



Booklets

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Title: Intelligent algorithm using convolutional neural networks for facial recognition of people with Autism Spectrum Disorder (ASD)

Authors: Paredes-Xochihua, Maria Petra, Sánchez-Juárez, Ivan Rafael and Pedroza-Méndez, Blanca Estela

- Tecnológico Nacional de México KVA-5814-2024 0000-0003-1753-2313
- Universidad Da Vinci ABW-3403-2022 0000-0001-8296-5532
- Tecnológico Nacional de México HKF-7420-2023 0000-0002-9819635X

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MARVID-México

Park Pedregal Business. 3580,
Anillo Perif., San Jerónimo
Aculco, Álvaro Obregón,
01900 Ciudad de México, CDMX,
Phone: +52 1 55 6159 2296
Skype: MARVID-México S.C.
E-mail: contact@marvid.org
Facebook: MARVID-México S. C.
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Introduction

- In Mexico, a 2016 study conducted by Autism Speaks and the Mexican Autism Clinic (CLIMA) identified that 1 in every 115 children has autism, occurring more frequently in boys than in girls, and identifying that, for every 5 cases of autism, 4 of them are men and 1 is a woman (Teletón México, 2024).
- Due to the diversity of their characteristics and the complexity of their diagnosis, identifying individuals with ASD early and accurately represents a significant challenge for healthcare professionals and society at large.

Introduction

- The objective is to identify and implement an algorithm to recognize facial features associated with individuals with ASD, with the goal of implementing it in a system that helps identify these individuals. For this important task, machine learning and convolutional neural networks were used for the image selection and classification process.

Related works

- Ahmad et al. (2024) performed autism spectrum disorder detection using facial images: comparing the performance of pre-trained convolutional neural networks.
- Juárez et al. (2024) developed a computer vision system that uses facial and text recognition to recommend professional profiles.
- Cadena, J.,'s thesis (2021) presents an efficient technique for global face recognition using wavelet transforms and support vector machines (SVMs) on 3D images.
- Feng (2023) presents research addressing the early detection of Autism Spectrum Disorder (ASD) in children, using advanced deep learning techniques applied to functional magnetic resonance imaging (fMRI).

Materials and Techniques

- CNNs have established a strong reputation in the field of image data processing, producing superior results compared to traditional methods. However, they require a large amount of data for the training phase, which is sometimes referred to as data-hungry algorithms, especially training from scratch. However, transfer learning (TL) has largely solved this problem, where a pre-trained model is retrained to perform a specific task with fewer data samples (Pineda, 2021).
- Pre-trained deep learning models provide substantial benefits in artificial intelligence and machine learning. These models allow practitioners to save time and computing resources by providing powerful starting points for numerous tasks, leveraging knowledge from extensive training on large and diverse datasets. The ability to adapt pre-trained models to specific tasks using limited labeled data is an important feature of transfer learning. It reduces the need for large datasets (Pineda, 2021).

Materials and Techniques

- Python was used as the programming language due to its simplicity and variety of specialized libraries, such as OpenCV, TensorFlow, Keras, and Scikit-Learn.

Algorithm for ASD detection

- Based on related work and the analysis of deep learning techniques, it is proposed to follow the algorithm consisting of the steps presented in figures 1, 2 and 3.

