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Might it be possible to construct a quantitative framework for specifying and comparing sound marks?

Contents

Might it be possible to construct a quantitative framework for specifying and comparing sound marks?

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Abstract

This paper follows on from previous work regarding algorithms for measuring the similarity of marks (focusing on the cases of colour and word marks which are amenable to exact definition and thereby lend themselves to objective quantitative comparison). This follow-up considers the case of sound marks (and other melodic sequences), which could also benefit from a more objective framework, to potentially augment or replace the existing scenario in which comparisons are primarily made on the basis of the subjective opinions of expert musicologists. A quantitative framework of this type has potential applications in the comparison of sound marks, and in the measurement of similarity between musical compositions, as is relevant to copyright disputes.

The proposed framework is directly applicable to melodies which are representable as sheet-music snippets, and comprises an 'encoding' of the melody as a string of text characters (representing both the relative pitches and relative lengths of the notes), together with the use of an algorithm previously proposed for use in word-mark comparisons (in this case, a library algorithm based on the concept of *Levenshtein distance*), to quantify the degree of similarity between the textual representations. The paper is illustrated using case studies, showing how the framework can be applied to produce quantitative measurements of the degree of similarity between two melodic lines.

A similar approach could potentially also be used for analysis of more complex musical elements, or in the comparison of chord progressions. Additionally, the specific configuration of the framework could be modified, based on the exact musical features requiring analysis. The option for applying 'correction factors', to take account of the *commonness* of use of musical sequences, to 'offset' the measured similarity, is also considered.

There is also potential for additional future development of the framework, potentially encompassing more complex melodic comparison concepts (such as the use of contour- or

shape-similarity measurement ideas, or the analysis of *N-grams* – short combinations of notes comprising the basic 'building blocks' of more complex melodic lines, in some ways analogous to the concept of 'tokens' in word-mark analysis).

Going forward, as the representation of sound marks is likely to move more toward the use of digital files such as MP3s, it is likely that the use of other concepts, such as the use of file 'hashes', may also need to be explored.

1 Introduction

In my previous work on mark similarity measurement[1,2], I considered the case of colour and word marks which – as features amenable to *exact definition* (up to a point) – potentially lend themselves to a(n at least partial) objective framework for quantitative comparison.

The world of sound marks adds an additional level of complexity but, as they can (generally, at least in part) also be specified precisely, is one where similar ideas may be applicable. This approach might be preferable to the current scenario, where musical comparisons are often based just on the (still subjective) opinion of an expert musicologist – an option which is still used because there is no widely accepted alternative objective framework and, in many disputes, no such exact specifications of the marks in question have been requested.

In this initial exploration, I consider the most basic case of a simple melody (such as a jingle or distinctive musical motif) which can be written as a sheet-music snippet, although some of the ideas might be generalisable to more complex cases, such as music which is representable as more detailed (e.g. orchestral) written scores, or even to any arbitrary sound which can be represented as a digitised waveform (which, in essence, can be expressed simply a sequential set of discrete values) – noting that more complex marks are increasingly becoming registrable, following the relaxation of the requirement for trademarks to be representable in a graphical form (under e.g. EU Directive 2015/2436[3]).

The ideas are also applicable to assessments of similarity between longer compositions, as would be likely to be more relevant to copyright (rather than trademark) disputes. It is

[1] https://www.linkedin.com/pulse/measuring-similarity-marks-overview-suggested-ideas-david-barnett-zo7fe/
[2] 'Towards a new paradigm for objectively measuring the quantitative similarity of marks – Colour and word marks' [*summary paper; not yet published*]
[3] https://eur-lex.europa.eu/eli/dir/2015/2436/oj/eng

also worth noting that the legal test for copyright infringement (namely, *substantial similarity*, or whether all or a substantial part of the copyrighted work has been copied) is perhaps actually even more amenable to quantitative analysis than is an assessment of trademark infringement, in which the *perception* of the average consumer must be borne in mind, and ideas such as the doctrine of imperfect recollection[4] and cultural associations come into play.

Additionally, it is worth noting that the proposed framework is generally consistent with established principles regarding the nature, comparison and infringement of sound marks. A summary of many of the relevant ideas is provided by Geiregat (2022)[5], with significant points including the facts that: (i) in the EU, sound marks may be represented by digital audio files or by graphical representation in musical score notation, to represent the pitch and duration (as the most significant characteristics) of the sounds; (ii) sound marks must be distinctive indicators of commercial origin, rather than being exclusively functional, also implying that they cannot be too short ('banal') or too long ('complex', and therefore not easily memorable); and (iii) comparison between sound marks will often consider aural similarity as the decisive factor, and instrumentation and tempo will generally be of secondary importance in this assessment. Similar remarks can be taken directly from the EUIPO's 2021 published guidance on common practice regarding new types of marks[6], which explicitly states that the melodic element of a sound mark "*has a considerable impact on the way the mark is perceived … and therefore … [on] the aural comparison of such a mark*". Other elements, including instrumentation, tempo, intonation, voice, etc. are stated as having a lower impact.

