Handbook 0.27 (work in progress)

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The latest version should be available via http://www.nonmonotonic.net/re-isearch

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I. Background / History

Isearch was an open-source text retrieval software first developed in 1994 as part of the Isite Z39.50 information framework. The project started at the Clearinghouse for Networked Information Discovery and Retrieval (CNIDR) of the North Carolina supercomputing center MCNC and funded by the National Science Foundation to follow in the track of WAIS[1] (Wide Area Information Server) and develop prototype systems for distributed information networks encompassing Internet applications, library catalogs and other information resources. Edward Zimmermann having worked both on WAIS and his own Z39.50 server, seeing the need for a massive redesign, quickly joined the fray with his company BSn. From 1994 to 1998 most of the development was centered on the Clearinghouse for Networked Information Discovery and Retrieval (CNIDR) in Research Triangle, North Carolina and BSn in Munich. By 1998 much of the open-source core developers re-focused development into several spin-offs. In 1998 it became part of the Advanced Search Facility reference software platform funded by the U.S. Department of Commerce. Others joined a team at WIPO in Geneva.

Isearch (and its forks) was widely adopted and used in hundreds of public search sites, including many high profile projects such as the U.S. Patent and Trademark Office (USPTO) patent search, the Federal Geographic Data Clearinghouse (FGDC), the NASA Global Change Master Directory, the NASA EOS Guide System, the NASA Catalog Interoperability Project, the astronomical pre-print service based at the Space Telescope Science Institute, The PCT Electronic Gazette at the World Intellectual Property Organization (WIPO), the SAGE Project of the Special Collections Department at Emory University, Eco Companion Australasia (an environmental geospatial resources catalog), the Open Directory Project and numerous governmental portals in the context of the Government Information Locator Service (GILS) GPO mandate (ended in 2005). A number of sites worldwide continue (despite development long ago suspended) continue to use Isearch in their production systems.

One of the main split-offs was the (closed source and proprietary) IB engine developed by BSn. With some new algorithms it was bespoke deployed in a large number of high profile projects ranging from news search for *Wirtualna Polska* (one of the largest and most known Web portals in Poland); genomic search for the *Australian National Genomic Information Service*'s (ANGIS) human genome project (and its eBiotechnology workbench split-off); the D-A-S-H search portal against racism, antisemitism and exclusion (funded within the framework of the action program "*Youth for tolerance and democracy - against right-wing extremism, xenophobia and anti-Semitism*", the YOUTH program of the European Community and with additional support from the German Federal Agency for Civic Education); the e-government search (*Yeehaw*) of the U.S. State of Utah to agronomic cooperation across the Mediterranean region (supported by the EU's DG). Integrated into a number of CMS platforms it powered search for a number of high volume web sites. It was also used as a database accelerator by a number of eCommerce shops.

Its radical approach and re-think of search was even on display at the ISEA2008[2]: 14th International Symposium on Electronic Art in a collaboration with the Dutch design cooperative Metahaven: https://isea-archives.siggraph.org/art-events/metahaven-exodus-cross-search/. In the words of the project "*Exodus is the compound name for a 'research engine' into algorithms and visual strategies for searching the internet, revealing*

1 A distributed information server started in 1989 at Thinking Machine Corp by Brewster Kahle currently of the Internet Archive. Inspired by the WAIS project on full-text databases and emerging SGML projects, Z39.50 version 2 (Z39.50:1992) was released.

2 ISEA is one of the world's most prominent international arts and technology events, bringing together scholarly, artistic, and scientific domains in an interdisciplinary discussion and showcase of creative productions applying new technologies in art, interactivity, and electronic and digital media.

the structural properties of web content and its inherent distribution of influence. Exodus promotes bridging behaviour across the web's new borders of power."

Development of IB halted in 2011 as its main developers moved on to other projects. While still being deployed by a number of sites—why break a working system—it was no longer updated or actively maintained (even before 2011 it seemed that most sites only bothered updating when they shifted hardware platforms and had to). The software sat idle in the attic for 10 years.

Now through the generous support of the NLnet Foundation and the European Union's Next Generation Internet (NGI) initiative its being reborn, open-sourced and renamed as the re-Isearch engine (as a tribute to its roots).

II. Motivation. What does re-Isearch offer?

Mainstream search engines are about finding any information: "*a list of all documents containing a specific word or phrase*". Because of this, search engines paradoxically return both too much information (i.e. long lists of links) and too little information (i.e. links to content, not content itself). The re-Isearch engine is, by contrast, about exploiting document structure, both implicit (XML and other markup) and explicit (visual groupings such as paragraph), to zero in on relevant sections of documents, not just links to documents.

Organizations of all sizes and within all industries generally distribute their corporate knowledge amid a variety of applications: from customer relationship systems, staff directories, content management systems (CMS), electronic document and records management systems (EDRMS) to library catalogs. These Balkanized data stores tend to demand large efforts to extract, transform, load (or ingest).

Our goal is, by contrast, to provide enabling technology to develop and provide distributed federated information search and retrieval services to a heterogeneous mix of text, data (a large number of standard types such as numerical, ranges, dates etc), images/video/audio, geographic information, network objects and databases.

- ✔ Low-code ETL / "Any-to-Any" architecture
- ✔ Handles a wide range of document formats including "live" data.
- ✔ Powerful Search (Structure, Objects, Spatial) / Relevancy Engine
- ✔ NoSQL-like Datastore
- ✔ Set based with an exhaustive collection of (binary and unary) set operations.
- ✔ Useful for Analytics
- ✔ Useful for Recommendation / Autosuggestion
- ✔ Embeddable in products (comparatively low resource demands)
- ✔ Customization.
- ✔ Support Peer-to-Peer and Federated architectures.
- ✔ Freely available under a permissive software license.

Key Features and Benefits:

- ➔ Cost effective access to a heterogeneous mix of XML and other data of any shape and size. Allows for the rapid creation of scalable (XML) warehouses.
- ➔ All the capabilities you can ever expect in an enterprise search solution and then some: including phrase, boolean, proximity, wildcard, parametric, range, phonetic, fuzzy, thesauri, polymorphism, datatypes (including numeric, dates, geospatial, ranges etc.) and object capabilities.

- ➔ Relevant ranking by a number of models including spatial score for geospatial queries, date, term frequency, match distribution etc.
- ➔ Object oriented document model: Supports W3C XML, ISO Standard 8879:1986 SGML and a wide range of common file (such as Word, Excel, RTF, PDF, PostScript, HTML, Mail, News), citation (such as BibTex, Endnote, Medline, Papyrus, Refer, Reference Manager/RIS, Dialog, etc), scientific, ISO and industry formats including standards such as USPTO Green Book (patents), DIF (Directory Interchange Format), CAP (Common Alerting Format) and many more.
- ➔ Automatic structure recognition and identification for "unstructured" textual formats (e.g., such as, alongside metadata, lines, sentences, paragraphs and pages in PDF documents).
- ➔ Sophisticated extendable type system allowing for numerical, date, geospatial and other search strategies, including external datastores and brokers parallel to textual methods: "Universal Indexing".
- ➔ Synchronized information: As soon as context its indexed (appended) its available. Functional Append/Delete/Modify and transaction-consistent revision information deliver consistence and up-to-date information without the time-lag typical of many search engines.
- ➔ True search term highlighting (exactly what the query found, structure etc.) including Adobe Acrobat PDF Highlighting.
- ➔ Extendable/Embeddable/Programmable: Java, Python, Tcl, C++ and other other language APIs.
- ➔ Support for a number of information retrieval protocols including ISO 23950 / ANSI NISO Z39.50, SRW/U and OpenSearch.
- ➔ Runs on a wide range of hardware and operating systems.
- ➔ Easy to maintain, tiny, scalable and fast. Energy efficient: One can even start off with inexpensive low-power hardware (even embedded boards like NVIDIA’s Jetsons). On small machines we’ve supported several concurrent user sessions searching GB of data and still delivered search performance measured in fractions of a second.
- ➔ Does not demand advance setup or pre-processing.
- ➔ Unlike most search engines it is not based on "Inverted file indexes". Because of the limitation of "inverted indexes" most search engines typically index text (excluding common words and long terms as "stop words") and only a fixed and limited number of (defined at indexing time), additional fields (since they are expensive). Our aim is to provide unlimited query flexibility without having to know in advance what questions users are going to ask.
- ➔ Unlike databases we don’t require conversion into a "common format" with a schema set in concrete.
- ➔ Unlike XML databases we support also non-hierarchical structures and overlap.
- ➔ Unlike search engines we can index all elements, their structure, and their contents. This means that one can quickly evaluate text queries, structural queries, and queries that combine both text, objects (numerical, geospatial etc.) and structural constraints (e.g.,find diagram captions that mention engine in articles whose title contains Airbus).
- ➔ Virtual "indexes" allow for the design of logically segmented information indexes and fast on-demand search of arbitrary combinations thereof. Via the field and path mapping architecture this can be implemented completely transparent to search.
- ➔ Index collection binding: multiple indexes can be imported into an index. This allows for the custom creation of indexes on the basis of a large catalog of indexes— highly relevant to publishers as their customers tend to subscribe to only a sub-set of products (e.g. journals).
- ➔ Full ability to search specific structure/context in information without even knowing their details (such as tag or field names).
- ➔ User defined "search time" unit of retrieval: the structure of documents can be exploited to identify which document elements (such as the appropriate chapter or page) to retrieve. No need for intermediate documents or re-indexing.

- ➔ No need for a “middle layer” of content manipulation code. Instead of getting URLs from a search engine, fetching documents, parsing them, and navigating the DOMs to find required elements, it lets you simply request the elements you need and they are returned directly.
- ➔ "Any-to-Any" architecture: On-the-fly XML and other formats.

The default modus is to index all the words and all the structure of documents. It provides powerful and fast search without prior knowledge about the content yet enables arbitrarily complex questions across all the content and from different perspectives. Not bound by the constraints of "records" as unit of information, one can immediately derive value from content with the flexibility to enhance content and the application incrementally over time without "breaking anything".

Differences from typical NoSQL, XML and Graph databases

First and foremost, re-Isearch is **not** meant to be a primary datastore. It does not adhere to ACID (atomicity, consistency, isolation, durability) properties. Re-Isearch is about quickly searching high volumes of unstructured, semi-structured, or structured text for specific objects (words, phrases, numbers etc.) and less about storing and manipulating structured data.

In contrast to typical fulltext indexes, re-Isearch is about powerful structural search without limitations. NoSQL databases don’t need a fixed schema but most don’t really allow for powerful structural search and relationship exploration as they are are aggregate-oriented, grouping the data based on a particular criterion into a specific pigeon hole model (e.g. json store or..). One well-known strategy for adding relationships to such stores is to embed an aggregate’s identifier inside the field belonging to another aggregate — effectively introducing foreign keys. These joins, however, can become prohibitively expensive. Graph databases are, by contrast, designed for relations but tend for fulltext search within nodes to be quite sub-optimal. Most use an inverted index—not much different from both SQL and typical NoSQL indexes—to build a text index. Given the potentially high number of nodes in a graph this tends to be only realistic when applied to a small number of nodes. Running fulltext on the labels of all nodes in a graph (a not terribly uncommon worst practice) results in extremely poor performance and does not scale.

Difference to XML databases

Look that the following two documents:

```
<!-- doc 1 -->
<document id="1" foo="bar"/>

<!-- doc 2 -->
<document id="2">
   <element foo="bar" />
</doc>
```

A typical XML database won’t be able to link the two “documents” via “bar” of type “foo”. With a graph database design the Bar node is shared and we can query for all nodes connected to Bar.
With re-Isearch we expliot its support of complex attributes just search for “bar” in @foo (which is the anonomyous attribute “foo”, alongside document@foo and element@foo from doc1 resp. doc2).

Differences to Graph Databases (Joins)

In an RDMS a join statement is mainly used to combine two tables based on a specified common field between them. If we talk in terms of Relational algebra, it is the cartesian product of two tables followed by the selection operation.

In a Graph Database we traverse and don't join. We build and extend a graph. There is the concept of graph and not document (or record). While re-Isearch can traverse the implicit graph of a record it can do more. Re-isearch is designed and optimized for a generic and flexible search and provides a mechanism to support searching for virtually joined (or related) records in completely different indexes via a shared common index key. Our joins can apply across results from search in different indexes (normal conjugation like AND, OR can only apply within an index).

The motivation is to allow a search for two different indexes with different views to data to be able to aggregate and filter into a result.

Example (using XML syntax for ease of explanation) motivated by RDBMS use cases:

In index1:

```
<document id=1234567”>
 <name>"Edward Zimmermann</name>
 <key=”1234567”  />
...
```

In index2:

```
<document id="1234567">
  <org>Nonmonotonic<org/>
…
```

In Index1 we have names (typical relational model). In Index 2 we have orgs and other information.

We can search Index2 for records that have org “nonmonotonic” and search Index1 for people named “Edward” to answer the question do we have any Edwards wotking for an org named Nonmonotonic? What is their id (which we use as a unique key to identify a person).

This is a bit different from the models searching RDMS. With these systems we typically join a number of tables together and then search that new table. That is why SQL has inclusive and exclusive, multiple types—inner, outter and cross—and left, right etc. joins.

Our joins apply like a variation of conjunction (OR, AND) applied across results from search to create a new search result set rather than search applied to conjugated data.

We support 3 variantions to join two result sets:

JOIN	Join, a set containing elements shared (common record keys) between both sets.
JOINL	Join left, a set containing those on the right PLUS those on the left with common keys
JOINR	Join right, a set containing those of the left PLUS those on the right with common keys

Beyond this simple example there are a weath of use cases where different searchers may have different index views. Since these indexes can be themselves collections (even on-the-fly defined) we have a means to efficiently search and combine.

We **don't** support arbitary elements at search time for the key to use for joins but use the record keys which were defined (or created) at index time. This has been a conscious and explicit design decision as we have, to date, not seen a business cases for joins using arbitary field/path contents as keys for search. These joins using a search time specified foreign key not only would demand some knowledge about the structure and inter-relationships of the data (in SQL we have fixed schemas which have apriori been crafted for specific use cases and models of search and retrieval so this is a reasonable assumption but in re-Isearch we are completely unbrideled and generally have no unified much less fixed schema) but also slower as it would have to retrieve the contents of the specified field/path (see also the scan operation) to create the key values to join against—in re-Isearch the result sets (IRSETs) that are joined don't yet have their paths etc. resolved (RSETs).

Should this functionality be needed it could be easily implemented using one of the extension languages (Python, Tcl et al). Using the extension language for an application rather than relying solely on the query language is not just more powerful and flexible but would also typically be also more performant as it need not be as generic in approach.

Let's look at the following:

from index1:

```
<document>
 <name>"Edward Zimmermann</name>
 <org>Nonmonotonic Networks</org>
...
```

from index2:

```
<document>
  <name>Nonmonotonic<name/>
  <field>machine learning</field>
…
```

Let's assume in this example that the first index contains records about people and the second contains intelligence about organizations.

Now I'm interested in searching for an "Edward" that is working in an organization is is active in "machine learning".

