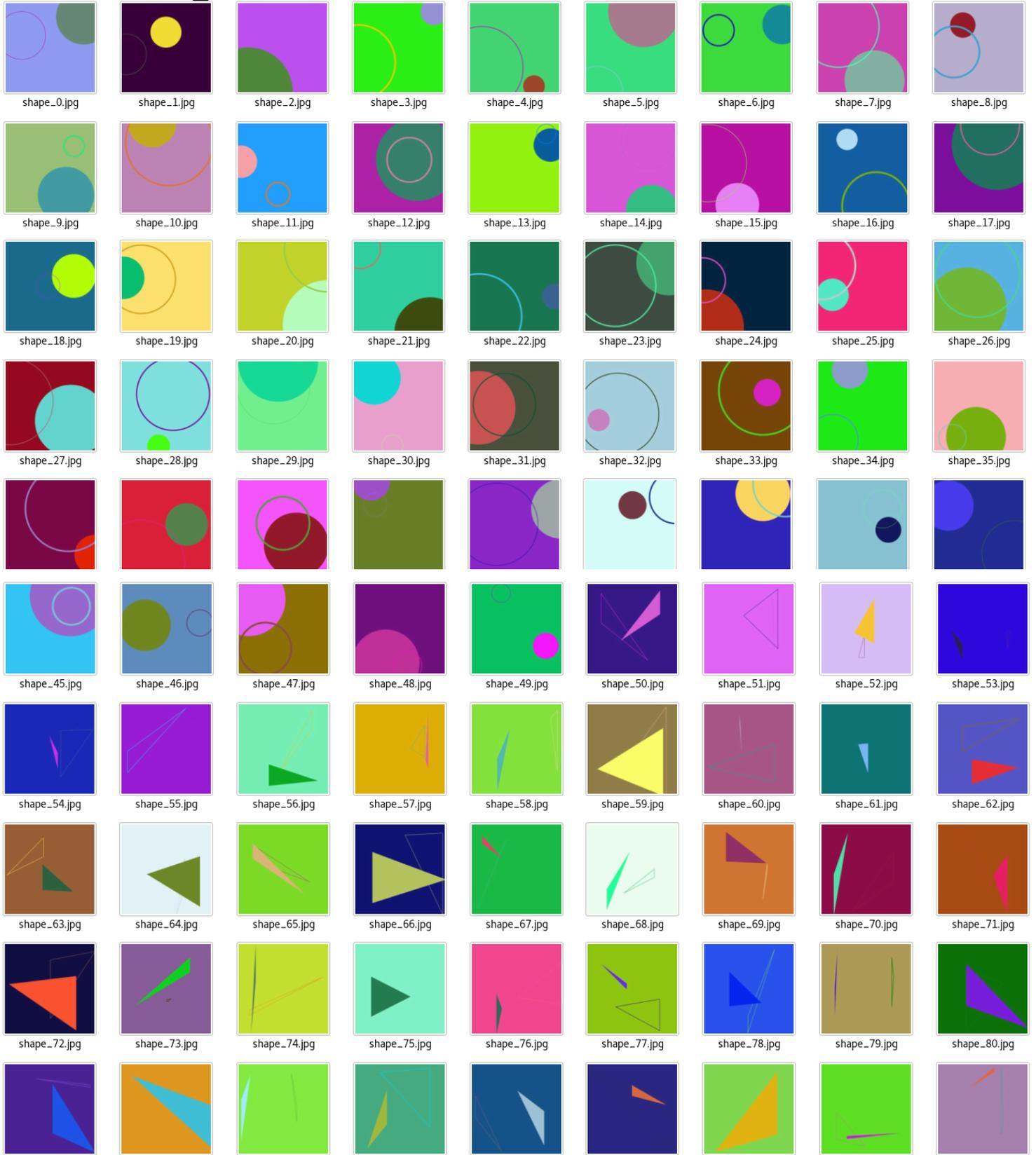
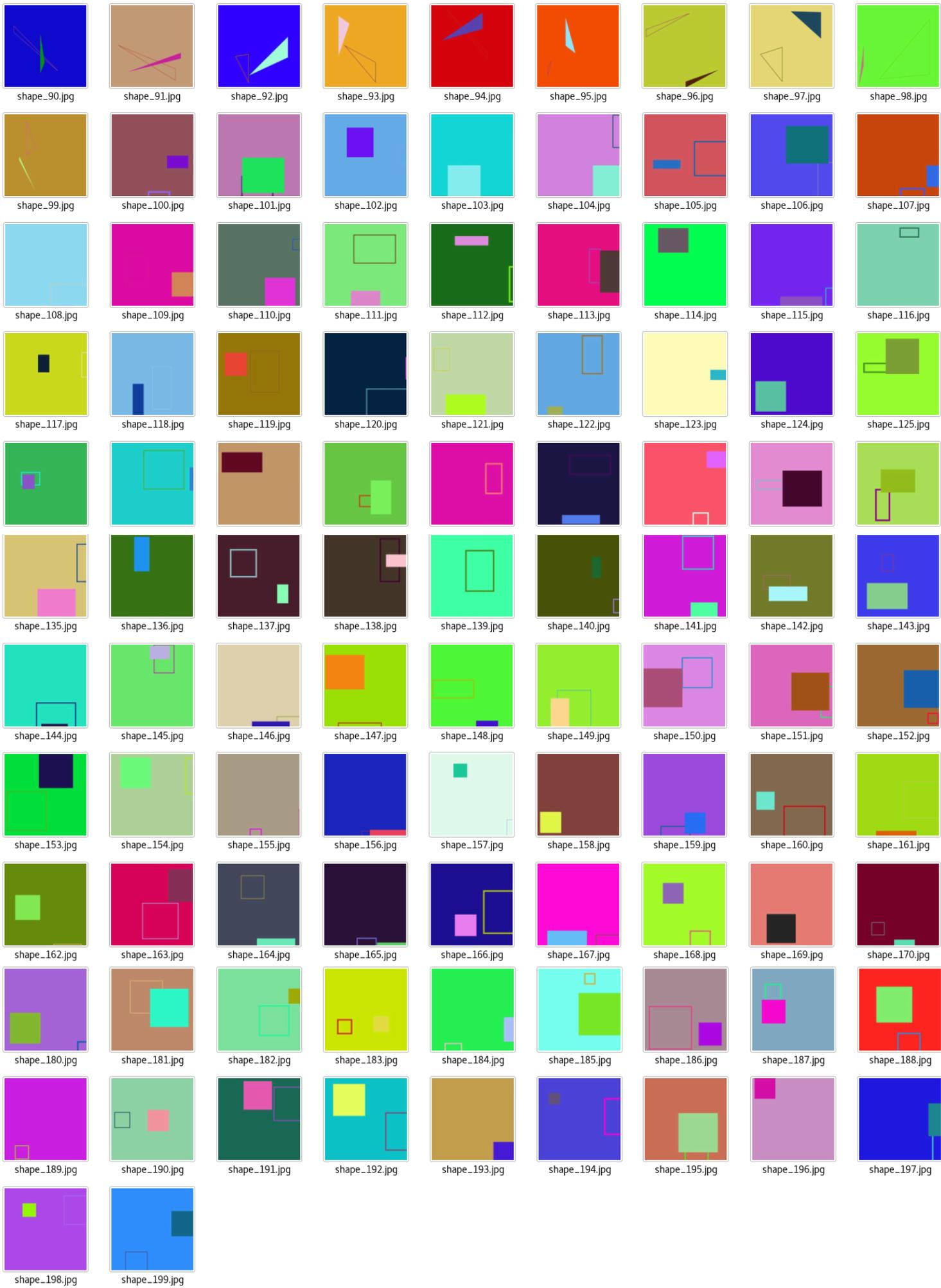
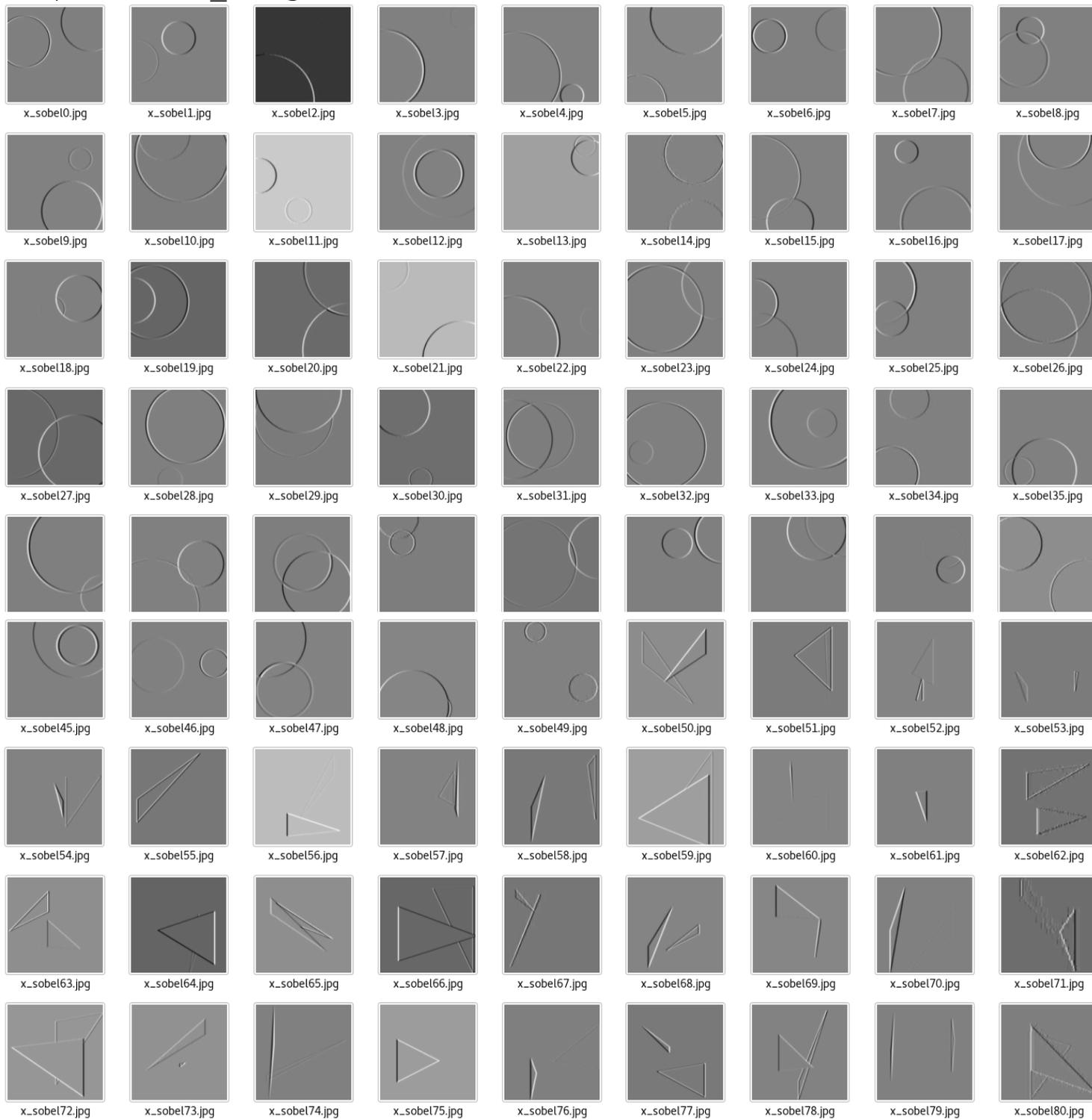


