giorgio tedde
conservatoire of milan

Playing and Composing:

Tuning the Gestures by Psychophysical Insight into Music

EPARM - Teaching of Music

teaching to produce MUSIC

- teaching to play MUSIC
- teaching to compose MUSIC

QUESTIONS

- what (concept of) MUSIC should be taught to be composed and performed ?
- what do we mean as MUSIC ?

Teaching of Music

- what we do mean as MUSIC ?

I do not want to investigate the complexity of this phenomenon

but I directly consider the action of MUSIC
in its manifestation without defining what it is

Teaching of Music

- what we do mean as MUSIC ?

MUSIC and its ACTION on the human being
is the key point of our interest.
A wide investigation on it is necessary
to teach, play and compose MUSIC
with awareness of its potential

Teaching of Music

- what we do mean as MUSIC ?

We assume that good music can modify
the psychophysiological asset of the listener
roughly according to the purpose
of the performer and
the composer (if there is one!)

Teaching of Music

- what we do mean as MUSIC ?

The student that knows the relationship between MUSIC and its ACTION

will be able to compose/perform music according his desired artistic intentions

Teaching of Music

- what we do mean as MUSIC ?

We try to understand the foundation of this relationship deepening the different forms of the music perception
through the knowledge brought
from the natural sciences in the last years

Teaching of Music

- what we do mean as MUSIC ?

I think that HME
should understand the effectiveness of music
even within the meaning brought to light
by natural scientific research

Teaching of Music

Here I want to introduce
a new aspect of understanding music.
I do not bring any "new pedagogical method",
but I will show new possibilities
to enrich any pedagogical method.

operative MUSIC concept

we focus the concept of MUSIC
on its production and on its listening process

operative MUSIC concept

we focus the concept of MUSIC
on its production and on its listening process

- what is music?
- what is music listening (process)?

operative MUSIC concept

- what is music?
  - ordered system of sounds?
  - acoustic artistic expression?
  - communication process?
    - » source > music > receiver
  - aesthetical process? (what is an aesthetical process?)
    - » source >>>>> music <<<< receiver

operative MUSIC concept

- what is music?
  - ordered system of sounds?
  - acoustic expression of a person?
  - communication process? (natural sciences)
    - » source > music > receiver
      - the receiver receives the sound information
  - aesthetical process? (humanities)
    - » source >>>>> music <<<< receiver
      - the receiver listens to the music (active!)

operative MUSIC concept

- what is music?
- what is music listening process?

  two main opposite forms

  - physiological sound perception
  - cultural listening

operative MUSIC concept

- what is music listening process?
  - physiological sound perception features
    - » immediate reaction to external environment information
    - » decoding acoustic information by Short Term Memory (STM)
    - » perceiving acoustical structures through experiential time
    - » reconstructing the properties of external mass and space

      concrete
  - cultural listening features
    - » mediate reflection to a defined ritual (uses/customs)
    - » looking for known sound elements and units (blocks)
    - » decoding by Long Term Memory (LTM)
    - » reconstructing known formal structures abstract

operative MUSIC concept

- what is music listening process?
  - we concentrate our attention to
    - physiological sound perception
      - » immediate reaction to external environment information
      - » decoding acoustic information by Short Term Memory (STM)
      - » perceiving acoustical structures through experiential time
      - » reconstructing the features of external mass and space
  - leaving out of our interest of our discussion
    - cultural listening
      - » mediate reflection to a defined ritual
      - » looking for known sound elements and units (blocks)
      - » decoding by long term memory (LTM)
      - » reconstructing formal structures

operative MUSIC concept

- what is music listening process?
  - we concentrate our attention to
    - physiological sound perception
      - » immediate reaction to external environment information
      - » decoding acoustic information by Short Term Memory (STM)
      - » perceiving acoustical structures through experiential time
      - » reconstructing the features of external mass and space

    and we deepen its main characteristics

operative MUSIC concept

- what is music listening process?
  - we concentrate our attention to
    - physiological sound perception
      - » immediate reaction to external environment information
        - critical element: INFORMATION
        - critical function: DIFFERENTIAL FEELING
          - we are able to perceive CHANGES
          - CHANGES are the cause of receiving information
          - information stimulates the attention
          - information flow oscillations produce attention
          - peaks of information value active STM processes

operative MUSIC concept

- what is music listening process?
  - we concentrate our attention to
    - physiological (neurophysiological) sound perception
      - » immediate reaction to external environment information
      - » decoding acoustic information by Short Term Memory (STM)
        - decoding process is based on the parsing function
        - parsing function is possible through PERCEIVING AND DISTINGUISHING (acoustic) STRUCTURES (boundaries)
        - distinguishing structures > boundaries recognition
        - critical element: INFORMATION PEAKS
        - INFORMATION PEAKS are normally located in the BOUNDARIES of the sound structures

operative MUSIC concept

- what is music listening process?
  - today we concentrate our attention to
    - neurophysiological sound perception

- the action of music on the listener is strong influenced by the information flow shape (information dynamics) of the music
  - critical element: INFORMATION PEAKS
  - INFORMATION PEAKS are normally located in the BOUNDARIES of the sound structures

operative MUSIC concept

- what is music listening process?
  - today we concentrate our attention to
    - neurophysiological sound perception

- the knowledge of this feature in the music parameters could give to the player/composer crucial behavior hints in playing/composing
  - critical element: INFORMATION PEAKS
  - INFORMATION PEAKS are normally located in the BOUNDARIES of the sound structures

operative MUSIC concept

- what is music listening process?
  - today we concentrate our attention to
    - neurophysiological sound perception

- the awareness of the player/composer on the "information dynamics" of their music allows a targeted gesture management
  - critical element: INFORMATION PEAKS
  - INFORMATION PEAKS are normally located in the BOUNDARIES of the sound structures

operative MUSIC concept

- what is music listening process?
  - today we concentrate our attention to
    - neurophysiological sound perception

- HOW CAN WE TOUCH THIS INFORMATION FLOW?
  HOW CAN WE FEEL THIS INFORMATION FLOW?
  HOW CAN WE SEE THIS INFORMATION FLOW?

  - critical element: INFORMATION PEAKS
  - INFORMATION PEAKS are normally located in the BOUNDARIES of the sound structures

THE QUESTIONS OF MY RESEARCH

THE QUESTIONS OF MY RESEARCH

1. HOW CAN WE MEASURE INFORMATION FLOW?
2. HOW CAN THIS KNOWLEDGE BE HELPFUL TO PLAY AND COMPOSE?
3. HOW CAN I SHARE THIS KNOWLEDGE TO MUSIC STUDENTS

THE QUESTIONS OF MY RESEARCH

HOW CAN WE MEASURE INFORMATION FLOW?

There are different approaches to the question

the most starting from

- informational analysis of music by
  The Mathematical Theory of Communication

  related to human brain behaviour

  and

- statistical analysis of music by
  Hidden Markow Models (HMM)

  related to computer behaviour

THE QUESTIONS OF MY RESEARCH

HOW CAN WE MEASURE INFORMATION FLOW?

I am oriented to use the model related to **the human perception of music and mental decoding processes**

- informational analysis of music by
  The Mathematical Theory of Communication
  related to human brain behaviour

THE QUESTIONS OF MY RESEARCH

HOW CAN WE MEASURE INFORMATION FLOW?

I am oriented to use the model related to **the human perception of music and mental decoding process**

- informational analysis of music by
  The Mathematical Theory of Communication
  related to human brain behaviour
- measurement of the information content of MUSIC through
  - physical
  - mathematical
  - heuristic

METHODS

THE QUESTIONS OF MY RESEARCH

WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS?

Abraham Moles (1986) hypothesizes in his analysis of the music information content:

1. It is possible, at least statistically, to know how the human operator perceives and reacts to the musical signal as it reaches him through his auditory sense

"L'attitude de base (dans cette analyse) que l'on peut appeler, « informationnelle » ou « structurale » est donc basée sur une hypothèse: il est possible, au moins de façon statistique, de connaître la façon dont l'opérateur humain perçoit et réagit au signal musical tel qu'il lui parvient par son sens auditif de l'environnement."

in : Moles, A., Approche informationnelle de la perception et de la création musicale, International Review of the Aesthetics and Sociology of Music (IRASM), Vol. 17, No. 2, Dec. 1986, S. 273-274.

THE QUESTIONS OF MY RESEARCH

WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS?

Recent experiments have shown important features of music perception process that give an answer to this question.

2. **The Information content of pitch sequences (musical melodies) increase energetic demands of neural activity (2007)**

"By systematically varying the entropy of pitch sequences, we sought brain areas where neural activity and energetic demands increase as a function of entropy. Such a relationship is predicted to occur in an efficient encoding mechanism that uses less computational resource when less information is present in the signal: we specifically tested the hypothesis that such a relationship is present in the planum temporale (PT). In two convergent functional MRI studies, we demonstrated this relationship in PT for encoding, ..."

in: Overath, T., Cusack, Rh., Kumar, S., von Kriegstein, K., Warren, J. d., Grube, M., Carlyon, R. P., Griffiths, T. D., An Information Theoretic Characterisation of Auditory Encoding, PLoS Biology, November 2007, Volume 5, Issue 11, S. 2723-2732

THE QUESTIONS OF MY RESEARCH

WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS?

Recent experiments have shown important features of music perception process that give an answer to this question.

3. Phrase boundaries will occur before events for which Information Dynamics (i) and Entropy (h) are high (2008)

"The information content can be interpreted as the contextual unexpectedness or surprisal associated with an event. We propose that boundaries will occur before events for which unexpectedness (h) and uncertainty (H) are high.In addition to the musicological basis, there is a precedent for these ideas in experimental psychology."

in: Pearce, M. T., Müllensiefen, D. und Wiggins, G. A., A Comparison of Statistical and Rule-Based Models of Melodic Segmentation, 2008, ISMIR

THE QUESTIONS OF MY RESEARCH

WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS?

Recent experiments have shown important features of music perception process that give an answer to this question.

4. A information contents based model (Information Dynamics Of Music = IDyOM) identifies segment boundaries before unexpected events (i.e. with high information content) in a melodic sequence (2010)

"we hypothesized a relationship between expectation and grouping in auditory perception. To test this hypothesis, we introduced a new cognitive model of melodic segmentation (IDyOM) derived from an existing cognitive model of pitch expectations based on unsupervised probabilistic learning and information-theoretic prediction (Pearce and Wiggins 2006). The segmentation model identifies segment boundaries before unexpected events in a melodic sequence."

in: Pearce, M. T., Müllensiefen, D. und Wiggins, G. A., The role of expectation and probabilistic learning in auditory boundary perception: A model comparison, Perception, 2010, volume 39, S. 1367-1391.

THE QUESTIONS OF MY RESEARCH

WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS?

Recent experiments have shown important features of music perception process that give an answer to this question.

5. **Phrase boundaries have been shown to be perceived before notes with very high information content (2013)**

"In this study, analyses were based on a segmentation provided by two music theorists. In future research, segmentation might be also based on the IC itself, since phrase boundaries have been shown to be perceived before notes with very high IC (Pearce, Müllensiefen, & Wiggins, 2010). Furthermore, average IC across a segment might not be representative for all notes within one segment. Individual unexpected notes might also be effective in inducing emotional responses, as was confirmed by preliminary analysis of this data set (not presented here)."

in: Hauke Egermann & Marcus T. Pearce & Geraint A. Wiggins & Stephen McAdams, Probabilistic models of expectation violation predict psychophysiological emotional responses to live concert music, Psychonomic Society, Inc. 2013

THE QUESTIONS OF MY RESEARCH

now we have an idea of WHY INFORMATION FLOW OF MUSIC IS DECISIVE IN MUSIC DECODING PROCESS

and of

HOW CAN WE MEASURE INFORMATION FLOW OF MUSIC

and I show what I am making in order to answer to the second question

HOW CAN THIS KNOWLEDGE BE HELPFUL TO PLAY AND COMPOSE?

THE QUESTIONS OF MY RESEARCH

HOW CAN WE MEASURE INFORMATION FLOW OF MUSIC?

HOW CAN THIS KNOWLEDGE BE HELPFUL TO PLAY AND COMPOSE?

My research tries to set up analytical tools that give the possibility of measuring the potential information content of a music piece and its evolution over time. The material of the inquire may be the sound, its symbolic representation in the score, but it can also be reduced to the symbolic representations of the syntactic material identified in the semiological analyses. The goal is to give awareness of the gestures that mainly generate the flow of information.

These analytical tools are aimed at musicians and do not necessarily require advanced mathematical knowledge, but they need to be approached to understand the heuristic evaluation methods that can be undertaken.

What is new is given by the consideration not only of the physical parameters of the sound, but also of the **gestures codified in the score**, which allows the **analysis of the different layers corresponding to different musical parameters** (corresponding to different gestures).

THE QUESTIONS OF MY RESEARCH

the last question

HOW CAN I SHARE THIS KNOWLEDGE TO MUSIC STUDENTS?

The student that knows the potential information content of a piece can understand the potential of the musical material for stimulating attention and highlighting musical structures. He can couple this information to certain sound and gestural parameters, and modulate them (emphasising/dissolving) to improve his performance/composition.

The goal of perform/compose music that has the capability to modify the listener's psychophysiological asset is realized through this awareness (to give to the listener effectiveness in structure recognition).

Through the educational activity the analytical approach should accompany the musician in everyday musical life, entering deeply into the practice of playing and composing. The exploration of the potential of the musical material is thus enriched by a conceptual instrument that permeates and supports the skills of the player and of the composer.

Playing and Composing:
Tuning the Gestures by Psychophysical Insight into Music

THE CORE OF MY RESEARCH

APPLICATION IN MUSIC LITERATURE EXAMPLE

PRACTICAL ANALYTICAL EXPERIENCES REALIZED BY THE STUDENTS

In a multi-purpose approach different methodologies are used in a combined way, based mainly on parametrical, semiological and informational analysis.

The hearth of the research is focused on the evaluation/interpretation (mathematical, physical, heuristical) of the dynamic content of musical information of the different systems of signs (score, sound, syntactical units). All that gives hints about the potential reactions of the listener to the corresponding different performative/compositional gestures.

Here I will show some examples from the musical literature:

Bartok, Webern, Chopin, (external pdf file)

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

DURCH DIE PROGRAMMIERTEN INFORMATIONSFLUSSFUNKTIONEN WURDEN DREI STÜCKE AUS VERSCHIEDENEN STILEN ANALYSIERT

1. SARABANDA, AUS DER „PARTITA IN A-MOLL FÜR FLÖTE“ VON J.S. BACH BWV 1013
   MONODISCH
   ES WIRD IN VERSCHIEDENEN UNTERTEILUNG BERÜCKSICHTIGT

2. VARIATIONEN, AUS „MIKROKOSMOS“ FÜR KLAVIER VON B. BARTOK
   MEHRSTIMMIG (BIS 4 STIMMEN)
   ES WIRD IN VERSCHIEDENEN UNTERTEILUNG BERÜCKSICHTIGT

3. BAGATELLE N. 1, AUS „SECH BAGATELLEN FÜR STREICHQUARTETT“ VON A. WEBERN, OP. 9
   MEHRSTIMMIG (BIS 8 STIMMEN)
   ES WIRD NUR ALS GANZES STÜCK BERÜCKSICHTIGT

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

DIE SARABANDA, AUS DER „PARTITA IN A-MOLL FÜR FLÖTE“ VON J.S. BACH BWV 1013, BESTEHT AUS 46 TAKTEN.

UM DIE INFORMATIONSFLUSSWERTE IM BEZUG AUF IHREN SAMPLEGRÖSSEABHÄNGIGKEIT ZU UNTERSUCHEN HABE ICH DAS STÜCK IN DEN FOLGENDEN FÜNF SAMPLES UNTERGETEILT:

VON TAKT 1 BIS TAKT 9

VON TAKT 1 BIS TAKT 16

VON TAKT 17 BIS TAKT 34

VON TAKT 35 BIS TAKT 46

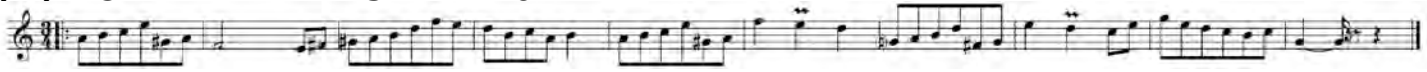
VON TAKT 1 BIS TAKT 46

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

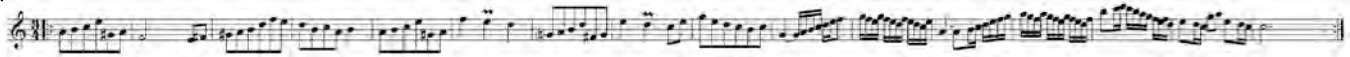
SARABANDA

5 UNTERTEILUNGEN

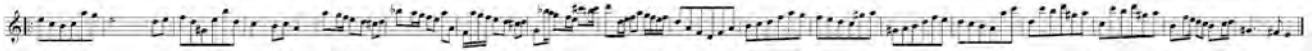
(A) VON TAKT 1 BIS TAKT 9



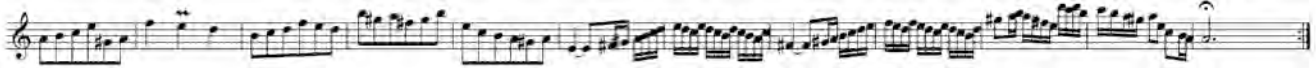
(B) VON TAKT 1 BIS TAKT 16



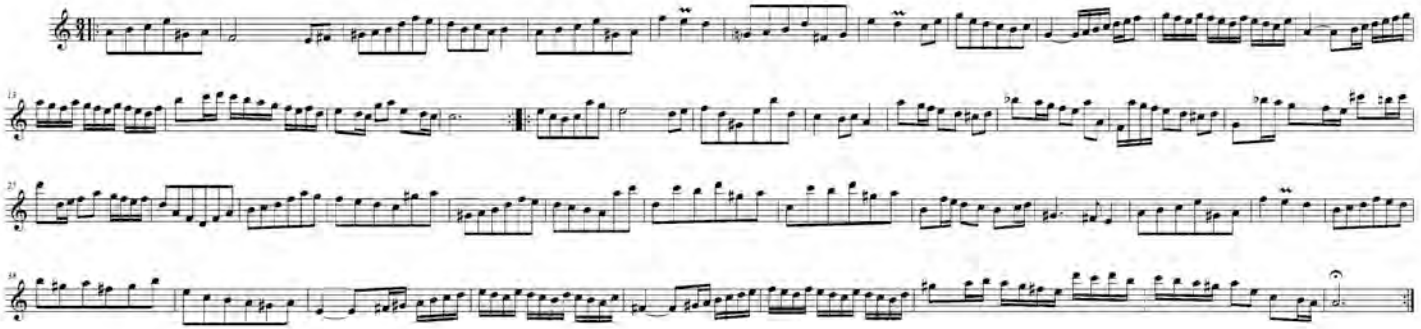
(C) VON TAKT 17 BIS TAKT 34



(D) VON TAKT 35 BIS TAKT 46



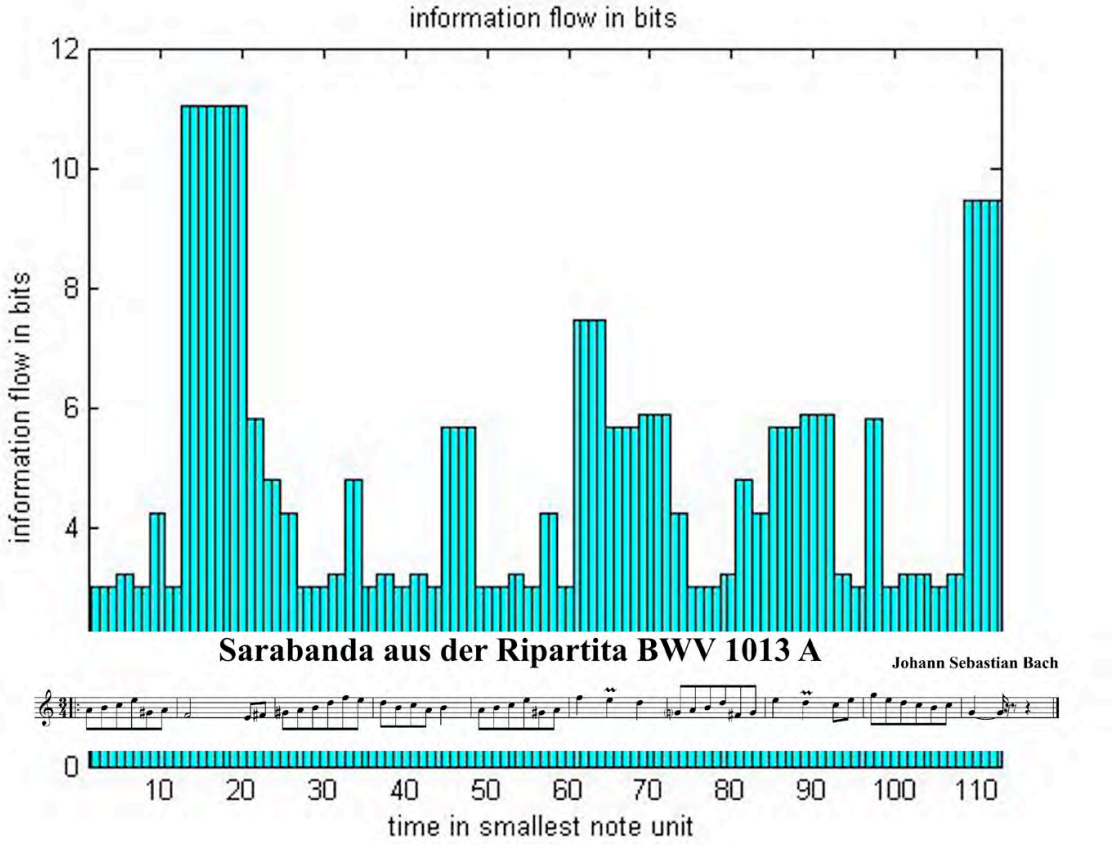
(E) VON TAKT 1 BIS TAKT 46

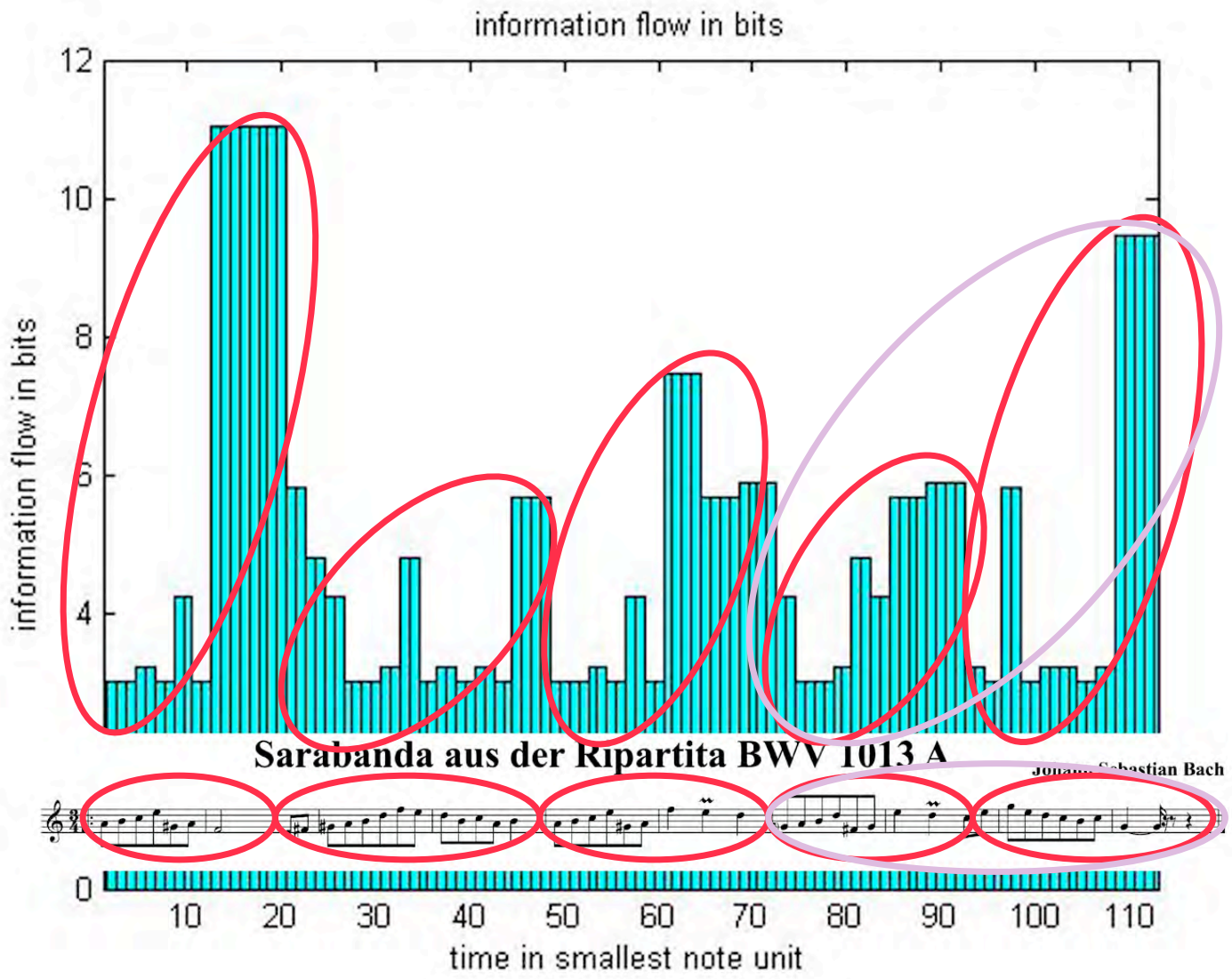


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

INFORMATIONSFLUSS DES ERSTEN SAMPLES

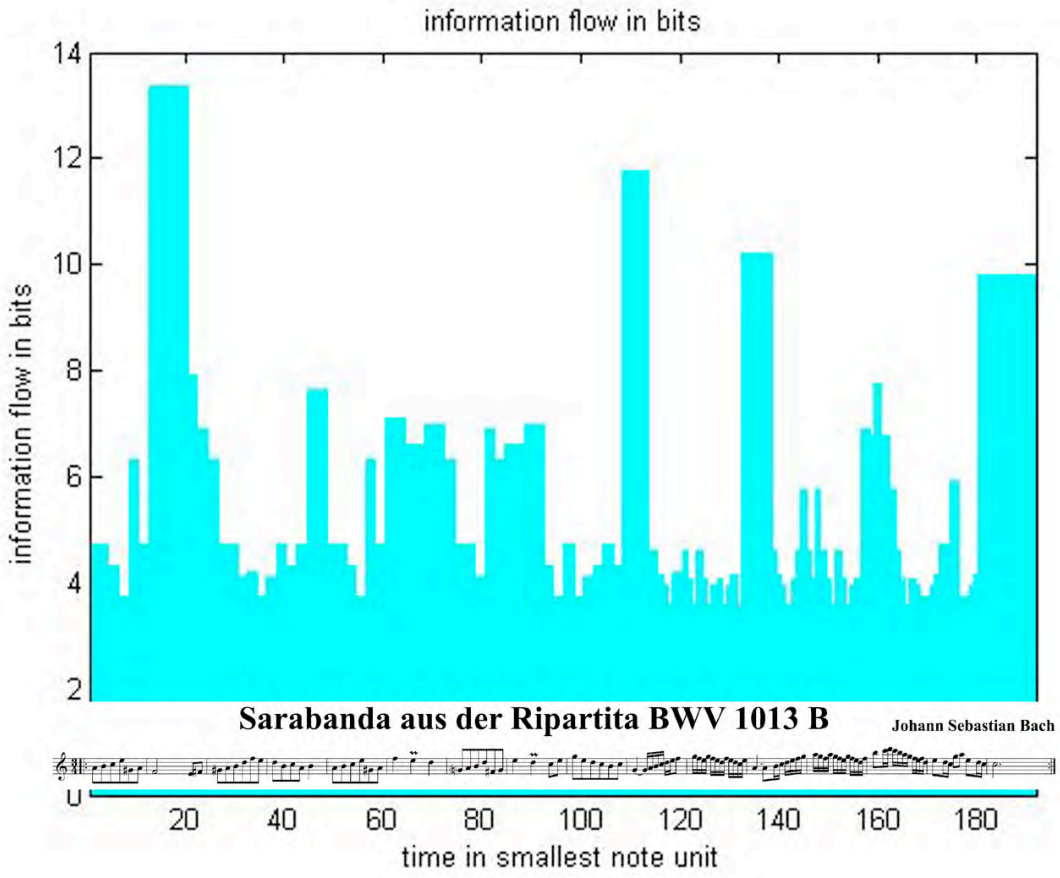


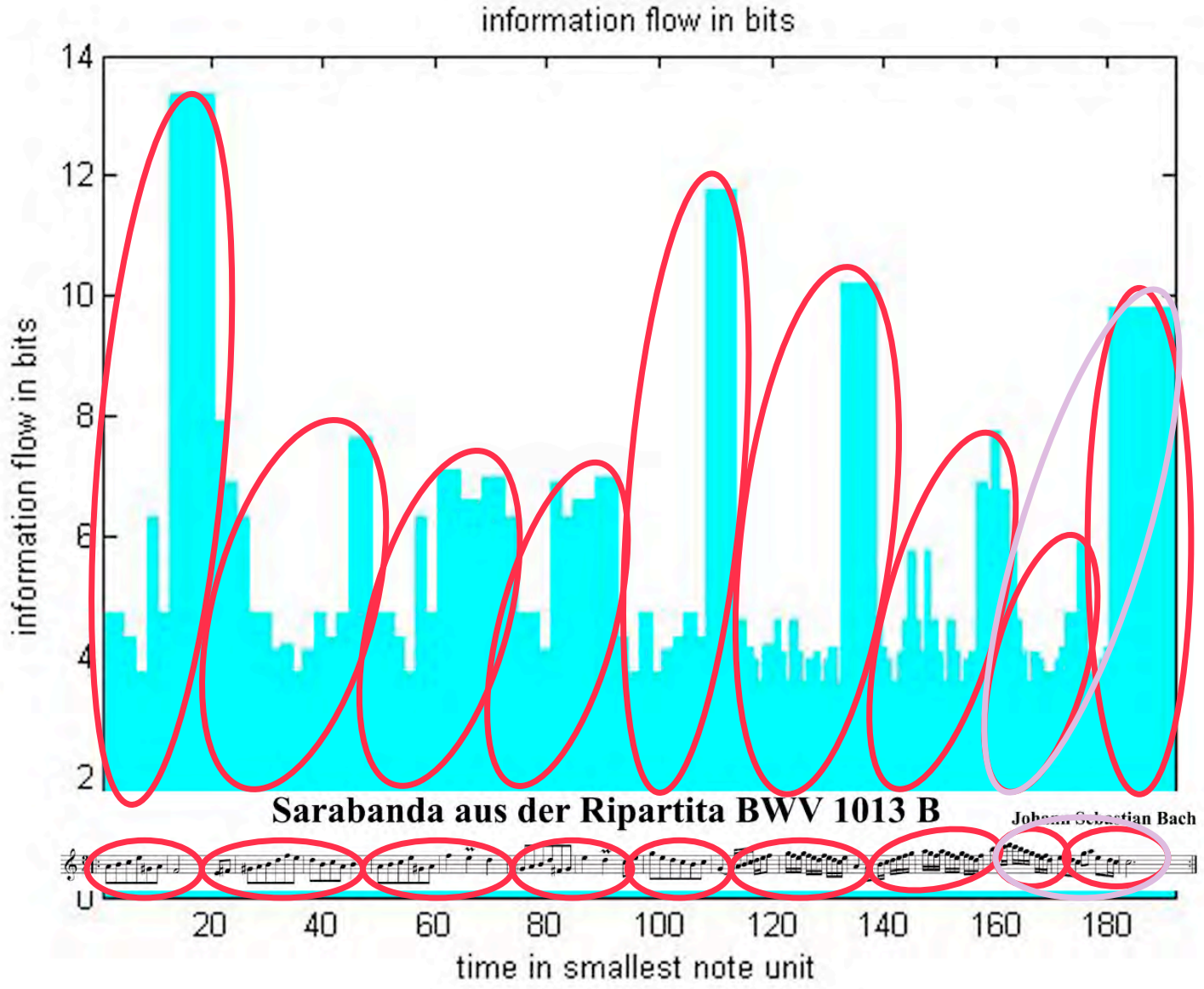

information flow in bits
12
10
8
4
0
information flow in bits
Sarabanda aus der Ripartita BWV 1013 A
10
20
30
40
50
60
70
80
90
100
110
time in smallest note unit

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

INFORMATIONSFLUSS DES ZWEITEN SAMPLES




information flow in bits
information flow in bits
14
12
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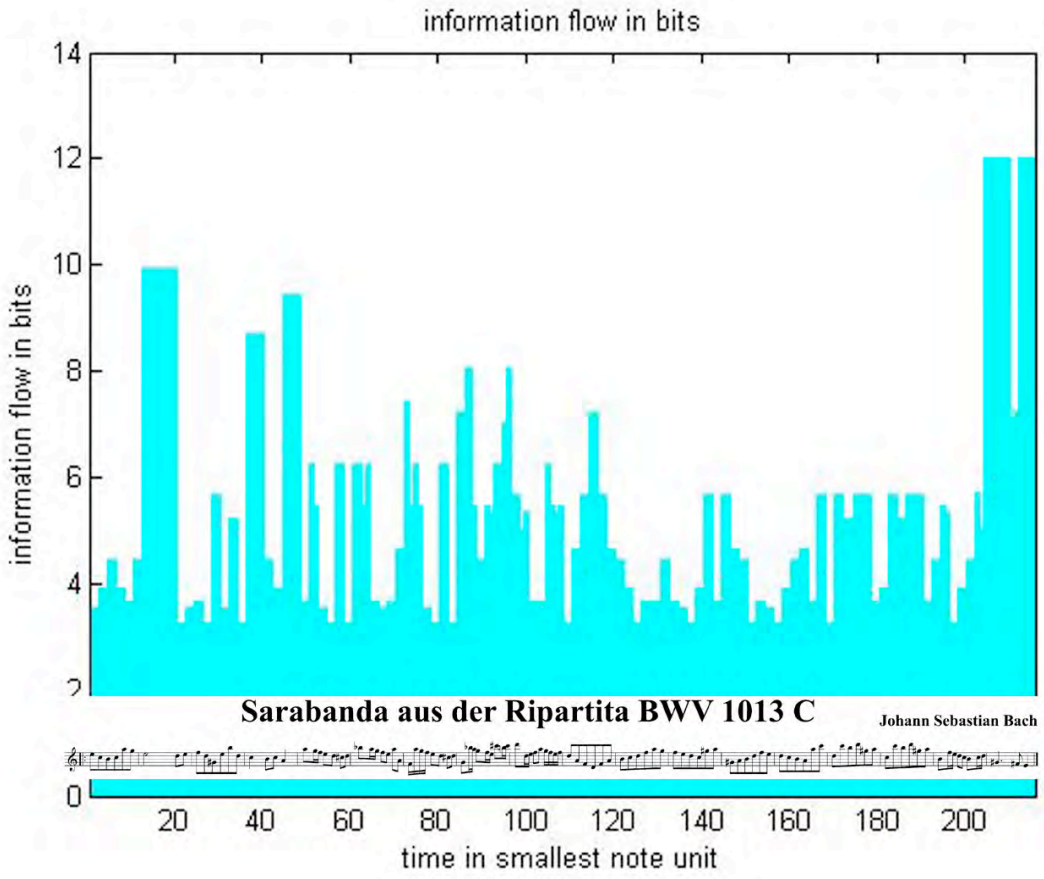
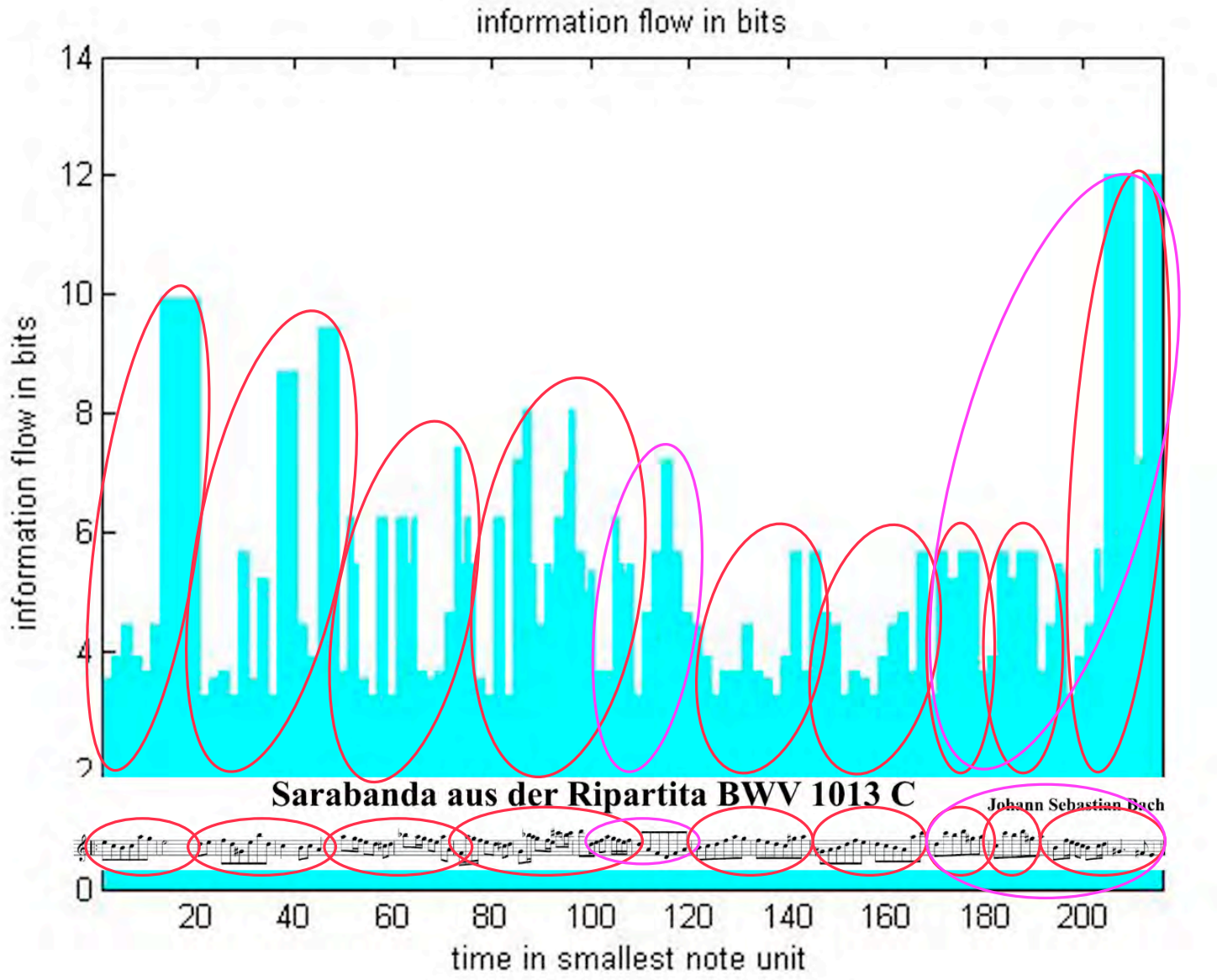
Sarabanda aus der Ripartita BWV 1013 B
Johann Sebastian Bach
20
40
60
80
100
120
140
160
180
time in smallest note unit

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

INFORMATIONSFLUSS DES DRITTEN SAMPLES




information flow in bits
information flow in bits
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Sarabanda aus der Ripartita BWV 1013 C
Johann Sebastian Bach
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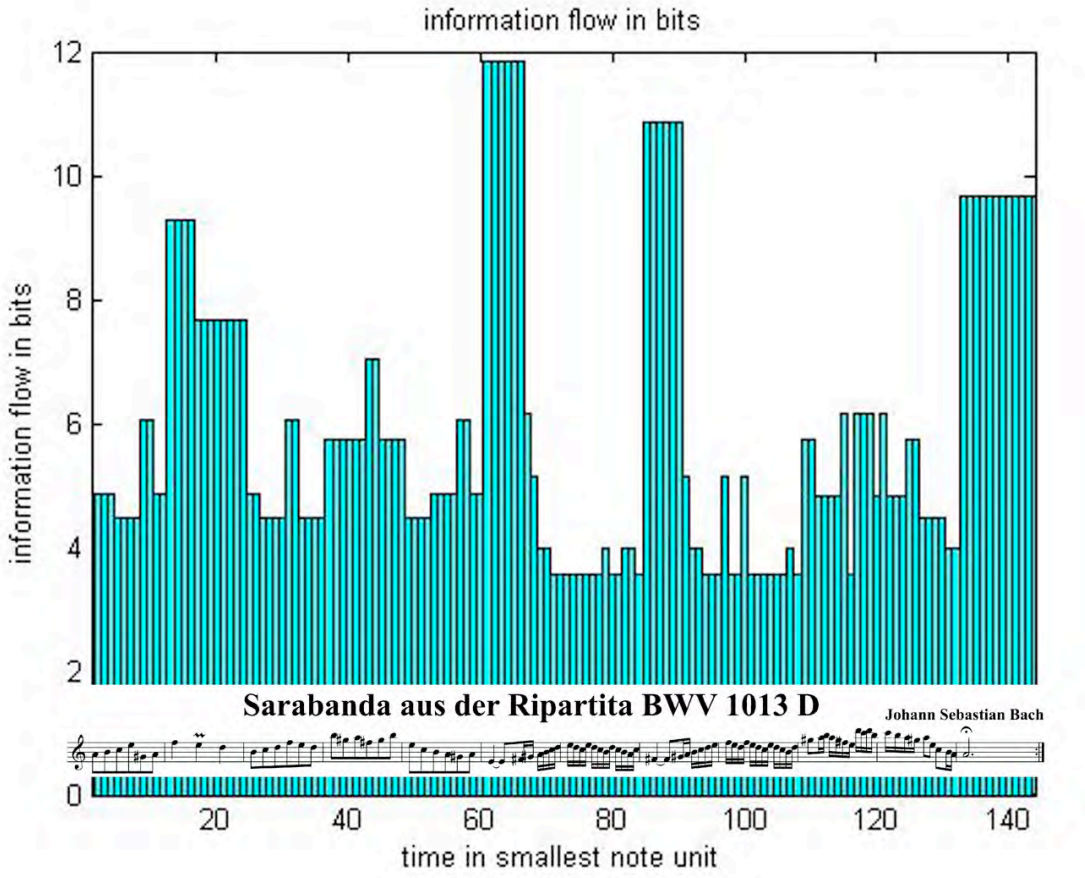
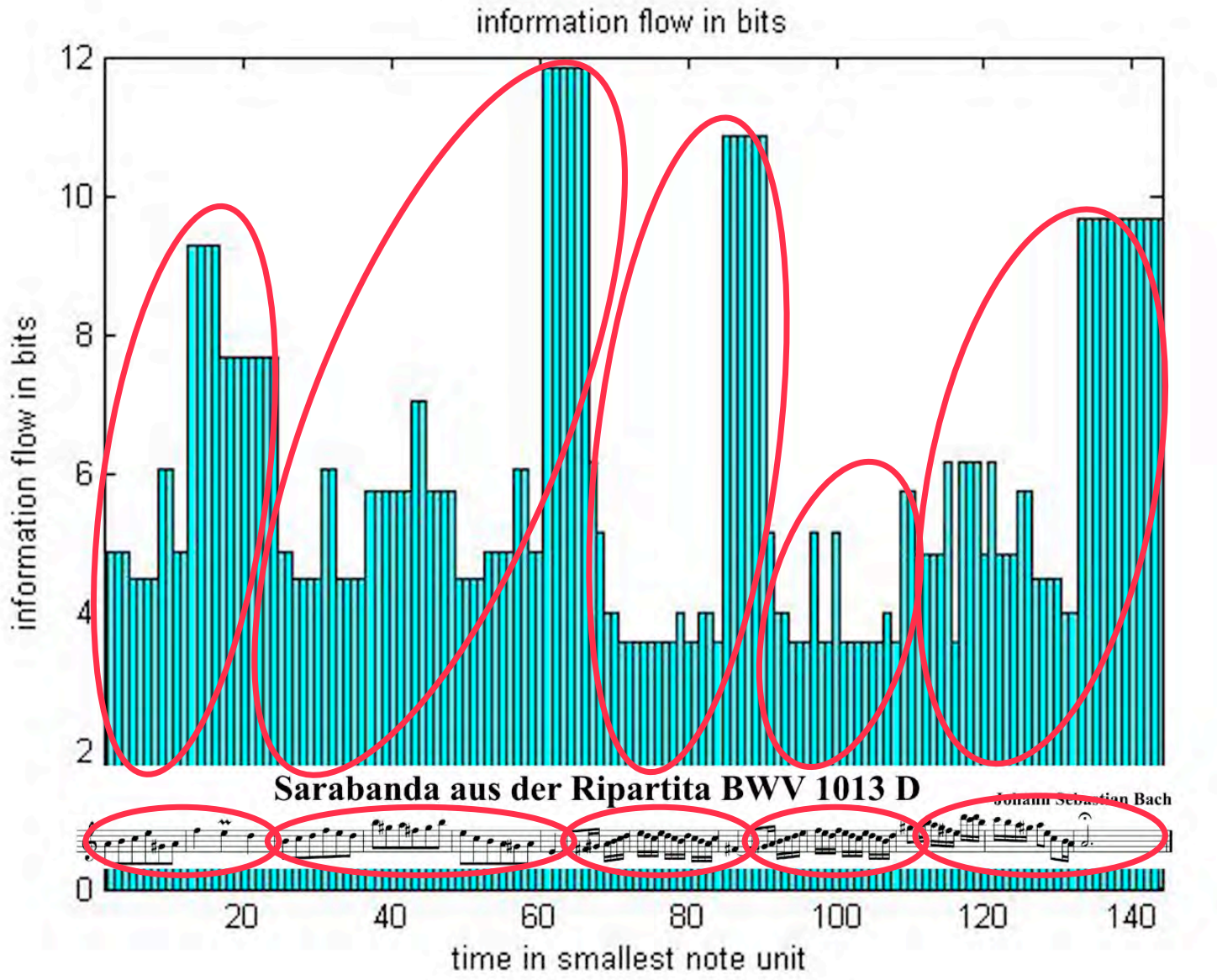
160
180
200
time in smallest note unit

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

INFORMATIONSFLUSS DES VIERTEN SAMPLES




information flow in bits
information flow in bits
12
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60
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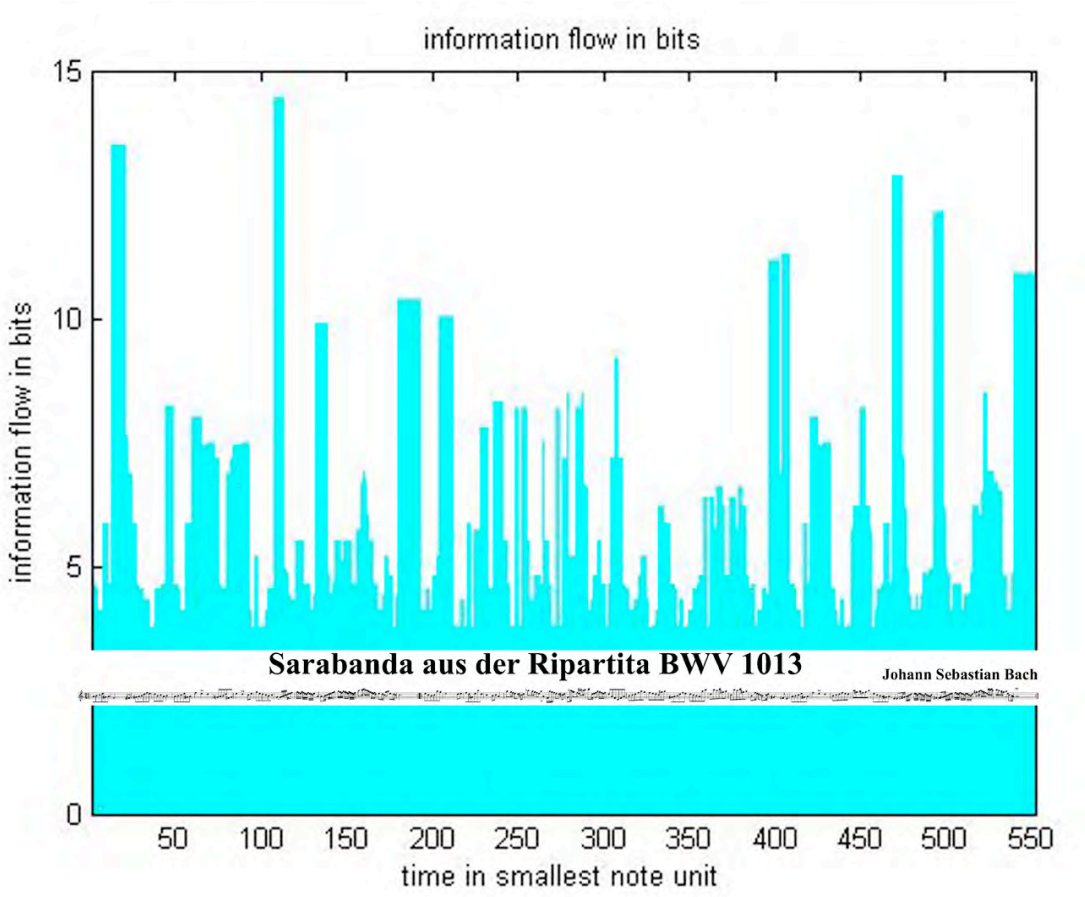
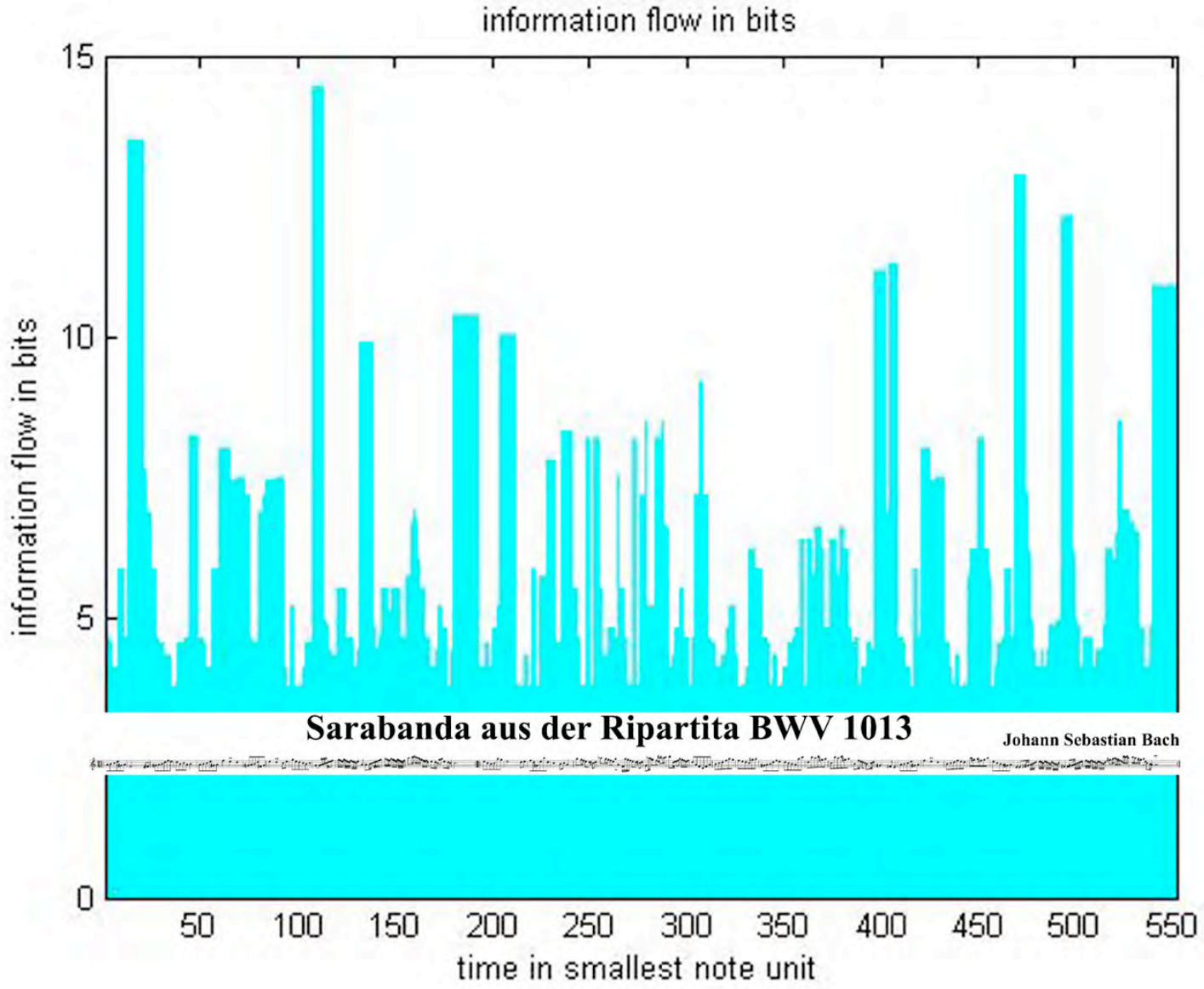
100
120
140
time in smallest note unit
Sarabanda aus der Ripartita BWV 1013 D
Johann Sebastian Bach

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

SARABANDA

INFORMATIONSFLUSS DES GANZEN STÜCKS




information flow in bits
15
10
5
0
information flow in bits
Sarabanda aus der Ripartita BWV 1013
Johann Sebastian Bach
50
100
150
200
250
300
350
400
450
500
550
time in smallest note unit

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

DIE VARIATIONEN, NR. 87 AUS „MIKROKOSMOS“ FÜR KLAVIER VON B. BARTOK, BESTEHT AUS 69 TAKTEN.

