Pixels

- $p$: $u = 0, v = 0$.
- $q$: $u = u_m, v = v_m$. 
Lines

A line is approximated by the pixels that it touches.

Tiny pixels make the approximation look smooth.
Curves

A curve is approximated in the same way.
Curves

Smaller pixels are often needed.
Text characters are treated as curves.

Text has a fixed resolution in bit-mapped fonts.

Resolution scales with window size in scalable fonts.
A window system divides the computer screen into windows.
Each window has its own coordinate system.

These coordinates do not change if the window is moved or resized.

The coordinates employ the standard $xy$ axes.

Using window coordinates makes graphics programming much easier!
Coordinate Transformation

- $x$ increases from $x_1$ to $x_2$.
- $y$ increases from $y_1$ to $y_2$.
- solve for $u = ax + b$ and $v = cx + d$

\[
\begin{align*}
ax_1 + b & = 0 \
ax_2 + b & = u_m \
\rightarrow & \\
ax_2 + b & = u_m \
ax_2 + b & = u_m \\
\end{align*}
\]

\[
\begin{align*}
a & = \frac{u_m}{x_2 - x_1} \\
b & = -\frac{x_1 u_m}{x_2 - x_1} \\
\end{align*}
\]

\[
\begin{align*}
c & = \frac{v_m}{y_1 - y_2} \\
d & = -\frac{y_2 v_m}{y_1 - y_2} \\
\end{align*}
\]