Fourier Methods for Computational Analysis of Enharmonicism and Other Harmonic Properties.

Méthodes basées sur la Transformée de Fourier pour l'analyse computationnelle de l'enharmonie et des autres propriétés harmoniques

Jason Yust, BOSTON UNIVERSITY.
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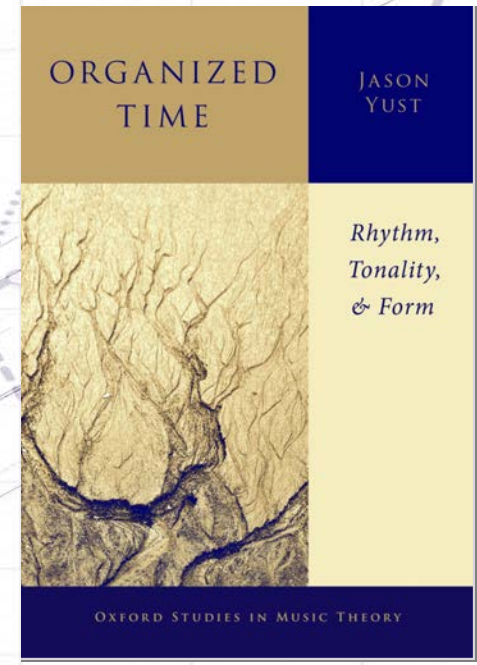


Journées d'informatique musicale
Strasbourg, 26 octobre, 2020.

Méthode: Analyse par fênetrage

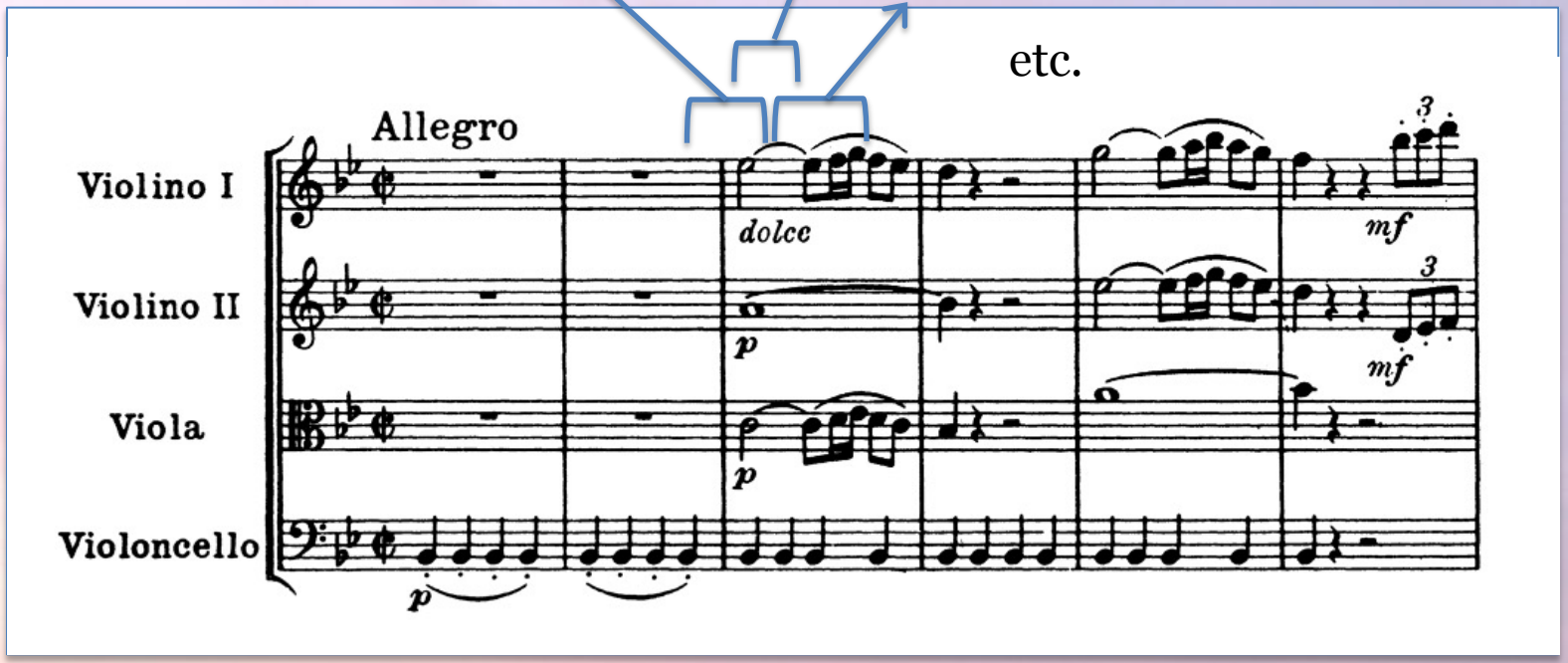
Vecteurs des classes de hauteurs pour deux noires

(1,0,0,1,0,0,0,0,0,1,2,0)

(2,0,0,2,0,0,0,0,0,2,2,0)

(2,0,1,3,1,0,1,0,0,2,2,0)

etc.



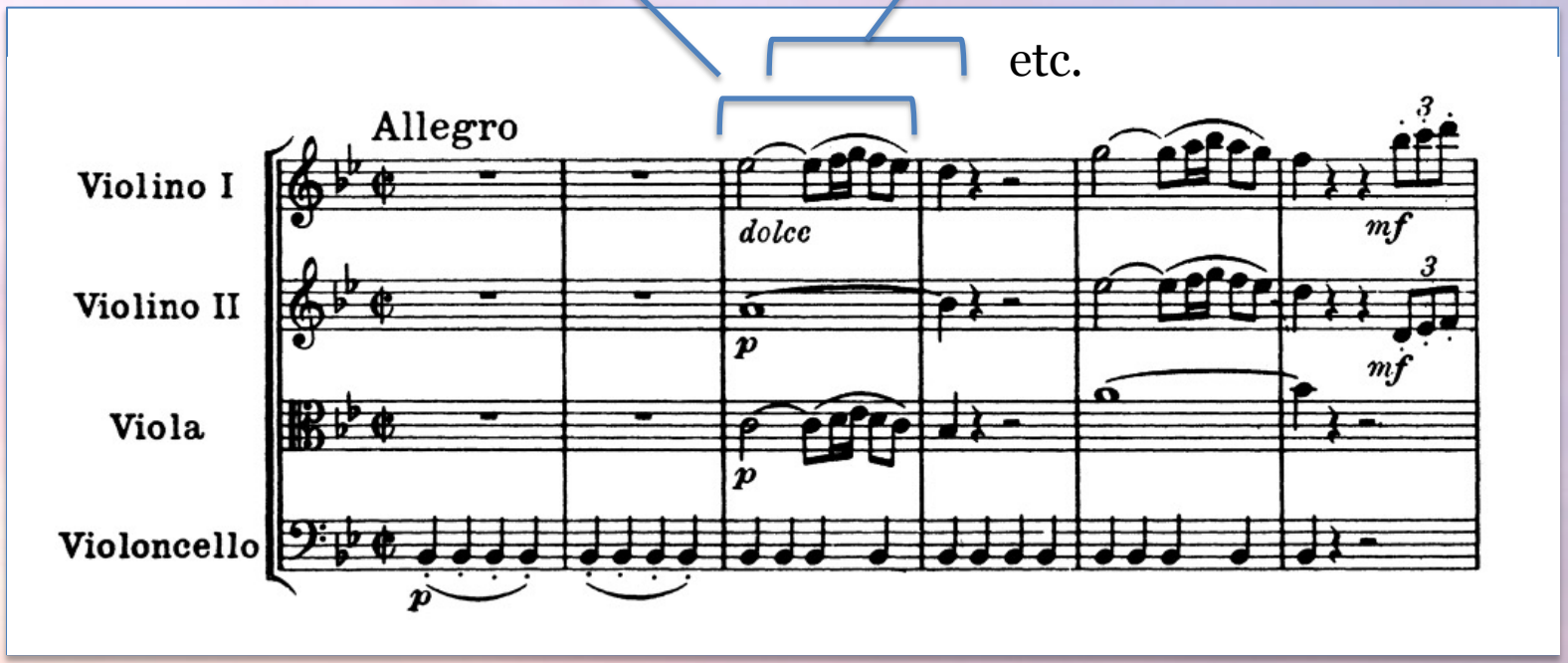
Méthode: Analyse par fênetrage

Vecteurs des classes de hauteurs pour quatre noires

(4,0,2,5,0,2,0,1,0,4,4,0)

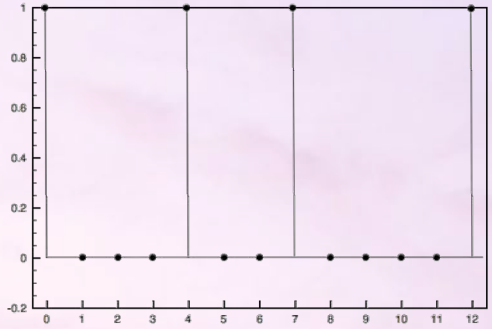
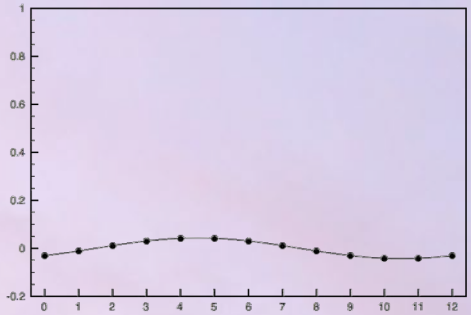
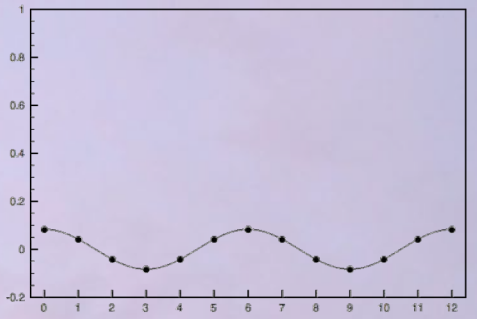
(3,0,3,4,0,2,0,1,0,3,6,0)

etc.

