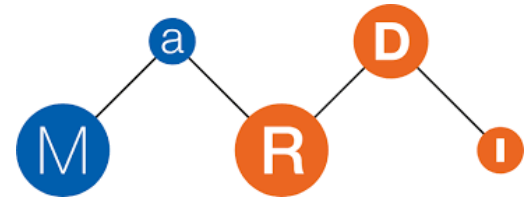




Future Gateway to FAIR Mathematical Data



Dr. Marco Reidelbach
MMS Days, 28.03.2025



Mathematical Research Data Initiative

“I have no data, I am just doing math!”

Raise awareness

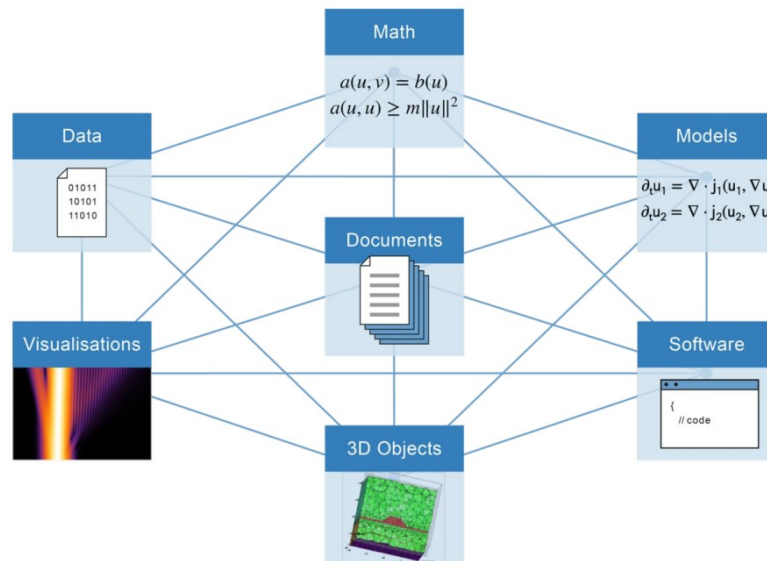
Researchers
RDM Staff

Establish Standards

Metadata
Interfaces

Support & Training

Software Reviews



Research Data in Mathematics¹

Services

MaRDI Portal

Packaging System

MaRDMO

Open Interfaces

MaRDIFLOW

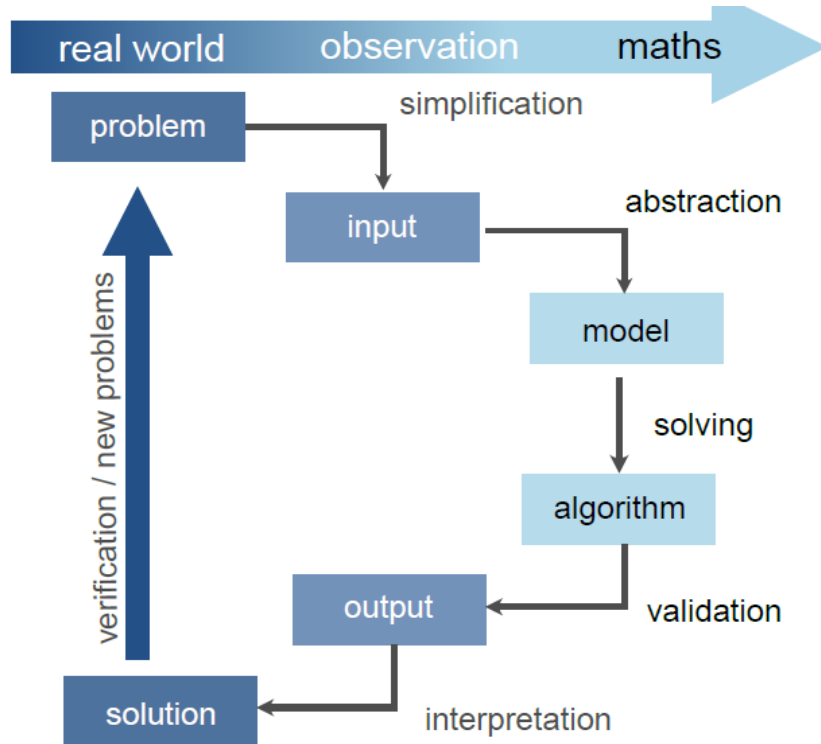
MathAlgoDB

MathModDB

others...

“I don’t know how to assist mathematicians in their RDM efforts.”

