

# Larger goals in representation: Data archiving, interchange, and analysis

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MUSIC 253/CS 275A  
STANFORD UNIVERSITY

# Durable (non-audio) encoding projects

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## Single-focus

- Folk-music collections (esp. German)
- Music-manuscript finding aids

## Multi-focus (vertical integration)

- MuseData (classical/orchestral-chamber)
- KernScores (classical/keyboard)
- Choral Public-domain Library (CPDL)

# Characteristics of most

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- Representation: Neither *time* nor *space* is a dominant consideration
- Central aim: **Repurposable data**, interoperability
- Examples
  - *Archiving*: canonical format that facilitates interoperability
  - *Interchange*: canonical format that is easily interpreted by sending and receiving systems whose formats may be unknown
  - *Analysis*: flexible format that can be modified to suit a range of needs (can sometimes be distilled from richer format)

# Common distinguishing features

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## Monophonic encodings

- EsAC, P&E (monophonic)

## Polyphonic encodings

- MuseData (polyphonic)

All ASCII

All accessible

## Markup and interchange codes

- MusicXML, MEI

## Essential features

- Humdrum (Toolkit)

Not ASCII

Not accessible

## De facto datasets (e.g. SCORE repertories)

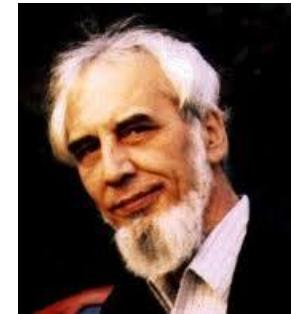
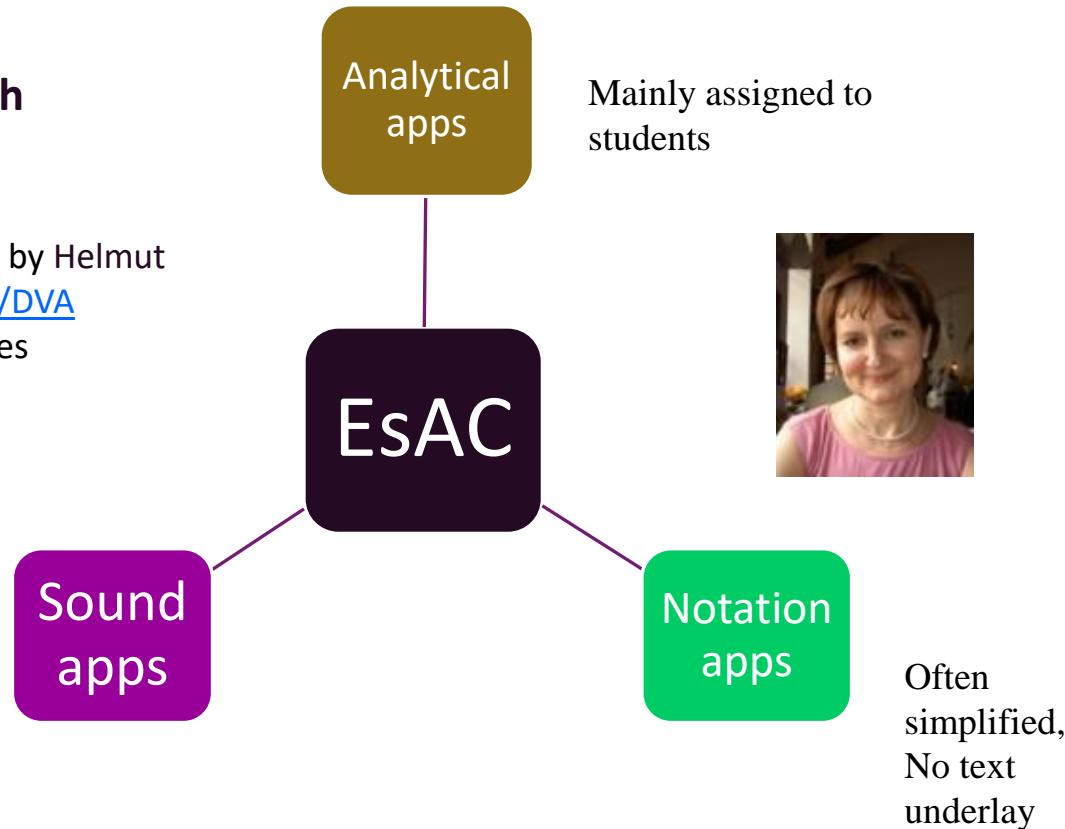
# Early prototype: EsAC network model (1982-1994)

