Ryan Brinkley

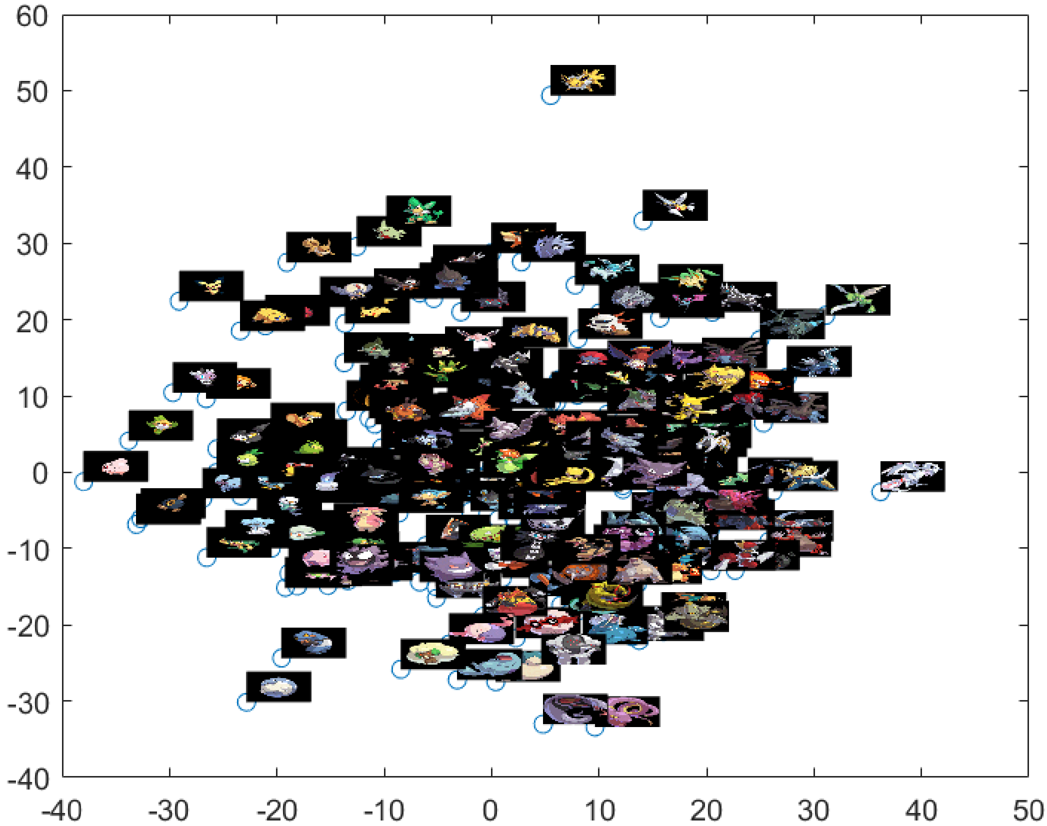
CSE 408 Project 2 Report

All of the algorithms worked well in categorizing the different images based on their similarity in color or edges. Pokémon are often very colorful and have several colors that make up their image. This often confused the algorithms. Average Pixel Color had some issues when there several different colors and shades of colors in an image, which resulted in a very mottled and dull average color for the image. This resulted in many of the outputs being different from what you would typically expect. For example, a picture of Charmander (4.png) is very bright and orange, but brown Pokémon like Sandile (551.png) were returned when using SSD to determine the relationship. Spatial Grid of Average Pixel Colors had similar issues when there were several different colors in the same grid space. This was most likely due to the reduction in size of the original matrix to make the submatrices. When this is done, some of the detail is lost in the image, which would ultimately affect the output. Color Histograms didn’t experience this problem as much as the first two algorithms, but there were still a few issues where large numbers of pixels with colors the same as the input image would result in incorrect outputs. For example, Charmander (4.png) has many oranges and tan colors, but the outputs of Servine (496.png) and Persian (53.png) aren’t close at all to the input. Edge Energy in a Spatial Grid worked well in finding Pokémon with similar edges to the input image, but Pokémon are often complex in the different edges in the image. This resulted in some outputs that weren’t completely consistent with the main shape of the input. Charmander (4.png) produced Charmeleon (5.png) which is very similar, but it also produced Spheal (363.png) which isn’t all that similar in shape. The best feature extraction would take both color and shape into consideration in order to more accurately capture the innate qualities of the image and not ignore important details.

