
Mathematics and the Groove in Music

Nationale Wiskunde Dagen

February 6, 2009

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Outline

- Introduction
 - Rhythm
 - Importance of Rhythm
- Inner Metric Analysis
 - Mathematical Model for Analyzing the Rhythm
 - Some Applications
- Dance Music Classification, Music Information Retrieval

Introduction



Mambo !



Picture from hcs.harvard.edu/~hma-bdc



Merengue !

*In how far are all **mambos** more similar to each other than to a **merengue**??*

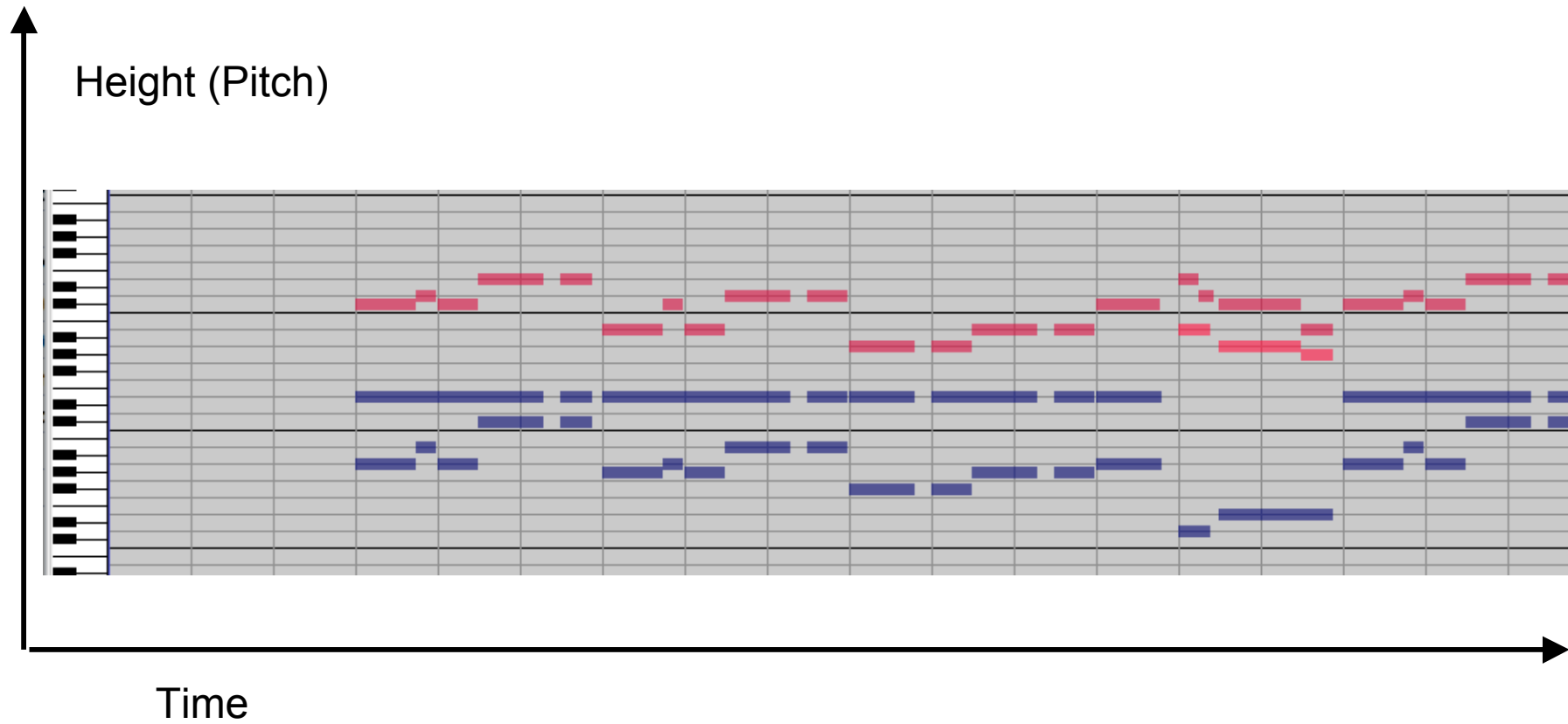


Jessica Phillips-Silver: Infant Rhythm and Music Research

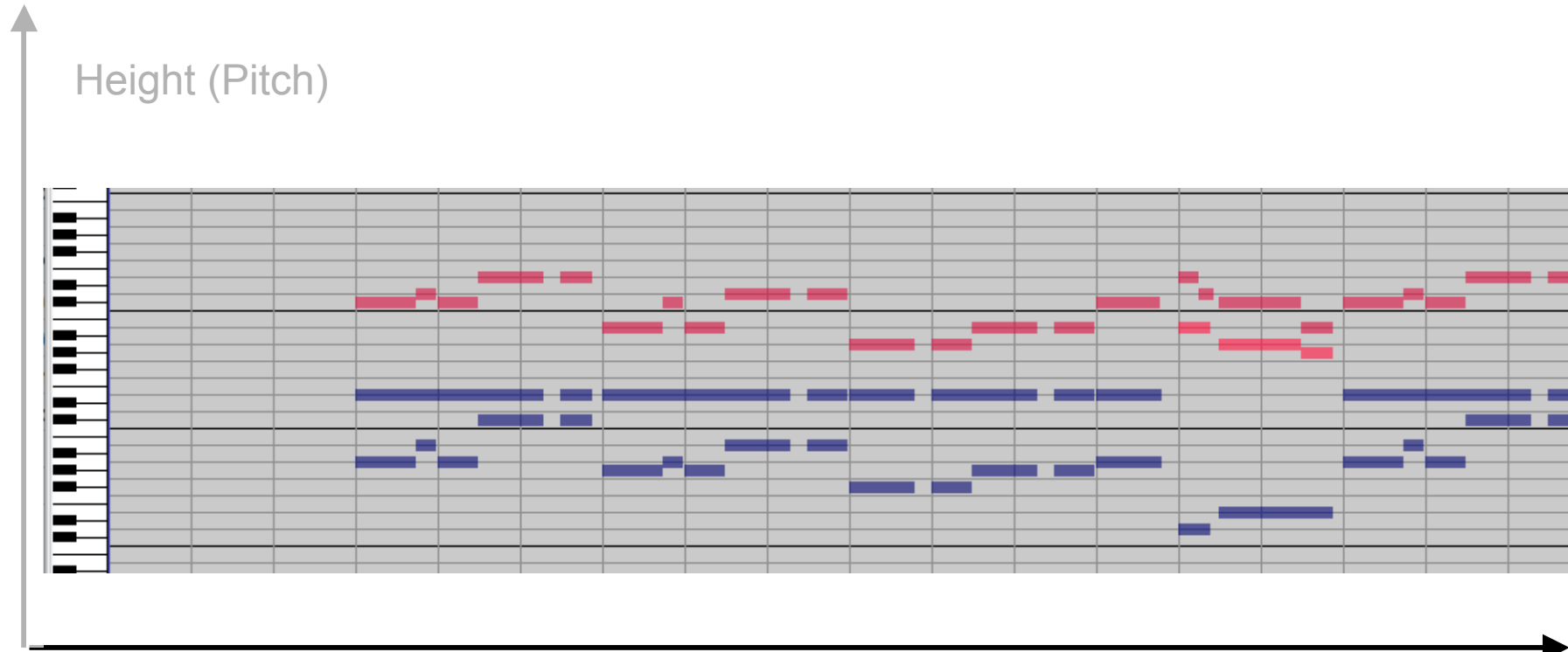
7 months old babies: triple meter bouncing, duple meter bouncing

Phillips-Silver/Trainor: Feeling the Beat: Movement Influences Infant Rhythm Perception, 2005

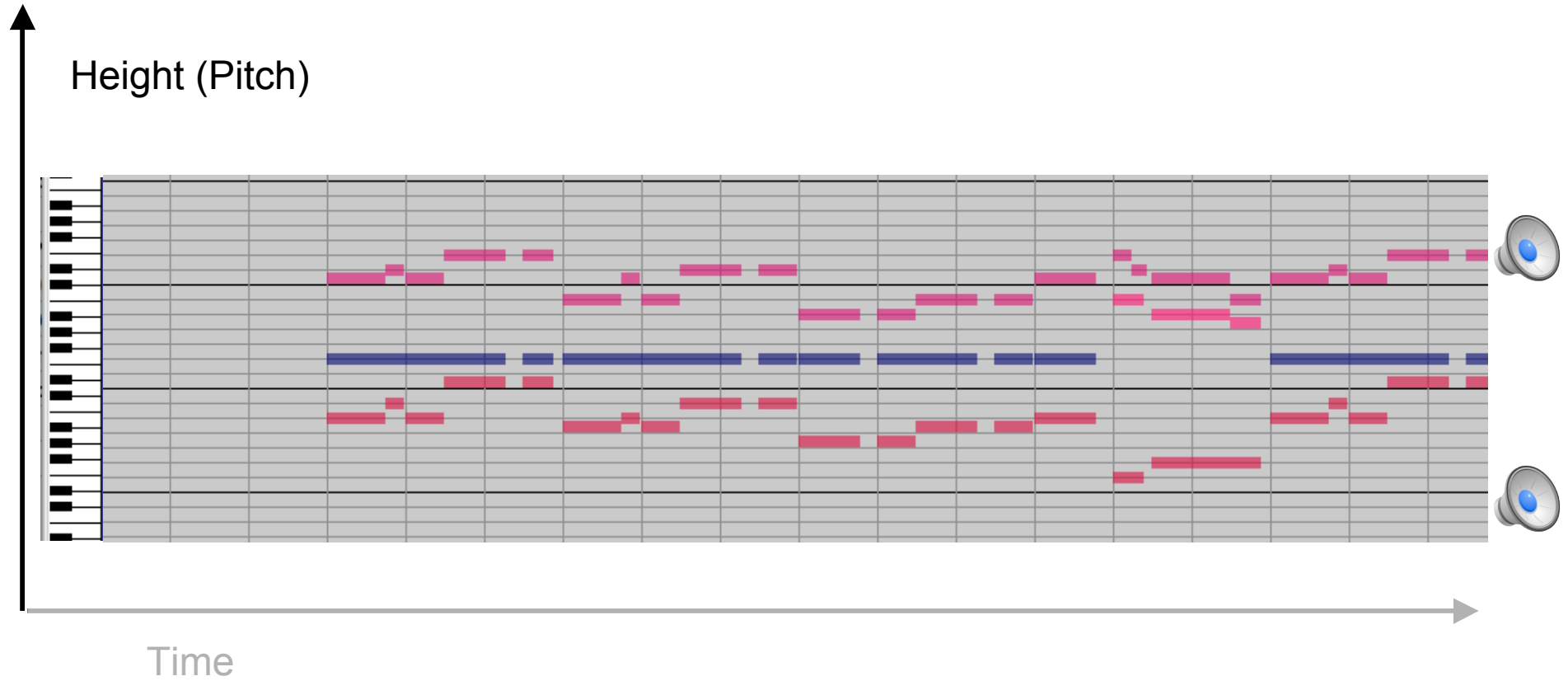
Music Features



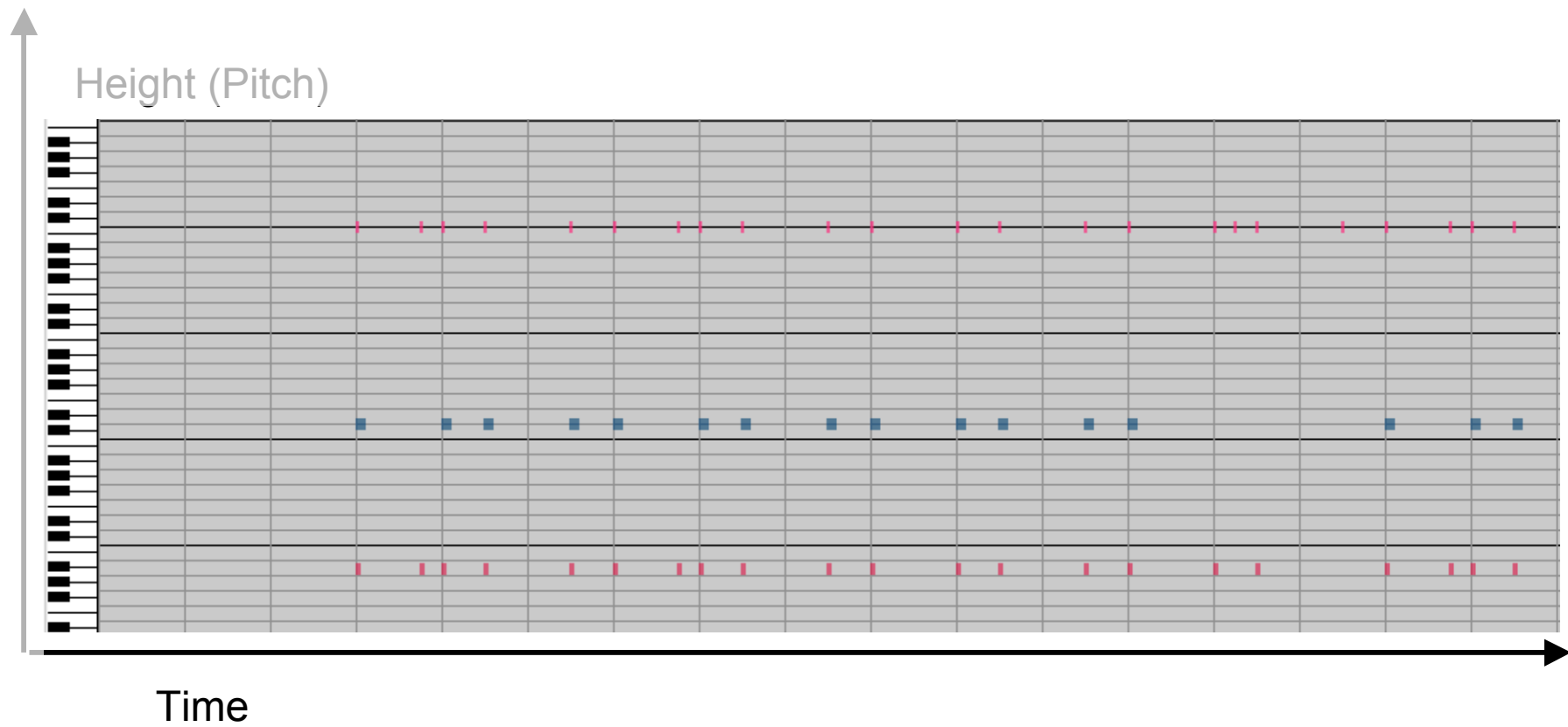
Music Features



Music Features



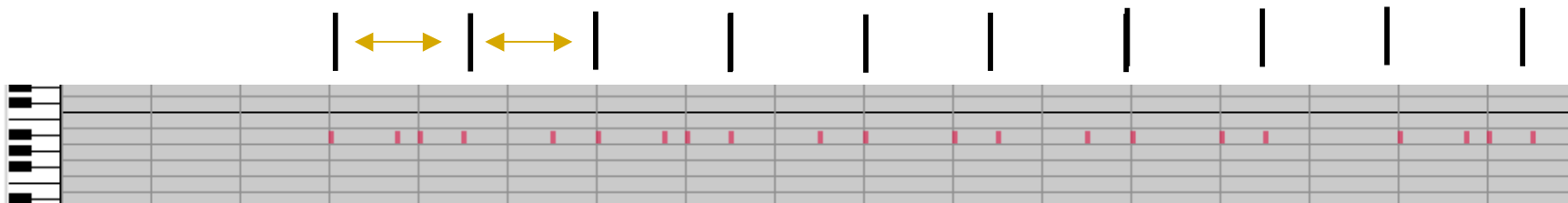
Time: Rhythm



Rhythm



Spontaneous reaction: tapping

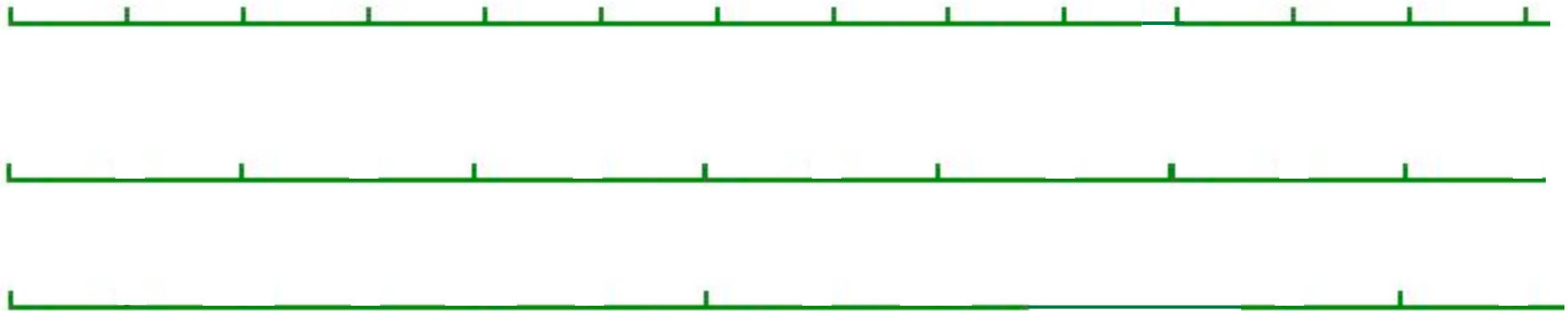


Rhythm

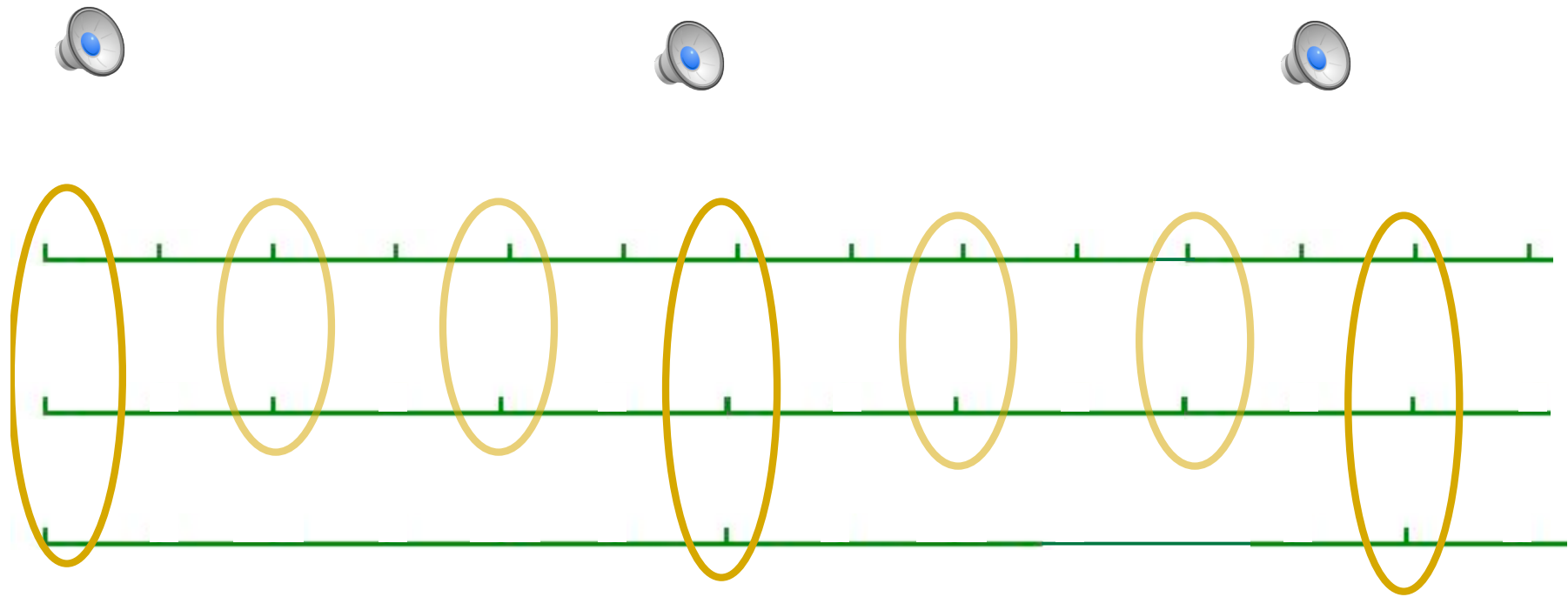


Rhythm: Meter

nested pulses



Rhythm: Meter





Rhythm: Meter


Accent Pattern

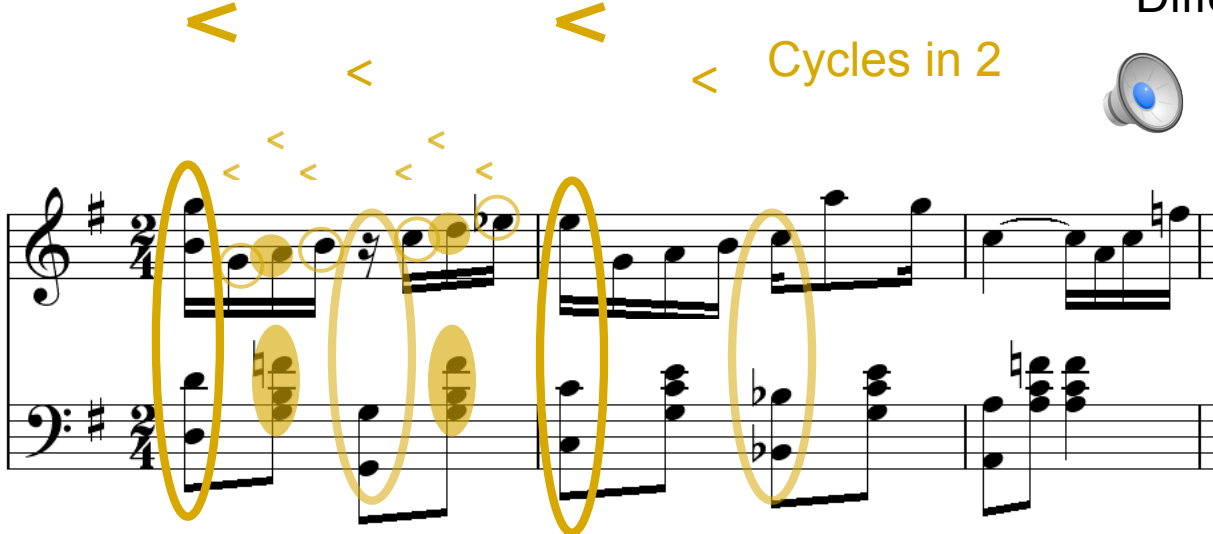
The image illustrates the concept of meter in music. It features a musical staff with a treble clef and a key signature of one flat. The first measure contains a sequence of notes: a quarter note, an eighth note, a quarter note, an eighth note, a quarter note, and a quarter note. The first five notes are circled in yellow, and yellow arrows point from these circles to a timeline below. The timeline consists of three horizontal green lines with vertical tick marks. Large yellow ovals are drawn around the timeline, grouping the tick marks into rhythmic units. Above the staff, yellow accent marks (<) are placed above the first, second, and fifth notes. Vertical red lines indicate the boundaries of the measures. The text 'Accent Pattern' is written in yellow above the staff.

Rhythm: Meter

Cycles in 3 



Different Accent Patterns
Cycles in 2 



Rhythm: Meter



Anton Webern

Piano Variations Op. 27, II



Scott Joplin

Nonpareil Rag



Rhythm: Meter

Sehr schnell ♩ = ca 160

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

The image shows a piano score for 22 measures. The time signature is 2/4, which is circled in red. Vertical red lines separate each measure. The score includes dynamic markings such as *f*, *p*, *ff*, and *pp*, and various musical notations like slurs and accents. The tempo is marked 'Sehr schnell' with a metronome marking of approximately 160 beats per minute.

Outer Metric Structure

Measures 1-4 of the piano score, showing the outer metric structure. The time signature is 2/4. The music consists of a series of eighth notes in the right hand and a bass line in the left hand.

Measures 5-8 of the piano score, showing the outer metric structure. The music continues with eighth notes and rests.

Measures 9-12 of the piano score, showing the outer metric structure. The music continues with eighth notes and rests.

Inner Metric Structure

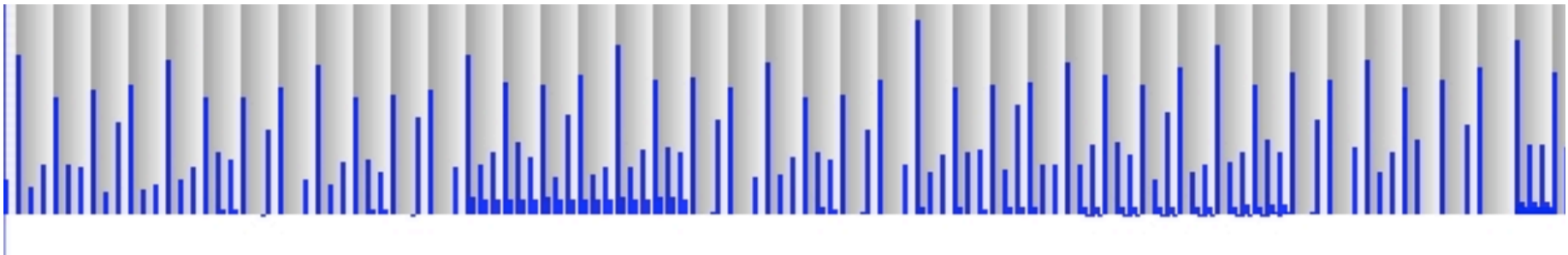
Measures 13-16 of the piano score, showing the inner metric structure. The music continues with eighth notes and rests.

Measures 17-20 of the piano score, showing the inner metric structure. The music continues with eighth notes and rests.

