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Challenges and opportunities for computational analysis of wax cylinders

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Overview I

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Wax cylinders

Figure: A wax cylinder recording from a 1911 expedition by Hutereau.

Early field recordings were captured on wax cylinders.

- 1895-1935
- No electricity needed
- Noisy
- Limited frequency range

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Archives: ATM (USA), RMCA (Belgium)

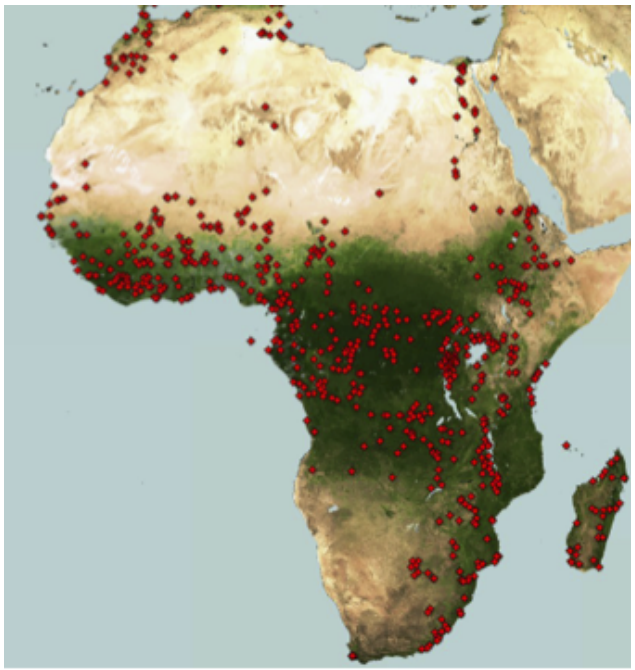

Figure: Locations of recordings in the RMCA-archive.

Collection of the Royal Museum for Central Africa (RMCA), Tervuren, Belgium

- More than 35 000 items
- Mainly field recordings from Central Africa
- First recordings from 1890s
- Many analogue carriers types
- Challenging meta-data

Archives of Traditional Music at Indiana University (ATM, USA)

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Signal/noise

- Segmentation
- Noise levels
- Some repetitive noise sources

Most wax cylinders contain segments with a reasonable signal/noise ratio.

Figure: Wax cylinder, a source of noise

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Reliability of meta-data — Problems

Meta-data problematic [2, 3]:

- Changing geographical nomenclature
- Many vernacular names for musical instruments
- Transcription of tonal languages (Yoruba, Igbo, Ashanti, Ewe)
- Collection vs scientific field work

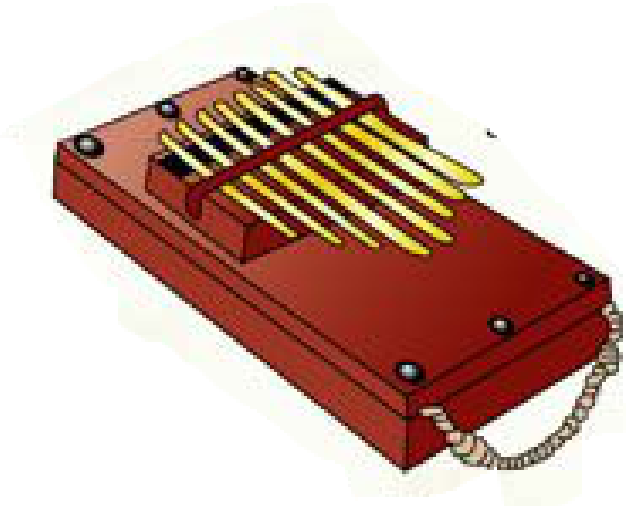

Figure: Kombi, Kembe, Ekembe, Ikembe, Dikembe or Likembe?

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Reliability of meta-data — Quantify

Check meta-data via duplicate detection[4]

1. Find duplicate items[6]
2. Compare meta-data
3. Analyze differences

2.5% (887 of 35306) duplicates in RMCA archive.