UM DIE INFORMATIONSFLUSSWERTE IM BEZUG AUF IHREN SAMPLEGRÖSSEABHÄNGIGKEIT ZU UNTERSUCHEN HABE ICH DAS STÜCK IN DEN FOLGENDEN ZEHN SAMPLES UNTERGETEILT:

(A) VON TAKT 1 BIS TAKT 13

(B) VON TAKT 1 BIS TAKT 20

(C) VON TAKT 21 BIS TAKT 33

(D) VON TAKT 21 BIS TAKT 40

(E) VON TAKT 1 BIS TAKT 40

(F) VON TAKT 41 BIS TAKT 51

(G) VON TAKT 41 BIS TAKT 56

(H) VON TAKT 41 BIS TAKT 61

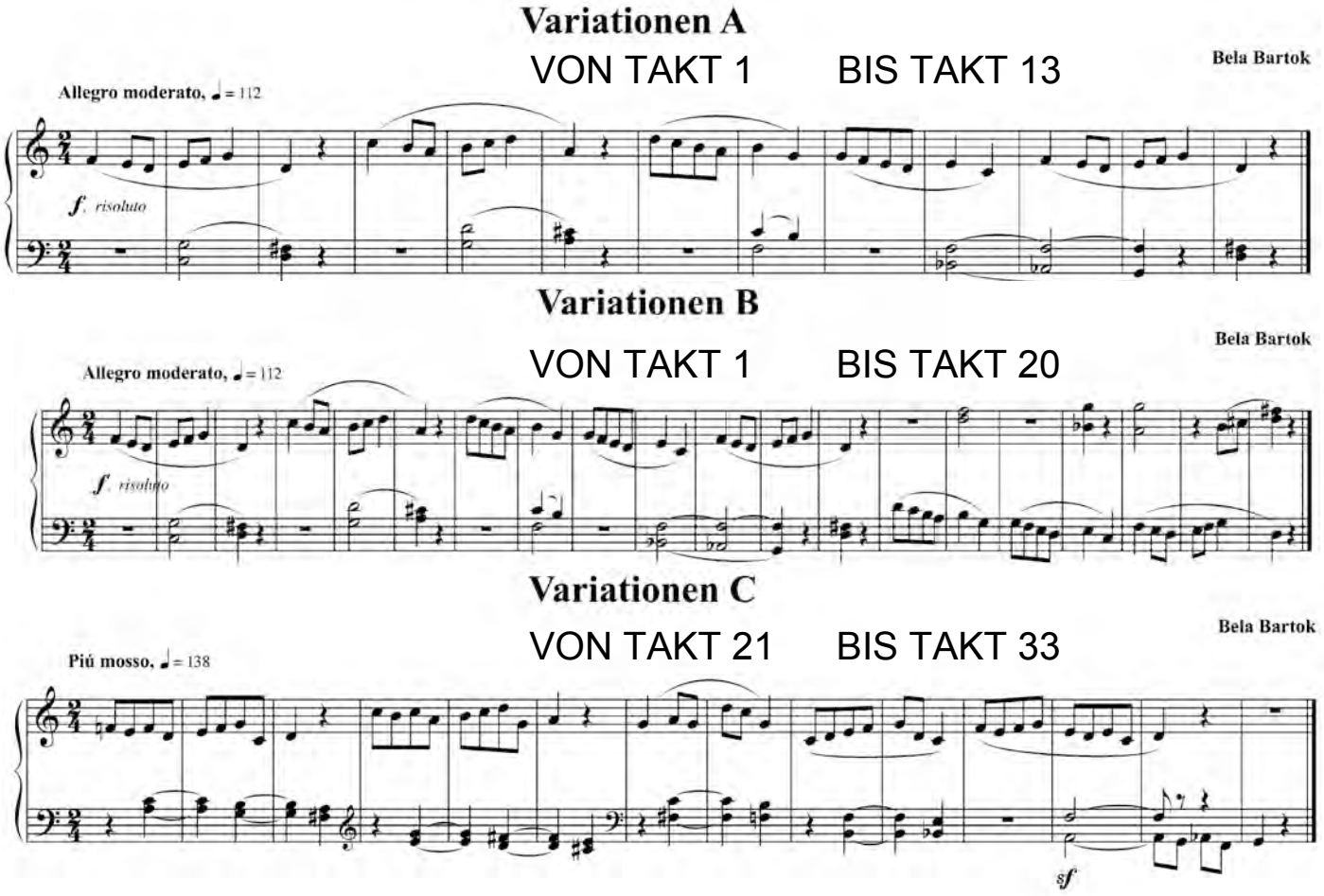
(I) VON TAKT 41 BIS TAKT 69

(J) VON TAKT 1 BIS TAKT 69

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

10 UNTERTEILUNGEN



ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

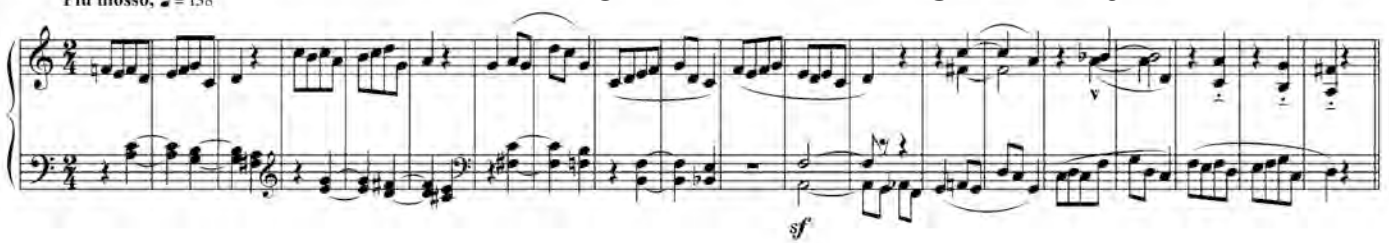
VARIATIONS

10 UNTERTEILUNGEN

Variationen D

Bela Bartok

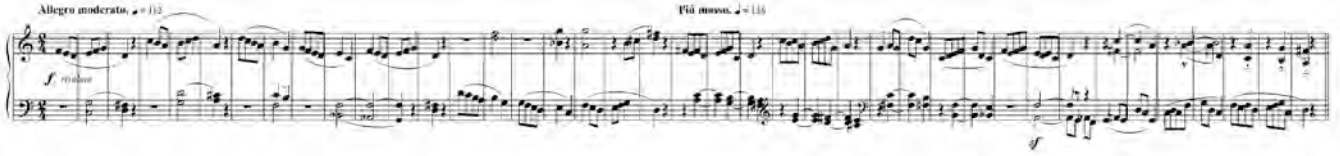
VON TAKT 21 BIS TAKT 40



Variationen E

Bela Bartok

VON TAKT 1 BIS TAKT 40



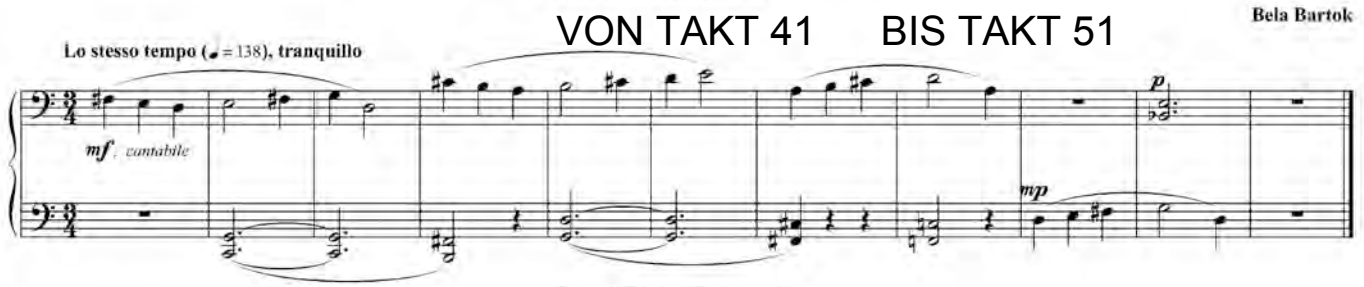
ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

