Coherent Knowledge Solutions From Prehistory to Future

Towards Coherent Multi-disciplinary Knowledge Reference Implementation Blueprints for Industrial Learning: Insight from Consistent Coherent Conceptual Integration of Prehistory, Archaeology, Natural Sciences, and Humanities

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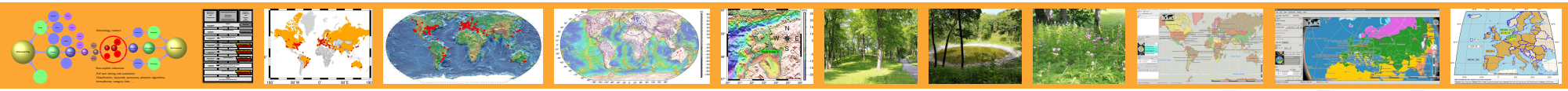

Epitome / Abstract

Epitome / abstract (motivation, assets, approach)

- **Central goals: Consistent coherent conceptual integration of knowledge.**
- **Addresses: Scientific methodologies. Valorisation and intelligent re-valorisation of any scientific insight. Learning-Improvement-Cycles. Cognostic addressing of structures / nucleal cognstructures [1]. Productive, fertile environments.**
- **Motivation:**
  Omnipresent lack of a general approach for cognitive addressing of knowledge structures.
- **Industrial learning is a key asset of industrial achievements.**
  Industrial achievements are key assets of industrial learning.
- **Industry as the great protagonist of innovation should take into account that knowledge in its true dimension must be treated as inter-linked knowledge.**
- **Prehistory and its contexts/contextualisation provide a plethora of instructive multi-disciplinary scientific scenarios of high complexity.**
  Thus, it is an implementation blueprint for industrial learning.
- **The results of this long-term research provide solutions based on practical information science.**

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Information Science: Complements of Knowledge

Complements of Knowledge and Corresponding Sample Implementations:

- **Factual Knowledge** $\Leftrightarrow$ Numerical data, data ...
- **Conceptual Knowledge** $\Leftrightarrow$ Classification ...
- **Procedural Knowledge** $\Leftrightarrow$ Computing ...
- **Metacognitive Knowledge** $\Leftrightarrow$ Experience ...
- **Structural Knowledge** $\Leftrightarrow$ Standard hybrid formats ...
- ...

(Sources/references:
SACINAS Delegates' Summit, Best Practice and Definitions, 2015–2021, [2], [3], [4], [5], [6], [1];
Rückemann, Keynote on Structured Data Comprehension, MIM 2021 [7]; Knowledge Mapping, 2018 [8];
Aristotle, 350 B.C.E. / Platon's Phaidon, [9] [10] [11]; Anderson & Krathwohl, 2001 [12])

Further, Requirements Excerpts

Further, requirements (unsorted, excerpt):

- Implementation blueprint, prototypish implementation and realisation. ('invention of (*using*) the wheel').
- Multi-disciplinary multi-lingual Knowledge Resources (KR), distributed/centralised.
- Universal faceted conceptual knowledge.
- Features for long-term consistency.
- Support of prehistory, archaeology, natural sciences, humanities. Reference implementations, prehistory, soil science, computation, environmental sciences.
- Symbolic representation.
- Visualisation.
- Parallelisation, industry standards.
- Hybrid data formats, standards.
- Procedural components.
- Standard regular expressions.
- Standard tools.
- Effective and efficient implementations.
- Support for separation, modularisation, and change management processes.
- All components in continuous dynamic development.
- ...

IMPL. SAMPLE: Contexts and Chronology [14]