Since the second index is about activity we search it for records where the field contains "machine learning" (field/"machine learning"). In this result set we use the value of the name field and use that to search in index1 as the value for org. Using the field for name will give us a result set listing the relevant names.

This approach is not only more flexible and more powerful it is also potentially much more performant than generic foreign key joins as the intermediate sets will often be significantly smaller (average sort performance is O(n log n) where n is the number of results while the search itself is O(p log m) where m is the number of unique

terms in the index and p is the number of terms in the query so as n grows it tends to dominate the limiting performance).

Unit of Retrieval

In "traditional" search engine models there is a standard unit of the record. Its the unit of index (the page, PDF, Word document) and retrieval. By contrast we have a user defined "search time" unit of retrieval: the structure of documents can be exploited to identify which document elements (such as the appropriate chapter or page) to retrieve. Retrieval granularity may be on the level of sub-structures of a given document or page such as line, paragraph but may also be as part of a larger collection. Since we know the location of hits (matches) within a record we can transverse its structure (which can be viewed as a graph) to find other relevant bits or retrieve relevant elements.

The domain of search is information and this may be a relevant part of a document or a collection of relevant documents (such as a Journal, Newspaper, Encyclopedia, Social Network etc.).

III. Hardware & OS Prerequisites

The re-Isearch engine is developed in a simplified version of C++. Standard object paradigms like strings, lists, hashmaps etc. are handled internally. It is intended to be compile-able on the widest possible range of hardware, operating systems and compilers. It is designed to be completely unencumbered by license restrictions[3]. It is also designed to run, if needed, in a comparatively small memory footprint (previous version have run on 32-bit machines with as little as 8 MB physical RAM[4]) making it suitable for appliances. It has also been designed to try to impose a minimal computing impact on the host. Rather than run multiple threads and a high CPU workload it's strategy is to be fast but not at the cost of other processes, heat or increased energy consumption.

Within this design, the limiting factor is I/O. Performance is related more to memory and storage throughput than CPU speed. Fast SSDs (SAS SSDs and for those with external disks NVMe units connected via USB versions USB 3.1 rev 2 or Thunderbolt are at an obvious advantage) are preferable over HDDs. Using mainboards with more PCIe lanes and Gigabit interconnect for clusters delivers more than CPU cores—a suitably designed machine using, for example, an energy efficient ARM CPU can outperform a 24-core Xenon for this use case. The faster the RAM, the better the I/O bandwidth and the faster the mass storage the better. More RAM memory too delivers a boost since the engine can use it to speed up indexing (and in searching large collections can cache more in memory and avoid swapping). While indexing is more or less sequential, search is random access but using memory mapping.

While a board such as the Raspberry Pi Zero or B might be ill-suited due to their poor I/O performance (typically max. 25 MB/s), the Raspberry 4 with its USB 3.0 interface is already fine for some use cases. Keeping to lower cost ARM based embedded boards[5] the $50 USD NVIDIA Nano is probably a better choice. With its 4 lanes and 5 GB/s interfaces it can get beyond 200 MB/s. On personal hardware, performance on Apple's new M1 hardware (iPad, Macbook)--which also have Thunderbolt 4 interfaces—is impressive.

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3 Java libraries depend, by contrast, upon Java which is itself not free software. The Java Runtime Environment (JRE) use for embedded devices may, for instance, even require a license fee from Oracle.

4 By comparison alone a Java runtime requires 128 MB physical RAM to run.

5 In NONMONOTONIC's Munich lab we have a large selection of embededed boards from the tiny NodeMCU to NVIDIA's Xavier.

Benchmarking on more mainstream hardware. Tests running on our reference Intel® Core™ i7-6920HQ (2.90 GHz) notebook using a low cost Samsung T5 USB 3.2 drive (500 MB/sec read/write) and indexing with 512MB Memory, get on average around 5600k words/min (roughly ½ million emails in under 20 minutes). Indexing full text (without deep parsing) we see speeds 17-20x as fast. On the i7 notebook that results in better than 70 million words/min. Despite the process being I/O bound and designed for minimal system impact, we see on generic desktops and servers performance as fast as 99000k words/min . Most of the indexing time is spent analyzing document structure and parsing.

This all without a noticeable workload. Thunderbolt 4 (already provided on a 2021 Apple hardware) provides up to 40 Gbit/s and some newer drives are already appearing that have read/write rates over 2.5 GB/s.

A typical data center server can easily handle many parallel indexing jobs while concurrently providing search without a hitch and substantially higher I/O throughputs.

Search time depends too on I/O but also the memory allocator and is most strongly tied to the size of each intermediate set built to process the query. Each query must allocate storage and has performance O(ln n + ln m) where n is the number of unique words in the index and m is the number of instances of the field searched. The query time is then the sum of all these. Once done we have the time it takes to rank (should that have been requested) the results. Sorting alone by score is O(ln n) where n is the number of items in the set.

While the primary development platform for the precursor to re-Isearch, the IB engine, was Solaris SPARC it was used extensively on x86, MIPS, PowerPC, Alpha, PA-Risc and a number of Unix operating systems (Solaris, Scientific Linux, IRIX, AIX, Tru64, HP-UX) and Microsoft's Windows (pre-Windows 10). Re-Isearch, by contrast, has as primary development platform x86 Ubuntu with ARM based Ubuntu (currently NVIDIA) as 2nd platform. It should compile and run without issues on other x86 and ARM based Unix and Linux operating systems.

For Windows it will need a little bit of work, mainly in the build system. Compatibility support code for Win32/64 API is included but is, at this time, not supported. Official support for Windows (ARM and x86), Android (ARM) , Apple IOS (ARM) and iPadOS are on the road-map. An experimental fork for HPC clusters too are in planning.

✗ File Systems

Given the want for portability and to be able to transfer indexes between machines (or via distributed file systems like AFS) we selected to use many compact (dense) files rather than single files with "holes" (which when copied are large and sparse). This design decision pushes the organization of reading and writing to the file system. Under Unix, especially Linux, one might want to consider alternative file systems (or non-standard configurations) to improve performance.

The use of file systems such as XFS is strongly advised against. Good choices range for use on external SSDs range from F2FS (Flash-Friendly File System) to exFAT (its main disadvantage is that it is proprietary and even the reverse engineered versions have run afoul of Microsoft patents).

File System	Max. number of files

F2FS	Depends on volume size
exFAT	2,796,202 per directory
ext2, ext3	32K per directory
ext4	64K per directory (by default)
Reiser4	Unlimited
NTFS	4,294,967,295 (Total folder = Total disk)

Ext4 is not a bad file system (and the 64K limit can be lifted) but journals are counter-productive for indexes.

While journals offer data consistency for unexpected system crashes or power losses they also suffer from performance decrease due to the extra journal writes. Generally indexes are easily reconstructed so have little need for the level of data consistency afforded.

If one want to use ext4 on an external SSD for indexing it is advised that one disable journaling. Assuming that the SSD is /*dev*/sda2 mounted on /*media*/ssd:

i. unmount /*media*/ssd
   Unmount the disk. Note that in general it is not safe to run e2fsck on mounted filesystems.
ii. tune4fs -O ^has_journal /dev/sda2
   Turn off the journal feature
iii. e4fsck –f /dev/sda2
   Optionally check the filesystem to confirm its integrity
iv. reboot
v. dmesg | grep EXT4
   Check the messages to confirm that its without journaling

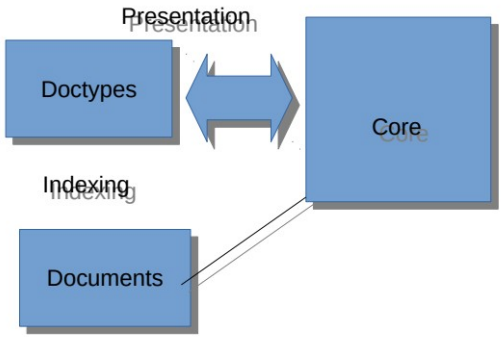
On Apple platforms (IpadOS, MacOS, IOS) we have alongside Ex-FAT, FAT-32, HSF+, and APFS for external drives—2021 models with Thunderbolt 4.

✗ Hardware and OS Checklist:

- ✔ 32 or 64-bit POSIX Unix/Linux.
- ✔ Min. 8 MB Physical RAM.
- ✔ Virtual Memory System activated.
- ✔ Choose a faster file system configured for the use case
- ✔ If possible choose faster memory, fast disks, preferably SSDs

IV. Design

The **Core** engine contains all the classes and methods (C++) to ingest documents, parse them, create indexes, store objects and provide search thereto. On a higher metalevel we have the engine kernel which provides the core indexing, search, retrieval and presentation services, manages objects and dispatches to handlers.



Datatypes (object data types handled polymorphic to text)

Data types are handled by the core and extendable within code. Many of these are well known from standard schemas such as string, boolean, numerical, computed, date and many more motivated by user needs such as phonetic types. Milestone 1 (CORE) shall contain a large assortment including the possibility to install a callback and some local types. A list and some documentation of available types is available at runtime as the system contains a rudimentary self documentation of the installed handlers.

Data-type name	**Description**
string	String (full text)
numerical	Numerical IEEE floating
computed	Computed Numerical
range	Range of Numbers
date	Date/Time in any of a large number of well defined formats including common ISO, W3 and IETF formats.
date-range	Range of Date as Start/End but also +N Seconds (to Years)
box	Geospatial bounding box coordinates (N,W,S,E): RECT{c0 c1 c2 c3}
gpoly	Geospatial n-ary coordinates as list of vertices.
time	Numeric computed value for seconds since 1970, used as date.
ttl	Numeric computed value for time-to-live in seconds.
expires	Numeric computed ttl value as date of expiration
boolean	Boolean type. 1, 0, True, False, Yes, No, Ja, Nein, Ein, Aus, On, Off, Oui, No, Tack ...
currency	Monetary currency
dotnumber	Dot number (Internet v4/v6 Addresses, UIDs etc)
phonetic	Computed phonetic hash applied to each word (for names)
phone2	Phonetic hash applied to the whole field
metaphone	Metaphone hash applied to each word (for names)
metaphone2	Metaphone hash (whole field)
hash	Computed 64-bit hash of field contents
casehash	Computed case-independent hash of text field contents
lexi	Computed case-independent lexical hash (first 8 characters)
privhash	Undefined Private Hash (callback)
isbn	ISBN: International Standard Book Number
telnumber	ISO/CCITT/UIT Telephone Number
creditcard	Credit Card Number
iban	IBAN: International Bank Account Number
bic	BIC : International Identifier Code (SWIFT)
db_string	External DB String (callback)
callback	Local callback 0 (External)
Local1 – local7	Local callback 1 - 7 (External)
special	Special text (reserved)

Dataypes may be set in the .ini (see sections below) or in some document types such as XML explicitly in the document, e.g. <DATE type=”date”> … </DATE> to define an element DATE as type “date”. In this light we support a number of synonyms for the datatypes as known in XML schemas.

xs:string	Alias of string
xs:normalizedString	Alias of string
xs:boolean //	Alias of boolean
xs:decimal	Alias of numerical
xs:integer	Alias of numerical
xs:long	Alias of numerical
xs:int	Alias of numerical
xs:short	Alias of numerical
xs:unsignedLong	Alias of numerical
xs:unsignedInt	Alias of numerical
xs:unsignedShort	Alias of numerical
xs:positiveInteger	Alias of numerical
xs:nonNegativeInteger	Alias of numerical
xs:negativeInteger	Alias of numerical
xs:positiveInteger	Alias of numerical
xs:dateTime	Alias of date
xs:time	Alias of time

Once an element is associated with a datatype it is assumed all instances of that element contain the same datatype. Should the indexer encounter a mismatch it will generally issue a warning message.

✗ Notes on the DATE datatype:

The date datatype parser and search algorithms are probably the least straightforward type in the engine. This is to a great extent due to the large range of date formats and semantics in widespread use.

- The date parser for long date names understand only the following languages: English, French, German (and Austrian variants), Spanish, Italian and Polish. Adding additional languages is straightfoward: see date.cxx
- Valid dates included are also the national numerical only (non-ISO) standards using the ‘-’. ‘.’ and ‘/’ styles of notation. Dates are either intrinsically resolved or should they be ambiguous using the locale. In a date specified as 03/28/2019, its clear that the 28 refers to day of the month, while an expression such as 03-03-23 is ambiguous. Sometimes the the use of a dash, slash or period has a semantic difference but sometimes they are used interchangeably. In Sweden for instance the ‘-’ notation is generally used as Year Month Day (e.g. 99-12-31) while in the US it is written as Month Day Year and in much of the European continent its Day Month Year. In Britain both Month Day Year and from the end of the 19th Century Day Month Year are, aligning with the Continent, commonly encountered. In the UK, in fact, all of the following forms 31/12/99, 31.12.99, 31.xii.99 and 1999-12-31 are encountered. With years in YYYY notation or with NN > 31 its clear that it can’t be day of the month just as NN > 12 can’t be the number of the month.

- In two digit YY specified years the year is resolved as following:

Current Year Last Two Digits	Two Digit Year Specified	Year RR Format Returns
0-49	0-49	Current Century
50-99	0-49	One Century after current
0-49	50-99	One Century before current
50-99	50-99	Current Century

Unix Model: Year starts at 70 for 1970

00-68	2000-2068
69-99	1969-1999

- The parser understands precision of day, month, year
- The parser understands BC and BCE dates, e.g. “12th century b.c.”

The parser supports number of special reserved terms for dates such as "Today", "Now", "Yesterday", "Last Week", "Past Month", "14 days ago" etc. Inputs such as 2/10/2010 are ambiguous and should they be desired added as local formats (See next section).

Relative dates controlled vocabulary

“Today” := the LOCAL date (of the server) without time (day precision).
“Yester[day|week|month|year]” := the past X (X precision) from the point of view of the local date/time where X is one of day, week, month or year (e.g. Yesterday is the day before today in day precision)

“Tomorrow” := the day after today (day precision)
"This day" := Today
"This Month" := the current month (LOCAL) in month precision
"This year" :? the current year (LOCAL) in year precision.
Now or Present -- the date/time at the moment the word is parsed.
[Last|Past] [NNN] Sec[onds]|Min[utes]|H[ours]|Day[s]|Week[s]|Month[s]|Year[s]|Decade[s]|Millennium [Ago|Past]
Last|Past&nsp;Sun[day]|Mon[day]|Tue[sday]|Wed[nesday]|Thu[rsday]|Fri[day]|Sat[urday]

Examples: "*14 hours ago*", "*6 days past*", "*Last year*", "*Past month*", "*200 minutes ago*", "*Last Monday*"

Note: "Yesterday" is date precision while "Past Day" is date/time precision. The two also might refer to two different days due to the time difference between local time (from the perspective of the server) and UTC/GMT: "Past Day" is based upon the date/time as per UTC/GMT while Today, Yesterday and Tomorrow are based upon "local" time.
Note also that "14 days ago" defines a date as well as method of comparison based upon day precision---thus something different from 335 hours ago or 2 weeks ago. Last year, resp. month etc., each define a precision of year, resp. month etc.

The prefix "*End of*" is interpreted as the end of the period.

