Data audifications and 3D visualizations within GRID

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Introduction

- Data audification is the representation of data by sound signals;
- it can be considered as the acoustic counterpart of data graphic visualization, a mathematical mapping of information from data sets to sounds.
- In the past twenty years the word “audification” has acquired a new meaning in the world of computer music, computer science, and auditory display application development.

Motivations

- Sonic representations are particularly useful when dealing with complex, high-dimensional data, or in data monitoring tasks where it is practically impossible to use the visual inspection.
- Patterns and/or trends recognizing through sound, (in particular for some categories of evolutions, which were hardly perceivable otherwise).

Advantages of hearing

- Hearing is non-directional
- It is surely easier to recognize a change in a sound with respect to a modification in something which has to be looked at.
- It is quite impossible to distinguish a blinking light flashing 100 times a second from another one flashing at 200, 1000, or 10000 times a second, while anyone can recognize periodic signals from 20 Hz to (almost) 20000 Hz

Sonification on the GRID network

- First experiments involving sound production with INFN-GRID facilities started during the last months of 2003.
- In September 2003, it was installed CSound, a free and cross-platform acoustic compiler, on a GRID test site, the Catania INFN-GRID computer farm
- The compiler was tested within the new environment and since its beginning, the test phase produced interesting results: efficient use of the calculus resources, customizable quality of the audio files.

Second Phase: Java

- Second test phase: development of a sound production suite based on Java (equipped with the standard audio and math libraries), more flexible and easy to manage.
- All the results presented in this website have been carried on using this last approach: sample computation, audio rendering, DFT computing were obtained with the Java sonification program

Sound form volcanoes

- Sonified data (provided by the INGV) were geophysical data collected by a digital seismograph placed on the Etna volcano in Catania (Italy).
- The hope is to learn more about eruption dynamics from sonograms
- We performed both a seismogram sonification (tranformation into an audible waveform) and a seismogram melodisation (tranformation into a melody)

About seismograms audification

- In both the cases, structural properties of the seismographic information would be straightly mapped into sound or melody properties

- In the first case, regularities in the seismograms will be reflected by the existence of spectral lines in the sonified signal

- In the second case, regularities in the seismograms will be transferred into regularities in the melody (such as a repeated set of data will become a repeated musical phrase)

Seismograms sonification

- Seismographical data have been recorded onto the surface of Mount Etna volcano, by a digital seismograph at a sampling frequency of about 100 Hz (100.1603 Hz).
- Here follows an example taken from one of the ASCII files processed:

Original data

ASCII files processed (sample):

Starting time: 15/06/2001 00:03:39.920

Frequency: 100.1603 Hz

Samples: 168960

44

43

42

44

44

46

43

45

From data to waveform

- Scaling procedure to properly arrange the samples in the [-1,1] interval, according to their sampling frequency.
- In particular, users can specify in the program a certain resample frequency (pitch shift).
- An array of audio samples is constructed.

