LEGACY, ACTIVE & FUTURE SOFTWARE TOOLS IN SONIFICATION RESEARCH

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ABSTRACT

This article provides an overview of the development of active and legacy software tools for sonification. A collection of tools has been compiled and categorized according to research trends suggested in this paper, for the period 1990 to the present. The tools are categorized into five main user scenarios, highlighting key features of sustainable software, and identifying major challenges. The article also outlines a research agenda that considers the application of machine learning for generating intuitive and adaptive sonifications.

1. INTRODUCTION

The development of sonification research has been discussed, possibly because the initial expectations of the potential of auditory display did not match the following number of resulting applications or research output which has rather settled at a stable level [1]. Specifically, a detailed analysis of the development of the field was carried out from the perspective of sociology of science [2], and highlighted the lack of a *"killer app"*. Worrall [3] wrote a *"prehistory of sonification*", still arguing for this potential, while Neuhoff [4] questioned whether sonification was *"doomed to fail"*. Recently, the data sonification archive was categorized to see where sonifications have been applied most [5], however, this analysis only covers a curated set of online examples of sonifications. Within research, the development and use of specialized tools is crucial. Sonification tools have evolved to serve a range of users, from scientists in highly specialized fields to artists and educators seeking intuitive platforms. Still, there are no standard tools that are widely used besides general purpose audio programming languages. In this paper, we try to assess factors for success and challenges for sonification tools.

Recently, Peng et. al. [6] provided a compact overview of tools that have been *developed for* sonification. Our paper attempts a more complete collection of tools. The question of which tools are mainly used for sonification has been discussed by Bearman & Brown [7]. In their analysis of ICAD and non-ICAD papers, they found that most of the sonifications described there were created with SuperCollider and PureData. As highlighted already in the Sonification Report [8], the preference of general-purpose platforms is driven by several key considerations: familiarity, flexibility, and the demanding learning curves often associated with specialized tools. General-purpose environments remain popular because they are widely known and supported. Practitioners tend to stick to software they have already mastered, rather than investing time learning new platforms [7]. These established environments also benefit from large user bases, which translate into extensive documentation, active forums, and extensive shared code and examples. In contrast, specialized sonification tools may offer fewer community resources and require additional technical knowledge to integrate with existing workflows [9]. In addition, the robust real-time performance capabilities in general-purpose tools, critical for rapid feedback applications, make them highly appealing for interactive installations or live performances [8].

For this paper, we conducted an analysis to eventually find out how the research field of sonification has been evolving and how tool development was answered by upcoming trends. We compiled data as described in Sec. 2, discuss five main use case scenarios in Sec. 3, and draw conclusions on how Machine Learning (ML) may be used in future tools in Sec. 4.

2. SONIFICATION TOOLS AND RESEARCH TRENDS

In a first step, we conducted an updated analysis of research trends in sonification research, in order to give a meaningful context for the development of sonification software tools. Then we conducted a web search for sonification tools and assigned them to one of five main user scenarios.

2.1. Development of sonification research

Following our previous analysis of the development of sonification research [1][1], we drew an updated data set of the most relevant papers in the field of sonification from Google scholar[2]. In our data set, we took into account the first 300 most cited publications from the updated data set, leading to a list of papers that were cited each 27 times or more often. Then, we tagged the papers semi-automatically, assigning only one main category for each paper. The categories followed from content analysis [10] of one of the authors, working with the titles and abstracts of the articles. Categories emerged and were incrementally added and / or merged according to the number of articles related. This process is obviously subjective, as most papers could be categorized as one or another main topic. Furthermore, the choice of Google scholar and

[1]Original data set: https://zenodo.org/records/8171076
[2]Updated data set for this paper: https://phaidra.kug.ac.at/view/o:136199

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the limit to 300 papers are limitations to our analysis. However, at this stage only general trends should be highlighted.

The outcome is shown in Fig. 1(a) and shows the period 1990-2024, though none of the more recent papers than 2022 has been cited often enough to appear in our list. We found the following categories and list them in the order of the weighted mean year (see caption of Fig. 1(a) for explanation):

- *Tool/ framework*,
- *Psychoacoustics/ Mapping*,
- *Sonification of visual information* such as graphs or pictures,
- *Sonification in Web & VR*,
- *Sonification methods* referring to the development of specific sonification methods,
- *Scientific sonification and sonification of finances' data*,
- general *Introduction & Theory* of sonification,
- *Monitoring* applications,
- *Navigation* applications,
- *Musification*, i.e. sonification that generates music,
- *Interaction, HCI and robotics*,
- *Design theory*,
- *Accessibility*,
- *Medical and EEG sonification*,
- *Movement sonification*,
- *Aesthetics / Music relation* – i.e. the relation of sonification to aesthetics and music,
- *Multi-modality* that explores correlations to other, mostly non-visual, sensory inputs,
- a *Meta perspective*, for instance the discussion of sonification as a research field,
- and, most recently, *Rehabilitation*.

