Assignment 1: Ray Casting

1 代码实现

1.1 Object3D类

```
class Object3D
{

public:
    virtual bool intersect(const Ray& r, Hit& h, float tmin) = 0;

    Object3D(Material* mat) : material(mat) {};
    Object3D() {};
    ~Object3D() {};

    Material* getMaterial()
    {
        return material;
    }

private:
    Material* material;
};
```

1.2 Sphere子类

使用代数法求交点

```
class Sphere : public Object3D
{

public:
    Sphere(const Vec3f center, const float radius, Material* mat) :
Object3D(mat), center(center), radius(radius) {}
    virtual bool intersect(const Ray& r, Hit& h, float tmin)
    {
        Ray raySphereSpace(r.getOrigin() - center, r.getDirection());
        float disRayOrigin = raySphereSpace.getOrigin().Length();

        float a =
raySphereSpace.getDirection().Dot3(raySphereSpace.getDirection());
        float b = 2 *
raySphereSpace.getDirection().Dot3(raySphereSpace.getOrigin());
```

```
        float c = raySphereSpace.getOrigin().Dot3(raySphereSpace.getOrigin()) -
radius * radius;
        float delta = b * b - 4 * a * c;
        if (delta < 0)
        {
            return false;
        }
        delta = sqrtf(delta);
        float t1 = (-b - delta) / (2 * a);
        float t2 = (-b + delta) / (2 * a);
        //cout << "t1:" << t1 << endl;
        //cout << "t2:" << t2 << endl;
        if (t1 > tmin && t1 < h.getT())
        {
            h.set(t1, getMaterial(), r);
            return true;
        }
        else if (t2 > tmin && t2 < h.getT())
        {
            h.set(t2, getMaterial(), r);
            return true;
        }
        return false;
    }

private:
    Vec3f center;
    float radius;
};
```

1.3 Group子类

```
class Group : public Object3D {
public:
    Group(){}
    Group(int num)
    {
        objectsNum = num;
        objects.reserve(objectsNum);
    }
    ~Group()
    {
        for(int i=0;i<objects.size();i++)
        {
            delete objects[i];
        }
    }
    void addObject(int index, Object3D* obj)
    {
        objects.insert(objects.begin()+index, obj);
    }

    virtual bool intersect(const Ray& r, Hit& h, float tmin)
    {
        bool flag=false;
        for (auto it = objects.begin(); it != objects.end(); it++)
        {
            flag|=(*it)->intersect(r, h, tmin);
        }
        return flag;

    }

private:
    int objectsNum;
    vector<Object3D*> objects;

};
```

1.4 Camera类

```
class Camera {
public:
    Camera() {}
    Camera(float tmin) :tmin(tmin) {}
    virtual Ray generateRay(Vec2f point) = 0;
    virtual float getTMin() const = 0;
private:
    float tmin;

};
```

1.5 正交相机类

tmin应设为-INFINITY

```
class OrthographicCamera : public Camera
{
public:
    OrthographicCamera() : Camera(-INFINITY) {}
    Ray generateRay(Vec2f point)
    {
        float pointX, pointY;
        point.Get(pointX, pointY);

        Vec3f origin = center + (pointX - 0.5) * size * horizontal + (pointY - 0.5) * size * up;
        //cout << "Origin: " << origin<<endl;
        return Ray(origin, direction);
    }

    virtual float getTMin() const
    {
        return tmin;
    }

    OrthographicCamera(Vec3f center, Vec3f direction, Vec3f up, float size) : Camera(-INFINITY), center(center), direction(direction), up(up), size(size)
    {
        this->direction.Normalize();
        this->up = this->up - this->direction * this->up.Dot3(this->direction);
        this->up.Normalize();
        Vec3f::Cross3(this->horizontal, this->direction, this->up);
        this->horizontal.Normalize();
    }

private:
    Vec3f center;
    float size;
    Vec3f horizontal;
    Vec3f up;
    Vec3f direction;
    float tmin;
};
```

1.6 构造Raytracer类

GenerateRayAtIndex函数可以根据当前遍历像素的index构造一个对应的Ray

```
class Raytracer
{
public:
    Raytracer()
    {
        assert(0);
    }

    Raytracer(char *input_file, int width, int height, char *output_file, char
*depth_file) : input_file(input_file), width(width), height(height),
output_file(output_file),depth_file(depth_file)
    {
        scene = new SceneParser(input_file);
        hits= new Hit[width * height];
    }

    void doRaytrace();
    ~Raytracer();

private:
    char *input_file;
    SceneParser *scene;
    char *output_file;
    char *depth_file;
    int width;
    int height;
    Hit* hits;
    float maxT=-INFINITY;
    float minT=INFINITY;


    Ray GenerateRayAtIndex(int index)
    {
        int xindex=index%width;
        int yindex = index / width;
        Vec2f point((float)xindex / (float)(width-1), (float)yindex / (float)
(height-1));
        //float d0, d1;
        //point.Get(d0, d1);
        //cout << "pointInfo:" << d0<< " " <<d1<< endl;
        return scene->getCamera()->generateRay(point);
    }

};
```

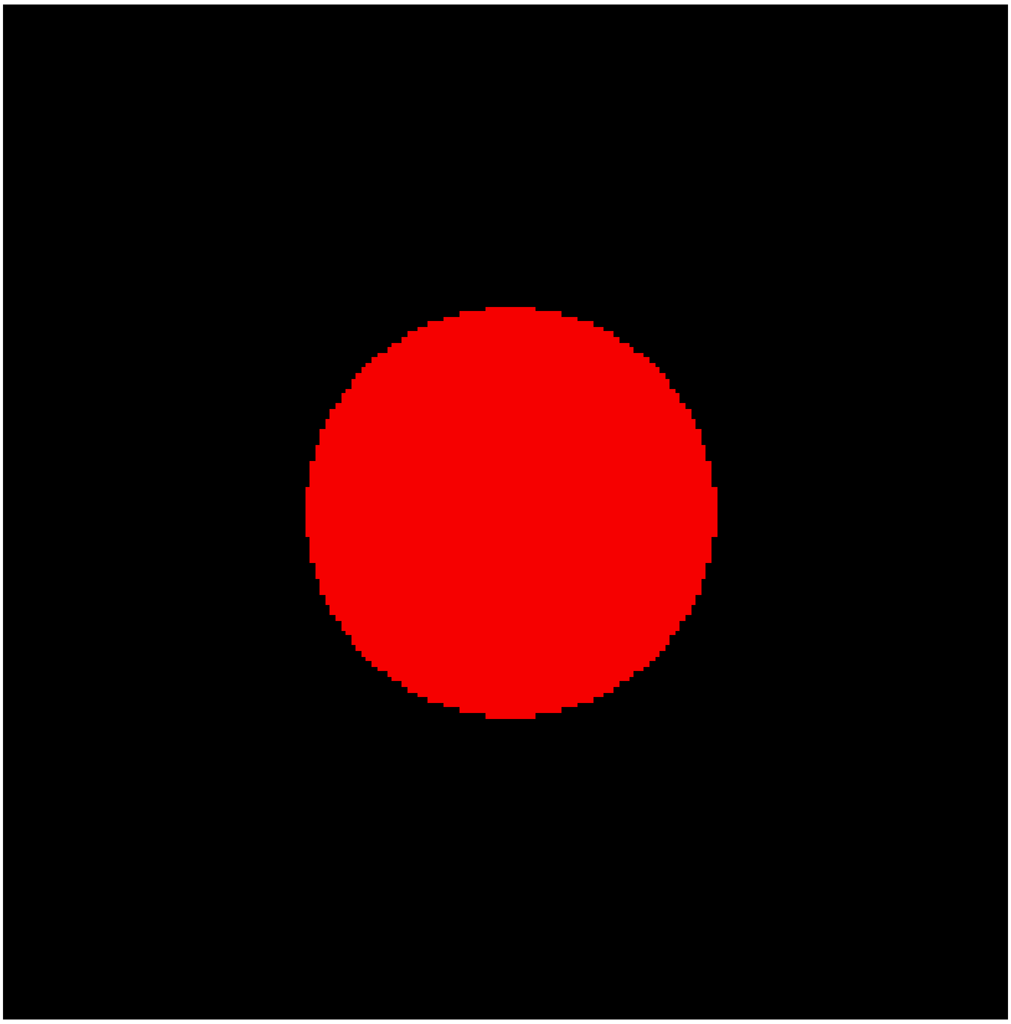
1.7 doRaytrace()

