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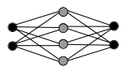
The Importance of Hyperparameter Optimisation for Facial Recognition Applications

Introduction

- Recognising human faces is important for various applications, including biometric authentication, identifying criminals and potentially preventing future attacks.
- 51% of all countries worldwide already utilise facial recognition technologies [1].
- However, most of these technologies misclassify 34.7% of darker-skinned females, compared to 0.8% of lighter-skinned males [2].
- Thus, optimising the hyperparameters of an Artificial Neural Network (ANN) is crucial for achieving the best recognition accuracy and minimising errors.

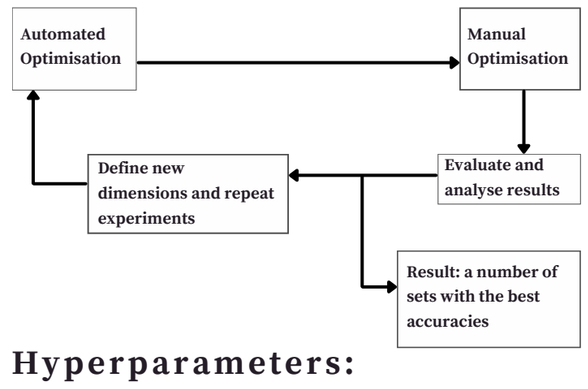
What can be changed?



Methodology

- Focusing on the optimisation of the most important parameters, four methods are implemented.
- The dataset (Yale Face Database) contains 1500 images of 30 different people, 50 images each in different lighting conditions [3].
- The ANN consists of a multi-layer perceptron classifier with principal component analysis for dimensionality reduction [4].

Optimisation Process:



Examples:

Hyperparameters:

- principal components
- number of hidden neurons
- batch size
- learning rate
- weight optimisation
- activation function

Related Work

Random Search for Hyper-Parameter Optimization

James Bergstra, Yoshua Bengio

Journal of Machine Learning Research, Vol. 13, pp. 281-305, 2012

- Demonstrate the differences between Grid Search and Random Search.
- State that Random Search explores the space of hyperparameters more widely because it chooses the values of the parameters randomly.
- Thus, a broader spectrum of sets can be tested and further optimised.

Implementation

1.Manual Optimisation

Manually trying every possible combination in a defined range.

2.Grid Search

Automated process to try every possible combination in a defined grid.

3.Random Search

Automated process to try random possible combinations in a defined range.

4.Further Optimisation

Combining automated optimisation and manual optimisation.

Issues

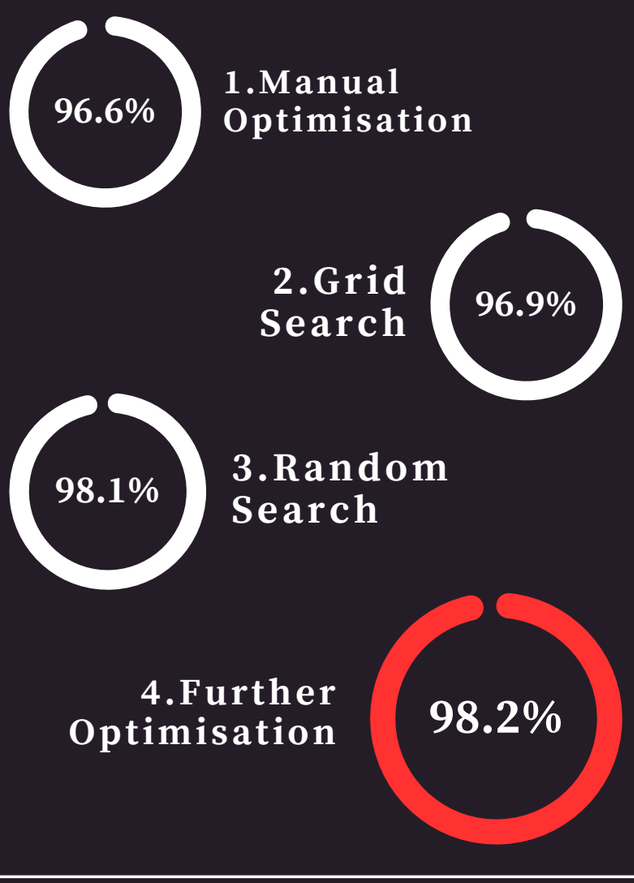
- There are still a lot of unanswered questions, e.g.:
  - Who owns the data?
  - Who is responsible for misclassification and its consequences?
  - What behavioural changes will we see in our society caused by the increasing use of facial recognition?
  - What changes need to be made in law enforcement?
  - Who creates the ethical regulations needed?
  - How can we ensure that facial recognition systems are not used for unethical purposes or surveillance?
- Most of the current applications were trained with biased datasets, which can create a bias against or in favour of specific groups [2].

Analysis

- The recognition accuracy could be improved by **+1.6%**
- The error was minimised from 30% to **<1%**
- There is not one single set of optimal hyperparameter values, but a range of values.
- Through optimisation, the application can successfully be implemented.
- However, the dataset is outdated and certainly needs more diverse data in order for the application to be used worldwide.

Results

The best average recognition accuracies



References:

[1] Carnegie Endowment for International Peace. (2020). AI Global Surveillance.

[2] Buolamwini, J., Gebru, T., Friedler, S. and Wilson, C. (2018). Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification. Proceedings of Machine Learning Research, 81, pp.1–15.

[3] Belhumeur, Peter N. and David J. Kriegman.“The yale face database.” (1997).

[4] Karamizadeh, S.; Abdullah, S.; Manaf, A.; Zamani, M.; and Hooman, A. 2013. An Overview of Principal Component Analysis. Journal of Signal and Information Processing, 4: 173–175.

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Conclusion

- Optimisation works best when combining manual and automated methods.
- Optimisation is important in order to implement safe facial recognition applications worldwide.
- Diversity within the training dataset matters, so that bias and errors can be minimised.
- Questions need to be answered and new laws and regulations have to be created.