

Placeholder 3rd FAIR Digital Objects Conference

Placeholder Session title

<https://doi.org/10.52825/xxxx.....> DOI placeholder (WILL BE FILLED IN BY TIB Open Publishing)

© Authors. This work is licensed under a Creative Commons Attribution 4.0 International License

Published: (WILL BE FILLED IN BY TIB Open Publishing)

Using FAIR Digital Objects for FAIR AI Attribution

Sebastian Posth^{1,*}  <https://orcid.org/0000-0003-4571-2549>, Sylvia Le Dévedeck²  <https://orcid.org/0000-0002-0615-9616>, Kristina Hettne³  <https://orcid.org/0000-0002-4182-7560>, Alessa Gambardella⁴  <https://orcid.org/0000-0002-4930-2662>, Yury Kharytanovich¹  https://orcid.org/****-****-****-****-2195-3997, Barbara Magagna⁵  <https://orcid.org/0000-0003-2195-3997>, and Erik Schultes^{2,5}  <https://orcid.org/0000-0001-8888-635X>

¹Licium B.V., Leiden, the Netherlands

²Leiden Academic Center for Drug Research, Leiden University, Leiden, the Netherlands

³Leiden University Library, Leiden University, Leiden, the Netherlands

⁴Faculty of Science, Leiden University, Leiden, the Netherlands

⁵GO FAIR Foundation, Leiden, the Netherlands

*Correspondence: Erik Schultes, e.a.schultes@lacdr.leidenuniv.nl

Abstract. We demonstrate a solution for robust Artificial Intelligence (AI) attribution using FAIR Digital Objects (FDOs). The FAIA vocabulary, developed with Leiden University and GO FAIR Foundation and Licium B.V., defines declarations for core attribution with three flags: Human-Created, AI-Assisted, AI-Generated. The Licium platform implements FAIA declarations as FDOs, utilizing ISO 24138:2024 (ISCC) for persistent identifiers binding metadata to digital object assets, federated registries for type-specific metadata, and W3C Verifiable Credentials for verifiable provenance. This architecture ensures persistent, verifiable content-metadata binding, decentralized infrastructure, comprehensive FAIR compliance, and regulatory alignment. This demonstrates FDOs as a viable, trustworthy production infrastructure for the urgent problem of AI attribution.

Contribution type: application

Contribution for: lightning talk

Keywords: AI Attribution, FAIR Digital Objects, Licium, Content-Addressing, Verifiable Credentials,

1. The Problem

By now, generative AI may have produced the majority of online content [1], and is projected to reach up to 90% in 2026 [2]. The consequences for the Internet as a whole are manifold. Without machine-actionable AI attribution, research integrity becomes unverifiable, content platforms cannot manage rights, and AI training suffers model collapse from contaminated datasets. EU AI Act Article 50 [3] mandates synthetic content disclosure, yet no scalable solution has emerged. Current approaches (watermarking, embedded manifests, IPTC, C2PA) are fragmented, strippable, lack cryptographic verification, persistent binding, and FAIR compliance. Production-grade AI attribution demands machine-actionable metadata enabling automated verification and compliance checking at scale. FAIR Digital Objects

(FDOs) implemented with existing technologies described below, provide a viable solution. New paragraphs are indented.

2. The Requirements

FAIR AI attribution requires several robust features, including: content-metadata binding that is persistent and survives file transformations and redistribution; cryptographic non-repudiation proving authenticated parties made verifiable claims; decentralized infrastructure functioning as a pre-competitive common good accessible to content creators, publishers, platforms, and regulatory authorities without vendor lock-in; comprehensive FAIR compliance, particularly F3 (explicit identifier linking metadata to data), R1.2 (detailed provenance), and I1-I3 (standardized vocabularies and machine-actionable metadata schema); regulatory pathways accommodating EU AI Act transparency requirements and eIDAS-compliant digital signatures; and extensibility across media types and domains without reimplementation.

3. A Solution: FAIA/Liccium Implemented as FAIR Digital Objects

FAIA Vocabulary: Developed jointly by Leiden University, the GO FAIR Foundation, and Liccium B.V., FAIR AI Attribution (FAIA) declarations use a FAIR vocabulary defining three core attribution flags—Human-Created, AI-Assisted, and AI-Generated. These are extended with sector-specific activity codes from, for example, International Press Telecommunications Council (IPTC) and International Association of Scientific, Technical and Medical Publishers (STM) frameworks describing operations such as language correction, image enhancement, or data visualization. System attribution specifies the AI model, version, and provider involved in generating or assisting the content.

