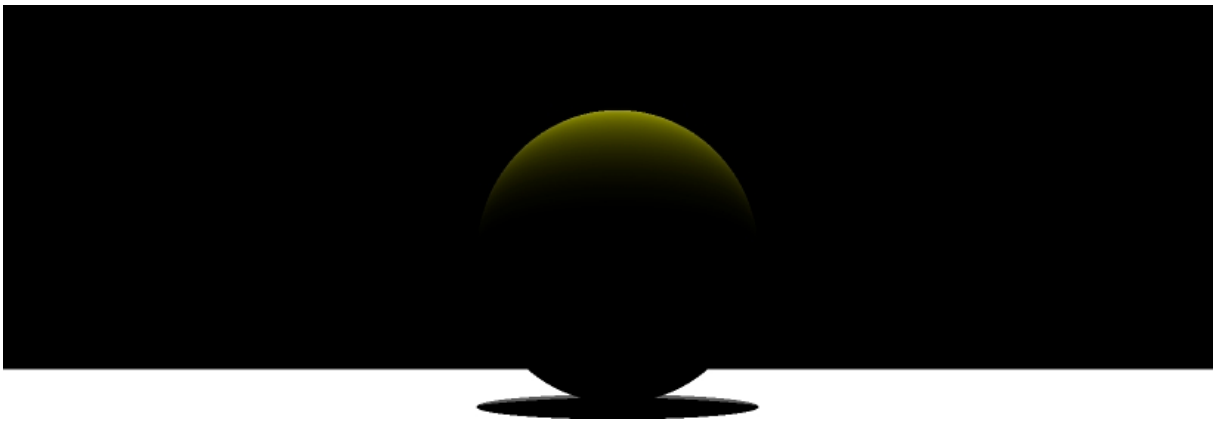
Raytracer

User documentation



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     - **Epitech Nantes PGE 2027. 2nd year.**

2. **Useful links (user):**
   - Github: https://github.com/Njord201/Raytracer

3. **The project:**
   The Raytracer project is being carried out in groups of 4 as part of the 2nd year at Epitech. The aim is to create raytracing software, i.e. to create a realistic image based on a scene supplied by the user, which can contain shapes, lighting effects, etc. When executed, the programme takes the link to a .cfg file (scene configuration) as a parameter and displays it directly on the screen.

4. **Supported by our Raytracer:**
   - **Primitives**
     - Sphere
     - Infinite cylinder
     - Plan
     - Cube
     - Infinite cone
     - Triangle
     - .OBJ files
       - Primitive materials (flatColor: flat colour)
   - **Camera**
     - Resolution
     - Position
     - Rotation
     - FOV (Field of View)
   - **Lights**
     - Ambient light
     - Diffused light
     - Light points
     - Directional lights
     - Shadows
   - **Transformations:**
     - Rotation
     - Translation
   - **Scenes**:
     - Loading a scene from a scene

5. **Dependencies:**

Make sure that these dependencies are met on your system so that the Raytracer works correctly.

- Make
- G++ (C++ compiler)
- SDL2
- Git (Have user logged in)

6. **Installing + running Raytracer:**
   - Open your terminal
   - Type "**git clone** https://github.com/Njord201/Raytracer.git"
   - Type "**cd Raytracer/**"
   - To compile the Raytracer properly, type "**make re**".
   - To run it, type "**./Raytracer {path_file.cfg}**" and enter a valid configuration file. Or **-help** for help.

