Look at the behaviour of $f(x) = y$ when we fix a y and investigate the acceptable range of values x can take while still being within the line of the graph. First fix Δ to be the cutoff value where we set a pixel to on given the following holds

$$|f(x) - y| < \Delta$$

When we fix $y = b$ for some constant b, then for x satisfying

$$b - \Delta < f(x) < b + \Delta$$

The pixel is on. So this gives a range of 2Δ for values of $f(x)$. So that the range of values for x will often vary along the length of the function.
For a particular example look at the function $f(x) = x^3$ which has an inverse function $x^{\frac{1}{3}}$.

$$b - \Delta < x^3 < b + \Delta$$
$$(b - \Delta)^{\frac{1}{3}} < x < (b + \Delta)^{\frac{1}{3}}$$

Giving values of x a range of

$$|(b - \Delta)^{\frac{1}{3}} - (b + \Delta)^{\frac{1}{3}}|$$

Which gives a large cutoff for b close to zero and a smaller cutoff as b increases.