Step 1: get_edges get original images from dataset



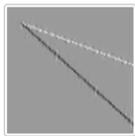


Step 2: Sobel_x algorithm detects contours in the horizontal derivative

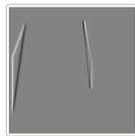




x_sobel81.jpg



x_sobel82.jpg



x_sobel83.jpg



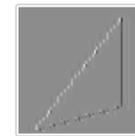
x_sobel84.jpg



x_sobel85.jpg



x_sobel86.jpg



x_sobel87.jpg



x_sobel88.jpg



x_sobel89.jpg



x_sobel90.jpg



x_sobel91.jpg



x_sobel92.jpg



x_sobel93.jpg



x_sobel94.jpg



x_sobel95.jpg



x_sobel96.jpg



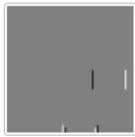
x_sobel97.jpg



x_sobel98.jpg



x_sobel99.jpg



x_sobel100.jpg



x_sobel101.jpg



x_sobel102.jpg



x_sobel103.jpg



x_sobel104.jpg



x_sobel105.jpg



x_sobel106.jpg



x_sobel107.jpg



x_sobel108.jpg



x_sobel109.jpg



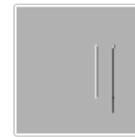
x_sobel110.jpg



x_sobel111.jpg



x_sobel112.jpg



x_sobel113.jpg



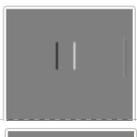
x_sobel114.jpg



x_sobel115.jpg



x_sobel116.jpg



x_sobel117.jpg



x_sobel118.jpg



x_sobel119.jpg



x_sobel120.jpg



x_sobel121.jpg



x_sobel122.jpg



x_sobel123.jpg



x_sobel124.jpg



x_sobel125.jpg



x_sobel126.jpg



x_sobel127.jpg



x_sobel128.jpg



x_sobel129.jpg



x_sobel130.jpg



x_sobel131.jpg



x_sobel132.jpg



x_sobel133.jpg



x_sobel134.jpg



x_sobel135.jpg



x_sobel136.jpg



x_sobel137.jpg



x_sobel138.jpg



