



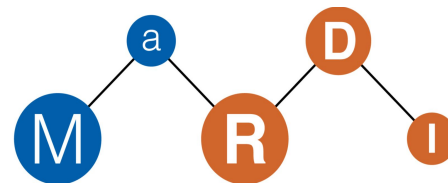
# MATHREPO

MATHEMATICAL RESEARCH-DATA  
REPOSITORY

Tabea Bacher, Ben Hollering

Nov 24th, 2022

MOM Workshop, Berlin

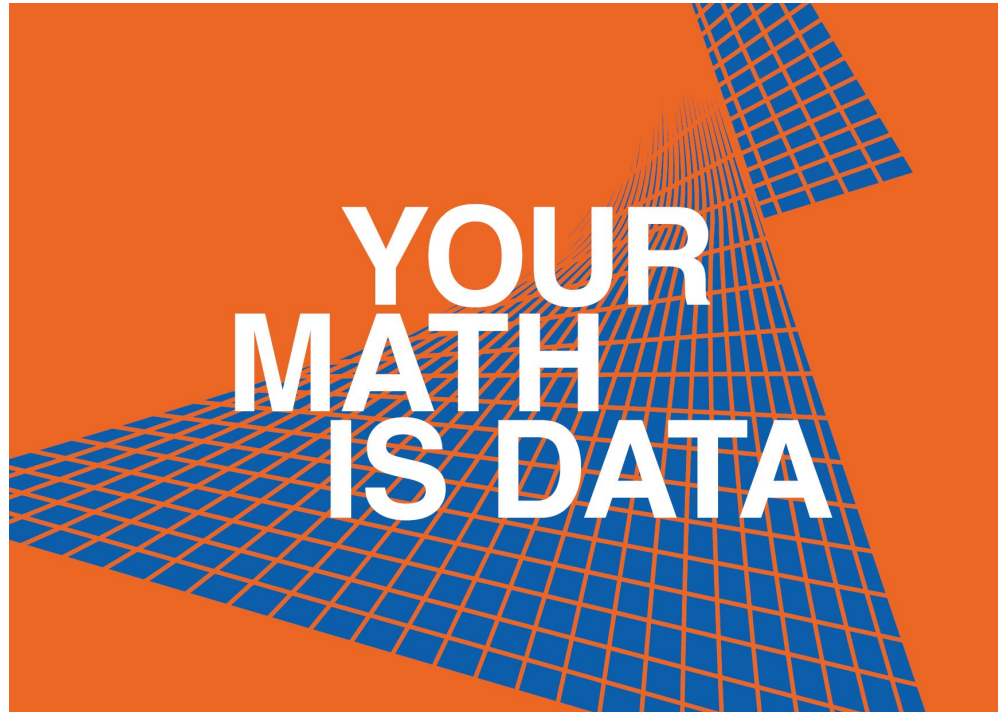


**MAX-PLANCK-INSTITUT**  
FÜR MATHEMATIK  
IN DEN NATURWISSENSCHAFTEN





# What is research data?



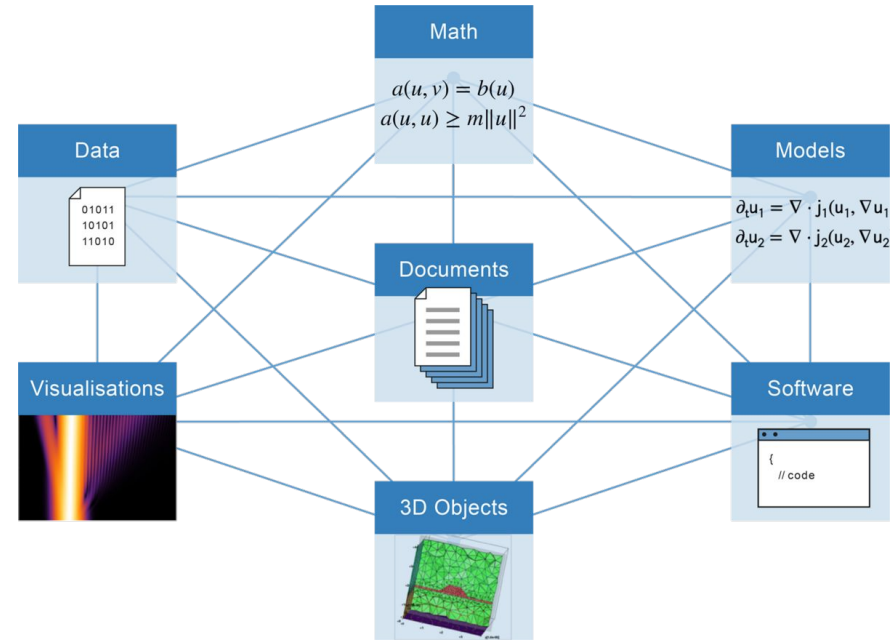


# What is research data?

“We define research data as all digital and analog objects that are generated or handled in the process of doing research”\*



