Fig. 1. Tan Macbeth Chart, width = 1280 pixels, height = 960 pixels

COLOR SEGMENTATION AND PROCESSING

RIVERA, MIB

PHYSICS 301 WFZ

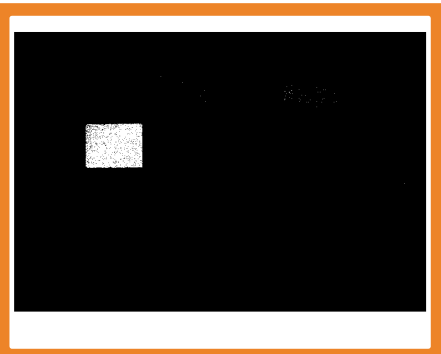
OBJECTIVES

- Use digital color histograms to segment regions of interest in an image.
- Demonstrate how color changes under varying illumination.

WAYS OF SEGMENTING COLORS

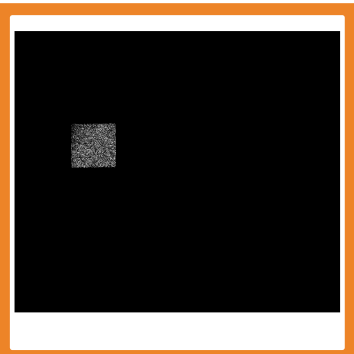
- We first choose a region of interest and let the program recognize the colors in that region
- Segmentation allows us to pick out the same colors as those identified in the ROI
- For the Macbeth chart, we pick out the blue color in the second row from above (marked by red square)

WAYS OF SEGMENTING COLORS



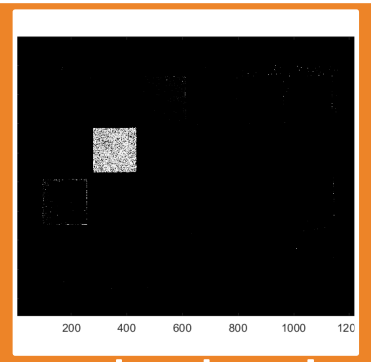
Thresholding

- Models the color histogram of the ROI as a cube; outputs either 0 or 1



Parametric segmentation

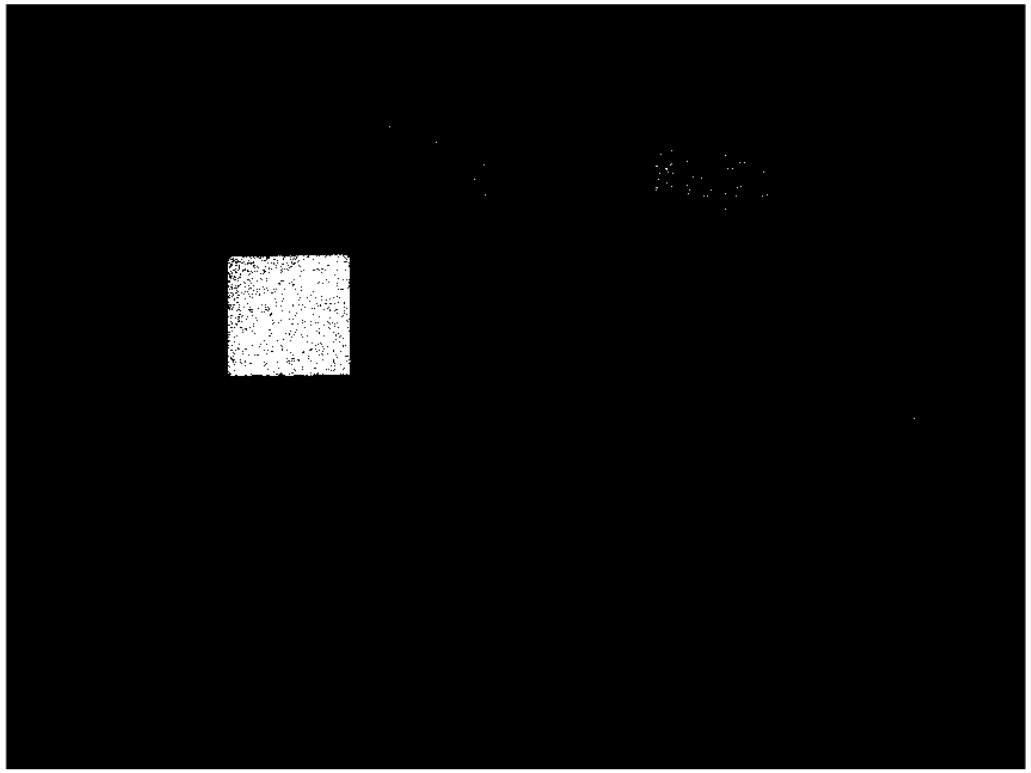
- Models the ROI histogram as an ellipsoid; outputs numbers between 0 and 1