x_sobel139.jpg



x_sobel140.jpg



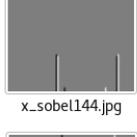
x_sobel141.jpg



x_sobel142.jpg



x_sobel143.jpg



x_sobel144.jpg



x_sobel145.jpg



x_sobel146.jpg



x_sobel147.jpg



x_sobel148.jpg



x_sobel149.jpg



x_sobel150.jpg



x_sobel151.jpg



x_sobel152.jpg



x_sobel153.jpg



x_sobel154.jpg



x_sobel155.jpg



x_sobel156.jpg



x_sobel157.jpg



x_sobel158.jpg



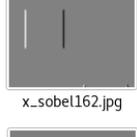
x_sobel159.jpg



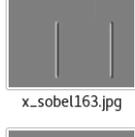
x_sobel160.jpg



x_sobel161.jpg



x_sobel162.jpg



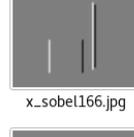
x_sobel163.jpg



x_sobel164.jpg



x_sobel165.jpg



x_sobel166.jpg



x_sobel167.jpg



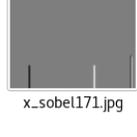
x_sobel168.jpg



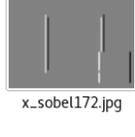
x_sobel169.jpg



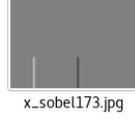
x_sobel170.jpg



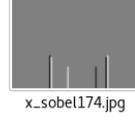
x_sobel171.jpg



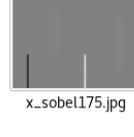
x_sobel172.jpg



x_sobel173.jpg



x_sobel174.jpg



x_sobel175.jpg



x_sobel176.jpg



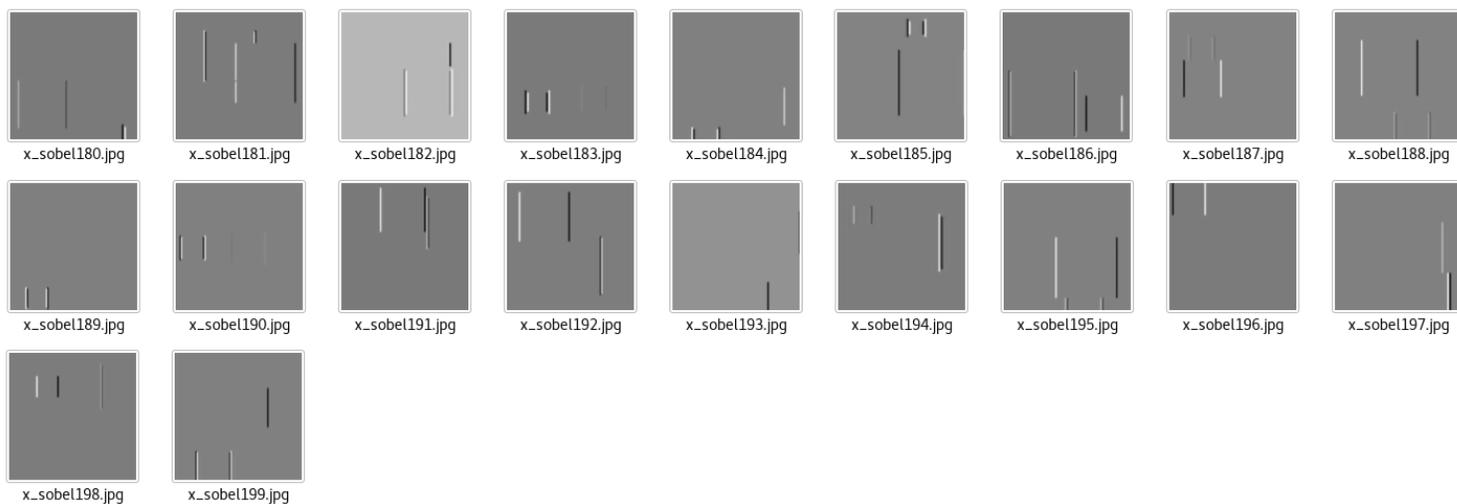
x_sobel177.jpg



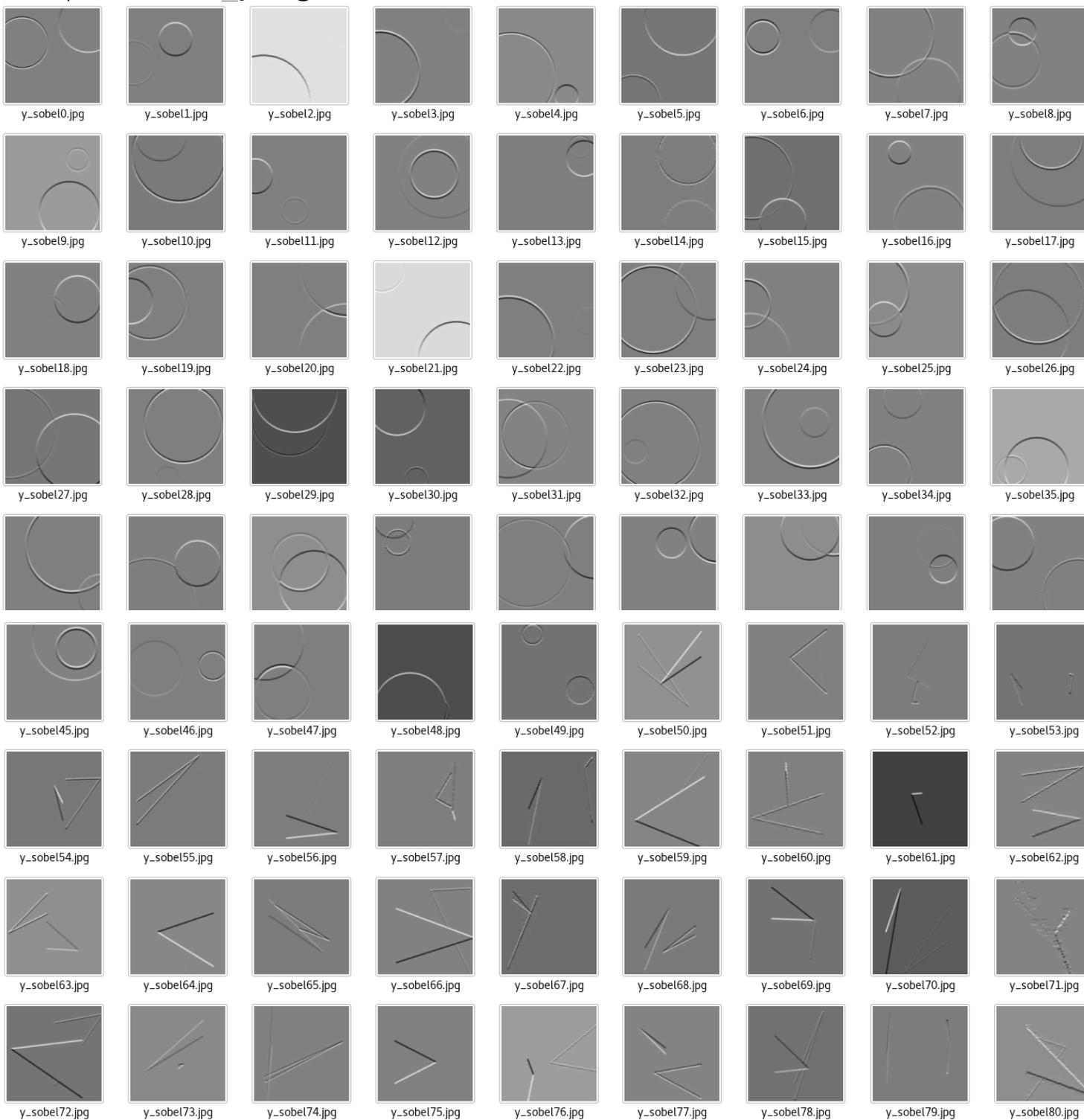
x_sobel178.jpg

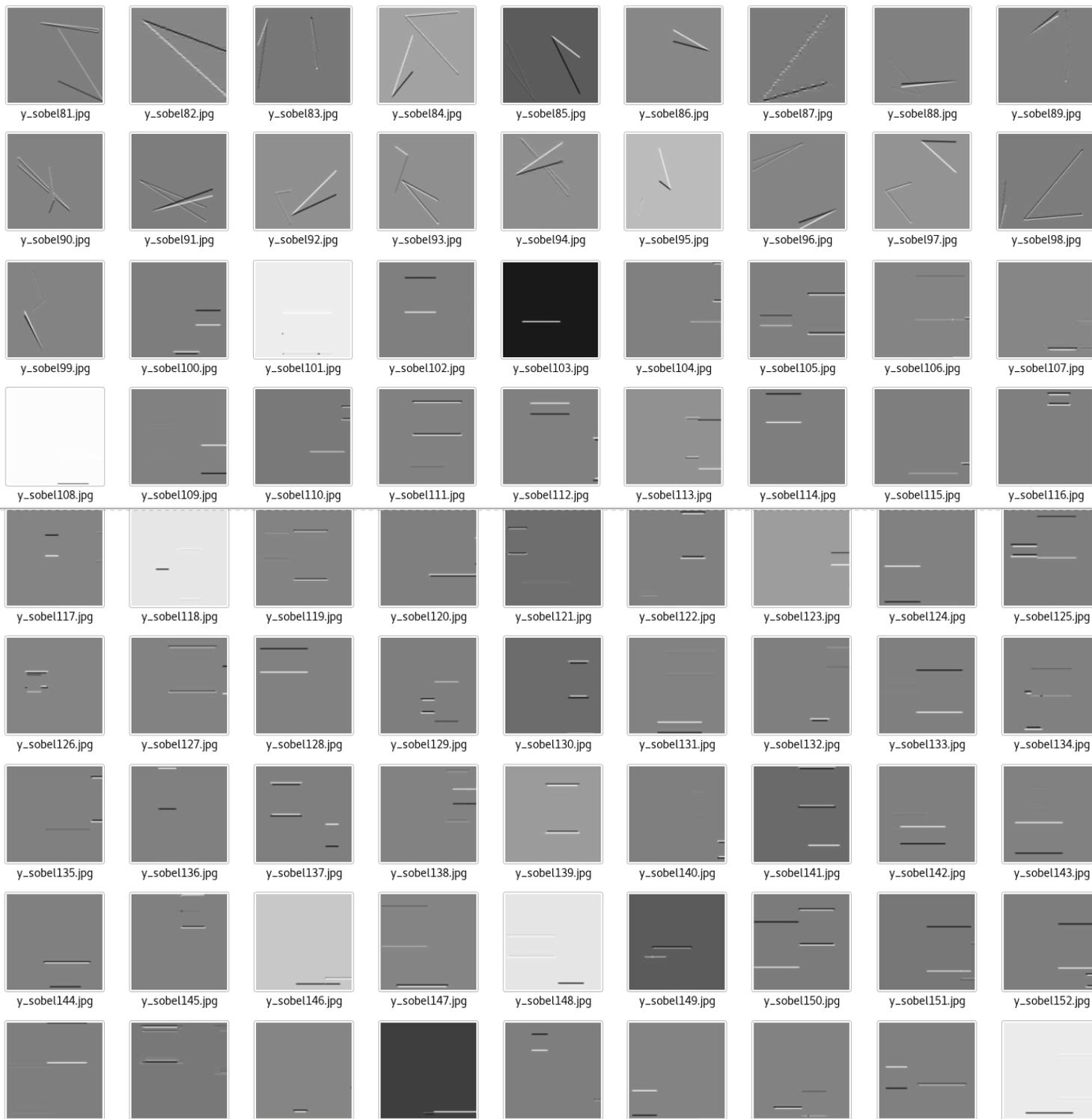


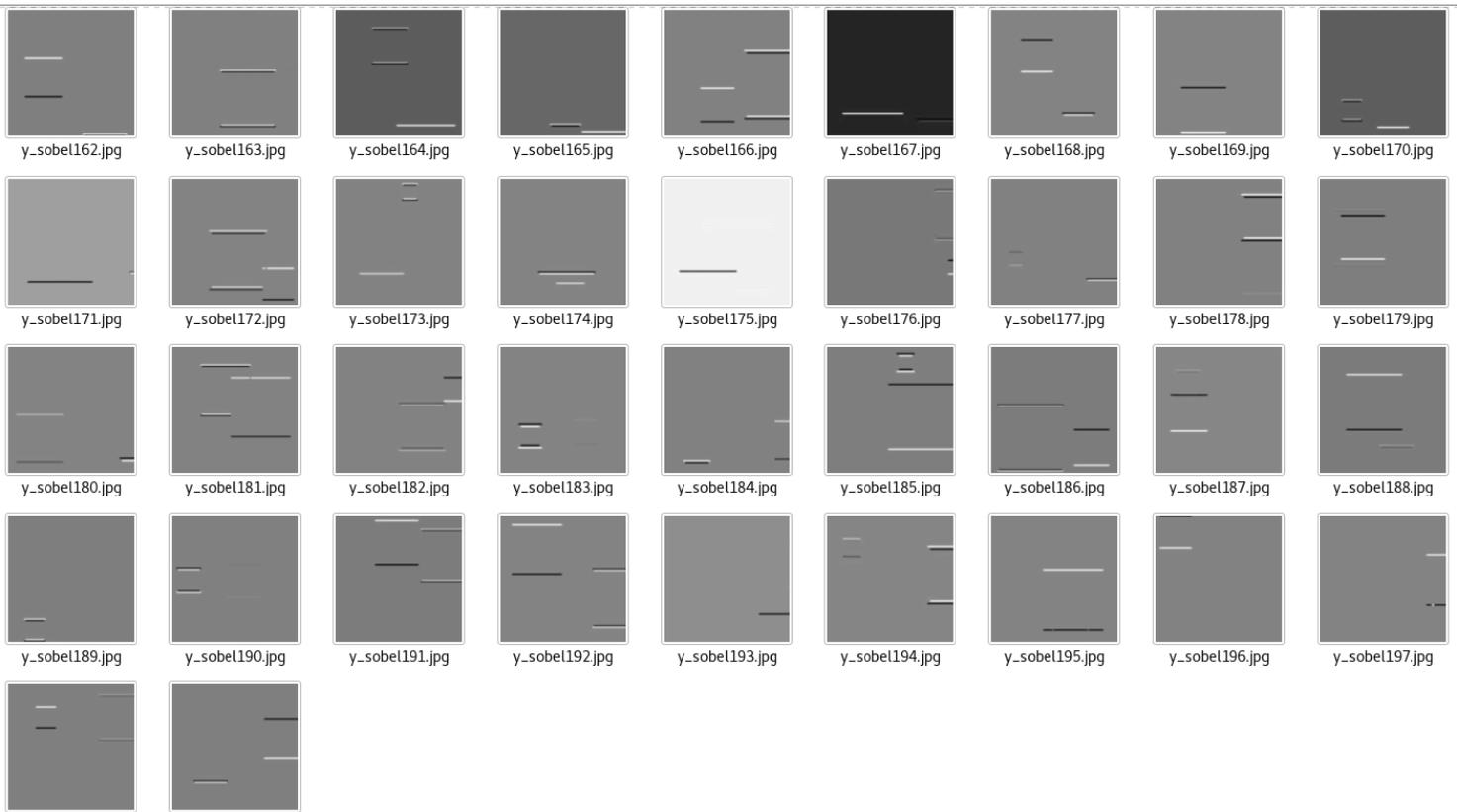
x_sobel179.jpg



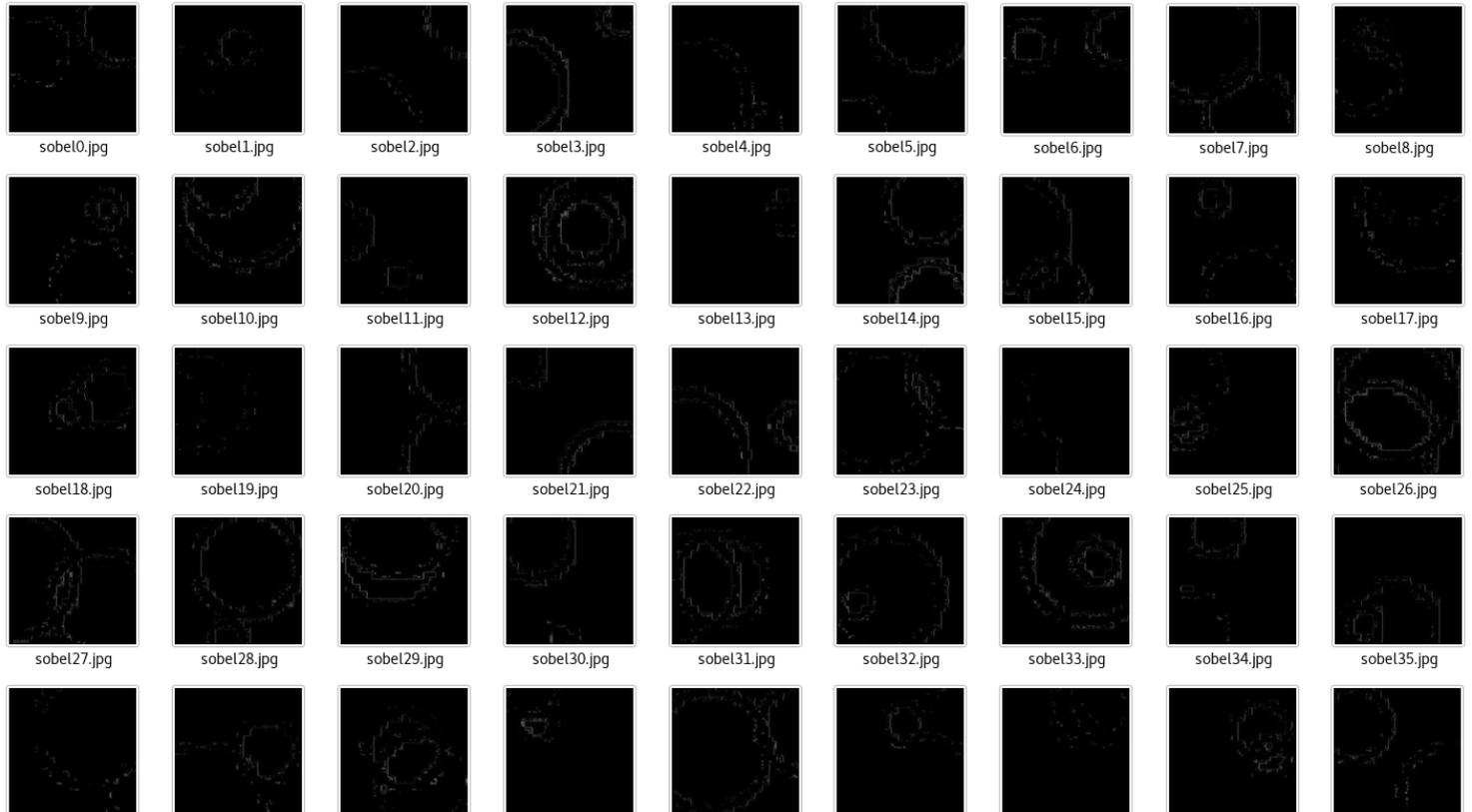
Step 3: Sobel_y algorithm detects contours in the vertical derivative





