

Oregon State University

EmotioNotes Dataset: Decoding emotions in classical music using Concert Program Notes

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soundbendor lab

Music emotion recognition (MER)

- Task to identify emotions associated with music
- Studies have been done in audio waveforms [1], lyrics [2], acoustic features [3], and social media discourse [4].
- Applications in entertainment and health
  - Personalized music recommendation [5]
  - Mood-dynamic playlist generation [6]
  - Music therapy for patients of depression, autism, and alzheimer's [7]

Motivation

- Very few datasets of music and emotion available [8]–[11]
- Available data contain only less than 2,000 tracks
- Copyright restrictions limit access to audio data
- No existing music annotation dataset for classical music

Objective

- Create a large publicly available data set of concert program notes
- Provide affective labels for program notes as pseudo-annotations
- Release first dataset of annotated emotions for classical music work

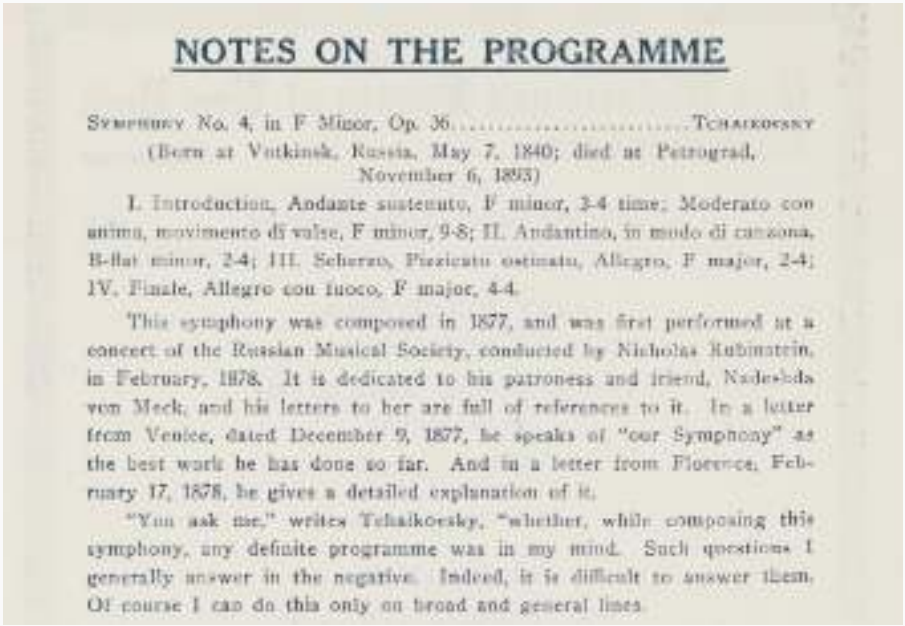
Approach

- Extract program notes from text converted from Optical Character Recognition (OCR)
- Use large language model (LLM) to obtain clean program notes
- Annotate each program note with emotion scores
- Train a model on our dataset to predict emotion directly from texts

Program Notes: What are they?

- Find at chamber music performances, orchestral concerts, or operas
- Describes the music piece in detail, with historical context
- Guide audience through the musical understanding and appreciation
- Often contains semantically meaningful, emotive descriptions

