AugmentedNet

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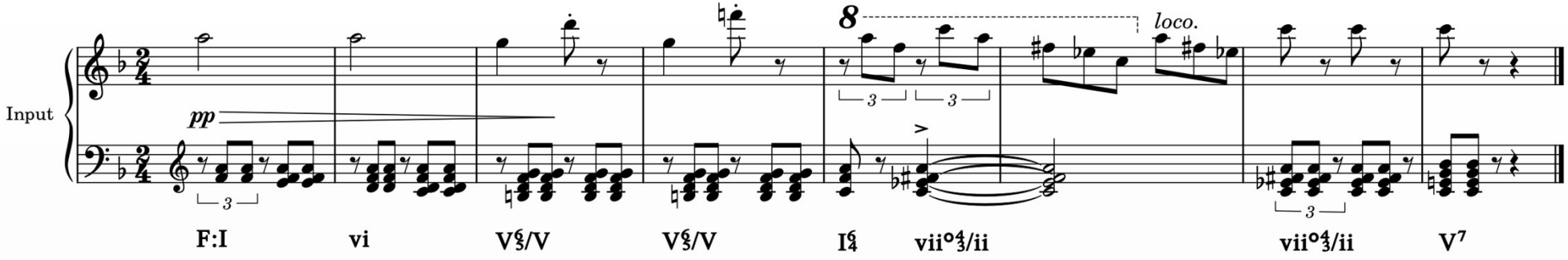
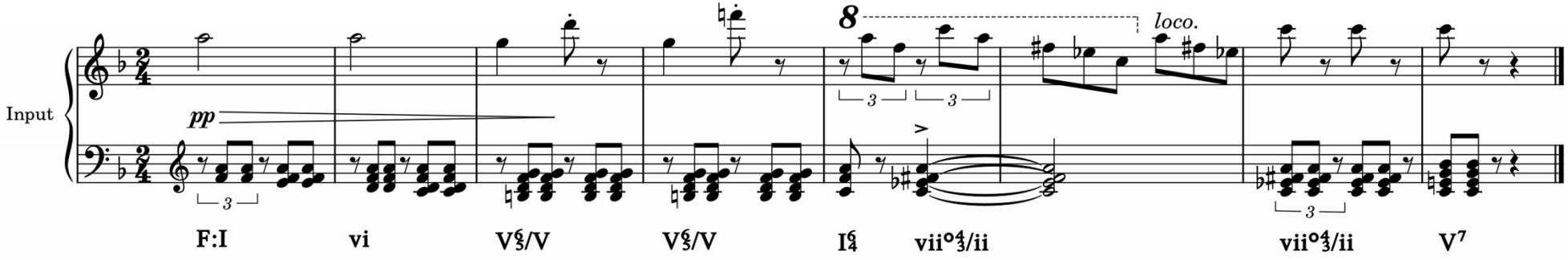
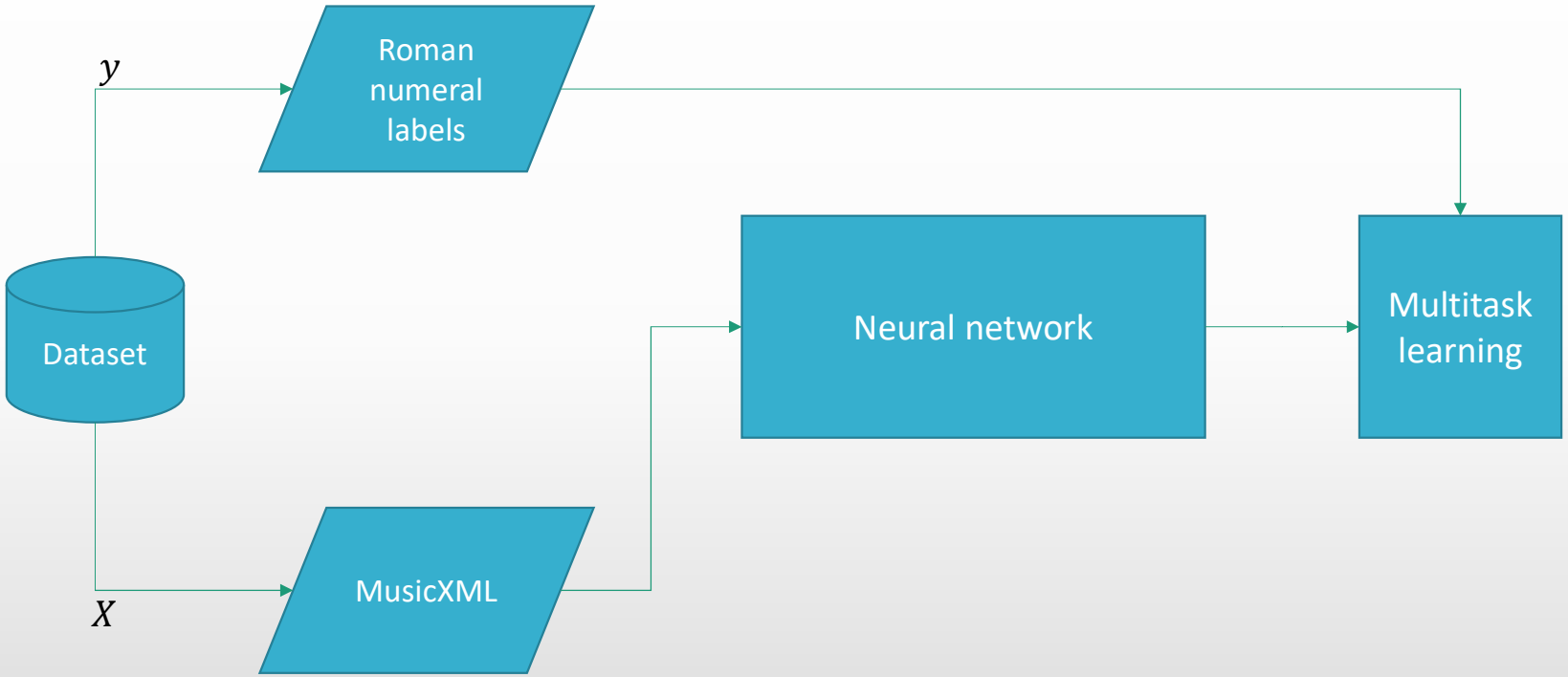
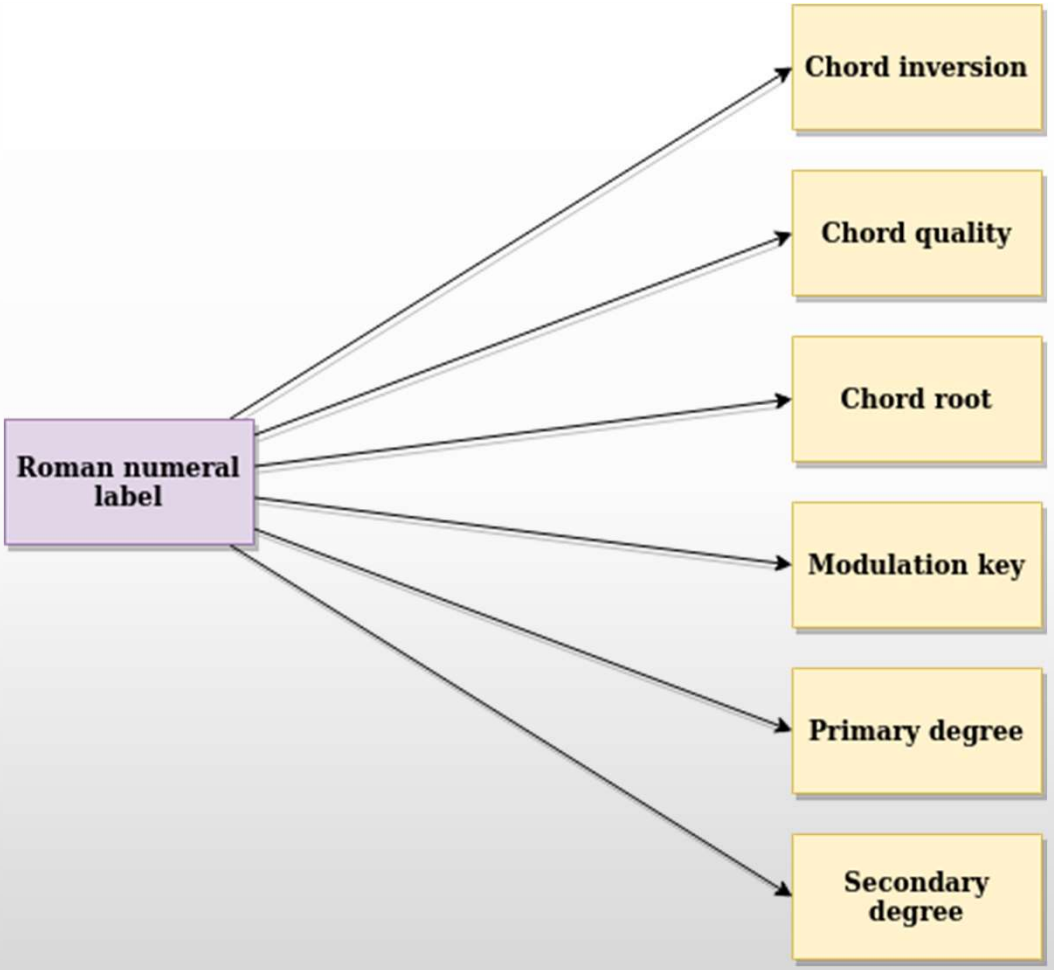