## Folk music research

Developed in Essen, DE, by Helmut Schaffrath from the [Kiel/DVA archive](#) and other sources

[esac-data.org](#)

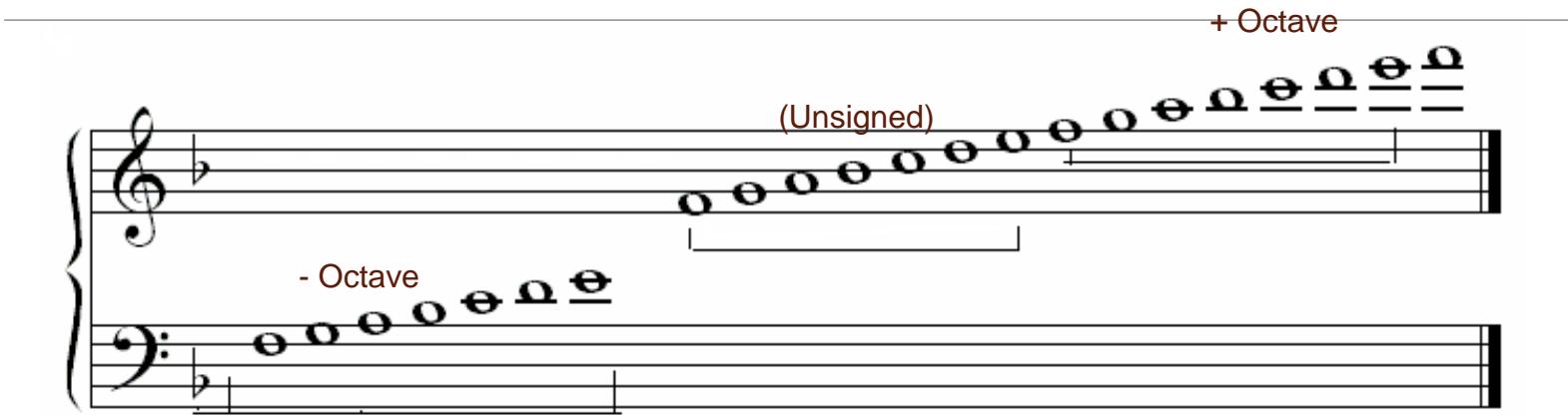
Often transcribed by hand



*Above:* H. Schaffrath,  
*L:* Ewa Dahlig

Reflected widely used 19<sup>th</sup> century typescript encoding foundation

# Essen Associative Code (EsAC)



## Music rep. in general

- **Pitch** name
- Pitch inflection
- Octave name or number

## EsAC specifics

- **Pitch** = number
- Inflection = symbol
- Octave = symbol

See <http://www.esac-data.org>

# EsAC code vs other codes

Pitch relative to a “tonic”

The image shows a musical score for the first movement of Mozart's Trio K496. The score consists of two staves: treble and bass. Measure 1 starts with a bass note followed by a treble note. Measure 2 starts with a bass note followed by a treble note. The notes are represented by small black squares on the staff lines.

ESAC:	+1 +3	+5 +3 +1_ +5 +3	+2 +1 +6_ +1 +2	+1 7 +3 +2 +5 +4	+2#_ +3_
a JIANPU:	<u>i</u> <u>3</u>	<u>5</u> <u>3</u> <u>i</u> <u>5</u> <u>3</u>	<u>2</u> <u>4</u> <u>6</u> <u>4</u> <u>2</u>	<u>i</u> <u>7</u> <u>3</u> <u>2</u> <u>5</u> <u>4</u>	<u>#2</u> <u>3</u>
b DARMS1:	26E 28E	30E 28E	33Q 30E 28E	..... (etc.)	
c DARMS2:	6E 8E	10E 8E	13Q 10E 8E	..... (etc.)	
d SCORE:	c5/e/m/ ex4/	g/e/c6/g5/e/m/ q/ex4/....	d/f/ a/ f/ d/ m ....	(etc.)	
e MTeX:	\a 5 \a 7 : \a 9 \a 7 \u12 \a 9 \a 7 \u ....		(etc.)		

