

2020 CV midterm note

tags: Computer Vision

1. 名詞解釋

- **1. corner:**

- 內容：

- A corner is a point or an area where two or more edges, sides, or surfaces of something join.
 - Other types of features that may be extracted from intensity images include corners, holes, and topographic labelings of the gray tone intensity surface, such as peaks, gits, ridges, and valleys.
 - 邊與邊的交點，通常為兩條邊轉向的頂點；2條edge的intersection；兩條線的交點；指稱為2條邊緣的轉角頂端處，也為2條線快速轉彎的頂點

- 目的：

- 可以從影像中提取的其他類的特徵包括角、孔和地形標記(峰、脊和谷)。

- 應用：

- corner detection

- **2. computer vision:**

- 內容：

- Computer vision is the science that develops the theoretical and algorithmic basis by which useful information about the world can be automatically extracted and analyzed from an observed image, image set, or image sequence from computations made by special-purpose or general-purpose computers.

- 目的：

- To emulate human vision with computers. dual process of computer graphics: 2D→3D

- 應用：

- AR、VR、人臉辨識、影像之物件偵測

- **3. computer graphics:**

- 內容：

- Computer graphics studies the manipulation of visual and geometric information using computational techniques. Computer graphics is the branch of computer science that deals with generating images with the aid of computers.

- 目的：
 - 要利用電腦產生令人賞心悅目的真實感影像。
- 應用：
 - digital photography、film、video games、cell phone、computer displays、Print design、Digital art、Special effects、Visual effects。

- **4. conditioning:**

- 內容：
 - Conditioning is based on a model that suggests that the observed image is composed of an informative pattern modified by uninteresting variations that typically add to or multiply the informative pattern.
 - 在具有眾多pattern得影像中，也就是在informative的影像中，我們想要知道特定的pattern，因此要將informative image uninteresting pattern，去除其他干擾
 - 調節是基於一個模型的，該模型表明觀察到的影像由訊息模式組成，該訊息模式由通常不會增加或增加訊息模式的無趣變化所修飾。
 - 基於模型指出觀測到的影像會有一些帶有訊息的pattern組成(informative pattern)，而這些帶有訊息的pattern，可以經由在informative pattern加上uninteresting variation
- 目的：
 - 去除無用的資訊、雜訊
- 應用：
 - 降噪、背景均一化

- **5. labeling:**

- 內容：
 - Labeling is based on a model that suggests that the informative pattern has structure as a spatial arrangement of events, each spatial event being a set of connected pixels.
 - 基於一個模型，該模型表明訊息模式具有事件空間排列的結構，每個空間事件都是一組相連的像素。
 - 針對像素的灰階色澤進行標籤
- 目的：
 - 讓電腦能夠透過學習來認知影像中的物件
- 應用：
 - 閾值化、邊緣檢測、自駕車、機器人、相片搜尋、影片檢索、商品搜尋、辨識影像中的各種物體、thresholding、edge detection、corner finding

- **6. grouping:**

- 內容：

- The grouping operation identifies the events by collecting together or identifying maximal connected sets of pixels participating in the same kind of event.
- 把標籤值相同或相近的區塊圈選出來
- 分組操作通過收集在一起或識別參與相同類型事件的最大像素連接集來識別事件。
- 分組前：像素；分組後：像素集
- 目的：
 - 有利於將群組化後的資訊進行一些計算
- 應用：
 - segmentation分割、edge linking邊緣鏈接

• 7. extracting:

- 內容：
 - The extracting operation computes for each group of pixels a list of its properties.
 - example properties: centroid, orientation, area, spatial moments
 - 提取操作為每組像素計算其屬性列表。
 - 針對群組化後的資訊進行一些計算，算出一些能代表群組特性的數值，例如：標準差、平均值等
- 目的：
 - 把觀察物區塊標明出來，並且得到夠多的資訊以理解觀察物。
- 應用：
 - 解析質心、orientation方向、面積、空間矩

• 8. matching:

- Matching operation determines the interpretation of some related set of image events, associating these events with some given three-dimensional object or two-dimensional shape.
- e.g. template matching

• 9. binary machine vision:

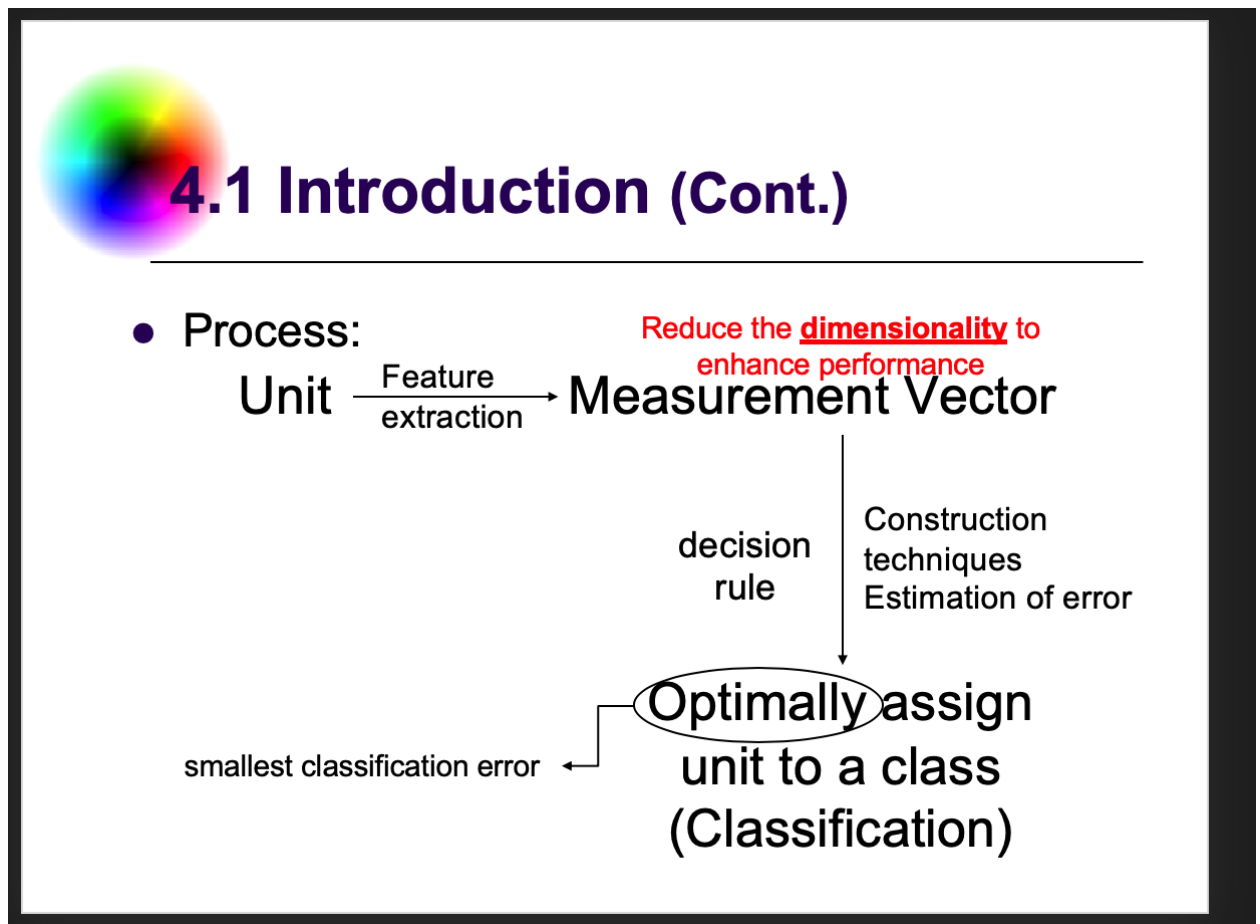
- 此技術在分析二元圖片
- ex:
Dilation, Erosion, Opening, Closing ...

• 10. region analysis:

- 從圖片一給定區域中萃取特定資訊加以分析, 進而將結果
- ex:
Extract frontend or backend, 紋理分析 ...

