



ĐẠI HỌC TÔN ĐỨC THẮNG
Ton Duc Thang University (TDTU)

Digital Image Processing

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Lecture 03

Morphological Operations

1. Image thresholding (binarization)

Example: Foreground extraction

2. Connected-components

- Pixel neighborhoods
- Region labeling
- Region properties

Application: Blob-based motion detection

3. Morphological operations

- Erosion/dilation/opening/closing

Applications

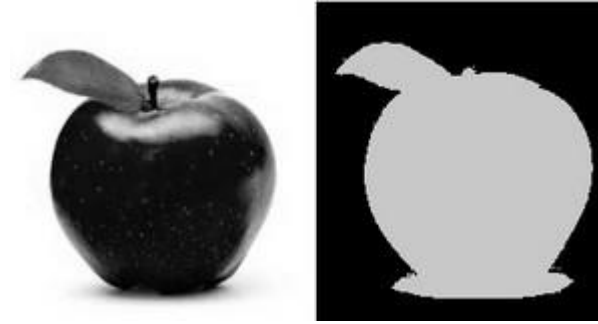


Python
OpenCV

Binary image processing

- Binary images are common
 - Intermediate abstraction in a gray-scale/color image analysis system
 - Thresholding/segmentation
 - Presence/absence of some image property
 - Text and line graphics, document image processing
- Representation of individual pixels as 0 or 1, convention:
 - foreground, object = 1 (white)
 - background = 0 (black)
- Processing by logical functions is fast and simple
- Shift-invariant logical operations on binary images:
“morphological” image processing
- Morphological image processing has been generalized to gray-level images via level sets

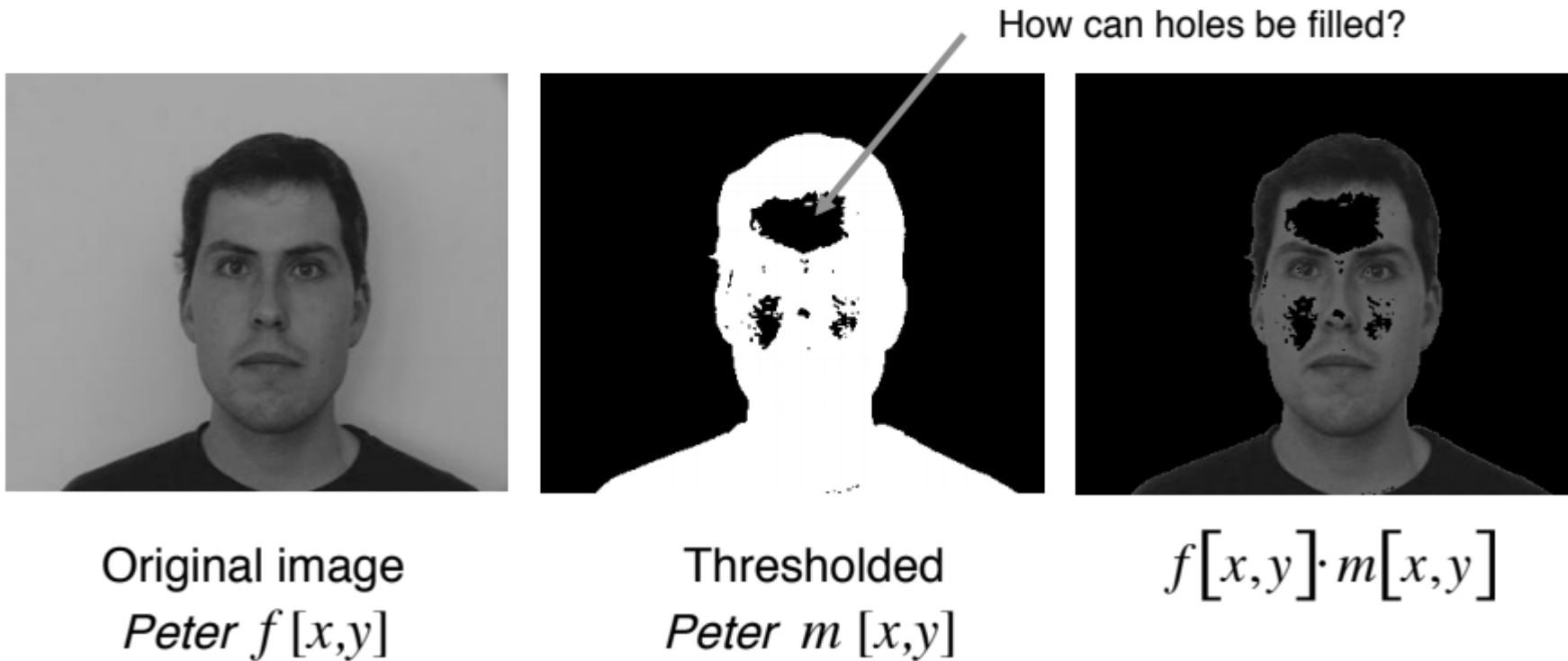
What is Thresholding?



