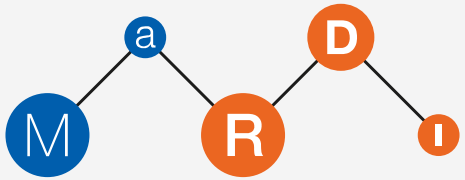


The Algorithm Knowledge Graph – A Seed for Linked Math

R. Fritze, C. Himpe, H. Kleikamp, M. Ohlberger, S. Rave

DMV Annual Meeting 2022
(MS9: The Future of Digital Infrastructures for Mathematical Research)
2022–09–14

WWU MÜNSTER

MAX PLANCK INSTITUTE
FOR DYNAMICS OF COMPLEX
TECHNICAL SYSTEMS
MAGDEBURG

MaRDI: Task Area 2

TA2: Scientific Computing

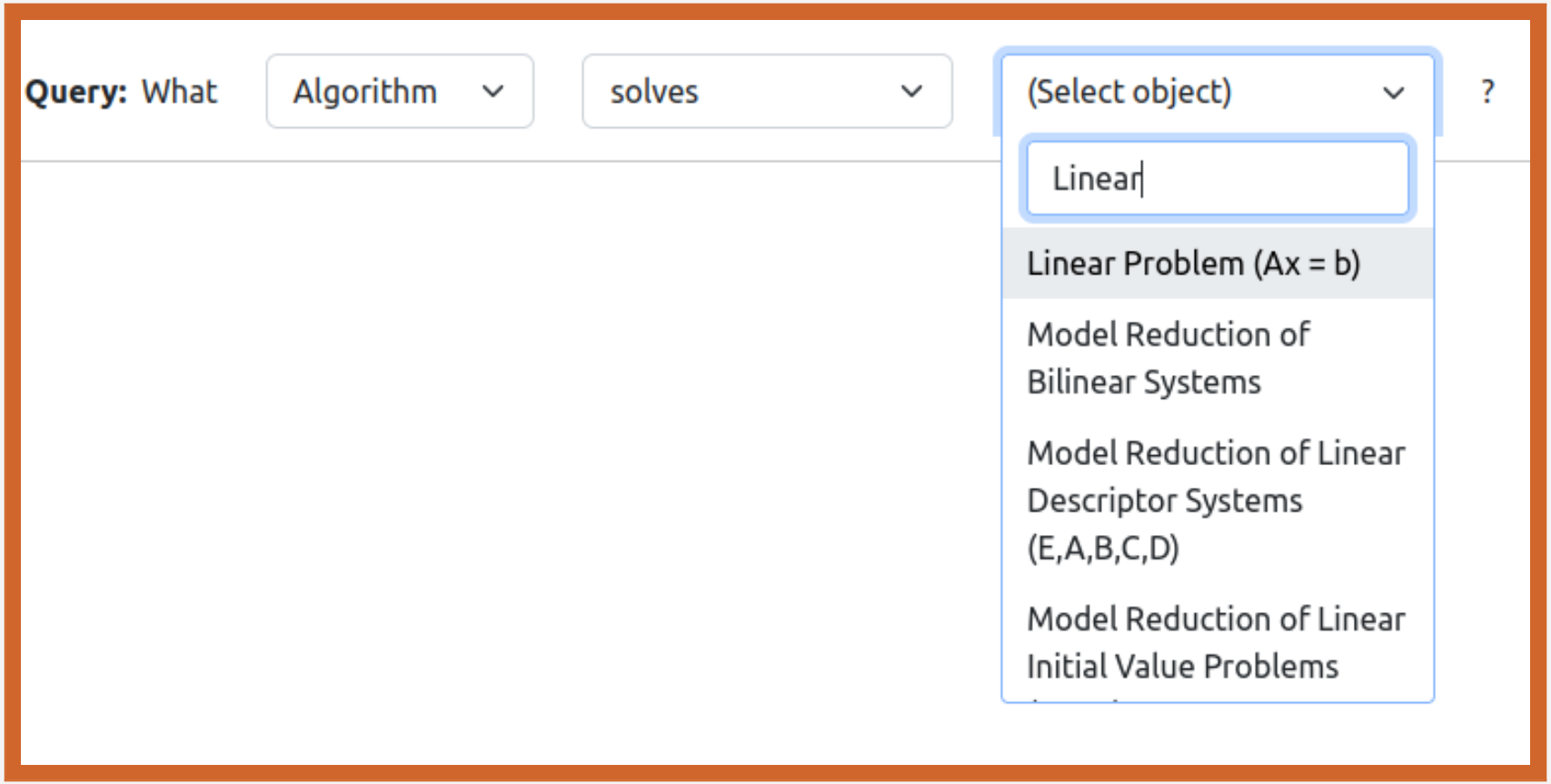
- Measure 1: Algorithm Knowledge Graph
- Measure 2: Open Interfaces
- Measure 3: Benchmark Framework
- Measure 4: CSE Workflows