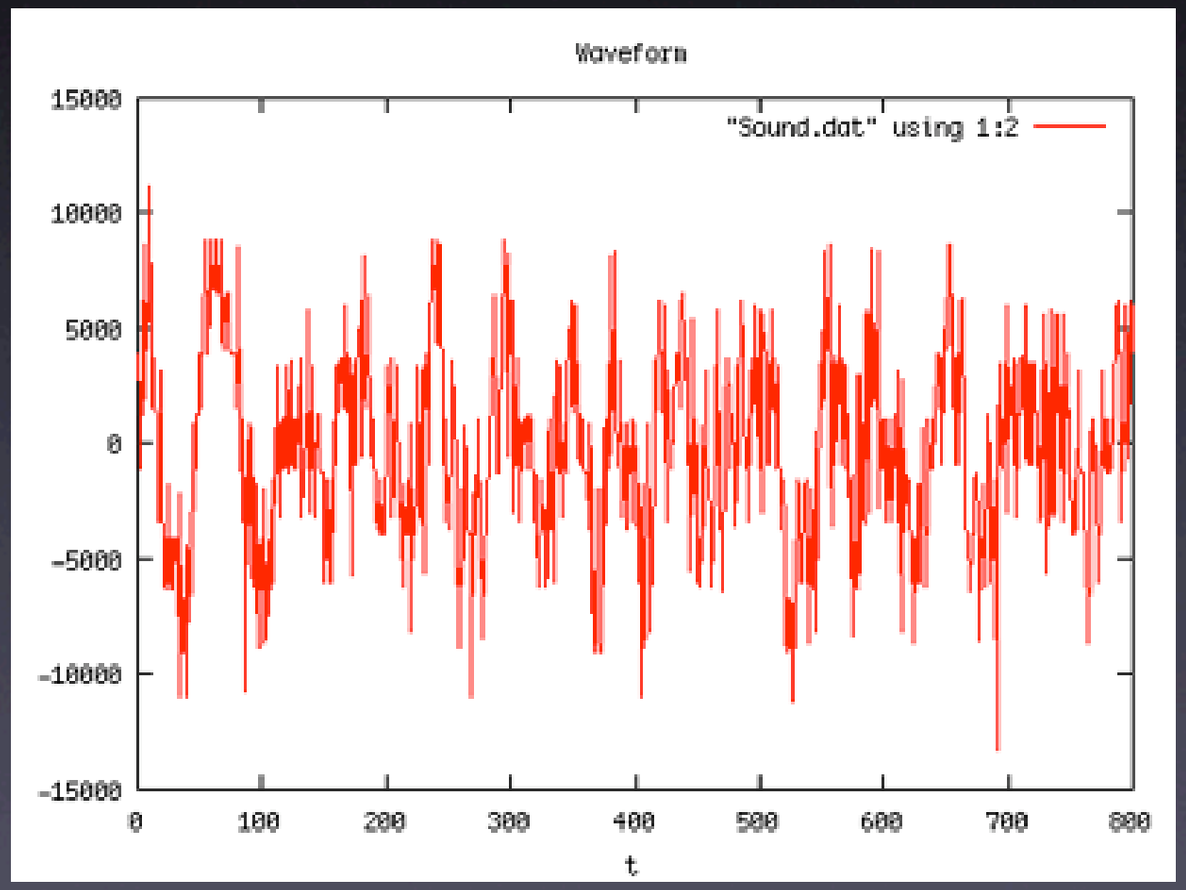
Resample factor

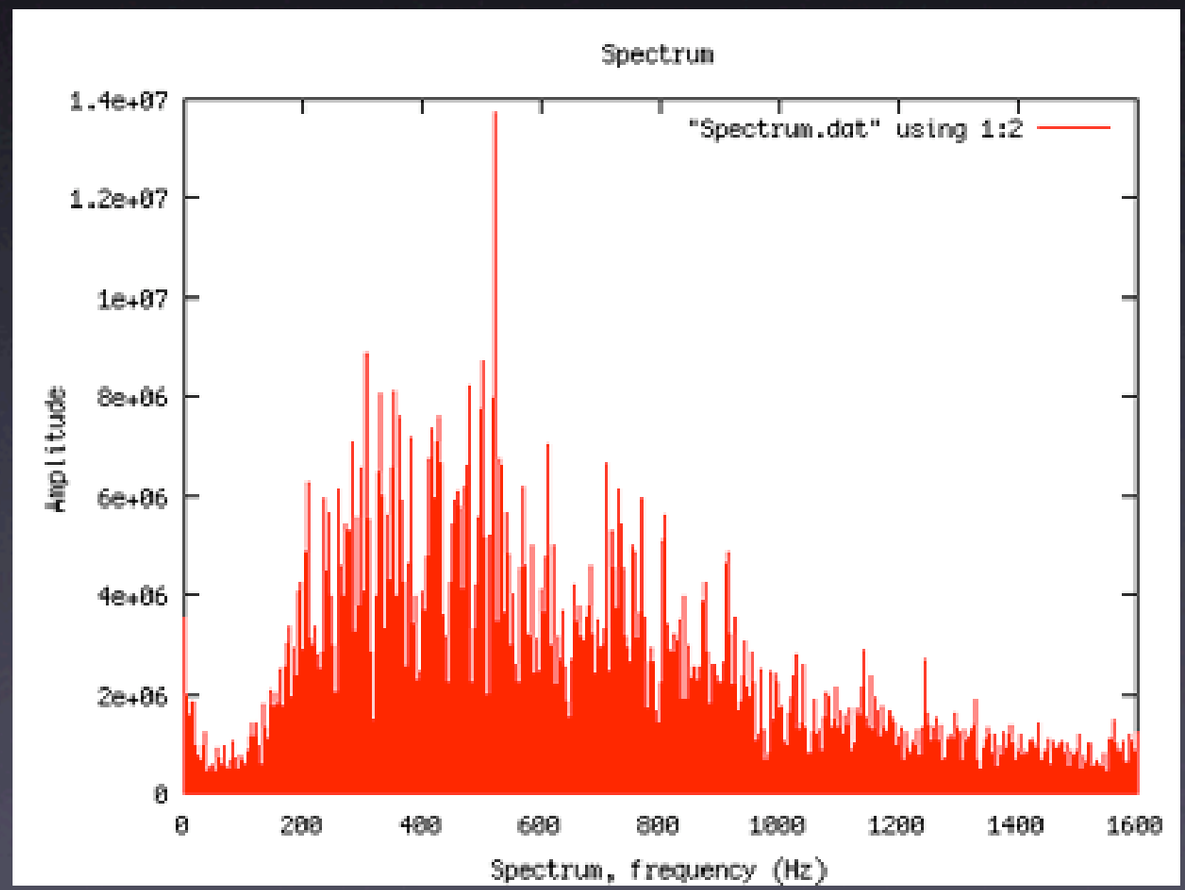
- Setting resample factors in the Java code greater than 1 won't preserve the original pitch, allowing a frequency shift...
- ....making audible regular phenomena happening at very low frequencies.
- In this way it is possible to observe and study periodical patterns, regular behaviors, long-range correlations, which can happen at different time scales.

Quasi-regular phenomena

- The waveform coded in the audio file will have exactly the same regularities, also recognizable thanks to the presence of some higher lines in the spectrum.
- The order of magnitude of the frequency of quasi-regular phenomena is in the range 0-50 Hz, with a spectral envelope centered around 25-30 Hz.

