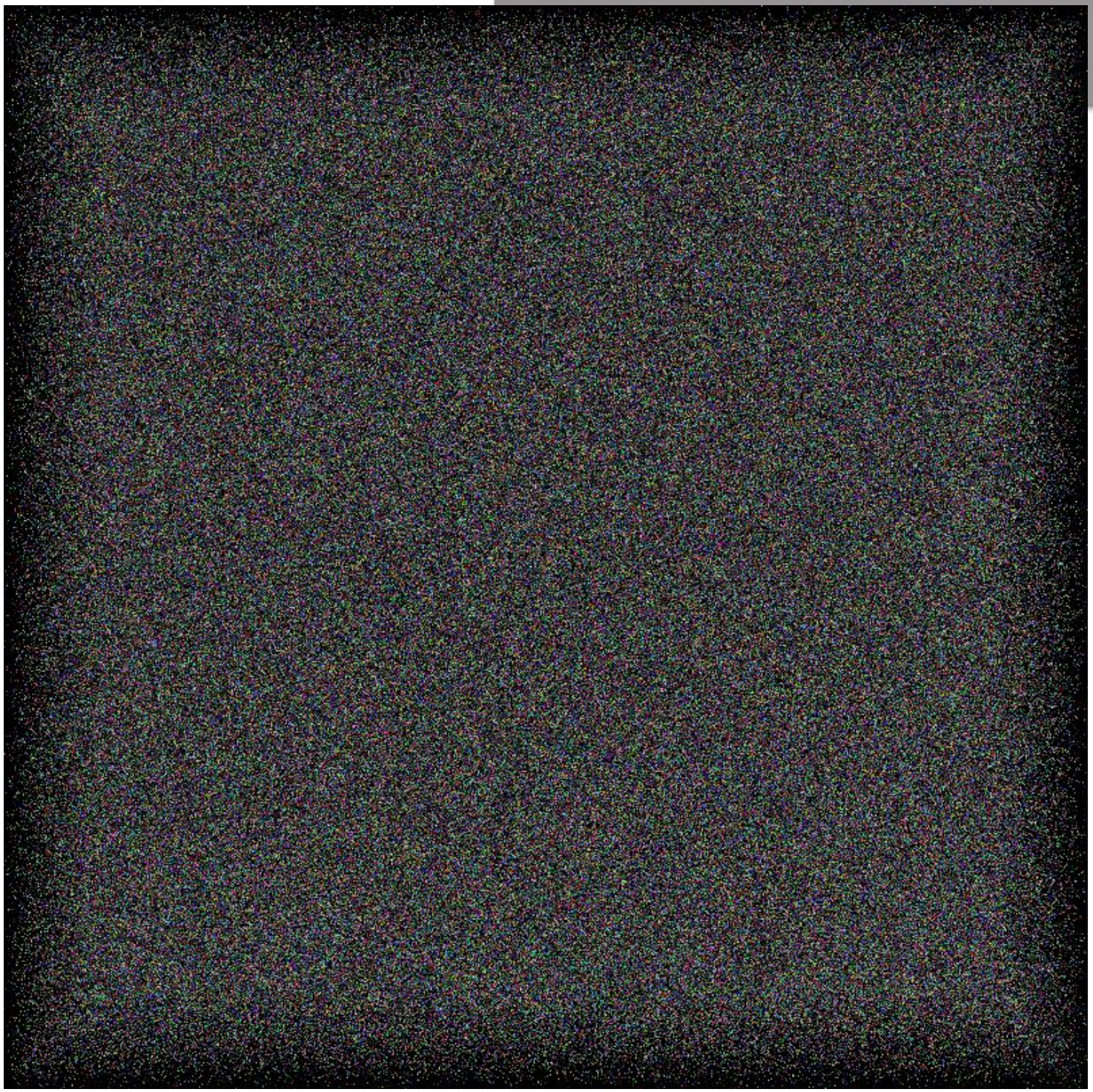
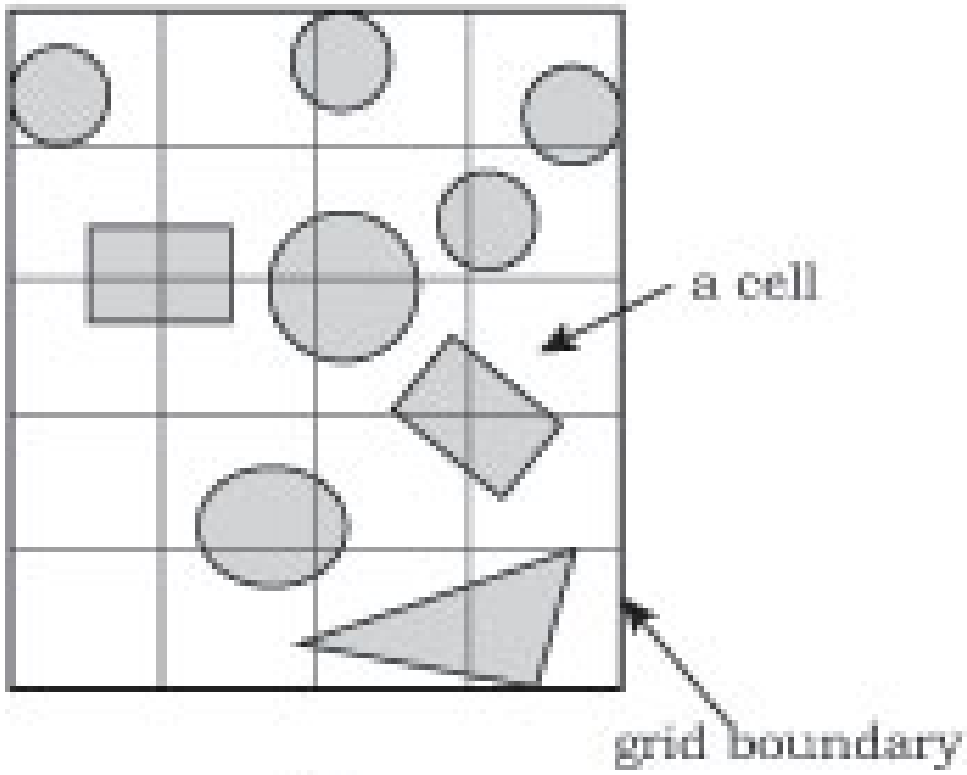
CS 563 Advanced Topics in Computer Graphics
Regular Grids