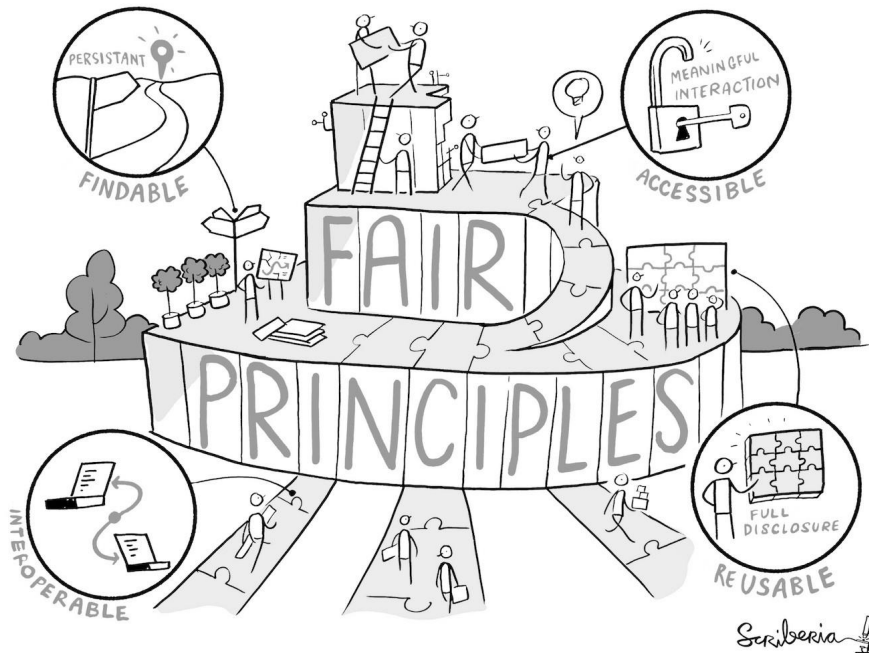
developing services and guidelines/best practices for handling research data



\* T.Boege, R. Fritze, C. Görden et al. (2022) Research-Data Management Planning in the German Mathematical Community. [arXiv:2211.12071](https://arxiv.org/abs/2211.12071) [math.HO]



# How to handle research data



Mark Wilkinson, Michel Dumontier, IJsbrand Jan Aalbersberg, Gaby Appleton, et al. The FAIR guiding principles for scientific data management and stewardship. *Scientific Data*, 3(160018), 2016.



# Where to store mathematical research data?

GitHub/GitLab

<https://wissenschaftliche-integritaet.de/kommentare/software-entwicklung-und-umgang-mit-forschungsdaten-in-der-mathematik/>



# Where to store mathematical research data?

GitHub/GitLab

Versionsverwaltungsplattform GitLab plant wohl, inaktive Repositories zu löschen

Offenbar will das Unternehmen mit dem Löschen von Accounts, die länger als ein Jahr ohne Änderung sind, bis zu einer Million US-Dollar jährlich sparen.

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<https://wissenschaftliche-integritaet.de/kommentare/software-entwicklung-und-umgang-mit-forschungsdaten-in-der-mathematik/>



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MathRepo

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» Mathematical Research Data

**MATHREPO**  
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This is a repository of the [Max Planck Institute for Mathematics in the Sciences](#) in Leipzig, dedicated to mathematical research data. [Research data](#) are all digital objects that arise during the process of doing research or are a result thereof. In particular, the purpose of this repository is to collect scripts and code, to explain applications of mathematical software, to showcase additional examples to paper publications, and more generally to host supplementary material developed for research projects or discussed in workshops.

