

CS 331

Computer Vision

09 / 24 / 2026

Instructor: Michael Eckmann

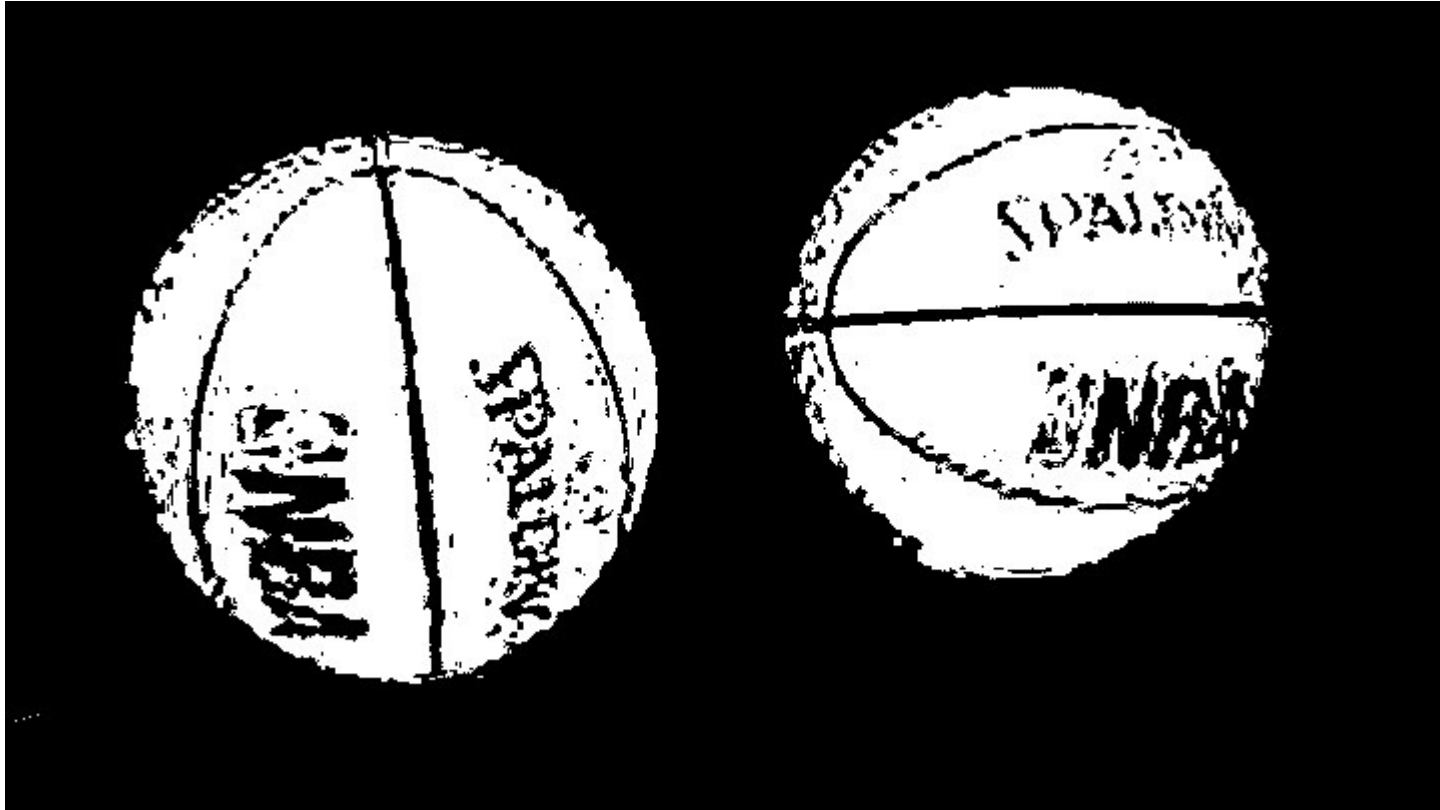
Today's Topics

- Questions / Comments?
- Another example use of morphology
- Region properties
- In-class exercises on Morphology, Connected-components, region properties
- Histograms

