Neo-Riemannian tools for compositional adventures and empirical research



Theory, analysis & composition in Music Infomation Research













✓ Majorthirds axis

Fifths axis



Speculum Musicum (Euler, 1773)







From the Tonnetz to the dual one



The topological structure of the *Tonnetz*.





THE TONNETZ ONE KEY - MANY REPRESENTATIONS

→ DEMO



C. Guichaoua

https://morenoandreatta.com/software/



Paul Lascabettes (PhD student) 10



Erstbetreuer: Prof. Dr. Marlon Schumacher *Zweitbetreuer:* Moreno Andreatta (Université de Strasbourg)

11

List of 124 Hamiltonian Cycles (Bigs/Andreatta, February 2016)

- C-Cin Ab-Abin-D-Din-C-Cin Bi-Bin-D-Oin Bi-Bin-79-F#in-A-CPin-C#-Fin-F-Ani-PLPLPPR/PLPRPIPLPR/PLPRPIPL
- C.C.n.Ab.Abs.D.Em.C.Gas.Eb.Box & Bits D.F#ss.F# Ebss.8b.Gm F.Fis.Of.Cfm.&Ass-PUPPPUPPIPUPPIPUPP
- C-Cm Ab-Abm Z-Dm G-Rm & Dhm Eb-Cm-Ho-Bbm F# F#m-D-Om F-Fm C#-C#m-A-Am-PL/PER/DPL/REPLPL/PE/PE/PE/PE
- C-Cn-Ab-Abn-E-C#an-C#-Em-F-Ann-A-F#m-F#-ibm-ibb-Om-O-Ann-B-Dom-ibb-Gm-G-Em-FCPUIPCR/PEPCR/PERCH290.
- C-Cm-Ab-Ahm-E-C#m-A-Am-F-Fm-C#-Bhm-F#-F#m-O-Dm-Bb-Gm-Bb-Gm-Bb-Em-PLPSAL
- C.Co.Ab-Abs-D-Bis-C.Co. (2):Elm-F# P#n D-Dir-Bis Biss-C# Pix-F-An-A-C#n-E-En-PLPRP-PURP-PURP-PAULT-RAYL
- C.C.B. Ab Aber, D.Be. C.C.B. Shine F# Blow Sh On O F#w.3 Am F Fm C# C#w.E.Em-PLPRH, PLPRHPH, AN PLPRH.
- C.Cn Ah-Abm & Bm G &n & Ohn A FPm D Dn 8b Gn ID-Dim P# 8bm C# Fn F Am-POPRICATION PRINCIPLE.
- C-Cm Ab-Abm-8-Ibm-Ib-Gm G-Rm-D-Dm-8b-Rbm F#-P4m-A-Am F-Fm-C#-C4m-8-Em-PCPRDPLNAR/PDPRPLPRPL
- C. Can-Ab-Ahm-B-Ehm-Eb Gan-Eb-Onn-D-Bas-G-Em-E-C#m-A-F#m-F#-Hhm-C#-Fm-F-Am-PCPR1PLAE/PELRPIELRPLAE/PLR
- 11. C Cn-Ab-Abar-D-Dan To Gn-Do-Dan F-Fau-CR-Dhan-FR-TWas D-Dan-G-Dan-G-Dan-G-CRan-R-Ana-PCPRUPARAPURCHARRAPULPR
- 12. C Cm Ale Fm F Am A CFm CF Birn Be Do D 78m F# Birn Cb Cm C 8m B Alem E Em-PURPLPURPLPURPLPURPLPU
- C. Cu, Ab-En, F. Am, J. Fite, FP, Bhm CP CPin, E. Alm, B. Elim, Hi-Gu, Bb. Du, D. Bm, C-Em-PERPERPERATE/REPEAL.
- C.C.n. Mi Pan F.Am & Plin O.Dm Rb Ger Eh-Ben F# Blen CF Chin E-Man B-Ben C-Em-PLRP1P81P181P818P818P1891
- C. Cun Ab-Pin F. Dan Shi Gan Di-Dan B. Alum E. Em G. Bin G. Fitm Fit 8bin C# Citra A. Am-PLRPHERIPERPERPERPENDENCE.
- C. Cui, Ali-Pin-OF-Oras, A. Am-P.-Bin-Bhin-F#-FFin-D-Bin-G-Gao Els-Elsin-B-Alim-E-En-PLALPL.
- 17. C Cm Ab Fm C4-Chu A-F8m F4-Bhm 40-Cm-Ib-Ibm 8-Abm E-Em G-Bm-D-Dm F-Am-PLALMARLPALPALAPALA
- 18. C Cn Ab Fn CF CPan A FNn D Bn B Alm E En C Cn Eb Bin FF Bin Bi On F An-PLALAISPRIPRIPRIMIER
- 15. C Cn Ali Pin CF Olm E Alim B Ro D Him A Am F De 30-Bei FF Bin El-Gn G En-PLALPRIAPERPLAPERE
- C Cn Ab Fm CF Ofm E Abto B Ibm Ib Gn 8b-8bm F# F#m A Am F Om D-8m G Em-PLRLPRLRIPLRPLRPLRPLR1
- C. C. M. J. F. C. Hon-Ho. On F. Am. A. One D. Also B. Em. D. Phys. 74 (Em. Eb. Co. C. Em-PLRIAPLRIPERLAPRIPERL).
- 22. C-Cm-Ah-Fin-CH-Bhos Bb-Gin-DH-Dhos F# Fitm-D-Dm-F-Am-A-C+m-E-Alson-B-Bm-C-Em-PLACAPRELPREPARATION
- 21. C-Cm-Eh-Ehm-E-Em-E-Ehm-F#-F#m-D-Dm-F-Am-A-Otm-C#-Fm-Ab-Abm-E-Em-PERCEPERCEPERCEPERCE
- 24. C-Cm-ED-EBIN-E-EBIN-E-EBIN-D-FFIN-FFI-BBIN-CF-CFIR-A-Am-F-FIN-AD-Abin-E-EBIN-PAPUR/PALPUPUPUPUPUPUPUPU
- C.C.M. (2) Elim II: En: D-Fitter Fit Elim CF Fits Ab Alim D-CF in Article T-Dim Bit-Cm C-Em-PAPLIFICITUM PLACEMENTS.
- C. C. Cen El-Elmo B-Alson Als Fan C#-Elmo F#-F#en D-Res C-Cen Els-Den-F-Ans-A-C#en E-Em-PRPURPELIE/PRE/PELIE/PELIE/ER/L

