Resistor Detection and Classification Using Support Vector Machines

David McNeil

Rose-Hulman Institute of Technology

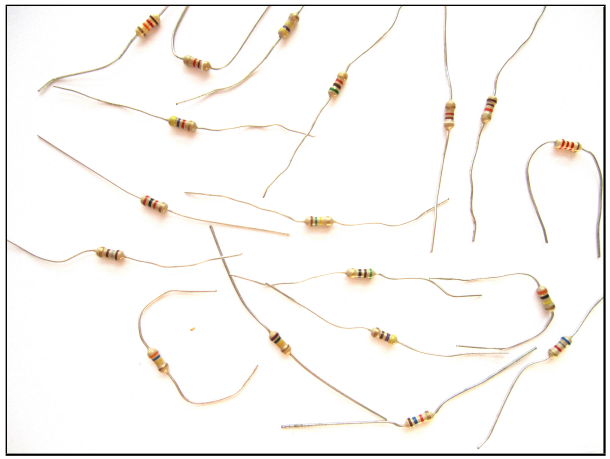
mcneilde@rose-hulman.edu

Overview

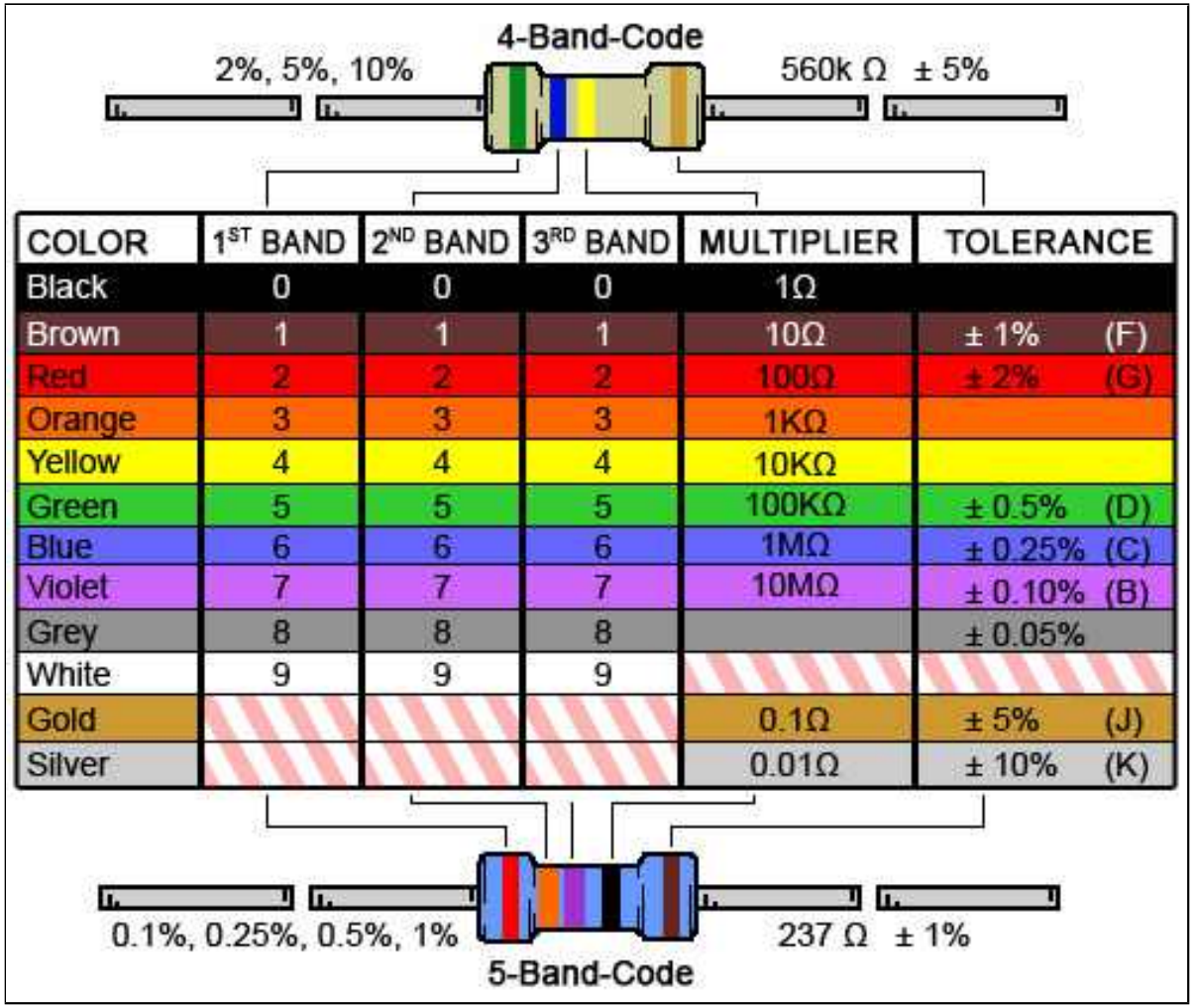
Objective

Successfully be able to detect and classify resistors in an image.

- Detection– Determining the location of the resistors in the image
- Classification– Determining the resistor value based on color codes



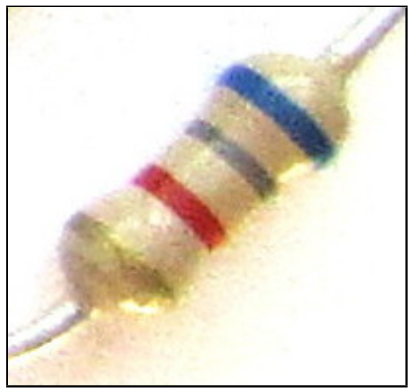
Resistor Color Codes



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8		± 0.05%
White	9	9	9		
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

Assumptions

- Resistors are all of a standard type
- Resistors are of a similar size in images
- Images are all of the same resolution
- Images have a similar white balance
- Images have been taken on a white background
- Images have been taken with a consistent camera angle
- Images only include resistors



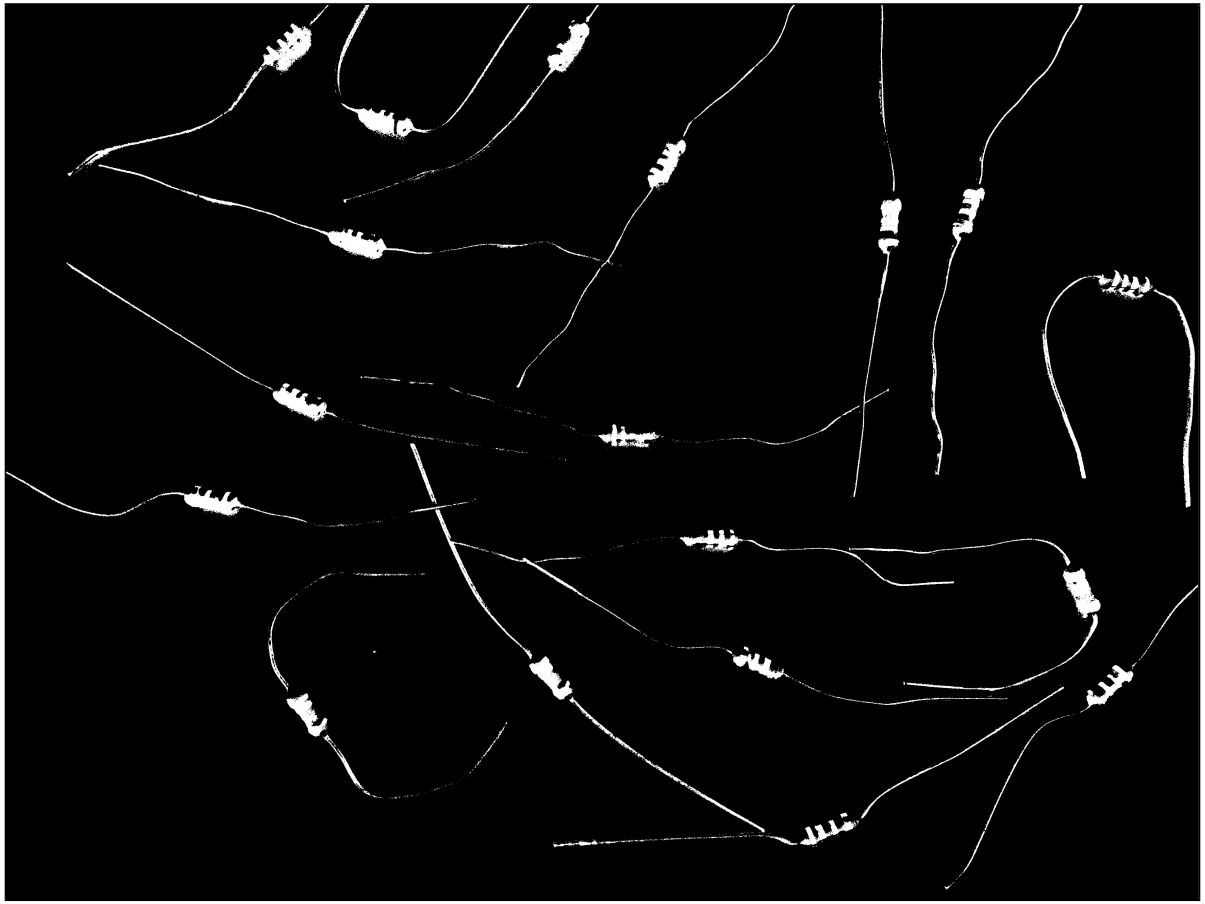
Detection

Basic Approach

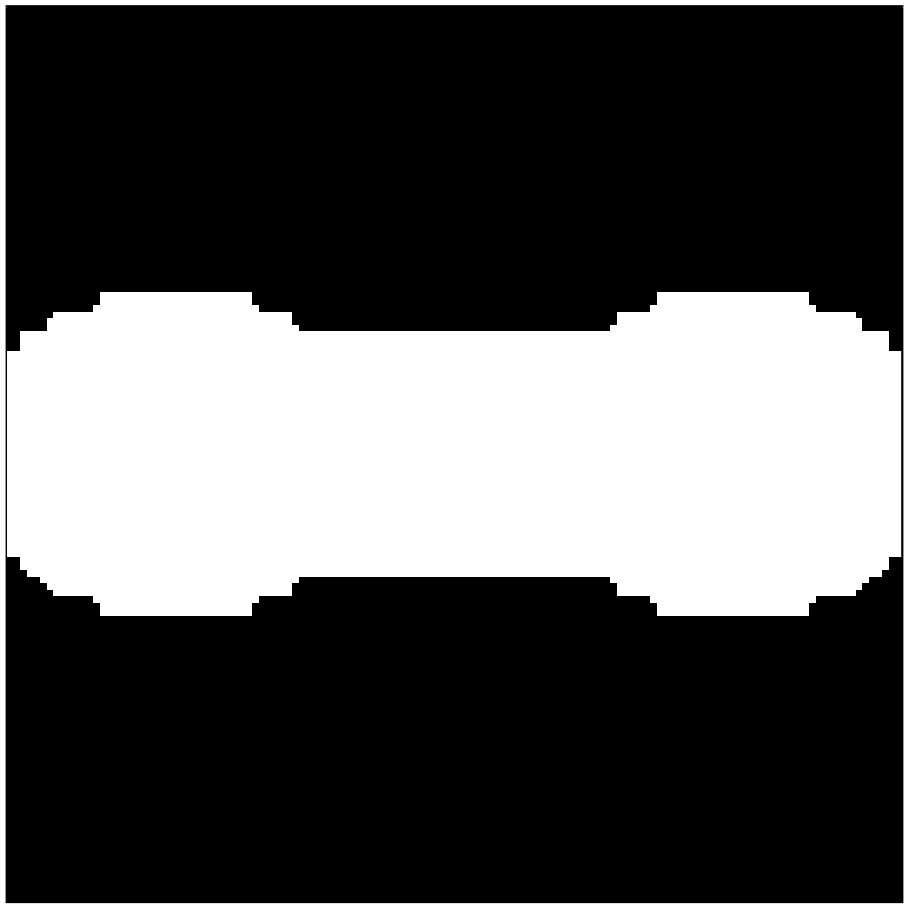
- Convert image to black and white (binary image)
- Convolve the binary image with a binary mask of a resistor
- Rotate the binary mask and convolve again, repeat at 10°intervals
- Find local maximum in the convolved space

Initial Image

Binary Image

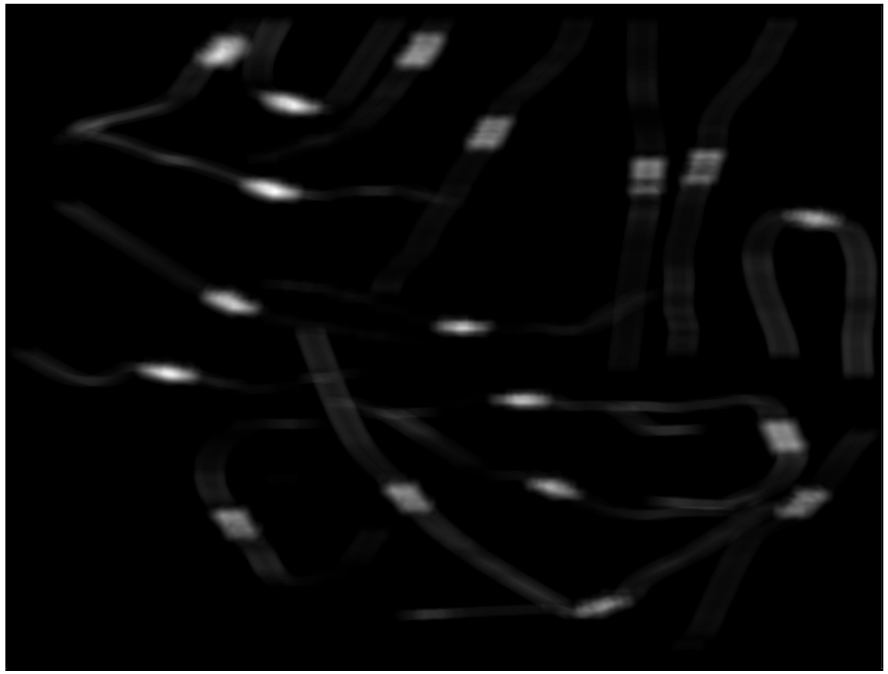


Resistor Mask

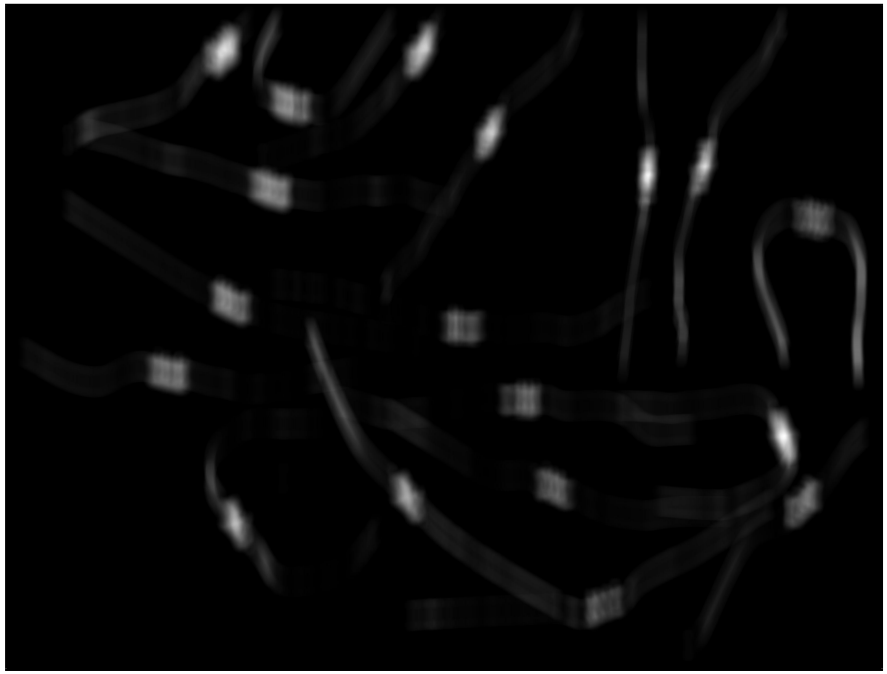


Convolved Images

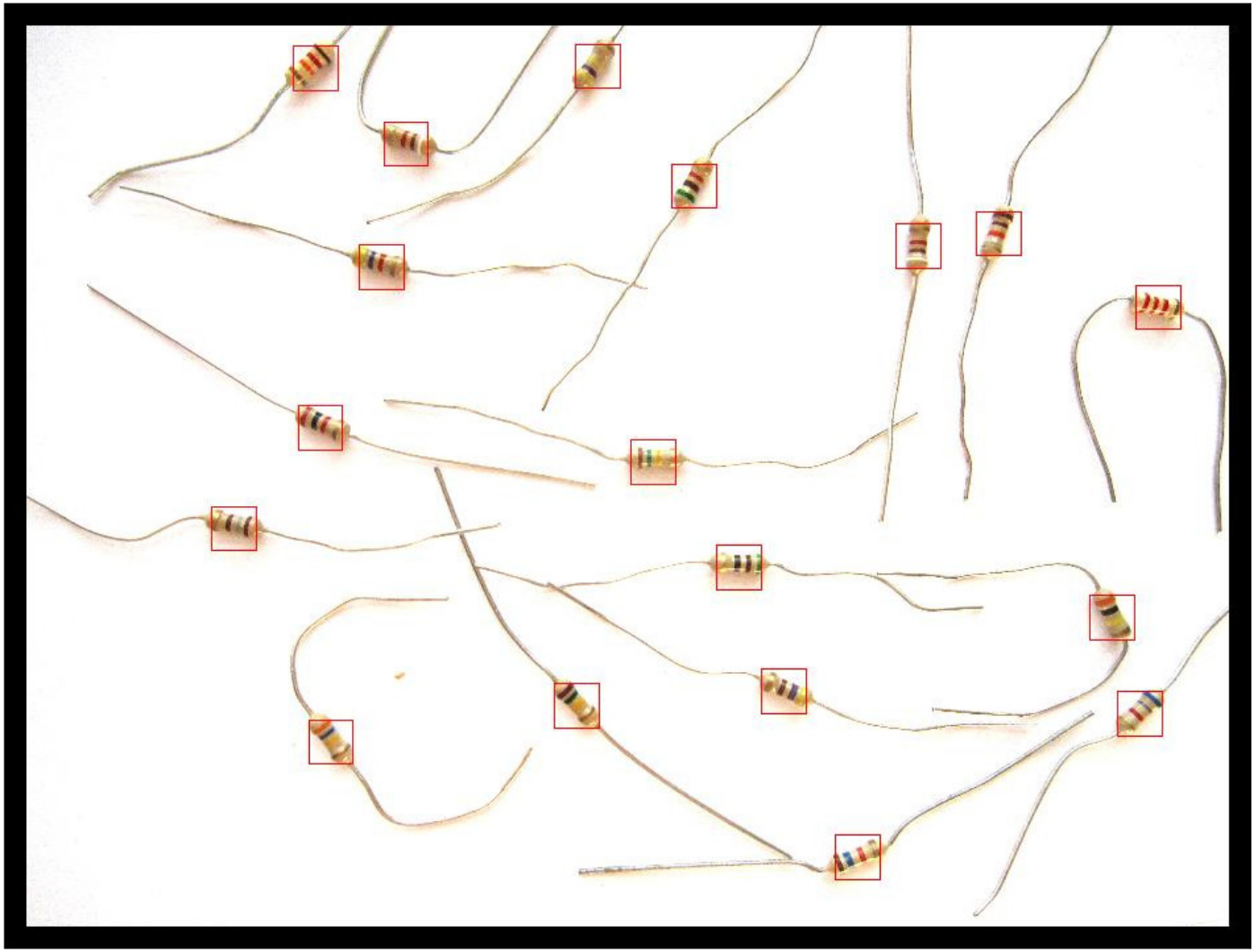
Mask at 0°



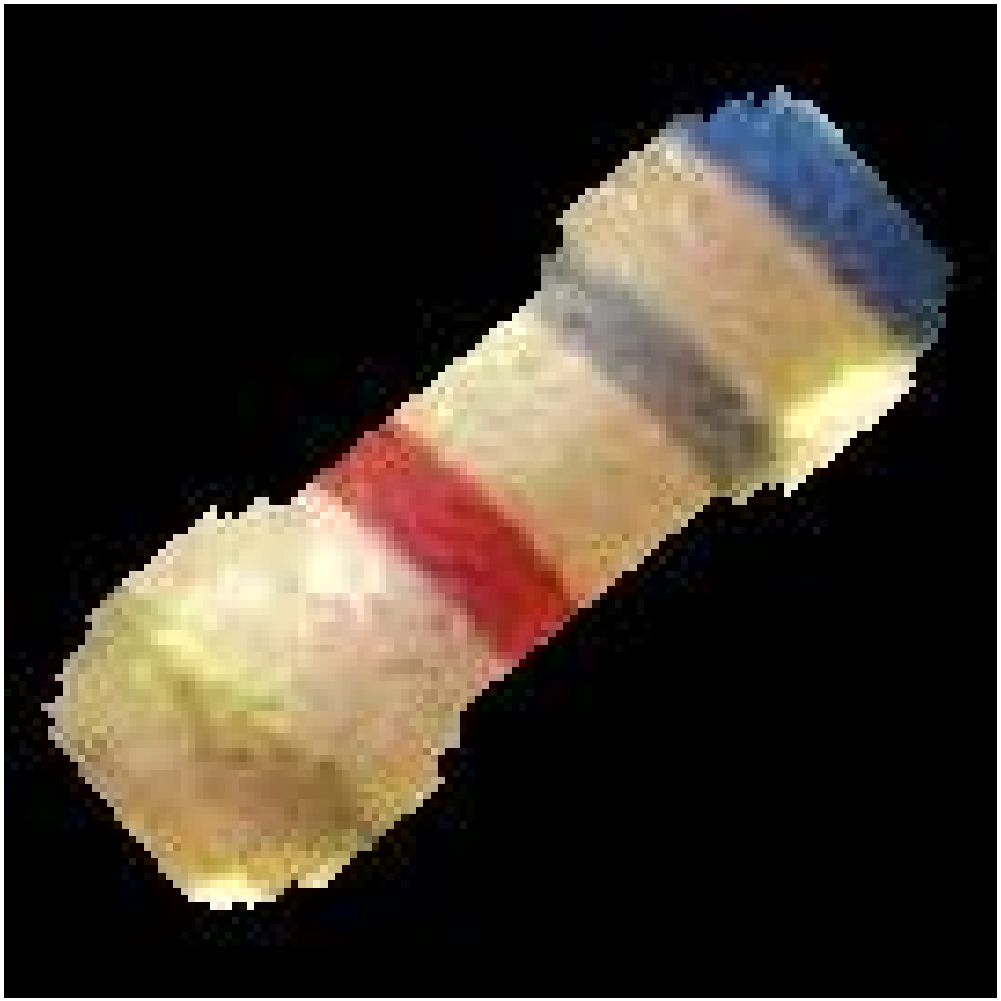
Mask at 90°



Resistor Bounding Boxes



Resistor Bounding Box



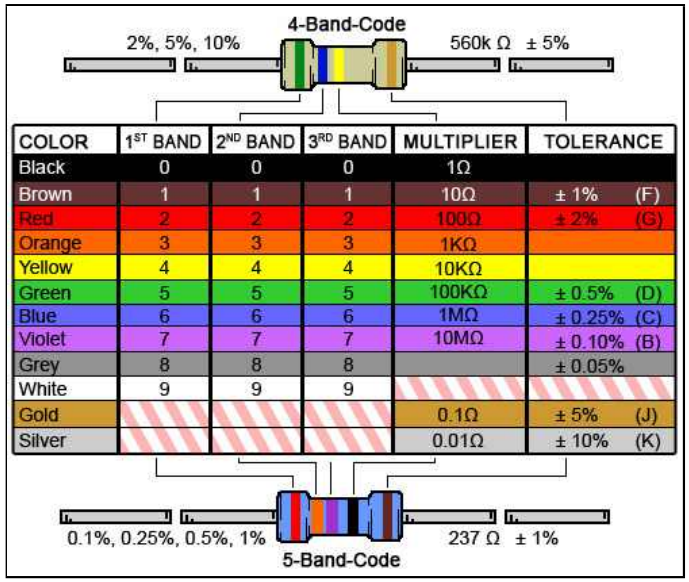
Classification

Basic Approach

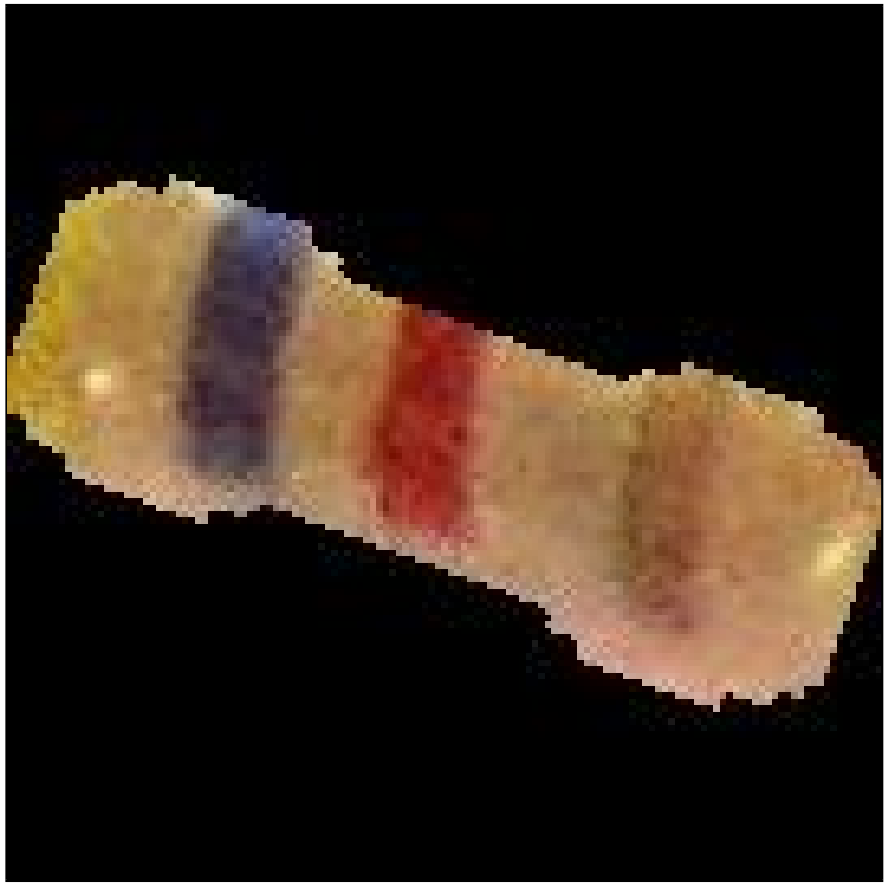
- Collect 3x3 mean RGB data from each color band and base resistor color
- Train support vector machine (SVM) classifier
- Apply prediction to each pixel in resistor
- Use statistical results of classification to determine resistor value