Program Note: Example



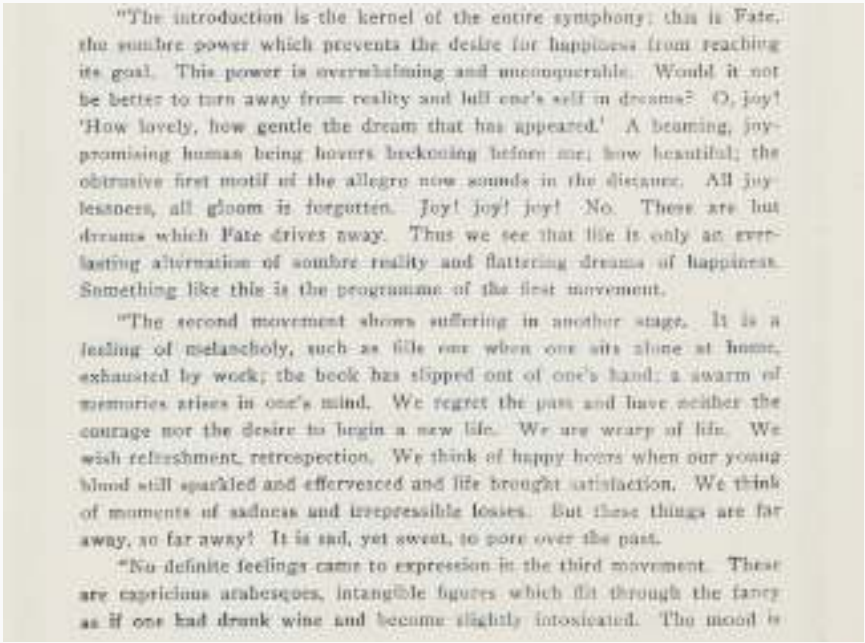
NOTES ON THE PROGRAMME

Symphony No. 4, in F Minor, Op. 36.....Tchaikovsky
(Born at Votkinsk, Russia, May 7, 1840; died at Petrograd, November 6, 1893)

I. Introduction, Andante sustenuto, F minor, 3-4 time; Moderato con anima, movimento di valse, F minor, 9-8; II. Andantino, in modo di canzona, B-flat minor, 2-4; III. Scherzo, Pizzicato ostinato, Allegro, F major, 2-4; IV. Finale, Allegro con fuoco, F major, 4-4.

This symphony was composed in 1877, and was first performed at a concert of the Russian Musical Society, conducted by Nicholas Rubinstein, in February, 1878. It is dedicated to his patroness and friend, Nadejeda von Meck, and his letters to her are full of references to it. In a letter from Venice, dated December 9, 1877, he speaks of "our Symphony" as the best work he has done so far. And in a letter from Florence, February 17, 1878, he gives a detailed explanation of it.

"You ask me," writes Tchaikovsky, "whether, while composing this symphony, any definite programme was in my mind. Such questions I generally answer in the negative. Indeed, it is difficult to answer them. Of course I can do this only on broad and general lines.



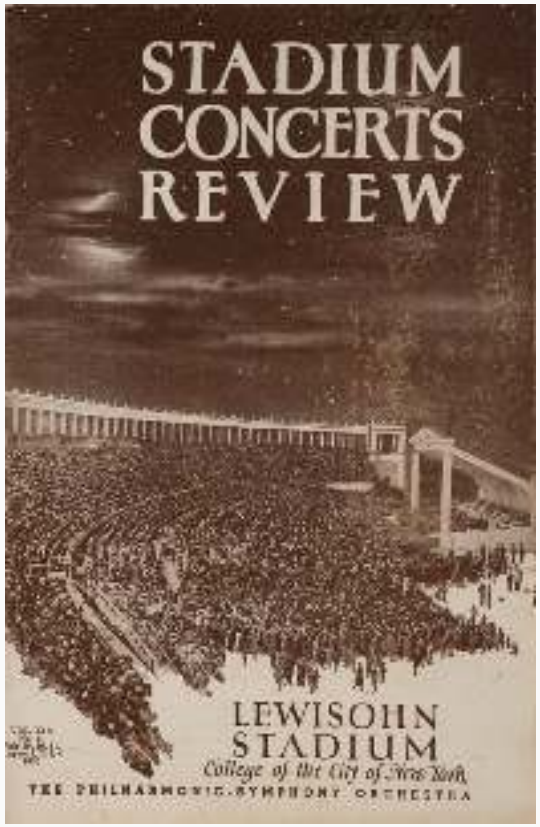
"The introduction is the kernel of the entire symphony; this is Fate, the sombre power which prevents the desire for happiness from reaching its goal. This power is overwhelming and unconquerable. Would it not be better to turn away from reality and lull one's self in dreams? O, joy! 'How lovely, how gentle the dream that has appeared.' A beaming, joy-promising human being hovers beckoning before me; how beautiful; the obtrusive first motif of the allegro now sounds in the distance. All joylessness, all gloom is forgotten. Joy! joy! joy! No. These are but dreams which Fate drives away. Thus we see that life is only an everlasting alternation of sombre reality and flattering dreams of happiness. Something like this is the programme of the first movement.