The Angle Between Vectors knn classification appeared to work better than SSD for most of the input images used. This was most likely due to the more complex association between the vectors. SSD only uses distance, and the exclusion or inclusion of similar or dissimilar pixel colors can greatly alter the distance and the resulting output. Angle Between Vectors takes into consideration additional qualities and computations on the vectors, which results in a more refined classification of the images based on their features.

The output quality was usually very good when the Pokémon used a consistent color and didn’t have any colors that were on different ends of the color spectrum. This would confuse the program. More often than not evolution lines were not outputted. This was often due to the different base colors that many of the evolution lines use. For example, Charmander (4.png) is a basic orange, but its family members are a bright red or include blues that confused the system. Sewaddle (540.png) did produce all of its family members when using the Color Histograms approach due to their highly similar color palettes. Additionally, the database images had the Pokémon in very different stances and positions that were not similar base input. This made it very difficult for evolution lines to be returned when using the Edge Energy in a Spatial Grid approach. If the database images were more consistent with the official images for the Pokémon, the system would be consistent as they are typically in similar positions that would make the edge energy better. To further test the accuracy and validity of the tests, one could measure the percentage of test inputs that result in an evolution family member in the output. Or, one could measure the precision based on the relative similarity between the outputs and the input image.

The PCA feature embedding seemed to work fairly well. The 1st principal component was graphed along the x axis, and the 2nd principal component was graphed along the y. It is somewhat difficult to determine the correctness of the plot without knowing how the coordinates are evaluated, but generally it appears to be correct. Most of the very similar Pokémon were clumped together in one section of the graph, and some of the more unique Pokémon were farther away from the center of the mass. In addition, evolution lines were generally very close to one another on the plot. For example, Ekans and Arbok are close to one another along the same y axis. A reasonable evaluation metric could be the average distance between a Pokemon and its evolution family members. You would generally expect this to be a fairly low distance if this was a successful extraction of features.



Below are the results from the 10 different image inputs with both SSD and Angle Between Vectors knn classification.

- Average Pixel Color
  - 4.png
    - SSD

      136.png
      129.png
      554.png
      26.png
      499.png
      595.png
      551.png
      400.png
      552.png
      63.png

    - Angle Between Vectors

      499.png
      136.png
      390.png
      433.png
      498.png
      560.png
      399.png
      559.png
      391.png
      514.png

  - 25.png
    - SSD

      559.png
      595.png
      390.png
      433.png
      496.png
      499.png
      133.png
      410.png
      52.png
      246.png

    - Angle Between Vectors

      64.png
      65.png
      595.png
      63.png
      181.png
      135.png
      559.png
      399.png
      433.png
      149.png

  - 39.png
    - SSD

      628.png
      196.png
      150.png
      398.png
      573.png
      355.png
      634.png
      493-norma…
      493.png
      426.png

    - Angle Between Vectors

      534.png
      398.png
      624.png
      174.png
      396.png
      397.png
      361.png
      533.png
      639.png
      442.png