by Damon Blanchette

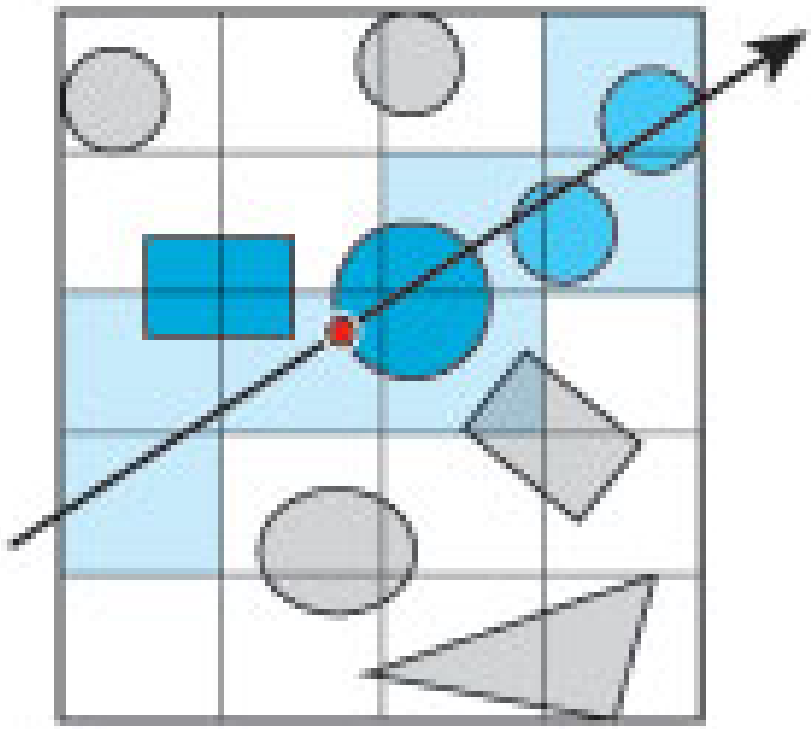


What is a regular grid?



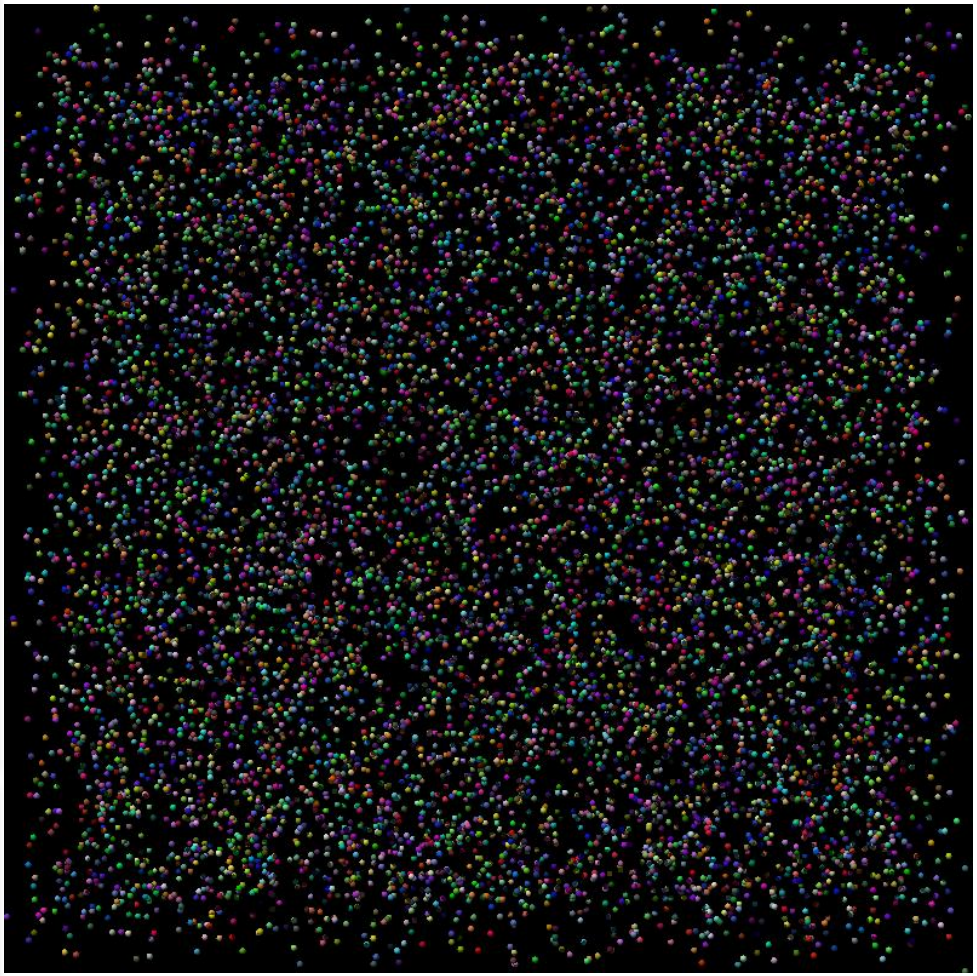
(a)

Grid with a ray



(b)

What kind of savings are we talking about?

