International Tutorial DigitalWorld

Information Science, its Assets, Applications, and Instruments

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Contents

The Tutorial

Topic, focus, and goal:

- **Topic and focus:** Information science comprises the fields of collection, documentation, classification, analysis, manipulation, storage, retrieval, movement, dissemination, and protection of information. The key to information science is a solid understanding of knowledge and its context for day-to-day application.
- **Goal:** The goal of this tutorial is an advanced understanding of information science, knowledge, and its contexts in scientific and technical disciplines, humanities, and management. The tutorial discusses selected topics, scholarly and practical aspects, from the complements of knowledge, information management, and the most important fundaments of education to application scenarios, decision making, long-term aspects, and High End Computing.
- It is intended to have a concluding dialogue with the participants on practical scenarios and experiences.
- This tutorial is addressed to all interested users and creators of knowledge and data, in various disciplines, geosciences, environmental sciences, archaeology, social and life sciences, as well as to users of advanced applications and providers of resources and services, e.g, library sciences and High End Computing. There are no special informatics prerequisites or High End Computing experiences necessary to take part in this tutorial.

Way (NOT) to go: Information is Data, Data is Created by Instruments . . .

What others do: "Technology can create excellent results with any input and staff."

Let us take a look on what a virtual, "effective" institution will do.

NUTS' initiative:

- **Hire management, administration, and data services, and excellence is at your hands.**

"N"ewtoneless
"U"niversity
"T"echnology
"S"ervice

NUTS' strategy:

- **Today, research and planning phases are not relevant anymore.**
- **Any result can be created from Big Data.**
- **All relevant algorithms can automatically be generated.**
- **The key asset of any science is its market strategy.**

NUTS' results and recommendations:

- **Recognise that any past insight and knowledge has shown useless.**
- **Only invest in the latest upcoming trends.**
- **Get rid of activities, which mean years of research and dedication.**
- **Choose the right apps and staff.**

In Contrast: Information, History, and Information Management

Classical, medieval, modern, . . .

Heron of Alexandria: (greek antique, “Steam Ball”)
⇒ “entertainment” but **not used as technology**.

Isidore of Seville: (encyclopedic, broad documentation)
⇒ end of medieval phase, **not further used**.

Polyhistor: (Martin Fogel, broad knowledge)
⇒ broad base, **not further used**.

Last decades / Internet: (knowledge?)
⇒ huge amounts of knowledge lost (besides contrary claims).

In percentage we nearly know nothing about the past.

- Ancient, historical, and even near history: Objects are mostly lost.
- Ancient, historical, and even near history: Documentation is mostly lost.
- Ancient, historical, and even near history: Technology is not fully understood.
- Context of past objects and applications is not available anymore. . . .

Information Science

Definition

Information Science:

Information science is the science of information in theory and practice.

Fundaments

The essential fundaments of information science are information and philosophy.

Information Science

Focus

Information science investigates the being of information, information related properties, and information processes.

Information science focuses on theory and methodologies and their application in practice, understanding information related problems, preserving, developing, and making use of information.

Information science primarily tackles systemic problems rather than individual pieces of technology within systems.

Information science comprises ...

Information science comprises the fields of collection, documentation, classification, analysis, manipulation, storage, retrieval, movement, dissemination, and protection of information.

Information Science

Associated fields

Information science is associated with psychology, computer science, and technology.

Interlinks

Information science is interlinked with cognitive science, archival science, linguistics, museology, management, mathematics, philosophy, commerce, law, public policy, and social sciences.

Information Science

Information and communication

Information science deals with any information and communication, e.g.:

- *knowledge in organisations,*
- *interaction between people,*
- *information systems,*
- *understanding information systems,*
- *creating, replacing, improving information systems.*

Fundament of Intrinsically Tied Complements

Information Science and the fundament of intrinsically tied complements

- Episteme:

  refers to ‘ knowledge”, “understanding”, “science”.

- Techne:

  “craft”, “art”.

- Doxa:

  from “to appear”, “to seem”, “to accept”, “to think”.

Way to go: Cultural and Technological Development (Motivation)

Knowledge base:

Knowledge transfer is essential.

Over generations of objects and subjects, this requires:

- Knowledge recognition (expertise).
- Knowledge documentation, for any aspect of nature and society (sciences, literature, technical descriptions, tools, cultural heritage, mythology, songs, media, ...).
- Long-term means.