MathRD Across Research



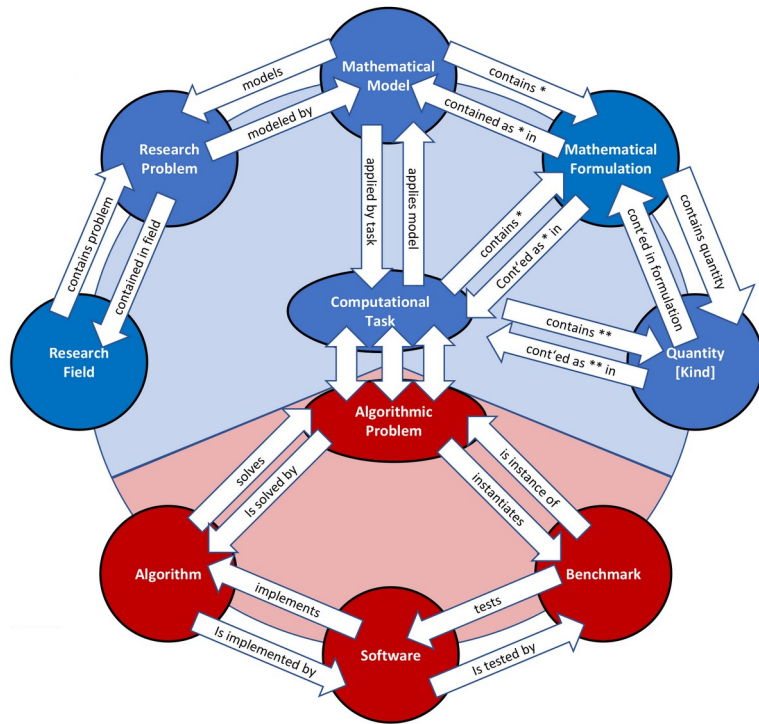
Model-Simulation-Optimization Workflow¹

- Simulating problems using mathematical models and algorithms.
- Collecting empirical data and analyzing it computationally.
- Using data-driven methods to extract insights from existing data.

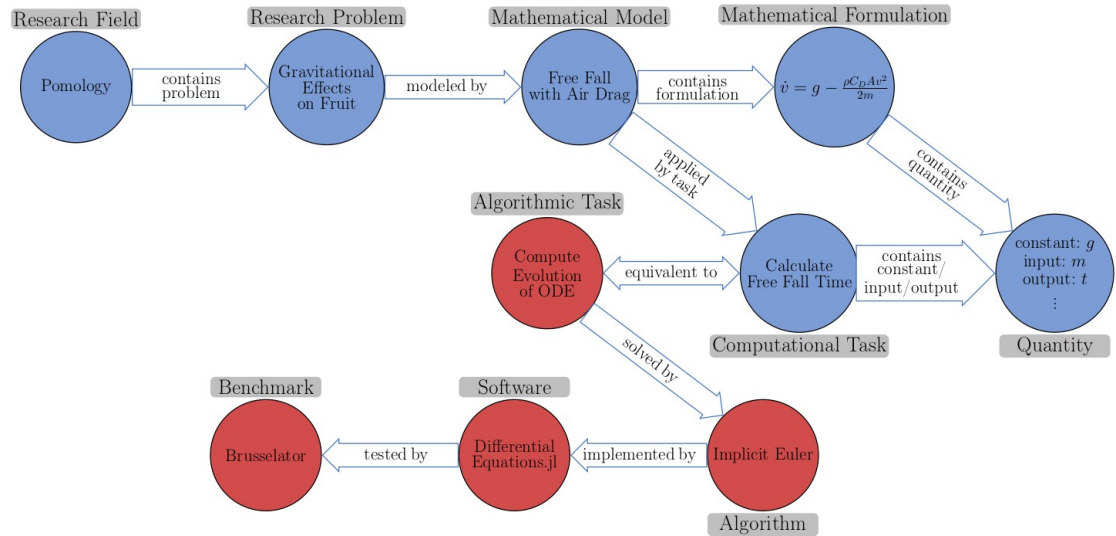


FAIR RD REQUIRES FAIR MathRD

MathModDB & MathAlgoDB



Ontologies



Practical Example²

Interdisciplinary Workflows

Logical Data Analysis for Egyptian Objects

🌐 Add languages ▼

Workflow Discussion

Read View source View history ☆ Tools ▼

From MaRDI portal

Workflow:6032641

Available identifiers

Q6032641

Problem statement

Common Destruction Patterns in Egyptian Objects from the Cachette de Karnak

Object of research and objective

Do Destruction Patterns Follow Specific Rules?

