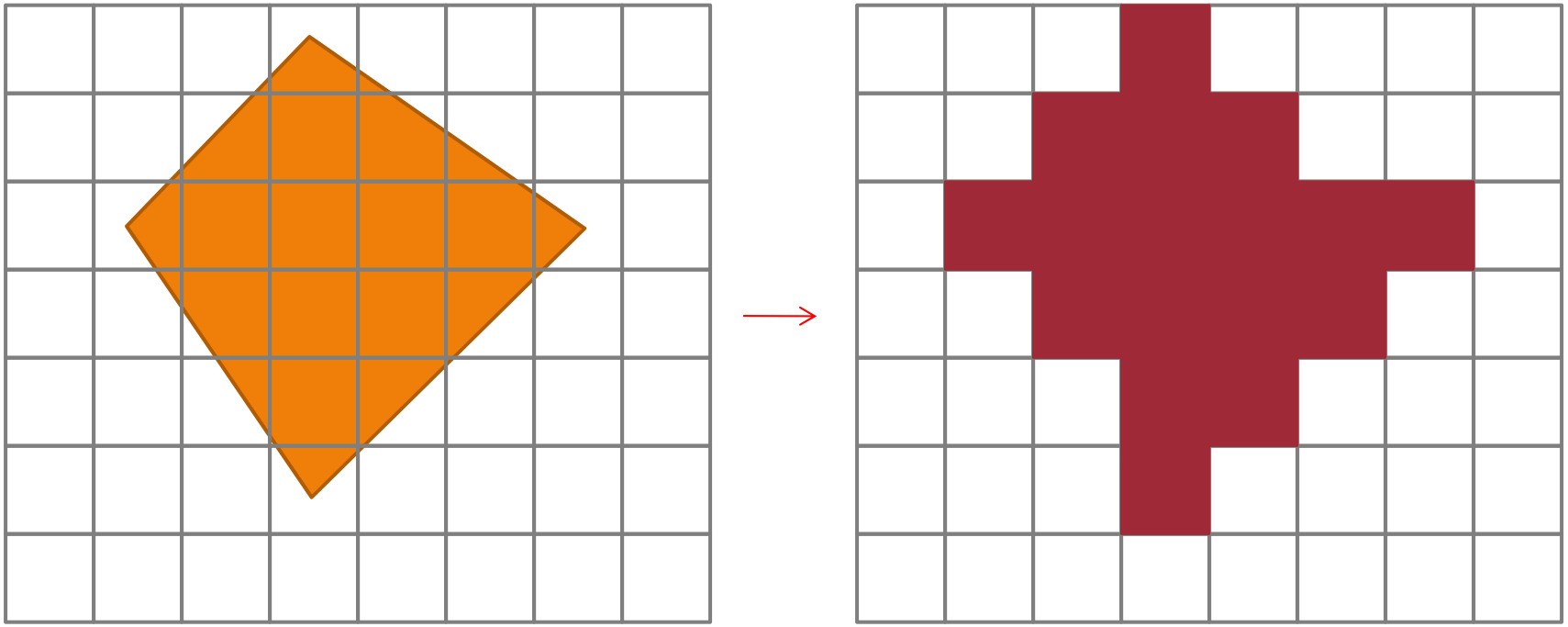
CS3241 COMPUTER GRAPHICS

Tutorial #2

Scan Conversion Algorithm

(aka)Rasterisation

- Given a polygon
  - E.g. it's vertices in a clockwise fashion
- Pixelation : how to pixelize and draw it on the screen



