Discretization

- Class so far about turning 3D world into 2D image.
  - Representing viewpoint
  - Projecting 3D world into 2D
  - *Turning 2D continuous world into discrete image.*
    - *Geometric objects*
    - *Intensities*

Continuous vs. real

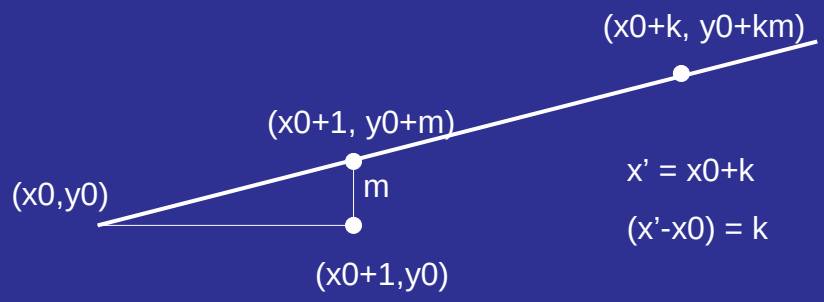
- This is one of the deep issues in graphics.

Geometric Primitives

- Line Segment
- Triangle – *These are key primitives*
- General polygon.

Line Segments

- I want to try to discuss this as a simple example of linear interpolation (more later).
- y = mx + b
- Given (x0,y0) to (x1,y1)
  - m = (y1-y0)/(x1-x0)
  - b = y0 – mx0
- Set of points: (x', y0 + m(x'-x0))



So we can think of a line as what we get when y is a function of x, and we linearly interpolate y between a starting value, y0, at x0, and an ending value of y1, and x1.

Another way to think of this is that we compute a y' to go with an x' by taking a weighted average of x0 and x1 to get x', and then taking the same weighted average of y0 and y1 to get y'.

x' = ax1 + (1-a)x0. a = (x'-x0)/(x1-x0)

Then find y' by taking:

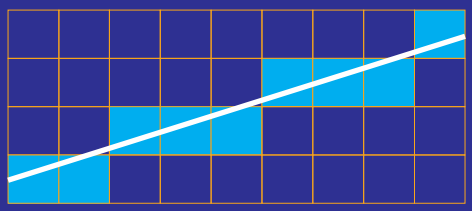
y' = ay1 + (1-a)y0.

Note: y' = (y1-y0)(x'-x0)/(x1-x0) + y0

= m (x'-x0) + y0

This is what we got before. This way of looking at it, though, can be generalized to interpolating between three points in the plane.

Line with slope 0<= m <= 1



For each x value, find y and round off.

y(x0) = y0.

y(x0+1) = y0 + m

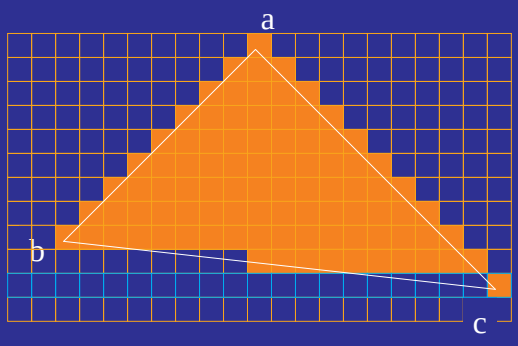
y(x0+k) = y(x0+k-1) + m

Fill in (xi, round(y(xi)))

Other Slopes

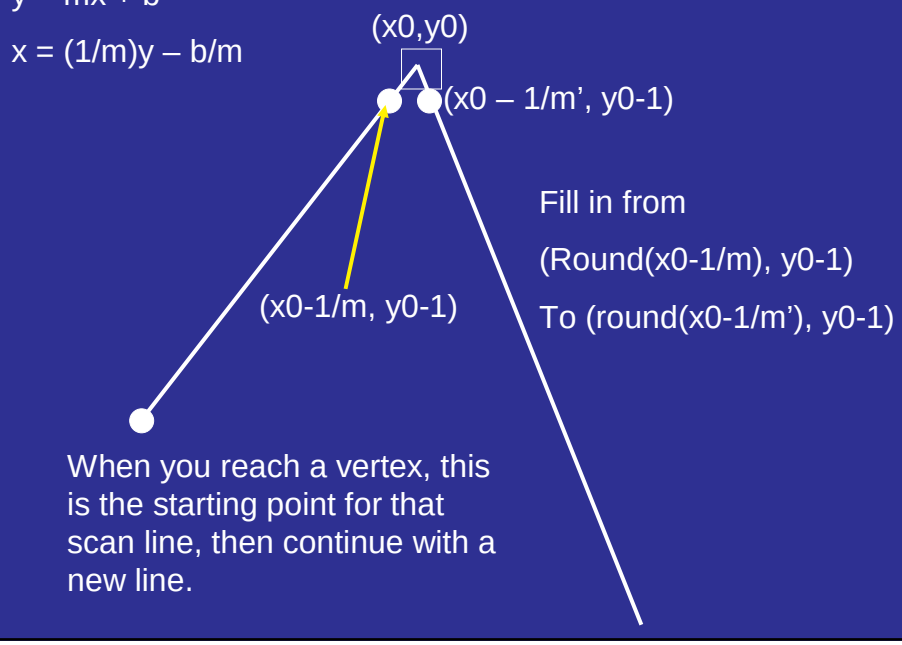
- For 1 <= m just reverse role of x and y.
  - y = mx + b => x = (1/m)y – b/m
- For -1 <= m <= 0 we can do the same thing as 0 <= m <= 1
- m <= -1 same as m >= 1, except we reduce y.
- Other cases are similar.

