Aliasing and Anti-aliasing

• What is aliasing?
  – Aliasing is a phenomenon that occurs when sampling a continuous function with insufficient resolution

• What is antialiasing?
  – Antialiasing is the application of techniques that reduce or eliminate aliasing

• Why is it necessary?
  – To make the graphics look more realistic

• How is it performed?
  – We’ll see
Antialiasing: Increasing Resolution

- Doubling resolution in x and y

(a) Standard midpoint line on a bilevel display. (b) Same line on a display that has twice the linear resolution.

- This method only lessens the problem
- Costs 4 times memory, memory bandwidth and scan conversion time
Antialiasing: Unweighted Area Sampling (1/3)

- Drawing a line as a 1-pixel width rectangle

  ![Line from point (2,3) to point (8,8)]

- For now pixel is unit square centered on x-y intersection
- Midpoint algorithm: pick single pixel closest to center line of rectangle. This is a form of point sampling
Antialiasing: Unweighted Area Sampling (2/3)

- Set each pixel’s intensity value proportional to its area of overlap covered by primitive
- Note more than one pixel/column for lines of $0 < \text{slope} < 1$
- This is a form of unweighted area sampling
  - the further pixel center is from the line, the less influential it has
  - only pixels covered by primitive can contribute
  - only amount of area of overlap matters, regardless of distance of area of overlap from pixel’s center
Antialiasing: Unweighted Area Sampling (3/3)
"Box Filter" Represents Unweighted Area Sampling

- Weight function $W(x,y)$ gives weight for incremental area $dA$ centered at $(x,y)$; it is constant here, hence the name "box"
- The intensity contribute by $dA$ is $(W(x,y)*dA(x,y))$
- Then the total intensity $(0\text{-}1)$ is

$$\int W(x, y)dA(x, y)$$

this is volume over the area of overlap
Cone Filter for Weighted Area Sampling (1/2)

- We change to circular pixel; we set cone’s diameter to 2 pixel units
- dA has greater weight if closer to center of pixel
- Normalize so that volume=1, sub volume is conical wedge
Cone Filter for Weighted Area Sampling (2/2)

- 2 unit support implies up to 3 pixels/column
- Gupta-Sproull algorithm provides fast anti-aliased lines via table look-up