Some of the assigned categories are actually sub-categories of another (such as Movement sonification and Rehabilitation), but were categorized separately because of the high number of specific publications. Fig. 1(a) shows that some categories span almost the entire period (such as Tool/framework or Introduction & Theory). Others give some insight into more trending topics, e.g. relevant Sonification methods being mainly developed 1999-2014. Recent and stable research topics in our analysis include Interaction, HCI and robotics, Accessibility, and Medical sonifications plus Rehabilitation.

2.2. Development and Use of Sonification Tools

We conducted an extensive web search combined with a literature review (that started from [6, 7]) on which tools are used or have been developed for sonification. The full list is available as extra material[3], while an overview is given in Tabs. 1 and 2. This is not a complete list, as there certainly are additional tools or outdated and unfinished projects that could not be identified. In total, we identified 57 tools, of which 32 are active by May 2025. Table 1 presents the overview of active sonification tools, from long-standing audio programming environments to more specialized or recent solutions that specifically target sonification. Tab. 2 presents tools that no longer run. In Fig. 1(b), all tools are shown in order of appearance and are sorted in their main scenario as discussed below.

Most of all tools are open-source (43/57) and support real-time processing (44/57), making them suitable for interactive applications and live performances. All actively maintained tools, except for one, are cross-platform, ensuring broad accessibility across different operating systems.

While Table 1 shows all active tools, we would like to differentiate between *sustainable active* tools that are older than five years and still active (18), *active* ones that were recently developed (15), and *discontinued or legacy* tools (24). Key factors for success can best be derived from the sustainable active ones.

Despite the strong appeal of all-in-one audio environments, specialized sonification tools do play a significant role, especially when they address specific needs or communities. Some programs, such as MIDITime [11], TwoTone [12], and SonoUno [13], even if diverging in their main purpose, have shown consistent usage within the community over multiple years, as reflected by their GitHub activity. In our view, general-purpose software's familiarity and scope usually outweigh whatever advantages specialized sonification software can offer. However, it appears that specialized software wins if it offers clear and targeted advantages and receives enough institutional or community support to remain current and relevant. We will discuss more detailed takeaways in Sec. 3.

3. USE CASE SCENARIOS AND TOOL'S FEATURES

We categorized all tools for their main purpose into five basic scenarios, and discuss key features for their success ("+") as well as challenges and limitations ("-"). Obviously, some tools would fit into more than one category and can be used for diverse goals, but we mainly followed the creator's own description. The categories include: general-purpose audio programming languages ("APL"), specific sonification methods ("SON"), domain-specific scientific tools ("SCI"), interactive sonification ("IS"), musification of data ("MU") Additionally, we included a section for tools aimed at accessibility and assistive technology. This is not a single functional category, but highlights tools designed with blind or visually impaired users ("BLV") in mind, which often overlap with other categories.