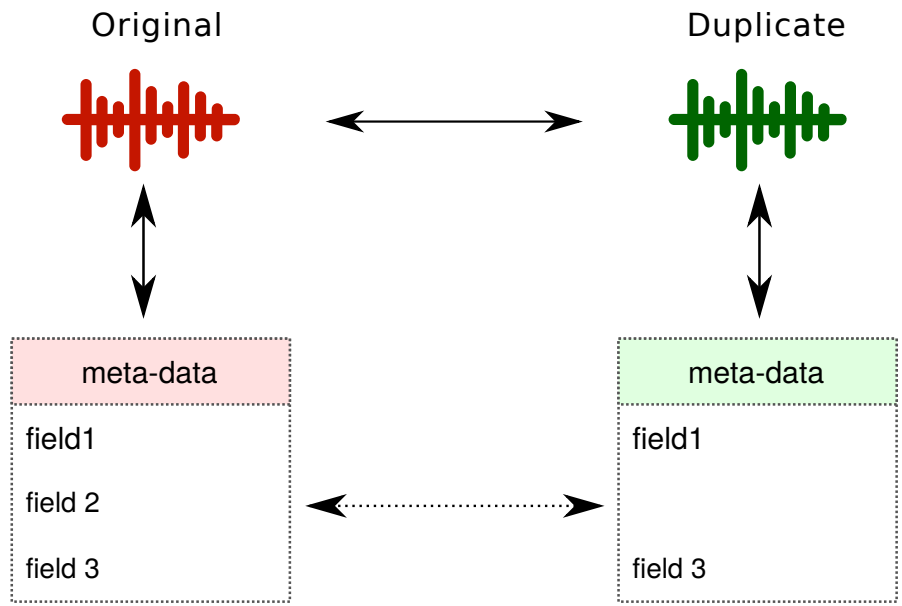

Figure: Comparison of meta-data fields using duplicates

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Reliability of meta-data — Fields

Field	**Empty**	**Different**	**Exact match**	**Fuzzy or exact match**
Year	20.83%	13.29%	65.88%	65.88%
People	21.17%	17.34%	61.49%	64.86%
Country	0.79%	3.15%	96.06%	**96.06**%
Province	55.52%	5.63%	38.85%	38.85%
Place	33.45%	16.67%	49.89%	55.86%
Language	42.34%	8.45%	49.21%	55.74%
Title	42.23%	38.40%	*19.37%*	*30.18%*
Collector	10.59%	14.08%	75.34%	86.71%

Table: Comparison of pairs of meta-data fields

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Reliability of meta-data — Fuzzy

Original title	**Duplicate title**
Warrior dance	Warriors dance
Amangbetu Olia	Amangbetu olya
Coming out of walekele	Walekele coming out
Nantoo	Yakubu Nantoo
O ho yi yee yi yee	O ho yi yee yie yee
Enjoy life	Gently enjoy life
Eshidi	Eshidi (man's name)
Green Sahel	The green Sahel
Ngolo kele	Ngolokole

Table: Pairs of fuzzily matched titles. The fuzzy match algorithm is based on Srensen/Dice coefficients.

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Recording/playback speed of wax cylinders

Recording speed often unknown.

- Various systems (G)
- 80-240 cycles/s
- Some use reference tones

Absolute pitch unreliable.

Figure: Wax cylinder, speed unkown

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Missing context

Context needed for a deep understanding of single recordings. A few aspects:

- Dance
- Language
- Religion
- Instrument building

Audio only offers a limited snapshot of (music) culture. Context might be changed dramatically and impossible to re-create.

Figure: Wax cylinder, without context

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Opportunities

Unique snapshots of century old musical practices. Opportunities for comparative studies:

- Compare current with past practices
- Compare musical idioms with western idioms
- Universals in scales?

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Opportunities

Pitfall	Avoidance
▸ Noisy	▸ Select less noisy segments manually
▸ Unreliable meta-data	▸ Limit meta-data dependency
▸ Recording speed unknown	▸ Avoid claims about absolute pitch
▸ Context missing for individuals	▸ Focus on patterns, systems, populations

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Pitch interval analysis

Manual, computer assisted analysis with Tarsos [5]

