

# Non-chord Tone Identification

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# 1 Introduction

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Non-chord tones are:

- Elaborative notes, usually marked by particular step-wise melodic contours, which don't belong to the local structural harmony

Non-chord tone identification can be used in:

- Melodic analysis (Illescas et al. 2011)
- Polyphonic music retrieval (Pickens et al. 2004)
- Harmonization (Chuan and Chew 2011)
- **Harmonic analysis** (Pardo and Birmingham 2002; Sapp 2007; Mearns 2013; Willingham 2013)



# 1 Introduction

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Harmonic analysis:

- Identifying local harmony in complex music textures
- Can be greatly simplified by identifying and eliminating all non-chord tones before determining a chord label

Few scholars have proposed complete, dedicated non-chord tone identification models



# 1 Introduction

Original score

Identifying and eliminating non-chord tones

Determining chord labels



## 2 Method

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We propose a non-chord tone identification model:

- Using machine learning (feedforward neural networks, FFNN), which learns to conduct non-chord tone identification automatically from the provided training examples
- Rameau (Kröger et al. 2008), a dataset consisting of 140 Bach chorales with non-chord tone labels, is used



## 2. Method

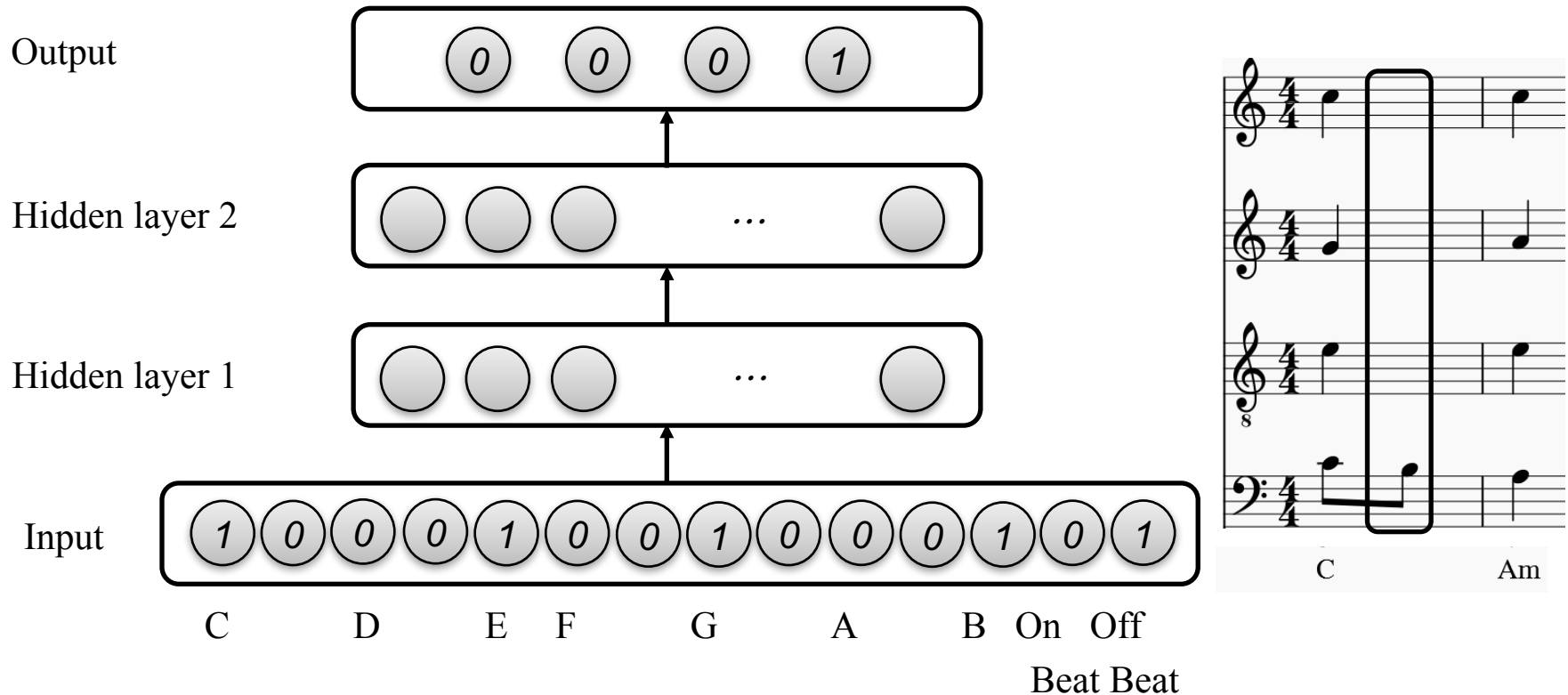


Fig. 1: Illustration of the structure, the input and output of FFNN, which is generated from Bach chorales.



# 3 Evaluation

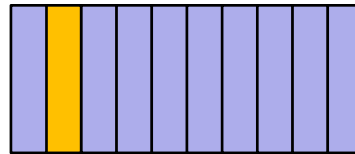
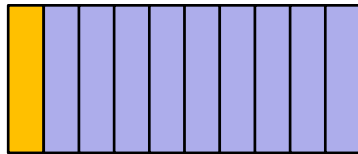


Test Set

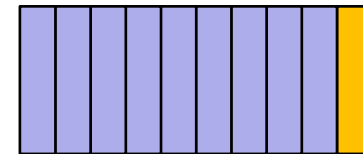


Training Set

10-fold cross validation:



...



F1-measure:  $70.21 \pm 7.97\%$

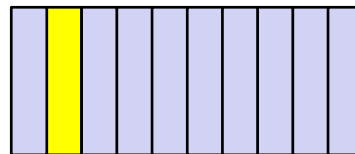
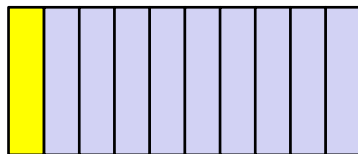


Shuffled Test Set

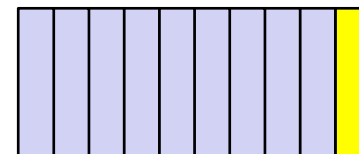


Shuffled Training Set

10-fold cross validation:



...



F1-measure:  $71.55 \pm 0.35\%$  (Averaged performances for 10 shuffles)



## 3 Results

F1-measure: 71.55%

Chords and non-chord tones for the first 9 measures:

Measure	Chord	Non-chord tones
1	C	b
2	Am	b
3	Em	g
4	Em7	g
5	F	df
6	C	df
7	C/E	d
8	Dm7/F	d
9	G	
10	C	

Fig. 2: Illustration the first 9 measures of BWV 389 “Nun lob, mein Seel, den Herren”. The second line is the non-chord tone ground truth, and the third line is the predicted non-chord tones.





## 3 Results

F1-measure: 71.55%

4

Dm7/C E/G# E7/G# Am Am7/G Dm7/F G C/E Dm7/F G G7 C

Fig. 2: Illustration the first 9 measures of BWV 389 “Nun lob, mein Seel, den Herren”. The second line is the non-chord tone ground truth, and the third line is the predicted non-chord tones.



## 3 Results

F1-measure: 71.55%

7

8

F Dm/FC/E F7+ G G7 E/G# Am E Am D/F#D7/F#G C/E C7+ D D7

b a gb f# b

Fig. 2: Illustration the first 9 measures of BWV 389 “Nun lob, mein Seel, den Herren”. The second line is the non-chord tone ground truth, and the third line is the predicted non-chord tones.



## 4 Conclusion

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- F1-measure: 71.55%
- An innovative and promising approach to tackling the problem of non-chord tone identification, as well as harmonic analysis.
- If more data is available, better performances can be achieved
- Complete the whole Bach chorale dataset, with 371 chorales fully annotated with non-chord tone labels
  - Enables the model to achieve better performances
  - The dataset can be used in other music analytical tasks



# Andrew Hughes' Chants

- Andrew Hughes encoded about 6000 medieval chants into a special format, which are converted into music scores with MEI ([Music Encoding Initiative](#)) format (rendered by Verovio)

|g19 =VE.1d

```
/ gloria sanctoruM rex unica christe tuoruM nos in  
laude tuI fac convotos adalardI ut per eum cuius  
sollemnia concelebramuS te laudando deuM mereamur  
in ethere regnuM /()
```

```
\ gloria.13.21.2 sanctoruM.10,.121.1; $ rex.32  
unica.34.43.45 christe.5423.21 tuoruM.21.01.1;  
nos.2 in.45 laude.56.54 tuI.4513.3; fac.3=2  
convotos.12.10.0 adalardI.01.32'12.21.12; ut.21, $  
per.4 eum.45.543'452 cuius.343=2.1 $  
sollemnia.12.2.10.0 concelebramuS.10,.2.343.1.1; $^  
te.57=6 laudando.45=45434.45.5 deuM.57'865'745.5;  
mereamur.57.654.5675.5 in.54 ethere.5654.5.43'21  
regnuM.03=245'1032=.1; ! \()
```





# Non-chord Tone Identification



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