Input
pp
8
loco.
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7


Input
pp
8
loco.
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7


y
Roman numeral labels
Dataset
Neural network
Multitask learning
MusicXML
X

Chen and Su (2018)

- Divided the problem into 6 sub-tasks
- Each task was learned independently
- Then, the tasks were learned simultaneously using *multitask learning*



Multitask learning

- Hard (or soft) parameter sharing
- Figure taken from Ruder (2017)

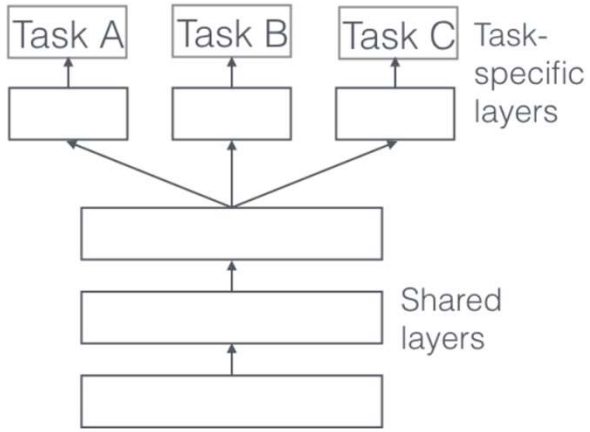
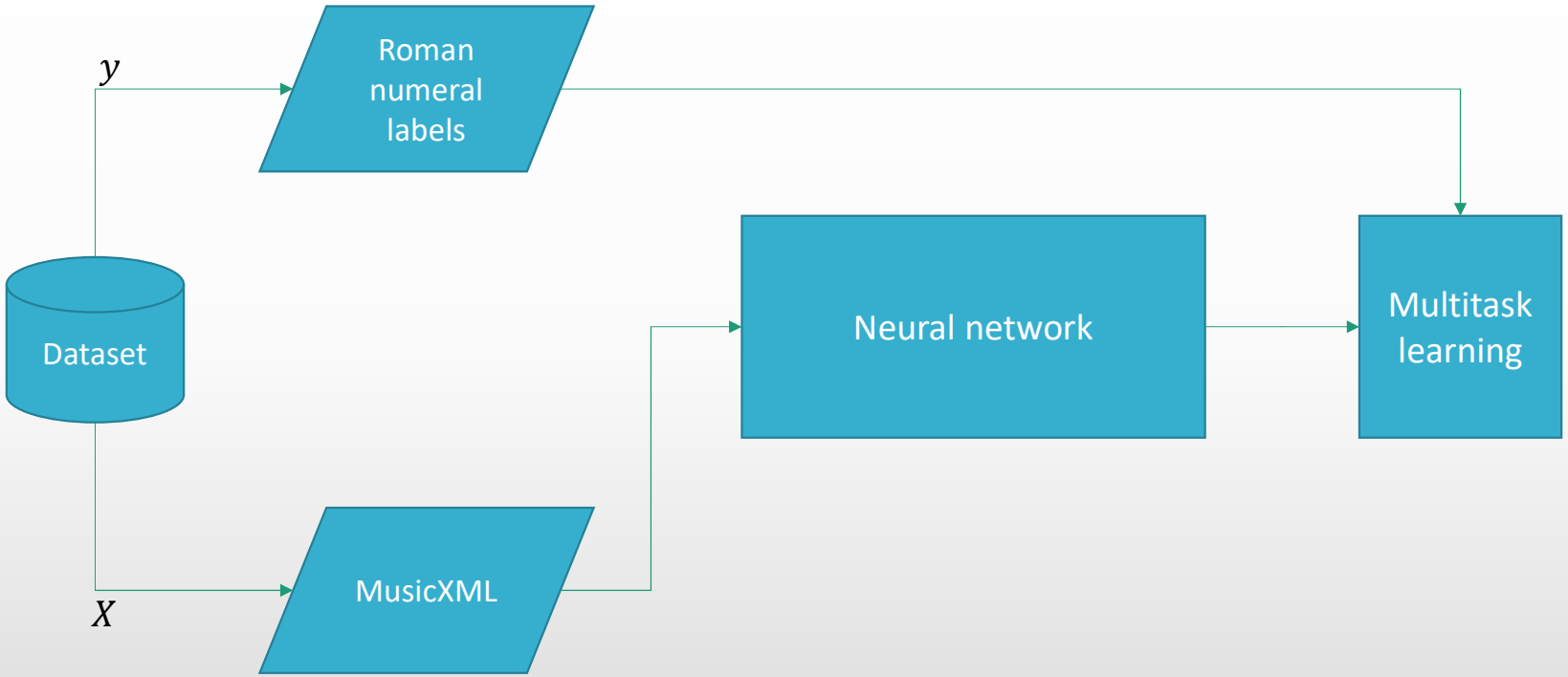
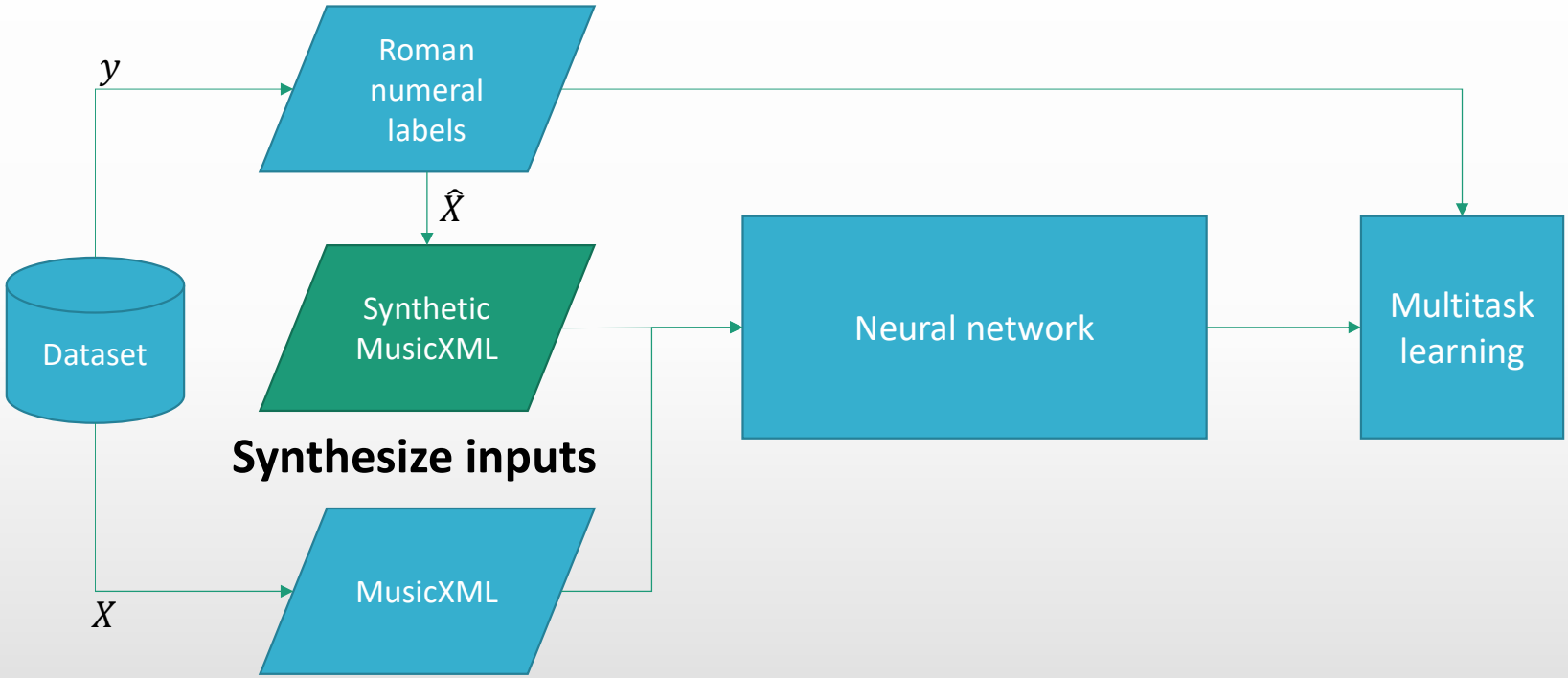
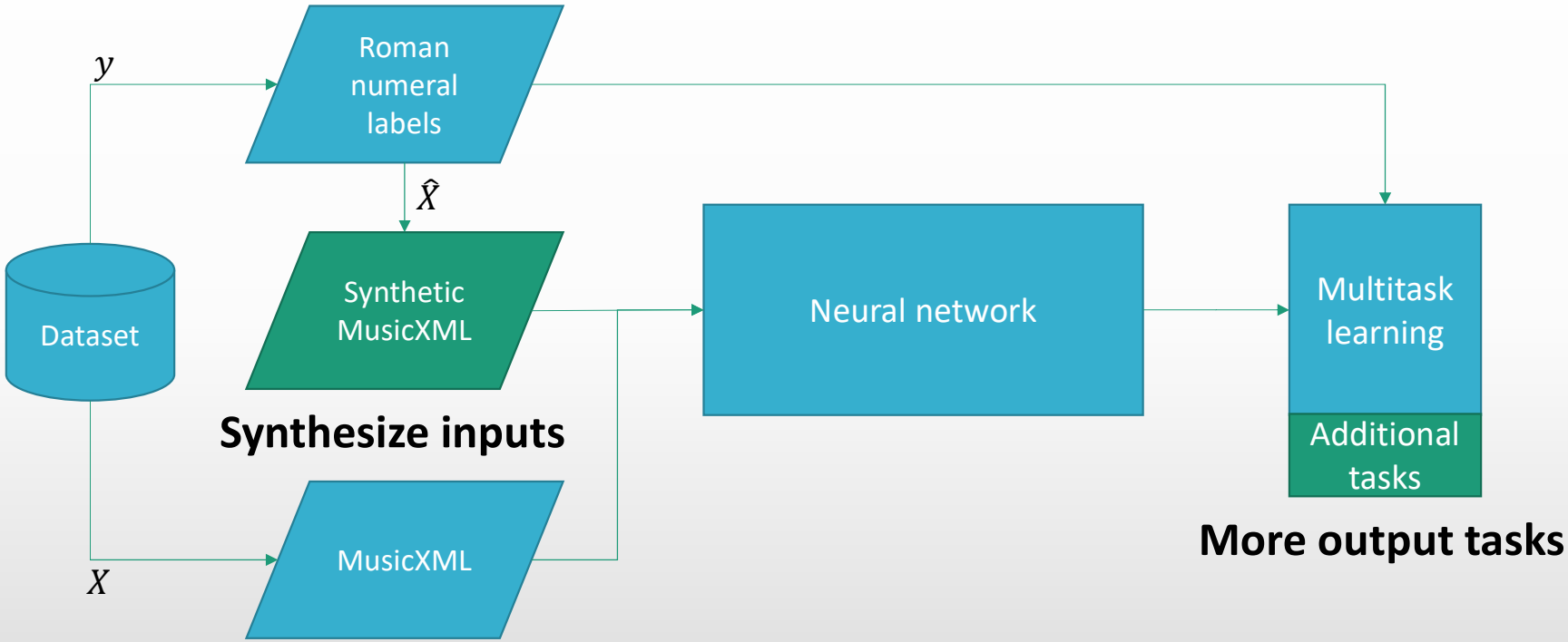