- 27. C Cm-Do Don F# FMm & CMm E Em-G Cm ID-Bhm C# Fm Ab-Ahm B Bm O Dm F Am-FRFRFRLR
- C. Can, Dr. Dan, D. Ban, C.F. Chin, E. Dan, G. Gan, Hu, Dan, P. Fan, Adam, B. Ban, D. Tillin, A. Am-PRPELISPR.
- C.C.m. En-Eben F.W. Blues C.W.Ten. Also Alson B. Ban D. J. Was A. Orten E. Ean G. Gan. Ho. Dan. F. Am-PERPERSING
- C.C.n.-D.-Gro.-G.Hm.-H. Elsen-F.F. Film. D. Dro.-Ho. Blom. C4-C4to.-A. Am. F.-Fro.-Ab. Alter. E-Len-PELIFUCKIPULPER/PULPER/L
- 31. C-Cm-Eb-Gm-G-EW-D-FW-EV-Eb-D-John-Ab-Fm-CH-Bho-Bh-Dm-F-Am-A-CHm-E-En-PRLPAR/PRLPPRLPPLIPL
- 32 C-Cin-Do-Cin-D-DY-IN-AL AR-P Dise Bh-Dhin-P#-Dise B-Abin-Ab-Pin-C#-C#in-D-Chin-PRLPLAR.RPLAL.PURLAPROPER
- 33. C Cai-O-Cai-C-Cai-C-Cai-C-Ai-Pen-D-Bo-D-D-Bo-D-Dim-FY-Blow-Bb-Do-F-Am-PRLPRD:PRUPALIPLICIA.IR
- 34. C Chilli Go Rh Rhn FF Elm R Ro G En S Abn Ab Fo CR CRo A FRo D Do F An-PRAPLAPLAPLAPLYRA UNA
- 35. C Cm-Rh-Cm-Rh-Rhm C#-C#m-E-Rm-G-Rm-D-Dm-F-Fm-Ab-Ahm-B-Chm-F#-F#m-A-Am-PRLRPR28
- 36. C Cm Oo Gn Hb Rhm C# Pm Ab Alon E C#m A Am F 3m O P#m F# Elon B Bm C Em-PEL8PRL8PL8PL8PLPLPLPLAL
- C. Can-Di-Gan-Bi-Hom C# Pan-Ab-Aban-Bi-Hom P# P#m-A: C#m-E-Em-G-Ban-D-Dan-F-Am-PRLR
- C. C. D. Gu. H. Du. D. F. Ku. A. Am F. Fu. Ab. Alon E. Chu. Ci. Hun. Fit. Hun. B Him. C. En-PELREPERPERPERPENDENT.
- C.C.R.-Di-Gn-Hi-Din-D-FRee-A-CRin-OF-Him-FF-Him-H-Him-G-En-H-Alten-Ab-Fm-F-An-PELACPELIALIZED ADDRESS
- C.C.m.-Di-Gm-Bb-Dm-T-Fm-Ab-Abm-& Ehm-F#-Bbm-C#-C#m-E-Em-G-Bm-D-T#m-A-Am-PELRL3098
- C-Em-E-Man-Ab-Cas-Eb-Ban-B-Ban-G-Gan-Bo-Ban-FF-Frien-D-Dan-F-Fran-CH-CHan-A-Am-UR-29/XPDP-09/PDP-09/PDP-09/XPA
- C. C. En-E. Also: Al-Cou-El-Gas G Bas & Elso: F# Obser-Bi-2ni: O-F#m-A-C#m-C# Fox F Am-LPLPLR
- C En & Ales AL Pie F An A CP in CP Ibin ID-On D FPie FF Ibin II In C Cn Ib Co-UK/PPC/K/PRCK/PRCK/PRC
- 44. C Em & Alm Ab Fm F Am A CAS CP 80m F# FFm O Dm 8b Cm G 8m 8 82m 4b Cm-LH2NPALHPALPPARPLPPAP
- C.E.n.-E.Abm Ab Fox C# C#m A Am F Dox D F#m F# 80m 8b Cm G 8m 8 82m 8b Cm-LINERCPERSPERSION
- C-En-Z-Min-B-Bin-G-Go Bh-Bin-F#-Ebin-Eb-Cn-Ab-Fm-C#-C#in-A-T#in-D-Din-F-Am-LITARI/PRODUCTION (ICC).
- 48, C-Em-E-Ahm-B-Am-G-Gm-Bb-Om-D-F#m-A-Ofm-C#-Bhm-EH-Em-Bb-Em-Ab-Fm-F-Am-Lincarro/HL/PEE/PEE/PEE/PEE
- 45. C-En-E-Rim-B-Ehn-Eh-Gin-G-Bin-O-F#in-F# Ehin-Bh-Din-F-Ain-A-C#in-C#-Fin-Ab-Cin-UPLAUP
- 56: C Can-E-Man-B-Cho-Ch-Ch-An-Pin-Pi Cho-Ch-Ch-Ch-An-LPALPRIAPRIAPAUPUPUP
- 11. C En-E Alex & Elex El-Cox Ale Pin OF CRo & FR & FR Elex Ele Cox C Bin D Dor F An-LPLAUPAUR/PAPERPARE
- 53. C-8m-8-Alm-8-Ebox F8 F8m-A-C8m-C8-Blox-B5-Dm-D-8m-C-Gm-B5-Cm-8b-Fm-F-Am-LFLR1RPH2PR2PR2FR2FR2FR2FR

