

Trim, Sweeps, CSG, and Trees

CS116B

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Outline

- More NURBS
- GLU Surface Trimming Functions
- Sweep Representations
- Constructive Solid Geometry Methods
- Octrees
- BSP Trees
- Fractals 101

More GLU Nurbs

- To get the current setting of a NURBS property use:

```
gluGetNurbsProperty(splineName, property,  
value);
```

For example, if property was `GLU_CULLING` value returned by reference might be `GL_TRUE`.

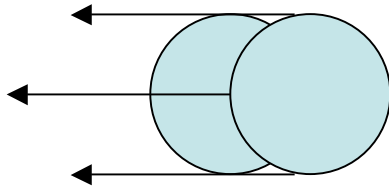
GLU Surface Trimming Functions

- Can specify trimming curves to apply to a GLU surface:

```
gluBeginTrim(surfName);  
    gluPw1Curve1(surfName, nPts, *curvePts, stride,  
                GLU_MAP1_TRIM_2);  
    //cuts polyline region specified by curvePts  
    // TRIM_3 for homogeneous coordinates  
    //use gluNurbsCurve for Bezier trim functions  
gluEndTrim(surfName);
```

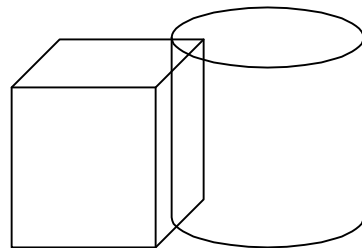
Sweep Representations

- A useful way to specify a 3D object.
- Start with a 2D object, say a closed Bezier Curve...Then translate or rotate curve slightly and create a surface



Constructive Solid Geometry Methods

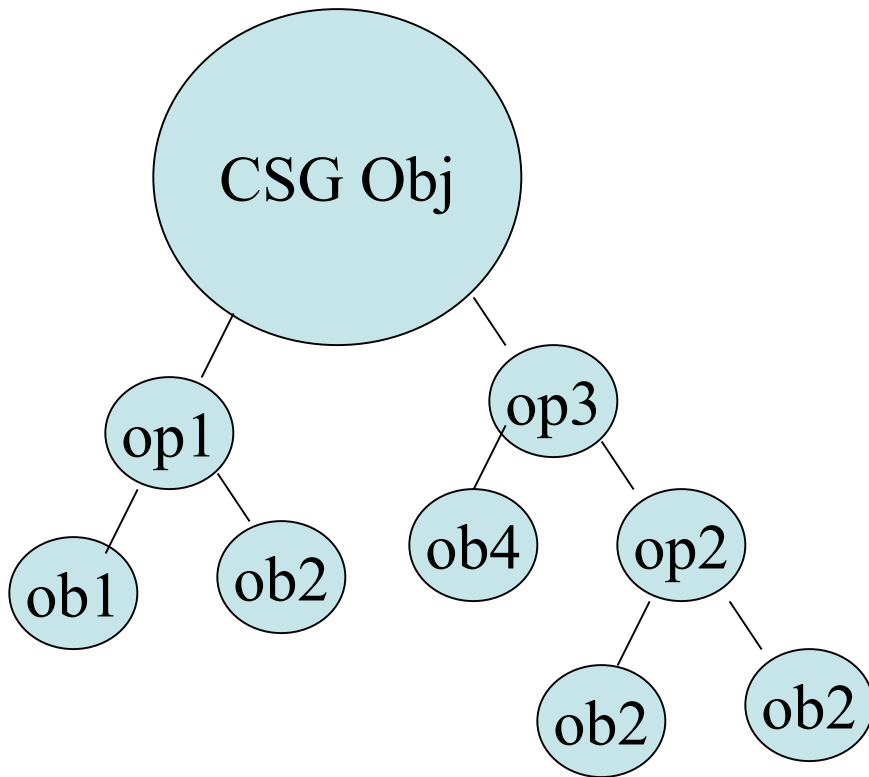
- Another way to generate 3D Objects is to have a set of primitive objects and support operations like union, intersection, set difference on them. These kind of techniques are called **constructive solid geometry methods**.



Might compute
intersection of these
figures

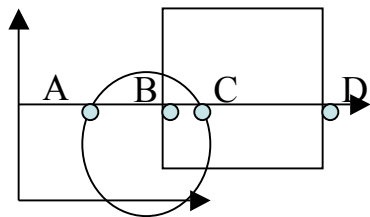
More CSG

- Objects can be viewed as binary trees:



Still More CSG

- **Ray casting** is typically used to implement CSG when objects given by boundary representations.
- We imagine shooting a rays perpendicular to the x-y plane along the z-direction. Surface intersections along each ray path are calculated and sorted by depth. Using thing and the set operations of the CSG we determine the surface limits of the object.



