Scan-line and Flood-fill Algorithms

CS116A

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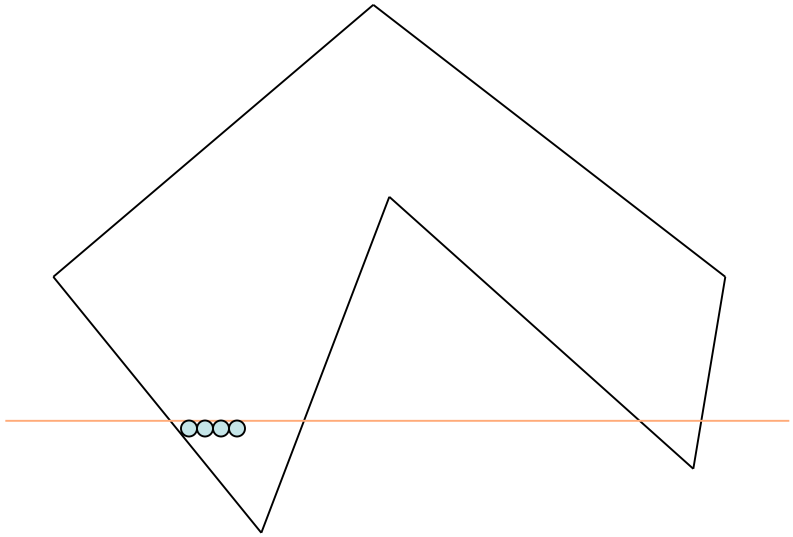
Introduction

- Scan-line Algorithm
- Scan-line for Convex Polygons
- Scan-line for Curved Boundaries
- Methods for Irregular Boundaries
  - Boundary-fill
  - Flood-fill
- OpenGL Fill-area Attributes

Scan-line Algorithm

- Basic idea: Figure out where the scan line crosses a line of the figure and use even odd rule to determine if inside-outside figure. If inside fill.
- Determining where a scan line intersects an edge involves solving a pair of simultaneous linear equations where one of the two lines of the form y = constant.

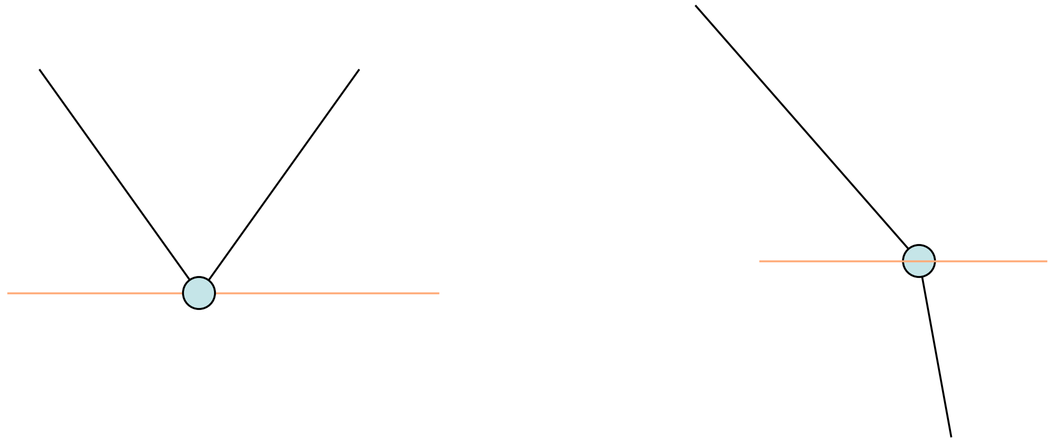
Scan-line Fill Diagrams



One would continue to fill in linefor rest of the interiors.