The sequel in date ranges: NNNNs (as in "*1950s*") NNNN century (as in "*19th century*", "*19 Jh.*" etc) Past|Last [NNN] Seconds|Minutes|Hours|Days|Weeks|Months|Years|Decades|Millennium

Last|Past Sun[day]|Mon[day]|Tue[sday]|Wed[nesday]|Thu[rsday]|Fri[day]|Sat[urday]

Examples: "*Past 14 days*", "*Past 24 hours*", "*Past month*", "*Since last Friday*" NOTE: The prefix words "*Within*", "*during*" and "*the*" are skipped, e.g. "*Within the past day*" is reduced to "*Past day*".

Since means from then until now. Since last week means from the start of last week to now. "*Last week*, by contrast, means only the days of last week (Sunday through Sat.). Date ranges, in contrast to dates, are precise to time but start at the beginning and end at the end of their respective unit, e.g. last month starts at midnight of the first and ends just as midnight strikes on the last day of the month (in Oct. its the 31th day).

Local Extensions to handle "ambiguous" national formats

A number of local formats can be easily added via a "datemsk.ini" file. That file is quite simple and uses host-platform STRPTIME(3) function.

ISO-8601:2019

ISO 8601:2004 has been superseded by ISO 8601:2019 which now contains two parts. Part 1 specifies basic rules. Part 2 specifies extensions, including community profiles to specify conformance levels for use of which rules.

Fundamentally from the perspective of activities such as search where data comparison is required, it represents a paradigm shift. The W3C, OASIS and their ilk view of dates are really timestamps assuming a common reference written in a consistent manner following a specific ISO-8601 expression cookie-cut. This is wholly ill-suited to task. The new 8601 revision now views dates and times as having an implicit (or explicit) accuracy, precision and readability just as the other standards of weights and measures. It also includes vagueness, uncertainty, wildcards and missing information.

Part 1 Basic Rules

The main changes of interest are representing positive leap seconds as [23:59:60Z] and disallowing the value “24” for hour, so that there is no “end of day” overlap with the beginning of the day [00:00.00Z].

The extended format date times have separators (YYYY-MM-DDThh:mm:ss.i). The basic format date times are without separators, except that basic times always start with “T”. Year is ordinarily an ordinal between 0000 and 9999, however expanded representations allow larger and negative years by mutual agreement. A time may include a decimal fraction (seperated using comma or period) in the lowest order time scale component.

A complete representation of duration can be expressed as a combination of units with designators starting with “P” : PYYMMDDTHHMMSS . By mutual agreement the basic and extended formats prefixed with “P” can be used.

In Part 2 Extensions many extensions are provided. EDTF functionality has now been integrated into ISO 8601-2019. For level 2, It adds the ablity to express years with exponents, and to specify number of significant digits; divisions of a year into seasons, quarters, semestrals and quadrimesters; and the ability to specify multiple dates with {braces}, one of a set with [square brackers], or a time interval with an unknown (blank) or open (double dot ..) start or end.

Re-Isearch Handbook

The re-Isearch engine does not support the full ISO-8601:2019 including extensions but does include large bits as well as its own extensions—many from the involvement of it's main author in the creation of the EDTF standardized that formed the 2019 revision of the 8601 standard.

Of significant is the algorithm for matching dates (and times). While timestamps can be easily extended to assumed precision (and accuracy can be rationalized out of the equation) for general date and time expressions this is not possible. Observing that the range of timezones alone throughout the word surpasses the 24 hours in a day means that without an expression of time against a standard or geospatial location two expressions of date with an expression of day may refer to the same instant despite being on different days. The Line Islands (part of Kiribati) is UTC+14. The timezone of Baker and Howland Islands is UTC-12. Wall clocks in Kiritimati and Howland always read 2 hours apart but on two distant separate days—they are 26 hours apart!

A common error is ETL pipelines is to try to resolve date expressions as-if they were timestamps. All too often they get resolved to the local time where the pipeline runs. A date such as 22 August 2021 would get encoded according to the local time, e.g. 20:19 (Munich) or resolved in UTC as 18:20. As one can see, however, an expression of 20210822T18:20:20Z for an event that gets processed on a machine in Tokyo using the same algorithm would get 20210823T03:20:20Z. As timestamps they clearly don't match. Even as a range, the one processed in Munich gets 2021-08-22 while the Tokyo process gets 2021-08-23. The process of "cleaning" the data in the pipeline did not clean anything but added noise and error. What date did the US land on the moon? Ask any schoolchild? 20. July 1969. 20. Juli 1969, 20:17:40 UTC. But that was 21th July in Tokyo! The moral of this story is that we can't add information we don't have. If we don't know or are uncertain of the time we can't just fill in. ISO-8601:2019 goes even a step further as it even allows for dates to have uncertain or even unknown values—values that may be corrected in the future or filled-in once additional information is available.

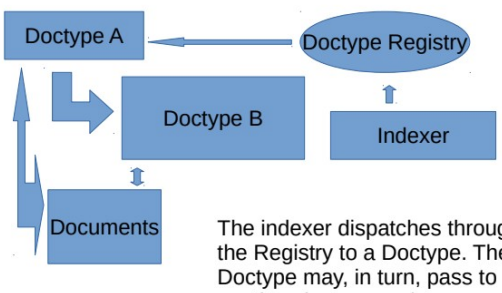
Object Indexes (data type handlers)

The indexer supports a number of datatypes. These are handled by a data type registry. All data is stored as string (the octets defining the words/terms, e.g. xs:string or xs:normalizedString in XML schema jargon) and, if specified or determined, the specific object type. These different data types have their own for-purpose indexing structures—and search algorithms and and semantics for matching as well as relations. Some have also very special functions. The datatype TTL, for example, is a numeric computed value for time-to-live in seconds. The same structures are used for another datatype called „expires" but with the time-to-live associated with the record to define record expiration. There are also a number of datatypes that use hash structures such as sound or phonetic hashes which have proven useful in name searches. All datatypes carry their own most basic documentation into the registry.

Paths to index items of a specific datatype have the optional :type qualified, e.g. `DATE` is as datatype specifically as date `DATE:date`.

Doctypes (Document handlers)

Services to handle the various document formats (ingest, parse, recognize start and end of records with multi-record file formats, recognize start and end of fields, decode encodings, convert and present) are handled by a so-called "doctype" system. These doctypes are built upon a base DOCTYPE class. They are managed and dispatched by a



The indexer dispatches through the Registry to a Doctype. The Doctype may, in turn, pass to another doctype and so on.

registry. All doctypes carry their own basic documentation (and tree heirarchy) when they register into the registry. We have both a growing collection of “built-in” types (provided with the core engine and covered by the same license and conditions as the rest of the engine) and “plugin-in” types. The latter are loadable at run-time. These loadable plug-ins can handle all or just partial services and are not just descendents of a built-in document handler class but also can pass control to other types not immediately in its class path. Milestone 1 shall contain some 60 formats including several multi functional that transparently use confiigurable external conversion tools—for example OCR to process scanned documents or an image captioning tool to process photographs alongside the embedded metadata is readily implemented. All parsers have some self documentation available at runtime of their options and class tree.

Field Unification (indexing/search)

Since the engine is designed to support a wide range of heterogenous documents and record formats a facility was developed to allow for name, resp. query path alignment. Defined by a configuration file, field names (and paths) can to be mapped during indexing to alternative names. This is intended to handle the issue of semantically equivalent field (or path) contents having syntactically different names (or paths). It also allows one to skip fields (for example P=<Ignore>). These settings may be defined unique to doctype, to doctype instance or to database (e.g. the search indexing target). Field unification can also be used to map elements that the same name and similar semantics but different different datatypes (such as computed versus numerical).

Ranking (search results)

The set of elements (records) on a search response tends to be sorted by scores—but there are a number of other sorting methods available. Scores are normalized by a number of methods (that impact the sort). The standard methods in the core engine are NoNormalization, CosineNormalization (Salton Tf-idf), MaxNormalization (weighted Cosine), LogNormalization (log cosine score), BytesNormalization (normalize frequency with a bias towards terms that are closer to one another) and CosineMetricNormalization.

Scores and ranking can also be boosted by a number of progressions: Linear, Inversion, LogLinear, LogInversion, Exponential, ExpInversion, Power and PowInversion.

Both sorting and normalization algorithms are user extendable and designed for customizations.

Queries can also weight various matches or field results to give them more importance (or less). There are also methods to cluster or shift position in results ranking with hits (matches) that are closer to one another („magnitism“).

Presentation (retrieval)

For presentation the engine uses something called “Record Syntax” to define the response syntax either through reconstruction, reconstitution or transformation. Like datatypes and doctypes it too is handled by an extensible registry. These are defined by internally registered OIDs. A ITU-T / ISO/IEC object identifier (OID) is an extensively used identification mechanism. It is the job of the DOCTYPE subsystem (using the doctype associated with the record whose data the response contains either partially or in full) to build the appropriate reponse as requested. It is typically built as a reconstruction using the indexed structure and addresses of content. This allows one to control the final reconstruction to exclude sensitive information that might have been in the original record but to be excluded from some presentations.

V. Indexing

There are many options and hyperparameters available to indexing. One can create applications using either the native C++ interface, one of the language bindings (such as Python) or via the Iindex command line utility. The simplist way to index files is with the Iindex command line tool. It offers a host of options.

The most minimal run is something like:

```
Iindex -d MYDB file1 file2 file3
```

Here the indexer will create a MYDB index (should an index already exist it will be erased) and add file1 file2 file3 to it. Since the default document handler is AUTODETECT it tends to be able to guess a suitable handler.

The -d option sets the database path/name. In the above example it will create a number of files MYDB.xxx in the current working directory. If one wanted the index to do into /var/opt/index/MYDB one would use just that:

```
Iindex -d  /var/opt/index/MYDB  ….
```

Say you want to index all the HTML files in /var/opt/web, including sub-directories, using the HTMLHEAD document handler:

```
Iindex -d MYDB -t HTMLHEAD -name “*.htm*”  /var/opt/web
```

To control the files to be indexed there are a wealth of options:

```
-f list            // File containing list of filenames; - for stdin.
-recursive         // Recursively descend subdirectories.
-follow            // Follow links.
-include pattern   // Include files matching pattern.
-exclude pattern   // Exclude files matching pattern.
-incldir pattern   // Include dirs matching pattern.
-excldir pattern   // Exclude dirs matching pattern.
-name pattern      // Like -recursive -include.
                   // pattern is processed using Unix "glob" conventions:
                   // * Matches any sequence of zero or more characters.
                   // ? Matches any single character, [chars] matches any single
                   // character in chars, a-b means characters between a and b.
                   // {a,b...} matches any of the strings a, b etc.
                   // -include, -incldir, -excldir and -name may be specified multiple
                   // times (including is OR'd and excluding is AND'd).
```

✗ Index Combination

Indexes can be combined by two means:

- Import: the import of one db into another
- Virtualization: a map that defines what dbs to use for search

Import

Imagine we have two indexes: db1 and db2. One contains file1, file2, file3 and the other contains file4, file5 and file6.

By importing db2 into db1 we get a db that is as-if it had indexed file1, file2, file3, file4, file5 and file6. The simplest means to import dbs into other is with the Iutil tool:

-import (X) // Import database: (X) as the root name for imported db files.
In the above example:

```
Iutil -d db1 -import db2
```

Performance searching the combined database is no different than if a single database was initially created rather than two. If db1 has n unique words and db2 has m unique words the big O performance is typically O(ln (n+m)),

✗ Index organization

An index is organized in a number of files

Extension	Contents
.ini	The database configuration. MS style profile.
.vdb	Definition of a virtual DB (out of multiple DBs)
.cwi	Common words (this is an information created during the indexing process)
.cat	Metadata Record file catalog (key, value)
.dfd	Database field data. This contains a table of fields and their associated datatypes
.inx	The index. This contains addresses
.mdt	The table associating record to key, address (in .mds) etc.
.mds	The mapping between address and files on the data system.
.sis	SIS cache. A file that contains a cache of prefixed terms (n octects)
.inf	Generated Metadata file (describes a resource)
.path	Meta file with linkage to source (used by externally processed documents/records)
.syn	External Synonyms
.spx	External Synonyms Parents
.scx	External Synonyms Children
.001 - .9zz	Field (path address data). NOTE: By default to keep to both 9.3 and case independent file names (to maintain compatibility with other operating systems) we have as default a max. of 12959 fields (paths). This limit could be easily increased.
As above but with a suffix to indicate the data type, e.g. .001d indicates an index of type “date”.	n Numeric r Num Range d Date e Date Range p Poly b Box h Phonetic hash c 64-bit/Numeric hash

	t	Telephone num
	v	Credit Card Number (Visa etc.)
	i	IBAN (includes Checksum)

NOTE: Given the want for portability and to be able to transfer indexes between machines (or via distributed file systems like AFS) we selected to use many compact files rather than single files with “holes” (which when copied are large and sparse). This design decision pushes the organization of reading and writing to the file system.

Other files:

Extension	**Contents**
.iq1	Pass 1 queue (file queue)
.iq2	Pass 2 queue (record queue)
.mdk	MDT Key Index
.dbi	Database info
.sta	DB status
.gils	Centroid file (optionally generated)
.glz	Compressed Centroid file
.rca	Results Cache

When files are added to the indexer they get added to index queue#1 (.iq1). These files are read and the doctype parser segments it into records. This list of records is written to the index queue#2 (.iq2). The 2nd queue (.iq2) is read and the records are indexed. The reason for this is that a single file may contain many records and these records need not be of the same document type. Typically the work to pass from queue#1 to queue#2 is relatively minor. Parsing of record structure, fields, data types etc. is part of the processing associated with queue#2.