"The second movement shows suffering in another stage. It is a feeling of melancholy, such as fills one when one sits alone at home, exhausted by work; the book has slipped out of one's hand; a swarm of memories arises in one's mind. We regret the past and have neither the courage nor the desire to begin a new life. We are weary of life. We wish refreshment, retrospection. We think of happy hours when our young blood still sparkled and effervesced and life brought satisfaction. We think of moments of sadness and irrepressible losses. But these things are far away, so far away! It is sad, yet sweet, to pore over the past.

"No definite feelings came to expression in the third movement. These are capricious arabesques, intangible figures which flit through the fancy as if one had drunk wine and become slightly intoxicated. The mood is

Program note for Tchaikovky's Symphony No. 4 in F Minor, Op. 36

Program booklet



Example of a program booklet [1]

[1] https://archives.nyphil.org/index.php/artifact/0860e6a1-8235-457b-b66e-e85e3735b904-0.1

Data collection

Dataset

NY Philharmonic Society (NY Phil) [2]

- Large collection of historical concert data spanning 180 years
- Data of 14,743 digitized program booklets [3]
- Optical Character Recognition (OCR) used to extract page-wise text
- Contain program notes for the performed music works
- Also contain advertisements, prefatory remarks, and headers

[2] https://archives.nyphil.org/
[3] https://github.com/nyphilarchive/PerformanceHistory

Program note extraction using an LLM with task-specific prompting

Our approach: Noisy example



Program note for Tchaikovky's Tchaikovsky's Overture, 1812, Op. 49

OCR text from the noisy example



S. HUROK presents . . . 1942-43 SEASON The First Public Appearance at Carnegie Hall E| FRANK BLACK and the NBC STRING SYMPHONY 1 IN A SERIES OF 3 PERFORMANCES EOCT. 23 MISCHA ELMAN,SoloistSuite by Bach; G Minor Concerto by Vivaldi; Sonata, Opus 2 No. 3 by Beethoven; A Major Concerto by Mozart; Eine Kleine Nachtmusik by MozartNov. 27 EGON PETRI,SoloistSonata, Opus 7 by Beethoven; D Minor Concerto by Bach; Divertimento No. 1 by Weiner; Quartette, Opus 10 by DebussyJan. 15 ALL-RUSSIAN PROGRAMVariations on An Original Theme by Tchaikowsky; Serenade Suite, Opus 48 by Tchaikowsky; Variations on A Theme by Tchaikowsky Opus 35Aby Arensky; Sinfonietta, Opus 32 No. 2 by MiaskowskyE ENTIRE SERIES \$2.20, \$2.75, \$3.85, \$4.40, \$5.50, Tax Included. Reservations Filed In Order of Receipt. E Make Checks Payable to HUROK ATTRACTIONS, INC., 711 FIFTH AVE., N. Y. C. PLaza 3-0620

