

INF???: Machine Learning Final Report

**Skin Segmentation**

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INTRODUCTION = motivations

# The Dataset

<https://archive.ics.uci.edu/ml/datasets/Skin+Segmentation>

3 Attributes B, G, R ranged from 0 to 255.

Y = 1 or 2 respectively Skin or Non-Skin

245057 instances

Not really balanced: 50859 skin against 194198 non-skin.

It was obtained from by randomly sampling face images from different age groups, skin colours and gender from FERET database (http://face.nist.gov/colorferet/request.html) and PAL database (<http://agingmind.utdallas.edu/facedb/>).

Points (R,G,B) were displayed in 3D to allow visual appraisal of the data (Figure 1).

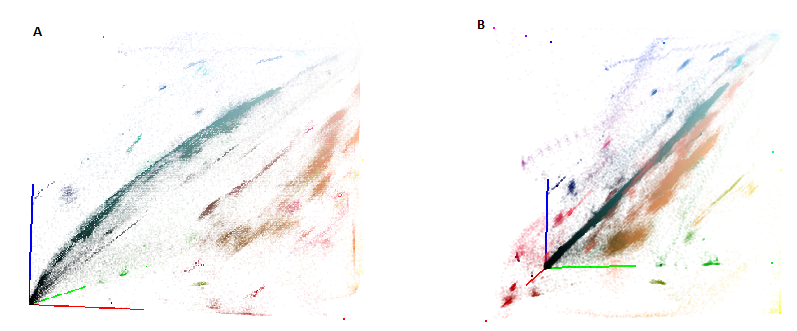


Figure 1: Dataset in 3D, points coordinates are (R,G,B). Colors of the axis correspond to attributes. (A) View from R axis. (B) View from G axis. Data are gathered in some places (clusters).

# State of the Art

[Bhatt et al., 2009] use a fuzzy decision tree to classify the data.

Indeed, the dataset is fuzzy: skin color varies smoothly between different persons and there is no exact limit between those different colors. Consequently, one point (R,G,B) can belong to several skin types with a certain degree of membership. The term “fuzzy” is a synonym of “blur”: limits between classes are blurred. The fuzzy decision tree allows one point to follow different paths and this represents well this fuzziness.

[Bhatt et al., 2009] arrive at a result of 0,941. Their confusion matrix is given below (Figure 2).

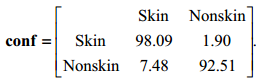


Figure 2:

# Fuzzy decision tree

## General principle

As introduced in Part 2, fuzzy decision tree takes into account the blur that may occur at the limit between classes. For example, say we have one attribute *Temperature* and we want to know if a given temperature reading is “hot”, “mild” or “cold”. Can we consider a temperature of 15◦C as being mild or cold? This appraisal depends on every person.

Consequently, one data can follow different path in the tree and will eventually be classified with a probability of belonging to the given class.

The first step in building the decision tree is to cluster the data. Here the fuzzy c-mean method was applied. Then the tree is buit on the principle of maximum information gain for every attribute. Finally some rules are extracted in order to read the tree when classifying a new data point.

## Fuzzy clustering

The fuzzy c-mean algorithm was used: it allows one point to belong to several clusters at the same time, with a degree of membership. The method was developed by [Dunn et al., 1973] and consists in minimizing the following objective function:

|  |  |  |
| --- | --- | --- |
|  |  | ( 1 ) |

Where *µij* is the degree of membership of point *xi* to the cluster *j* with center *cj*. *N* is the number of data point and *C* is the number of clusters to extract. *m* is the so-called fuzzifier that will give information on the degree of fuzzification (mixing) of the data. It is generally set to 2 (). The norm here represents the Euclidean distance.

This minimization is carried out through and iterative process that will update *µij* and *cj* until for every *µij*, with *k* the iteration step.

The algorithm is as follows :

Following [Bhatt et al., 2009] the clustering was first done with 5 classes (*C* = 5). Figure 3 shows the cluster centers in the 3D representation and the extracted membership functions drawn as Gaussian curves with parameter σ = 10, for ε = 0.0005.

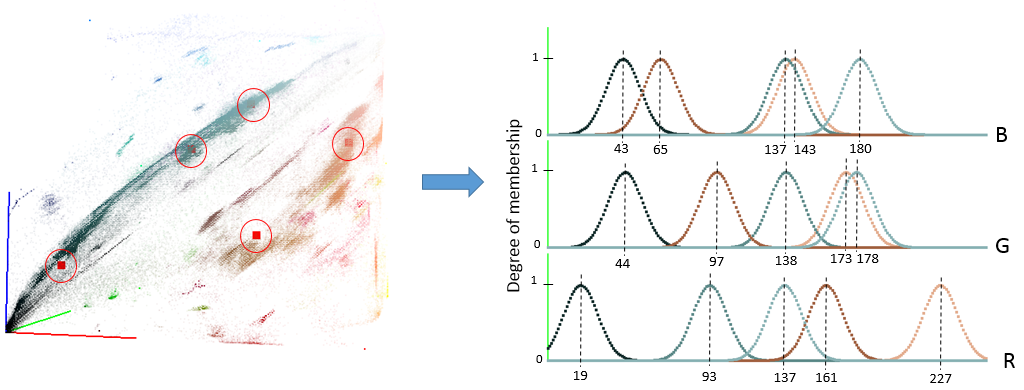


Figure 3:

Visually, two clusters may correspond to skin color (beige and brown). It seems like there is a wider range of colors for human skin and looking at the initial data it was assumed that more clusters could be found for skin colors. The second clustering then increased to 10 classes. Figure 4 shows the result for *C* = 10, with the same parameters as before.

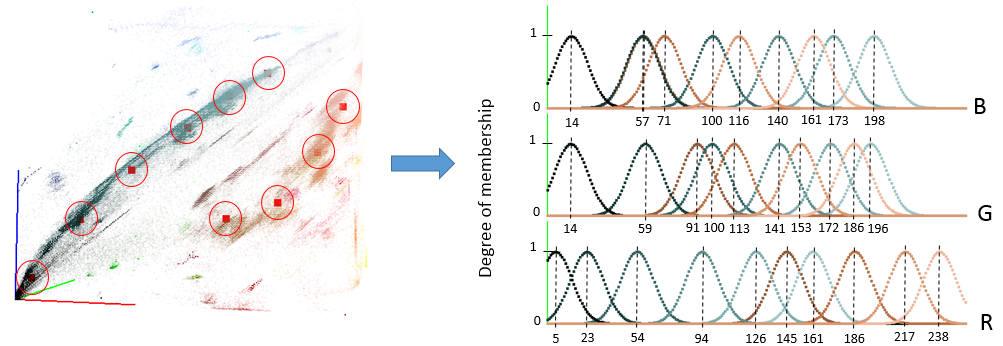


Figure 4:

The second clustering highlighted new shades for skin color (light beige, dark brown, light brown). However the process was longer, as resumed in Table .... In the following, the two parameterization are used to build the decision tree and show that better results are obtained with 10 clusters.

## Fuzzy decision tree building

## Testing

# Results

Conclusion

References

Rajen Bhatt, Abhinav Dhall, 'Skin Segmentation Dataset', UCI Machine Learning Repository