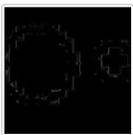


Step 4: Combine gradients of x and y changes





sobel45.jpg



sobel46.jpg



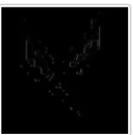
sobel47.jpg



sobel48.jpg



sobel49.jpg



sobel50.jpg



sobel51.jpg



sobel52.jpg



sobel53.jpg



sobel54.jpg



sobel55.jpg



sobel56.jpg



sobel57.jpg



sobel58.jpg



sobel59.jpg



sobel60.jpg



sobel61.jpg



sobel62.jpg



sobel63.jpg



sobel64.jpg



sobel65.jpg



sobel66.jpg



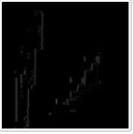
sobel67.jpg



sobel68.jpg



sobel69.jpg



sobel70.jpg



sobel71.jpg



sobel72.jpg



sobel73.jpg



sobel74.jpg



sobel75.jpg



sobel76.jpg



sobel77.jpg



sobel78.jpg



sobel79.jpg



sobel80.jpg



sobel81.jpg



sobel82.jpg



sobel83.jpg



sobel84.jpg



sobel85.jpg



sobel86.jpg



sobel87.jpg



sobel88.jpg



sobel89.jpg



sobel90.jpg



sobel91.jpg



sobel92.jpg



sobel93.jpg



sobel94.jpg



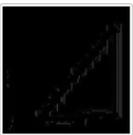
sobel95.jpg



sobel96.jpg



sobel97.jpg



sobel98.jpg



sobel99.jpg



sobel100.jpg



sobel101.jpg



sobel102.jpg



sobel103.jpg



sobel104.jpg



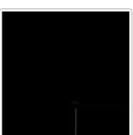
sobel105.jpg



sobel106.jpg



sobel107.jpg



sobel108.jpg



sobel109.jpg



sobel110.jpg



sobel111.jpg



sobel112.jpg



sobel113.jpg



sobel114.jpg



sobel115.jpg



sobel116.jpg



sobel117.jpg



sobel118.jpg



sobel119.jpg



sobel120.jpg



sobel121.jpg



sobel122.jpg



sobel123.jpg



sobel124.jpg



sobel125.jpg



sobel126.jpg



sobel127.jpg



sobel128.jpg



sobel129.jpg



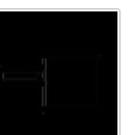
sobel130.jpg



sobel131.jpg



sobel132.jpg



sobel133.jpg



sobel134.jpg



sobel135.jpg



sobel136.jpg



sobel137.jpg



sobel138.jpg



sobel139.jpg



sobel140.jpg



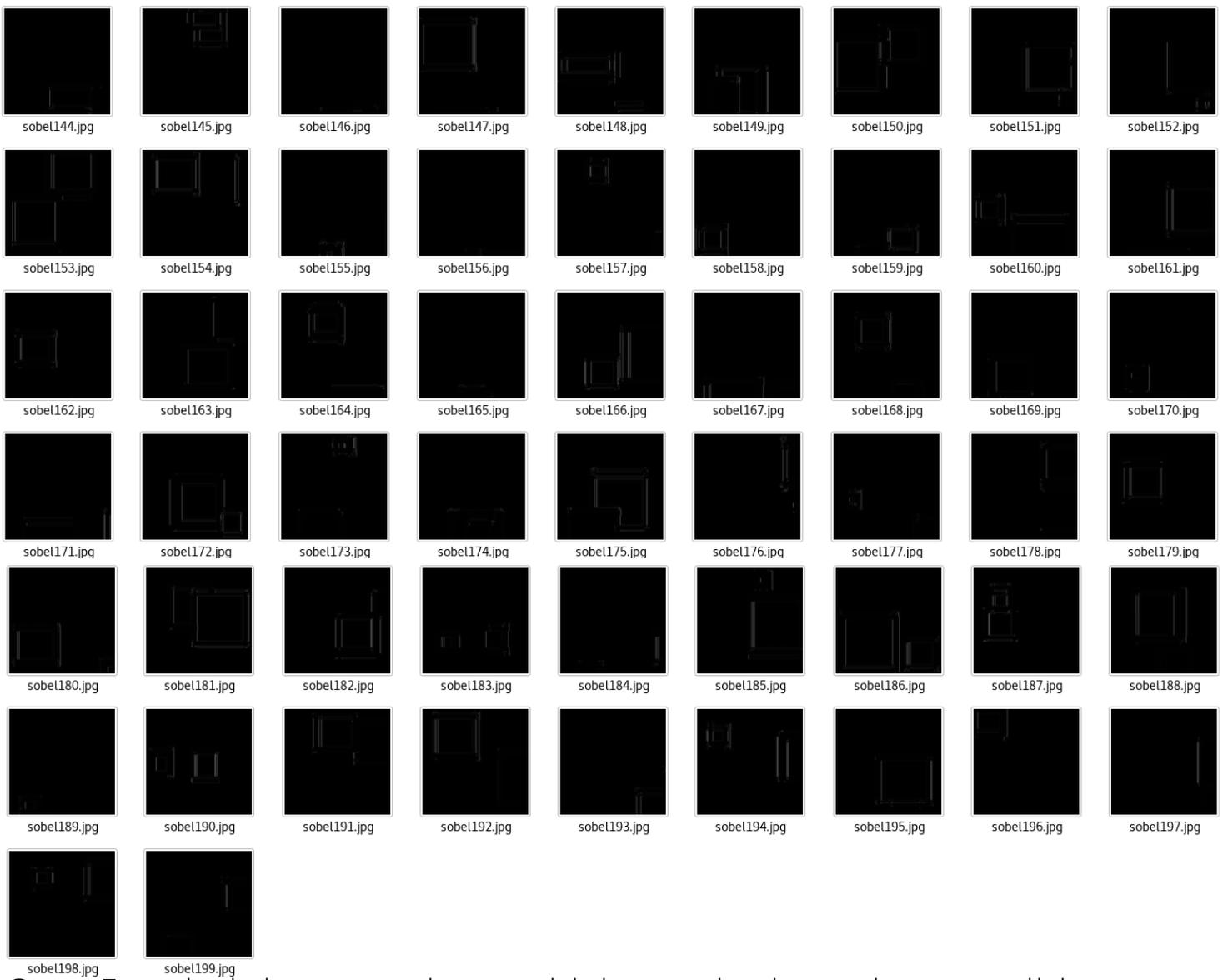
sobel141.jpg



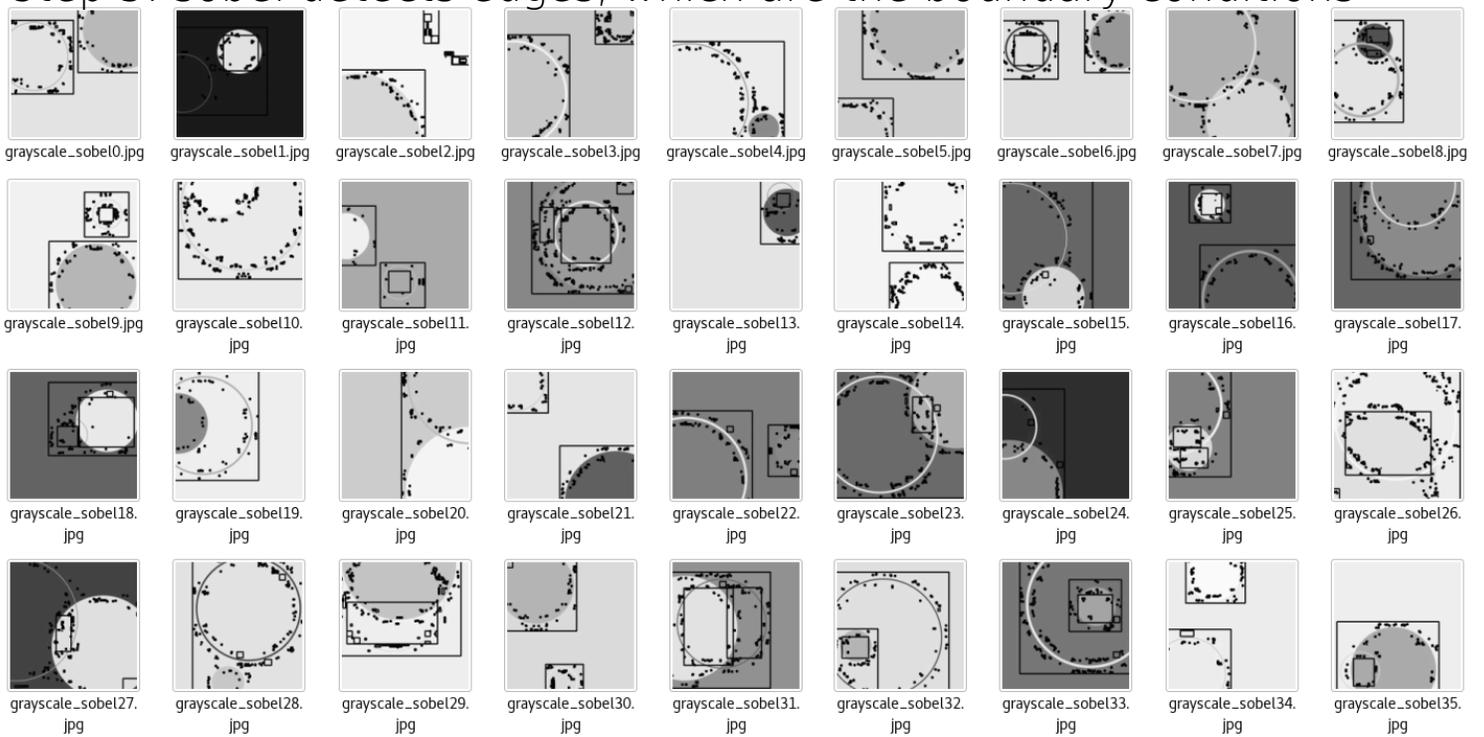
sobel142.jpg



sobel143.jpg



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

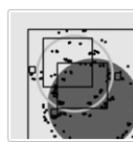




grayscale_sobel36.
jpg



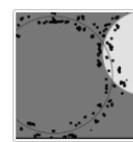
grayscale_sobel37.
jpg



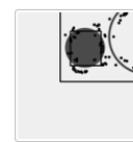
grayscale_sobel38.
jpg



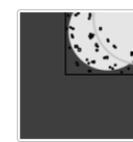
grayscale_sobel39.
jpg



grayscale_sobel40.
jpg



grayscale_sobel41.
jpg



grayscale_sobel42.
jpg



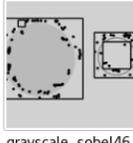
grayscale_sobel43.
jpg



grayscale_sobel44.
jpg



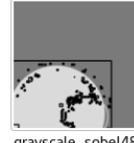
grayscale_sobel45.
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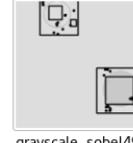
grayscale_sobel46.
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grayscale_sobel47.
jpg



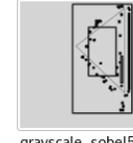
grayscale_sobel48.
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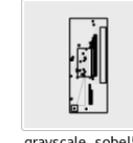
grayscale_sobel49.
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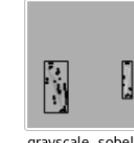
grayscale_sobel50.
jpg



grayscale_sobel51.
jpg



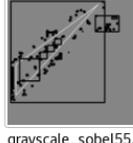
grayscale_sobel52.
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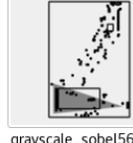
