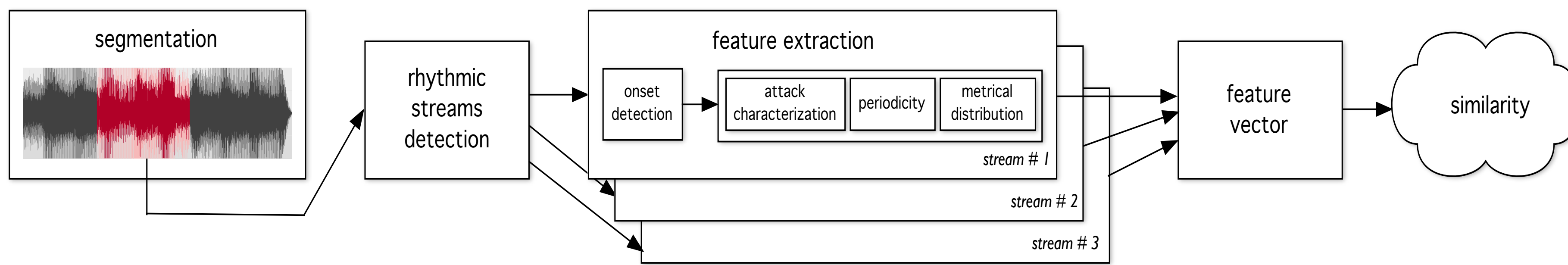


Modeling Rhythm Similarity for Electronic Dance Music

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Introduction

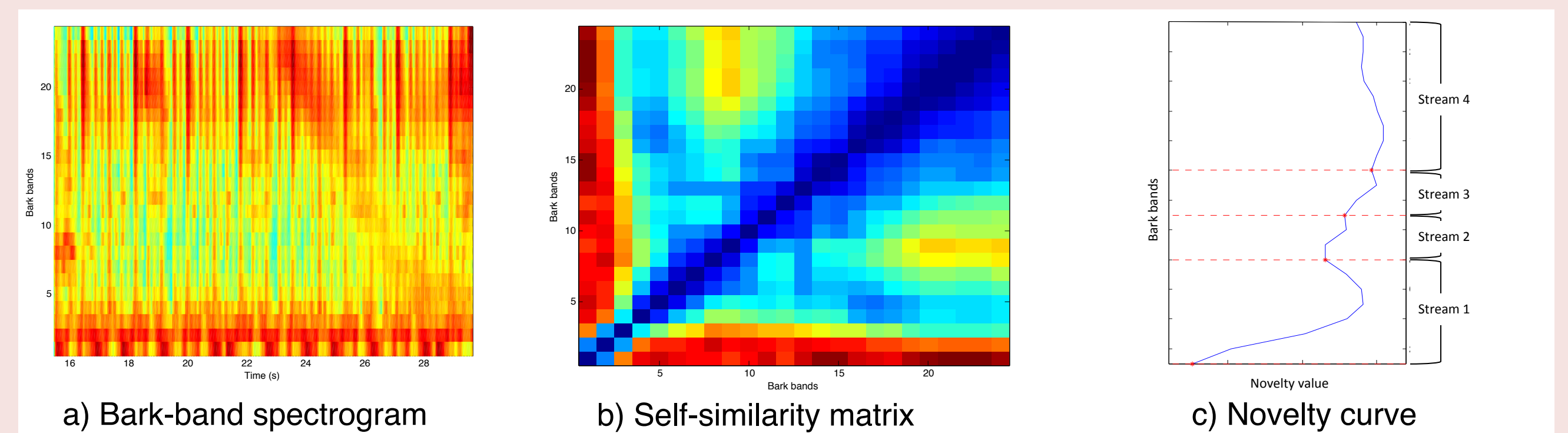
Inter-segment rhythm similarity in EDM [1]

- audio segment [2] split in rhythmic streams
- streams characterized by features; attack phase, periodicity, metrical distribution
- similarity evaluated with perceptual ratings

Rhythmic Streams

Detection of rhythmic streams using the novelty approach

- compute Bark-band spectrogram: FFT, Bark Bands, Log, Masking (spreading function [3], smoothing window 50 ms)
- get self-similarity matrix using cosine distance
- apply novelty [4]; peaks define the stream boundaries



