

# **Funktionslust**

for string quartet

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Christopher Fisher-Lochhead

## **Funktionslust [2018-21]** for string quartet

written for the JACK Quartet

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In college, I studied viola with a teacher who hewed closely to a very old-school type of classical pedagogy. All his students practiced the standard scales, finger exercises, and etudes; we learned the standard orchestral excerpts: Strauss's Don Juan, Mendelssohn's Midsummer Night's Dream Overture, Shostakovich's Fifth Symphony; and we cycled through the meager repertoire written or purloined for the viola: Walton, Bartok, Bach, Clarke, Brahms, and more Bach. At this time, my relationship to my instrument (a 2002 viola made by Long Island institution Charles Rufino that I still play today) was one of antagonism—its shape and substance, not to mention my body's own physical limitation, seemed to exist primarily as vectors of resistance that had to be conquered. This notion of music-making as subjugation was one that was reinforced over and over: we all idolized our peers who could execute the notes in the score with mechanical perfection (to call someone "a machine" was the highest compliment). At one point I even remember a visiting artist describing Bach's Chaconne as "Everest," aptly capturing the rapaciousness of classical pedagogy with an image of heteropatriarchal imperialist conquest.

It was only by immersing myself in the music of improvisers and by studying the interventions of 20th Century experimentalists and firebrands into classical instrumental technique that I was able to finally shed the antagonistic relationship I had to my viola. I have come to embrace an approach to my instrument that values listening, exploration, and play—and it is this approach that I have tried to channel in this piece.

"Funktionslust" is an antiquated psychological term describing the pleasure one takes in doing what one is best suited to: a fish swimming, a bird flying, a cheetah running. Its choice as the title of this piece—while a bit tongue in cheek given the virtuosity of the instrumental writing—reflects my desire to ground the musical language of the piece in the physical structure of the instruments themselves and the bodies of the performers. The adapted tablature notation is detailed and specific, but it offers the performer bodily choreographies and fluctuations of velocity and muscle tension instead of prescribing results to be achieved.

The process of composing this piece unfolded slowly and methodically starting in the Fall of 2018 and stretching through the first year of the COVID-19 Pandemic. Because of personal and professional pressures during that period, I often could only manage to peck away at it once or twice a week. Tinkering with the minutia of a score as detailed and dense as this can come to feel like an abstract ritual of penance for an absent and unknowable transgression. But, as disconnected as such work can feel from the act of making music, it is nevertheless intensely pleasurable to me. I guess that is the other significance of the title: the perverse joy I get from sitting alone making scores—reifying imagined ideations, choreographies, and soundings.

—Chris Fisher-Lochhead

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## Tuning / Scordatura

With the exception of the cello's top string, all the instruments in the quartet employ standard tuning—although they should be tuned in just fifths (3/2's) and not adjusted to equal-tempered approximations. The cello's top string should be tuned down a just major second (9/8) so that it matches the G-string of the violins and the viola.

Cello tuning:

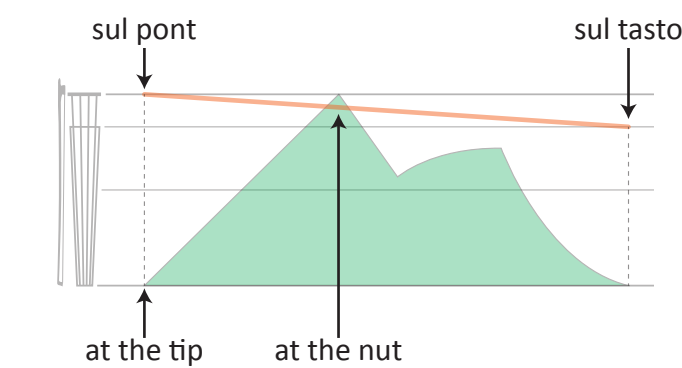


## Pitch and Instrumental Technique Notation

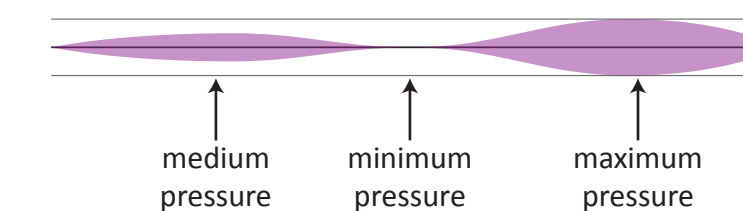
This score uses a system of notation that is a hybrid between traditional descriptive notation and tablature notation. The action of the left hand is indicated on a standard 5-line staff using the pitches that correspond to the sounding pitch achieved with normal (non-harmonic) finger pressure. It will normally be clear which string is to be stopped, but when clarification is needed, strings are indicated using roman numerals, with [i] corresponding to the highest string and [iv] corresponding to the lowest string. Whenever string crossings are not specifically indicated with tablature (see below), all of the notated pitches should be played. When open strings are to be played, they will be notated using traditional pitch notation, even though no actual action by the left hand is required.