Duration relative to a stated value

Octave relative to central 8ve

Mozart trio (EsAC with 5 data translations)

<http://esac-data.org/>

<http://kern.humdrum.org/search?s=t&keyword=essen&type=Text>

# Sample EsAC record

F [BALLADE]

CUT [Schloss in Oesterreich  
Es ligt ein schlos in Ostereich,]  
CNR [das ist gar wol erbawet]  
REG [Mitteleuropa, Deutschland]  
SRC [1, S. 250]

1549 gedruckt in Nuernberg]

KEY [Q0024A 08 F FREI]

MEL [1\_ 1\_2\_3\_4\_ 5\_3\_1\_0\_

1\_ 3\_4\_5\_1\_ 1\_-7-6-7\_1\_-6\_ -5\_0\_

5\_ 5\_5\_6\_.56\_ 5\_4\_3\_0\_

6\_ 5\_2\_3\_1\_ -7\_1\_2\_3\_ 212\_ 1\_ //] >>

FCT [Ballade, Gefangenschaft, Hinrichtung, Tod, Vergeltung]

CMT [Kleinere Melodievarianten aus anderen Quellen abgedruckt.

Refrainartiges Anhaengsel an der letzten Zeile.]

Schloss in Oesterreich Es ligt ein schlos in Ostereich,



# EsAC: Essen Folksong Collection

Monophonic music (8500 songs)

## Purposes

- Archiving
- Comparing versions
- Teaching
- Sound output

## Contributions

- Earliest model of analysis  
**(Leppig, 1987)**

## Code-recode comparison

R: nearest matches for  
Mozart trio



Analytical recoding

Pitch and duration uncoupled

Mozart

First lines Mozart

B0397

E0699A

# Plaine & Easie (P&E)

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- Designed in 1967 for music-indexing
- Most widely used in the RISM database of music manuscripts
  - 60+ countries
  - 2.3 million entries (c1.4 million currently online)
  - Most fields (of 112) bibliographical; one music field for encoded incipits
  - Original purpose: to attribute anonymous manuscripts

Website: <https://rism.info/>

# Advanced search



All Fields Beethoven Fifth Symphony

and Title Title

and Composer Composer

and Incipit beginning via piano keyboard (with transposition) Incipit beginning via piano keyboard (with transposition)

and Previous Searches

Clear Search

Keyboard and staff icons

5 result(s)

Select titles:  
all none

1. Beethoven, Ludwig van <1770-1827>  
Symphonies (Excerpts) - D minor; LvBWV op.125, ; KinB 125;  
Manuscript copy; D-RUI Sa 118

2. Beethoven, Ludwig van <1770-1827>  
Symphonies (Fragments) - C minor; LvBWV op.67, ; KinB 67;  
Autograph manuscript; D-B Mus.ms.autogr. Beethoven, L. v.,  
Mendelssohn-Stiftung 20

3. Beethoven, Ludwig van <1770-1827>  
Symphonies - C minor; LvBWV op.67, ; KinB 67; Autograph  
manuscript; D-B Mus.ms.autogr. Beethoven, L. v., Mendelssohn-  
Stiftung 8

[View Online ▾](#)[View Online ▾](#)

## Simple search

Beethoven, Ludwig van: Sinfonien; orch; c-Moll; op.67 , 1807

Text [Scanseite] - Druckseite Blättern Zoom

A detailed image of a handwritten musical manuscript page. The page is filled with dense musical notation on multiple staves. The notation includes various note heads, stems, and rests. There are several large, expressive ink marks and annotations, including a prominent 'con 96' at the top left. The paper has a aged, yellowish tint.

# Plaine & Easie Code

Monophonic

Industrial strength (interfaces with MARC et al.)



```
@clef:C-4  
@keysig:xFc  
@timesig:c/  
@data:{8.A6A}'/4.Dt8D4.Ct8D/{8.E6C},8(A)'E4DtE/{8.Ft3GE}8(D)-2-/
```



```
@clef:F-4  
@keysig:xF  
@timesig:c  
@data:qq,3{DnF'D}r/2Fqq,3{DnF'D}r2Aqq3,{DF'D}r/b1B,qq3{EG'C}r/1A//
```