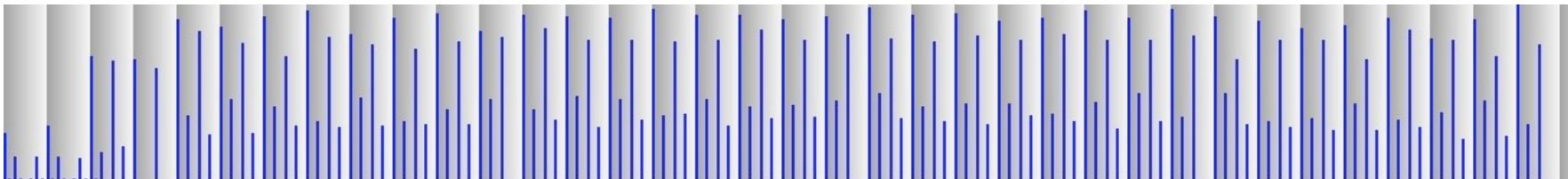
Inner Metric Analysis

Metric Weight

Cycles in 3



Cycles in 2



Outline

- Introduction
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 - Importance of Rhythm
- Inner Metric Analysis

Inner Metric Analysis

Metric Weight



Picture from www.ritzenhoff.de

Inner Metric Analysis

Metric Weight



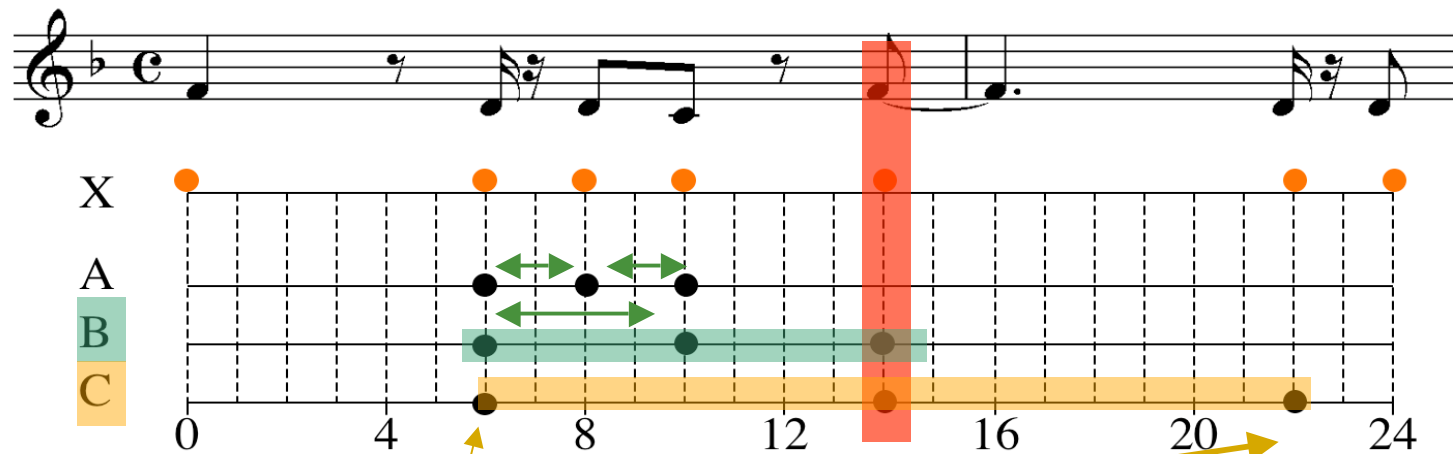
A musical staff in treble clef with a key signature of one flat (Bb) and a common time signature (C). The melody consists of the following notes: quarter note Bb, eighth rest, eighth note Bb, quarter note A, quarter note G, eighth rest, eighth note F, quarter note E, quarter note D. Below the staff, a horizontal line contains an 'X' under the first note and seven orange dots under the subsequent notes, representing metric weight analysis.



Picture from www.ritzenhoff.de

Inner Metric Analysis

Metric Weight



$$m(s, d, k) = \{s + id, i = 0, \dots, k\} \subset X$$

$$M(\ell) = \{m(s, d, k) : k \geq \ell\}$$

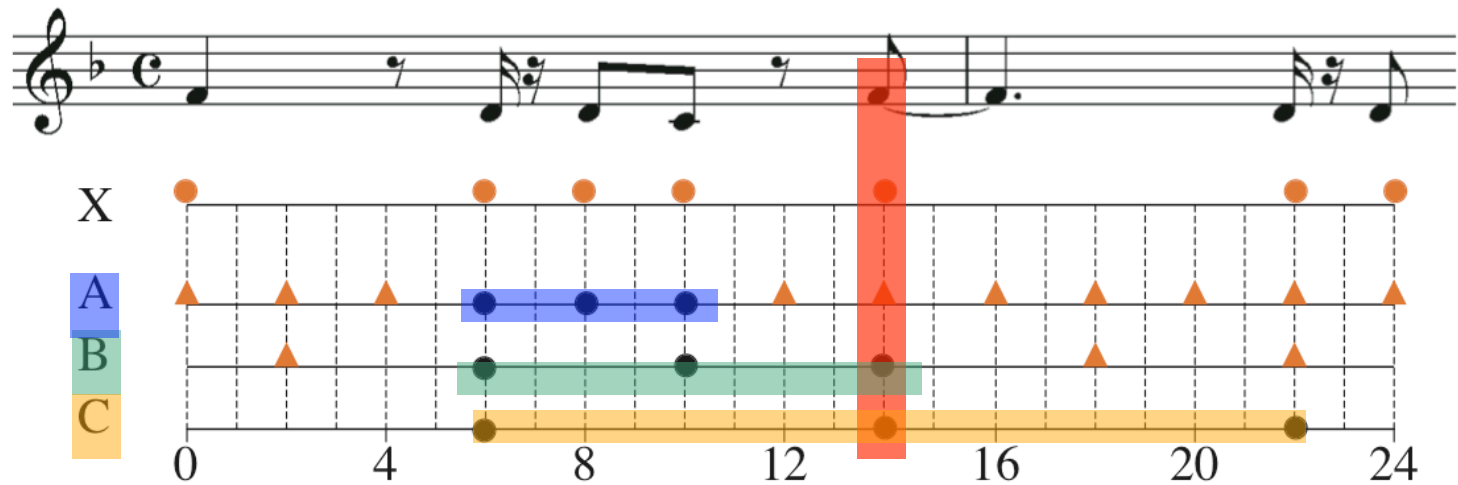
$$W_{\ell, p}(o) = \sum_{\{m \in M(\ell) : o \in m\}} k^p$$



Picture from www.ritzenhoff.de

Inner Metric Analysis

Spectral Weight



$$m(s, d, k) = \{s + id, i = 0, \dots, k\} \subset X$$

$$\text{ext}(m(s, d, k)) = \{s + id, \forall i\}$$

$$SW_{\ell, p}(t) = \sum_{\{m \in M(\ell) : t \in \text{ext}(m)\}} k^p$$



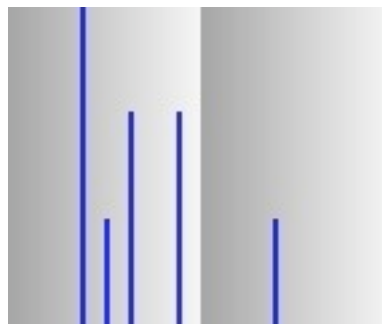
Picture from www.ritzenhoff.de

Inner Metric Analysis

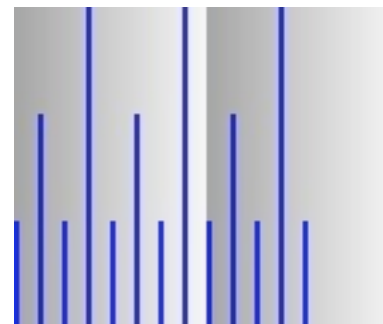
Metric Weight



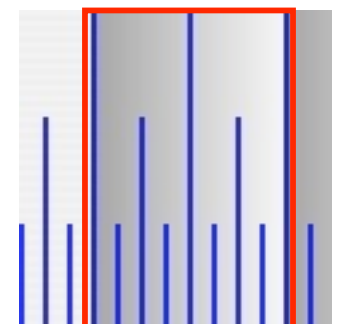
Picture from www.ritzenhoff.de



Metric Weight



Spectral Weight



Webern versus Joplin



Anton Webern

Piano Variations Op. 27, II



Scott Joplin

Nonpareil Rag



Webern versus Joplin

Sehr schnell ♩ = ca 160

This musical score is for Webern's 'Sehr schnell' piece, marked with a tempo of approximately 160 beats per minute. It consists of 22 measures. The notation is in 2/4 time and features a complex, rhythmic structure with frequent rests and dynamic markings such as *f*, *p*, and *ff*. The score is written for piano and includes a red circle around the first measure.

This musical score is for Joplin's 'The Ragtime Dance' piece, marked with a tempo of approximately 160 beats per minute. It consists of 18 measures. The notation is in 2/4 time and features a complex, rhythmic structure with frequent rests and dynamic markings such as *f*, *p*, and *ff*. The score is written for piano and includes a red circle around the first measure.

Webern versus Joplin

Sehr schnell ♩ = ca 160

Musical score for measures 1-4 of Webern's piece. The score is in 2/4 time and features a complex, atonal melody with dynamic markings of *f* and *p*. Measure numbers 1, 2, 3, and 4 are indicated above the staff.

Musical score for measures 1-4 of Joplin's piece. The score is in 2/4 time and features a rhythmic, blues-influenced melody with dynamic markings of *f* and *p*. Measure numbers 1, 2, 3, and 4 are indicated above the staff.

Musical score for measures 5-9 of Webern's piece. The score is in 2/4 time and features a complex, atonal melody with dynamic markings of *f*, *p*, and *ff*. Measure numbers 5, 6, 7, 8, and 9 are indicated above the staff.

Musical score for measures 5-9 of Joplin's piece. The score is in 2/4 time and features a rhythmic, blues-influenced melody with dynamic markings of *f* and *p*. Measure numbers 5, 6, 7, 8, and 9 are indicated above the staff.

Musical score for measures 10-14 of Webern's piece. The score is in 2/4 time and features a complex, atonal melody with dynamic markings of *f*, *p*, and *ff*. Measure numbers 10, 11, 13, and 14 are indicated above the staff.

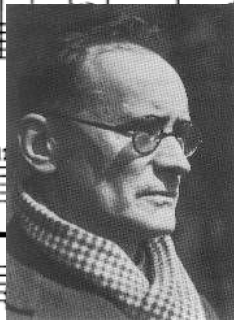
Musical score for measures 10-14 of Joplin's piece. The score is in 2/4 time and features a rhythmic, blues-influenced melody with dynamic markings of *f* and *p*. Measure numbers 10, 11, 13, and 14 are indicated above the staff.

Musical score for measures 15-18 of Webern's piece. The score is in 2/4 time and features a complex, atonal melody with dynamic markings of *ff*, *p*, *f*, and *ff*. Measure numbers 15, 16, 17, and 18 are indicated above the staff.

Musical score for measures 15-18 of Joplin's piece. The score is in 2/4 time and features a rhythmic, blues-influenced melody with dynamic markings of *f* and *p*. Measure numbers 15, 16, 17, and 18 are indicated above the staff.

Musical score for measures 19-22 of Webern's piece. The score is in 2/4 time and features a complex, atonal melody with dynamic markings of *p*, *ff*, and *f*. Measure numbers 19, 20, 21, and 22 are indicated above the staff.

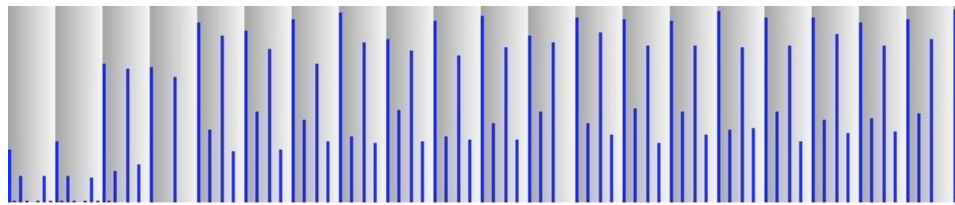
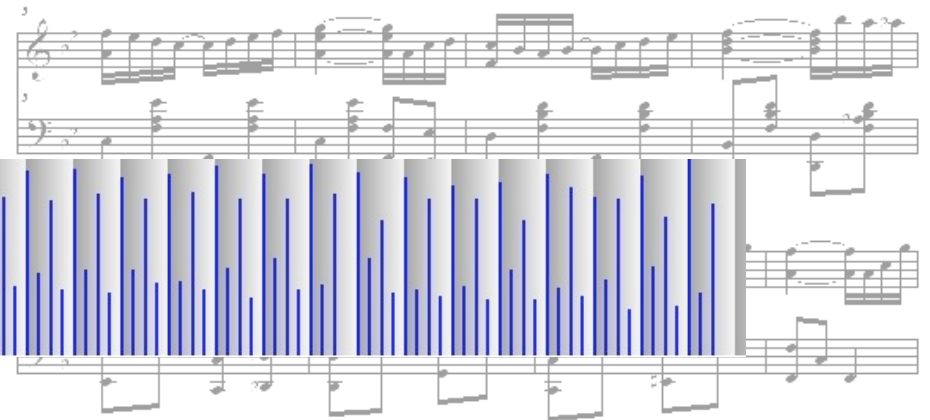
Musical score for measures 19-22 of Joplin's piece. The score is in 2/4 time and features a rhythmic, blues-influenced melody with dynamic markings of *f* and *p*. Measure numbers 19, 20, 21, and 22 are indicated above the staff.



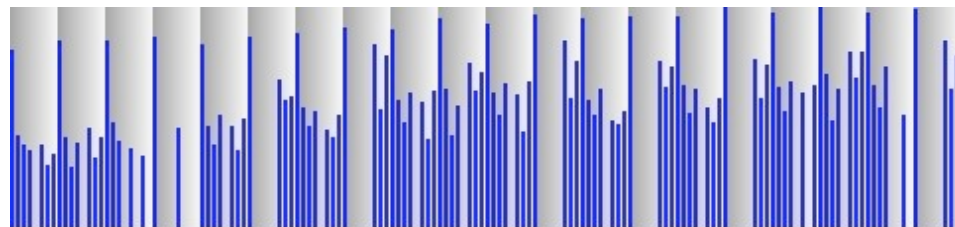
Webern versus Joplin



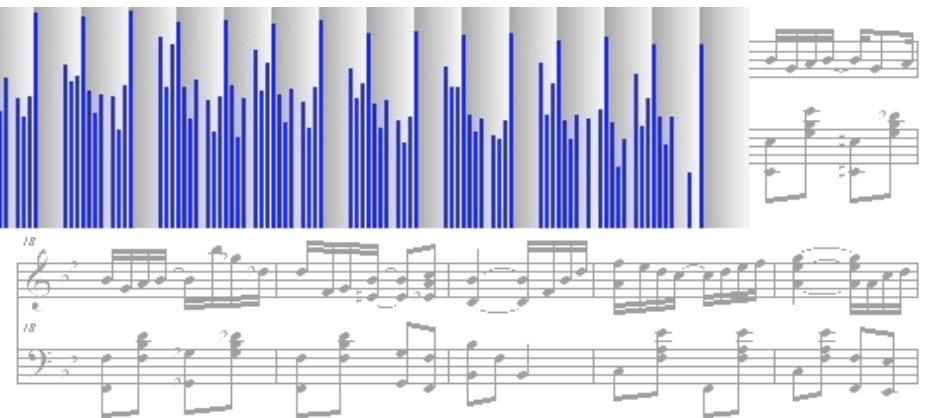
Webern versus Joplin



left hand



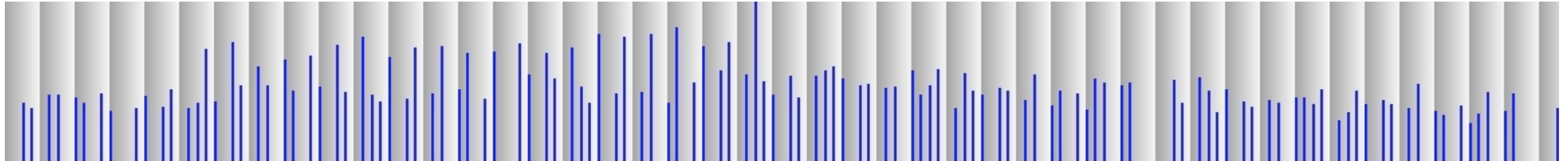
right hand



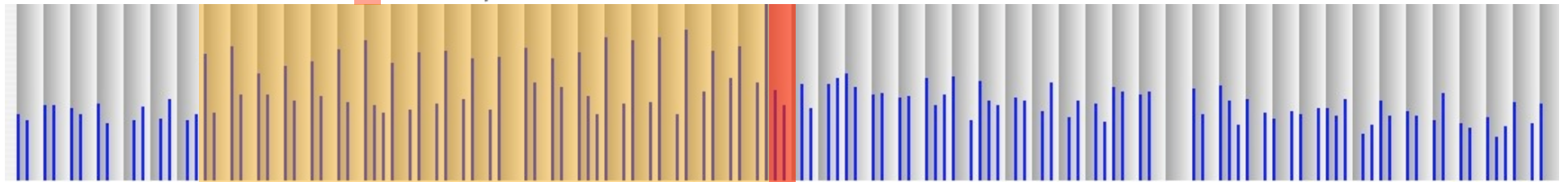
Webern versus Joplin

Sehr schnell ♩ ca 160

Musical score for measures 1-4. The tempo is marked 'Sehr schnell' with a quarter note equal to approximately 160 beats per minute. The score is in 2/4 time and features dynamic markings of *f* and *p*. Measure numbers 1, 2, 3, and 4 are indicated above the staff.



Musical score for measures 10-14. The score continues with dynamic markings of *f* and *p*. Measure numbers 10, 11, 12, 13, and 14 are indicated above the staff. A vertical red bar highlights measure 12.



Musical score for measures 19-22. The score continues with dynamic markings of *p* and *ff*. Measure numbers 19, 20, 21, and 22 are indicated above the staff.



Webern versus Joplin

Sehr schnell ♩ = ca 160

Musical score for measures 1-4. The piece is in 2/4 time and marked 'Sehr schnell' (Very fast) with a tempo of approximately 160 beats per minute. The key signature has one flat (B-flat). The notation includes dynamic markings of *f* (forte) and *p* (piano) and articulation marks.

Musical score for measures 5-9. The notation continues with dynamic markings of *f*, *p*, and *ff* (fortissimo).

Musical score for measures 10-14. The notation continues with dynamic markings of *f* and *p*.

Musical score for measures 15-18. The notation continues with dynamic markings of *ff*, *p*, and *f*.

Musical score for measures 19-22. The notation continues with dynamic markings of *p*, *ff*, and *f*.

Musical score for measures 1-3 of Joplin's piece. The piece is in 2/4 time and has a key signature of two flats (B-flat and E-flat). The notation includes a complex rhythmic pattern in the right hand and a steady bass line.

Musical score for measures 4-5 of Joplin's piece. The notation continues with complex rhythmic patterns.

Musical score for measures 6-9 of Joplin's piece. The notation continues with complex rhythmic patterns.

Musical score for measures 10-13 of Joplin's piece. The notation continues with complex rhythmic patterns.

Musical score for measures 14-18 of Joplin's piece. The notation continues with complex rhythmic patterns.

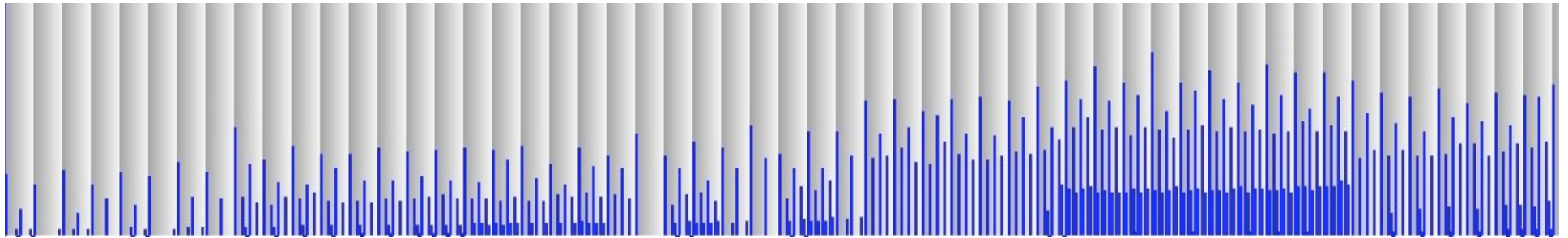
**not
metric
coherent**

**metric
coherent**

Symphony C Major K. 551

1. Movement (4/4)

Wolfgang A. Mozart



Excerpt from Metric weight $W_{2,2}$ of the exposition (bars 1-55)



Tanzen und Springen (3/4)

Hans Leo Haßler

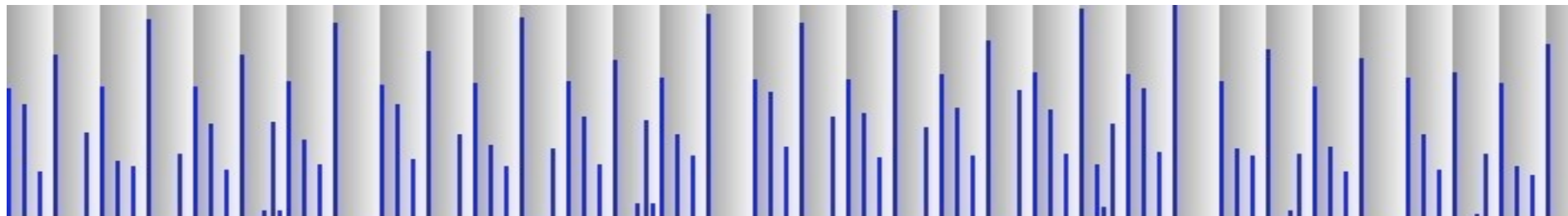
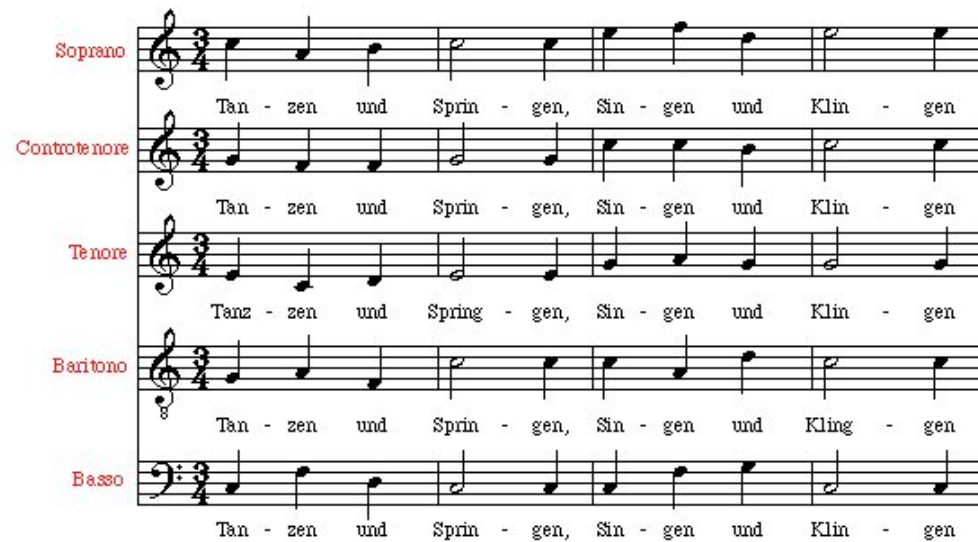
Soprano
Tan - zen und Sprin - gen, Sin - gen und Klin - gen

Controtenore
Tan - zen und Sprin - gen, Sin - gen und Klin - gen

Tenore
Tanz - zen und Spring - gen, Sin - gen und Klin - gen

Baritono
Tan - zen und Sprin - gen, Sin - gen und Kling - gen

Basso
Tan - zen und Sprin - gen, Sin - gen und Klin - gen



Igor Stravinsky: The Rite of Spring

Danse Sacrale

Part B: Measures 149-167 (rhythmical accompaniment)

First system of musical notation for measures 149-156. It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The music is in 3/4 time and features a complex, rhythmic accompaniment with many beamed notes and rests.

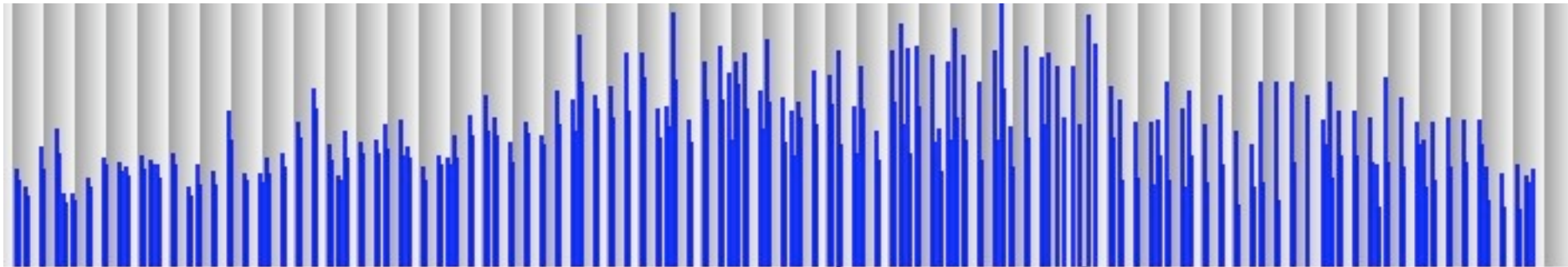
Second system of musical notation for measures 157-164. It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The music continues the rhythmic accompaniment from the previous system.

Third system of musical notation for measures 165-172. It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The music continues the rhythmic accompaniment from the previous system.

Fourth system of musical notation for measures 173-180. It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The music continues the rhythmic accompaniment from the previous system.

Fifth system of musical notation for measures 181-188. It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The music continues the rhythmic accompaniment from the previous system.





Evaluation of the model: music theoretic knowledge

different epochs and styles:

*e.g. Ockeghem, Dufay, Morley, Wilbye, Händel, Bach, Mozart,
Beethoven, Schumann, Schubert, Brahms, Stravinsky, Webern*

corpus:

Brahms' 4 symphonies, Bach's B-Minor-Mass

Meter in Music as a Dynamic Process

Sehr schnell ♩ ca 160

The musical score consists of five systems of two staves each (treble and bass clef). The tempo is marked 'Sehr schnell' with a quarter note equal to approximately 160 beats per minute. The key signature has one flat (B-flat). The score includes various dynamic markings: *f* (forte), *p* (piano), *ff* (fortissimo), and *mf* (mezzo-forte). Measure numbers 1 through 22 are indicated above the staves. The music features complex rhythmic patterns, including triplets and syncopation, and frequent changes in dynamics and articulation.