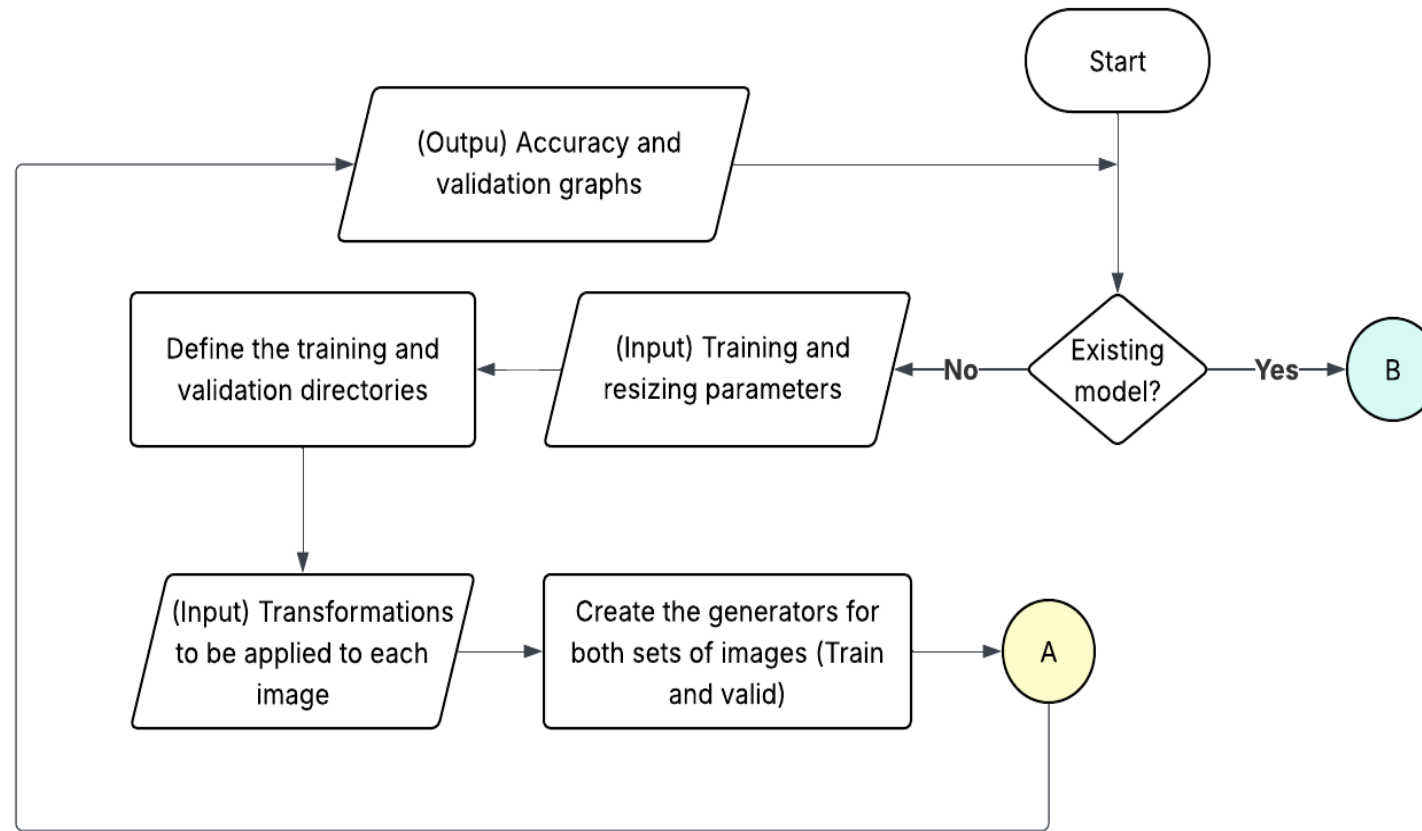


Figure 1. Flowchart of the algorithm

Algorithm for ASD detection

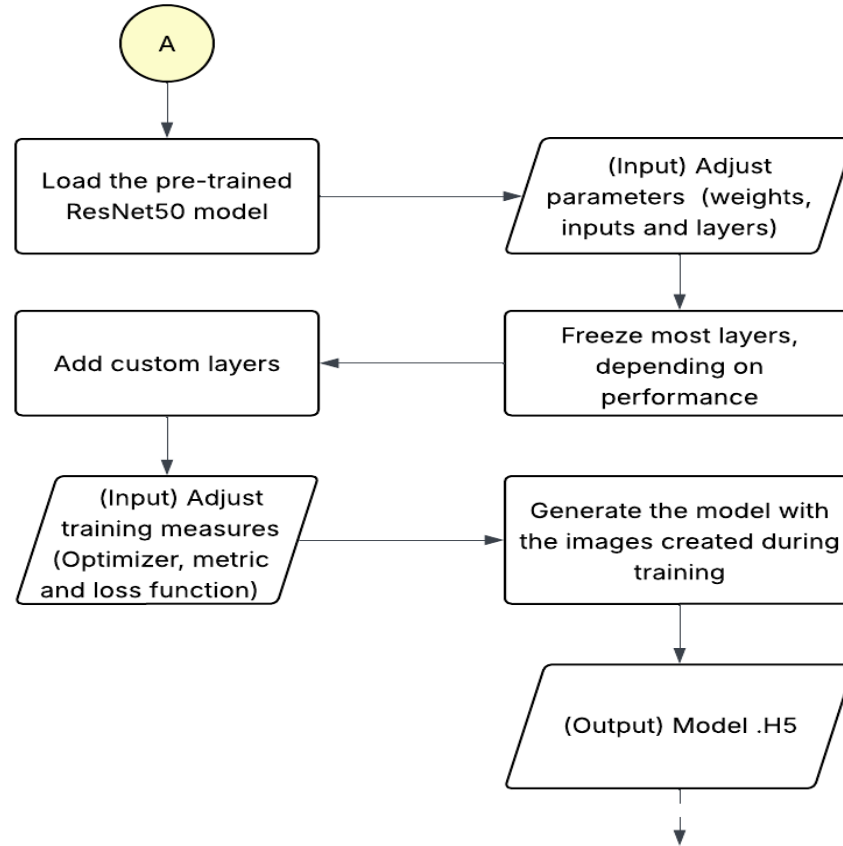


Figure 2. Flowchart of section A of the algorithm.