✗ Iindex Command Line tool:

The standard indexing utility is called Iindex. It takes a number of options:

```
re-Isearch indexer 2.20210608.3.8a 64-bit edition (x86_64 GNU/Linux)
(C)opyright 1995-2011 BSn/Munich; 2011-2020 NONMONOTONIC Networks; 2020,2021 re.Isearch
Project.
This software has been made available through a grant 2020/21 from NLnet Foundation and
EU NGI0.

Usage is: Iindex [-d db] [options] [file...]
Options:
 -d db              // Use database db.
 -setuid X          // Run under user-id/name X (when allowed).
 -setgid X          // Run under group-id/name X (when allowed).
 -cd X              // Change working directory to X before indexing.
 -thes source       // Compile search thesaurus from file source.
 -T Title           // Set Title as database title.
 -R Rights          // Set Rights as Copyright statement.
 -C Comment         // Set Comment as comment statement.
 -mem NN            // Advise min. of NN RAM.
 -memory NN         // Force min. of NN RAM.
```

```
                    // Note: Specifying more memory than available process RAM can
                    // have a detrimental effect on performance.
 -relative_paths    // Use relative paths (relative to index path).
 -base path         // Specify a base path for relative paths.
 -rel               // Use relative paths and assume relation between index location
                    // and files remains constant.
 -absolute_paths    // Make file paths absolute (default).
 -ds NN             // Set the sis block to NN (max 64).
 -mdt NN            // Advise NN records for MDT.
 -common NN         // Set common words threshold at NN.
 -sep sep           // Use C-style sep as record separator.
 -s sep             // Same as -sep but don't escape (literal).
 -xsep sep          // Use C-style sep as record separator but ignore sep.
 -start NN          // Start from pos NN in file (0 is start).
 -end nn            // End at pos nn (negative to specify bytes from end-of-file).
 -override          // Override Keys: Mark older key duplicates as deleted (default).
 -no-override       // Don't override keys.
 -centroid          // Create centroid.
 -t [name:]class[:] // Use document type class to process documents.
 -charset X         // Use charset X (e.g. Latin-1, iso-8859-1, iso-8859-2,..).
 -lang ISO          // Set the language (ISO names) for the records.
                    // Specify help for a list of registered languages.
 -locale X          // Use locale X (e.g. de, de_CH, pl_PL, ...)
                    // These set both -charset and -lang above.
                    // Specify help for a list of registered locales.
 -stop              // Use stoplist during index (default is none)
 -l name            // Use stoplist file name; - for "builtin".
 -f list            // File containing list of filenames; - for stdin.
 -recursive         // Recursively descend subdirectories.
 -follow            // Follow links.
 -include pattern   // Include files matching pattern.
 -exclude pattern   // Exclude files matching pattern.
 -incldir pattern   // Include dirs matching pattern.
 -excldir pattern   // Exclude dirs matching pattern.
 -name pattern      // Like -recursive -include.
                    // pattern is processed using Unix "glob" conventions:
                    // * Matches any sequence of zero or more characters.
                    // ? Matches any single character, [chars] matches any single
                    // character in chars, a-b means characters between a and b.
                    // {a,b...} matches any of the strings a, b etc.
                    // -include, -incldir, -excldir and -name may be specified multiple
                    // times (including is OR'd and excluding is AND'd).
 -r                 // -recursive shortcut: used with -t to auto-set -name.
 -o opt=value       // Document type class specific option.
                    // Generic: HTTP_SERVER, WWW_ROOT, MIRROR_ROOT, PluginsPath
 -log file          // Log messages to file; <stderr> (or -) for stderr, <stdout>
                    // for stdout or <syslog[N]> for syslog facility using LOG_LOCALN
when
                    // N is 0-7, if N is 'D' then use LOG_DAEMON, and 'U' then LOG_USER.
 -e file            // like -log above but only log errors.
 -syslog facility   // Define an alternative facility (default is LOG_LOCAL2) for
<syslog>                        // where facility is LOG_AUTH, LOG_CRON, LOG_DAEMON,
LOG_KERN,
                   //  LOG_LOCALN (N is 0-7), etc.
 -level NN          // Set message mask to NN (0-255) where the mask is defined as (Ord):
```

```
                    // PANIC (1), FATAL (2), ERROR (4), ERRNO (8), WARN (16), NOTICE
(32),
                    // INFO (64), DEBUG (128).
 -quiet             // Only important messages and notices.
 -silent            // Silence messages (same as -level 0).
 -verbose           // Verbose messages.
 -maxsize NNNN      // Set Maximum Record Size (ignore larger)[-1 for unlimited].
 -nomax             // Allow for records limited only by system resources [-maxsize -1].
 -a                 // (Fast) append to database.
 -O                 // Optimize in max. RAM. (-optimize -mem -1)
 -Z                 // Optimize in max. RAM but minimize disk (-merge -mem -1)
 -fast              // Fast Index (No Merging).
 -optimize          // Merge sub-indexes (Optimize)
 -merge             // Merge sub-indexes during indexing
 -collapse          // Collapse last two database indexes.
 -append            // Add and merge (like -a -optimize)
 -incr              // Incremental Append
 -qsort B[entley]|S[edgewick] // Which variation of Qsort to use
 -copyright         // Print the copyright statement.
 -version           // Print Indexer version.
 -api               // Print API Shared libs version.
 -capacities        // Print capacities.
 -kernel            // Print O/S kernel capacities.
 -help              // Print options (this list).
 -help d[octypes]   // Print the doctype classes list (same as -thelp)
 -help l[ang]       // Print the language help (same as -lang help)
 -help l[ocale]     // Print the locale list (same as -locale help)
 -help o[ptions]    // Print the options (db.ini) help.
 -help t[types]     // Print the currently supported data types.
 -thelp             // Show available doctype base classes.
 -thelp XX          // Show Help for doctype class XX.
 -xhelp             // Show the information Web.

NOTE: Default "database.ini" configurations may be stored in _default.ini
in the configuration locations.
Options are set in section [DbInfo] as:
   Option[<i>]= # where <i> is an integer counting from 1 to 1024
Example:  Option[1]=WWW_ROOT=/var/httpd/htdocs/
```

An existing index can be appended to (and optimized) without interrupting search. While during the index phase many of the new records are not yet available the existing records (and whose addition has been completed) are available.

✗ Help Subsystem:

The system provides a large amount of tense information about the type system, available document type handlers and their options. While this and other documentation might attempt to be up-to-date the absolute up-to-date documentation is embedded into the software itself. This is especially important for the doctype and datatype registries.

The command line tool Iindex includes among it many functions a simple command line access to much of this information.

```
Iindex -help
```

provides the usage including a list of help options:

```
 -help              // Print options (this list).
 -help d[octypes]   // Print the doctype classes list (same as -thelp)
 -help l[ang]       // Print the language help (same as -lang help)
 -help l[ocale]     // Print the locale list (same as -locale help)
 -help o[ptions]    // Print the options (db.ini) help.
 -help t[types]     // Print the currently supported data types.
 -thelp             // Show available doctype base classes.
 -thelp XX          // Show Help for doctype class XX.
 -xhelp             // Show the information Web.
```

As well as a number of information options

```
 -copyright         // Print the copyright statement.
 -version           // Print Indexer version.
 -api               // Print API Shared libs version.
 -capacities        // Print capacities.
 -kernel            // Print O/S kernel capacities.
```

```
Iindex -copyright
Portions Copyright (c) 1995 MCNC/CNDIR; 1995-2011 BSn/Munich and its NONMONOTONIC Lab;
1995-2000 Archie Warnock; and a host of other contributors;
Copyright (c) 2021 NONMONOTONIC Networks for the re.Isearch Project.

This software has been made available through a grant 2020/21 from NLnet Foundation and
EU NGI0.

Iindex -api
API 4.0a/6  built with: g++-10 (Ubuntu 10.1.0-2ubuntu1~18.04) 10.1.0 (x86_64 GNU/Linux)

Iindex -capacities
Physical Index Capacities for this 64-bit edition:
  Max Input:   16384 Tbytes (Total of all files)
  Max Words:   1099511 trillion (optimized), >8796093 trillion (non-optimized)
  Max Unique:  120494 trillion words (optimized), >8796093 trillion (non-optimized)
  Word Freq:   Maximum same as "Max Words"
  Max Records: 12 million.
  Min. disk requirements: some fixed and variable amounts plus each
    record (160); word (8); unique word (~45); field (16).
Virtual Database Search Capacities:
  Max Input:   aprox. 4.1943e+06 Terabyte(s)
  Max Words:   unlimited (limit only imposed by physical index)
  Max Unique:  unlimited (limit only imposed by physical index)
  Max Indexes: 255
  Max Records: 31 million (Total all indexes)
Preset Per-Record Limits:
  Max Key:     36 characters
  Max Doctype Child Names: 15 characters
```

The above capacities are just theoretical and for the largest 64-bit configuration. Most of our 64-bit kernels can’t address the entire 64-bit space. Preset per-record limits, on the other hand, are arbitrary and set hardwired and should the need arise may be extended—or even shrunk. While in our many years we have not found a use case yet demanding keys beyond 36 characters in length we don’t exclude that they may be warranted.

The read should notice that the total number of records in a physical index has been limited to 12 million. This was a design choice to fit within an address space.

While it may be possible to increase the number of sub-indexes beyond 255 it is strongly advised against as Big O search performance is:

O(m*log n) => worse and average case

O(m) => Best case

where m is the number of sub-indexes and n is the number of unique words. Observe also that irrespective of the number of sub-indexes the total number of records is limited to 31 million. To put that number into perspective: the 14 million books in the Bibliothèque nationale de France, 15.5 million book in the German National Library and even the 25 million books in the British Library could fit each into a single search target— almost sufficient to fit the 39 million cataloged books in the US Library of Congress. Segmenting, however, by language or type the capacity is more than sufficient to handle the collections of any library including the 200 million items of the British Library or the 170 million in the Library of Congress.

```
Iindex -kernel
Max file handles: 1024
Max file streams: 1020
```

To get the list of available document handlers one uses the option -thelp:

```
$ Iindex -thelp
Available Built-in Document Base Classes (v28.8):
        AOLLIST           ATOM     AUTODETECT       BIBCOLON
         BIBTEX         BINARY            CAP       COLONDOC
       COLONGRP         CSVDOC       DIALOG-B            DIF
           DOCX        DVBLINE        ENDNOTE      EUROMEDIA
       FILMLINE         FILTER    FILTER2HTML    FILTER2MEMO
    FILTER2TEXT     FILTER2XML      FIRSTLINE            FTP
           GILS        GILSXML        HARVEST           HTML
         HTML--      HTMLCACHE       HTMLHEAD       HTMLMETA
     HTMLREMOTE       HTMLZERO        IAFADOC       IKNOWDOC
         IRLIST        ISOTEIA           JIRA          LATEX
     LISTDIGEST     MAILDIGEST     MAILFOLDER       MARKDOWN
        MEDLINE           MEMO        METADOC       MISMEDIA
     NEWSFOLDER         NEWSML            OCR            ODT
        ONELINE       OZSEARCH         PANDOC        PAPYRUS
           PARA            PDF      PLAINTEXT             PS
          PTEXT            RDF       REFERBIB            RIS
        ROADS++         RSS.9x           RSS1           RSS2
     RSSARCHIVE        RSSCORE           SGML       SGMLNORM
        SGMLTAG         SIMPLE           SOIF            TSV
         TSVDOC        XBINARY        XFILTER            XML
        XMLBASE         XMLREC      YAHOOLIST
External Base Classes ("Plugin Doctypes"):
  RTF:               // "Rich Text Format" (RTF) Plugin
  ODT:               // "OASIS Open Document Format Text" (ODT) Plugin
  ESTAT:             // EUROSTAT CSL Plugin
  MSOFFICE:          // M$ Office OOXML Plugin
  USPAT:             // US Patents (Green Book)
  ADOBE_PDF:         // Adobe PDF Plugin
  MSOLE:             // M$ OLE type detector Plugin
  MSEXCEL:           // M$ Excel (XLS) Plugin
  MSRTF:             // M$ RTF (Rich Text Format) Plugin [XML]
  NULL:              // Empty plugin
  MSWORD:            // M$ Word Plugin
  PDFDOC:            // OLD Adobe PDF Plugin
  TEXT:              // Plain Text Plugin
  ISOTEIA:           // ISOTEIA project (GILS Metadata) XML format locator records
```

```
Format Documentation: http://www.nonmonotonic.net/re:search/[DOCTYPE].html
  Example: http://www.nonmonotonic.net/re:search/MAILFOLDER.html

Usage Examples:
  Iindex -d POETRY *.doc *.txt
  Iindex -d SITE -t MYHTML:HTMLHEAD -r /var/html-data
  find /public/htdocs -name "*.html" -print | Iindex-d WEB -t HTMLHEAD -f -
  Iindex -d DVB -include "*.dvb" -locale de_DE -recursive /var/spool/DVB
  Iindex -d WEB -name "*.[hH][tT][mM]*" -excldir SCCS /var/spool/mirror
```

Each doctype has its own documentation. It is available via -thelp DOCTYPE

```
Iindex -thelp XMLBASE
"XMLBASE": XML-like record format for with special handling for heirarchical
fields (example: for <a><b><c> defines a field a\b\c)

Index options:
  [XML]
  TagLevelSeperator=<character>  # default '\'
alternatively in the [<Doctype>] section of <db>.ini.
NOTE: Root level tags then get a trailed character. Example:
LOCATOR\
LOCATOR\AVAILABILITY
AVAILABILITY
would be produced from <LOCATOR>..<AVAILABILITY>...</AVAILABILITY></LOCATOR>
```

```
XMLBASE Class Tree:
      DOCTYPE
         |
      SGMLNORM
         |
        XML
         v
      XMLBASE
```

Every document type has its own information.

To get the available datatypes its -help t

```
Iindex -help t
The following fundamental data types are currently supported (v.37.17):
   string    // String (full text)
   numerical       // Numerical IEEE floating
   computed  // Computed Numerical
   range     // Range of Numerbers
   date      // Date/Time in any of a large number of well defined formats
   date-range      // Range of Date as Start/End but also +N Seconds (to Years)
   gpoly     // Geospatial n-ary bounding coordinates
   box       // Geospatial bounding box coordinates (N,W,S,E)
   time      // Numeric computed value for seconds since 1970, used as date.
   ttl       // Numeric computed value for time-to-live in seconds.
   expires   // Numeric computed ttl value as date of expiration.
   boolean   // Boolean type
   currency  // Monetary currency
   dotnumber       // Dot number (Internet v4/v6 Addresses, UIDs etc)
```

```
   phonetic  // Computed phonetic hash applied to each word (for names)
   phone2    // Phonetic hash applied to the whole field
   metaphone        // Metaphone hash applied to each word (for names)
   metaphone2       // Metaphone hash (whole field)
   hash      // Computed 64-bit hash of field contents
   casehash  // Computed case-independent hash of text field contents
   lexi      // Computed case-independent lexical hash (first 8 characters)
   privhash  // Undefined Private Hash (callback)
   isbn      // ISBN: International Standard Book Number
   telnumber        // ISO/CCITT/UIT Telephone Number
   creditcard       // Credit Card Number
   iban      // IBAN: International Bank Account Number
   bic       // BIC : International Identifier Code (SWIFT)
   db_string        // External DB String (callback)
   callback  // Local callback 0 (External)
   local1    // Local callback 1 (External)
   local2    // Local callback 2 (External)
   local3    // Local callback 3 (External)
   local4    // Local callback 4 (External)
   local5    // Local callback 5 (External)
   local6    // Local callback 6 (External)
   local7    // Local callback 7 (External)
   special   // Special text (reserved)
They are also available via the following alternative 'compatibility' names:
   text      // Alias of string
   num       // Alias of numerical
   number           // Alias of numerical
   num-range        // Alias of range
   numrange         // Alias of range
   numericalrange          // Alias of range
   numerical-range         // Alias of range
   daterange        // Alias of date-range
   duration         // Alias of date-range
   bounding-box             // Alias of box
   boundingbox      // Alias of box
   phonhash         // Alias of phonetic
   name      // Alias of metaphone
   lastname         // Alias of metaphone2
   hashcase         // Alias of casehash
   hash1     // Alias of privhash
   tel       // Alias of telnumber
   telnum           // Alias of telnumber
   phone     // Alias of telnumber
   telephone        // Alias of telnumber
   inet      // Alias of dotnumber
   ipv4      // Alias of dotnumber
   ipv6      // Alias of dotnumber
   xs:string        // Alias of string
   xs:normalizedString           // Alias of string
   xs:boolean       // Alias of boolean
   xs:decimal       // Alias of numerical
   xs:integer       // Alias of numerical
   xs:long          // Alias of numerical
   xs:int           // Alias of numerical
   xs:short         // Alias of numerical
   xs:unsignedLong         // Alias of numerical
```

```
   xs:unsignedInt         // Alias of numerical
   xs:unsignedShort       // Alias of numerical
   xs:positiveInteger     // Alias of numerical
   xs:nonNegativeInteger         // Alias of numerical
   xs:negativeInteger     // Alias of numerical
   xs:positiveInteger     // Alias of numerical
   xs:dateTime      // Alias of date
   xs:time          // Alias of time
Iindex [Fatal]: Usage: No files specified for indexing!
```

