SHIFT IF YOU CAN:
COUNTING AND VISUALISING CORRECTION OPERATIONS FOR BEAT TRACKING EVALUATION

António Sá Pinto[1,2] **Inês Domingues**[3] **Matthew E. P. Davies**[4]

[1] INESC TEC, Porto, Portugal
[2] FEUP, University of Porto, Portugal
[3] IPO Porto, Portugal
[4] CISUC, DEI, University of Coimbra, Portugal

ISMIR MTL2020

Overview and Motivation

Position the work in the context of creative music applications where we need to obtain very high accuracy

Reformulate beat tracking evaluation from a user workflow perspective, i.e. *how do we need to change the detections such that they are acceptable for the end-user?*

Simulate this process by counting the number and type of interaction operations required to maximise the F-measure of the beat detections compared to ground truth annotations

In addition to insertions (false negatives) and deletions (false positives), we introduce a shift operation

Shifts are used when detections occur within an outer tolerance window (i.e. +/- 1s) around each ground truth annotation

Each executed shift operation replaces a deletion and an insertion

By counting the number of operations, we can calculate an *Annotation Efficiency*

To aid in qualitative assessment of beat tracking performance we present a visualisation tool

Processing stages

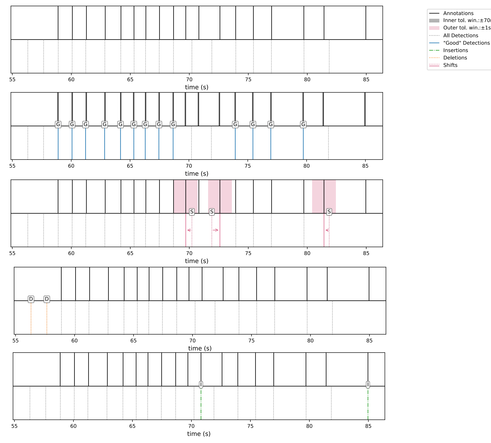
0. Raw beat detections
- The unlabelled comparison of beat detections to annotations is not very informative

1. "Good" Detections
- If the closest beat to each ground truth annotation is inside the inner tolerance window (+/- 70ms)

2. Shifts
- If detections occur within the outer tolerance window (+/- 1s) around each annotation

3. Deletions
- Any detections that remain are deletions

4. Insertions
- Unnacounted for annotations become insertions



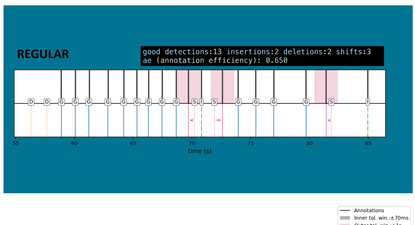
Comparing variations of detections

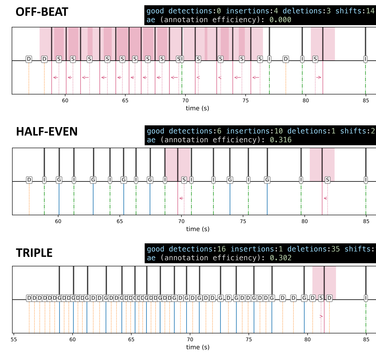
To allow for the modelling of metrical ambiguity in beat tracking, we can generate multiple variations of the detections and calculate the *Annotation Efficiency* accordingly

Annotation Efficiency

$$ae = t^{+}/(t^{+} + s + f^{+} + f^{-})$$

t^{+} – *true positive*
f^{+} – *false positive*
f^{-} – *false negative*
s - *shift*





Conclusions

New tool for visualisation of beat tracking performance

Categorisation and counting of different detection correction operations can enhance the understanding of the behaviour of beat tracking algorithms

The proposed approach can be readily applied to other temporal labelling problems, e.g. onset detection, structural boundary detection

In future work, we will orient our approach within the existing theory of edit distances

Code

All code is available with easy-to-follow examples at https://github.com/MR-T77/ShiftIfYouCan

Funding Acknowledgements

This work is funded by national funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project CISUC - UID/CEC/00326/2020 and by European Social Fund, through the Regional Operational Program Centro 2020. It is also supported by the FCT-Fundation for Science and Technology, I.P., under the grant SFRH/BD/120283/2016 and the projects IF/01566/2015 and UIDP/00776/2020.

Cofinanciado por: