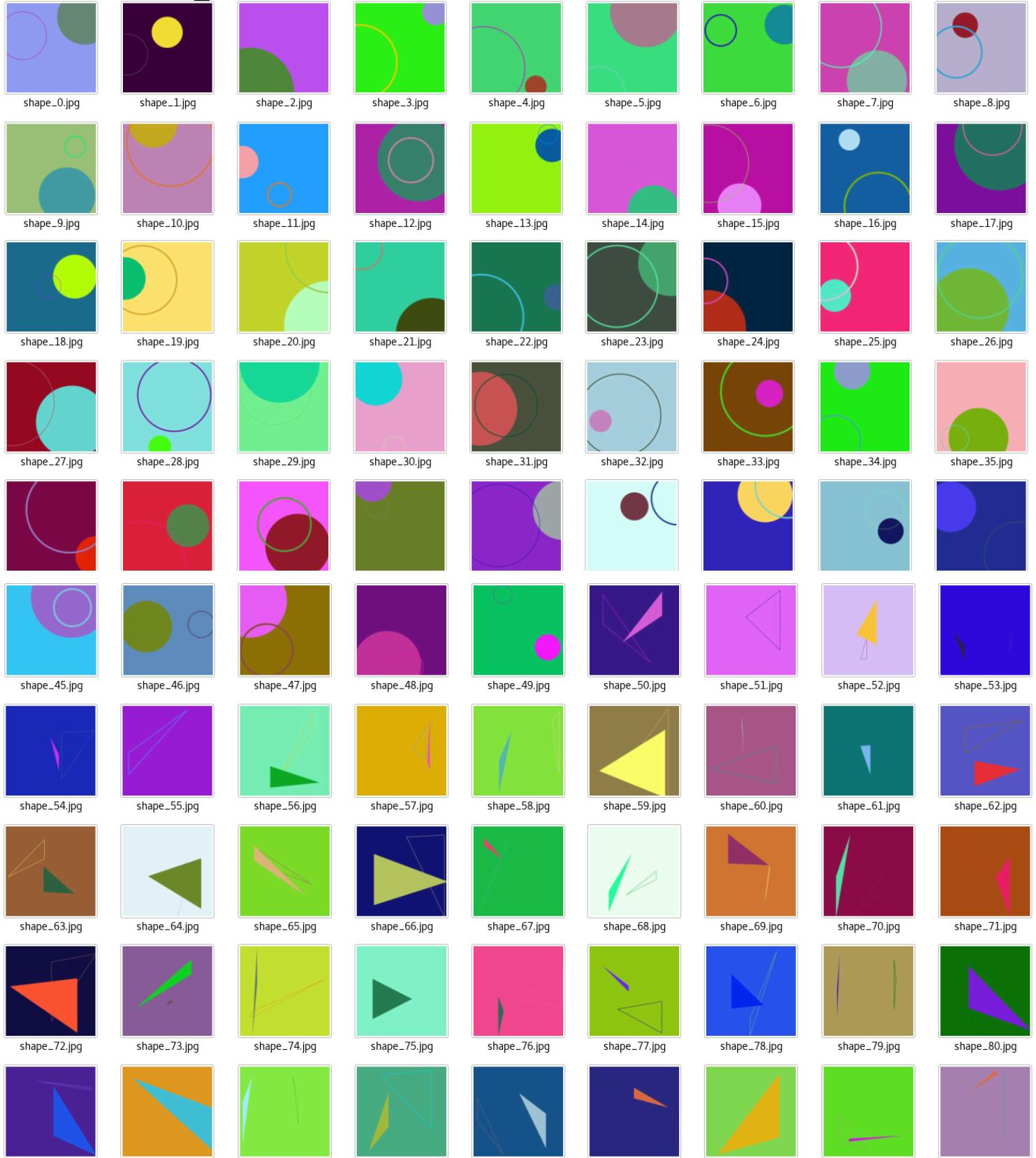
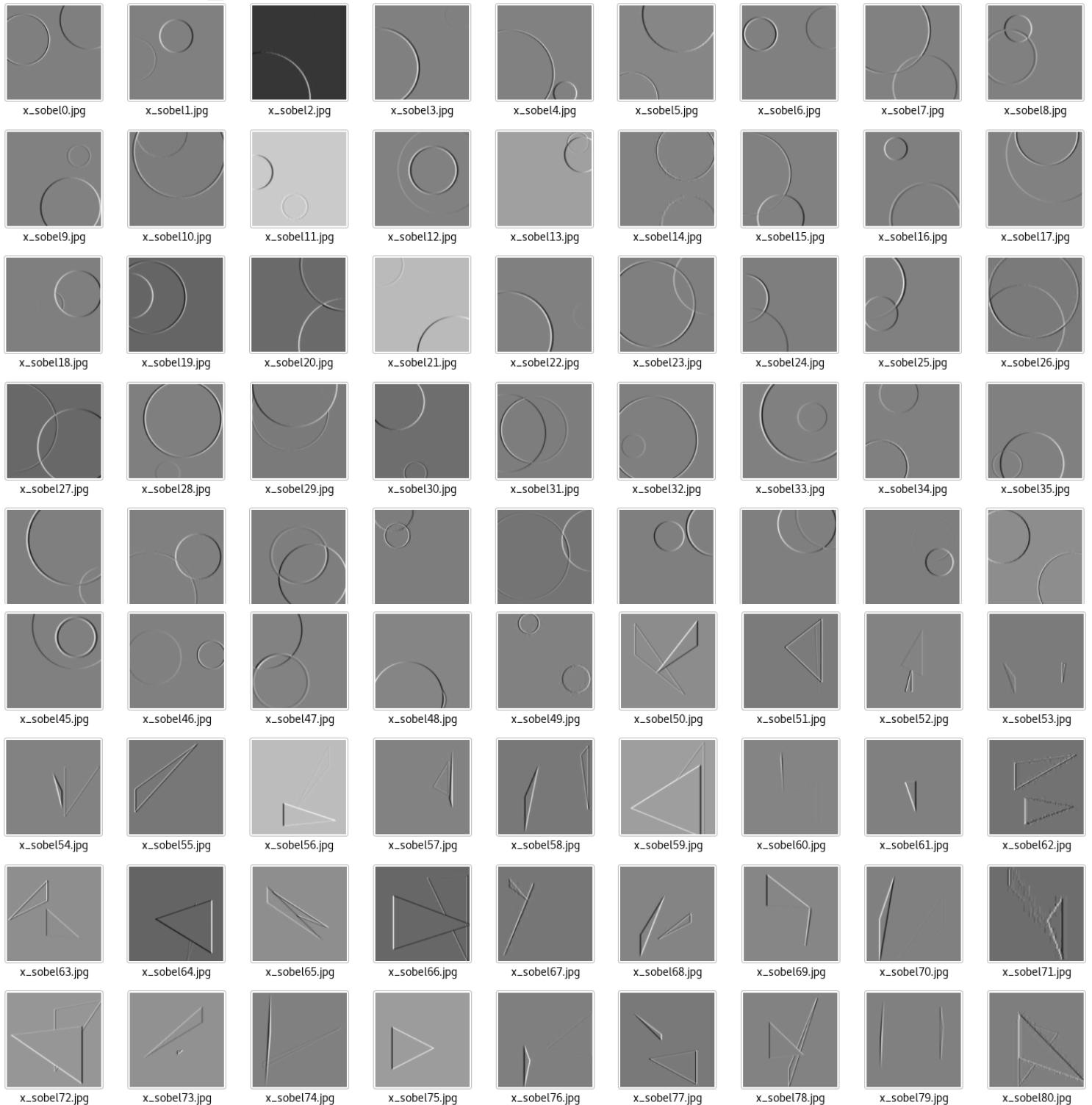