PAGE 6STADIUM CONCERTS REVIEWNOTES ON THE PROGRAMS(Continued from previous page)"OVERTURE, 1812, OP. 49Peter Ilyitch Tschaikowsky(Born at Votinsk, May 7, 1840; died at St. Petersburg, November 6, 1893)(Wednesday, July 22)Although clearly a piece d'occasion prompted by the commemoration of a crucial page in Russian history, the Overture, 1812 is a minor mystery in the Tschaikowsky catalogue. Supposedly NicholasRubinstein commissioned Tschaikowsky in 1880 to write a festival overture for the Moscow Exhibition. At least the composer admits as much in letters to Nadeshka von Meek and the conductor Napravnik.But his friend Kashkin insisted the piece was requested for the ceremonies consecrating the Moscow Cathedral of the Saviour, intended to symbolize Russia s part in the Napoleonic struggle. The overture, accordingly, pictured the great events begin-Ballet"sf OR BEACHCo l A""rU"1CottonsJoset Walker ... Fashion designerAt right, Joset Walker s 1942 version of the Gay Nineties bloomers . . . snug at waist, ballooning at knee. Also for biking the camel-colored shirt and shorts, wrap-around skirt. An ingenious American designer, Joset Walker is at work on a new collection emphasizing the slim, untrimmed silhouette Fashion work these days calls for steady nerves, she says. I keep my smoking mild with Camels! Designed by Joset Walker In these days of hard work,I appreciate a mild cigarette morethan ever;so I stick to Camels.Milder and so good-tasting! STADIUM CONCERTS REVIEWPAGE 7ning with the Battle of Borodino (September 7, 1812) and ending with Napoleon s flight from Moscow, after the city was set aflame. To make it more effective, the work was to be performed in the public square before the cathedral. An electric connection on the conductor s desk would set off salvos of real artillery, and all Moscow would thrill with thoughts of its heroic past. In any case Tschaikow-sky finished the overture at Kamenka in 1880, and though the cathedral was dedicated in the summer of 1881, there is no record of the planned street scene having come off.Instead, we find Tschaikowsky offering the overture to Eduard Napravnik, then directing the Imperial Musical Society of St. Petersburg: Last winter, at Nicholas Rubinstein s request, I composed a Festival Overture for the concerts of the exhibition, entitled T812 . Tschaikowsky then makes a statement that possibly suggests an earlier rebuff: Could you possibly manage to have this played? It is not of great value, and I shall not be at all surprised or hurt if you consider the style of the music unsuitable to a symphony concert. Ap-(Continued on next page)THE SMOKE OF SLOW BURNINGcontains LESS NICOTINER. J. Reynolds Tobacco Company Winston-Salem, North CarolinaFor town, country, beach, Joset Walker styles cotton. At left, ballet-length beach robe, belted in gold kid. Bright green swimsuit two-piece, with soft surplice neckline.For relaxation, this young designer spends week-ends on her farm. "And you ll usually see me with a Camel in my hand," she remarks. "I never tire of smoking Camels. They re so cool and mild and have the most delightful flavor I could ask for in a cigarette! than that of the four other largest-selling brands tested less than any of them according to independent scientific tests of the smoke itself!

OCR text containing Tchaikovky's Overture, 1812, Op. 49

Different contents in OCR text from the adverse example



yiiiiiiimiiiiii

Our approach: Program Note Extraction

Our solution

- Use a large language model, `Llama 3.1` to extract clean program notes from scratchy, unorganized OCR texts

`Llama 3.1`

- An open-source LLM released by Meta AI in July, 2024 [12]
- Upgrade to the `Llama 3` model with further performance improvements in standard benchmarks
- An extended context window of up to 128,000 tokens
- 70B parameter model trained on more than 15 trillion tokens

Example of a query

Query

Please provide the complete program note for {composition_name}, {movement_name} by {composer_name}. Do not include any starting sentences such as 'Here is the complete program note for ...'. If you do not find any program note description for the requested music composition, please just respond with: 'Not Available'.

OCR text from the noisy example



yiiiiiiimiiiiii

Cleaned program note from OCR text using our approach

Although clearly a piece d'occasion prompted by the commemoration of a crucial page in Russian history, the "Overture, 1812" is a minor mystery in the Tschaikowsky catalogue. Supposedly Nicholas Rubinstein commissioned Tschaikowsky in 1880 to write a festival overture for the Moscow Exhibition. At least the composer admits as much in letters to Nadeshka von Meek and the conductor Napravnik.

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Apparently Napravnik turned down the overture, and its premiere was postponed to August 20, 1882, when it figured on an all-Tschaikowsky concert in the Art and Industrial Exhibition at Moscow.

Tschaikowsky's attitude to the work is further expressed in the letter to his patroness-saint Mme. von Meek. There he speaks of the overture as "very noisy" and having "no great artistic value" because it was written "without much warmth of enthusiasm." And in a diary entry of the time he refers to it as having "only local and patriotic significance."

The "patriotic significance", of course, is what gives the overture its raison d'être as a motion picture of historical events. Tschaikowsky's brushstrokes are bold and obvious. The French and Russians are clearly depicted through the use of the Czarist National Anthem and the "Marseillaise". Fragments of Cossack and Novgorod folk songs enter the scheme, and the battle and fire scenes are as plain as pictures. As the overture develops, one envisions the clash of arms at Borodino, with the Russians stiffly disputing every step and the "Marseillaise" finally rising dominant. The Russians are hurled back; the French are in Moscow. Finally the city is ablaze and the dismal rout begins, as cathedral bells mingle with the roll of drums and the hymn, "God Preserve Thy People", surges out in a paean of victory.