- **11. measurement vector:**

- 量測向量，是 Statistical Pattern Recognition 的一個步驟，是圖片經過特徵提取後壓縮的產物（維度下降）



- **12. classifier:**

- 將影像萃取出特徵值後，依照特徵值將影像分類。
- 可以用在分辨不同動物的照片，或是分類手寫的數字

- **13. bounding rectangle:**

- 可以將目標區域包起來的最小矩形
- 常用來 Object detection 中將特定物體的位置標示出來，藉此將區域切割出來

- **14. dilation:**

- 膨脹操作會把高亮（即值為255）的邊界膨脹開。設定卷積核尺寸，卷積核沿著圖像滑動，與卷積核對應的原圖像的像素值中只要有一個是1，中心元素的像素值就是1。
- combines two sets by vector addition of set elements，膨脹，形態學中基本的算子之一
- The dilation of A by B is defined by
- $A \oplus B = \{c \in E^N \mid a+b \text{ for some } a \in A \text{ and } b \in B\}$
- 其中 (A下標b) 為 A 平移向量 b 得到。

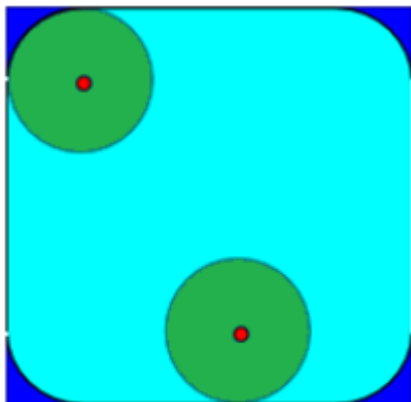
- 如果以白色部分為前景，會使圖片中較亮的範圍變大，可用於填補圖片中的小黑洞

- **15. erosion:**

- 會把高亮 (即值為255) 的邊界腐蝕掉。設定卷積核尺寸，卷積核沿著圖像滑動，如果與卷積核對應的原圖像的所有像素值都是1，那麼中心元素就保持原來的像素值，否則就變為0。
- morphological dual of dilation
- The erosion of A by B is defined by
- $A \ominus B = \{x \in E \wedge N \mid x + b \in A \text{ for every } b \in B\}$
- 如果以白色的部分為前景，會使圖片中較暗的部分縮小，能消除部分雜訊

- **16. opening:**

- 在形態學中，opening 被定義為先腐蝕後膨脹，在電腦視覺領域中是基本的形態學噪點消除模塊。Opening 用來移除圖片 Background 中的 small objects。開運算可以用來消除小物體，在纖細點出分離物體，平滑較大物體的邊界同時並不明顯改變其面積
- opening of image B by kernel K: $B \circ K = (B \ominus K) \oplus K$

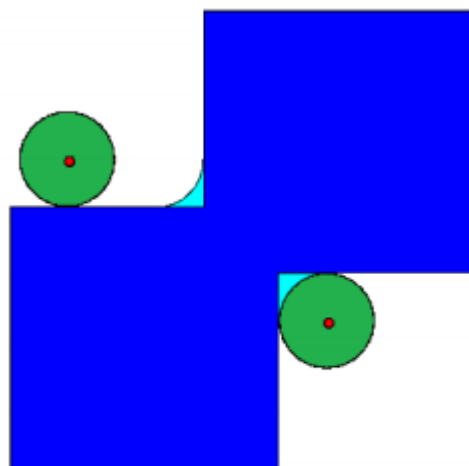


Opening

- **17. closing:**

- 在數學形態學中，閉運算被定義為先膨脹後腐蝕。能夠消除小型黑洞

- closing of image B by kernel K: $B \cdot K = (B \oplus K) \ominus K$



closing

- **18. hit and miss:**

- The hit-and-miss transform is a general binary morphological operation that can be used to look for particular patterns of foreground and background pixels in an image. It is actually the basic operation of binary morphology since almost all the other binary morphological operators can be derived from it. As with other binary morphological operators it takes as input a binary image and a structuring element, and produces another binary image as output.