- 55. C Em E Cém Cé Por F An A FRan O Don-Ib-Rom FF -Bon-Ib-Gon-G Rom-B-Abon-Ab-Con-UNITATURATURATURATURATURA
- 56. C-Em-E-CRin-CR-Pin-F-Dim-FH-Dim-F-Abst-Ab-Cin-D-Gin-G-Bin-O-FRin-A-Ass-LPRIN-PRE-PURIARIAR PROFESSION (2017)
- 57. C-Em-E-CRIE-CRIE-TH-Ab-Abier-B-Ebier-FR-Ebier-Bb-Ore-P-Am-A-FRIE-D-Bier-G-Cox-Eb-Crie-UPRPCAPRCALPCALPCALPCAP
- SIL G En E CAN A AN F FIN CA BIN BOD D FAN FA DIN DE GN G BU B ADM AD CU-LPRIFUNANCE/PRIFU
- 59. C Em E CRis A An F On R5-Bhn CR Fin Ab Abm 8-Bhn FR FRi O Bin G Cm (b Cm-LPRIPLAPRIAPRAPLAI)CRF
- C. Cam, E. Cam, A. An, F. One, BL-Can, C. Ban, D. Film, Fill-Mon, C.P. Fan, Ab. Alton. B. Dan, US Com-UPREPUBLIC PLATER PREPRINT
- C. David C. Raw & Fill and Allow All-Caulty-Caulty-Down Of File P Associated Report Report Report PARAMILIPAL PROPERTY AND ALL CAULTY AND ALL C
- C. Gan, E. Chen, A. Film, D. Can, & G. Ban, & Alter, Mr. Can, D. Klam, F.F. Ban, C.F. Fin, F. Ann-LPRIAL, PARPER PROCESSING.
- 64. C-Em-G-Gan Eb-Eban F# F#m O-Ban B-Aban E-C#m A-Am F-Dan Bh-Blan-C#-Fan-Ab Can-LPP1PR/LAPRLALPLALPLALF
- 66. C Din G Cin Di Cin Jb Abri & CH n CH Fin F Ora 35 Blos F# Ebm 8 Bin D F#n A An-IEPIRE/HAPI-PREPRIATR
- C. Em G. Cm Eb-Cm Ab Abm E. Chin A. Fifth FH Abm B. Bin D. Sm His Abm CF Fith F Am-UPPLICHAL RPREPRIPRIPRIA
- C. Emir C. Gui, Bhi Hinn, C.R. Chan, B. Alon, B. Alon, B. Alon, D. Dao, F. Fan, Alo, Con, Els, Elson, P.R. Filler, A. An-Liky RyPoli.
- 49. C Doi G Go Bh Bhn Of For Ab Co Eb Bhn F# F#m-b C#m E-Abm B-Bis O Din F Am-LEPRERLE
- C. Des G. Ges Bis Des D. Bes -Dis Cos-Mis-Rose E. Chen & Phys. 74: Box C4 Fes P. Am-LAPREPRINT PREPRINT INTERNAL PLAN
- C-Em-G-Gm-Bi-Dm-F-Fin-C4-Hom F#-F#m-D-Hm-Bi-Hom-Et-Cm-Abi-Hom-Et-C4m-A-Am-UP94189180;FI:8FU-FILP130;FR
- 72. C-Em-C-Sm-8h-Dm-8-Fin-Ab-Cm-Eb-Bhm-Fit-Bhm-Cit-Otm-8-Abm-8-Aim-D-Fitm-A-An-1979.
- 73. C Em-G-Gm-B-Sm-F-Am-A: Ofm-E-Alten-Ab-Em-OF-Boxe-F#-F#m-D-Bm-B-Elten-Eb-Cm-UPPER-D/ALIPRER/CARPUNP
- 14. C-Em-G-Bin-B-Dim-Eb-Gin-Bb-Dim-D-TWin F#-Bhin-C#-Trin-T-Am-A-C#to-E-Abin-Ab-Cm-URUPLP
- C-Em-G-Bin-B-Elim-F#-F#m-D-Em-F-Am-B-C#m-E-Alon-Ab-Fm-C#-Binm-Bb-Gm-Eb-Cm-ULC/LBHC/PEC/PECHICAPICLIP
- 77. C-Em-G-Bin-B-Etxin F#-Bhin-B5-Gin-Eb-Cin-Ab-Abin-E-Own-C#-Fin-F-Din-O-Fifen-A-Asin-URL/LAUPRIDE/FIAPLPR/APR
- C. Das-C. Bas & Alam E. Citra-Cit. Blow Ph. Blow Eb-Gas Blo Das D. Fitter A. Am F. Fos Ab-Cas-LIAL HILAPRG RPL REPUBLICATION. P
- C.Em-C-Im-R-Ahn-R-CHu-A-An-F-On-D-FHu-FH-Ibm-Ib-Gn-Ib-Ibm-CH-Fu-Ab-Cm-URLPLAP.PRPTUPPLICEP