7. **Scenes (configuration):**
    I. **Preamble:**

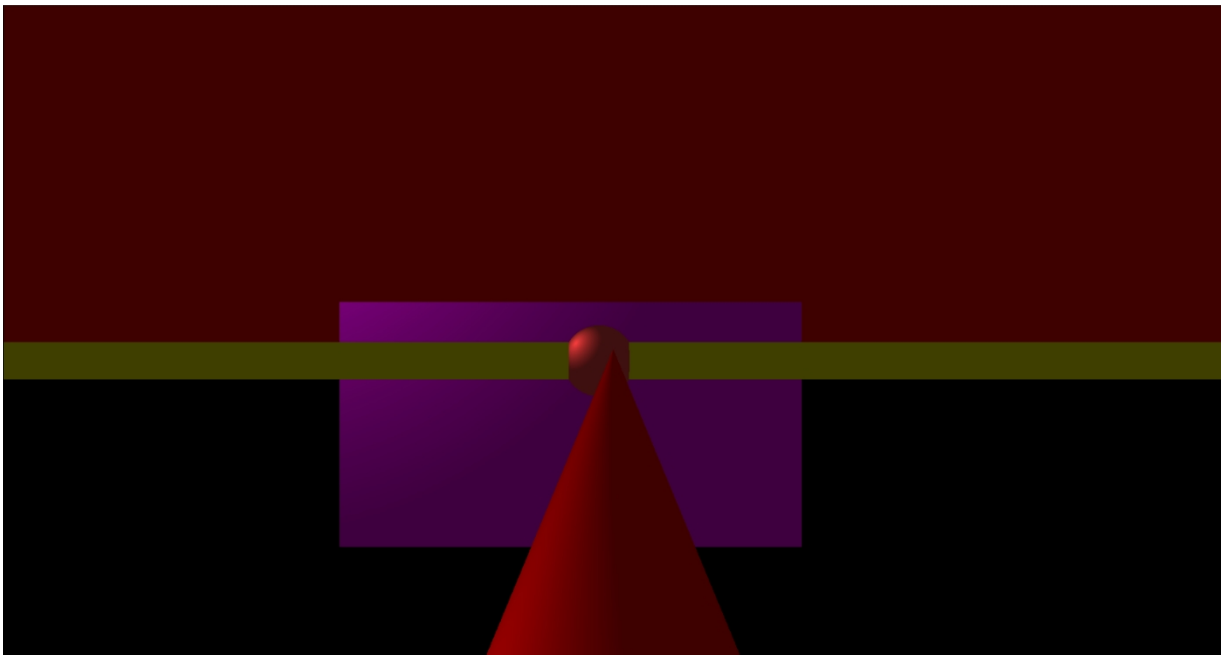
When you run Raytracer, you provide a link to a .cfg file. Several examples are available in **tests/files_samples/**.

Your configuration files, in English, must follow the Libconfig file format, like this one:

```
camera :
{
    resolution = { width = 1920; height = 1080; };
    position = { x = 0.0; y = -0.0; z = 0.0; };
    rotation = { x = 0.0; y = 0.0; z = 0.0; };
    fieldOfView = 72.0; # In degree
};
# Primitives in the scene
primitives :
{
    # List of spheres
    spheres = (
    { x = 6; y = -5; z = 200; r = 15; material = { type = "flatColor"; color = { r = 255; g = 64; b = 64;};};},
    ) ;

    # List of cylinders
    cylinders = (
    { x = 6; y = -5; z = 200; r = 10; axis="X"; material = { type = "flatColor"; color = { r = 255; g = 255; b = 0;};} },
    );

    #list of cones
    cones = (
        { x = 0; y = 0; z = 100; angle = 45; axis="Y"; material = { type = "flatColor"; color = { r = 255; g = 0; b = 0;};} }
    );

    #list of planes
    planes = (
        { position = 500; axis="Y"; rotation = { x = 0.0; y = 0.0; z = 0.0; }; material = { type = "flatColor"; color = { r = 255; g
= 0; b = 0;};} }
    );

    # List of rectangulars cuboids
    rectangular_cuboids = (
    { minX = -200; minY = -105; minZ = 250; maxX = 45; maxY = 25; maxZ = 260; material = { type = "flatColor"; color = { r = 255; g =
0; b = 255;};}; translation = {x = 100, y = 0, z = 0};},
    );
};
# Light configuration
lights :
{
    ambient = 0.5; # Multiplier of ambient light
    diffuse = 0.6; # Multiplier of diffuse light
    # List of point lights
    point = (
        {x = 200; y = 150; z = 0;},
    );
    # List of directional lights
    directional = (
        {position = {x = 0; y = 500; z = 10;};  direction = {x = 0; y = 0; z = 0;} }
    );
};
imports : {
    scenes = (
        {path = "tests/files_examples/subjects/subject2.cfg"},
    );
};
```

As you can see, we can configure the camera, the primitives and the lights. All three are mandatory. The imports are optional.