Underlaid behind this 5-line staff is a tablature staff that indicates bowing and contact point. For the notation of bowing—given in green—the vertical position on the staff corresponds to the location on the bow, with the bottom mapping on to the bow's tip and the top mapping on to its nut. Thus, upward movement of the bowing notation on the staff corresponds to an upbow, downward movement to a downbow. For the notation of contact point—given in orange—the vertical position on the staff corresponds to the point of contact (for the bow or finger) on the string(s), with the top mapping on to the bridge and the bottom mapping on to the end of the strings by the pegs.

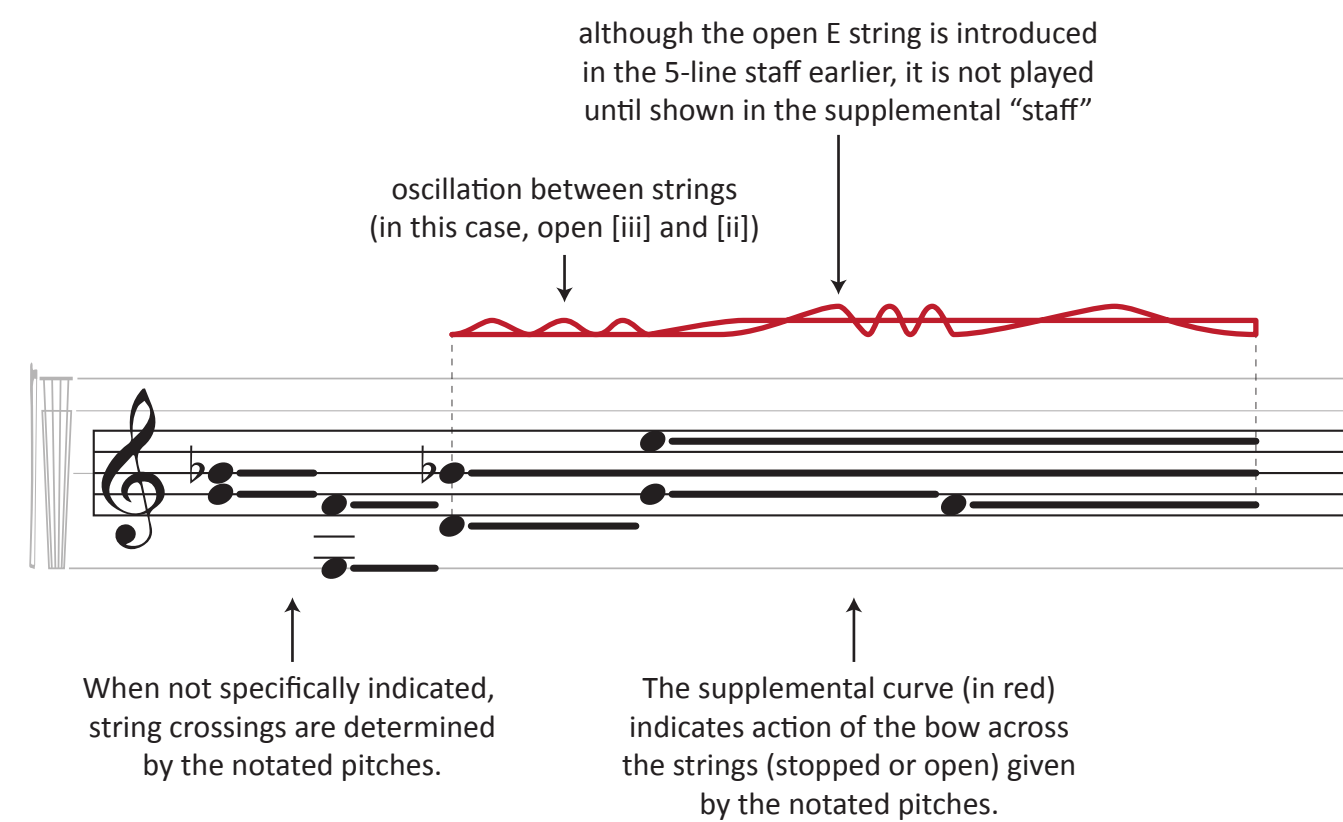
Horizontal guidelines are provided that indicate the edge of the fingerboard (mostly used to indicate a *sul tasto* contact point) and the halfway point of the string (octave harmonic). With the 5-line staff superimposed, the halfway guideline aligns with the middle line of the staff.