- E1: C-Das-C-Bas-O-Das-ID-Gas-D-Alias-D-Alias-D-CHas-C+ Das-T+ Fitter-A-Ans-F-Fitte-Ab-Cas-LAUAPURL/PERL/PRI-PRI-PRI-P
- E2: C-Exe-C-Bas-O-Das-F-Pas-Ab-Cas-Da-Gas-Bb-Blow CP-CPas-S-Abas-B-Das-FP-FPas-A-Aas-LRUAPSPR
- 84. C-Em-G-8m-D-F#m-A-C#m-E-Abm-B-Ehm-F#-48tm-C#-Fm-Ab-Cm-Eb-Gm-8b-Dm-F-Am-Lik
- C-An-A Chin-Ch-Fan F-Din-D-Fhin-Fe Blue Bis-Gin-D-Elim-B-Bin-C-Em-D-Alim-Ali-Ca-BPCR/PRPCR/PRCPUP.
- ET. C-Jan & Chu CA. Fee F. Des Bie Bien F.F. Phys. D Biel D Biel Th-Cau-C-Das D Alies Ab Cam RPUN PREPERFURIER.
- C.Am, A.Chu, D.F.Bun, Hu Du, F. Fan, Ab. Cu, Sh. Cu, G. Su, D. Film, F.F. Ebus, B. Alam, E. Su-RPL: RPL:RPRIACE/REPRESENCE.
- FS. C-Jun J. Citra Of Born FF FFen D Bin G Gin Bb Din F Fm Ah Cin ID-Ebin B Abin E Em-RPLIRE, PLEPRERPERPERP.
- C.Am. & Chin. Of Hom Fit Fhim. D Bin. G Em & Abin. B Ebin. El-Gin. Bb. Din: F.Fin. Ab-Can-RPURILI, ALISPLAU, FIGURE PAIL
- CAIR-A CRIED-EIN-G-BIN-D-FRIEFFER FRIEF-Dim-Ho-Gin-Ho-Gin-Ho-Gin-Adversaria BPLRPRLRLP10C/PRLRLP1.RPLP
- 92. CAN-& CRIE-EARN-AD-Con ED-ERN-ID-BIN-D-FRN-FR-BINE CR-FIN-P Dm-BD-Gin G-Ein-RPLALPDPUPRUPALPEUPRU
- C.Am, J. Chu, E.Alen, Ab Can Eb Gin Bh Blim CP Fin F Des D Film F# Ebm 8 Bin G Em-RFLRLPLRLPRLPRLPRLPLL
- C-Amir A FRIE-TH-Dan-Di-Cm-Ab-Frie-F-Dan-D-Ban-B-Ahm-S-CRim-CP-Bhm-Bb-Gin-G-Ean-RP320893L
- C. Ann A. Fitm Fit Don & Alon Ab Fits F Om D Sin G Ent E Citin Cit Blom B1-Gn-E1-Cn-HFR/HEAP
- C.Am. J. Peter JW Don B Ahm & Ohm OF Blon Hb Gen Hb Cm Ab Pet F Den D Ban G Em-BPRIMIZED.
- C-An-A-Fitm-O-Don-F-Fitm-O-Con-E-Alton-Ab-Con-Ib--Bitm-Fit--Ibon-Ib-Bitm-G-Em-IEPREPREPREPREPARAMINAL
- C-Am-A-Fitm-D-Rm-R Elson-Fit-Rhon-Bh-Dm-F-Fitm-CP-CHTm-R-Alton-Alb-Cm-Rb-Gm-G-Elson-RPALRPLAE/PLOPIN/PAL/PAL/PAL
- 19. C-Am-A-Film-D-Bm-B-Ahm-Ah-Fin-F-Dm-Bh-Gm-G-Em-E-Citm-E-Cit-Bhin-Fil-Ehm-Eh-Ch-RP918793P
- C Ane & Fen D Bes & Mon E Orn CF Shin FF Elses ID Cn Mi Fin F On Sh Gn G En-4985.
- CAN & HYD D Bn & Em E-CPs CH Box PH-Dox B-Abn Jh Pn F Dn Bi Gn Es Cn 40103107
- CAN-F-Pas-C4-Ofm-A-F4m-F4-Bbm-Bb-Dm-D-Bm-8-Bbm-Bb-Gm-G-Em-E-Abm-Ab-Cmdisputcion/proprint/proprin
- CAN-F-Par-CP-CPan-A-PPan-D-Dan-Bh-Bhan-FP-Usin-B-Ban-G-Gan-Bb-Gan-Bb-Aban-E-Gan-AUPL/R.
- CAN-F.Fm CF-Bin-Bi-OBI-O-Bin-D-Bin-F#-F#in-A-CHIN-E-Abin-Ab-Cin-Di-Cin-G-En--RUPURPURPURPURPURPUL
- C.Am F.Fm C# Bits Bi-Om D Bits G Cm Eb Cm Ab Alm B Ebm F# F#m A C#m E Em-RIPLRIT.PRLPIR.PRLPIR.
- 187. CAM F Fm CF 30m FF FM A Chu E Em C the D Dm 85 Cm Eh Ehm R Ahm Ah Cm REPERPERPERPERPERPER