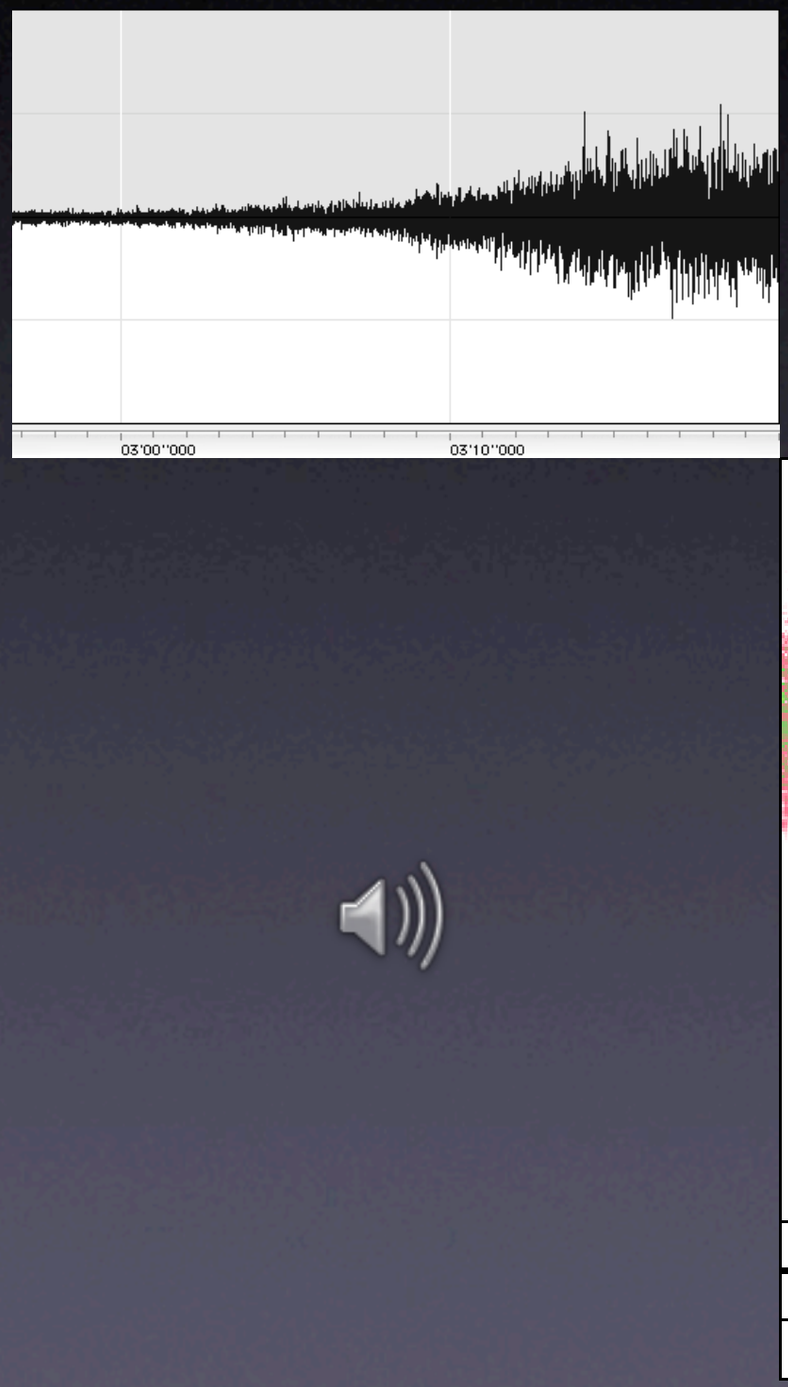
Waveform and spectrum





200x resampled seismogram

Sonogram



Sonification within GILDA

https://gilda.ct.infn.it/

https://grid-demo.ct.infn.it/

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Welcome to the GILDA Grid Demonstrator powered by GENIUS

GILDA Grid Demonstrator User's Guide (html, pdf)
Credits

This portal is best viewed with Mozilla 1.6.
Netscape (4.79, 4.80, 6 and higher) and Internet Explorer (5 or higher) can also be used.
The use of any other web browsers could induce some visualization mismatches and is not currently suggested.
Last update: **Fri 24 May 2005**

Done

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Login to the GRID

Username: demo40

MyProxy Passphrase: **********

Validity (hours): 4

Login

Done

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GILDA

GRID INFN LABORATORY for DISSEMINATION ACTIVITIES

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Please, select a Group Type to submit.

Group Type: 01. Sound Creation.

Next

Done

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RB: gilda | VO: gilda | Catalog: GILDA | Logout

Please, select a Job Type to submit.

Job Type: 04. Etna Sonification (EtnaPerGRID.jdl exec. time: 4 min.)

Next

Done

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Now you may also choose a specific Computing Element for your job.

Job Type Selected: EtnaPerGRID.jdl

Specify the CE Resource: grid010.ct.infn.it:2119/jobmanager-lcgpbs-long

Submit Job

Done

grid-demo.ct.infn.it

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Job Data
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```
Selected Virtual Organisation name (from UI conf file): gilda
Connecting to host grid004.ct.infn.it, port 7772
Logging to host grid004.ct.infn.it, port 9002

================================== edg-job-submit Success ==================================
 The job has been successfully submitted to the Network Server.
 Use edg-job-status command to check job current status. Your job identifier (edg_jobI