10 UNTERTEILUNGEN

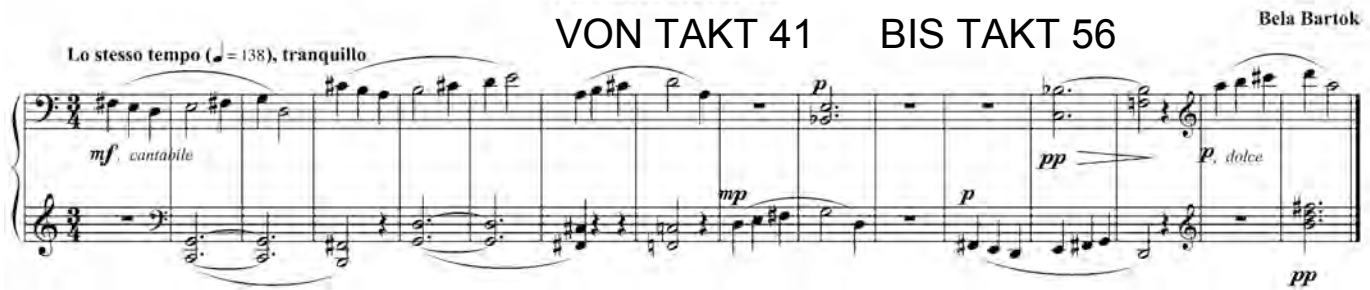
Variationen F

VON TAKT 41 BIS TAKT 51



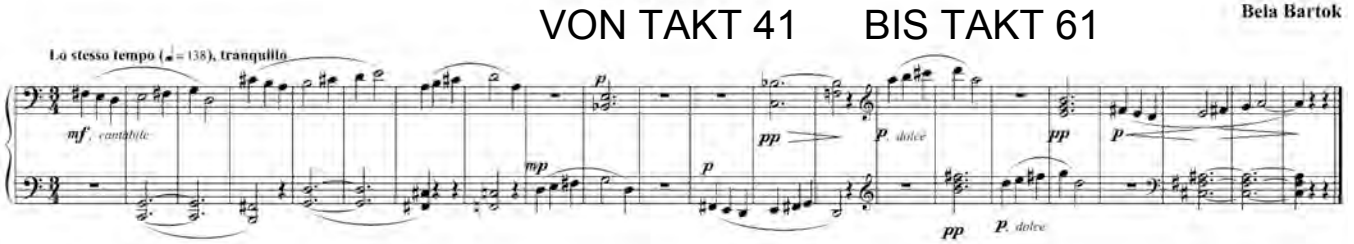
Variationen G

VON TAKT 41 BIS TAKT 56



Variationen H

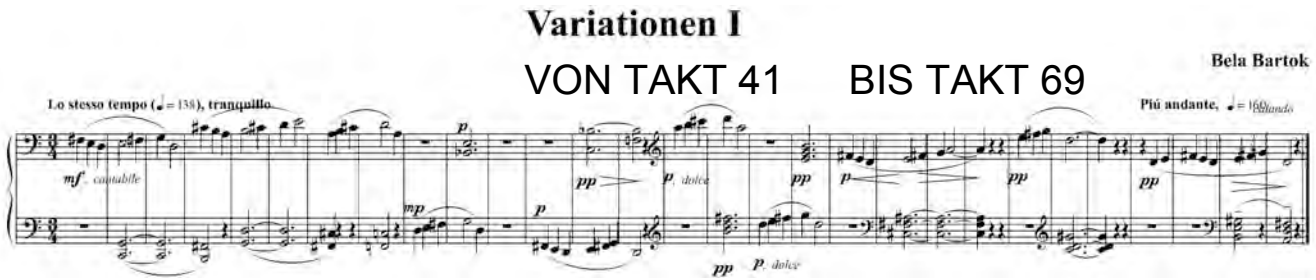
VON TAKT 41 BIS TAKT 61



ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

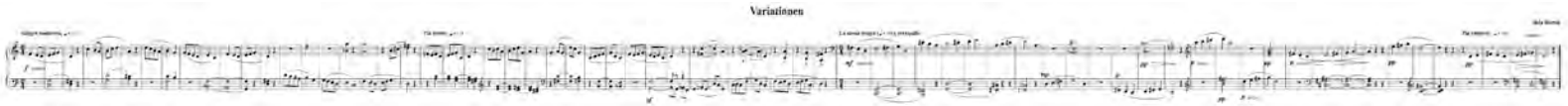
VARIATIONS

10 UNTERTEILUNGEN



VON TAKT 41 BIS TAKT 69

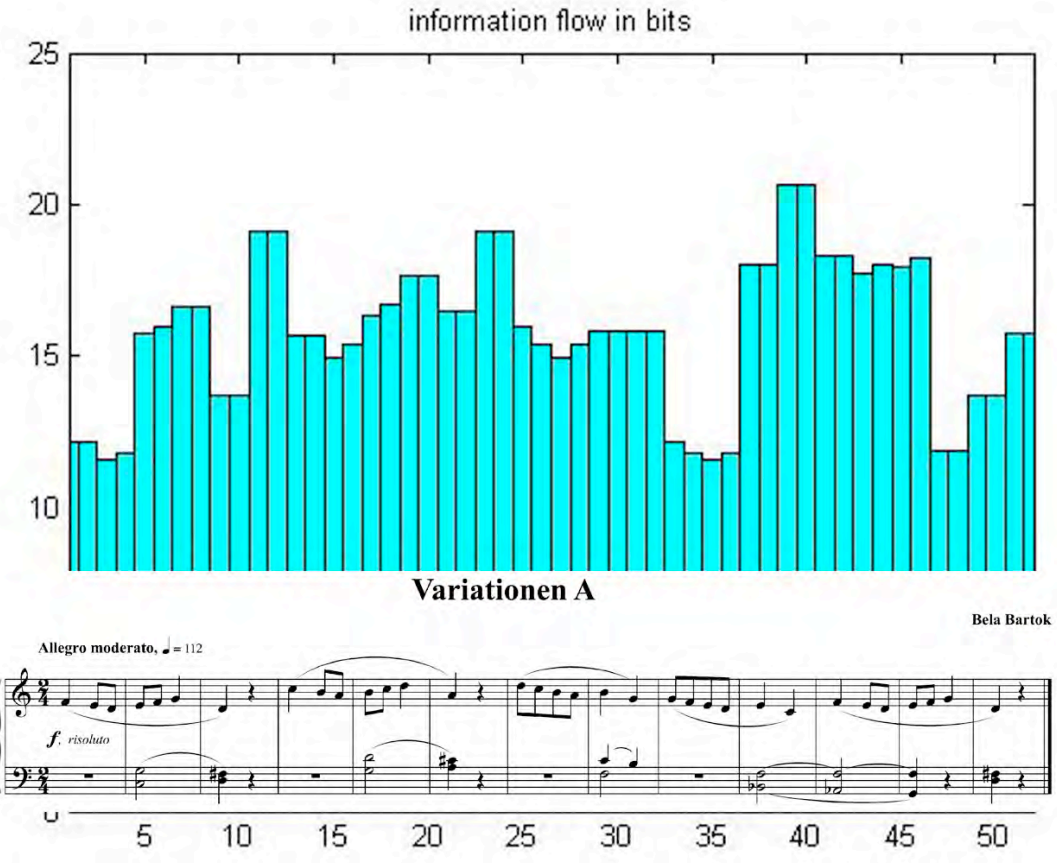
VON TAKT 1 BIS TAKT 69

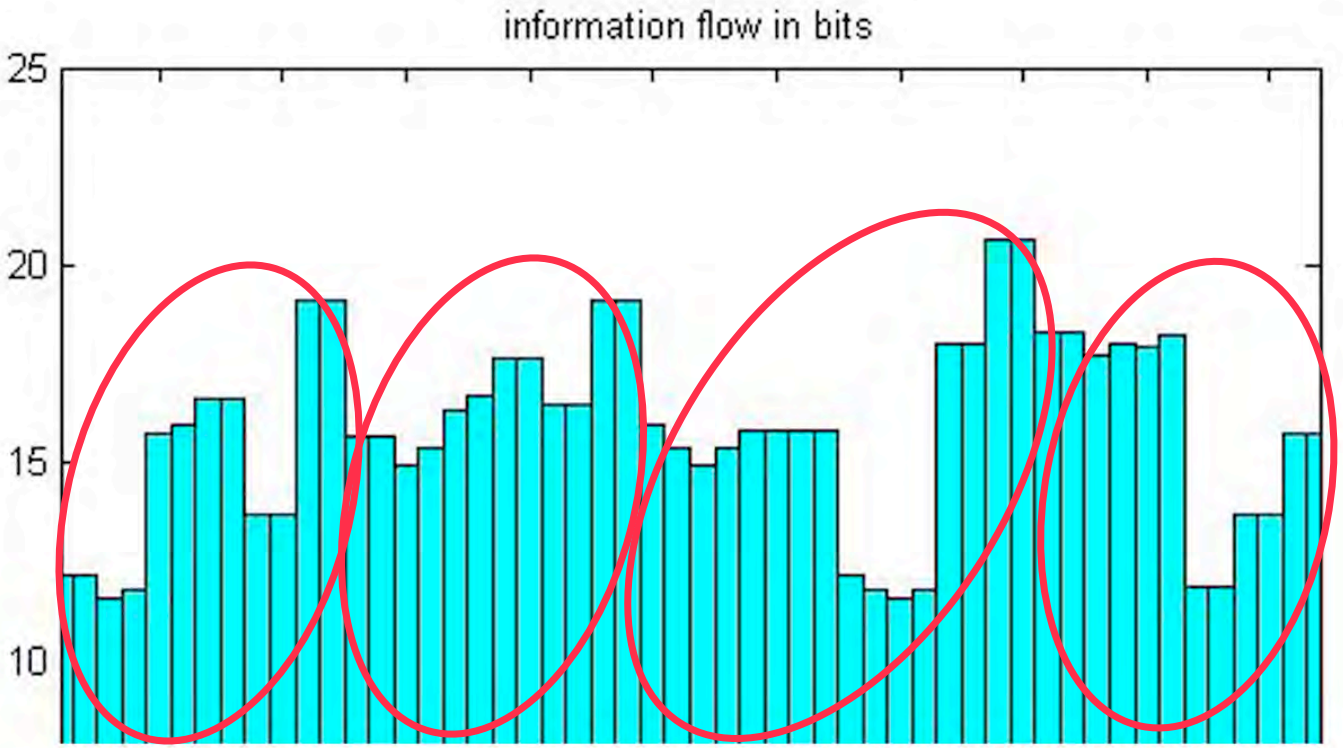


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

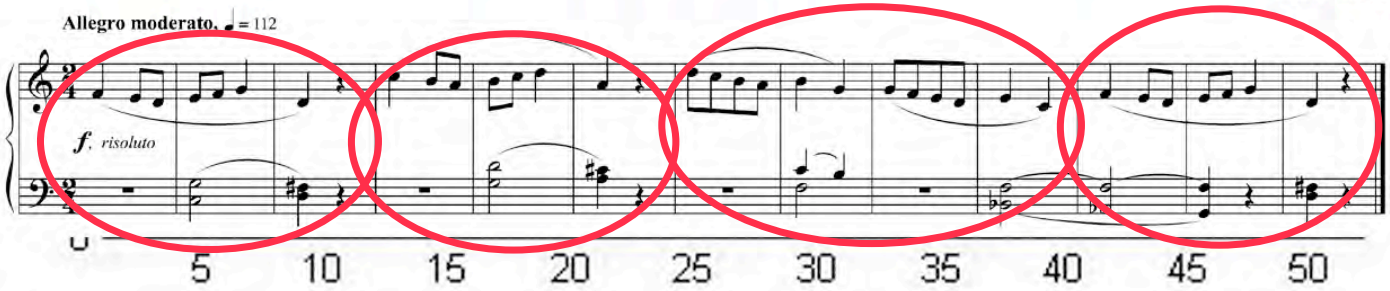
INFORMATIONSFLUSS DES ERSTEN SAMPLES





Variationen A

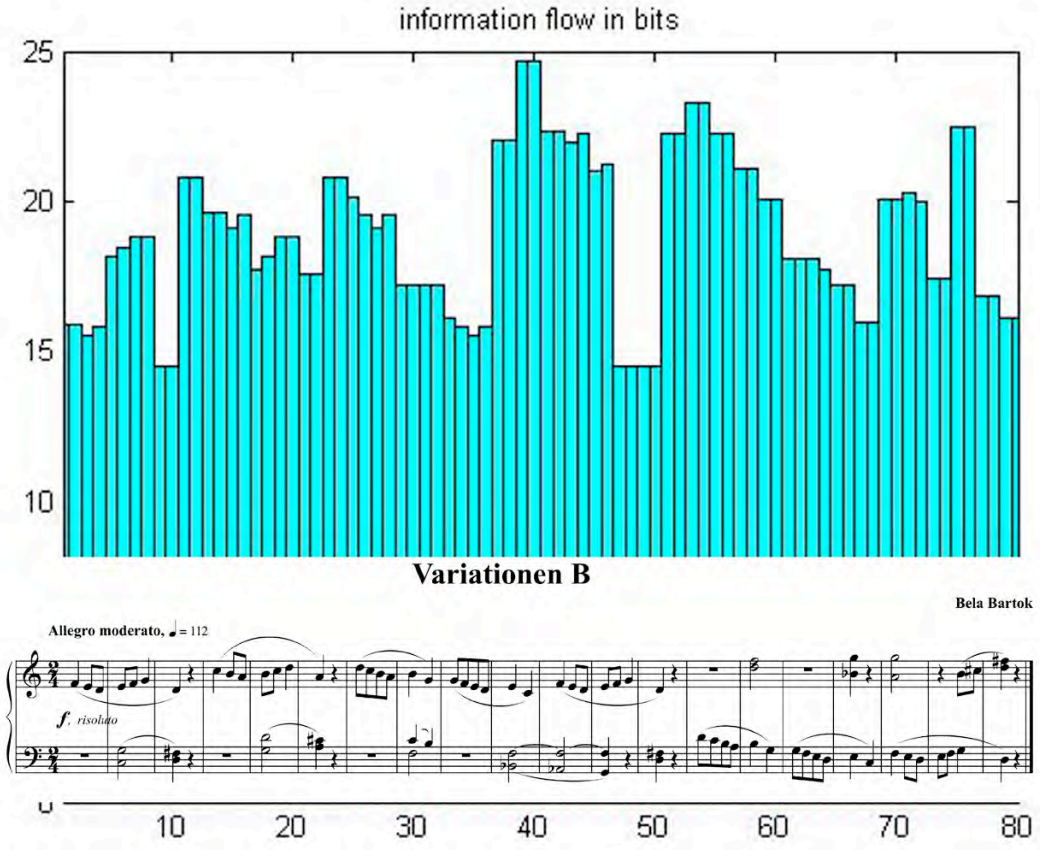
Bela Bartok

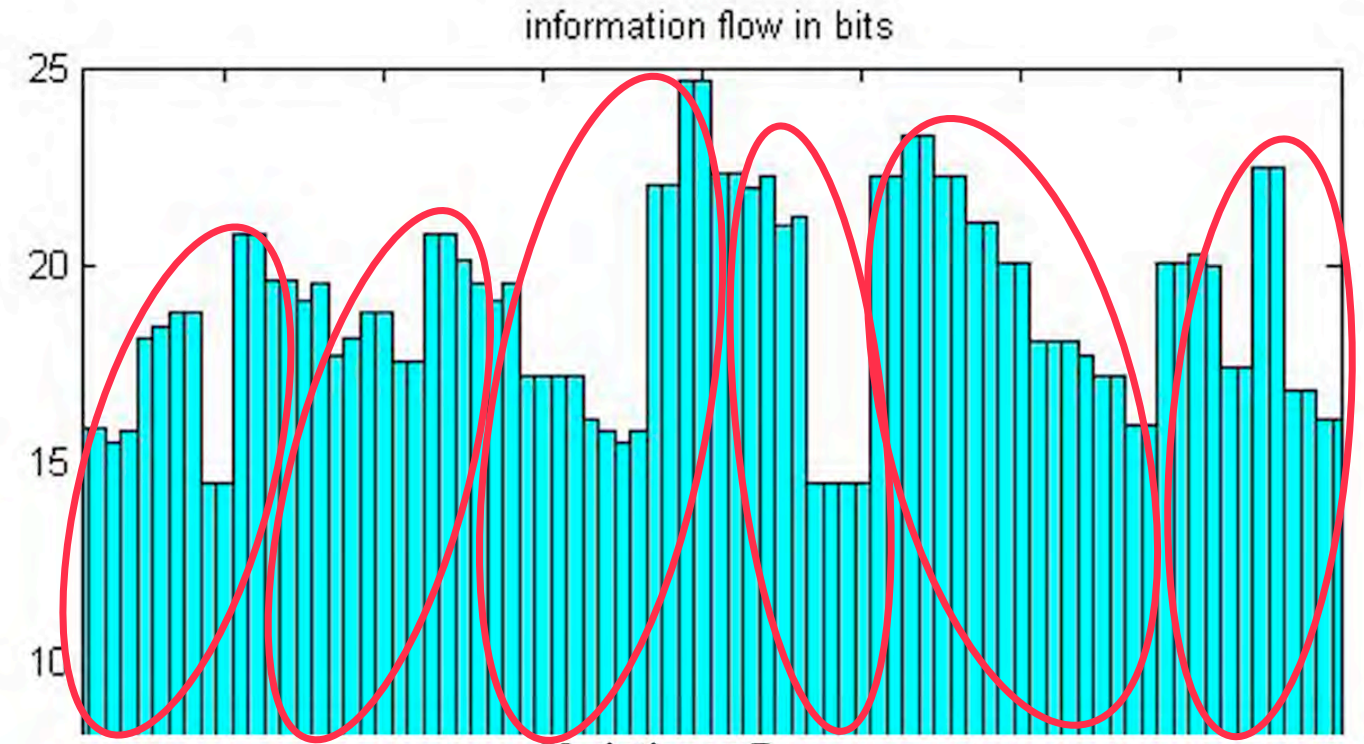


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

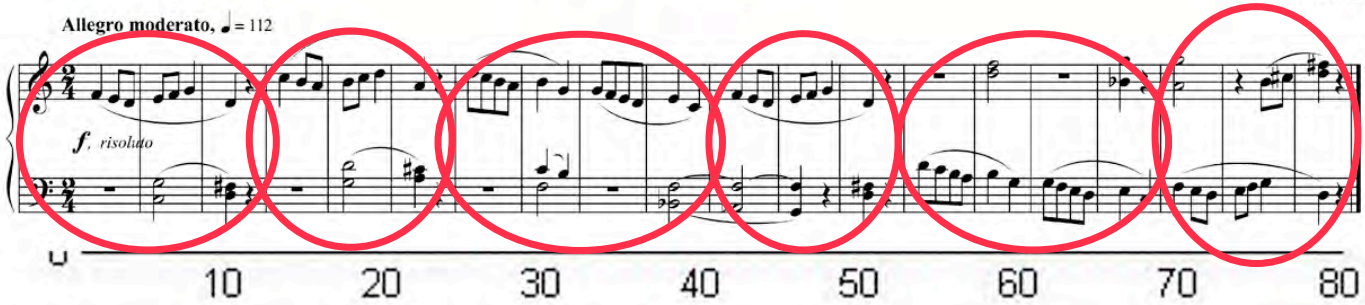
INFORMATIONSFLUSS DES ZWEITEN SAMPLES





Variationen B

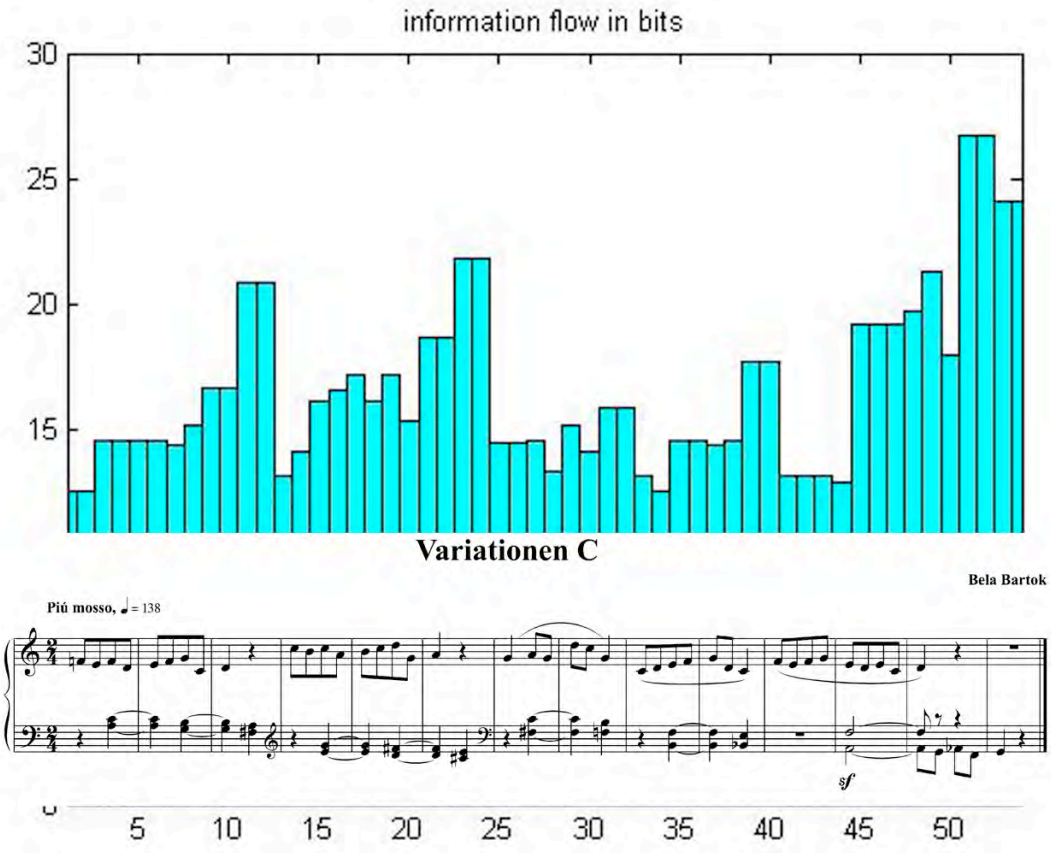
Bela Bartok

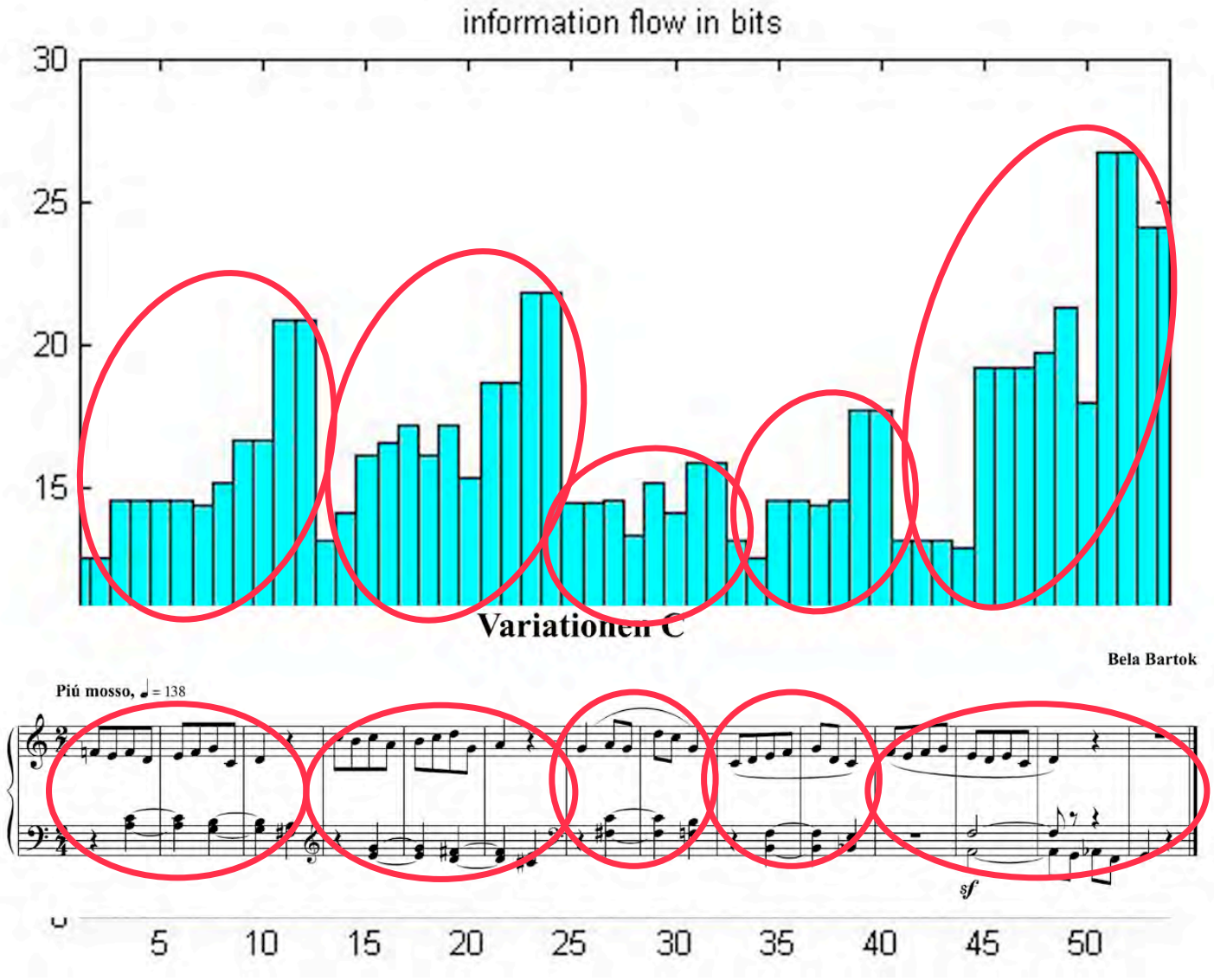


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

INFORMATIONSFLUSS DES DRITTEN SAMPLES

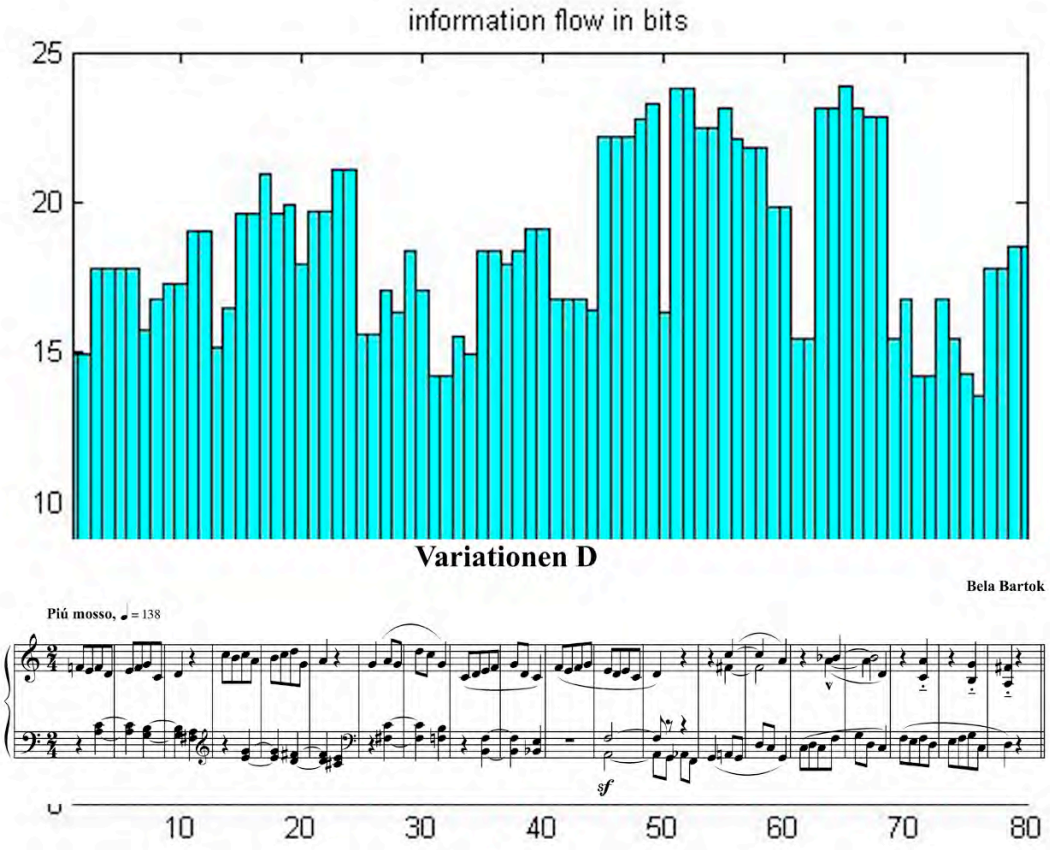


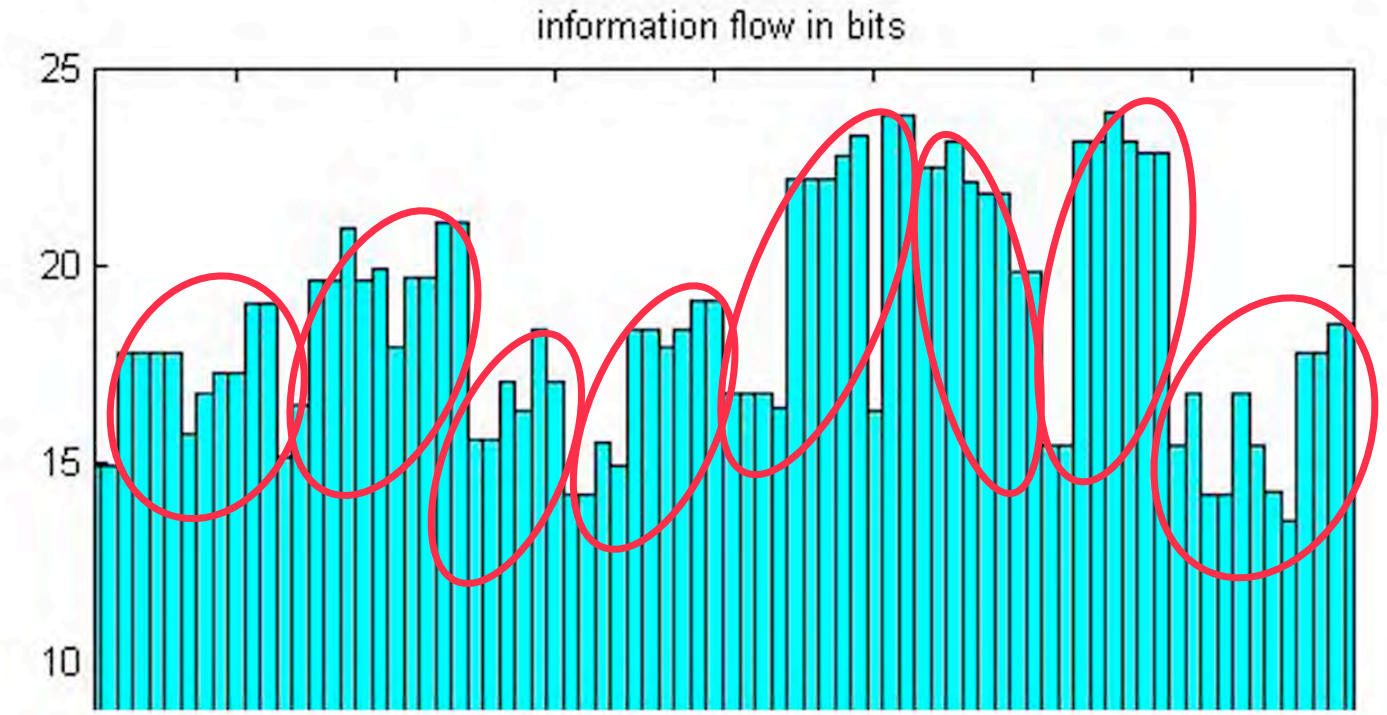

information flow in bits
30
25
20
15
Variationen C
Bela Bartok
Piú mosso, ♩ = 138
sf
5
10
15
20
25
30
35
40
45
50