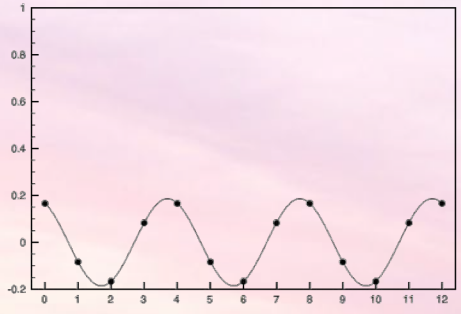
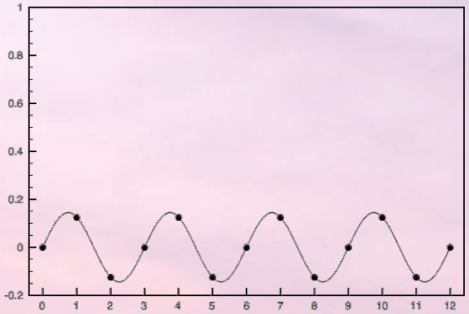
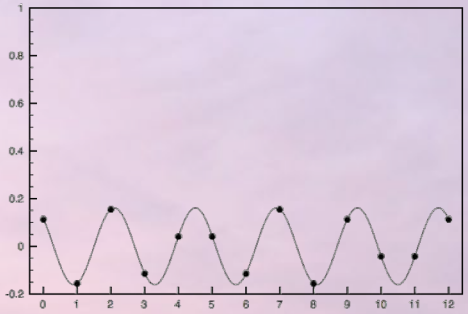
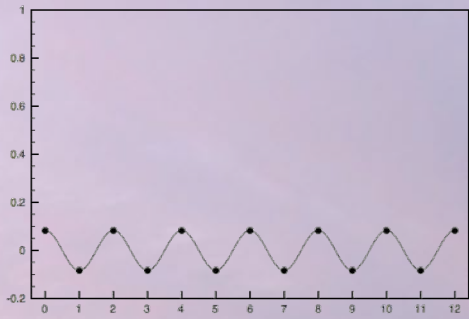


Coefficients de la TFD

Triad de do majeur = f_0 + f_1 + f_2

+ f_3 + f_4 + f_5 + f_6 + . . .

La TFD transforme un vecteur des classes des hauteurs en douze fonctions periodiques

Analyse TFD données de Prince et Schmuckler

Majeur:

Composer	$\|f_1\|^2$	$\|f_2\|^2$	$\|f_3\|^2$	$\|f_4\|^2$	$\|f_5\|^2$	$\|f_6\|^2$	Ph_1	Ph_2	Ph_3	Ph_4	Ph_5	Ph_6
Bach	2	79	150	10	2095	2	9.89	0.96	0.38	3.74	1.96	6
Mozart	9	243	310	1	2158	4	9.34	11.91	0.96	8.04	1.66	0
Beethoven	4	182	287	7	1427	0	8.31	11.53	1.34	6.43	1.53	6
Schubert	7	127	337	18	1931	0	8.25	0.18	1.06	7.70	1.65	0
Chopin	10	186	357	1	1638	1	7.43	11.72	1.03	8.22	1.26	0
Brahms	2	49	224	5	1009	2	7.74	0.27	0.68	9.37	1.59	0
Liszt	5	85	402	30	394	43	6.21	0.12	0.68	9.37	1.59	0
Scriabin	11	117	352	47	2154	2	8.93	1.09	0.89	7.12	1.93	6

Mineur:

Composer	$\|f_1\|^2$	$\|f_2\|^2$	$\|f_3\|^2$	$\|f_4\|^2$	$\|f_5\|^2$	$\|f_6\|^2$	Ph_1	Ph_2	Ph_3	Ph_4	Ph_5	Ph_6
Bach	8	69	208	49	1489	3	8.72	10.80	2.29	2.60	11.60	6
Mozart	17	195	656	10	1515	6	8.97	10.53	2.24	0.15	11.91	6
Beethoven	2	239	457	5	1150	16	6.33	10.18	2.51	1.73	11.70	6
Schubert	9	238	540	14	1815	1	9.20	10.47	2.62	11.76	11.93	0
Chopin	0	149	336	6	1002	6	6.57	10.36	2.39	2.21	11.88	6
Brahms	9	194	390	2	847	19	8.23	9.89	1.87	2.14	11.68	6
Liszt	0	254	651	1	1179	14	4.83	10.75	1.75	1.30	0.40	6
Scriabin	5	237	399	48	1524	19	10.10	10.88	1.25	0.61	11.91	0

From Yust, J. 2017. “Probing Questions about Keys: Tonal Distributions through the DFT.” *Mathematics and Computation in Music* 2017.

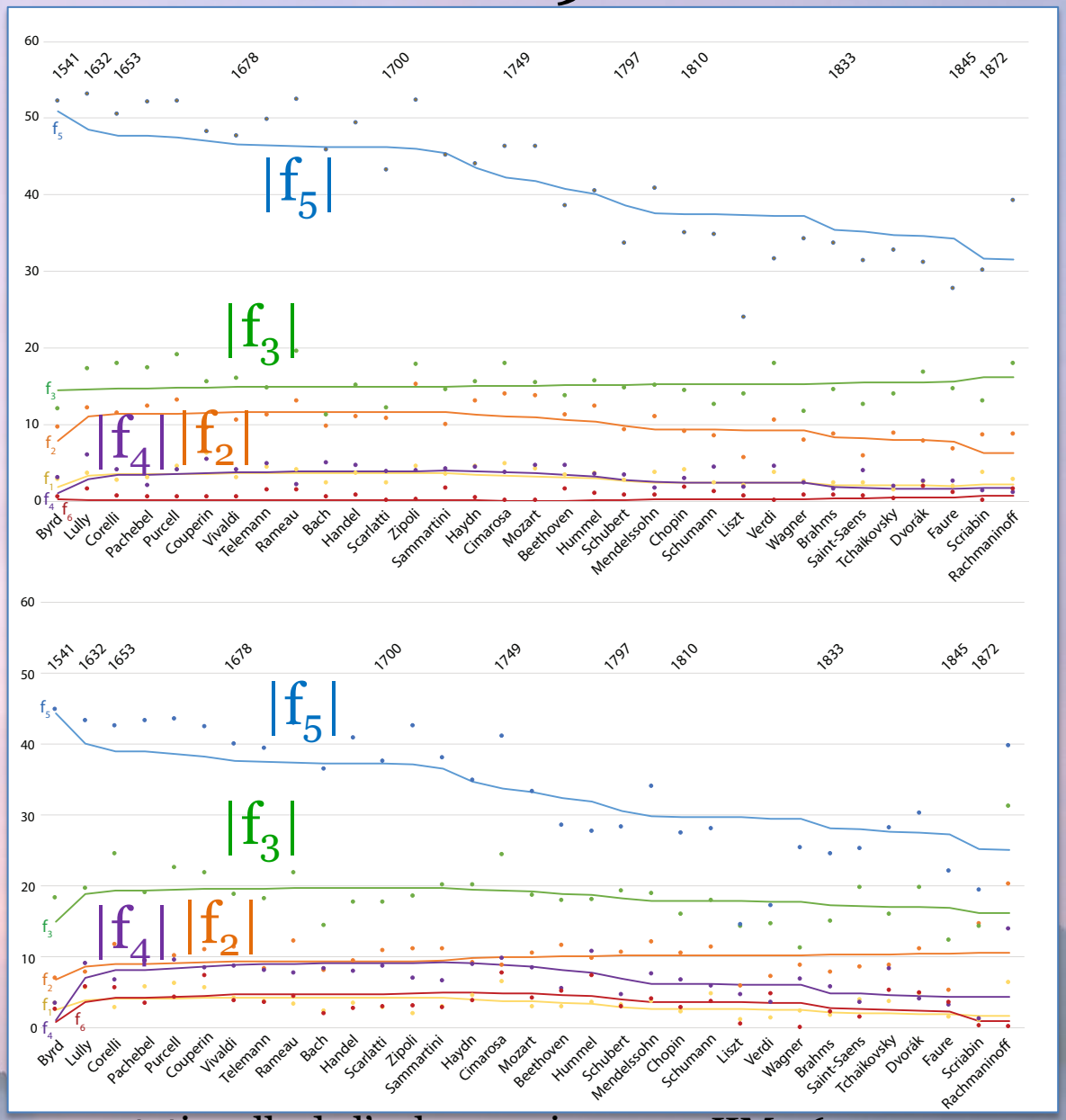
Prince, J.B. & Schmuckler, M.A. 2014. “The Tonal-Metric Hierarchy: A Corpus Analysis.” *Music Perception* 31.

Résultats de Yust 2019

Analyse des pièces entières de Yale Classical Archives

Yust, J. 2019 “Stylistic Information in Pitch-Class Distributions.” *Journal of New Music Research* 48/3

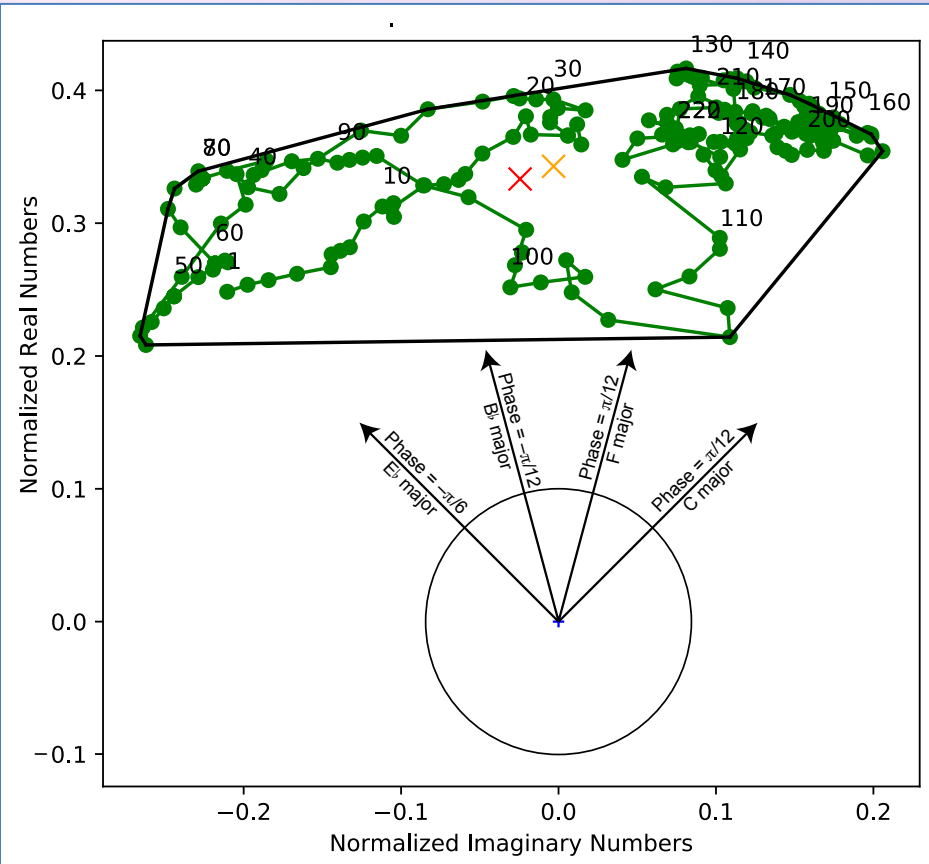
Majeur:



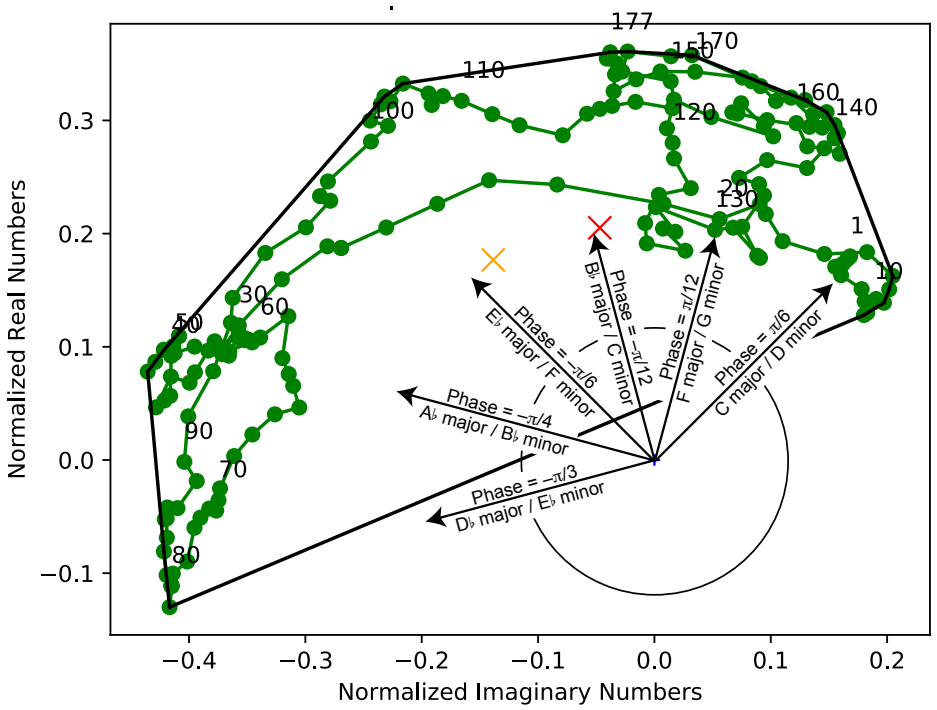
Mineur:

Exemple: Haydn Op. 50/1

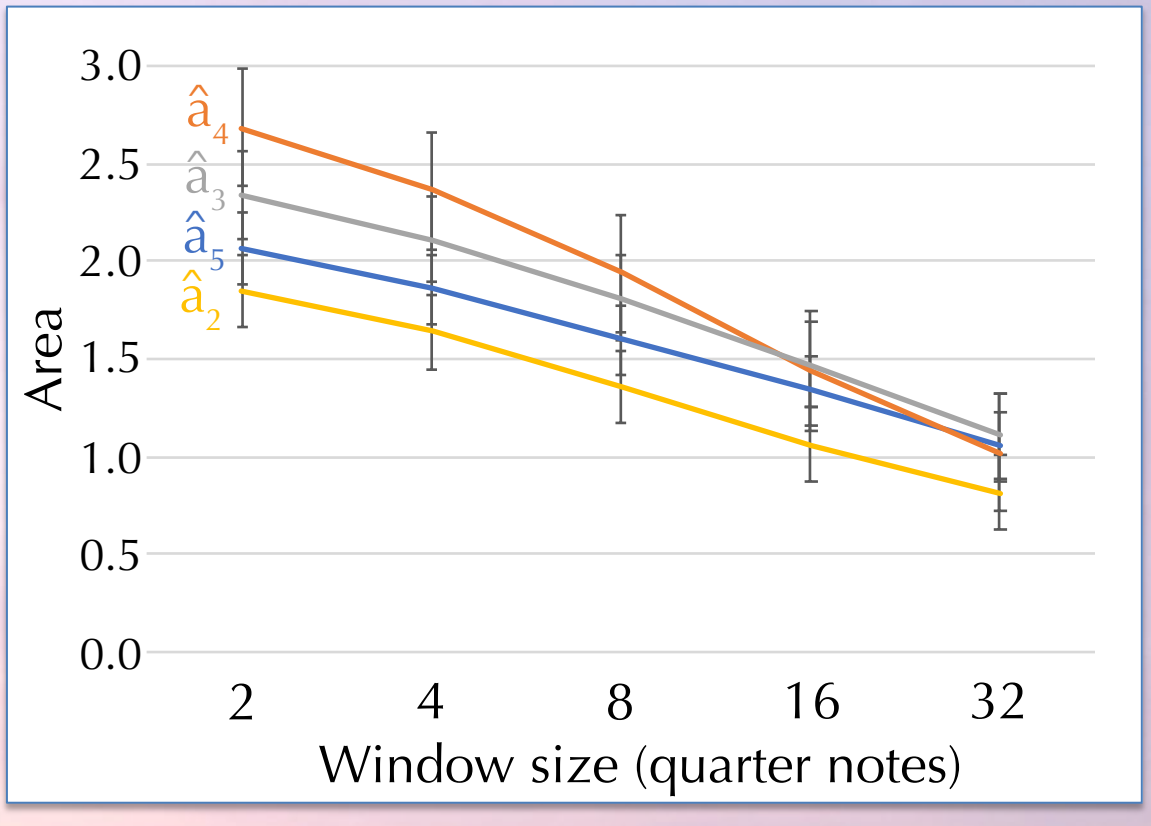
Exposition, f_5:



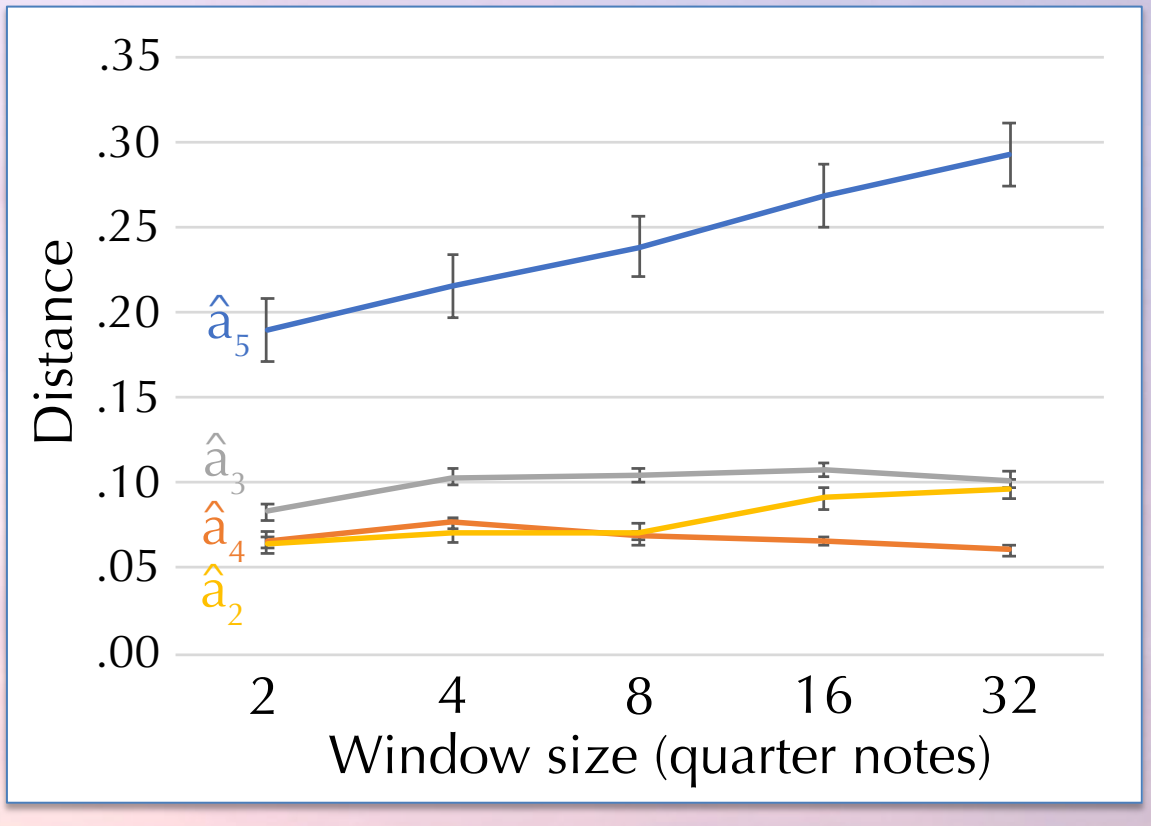
Développement, f_5:



Aire de l'enveloppe convexe par taille de fenêtre



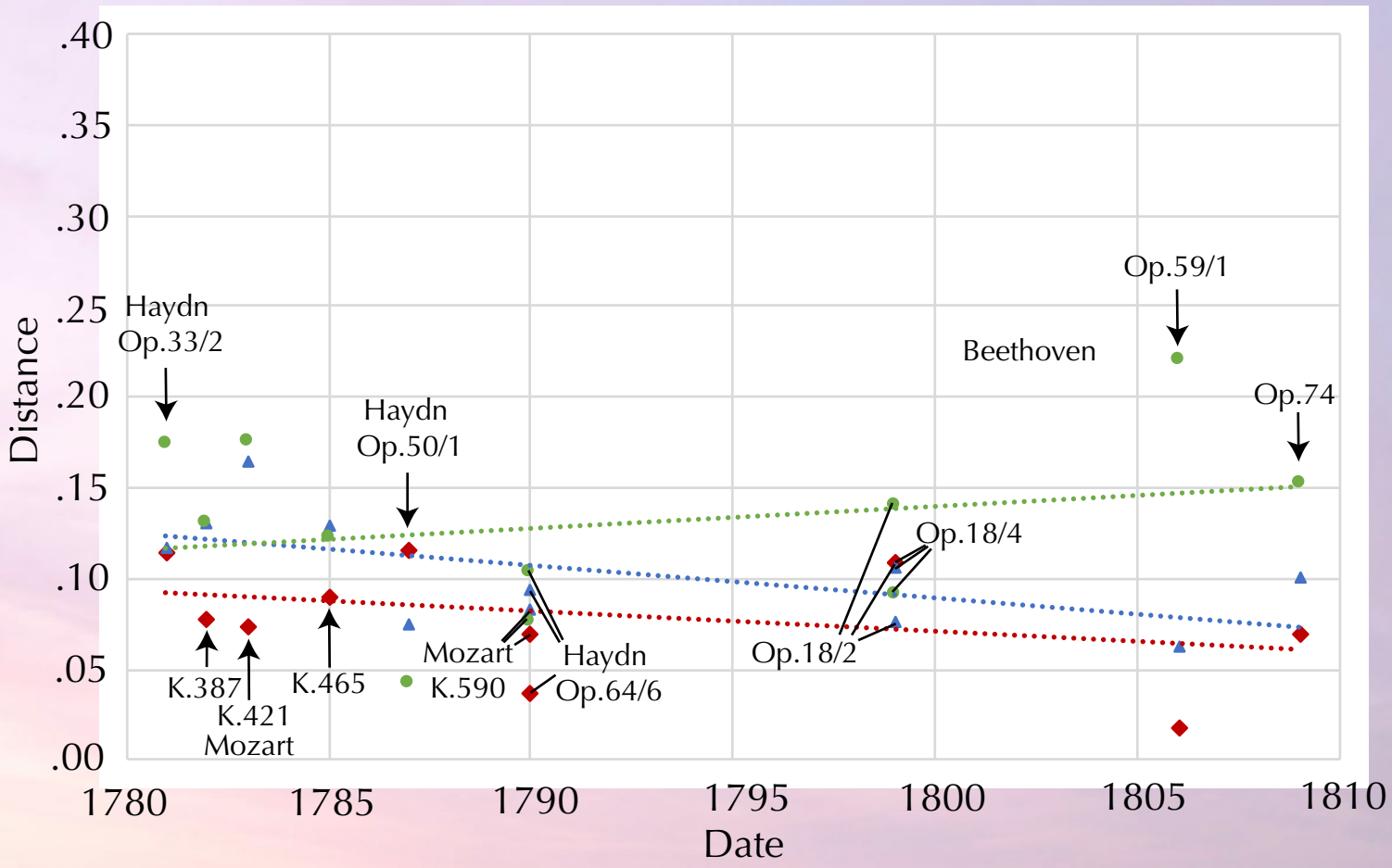
Distance de l'origine par taille de fenêtre



