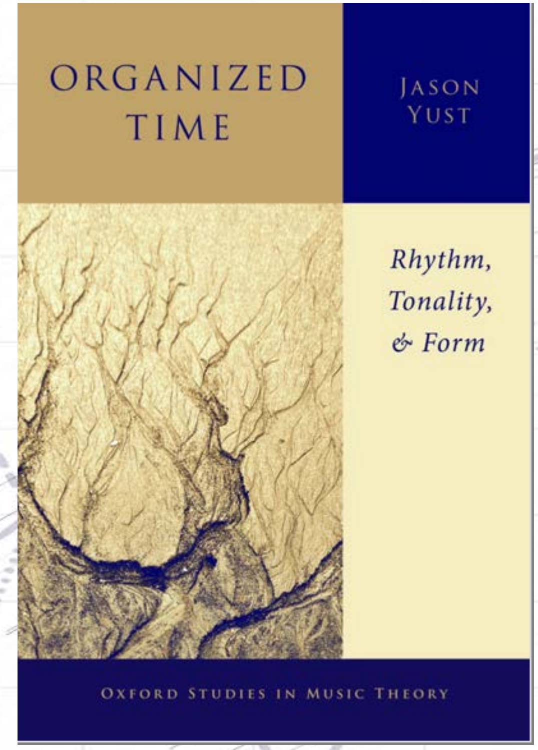
Tonality, Fuzzy Voice Leading, and all that Jazz

Jason Yust, BOSTON UNIVERSITY
http:/people.bu.edu/jyust



Presentation to the
Eastman Theory Colloquium,
1/31/2020

(1) Distributional Model of Key

The state of the art cognitive model of a key is a
pitch-class distribution

which weights pitch classes according to their

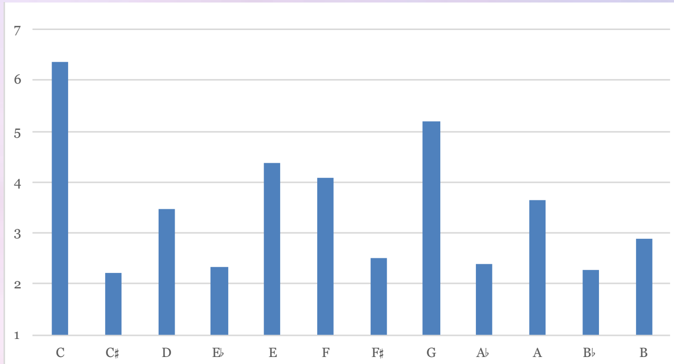
- perceived stability
- likelihood of occurring

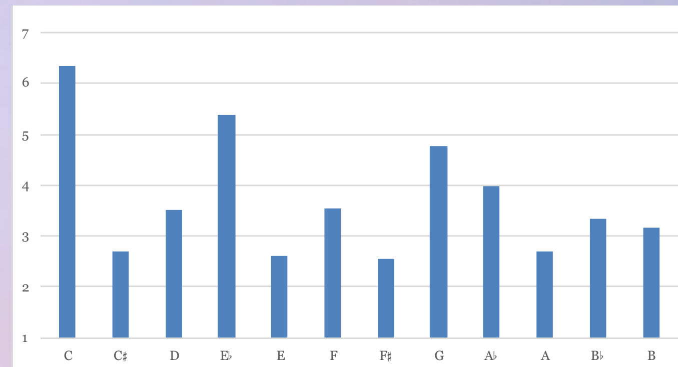
Distributional Model of Key

C major

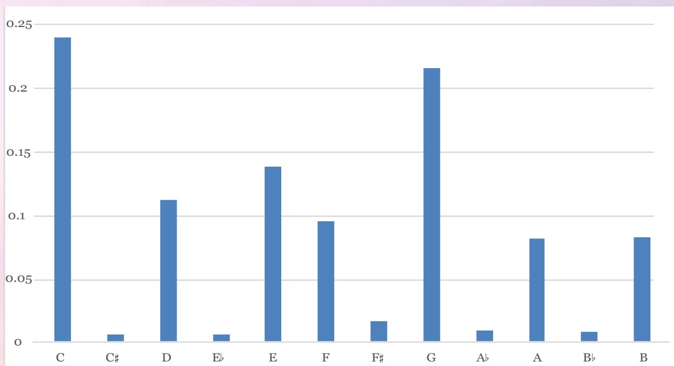
C minor

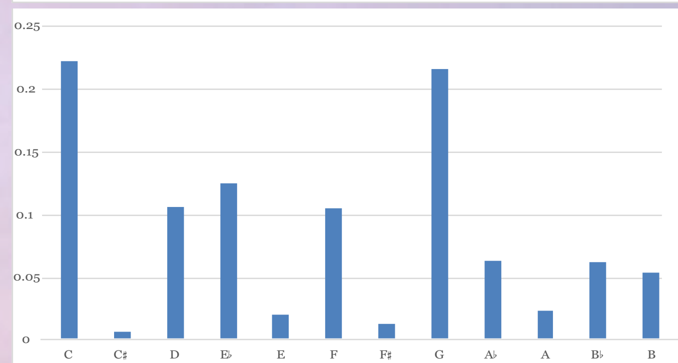
Krumhansl-Kessler probe tone ratings



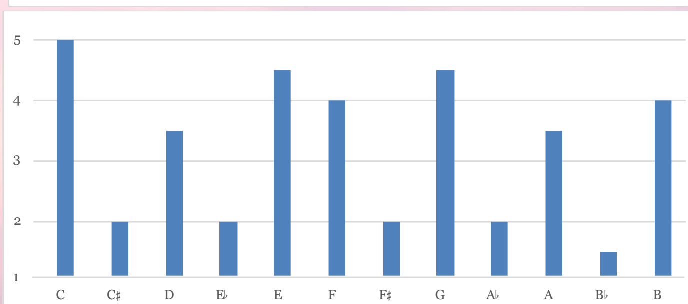


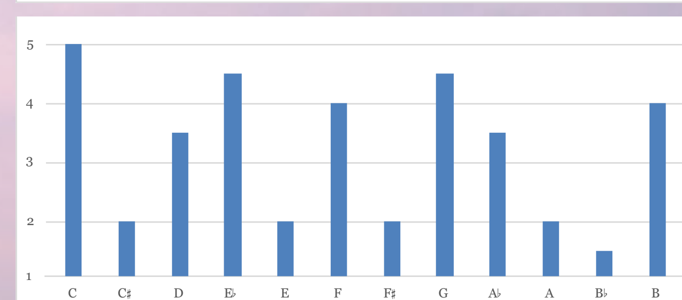
Albrecht-Shanahan pitch-class counts





Temperley weightings for key-finding





Distributional Model of Key

The distributional model has been used to explain:

- How tonality is passively learned (**statistical learning**)
- Melodic expectation
- Harmonic syntax (**wrong notes**)
- Scale-degree qualia
- Key relatedness
- Modulation/tonality induction (**key-finding algorithms**)

Pitch-Class Vectors

Key profiles are *pitch-class vectors*

Example:	C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
Krumhansl-Kessler C major:	(6.4,	2.2,	3.5,	2.3,	4.4,	4.1,	2.5,	5.2,	2.4,	3.7,	2.3,	2.9)
Krumhansl-Kessler C minor:	(6.3,	2.7,	3.5,	5.4,	2.6,	3.5,	2.5,	4.8,	4.0,	2.7,	3.3,	3.2)

Pitch-class sets and multi-sets are also pitch-class vectors

Example:	C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
C major triad:	(1,	0,	0,	0,	1,	0,	0,	1,	0,	0,	0,	0)
C major scale + tonic triad:	(2,	0,	1,	0,	2,	1,	0,	2,	0,	1,	0,	1)

Other names: “Characteristic function,” “pitch-class distribution”

Pitch-Class Vectors

Key profiles are *pitch-class vectors*

Example:	C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
Krumhansl-Kessler C major:	(6.4,	2.2,	3.5,	2.3,	4.4,	4.1,	2.5,	5.2,	2.4,	3.7,	2.3,	2.9)
Krumhansl-Kessler C minor:	(6.3,	2.7,	3.5,	5.4,	2.6,	3.5,	2.5,	4.8,	4.0,	2.7,	3.3,	3.2)

Pitch-class vectors "**fuzzify**" pitch class: i.e. they make the presence of a pitch class a **continuously variable** quantity.

Other names: "Characteristic function," "pitch-class distribution"

Voice Leading

A concept central to a lot of music theory:

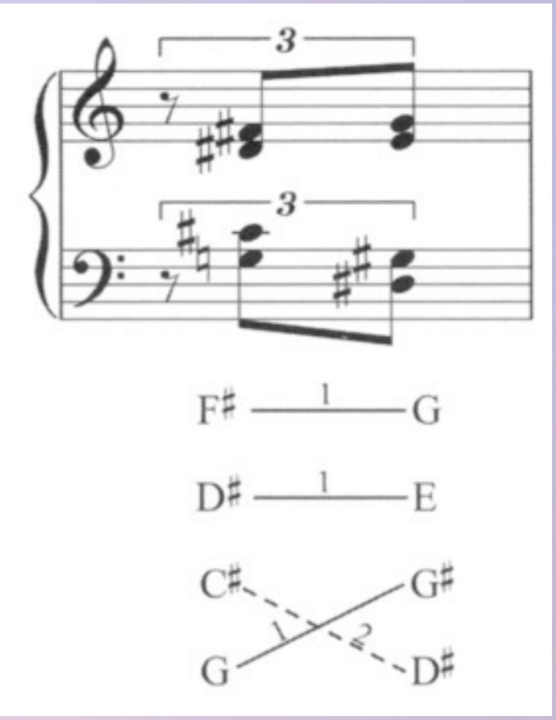
- Neo-Riemannian theory
- Schenker
- Voice-leading geometries (Callender, Quinn, & Tymoczko)
- Scale theory / spelled pitch-class sets
- Post-tonal harmony (Straus, Lewin, Morris, Roeder)

Voice Leading

What is it?

- Mapping between pitch(-class)es

- Measure of distance based on proximity in pitch(-class) space



Ex.: Straus 2005

Voice Leading

Bijective (one-to-one):

Examples:

(C, E♭, G) → (C, E♭, A♭)

(F, B, D♯, G♯) → (E, B, D, G♯)

(CDEFGAB) → (CDEFGAB♭)

Bijective voice leadings have a robust geometrical interpretation. We can talk about them in terms of **distance** and **space.**

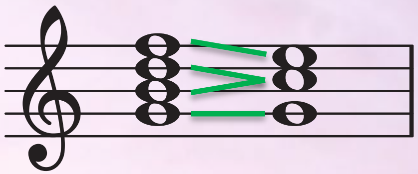
Callender, Quinn, Tymoczko 2008. “Generalized Voice Leading Spaces,” *Science*
Tymoczko 2011. *A Geometry of Music*. Oxford Univ. Press

Voice Leading

Many situations call for ***non-bijective*** voice leadings:

Examples:

Sets of **different cardinality**



{ B D F G }

{ C E G }

C acoustic → WT_0

{ C D E F♯ G A B♭ }

{ C D E F♯ A♭ B♭ }

Acoustic collection =
"Lydian dominant" or mode 4 of melodic minor

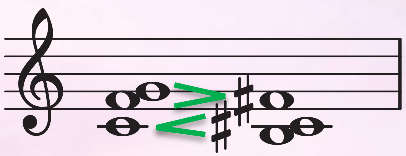
Tymoczko "Scale Networks and Debussy" (2004),
Geometry of Music (2011)

Voice Leading

Many situations call for ***non-bijective*** voice leadings:

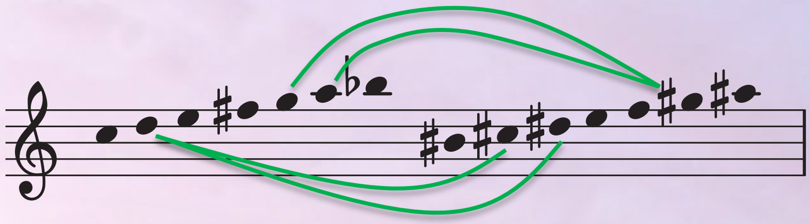
Examples:

Same cardinality but more efficient
with non-bijective voice leadings



{ C F G }

{ B C♯ F♯ }

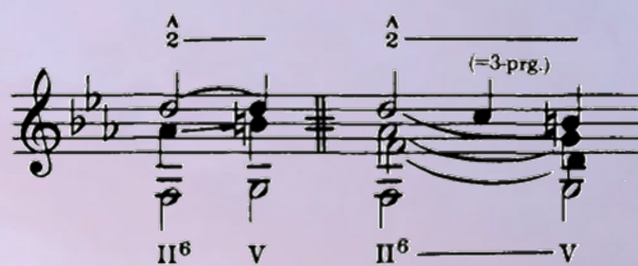


{ C D E F♯ G A B♭ }

{ B♯ C♯ D♯ E F♯ G♯ A♯ }

Callender "Voice-Leading Parsimony in the
Music Of Alexander Scriabin" (1998)

In **Schenker**:



{ F A♭ D }

{ G B D }

Frei Satz Ex. 36

Problem: non-bijective voice leadings do not produce robust voice-leading geometries.

Voice Leading

Non-bijective:

Voice leadings that omit notes?

{ G B D F }

{ C E G }

Voice Leading

Jazz progressions as dyadic voice leading on guide tones

Example: “All the Things You Are”

E♭	A♭	D♭	G	C	F	B	B♭	E♭	A♭	D	G	C	F♯
A♭	D♭	G	C	F	B	E	E♭	A♭	D	G	C	F♯	B
F	B♭	E♭	A♭	D♭	G	C	C	F	B♭	E♭	A♭	D	G

See: Michael McKlimon (2017), “Transformations in Tonal Jazz: ii–V Space.” *MTO* 23/1

Joe Mulholland and Tom Hojnacki (2013), *The Berklee Book of Jazz Harmony*. Berklee Press

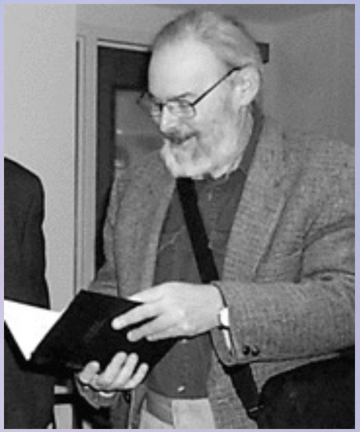
The Interval Function

Voice-leading theory has promoted continuous models of pitch-class space, but discrete models of voice / pitch-class quantity

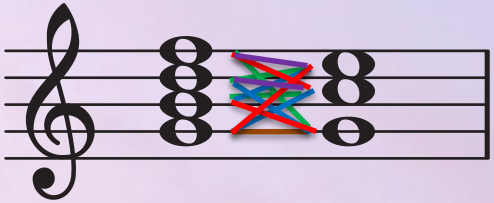
Cognitive models of tonality, on the other hand, rely upon continuous models of pitch-class quantity

Can these two be reconciled?