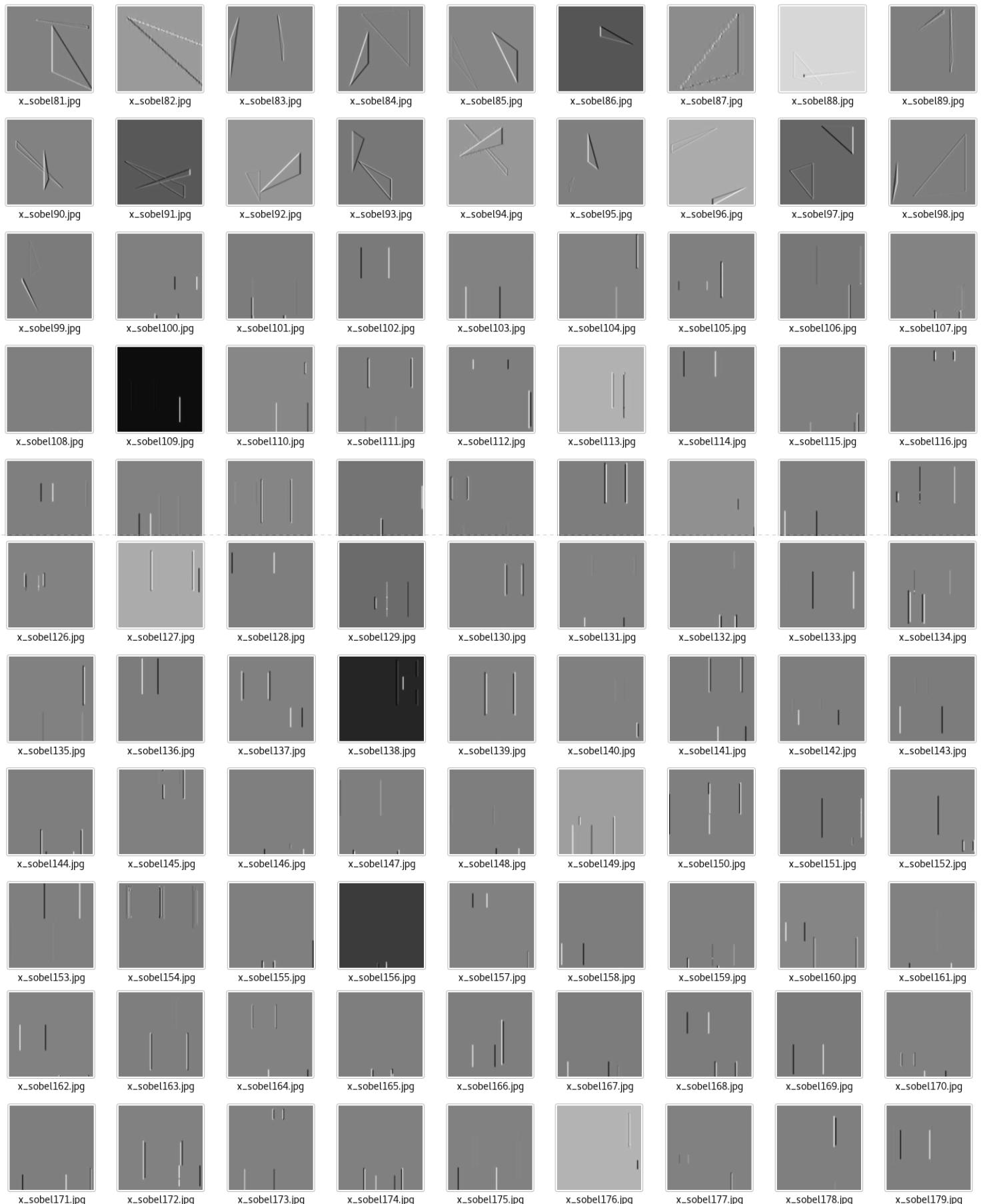
## Step 1: get\_edges get original images from dataset

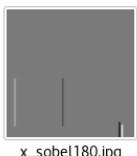




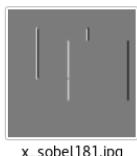
## Step 2: Sobel\_x algorithm detects contours in the horizontal derivative