Manual: <https://www.iaml.info/plaine-easie-code>

# *MuseData* : overview

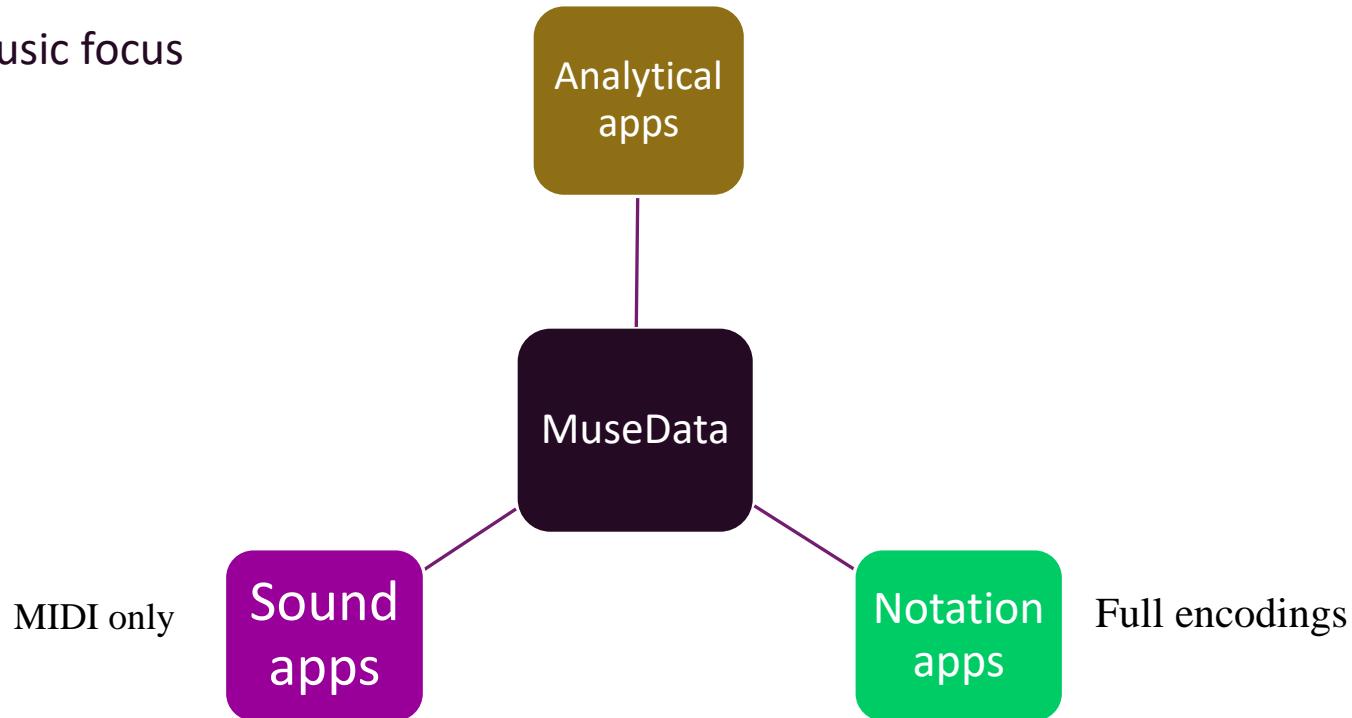
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- Developed by Walter Hewlett (from 1982)
- Served by CCARH
- Many implementations, extensions, refinements by Craig Sapp
- Largest verified dataset online