Lewin's Interval Function



The **interval function** on sets $A \to B$ lists all intervals from any member of A to any member of B



0	1	2	3	4	5	6	7	8	9	10	11
(1,	1,	2,	0,	0,	3,	0,	1,	1,	1,	1,	1)

$\underbrace{1,\ 2}_{\text{Ascending steps}}$ $\underbrace{1,\ 1}_{\text{Descending steps}}$

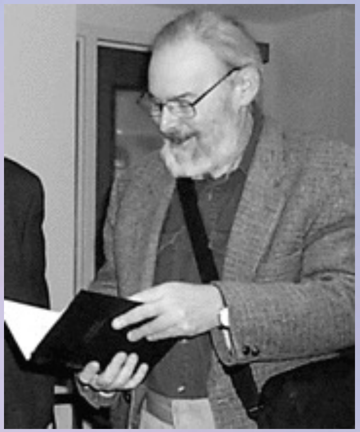
Common tones

Ascending steps

Descending steps

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin’s Interval Function



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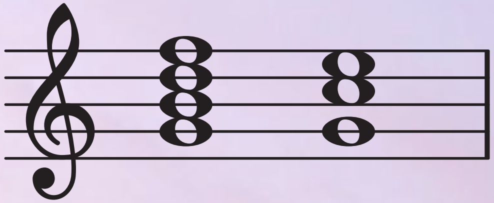

0	1	2	3	4	5	6	7	8	9	10	11
(1,	1,	2,	0,	0,	3,	0,	1,	1,	1,	1,	1)

Common tones

Ascending steps

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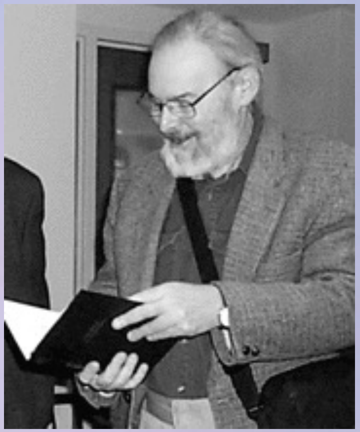
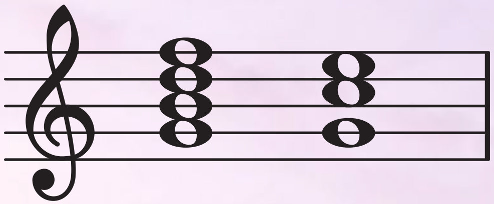
Lewin's Interval Function



The interval function is a **cross-correlation** of pitch-class vectors

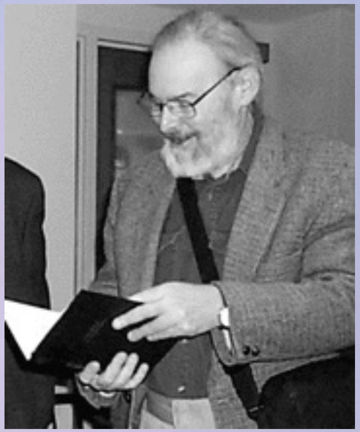


0	1	2	3	4	5	6	7	8	9	10	11
(1,	1,	2,	0,	0,	3,	0,	1,	1,	1,	1,	1)

$$
\begin{array}{cl}
 & (0,\ 0,\ 1,\ 0,\ 0,\ 1,\ 0,\ 1,\ 0,\ 0,\ 0,\ 1\ ) \\
\times & (1,\ 0,\ 0,\ 0,\ 1,\ 0,\ 0,\ 1,\ 0,\ 0,\ 0,\ 0\ ) \\
= & 0 + 0 + 0 + 0 + 0 + 0 + 0 + 1 + 0 + 0 + 0 + 0 = 1
\end{array}
$$

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



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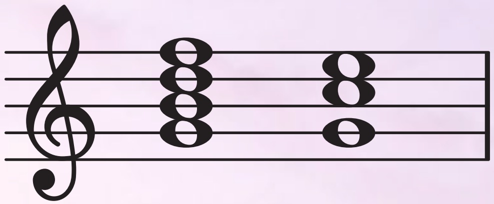


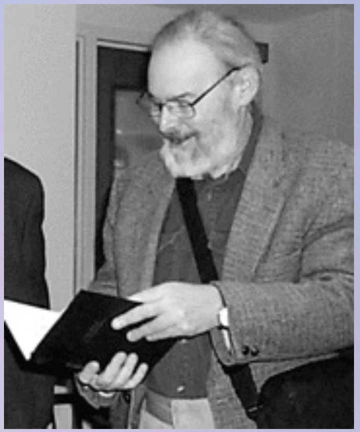
$$\begin{array}{cccccccccccc} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \\ (1, & 1, & 2, & 0, & 0, & 3, & 0, & 1, & 1, & 1, & 1, & 1) \end{array}$$

$$\begin{array}{lcccccccccccc} & (0, & 0, & 1, & 0, & 0, & 1, & 0, & 1, & 0, & 0, & 0, & 1\ ) \\ \times & (0, & 0, & 0, & 1, & 0, & 0, & 1, & 0, & 0, & 0, & 0, & 1\ ) \end{array}$$

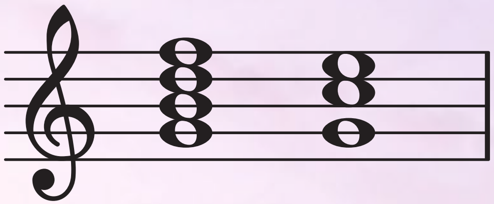
$$= \quad 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 1 = 1$$

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



The interval function is a **cross-correlation** of pitch-class vectors



0	1	2	3	4	5	6	7	8	9	10	11
(1,	1,	2,	0,	0,	3,	0,	1,	1,	1,	1,	1)

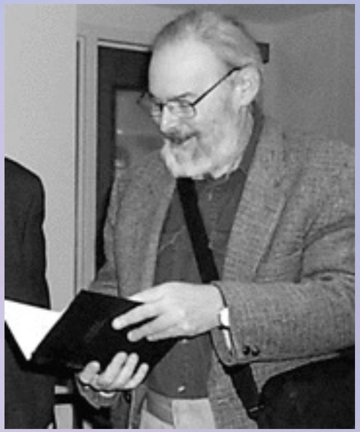
$$(0,\ 0,\ 1,\ 0,\ 0,\ 1,\ 0,\ 1,\ 0,\ 0,\ 0,\ 1)$$

$$\times\ (0,\ 0,\ 1,\ 0,\ 0,\ 1,\ 0,\ 0,\ 0,\ 0,\ 1,\ 0)$$

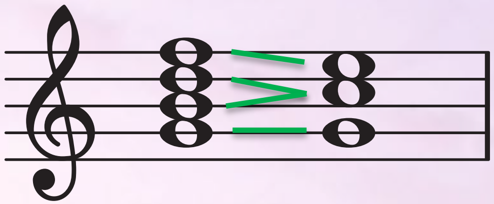
$$=\ 0 + 0 + 1 + 0 + 0 + 1 + 0 + 0 + 0 + 0 + 0 + 0 = 2$$

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



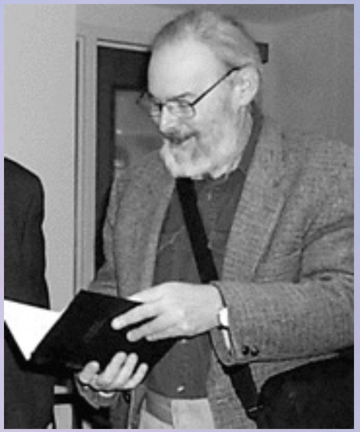
The interval function shows the possible intervals of any non-bijective voice leading



0	1	2	3	4	5	6	7	8	9	10	11
(1,	1,	2,	0,	0,	3,	0,	1,	1,	1,	1,	1)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function

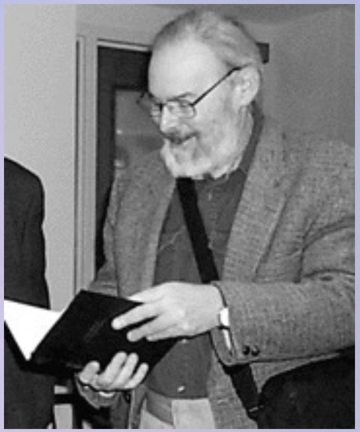


Individually transposing chords simply rotates the interval function

G7 → C	(1, 1, 2, 0, 0, 3, 0, 1, 1, 1, 1, 1)
F♯7 → C	(1, 1, 1, 2, 0, 0, 3, 0, 1, 1, 1, 1)
C7 → C	(3, 0, 1, 1, 1, 1, 1, 1, 1, 2, 0, 0)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function

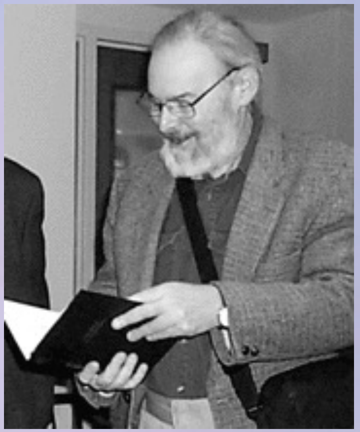


The interval function from a chord to itself is the interval vector (note retrograde symmetry)

$C \rightarrow C$ (3, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



Example: Voice leadings between major and minor triads.

$C \rightarrow c$ (2, 0, 0, 2, 0, 1, 0, 1, 2, 0, 0, 1)

Parallel
(2 common tones,
1 descending semitone)

Leittonwechsel
(2 common tones,
1 descending semitone)

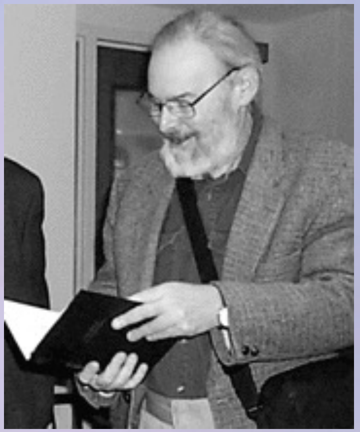
Relative
(2 common tones,
1 ascending whole step)

or

Hexatonic pole
(2 descending semitones,
1 ascending semitone)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



Example: Voice leadings between dominant and half-diminished sevenths.

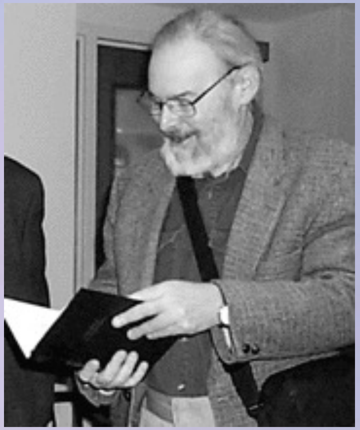
$C^7 \rightarrow c^{ø7}$ (2, 0, 2, 2, 0, 2, 2, 0, 3, 0, 1, 2)

There are three voice leadings with 2 common tones and 2 ascending semitones, and three with 2 common tones and 2 descending semitones

One voice leading has 3 common tones and one ascending whole tone (or three descending semitones and one ascending semitone)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



Examples: Voice leadings between sus4 chords and Mystic collections

Csus → Csus (3, 0, 1, 0, 0, 2, 0, 2, 0, 0, 1, 0)

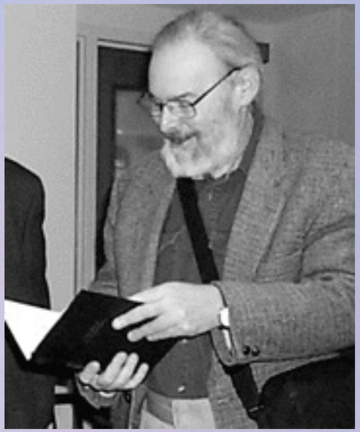
Callender's non-bijective voice leading between (027)s

{CDEF♯GB♭} → {CDEF♯AB♭} (5, 0, 5, 2, 4, 2, 4, 2, 4, 2, 4, 2)

Non-bijective semitonal voice leading between complementary Mystic collections

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



Lewin showed how to predict when the interval function would be **flat**

C hex $\rightarrow$ WT_0 (3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3)

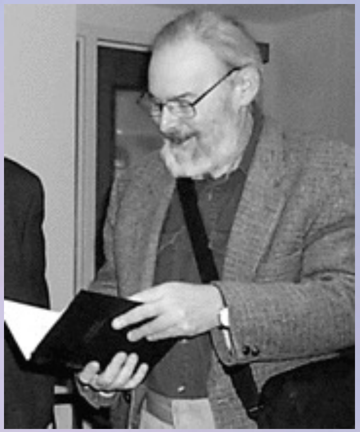
C hex $\rightarrow$ Oct_{01} (4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4)

$WT_0 \rightarrow Oct_{01}$ (4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4)

For instance, the interval functions between **Guidonian hexachords, whole tone,** and **octatonic** collections are flat

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Lewin's Interval Function



We can similarly predict when the interval function will be peaked

C acoustic $\rightarrow$ WT_0 (5, 2, 5, 2, 5, 2, 5, 2, 5, 2, 5, 2)

C acoustic $\rightarrow$ Oct_{01} (6, 4, 4, 6, 4, 4, 6, 4, 4, 6, 4, 4)

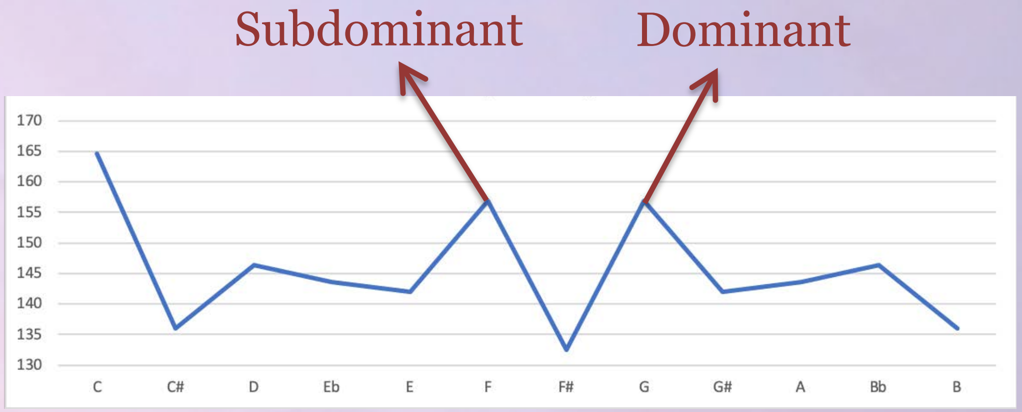
C hex $\rightarrow$ C pent (5, 0, 4, 2, 2, 4, 0, 5, 1, 3, 3, 1)

"Special Cases of the Interval Function between Pitch Class Sets X and Y." *JMT* 45/1 (2001).

Generalizing the Interval Function

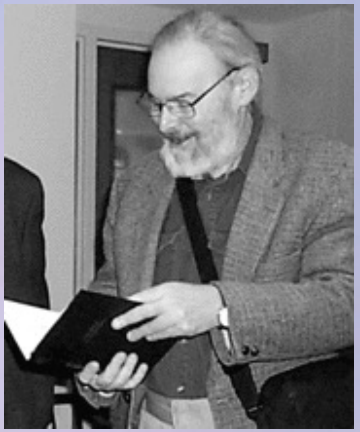
The interval function (cross correlation) can operate on any pitch-class vector.

Cross-correlation of the Krumhansl-Kessler **major** key profile to itself



Cross-correlation of Krumhansl-Kessler key profiles, **major** to **minor**

Lewin’s Interval Function



Lewin’s insight:

(1) The **discrete Fourier transform** on pitch-class vectors relates to important harmonic properties of pcsets.

(2) The ***convolution theorem*** states that the DFT turns **cross correlation** (the interval function) into **multiplication**.

“Special Cases of the Interval Function between Pitch Class Sets X and Y.” *JMT* 45/1 (2001).

Fourier Transform on Pitch-Class Vectors

We can use the discrete Fourier transform to

- Quantify concepts of harmonic quality
- Relate harmonic objects using the interval function
  - Similarity of sets
  - Voice-leading properties

Fourier Transform on Pitch-Class Vectors: A brief history

Lewin, David (1959). “Re: Intervallic Relations between Two Collections of Notes,” *JMT* 3/2.

——— (2001). “Special Cases of the Interval Function between Pitch Class Sets X and Y.” *JMT* 45/1.

Quinn, Ian (2006–2007). “General Equal-Tempered Harmony,” *Perspectives of New Music* 44/2–45/1.

Callender, Cliff (2007). “Continuous Harmonic Spaces,” *JMT* 51/2

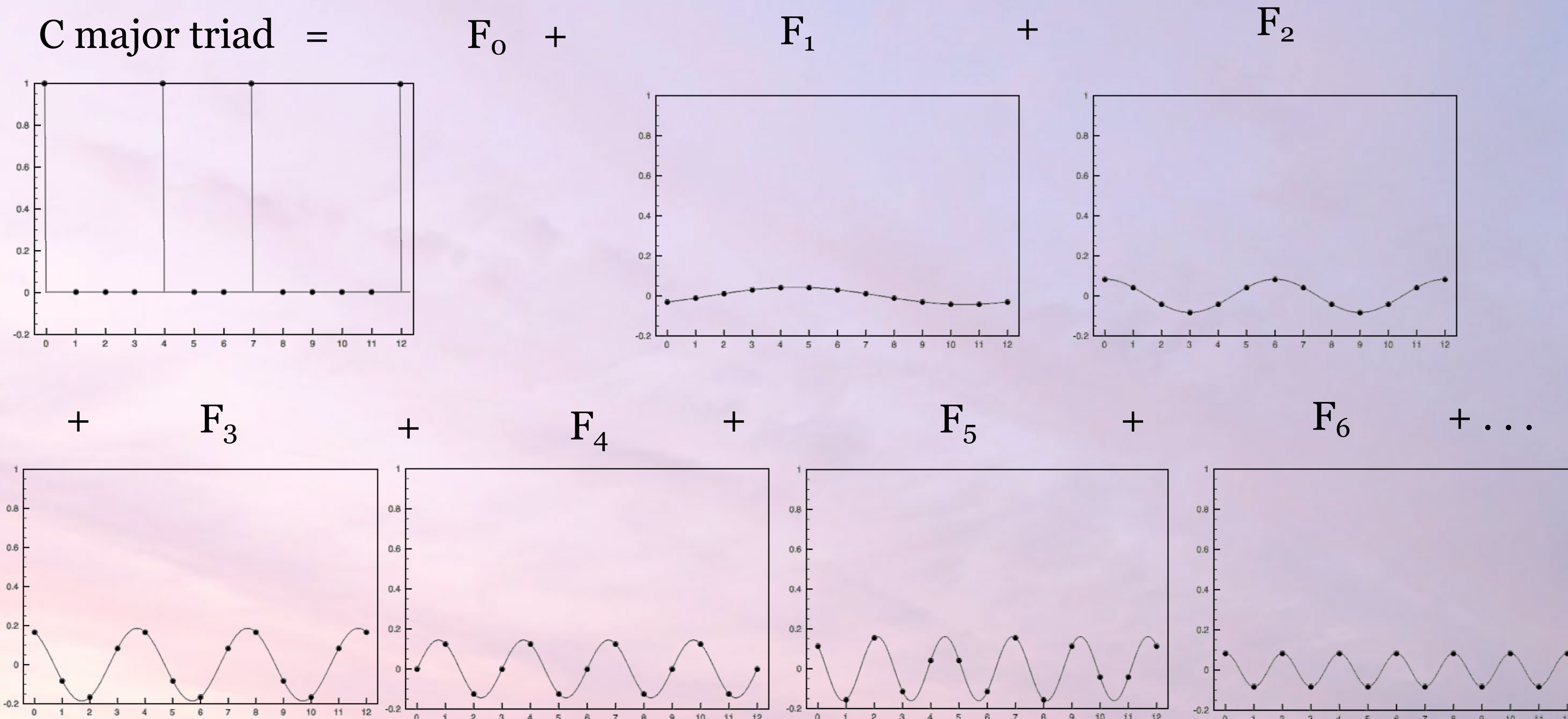
Amiot, Emmanuel (2007). “David Lewin and Maximally Even Sets.” *Journal of Mathematics and Music* 1/3.

