Age detection using neural networks and machine learning

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ABSTRACT

This proposal uses neural networks to predict a human subject's age from a photo. Neural networks are computing systems inspired by how the neurons of living beings operate. Machine learning is a technique, including neural networks, that involves training machines to learn from provided data to the program. Through the use of neural networks and machine learning, photos of people will be analyzed, the system will train the model. In the analysis process, the face of human subjects will be the area of a photo that the program will work with, and based on the selected area of a photo by max pooling method and CNN analysis layers the program will predict age. In this work, the program will be trained with a dataset that contains images of people and their ages.

ACM Reference Format:
Darab Qasimi. 2022. Age detection using neural networks and machine learning. In *Proceedings of ACM Conference (Conference'17).* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

The proposed project will implement systems that allow us to detect the age of human subjects using neural networks. Neural networks are computing systems where machines learn from data, and based on found patterns, derive conclusions. Neural networks use interconnected nodes in a layered structure inspired by how human neurons work. Age detection can potentially be important in industries and organizations for authentication, behavior analysis, and other purposes. Age detection is important in smart human-machine interfaces, e-commerce, etc. [3]. I propose a project to process more accurate by analyzing a dataset and continuous training as people test the program with their photos. Using machine learning, the program will be trained using a dataset that contains photos of people from different age groups. After the model is trained, it will be tested with a quarter of photos from the dataset that was not used for training. Then, in the future when someone gives their photo to the program for age prediction, machine learning concepts will be used to predict a person's age from their provided photo to the program. Some of the programs that I've seen on the internet predict an age by giving a range where the age of the person falls into e.g., the age prediction for a 24-year-old person might be 22 to 28 years old. This project is unique because the program will be programmed to predict age with a small range closer to the actual age, although there still might be other project which their result might come close to my program.

Conference'17, July 2017, Washington, DC, USA

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

2 BACKGROUND AND RELATED WORK

The proposed project involves many methods which will be used in predicting a person's age. These methods include CNN facial feature analysis, photo dimension conversion, and max pooling. In Othmani et al. [5] estimates age using deep learning methods. The article compares many different Convolutional Neural Network (CNN) algorithms based on their performance in detecting age. In the datasets used for the experiment, the robustness of the best deep estimator is evaluated under noise, expression changes, different ethnicity, and different genders. A layer-wise transfer learning evaluation is done to study the optimal number of layers to fine-tune Automatic Age Estimation (AAE). The results demonstrate the high performance of the popular CNN frameworks against state-of-the-art methods based on deep or shallow learning for automatic age estimation.

2.1 Supervised

In the research paper [9] by Verma, supervised CNNs have been used for image processing and age detection. A CNN that handles multitasking, facial detection and emotional classification is made by combining CNN and other algorithms and approaches. In the research, through CNN the object's face is first detected, then extracted from the photo, meaning the photo's background is eliminated first. In this research, I'll implement a supervised learning method of machine learning. Supervised machine learning is feeding and teaching the algorithm with labeled data, and based on what the program has learned from the fed information, it will predict a person's age from a photo. Verma's work has used some supervised learning methods using modules such as pandas, pandas, cv2, and many more which is essential in analysis and computing. In this project, supervised CNN training with some Python modules that are used in Verma's work will be used to make age detection more accurate.

2.2 Facial features

In age detection, detecting a person's facial features in a photo is important because the facial features of a person change as they age. In Zaghbani et al.'s work [10], human facial features such as wrinkles are seen as elements of facial analysis and age estimation. The research presents facial image age estimation based on autoencoders, an artificial neural network used for unsupervised learning. One of the age estimation methods used in the study uses autoencoders, where a network of artificial neurons learns a hidden representation to reconstruct its inputs [4]. Figure 1 represents how the autoencoders impose in the network, which forces

a compressed knowledge representation of the original input. I'll

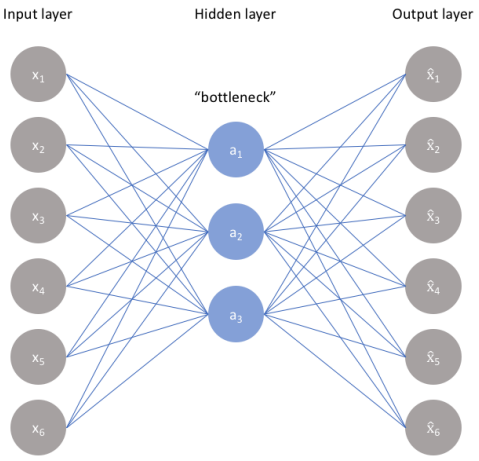

Figure 1: Autoenconders [4]

be using some of the concepts presented in the cited source as a comparison to how I'll implement a supervised method of analysis and machine learning to better understand the differences between the two methods.