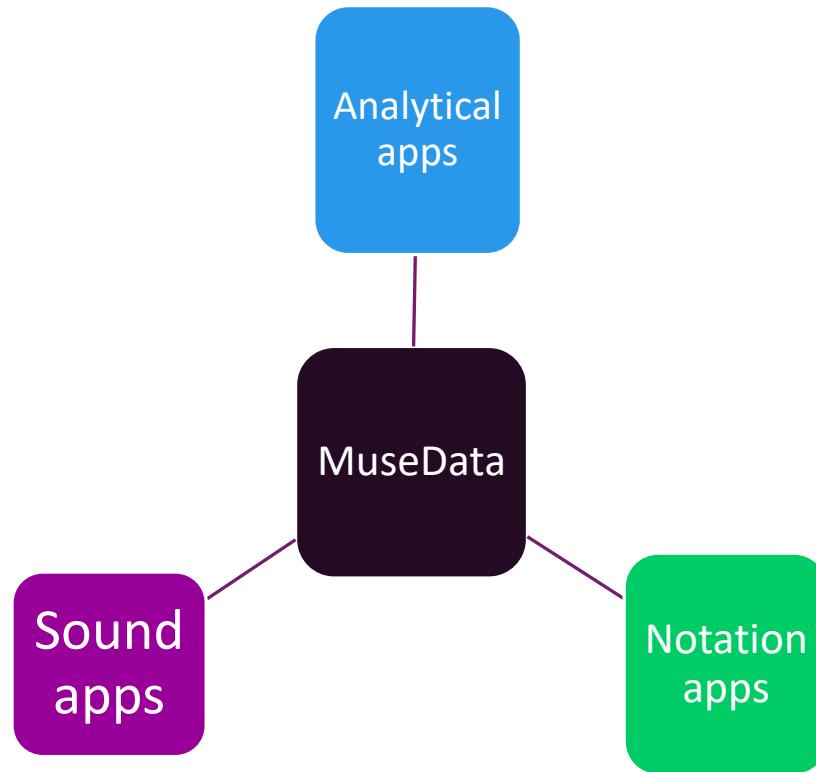
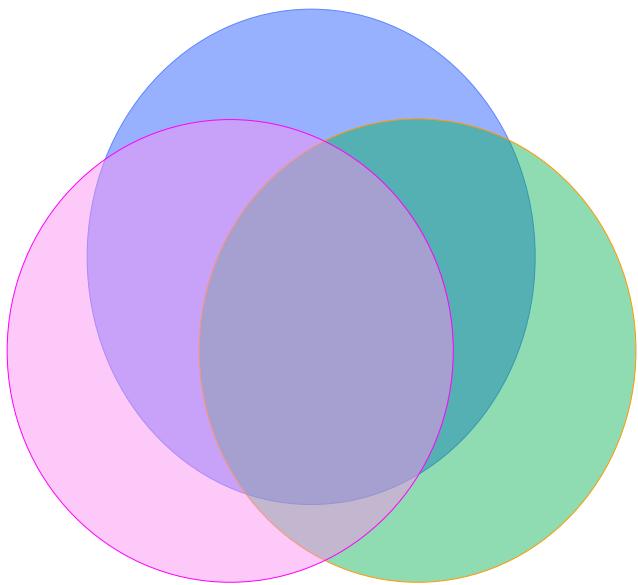
# *MuseData's* “solar” network models

Classical music focus



# Comparison of models

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# Part/score orientation in MuseData

1. Encode voice by voice for full movement
2. Add lyrics, other refinements
3. Repeat until all movements are encode
4. Assemble score

The image displays two staves of a musical score. The top staff shows five voices: clarinet in A, violin I, violin II, viola, and violoncello. The bottom staff shows four voices: piano (represented by a piano icon) and three string parts (violin I, violin II, and cello). The piano part includes dynamic markings such as *p*, *pianissimo*, and *pianississimo*. The staves are enclosed in a light purple rectangular frame.

# MuseData: encoding

## Two-step process

- MIDI-level data
- Non-sounding data

## Serial processes

## Storage formats

- Stage 1 (pitch, duration)
- Stage 2 (stems, lyrics, etc)
- Internal format (notation)

The screenshot shows a page from the MuseData website with a light beige background. At the top right are navigation links: "About MuseData", "Sources", "Repertoires", "Data Formats [ MuseData | Humdrum | MIDI1 | MIDI+ ]", "Works and Title Numbers", and "Legal Considerations". Below these are search fields for "Search:" and "Printable Scores/Parts | MIDI1 files for listening". A table lists the number of encoded compositions, movements, and PDF files for works by Bach, Beethoven, Corelli, Dvorák, Handel, Haydn, Marcello, Mozart, Rovetta, Telemann, and Vivaldi.

<i>composer's name</i>	<i>number of encoded compositions</i>	<i>movements (approx.)</i>	<i>PDF files (by work)</i>
Johann Sebastian Bach	417	1534	51 (418 pages)
Ludwig van Beethoven	10	58	9 (1339 pages)
Arcangelo Corelli	72	363	0
Antonín Dvořák	1	0	0
George Frederick Handel	80	904	0
Franz Josef Haydn	87	352	12 (693 pages)
Benedetto Marcello	1	3	0
Wolfgang Amadeus Mozart	47	171	0
Giovanni Rovetta	1	9	0
Georg Philipp Telemann	109	553	0
Antonio Vivaldi	56	168	12

