

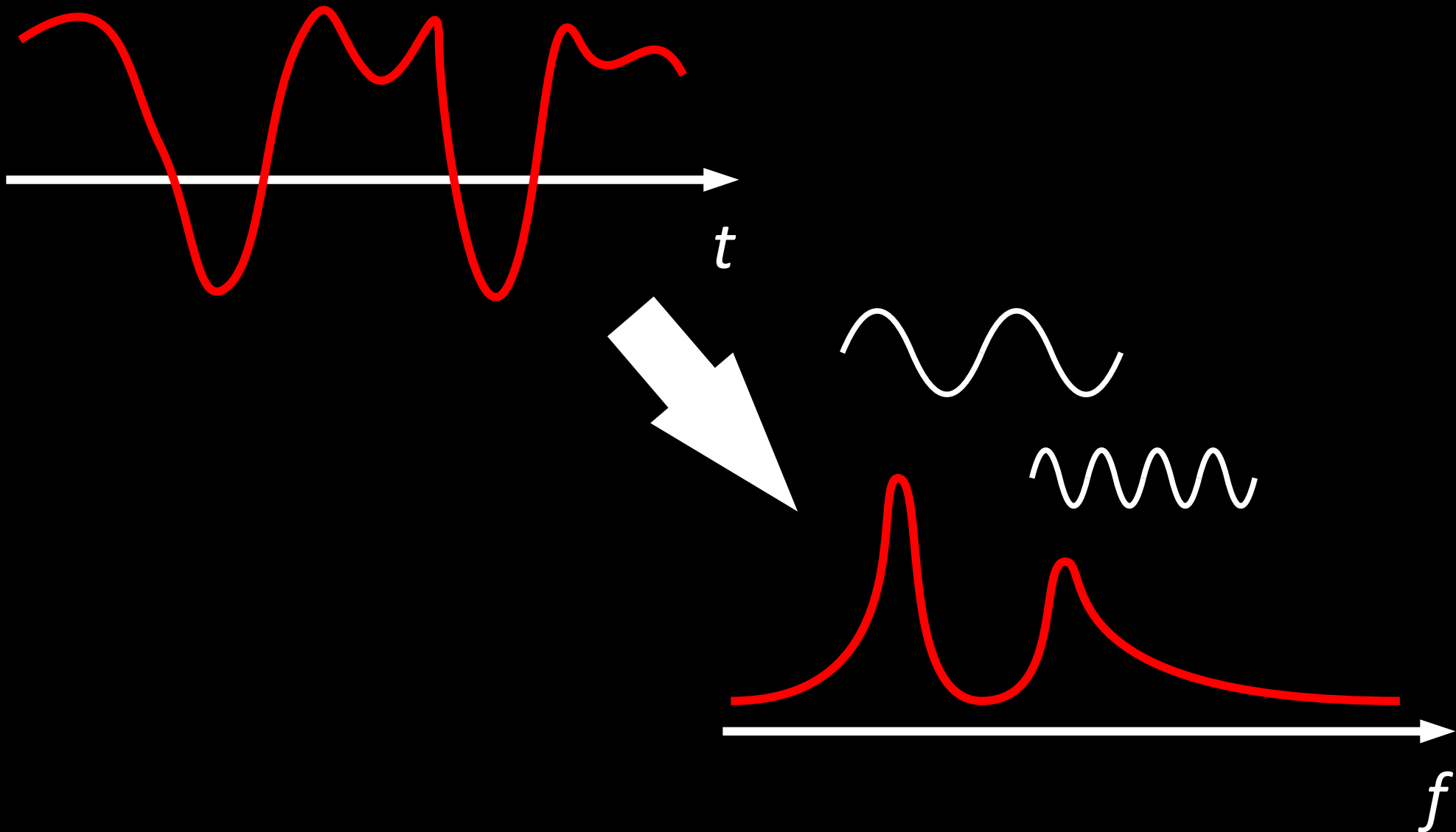
Spectral Synthesis of Rhythms

Jörn Loviscach

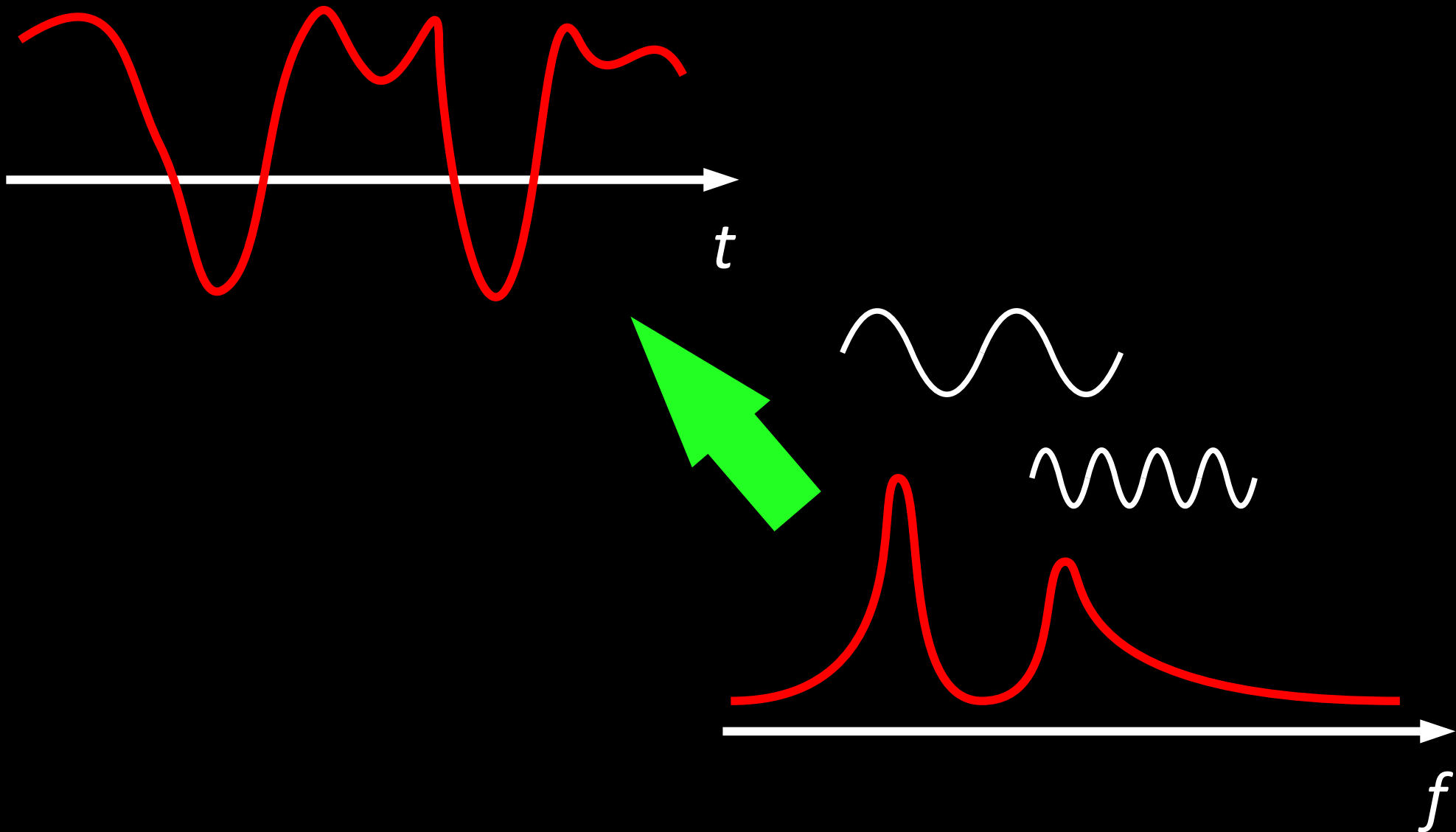
Fachhochschule Bielefeld, Germany
(University of Applied Sciences)