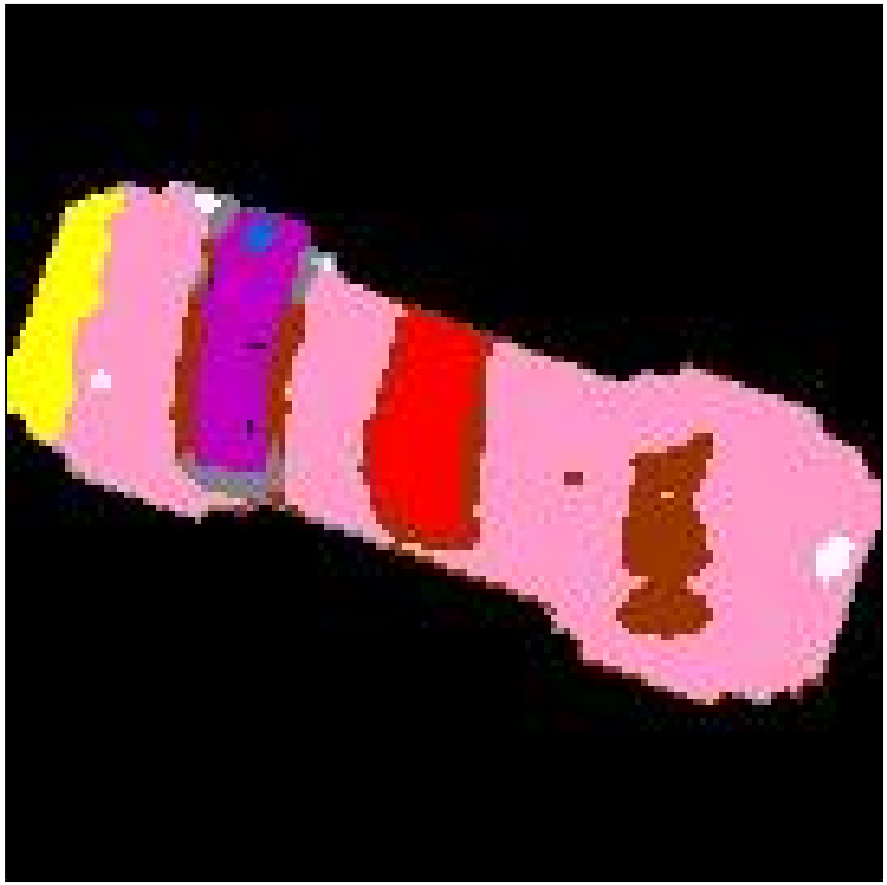
Train Classifier

- 11 class problem
- 880 training points
- 220 verification points
- Used radial basis kernel function $K(x, x') = \exp(\gamma||x - x'||)$
- 5 fold cross validation
- Grid search for cost function (C) and γ
- Cross Validation Accuracy = 95.4649%
- Verification Accuracy = 94.5701%