grayscale_sobel53.
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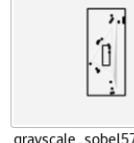
grayscale_sobel54.
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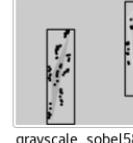
grayscale_sobel55.
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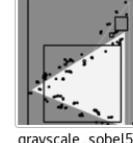
grayscale_sobel56.
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grayscale_sobel57.
jpg



grayscale_sobel58.
jpg



grayscale_sobel59.
jpg



grayscale_sobel60.
jpg



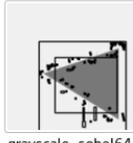
grayscale_sobel61.
jpg



grayscale_sobel62.
jpg



grayscale_sobel63.
jpg



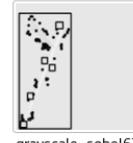
grayscale_sobel64.
jpg



grayscale_sobel65.
jpg



grayscale_sobel66.
jpg



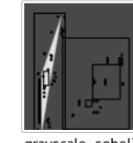
grayscale_sobel67.
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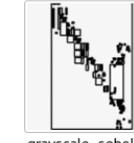
grayscale_sobel68.
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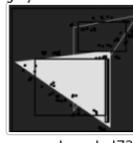
grayscale_sobel69.
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grayscale_sobel70.
jpg



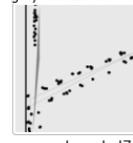
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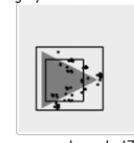
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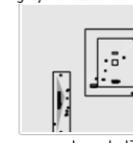
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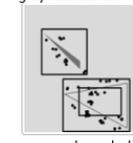
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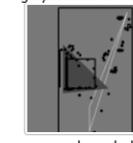
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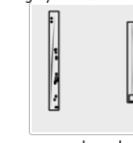
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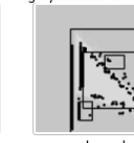
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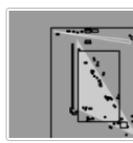
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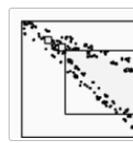
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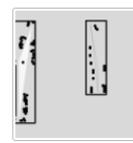
grayscale_sobel80.
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grayscale_sobel81.
jpg



grayscale_sobel82.
jpg



grayscale_sobel83.
jpg



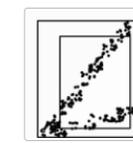
grayscale_sobel84.
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grayscale_sobel85.
jpg



grayscale_sobel86.
jpg



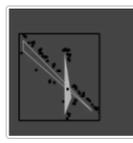
grayscale_sobel87.
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grayscale_sobel88.
jpg



grayscale_sobel89.
jpg



grayscale_sobel90.
jpg



grayscale_sobel91.
jpg



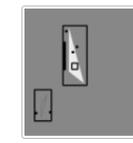
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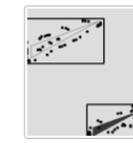
grayscale_sobel93.
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grayscale_sobel94.
jpg



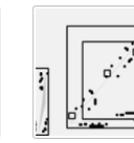
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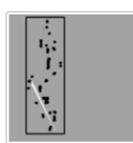
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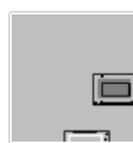
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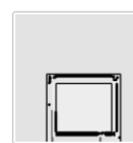
grayscale_sobel98.
jpg



