



北京交通大学

图像处理与机器学习

Digital Image Processing and Machine Learning

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第九章 应用实例

复杂背景人脸检测算法

Face detection from cluttered images



Face Detection from Cluttered images



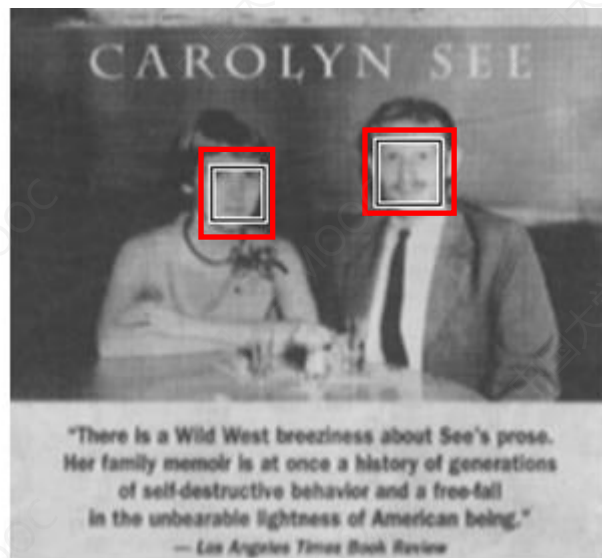
Definition of face detection

- Arbitrary images
- Detect and localize faces



Applications

- Intelligent system
- Security, surveillance system
- Human-computer interact system





Face Detection from Cluttered images





Face Detection from Cluttered images

- ◆ Template matching methods
- ◆ Feature-based methods
- ◆ Learning-based methods



Face Detection from Cluttered images

□ Template matching methods

- Compute a difference measurement
- Threshold
- Insufficient to grasp the wide variety of faces

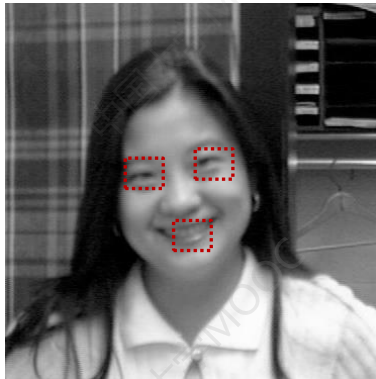




Face Detection from Cluttered images

□ Feature-based methods

- Search facial features: eyes, nose, mouth
- Geometrical relationship between facial features
- Susceptible to occlusion, low image quality etc.





