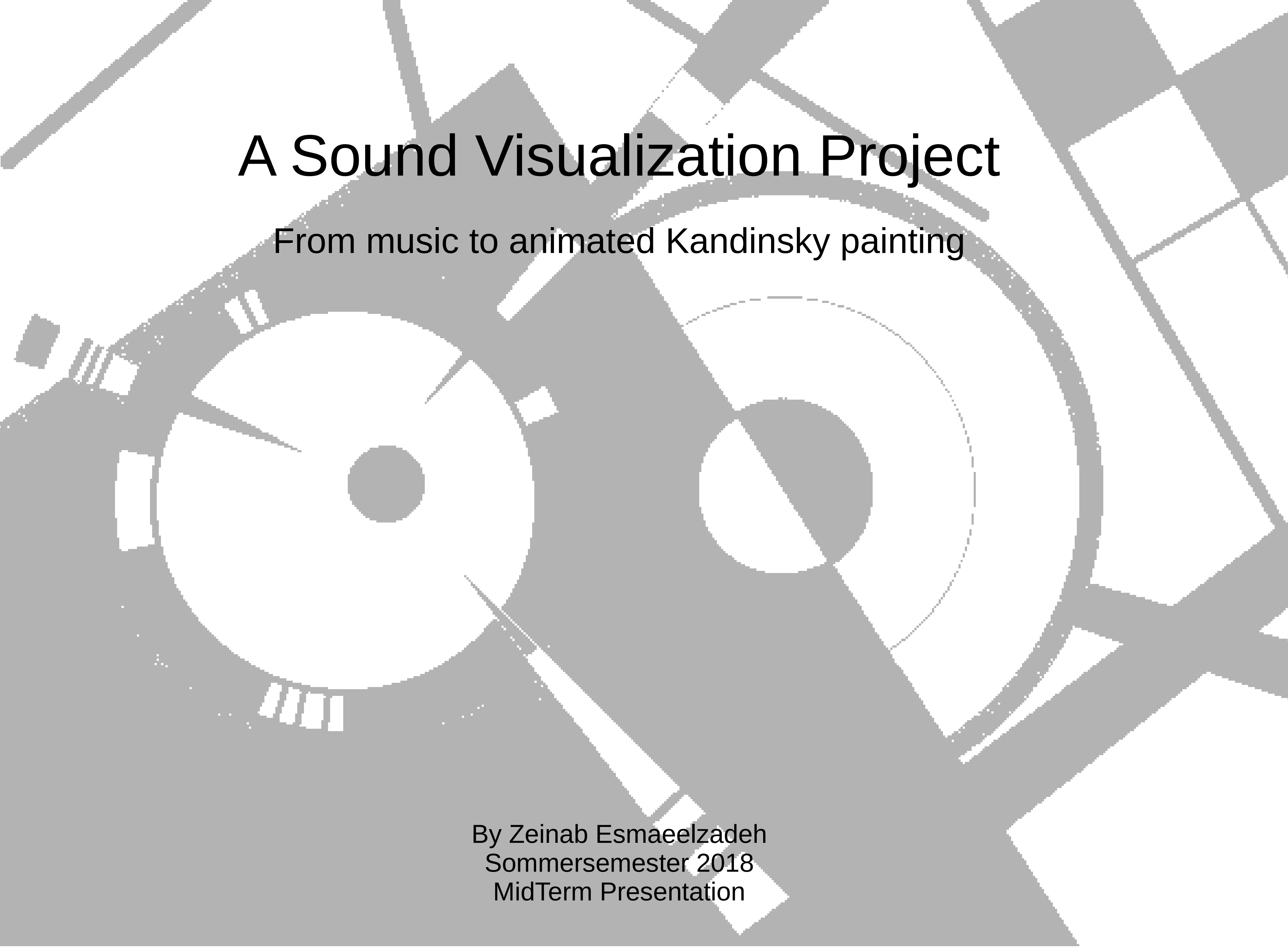


A Sound Visualization Project

From music to animated Kandinsky painting

By Zeinab Esmaeelzadeh
Sommersemester 2018
MidTerm Presentation

The project is divided in 2 parts:

Part I :
Sound analysis/Signal processing

Input :

- Analogue
  Sound
  Noise
  Microphone
  (AUX input)

- Digital:
  Midi

Output:
Matrices of numbers:
- Columns: Selected feature/Properties:
 Pitch,ADSR,Velocity,Selected frequency,etc
- Rows: Slice of time considering beat or feasibility of CPU

Part II:
Visualization in R language

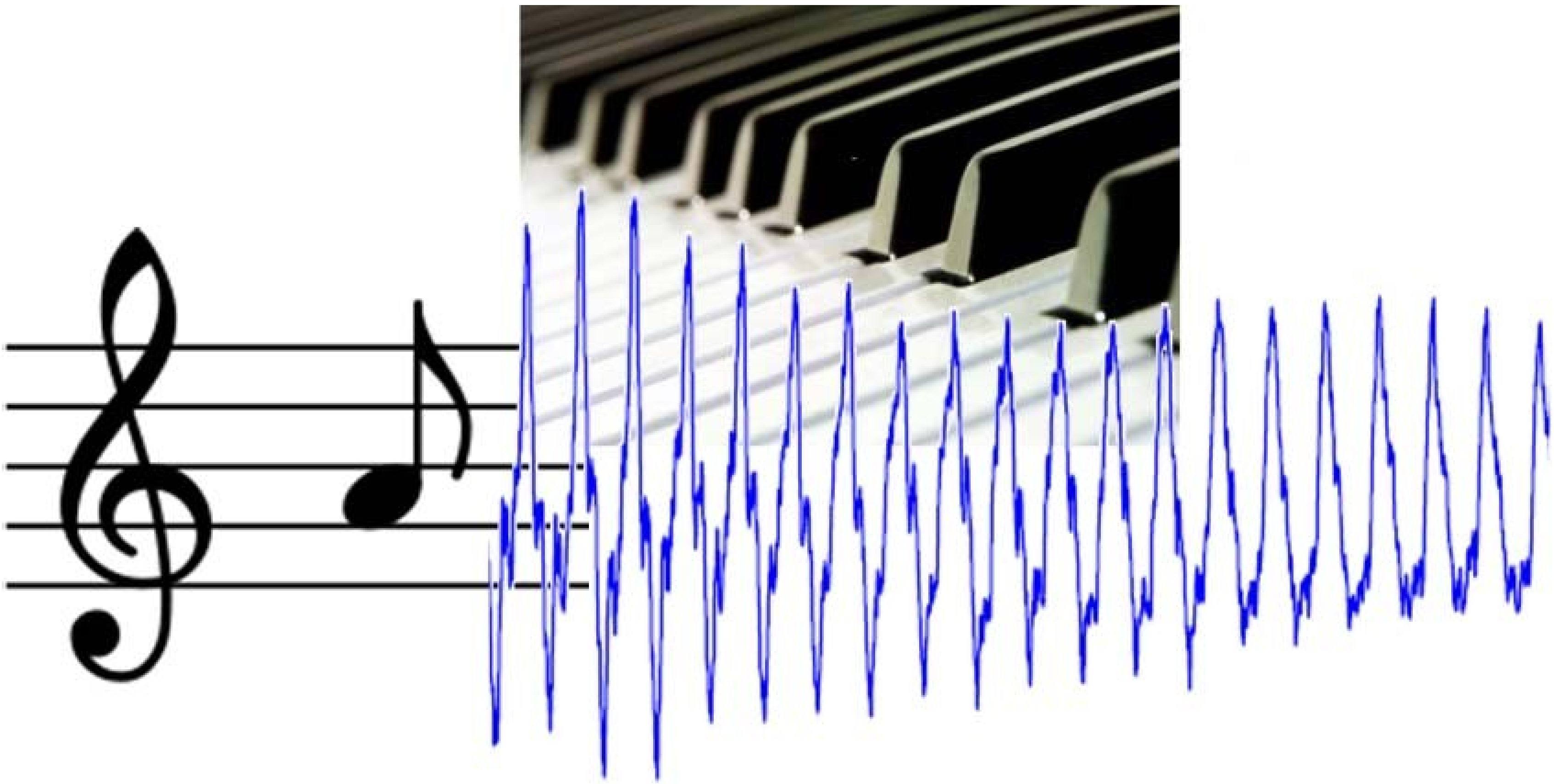
Input:
Matrices → R data frame

Output:
Pictures similar to Kandinsky’s Paintings for each feasible slice of time.
(modified Kandinsky R package)