[4] https://guidelines.euipo.europa.eu/1922895/1924826/trade-mark-guidelines/3-imperfect-recollection

[5] Geiregat, S. (2022). Trade Marks in Sounds and Gestures: A Critical Analysis of Two Non-Traditional Signs in the EU. *GRUR International*, **71** (8), pp. 702–718. (Available at: https://academic.oup.com/grurint/article/71/8/702/6645926)

[6] https://www.ipoi.gov.ie/en/law-practice/legislation/trade-marks/trade-marks-practice-and-procedures/common-communication-on-new-types-of-marks.pdf

2 (Musical) steps towards a possible definition framework

2.1 Formulation

For a basic musical melody, I assert that the two primary features which make the tune recognisable are the ***relative pitches*** and ***relative lengths*** of the notes. The *absolute* pitch is probably less important (since a piece of music when transposed, or a key-change applied, is still recognisable as the same piece[7] – e.g. the snippets shown in Figure 1 (even ignoring the associated chord symbols) are *both* clearly the first line of 'Happy Birthday'), as is the *speed* of the meter (such that additionally, for example, a melody could be written with all note-values halved, or doubled, without *materially* changing the melody). The proposed framework for representing a musical snippet therefore focuses on these first two features referenced above.

[7] Note that a 'key-change' in this context refers to one in which all notes in the scale are transposed *equally*; this is distinct from (say) a change from a major to a minor key, in which the intervals between the respective notes in the scale will be different, and which would be reflected by a distinct representation within the proposed framework.

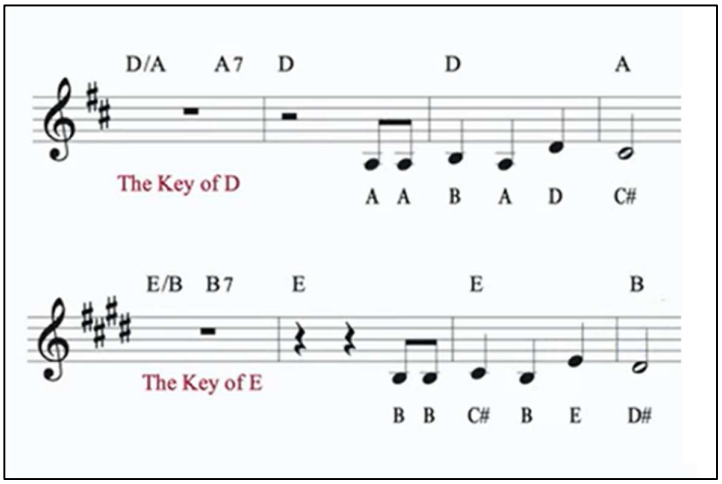

Figure 1: The first line of 'Happy Birthday' in D major (top) and E major (bottom) (courtesy of *PatternPiano*[8])

For ***pitch***, I propose expressing all intervals in terms of the number of *semitones*, which will allow us to specify *any* possible note (at least, in standard Western music). This is likely preferable to the classic musical terminology notation of 'firsts', 'seconds', 'thirds', etc., which do not cover notes outside the basic major scale (e.g. 'minor thirds', 'augmented fourths', etc.).

The significance of an absolute difference between two notes, expressed as a number of semitones, will, however, depend on the *context* (i.e. the key signature). For example, a difference of one semitone can be the difference between a note in the basic major scale and one which is not (e.g. C and C♯ in the scale of C major) *or* the difference between two notes in the scale (e.g. between E and F). I therefore propose a framework where each note is assigned a value equal to the number of semitones above the note at the 'base' of the scale (i.e. the 'root' or 'key' note) – actually, one more than this value, since the base note is assigned a value of 1. (For shorter musical snippets, or ones where the key signature is unclear or undefined, it might be appropriate just to set this base pitch as that of the first note of the snippet.*)

[8] https://www.youtube.com/watch?v=MfBRW6qmMKc

Accordingly, therefore, the thirteen distinct semitones in a chromatic scale starting at C would be assigned the values shown in the middle row of Table 1. (N.B. The notation is similar to that used in hexadecimal, etc., where letters are used after the value '9', such that the pitch of each note can be represented just as a *single* character – though I propose the use of lower-case letters to avoid confusion with note names).

Note	C	C♯	D	D♯	E	F	F♯	G	G♯	A	A♯	B	C
Pitch symbol	1	2	3	4	5	6	7	8	9	a	b	c	d
'Classic' interval descript.	unis.	min. 2nd	maj. 2nd	min. 3rd	maj. 3rd	pfct. 4th	aug. 4th	pfct. 5th	min. 6th	maj. 6th	min. 7th	maj. 7th	8ve

Table 1: Semitone-based notation for the notes in a chromatic scale, relative to the base / root note (in this case, C)

For note ***lengths***, one simple option would be to consider each note as a *multiple* of the shortest note used in the overall representation, and represent it by repeating its pitch symbol a number of times equal to that multiple. For example, in a musical snippet consisting of a mixture of quavers (♪) (half a beat; sometimes called 'eighth notes') and crotchets (♩) (a full beat; 'quarter notes'), the quavers would be written as one repeat of the appropriate pitch symbol, and the crotchets – twice the length – as two repeats. Finally, distinct notes can be denoted using a separator (say, '-'), and rests by a zero ('0').