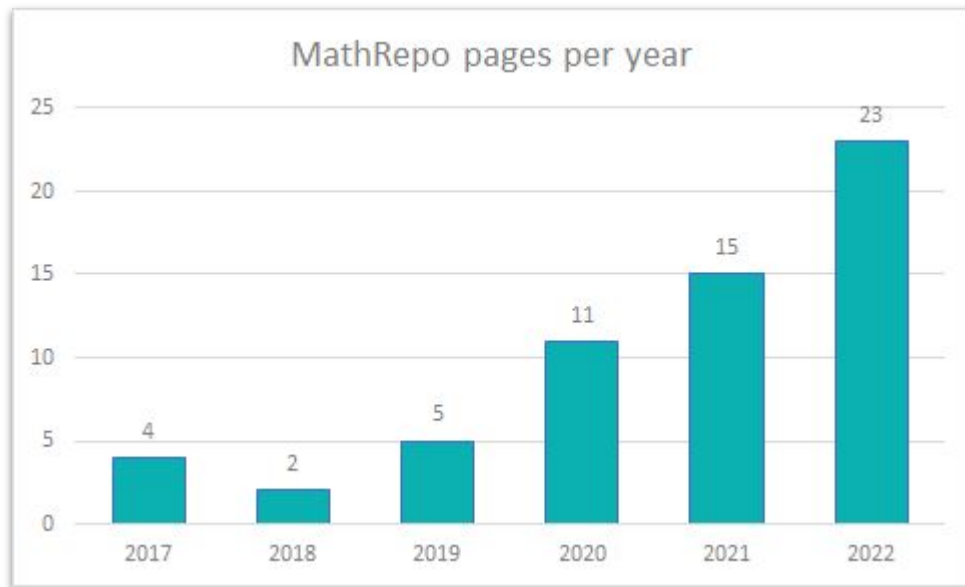
This website is currently maintained by Tabea Bacher, Claudia Fevola and Ben Hollering. It was set up and curated by Carlos Améndola, Christiane Görgen, Lukas Kühne and Verena Morys, and Yue Ren and Mahsa Sayyary Namin from 2017 until 2022. You can contact us at [mathrepo@mis.mpg.de](mailto:mathrepo@mis.mpg.de).

MathRepo is in the process of transformation. The current standards and requirements for contribution are outlined in the [Terms of Use](#) page. We aim to restructure the repository so that its content meets the [FAIR Principles](#) for sustainable research. In the future, MathRepo will follow the guidelines developed by the Mathematical Research Data Initiative [MaRDI](#).




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- run by the MPI MiS in Leipzig
- based on the institutes GitLab
- planned to be maintained at least for the next decade
- blog-style entries, high flexibility in how you display your content
- no hard quality control





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D-Algebraic Functions

Real Circles Tangent to 3 Conics

An algorithm for the identifiability of rank-3 tensors

Crossing the transcendental divide: from translation surfaces to algebraic curves

Combinatorics of Correlated Equilibria

Identifiability in Continuous Lyapunov Models

**Four-Dimensional Lie Algebras Revisited**

Vector Spaces of Generalized Euler Integrals

Sampling from a  $p$ -adic manifold

Tropical invariants for binary forms and reduction types of Picard curves

Classifying one-dimensional discrete models with maximum likelihood degree one

Recovery of Plane Curves from Branch Points

» 2022 » Four-Dimensional Lie Algebras Revisited

## Four-Dimensional Lie Algebras Revisited

This page contains auxiliary files to the paper:

Laurent Manivel, Bernd Sturmfels and Svala Sverrisdóttir: Four-Dimensional Lie Algebras Revisited

ARXIV: <http://arxiv.org/abs/2208.14631> CODE: <https://mathrepo.mis.mpg.de/Lie4>

**ABSTRACT:** The projective variety of Lie algebra structures on a 4-dimensional vector space has four irreducible components of dimension 11. We compute their prime ideals in the polynomial ring in 24 variables. By listing their degrees and Hilbert polynomials, we correct an earlier publication and we answer a 1987 question by Kirillov and Neretin.

### Verifications of Theorems 1 and 2

We used [Macaulay2](#) (version 1.20) to verify Theorems 1 and 2 from the paper.

The file [Lie 4 Component](#) includes the explicit generators of the irreducible components  $C_1, C_2, C_3, C_4$  which are explained in Section 3 of our paper. We calculate the dimension, degree, Betti numbers and the Hilbert polynomial of each of these components. We also verify that our ideals for  $C_1, C_3, C_4$  are prime. To show that  $C_1$  and  $C_3$  are prime it is enough to run the `isPrime` command in Macaulay2. To show  $C_4$  is prime we run

```
# minimalPrimes C4;  
radical C4 == C4
```

Since we get the output 1 and `true` we see that  $C_4$  is prime. Finally we take the intersection of these components to get the radical ideal of  $\text{Lie}_4$  and calculate its dimension, degree and Betti numbers.