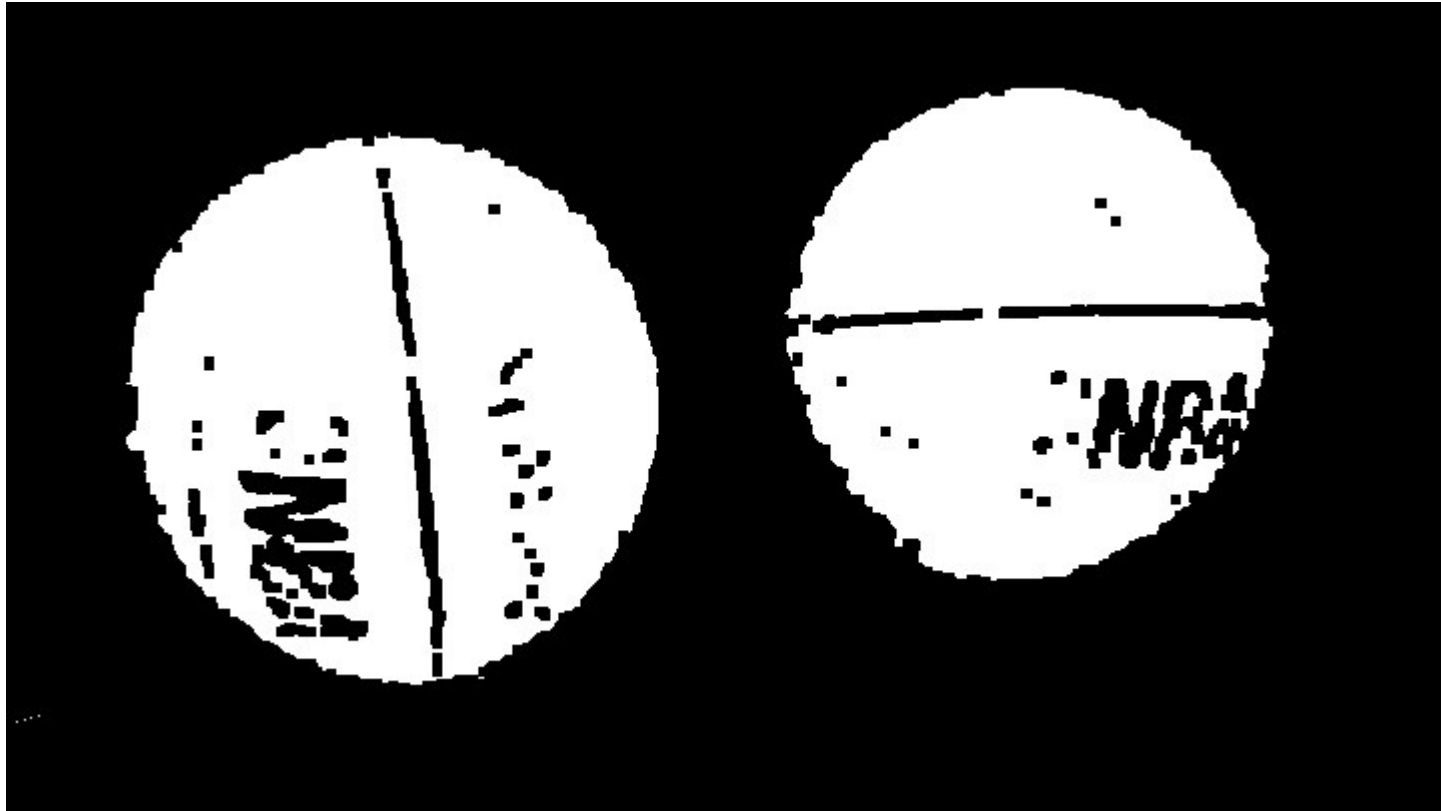
- An image of basketballs



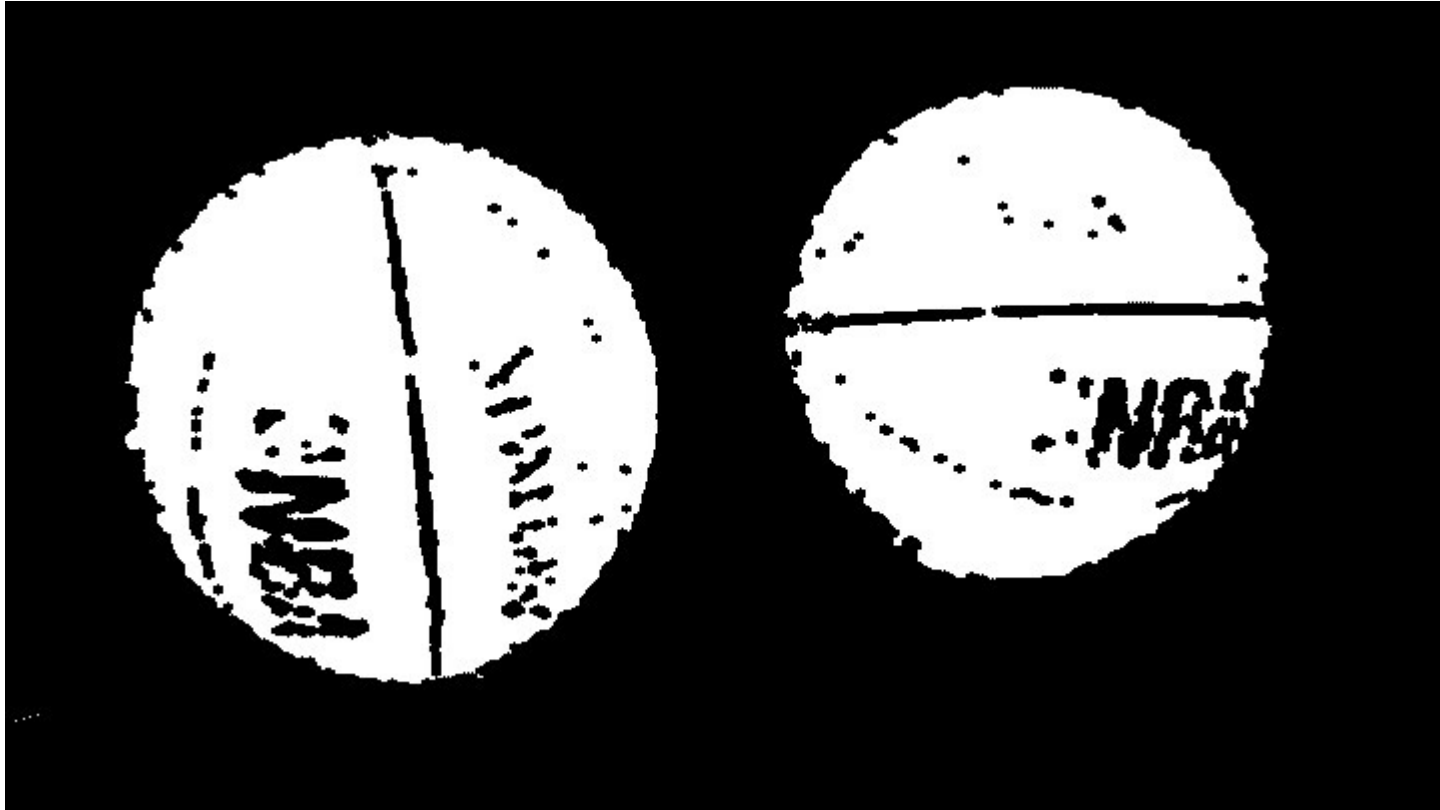
- A mask created by selecting all the basketball color hues (I converted to HSV and selected hue angles 0-20 (on the 0-359 scale))