 - https://grid004.ct.infn.it:9000/lS9gGYiBa-YMcyzGqvLMUg

 The edg_jobId has been saved in the following file:
 /home/demo40/.genius/.tmp_submittedjob_demo40
============================================================================================
```

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Job Queue

JDL Name	Last Update	Destination	Status	Exit Code	Action
ıome/demo40/EtnaPerGRID.jdl	Fri Nov 18 15:51:46 2005	grid010.ct.infn.it:2119/jobmanager-lcgpbs-long	**Done**		

https://grid-demo.ct.infn.it/gilda/gilda.grid.xml?_uri=//gilda.grid/job-queue

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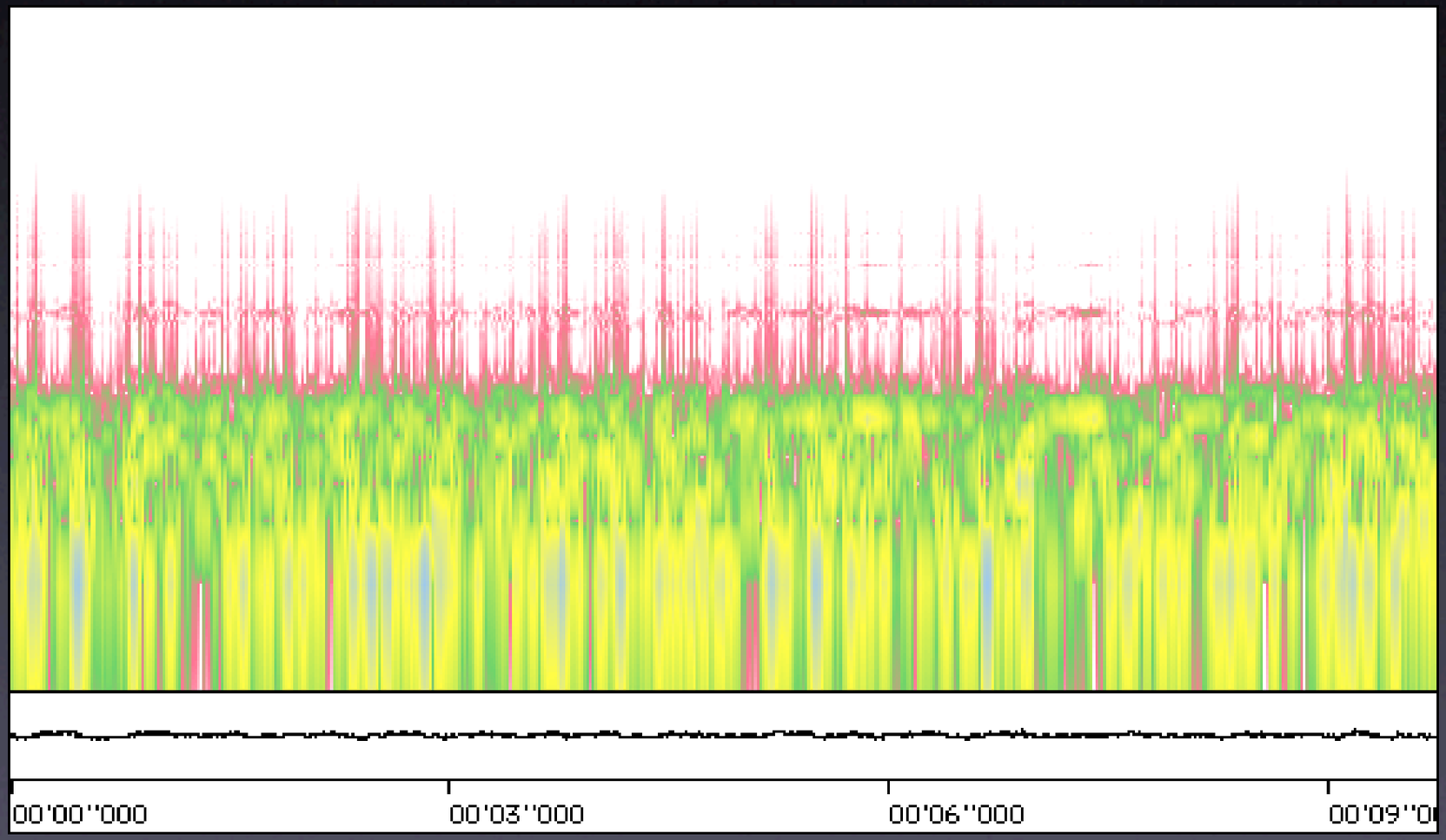
RB: gilda	VO: gilda	Catalog: GILDA	Logout