An analogy

Spectral analysis of waveforms



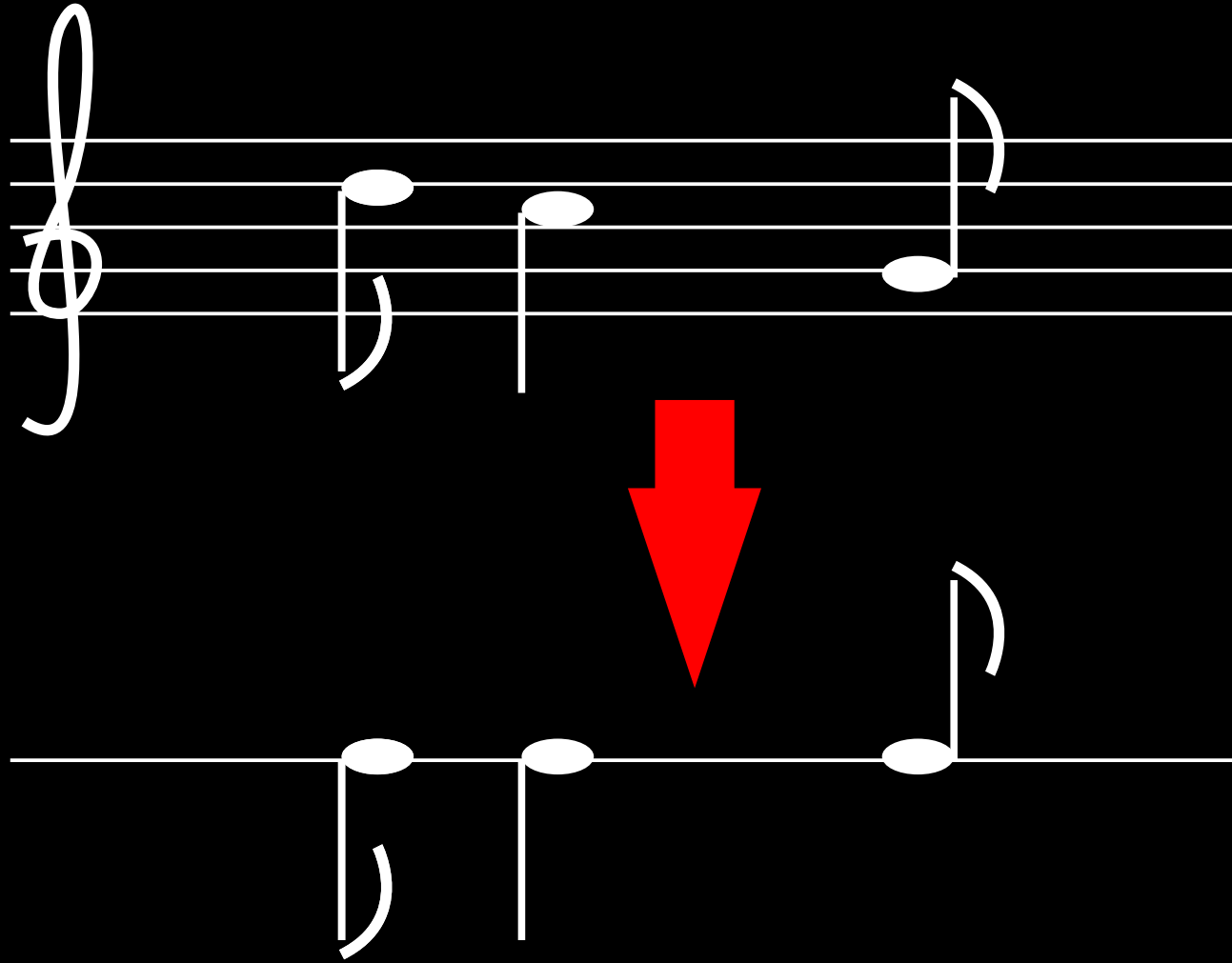
Spectral **synthesis** of waveforms



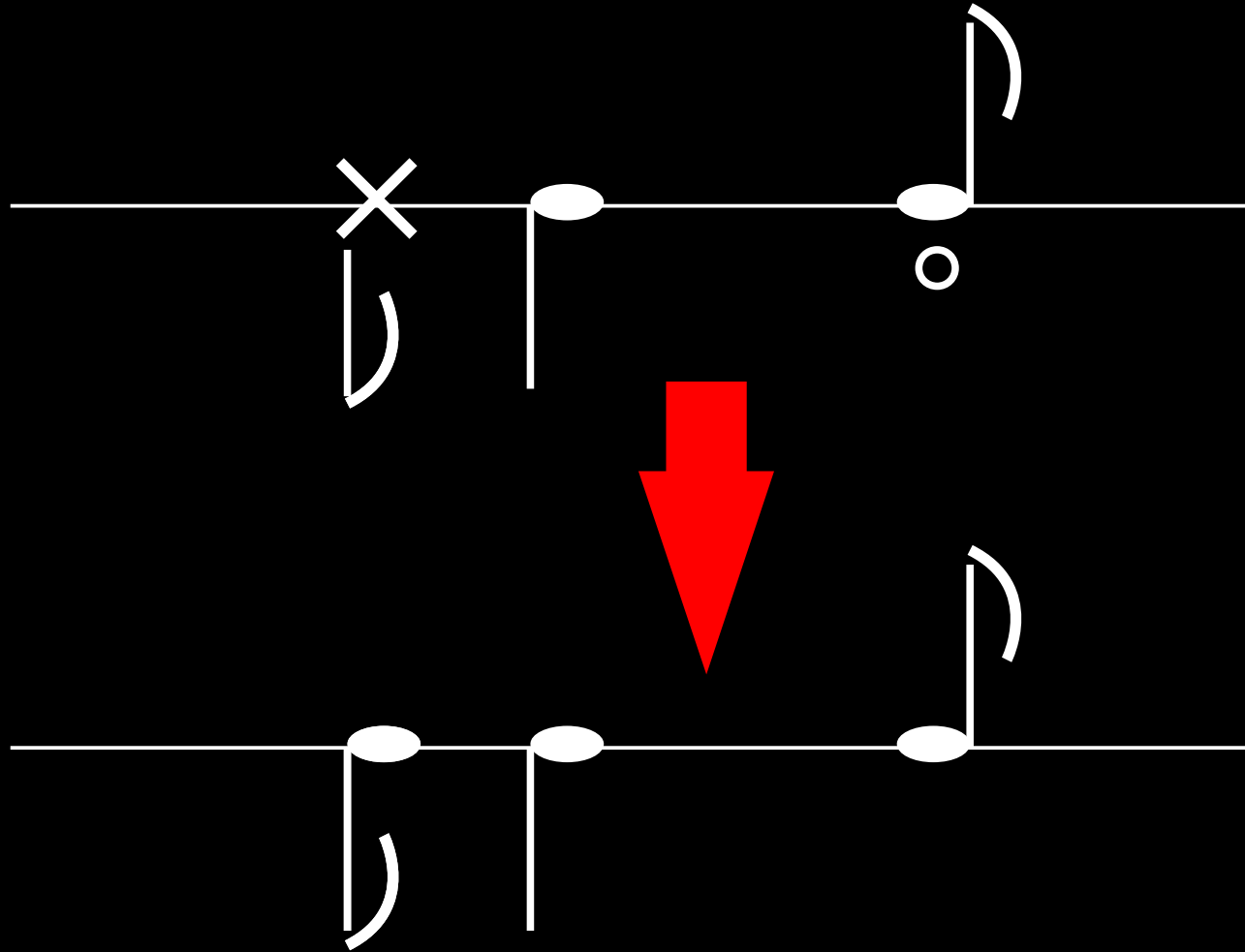
Can we do the same for rhythms?

What is a rhythm?