Assets

Assets

- Knowledge (factual, conceptual, procedural, metacognitive, . . .
- Existing plethora of knowledge and insight.

Information, Sciences, and Knowledge

Fundaments

- The fundaments of terminology and of understanding knowledge are layed out by **Aristotle** being an essential part of **‘Ethics’**.

Information, Sciences, and Knowledge

Fundaments

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- Information science can very much benefit from Aristotle’s fundaments and a knowledge-centric approach **(Anderson and Krathwohl)** but for building holistic and sustainable solutions they need to go beyond the available technology-based approaches and hypothesis as analysed in **Platons’ Phaidon**.

Information, Sciences, and Knowledge

Fundaments

- The fundaments of terminology and of understanding knowledge are layed out by **Aristotle** being an essential part of **‘Ethics’**.
- Information science can very much benefit from Aristotle’s fundaments and a knowledge-centric approach **(Anderson and Krathwohl)** but for building holistic and sustainable solutions they need to go beyond the available technology-based approaches and hypothesis as analysed in **Platons’ Phaidon**.
- In consequence, an updated view on the knowledge complements including the creation of interfaces between methods and applications (e.g., based on the methodology of Knowledge Mapping) is addressed in the following excerpts.

Systematical View on Knowledge: FCPM Complements

Complements of Knowledge and Corresponding Sample Implementations:

(Source: Aristotle; Anderson & Krathwohl; SACINAS Delegates' Summit 2015–2018)

- **Factual Knowledge** $\Leftrightarrow$ **Numerical data, data . . .**

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- **Factual Knowledge** ⇔ **Numerical data, data . . .**
- **Conceptual Knowledge** ⇔ **Classification . . .**
- **Procedural Knowledge** ⇔ **Computing . . .**

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

Best Practice: Knowledge and Computing

In 80 Words Around The World.

Knowledge and Computing (Delegates and other contributors)

- **"Knowledge is created from a subjective combination of different attainments as there are intuition, experience, information, education, decision, power of persuasion and so on, which are selected, compared and balanced against each other, which are transformed, interpreted, and used in reasoning, also to infer further knowledge. Therefore, not all the knowledge can be explicitly formalised. Knowledge and content are multi- and inter-disciplinary long-term targets and values. In practice, powerful and secure information technology can support knowledge-based works and values."**
- **"Computing means methodologies, technological means, and devices applicable for universal automatic manipulation and processing of data and information. Computing is a practical tool and has well defined purposes and goals."**

Citation: *Rückemann, C.-P., Skurowski, P., Staniszewski, M., Hülsmann, F., and Gersbeck-Schierholz, B. (2015): Post-Summit Results, Delegates' Summit: Best Practice and Definitions of Knowledge and Computing; Sept. 23, 2015, The Fifth Symposium on Advanced Computation and Information in Natural and Applied Sciences (SACINAS), The 13th Internat. Conf. of Numerical Analysis and Applied Mathematics (ICNAAM), Sept. 23–29, 2015, Rhodes, Greece. URL: http://www.user.uni-hannover.de/cpr/x/publ/2015/delegatessummit2015/rueckemann_icnaam2015_summit_summary.pdf*

Delegates and contributors: *Claus-Peter Rückemann, Friedrich Hülsmann, Birgit Gersbeck-Schierholz, Knowledge in Motion / Unabhängiges Deutsches Institut für Multi-disziplinäre Forschung (DIMF), Germany;Przemysław Skurowski, Michał Staniszewski, Silesian University of Technology, Gliwice, Poland; International EULISP post-graduate participants, ISSC, European Legal Informatics Study Programme, Leibniz Universität Hannover, Germany*

Best Practice: Data-centric and Big Data

In 80 Words Around The World.