Triangles



y = mx + b

x = (1/m)y – b/m



Fill in from

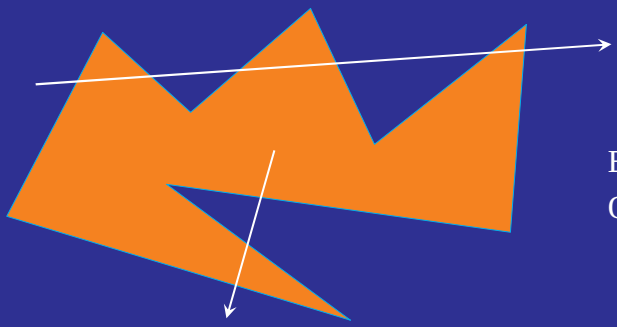
(Round(x0-1/m), y0-1)

To (round(x0-1/m'), y0-1)

When you reach a vertex, this is the starting point for that scan line, then continue with a new line.

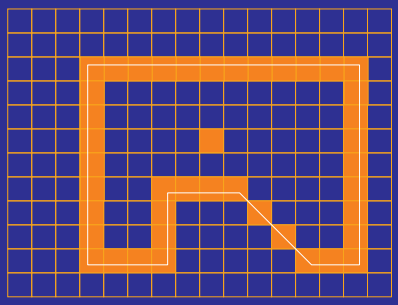
General Polygon

- Break up into triangles
- Test each pixel – crossing number test



Even: Outside
Odd: Inside

Flood Fill / Seed Fill



```
flood_fill (x, y)
{ if (read_pixel (x, y) != ORANGE)
  { write_pixel (x, y) = ORANGE;
    flood_fill (x - 1, y);
    flood_fill (x +1, y);
    flood_fill (x, y - 1);
    flood_fill (x, y +1);
  }
}
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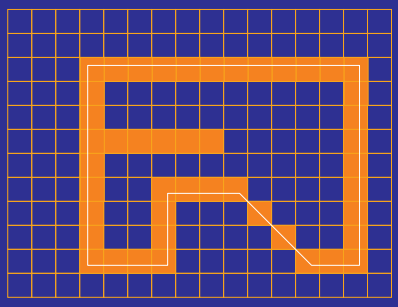
Flood Fill / Seed Fill



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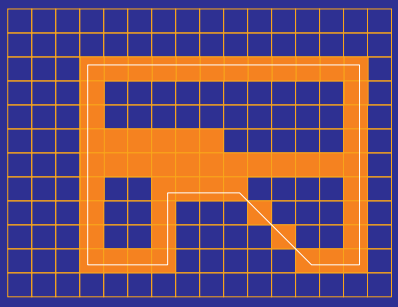

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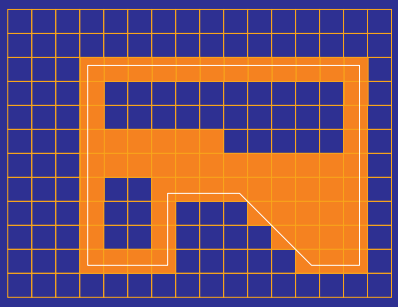

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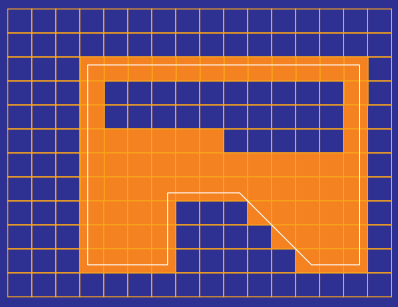

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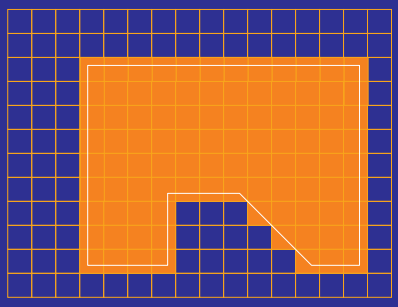

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