Algorithm for ASD detection

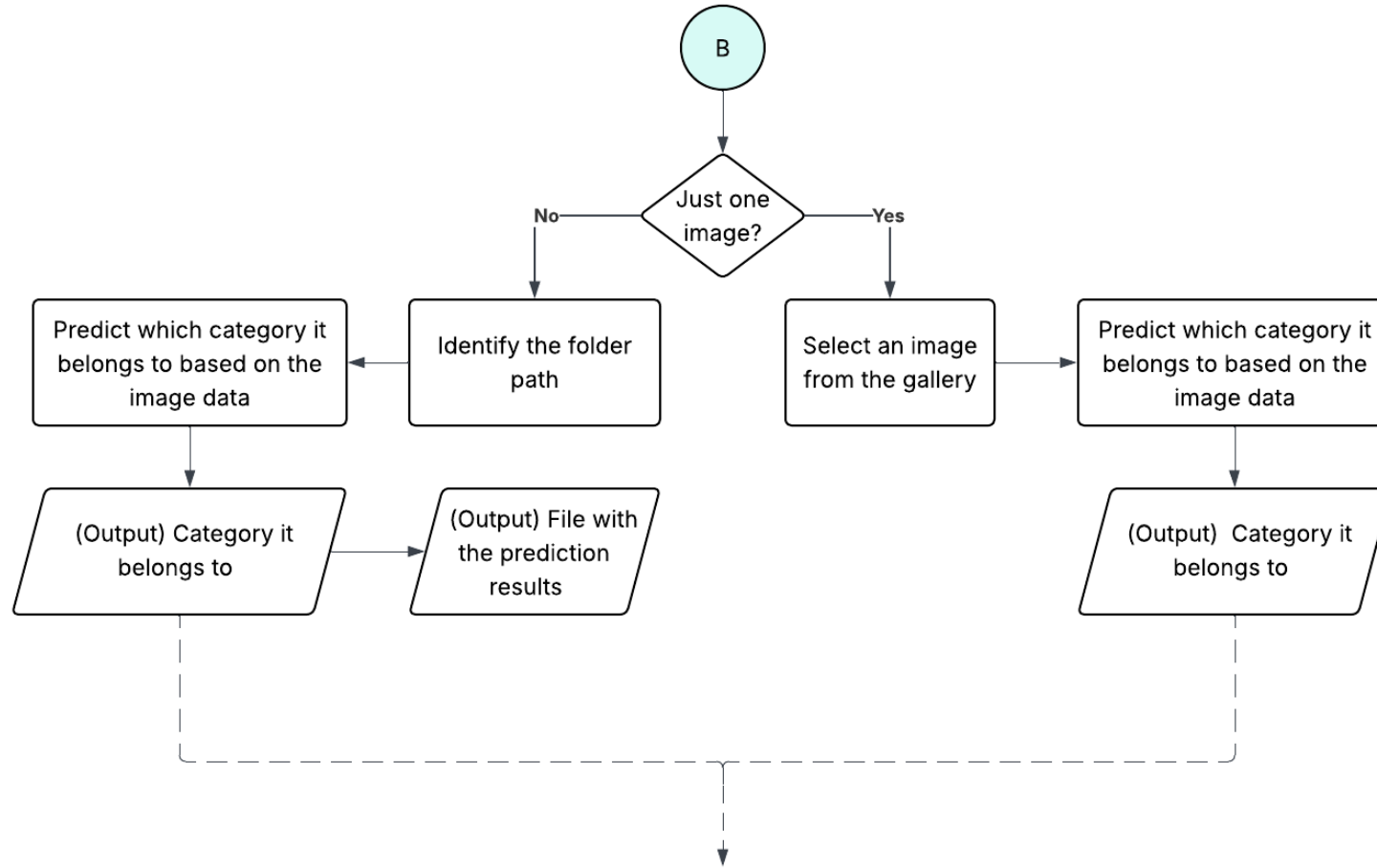


Figure 3. Flowchart of section B of the algorithm.

Models and test of the algorithm

- To evaluate the proposed model, in pre-training the ResNet model uses the ImageNet dataset (ImageNet, 2020) and in the testing phase the Kaggle dataset is used together with a dataset built for this specific study, the datasets used are freely licensed (Autism dataset, 2024).
- The training and testing dataset is composed of four subsets: Consolidate, Test, Training, and Valid.

Table 1. Dataset.