Involved disciplines

1. Egyptology
2. boolean algebra

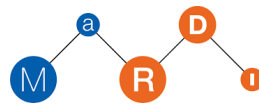
Model



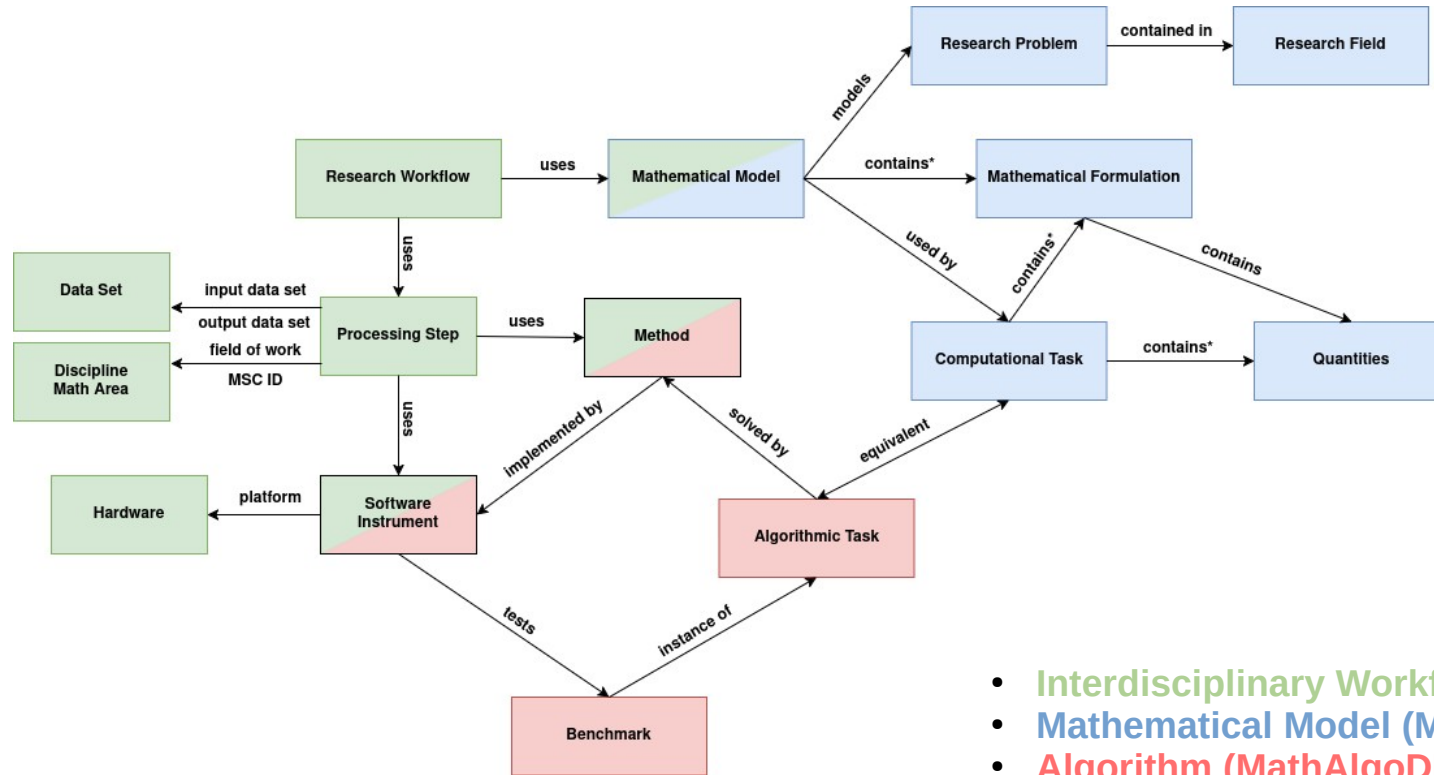
Label	Description	Time	Space
Object Comparison Model	model comparing objects using a boolean ring over the object properties	independent	independent

Workflow Documentation Template:

- Research Objective
- Processing Steps
- Data Sets
- Methods (exp/comp)
- Hardware
- Instruments
- Software
- Reproducibility



Combining Resources



- Interdisciplinary Workflow (MaRDI Portal)
- Mathematical Model (MathModDB KG)
- Algorithm (MathAlgoDB KG)

Bringing Services to Researchers

MaRDI Portal

Additions

Statements

instance of quantity edit

0 references

+ add reference

+ add value

defining formula

$$G_{\{m,n\}} \equiv \begin{cases} \frac{W_{\{m,n\}}}{P_m} + \frac{W_{\{n,m\}}}{P_n} & \text{if } m \neq n \\ \frac{W_{\{m,m\}}}{P_m} & \text{if } m = n \end{cases}$$

save remove cancel

+ add qualifier

0 references

+ add reference

+ add value

Query

MaRDIQueryService

Examples Help More tools Query Builder

```

1 SELECT ?MathematicalModel
2 WHERE {
3   #Research Problem modelled by Mathematical Model
4   wd:Q6684658 wdt:P1513 ?MathematicalModel.
5 }
    
```

MathAlgoDB / MathModDB

Propose additions to the knowledge graph

Category: Model Order Reduction Help

Select class:

Algorithm +

+ Add new subject

Submit

Graph Query

First, select to query the whole graph (all fields) or select a specific field of applied mathematics.

1. Field: All Fields

Second, form a question by selecting from the given options, for example: Which [Algorithm] solves [Linear Problem (Ax = b)] ? [Answer](#)

2. Query: Which Algorithm solves

Select object

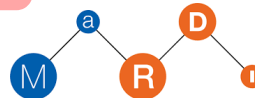
(Select object)

Combined State and Parameter Reduction

Computerized Tomography

Construction of a Reduced Basis for Parametric Differential

Diverse Services - Varying Requirements - Fragmented User Experience



RDMO as Connector



Research Data Management Organiser³

- Established DMP / SMP Software
- Already used in many Research Institutions
- 2/3 of NFDI Consortia want to use RDMO

Customization through Catalogs



Customization through Plugins

Development of MaRDMO

Interdisciplinary Workflow Documentation

→ single catalog, documentation as static webpage

Interdisciplinary Workflow Documentation (MMS Days 2023)

→ **important aspects integrated in knowledge graph**

Interdisciplinary Workflow + Mathematical Model Documentation

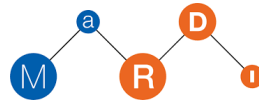
→ complete integration of MathModDB ontology