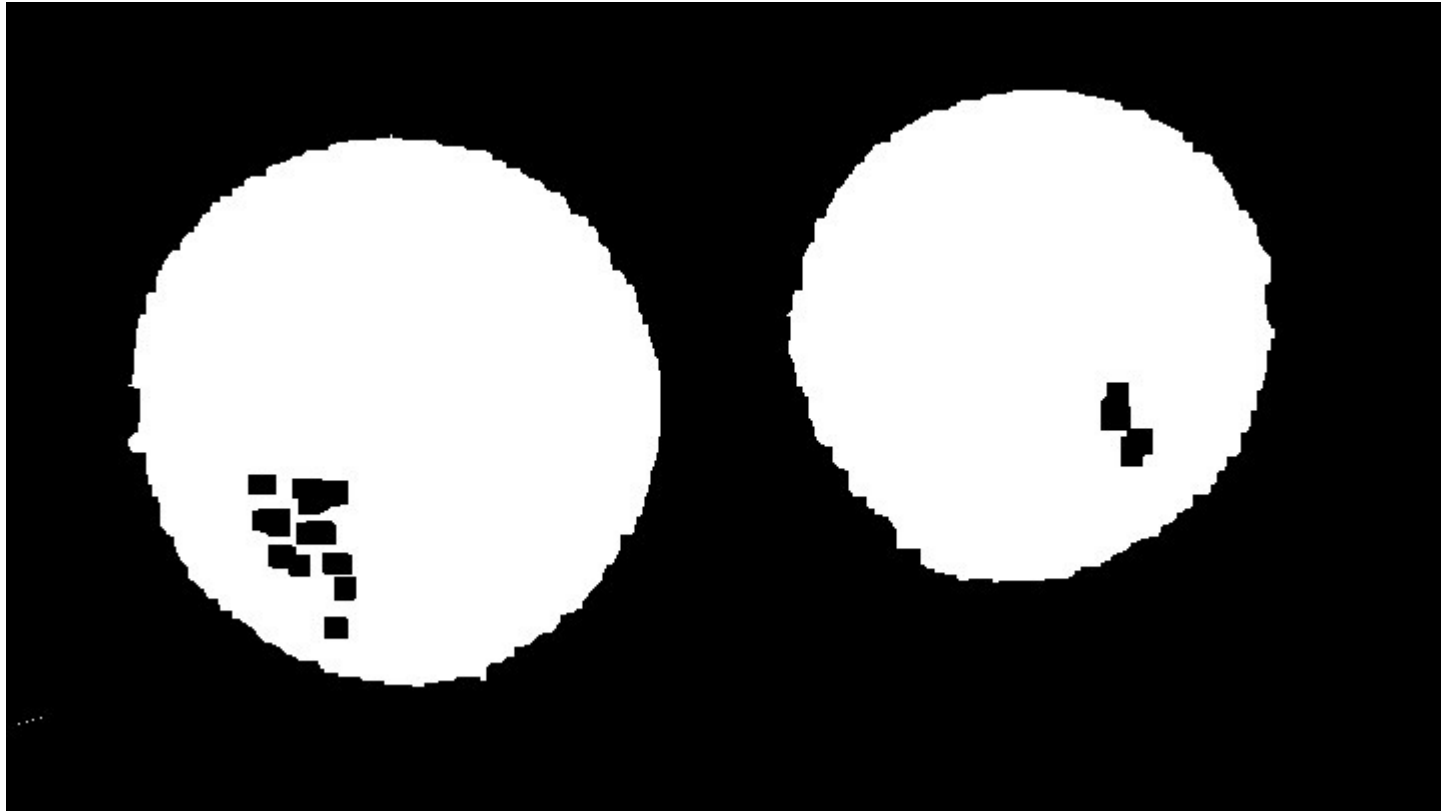
- The mask after closing with a 5x5 box structuring element



