Visualizing Shostakovich: How the DSCH motif appears throughout his Tenth Symphony

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"I affirm my awareness of the standards of the Harvard College Honor Code."

Introduction

Dimitri Shostakovich's Tenth Symphony came into the world following one of the most monumental moments in Soviet history: the death of Stalin. Although every citizen of the Soviet Union at the time was impacted in some way during his reign, Shostakovich, as a public figure, faced personal scrutiny from Stalin himself. His works were constantly judged and criticized on party lines, despite (or perhaps due to) their immense public support. In some cases, his works were even prohibited from being performed, such as his opera *Lady Macbeth* after the now-infamous "Middle Instead of Music" article, allegedly published in response to Stalin's viewing of the opera[1].

It's clear then that the presence of Stalin and party guidelines exerted no small amount of pressure on the works Shostakovich released, and following Stalin's death, Shostakovich released three substantial works that he presumably had to hold back from performance—the Tenth Symphony being one of them[2]. It's almost foolish to presume, then, that there was not at least some emotion from this monumental event reflected in these works. The specific thoughts and feelings Shostakovich aimed to evoke, however, are more difficult to distinguish.

The Tenth Symphony has one other notable feature, this time with its musical contents: the use of Shostakovich's personal DSCH motif, heavily featured in the third movement and a few more times in the final movement. This motif, composed of the notes D, E-flat, C, B, spells

[1] Elizabeth Wilson, *Shostakovich: A Life Remembered, 2nd edition* (Princeton University Press, 2006), 130
[2] Ibid., 301

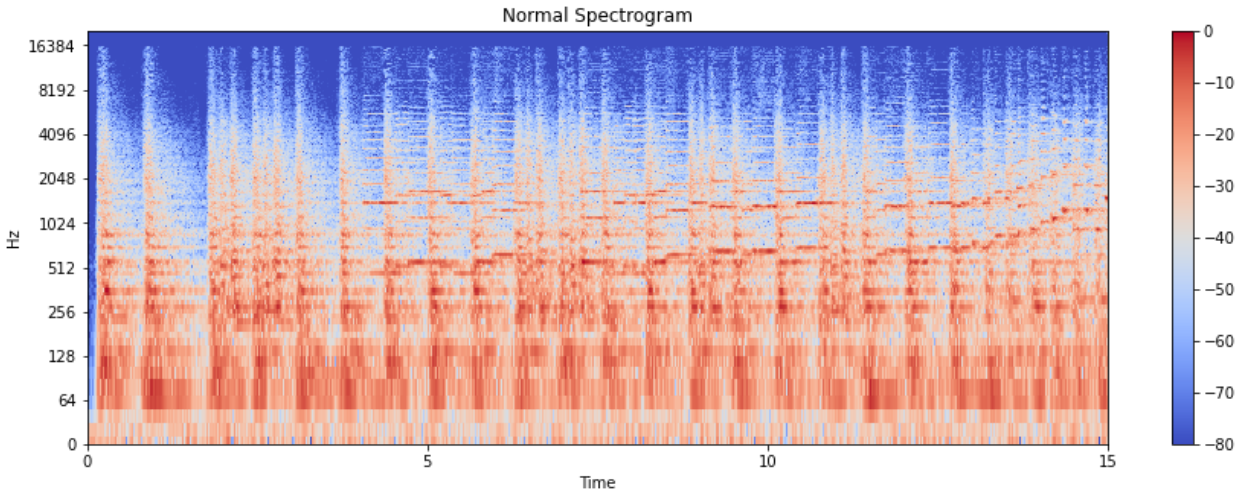
out an acronym for Shostakovich's name and is used by the composer as a kind of "autobiographical reference".[3] By tracking how Shostakovich weaves this musical signature into the melody and accompaniment, primarily in the third movement, we may be able to glean some insight into the more personal emotions Shostakovich intended to convey in his Tenth symphony.