Potential Headaches

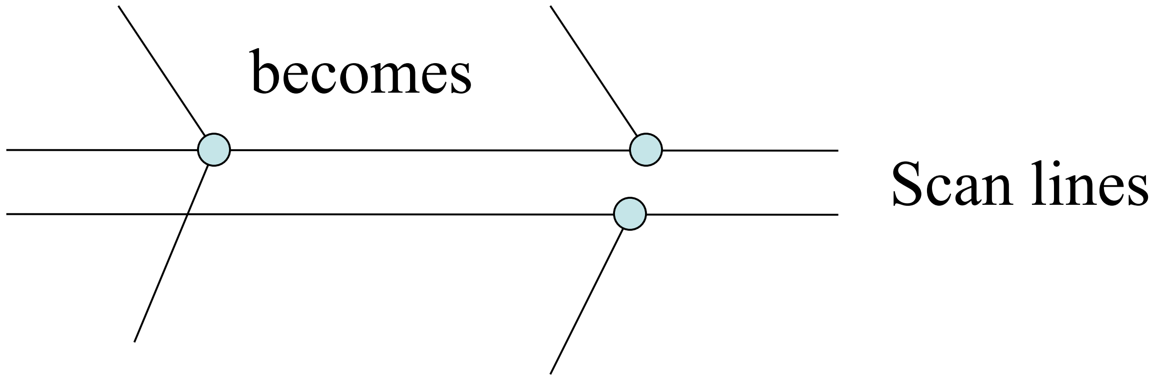
- Where two edges meet:



- Left case can count edges crossed at vertex as 2, but in right case should count as 1

Solution

- For right case shorten by one pixel one of the two edges.