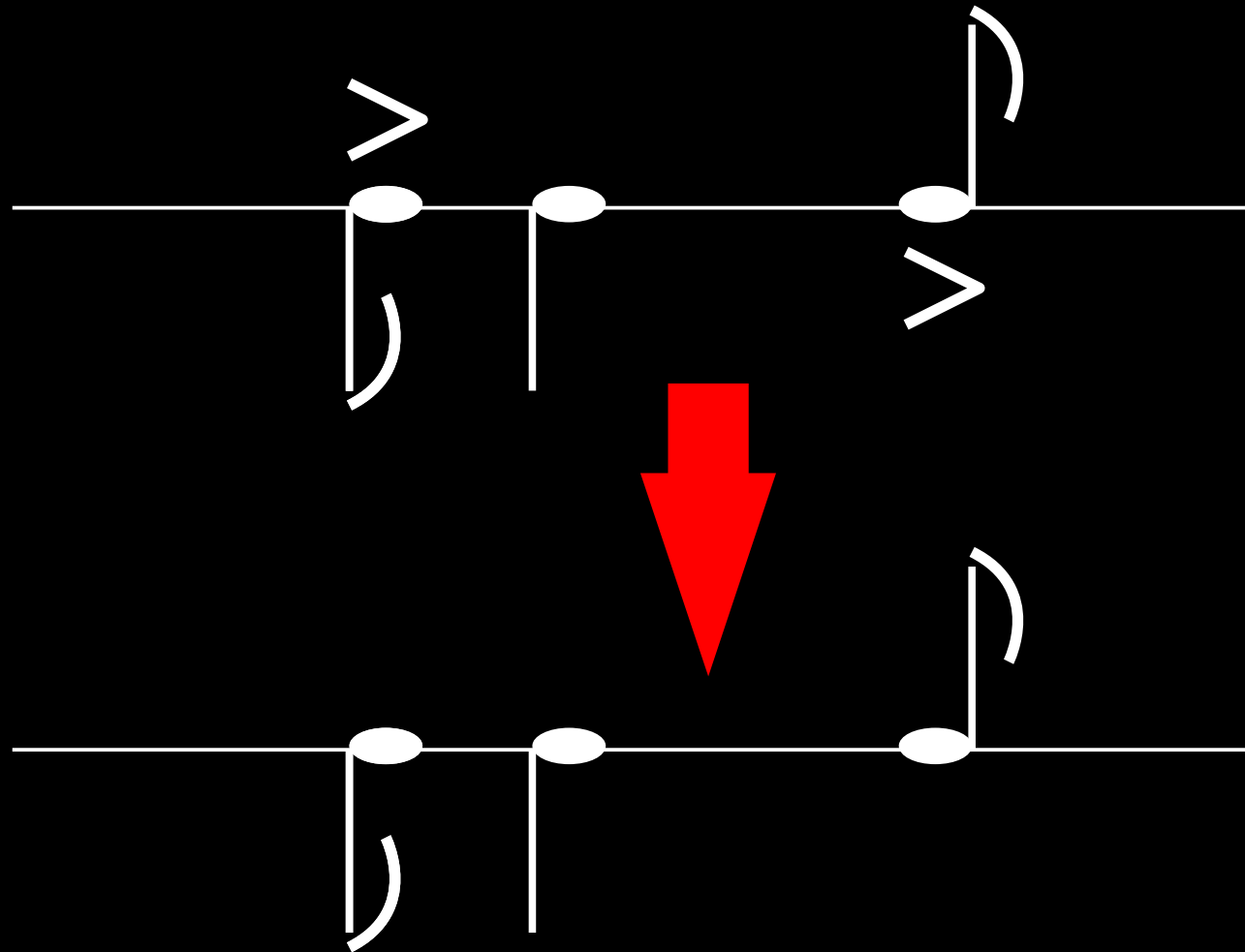
No pitch



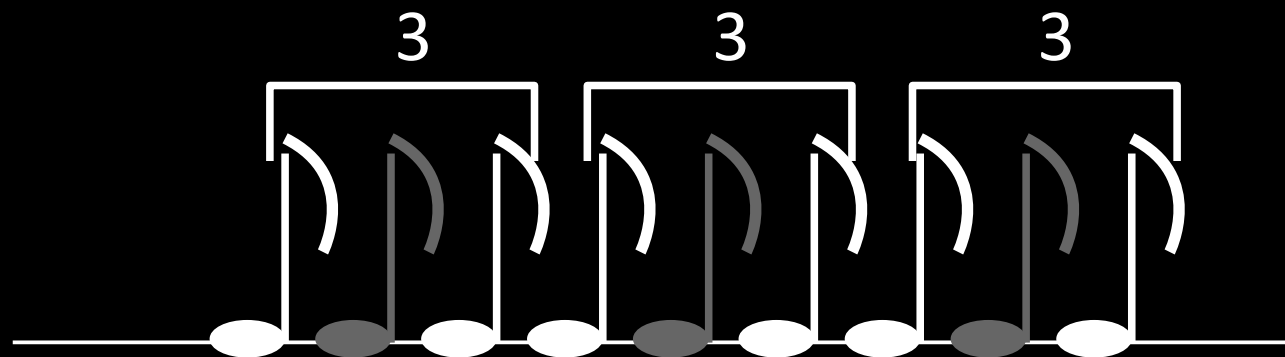
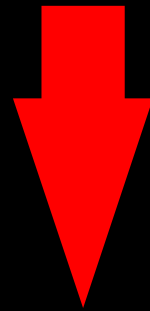
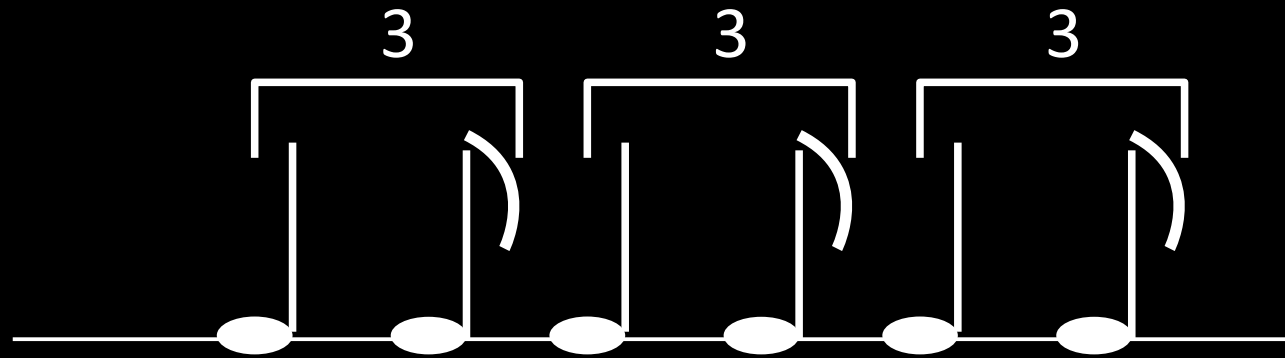
No timbre



