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SCORE DIFFICULTY ANALYSIS FOR PIANO PERFORMANCE EDUCATION BASED ON FINGERING

In this paper, we introduce score difficulty classification as a sub-task of music information retrieval (MIR), which may be used in music education technologies, for personalised curriculum generation, and score retrieval. We introduce a novel dataset for our task, Mikrokosmos-difficulty, containing 147 piano pieces in symbolic representation and the corresponding difficulty labels derived by its composer Be la Barto k and the publishers. As part of our methodology, we propose piano technique feature representations based on different piano fingering algorithms. We use these features as input for two classifiers: a Gated Recurrent Unit neural network (GRU) with attention mechanism and gradient-boosted trees trained on score segments. We show that for our dataset fingering based features perform better than a simple baseline considering solely the notes in the score. Furthermore, the GRU with attention mechanism classifier surpasses the gradient-boosted trees. Our proposed models are interpretable and are capable of generating difficulty feedback both locally, on short term segments, and globally, for whole pieces. Code, datasets, models, and an online demo are made available for reproducibility.

Introduction

Classification of music corpora is a problem well-studied under Music Information Retrieval, which is often targeted from the listeners' perspective as exemplified in genre/style and emotion classification. In a paradigm shift, music may be classified from the point of view of the performer by focusing on the required performance skills, which is a newly emerging field of study. This paper focuses on music classification of performance difficulty, with applications in the formation of large pedagogical score databases, personalised score recommendation systems, and as an aid to both individual instrument learners and music teachers. Towards helping the students in determining where to focus their effort, and thus, increasing the efficacy in self-induced music studies, we aim at giving feedback on relative local difficulty over multiple segments of a piece.

Difficulty analysis challenges:
1. Difficulty is a very subjective term.
2. A multidimensional task.
3. No previous available datasets.

Contributions

As a first contribution, we release Mikrokosmos-difficulty -- a benchmark dataset for piano score difficulty analysis derived from a corpus of 147 educational pieces authored by Béla Bartók for use in piano education. To our best knowledge, this is the first open dataset containing piano scores ranked in terms of difficulty and matching different technical levels where all the scores are composed by a single composer.

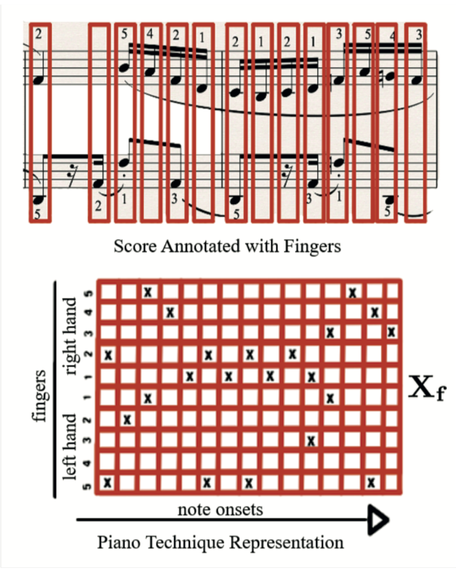
Alongside the data, we also provide three different difficulty labels to study the subjectivity of performance difficulty: the first labels are the order of pieces generated by the composer himself, the second is the book divisions by the original publisher, and the third is difficulty labels in the range 1-9 by the publisher Henle, respectively. Since all the scores are composed by the same composer, the difficulty rankings are less prone to style biases, and more focused on technique difficulty.

As a second contribution, we introduce several piano technique features and two classification algorithms capable of giving both score-level and segment-level difficulty feedback, whilst being trained solely using score-level labels. To that end, we model the score with a novel feature representation based on piano fingering, and taking that as the input, we propose two difficulty classification methods: (XGBoost) gradient-boosted trees [3] applied to short-term segments and (DeepGRU) GRU neural network with an attention mechanism [4]. We want the selected classifiers to give feedback related to the local difficulty of a piece allowing students and teachers to focus and improve on the most difficult passages. Further, we provide a corpus visualisation tool for exploring local difficulty representations derived from both attention weights and the segment-level classification models.

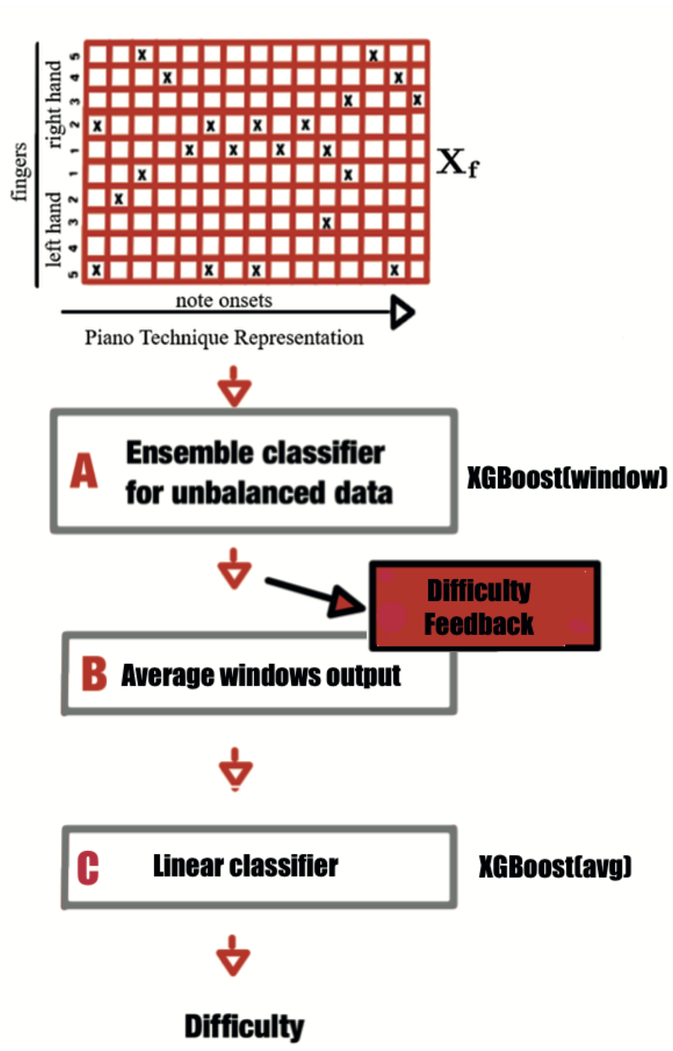
Paper | Code, results and models | Mikrokosmos-difficulty dataset | Corpus visualization tool