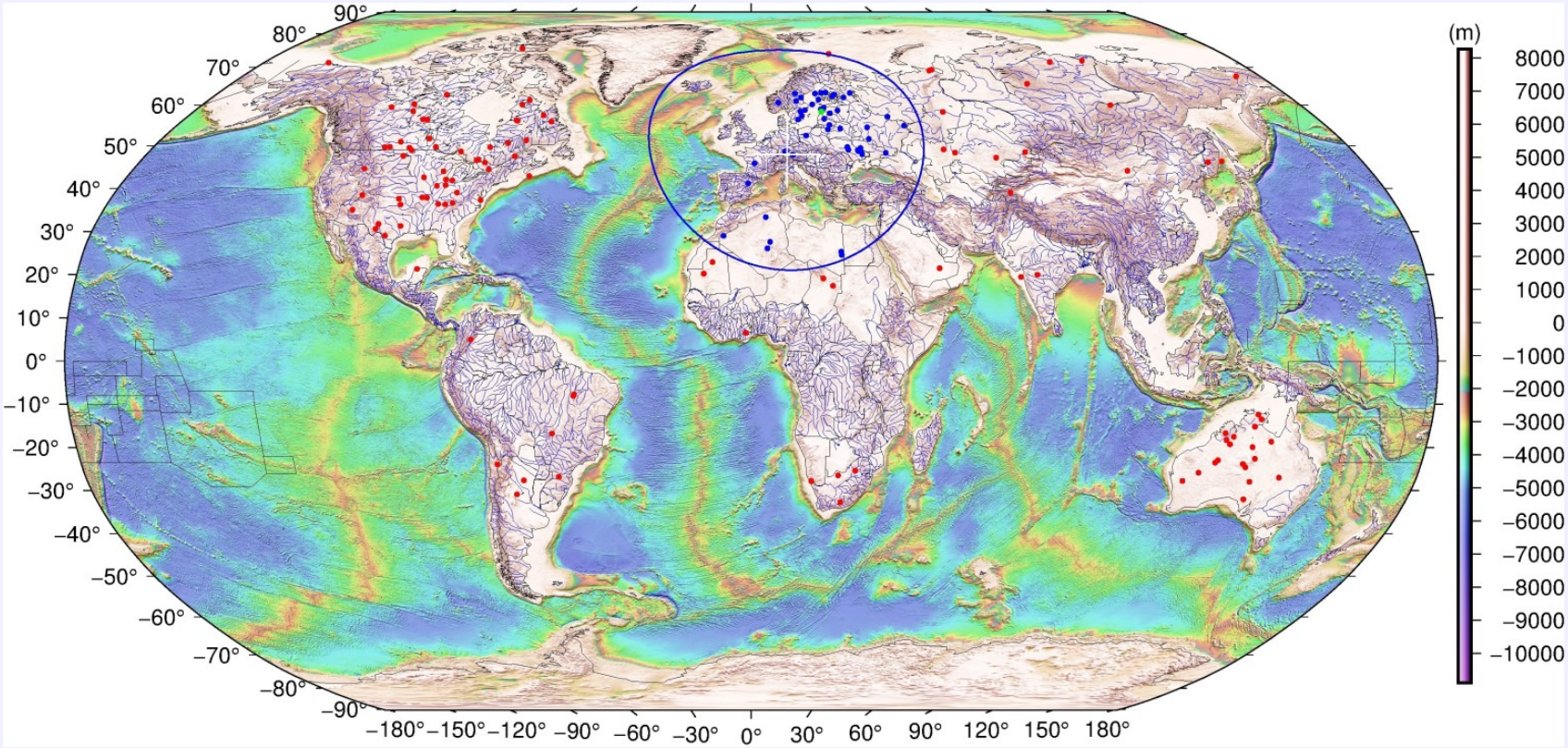
Prehistoric archaeology, contexts, and chronology

The conceptual view group is prehistory, prehistoric remains, artefacts, and antiquities. A prehistoric valorisation sample is the renowned **swimming reindeer** [13], details and conceptual knowledge of seasons and other time divisions are discussed in [14]. Other examples are common relative chronological intervals, dendrochronological aspects, etc.

The resources have been in continuous development, which follows information science research, and can be consistently and seamlessly deployed with integrated conceptual reference frameworks and components. In addition, the conceptual views groups are a unique, flexible, and extendable approach of addressing multi-lingual verbal descriptions with a systematic approach and standardised implementation framework for coherent multi-disciplinary and multi-dimensional scenarios, beyond plain representation.

IMPL. SAMPLE: Contexts and Chorology [18, 19, 20]