——— (2016). *Music Through Fourier Space: Discrete Fourier Transform in Music Theory*. (Springer)

Yust, Jason (2015). “Schubert’s Harmonic Language and Fourier Phase Spaces.” *JMT* 59/1.

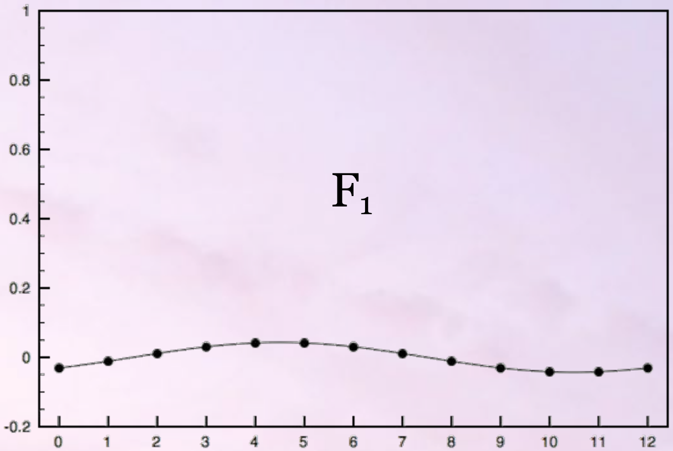
——— (2016). “Special Collections: Renewing Forte’s Set Theory.” *JMT* 60/2.

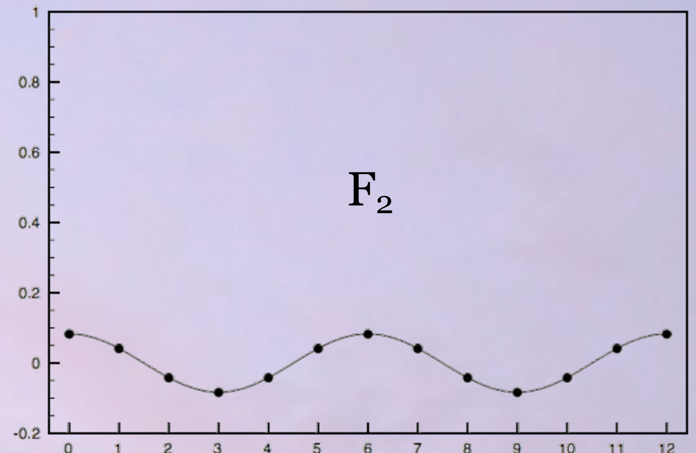
Fourier Transform of a Pitch-Class Vector



The DFT is a **lossless transformation** from a pitch-class vector to a sum of **periodic functions** dividing the octave into 1–6 parts.

Fourier Qualities

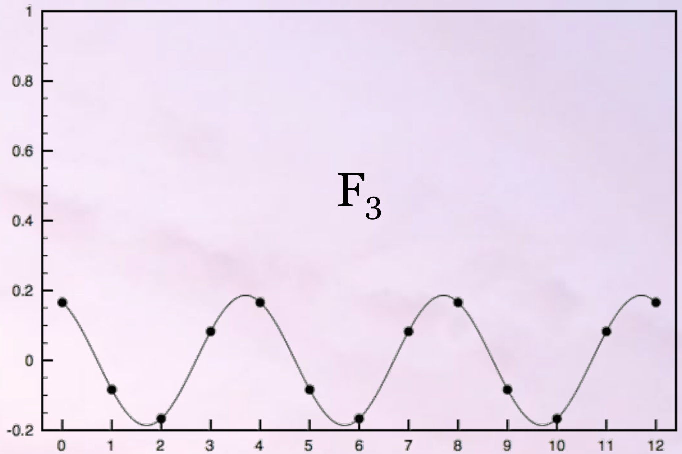




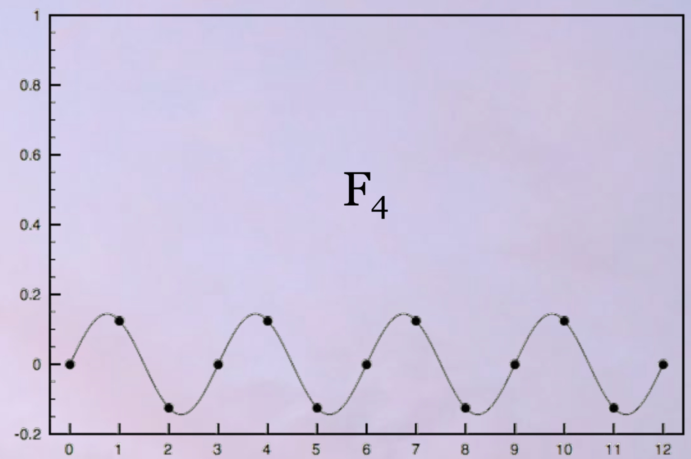
F_1 represents a concentration of pitch-class weight on the full pc circle.

F_2 represents a concentration of pitch-class weight on a half-octave (tritone) cycle.

Fourier Qualities

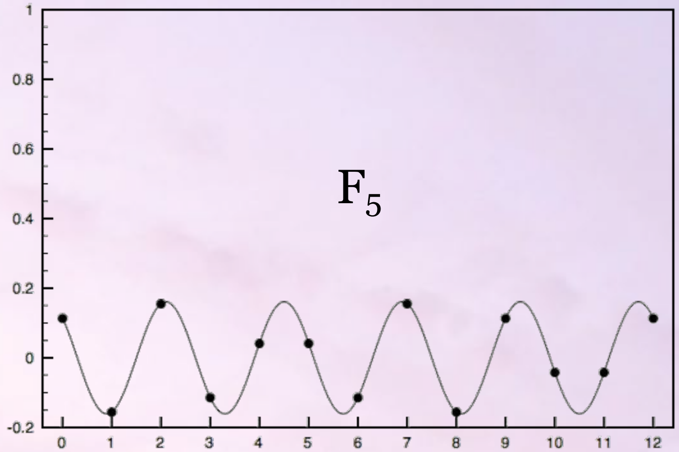


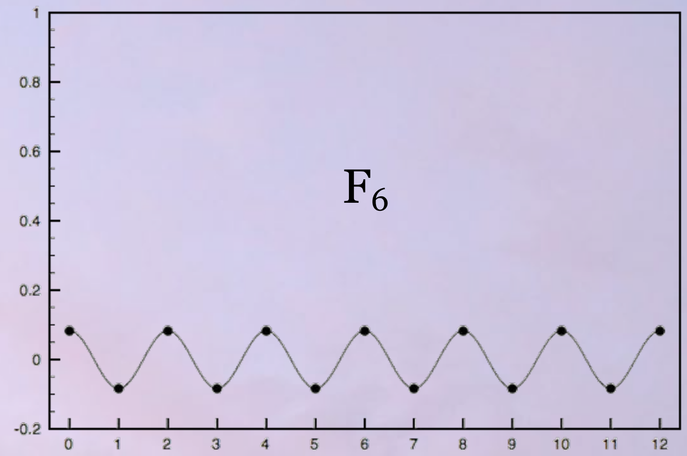
F_3 gives the weighting on the nearest *augmented triad* or ***hexatonic*** *scale*.



F_4 gives the weighting on the nearest *diminished seventh* or ***octatonic*** *scale*.

Fourier Qualities





F_5 give the balance on the ***circle of fifths***

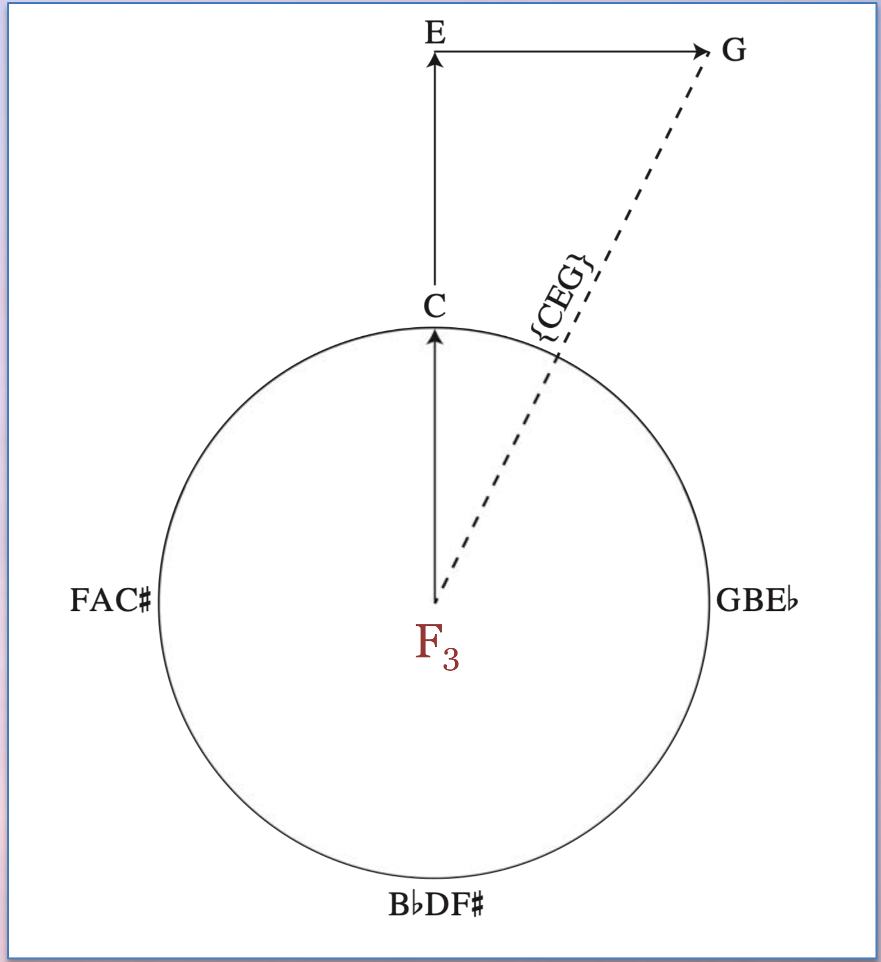
F_6 gives the relative weighting on the two ***whole-tone*** collections.

Fourier Transform as Vector Sums

Fourier component F_k can be derived as a vector sum with each pitch class as a unit vector, where the unit circle is the 8ve/k.

The length of the resulting vector is the **magnitude** of the component, and the angle is its **phase.**

Example: C maj. triad, k = 3

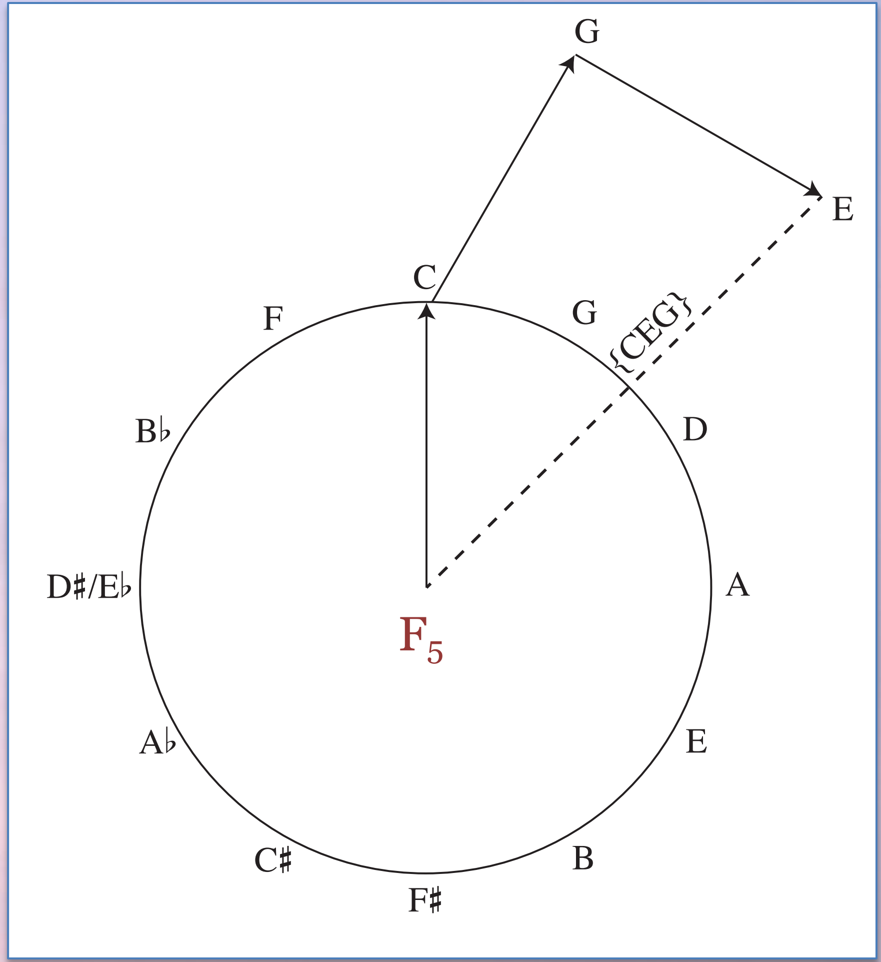


Fourier Transform as Vector Sums

Fourier component F_k can be derived as a vector sum with each pitch class as a unit vector, where the unit circle is the 8ve/k.

The length of the resulting vector is the **magnitude** of the component, and the angle is its **phase.**

Example: C maj. triad, k = 5



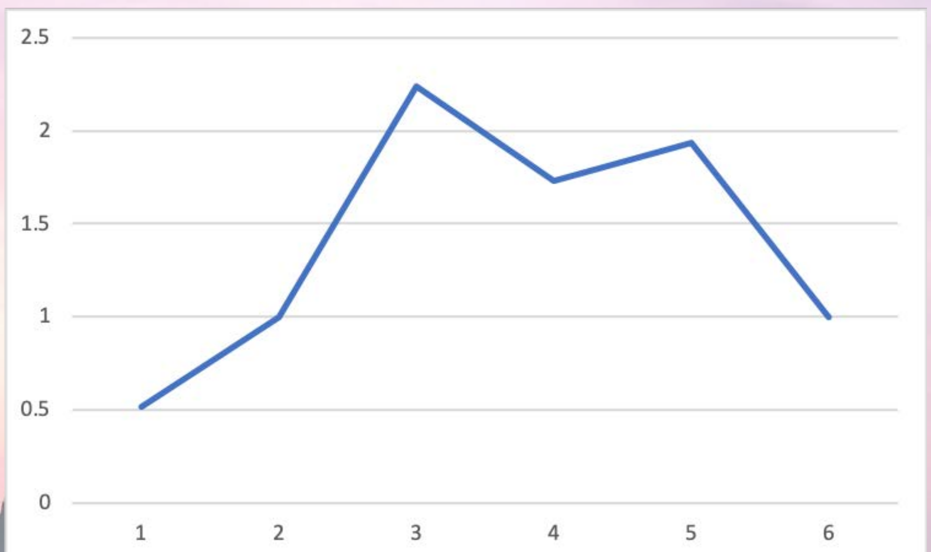
Fourier Spectra

The ***spectrum*** of a pitch-class vector shows the magnitudes of all its Fourier coefficients (ignoring phases)

The spectrum is **invariant with respect to transposition and inversion** (i.e. it is a *set class* property)

Examples:

Major/minor triad



Dominant 7th

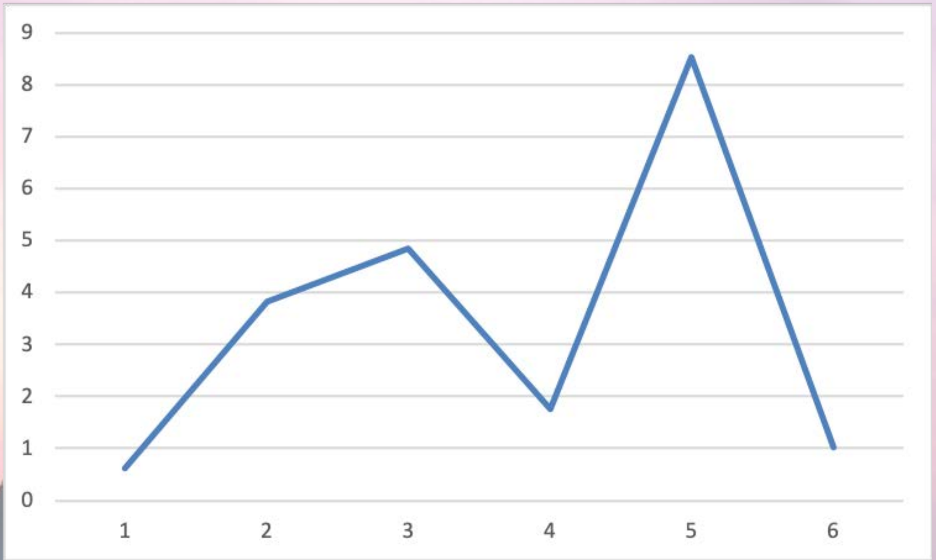
Fourier Spectra

The ***spectrum*** of a pitch-class vector shows the magnitudes of all its Fourier coefficients (ignoring phases)

