# Unraveling guitar song chord playability

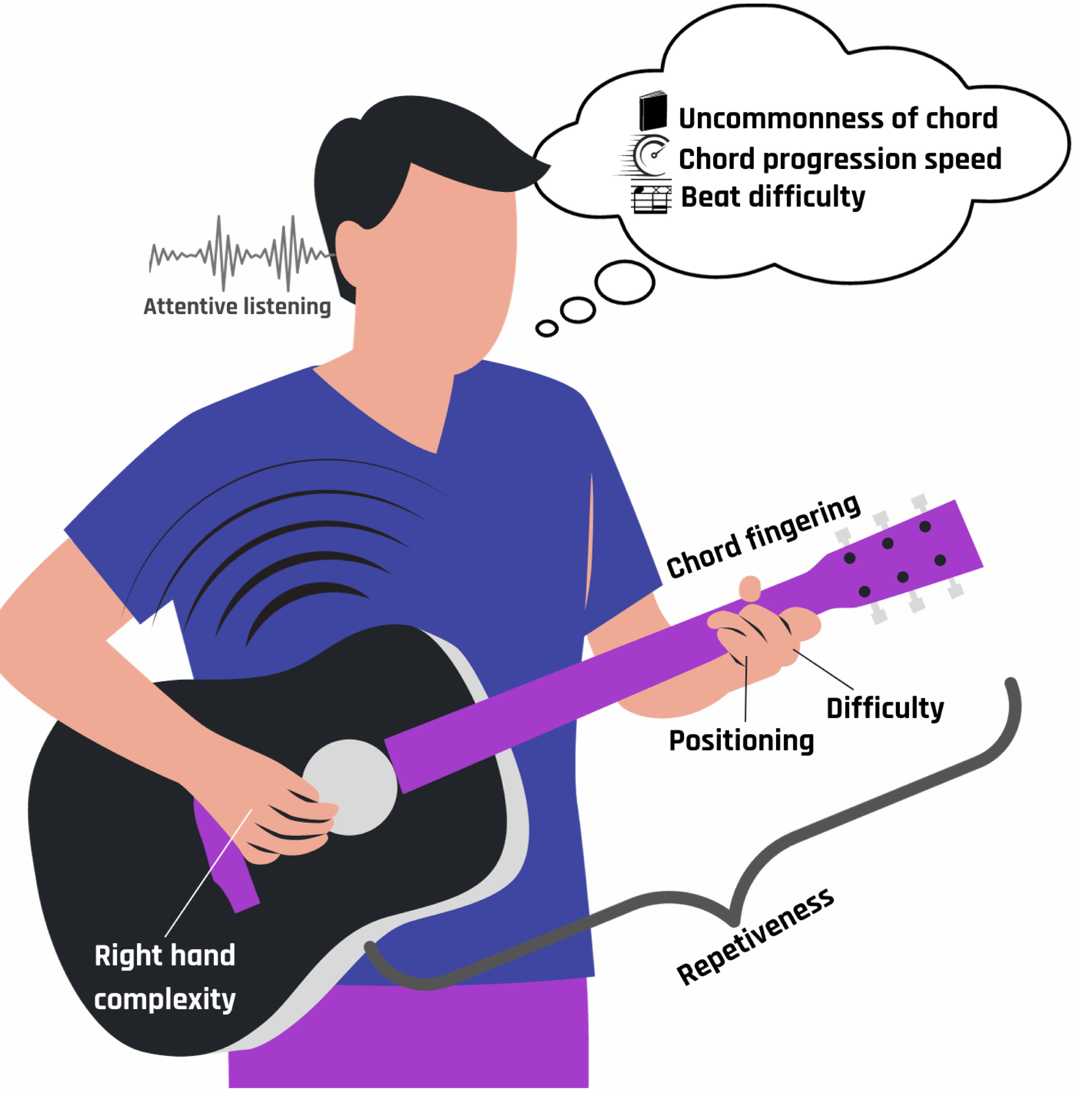
Marcel A. Vélez Vásquez, Mariëlle Baelemans, Jonathan Driedger, Willem Zuidema, John Ashley Burgoyne

