ECE532 - Final Project Proposal

Mike Hagenow, mhagenow@wisc.edu

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1 Project Dataset

My research revolves around human robot interaction and shared autonomy (i.e., combining together human input and autonomous robot behavior). To best relate this project to my research area, I sought a dataset relevant to either fault detection (so the robot can alert the human when it needs help) or human intent detection (so the robot can know what the human wants). From the UCI repository, I was able to find two relevant repositories: Steel Plate Faults and Motion Capture Hand Postures.

For this project, my plan is to explore both of these datasets, though the focus will be on the first set. The fault detection set will be used as the main set as it represents fairly structured data that is well-suited for a classification problem. This data set has the following properties:

- Total instances: 1941
- Attributes (features) per instance: 27
- Number of labels: 7

The features represent a variety of measurements taken from the different steel plates, including luminosity and edges. The labels represent a variety of types of faults including stains, bumps, Z-scratches. Thus, the classification problem is whether the correct type can be determined based on material properties and measurements of the steel plates.

The second dataset, the motion capture hand postures, is less structured. The data are the cartesian coordinates of 11 trackers attached to a person's hand. Since the markers are not unique, this dataset has the additional challenge that the input data are less structured (e.g., the location of marker 2 at one point is not guaranteed to be marker 2 at a different point). I would like to use this dataset to explore some basic feature extraction and the resulting quality of the proposed algorithms. The motion capture dataset has the following properties:

- Total instances: 78095
- Attributes (features) per instance: 38
- Number of labels: 5

As noted above, the input data are the cartesian positions of various markers attached to a person's hand. The labels are different gestures the hand may assume, such as fist, stop, point, and grab. Thus, the classification problem is whether the correct hand gesture can be recognized based purely on tracking marker locations.

2 Algorithms

2.1 Algorithm 1: Linear Classification

A linear classifier will serve as the baseline comparison. Given that the linear independence of the data is not known a priori, I will employ a regularized version and test a set of logarithmically spaced regularization parameters using cross validation. Since the dataset is a multiclass problem, I plan to use the 'One' vs 'all' testing tactic where several binary classifiers will be trained that can either be used for voting or to compare to a similar form of the binary classifier applied to the later algorithms.

2.2 Algorithm 2: SVM

Support vector machines (SVM) will serve as the second classifier. The data will be arranged similarly to the previous algorithm to assure that proper comparison is allowed (e.g., 'one' vs 'all'). Similar to the linear classifier, I plan to explore the effect of the regularization parameter.

2.3 Algorithm 3: Neural Network

The final method comparison will be a neural network with a limited number of layers (e.g., 2-5). Similar to the previous algorithms, this will be arranged to allow proper comparison to the previous algorithms, using a network structure to allow for a similar set of binary labels (e.g., yes/no for each label with a softmax constraint). As far as parameter variance, I am not exactly sure what will be covered in this class, but I plan to explore the learning rate or number of layers (2-5) (or a different parameter if there is a different focus in this class).

2.4 Additional Algorithms

While the three above algorithms were chosen to meet the requirements of this project, I also plan to add a few additional elements to my project submission. First, I plan to explore at least one additional algorithm. Given that we have not discussed a majority of the algorithms in the class yet, I would like to wait to choose until I find one most relevant to helping with the problems I am encountering later on. Second, I plan to choose one recent algorithm from the literature (where an open source implementation is available) to compare a method that is more state of the art.

2.5 Validation

Given the number of samples in the steel plate fault dataset, I mainly plan to validate the data using hold-one-out testing across the range of algorithms explored.

For the hand tracking dataset, I will employ both hold-one-out testing as well as having a strict test dataset since there are more data to use. I think it would be interesting to compare how these two evaluation methods line up.

3 Project Tracking and Github

All of the relevant work related to this final project will be tracked in the following github: Repository. The key deadlines and time planning are seen in Figure 1 below.

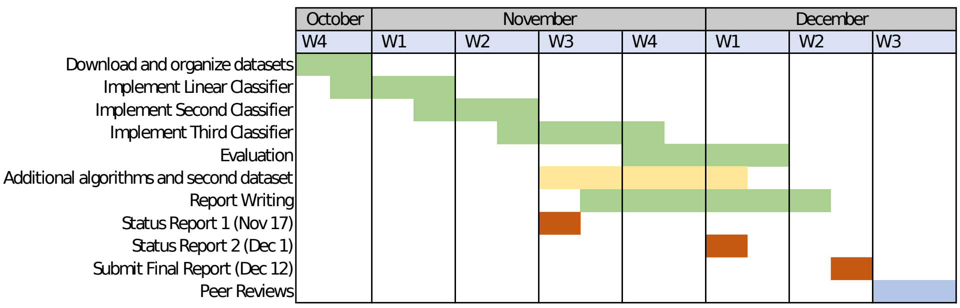

Figure 1: Proposed Project Timeline