Rhythm analysis

Martin Clayton, Barış Bozkurt

Agenda

- Introductory presentations (Xavier, Martin, Baris) [30 min.]
- Musicological perspective (Martin) [30 min.]
- Corpus-based research (Xavier, Baris) [30 min.]

  ----- *break* ------

- **Rhythm analysis (Martin, Baris) [30 min.]**
- Tuning analysis (Baris) [30 min.]
- Closing remarks (Xavier) [10 min.]
- Open discussion [20 min.]

Rhythm analysis tasks

- Detecting metrical structure
  - Where are the beats?
  - Where are the measures/ cycles?, and
  - How are they organised (teental, 4/4, waltz etc)?
- Analysing (micro)timing
  - When do musical events (notes) begin? (importance of *precision*)
  - Patterning of inter-onset intervals (IOIs)
  - Relationships between the timing of parts (instruments)

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Outline

1. Introduce case study: Interpersonal Entrainment in Music Performance
2. Corpus, shared data, hands-on

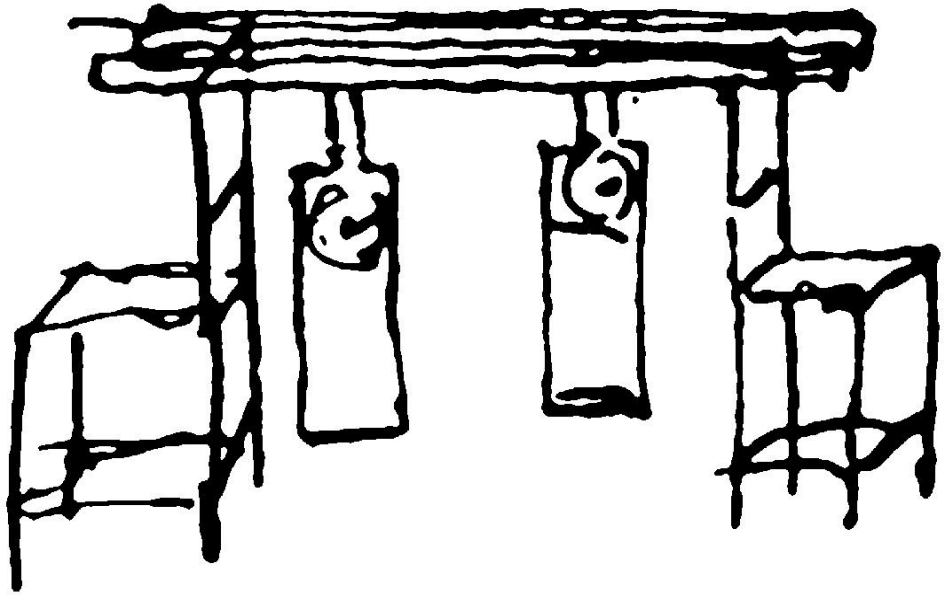
Interpersonal entrainment in Music Performance (IEMP) Project

- Collaborative project exploring how musicians coordinate in time in diverse musical genres
- Martin Clayton and Tuomas Eerola (Durham), Peter Keller (Sydney) & Antonio Camurri (Genoa) plus many collaborators
- Funded by Arts and Humanities Research Council (AHRC)

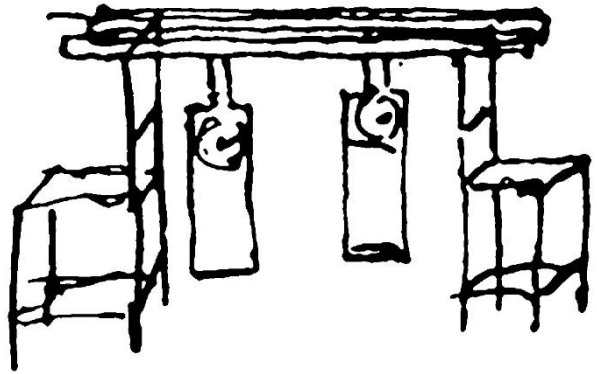
Arts & Humanities Research Council

Entrainment

- Entrainment theory explains how independent rhythmic processes become synchronised
- It occurs when at least 2 independent systems are connected by a coupling force
- The classic example: Huygens' clocks



Entrainment, beat tracking and music



Entrainment and sensorimotor synchronisation

- Lab studies show people can synchronise to a regular beat with a standard deviation (SD_{async}) of c. 20-30ms
- There are individual differences in synchronisation ability
- We can now measure how musicians actually perform, using this measure of variability

Methodology: Measuring synchronisation

1. Manually annotate metre
2. Extract onset times
3. Assign onset times to metrical positions
4. Calculate timing asynchronies in each position
5. Calculate synchronisation precision from asynchronies