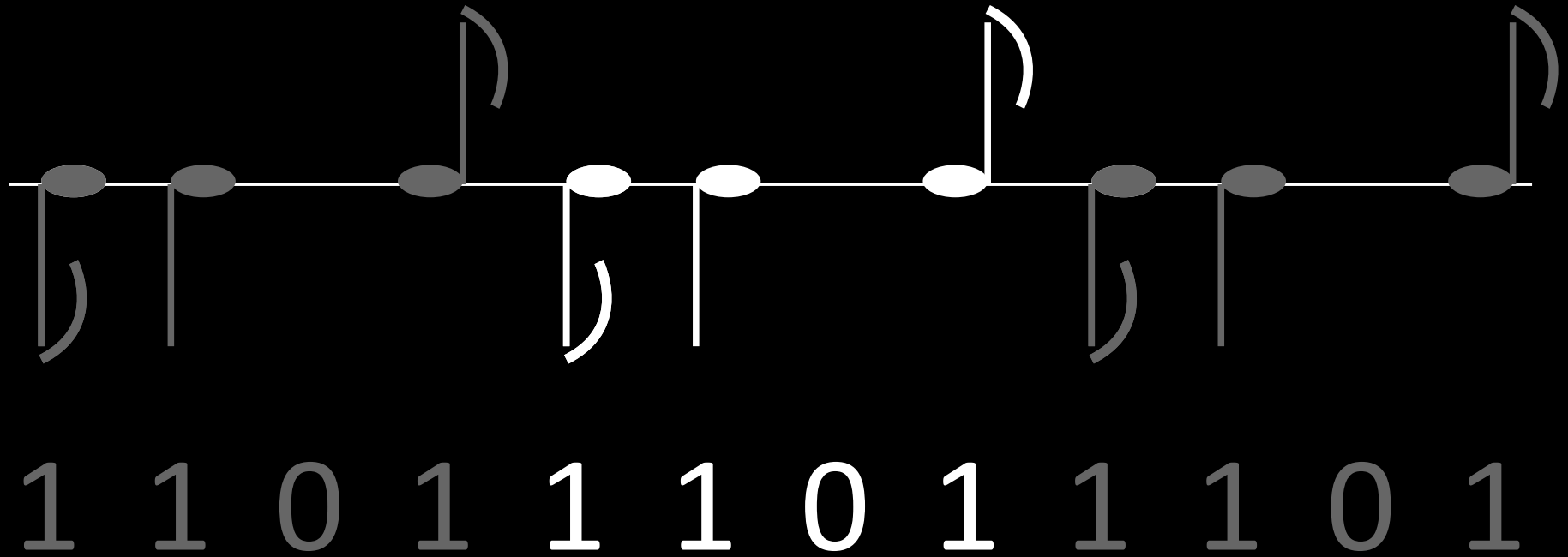
No accents



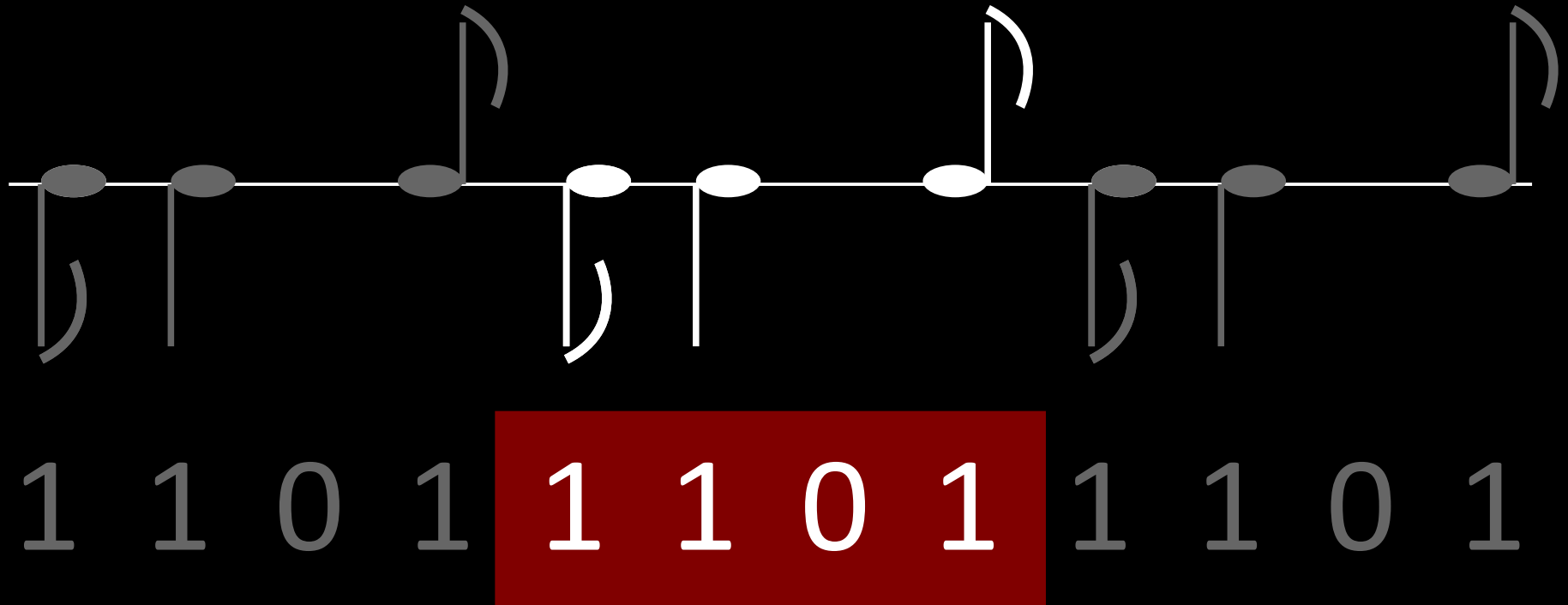
Regular grid



Only rests and onsets

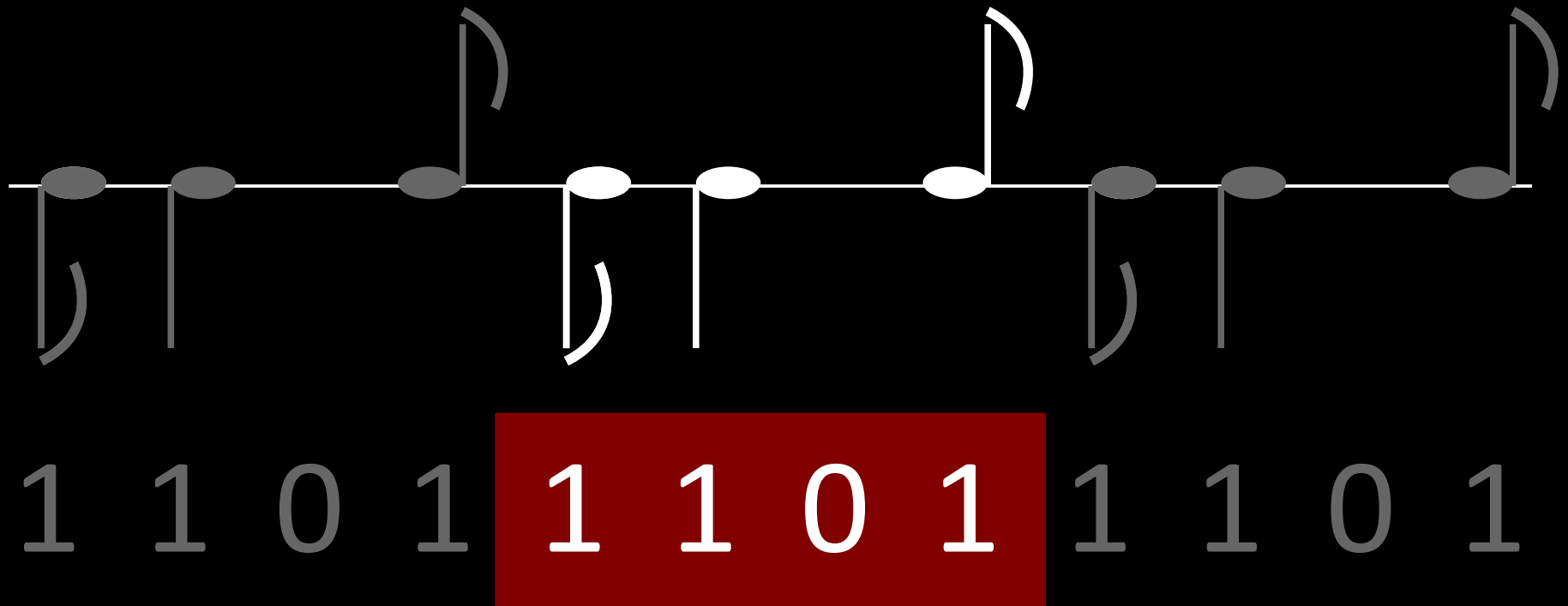


Only rests and onsets



A string of ones and zeros,
repeated indefinitely

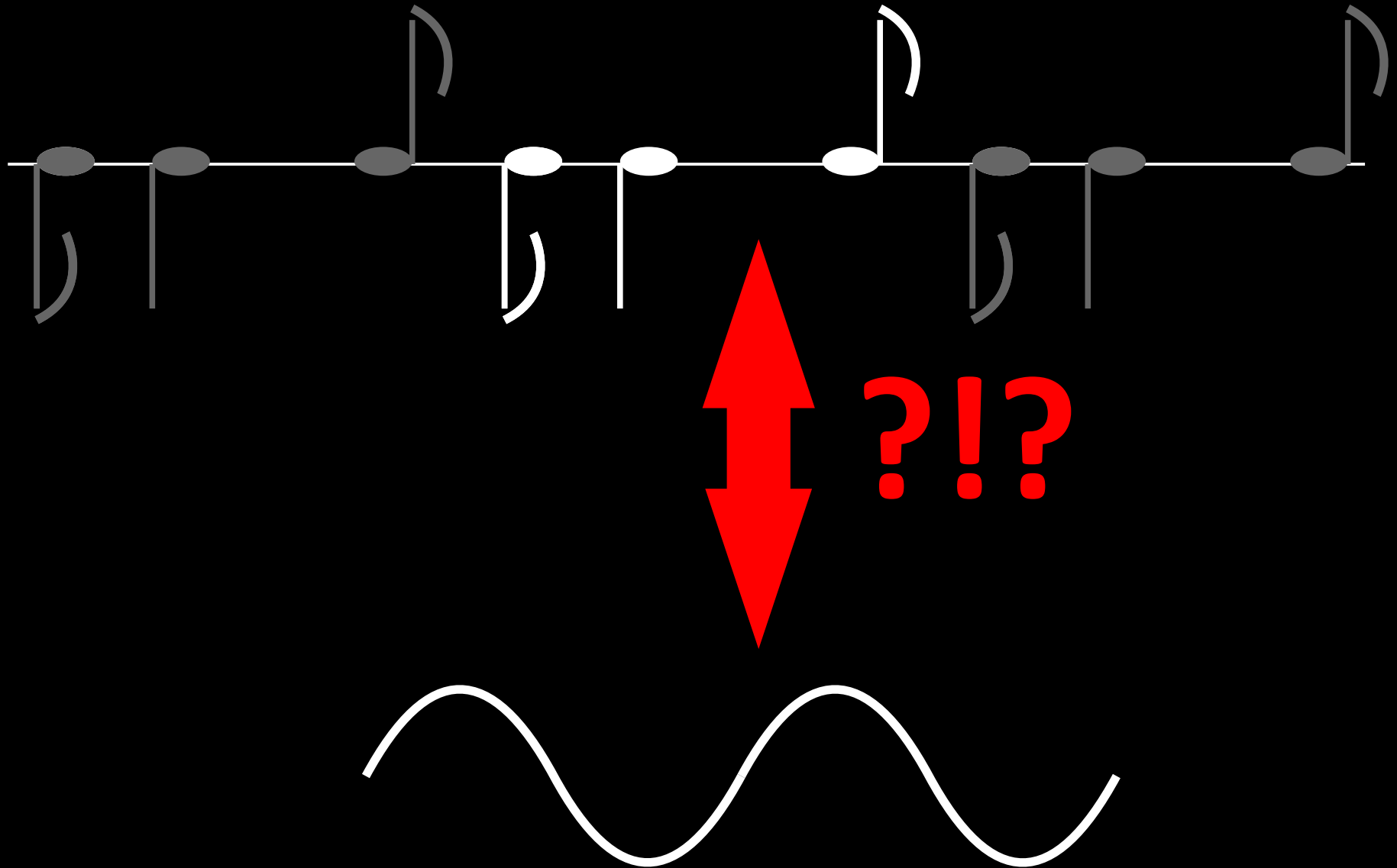
Only rests and onsets



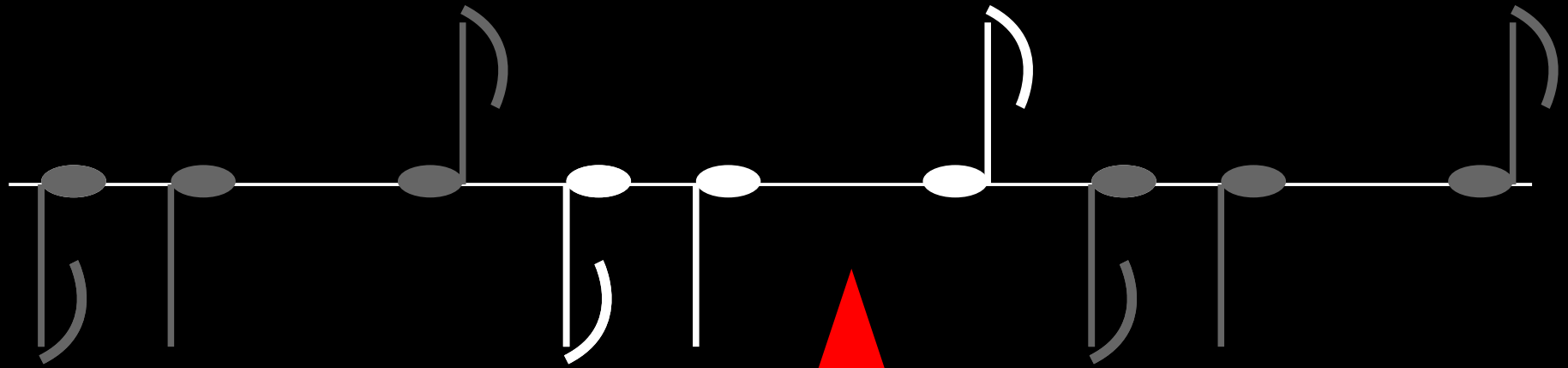
Or: a binary number