Histogram backprojection

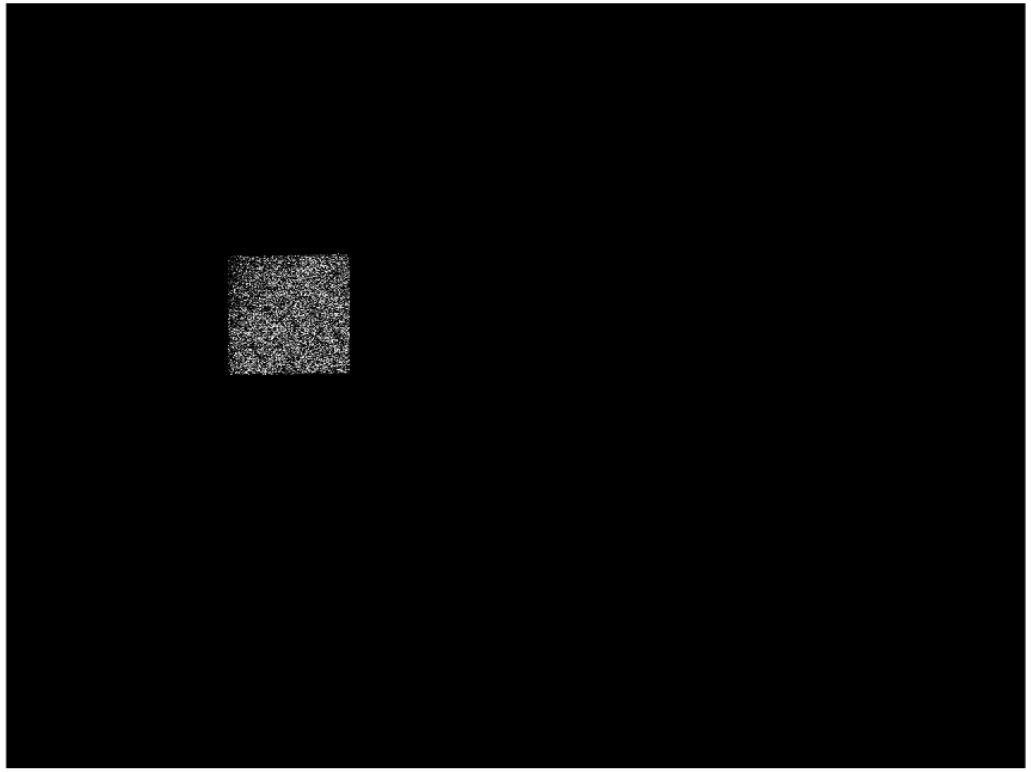
- Transforms the histogram space to chromacity space then assigns the value for a specific pixel from that space back to the histogram

THRESHOLDING



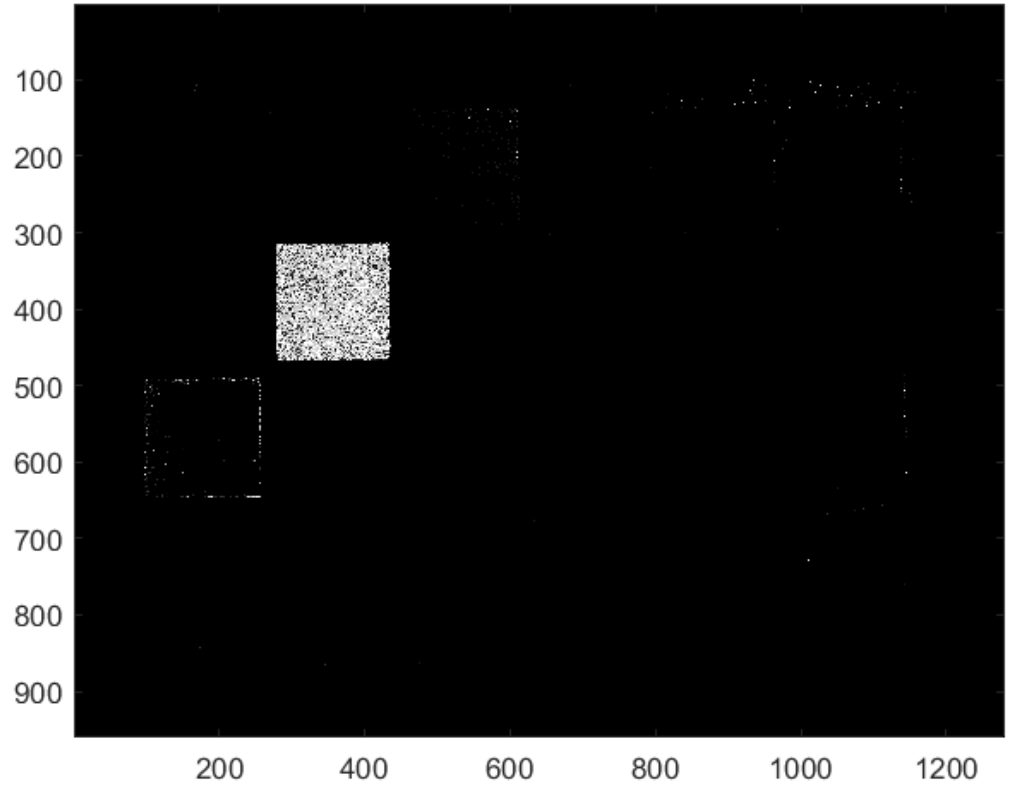
Can still pick out pixels from other regions; accuracy depends on the range noted from the histogram