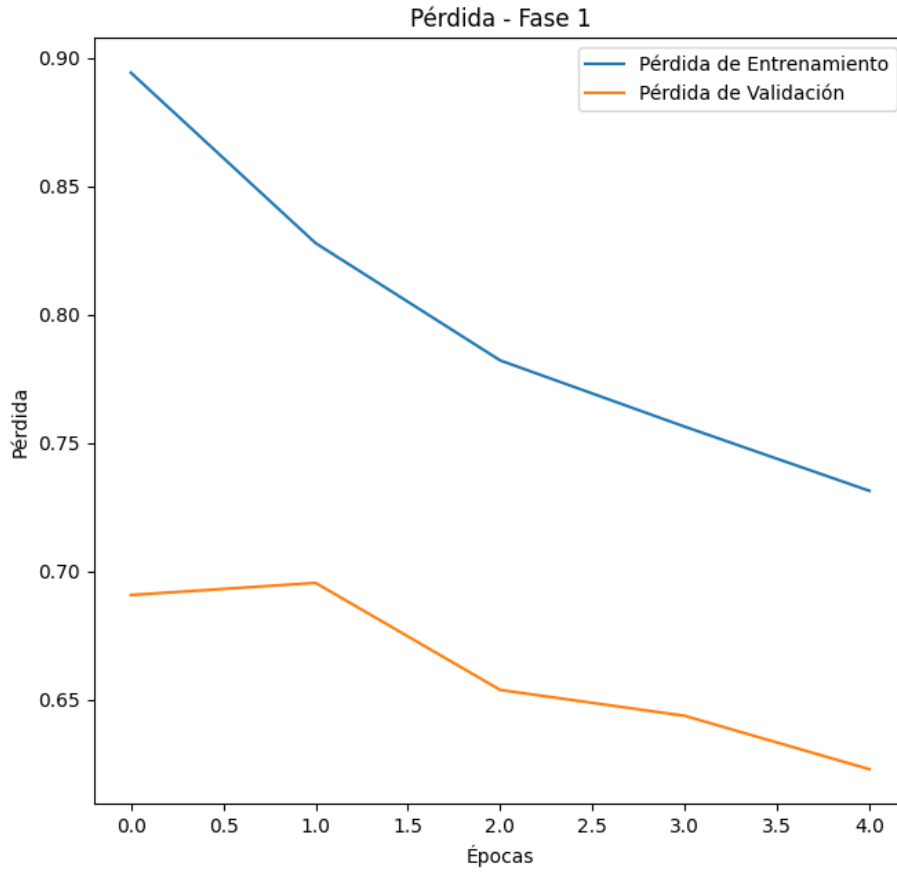
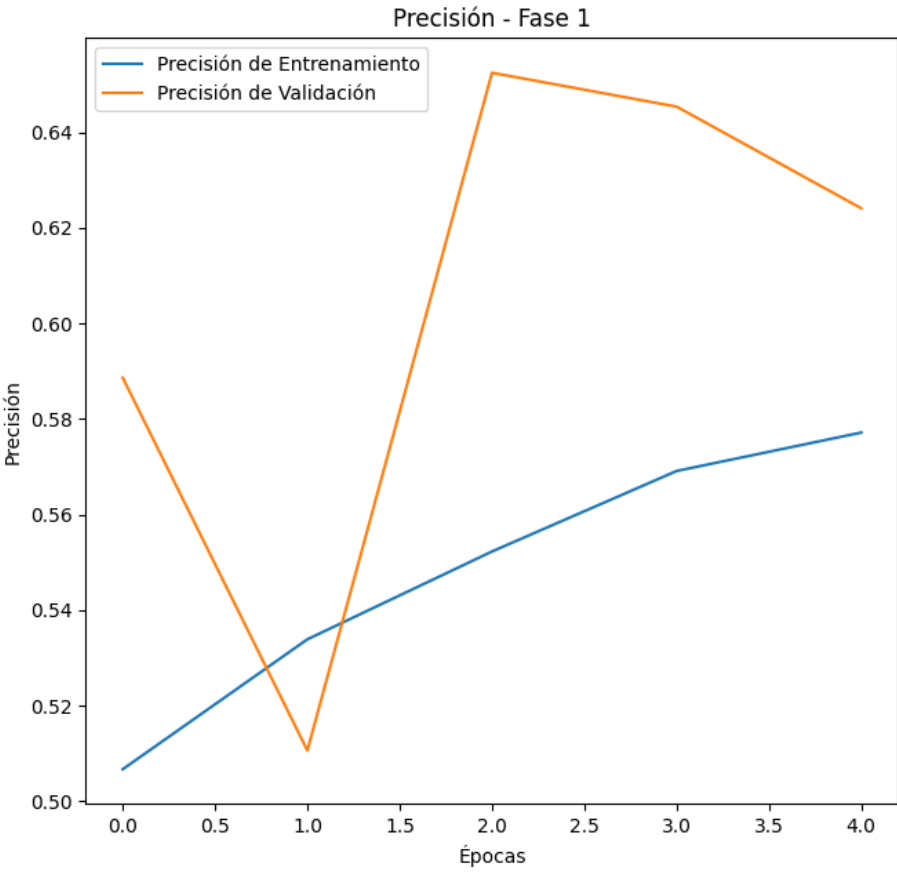
No.	Subset	Autism	Non- Autism
1	Consolidate	1523	1521
2	Test	361	
3	Training	1290	1321
4	Valid	70	71

