Modelling odd meters

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Goal: detect funny bars

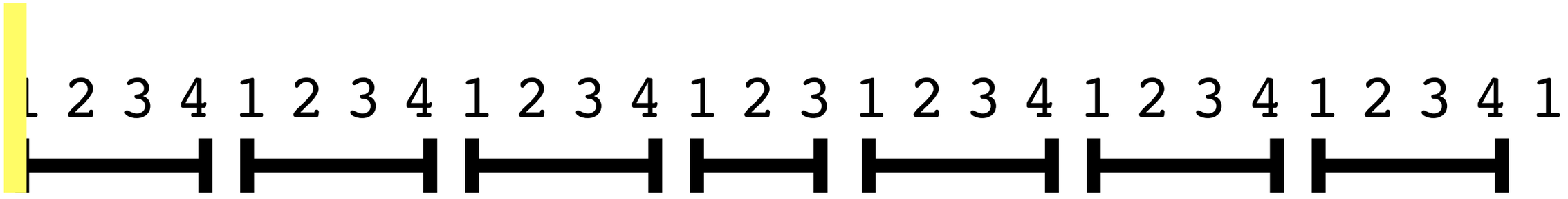
Time signature is often constant for an entire song — but there are lots of examples where it isn't!

- "Love Is All" : all in 4/4 time, but a middle section in 3/4
- "The Stars": all in 4/4, except there are two isolated bars of 3/4
- "Hey Ya!": all in 4/4, but every phrase has a bar of 2/4

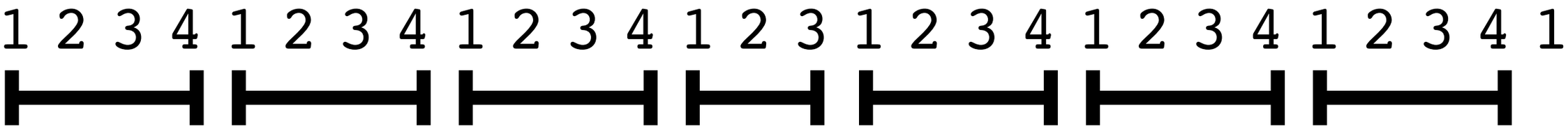
These unusual situations are likely to lead to beat- or downbeat-tracking errors.

"Unusual" time signatures are not rare: out of 180 Beatles songs, 56 have measures of non-uniform length.

Isolated 3/4 in “The Stars” by Jukebox the Ghost



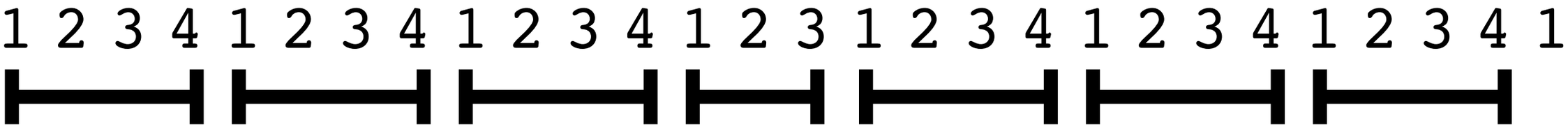
True bars / beats:



Estimated constant bar-length bars / beats:

NB: we used the Python madmom package to generate downbeat detection function.

True bars / beats:



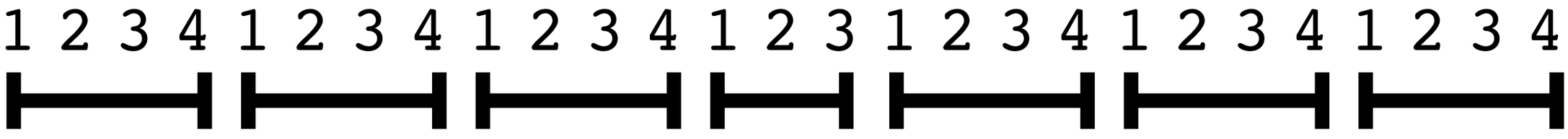
Estimated constant bar-length bars / beats:

Let:

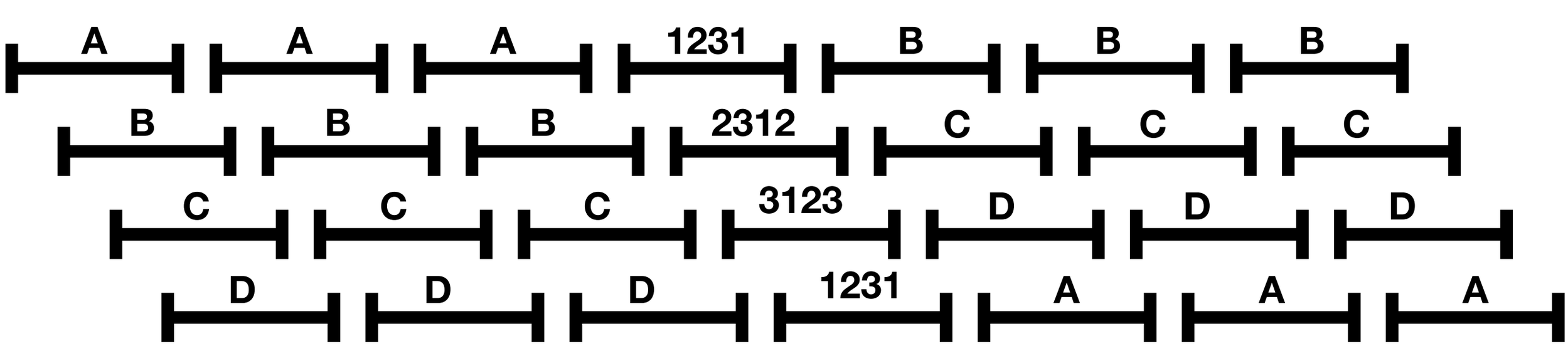
1234 = A

2341 = B

True bars / beats:

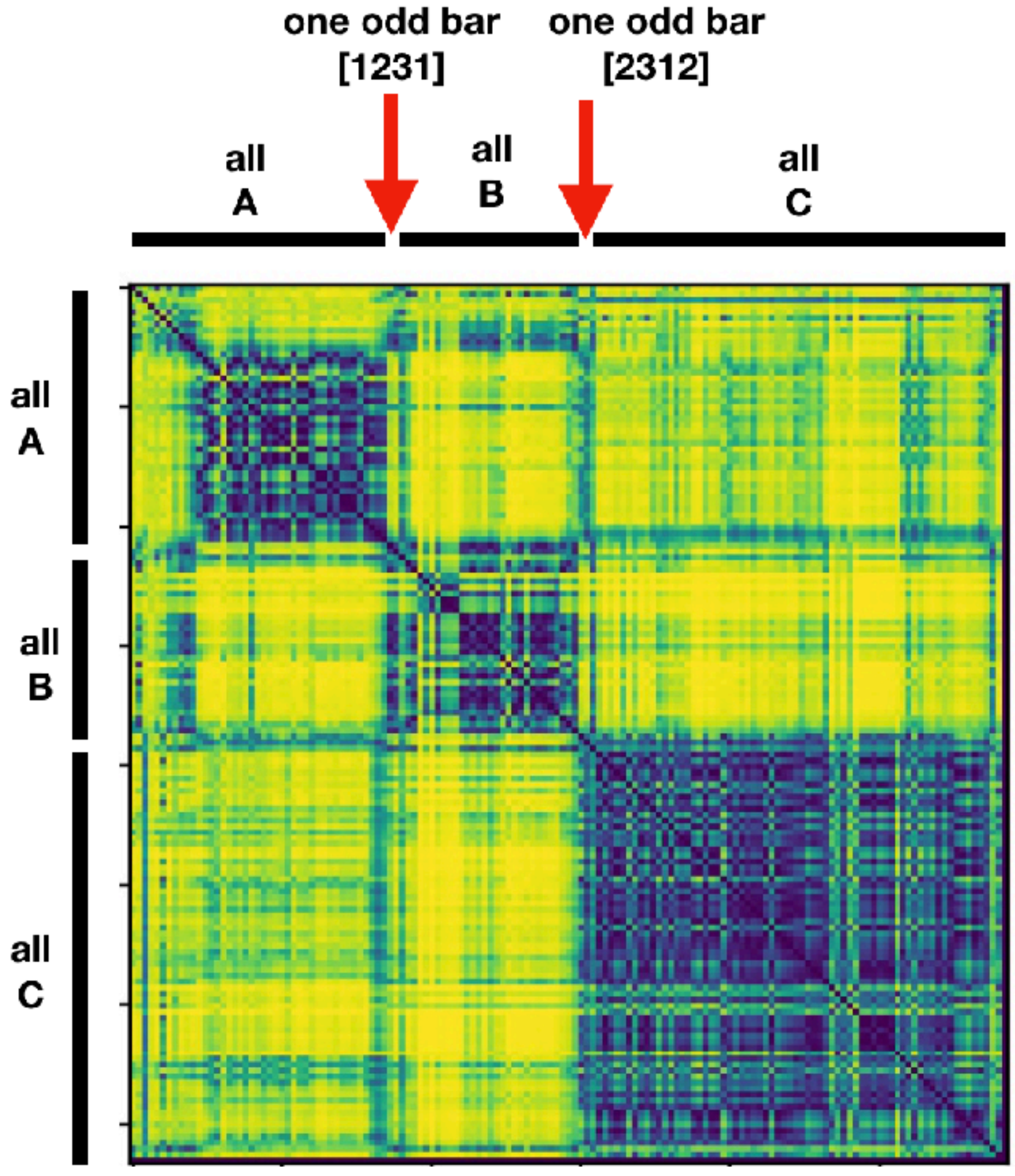


Estimated constant bar-length bars / beats:



Proposal: compute similarity matrices between each of these shifted sequences

Self-similarity reveals consistent sections:



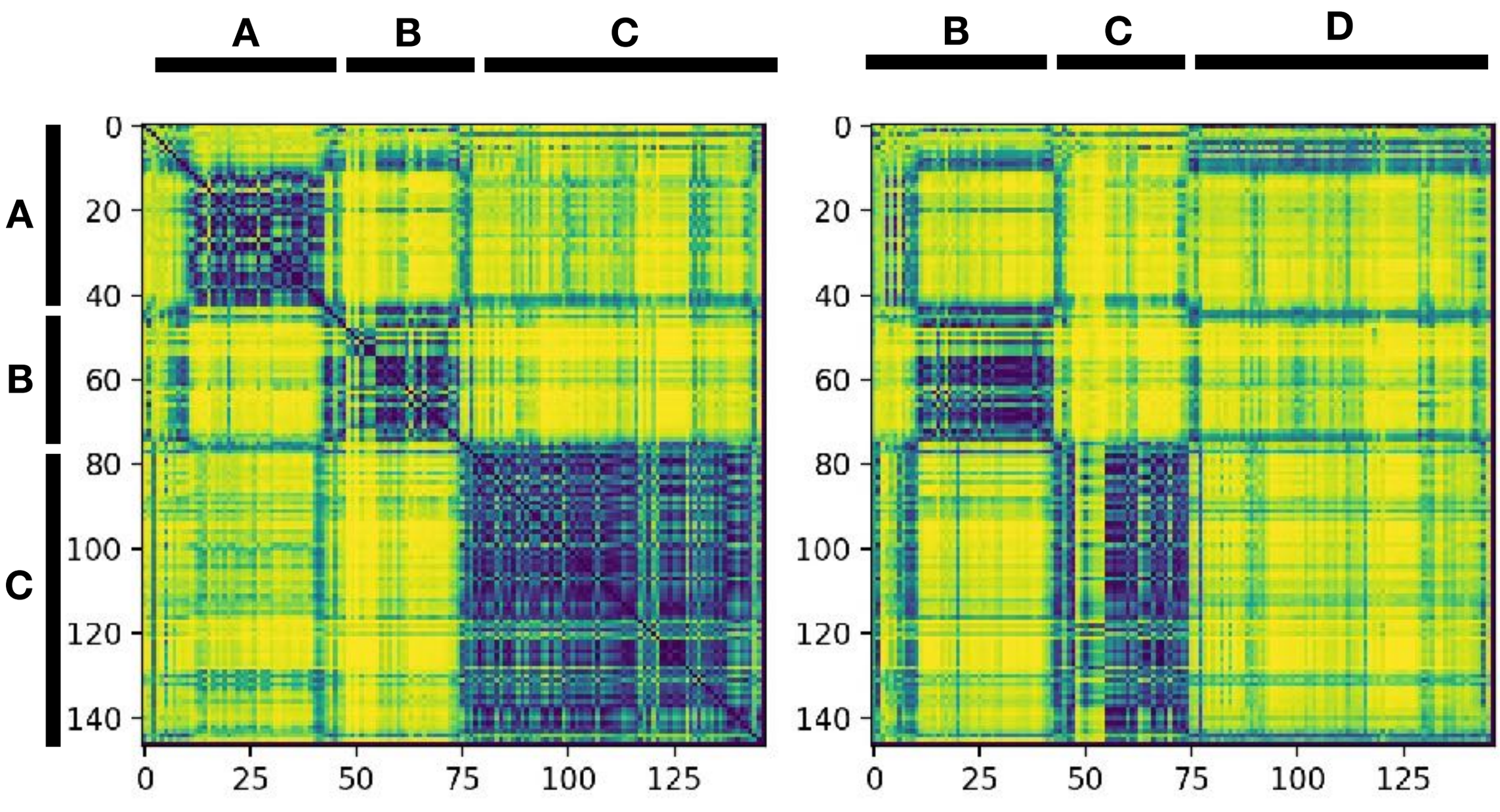
NB:

Feature: cosine distance between windows of madmom's downbeat detection function

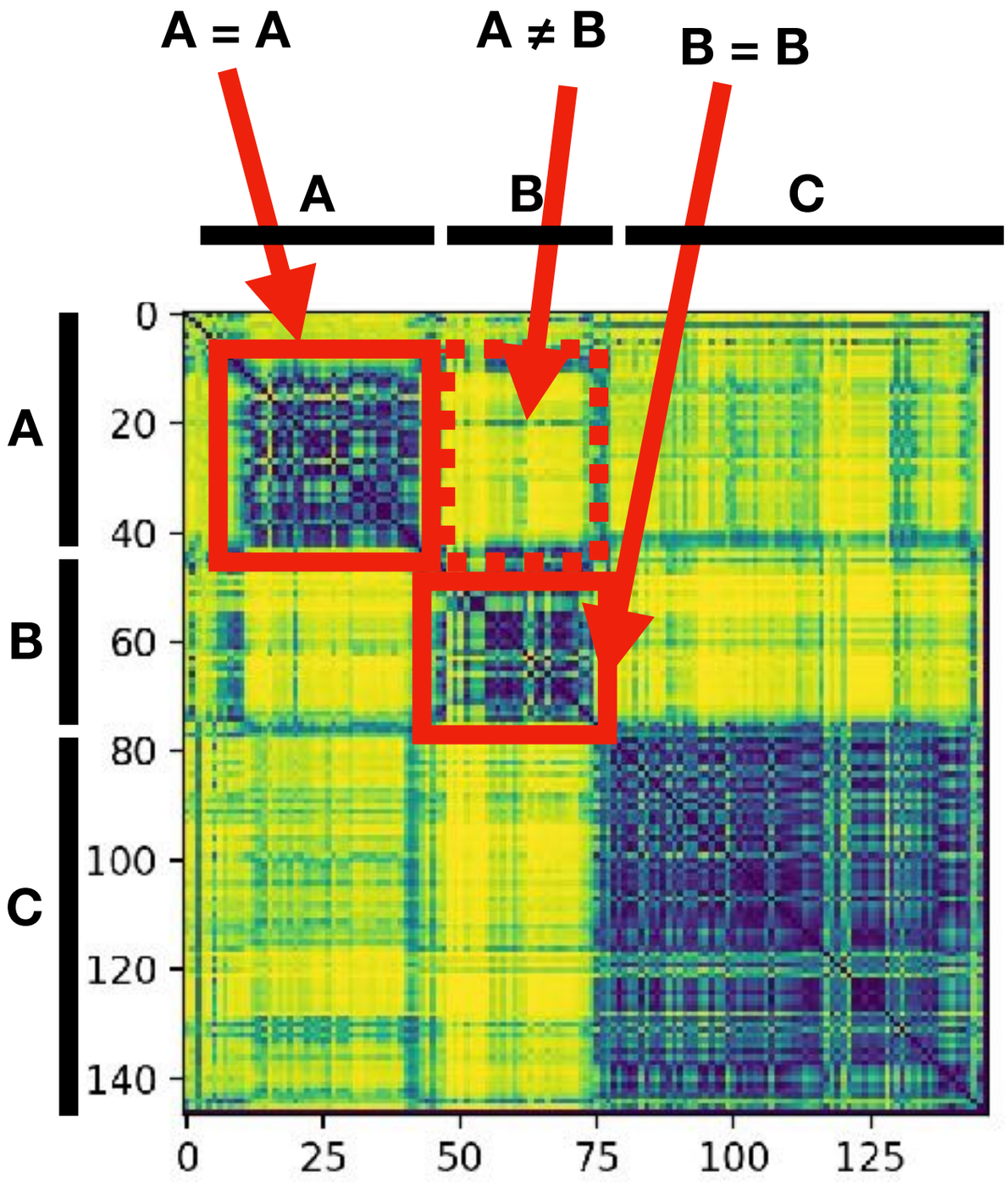
Recall our **bar types**:
A = [1234]
B = [2341]
C = [3412]

Blocks in self-similarity matrix indicates consistent meter

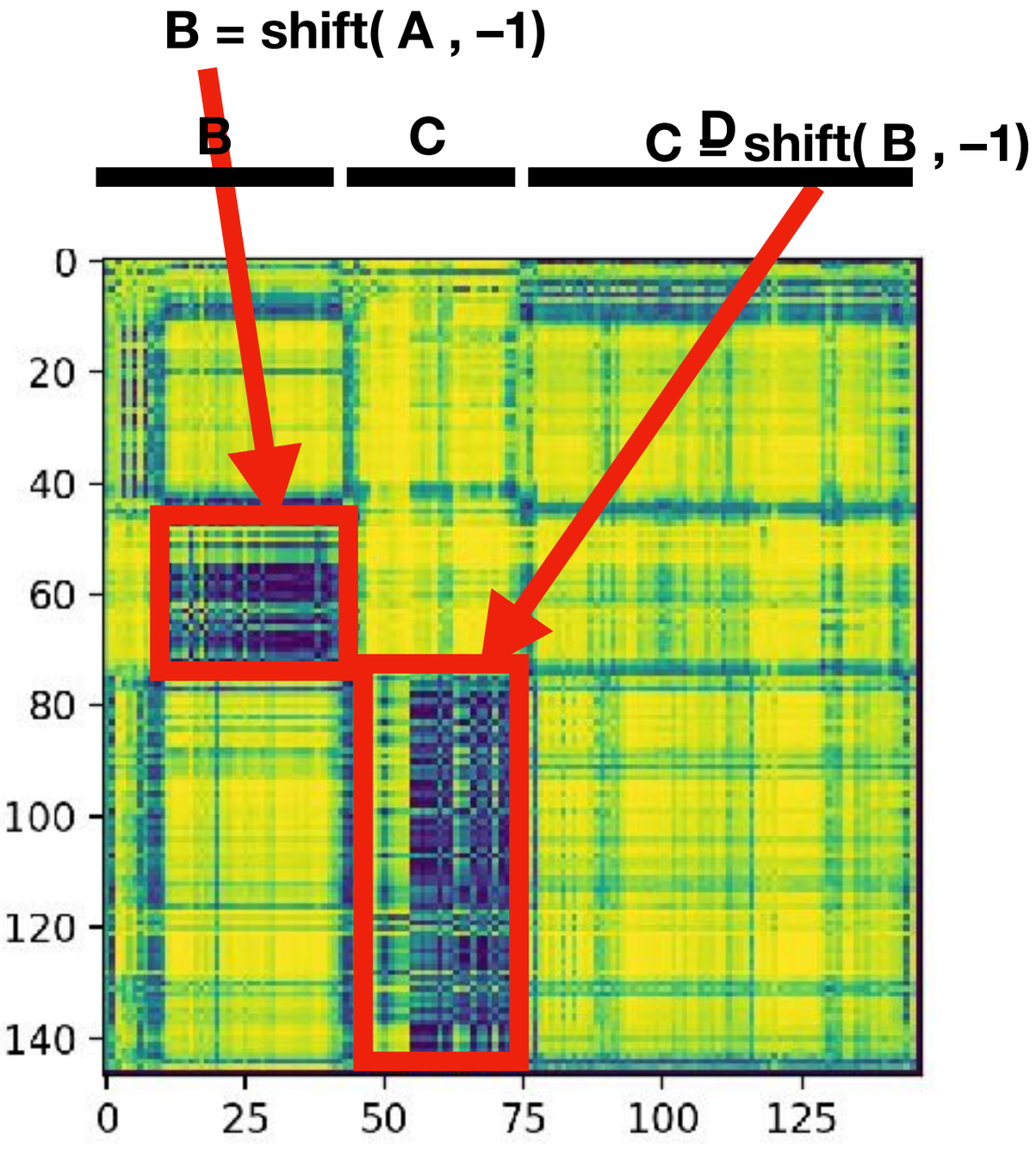
Blocks in cross-similarity matrix indicate consistent meter — with a phase shift



