Institute for Data, Process, and Knowledge Management (DPKM)

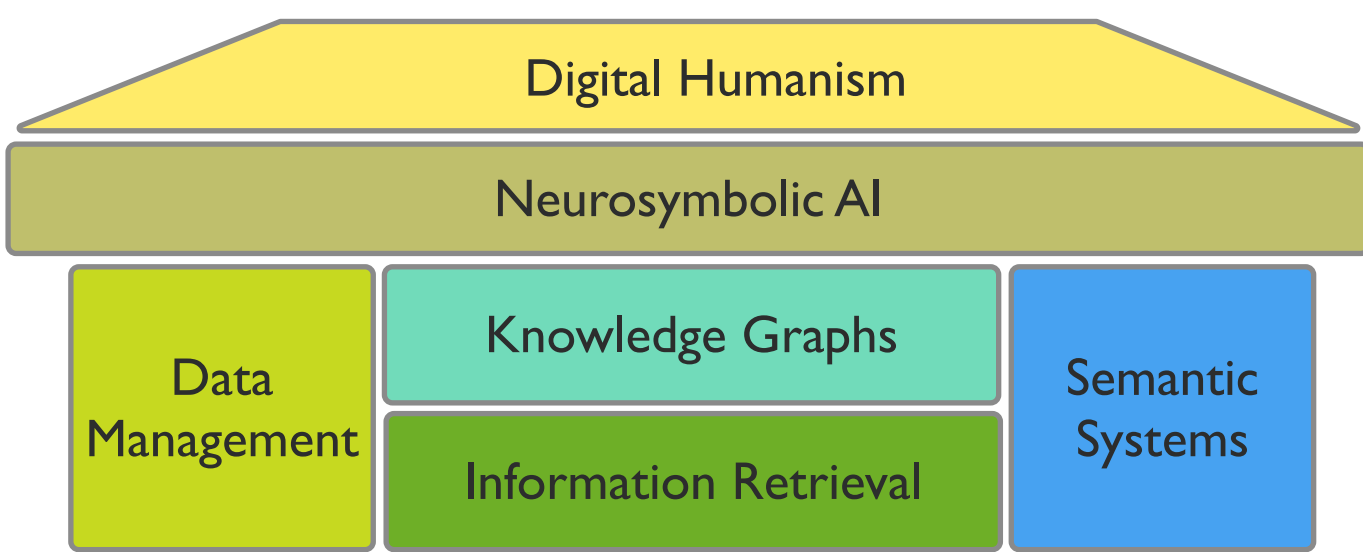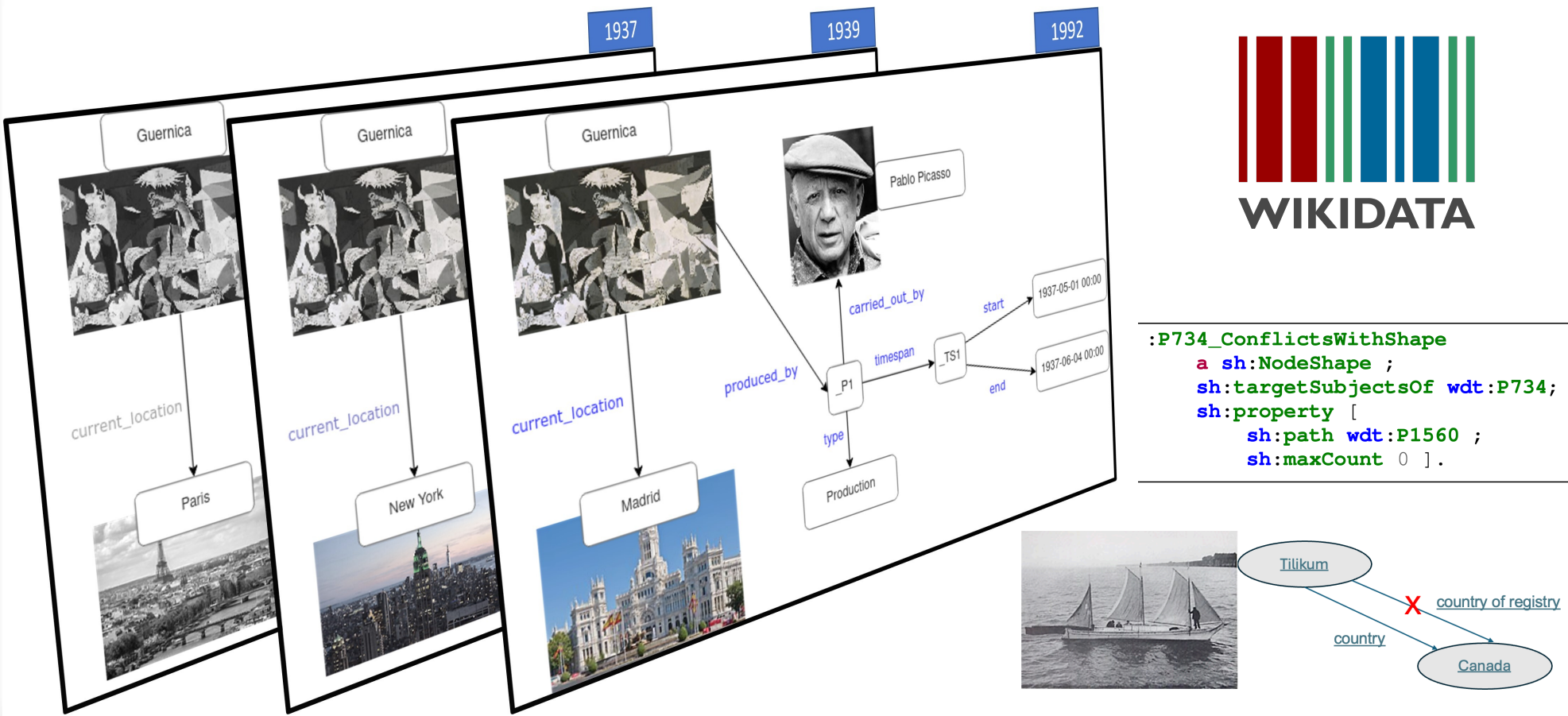**WU** WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