Options

The .ini files have a large number of options. The general ones are available via the -help o command

```
Iindex  -help o
Ini file (<database>.ini) options:
Virtual level <database>.ini Options:
[DbInfo]
Collections=<List of virtual databases>
Databases=<List of physical databases>
vdb-file=<Path to file list> (default: <database>.vdb) # File has 1 entry per line

Physical database level <database>.ini Options:
[DbInfo]
Databases=<Path to db stem (Physical Indexes)> # Default: same directory as .ini
BaseDir=<Base Directory> # WARNING: CRITICAL VALUE
useRelativePaths=<bool> # Use relative paths (0 or 1)
AutoDeleteExpired=<bool> # Automatically delete expired records (0 or 1)
MaxRecordSize=nnnn # Max. Record size (bytes) to index (default 51mb).
Headline[/RecordSyntax]=<format of headline>
Summary[/RecordSyntax]=<format of summary>
CacheSize=nnn  # Size of cache
Persist=<bool>  # Should the cache persist?
SearchCutoff=nnn    # Stop searching after nnn hits
MaxRecordsAdvice=nnnn   # Suggest limit for set complements.
CacheDir=<Directory to store cache>
VersionNumber=<Version>
Locale=<Global Locale Name>
Segment=<Short DB Title for use as virtual segment name>
Title=<Database Title> # Complete (exported) title
Comments=<Comments>
Copyright=<Copyright Statement>
StopList=<Language or Path/Format to stopwords list file>
DateCreated=<DateCreated>
DateLastModified=<Date of last modification>
Maintainer.Name=<Name of DB maintainer>
Maintainer.Email=<Email address for maintainer>
PluginsPath=<path to directory where plugins are installed>

[External Sort
<nn>=<path> # <nn> is number and path is to the external sort file
            # if not defined it looks for <DB>.__<nn>

[Ranking]
PriorityFactor=fff.ff   # Priority factor
```

```
IndexBoostFactor=fff.ff # Boost score by index position
FreshnessBoostFactor=fff.ff # Boost score by freshness
FreshnessBaseDateLine=date # Date/time, Records newer than this date
# get FreshnessBoostFactor added, older get substracted. The unit
# of resolution is defined by the precision of the specified date. Default is the date
# specified in DateLastModified [DbInfo] (Minutes resolution)
LongevityBoostFactor=fff.fff # Boost score by difference in days between
# the date created and date modified of the records.

[HTTP]
Pages=<Path to root of htdoc tree>
IP-Name=<ip address of server>
Server=<Server Name, e.g. www.nonmonotonic.com>

[Mirror]
Root=<Path to root of mirror tree>

[<Doctype>/Metadata-Maps]
<Tag>=<TagValue> # TagValue of <Ignore> means Ignore it

Low level index <database>.ini Options:
 [DbSearch]
 MaxTermSearchTime=<nnn>  # Max. time in seconds to search for a term (advice) [default
6].
 MaxSearchTime=<nnn>      # Max. time in seconds (nnn) to run a query (advice) [default
18].
 FindConcatWords=<bool>   # True/False: Search "flow-er"? Not found then "flower".
 PhraseWaterlimit=nnn     # At this point we go into heuristic modus for phrases.
 Freeform=<bool>    # Should we NOT store hits (no proximity etc.)?
 Phonetic=[soundex|metaphone] # Algorithm to use for phonetic term searches.

 [FindConcatWords]
 Force=<bool># Force search of XX-YY-ZZ for XXYYZZ if no match.

 [TermAliases]
 <Term>=<TermAlias> # To map one term to another

 [CommonWords]
 Threshold=nnnn     # Frequency to call common
 Words=<word1> <word2> .... # A list of common words with space seperators

Geospatial RECT{North West South East} [Note the canonical order]
queries need to have their data fields defined via Gpoly-types or:
 [BOUNDING-BOX]
 North=<Numeric Field for North Coordinates [NORTHBC]>
 East= <Numeric Field for East Coordinatesi [EASTBC]>
 West= <Numeric Field for West Coordinatesi [WESTBC]>
 South=<Numeric Field for South Coordinates [SOUTHBC]>

Stopwords are used during search on the basis of STOPLISTS.
STOPLIST can be passed a path or format (see below) or with a language
searches the formats:
       %F/%o.%l
       %B/lib/%o.%l
       %B/conf/%o.%l
       %B/conf/%l/%o
```

```
       %B/conf/%os/%l
       %B/%os/%l
       %B/%os/%o.%l
       /usr/local/lib/%l.%o
       /usr/local/lib/%o.%l
Where:
       %B      the pathname of the base of the package (e.g. )
       %F      the pathname of the library (e.g./home/edz/ib/ib2/lib/)
       %l      the locale (eg. de.iso-8859-1)
       %o      the object (eg.stoplist)
       %<x>    the <x> character (e.g. ``%%'' results in ``%''

NOTE: .INI files may contain other .ini files via an include directive:
#include <path>     # alternative include "path" (may be .ini or XML/SGML format)



Doctype.ini options may also be embeded into database.ini files as:
[<Doctype>]  # Doctype, e.g. [TEXT]
# Options are those from the <doctype>.ini [General] section <key>=<value>. Example:
FieldType=<file to load for field definitions>  # default <doctype>.fields
DateExpiresField=<Date of record expiration>
# Consult the individual Doctype documentation:  -thelp <doctype>

Note: If the software has NOT been installed in /opt/nonmonotonic please confirm that
you have created either a user "asfadmin" (if you are running ASF) or "ibadmin"
whose HOME directory points to where the software has been installed.
```

Some of the options like title and copyright notice set in the .ini configuration files can be conveniently set using the Iutil command line utility.

```
Iutil, Version 3.8a Jun  8 2021 (x86_64 GNU/Linux)
(C)opyright 1995-2011 BSn/Munich; 2011-2020 NONMONOTONIC Networks; 2020,2021 re.Isearch
Project.
This software has been made available through a grant 2020/21 from NLnet Foundation and
EU NGI0.

Usage is: Iutil [-d db] [options]
Options:
 -d (X)         // Use (X) as the root name for database files.
 -id (X)        // Select document with docid (X).
 -thes (X)      // File (X) contains Thesaurus.
 -import (X)    // Import database: (X) as the root name for imported db files.
 -centroid      // Create centroid.
 -vi            // View summary information about the database/record.
 -vf            // View list of fields defined in the database.
 -v             // View list of documents in the database.
 -mdt           // Dump MDT (debug option).
 -inx           // Dump INX (debug option).
 -check         // Check INX for consistency (WARNING: Slow and I/O expensive!).
 -skip [offset] // Skip offset in above test
 -level NN      // Set message level to NN (0-255).
 -newpaths      // Prompt for new pathnames for files.
 -relative (Dir)// Relativize all paths with respect to (Dir).
                // "." is current directory, "" is db path.
 -mvdir old=new // Change all paths old to new.
                // Example: /opt=/var will change /opt/main.html to /var/main.html but
```

```
                // not change /opt/html/main.html (see -dirmv below to change base of
tree)
 -dirmv old=new // Move the base of tree from old to new.
                // Example: /opt=/var will change /opt/html/main.html to
/var/html/main.html
 -del key       // Mark individual documents (by key) to be deleted from database.
                // Note: to remove records by file use the Idelete command instead.
 -del_expired   // Mark expired documents as deleted.
 -autodelete    // Set the autodelete expired flag to true.
 -deferdelete   // Set the autodelete expired flag to false.
 -undel key     // Unmark documents (by key) that were marked for deletion.
 -c             // Cleanup database by removing unused data (useful after -del).
 -erase         // Erase the entire database.
 -g (X)         // Use (X) as Stopwords list (language).
 -gl0]          // Clear external stopwords list and use default.
 -gt (X)        // Set (X) as the global document type for the database.
                // Specify X as * to get a list of available doctypes.
 -gt0           // Clear the global document type for the database.
 -server host   // Set the server hostname or IP address.
 -web URL=base  // map base/XXX -> URL/XXX (e.g.
http://www.nonmonotonic.com/=/var/data/).
 -mirror ROOT   // Set Mirror root.
 -collapse      // Collapse last two database indexes.
 -optimize      // Optimize database indexes.
 -pcache (X)    // Set presentation cache base directory to (X).
                // Uses X/<DATABASE> for files. (X) must exist and be writable.
 -fill (X)[,..] // Fill the headline cache (not CacheDir must be set beforehand!) for the
                // different record syntaxes (,-list), where (X) is the Record Syntax OID
                // or any of the "shorthand names" HTML, SUTRS, USMARC, XML.
 -clip (NN)     // Set Db Search cut-off default.
 -priority (N.N)// Set priority factor.
 -title (X)     // Set database title to (X).
 -copyright (X) // Set database copyright statement.
 -comments (X)  // Set database comments statement.
 -o (X)         // Document type specific option.

Example:  Iutil -d POETRY -del key1 key2 key3
          Iutil -d LITERATURE -import POETRY
```

VI. Idelete Command Line Utility

The Idelete command line utility is used to delete files from an index (database). To remove individual records by key one uses the Iutil tool. Here one removes entire documents (files)--including all the records they may contain —from an index.

```
Usage: Idelete [options] file ...
  -d (X)      // Use (X) as the root name for database files.
  -o (X)      // Document type specific option.
  -sub (X)    // Default=".wastebasket"
  -pre (X)]   // Prepend base to path (default="")
  -quiet      // Quiet
  -f [(X)|-]  // Read list from a file (X) or - for stdin
  -mark       // Just mark as Deleted and don't move or remove
              // like Iutil -del but by file name and not by key.
  -shredder   // WARNING: Dangerous option!!
  -debug      // debug...
```

WARNING: -shredder is a **very dangerous** option!! It **does not** move things to wastebasket but removes it and **destroys** the source. It is called “shredder” for good reasons as it is the database equivalent to a document shredder. With a normal “delete” (here called “mark”) records remain in the database but is just marked as “deleted” and whence won’t show up in search results. They are, however, still there. A delete with this tool not only marks all its records as deleted but also move the document on the file system to another location. This is useful, for example, as part of a document life-cycle workflow to make room for new updated versions.

Example: `Idelete -d DATABASE foo`
This marks all the records in foo as deleted and moves path/foo to path/.wastebasket/foo.

Note: The values in the `datebase.ini` **override** the command line arguments

```
[Idelete]
.wasterbasket=
.prepend=
```

VII. Iwatch Command Line Tool

Iwatch is a very simple but useful command line utility. It watches a directory on the file system and then executes a program when a file is added or deleted from it.

```
Usage: Iwatch [-s sec] [-d dir] command args ...
 [-s sec]    Number of seconds between checks (300)
 [-d dir]    Directory to watch ('.')
 [-p sec]    Number of seconds to not look after command (10)
```

Typical use case is a document spool. Incoming document deposited in a directory can be moved to a processing directory and then added to an index.

VIII. Record Organization

During indexing each document is broken down into a number of records. Each of these records has a number of metadata elements associated with it:

- Date of the record (without precise specification of its semantics). Additionally
  - Date of document modification
  - Date of document creation
  - Expiration date of the document
- Key (unique)
- Document type (associated doctype class)
- Paths and addresses to source and indexed documents
- Locale (language and character set encoding)
- Category
- Priority

Date

The Date of the record is defined by `DateField`. The contents of the field are parsed as a date fieldtype.

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Language

The language of the record is defined by `LanguageField`. The contents of the field are parsed to identify a language according to language codes from Z39.53-1994. We support both 2 and 3 character codes as well as common extensions for dialects.

Example (French):

```
  {"fr",        183,    "Francais"},
  {"fr-BE",     184,    "French (Belgium)"},
  {"fr-CA",     185,    "French (Canadian)"},
  {"fr-CH",     186,    "French (Swiss)"},
  {"fr-FR",     187,    "French (France)"},
  {"fra",       188,    "Francais"},
  {"fre",       189,    "Francais"},
  {"frm",       190,    "Middle-French"},
  {"fro",       191,    "Old-French"},
```

For unknown or unspecified or mixed

```
  {"zz",        596,    "Misc"},
  {"zzz",       597,    "Unknown"}
```

Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Northwest Caucasian	Abkhazian	аҧсуа бызшәа, аҧсшәа	ab	abk	abk	abk	also known as Abkhaz
Afro-Asiatic	Afar	Afaraf	aa	aar	aar	aar	
Indo-European	Afrikaans	Afrikaans	af	afr	afr	afr	
Niger–Congo	Akan	Akan	ak	aka	aka	aka + 2	macrolanguage, Twi is tw/twi, Fanti is fat
Indo-European	Albanian	Shqip	sq	sqi	**alb**	sqi + 4	macrolanguage, "Albanian Phylozone" in 639-6
Afro-Asiatic	Amharic	አማርኛ	am	amh	amh	amh	
Afro-Asiatic	Arabic	العربية	ar	ara	ara	ara + 29	macrolanguage, Standard Arabic is arb
Indo-European	Aragonese	aragonés	an	arg	arg	arg	
Indo-European	Armenian	Հայերեն	hy	hye	**arm**	hye	also known as Հայերէն; ISO 639-3 code hye is for Eastern Armenian, hyw is for Western Armenian, and xcl is for Classical Armenian
Indo-European	Assamese	অসমীয়া	as	asm	asm	asm	
Northeast Caucasian	Avaric	авар мацI, магIарул мацI	av	ava	ava	ava	also known as Avar
Indo-European	Avestan	avesta	ae	ave	ave	ave	ancient
Aymaran	Aymara	aymar aru	ay	aym	aym	aym +	macrolanguage