- C.Am-F.Fan-C#-Bhm-F#-F#an-A-C#an-E-Abm-Ab-Can-Eb-Eban-B-Ban-D-Oan-Bb-Gan-G-Ean--RIPLRIPRIRE/FR.RPL2PRPLRPRL
- CAn-F-Fm-C#-8bm-F#-Ibm-Eb-Gn-8b-Dm-0-F#m-A-C#m-E-Em-G-Bm-B-Abm-Ab-Cm--RIPLALRPIR: PLAIRPRIPAPEP
- CAn-F-Pin-Ab-Abin-&-Ein-G-Bin-B-Ebin-F#-Bbin-C#-C#in-A-F#in-D-Din-Bb-Gin-Eb-Cin--RIPPR/PRIP/RIP/RIP/RIP/RIPP
- CAn-F-Fin-Ab-Cin-Bi-Shm-Fil-Bhm-Cil-Celm-A-Film-D-Din-Bb-Cin-G-Bin-B-Ahm-E-Sin--RIPRLRPRLRPR.RPR.IPILPIL
- CAm-F-Fm-Ab-Cm-Eb-Gm-G-Bm-D-Dm-Bb-8bm-C#-C#m-A-5#m-5#-Ebm-8-Abm-5-Em--RIPRIALPIAPRIAPRIAPRIA
- 114. CAn-F-Dm-D-FRm-A-CRm-C#-Pm-Ab-Abm-E-Em-G-8m-8-Ebm-F#-8bm-Eb-Cm--REPLREPERPERPERPERPERPERP
- CAm F Dm D FRin A CRin C# Fin Ab Cm Eb Ehm F# 8bm 8b Cm G 8m 8 Abm E Em-BLRPLRLPLRPRLPRLPRLPLPL
- 116. CAn-F-Dm-D-Bm-B-Abm-Ab-Fm-C#-Bbn-Bb-Gm-G-Em-S-C#m-A-F#m-F#-Bbm-Eb-Cm -RLRPRIRP
- CAn-F-Do-D-Ro-B-Abo-E-C#n-A-F#n-F#-Ebo-Eb-Cn-Ab-Fm-C#-Bbn-Sb-Co-G-En--RIE98981.
- 118. CAn-F-Dm-D-Bm-G-Gm-Bb-Bhm-F#-F#m-A-C#m-C#-Fm-Ab-Cm-Bb-Ehm-B-Ahm-E-Emaltronometers.extense