It is worth noting that this framework will not cover all elements of a written melody (such as time signature / position of bar lines), and will also not take account of features such as the nature of any associated instrumentation, playing techniques, or underlying chord progressions, but should capture the primary elements which make the melody recognisable. The characteristics which are *unrepresented* in this simple framework will, of course, all contribute to the 'overall impression' of a musical piece, and (at least in a trademark sense) probably *would* be relevant in any fully rigorous overall determination of likelihood of confusion (though, as per the comments in the introduction, can

probably reasonably be considered to be of *secondary* importance).

How would the suggested construction look in practice? The simplest case of a basic major scale of notes of equal length (Figure 2) would be expressed as *1-3-5-6-8-a-c-d*.

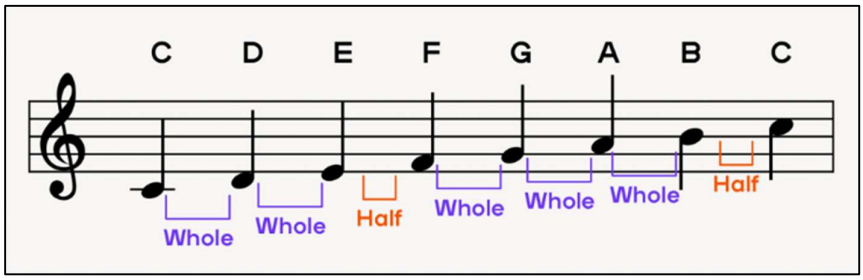

Figure 2: A scale in C major (image courtesy of *Playground Sessions*[9])

* The point mentioned above might be applicable to a musical motif such as the small set of alternating notes, separated by a semitone, at the start of the Jaws theme (Figure 3), which arguably is distinctive even in isolation (and would be represented, taking E as the 'base' note, and taking the quaver as the basic 'unit' of note length, as *11-2-00000-11-22-1-000*).

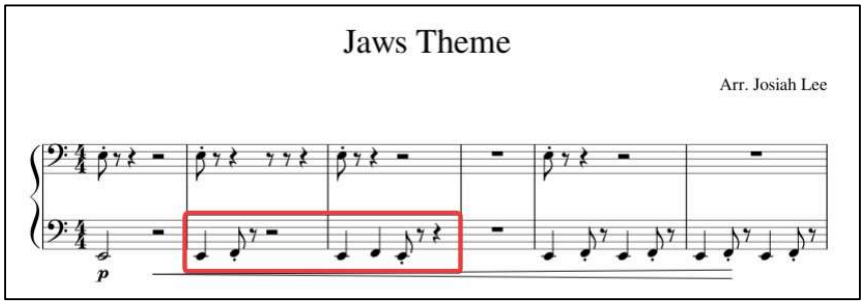

Figure 3: The distinctive motif of the Jaws theme (image courtesy of *Musescore*[10])

[9] https://blog.playgroundsessions.com/how-to-play-any-major-scale-on-the-piano/
[10] https://musescore.com/user/282671/scores/1030571

By adopting this approach – essentially, allowing us to represent a musical snippet as a text string analogous to a word mark – there is the potential for a framework for specifying the snippet as a convenient, character-based format *and* for comparing snippets against each other using some of the word-similarity metrics defined in the previous studies. There is therefore the possibility either for quantifiably specifying how similar two complete musical motifs are to each other, or to identify the length of common elements between two longer tunes (essentially, by looking for the longest common substring[11] between the two). This might have applications in, say, copyright disputes.

Furthermore, the character-based representations of the musical snippets and/or the similarity metrics themselves could be modified, to adjust exactly which aspects of the compared snippets are being considered (or disregarded). For example, it might be appropriate to disregard the separators between the notes (so that, for example, a pair of quavers on the same note would be considered to be identical a crotchet of that note – if we wanted to assume that these two were essentially interchangeable from the point of view of musical distinctiveness.

Another option might be to modify the similarity metric so that the 'score' assigned to the similarity between two snippets would be modified according to the *size* of the difference in pitch between differing notes (rather than just considering whether a note is different *or not*). For example, we might want to consider that the difference between a C and a D is 'numerically' smaller than the difference between a C and a G, or that notes which are more harmonically similar (e.g. a C with an E (a perfect third) or a G (a perfect fifth)) should be 'scored' as less distinct than notes which are more harmonically dissimilar (e.g. a C with a D♯ or an F♯).

