Morphological Operations

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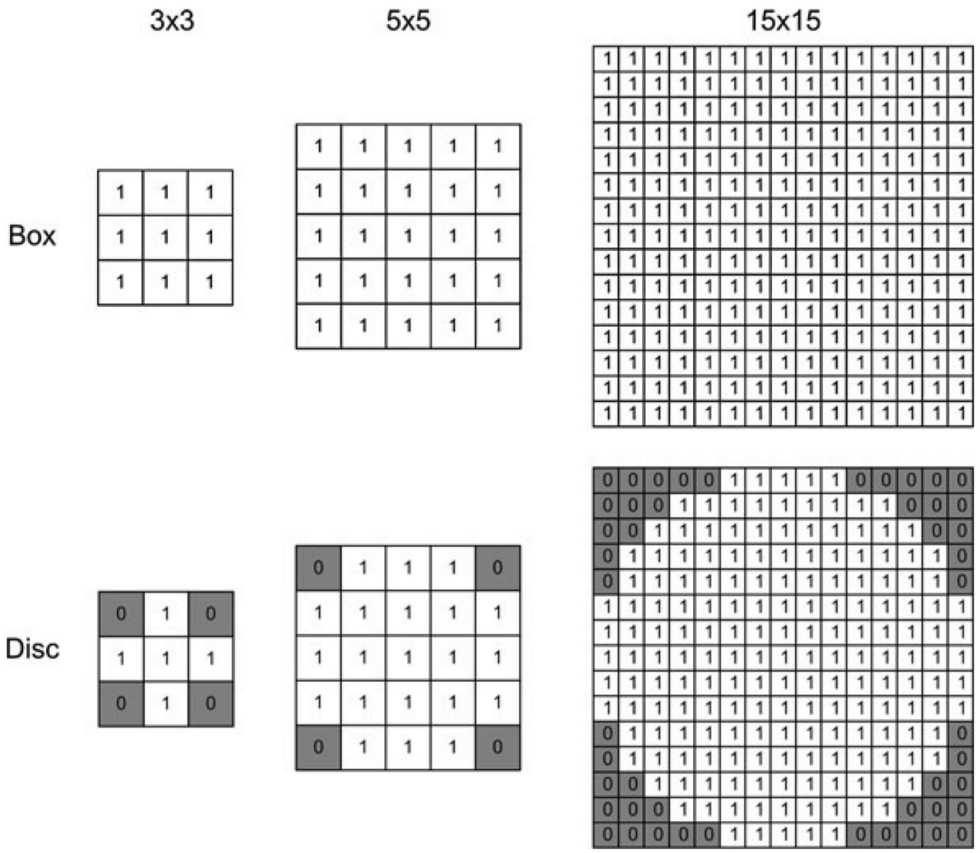
What is Morphology

- Morphology is **a broad set of image processing operations that process images based on shapes.**
- Morphology is an approach to image analysis which is based on the assumption that an image consists of structures which may be handled by set theory.
- Morphological operations rely only on the relative ordering of pixel values, not on their numerical values

These operations are mostly applied on binary images but can be extended to grayscale images as well

Structring Element



In OpenCv can use `cv2.getStructuringElement`

Fundamental Operations

- **Erosion**
  - A foreground pixel in the input image will be kept **only if *all* pixels** inside the structuring element are *> 0*. Otherwise, the pixels are set to *0*
  - Discards pixels at object boundaries
  - Removes small blobs present in an image
  - Can consider it like a local minimum filter