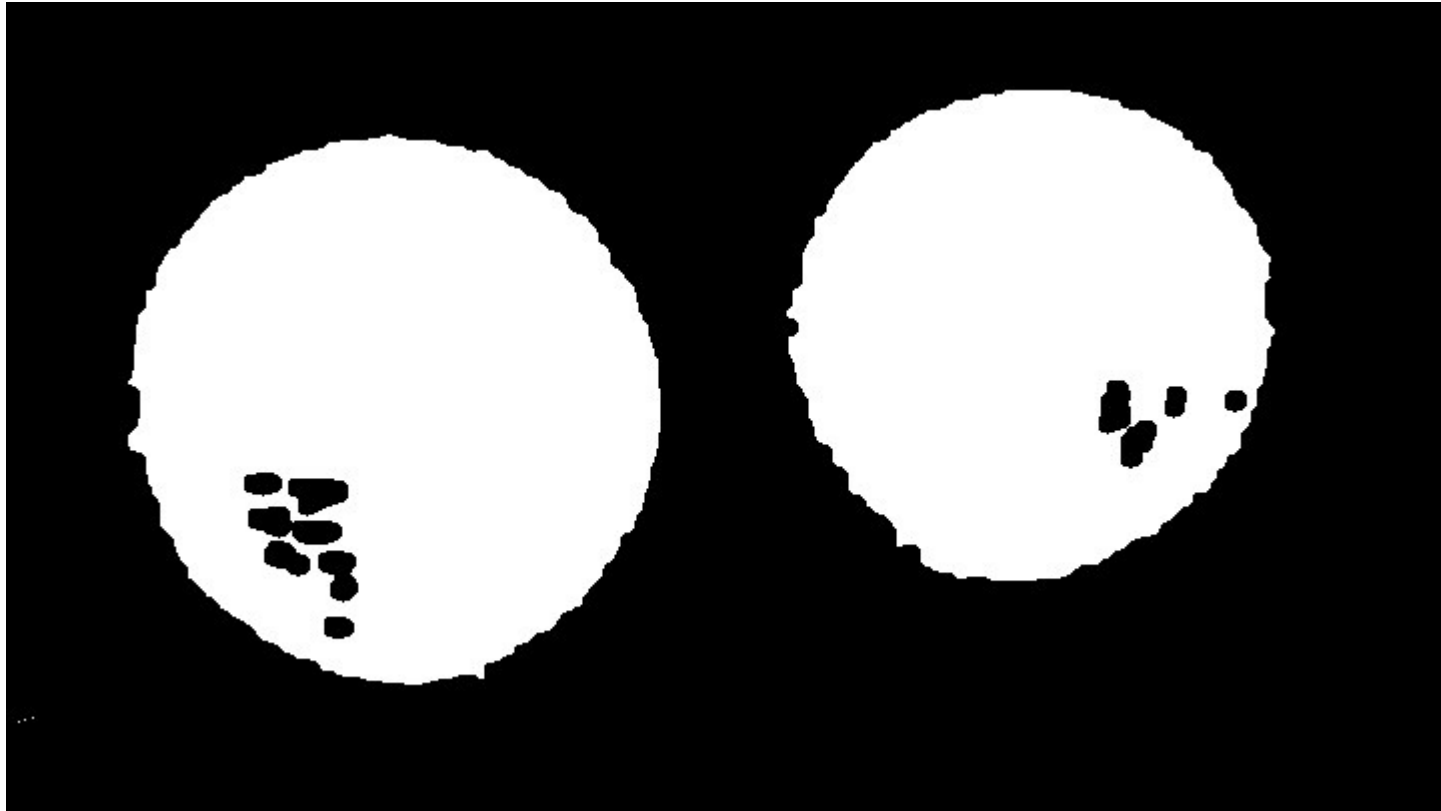
- The mask after closing with a 5x5 circle structuring element