Modèle de régression pour les distances

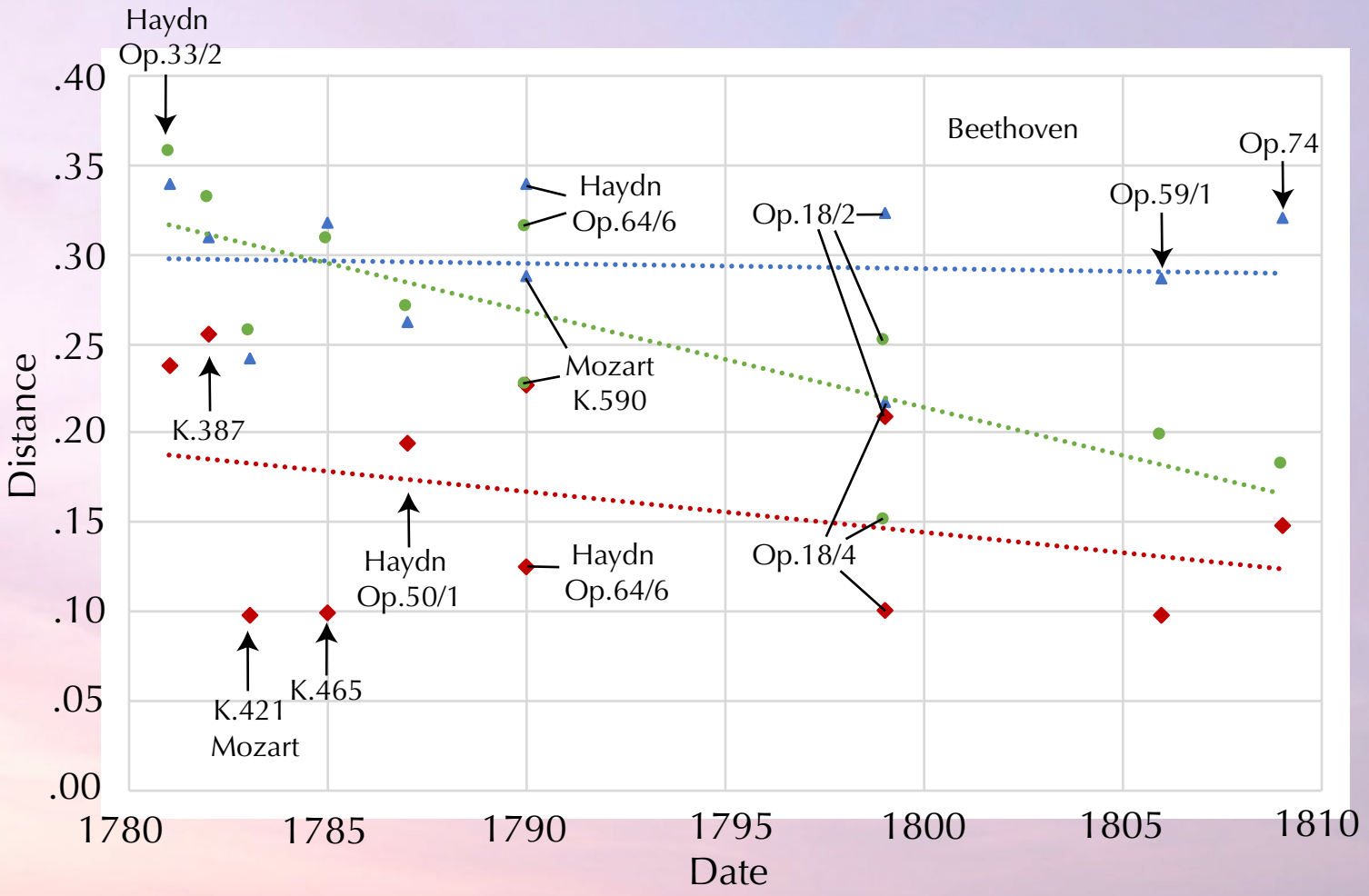
Factor	Coeff.	sig.
Date	-0.0002	—
Expo	0.0242	—
Recap	0.0282	—
$\hat{a}_3$	0.5824	—
$\hat{a}_4$	-5.050	$p < .01$
$\hat{a}_5$	4.766	$p < .01$
Minor	0.0114	—
Date$\times\hat{a}_3$	-0.0003	—
Date$\times\hat{a}_4$	0.0028	$p < .01$
Date$\times\hat{a}_5$	-0.0026	$p < .01$
Expo$\times\hat{a}_3$	-0.0008	—
Recap$\times\hat{a}_3$	0.0214	—
Expo$\times\hat{a}_4$	-0.0346	—
Recap$\times\hat{a}_4$	-0.0243	—
Expo$\times\hat{a}_5$	0.1080	$p < .0001$
Recap$\times\hat{a}_5$	0.0677	$p < .01$
Minor$\times\hat{a}_3$	0.0064	—
Minor$\times\hat{a}_4$	-0.0212	—
Minor$\times\hat{a}_5$	-0.0893	$p < .001$

Distance de l'origine par date pour f_3



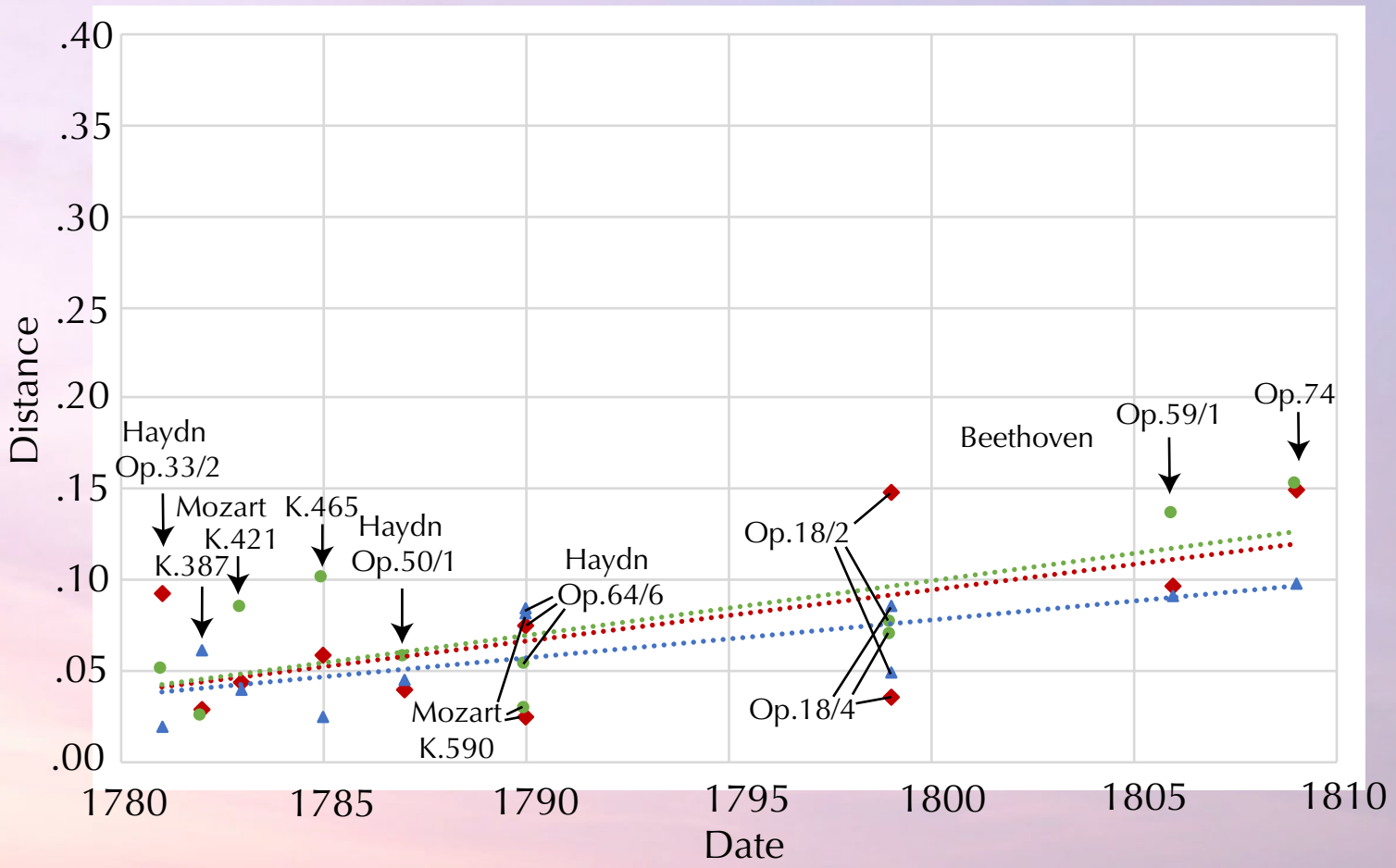
Verte: l'exposition, Rouge: le développement, Bleu: la réexposition

Distance de l'origine par date pour f_5



Verte: l'exposition, Rouge: le développement, Bleu: la réexposition

Distance de l'origine par date pour f_4

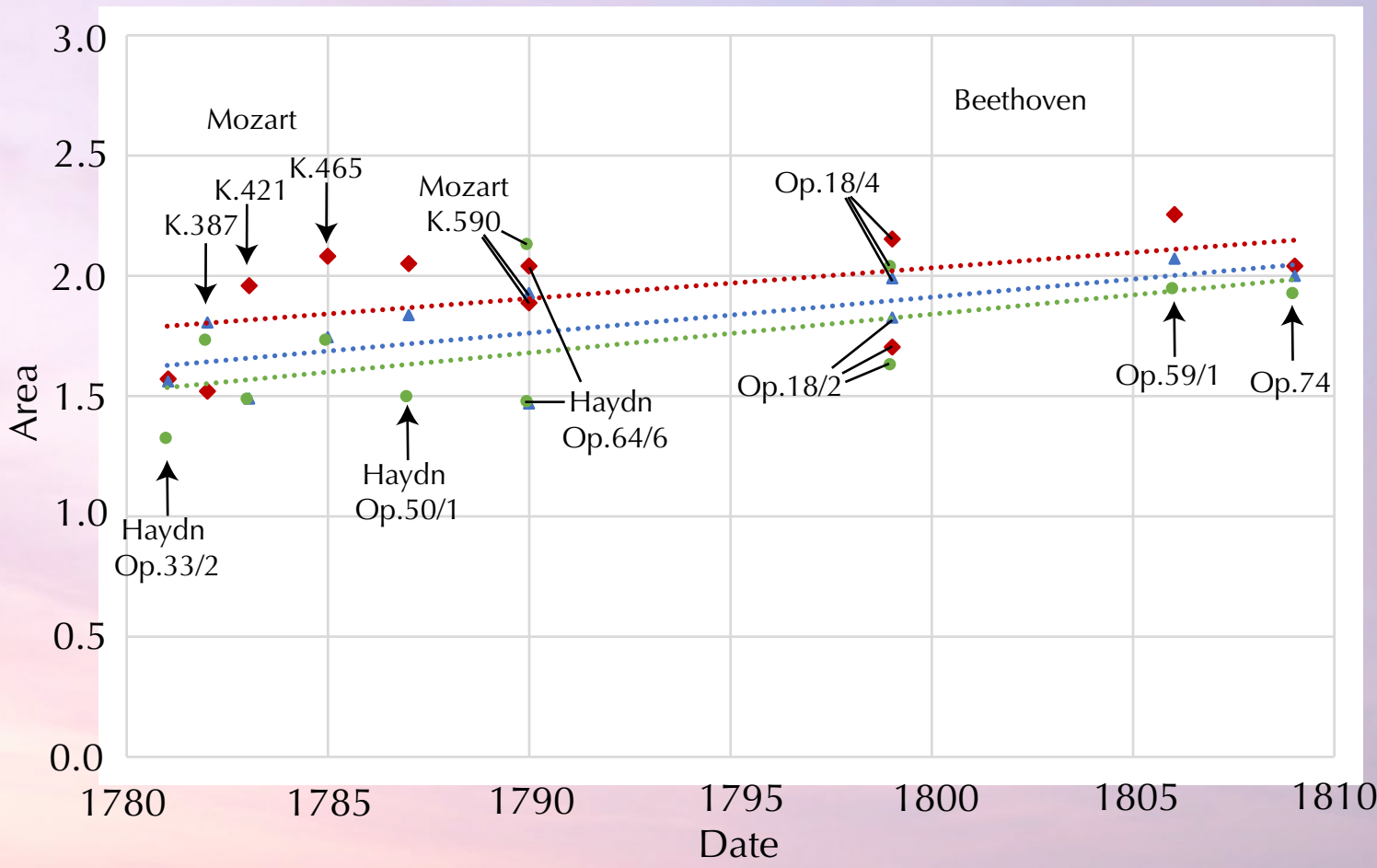


Verte: l'exposition, Rouge: le développement, Bleu: la réexposition

Modèle de régression pour les aires

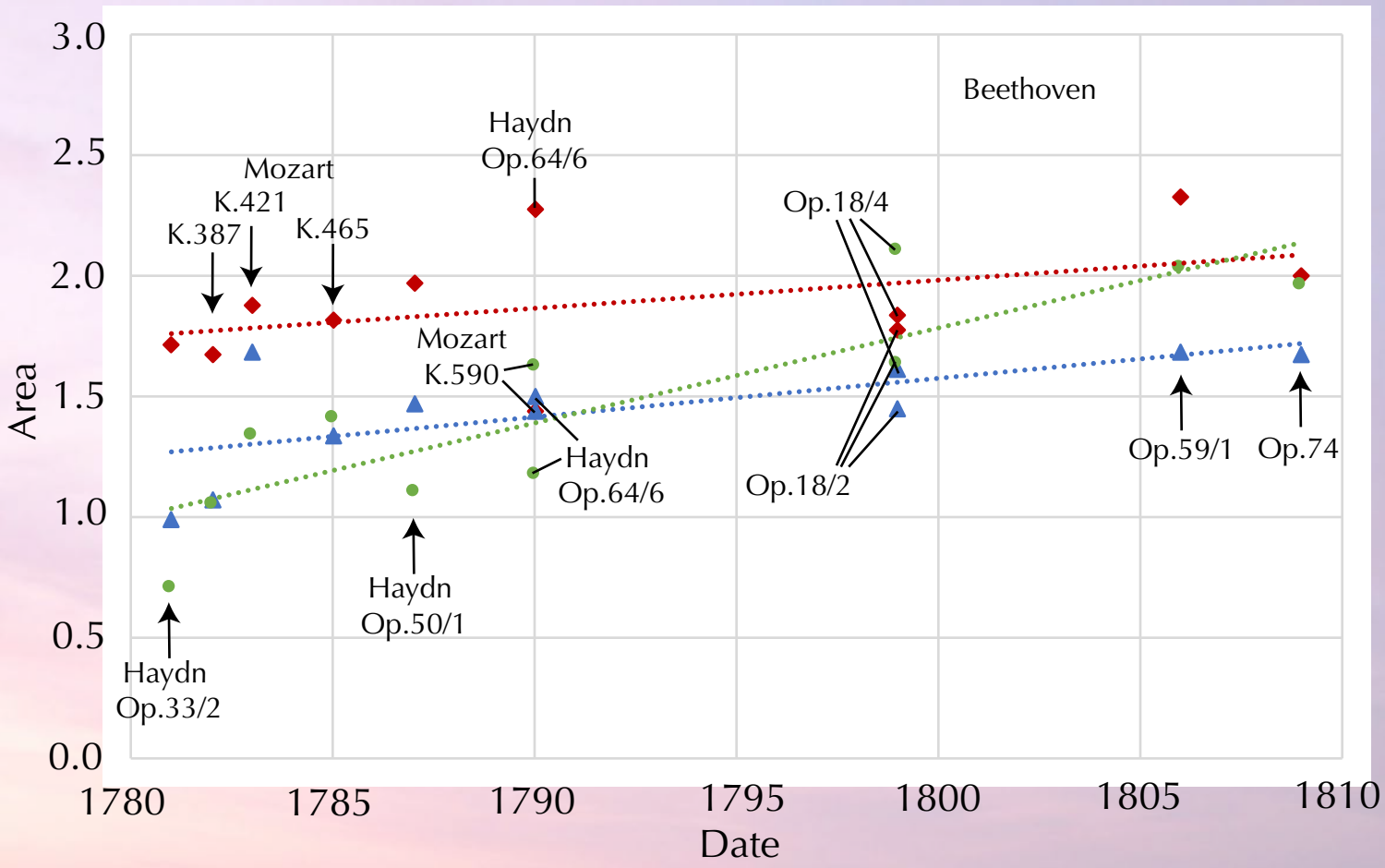
Factor	Coeff.	sig.
Date	0.0237	$p < .0001$
Expo	−0.2901	$p < .0001$
Recap	−0.3512	$p < .0001$
$\hat{a}_3$	0.3741	$p < .01$
$\hat{a}_4$	0.1424	—
$\hat{a}_5$	0.0850	—
Haydn	0.2738	$p < .01$
Mozart	0.3041	$p < .01$
Minor	0.1463	$p < .01$
Length	0.0005	—
Length$\times\hat{a}_3$	0.0003	—
Length$\times\hat{a}_4$	0.0017	$p < .001$
Length$\times\hat{a}_5$	0.0002	—

L'aire de l'enveloppe convexe par date pour f_3



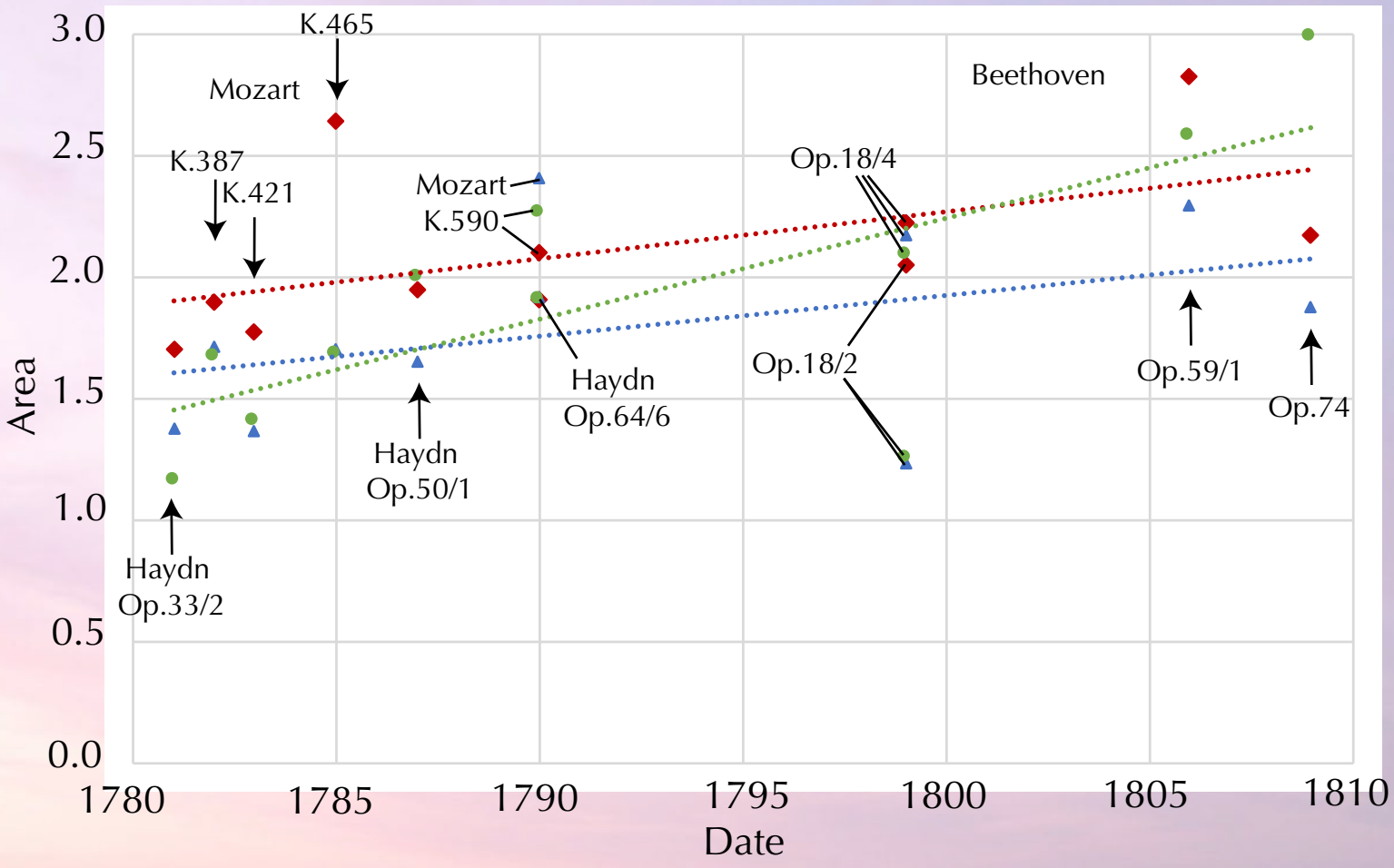
Verte: l'exposition, Rouge: le développement, Bleu: le réexposition