Vision

The Institute for **Data, Process and Knowledge Management** is dedicated to pioneering research at the intersections of *data management and integration*, *the semantic web*, and *artificial intelligence* to tackle intricate challenges within the business and knowledge management domains.

Digital Humanism
Neurosymbolic AI
Data Management | Knowledge Graphs | Semantic Systems
Information Retrieval

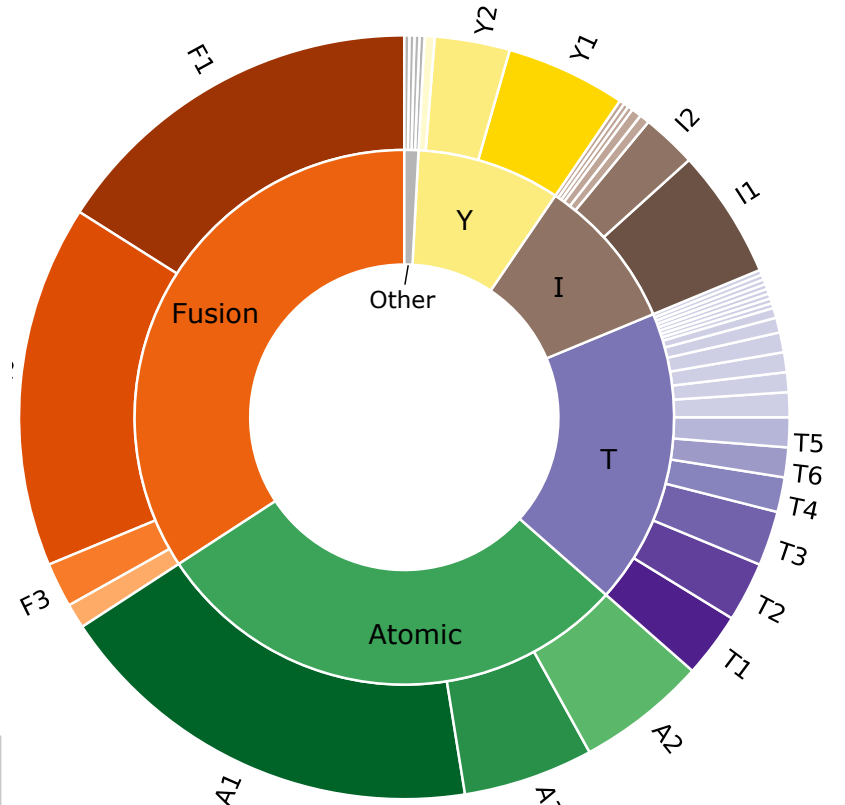**Axel Polleres** — Data Management Group
Svitlana Vakulenko — Information Retrieval Group
Marta Sabou — Semantic Systems Group