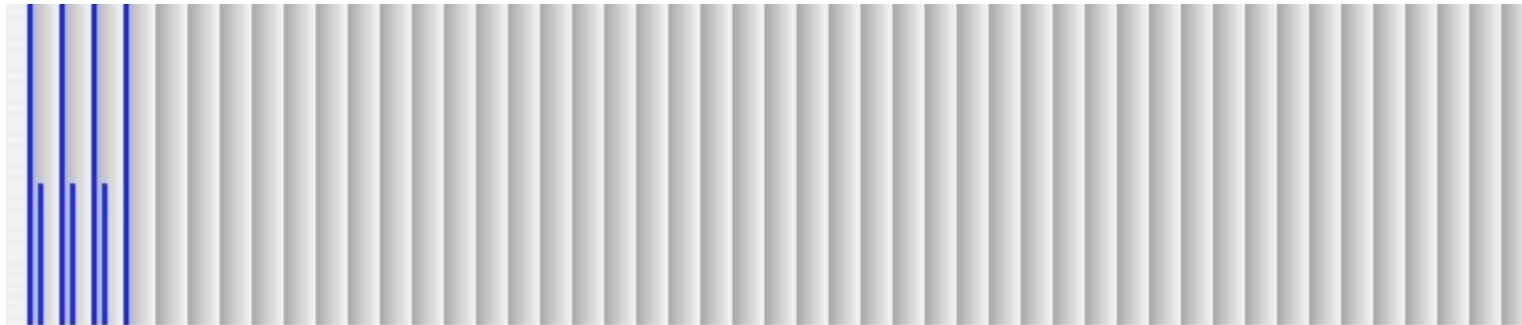
Meter in Music as a Dynamic Process



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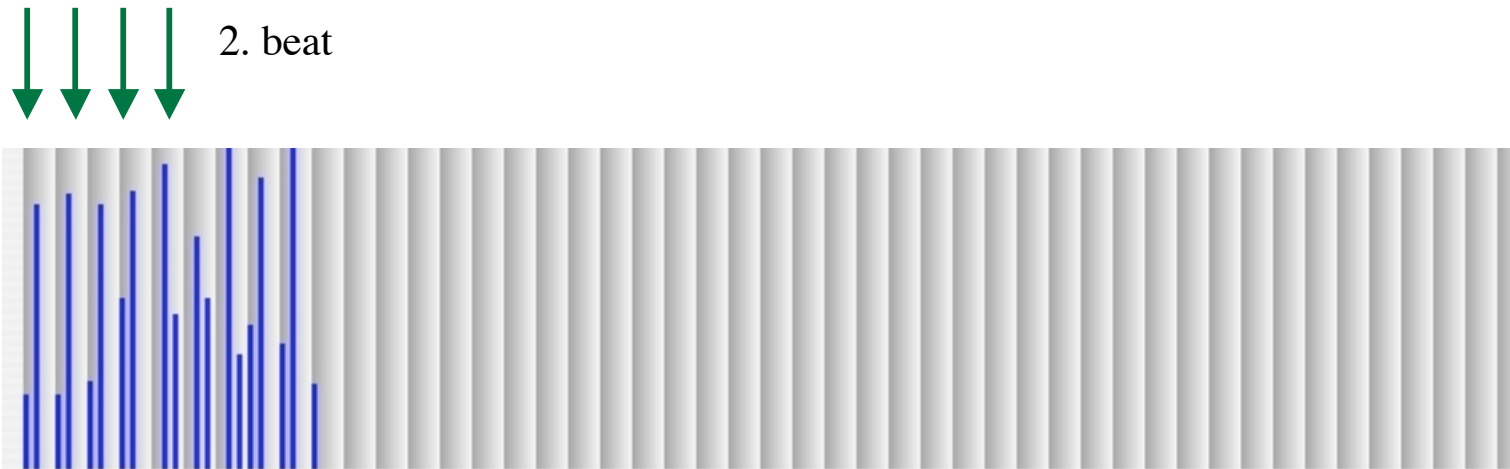
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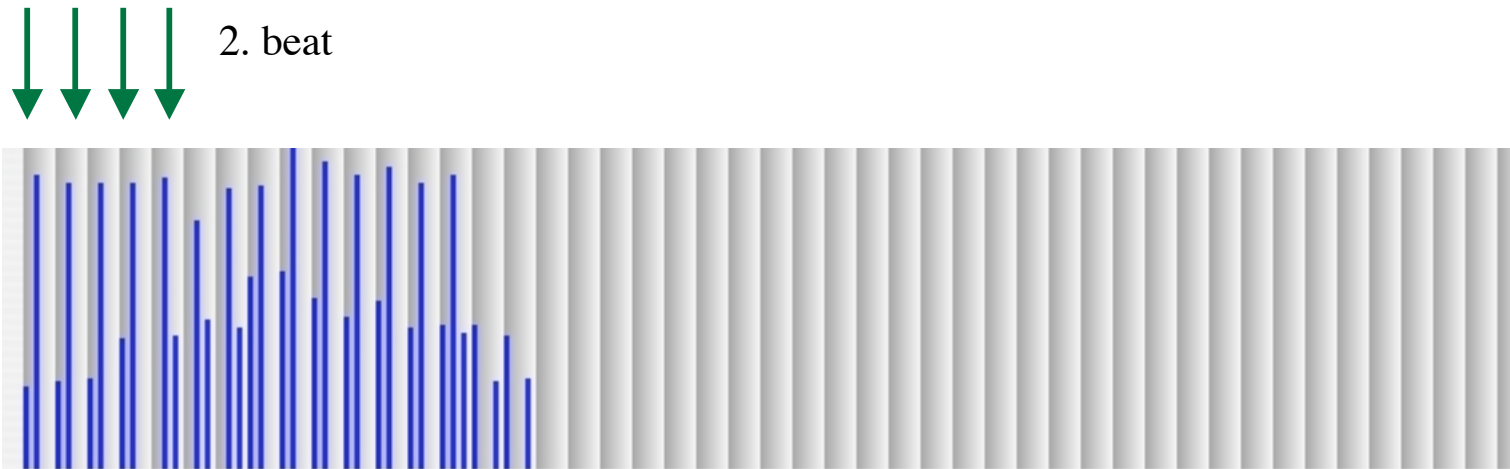
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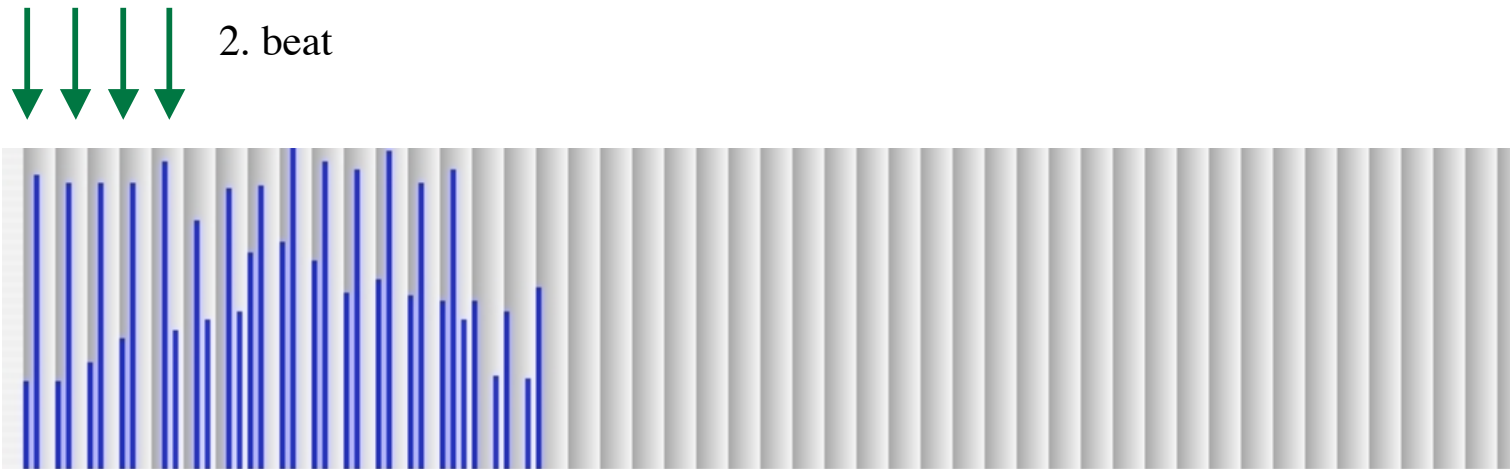
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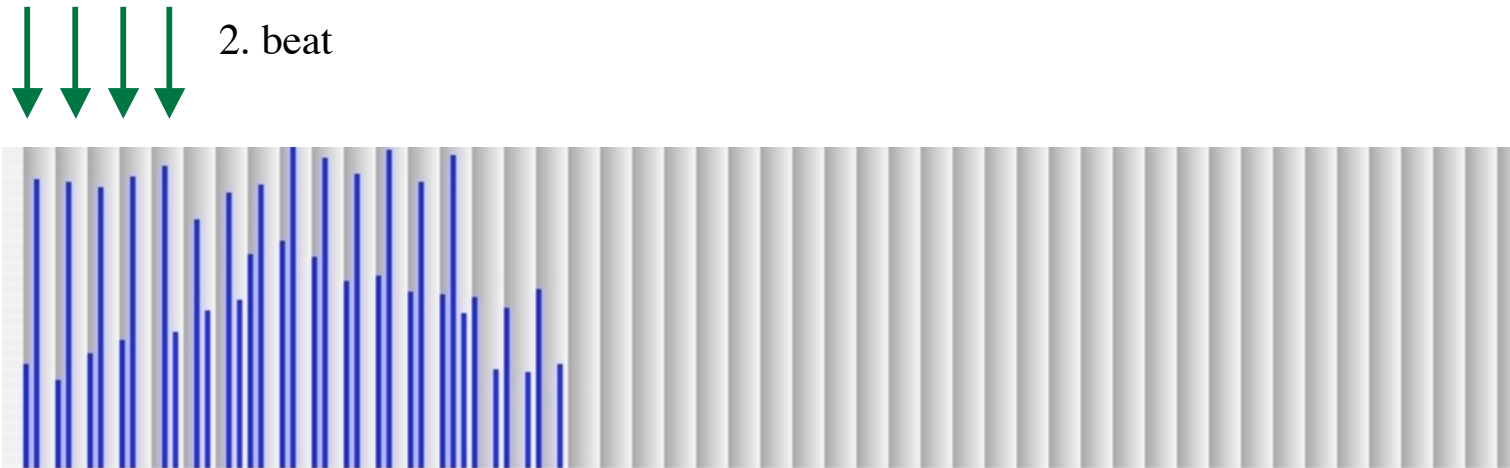
Meter in Music as a Dynamic Process



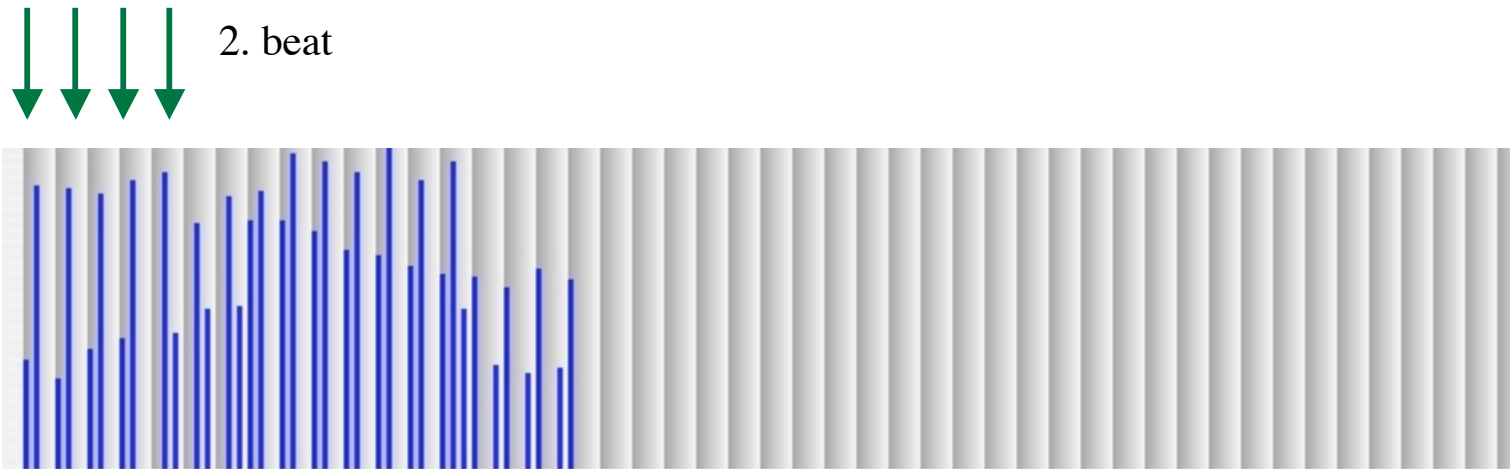
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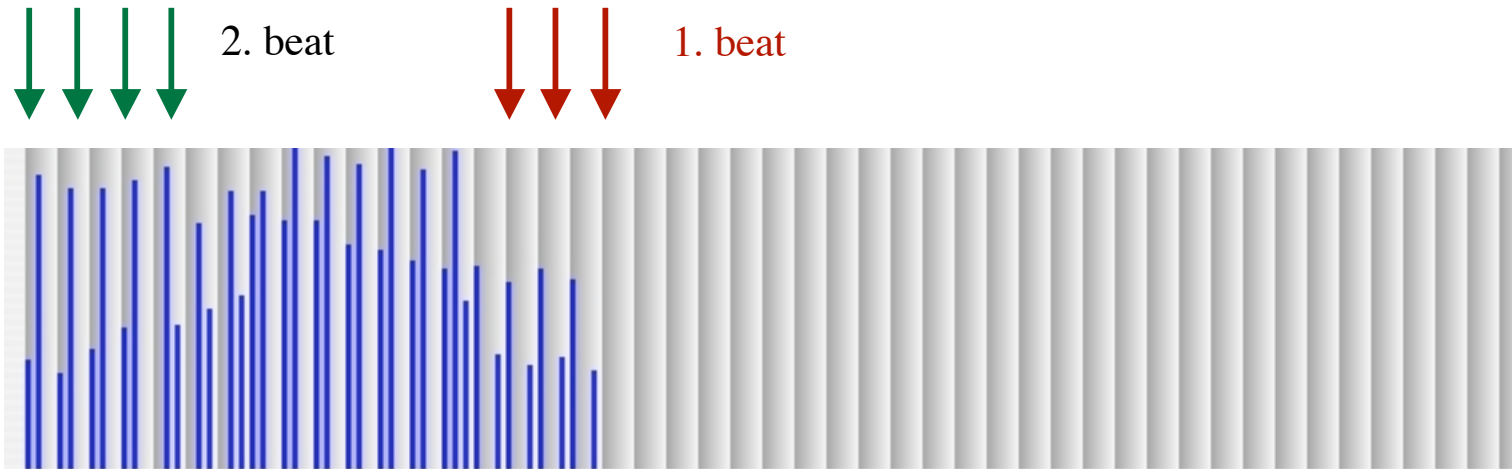
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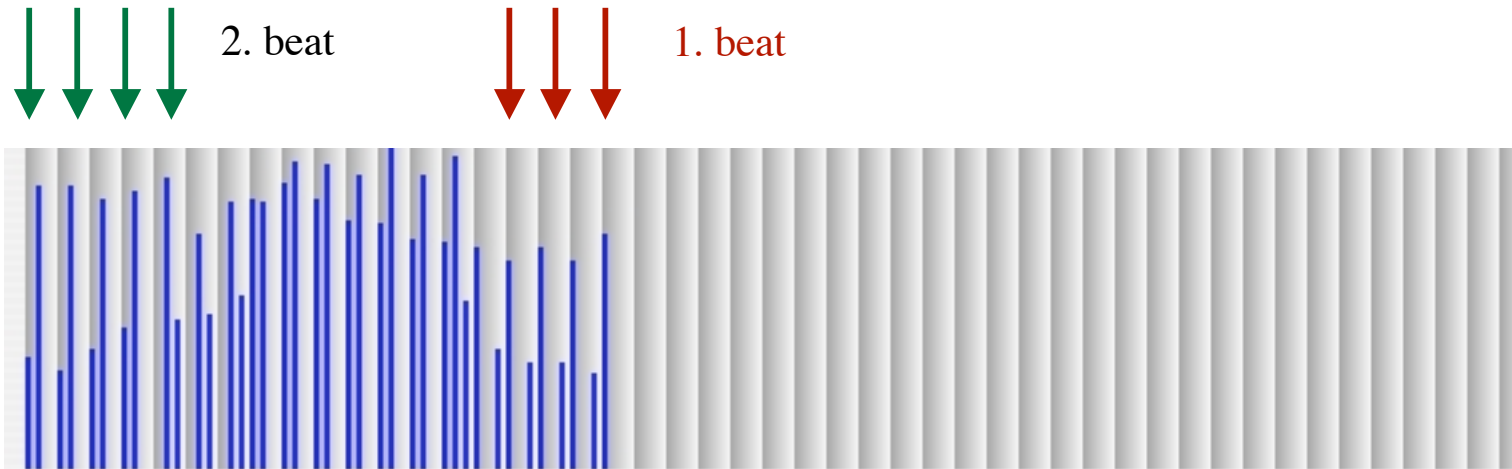
Meter in Music as a Dynamic Process