grayscale_sobel99.
jpg



grayscale_sobel100.
jpg



grayscale_sobel101.
jpg



grayscale_sobel102.
jpg



grayscale_sobel103.
jpg



grayscale_sobel104.
jpg



grayscale_sobel105.
jpg

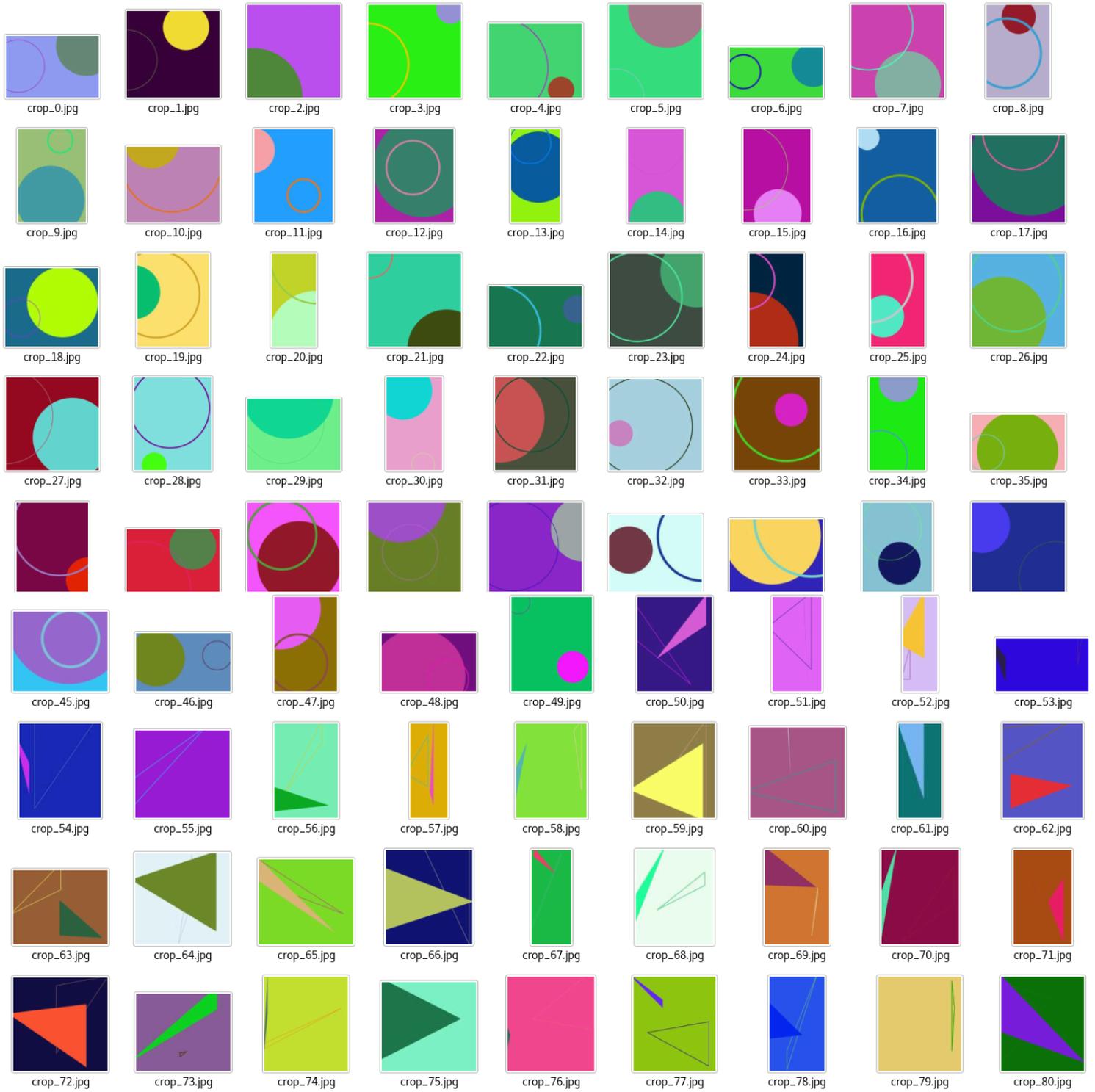


grayscale_sobel106.
jpg



grayscale_sobel107.
jpg

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





crop_81.jpg



crop_82.jpg



crop_83.jpg



crop_84.jpg



crop_85.jpg



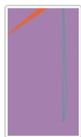
crop_86.jpg



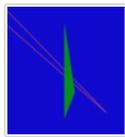
crop_87.jpg



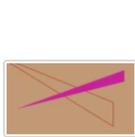
crop_88.jpg



crop_89.jpg



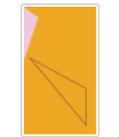
crop_90.jpg



crop_91.jpg



crop_92.jpg



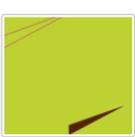
crop_93.jpg



crop_94.jpg



crop_95.jpg



crop_96.jpg



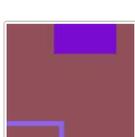
crop_97.jpg



crop_98.jpg



crop_99.jpg



crop_100.jpg



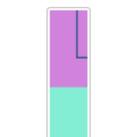
crop_101.jpg



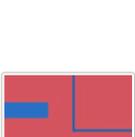
crop_102.jpg



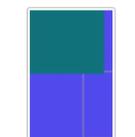
crop_103.jpg



crop_104.jpg



crop_105.jpg



crop_106.jpg



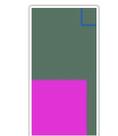
crop_107.jpg



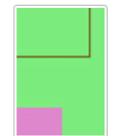
crop_108.jpg



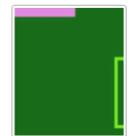
crop_109.jpg



crop_110.jpg



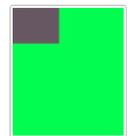
crop_111.jpg



crop_112.jpg



crop_113.jpg



crop_114.jpg



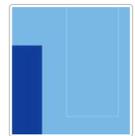
crop_115.jpg



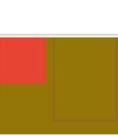
crop_116.jpg



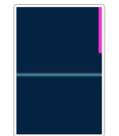
crop_117.jpg



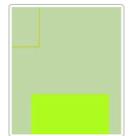
crop_118.jpg



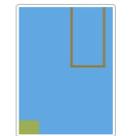
crop_119.jpg



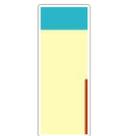
crop_120.jpg



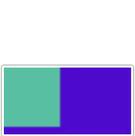
crop_121.jpg



crop_122.jpg



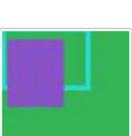
crop_123.jpg



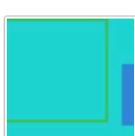
crop_124.jpg



crop_125.jpg



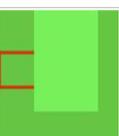
crop_126.jpg



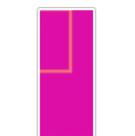
crop_127.jpg



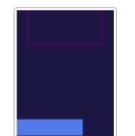
crop_128.jpg



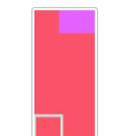
crop_129.jpg



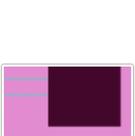
crop_130.jpg



crop_131.jpg



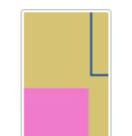
crop_132.jpg



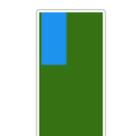
crop_133.jpg



crop_134.jpg



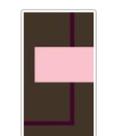
crop_135.jpg



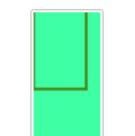
crop_136.jpg



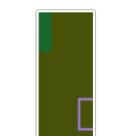
crop_137.jpg



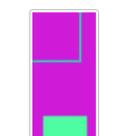
crop_138.jpg



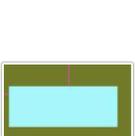
crop_139.jpg



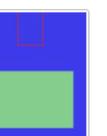
crop_140.jpg



crop_141.jpg



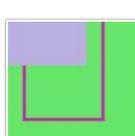
crop_142.jpg



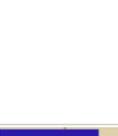
crop_143.jpg



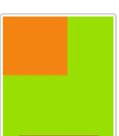
crop_144.inn



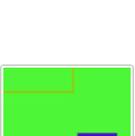
crop_145.inn



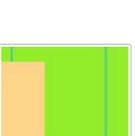
crop_146.inn



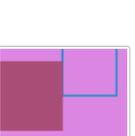
crop_147.inn



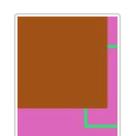
crop_148.inn



crop_149.inn



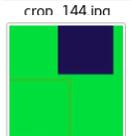
crop_150.inn



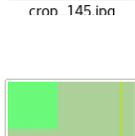
crop_151.inn



crop_152.inn



crop_153.jpg



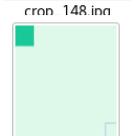
crop_154.jpg



crop_155.jpg



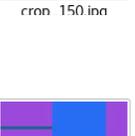
crop_156.jpg



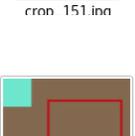
crop_157.jpg



crop_158.jpg



crop_159.jpg



crop_160.jpg



crop_161.jpg



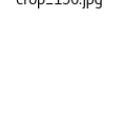
crop_162.jpg



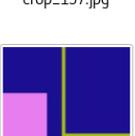
crop_163.jpg



crop_164.jpg



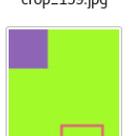
crop_165.jpg



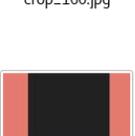
crop_166.jpg



crop_167.jpg



crop_168.jpg



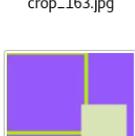
crop_169.jpg



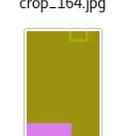
crop_170.jpg



crop_171.jpg



