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Ontologies in Motion: A BFO-Based Approach to Knowledge Graph Construction for Motor Performance Research Data in Sports Science

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Leibniz ScienceCampus Digital Transformation of Research

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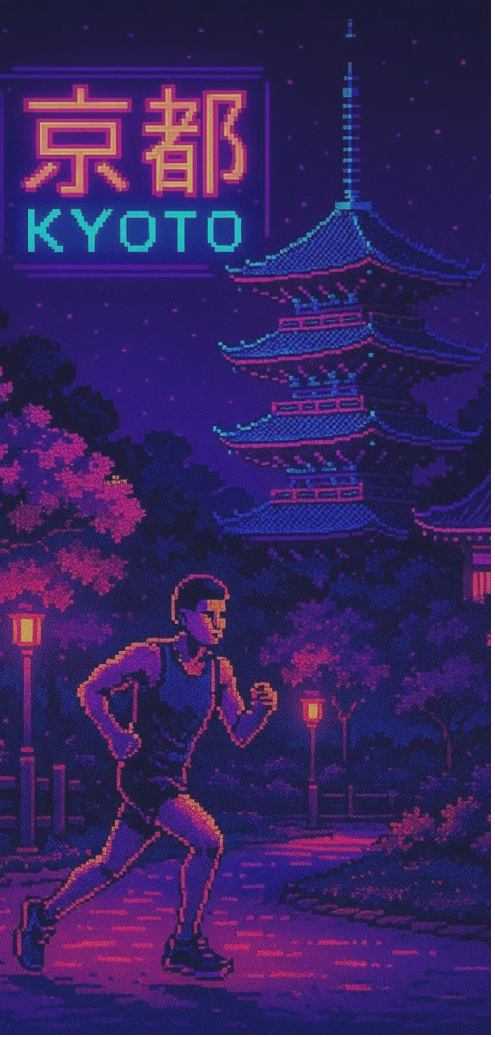


The DiTraRe project

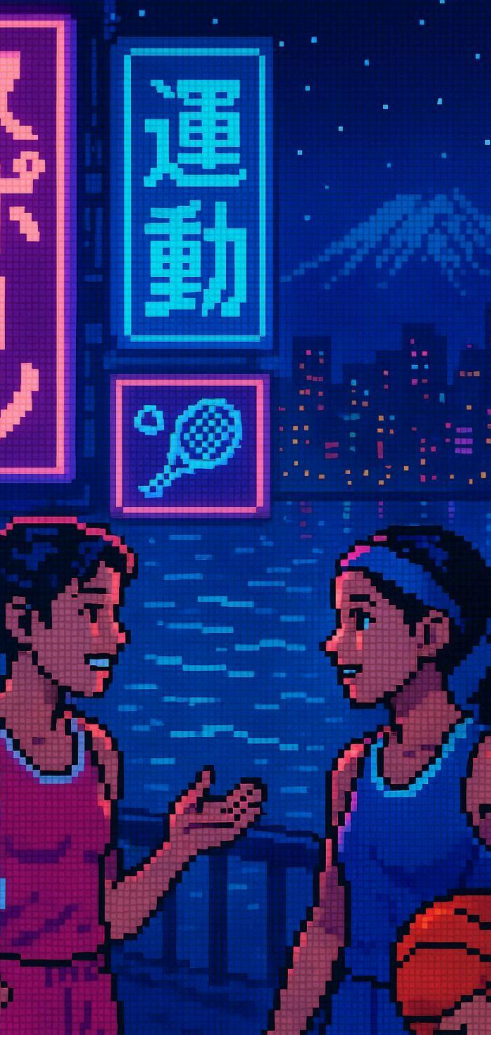
- DiTraRe = **Leibniz Science Campus Digital Transformation of Research**.
- **Focus** areas of this **DiTraRe use case**:
  - Ontology-based modelling of research processes.
  - FAIR data publication and reuse.
  - Provenance, privacy, and knowledge graph generation.
- The MO|RE ontology and knowledge graph demonstrate these principles.

