$$\sigma^2 = \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} \left[I(x,y) - \mu_I \right]^2 \quad =$$

$$\Longrightarrow \quad \sigma^2 = \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} \left[I(x,y) - \mu_I \right]^2$$

$$\left| \sum_{i}^{n} f(i) - c = \sum_{i}^{n} f(i) - \sum_{i} c \right.$$

$$= \quad \sigma^2 = \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} I(x,y)^2 - \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} \mu_I{}^2$$

$$\Longrightarrow \quad \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} I(x,y)^2 - \frac{N \cdot M \cdot \mu^2}{N \cdot M}$$

$$\Longrightarrow \quad \frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} I(x,y)^2 - \mu^2$$

$$= \quad \sigma^2 = \left[\frac{1}{N_{\text{cols}} N_{\text{rows}}} \sum_{x=1}^{N_{\text{cols}}} \sum_{y=1}^{N_{\text{rows}}} I(x,y)^2 \right] - \mu_I^2$$

□