PARAMETRIC SEGMENTATION



Assigns values lower than 1 to the ROI; accuracy depends on the range (which depends on the std dev)

HISTOGRAM BACKPROJECTION

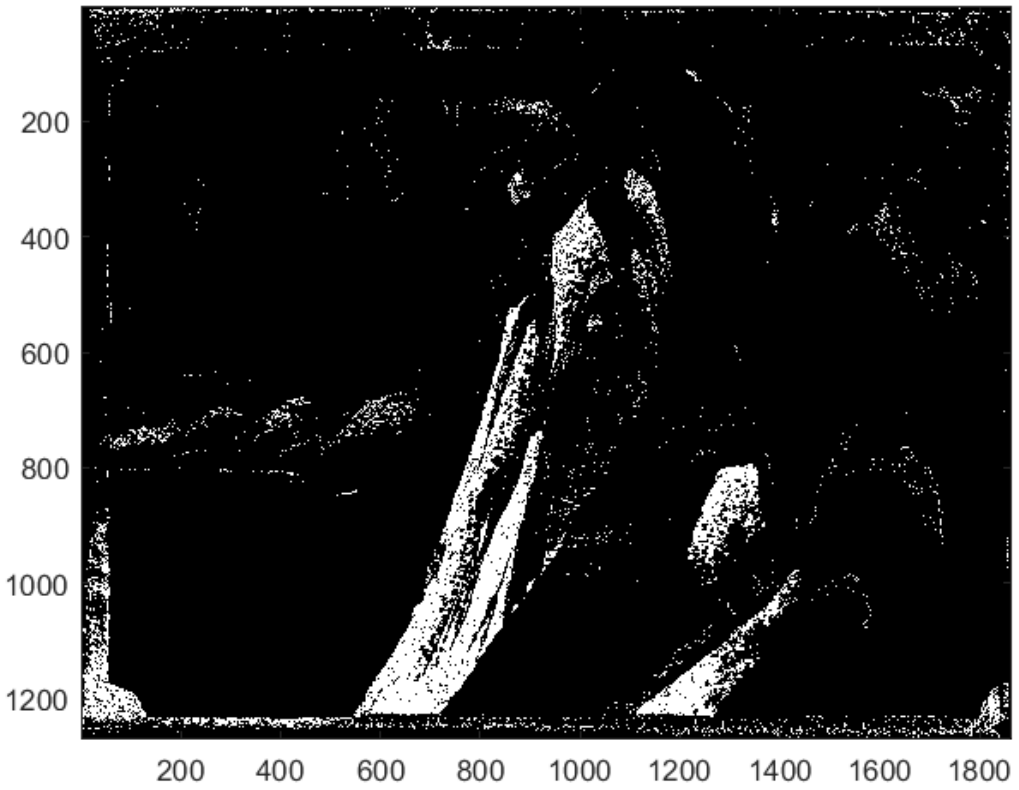


Depends entirely on chromacity value per pixel; no need to compute anything or look for ranges

