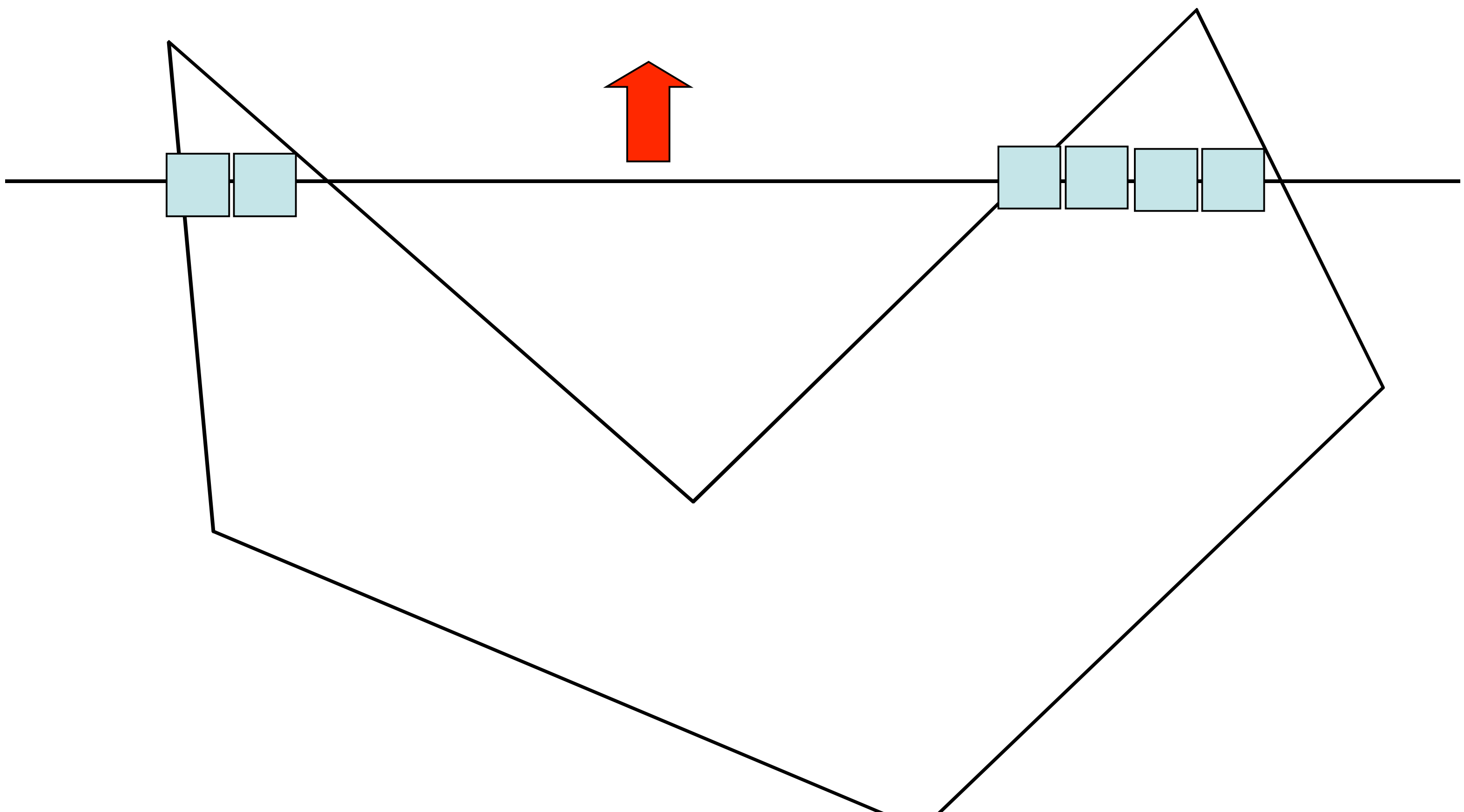
Sweep fill

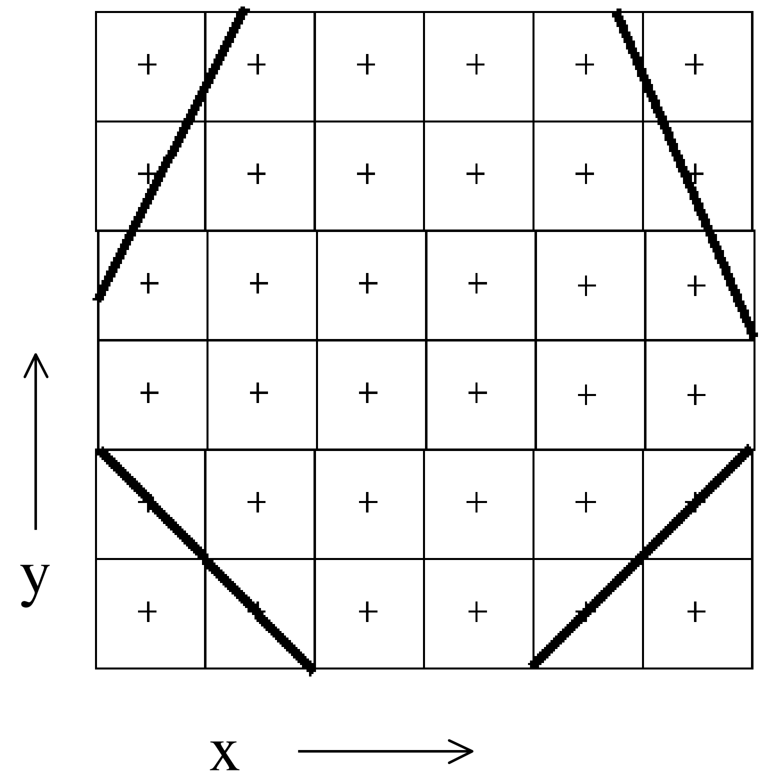


Sweep fill

- Reduces to filling many spans
- Inside/outside parity is relatively straightforward
- Need to compute the spans, then fill
- Need to update the spans for each scan
- Need to implement "inside" rule for ambiguous cases.

Spans

- Fill the bottom horizontal span of pixels; move up and keep filling
- Assume we have xmin, xmax.
- Recall--for non integral xmin (going from outside to inside), r**ound up** to get first interior point, for non integral xmax (going from inside to outside), **round down** to get last interior point