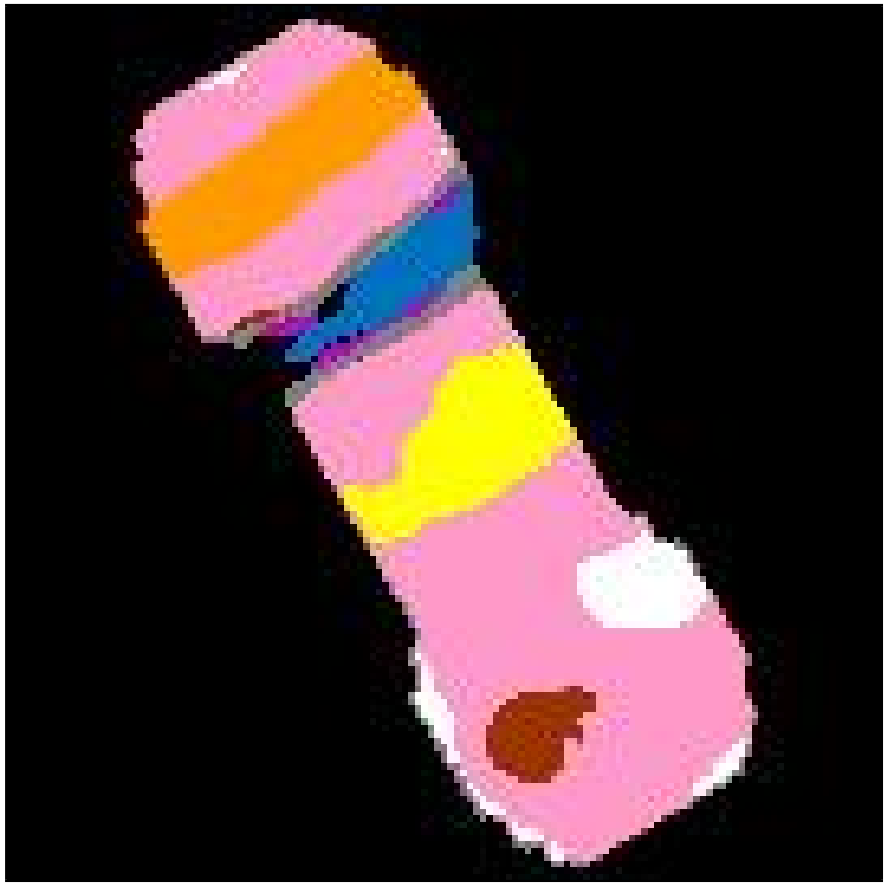


Apply Classifier



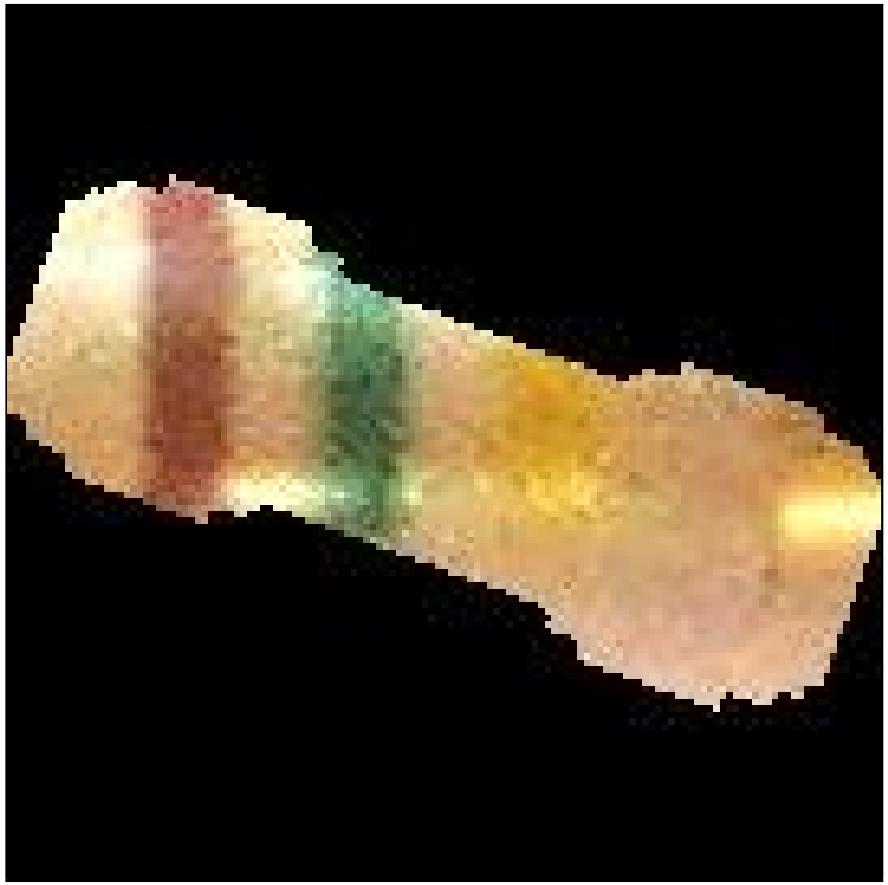


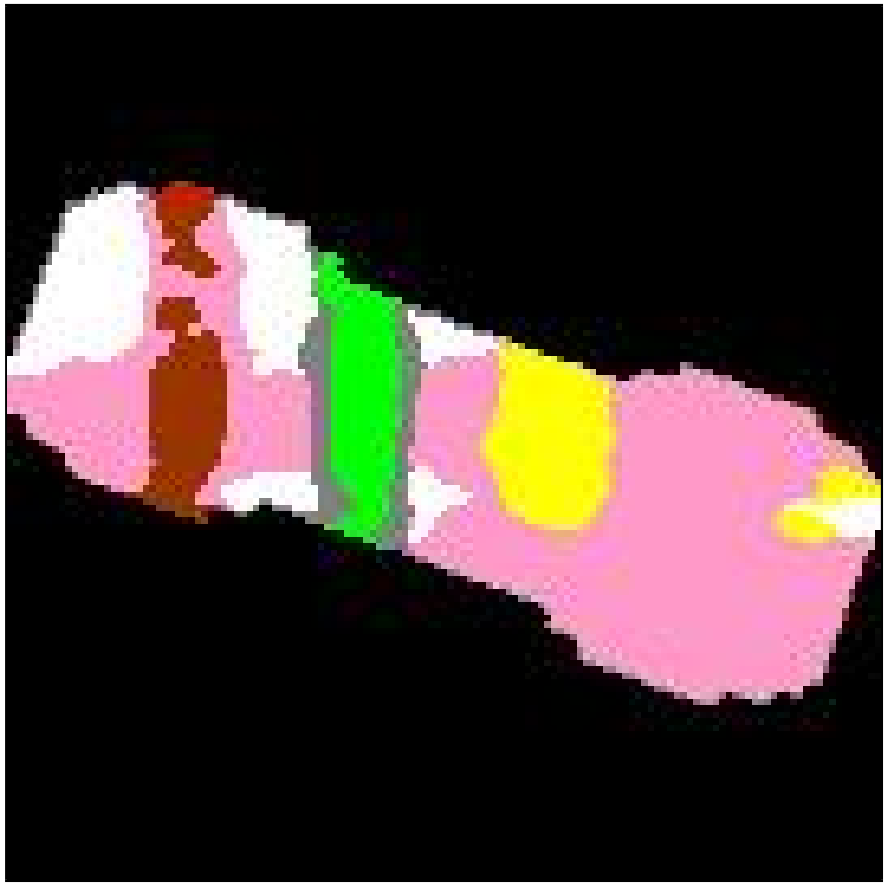
Apply Classifier



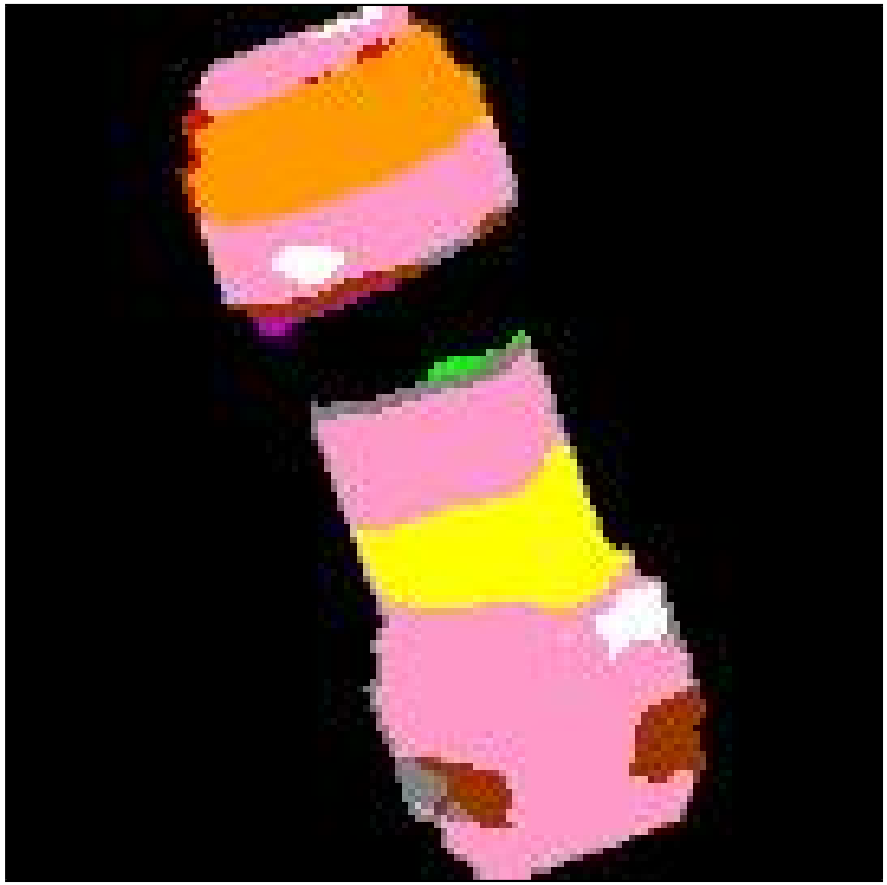
Apply Classifier

Apply Classifier

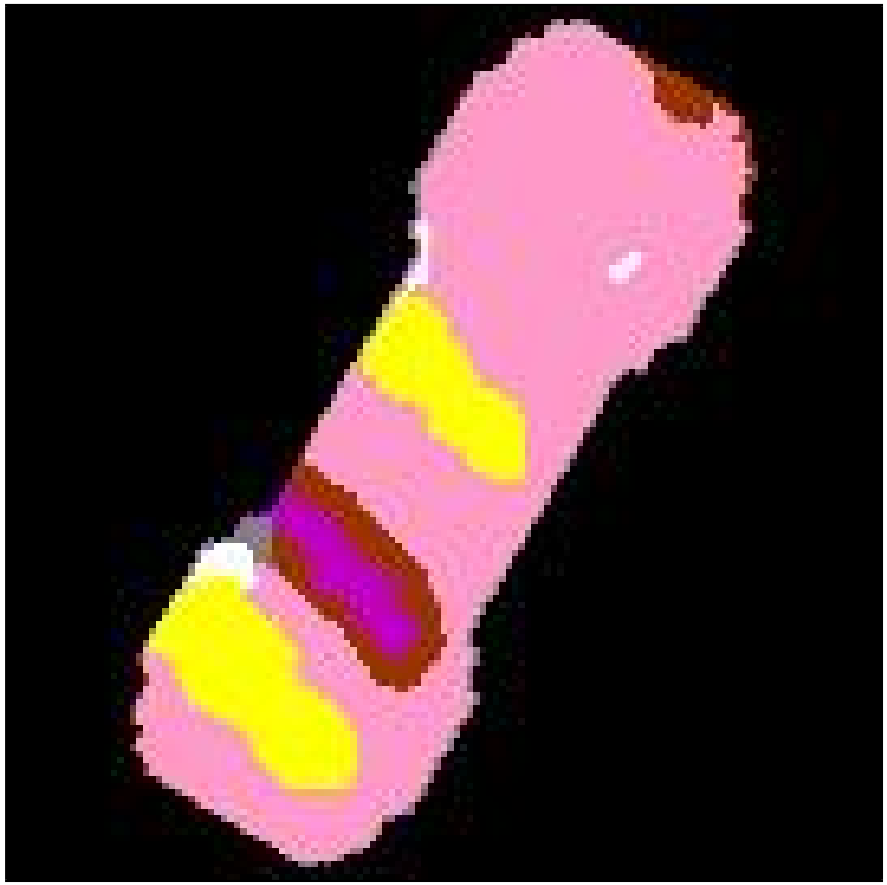




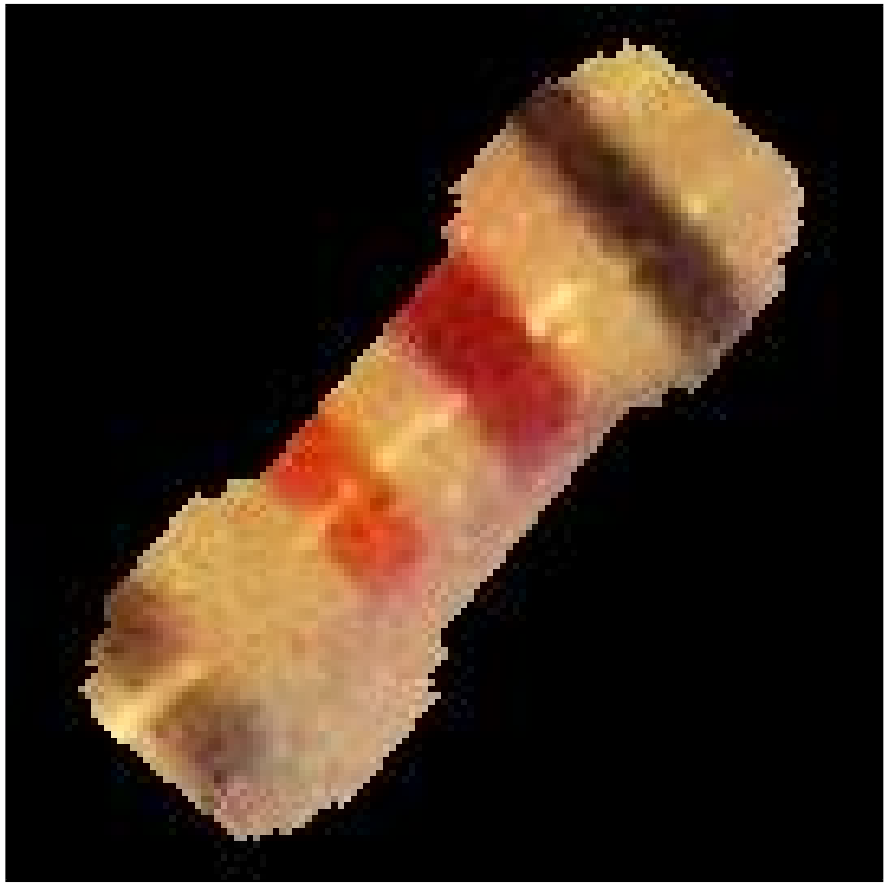
Apply Classifier

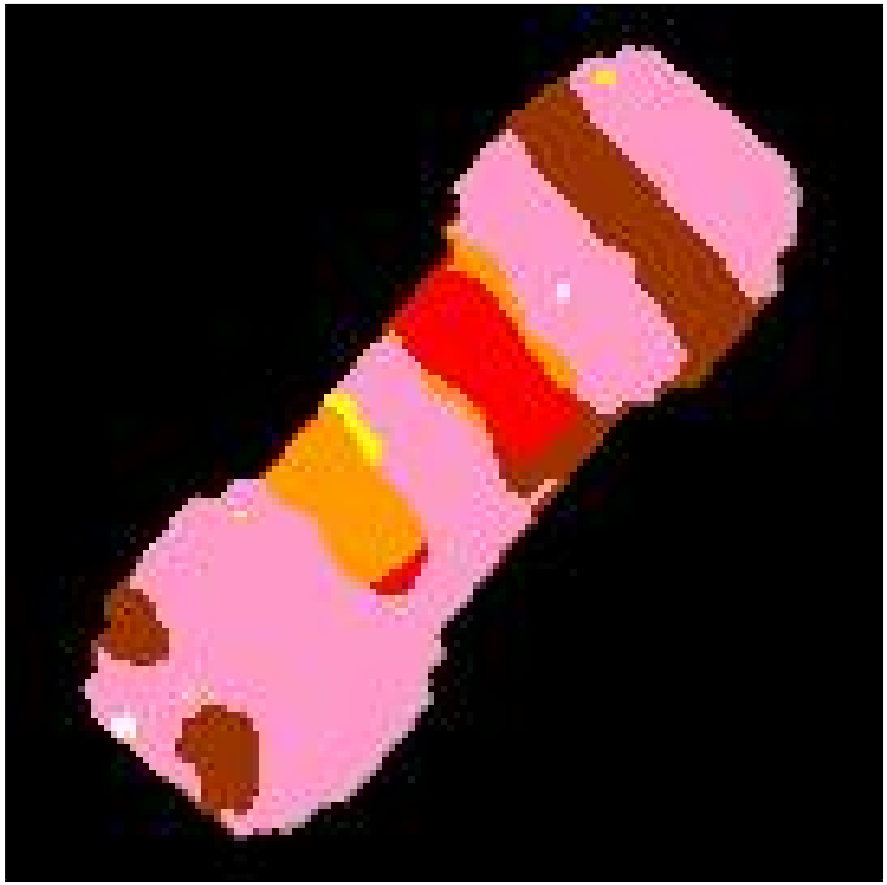


Apply Classifier

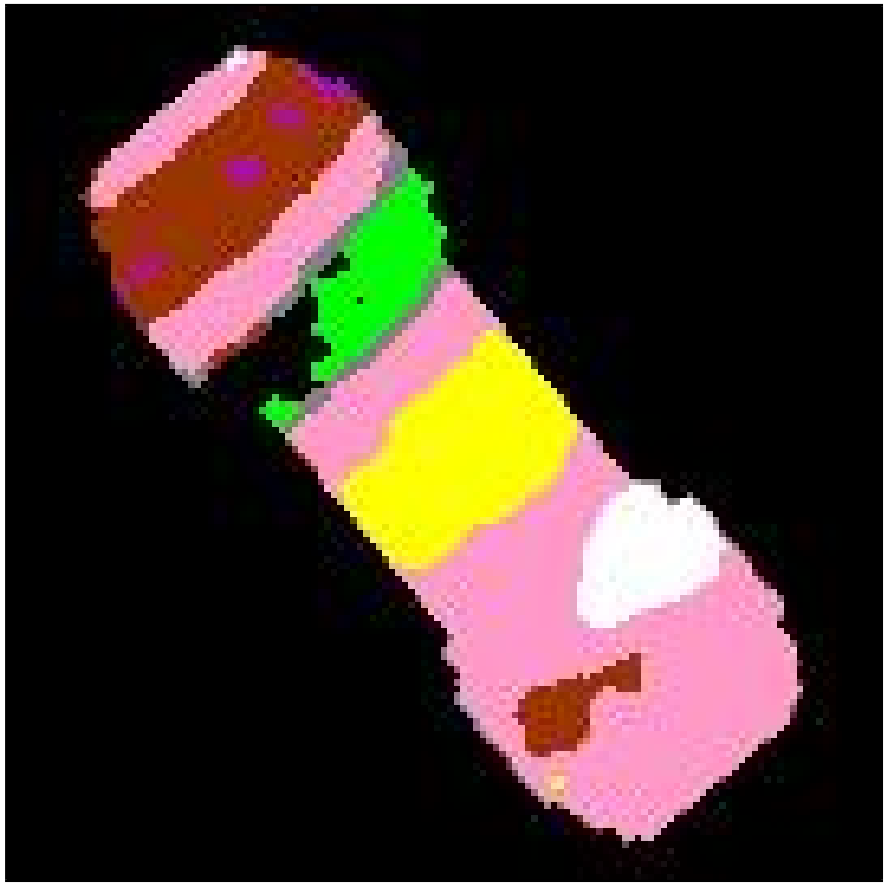


Apply Classifier

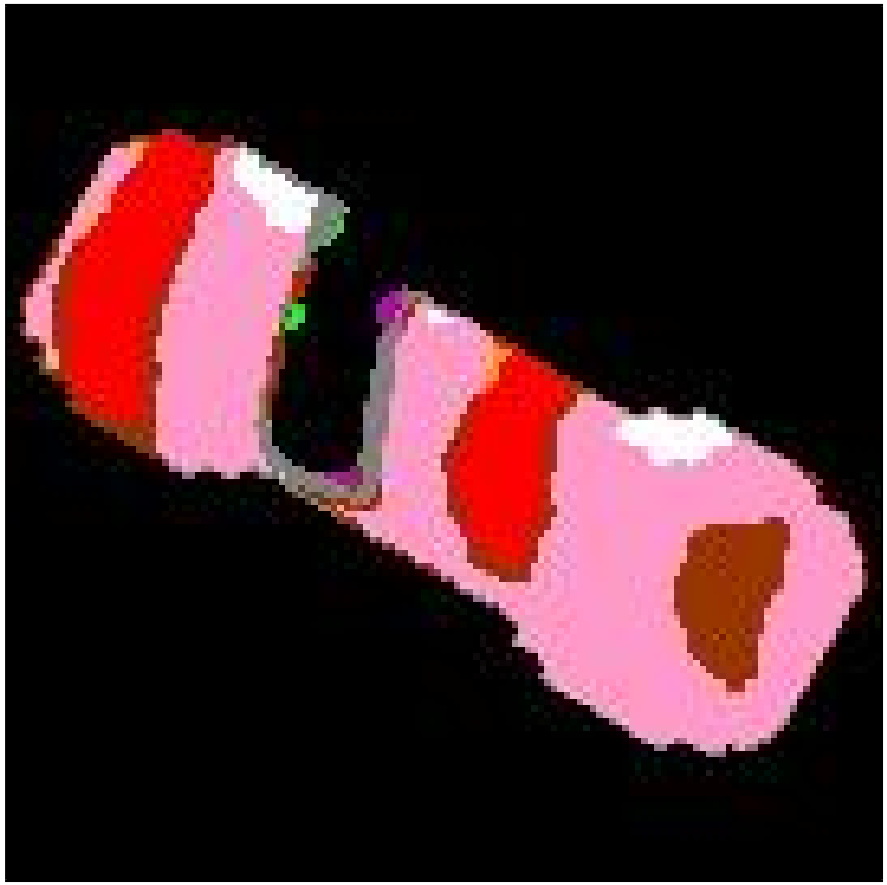




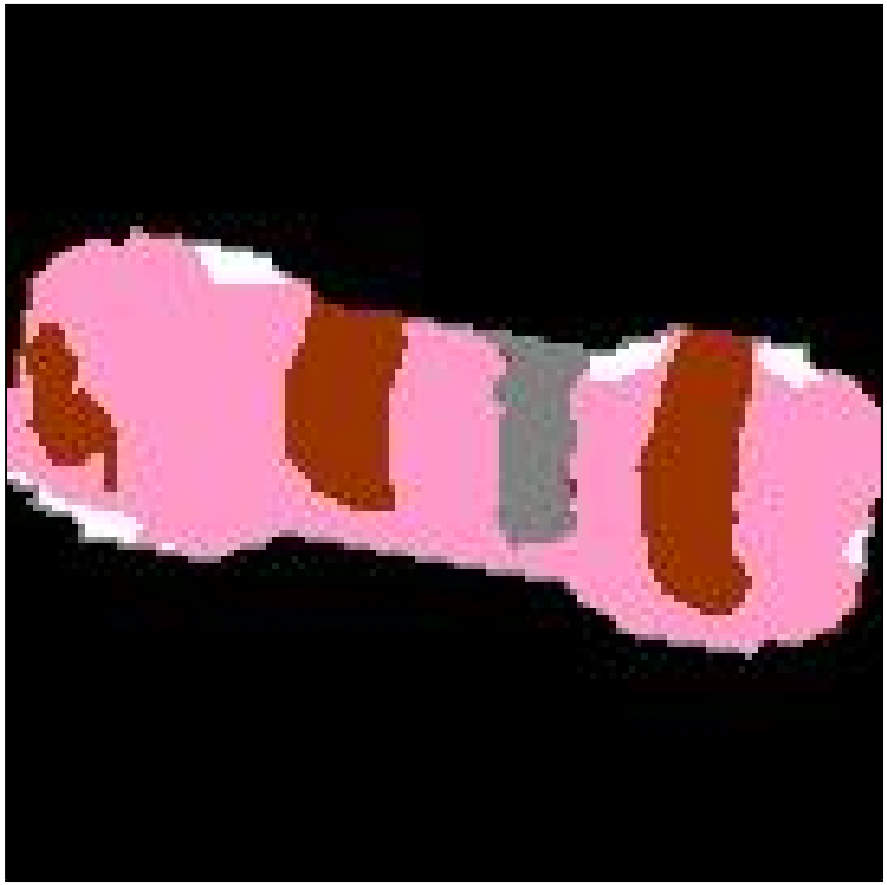
Apply Classifier



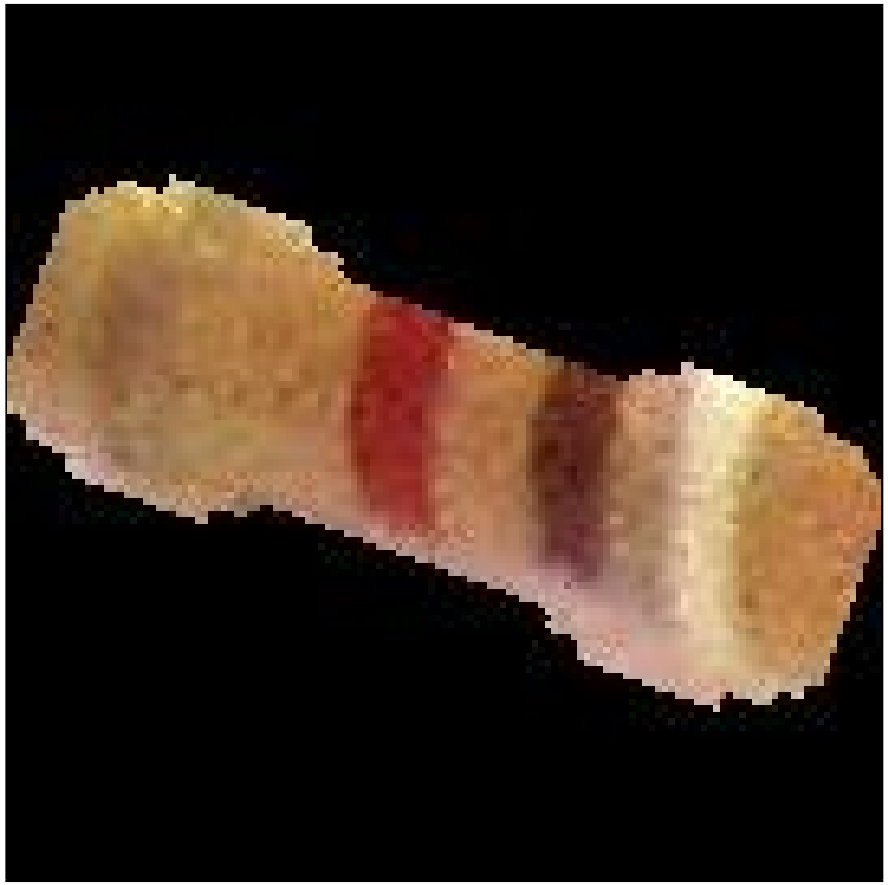