Use case: Motor research data

- **MO|RE (Motor Research) Data Repository** at KIT IfSS.
- Discipline-specific repository for **human motor performance data**.
- Stores test items, participant metadata, and measurement results.
- Offers editorial review, DOI assignment, and long-term archiving.
- Provides a **testbed for DiTraRe's aims**.

Motivation

- Sports-science research is increasingly **data-intensive**.
- Motor performance tests are central for assessing **human movement** capabilities.
- Data are stored in **diverse formats**, **structures**, and **spreadsheets** → data silos.
- Difficult to ***compare*** results or reuse datasets across studies.



Research gap(s)

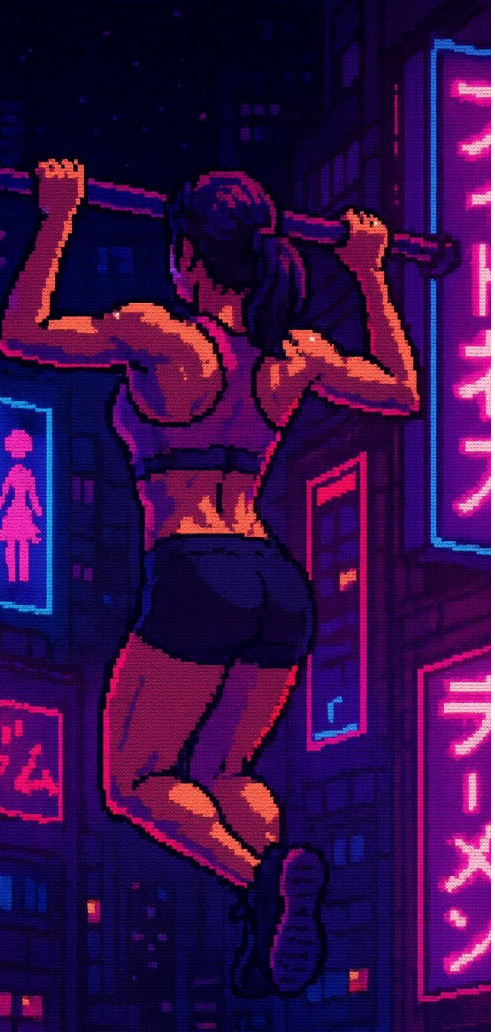
- Existing ontologies for sports or health data often lack:
  - a connection between **plan specifications, executions, and results**.
  - **temporal** and **contextual** reasoning.
  - semantic representation of **privacy/anonymization**.
- Consequence: limited machine understanding, interoperability.
- The solution? **A Basic Formal Ontology (BFO)-grounded ontology capturing both static and dynamic aspects of the data**.

Proposed solution

- Develop a **BFO-based ontology for motor performance data**.
- This ontology represents:
  - Plan specifications (studies, test items).
  - Processes (executions of tests).
  - Results (measurement data, outcomes).
  - Dispositions of participants.
- The ontology is the semantic backbone of a **knowledge graph** (in development).

Key aspects of the MO|RE ontology

- **Upper level: BFO**
  - Continuants vs. occurrents.
  - Qualities → formal representations of measurable features of participants, such as their height, weight, or results in fitness evaluations.
- Reuse:
  - OBI (Ontology for Biomedical Investigations).
  - IAO (Information Artifact Ontology).
- Privacy aspects currently in development: sensitive attributes & role-based access modelled in the ontology.



Key aspects of the MO|RE ontology

- Diverse key concepts, e.g.,
  - Study → plan specification
  - Test Item → plan for motor test
  - Test Process → realization of plan, …
  - Participant → bearer of qualities/dispositions
  - Measurement Datum → output of test process.

The Handgrip motor test

- A handgrip test is a **standard motor performance test** used in sports science to measure **maximal voluntary grip strength**.
- Formal representation should enable answering competency questions about a hand grip, such as:
  - “Which plan specification does this execution follow?”,
  - “How much stronger are children in the age groups 6-10 when comparing locations?”.