- **19. Yokoi connectivity number:**

- 用來定義一個像素在圖片中連接狀態的數字標籤。以移除此像素後，周圍像素會被分成幾個部分來定義數字。
- 例如：0: isolated, 1: edge, 2: connecting, 3: branching, 4: crossing, 5: interior

- **20. noise reduction:**

- Noise reduction is the process of removing noise from a signal. Noise reduction techniques exist for audio and images. Noise reduction algorithms tend to alter signals to a greater or lesser degree.
- 可以用 opening, box filter, median filter 等做到

- **21. box filter:**

- A box filter 也可以被稱為Mean filter(均值濾波器)。Box Filter對一個像素跟這個像素相鄰的像素點都視為相同(也就是說權重值一樣)，統一進行平均處理，這樣就可以濾掉影像中的雜訊。Box Filter中所有係數都取相同的值。
- 在定義中Box filter 有3個特點：1.鄰域內的pixel權重相等。2.運算可分離，mask矩陣可以分拆成一個列向量*行向量(Column vector) * (Row vector)。3.可以用遞迴做實作，只需要兩個加法、兩個減法，一個除法。

- Box filtering 意味著用這個框中的平均值替換影像的每個像素。

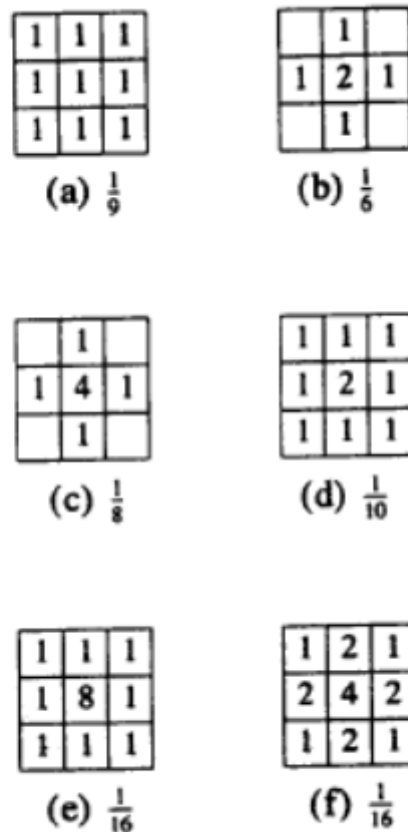


Figure 6.2 Common 3×3 masks used for noise cleaning. The mask in (a) is called the 3×3 box filter.

2. Please list at least four directions of projection for signature analysis and segmentation.

- 垂直、水平、兩個斜向

3. Please list at least two thresholding algorithms to determine the optimum threshold and explain in detail.

- Kullback directed divergence: entropy
- Otsu:
 - 利用窮舉法(從0~255)，找出一個最佳的域值(threshold)，使得類&類之間的變異數最大，類內的變異數最小。
 - 類內變異數為各類變異數的權重和；類間變異數為 總變異數扣掉類內變異數。

4. Please describe the method, steps, and results of 3D Visualization of Probe Card Pins.

- method: Mayavi、openCV、全光譜共焦線性掃描器
- steps：透過全光譜共焦線性掃描器掃描出的座標、高度、光強度之地理資訊，透過標準檔與忍受值，計算出掃描物是否符合要求。並且利用Mayavi套件來成像。
- results: 可以呈現出掃描立體圖，並抓出針頭位置與大小(將數據以3D的方式呈現)

5. Please describe the method, steps, and results of Separation of Heart and Lung Sound.

- method : Unsupervised learning – AutoEncoder
- steps: 收集音訊 – FFT 轉頻譜圖 – 訓練Autoencoder – Modulation Frequency Analysis (心音肺音)
- results: 可區分出心音與肺音