APPLICATION

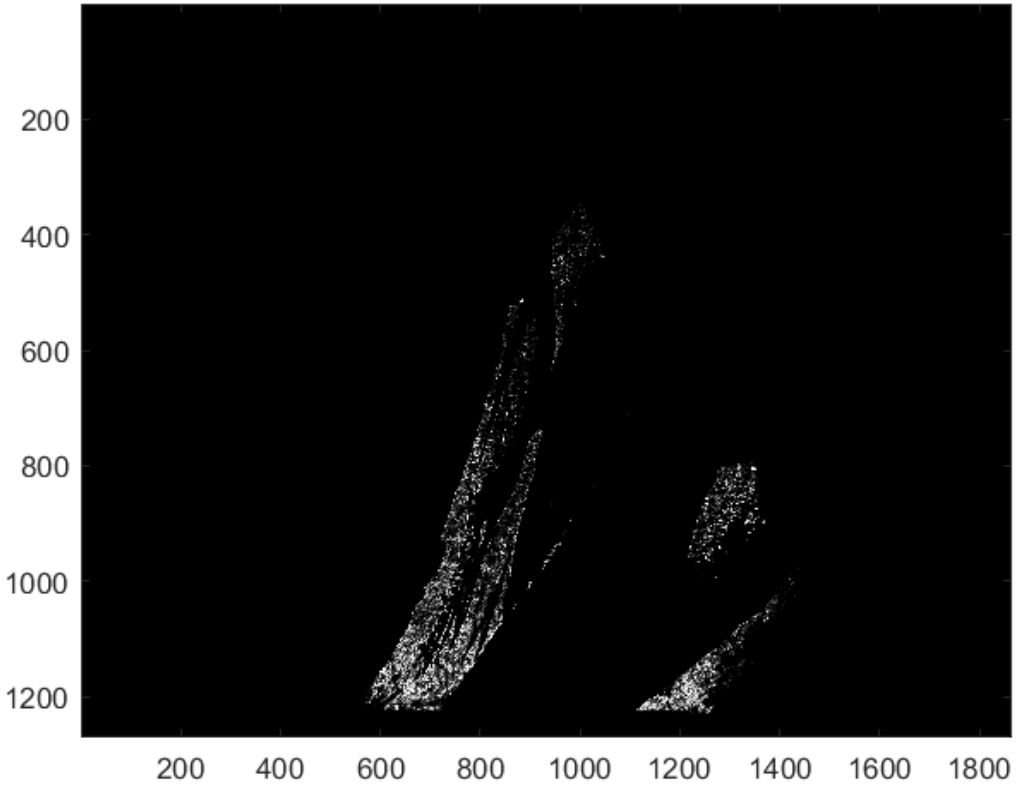
Red square at the bottom indicates ROI; image taken from the Met Museum public domain images.

THRESHOLDING



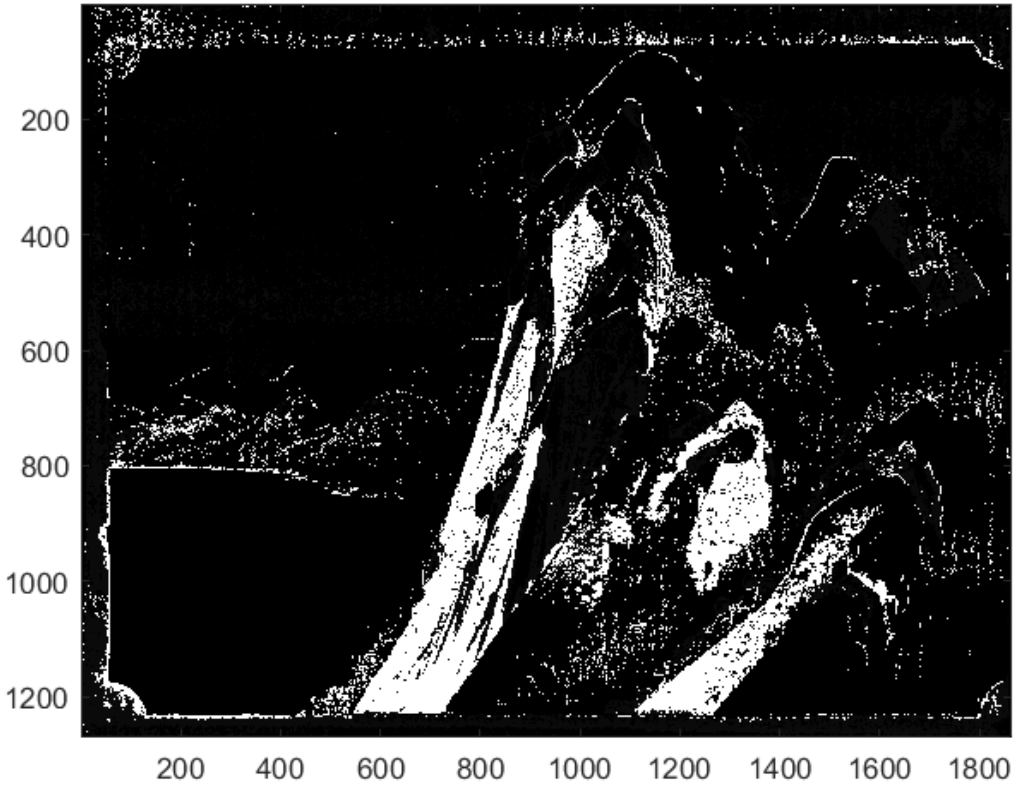
Picks out areas outside the painting; low accuracy

PARAMETRIC SEGMENTATION



More accurate than thresholding; low probabilities given to same colors, thus the dimness

HISTOGRAM BACKPROJECTION



Same colors in chromacity space correspond to white pixels; treats mountains at the back as same color

HOW IS ACCURACY DEFINED FOR COLOR SEGMENTATION?