Background and Setup

If we want to track the appearance of the DSCH motif throughout the symphony, we first need to be able to recognize it. If an available, easy-to-manipulate score were available online, this would not be an issue; unfortunately, audio recordings are currently the only source we can work with, and so there is the extra problem of determining what notes are being played from an audio source. I decided to use Vasily Petrenko's recording with the Royal Liverpool Philharmonic Orchestra[4], although the following analysis should be consistent with any recording of the Tenth Symphony.

At the most basic level, notes are simply sound at a certain frequency--A4, for example, is normally 440 Hz. We can see this through the use of a spectrogram, which highlights the intensity, or loudness of each frequency over time. The first 15 seconds of the 2nd movement, for instance, appear like this:

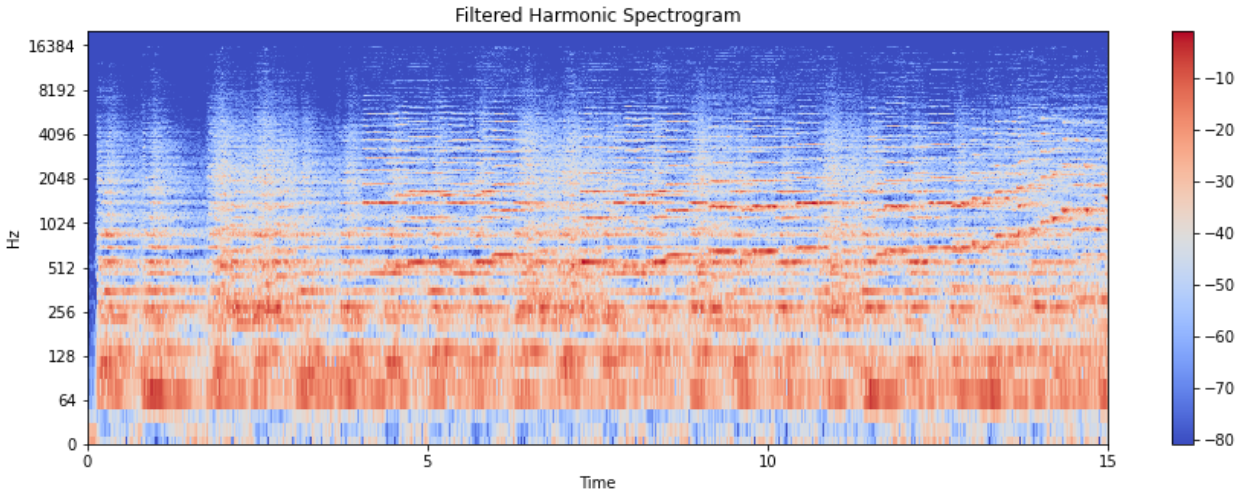
[3] Wilson, *Shostakovich: A Life Remembered*, 303
[4] Royal Philharmonic Orchestra, *Shostakovich: Symphony No. 10*



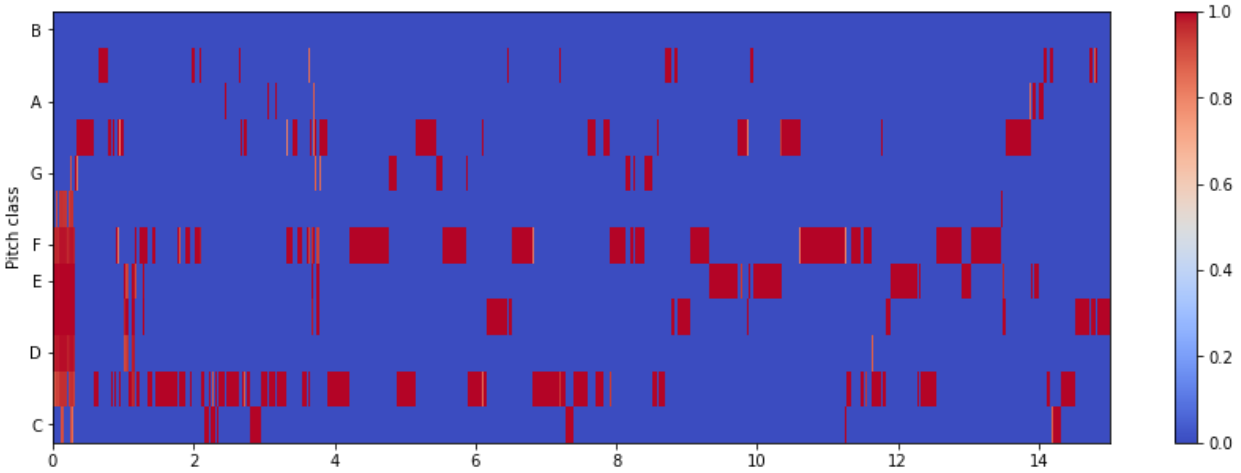
Examining this spectrogram, we can see that the lower frequencies, around 100 Hz, have a consistent intensity, corresponding to the cellos that are consistently driving the melody forward. Additionally, we can see a set of higher frequencies, around 1500 Hz, enter four seconds in; listening to the audio, these higher frequencies clearly correspond to the woodwinds that enter.

