

# Extrapolating Multi-class classification curves

Charles Zheng and Yuval Benjamini

March 31, 2016

## 1 Introduction

Object recognition, face recognition (or more generally person recognition) and language are a few of the cognitive building blocks which are fundamental to human cognition, and which can be understood as examples of generalized classification tasks. Fundamentally, humans learn to recognize objects, persons, or linguistic entities and learn equivalence relationships between perceived objects, words, or individuals. A child will encounter their neighbor's dog for the first time, and at a later date, encounter the same dog in a different time or place. But they will recognize that the dog is the same dog they met before.

Machine classification can be employed to mimic this power of recognition. A robot equipped with a camera can algorithmically segment its input image into objects, and to learn to recognize unique objects and people which regularly appear in its environment. A general approach to implement such a recognition ability starts by employing some parametric featurization of the object to be identified. For example, for the task of face recognition, one might define features such as the proportions between the eyes and the relative position and size of the nose. Such features can be estimated from the video input, and while the estimated features might vary slightly depending on the configuration of the object (e.g. posture of the body, emotional expression of the face, opening/closing of the mouth) and while some features might be unobserved because of occlusion, the regularity of the identified features can still be used as a basis for recognition. In the simplest case, a feature vector can be extracted from a given object from the input data, and this feature vector can be evaluated against a library of learned models for the distribution of the feature vector for various objects. In other words,

given a method for extracting objects from input and producing feature vectors for those objects, one can employ multi-class classification to identify the object corresponding to the feature vector. In our discussion thus far, we neglected to mention how to learn object categories for novel objects, but this falls outside of the scope of the paper.

A limitation to such recognition systems, whether they be natural or artificial, is that the performance of the system (in terms of correct classification) can degrade if there are too many categories. A face recognition algorithm can have very high success rate if it only needs to distinguish between 100 different faces, but its identifications may be less reliable when it needs to distinguish between 10000 different faces. In humans, it is known that repetition learning is hampered when there are too many similar concepts to be learned.

## **2 Definitions**