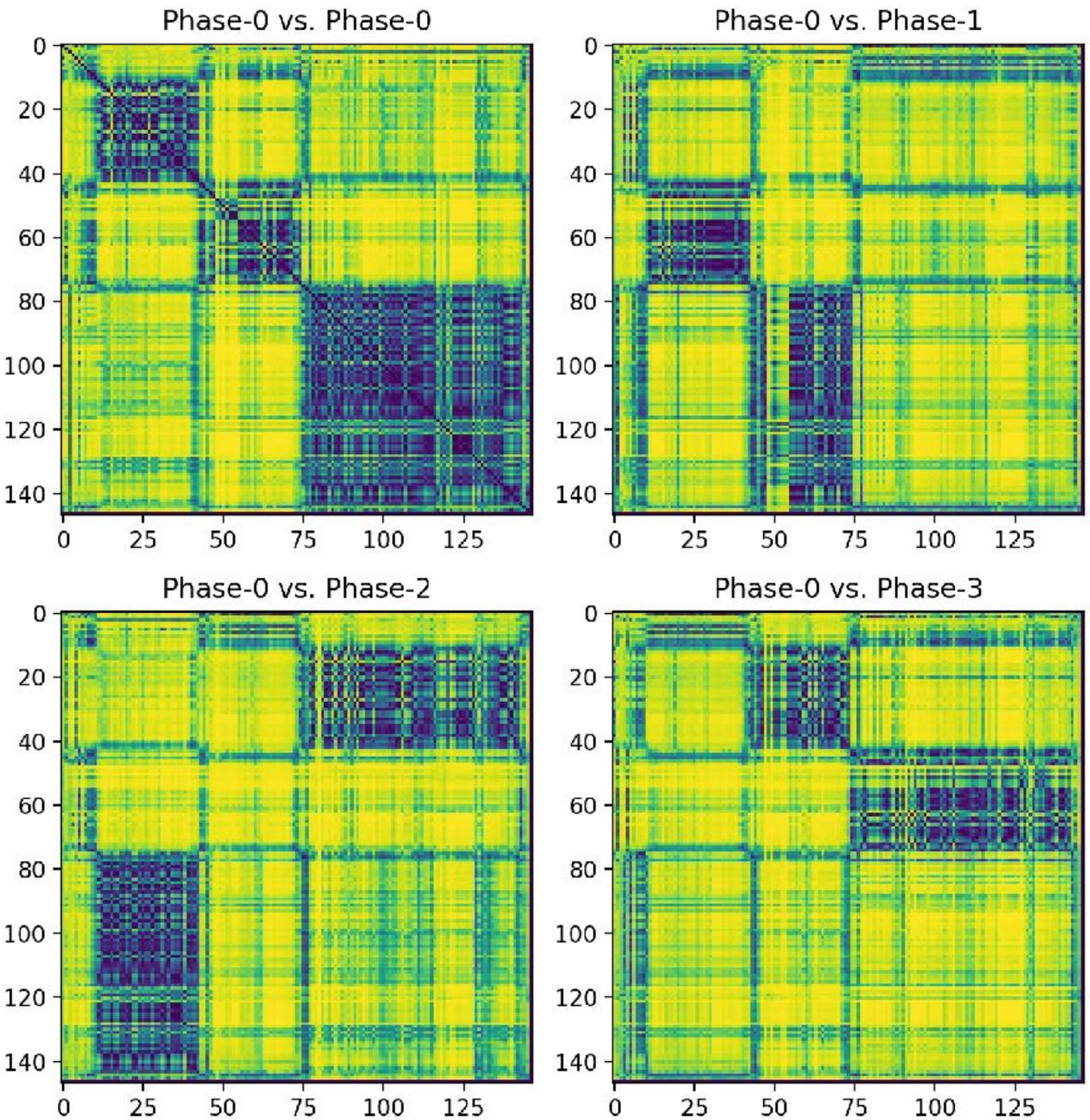
Blocks in self-similarity matrix indicates consistent meter



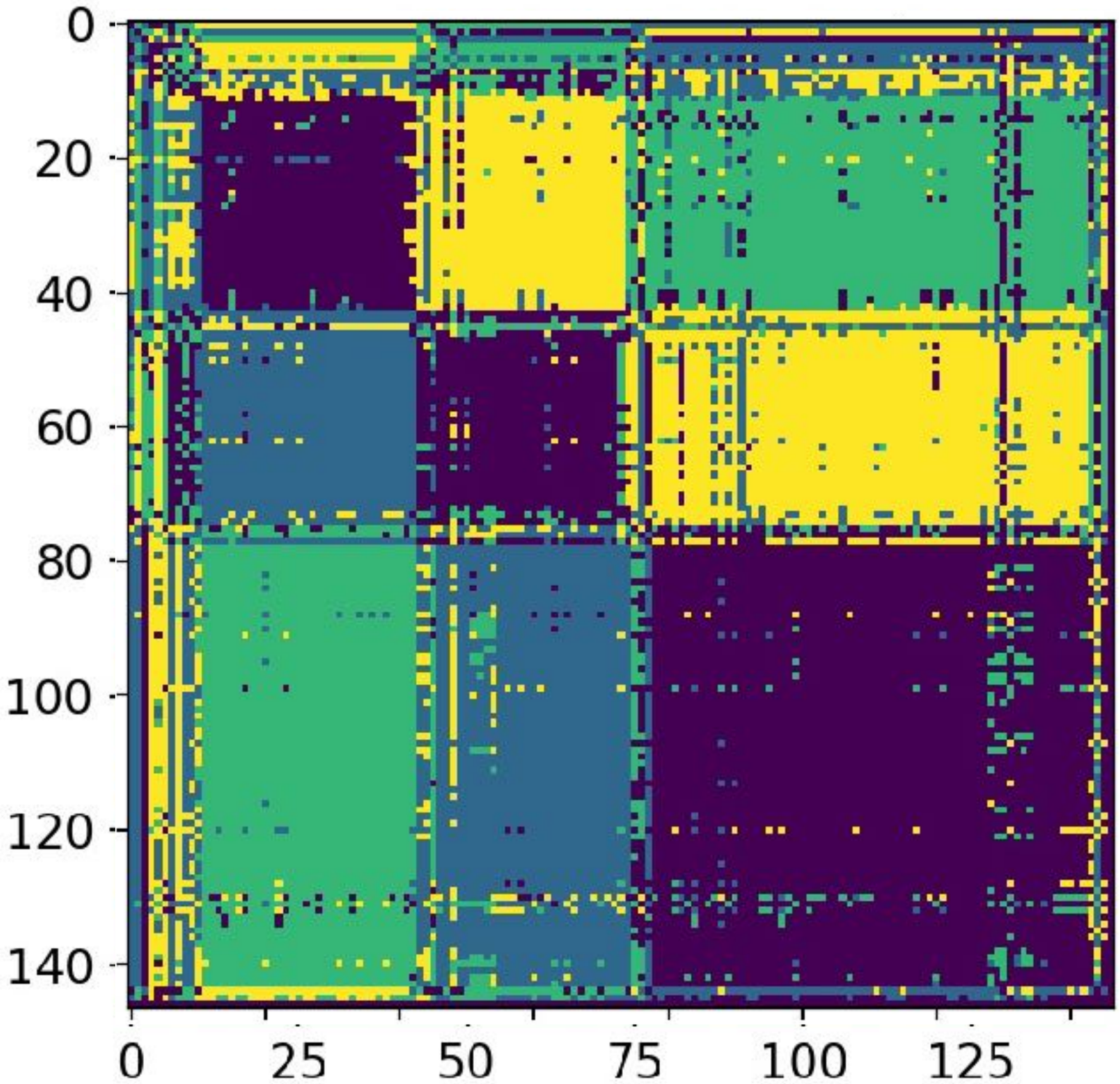
Blocks in cross-similarity matrix indicate consistent meter — with a phase shift



Compute cross-similarity for all possible shifts...

