



# Adaptive Thresholding

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# Introduction

- **Definition of Thresholding:** A technique in image processing used to create binary images from grayscale ones by turning all pixels below a certain threshold to black and all above to white.
- **Application of Thresholding:** Essential in various tasks such as edge detection, image segmentation, and object recognition, and multispectral transformation.
- **The Challenge:** finding the value of threshold

# Global Thresholding

Determines the threshold value based on the histogram of the overall pixel intensity distribution of the image.

Simple thresholding: binary thresholding, inverse binary thresholding, triangle thresholding and etc.

Ridler-Calvard (Iterative based),

Otsu's method,

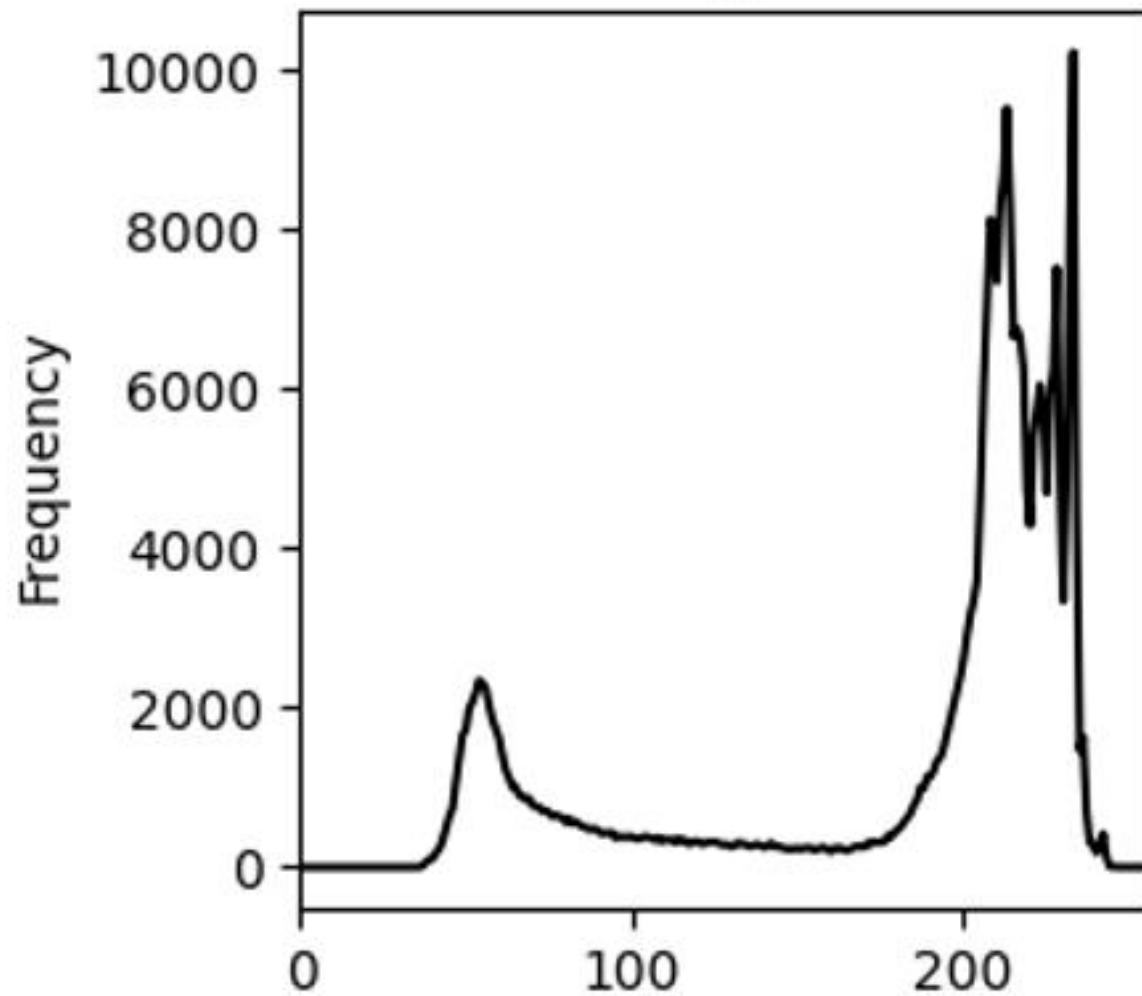
**Problem :** Does not work well for images with uneven illumination.

