

## SONOUNO WEB INTERFACE FOR SONIFICATION AND ANALYSIS OF ASTROPHYSICAL DATA

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### ABSTRACT

Nowadays visualization is the main method to display and analyze scientific information in astronomy, only one sense analyzing a big amount of datasets, even after 20 years of formal meeting to discuss the use and capabilities of sonification. Beyond the reluctance to use sonification, there is a growing need for new forms of data display either for research or for outreach. In this sense, and centred mainly on research, SonoUno start been developed. In this opportunity, the sonoUno web interface is presented, the aim of this contribution is to produce a tool for users who don't need large datasets, or are simply interested in testing the concepts of the SonoUno project, without going through all the trouble of installing a full featured SonoUno system. The results are promising, real data sets were opened, sonified and some mathematical functions applied.

### RESUMEN

Hoy en día, la visualización es el método principal para mostrar y analizar información científica en astronomía, solo un sentido analizando una gran cantidad de datos, incluso luego de 20 años de reuniones formales discutiendo las capacidades y el uso de la sonificación. Más allá de la renuencia a utilizar la sonificación, existe una creciente necesidad de nuevas formas de análisis de datos, ya sea para la investigación o para la divulgación. En este sentido, y centrado principalmente en la investigación, se ha desarrollado SonoUno. En esta oportunidad, se presenta la interfaz web de este software, cuyo objetivo es producir una herramienta para usuarios que desean sonorizar pequeños conjuntos de datos, o simplemente están interesados en probar los conceptos del proyecto SonoUno, sin pasar por los problemas de instalar el software en su computadora, con todas las funciones y librerías necesarias. Los resultados son prometedores, se abrieron conjuntos de datos reales, se sonificaron y se aplicaron algunas funciones matemáticas para su análisis y se pudieron almacenar datos, gráficos y archivos de sonido.

*Key Words:* astronomy outreach — sonification

### 1. INTRODUCTION

The need to explore data sets beyond the visual access has led the community to explore new ways to represent it. Since 1992 the International Community of Auditory Display (ICAD) provides a place for the sonification field, centered on the display and perception research of using sonification to analyze data. The last twenty years have included some other workshops like the Interactive Sonification Workshop (Interactive-sonification web page), and this year the Audible Universe workshop (The Audible Universe web page), which one bring together a lot of researchers from different fields to talk and exchange knowledge about sonification in

astronomy. These make evident the need to use more than one sense to explore astronomical data.

To address that need, and in search of more accessible tools, SonoUno development was started. It is a user centered sonification software that allows to open datasets (.csv or .txt format), sonify it and even apply some mathematical analysis functions. The software presents a desktop version with the possibility of using octave commands to work with the data (soUno website) (Casado et al. 2022c). The graphic user interface framework of SonoUno was based on theoretical frameworks (Casado et al. 2022a), and focus group evaluation (Casado et al. 2021, 2022b).

In this contribution, the SonoUno web version is presented, unlike others, it allows the end users to open their own data and explore it through visual and sound deployment. To test it, a real dataset is opened with this resource. Besides enhancing the actual astronomical data display, this tool, and in general the sonification technique, presents the potential to enable functional diverse people to do science.

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### 1.1. *Related works*

Despite sonification being a new multidisciplinary research field, a lot of sonification tools and scripts have been done in the last years. Just to name some of them xSonify (Díaz-Merced et al. 2011), Sonification Sandbox (Davison & Walker 2007), Sonipy (Worrall et al. 2007) (sonipy), StarSound (Cooke et al. 2017) and SonoUno (Casado et al. 2022c) (sonUno-github). All of them have applications in astrophysics, only sonipy doesn't present a graphic user interface and only SonoUno expresses the need of a user centred approach from the beginning of the tool's development.

The mentioned are stand-alone software where the user needs to install it and can load some data set to visualize and sonify it. Moreover, there are other sonification tools available on the web, such as TwoTone, TimeWorkers (Chafe 2019), (Sonification Blocks) and Web Sandbox (Kondak et al. 2017), (Highcharts Sonification Studio). In the case of TwoTone only tutorials and videos are available and showed a framework where the user can open some dataset and sonify it with different sound settings. In the case of TimeWorkers, the user has to download a zip folder and change some browser settings in order to run the program. Sonification Blocks presents a drag and drop interface that allow sound generation with different sound settings. Finally, Web Sandbox, actually named Highcharts Sonification Studio, based on Sonification Sandbox software, allows the user to produce auditory and visual plots from equations and to open csv data sets, besides it allows to download the current work in different formats. In addition, Highcharts Sonification Studio allows to customize visual and audio settings in the same page.