# Encoding in multiple domains: Actualities



## Work Information

Composer	Haydn, Franz Joseph
Title	Symphony in E-flat Major
Popular Title	Drumroll
Scholarly catalog num.	H I:103
Copyright notice	Copyright (c) 1994, 2000 Center for Computer Assist
Copyright message	Rights to all derivative editions reserved.
Copyright message	Refer to licensing agreement for further details.
Scholarly catalogue	Thematisch-bibliographisches Werkeverzeichnis (A.
Derived from	Dover Edition; reprint of Eulenburg Edition
Encoding state	stage2
Error reports	None [Submit error report]

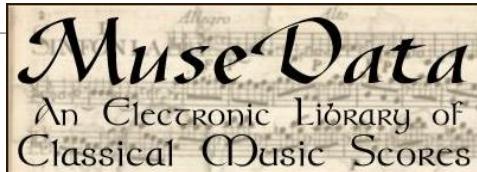
## Musical Data

	kern	MIDI	PDF	SCORE	stage2	parts
Entire work	all	all	all	all	all	
<i>By movement:</i>						
1. Adagio -- Allegro con spirto	01	01	01	01	01	01 02 03 04 05 06 07 08 09 10 11 12 13 13z14 14z15 16 17 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11 s12
2. Andante	02	02	02	02	02	01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11
3. Menuetto and Trio	03	03	03	03	03	01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11
4. Finale	04	04	04	04	04	01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11

A musical score for the 'Adagio' movement of Haydn's Symphony in E-flat Major. The score is for ten instruments: 2 Flauti, Oboe 1, 2, Clarinet 1, 2 in B-flat, Fagotto 1, 2, Corno 1, 2 in E-flat, Tromba 1, 2 in E-flat, Timpani in E-flat, B-flat, Violino I, Violino II, Viola, and Violoncello e Basso. The score shows various dynamics like piano (p), forte (f), and sforzando (sf). The violoncello part includes a basso continuo line with a cello and a harpsichord. The score is in common time and has a key signature of one flat.

[musedata.org](http://musedata.org)

# Encoding in multiple domains: samples



From PDF list

Haydn, Franz Joseph	<a href="#">Symphony in E-flat Major, H I:99</a> <a href="#">Symphony in G Major ("Military"), H I:100</a> <a href="#">Symphony in D Major ("The Clock"), H I:101</a> <a href="#">Symphony in B-flat Major, H I:102</a> <a href="#">Symphony in E-flat Major ("Drumroll"), H I:103</a>
Vivaldi, Antonio	<a href="#">Concerto in E Major ("La Primavera"), Op. 8, No. 1</a> <a href="#">Concerto in G Minor ("L'Estate"), Op. 8, No. 2</a> <a href="#">Concerto in F Major ("L'Autunno"), Op. 8, No. 3</a> <a href="#">Concerto in F Minor ("L'Inverno"), Op. 8, No. 4</a> <a href="#">Concerto in E-flat Major ("La Tempesta di Mare"), Op. 8, No. 5</a> <a href="#">Concerto in C Major ("Il Piacere"), Op. 8, No. 6</a> <a href="#">Concerto in D Minor, Op. 8, No. 7</a> <a href="#">Concerto in G Minor, Op. 8, No. 8</a> <a href="#">Concerto in D Minor, Op. 8, No. 9</a> <a href="#">Concerto in B-flat Major ("La Caccia"), Op. 8, No. 10</a> <a href="#">Concerto in D Major, Op. 8, No. 11</a> <a href="#">Concerto in C Major, Op. 8, No. 12</a>

From MIDI file list

Beethoven, Ludwig van	<a href="#">Piano Concerto No. 2 in B-flat Major, Op. 19</a> <a href="#">Violin Concerto in D Major, Op. 61</a> <a href="#">Symphony No. 5 in C Minor, Op. 67</a>
Haydn, Franz Joseph	<a href="#">Symphony in D Major, H I:1</a> <a href="#">String Quartet in C Major, H III:57</a> <a href="#">Symphony in E-flat Major, H I:99</a> <a href="#">Symphony in G Major ("Military"), H I:100</a> <a href="#">Symphony in D Major ("The Clock"), H I:101</a> <a href="#">Symphony in B-flat Major, H I:102</a> <a href="#">Symphony in E-flat Major ("Drumroll"), H I:103</a> <a href="#">Symphony in D Major ("London"), H I:104</a>