Original Image

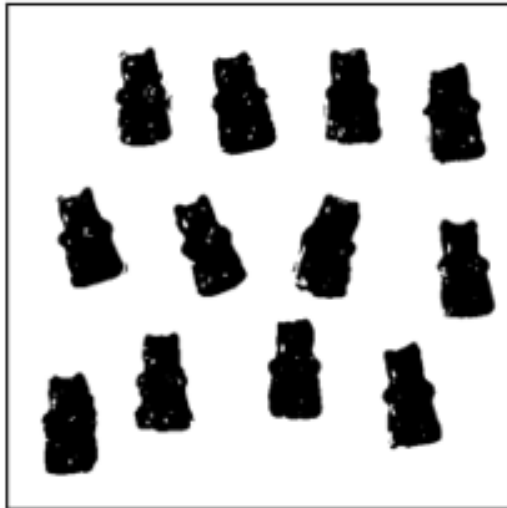


<https://amagicalmess.com/juice-gummy-bears/>

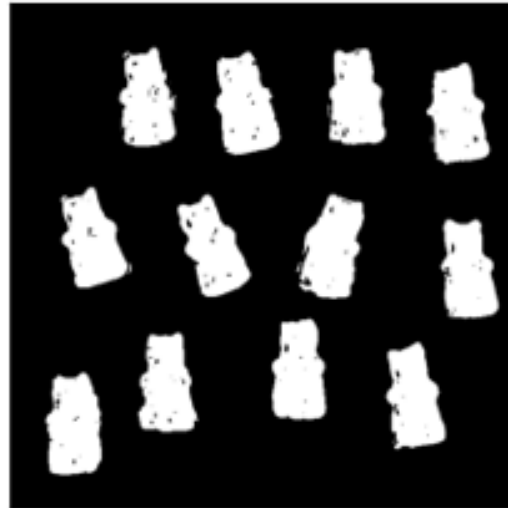
Histogram



Binary



Binary Inv



Otsu

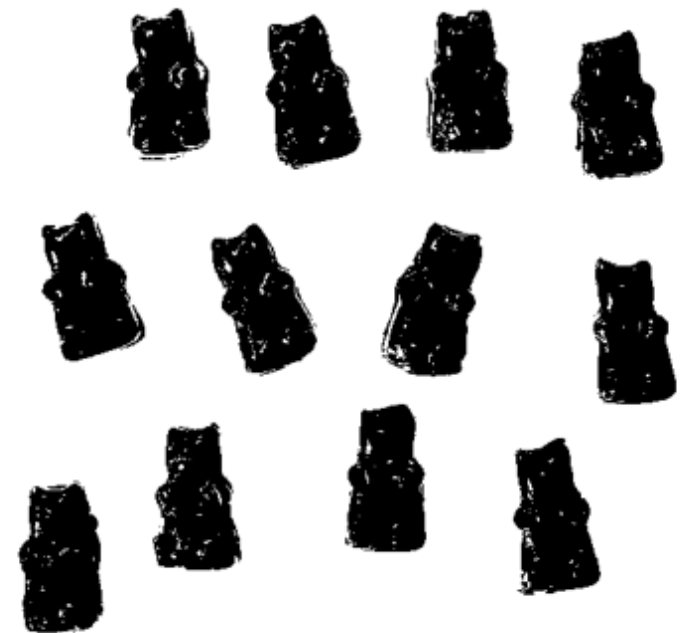


Triangle



Ridler-Calvard after 4 iteration

Iter 4  
T=142.24