L'aire de l'enveloppe convexe par date pour f_5



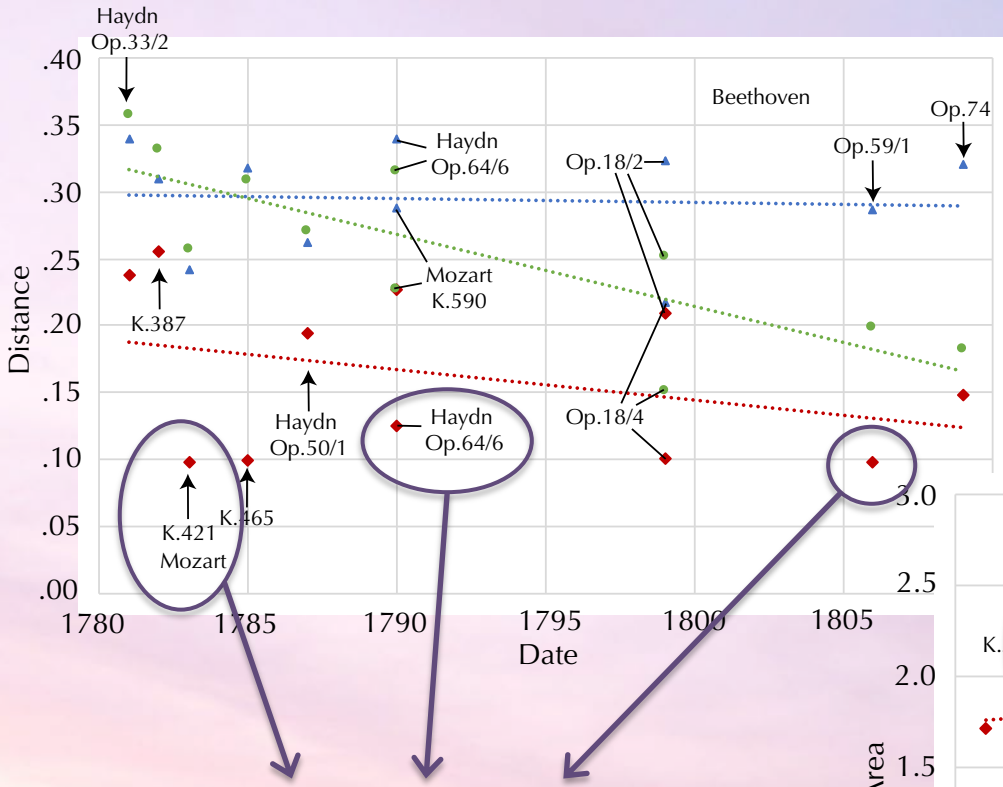
Verte: l'exposition, Rouge: le développement, Bleu: la réexposition

L'aire de l'enveloppe convexe par date pour f_4



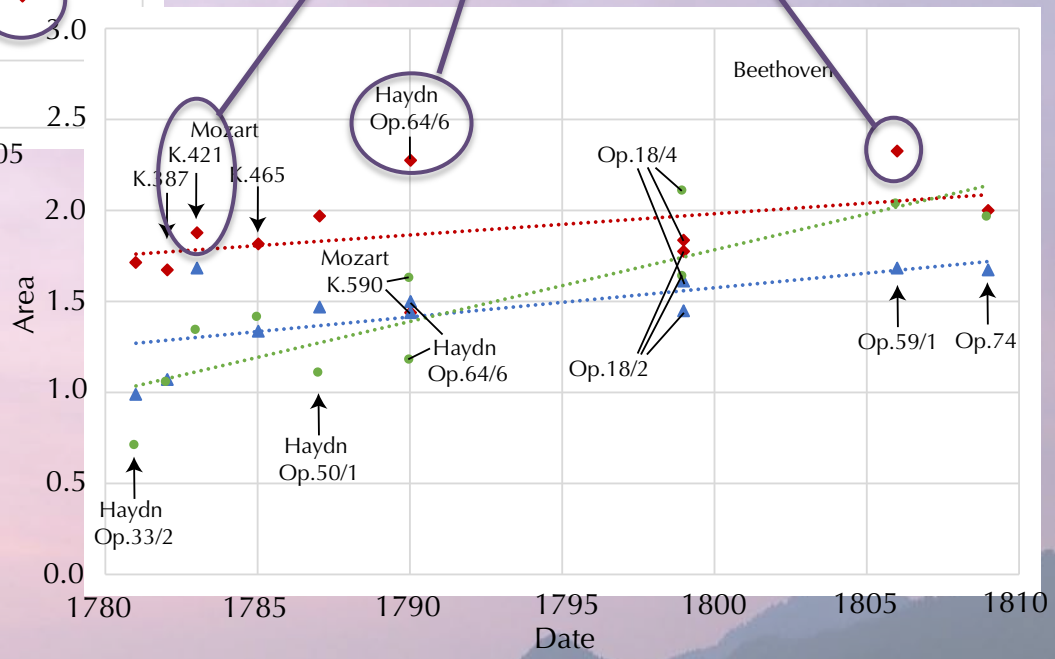
Verte: l'exposition, Rouge: le développement, Bleu: la réexposition