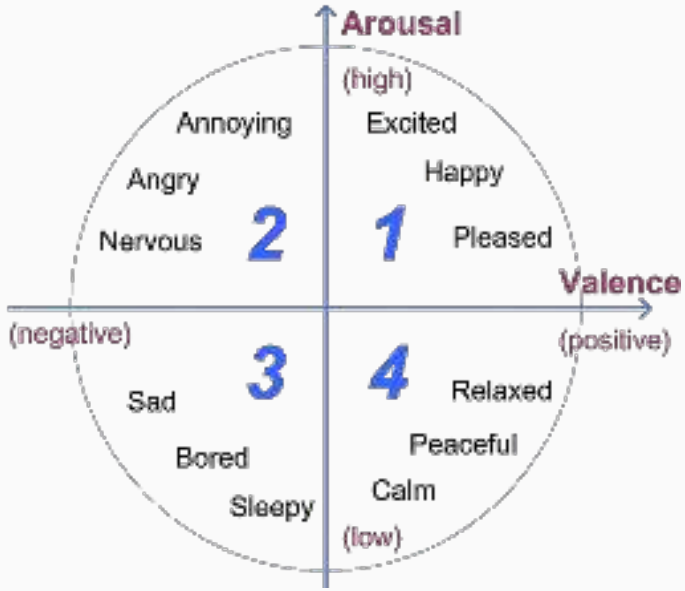
Cleaned program note extracted from the scratchy OCR text

Annotation of emotion scores

Annotation of emotion scores

Dimensional annotation of emotion

- Attempts at quantifying emotions as a stream of continuous values
- Allows precise measurement of emotion as numerical values
  - **Valence** (unpleasant to pleasant)
  - **Arousal** (calm to excited)
  - **Dominance** (controlled to in-control)



Circumplex model for emotions

Annotation of emotion scores: affective ratings

Extended Affective Norms for English Words [13]

- More than 1,800 participants for annotations
- VAD emotion scores given on a 9-point scale
- Emotion norms for a word is an average of all participant responses
- Popular in research due to the large vocabulary of annotated words

Word norms for emotion in text: Literature

Carney et al. [14]

- Calculated emotion scores for 12 fictional novels, 4,000 short stories, and social media discussions

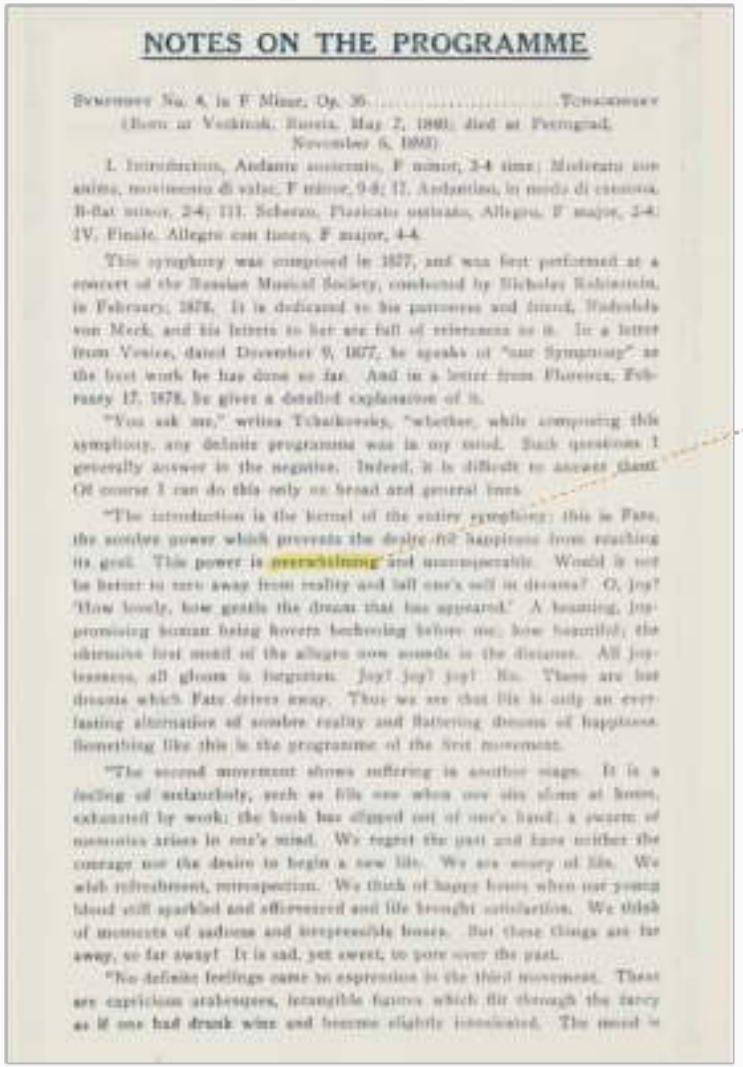
Delbouys et al. [15]