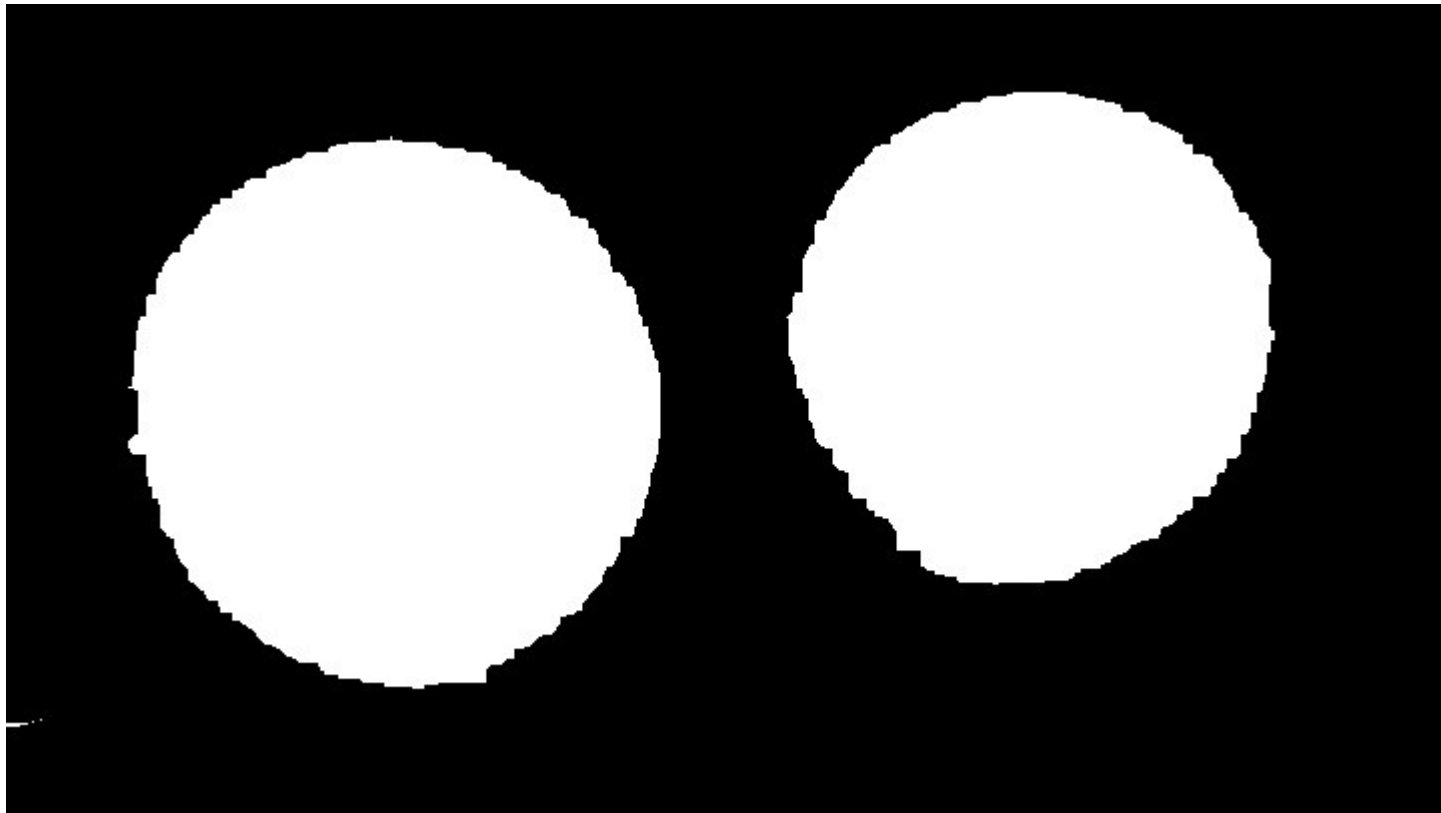
- The mask after closing with a 10x10 box structuring element



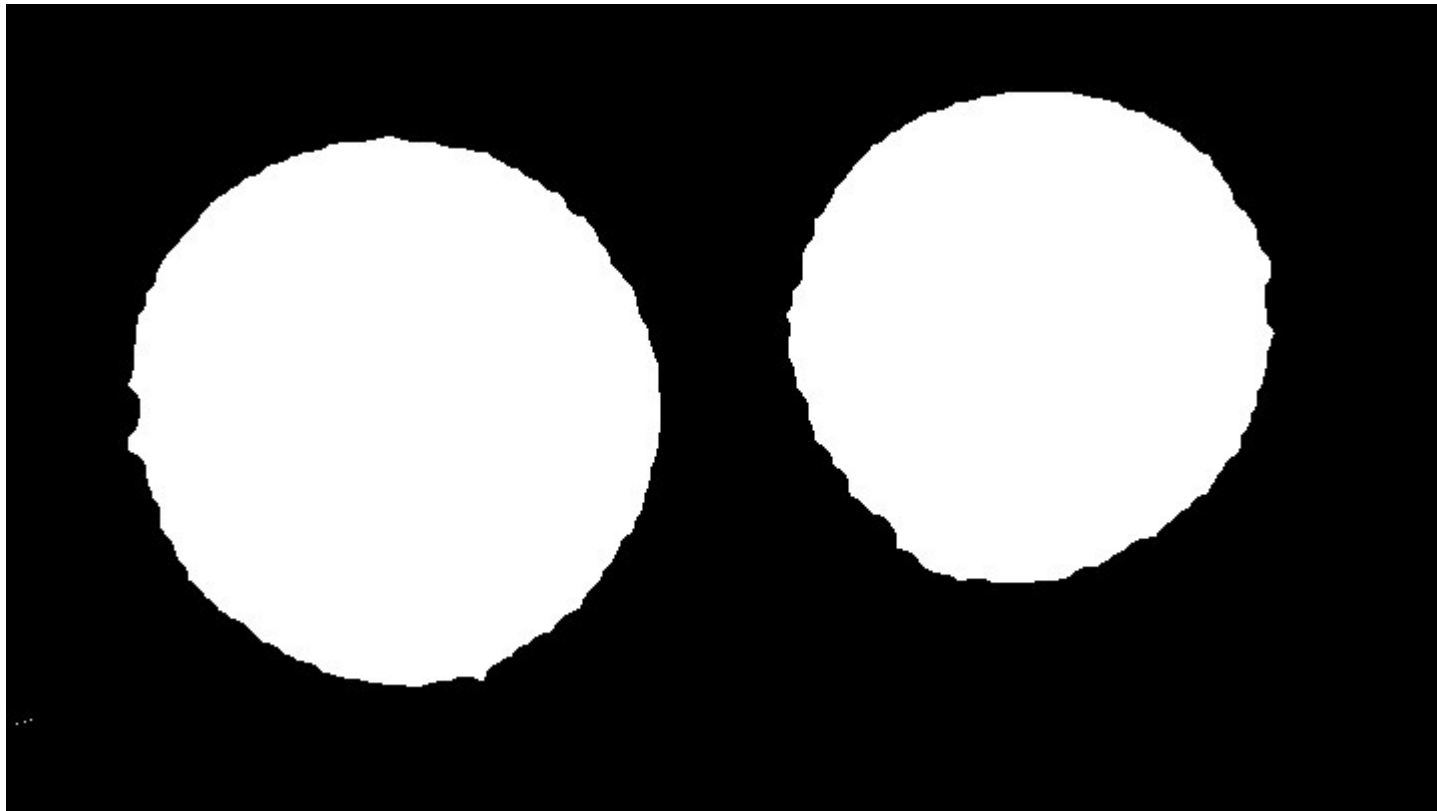
- The mask after closing with a 10x10 circle structuring element