Data-centric and Big Data (Delegates and other contributors)

- **“The term data-centric refers to a focus, in which data is most relevant in context with a purpose. Data structuring, data shaping, and long-term aspects are important concerns. Data-centricity concentrates on data-based content and is beneficial for information and knowledge and for emphasizing their value. Technical implementations need to consider distributed data, non-distributed data, and data locality and enable advanced data handling and analysis. Implementations should support separating data from technical implementations as far as possible.”**
- **“The term Big Data refers to data of size and/or complexity at the upper limit of what is currently feasible to be handled with storage and computing installations. Big Data can be structured and unstructured. Data use with associated application scenarios can be categorised by volume, velocity, variability, vitality, veracity, value, etc. Driving forces in context with Big Data are advanced data analysis and insight. Disciplines have to define their ‘currency’ when advancing from Big Data to Value Data.”**

Citation: *Rückemann, C.-P., Kovacheva, Z., Schubert, L., Lishchuk, I., Gersbeck-Schierholz, B., and Hülsmann, F. (2016): Post-Summit Results, Delegates' Summit: Best Practice and Definitions of Data-centric and Big Data – Science, Society, Law, Industry, and Engineering; Sept. 19, 2016, The Sixth Symposium on Advanced Computation and Information in Natural and Applied Sciences (SACINAS), The 14th Internat. Conf. of Numerical Analysis and Applied Mathematics (ICNAAM), Sept. 19–25, 2016, Rhodes, Greece. URL:* `http://www.user.uni-hannover.de/cpr/x/publ/2016/delegatessummit2016/rueckemann_icnaam2016_summit_summary.pdf`

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Best Practice: Data Science

In 80 Words Around The World.

Data Science Definition (Delegates and other contributors)

- **"Qualified Data, especially for an enterprise, represents frozen knowledge or in other words frozen value.**
  The abilities to understand and manage these data is what we call data science.
  Data results from action, hence, data science can be defined secondary to data. The essence of Data Science is to give qualified access to relevant data to owners and users.
  Hardware and software and their implementation represent the tertiary level of qualified and high level data."

Citation: *Rückemann, C.-P., Iakushkin, O. O., Gersbeck-Schierholz, B., Hülsmann, F., Schubert, L., and Lau, O. (2017): Post-Summit Results, Delegates' Summit: Best Practice and Definitions of Data Sciences – Beyond Statistics; Sept. 25, 2017, The Seventh Symposium on Advanced Computation and Information in Natural and Applied Sciences (SACINAS), The 15th Internat. Conf. of Numerical Analysis and Applied Mathematics (ICNAAM), Sept. 25–30, 2017, Thessaloniki, Greece. URL: http://www.user.uni-hannover.de/cpr/x/publ/2017/delegatessummit2017/rueckemann_icnaam2017_summit_summary.pdf*

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Best Practice: Data Value

In 80 Words Around The World.

Data Value Definition (Delegates and other contributors)

"Data value is the primary ranked value in scenarios comprised of data and computing context. In general, processing of data, is the cause for computing. In consequence, data, including algorithms and other factual, procedural, and further knowledge, have to be ranked primary on the scale of values whereas machinery for processing data, including computing, are providing means of secondary ranked value. In addition, further values, including economic values, can be associated with consecutive deployment of data and machinery."

This is unaffected by varying views and attributions, including quality. Nevertheless, different views can scale values.

Citation: *Rückemann, Claus-Peter; Pavani, Raffaella; Schubert, Lutz; Gersbeck-Schierholz, Birgit; Hülsmann, Friedrich; Lau, Olaf; and Hofmeister, Martin (2018): Post-Summit Results, Delegates' Summit: Best Practice and Definitions of Data Value; Sept. 13, 2018, The Eighth Symposium on Advanced Computation and Information in Natural and Applied Sciences (SACINAS), The 16th Internat. Conf. of Numerical Analysis and Applied Mathematics (ICNAAM), Sept. 13–18, 2018, Rhodos, Greece.*
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Application Scenarios

Application scenarios

- Knowledge creation.
- Valorisation.
- Integration.
- ...

Understanding Knowledge

Where knowledge is ...

Knowledge is created from a subjective combination of different attainments as there are intuition, experience, information, education, decision, power of persuasion and so on, which are selected, compared and balanced against each other, which are transformed and interpreted.

And the consequences ...

Authentic knowledge therefore does not exist, it always has to be enlived again. Knowledge must not be confused with information or data which can be stored. Knowledge cannot be stored nor can it simply exist, neither in the Internet, nor in computers, databases, programs or books.

Knowledge and Application

Processes

- Knowledge base creation,
- Knowledge base transfer over generations,
- Documentation of requirements respective algorithms,
- Documentation of context respective architectures,
- Usage development within tender processes.

