LDA, Decision Trees, and Extra Trees

on the MNIST and Yale B Datasets

Kudiyar Orazymbetov, Nico Casale

NCSU

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outline

motivation

- classifiers are a foundation of data science
- applications: general classification, subspace analysis

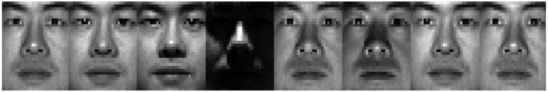
datasets

Modified Nat'l Institute of Standards and Technology (MNIST) database

- source: Yann LeCun et al. [1]
- 70k 28x28 images of handwritten digits (0-9)

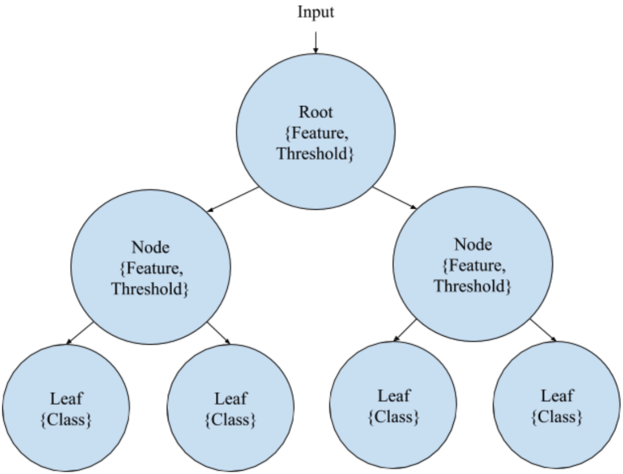
Yale Exended Face Database B

- source: Yale University [2]
- 2414 32x32 images of 38 subjects



progress

decision trees



training decision trees

recursive training algorithm:

1. check stopping conditions
   - no more features
   - set is smaller than `minLeaf`
   - all samples in the same class
   - no feature improves information gain (IG)
2. iterate over each available feature, perform a line search to approximate the highest IG
3. recur over the subsets given by splitting at the feature and threshold with the highest IG

$$\mathrm{IG}(X) = \mathrm{H}(X) - \sum_{i=1}^{2} \frac{|S_i|}{|X|} \mathrm{H}(S_i) \tag{1}$$

$$\mathrm{H}(X) = -\sum_{i=1}^{n} \mathrm{P}(x_i) \log_2 \mathrm{P}(x_i) \tag{2}$$

progress

extremely randomized (extra) trees

recursive, random tree

1. check stopping conditions
   - no more features
   - set is smaller than `minLeaf`
   - all samples in the same class
2. choose random feature. simply use the raw pixels as features.
3. find the mean and variance of this feature across the set. generate a random value from a normal distribution with this mean and variance.
4. recur on the subsets obtained by splitting the parent set on the randomly chosen feature and threshold

ensemble of random trees votes on test data to build extra-tree classifier

progress

1 introduction

2 decision trees

3 extra trees

4 linear discriminant analysis (LDA)

5 results

6 conclusion

progress

results

best performance

algorithm	MNIST	Yale B
LDA	13.5%	6.8%
decision tree	16.6%	57.9%
extra-trees	4.9%	34%

5-fold cross-validated performance

algorithm	MNIST	Yale B
LDA	14.5%	2.5%
decision Tree	17.9%	74.9%
extra-trees	5.4%	36.3%

conclusion

- intuition needed for feature generation
- choice of algorithm depends on type of data, time available
- future work:
  - alternative features
  - parallelize algorithms

references

Yann LeCun and Corinna Cortes.
MNIST handwritten digit database.
2010.

Yale face database b.

thanks!