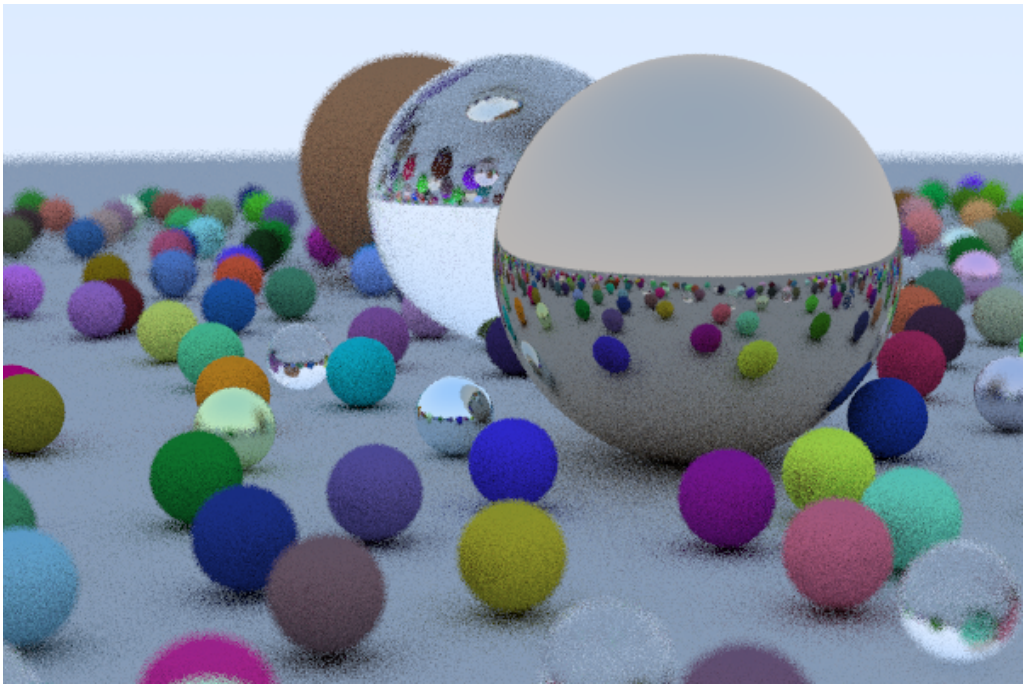
Assignment 3 – Bounding Volume Hierarchy – Jonathan Healy

Analysis:

Bounding volumes cost more for hits and near misses but less for far misses. In a very simple scene, for example with the scene that was rendered with only 3 balls all very close to each other, the version of the ray tracer not using Bounding Volume Hierarchies (BVH) was almost twice as fast. With a more complicated scene the BVH version of the ray tracer performed considerably faster at just over 2 minutes compared to over 3 for the non BVH version.

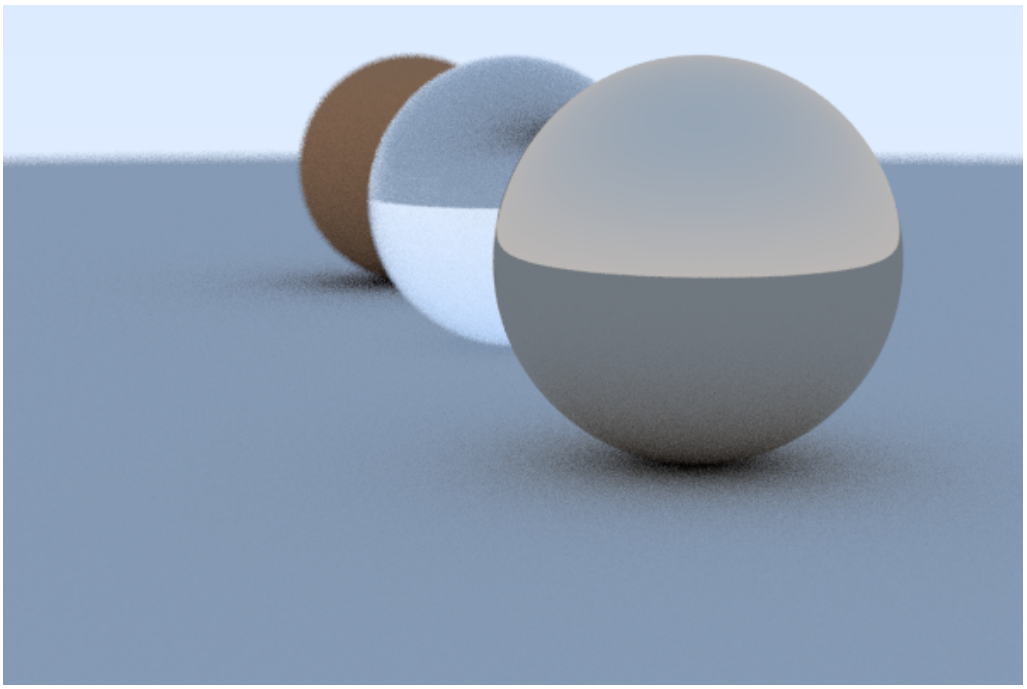
In simple ray tracer every ray is tested against every object in the scene. With N object and M rays the time complexity is O(N*M). Using an acceleration method like BVH this can be reduced to O(log(N)*M). For very complex scenes speedups of over 100 times are apparently possible. With BVH a scene is recursively divided into nodes that enclose space or objects. With the implementation in this program objects are divided not space. Objects are placed into nodes until either one or two objects remain and the recursion ends. If there is only one object remaining it is place in both the left and right nodes for simplicity.

The root node is the minimum bounding volume that enclose all of the objects in a scene. BVH alternates splitting nodes in half along the X, Y, and Z axes. Nodes may overlap other nodes but objects must end up in only one node. A ray box test is used and each node must store coordinates of a box which are called AABB or axis aligned boxes. If a ray overlaps a child test its children and so on. Only leaf nodes contain objects.



600 X 400 image with 10 rays per pixel:

without BVH: 3:12.53, 3:15.89
with BVH: 2:08.44, 2:01.26



600 X 400 image with 40 rays per pixel:

without BVH: 18.58, 17.35
with BVH: 39.42, 36.34