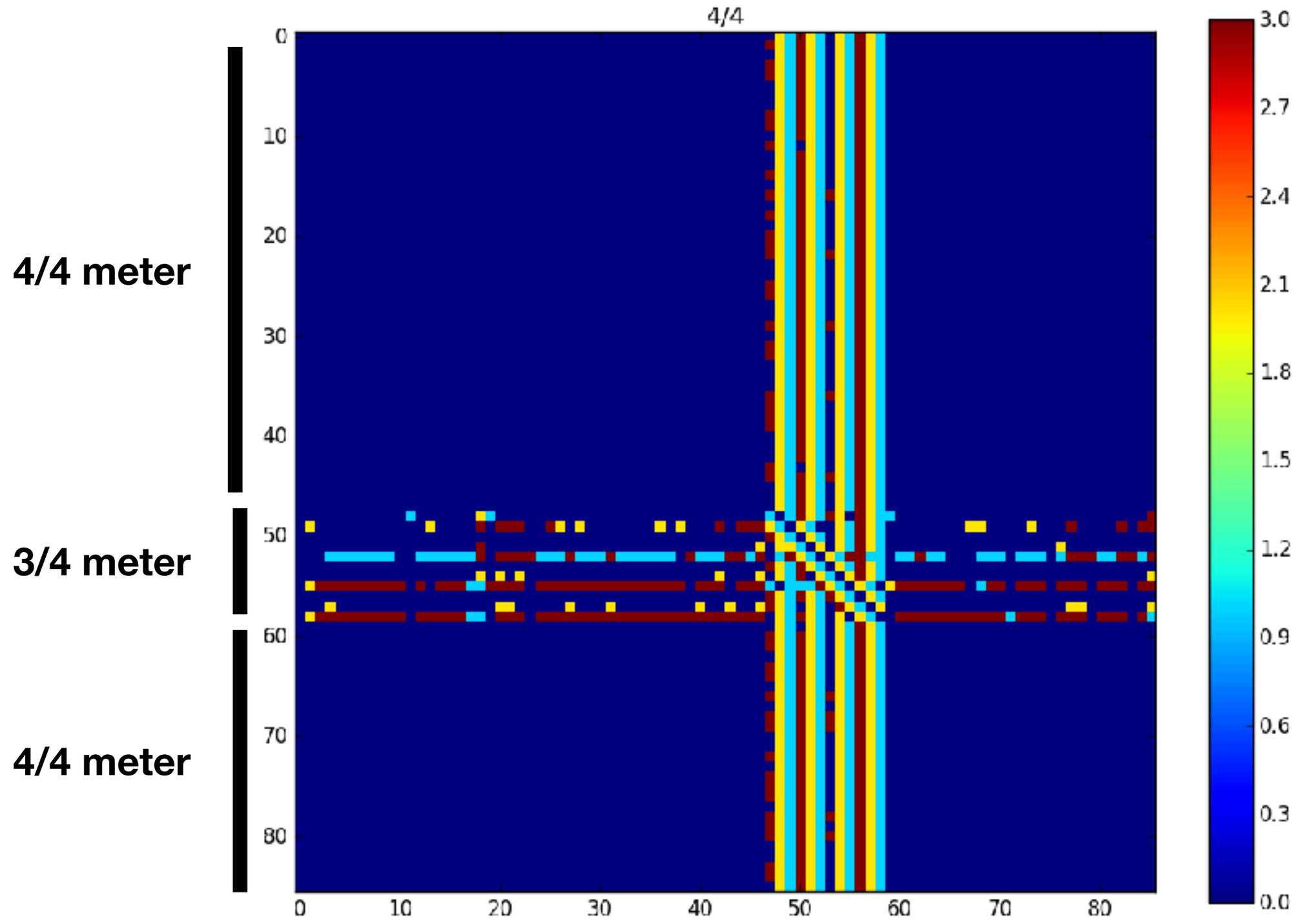


...and take argmin over these matrices to find optimal shifts!



We have assumed 4/4 meter so far.
If the assumed meter is wrong, this method leads to noisy blocks:

“Love Is All” by Roger Glover (sung by Dio)