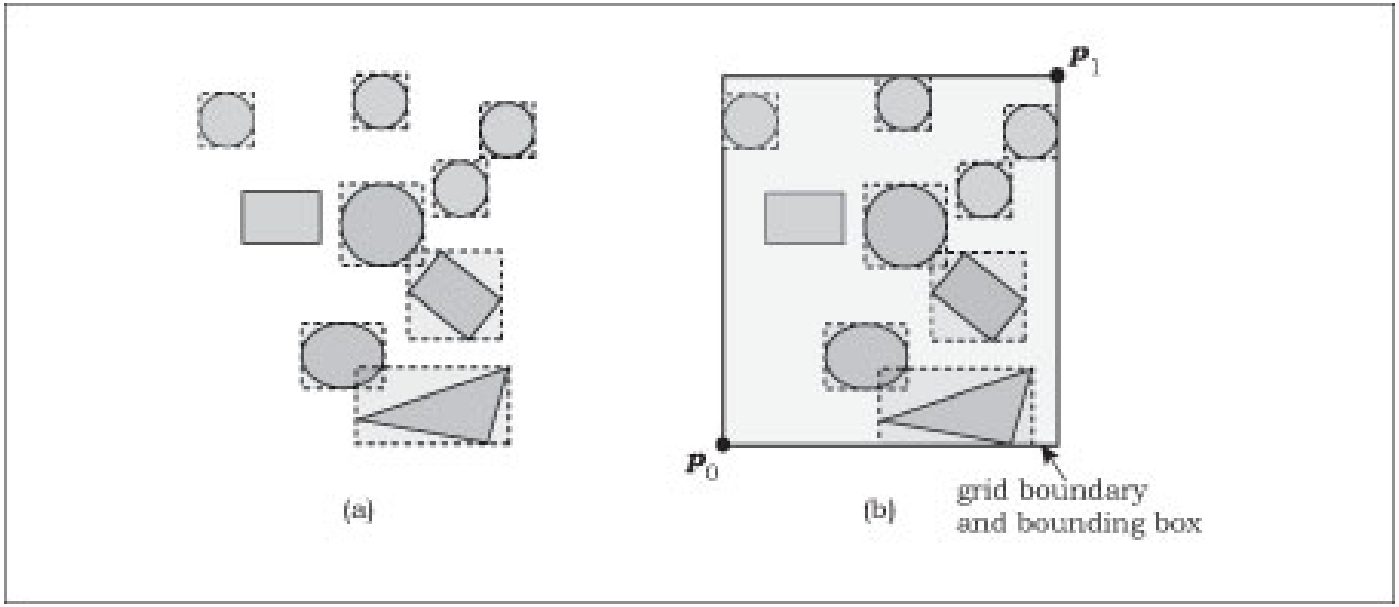


$O\left(\sqrt[3]{n}\right)$ cells

$O\left(\sqrt[3]{n}\right)$ objects

Best case: $O(\log n)$ intersections

How do we make a grid?



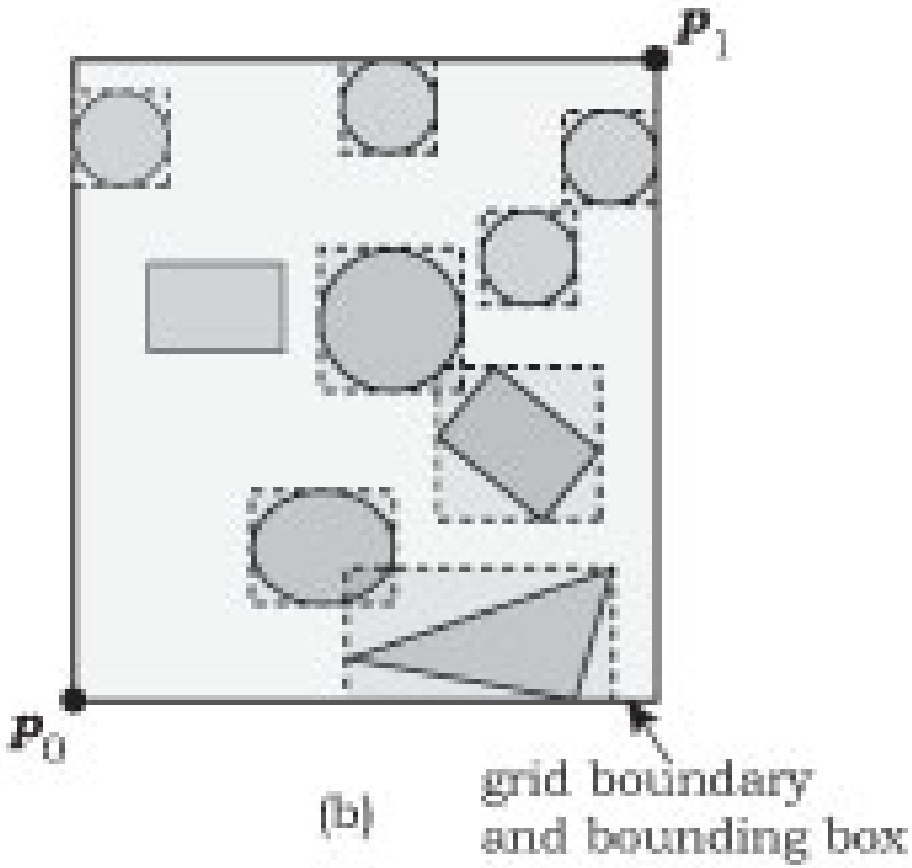
1. Add the objects
2. Compute the bounding box
3. Set up the cells

Part 1: Add the objects

```
Grid* grid_ptr = new Grid;

grid_ptr->add_object(sphere_ptr);
```

Part 2: Compute the bounding boxes



(b)