- Recall--convention for for integral gives a span closed on the left and open on the right
- **Thus**: fill from ceiling(xmin) up to but not including ceiling(xmax)



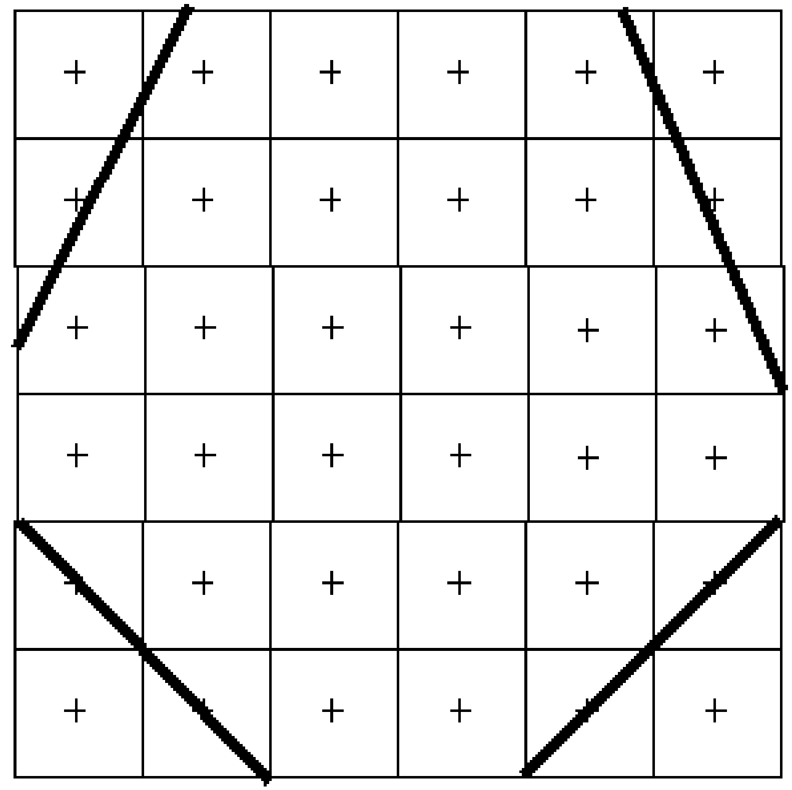
Algorithm

- For each row in the polygon:
  - Throw away irrelevant edges (horizontal ones, ones that we are done with)
  - Obtain newly relevant edges (ones that are starting)
  - Fill spans
  - Update spans
- Issues:
  - what aspects of edges need to be stored?
  - when is an edge relevant/irrelevant?