What is the spectrum of a rhythm?

Sinusoidal waves?



Harmonics?



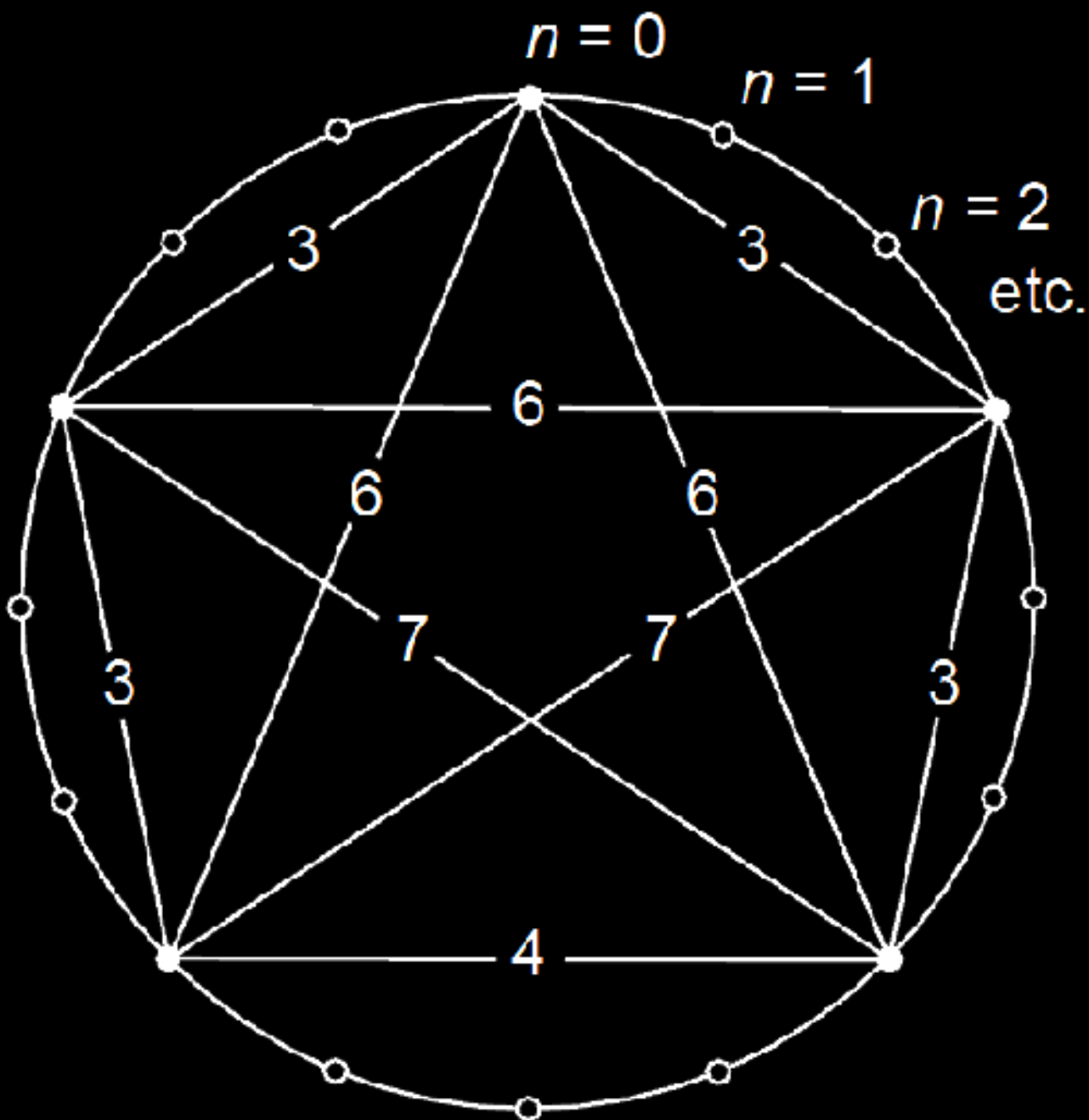
? ! ?

$5f$



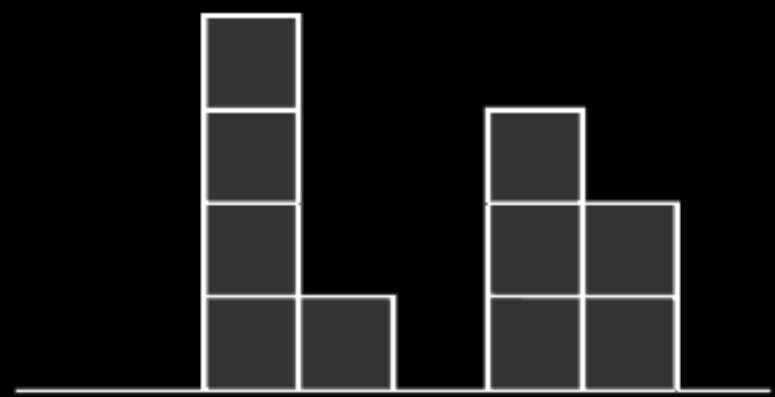
Inter-onset duration histogram

See paper
for literature



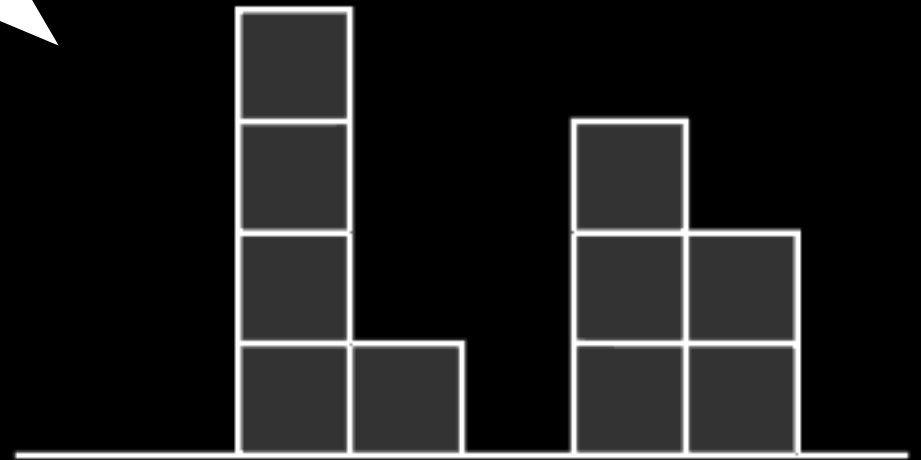
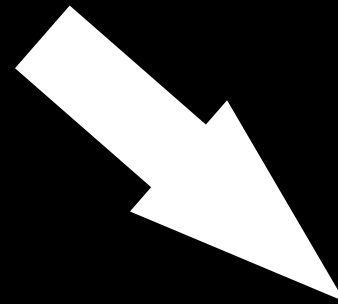
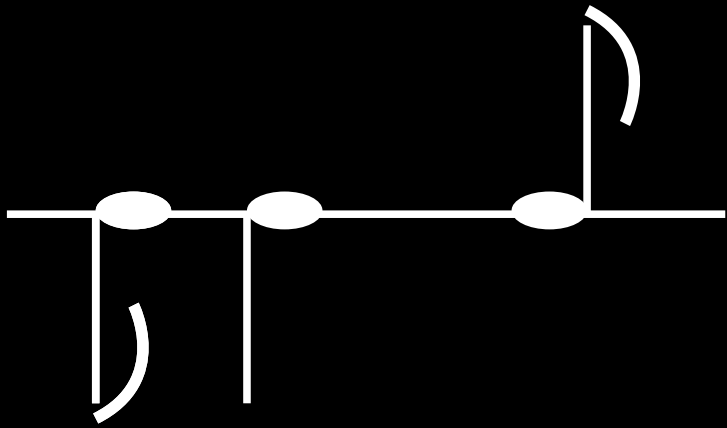
1001001000100100