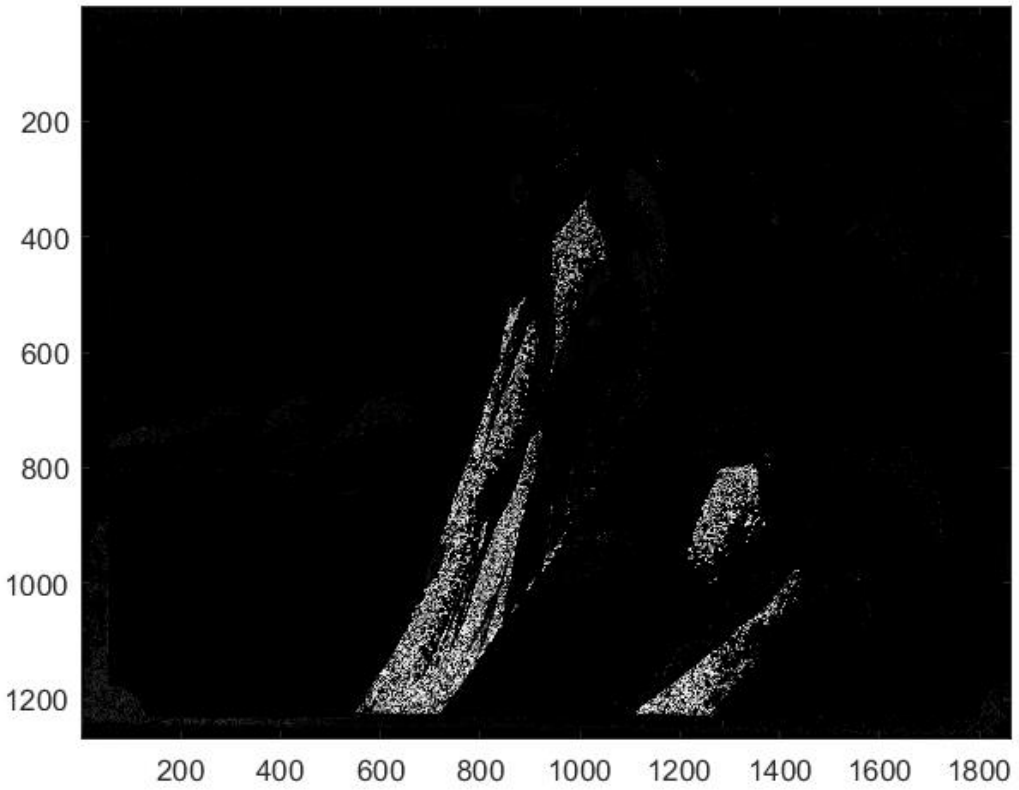
PARAMETRIC SEGMENTATION

- Models the ROI histogram space as an ellipsoid; treats all pixels has having a probability that they belong to the ROI
- Assumes the pixels' colors are distributed Gaussian, with specified mean and standard deviation per color. However there are also covariances between colors which deteriorate the accuracy of the probability assignments.
- We thus look at how these Gaussians behave when treated in a joint probability distribution.