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Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
						2	
Turkic	Azerbaijani	azərbaycan dili, تۆرکجه	az	aze	aze	aze + 2	macrolanguage also known as Azeri
Niger–Congo	Bambara	bamanankan	bm	bam	bam	bam	
Turkic	Bashkir	башҡорт теле	ba	bak	bak	bak	
Language isolate	Basque	euskara, euskera	eu	eus	**baq**	eus	
Indo-European	Belarusian	беларуская мова	be	bel	bel	bel	
Indo-European	Bengali	বাংলা	bn	ben	ben	ben	also known as Bangla
Creole	Bislama	Bislama	bi	bis	bis	bis	Language formed from English and Ni-Vanuatu, with some French influence.
Indo-European	Bosnian	bosanski jezik	bs	bos	bos	bos	
Indo-European	Breton	brezhoneg	br	bre	bre	bre	
Indo-European	Bulgarian	български език	bg	bul	bul	bul	
Sino-Tibetan	Burmese	ဗမာစာ	my	mya	**bur**	mya	also known as Myanmar
Indo-European	Catalan, Valencian	català, valencià	ca	cat	cat	cat	
Austronesian	Chamorro	Chamoru	ch	cha	cha	cha	
Northeast Caucasian	Chechen	нохчийн мотт	ce	che	che	che	
Niger–Congo	Chichewa, Chewa, Nyanja	chiCheŵa, chinyanja	ny	nya	nya	nya	
Sino-Tibetan	Chinese	中文 (Zhōngwén), 汉语, 漢語	zh	zho	**chi**	zho + 16	macrolanguage
Turkic	Chuvash	чăваш чĕлхи	cv	chv	chv	chv	
Indo-European	Cornish	Kernewek	kw	cor	cor	cor	
Indo-European	Corsican	corsu, lingua corsa	co	cos	cos	cos	
Algonquian	Cree	ᓀᐦᐃᔭᐍᐏᐣ	cr	cre	cre	cre + 6	macrolanguage
Indo-European	Croatian	hrvatski jezik	hr	hrv	hrv	hrv	
Indo-European	Czech	čeština, český jazyk	cs	ces	**cze**	ces	
Indo-European	Danish	dansk	da	dan	dan	dan	
Indo-European	Divehi, Dhivehi, Maldivian	ދިވެހި	dv	div	div	div	
Indo-European	Dutch, Flemish	Nederlands, Vlaams	nl	nld	**dut**	nld	Flemish is not to be confused with the closely related West Flemish which is referred to as *Vlaams* (Dutch for "Flemish") in ISO 639-3 and has the ISO 639-3 code vls
Sino-Tibetan	Dzongkha	རྫོང་ཁ	dz	dzo	dzo	dzo	
Indo-European	English	English	en	eng	eng	eng	
Constructed	Esperanto	Esperanto	eo	epo	epo	epo	constructed, initiated from L.L. Zamenhof, 1887

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Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Uralic	Estonian	eesti, eesti keel	et	est	est	est + 2	macrolanguage
Niger–Congo	Ewe	Eʋegbe	ee	ewe	ewe	ewe	
Indo-European	Faroese	føroyskt	fo	fao	fao	fao	
Austronesian	Fijian	vosa Vakaviti	fj	fij	fij	fij	
Uralic	Finnish	suomi, suomen kieli	fi	fin	fin	fin	
Indo-European	French	français	fr	fra	**fre**	fra	
Niger–Congo	Fulah	Fulfulde, Pulaar, Pular	ff	ful	ful	ful + 9	macrolanguage, also known as Fula
Indo-European	Galician	Galego	gl	glg	glg	glg	
Kartvelian	Georgian	ქართული	ka	kat	**geo**	kat	
Indo-European	German	Deutsch	de	deu	**ger**	deu	
Indo-European	Greek, Modern (1453–)	ελληνικά	el	ell	**gre**	ell	For ancient Greek, use the ISO 639-3 code grc
Tupian	Guarani	Avañe'ẽ	gn	grn	grn	grn + 5	macrolanguage
Indo-European	Gujarati	ગુજરાતી	gu	guj	guj	guj	
Creole	Haitian, Haitian Creole	Kreyòl ayisyen	ht	hat	hat	hat	
Afro-Asiatic	Hausa	هَوُسَ (Hausa)	ha	hau	hau	hau	
Afro-Asiatic	Hebrew	עברית	he	heb	heb	heb	Modern Hebrew. Code changed in 1989 from original ISO 639:1988, iw.[1]
Niger–Congo	Herero	Otjiherero	hz	her	her	her	
Indo-European	Hindi	हिन्दी, हिंदी	hi	hin	hin	hin	
Austronesian	Hiri Motu	Hiri Motu	ho	hmo	hmo	hmo	
Uralic	Hungarian	magyar	hu	hun	hun	hun	
Constructed	Interlingua (International Auxiliary Language Association)	Interlingua	ia	ina	ina	ina	constructed by International Auxiliary Language Association
Austronesian	Indonesian	Bahasa Indonesia	id	ind	ind	ind	Covered by macrolanguage ms/msa. Changed in 1989 from original ISO 639:1988, in.[1]
Constructed	Interlingue, Occidental	(originally:) *Occidental*, (after WWII:) *Interlingue*	ie	ile	ile	ile	constructed by Edgar de Wahl, first published in 1922
Indo-European	Irish	Gaeilge	ga	gle	gle	gle	
Niger–Congo	Igbo	Asụsụ Igbo	ig	ibo	ibo	ibo	
Eskimo–Aleut	Inupiaq	Iñupiaq, Iñupiatun	ik	ipk	ipk	ipk + 2	macrolanguage
Constructed	Ido	Ido	io	ido	ido	ido	constructed by De Beaufront, 1907, as variation of Esperanto
Indo-European	Icelandic	Íslenska	is	isl	**ice**	isl	
Indo-European	Italian	Italiano	it	ita	ita	ita	

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Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Eskimo–Aleut	Inuktitut	ᐃᓄᒃᑎᑐᑦ	iu	iku	iku	iku + 2	macrolanguage
Japonic	Japanese	日本語 (にほんご)	ja	jpn	jpn	jpn	
Austronesian	Javanese	□□□□, Basa Jawa	jv	jav	jav	jav	
Eskimo–Aleut	Kalaallisut, Greenlandic	kalaallisut, kalaallit oqaasii	kl	kal	kal	kal	
Dravidian	Kannada	ಕನ್ನಡ	kn	kan	kan	kan	
Nilo-Saharan	Kanuri	Kanuri	kr	kau	kau	kau + 3	macrolanguage
Indo-European	Kashmiri	كشميري ,कश्मीरी	ks	kas	kas	kas	
Turkic	Kazakh	қазақ тілі	kk	kaz	kaz	kaz	
Austroasiatic	Central Khmer	ខ្មែរ, ខេមរភាសា, ភាសាខ្មែរ	km	khm	khm	khm	also known as Khmer or Cambodian
Niger–Congo	Kikuyu, Gikuyu	Gĩkũyũ	ki	kik	kik	kik	
Niger–Congo	Kinyarwanda	Ikinyarwanda	rw	kin	kin	kin	
Turkic	Kirghiz, Kyrgyz	Кыргызча, Кыргыз тили	ky	kir	kir	kir	
Uralic	Komi	коми кыв	kv	kom	kom	kom + 2	macrolanguage
Niger–Congo	Kongo	Kikongo	kg	kon	kon	kon + 3	macrolanguage
Koreanic	Korean	한국어	ko	kor	kor	kor	
Indo-European	Kurdish	كوردی ,*Kurdî*	ku	kur	kur	kur + 3	macrolanguage
Niger–Congo	Kuanyama, Kwanyama	Kuanyama	kj	kua	kua	kua	
Indo-European	Latin	latine, lingua latina	la	lat	lat	lat	ancient
Indo-European	Luxembourgish, Letzeburgesch	Lëtzebuergesch	lb	ltz	ltz	ltz	
Niger–Congo	Ganda	Luganda	lg	lug	lug	lug	
Indo-European	Limburgan, Limburger, Limburgish	Limburgs	li	lim	lim	lim	
Niger–Congo	Lingala	Lingála	ln	lin	lin	lin	
Tai–Kadai	Lao	**ພາສາລາວ**	lo	lao	lao	lao	
Indo-European	Lithuanian	lietuvių kalba	lt	lit	lit	lit	
Niger–Congo	Luba-Katanga	Kiluba	lu	lub	lub	lub	also known as Luba-Shaba
Indo-European	Latvian	latviešu valoda	lv	lav	lav	lav + 2	macrolanguage
Indo-European	Manx	Gaelg, Gailck	gv	glv	glv	glv	
Indo-European	Macedonian	македонски јазик	mk	mkd	**mac**	mkd	
Austronesian	Malagasy	fiteny malagasy	mg	mlg	mlg	mlg + 11	macrolanguage
Austronesian	Malay	,*Bahasa Melayu* بهاس ملايو	ms	msa	**may**	msa + 36	macrolanguage, Standard Malay is zsm, Indonesian is id/ind
Dravidian	Malayalam	മലയാളം	ml	mal	mal	mal	
Afro-Asiatic	Maltese	Malti	mt	mlt	mlt	mlt	

Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Austronesian	Maori	te reo Māori	mi	mri	**mao**	mri	also known as Māori
Indo-European	Marathi	मराठी	mr	mar	mar	mar	also known as Marāṭhī
Austronesian	Marshallese	Kajin M̧ajeļ	mh	mah	mah	mah	
Mongolic	Mongolian	Монгол хэл	mn	mon	mon	mon + 2	macrolanguage
Austronesian	Nauru	Dorerin Naoero	na	nau	nau	nau	also known as Nauruan
Dené–Yeniseian	Navajo, Navaho	Diné bizaad	nv	nav	nav	nav	
Niger–Congo	North Ndebele	isiNdebele	nd	nde	nde	nde	also known as Northern Ndebele
Indo-European	Nepali	नेपाली	ne	nep	nep	nep + 2	macrolanguage
Niger–Congo	Ndonga	Owambo	ng	ndo	ndo	ndo	
Indo-European	Norwegian Bokmål	Norsk Bokmål	nb	nob	nob	nob	Covered by macrolanguage no/nor
Indo-European	Norwegian Nynorsk	Norsk Nynorsk	nn	nno	nno	nno	Covered by macrolanguage no/nor
Indo-European	Norwegian	Norsk	no	nor	nor	nor + 2	macrolanguage, Bokmål is nb/nob, Nynorsk is nn/nno
Sino-Tibetan	Sichuan Yi, Nuosu	⊠⊠⊠ Nuosuhxop	ii	iii	iii	iii	Standard form of Yi languages
Niger–Congo	South Ndebele	isiNdebele	nr	nbl	nbl	nbl	also known as Southern Ndebele
Indo-European	Occitan	occitan, lenga d'òc	oc	oci	oci	oci	
Algonquian	Ojibwa	ᐊᓂᔑᓇᐯᒧᐎᓐ	oj	oji	oji	oji + 7	macrolanguage, also known as Ojibwe
Indo-European	Church Slavic, Old Slavonic, Church Slavonic, Old Bulgarian, Old Church Slavonic	ѩзыкъ словѣньскъ	cu	chu	chu	chu	ancient, in use by Orthodox Church
Afro-Asiatic	Oromo	Afaan Oromoo	om	orm	orm	orm + 4	macrolanguage
Indo-European	Oriya	ଓଡ଼ିଆ	or	ori	ori	ori + 2	macrolanguage, also known as Odia
Indo-European	Ossetian, Ossetic	ирон æвзаг	os	oss	oss	oss	
Indo-European	Punjabi, Panjabi	پنجابی , ਪੰਜਾਬੀ	pa	pan	pan	pan	
Indo-European	Pali	पालि, पाळि	pi	pli	pli	pli	ancient, also known as Pāli
Indo-European	Persian	فارسی	fa	fas	**per**	fas + 2	macrolanguage, also known as Farsi
Indo-European	Polish	język polski, polszczyzna	pl	pol	pol	pol	
Indo-European	Pashto, Pushto	پښتو	ps	pus	pus	pus + 3	macrolanguage
Indo-European	Portuguese	Português	pt	por	por	por	
Quechuan	Quechua	Runa Simi, Kichwa	qu	que	que	que + 43	macrolanguage
Indo-European	Romansh	Rumantsch Grischun	rm	roh	roh	roh	

Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Niger–Congo	Rundi	Ikirundi	rn	run	run	run	also known as Kirundi
Indo-European	Romanian, Moldavian, Moldovan	Română, Moldovenească	ro	ron	**rum**	ron	The identifiers mo and mol are deprecated, leaving ro and ron (639-2/T) and rum (639-2/B) the current language identifiers to be used for the variant of the Romanian language also known as Moldavian and Moldovan in English and moldave in French. The identifiers mo and mol will not be assigned to different items, and recordings using these identifiers will not be invalid.
Indo-European	Russian	русский	ru	rus	rus	rus	
Indo-European	Sanskrit	संस्कृतम्, □□□□□□□□□	sa	san	san	san	ancient
Indo-European	Sardinian	sardu	sc	srd	srd	srd + 4	macrolanguage
Indo-European	Sindhi	سنڌي, सिन्धी سندھی	sd	snd	snd	snd	
Uralic	Northern Sami	Davvisámegiella	se	sme	sme	sme	
Austronesian	Samoan	gagana fa'a Samoa	sm	smo	smo	smo	
Creole	Sango	yângâ tî sängö	sg	sag	sag	sag	
Indo-European	Serbian	српски језик	sr	srp	srp	srp	The ISO 639-2/T code srp deprecated the ISO 639-2/B code scc[2]
Indo-European	Gaelic, Scottish Gaelic	Gàidhlig	gd	gla	gla	gla	
Niger–Congo	Shona	chiShona	sn	sna	sna	sna	
Indo-European	Sinhala, Sinhalese	සිංහල	si	sin	sin	sin	
Indo-European	Slovak	Slovenčina, Slovenský jazyk	sk	slk	**slo**	slk	
Indo-European	Slovenian	Slovenski jezik, Slovenščina	sl	slv	slv	slv	also known as Slovene
Afro-Asiatic	Somali	Soomaaliga, af Soomaali	so	som	som	som	
Niger–Congo	Southern Sotho	Sesotho	st	sot	sot	sot	
Indo-European	Spanish, Castilian	Español	es	spa	spa	spa	
Austronesian	Sundanese	Basa Sunda	su	sun	sun	sun	
Niger–Congo	Swahili	Kiswahili	sw	swa	swa	swa + 2	macrolanguage
Niger–Congo	Swati	SiSwati	ss	ssw	ssw	ssw	also known as Swazi

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Language family	ISO language name	Native name (endonym)	639-1	639-2/T	639-2/B	639-3	Notes
Indo-European	Swedish	Svenska	sv	swe	swe	swe	
Dravidian	Tamil	தமிழ்	ta	tam	tam	tam	
Dravidian	Telugu	తెలుగు	te	tel	tel	tel	
Indo-European	Tajik	тоҷикӣ, *toçikī* تاجیکی	tg	tgk	tgk	tgk	
Tai–Kadai	Thai	ไทย	th	tha	tha	tha	
Afro-Asiatic	Tigrinya	ትግርኛ	ti	tir	tir	tir	
Sino-Tibetan	Tibetan	བོད་ཡིག	bo	bod	**tib**	bod	also known as Standard Tibetan
Turkic	Turkmen	Türkmen, Түркмен	tk	tuk	tuk	tuk	
Austronesian	Tagalog	Wikang Tagalog	tl	tgl	tgl	tgl	Note: Filipino (Pilipino) has the code fil
Niger–Congo	Tswana	Setswana	tn	tsn	tsn	tsn	
Austronesian	Tonga (Tonga Islands)	Faka Tonga	to	ton	ton	ton	also known as Tongan
Turkic	Turkish	Türkçe	tr	tur	tur	tur	
Niger–Congo	Tsonga	Xitsonga	ts	tso	tso	tso	
Turkic	Tatar	татар теле, *tatar tele*	tt	tat	tat	tat	
Niger–Congo	Twi	Twi	tw	twi	twi	twi	Covered by macrolanguage ak/aka
Austronesian	Tahitian	Reo Tahiti	ty	tah	tah	tah	One of the Reo Mā`ohi (languages of French Polynesia)[3]
Turkic	Uighur, Uyghur	ئۇيغۇرچە, *Uyghurche*	ug	uig	uig	uig	
Indo-European	Ukrainian	Українська	uk	ukr	ukr	ukr	
Indo-European	Urdu	اردو	ur	urd	urd	urd	
Turkic	Uzbek	*O‘zbek*, Ўзбек, أۇزبېك	uz	uzb	uzb	uzb + 2	macrolanguage
Niger–Congo	Venda	Tshivenḓa	ve	ven	ven	ven	
Austroasiatic	Vietnamese	Tiếng Việt	vi	vie	vie	vie	
Constructed	Volapük	Volapük	vo	vol	vol	vol	constructed
Indo-European	Walloon	Walon	wa	wln	wln	wln	
Indo-European	Welsh	Cymraeg	cy	cym	**wel**	cym	
Niger–Congo	Wolof	Wollof	wo	wol	wol	wol	
Indo-European	Western Frisian	Frysk	fy	fry	fry	fry	also known as Frisian
Niger–Congo	Xhosa	isiXhosa	xh	xho	xho	xho	
Indo-European	Yiddish	יידיש	yi	yid	yid	yid + 2	macrolanguage. Changed in 1989 from original ISO 639:1988, ji.[1]
Niger–Congo	Yoruba	Yorùbá	yo	yor	yor	yor	
Tai–Kadai	Zhuang, Chuang	Saɯ cueŋƅ, Saw cuengh	za	zha	zha	zha + 16	macrolanguage
Niger–Congo	Zulu	isiZulu	zu	zul	zul	zul	

Source: Wikipedia

Key

The Key of the record is defined by `KeyField`. The contents of the field are parsed as a string. The Key is expected to be unique to the record within the index. Should the Key already exist the previous record in the index will typically be renamed and marked as deleted. It is best practice to use keys as unique record identifiers across all databases. Records with the same Key in different indexes are considered the name resource and can be combined using Joins.