- CAN-F-Fm-C4-8bm-F4-F4m-A-C4m-E-Abm-Ab-Cm-Eb-Ebm-B-Bm-D-Om-8b-Gm-G-Em-RIPALPRIRE, RAPLPRP, RPRI.
- 109. CAn-F-Fm-C#-8bm-F#-Bbm-Eb-Gm-8b-Dm-0-F#m-A-C#m-8-8bm-Ab-Cm---RIPLALRPILR/FRILRPRIP
- CAn-F-Fm-Ab-Abm-& Em-G-Bm-B-Ebm-F#-Bbm-C#-C#m-A-F#m-D-Dm-Bb-Gm-Eb-Cm--RIPPPIPPIPLPLRI2PI2LIZP
- CAn-F-Fin-Ab-Cin-Bi-Shm-Fil-Bhm-Cit-Citin-A-Film-D-Din-Bb-Cin-G-Bin-B-Ahm-E-Sin--RIPRLRPRLRPRLPL
- CAm-F-Fm-Ab-Cm-Eb-Gm-G-Bm-D-Dm-Bb-8bm-C#-C#m-A-5#m-5#-Ebm-8-Abm-5-Em--RIPRIALPIRPLRPICATION
- 114. CAm-F.Dm-D-FRim & CRim C#-Pin-Ab-Abm-E-Ein-G-Bin-B-Ebm-F#-Bhm-Bb-Cm--REPLICE/REPLICE/REPREP
- CAm F-Dm D-F#m A-C#m C# Fm Ab-Cm Eb-Ehm F#-8bm 8b-Cm G-8m 8-Abm E-Em--RIPPLRIPILIPRI.PRI.PRI.PRI.PL
- 116. CAn-F-Dm-D-Bm-B-Abm-Ab-Fm-C#-Bbm-Bb-Gm-G-Em-E-C#m-A-F#m-F#-Bbm-Eb-Cm -RLRPMRP
- CAm-F-Dm-D-Bm-B-Abm-E-C#m-A-F#m-F#-Ebm-Eb-Cm-Ab-Fm-C#-Bbm-Sb-Cm-G-Em--RIP98981.
- 118. CAm-F-Dm-D-Bm-G-Gm-Bb-Bhm-F#F#m-A-C#m-C#-Fm-Ab-Cm-Bb-Ebm-B-Abm-E-Emautorational Antibation (International Antibational Antibation (International Antibational Antibatio







Gilles Baroin



From poetry to song writing: hamiltonian compositional strategies



A part (Andrée Chedid, poème tiré du recueil Rhymes Collection Poésie/Gallimard (n. 527), Gallimard, 2018)

→ <u>http://repmus.ircam.fr/_media/moreno/prix_chedid_2018_moreno.mp3</u>



Less trivial Hamiltonian Cycles

- 41. C-Em-E-Abm-Ab-Cm-Eb-Ebm-B-Bm-G-Gm-Bb-Bbm-F#-F#m-D-Dm-F-Fm-C#-C#m-A-Am--LPLPLRPLPLPRPLPLPRPLPLPR
- 42. C-Em-E-Abm-Ab-Cm-Eb-Gm-G-Bm-B-Ebm-F#-Bbm-Bb-Dm-D-F#m-A-C#m-C#-Fm-F-Am--LPLPLR
- 43. C-Em-E-Abm-Ab-Fm-F-Am-A-C#m-C#-Bbm-Bb-Dm-D-F#m-F#-Ebm-B-Bm-G-Gm-Eb-Cm--LPLPRPLPLPRPLPLPRLPLPLRP





La sera non è più la tua canzone (Mario Luzi, 1945, in *Poesie sparse*)

La sera non è più la tua canzone, è questa roccia d'ombra traforata dai lumi e dalle voci senza fine, la quiete d'una cosa già pensata.