Before classifying these frequencies into individual notes, however, some filtering and denoising of the data can be done. Most notably, we can try and remove these high-intensity spikes that don't appear to coincide with any particular note being played. These spikes come from the percussive sounds, such as the sound of the bow hitting the string, and differ from the harmonic sounds that we want to have.[5] To focus on just the harmonic frequencies, we can use a technique known as Harmonic-Percussive Source Separation, or HPSS, which attempts to focus on the horizontally-changing, harmonic frequencies. After this filtering, we arrive at a cleaner spectrogram that comprises mostly of these harmonic frequencies.

[5] Jonathan Driedger and Thomas Prätzlich, *Harmonic Percussive Source Separation*, 3



With this cleaner spectrogram, we can finally start classifying notes from these frequencies. To do so, we only focus on the note value itself; as such, notes that are exactly an octave apart will be classified as the same note.[6] This produces a graph known as a chromagram, which is similar to the spectrogram, but plots out note values over time rather than frequencies over time. If we then filter out the notes that have a comparatively weak intensity to the rest of the notes playing, which usually corresponds to the weaker overtones of the instruments, we then arrive at a graph that plots out the notes of the symphony fairly accurately:



[6] Meinard Müller and Stefan Balke, *Short-Time Fourier Transform and Chroma Features.*

We can, for instance, make out the main melody of the woodwinds starting around four seconds in: F, G, A-flat, G, F, G, A-flat, B-flat, F. Using this filtered chromagram, we can start searching for the DSCH pattern within these highlighted notes.

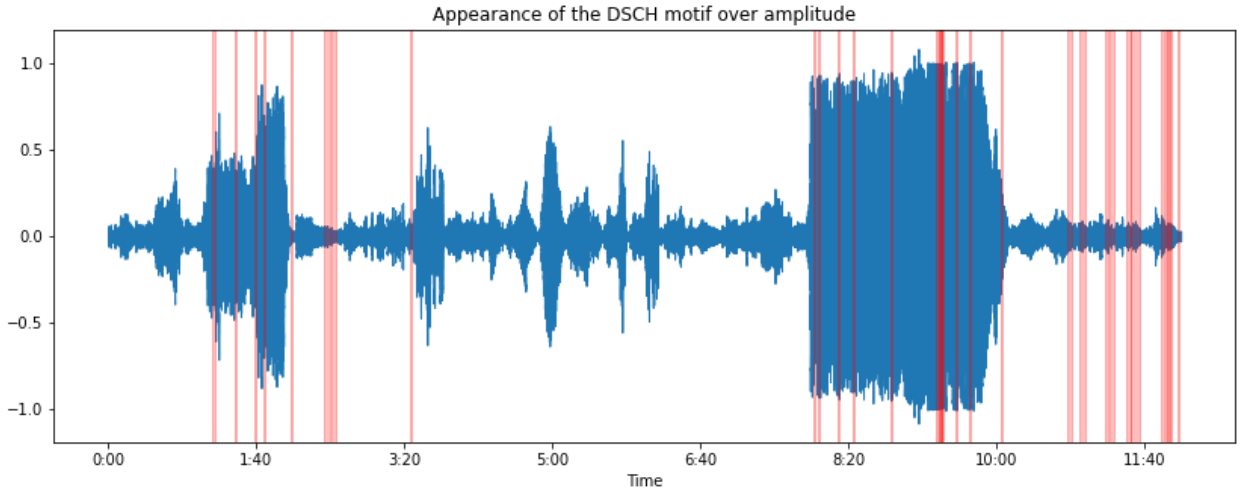
The main challenge in finding the DSCH pattern from our filtered chromagram is describing to the computer what exactly we're looking for. Although there are general pattern-matching algorithms that can match across slight variations in rhythm or pitch,[7] the DSCH pattern is simple enough that we can use a fairly rudimentary search. To make things even simpler, we only look for exact matches of the motif--although transpositions of the motif do occur, they're used near the normal version of the motif, and so that segment of the movement still gets marked down.