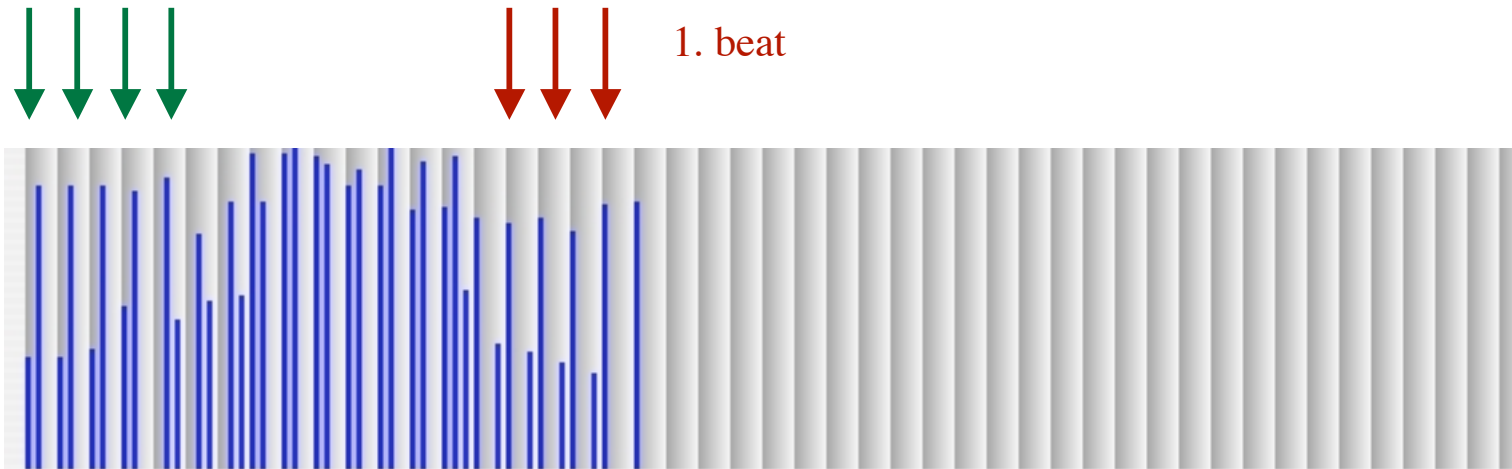
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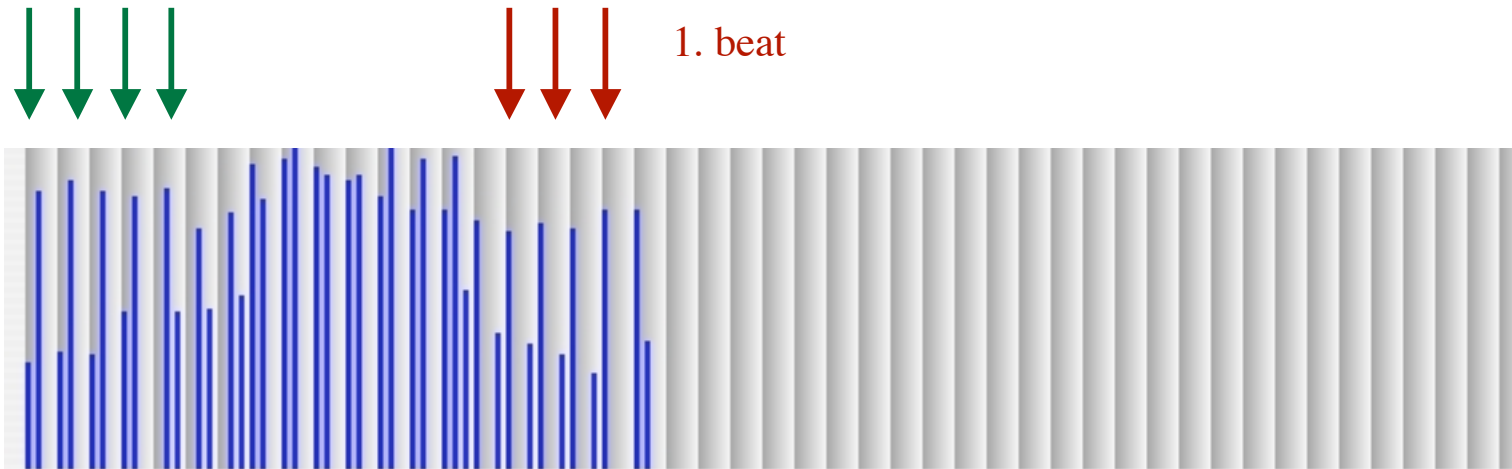
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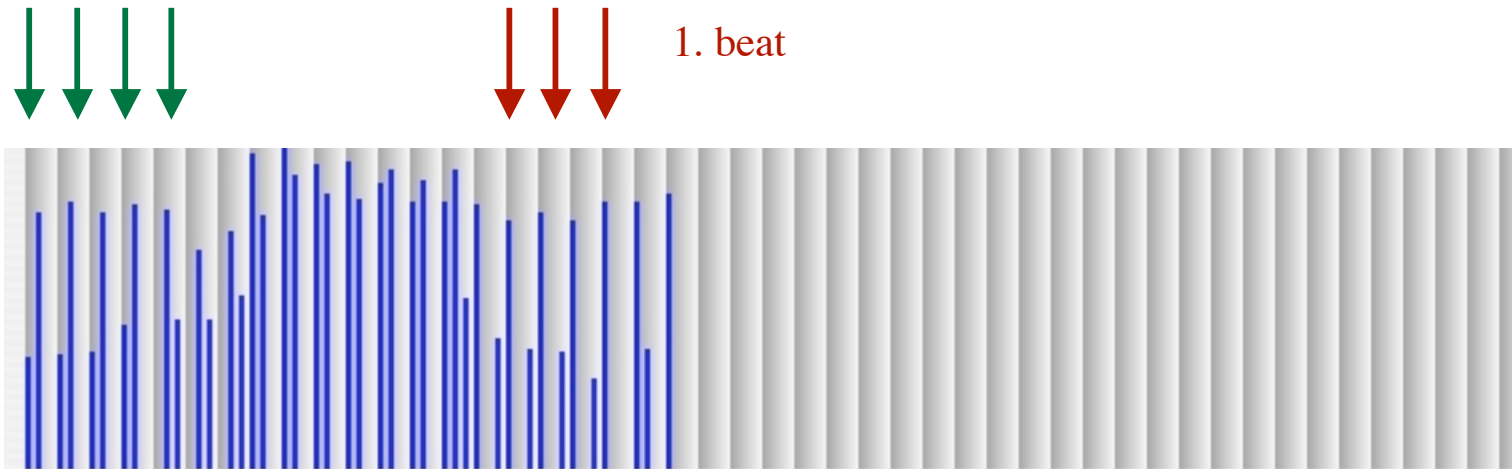
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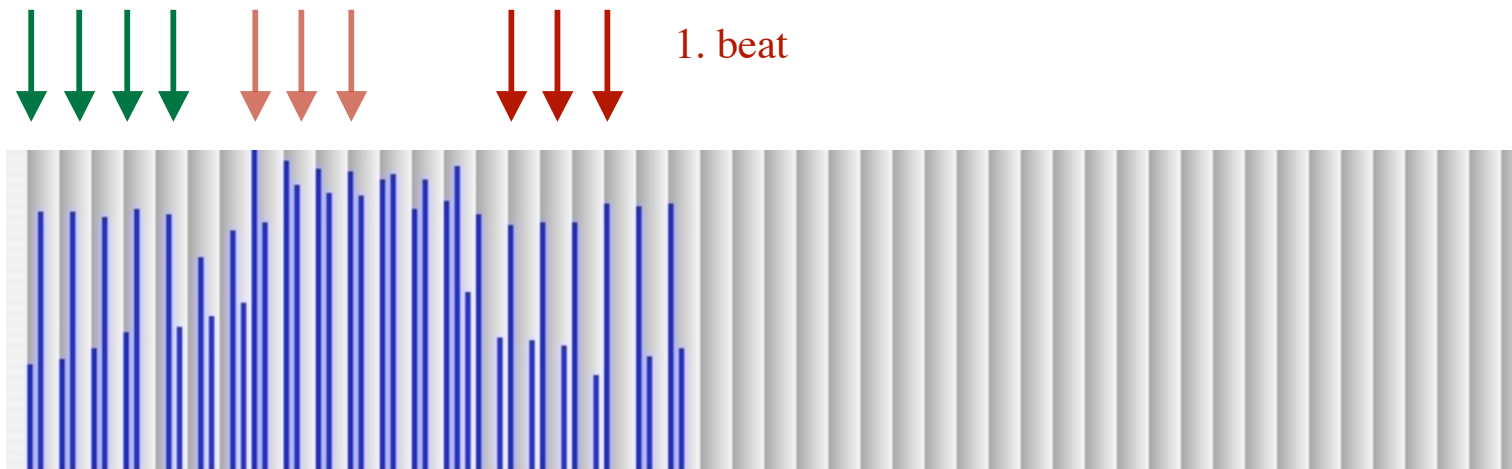
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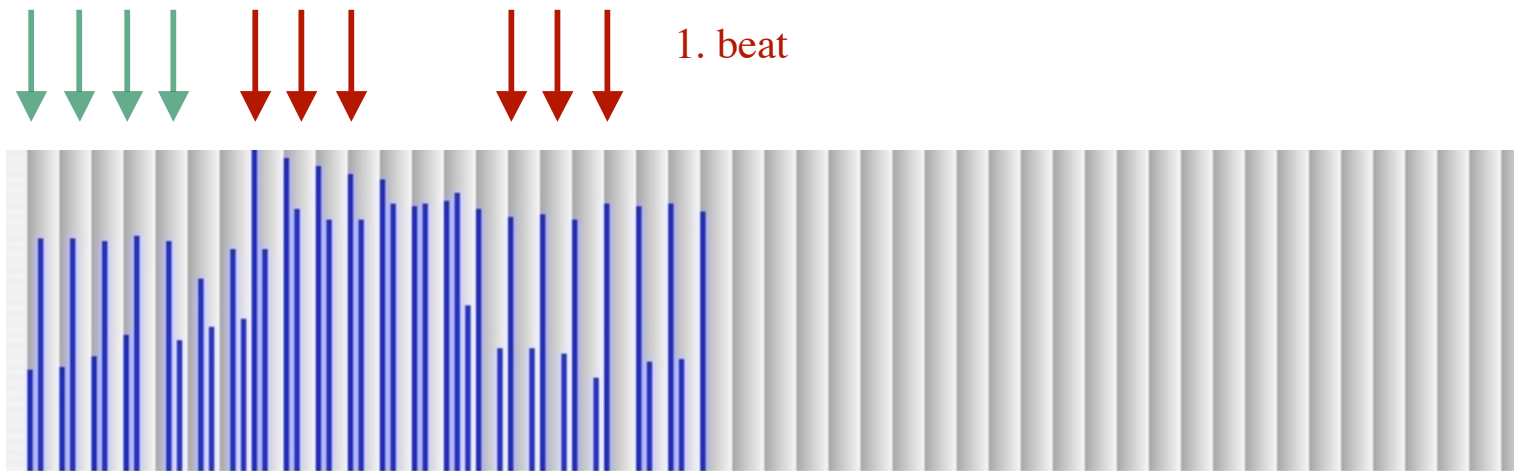
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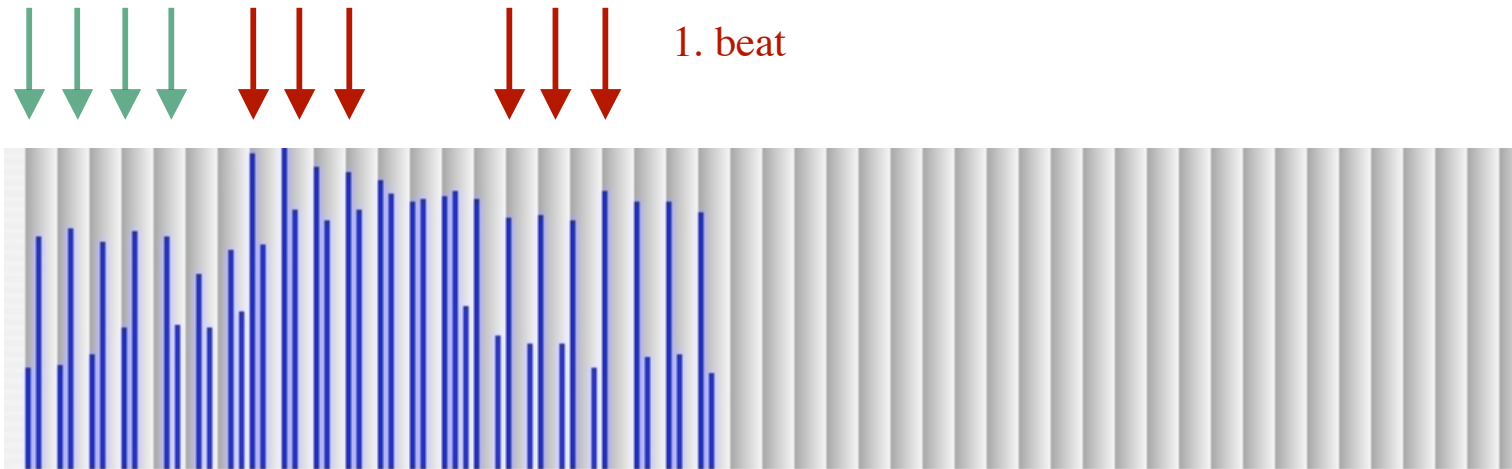
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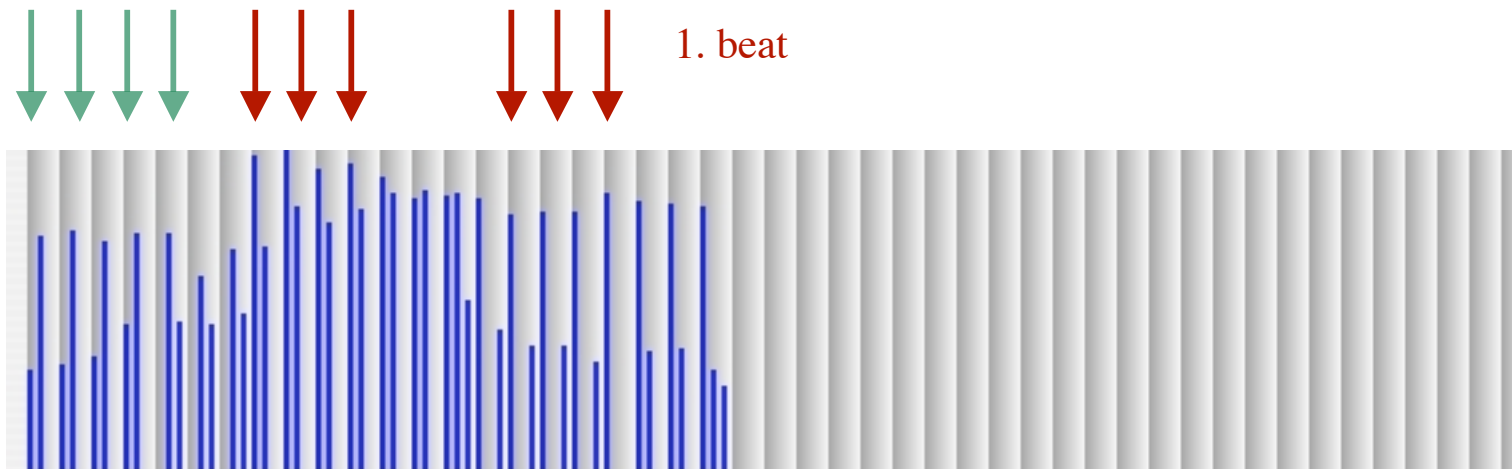
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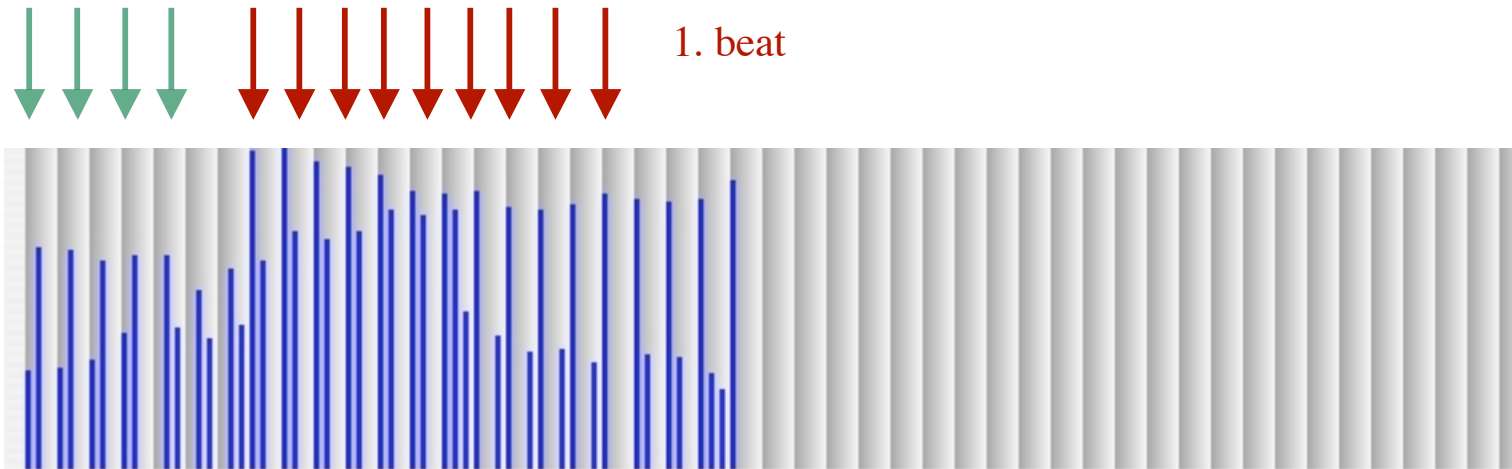
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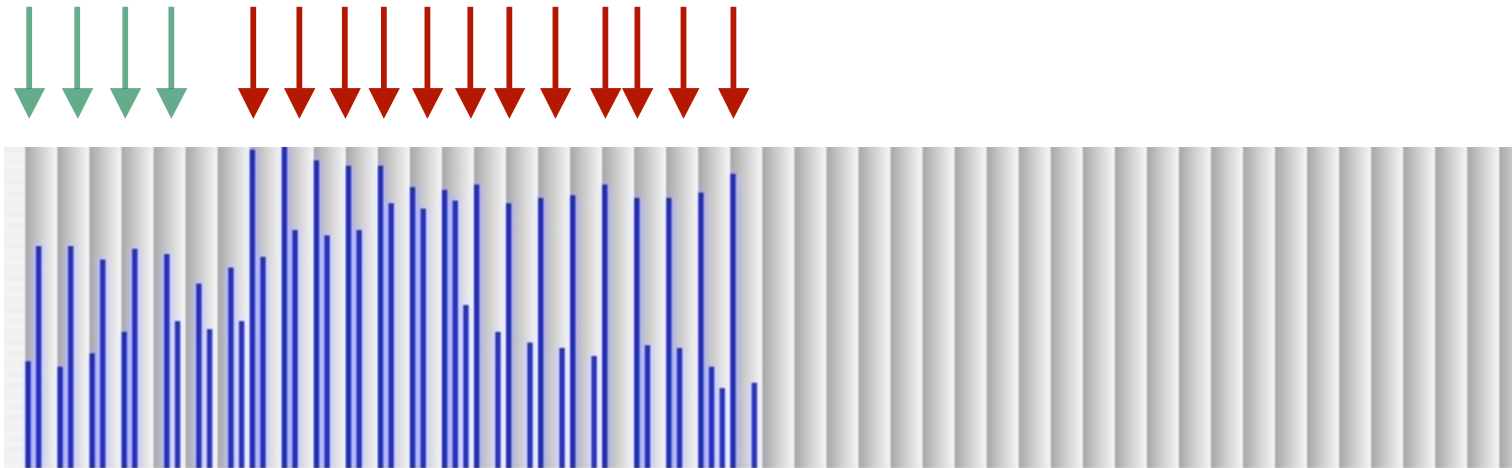
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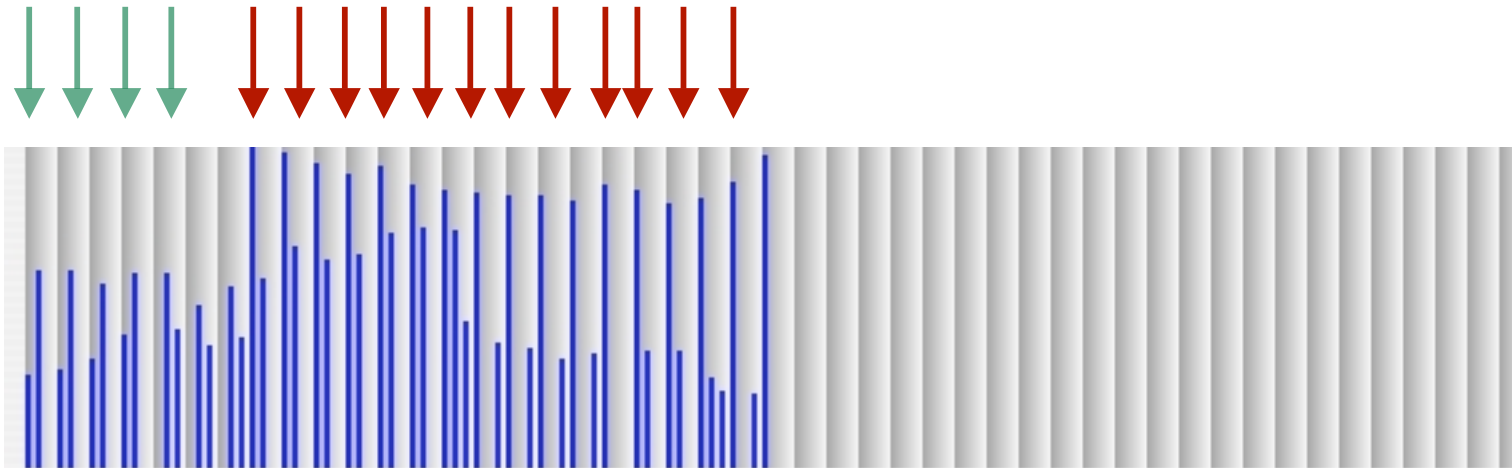
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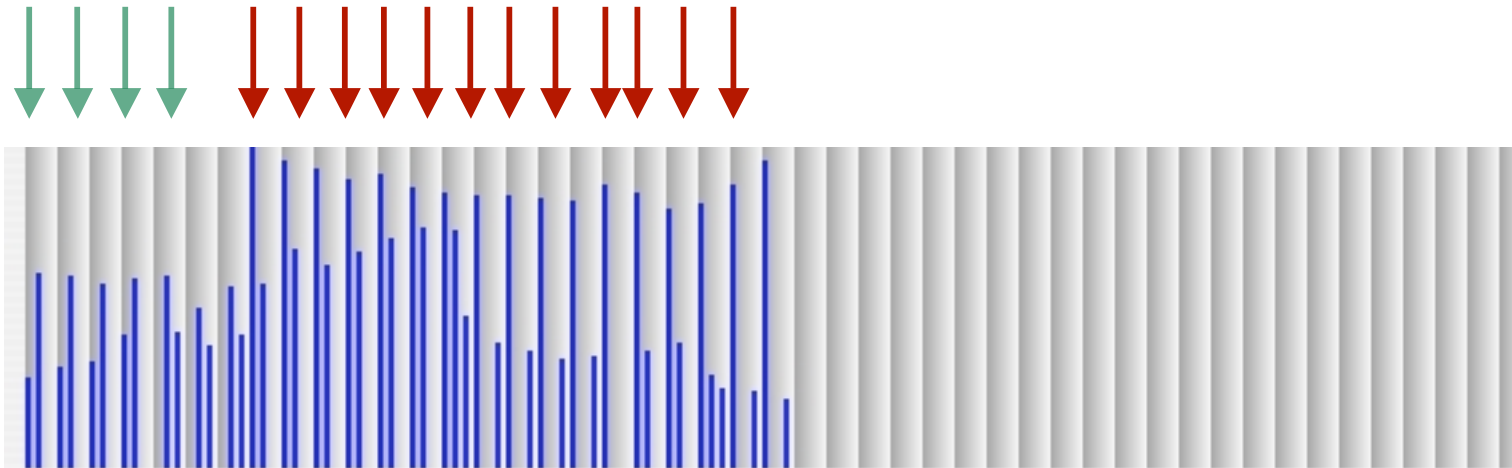
Meter in Music as a Dynamic Process



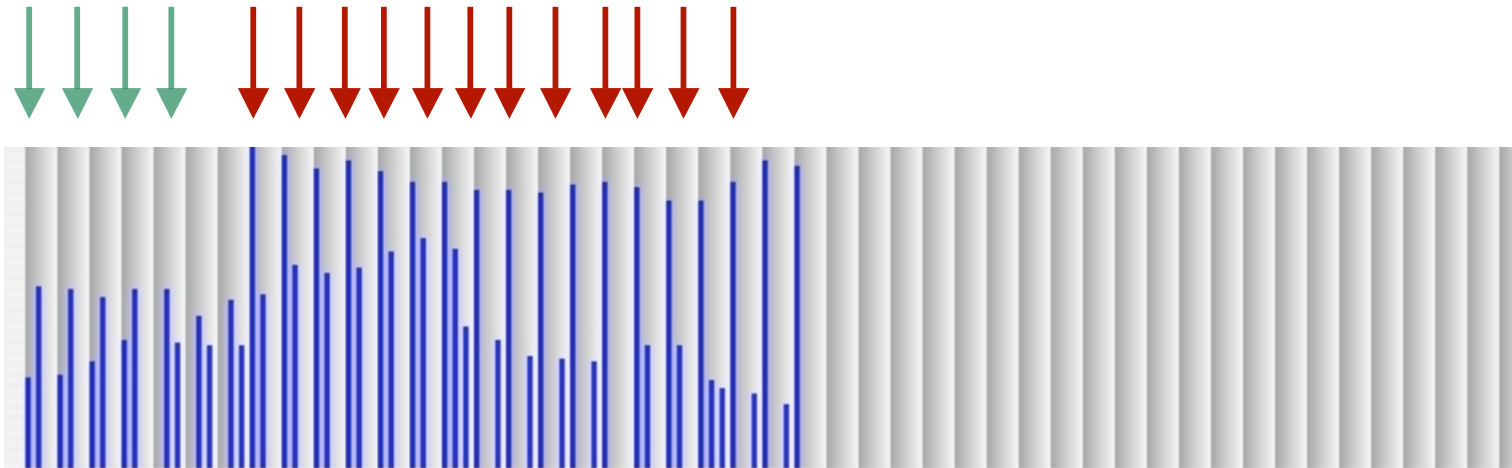
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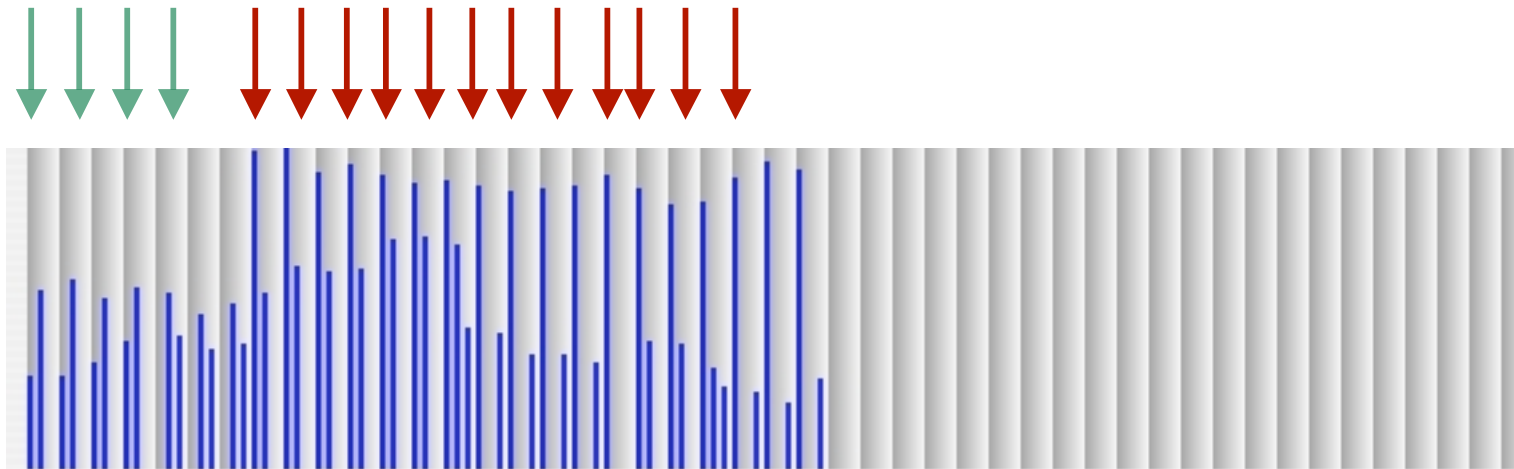
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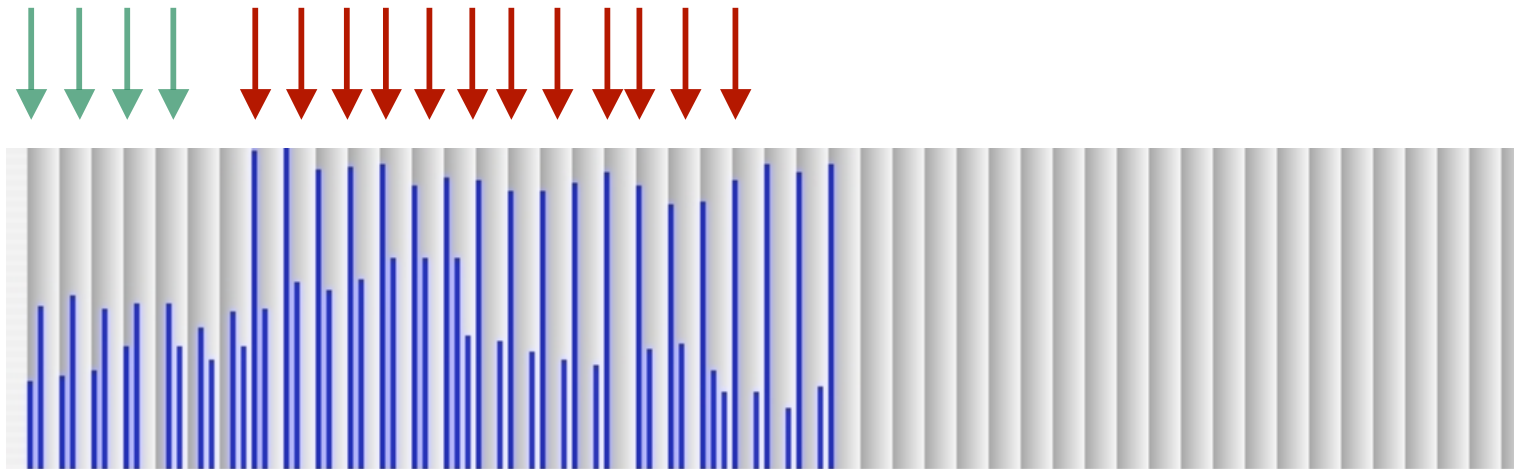
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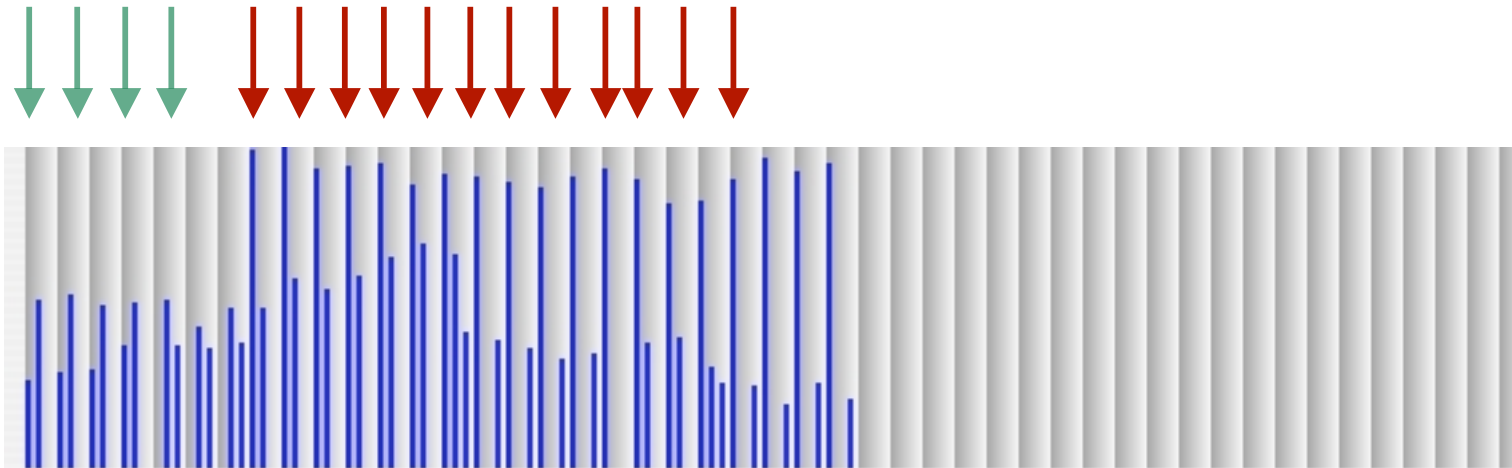
Meter in Music as a Dynamic Process