- The simplest binarization method
- Application example:
 - Separate out regions of an image corresponding to objects which we want to analyze. This separation is based on the variation of intensity between the object pixels and the background pixels.
- To differentiate the pixels we are interested in from the rest (which will eventually be rejected),
 - we perform a comparison of each pixel intensity value with respect to a threshold (determined according to the problem to solve).
- Once we have separated properly the important pixels,
 - we can set them with a determined value to identify them (i.e. we can assign them a value of (black), (white) or any value that suits your needs).

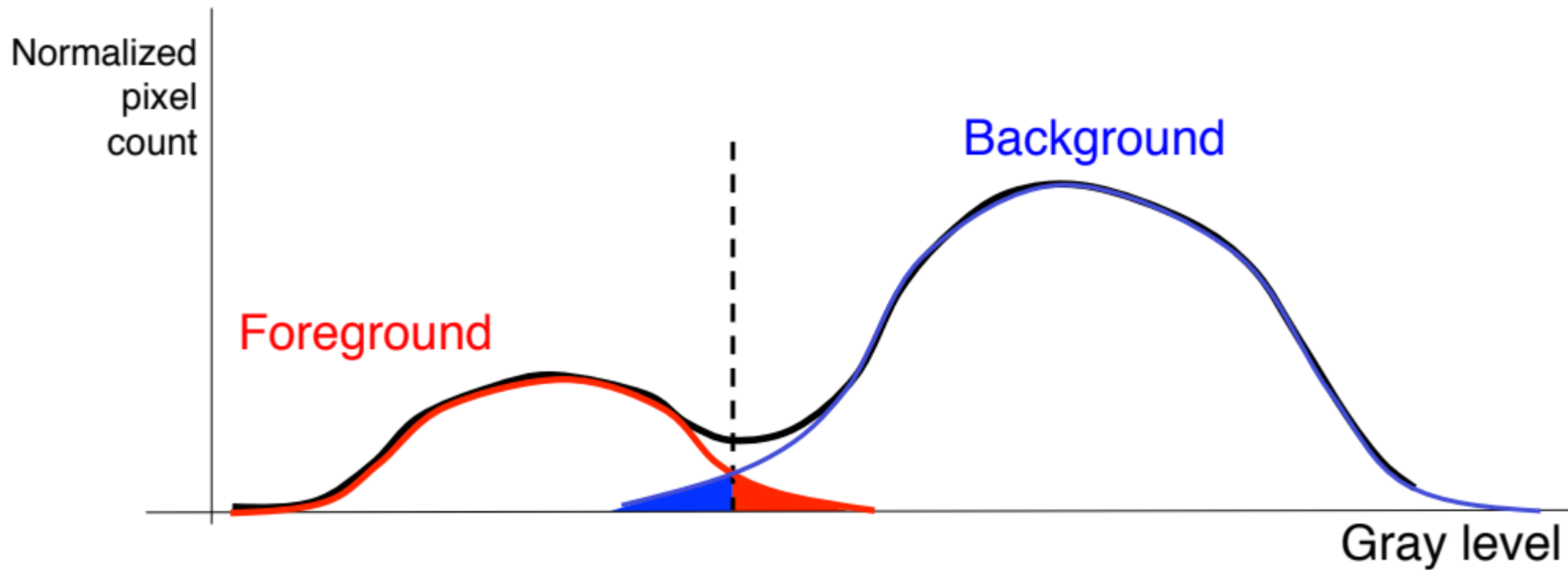
Thresholding

Gray-level thresholding



Thresholding

How to choose the threshold?

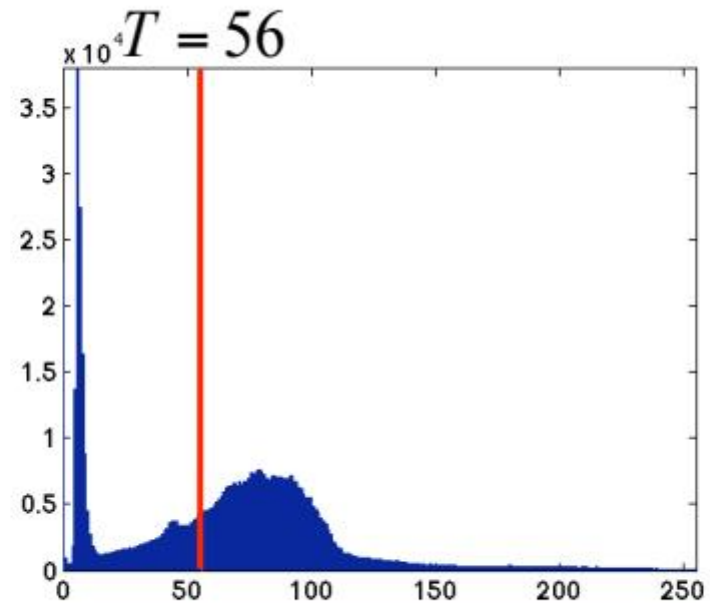


- Image segmentation based on a simple threshold:

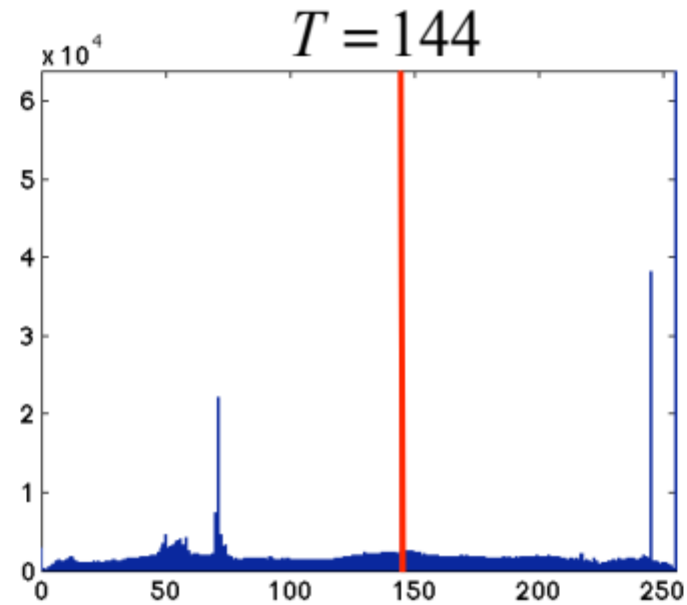
$$g[n, m] = \begin{cases} 255, & f[n, m] > 100 \\ 0, & \text{otherwise.} \end{cases}$$