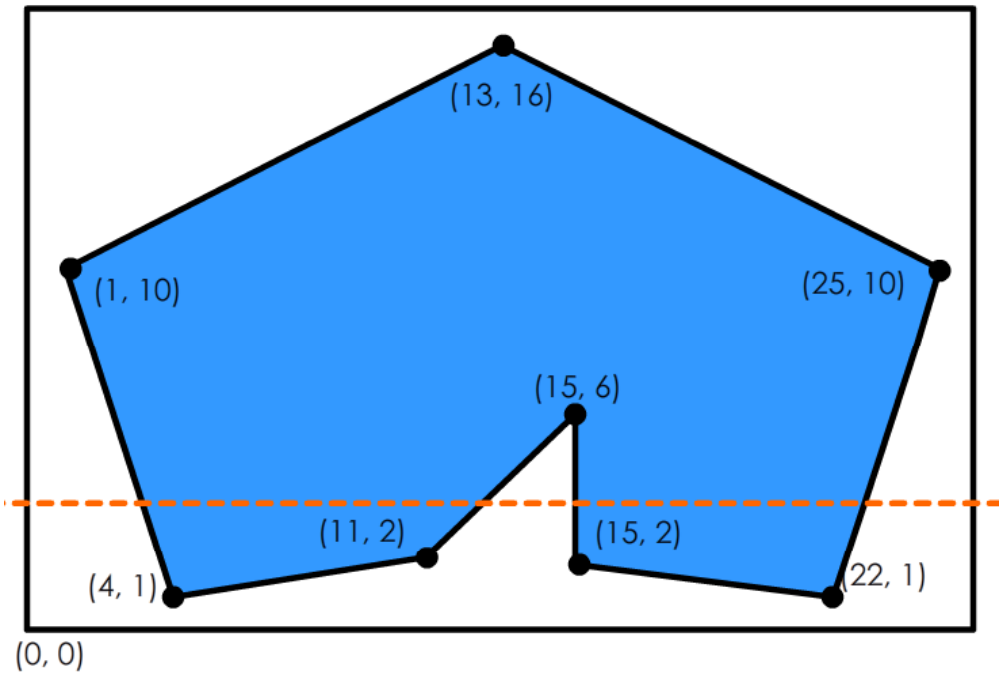
Scan Convert Algorithm

- "Paint" every polygon

Question 1a

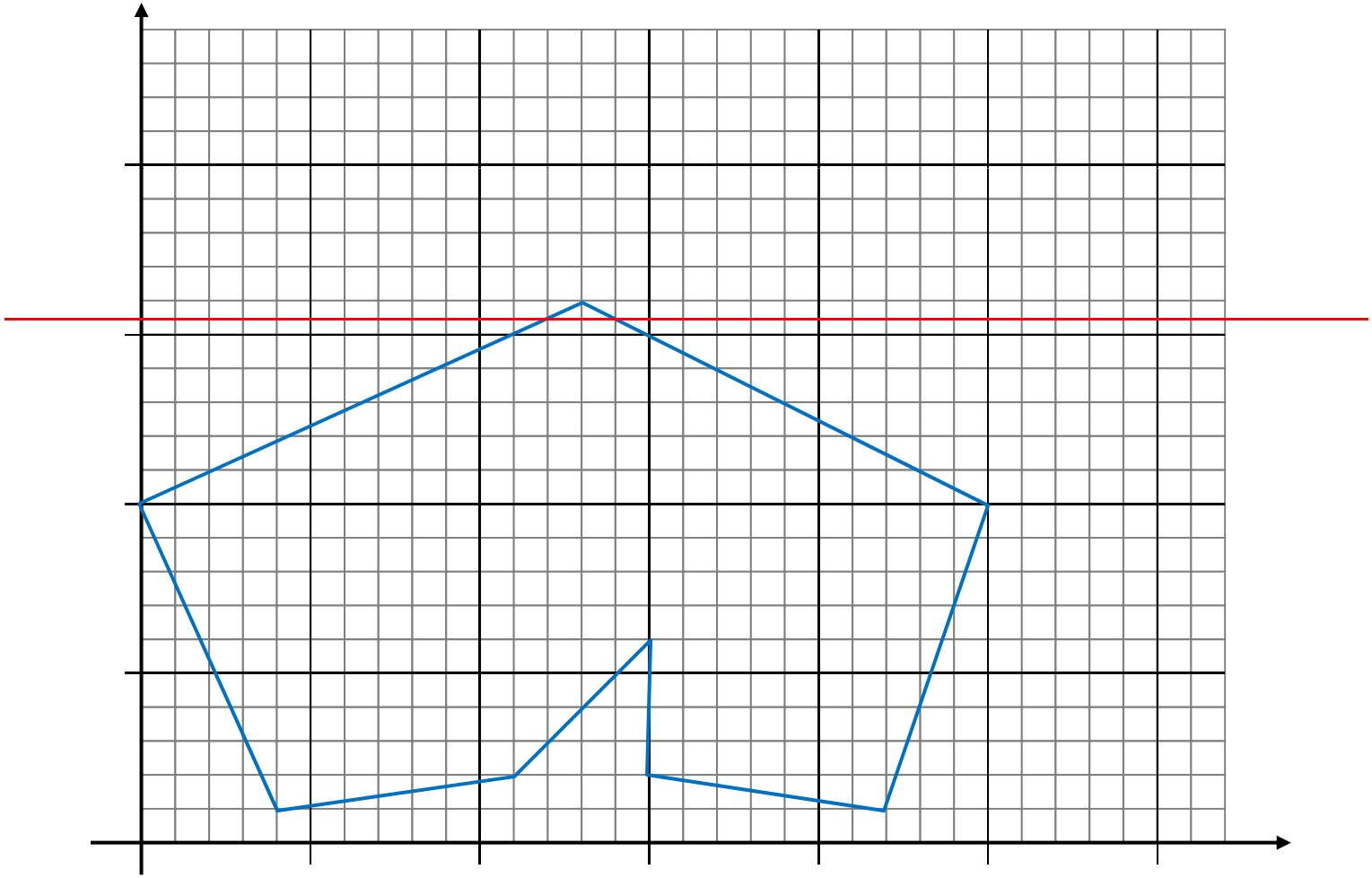
- Sort the vertices in vertical order (from top to bottom) and give the ordering of the vertices.

