

A Novel Approach for Effective Learning in Low Resourced Scenarios

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Motivation

- Neural networks, being state-of-the-art discriminative algorithms, require **substantial amount of training data**.
- What do we do when we have **limited data**?
- Can we **generate sufficient amount of data**, from the available **limited data**, for neural networks to learn better?

One such **approach**...

Objective

- Propose novel approach to **effectively learn** the system parameters even from **limited data**.

Contributions

- Representation of data for learning effectively from limited number of examples.
- Introduce modifications to neural network for handling proposed data representation.
- Novel decision making based on the proposed data representation.

Proposed Approach

Data Representation (for training multi-layer perceptron (MLP))

- Data representation in general is:

$$(\vec{x}_{ij}, C_i), \quad i = 1, 2; \text{ and } j = 1, 2, \dots, N_i,$$

where, \vec{x}_{ij} : Feature vectors; C_i : Class label; N_i : Number of samples in class i .

Proposed data representation format:

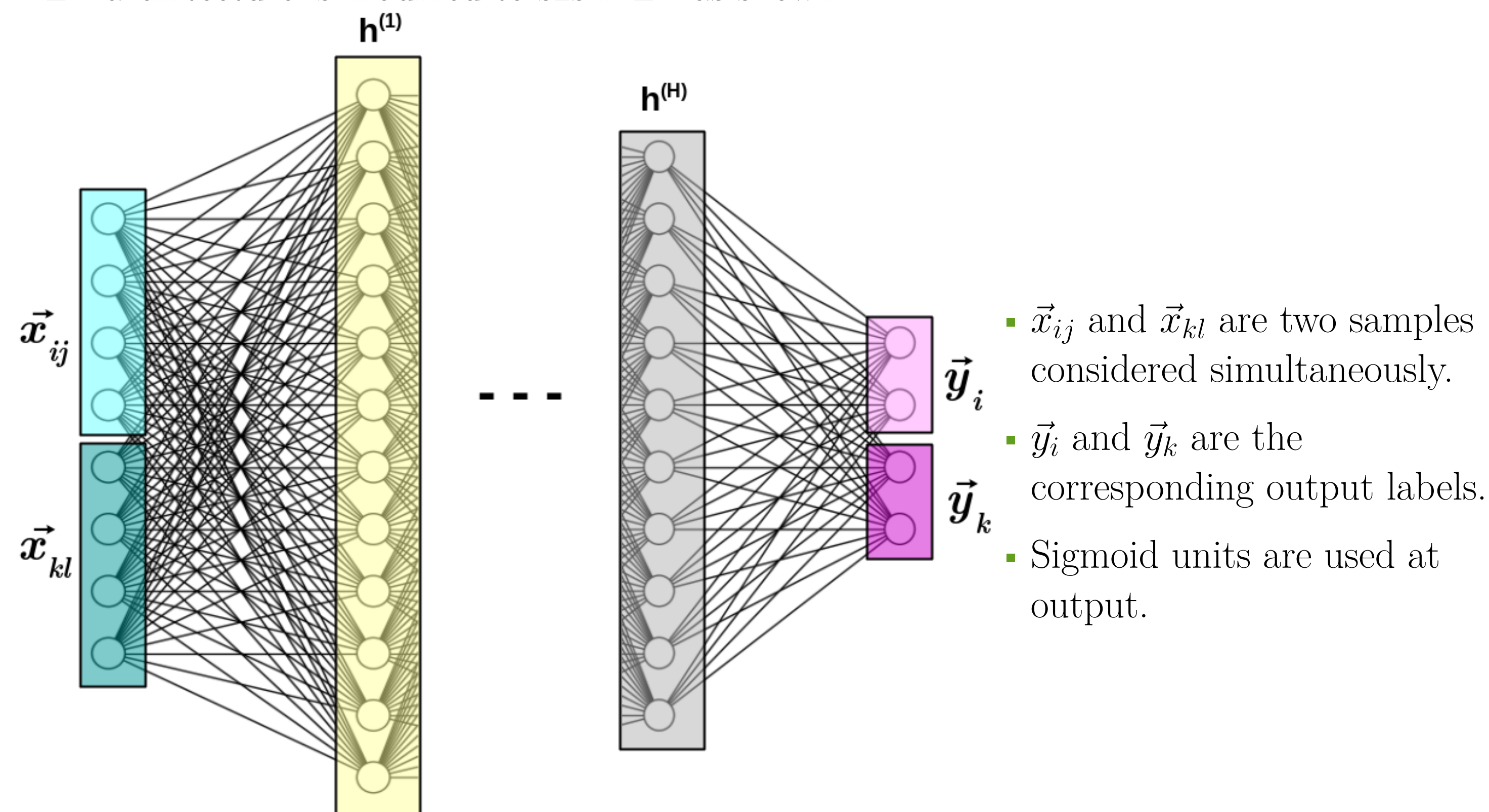
$$([\vec{x}_{ij}, \vec{x}_{kl}], [C_i, C_k]), \quad \forall i, k = 1, 2; j = 1, 2, \dots, N_i \text{ and } l = 1, 2, \dots, N_k,$$

where $\vec{x}_{ij}, \vec{x}_{kl} \in \mathbb{R}^{d \times 1}$: Feature vectors; C_i, C_j : Class labels; N_i, N_k : Number of class samples.

- Each sample is obtained by simultaneously considering two samples, hence, the name “**Simultaneous two sample (s2s)**” representation.
- Using s2s representation, the number of samples are increased to $(N_1 + N_2)^2$ from $(N_1 + N_2)$ samples.

Neural Network Design

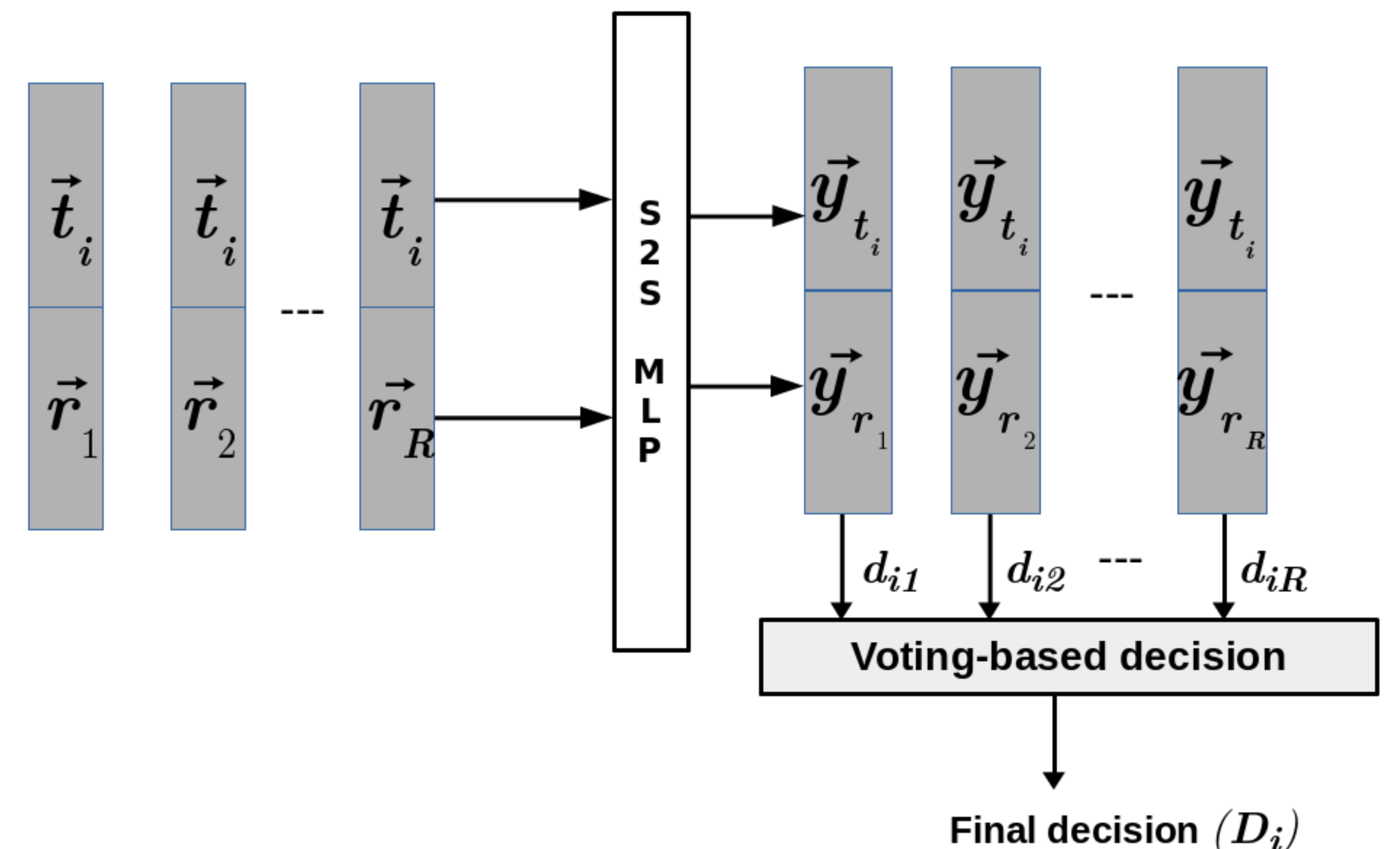
MLP architecture is modified to s2s-MLP as shown:



Modified neural network architecture

Training of the s2s-MLP using the s2s data representation format is referred to as **simultaneous two sample learning (s2sL)**.

Decision Making



Approach for testing s2s-MLP

\vec{t}_i refers to the test feature vector.

$\vec{r}_1, \vec{r}_2, \dots, \vec{r}_R$ refers to the set of R reference feature vectors.

Experiments

Proposed approach is validated on three different classification tasks:

- Balanced datasets**
 - Speech/Music classification
 - Emotion (Neutral/Sad) classification
- Imbalanced dataset**
 - Emotion (Anger/Happy) classification

Results

Table 1: Classification accuracies (in %) for balanced datasets.

Task		Data proportion			
		1/4	2/4	3/4	4/4
Speech/ Music	MLP	70.8	74.6	80.1	81.2
	s2sL	75.2	79.3	82.7	85.1
Neutral/ Sad	MLP	86.3	88.0	90.5	91.1
	s2sL	90.4	91.2	92.1	92.9

Table 2: F_1 for classification on imbalanced dataset (EB: Eusboost; MM: MWMOTE).

Task		Data proportion			
		1/4	2/4	3/4	4/4
Anger/ Happy	MLP	.41	.49	.53	.56
	EB	.47	.54	.59	.64
	MM	.48	.55	.61	.66
	s2sL	.54	.60	.64	.69

Discussion

- s2sL approach works better for limited data compared to MLP. s2sL approach also works better on imbalanced data.
- Psychologists suggest that **Comparative analysis** (by identifying the similarities and differences between the pair of items) helps Human **better learn and memorize** the patterns.
s2sL seems to emulate comparative analysis??

Indian Patent (Provisional)

- System and Method for Simultaneous Multi-class Learning
- PS # 201721017694 (29-May-2017)
- Tata Consultancy Services (Dumpala, S. H., Chakraborty, R. & Kopparapu, S. K.)