Inter-Onset Duration Histogram

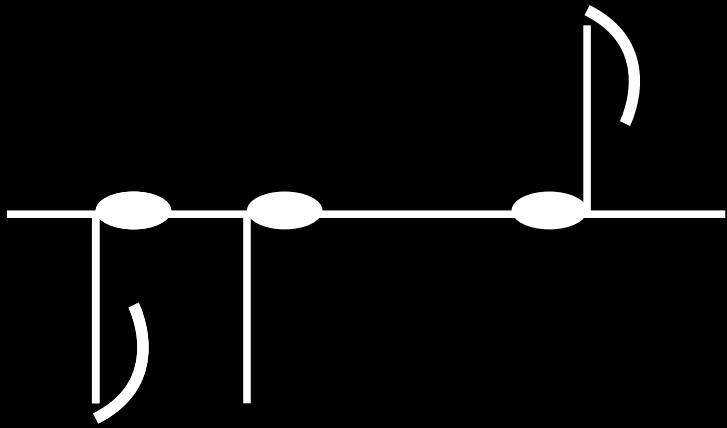


$d = 1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8$

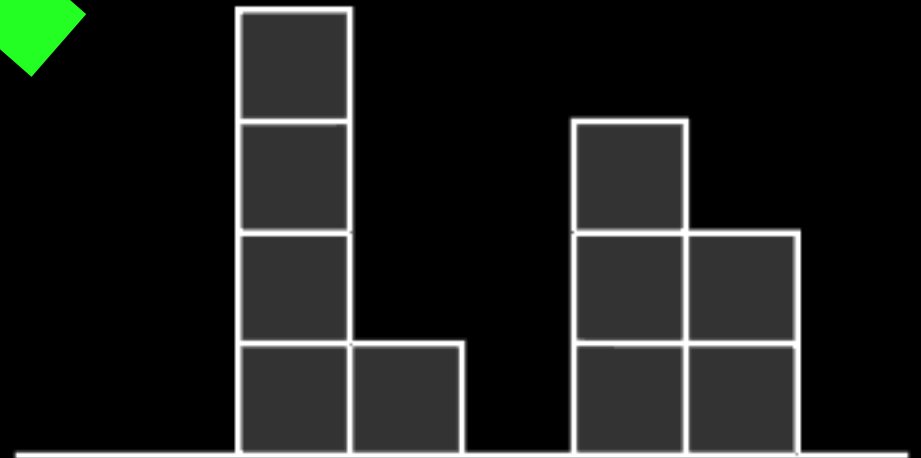
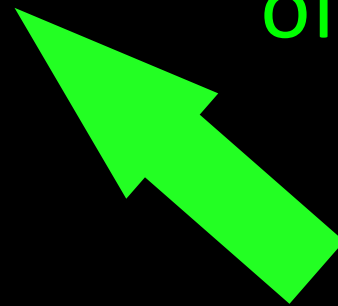
Spectral analysis of rhythms



Spectral **synthesis** of rhythms



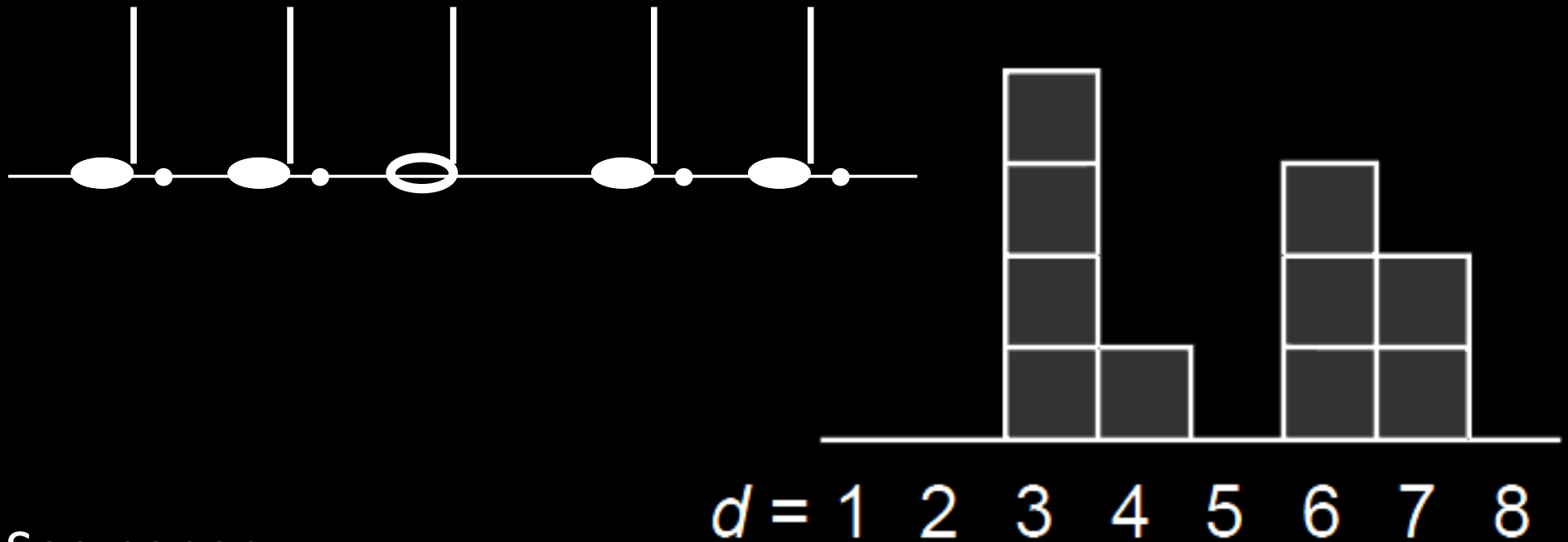
The objective
of this work



Why is that helpful?

Why is that helpful?

Many traditional rhythms
have interesting histograms



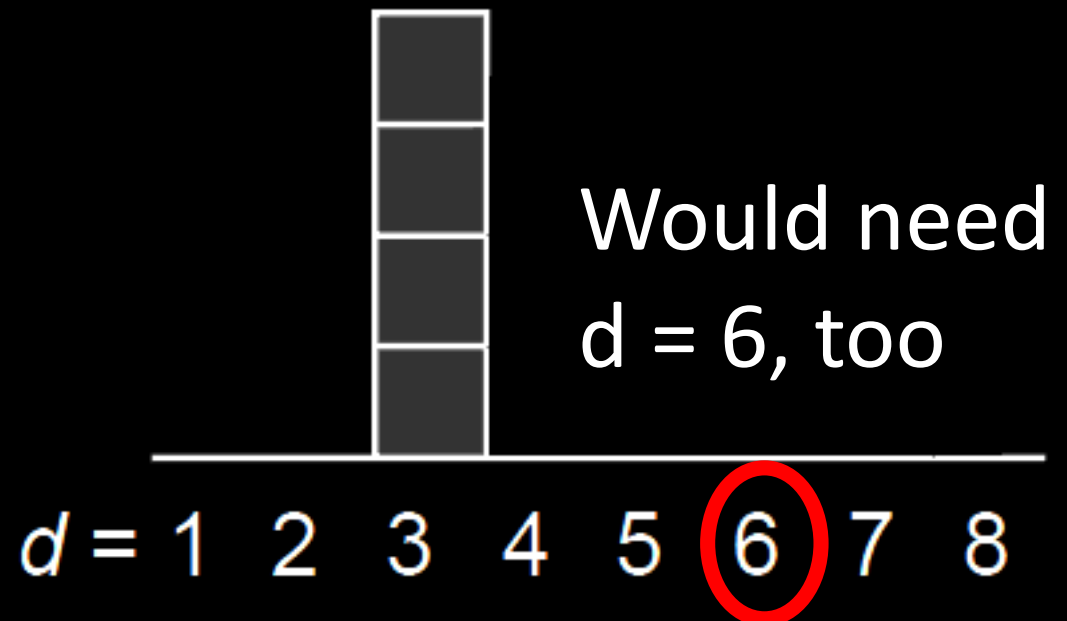
See paper
for literature

Why is that helpful?