IIIC, University of Amsterdam, the Netherlands Chordify, Groningen, the Netherlands

# The playability rubric

- We propose a playability rubric focused on rhythm guitar playability over solo guitar playability.
- We introduce the playability prediction task by adding annotations to a subset of 200 songs from the McGill Billboard dataset, labelled by a guitar expert using the proposed rubric.
- We use this dataset to weight each rubric criterion for maximal reliability.
- Finally, we created a rule-based scoring system using chord data and timing, and then compared it to an LSTM and DeepGRU model trained on chord symbols and textual representations of guitar tablature.

Criterion	Weight	Very difficult (3 points)	Difficult (2 points)	Easy (1 point)	Very Easy (0 points)
Uncommonness of chord	3	A lot of uncommon chords	Some uncommon chords	Few uncommon chords	No uncommon chords
Chord finger positioning	3	Very cramped or very wide fingerspread	Uncomfortable or spread out fingers	Slightly uncomfortable or spread out fingers	Comfortable hand and finger position
Chord fingering difficulty	2	Mostly chords that require four fingers or barre chords	Some chords require four fingers to be played or are barre chords (not A or E)	Most chords require three fingers or are A or E barre chords	Most chords can be played with two or three fingers
Repetitiveness	2	No repeated chord progressions	A few repeated chord progressions	Quite a bit of repetition of chord progressions	A lot of repetition of chord progressions
Right-hand complexity	2	For some chords multiple inner strings are not strummed	For some chords one inner string is not strummed	For some of the chords one or more outer strings are not strummed	For the chords all strings are strummed
Chord progression time	1	Very quick chord transitions	Quick chord transitions	Slow chord transitions	Very slow chord transitions
Beat difficulty (syncopes/ghostne	0 otes)	A lot of syncopes or ghostnotes	Some syncopes or ghostnotes	A few syncopes or ghostnotes	No syncopes or ghostnotes



**Table 1**. Proposed rubric for human annotators evaluating the difficulty of playing the chords of a song on the guitar. Although the rubric functions acceptably using the raw scores from the table header, it has even better predictive power when weighting the criteria according to the factor in the weight column. Note that the beat difficulty criterion provides so little extra information that we recommend omitting it (i.e., setting its weight to zero).

### The creation process

1. We interviewed music teachers and musicians.

- 2. Formulated a draft of the rubric.
- 3. Asked for feedback.
- 4. Incorporated feedback.
- 5. Repeated 3 and 4 till both teachers and musicians were satisfied.

**Figure 1.** Physical and cognitive criteria for evaluating the playability of songs on the guitar position during guitar performance. Note that repeetitiveness reflects both cognitive and physical factors, nad that attentive listening to auditory feedback, while not a criterion itself, is necessary for developing and refining performative gestures.