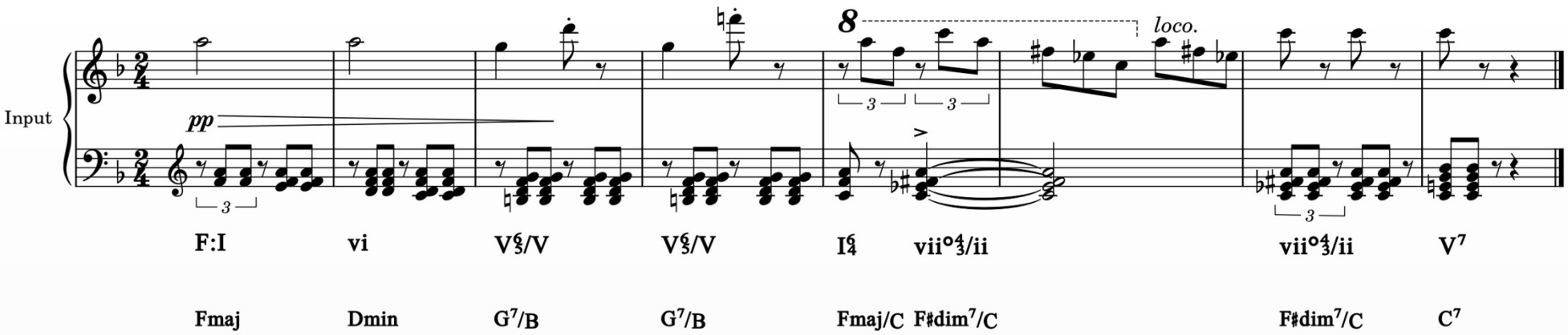
Figure 1: Hard parameter sharing for multi-task learning in deep neural networks


y
Roman numeral labels
Dataset
Neural network
Multitask learning
MusicXML
X

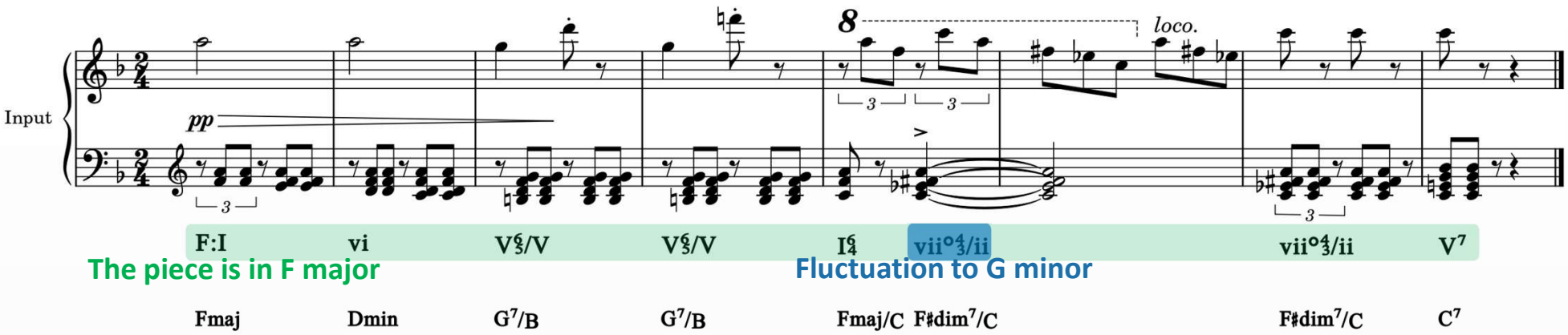

y
Roman numeral labels
$\hat{X}$
Dataset
Synthetic MusicXML
Neural network
Multitask learning
Synthesize inputs
MusicXML
X


y
Roman numeral labels
$\hat{X}$
Dataset
Synthetic MusicXML
Neural network
Multitask learning
Additional tasks
Synthesize inputs
MusicXML
X
More output tasks

NNL1


Input
pp
8
loco.
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7
Fmaj
Dmin
G7/B
G7/B
Fmaj/C
F♯dim7/C
F♯dim7/C
C7

