

Probabilistically Modeling Scale Theory – Handout

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Prose/Slides: <https://tinyurl.com/TSMTChiu>

Voice
Par - fois, je suis tris - - te

Piano
p

compare to embeddings for surrounding context windows

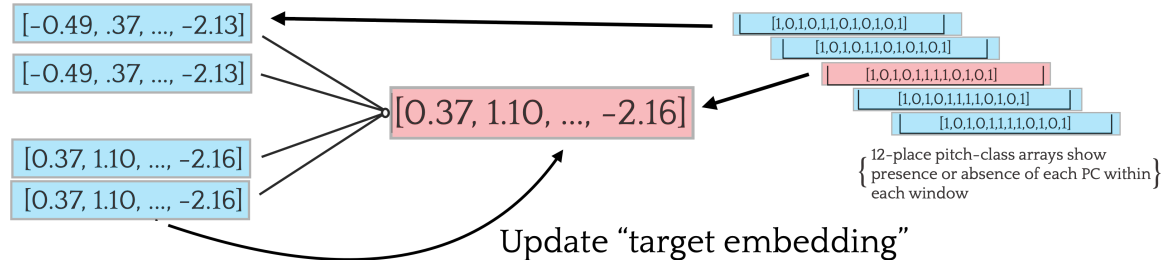


Figure 1. Process of extracting "scale embeddings."

Composer	No. of Piece in YCAC	No. of Notes	Avg. Notes per Piece
Mozart	882	3,865,439	4,382.58
Liszt	125	806,025	6,448.2
Saint-Saëns	72	504,663	6,913.19
Debussy	39	170,773	4,378.79

Figure 2. Sample dataset from the Yale Classical Archives corpus.

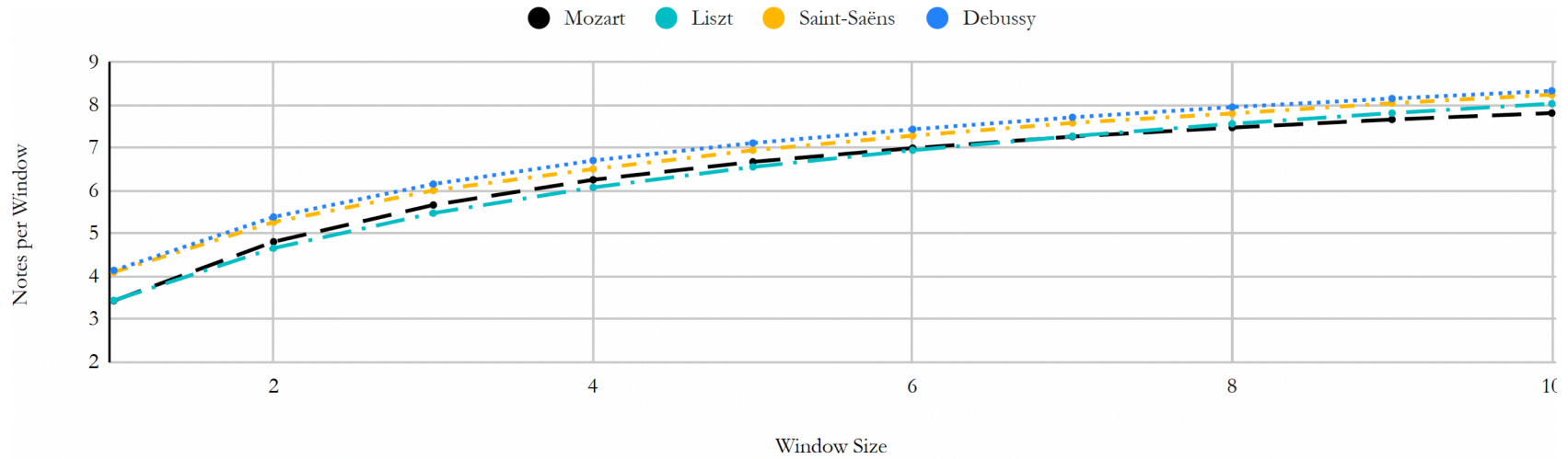


Figure 3. Average note content per window size.

Composer	1 Frequent	2 Frequent	3 Frequent	4 Frequent	5 Frequent
Mozart	C maj: 18,347	Bb maj: 17,580	D maj: 17,395	G maj: 16,189	Eb maj: 15,055
Liszt	All PCs: 3,187	F maj: 927	C maj: 798	E maj: 726	A maj: 620
Saint-Saëns	No PCs: 1,067	C maj: 921	Eb maj: 853	All PCs: 689	E maj: 588
Debussy	All PCs: 487	E maj: 352	C maj: 258	A maj: 207	F maj: 186

Figure 4. Highest frequency (top 5) pitch-class vectors.