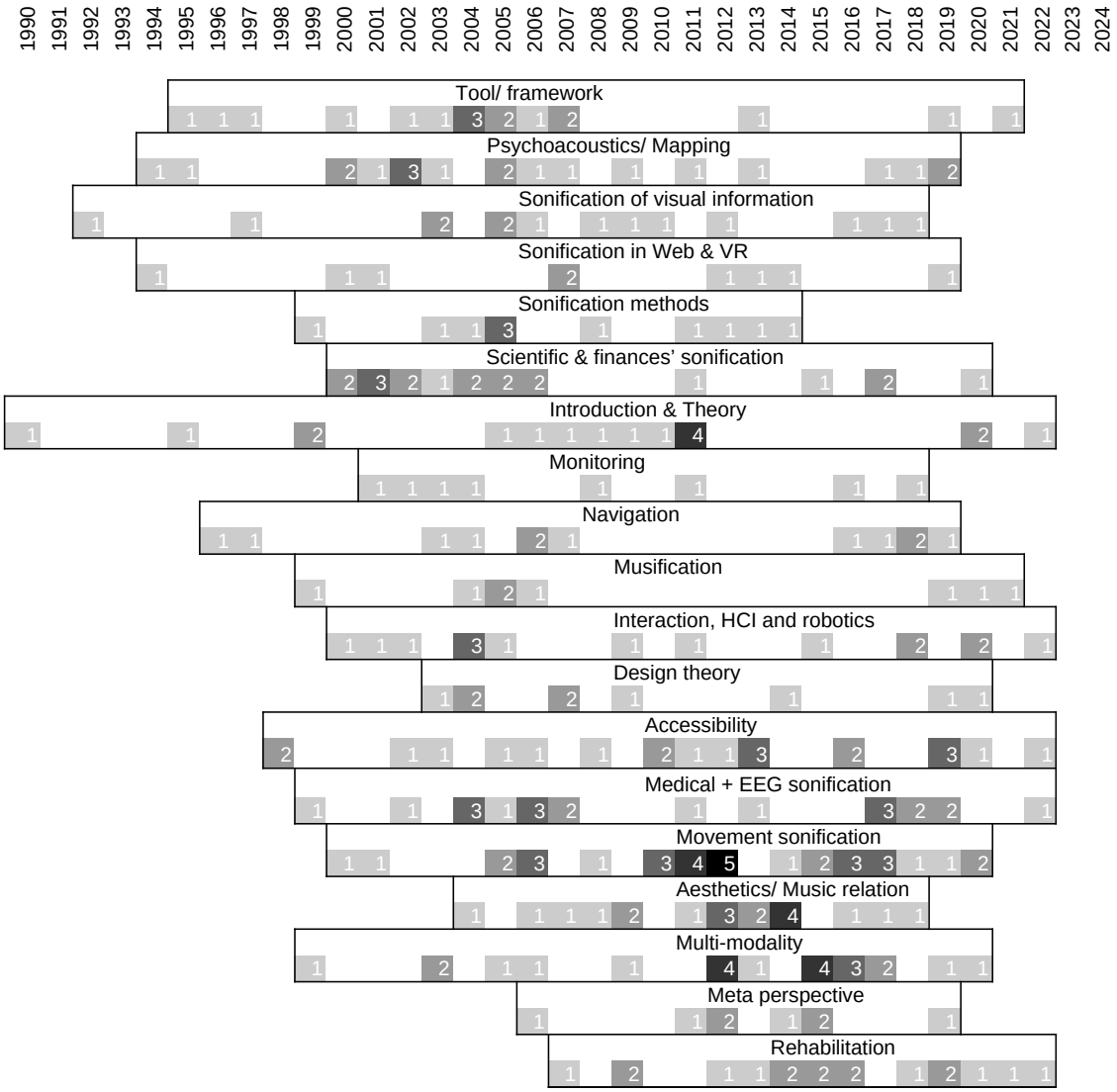
General-purpose tools like SuperCollider [14] and PureData [15] fall under the APL category and are widely used. However, since they serve as foundational frameworks rather than dedicated sonification tools, they are not discussed further in the following sections.

3.1. Supporting a specific sonification method (SON)

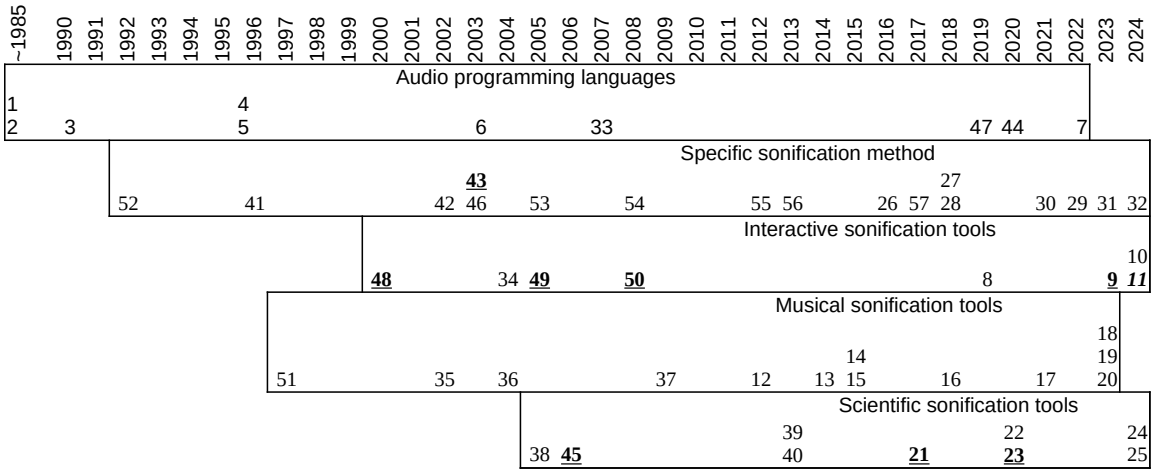
A relative majority of the listed tools realize one specific sonification method, most often parameter mapping (audification was only realized with Sonifyer which is outdated since 2019). Some of them are more restricted, for instance, creating only MIDI sounds, though some of them are relatively sustainable, such as MIDITime [11]. In total, 16 tools (7 active and 9 inactive ones) were tagged as "SON".