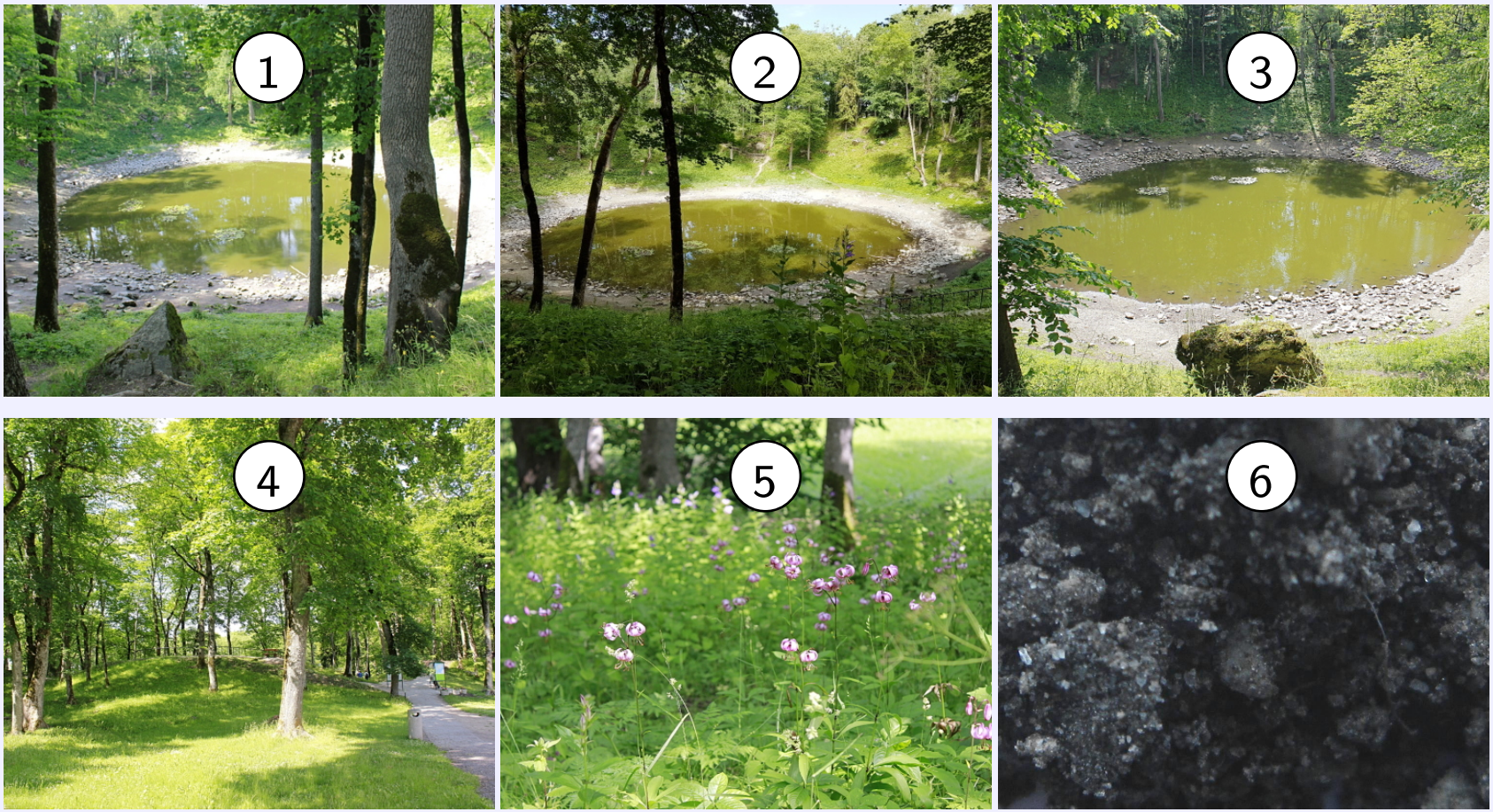
Knowledge mining methodology applied, final result: Kaali crater field, Estonia



Criteria for decision making: Resulting target structures (meteorite impacts, all coloured bullets) on land (topography, longitude, latitude, elevation, and coverage, all coloured bullets), especially confirmed Earth crater groups (meteorite impact features, bullets, red, blue, and green colours), age and size of (on-land) structures, reasonable catchment area for Europe (blue), Catchment center choosen: Circular area with a respective radius of 3000 km, automatically fitted with the map projection. Blue circle marks an area to cover continent Europe in this context. Blue and green bullets mark the craters inside that area. Data, items, and marks are automatically computed and visualised. Final resulting object (bullet, green colour), which fits all criteria: Kaali crater field (green), Saaremaa, Estonia. Region of positive final result computed and visualised via GMT [15, 16, 17], too. Base: LX factual and conceptual knowledge, factual data.

IMPL. SAMPLE: Contexts and Chorology [18, 19, 20]

Integrated media photo objects associated with the knowledge object "Kaali crater"



Media references (Photos: BGS) [18, 19, 20] for "Kaali crater", Saaremaa, Estonia (LX resources) delivered in association from the final result: Integrated knowledge resources can contain references to any data, e.g., media objects. Media objects contain own references, e.g., classification, citations, documentation, and keywords and contribute in many ways to new insight – besides the intrinsic media content.

IMPL. SAMPLE: Contexts and Chorology [18, 19, 20]

Integrated media photo objects . . .

The references of these media photo objects are part of objects in the knowledge resources. In detail, the resulting photo objects of the examined site (from left to right, from top to bottom) show in this sort order:

1: Major crater, view in northern direction.
2: Major crater, view in north-eastern direction.
3: Major crater, view in western direction.
4: Path towards major crater, view from southern direction.
5: Vegetation, **Lilium martagon**, at top of crater rim.
6: Specimen crater pond material (quartz, melane particles, lacustrine deposits, biogenic material).

The references included in the knowledge mining workflow provide the complementary information that fine particles from the Kaali crater include **impactor remains** (esp. significant **Ni-Wüstite, Ni-Maghemite, Ni-Goethite, Hematite, Magnetite, Taenite, Kamacite**), spherules and splash-forms.
Lilium martagon: Ruderal plants, **indicator plants** [18, 19, 20].
Prehistoric mining, ritual . . . modern prospection, mining . . .

Media results [18, 19, 20] (1–5) and specimen (6) photos from the Natural Sciences Specimen Archive are dated June 29, 2016. The photos and physical samples have been taken in 2016 by the Knowledge in Motion (KiM) natural sciences and archaeology sections at the Kaali meteorite crater field on the island of Saaremaa, Estonia, during the Geo Exploration and Information (GEXI) Baltic research and studies campaign.