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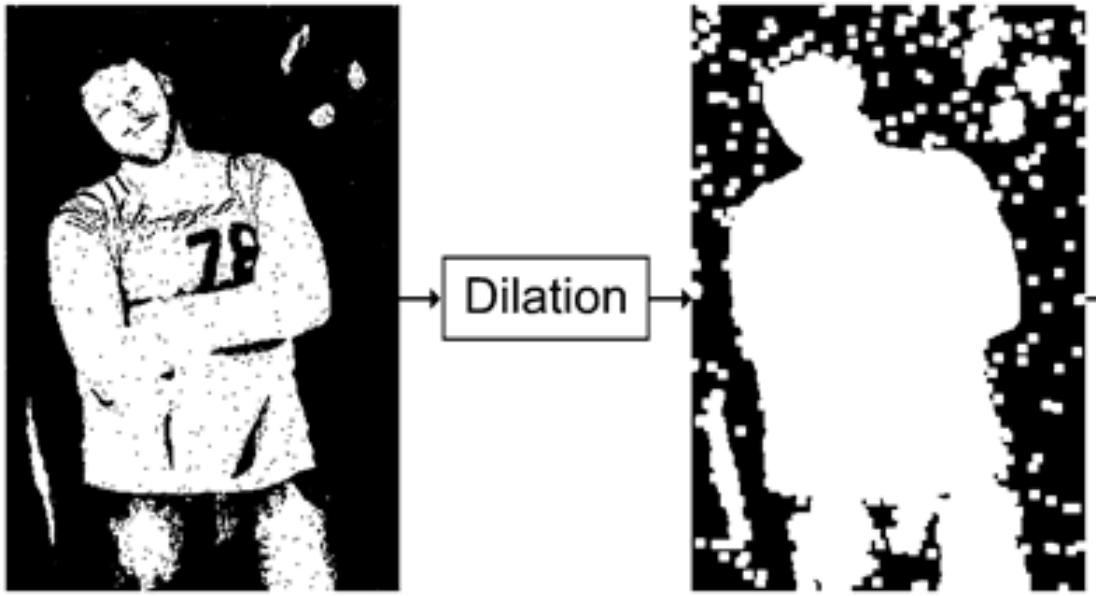
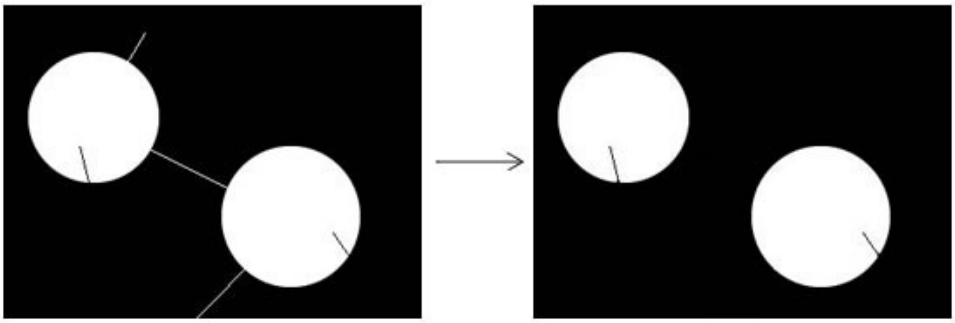
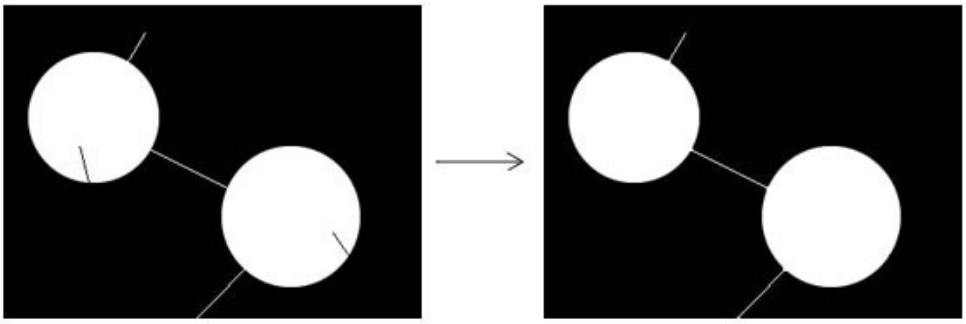
- **Dilation**
    - A center pixel *p* of the structuring element is set to *white* if ***ANY*** pixel in the structuring element is *> 0*
    - *Increase* the size of foreground objects
    - Opposite of erosion but *not it's complement*
    - Fills up holes present in an image, also helpful to "connect" broken components
    - 

- **Compounding Operations**
  - **Opening**
    - First *erode* then *dilate*
    - 

      Morphological Opening
    - Useful for removing small blobs from image while preserving large blob structure
  - **Closing**
    - First *dilate* then *erode*
    - 

      Morphological Closing
    - Fill gaps present in an object and preserve the shape
  - **Gradient**
    - Difference b/w *dilation* and *erosion*

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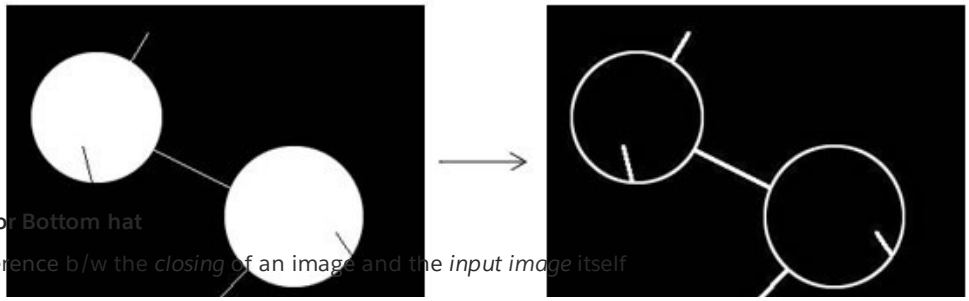