## The Amsterdam Playability Dataset

### Can playability be measured?

#### Annotation process

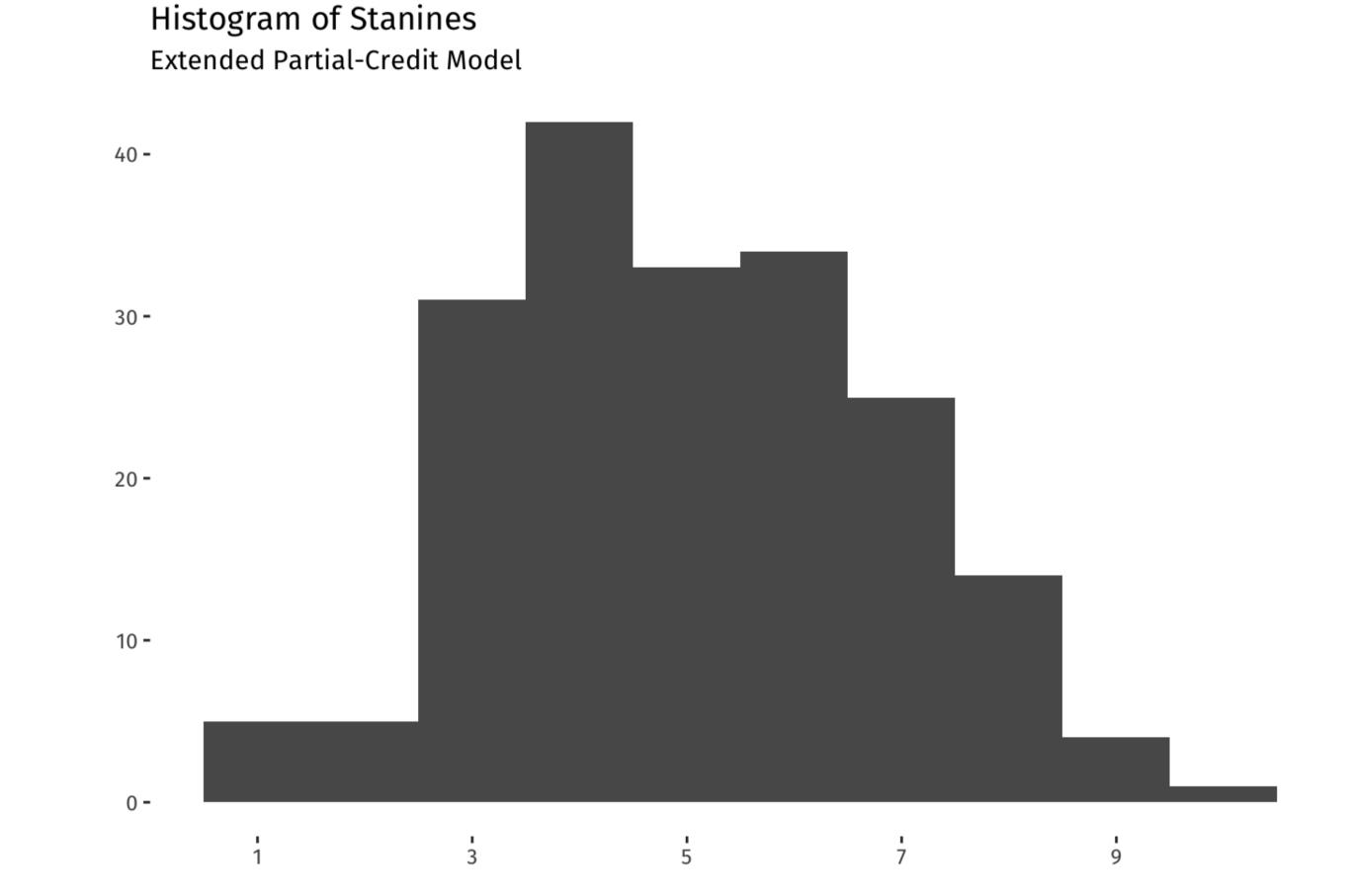
- We instructed the annotator to play the songs as is, without capo or transposing the song.
- The annotator played along with the song.
- After playing along he filled in the rubric.
- The remarks field, e.g. a segment of a song was particularly easy or difficult compared to the rest of the song, was never used.