- (13, 16)
- (1, 10), (25, 10)
- (15, 6)
- (11, 2), (15, 2)
- (4, 1), (22, 1)



Question 1b

- First scanline?



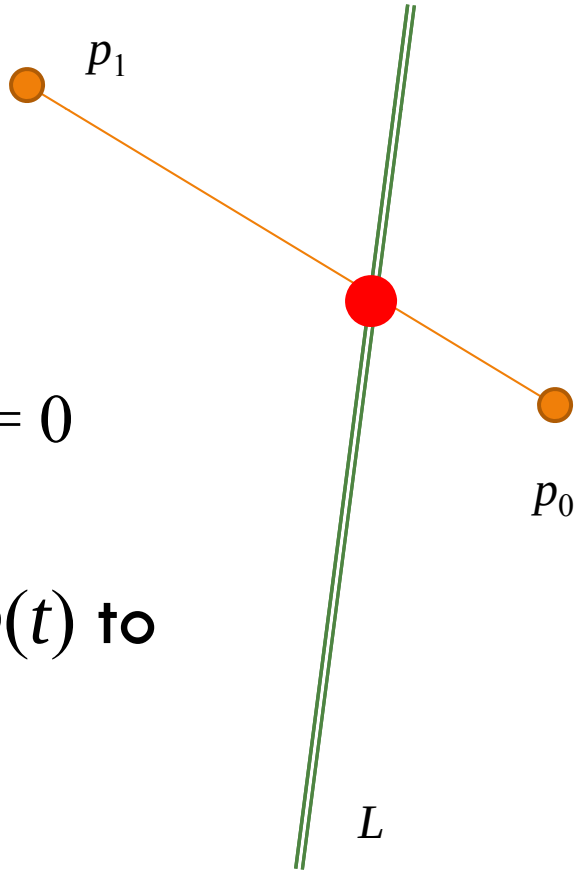
Question 1b

- Based on your answer in (a), which is the 1st scanline to be processed by the algorithm?

- (13, 16) → scanline $y = 15.5$
- (1, 10), (25, 10)
- (15, 6)
- (11, 2), (15, 2)
- (4, 1), (22, 1)

Line Intersection

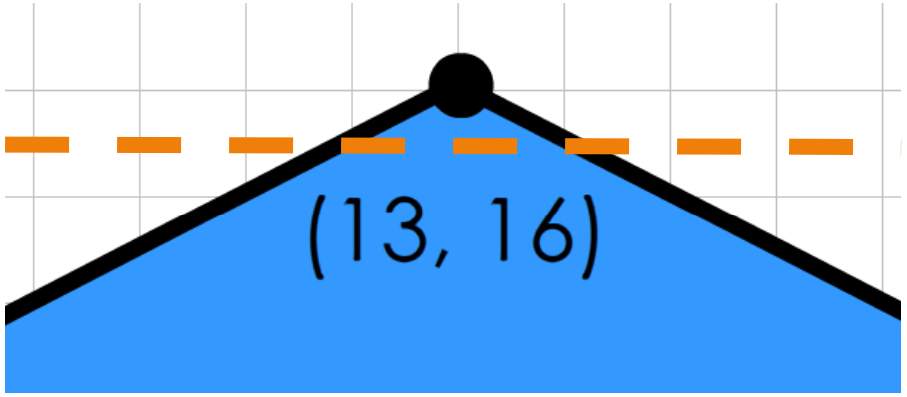
- Given one infinite line and one line segment
  - Let $p_0 = (x_0, y_0)$ and $p_1 = (x_1, y_1)$
  - $L : ax + by + c = 0$
- Substitute $p(t) = (x(t), y(t))$ into L
  - $a\,x(t) + b\,y(t) + c = 0$
  - $a\,[(1-t)x_0 + tx_1] + b[(1-t)y_0 + ty_1] + c = 0$
- A linear equation in t
- Solve t and substitute it back into $p(t)$ to find the intersection



Question 1c

- For the 1st scanline, give the left most and right most bounds/intersections of the polygon with the scanline

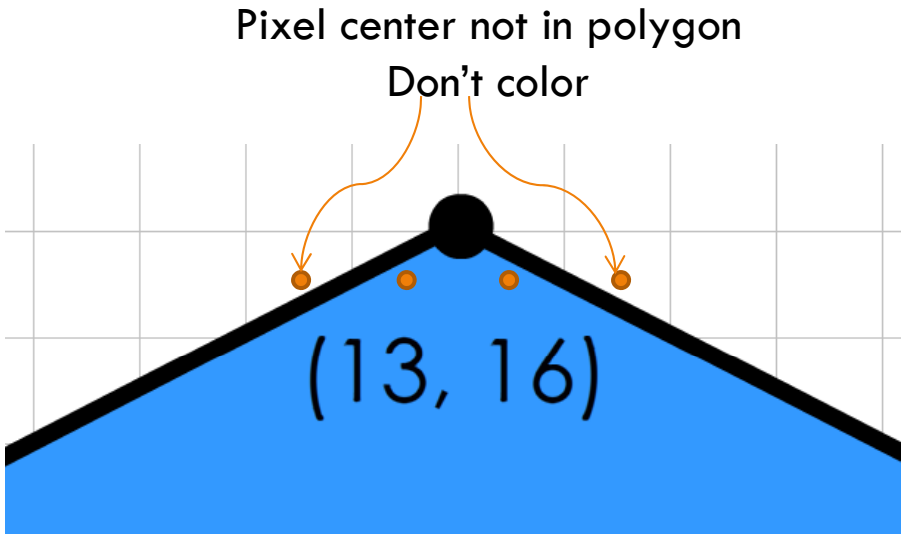
- Plot on grid to obtain:
- Left = (12, 15.5)
- Right = (14, 15.5)