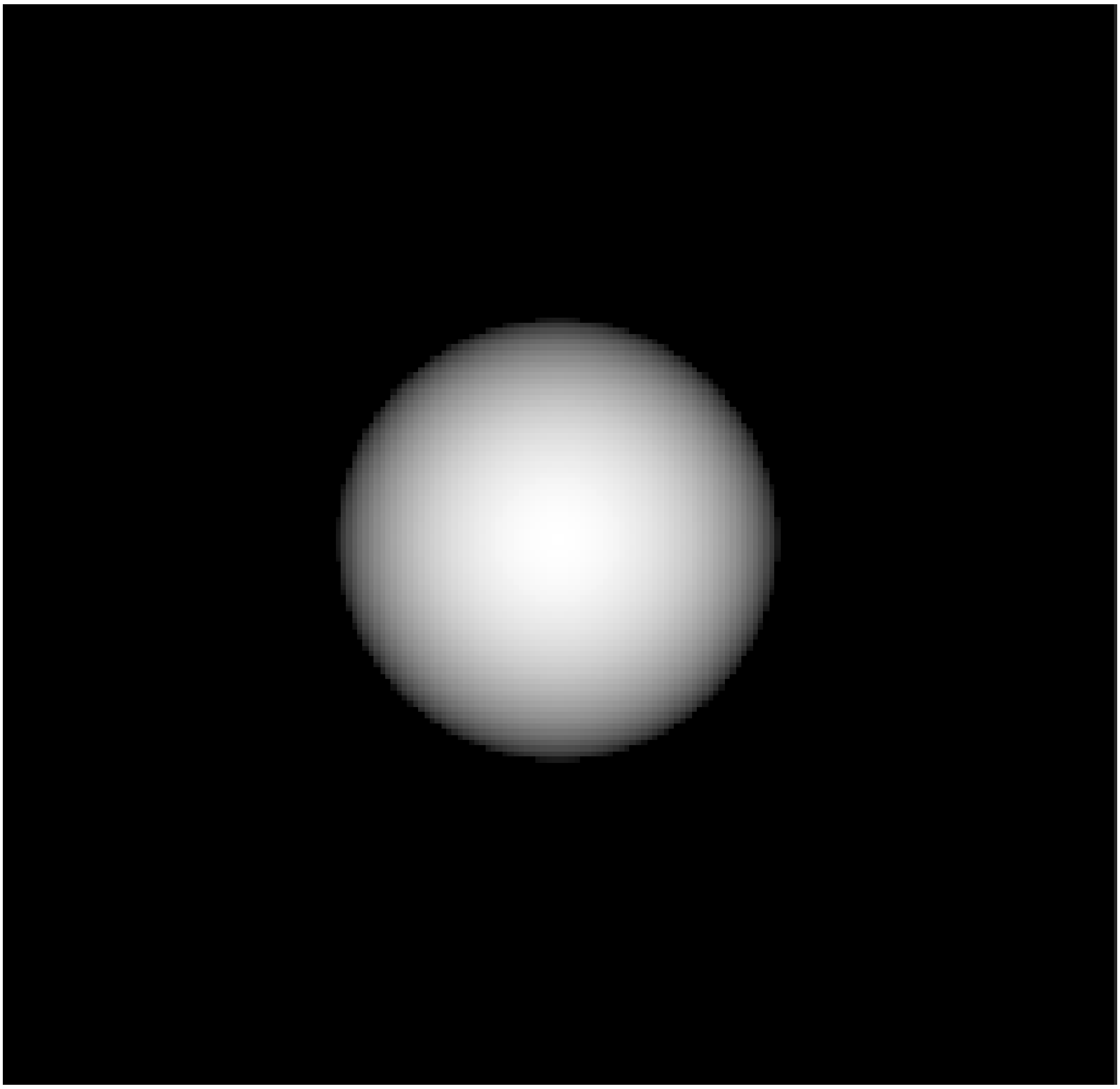
该函数循环所有像素构造光线并调用group->intersect与场景求交，最后输出颜色值和深度值到文件

```
    void doRaytrace()
    {
        Material mat(Vec3f(1, 0, 0));
        for (int i = 0; i < width * height; i++)
        {

            bool hasIntersect =scene->getGroup()-
>intersect(GenerateRayAtIndex(i), hits[i], scene->getCamera()->getTMin());
            if (!hasIntersect)
            {
                hits[i].setBackgroundMaterial(scene->getBackgroundMaterial());
            }
            float nowT = hits[i].getT();
            if (nowT != INFINITY&&nowT > maxT )
            {
                maxT = nowT;
            }
            if (nowT != INFINITY && nowT < minT)
            {
                minT = nowT;
            }
        }

        Image outputImage(width, height);
        for (int i = 0; i < width * height; i++)
        {
            int x = i % width;
            int y = i / width;
            outputImage.SetPixel(x, y, hits[i].getMaterial()-
>getDiffuseColor());
        }
        outputImage.SaveTGA(output_file);

        Image depthImage(width, height);
        for (int i = 0; i < width * height; i++)
        {
            int x = i % width;
            int y = i / width;
            //float t = hits[i].getT();
            float t = (maxT - hits[i].getT()) /(maxT-minT);
            //cout << "t " << t << endl;
            Vec3f depthColor(t, t, t);
            depthImage.SetPixel(x, y, depthColor);
        }

        depthImage.SaveTGA(depth_file);

    }
```

