Simulating Motion and Spatial Data Structures
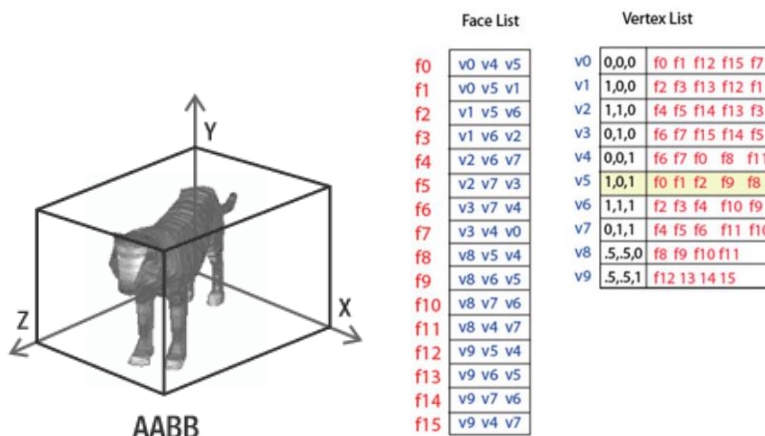
1. **Numerical Integration**
   Given a function for acceleration and an initial position and velocity,
   at a time t=0 we can approximate the function for position with
   respect to time by using Euler integration:

   $$p(t+1) = p(t) + \dot{p}(t)\Delta t \quad \text{and} \quad \dot{p}(t+1) = \dot{p}(t) + \ddot{p}(t)\Delta t$$

   What are two factors that influence the amount of error in our
   approximation?

2. **Axis-Aligned Bounding Box**

   Suppose we have a geometric model expressed as a triangle mesh in
   an indexed-face format. Describe an efficient way to compute an
   AABB that encloses the mesh.

Face List		Vertex List		
f0	v0 v4 v5	v0	0,0,0	f0 f1 f12 f15 f7
f1	v0 v5 v1	v1	1,0,0	f2 f3 f13 f12 f1
f2	v1 v5 v6	v2	1,1,0	f4 f5 f14 f13 f3
f3	v1 v6 v2	v3	0,1,0	f6 f7 f15 f14 f5
f4	v2 v6 v7	v4	0,0,1	f6 f7 f0 f8 f11
f5	v2 v7 v3	v5	1,0,1	f0 f1 f2 f9 f8
f6	v3 v7 v4	v6	1,1,1	f2 f3 f4 f10 f9
f7	v3 v4 v0	v7	0,1,1	f4 f5 f6 f11 f10
f8	v8 v5 v4	v8	.5,.5,0	f8 f9 f10 f11
f9	v8 v6 v5	v9	.5,.5,1	f12 13 14 15
f10	v8 v7 v6			
f11	v8 v4 v7			
f12	v9 v5 v4			
f13	v9 v6 v5			
f14	v9 v7 v6			
f15	v9 v4 v7			

AABB

3. Bounding Volume Hierarchy

    a. Draw the next 3 levels of a bounding volume hierarchy for the following objects below, splitting either on the median centroid or the average centroid. Split on the longest axis.
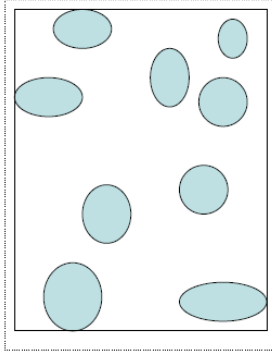
    b. Is it possible for two nodes in a BVH to intersect? If not, why not? If so, draw such a situation and describe in what way this will affect a collision detection system.