+ Quick Access and Understanding: Focused functionality simplifies setup, making it easier for newcomers to grasp

[3] https://phaidra.kug.ac.at/o:136197



(a) General research topics in sonification.



(b) Specific topics where sonification was applied

Figure 1: (a) shows the timeline of general research trends, deduced from 300 most relevant papers, drawn from Google scholar in January 2025, and subjectively categorized by the authors following the procedure described in [1]. The number of articles published in the respective year is shown in numbers and respectively gray-scaled boxes. The category *title* is positioned on the position of the year that corresponds to the weighted mean (wm) of years, i.e., the rounded mean year of years * number of publications (e.g., one publication in 2002 and three papers in 2004 would lead to a weighted mean year of 2003). The table is sorted along the wm year of the category.
(b) shows the publishing of tools as numbered in Tab.s 1 and 2 following the same sorting of wm categories as above.

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sonification fundamentals and generate basic auditory representations.

+ Straightforward Configuration: Because these tools specialize in a single method, mostly Parameter Mapping, configuring data inputs and producing sound often requires minimal steps, easing adoption for straightforward use cases.

– Sound Limitations: Restricting output to a single format such as MIDI or a limited set of parameters can reduce the flexibility and richness of the sound.

– Narrow Application Scope: Tools that concentrate on only one technique may not integrate well into broader data analysis pipelines or adapt to more complex datasets and research questions.

3.2. Scientific Data Exploration with Domain-Specific Tools (SCI)

We tagged 10 tools as specific and scientific ("SCI", 5 active and 5 inactive). Most of them are in the fields of physics, specifically astronomy and Earth sciences including climatology, and one in medicine (SoniScan [16]). In fields like astronomy, where vast datasets present complex patterns, auditory analysis can reveal insights that might be missed visually. Tools like Astronify [17] and SonoUno [13] enable both researchers and a broad public to explore these datasets through sound.

+ Handling Datasets: Tools support extensive scientific datasets which often use their own data format standards.

+ Straightforward sound options: As these tools are tailored for users with few insights into sound and sonification, they realize adjustable and simple mappings.

+ Outreach: Even if created for data analysis, resulting sonifications may be used for outreach and attract attention.

– Limited Real-Time Features: Some of the tools involve a tedious workflow, affording the iterative adaption and preprocessing of data before entering the sonification software, and thus restrict their use in interactive data analysis.

– Basic sound options: as the users are experts in their respective field, rather than in sonification, resulting sounds are often limited.

– Niche Adoption: Despite their potential, these tools often struggle to gain widespread attraction even within the field. One reason might be, that, even within a scientific domain, they are very specific in the applicable data.

3.3. Real-time and Interactive Sonification (IS)

Real-time and interactive sonification emphasizes immediate feedback and user manipulation of data. This approach is especially beneficial in contexts where rapid adjustments or sensor-based inputs are crucial, such as rehabilitation and health monitoring, or live performances. We identified 8 (4 active and 4 discontinued) tools as "IS" that implement this kind of dynamic functionality. The only active one which is also relatively sustainable (active since 2019), is Holon.ist [18], which enables real-time mapping of smartphone sensor data and wearable data to sound, offering on-the-go feedback for activities like fitness or environmental monitoring.

+ Integration of real-time data, either from sensors or other software

+ Easy access for experts: As part of a familiar development environment, such as Unity [19] or Pure Data [15], users who are familiar with that environment can easily use the tools.

+ Liveliness and engagement: Interactive systems may provide quicker understanding of the resulting sounds and are more engaging to play with.

– Specialized Framework Dependence: Some tools (e.g., the Interactive Sonification Toolkit [20]) relied on programming environments like Pure Data [15], Unity [19], MATLAB [21], among others. This can present a steep learning curve and require users to have technical expertise. Some also are not cross-platform (iOS for Holon.ist [18]).

– Prototype and Discontinuation Gaps: For their dependance on inputs from other software, constant updates of interactive systems can be more crucial than, for instance, standalone applications that only read in text-based data.

3.4. Creating musical or entertaining content (MU)

In addition to its analytical benefits, sonification also serves as a creative practice for live coding performances, generative music, and interactive web-based experiences. These tools often integrate with digital audio workstations, leverage music theory, or provide real-time coding environments that transform data streams into compelling sonic outputs. We identified 13 (9 active and 4 discontinued) tools that specifically cater to musical or entertaining applications of sonification, tagged as "MU". SonicPi [22] and Tone.js [23] are the oldest, still active tools, in our compilation.

+ Performance and Live Coding Flexibility: Tools empower users to craft sonifications in real time, making them popular for performances or interactive demos.

+ Proficient users and good sound: As these tools address sound producers or the creative industry, their sound possibilities are often more advanced and compelling.