## 2. SONOUNO WEB DEVELOPMENT

The development frameworks selected for the present proposal simplifies the use of libraries and reuses well known code. Angular has been selected to this end, as it is a widespread framework and also very easy to learn for anyone familiar with HTML, CSS and JavaScript. In this case, the development of a web browser compatible interface requires the use of all these to achieve all interfaces design and functions. In addition, the web interface permits to work interactively and in real time in order to achieve the data exploration experience of the desktop version.

The SonoUno web interface has been developed as a stripped down version of SonoUno desktop, that can run entirely on the web browser. Concerning the accessibility, it uses the same framework cen-

tered on the end user from the beginning of the SonoUno development. Related to the screen readers, it is the ARIA standard that provides the means and drives the implementation, allowing for the inclusion of tags specially design for screen readers specifying the text, reading priority as well as the ability to "trap" the navigation within certain context when needed, e.g.: when issuing an alert message. In a video-demo the use of NVDA screen reader can be seen to operate the SonoUno web interface in Windows with Chrome.

About the sound synthesis, one of the main differences between the Python and web implementations is the use of JavaScript for implementing the sound synthesis back-end. For the sound synthesis itself, the Tone.js library was selected. This library allows for pure tone generation, in the same way the SonoUno Python version does, ensuring precise frequencies can be used to represent variables values, as opposed to used notes with predefined frequencies and frequency steps.

While using Tone.js, the execution of synthesis of single tones is carried on asynchronously making it impractical to just loop through the array of values while waiting for the next tone production to finish playing. Instead, all tones are scheduled ahead for time and timers are held or destroyed if pause or stop commands are issued respectively. This scheduling also takes care of updating the position of the visual vertical marker and abscissa slider.

Besides the method used to translate the wave form to the computer hardware, the way the sound itself is configured and calculated is the same in both SonoUno versions, giving a consistent user experience.

## 3. RESULTS

The home page of SonoUno web greets the user with three distinct sections: 1. The navigation bar, providing access to the File functionalities, Input/Output functions, Sample data and access to the Help and Quickstart guides. The design of this element was based on a user case study conducted in Southampton University with both sighted and blind people, using the desktop version of SonoUno; the results confirm the need for a simple interface that only shows the principal functionalities in the main framework. 2. The plot area, providing four control buttons: Play/Pause, Stop, Mark Point and Delete Mark. 3. Below the plot, a tools area, supplying: two sliders, with which to control the abscissa position and tempo; a Math Functions bar, permitting the selection of simple mathematical functions

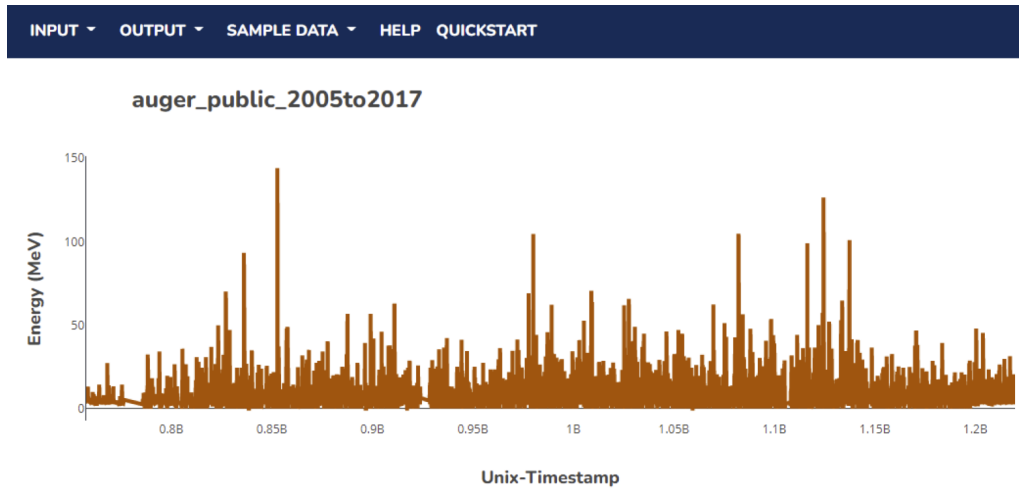


Fig. 1. Deployment of the SonoUno web interface with a data set downloaded from Pierre Auger Observatory open data web.