Knowledge: Prejudice and getting the right meaning

Wrong terms can be very persistent:

- Sunrise (earth is flat?),
- Sunset (from dusk till dawn?),
- Malaria (and prejudice is ahead of scientific results?).
- ...

Knowledge: Perception

Examples

- Depiction, traffic signs and their description different.
- Companies do try critical products in countries with reduced privacy perception.
- Overall personal security will mean insecurity for society.
- Color perception is different by society.

Description

- "*Standardisation*" and "*internationalisation*".
- Foreign word "*privacy*".
- Trend for *hidden security*.
- Words for new colors have been *added* to languages and perception.

Knowledge: Cultural Background

International and other differences

- Privacy perception,
- Different terminology,
- Legal regulations,
- Legal frameworks.

Selection on Structure, Content, Context, and Computing

Theory and practice

- Structural deficits.
- Content can be described and even signed to a certain extend.
- Context cannot be handled to a comparable extent. (Users can sign a PDF document, but what about signing it's context?)
- Long-term issues are mostly out of sight. (What will signature validity mean to archiving and reuse?)
- What does this in general mean to long-term knowledge-based processes?

Application Scenarios in Research and Education

– Application Scenarios –

Application scenarios and decision making support

The following case studies show simplified, practical application scenarios for

- separating essential knowledge *(e.g., knowledge resources, structure)*
- creating knowledge based components *(e.g., Active Source)*
- supporting increased decision potential *(e.g., UDC classification)*
- integrating high end resources *(e.g., compute and storage)*

Examples for Multi-Disciplinary Use

Multi-disciplinary status

- Medical Informatics,
- Geoinformatics,
- Legal Informatics,
- Geoforensics,
- Archaeology and Digital Archaeology,
- Medical Geology,
- Digital Forensics,
-
- ...

Archaeology

Content

- Overall information is widely distributed.
- Sometimes very difficult and a long lasting challenge not only to create information but even to get access to a few suitable information sources.
- Digital and realia objects.
- All participating disciplines, services, and resources have to be prepared for challenges as big data, critical data, accessibility, longevity, and usability.

. . . digital and long-term issues

- Even best practice cannot preserve realia and data context.
- Context is often destroyed.
- Long-term issues.
- Currently neither a standard being used for one discipline nor an international standard.
- . . .

Archaeology

Goal

- Need integrated knowledge base for archaeological and natural sciences.
- Necessary to collect data from central data centers or registers.
  Examples archaeological and geophysical data:
  - North American Database of Archaeological Geophysics (NADAG).
  - Center for Advanced Spatial Technologies (CAST).
  - Archaeology Data Service (ADS).
  - Records as with Center of Digital Antiquity.
  - Records as with the Digital Archaeological Record (tDAR).
- An integrated "Collaboration house" framework is designed to consider all aspects and to handle any kind of object.

Medicine

. . . digital and long-term issues

- Documentation.
- Natural sciences data integration?
- Catalogs (International Classification / Catalog of Diseases, ICD).
- Classification (Universal Decimal Classification, UDC).
- Data security.
- Privacy.
- Anonymity.
- . . .

Libraries

. . . digital and long-term issues

- Documentation.
- Catalogues.
- Classification (Universal Decimal Classification, UDC). Today about 150000 libraries are using UDC classification and implementing information systems herewith.
- Referencing.
- Search.
- Licensing.

Decision Making

Basics of Decision Making ("DM")

Decision making is the fundamental base for any process as well as decision making is a process and result itself.

Nevertheless it is very common

- ... to have deficits in decision making processes.
- ... to underestimate the value of knowledge creation.
- ... to have opposition due to historical and social development.

Aware of!

- No decision is an influence to the "selection", too!
- To shorten planned decision making processes means significant interaction.

About Decisions

Lemma 1:

- **It is easy to do any decision without expertise.**

Lemma 2:

- A decision (making process) should be **fast and perfectly correct**.

  In case a decision cannot be fast **and** perfect,
  it should be fast **or** perfect.

  In **no** case should a decision be slow and wrong.

Base for Decision

Essential relation:

Decision making! $\Longleftrightarrow$ **Selection making!**

Essential complement to decision:

Making a choice!