Right-hand pressure (roughly corresponding to loudness or dynamics) is indicated with a separate staff underneath the hybrid 5-line/tablature staff. The thickness of the shape on that staff (in purple) indicates the amount of pressure to be used, from almost none to maximum pressure. The actual resulting loudness will be determined by a number of other factors beyond pressure and no effort should be made to interpret the pressure staff as strictly indicating loudness; it indicates only the amount of physical force exerted by the right hand.



When not specifically indicated, string crossings are determined by the pitch notation on the 5-line staff. However, when string crossings are decoupled from the left-hand action, a supplemental “staff” is added above the hybrid 5-line/tablature staff. The string crossings—given in red—are indicated by the shape of this supplemental figure. There is no fixed vertical orientation for this “staff.” Instead, the relative shaping of the string crossings indicate the action of the bow across whichever strings are notated at that given moment according to the pitch notation on the 5-line staff.



## Rhythm

The rhythmic notation in this piece is completely proportional. In other words, the horizontal spacing of objects in the visual space corresponds exactly to their rhythmic positions. Rational rhythmic proportions are given on the "rhythm staff" above the hybrid 5-line/tablature staff using a quasi-traditional form of notation. In addition to the beams and tuplets that indicate rhythmic values, the rhythm staff also houses the dots that arte traditionally found next to the notehead. Each vertical stem descending from the rhythm staff corresponds to a musical event: the beginning or end of a gesture, the beginning or end of a new playing technique, the peak or turning point of an intensity envelope, etc. "Empty" rhythmic values are given by stem nubs.

Given that stems only indicate musical events, the rhythm staff does not directly indicate duration. In this system, a musical object's duration can be determined as the distance between the points of its onset and its end. Sustained events—including sounding objects and performance acts—are indicated by horizontal lines (solid lines, dotted lines, or wavy lines, depending on the type of event). When there is a rapid succession of events, the sustain line can be omitted for the sake of clarity. In such cases, the notated event lasts until the next event, and therefore its duration matches the rhythmic value given in the rhythm staff.

Grace notes are used to indicate any rhythmic placement that does not fit the grid given in the rhythm staff. In the two "drift" sections, some entrances are cued by events in other parts, indicated by a red vertical arrow from the trigger event to the cued entrance.

Conventional time signatures are not used. For the sections of the piece labelled with roman numerals (i to xiii), the rhythm is determined by a modified talea structure. The talea's durational values (analogous to beats) are given in the space between the 1st and 2nd violin staves and between the viola and cello staves. Vertical dotted lines are used to show the division of rhythmic time into these values; vertical solid lines indicate a larger grouping of values (analogous to downbeats). For the remaining sections, the rhythmic pulse is given in the same way. For purposes of rehearsal or performance, a click track is available on demand.

## Techniques

- groan** The bowing technique I call "groan" is executed by using low bowspeed and high bow pressure to create a noisy, perforated timbre that nonetheless still has a discernible central pitch. As is indicated in the notation, the bow's contact point itself determines the sounding pitch. With the left hand, dampen the other strings as needed.
- distal** Distal bowing indicates a contact point for the bow on the "wrong" side of the left hand. The notation of the left hand's placement corresponds to a traditional contact point (proximal bowing) and the new sounding pitch is given in parentheses. This is only used for the 2nd violin while it is held in the lap.
- proximal** Proximal bowing indicates the traditional contact point for the bow (between the left hand and the bridge).



A left-hand oscillation (trill or tremolo) between two fingers. The initial noteheads define the oscillating pitches and the secondary beams define the rate of oscillation.



A left-hand single-finger oscillation. This is exclusively used with harmonic pressure (indicated by the notehead and the light color of the sustain).

**pizz.**

For pizzicato, the contact point is indicated with orange [x] noteheads. In passages where the bow is also being used, this same notehead—along with the standard + symbol—is used to indicate left-hand pizzicato, except in the “drift” sections in the cello, where the recurring open-G-string left-hand pizzicato is indicated with the + alone.



Dampen all sound at the indicated rhythmic position.



Taking a parallel orientation between the bow and the bridge as the horizontal baseline, bow rotation is indicated using an approximate angle above or below that baseline.



Although the tablature notation employed here is able to implicitly indicate traditional articulations and expressive indications, occasionally a supplemental articulation is added (bow tremolo, accents, and tenuto marks in particular). These should not be interpreted as taking the place of the tablature notation, but rather as providing clarification or a subtle modulation of those parameters.

This piece uses the Helmholtz-Ellis system of accidentals. For a comprehensive overview of this system and just intonation (JI) more generally, see [plainsound.org](http://plainsound.org).

With a few exceptions, this piece uses a 13-limit JI harmonic system. The accidentals used are summarized below.

# ♯ ♭ 3-limit (Pythagorean) Intervals

♯♯ ♯♯ ♯♯ ♯♯ ♯♯ ♯♯ 5-limit (Ptolemaic) Intervals

♯ ♯ ♯ 7-limit (Septimal) Intervals

♯ ♯ 11-limit (Undecimal) Intervals

♯ ♯ 13-limit (Tridecimal) Intervals

The rational relationship of frequencies created by both parts of a divided string determines the harmonic materials (and some of the rhythmic materials) used herein. The two pitches produced, along with the open string's pitch—G (195.5 Hz)—are notated below using Helmholtz-Ellis accidentals. Below those three pitches is a harmonic extrapolation, which includes the integer factors necessary to express their rational interval relationships, plus any other pitches resulting from the interaction of those same factors. It is this harmonic extrapolation that generates the harmonic material.

The image displays a musical score with two systems. The first system is divided into two parts: "smaller part of string" and "larger part of string".

**System 1: Smaller part of string**

- Notes: 1/2, 7/15, 6/13, 5/11, 4/9, 7/16, 3/7, 5/12, 2/5, 5/13, 3/8, 4/11, 5/14, 1/3, 5/16, 4/13, 3/10, 2/7, 3/11, 4/15, 1/4
- Accidentals: Helmholtz-Ellis symbols (circles with lines) indicating pitch classes.
- Integer factors: (1), 3•5•7, 3•7•13, 3•5•11, 3<sup>2</sup>•5, 3<sup>2</sup>•7, 3•7, 3•5•7, 3•5, 5•13, 3•5, 7•11, 3<sup>2</sup>•5•7, 3, 5•11, 3<sup>2</sup>•13, 3•5•7, 5•7, 3•11, 3•5•11, 3

**System 1: Larger part of string**

- Notes: 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va, 8va
- Accidentals: Helmholtz-Ellis symbols.
- Integer factors: 3/13, 2/9, 3/14, 1/5, 3/16, 2/11, 1/6, 2/13, 1/7, 2/15, 1/8, 1/9, 1/10, 1/11, 1/12, 1/13, 1/14, 1/15, 1/16 → ∞

**System 2: Smaller part of string**

- Notes: 10/13, 7/9, 11/14, 4/5, 13/16, 9/11, 5/6, 11/13, 6/7, 13/15, 7/8, 8/9, 9/10, 10/11, 11/12, 12/13, 13/14, 14/15, 15/16 → 1
- Accidentals: Helmholtz-Ellis symbols.
- Integer factors: 3•5•13, 3<sup>2</sup>•7, 3•7•11, 5, 3•13, 3<sup>2</sup>•11, 3•5, 11•13, 3•7, 3•5•13, 7, 3<sup>2</sup>, 3<sup>2</sup>•5, 5•11, 3•11, 3•13, 7•13, 3•5•7, 3•5

**System 2: Larger part of string**

- Notes: +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va, +8va
- Accidentals: Helmholtz-Ellis symbols.

This musical score is divided into two sections, **i** and **ii**, separated by a vertical line. It consists of four staves:

- Staff 1:** Treble clef, key signature of two flats. It features complex rhythmic patterns with time signatures of 3:2, 5:4, and 7:4. A red wavy line above the staff indicates a vibrato or tremolo effect. Green shading is used for dynamic markings, and purple arrows indicate phrasing or breath marks.
- Staff 2:** Treble clef, key signature of two flats. It contains a series of notes with rhythmic values of 3, 5, 3, 3, 7, 7, and 3. A box labeled "lap" is positioned above the staff, and a box labeled "groan" is below it. A "distal" marking is also present.
- Staff a:** Bass clef, key signature of two flats. It mirrors the rhythmic complexity of Staff 1, with time signatures of 3:2, 5:4, and 7:4. Roman numerals  $[iii]$  and  $[iv]$  are used for chordal indications. Green shading and purple arrows are also present.
- Staff c:** Bass clef, key signature of two flats. It contains notes with rhythmic values of 3, 5, 3, 3, 7, 7, and 3. A "groan" box is located below the staff.