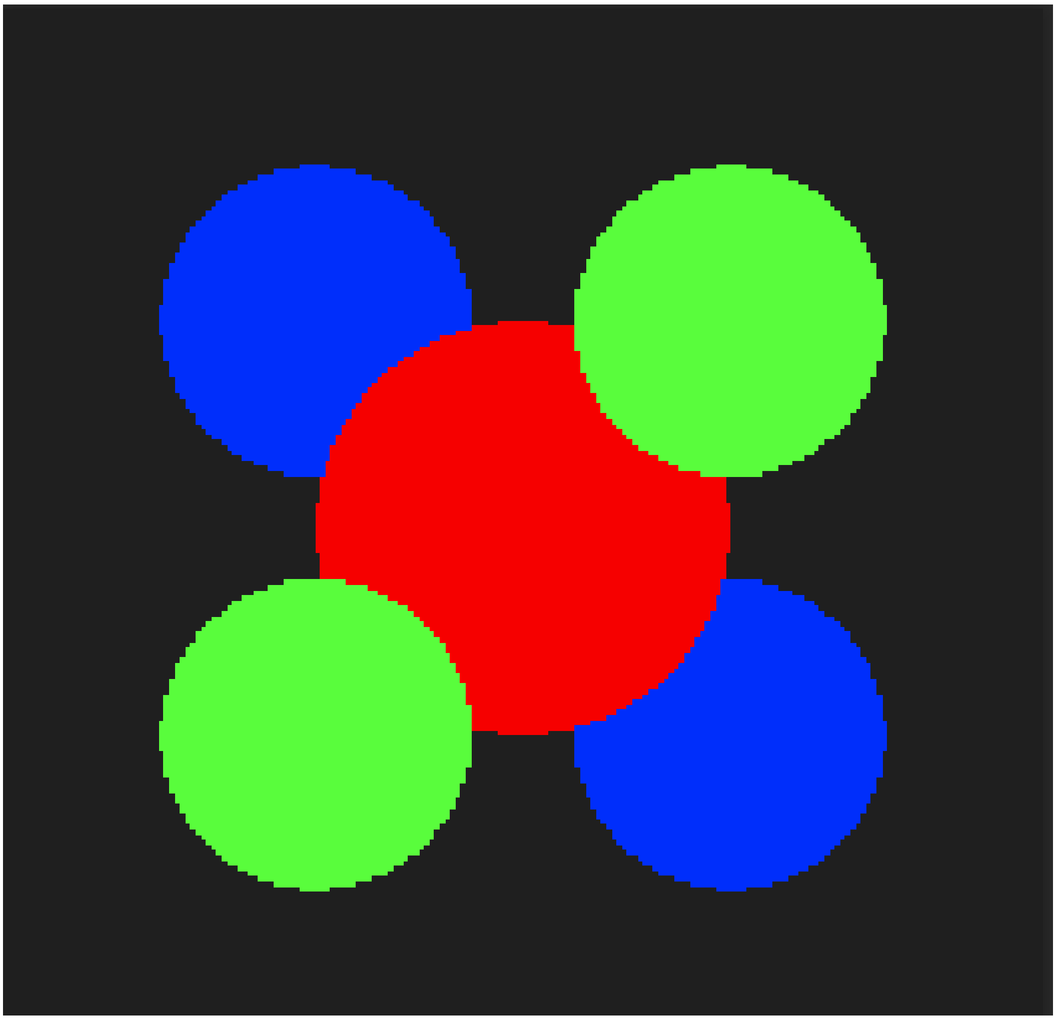
2 实验结果

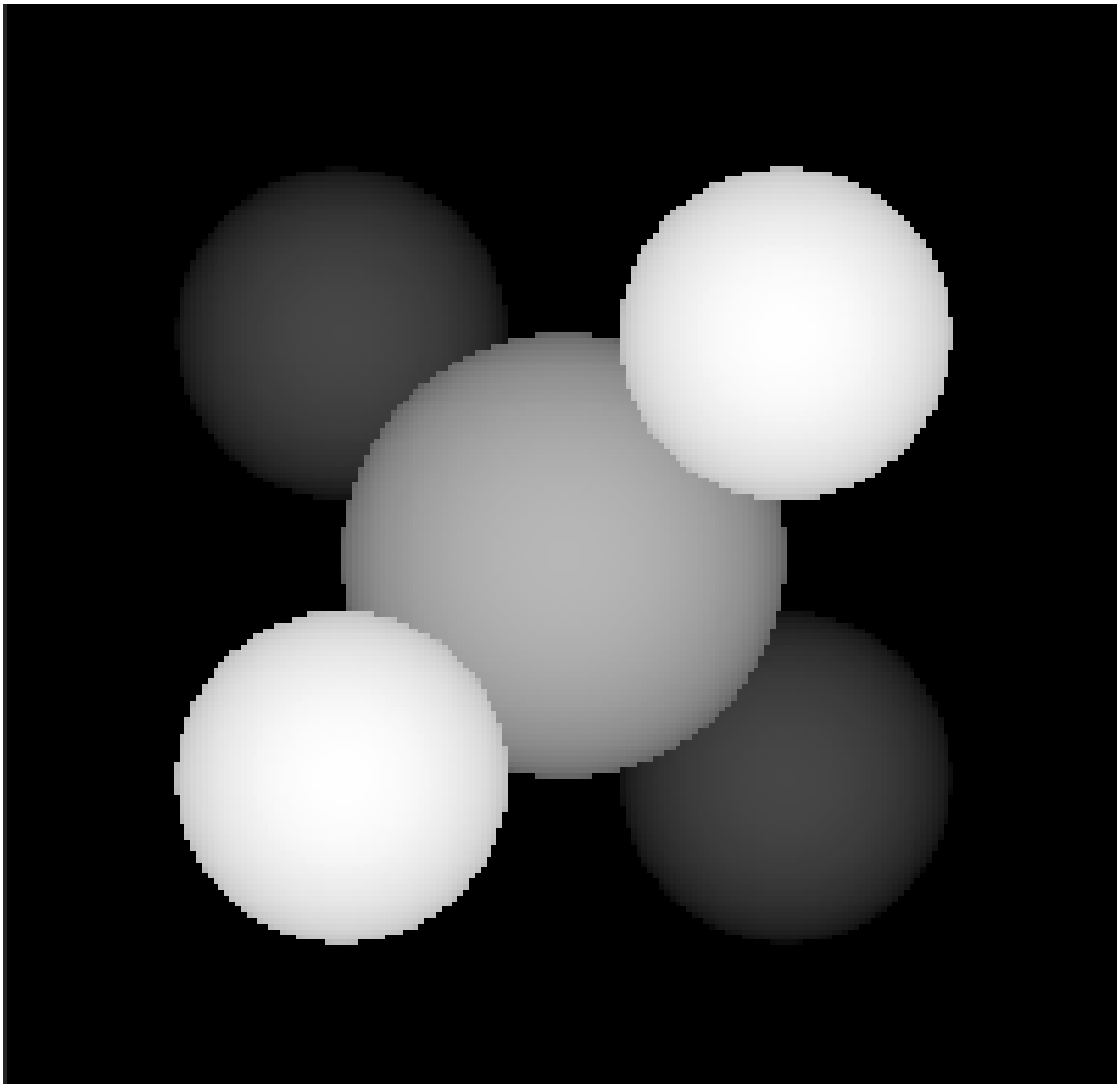
```
raytracer -input scene1_01.txt -size 200 200 -output output1_01.tga -depth 9 10
depth1_01.tga
```