Question 1d

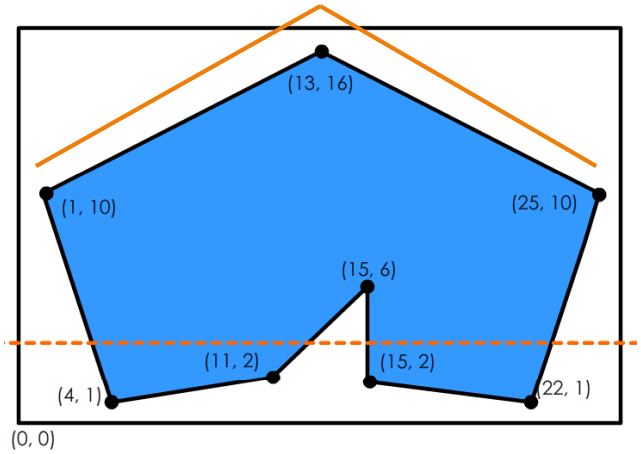
- For the 1st scanline, give the left most and right most coordinates of the pixels that needs to be colored

- Pixels to color
- Left = (12, 15)
- Right = (14, 15)



Question 1e

- For the 1st scanline, calculate Δx for both of the edges in the scanline.



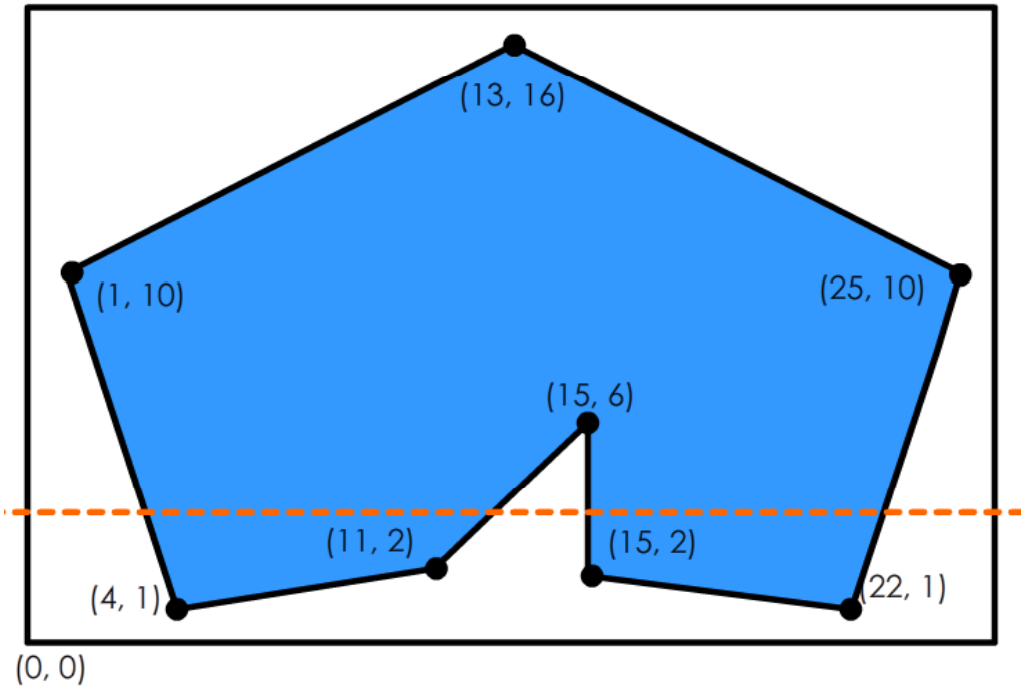
- Left = (12, 15.5)
- Right = (14, 15.5)

- Left edge Δx = (12-13)/(16-15.5) = -2
- Right edge Δx = (14-13)/(16-15.5) = 2

Question 1f

- Using the Δx values calculated in (d), find the left and right most coordinates for the next 6 scanlines.

