CSC418 Computer Graphics

- Polygons
  - Triangulation
  - Scan conversion
  - Convex/Concave
  - clipping)
- 2D affine transformations and properties, Homogeneous coordinates
Scan Conversion

- Convex versus concave polygons?
- Triangulating a polygon
- Scan Converting a triangle
- Pattern Filling a polygon
- Flood filling a polygon
Polygon Clipping

- Clipping is a procedure for *spatially partitioning* geometric primitives, according to their containment within some region.

- Why do we clip?
  - Distinguish whether geometric primitives are inside or outside of a *viewing region*
  - Distinguish whether geometric primitives are inside or outside of a *picking region*
  - Detecting intersections between primitives
  - Binning geometric primitives into spatial data structures.
  - Shadows.
Sutherland-Hodgman clipping

- Given: Polygon (list of vertices), clipping window (convex)
  
  for each clip edge
  for each vtx and next in polygon
  {
    clip against edge
  }

```
 vertex list -> clip L -> clip B -> clip R -> clip T -> vertex list
```
Sutherland-Hodgman clipping

<table>
<thead>
<tr>
<th>case</th>
<th>first point</th>
<th>second point</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>inside</td>
<td>inside</td>
<td>second point</td>
</tr>
<tr>
<td>2</td>
<td>inside</td>
<td>outside</td>
<td>intersection point</td>
</tr>
<tr>
<td>3</td>
<td>outside</td>
<td>outside</td>
<td>none</td>
</tr>
<tr>
<td>4</td>
<td>outside</td>
<td>inside</td>
<td>intersection point and second point</td>
</tr>
</tbody>
</table>

Vertex list

- clip L
- clip B
- clip R
- clip T

Vertex list
**Sutherland-Hodgman clipping**

<table>
<thead>
<tr>
<th>case</th>
<th>first point</th>
<th>second point</th>
<th>output point(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>inside</td>
<td>inside</td>
<td>second point</td>
</tr>
<tr>
<td>2</td>
<td>inside</td>
<td>outside</td>
<td>intersection point</td>
</tr>
<tr>
<td>3</td>
<td>outside</td>
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<td>none</td>
</tr>
<tr>
<td>4</td>
<td>outside</td>
<td>inside</td>
<td>intersection point and second point</td>
</tr>
</tbody>
</table>

original: 1,2,3,4,5,1  
clip L: 1,2,A,B,4,5,1  
clip B: 1,2,A,B,C,D,5,1  
clip R: 1,2,A,B,C,E,F,1  
clip T: (same)
2D Primitives

- Conic Section: Defined as the intersection of an ellipse and a plane.

Circle

Ellipse (h) Parabola (h) Hyperbola (h)

Ellipse (v) Parabola (v) Hyperbola (v)
Conics

- The General Equation for a Conic Section:
  \[ Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0 \]

- The type of section can be found from the sign of: \( B^2 - 4AC \)
  - If \( B^2 - 4AC \) is
    - \( < 0 \) ellipse, circle, point or no curve.
    - \( = 0 \) parabola, 2 parallel lines, 1 line or no curve.
    - \( > 0 \) hyperbola or 2 intersecting lines.
2D Transformations

• Live maya demo
• Coord-free Geom.
• Translate/Rotate/Scale
• Rotate about a point
• Transform Matrices
• Composition/Inversion of Transforms
• Homogeneous Coordinates, Affine Transforms
• Hierarchies