Ah questa luce viva e chiara viene solo da te, sei tu così vicina al vero d'una cosa conosciuta, per nome hai una parola ch'è passata nell'intimo del cuore e s'è perduta.

Caduto è più che un segno della vita, riposi, dal viaggio sei tornata dentro di te, sei scesa in questa pura sostanza così tua, così romita nel silenzio dell'essere, (compiuta).

L'aria tace ed il tempo dietro a te si leva come un'arida montagna dove vaga il tuo spirito e si perde, un vento raro scivola e ristagna.

Hamiltonian Cycles of maximal complexity



The same cycles have been used in the song *Aprile* (after a poem by Gabriele D'Annunzio): → <u>https://www.youtube.com/watch?v=AB8By7ghTkU&ab_channel=MatheMusic4D</u> 1

Neo-riemannian analysis and perception

Mental key maps. (A) Unfolded version of the key map, with opposite edges to be considered matched. There is one circle of fifths for major keys (red) and one for minor keys (blue), each





wrapping the torus three times. In this way, every major key is flanked by its relative minor on one side (for example, C major and a minor) and its parallel minor on the other (for example, C major and c minor). (B) Musical keys as points on the surface of a torus.





J. L. Besada

da C. Guichaoua

M. Andreatta





The sensation of music. (A) Auditory cortical areas in the superior temporal gyrus that respond to musical stimuli. Regions that are most strongly activated are shown in red. (B) Metabolic activity in

> the ventromedial region of the frontal lobe increases as a tonal stimulus becomes more consonant.



Multimodal interaction and perceptual processes





LaLab Exhibition, Heidelberg May 2019 – Dec 2020





- Despite the apparent geometrical simplicity of the *Tonnetz*, its deep structural implications are very complex. Only people with high skills in music theory are able, at least, to partially grasp its overall structure at first sight.
- The geometry of the *Tonnetz* is not consistent with the widely spread vertical schema for pitches; nor does it provide self-evident patterned representations of tonal functionality. Both facts may bias the apprehension of the *Tonnetz*, particularly in non-functional harmonic contexts.

Method: Participants

88 participants (44.32% female,55.68% male) took part in the study,split into 4 balanced groups:

- 1) Music professionals [MusPro] (age: M=38.32, SD=8.07)
- 2) Science professionals [SciPro] (age: M=43.68, SD=12.10)
- 3) Music students [MusStu] (age: M=22.82, SD=2.89)
- 4) Science students [SciStu] (age: M=20.31, SD=1.77)



Method: Materials







Method: Procedure

Task performed twice Video tutorial



pitch classes



major chords



axes (interval generators)



minor chords

Questionnaire

	Attempt 1				Attempt 2				
Group	Total	0 s.pc.	1 s.pc.	2 s.pc.	Total	0 s.pc.	1 s.pc.	2 s.pc.	
MusPro	3.32 ± 1.46	0.64 ± 0.66	0.73 ± 0.88	1.95 ± 1.09	3.50 ± 2.06	$\begin{array}{c} 0.68 \pm \\ 0.84 \end{array}$	1.32 ± 1.09	1.50 ± 1.06	
SciPro	2.23 ± 1.02	0.32 ± 0.65	0.41 ± 0.73	1.50 ± 1.14	2.55 ± 1.26	0.23 ± 0.43	0.82 ± 0.96	1.50 ± 0.74	
MusStu	2.09 ± 1.27	0.36 ± 0.58	0.50 ± 0.60	1.23 ± 1.07	2.32 ± 1.70	0.59 ± 0.80	0.82 ± 0.85	0.91 ± 0.68	
SciStu	1.95 ± 1.40	0.41 ± 0.59	$\begin{array}{c} 0.50 \pm \\ 0.80 \end{array}$	1.05 ± 1.05	2.27 ± 1.12	0.23 ± 0.53	0.68 ± 0.72	1.36 ± 0.90	
Mus	2.70 ± 1.49	0.50 ± 0.63	0.61 ± 0.75	1.59 ± 1.13	2.91 ± 1.96	0.64 ± 0.81	1.07 ± 1.00	1.20 ± 0.93	
Sci	2.09 ± 1.22	0.36 ± 0.61	0.45 ± 0.76	1.27 ± 1.11	2.41 ± 1.19	0.23 ± 0.48	0.75 ± 0.84	1.43 ± 0.82	

