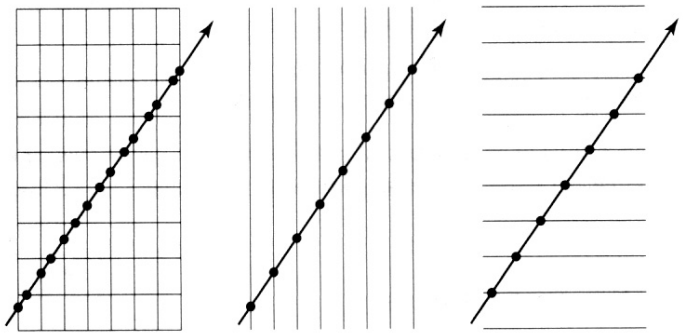
CS 465 Homework 5

out: Monday 5 November 2007
due: Wednesday 14 November 2007

Problem 1: [Tracing rays through uniform spatial subdivisions]

Consider the problem of tracing a ray through a uniform 3D spatial subdivision, and iterating over the ordered list of intersected cells. Assume that the subdivision is axis aligned, that cells are cubical of length h, and that the array dimensions are $N_x \times N_y \times N_z$. Denote the 3D ray by $\mathbf{r}(t) = \mathbf{e} + \mathbf{d}t$, where $\mathbf{e} = (e_x, e_y, e_z)$ and $\mathbf{d} = (d_x, d_y, d_z)$.

One approach for determining the next intersected cell is to evaluate t values for all axis-aligned slabs of each axis (see figure) and then determining whether the next t value is from an x, y, or z slab, and then intersecting the corresponding cell.



Instead of computing all values at once, an incremental DDA-type algorithm is preferrable in practice. In this problem, you will state concisely an efficient incremental algorithm to iterate over cells pierced by the advancing ray by effectively determining which of the x, y or z dimensions has the smallest t value. Assume that you can output a intersected cells by issuing the command `output(i,j,k)`.

Similar to efficient DDA rasterizers, your algorithm should only require simple addition and comparison operations in the inner loop. State your initial setup operations, assuming that the first boundary cell the ray hits is (i_0, j_0, k_0)—here indices are 0-based and run from $0, \ldots, N-1$—at position $\mathbf{e}$ and $t = 0$ for simplicity.

Problem 2: [Rasterization]

Rational linear interpolation (RLI) is used to interpolate texture coordinates in screen space without the artifacts introduced by linear interpolation of (u, v) values in screen space [Heckbert and Moreton 1991; `http://citeseer.ist.psu.edu/36582.html`]. Describe the screen space values obtained if RLI were used to interpolate (x, y, z) values in screen space (Hint: consider the case where the texture coordinates are spatial coordinates). *Clearly state and compare how the RLI z value differs from the screen-space depth value z' used in the Z buffer algorithm. Why not use RLI z values for the Z buffer algorithm?*