“See Link for More Details”: Towards a Pragmatic Open Methodology at NIME

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Abstract

Since its inception, NIME has been committed to open research, with a strong tradition of open source practice running through its history. In the context of the NIME 2026 theme of communities, this paper examines current open research practices at NIME and explores how they might be developed to better engage a new generation of creators beyond the conference itself. Through an analysis of NIME proceedings 2009–2025, we assess how source materials—including software, hardware designs, data, and documentation—are shared, discovered, and cited. The analysis reveals a growing familiarity with open source tools, alongside persistent barriers to discoverability, reuse, and long-term access. Drawing on the documentation and dissemination process of a recent NIME, the paper outlines a deliberate and visible open methodology that treats Digital Musical Interfaces as evolving, reusable research objects for a wider community rather than closed artefacts tied solely to a publication. The paper concludes by reflecting on current limitations and proposes practical ways to lower barriers to reusing and recreating NIMEs, framing “good-enough” open research as a catalyst for further participation, knowledge exchange, and impact beyond the current NIME community.

CCS Concepts

• **Human-centered computing → Empirical studies in collaborative and social computing**; **Open source software**.

Keywords

openness, fair, reproducibility, versioning, citation, archiving, documentation, repositories

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1 Introduction

Over the past decade, academia has increasingly embraced “open methodology” [36], encompassing open science [52] and FAIR (findable, accessible, interoperable, and reproducible) digital research principles [55]. Collectively described here as ‘open research practice,’ these approaches are essential for ensuring transparency, validation, reuse, and access within scholarly work. This movement has raised awareness across research communities and led to the development of widely accepted best-practice frameworks [44]. While these frameworks have primarily focused on scientific research [52], their adoption is increasingly evident within the humanities [26].

The FAIR principles and open science are not just a benefit to the longevity and reuse of digital academic research, but they also allow for wider engagement, study and recreation of research at an educational level. Despite these benefits, open research practice is not yet standard within the humanities [48]. The underlying materials of research—such as datasets, source code, design files, and other artefacts that are often regarded as disposable—are, in fact, critical for understanding how a project was constructed and the rationale behind key decisions. These research outputs embed tacit knowledge of hardware design and fabrication practice [41], knowledge that is seldom explicitly documented yet remains highly valuable for skill development and future comprehension.

As a student, there is educational value and knowledge to be gained in recreating and iterating on work as a means of learning skills through practice [14]. The benefits of ‘apprenticing’ through DMI design and fabrication have already been demonstrated [57]. Currently, there is no common framework for organising or sharing a paper’s source material, making it harder to find and engage with the work. This paper examines current open research practices within NIME, identifying areas for further development and highlighting missed opportunities to engage a broader community of emerging creative developers.

This paper first reviews work within the NIME community that addresses open research practice. That work is then used to establish a framework for analysing the use of open source at NIME spanning 2009–2025. This is followed by a case study of a project from NIME 2025, examining the open research practices employed before and after the conference. Based on this analysis and case study, the paper concludes with recommendations aimed at strengthening open research practice and enabling NIME work to be more readily engaged with by a wider community of students, creators and researchers.

2 Related Work

Since its inception, NIME has been committed to making its proceedings open access (gold), more specifically under a CC BY 4.0 licence since 2017. In parallel, research projects within the NIME community have developed a strong tradition of open research practice accompanied by ongoing discussions on how to better support, formalise, and sustain open source culture [32]. This commitment was formalised in 2020 with the inclusion of free/libre open source research practices as part of NIME’s ethical guidelines [34]. Questions of replication [7], iteration [8], and long-term sustainability [20] have been recurring themes at NIME. This section reviews both past discussions and current