Exemples d'enharmonie



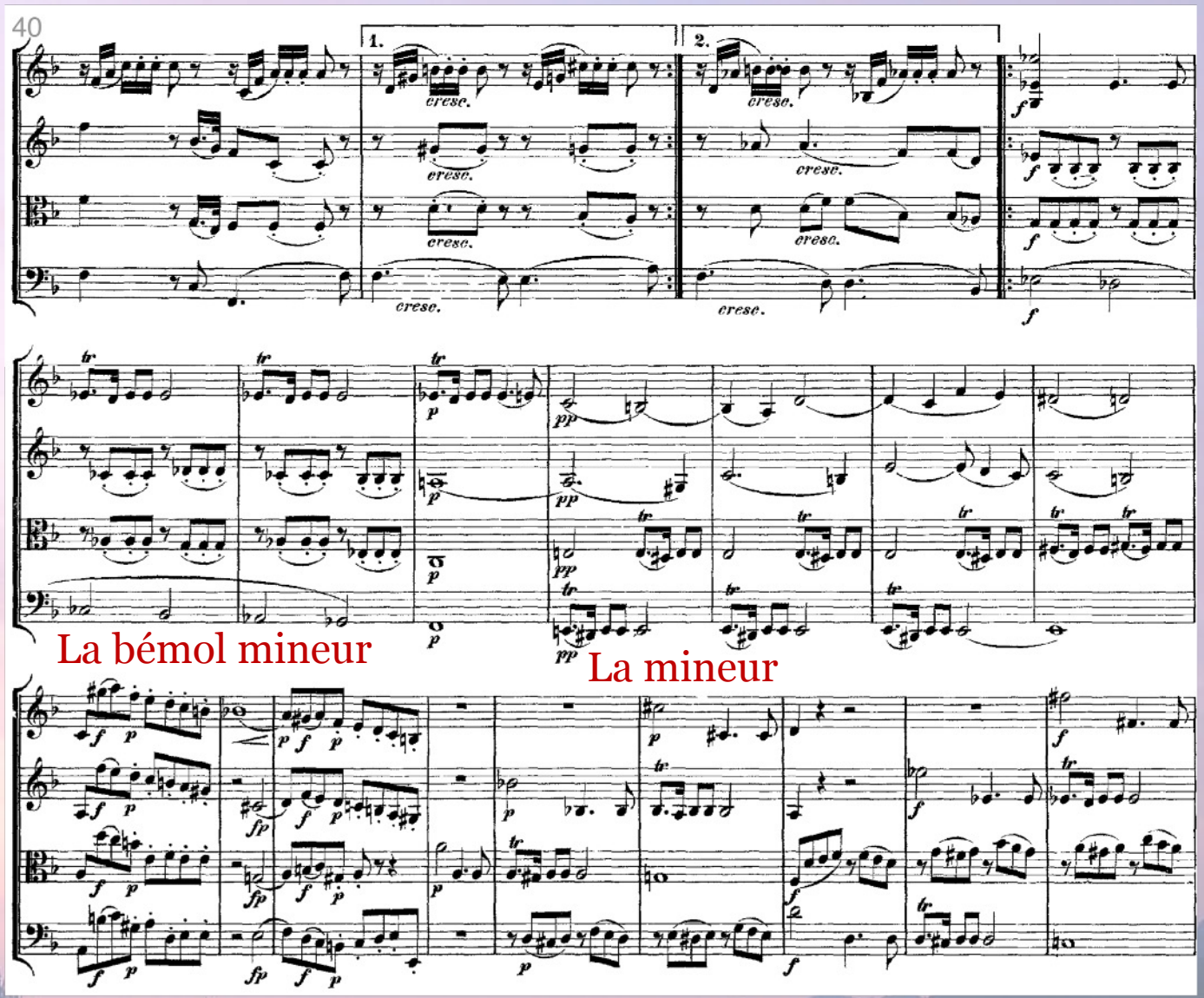
Distance minimale

Aire maximale

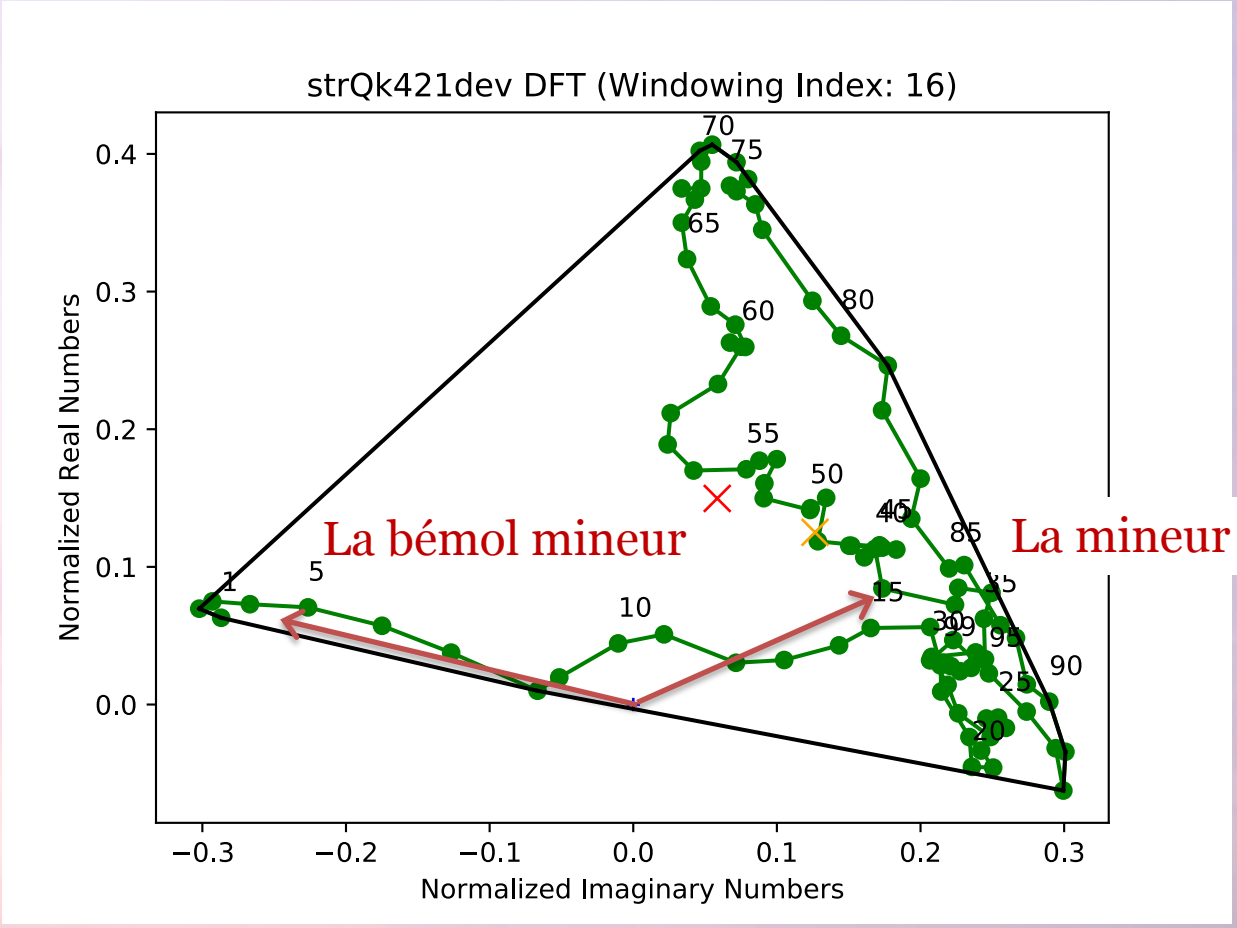


Verte: l'exposition, Rouge: le développement, Bleu: le réexposition

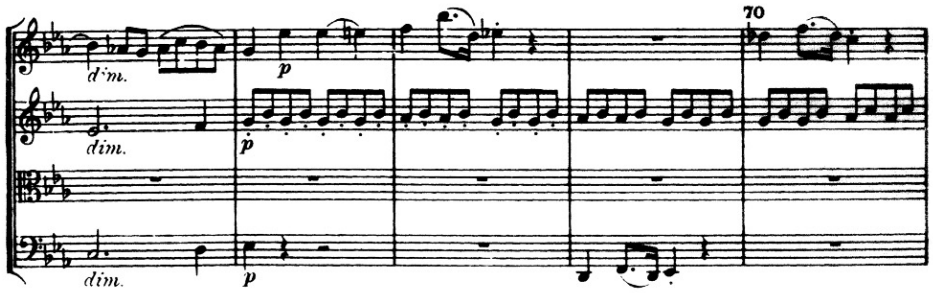
Mozart K.421, Développement



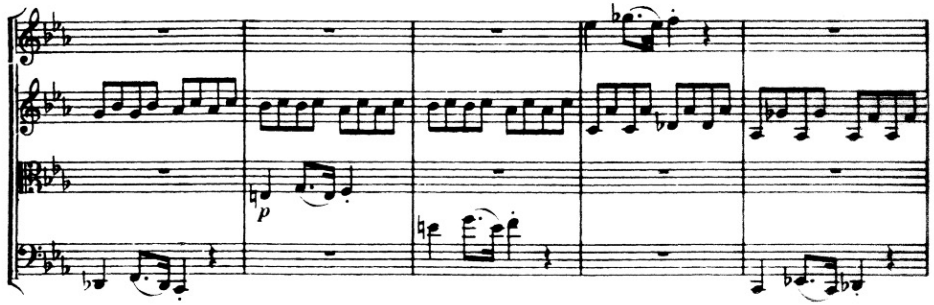
Mozart K.421, Développement

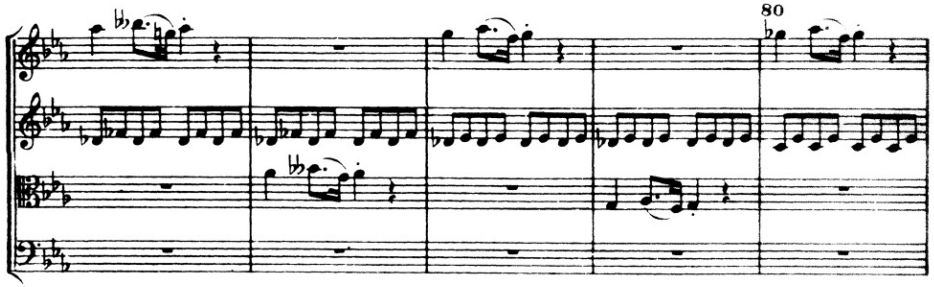


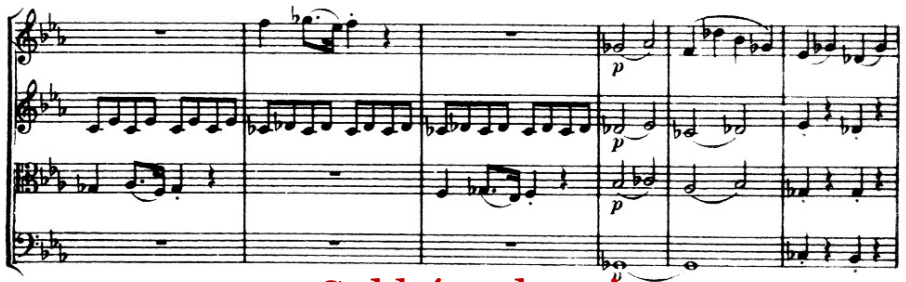
Haydn Op. 64 no. 6, Développement



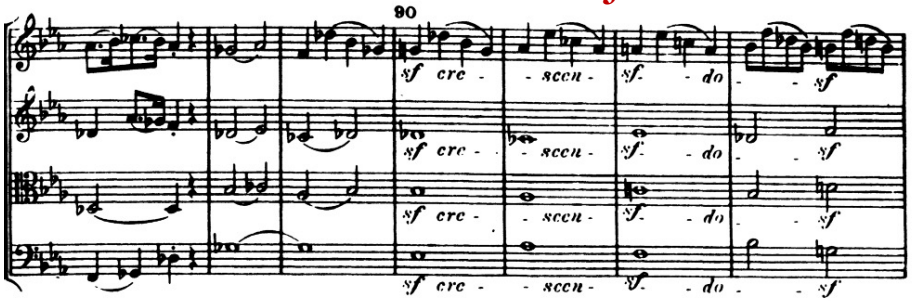
Mi bémol