With these simplifications, the algorithm can be described as follows: for every D played, see if it's followed by an E-flat, then a C, then a B. Some parameters can be tweaked, such as how long each note has to be or how long of a pause there can be between each note, but after experimenting with different parameters and sanity checking the output of the algorithm, we're rewarded with a list of when each DSCH motif occurs in any movement.

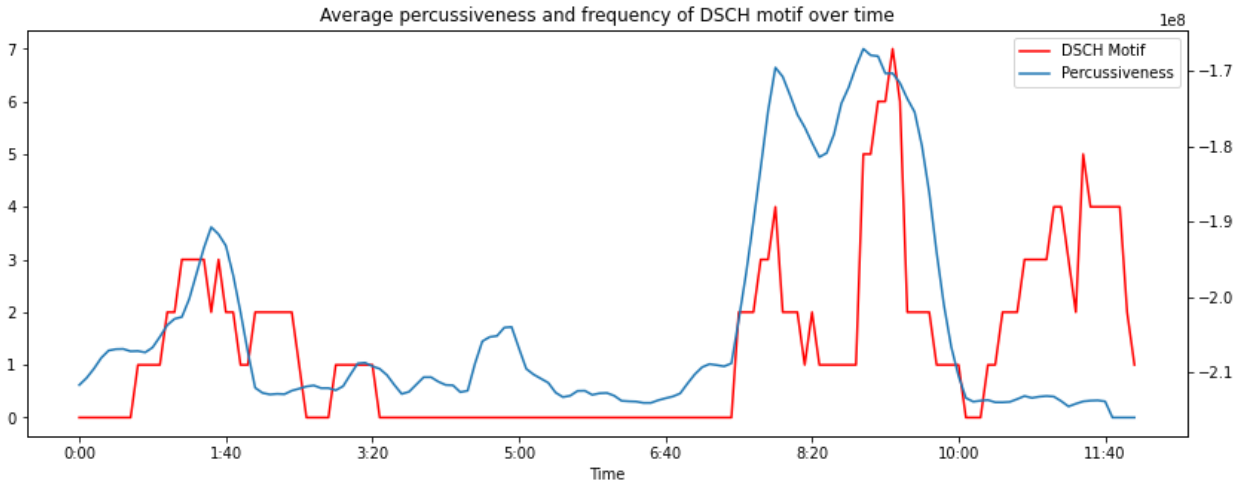
Visualizations and Analysis

The primary focus of this analysis will be on the third movement, as this movement is the most prolific with its use of the DSCH motif. Once we have a list of timestamps for each occurrence of the motif in this movement, we can start exploring the audio to see if any notable or insightful patterns emerge. To start, we can plot the amplitude, or overall loudness, of the movement and mark where the motifs lie.