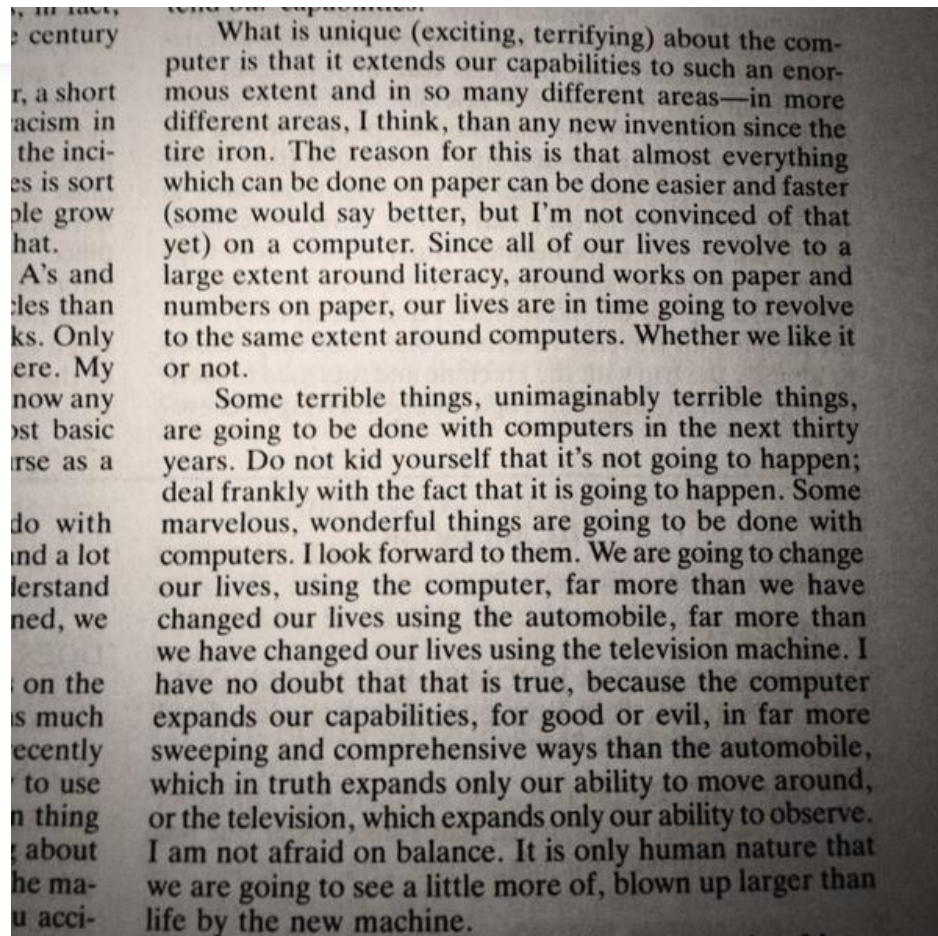
# Adaptive Thresholding

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**Adaptive Thresholding:** Threshold values adjust dynamically according to the characteristics of the local image region.

Best suited for images with shadows, uneven illumination.