Apply Classifier

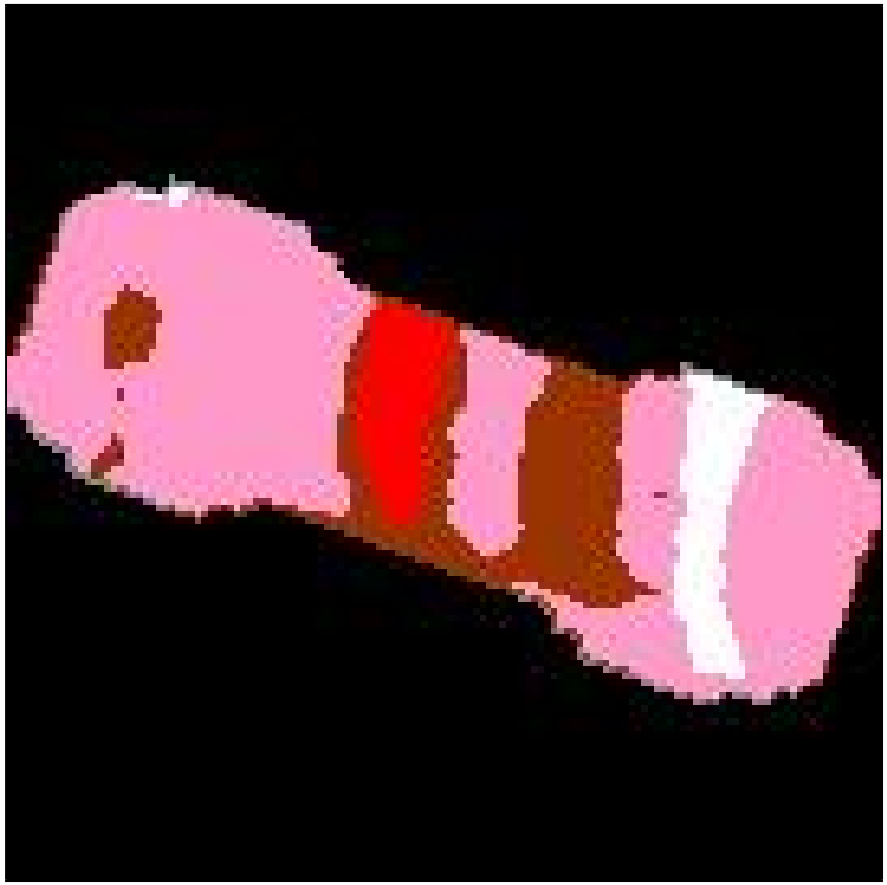


Apply Classifier

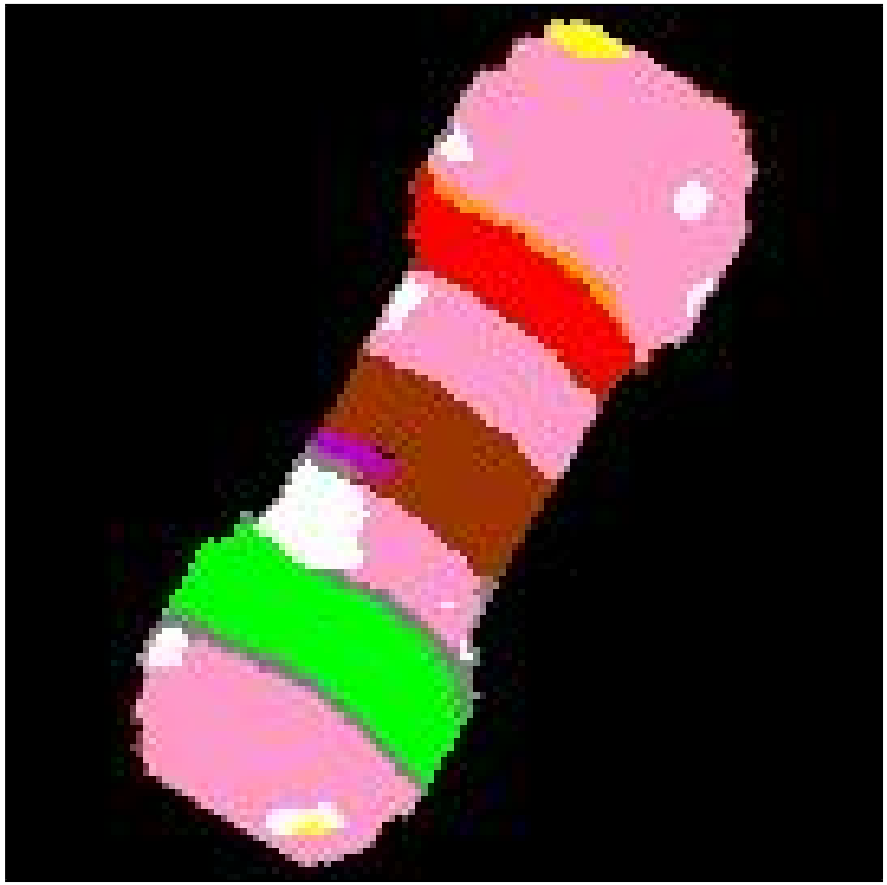


Apply Classifier

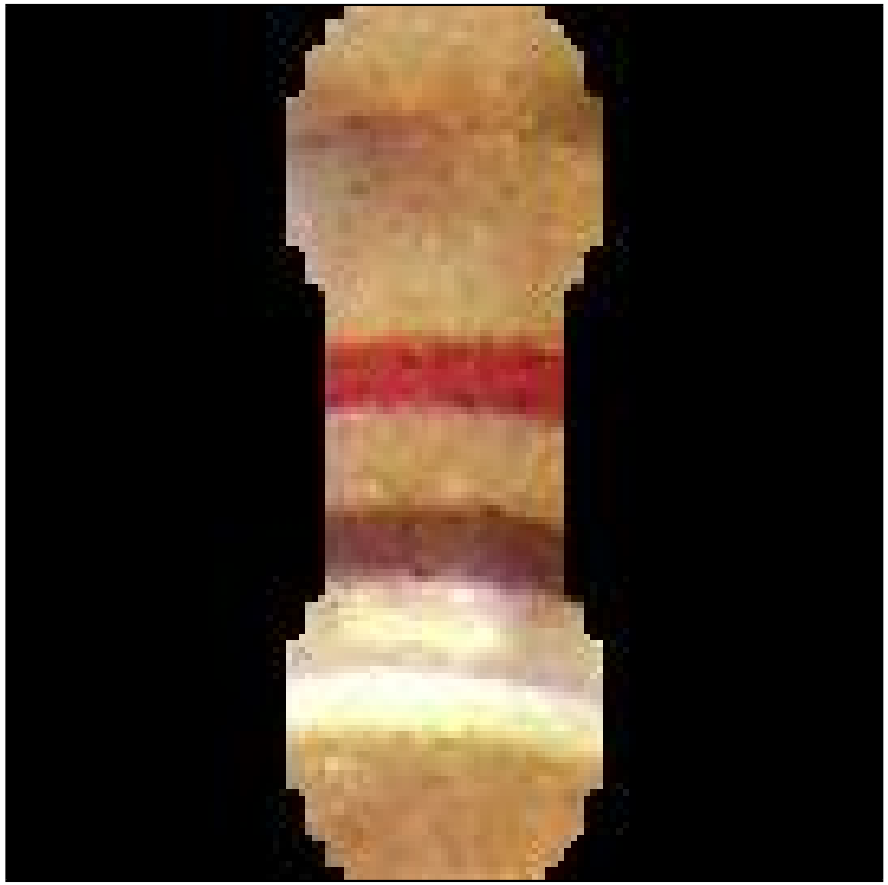


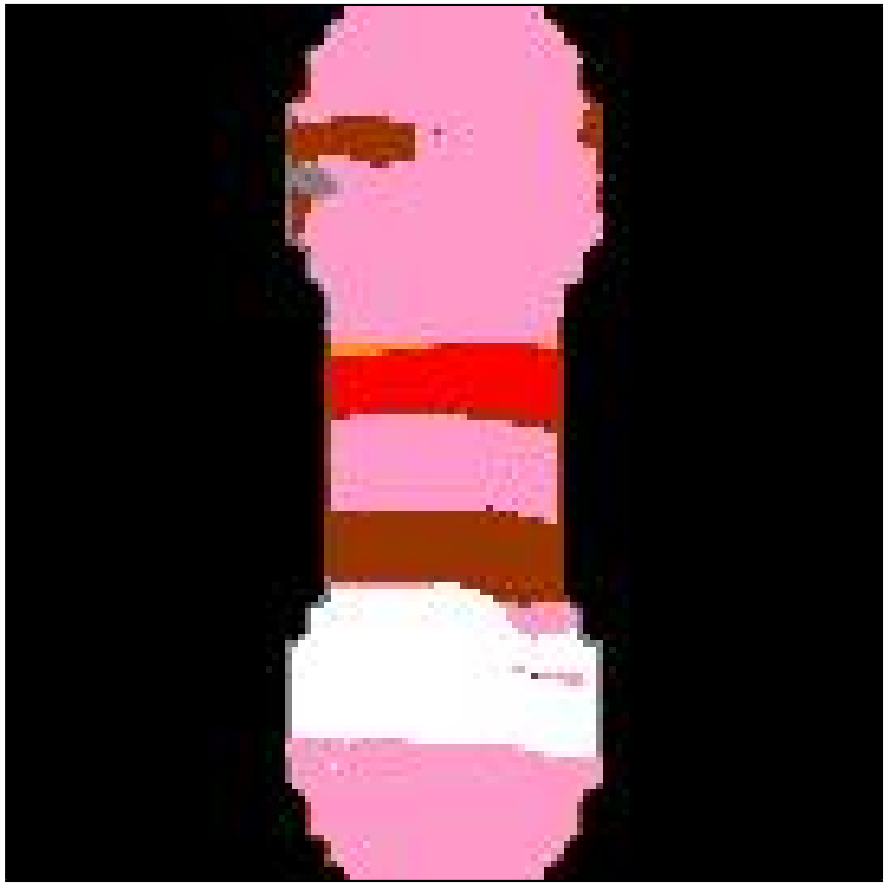


Apply Classifier

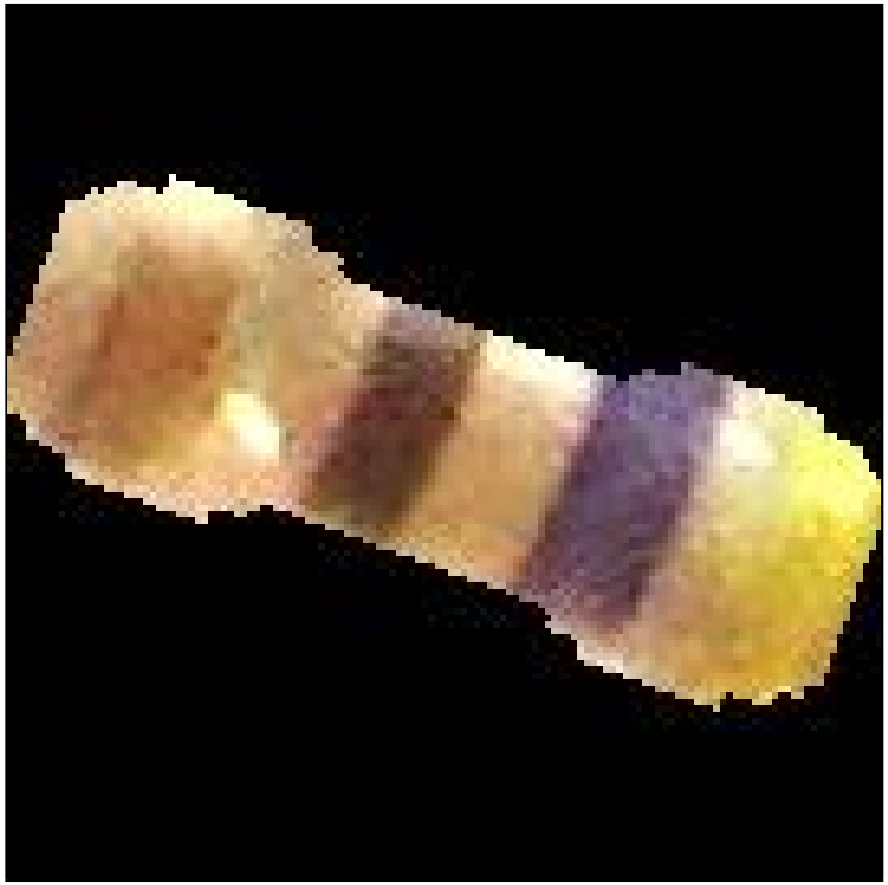


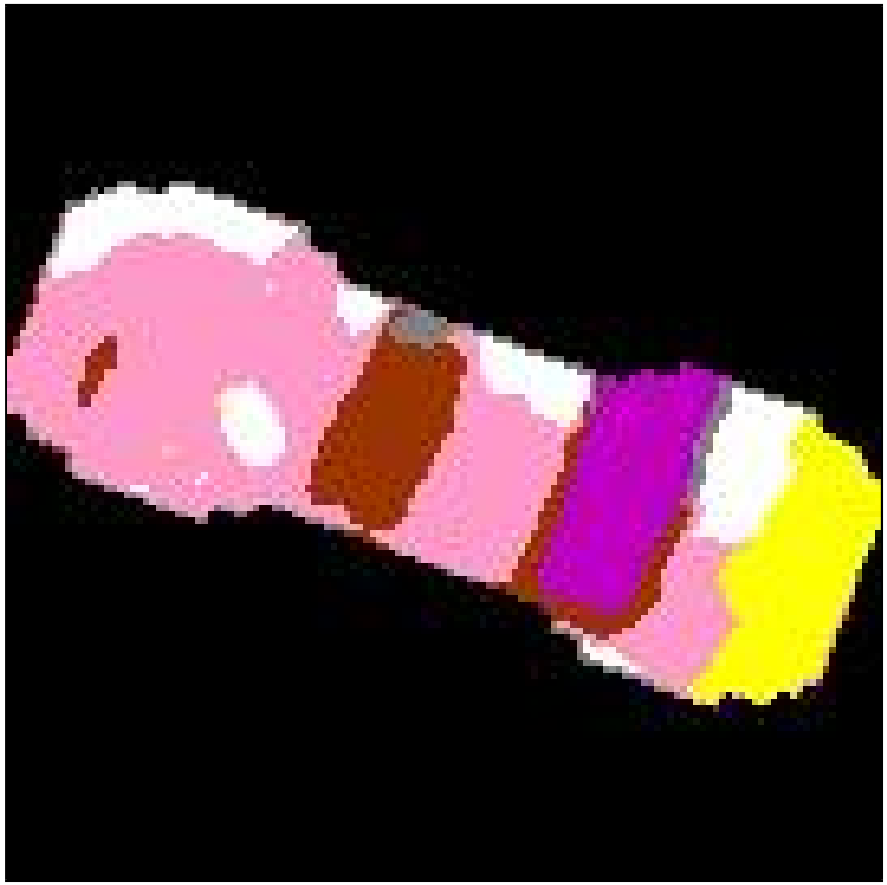
Apply Classifier



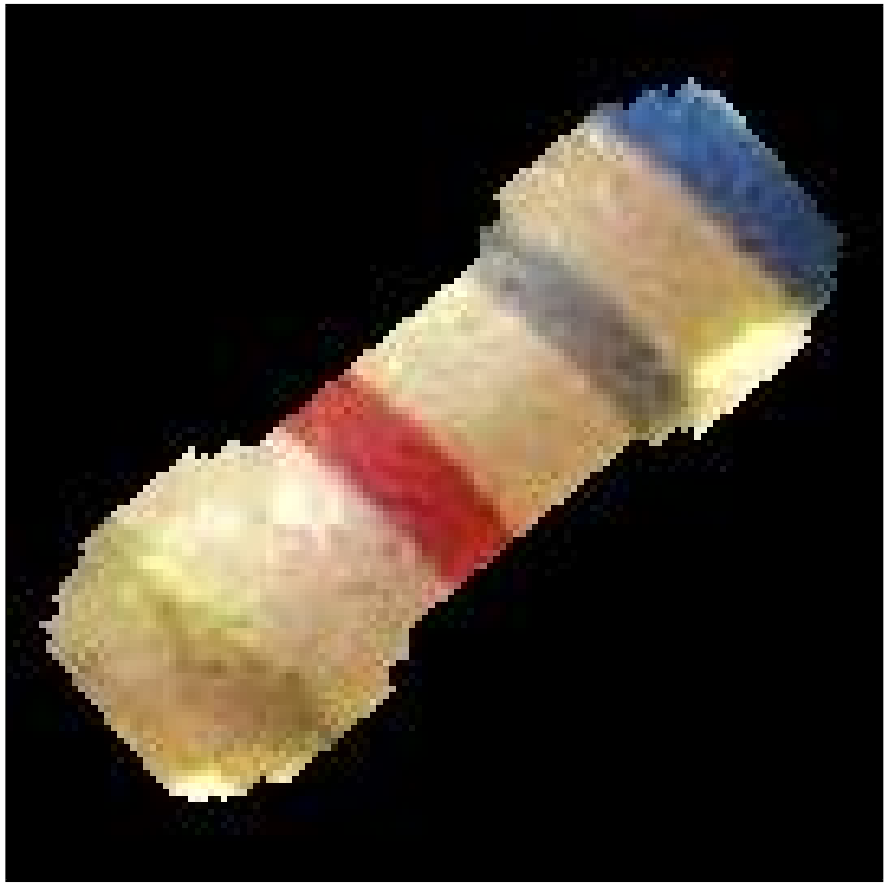


Apply Classifier

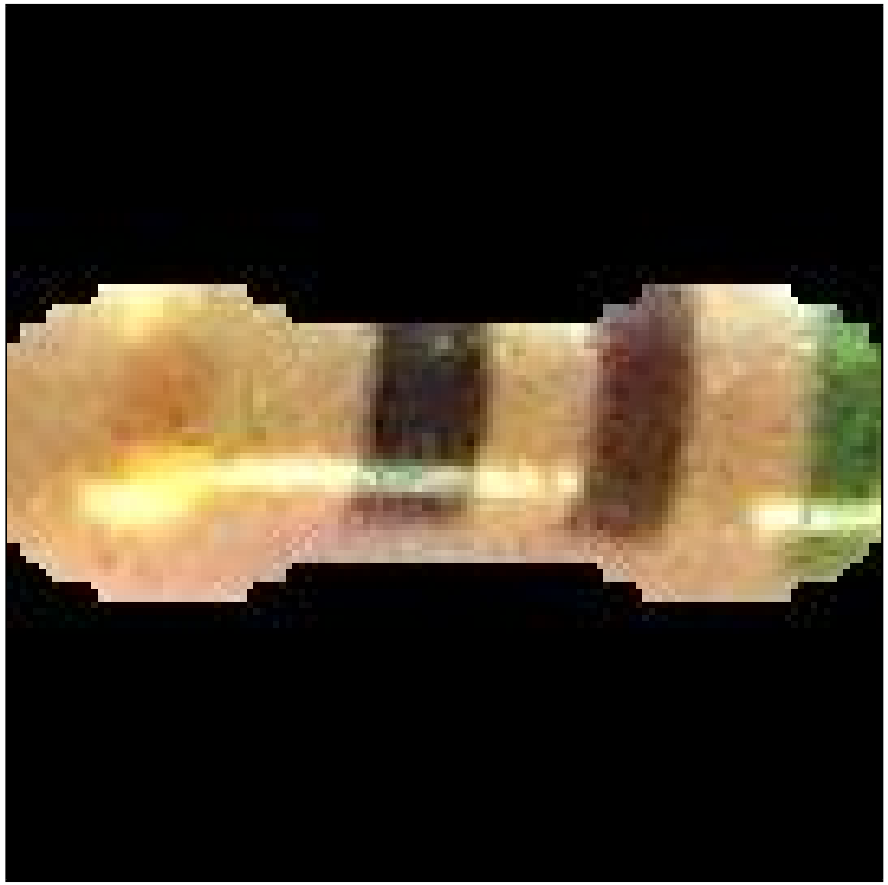


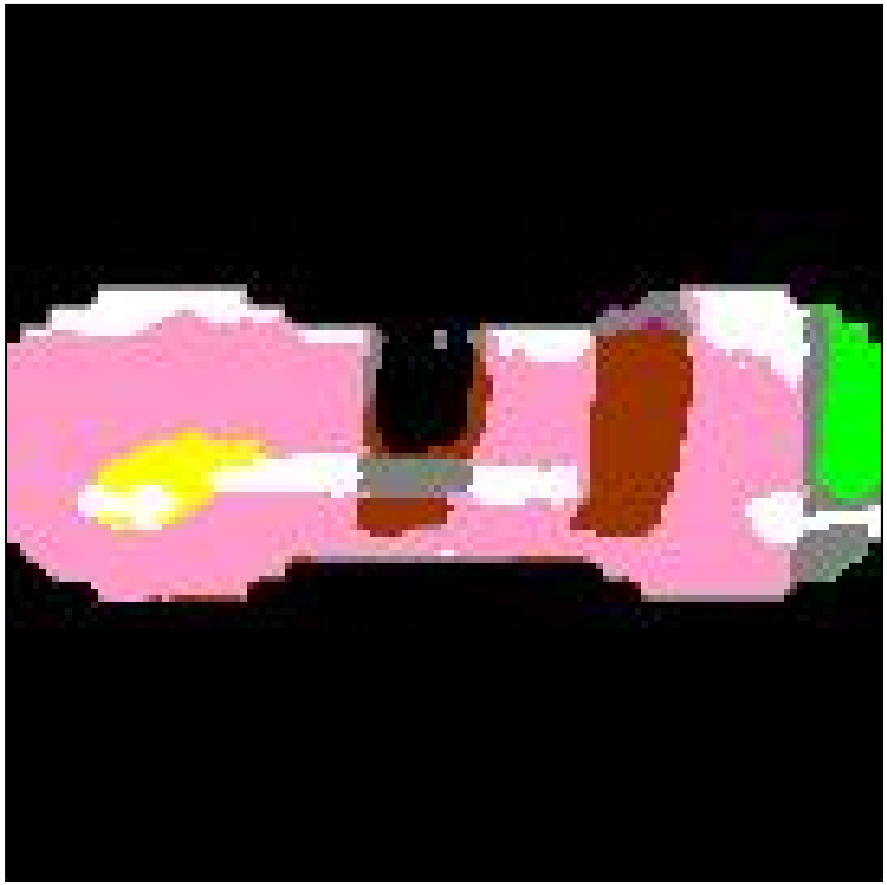


Apply Classifier



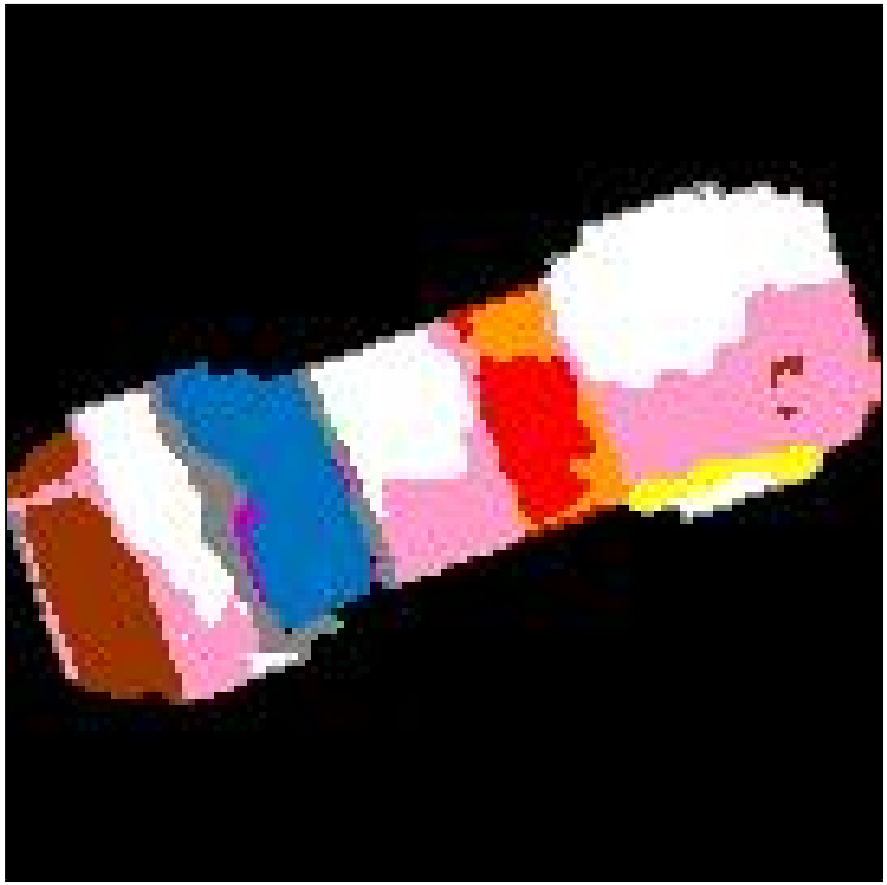
Apply Classifier