[7] David Meredith, *Computational Music Analysis* (Springer International Publishing), Chapter 12

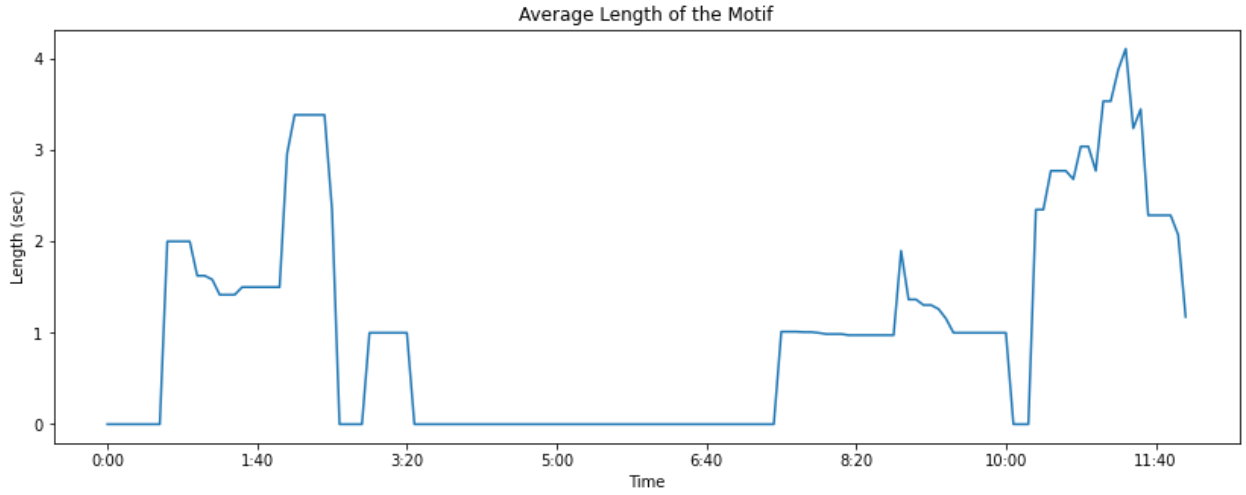


From this graph, we can see that the motif is generally expressed in the more energetic passages. We can also note that the middle passage, which corresponds to the development section of the movement, does not feature the DSCH motif at all. To quantify this, we can instead look at the percussive frequencies mentioned previously; as percussion sounds generally convey a sudden burst of noise, we can imagine that more energetic percussion sounds in a passage can serve as some measure of the fervor or passion of the passage. Plotting the number of motif occurrences and the overall percussive energy of passages across the movement, we can see a strong correlation between the two:

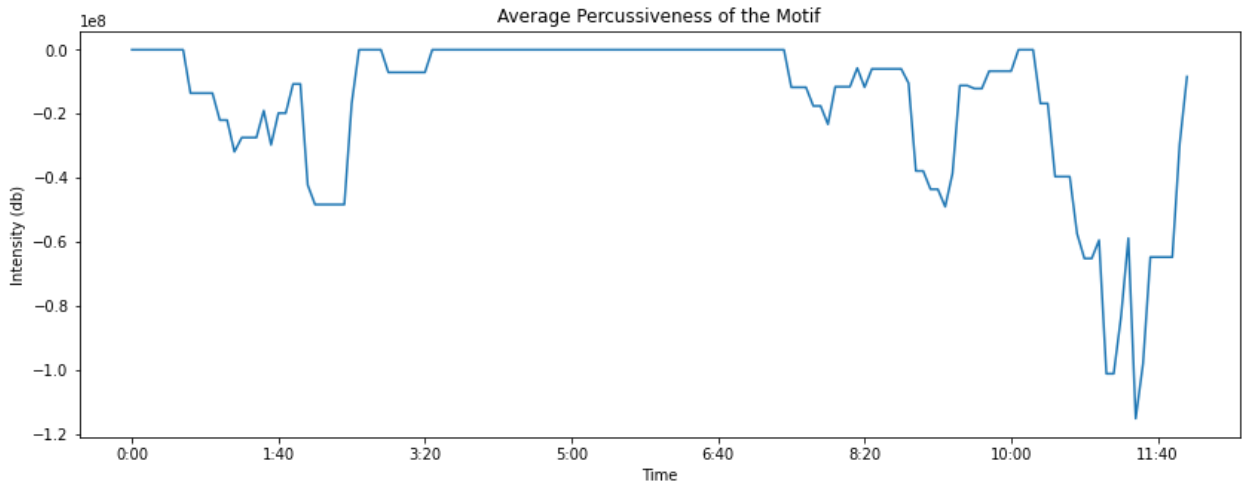


This correlation can be quantified by a measure known as the Pearson correlation, which tries to express whether two signals, changing over time, increase or decrease similarly or not.[8] Simply comparing the two graphs across the entire movement only yields a correlation coefficient of 0.475, which doesn't seem to suggest a very strong correlation. However, if we instead ignore the end of the movement, which seems to exhibit different behavior compared to the rest, and only compare the two graphs up to 10:00 minutes, we arrive at a much higher correlation coefficient of 0.729, which is more convincing.

This difference also suggests the motif is being used in a different manner at the end compared to the rest of the movement. Although the ending is not an energetic passage, the motif is still repeated numerous times. This difference can be explained by listening to the end of the movement specifically; here, the motif is repeated in pizzicato by the lower strings, barely audible in the background. Looking at how the motif is performed, we can also note differences in both the average percussiveness as well as the average length of each motif at the end of the movement.



[8] Statistics HowTo, "Correlation Coefficient: Simple Definition, Formula, Easy Steps"

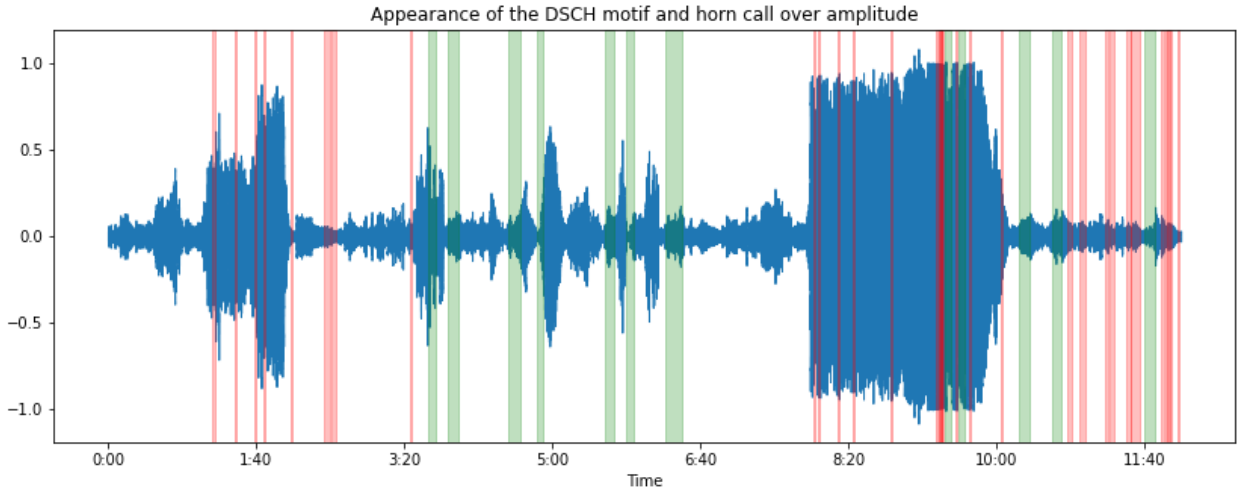


Together, these two graphs highlight how the motifs performed in the ending are both longer and less percussive, or more melodic, compared to the rest of the movement. It implies that the motif takes on a completely different character in the ending, one that is softer, less hurried, and no longer the main focus of the piece. Even when the motif returns for the final notes of the movement, it comes as "a self-deprecating whimper," lacking any support or urgency behind it.[9]