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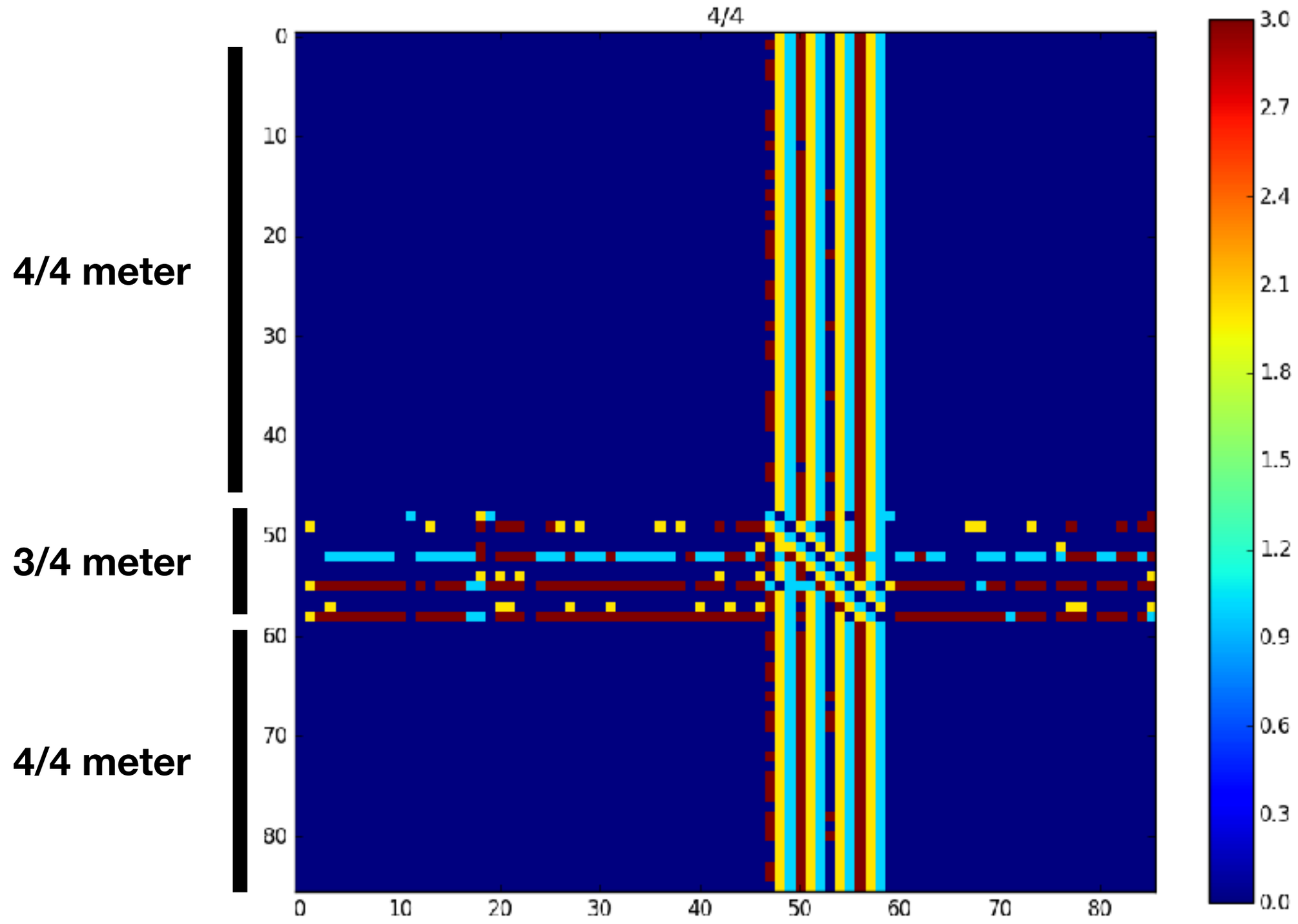
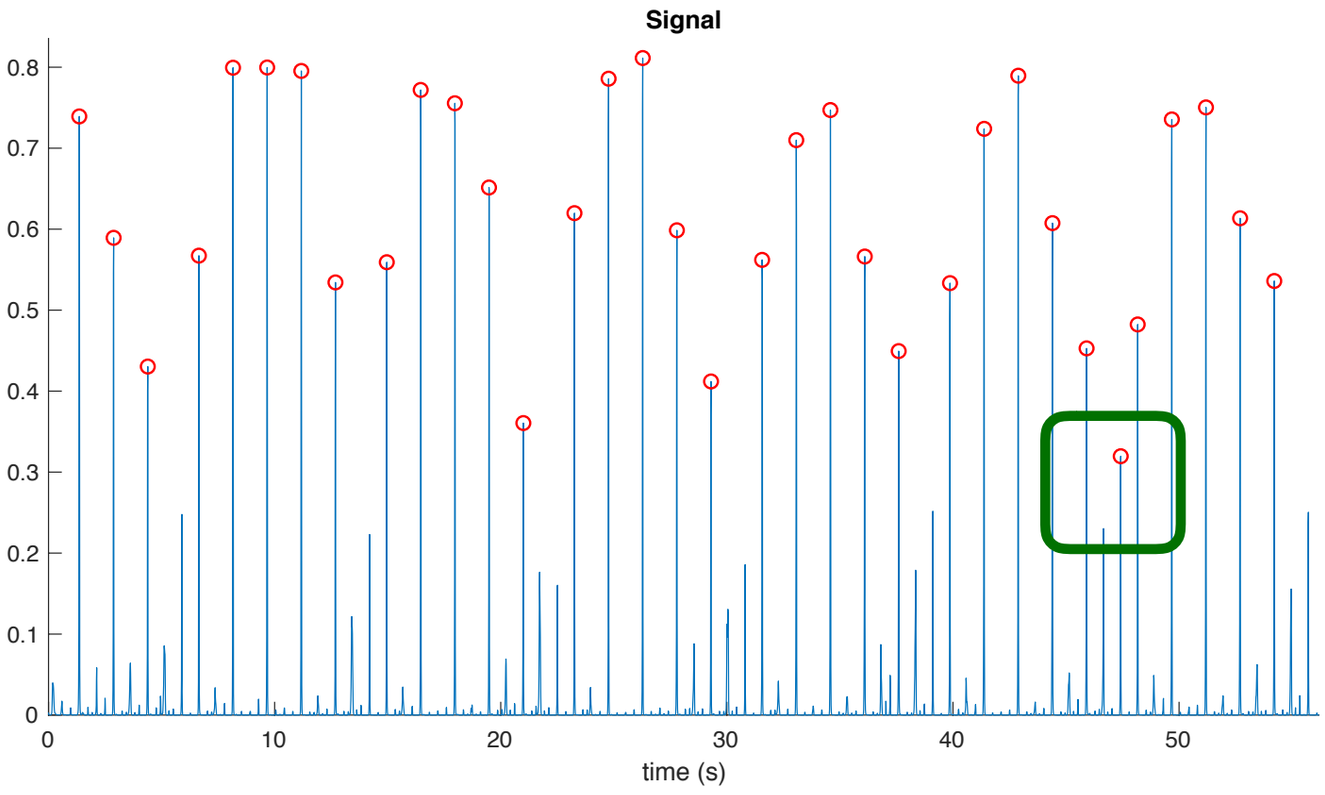


Another proposal: decode the downbeat detection function in a different way, picking peaks based on thresholds and a heuristic rule for fusing neighbouring bars.