Task Area 2: Measure 1

M1: Algorithm Knowledge Graph

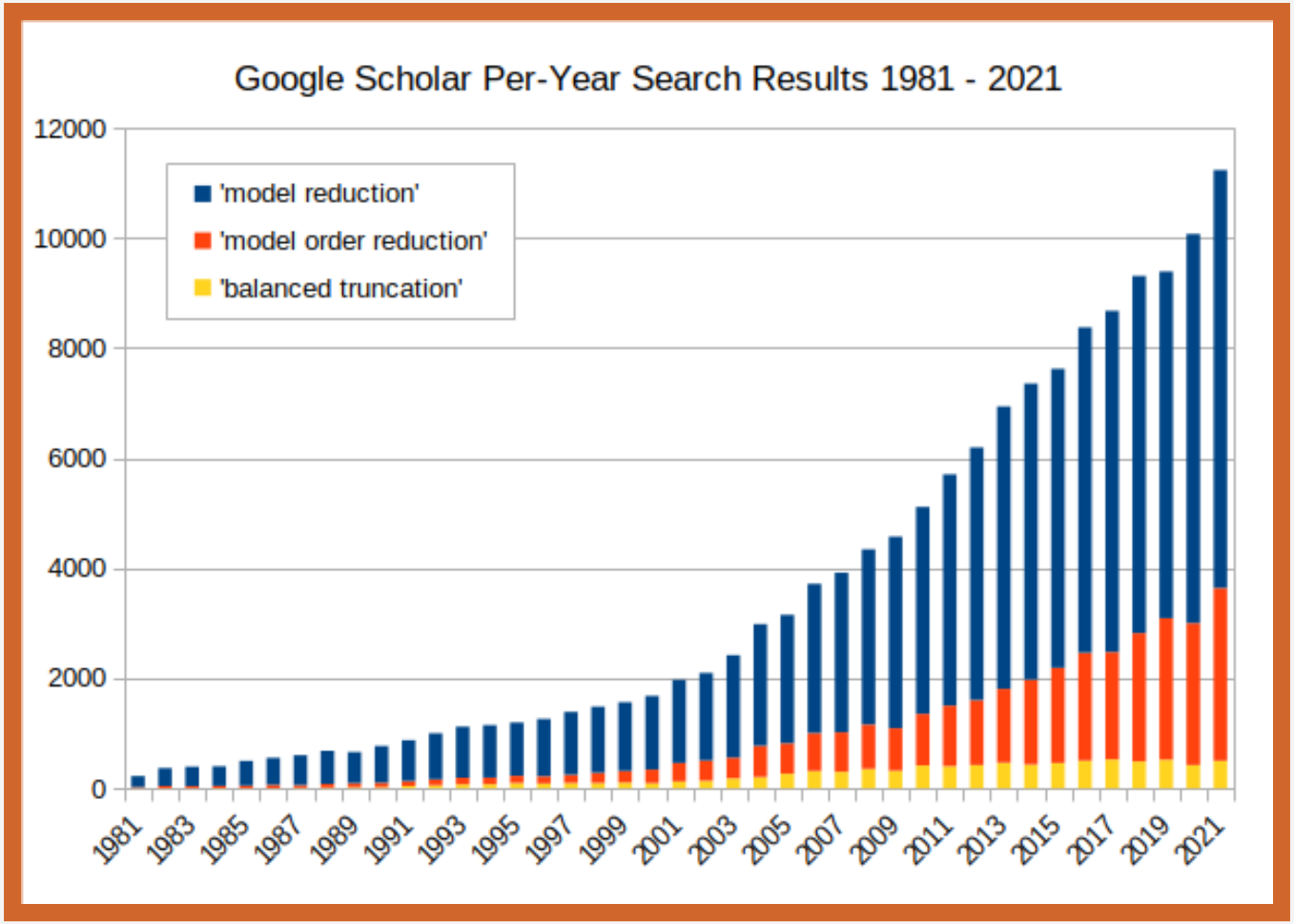
- Increase discoverability of numerical algorithms
- Build a linked data graph for semantic queries
- Practically: search by relation instead of full-text
- Focus on the “F” in FAIR