Thresholding

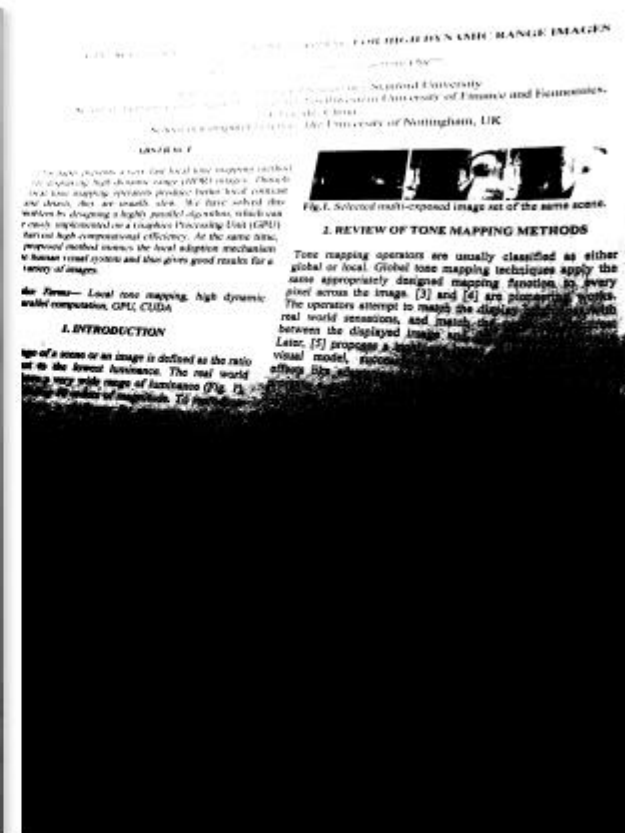
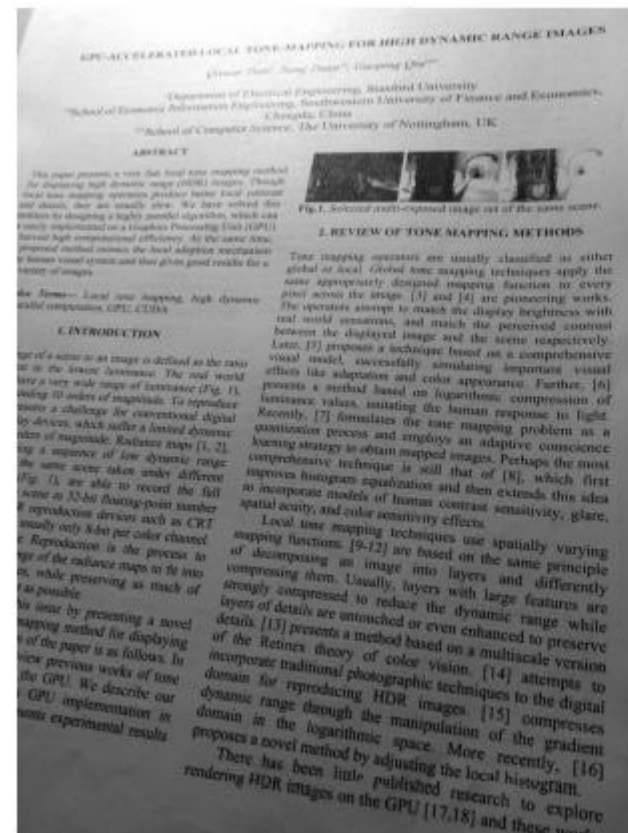


Thresholding



Thresholding

- Sometimes, a global threshold does not work



Thresholding

The Stanford Daily

Tuesday, September 18, 2012 ♦ 13



Stanford defensive lineman Josh Mauro put the pressure on USC's Matt Barkley. Mauro was relentless in the second half as Stanford's defense completely shut down Barkley and his tested wide receivers.

Handing out the USC game balls

By SAM FISHER
FOOTBALL EDITOR

about Andrew Luck.