Interdisciplinary Workflow + Mathematical Model + Algorithm Documentation

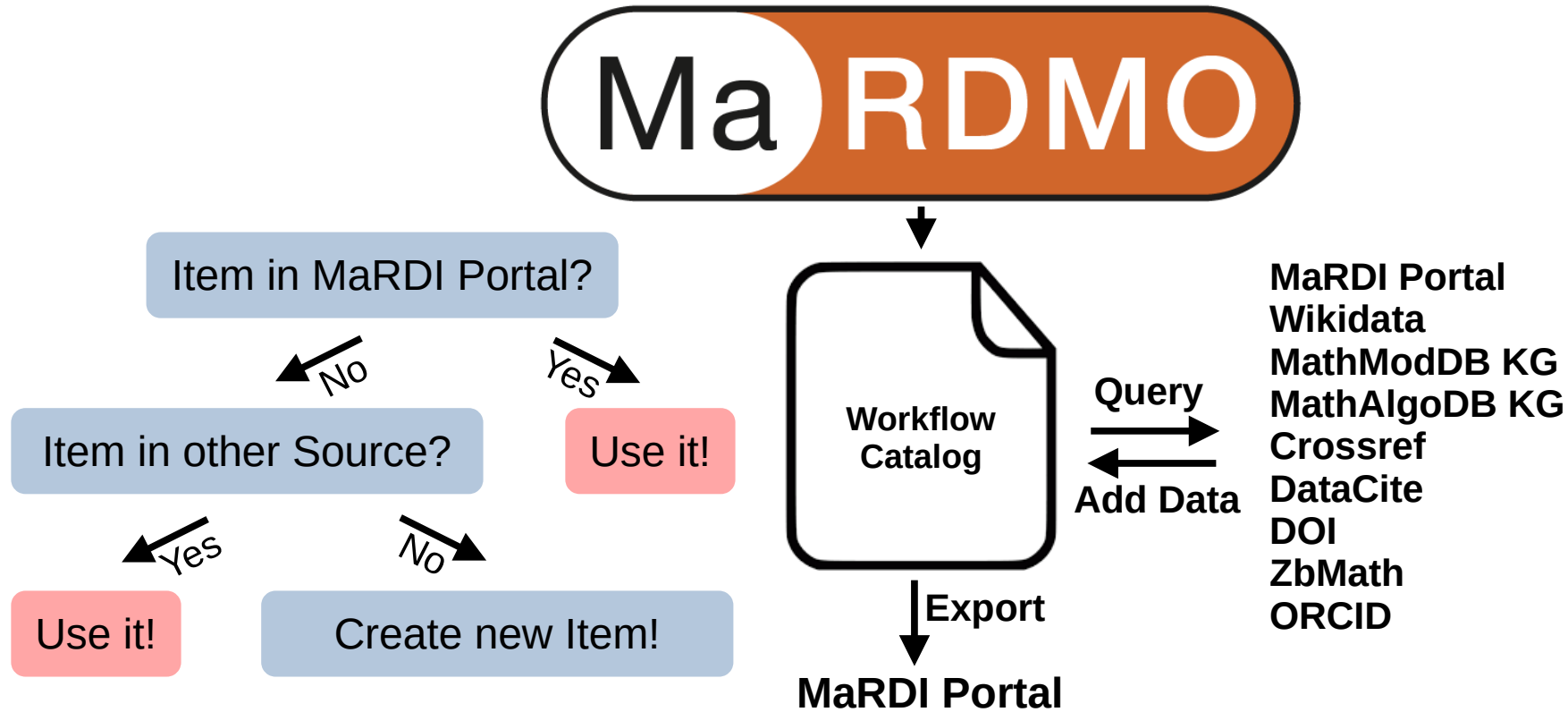
→ complete integration of MathAlgoDB ontology

Interdisciplinary Workflow + Mathematical Model + Algorithm Documentation

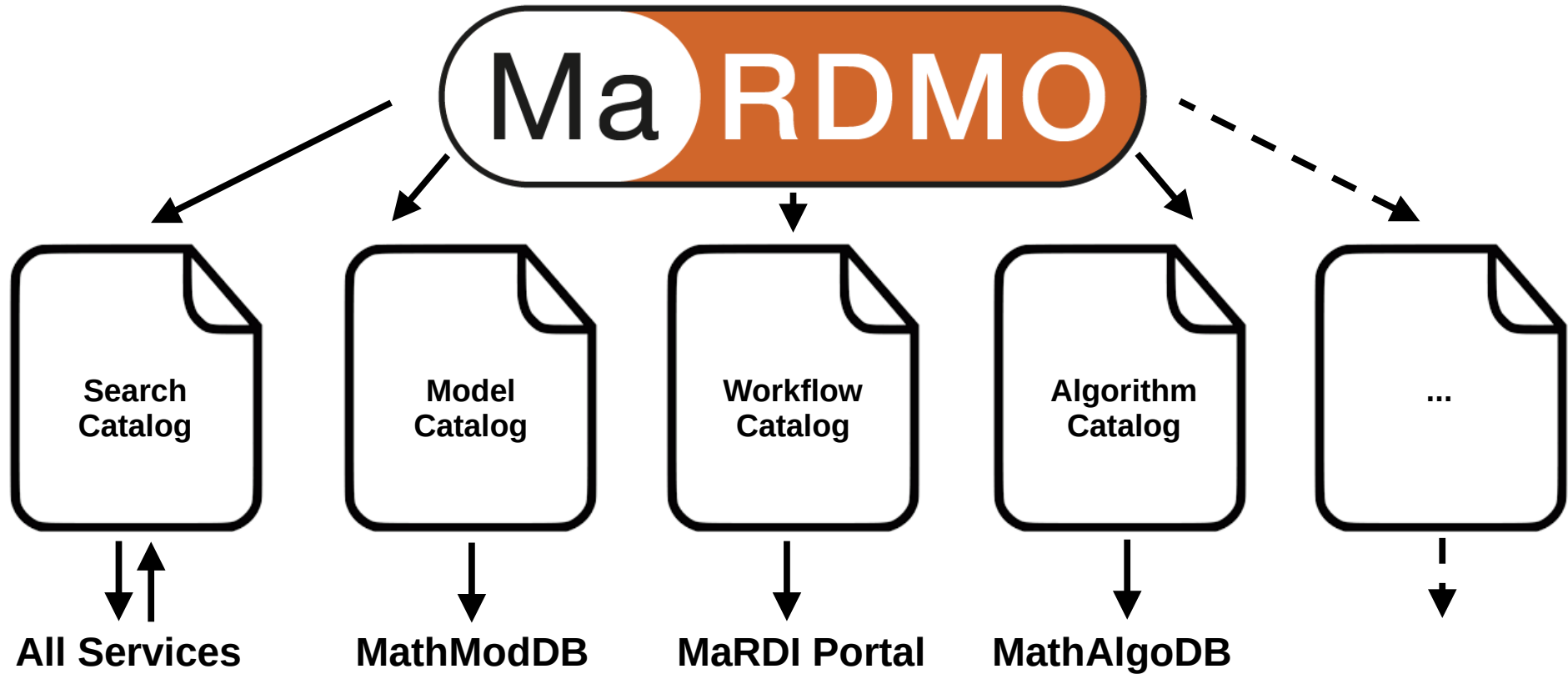
→ **separate catalogs, complete automating scheme,
dynamic wikispaces**



MaRDMO Plugin (I)



MaRDMO Plugin (II)



Model Catalog

Research Problem

Select, define and relate research problems associated with the mathematical model.

Please fill in the form for each tab. The same tabs may be used later on other pages. You can add a new tab using the green button. Once created, you can edit or delete tabs using the buttons in the top right corner.

0 [+ Set](#)

Select a Research Problem related to the Mathematical Model!

For all research problems "label (description) [source]" is provided. If a research problem is chosen, WAIT until further information are added to the questionnaire. If no appropriate research problem is present in MathModDB, the MaRDI Portal or Wikidata, choose 'not found'.

Identify destruction rules in ancient egyptian objects (common destruction patterns in ancient egyptian objects from the 'Cachet...

Research Problem Information

Name of the Research Problem



Identify destruction rules in ancient egyptian objects

Description of the Research Problem

common destruction patterns in ancient egyptian objects from the 'Cachette de Karnak' suggest that specific rules govern th

Research Field containing the Research Problem?

For all research fields "label (description) [source]" is provided.
Please enter your entries line by line. You can add lines using the green button and remove them using the blue cross (x).

Egyptology (scientific study of ancient Egypt) [mathmoddb]  

[+ Entry](#)

Research Problem - Research Problem Relations

Optionally, user-defined research problems and research problems from MathModDB can be related to each other.

Please enter your entries block by block. You can add blocks using the green button and remove them using the blue cross (x).

[+ Block](#)

[Back](#) [Proceed](#)

Query different sources



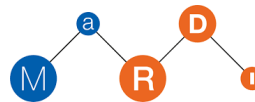
All available Information added automatically