Just Ask


Query: What
Algorithm
solves
(Select object)
?
Linear
Linear Problem (Ax = b)
Model Reduction of Bilinear Systems
Model Reduction of Linear Descriptor Systems (E,A,B,C,D)
Model Reduction of Linear Initial Value Problems

Let's Say ...

... you are a model reducer:



How Do You Keep Track?

State of the art:

- Preprints (i.e. arXiv)
- Articles (i.e. various journals)
- Conferences (i.e. proceedings)
- Social media (i.e. ResearchGate)

Why Do You Keep Track?

From a numerical point of view:

- Problems
- Algorithms
- Benchmarks (implementation of problems)
- Software (implementation of algorithms)

Let's Say ...

... you are ...

- ... a mathematician changing fields (to model reduction)
- ... an engineer seeking to apply (model reduction)
- ... a beginning (model reduction) graduate student
- ... an undergrad student trying learn (about model reduction)

Unsustainability

The (unfortunate) bigger picture:

- This is not only model reduction.
- This is not only numerical mathematics.
- This is not only mathematics.
- This is all of science!

Turning Ship

We need to ...

- ... collect knowledge
- ... categorize knowledge
- ... interlink knowledge
- ... encode knowledge

Encoding Knowledge

With a knowledge graph:

- List of statements
- A statement consists of subject (S), predicate (P), object (O)
- Together statements form a (directed) graph
- S/O are the vertices, P are the edges

The Goal

An algorithm knowledge graph:

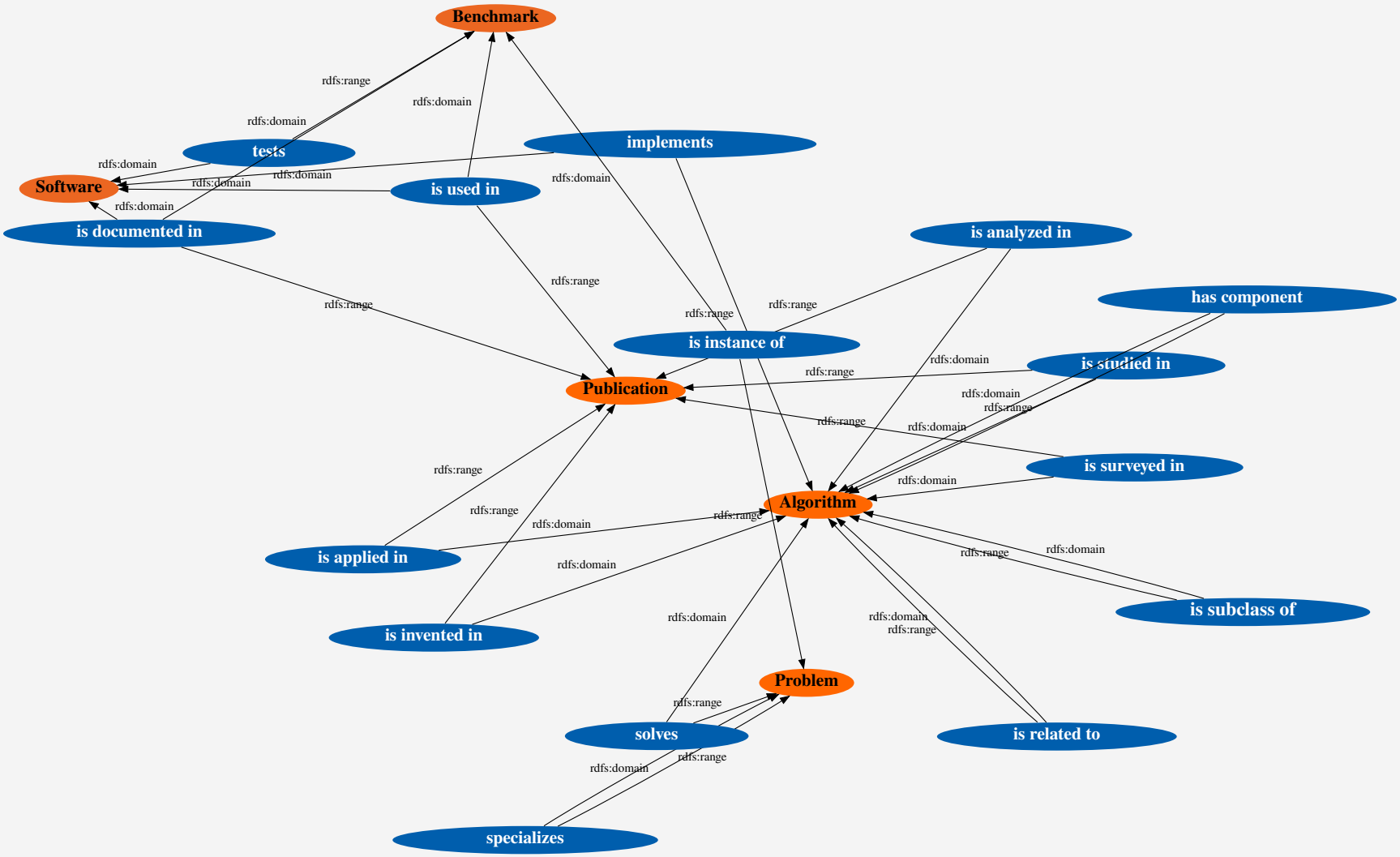
- Numerical algorithms as the core subject
- Facilitate discoverability and trailing breadcrumbs
- Integrate back-log over time
- Track current developments

Ontology-Driven

A knowledge graph's usability:

- It defines vocabulary and syntax of statements
- S/O: Algorithm, Problem, Implementation, Benchmark, Publication
- P: Minimal set of relevant relations
- Strict adherence is necessary!

The Ontology



AlgoData

The Algorithm Knowledge Graph:

- Semantically categorize and classify numerical algorithms
- Associate with problems, implementations and publications
- Provide full-text and semantic search of graph
- Enable exploratory traversal of graph

How We Did It

Technology stack:

- Meta-data: RDF (Turtle)
- Ontology: RDFS & OWL
- Server: Apache Jena Fuseki
- Query: SPARQL

What Is Next?

Work in progress:

- Graph validation (SHACL?)
- Automatic submissions (editorial system)
- Knowledge annotation (reification)
- Open endpoint for custom queries

What Is Needed?