Result with our Raytracer on 10/05/2024 for this scene:



II. **Camera configuration:**

```
camera :
{
    resolution = { width = 1920; height = 1080; };
    position = { x = 0.0; y = -0.0; z = 0.0; };
    rotation = { x = 0.0; y = 0.0; z = 0.0; };
    fieldOfView = 72.0; # In degree
};
```

Camera takes:

- **Resolution**
  - "width
  - "height
- **Position**
  - **"x" "y" "z**
- **Rotation**
  - **"x" "y" "z**
- The "**fieldOfView**" field of view **increases by degrees.**

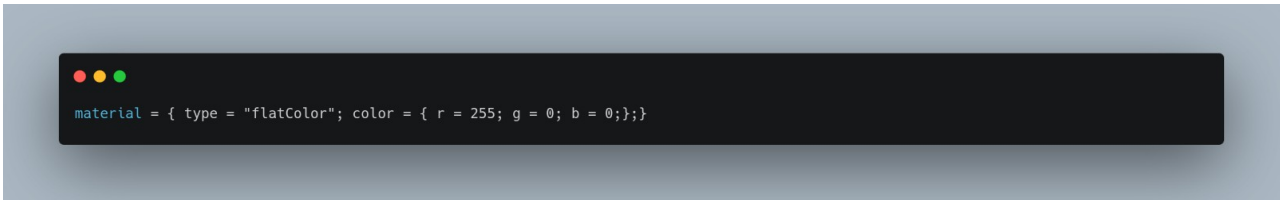
III. Configuring primitives:

For each primitive (cylinders, spheres, etc.), you can specify several.

```
primitives :
{
    #ici les primitives
};
```

a. Colour/Materials of the primitives

We support flatColor. You can find this material in the following configurations.



```
material = { type = "flatColor"; color = { r = 255; g = 0; b = 0;};}
```

A **material** takes parameters:

- **Type** (flatColor available).
- **Color,** itself taking **"r" "g" "b"** for the rgb colour of the flatColor.

b. Spheres

```
spheres = (
    { x = 6; y = -5; z = 200; r = 15; material = { type = "flatColor"; color = { r = 255; g = 64; b = 64;};};},
) ;
```

A **sphere** takes parameters:

- **Origin "x" "y" "z"**.
- **Radius "r"**.
- **Material** (Cf. 7.III.a)**.**

c. **Cylinders**

A **cylinder** takes parameters:

- **Origin "x" "y" "z"**.
- **Radius "r"**.
- **Axis**.
- **Material** (Cf. 7.III.a)**.**

d. **Infinite cones**

A **cone** takes parameters:

- **Origin "x" "y" "z"**.
- **Angle "angle"** in degrees.
- **Axis "axis"** either "X" "Y" or "Z".
- **Material** (Cf. 7.III.a)**.**

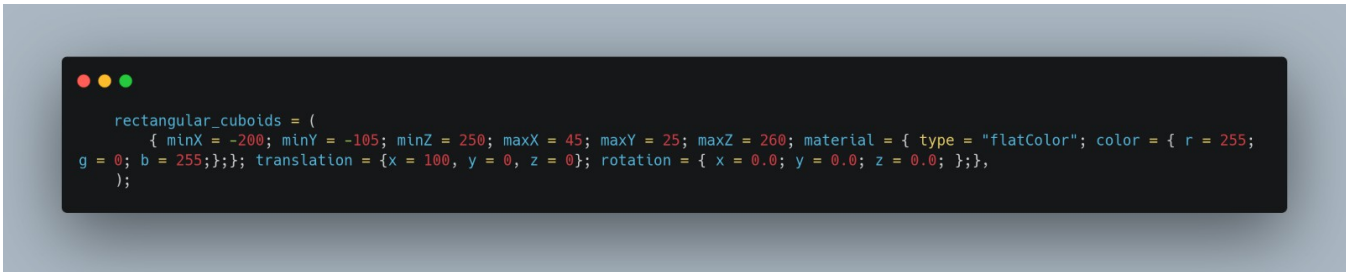
e. **Plans**

A plan takes into account the parameters:

- **Position**.