There may also be cases where other modifications to the framework may be appropriate, such as assuming notes separated by an octave to be 'the same' (i.e. having just 12

[11] https://circleid.com/pdf/similarity_measurement_of_marks_part_3.pdf – 'Part 2 – Subsequences and substrings'

basic distinct pitches – '1' to 'c' – and then repeating the symbols for subsequent octaves).

2.2 Illustrations and case studies

2.2.1 *"Plim"*

One frequently-cited legal case concerns a short sound mark represented using musical notation (Figure 4).

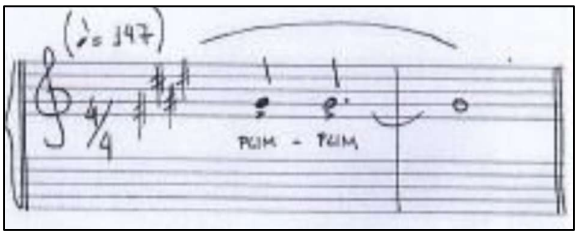

Figure 4: The graphical representation of the Plim sound mark, as presented in its application

There is a detailed case history regarding the attempted registration of this particular mark, initially rejected by the examiner, a decision which was ultimately maintained following appeal – with additional complexity resulting from the fact that the mark itself includes a *textual* element ("*PLIM PLIM*" – i.e. '*ring, ring*'), but it has generated some accepted case law. This includes the (paraphrased) statements that the criteria for assessing the distinctive character of sound marks are no different from those applicable to other categories of trademark (*Para 41*) and that it is common for a consumer to be able to identify a specific product or service as a result of a sound element (*Para 43*)[12]. Furthermore, the test for whether a mark is devoid of distinctive character should be no stricter for sound marks than for other marks, and the simplicity alone of a musical element does not *in itself* imply a lack of distinctive character.

[12] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:62015TJ0408

Regardless of the specifics of this particular case, (the melodic component of) this mark does make it amenable to representation using the proposed framework (as the very simple string *5-5555555* – or, arguably, as *1-1111111*, since the key is essentially arbitrary), which could allow it to be *quantifiably* compared against other marks.

2.2.2 The James Bond theme

The James Bond theme – one which is highly familiar to generations of movie-goers, and distinctive to the franchise – has a somewhat complex history from an intellectual property point of view. A 25-second segment of the introduction to an orchestrated version of the theme was finally successfully registered as a sound mark[13] by brand owners Danjaq LLC in 2021[14], following an earlier refusal on grounds including the length of the segment. One of the central points of the complexity is the distinction between short musical snippets (such as jingles), which can have clear brand associations and can potentially serve as a *mark*, and longer pieces of music (which are more usually protected by copyright).

Is there perhaps a case to be made that a more appropriate sound mark for James Bond would have been just the musical motif shown in Figure 5 (the initial guitar solo in the full orchestrated version), which is arguably distinctive as an 'indicator of origin' in its own right? This snippet would be 'encoded' (noting that the key is E minor, and taking the semiquaver as the base unit of length) as *11-3-3-33-3333-11-11-11-11-4-4-44-4444-33-33-33*.

[13] https://euipo.europa.eu/eSearch/#details/trademarks/018168977 – includes a downloadable version of the sound mark

[14] https://euipo.europa.eu/copla/trademark/data/018168977/download/CLW/APL/2021/EN/20210312_R1996_2020-5.pdf

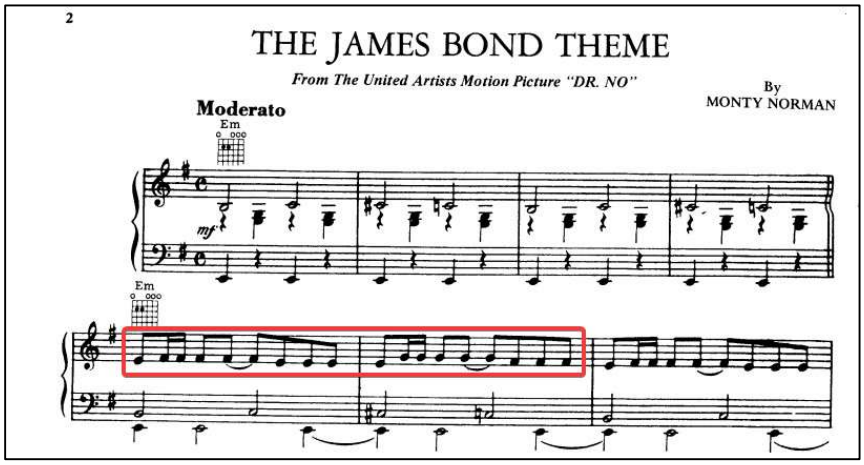

Figure 5: The distinctive motif of the James Bond theme (image courtesy of *007museum.com*[15])

2.2.3 *Amazing* vs *Photograph*

The (purported) similarity between sections of these two songs was the subject of a copyright dispute in 2017, in which the writers of the former – released as a single by Matt Cardle in 2012 – sued Ed Sheeran, the writer of the latter, in a case which was ultimately settled out of court by Sheeran. The writers of *Amazing* claimed the chorus of the songs had 39 identical notes in common, with similarities "instantly recognisable to the ordinary observer", submitting court documents highlighting the similarities in chord progression and melody (Figure 6)[16,17].