NNL1 Néstor Nápoles López, 2021-10-19



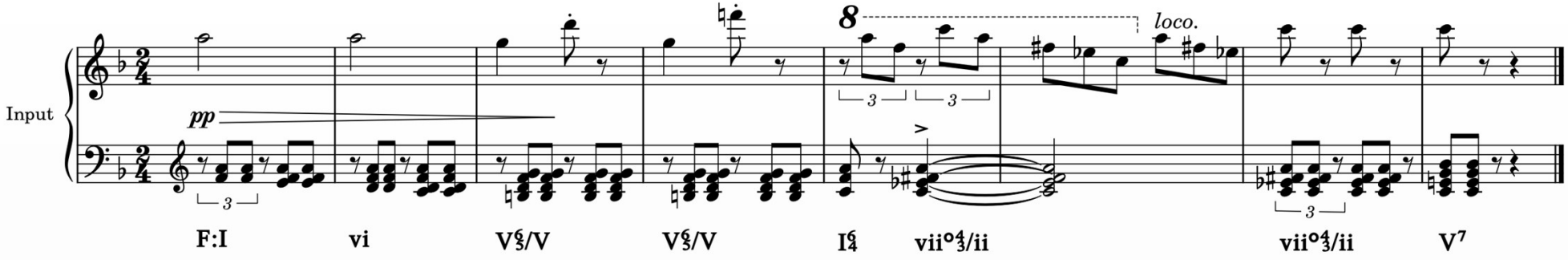
The piece is in F major

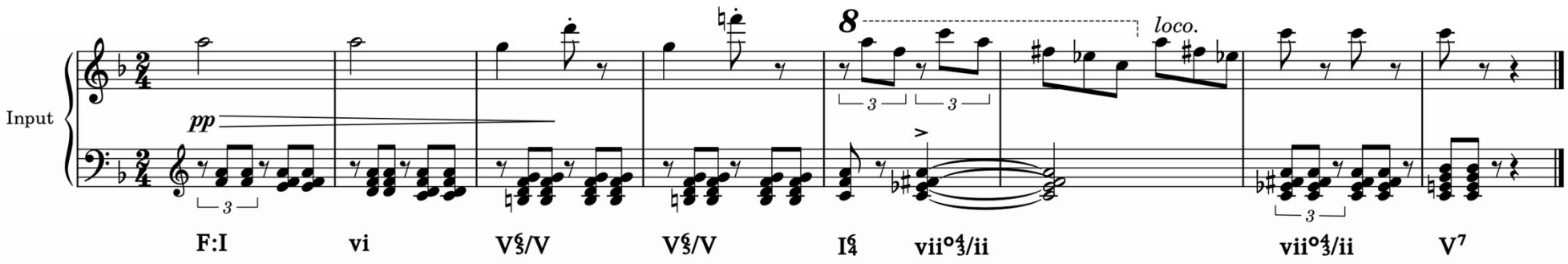
Fluctuation to G minor

Roman numeral analysis

Music theory:
An analytical framework

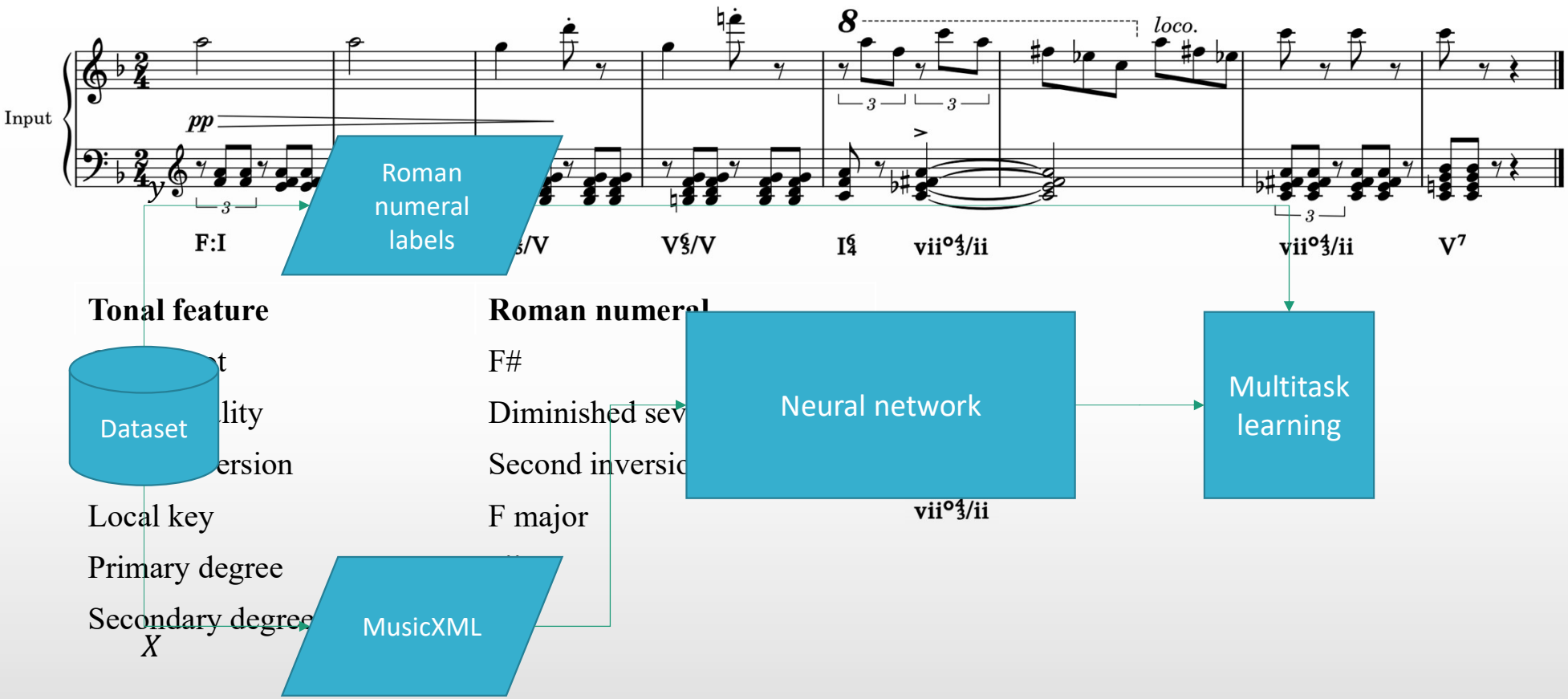
Music Information Retrieval:
A compact annotation system

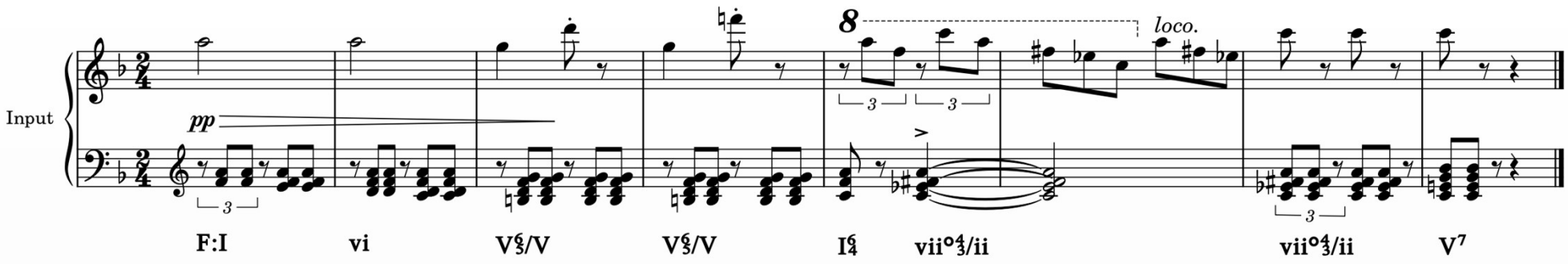

Input
pp
8
loco.
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7



Tonal feature	Roman numeral
Chord root	F#
Chord quality	Diminished seventh
Chord inversion	Second inversion
Local key	F major
Primary degree	vii
Secondary degree	ii

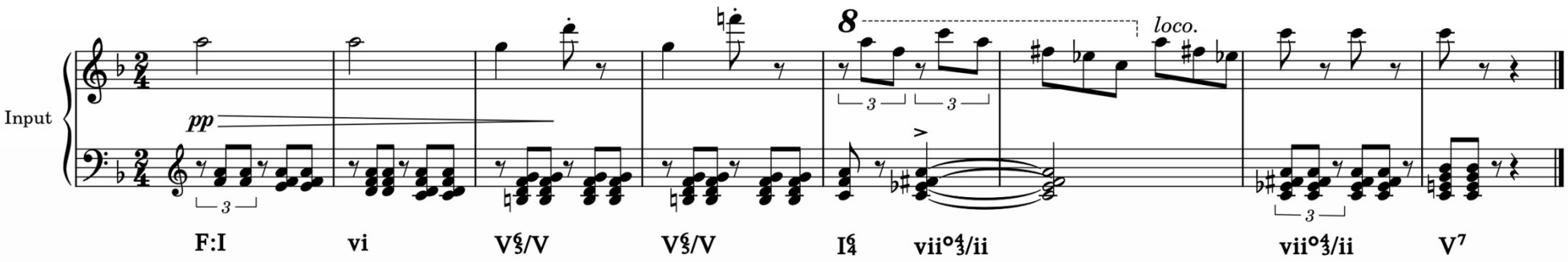
vii°4/ii


Input
pp
loco.
F:I
V6/V
I6
vii°4/ii
vii°4/ii
V7
Roman numeral labels
Tonal feature
Local key
Primary degree
Secondary degree
Roman numeral
F#
F major
vii°4/ii
Dataset
MusicXML
Neural network
Multitask learning



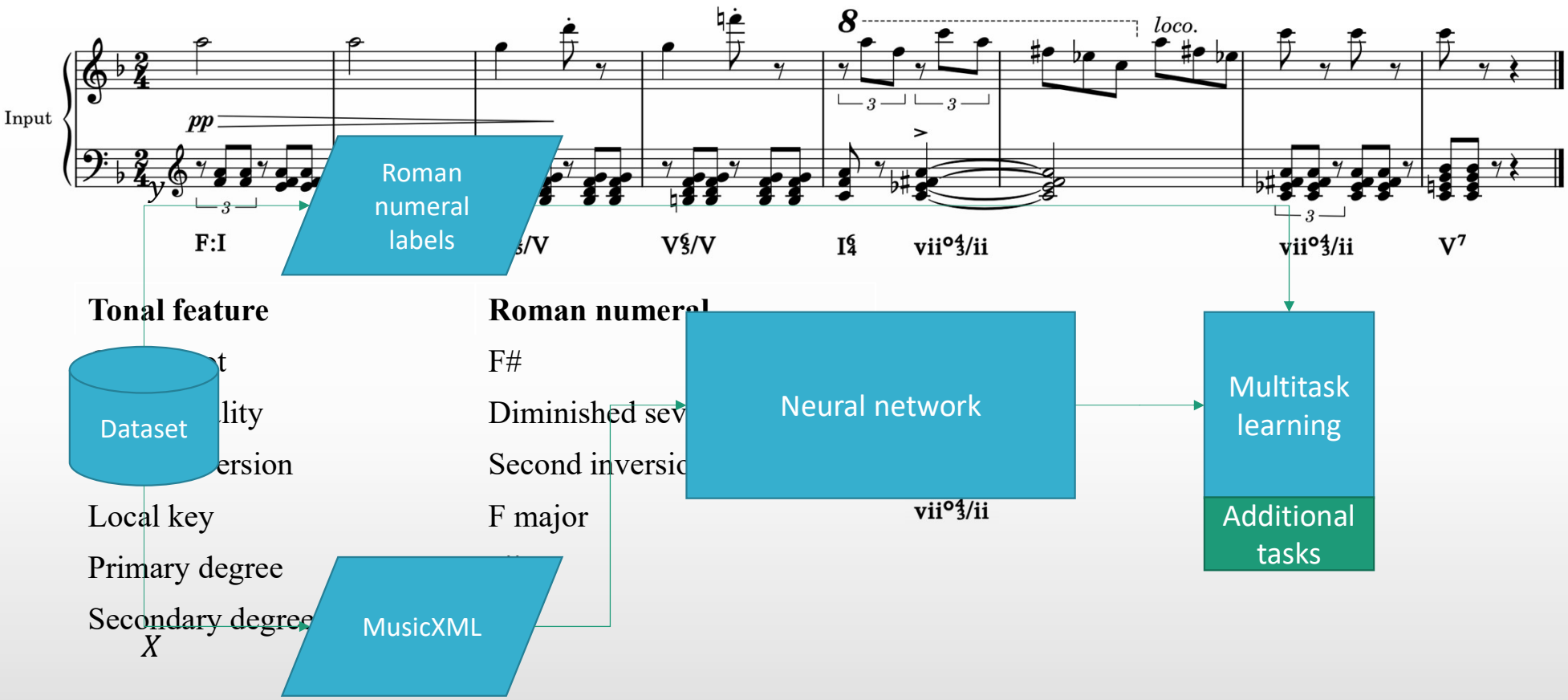
Tonal feature	Roman numeral
Chord root	F#
Chord quality	Diminished seventh
Chord inversion	Second inversion
Local key	F major
Primary degree	vii
Secondary degree	ii