And then animating pictures in video

Introduction to music representation

1.1 Sheet Music Representations
1.2 Symbolic Representations
1.3 Audio Representation



1.1 Sheet Music Representations

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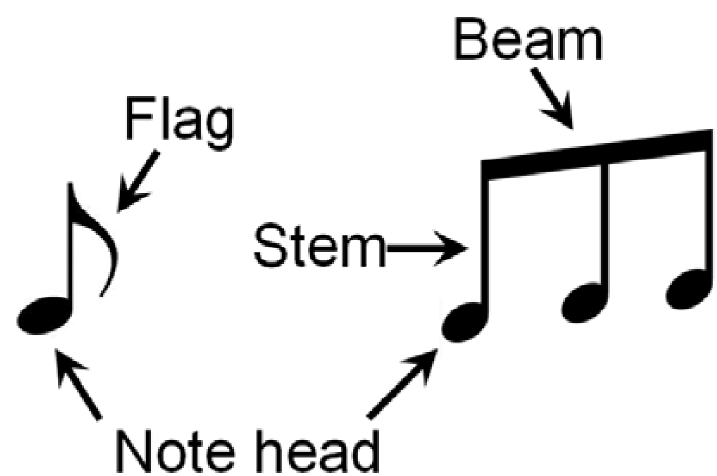
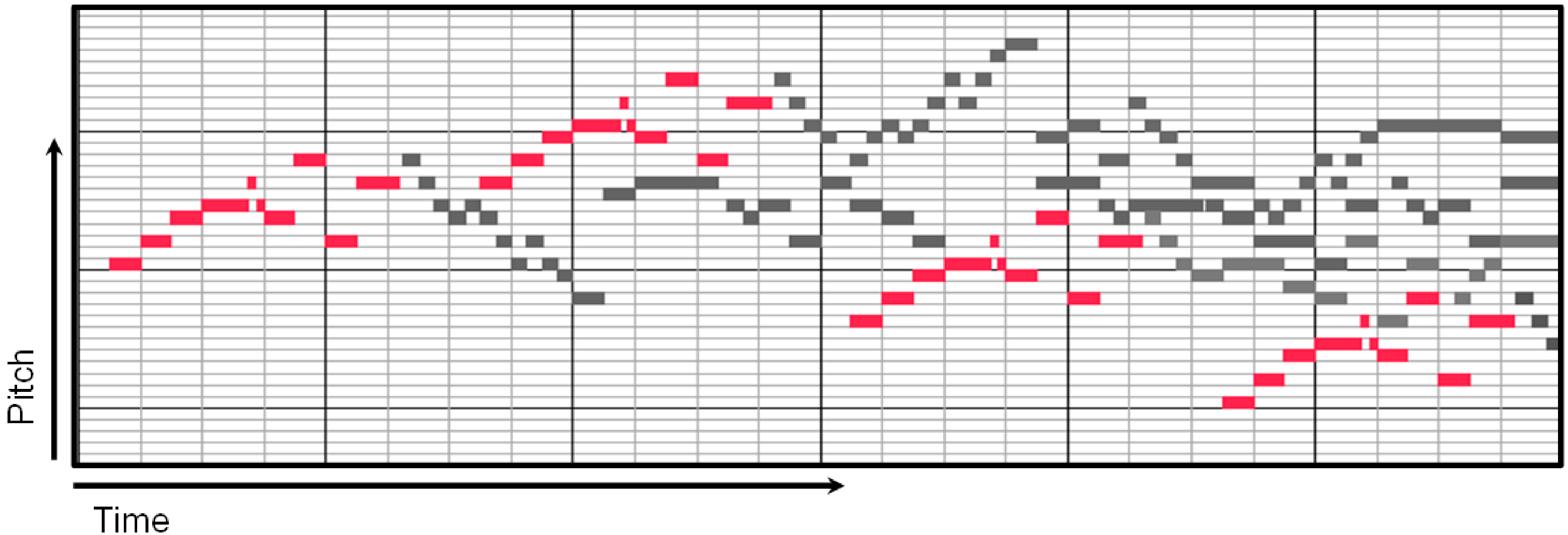
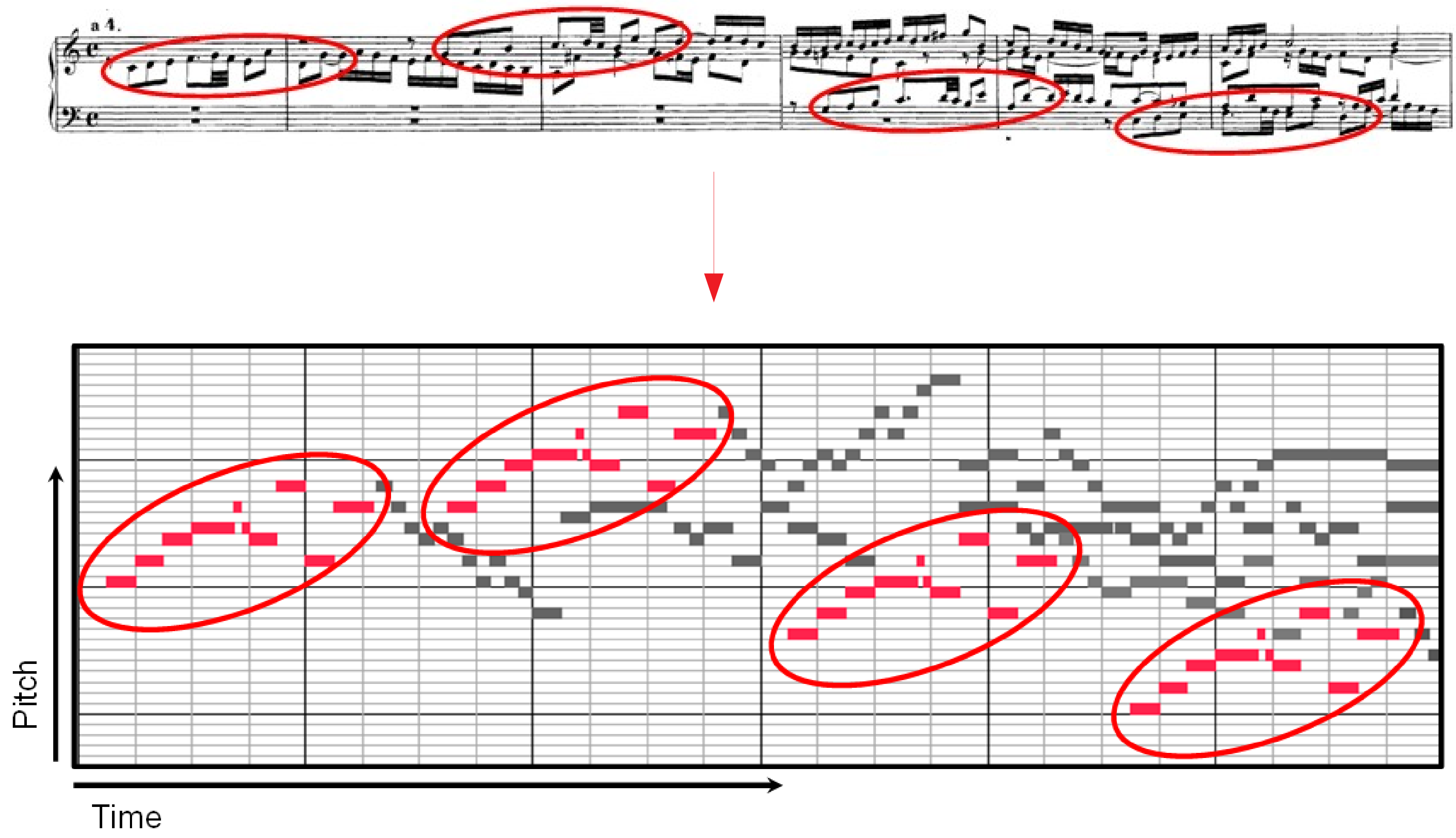