Category

The category is a natural whole number (internally a 4-byte integer) used to identify the record's belonging to a specific set, for example a subject category. By default it is 0 which denotes "uncategorized".

During indexing, if so defined, the parser uses the "Category Field" (by default "`CategoryField`") to set the category.

Priority

The priority is a natural whole number (internally a 2-byte integer) used to specify the record's priority in a sort.

During indexing, if so defined, the parser uses the "Priority Field" (by default "`PriorityField`") to set the priority..

IX. Searching

The re-Isearch works with sets. The result of a query is a set called a "result set". Result sets may be combined and operations performed upon them. The engine supports several query language variants with many binary and unary operators.

Targets

When we search, we search a database (index) also known outside of the context of the engine itself as a "target". Targets (search databases) are either individual indexes, defined by a <DB>.ini where <DB> is the name of the index or a virtually defined ensemble of indexes.

The engine first tries to reads ".ini" and, if it exists, gets a few fields and a file list. If the file list is empty or the ".ini" file did not exist it attempts to locate a file with extension ".vdb". If that file does not exist, it attempts to open the database normally. If it does exist, it opens that file and assumes there to be a list of database names separated by newline characters. It loads each database listed in the ".vdb" file and subsequent search and present operations are performed on the entire list of databases.

The important group of configuration settings are defined in the "DbInfo" section

```
[DbInfo]
Collections=
Databases=
vdb-fle=
```

Collections and Databases contain a list that is ‘,’ (comma) seperated (e.g. a,b,c). It understands quotations marks and escapes to allow names to include ‘,’. Since filenames with comma characters tend not to be terribly portable their use is advised against. See https://en.wikipedia.org/wiki/Filename#Comparison_of_filename_limitations

When it is not a virtual:

```
Databases=<Path to db stem (Physical Index)>
```

The subtle difference between Collections and Databases is that a “collection” can itself be a virtual database with a collection of databases while we normally assume a “database” to be an index. The heuristic for collections tries to detect if there is a circular definition (a collection that includes something that includes something that includes itself). We need to resolve everything into a unique list of physical indexes to search.

Virtualization/Shards/Clusters

Having a “database” or index divided into a number of different “indexes” or databases is called a number of things by different software packages. Shards or clusters (of shards) is common names. Our concept is a little bit different as these combinations of shards and clusters can be organized at will into a “database” that is really just “virtual”. These virtual databases are quite powerful and since they are defined by a single file and can be created on-demand it allows for extremely flexible definitions of searching.

Here instead of importing the data from one database into another we just create a virtual map of databases to search. Search is linear across each database. Performance is $\sum Oi \; where \; Oi \; is \; the \; performance \; of \; the \; ith \; database$—*typically* $Oi \; is \; O(ln \; n)$ *where n is the number of unique words in the index.* As one can see import (physically importing and merging one database into another) provides faster search than virtualization. With two databases db1 and db2 with respectively n and m unique words the typical big O performance is O(ln(n) + ln(m)).

The overwhelming advantage of virtualization is the speed and ease of their creation as they are defined by a single plain text configuration file. They can be created on the fly and disposed of at will.

There are two ways: either setting the correct values in a db.ini file or by providing a db.vdb file

In an .ini

```
[DbInfo]
Collections=<List of virtual databases>
Databases=<List of physical databases>
vdb-file=<Path to file list> (default: <database>.vdb) # File has 1 entry per line
```

A db.vdb file is just a line (one per line) of paths to db.ini files.

Using Virtualization to optimize high frequency conjunctions

By moving high frequency search terms to their own index one can significantly improve performance on these queries. A store, for example, might have a number of departments: electronics, clothing, food. Moving each department to its own index can improve performance when searching for items in a specific department.

This can also work with more complex queries such as conjuctions of high frequency terms. Many of these expensive as they comparatively low number of result records but a high number of intermediate sets. Imagine, for instance, a collection of records describing motorcars, electronics and tools. Television here is probably a high frequency term just as Toyota but the only records about both concern the small number discussing the camera

display assembly, for example Part Number: 8679562020 which is listed as “CAMERA ASSEMBLY, TELEVISION, SIDE RIGHT”. Instead of keeping these in a the main index one can move all the records into their own index, say one containing all of each motorcar brand’s records around electronics. Since we know, apriori, that all the documents in a Toyota electronics index are, for example, about Toyota we need only search for the term(s) relevant to the search in the domain electronics. Using the virtual feature on can, at will, extend the search by selecting brands.

Keep in mind that while these smaller indexes provide better performance on queries within them searching spanning a large number of indexes increases costs. Looking for the term “apple” across a whole department store is much cheaper in a single unified index then searching through, following our example, the clothing (beyond a number of apple motives and companies with “apple” in name, the computer company Apple even had a line of Apple branded clothing at one time), food and electronic indexes.

X. re-Isearch Query Language

The result of a query is a result set. The most primitive set is the set of records that contain a single term (word or phrase). The engine supports also fielded data with extremely powerful and flexible methods. In its most basic form (when performing a search) you may specify a field, or a field path--- If no field is specified it means ANYWHERE in the record.

At the core is RPN and Infix notations:

Infix Notation

Infix notation is the common arithmetic and logical formula notation, in which operators are written infix-style between the operands they act on (e.g. 2 + 2).

RPN Notation

Reverse Polish notation (RPN), also known as postfix notation, was invented by Australian philosopher and computer scientist Charles Hamblin in the mid-1950s. It is derived from the Polish notation, which was introduced in 1920 by the Polish mathematician Jan Łukasiewicz.

In RPN the operands precede the operator, removing the need for parentheses. For example, the expression 3 * (4 + 7) would be written as `3 4 7 + *`.

Infix Expression	Prefix Expression	RPN (Postfix) Expression
`A + B`	`+ A B`	`A B +`
`A + B * C`	`+ A * B C`	`A B C * +`
`A + B * C + D`	`+ + A * B C D`	`A B C * + D +`

Infix Expression	Prefix Expression	RPN (Postfix) Expression
(A + B) * (C + D)	* + A B + C D	A B + C D + *
A * B + C * D	+ * A B * C D	A B * C D * +
A + B + C + D	+ + + A B C D	A B + C + D +

The overwhelming advantage of “Polish notations” is that one has no concern for the precedence of operators whence no need for parenthesis or other notational groupings. In RPN we process from left to right. Values are pushed onto the stack. With operators we pop the stack and perform the operation. Infix expressions are by their very nature much more difficult for computers to evaluate given the need to handle operator precedence. It is also more difficult, once people understand RPN, for humans as many are overwhelmed by operator precedence. The Internet is filled with loads of quizzes such as what the the result of “50 + 50 – 25 * 0 + 2 + 2” or “6 ÷ 2 * (1 +2)”.

All parts of the query language are case insensitive apart from terms. Fields (paths) are case insensitive. While XML, for example, is case-sensitive, we are ***case insensitive***. Should the same element name have different semantics (generally a very bad practice) by case in the source it needs to be converted (e.g. with a prefix).

Queries to the engine are done by a number of means: *1)* RPN expressions *2)* Infix (algebraic) *3)* Relevant feedback (a reference to a fragment) *4)* so called **smart** plain language queries *5)* C++ *6)* Via a bound language interface in Python or one of the other SWIG supported languages (Go, Guile, Java, Lua, MzScheme, Ocaml, Octave, Perl, PHP, R. Ruby. Scilab. Tcl/Tk).

Relevant Feedback

The idea behind relevance feedback is to take the results that are initially returned from a given query, to gather user feedback, and to use information about whether or not those results are relevant to perform a new query.

Relevant feedback performs a query expansion that utilizes explicit relevant feedback with word synonyms and semantic relatedness.

The particular implementation is designed to allow explicit feedback to transcend a particular index (target). Central is the so-called “QueryRelevantId”. This is a string expression:

```
DBFullPath//Key/Element:Weight
```

The engine internally opens that the target (which can be a virtual database) whose path is `DBFullPath` and retrieves the terms in the defined record’s (using the `Key`) element (path) and builds a union (OR’d) query expression, potentially with is inherent sub-structure, boosted with the defined weight.

This method has proven quite powerful in a number of use case scenarios such as transcript search of videos (processed by speech-to-text) for finding “similar to”.

Smart Queries

One of the overriding motivations for “smart queries” is to counter the typical problem with full-text information search and retrieval systems: they either return too little or too many results. Looking at the intersection of all terms (AND’d) can miss some important and highly relevant records, while looking at the union (OR’d) can sometimes overwhelm, depending all too heavily on some score normalization algorithm to relay relevance. Smart ties to guess intention.

Smart queries try to interpret the query if its RPN or Infix or maybe just some terms. The logic for handling just terms is as-if it first searched for a literal expression, if not then tying to find the terms in a common leaf node—either anonymous or path specified—in a record’s object model, if not then AND‘d (Intersection of sets), if not then OR‘d (Union) but reduced to the number of words in the query.

Example: Searching in the collected works of Shakespeare:

(a) `rich water`

It find that there are no phases like “rich water” but in the `The Life of Timon of Athens' it finds that both the words “rich” and “water” are in the same line: “.. And rich: here is a water, look ye..”. The query is confirmed as `"rich" "water" PEER` (see binary operators below)

(b) `hate jews`

It finds that there are no phrases like “hate jews” but in the `The Merchant of Venice' we have in act lines that both talk about “hate” and “jews”. The smart query gets confirmed as `"hate" "jews" || REDUCE:2` (see unary operators below)

with the result “.. I hate him for he is a Christian ..” found in PLAY\ACT\SCENE\SPEECH\LINE

(c) `out out`

It finds a number of lines where “out out” is said such as “Out, out, Lucetta! that would be ill-favour'd” in `The Two Gentlemen of Verona'. The confirmed query is: `“out out”`.

Expressions

While „Smart“ searches is fantastic for many typical use cases (and why we developed it), power users tend to want to perform more precise queries. The implemented infix and RPN languages support fields and paths (like Xquery) as well as a very rich set of unary and binary operators and an assortment of modifiers (prefix and suffix). Since the engine supports a number of data types it includes a number of relations /.<,>,>=,<=,<> whose semantics of depends upon the field datatype. These operators are all overloaded in the query language.

Terms are constructed as **`[[path][relation]]searchterm[:n]`**

Example: `design`

This is the most basic search. Example `"design"` to find "design" anywhere. Or `title/design` to find "design" just in `title` elements. Since paths are case-insensitive there is no difference between `Title/design`, `tITle/design` and `title/design`.

```
Example: title/design
```

Paths can be from the root '\' (e.g. *record**metadata*\title) or from any location (e.g. title or metadata\title)). Paths can be specified with, depending upon indexing, '|' or '/' (or '\\') but one needs in the `field/term` format to be quite careful (with quotes) to delineate the field from the term.

Another way to approach the problem of searching an element (RPN):

Is to use special unary operator called WITHIN:path.

```
Searching
                    Design WITHIN:title
```

is equivalent to title/Design but often more convenient, especially where for the element we have a path. Instead of `\\A\\B\\C\\D\\E/"word"` (since we need to escape the \) we can use the expression: `"word" WITHIN:/A/B/C/D/E`

Note: the expressions:

```
term1 term2 && WITHIN:title
```

and

```
term1 WITHIN:title term2 WITHIN:title &&
```

yield the same results as they are both looking for term1 and term2 in the title element BUT they have different performance. The first expression can be slower since it builds the set for term1 and the set for term2 and then reduces the intersection to a new set that contains only those hits where term1 and term2 were within the title element. The second is taking an intersection of two potentially smaller sets. It is generally faster and better.

✗ Term and datatype search

Elements when searched are assumed to be of their intrinsic datatype when the query if of the same type. Searching a date field, for example, with a date implies a search using the date data type matching algorithms rather than as the individual terms. What constitutes a match depends upon the data type. Dates for example follow the rules of least precision comparison. A date query for 2001 matches, for example, 20010112. While >19 as a string is equivalent to 19* and matches 199 or even 19x as a numerical field all values > 19, e.g. 20, 21, 22, 23 etc.

Term and field paths support "Glob" matching

We support left (with some limitations in terms) and right (without limitations) truncated search as well as a combination of * and ? for glob matching. This can be universally applied to path (fieldname) and with some limitations to searchterm. These can be connected by more than a dozen binary as well as a good dozen unary relational operators.

Wildcard	Description	Example	Matches
*	matches any number of any characters	Law*	Law, Laws, or Lawyer
?	matches any single character	?at	Cat, cat, Bat or bat
[abc]	matches one character given in the bracket	[CB]at	Cat or Bat
[a-z]	matches one character from the (locale-dependent) range given in the bracket	Letter[0-9]	Letter0, Letter1, Letter2 up to Letter9
{xx,yy,zz}	match any of "xx", "yy", or "zz"	{C,B}at	Cat or Bat

Example: `t*/design would if there was only one field starting with the letter t and it was title search for title/design.`

Glob in path names is quite powerful as it allows one to narrow down search into specific elements.

For every hit we can also examine where it occurred. Example: Searching for
Example: `PLAY\ACT\SCENE\SPEECH\LINE`

XI. Query Operators (re-Isearch Language)

The re-Isearch engine has been designed to have an extremely rich and expressive logical collection of operators. Some operators can, however, be quite expensive. The complement, for example, of a set with a single result in a large dataset is large. Search time is directly related to the time to build the result set.