- The mask after closing with a 20x20 box structuring element



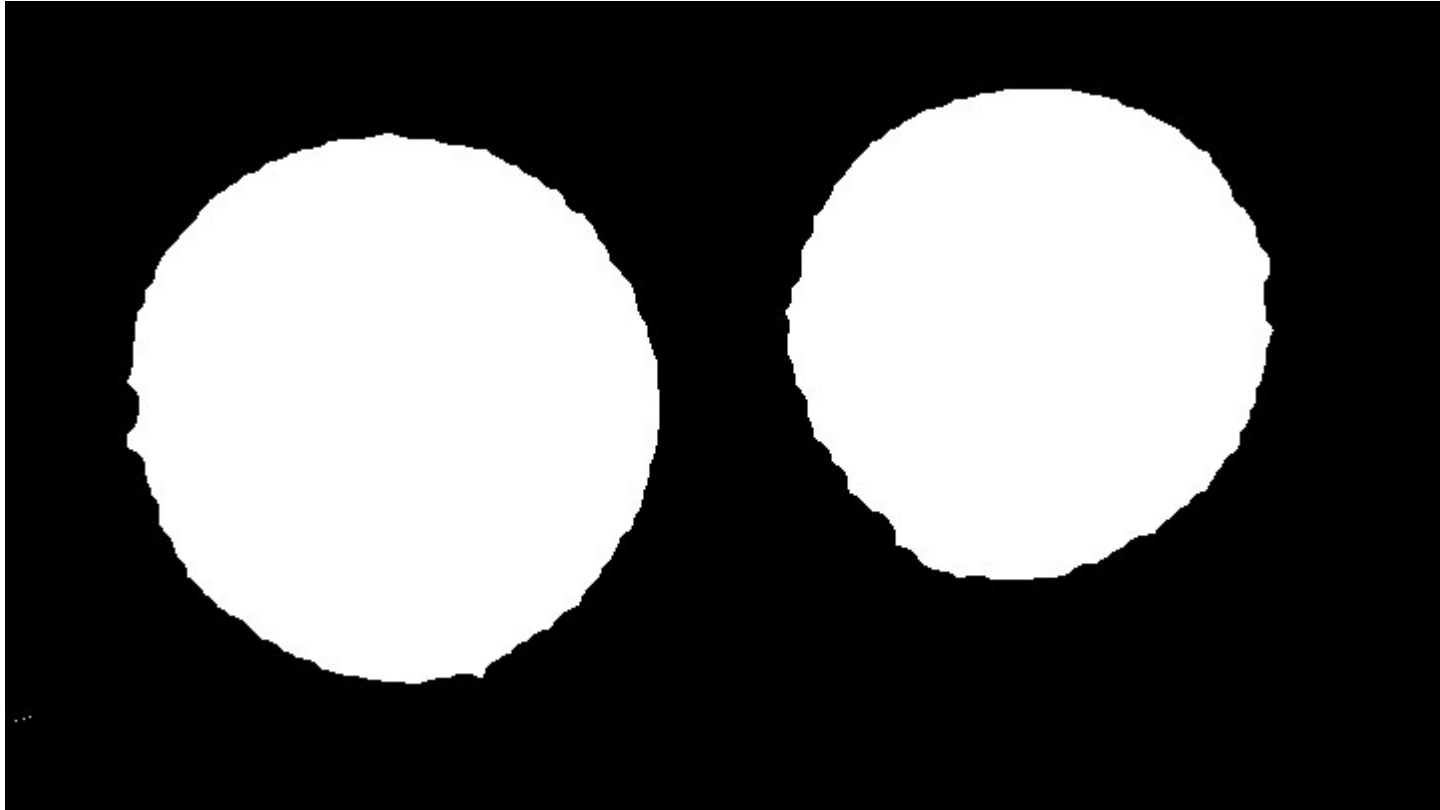
- The mask after closing with a 20x20 circle structuring element