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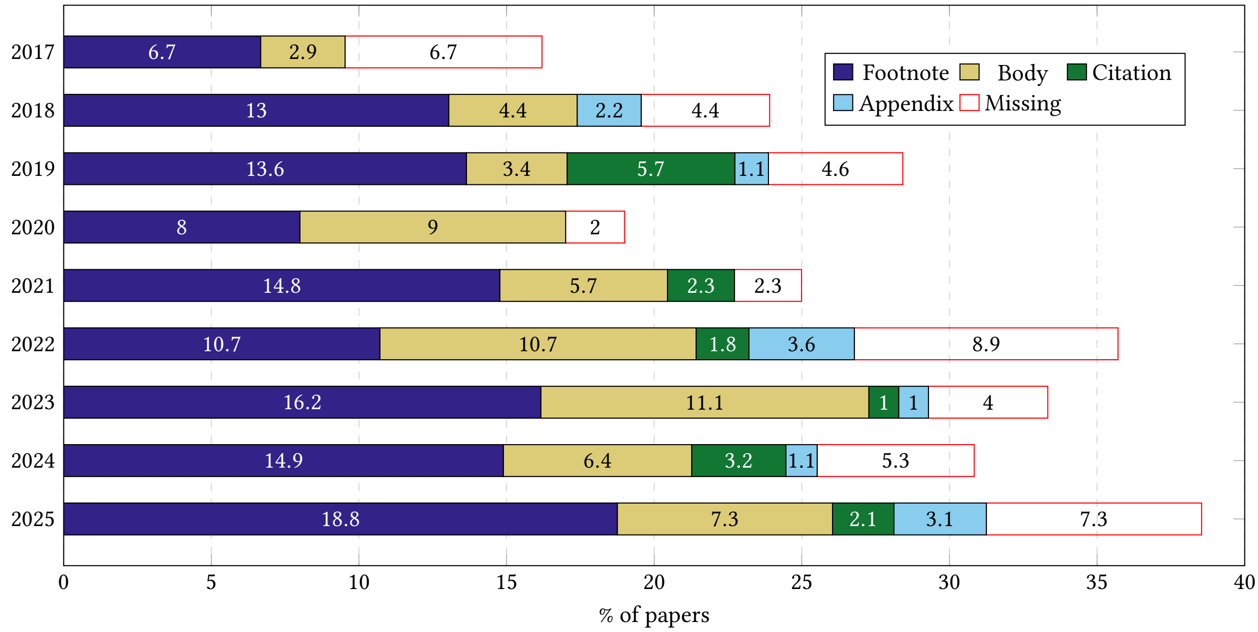


Figure 1: Methods used to share project source URLs in NIME 2017–2025 papers. 'Missing' includes incorrect URLs, empty repositories, or extant repositories inferred via web search at the time of analysis.

practice in order to identify opportunities for strengthening open research practices within the NIME community.

McPherson et al. [32] presented one of the earliest discussions of open and reproducible research practices within the NIME community. Among that workshop's eight primary goals were several aims adjacent to the FAIR principles, including encouraging reproducibility, promoting open access, and normalising documentation practices. A central focus of the workshop was the proposal of a shared repository for DMI designs. Although the NIMEhub itself did not ultimately materialise, the workshop catalysed ongoing discussion around open research at NIME [27, 28].

Subsequent discussions of open research at NIME have largely focused on methodologies relevant to open hardware [7, 19], particularly the accessibility of electronic designs that enable fabrication beyond a central manufacturer. Unlike software, open hardware cannot be effectively distributed solely through licensing and source files [38] without risking "openwashing," whereby a project is claimed to be open source despite the absence of published product-related information [5]. In practice, supporting hardware reproducibility requires access to well-archived source materials, which significantly lowers the barriers to understanding, reconstructing, and iterating upon the original design.

Both McPherson et al. [32] and Fiordelmondo et al. [19] highlight the importance of repository structure, with the latter proposing a prescriptive framework applicable across DMI projects. Research outputs in the form of open hardware or open software can, and should, leverage existing platforms designed for the distribution and maintenance of such work.

Discussions of "recreating" a NIME have predominantly emphasised its role in musical practice [31, 51, 54]. However, an equally valid motivation for recreation lies in acquiring operational knowledge and developing craft through the act of building itself [7], rather than solely through performance or use [29].

3 Analysis of Open Research Practice at NIME

The NIME archive hosts 2,000+ open-access projects that support exploration and iteration in creative microcontroller, electronics, and programming practices. Though many of the projects are open source, far too often this is only on condition that the source can be located in the first place. Two papers [7, 19] formed the basis for an analysis of open research practice at the NIME. Calegario et al. [7] considered NIME 2018–2020 collectively and discussed the number of papers which provided additional documentation of their artefacts and of what that documentation was comprised. Fiordelmondo et al. [19] reviewed the percentage of papers using open source repositories by type of service (e.g., GitHub, GitLab, Google Drive &c.) across NIME's entire archive. This paper also touched upon the number of source material repositories created for NIME papers 2022–2024. Prompted by these previous analyses, two questions were raised.