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

Prehistory and multi-disciplinary contextualisation and motivation

- **Contexts in prehistory are peculiar in a way that there are no direct historical sources and respectively no literary reference and documentation. Contextualisation is therefore a main intrinsic task in prehistory and protohistory. 'Witness contexts' and 'memory features' are key assets.**
- Prehistoric context, *even for chorologically, chronologically, and thematically restricted object groups* [21] [22] [23] comprises of a **wide and highly multi-faceted spectrum of knowledge**, **applied approaches**, and **formalisation**, including **abstraction** [24] and **documentation** [25]. Further, the application practices of not well satisfying approaches and methodological deficits, especially in multi-disciplinary context, are often **fragmented, heterogeneous, and lacking required coherence and precision** [26] or require **unnecessary estimations and approximations** [27].
- Approaches have to conform with **information science fundaments and universal knowledge** and **enable an integration of required components from methodologies to realisations** for knowledge representations of realia and abstract contexts (fundamental methodological algorithm base of the **Conceptual Knowledge Pattern Matching (CKPM) methodology**) [28] while many **facets of knowledge**, epistemological contexts, including prehistory, need to be **continuously acquired and reviewed** [29] [30] [31].

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

1) REFERENCE IMPLEMENTATION: Conceptual knowledge frameworks

- Examples of reference implementations developed and used in practice with ongoing long-term research and applied for **KR** [32]:
- **Prehistory-protohistory and archaeology Conceptual Knowledge Reference Implementation (CKRI)**, including multi-disciplinary contexts of **natural sciences and humanities** [14] [34].
- **Mathematical and computational conceptual knowledge framework** [35].
- **Environmental information systems conceptual knowledge framework** [36].

2) REFERENCE IMPLEMENTATION: Conceptual knowledge base

- Conceptual knowledge base is The **Universal Decimal Classification (UDC)** [37], a general plan for knowledge classification, providing an analytico-synthetic and **faceted** classification, designed for subject description and indexing of content of information resources **irrespective of the carrier, form, format, and language**. UDC-based references for demonstration are taken from the multi-lingual UDC summary [37] released by the UDC Consortium, Creative Commons license [38].

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

3) REFERENCE IMPLEMENTATION: Integration of scientific reference frameworks

- Relevant scientific practices, frameworks, and standards from disciplines and contexts. **Natural sciences**, **geosciences**, and **soil science** are continuously delivering updated state of the art research and insight, including geodiversity and standardisation [39] [40]. Associated information, e.g., on **soil drainage, wetness, pH status, base saturation, chloride, subsoil organic material, and stiffness** can be found as reference in the **World Reference Base (WRB) for soil resources** [41, 42] from the **Food and Agriculture Organisation (FAO)**, United Nations.

4) REFERENCE IMPLEMENTATION: Formalisation

- All integration components, for all disciplines, require an **explicit and continuous formalisation** [6] **process** in order to conform with the information science principles according to the practices in the disciplines [43]. This includes **knowledge objects and entities** as well as **procedural components** (e.g., **C** [44], **Fortran** [45], **Perl** [46], **Shell wrapper**, **Julia** [47] [48] [49]), computation model support, e.g., **parallelisation standards, OpenMP** [50] [51], Reg Exp patterns, e.g., **Perl Compatible Regular Expressions (PCRE)** [52], further standard tools, e.g., **Structured Query Language (SQL)**, **Tool Command Language (TCL)** [53], Extract Transform Load (ETL), Extract Load Transform (ELT), and hybrid solutions. Addressing aspects of **discipline related parole** [54].

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

5) REFERENCE IMPLEMENTATION: Methodologies and workflows integration

- **Methodologies for creating and utilising methods include model processing, remote sensing, spatial mapping, high information densities, and visualisation.** Respective contextualisation of (prehistoric) scenarios should each be done under specific (prehistoric) conditions, especially supported by **standard algorithms** [55], **multi-dimensional criteria, spatial operations**, **interpolation geodesic computation** [56], **triangulation** [57], **gradient computation** [58], and **projection** [59]. Workflow integration includes problem solving, e.g., **mathematical algorithms, mathematical processes, filter processes**, **phonetic and linguistic context support** [60]. **Visualisation**, **Generic Mapping Tools (GMT)** [15].

6) REFERENCE IMPLEMENTATION: Prehistory Knowledge Resources

- Common sources of information in many disciplines are often not yet aware of universal knowledge concepts and multi-lingual approaches. Common sources are in many cases not sufficiently coherent, consistent, and structured and more often they show to be fragmented and heterogeneous. In order to overcome basic shortcomings of public 'data collections' the objects, entities, and respective conceptual knowledge references' excerpts and examples are taken from **The Prehistory and Archaeology Knowledge Archive (PAKA)**, in continuous development for more than three decades [61] and is released by DIMF [62].

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

7) REFERENCE IMPLEMENTATION: Natural Sciences Knowledge Resources

- Several coherent systems of major natural sciences' context object groups from **KR** realisations have been implemented [32] [37] [63].