Community contributions:

- General feedback
- Publication suggestions
- Volunteer editors
- **Users!**

A Part of MaRDI

How we (will) collaborate:

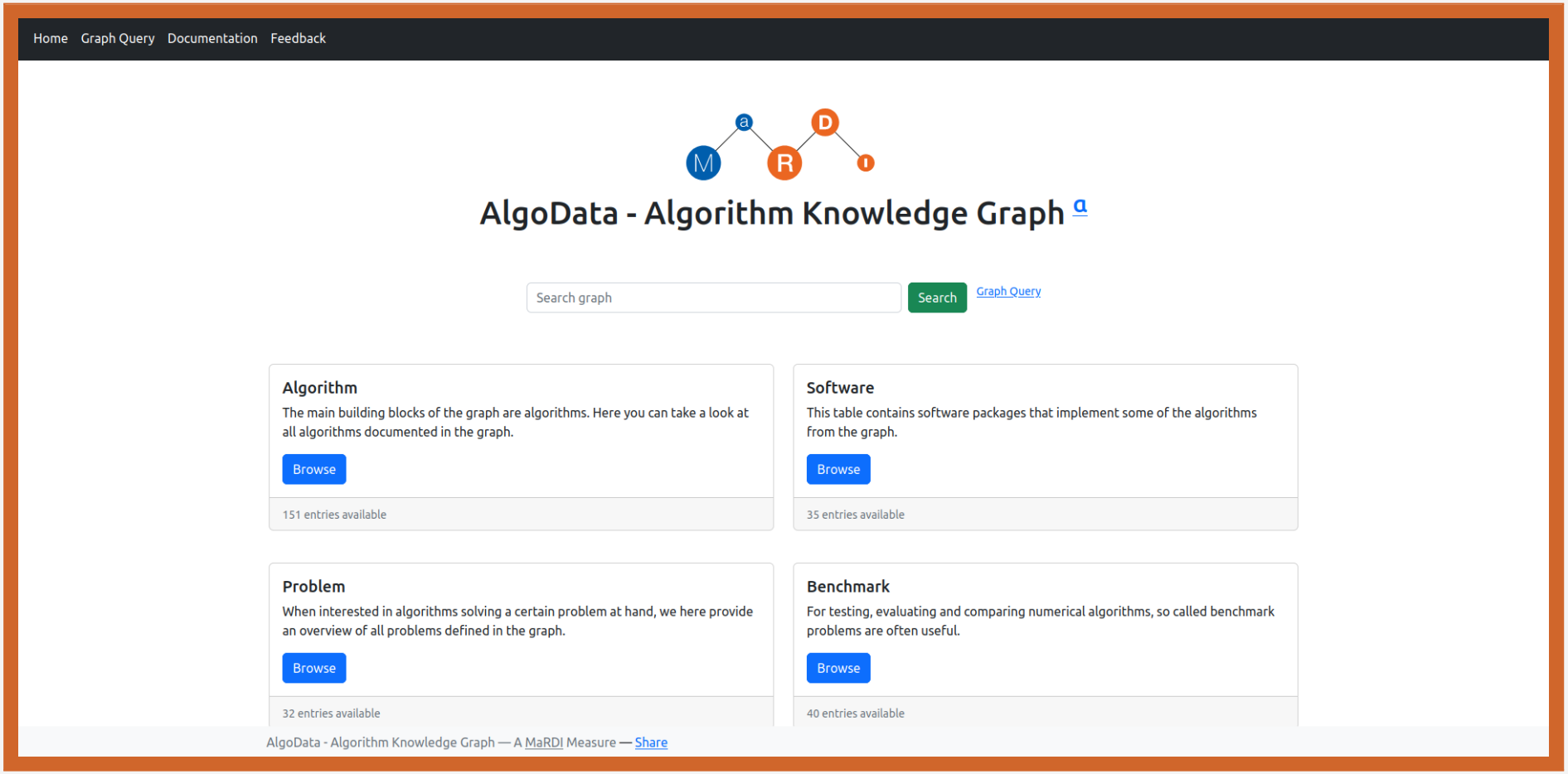
- TA1: What is computer algebra's view?
- TA3: Is ML a potential field of algorithms?
- TA4: Synchronize ontologies and connect graphs.
- TA5: MaRDI portal imports AlgoData graph.

Sustainability

Beyond MaRDI:

- Automate as much as possible
- Incentivize contributions
- Build a user community
- Demonstrate value

Try It (With Your ORCID)



https://algodata.mardi4nfdi.de