- Used the same approach to infer emotions in songs using norms for tags associated with the song

Beery and Donnelly [16]

- Estimated emotions in songs using social media comments

Program Notes: Emotion-related words



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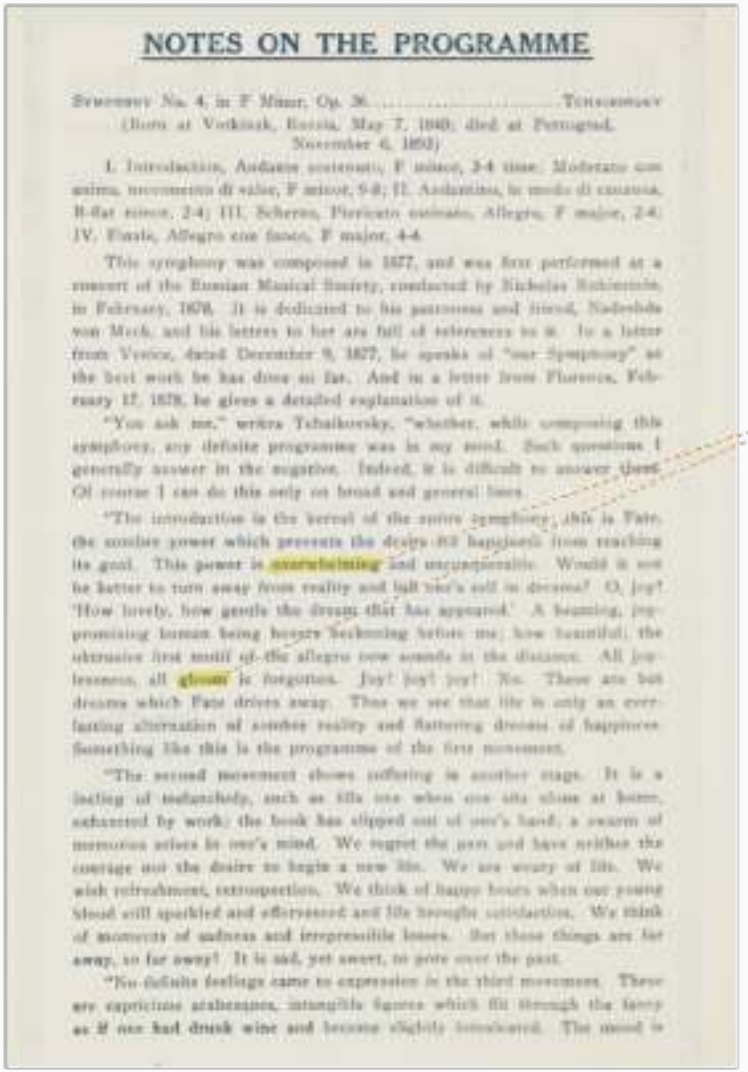
"No definite feelings come to expression in the third movement. These are capricious arabesques, intangible figures which flit through the fancy as if one had drunk wine and become slightly intoxicated. The mood is