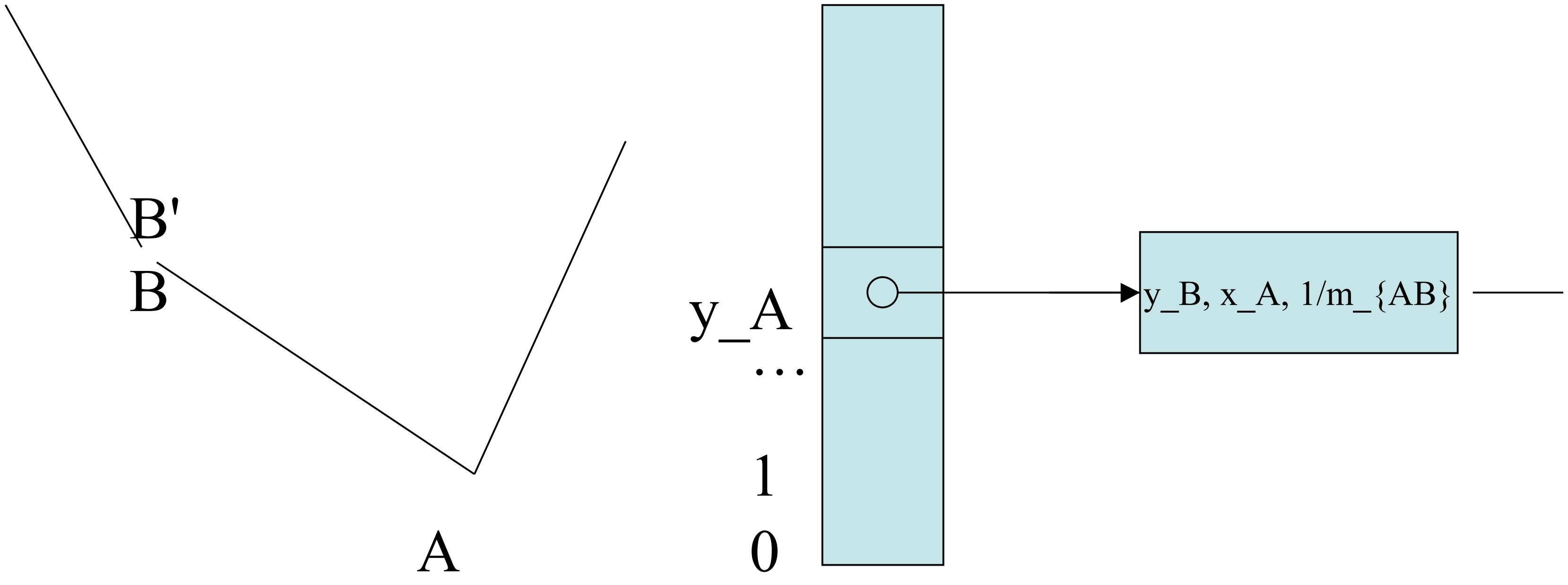


Making the Algorithm Incremental

- We don’t want to solve linear equations for each scan line.
- To incrementally calculate intersection use slope: m = (y_{k+1} - y_k)/(x_{k+1} -x_k}
  - In going from one scan line to the next y_k changes by one, x_{k+1} = x_k + 1/m.
  - If do things in parallel, and start position of a processor was x_k could calculate as x_k = x_0+k/m.
  - Assuming slope is rational 1/m = Δx/Δy. Have a counter for change in x -- step by Δx when this gets bigger than Δy decrement it and move are x loc over by 1.

Using a Sorted-edge Table

- Still need to deal with start and end positions of edges. Can keep an active edge list sorted by starting scan-line

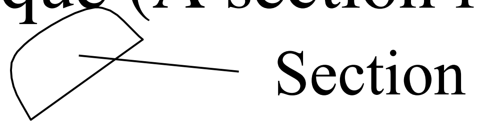


Scan-line Fill of Convex Polygons

- Only need to find two boundary for each scan-line
- If a scan line intersects a single vertex only plot that point

Scan-line Fill for Regions with Curved Boundaries

- Boundary intersections now must be calculated using the curves equations
- For some curves this isn’t too hard. Ex. Conics.
- In which case can adapt the previously described algorithm and come up with incremental variants.
- Can also fill sections of curves using this technique (A section is area between a curve and a line)



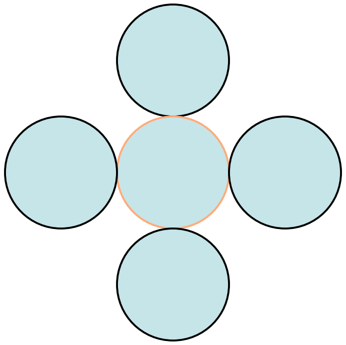
- For complicated curves hard to compute intersection and other methods must be used

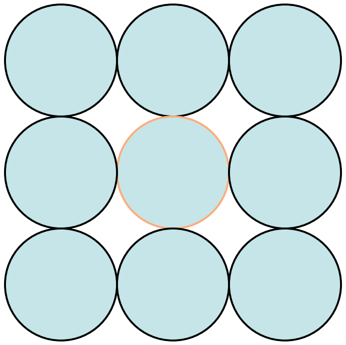
Fill Methods for Areas With Irregular Boundaries

- Basic idea for these techniques is to start at some position interior to fill
- Fill outward to boundary

Boundary Fill

- Boundary is assumed to be one fixed color
- Fill towards this boundary using either:





4-connected or 8-connected fill pattern

- Algorithm can be implemented either recursively or using a stack of places to be filled

Flood Fill

- Similar to boundary fill but now boundary is given by any colors other than the color of pixel started fill on.
- Implementation is similar.

OpenGL Fill area attribute Functions

Four steps to filling a convex polygon in OpenGL:

1. Define a fill pattern
2. Invoke the polygon-fill routine
3. Activate the polygon-fill feature of OpenGL
4. Describe the polygons to be filled.

Define a Fill Pattern

```
Glubyte fillPattern[] = {0xff, 0x00, …};
/* masks are 32 by 32 bits starting at bottom row */

//To use
glPolygonStipple(fillPattern);

//To enable
glEnable(GL_POLYGON_STIPPLE);

//To disable
glDisable(GL_POLYGON_STIPPLE);
//Start position of tiling bottom left of screen
```

OpenGL Texture and Interpolation Patterns

Another method to specify the kind of fill is to use a texture or interpolation patterns. We’ll talk about the former much later. For the latter can do:

```
glShadeModel(GL_SMOOTH);

    glBegin(GL_TRIANGLES);
        glColor3f(0.0, 0.0, 1.0);
        glVertex2i(50, 50);
        glColor3f(1.0, 0.0, 0.0);
        glVertex2i(150, 50);
        glColor3f(0.0, 1.0, 0.0);
        glVertex2i(75, 150);
    glEnd();
```