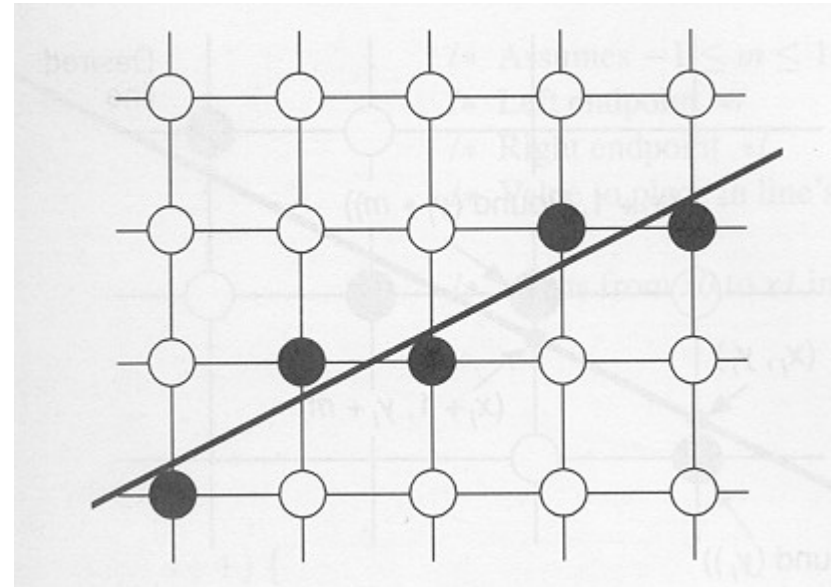


Drawing Lines & Anti-Aliasing

**CSCI 4229/5229
Computer Graphics
Fall 2019**

Scan Converting Lines

- Which pixels to turn on?
 - Floating point
 - Bresenham algorithm



Floating Point Algorithm

- Functional form

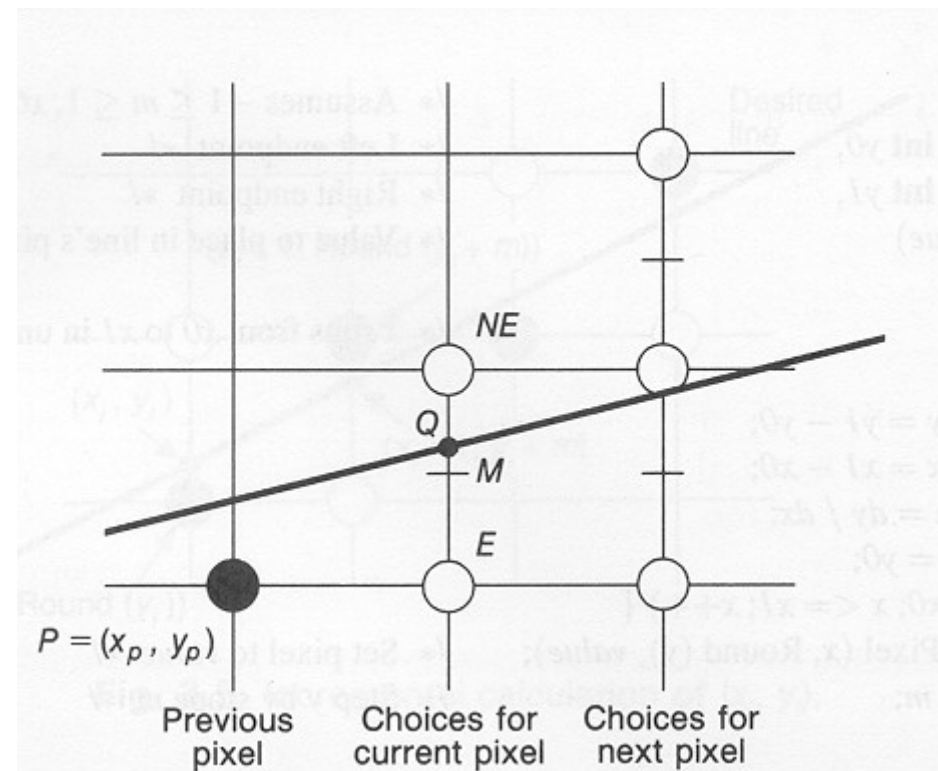
$$y = (x-x_0)(y_1-y_0)/(x_1-x_0)+y_0 \quad (\text{use when } |y_1-y_0| < |x_1-x_0|)$$

$$x = (y-y_0)(x_1-x_0)/(y_1-y_0)+x_0 \quad (\text{use when } |x_1-x_0| < |y_1-y_0|)$$