Information Section

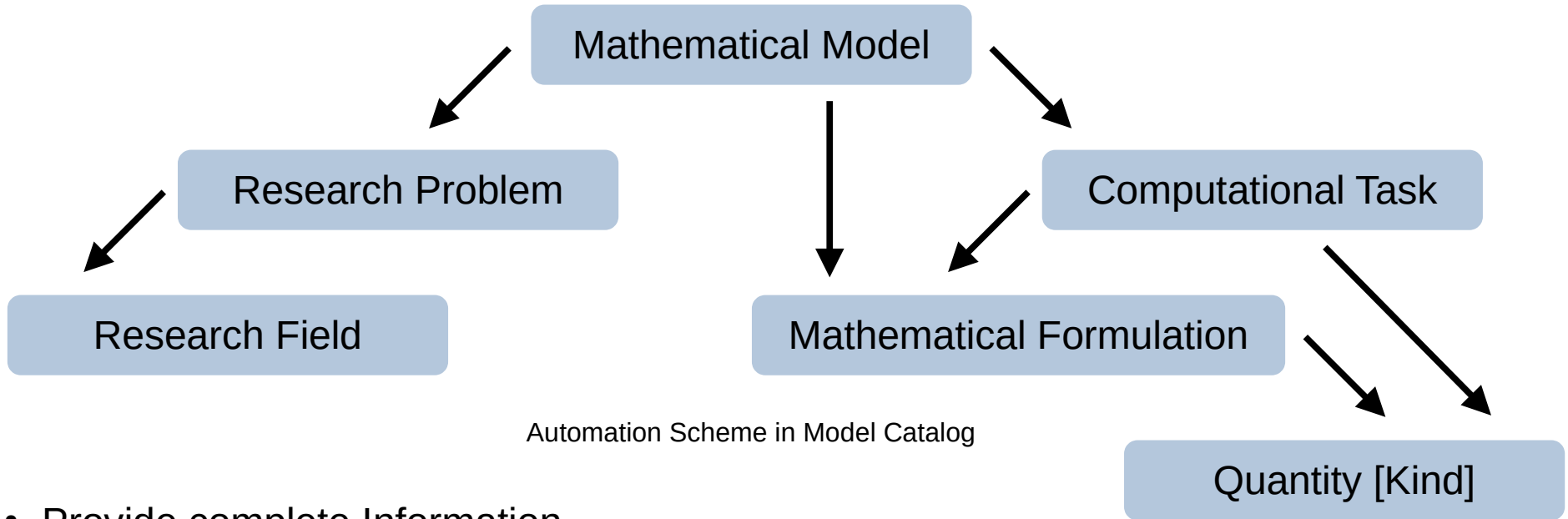


Information added to Research Field Page

Optional Relations

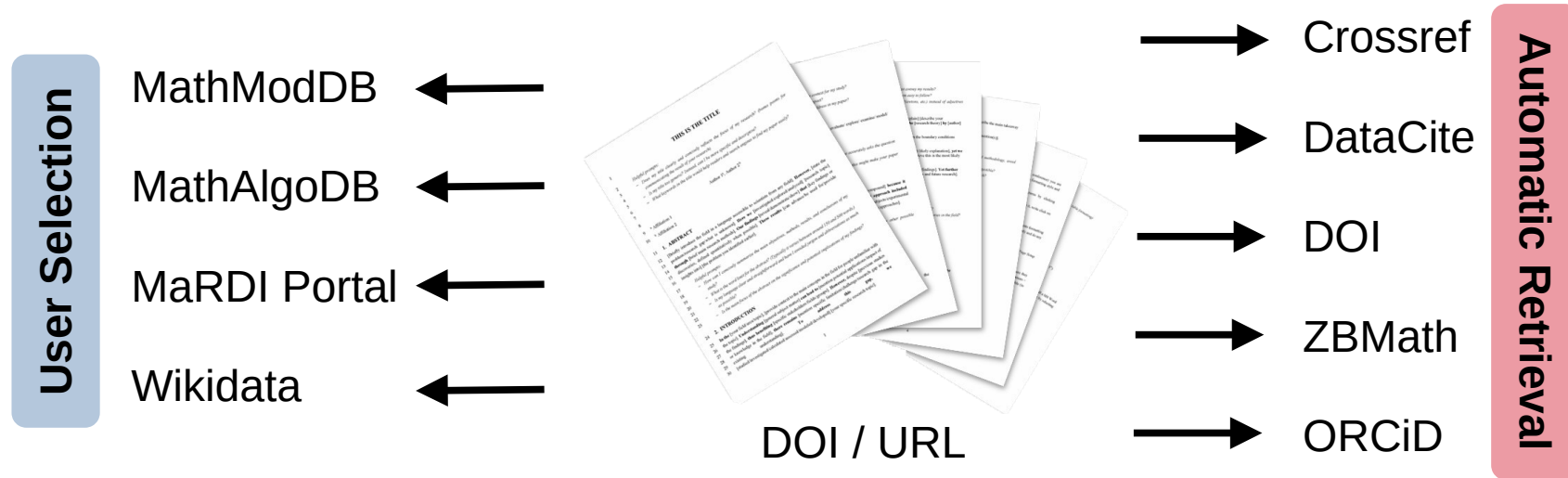


Automating the Catalog



- Provide complete Information
- Prevent Duplications
- Existing Items as Templates for new Ones

What about Publications?



Citation Information stored in Background.

MaRDMO Export

Algorithm

Select, define and relate algorithms.

Please fill in the form for each tab. The same tabs may be used later on other pages. You can add a new tab using the green button. Once created, you can edit or delete tabs using the buttons in the top right corner.

0 1 [+ Set](#)

Select an Algorithm!

For all algorithms "label (description) [source]" is provided. If an algorithm is chosen, WAIT until further information are added to the questionnaire. If no appropriate algorithm is present in MathAlgoDB, the MaRDI Portal or Wikidata, choose 'not found'.

Buchberger's algorithm (algorithm) [mathalgotdb]

Algorithm Information

Name of the Algorithm

Buchberger's algorithm

Description of the Algorithm

algorithm

Algorithmic Problem solved by the Algorithm

For all algorithms "label (description) [source]" is provided.

Please enter your entries line by line. You can add lines using the green button and remove them using the blue cross (x).

Compute Gröbner Basis for an Ideal (reducing a set of polynomials or relations to a canonical, simplified form (the Gröbner

[+ Entry](#)

Software implementing the Algorithm

For all software "label (description) [source]" is provided.

Please enter your entries line by line. You can add lines using the green button and remove them using the blue cross (x).