Part 3: Set up the cells

vector<GeometricObject*> cells;

$$s = \left(w_x w_y w_z / n\right)^{1/3}$$

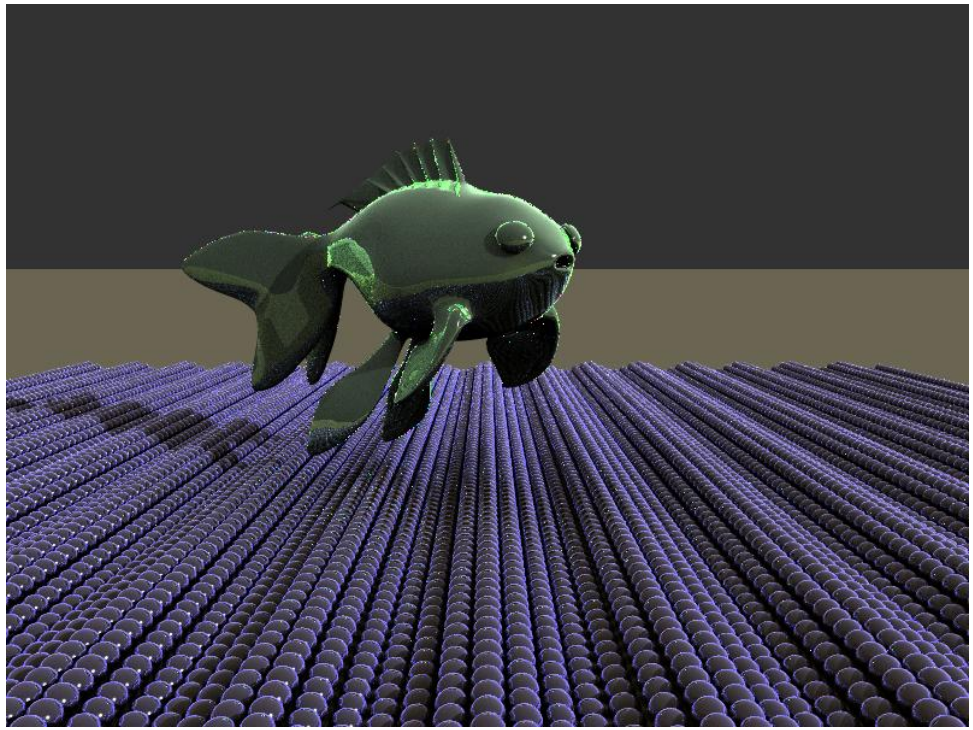
$$n_x = trunc\left(mw_x / s\right) + 1$$

$$n_y = trunc\left(mw_y / s\right) + 1$$

$$n_z = trunc\left(mw_z / s\right) + 1$$

Number of cells will be around $m^3 n$

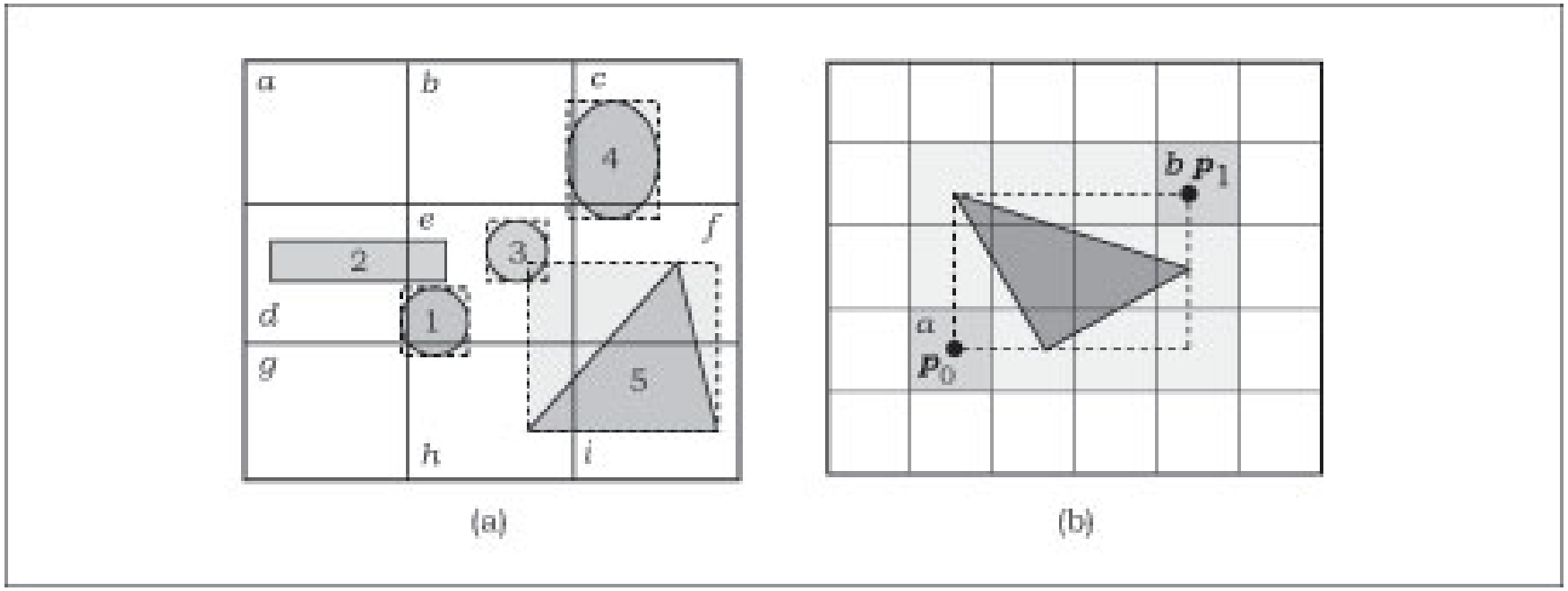
Indexing: Which Cell is my Home?