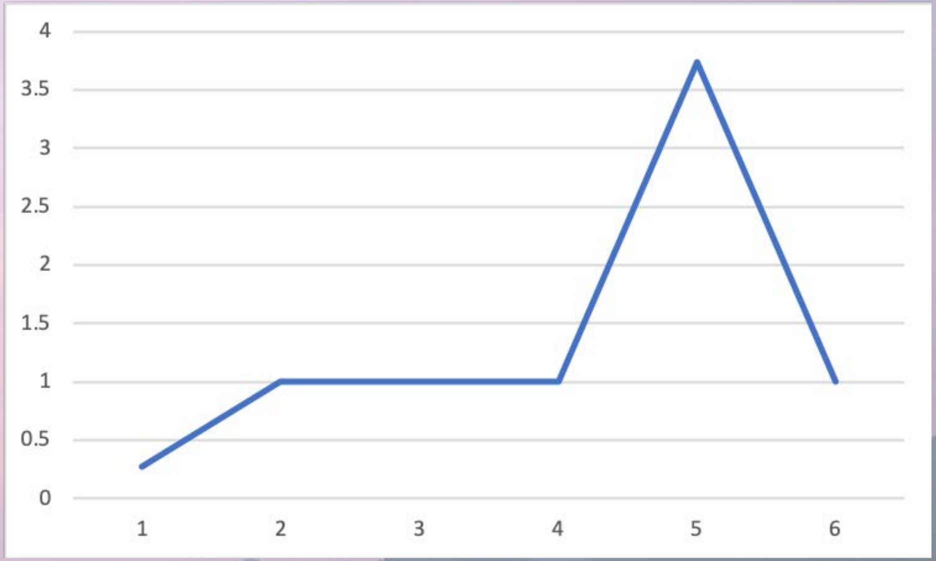
The spectrum is **invariant with respect to transposition and inversion** (i.e. it is a *set class* property)

Examples:

Krumhansl-Kessler major key



Diatonic scale



Convolution Theorem

The Fourier transform turns *convolution* (cross-correlation) into *multiplication*

i.e.
for pc-vectors *A*, *B*

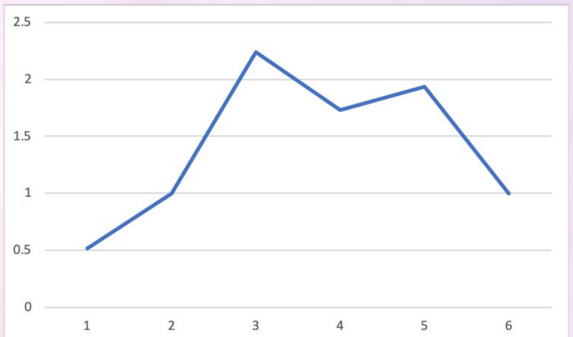
$$\mathrm{DFT}(\text{Int. Funct.}(A, B)) = \overline{\mathrm{DFT}(A)} \times \mathrm{DFT}(B)$$

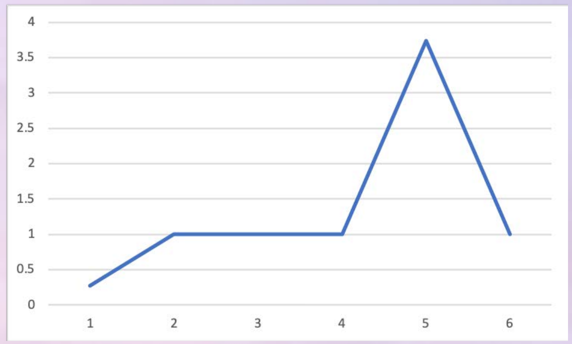
(Multiply magnitudes and subtract phases)

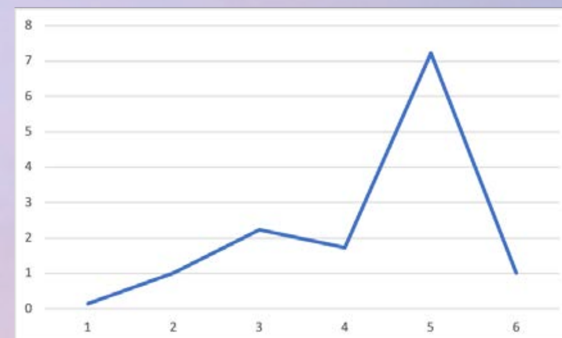
* The line over DFT(*A*) indicates complex conjugation, so that phases are subtracted (cross-correlation) instead of added (convolution)

Examples (Interval Vector through DFT)

Q: How many common tones does a major triad have with a diatonic scale?







Spectrum of major triad × Spectrum of diatonic scale = Spectrum of interval func.

A: It is determined primarily by f_5,

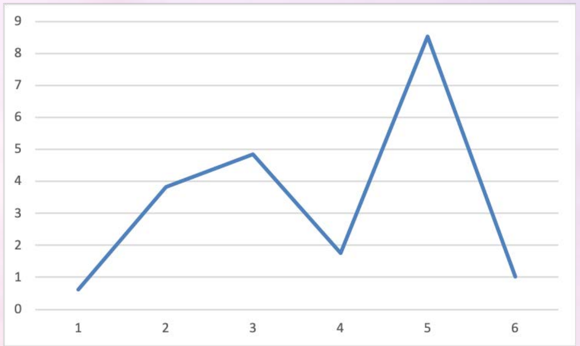
i.e. if the f_5 phase difference is small, there will be more CTs

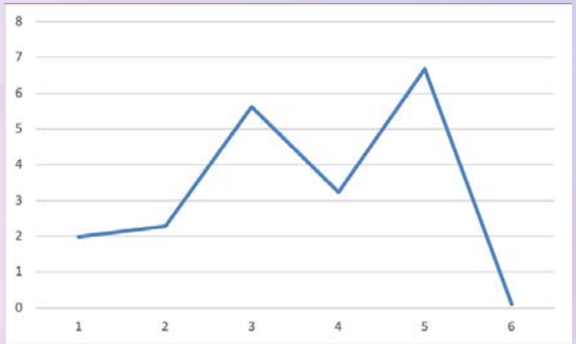
Examples (Interval Vector through DFT)

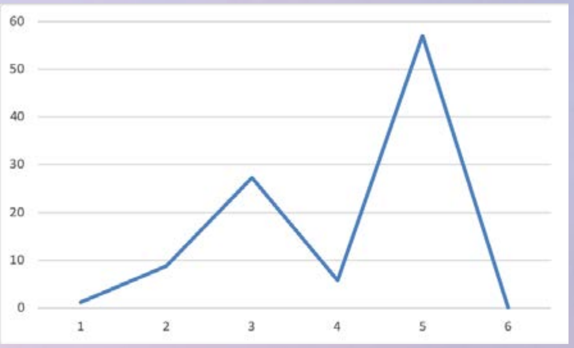
Major Triads:	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F♯
CTs with C diat.:	1	1	1	2	3	3	3	2	2	2	1	0

Examples (Interval Vector through DFT)

Q: How correlated are key profiles of major and minor keys?





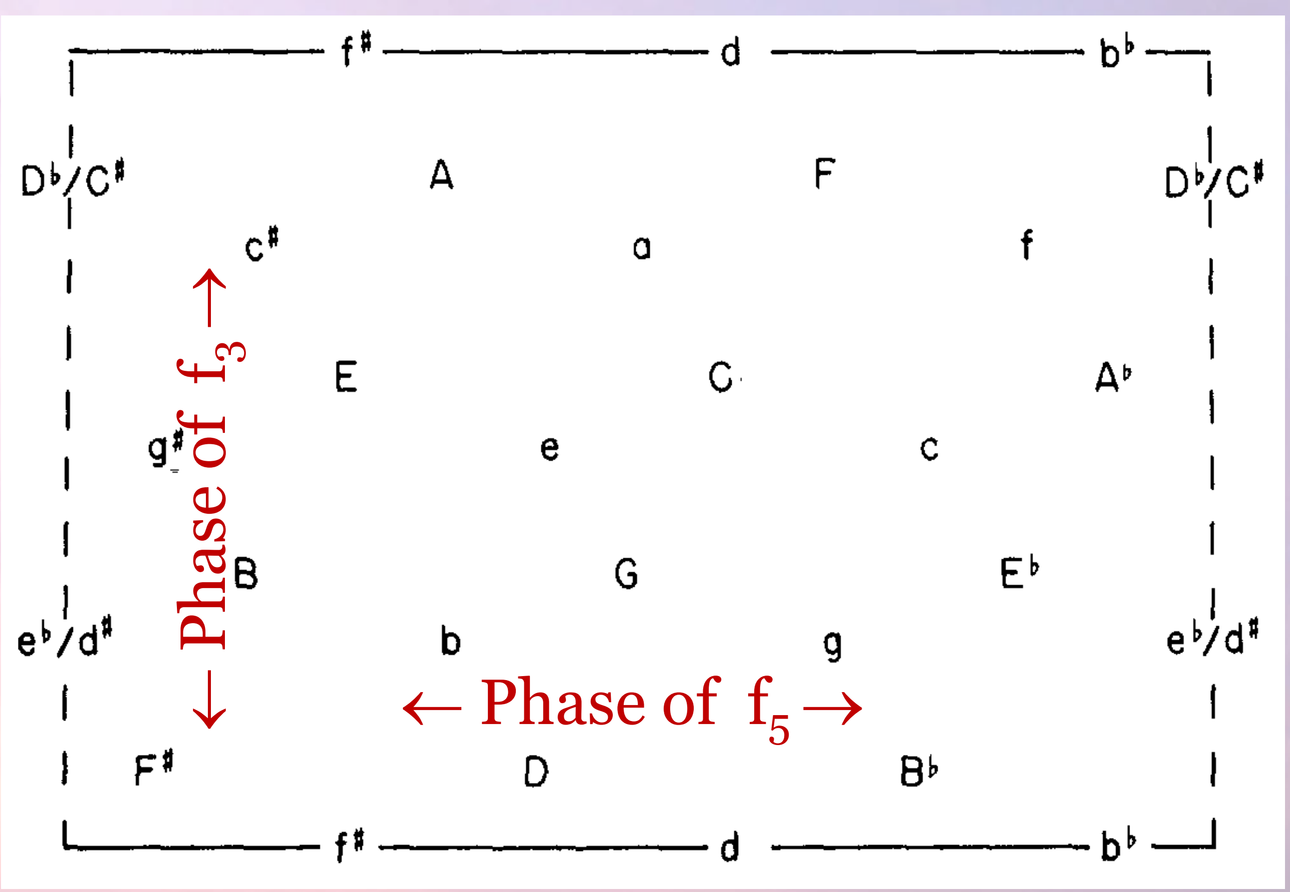


Spectrum of major key × Spectrum of minor key = Spectrum of interval func.

A: It is determined primarily by f_5,
and secondarily by phase differences in f_3

Examples (Interval Vector through DFT)

Hence: A ***phase space*** shows these relationships



From Krumhansl & Kessler 1982

Jazz Harmony

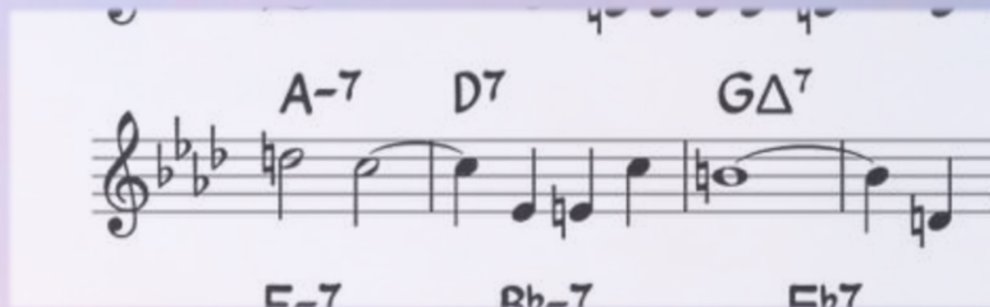
PC vectors are good for interpreting lead-sheet harmony symbols

To better understand jazz harmony, consider:

- Spectra of typical chord types
- Voice-leading properties (interval vector)
- Phase space

Jazz Chords as Pitch-Class Vectors

What is the meaning of a lead-sheet chord symbol?



- A **pitch-class set is a poor model**, because in practice not all notes need to be played, and certain notes may be added.
- A **pitch-class vector** can account for the varying probabilities of each pitch-class occurring.

—The **root** has a special significance in determining the bass line.

—**Guide tones** (3^{rd} and 7^{th}) are especially important harmonic tones

—Each chord also has optional **extensions** or "tensions"

—Chords also have certain **"avoid tones"**

Jazz Chords as Pitch-Class Vectors

Dominant

Guide tones

7
3

Extensions:

9
6
5

♭13
♯11
♭9 / ♯9

Avoid:

♯7
4

Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	1,	1,	1,	2,	0,	1,	1,	1,	1,	2,	0)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

Jazz Chords as Pitch-Class Vectors

Minor

Guide tones

7
3

Extensions:

11
9
6
5

♭13
♯11

Avoid:
♭9
♯7
♯3

Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	0,	1,	2,	0,	1,	1,	1,	1,	1,	2,	0)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

Jazz Chords as Pitch-Class Vectors

Major

Guide tones	Extensions:		Avoid:	
				♭9
7	9		♭7	♭6
3	6	♯11	♭3	4
	5			

Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	0,	1,	0,	2,	0,	1,	1,	0,	1,	0,	2)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

Jazz Chords as Pitch-Class Vectors

Minor flat-5

Guide tones

Extensions:

Avoid:

7
3

11
9
♭5

♭13

♯7 ♭9
♯5 6
♯3

Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	0,	1,	2,	0,	1,	1,	0,	1,	0,	2,	0)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

Jazz Chords as Pitch-Class Vectors

Sus7

Guide tones

7
3

Extensions:

9
6
5

♭13
♭9 / ♯9

Avoid:

♯7
♯4
♯3

Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	0,	1,	1,	0,	1,	0,	1,	1,	1,	2,	0)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

Jazz Chords as Pitch-Class Vectors

Alt7

Guide tones | Extensions: | Avoid:

7 | 9 | ♯11 | ♯7 | 6

3 | ♯5 | ♭9 / ♯9 | ♯3 | 4

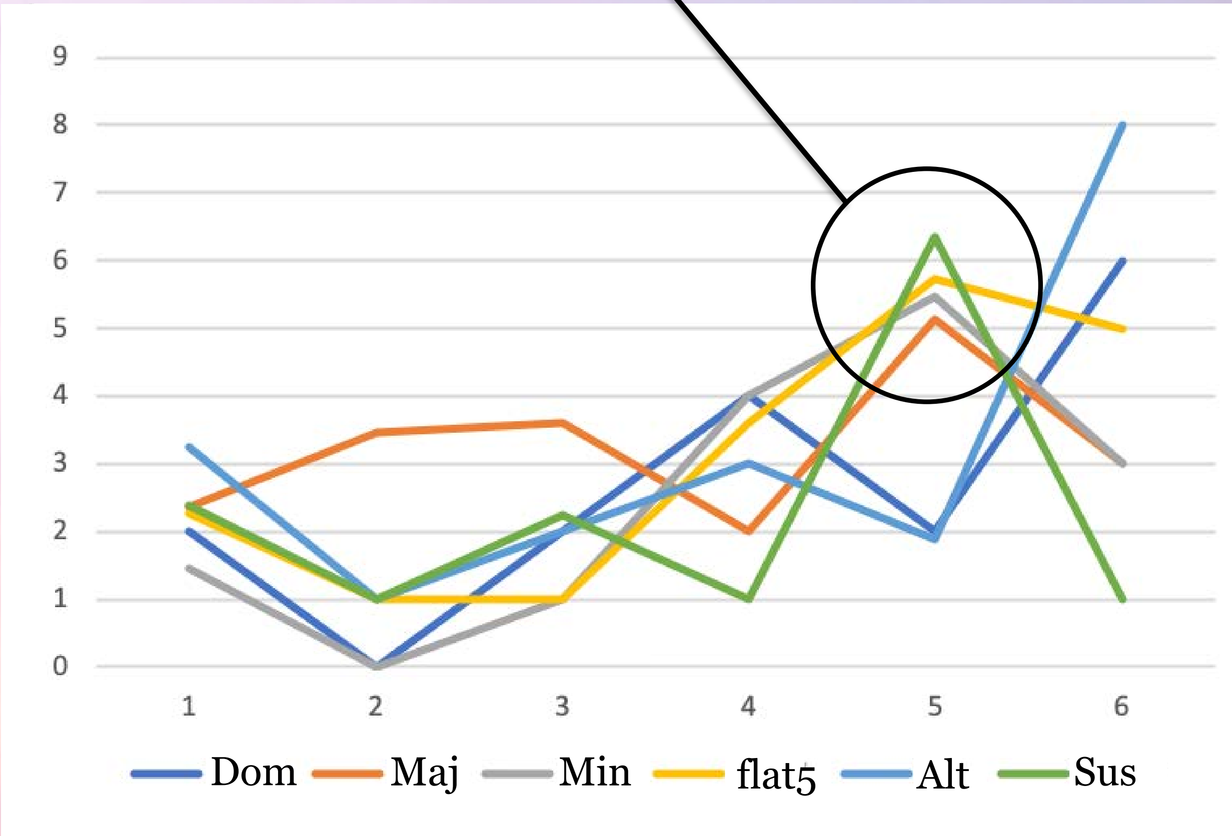
Root

C	C♯	D	E♭	E	F	F♯	G	A♭	A	B♭	B
(3,	1,	1,	1,	2,	0,	1,	0,	1,	0,	2,	0)

Source:
Terefenko, D. 2014. *Jazz Theory: From Basic to Advanced Study* (Routledge).

