# Towards Explaining Expressive Qualities in Piano Recordings: Transfer of Explanatory Features via Acoustic Domain Adaptation

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## INTRODUCTION

Acoustic features learnt from smaller datasets may not generalise well to specific domains. In this work, we explore this problem for *mid-level* features and provide a strategy to transfer these features to the domain of solo piano recordings.

### Why Transfer Mid-level Features?

These features are based on perceptual and intuitive musical qualities that have been shown to be effective in explaining musical emotion [1].

### Approach:

Two-step approach:

1. Gradient-based unsupervised domain adaptation (UDA)
2. Teacher-student mediated refinement

### Model Architecture

Receptive-Field regularised ResNet (RF-ResNet): Modified ResNet with smaller CNN kernels and fewer layers. This architecture has been shown to improve generalisation in audio and musical applications.

### Modeling Expressive Performance Descriptors

We use our models to extract average mid-level features for piano performance recordings and fit them to four dimensional embeddings obtained from the occurrence matrix of words used by participants in [3] to describe expressive piano performances.

References

[1] Chowdhury, S, Vall, A, Haunschmid, V, Widmer, G Towards Explainable Music Emotion Recognition: The Route via Mid-level Features. In Proceedings of the 20th International Society for Music Information Retrieval Conference (ISMIR) 2019

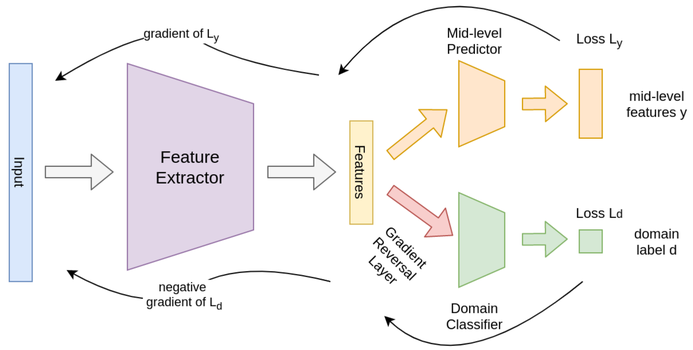
[2] Ganin, Yaroslav, and Victor Lempitsky. "Unsupervised domain adaptation by backpropagation." International conference on machine learning. PMLR, 2015.

[3] Cancino-Chacón, C, Peter, S, Chowdhury, S, Aljanaki, A, Widmer, G On the Characterization of Expressive Performance in Classical Music: First Results of the Con Espressione Game. In Proceedings of the 21st International Society for Music Information Retrieval Conference (ISMIR) 2020.

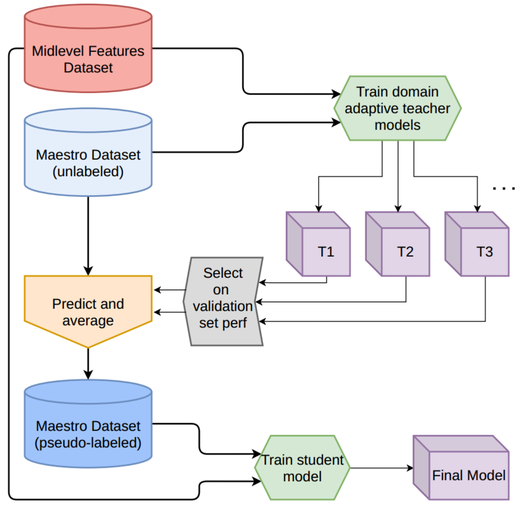
## GRADIENT-BASED UDA

We adopt the method of **gradient reversal** for unsupervised domain adaptation [2].

MAESTRO dataset is used as the target domain.




## TEACHER-STUDENT REFINEMENT



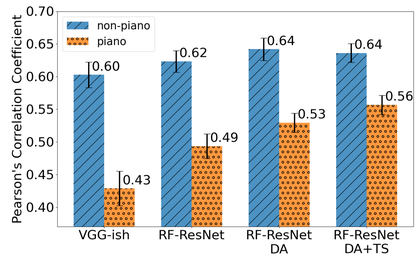

Only UDA results in some models not improving in performance on the target domain.

A refinement step helped overcome this problem.

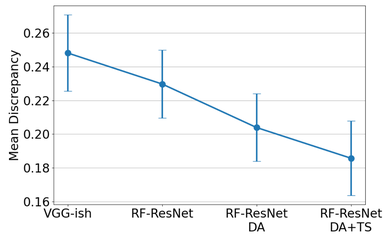
We selected the best-performing UDA models on the validation set, and used them as teacher models.

The student model trained using pseudo-labels from the teacher models performed better on average.

## RESULTS




Performance on piano and non-piano test sets




Mean discrepancy between piano and non-piano sets

## REGRESSION FOR EXPRESSIVE PERFORMANCE DESCRIPTORS

Evaluate whether our domain-adapted models can indeed predict better mid-level features for modelling the four dimensional expressive descriptor embeddings of the Con Espressione dataset [3].

| | Dim 1 | Dim 2 | Dim 3 | Dim 4 |
|---|---|---|---|---|
| VGG-ish | 0.35 | 0.10 | 0.22 | 0.32 |
| RF-ResNet | 0.36 | 0.07 | 0.28 | 0.33 |
| RF-ResNet DA | **0.40** | 0.09 | **0.29** | 0.32 |
| RF-ResNet DA+TS | 0.35 | **0.15** | **0.29** | **0.34** |

R2-score

We specifically look at dimension 1, the one that came out most clearly in the statistical analysis of the user responses characterized by a spectrum of descriptions like “hectic” and “agitated” to “calm” and “tender”.

| RF-ResNet | | RF-ResNet DA+TS | |
|---|---|---|---|
| Feature | $r$ | Feature | $r$ |
| articulation | 0.47 | melodiousness | − 0.39 |
| rhythmic complexity | 0.41 | articulation | 0.46 |
| | | rhythmic complexity | 0.41 |
| | | dissonance | 0.40 |

Pearson’s correlation (r) for mid-level features with the first description embedding dimension, with (right) and without (left) domain adaptation. Features with $p < 0.05$ and $|r| > 0.20$ are selected.

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