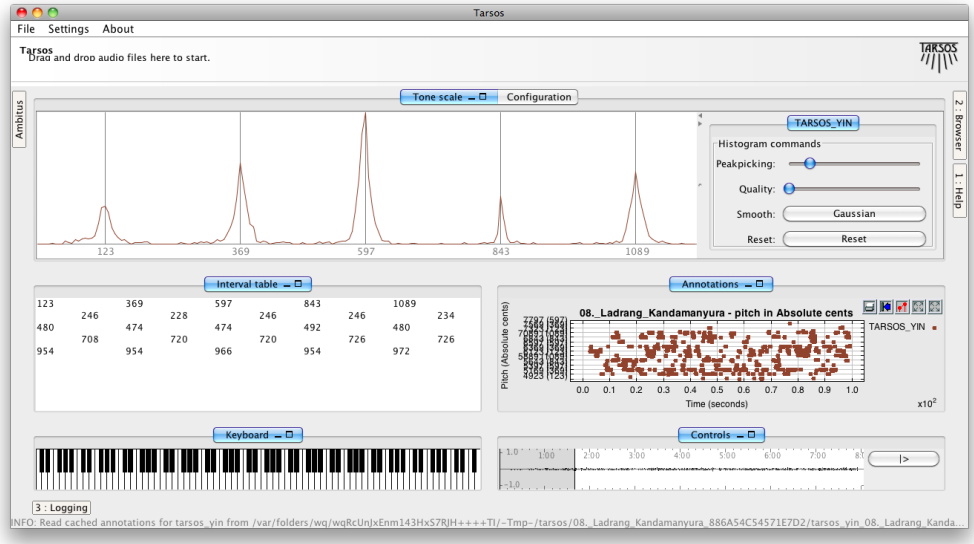

Figure: Tarsos software system for pitch analysis.

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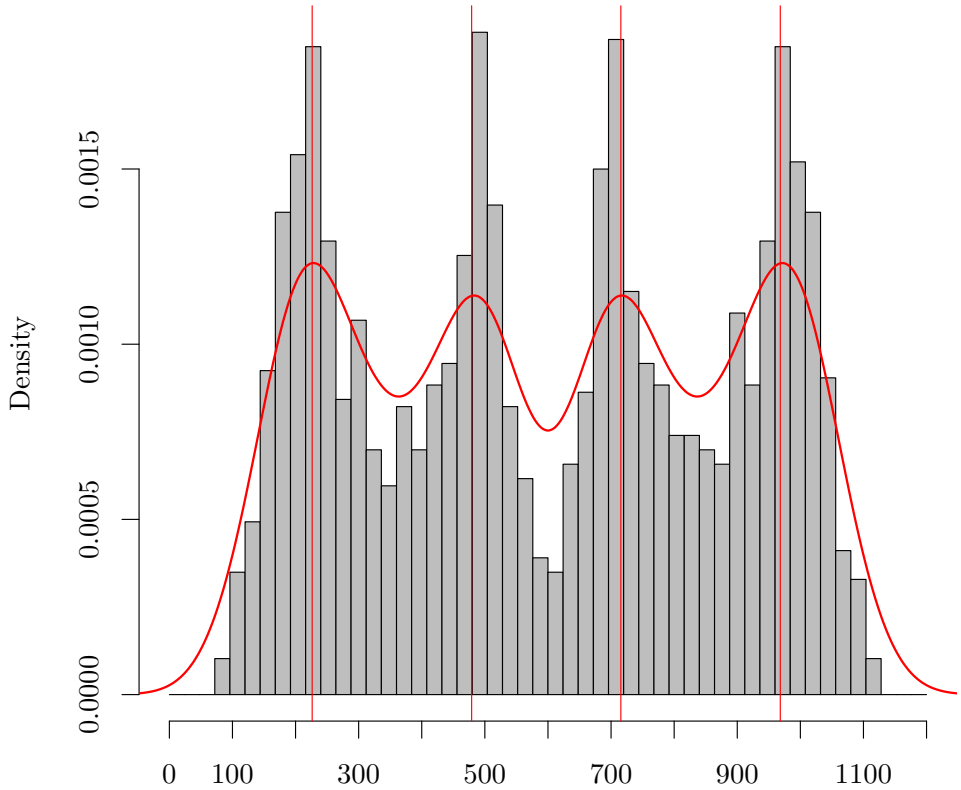
Pitch interval analysis - 4 PC