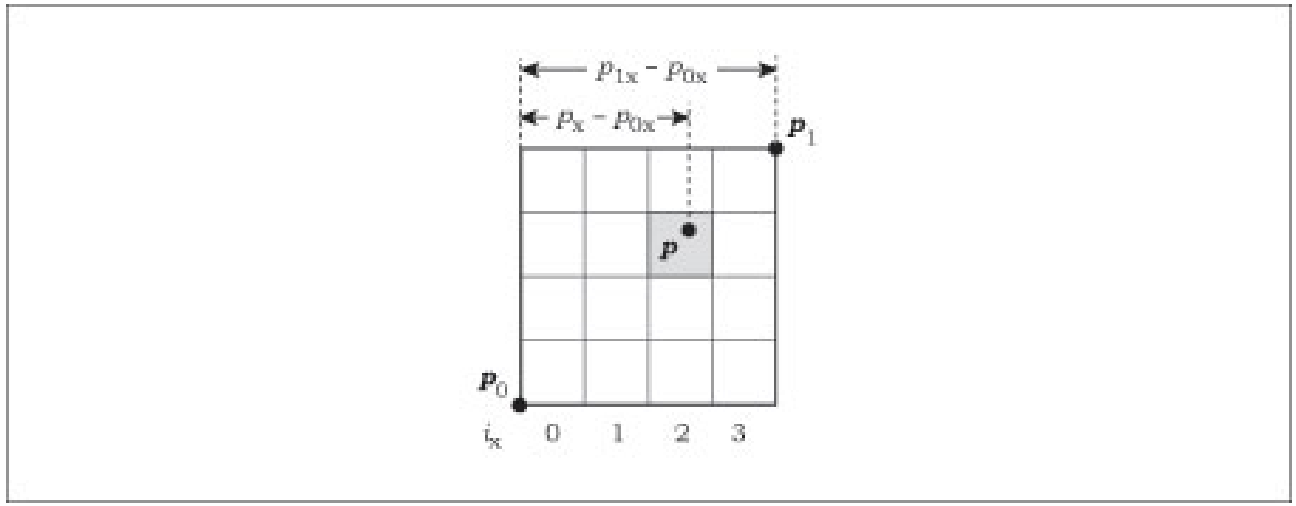
vector<GeometricObject*> cells;

index of the (i_x, i_y, i_z) cell = $i_x + n_x i_y + n_x n_y i_z$

Which Cell is my Home?

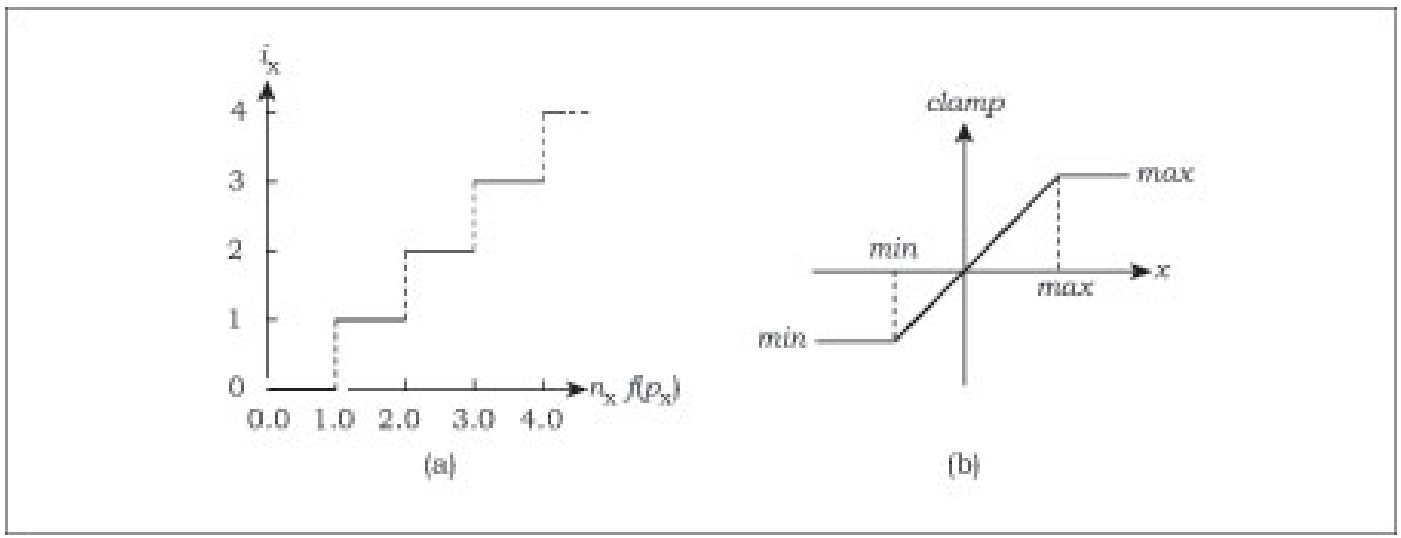


Which Cell is my Home?