Accuracy:

MusPro was significantly different (p < .050) for both attempts when compared with both Sci groups

	Qua	ality	Visual bias			
Group	Attempt 1	Attempt 2	Attempt 1	Attempt 2		
MusPro	7.05 ± 1.79	8.32 ± 2.44	4.68 ± 2.88	3.77 ± 1.54		
SciPro	5.91 ± 1.15	6.68 ± 1.21	6.55 ± 3.63	5.82 ± 3.70		
MusStu	6.18 ± 1.50	7.45 ± 2.42	4.00 ± 3.51	4.00 ± 2.09		
SciStu	6.41 ± 1.53	6.32 ± 1.25	4.50 ± 3.07	4.00 ± 2.02		
Mus	6.61 ± 1.69	7.89 ± 2.44	4.34 ± 3.19	3.89 ± 1.82		
Sci	6.16 ± 1.36	6.50 ± 1.23	5.52 ± 3.48	4.91 ± 3.09		

Quality:

MusPro was significantly different for both attempts when compared with both Sci groups The difference between both attempts per group was slightly significant (except SciStu)

Visual bias:

SciPro stands as a signifiatively different group





Distance:

$$d = |s_{\rm p} - s_{\rm r}|$$



Distance:

MusPro is significantly different for the second attempt when compared with both Sci groups. In addition, MusPro performed significantly different in their second attempt.



Time ratio (log₂)

Time ratio:

 $T = \log_2(t_2/t_1)$



Time ratio (log₂)

Time ratio:

Positive on average, lower for 2 shared pitch class sets. Particular and significant behavior for MusPro.



One SciPro participant:

"Although I am aware that I am wrong, the only logical answer for me is to follow the alignment of the triangles "

Mus group	Attempt 1				Attempt 2				
Strategy	mean A	mean Q	mean D	mean B	mean A	mean Q	mean D	mean B	
Quality	0.31	0.23	-0.13	0.19	0.36	0.32	-0.22	0.02	
Shared pitches	0.19	0.20	-0.08	0.02	0.45	0.44	-0.43	-0.14	
Visual distance	0.08	0.17	-0.06	0.15	0.02	0.10	-0.13	-0.05	
Alt. pitches	-0.01	-0.14	0.19	0.02	-0.19	-0.12	0.01	-0.19	
Alt. visual	0.13	0.07	-0.23	-0.05	-0.13	-0.31	0.25	0.23	
Sci group	Attempt 1				Attempt 2				
Strategy	mean A	mean Q	mean D	mean B	mean A	mean Q	mean D	mean B	
Quality	0.01	0.10	-0.10	-0.02	0.22	0.36	-0.37	-0.13	
Shared pitches	-0.21	-0.03	-0.21	-0.23	-0.22	-0.17	-0.00	-0.15	
Visual distance	-0.14	-0.24	0.12	-0.02	-0.05	-0.06	-0.22	-0.10	
Alt. pitches	0.08	-0.26	-0.07	0.06	0.11	0.18	-0.24	0.12	
Alt. visual	0.11	-0.05	0.23	0.12	-0.11	-0.05	0.06	-0.03	

Correlations over |0.30| in italics, variations greater than |0.25| in bold.

Discussion

• Despite the apparent geometrical simplicity of the *Tonnetz*, its deep structural implications are very complex. Only people with high skills in music theory are able, at least, to partially grasp its overall structure at first sight.

Quality and distance have proven more useful variables for checking this fact than accuracy. However, participants have behaved quite different according to them.

Hypotheses for quality recognition:

MusPro: detection of the feature prior to the video tutorial?

Sci: Rather intuitive than rationalized

Discussion

• The geometry of the *Tonnetz* is not consistent with the widely spread vertical schema for pitches; nor does it provide self-evident patterned representations of tonal functionality. Both facts may bias the apprehension of the *Tonnetz*, particularly in non-functional harmonic contexts.

Induced visual bias depends on previous skills with music theory and systematic geometrical thinking.

Proximity (in terms of parsimony) related to response time after the video tutorial. Particular behavior of MusPro when tonal functionality and non-functionality clashes.



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Plagal cadence!

From the Tonnetz to the generalized (*a*,*b*,*c*)-Tonnetze



ICMPC17-APSCOM7, Tokyo, August 24-28, 2023

Cognitive Inspections of the Tonnetz: A Multimodal Approach

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Thank you for your attention!

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