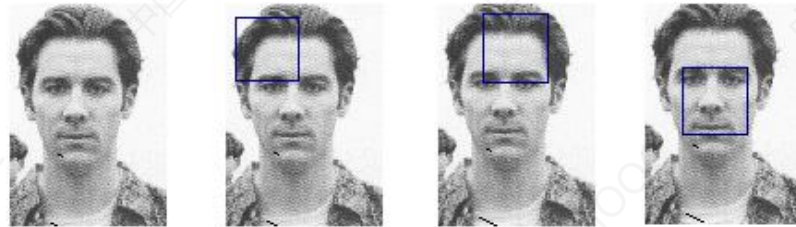
Face Detection from Cluttered images

❑ Classification-based methods

-- Two-class classification problem

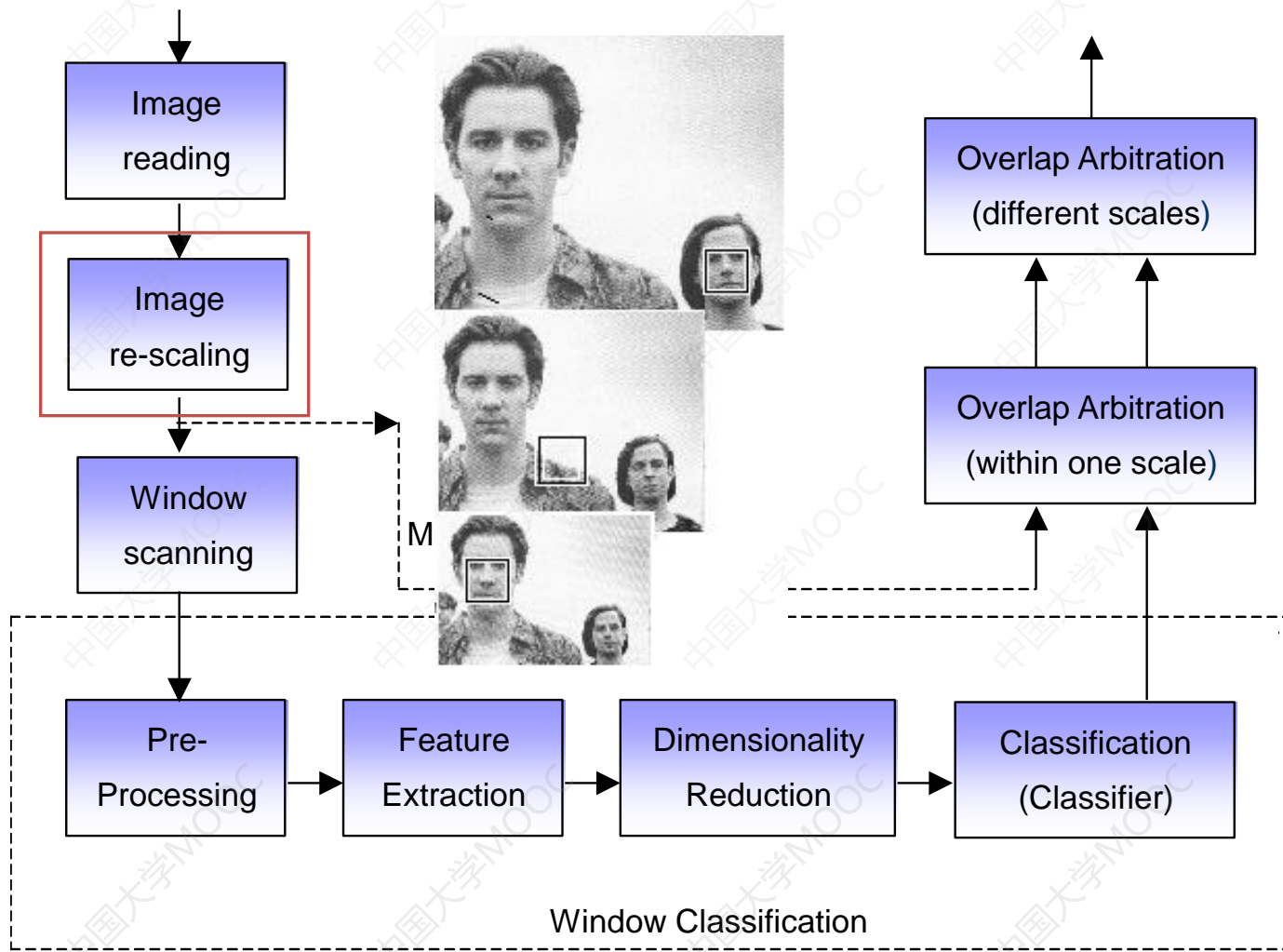
-- Window scanning

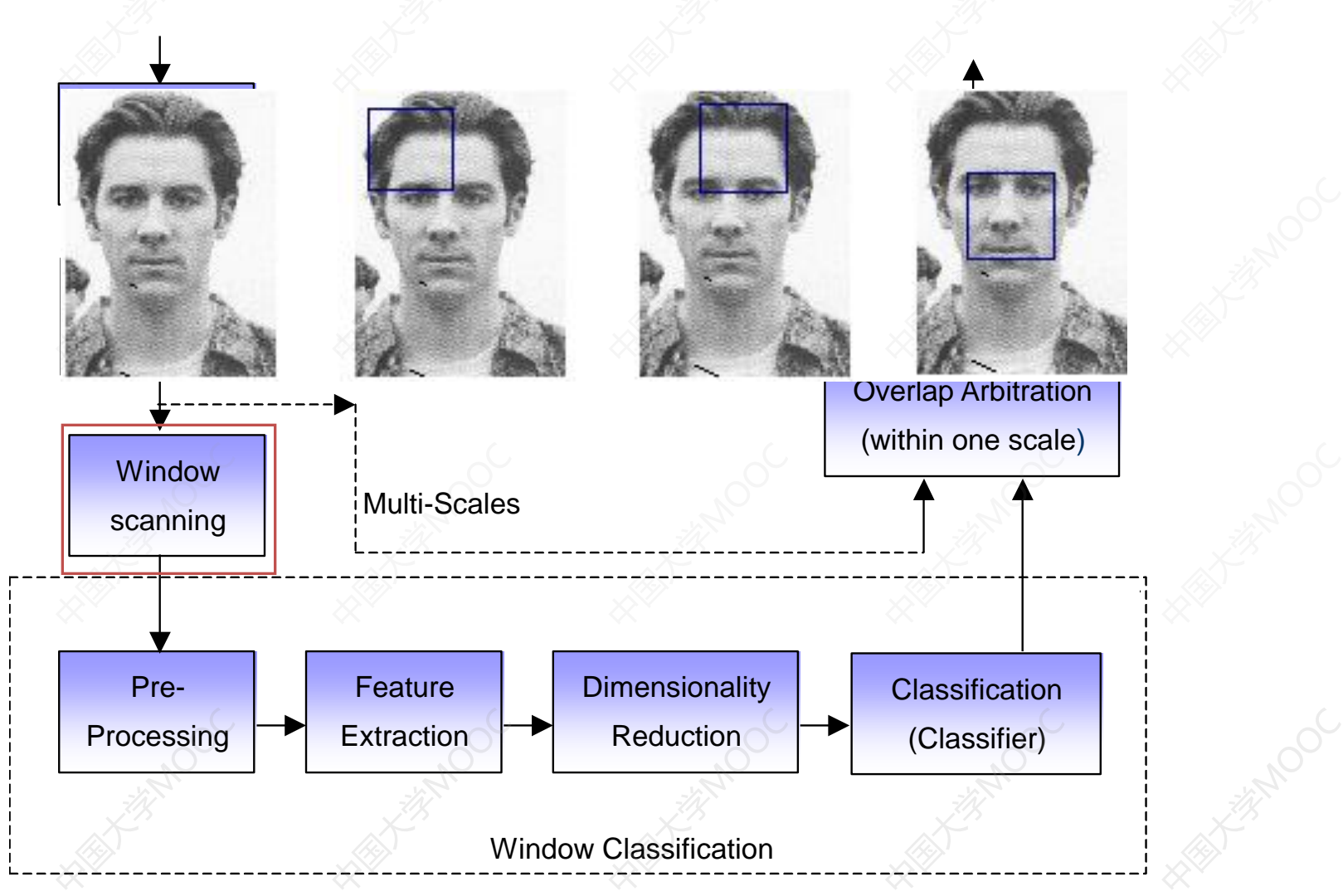
-- Window classification