Problem Analysis

Description:

- Performance analysis (current status / resulting status),
- Problem / target identification (e.g., deviations from performance standard, causes, change of distinctive feature),
- Problem / target description,
- Distinguishing marks between what has been effected by a cause and what has not,
- Deduction of causes from relevant changes found with the problem analysis (identification),
- Cause to a problem is most likely the one that exactly explains the sum of facts.

Example Decision Making Process

Description:

- Establishing the objectives,
- Classification of objectives,
- Place classified objectives in order of importance,
- Development of alternative actions,
- Evaluation of alternatives against all the objectives,
- The tentative decision is that alternative being is able to achieve all the objectives,
- Evaluation of the tentative decision for possible consequences,
- Take decisive actions, take additional actions (prevent adverse consequences from becoming problems)
- Start problem analysis and decision making process iteratively,
- Steps for decision model in order to determine an optimal production plan and reduce conflict potential.

Decision Planning Process

Description:

For best practice, introduce a decision planning process to important decisions in order to result in the following benefits:

1. **Establish independent goals.**
   That means a conscious and directed series of choices.
2. **Aim to a standard of measurement.**
   The measurement should provide information on the distance to the goal.
3. **Convert values to action.**
   The resulting information should be used to support the planning.
4. **Commit limited resources in an orderly way.**
   Planning and commitments for any kind of resources, e.g., staff, money, time.

Example Decision Making Phases

Phases:

Orientation stage: Starting with kick-off or warm-up, exchange with all parties.

Conflict stage: Dispute, arguments, working on common denominators and positions.

Emergence stage: Vague positions and opinions being discussed.

Reinforcement stage: Decision making and justification.

Selected Decision Making Techniques

Techniques:

Rational decision making: List the pro and contra (advantages and disadvantages) of each option. Contrast the costs and benefits of alternatives.

Elimination by aspects: Choosing alternatives by "mathematical psychology". Covert elimination process, comparing the available alternatives by aspects. Choose an aspect and eliminate the alternatives without the aspect. Repeat until one alternative remains.

Simple prioritisation: Choosing an alternative showing the highest probability-weighted utility from all alternatives, resulting from the decision analysis process.

Satisficing: The examination of alternatives is stopped as soon as an acceptable alternative is found.

Instruments

Instruments, examples

- Knowledge Resources, ...
- Universal Decimal Classification (UDC), ...
- Unified Modeling Language (UML), ...
- High End Computing (HEC), ...
- Open Archives Initiative (OAI) and OAI-Protocol for Metadata Harvesting (OAI-PMH), ...
- ...

Knowledge, Documentation, and Classification

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.

Documentation and Form

Form (UDC, excerpt, English)

```
(0.02)     Documents according to physical, external form
(0.03)     Documents according to method of production
(0.034)    Machine-readable documents
(0.04)     Documents according to stage of production
(0.05)     Documents for particular kinds of user
(0.06)     Documents according to level of presentation and availability
(0.07)     Supplementary matter issued with a document
(0.08)     Separately issued supplements or parts of documents
(01)       Bibliographies
(02)       Books in general
(03)       Reference works
(04)       Non-serial separates. Separata
(041)      Pamphlets. Brochures
(042)      Addresses. Lectures. Speeches
(043)      Theses. Dissertations
(044)      Personal documents. Correspondence. Letters. Circulars
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(05)       Serial publications. Periodicals
(06)       Documents relating to societies, associations, organizations
(07)       Documents for instruction, teaching, study, training
(08)       Collected and polygraphic works. Forms. Lists. Illustrations. Business publ.
(09)       Presentation in historical form. Legal and historical sources
(091)      Presentation in chronological, historical form. Historical presentation.
(092)      Biographical presentation
(093)      Historical sources
(094)      Legal sources. Legal documents
```