- **Axis "axis"** either "X" "Y" or "Z".
- **Material** (Cf. 7.III.a)**.**

f. Cubes

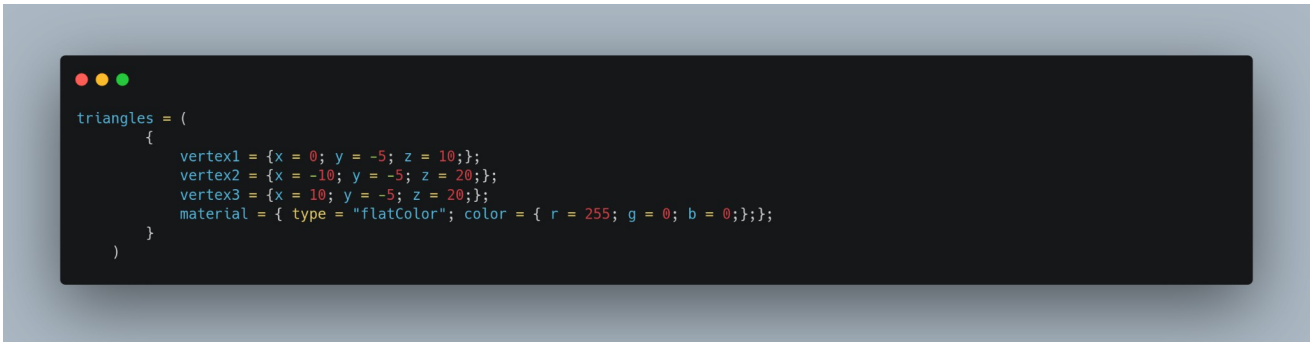


```
rectangular_cuboids = (
    { minX = -200; minY = -105; minZ = 250; maxX = 45; maxY = 25; maxZ = 260; material = { type = "flatColor"; color = { r = 255;
g = 0; b = 255;};}; translation = {x = 100, y = 0, z = 0}; rotation = { x = 0.0; y = 0.0; z = 0.0; };},
);
```

A cube takes parameters:

- **Coordinates of its points: "minX" "minY" "minZ" "maxX" "maxY" "maxZ"**.
- **Material** (Cf. 7.III.a)**.**
    - *Here is an example of translation + rotation*.

g. Triangles



```
triangles = (
        {
            vertex1 = {x = 0; y = -5; z = 10;};
            vertex2 = {x = -10; y = -5; z = 20;};
            vertex3 = {x = 10; y = -5; z = 20;};
            material = { type = "flatColor"; color = { r = 255; g = 0; b = 0;};};
        }
    )
```

A triangle takes parameters:

- **"vertex1"** comprising **"x" "y" "z"** the coordinates of an angle.
- **"vertex2"** comprising **"x" "y" "z"** the coordinates of an angle.
- **"vertex3"** comprising **"x" "y" "z"** the coordinates of an angle.
- **Material** (Cf. 7.III.a)**.**

h. .OBJ files

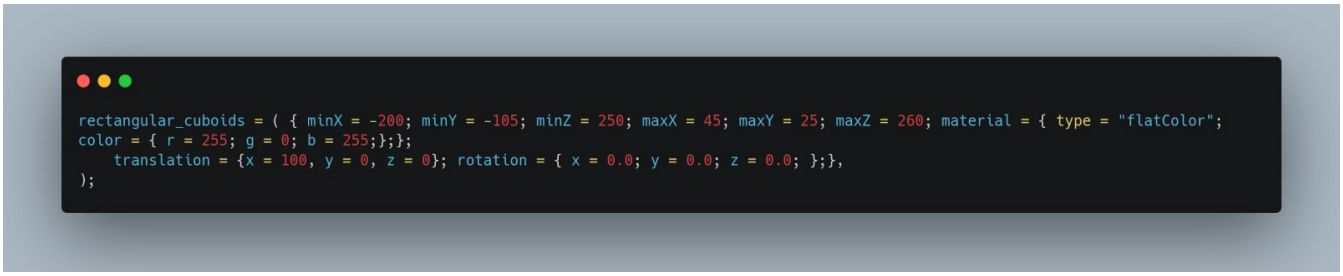
```
imports : {
    meshes = (
        {
            path = "tests/obj_files/cow-nonormals.obj";
            material = { type = "flatColor"; color = {  r = 255; g = 0; b = 0;};}
        }
    );
};
```