Liccium Architecture: FAIA declarations can be published at the Liccium platform. Liccium leverages mature technologies that together realize multiple aspects of the FAIR Principles. First, the International Standard Content Code (ISCC, ISO 24138:2024) provides content-derived Global Unique Persistent Resource Identifiers enabling soft-binding of external metadata to digital assets. This operationalizes F3 through persistent, verifiable cryptographic linkage between content and metadata. Second, Federated Liccium registries implement content-addressable metadata storage using Content Identifiers (CIDv1) with InterPlanetary File System (IPFS)-compatible resolution, delivering F4-compliant searchable metadata in RDF and JSON-LD formats. Third, W3C Verifiable Credentials establish authenticated identity bindings through institutional issuers and recognized trust services under the EU eIDAS Regulation (Regulation (EU) No 910/2014), supporting community identifiers such as ORCID for attribution, addressing the A1.2 (authentication) principle, while forming cryptographically verifiable provenance chains that elevate R1.2 from descriptive to evidential quality.

FDO Implementation: Each FAIA declaration has a CIDv1-based persistent identifiers, includes ISCC object PIDs linking to described content, specifies types from the FAIA vocabulary satisfying type requirements, and incorporates Verifiable Credential authentication metadata. Declarations distribute across Liccium's federated peer-to-peer node infrastructure, ensuring verifiable persistence, indexing and search, accessibility, and synchronization. Liccium provides production APIs, web applications, REST endpoints, and multi-format export (JSON-LD, nanopublication RDF, C2PA manifests). Taken together, these attributes bring FAIA declarations, when implemented via Liccium, close to compliance with emerging FDO specifications.

4. Impact and Significance

FAIA demonstrates FDOs as viable production infrastructure for the urgent, high-stakes challenge of AI attribution. The implementation satisfies competing requirements: semantic precision (RDF/linked data), scalability (content-addressing, federation), legal standing (eIDAS credentials), and accessibility (standard APIs). For trust-critical applications where fraudulent metadata creates tangible harms, FDOs' persistent identification, cryptographic provenance, and machine-actionable metadata address failures in conventional systems. FAIA demonstrates implementation paths leveraging existing production technologies. Patterns established—content-derived identification, federated registries, credential-based authentication—generalize to research data provenance, workflow documentation, rights management, supply chain transparency, and clinical trial reporting. For the FDO community, FAIA provides empirical validation of design choices regarding serialization formats, type registries, and persistence mechanisms. As governance frameworks (EU AI Act, Data Governance Act) mandate machine-actionable transparency, FDOs gain competitive advantage as reference architecture for scalable, trustworthy regulatory metadata infrastructure.

Early adopters include researchers certifying publication provenance, academic publishers documenting AI involvement in peer review, and platforms implementing verification for indexing and compliance. FAIA is operational, handling real-world attribution under regulatory pressure.

4. Conclusion

FAIA declarations, implemented by Liccium, operationalizes FDO specifications using a combination of deployed technologies addressing economically consequential challenges. By integrating ISCC identification, federated infrastructure, Verifiable Credentials, persistent identifiers and controlled vocabularies, FAIA establishes implementation patterns transferable to diverse trust-critical applications, positioning FDOs as strategic architecture demonstrating pathways from specification to scaled production systems.

Data availability statement

The FAIA FAIR vocabulary will be made open and publicly available in Github and the schema registered in the Metadata Schema and Crosswalk Registry and FAIRsharing at the end of the project in May 2026.

Underlying and related material

The FAIA Project <https://faia.liccium.com/> (accessed November 2 2026) and Liccium platform <https://liccium.com> (accessed November 2 2026).

Author contributions

Conceptualization: ES; Methodology: ES, SP, SLeD, KH, BM; Software Programming: YK ; Formal analysis: KH, AG, SP, BM; Investigation: ES, SP, BM; Writing – Original Draft: ES; Writing – Review & Editing: SP, SLeD, BM, KH; Project administration: SLeD; Funding acquisition: SLeD, SP.

Competing interests

The authors declare that they have no competing interests.

Funding

FAIR AI Attribution (FAIA) project is funded under the call for proposals focusing on "Responsible AI in Practice" from the SIDN Foundation for innovative research projects that offer practical solutions for responsible AI, in which together with Top Sector ICT, a total of ten projects were selected: <https://www.sidnfonds.nl/projecten/fair-ai-attribution-faia>.

Acknowledgement

-

References

[1] More Articles Are Now Created by AI Than Humans <https://graphite.io/five-percent/more-articles-are-now-created-by-ai-than-humans> (accessed November 2 2026)

[2] By 2026, Online Content Generated by Non-humans Will Vastly Outnumber Human Generated Content <https://oodaloop.com/analysis/archive/if-90-of-online-content-will-be-ai-generated-by-2026-we-forecast-a-deeply-human-anti-content-movement-in-response/> (accessed November 2 2026)

[3] European Union. Artificial Intelligence Act. Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 on Artificial Intelligence. Official Journal of the European Union, L 172, 12 July 2024, pp. 1–128.