Data Structures Course Project

Content-Based Image Retrieval Using Barcode

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Group 6

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A) Algorithm Explanation In Detail:

Our algorithm's purpose is to create a barcode to present handwritten digits. We would achieve this by making multiple functions to generate barcodes and additional steps as it advances. The barcode would be based on the Radon barcode that employs binarization. We use a Radon barcode to convert our image into a binary code, where "1" represents a greater mean and a "0" represents a lesser mean. The algorithm primarily focuses on images with a size of 28x28.

The algorithm would employ projections specific angles of 0, 45, 90, and 180 when looking at the handwritten images creating many arrays. The function would calculate the sum of the array based on the angles previously mentioned. The first array would store the binary digits and scan through the given amount of projections. The array can additionally be a smaller size to ensure and maintain accuracy.

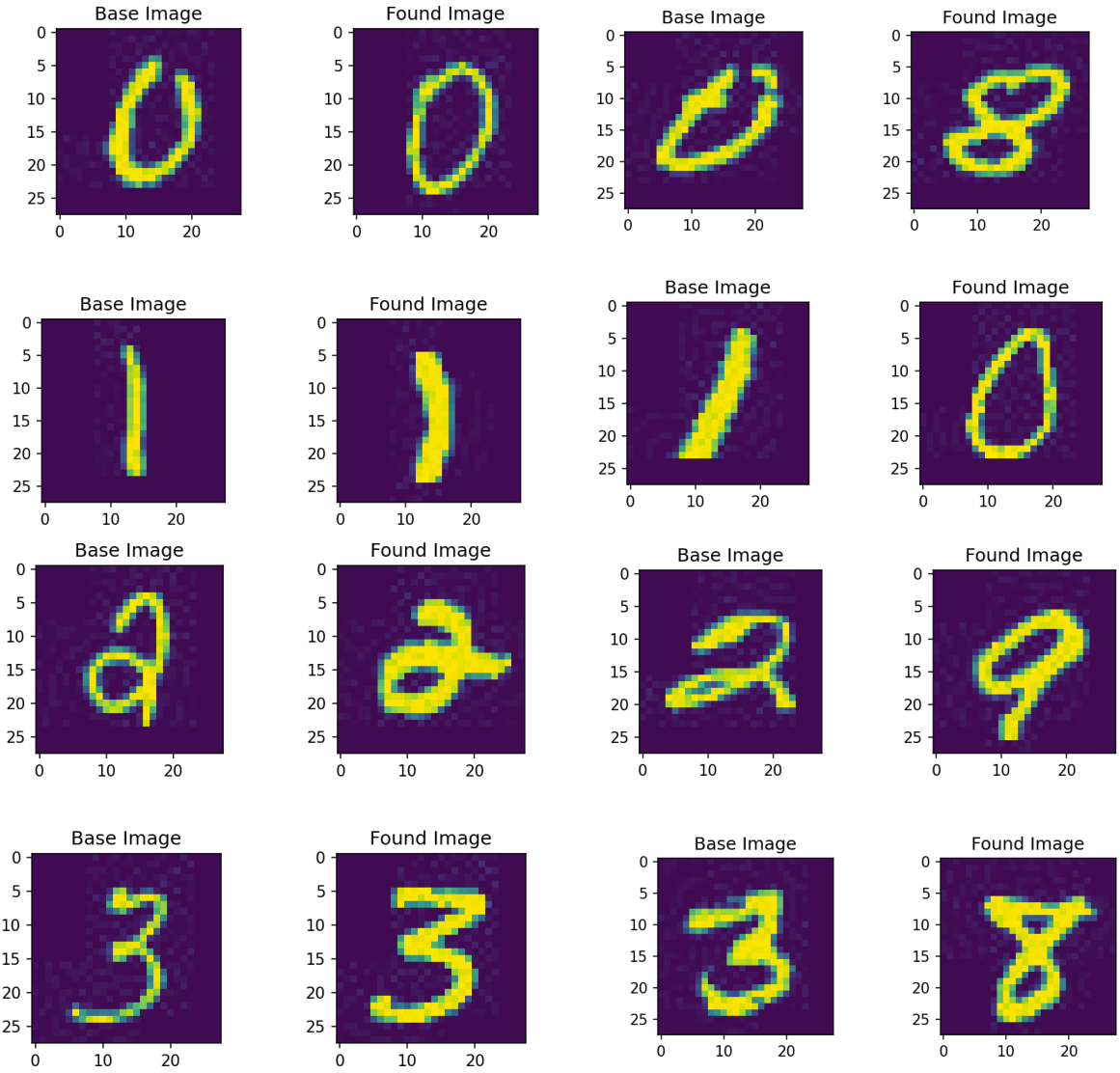
A search algorithm was created where multiple values were defined. This algorithm is used to determine the most corresponding image in our dataset. We would set variables for the number of hits, the minimum hamming distance, the distance between the two barcodes and the current image with the lowest distance. The algorithm iterates through all the barcodes to ensure that it was not a barcode from reference. Hamming distance would be calculated using a function defined in our algorithm. The Hamming distance would provide a comparison of two binary sets. The function includes a while loop using the function "len" inside. The parameter would be a variable defined by the function. The last step of the algorithm would be to determine if the algorithm is a hit.