[15] https://www.007museum.com/James_Bond_dr_no.pdf
[16] https://www.bbc.co.uk/news/entertainment-arts-39556351
[17] https://www.theguardian.com/music/2017/apr/11/ed-sheeran-20m-dollar-copyright-claim-matt-cardle-x-factor – This article also includes links to YouTube videos of the two songs in question, with the relevant sections found at 2:26 (*Photograph*) and 1:46 (*Amazing*)

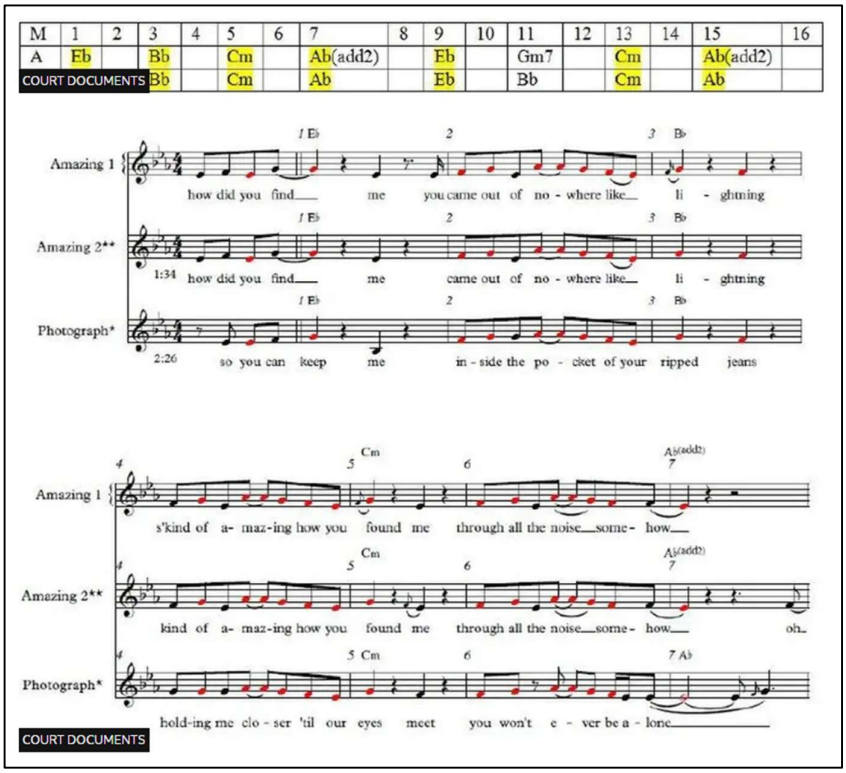

Figure 6: A comparison of the similar sections of *Amazing* and *Photograph*, taken from court submissions (image courtesy of BBC[18])

In the context of this paper, the case is interesting because it can be used to illustrate how the use of the textual representations of the two melodies, derived from the side-by-side standard musical notations shown in Figure 5 (though not considering the chord progressions for now), can be used to *quantify* the degree of similarity between the two.

Considering the similar portions from bar 1 to the first beat of bar 7, and comparing the *second* of the two versions of the *Amazing* melody with *Photograph* (plus also making a couple of other simplifications[19]), the two snippets can be written as:

[18] https://www.bbc.co.uk/news/entertainment-arts-39556351

[19] The additional simplifications are: (i) ignoring the grace note in bar 5 of *Amazing*; and (ii) neglecting the trailing semiquaver in the last beat of bar 6 of *Photograph*, so as to allow the use of the *quaver* as the basic unit of length and thereby halve the overall length of the textual representation.

Amazing (v2):

- *1-3-1-555-00-11-00-3-5-1-66-5-3-1-55-00-33-00-3-5-1-66-5-3-1-55-00-11-00-3-5-1-66-5-3-3-11*

Photograph:

- *0-1-1-3-55-00-8'8'-00-3-5-5-66-5-3-1-55-00-33-00-5-5-5-66-5-3-1-55-00-33-00-3-5-0-66-5-3-111*

N.B. ‘ 8' ’ is actually ‘ 8 ’ transposed down by an octave

By any measure, these can be seen to be extremely similar, differing only in the characters highlighted in bold / underlined (equivalent to the *unhighlighted* notes in Figure 4). However, the key point – and the one of relevance for application in copyright and/or mark disputes – is in quantifying *how* similar. Any appropriate metric will probably need to include some element of ‘normalisation’ relative to the overall length of the snippet / string (e.g. two passages of 40 notes differing by only 5 notes should reasonably be considered to be more similar than two passages of *10* notes differing by 5), and it may also be appropriate in future modifications of the methodology to consider the length of the similar sections relative to the lengths of the songs *as a whole*.