vii°4/ii

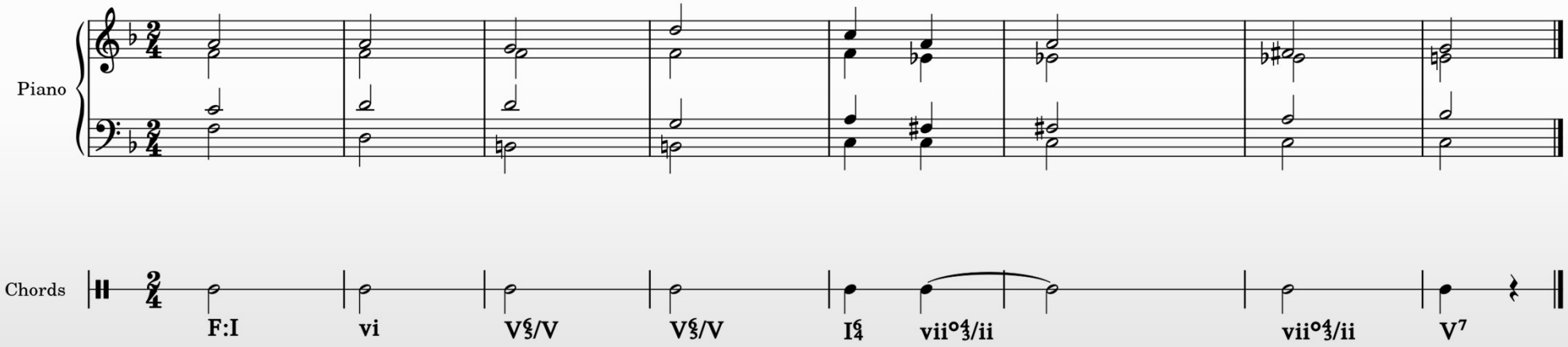


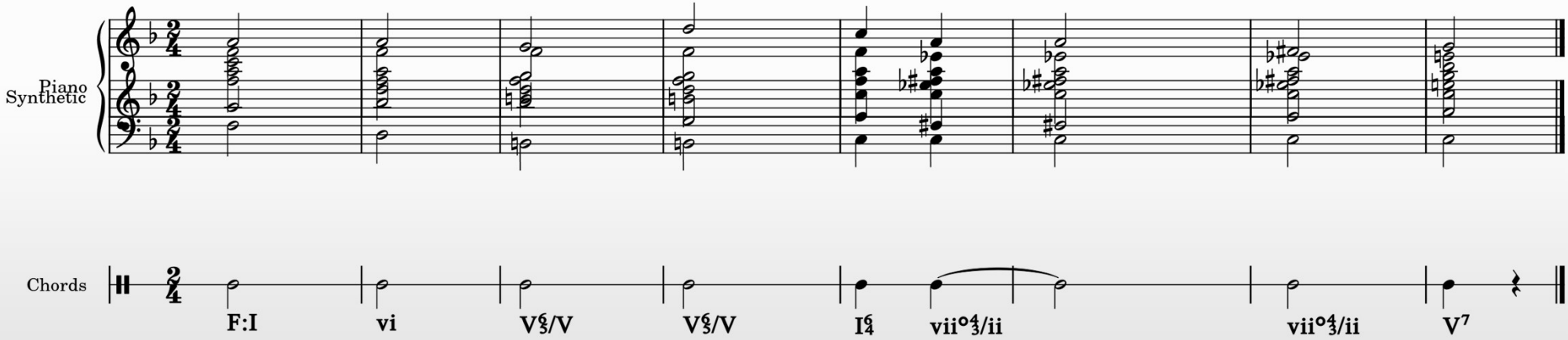
Tonal feature	Roman numeral
Chord root	F#
Chord quality	Diminished seventh
Chord inversion	Second inversion
Local key	F major
Primary degree	vii
Secondary degree	ii
Bass	**C**
Tonicized key	**G minor**
Pitch class set	**{ 0, 3, 6, 9 }**
Roman numeral class (minus inversion)	**vii°/ii**

vii°4/ii

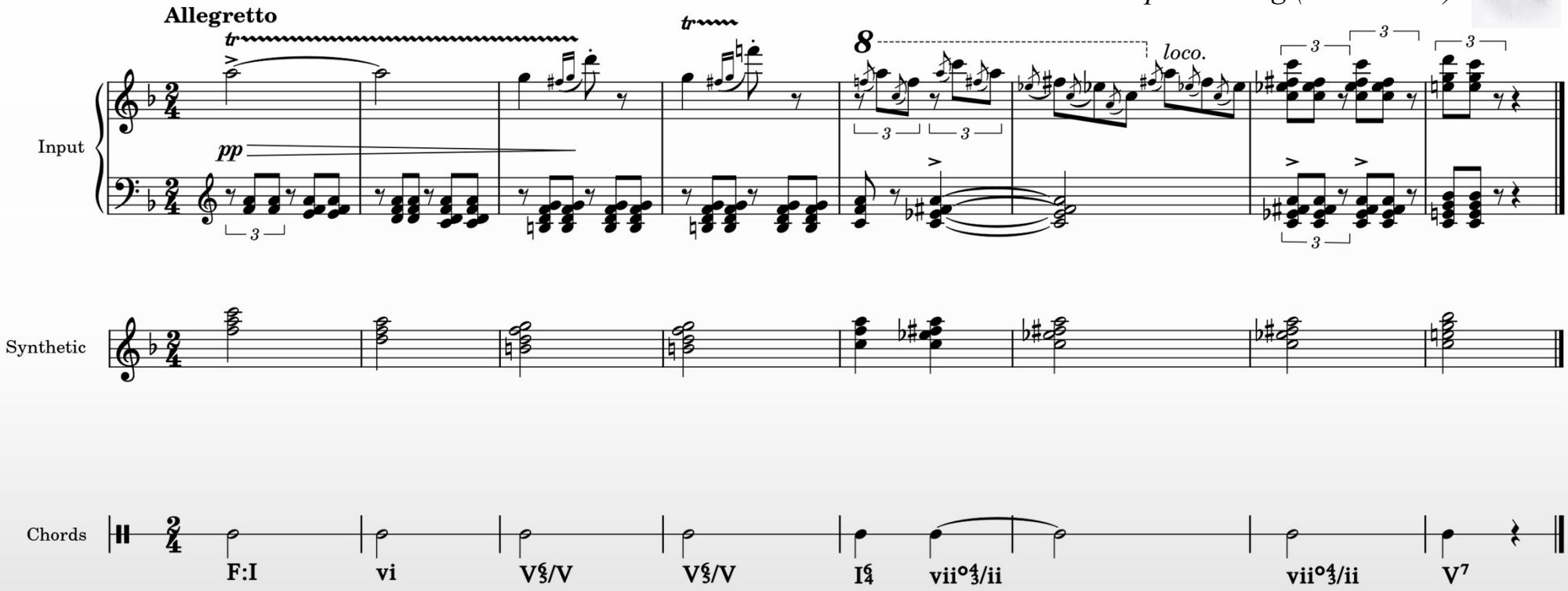

Input
pp
loco.
F:I
V6/V
I6
vii°4/ii
vii°4/ii
V7
Roman numeral labels
Tonal feature
Local key
Primary degree
Secondary degree
X
Roman numeral
F#
F major
vii°4/ii
Dataset
MusicXML
Neural network
Multitask learning
Additional tasks

