## Learning like human for time series classification

Time Series Classification which is prediction of class label for the sequentially ordered data measurements is an important and challenging problem in machine learning. With increase in the availability of time series data, various algorithms have been proposed for the task of time series classification. Among these models, however, very few have considered Deep Neural Networks for this task [7]. Though Deep Neural Networks have been revolutionised the field of computer vision, they are still in primitive state for the task of time series classification.

The main research question I would like to pose in my thesis is, "Can machine learning models learn like humans?" Most of the existing machine learning models are considered to be static means, the number of classes are fixed while learning and it cannot learn any new classes. Though the class incremental learning [6] models learn new classes, one has to teach them that a new class is coming which is not completely independent. In my PhD, I would like to develop the dynamic and completely independent model which can learn the new classes when ever significant number of new class examples are arriving in the data for time series using deep learning techniques.

The proposed work can be divided into three problems mentioned below:

1. **Openset recognition** for Time series classification: In this problem, the task is to recognize a new unseen class example while testing the model.

2. Learning to clustering Time series data: If unknown class examples are appearing in more volumes than the predefined threshold it is an indication that new class or classes is being created in the world. For this we develop novel models to cluster these new class examples.

3. **Class incremental learning:** Once we made sure that a new class is appeared in the testing, now the task is to learn that new class using online learning models.

My PhD work will focus on solving these three problems which will take me to the final goal of developing a robust model for the online learning. In the next section, I will briefly explain the three proposed problems.

Problem 1: Openset recognition for Time series classification In real-world classification tasks, limited by various objective factors, it is impossible to collect the training samples to exhaust all the classes while training a classifier. A more realistic scenario is open set recognition where the model is trained with the known classes and unknown classes can be submitted at the time of testing. The challenge is to recognize the unknown classes that model have not seen at the time of training while classifying the known classes accurately. Existing works [2, 5, 1] address the openset recognition problems for the image datasets. However, I would like to work on time series dataset where I can exhaust the temporal correlation between the data points.

Problem 2: Learning to cluster Time series data

This is the second problem we define for developing the human like learning model. Once, we recognise that a new class labels are appearing in the testing data, we have to cluster them to learn that new class or classes are being appeared. Though it is an important challenge to develop a learning paradigm mimicking humans, to the best of my knowledge, there has not been any research in this direction. Hence, i would like to explore significantly in this direction. To this end, I would like to develop a multitask learning model [3] that could perform both classification of the existing class examples and clustering of the unknown samples.

Problem 3: Class incremental learning for time series data Once, we realise a new class has been appeared in our test set, our model has to learn that new class. To solve this we want to develop class incremental learning models where the task is to learn new classes that do not appear while training. The problem with the class incremental learning for deep networks is the catastrophic forgetting [6, 4] - an abrupt degradation of performance on the original set of classes when the training objective is adapted to a newly added set of classes. Again, researchers are significantly concentrating on image datasets leaving time series datasets. Hence, in my thesis, I would like to verify the usefulness of those models to the time series datasets and would like to develop new models to new classes specific to time series datasets.

At the end, I would like combine all the three challenges and develop an end to end multitasking model. The proposed model would be able to learn like a human where it can differentiate the known classes while learning the new classes for the time series datasets.