+ Accessible framework: Either being web-based (the majority), or implemented into a well known software framework, these tools lower the installation barriers and facilitate quick experimentation or classroom use.

+ Attractive look: The success factor of a compelling web presence and aesthetic user interfaces can be found in many musification projects, which is possibly due to their relation to the creative industry.

– Niche and Legacy Approaches: Discontinued tools like sMax [24] targeted very specific data domains (stock market trends, genomic sequences), limiting their broader appeal. Others, such as MUSE [25], adopted music-theory-driven methods but remained at the proof-of-concept stage, eventually becoming outdated or incompatible with current systems.

– Simple data limitations: Many systems do not support the handling of more complex data or larger data sets.

– Limited Workflow Integration: These prototypes often predated modern plugin standards or DAW (Digital Audio

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Workstation) ecosystems, making them difficult to incorporate into current music production environments. As a result, they never developed vibrant user communities or secured the sustained support needed to evolve beyond initial research.

3.5. Accessibility and Assistive Technology

We did not tag tools in their main use case scenario for accessibility, because their use scenarios may be different, but in the following take those tools into account that are tagged for their target users with ""BLV" for blind and low vision community. For BLV individuals, sonification is more than a research tool: It is a means of accessing information independently. Despite this huge potential, we identified only 4 active and 5 legacy tools that were explicitly created for BLV users, with their main purposes being related to interactivity and scientific data exploration. The most sustainable in our compilation is SonoUno [13] that targets the sonification of astronomical data and is created by the National Aeronautics and Space Administration (NASA).

+ Accessible and Multimodal Interaction: By incorporating sound, haptics, and speech output, these tools enhance accessibility for blind and visually impaired users.
+ User-Friendly Interfaces for BLV: Minimal technical expertise is required.
+ Community-Driven Development : Regular updates and user feedback are crucial for refining and maintaining effective assistive technologies. Some of the analyzed projects have a large user basis, which is specifically true for the ones developed by NASA.
+ Sustainable funding: Accessibility might be a good and valid argument for acquire research and development funds.
– Limited scope: Tools are tailored to specific domains and do not work for general purpose sonifications.
– Limited sound: Again, due to the simple to use interface, the options for sound output are limited both in terms of methods used and their sound quality.
– Prototype fate: Specifically in accessibility, we found academic prototypes that did not evolve into projects.

3.6. General success factors and obstacles

Among the 19 active and sustainable tools, 12 are academic and 7 are commercial, while all 24 discontinued projects originated in academia. This pattern suggests that commercial tools tend to have greater longevity, likely due to stable funding, market demand, and long-term maintenance structures. While some academic tools do persist, they are often outnumbered by commercial solutions, reflecting the challenge of sustaining projects beyond initial research funding cycles. Academic tools often lack dedicated long-term support, making them vulnerable to discontinuation once grants expire or researchers shift focus.

We identified general success factors and challenges across all user scenarios:

+ Interdisciplinary and Real-World Applications: Sonification tools with applications beyond academic contexts – such as those used in music education (e.g., SonicPi [22]), accessibility (SonoUno [13]), and applied scientific domains (Astronify [17])– tend to receive long-term support. These tools often align with ongoing funding initiatives in accessibility: science, technology, engineering and mathematics (STEM), education, and creative arts, enhancing their sustainability.
+ Ease of Integration and Accessibility: The ability to integrate with other data analysis workflows is a crucial determinant of tool adoption. Cross-platform support (Windows, macOS, Linux) and web-based applications lower barriers to entry and encourage broader use. Tools such as Tone.js [26], TwoTone [12], and Highcharts Sonification [27] have gained traction due to their ease of use and web-based deployment. In contrast, tools requiring complex installations or specialized environments often see limited adoption.
– Sustainability Issues: Most of academic initiatives are discontinued due to limited funding and institutional backing. Funding must continue to allow maintenance and upgrades to occur.
– Lack of Standardization: Inconsistent formats and protocols between various tools create compatibility issues that make it difficult to integrate several systems or transition between platforms.
– Integration Challenges: Integrating sonification software into general-purpose data analysis workflows is difficult because they have limited adoption outside research communities.
– Unfulfilled Potential: Many promising proofs-of-concept never reach their full potential as instruments, due to a lack of funding, lack of user adoption, or inability to transition research initiatives to real-world applications.

Despite such adversity, specialized software can thrive in committed niche communities with high usage and domain-specific demands facilitating development. Multidisciplinary platforms, while not as universally adopted as general-purpose software like Max/MSP[28], Pure Data [15], SuperCollider [14] or as broadly used as programming languages like Python, do tend to have user bases in their niches. Web-based applications have an advantage that they can seamlessly integrate into broader analytical workflows without requiring complicated installs or technical knowledge. External funding, grants, industry partnerships, or institutional funding, also facilitates ongoing development of such software, particularly in applications related with accessibility and STEM education.