1.1 Sheet Music Representations

1.2 Symbolic Representations

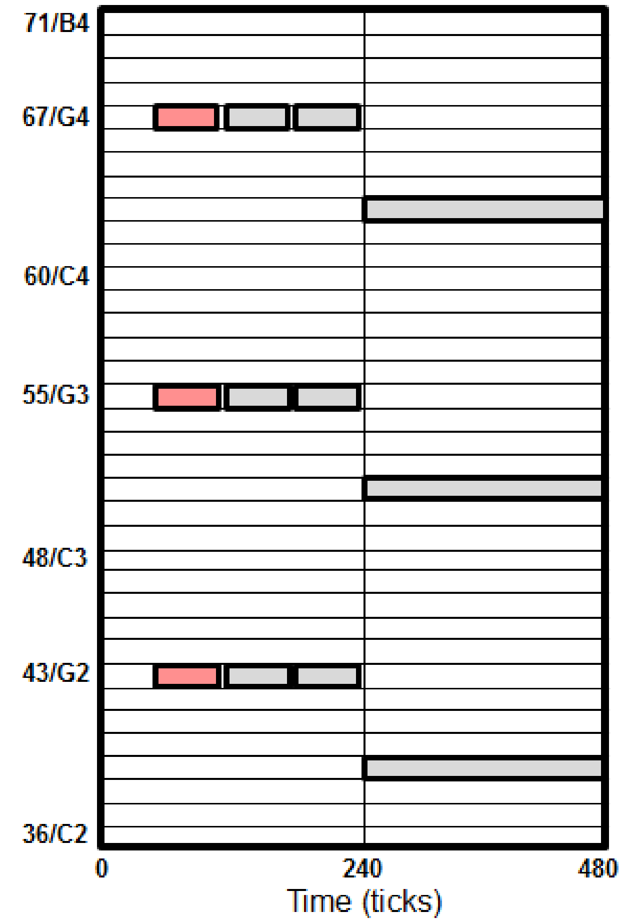


1.2 Symbolic Representations

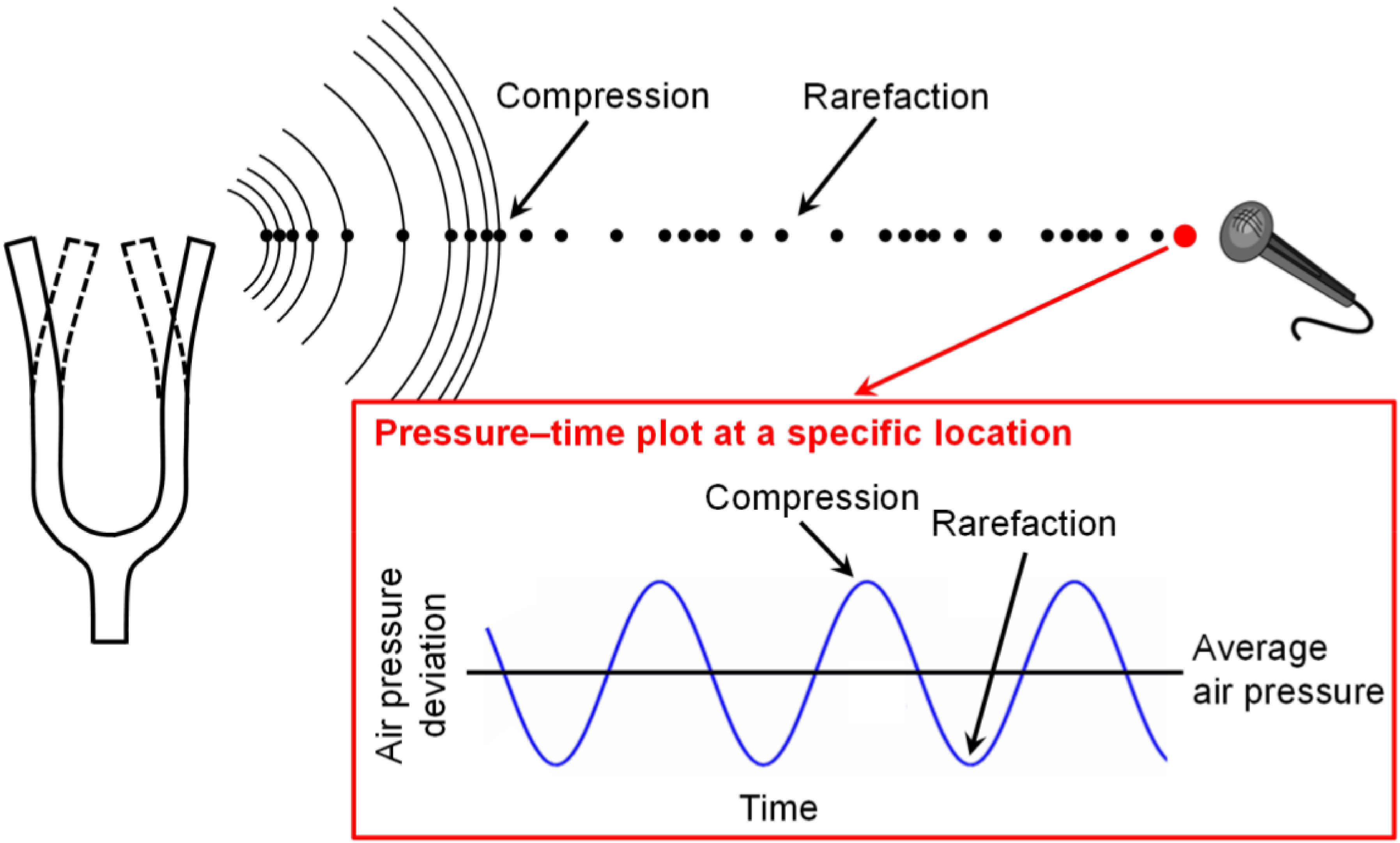


1.2 Symbolic Representations

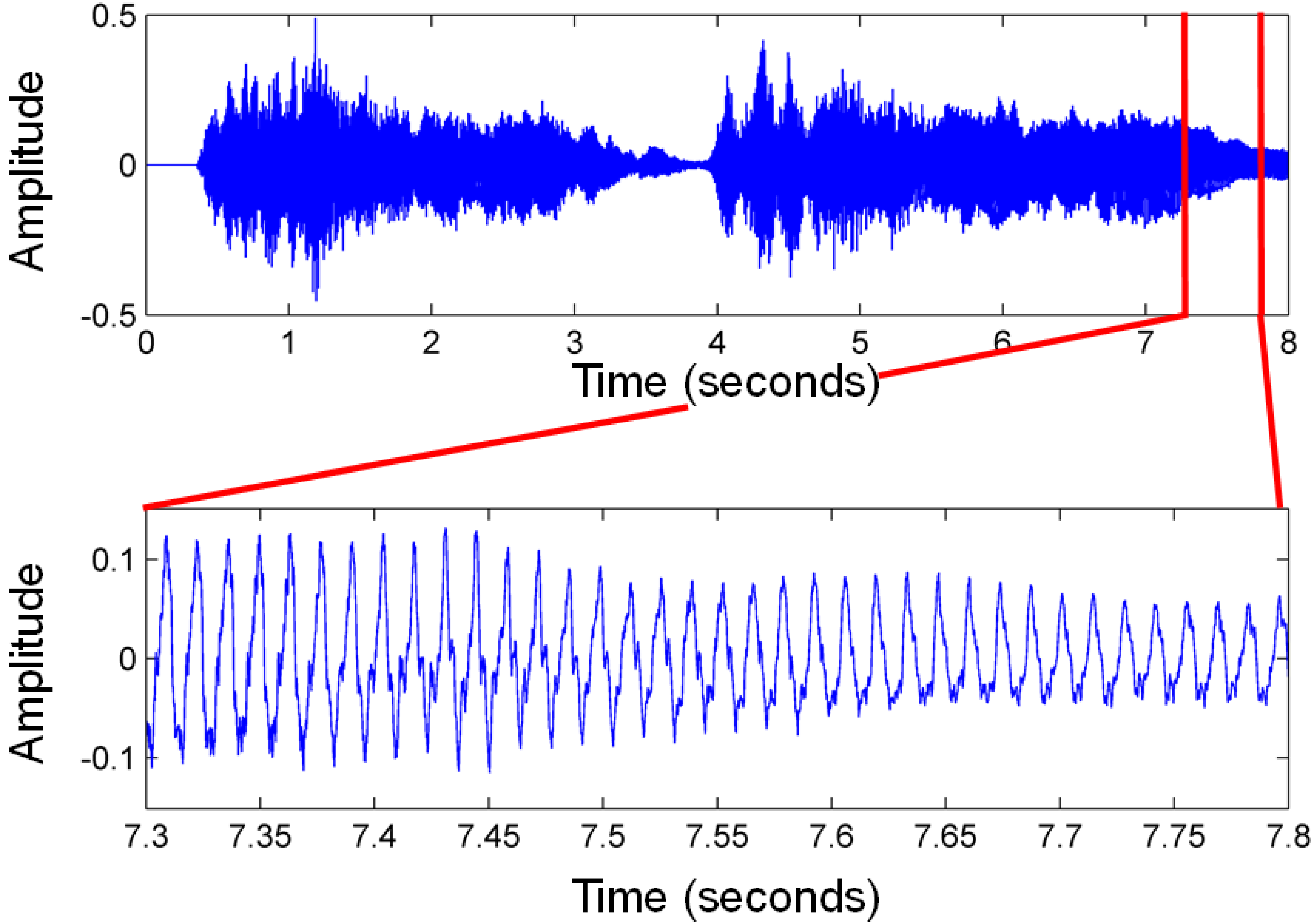
Time (Ticks)	Message	Channel	Note Number	Velocity
60	NOTE ON	1	67	100
0	NOTE ON	1	55	100
0	NOTE ON	2	43	100
55	NOTE OFF	1	67	0
0	NOTE OFF	1	55	0
0	NOTE OFF	2	43	0
5	NOTE ON	1	67	100
0	NOTE ON	1	55	100
0	NOTE ON	2	43	100
55	NOTE OFF	1	67	0
0	NOTE OFF	1	55	0
0	NOTE OFF	2	43	0
5	NOTE ON	1	67	100
0	NOTE ON	1	55	100
0	NOTE ON	2	43	100
55	NOTE OFF	1	67	0
0	NOTE OFF	1	55	0
0	NOTE OFF	2	43	0
5	NOTE ON	1	63	100
0	NOTE ON	2	51	100
0	NOTE ON	2	39	100
240	NOTE OFF	1	63	0
0	NOTE OFF	2	51	0
0	NOTE OFF	2	39	0