- Evaluate y or x at integral values of x or y
- Round result to nearest integer to decide pixel
- Slow
 - integer \rightarrow float
 - float multiply and two float additions
 - float \rightarrow integer

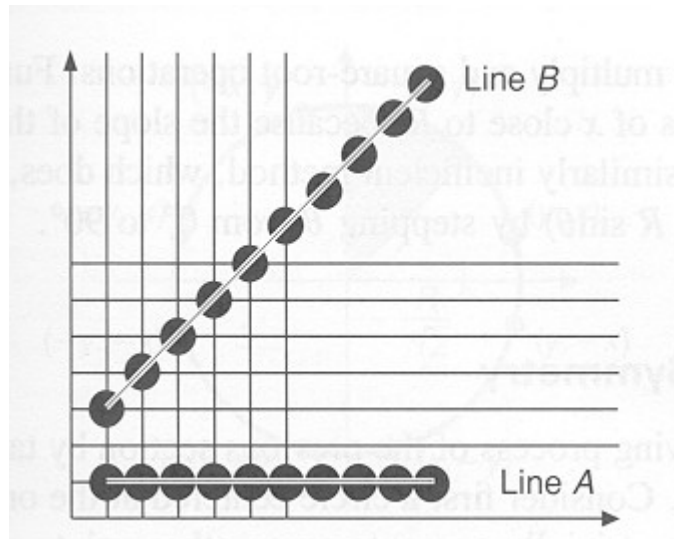
Bresenham Algorithm

- Select next pixel from two choices: E or NE
 - Only works when slope is ≤ 1
 - Is midpoint above or below the line?
- All integer operations
 - One or two adds



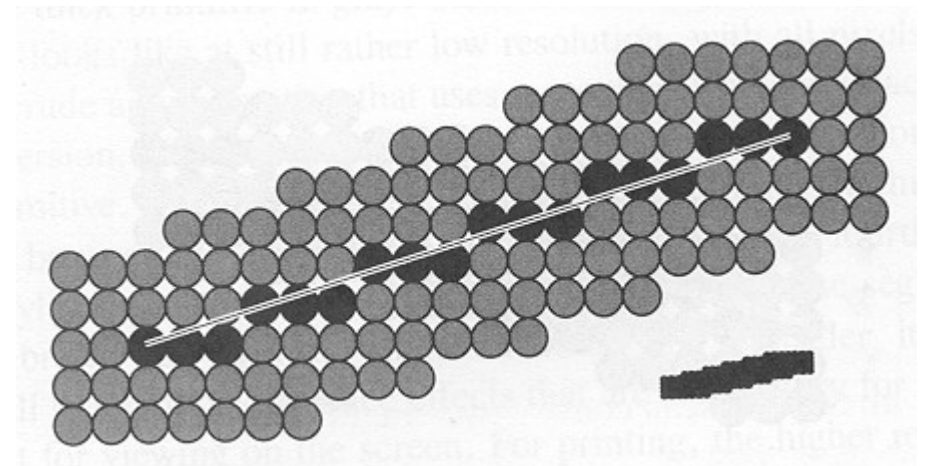
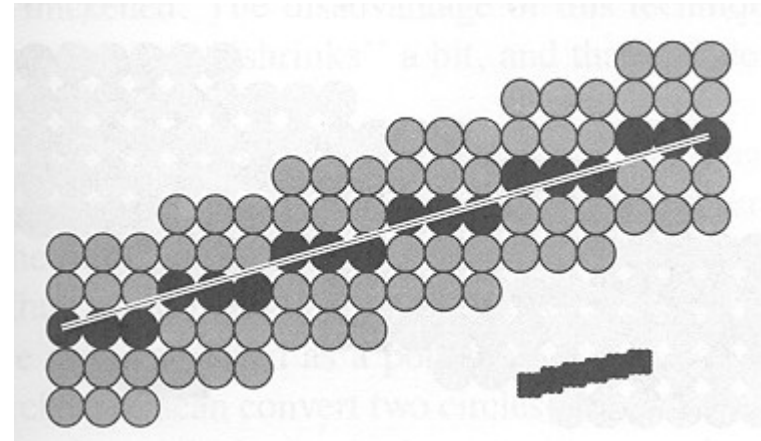
Line intensity

