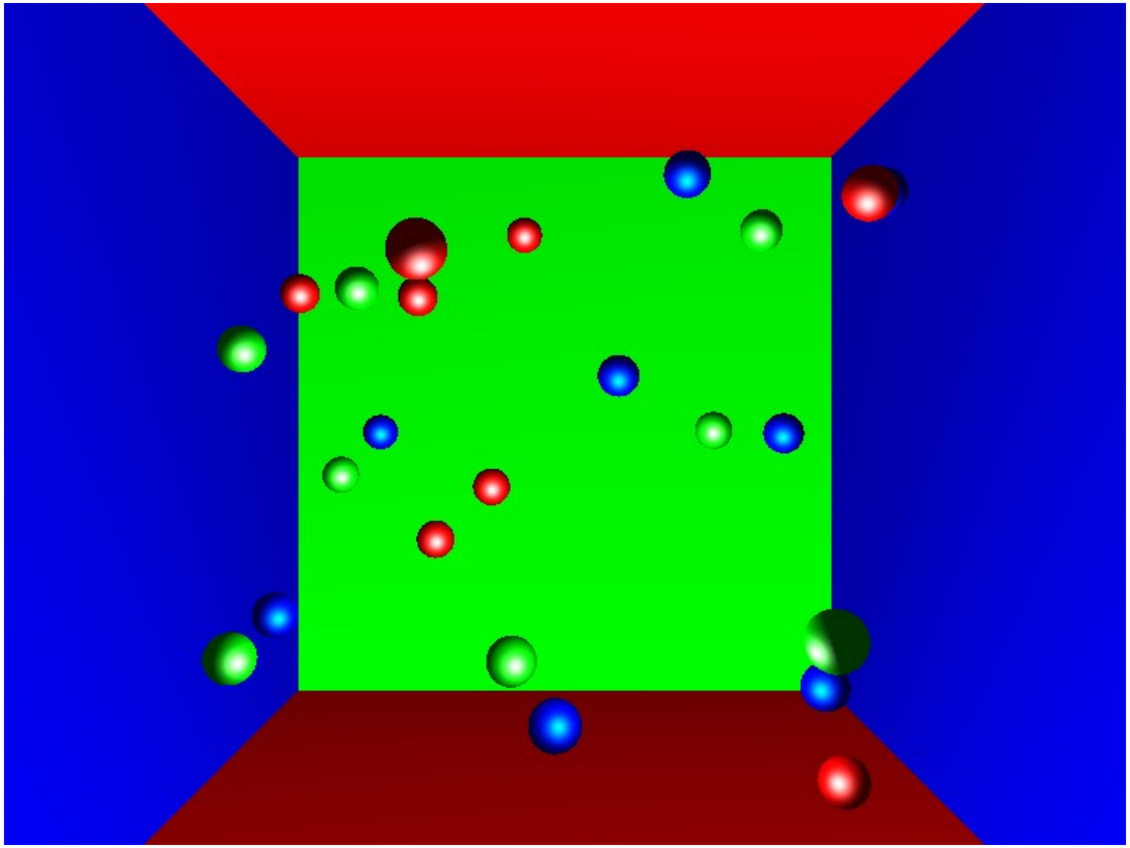
Simple Physics Engine



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What You Need to Do

- Runge-Kutta 4th Order
- Collision Detection
  - Elastic
  - 3 Different Kinds
- Springs
- Several Additional, yet small Physics calculations

Physics Review

- Newton's Second Law

$$F = ma$$

- Angular Acceleration

$$\tau = I\alpha$$

  - Only have to compute for spheres
  - Our spheres are uniformly dense, solid objects

$$I = \frac{2}{5} m r^2$$

Runge-Kutta 4

- You will have to use these equations when implementing Runge-Kutta
- Be careful when implementing, since floating point error can go poorly for you.
- See lecture slides for implementing this Differential Equation

Collisions: Sphere to Sphere

- First define the two spheres:

$$s_{1,} s_2$$

- There is a collision if the distance between the centers of the spheres is less than the sum of the radii.

$$length(s_1.p - s_2.p) < s_1.r + s_2.r$$

- An elastic collision is performed. The formula is clearly explained in the project description.

Collisions: Sphere to Plane

- First define the sphere and the plane

$$s, p$$

- If given a point on the plane and the normal of the plane, we can find the distance to the plane

$$d = p.n \cdot (s.p - p.p)$$

- If this distance is less than the radius of the sphere, there is a collision

Collisions: Sphere to Triangle

- You can use the same formula as used in plane collisions to find a point that is coplanar to the triangle.

$$s.p' = s.p - n(n \cdot (s.p - p.p))$$

- Using barycentric coordinates, you can check if the point is within the triangle. Is so use that and check the distance.
- Otherwise, project the point onto the edges and check the distance to those.

Collisions: Sphere to Triangle(cont)

- The following formula may be used to project a point onto a line defined by two points.

$$p' = a + \frac{((p-a)\cdot(b-a))(b-a)}{(b-a)^2}$$

- You can check the distance between these points and the center of the sphere.