# Samples of shadowed images

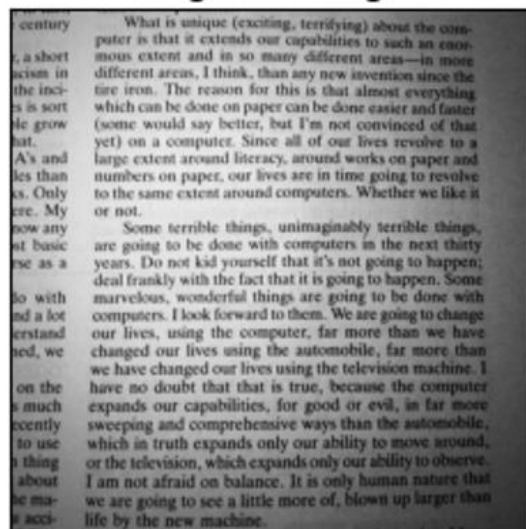


<https://twitter.com/tomhaberstroh/status/421251111618871296>

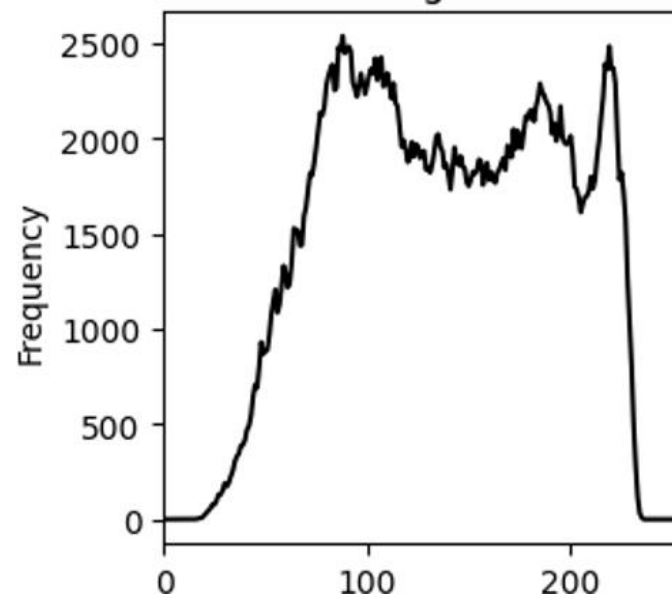


<https://pin.it/2scDvqE>

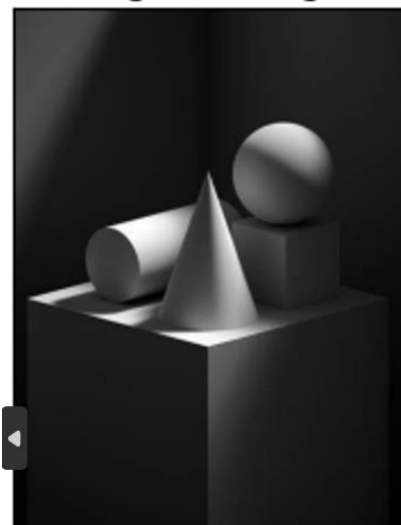
# Original Image



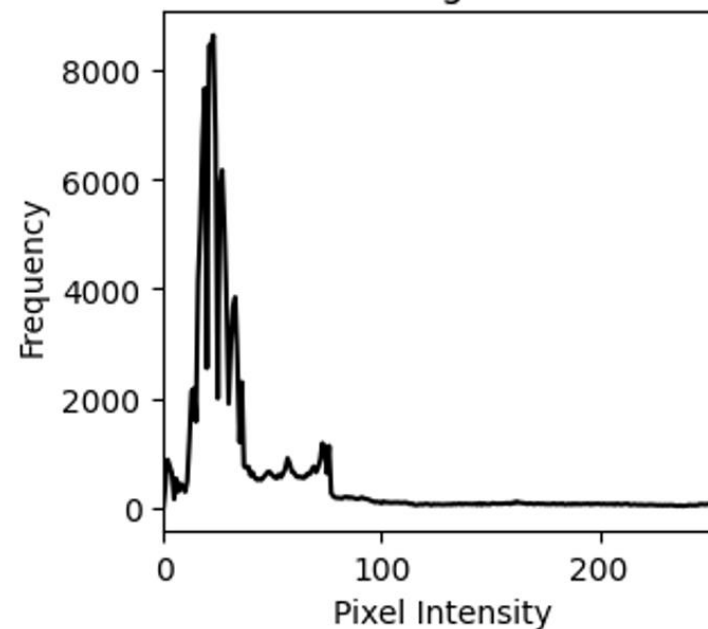
# Histogram



# Original Image



# Histogram





# Global methods applied

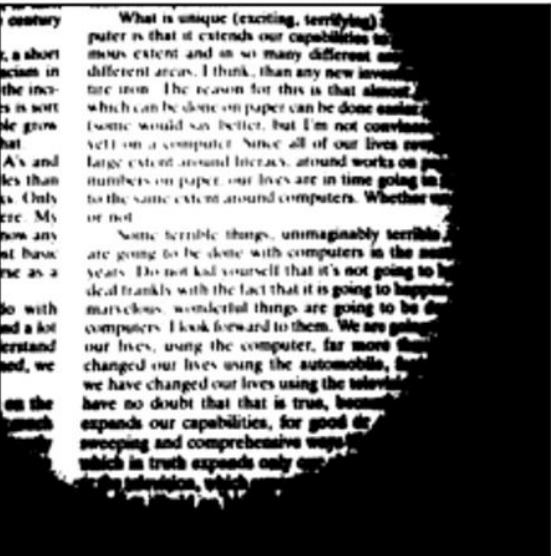
Binary



Binary Inv



Otsu



Triangle



Global methods applied don't show good results!

Binary



Binary Inv



Otsu



Triangle



# Adaptive thresholding Methods

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- ✓ adaptive mean thresholding
- ✓ adaptive Gaussian thresholding
- ✓ Niblack
- ✓ Sauvola

# Adaptive mean and Adaptive Gaussian Thresholding

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## Overview:

- The method calculates the mean of the pixel intensities in the predefined neighborhood and sets this as the threshold value for each pixel (depends on kernel size).
- *Library: OpenCV*
- *Method's parameter:  $C$*  is a constant subtracted from the mean to fine tune the threshold

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What is unique (exciting, terrifying) about the computer is that it extends our capabilities to such an enormous extent and in so many different areas—in more different areas, I think, than any new invention since the tire iron. The reason for this is that almost everything which can be done