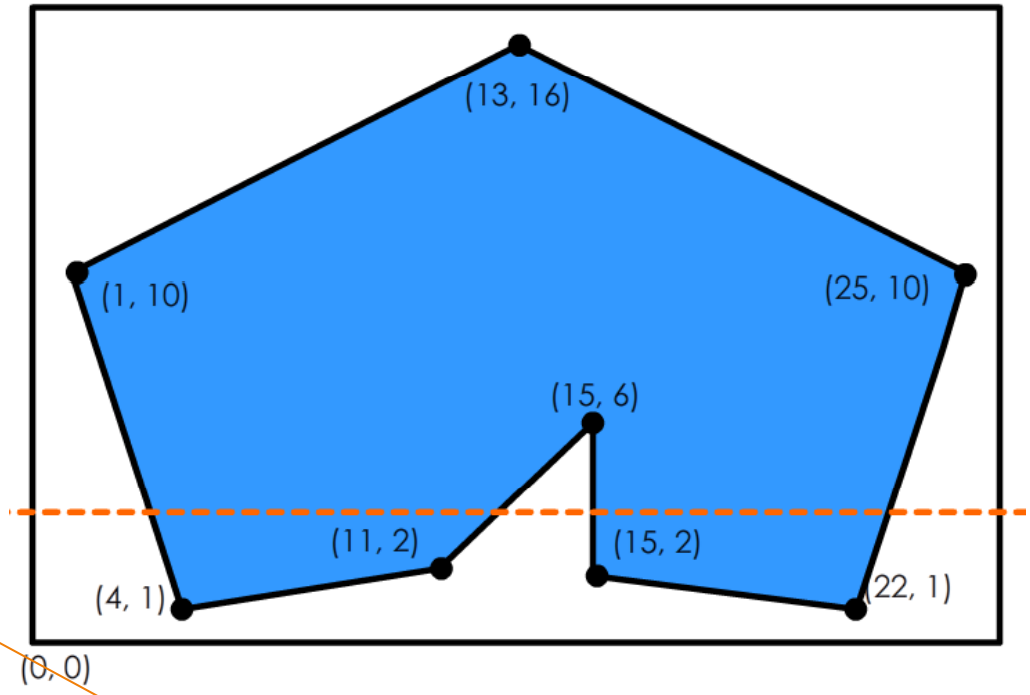
- Scanline 1:
  - Left: 12+(-2) = 10
  - Right: 14+2 = 16
- Scanline 2:
  - Left: 10+(-2) = 8
  - Right: 16+2 = 18
- Scanline 3:
  - Left:8+(-2) =6
  - Right: 18+2 = 20



Question 1f

- Using the Δx values calculated in (d), find the left and right most coordinates for the next 6 scanlines.

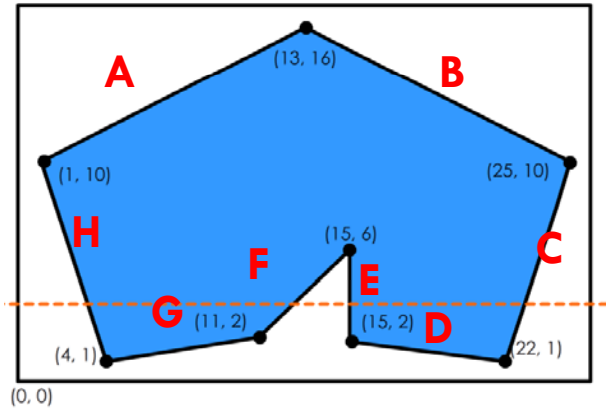
- Scanline 4:
  - Left: 6+(-2) = 4
  - Right: 20+2 = 22
- Scanline 5:
  - Left: 4+(-2) = 2
  - Right: 22+2 = 24
- Scanline 6: y=9.5
  - Out of edge limits!
  - What do we do here?



•How do we know the edge has ended?