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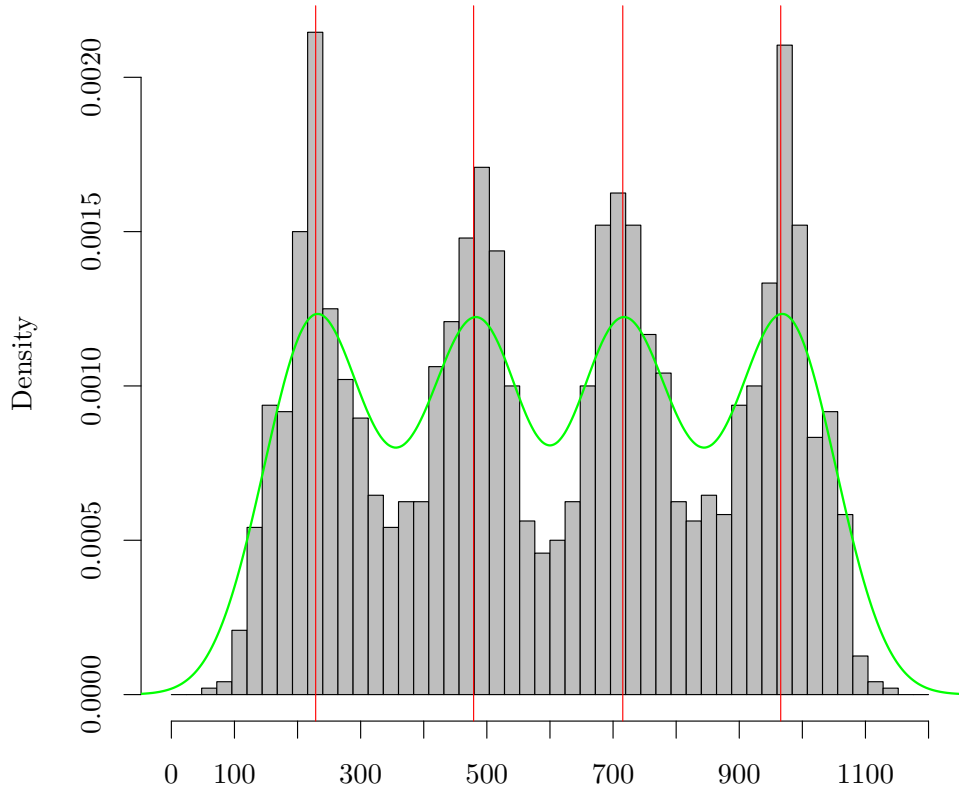
Pitch interval analysis - 5 PC



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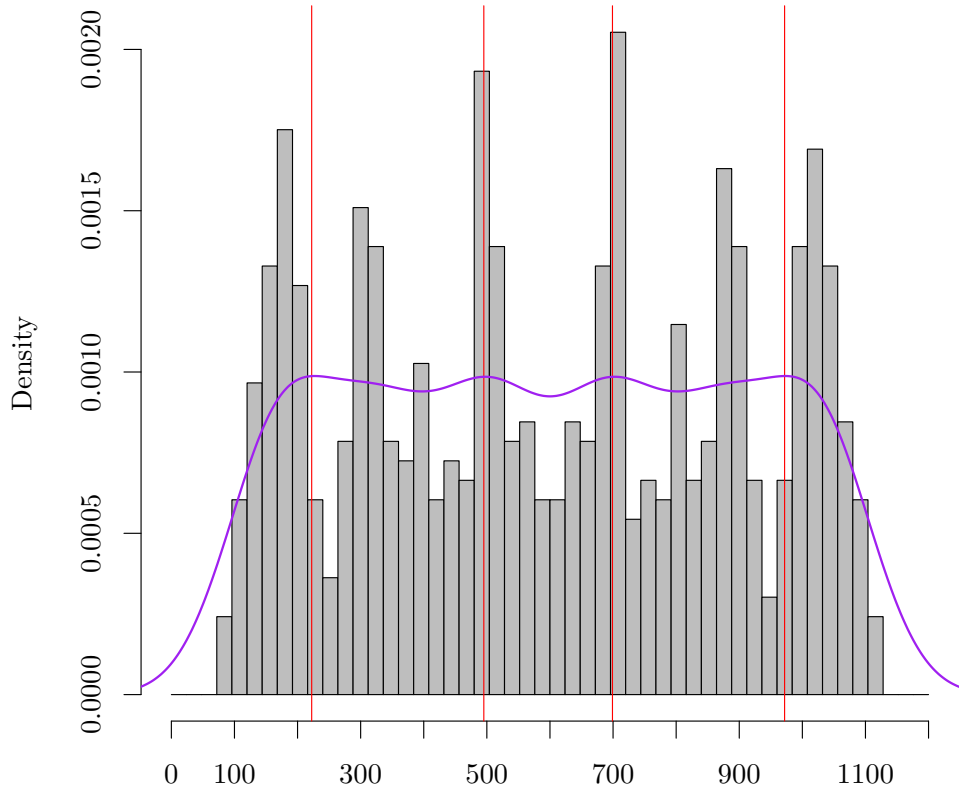
Pitch interval analysis - 6 PC