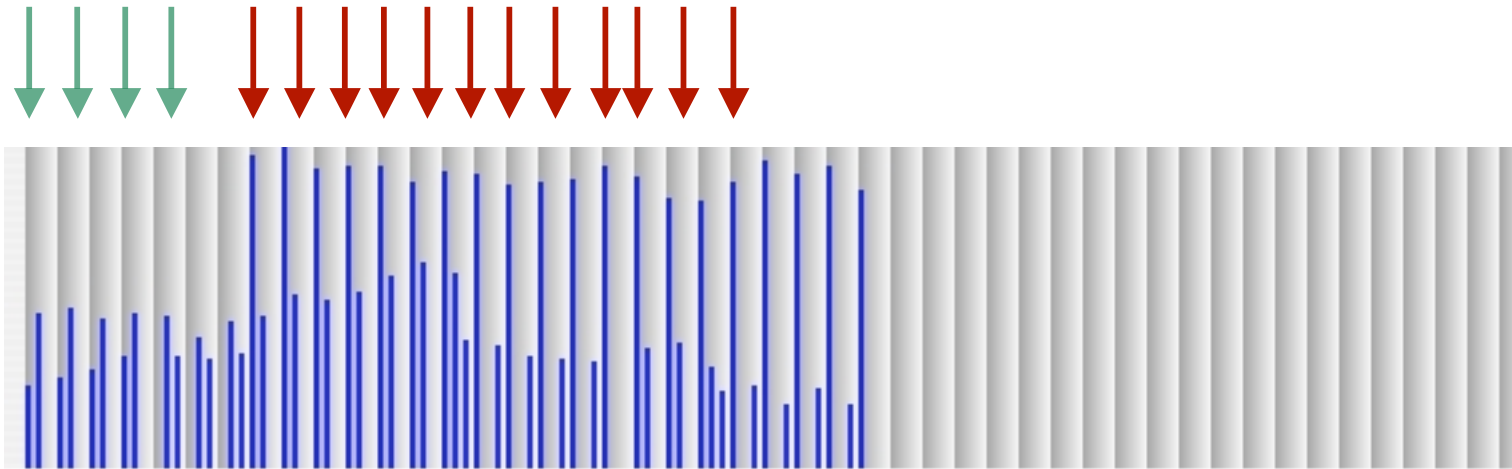
Meter in Music as a Dynamic Process



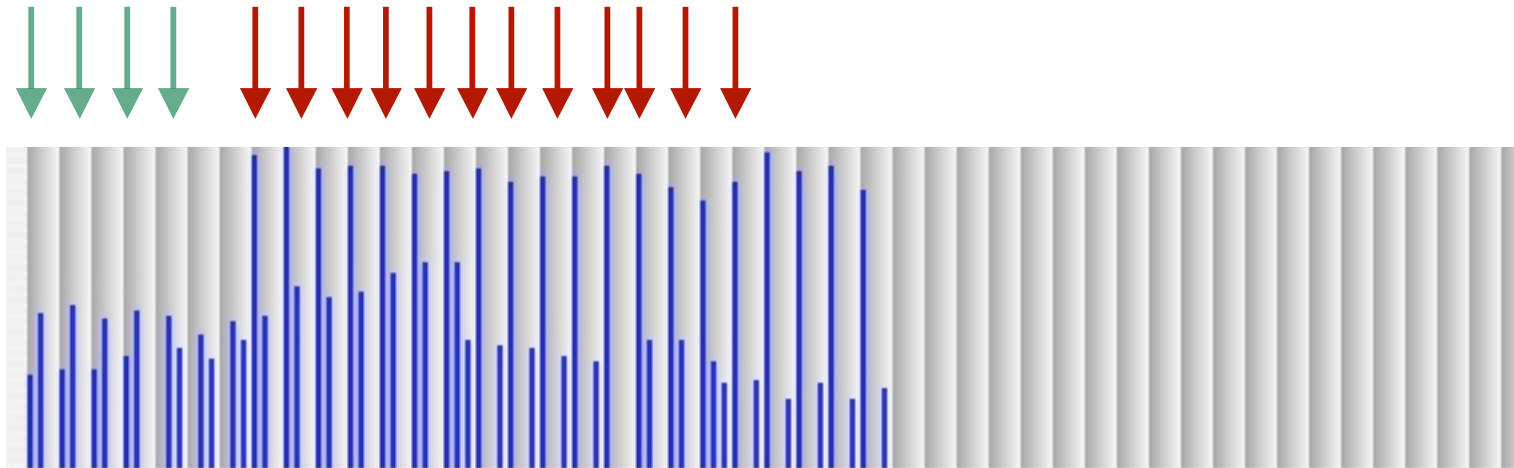
Meter in Music as a Dynamic Process



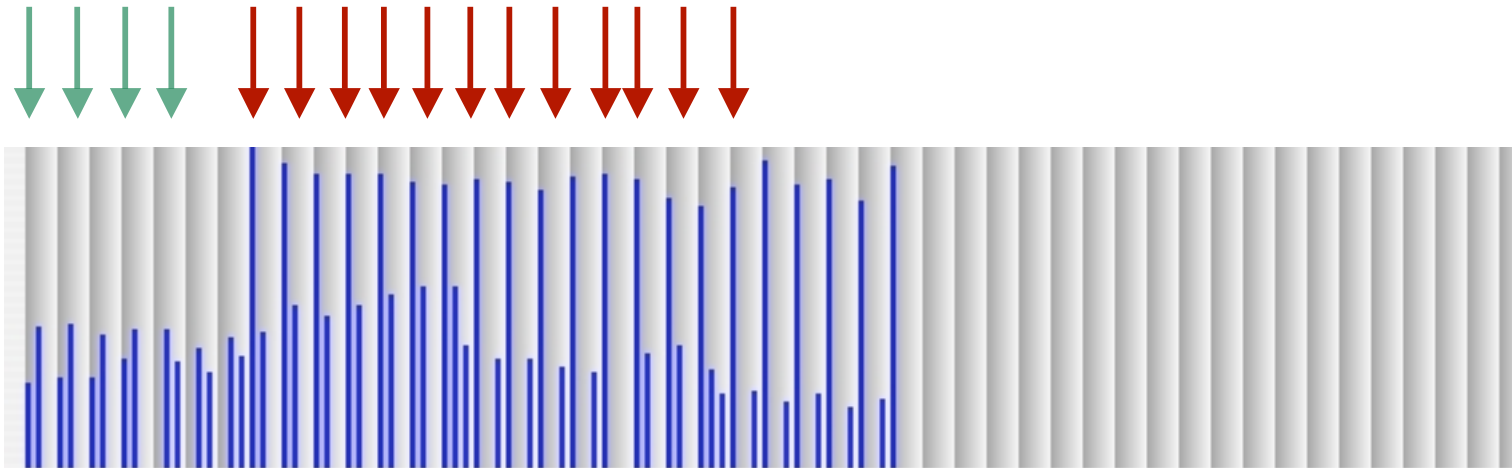
Meter in Music as a Dynamic Process



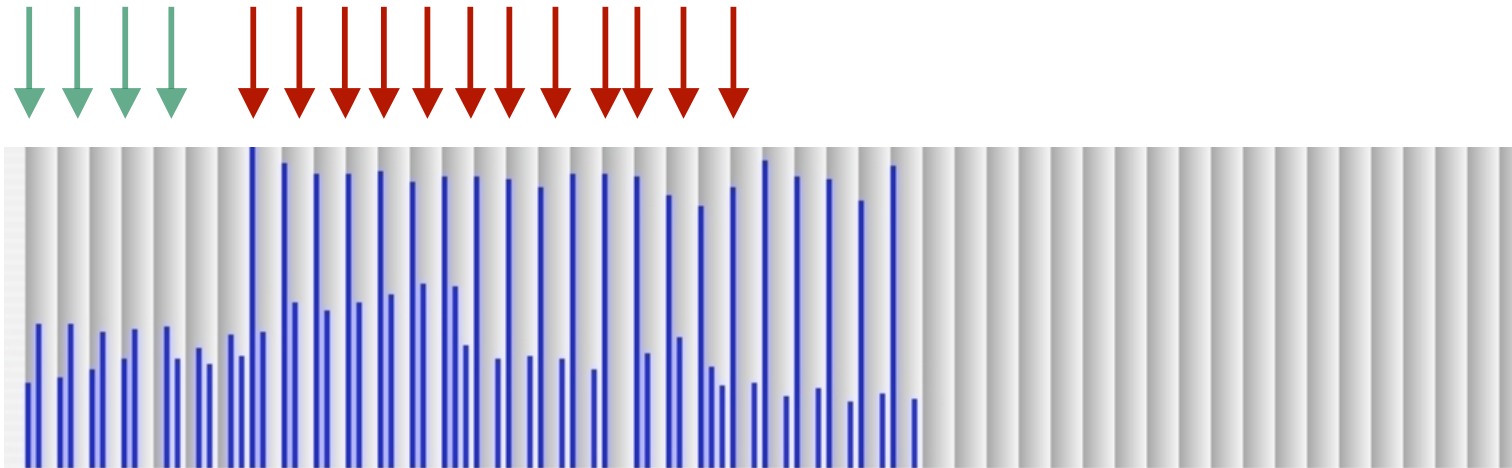
Meter in Music as a Dynamic Process



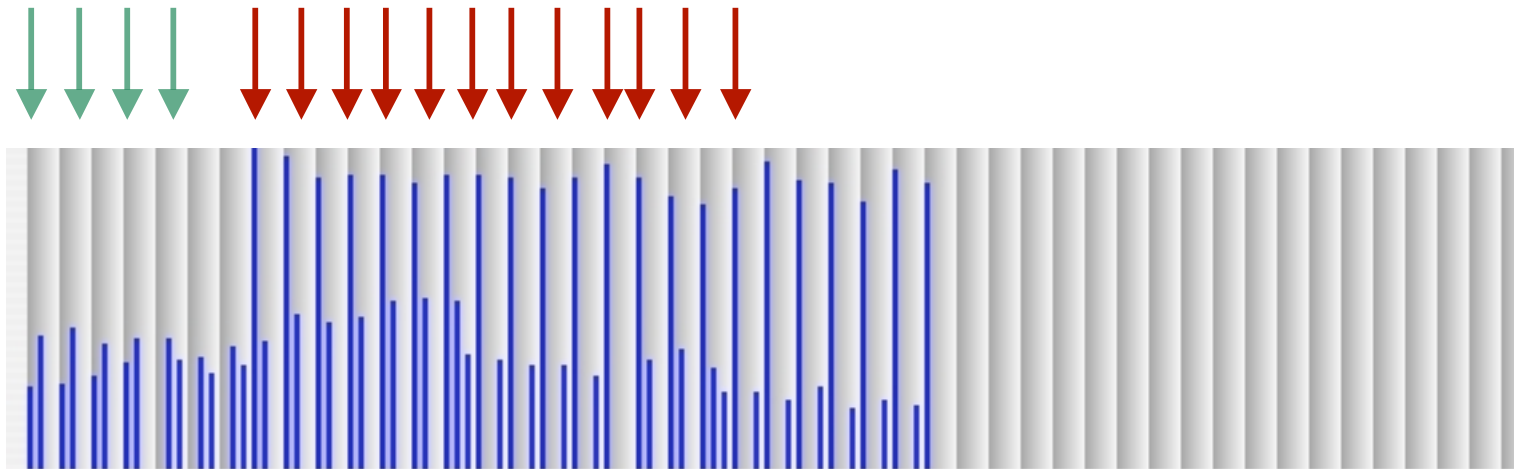
Meter in Music as a Dynamic Process



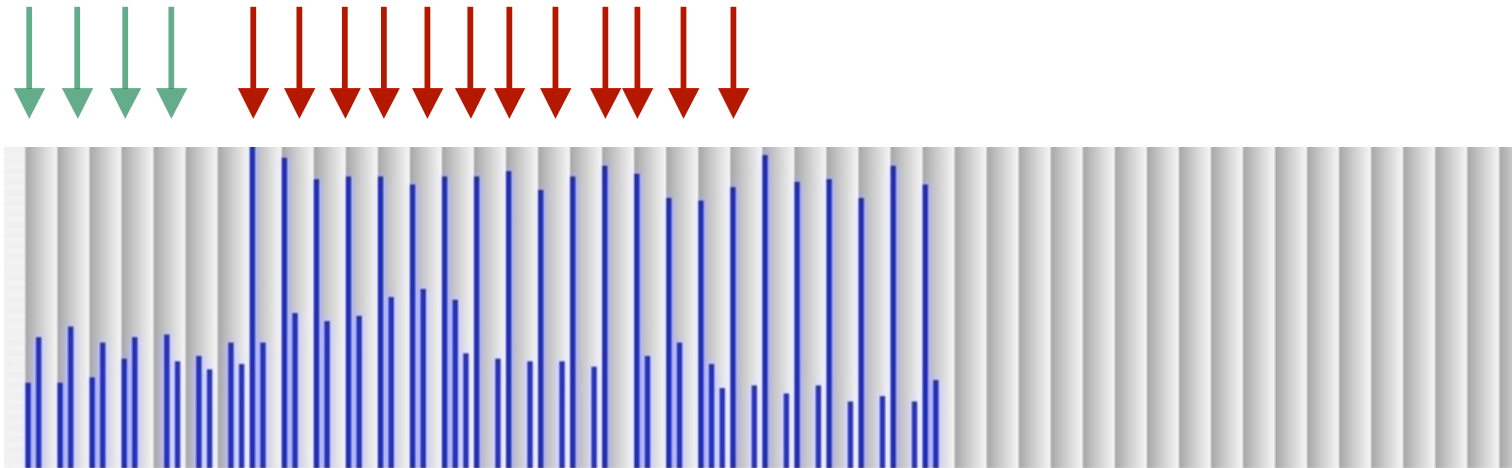
Meter in Music as a Dynamic Process



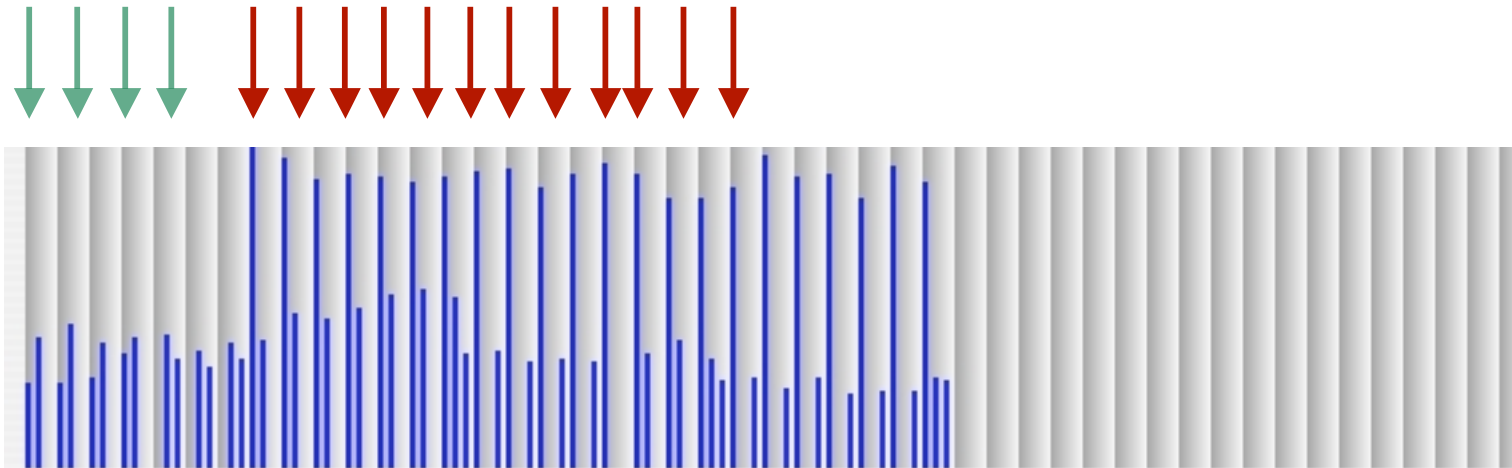
Meter in Music as a Dynamic Process



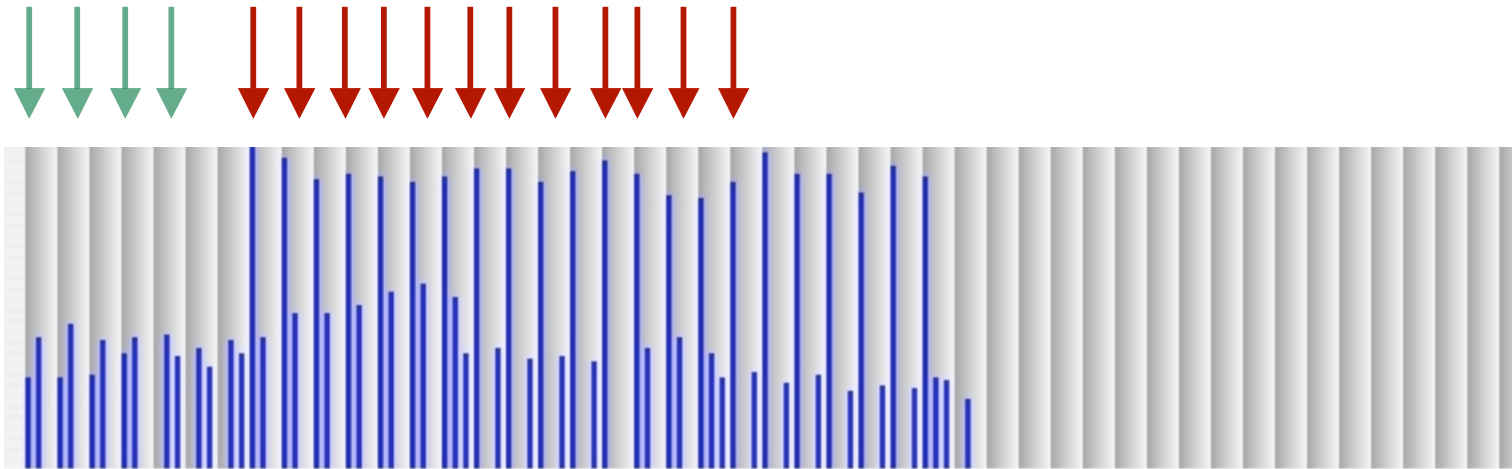
Meter in Music as a Dynamic Process



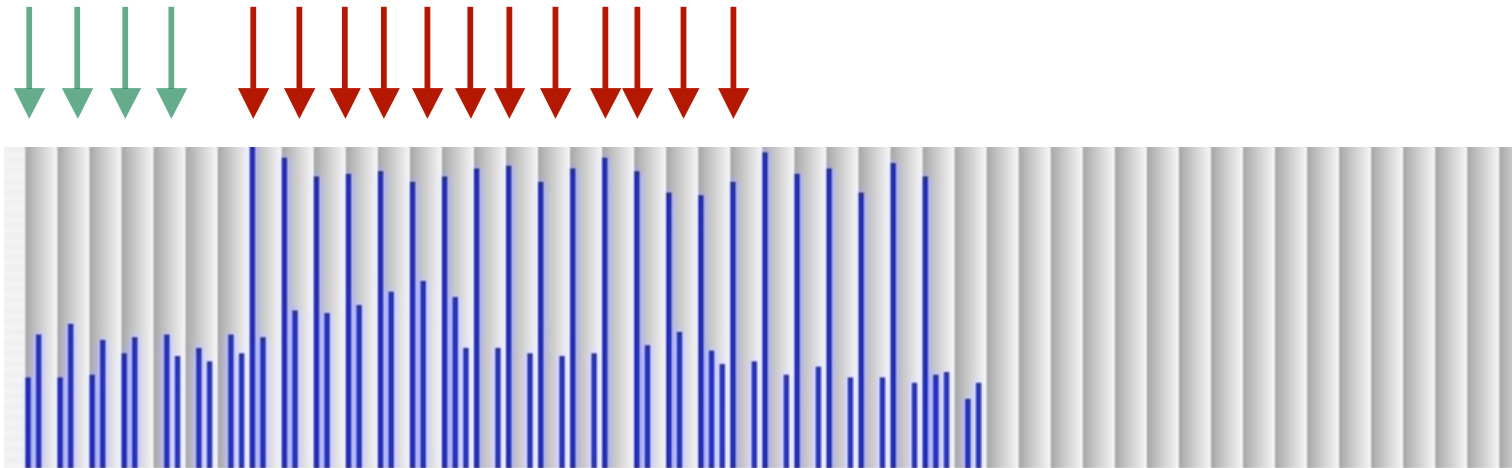
Meter in Music as a Dynamic Process



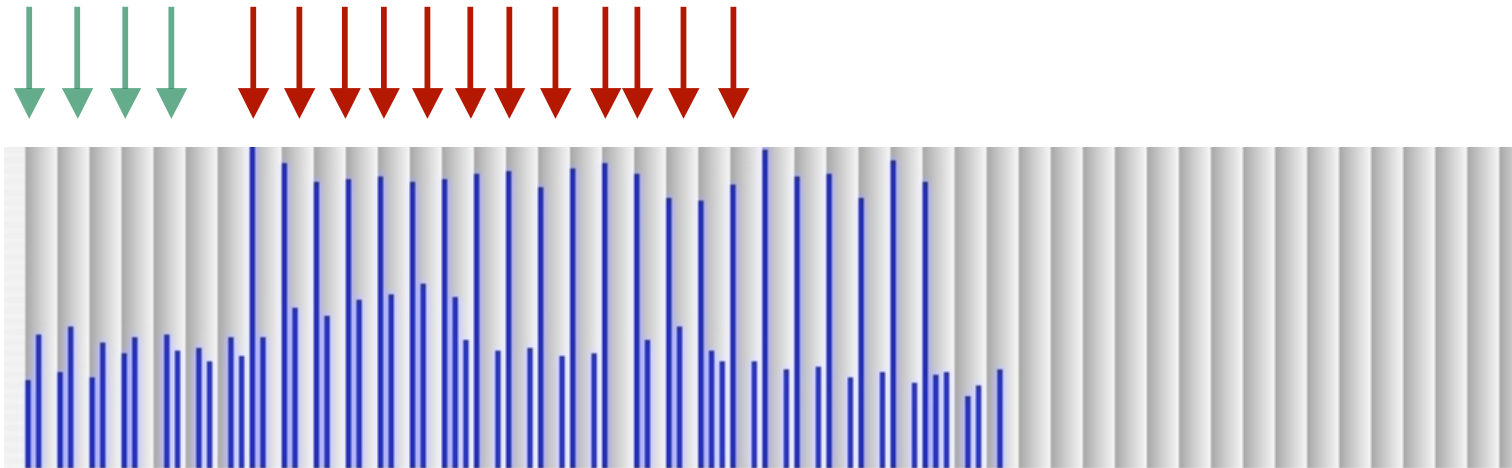
Meter in Music as a Dynamic Process



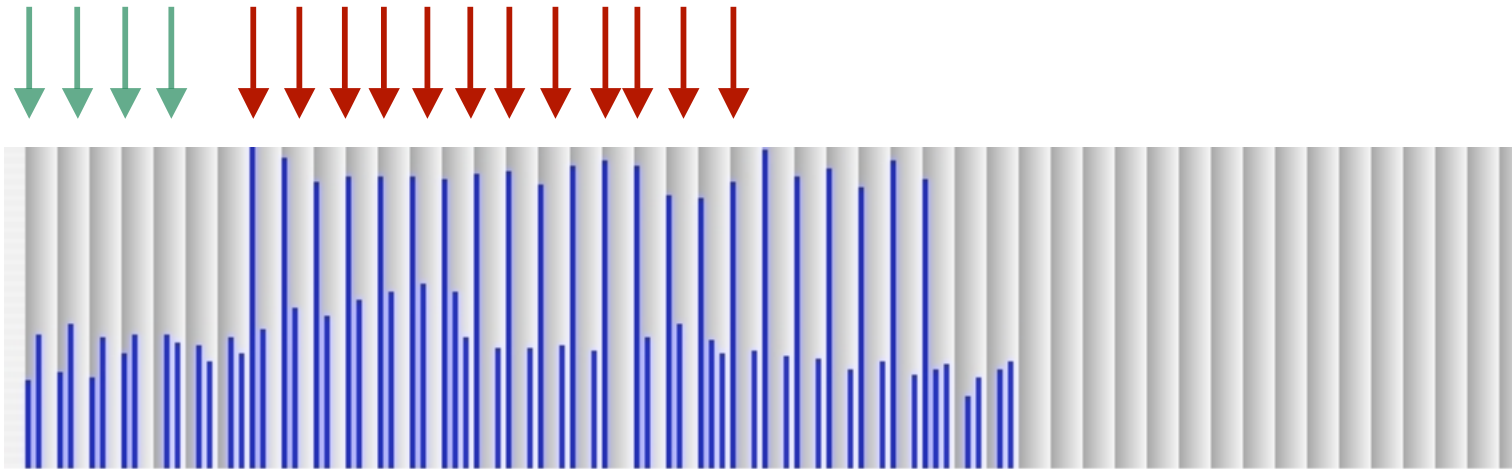
Meter in Music as a Dynamic Process



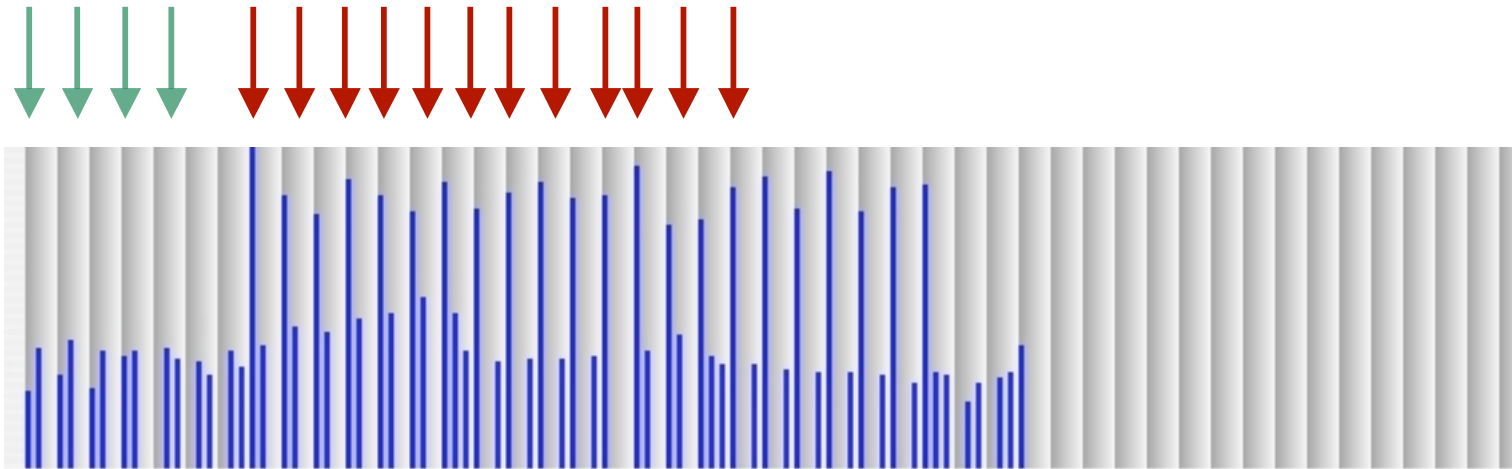
Meter in Music as a Dynamic Process



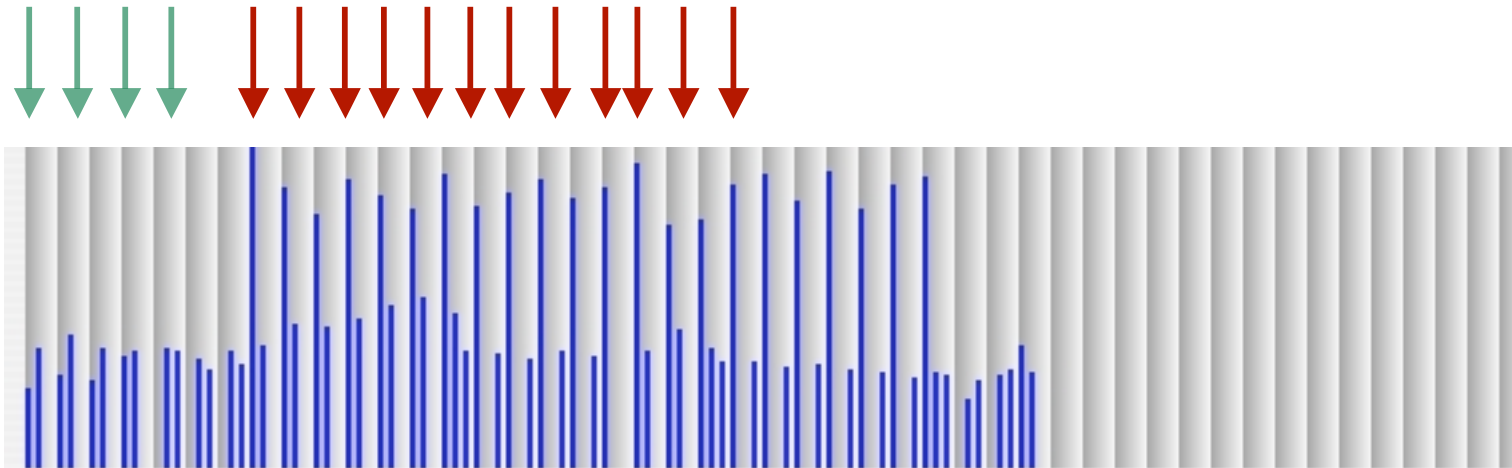
Meter in Music as a Dynamic Process



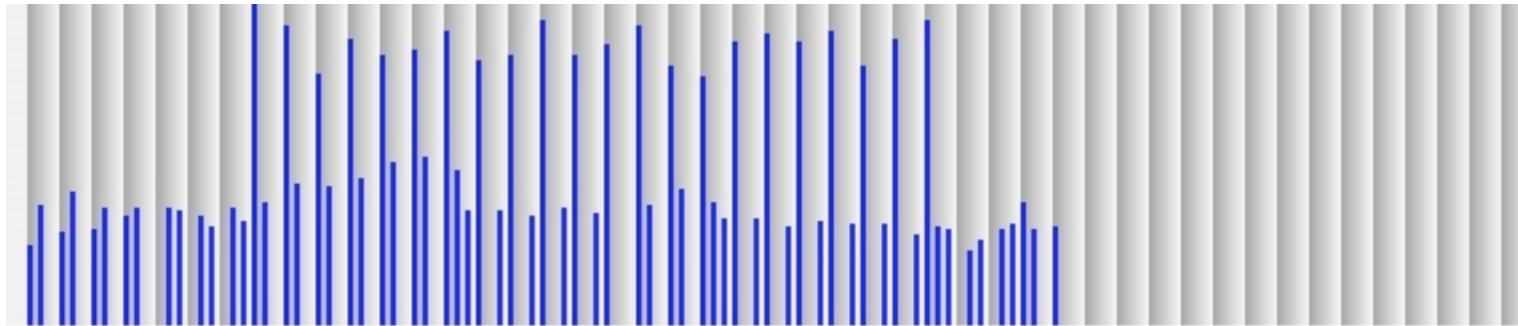
Meter in Music as a Dynamic Process



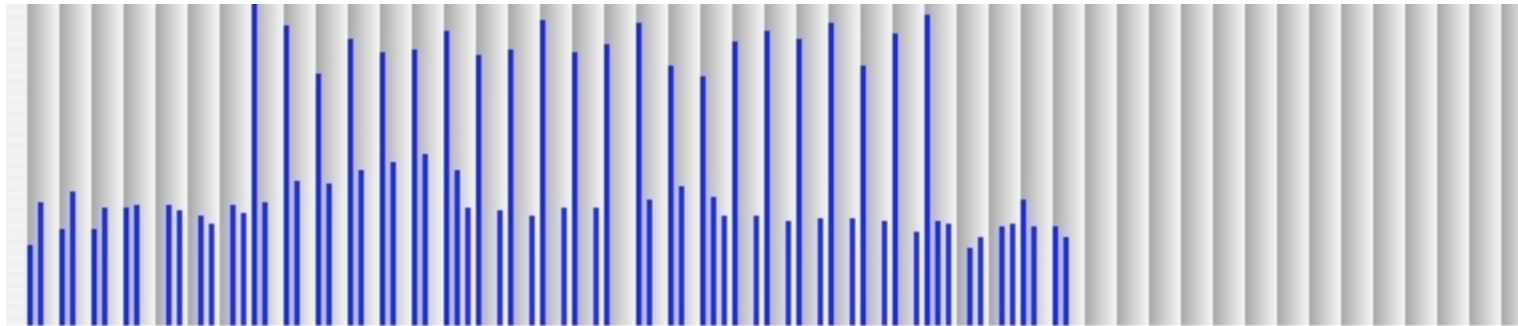
Meter in Music as a Dynamic Process



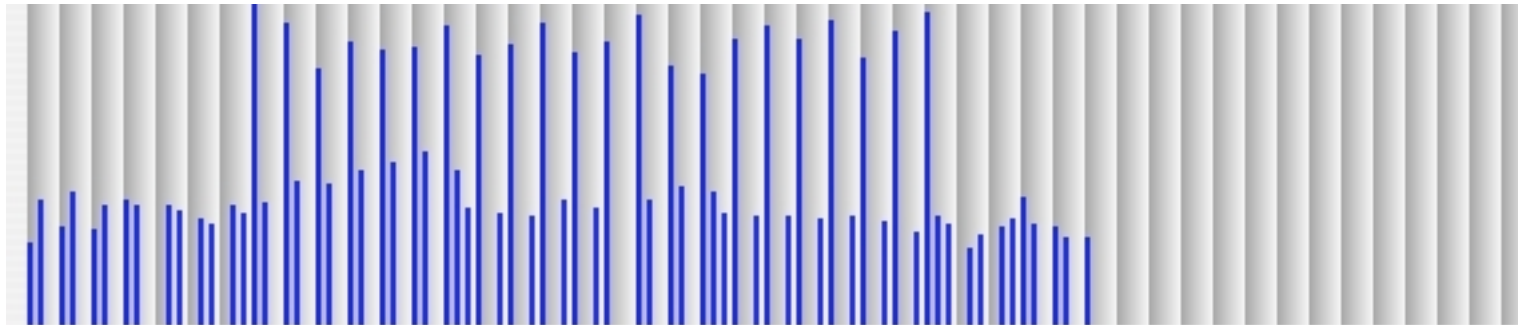
Meter in Music as a Dynamic Process



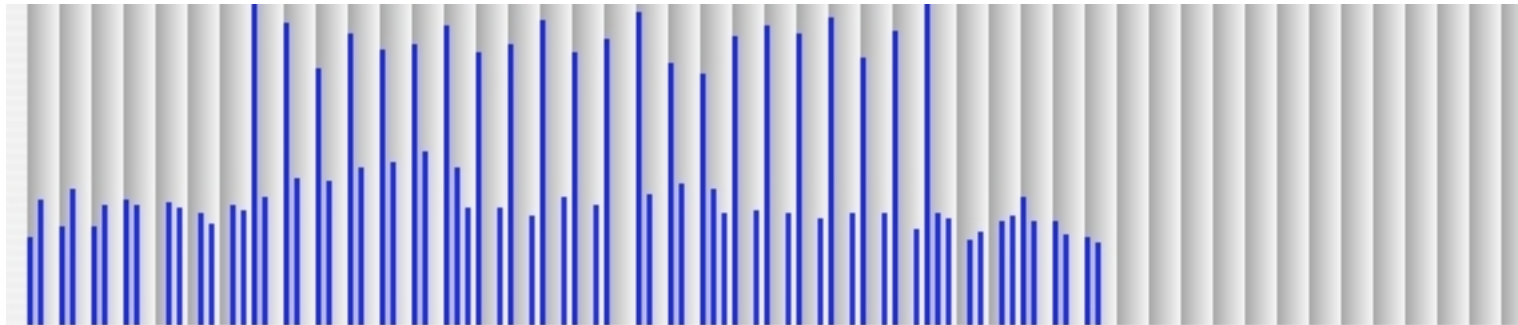
Meter in Music as a Dynamic Process



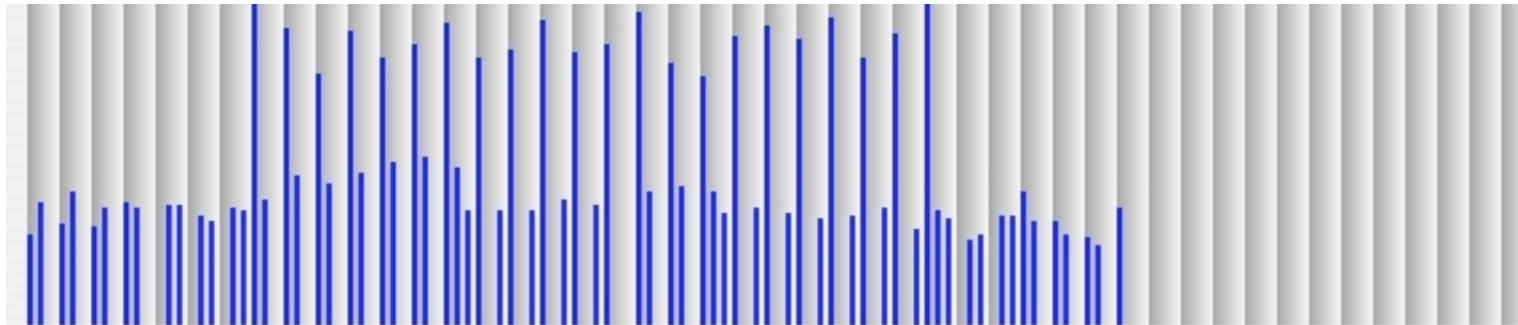
Meter in Music as a Dynamic Process



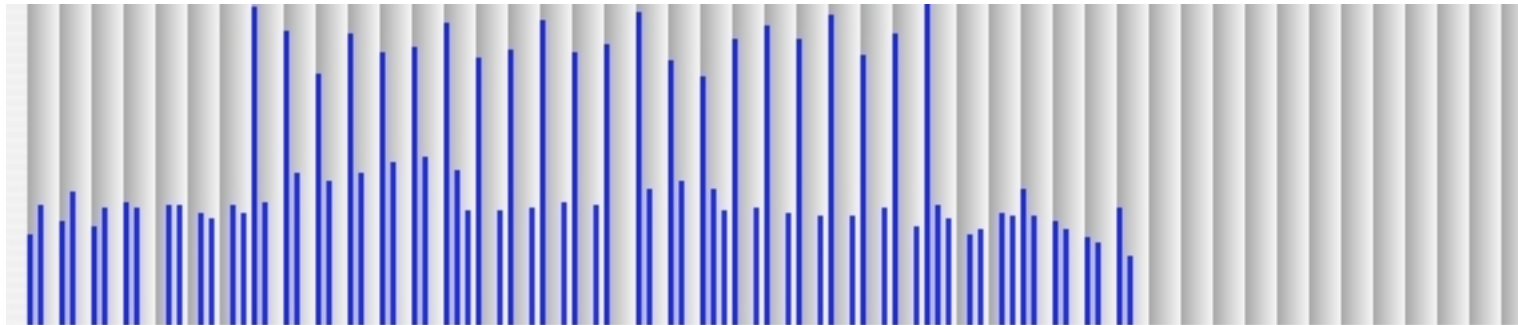
Meter in Music as a Dynamic Process



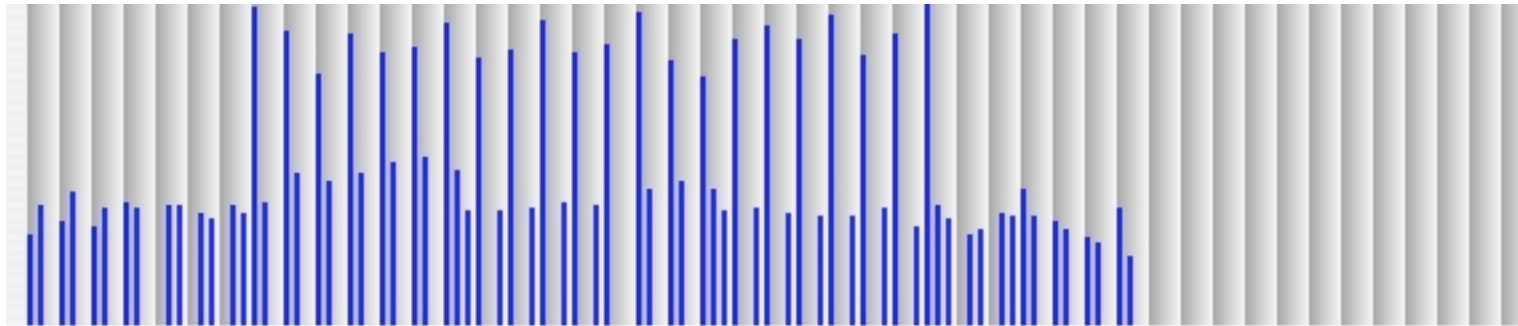
Meter in Music as a Dynamic Process



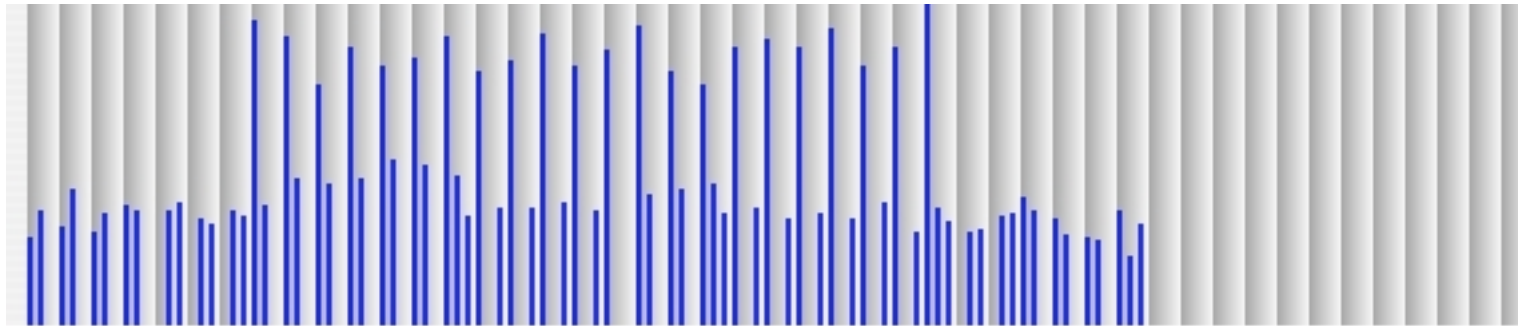
Meter in Music as a Dynamic Process



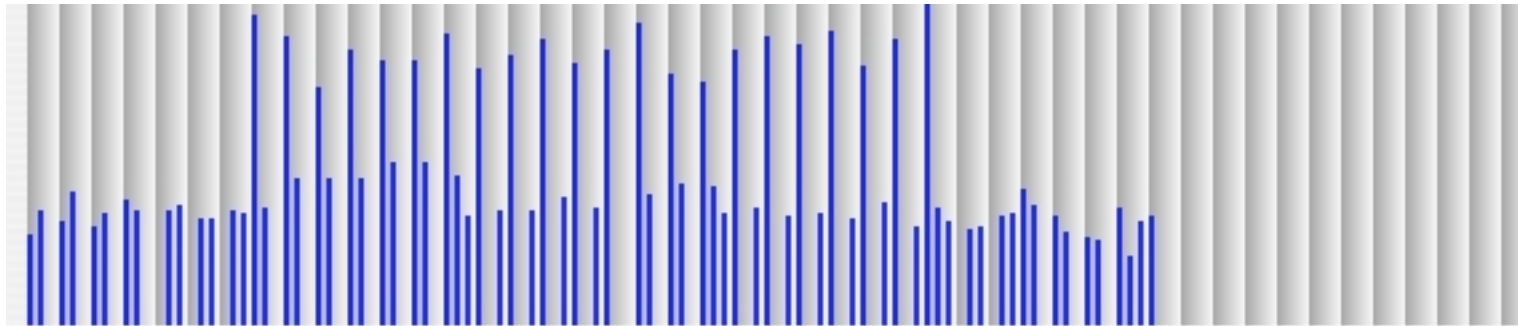
Meter in Music as a Dynamic Process



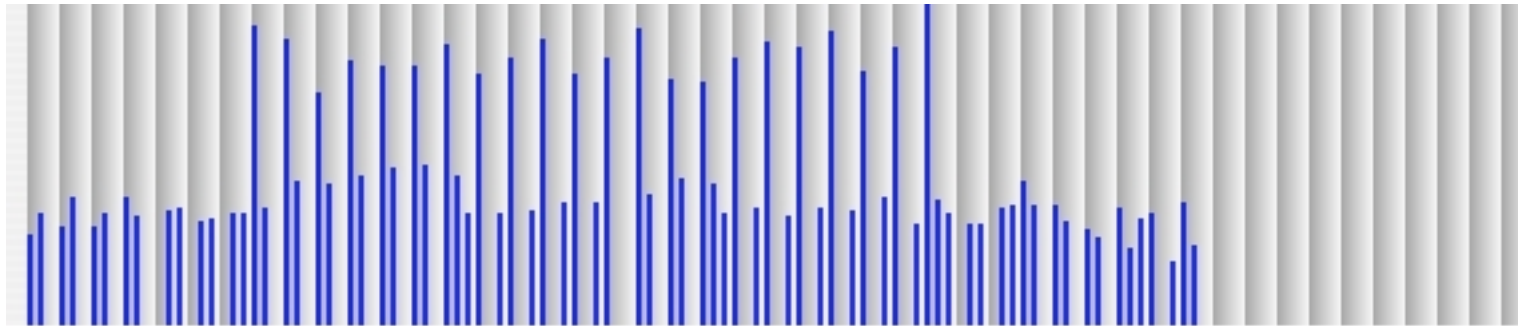