(1) "How often do NIME papers link to source material?"
(2) "How prevalent is open research practice at NIME?"

Answering these questions may reveal a method that encourages open research practice and fosters engagement with a wider community beyond NIME.

Both questions would be answered through a search of the NIME proceedings up to 2025. This first required the download of all PDF files in the NIME paper archive, which were organised into subdirectories by year. The text of the PDF files would then be searched using the open source software `pdfgrep` [15].

3.1 Question 1: Navigating to Source

To answer the first question, a search was conducted on the NIME proceedings from 2017 to 2025. Open source research practice has evolved since 2001, and guidance for best practices in academia has matured through recommendations in open science [52, 55], open hardware [38], and, more specifically, open research practice at NIME [20, 28, 32]. With the addition of the open source clause to NIME's ethical guidelines in 2020 [34], NIME proceedings 2020–2025 should showcase the strongest examples of open research practice.

The presence of a URL in a paper—that links to source material—was taken as a marker of the authors' intention to make the project accessible. Using this criterion, we followed the approach of Calegario et al. [7] and Review B from Fiordelmondo et al. [20] as the framework for a source material URL search. It was not necessary that the source be buildable, executable, or complete—only that there was a clear effort to share additional material in a repository representing the work described in the paper.

Over the past decade, the git version control system (VCS) has become a de facto standard for open source repositories, making source material links easier to identify. Nevertheless, the search was designed to be as forgiving as was practical, since not all papers contain or reference the term 'git' or its variants with respect to their source repositories (e.g., [9, 13]).

The search began with the regular expression '\Wgit,' which matches references to, and URLs of, repositories using the git VCS. If no results were found, additional searches were made using regular expressions `'(open source|open-source)'` `'source code'` and `'repository'`. Each year's proceedings, from 2017 to 2025, were searched individually. When a link to a project's source repository was found, the URL and the context in which it was used were recorded, after which the paper was removed from the search pool. In the initial stages of the search, the context in which the URL appeared was classified into one of four categories: 'footnote,' 'body,' 'citation,' and 'appendix.' Upon failing to find any result, the remaining papers from that year were manually read to identify if an alternate method was used to reference the source repository. NIME 2017–2025 consisted of a total of 818 papers. This was a small enough number that a combined automated/manual approach of the proceedings was achievable in just over 20 hours. While this combined approach substantially reduces the likelihood of missed references, the results should be interpreted as conservative estimates rather than exhaustive counts.

The standards for what qualified as a link to the project's source material were deliberately broad. Papers that provided a URL to a web page, containing a link to the source, qualified (e.g., [1, 9, 10, 18, 37]). Cases where the hyperlink was broken in the PDF, but the correct URL could be easily ascertained and typed manually, qualified (e.g., [6, 53]). During the course of the search, an additional category—'missing'—was added. The 'missing' category includes cases where the repository was unreachable, entirely empty, or the link was absent, but a web search for the project name returned the repository within the first page of results. These repositories qualified and are included in the total percentage of papers with source repositories for that year.

Of the 96 papers from NIME 2025, 37 intend to share their source, whether software, datasets, or even zines [35]. Figure 1 shows the ways in which authors disseminated source URLs, with footnotes being the most common method. The practice of sharing source repositories has increased over the period considered, but so too have instances of 'missing' repositories.

3.2 Question 2: Adoption of Open Source

To answer the second question, all NIME paper proceedings were searched for any direct link to source code of open source projects as part of a paper. The search was to match any reference to git or SourceForge repositories, following the method of Fiordelmondo et al. [19] which counted papers containing terms related to open source repositories from NIME proceedings 2001–2024. A deviation from this previous method was the inclusion of `github.io` links, as authors often use GitHub Pages to host sites linking to project source repositories, therefore familiarity with git and GitHub can be inferred.