- **Black hat or Bottom hat**
  - Difference b/w the *closing* of an image and the *input image* itself
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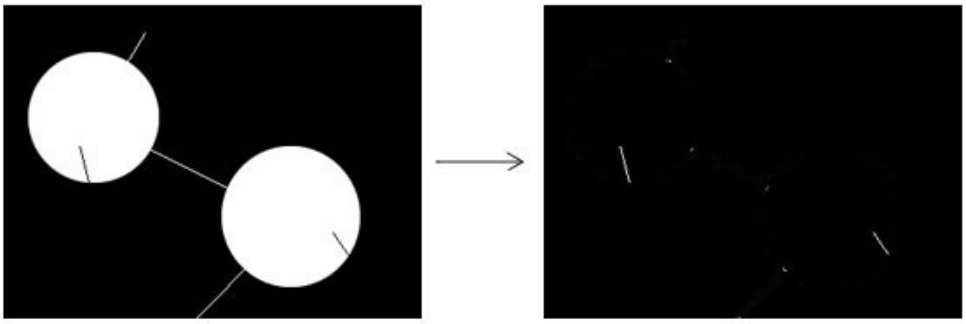

Morphological Black hat

  - Used to find *intensity troughs* in a **grayscale** image
  - Black hat reveals areas that are **darker than the surrounding** region
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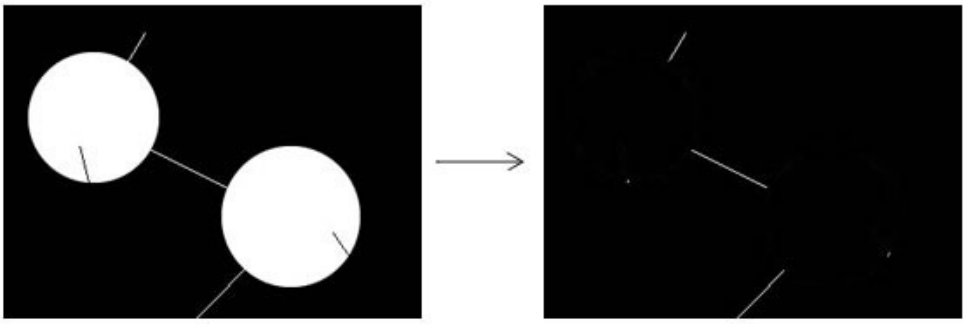
- **Top Hat or white hat**
  - Difference b/w *input* image and the *opening* of the image

- 

Morphological Top hat

- Converse of black hat
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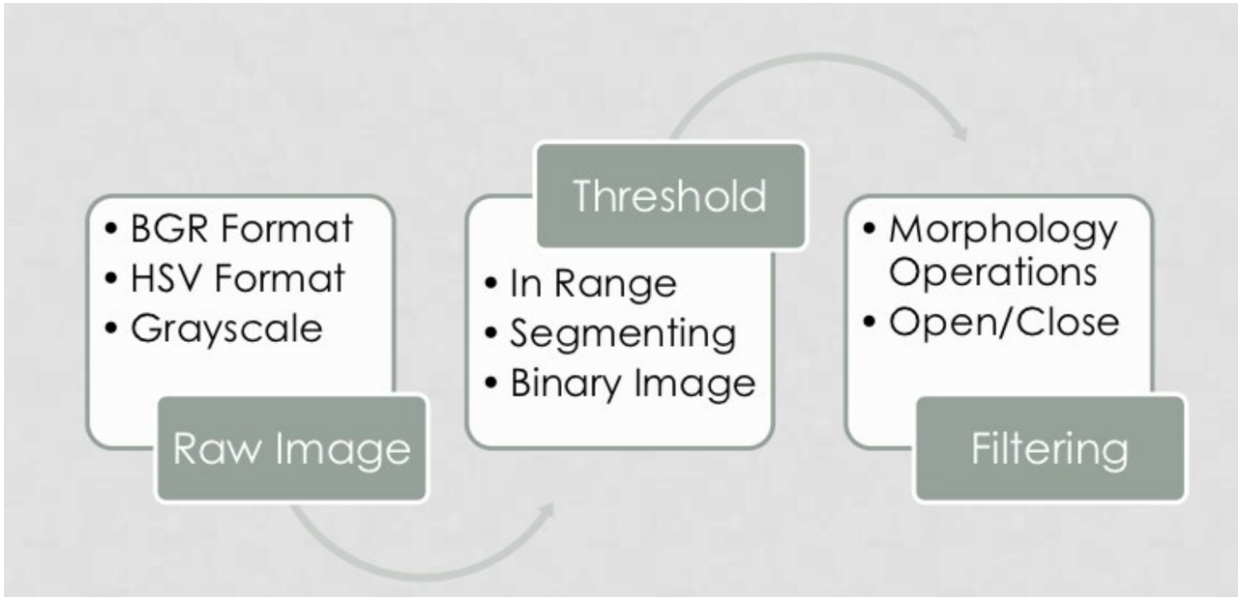
Applications and methodology



Morphological operations are commonly used as pre-processing steps to more powerful computer vision solutions such as **OCR, Automatic Number Plate Recognition (ANPR), and barcode detection and even counting coins**! ☺