$$f(p_x) = (p_x - p_{0x})/(p_{1x} - p_{0x}) \in [0.0,1.0],$$

$$i_x = \lfloor n_x f(p_x) \rfloor \in [0, n_x]$$

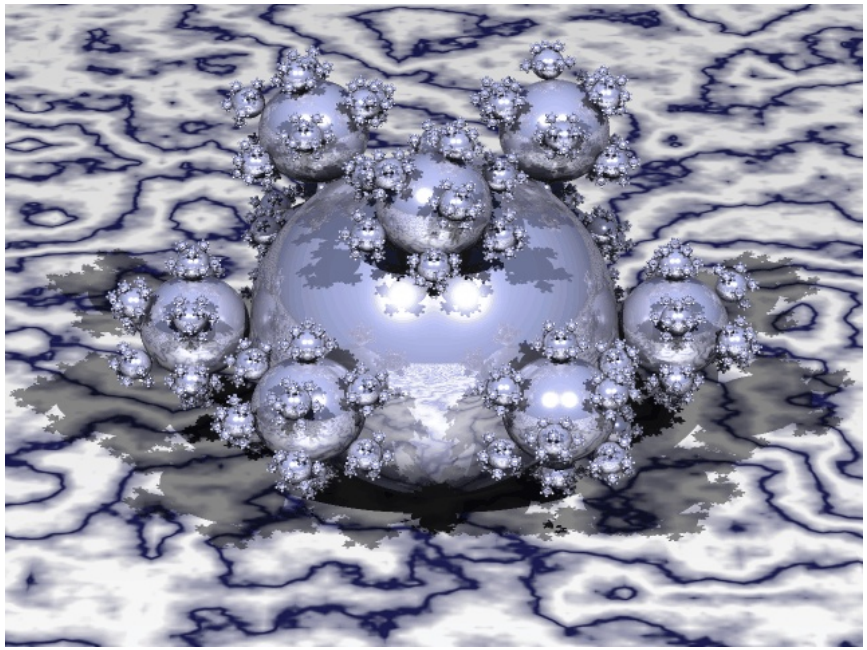


Traversal

If the ray misses the grid's bounding box
    return false

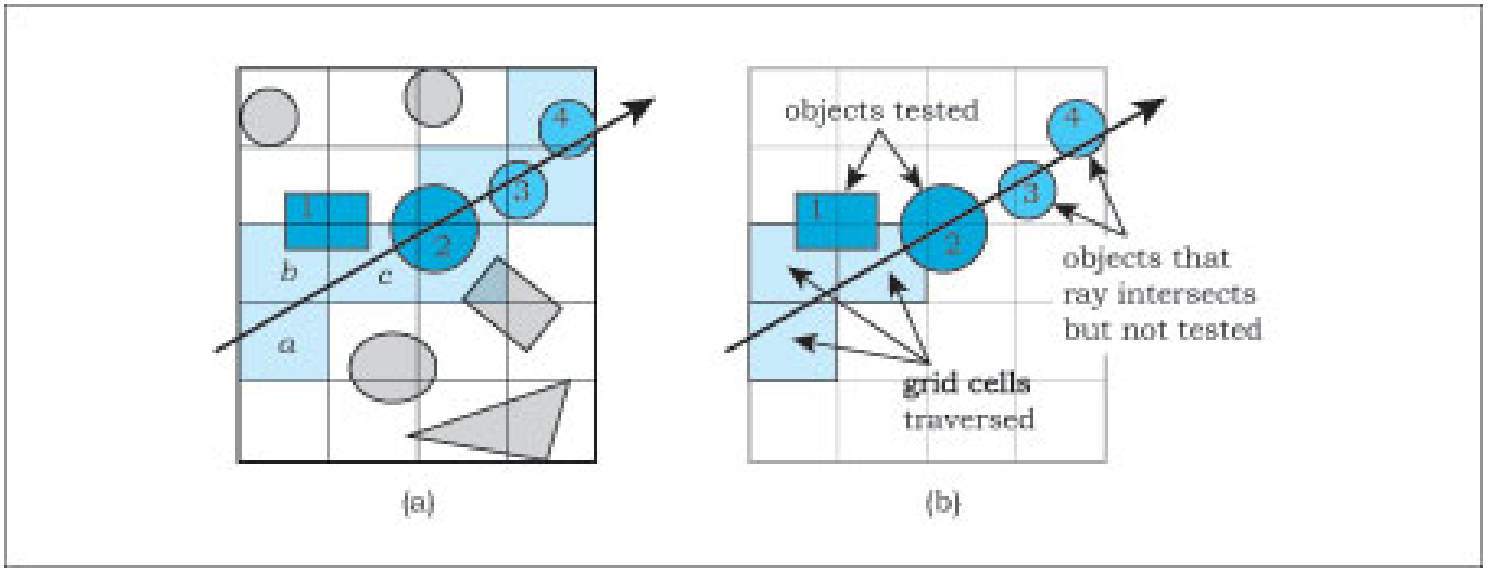
If the ray starts inside the grid
    find the cell that contains the ray origin
Else
    find the cell where the ray hits the grid from the outside

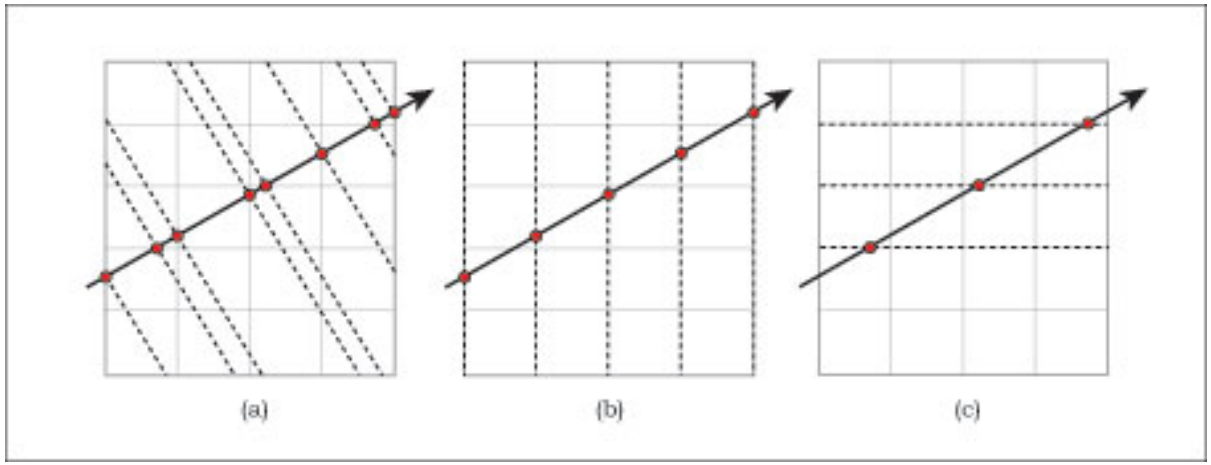
Traverse the grid



Sphereflake, Henrik Wann Jensen, http://graphics.ucsd.edu/~henrik/images/raytrace.html