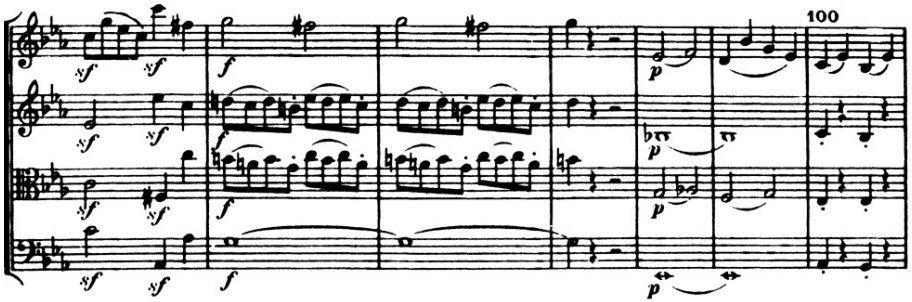






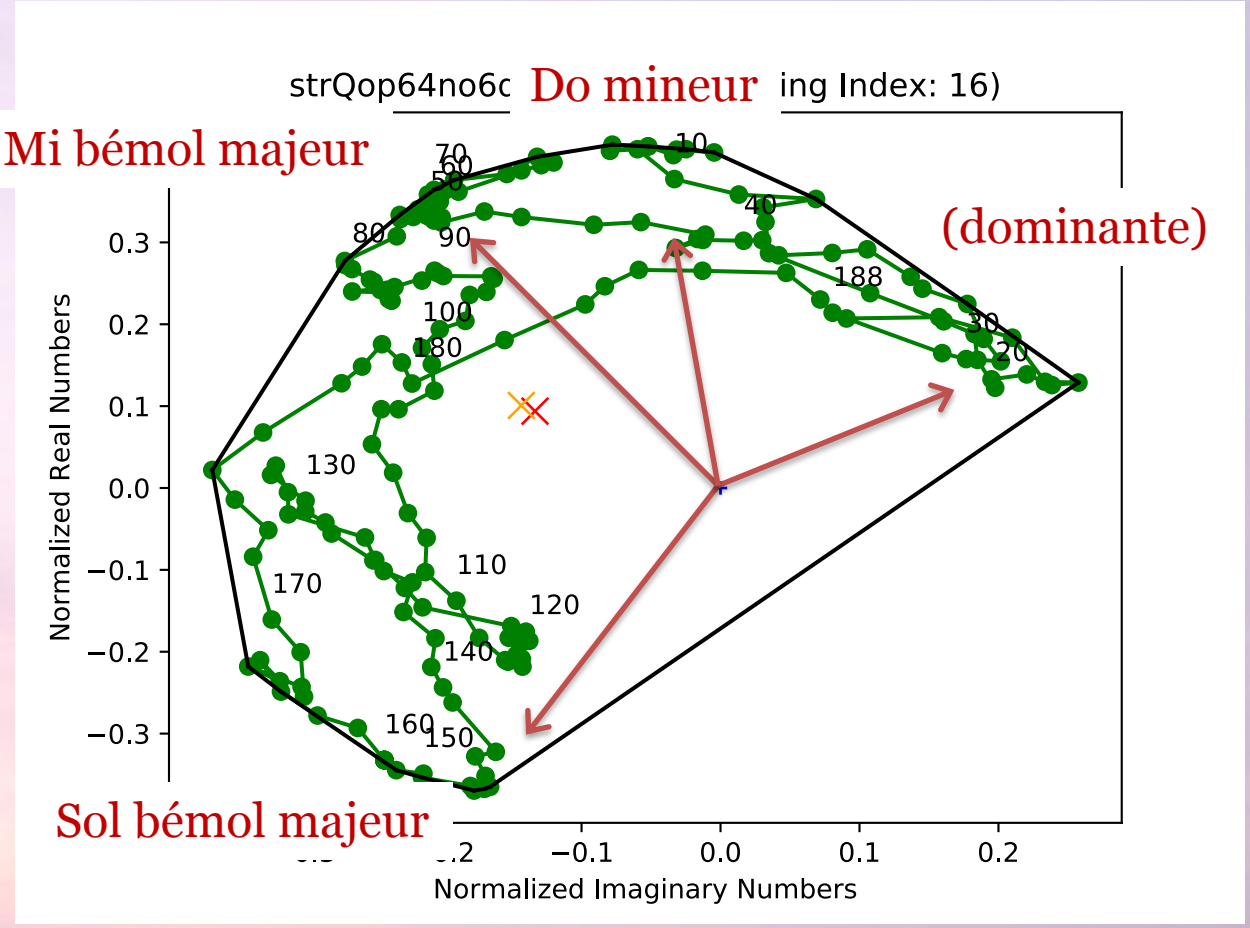
Sol bémol majeur



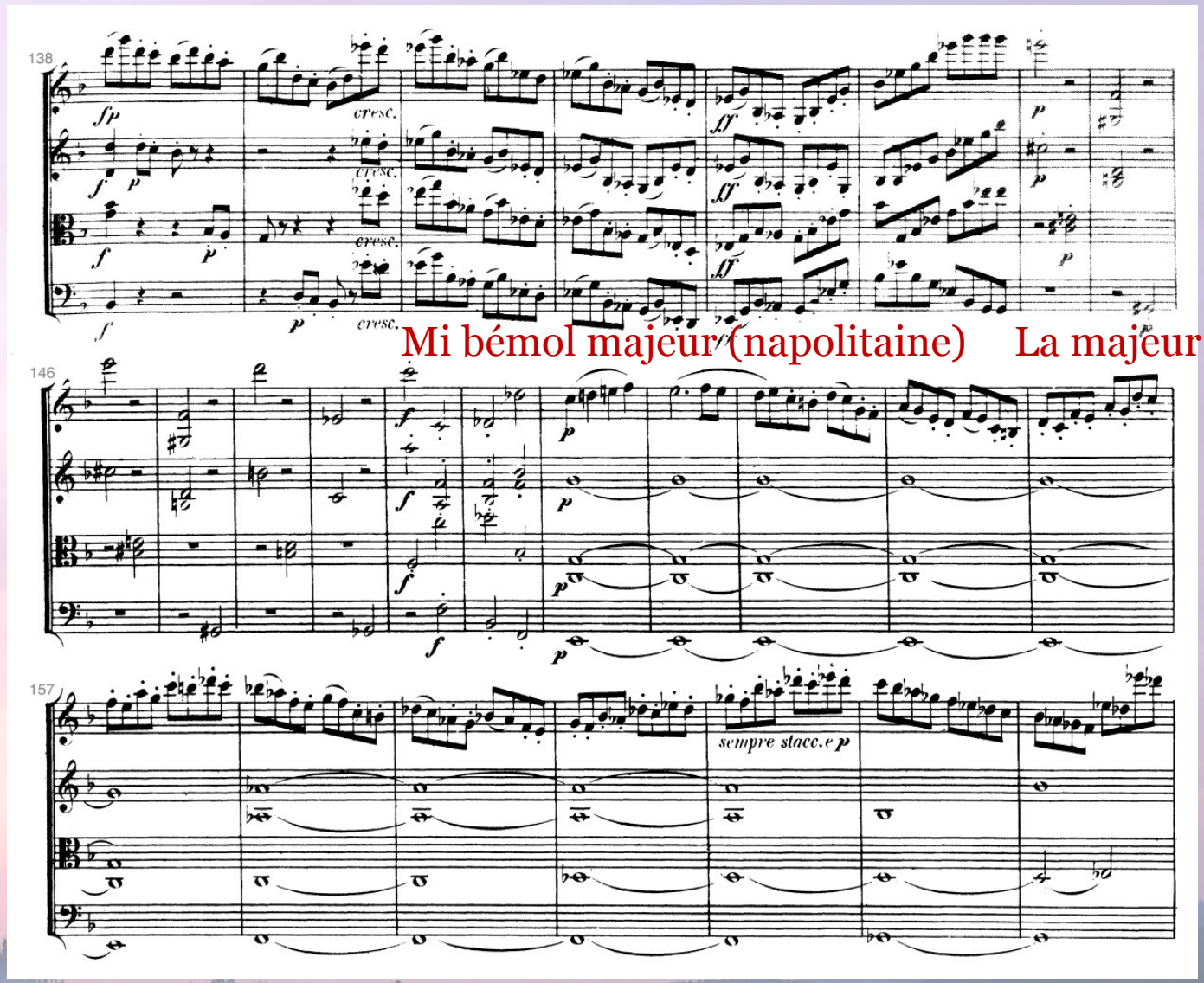


Do mineur (dominante)

Haydn Op. 64 no. 6, Développement

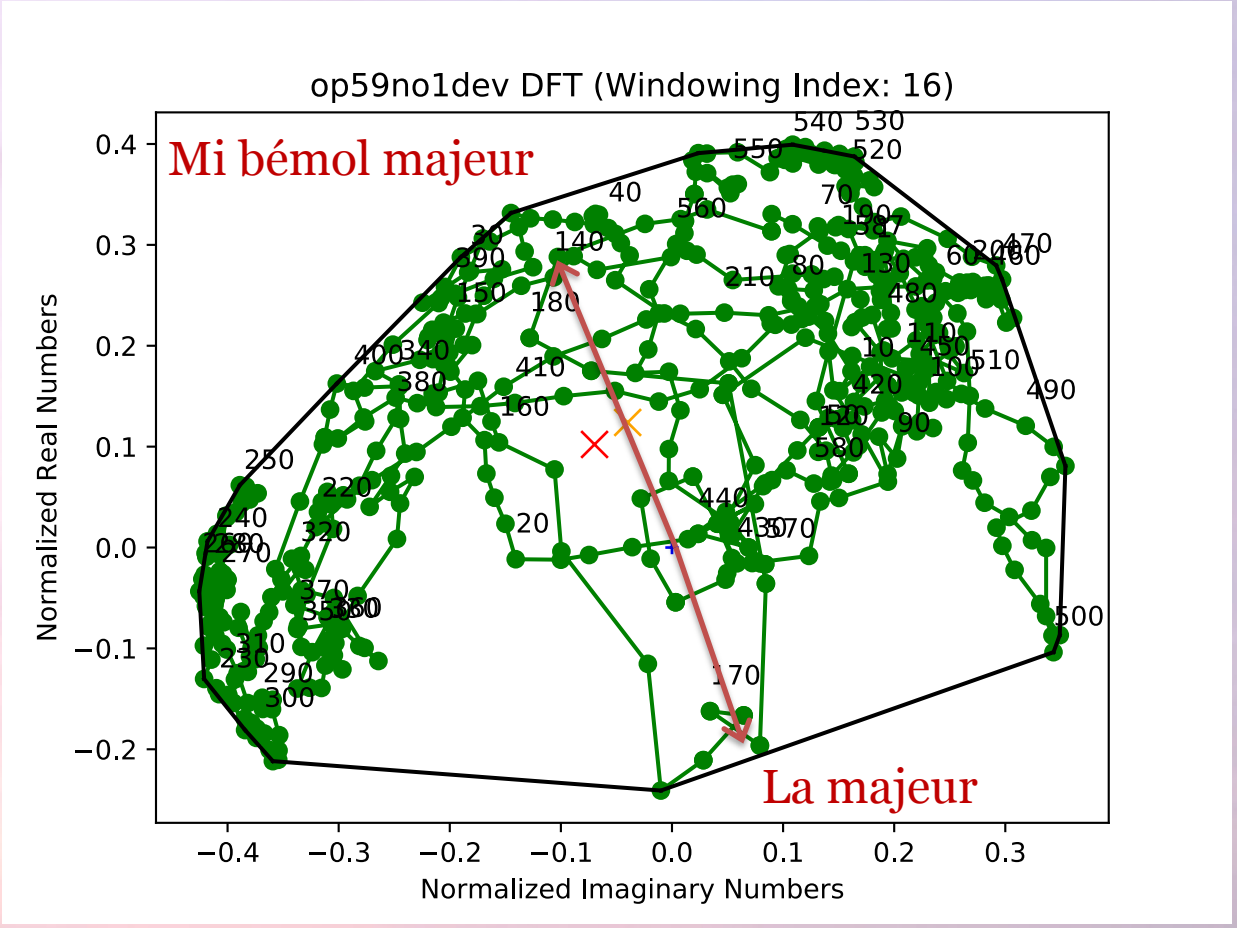


Beethoven Op. 59 no. 1, Développement



Mi bémol majeur (napolitaine) La majeur (dominante)

Beethoven Op. 59 no. 1, Développement



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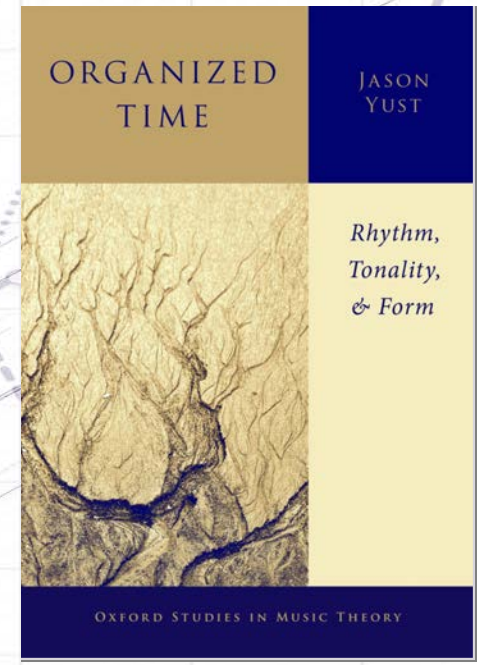

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Strasbourg, 26 octobre, 2020.