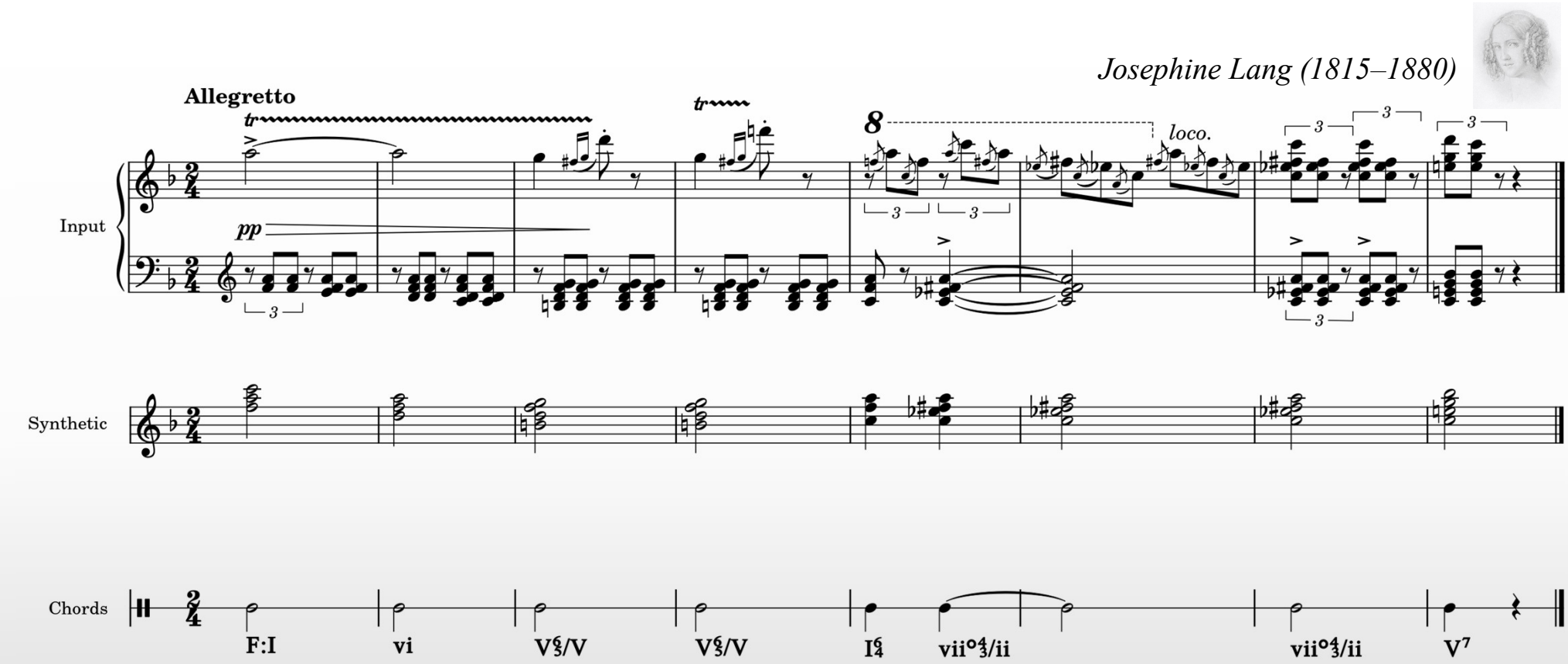

Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7

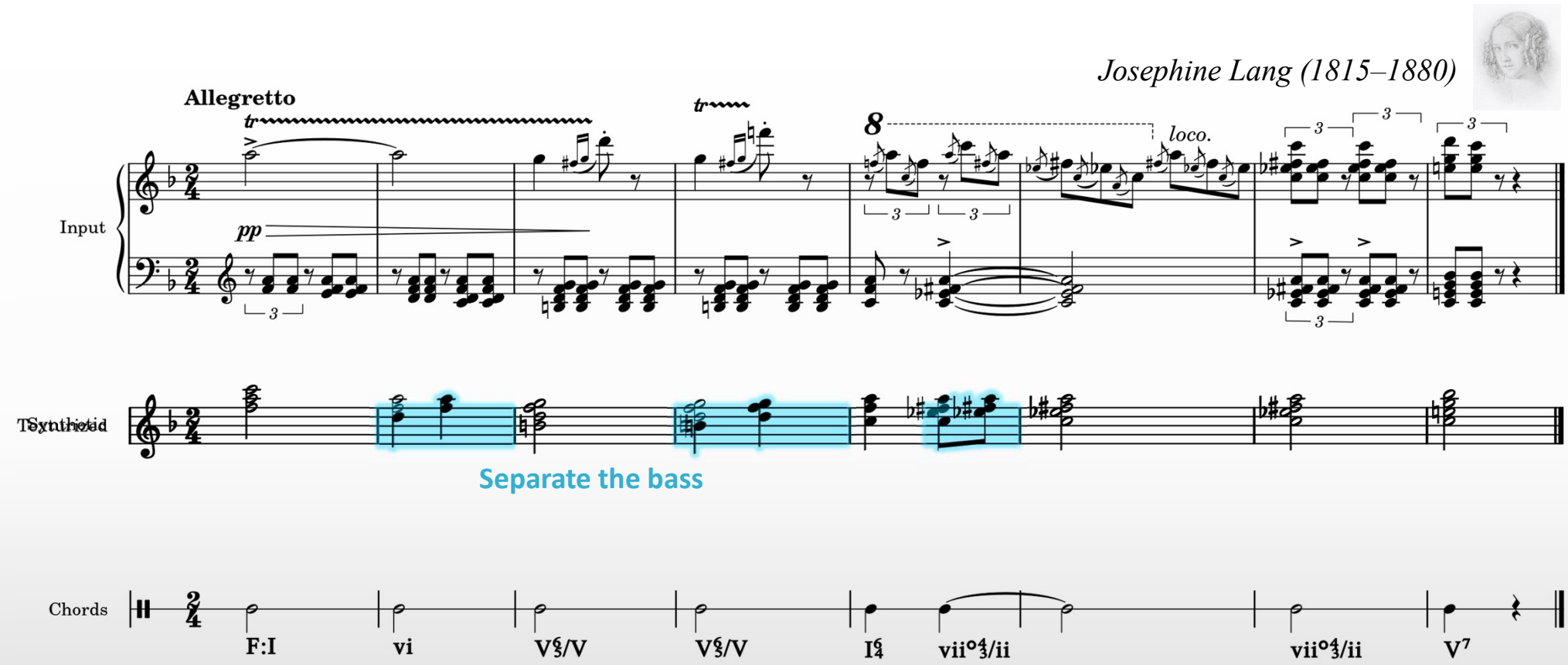

Piano
Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7


Piano
Synthetic
Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7

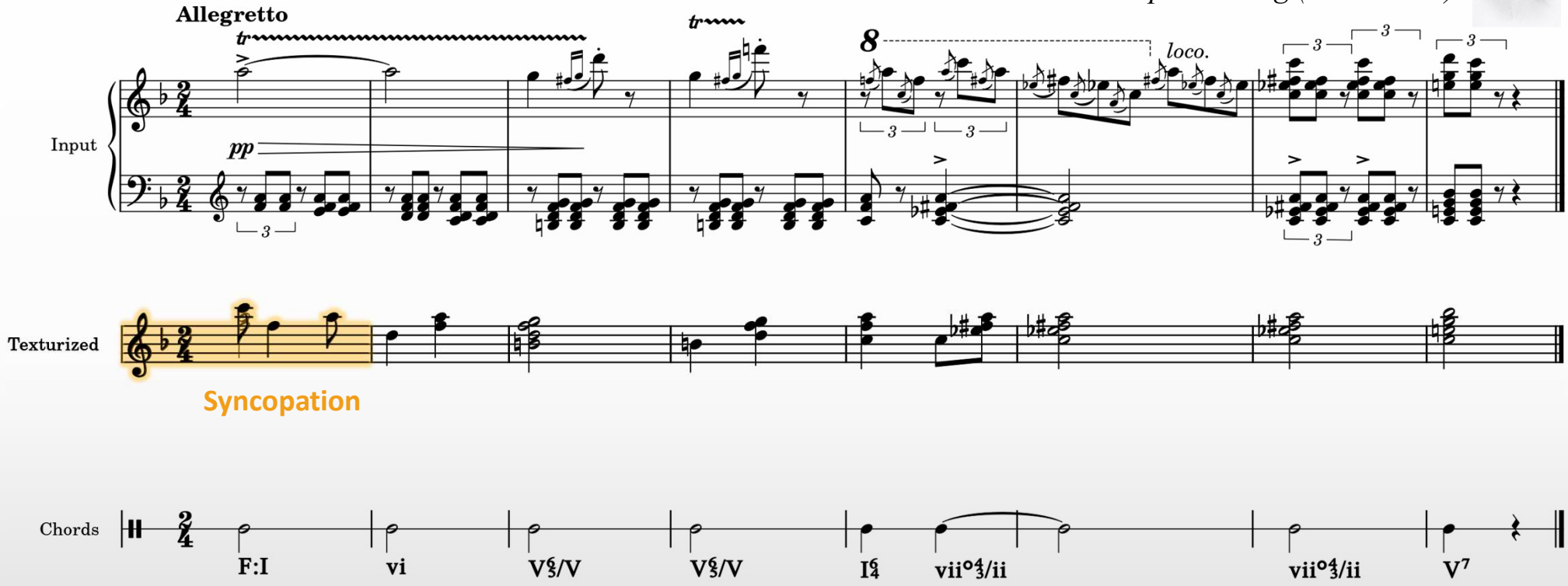
Josephine Lang (1815–1880)