Destroy	Directory contents - 20051118_171145_lS9gGYiBa-YMcyzGqvLMUg		
Sonification.aiff	5,292,054	Sound.dat.txt	70,336,512
sonification.err	0	sonification.out.txt	35

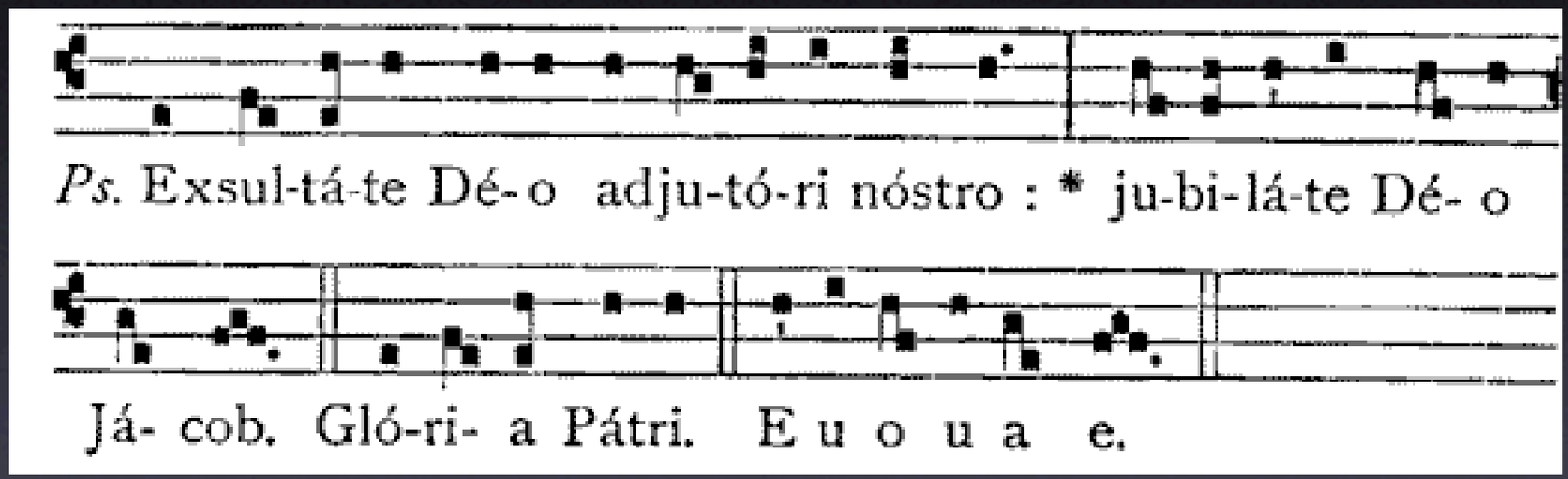
Done

grid-demo.ct.infn.it

Listening to sonification.aiff



Melodisation



https://gilda.ct.infn.it/

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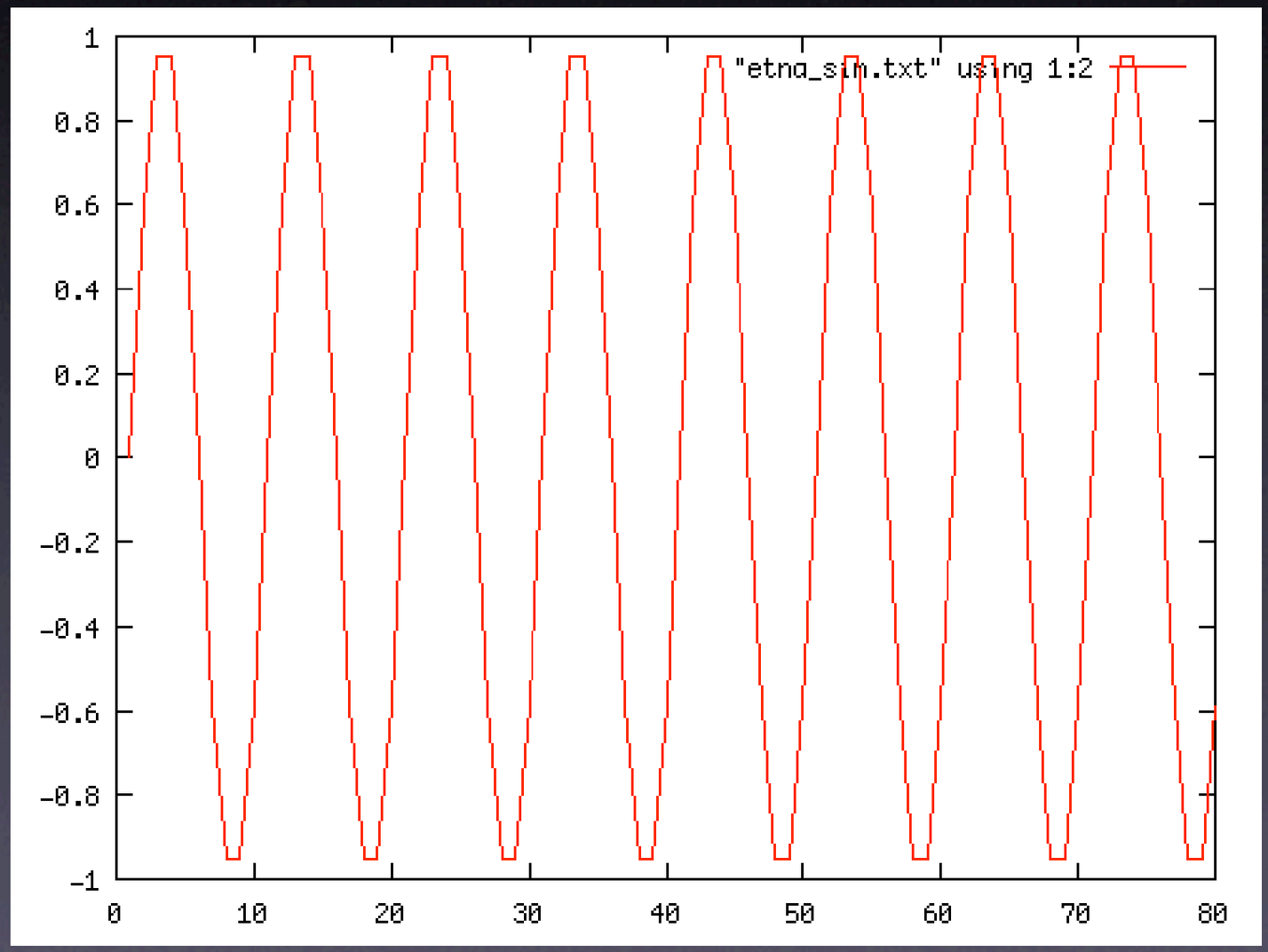
Data melodisation

- The whole data set interval is mapped on the (equally tempered) piano keyboard
- The min value of the seismographic data will correspond to the lowest playable note on the piano keyboard
- The max value to the highest playable note

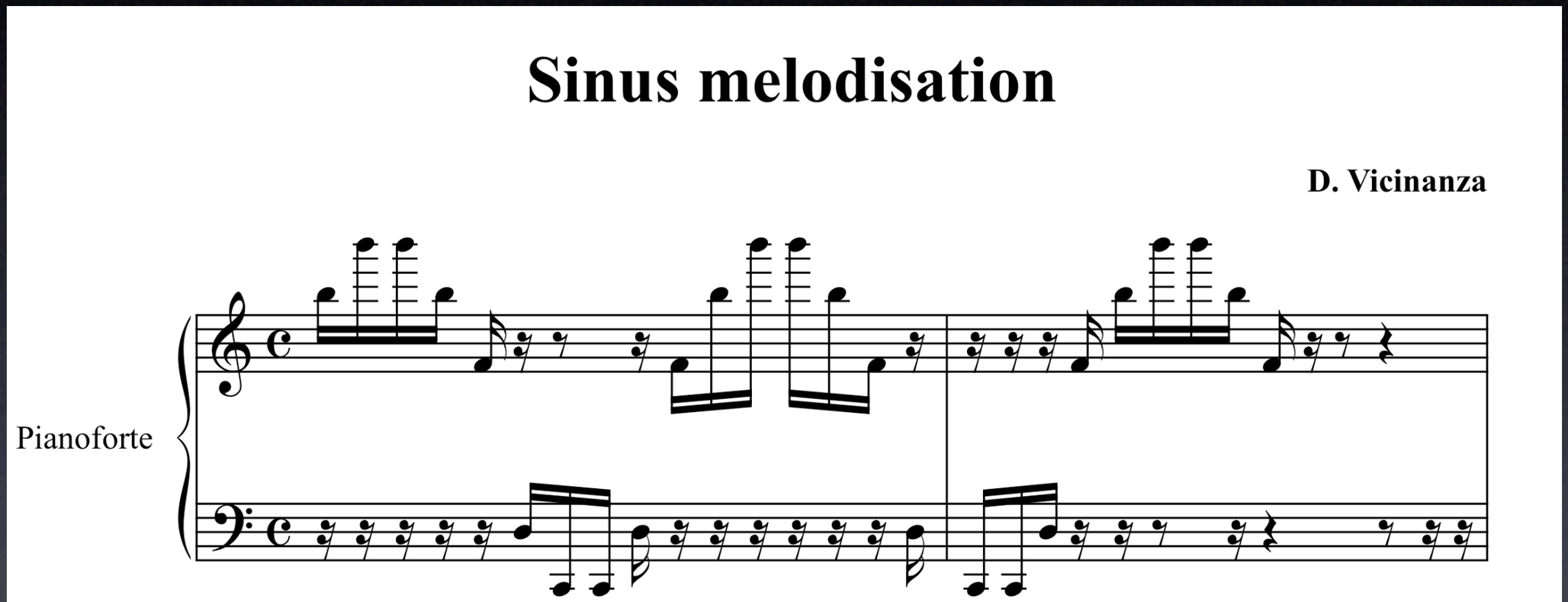
Example: Sinusoidal behavior

0.0
0.587785252292