Tempo markings are provided for the first and second parts:  $\text{♩} = 56$  and  $\text{♩} = 80$ .

iii iv

1  
2  
a  
c

iii iv

Annotations: groan, distal, proximal

Tempo markings: ♩ = 56, ♩ = 48

Rhythmic ratios: 3:2, 5:4, 7:4

Staff 1: Treble clef, complex melodic line with red wavy lines above. Includes a circled 'iii' and a circled 'iv'.

Staff 2: Treble clef, rhythmic notation with notes and stems. Includes a circled 'iii' and a circled 'iv'.

Staff a: Bass clef, complex melodic line with red wavy lines above. Includes a circled 'iii' and a circled 'iv'.

Staff c: Bass clef, complex melodic line with red wavy lines above. Includes a circled 'iii' and a circled 'iv'.

The score is divided into two main sections by a vertical line labeled 'iii' and 'iv'. The first section (iii) contains measures with rhythmic ratios of 3:2, 5:4, and 3:2. The second section (iv) contains measures with ratios of 3:2, 3:2, 5:4, and 7:4. Annotations 'groan', 'distal', and 'proximal' are placed below the staves. Tempo markings of ♩ = 56 and ♩ = 48 are present. Red wavy lines and dashed boxes highlight specific melodic passages in staves 1 and a.



This musical score is divided into four staves, labeled 1, 2, a, and c. A vertical line labeled 'V' is positioned at the beginning of the second system. Staff 1 (treble clef) features a complex melodic line with various rhythmic groupings (7:4, 3:2, 5:4) and chord diagrams such as [iv], [ii], and [iii]. A red waveform is overlaid on the staff. Staff 2 (treble clef) contains a bass line with notes marked with numbers 7, 3, 5, 3, 5, 3, 5. It includes a 'groan' marking and a box indicating a tempo of 56. Staff 'a' (alto clef) has a melodic line with notes marked with numbers 7, 3, 5, 3, 5, 3, 5. It includes a 'proximal' marking, a 'beating: 13.037 hz' annotation, and a box indicating a tempo of 56. Staff 'c' (bass clef) contains a bass line with notes marked with numbers 7, 3, 5, 3, 5, 3, 5. It includes a 'groan' marking and a box indicating a tempo of 56. The score is heavily annotated with rhythmic ratios, chord diagrams, and performance markings.

vi

vii

1

2

a

c

vi

vii

The image displays a musical score for four staves, labeled 1, 2, a, and c. The score is divided into two sections, vi and vii. Staff 1 (treble clef) features a complex melodic line with various intervals and fingerings. Staff 2 (treble clef) provides a harmonic accompaniment with a 'distal' instruction. Staff a (alto clef) has a similar melodic line to staff 1. Staff c (bass clef) provides a low-frequency accompaniment with a 'proximal' instruction. Annotations include ratios (3:2, 13:8, 5:4, 7:4, 4:3), fingerings (3, 13, 5, 7), and performance directions like 'groan' and 'other strings as necessary'. A tempo marking of ♩ = 80 is present in the first section, and ♩ = 48 in the second. A 'beating: 13.037 hz' is noted in the lower right.

3:2 3:2 3:2 13:8 13:8 3:2 13:8 3:2 3:2 3:2 3:2 5:4 7:4 7:4

♩ = 80 3 13 13 3 13 13 3 3 5 7 7

distal

groan  
[⊕ other strings as necessary]

♩ = 80 3 13 13 3 13 13 3 3 5 7 7

beating: 13.037 hz

3:2 13:8 13:8 3:2 3:2 13:8 3:2 3:2 5:4 5:4 7:4 7:4

♩ = 48 3 5 7 7

proximal

groan

**viia** **[231]**

1

2

a

c

**viia** **[231]**

**distal** **groan**

$\text{♩} = 56$   $\text{♩} = 44$

$\text{♩} = 56$   $\text{♩} = 44$

Time signatures: 3:2, 5:4, 7:4, 11:8

Tempo markings:  $\text{♩} = 56$ ,  $\text{♩} = 44$

Dynamic markings: **distal**, **groan**

Staff 1: Treble clef, complex rhythmic patterns with fermatas and red wavy lines above.