Operation	Surface Limit
Union	A,D
Intersection	B, C
Diff	C, D

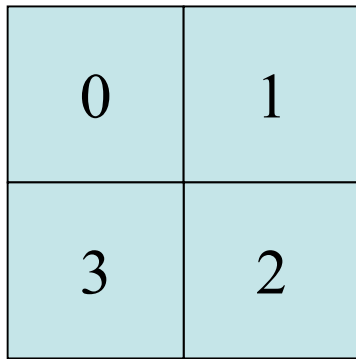
Other uses of Ray Casting

- Ray casting can also be used to calculate:
 - volumes of objects
 - centers of mass

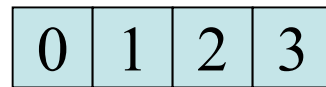
Octrees

- Are another hierarchal structure sometimes used to represent 3D-objects.
- Often used when want to be able to draw cross sections of a figure as in medical imaging.
- Octree are essentially the extension to 3D of quadtrees which are used in 2D (and fit on Powerpoint slides better...)

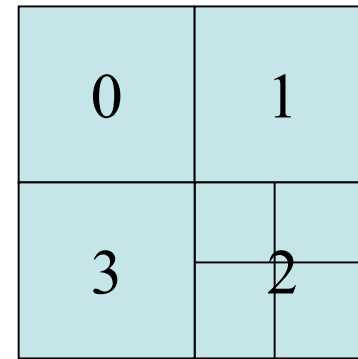
Quadrees



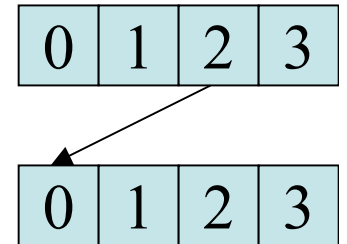
Region split into
4 quadrants



Data for each
quadrant



Further Partitioning



- A quadtree for encoding colors for an area would first check if whole area same color, if yes store that color in a data bit, if no divide region into four, have a data bit for each and recurse.

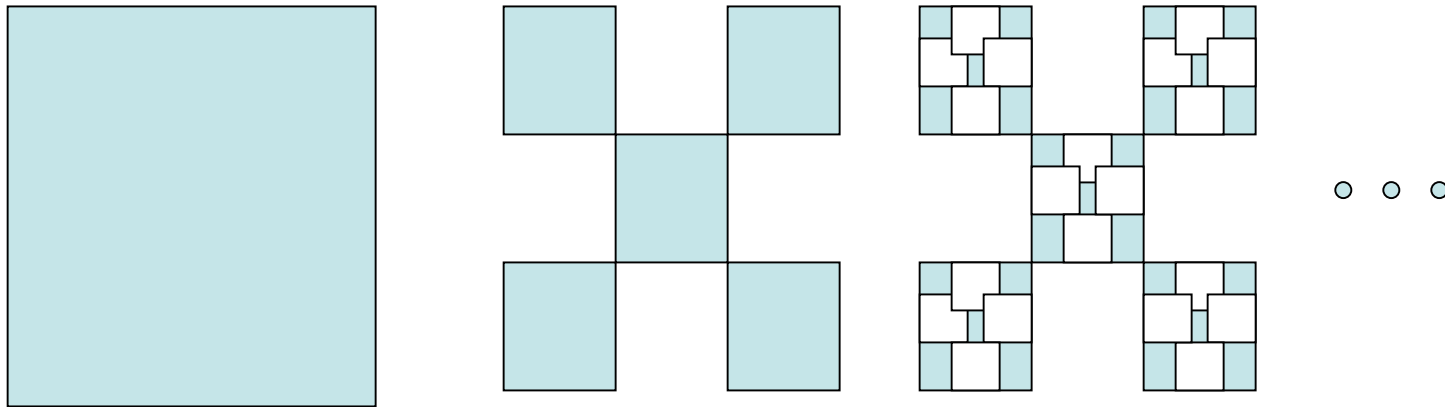
BSP Trees

- Similar to octrees except rather than divide the space into 8 at each recursion split into two not necessarily equal volumes in a greedy fashion.

Fractals 101

- Try to use iterative procedures to realistically model natural objects.
- A typical fractal might be constructed by looking at the points in the object already constructed by stage n , then applying some fixed function, and outputting what the object looks like in stage $n+1$.

Fractal Example



Types of Fractals

- Self Similar Fractals -- fractals which have parts which are scaled down versions of the entire object
- Self Affine -- fractals which have parts that are formed from the figure where different scaling parameters on the current figure have been applied. Used to model terrain
- Invariant Fractal Set -- the fractal is the result of iterating some non-linear function. Ex: the mandelbrot set

Fractal Dimension

- Used to estimate how complex the fractal is.
- For a self-similar fractal
 - Let n equal usual dimension of space where draw fractal.
 - Let s be the number of scaling factor used in the self-similarity.
 - Then the dimension D is the number such that
 - $n \cdot s^D = 1$.