on paper can be done easier and faster (some would say better, but I'm not convinced of that yet) on a computer. Since all of our lives revolve to a large extent around literacy, around works on paper and numbers on paper, our lives are in time going to revolve to the same extent around computers. Whether we like it or not.

Some terrible things, unimaginably terrible things, are going to be done with computers in the next thirty years. Do not kid yourself that it's not going to happen; deal frankly with the fact that it is going to happen. Some marvelous, wonderful things are going to be done with computers. I look forward to them. We are going to change our lives, using the computer, far more than we have changed our lives using the automobile, far more than we have changed our lives using the television machine. I have no doubt that that is true, because the computer expands our capabilities, for good or evil, in far more sweeping and comprehensive ways than the automobile, which in truth expands only our ability to move around, or the television, which expands only our ability to observe. I am not afraid on balance. It is only human nature that we are going to see a little more of, blown up larger than life by the new machine.

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## Adaptive Gaussian

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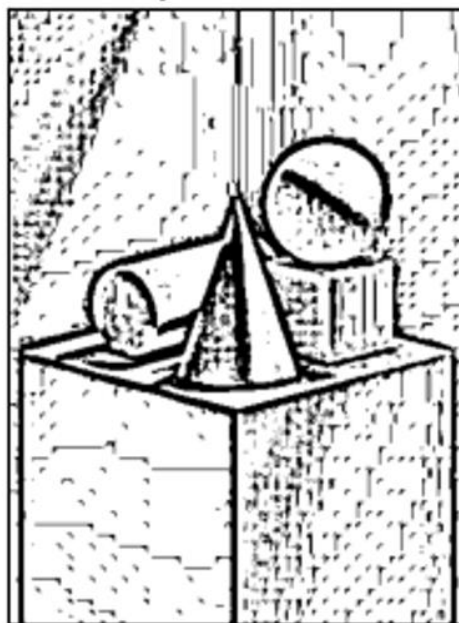
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Original Image