Results with evaluation metrics

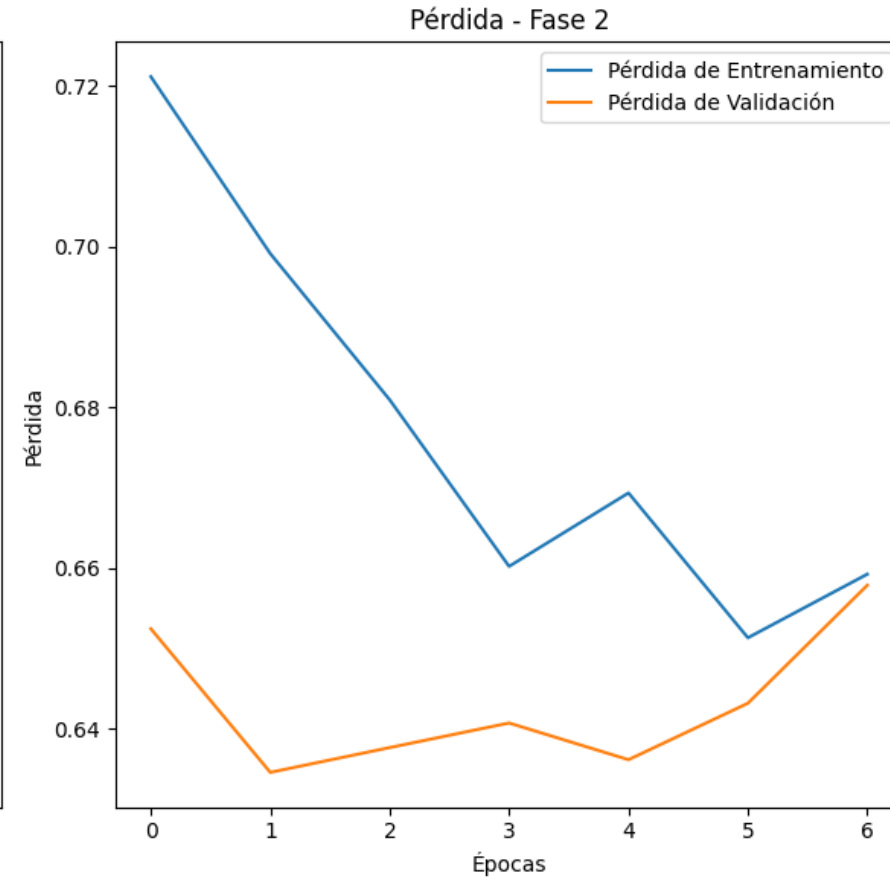
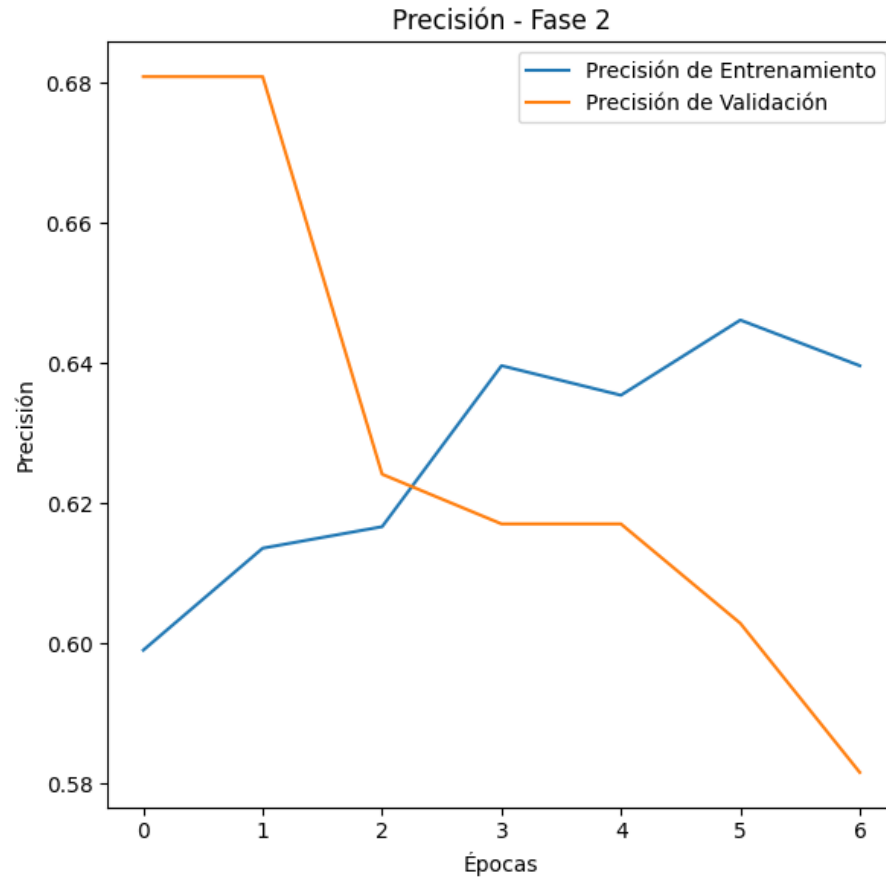
- Table 2 presents the parameters with which the different models with which tests were performed with ResNet were defined.