Documentation and Language

Languages, natural and artificial (UDC, excerpt, English)

```
=1      Indo-European languages of Europe
=11     Germanic languages
=12     Italic languages
=13     Romance languages
=14     Greek (Hellenic)
=15     Celtic languages
=16     Slavic languages
=17     Baltic languages
=2      Indo-Iranian, Nuristani (Kafiri) and dead Indo-European languages
=21     Indic languages
=29     Dead Indo-European languages (not listed elsewhere)
=3      Dead languages of unknown affiliation. Caucasian languages
=35     Caucasian languages
=4      Afro-Asiatic, Nilo-Saharan, Congo-Kordofanian, Khoisan languages
=5      Ural-Altaic, Palaeo-Siberian, Eskimo-Aleut, Dravidian and Sino-Tibetan
=521    Japanese
=531    Korean
=541    Ainu
=6      Austro-Asiatic languages. Austronesian languages
=7      Indo-Pacific (non-Austronesian) languages. Australian languages
=8      American indigenous languages
=81     Indigenous languages of Canada, USA and Northern-Central Mexico
=82     Indigenous languages of western North American Coast, Mexico and Yucatán
=84     Ge-Pano-Carib languages. Macro-Chibchan languages
=85     Andean languages. Equatorial languages
=86     Chaco languages. Patagonian and Fuegian languages
=88     Isolated, unclassified Central and South American indigenous languages
=9      Artificial languages
=92     Artificial languages for use among human beings. Int. aux. languages (interlanguages)
=93     Artificial languages used to instruct machines. Programming/computer languages
```

Documentation and Computer Science

Computer Science and Technology (UDC, excerpt, English)

```
004.2        Computer architecture
004.3        Computer hardware
004.31       Processing units. Processing circuits
004.33       Memory units. Storage units
004.382.2    Supercomputers
004.4        Software
004.414      Definition phase of system and software engineering
004.414.2    Computer system analysis and design
004.414.3    Software requirements analysis
004.415      Development phase of system and software engineering
004.415.5    Software quality assurance
004.416      System and software maintenance
004.42       Computer programming
004.423      Syntax and semantics of programs
004.43       Computer languages
004.43.C     C programming language
004.43.C++   C++ programming language
004.43.FOR   FORTRAN programming language
004.431      Low level languages
004.432      High level languages
004.451      Operating systems
004.62       Data handling
004.7        Computer networks
004.71       Computer communication hardware
004.738.5    Internet
004.774      HTTP application. World Wide Web in the strict sense. Web resources / content
004.82       Knowledge representation
004.89       Artificial intelligence application systems. Intelligent knowledge-based systems
004.932      Image processing
004.94       Simulation
```

Creating Groups and References

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

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

Obstacles

Obstacles reducing success and efficiency with the processes

- Time consumption (e.g., staff, project timelines),
- Documentation (e.g., low percentage of reusability),
- Classification (e.g., limited views),
- Tools (e.g., changing repeatedly),
- "Standards" (e.g., changing repeatedly),
- ...
- Different perception of goals, strategies, and completeness.

Complementary

Structure

- Must be able to contain and refer to any content.

Full text and keywords

- Groups, regular expressions, search functions, ...

Soundex

- Algorithm for calculating codes from text strings, representing phonetic properties.
- Originally only used for names, in Englisch.
- The original algorithm mainly encodes consonants.
- Goal is to encode homophones with the same representation, minor spelling differences do result in the same representation.
- Various modifications for any language, topics, any kind of words, support for many programming environments.

Helpers – you always need

Staff and resources

- Quantity of Staff and Resources depends.
- Quality of Data (QoD) can optimise requirements for staff and resources.

Modeling and applications

Unified Modeling Language (UML)

The Unified Modeling Language (UML) can be used for various purposes with information sciences, software development, and even independent from information sciences, e.g. in economics and business context:

- “business model”
- classes
- messages, objects in their timing sequence
  - coarse overview
  - dynamic
  - parallel processes
  - distributed systems

UML Diagrams

UML Diagrams

- Use-case diagram
- Class diagram
- Package diagram
- Interaction diagram
- State diagram
- Activity diagram
- Implementation diagram

Use-case Diagram, Class Diagram, Package Diagram

Use-case diagram

Diagram: Use-Case

Phase: Requirements, predefinition, application design – building, delivery

Operational area: business processes, common

Use-case Diagram, Class Diagram, Package Diagram

Use-case diagram

Diagram: Use-Case

Phase: Requirements, predefinition, application design – building, delivery

Operational area: business processes, common

Class diagram

Diagram: class diagram

Phase: predefinition, application design – building

Operational area: anywhere, the class diagram is the most important UML diagram.

Use-case Diagram, Class Diagram, Package Diagram

Use-case diagram

Diagram: Use-Case
Phase: Requirements, predefinition, application design – building, delivery
Operational area: business processes, common

Class diagram

Diagram: class diagram
Phase: predefinition, application design – building
Operational area: anywhere, the class diagram is the most important UML diagram.