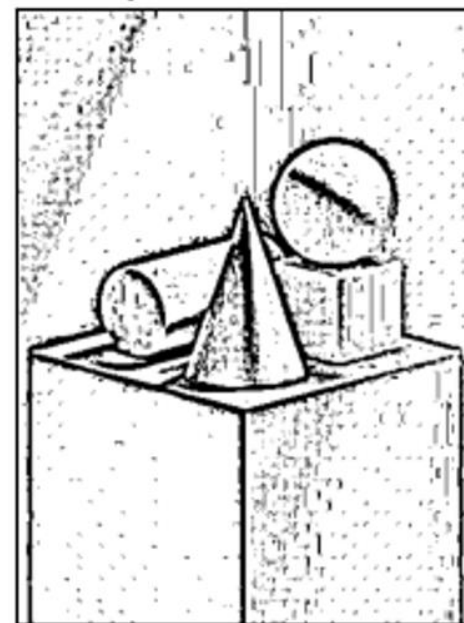


Adaptive Mean

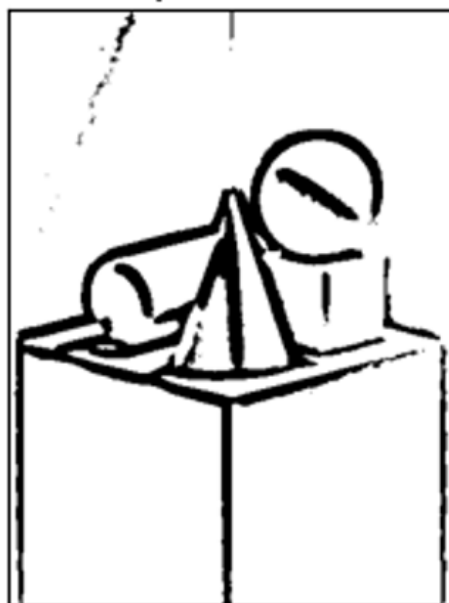


Filter size: 9  
C:3

Adaptive Gaussian

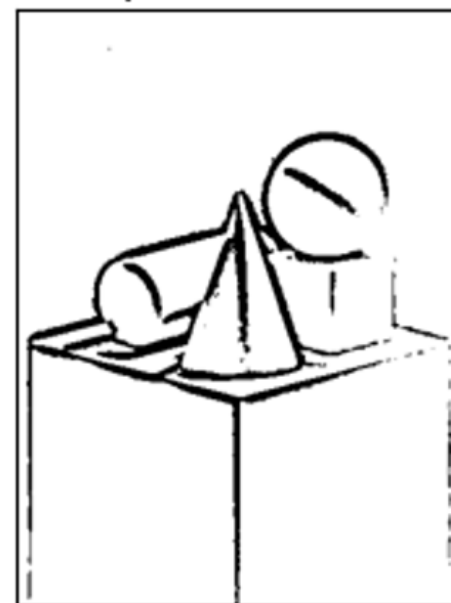


Adaptive Mean



Filter size: 17  
C:3

Adaptive Gaussian



# Niblack and Sauvola Methods

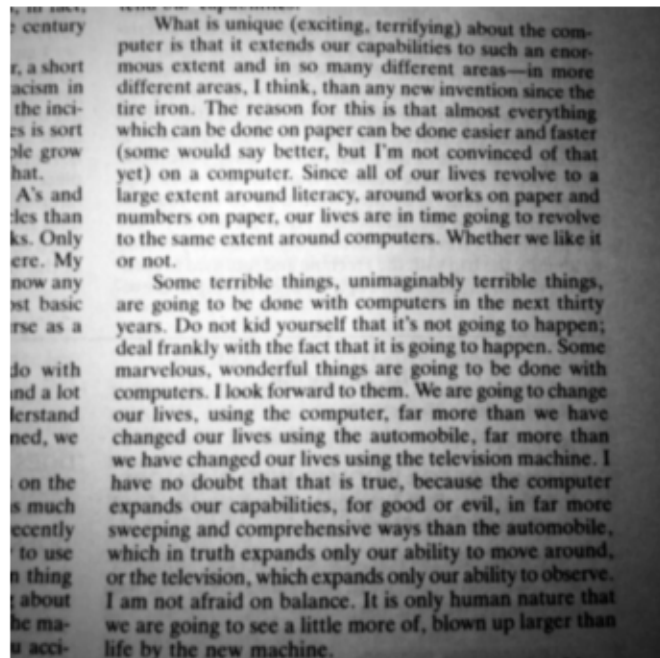
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## Overview:

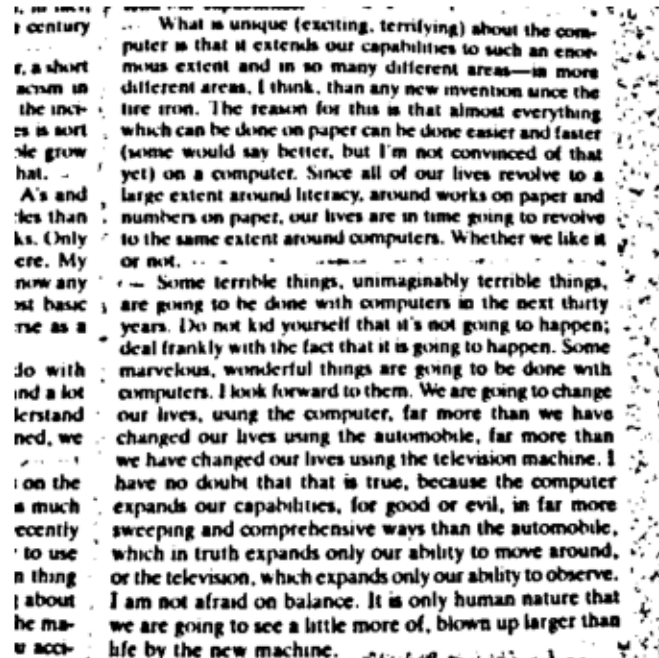
- considers both the mean and standard deviation of the pixel values in the neighborhood
- Library: *scikit-image*
- Method parameters:
  - $K$ : to control noise sensitivity.
- Niblack is sensitive to noise, When the variance is too small in the local area it is almost the same as mean or Gaussian adaptive thresholding
- Sauvola is the improved version of Niblack