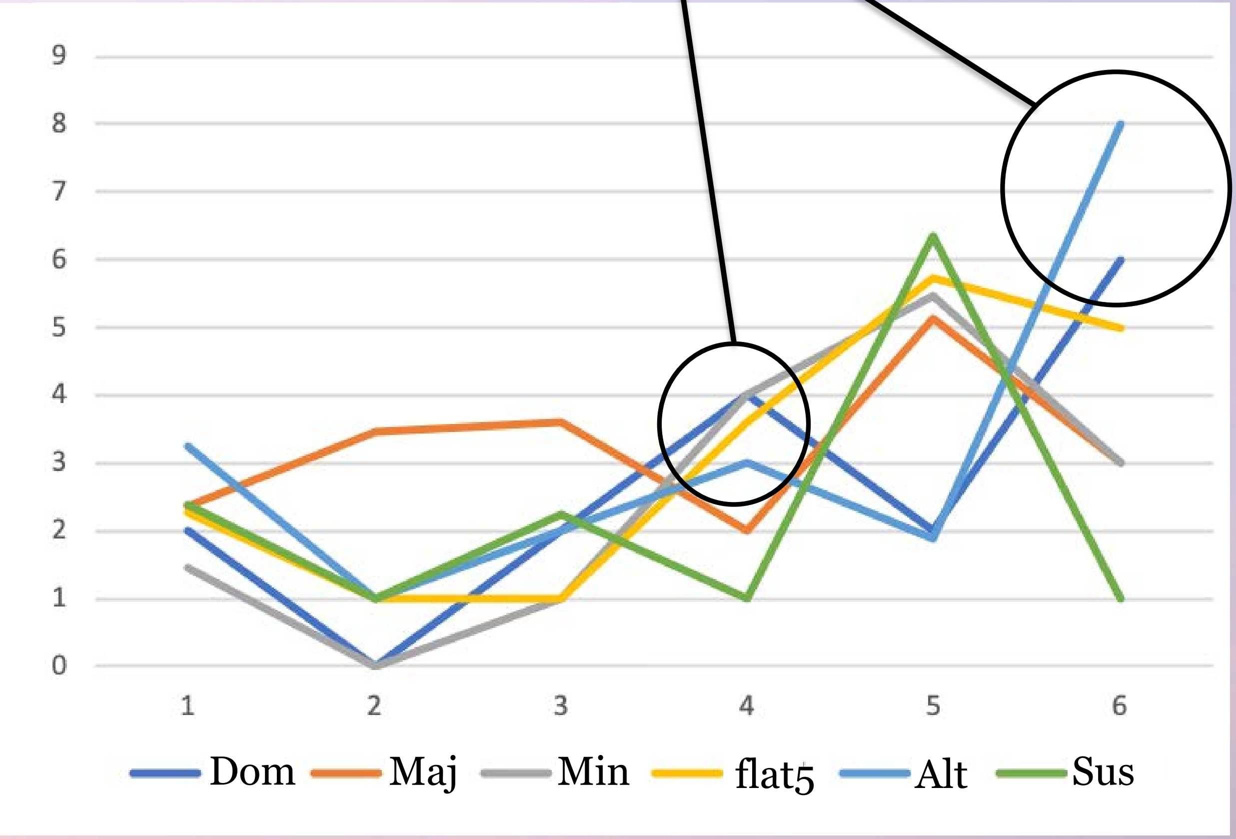
Spectra of Jazz PC Vectors

Most chords peak at f_5 (exceptions: Dom. & Alt.)



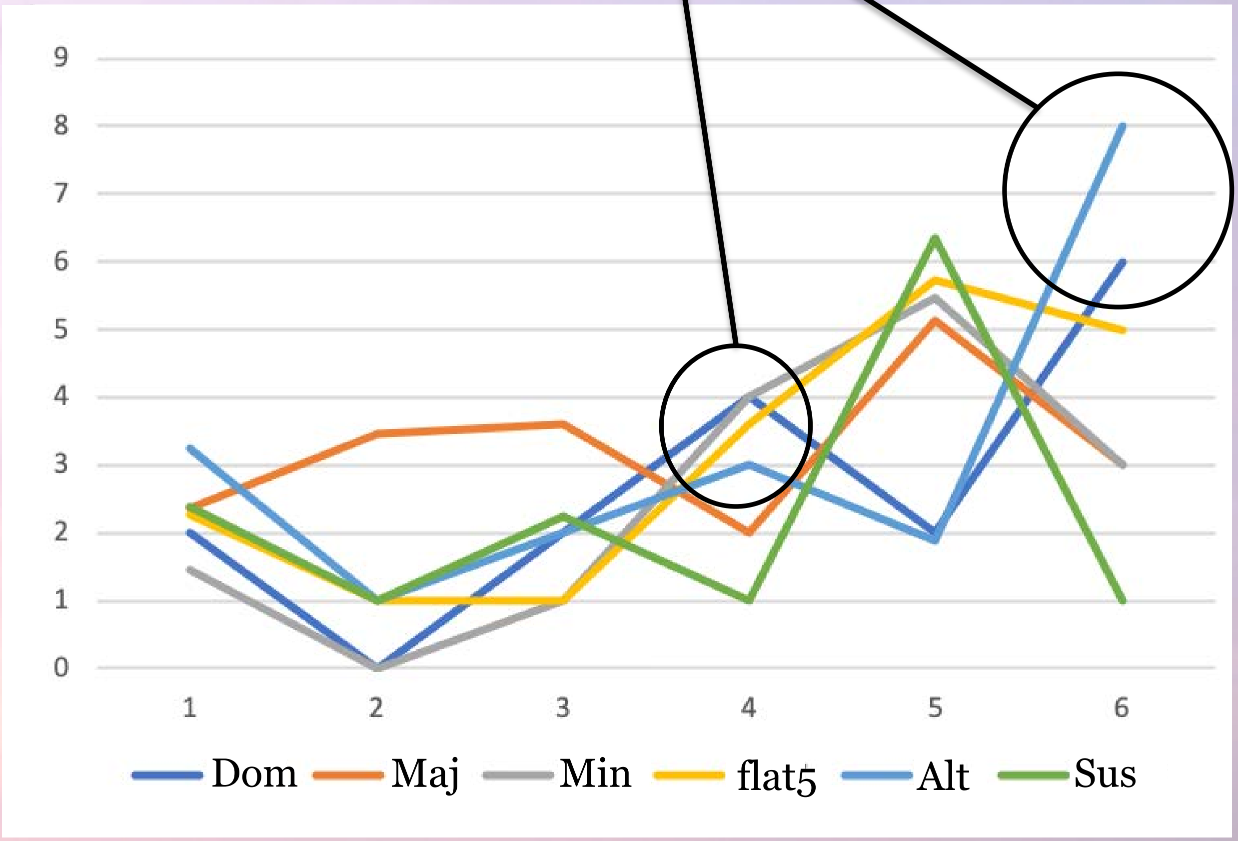
Spectra of Jazz PC Vectors

Dom. & Alt. chords instead peak at f_4 and f_6

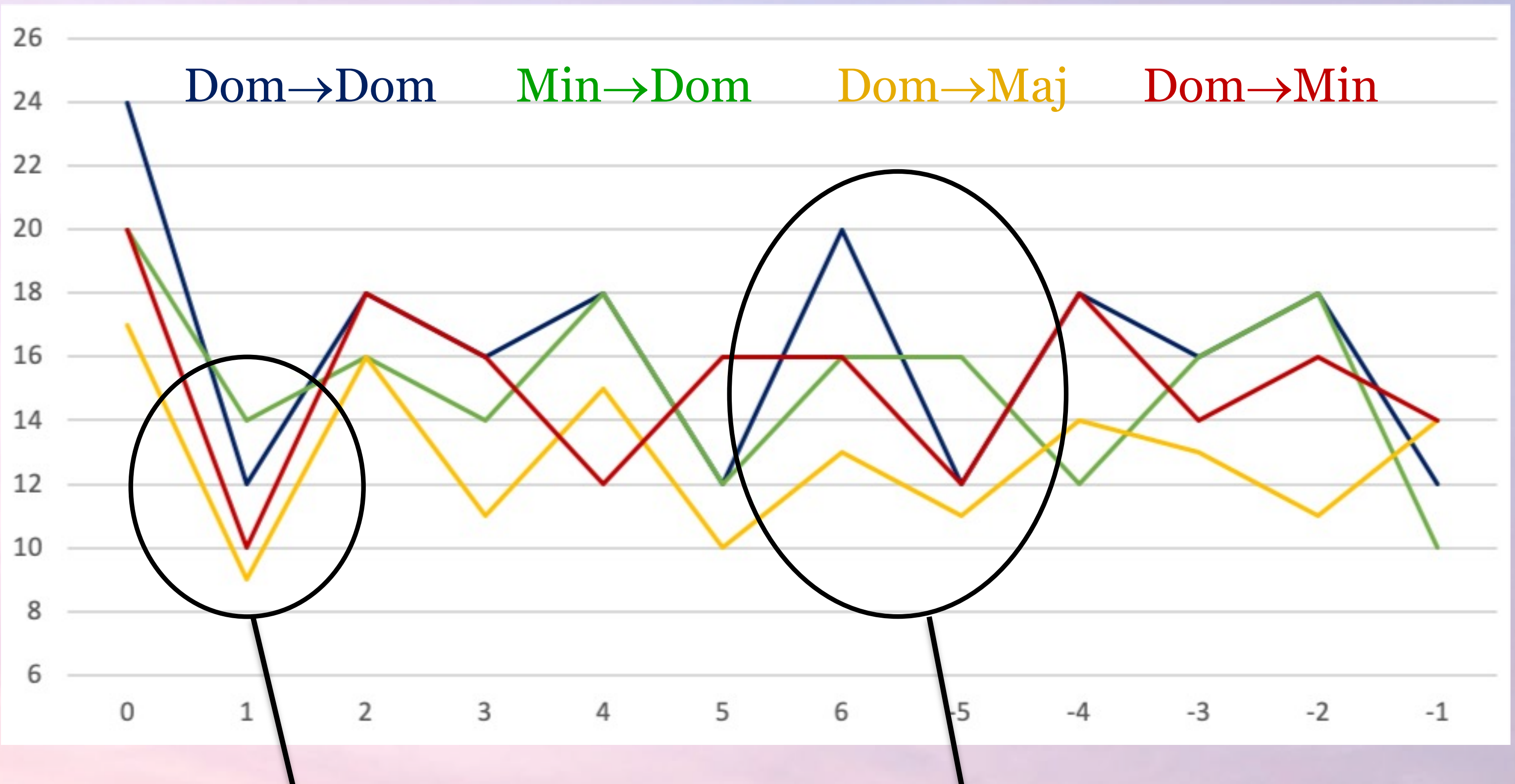


Spectra of Jazz PC Vectors

Most chords have a secondary peak at f_4 (except: Maj. & Sus)



Interval functions of jazz chords



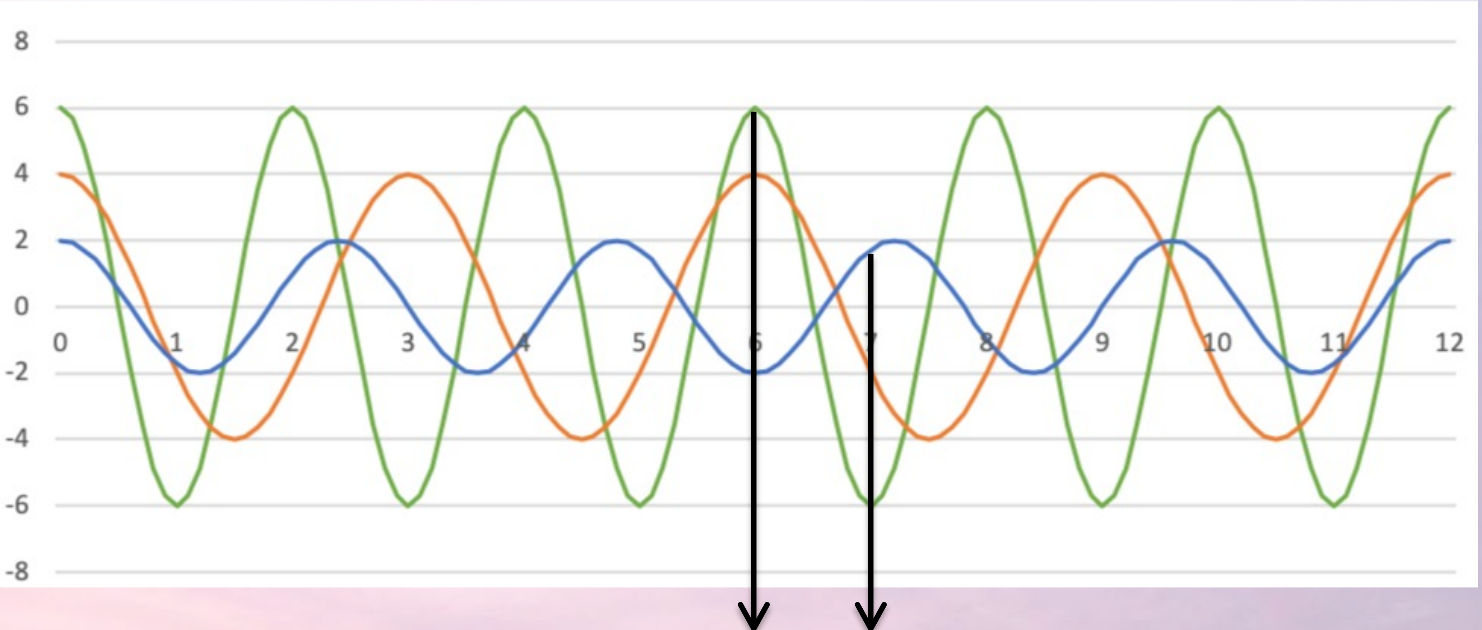
Root motion **down by semitone** gives ***few common tones***

Root motion **down by fifth** gives ***few common tones*** and ***many descending semitones***.

Interval functions of jazz chords

Why?

f_4, f_5, f_6, aligned with zero:



f_4 and f_6 have *maxima* at 6 and *minima* at 5

f_5 is the opposite: minimum at 6 at near-maximum at 5

$\Rightarrow$ The pattern obtains for chords with high f_4 and f_6 (dominant), weakens for chords with high f_5 (major, minor)

Phase Space for Jazz Harmony

Interval functions for jazz harmony will be mostly determined by f_4, f_5, and f_6.

However, phase of f_6 is degenerate: it only takes two values, 0 and π.

$$\Rightarrow$$

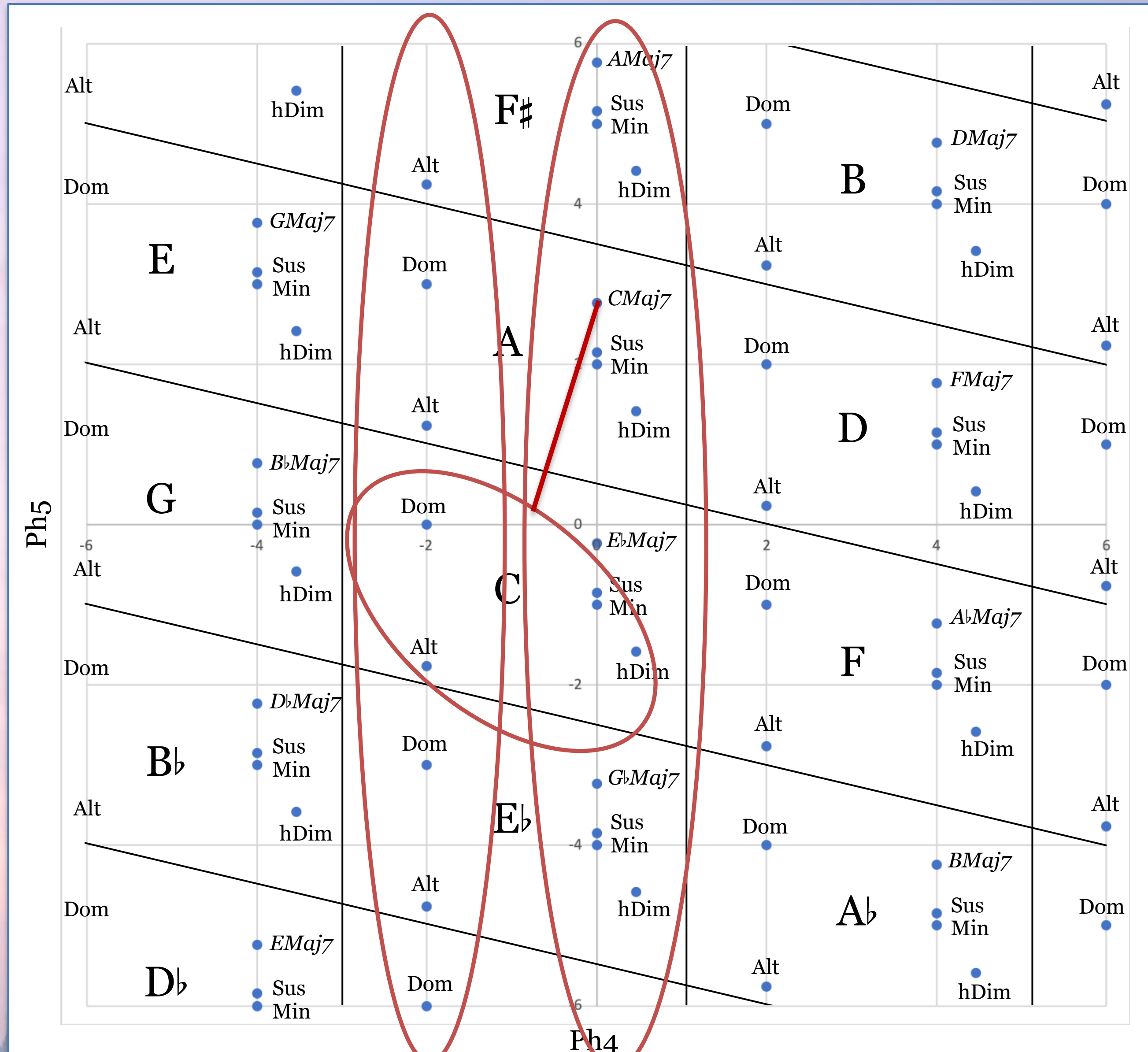
Chords relationships can be mapped in **a phase space for $\mathbf{f_4}$ and $\mathbf{f_5}$**, with an added consideration of whole-tone relations (WT_0 vs. WT_1: the phase of f_6 always corresponds to the root)