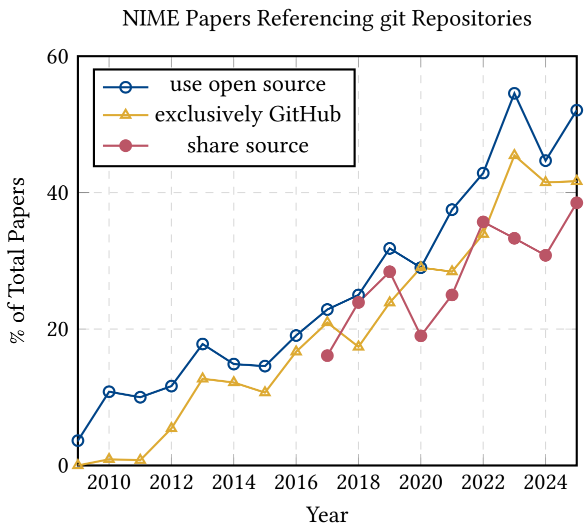


Figure 2: Yearly percentage of NIME papers (2009–2025) in three categories: papers referencing at least one open source project using a git or SourceForge repository, papers referencing exclusively GitHub repositories, and papers that included a link to their source material. Each plot is the percentage of total papers in that year. Git was initially released in 2005 and NIME papers published 2001–2009 contain no references to it. GitHub was launched in 2008 and does not appear in NIME publications until 2010.

The search was run over a directory containing all NIME papers to date, iteratively applying stricter constraints to prune false positives. The process began with a `pdfgrep` search which removed the majority of obvious genuine matches.[1] The false positives could then be more easily identified, after which an appropriate regular expression was applied to filter results.

Examples of false positives were words split across line breaks at 'git' (e.g., legitimation, with its word fragments broken across lines into "le-" and "**git**imation"), as well as unrelated terms such as "gitaroo" or "gitarre." The search could not be overly restrictive, however, because it needed to retain valid matches such as "gitorious," a git-based hosting service that was acquired by GitLab and discontinued in 2015 [4].[2]

The resulting yearly percentages of NIME papers referencing a git repository are shown in Figure 2, which incorporates the data from Figure 1. There is substantial overlap between git as a technology and GitHub as a service, suggesting that most interactions with open source projects occurs via GitHub. This is corroborated by Table 1 which shows the number of project source repositories using GitHub since NIME 2020. Figure 2 also illustrates the gradually increasing gap between usage of open source and publishing a project's source since NIME 2017.

[1] `pdfgrep -P '\Wgit(?!hub|lab)' -ri .`
[2] The process yielded the regular expression: `\Wgit(?!ch|imation|ter|udinal|arr|al|aroo|a\b)`

	GitHub	GitLab	Other
2017	15	1	1
2018	17	0	5
2019	20	3	2
2020	18	0	1
2021	21	1	0
2022	18	1	2
2023	31	3	0
2024	25	0	2
2025	31	0	5

Table 1: Services used to host NIME source material. The GitLab column includes both gitlab.com and self-hosted instances.

4 Open Methodology for DMIs: A Case Study

Section 3 indicates that while open source *use* in NIME papers is increasing, access to the underlying project materials remains uneven. Links to repositories are often missing, fragile, or routed through intermediary pages (Figure 1), and a subset of projects can only be located via manual inference or web search. For DMIs—where reproducibility depends on multiple interdependent artefacts—this makes 'openness' a practical question of navigation and reconstruction rather than intent.

Below is a case study that responds to this findability gap by showing how one DMI can be packaged as a versioned, cross-referenced object—so that the materials implied by the paper can be located, checked out, and cited without recourse to external search. The case study is the open methodology applied to the interface described in Hamilton et al. [24]. The interface was created as part of the NEMUS project, which is dedicated to making most digital research products open source. From the outset, the project aimed to incorporate best open research practices [12].

Established guidance on open research software converges on a small set of infrastructural elements: publicly accessible source under version control, clear licensing, adequate documentation, and persistent archival identifiers [44, 50]. Tools such as the Citation File Format [16] and hardware-oriented extensions [19] further support formal citation and interoperability. Rather than aiming for exhaustive compliance with every available recommendation, this case study operationalises openness through five practical dimensions that determine whether a DMI can be located, reconstructed, and cited over time.

Five infrastructural dimensions were identified:

(1) **Source:** Defining the full set of artefacts that constitute the project (firmware, schematics, models, datasets, documentation).
(2) **Version Control:** Tracking changes to those artefacts over time.
(3) **Archive:** Providing stable, citable snapshots through persistent identifiers (e.g., DOI).
(4) **Documentation:** Enabling understanding, reuse, and modification.
(5) **License:** Stating the terms under which the work may be used, modified, and redistributed.