Package diagram

Diagram: package diagram
Phase: application design – building
Operational area: overall orientation purposes, which classes in which modules. partitioning into sub-projects, libraries, translation units.

Interaction Diagram and State Diagram

Interaction diagram

Diagram: interaction diagram

Phase: Requirements, predefinition, application design – building, delivery

Operational area: shows the message flow an therefore the cooperation of objects in timing sequence.

Special interaction diagrams are:

- Sequence diagram: timing call structure with few classes.
- Collaboration diagram: timing call structure with few messages.

Interaction Diagram and State Diagram

Interaction diagram

Diagram: interaction diagram

Phase: Requirements, predefinition, application design – building, delivery

Operational area: shows the message flow an therefore the cooperation of objects in timing sequence.

Special interaction diagrams are:

- Sequence diagram: timing call structure with few classes.
- Collaboration diagram: timing call structure with few messages.

State diagram

Diagram: state diagram

Phase: Requirements, predefinition, application design – building, delivery

Operational area: presentation of dynamical behaviour

Activity diagram and Implementation Diagram

Activity diagram

Diagram: activity diagram

Phase: predefinition, application design – building

Operational area: various purposes.

Activity diagram and Implementation Diagram

Activity diagram

Diagram: activity diagram

Phase: predefinition, application design – building

Operational area: various purposes.

Implementation diagram

Diagram: Implementation diagram

Phase: predefinition, application design – building, delivery

Operational area: especially for presentation of distributed applications and components; in general: presentation of implementation aspects (translations units, executable programs, hardware structure)

Special implementation diagrams are:

- component diagram: coherence of software.
- deployment diagram: hardware structure.

High End Computing

Basics and prerequisites

- Real goals. Define the goals, different views.
- Need for basic understanding and knowledge base for HEC.
- Prominent HEC and collaboration aspects decision making processes are necessary for.
- Separate the topics (disciplines, resources, ...).
- Gather the real requirements for the analysis.
- Up-to-date resource policies in theory and practice.
- Interesting fields of application are processes within disciplines.
- Future deployment of integration and classification with components of complex systems.

Decisions and Computing

Components (all areas, no sort order):

- Architecture,
- Operating System,
- Applications,
- Programming languages,
- Tools,
- System modeling,
- Vendors,
- Strategy,
- Targets,
- Staff,
- Operation,
- Services,
- System management,
- Complex licensing,
- Policies,
- Governance,
- ...

Decisions and High End Computing

Components (all areas, no sort order):

- Components (all areas) with strong focus on
- Applicability, efficiency,
- Architecture applicability,
- Operating System applicability,
- Efficient applications,
- Programming languages,
- Tools,
- System modeling,
- Vendors,
- Strategy,
- Targets,
- Staff,
- Operation,
- Services,
- System management,
- Complex licensing,
- Policies,
- Governance,
- ...

Decision Making and High End Computing

Process fundamentals:

- Knowledge and experience are more important than hierarchy.
- Find the essential information.
- Rational problem analysis and decision planning.
- Add forensics to all possible information.
- The decision making process needs to define the focus.
- The decision making process needs to define goals.
- There should be only one final instance for selection processes.
- Multiple views for a process must be allowed and supported.
- Define results.
- Define service and responsibilities.
- List requirements and parts.
- Tools are needed for making the selection.
- Keep the tools simple.
- Best practice should be used in order to support the process.

Decision Making and High End Computing

Essential aspects:

- Dissemination.
- Scientific research and consultancy.
- Service and operation.
- Transparency for legal issues.
- Written definition of goals, acknowledged by all parties.
- Quality of Data counts, aware of long-term usage.
- Support structuring the application scenarios with architecture/disciplines.
- Support essential knowledge to be long-term persistent (structure, UDC, OEN, CEN, ...).
- Try to support dynamical application scenarios.
- Acknowledge that for some party prestige and presentation might be an aspect with any system.

Decision Subjects

Decision on:

- User (scientific and industry) requirements,
- Content,
- Context,
- Operation lifecycle,
- Staff and operation,
- Services,
- Architecture (specification, networks),
- Policies,
- Goals (of the system/service),
- Dissemination,
- (Funding).