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

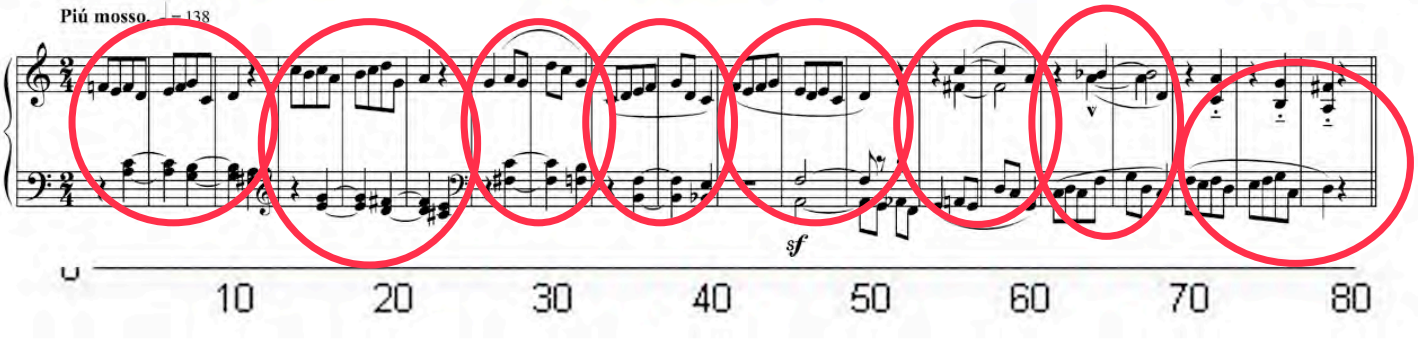
INFORMATIONSFLUSS DES VIERTEN SAMPLES





Variationen D

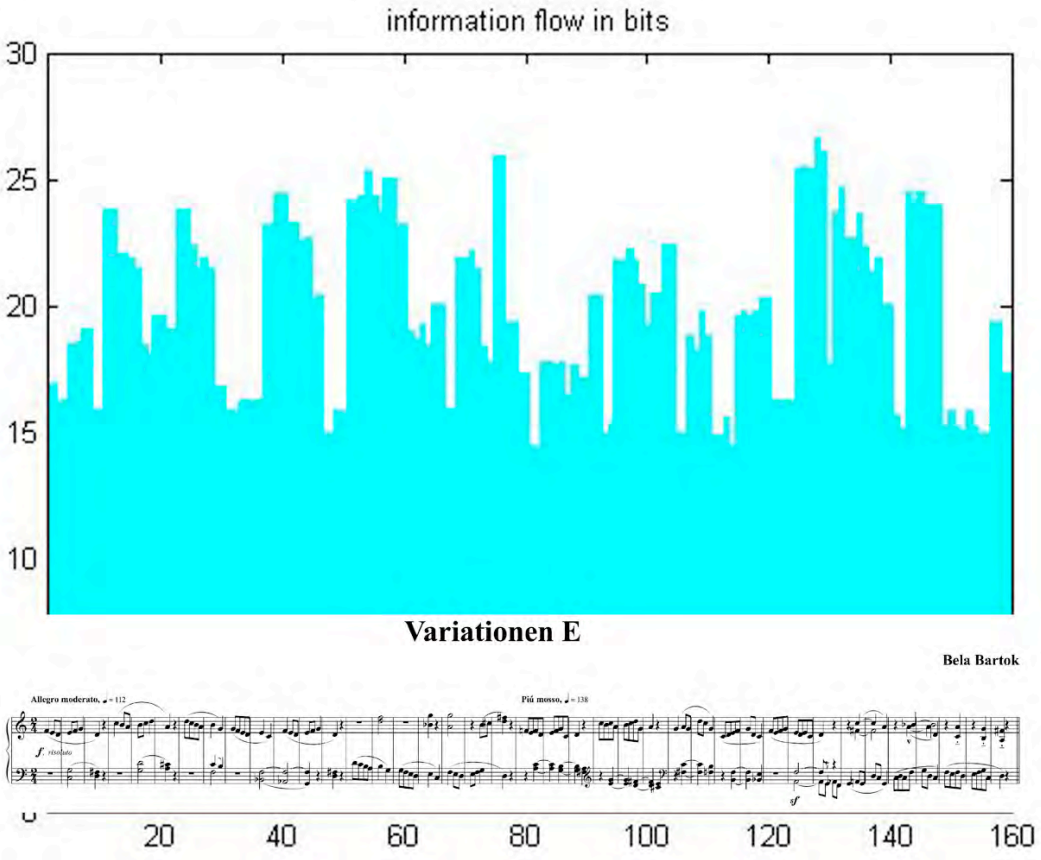
Bela Bartok

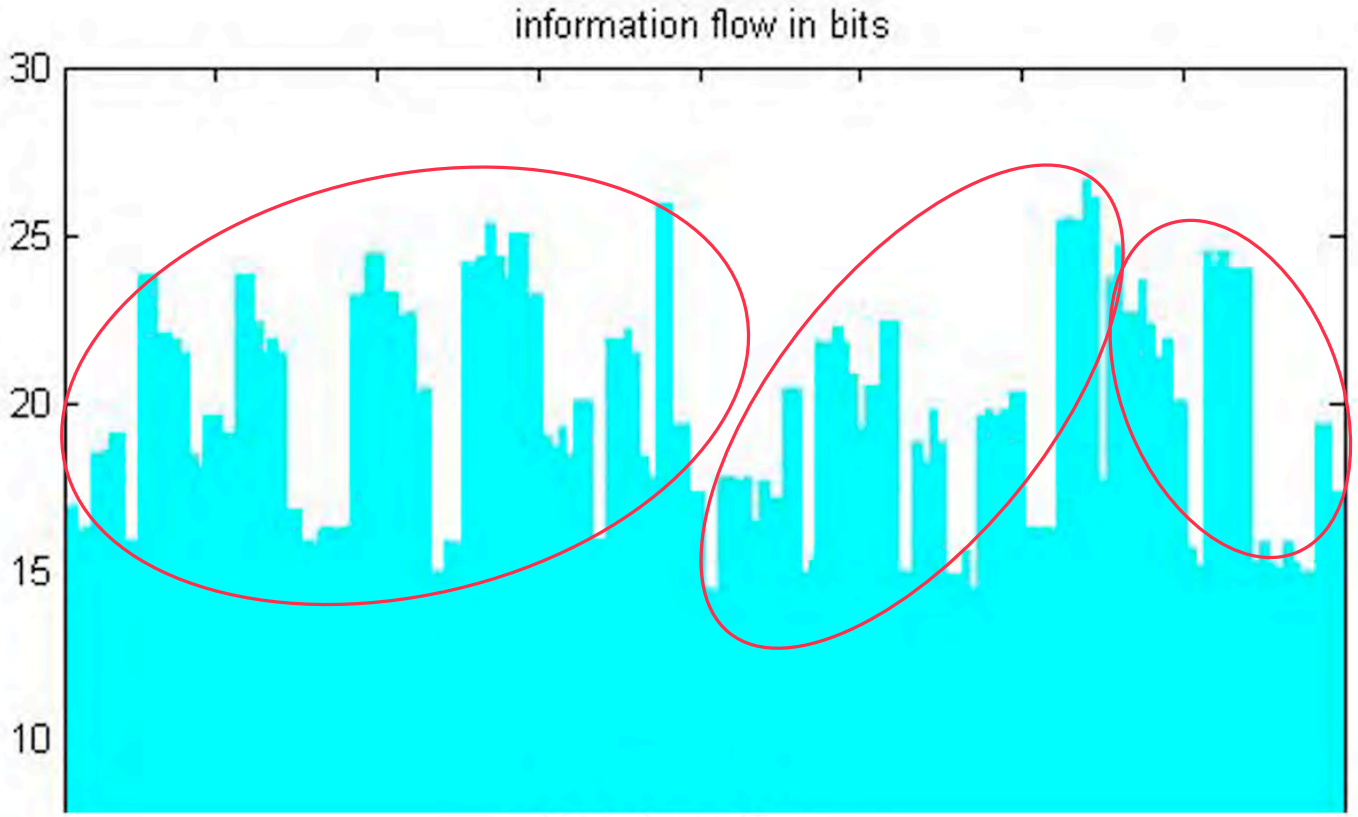


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

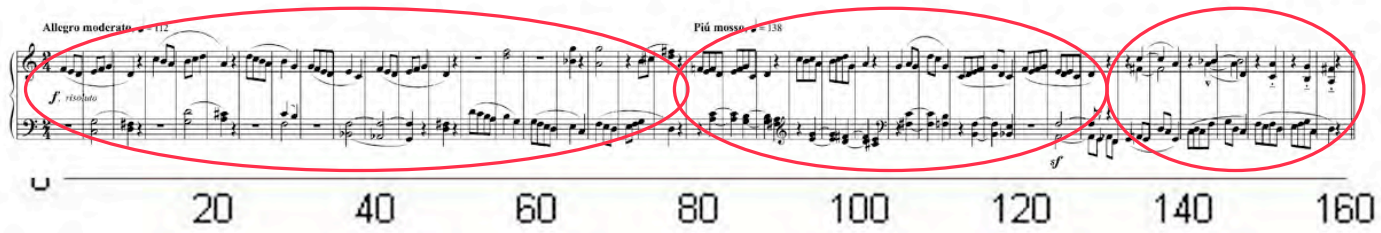
INFORMATIONSFLUSS DES FÜNFTEN SAMPLES





Variationen E

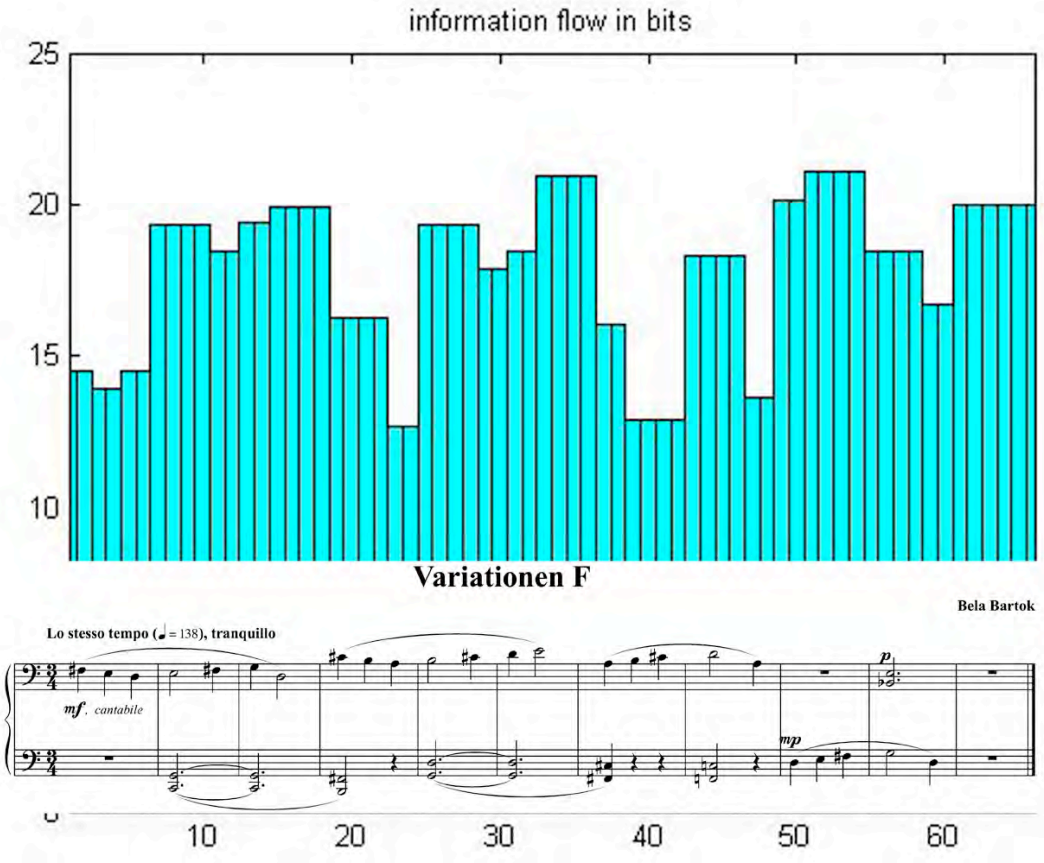
Bela Bartok

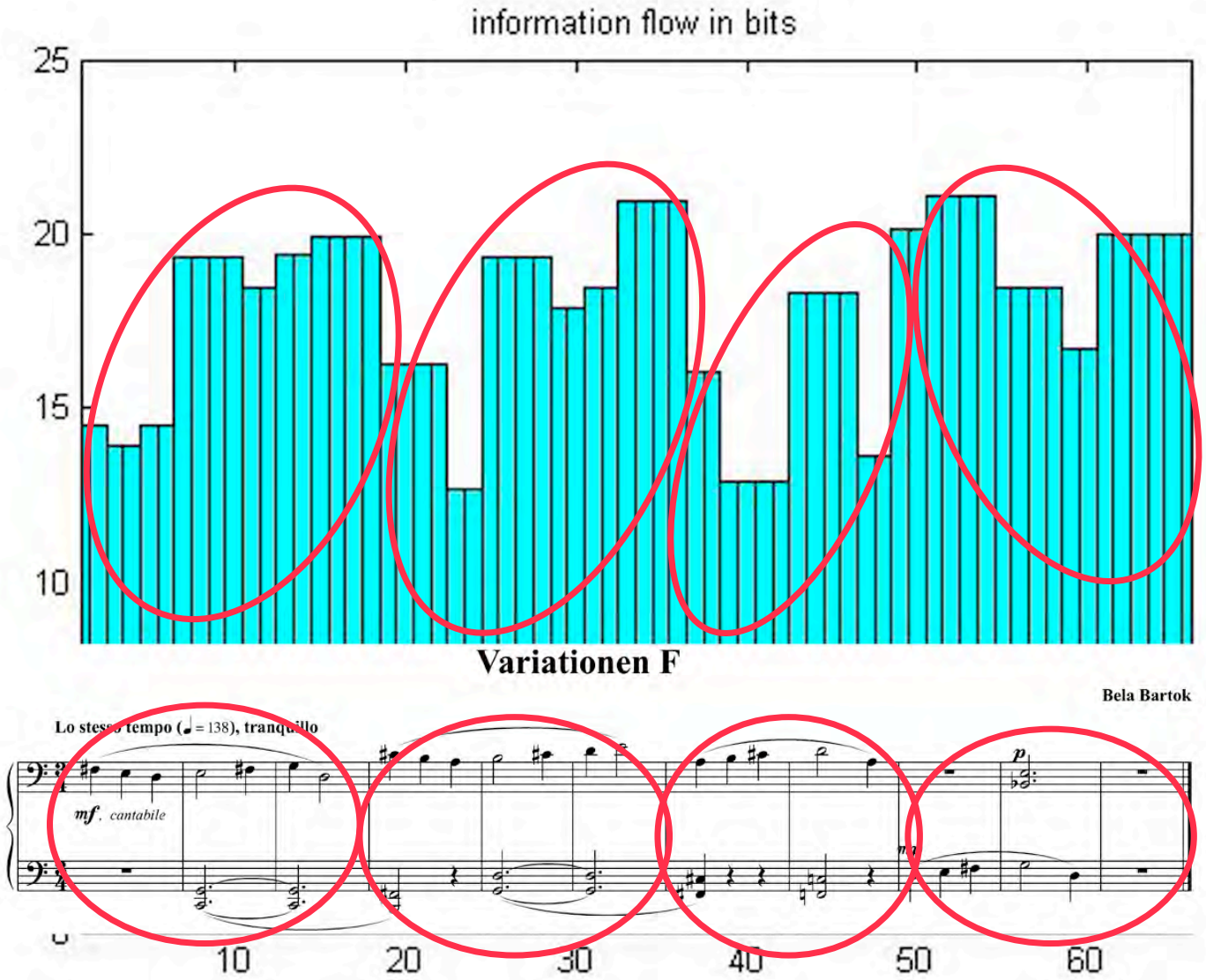


ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

INFORMATIONSFLUSS DES SÄCSHTEN SAMPLES

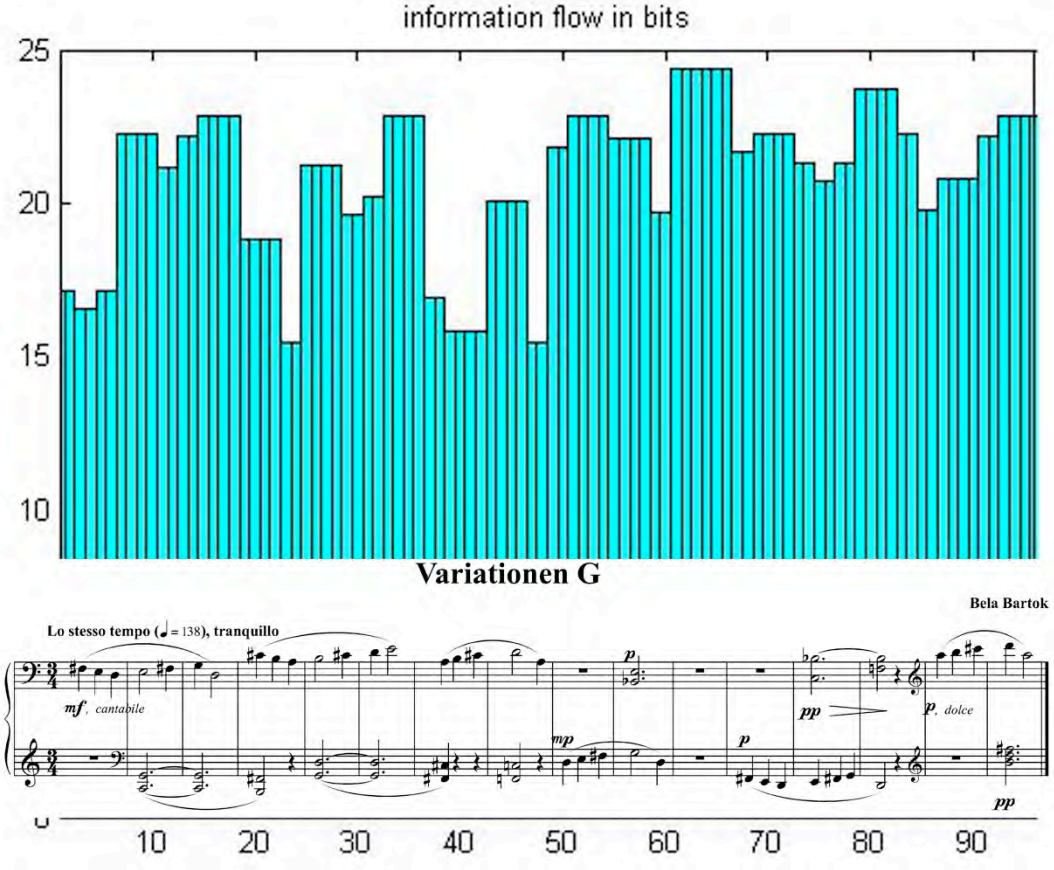


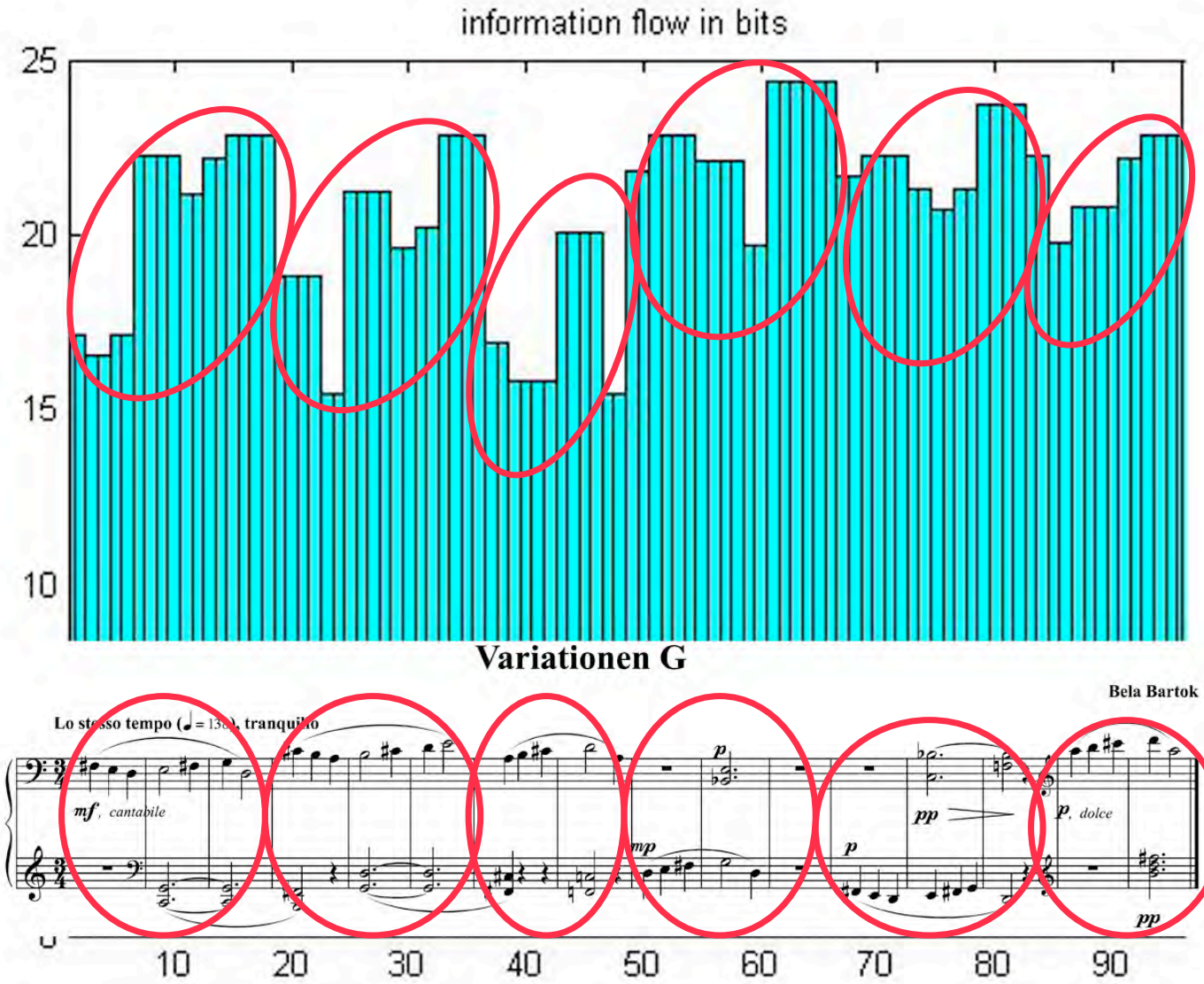

information flow in bits
25
20
15
10
Variationen F
Bela Bartok
Lo stesso tempo (♩= 138), tranquillo
mf. cantabile
p
10
20
30
40
50
60

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

INFORMATIONSFLUSS DES SIPTEN SAMPLES

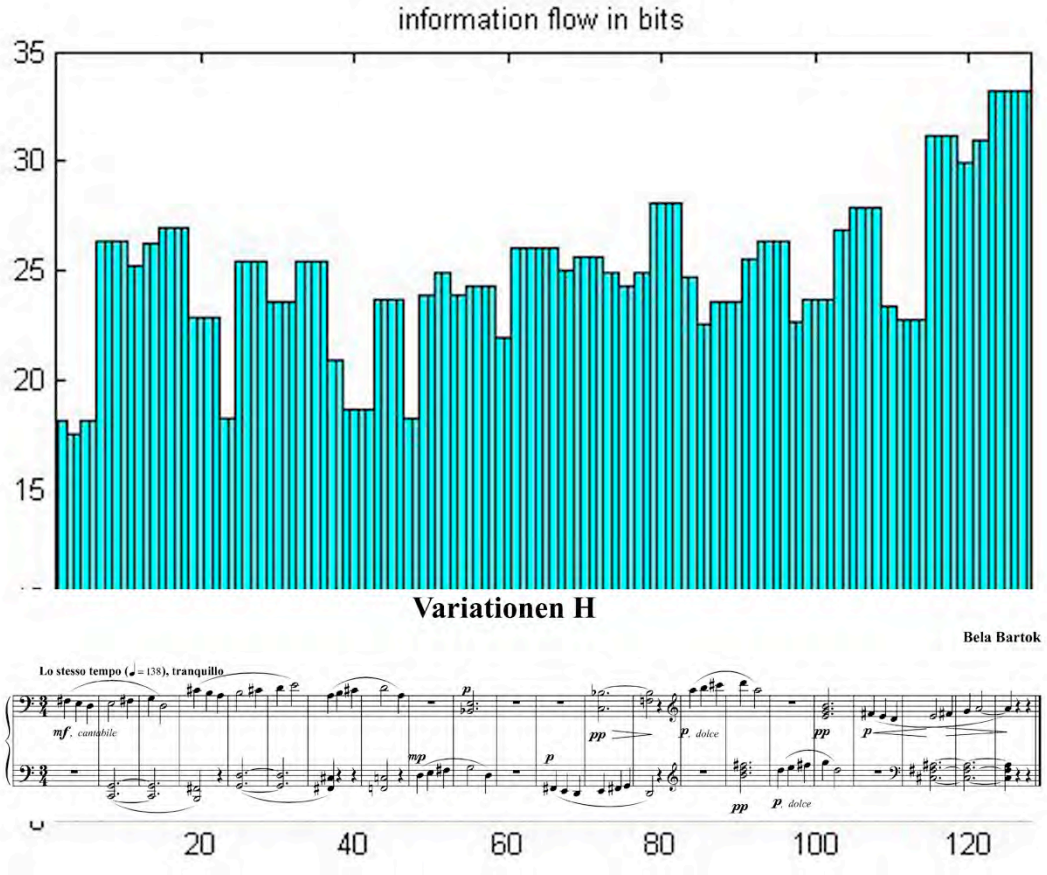


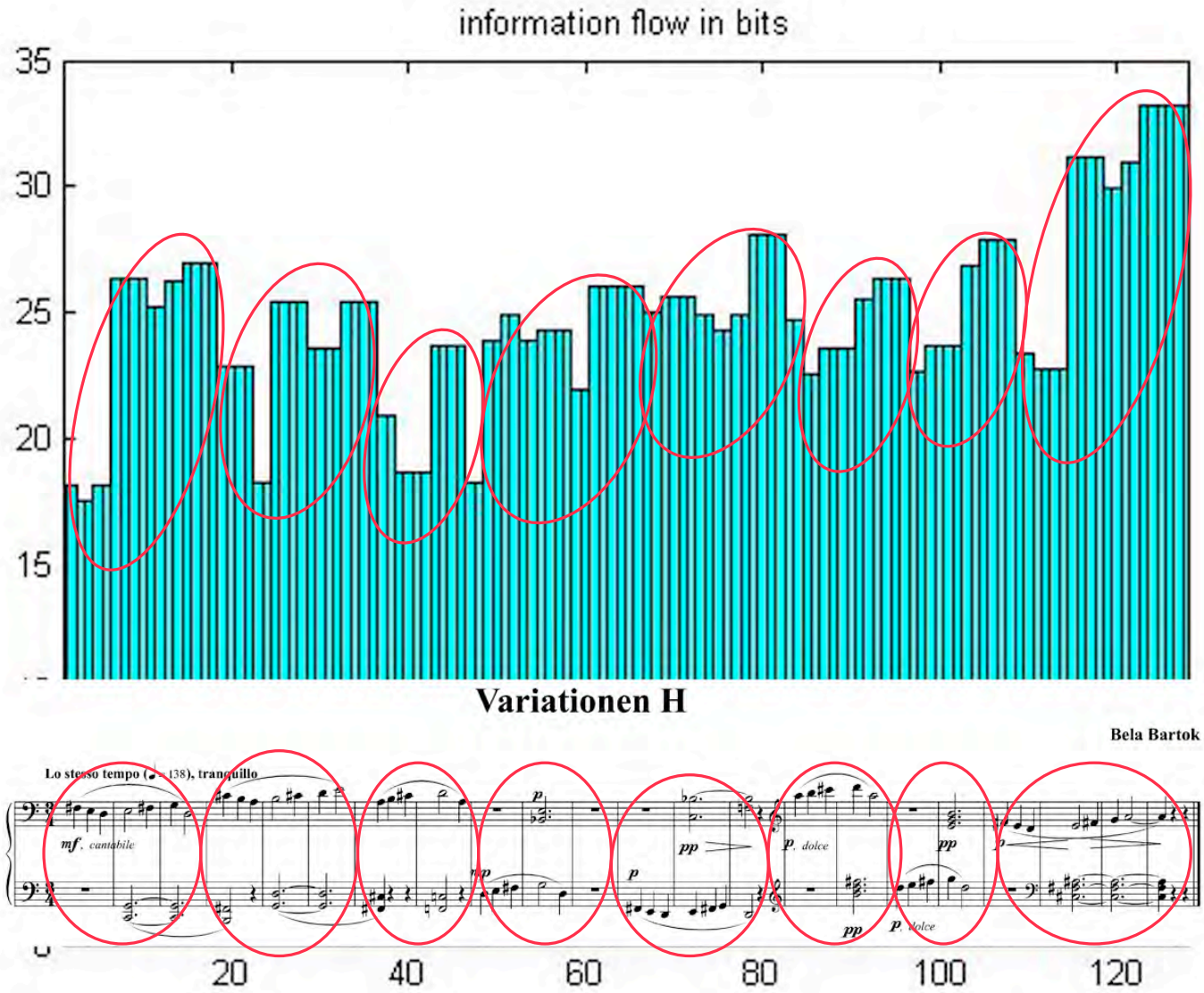

information flow in bits
25
20
15
10
Variationen G
Bela Bartok
Lo stesso tempo (♩ = 13c), tranquillo
mf, cantabile
mp
p
pp
p, dolce
pp
10
20
30
40
50
60
70
80
90

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

INFORMATIONSFLUSS DES ACHTEN SAMPLES

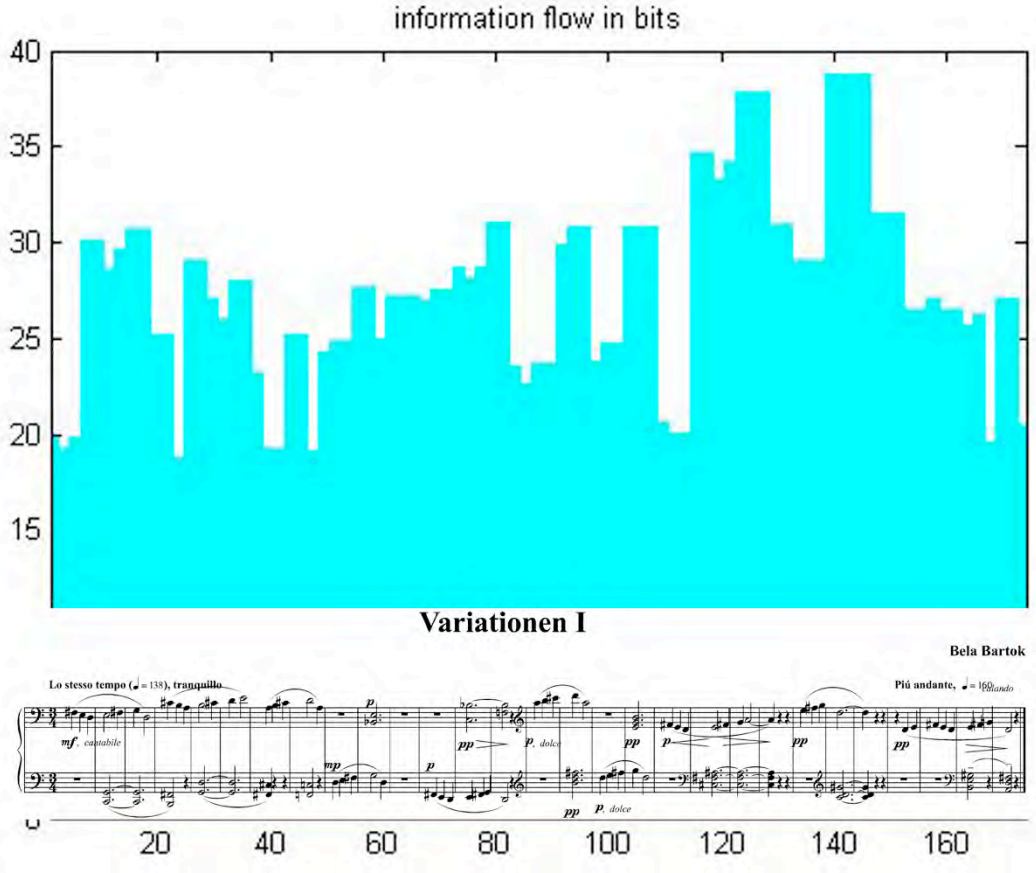


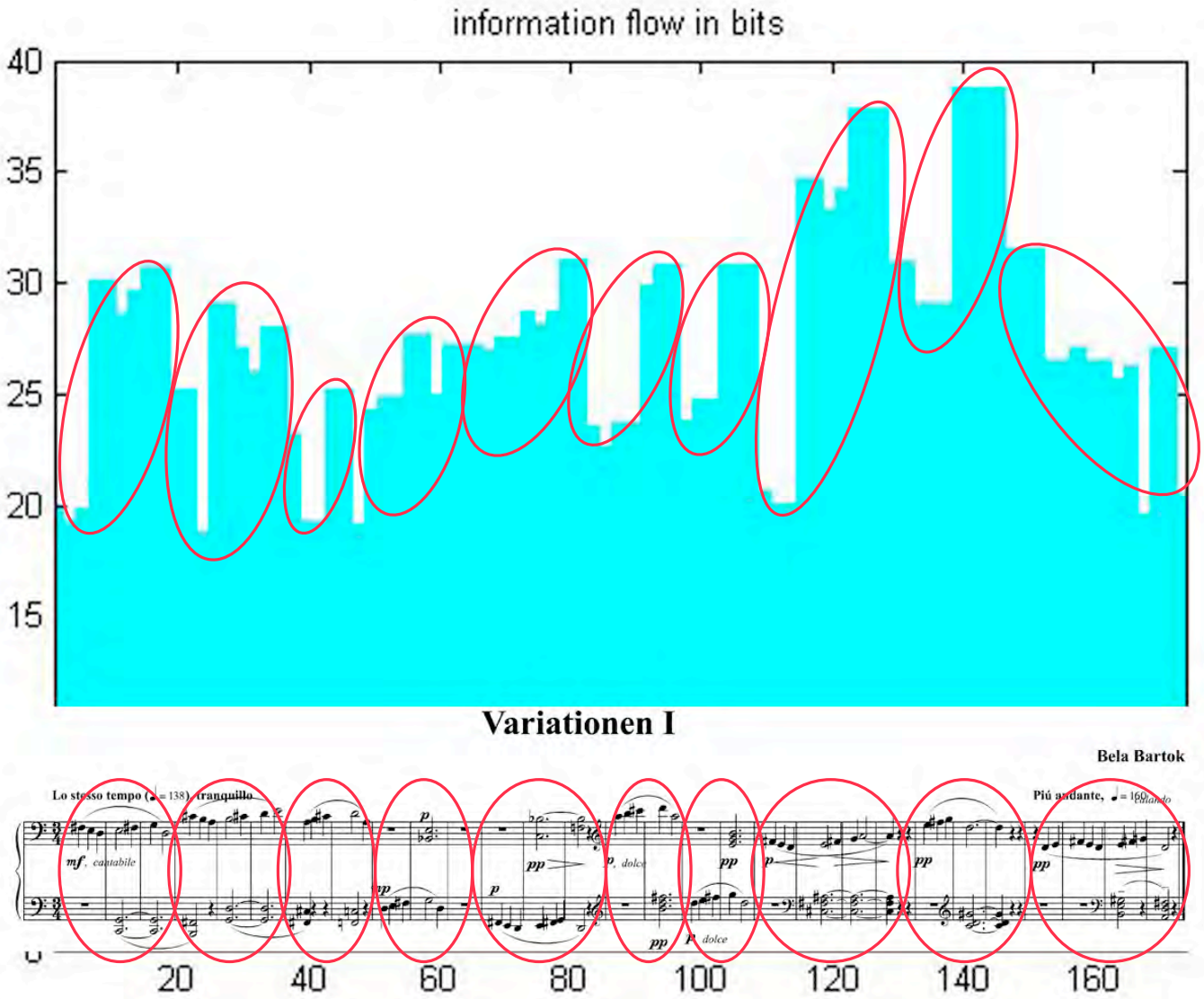

information flow in bits
35
30
25
20
15
Variationen H
Bela Bartok
Lo stesso tempo (♩= 138), tranquillo
mf, cantabile
mp
p
pp
p, dolce
pp
p, dolce
20
40
60
80
100
120

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

INFORMATIONSFLUSS DES NEUNTEN SAMPLES

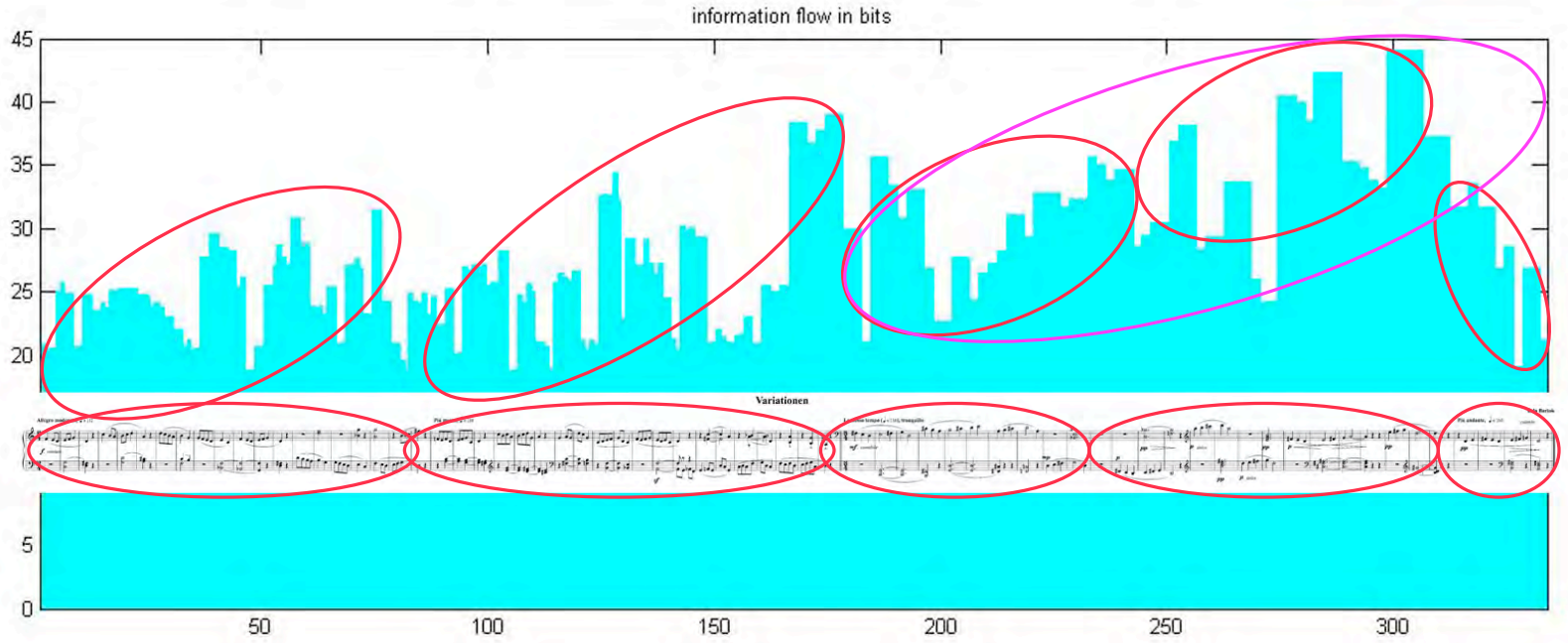



information flow in bits
40
35
30
25
20
15
Variationen I
Bela Bartok
Lo stesso tempo (♩= 138) tranquillo
Più andante, ♩= 160
mf, cantabile
p, dolce
pp
20
40
60
80
100
120
140
160

ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

VARIATIONS

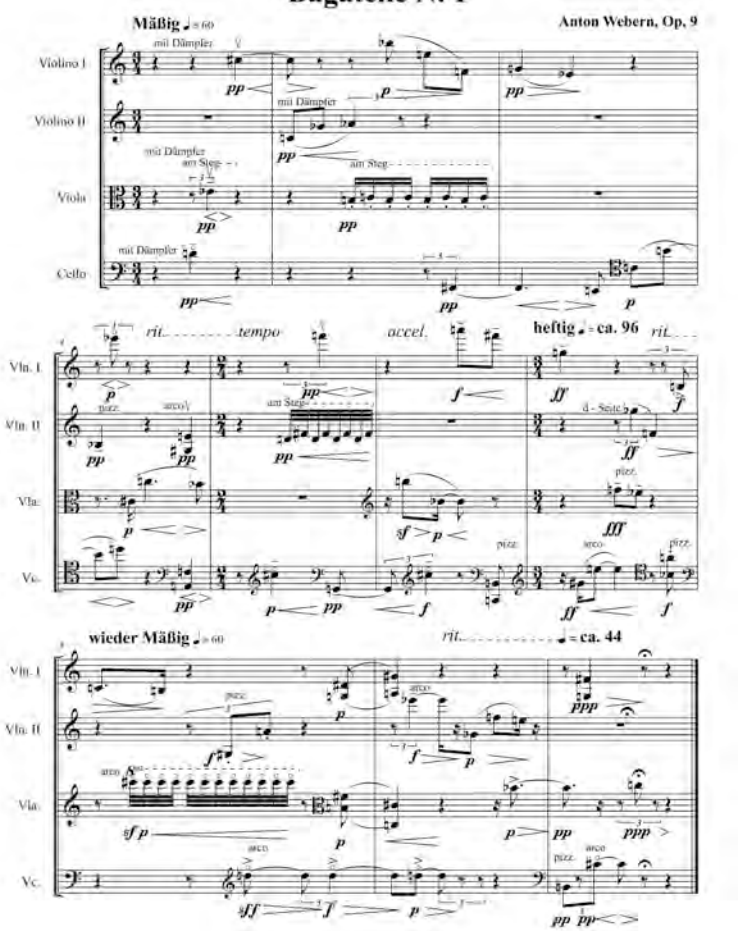
INFORMATIONSFLUSS DES ZEHNTEN SAMPLES = GANZES STÜCK



ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

BAGATELLE

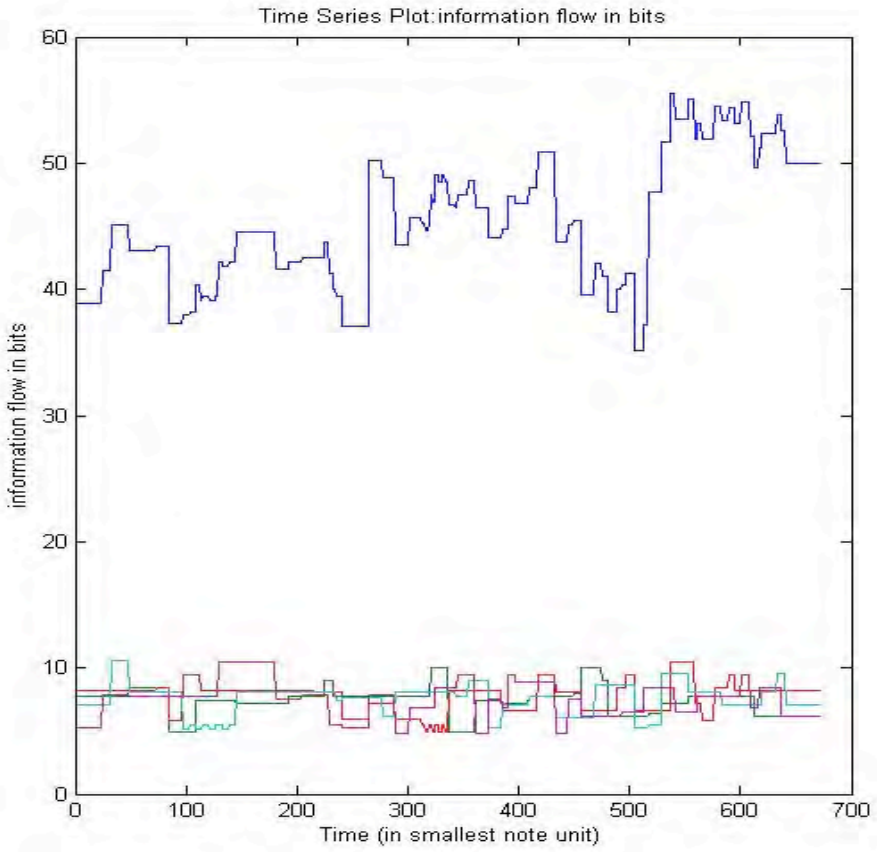
GANZES STÜCK

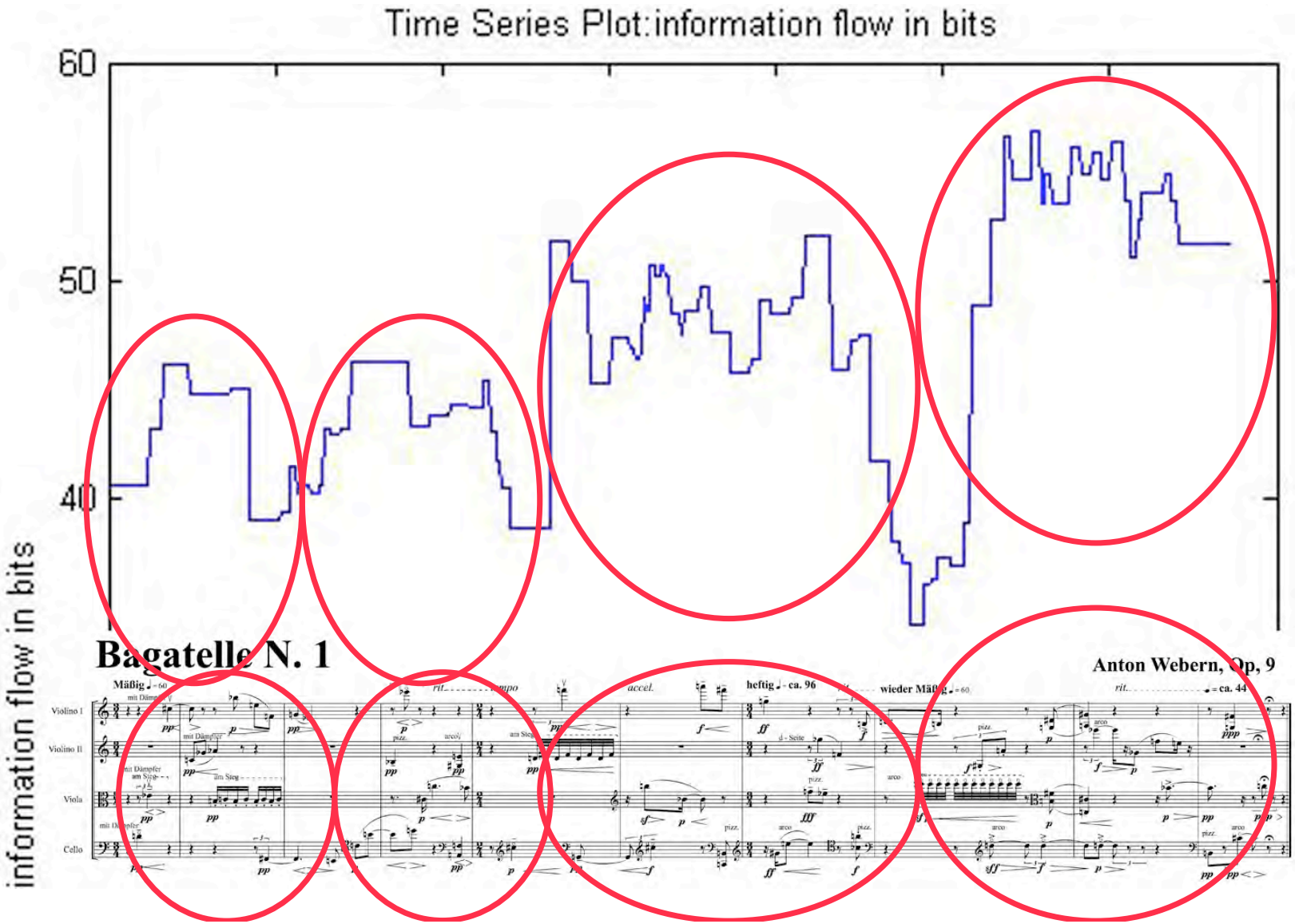


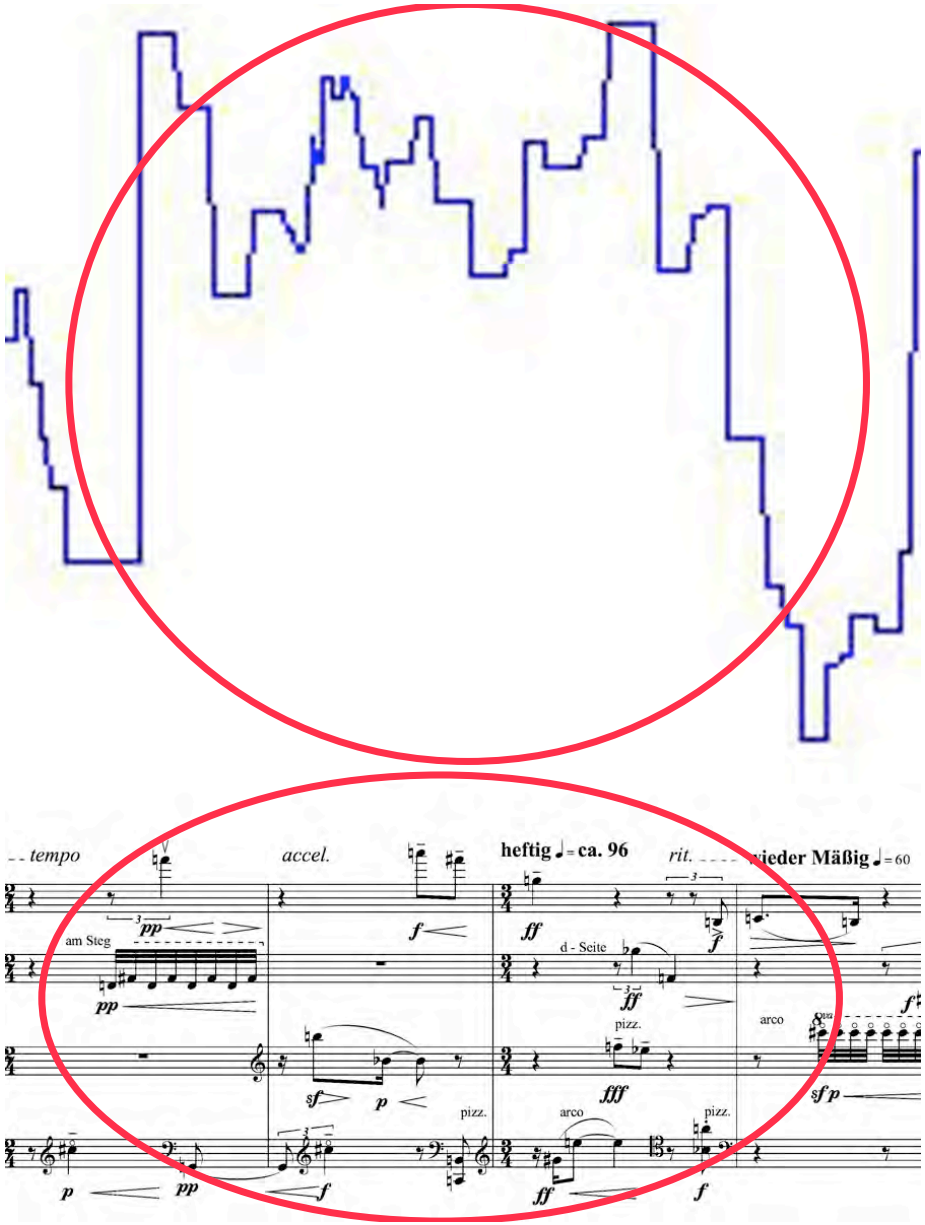
ANWENDUNG DER INFORMATIONSFLUSSFUNKTIONEN

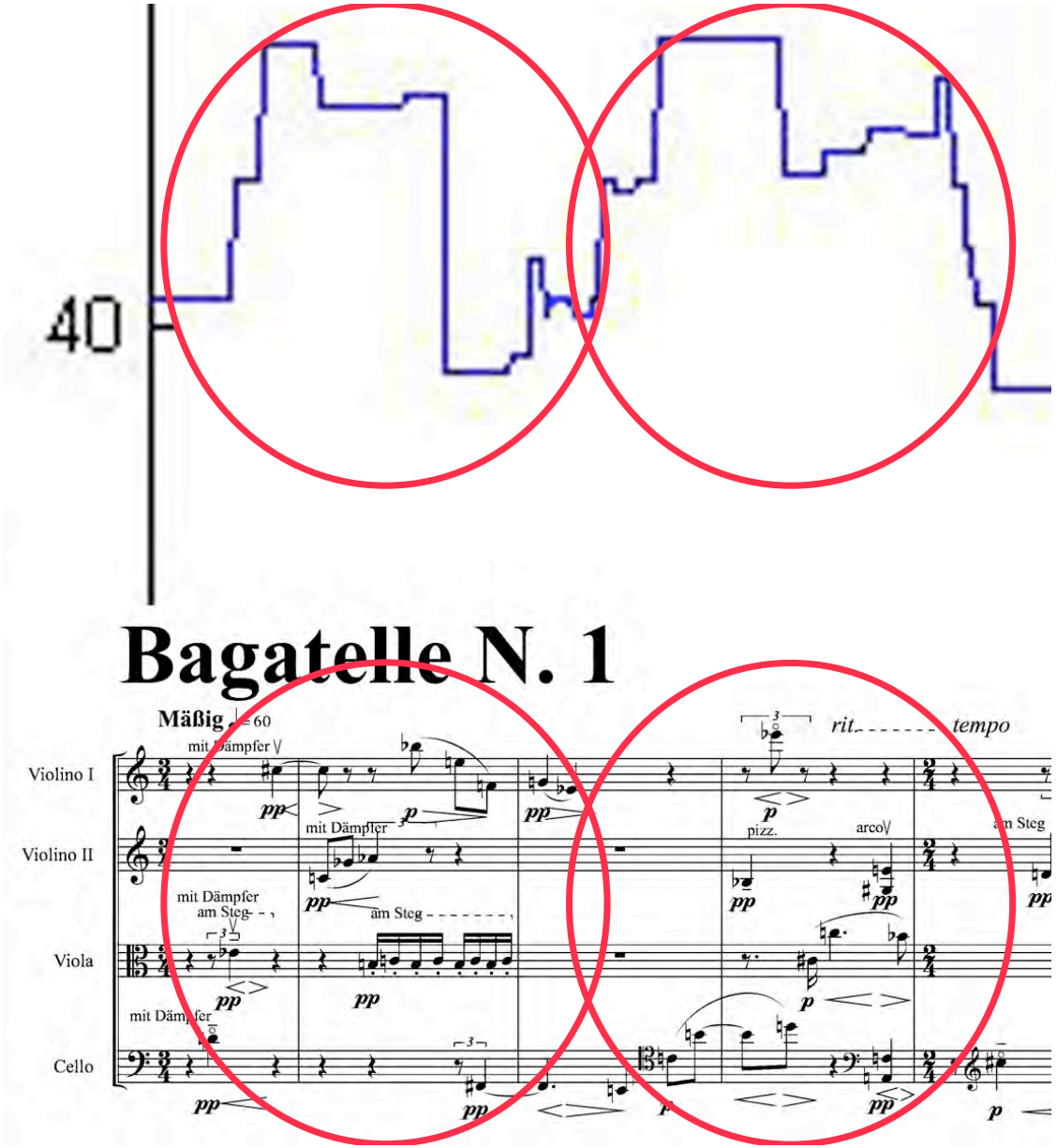
BAGATELLE

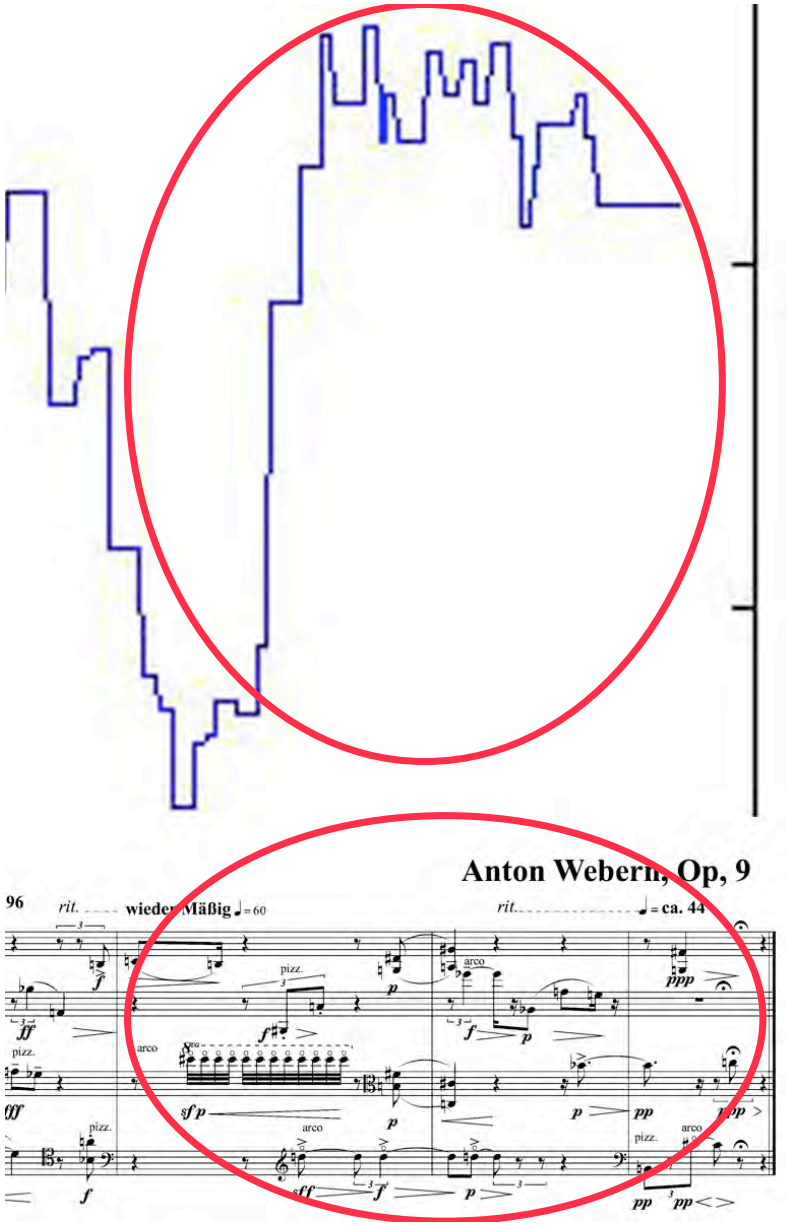
INFORMATIONSFLUSS DES GANZEN STÜCKS




Time Series Plot:information flow in bits
60
50
40
information flow in bits
Bagatelle N. 1
Anton Webern, Op, 9
Violino I
Violino II
Viola
Cello


tempo
accel.
heftig ♩= ca. 96
rit.
ieder Mäßig ♩= 60
am Steg
d - Seite
pizz.
arco
pizz.
arco
pizz.


40
Bagatelle N. 1
Mäßig
Violino I
Violino II
Viola
Cello
mit Dämpfer
am Steg
pizz.
arco
rit.
tempo


Anton Webern, Op, 9
96
rit.
wieder Mäßig ♩= 60
rit.
♩= ca. 44
pizz.
arco
ff
f
p
sf p
ff
ppp
pp

Giorgio Tedde

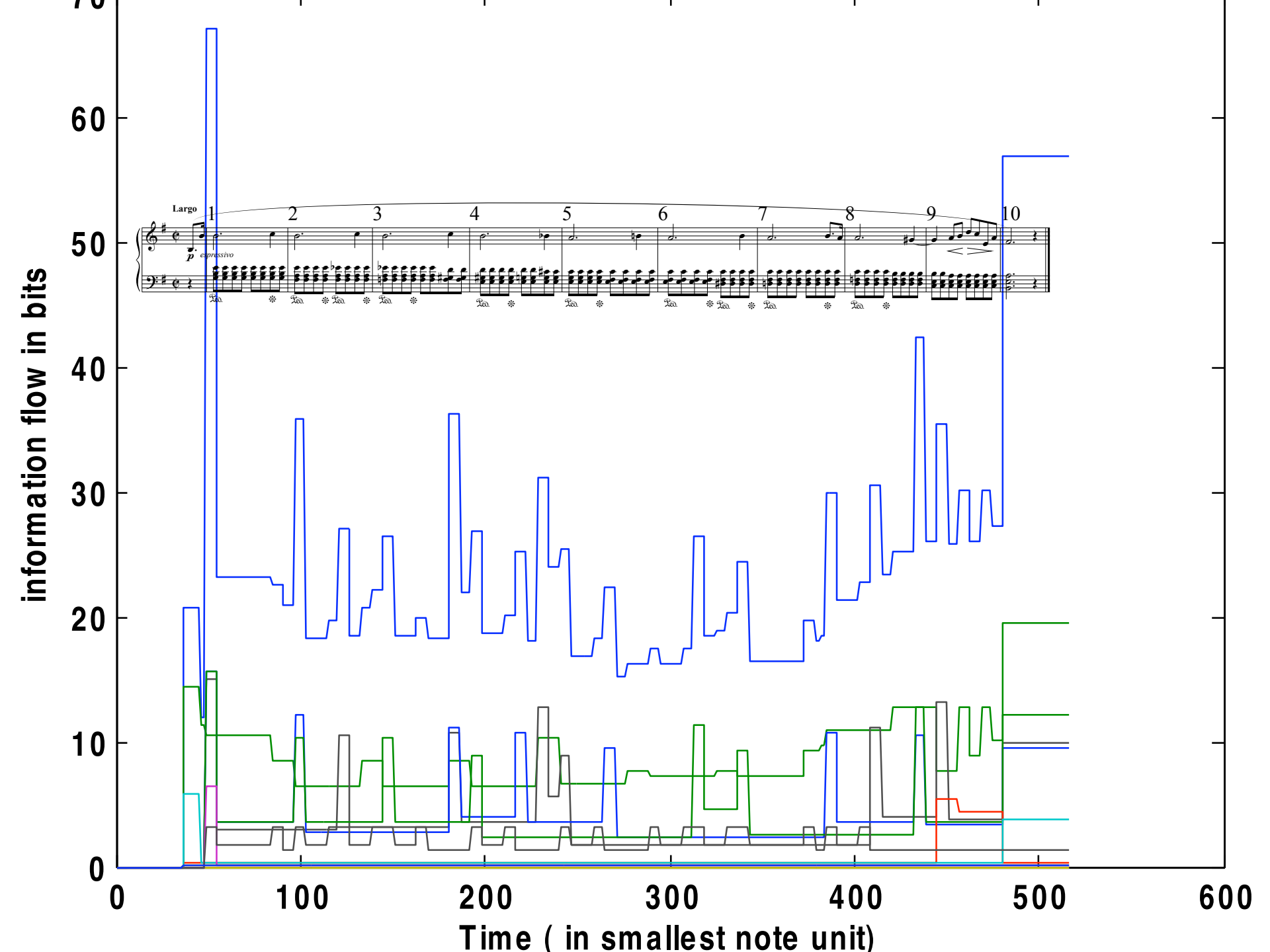
Dissertationsprojekt für die Promotion an der Fakultät Musik der Universität der Künste, Berlin

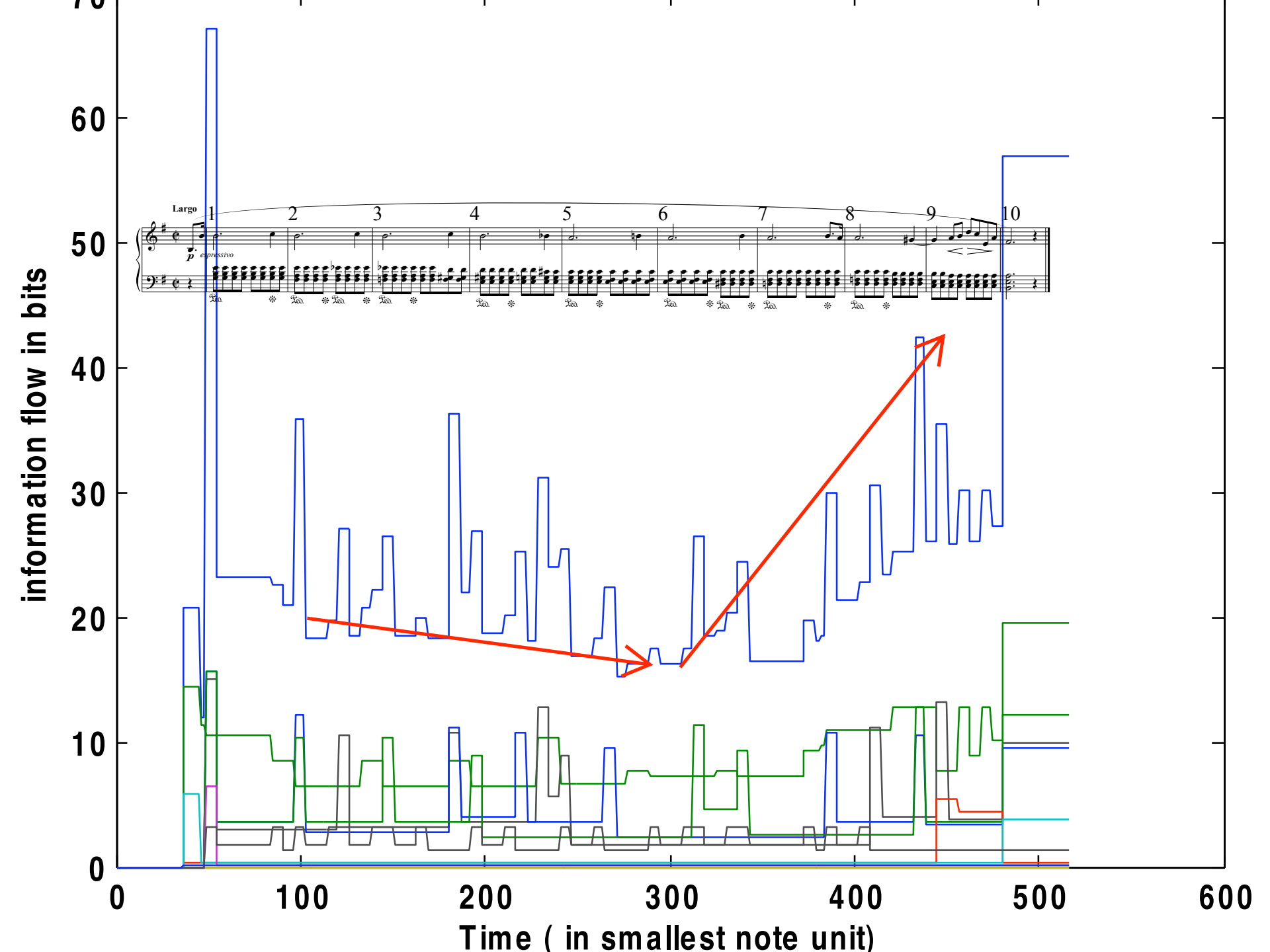
Ein naturalisierter Ansatz zu kognitiven Musiktheorien durch informationelle Klang- und Partituranalyse.