In this case of the two textual representations shown above, the strings differ by only 12 characters out of the total of 54 (i.e. 78% similar) (ignoring the ‘-’ separators for now). However, the use of one of the similarity metrics discussed in the previous work on word-mark comparisons may yield a more robust approach (because of the greater flexibility in considering different *aspects* of the similarities and differences between the strings). Using the *fuzz.ratio* metric, for example – an algorithm based on the concept of *Levenshtein distance*, and which also incorporates an element

of normalisation relative to the length of the strings[20,21,22] (rather than the *full* similarity score formulation previously proposed for word marks, which – through the use of the Jaro-Winkler similarity metric – includes consideration of the proximity of the matching characters to the *start* of the string, and which may not be appropriate where considering musical passages), we find that the strings are measured as being ***86% similar***.

2.3 Comparison with previous research on melodic comparison

Outside the various machine-learning and AI-based approaches which have been explored by researchers in attempting to measure the degree of similarity between different musical compositions and genres, a number of other *algorithmic* approaches have also been proposed – which are generally more deterministic, and potentially better suited to the type of quantitative repeatable frameworks most suitable to melodic comparisons in a legal / IP context (i.e. for addressing sound-mark or copyright disputes). Some of these previous ideas share significant parallels with the framework proposed in this paper, indicating that the approach is broadly potentially robust, but with the research also providing a number of potential routes for expanding the methodology.

One of the strongest parallels appears in the overview provided by Gurjar & Moon (2018)[23], who explicitly reference

[20] https://pypi.org/project/fuzzywuzzy/
[21] В. И. Левенштейн (1965). Двоичные коды с исправлением выпадений, вставок и замещений символов [*Binary codes capable of correcting deletions, insertions, and reversals*]. *Доклады Академии Наук СССР* (in Russian), **163** (4): pp. 845–848. Appeared in English as: Levenshtein, V.I. (1966). Binary codes capable of correcting deletions, insertions, and reversals. *Soviet Physics Doklady*, **10** (8): pp. 707–710. (https://ui.adsabs.harvard.edu/abs/1966SPhD...10..707L/)
[22] This is the same approach as was used to compare the *phonetic* representations of word marks, when assessing (just) their *aural* similarity.
[23] Gurjar, K. and Y.-S. Moon (2018). A Comparative Analysis of Music Similarity Measures in

the option to represent a (monophonic) musical piece as a one-dimensional string of characters and then use an edit-distance algorithm (such as Levenshtein) to compare strings against each other. Their summary suggests that, in many such implementations, the duration of notes is generally *not* considered, but the framework presented in *this* paper does address this point (through the use of the number of character repeats to denote note length). An overview of other approaches which take account of these and other musical features is provided by Cahill (2008)[24].

Other common possible approaches include implementations of *contour- or shape similarity* measurement (essentially, representing melodies geometrically (e.g. using curve- ('spline') fitting) and then comparing the shapes of the geometric representations – in some cases, also using similar edit-based algorithms) (e.g. da Silva Sampaio, 2018[25], Urbano *et al.*, 2011[26], Hu *et al.*, 2002[27]), and/or *N-gram analysis* (i.e. representing melodies as combinations of short distinctive elements).

Music Information Retrieval Systems. *J Inf Process Syst*, **14** (1), pp. 32–55.(Available at: https://s3.ap-northeast-2.amazonaws.com/journal-home/journal/jips/fullText/64/jips_527.pdf)

[24] Cahill, M. (2008). Melodic Similarity Algorithms for Scores – A Comparative Evaluation of Contrasting Approaches. *PhD thesis*, University of Limerick. (Available at: https://researchrepository.ul.ie/articles/thesis/Melodic_similarity_algorithms_for_scores_a_comparative_evaluation_of_contrasting_approaches/19811551?file=35260366)

[25] da Silva Sampaio, M. (2018). Contour Similarity Algorithms. *J. MusMat*, **2** (2), pp. 58–78. (Available at: https://musmat.org/wp-content/uploads/2018/12/08-contour-similarity-algorithm.pdf)

[26] Urbano, J., J. Lloréns,, J. Morato and S. Sánchez-Cuadrado (2011). Melodic Similarity through Shape Similarity. CMMR 2010, LNCS 6684, pp. 338–355. (Available at: https://julian-urbano.info/files/publications/019-melodic-similarity-through-shape-similarity.pdf)

[27] Hu, N., R.B. Dannenberg and A.L. Lewis (2002). A Probabilistic Model of Melodic Similarity. In: *Proceedings of the International Computer Music Conference* (San Francisco, International Computer Music Association). (Available at: https://www.cs.cmu.edu/~rbd/papers/icmc02melodicsimilarity.pdf)

3 Discussion

The landscape of *copyright* disputes in popular music is an extensive one, including a number of other high-profile cases in recent years[28]. One such example is another (2023) case involving Ed Sheeran, who was ultimately found not to have copied the Marvin Gaye hit *Let's Get It On* when writing *Thinking Out Loud*, as had been asserted. The case primarily surrounded the use of a shared similar pattern of syncopated chords between the two songs, though the claim was ultimately accepted that these are simply "*commonplace musical building blocks*" [29,30,31,32]. However, the history of similar cases has proved somewhat inconsistent, with (for example) *Blurred Lines* found to have infringed Gaye's *Got to Give It Up* in 2015, but Led Zeppelin winning an appeal regarding *Stairway to Heaven* (re *Taurus*) in 2020 – a case which provided guidance on the preferred handling of other future cases, and which was followed in one concerning Katy Perry's *Dark Horse*[33].