Phase Space for Jazz Harmony (Ph_4-Ph_5)

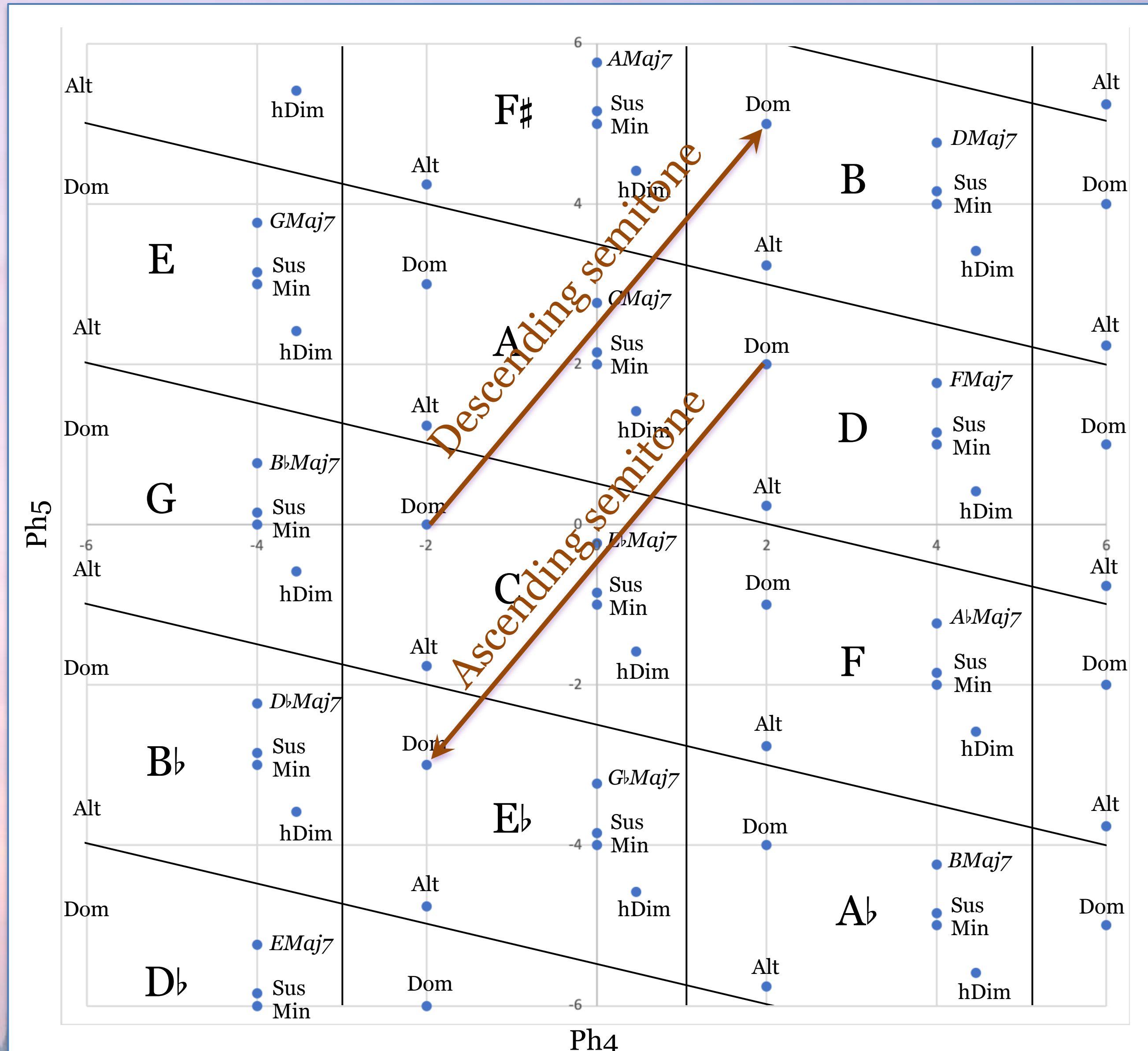
Proximity in phase space = **similarity of pc content.**

Chords with the same root group together *except major 7ths.*

Dominant and alt-dominant have distinct Ph_4 values.



Phase Space for Jazz Harmony (Ph_4-Ph_5)

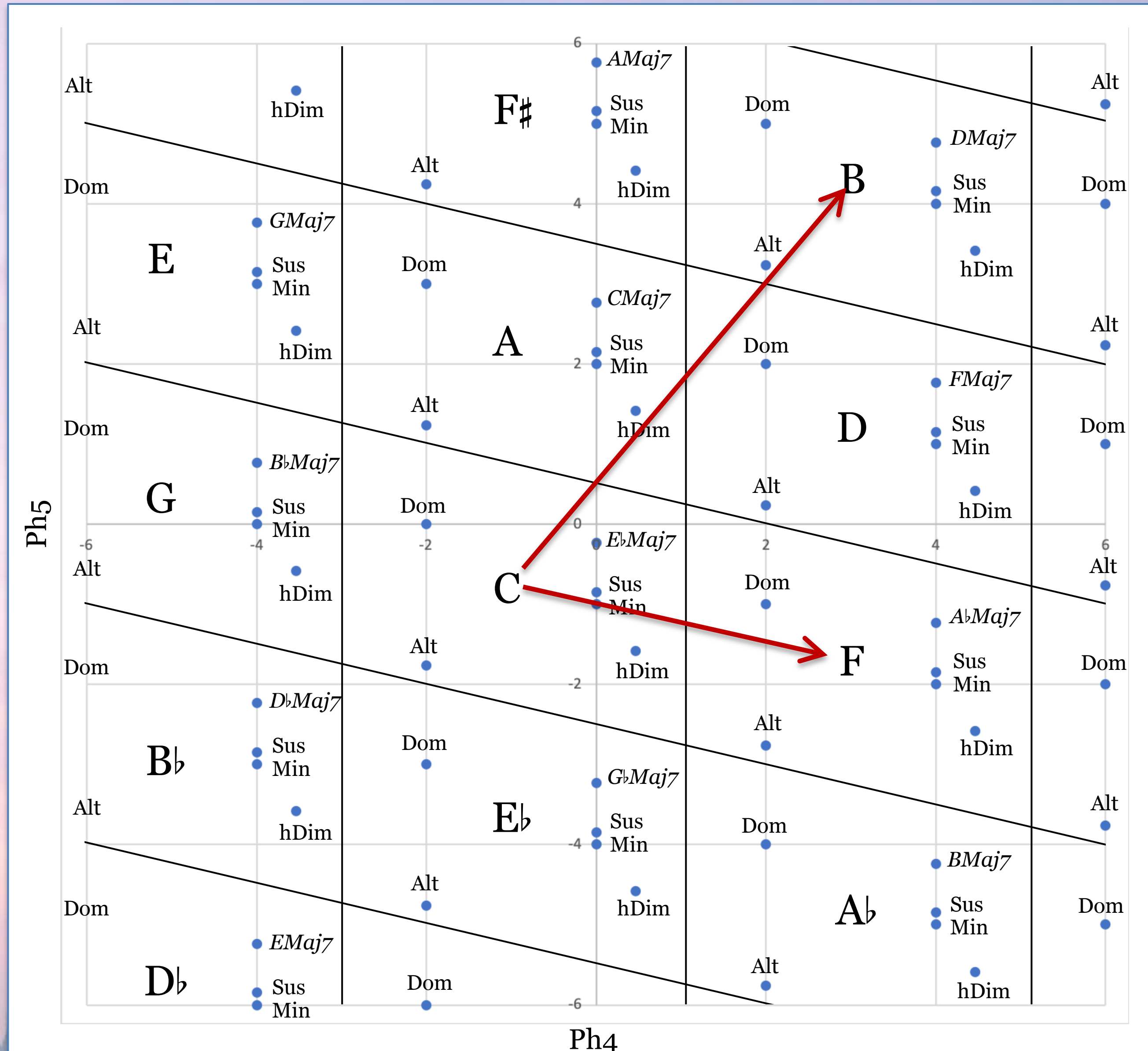


Similarity to the T_1 and T_{-1} vectors indicates the number of **ascending** or **descending semitones** in an interval function.

Phase Space for Jazz Harmony (Ph_4-Ph_5)

Typical functional motion (such as descending fifths) is to the left

Restricted vertical motion produces **diatonicism,** while **chromaticism** results from large vertical motion.

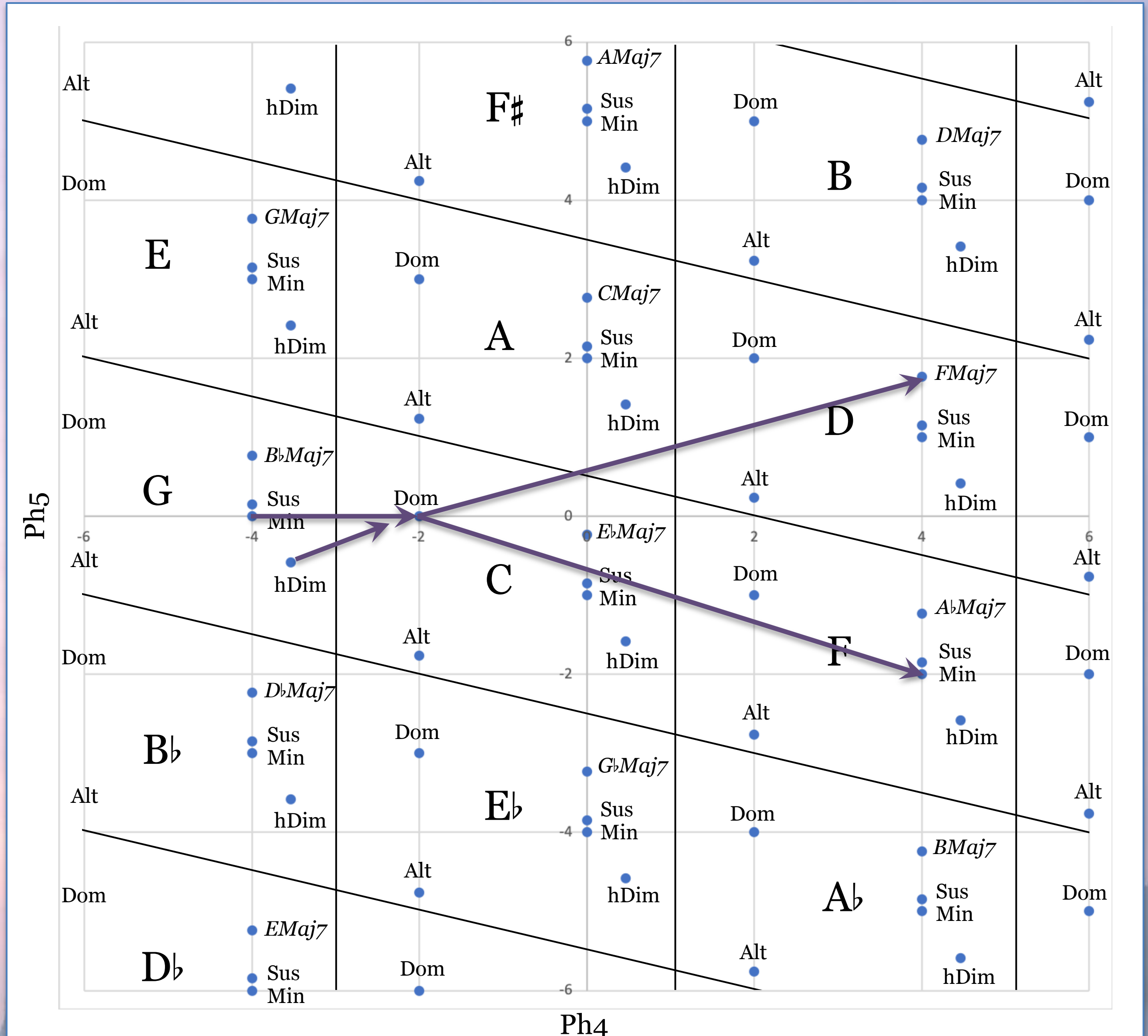


Phase Space for Jazz Harmony (Ph_4-Ph_5)

Typical ii-V-I progression

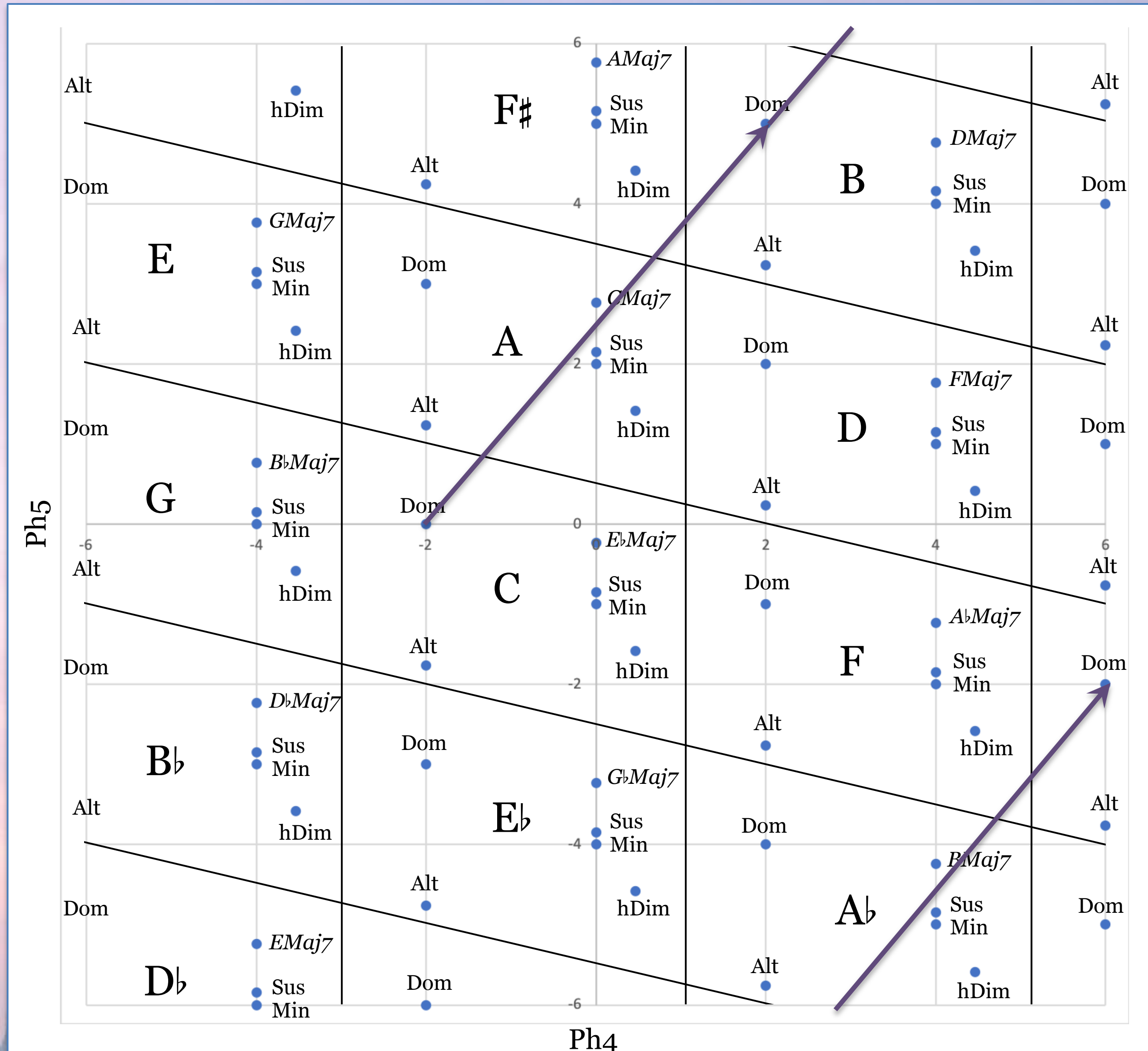
(F major)

(F minor)



Phase Space for Jazz Harmony (Ph_4-Ph_5)