View: Disciplines

– View: Disciplines –

Requirements

Needs and requirements from disciplines classically are in contrast with how resources and services are managed and operated.

Building services on this base typically polarises interests of participated groups.

From this point of view, most building processes regarding computing environments reveal a very small grade of efficiency.

View: Services and Developers

– View: Services and Developers –

Provided

In almost all cases the percentage of re-used knowledge over system generations is very small, leading to perpetuous "re-invention" and "re-discussion" for every cycle.

The suggested rate of re-use is below 10 percent.

Compute Portfolio

Services differ by physics and intention, especially:

- **Latencies and bandwidth:** Low segment: Latency 100 μs to several milliseconds (distributed), latency 1–2 μs (local), bandwidth 1.5–4 GB/s (local),
- **Distributed data transfer:** Data transfer for supercomputing is essential with any big (volume) data, physics provide limitation to economical distributed solution.
- **Distributed memory usage:** Shared memory usage for supercomputing is essential with shared memory algorithms, physics provide limitation to economical distributed solution.

View: Providers

– View: Providers –

Requirements

- Economical environment.
- Efficient operation.
- Sustainable investment.
- Defined policies.
- ...

Architecture

Which architecture?

- Standalone / workstation,
- Cluster,
- Grid,
- Cloud,
- High Performance Computing (HPC),
- Other.

Provisioning

How do you provision services or resources?

- Institute,
- Alliance,
- Hosting,
- Housing,
- Other.

Type

Which type?

- Research
- Industry
- Mix
- Other

State

Which kind of usage?

- Interactive
- Batch
- Hybrid
- Other

Usage

How can the architecture be used efficiently?

- MPP (Massively Parallel Processing),
- SMP (Shared-Memory Parallel),
- Other.

Programming

Which model?

- Low Level: MPI (Message Passing Interface),
- Low Level: OpenMP,
- High Level: PGAS (Partitioned Global Address Space),
- Virtualisation: PVM (Parallel Virtual Machine),
- Other.

Information Management and Valorisation

Example Information and Archives

- Open Archives Initiative (OAI), http://www.openarchives.org/
- An initiative aimed at defining an open interface for the exchange of metadata. OAI permits continuous synchronisation of large amounts of data.
- Institution: German National Library
- Tools: OAI harvester, OAI-Protocol for Metadata Harvesting (OAI-PMH), http://www.openarchives.org/pmh/

Examples, OAI, Gallica, Bibliothèque nationale de France (BnF)

- Gallica is one of the major digital libraries available for free via the Internet.
- URL: https://gallica.bnf.fr/accueil/en/content/accueil-en?mode=desktop
- URL: https://gallica.bnf.fr/services/engine/search/advancedSearch/?lang=en

Lessons Learned

Lessons learned:

- **Improve long-term creation of knowledge complements.**
- **Improve Quality of Data.**

Lessons Learned

Lessons learned:

- Improve long-term creation of knowledge complements.
- Improve Quality of Data.
- Foster the creation and application of best practice.
- Foster multi-disciplinary education and work.
- Create knowledge-centric, modular implementations.

Lessons Learned

Lessons learned:

- **Improve long-term creation of knowledge complements.**
- **Improve Quality of Data.**
- **Foster the creation and application of best practice.**
- **Foster multi-disciplinary education and work.**
- **Create knowledge-centric, modular implementations.**
- **Create and provide instruments based on standards.**

Conclusions

– Information Science–

Assets:

Knowledge complements are the assets of information science!

Applications:

. . . provide solutions to application scenarios!

Instruments:

. . . provide fundaments for creating instruments!

References

References and acknowledgements, see:

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⇒ C.-P. Rückemann, "Methodology of Knowledge Mapping for Arbitrary Objects and Entities: Knowledge Mining and Spatial Representations – Objects in Multi-dimensional Context," in *Proceedings of The Tenth International Conference on Advanced Geographic Information Systems, Applications, and Services (GEOProcessing 2018), March 25 – 29, 2018, Rome, Italy.* XPS Press, 2018, ISSN: 2308-393X, ISBN-13: 978-1-61208-617-0, URL: http://www.thinkmind.org/index.php?view=instance&instance=GEOProcessing+2018 [accessed: 2019-02-10].

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Networking