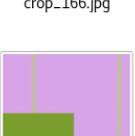
crop_172.jpg



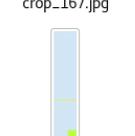
crop_173.jpg



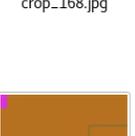
crop_174.jpg



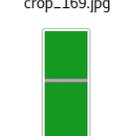
crop_175.jpg



crop_176.jpg



crop_177.jpg



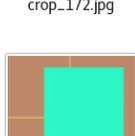
crop_178.jpg



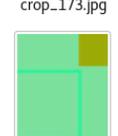
crop_179.jpg



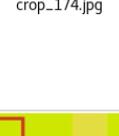
crop_180.jpg



crop_181.jpg



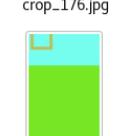
crop_182.jpg



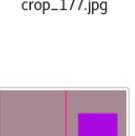
crop_183.jpg



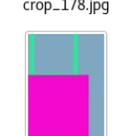
crop_184.jpg



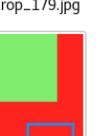
crop_185.jpg



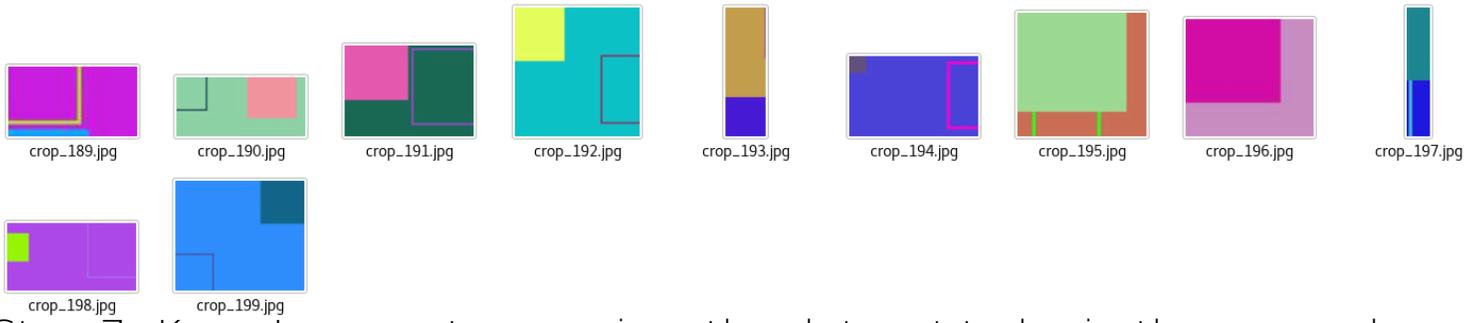
crop_186.jpg



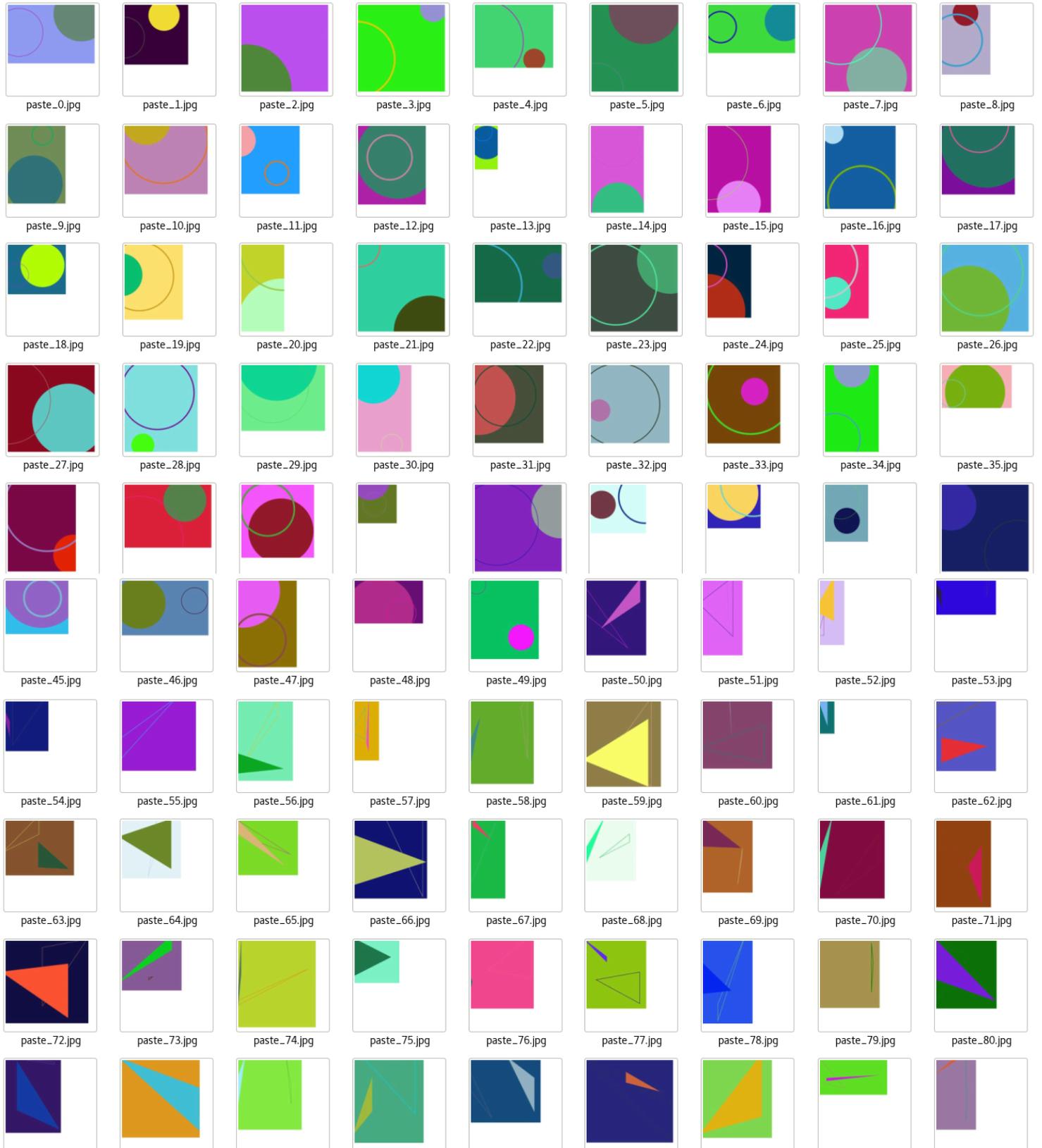
crop_187.jpg



crop_188.jpg



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





paste_90.jpg



paste_91.jpg



paste_92.jpg



paste_93.jpg



paste_94.jpg



paste_95.jpg



paste_96.jpg



paste_97.jpg



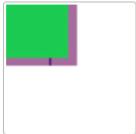
paste_98.jpg



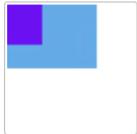
paste_99.jpg



paste_100.jpg



paste_101.jpg



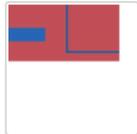
paste_102.jpg



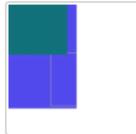
paste_103.jpg



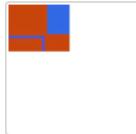
paste_104.jpg



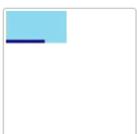
paste_105.jpg



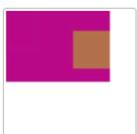
paste_106.jpg



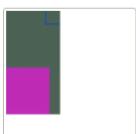
paste_107.jpg



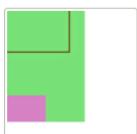
paste_108.jpg



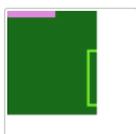
paste_109.jpg



paste_110.jpg



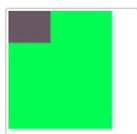
paste_111.jpg



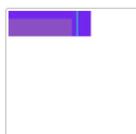
paste_112.jpg



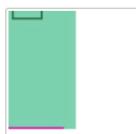
paste_113.jpg



paste_114.jpg



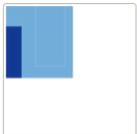
paste_115.jpg



paste_116.jpg



paste_117.jpg



paste_118.jpg



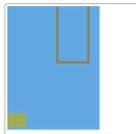
paste_119.jpg



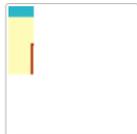
paste_120.jpg



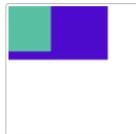
paste_121.jpg



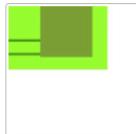
paste_122.jpg



paste_123.jpg



paste_124.jpg



paste_125.jpg



paste_135.jpg



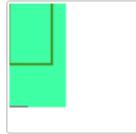
paste_136.jpg



paste_137.jpg



paste_138.jpg



paste_139.jpg



paste_140.jpg



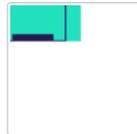
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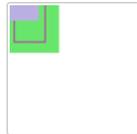
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paste_143.jpg



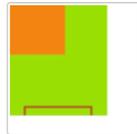
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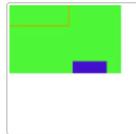
paste_145.jpg



paste_146.jpg



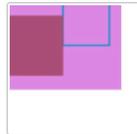
paste_147.jpg



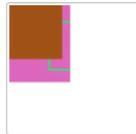
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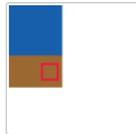
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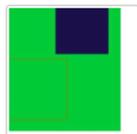
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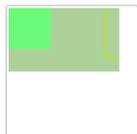
paste_151.jpg



paste_152.jpg



paste_153.jpg



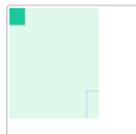
paste_154.jpg



paste_155.jpg



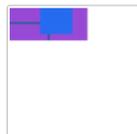
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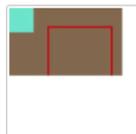
paste_157.jpg



paste_158.jpg



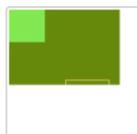
paste_159.jpg



paste_160.jpg



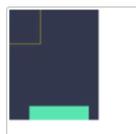
paste_161.jpg



paste_162.jpg



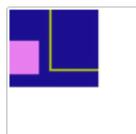
paste_163.jpg



paste_164.jpg



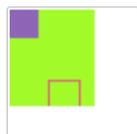
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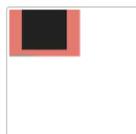
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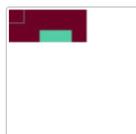
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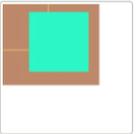
paste_169.jpg