JOINT PARAMETRIC SEGMENTATION

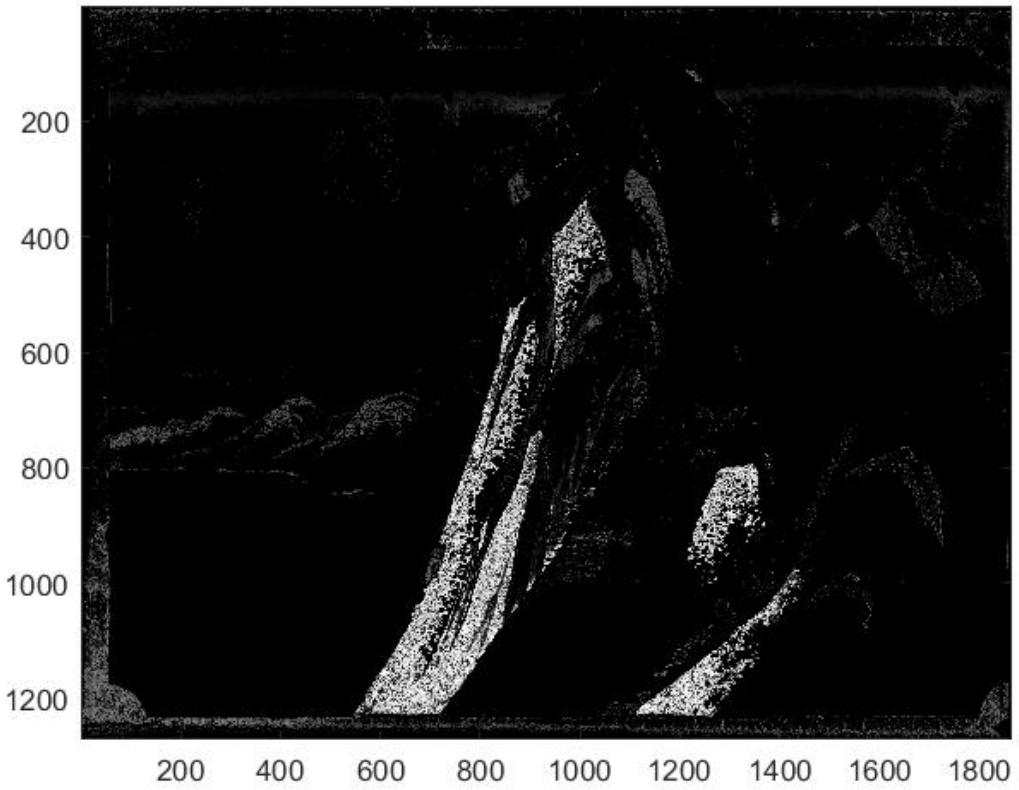
- Calculate the mean and standard deviation per color. This results in a 1D Gaussian per color (as opposed to 3D Gaussian ellipsoid calculated earlier that includes covariances)
- Multiply the probabilities per channel per pixel. You can adjust the range considered per histogram by adjusting the standard deviation per color.

JOINT PARAMETRIC SEGMENTATION – 1 SIGMA



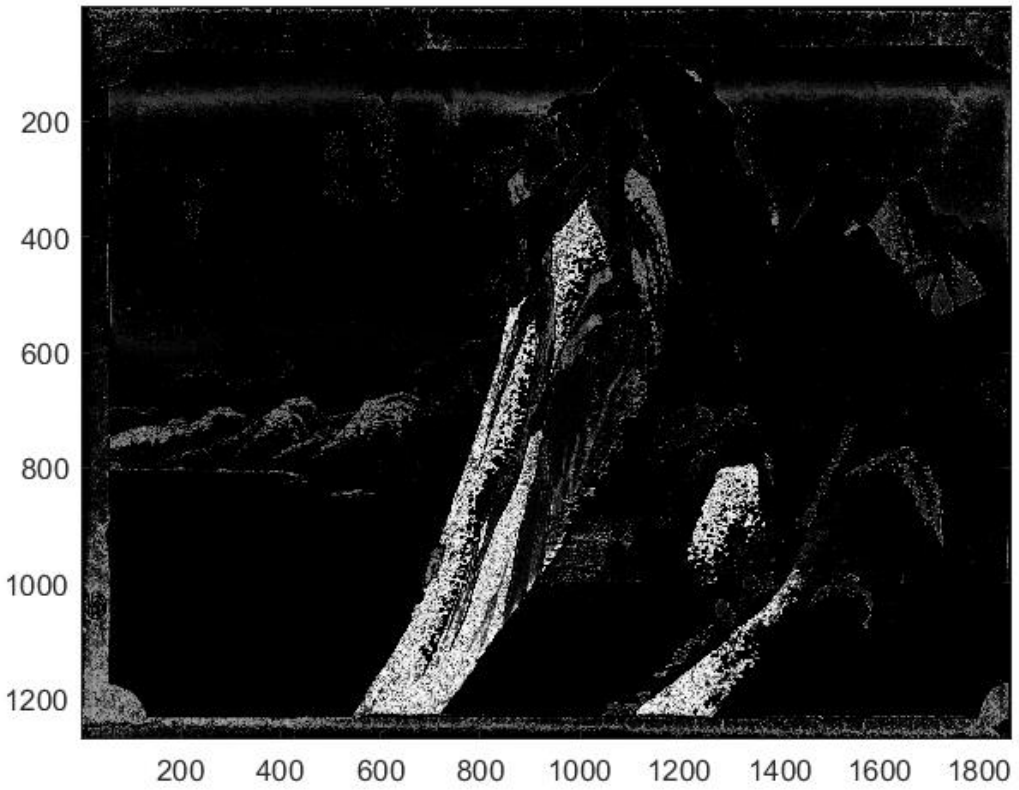
Looks the same as earlier; only brighter pixels due to higher probabilities due to loss of covariance