OSCAR (No Description Provided!) [mathalgotdb]

[+ Entry](#)

Rules and Pattern Algorithm

Algorithms

A1: Buchberger's algorithm

Description: algorithm

MathAlgoDB ID: mardmo41

Relations to Algorithmic Problems

solves: AP1

Relations to Software

implemented by: S1

Relations to Algorithms

component of: A2

Buchberger's algorithm

Class:

Algorithm

Properties

→ Comment: algorithm

...solves 1

→ Compute Gröbner Basis for an Ideal

...is component of 1

→ RAP Algorithm

...is implemented by 1

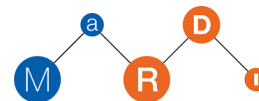
→ OSCAR

Documentation

Preview

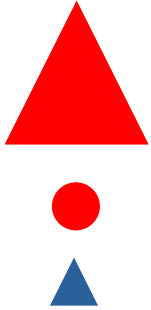
Rest API (OAuth2)
SPARQL INSERT

Export



Sharing and Finding MathRD (I)

Toy Example



Si = 0 / 1 (small / large) ; C = 0 / 1 (blue / red) ; Sh = 0 / 1 (triangle / circle)

$$\begin{aligned} P_1 &= SiC(Sh+1) \\ P_2 &= (Si+1)CSh \\ P_3 &= (Si+1)(C+1)(Sh+1) \end{aligned}$$

Gröbner Basis
over Boolean Ring

$$\begin{aligned} Si + C + Sh & \quad (\text{"too complex"}) \\ Sh^2 + Sh & \quad (\text{trivial}) \\ CSh + Sh & \quad \text{If obj blue, it's triangle.} \\ C^2 + C & \quad (\text{trivial}) \end{aligned}$$

Algorithm Page

Algorithm
Select, define and relate algorithms.

Please fill in the form for each tab. The same tabs may be used later on other pages. You can add a new tab using the green button. Once created, you can edit or delete tabs using the buttons in the top right corner.

0 1 [+ Set](#)

Select an Algorithm!
For all algorithms "label (description) [source]" is provided. If an algorithm is chosen, WAIT until further information is added to the questionnaire. If no appropriate algorithm is present in MathAlgoDB, the MaRI Portal or Wikidata, choose "not found".

RAP Algorithm (rules and pattern algorithm) [mathalgodb]

Algorithm Information

Name of the Algorithm
RAP Algorithm

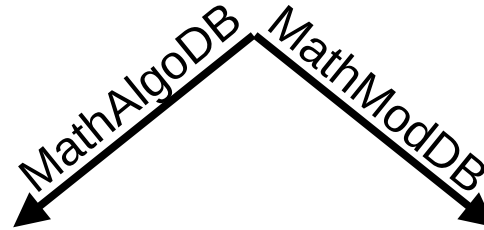
Description of the Algorithm
rules and pattern algorithm

Algorithmic Problem solved by the Algorithm
For all algorithms "label (description) [source]" is provided.
Please enter your entries line by line. You can add lines using the green button and remove them using the blue cross (+x).
Computing a Gröbner Basis from Boolean Object Properties (boolean properties to boolean ring to Gröbner basis) [mathalx]

[+ Entry](#)

Software implementing the Algorithm
For all software "label (description) [source]" is provided.
Please enter your entries line by line. You can add lines using the green button and remove them using the blue cross (+x).
Julia (No Description Provided) [mathalgodb]

[+ Entry](#)



Mathematical Model
Select, define and relate mathematical models.

Please fill in the form for each tab. The same tabs may be used later on other pages. You can add a new tab using the green button. Once created, you can edit or delete tabs using the buttons in the top right corner.

0 [+ Set](#)

Select a Mathematical Model!
For all mathematical models "label (description) [source]" is provided. If a mathematical model is chosen, WAIT until further information is added to the questionnaire. If no appropriate mathematical model is present in MathModDB, the MaRI Portal or Wikidata, choose "not found".

Object Comparison Model (model comparing objects using a boolean ring over the object properties) [mathmoddb]

Mathematical Model Information

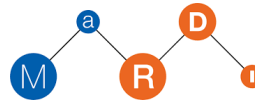
Name of the Mathematical Model.
Object Comparison Model

Description of the Mathematical Model
model comparing objects using a boolean ring over the object properties

Properties of the Mathematical Model

- ☐ is convex
- ☒ is not convex
- ☒ is deterministic
- ☐ is stochastic
- ☒ is dimensionless
- ☐ is dimensional
- ☐ is dynamic
- ☒ is static
- ☐ is linear
- ☒ is not linear

Model Page



Sharing and Finding MathRD (II)

“Destruction patterns suggest underlying rules.”



CK 3⁵



Cachette de Karnak (1903)⁴



Object Database⁵



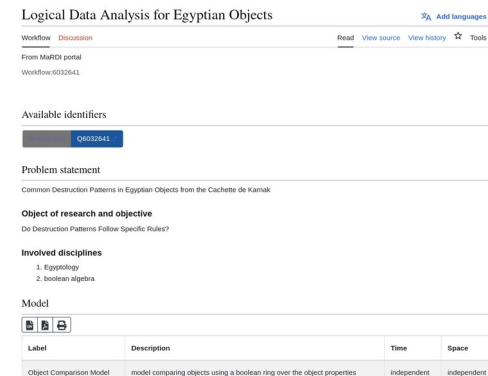
CK 8⁵

“Which model is used to extract rules?”