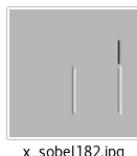




x\_sobel180.jpg



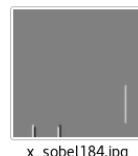
x\_sobel181.jpg



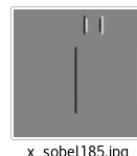
x\_sobel182.jpg



x\_sobel183.jpg



x\_sobel184.jpg



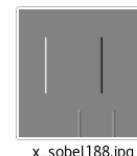
x\_sobel185.jpg



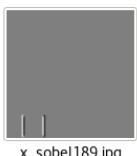
x\_sobel186.jpg



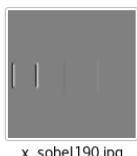
x\_sobel187.jpg



x\_sobel188.jpg



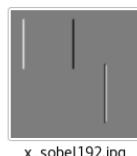
x\_sobel189.jpg



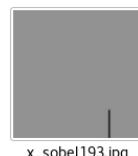
x\_sobel190.jpg



x\_sobel191.jpg



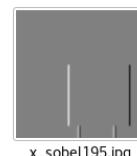
x\_sobel192.jpg



x\_sobel193.jpg



x\_sobel194.jpg



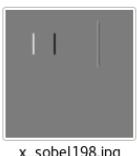
x\_sobel195.jpg