- 63.png
  - SSD
    - 26.png
    - 136.png
    - 400.png
    - 4.png
    - 391.png
    - 595.png
    - 596.png
    - 135.png
    - 470.png
    - 129.png
  - Angle Between Vectors
    - 65.png
    - 25.png
    - 595.png
    - 64.png
    - 612.png
    - 559.png
    - 433.png
    - 399.png
    - 181.png
    - 135.png
- 129.png
  - SSD
    - 551.png
    - 136.png
    - 4.png
    - 526.png
    - 391.png
    - 400.png
    - 552.png
    - 533.png
    - 554.png
    - 5.png
  - Angle Between Vectors
    - 551.png
    - 464.png
    - 637.png
    - 383.png
    - 500.png
    - 391.png
    - 560.png
    - 499.png
    - 400.png
    - 514.png
- 147.png
  - SSD
    - 454.png
    - 363.png
    - 93.png
    - 364.png
    - 148.png
    - 95.png
    - 40.png
    - 305.png
    - 553.png
    - 131.png
  - Angle Between Vectors
    - 68.png
    - 348.png
    - 607.png
    - 454.png
    - 609.png
    - 67.png
    - 111.png
    - 66.png
    - 633.png
    - 395.png

- 252.png
    - SSD

      246.png
      496.png
      495.png
      52.png
      410.png
      280.png
      540.png
      397.png
      253.png
      404.png

    - Angle Between Vectors

      470.png
      496.png
      495.png
      246.png
      548.png
      610.png
      547.png
      172.png
      549.png
      477.png

- 374.png
    - SSD

      403.png
      633.png
      501.png
      280.png
      574.png
      197.png
      447.png
      575.png
      525.png
      587.png

    - Angle Between Vectors

      446.png
      195.png
      376.png
      204.png
      502.png
      375.png
      131.png
      483.png
      134.png
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- 540.png
    - SSD

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      433.png
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      532.png

    - Angle Between Vectors

      549.png
      455.png
      135.png
      470.png
      496.png
      181.png
      495.png
      548.png
      172.png
      25.png

- 572.png
    - SSD

      15.png
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      523.png
      576.png
      405.png
      544.png
      515.png
      445.png
      174.png

    - Angle Between Vectors

      15.png
      611.png
      355.png
      411.png
      493-normal.png
      493.png
      627.png
      587.png
      522.png
      478.png

- Spatial Grid of Average Pixel Colors
  - 4.png
    - SSD

      5.png
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      513.png
      136.png
      499.png
      498.png
      470.png
      554.png
      390.png
      400.png

    - Angle Between Vectors

      5.png
      26.png
      136.png
      513.png
      135.png
      636.png
      531.png
      560.png
      40.png
      498.png

  - 25.png
    - SSD

      410.png
      587.png
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      610.png
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      541.png
      280.png
      403.png
      559.png

    - Angle Between Vectors

      587.png
      410.png
      548.png
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      524.png
      499.png
      607.png
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      40.png

  - 39.png
    - SSD

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      304.png
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      572.png
      111.png
      281.png
      174.png
      247.png
      613.png
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    - Angle Between Vectors

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      363.png
      572.png
      529.png
      546.png
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      544.png
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  - 63.png
    - SSD

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      391.png
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    - Angle Between Vectors

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      611.png
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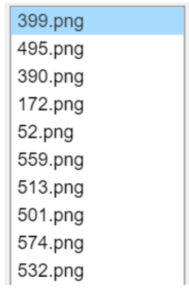
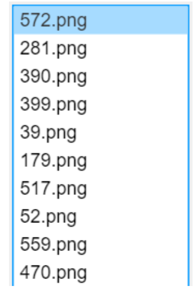
- 129.png
  - SSD
    - 544.png
    - 399.png
    - 52.png
    - 554.png
    - 530.png
    - 595.png
    - 361.png
    - 136.png
    - 559.png
    - 433.png
  - Angle Between Vectors
    - 399.png
    - 532.png
    - 39.png
    - 544.png
    - 52.png
    - 517.png
    - 546.png
    - 180.png
    - 390.png
    - 514.png
- 147.png
  - SSD
    - 453.png
    - 531.png
    - 68.png
    - 512.png
    - 553.png
    - 92.png
    - 493-normal.png
    - 493.png
    - 134.png
    - 148.png
  - Angle Between Vectors
    - 512.png
    - 453.png
    - 531.png
    - 66.png
    - 633.png
    - 68.png
    - 94.png
    - 15.png
    - 92.png
    - 639.png
- 252.png
  - SSD
    - 246.png
    - 133.png
    - 495.png
    - 498.png
    - 511.png
    - 552.png
    - 443.png
    - 403.png
    - 610.png
    - 172.png
  - Angle Between Vectors
    - 246.png
    - 133.png
    - 573.png
    - 443.png
    - 533.png
    - 636.png
    - 595.png
    - 498.png
    - 495.png
    - 511.png
- 374.png
  - SSD
    - 280.png
    - 624.png
    - 575.png
    - 42.png
    - 529.png
    - 609.png
    - 361.png
    - 548.png
    - 447.png
    - 522.png
  - Angle Between Vectors
    - 624.png
    - 280.png
    - 529.png
    - 575.png
    - 471.png
    - 524.png
    - 446.png
    - 42.png
    - 53.png
    - 544.png