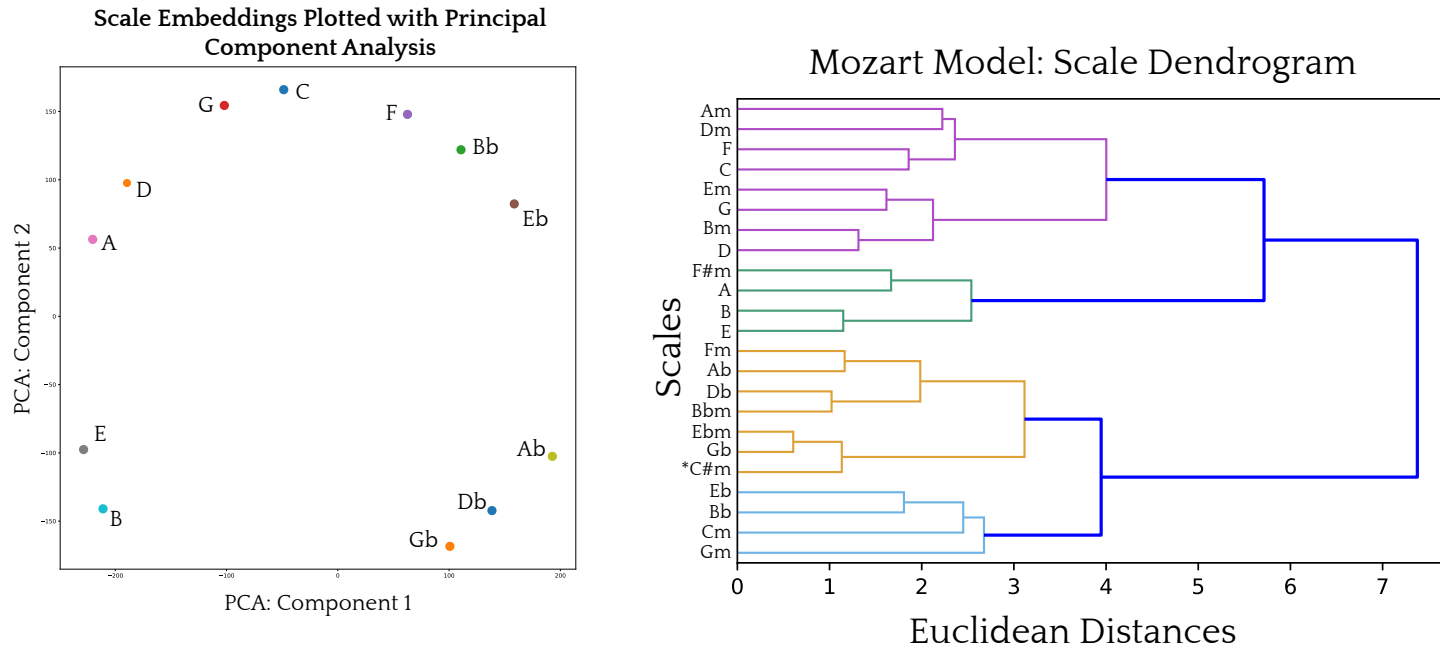


Figure 5a–b. Mozart scale embeddings grouping by fifths.

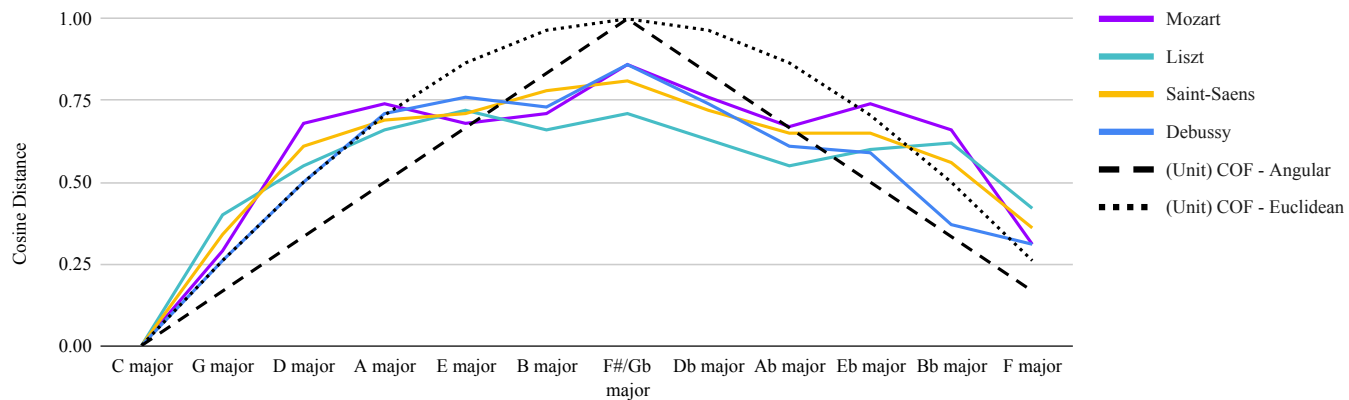


Figure 6. Correlating composer with circle of fifth distances.