8) REFERENCE IMPLEMENTATION: Inherent representation groups

- The methodology can consider a wide range of **representation groups** for major disciplines and context object groups regarding their inherent representation and common utilisation, e.g., **points**,**polygons**, **lines**, **Digital Elevation Model (DEM) representations** sources, e.g., from **satellites**, **drones** (raster data, RAdio Detection And Ranging (RADAR), Synthetic Aperture Radar (SAR), Light Detection And Ranging (LiDAR), ...), **positioning/navigation** (common satellite systems / satellite navigation systems, e.g., Galileo, Europe; Global Positioning System (GPS), USA; GLObalnaja NAwigazionnaja Sputnikowaja Sistema (GLONASS), Russia; Quasi-Zenith Satellite System (QZSS), Japan; Indian Regional Navigation Satellite System (IRNSS) / Navigation Indian Constellation (NAVIC), India), **z-value representations**, **distance representations**, **area representations**, **raster**, **vector**, **binary**, and **non-binary data**.
- Essential base context sources should provide **worldwide homogeneous and consistent data** [40] allowing extrapolation and interpolation in various dimensions, e.g., from the School of Ocean and Earth Science and Technology (SOEST), National Aeronautics and Space Administration (NASA), Goddard National Space Science Data Center (NSSDC), National Oceanographic and Atmospheric Administration (NOAA), Central Intelligence Agency (CIA) resources, European Community (EC) resources, and national and federal organisations and initiatives for further integration and future solutions.

Coherent Conceptual Integration Prehistory, Archaeology, Natural Sciences, Humanities [32] [33]

9) REFERENCE IMPLEMENTATION: Scientific context parametrisation

- Scientific **context parametrisation of prehistoric targets** can use the overall insights, e.g., from **geoscientific disciplines** [64] [65].
- A relevant example is contextualisation with **palaeolandscapes** [66]. In case of prehistory, parametrisation depends on the prehistorical context, e.g., the geoscientific parametrisation and geoscientific contextualisation depend of the respective selected prehistorical object groups and associated properties. The highly inter-dependent complexity can make the **scientific parametrisation** an extremely **advanced long-term challenge**.

10) REFERENCE IMPLEMENTATION: Structures and symbolic representation

- The deployment of long-term universal structure and data standards is essential.
- Relevant examples of sustainable implementations are **NetCDF** [67] based standards, including advanced features, hybrid structure integration, and parallel computing support (**PnetCDF**) and generic multi-dimensional table data, universal source and text based structure and code representations.

IMPL. SAMPLE: Knowledge, Documentation, and Classification [32, 33]

Universal Decimal Classification (UDC)

- The **Universal Decimal Classification** (UDC) [37] is the world's foremost document indexing language in the form of a multi-lingual classification scheme covering all fields of knowledge and constitutes a sophisticated indexing and retrieval tool. The UDC is designed for subject description and indexing of content of information resources irrespective of the carrier, form, format, and language. UDC is an **analytico-synthetic and faceted classification**.
  UDC implementations currently support more than **50 languages**.
  Today about **150,000 institutions** are using UDC classification and implementing information systems herewith.
- UDC schedules are organised as a **coherent system of knowledge** with associative relationships and references between concepts and related fields.
- UDC-based references for demonstration are taken from the multi-lingual UDC summary [37] released by the UDC Consortium (Creative Commons lic.) [38].
- **Facets can be created with any auxiliary tables.** Means to achieve overall efficient realisations, even for complex scenarios: Core assembly elements of **Superordinate Knowledge** are **methodology, implementation, and realisation** [68] [69].

IMPL. SAMPLE: Knowledge, Documentation, and Classification [32, 33]

Universal Decimal Classification (UDC)

The Universal Decimal Classification (UDC) is a general plan for the knowledge classification. UDC is a hierarchical decimal classification system that divides the main knowledge fields into 10 main categories (numbered from 0 to 9). Each field is in turn divided into 10 subfields, each subfield is inturn divided into 10 subsubfields, and so on. A more extensive classification code in general describes a more specific subject.

Faceted and multi-disciplinary context

"Facetted" and "multi-disciplinary" is synonym to the Universal Decimal Classification (UDC), `http://www.udcc.org`. UDC uses a "(...)" notation in order to indicate aspect. These descriptions are called facets. In multi-disciplinary object context a faceted classification does provide advantages over enumerative concepts.
The classification deployed for a universal documentation must be able to describe any object with any relation, structure, and level of detail. Objects include any media, textual documents, illustrations, photos, maps, videos, sound recordings, as well as realia, physical objects such as museum objects.

IMPL. SAMPLE: Knowledge, Documentation, and Classification [32, 33]

UDC Operations

Standardised operations with UDC are, e.g.,

Operation	Symbol
Addition	"+"
Consecutive extension	"/"
Relation	":"
Subgrouping	"[]"
Non-UDC notation	"*"
Alphabetic extension	"A-Z"

besides place, time, nationality, language, form, and characteristics.