Meter in Music as a Dynamic Process



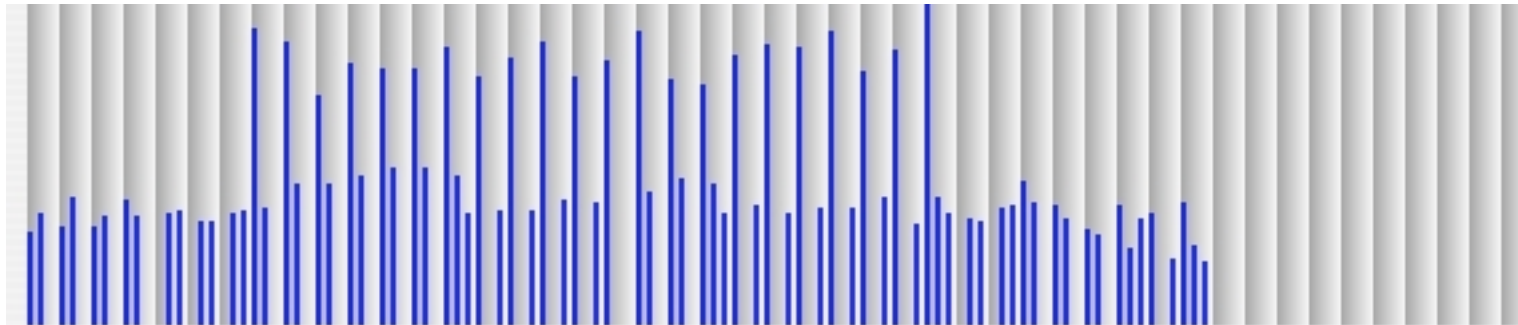
Meter in Music as a Dynamic Process



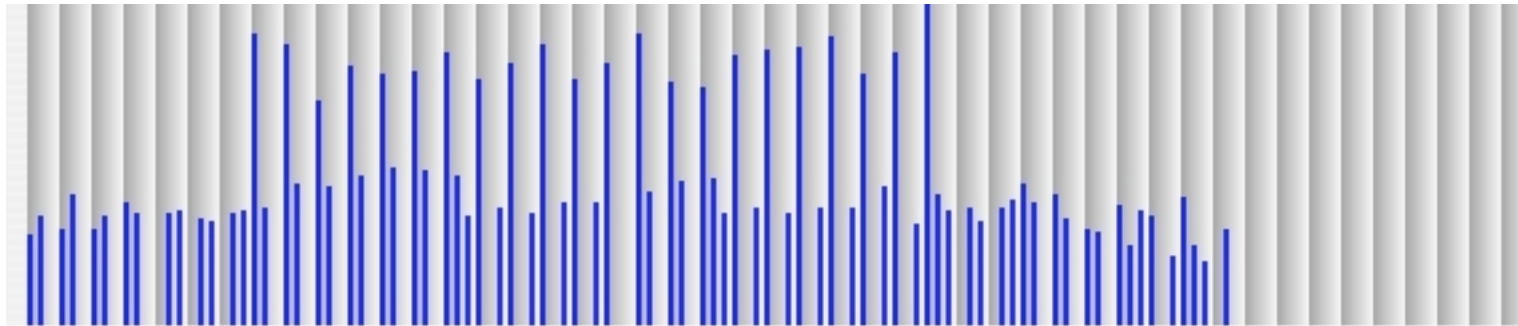
Meter in Music as a Dynamic Process



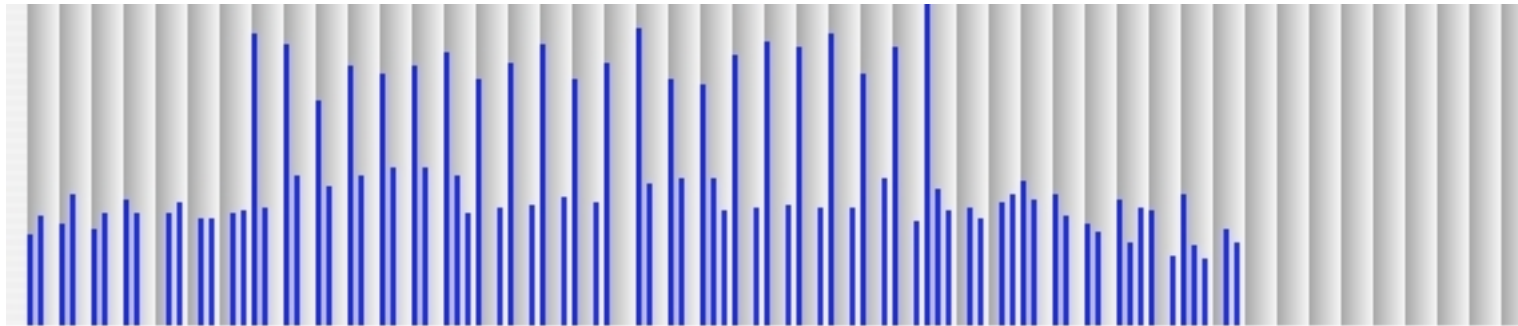
Meter in Music as a Dynamic Process



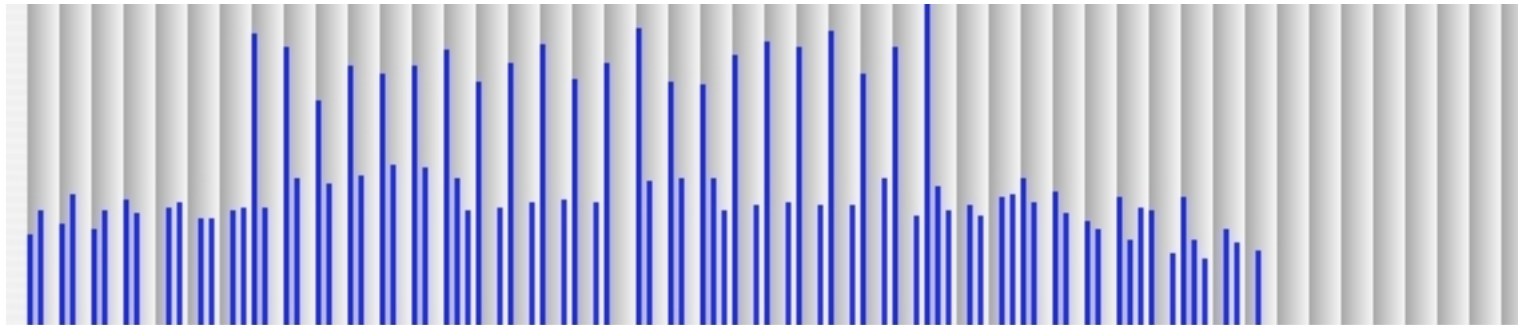
Meter in Music as a Dynamic Process



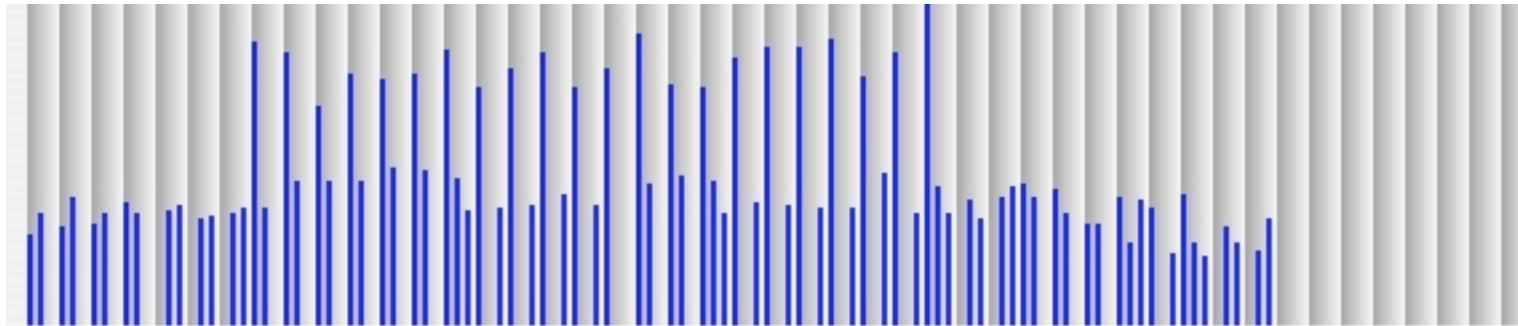
Meter in Music as a Dynamic Process



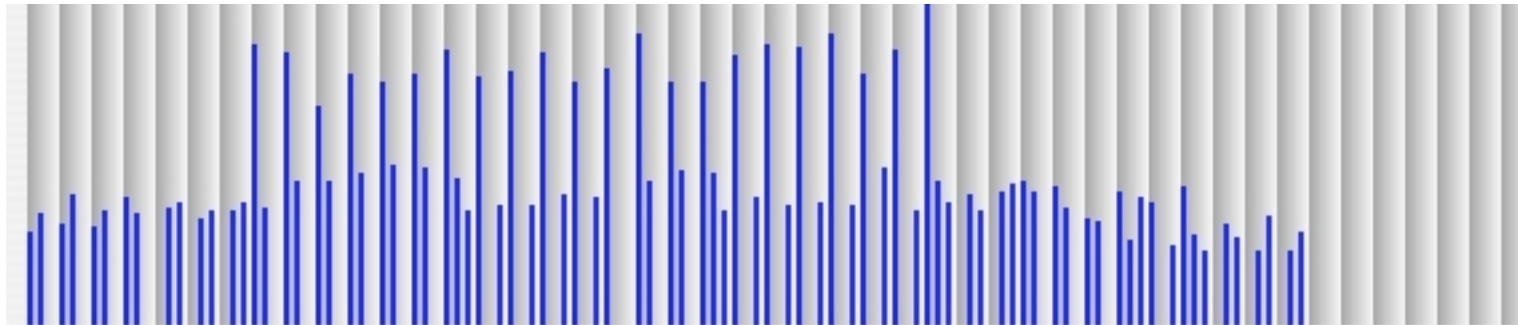
Meter in Music as a Dynamic Process



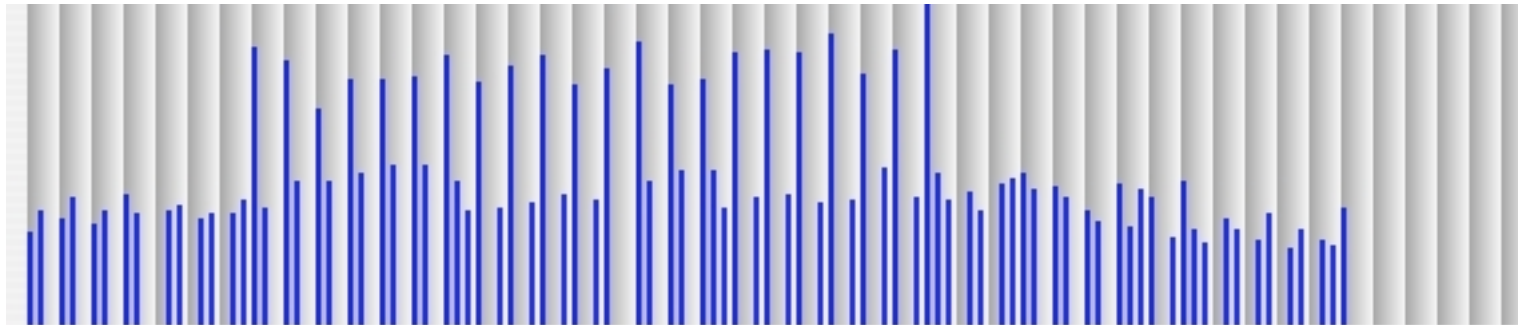
Meter in Music as a Dynamic Process



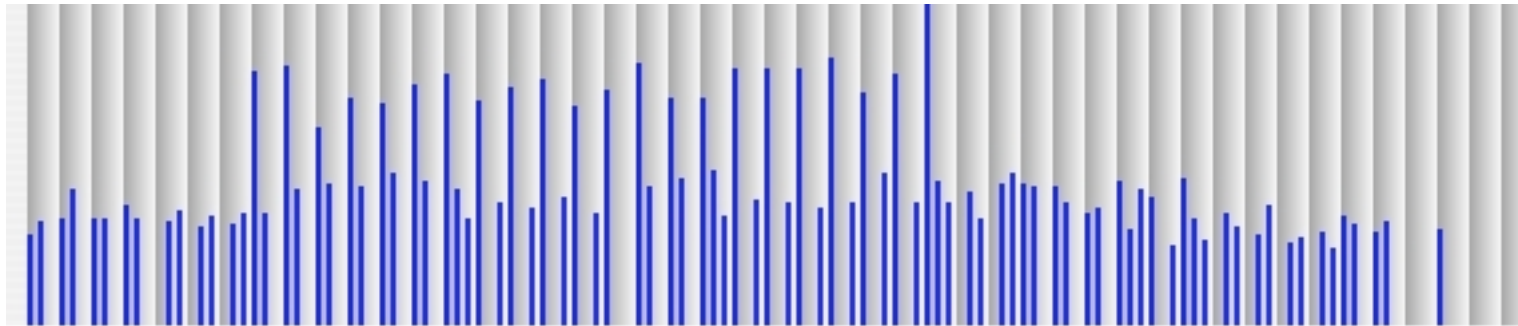
Meter in Music as a Dynamic Process



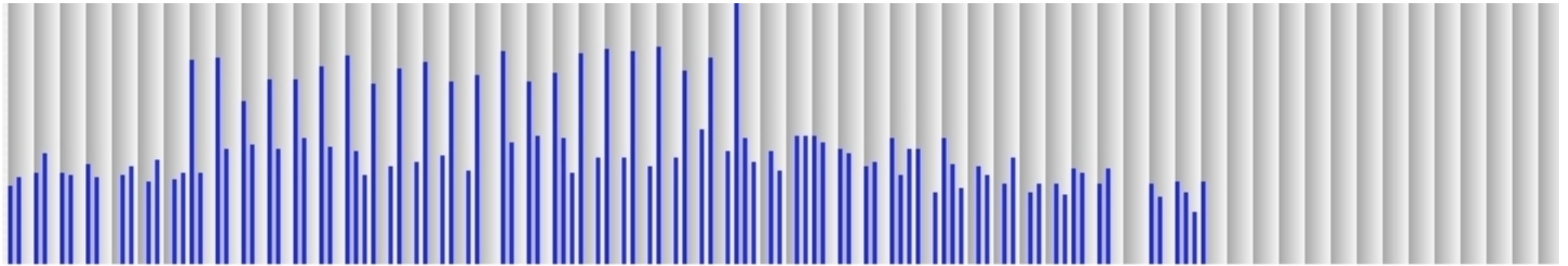
Meter in Music as a Dynamic Process



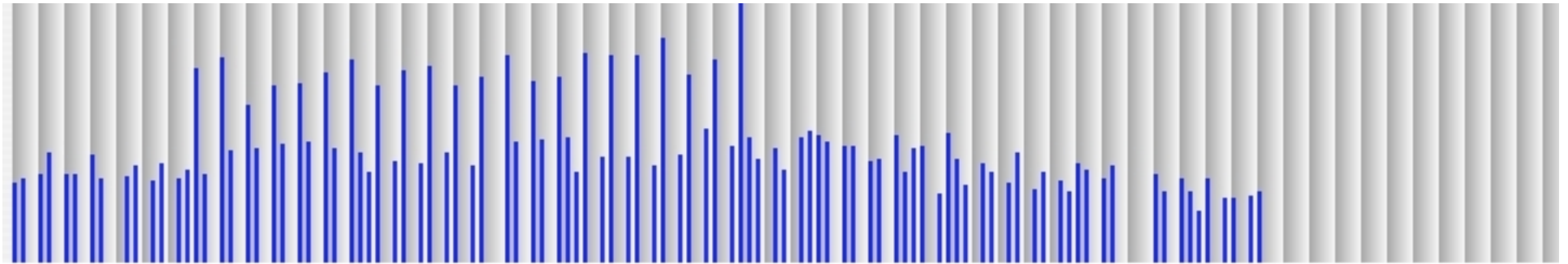
Meter in Music as a Dynamic Process



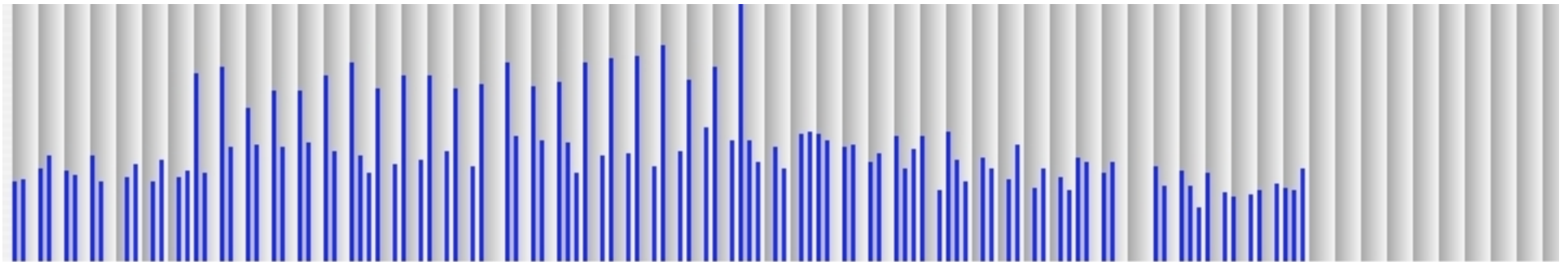
Meter in Music as a Dynamic Process



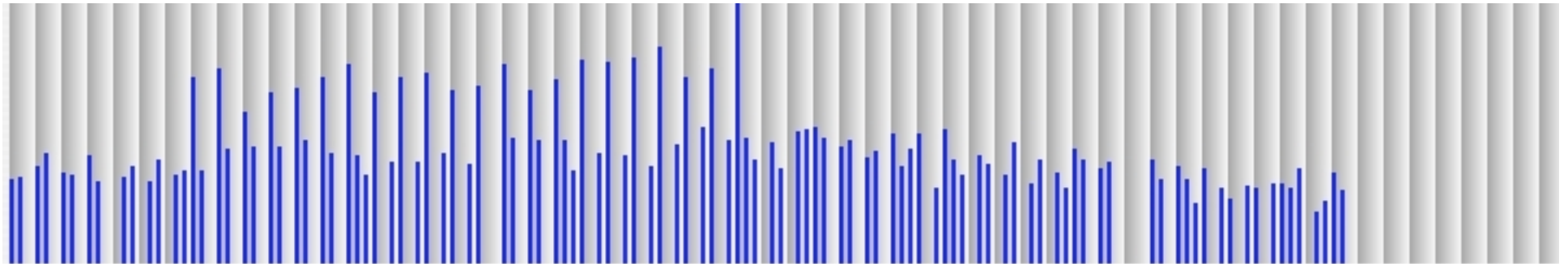
Meter in Music as a Dynamic Process



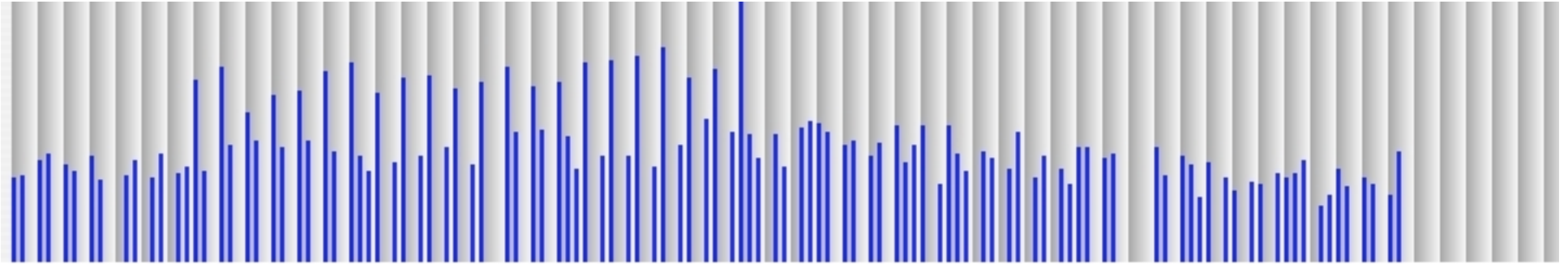
Meter in Music as a Dynamic Process



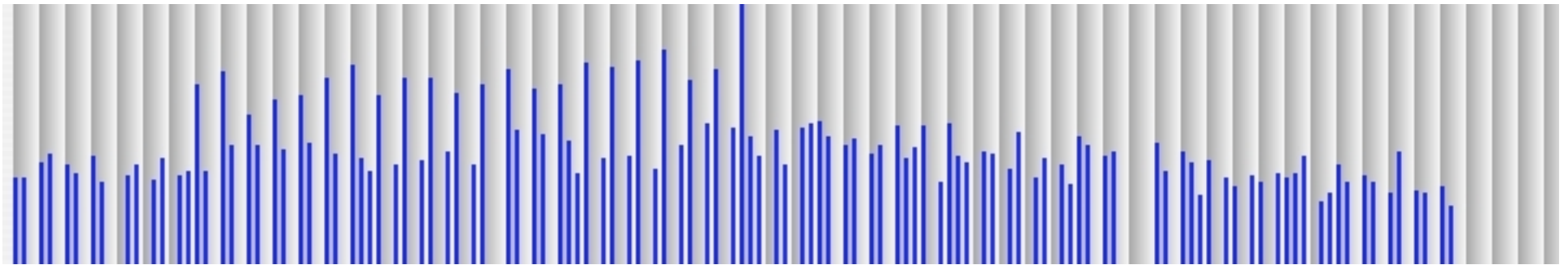
Meter in Music as a Dynamic Process



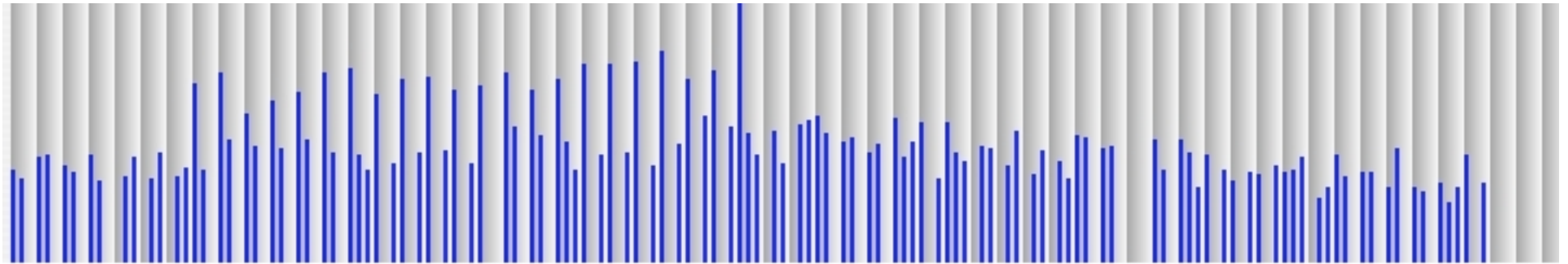
Meter in Music as a Dynamic Process



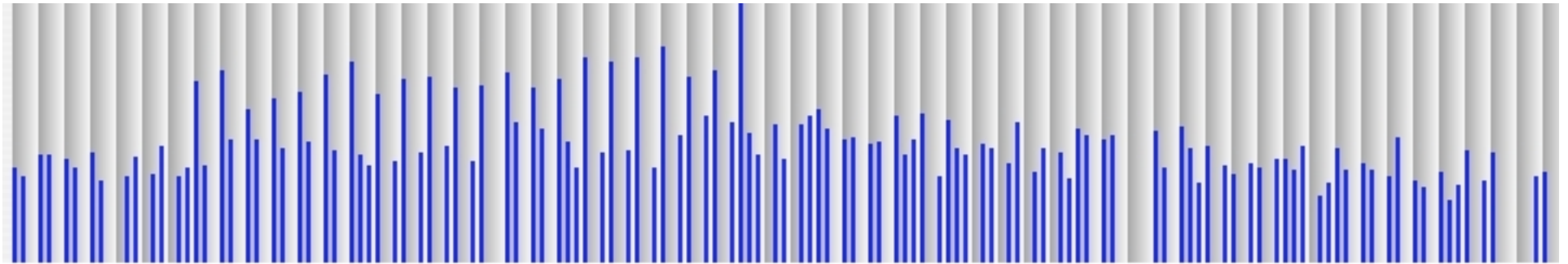
Meter in Music as a Dynamic Process



Meter in Music as a Dynamic Process



Meter in Music as a Dynamic Process



Outline

- Introduction
 - Rhythm
 - Importance of Rhythm
- Inner Metric Analysis
 - Mathematical Model for Analyzing the Rhythm
 - Some Applications
- Dance Music Classification, Music Information Retrieval

Classification

Genre classification: Latin American Dances in 4/4



Picture from hcs.harvard.edu/~hma-bdc

How to distinguish between dances of same Tempo and Meter?

Classification



Picture from www.ritzenhoff.de