2.3 Deep learning and photo dimension conversion

Age and Gender Detection Using Deep Learning [8] is a blog that has used deep learning to predict a person's age from a photo. The dataset used in the research comprises age, gender, image, and pixels stored in .csv format and analyzed in Python. Using Keras, an open-source Neural Networks library, images are processed to detect age and gender. After reading the dataset's data, the photos' dimensions are converted to 48 by 48 to standardize images and sharpen the precision of age detection. Although deep learning can analyze a person's age from a photo, no matter the size of the photo, using the specific parts of a photo that we require will help with the program's performance. The performance of a program can improve by using specific parts of a photo because the program doesn't go through so many useless pixels. Some of the program libraries in Python, coding techniques, and machine learning implementation used in the blog are close to how I want to implement the programming side of my capstone. Python libraries such as pandas, numpy, and seaborn [7] will be used in the implementation stage of the neural networks algorithm and analyzing photos. Through Pandas library, I'll be analyzing data, numpy library will be used to perform mathematical operations, and seaborn will be used to visualize random distributions. I'll standardize the size of photos in the dataset, and I'll analyze images based on their pixels and characteristics.

2.4 Traning with dataset

In this work [2] Chen has written a research paper that has studied methods of human face analysis and age prediction. The images in the dataset have been categorized, and each approach of CNN has been trained with ordinal age labels. The study has used two methods of CNN: the first one is pre-training the program with facial images, and the second is fine-tuning with age-labeled faces. In the photo analysis, many features are studied, such as the distance of eyes from mouth to train AI with features that are easily noticeable to humans. On the technical side, the paper has not only explained algorithms such as max pooling, but it has done mathematical proves and how algorithms have come to the conclusion.

2.5 Max pooling

In neural networks, methods such as max pooling can increase the accuracy of a program. In Qiu, [6], Convolution Neural Networks (CNN) have been used to predict age based on a given image to a program. In the thesis, multiple layers of CNN are used to analyze an image, and after analysis, through the filters, a prediction of age is given to the user. When an image is given to the program, first, a 4X4 patch of the image is used for analysis which is then down-sampled to a 2X2 patch by putting it through the max pooling layer. In modern CNNs, max pooling combines the maximal responses of the feature maps into a summarized joined distribution of the features over some region of interest [11]. During photo analysis, max pooling preserves the maximal value from a region of interest. During the analysis, layers of neural networks use that information about the important features of photos through max pooling. In max pooling, the maximum numbers present the important features of the specific parts of a photo. I'll be using max pooling in this project to increase precision in decision-making over how old a person in the photo is.

3 DESIGN AND IMPLEMENTATION

The proposed project here will be implemented using Python. At first, the photos in Face: Age Detection Dataset [1] will be standardized by converting the size of each photo to the size of the smallest photo in the dataset by using the resize() method in Python. Then, the program will use deep learning for the analysis of photos. There will be three layers of deep learning in the photo analysis where the first layer will be the reading photos from the dataset in the program, the second layer will be the analysis, and the third layer will be the output layer. The second layer of deep learning can be implemented using many methods. One of the methods that I plan to use in the second layer of deep learning is max pooling (it might take more than three layers to use Max Pooling). Besides, in the second layer of deep learning, the program will also look at a person's facial features in photos. Some facial features that can help predict a person's age are wrinkles, skin intonation, etc. To identify facial features methods such as converting color photos to grayscale and then getting the face coordinates can help identify facial features. After completing the second step of deep learning in the final step, the program will output an age prediction based on the result processed in step two of the deep learning. Figure 2 is an illustration of how the software structure will look like in implementation.