JOINT PARAMETRIC SEGMENTATION – 1.6 SIGMA



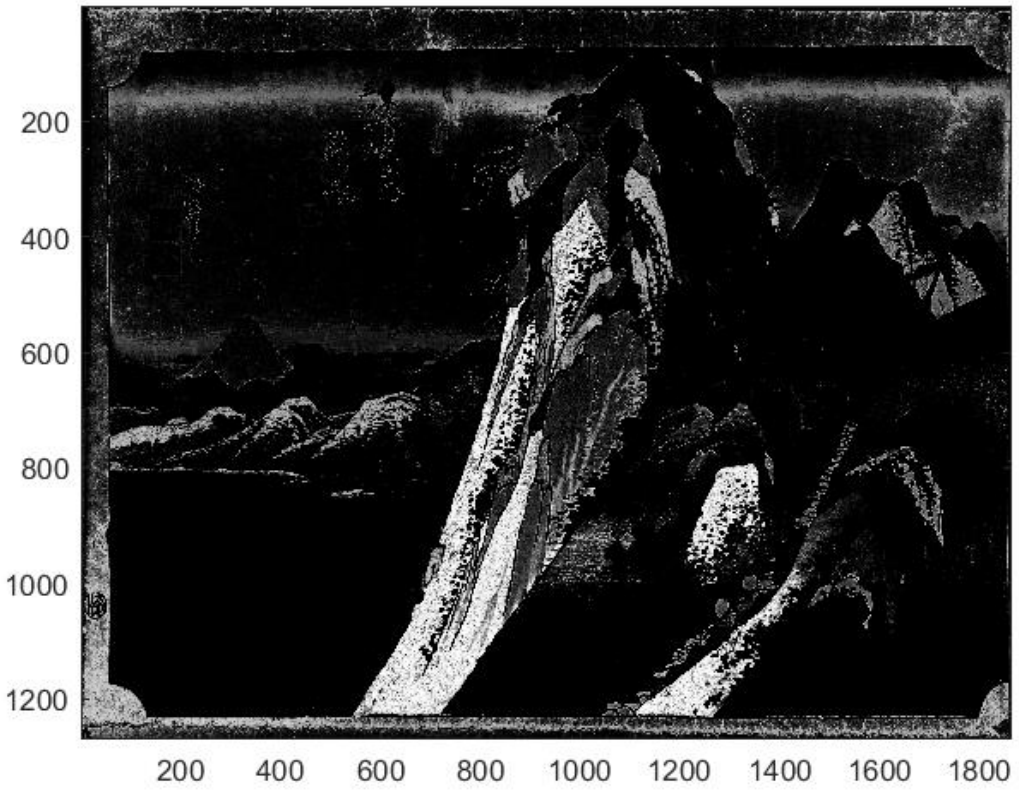
1.6 sigma = 90% of the range of the bell curve; already includes some backdrop mountains and background paper