- Lines parallel to axes appear more dense than lines at 45 degree angles by $\sqrt{2}$
- If this is an issue you can adjust the pixel intensity inversely proportional to the cosine



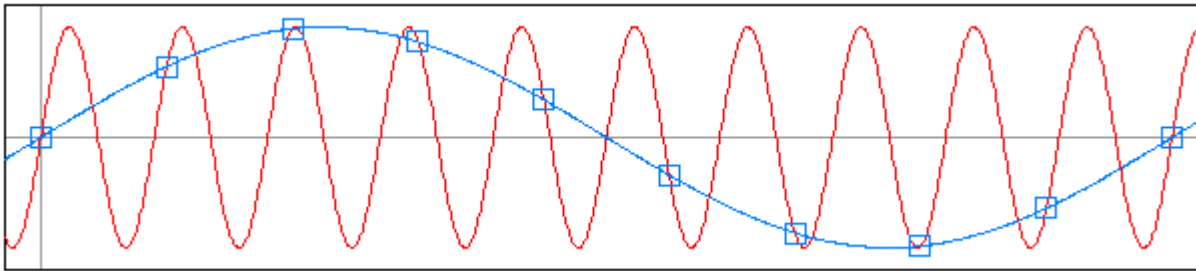
Thick Lines

- Column replication
- Rectangular pen
- Polygon fill



Anti-aliasing in signal processing

- Discrete samples of a signal

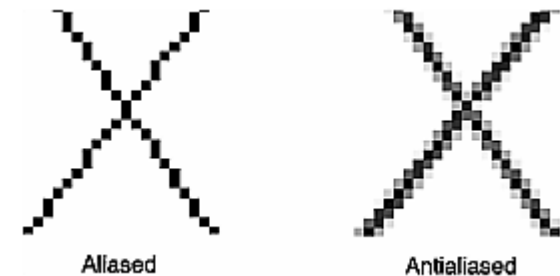


- Low and high frequency samples are the same

Anti-aliasing in Computer Graphics

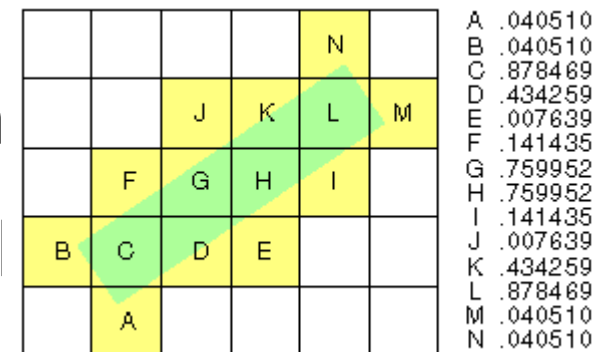
- Aliased lines

- Discrete pixels are turned on
- Nearest pixel selected
- Leads to “jaggies”



- Anti-aliased lines

- Pixels are partially turned on
- Level selected by line overlap
- Leads to smoother lines



OpenGL Anti-aliased Lines

- `glEnable(GL_LINE_SMOOTH);`
- `glEnable(GL_BLEND);`
- `glBlendFunc (GL_SRC_ALPHA,
 GL_ONE_MINUS_SRC_ALPHA);`
- `glLineWidth(1.5);`