How to update the Edge Table

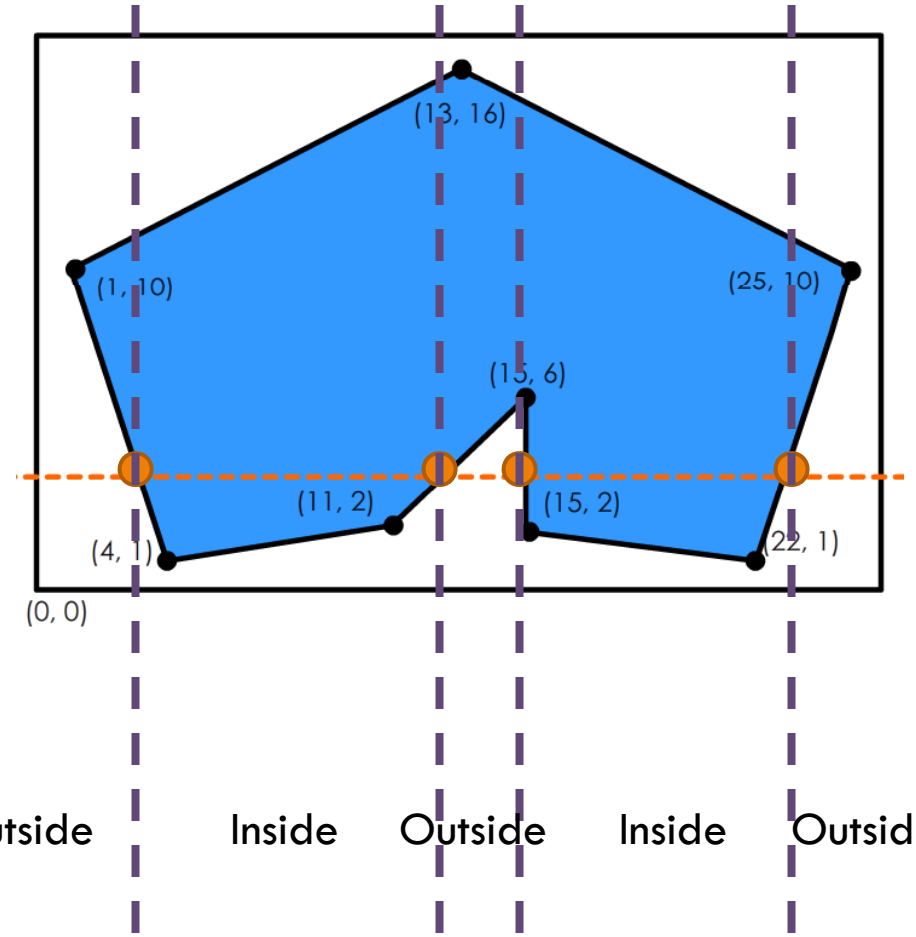
- Scan line 5: ET = {A, B}
- Vertices just above the scan line 6: (1, 10), (25, 10)
- Delete edges associated with those vertices and not intersect the scan line 6. ET = {}
- Add edges associated with those vertices and intersect with the scan line 6. ET = {C, H}



Edge table maintain the list of edge that always intersect with the scan line!

Question 1g

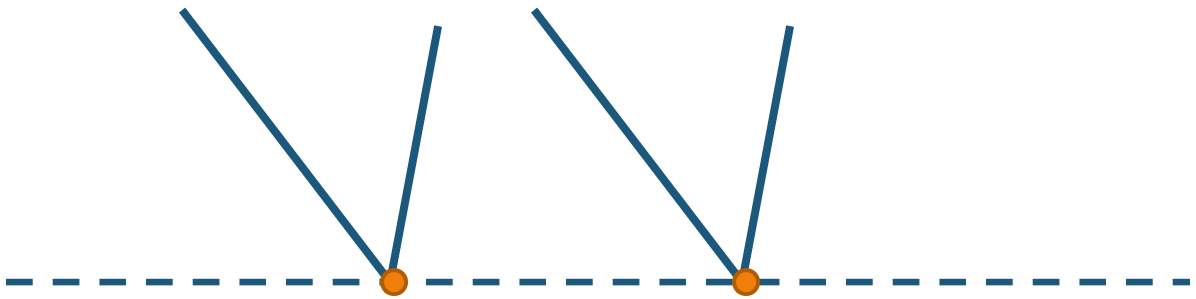
- For the scanline highlighted by the dotted line, describe how it can be converted into pixels using the scan-conversion algorithm
- Use a parity bit to keep track of whether you are inside the polygon or outside
- Initially, set parity bit to false – meaning outside
- Flip the parity at every intersection
- Draw the portions that are inside the polygon as per normal



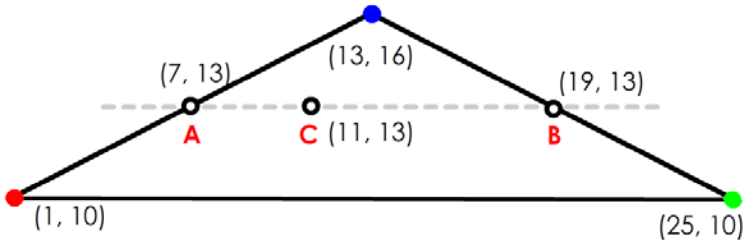
Parity: Outside Inside Outside Inside Outside

A Boundary case

- We have two pairs of two identical intersection points
- Should we discard the duplicate ones?

