Pattern Recognition and Machine Learning

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ENSIMAG 3 - MMIS Fall Semester
Lab Project 2: 25 November 2020

Face Detection with fully connected Artificial Neural Networks

The objective of this project is to evaluate the effectiveness of fully connected neural networks for detecting faces in Images. The written report for this exercise is due on 23 December 2020. Oral presentations by three project groups will be made on 16 December.

Each programming team should

1) Construct a balanced data-set of resolution-normalized face imagettes using the FDDB, WIDER and other face data image data bases.
2) Implement and train one or more fully connected neural networks for detecting faces, using a range of hyper-parameters including input imagette resolution, number of layers, number of units per layer, activation functions, loss functions, training and optimization techniques.
3) Plot error rates (Precision, recall, F1, AUC for ROC curves, etc) for each network over a range of hyper-parameters and training and optimization techniques.
4) Evaluate the effectiveness and computational cost for each network when used as a sliding window detector.
5) Explain and interpret the results, describing the effects in variations of different parameters and training techniques and explaining the sources of errors.

Lab work will be reported with a written report (not just a jupyter notebook) in either French or English. Work will be evaluated based on the range of techniques tested, the effectiveness of the experimental evaluations, and the clarity and depth of the explanation of experimental results.

Programming teams are given considerable freedom in their choice of techniques to evaluate. You may use any framework or programming environment. The objective of this project is to evaluate effects of different variations in training data, training techniques and network architectures Creativity is encouraged and will be rewarded!

The following is an indicative barometer for grading. Actual grades will depend on a subjective appreciation for the amount of effort deployed and the depth of understanding displayed in the results.

Grade	Example of Criteria (Max grade is 20)
10-12	Build a balanced data set of face imagettes using the FDDB data sets. Divide this into Training, test and validation data sets. Use the training set to train a fully connected network. Use the validation data set to determine when to halt training. Use the test data set to evaluate the results. Provide Accuracy, ROC and precision-recall plots for the network. Provide an insightful explanation of the training and evaluation processes and discuss the results.
+1	Build a balanced data set of face imagettes using the several image data sets and use this larger data set for training and evaluation. Describe the variations in image acquisition condition and data quality for each source.
+1	Compare performance results for fully connected networks over a range of face window resolutions (8x8 to 64x64). Explain the results.
+1	Evaluate the performance of your networks over a range of face orientations.
+1	Compare performance results for fully connected networks over a range of number of hidden layers and a range of number of units per layer. Describe and explain the results.
+1	Compare performance results using different activation function. Describe and explain the results and discuss the usefulness for each function.
+1	Compare performance results when training with different training and optimization techniques, such as batch learning vs SGD, different loss functions, ablation, etc. Describe and explain the results and discuss the usefulness for each technique.
+1	Demonstrate the usefulness of one or more of your networks as a sliding window face detector for images. Discuss problems encountered in precisely estimating the size and position of the face in an image, and describe an evaluate solutions to these problems.
+1	Demonstrate the usefulness of one or more of your networks as a sliding window face detector for live images taken from your computer web camera. Evaluate the performance for this use.
+1	Demonstrate and provide an insightful explanation for some training or evaluation technique not described above