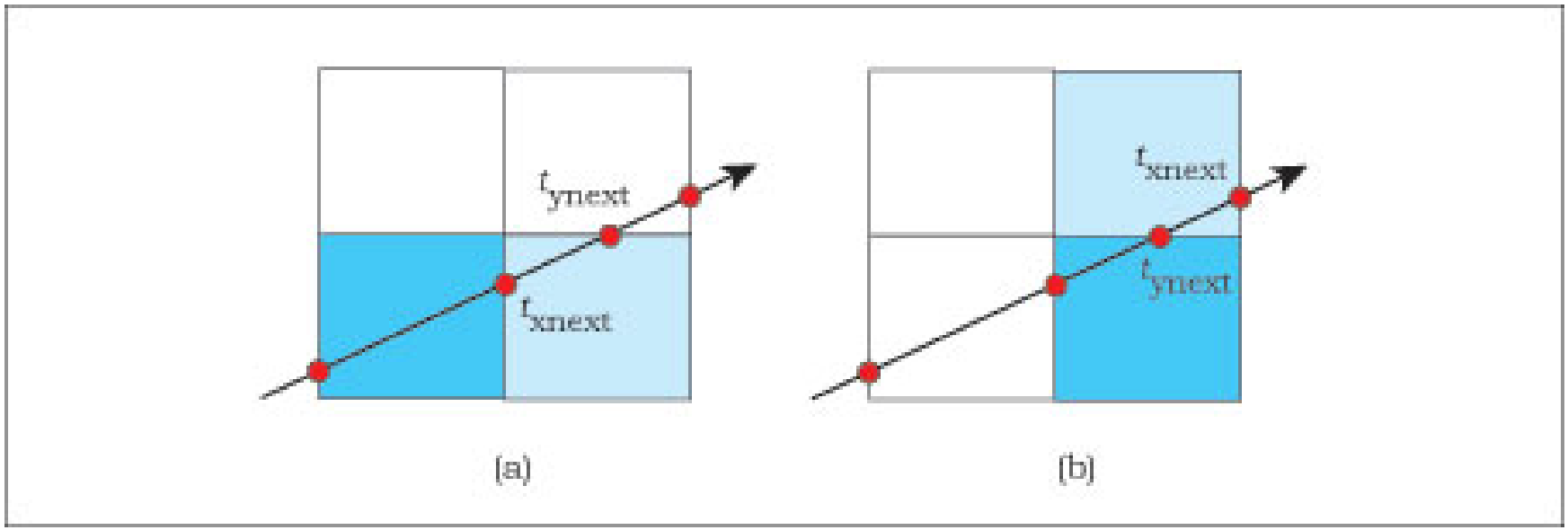
Traversing the Grid





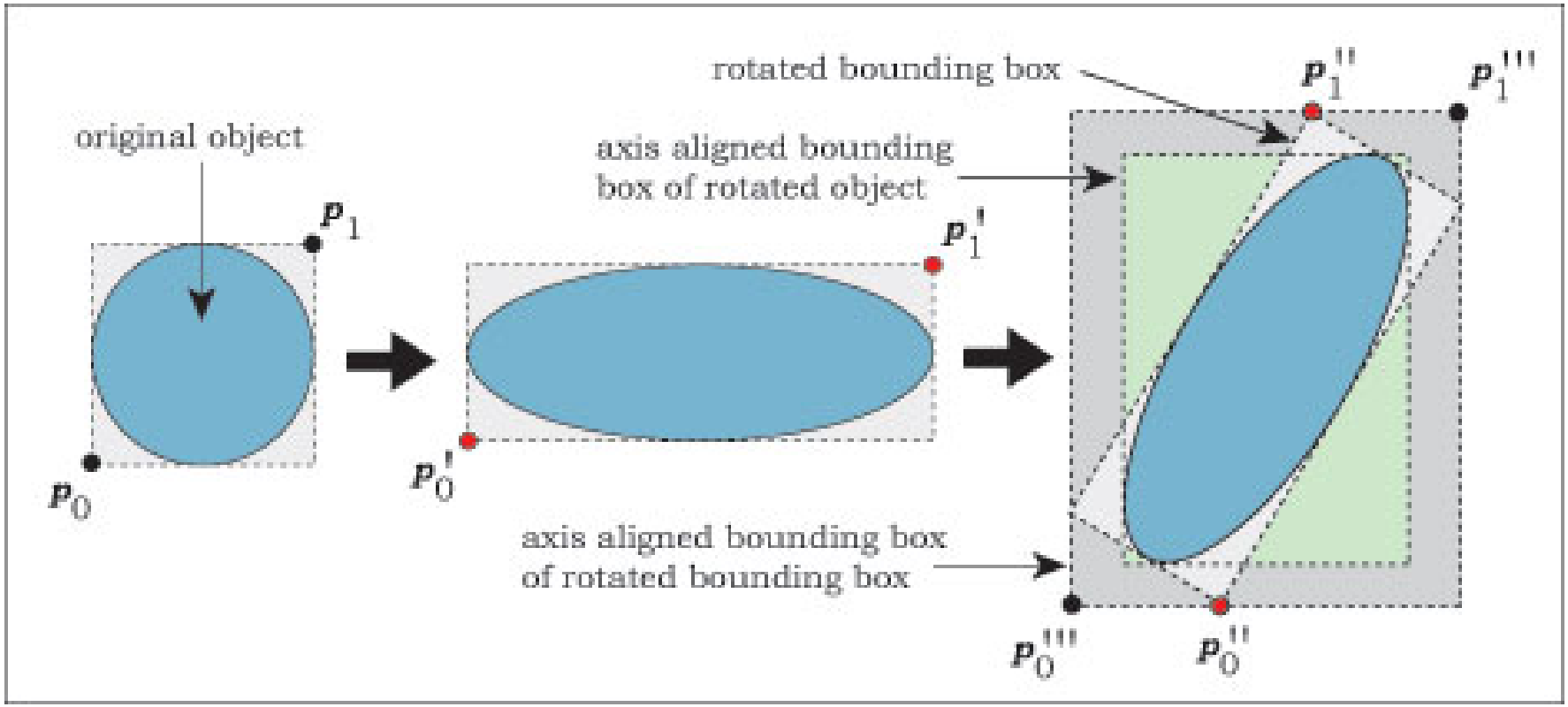
$$dt_x = (t_{x\max} - t_{x\min})/n_x$$
$$dt_y = (t_{y\max} - t_{y\min})/n_y$$
$$dt_z = (t_{z\max} - t_{z\min})/n_z$$