The next span - 1

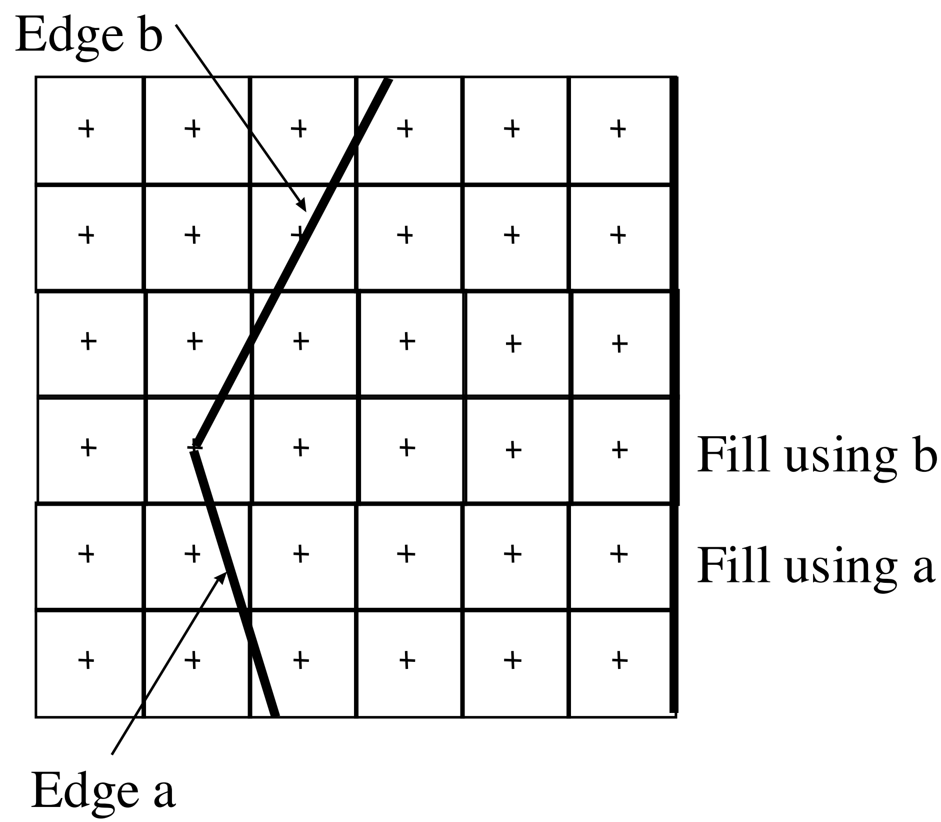
- for an edge, have $y=mx+c$
- hence, if $y_n=m\ x_n+c$, then $y_{n+1}=y_n+1=m\ (x_n+1/m)+c$
- hence, *if there is no change in the edges*, have:

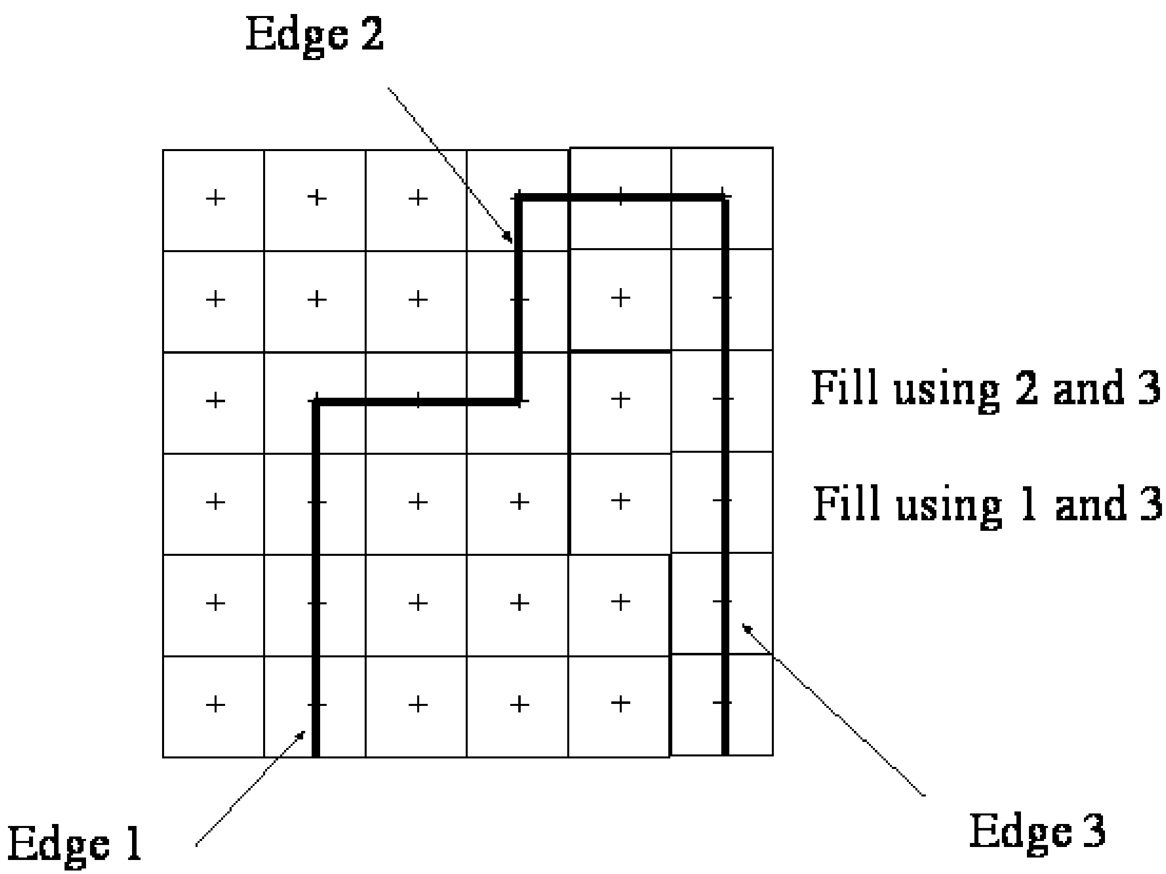
  $x \mathrel{+}= (1/m)$



The next span - 2

- Horizontal edges are irrelevant (typically would be pruned at the outset)
- Edge becomes relevant when y>=ymin of edge
- Edge becomes irrelevant - when y>=ymax of edge (note appeal to convention)



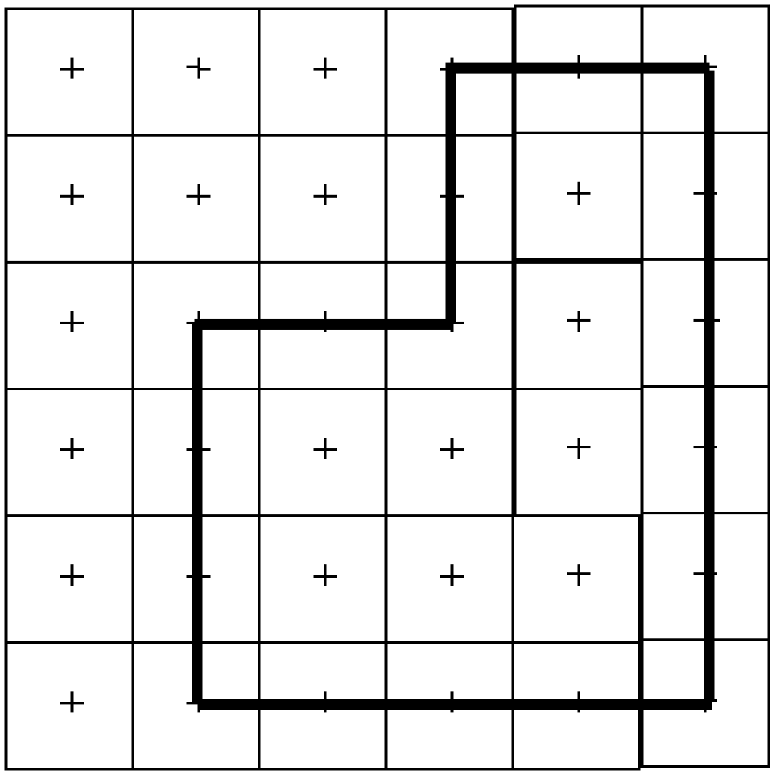

Edge 2
Fill using 2 and 3
Fill using 1 and 3
Edge 1
Edge 3

Filling in details -- 1

- For each edge store: x-value, maximum y value of edge, 1/m
  - x-value starts out as x value for y_{min}
  - m is never 0 because we ignore horizontal ones
- Keep edges in a table, indexed by minimum y value (Edge Table==ET)
- Maintain a list of active edges (Active Edge List==AEL).