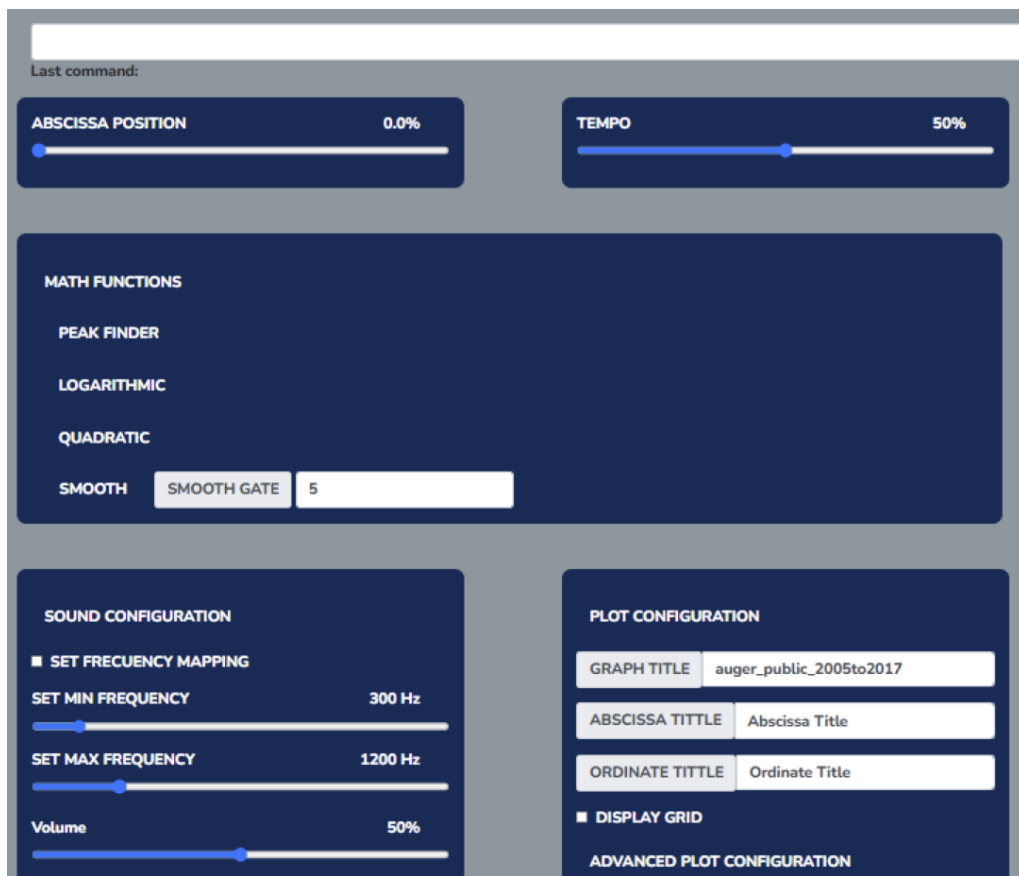


Fig. 2. SonoUno web interface functionalities: abscissa position and tempo slider, math functions, sound settings and plot configurations.

to be applied to the data; a sound-configuration section, containing tools with which to modify the way audio is processed; and a plot-configuration section,

which allows the user to modify the way the data is displayed in the plot.

In order to test the software functionalities, open access data from Pierre Auger Observatory were se-

lected (Fig. 1). The data set was opened without problems or delay (this step permits a visual inspection, when it is possible), the sonification was successful, the sound file was saved and the full process was recorded in a video. The length of the sound file depends on the data set because the sonification assign one tone to each data point. Finally, some marks for special signals, mathematical functions and changes in volume and frequency were applied to the data (Fig. 2), producing new plots and sounds which can be saved for future analysis. In addition, the screen reader navigation inside the web was considered and tested.

Further, a SonoUno web site devoted to the development is available; there the end users can access the user manuals of desktop and web version, installation instructive by operative system for desktop version, SonoUno web version, a gallery with different data sets and the github access of the open access source code.

#### 4. CONCLUSIONS

This project provided an open sonification web platform which can be used from any place with internet connection and without any special installation or libraries. The tool presents the advantage to grant the possibility of adjusting the sonification parameters on-the-fly, during the reproduction, and apply pre-loaded and user defined mathematical functions. In addition, the plot settings are available and it is

possible to save PLOT, SOUND and MARKS during the analysis and recover the results. The use of this tool will permit to add more functionalities and adapt it to each need or research.

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