The *Thinking Out Loud* case also highlighted the commonalities and similarities (particularly in terms of features such as chord progressions) shared by large numbers of distinct songs in many cases[34,35]. It is also clear that inspiration by previous work is a significant component of songwriting[36],

[28] https://www.nytimes.com/2023/04/27/arts/music/music-copyright-lawsuits-ed-sheeran-blurred-lines.html
[29] https://www.bbc.co.uk/news/av/world-us-canada-65420696
[30] https://www.rollingstone.com/music/music-news/ed-sheeran-wins-marvin-gaye-copyright-lawsuit-appeals-1235150674/
[31] https://trademarklawyermagazine.com/from-love-song-to-lawsuit-ed-sheerans-copyright-win-over-marvin-gayes-lets-get-it-on/
[32] https://www.brunel.ac.uk/news-and-events/news/articles/Whats-going-on-Ed-Sheerans-Marvin-Gaye-copyright-case
[33] https://www.nytimes.com/2023/05/04/arts/music/ed-sheeran-marvin-gaye-copyright-trial-verdict.html
[34] https://www.newyorker.com/magazine/2023/06/05/ed-sheeran-copyright-infringement-lawsuit-marvin-gaye
[35] https://www.independent.co.uk/arts-entertainment/music/news/ed-sheeran-lawsuit-marvin-gaye-song-b2327312.html
[36] https://www.reddit.com/r/WeAreTheMusicMakers/comments/8w13rs/ed_sheeran_vs_marvin_gaye_lawsuit_lets_compare/?rdt=54653

and an over-overly enthusiastic approach to protection could stifle creativity[37]. The point was also picked up by veteran songwriter Burt Bacharach, though with the suggestion that the issue could be addressed through the use of a panel of music experts to decide on copyright issues[38].

As alluded-to at the outset of this article, much of the discussion of the case has indeed focused on musicological analysis[39,40,41], but it seems reasonable that the additional application of some sort of *quantitative* approach in such cases could yield some useful insights. Chord progressions could potentially be represented within a similar framework to that proposed in this article for melodic lines, meaning that an analogous approach to their comparison could be applied. However, it would probably be appropriate to include a 'normalisation' (or 'correction factor') to the calculated degree of similarity between two sequences, based on how common they are *generally* in the 'corpus' of recorded songs (i.e. the shared use of a chord progression which is very *common* would be *less likely* to imply a creative link than for a much more *unusual* chord sequence). Common sequences – which have been used extensively in a wide range of songs – would include examples such as I–V–vi–IV[42] (or, in the key of D, D-A-Bm-G) (the 'Axis of Awesome' progression)[43,44], or I-V-vi-iii-IV-I-IV-V (in D: D-A-Bm-F♯m-G-D-G-A) (the sequence derived from

[37] https://news.sky.com/story/ed-sheeran-beats-copyright-appeal-over-claim-thinking-out-loud-ripped-off-marvin-gayes-lets-get-it-on-13246150
[38] https://www.bbc.co.uk/news/entertainment-arts-40813002
[39] https://www.musicologize.com/thinking-out-loud-v-lets-get-it-on-lawsuit-deep-dive/
[40] https://www.musicologize.com/lets-get-it-on-vs-thinking-out-loud-infringement-or-just-similarity/
[41] http://www.popularmusicology.com/2016/08/12/musicology-thinking-loud-v-lets-get/
[42] This is using the Roman numeral analysis system for chords, where the *number* denotes the 'degree' (in the sale) of the chord, and the *case* represents the 'quality' (upper = major; lower = minor) – see e.g. https://viva.pressbooks.pub/openmusictheory/chapter/roman-numerals/
[43] https://en.wikipedia.org/wiki/The_Axis_of_Awesome
[44] https://www.woovebox.com/support/guides--tutorials/chords/popular-chords/i-v-vi-iv-axis-of-awesome/

Pachelbel's Canon)[45,46,47]. At the other end of the spectrum would be something like the sequence from the Beach Boys' *God Only Knows*, an innovative and fairly unique chord progression (D/A-Bm-F♯m-F♯m/A-E/B-Cdim- E/B- A♯ø) which is so 'non-standard' that it is not even clear which key the song is written in[48,49]. It may be the case that similar comments are true for the comparison of melodies or melodic 'snippets', rather than just for chord progressions.