6. Please compute the probability of decision rule $f(a|d)$, and fill in the below probability table.

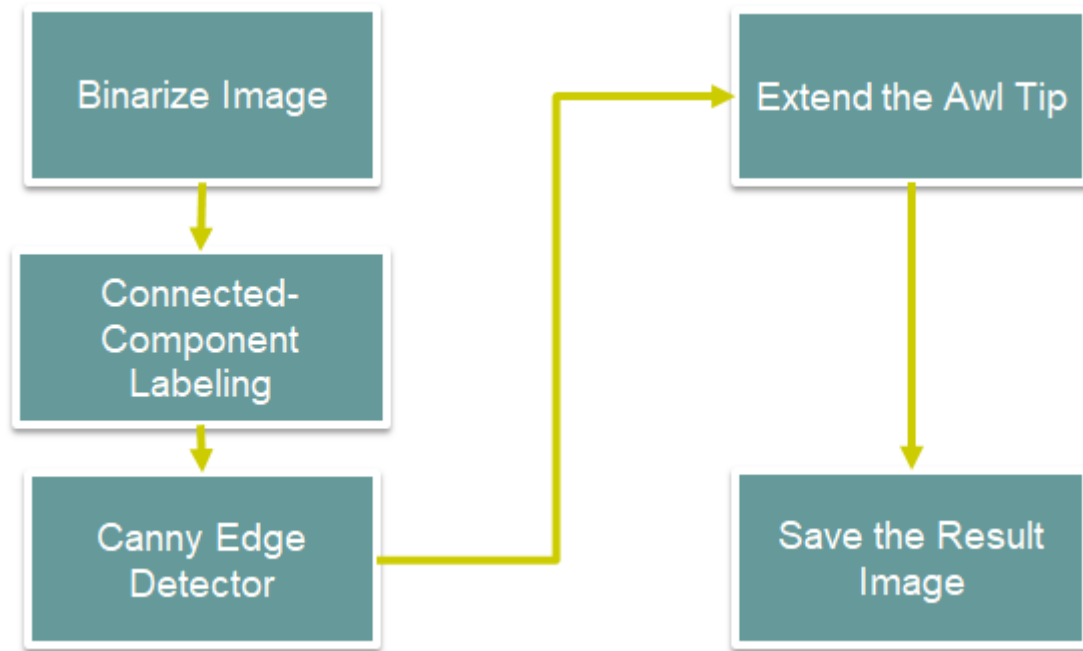
		Assigned	
		c^1	c^2
True	c^1	$\begin{array}{r} .18 \\ .30 \\ \hline .48 \end{array}$.12
	c^2	$\begin{array}{r} .16 \\ .04 \\ \hline .20 \end{array}$.20