You can load an .obj file containing complex shapes (cows, etc.). To import an .obj file, go to **"meshes"** in **"imports".** Each mesh takes parameters:

- The link to the **"path"** file.
- A **material** (Cf. 7.III.a)**.**

i. Configuring primitive transformations

You can actually move your primitives in space.

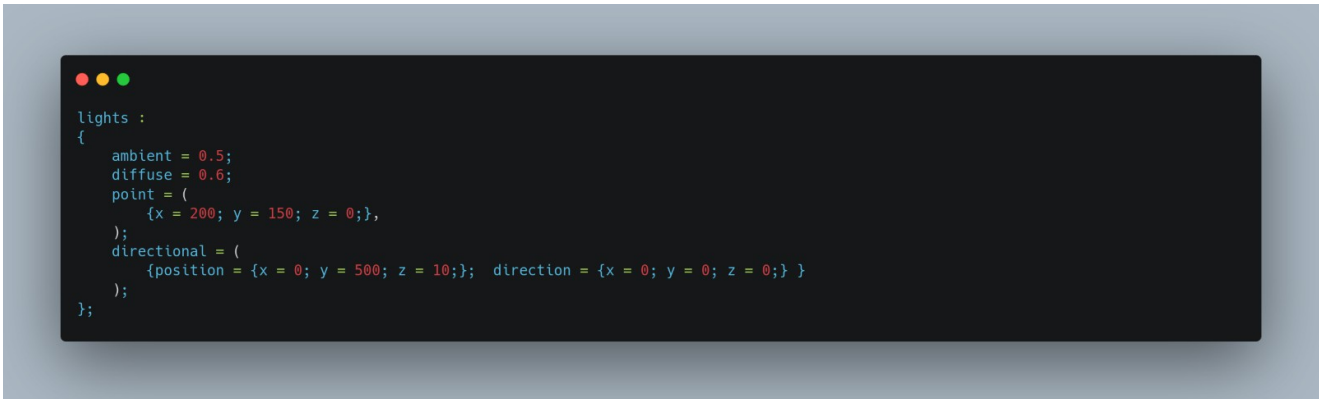


```
rectangular_cuboids = ( { minX = -200; minY = -105; minZ = 250; maxX = 45; maxY = 25; maxZ = 260; material = { type = "flatColor";
color = { r = 255; g = 0; b = 255;};};
    translation = {x = 100, y = 0, z = 0}; rotation = { x = 0.0; y = 0.0; z = 0.0; };},
);
```

Available in **translation** and **rotation**.

- **Rotation** takes **"x" "y" "z"**.
- **Translation** takes **"x" "y" "z"**.

IV. Configuring the lights:



```
lights :
{
    ambient = 0.5;
    diffuse = 0.6;
    point = (
        {x = 200; y = 150; z = 0;},
    );
    directional = (
        {position = {x = 0; y = 500; z = 10;};  direction = {x = 0; y = 0; z = 0;} }
    );
};
```

The **lights** take parameters:

- **Ambient** light, a multiplier.
- The diffusion of light, "**diffuse",** a multiplier.
- **"point"** or light points
    - **A point takes coordinates "x" "y" "z".**
- "directional lights
    - A directional light takes the parameter:
        - **x" "y" "z"** coordinates
        - Direction **"x" "y" "z**

V. Import configuration:

This "**imports**" configuration is optional. It is used to import another scene or a .cfg file from a scene. The **import** parameters**, primitives and lights** will be imported.

```
imports : {
    scenes = (
        {path = "tests/files_examples/subjects/subject2.cfg"},
    );
};
```

Imports can take scenes as parameters**,** each with a **path** link to the configuration.

Potential infinite loops are well managed, so if a file imports itself the program will detect it.