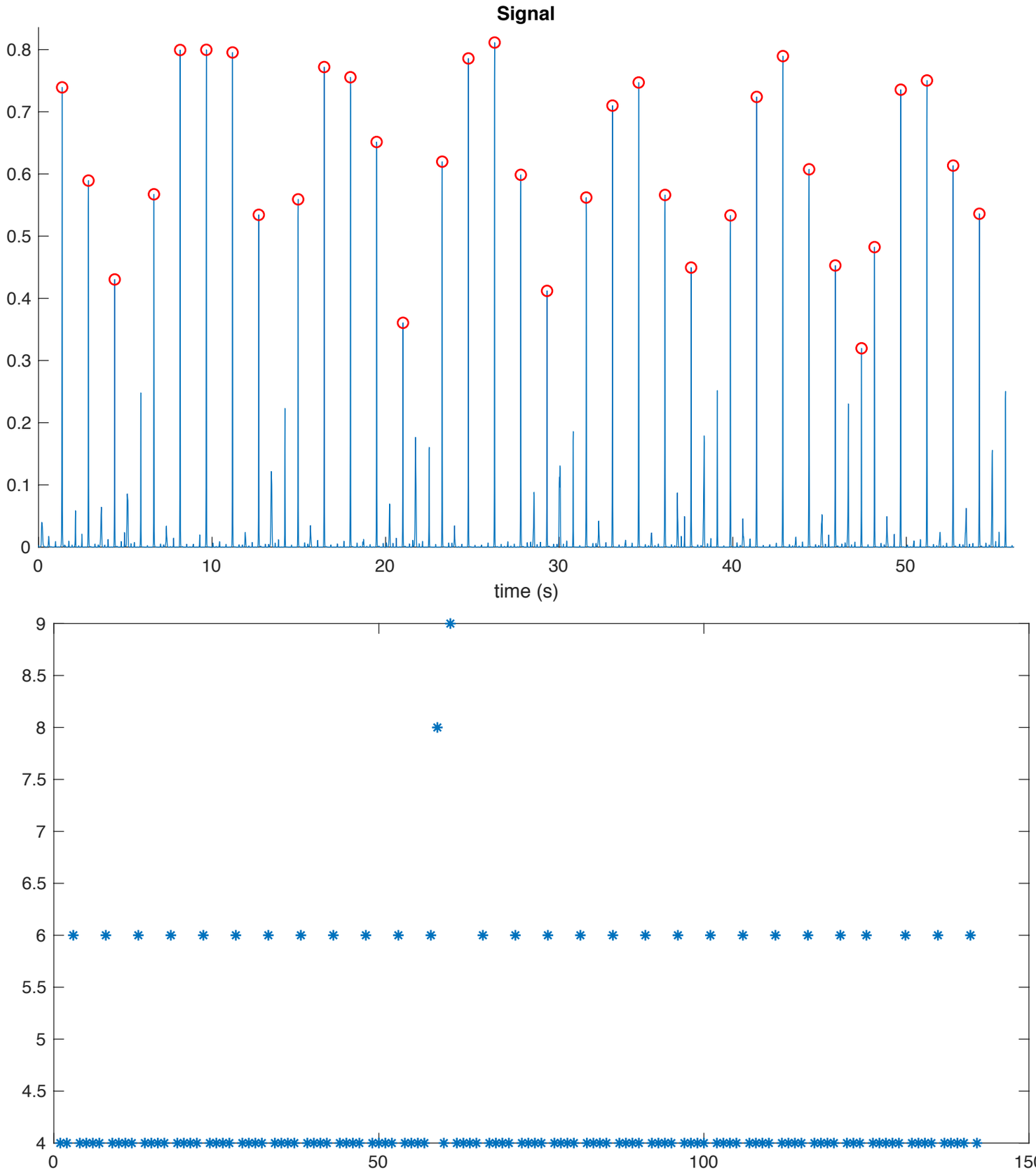


Threshold: 0.33

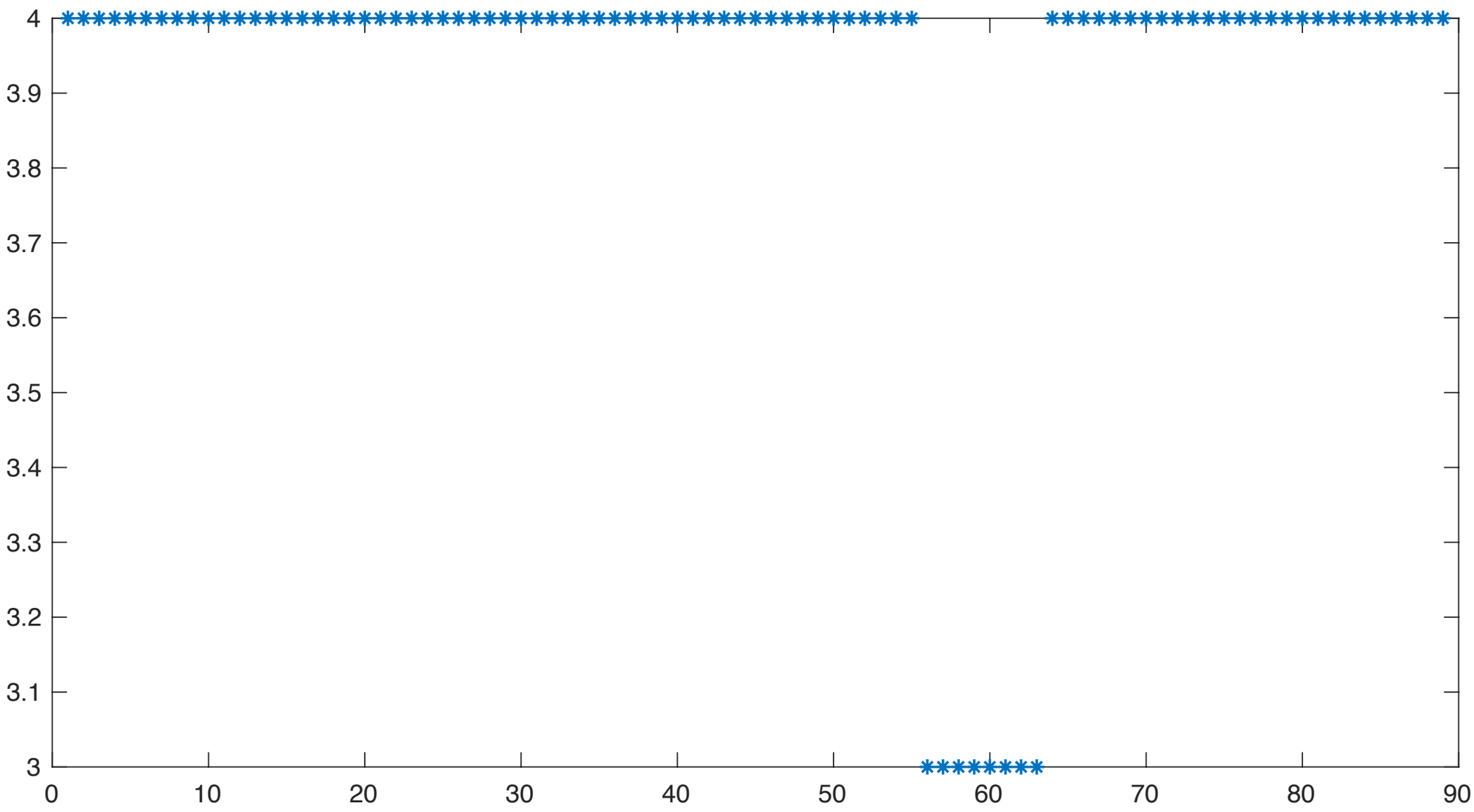
Bar fusion heuristics

Hey Ya

Hey Ya


Signal
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
time (s)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
0
50
100
150