Research Highlight: KG Evolution & Repairs

We investigate how to **automate Knowledge Graph (KG) repairs**, by
- researching the evolution of collaboratively curated KGs like Wikidata [DOI: 10.4230/TGDK.1.1.11]
- formalizing evolving constraints in such Knowledge graphs in standard languages such as SHACL and SPARQL [DOI: 10.3233/SW-243611]
- using declarative symbolic methods to recommend repairs [DOI: 10.1007/978-3-031-19433-7_22]

A **final goal** of this work is extensions towards *semi-automatic neurosymbolic repairs*, including aspects of editors' behaviours.
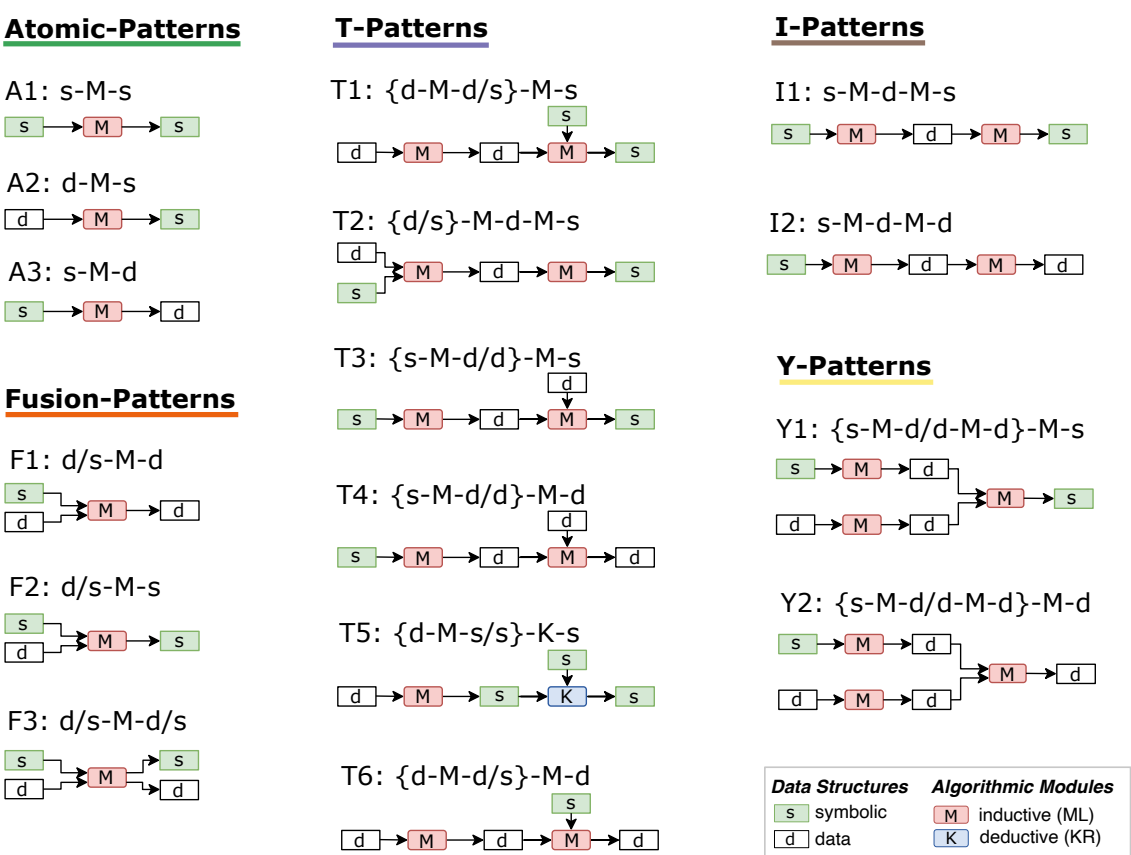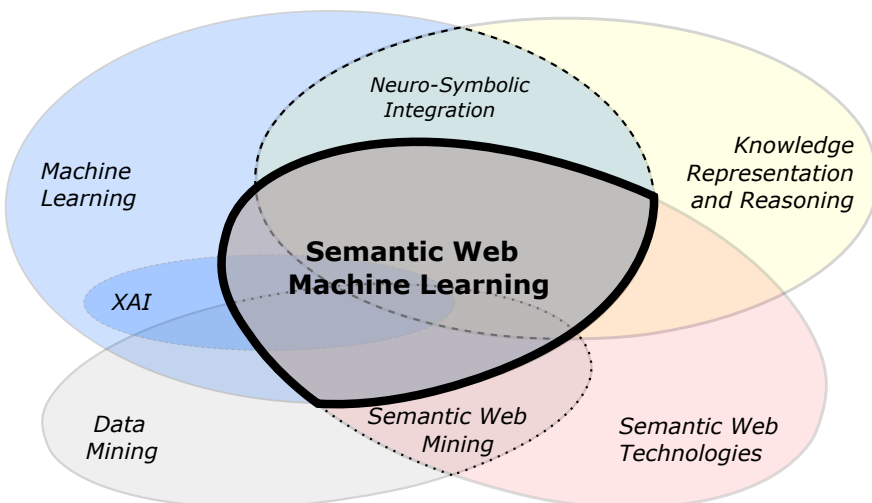


```
:P734_ConflictsWithShape
    a sh:NodeShape ;
    sh:targetSubjectsOf wdt:P734;
    sh:property [
        sh:path wdt:P1560 ;
        sh:maxCount 0 ].
```
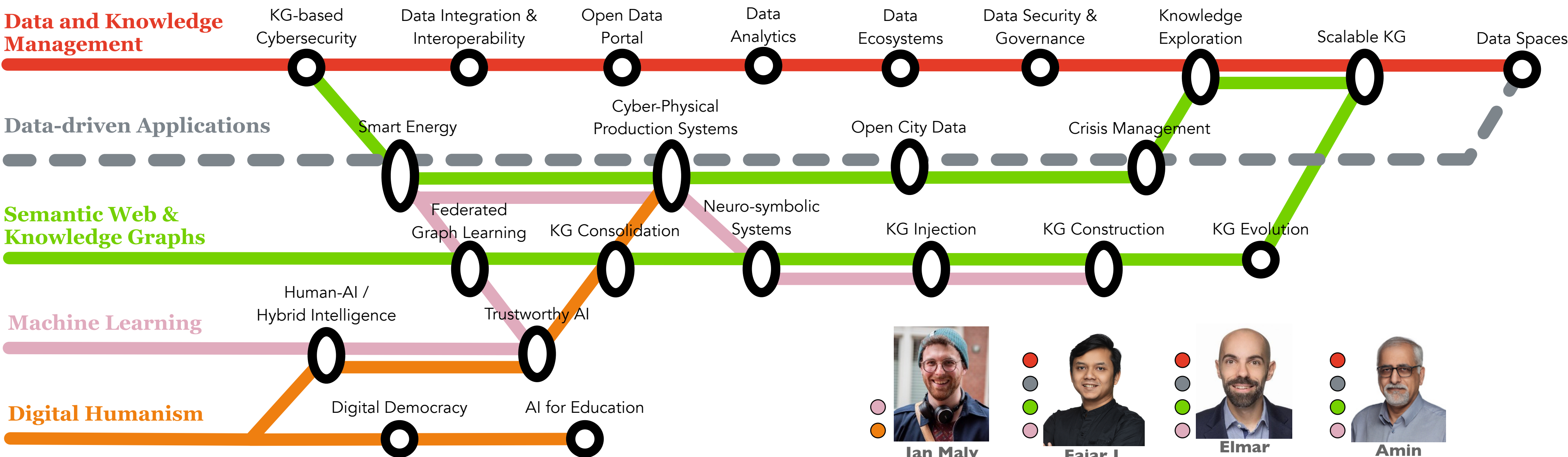
WIKIDATA

