

Quantization: how many bits per pixel?



8 bits



5 bits



4 bits



3 bits



2 bits



1 bit

„Contouring“



How many gray levels are required?

- Contouring is most visible for a ramp

32 levels



64 levels



128 levels

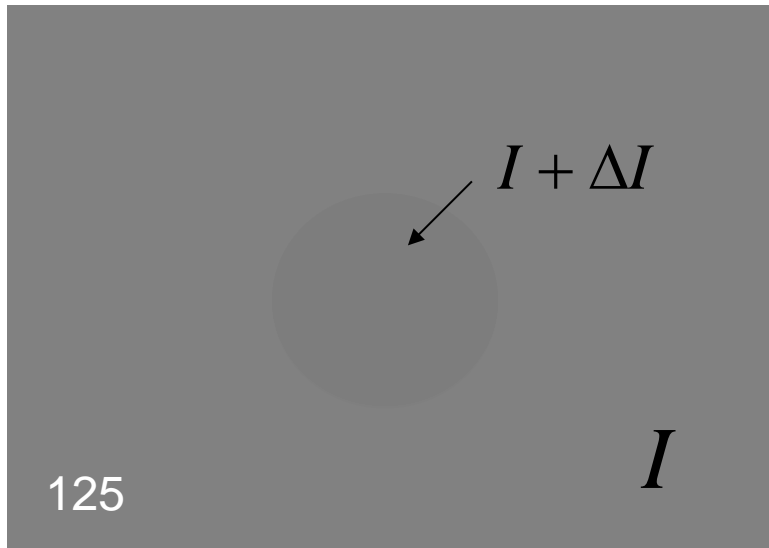


256 levels



- Digital images typically are quantized to 256 gray levels.

Brightness discrimination experiment



Visibility threshold

$$\Delta I / I \approx 1 \dots 2\%$$

„Weber fraction“
„Weber's Law“



Note: I is luminance, measured in cd/m^2

Can you see the circle?

Human brightness perception is uniform
in the $\log(I)$ domain („Fechner's Law“)

Contrast ratio without contouring

- Luminance ratio between two successive quantization levels at visibility threshold

$$\frac{I_{\max}}{I_{\min}} = (1 + K_{Weber})^{N-1}$$

- For $K_{Weber} = 0.01 \dots 0.02$ $N = 256$ $I_{\max} / I_{\min} = 13 \dots 156$
- Typical display contrast ratio
 - Modern flat panel display in dark room 1000:1
 - Cathode ray tube 100:1
 - Print on paper 10:1