Word	Valence	Arousal	Dominance
overwhelming	0.361	0.527	0.150

Program note for Tchaikovky's Symphony No. 4 in F Minor, Op. 36

Program Notes: Emotion-related words



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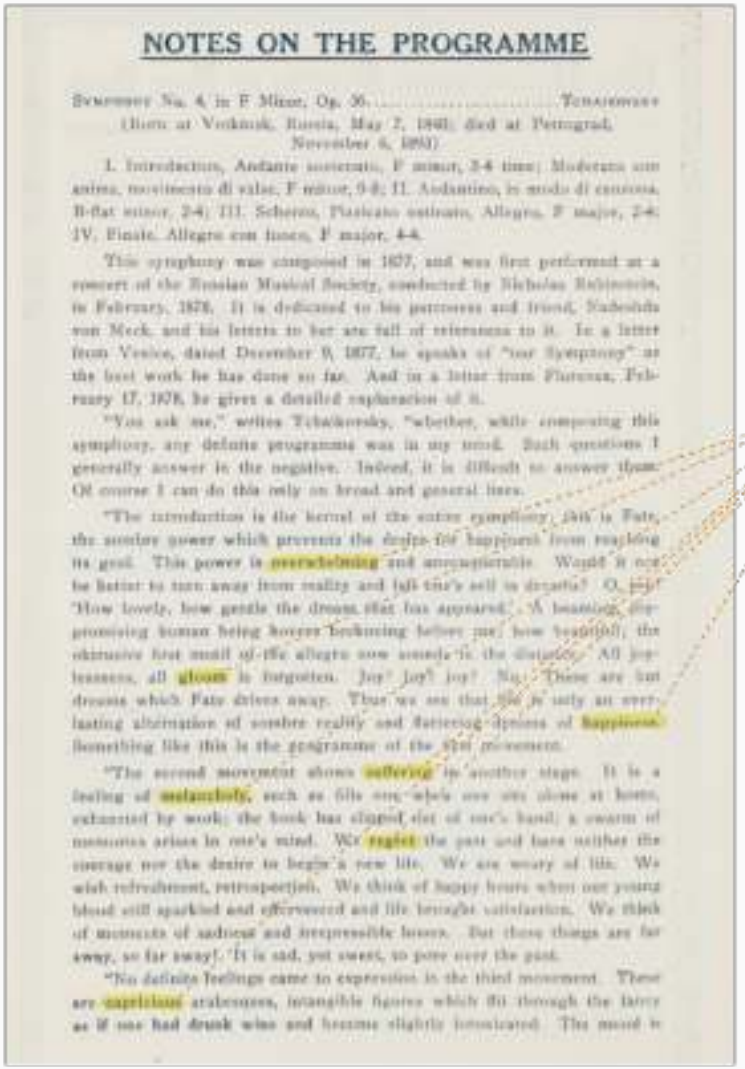