1.3 Audio Representation

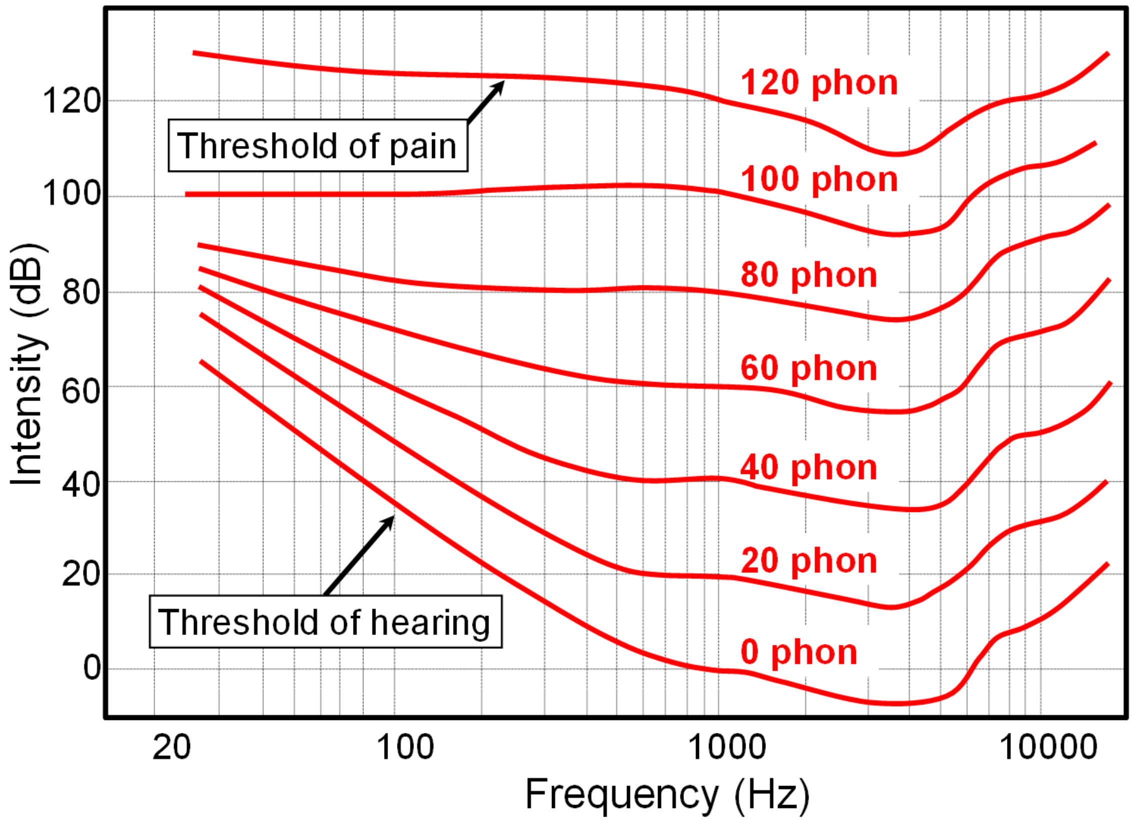


1.3 Audio Representation

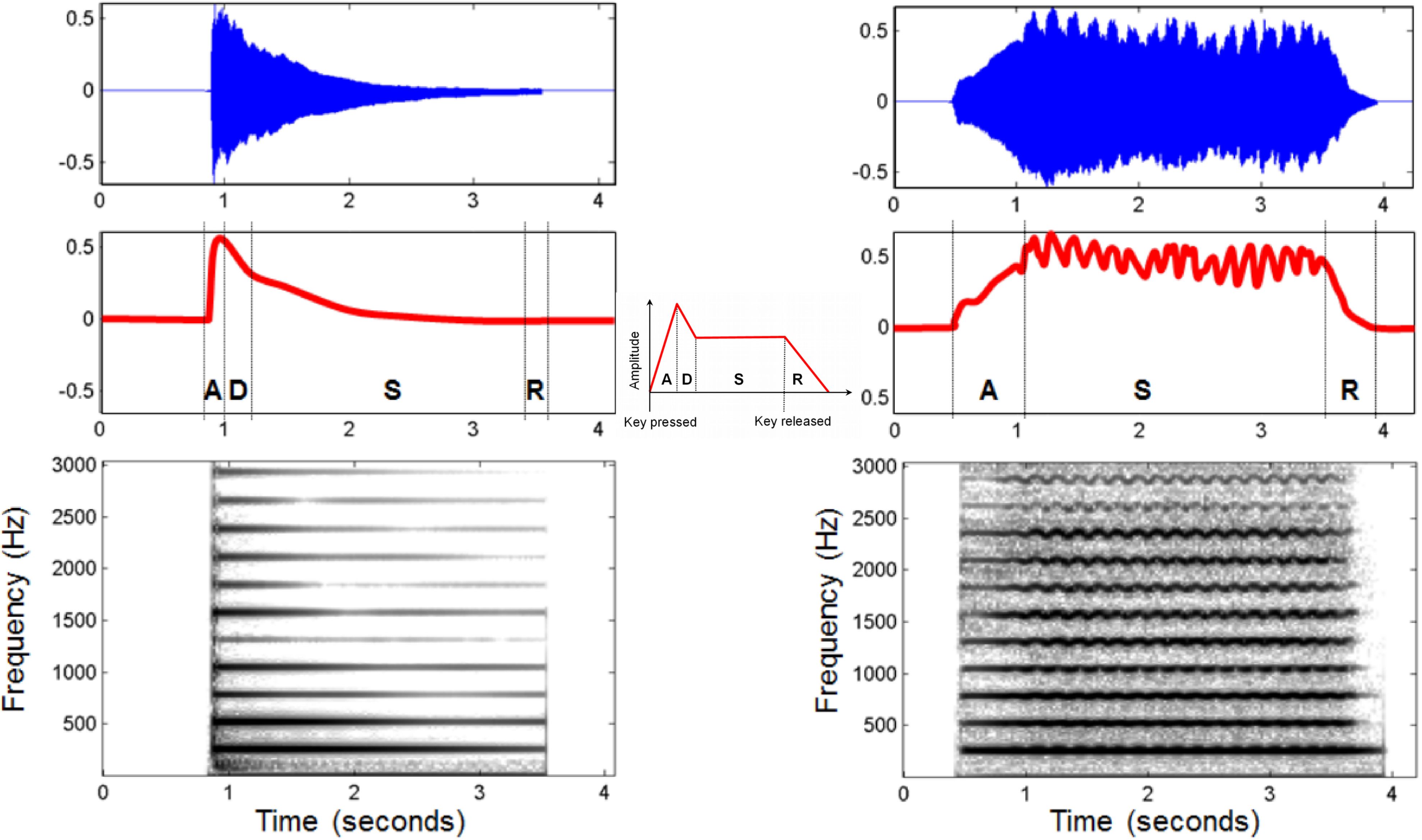


1.3 Audio Representation

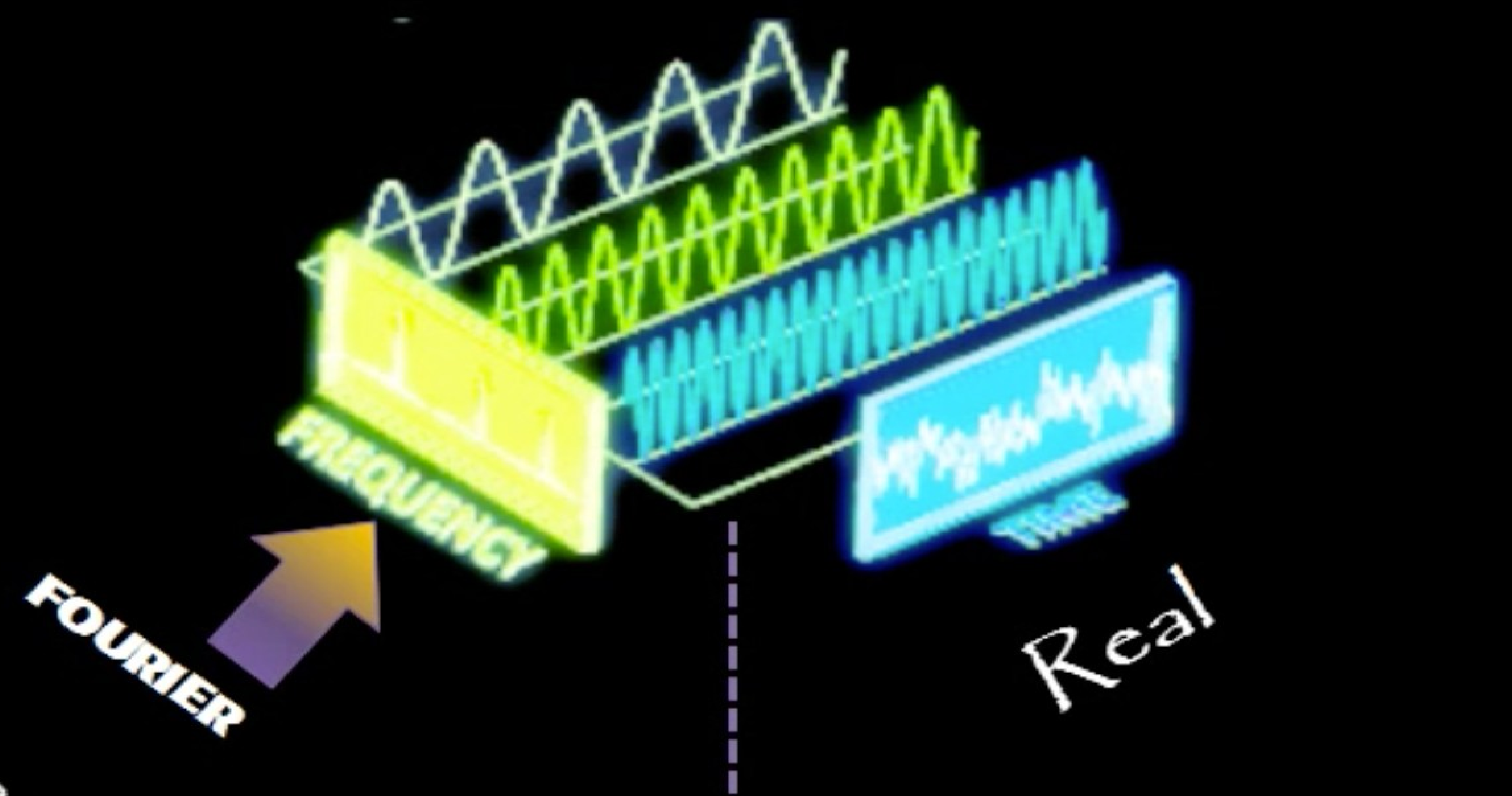
Source	Intensity	Intensity level	× TOH
Threshold of hearing (TOH)	10^{-12}	0 dB	1
Whisper	10^{-10}	20 dB	10^{2}
Pianissimo	10^{-8}	40 dB	10^{4}
Normal conversation	10^{-6}	60 dB	10^{6}
Fortissimo	10^{-2}	100 dB	10^{10}
Threshold of pain	10	130 dB	10^{13}
Jet take-off	10^{2}	140 dB	10^{14}
Instant perforation of eardrum	10^{4}	160 dB	10^{16}