Filling in details -- 2

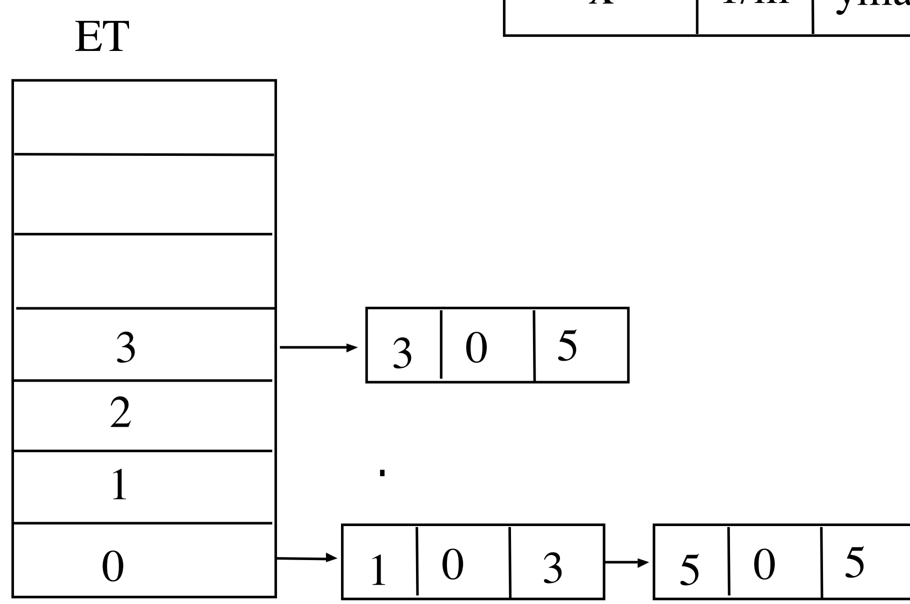
- For row = min to row=max
  - AEL=append(AEL, ET(row)); (add edges starting at the current row)
  - remove edges whose ymax=row
    - OK since we are assuming integral coordinates; otherwise one would use ceil(ymax)
  - sort AEL by x-value
  - fill spans
    - parity rule
    - convention for integral x_{min} and x_{max}
  - update each edge in AEL
    - x += (1/m)

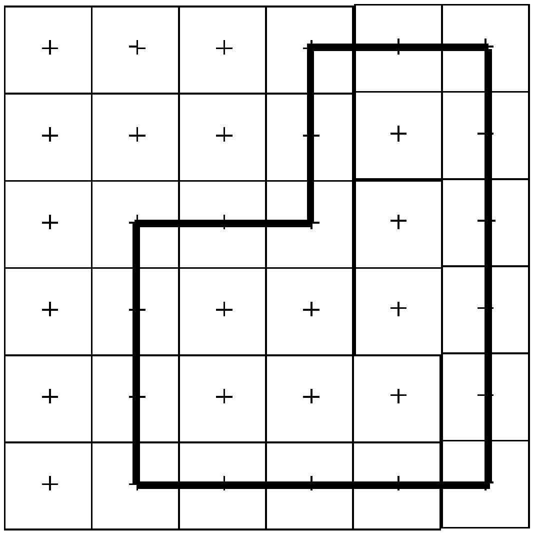


Compute the edge table (ET) to begin. Then fill polygon and update active edge list (AEL) row by row.