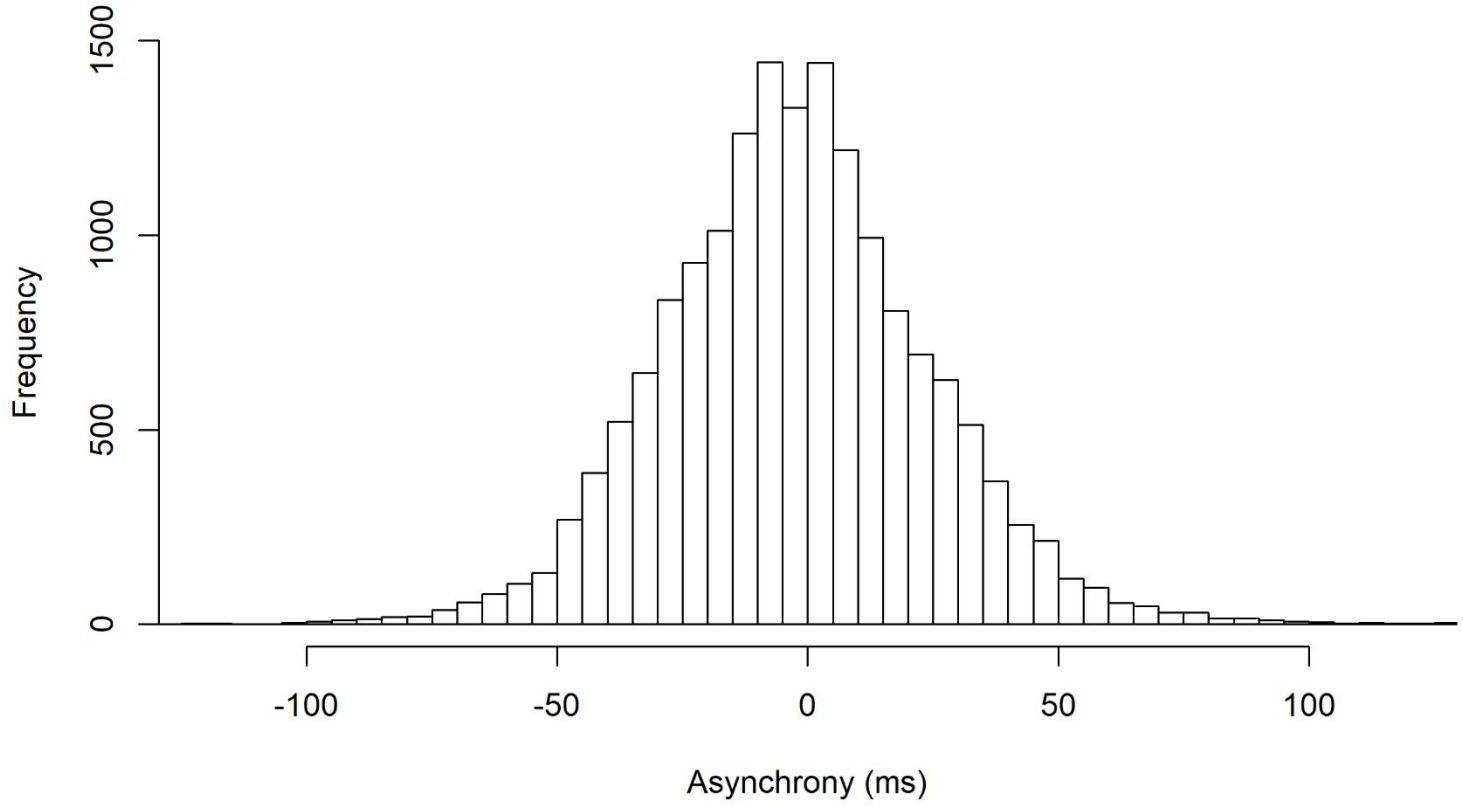
Metre	Sitar	Tabla	Async. (ms)
1:1	1146.9	1146.9	-9.1
1:1&			
1:2	1148.3		
1:2&			
1:3	1149.6		
1:3&			
1:4	1151	1151	43.1
1:4&	1151.6	1151.6	14.0
1:5	1152.3	1152.3	3.0
1:5&			
1:6	1153.7		
1:6&	1154.4		
1:7	1155.1	1155.1	29.0
1:7&		1155.7	
1:8	1156.4	1156.4	18.9

Onset detection challenge

- Detecting onsets in (e.g.) sitar and tabla audio is not trivial
- Wide dynamic range
- Varied onset types
- Continuous background with high frequency energy
- Bleed between tracks

Asynchronies: IEMP NIR Corpus

- 16,700 data points
- Analysed by tempo, density, metrical position etc…



Corpora and collaborators

Corpus	Size of groups	Instrumentation	Duration (min)	Researcher
North Indian Raga	2	Sitar, sarod or guitar + tabla (tanpura not analysed)	91	M. Clayton, L. Leante
Uruguayan Candombe	3-4	Chico, piano and repique drums	35	L. Jure, M. Rocamora
Malian Jembe	2-4	Jembe and dundun drums	51	R. Polak
Cuban Son and Salsa	7	Bass, Spanish guitar, tres, clave, bongos and other percussion, trumpet, vocals	33	A Poole
Tunisian Stambeli	≥4	Gumbri (lute), shqashiq (cymbals), vocals, drum	35	R. Jankowsky
String Quartet	4	Violin, viola, cello	5	M. Clayton, T. Eerola, K. Jakubowski