Representation

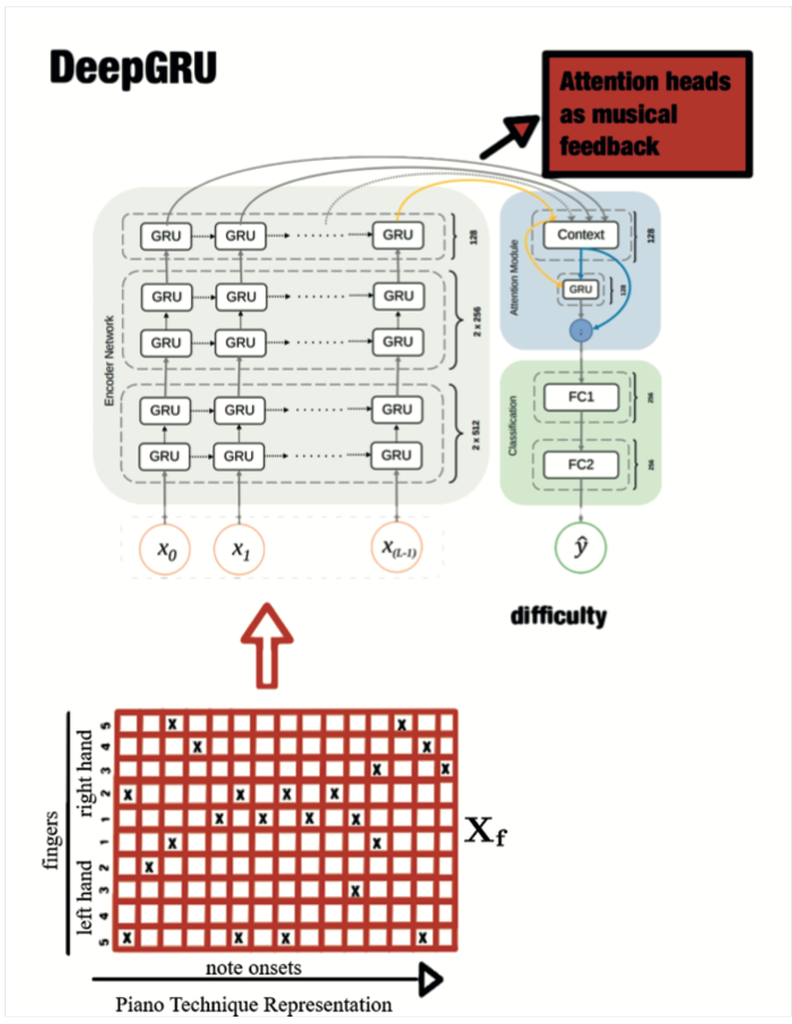
Automatic piano fingering systems aim to describe the movements of hands and fingers on the piano departing from the score. This task is related to piano technique and a proxy to modelling the difficulty of playing a score. Towards modelling difficulty, we derive piano technique features from two piano fingering approaches, a knowledge-driven system, Pianoplayer [1], and a data-driven system proposed by Nakamura et al. [2]. Therefore, we present five piano technique-based feature representations to analyse the performance difficulty and an additional baseline using solely the notes. Note that to reduce the size of the representation and the computational complexity, we do not consider the note duration.



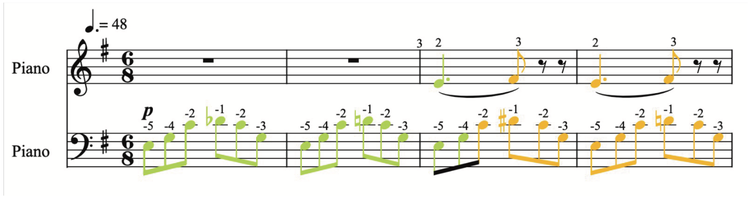
XGBoost Method



DeepGRU Method

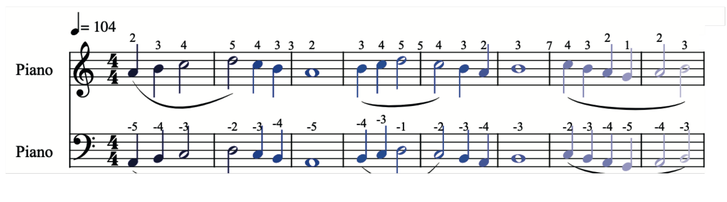


XGBoost FeedBack



* We colour level 1 notes with green (♩), level 2 notes with yellow (♩) and level 3 with red (♩).

DeepGRU FeedBack



* The attention weights corresponding to each note control the intensity of the color. (more attention) ♩ ♩ ♩ ♩ ♩ ♩ ♩ ♩ (less attention)

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