	Song audio: 0:00 / 2:37 ◀) ——●				
Chord annotations			Rubric		
# title: Till The End Of The Day # artist: The Kinks	Category	Very easy	Easy	Difficult	Very difficult
# metre: 4/4 # tonic: D 0:00 silence	Chord finger positioning:	<ul> <li>Comfortable hand/finger position</li> </ul>	<ul> <li>Slightly uncomfortable/ spread out fingers</li> </ul>	<ul> <li>Uncomfortable/ spread out fingers</li> </ul>	<ul> <li>Very cramped or very wide fingerspread</li> </ul>
<ul> <li>2</li> <li>A, intro,   D:5   C:5   A:5   &amp;pause  </li> <li>B, chorus,   C:5 D:5 F:5 C:5   D:5   C:5 D:5 F:5 C:5   D:5  , (voice)</li> <li>  F:5 G:5   Bb:5 A:5  </li> <li>  C:5 D:5 F:5 C:5   D:5   C:5 D:5 F:5 C:5   D:5 C:5  </li> </ul>	Chord fingering difficulty:	<ul> <li>Most chords can be played with two/three fingers</li> </ul>	<ul> <li>Most chords require three fingers or are A/ E bar chords</li> </ul>	<ul> <li>Some chords require four fingers to be played or are bar chords (not A/ E)</li> </ul>	<ul> <li>Mostly chords that require 4 fingers or bar chords.</li> </ul>
0:36       B, chorus,   D:5 C:5   F:5 C:5   D:5 C:5   F:5 C:5           0:42         D:5   C:5   F:5   A:5           0:48         D:5   C:5   D:5   C:5 Bb:5	Uncommonness of chord:	○ No uncommon chords	<ul> <li>Few uncommon chords</li> </ul>	○ Some uncommon chords	○ A lot of uncommon chords
<ul> <li>(55 G:5   Bb:5 A:5  , voice)</li> <li>(C:5 D:5 F:5 C:5   D:5   C:5 D:5 F:5 C:5   D:5 C:5  , (guitar)</li> <li>B, chorus,   D:5 C:5   F:5 C:5   D:5 C:5   F:5 C:5  , (voice)</li> <li>(D:5   C:5   F:5   A:5  </li> <li>(D:5   C:5   D:5   C:5 Bb:5  </li> </ul>	Right hand complexity:	<ul> <li>For all chords all strings are struck</li> </ul>	<ul> <li>For some of the chords one or more outer strings are not struck</li> </ul>	<ul> <li>For some chords one inner string is not struck</li> </ul>	<ul> <li>For some chords multiple inner strings are not struck</li> </ul>
121        F:5 G:5   Bb:5 A:5  , voice)         124        D:5   C:5   D:5   C:5  , (guitar)         1:30        D:5   C:5   D:5   C:5	Chord progression time:	<ul> <li>Very slow chord transition</li> </ul>	○ Slow chord transition	○ Quick chord transition	<ul> <li>Very quick chord transitions</li> </ul>
1:36       B, solo,   D:5 C:5   F:5 C:5   D:5 C:5   F:5 C:5           1:42         D:5   C:5   F:5   A:5           1:48         D:5   C:5   D:5   C:5 Bb:5  , (voice	Beat difficulty (syncopes/ ghostnotes):	<ul> <li>No syncopes/ ghostnotes</li> </ul>	<ul> <li>A few syncopes/ ghostnotes</li> </ul>	<ul> <li>Some syncopes/ ghostnotes</li> </ul>	○ A lot of syncopes / ghostnotes
<ul> <li>1:54   F:5 G:5   Bb:5 A:5  , voice)</li> <li>1:57   D:5   C:5   D:5   C:5  </li> <li>2:03   D:5   C:5   D:5   C:5  </li> <li>2:09   D:5   C:5   D:5   C:5  </li> <li>2:15   D:5   C:5   D:5 C:5   (6/4) A:5 Bb:5 A:5 Bb:5   (6/4) A:5 Bb:5 A:5 Bb:5 A:5 Bb:5 A:5 Bb:5  </li> </ul>	Repetitiveness:	<ul> <li>A lot of repetition of chord progressions</li> </ul>	<ul> <li>Quite a bit of repetition of chord progression</li> </ul>	<ul> <li>A few repeated chord progressions</li> </ul>	<ul> <li>No repeated chord progression</li> </ul>
2:23   A:maj  , guitar) 2:30 Z 2:37 end	Remarks (e.g. certain sections being way different or difficult/easy compared to general song difficulty):			11.	

**Figure 2**. The annotation dashboard made for the McGill Billboard playability annotations. At the top we have the title of the song and an audio player, on the left an overview of the phrases with corresponding timestamps, and on the right the rubric.