Features

Onsets

Onset function [5]: $O_b(\mathbf{k}) = (1 - \lambda) N_b(\mathbf{k}) + \lambda N'_b(\mathbf{k})$
 weighting factor $\lambda < 0.5$, bark band $b = 1, \dots, 24$, frame $k = 1, \dots, K$,
 normalized loudness $N_b(k)$, derivative $N'_b(k)$

Attack Phase

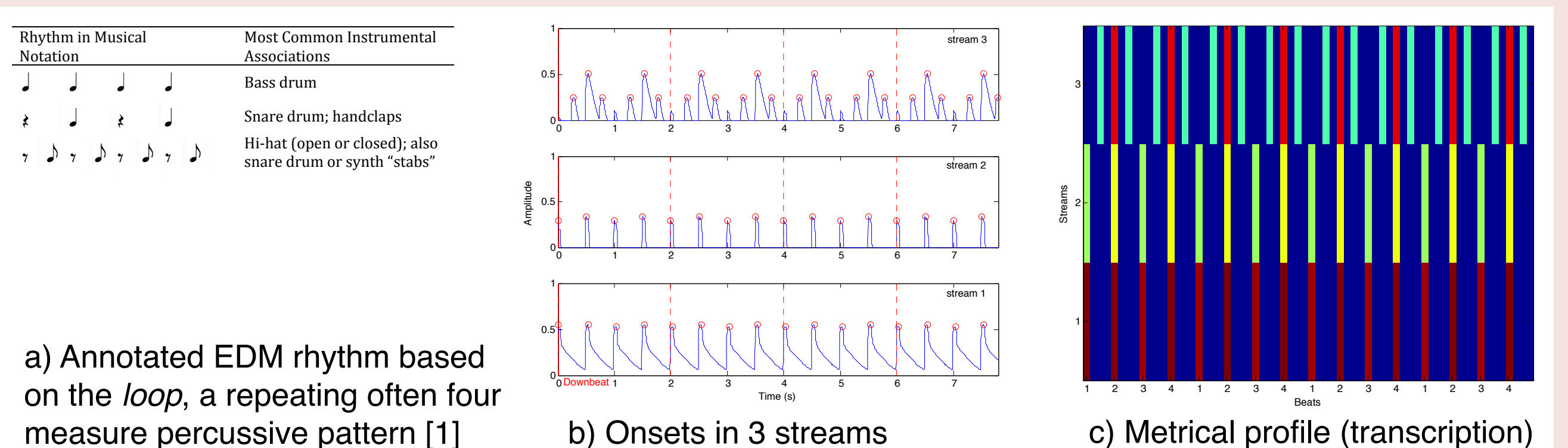
Describes percussiveness
 From attack phase [6] of onsets

- Attack time (mean, std)
- Attack slope (mean, std)

Periodicity

Describes degree of repetition
 From autocorrelation of onset function

- Max autocorrelation (lag time, strength)
- Peaks' harmonicity [7], entropy, flatness



Metrical distribution

Describes metrical relations of events
 From onsets' quantization (incl. downbeat [8], bpm [2] detection)

- Metrical profile [9]: quantization (4 bars x 4 beats x 4 sixteenth)
- Syncopation, center of gravity, density, symmetry

Evaluation

Listening experiment

Task rate perceptual rhythm similarity for a pair of EDM segments
 Stimuli 18 segments with distinct rhythms, 28 pairs for evaluation
 Participants 28 participants, age 27 ± 7 , 50% formal musical training, 64% familiar with EDM, 46% experienced EDM musician/producer

Algorithmic steps

accuracy	algorithmic step	evaluation method
93%	rhythmic streams	compare with annotated perceived number of streams (t-test)
85%	onsets	25 MIDI and corresponding audio excerpts (MIREX Onset Detection F-measure)
51% (59%)	downbeat	compare with annotated downbeat (also compare with strong beats of meter)

correlation	p-value	feature set
-0.17	0.22	attack phase
0.48	0.00	periodicity
0.33	0.01	metrical distribution excl. metrical profile
0.69	0.00	metrical distribution incl. metrical profile
0.70	0.00	all

Table) Pearson's correlation and p-value between perceptual ratings and different sets of features.

Conclusion

A model for rhythm similarity of EDM audio segments

- Unsupervised detection of number and freq. range of rhythmic streams.
- Features extracted per stream benefit the analysis.
- Similarity predictions match perceptual ratings with high correlation.
- Future work: improve downbeat detection, tune features via regression

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