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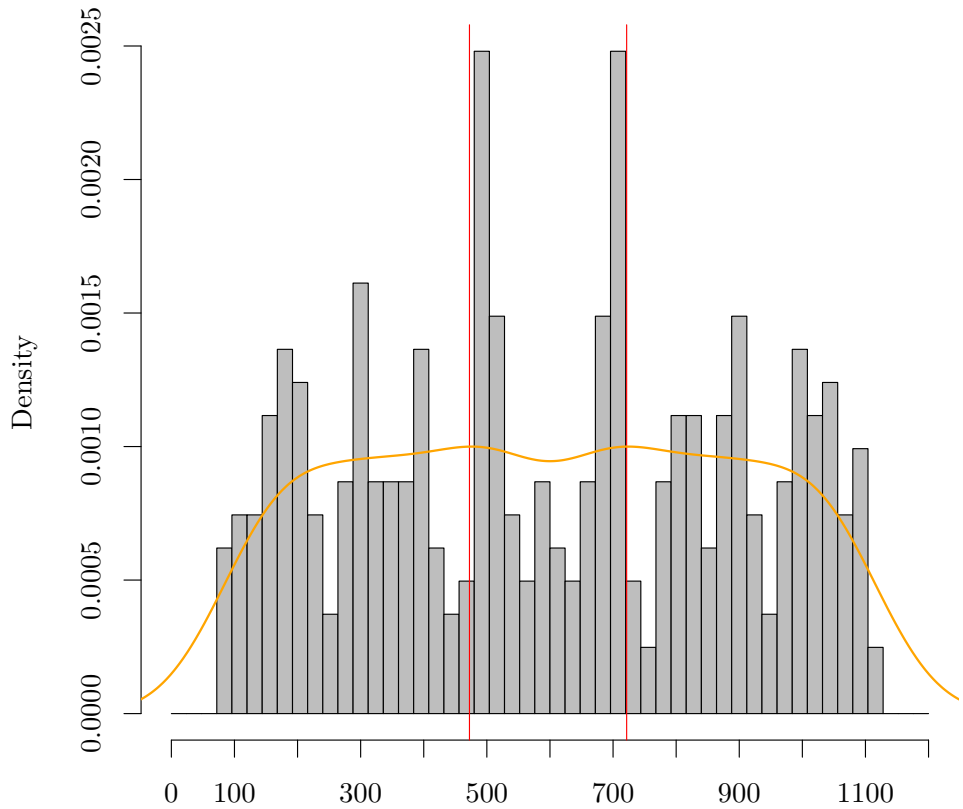
Pitch interval analysis - 7 PC



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Pitch interval analysis - Preliminary results

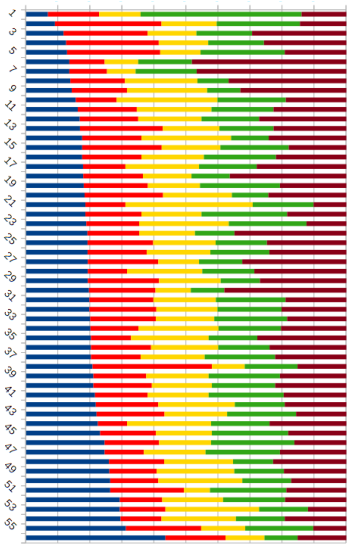

Figure: Diversity in 55 pentatonic scales, ordered by interval size of first interval.

Very large diversity but some general findings:

- The fifth is almost always present.
- Scales with four and five PC's share 240 cents as basic interval.
- Scales with six and seven pitch classes share 170 cents

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Conclusion

- Presented a way to quantify meta-data quality in digital music archives via duplicates[4, 1]
- Presented challenges and opportunities to research on wax cylinder recordings
- Preliminary results on pitch content of 400 wax cylinders

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