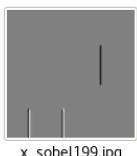
x\_sobel196.jpg



x\_sobel197.jpg



x\_sobel198.jpg



x\_sobel199.jpg

### Step 3: Sobel\_y algorithm detects contours in the vertical derivative



y\_sobel0.jpg



y\_sobel1.jpg



y\_sobel2.jpg



y\_sobel3.jpg



y\_sobel4.jpg



y\_sobel5.jpg



y\_sobel6.jpg



y\_sobel7.jpg



y\_sobel8.jpg



y\_sobel9.jpg



y\_sobel10.jpg



y\_sobel11.jpg



y\_sobel12.jpg



y\_sobel13.jpg



y\_sobel14.jpg



y\_sobel15.jpg



y\_sobel16.jpg



y\_sobel17.jpg



y\_sobel18.jpg



y\_sobel19.jpg



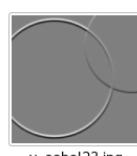
y\_sobel20.jpg



y\_sobel21.jpg



y\_sobel22.jpg



y\_sobel23.jpg



y\_sobel24.jpg



y\_sobel25.jpg



y\_sobel26.jpg



y\_sobel27.jpg



y\_sobel28.jpg



y\_sobel29.jpg



y\_sobel30.jpg



y\_sobel31.jpg



y\_sobel32.jpg



y\_sobel33.jpg



y\_sobel34.jpg



y\_sobel35.jpg



y\_sobel36.jpg



y\_sobel37.jpg



y\_sobel38.jpg



y\_sobel39.jpg



y\_sobel40.jpg



y\_sobel41.jpg



y\_sobel42.jpg



y\_sobel43.jpg



y\_sobel44.jpg



y\_sobel45.jpg



y\_sobel46.jpg



y\_sobel47.jpg



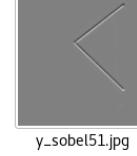
y\_sobel48.jpg



y\_sobel49.jpg



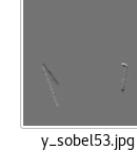
y\_sobel50.jpg



y\_sobel51.jpg



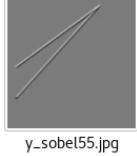
y\_sobel52.jpg



y\_sobel53.jpg



y\_sobel54.jpg



y\_sobel55.jpg



y\_sobel56.jpg



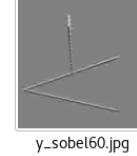
y\_sobel57.jpg



y\_sobel58.jpg