Research Highlight: SWeMLS

We developed a classification system and identified a set of patterns for **Semantic Web Machine Learning Systems (SWeMLS),** systems which make use of a Semantic Web knowledge structure and Machine Learning sub-systems. Our findings are based on a Systematic Mapping Study of almost 500 papers.
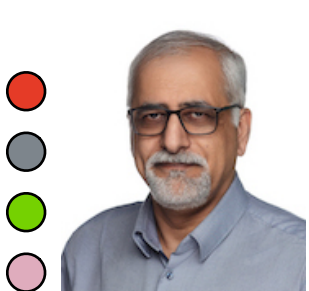

Atomic-Patterns
A1: s-M-s
A2: d-M-s
A3: s-M-d

Fusion-Patterns
F1: d/s-M-d
F2: d/s-M-s
F3: d/s-M-d/s

T-Patterns
T1: {d-M-d/s}-M-s
T2: {d/s}-M-d-M-s
T3: {s-M-d/d}-M-s
T4: {s-M-d/d}-M-d
T5: {d-M-s/s}-K-s
T6: {d-M-d/s}-M-d

I-Patterns
I1: s-M-d-M-s
I2: s-M-d-M-d

Y-Patterns
Y1: {s-M-d/d-M-d}-M-s
Y2: {s-M-d/d-M-d}-M-d

Data Structures		Algorithmic Modules	
s	symbolic	M	inductive (ML)
d	data	K	deductive (KR)

https://w3id.org/semsys/sites/swemls-kg

Research Map

Data and Knowledge Management: KG-based Cybersecurity · Data Integration & Interoperability · Open Data Portal · Data Analytics · Data Ecosystems · Data Security & Governance · Knowledge Exploration · Scalable KG · Data Spaces

Data-driven Applications: Smart Energy · Cyber-Physical Production Systems · Open City Data · Crisis Management

Semantic Web & Knowledge Graphs: Federated Graph Learning · KG Consolidation · Neuro-symbolic Systems · KG Injection · KG Construction · KG Evolution

Machine Learning: Human-AI / Hybrid Intelligence · Trustworthy AI

Digital Humanism: Digital Democracy · AI for Education

Jan Maly · **Fajar J. Ekaputra** · **Elmar Kiesling** · **Amin Anjomshoaa**

Selected Projects

FWF Cluster of Excellence on Bilateral Artificial Intelligence (BILAI) has recently been awarded as one of Austria's highest-funded research projects to date. BILAI will conduct fundamental research integrating symbolic and sub-symbolic methods as fundamental steps towards Broad AI. DPKM is part of the WU team in the project and will focus on automatically creating and improving knowledge graphs to make machine learning more explainable and robust.
https://bilateral-ai.net

Horizon Europe PERKS project supports the holistic governance of industrial Procedural Knowledge (PK) in its entire life cycle, from elicitation to management and from access to exploitation. PERKS bases its solutions on leading-edge AI, data technologies and people, by advancing and integrating existing methodologies and tools in terms of readiness, flexibility and user acceptance.
https://semantic-systems.org/perks

Fair Online Group Decision-making (FairOGD). In this project, funded by the FWF and netted Science , we want to leverage the recent advances in our understanding of fairness and proportionality in approval-based multi-winner voting and Participatory Budgeting to provide a novel tool-box for fair group decision making in online applications.
https://short.wu.ac.at/4sws

FAIR-AI addresses the research gap created by dealing with society-related risks in the application of AI. In particular, it focuses on the requirements of the upcoming European AI Act and the obstacles to its implementation - focusing on risk detection, monitoring, mitigation and anticipation at all levels of system development. The project develops methodologies to disentangle risks and provide active support and guidance.
https://fair-ai.at/

WWTF Vienna Research Group (VRG24-013) focuses on Knowledge Representation Learning for Large Language Models (LLMs), which blends the core expertise of the institute with the recent advancements in machine learning and artificial intelligence. Since LLMs are parametric models unlike databases they were not designed to reliably store data. Designing an internal knowledge representation for an LLM is the major goal of the project.
https://short.wu.ac.at/zwux