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Please see **AWARDS**, page 15

FOOTBALL

The winding road ahead

By SAM FISHER
FOOTBALL EDITOR

Andrew Luck may be gone, but with Saturday night's win over USC, the Stanford Cardinal put itself in position to achieve beyond the path paved by number 12. You heard right: though there's plenty of work left to do, this 2012 Stanford team showed that it is capable of playing at a national championship level.

Though Stanford survived one of its toughest tests in the quarter that is the BCS National Championship, it estimates the road to Miami 2013 is no walk in the park. The toughest challenges remaining on the schedule are games at Notre Dame, Oregon and UCLA, all of whom are currently ranked in the top 20. The next two games, at Washington and then at home against Arizona, are no pushovers either. And as Stanford has shown, top-ranked opponents in years past, any team on the Cardinal's schedule has the potential for a magical upset.

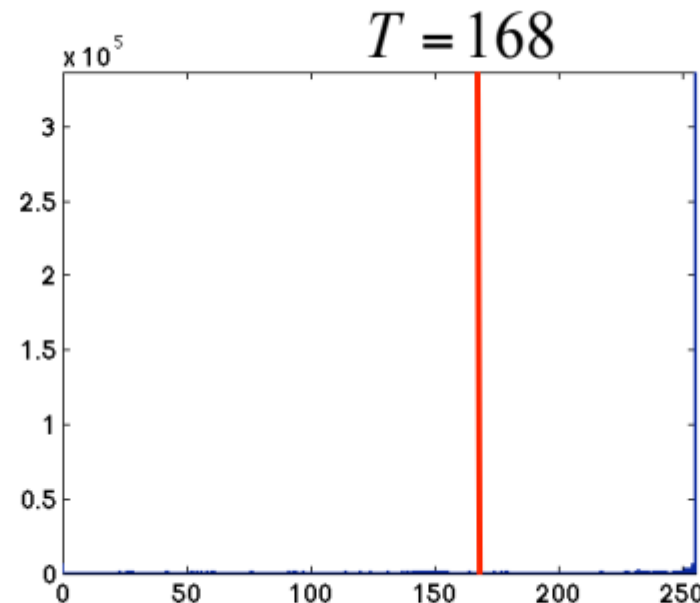
From Stanford's current vaunted point, there are three paths the rest of the season could take. Door Number One leads to The Promised Land, a berth in the BCS National Championship Game. In all likelihood, because Stanford is not named Alabama or LSU, the Cardinal will have to win out to earn a trip to South Beach, including wins at No. 3 Oregon and a potential rematch against USC for the Pac-12 title.

the last two seasons, beating everyone on the schedule except for Oregon is probably good enough to warrant a top-four BCS ranking and an automatic bid to a BCS game.

Door Number Three is the disappointment, the setback, the wasted opportunity. Stanford put itself in a remarkable position with its win over the second-ranked Trojan. However, if the Card regresses to San Jose State-game form at any point, it is priced to be upset a few times. It might not exist today that had of a performance, as Stanford has five teams left on its schedule in the AP Top 25, including road games at No. 3 Oregon, No. 11 Notre Dame and No. 19 UCLA. If Stanford loses more than two games, it will be in all likelihood end up in a second-tier bowl game for the first time since the 2009 season, when Stanford lost a close game to Oklahoma in the Sun Bowl.

There is already tremendous uncertainty as to where the rest of the season leads, but it's truly remarkable for Stanford to be in the position it is in now. No Telly Cervant, no Ian Hartung and no Andrew Luck, just Josh Nunes, Stephen Taylor, a solid defense and a whole bunch of guys showing a lot of heart. The superior status might be gone, but the talent left behind is rising to the top, making Door Number One not so crazy to think about.

Contact Sam Fisher at sfisher@stanford.edu.