One possible explanation for this shift in expression may come from looking at the other motif that is extensively featured in this movement: the five-note horn call. This motif "bears a striking and self-conscious resemblance to the horn motif in the first song of Mahler's *Das Lied von der Erde*," of which Shostakovich himself explained in a letter that Mahler associated the horn call with the call of "a giant monkey … as the harbinger of death, cruel fate, and misfortune".[10] Before the ending, the horn call and DSCH motif are wholly separate--the DSCH motif appears in the opening of the movement, while the horn call appears in the development. It is only once we reach the final climax when both the horn and DSCH motif are used

[9] Wilson, *Shostakovich: A Life Remembered*, 304
[10] Ibid., 304

simultaneously, screamed out by the orchestra and overlapping and interrupting each other like a vicious argument.



After one last triumphant horn call and nearly two minutes of this hysterical climax, the energy finally begins to wind down, carried along by a passage of descending DSCH motives. This is the point when the motif begins to change its character, taking on a more passive tone as it fades into the background. At the same time, the horn call reappears and remains incorporated in the melody, now clearly dominating over the DSCH motif. Programmatically, it implies that the horn call, threatening "cruel fate and misfortune", finally succeeds in forcing the DSCH motif out of the limelight. In the end, the DSCH motif, and thus Dimitri Schostakovich himself, is only able to let out timid calls, devoid of the same passion and power as before.

Interpretations

If we are to take Shostakovich's use of his motif as being autobiographical, then one tempting interpretation of these motivic interactions is as a reflection of Shostakovich's early fame and interactions with party pressures, or perhaps Stalin himself. The opening of the movement, with its use of the DSCH motif and "emotionally ambivalent, 'hear no evil, see no

evil'" sound, may be reflective of the start of Shostakovich's career, with his immediately successful First Symphony and more experimental Second and Third symphonies.[11] Meanwhile, the development section switches its focus to the horn call motif. If we assume that this movement documents Shostakovich's interactions with party pressures, then this horn call may very well represent the party itself, constantly lurking over this dark and solemn development section. The climax, then, is a parallel to the fiasco with Shostakovich's *Lady Macbeth*, with the threats of "cruel fate and misfortune" eventually forcing Shostakovich to bow to political pressures, not just with this piece but in his following works as well.

This interpretation seems to be consistent with the material in the third movement, but is there any support for it in the other movements as well? One analysis of the finale, done by Natalia Naiko, describes it as a "patchwork quilt" of numerous themes, consciously constructed in an "illogical process" to ultimately serve as a "mockery … [of] official musical language".[12] The finale also features the DSCH motif, with it appearing just before the recapitulation as it's played by the entire orchestra. Unlike the third movement, however, the motif doesn't face any more interruptions or threats, and it triumphantly stays in the melody as the movement ends in an exuberant resolution.

Taken together, this leads to a possible interpretation of the finale, continuing from the narrative told in the third movement. Shostakovich's "patchwork quilt" of themes can be seen as a reflection and mockery of the changes he needed to make to his works following the increased attention from the party, such as the adoption of Socialist Realism. The lack of Shostakovich's motif throughout this portion of the finale may also reflect his sentiment that the changes and music he was forced to release didn't reflect the works he truly wanted to create. It's only after

[11] David Hurwitz, *Shostakovich Symphonies and Concertos: An Owner's Manual*, 129
[12] Natalia M. Naiko, ""The Problem of the Finale" in Symphony No. 10 by D. Shostakovich Through the Prism of Composer's Work with Genre Material.", 10, 12-13

Stalin's death when Shostakovich can finally return with more musical freedom, as he blasts his motif with the entire orchestra and jubilantly brings the finale to a close.