0.951056516295
0.951056516295
0.587785252292
0.0
-0.587785252292
-0.951056516295
-0.951056516295
-0.587785252292
0.0
0.587785252292
0.951056516295
0.951056516295
0.587785252292
0.0



Original data

Melodisation



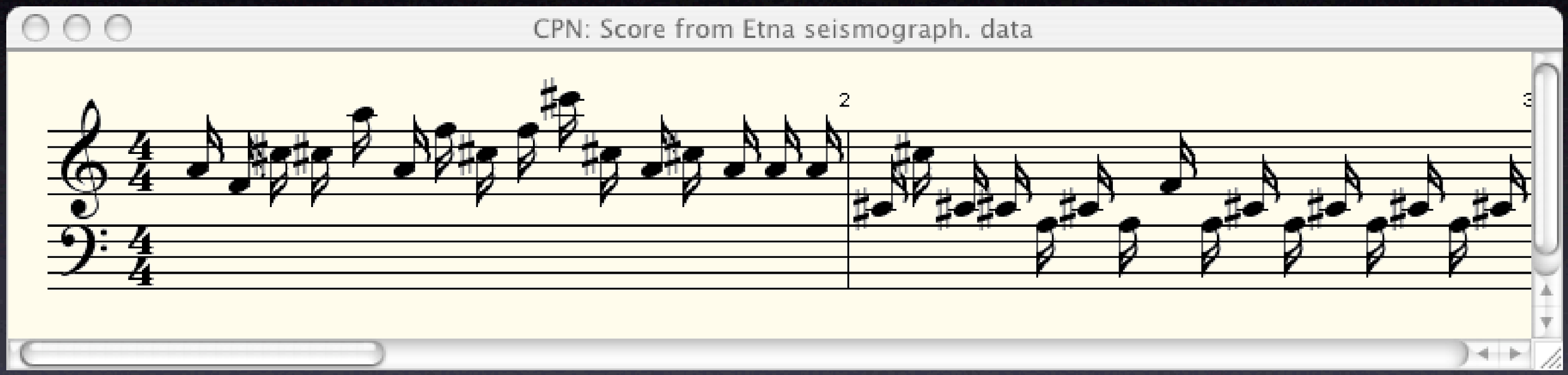
music from volcanoes

from seismograms to scores...

GRID Sonifications

Domenico Vicinanza

Seismograms melodisation

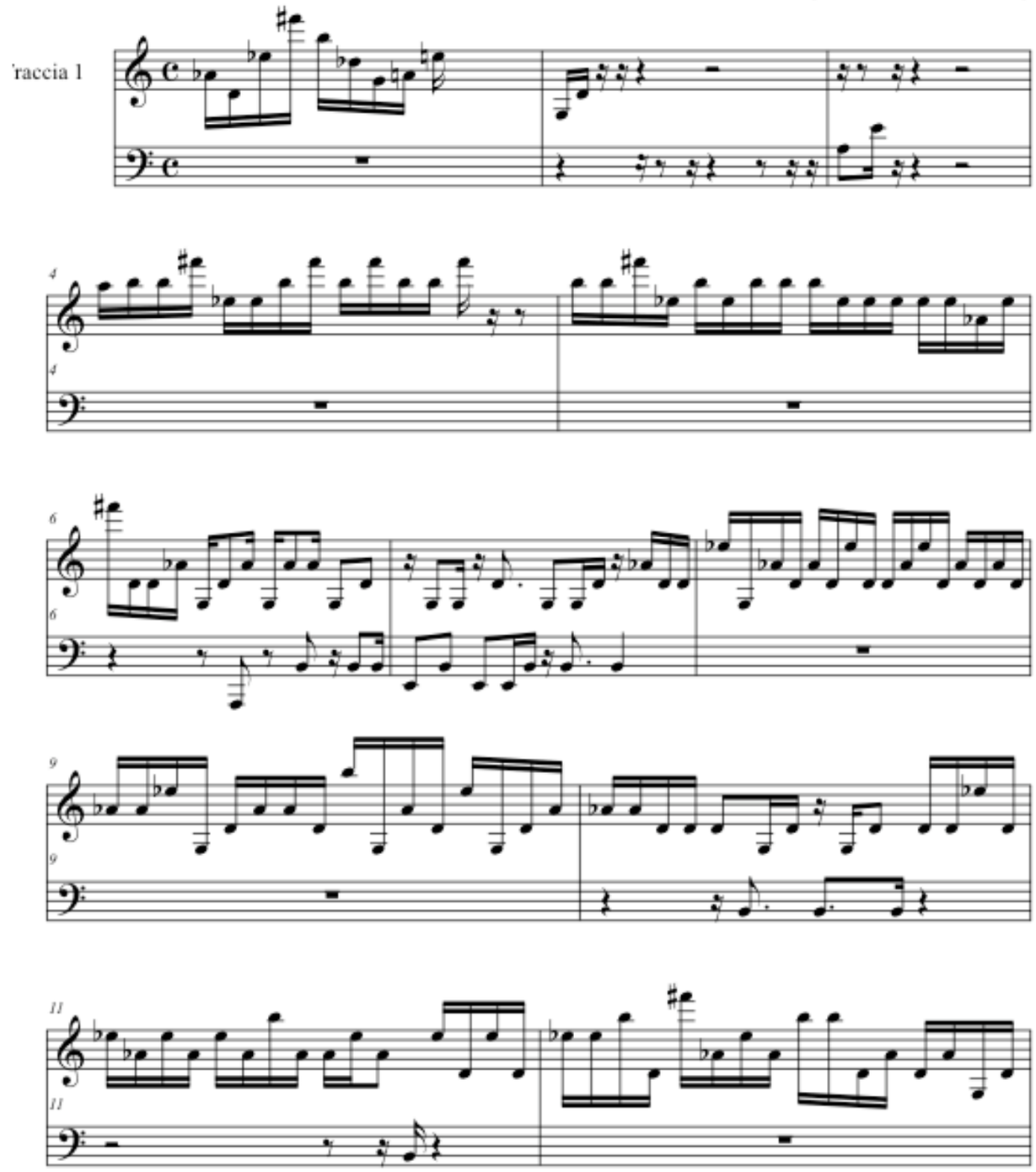


To each value of the seismograms it has been associated a note on the pentagram.

Repeated sequences in data set of the digital seismograph become repeated melodies

Etna Volcano
Seismograms Sonification

Domenico Vicinanza
(INFN-GRID network)



Text sonification