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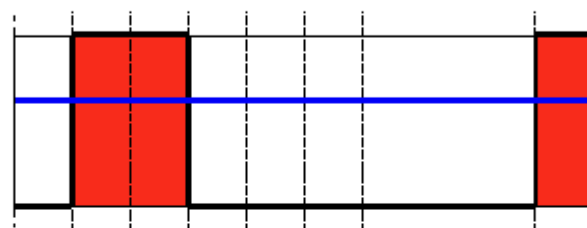
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Threshold Binary

- This thresholding operation can be expressed as:

$$\text{dst}(x, y) = \begin{cases} \text{maxVal} & \text{if } \text{src}(x, y) > \text{thresh} \\ 0 & \text{otherwise} \end{cases}$$

- So, if the intensity of the pixel $\text{src}(x, y)$ is higher than thresh , then the new pixel intensity is set to a MaxVal . Otherwise, the pixels are set to 0.

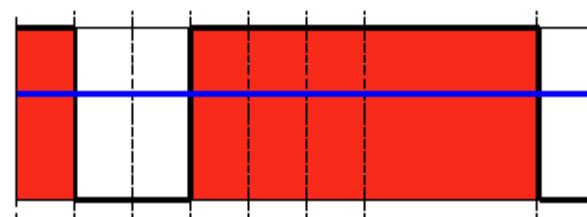


Threshold Binary, Inverted

- This thresholding operation can be expressed as:

$$\text{dst}(x, y) = \begin{cases} 0 & \text{if } \text{src}(x, y) > \text{thresh} \\ \text{maxVal} & \text{otherwise} \end{cases}$$

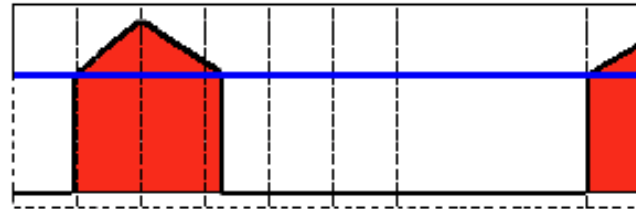
- If the intensity of the pixel $\text{src}(x, y)$ is higher than thresh , then the new pixel intensity is set to a 0. Otherwise, it is set to MaxVal .



- This operation can be expressed as:

$$\text{dst}(x, y) = \begin{cases} \text{src}(x, y) & \text{if } \text{src}(x, y) > \text{thresh} \\ 0 & \text{otherwise} \end{cases}$$

- If $\text{src}(x, y)$ is lower than thresh , the new pixel value will be set to 0.

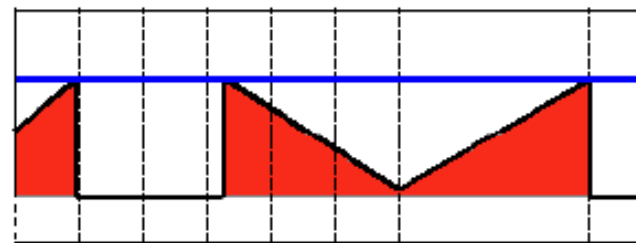


Threshold to Zero, Inverted

- This operation can be expressed as:

$$\text{dst}(x, y) = \begin{cases} 0 & \text{if } \text{src}(x, y) > \text{thresh} \\ \text{src}(x, y) & \text{otherwise} \end{cases}$$

- If $\text{src}(x, y)$ is greater than thresh , the new pixel value will be set to 0.



Python:

```
retval, dst = cv.threshold( src, thresh, maxval, type[, dst] )
```

```
#include <opencv2/imgproc.hpp>
```

- **cv.THRESH_BINARY**
- **cv.THRESH_BINARY_INV**
- **cv.THRESH_TRUNC**
- **cv.THRESH_TOZERO**
- **cv.THRESH_TOZERO_INV**

<https://docs.opencv.org/2.4/doc/tutorials/imgproc/threshold/threshold.html>

Exercise