### **Reliability of annotations**

We checked our annotator's scores for reliability:
Reliability is the degree of criterion covariance, where high reliability implies strong covariance



### Can playability be predicted?

### Rule-based model

For our rule-based model we used the following formula:

 $\sum \mathsf{TF}(c) \times \mathsf{IDF}(c) \times \mathsf{difficulty}(c)$ 

To compute a playability score for a criteria, where *difficulty(c)* stands for the criteria specific measure:

- Uncommonness of chord (UC) uses a difficulty of one for all chords (i.e., it is the average TF-IDF weight).
- Chord finger positioning (CFP) requires the guitar diagram and is based on a naïve approach of counting the distance between the lowest and highest played fret, not considering which strings they are played.  $CFP = (1+simplified \times f_{simple}) \times finger distance$
- Chord fingering difficulty (CFD) is based on how many fingers are used, and if a finger is used for more than one string, it is counted as a barre chord. For this criterion, we had three learnable parameters, one for the importance of how many fingers were used, one the importance of barre chords, and one for simplification.
  - $CFD = (1 + simplified \times f_{simple})$

- Repetitiveness (R) is the number of unique phrases in a song according to the Billboard annotations.
- **Right-hand complexity (RHC)** is based on apply the rubric level descriptions to fingering diagrams.
  - $\mathsf{RHC} = \begin{cases} 0 & \text{if no un-strummed strings} \\ 1 & \text{if outer strings not strummed} \\ 2 & \text{if one inner string not strummed} \\ 3 & \text{if multiple inner strings not strummed} \end{cases}$
- Chord progression time (CPT) is the average chord duration (in s) according to the Billboard annotations.
- **Beat difficulty (BD)** is the ratio of chords that were longer or shorter than the most common chord duration in the Billboard annotations.

- among criteria, signifying a shared underlying factor.
- We used partial credit models to assess reliability.
- Given the fitted partial credit models we recommend the generalised partial credit model, resulting in the weighting scheme as in Table 1, resulting in the Stanines histogram as seen in Figure 3.

**Figure 3**. Stanine scores, when each category is multiplied by its weight and divided approimately divided by 40.

#### $\times (\mathbf{fingers} * f_{\mathbf{finger}} + \mathbf{bar} * f_{\mathbf{bar}})$

### LSTM & DeepGRU

We trained two ML models with an ordinal loss:

 $\mathsf{OL} = \sum_{i=0}^{\circ} \rho_i \times (\mathsf{target} - i)$ 

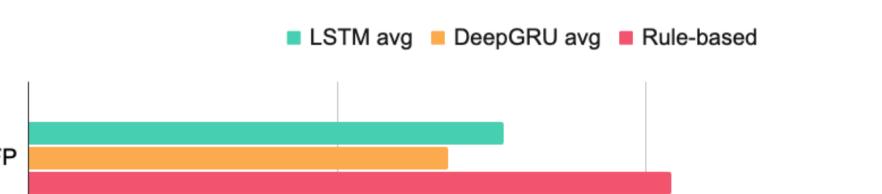
 We trained an LSTM and a DeepGRU model which contains attention layers.