Examples

```
1 (0.02/.08)                  Special auxiliary subdivision for document form
2 =1/=8                       Natural languages
3 =1/=2                       Indo-European languages
4 =9/=93                      Artificial languages
5 59+636                      Zoology and animal breeding
6 (7):(4)                     Europe referring to America
7 311:[622+669](485)          statistics of mining and metallurgy in Sweden
8 004.382.2:[902+550.8] CPR   Supercomputers ref. to archaeology and geosciences, CPR author
```

OVERVIEW: Prehistory to Future: Universal Combinatorial . . . [32, 33]

Conceptual knowledge references (Source: Excerpts from The Prehistory and Archaeology Knowledge Archive (PAKA), DIMF, 2021, [61, 62])

Code / Sign Ref.	*Verbal Description (EN)*
UDC:0	Science and Knowledge. Organization. Computer Science. Information. Documentation. Librarianship. Institutions. Publications
UDC:1	Philosophy. Psychology
UDC:2	Religion. Theology
UDC:3	Social Sciences
UDC:5	Mathematics. Natural Sciences
UDC:6	Applied Sciences. Medicine, Technology
UDC:7	The Arts. Entertainment. Sport
UDC:8	Linguistics. Literature
UDC:9	Geography. Biography. History
UDC:001	Science and knowledge in general
UDC:113	General laws of nature. Transformation and transience of matter. **Origin of the universe. Creation. Cosmogony**
. . .	
UDC:903	**Prehistory. Prehistoric remains, artefacts, antiquities**
UDC:902	**Archaeology**
UDC:904	Cultural remains of historical times
UDC:93/94	**History**
. . .	
UDC:001.18	**Future of knowledge**

Multilingual Universal Decimal Classification Summary, 2012, UDC Consortium, 2012, Web resource, v. 1.1. The Hague: UDC Consortium (UDCC Publication No. 088), URL: http://www.udcc.org/udcsummary/php/index.php; Creative Commons Attribution Share Alike 3.0 license, 2012, URL: http://creativecommons.org/licenses/by-sa/3.0/ (first release 2009, subsequent update 2012).

IMPL. SAMPLE: System of Discipline Object Groups (excerpt) [32, 33]

System of discipline object groups and conceptual view groups (excerpt)

Plain representation excerpt of a KR based system [37] [63] of major discipline object groups implemented for prehistory and protohistory and their chorological context:

Major Object Group	*Conceptual View Group*
Ritual places, burials	UDC:903. . .
Cemetery	UDC:903. . .
Barrow	UDC:903. . .
Dolmen	UDC:903. . .
Urn	UDC:903. . .
Earthworks	UDC:903. . .
Settlements	UDC:903. . .
Fortifications	UDC:903. . .
Architectures	UDC:903. . .
Structures and arrangements	UDC:903. . .
Timber	UDC:903. . .
Stone	UDC:903. . .
Relics, organic and non-organic	UDC:903. . .
Organic	UDC:903. . .
Metal	UDC:903. . .
Artefacts, organic and non-organic	UDC:903. . .
Rock art	UDC:903. . .
Sculptured objects	UDC:903. . .
Resources (usage, mining, etc.)	UDC:903. . .
. . .	. . .

IMPL. SAMPLE: System of Context Object Groups (excerpt) [32, 33]

System of context object groups and conceptual views groups (excerpt)

Table 1 : System of context object groups and conceptual views groups [37]: Natural sciences / Nature (excerpt); Knowledge Resources (collections and containers).

Major Object Group	*Conceptual View Group*
Landmarks	UDC:55+539+63
Height	UDC:55+539+63
Depth	UDC:55+539+63
Caves	UDC:55+539+63
Natural resources	UDC:55+539+63
Rock outcrops	UDC:55+539+63
Well springs	UDC:55+539+63
Soil features	UDC:55+539+63
Volcanological features	UDC:55+539+63
Impact features	UDC:55+539+63
...	...

The conceptual view group is earth sciences and geological sciences, physical nature of matter, agriculture and related sciences, including geophysics, historical geology, and palaeogeography, soil science and research.

IMPL. SAMPLE: Coherent Conceptual Integration (excerpt) [32, 33]

Resulting realisation components: Soil diversity reference system (excerpt)

Compiled UDC:631.4. . . base **soil reference system for prehistory and archaeology**:

Table 2 : Compilation of conceptual reference system (UDC:631.4. . .), implemented and realised WRB standard soil type reference groups and soil type specifications.

Soil type Reference group	*Soil type specification Name in WRB 2006 / WRB 1998*
Acrisol	Haplic / Ferric, Gleyic, Haplic, Humic, Plinthic
Alisol	Plinthic
Albeluvisol	Haplic / Endoeutric, Gleyic, Haplic, Histic, Stagnic, Umbric
Andosol	Aluandic / Dystric, Humic, Umbric, Mollic, Vitric
Anthrosol	Anthrosol, Plaggic
Arenosol	Albic, Haplic, Protic
Calcisol	Aridic
Chernozem	Calcic, Haplic, Gleyic, Haplic, Luvic
Cambisol	Haplic / Calcaric, Haplic / Chromic, Haplic / Dystric, Haplic / Eutric, Gleyic, Haplic, Mollic, Vertic
Fluvisol	Haplic / Calcaric, Haplic / Dystric, Haplic / Eutric, Gleyic, Haplic, Histic, Mollic, Salic, Thionic
Gleysol	Haplic / Calcaric, Haplic / Dystric, Haplic / Eutric, Haplic / Haplic, Histic, Humic, Mollic, Thionic
. . .	. . .

