Machine Learning Project Report

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***Abstract*—In the first part of this report, we compare k-means to KCM-F-GH, its hard clustering variation in feature space proposed by Cunha et al [?]. Both methods are evaluated on the segmentation dataset available in [?] by computing the adjusted rand index to analyze the similarity between the predicted cluster solutions and the ground-truth labels. In the second part, we perform a comparative analysis between three classifiers: a maximum likelihood gaussian estimator, a k-nearest neighbors classifier and a hybrid-model committee classifier. Those classifiers are also tested on the segmentation dataset. We run cross-validation multiple times to estimate the accuracy and the error margin of each classifier. At the end, we perform Friedman test to determine the best algorithm. Our results show that KCM-F-GH outperforms the standard k-means in most cases, with the tradeoff of being considerably more time-consuming. In the second part, our experiments show that both KNN and the hybrid classifier are equally accurate in the dataset, and better than the maximum-likelihood estimator.**

***Index Terms*—clustering, supervised learning, classification, pattern recognition**

I. Introduction

This research report contains two main sections. The first one briefly describes how k-means and KCM-F-GH were implemented, and how they performed in the experiments. In the second one, we point some implementation strategies for the maximum likelihood gaussian estimator (MLE), the k-nearest neighbors classifier (KNN) and the hybrid-model committee classifier. Then, we compare their accuracy in a series of experiments.

The *Python* code, the development history and the dataset are all available on Rodrigo Castiel's personal github (click here). Basic repository structure:

- *part_1.py*: main script for running and comparing the clustering algorithms.
- *part_2.py*: main script for running and comparing the supervised classifiers.
- *classifiers*: contains a list of classes, each implementing a classifier or a clustering algorithm.
- *core*: contains *data_loader.py*, a utility module for managing the segmentation data.
- *data*: training and test datasets.

Additionally, we use *Numpy* and *Scikit*, *Python* libraries for linear algebra, statistics and learning utilities.

II. Part I - Clustering

A. Implementation

The test code start point is located in *part_1.py*. The script arguments, to be passed in from the terminal, are a list of views which will be tested. For example the list *RGB* and *SHAPE* tells the program to run both k-means and KCM-F-GH on the RGB and the shape view, separately. For each view, the script then builds each classifier and calls the method fit on it. The parameter num_times controls how many times KCM-F-GH will be executed before the best fit run is taken. The implementation of k-means and KCM-F-GH are located in *k_means_clustering.py* and *kcm_f_gh_clustering.py*, respectively. They are both thoroughly documented.

Note. During the initial tests of KCM-F-GH, we noticed that the update of the hyper-width parameters is not robust to constant-valued features. That is, if at a given moment a specific feature becomes constant within each cluster, the denominator of equation (24) becomes 0 [**?**], which breaks the execution. It means that before actually running this algorithm in feature space, we must remove redudant dimensions in the dataset. For this reason, we removed the features "REGION-PIXEL-COUNT" and "SHORT-LINE-DENSITY-2" from the shape view.

B. Experiments and Results

III. Part II - Supervised Learning

A. Implementation

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- Use a zero before decimal points: "0.25", not ".25". Use "cm^3", not "cc".)

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- The word "data" is plural, not singular.
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- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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- There is no period after the "et" in the Latin abbreviation "et al.".
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [7].

F. Authors and Affiliations

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TABLE I
TABLE TYPE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
copy	More table copy[a]		

[a]Sample of a Table footnote.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

ACKNOWLEDGMENT

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REFERENCES

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For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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