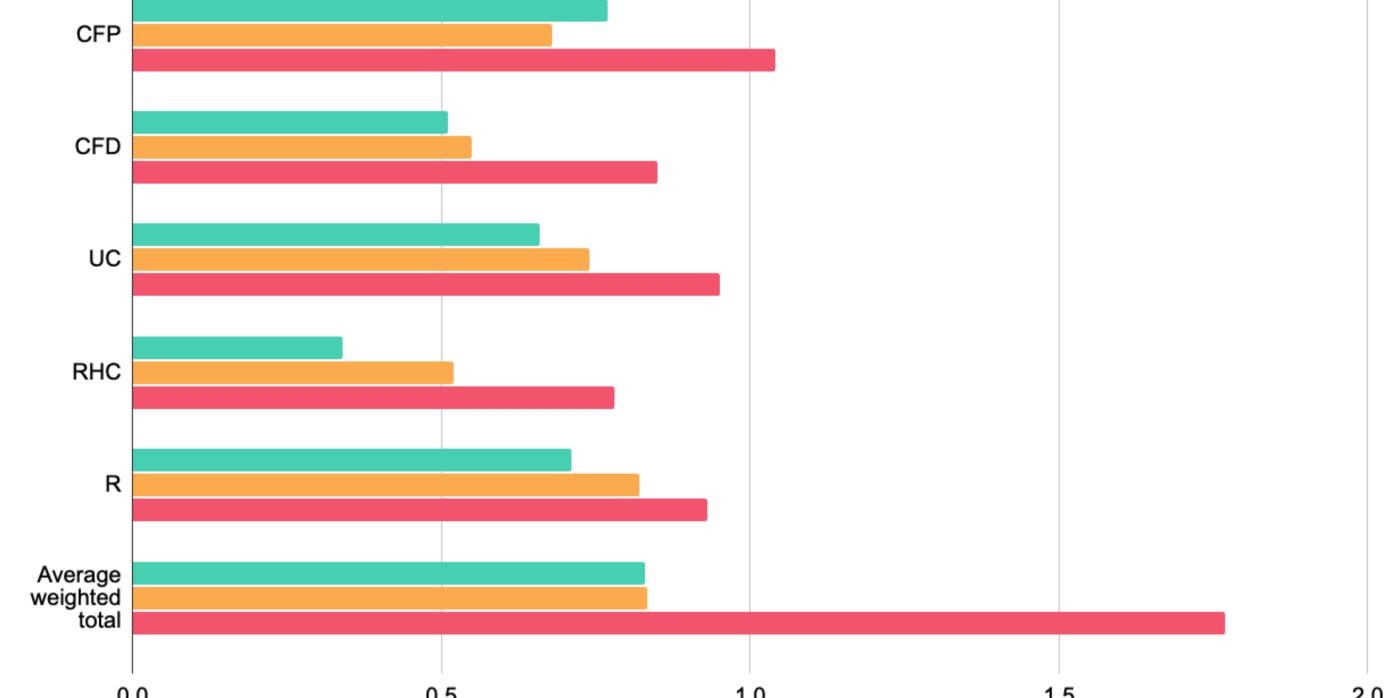
• The LSTM tends to perform slightly better on average.

### Encoding types

For our experiments we used the following three variants of encoding chords:

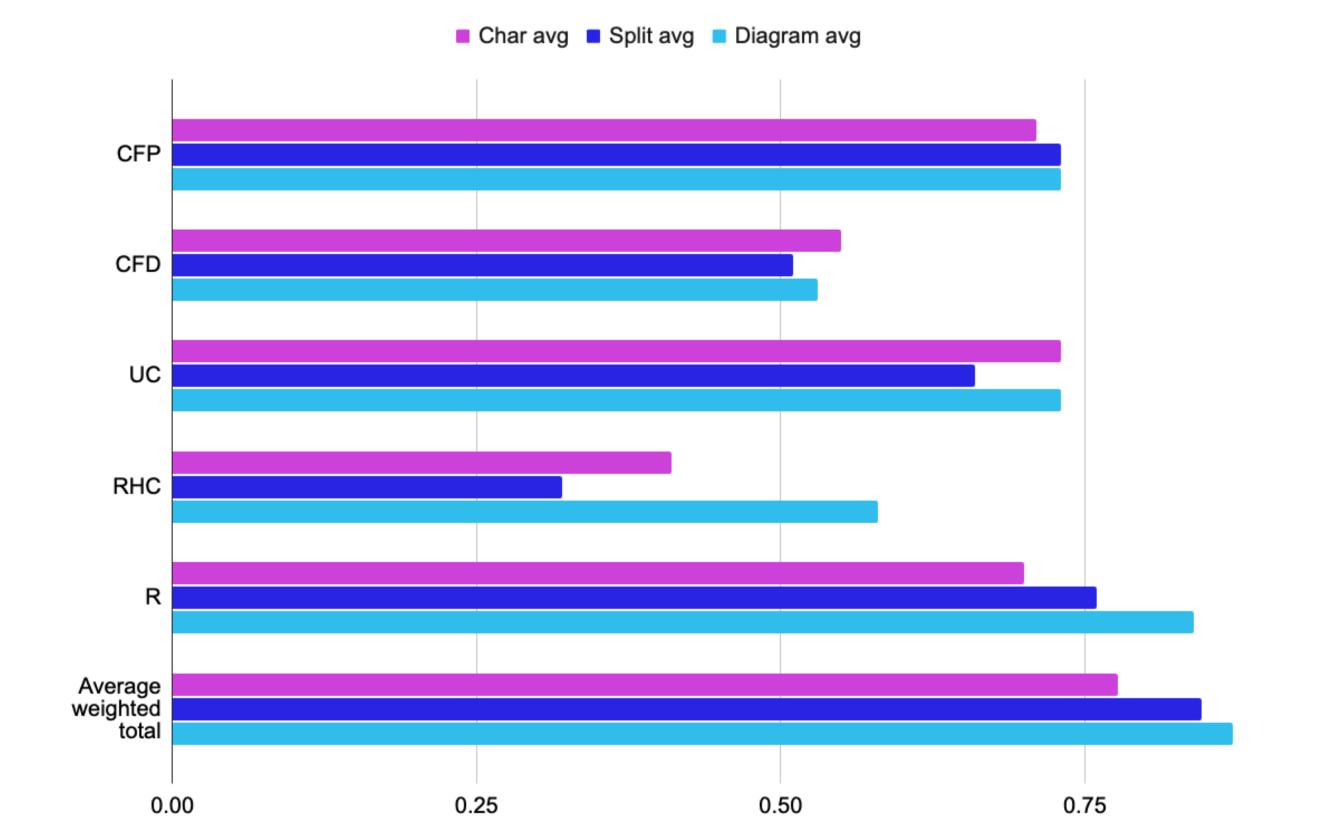
char-encoding: "A:maj" -> ['A', ':', 'm', 'a', 'j'];
root-quality: "A:maj" -> ['A', ':', 'maj'];
guitardiagram: "A:maj" -> ['x', 'o', '2:1', '2:2', '2:3', 'o'].