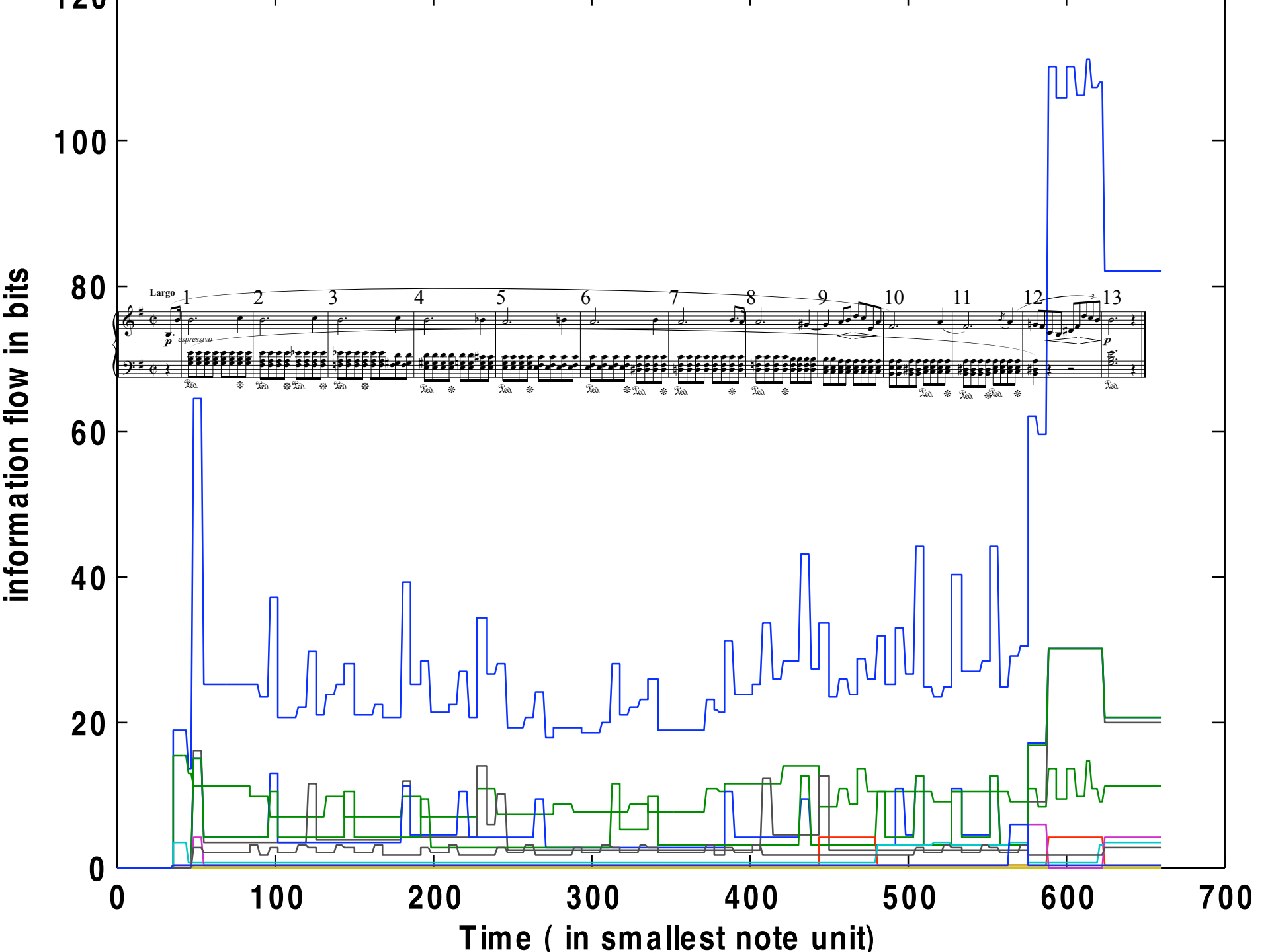
Entwicklung einer statistischen Methode zur Segmentierung der musikalischen Struktur durch ihren informationellen Zeitvorgang.

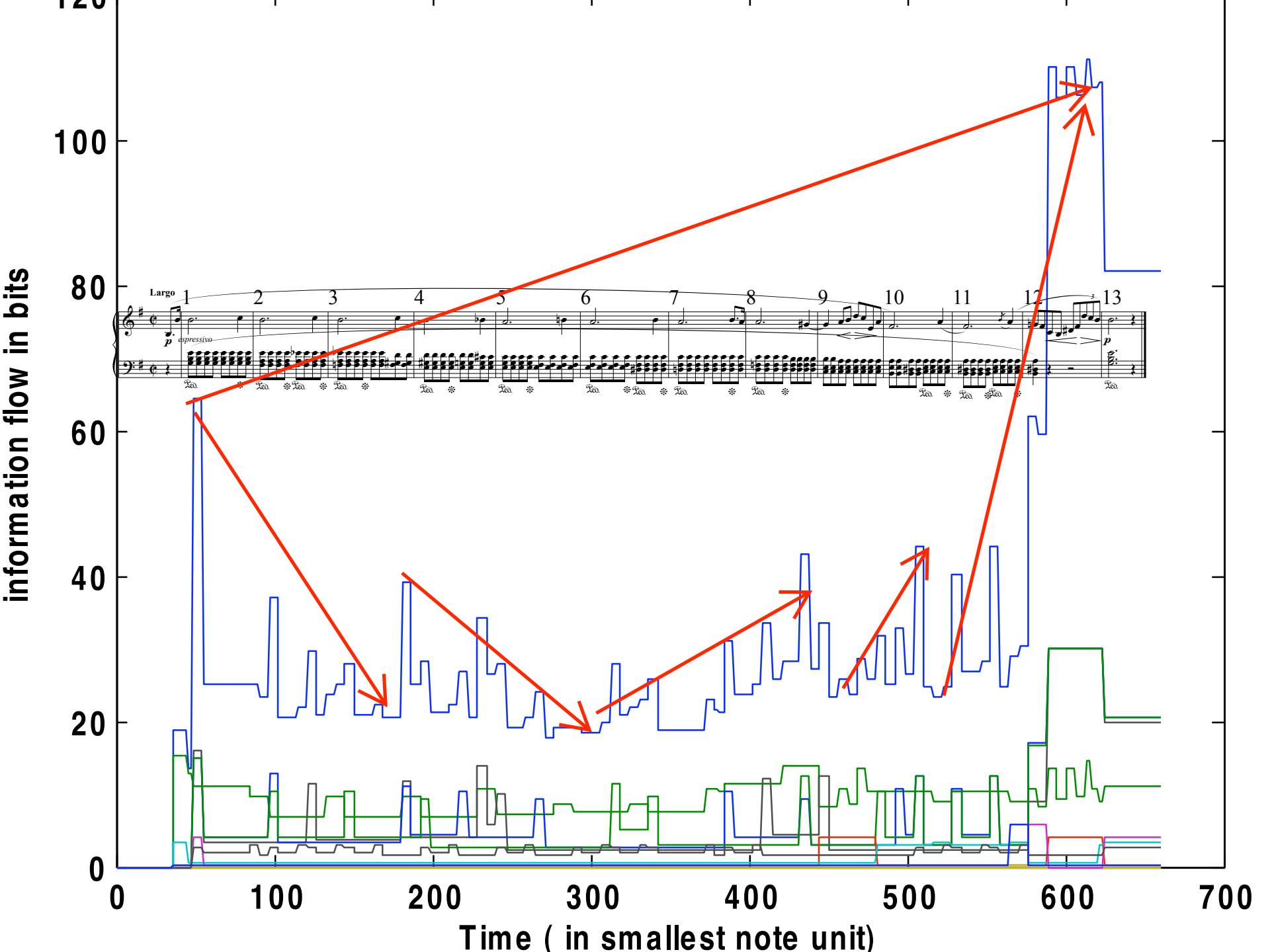
Information Flow Analysis of

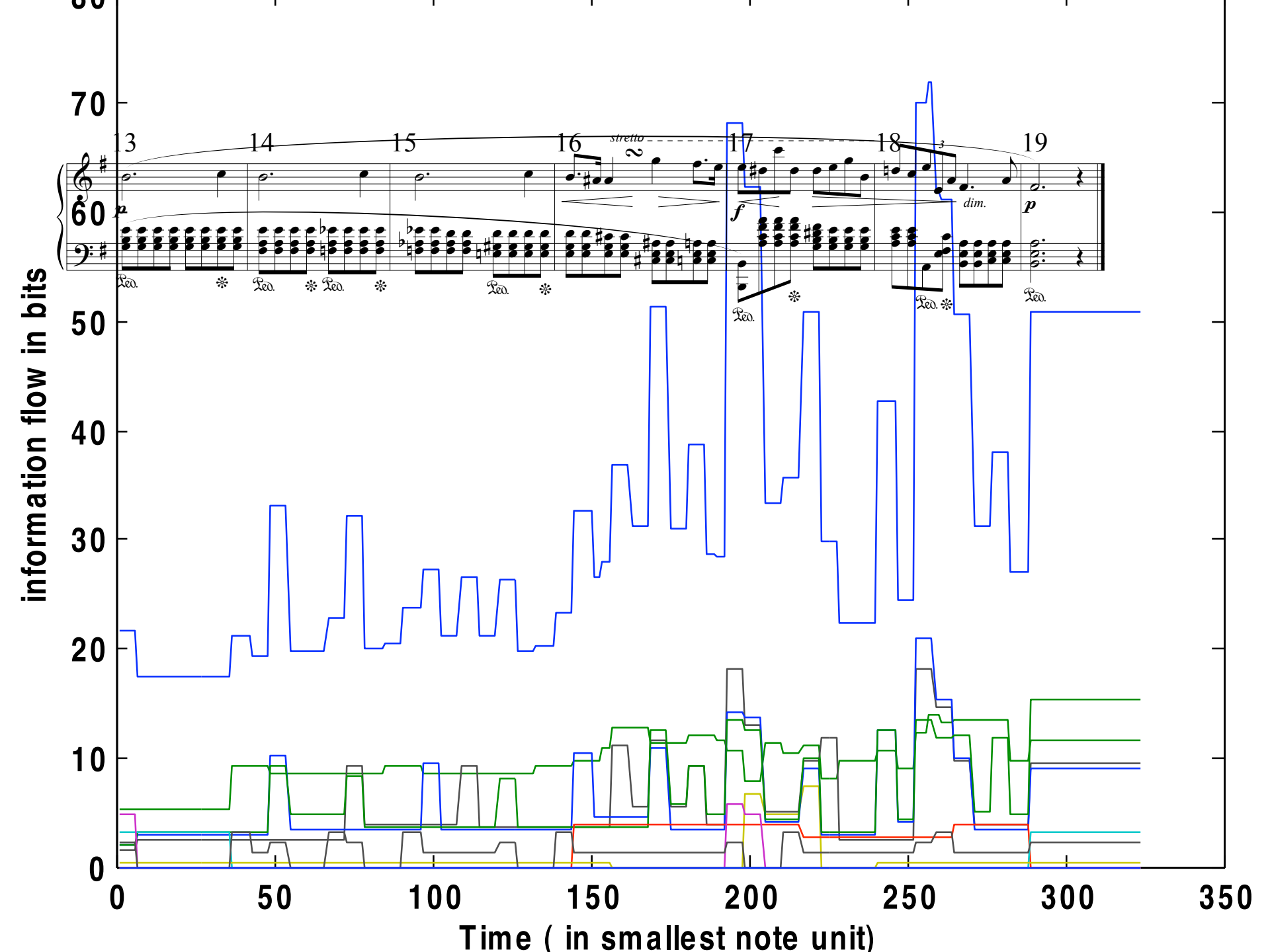
Frédéric Chopin, Prelude Nr. 4 in E moll from Preludes op. 28

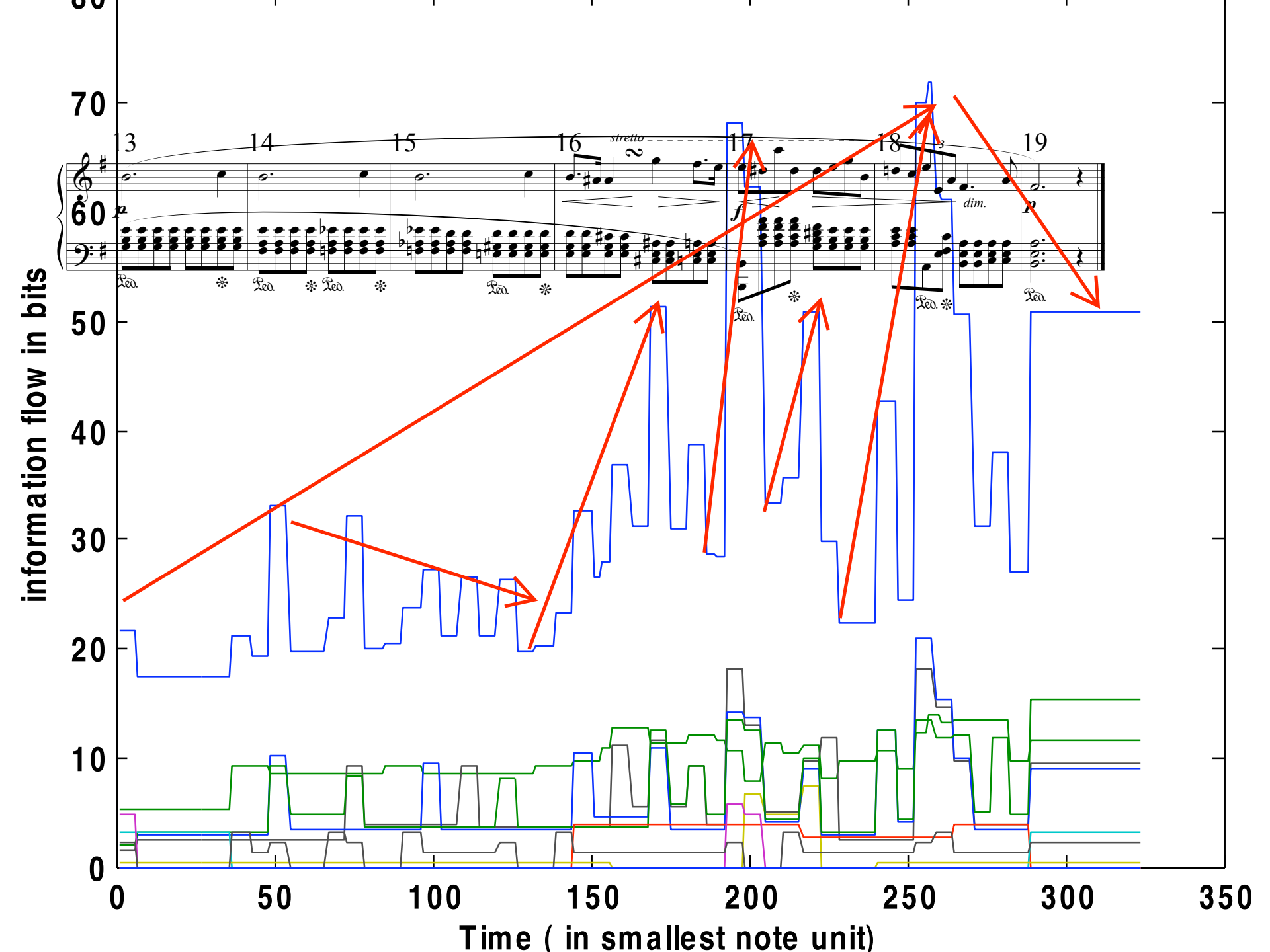

information flow in bits
Time (in smallest note unit)
0
10
20
30
40
50
60
0
100
200
300
400
500
600
Largo
1
2
3
4
5
6
7
8
9
10
espressivo

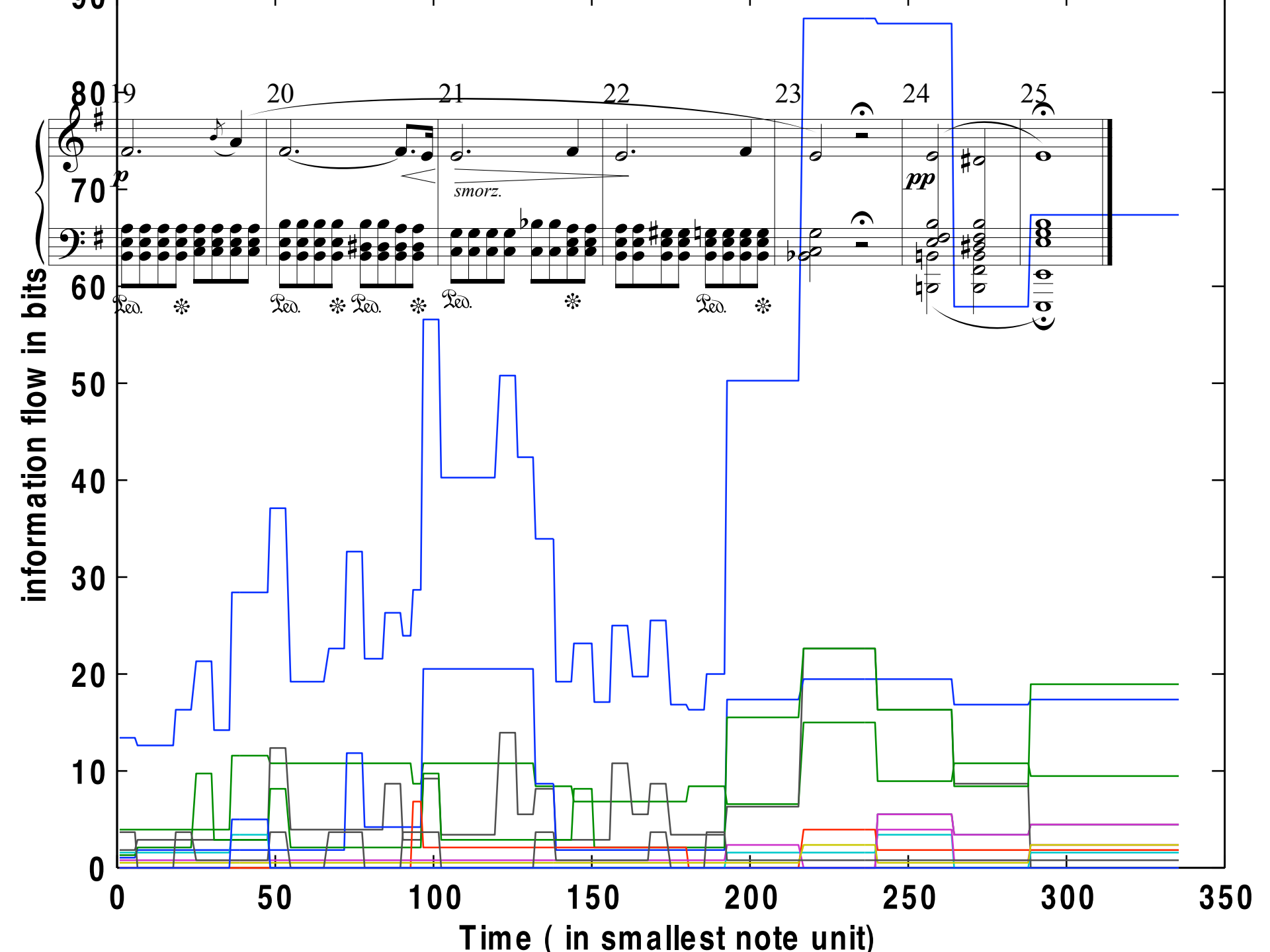

information flow in bits
Time (in smallest note unit)
0
10
20
30
40
50
60
0
100
200
300
400
500
600
Largo
1
2
3
4
5
6
7
8
9
10
p
espressivo

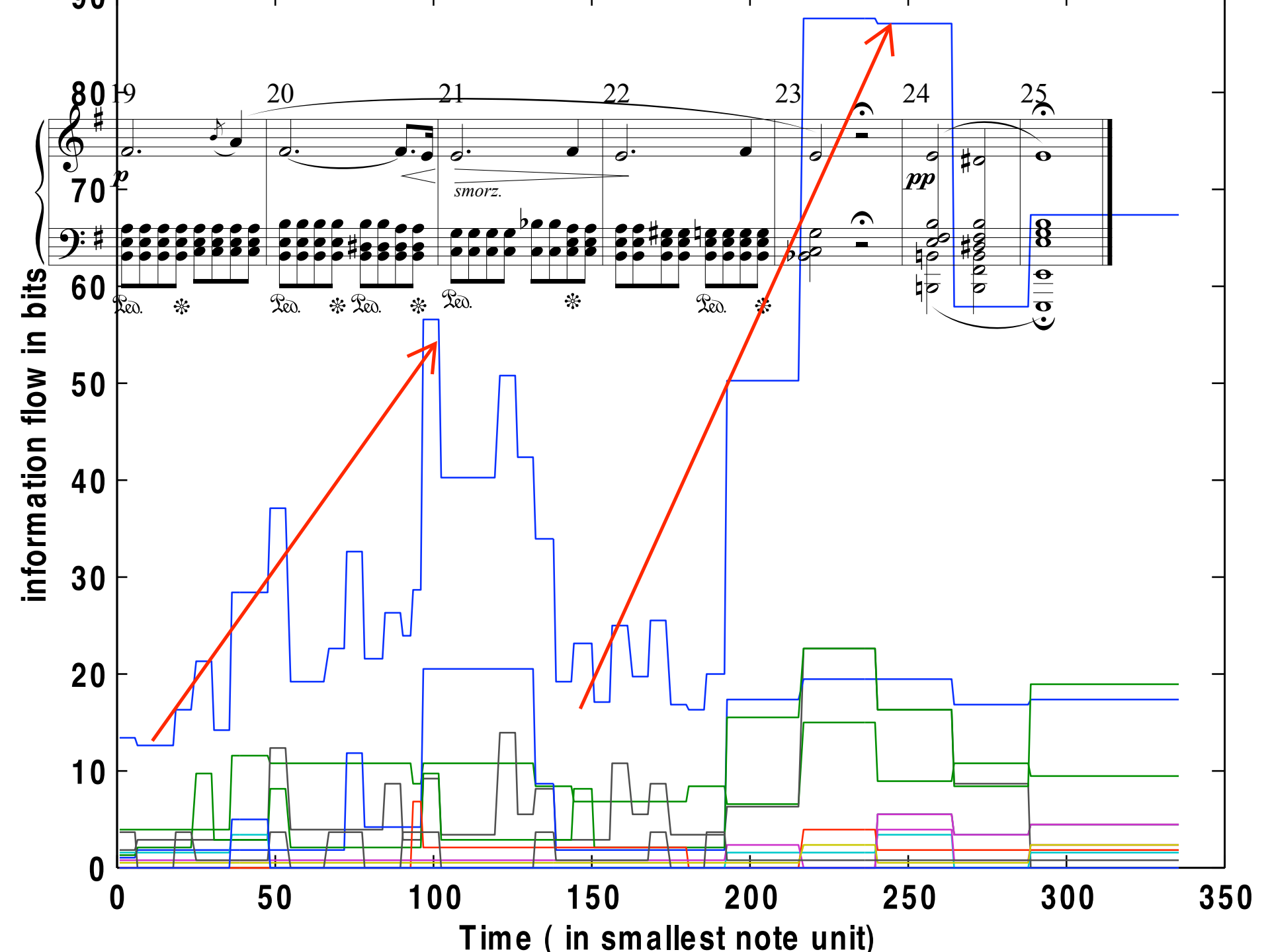

information flow in bits
120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
Time (in smallest note unit)
Largo
espressivo

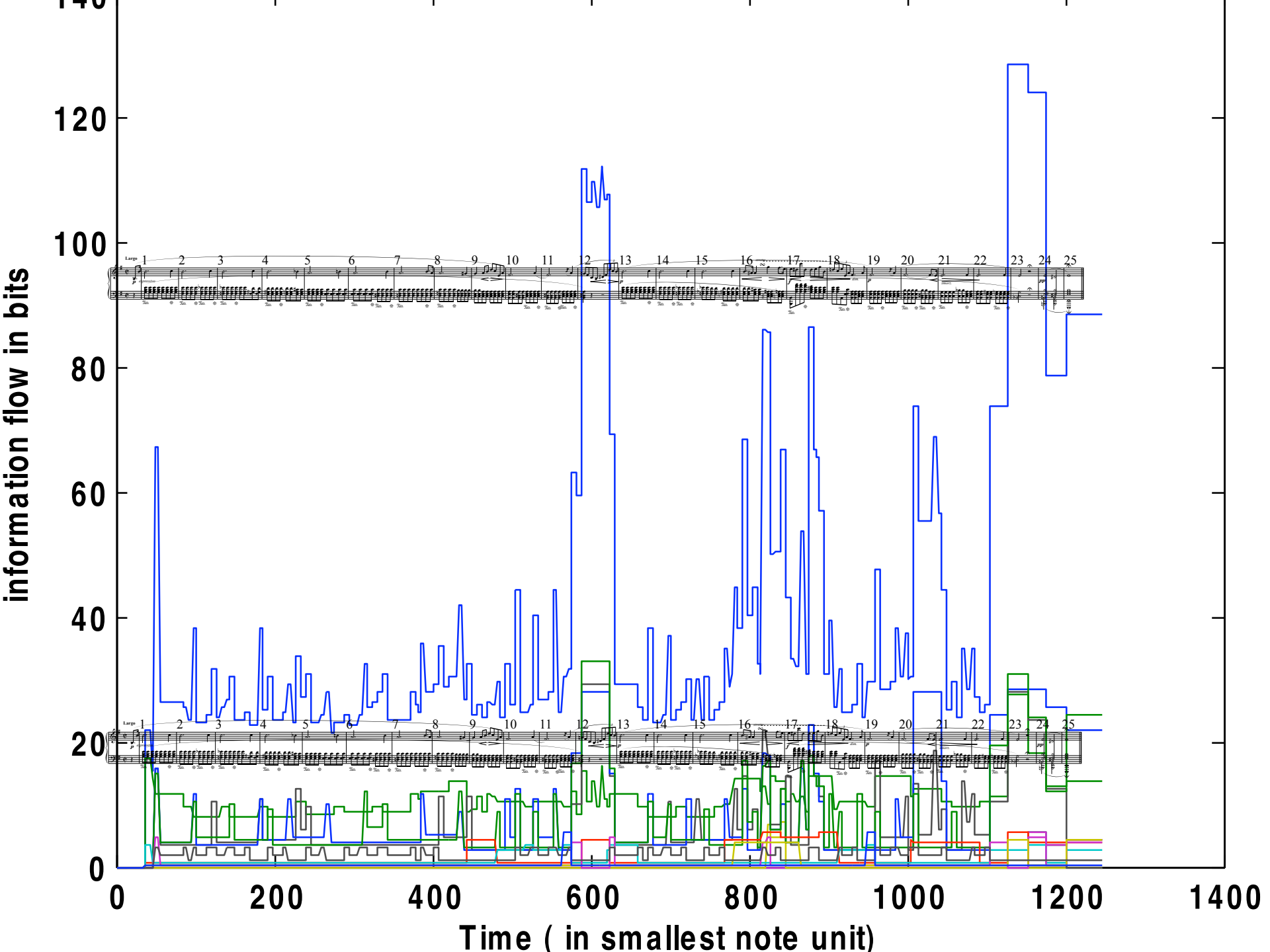

information flow in bits
Time (in smallest note unit)
0
20
40
60
80
100
120
0
100
200
300
400
500
600
700
Largo
espressivo