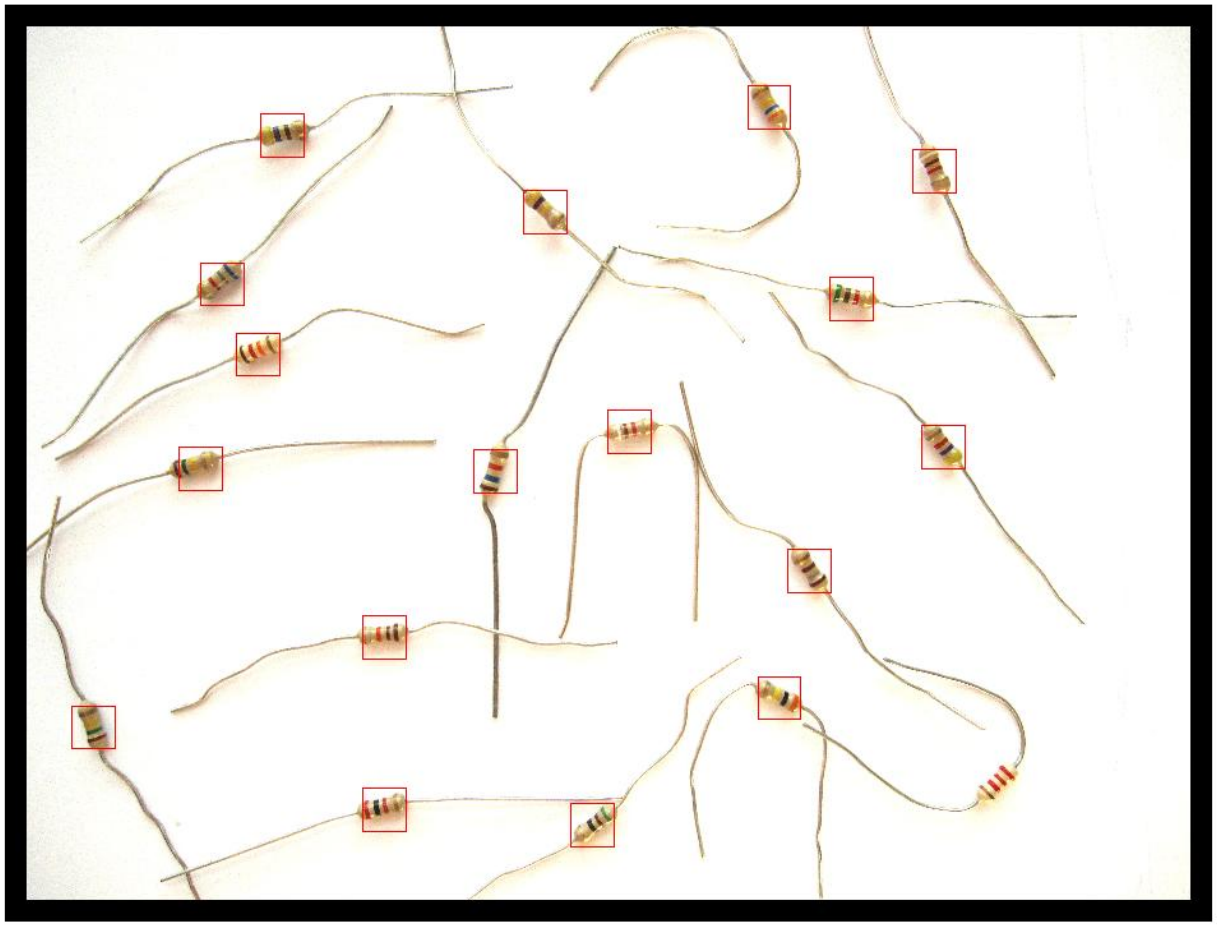


Apply Classifier

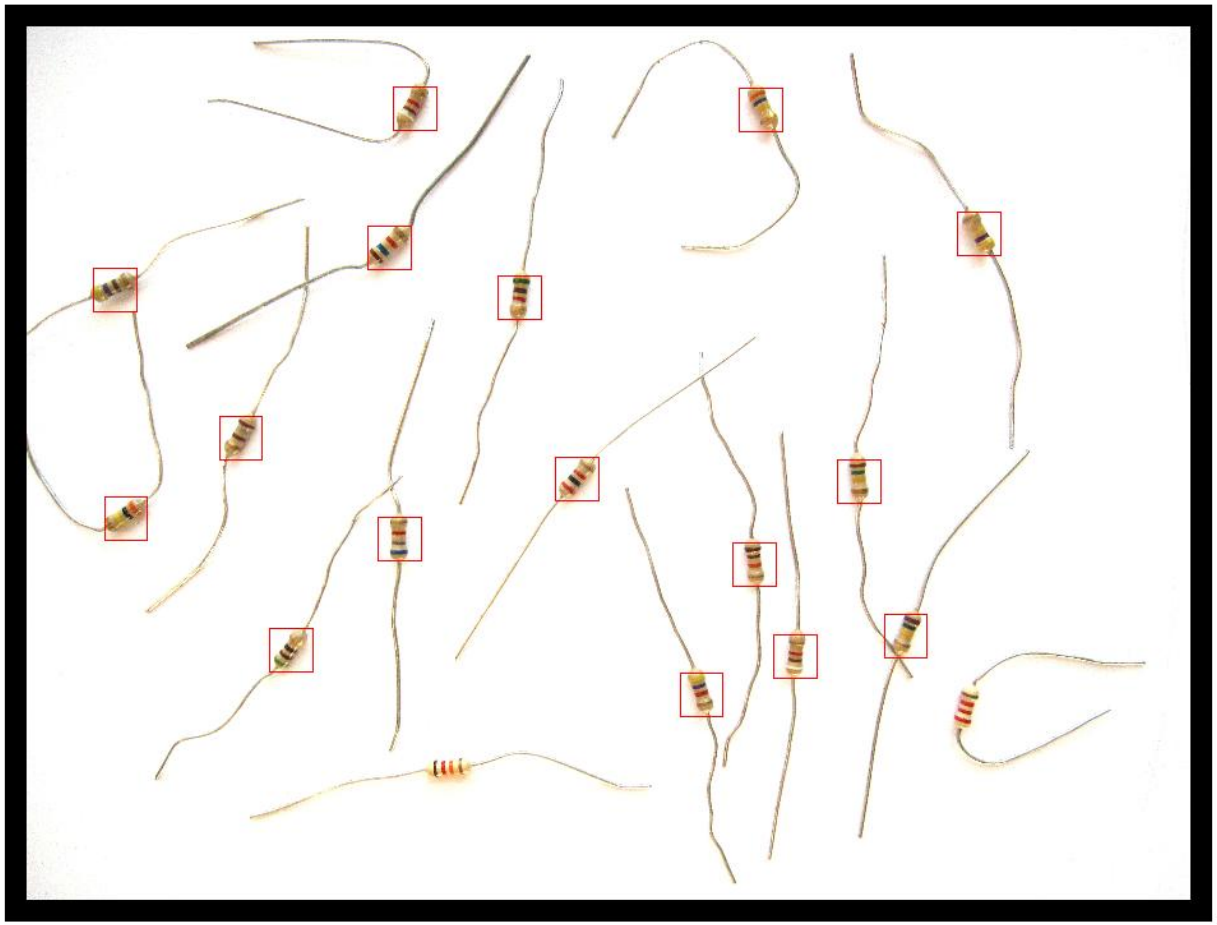
Apply Classifier



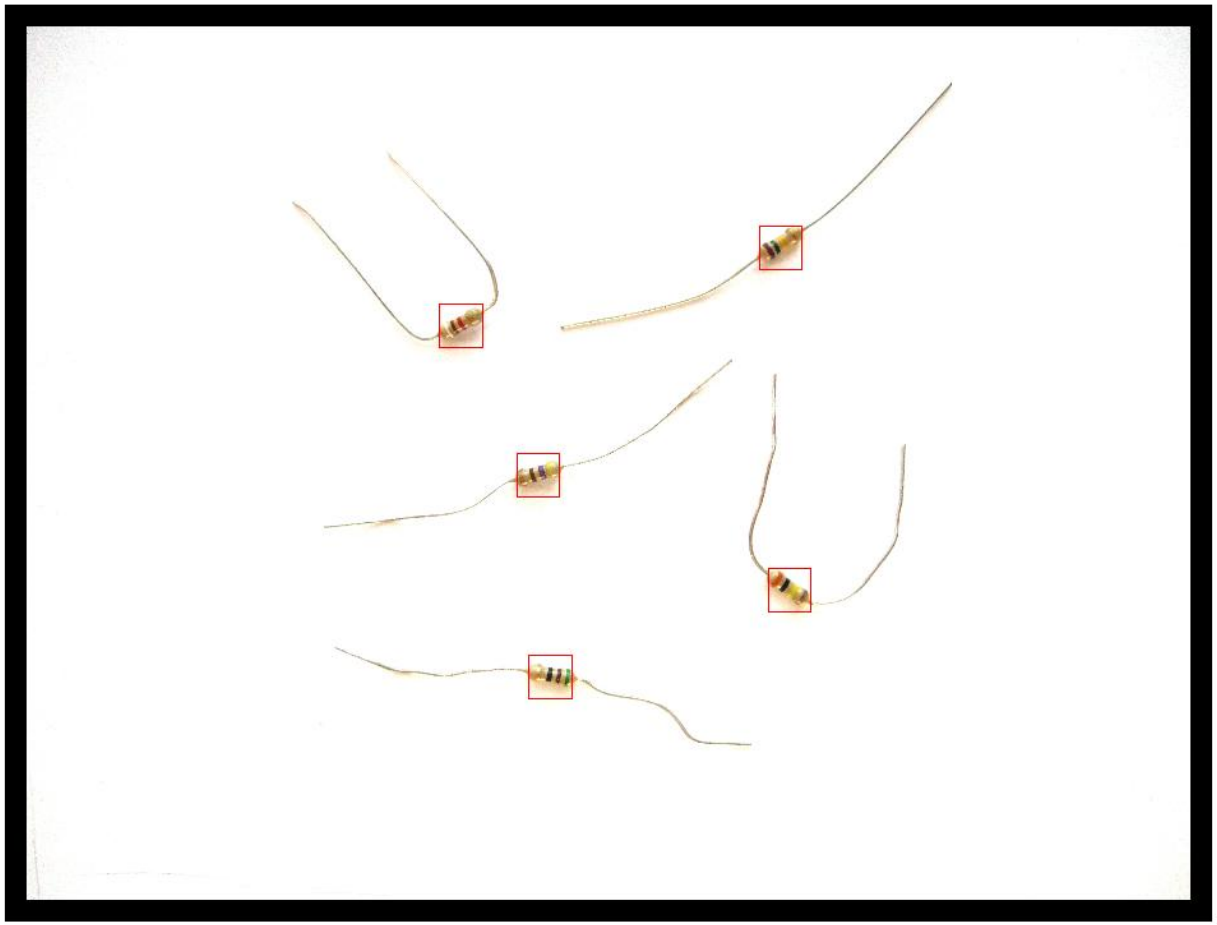
Resistor Bounding Boxes



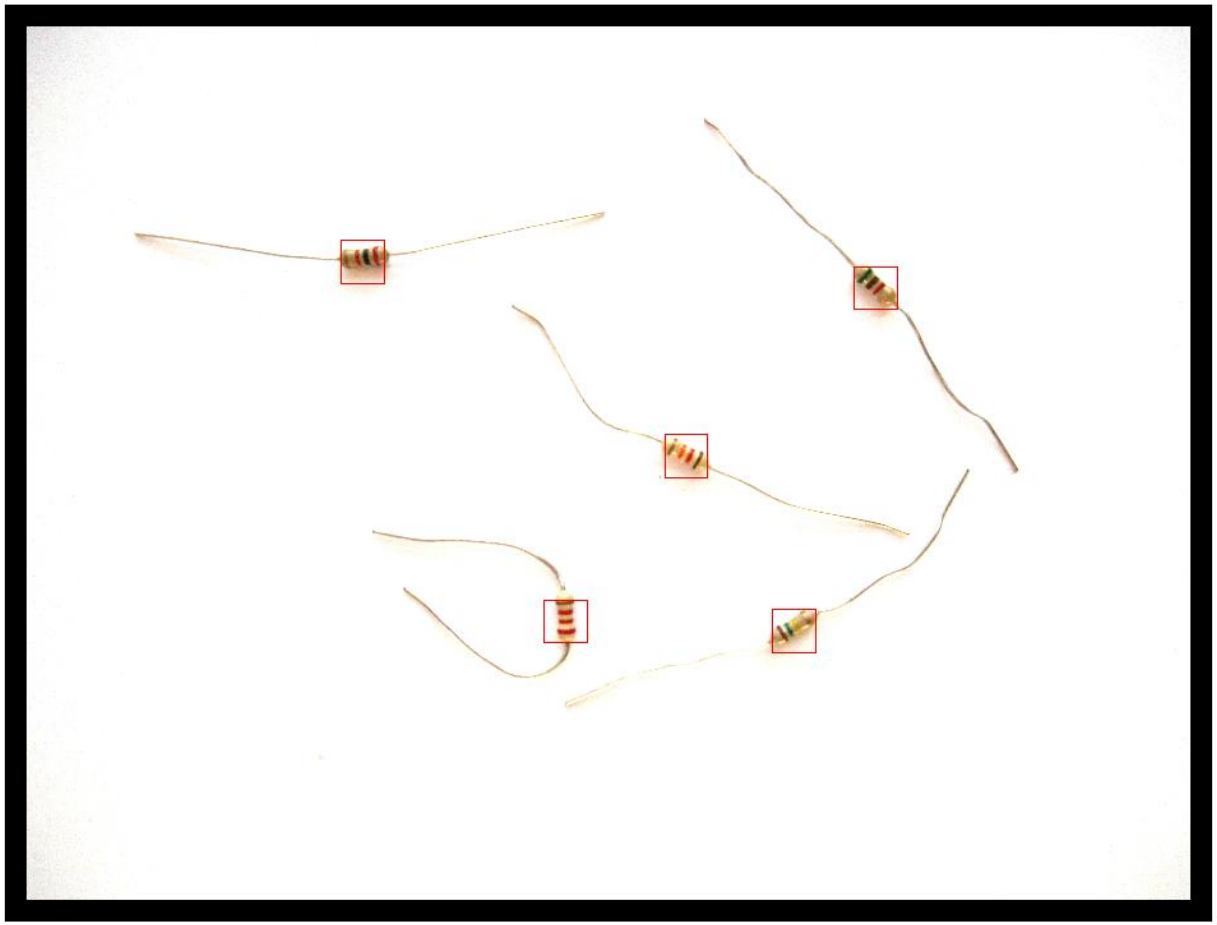
Resistor Bounding Boxes



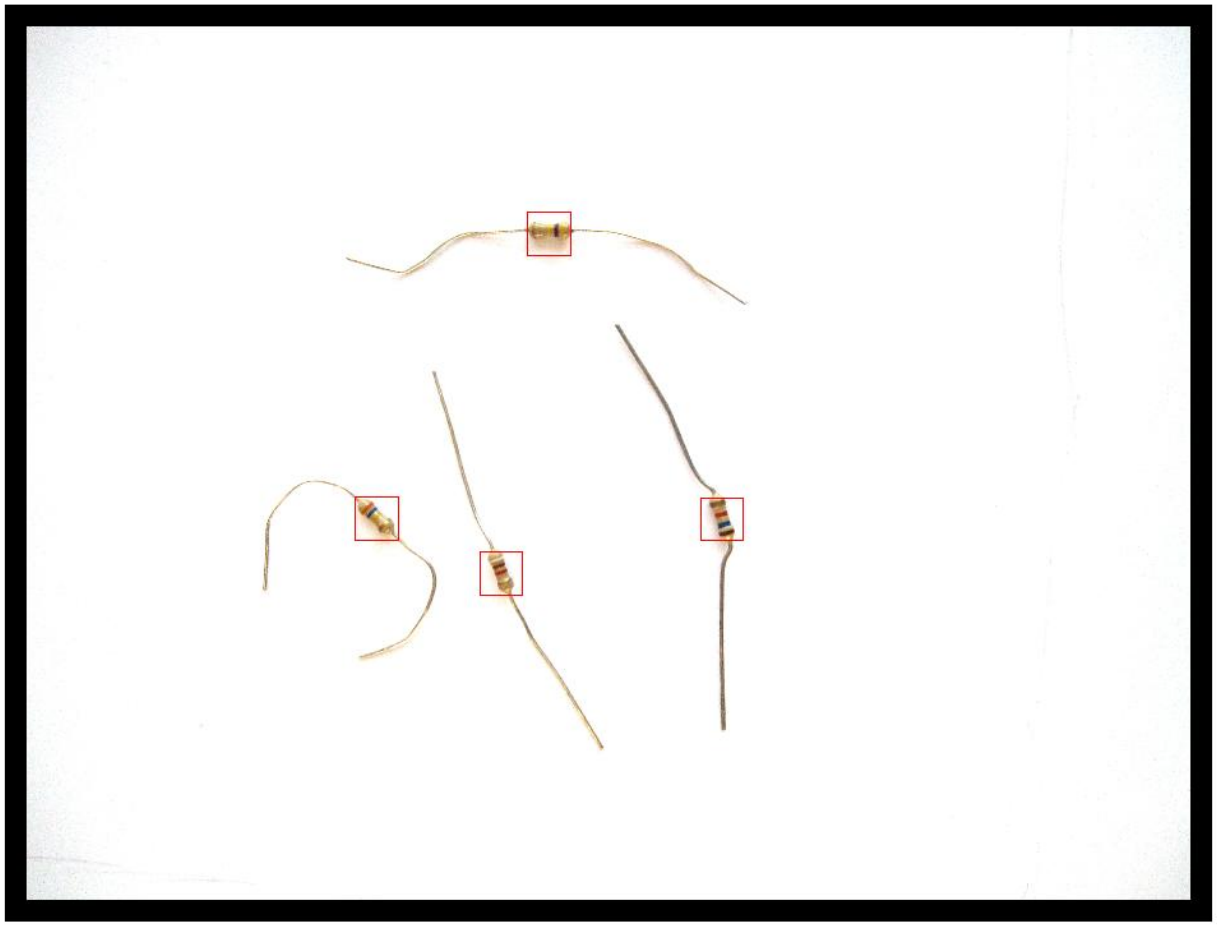
Resistor Bounding Boxes



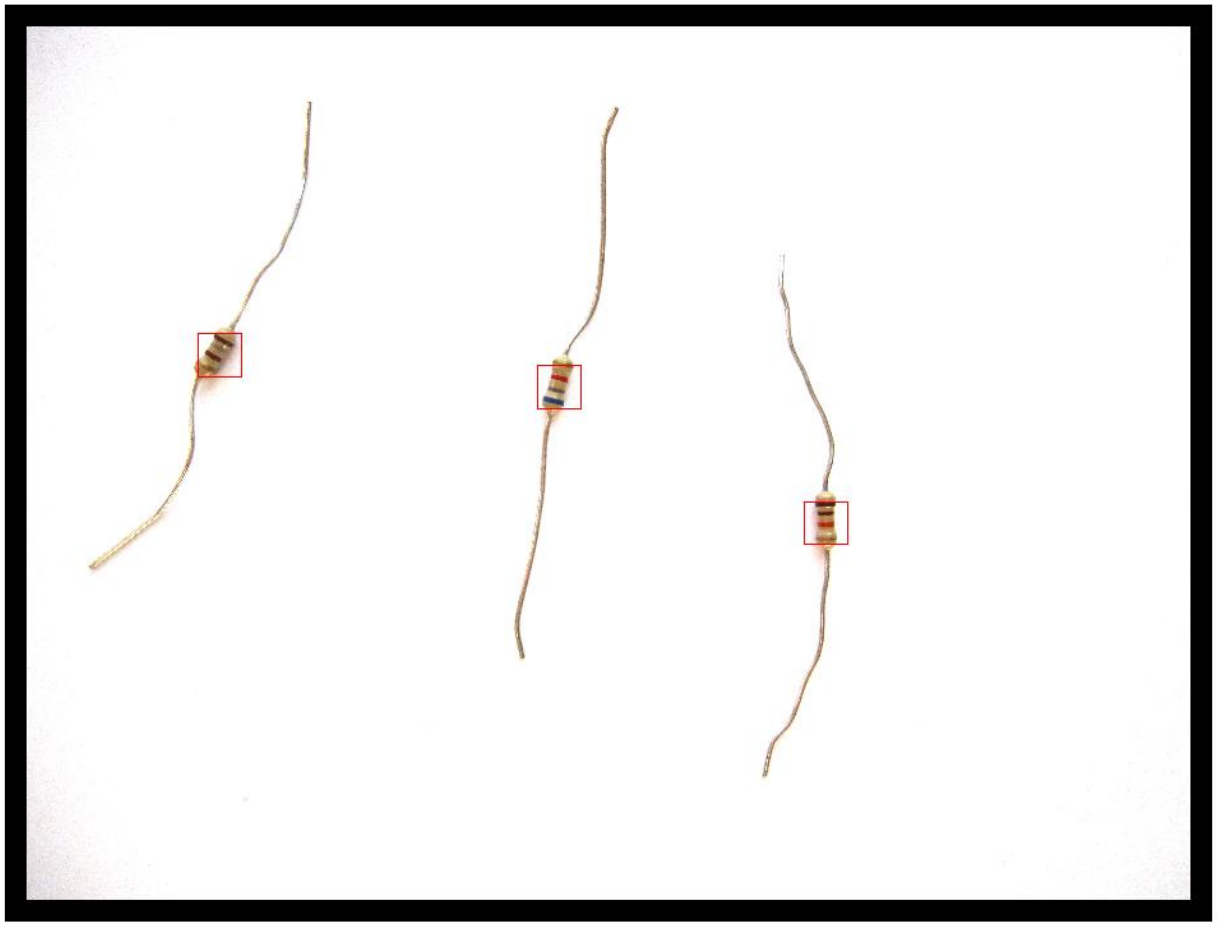
Resistor Bounding Boxes



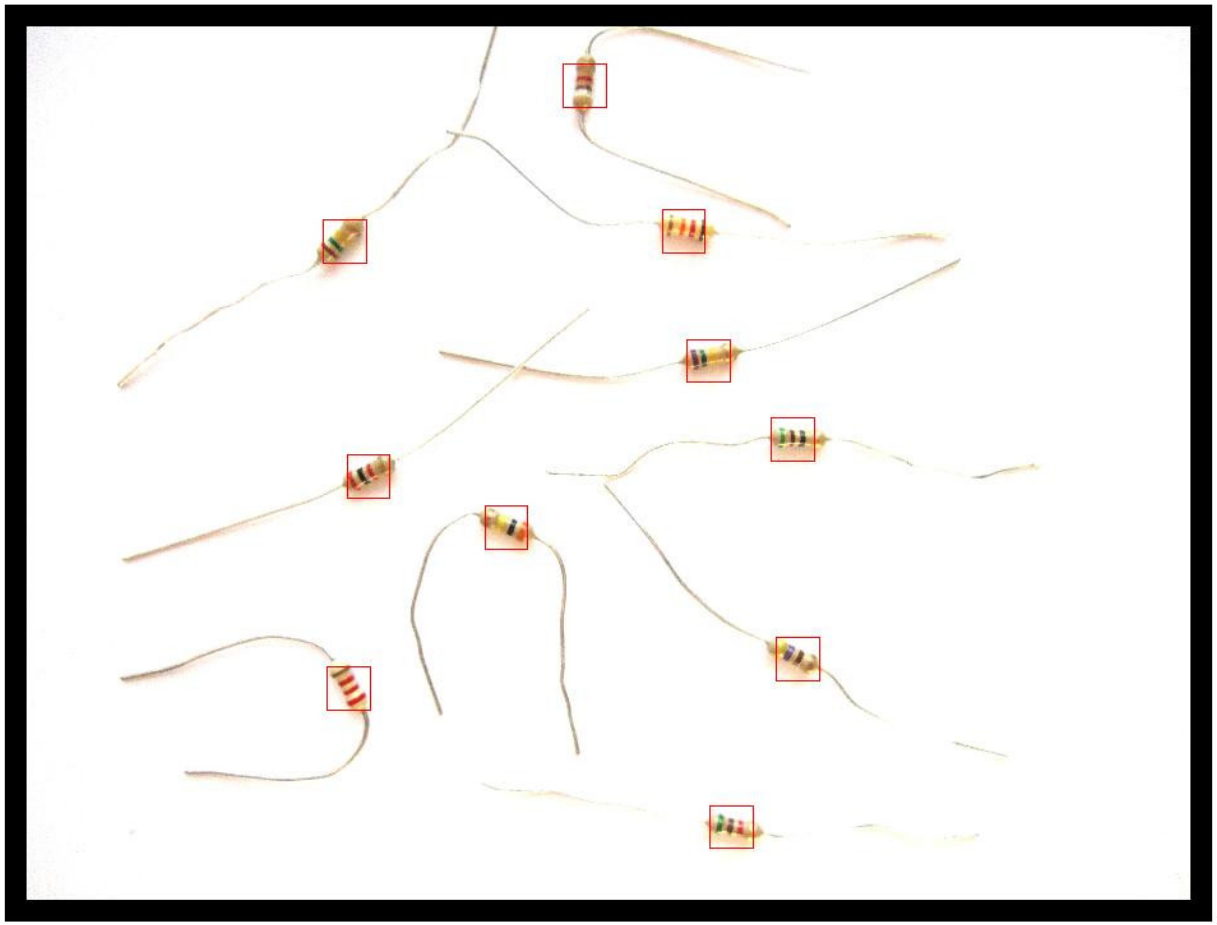
Resistor Bounding Boxes



Resistor Bounding Boxes

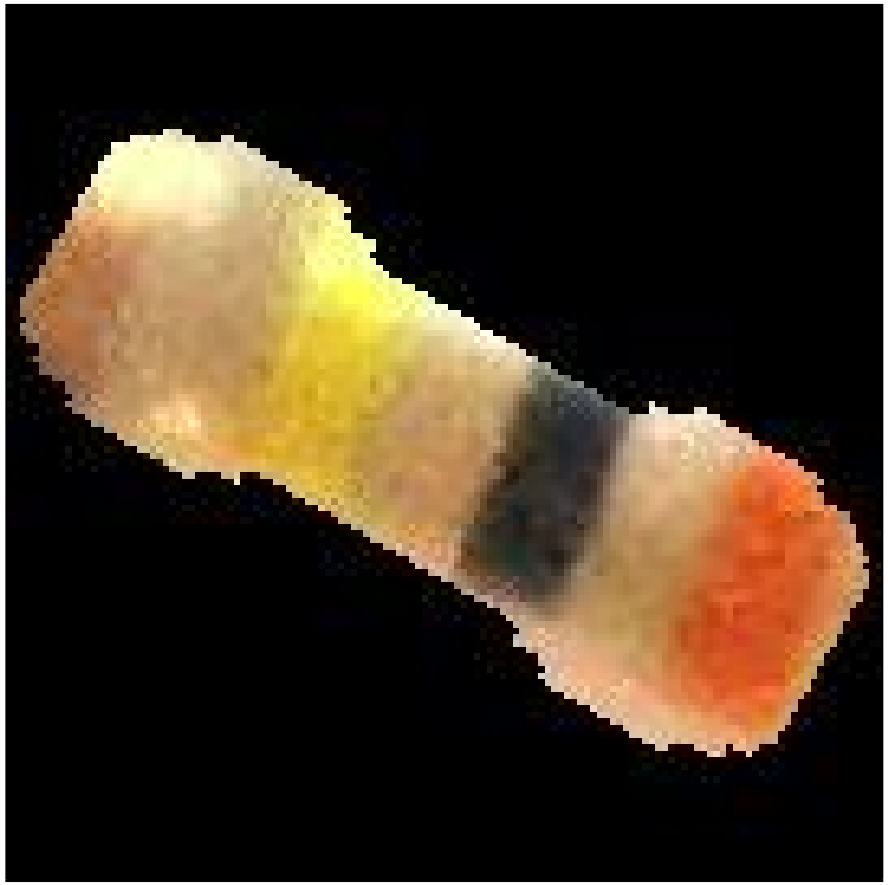


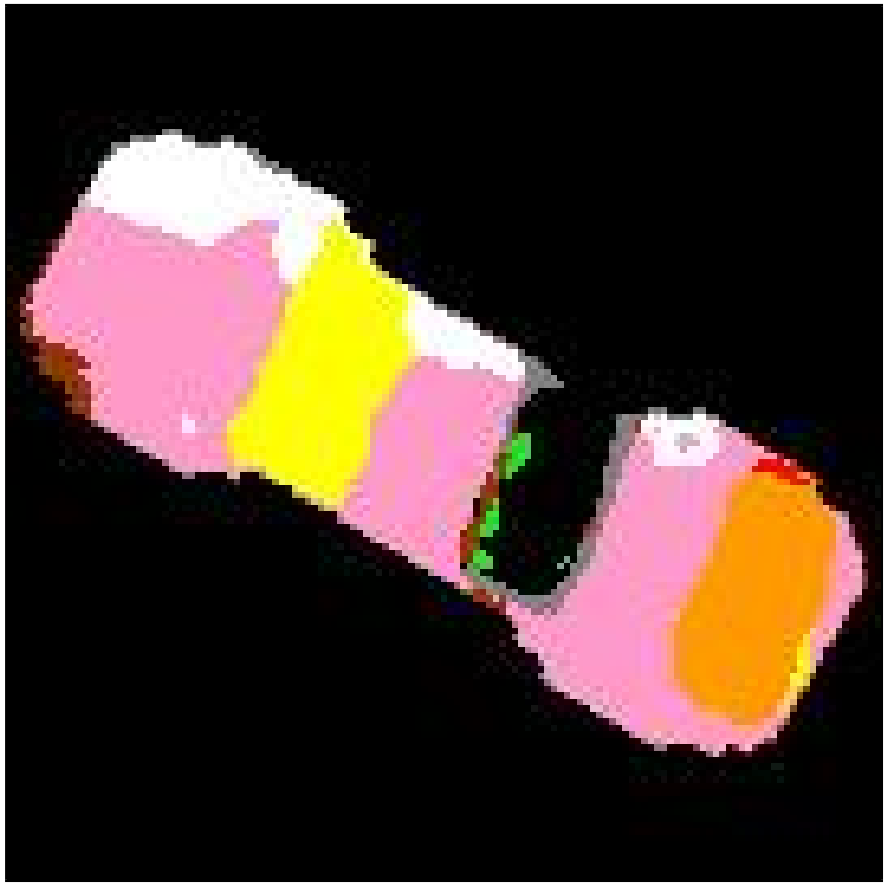
Resistor Bounding Boxes