Much of the open sourcing had to be carried out as the project developed. This resulted in some instances in which what was initially implemented was no longer relevant or needed to be adapted. Rather than a single, unified code base [7, 20], the source of project was divided into three components — *Firmware* [22], *CAD* [21], and *Model Data* [23]. Such an approach aligns closely with the FAIR principles as it promotes code reuse, interoperability, as well as seamless attribution. For the original paper, the links to the individual project repositories were included.

As the project developed, two distinct interfaces were created with different applications. One interface was for installation at San Colombano, while a second model was created for use in research within the NEMUS project and the University of Bologna. Both interfaces use the same core components, but at separate phases in their development. This means the original links no longer accurately reflect the interface as presented in the original paper [24]. To address this, the individual repositories were referenced under a single 'meta repository' (Figure 3). Referencing is achieved using git's submodules functionality [49]. The benefit of such an approach is two-fold. To navigate the project's states over time, only a single URL needs to be shared. The individual submodules can be updated or swapped out entirely. Version tagging demarcates distinct interface versions, making navigation easier.

The function of each component also shifted over time. The CAD component transitioned into files for electronic schematics and PCB manufacture, while the Model component has changed into a repository of documents describing measurements of the enclosure. Renaming either repository would break previous links to the work. The directory name of submodules can be changed in the meta repository, but this situation emphasised the importance of archiving the work. Rather than referencing through URLs to a git repository, the project was archived using CERN's digital archiving platform Zenodo [17]. Archiving exposed a few practical challenges. Zenodo's GitHub integration does not currently include git submodules when generating an archive [58]. As a result, each submodule must be archived independently, after which the meta repository archive must manually reference the corresponding DOIs or original sources to ensure a comprehensive record (Figure 4). Likewise, the future of data is tied to software sustainability. The PCB CAD for the project is in the XML format used by the Autodesk EAGLE software which has been discontinued [2]. Conversion from EAGLE to KiCad remains available [11], emphasising that openness depends not only on version control and archiving but also on the careful selection of formats and hosting infrastructure.

Documentation for the project still remains incomplete. The firmware was documented using the Doxygen documentation system [3], but this does not fill the role of a user manual [40, 46]. Best practice emphasises the importance of documentation [44], though it is less prescriptive about form and depth. Write the Docs Community [56] offers comprehensive guidance. A pragmatic rule is that documentation should enable one to still

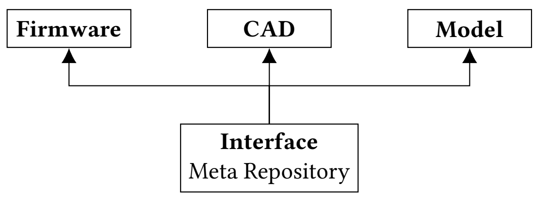


Figure 3: The DMI is divided into three submodules, each representing the firmware, electronics schematics and enclosure modelling data. These submodules are collected into a single repository that represents the interface.

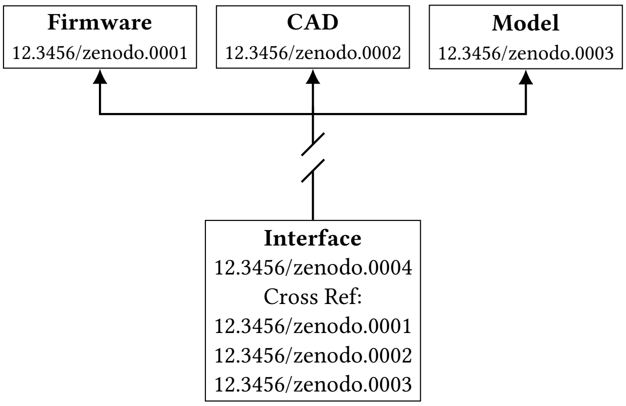


Figure 4: Zenodo's GitHub integration does not capture data stored in git submodules. As an alternative, each submodule can be archived independently at the appropriate version, after which the meta-repository referencing these components can be archived, resulting in a collection of linked DOIs.

"understand your code in six months" [56], a principle echoed in reproducibility studies [39].