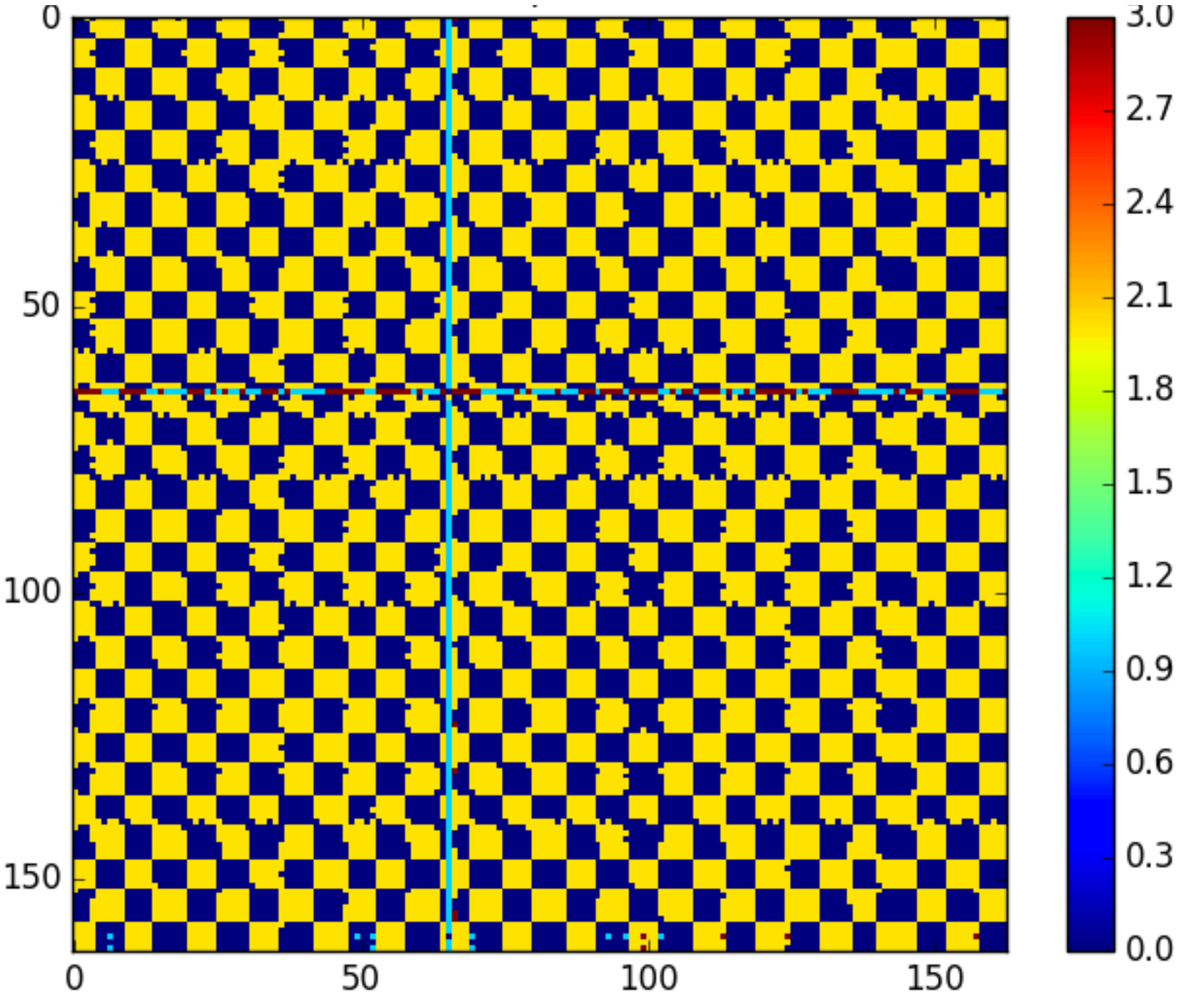
“Love Is All” by Roger Glover (sung by Dio)



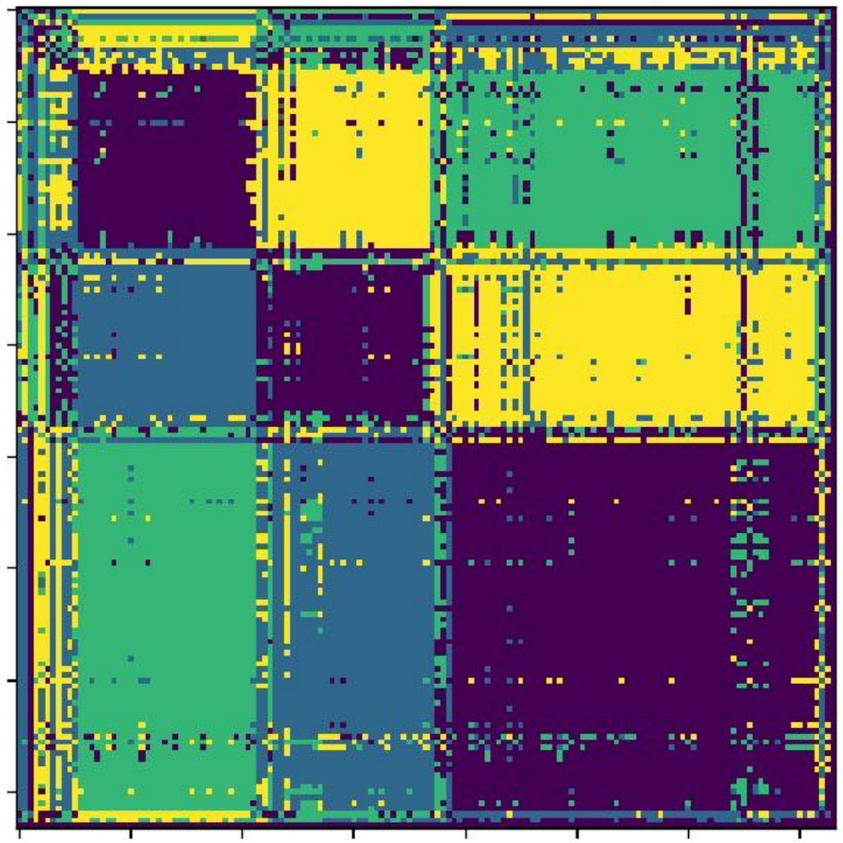
Conclusions

- We propose a new “phase-invariant similarity matrix”,
- Seems promising for detecting bar-length and time-signature anomalies:
    - Isolated odd bars → diagonal blocks
    - New time signatures
      → noisy blocks only where time signature is wrong
      → test with several time signature to get actual local meter
- Future directions:
    - Actually extract local meter all over a song from these matrices

“Hey Ya!” by Outkast



“The Stars” by Jukebox the Ghost



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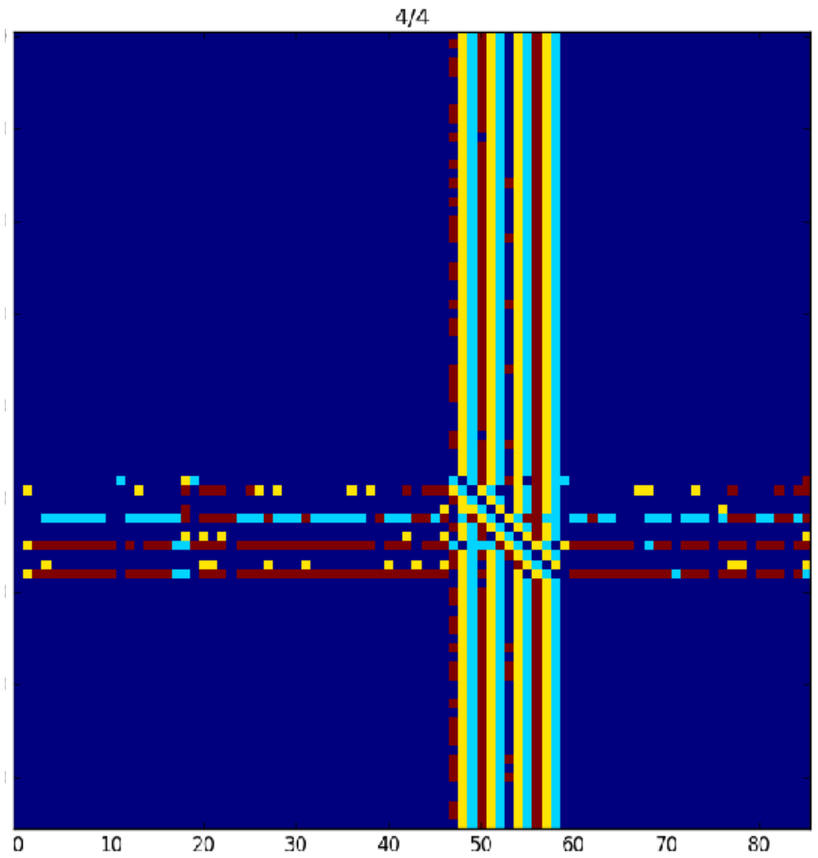

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