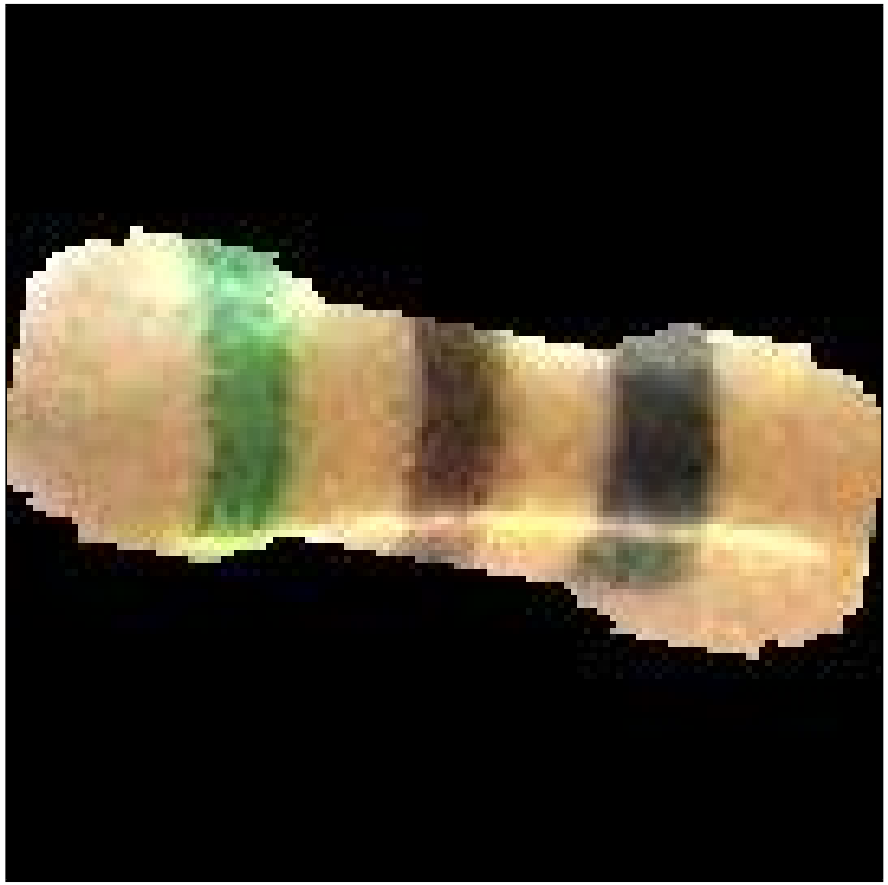
Apply Classifier

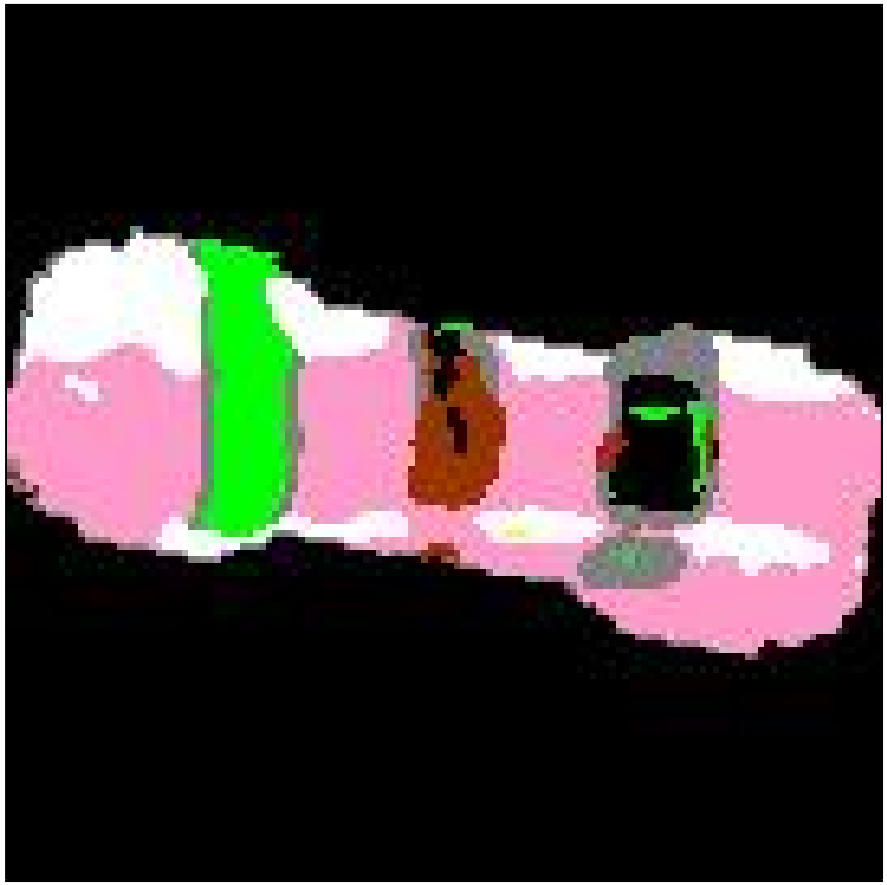
Apply Classifier



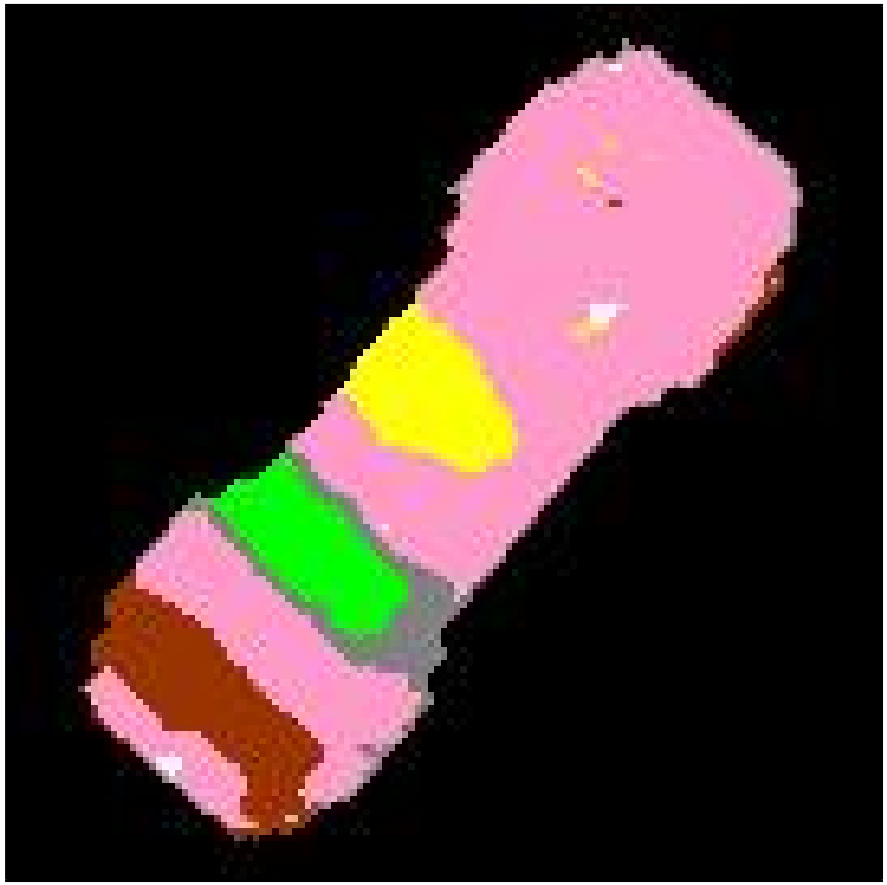


Apply Classifier

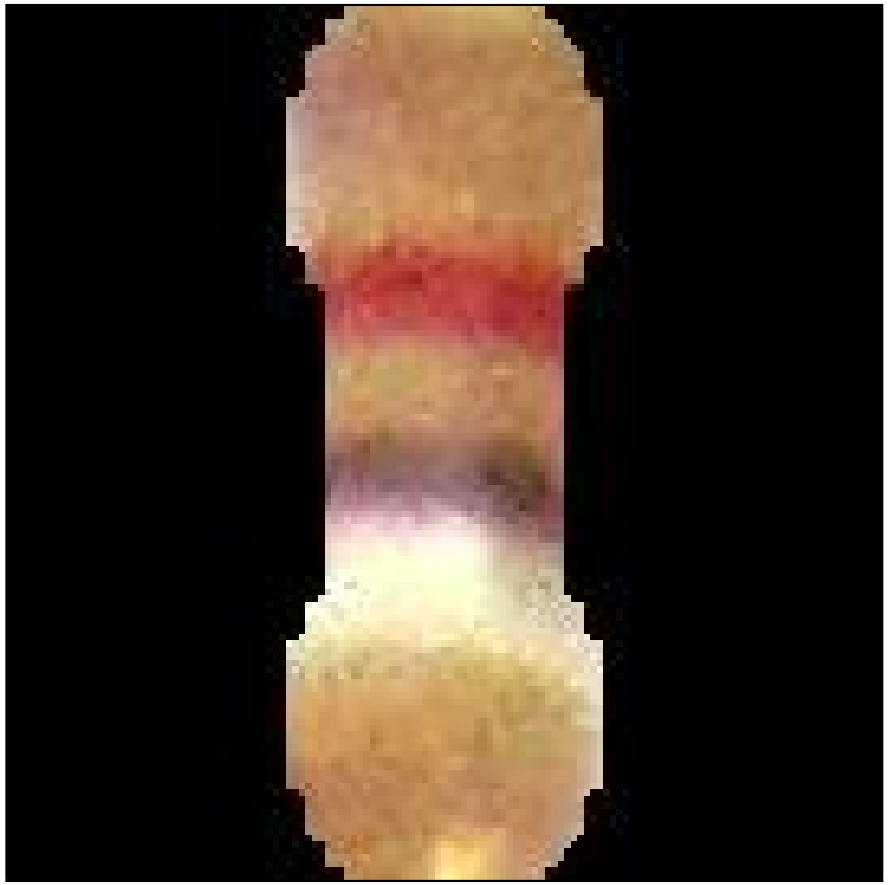


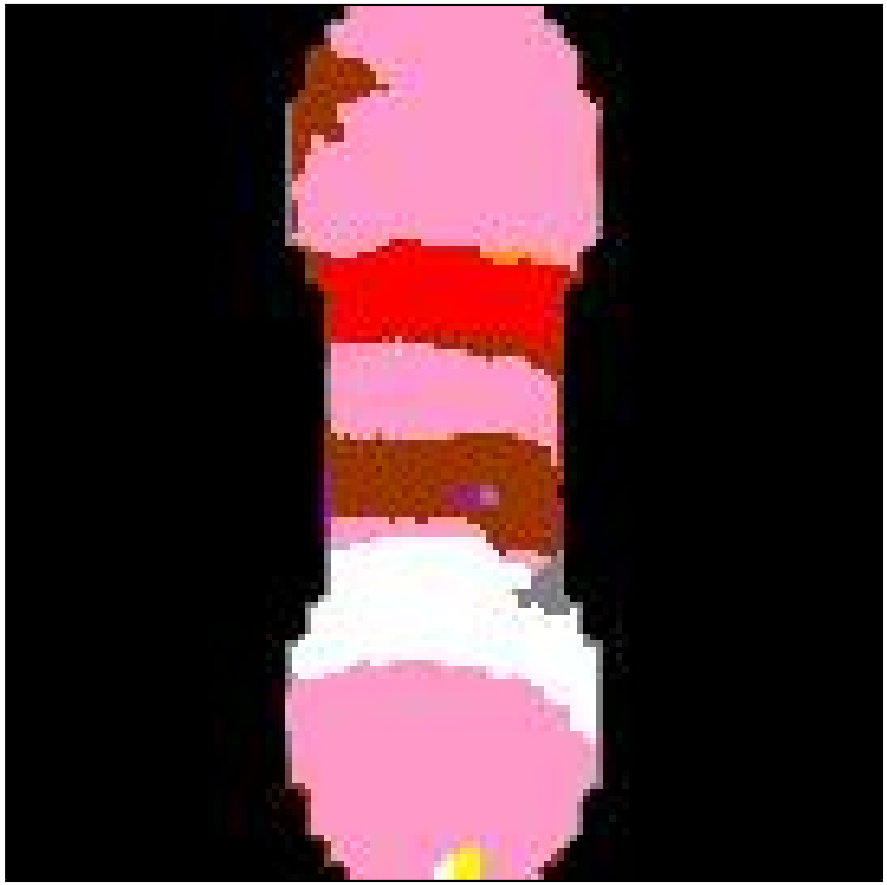


Apply Classifier

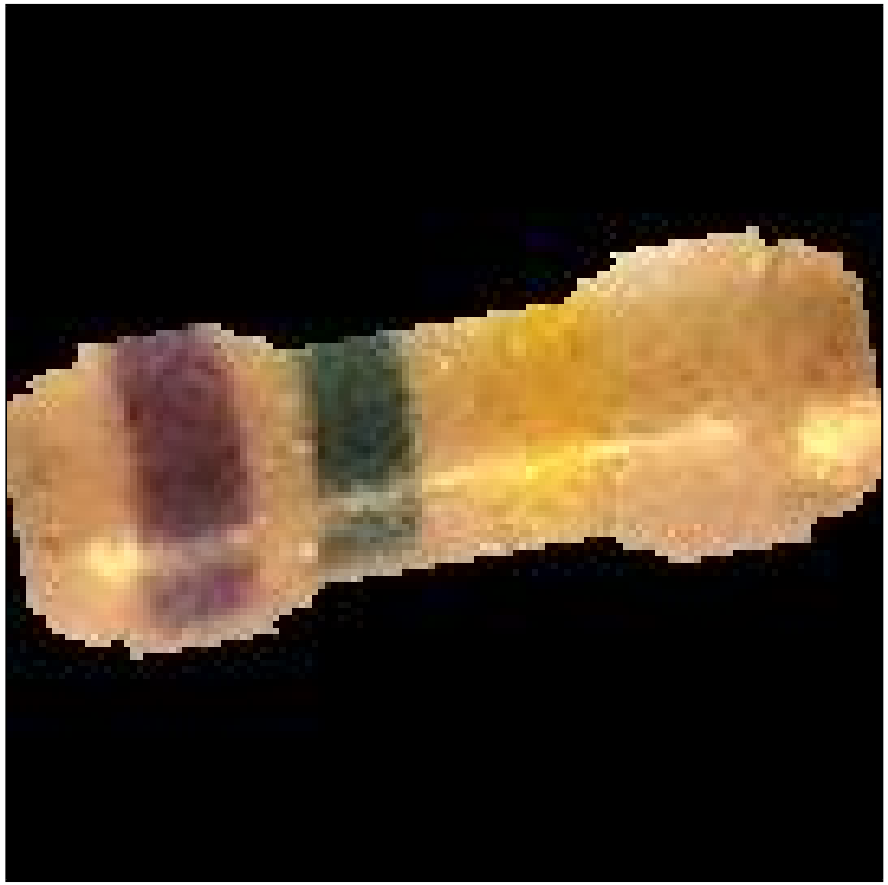


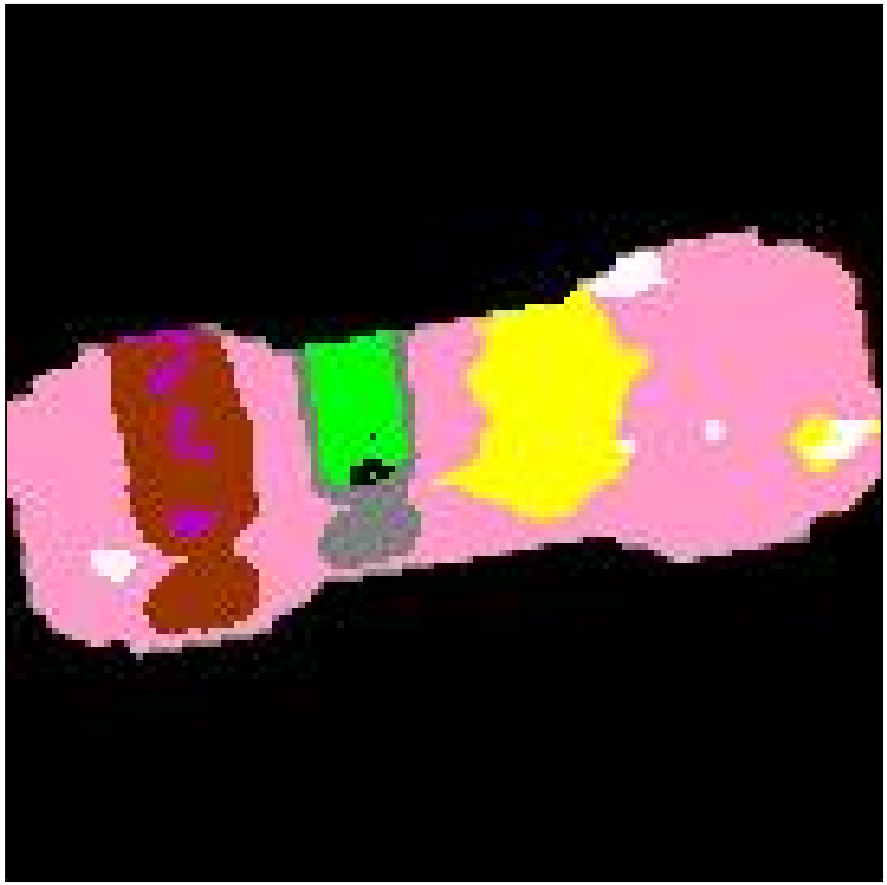
Apply Classifier



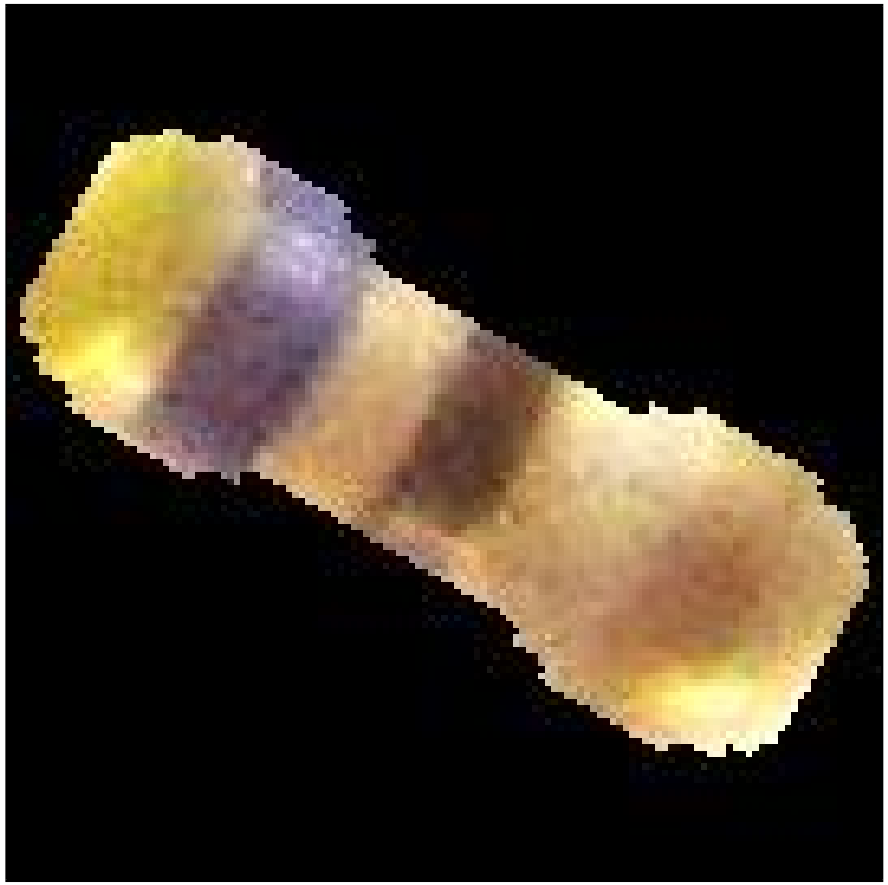


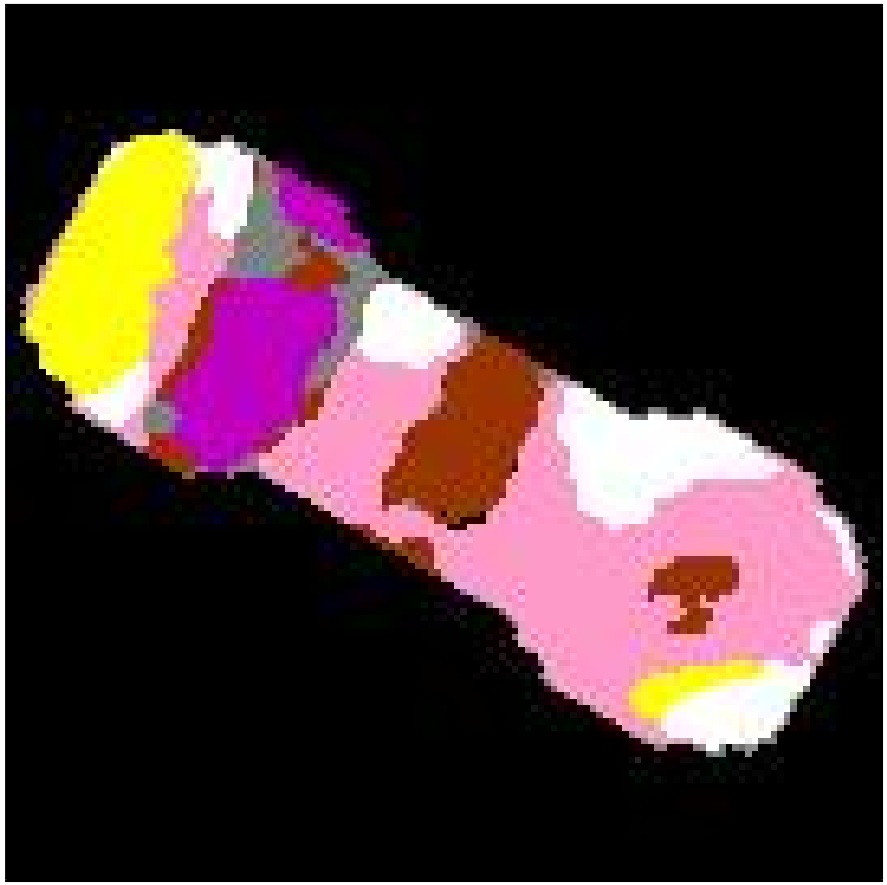
Apply Classifier



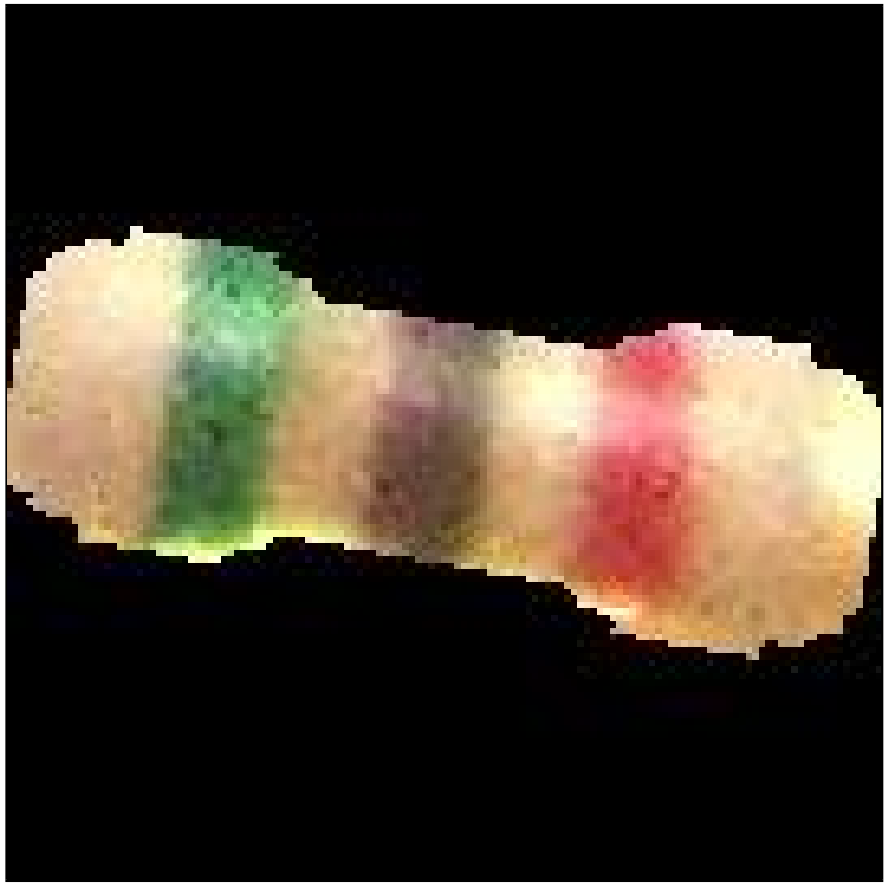


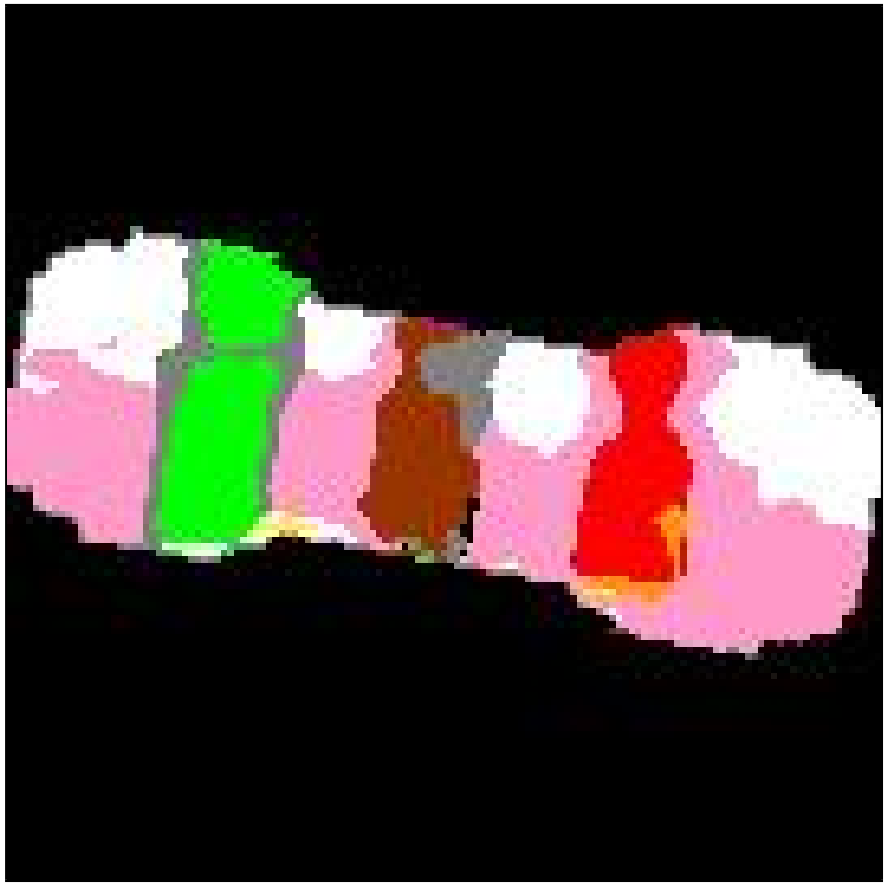
Apply Classifier





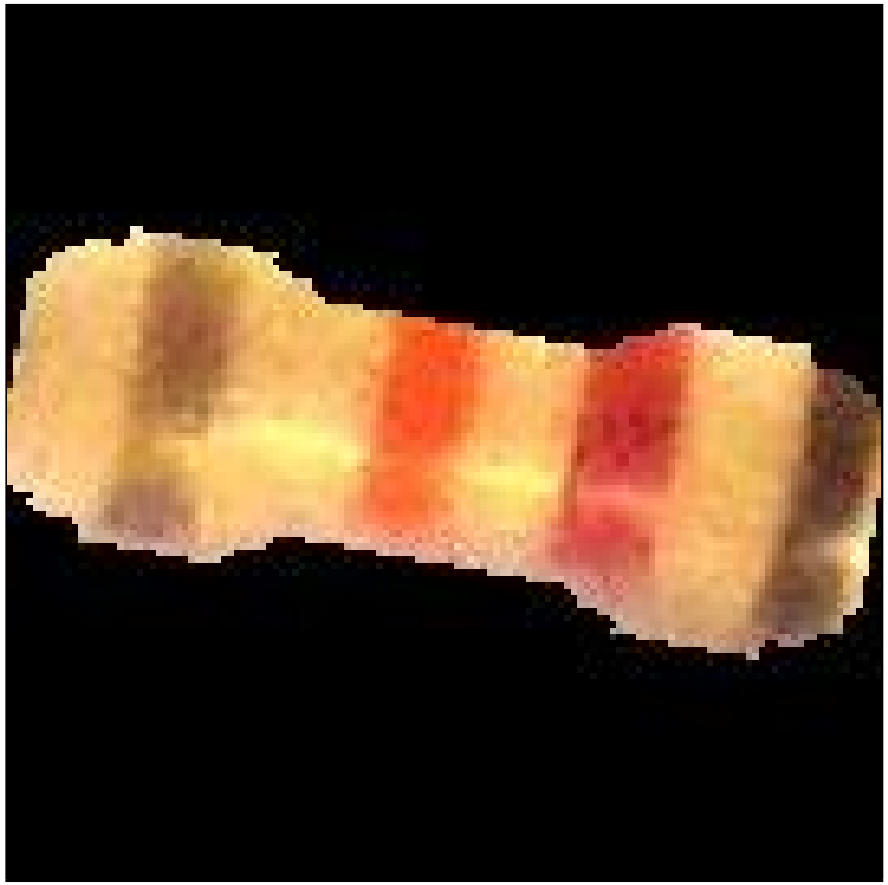