Descending fifths progression with tritone substitution

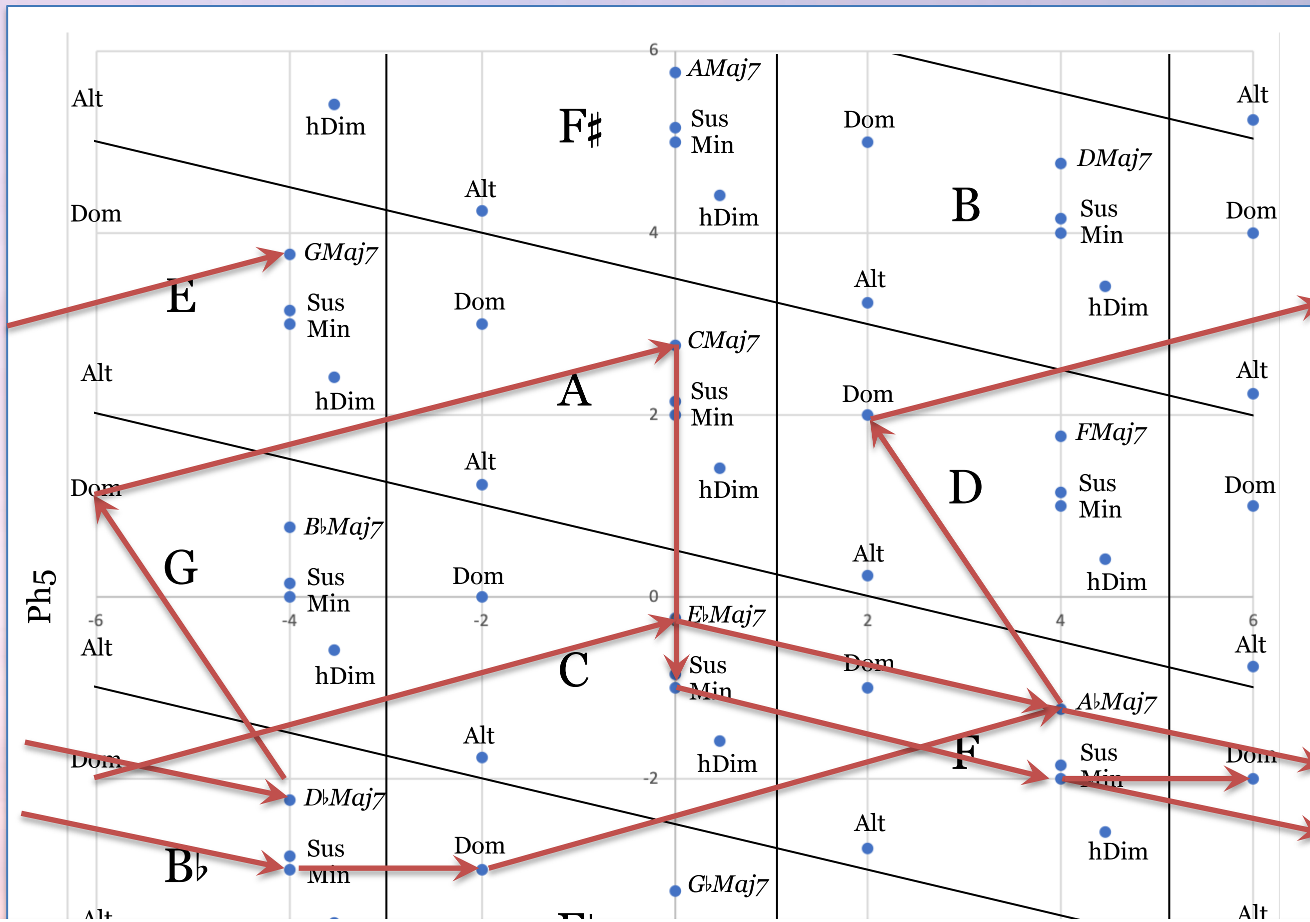


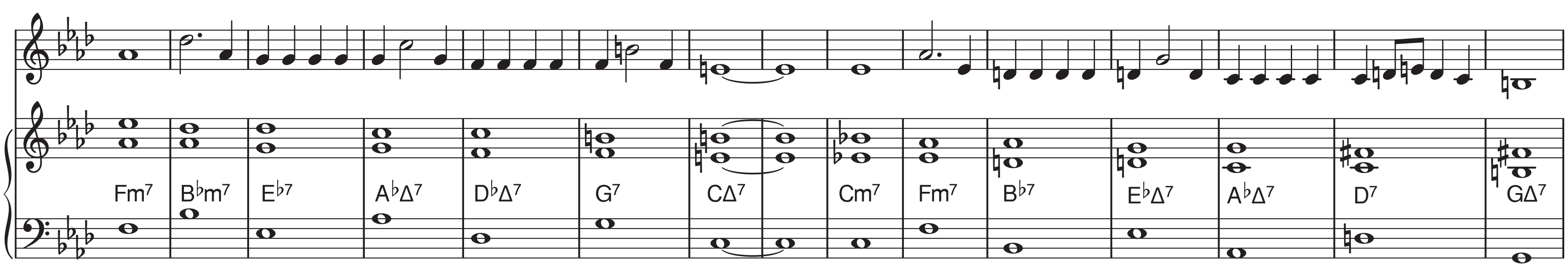
"All the Things You Are" in Ph_4-Ph_5 space

Meas. 1–4:
ii-V-I in A♭

Meas. 5–8:
Tritone shift takes us to C

Meas. 9–16:
Parallel shift leads to sequence of mm. 1–8





Example: “Daahoud” (Clifford Brown)

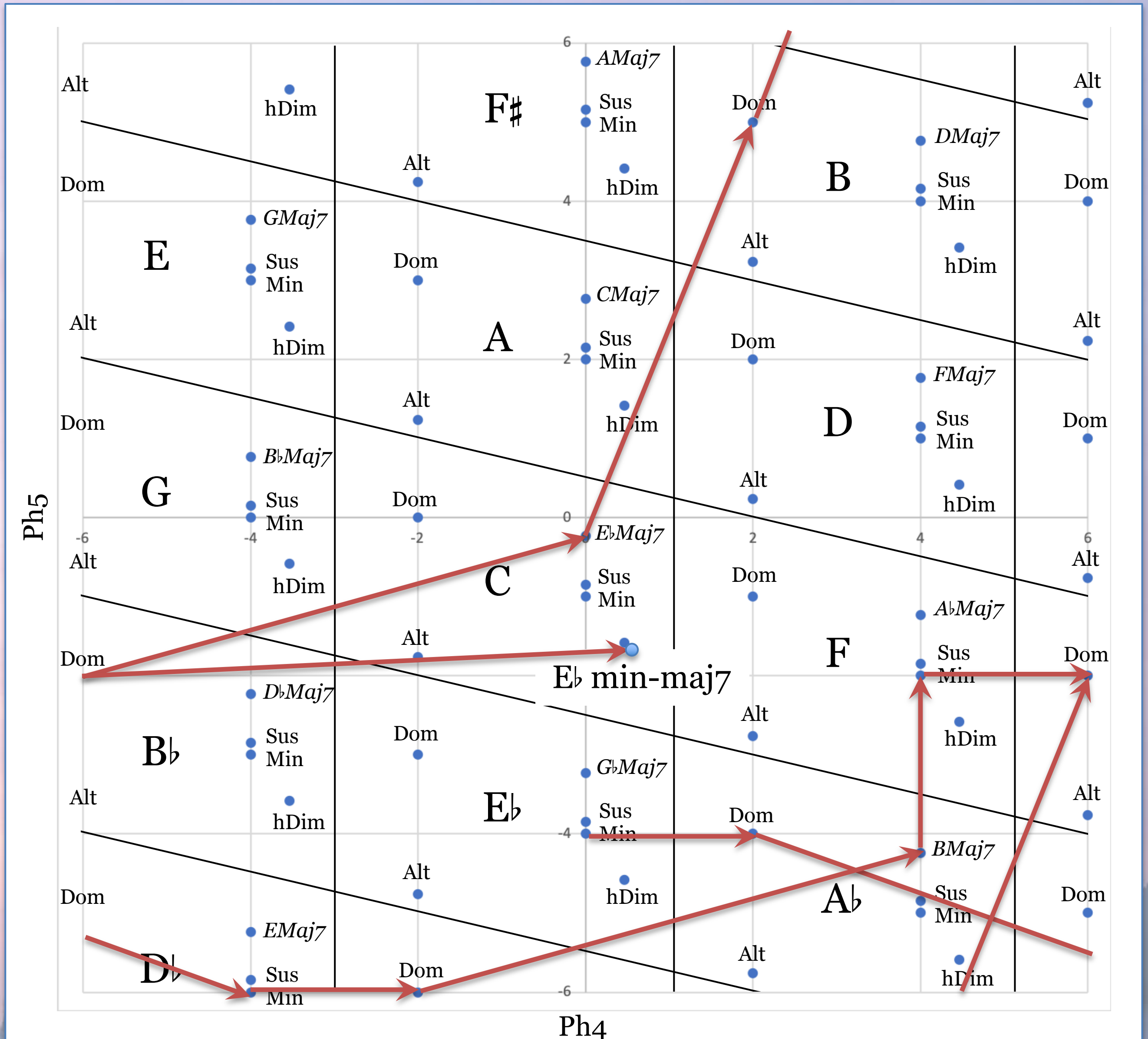
"Daahoud" in Ph_4-Ph_5 space

Chorus

Meas. 1–3:
Desc. 5ths (ii-V) to C♭

Meas. 4–6:
ii-V-I in E♭

Meas. 6–7:
Tritone sub. and resolution to E♭–Δ7



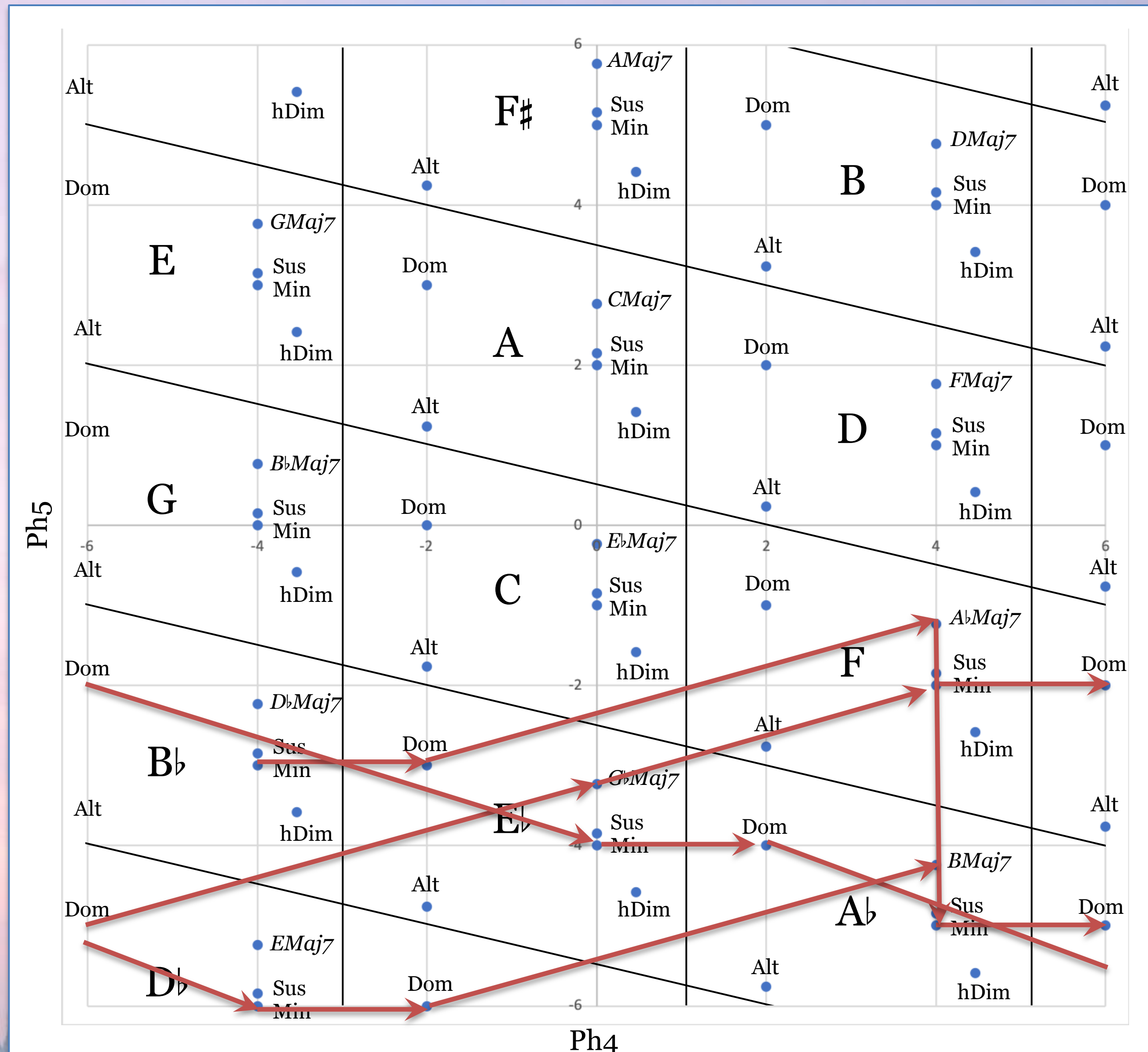
“Daahoud” in Ph_4-Ph_5 space

Bridge

Meas. 9–12:
ii-V-I in A♭

Meas. 13–15:
ii-V-I in G♭
(sequence)

Meas. 16:
ii-V in E♭



Repeat chorus

etc. . . .

Example: “Joy Spring” (Clifford Brown)