Staff 2: Treble clef, chordal accompaniment with Roman numerals [iv] and [v].

Staff a: Alto clef, complex rhythmic patterns with fermatas and red wavy lines above.

Staff c: Bass clef, complex rhythmic patterns with fermatas and red wavy lines above.

viii b

ix a

The image displays a musical score for violin (1) and cello (c) with detailed performance annotations. The score is divided into two sections: **viii b** and **ix a**. The violin part (1) features a treble clef and a key signature of one flat. The cello part (c) features a bass clef and the same key signature. The score includes various rhythmic markings such as 3:2, 5:4, 11:8, and 5:3. Performance instructions include **groan**, **distal**, **shoulder**, **gradually rotate bow in accordance with expanding interval**, **[change finger pressure on top string only]**, **[finger both nodes]**, and **[one bow]**. The tempo is marked as **[poco rit.]** with a metronome marking of  $\text{♩} = 56$  changing to  $\text{♩} = 52$ . The score also includes fingering numbers (3, 5, 11) and fingerings for both nodes (i, ii, iii, iv). The violin part includes a **shoulder** marking at the end. The cello part includes a **groan** marking and a **[gradually rotate bow in accordance with expanding interval]** instruction. The score is annotated with green and purple shaded areas and dashed lines indicating specific performance techniques.

viii b

ix a

[drift\_1]

The image displays a musical score for a piece titled "[drift\_1]". It consists of four staves, labeled 1, 2, a, and c. Staff 1 is a treble clef with a "pizz." marking and ratios such as  $[\frac{7}{4} = 96.9]$ ,  $[\frac{13}{13.8} = 97.5]$ , and  $[\frac{3}{3.2} = 98.2]$ . Staff 2 is a treble clef with "pizz. shoulder" and "arco" markings, and ratios like  $[\frac{15}{15.8} = 96.4]$  and  $[\frac{7}{7.4} = 96.9]$ . Staff a is a treble clef with "pizz." and "[8va]" markings, and ratios such as  $[\frac{105}{105.64} = 84.3]$ ,  $[\frac{91}{91.64} = 78.8]$ ,  $[\frac{39}{39.32} = 73.1]$ , and  $[\frac{33}{33.32} = 67.5]$ . Staff c is a bass clef with "[l.h. pizz]" and "[arco]" markings, and ratios like  $3:2$ ,  $7:4$ ,  $3:2$ ,  $7:4$ , and  $7:4$ . A tempo line at the top shows a sequence of numbers: 52, 56, 60, 66. A red line with circles connects the tempo line to the "arco" section in staff 2. Purple and green shaded regions are present in the lower parts of the staves.

[drift\_1]

ixb

The image displays a musical score for three staves, labeled 1, 2, and a. Staff 1 is a treble clef staff with a key signature of one flat. Staff 2 is a treble clef staff with a key signature of one flat, featuring a complex melodic line with various intervals and a red wavy line above it. Staff a is a treble clef staff with a key signature of one flat, featuring a simpler melodic line with an 8va marking. The score is annotated with various mathematical ratios and intervals, including  $[\frac{11}{7} = 99]$ ,  $[\frac{5}{4} = 100]$ ,  $[\frac{9}{8} = 101.3]$ ,  $[\frac{55}{32} = 61.9]$ ,  $[\frac{45}{32} = 56.3]$ , and  $[\frac{9}{5} = 50.6]$ . Intervals of 3:2, 5:4, and 11:8 are marked. A central box contains the formula  $\leftarrow \text{note} = 104 = \text{note} \rightarrow (\text{note} = 52)$ . The score is divided into sections by a vertical line labeled 'ixb' at the top and bottom. The bottom of the page is labeled 'ixb'.

ixb

**X**

arco

1

groan

2

arco

a

c

**X**

This musical score is divided into four systems, each with two staves. The first system (1) features a treble clef staff with 'arco' and a 'groan' staff with rhythmic notation. The second system (2) has a treble clef staff with various time signatures and a 'groan' staff. The third system (a) uses an alto clef with 'arco' and a 'groan' staff. The fourth system (c) uses a bass clef with a 'groan' staff. Annotations include time signatures (11:8, 7:4, 5:4, 3:2, 7:6), dynamics (arco, groan), and performance markings (short, slurs, accents). The score is framed by 'X' at the top and bottom.