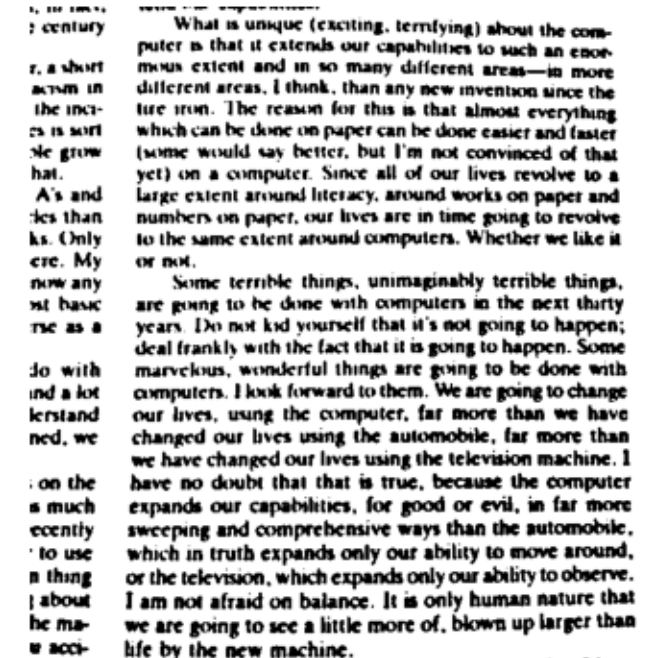
Original



Niblack Threshold



Sauvola Threshold



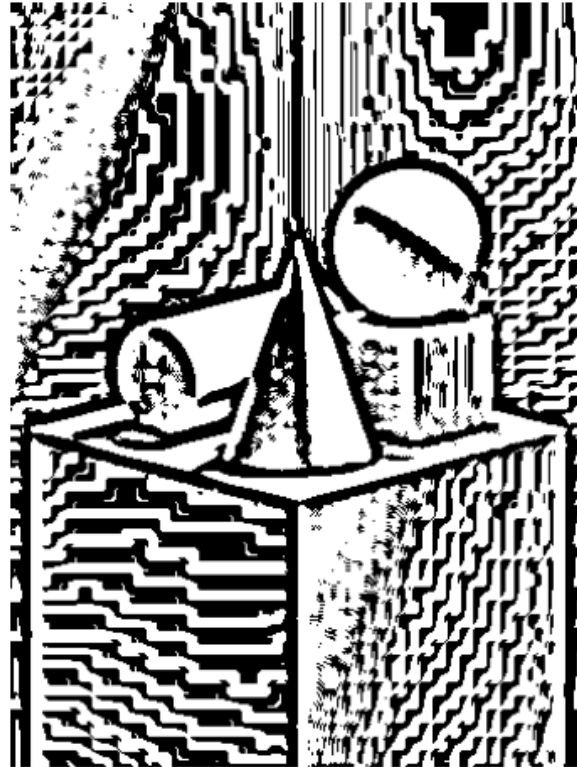
```
thresh_niblack = threshold_niblack(image, window_size=25, k=0.5)
thresh_sauvola = threshold_sauvola(image, window_size=25, k=0.2)
```



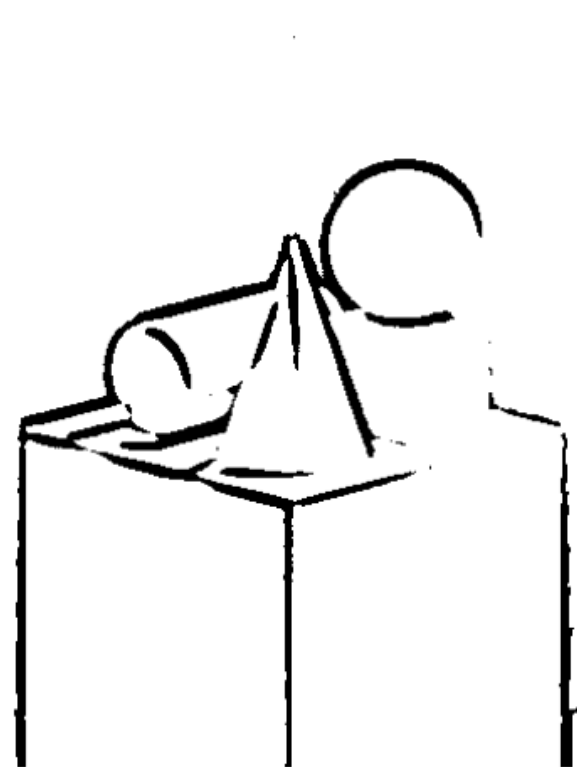
Original



Niblack Threshold



Sauvola Threshold



```
thresh_niblack = threshold_niblack(image, window_size=13, k=0.2)  
thresh_sauvola = threshold_sauvola(image, window_size=13, k=0.2)
```

# Conclusion

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- Global methods works well for images with bimodal histograms which have 2 distinct peaks and distanced means
- Adaptive methods shows better results for images with uneven illumination. Especially for text images.
- With the same filter size local Gaussian shows better result with less noise than the local Mean
- Between Sauvola and Niblack's methods Sauvola shows better result with the right window size ,  $K$  ,and  $r$  tuning.

The End