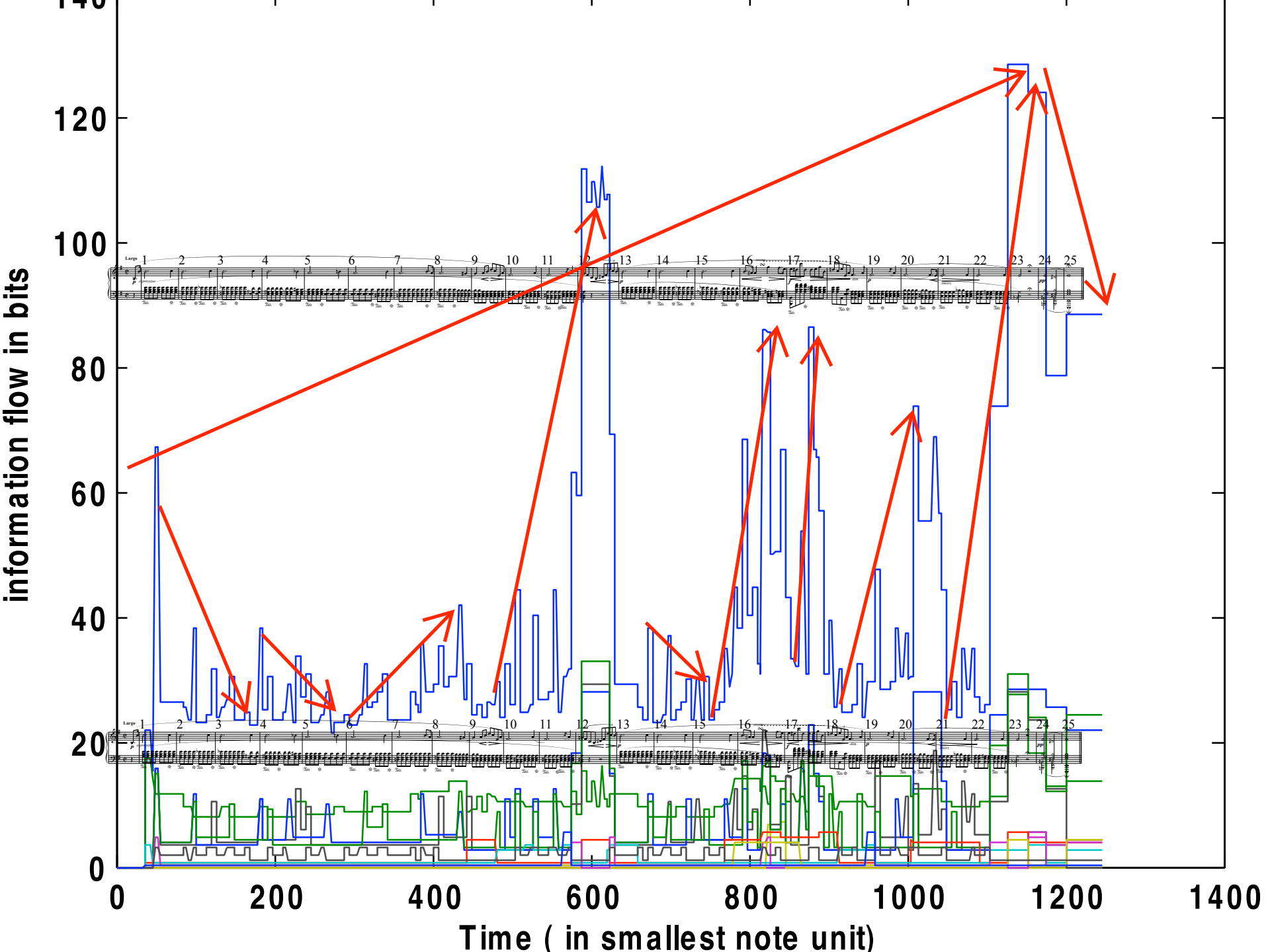

information flow in bits
Time (in smallest note unit)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
13
14
15
16
17
18
19
stretto
dim.
p
f
p


information flow in bits
Time (in smallest note unit)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
13
14
15
16
17
18
19
stretto
dim.


19
20
21
22
23
24
25
p
smorz.
pp
Ped.
information flow in bits
0
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
300
350
Time (in smallest note unit)


information flow in bits
Time (in smallest note unit)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
19
20
21
22
23
24
25
p
smorz.
pp
Ped.


information flow in bits
0
20
40
60
80
100
120
0
200
400
600
800
1000
1200
1400
Time (in smallest note unit)


information flow in bits
0
20
40
60
80
100
120
140
0
200
400
600
800
1000
1200
1400
Time (in smallest note unit)

THE CORE OF MY RESEARCH

APPLICATION IN MUSIC LITERATURE EXAMPLE
PRACTICAL ANALYTICAL EXPERIENCES REALIZED BY THE STUDENTS

In a multi-purpose approach different methodologies are used in a combined way, based mainly on parametrical, semiological and informational analysis.

The hearth of the research is focused on the evaluation/interpretation (mathematical, physical, heuristical) of the dynamic content of musical information of the different systems of signs (score, sound, syntactical units). All that gives hints about the potential reactions of the listener to the corresponding different performative/compositional gestures.

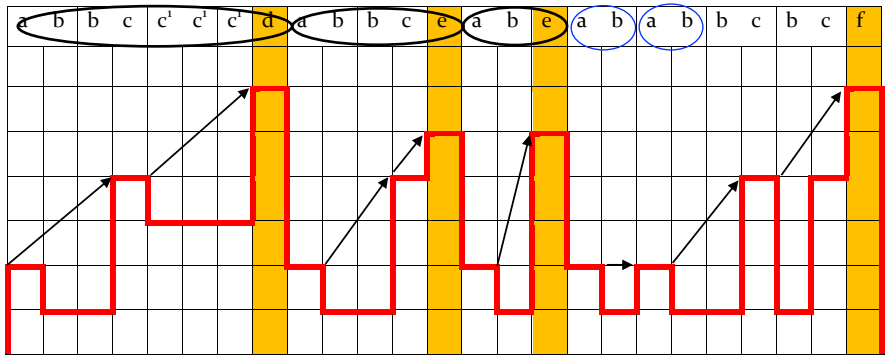
Here I will show some examples from the musical literature:
Bartok, Webern, Chopin, (external pdf file)

Following two short extracts from the analytic work of the student : (external pdf file)

- the first who calculated a value of the information flow of the pitches of a piece of Morton Feldmann and compared it with the articulations of the semiological analysis of the same piece;
- the second one that calculated the information flow of the syntactic units drawn from the semiological analysis of Schumann's 4th Symphony, here in the first movement.

EXAMPLE 1
Robert Schumann

Questi ultimi grafici mostrano come gli elementi di più elevata improbabilità di apparizione (f, d, e) coincidano, nel grafico dell'asse sintagmatico, ai segnali finali e dunque ai punti prevalentemente cadenzali e di conclusione fraseologica.



Conclusioni all'analisi del primo movimento

In conclusione, tirando le fila del lavoro fatto fino ad ora, ripercorro e sintetizzo brevemente i passaggi effettuati in questa prima analisi: sono partita da un'intuizione percettiva da dimostrare empiricamente, quella di un monotematismo di base unito ad un andamento ciclico degli elementi grammaticali principali, il tutto accompagnato dall'ipotesi di una costante accelerazione insita nel pezzo.

Dopo aver analizzato il primo movimento a livello formale (inquadrandone soprattutto i temi, l'andamento dinamico, ritmico e agogico, il tessuto armonico e l'elemento di densità strumentale), ho diviso e descritto i singoli parametri analizzandone la ricorsività e la variabilità.

Dopo aver quantizzato il grado di variazione con diversi grafici, ovvero l'elemento di novità inteso come poca ricorrenza, ho potuto individuare sull'asse sintagmatico i raggruppamenti, gli andamenti ed infine le funzioni dei diversi elementi grammaticali.

Ricorrenze dei singoli elementi sull'asse sintagmatico:

$x^3 = 7$

ab = 4

$j^2 = 10$

$g^1 = 6$

$g^2 = 6$

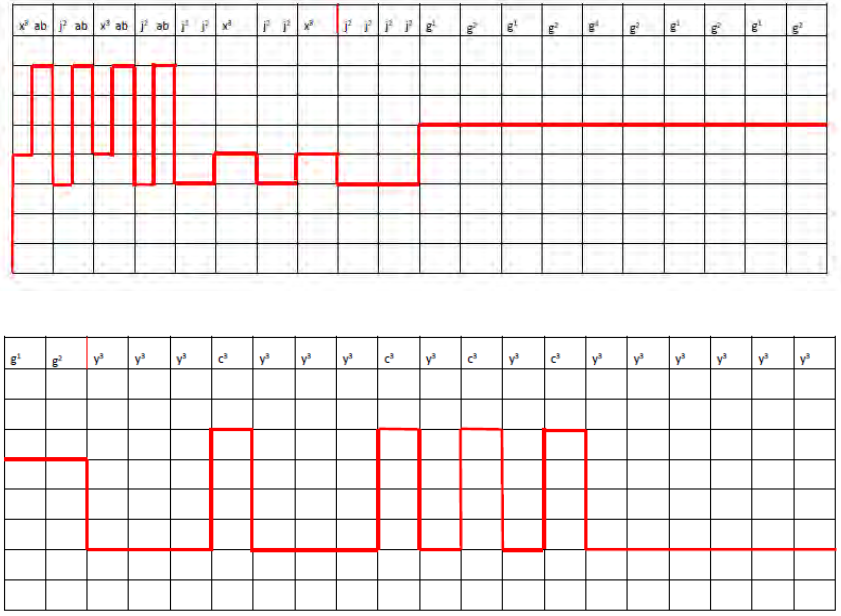
$y^3 = 15$

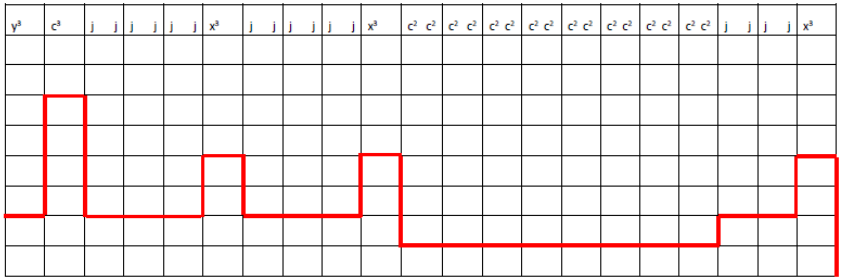
$c^3 = 5$

j = 16

$c^2 = 16$

Infine il seguente grafico mostra il grado di variazione (ricorrenza e improbabilità di apparizione) dei vari elementi grammaticali:

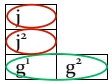




Abbiamo fin qui quantizzato il grado di variazione, ovvero la novità intesa come poca ricorrenza; tuttavia è da tenere presente che il valore di tale novità è strettamente correlato con l'elemento che lo precede. Questo dato ci fornisce gli strumenti per individuare dei raggruppamenti, degli andamenti e infine per distinguere le funzioni dei diversi elementi grammaticali.

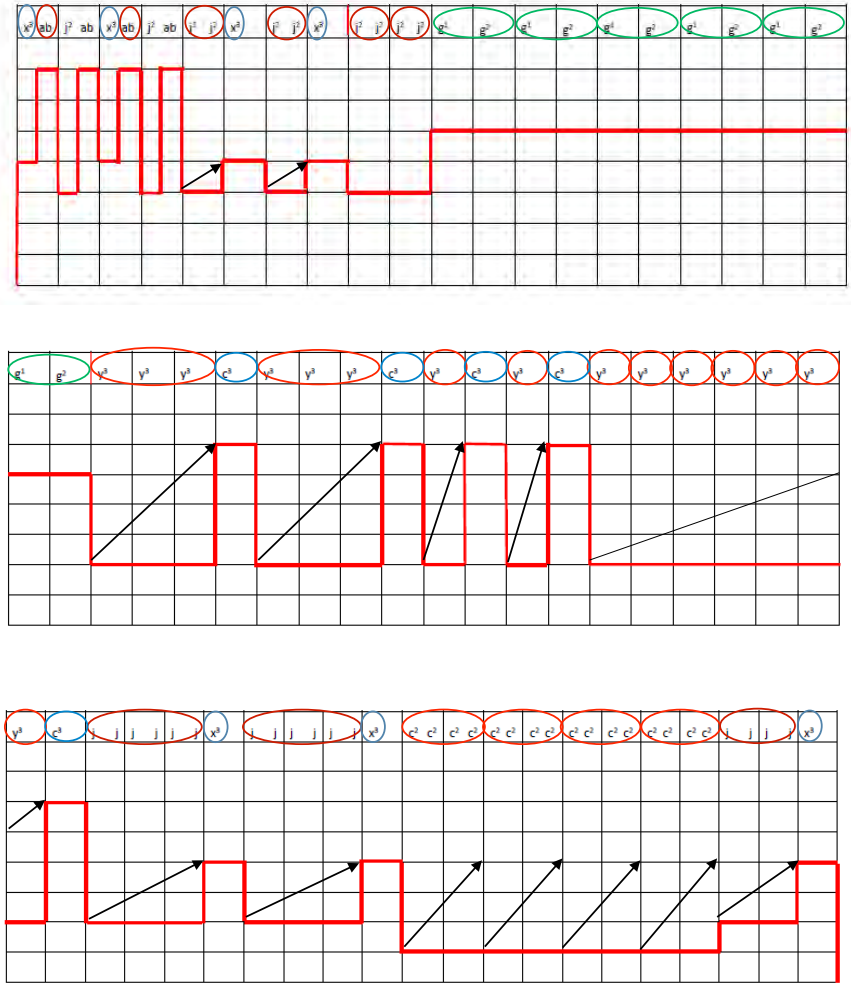
Passiamo quindi ora ad analizzare nel dettaglio le singole funzioni derivanti dalle varie tipologie di segnale (funzione iniziale, finale, interna e di prolungamento):

- Segnali Iniziali e Finali (SI) e (SF) = si trovano come incipit di una sezione o micro sezione e ricoprono sia una funzione iniziale che una funzione finale o conclusiva.



- Segnali Interni o di contenuto (SIn) = si trovano all'interno di sezioni e danno origine a varianti individuate lungo lo svolgimento della composizione.

Dall'unione infine dell'asse sintagmatico e del grafico che ci ha fornito il grado di variazione degli elementi grammaticali, ne consegue un ulteriore grafico mostrante un'accelerazione progressiva analoga a quella riscontrata nel primo movimento:



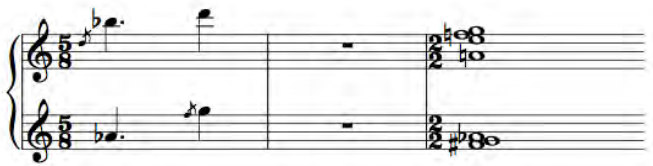
EXAMPLE 2
Morton Feldmann

La parte *e*, prolungamento della chiusura spande dalla misura 88 alla misura 101. Questa parte ha una *relexing* funzione grazie alla stasi delle prime 6 misure, in cui le stesse quattro unità si ripetono:

m. 88 - 93: {2-AA, 2N, 2-T, 2-S} + {2-AA, 2N, 2-T, 2-S}

Nella misura 95 si verifica lo stesso gesto di chiusura appena citata dalle misure 84 e 64. Tra queste tre trasformazioni dello stesso elemento, rimane tutte le unità uguali tranne la prima nota di acciaccatura e l'accordo finale:

prima acciaccatura + {2-C, 2-H, 2-D} + accordo lungo



Finalmente termina la parte *e* con un forte elemento di chiusura, vale a dire la doppia occorrenza delle note corte nella mano sinistra.

La chiusura della macro-sezione, 0-A, è affermato anche dall'analisi del flusso di informazione. Per definire questo parametro, partiamo dalla formula per l'entropia, *H*, usata da J. E. Youngblood:

$$H = -(p_1 \log_2 p_1 + p_2 \log_2 p_2 + \dots p_n \log_2 p_n)$$

dove p_n rappresenta la probabilità di occorrenza dell'unità *n*.

p_n = occorrenze dell'unità *n* ÷ occorrenze di tutte le unità

I *log* hanno un base di 2 per riflettere i due stati possibili (occorrente o non occorrente) di ogni unità. Con questa espressione si intende che il livello di informazione sia proporzionale alla imprevedibilità della occorrenza di una data

unità—quindi la regolarità della distribuzione probabilistica tra tutto ciò che appare affatto.

Per normalizzare il valore, questa espressione viene divisa da H_r, l'entropia relativa, ovvero il massimo livello di informazione possibile se la probabilità fosse distribuita ugualmente tra tutte le unità:

$$H_r = \log_2 n$$

Finalmente, essendo una misura statica l'entropia, includiamo una emivita, λ, che rappresenta più o meno la velocità con cui gli eventi passati sono dimenticati dall'ascoltatore. Un'emivita di 25 misure va bene per i nostri dati. Questa significa che le occorrenze lontane da 25 misure hanno una metà l'influenza sul calcolo della probabilità di occorrenza riferita a un dato punto.

In somma, il livello di informazione I_m in una misura m sarà definita secondo le seguenti funzioni:

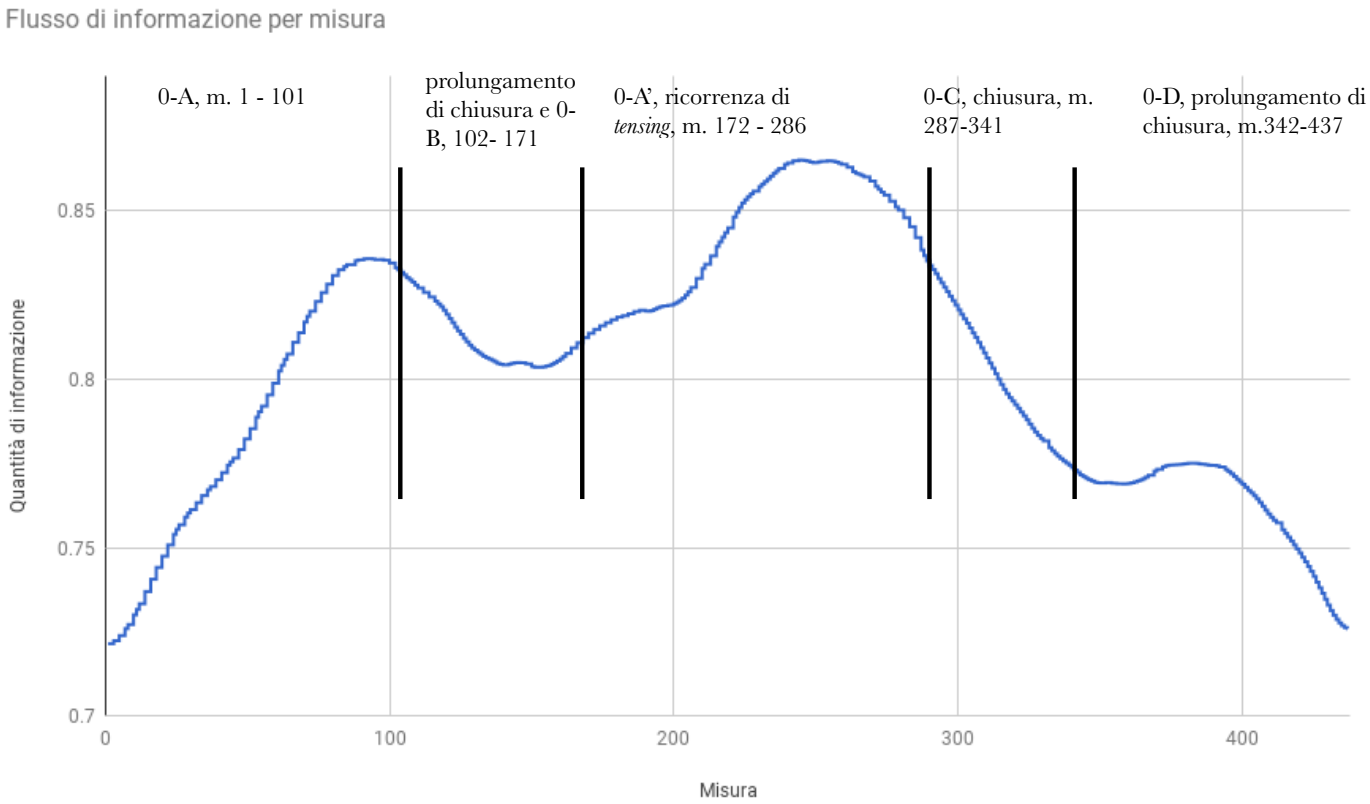
$$P_m = \sum_d (O_{m+d}\, 0.5^{d/\lambda}) \div O_t$$

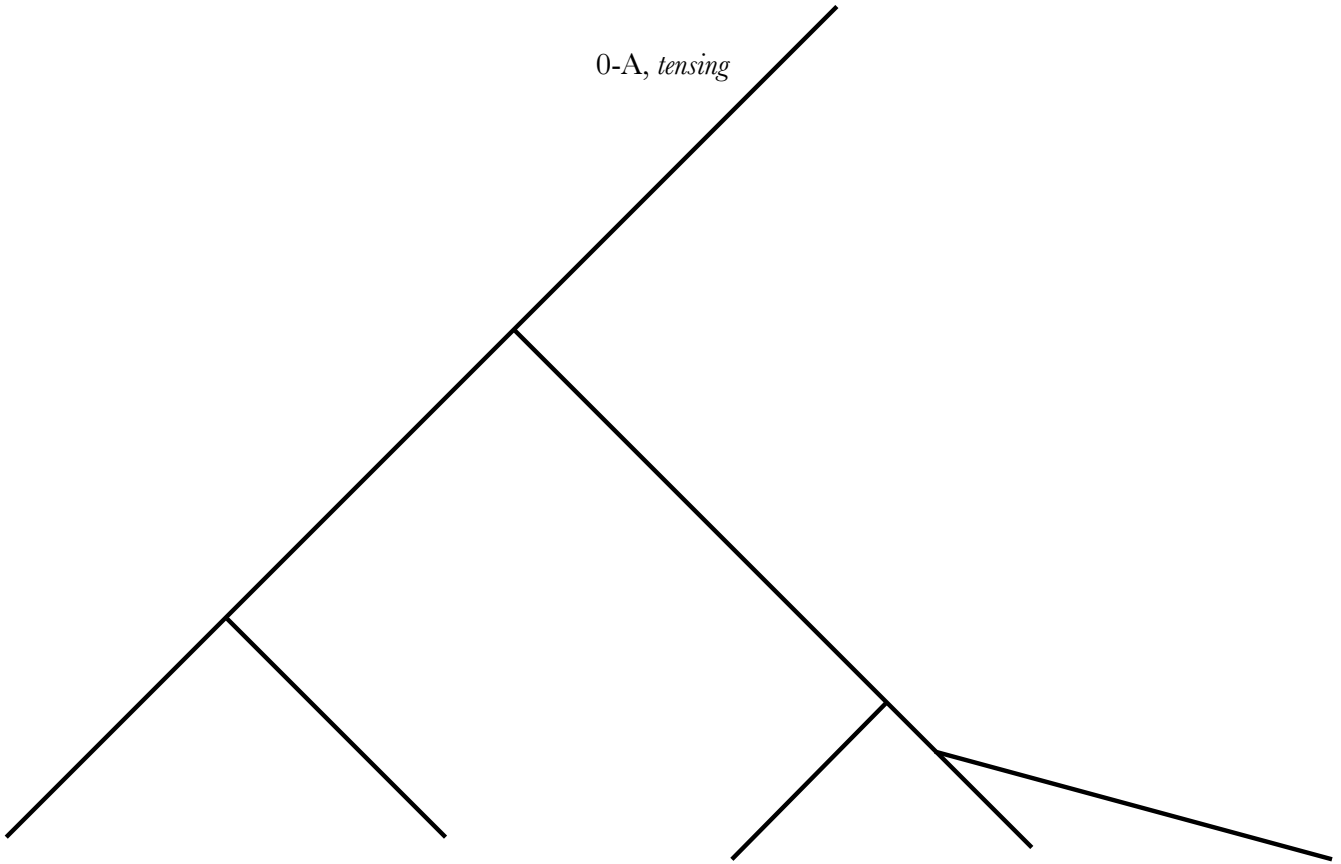
dove O_{m+d} significa le occorrenze di un'unità a distanza d dalla misura m, e O_t è l'occorrenze di tutte le unità

$$I_m = -(p_{1m} \log_2 p_{1m} + p_{2m} \log_2 p_{2m} + \ldots p_{nm} \log_2 p_{nm}) \div H_r$$

Da queste formule risulta il grafico sulla pagina successiva. Il livello di informazione arriva ad un picco locale verso la misura 101. Questo da conferma all'ipotesi che il segno 0-A chiude a quel punto. Poi il livello di informazione comincia a diminuire durante il prolungamento della chiusura, che costituisce un riassunto di molte delle unità di chiusura usate in precedenza. Questa tendenza *relaxing* continua durante il segno 0-B (m. 120 - 163) che secondo il nostro modello sarebbe la parte *b* sul livello 0. La sensazione di riposo come risposta al *tensing* di 0-A è dovuta sopra tutta a la regolarità metrica e la ridondanza relativa di questo segno.

Nelle seguenti due pagine si trova il grafico del flusso di informazione, e poi un riassunto del analisi finora di 0-A, m. 1 - 119.


Flusso di informazione per misura
0-A, m. 1 - 101
prolungamento di chiusura e 0-B, 102- 171
0-A', ricorrenza di *tensing*, m. 172 - 286
0-C, chiusura, m. 287-341
0-D, prolungamento di chiusura, m.342-437
Quantità di informazione
0.85
0.8
0.75
0.7
0
100
200
300
400
Misura



Parte del modello:	a. *tensing*	b. *relaxing*	c. ricorrenza	d. chiusura	d. prolungamento

THE CORE OF MY RESEARCH

EFFECTIVE SHARING AND TEACHING OF THE METHODOLOGY AND ITS INSIGHT IN THE MUSICAL ACTION

finally I show some aspects and impressions of my teaching practice of this vision of music

- countless opportunities for informational and syntactic evaluations on the compositional technique of writing (in the draft phase) during decades of lessons, the result of which remains in the trace of the compositional works revised according to the perceptual principles exposed;
- countless opportunities for informational and syntactical evaluations on the performing technique during chamber music sessions and rehearsals, which leave a trace in the awareness of the performers and more clarity and expressive intention in the performances.
- all this in the consideration of music as an art that modifies the psychological state of the listener:

  - the clearer the means is (stimulus generation),
  - the more effective the result (change of the listener's attitude)

THE WHISH OF MY RESEARCH

I HOPE

I HAVE INFORMED YOU ABOUT INFORMATION

AND

I HAVE AWEAKENED YOUR ATTENTION

ON THE ATTENTION GENERATED BY INFORMATION

THANK YOU FOR YOUR ATTENTION!

Playing and Composing:

Tuning the Gestures by Psychophysical Insight into Music

giorgio tedde