4. THE FUTURE OF SONIFICATION TOOLS

The rapid expansion in ML techniques is revolutionizing nearly all aspects of data analysis, and the expectation is that sonification should be on the same path. Sonification methods originated in pre-ML days but have some limitations that can be overcome using more advanced algorithms [8]. As scientific trends shift toward automation and adaptability, sonification's next step is to integrate predictive modeling, adaptive techniques, and personalization. The integration of ML with sonification workflows enables scientists to expose latent connections between data, control sound parameters adaptively, and personalize auditory representations to users.

The emergence of ML in the 21st century has accelerated sonification research in a more automated, flexible, and customized

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manner. ML has introduced new possibilities in sound design and real-time data-to-audio applications outside music that allow systems to learn meaningful mappings without ongoing human intervention [29, 30]. This introduces adaptability that traditional techniques like parameter mapping or audification lack when used alone, and supports more intuitive, user-aware listening experiences. In addition to traditional ML approaches, recent advances in generative AI and LLM have expanded the scope of sonification tools. These models support context-aware and multimodal sound creation that extends well beyond predictive analytics or classification [31, 32, 33].

However, despite these advances, a truly user-friendly and integrated ML-based sonification system is still missing. Many current tools face maintenance issues, limited adoption, or lack versatility. All such disadvantages point to a new paradigm that streamlines the data-to-audio pipeline while facilitating adaptive and customizable functionalities to serve professionals and general users alike.

Projects like FluCoMa [34] and Mesonic [35] indicate possible directions for AI-assisted audio tools in the future. FluCoMa does use ML to conduct complex manipulation of audio, but it is not a tool specifically designed for sonification; instead, it focuses on audio signal processing and ML rather than general data sonification [36, 37]. Mesonic provides a Python interface to make sonification more accessible to people, but it does not offer an ML integration, yet [35]. While both offer good ideas, neither has become a full-fledged system that integrates AI-powered analytics with user-friendly customization features such as natural language feedback.

Recent developments also highlight the growing role of generative AI in sonification. One such system, SonifyAR [31], exemplifies how modern ML tools can be used to bridge virtual and real-world audio contexts. It employs GPT-4 and AudioLDM (a diffusion-based model for audio generation) to generate context-aware sound effects through a programming-by-demonstration approach, capturing user intent and environmental context to match or synthesize appropriate sounds. Tested across five application domains, including accessibility and safety, SonifyAR demonstrates how LLM based systems can enable intelligent, adaptive auditory design in both research and real-world settings.

Even general-purpose LLMs like ChatGPT are now capable of assisting in basic sonification tasks by generating simple mappings or interpreting datasets to suggest sound structures. Although these capabilities are still developing, they mark an important step toward democratizing sonification and expanding its usability through conversational interfaces.

Other domains, particularly data visualization with machine learning, demonstrate that intuitive interfaces and automation can enhance access. Software such as Tableau [38], Zoho Analytics [39], and ThoughtSpot [40] use ML to find key patterns in the information and make interactive discovery possible through query-based or drag-and-drop interfaces. Applying those same principles to auditory display can make sonification more accessible to more people and make real-time, adaptive soundscapes a useful tool for data analysis [41].

Following from our analysis above, we believe that ML can also help tackle long-standing challenges in sonification:

a. **For creative users** such as musicians or sound designers, ML can handle complex processing in the background, freeing them to focus on aesthetics. Algorithms can turn large datasets into musical structures without requiring manual tuning of every parameter. This increases the expressive range of musification software.

b. **For scientists**, where the goal is data insight rather than musicality, ML could generate more natural auditory mappings. Systems could learn from data structure and user interaction to automatically choose effective mappings, making auditory exploration easier, especially in fields where visuals are limited or impractical [42, 43, 44].

c. **For accessibility**, ML can boost the usefulness of tools designed for BLV users. Most current systems are limited by minimalist design and narrow sound vocabularies. ML could adapt sound mappings to user behavior, learn over time, and even personalize audio feedback [45]. Features like intelligent speech synthesis or haptic integration could turn sonification into a robust multimodal solution [46]. This would also help these tools scale beyond prototypes into more sustainable, real-world applications.

When it comes to general success factors and issues, ML can help to address issues of sustainability by reducing frequent human maintenance and update requirements [47]. ML can also help with standardization through developing best practices in terms of sound design and translation of data so that sonification software is more compatible with other disciplines and applications [48]. Through the integration of ML into sonification platforms, developers can create more stable software that continues to improve, making sonification more accessible to research and commercial applications [49].