JOINT PARAMETRIC SEGMENTATION – 2 SIGMA



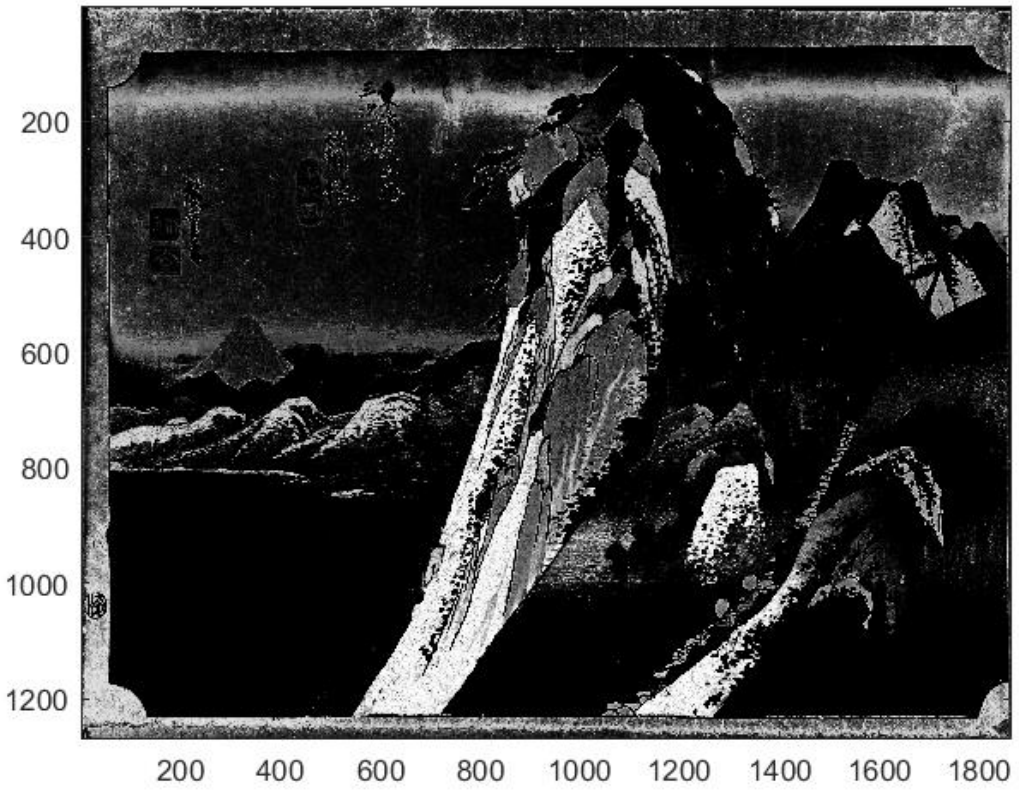
Backdrop mountains get brighter

JOINT PARAMETRIC SEGMENTATION – 3 SIGMA



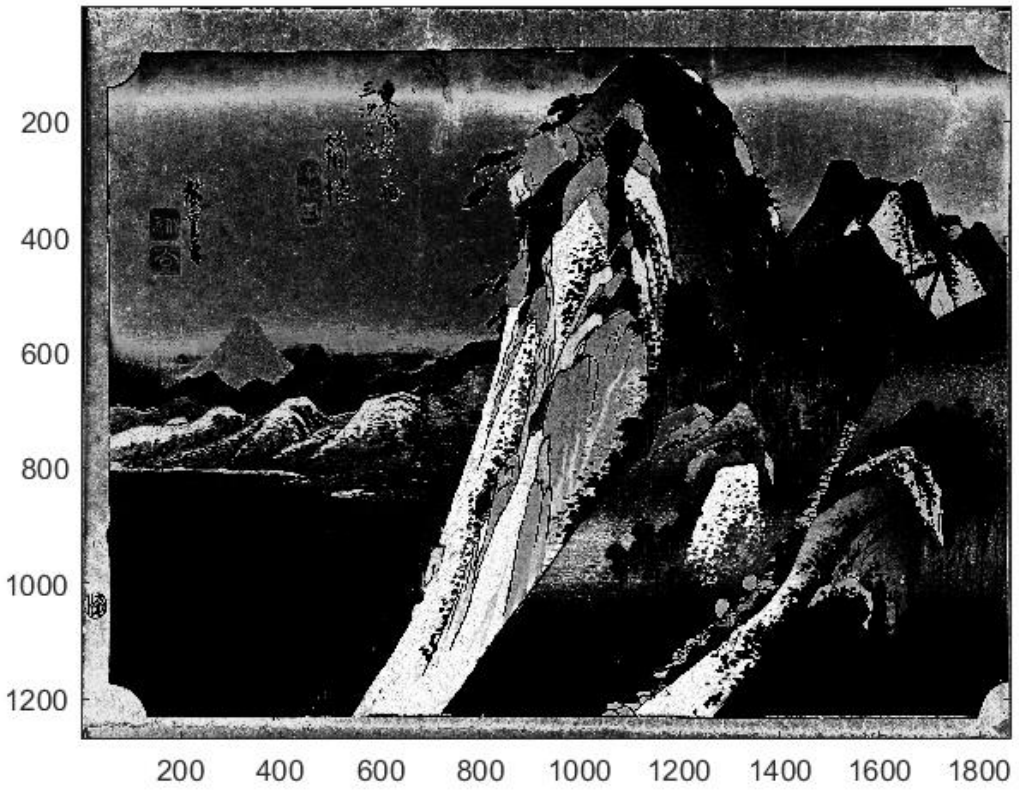
At this point, even the paper is being considered to have the same color as the ROI

JOINT PARAMETRIC SEGMENTATION – 4 SIGMA



Painting gets clearer and clearer the more pixels we deem to be included in our probability distribution

JOINT PARAMETRIC SEGMENTATION – 5 SIGMA



5 sigma = 99.99% of the bell curve is treated; gives the clearest picture and ROI

CONCLUSIONS

- Color segmentation can be applied to different image processing methods; each one can have a different purpose, so using the appropriate color segmentation technique can help
- Parametric segmentation can help recover the image fully when used with the proper range (via choosing the standard deviation)
- Histogram backprojection can help for a fast segmentation as we don’t need to model the ROI