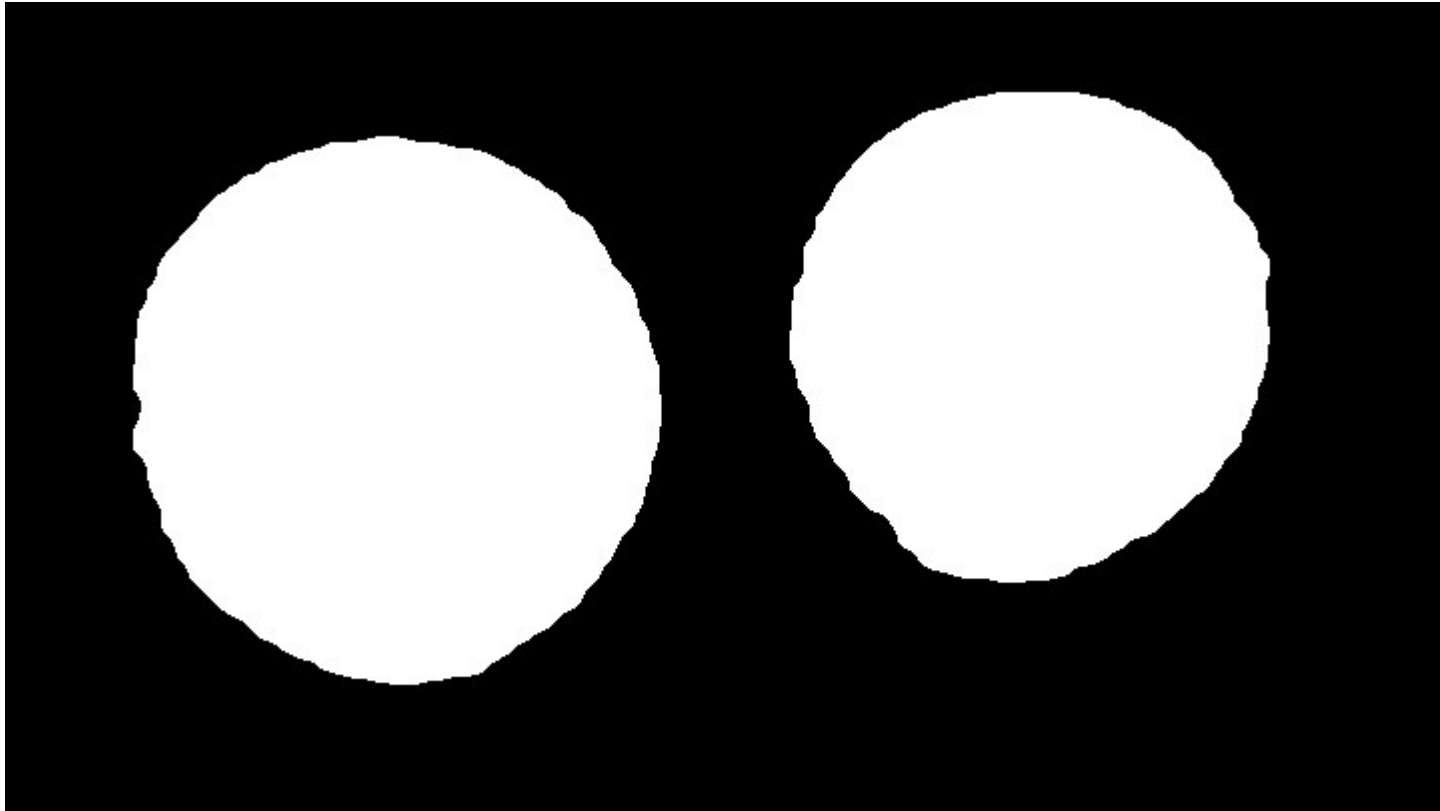
- The image after selecting only the pixels corresponding to the mask closed with a 20x20 circle structuring element



- Let me reshow the mask after closing with a 20x20 circle structuring element



The closed mask from last slide after opening with same (a 20x20 circle structuring element)



The image after selecting only the pixels corresponding to the mask closed and then opened with a 20x20 circle structuring element



histograms

- Reading on recent topics:
- section 3.3.3 Binary Image Processing, Distance Transforms and Connected Components
 - Pages 138 – top of 142
- section 3.1.4 Histogram Equalization which is the end of page 115 to the top of page 119

region properties of binary images

- Consider a region to be a set of connected ON pixels
- **area** of region is simply the count of the number of pixels in the region
- **centroid** = (row_c, col_c) where, row_c = mean row of all pixels in region and col_c = mean column of all pixels in region
- **perimeter** of a region without holes is the set of all pixels that are in the region AND have a neighbor outside of the region
 - neighbor can be defined as 4-connected or 8-connected
- **length of perimeter** can be computed by starting at a pixel and travelling around the whole perimeter and arriving back at the starting pixel
 - add 1 if the adjacent pixels are 4 connected
 - add $\sqrt{2}$ if the adjacent pixels are 8 connected but not 4 connected
 - Note: if there are n pixels in the perimeter, then there are n pairs of adjacent pixels, hence, n numbers added (each of which is either 1 or $\sqrt{2}$).

region properties of binary images

- “Circularity”
 - in some texts this is referred to as **compactness** and is defined as
 - $C_1 = (\text{length of perimeter})^2 / \text{area}$
 - this is a dimensionless number and in the analog world is minimized by a disk (Ballard & Brown 1982)
 - however, for digital shapes, that measure is minimized when the shape is a diamond (when we use the length of perimeter definition as before)
 - a different circularity measure (Haralick 1974) which is similar for both digital and analog shapes and monotonically increases as the shape becomes more circular is
 - $C_2 = \text{mean of radial distances} / \text{standard dev. of radial distances}$
 - the radial distance of a pixel on the perimeter is the distance between that pixel's center and the centroid of the region

region properties of binary images

- **“Circularity”**
 - C_2 = mean of radial distances / standard dev. of radial distances
 - the radial distance of a pixel on the perimeter is the distance between that pixel's center and the centroid of the region
 - the mean and standard deviation are statistical measures
 - the mean is what we mostly think of as the average
 - the standard deviation is a measure of how spread out the group is in values
 - lower sd => more compact group, higher sd => more spread out
 - standard deviation is the square root of the variance
 - whatever units the original data is in, the variance is in those units squared, if you want a measure of the spread in the same units, then use standard deviation