The fusion of ML and sonification is inevitable. By reducing human calibration to a minimum, offering customized auditory mappings, and being embedded within existing workflows in data science, ML-fueled sonification can make data exploration more accessible and interactive. The next phase of evolution will likely focus on developing stable, community-supported frameworks, much like modern visualization software, that will permit ongoing expansion and evolution within the field. In addition, establishing standardized methodologies, data formats, and best practices will be crucial in ensuring consistency, interoperability, and greater adoption. Standardization would help unify disparate approaches, facilitate collaboration between disciplines, and create a foundation for more scalable and reliable sonification tools.

5. CONCLUSIONS

Sonification software has progressed a lot but is still difficult to maintain in the long term. General-purpose programming languages have survived because they have large user communities, extensive documentation, and continuous development. Such platforms have the benefit of being cross-platform and flexible, while specialized sonification software is bailed down by low adoption rates, limited funding, and short-term maintenance.

Commercial products have a better chance of staying in the long term because they have market-driven demand and enough funding. Academic products have a tendency to become obsolete once initial research funding runs out or development staff shift priorities to other projects. However, some domain-specific products have survived nonetheless, likely due to institutional sponsorship and public demand.

Among the surprises is ongoing research on musification tools, showing that the connection between music and data is still an

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active and evolving field. Furthermore some accessibility tools do exist, they remain relatively few in number, suggesting that it is an area in which more investment would have a real impact.

Looking ahead, sonification's convergence with ML has great promise to create auditory displays. However, sonification still lacks standard methodologies, scalable frameworks, and mainstream adoption beyond niche communities. For sonification to reach its full potential, it will require more integration with mainstream data science workflows, increased usability, and continued research and development. As part of our future work, we aim to build on the key points discussed in this paper by developing a ML-supported sonification tool that addresses some of these challenges and opportunities.

6. ACKNOWLEDGMENT

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Num	Name*	Year	Use Case Scenario	Target User	Input Data	Notes
1	MATLAB*	1984	APL	DS	TX	Provides built-in functions like sonify and sound for data sonification
2	Csound*	1986	APL	SE	SP	Algorithmic composition, sound synthesis
3	Max/MSP*	1990	APL	SE	TX	Popular for music and interactive media
4	SuperCollider*	1996	APL	SE	TX	Powerful sound synthesis and live coding tool
5	Pure Data (Pd)*	1996	APL	SE	TX	Open-source visual programming for audio
6	ChucK	2003	APL	SE	TX	Live coding for sound, real-time audio synthesis
7	Mesonic	2022	APL	DS	TX	Python framework for sonification
8	Holon.ist*	2019	IS	GP	SP	Transforms real-time sensor data from smartphones and wearables into sound
9	Edukoi	2023	IS	BLV	SP	Interactive sonification software for visually impaired children
10	Interactive Sonification for Health and Energy	2024	IS	DS	TX	Uses ChucK and Unity for interactive sonifications of health and energy data
11	SonifyAR	2024	IS	BLV	SP	AR tool that uses AI to create context-aware sound effects, tested in five apps and a user study.
12	SonicPi	2012	MU	CI	TX	Live coding for music, education, and performance
13	Tone.js	2014	MU	SE	TX	Web Audio framework for interactive music creation
14	p5.sound	2015	MU	SE	TX	A JavaScript library extending p5.js with Web Audio functionality
15	FoxDot	2015	MU	SE	TX	Live coding music environment using Python and SuperCollider
16	TwoTone	2018	MU	GP	TX	A web-based tool that converts data into sound
17	Loud Numbers*	2021	MU	CI	TX	Converts CSV data to modular synth control voltages (cv)
18	DataSonifyer*	2023	MU	CI	TX	User-friendly tool for sonifying data with effects
19	Sonification Tools for Live*	2023	MU	CI	TX	Max for Live (Ableton) tools for turning data into sound
20	Supriya	2023	MU	SE	TX	Supriya is a Python API for SuperCollider, enabling users to boot and communicate with SuperCollider
21	SonoUno	2017	SCI	BLV	TX	Accessibility-focused for Astronomy, evolved from xSonify
22	Astronify	2020	SCI	DS	TX	Sonifies astronomical data like light curves mapping one axis to time and another to pitch
23	StarSound	2020	SCI	BLV	SP	Beta tool for accessible astronomical data exploration
24	Sonification Interface for REmapping Nature (SIREN)	2024	SCI	GP	TX	A web-based interface for sonification
25	Variational Quantum Harmonizer	2024	SCI	DS	SP	Sonifies Variational Quantum Algorithms for scientific and artistic applications
26	MIDITime	2016	SON	CI	TX	Converts time-series data into MIDI files
27	Highcharts Sonification*	2019	SON	GP	TX	Enhances Highcharts visualizations by converting data into sound, allowing users to hear data patterns
28	CSV-TO-MIDI	2019	SON	GP	TX	Web-based tool that converts CSV data into MIDI files
29	Data Mapper	2022	SON	GP	TX	Interactive tool mapping data to sound for exploration
30	WebAudioXML Sonification Toolkit (WAST)	2021	SON	GP	TX	Built upon WebAudioXML, WAST allows users without extensive programming skills to create sonifications directly in web browsers.
31	Sonification Tools and Resources for Analysis Using Sound Synthesis (STRAUSS)	2023	SON	GP	TX	Modular Python package for scientific data exploration and outreach
32	Erie	2024	SON	GP	TX	Web-based tool for creating sound-based data representations