1.3 Audio Representation



1.4 Fourier Analysis

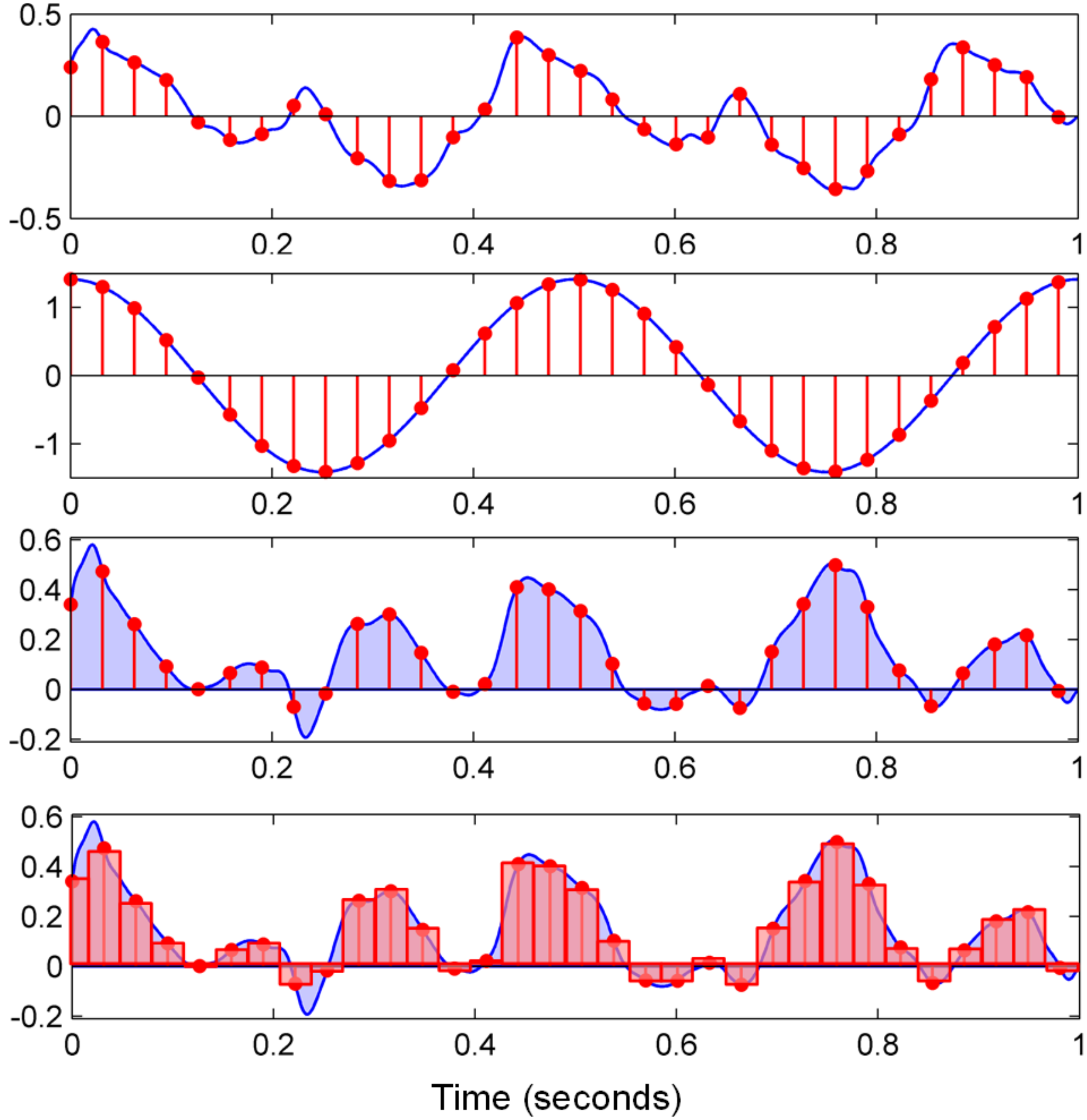


$$\sin\left(\frac{2\pi nx}{P}+\phi_n\right) \equiv \sin(\phi_n)\cos\left(\frac{2\pi nx}{P}\right)+\cos(\phi_n)\sin\left(\frac{2\pi nx}{P}\right)$$

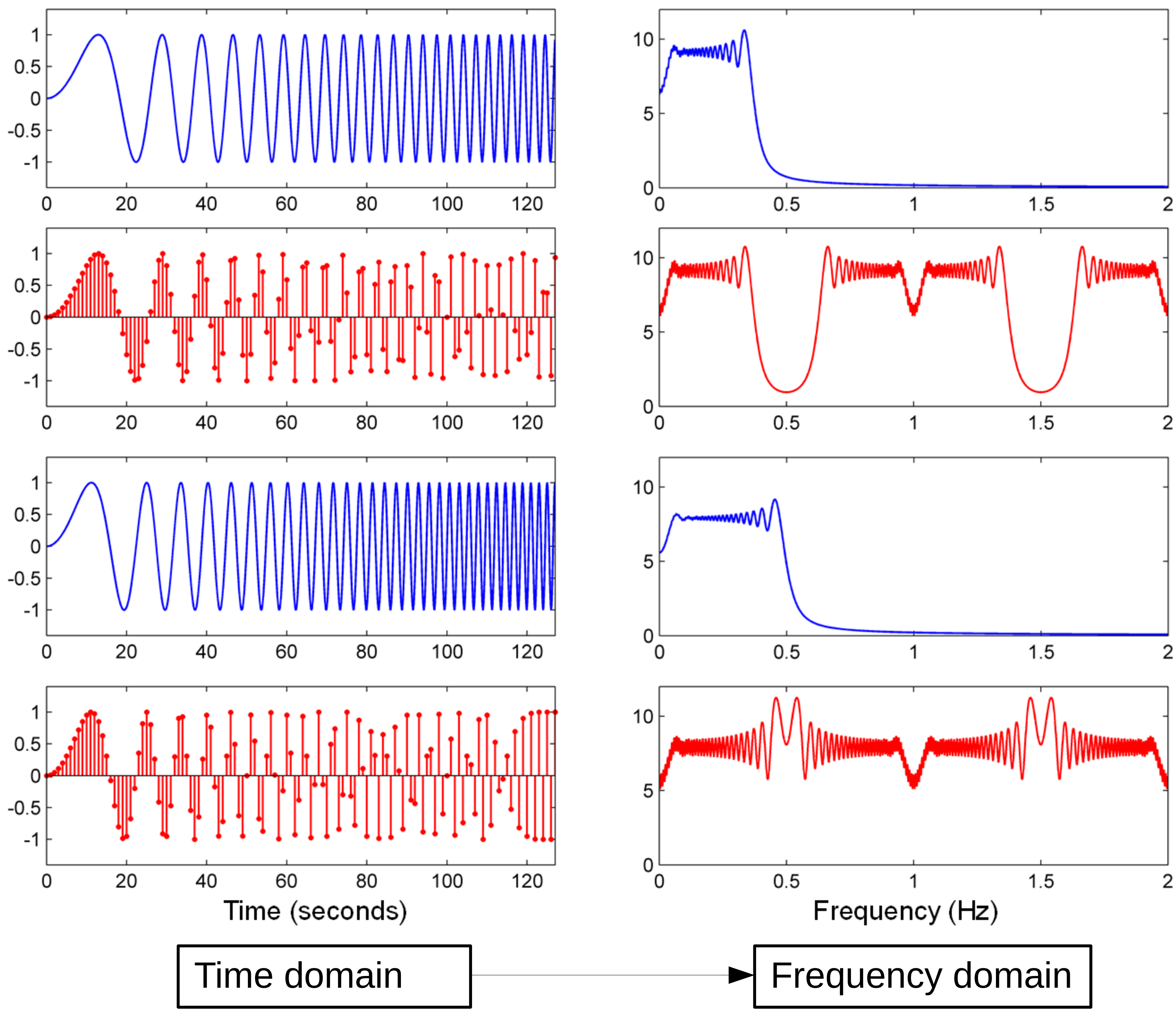
$$\sin\left(\frac{2\pi nx}{P}+\phi_n\right) \equiv \mathrm{Re}\left\{\frac{1}{i}\cdot e^{i\left(\frac{2\pi nx}{P}+\phi_n\right)}\right\} = \frac{1}{2i}\cdot e^{i\left(\frac{2\pi nx}{P}+\phi_n\right)} - \left(\frac{1}{2i}\cdot e^{-i\left(\frac{2\pi nx}{P}+\phi_n\right)}\right),$$

$$s_N(x) = \overbrace{a_0}^{A_0}/2 + \sum_{n=1}^{N}\left(\overbrace{a_n}^{A_n\sin(\phi_n)}\cos\left(\frac{2\pi nx}{P}\right) + \overbrace{b_n}^{A_n\cos(\phi_n)}\sin\left(\frac{2\pi nx}{P}\right)\right)$$
$$= \sum_{n=-N}^{N} c_n\cdot e^{i\frac{2\pi nx}{P}},$$