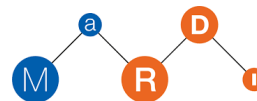


Object Comparison Model
RAP Algorithm

Workflow published
on MaRDI Portal



Interdisciplinary Workflow



Sharing and Finding MathRD (III)

Before:

Is object small, large,
red, blue, etc...?



Blood Sample⁶

“Which workflow is used to extract rules?”



Logical Data Analysis for Egyptian Objects

Workflow published
on MaRDI Portal

Mathematics
Egyptology
Medicine

Now:

Is concentration of
substance higher/
lower than threshold?

Results com-
parable to es-
tablished sta-
tistical methods.



Outlook

Add further MaRDI Services:

- CSE Workflows
- ...

Add other Services:

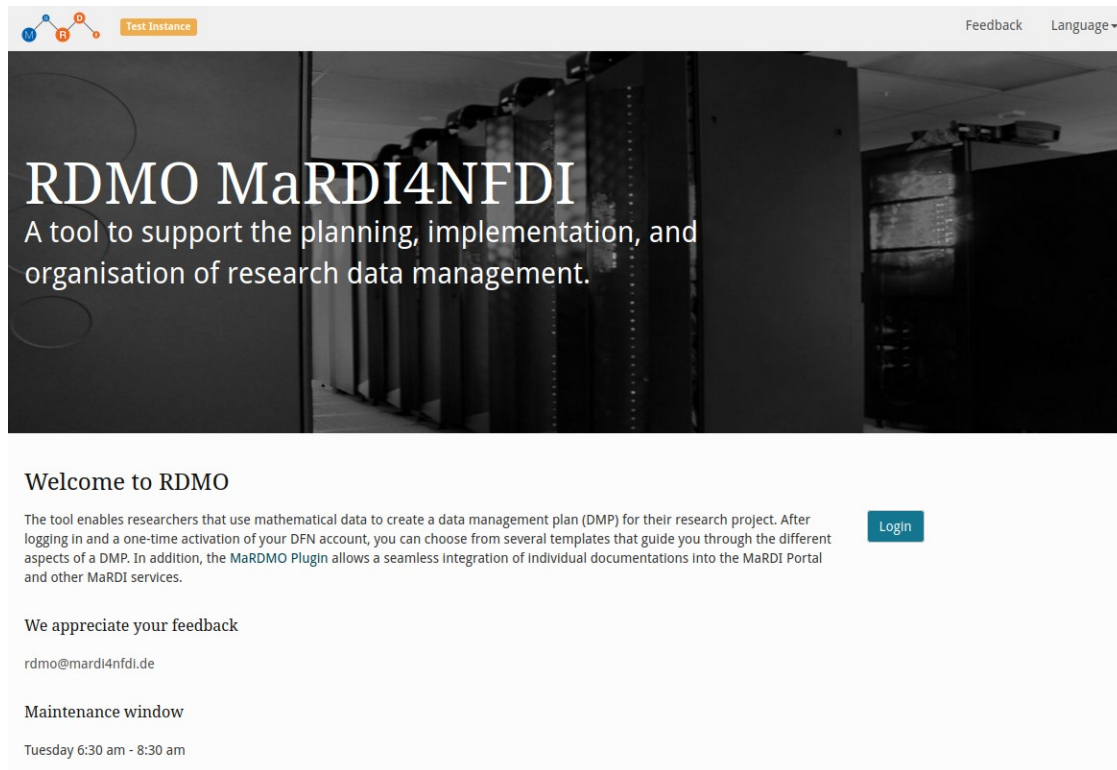
- Sensor AWI
- ...

- Harmonize MaRDMO Catalogs
- AI Publication Import
- Generate new Workflows from existing Workflows
- Provide MaRDMO Plugin through MaRDI RDMO Instance




Basic Service DMP4NFDI⁷

MaRDI RDMO Instance



The screenshot shows the homepage of the RDMO MaRDI4NFDI instance. At the top left is a logo with letters M, a, R, D, and I in colored circles. Next to it is a 'Test Instance' button. On the top right are links for 'Feedback' and 'Language'. The main banner features a server room background with the text 'RDMO MaRDI4NFDI' and a description: 'A tool to support the planning, implementation, and organisation of research data management.' Below the banner, a 'Welcome to RDMO' section explains the tool's purpose and includes a 'Login' button. Further down, there is a 'We appreciate your feedback' section with an email address and a 'Maintenance window' section with a scheduled downtime notice.

 [Test Instance](#) [Feedback](#) [Language](#)

RDMO MaRDI4NFDI

A tool to support the planning, implementation, and organisation of research data management.

Welcome to RDMO

The tool enables researchers that use mathematical data to create a data management plan (DMP) for their research project. After logging in and a one-time activation of your DFN account, you can choose from several templates that guide you through the different aspects of a DMP. In addition, the MaRDMO Plugin allows a seamless integration of individual documentations into the MaRDI Portal and other MaRDI services.

[Login](#)

We appreciate your feedback

rdmo@mardi4nfdi.de

Maintenance window

Tuesday 6:30 am - 8:30 am

**Thank you,
for your Attention!**