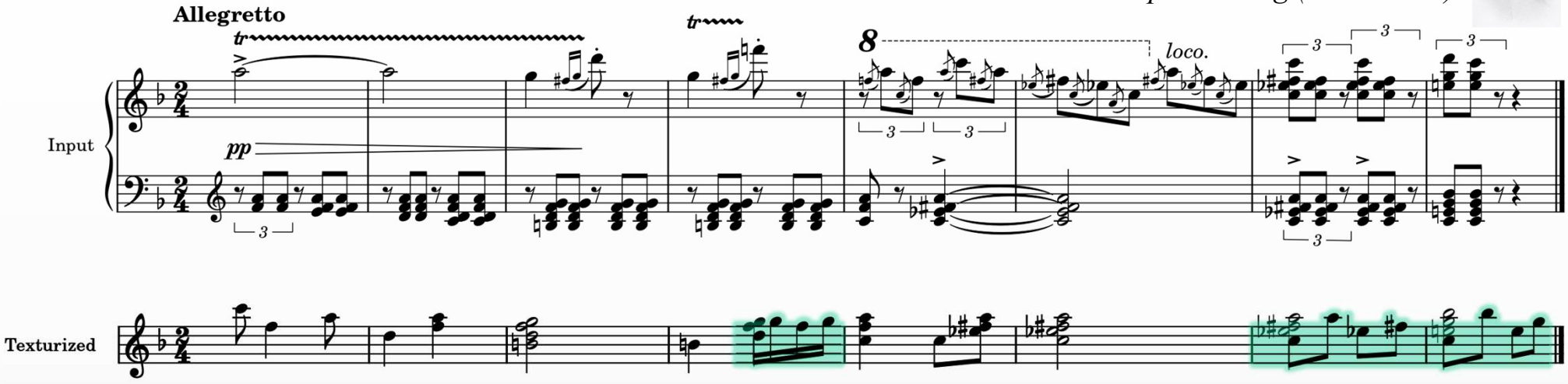

Josephine Lang (1815–1880)
Allegretto
tr
pp
8
loco.
Input
Synthetic
Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7


Josephine Lang (1815–1880)
Allegretto
Input
Synthesized
Separate the bass
Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7

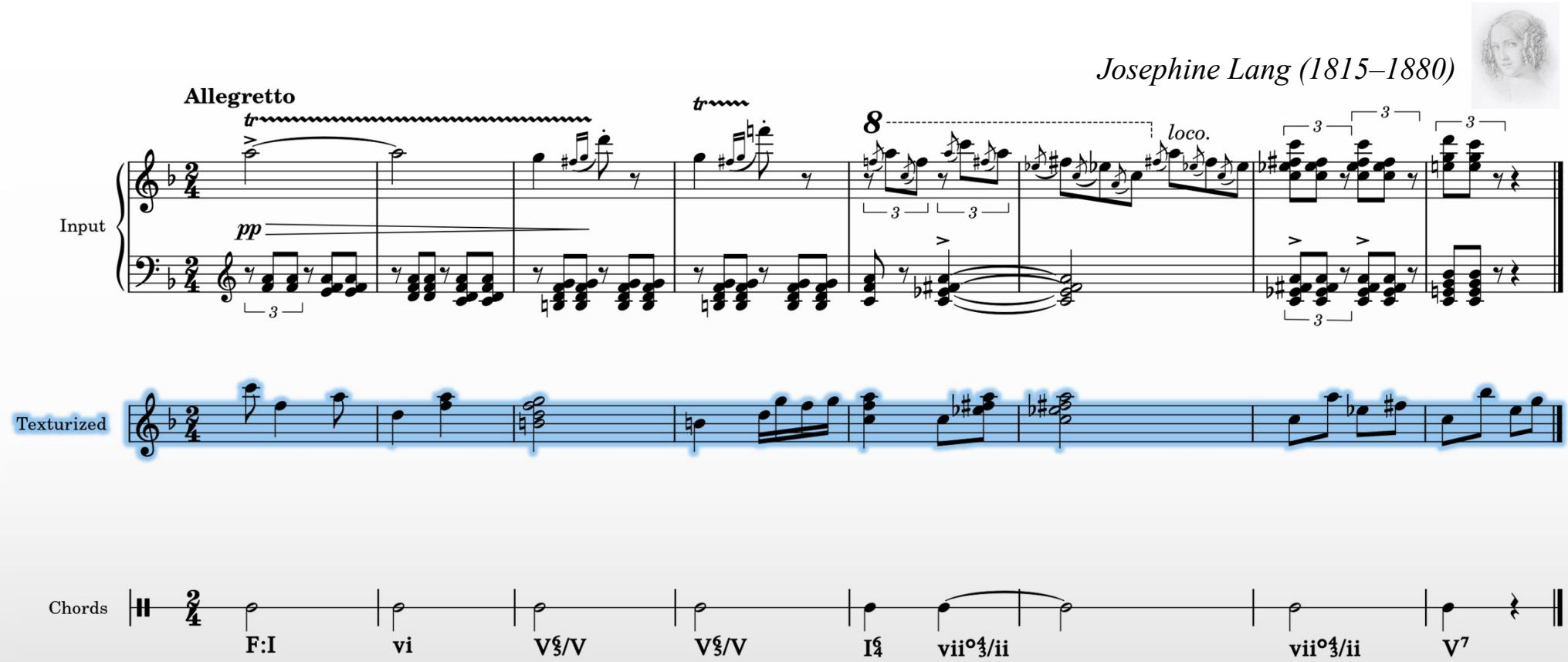
Josephine Lang (1815–1880)

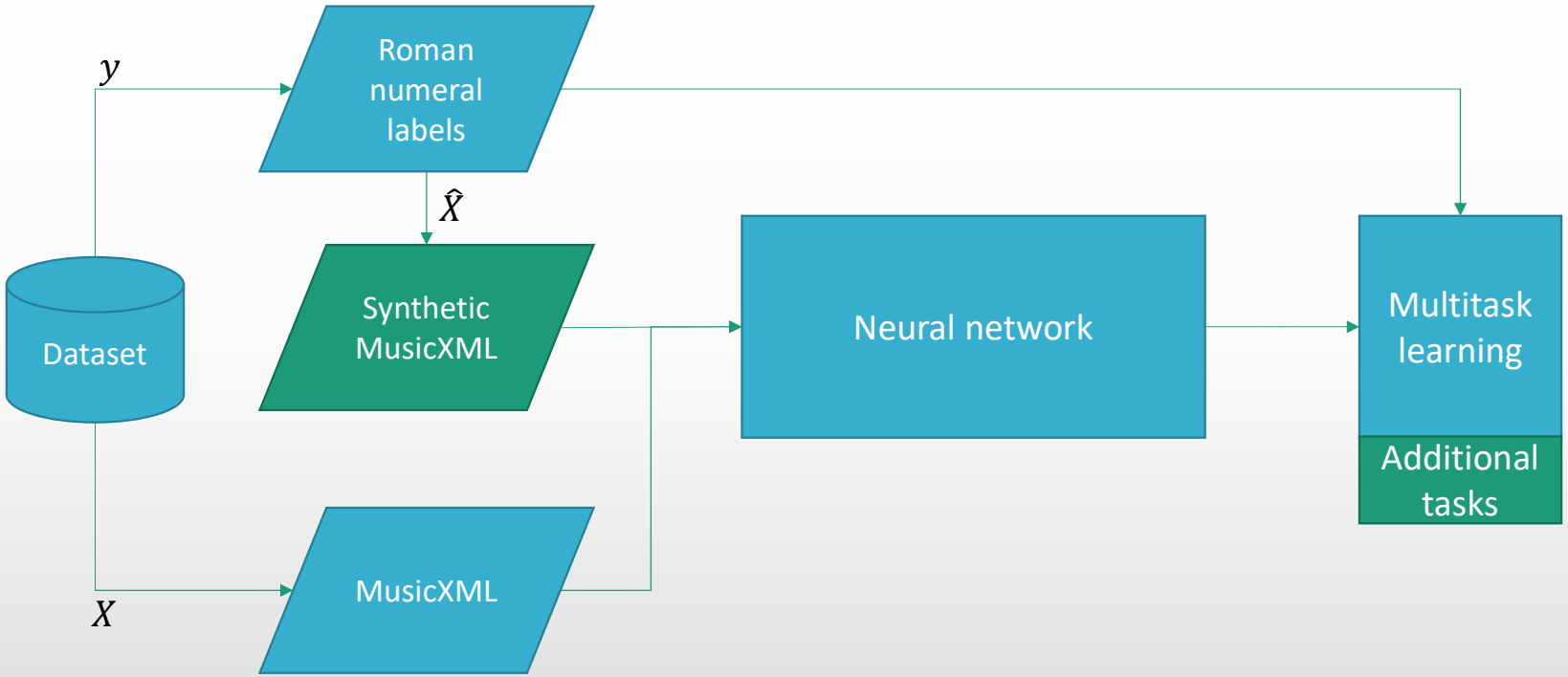


Josephine Lang (1815–1880)



