CS 498VR: Virtual Reality
In-class Worksheet

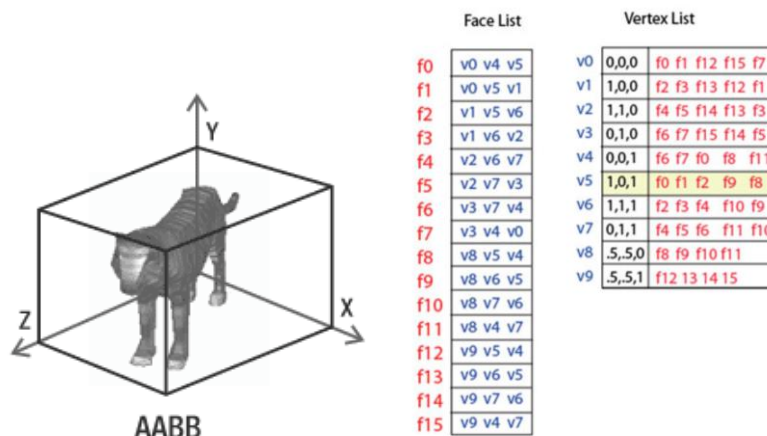# Simulating Motion and Spatial Data Structures

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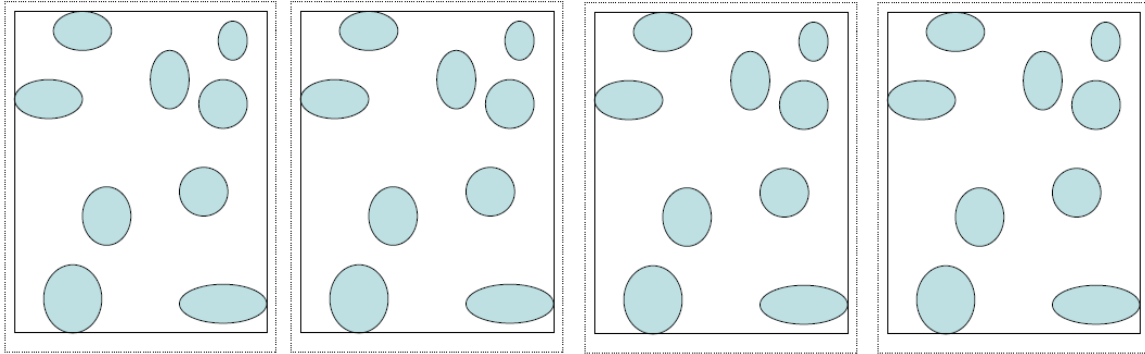
b. Is it possible for two nodes in a BVH to intersect? If not, why not? If so, draw such a situation and describe in what way this will affect a collision detection system.