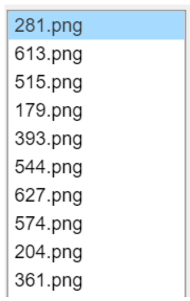
- 540.png
    - SSD



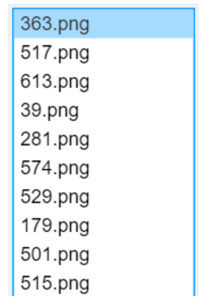
    - Angle Between Vectors



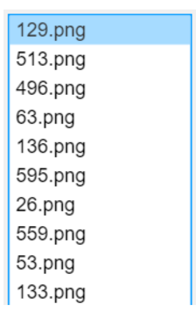
- 572.png
    - SSD



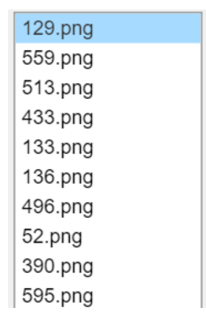
    - Angle Between Vectors



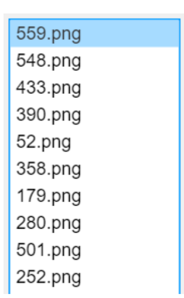
- Color Histograms
    - 4.png
        - SSD



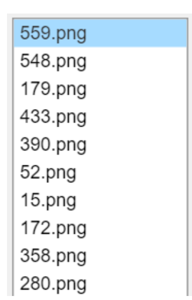
        - Angle Between Vectors



    - 25.png
        - SSD



        - Angle Between Vectors



- 39.png
  - SSD

    517.png
    174.png
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  - Angle Between Vectors

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  - Angle Between Vectors

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- 129.png
  - SSD

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    391.png
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    493-normal.png
    493.png
    136.png
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  - Angle Between Vectors

    513.png
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    559.png
    391.png
    135.png
    133.png
    433.png
    493-normal.png
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    496.png

- 147.png
  - SSD

    493-normal.png
    493.png
    363.png
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    471.png
    305.png
    573.png
    134.png
    347.png
    150.png

  - Angle Between Vectors

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    493-normal.png
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- 252.png
  - SSD

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  - Angle Between Vectors

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- 374.png
  - SSD

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  - Angle Between Vectors

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- 540.png
  - SSD

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  - Angle Between Vectors

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- 572.png
  - SSD

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  - Angle Between Vectors

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- Edge Energy in a Spatial Grid
  - 4.png
    - SSD

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      501.png
      613.png
      608.png
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    - Angle Between Vectors

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    - Angle Between Vectors

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  - 39.png
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    - Angle Between Vectors

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  - 63.png
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    - Angle Between Vectors

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- 129.png
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  - Angle Between Vectors

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- 147.png
  - SSD

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  - Angle Between Vectors

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    611.png
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    555-standard....

- 252.png
  - SSD

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  - Angle Between Vectors

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  - Angle Between Vectors

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- 540.png
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  - Angle Between Vectors

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- 572.png
  - SSD

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  - Angle Between Vectors

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