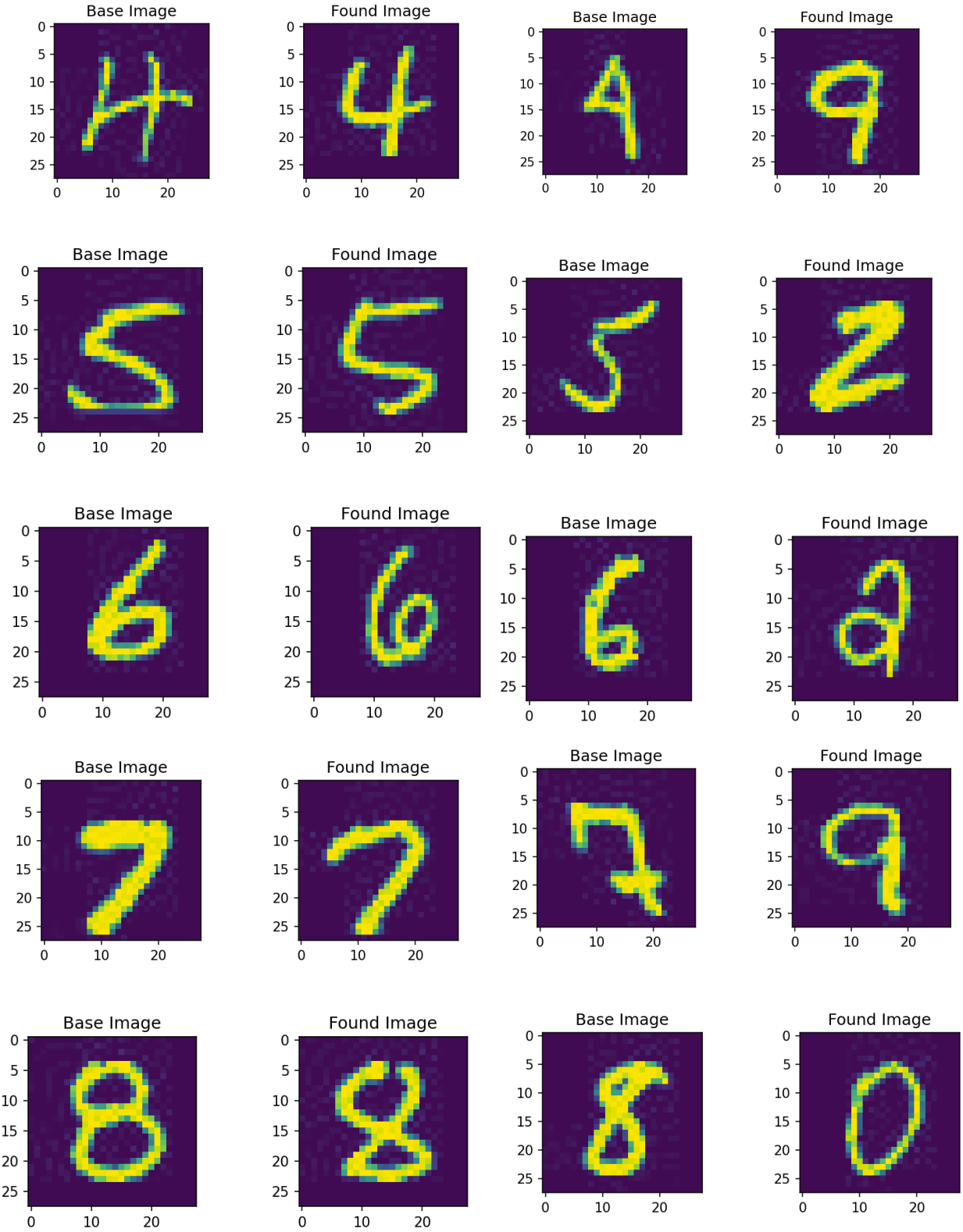
B) Required Measurements and Analysis:

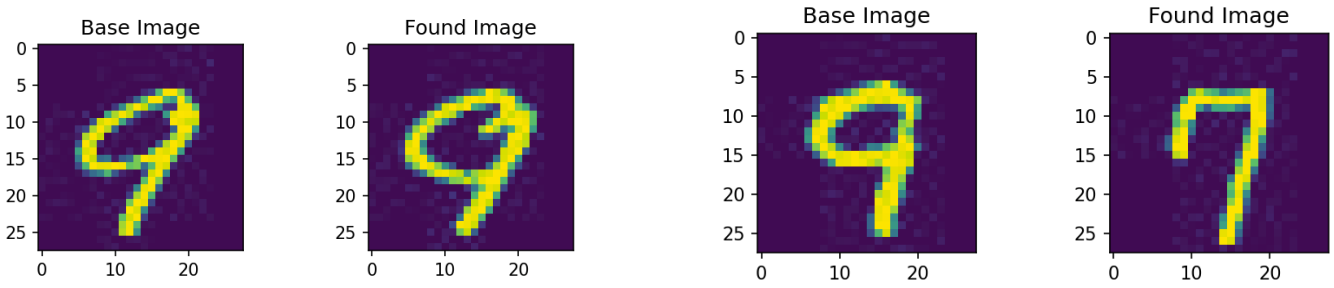
Our algorithm generated a hit ratio of 50%, meaning that half of our searches were hits. Calculating the hit ratio was very easy as there were 100 total searches, meaning the amount of hits we got would be the hit ratio percentage.

Both the Barcode_Generator and Search_Algorithm contain a for loop nested within another for loop. Therefore, the Big-O time complexity of both is $O(n^2)$. Although the Barcode_Generator inner loop does not go from 0 to N, it still has a Big-O of $O(n^2)$ times a constant value, and in Big-O complexities, constant factors are dropped. For the Search_Algorithm, both inner and outer loops go from 0 to N (length of barcodes), generating a time complexity of $O(n^2)$.

C) Sample Search Results:




Base Image
Found Image
Base Image
Found Image
Base Image
Found Image
Base Image
Found Image
Base Image
Found Image
Base Image
Found Image
Base Image
Found Image
Base Image
Found Image



Taking a look at our sample search results, we can see what were the strengths and weaknesses of the algorithm. As per above, you can see the matches and errors in the algorithm. For the digit 0, we can see that it will sometimes match itself with 8. However, where our main issue lies was using a base image of 4 and matching it with image 9. During testing, these were the most consistent matches when using multiple handwritten 4s, the algorithm would often match with the image 9 instead of 4. We have deduced that we could have used more projections to attain higher accuracy.

D) Conclusion:

Image retrieval from a specific archive of images is a useful and demanding task. Especially in the medical industry. Many analysts have researched the feasibility of binary descriptors to tag images that they can be found and recovered more quickly. The use of radon transformation has been proved useful particularly in the medical industry, where we see a positive impact on the accuracy of the diagnostics. For this project, two main algorithms were created. The *Barcode Generator* algorithm which is used to generate a barcode for each 28x28 pixel image in the given dataset; And the *Search* algorithm which is used to search for the most similar image in the dataset. The program worked by taking the generated barcodes and comparing them to search for the query image in the MNIST dataset. Afterwards, we were able to calculate the retrieval accuracy of the algorithms. Ultimately, we hit a ratio of 50% for the retrieval accuracy for the 100-radon projection-based barcodes. To improve performance, possibly increasing the quantity of projections is a potential approach that can be taken. Although we may see an increase in accuracy, by increasing the number of projections we negatively impact the time it would take to both generate and search through the barcodes.

E) Presentation Slides:

Content Based Image Retrieval (CBIR)

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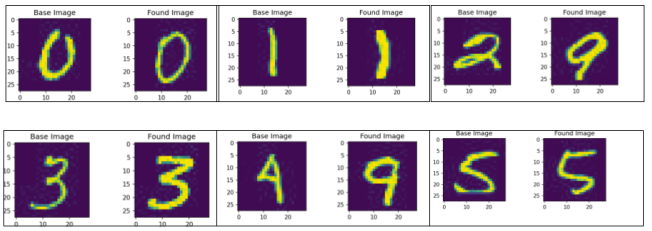
Search Results



Algorithm Explanation

- Our search algorithm accounts for the steps taken to determine the numerous factors.
- First, it would iterate through all the barcodes and confirm that it is not a reference barcode.
- Secondly, The algorithm would calculate the hamming distance and determine if it was a hit.
- Then it would print out the output.

Required Measurements & Analysis

- After running several times, we found the accuracy to be around 50%.
- Both algorithms have Big-O complexity of $O(n^2)$ due to them having a loop nested inside another loop

Improvements

- Increase number or projections of each image to have more accurate barcode
- Increase the amount of pixels within each image
- Have more images in the database to search through for a better chance of a hit

Questions?