y\_sobel59.jpg



y\_sobel60.jpg



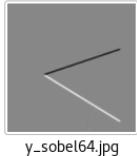
y\_sobel61.jpg



y\_sobel62.jpg



y\_sobel63.jpg



y\_sobel64.jpg



y\_sobel65.jpg



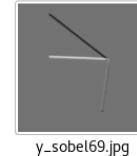
y\_sobel66.jpg



y\_sobel67.jpg



y\_sobel68.jpg



y\_sobel69.jpg



y\_sobel70.jpg



y\_sobel71.jpg



y\_sobel72.jpg



y\_sobel73.jpg



y\_sobel74.jpg



y\_sobel75.jpg



y\_sobel76.jpg



y\_sobel77.jpg



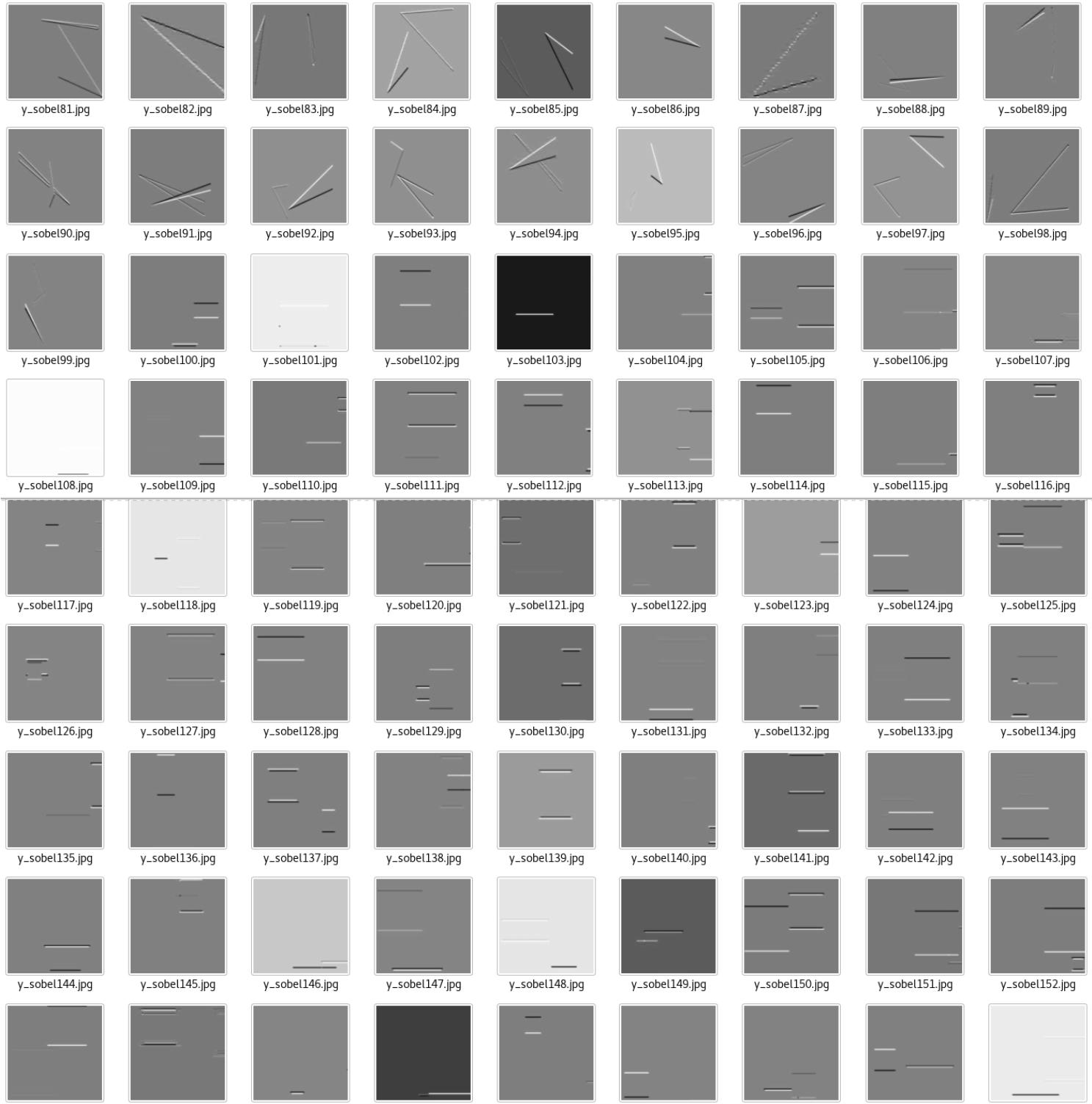
y\_sobel78.jpg

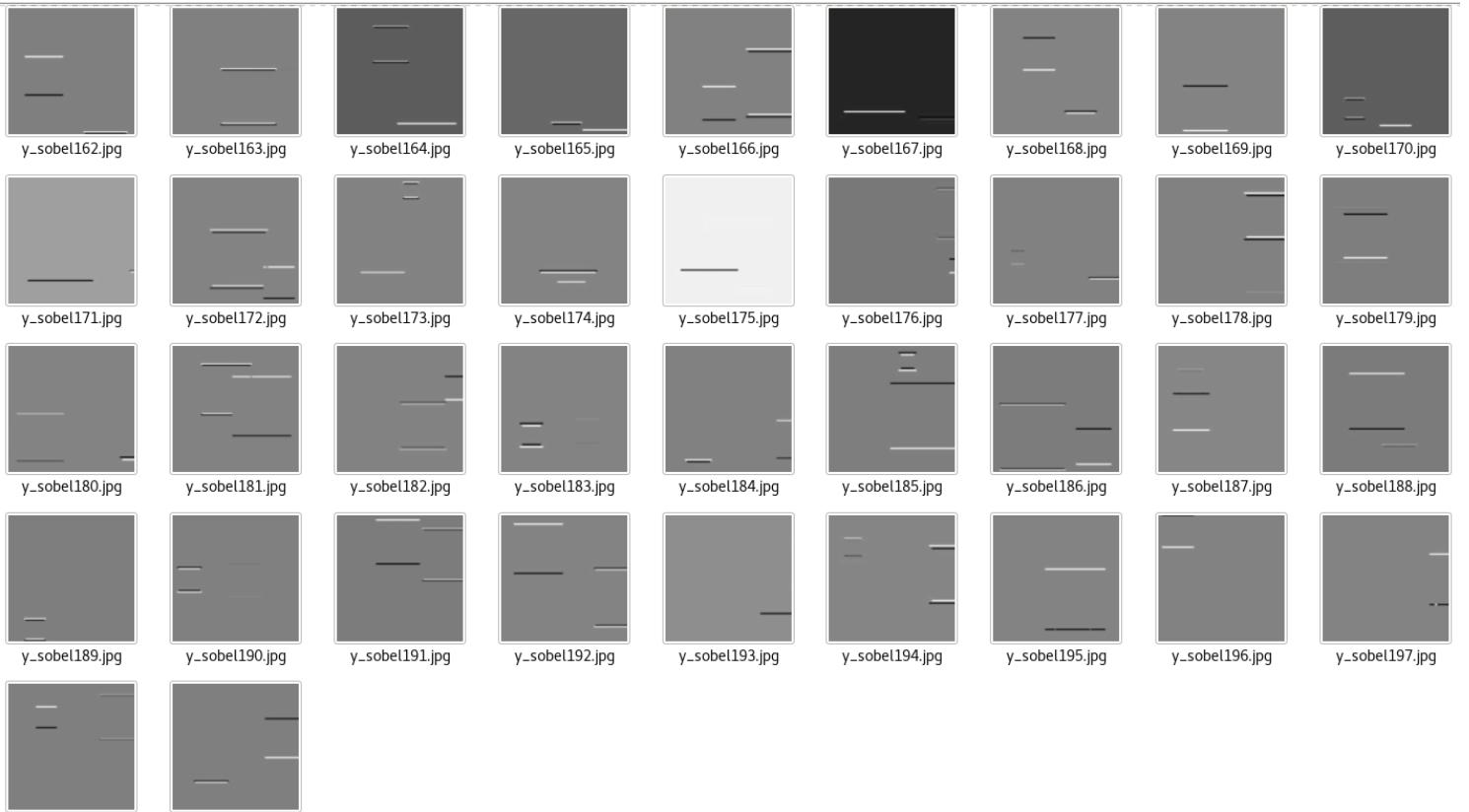


y\_sobel79.jpg

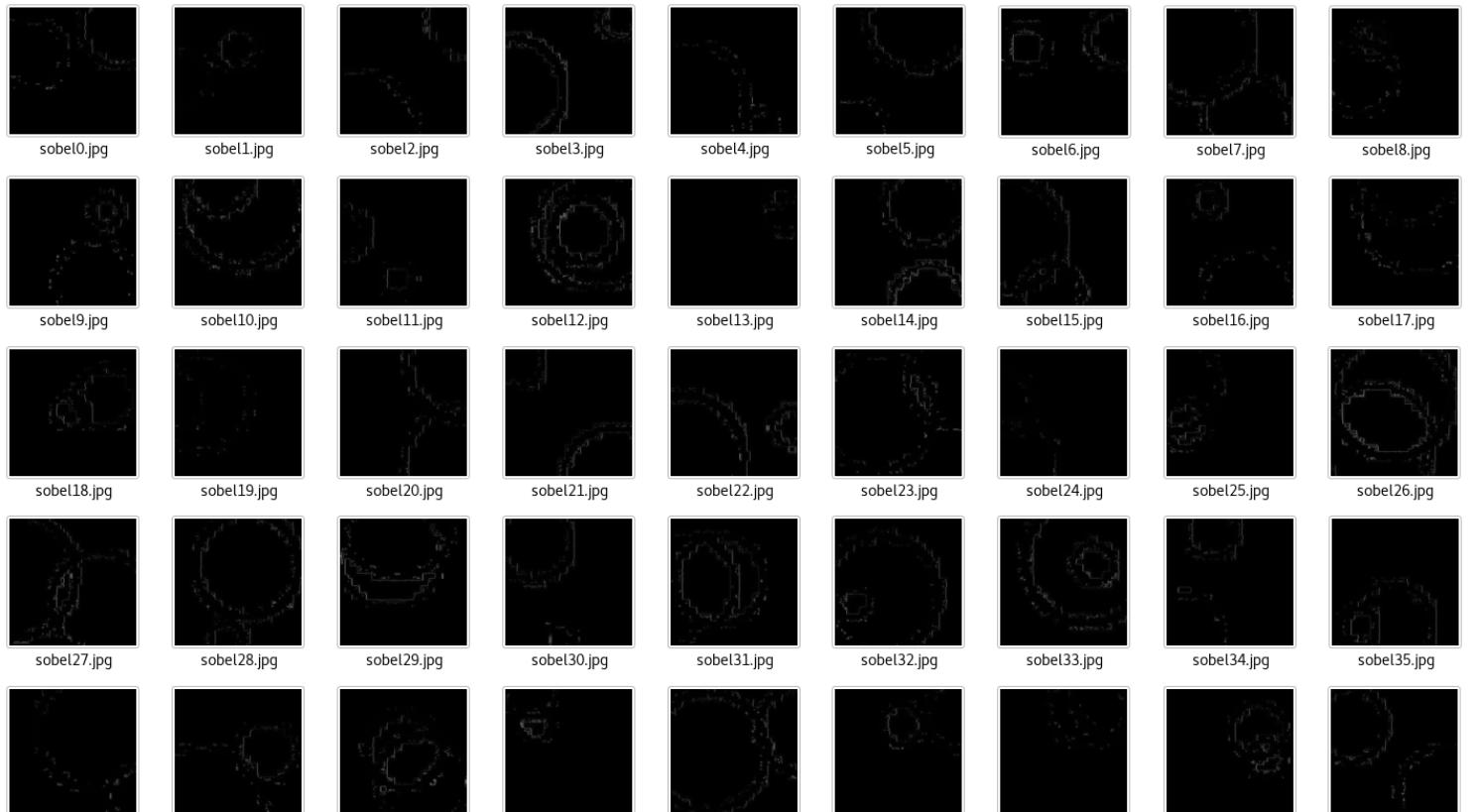


y\_sobel80.jpg

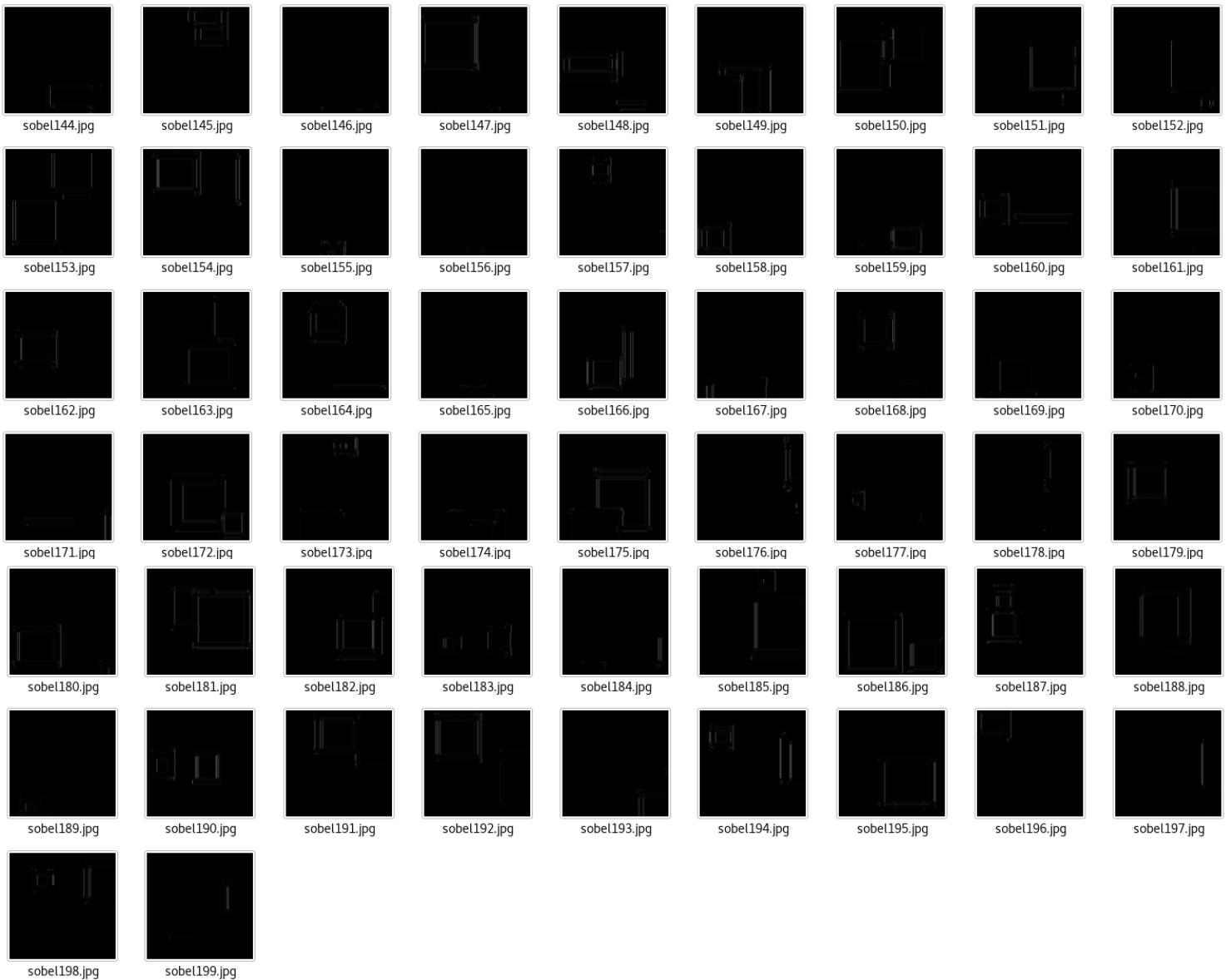




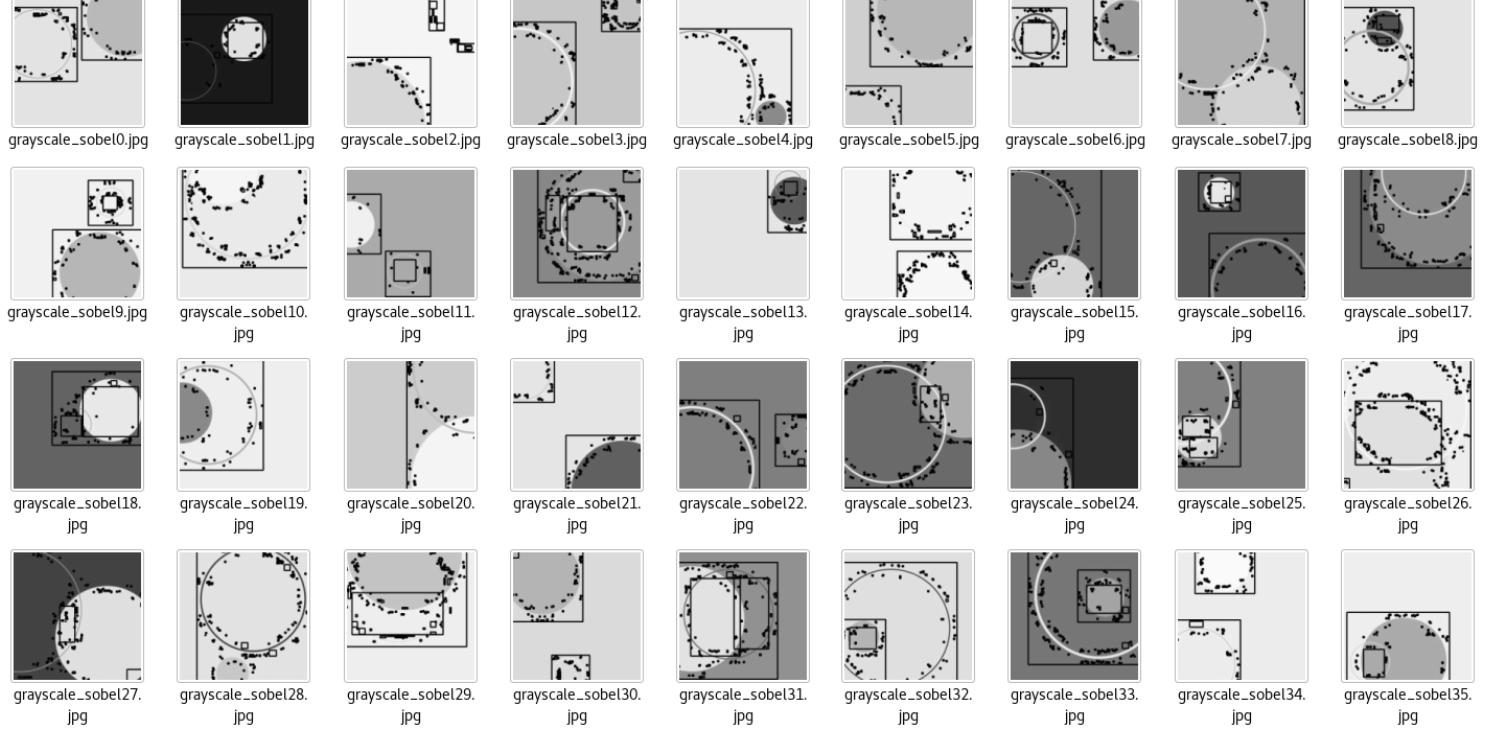
Step 4: Combine gradients of x and y changes