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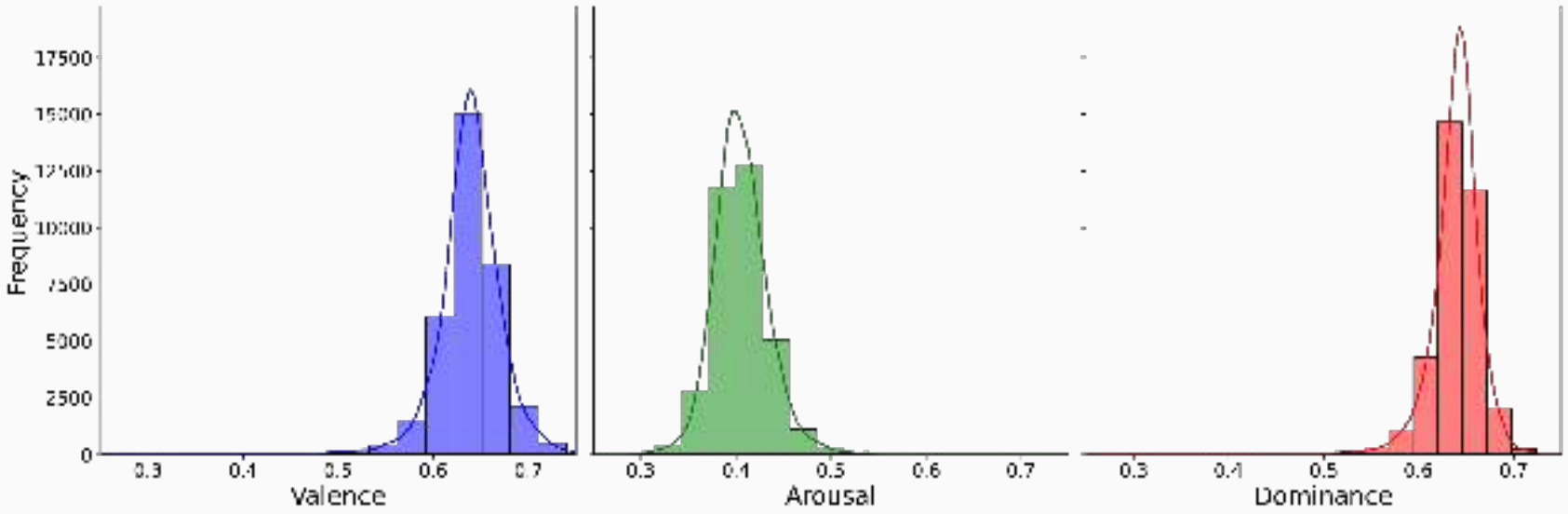
Word	Valence	Arousal	Dominance
overwhelming	0.361	0.527	0.150
gloom	0.224	0.372	0.384
happiness	0.993	0.792	0.863
suffering	0.109	0.468	0.264
melancholy	0.341	0.409	0.367
regret	0.296	0.533	0.635
capricious	0.514	0.420	0.590

Program note for Tchaikovky's Symphony No. 4 in F Minor, Op. 36

VAD Distribution in program notes obtained by `Llama 3.1`



Distribution of emotion scores across the dataset. Valence has a mean μ=0.637 $\pm$ 0.041; arousal, μ=0.406 $\pm$ 0.033; and dominance, μ=0.638 $\pm$ 0.030.

Analysis of the VAD distribution in our dataset

- Tends to collapse towards the center
- Normal distribution with some variance
- Mapping of words to emotions using norms is not ideal
- Can be done automatically and on a very large scale
- Reduces needs for costly human annotations

Emotion prediction

Our approach: `Longformer` for emotion prediction

- State-of-the-art in processing large sequences of tokens up to 4,096
- 12-layer encoder-only architecture
- Trained on the masked language modeling (MLM) task from `Roberta`'s pretrained checkpoint
- Combination of self-attention mechanism along with local windowed attention and a global attention

Results: Correlation analysis

	r	ρ	R^2
Valence	0.899	0.892	0.795
Arousal	0.860	0.868	0.698
Dominance	0.807	0.799	0.607

Pearson's correlation (r), Spearmans's correlation (p), and R-squared score between Longformer's predictions and the calculated values in our dataset.

Our contributions

- Novel dataset of classical music work with emotion annotations
- Enabling MER researchers to estimate emotion for classical music
- Data extraction from specific parts of books and documents applicable in other fields such as history, literature, and medicine
- Emotion prediction model trained on long-form program notes

Future work

- Collect copyright-free classical music recordings
- Creation of more robust MER systems with classical music audio
- Retrieval Augmented Generation (RAG) with `Llama 3.1`

References i

[1] N. HE and S. Ferguson, **"Multi-view neural networks for raw audio-based music emotion recognition,"** in *2020 IEEE International Symposium on Multimedia (ISM)*, 2020, pp. 168–172. DOI: 10.1109/ISM.2020.00037.

[2] Y. Agrawal, R. G. R. Shanker, and V. Alluri, **"Transformer-based approach towards music emotion recognition from lyrics,"** in *Advances in Information Retrieval*, D. Hiemstra, M.-F. Moens, J. Mothe, R. Perego, M. Potthast, and F. Sebastiani, Eds., Cham: Springer International Publishing, 2021, pp. 167–175, ISBN: 978-3-030-72240-1.

[3] R. Panda, R. Malheiro, and R. P. Paiva, **"Novel audio features for music emotion recognition,"** *IEEE Transactions on Affective Computing*, vol. 11, no. 4, pp. 614–626, 2020. DOI: 10.1109/TAFFC.2018.2820691.

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