In the file [C2 prime](#) we verify that our ideal for  $C_2$  is prime. We do this by representing the birational

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## Four-Dimensional Lie Algebras Revisited

Lyapunov Models

**Four-Dimensional Lie Algebras Revisited**

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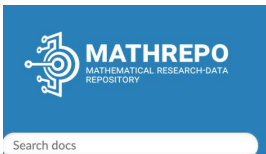
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Name	Last commit	Last commit
..		
 C2prime.m2	Variety of 4 dimensional Lie algebras	2 months ago
 index.rst	arxiv link to Lie4	2 months ago
 lie4.m2	Variety of 4 dimensional Lie algebras	2 months ago



# How FAIR is MathRepo?

## Findable

- ☒ URL stable for the foreseeable future
- ☒ findable in google search e.g.
- ☒ some metadata
- ☒ no DOI
- ☒ metadata is not indexed in a (machine-) searchable resource

## Accessible

- ☒ no pay walls
- ☒ no sign-up process for readers
- ☒ low barrier for new contributions
- ☒ no automated retrieval of (meta) data

## Interoperable

- ☒ maths with explanatory text, link to articles
- ☒ code annotated with software name, version, date, hardware setup
- ☒ very case specific, reproducibility might fail

## Reusable

- ☒ author names for contact
- ☒ often a lot of detail provided
- ☒ no license information

C. Fevola and Ch. G. (2022). The mathematical research-data repository MathRepo. Computer Algebra Rundbrief, Nummer 70. Preprint on arxiv:2202.04022[math.HO].



# Future Improvements

- Increase of user friendliness: "How to contribute" button on the main page
- more automation, less manual changes -> less mistakes
- for reusability: licenses



# Future Improvements - Licenses

- Different types of data require different licenses -> mixed permissive licenses

MathRepo suggested license statement

License for Code: MIT License (<https://spdx.org/licenses/MIT.html> )

License for all other content (Text, Images, numerical data, ...): Attribution 4.0 International (CC BY 4.0) <https://creativecommons.org/licenses/by/4.0/>

- next: add to template
- Any license is better than no license!



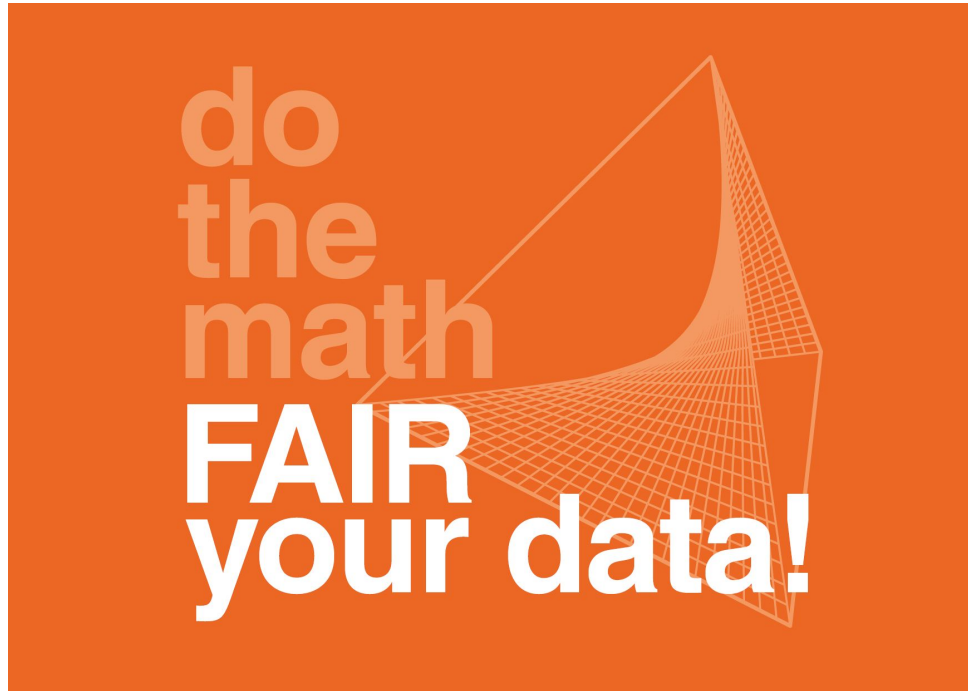


# The Vision

- embedding into the MaRDI Portal
  - with Lars Kastner (TU Berlin)
  - automated extraction of metadata
  - upload to wikidata
- “launch your own MathRepo”
  - we can not provide a repository for everyone, but you can start your own MathRepo



# The Vision



## Nonlinear Algebra

Algebraic Geometry

Commutative Algebra

Group Theory

Differential Algebra

Combinatorics

Number Theory

Algebraic Topology

Discrete Geometry

Convex Geometry

Multilinear Algebra

Representation Theory

## Computations

sage

julia



polymake

Macaulay2



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# What Can You Do With MathRepo?

- Host Code
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- Visualization
  - <https://mathrepo.mis.mpg.de/intersection-bodies/index.html>
- Teaching
  - <https://mathrepo.mis.mpg.de/ToricGeometry/index.html>



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# Who is the FAIRest of them all?

**The prize:** fame and honor, 1kg of FAIR chocolate for the contributing team, a badge on the MathRepo Page

**The criteria:** Compliance with FAIR principles, good documentation and description, reproducible results

**The jury:** You!

**The deadline:** tomorrow at noon



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