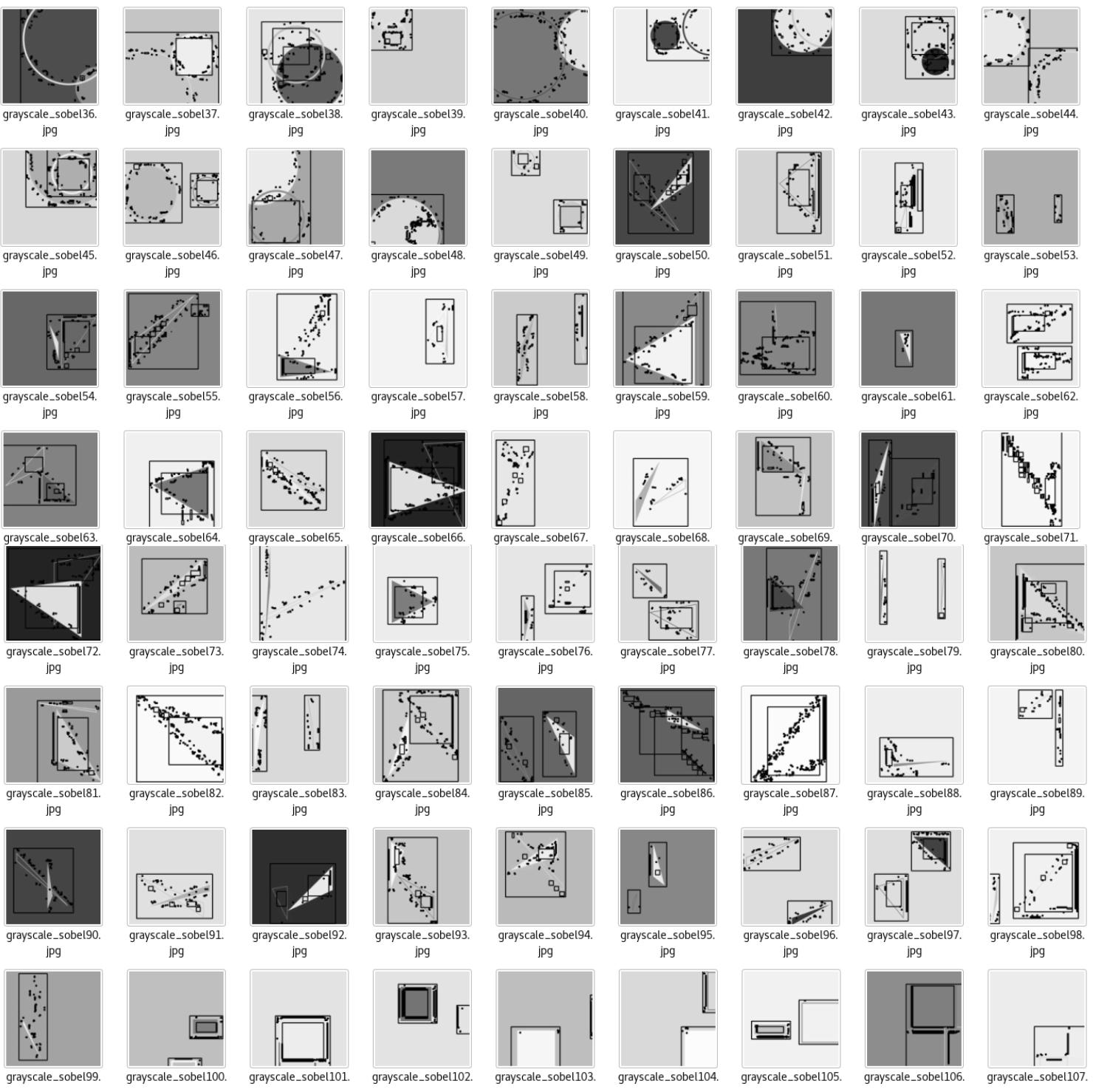






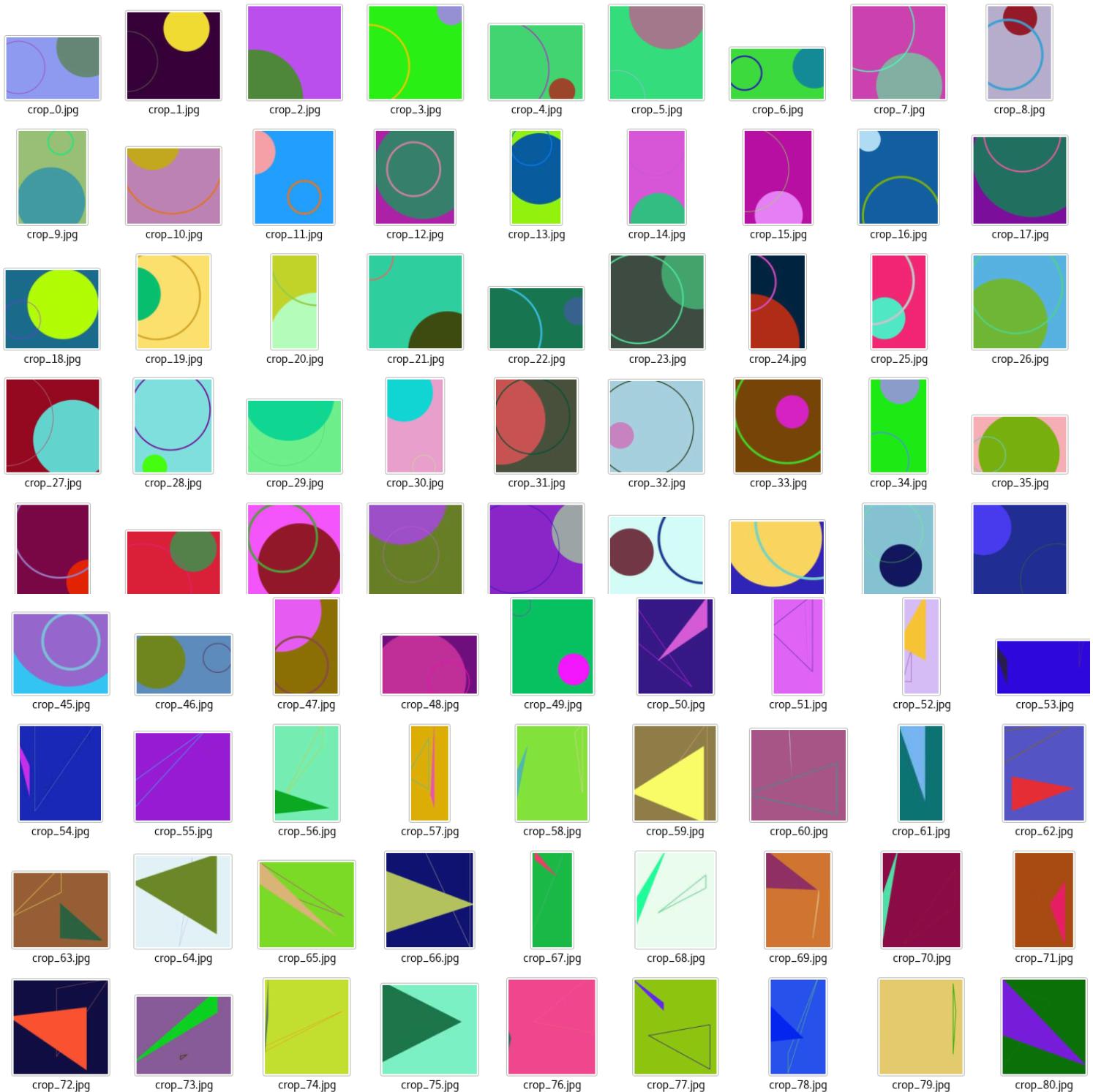
Step 5: sobel detects edges, which are the boundary conditions