Returning to the main focus of the article, despite its possible application in an assessment of similarity between sections of melody in copyright disputes, the proposed framework is primarily intended for use in the quantitative comparison of shorter musical motifs which may serve as (sound) *marks* – potentially as part of any dispute analysis process. It is worth pointing out again that this type of textual representation really adds benefit only for this type of quantitative *comparison* analysis, given that the *representation* of marks is better served by the use of traditional notation (i.e. sheet music), or (now) digital files such as MP3s. Going forward, these types of digital representations of sound marks may also lend themselves to more of a quantitative comparison approach, through the creation of 'hashes' (i.e. a digital 'fingerprint' or 'summary') of the file, which can be compared against each other, and are already utilised in areas such as the identification of copied digital imagery.

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45 https://en.wikipedia.org/wiki/List_of_variations_on_Pachelbel%27s_Canon

46 https://www.anneku.com/2023/06/12/pachelbel-progression/

47 https://www.reddit.com/r/musictheory/comments/fmrzgs/songs_with_the_same_chord_progression_as/

48 https://www.secretsofsongwriting.com/2011/10/26/classic-song-analysis-god-only-knows-wilsonasher/

49 https://www.the-solute.com/the-luxuriant-mysteries-of-god-only-knows-year-of-the-month/

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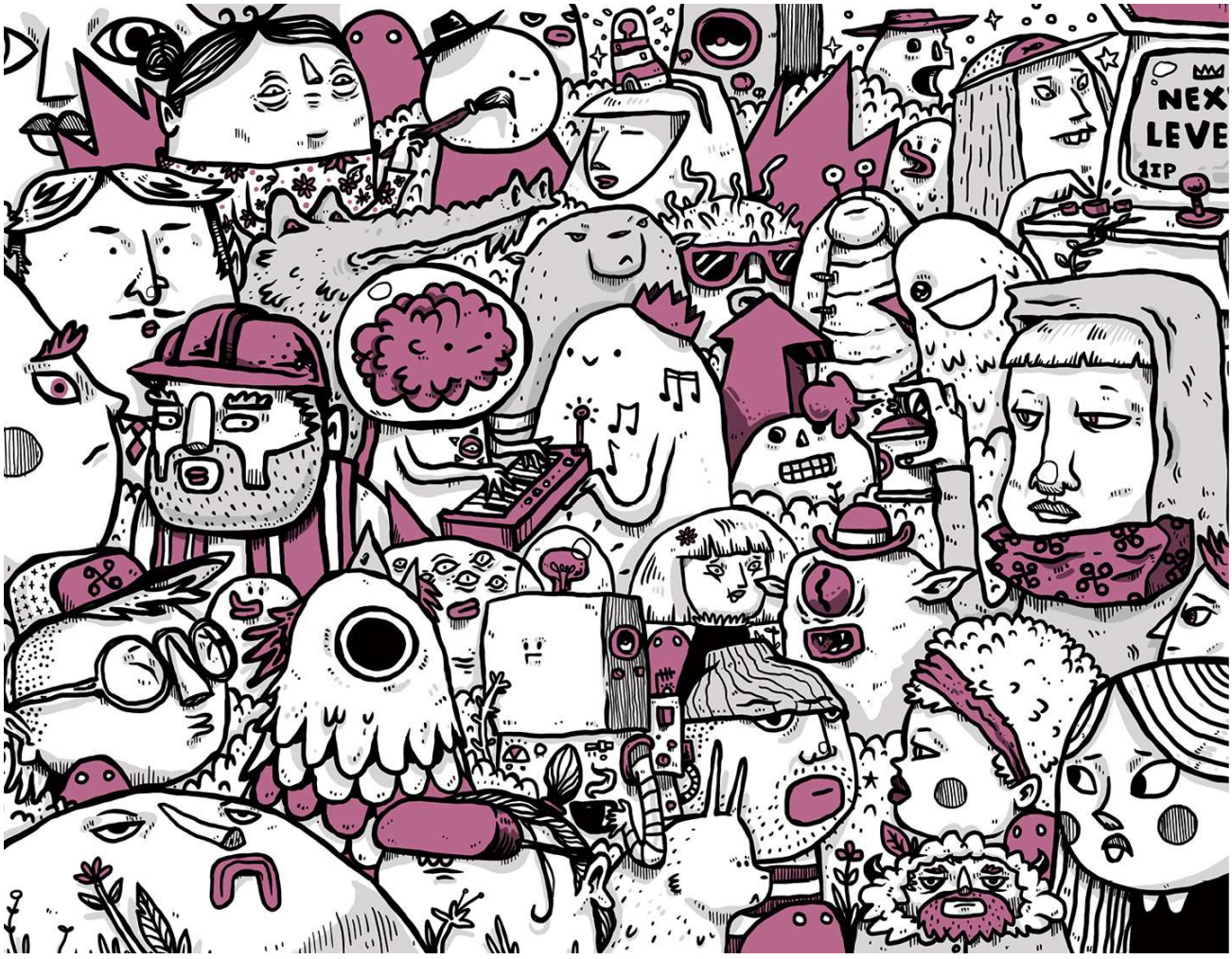

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