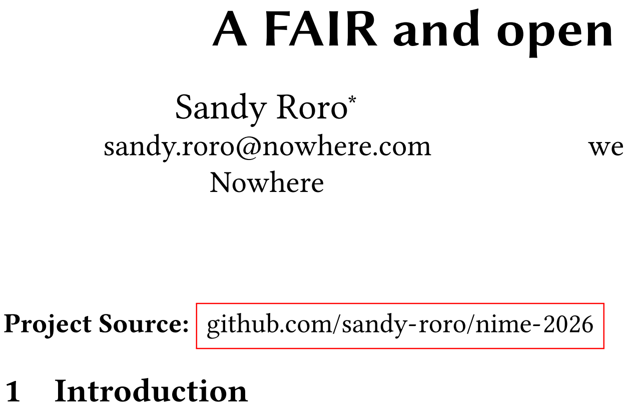
5 Discussion

Section 3 shows that open source usage at NIME has grown steadily, yet dissemination practices remain inconsistent. The issue is less reluctance to share than ambiguity in how project materials are structured and signposted. Repository links appear in heterogeneous locations—footnotes, body text, appendices, indirect project pages [9], or shortened URLs [59]—making identification interpretative and error-prone at scale. The burden is distributed across authors deciding how to disseminate materials, researchers analysing practice, and readers attempting to move from paper to artefact.

The case study in Section 4 shows that this ambiguity extends beyond link placement to project structure and longevity. As the DMI evolved, repositories were renamed, reorganised, and divided into modular components; references in the original paper no longer mapped cleanly to the current state of the work. Archiving exposed further limitations, including incomplete support for modular repositories and dependencies. These issues do not reflect a lack of openness, but the practical complexity of maintaining intelligible research artefacts over time.

The adoption–practice gap is therefore structural. The difficulty is not simply whether a repository exists, but whether it remains coherent and citable as the project evolves. Proposals such as centralised repositories [32], replicating officers [7], or prescriptive repository standards [19] address aspects of this challenge. The case study suggests that even careful structuring and archiving do not eliminate friction. Comprehensive compliance with evolving frameworks may be unrealistic across the diversity of NIME contributions. Encouraging broader uptake of transparent, "good enough" sharing practices [26] may therefore be more effective than imposing stricter formal requirements.

Within this context, a minimal intervention could improve consistency: adding a dedicated 'Project URL' field to the NIME paper template and metadata (Figure 5). Standardising this field would clarify authorial intent and reduce ambiguity about whether a link constitutes the project's source or related material. It would not resolve structural challenges of versioning or preservation, but it would reduce friction at publication and make repository presence explicit and extractable.



(a)

(b)

Figure 5: Project source as a standard field in the paper template (a). These details are not obligatory (b) and could be withheld, but the choice to do so becomes a conscious one.

6 Conclusion

For DMIs, openness is infrastructural rather than declarative. Version control provides traceability, but platforms such as GitHub are not preservation systems. Projects intended for reuse require persistent identifiers and archival deposits [44, 45]. Although NIME archives proceedings via Zenodo, supplementary digital deposits remain limited—for example, only a minority of NIME 2025 papers include citable archives [47] or accepted the invitation for supplementary materials to be archived on the authors' behalf.

The findings presented here suggest that improving openness at NIME does not primarily require new policies or comprehensive standards. Reducing ambiguity in how repositories are referenced and aligning disclosure with archival practice would already address a substantial portion of the current gap. Small infrastructural adjustments can lower barriers to reuse without overextending contributors, as the long-term reuse of NIME projects may depend on the continued discoverability and citability of their digital artefacts.

Finally, making a project's source code easy to locate removes unnecessary barriers for readers and a broader audience. NIMEs serve as a resource for teaching creative engineering, electronics, musicianship, and HCI, but difficult access limits opportunities for students to engage [57], remix [14], and foster creativity [30, 43]. By improving discoverability and citability, NIME can better support new contributors, laying "the groundwork for experiences of practice" [42, p. 277], and extend its impact across wider communities.

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7 Ethical Standards

This study analyses publicly available NIME proceedings to identify references to project source material and their open source dependencies. Where repository links were unclear or missing, authors were contacted solely to clarify the location of publicly shared materials. No personal data beyond that already published in the proceedings was collected. The analysis focuses on infrastructural and archival practices rather than individual evaluation.

In line with the NIME Principles and Code of Practice on Ethical Research [33], care has been taken to treat published works respectfully and to avoid framing results in ways that single out individual authors or projects. Findings are reported at an aggregate level to support reflection on community practices while upholding values of fairness, transparency, and inclusivity.

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A Source Repository

The scripts, data and LaTeXcreated for this paper are available via the NEMUS organisation's public GitHub repository and its associated Zenodo archive [25].