Test	Model generation parameters	Classification percentage	
		Autist	Non-Autist
3	Flatten BatchSize = 32 Epochs = 10 Loss = 'categorical_crossentropy' Optimizer = Adam(LearningRate = .0001) Width & Height shapes = 224 AdicionalLayers = Si	74.97%	25.03%
		24.08%	75.92%
16	Flatten BatchSize = 64 Epochs = 50 Loss = 'categorical_crossentropy' Optimizer = Adam(LearningRate = .0001) Width & Height shapes = 124 AdicionalLayers = Si	95.24%	4.76%
		38.44%	61.56%
23	GlobalAverage BatchSize = 32 Epochs = 5, 7 y 8 Loss = 'categorical_crossentropy' Optimizer = Adam(LearningRate = .0001) Width & Height shapes = 224 AdicionalLayers = No	95.03%	4.97%
		37.62%	62.38%

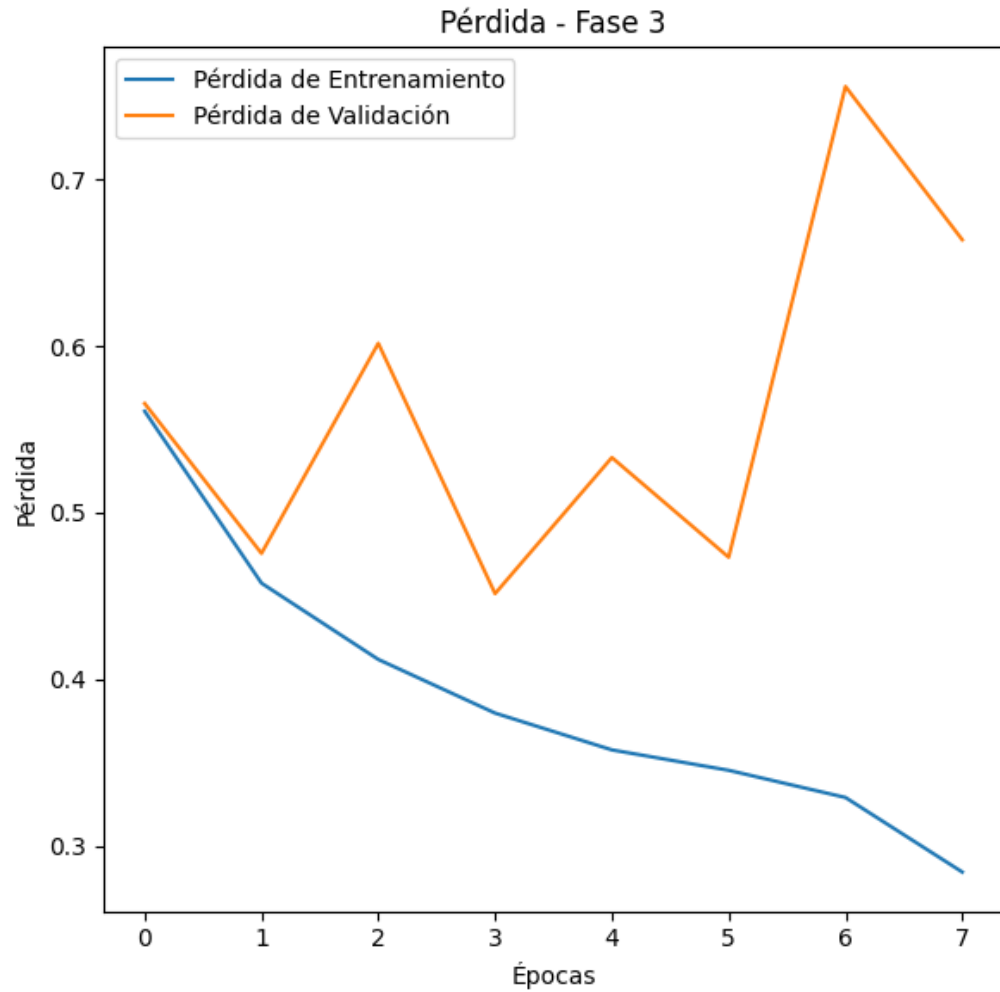
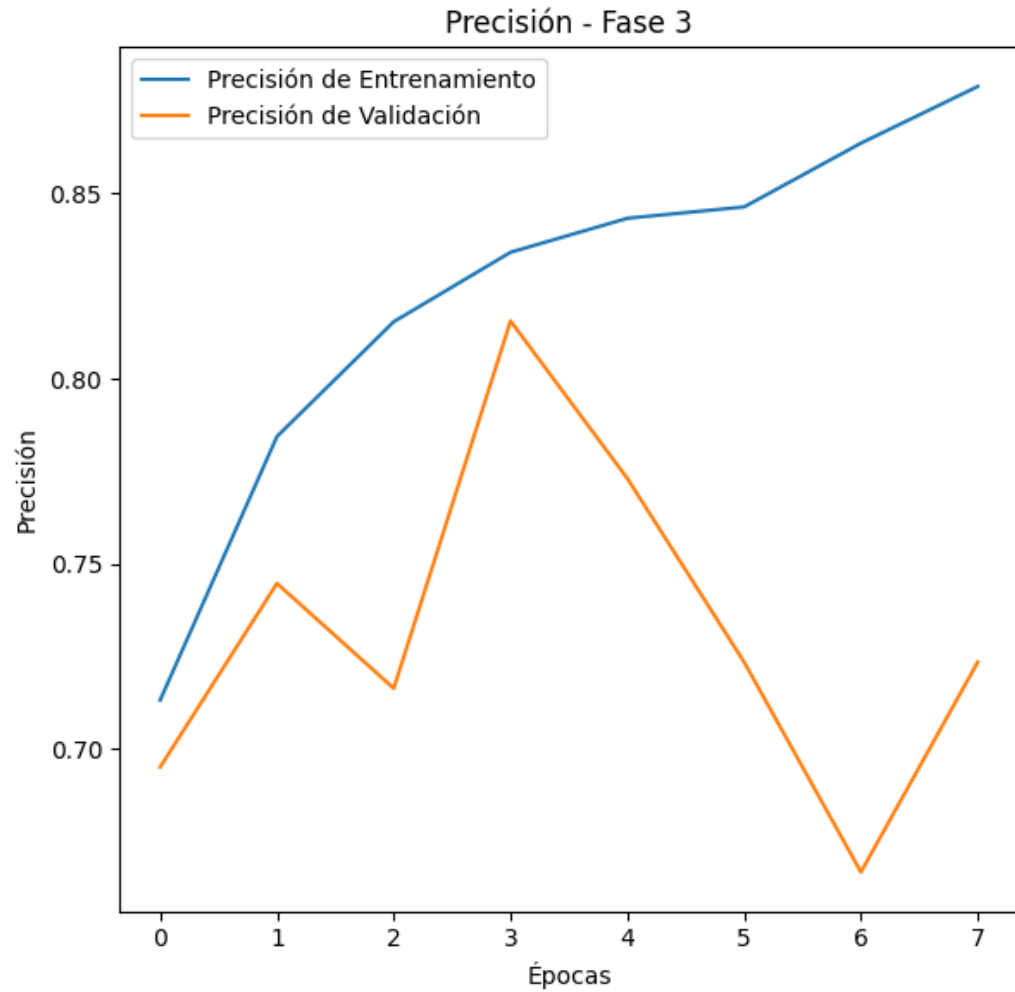
Results



Results



Results



Conclusions

The facial recognition algorithm was developed and implemented using artificial vision techniques, in which the face in the image is detected and convolutional neural networks were used for detection, however, prior to using CNNs, transformations are performed on the images such as rotation, horizontal and vertical flipping, displacement, zooming, in order for the classification model to identify patterns regardless of how the person's face is presented.

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