1.4 Fourier Analysis



1.4 Fourier Analysis



PART I : Sound analysis/Signal processing

Input :

- Analogue:
  Sound
  Noise
  Microphone
  (AUX input)

- Digital:
  Midi

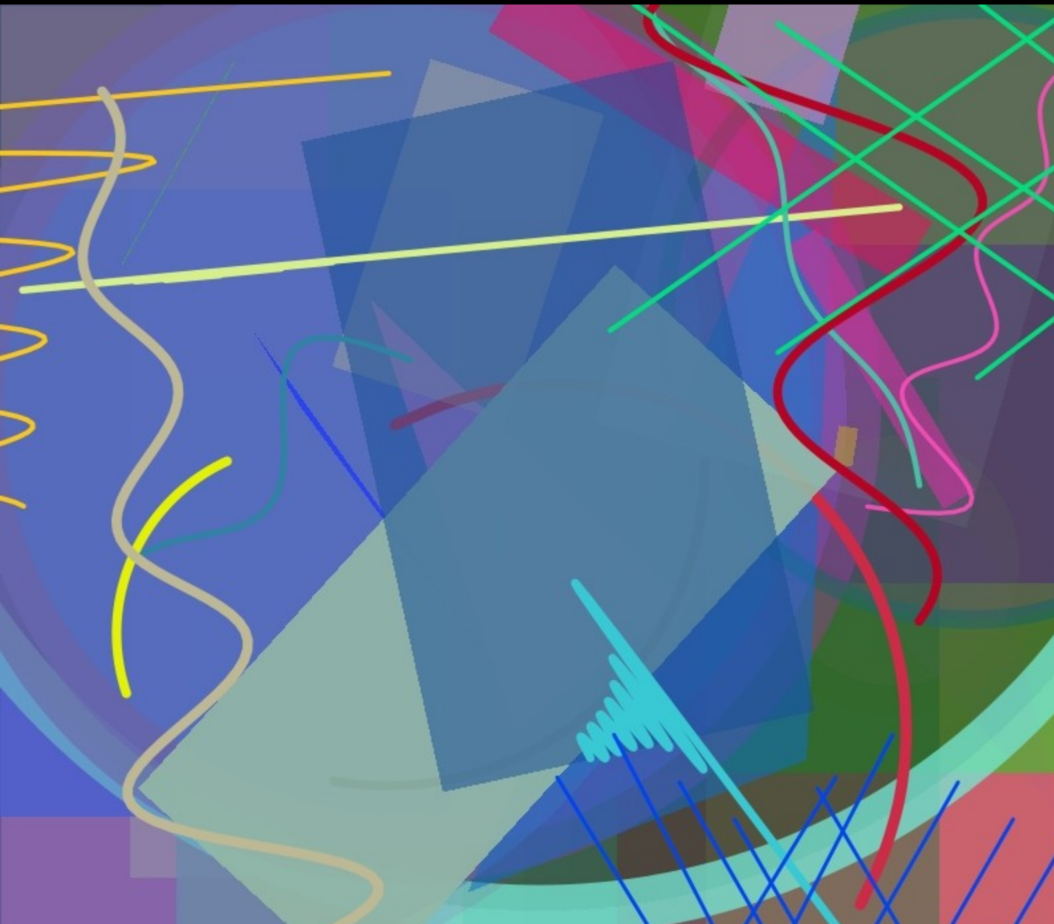
Output:
Matrices of numbers:

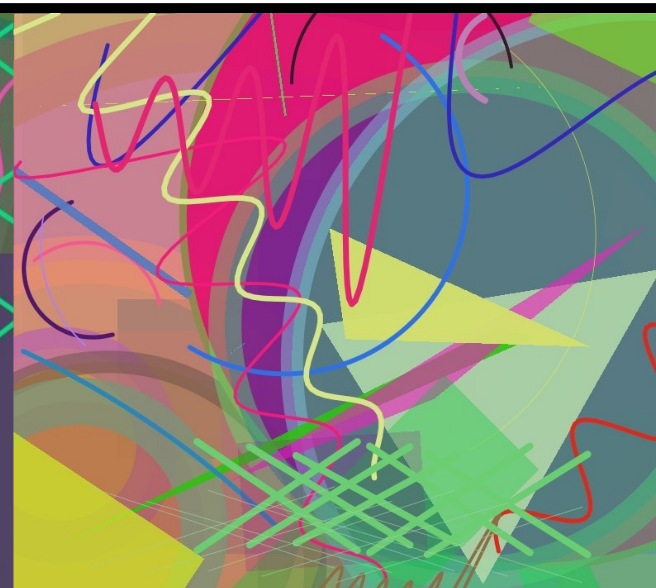
- Columns: Selected feature/Properties:
  Pitch,ADSR,Velocity,Selected frequency,etc
- Rows: Slice of time considering beat or feasibility of CPU

How it is done:

With Processing , R , Python (Scripting Languages)

PART II : Visualization in R language





Input:

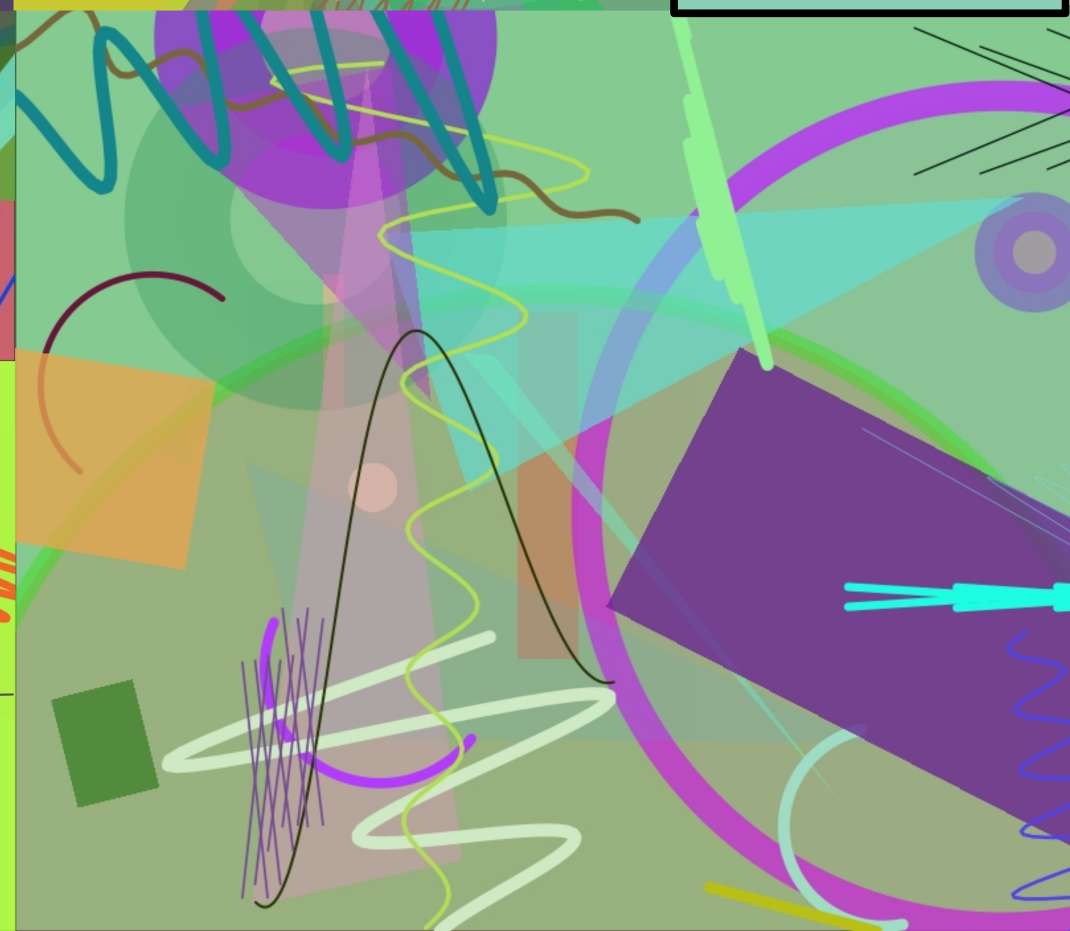
Matrices

↓

R data frame

Output:

Pictures similar to Kandinsky’s Paintings for each feasible slice of time.
(modified Kandinsky R package)



Visualization in R language

```
require(grid)
randomKandinsky <- function(n = 10) {
  grid.newpage()

  grid.rect(gp=gpar(fill=rgb(runif(1),
                             runif(1),
                             runif(1),
                             runif(1))))

  for (i in 1:n) {
    grid.rect(x = runif(1), y = runif(1), width = runif(1), height = runif(1),
              gp = gpar(col = NA,
                        fill=rgb(runif(1),
                                 runif(1),
                                 runif(1),
                                 runif(1))))
    grid.circle(x = runif(1), y = runif(1), r = runif(1),
                gp = gpar(
                  lwd = runif(1, 0, 100),
                  col = rgb(runif(1),
                            runif(1),
                            runif(1),
                            runif(1)),
                  fill=rgb(runif(1),
                           runif(1),
                           runif(1),
                           runif(1))))
    grid.polygon(x = runif(3), y = runif(3),
                 gp = gpar(col = NA,
                           fill=rgb(runif(1),
                                    runif(1),
                                    runif(1),
                                    runif(1))))

    grid.curve(runif(1), runif(1), runif(1), runif(1),
               curvature = runif(1, -1, 1), square = FALSE, ncp = sample(100, 1),
               gp = gpar(lwd = runif(1, 0, 10),
                         col = rgb(runif(1),
                                   runif(1),
                                   runif(1),
                                   1)))

    vp1 <- viewport(x = runif(1), y = runif(1), width = runif(1), height = runif(1), angle = runif(1) * 360)
    grid.rect(x = runif(1), y = runif(1), width = runif(1), height = runif(1),
              vp = vp1,
              gp = gpar(col = NA,
                        fill=rgb(runif(1),
                                 runif(1),
                                 runif(1),
                                 runif(1))))

    vp2 <- viewport(x = runif(1), y = runif(1), width = runif(1), height = runif(1), angle = runif(1) * 360)
    gCurve(sin(x)/(x), sample(5, 1), sample(10:50, 1), vp = vp2,
           gp = gpar(lwd = runif(1, 0, 10),
                     col = rgb(runif(1),
                               runif(1),
                               runif(1),
                               1)))
  }
  vp3 <- viewport(x = runif(1), y = runif(1), width = runif(1), height = runif(1), clip = "off")
  gCrissCross(vp = vp3,
              gp = gpar(lwd = runif(1, 0, 10),
                        col = rgb(runif(1),
                                  runif(1),
                                  runif(1),
                                  1)))

}
```

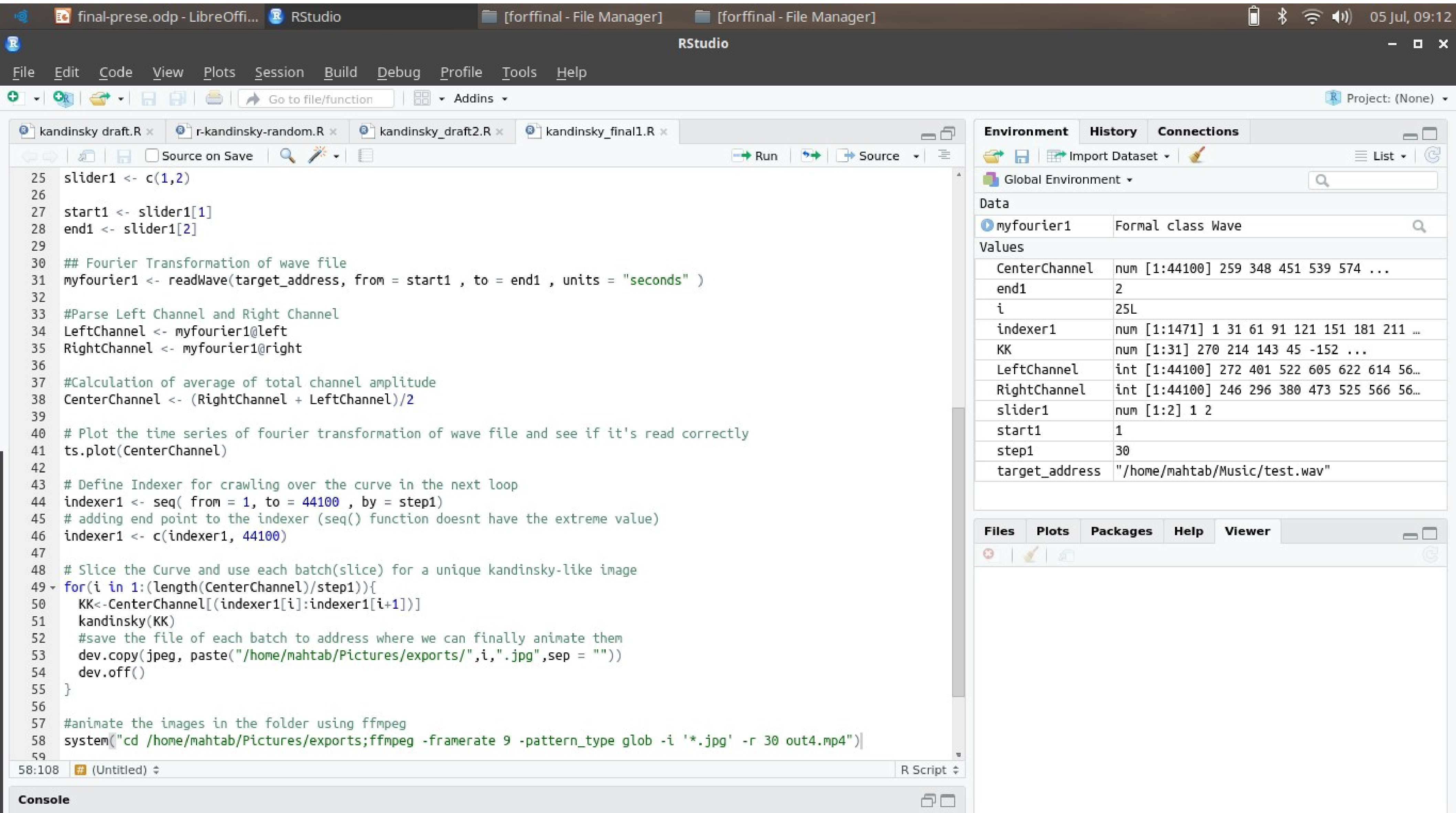
How it is done:

See the demo

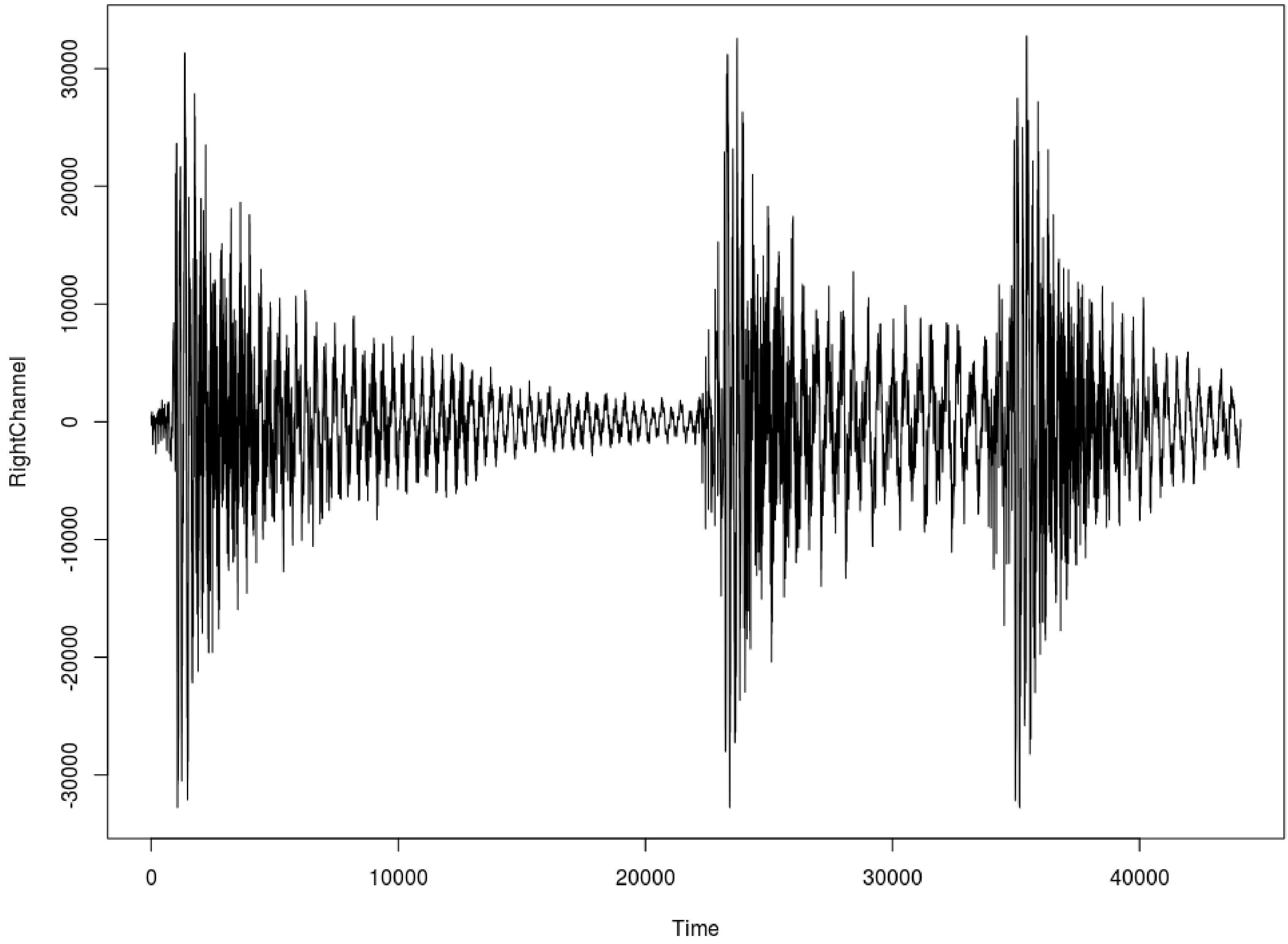
devtools::install_github("nautilus69/kandinsky")

