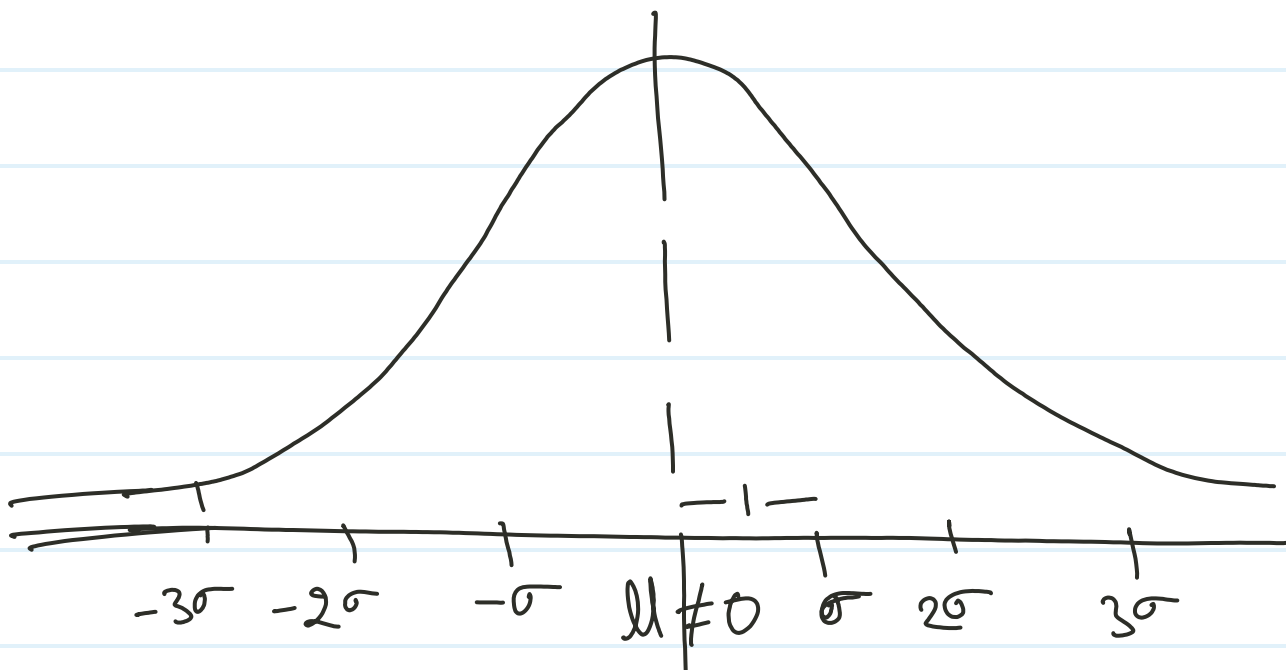
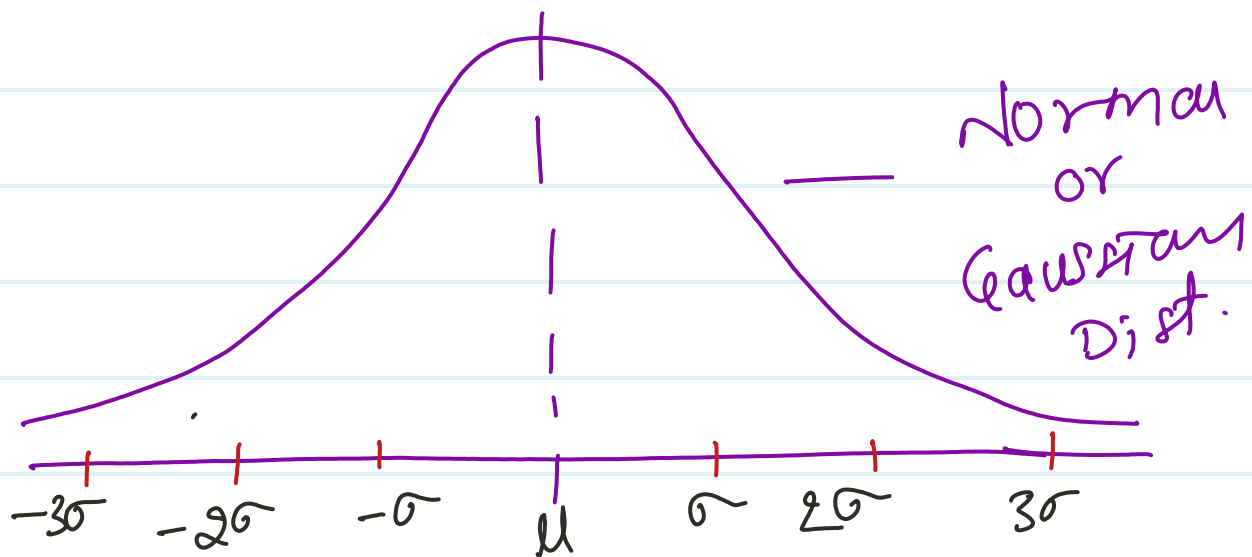