xi 35 231

1  
2  
a  
c

xi 35 231

This musical score is presented in four staves, labeled 1, 2, a, and c. The score is divided into three sections by vertical dashed lines, with section markers 'xi', '35', and '231' placed at the top and bottom of the page. Each staff contains a melodic line with various rhythmic values and accidentals. Below the main staves are two rows of rhythmic notation, each starting with a box containing a note followed by an equals sign and a number (e.g., ♩ = 56, ♩ = 72, ♩ = 44). These boxes are connected to the main staves by vertical lines, indicating the rhythmic values of specific notes. The score is heavily annotated with performance markings: red lines above the staves indicate dynamics or phrasing; green shaded areas under the notes represent pitch contours; purple shaded areas at the bottom of the staves represent vibrato or other effects; and various brackets and arrows indicate specific rhythmic groupings and relationships. Time signatures such as 3:2, 5:4, 7:4, and 11:8 are used throughout the score to denote complex rhythmic patterns. The notation includes a variety of note values, rests, and accidentals, all meticulously placed to convey the intended musical performance.



9/5

39

xiia

1

♩ = 45

♩ = 74

♩ = 80

2

a

♩ = 45

♩ = 74

♩ = 80

c

9/5

39

xiia

[drift\_2]

The image displays a complex musical score for a piece titled "[drift\_2]". It is organized into four vertical staves, labeled 1, 2, a, and c from top to bottom. Each staff contains musical notation, including notes, rests, and dynamic markings such as "pizz." (pizzicato) and "arco" (arco). The score is heavily annotated with mathematical ratios and brackets, indicating specific time intervals or ratios. For example, the top staff has ratios like  $\left[\frac{105}{64} = 84.3\right]$ ,  $\left[\frac{91}{64} = 78.8\right]$ ,  $\left[\frac{195}{128} = 84.4\right]$ ,  $\left[\frac{7}{7.4} = 90\right]$ ,  $\left[\frac{15}{15.8} = 96.4\right]$ , and  $\left[\frac{7}{7.4} = 96.9\right]$ . The second staff has ratios  $\left[\frac{15}{15.8} = 96.4\right]$  and  $\left[\frac{7}{7.4} = 96.9\right]$ . The third staff has ratios  $\left[\frac{105}{64} = 84.3\right]$ ,  $\left[\frac{15}{15.8} = 103.9\right]$ , and several instances of  $\frac{7}{7.4}$ . The bottom staff has ratios  $\frac{7}{7.4}$ ,  $\frac{3}{3.2}$ ,  $\frac{5}{5.4}$ , and  $\frac{7}{7.4}$ . Additionally, there are markings like "[8va]", "[1w]", and "[l.h. pizz]". The score also features various graphical elements such as red wavy lines, green shaded areas under notes, and purple dots on the staves. The overall layout is dense and technical, typical of a score for a contemporary or experimental music piece.

[drift\_2]

This musical score is divided into four staves, labeled 1, 2, a, and c. Each staff contains a complex arrangement of musical notation, including notes, rests, and dynamic markings. The score is characterized by its intricate rhythmic structure, featuring various time signatures and tempo markings.

**Staff 1:** Features a series of time signatures:  $\frac{13}{8}$  (97.5),  $\frac{13}{8}$  (78.8),  $\frac{7}{4}$  (160), and  $\frac{9}{8}$  (81). It includes performance instructions such as *arco* and *pizz.* and tempo markings of 60, 92, 72, 80, and 90. The staff contains several measures of music with notes and rests, and is accompanied by a purple waveform visualization.

**Staff 2:** Includes time signatures  $\frac{39}{32}$  (73.1),  $\frac{7}{4}$ ,  $\frac{11}{8}$  (99),  $\frac{5}{4}$  (100), and  $\frac{9}{8}$  (101.25). It features *arco* and *pizz.* markings and tempo markings of 60, 92, 72, 80, and 90. The staff contains several measures of music with notes and rests, and is accompanied by a purple waveform visualization.

**Staff a:** Includes time signatures  $\frac{7}{4}$  (105),  $\frac{9}{8}$  (102.8),  $\frac{45}{32}$  (101.3),  $\frac{3}{2}$ ,  $\frac{5}{4}$ , and  $\frac{5}{4}$ . It features *pizz.* and *arco* markings and tempo markings of 60, 92, 72, 80, and 90. The staff contains several measures of music with notes and rests, and is accompanied by a purple waveform visualization.