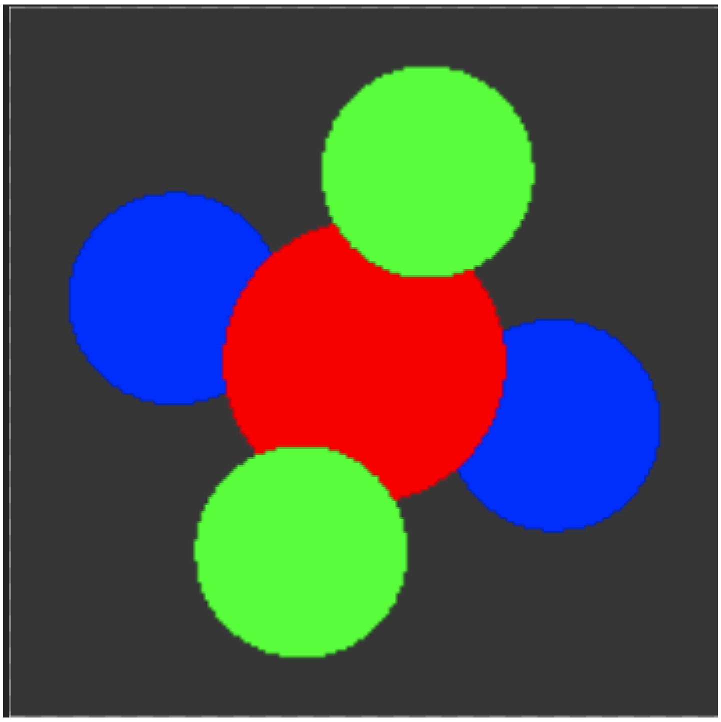


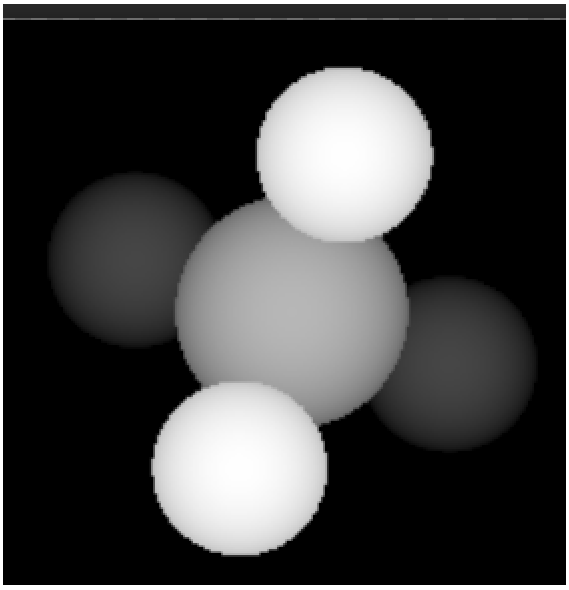
```
raytracer -input scene1_02.txt -size 200 200 -output output1_02.tga -depth 8 12 depth1_02.tga
```