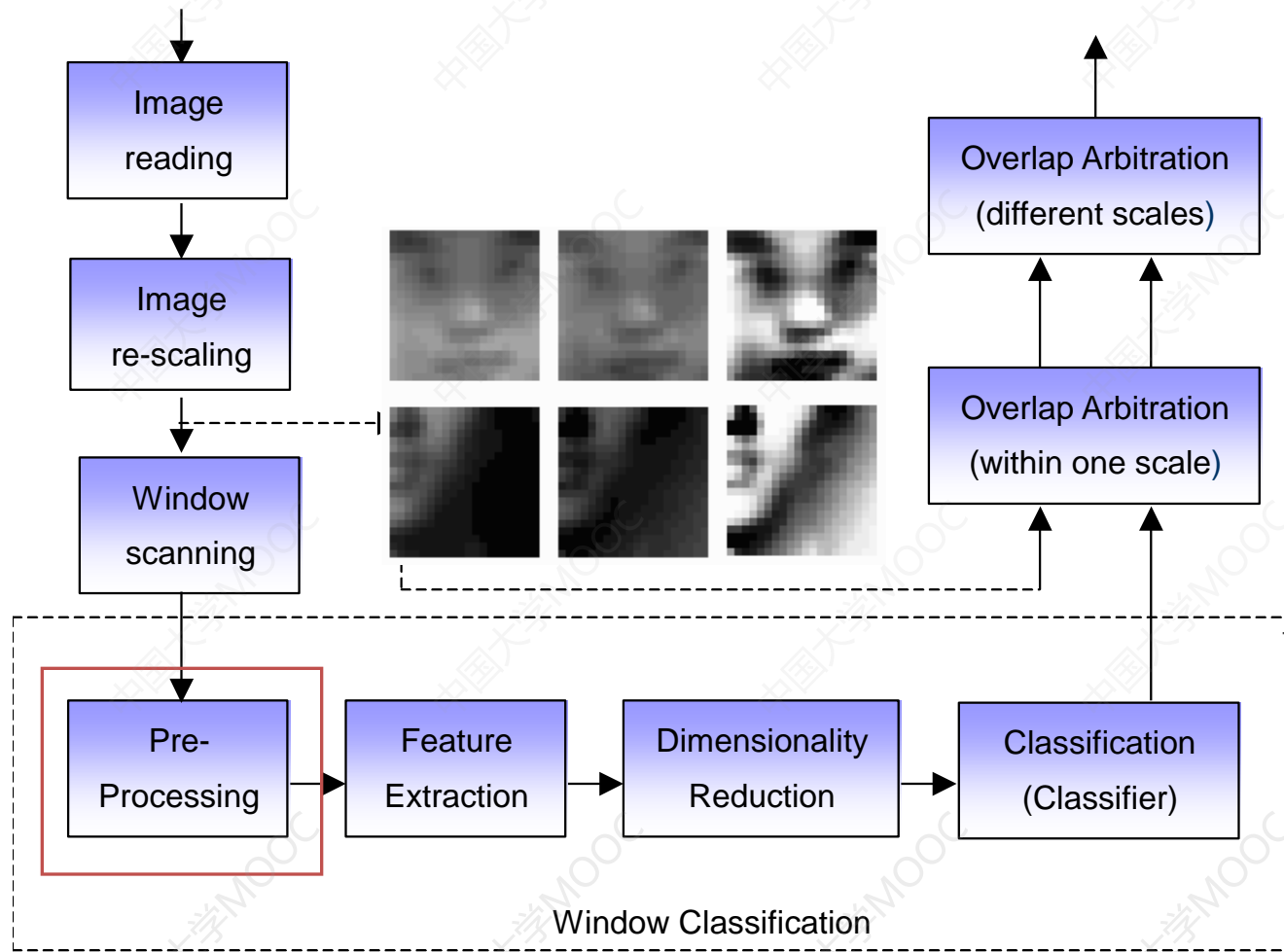


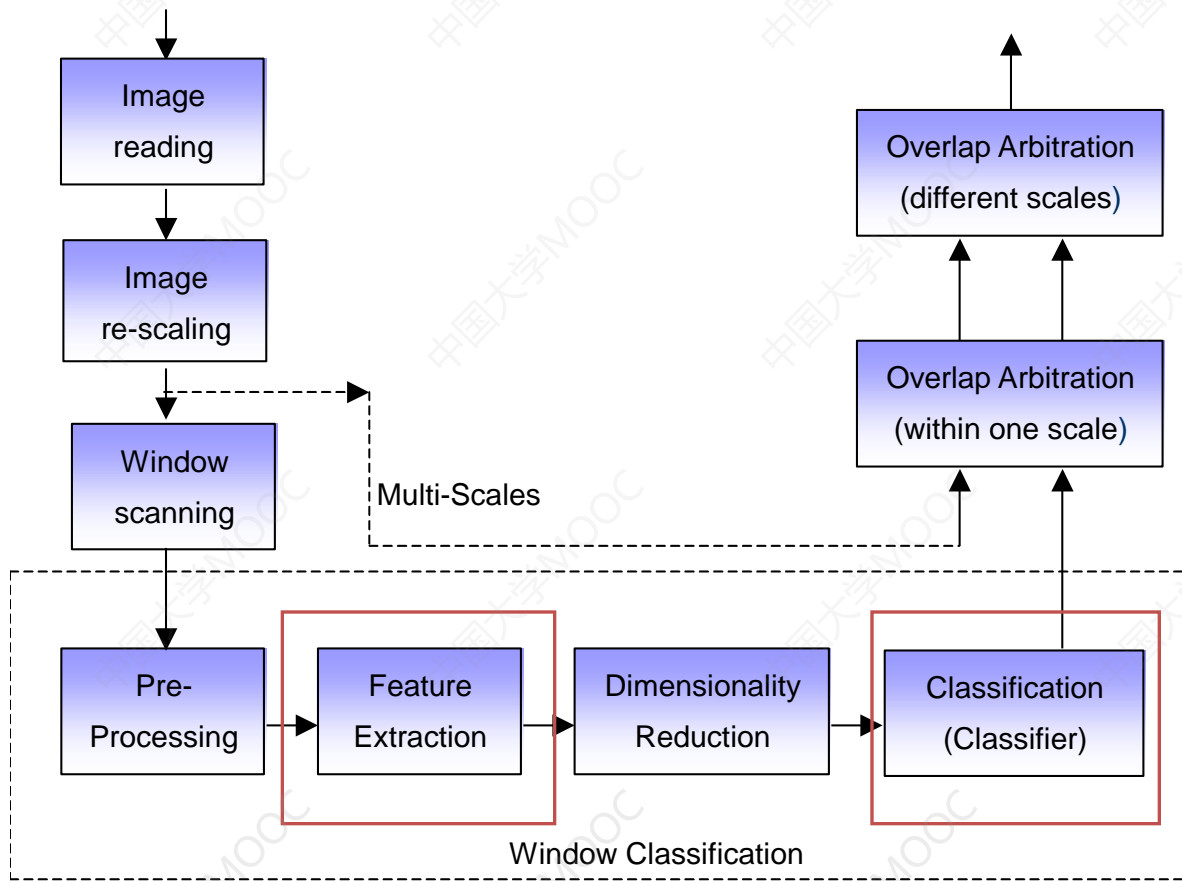
❑ Robust to face variations, complexity of image