IMPL. SAMPLE: Inherent Representation Groups (excerpt) [32, 33]

Discipline and context object groups and conceptual view groups (excerpt)

Plain representation excerpt of major discipline and context object groups regarding their inherent representation and common utilisation.

Table 3 : Discipline and context object groups and conceptual view groups [37]: Inherent representation (excerpt).

Major Object Group	*Conceptual View Group*
Points, (Points of Interest, PoI)	UDC:52+004
Polygons	UDC:52+004
Lines	UDC:52+004
Digital Elevation Model (DEM) representations	UDC:52+004
z-value representations	UDC:52+004
Distance representations	UDC:52+004
Area representations	UDC:52+004
Raster	UDC:52+004
Vector	UDC:52+004
Binary	UDC:52+004
Non-binary	UDC:52+004
...	...

The conceptual view group is astronomy, astrophysics, space research, and geodesy, computer science and technology, computing, and data processing, including earth measurement, field surveying, photogrammetry, remote sensing, data processing, interpretation, mapping, data representation, data handling, and computer languages.

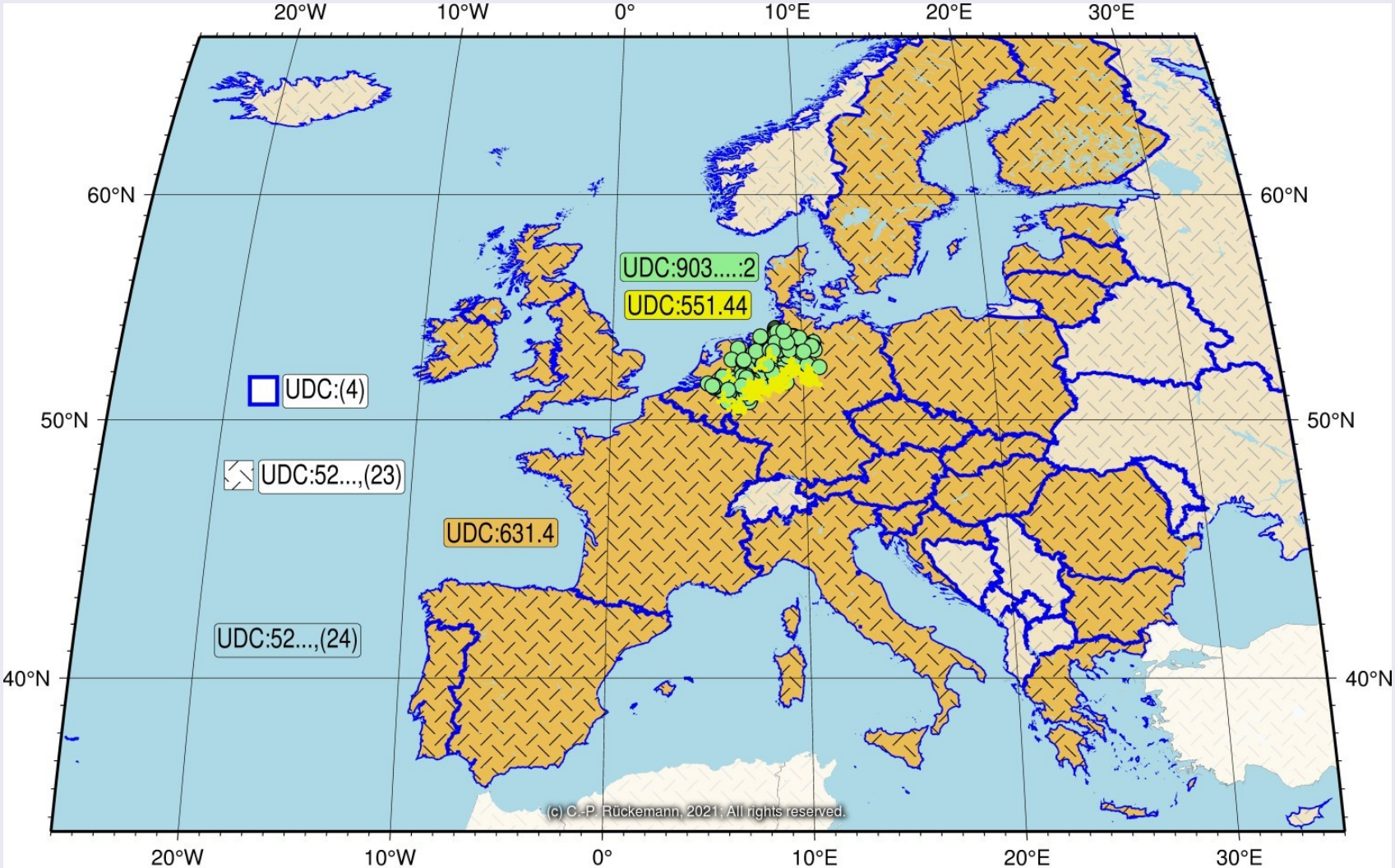
IMPL. SAMPLE: Integration . . . Facets [32, 33]

Example: Integration, multi-disciplinary, . . ., facets

Table 4 : Reference facets of a multi-disciplinary target contextualisation, based on CKRI, implemented and realised using UDC code references (excerpt).