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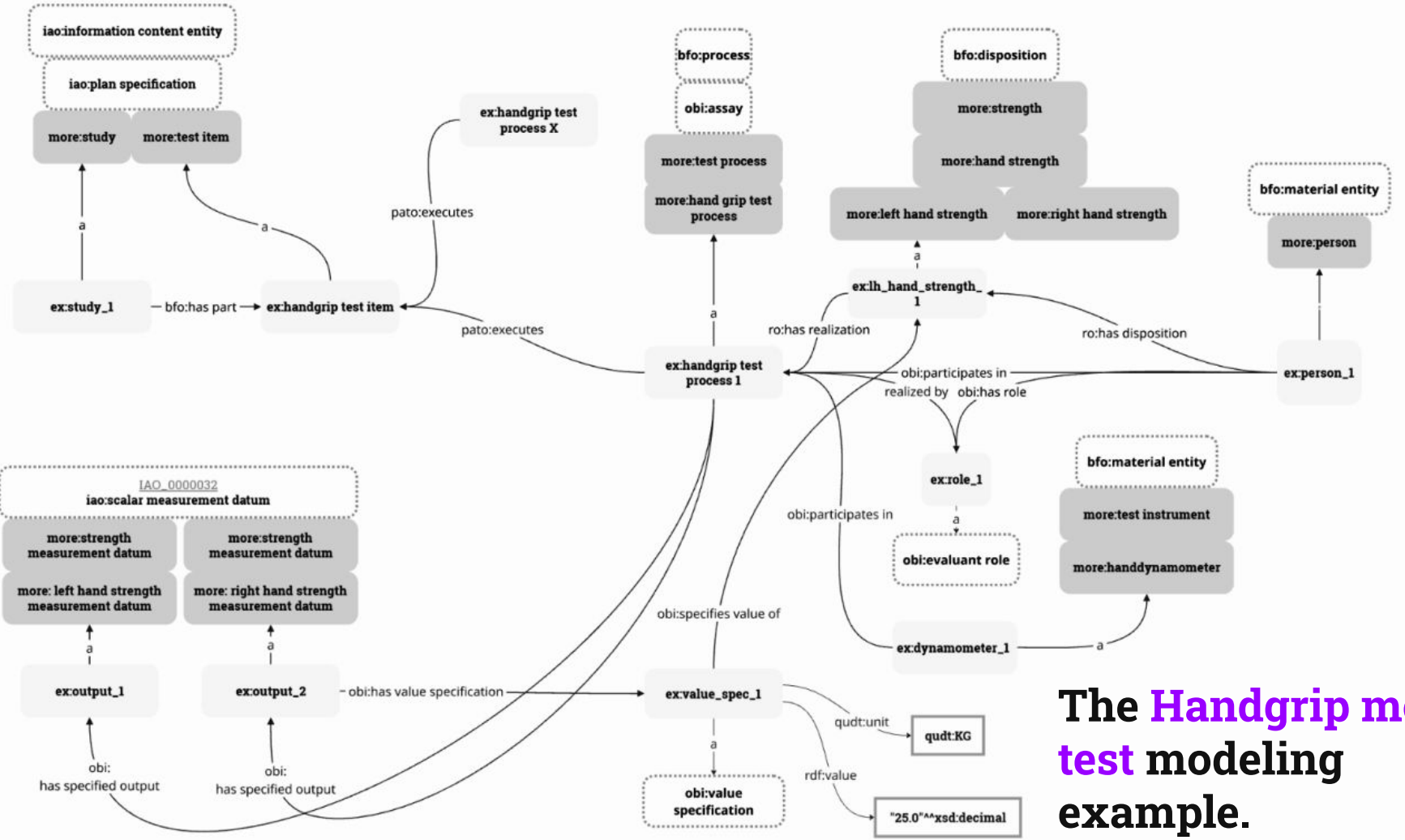

The Handgrip motor test modeling example.

Impact & future work

- **For sports science:**
  - Improved data interoperability, reproducibility, reuse.
  - Enables cross-study meta-analysis and longitudinal comparisons.
- **For semantic web research:** Demonstrates process-centric, BFO-based modelling in an applied domain.
- **Future work:**
  - Cross-domain linking (health, education).
  - Enhanced privacy and access control modules.

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THANK YOU!

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