Classification

	B2	R3	B1	T1	R1	M2	M1	T2	R2	A
metric wt	0.62	0.55	0.49	0.41	0.36	0.34	0.34	0.31	0.31	0.26
spectral wt	0.62	0.61	0.44	0.33	0.37	0.45	0.54	0.31	0.31	0.30

Merengue

Rumba



Picture from www.danceuniverse.co.kr

Tango



Picture from www.accomodationbsas.co.ar

BossaNova



Picture from www.ritzenhoff.de



Picture from www.mondolatino.it

March/Anthem



Picture from www.armygermany.com

Classification

CLASSIFICATION METHOD

STEP 1: Generate rhythm templates

- Complete Book of the Worlds' Dance Rhythm

Stage 1: Pre-processing of template rhythms

Step 1: Repeat the template rhythm four times.

Step 2: Calculate its metric/spectral weight.

Step 3: Extract metric/spectral weight profile of 2nd repetition.

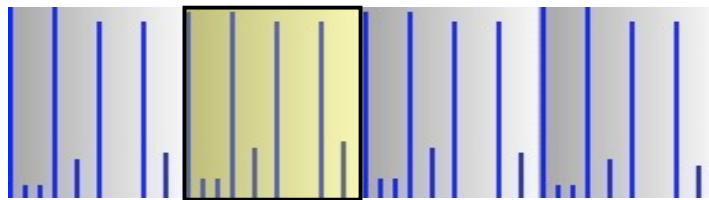
Step 4: Normalize all weights to fall between 0 and MAX (=10).

Classification

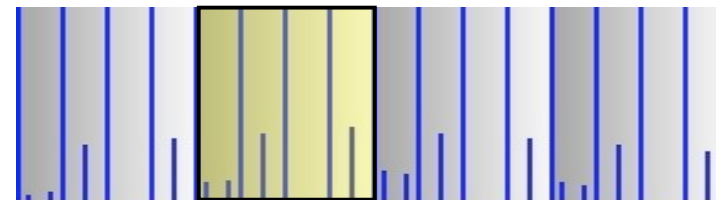


Picture from www.mondolatino.it

Example Template: Merengue



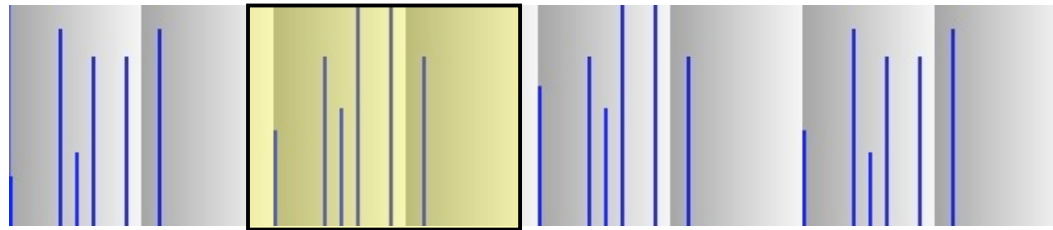
Metric Weight



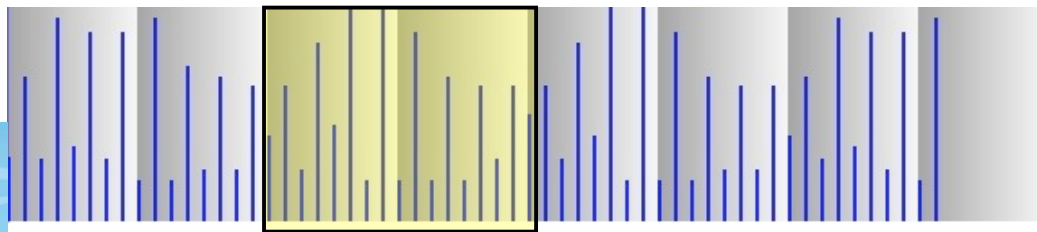
Spectral Weight

Classification

Example: Girl from Ipanema



Metric Weight



Spectral Weight



Picture from www.ritzenhoff.de

Classification

	B2	R3	B1	T1	R1	M2	M1	T2	R2	A
metric wt	0.62	0.55	0.49	0.41	0.36	0.34	0.34	0.31	0.31	0.26
spectral wt	0.62	0.61	0.44	0.33	0.37	0.45	0.54	0.31	0.31	0.30

Merengue



Picture from www.mondolatino.it

BossaNova



Picture from www.ritzenhoff.de

Tango



Picture from www.accomodationbsas.co.ar

March/Anthem



Picture from www.armygermany.com

Rumba



Picture from www.danceuniverse.co.kr

correct genre: 80%

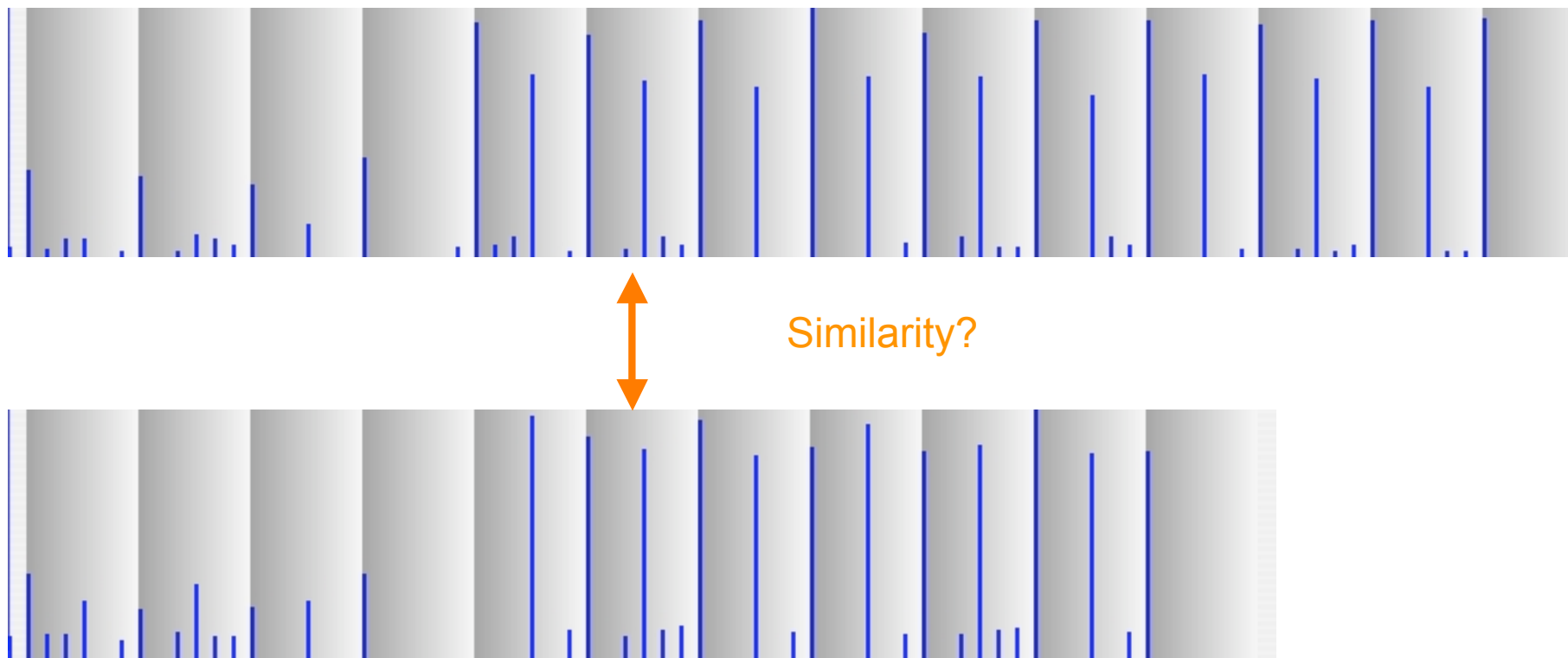
Rhythmic Similarity: Extension

What Is Topical in Cultural Heritage:
Content-based Retrieval Among Folk Tunes

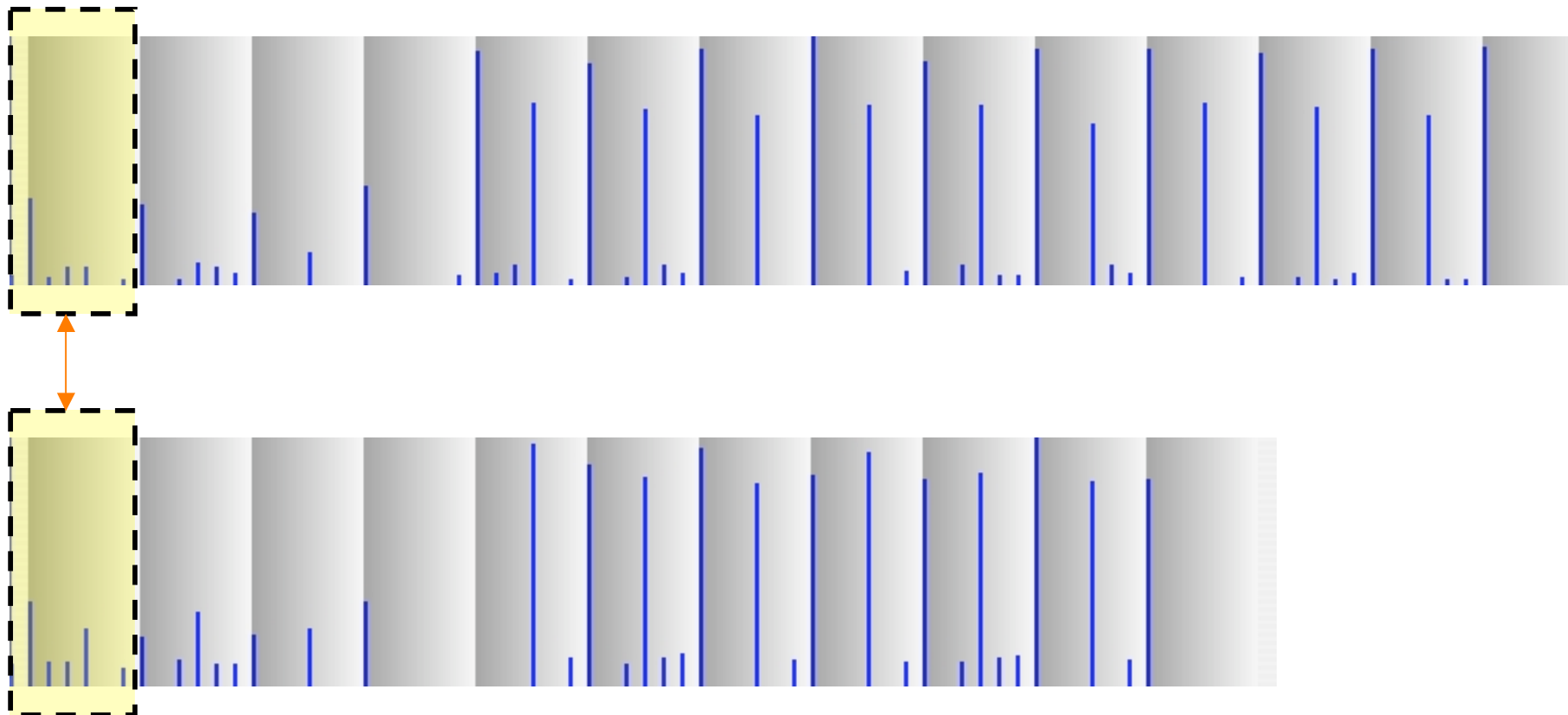
WITCHCRAFT:

Retrieval of folk songs

Rhythmic Similarity: Extension

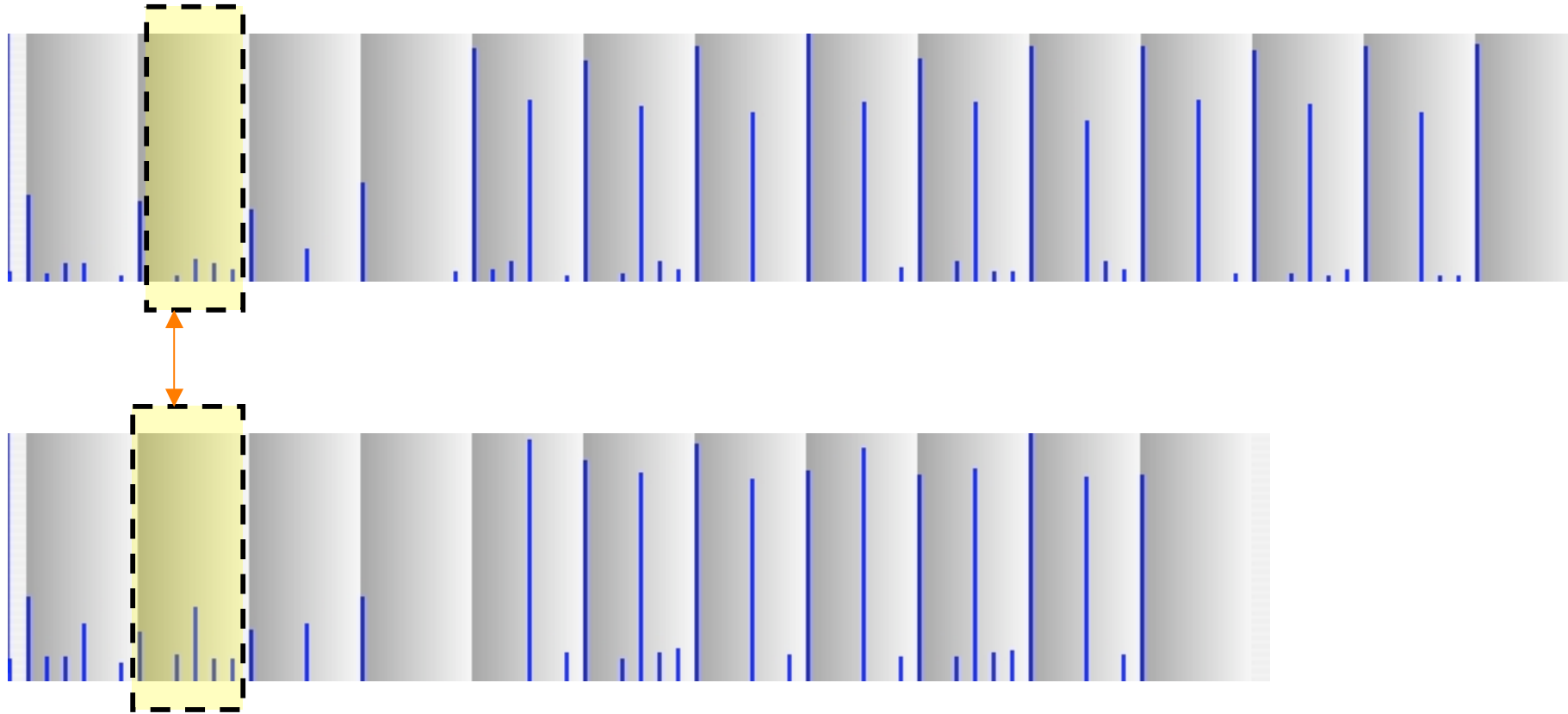


Rhythmic Similarity: Extension



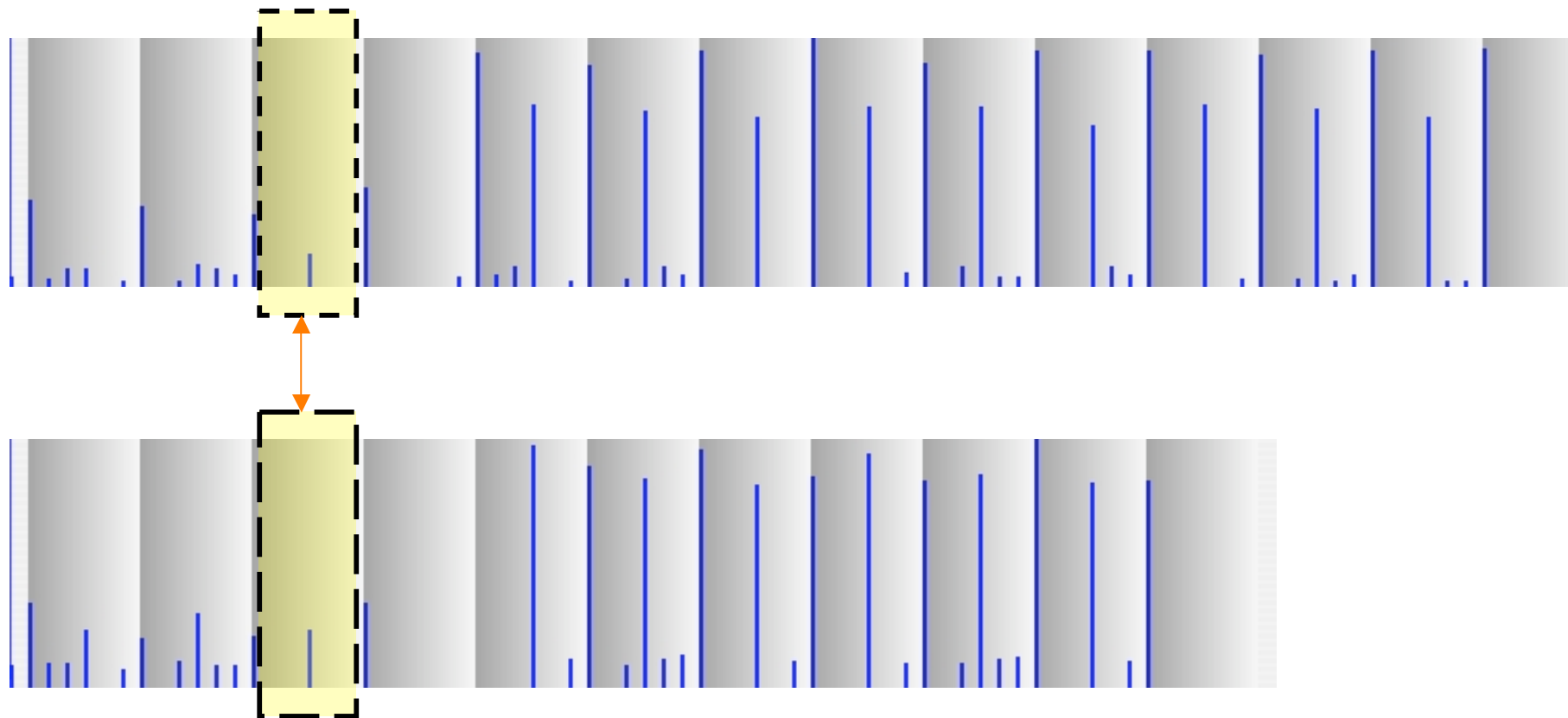
C_1

Rhythmic Similarity: Extension



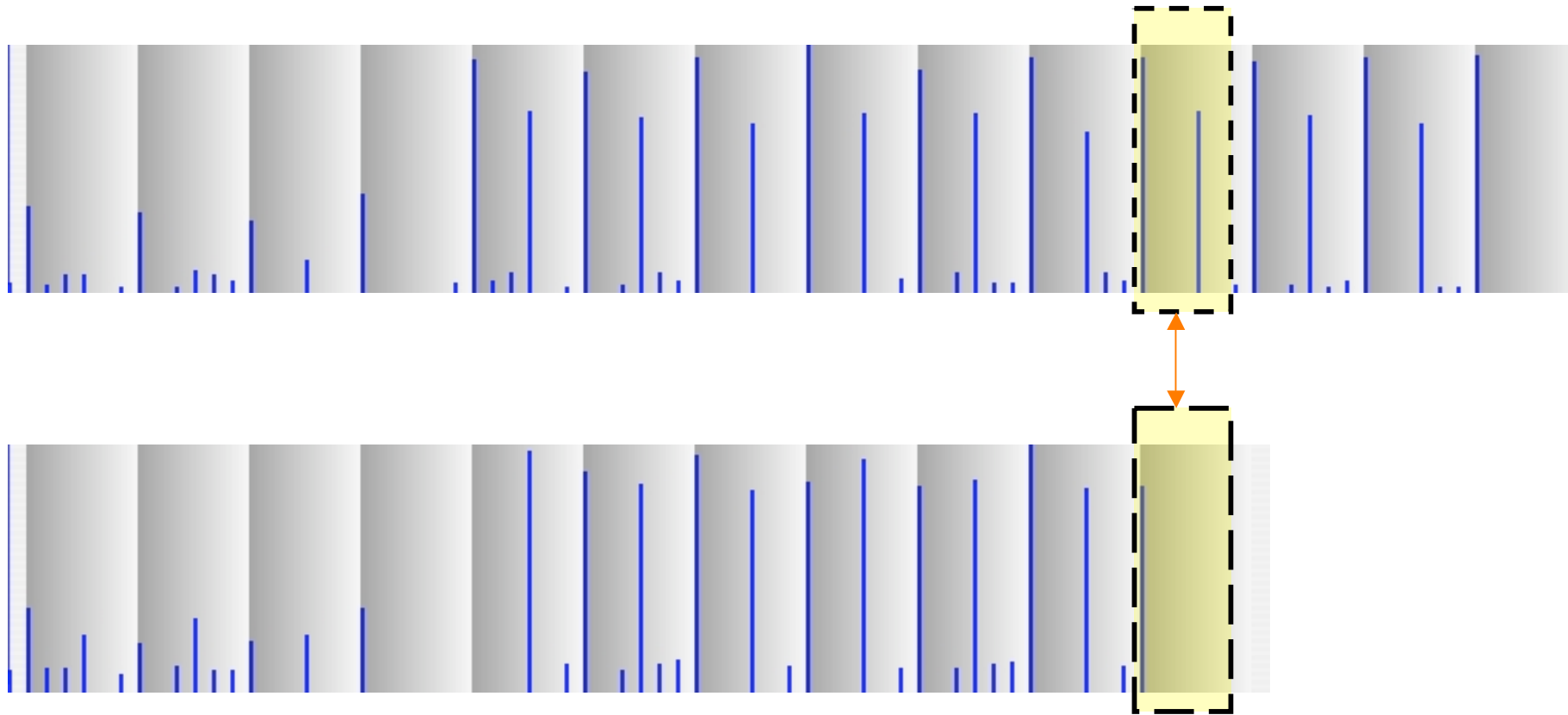
$$C_1 + C_2$$

Rhythmic Similarity: Extension



$$C_1 + C_2 + C_3$$

Rhythmic Similarity: Extension

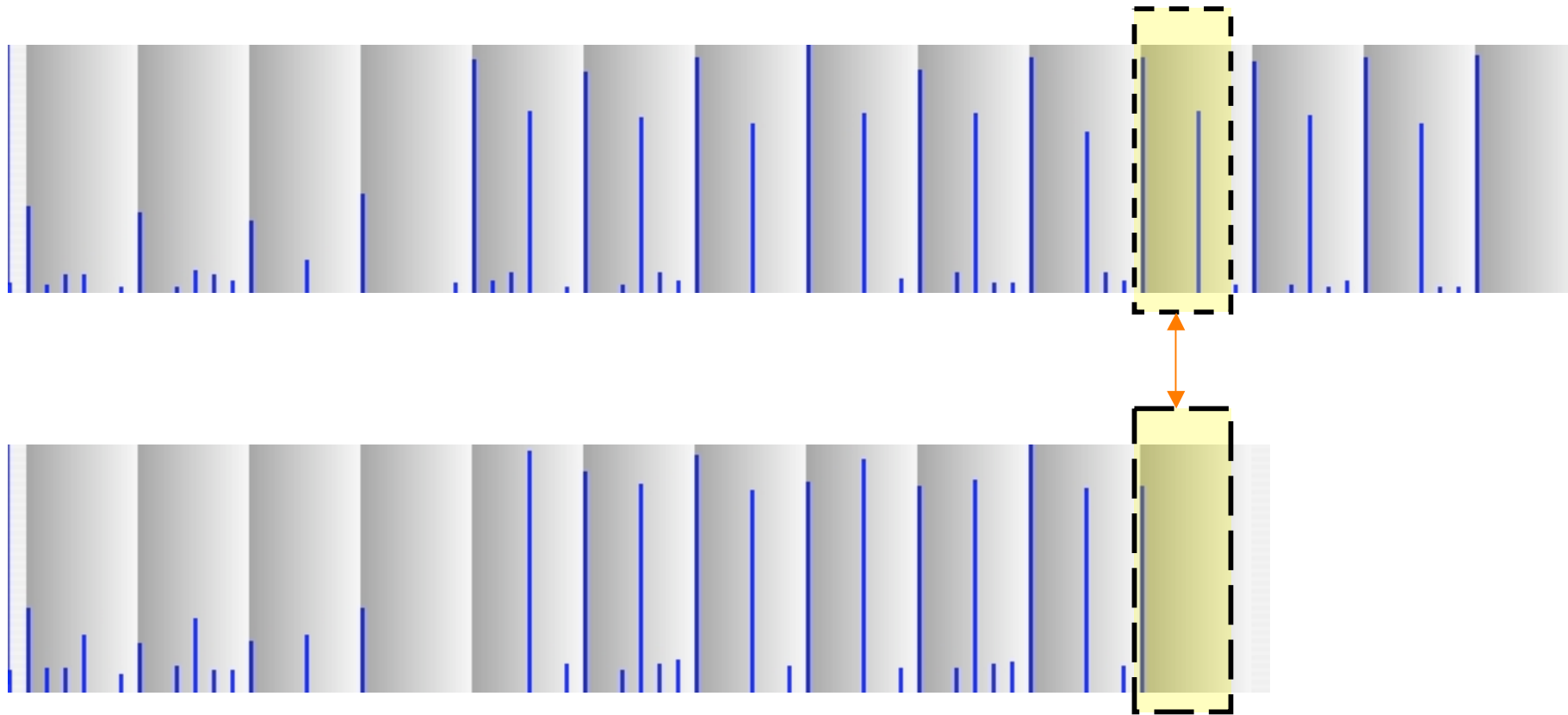


$C_1 + C_2 + C_3 + \dots$

\dots

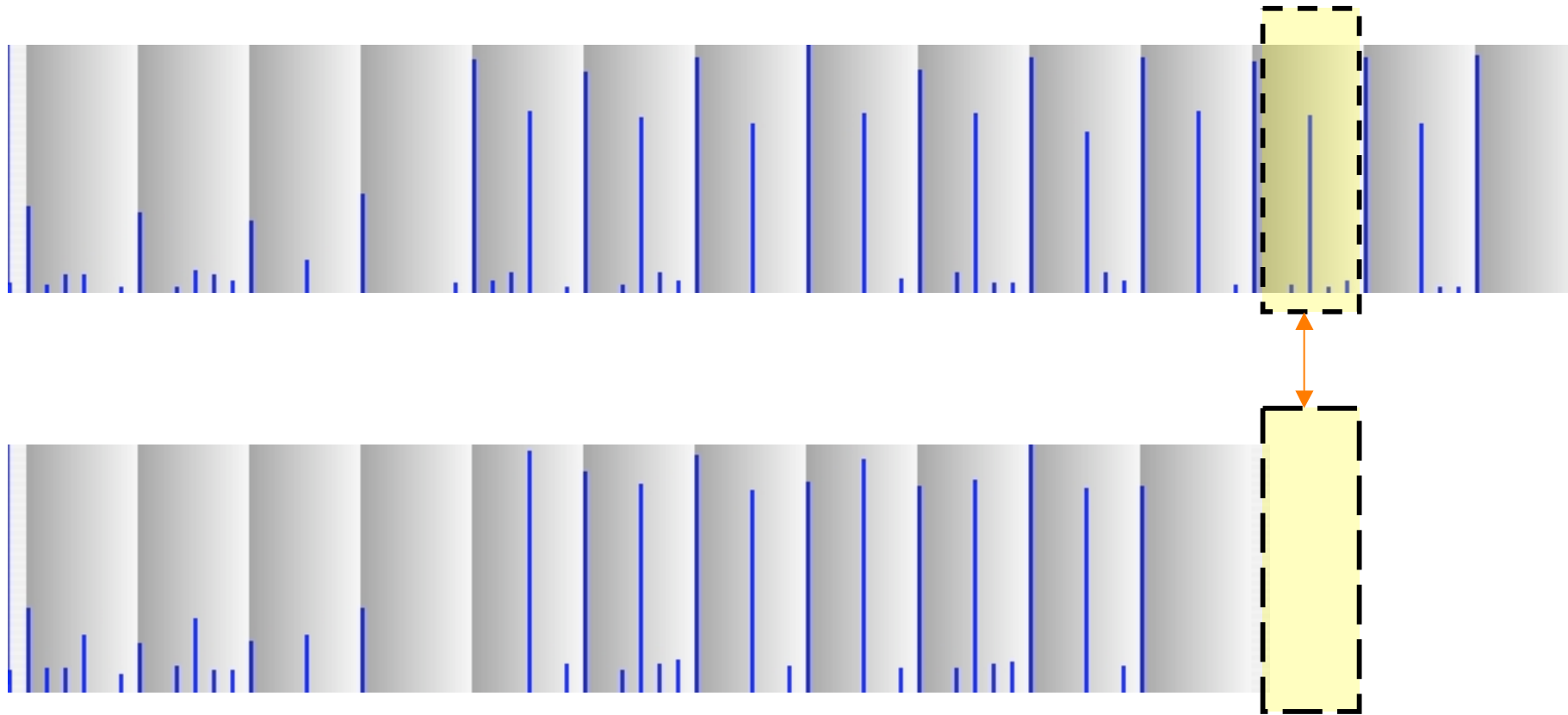
$\dots + C_n$

Rhythmic Similarity: Extension



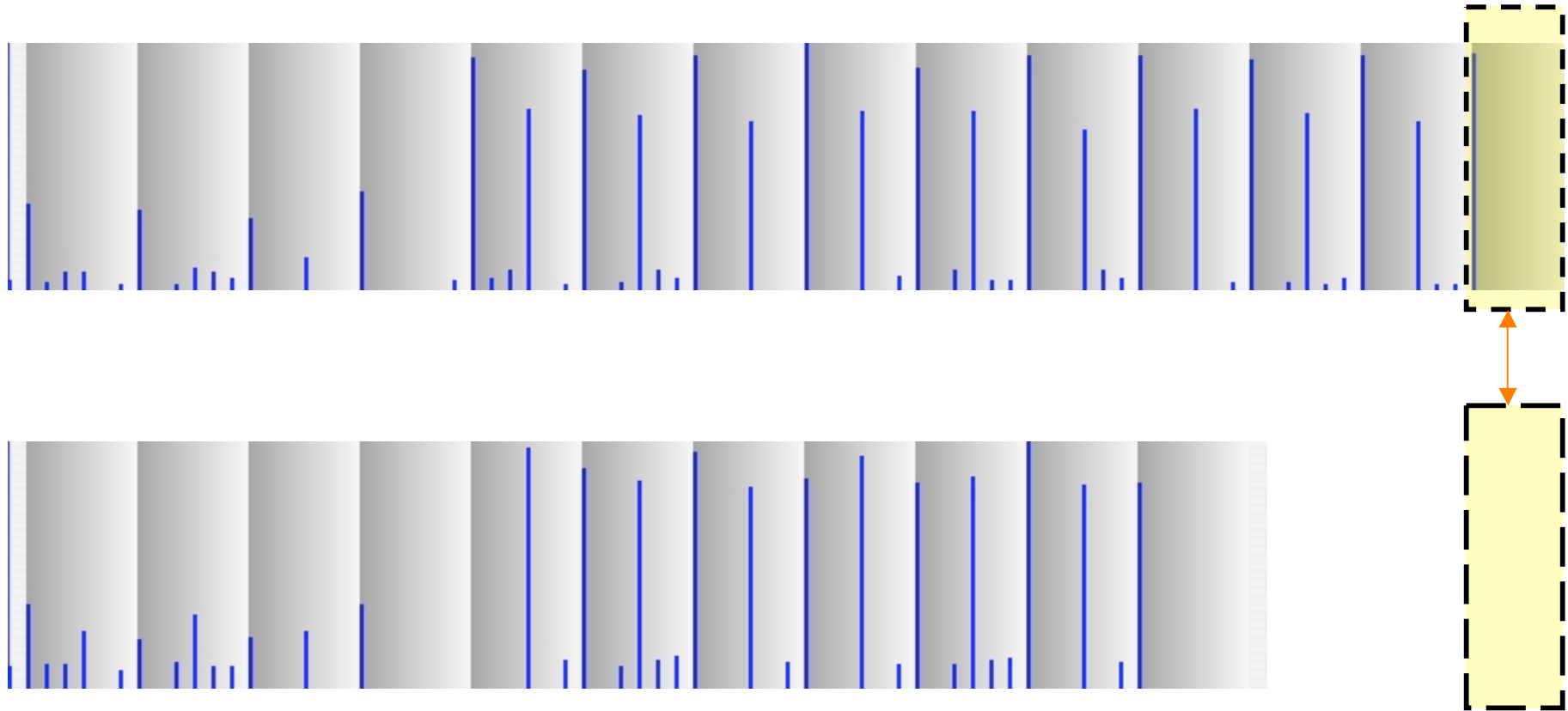
$$(C_1 + C_2 + C_3 + \dots \quad \dots \quad \dots + C_n) / n$$

Rhythmic Similarity: Extension



$$(C_1 + C_2 + C_3 + \dots \dots \dots + C_n) / n$$

Rhythmic Similarity: Extension



$$(C_1 + C_2 + C_3 + \dots \quad \dots \quad \dots \quad + C_m) / m$$

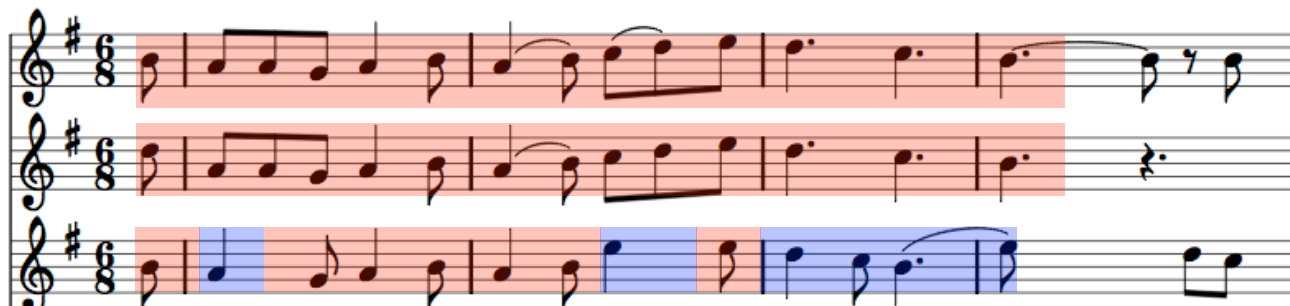
Application

Dutch Folk song collection: Onder de groene linde



Oral Tradition

Melody Group



Melody Group

A musical score for a melody group in D major (two sharps) and 2/4 time. The score consists of four staves. The first two staves are primarily highlighted in red, while the third and fourth staves have blue highlights. The melody is written in treble clef and features a sequence of eighth and quarter notes, with some phrases spanning across bar lines. The first staff ends with a quarter rest, and the second staff ends with a whole rest.

Melody Group

A musical score for a melody group consisting of ten staves. The score is written in treble clef with a key signature of two sharps (F# and C#). The music is organized into four measures per staff. The first measure of each staff begins with a treble clef, a key signature of two sharps, and a common time signature. The notation includes various rhythmic values such as quarter notes, eighth notes, and dotted notes, along with slurs and ties. The melody is primarily composed of eighth and quarter notes, with some dotted rhythms and occasional rests. The overall structure is consistent across all ten staves, suggesting a multi-voice setting of the same melodic material.

Melody Group

A musical score consisting of ten staves, each with a treble clef and a key signature of one sharp (F#). The notation is in a single melodic line across all staves, with various note values including quarter, eighth, and sixteenth notes, as well as rests and ties. The score is presented in a light gray color.



query

Melody Group



The image displays a musical score with ten staves, each beginning with a treble clef, a key signature of one sharp (F#), and a common time signature (C). The notation includes various note values, rests, and slurs. A solid black arrow on the right points to the first staff. Below it, a series of red dotted lines form a vertical path that highlights a specific sequence of notes across all ten staves, starting from the first staff and moving downwards. This sequence of notes represents the 'Melody Group' mentioned in the title.

IMA



Ik bend'r van de - ze mor - gen vroeg op - ge - staan,

IMA



Ik bend'r van de - ze mor - gen vroeg op - ge - staan,

Ik ben er van de - ze mor - gen en vroeg op - ge - staan

Ik bend'r van de - ze mor - gen en vroeg op - ge - staan

Ik bend'r van de - ze mor - gen en vroeg op - ge - staan.

Ik bend'r van de - ze mor - gen vroeg op - ge - staan

Ik bend'r van de - ze mor - gen en vroeg op - ge - staan.

Ik ben van de - ze mor - gen d'r vroeg op - ge - staan.

Ik ben er de - ze mor - gen vroeg op - ge - staan

Ik ben er de - ze mor - gen vroeg op - ge - staan





Ik bend'r van de - ze mor - gen vroeg op - ge - staan,



Ik ben er van de - ze mor - gen en vroeg op - ge - staan



Ik bend'r van de - ze mor - gen en vroeg op - ge - staan



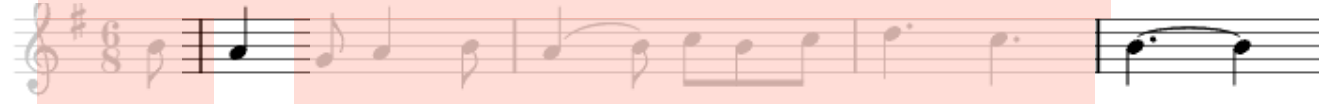
Ik bend'r van de - ze mor - gen en vroeg op - ge - staan.



Ik ben d'r van de - ze mor - gen vroeg op - ge - staan



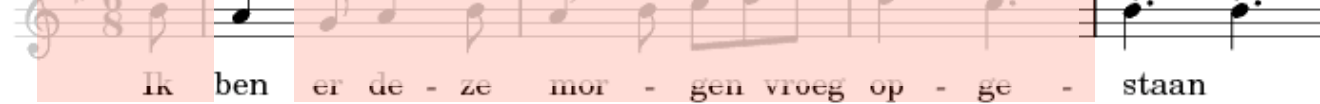
Ik bend'r van de - ze mor - gen en vroeg op - ge - staan.



Ik ben van de - ze mor - gen d'r vroeg op - ge - staan.



Ik ben er de - ze mor - gen vroeg op - ge - staan



Ik ben er de - ze mor - gen vroeg op - ge - staan





Ik ben d'r van de - ze mor - gen vroeg op - ge - staan,

Ik ben van de - ze mor - gen vroeg op - ge - staan

Ik ben van de - ze mor - gen vroeg op - ge - staan

Ik ben van de - ze mor - gen d'r vroeg op - ge - staan.

En ik ben er van de - ze mor - gen vroeg op gaan staan

Ik ben van de - ze mor - gen vroeg op - ge - staan

Ik ben van de - ze mor - gen vroeg op - ge - staan

En ik ben van de - ze mor - gen vroeg op - ge - staan

Ik ben van de - ze mor - re-gen vroeg op - ge - staan





Ik bend'r van de - ze mor - gen vroeg op - ge - staan,

Ik ben van de - ze mor - re-gen vroeg op - ge - staan,

Ik ben van de - ze mor - gen vroeg op - ge - staan

Tot dat er verhoor - de een ko - nings - kind.

en dan moest zij zich kle - den in't gou - den - belaan

Waar - om hij geen e - ten of drin - ken trac - teert.

Dan zul - len uw kleed' - ren in zij - de ver - gaan.

Ze zei - de van nee maar ze meen - de van ja

En wat zag hij van ver - re? Een ko - nings - kind staan.

Music Information Retrieval

- Find similar melodies based on their rhythmic structure!

More Information

- <http://people.cs.uu.nl/volk>
- Download JMetro-Tool:
<http://pierement.zoo.cs.uu.nl/joerg/MaMuTh/Metro/>
- Manual: email volk@cs.uu.nl