Code / Sign Ref.	*Verbal Description (EN)*
	Geography. Biography. History
UDC:903. . . .	Prehistory, prehistoric remains, artefacts, antiquities
. . .:2	referring to religion and rituals
. . .,"62. . ."	from Holocene
. . .,(4. . .DENW)	. . . in North-Rhine Westphalia, Germany
. . .,(4. . .DENI)	. . . in Lower Saxony, Germany
. . .,(4. . .NL)	. . . in The Netherlands
	Earth sciences, geological sciences
UDC:551.44	Speleology, caves, fissures, underground waters
	Applied sciences, agriculture in general
UDC:631.4	Soil research data
	Geodesy. Photogrammetry
UDC:52. . .,(23)	Remote sensing data, above sea level
UDC:52. . .,(24)	Remote sensing data, below sea level
	Contextualisation Place
UDC:(4)	Europe

IMPL. SAMPLE: Integration . . . Integration Sketch Map [32, 33]



IMPL. SAMPLE: Integration . . . Integration Sketch Map [32, 33]

Contexts and integration

- Knowledge objects and contexts are provided by **The Prehistory and Archaeology Knowledge Archive (PAKA)** [61] [62].
- The **multi-disciplinary coherent contextualisation** employs the base of:
- **New soil system reference development**/ (UDC:631.4. . .), WRB standard,
- reference contexts, especially for UDC:903. . . .:2,551.7+"628".. . .,
- **prehistorical, protohistorical time** & **artefacts related to religion and rituals**,
- **geology**, especially **stratigraphy** and
- **palaeogeography**, **quaternary, especially late glacial and Holocene**.
- The integrated natural sciences KR further provide information on **caves in the respective region**.

Contexts and symbolical representation, projection, and components

- In this illustration plain **Digital Chart of the World (DCW)** data are used [17]. The coastline database is the **Global Self-consistent Hierarchical High-resolution Geography (GSHHG)** [70] [71], which was mainly compiled from the **World Vector Shorelines (WVS)** [72], the **CIA World Data Bank II (WDBII)** [73], and the **Atlas of the Cryosphere (AC)**.
- An **equal area projection (Eckert IV)** is advised due to the type of discipline knowledge representation. The compilation uses the **World Geodetic System (WGS)**. The symbolic representation of the contextualisation is done via **LX Professional Scientific Content-Context-Suite (LX PSCC Suite)** deploying the **Generic Mapping Tools (GMT)** [15] for visualisation.

IMPL. SAMPLE: Integration . . . [32, 33]

Methodological fundaments and components

At these conditions and In summary, for the example scenarios, basic fundaments are:

- **Universal, coherent, and consistent conceptual knowledge system.**
- **Integration of scientific reference frameworks from disciplines and contexts.**
- **Formalisation for complements, coherence, consistency.**
- **Methodologies, general problem solution, workflow integration. Implementation and deployment of methods and algorithms.**
- **Prehistory and protohistory knowledge resources and complements.**
- **Natural sciences knowledge context resources and complements.**
- **Inherent representation groups of context resources.**
- **Scientific context parametrisation.**
- **Universal structures and data standards.**
- **Facilities for analysis.**
- **Spatial mapping.**
- **Symbolic representation of context information.**
- **Facilities for automation.**
- **Long-term development and sustainability.**

Conclusion

Conclusion

- The presented methodology and general approach of consistent coherent conceptual knowledge and cognostic addressing of structures showed to enable a consistent coherent conceptual integration of knowledge.
  This enables a consistent coherent conceptual knowledge contextualisation.
- Allows valorisation and intelligent re-valorisation based on scientific insight.
- Inter-linked knowledge is relevant for advanced, dynamical information science processes, including contextualisation.
- Versatile base of knowledge-based Decision Making (DM).
- Nucleal cognstructures [1] workflows can be used for creating productive, fertile environments and foster the improvement of industrial learning and development cycles, solution integrates with industrial learning processes, e.g., Machine 'Learning' (ML) and Deep 'Learning' (DL), enables knowledge complements, beyond taxonomies.
- Enables creation/integration of components based on Artificial Instruments (AI).
- Learned: Quality improvement cycles (e.g., interdependent science-sourced / crowd-sourced).
- Component integration benefits from coherent conceptual knowledge, e.g., parallelisation of creating chorology/chronology based slices.
- Ongoing and future research will include new detailed prehistoric and multi-disciplinary knowledge contextualisation scenarios.

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Networking

Thank you for your attention!
Questions?