❑ High computation cost





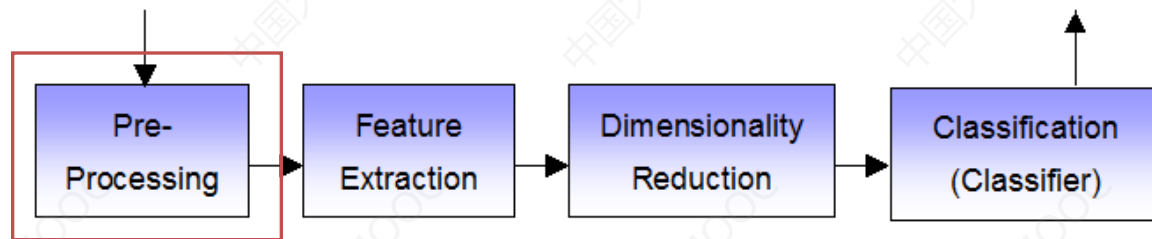






Face Detection from Cluttered images

◆ System Overview





Face Detection from Cluttered images

◆ Preprocessing

-- Illumination gradient correction

-- Histogram equalization

-- Masking



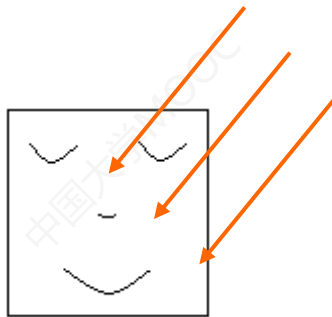


Face Detection from Cluttered images

➤ Illumination gradient correction

-- 光线为斜平面

-- 求出光平面, 减去光平面



线性平面: $aj + bi + c$, 图像平面: $f(j, i)$

$$E = \min_j \sum_i [f(j, i) - (aj + bi + c)]^2$$

$$E = \min_j \sum_i [f^2(j, i) - 2f(j, i)(aj + bi + c) + (aj + bi + c)^2]$$





Face Detection from Cluttered images

➤ Illumination gradient correction

$$E = \min \sum_j \sum_i [f^2(j, i) - 2f(j, i)(aj + bi + c) + (aj + bi + c)^2]$$

$$\frac{\partial E}{\partial a} = \sum_j \sum_i [-2f(j, i)j + 2(aj + bi + c)j] = 0$$

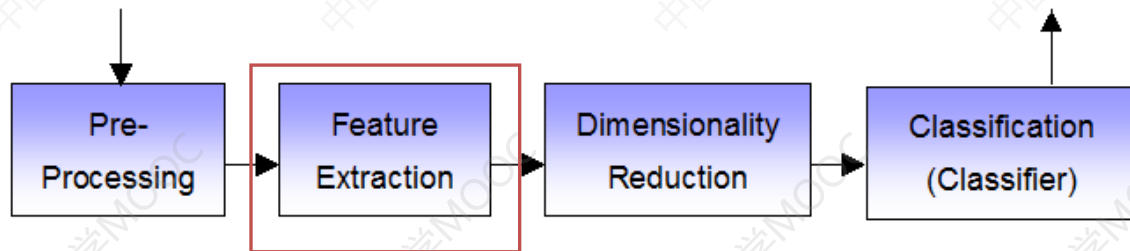
$$\frac{\partial E}{\partial a} = a \sum_j \sum_i j^2 + b \sum_j \sum_i ij + c \sum_j \sum_i j - \sum_j \sum_i jf(j, i) = 0$$

$$\begin{aligned} \frac{\partial E}{\partial a} &= a? + b? + c? \quad \dots = 0 \longrightarrow \\ \frac{\partial E}{\partial b} &= a? + b? + c? \quad \dots = 0 \longrightarrow \\ \frac{\partial E}{\partial c} &= a? + b? + c? \quad \dots = 0 \longrightarrow \end{aligned} \left\{ \begin{array}{l} a = ? \\ b = ? \\ c = ? \end{array} \right. \quad g(j, i) = f(j, i) - (aj + bi + c)$$



Face Detection from Cluttered images

➤ Histogram equalization





谢 谢

本课程所引用的一些素材为主讲老师多年的教学积累，来源于多种媒体及同事和同行的交流，难以一一注明出处，特此说明并表示感谢！