Apply Classifier

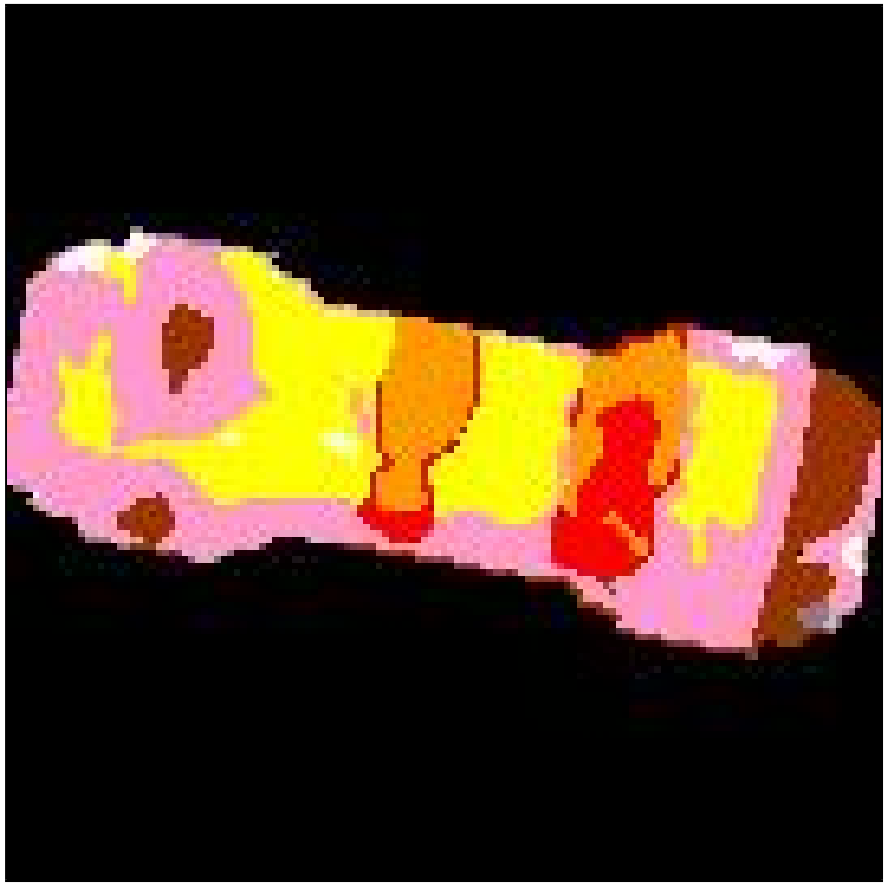




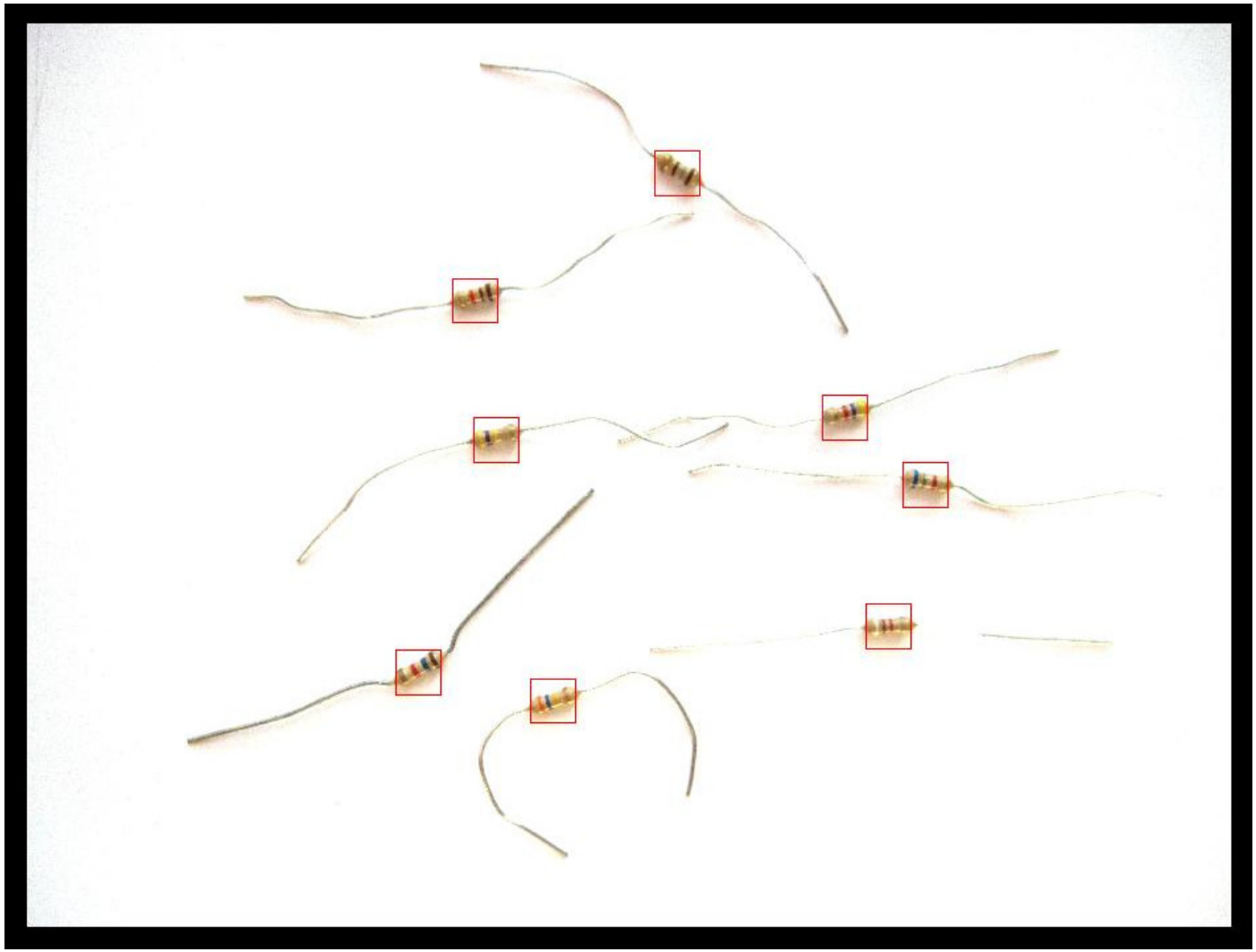
Apply Classifier

Apply Classifier

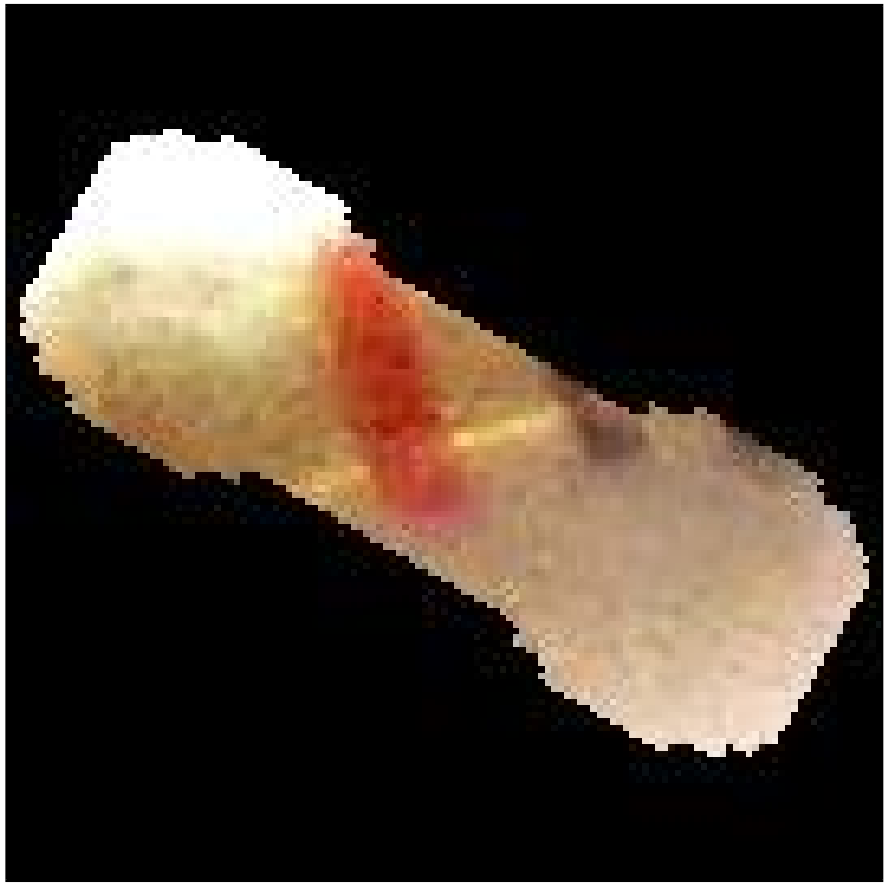


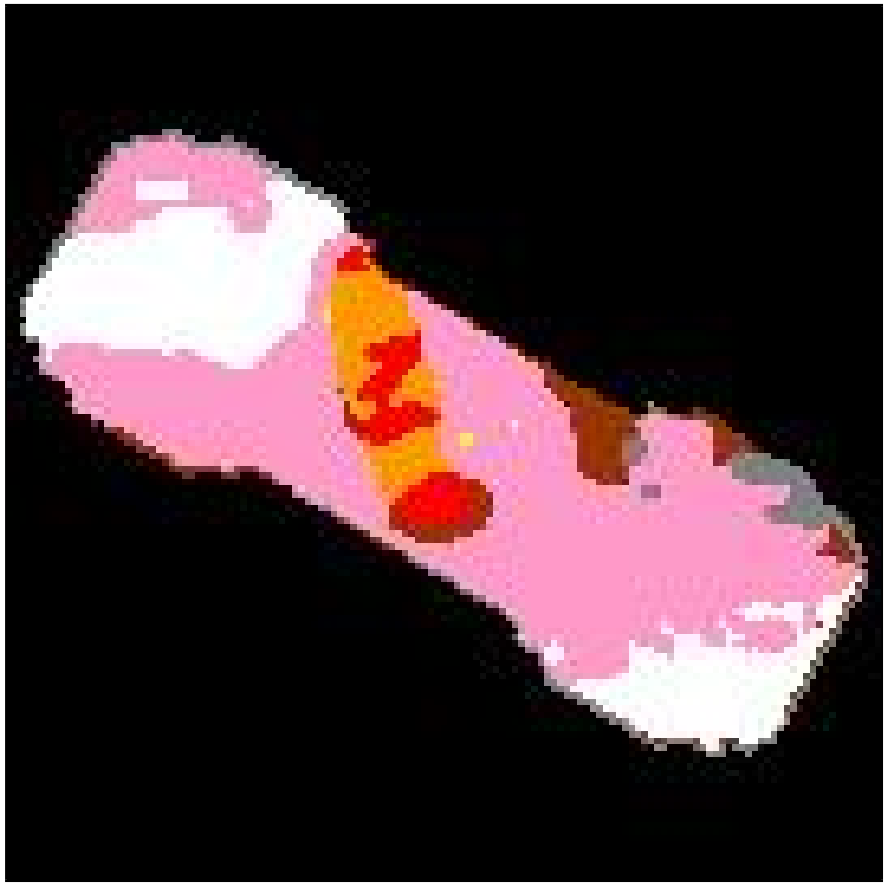


Resistor Bounding Boxes

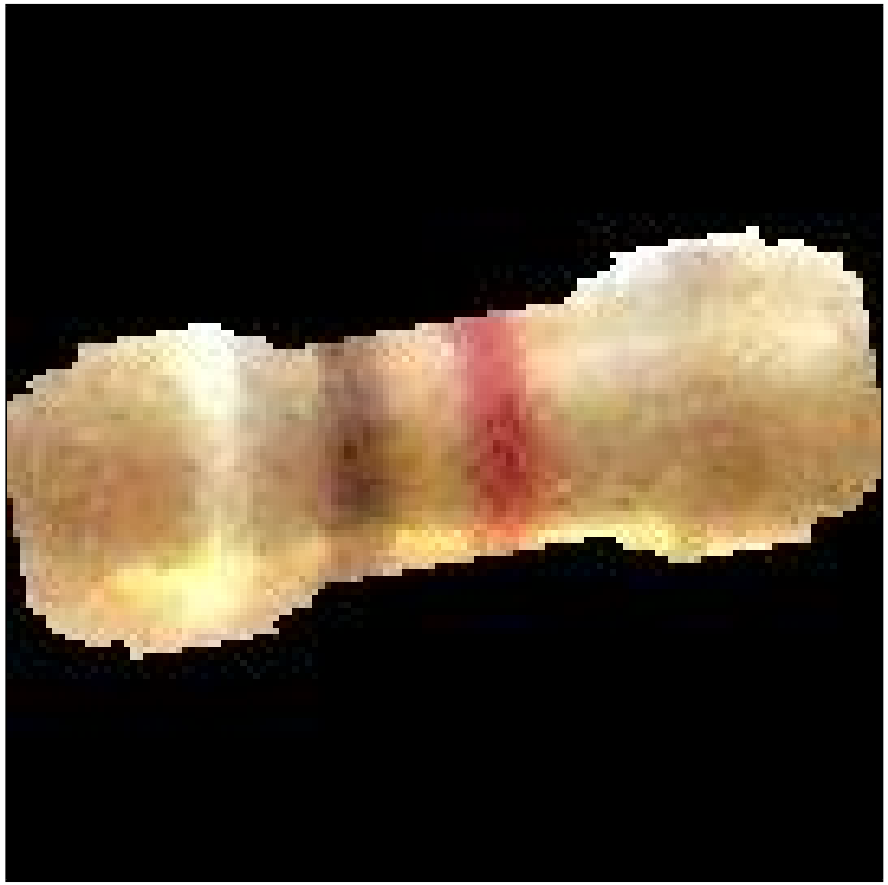


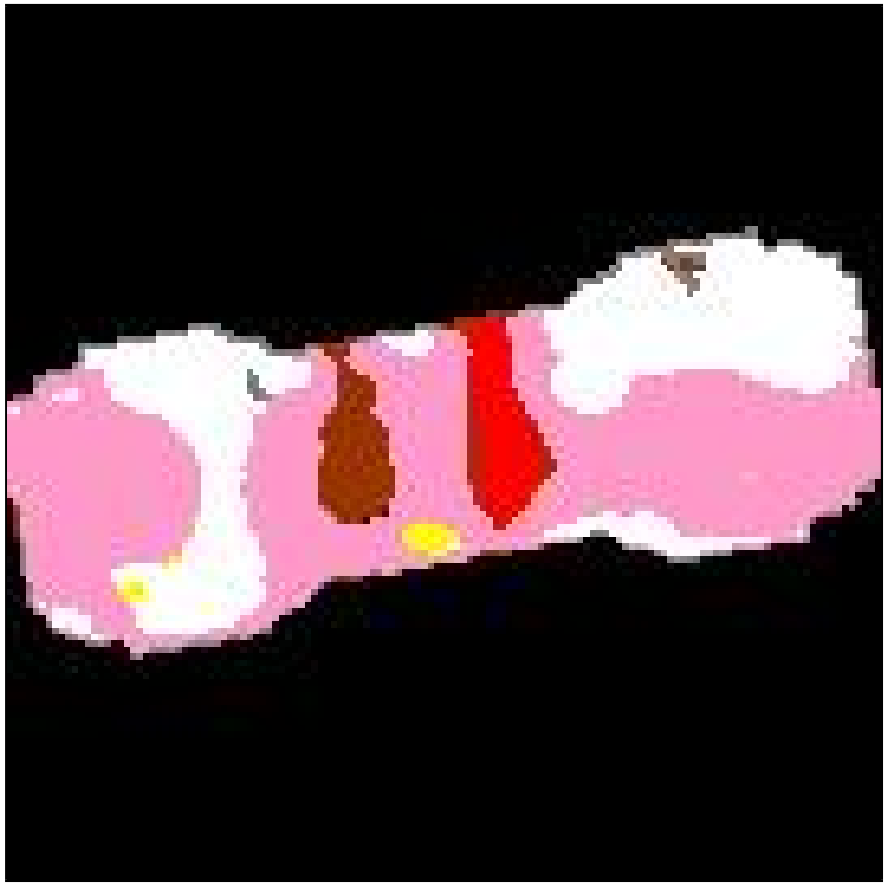
Apply Classifier



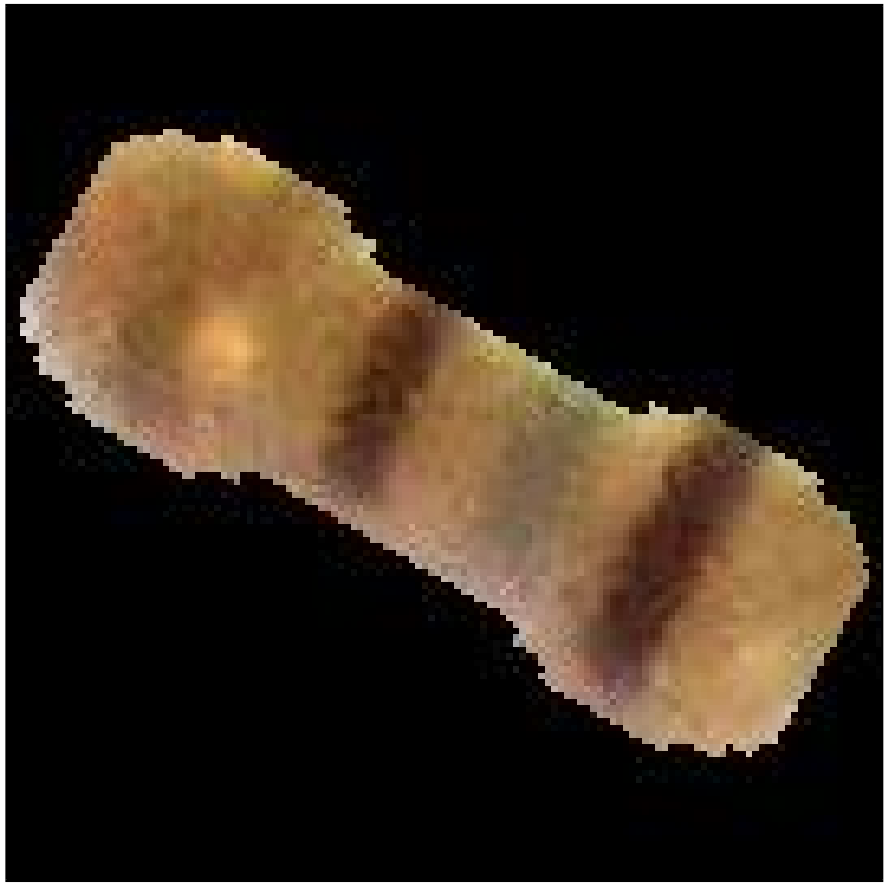


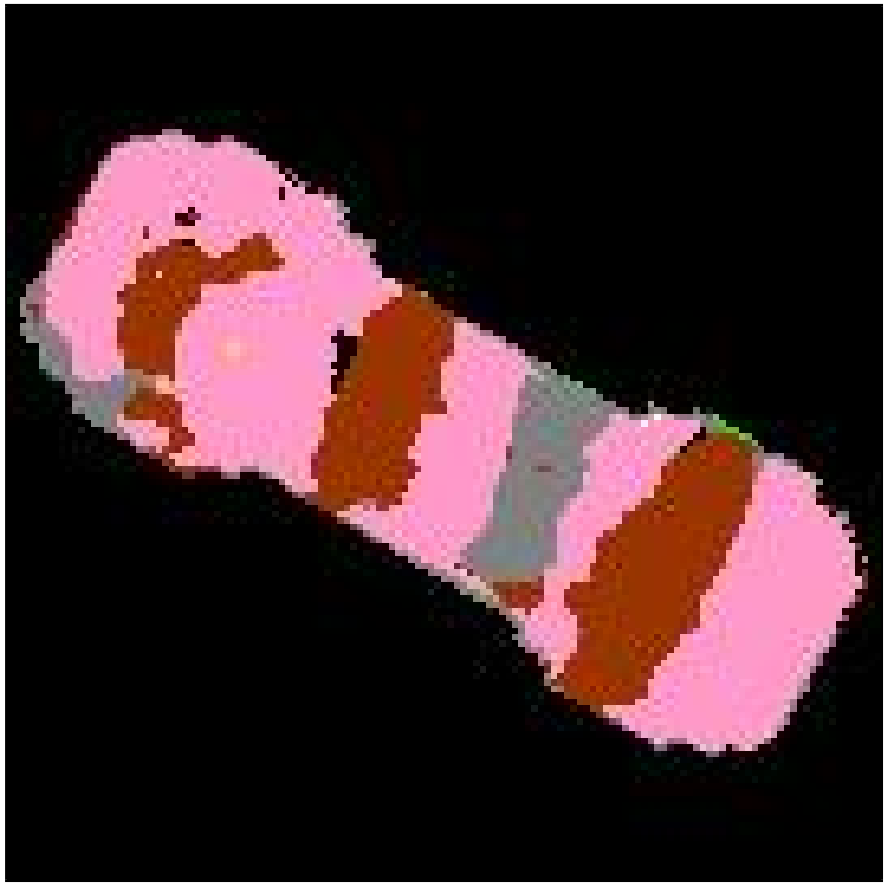
Apply Classifier



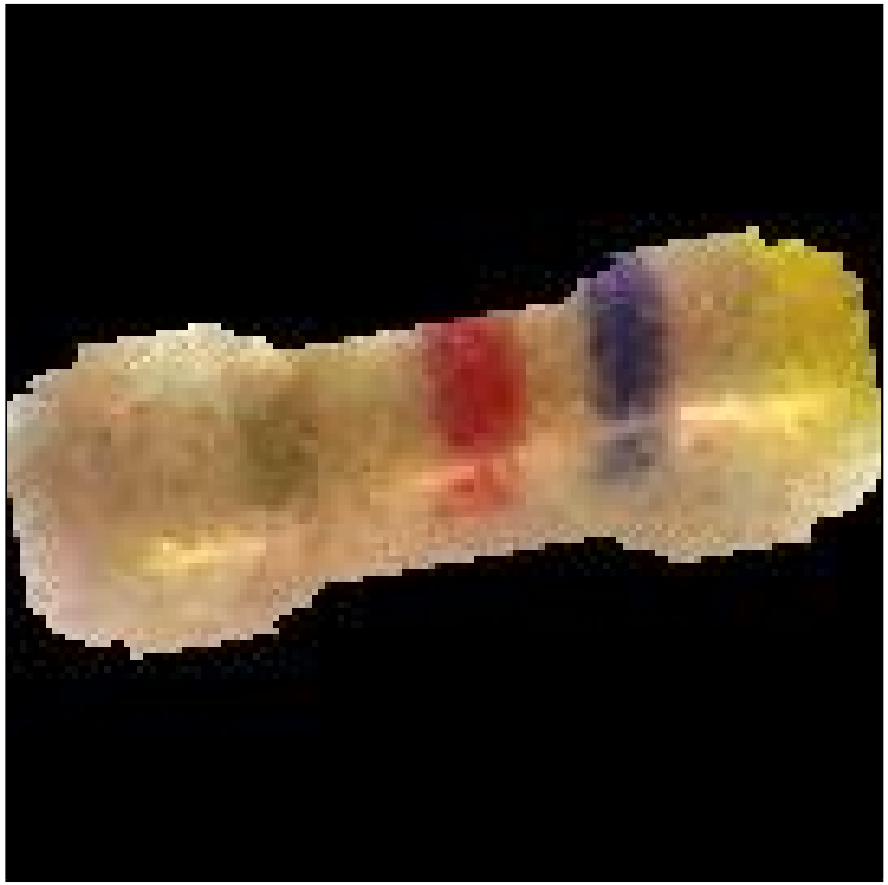


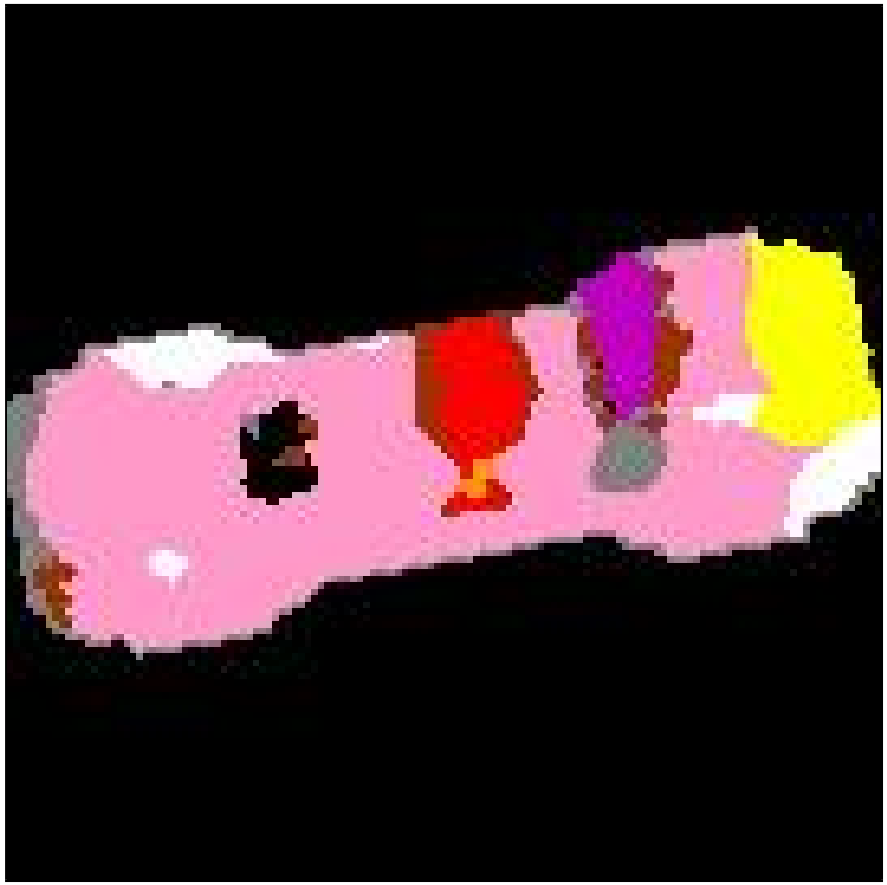
Apply Classifier



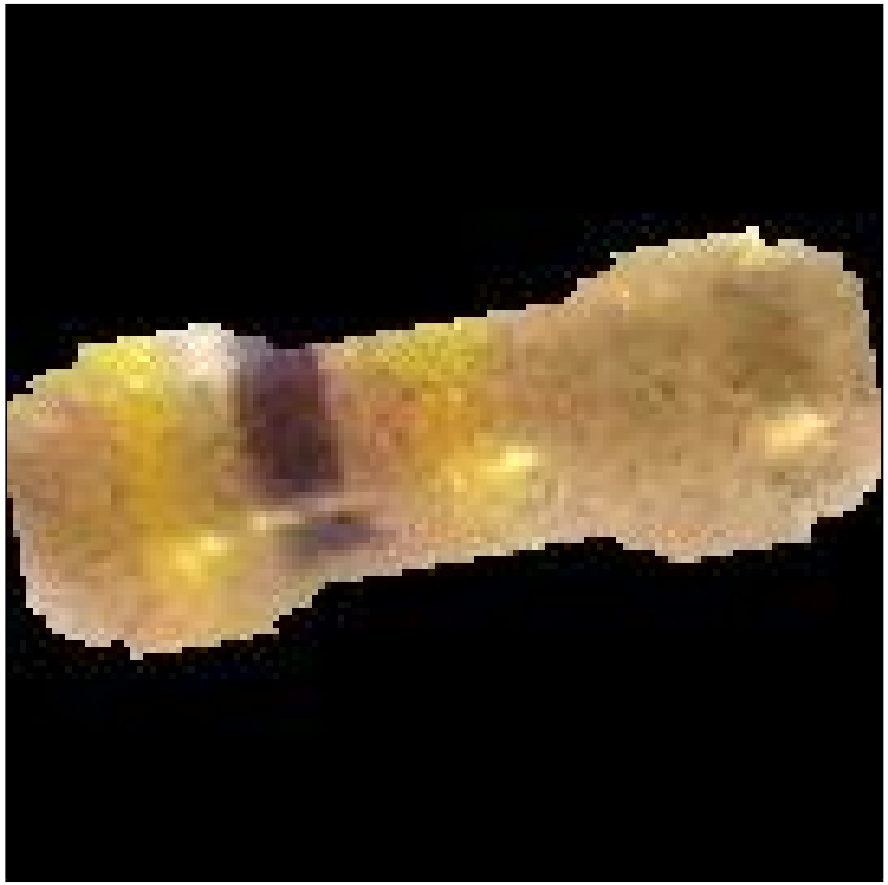