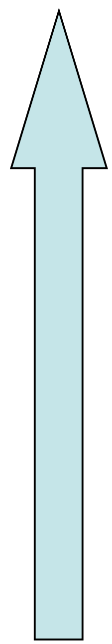
Format of edge entries

x	1/m	ymax





AEL just before filling



Row=5

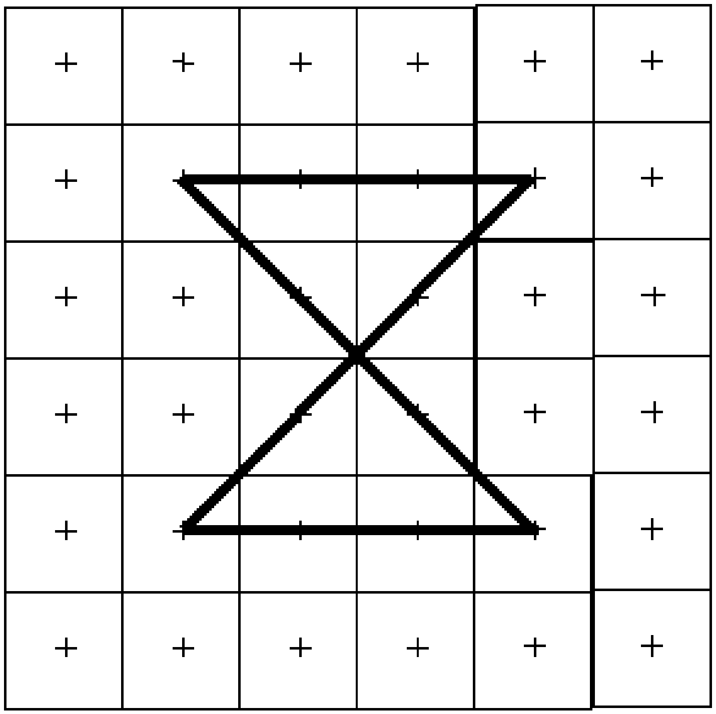
Row=4: [3 | 0 | 5] → [5 | 0 | 5]

Row=3: [3 | 0 | 5] → [5 | 0 | 5]

Row=2: [1 | 0 | 3] → [5 | 0 | 5]

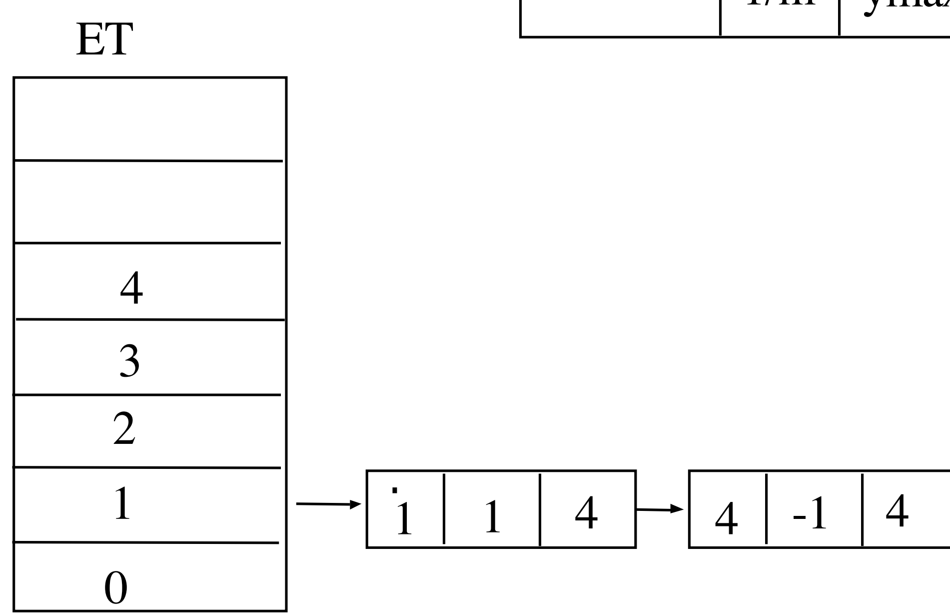
Row=1: [1 | 0 | 3] → [5 | 0 | 5]

