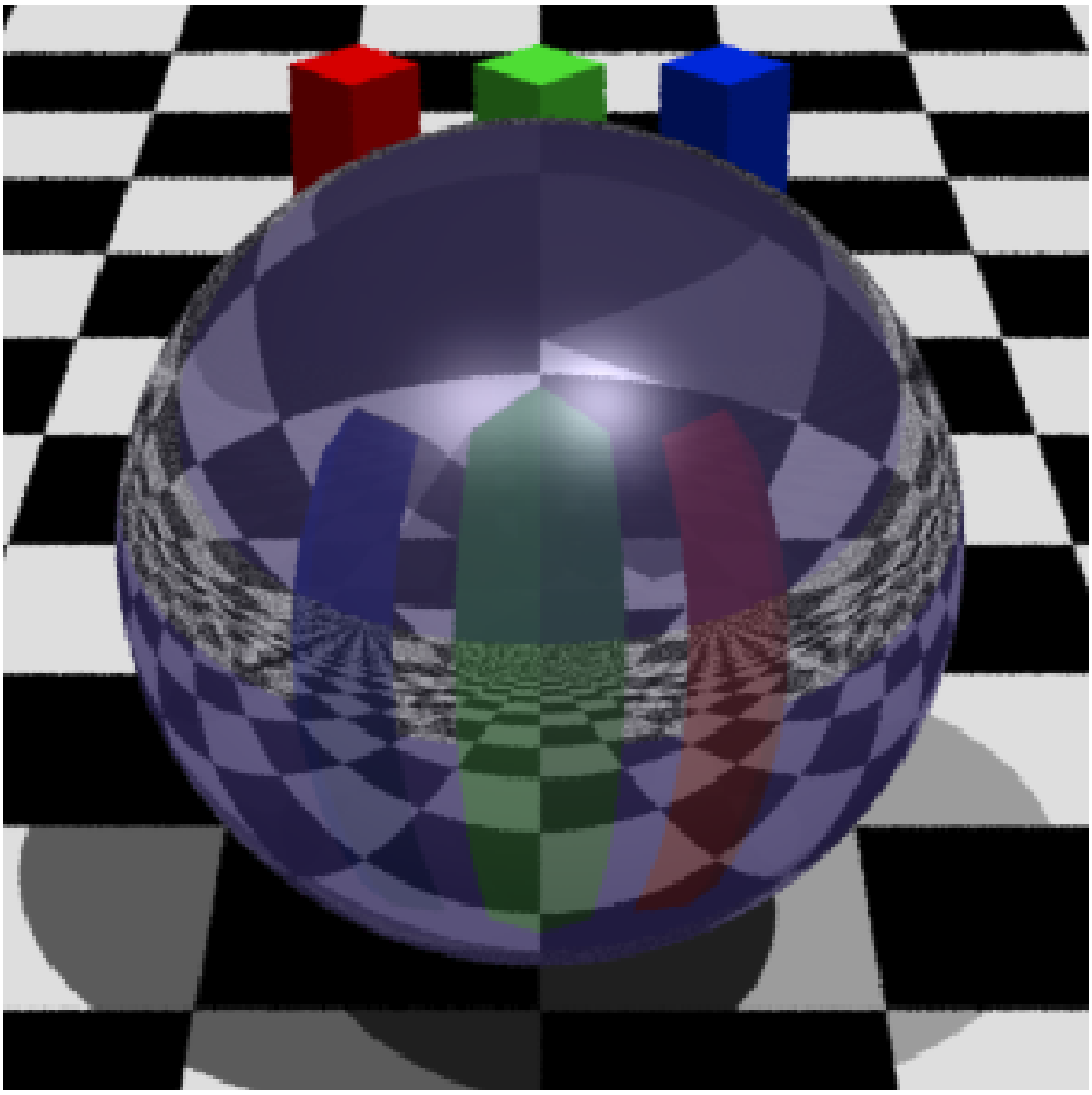
```
raytracer -input scene7_04_6.837_logo.txt   -size 400 200 -output
output7_04a.tga -shadows -shade_back -bounces 5 -weight 0.01 -grid 80 30 3
raytracer -input scene7_04_6.837_logo.txt   -size 400 200 -output
output7_04b.tga -shadows -shade_back -bounces 5 -weight 0.01 -grid 80 30 3 -
jittered_samples 9 -gaussian_filter 0.4
```

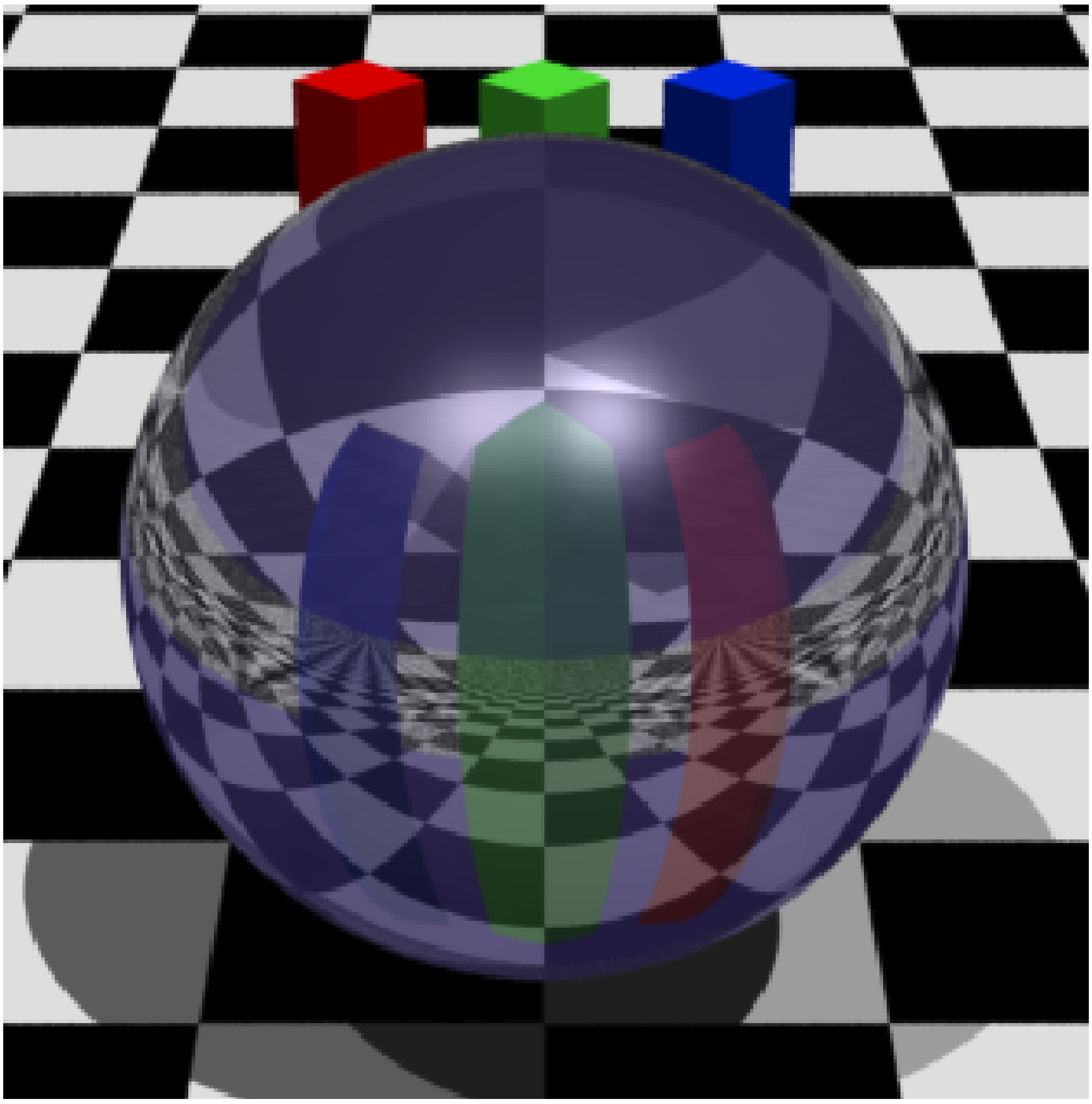




```
raytracer -input scene7_05_glass_sphere.txt -size 300 300 -output
output7_05a.tga -shadows -shade_back -bounces 5 -weight 0.01 -grid 20 20 20
raytracer -input scene7_05_glass_sphere.txt -size 300 300 -output
output7_05b.tga -shadows -shade_back -bounces 5 -weight 0.01 -grid 20 20 20 -
jittered_samples 4 -gaussian_filter 0.4
raytracer -input scene7_05_glass_sphere.txt -size 300 300 -output
output7_05c.tga -shadows -shade_back -bounces 5 -weight 0.01 -grid 20 20 20 -
jittered_samples 16 -gaussian_filter 0.4
```







```
raytracer -input scene7_06_faceted_gem.txt -size 200 200 -output output7_06a.tga
-shadows -shade_back -bounces 5 -weight 0.01 -grid 20 20 20
raytracer -input scene7_06_faceted_gem.txt -size 200 200 -output output7_06b.tga
-shadows -shade_back -bounces 5 -weight 0.01 -grid 20 20 20 -jittered_samples 9
-gaussian_filter 0.4
```