Feature scaling

① Standardization

② Normalization



$$\text{std} = \quad \mu = 0 \quad \sigma = 1$$

① standardization

$$z = \frac{x_i - \mu}{\sigma}$$

Height (cm)

$$\begin{array}{lll} \Rightarrow 150 & (150 - 164)^2 & = 196 \\ 160 & (160 - 164)^2 & = 16 \\ 165 & (165 - 164)^2 & = 1 \\ 170 & (170 - 164)^2 & = 36 \\ 175 & (175 - 164)^2 & = 121 \end{array}$$

magnitudine

||150||

cm în unit

$$\mu = \frac{150 + 160 + 165 + 170 + 175}{5} = 164$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n}}$$

$$= \sqrt{\frac{196 + 16 + 1 + 36 + 121}{5}}$$

$$\Rightarrow \sqrt{\frac{370}{5}} = \sqrt{74} = 8.60$$

$$z = \frac{x_i - \mu}{\sigma}$$

Height

$$150 \Rightarrow \frac{150 - 164}{8.60} = -1.63$$

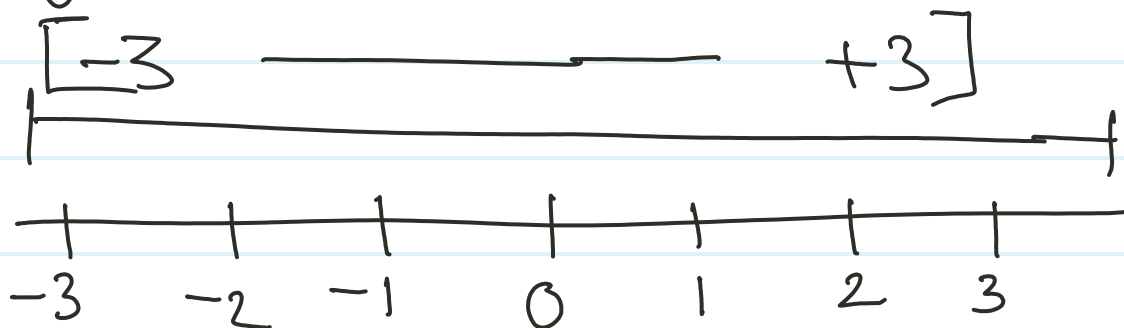
$$160 \Rightarrow \frac{160 - 164}{8.60} = -0.47$$

$$165 \Rightarrow \frac{165 - 164}{8.60} = +0.12$$

$$170 = \frac{170 - 164}{8.60} = +0.17$$

$$175 \Rightarrow \frac{175 - 164}{8.60} = +1.28$$

range =



Machine Learning - standardization

② Normalization

$$X' = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$$

Height (cm)

150

$$X_{\min} = 150$$

160

$$X_{\max} = 175$$

165

170

175

$$\textcircled{1} 150 = \frac{150 - 150}{175 - 150} \Rightarrow 0$$

$$\textcircled{2} 160 = \frac{160 - 150}{175 - 150} \Rightarrow 0.4$$

$$\textcircled{3} 165 = \frac{165 - 150}{175 - 150} \Rightarrow 0.6$$

$$\textcircled{4} 170 = \frac{170 - 150}{175 - 150} \Rightarrow 0.80$$

$$\textcircled{5} 175 = \frac{175 - 150}{175 - 150} \Rightarrow 1$$

Range of Normalization = $[0, 1]$

↓
Deep learning

Height ^{cm} age ^{year} weight ^{kg}.

150 40 70

└───┬───
|
magnitude

|
scaling └─── Standardization
 └─── Normalization