In-class exercises

- Exercises on Morphology (dilation and erosion), connected components, computing information about a region

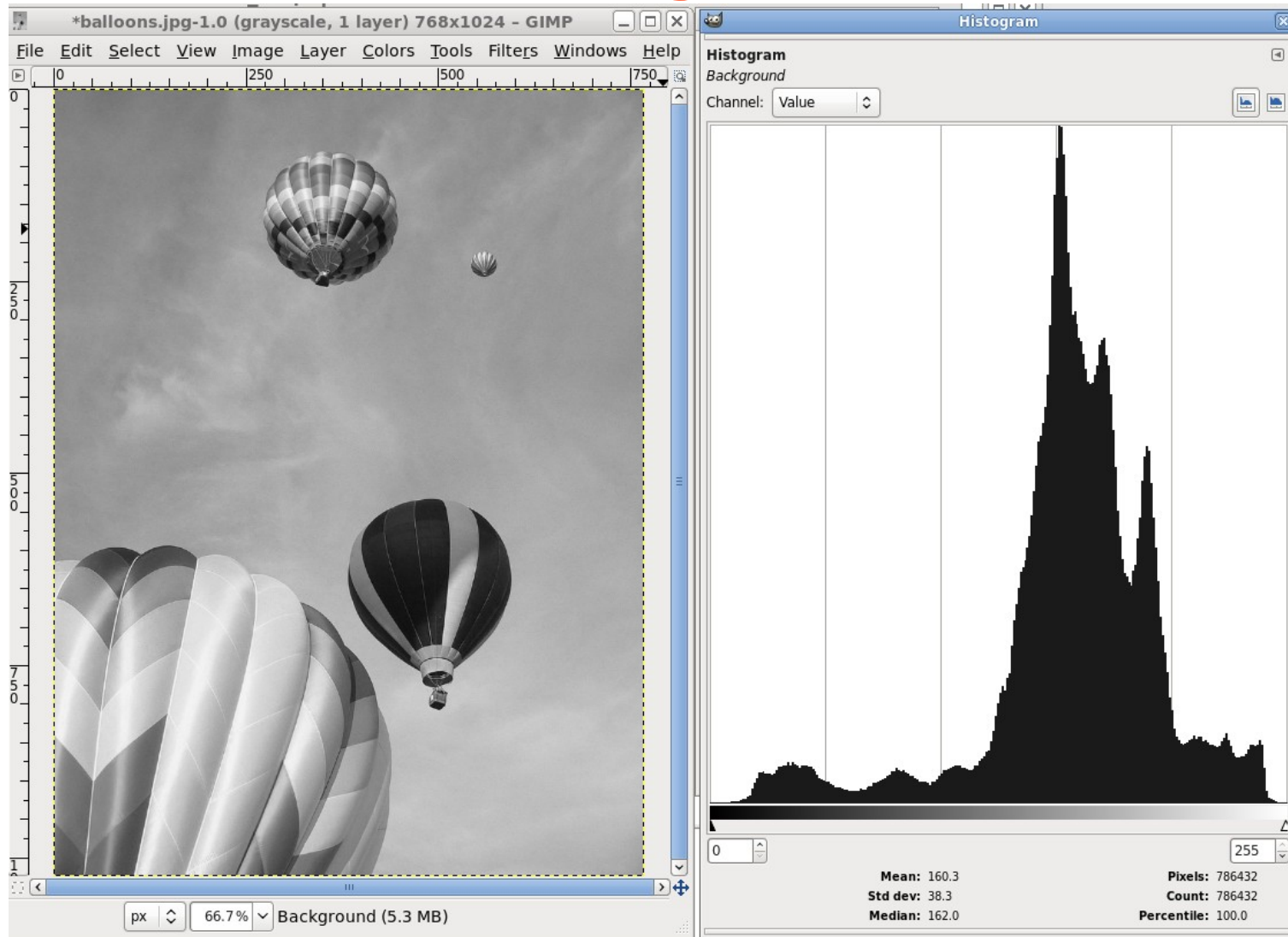
histograms

- A histogram of a greyscale (aka intensity) image is a function
 - whose domain is a set of grey values and
 - And whose value at a grey value is the number of pixels in the image with that grey value
- The domain could be the set of all grey values, where each grey value is a bin. Or it could be a smaller number of bins, where each contiguous set of grey values is a bin.
- e.g. for an 8 bit greyscale image, the range of values is 0 to 255
 - we could make 256 bins, where each bin is one grey value or
 - if we want 32 bins, then each bin will be associated with $256/32 = 8$ grey values. 0-7 in bin0, 8-15 in bin1, ..., 248-255 in bin31.
 - our histogram will be a function whose domain is the bins and whose value is the number of pixels in the image with any of the grey values corresponding to that bin

histograms

- A histogram then is a mapping from the domains (the bins) to the range (the number of pixels corresponding to a particular bin)

histograms



Michael Eckmann - Skidmore
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