## Work Information

Composer	Haydn, Franz Joseph
Title	Symphony in E-flat Major
Popular Title	Drumroll
Scholarly catalog num.	H I:103
Copyright notice	Copyright (c) 1994, 2000 Center for Computer Assisted Research in the Humanities
Copyright message	Rights to all derivative editions reserved.
Copyright message	Refer to licensing agreement for further details
Scholarly catalogue	Thematisch-bibliographisches Werkeverzeichnis (A. van Hoboken)
Derived from	Dover Edition, reprint of Eulerburg Edition
Encoding state	stage2
Error reports	None [Submit error report]
<b>Musical Data</b>	
Entire work	<b>kern</b> <b>MIDI</b> <b>PDF</b> <b>SCORE</b> <b>stage2</b> <b>parts</b>
By movement:	all   all   all   all   all   all
1. Adagio -- Allegro con spirto	01   01   01   01   01 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11 s12
2. Andante	02   02   02   02   02 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11
3. Menuetto and Trio	03   03   03   03   03 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11
4. Finale	04   04   04   04   04 s01 s02 s03 s04 s05 s06 s07 s08 s09 s10 s11

# MuseData uses

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- Performing editions
- Study scores (see Dover Publications)
- Experimental psychology (Krumhansl, Palmer)
- Data modeling (MusicXML)
- Data interchange
- Source comparison (musicology)

# Corelli Sonata Op. 5, No. 1

(comparative performance)

The image shows a musical score for Corelli's Sonata Op. 5, No. 1, presented in five staves. A vertical brace groups the first four staves, while the fifth staff stands alone below it.

- Corelli 1700:** The top staff, written in common time with a key signature of two sharps. It features a single melodic line with eighth-note patterns and a sixteenth-note grace note.
- Manchester MS 1:** The second staff from the top, also in common time with two sharps. It includes trill markings (tr) over several notes and uses red ink for some of the notes and markings.
- Geminiani:** The third staff from the top, in common time with two sharps. It shows a more complex melodic line with sixteenth-note figures and grace notes.
- Manchester MS 2:** The fourth staff from the top, in common time with two sharps. It features green ink for many of the notes and markings, particularly in the first half of the measure.
- Corelli 1700:** The bottom staff, written in common time with one sharp. It consists of a bass line with quarter notes and rests.

# Handel's Messiah

Halleluia chorus



A modern musical score for the Halleluia chorus from Handel's Messiah. The score consists of six staves, each with a different clef (G-clef, F-clef, C-clef, bass F-clef, bass G-clef, and bass F-clef). The music begins with a series of rests, followed by a vocal entry on the first staff. The lyrics "and He shall reign for ever and ever" are repeated three times across the staves. The music concludes with a final section of rests. The score is set against a white background with black musical notation.

46

and He shall reign for  
ever and ever, for ever and ever,  
and He shall reign for e - ver and e - ver, for e - ver and e - ver, for  
ver, and He shall reign for e - ver and e - ver, and He shall  
reign, and He shall reign for e - ver, for e - ver and e - ver, for e - ver and e - ver, for

# Vivaldi—*Juditha triumphans*

Notation for *viola d'amore* (retunable)

*JUDITHA*

*Viola d'amore*

*Violin 1*

*Violin 2*

A musical score for four parts: Juditha (retuned viola d'amore), Violin 1, Violin 2, and Juditha (retuned viola d'amore). The score is in common time (indicated by '3'). The key signature is two flats. The Juditha part (retuned viola d'amore) has sustained notes. The Violin 1 and Violin 2 parts provide harmonic support with eighth-note patterns.

1.15 Aria: Quanto magis generosa

A close-up of the musical score for the aria 'Quanto magis generosa'. It shows the Viola d'amore part, which consists of sixteenth-note patterns. The score is in common time (indicated by '3') and has a key signature of two flats.

# *Viola d'amore*

Brentner: part for *viola d'amore* with tuning key



Viol D'amour.

March

Handwritten musical score for Viola d'amore. The title 'Viol D'amour.' is written above the staff. Below it, the word 'March' is written in a stylized script. The music consists of two staves. The top staff uses a treble clef and the bottom staff uses a bass clef. Both staves have a common time signature. The music features various note heads, stems, and rests, typical of a march composition. The score is handwritten on aged paper.