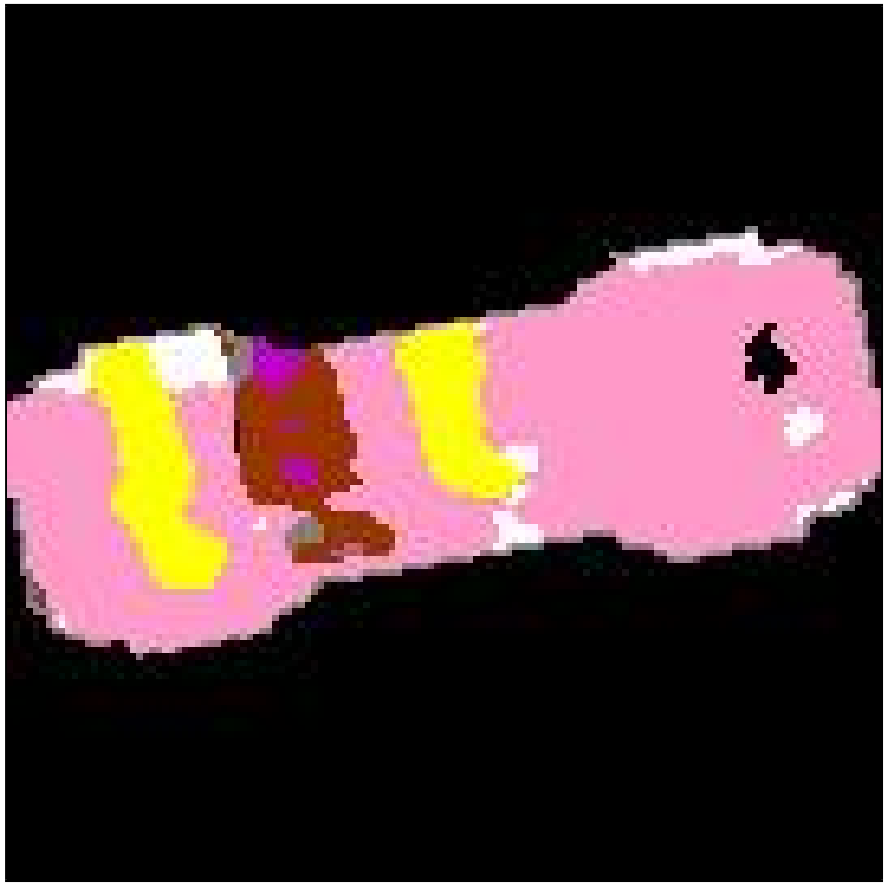
Apply Classifier



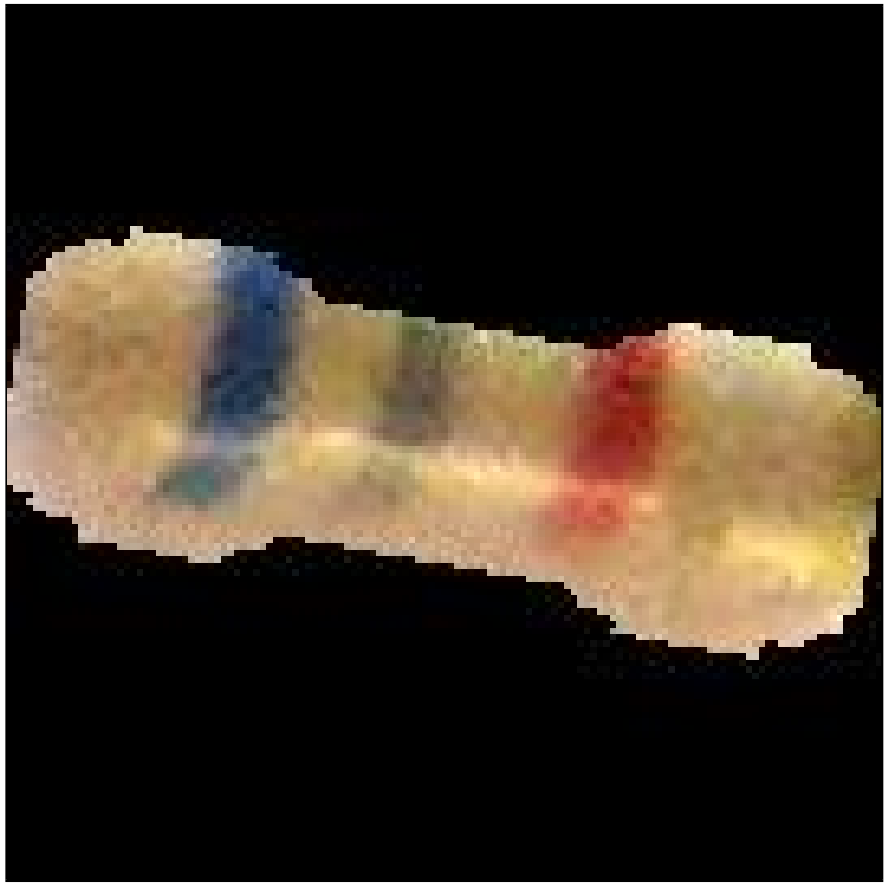


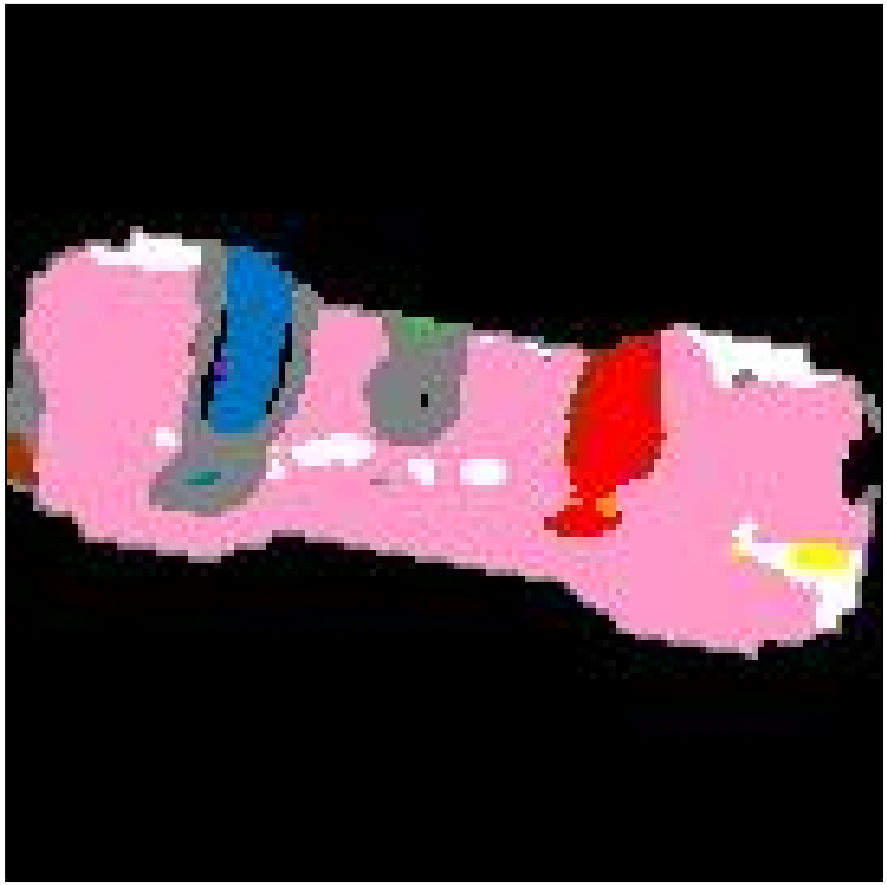
Apply Classifier



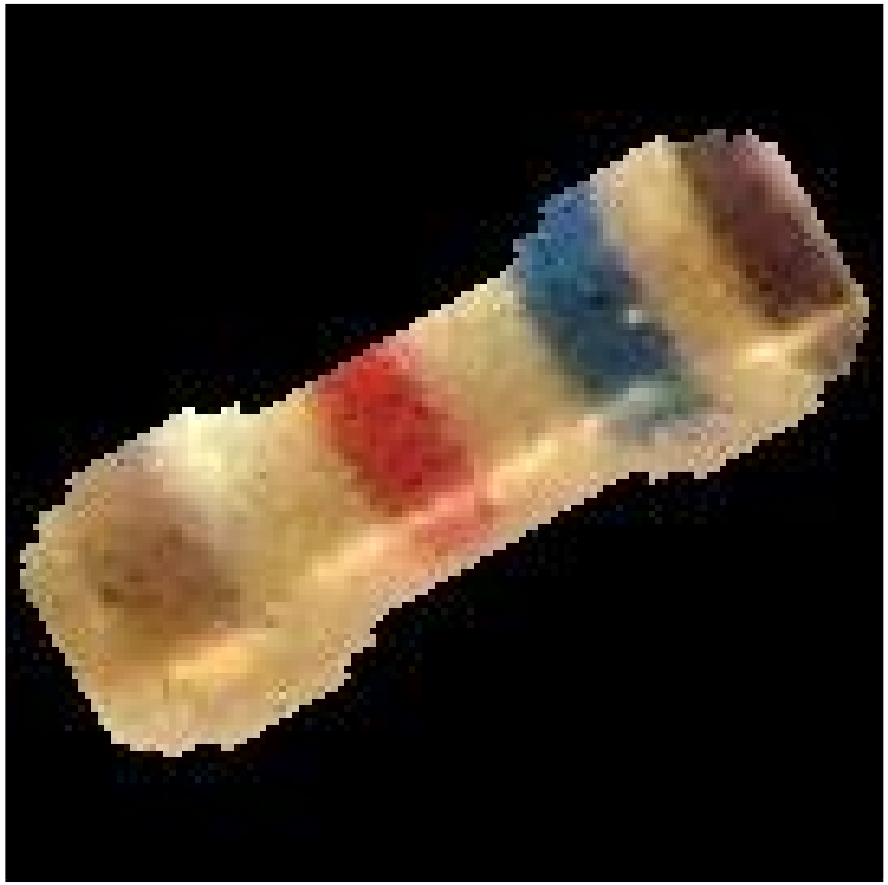


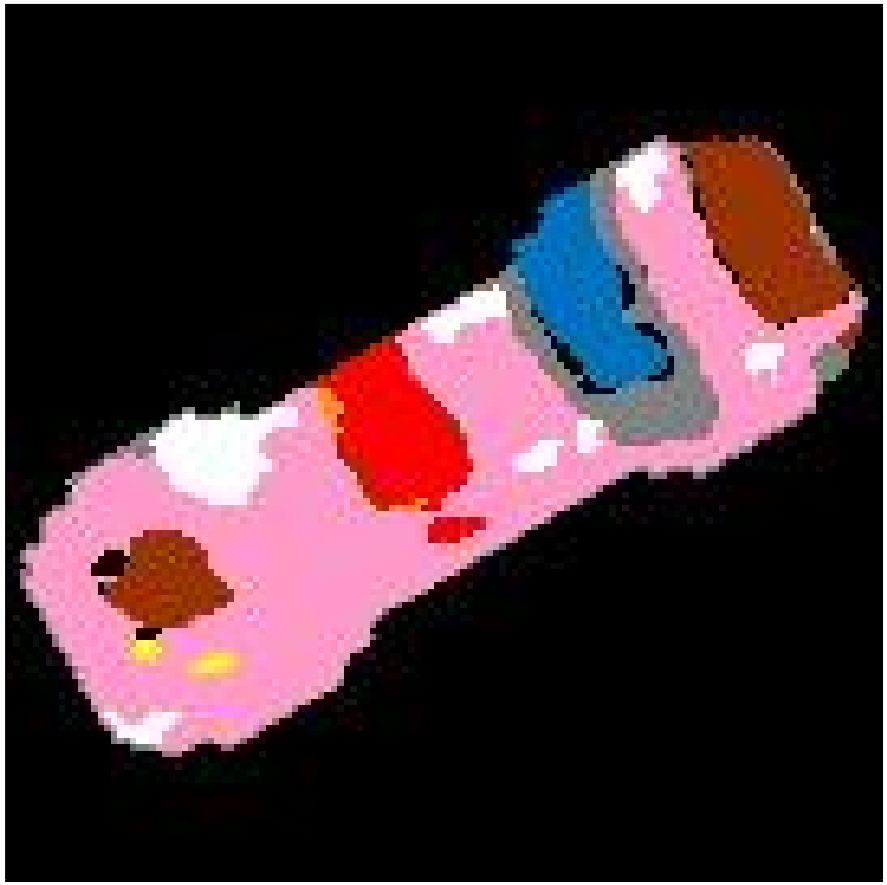
Apply Classifier



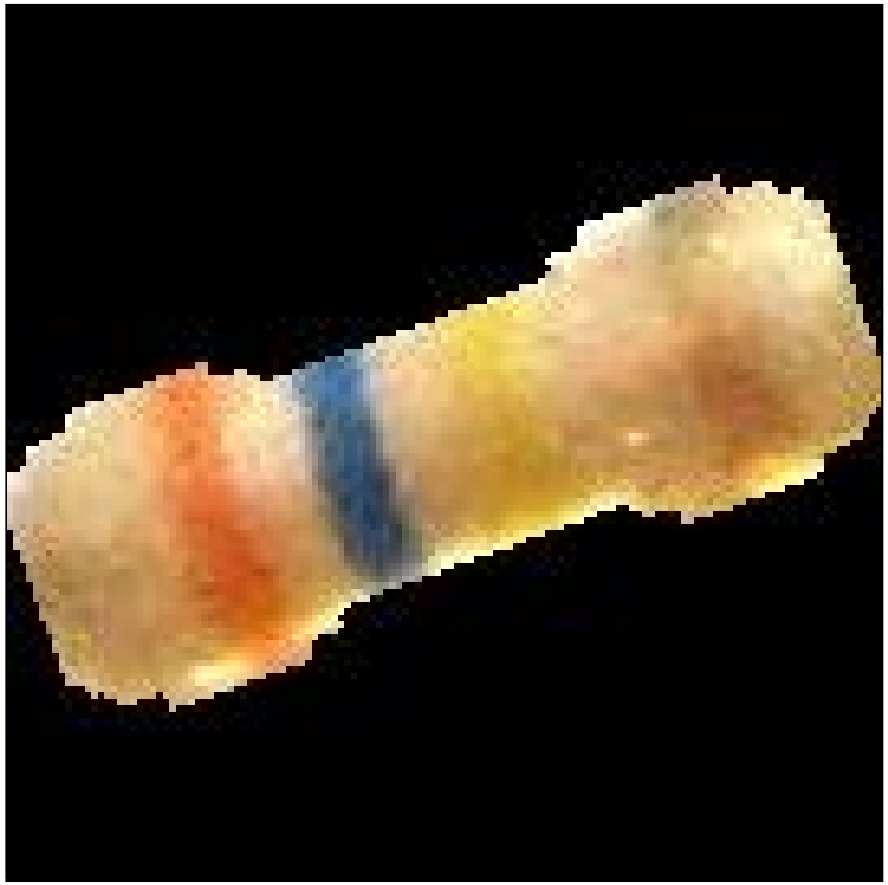


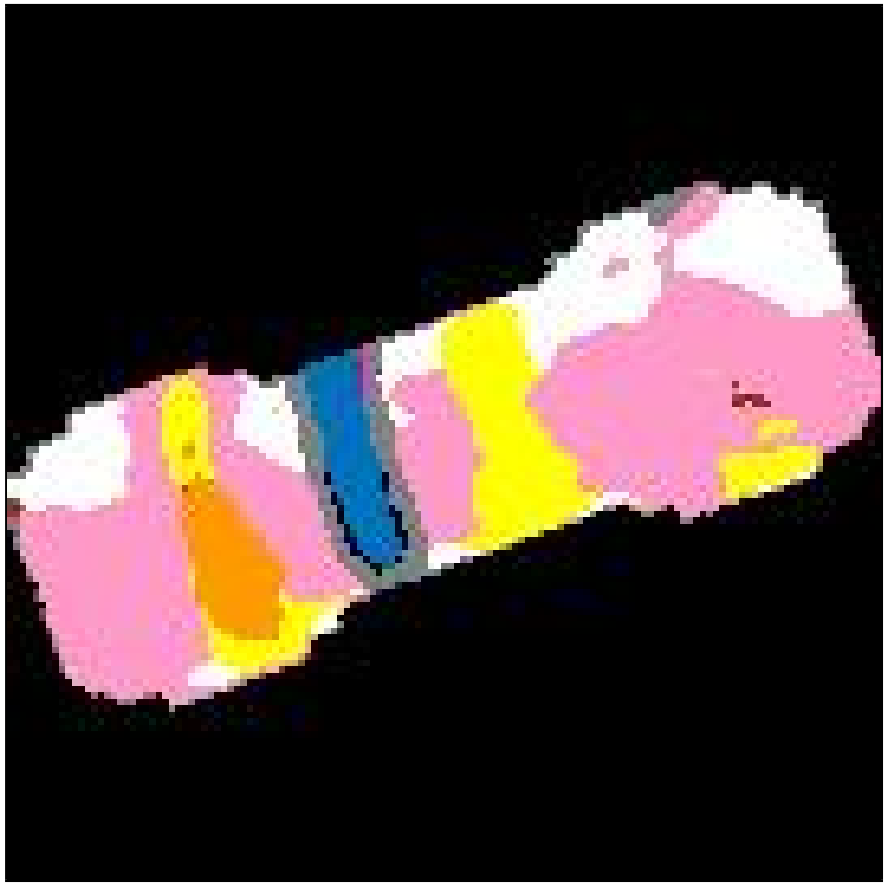
Apply Classifier





Apply Classifier





Future Work

- Use classification data to determine color code
- Use line walking method and standard resistor values to improve accuracy
- Create augmented reality mobile app

Questions?