- Analysis by Martin Clayton, Tuomas Eerola and Kelly Jakubowski

2. The IEMP Corpus

- North Indian Raga corpus (first 4 instrumental performances)
- PUBLIC NOW @ https://osf.io/ks325/
- Malian Jembe scheduled for October 2018
- Others planned by end 2018

2. The IEMP North Indian Raga Corpus

- Extent and materials
  - 3.5 hours of musical performance
  - 20.5 hours hours of audio
  - 9.5 hours of video
  - Onset data (raw and selected)
  - Manual annotations of musical structure form
  - Movement data (extracted from video)

2. The IEMP Corpus

- Example data (Prattyush Banerjee, 77 sec extract)
- See ‘Sample’ folder in NIR corpus at https://osf.io/ks325/

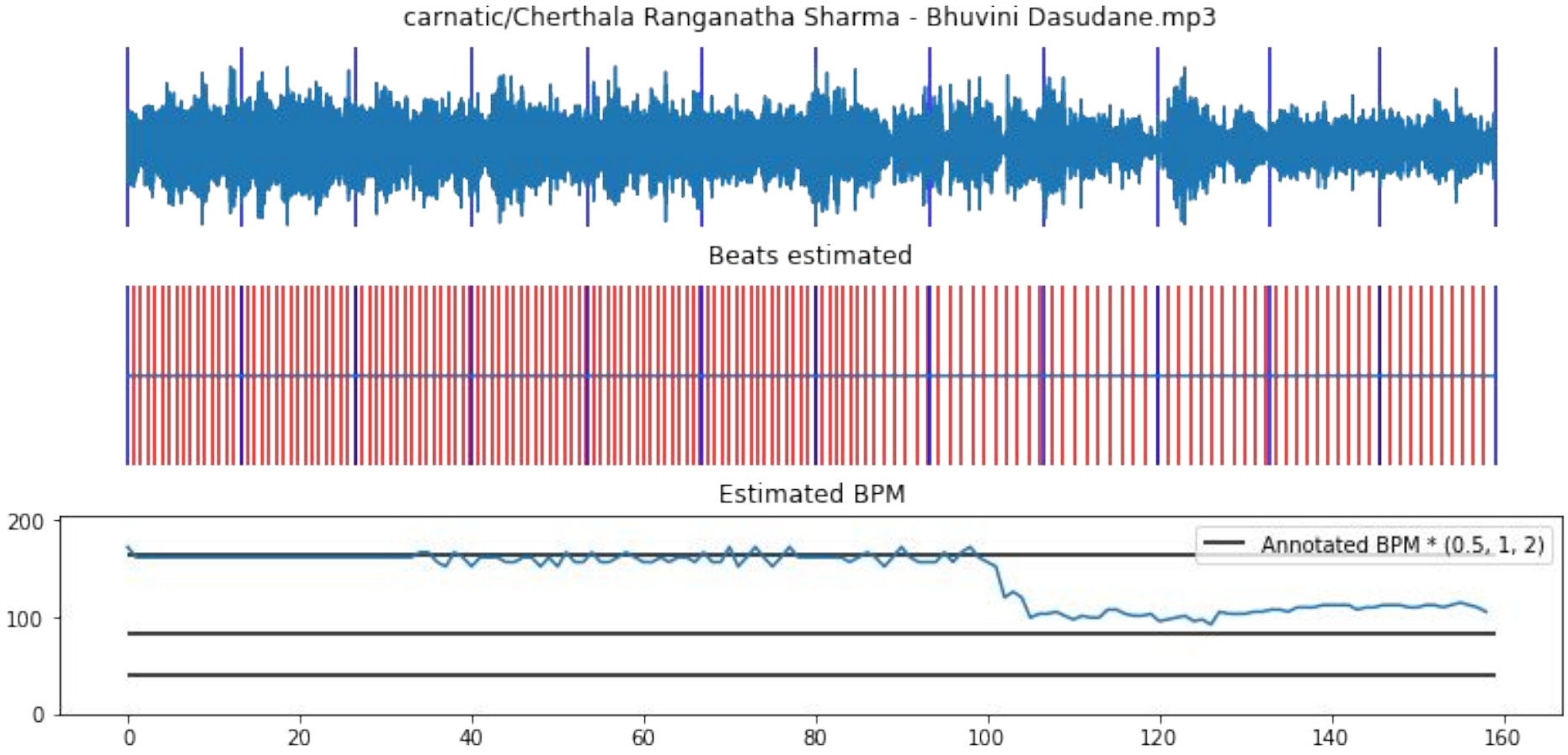
References

- Clayton, M., Jakubowski, K. & Eerola, T. (in press) Interpersonal entrainment in Indian instrumental music performance: Synchronization and movement coordination relate to tempo, dynamics, metrical and cadential structure. *Musicae Scientiae*.

- *Links to other publications by Martin Clayton can be found on* Martin Clayton's profile page: https://www.dur.ac.uk/music/staff/?id=8693

Rhythm analysis task

- **Hands On: visualizeAnnotations.ipynb**
- This notebook aims at demonstrating contents of IEMP Indian Corpus and Saraga database annotations: sections, typical phrases, sama and tempo annotations.



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