- To each character of a text it will be chosen a musical note according to the position of the letter (namely its ASCII code) into the English alphabet.
- In this way a "B" will be a semitone higher with respect to a "A", a "D" a third minor higher.
- The algorithm is case sensitive, so that a "B" will be lower than a "b".
- The duration of the consonants the one of a 1/16 note while the duration of vowels is a 1/8 note.

3D Data visualization

- As we have seen to each value of the data set we can associate a point of a waveform, a note of a melody...
- ...or even a graphical object
- The 3D data visualization package works associating a sphere to each datum
- Spheres radius, position, optical properties (such as IOR, reflection index, light diffusion, ...) are calculated as a function of the original data

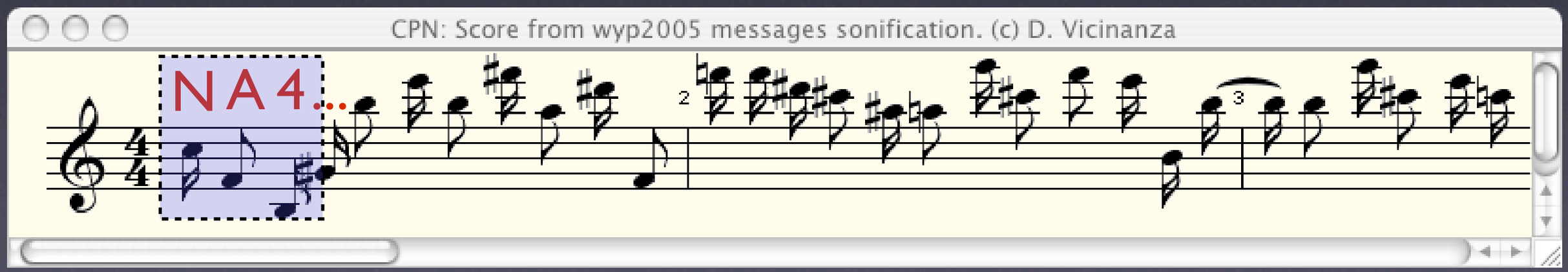
Rendering

- The whole set of data will be associated to a set of spheres ready to be rendered thanks to a Java program
- The final rendering is carried out using POVRay.
- It follows a list of examples produced using differente visulization parameters (namely, different backgrounds, lights, distortions, zooms, ...)

"NA4 Generic Appl." audification

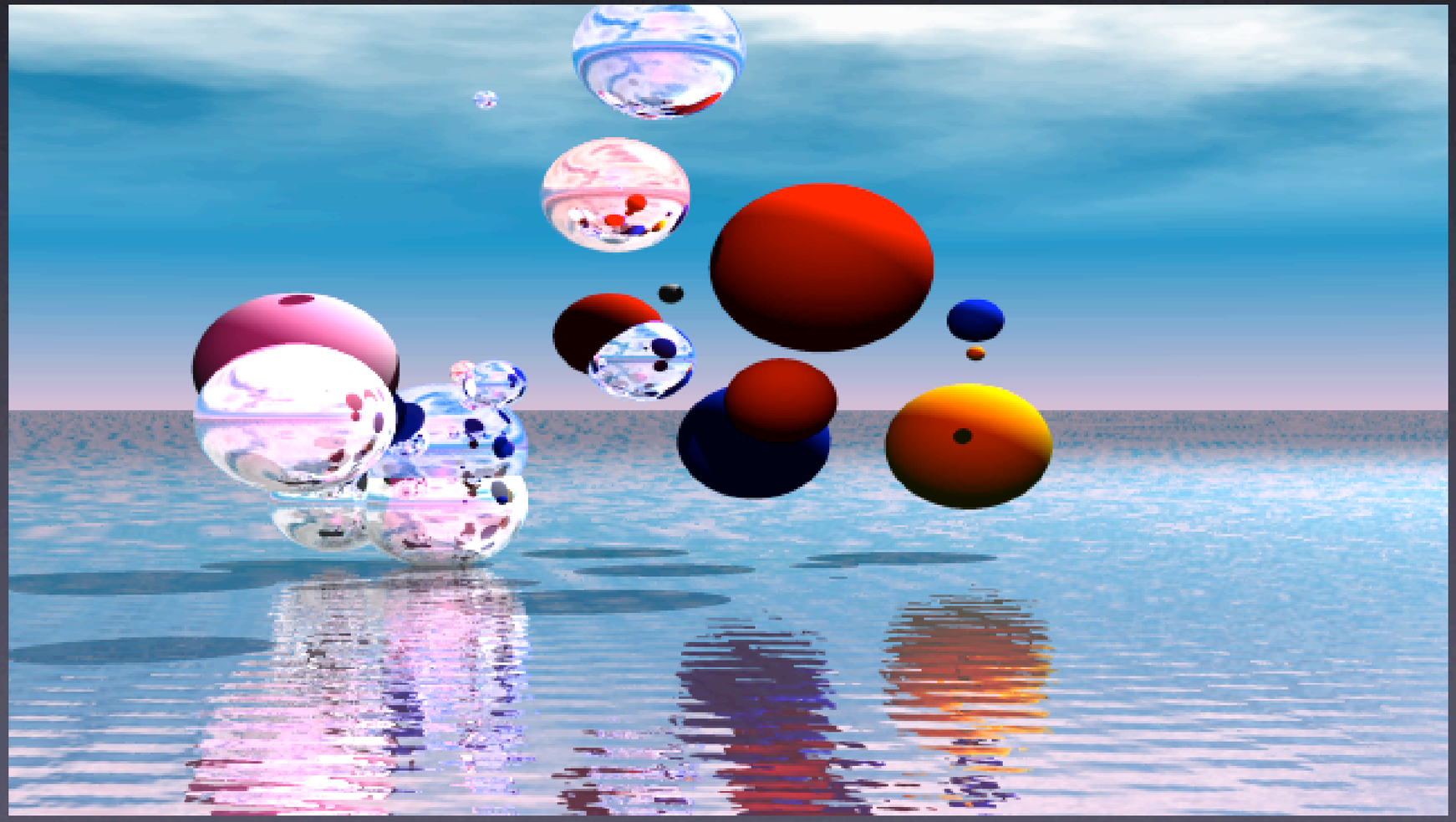
Starting string: "NA4 Generic Applications"

- *Audification* (melodisation): we associate a musical note to each letter of the text message:



“NA4 Generic Appl.” visualization

- *3D Visualization* (Java program + POVRay)



Thank you!