paste_170.jpg



paste_180.jpg



paste_181.jpg



paste_182.jpg



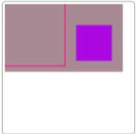
paste_183.jpg



paste_184.jpg



paste_185.jpg



paste_186.jpg



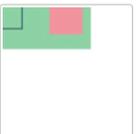
paste_187.jpg



paste_188.jpg



paste_189.jpg



paste_190.jpg



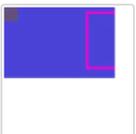
paste_191.jpg



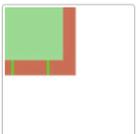
paste_192.jpg



paste_193.jpg



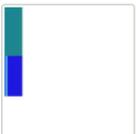
paste_194.jpg



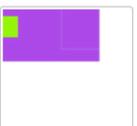
paste_195.jpg



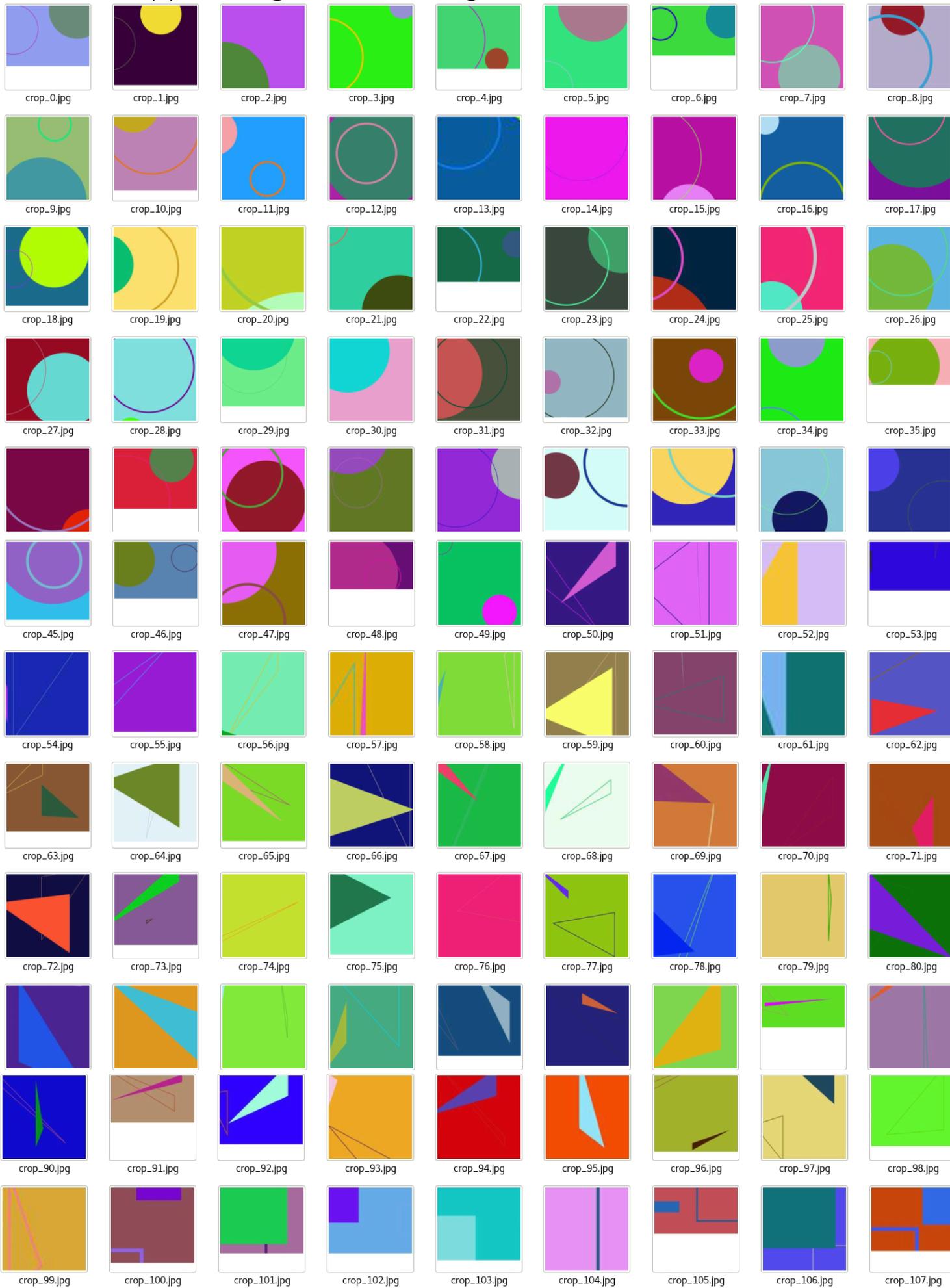
paste_196.jpg



paste_197.jpg



Step 8: Scaling the images to a fixed width of 300 with an aspect ratio for the cropped height of the image

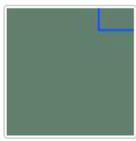




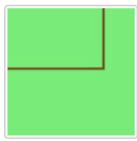
crop_108.jpg



crop_109.jpg



crop_110.jpg



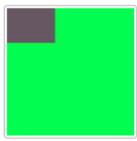
crop_111.jpg



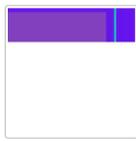
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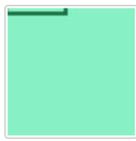
crop_113.jpg



crop_114.jpg



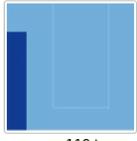
crop_115.jpg



crop_116.jpg



crop_117.jpg



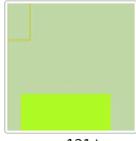
crop_118.jpg



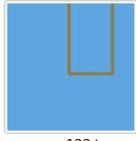
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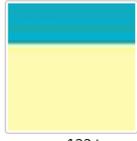
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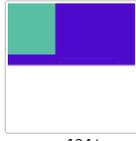
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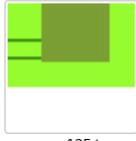
crop_122.jpg



crop_123.jpg



crop_124.jpg



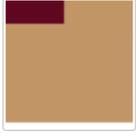
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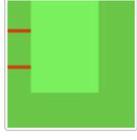
crop_126.jpg



crop_127.jpg



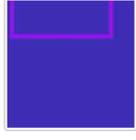
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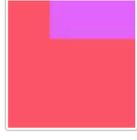
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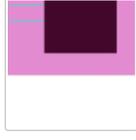
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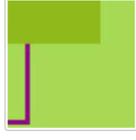
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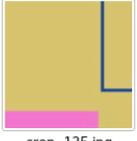
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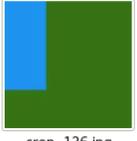
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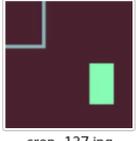
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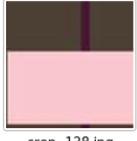
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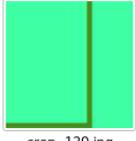
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crop_137.jpg



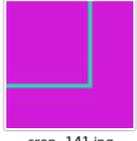
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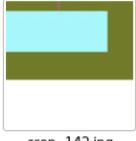
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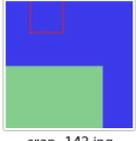
crop_140.jpg



crop_141.jpg



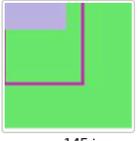
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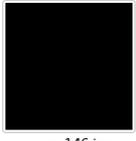
crop_143.jpg



crop_144.jpg



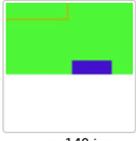
crop_145.jpg



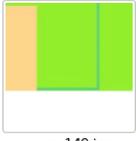
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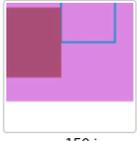
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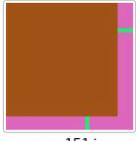
crop_148.jpg



crop_149.jpg



crop_150.jpg



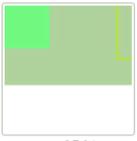
crop_151.jpg



crop_152.jpg



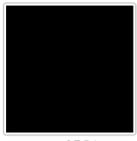
crop_153.jpg



crop_154.jpg



crop_155.jpg



crop_156.jpg



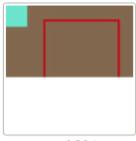
crop_157.jpg



crop_158.jpg



crop_159.jpg



crop_160.jpg



crop_161.jpg



crop_162.jpg



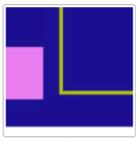
crop_163.jpg



crop_164.jpg



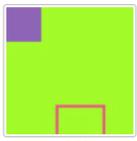
crop_165.jpg



crop_166.jpg



crop_167.jpg



crop_168.jpg



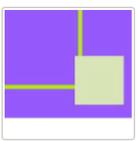
crop_169.jpg



crop_170.jpg



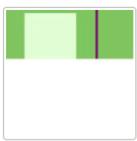
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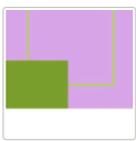
crop_172.jpg



crop_173.jpg



crop_174.jpg



crop_175.jpg



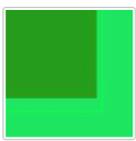
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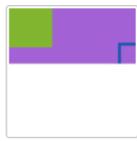
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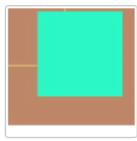
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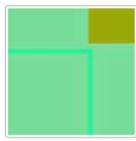
crop_179.jpg



crop_180.jpg



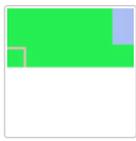
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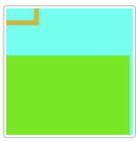
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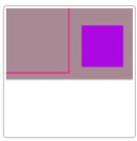
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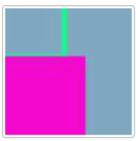
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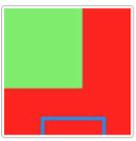
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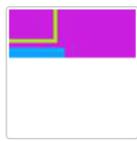
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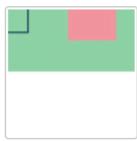
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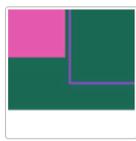
crop_188.jpg



crop_189.jpg



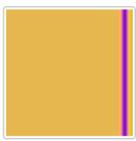
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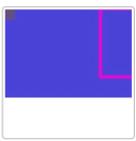
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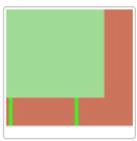
crop_192.jpg



crop_193.jpg



crop_194.jpg



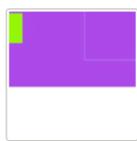
crop_195.jpg



crop_196.jpg



crop_197.jpg



crop_198.jpg



crop_199.jpg