



Open your mind. LUT.

Lappeenranta University of Technology

LUT Machine Vision and Pattern Recognition

2015-11-05

BM40A0700 Pattern Recognition

Lasse Lensu (Ville Kyrki, Leena Ikonen)

Practical Assignment

Gesture recognition — The Jedi Master

1 Problem Statement

Your task is to develop a learning control system for a computer game “Jedi Master” (nonexistent). The purpose of the system is to allow the player to control swordfights by swinging around a motion sensor equipped with accelerometers. Seven people have demonstrated their performance on seven different moves, and the developed system should be able to classify new demonstrations as one of the demonstrated moves.

The information from the demonstrations is available as a tar file which contains several files named `pXmYdZ.mat` where

- X is the number of the demonstrator (person),
- Y is the class (type of move), and
- Z is an index of each individual demonstration.

Therefore, each file will contain a single demonstration with three values on each line. The values correspond to the accelerometer measurements at the corresponding time instant. Each demonstration contains measurements over the whole motion. The demonstrated moves are as follows:

Class (Y)	Move
1	Slash left
2	Slash right
3	Cross strike
4	Parry & strike
5	Parry up
6	Overhead strike
7	Stab

Note that you need to load the data files to Matlab using `load -ascii`.

Your task is to implement a Matlab function `C = pr_classify(testdata)`, which classifies a single unknown example given as an $N \times 3$ matrix `testdata`. The output class `C` should correspond to the moves listed above.

2 Requirements

The practical assignment is meant to be done in freely selected groups of two persons. If someone wants to work alone, this is also possible.

To carry out the *programming task*, you must obey the following rules:

PO BOX 20, FI-53851 LAPPEENRANTA, FINLAND

E-mail: lasse.lensu@lut.fi

- Allowed: Use of “low-level” Matlab toolbox functions available at the course computer classroom.
- Not allowed: Use of “higher-level” Matlab functions such as `classify` or another single function doing all the work, or any other source code, for example, from the Internet.

To prepare the *documentation* of your work, you must obey the following rules:

- Allowed: You can use references if you acknowledge them (proper citation to the reference used) and do not copy text from a reference.
- Not allowed: Use of any material prepared by others (without properly acknowledging the source), or direct copying of sentences or their parts from a reference.

By returning the assignment you assure that i) you acknowledge all sources (no plagiarism), and ii) you have not used any forbidden material.

2.1 Matlab function

The Matlab function that performs the classification must have the name `pr_classify` and it must take parameters and return values in the way described above. This means that the function(s) for feature extraction must be called within the `pr_classify` function. Also, if you are using a classification technique which needs some extra parameter(s) (such as k in the k -nearest-neighbors classifier), the parameter(s) must be fixed or determined inside the `pr_classify` function.

Remember to properly comment your codes. Write also a help section to your codes that tells the purpose of the function, usage, and explanation of the parameters. In Matlab, comments following the first line of a function will show when the `help` command is used with the name of the function. You can see an example, if you type following command in Matlab:

```
>> help mean
>> type mean
```

Your `pr_classify` function and possible other functions connected to it must run in the Matlab of the course computer classroom. Your function must be able to classify 100 examples in 5 minutes in that environment.

Note that your classification function only needs to take in one sample to be classified. It can be totally separate from the training function, in which you are free to handle the training data in any way you want, for example, you can use temporary files for the extracted features. Your classification function just needs to extract the features from the one input sample. The rest of the function can basically be hardcoded with the ready-made classifier (for example, multilayer perceptron (MLP) with a pre-selected structure and weights optimized by using the training data).

Remember that you are not allowed to use the Matlab function `classify` in your solution. You must implement your own classifier using a classification method.

2.2 Documentation

Write a report in English about your project. The documentation should include a cover page where you give the course number and name, project title, date, and the names and student numbers of the authors.

Describe the methods used for the feature extraction and classification in such detail that a reader would be able to implement the same kind of functions for feature extraction and classification just based on your documentation and the cited references. Presenting an algorithm and explaining it in words is a good way to describe the principles of methods. Justify your choices, that is, present reasons to select the classifier and feature extraction technique for your solution.

Include in the report the classification results with the given data by performing the classification using the *leave-one-out testing method*.

At the end of your documentation, you should list all the references used. Note that you are allowed to use any references/information you want, but all source code must be written by yourself. The “low-level” functions of the official Matlab toolboxes available in the computer classroom can be used.

3 Deadline and submission

The deadline of submitting the results of your work to Moodle is **Wednesday, 2 December 2015 at 12:00 EET**. The results containing the pdf document and all relevant codes (feature extraction, training, classification, and analysis of results) must be packed into a single file using **zip**, or **tar** and **gzip**. The file name of the package must be **stnum.zip** or **stnum.tar.gz** where **stnum** is the student number of one of the authors. When **stnum.zip** is extracted, it should create a single directory **stnum**. This directory should contain the **classify** function and all the other files (except the standard Matlab functions) needed run the classification function, as well as your report.

4 Grading

The classifiers will be ranked according to their classification performance, that is, the smaller the classification error, the better classifier. The classification error will be determined using separate test data available only to the teacher. All classes will have equal proportions in the test set.

The operation of a classifier must be reasonable, that is, a classifier that returns randomly selected class labels is unacceptable. In addition, your classifier should perform better than a purely random classifier (which would be based on directly using the a priori probabilities).

The grade of the practical assignment is either passed or failed. However, the authors of the best classifier are given with 5 extra points to the personal exercise points, the second best classifier 3 points, and the third best 1 point. If two or more classifiers reach the same classification performance, they will be ranked according to the total execution (central processing unit (CPU)) times needed for training and testing: a classifier requiring less execution time is better.

5 Notes and tips

The data has been gathered using a WiiMote of the Nintendo Wii. For more information, see http://en.wikipedia.org/wiki/Wii_Remote.

The feature extraction part can have a significant effect on the system performance. Try to either develop a good method yourself, or look for more information in the literature (and cite the references whenever necessary).

If there are any problems with the assignment description and/or data, contact the person supervising the practical assignments before inventing your own interpretations or making radical assumptions.