Parfois, je suis triste. Et soudain, je pense à elle.
Alors, je suis joyeux. Mais je redeviens triste de ce que je ne sais pas combien elle m'aime. Elle est la jeune fille à l'âme toute claire, et qui, dedans son cœur, garde avec jalousie l'unique passion que l'on donne à un seul. Elle est partie avant que s'ouvrent les tilleuls, et, comme ils ont fleuri depuis qu'elle est partie, Je me suis étonné de voir, ô mes amis, des branches de tilleuls qui n'avaient pas de fleurs.

Sometimes I'm sad, and then suddenly I think of her and I'm happy. Then I'm sad again because I don't know how much she loves me. She is a bright-souled girl, and in her heart she jealously protects the one passion she will bestow on only one. She left before the lindens opened. They have flowered since then and I was amazed, my friends, to see linden branches with no flowers on them.

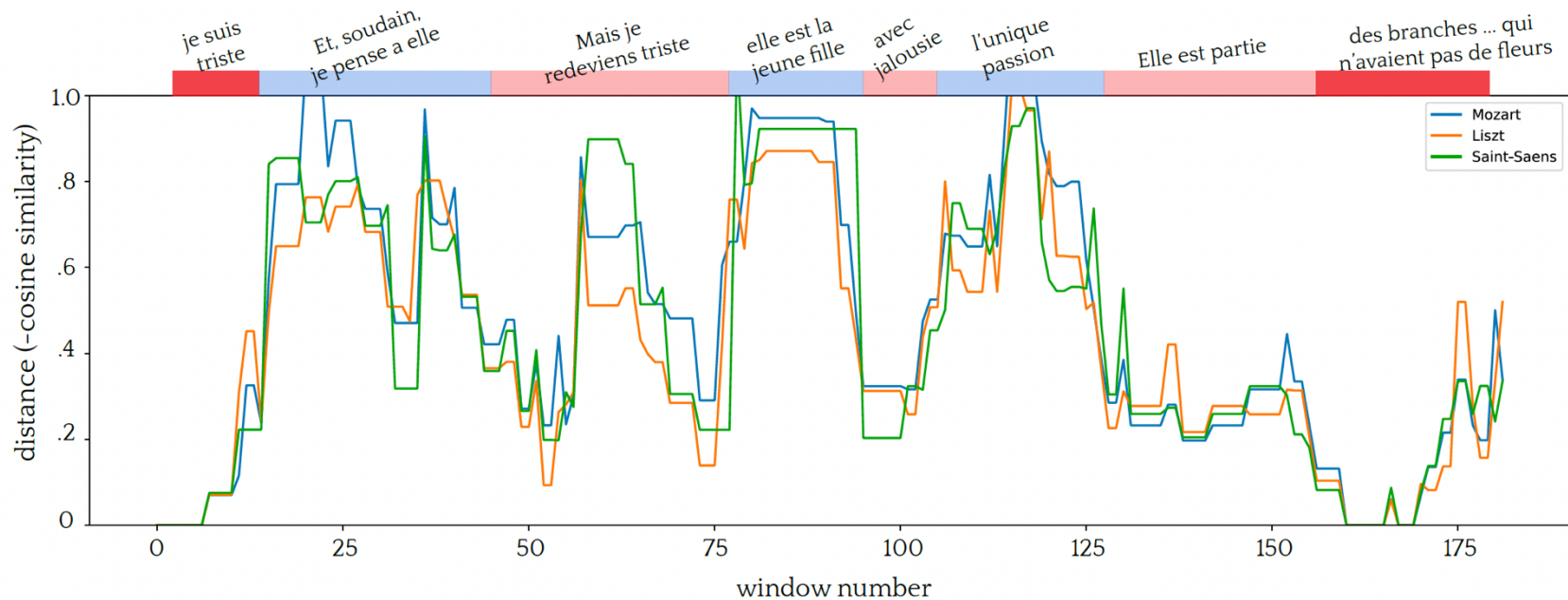


Figure 7. Windowed embedding analysis of L. Boulanger, "Parfois, je suis triste."