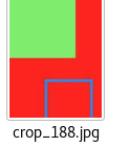
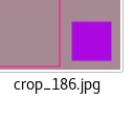
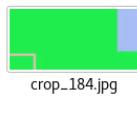
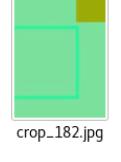
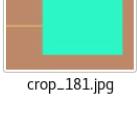
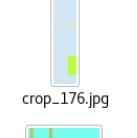
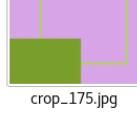
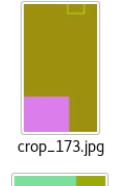
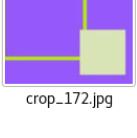
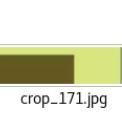
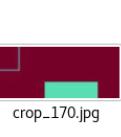
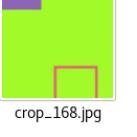
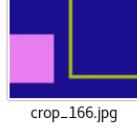
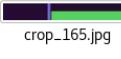
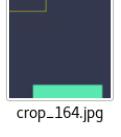
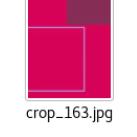
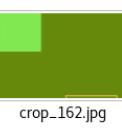
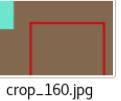
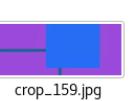
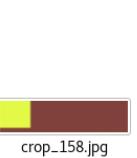
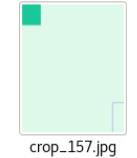
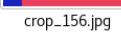
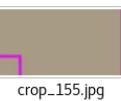
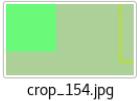
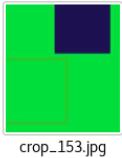
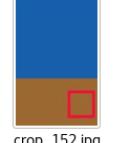
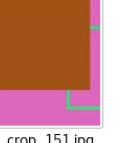
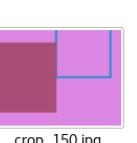
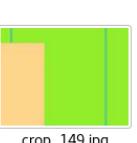
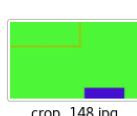
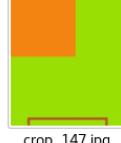
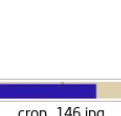
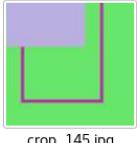
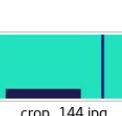
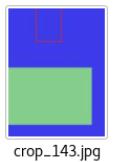
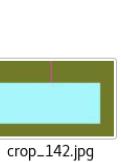
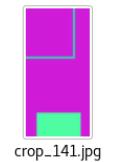
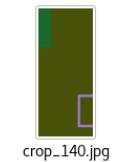
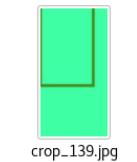
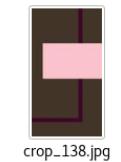
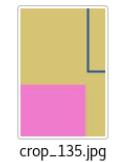
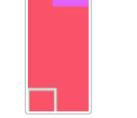
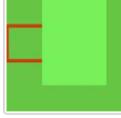
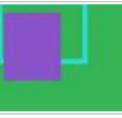
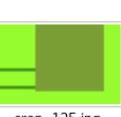
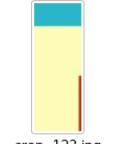
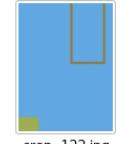
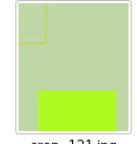
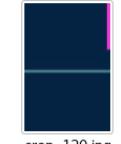
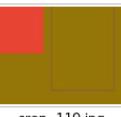
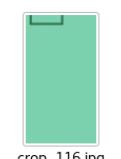
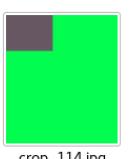
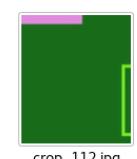
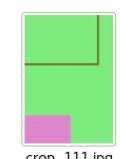
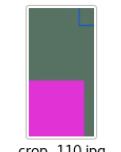
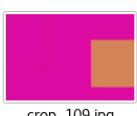
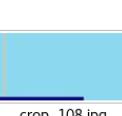
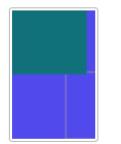
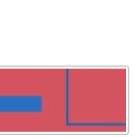
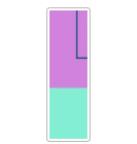
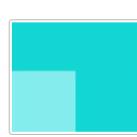
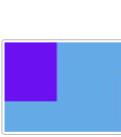
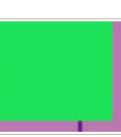
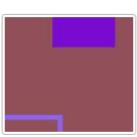
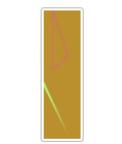
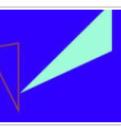
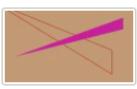
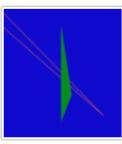
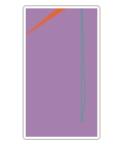


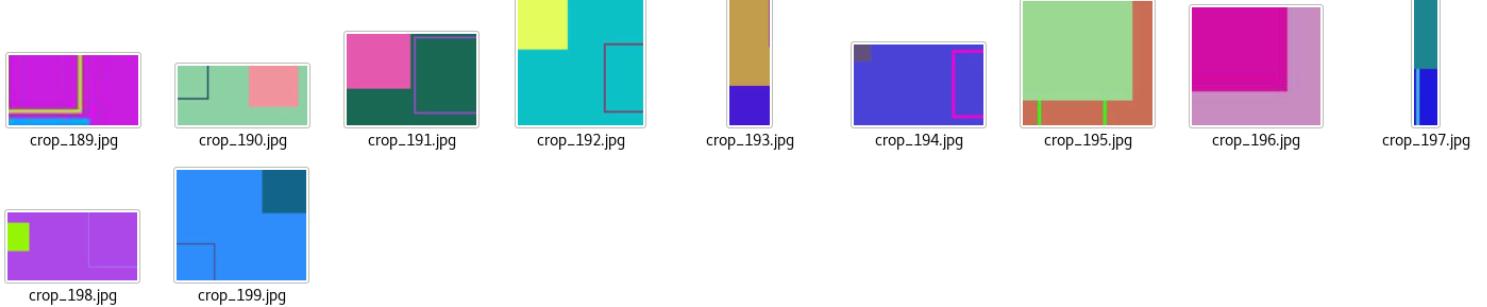




## Step 6: Original dataset is cropped by boundaries through sobel's Edae detection and contours search







Step 7: Keras' generator requires the dataset to be in the same shape; pasting cropped images on the white background of the same area.