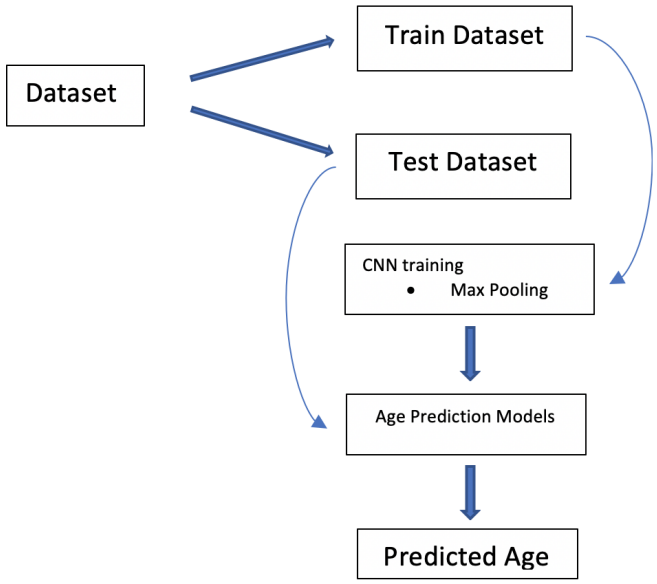

Figure 2: Software Architecture

4 MAJOR RISKS

The program might face some major risks due to lack of experience or the program's poor performance. Some potential risks to the project are wrong age prediction and longer time complexity.

4.1 Wrong prediction

One of the risks that I might face during the project is a poor problem solution or an inaccurate age prediction. Poor problem solutions might happen either because I lack the experience to write the algorithm correctly or because the algorithm might have issues working with unclear photos.

4.2 Time complexity

The time complexity of the program is another risk that the project might face. The program will analyze about a thousand photos for training and test purposes, and the major risk in doing that is the heavy time complexity. It would be fine if the program takes about an hour or two to analyze a photo in the testing stage, but if it takes more, then the algorithm might not be viable. A good time complexity to predict a person's age after they provide their photo to the program is about five minutes, and anything beyond that would make the software not user-friendly.

5 TIMELINE

The overall process for writing the project should take about fourteen to fifteen weeks. The following timeline is a rough estimation of how long it will take to finish the project.

- Week 1: Write the basic steps of the program, e.g., steps to reading the dataset.
- Week 2: Write the initial steps to analyze the dataset. At this time, I'll ensure the program can read the dataset properly and that each dataset's column is properly labeled and ready for analysis.
- Week 3: Develop the program and start implementing the CNN algorithm. This will be the initial stage of CNN, and there might still be no output through the algorithm.
- Week 4: Develop the CNN algorithm and implement the max pooling method. In the max pooling stage, the CNN algorithm implementation will almost be finished and ready to classify the dataset. Meanwhile, I'll be writing the first draft of the paper, which will include an introduction to the program, a literature review, and a data architecture diagram.
- Week 5: At this time, the dataset will get classified, and it will be easier for the CNN algorithm to work with photos. The first draft of the software will be ready to present this week.
- Week 6: During this week, the CNN algorithm will be trained with the dataset that has already been classified.
- Week 7: Review the program, and polish it. The program will also be checked for time performance and ensure it doesn't take too long to detect a person's age from a photo.
- Week 8: Test the algorithm with a different dataset close to how the current dataset is set up, and it's yet to be identified.
- Week 9: Keep testing the algorithm with the new dataset and check for accuracy. This week, the program's result will be checked against some authentic CNN algorithm implementations online. The paper's second draft will be ready this week, including initial results and visualizations.
- Week 10: At this stage, the program will be at its latest stages of development. This week, the program will be tested again for accuracy and to ensure it's doing what it intended. The first draft of the demonstration video will also be prepared this week.
- Week 11: Now that the program is complete and ready to submit, I'll take this week as a chance to create a diagram or a poster about what's happening in the program. In the poster, I'll draw how the CNN algorithm analyzes information and data flow. This diagram will be similar to Figure 1 in the facial features section. The draft of the poster will be ready this week.
- Week 12: Speak with a computer science faculty member to overlook the program. Showing the program to a faculty member will help me in finding issues in the program that I missed during the past eleven weeks. I'll also implement feedback I'll receive this week that will improve the program's performance. The third draft of the paper will be ready by the end of week 12.
- Week 13 and 14: During these two weeks, I'll be working on the second draft of the demonstration video and the second draft of the poster.
- Week 15: Everything, including the project, final paper, demonstration video, and poster, will be ready to submit.

During the last few weeks of the semester, the aim of testing my program with random people was to get diverse feedback about the performance of my program.

6 CONCLUSION

Age detection using neural networks and machine learning projects will heavily rely on the analysis of photos. The program will initially be trained with the photos from the dataset, and part of the dataset will be used for testing the accuracy. Currently, the plan is to use supervised CNN in the program with three layers of convolution for getting the optimal result in predicting age. Max pooling will be used for calculating and taking the maximum value from each selected photo patch that shows the most present feature of a photo that will help identify a person's age based on the found features. Meanwhile, photos will be classified based on their facial features during the dataset analysis using CNN for classification.

7 ACKNOWLEDGEMENT

I want to thank David Barbella for all the feedback he has given me throughout the process of producing this proposal.

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