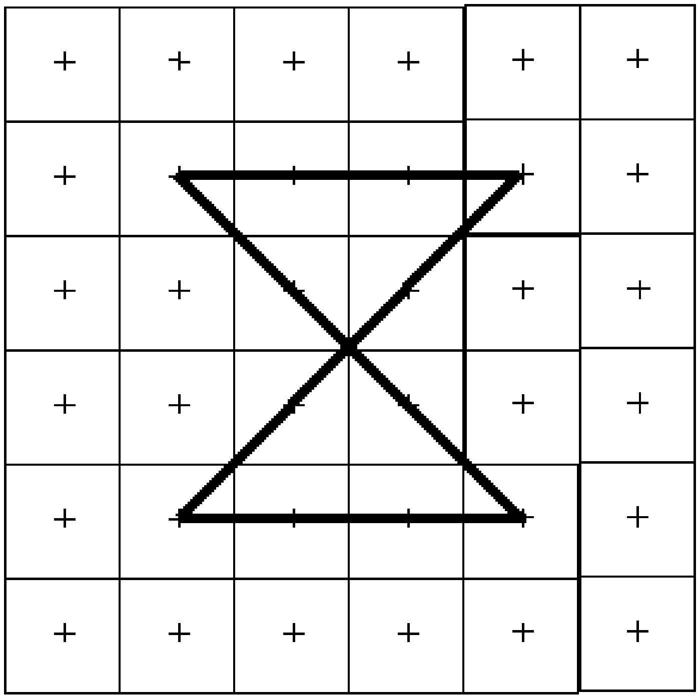
Row=0: [1 | 0 | 3] → [5 | 0 | 5]



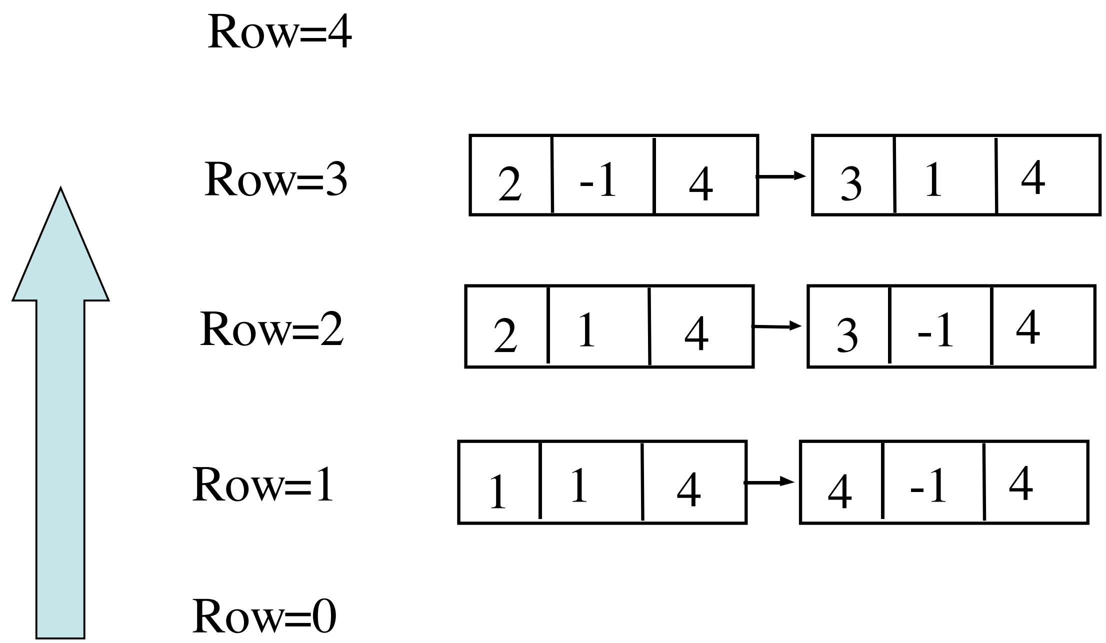
Format of edge entries

x	1/m	ymax





AEL just before filling



Comments

- Sort is quite fast, because AEL is usually almost in order.
- Nonetheless, OpenGL limits to convex polygons, so two and only two elements in AEL at any time, and no sorting.
- With additional logic to keep track of what color to use, can fill in many polygons at a time.
- Can be done *without* floating point

Dodging floating point

- 1/m=Dx/Dy, which is a rational number.
- x = x_int + x_num/Dy
- store x as (x_int, x_num),
- then x->x+1/m is given by:
  - x_num=x_num+Dx
  - if x_num >= x_denom
    - x_int=x_int+1
    - x_num=x_num-x_denom

- Advantages:
  - no floating point
  - can tell if x is an integer or not (check x_num=0), and get truncate(x) easily, for the span endpoints.