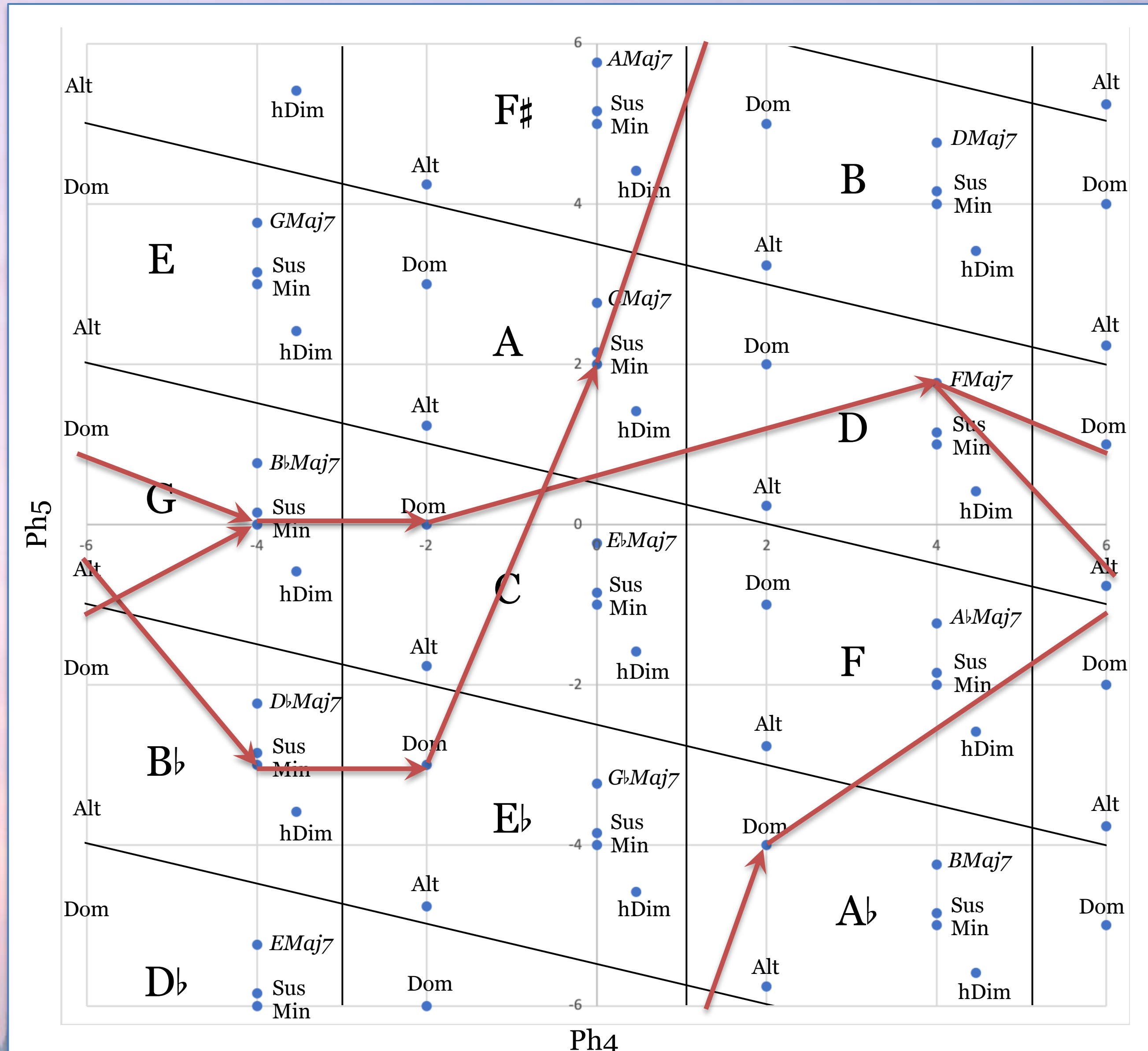
“Joy Spring” in Ph_4-Ph_5 space

First phrase

Meas. 1–3:
ii-V-I in F

Meas. 4–7:
ii-V in A♭

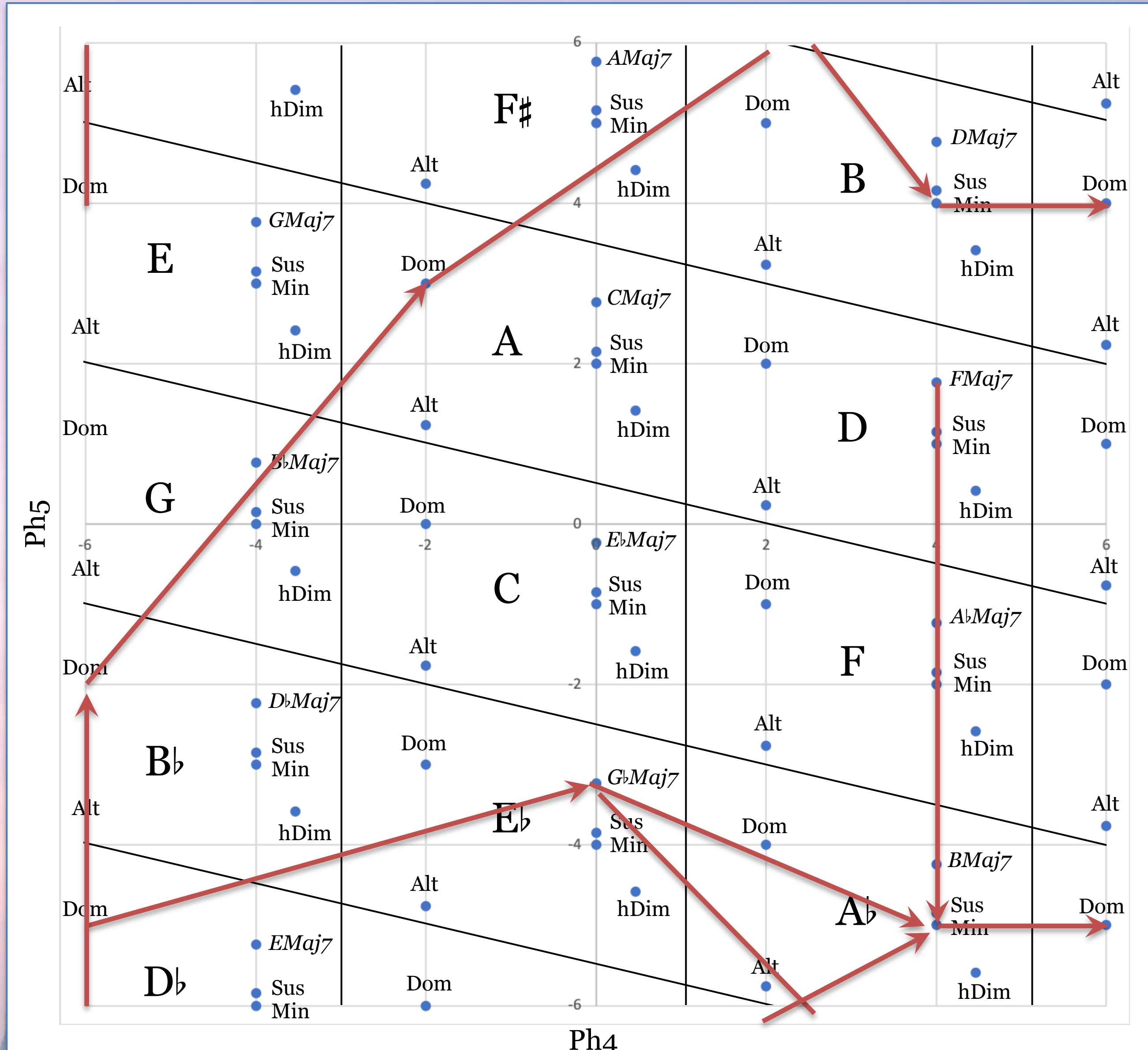
Tritone sub. progression back to F



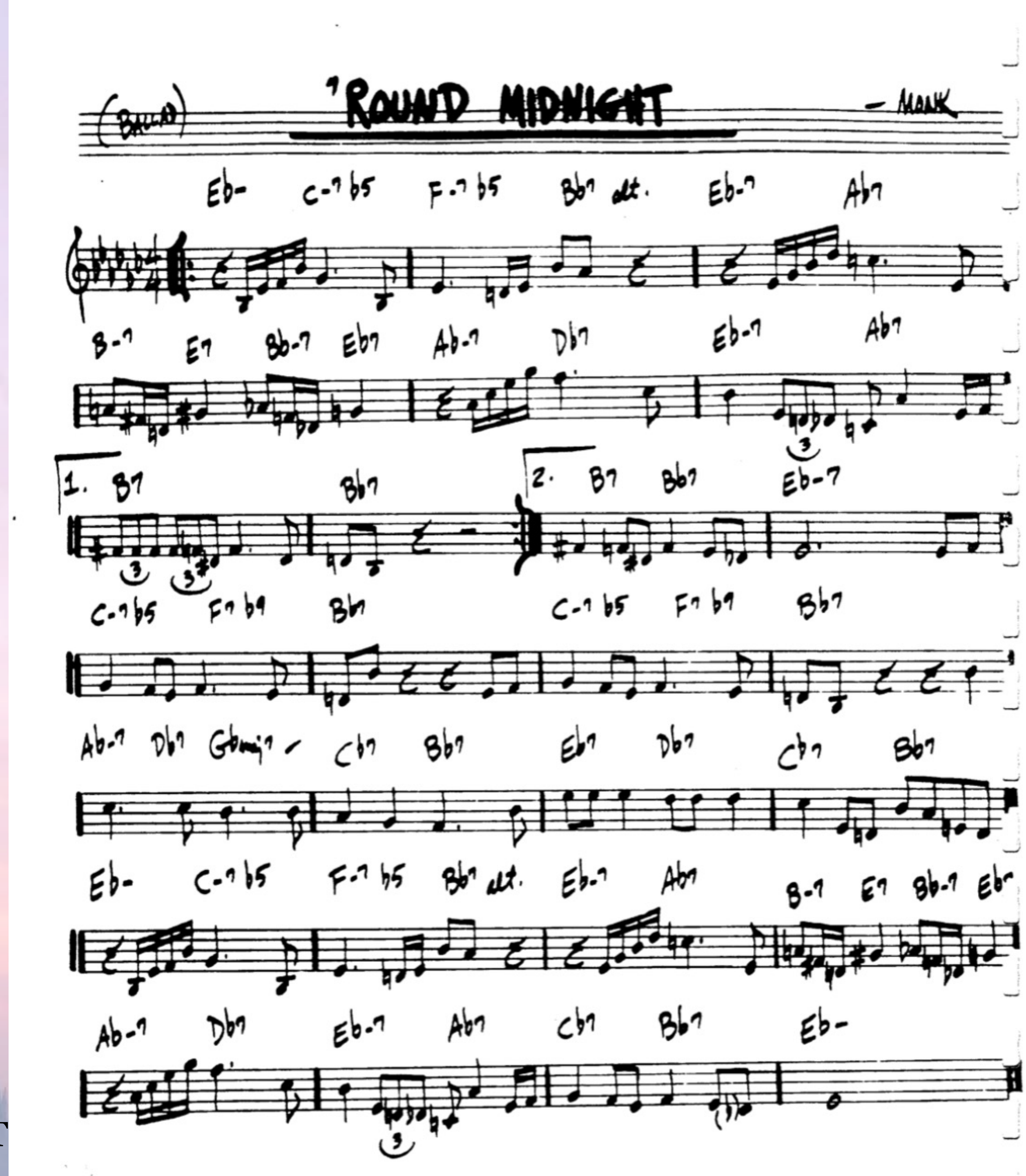
"Joy Spring" in Ph_4-Ph_5 space

Meas. 7–15:

Sequence up by semitone (G♭)



Example: “’Round Midnight” (Thelonious Monk)



"Round Midnight" in Ph_4-Ph_5 space

Meas. 1–3:
i-vi-ii-V-i in E♭ minor

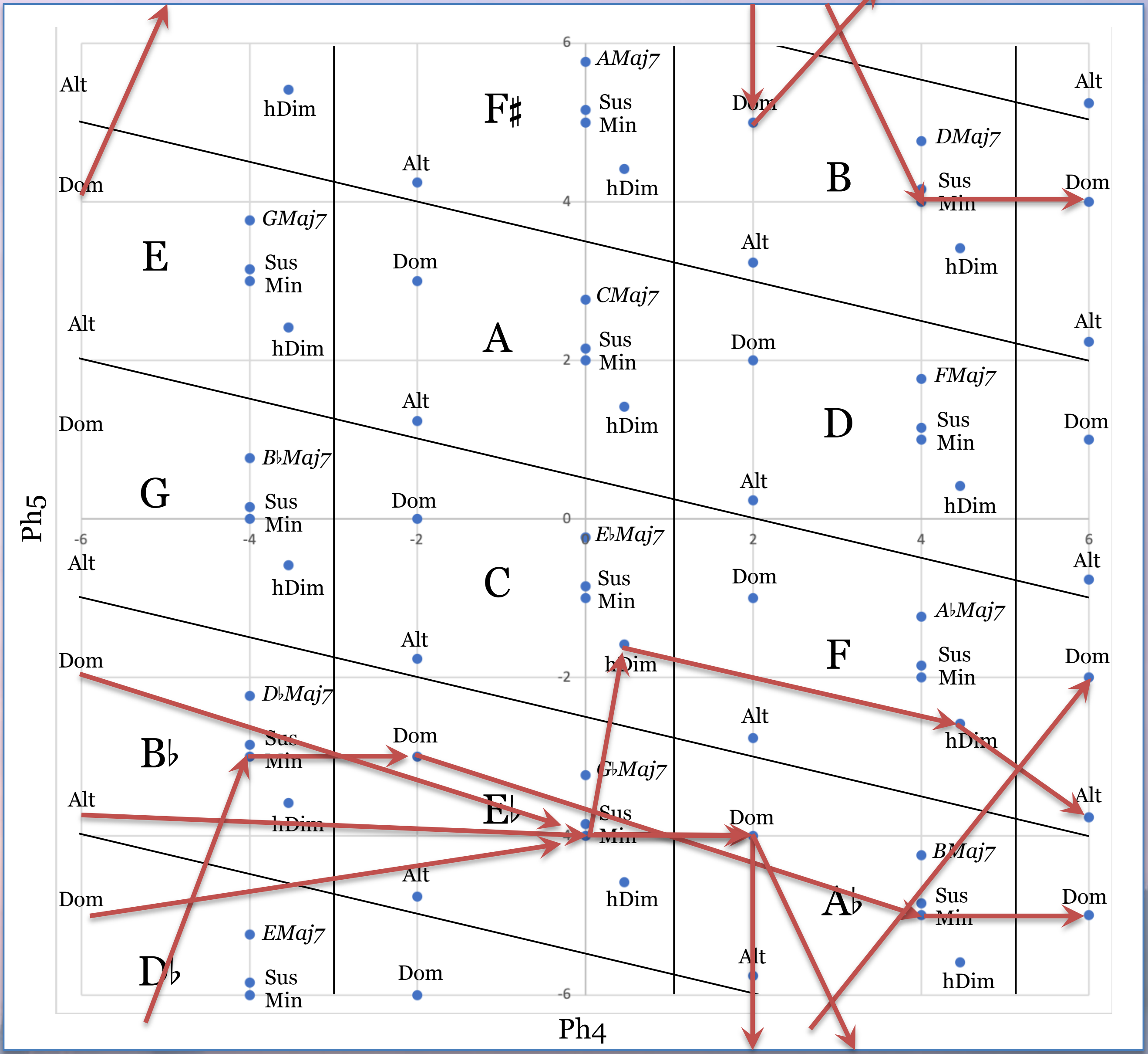
Meas. 3:
ii-V in D♭

Meas. 4:
Chromatic prog.

Meas. 5:
ii-V in G♭

Meas. 6:
ii-V in D♭

Meas. 7–8:
Tritone sub. of
ii-V in E♭



Addendum

Why do tonal chords and scales tend to emphasize certain qualities (f_3, f_4, f_5, f_6) regardless of style?

Fourier Qualities across Tonal Styles

Why do tonal chords and scales tend to emphasize certain qualities (f_3, f_4, f_5, f_6) regardless of style?

For example:

- Classical tonality: f_5, f_3
- Jazz, Ravel: f_5, f_4, f_6
- Late Scriabin: f_4, f_6
- Debussy: f_5, f_6, f_4, f_3

Fourier Qualities across Tonal Styles

Why do tonal chords and scales tend to emphasize certain qualities (f_3, f_4, f_5, f_6) regardless of style?

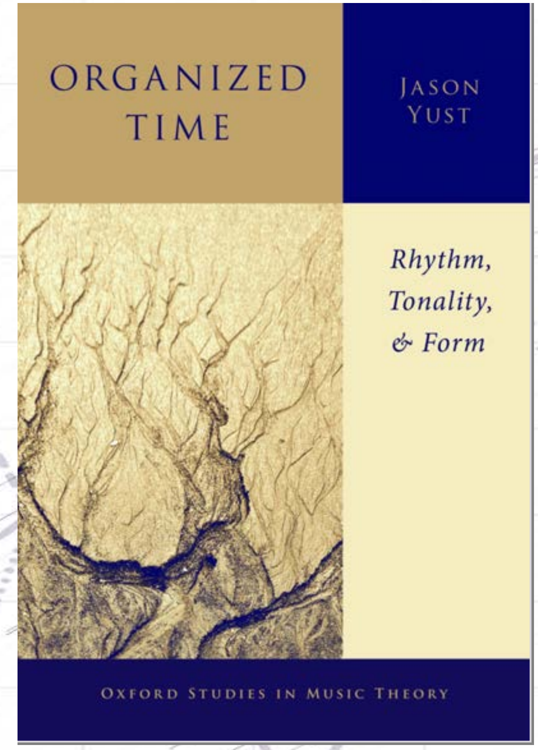
These qualities (f_3, f_4, f_5, f_6) are precisely those in which **semitones have relatively large phase distances.**

$\Rightarrow$

Semitonal voice leading is distinct from common tones. That is, semitones between chords tend to not overlap with common tones between chords.

Tonality, Fuzzy Voice Leading, and all that Jazz

Jason Yust, BOSTON UNIVERSITY

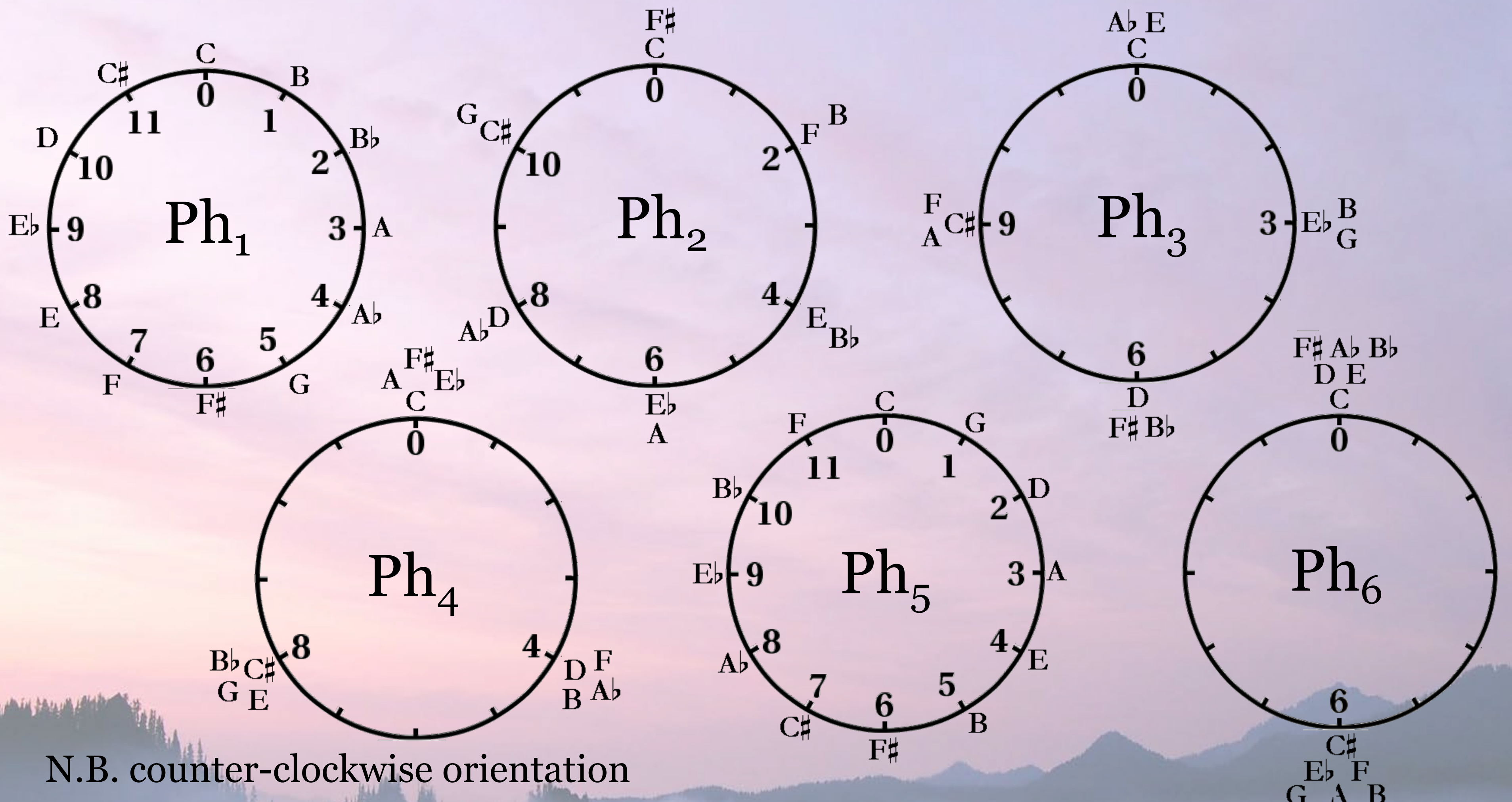


You can find this talk
and more at
http:/people.bu.edu/jyust

Thanks!

Phase Spaces

One-dimensional phase spaces are Quinn's *Fourier balances*, superimposed *n*-cycles created by multiplying the pc-circle by *n*.



N.B. counter-clockwise orientation