Sound file visualization with Fourier transformation in R

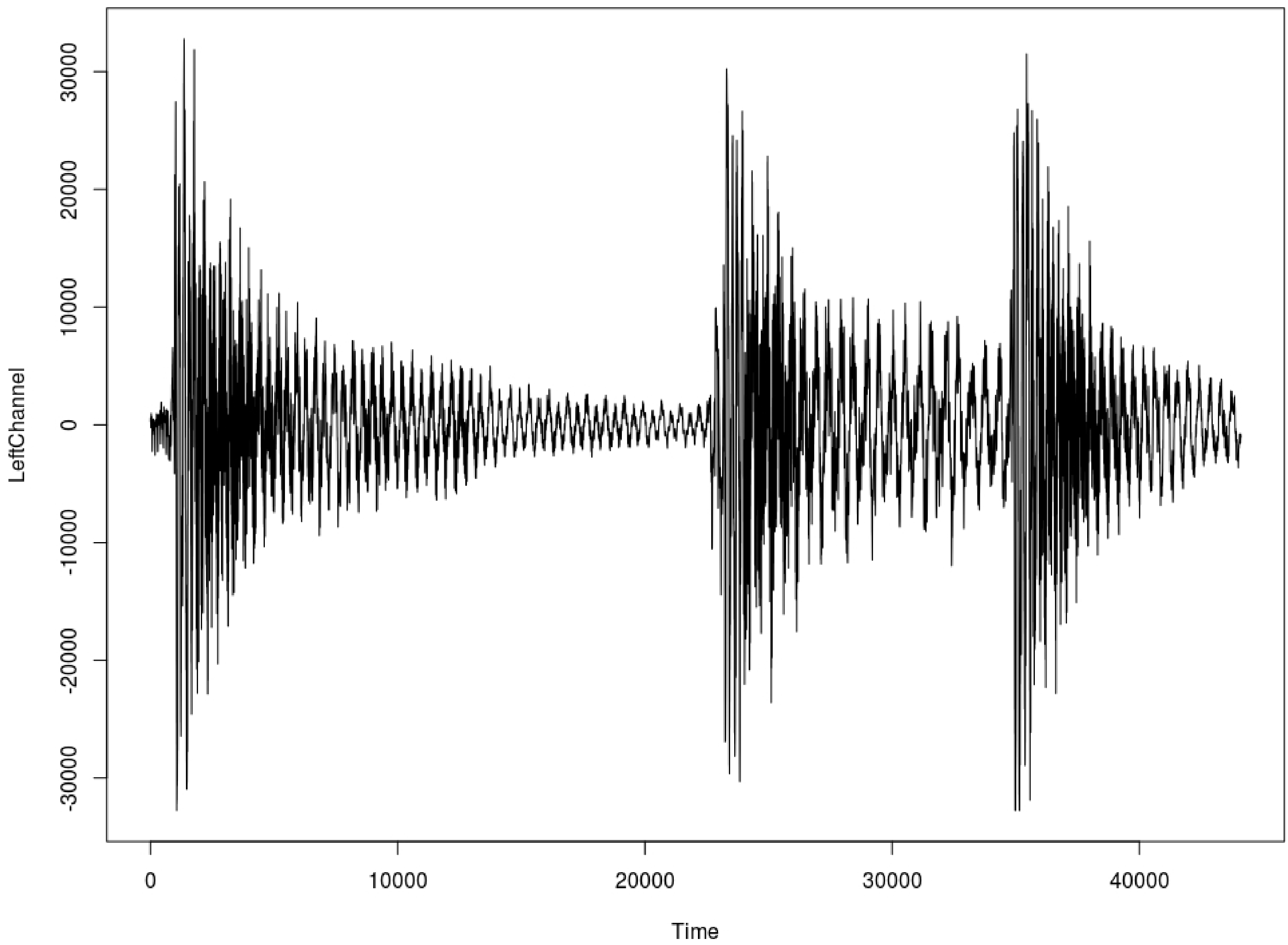
Descriptions: This Program Read a Wave music file from Local Hard Drive and Visualize the Fourier transformation processed music with Kandinsky-like output and animate them.
(I try to make a Web app with ShinyR so the user can interact with the parameters)



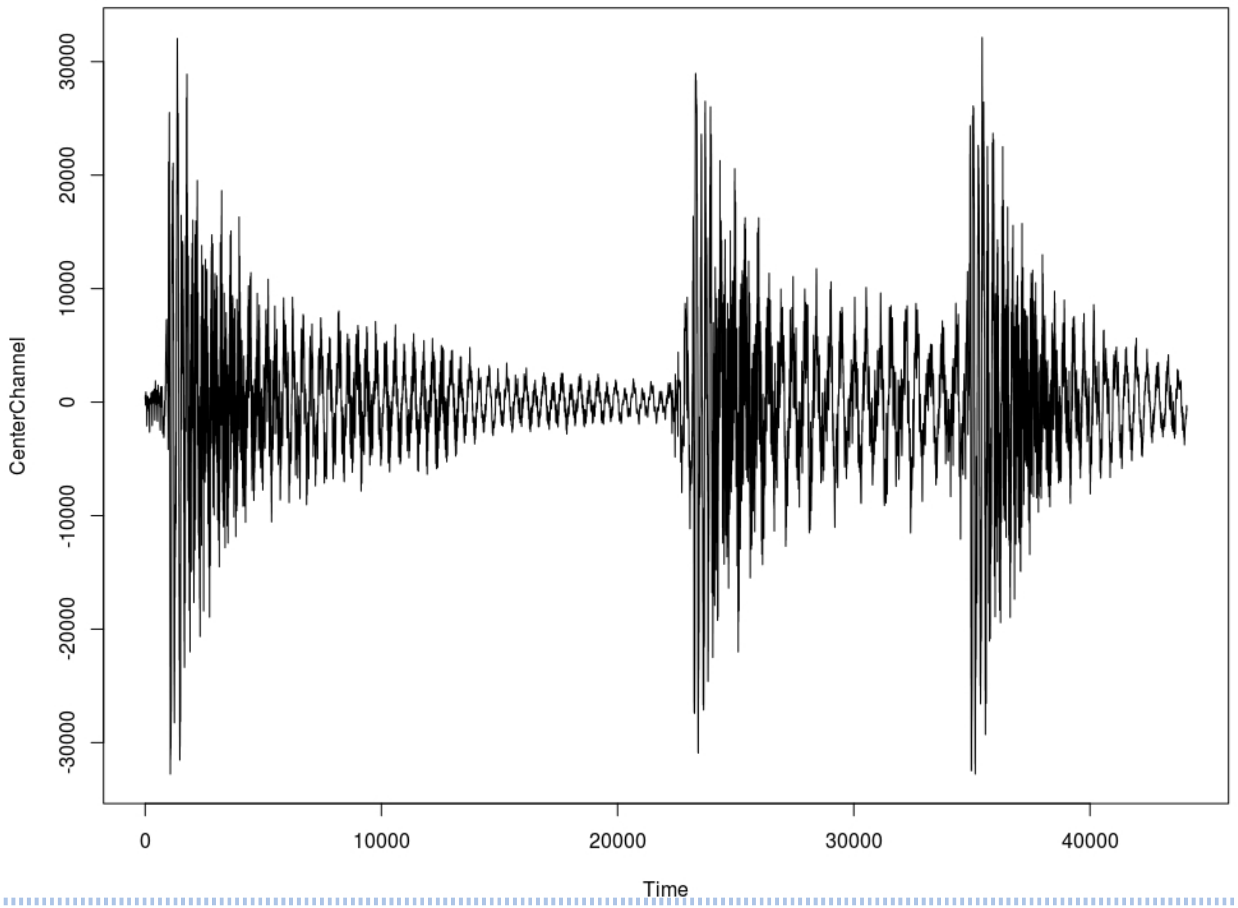
Sound file visualization with Fourier transformation in R



Sound file visualization with Fourier transformation in R



Sound file visualization with Fourier transformation (Amplitude per time)



Calculation of average of total channel amplitude

CenterChannel <- (RightChannel + LeftChannel)/2

Plot the time series of fourier transformation of wave file and see if it's read correctly

ts.plot(CenterChannel)

Sound file visualization with Fourier transformation (Amplitude per time)

DEMO

Thank You