- Design rhythms from scratch:
 histogram
 → rhythm
- Find variations to existing rhythms:
 existing rhythm
 → histogram
 → edited histogram
 → new rhythm

Why is that difficult? (1)

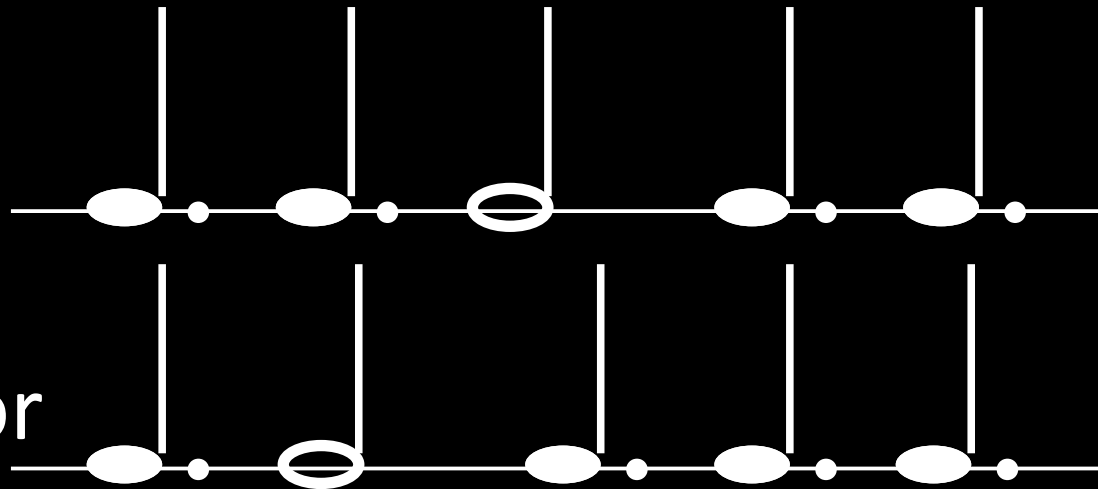
- Most histograms do not correspond to a rhythm



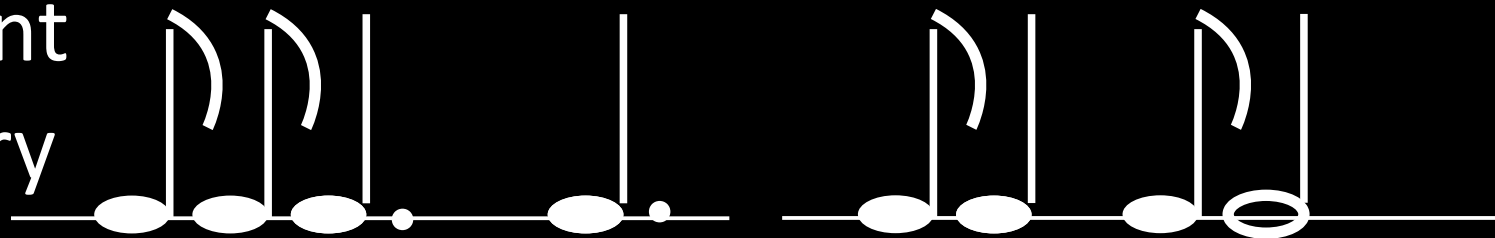
Why is that difficult? (2)

- Many rhythms correspond to the same histogram

Shift/mirror



Incongruent homometry



Why is that difficult? (3)

- Combinatorial explosion:

length = n

number of onsets = k

number of potential rhythms =

$$\binom{n}{k}$$

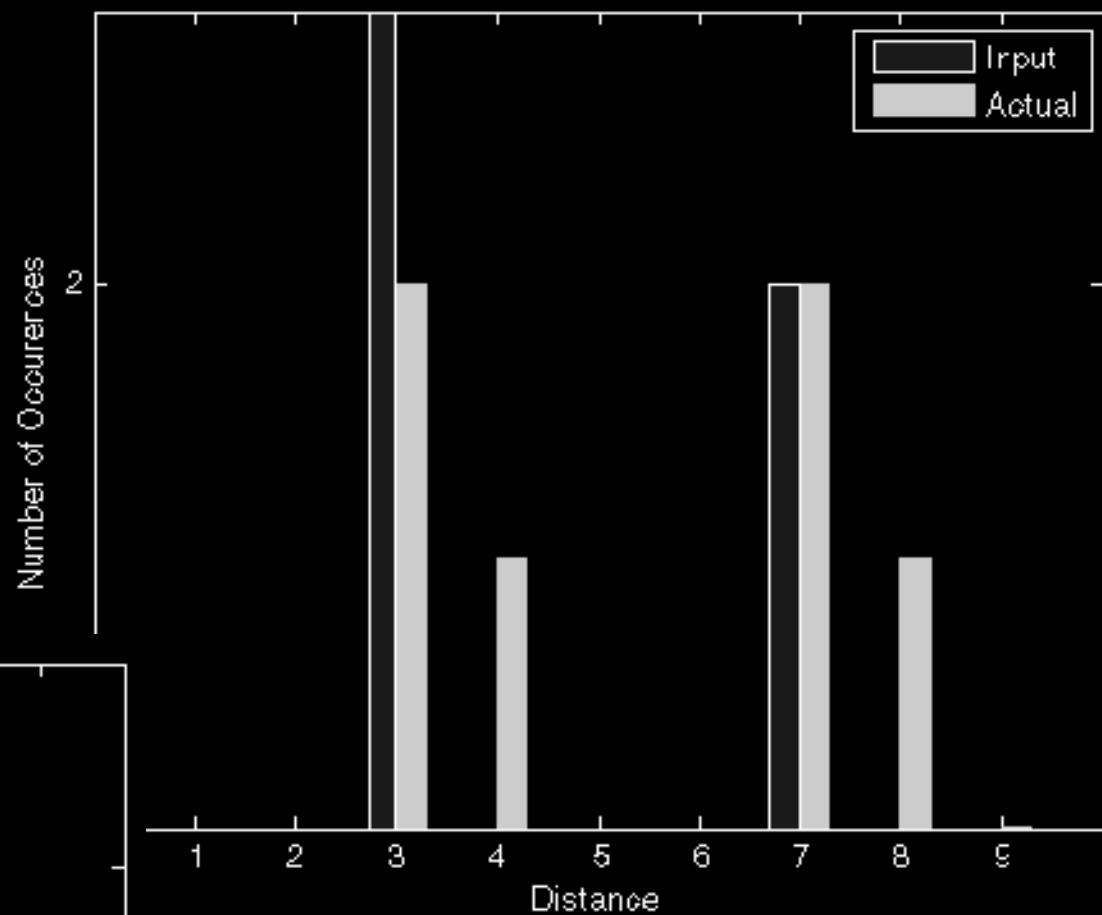
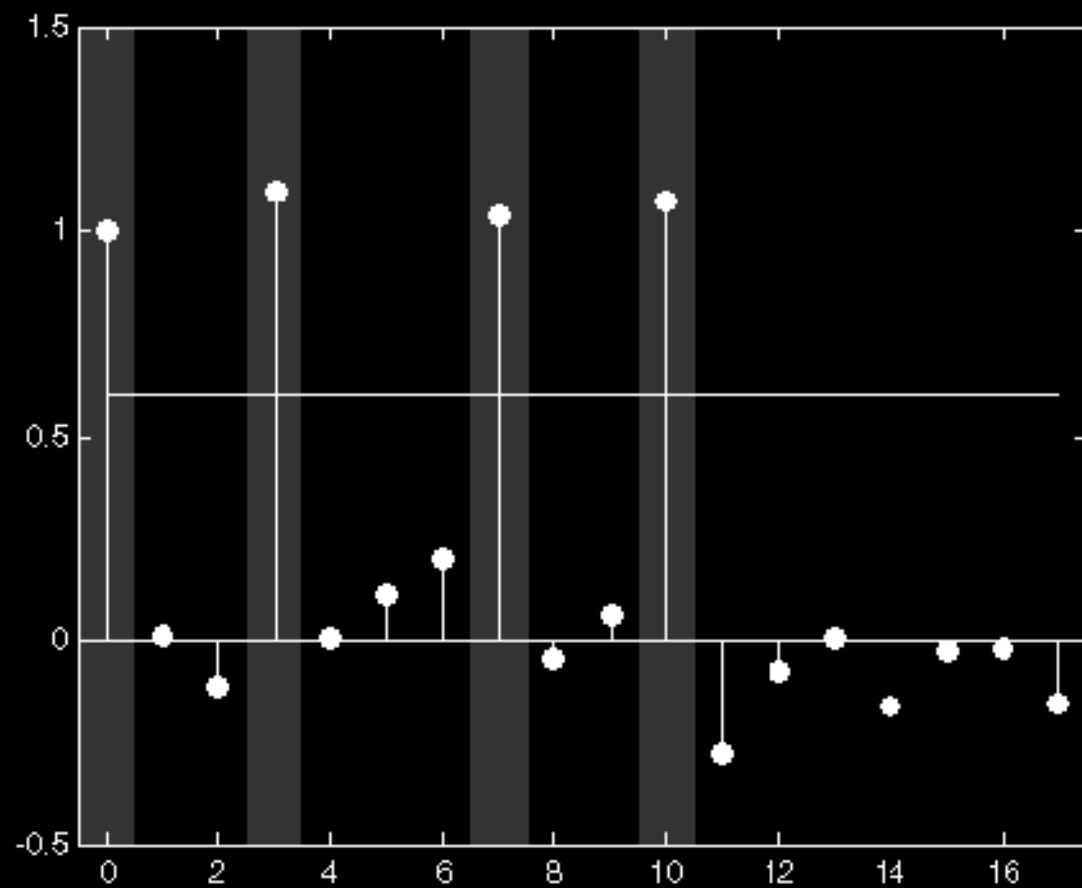
The approach