Encoding playability error

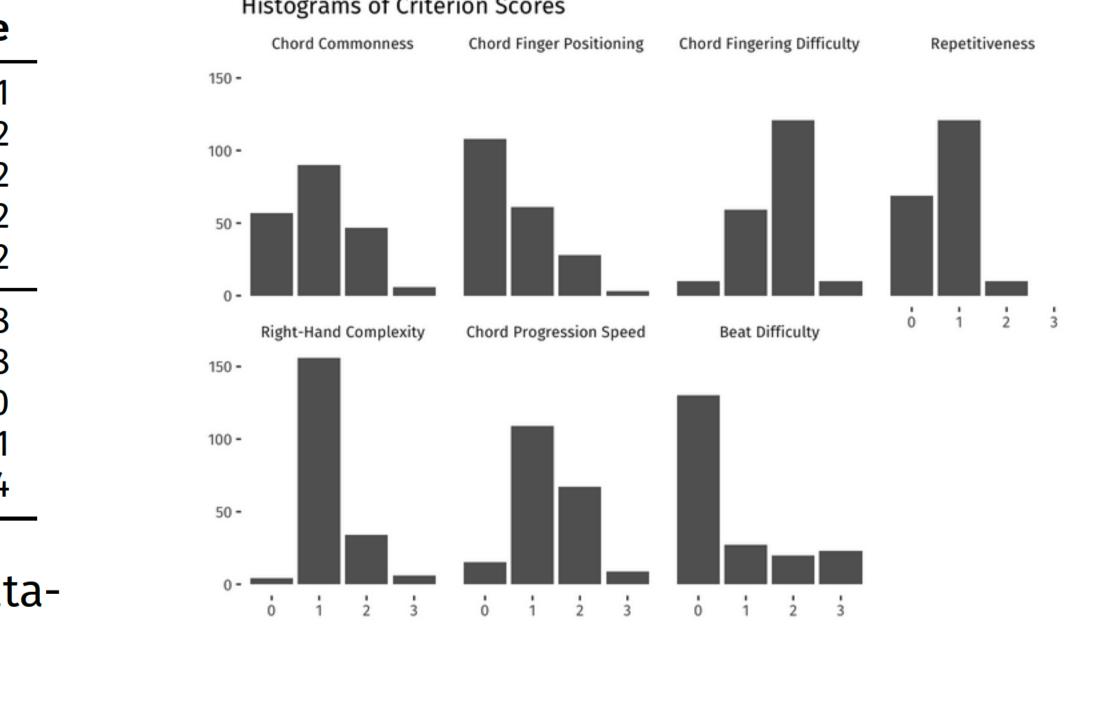
Model playability error





Song	Artist	Score
Stand By Me	David and Jimmy Ruffin	1
Miss You	The Rolling Stones	2
No Charge	Melba Montgomery	2
Jungle Boogie	Kool and the Gang	2
Sunshine of Your Love	Cream	2
I Don't Need You	Kenny Rogers	28
Man In The Mirror	Michael Jackson	28
One Less Bell To Answer	The 5th Dimension	30
That Girl	Stevie Wonder	31
DoIDo	Stevie Wonder	34

**Table 3**. Easiest and most difficult songs in the dataset with their weighted playability scores.

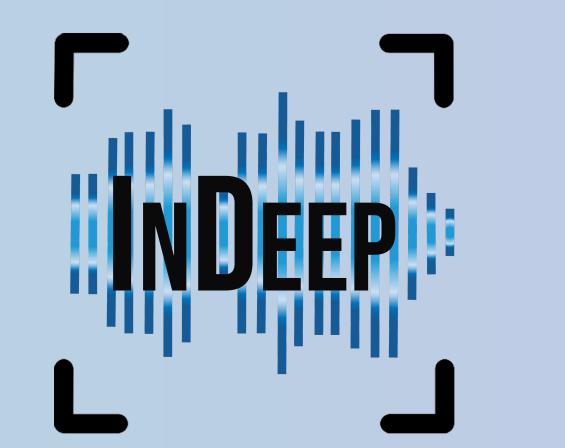


Bin	Chords	Bars	Phrases
All songs	156.03 (87.92)	135.95 (55.34)	29.26 (12.41)
Easy 25% Moderate 25% Hard 25% Expert 25%	139.21 (85.66) 152.25 (73.79) 158.29 (96.40) 175.20 (89.84)	133.17 (44.64) 132.69 (42.13) 135.59 (65.01) 142.47 (64.69)	27.87 (10.87) 28.63 (9.48) 28.27 (14.10) 31.35 (14.19)

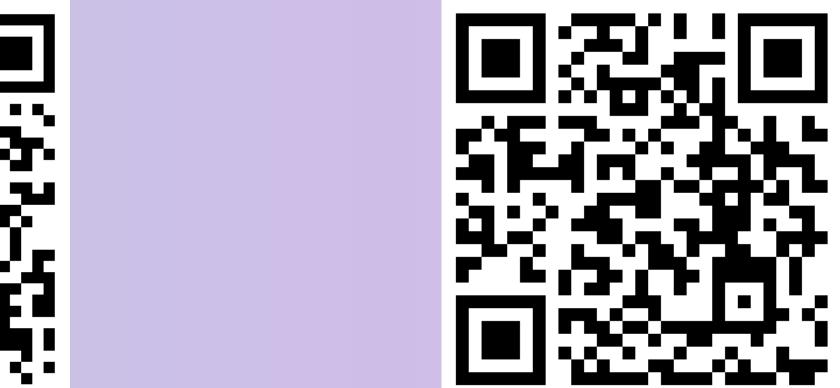
**Table 2**. Mean, and standard deviation (in brackets) of the number of chords, bars, and phrases for the entire dataset and per playability bins. The playability bins are based on quartiles of the weighted total score of the songs, the easiest having a score lower than 8, moderate lower than 12.5, hard lower than 18, and expert higher than 18.

#### Music Cognition Group















Music Cognition Group

Github + paper

Μ