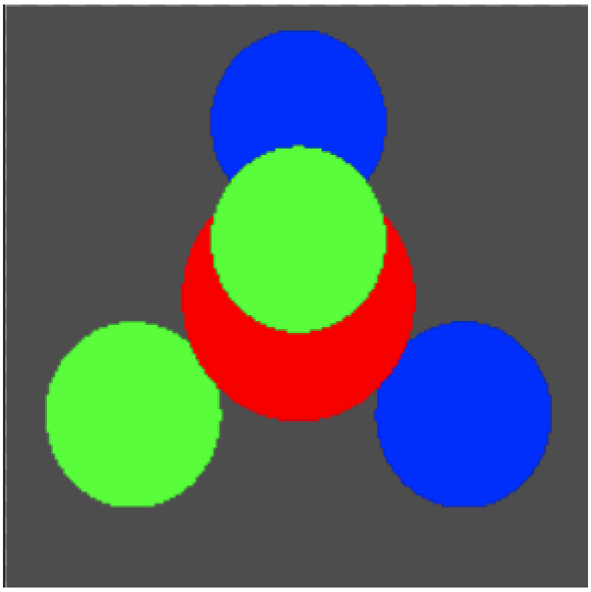


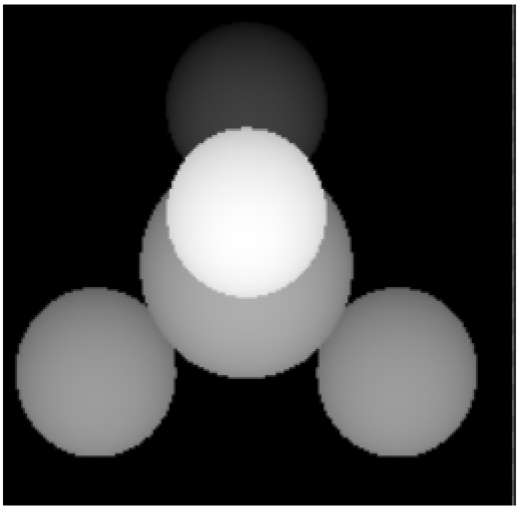
```
raytracer -input scene1_03.txt -size 200 200 -output output1_03.tga -depth 8 12
depth1_03.tga
```