Traversing – Next Cell

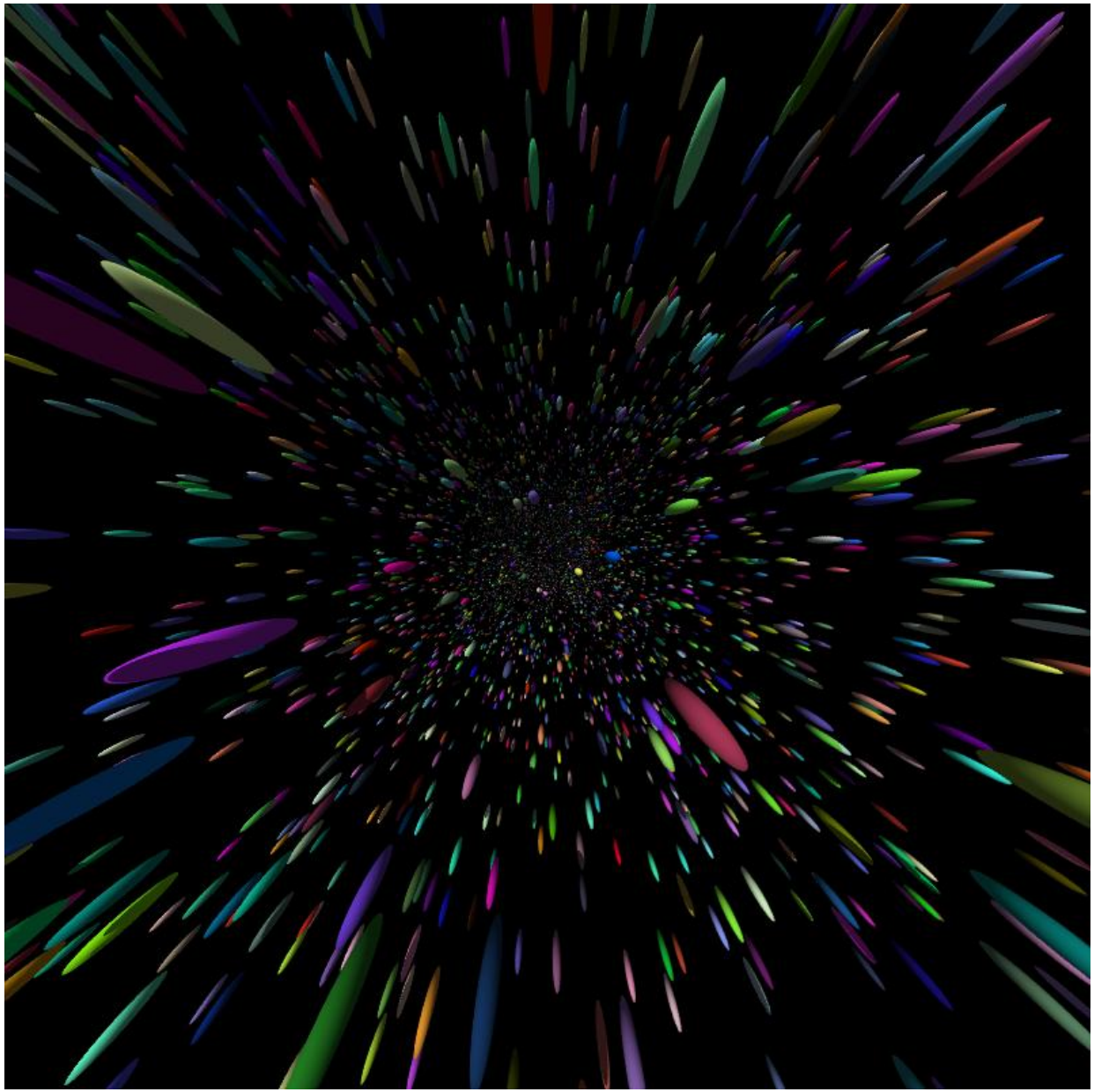


1. Compute t_{xnext} and t_{ynext} for the initial cell
2. Specify a condition to terminate the algorithm
3. Step the ray through the grid

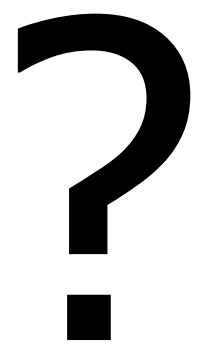
Transformed Objects



What about a BVH?



Questions?



References

- Suffern, Kevin. *Ray Tracing from the Ground Up.* A.K. Peters, 2007