Table 1: List of active sonification tools. Abbreviations: APL = Audio Programming Language, MU = Musification, SON = Sonification, SCI = Science, IS = Interactive Sonification, SE = Sound Experts, DS = Data Scientists, BLV = Blind and Low Vision Community, GP = General Purpose, CI = Creative Industry, TX = Text-based data, SP = Specific data. Tools marked with * are commercial.

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Num	Name	Year	Use Case Scenario	Target User	Input Data	Notes
33	SoniPy	2007	APL	DS	TX	OA Python-based sonification library that enables users to map data to sound parameters.
34	Sonification Workstation	2019	APL	DS	TX	Combined digital audio work station (DAW) navigation with a patcher interface for sonification.
35	Sonification Studio	2020	APL	GP	TX	A modern successor to Sonification Sandbox.
36	WebSound	2000	IS	BLV	TX	Transforms HTML documents into 3D audio to convey spatial and visual information non-visually.
37	Interactive Sonification Toolkit	2004	IS	GP	TX	Prototype in Pure Data for interactive sonification.
38	AcouMotion	2005	IS	BLV	SP	Integrates human body motion with sonification for applications.
39	iSonic	2008	IS	BLV	SP	Multimodal tool allowing interactive sonification and haptic feedback for data analysis
40	MUSical Audio Transfer Function Realtime Toolkit (MusART)	2002	MU	GP	SP	Utilizes music theory concepts to generate sonifications.
41	MUsical Sonification Environment (MUSE)	2002	MU	GP	SP	Utilized music theory concepts for sonification; project not maintained post initial research
42	sMax	2004	MU	DS	SP	Real-time stock market sonification via Java and Max/MSP.
43	DNAmusic1	2009	MU	DS	SP	Converts mRNA and protein sequences into music using Munakata's algorithm
44	MathTrax / Earth+	2005	SCI	DS	SP	Educational tool that uses auditory graphs and parameter mapping to help students visualize and analyze astronomical data
45	xSonify	2006	SCI	BLV	SP	Developed to help visually-impaired researchers analyze space physics data
46	SyssSon	2012	SCI	DS	SP	Focused on sonifying weather data
47	SonData	2013	SCI	GP	TX	Interactive sonification for complex and multidimensional datasets
48	SoniScan	2013	SCI	DS	SP	Focused on sonifying PET scans of the human brain for analysis
49	Porsonify	1992	SON	DS	TX	Porsonify was designed to encourage experimentation with aural data presentation on various sound devices.
50	Listen	1996	SON	GP	TX	Allows users to map data values to sound properties like pitch, volume, duration and timbre.
51	Sonification Application and Research Toolbox (SonART)	2002	SON	GP	TX	Open-source toolkit effort that was never fully realized as a stable product.
52	Smith-Kettlewell Display Tools	2003	SON	BLV	SP	Toolkit for MATLAB providing sonification and tactile display options
53	Sonification Sandbox	2003	SON	DS	SP	Allowed mapping data to auditory parameters; succeeded by Highcharts Sonification
54	Sonification Integrative Flexible Toolkit (SIFT)	2005	SON	DS	TX	Designed for flexibility and modularity, SIFT allows real-time modification and integration with existing applications
55	Sonifyer	2008	SON	GP	TX	Experimental app for image-to-sound sonification.
56	Personify	2013	SON	DS	TX	Focuses on perceptual aspects of sonification, allowing users to craft sonifications of data without requiring deep expertise.
57	Rotator	2017	SON	DS	SP	Web-based, real-time sonification tool that lets users dynamically shift high-dimensional data between visual and auditory displays to enhance perception

Table 2: List of discontinued sonification tools. Abbreviations: APL = Audio Programming Language, MU = Musification, SON = Sonification, SCI = Science, IS = Interactive Sonification, SE = Sound Experts, DS = Data Scientists, BLV = Blind and Low Vision Community, GP = General Purpose, CI = Creative Industry, TX = Text-based data, SP = Specific data formats .

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