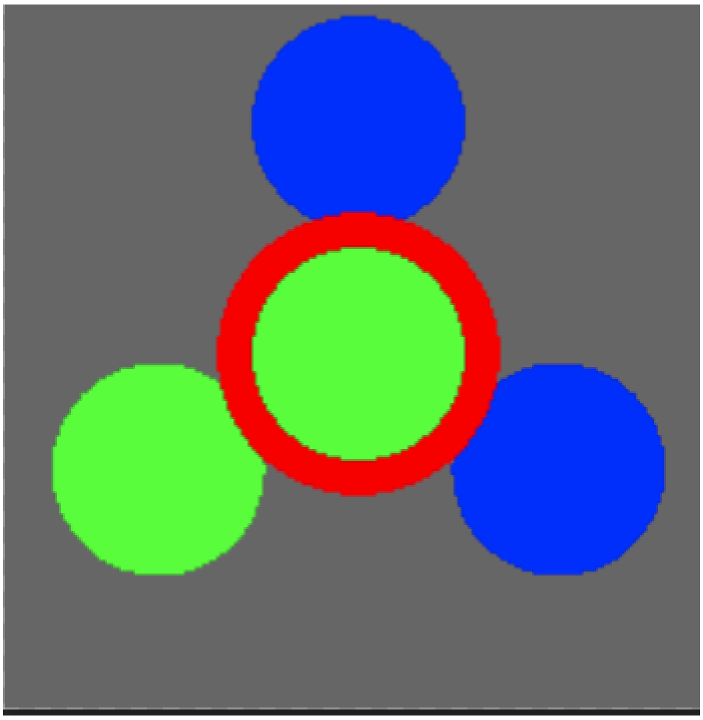


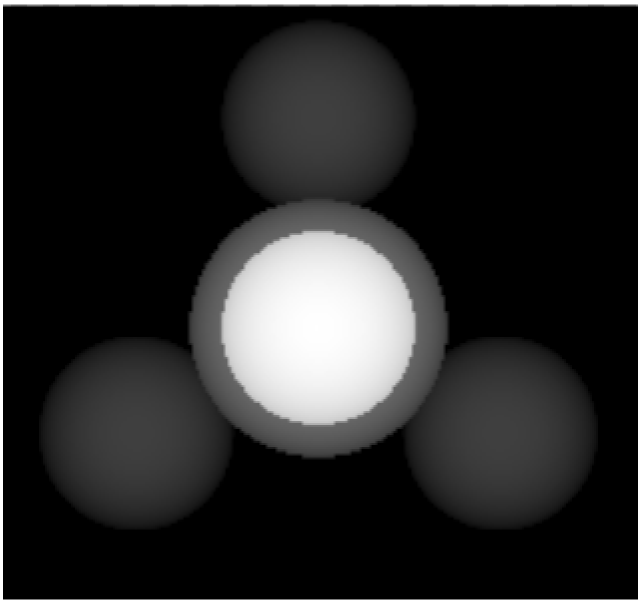
```
raytracer -input scene1_04.txt -size 200 200 -output output1_04.tga -depth 12 17
depth1_04.tga
```



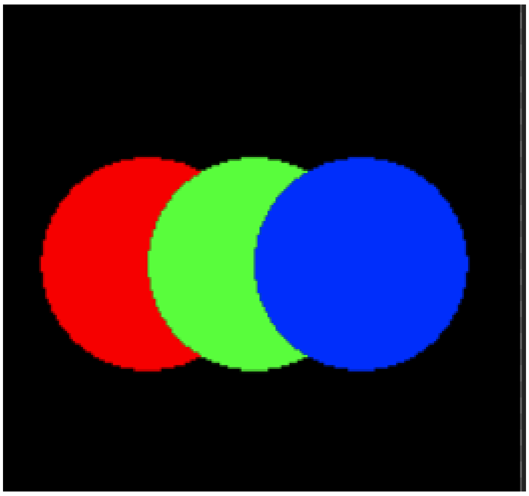


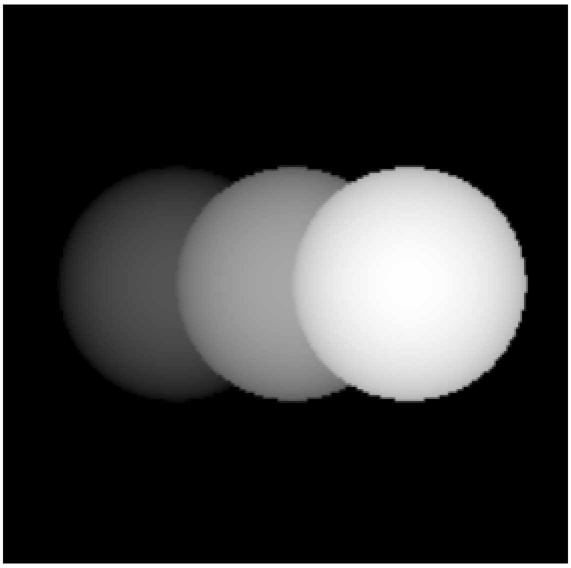
```
raytracer -input scene1_05.txt -size 200 200 -output output1_05.tga -depth 14.5
19.5 depth1_05.tga
```





```
raytracer -input scene1_06.txt -size 200 200 -output output1_06.tga -depth 3 7
depth1_06.tga
```





```
raytracer -input scene1_07.txt -size 200 200 -output output1_07.tga -depth -2 2
depth1_07.tga
```