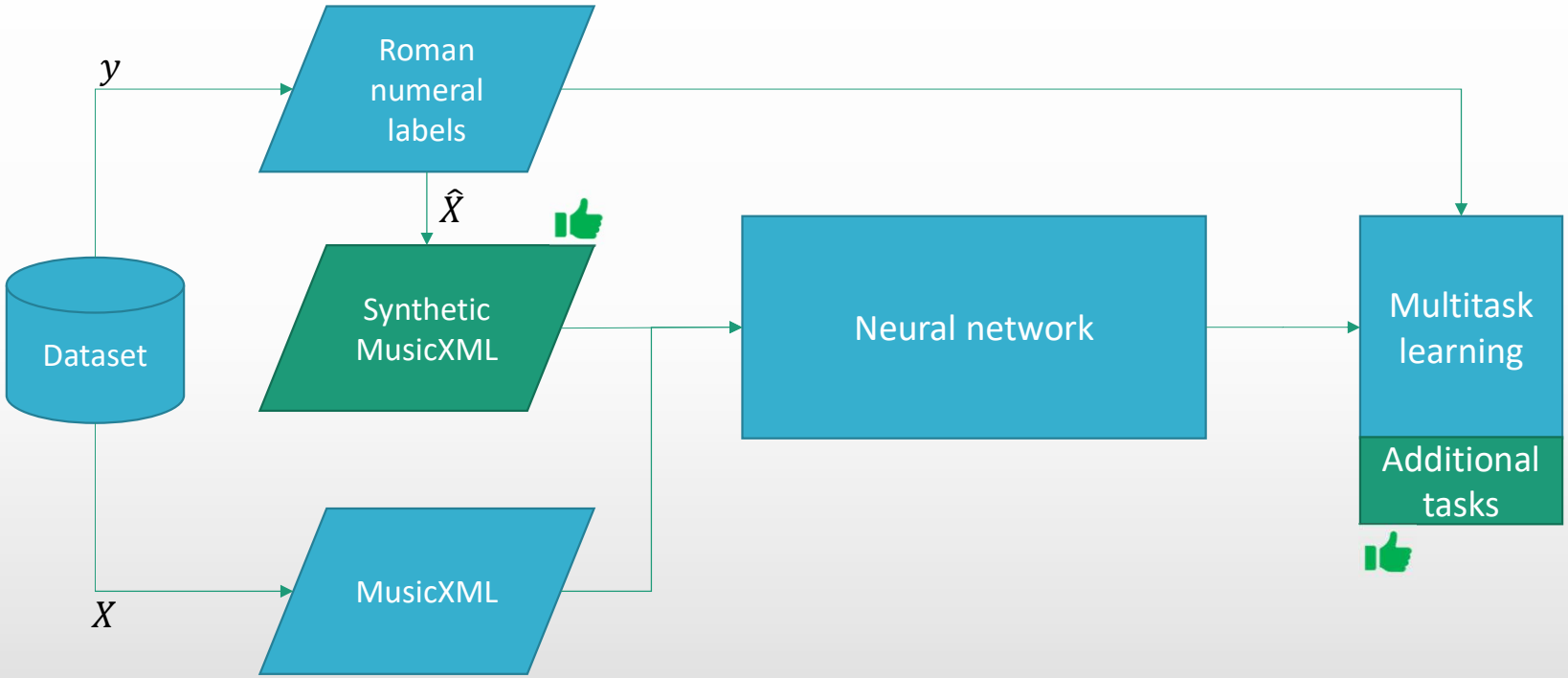
Alberti Bass


Josephine Lang (1815–1880)
Allegretto
Input
loco.
Texturized
Chords
F:I
vi
V6/5/V
V6/5/V
I6/4
vii°4/3/ii
vii°4/3/ii
V7


y
Roman numeral labels
$\hat{X}$
Dataset
Synthetic MusicXML
Neural network
Multitask learning
Additional tasks
MusicXML
X

Datasets

- Annotated Beethoven Corpus (Neuwirth et al., 2018)
- Beethoven Piano Sonatas (Chen and Su, 2018)
- Haydn Sun String Quartets (Nápoles López, 2017)
- TAVERN (Devaney et al., 2015)
- When-in-Rome (Gotham, 2021)
- The Well-Tempered Clavier (Tymoczko et al., 2019)


y
Roman numeral labels
$\hat{X}$
Dataset
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Multitask learning
Additional tasks
MusicXML
X

Model	Key	Degree	Quality	Inversion	Root	Roman Numeral
AugmentedNet$_6$	82.7	64.4	76.6	77.4	82.5	43.3
AugmentedNet$_{6+}$	83.0	65.1	77.5	**78.6**	83.0	44.6
AugmentedNet$_{11}$	81.3	64.2	77.2	76.1	82.9	43.1
AugmentedNet$_{11+}$	**83.7**	**66.0**	**77.6**	77.2	**83.2**	**45.0**

AugmentedNet vs. previous models

Test set	Training set	Model	RN (accuracy)
Well-Tempered Clavier	All available data (2021)	AugmentedNet	**46.2**
Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	AugmentedNet	**42.9**$_{(4.2)}$
Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	Chen and Su (2021)	26.0$_{(1.7)}$
Beethoven Piano Sonatas	All available data (2021)	AugmentedNet	**45.4**
Beethoven Piano Sonatas	All available data (2020)	Micchi et al. (2020)	42.8
Beethoven Piano Sonatas	BPS+WTC	AugmentedNet	**44.1**
Beethoven Piano Sonatas	BPS+WTC	Chen and Su (2021)	41.7
Beethoven Piano Sonatas	BPS	AugmentedNet	**44.0**
Beethoven Piano Sonatas	BPS	Micchi et al. (2020)	39.1
Beethoven Piano Sonatas	BPS	Chen and Su (2019)	-
Beethoven Piano Sonatas	BPS	Chen and Su (2018)	25.7

AugmentedNet vs. previous models

Test set	Training set	Model	RN (accuracy)
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Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	AugmentedNet	**42.9**$_{(4.2)}$
Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	Chen and Su (2021)	26.0$_{(1.7)}$
Beethoven Piano Sonatas	All available data (2021)	AugmentedNet	**45.4**
Beethoven Piano Sonatas	All available data (2020)	Micchi et al. (2020)	42.8
Beethoven Piano Sonatas	BPS+WTC	AugmentedNet	**44.1**
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Beethoven Piano Sonatas	BPS	AugmentedNet	**44.0**
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Beethoven Piano Sonatas	BPS	Chen and Su (2018)	25.7

AugmentedNet vs. previous models

Test set	Training set	Model	RN (accuracy)
Well-Tempered Clavier	All available data (2021)	AugmentedNet	**46.2**
Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	AugmentedNet	**42.9**$_{(4.2)}$
Well-Tempered Clavier$_{\text{crossval}}$	BPS+WTC	Chen and Su (2021)	26.0$_{(1.7)}$
Beethoven Piano Sonatas	All available data (2021)	AugmentedNet	**45.4**
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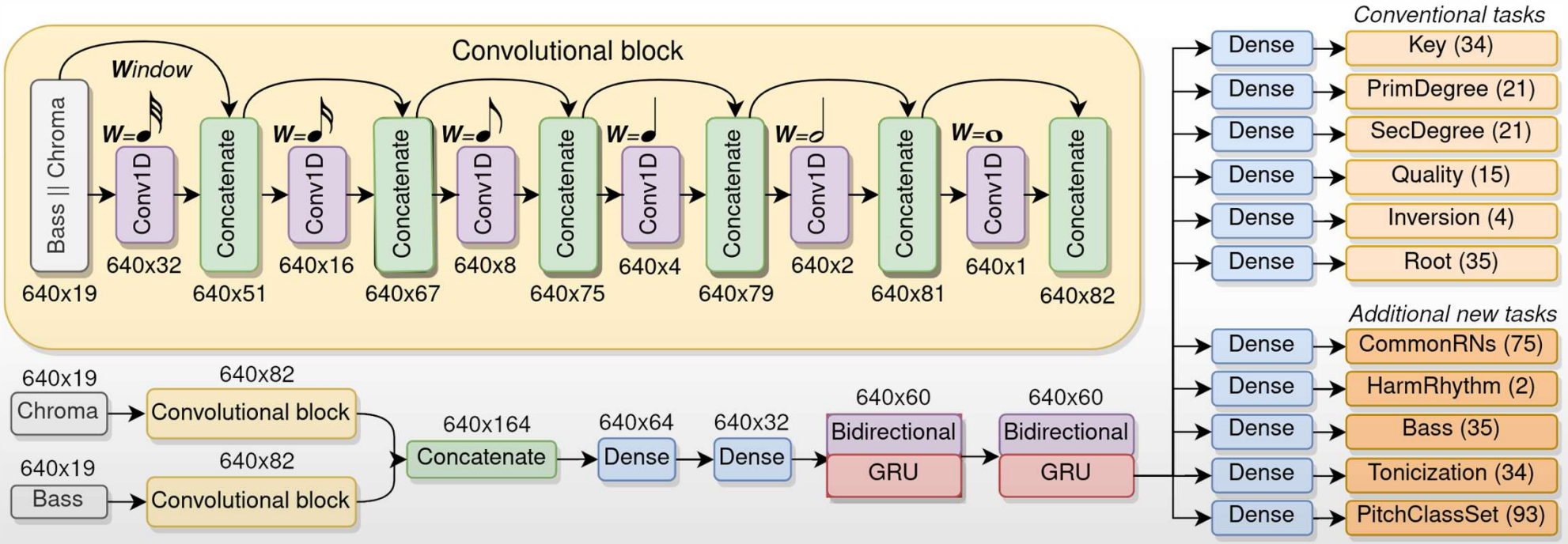
Convolutional block
Window
Bass || Chroma
Conv1D
Concatenate
640x19
640x32
640x51
640x16
640x67
640x8
640x75
640x4
640x79
640x2
640x81
640x1
640x82
640x19
Chroma
640x82
Convolutional block
640x19
Bass
640x82
Convolutional block
640x164
Concatenate
640x64
Dense
640x32
Dense
640x60
Bidirectional
GRU
640x60
Bidirectional
GRU
Conventional tasks
Dense
Key (34)
Dense
PrimDegree (21)
Dense
SecDegree (21)
Dense
Quality (15)
Dense
Inversion (4)
Dense
Root (35)
Additional new tasks
Dense
CommonRNs (75)
Dense
HarmRhythm (2)
Dense
Bass (35)
Dense
Tonicization (34)
Dense
PitchClassSet (93)

Paper - Code - Video - Experiments - Data

https://napulen.github.io/publication/augmentednet/

Thank you!