Shostakovich's use of his musical acronym then does seem to truly be autobiographical, as he sketches out his personal interactions with Stalin's rule through the third and fourth movements. We see the initial freedom Shostakovich enjoyed, until he drew the criticism of Stalin himself and had to be more cautious with his artistic voice. We see the mockery of the "official musical language" Shostakovich was pressured to incorporate into his new works, until finally the DSCH motif is allowed free reign and Shostakovich is allowed to breathe a little bit more, as much of the pressure is lifted due to Stalin's death. Is this ending a bit too simplistic for Shostakovich, who probably realized that the party would continue to the controlling despite Stalin's death? Perhaps; and this may be why some see the ending to the finale as "a private victory, albeit a dark victory" or "not convincing enough".[13] [14] Nevertheless, it is certainly conceivable that Shostakovich intended, with the use of his personal monogram, to express his personal reflections and relief that this heavy presence continually lurking over his shoulder was finally gone.

[13] John J. Puccio, "Shostakovich: Symphony No. 10 (CD review)," review of *Shostakovich Symphony No 10*, recorded by Andris Nelsons, Boston Symphony Orchestra, *Classical Candor*, August 2018.
[14] Boris Iarustovskii, Desiataia simfoniia D. Shostakovicha [The Tenth Symphony by Shostakovich], *In Sovetskaia Muzyka* [*Soviet Music*], 1954, 22

Bibliography

All code used in this paper can be found in the following Github Repository: https://github.com/AC-Dap/shosty-visualization

Brian McFee, Alexandros Metsai, Matt McVicar, Stefan Balke, Carl Thomé, Colin Raffel, Frank Zalkow, et al. “Librosa/librosa: 0.8.1rc2”. Zenodo, May 25, 2021. https://doi.org/10.5281/zenodo.4792298.

Driedger, Jonathan, and Prätzlich, Thomas. *Harmonic Percussive Source Separation*. International Audio Laboratories Erlangen, 2016. https://www.audiolabs-erlangen.de/content/05-fau/professor/00-mueller/02-teaching/2016w_mpa/LabCourse_HPSS.pdf

Fuller, Patrick. “Librosa: A Python Audio Libary,” Medium (blog), May 28, 2019, https://medium.com/@patrickbfuller/librosa-a-python-audio-libary-60014eeaccfb

Hurwitz, David. *Shostakovich Symphonies and Concertos: An Owner’s Manual*. Pompton Plains: Amadeus Press, 2006.

Iarustovskii, B. Desiataia simfoniia D. Shostakovicha [The Tenth Symphony by Shostakovich], *In Sovetskaia Muzyka* [*Soviet Music*], 1954.

Meredith, David. 2016. *Computational Music Analysis*. 1st ed. 2016. Cham: Springer International Publishing : Imprint: Springer.

Müller, Meinard, and Balke, Stefan. *Short-Time Fourier Transform and Chroma Features*. International Audio Laboratories Erlangen, 2015. https://www.audiolabs-erlangen.de/content/05-fau/professor/00-mueller/02-teaching/2016s_apl/LabCourse_STFT.pdf

Naiko, Natalia M. 2017. ““The Problem of the Finale” in Symphony No. 10 by D. Shostakovich Through the Prism of Composer’s Work with Genre Material.” *Journal of Siberian Federal University. Humanities & Social Sciences* 10 (8): 1209–23. https://doi.org/10.17516/1997-1370-0129.

Puccio, John J. “Shostakovich: Symphony No. 10 (CD review).” Review of *Shostakovich Symphony No 10*, recorded by Andris Nelsons, Boston Symphony Orchestra. *Classical Candor*, August 2018.

Shostakovich, Dimitri. *Shostakovich Symphony No. 10*. Royal Liverpool Philharmonic. Vasily Petrenko. 8.572461, 2010, Naxos Music Library, https://harvard-naxosmusiclibrary-com.ezp-prod1.hul.harvard.edu/catalogue/item.asp?cid=8.572461

Statistics HowTo. "Correlation Coefficient: Simple Definition, Formula, Easy Steps." https://www.statisticshowto.com/probability-and-statistics/correlation-coefficient-formula/

Wilson, Elizabeth. *Shostakovich: A Life Remembered*, 2nd edition. Princeton: Princeton University Press, 2006.