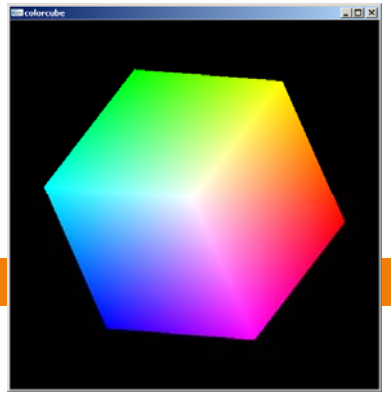


Question 2

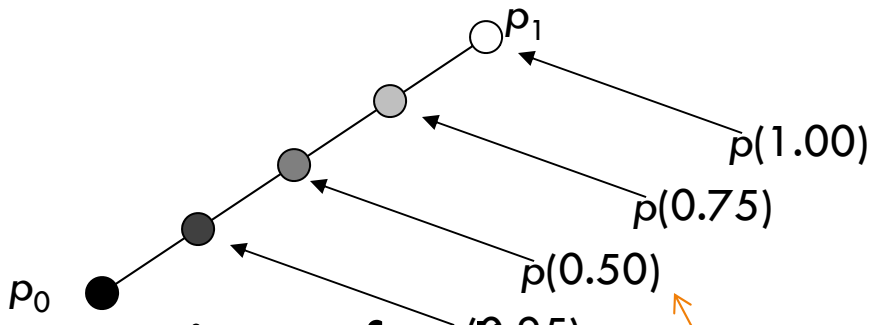


- Following the polygon given in Question 1, the above diagram shows the first three vertices with the vertices colored red, green and blue, with RGB value (1, 0, 0), (0, 1, 0) and (0, 0, 1) respectively. Given the coordinates and color information, find the RGB values of the points A, B, and C.
  - The scanline is supposed to be y=13.5, I just put it to y=13 for easier calculation

Interpolation of Colors



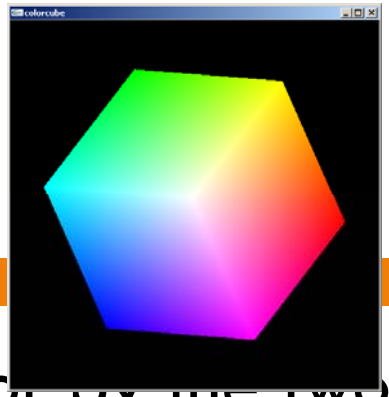
- Given a line segment $p(t) = (1\text{-}t)\, p_0 + t\, p_1$
  - With end points p_0, p_1



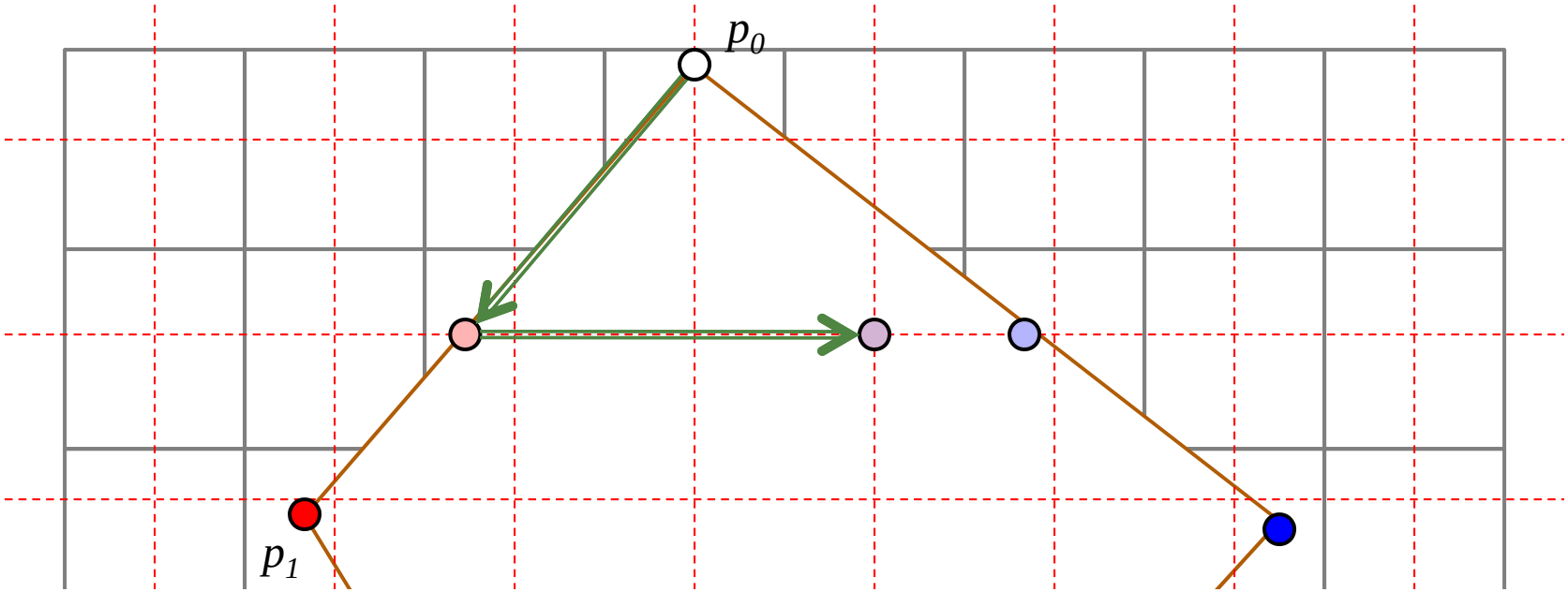
- If the colors of the two vertices of a line segment are different
  - $c_0 = (r_0, g_0, b_0)$ at p_0 and $c_1 = (r_1, g_1, b_1)$ at p_1
- The color of any point at t is $c(t) = (1\text{-}t)\, c_0 + t\, c_1$