**Staff c:** Includes time signatures  $\frac{55}{32}$  (123.75),  $\frac{45}{32}$  (112.5), and  $\frac{9}{8}$  (101.25). It features *pizz.* and *arco* markings and tempo markings of 60, 92, 72, 80, and 90. The staff contains several measures of music with notes and rests, and is accompanied by a purple waveform visualization.

This musical score consists of four staves, labeled 1, 2, a, and c. Each staff contains musical notation with various annotations and mathematical ratios.

- Staff 1:** Features a treble clef and a key signature of one sharp (F#). It includes a **pizz.** (pizzicato) section and an **arco** (arco) section. Annotations include  $[^7_2 = 90]$ ,  $[^{195}_{195} = 84.4]$ ,  $[^{15}_{15} = 96.4]$ , and  $[^{105}_{105} = 84.3]$ . A tempo marking  $\text{♩} = 52$  is present.
- Staff 2:** Features a treble clef and a key signature of one sharp (F#). It includes an **arco** section and a **pizz.** section. Annotations include  $[^{15}_{15} = 103.9]$ ,  $[^{91}_{91} = 78.8]$ , and  $[^{105}_{105} = 84.3]$ . A tempo marking  $\text{♩} = 52$  is present.
- Staff a:** Features a bass clef and a key signature of one sharp (F#). It includes an **arco** section and a **pizz.** section. Annotations include  $[^{15}_{15} = 96.4]$ ,  $[^7_7 = 97]$ , and  $[^{15}_{15} = 96.4]$ . A tempo marking  $\text{♩} = 52$  is present.
- Staff c:** Features a bass clef and a key signature of one sharp (F#). It includes an **arco** section. Annotations include  $[^7_7 = 97]$  and  $[^{15}_{15} = 96.4]$ . A tempo marking  $\text{♩} = 52$  is present.

Additional annotations include **arco**, **pizz.**, and **jeté**. Mathematical ratios such as 7:4, 15:8, 3:2, 5:4, and 105:64 are used to denote specific intervals or durations. A **beating: 13.968 hz** is noted at the bottom right.

1

2

a

c

91:64 [iii] [iii] [iii] [iii] [iv] [iv]

33:32 [iii] [iii] [iii] [iii] [iv] [iv]

39:32 [iv] [iv]

55:32 [iv] [iv]

$\text{♩} = 48$

13:12 3:2 7:4 11:8 3:2 5:4

7:6 3:2 13:8 5:4 3:2 11:8

13:12 7:4 3:2 11:8 5:4 3:2

3:2 13:12 7:4 11:8 5:4

7:6 13:8 3:2 5:4 11:8 3:2

3:2 7:6 13:8 3:2 5:4 11:8

xiib

xiii

arco

$\text{♩} = 80$

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

$\text{♩} = 80$

$\text{♩} = 52$

3 7 3 5 7

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

7:4 3:2 5:4 7:4

xiib

xiii

This musical score is divided into four systems, labeled 1, 2, a, and c. Each system contains a staff with a treble or bass clef, a set of fingerings, and a set of dynamics. The score is annotated with various musical notations and performance instructions.

**System 1:** Treble clef. Fingerings: 7, 3, 5, 3, 7, 5. Dynamics:  $7:4$ ,  $3:2$ ,  $5:4$ ,  $3:2$ ,  $7:4$ ,  $5:4$ . Includes a "groan" instruction with a circled cross symbol and the text "[other strings as necessary]".

**System 2:** Treble clef. Fingerings: 7, 3, 5, 3, 7, 5. Dynamics:  $7:4$ ,  $3:2$ ,  $3:2$ ,  $5:4$ ,  $3:2$ ,  $7:4$ ,  $5:4$ . Includes a red curved line above the staff.

**System a:** Bass clef. Fingerings: 7, 3, 5, 3, 7, 5. Dynamics:  $7:4$ ,  $3:2$ ,  $5:4$ ,  $3:2$ ,  $7:4$ ,  $5:4$ . Includes a red curved line above the staff.

**System c:** Bass clef. Fingerings: 7, 3, 5, 3, 7, 5. Dynamics:  $7:4$ ,  $3:2$ ,  $5:4$ ,  $3:2$ ,  $7:4$ ,  $5:4$ . Includes a red curved line above the staff.

Each system concludes with a "short" instruction and a fermata symbol.

saws

1

proximal

2

a

c

saws