3 Calculation of the decision rule error for the decision rule constructed

8. Please describe the method, steps, and results of Vertebra Pedicle Awl Tip Extension.

- method:
Computer vision techniques and YOLO v4 object detection

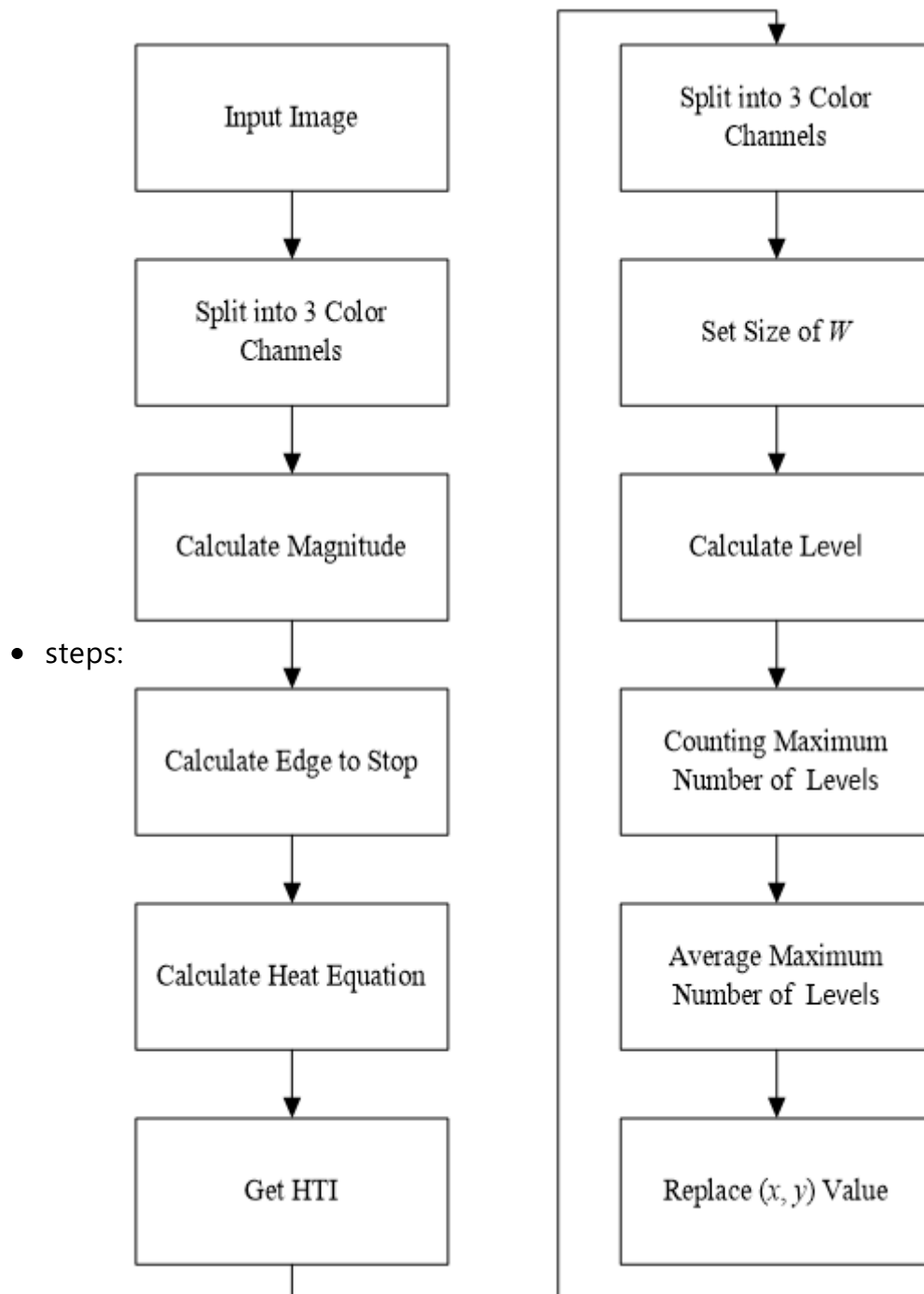
- step:



- result:
Good awl extension and pedicle bounding box

9. Please describe the method, steps, and results of Watercolorization of Photographic Image.

- method: Heat transferring technology



- results: Water-colored image style

10. Please write the equations and give examples of convolution and correlation. When are convolution and correlation the same?

Q & A

- $(f * w)(r, c) = \sum_{\substack{(r', c') \in W \\ (r-r', c-c') \in F}} f(r-r', c-c')w(r', c')$
- $(f \otimes w)(r, c) = \sum_{\substack{(r', c') \in W \\ (r+r', c+c') \in F}} f(r+r', c+c')w(r', c')$

- *When will the value of convolution and of correlation be the same?*

Ans. When the mask is point symmetric.

11. Please describe the method, steps, and results of Image Segmentation for Solder Defect Inspection.

• Method

- Python
- Tensorflow
- Unet model
- DL semantic segmentation
- OpenVINO

• Steps

1. Label x-ray files from 0 to 5
2. Training (Unet)
3. Testing (output segmented images)
4. Import our model onto machine by OpenVINO



Input

segmented →

- 1: Person
- 2: Purse
- 3: Plants/Grass
- 4: Sidewalk
- 5: Building/Structures

3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5
3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5
3	3	3	3	3	3	1	1	3	3	3	3	5	5	5	5	5	5
3	3	3	3	3	1	1	1	3	3	3	5	5	5	5	5	5	5
3	3	3	3	3	1	1	3	3	3	5	5	5	5	5	5	5	5
5	5	3	3	3	3	1	1	3	3	5	5	5	5	5	5	5	5
4	4	3	4	1	1	1	1	1	1	4	4	4	5	5	5	5	5
4	4	3	4	1	1	1	1	1	1	4	4	4	4	4	5	5	5
4	4	4	1	1	1	1	1	1	1	4	4	4	4	4	4	4	4
3	3	3	1	1	1	1	1	1	1	4	4	4	4	4	4	4	4
3	3	3	1	2	2	1	1	1	1	4	4	4	4	4	4	4	4
3	3	3	1	2	2	1	1	1	1	4	4	4	4	4	4	4	4

Semantic Labels