c(0.50) = $(c_0 + c_1)/2$

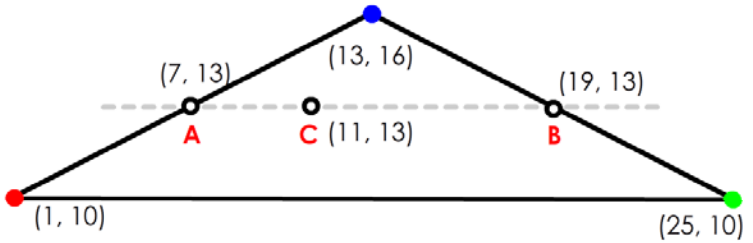
Interpolation of Colors



- For a point on an edge, interpolate its color by the two end points of that edge
  - Afterwards, interpolate the points between them on the pixel
  - Note that the increment of color values is also constant!!!



Question 2



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- *Solving A*
  - $p(t) = (1\text{-}t)\, p_0 + t\, p_1$

$$\begin{pmatrix} 7 \\ 13 \end{pmatrix} = (1-t)\begin{pmatrix} 1 \\ 10 \end{pmatrix} + t\begin{pmatrix} 13 \\ 16 \end{pmatrix}$$

$$7 = (1-t) + 13t$$

$$12t = 6$$

$$t = 0.5$$

  - $c(t) = (1\text{-}t)\, c_0 + t\, c_1$

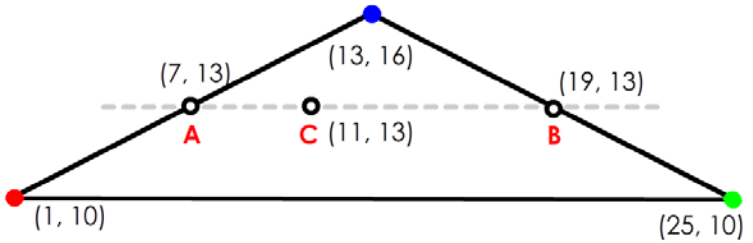
$$\begin{pmatrix} r \\ g \\ b \end{pmatrix} = (1-0.5)\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} + 0.5\begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

$$r = 0.5$$

$$g = 0$$

$$b = 0.5$$

Question 2



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- *Solving B*
  - $p(t) = (1\text{-}t)\, p_0 + t\, p_1$

$$\begin{pmatrix}19\\13\end{pmatrix} = (1-t)\begin{pmatrix}25\\10\end{pmatrix} + t\begin{pmatrix}13\\16\end{pmatrix}$$

$$19 = 25(1-t) + 13t$$

$$12t = 6$$

$$t = 0.5$$

  - $c(t) = (1\text{-}t)\, c_0 + t\, c_1$

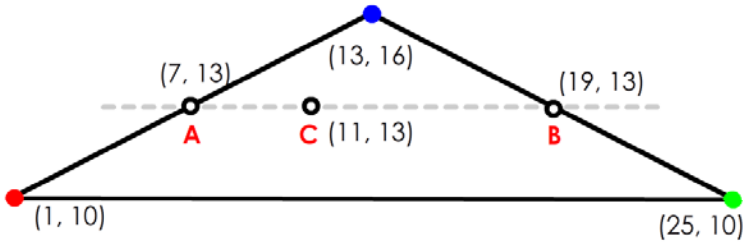
$$\begin{pmatrix}r\\g\\b\end{pmatrix} = (1-0.5)\begin{pmatrix}0\\1\\0\end{pmatrix} + 0.5\begin{pmatrix}0\\0\\1\end{pmatrix}$$

$$r = 0$$

$$g = 0.5$$

$$b = 0.5$$

Question 2



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- *Solving C*
  - $p(t) = (1\text{-}t)\, p_0 + t\, p_1$

$$\begin{pmatrix} 11 \\ 13 \end{pmatrix} = (1-t)\begin{pmatrix} 7 \\ 13 \end{pmatrix} + t\begin{pmatrix} 19 \\ 13 \end{pmatrix}$$

$$11 = 7(1-t) + 19t$$

$$12t = 4$$

$$t = 0.333$$

  - $c(t) = (1\text{-}t)\, c_0 + t\, c_1$

$$\begin{pmatrix} r \\ g \\ b \end{pmatrix} = (1-0.333)\begin{pmatrix} 0.5 \\ 0 \\ 0.5 \end{pmatrix} + 0.333\begin{pmatrix} 0 \\ 0.5 \\ 0.5 \end{pmatrix}$$

$$r = 0.3335$$

$$g = 0.1665$$

$$b = 0.5$$