- Histogram \rightarrow autocorrelation function

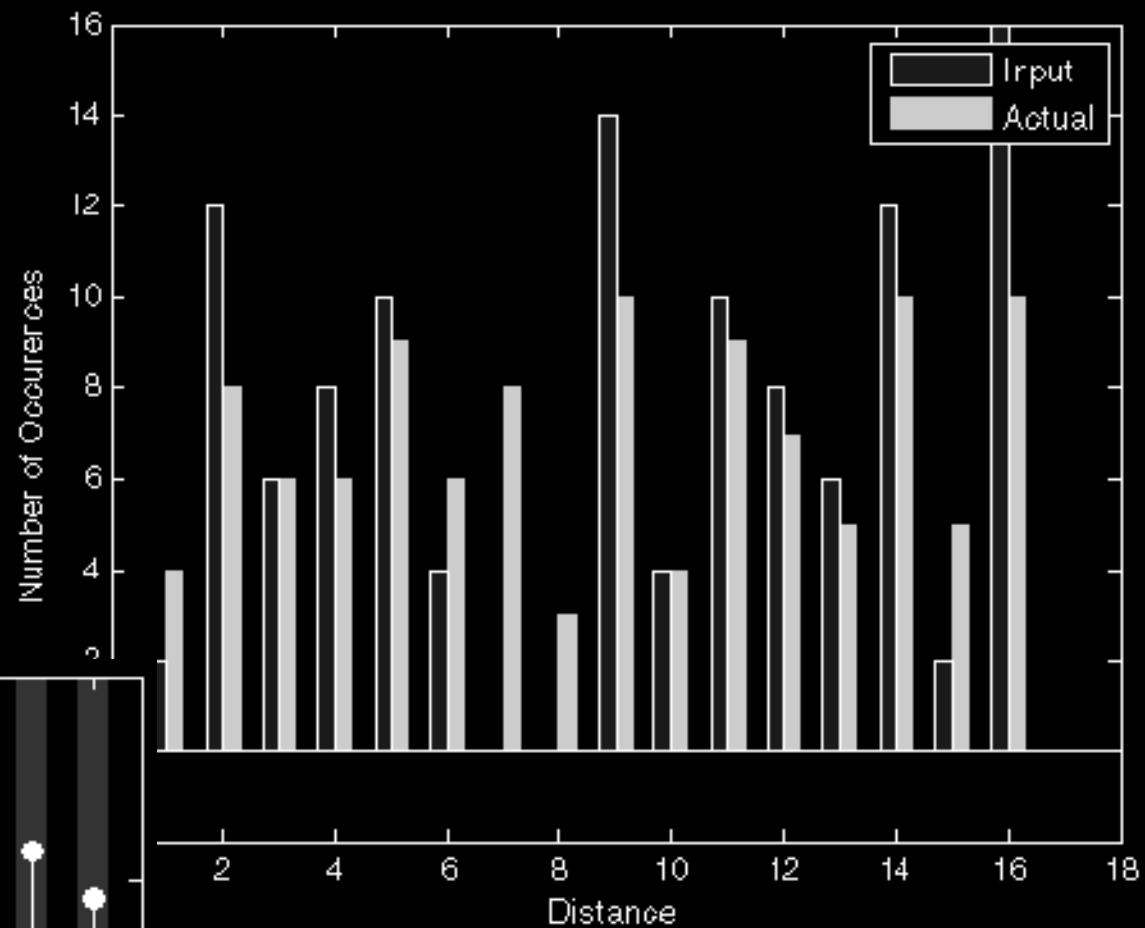
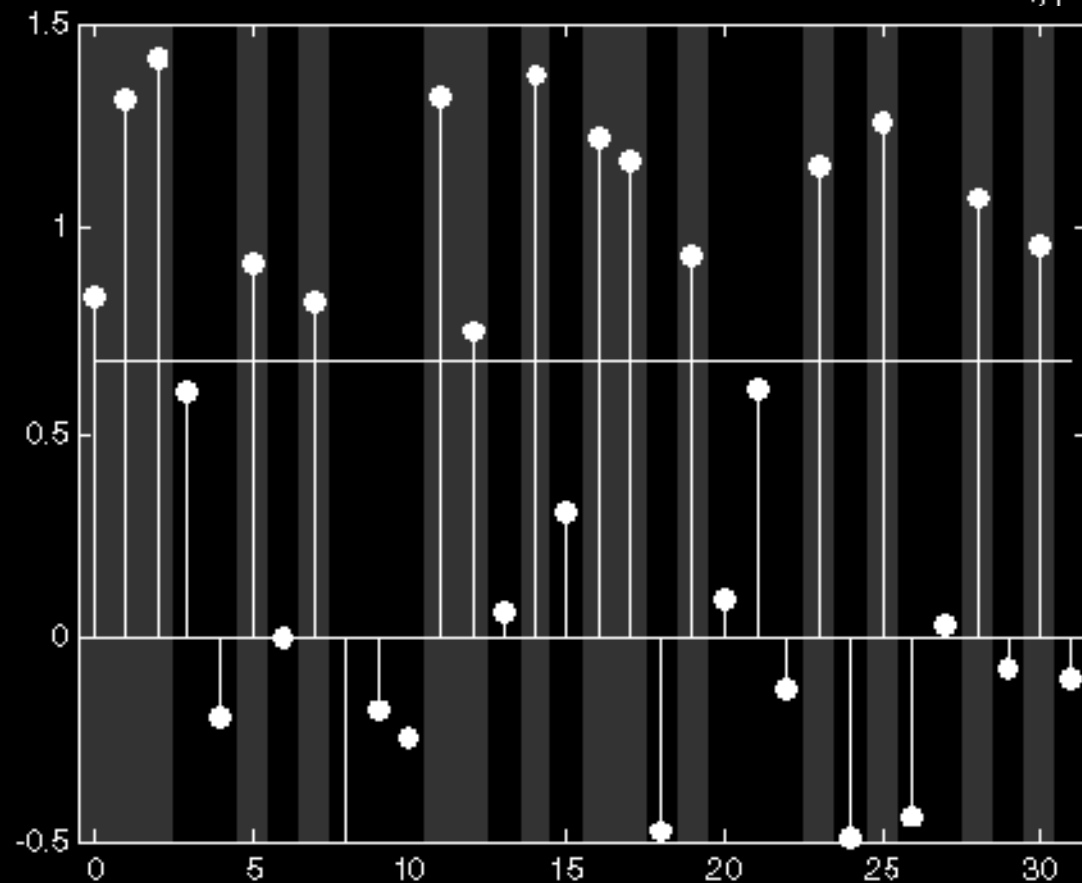
Wiener-Khinchin:
Autocorrelation function =
 $iDFT(|DFT(rhythm)|^2)$

- Autocorrelation function $\rightarrow |DFT(rhythm)|$
- Optimize phase angles of $DFT(rhythm)$
so that rhythm values are close to 1 and 0
- Ambiguities: concentrate power at start

Results



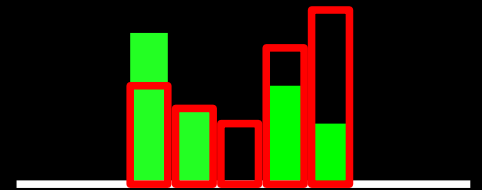
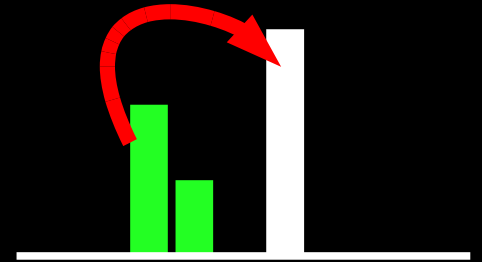
Results



See paper
for statistics

Outlook

- Evaluation as a compositional tool
- Helper tools that build “interesting” histograms
- User interface that indicates how the nearest *actual* histogram looks like



Thank you!

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