The image displays a musical score for a vocal and piano piece. The score is divided into four systems, each with a vocal line and a piano accompaniment. The first system (mm. 1-2) is marked "Assez lent et assez libre" and "p". The vocal line begins with "Par - fois,". The piano accompaniment features a w. 1 (whole note) chord. The second system (mm. 3-4) continues the vocal line with "je suis tris - te" and includes a w. 17 (whole note) chord. The piano accompaniment has a triplet of eighth notes. The third system (mm. 5-6) is marked "Plus animé" and "ardemment clair". The vocal line says "Et, sou - dain,". The piano accompaniment features a triplet of eighth notes. The fourth system (mm. 7) continues the vocal line with "je pen - se à". The piano accompaniment features a triplet of eighth notes. The score includes various musical notations such as dynamics (p), articulation (accents), and phrasing slurs.

Figure 8. "Parfois, je suis triste," mm. 1-7.

14 **Tempo I.** *do* *mf* *très soutenu* *sf* *v* *v* *v* *poco accel.*

Mais je re - de - viens tris - te de ce que je ne sais

♩ = 66
w. 61

Figure 9. "Parfois, je suis triste," mm. 14–16.

44 w. 157 $J = 80$
mf
Je me suis é - ton - né de voir,

46 w. 165 *p* *pp*
ô mes a - mis, des bran - ches de til-leuls qui n'a-vaient pas de

49 w. 177 w. 181 $J = 50$
fleurs.

pp *doux* *sim.* *rit.* *ppp*

Figure 10. "Parfois, je suis triste," mm. 44–51.

Select References

- Bengio, Yoshua, Re'jean Ducharme, Pascal Vincent, and Christian Jauvin. 2003. "A Neural Probabilistic Language Model." *Journal of Machine Learning Research* 3: 1137–1155.
- Chiu, Matt. 2021. "Macroharmonic Progressions through the Discrete Fourier Transform: An Analysis from Maurice Duruflé's *Requiem*." *Music Theory Online* 27 (3).
- Clough, John, and Jack Douthett. 1991. "Maximally Even Sets." *Journal of Music Theory* 35 (1): 93–173. doi: 10.2307/843811.
- Cuthbert, Michael Scott, and Christopher Ariza. 2010. "music21: A Toolkit for Computer-Aided Musicology and Symbolic Music Data." 11th International Society for Music Information Retrieval Conference (ISMIR).
- Dick, Philip K. *The Philip K. Dick Reader*. Citadel Press, 1997.
- Doll, Christopher. 2017. *Hearing Harmony: Toward a Tonal theory for the Rock Era (Tracking Pop)*. University of Michigan Press.
- Firth, John Rupert. 1968 [1957]. "A Synopsis of Linguistic Theory, 1930–55." In F.R. Palmer (eds) *Selected Papers of J.R. Firth (1952–59)*: 168–205. Indiana University Press.
- Gotham, Mark, Peter Jonas, Bruno Bower, William Bosworth, Daniel Rootham, and Leigh VanHandel. 2018. "Scores of scores: An openscore project to encode and share sheet music." In *Proceedings of the 5th International Conference on Digital Libraries for Musicology*, 87–95.
- Harasim, Daniel, Stefan E. Schmidt, and Martin Rohrmeier. 2016. "Bridging Scale Theory and Geometrical Approaches to Harmony: The Voice-Leading Duality Between Complementary Chords." *Journal of Mathematics and Music* 10 (3): 193–209.
- Liang, Feynman T., Mark Gotham, Matthew Johnson, and Jamie Shotton. 2017. "Automatic Stylistic Composition of Bach Chorales with Deep LSTM." In *ISMIR*, pp. 449–456.
- Mikolov, Thomas, Kai Chen, Greg Corrado, and Jeffrey Dean. 2013. "Efficient Estimation of Word Representations in Vector Space." arXiv preprint: 1301.3781.
- Nikrang, Ali, David RW Sears, and Gerhard Widmer. 2017. "Automatic Estimation of Harmonic Tension by Distributed Representation of Chords." In *International Symposium on Computer Music Multidisciplinary Research*, edited by Mitsuko Aramaki, Matthew E.P. Davies, Richard Kronland-Martinet, and Sølvi Ystad, 23–34. Springer, Cham.
- Nobile, Drew. 2016. "Harmonic Function in Rock Music: A Syntactical Approach." *Journal of Music Theory* 60 (2): 149–180.
- Temperley, David. 2018. *The Musical Language of Rock*. Oxford University Press.
- Tymoczko, Dmitri. 2004. "Scale Networks and Debussy." *Journal of Music Theory* 48 (2): 219–294.
- . 2010. *A geometry of music: Harmony and counterpoint in the extended common practice*. Oxford University Press.
- White, Christopher Wm., and Ian Quinn. 2016. "The Yale-Classical Archives Corpus." *Empirical Musicology Review* 11 (1): 50–58.
- . 2018. "Chord Context and Harmonic Function in Tonal Music." *Music Theory Spectrum* 40 (2): 314–335.
- Wittgenstein, Ludwig. 1953. "Philosophical investigations." Trans. by G.E.M. Anscombe. Blackwell.