Binary Operators

Polymorphic Binary Operators	
Operator	
>	Greater than
<	Less than
<=	Less than or equal to
>=	Greater then or equal to

The above operators are overloaded and their semantics are specific to the object type of a field.

Operator	Semantics
< <=	Objects like date, numbers etc. have an order and <, resp. <=, applies as one might expect. For general "string" fields its interpreted as the equivalent to "*" (right truncation)
=	For general "string" fields its interpreted just as "/", viz. a member of the field.
> >=	As </<= above. For general "string" types the sematics are left truncation (as in *term)

Long Operator Name	Sym	Description
OR	||	Union, the set of all elements in either of two sets
AND	&&	Intersection, the set of all elements in both sets

ANDNOT	&!	Elements in the one set but NOT in the other
NOTAND	!&	As above but operand order reversed
NAND	&!	Complement of AND, elements in neither
XOR	^^	Exclusive Union, elements in either but not both
XNOR	^!	Exclusive not OR, complement set of XOR
PROX:num		PROX:0 := ADJ. PROX:n := NEAR:n
NEAR[:num]		matching terms in the sets are within num bytes in the source
BEFORE[:num]		As above but in order before
AFTER[:num]		As above but in order after
DIST[>,>=,<,<=]num		Distance between words in source measured in bytes. (and order)
num > 1: integer for bytes. As fraction of 1: % of doc length (in bytes).		
NEIGHBOR	.~.	
PEER	.=.	Elements in the same (unnamed) final tree leaf node
PEERa		like PEER but after
PEERb		like PEER but ordered after
XPEER		Not in the same container
AND:field		Elements in the same node instance of field
BEFORE:field		like AND:field but before
AFTER:field		like AND:field but after
ADJ	##	Matching terms are adjacent to one another
FOLLOWS	#>	Within some ordered elements of one another
PRECEDES	#<	Within some ordered elements of one another
PROX		Proximity
FAR		Elements a "good distance" away from each other
NEAR	.<.	Elements "near" one another.

Since the engine produces sets of result we can also combine two sets from different database searches into a common set as either augmentation or by performing some operations to create a new set.

Operators that can act on result sets from searching different databases (using common keys)	
JOIN	Join, a set containing elements shared (common record keys) between both sets.
JOINL	Join left, a set containing those on the right PLUS those on the left with common keys
JOINR	Join right, a set containing those of the left PLUS those on the right with common keys

See: #2.2.1.2.Differences to Graph Databases (Joins)|outline

Unary Operators

Operator	Sym	Description
NOT	!	Set compliment
WITHIN[:field]		Records with elements within the specified field. RPN queries "term WITHIN:field"

		and "field/term" are equivalent. (for performance the query "field/term" is preferred to "term WITHIN:field")
WITHIN[:daterange]		Only records with record dates within the range
WITHKEY:pattern		Only records whose key match pattern
SIBLING		Only hits in the same container (see PEER)
INSIDE[:field]		Hits are limited to those in the specified field
XWITHIN[:field]		Absolutely NOT in the specified field
FILE:pattern		Records whose local file path match pattern
REDUCE[:nnn]		Reduce set to those records with nnn matching terms This is a special kind of unary operator that trims the result to metric cutoff regarding the number of different terms. Reduce MUST be specified with a positive metric and 0 (Zero) is a special case designating the max. number of different terms found in the set.
HITCOUNT:nnn		Trim set to contain only records with min. nnn hits.
HITCOUNT[>,>=,<,<=]num		As above. Example: HITCOUNT>10 means to include only those records with MORE than 10 hits.
TRIM:nnn		Truncate set to max. nnn elements
BOOST:nnn		Boost score by nnn (as weight)
SORTBY:<ByWhat>		Sort the set "ByWhat" (reserved case-insensitive names: "Key", "Hits", "Date", "Index", "Score", "AuxCount", "Newsrank", "Function", "Category", "ReverseHits", "ReverseDate", etc.)

SortBy:<ByWhat>

The SORTBY unary operator is used to specify a specific desired sort of the result set upon which it applies. It is used to sort (ByWhat keywords are case insensitive) by

- ➔ “Score” → Score (the default). The score, in turn, depends upon the selected normalization algorithm.
- ➔ “Key” → Alphanumeric sort of the record key.
- ➔ “Hits” → Number of hits (descending)
- ➔ “ReverseHits” → Number of hits (ascending)
- ➔ “Date” → Date (descending)
- ➔ “ReverseDate” → Date (ascending)
- ➔ “Index” → Position in the index
- ➔ “Newsrank” → Newsrank: a special mix of score and date
- ➔ “Category” → Category
- ➔ “Function” → Function
- ➔ “Private1” , “Private2” .. → A number of private sorting algorithms (installable) that use private data (defined by the algorithm) to perform its sort. This is quite site specific and “out-of-the-box” is not defined.
  - ➔ If the private sort handler is not installed (defined) it defaults to sorting by score (ascending).

Queries can also weight various matches or field results to give them more importance (or less). There are also methods to cluster or shift position in results ranking with hits (matches) that are closer to one another („magnitism“).

RPN vs Infix

Internally all expressions are converted into a RPN (Reverse Polish Notation) and placed on stacks.
In reverse Polish notation, the operators follow their operands; for instance, to add 3 and 4 together, one would write 3 4 + rather than 3 + 4. The notation we commonly use in formulas is called “infix”: the binary operators are between the two operands—and unary before—and groups are defined by parenthesis. RPN has the tremendous advantage that it does not need parenthesis or other groupings. It also does not need to worry about order and precedence of operations. In infix expressions parentheses surrounding groups of operands and operators are necessary to indicate the intended order in which operations are to be performed. In the absence of parentheses, certain precedence rules determine the order of operations (such as in the grade school mantra “Exponents before Multiplication, Multiplication before Addition”).

While Infix is generally more familiar (except perhaps users of HP Scientific calculators) with a bit of practice the RPN language is generally preferred for it clarity and performance.
Result sets from searches on terms on the stack are cached to try to prevent repeated searches. Caches may also be made persistent by using disk storage. This is useful for session oriented search and retrieval when used in stateless environments.

Since it is a true query language it is possible to write extremely ineffective and costly queries. There is a facility to give search expressions only a limited amount of „fuel“ to run. One can also explicitly select to use these partial results.

Example RPN	Example Infix
title/cat title/dog || title/mouse ||	title/cat || title/dog || title/mouse
	title/(“cat” || “dog” || “mouse”)
speaker/hamlet line/love AND:scene	(speaker/hamlet and:scene line/love)
out spot PEER	out PEER spot
from/edz 'subject/'"EU NGI0"' &&	from/edz && 'subject/'"EU NGI0"'

Personalized Thesauri

re-Isearch provides a flexible model for the support of personalized thesauri. They are hooked into the internal query structure (a push stack of terms and their associated attribute structures) as OR'd expansion. The expansion is fully independent of the query language originally used to write the expression.

Format:

```
# Rows of the form:
# parent phrase = child1:weight+child2+multiword child:weight+ ... +childN
#
# White space is ignored at the start and end of child terms
# Comments start with #
spatial=geospatial+geographic+terrestrial # Here are more comments
land use=land cover + land characterization + land surface + ownership property
wetlands=wet land+NWI+hydric soil+inundated
```

```
hydrography=stream+river+spring+lake+pond+aqueduct+siphon+well
Al-Qaida=Al-Qa'ida+Al-Kaida+Al-Qaida+Al-Qaida+al-qaeda
kernkraft=automkraft
nuclear=atomic
```

Thesauri are associated with query structures so its easy to implement an interface where each use can manage their own collection of personalized thesauri. Since the thesauri effect only the query structure they have no negative effect on search caching.

Examples

```
# Sample synonyms
war=krieg:2+combat+battle
peace=pax
```

The Infix query: (`"War" and "Peace"`) is expanded as-if (`("war" or "krieg":2 or "combat" or "battle")` and (`("peace" or "pax")`) was entered into the system. The RPN query: `"War":2 "Peace"` && (really the same as the above Infix query save the use of the weight "2" on the "war" term) is expanded as-if "war" `"krieg":4 || "combat" || "battle" || "peace" "pax" ||` && was entered into the system. Notice that the weights are multiplicative.

Geospatial Search

Two common types of spatial queries used in mapping are proximity and bounding box searches. While "*proximity searches*" return all results within a certain distance of a location, "*bounding box queries*" return all results in a bounding box of four points defined by its four corners. These types of searches are useful in a wide variety of mash-ups.
Proximity searches don't try to be precise since they ignore terrain and other factors. This makes them computationally simple as long as the distance is relatively small.

Haversine formula: R = earth's radius (mean radius = 6,371km) $\Delta lat = lat_2 - lat_1$ $\Delta long = long_2 - long_1$ $a = \sin^2(\Delta lat/2) + \cos(lat_1).\cos(lat_2).\sin^2(\Delta long/2)$ $c = 2.atan2(\sqrt{a}, \sqrt{(1-a)})$ $d = R.c$

Since we are only interested in relatively small distances and rough accuracy we can use the simpler law of cosines:

```
dist = acos ( sin(deg2rad(lat1)) * sin(deg2rad(lat2)) + cos(deg2rad(lat1)) *
cos(deg2rad(lat2)) * cos(deg2rad( lon1 - lon2 )) ) * factor
```

factor = 4552.15 for statue miles (* 0.8684 for nautical miles and * 1.609344 for km). See: http://www.movable-type.co.uk/scripts/latlong.html

Geospatial Proximity search

Fieldname{{Latitude, Longitude}[operator]value were operator: is <, <=, =, >, >= value=distance is km (default) with the modifiers N, K, M for, resp., nautical miles, km and statue miles.

Geospatial Bounding box search

Search for a box is defined by the RECT operator: RECT{N,W,S,E}.

Hierarchical Search

Since many formats (like XML, the underlying model for RSS, Atom and CAPS) have an explicit ancestry of nodes and paths we exploit them for contextual search. This allows for some interesting and powerful searches:

- Find stories with words in the same unnamed node (for instance in the same Title or same Description).
- Find stories with words in the same named node (for instance in the same explicit Title or same Description).
- Find stories with words in the same named explicit node path (for instance in the same explicit Title of an image of a ...).
- Select content of named nodes, named paths or object attributes.
- Select content of descendants of a named ancestor of record hits. Descendants or ancestors may be specified as the name of a node or a path or even a sub-path. This allows one to dynamically at query time define a view and model (unit of recall) to content.

In RSS, for example, this means that one can search for items in the same, for example, item description and request the title and URL of the items that match. Just what one needs given the multiple items per feed!

Lets look a bit closer by example of XML fragments (from SGML/XML markup of Shakespeare's works by Jon Bosak):

```
<SPEECH>
 <SPEAKER>LADY MACBETH</SPEAKER>
 <LINE>Out, damned spot! out, I say!--One: two: why,</LINE>
 <LINE>then, 'tis time to do't.--Hell is murky!--Fie, my</LINE>
 <LINE>lord, fie! a soldier, and afeard? What need we</LINE>
 <LINE>fear who knows it, when none can call our power to</LINE>
 <LINE>account?--Yet who would have thought the old man</LINE>
 <LINE>to have had so much blood in him.</LINE>
</SPEECH>
```

First off I we have an idea of "nearness": being in the same leaf. The words "*out*" and "*spot*" are in the same node (with path ...\SPEECH\LINE). Its named SPEECH ancestor is the above speech--- the only speech in all of Shakespeare's works to have the words "out" and "spot" in the same LINE. The SPEAKER descendant of that SPEECH is "LADY MACBETH".

The word "spot" is said within the works, by contrast, in many other speeches by speakers in addition to Lady Macbeth: SALISBURY in `The Life and Death of King John', BRUTUS as well as ANTONY in `The Tragedy of Julius Caesar', MISTRESS QUICKLY in `The Merry Wives of Windsor', VALERIA in `The Tragedy of Coriolanus', ROSALIND in `As You Like It' and MARK ANTONY in `The Tragedy of Antony and Cleopatra'.

```
<Videos>
  <Video ASIN="B0000DJ7G9">
 <Title Screenplay="William Shakespeare" Alt="Othello">The Tragedy of Othello: The Moor
of Venice</Title>
    <Director>Orson Welles
    <Length>90 minutes</Length>
    <Format>DVD</Format>
    <Certificationg>U</Certification>
```

```
  </Video>
<Videos>
```

In the above the value of the `Screenplay` attribute to `Title` is *William Shakespeare*. In re-Isearch one can search for the content of the tag (`TITLE`), the content of an attribute (named mapped with a default of `TITLE@SCREENPLAY` in this example) but also for information like films with Venice in the title whose screenplay was from Shakespeare. Here we appeal to an implicit direct parent (an abstract virtual container that contains the both attribute and field data).
In XML we not only have a parent/child ancestry of nodes but we also have within nodes a linear ordered relationship. One letter follows the next and one word follows the other in a container. In the above example "Yet" precedes "here's" and "a" follows after and finishing with "spot". We have order and at at least a qualitative (intuitive) notion of distance.
In XML we do not, however, have any well-defined order among the siblings (different LINEs). The XML 1.0 well-formedness definition specifically states that attributes are unordered and says also nothing about elements. Document order (how they are marked-up) and the order a conforming XML parser might decide to report the child elements of SPEECH might not be the same. Most systems handling XML from a disk and using popular parsers typically deliver it in the same order but the standard DOES NOT specify that it need be--- and for good reason.
See also: Presentation Methods and Elements.

Example

Searching the collected works of Shakespeare (using the Isearch command line tool) we'd like to know who says "to be or not to be"?

In the XML we have:

```
…
<SPEECH>
<SPEAKER>HAMLET</SPEAKER>
<LINE>To be, or not to be: that is the question:</LINE>
<LINE>Whether 'tis nobler in the mind to suffer</LINE>
<LINE>The slings and arrows of outrageous fortune,</LINE>
<LINE>Or to take arms against a sea of troubles,</LINE>
<LINE>And by opposing end them? To die: to sleep;</LINE>
<LINE>No more; and by a sleep to say we end</LINE>
<LINE>The heart-ache and the thousand natural shocks</LINE>
...
```

The match is a LINE and that is an element of SPEECH and we'd like to know the SPEAKER.

```
edz@icebear$ Isearch -d BART -P speech/speaker "to be or not to be"
Process time: 21 ms. (2) Search: 19 ms.
Query: "to be or not to be"

1 record of 37 matched your query, 1 record displayed.

       Score  File
   1.   100  /home/edz/ib/ib2/build/data/shakespeare.xml
`The Tragedy of Hamlet, Prince of Denmark'
** 'speech/speaker' Fragment:
```

```
HAMLET
```

Say instead we were interested in the TITLE of the SCENE associated with the match?

```
edz@icebear$ Isearch -d BART -P scene/title to be or not to be
Process time: 19 ms. (2) Search: 18 ms.
Query: "to be or not to be"

1 record of 37 matched your query, 1 record displayed.

       Score  File
   1.   100  /home/edz/ib/ib2/build/data/shakespeare.xml
`The Tragedy of Hamlet, Prince of Denmark'
** 'scene/title' Fragment:
SCENE I.  A room in the castle.
```

Order

Lady Macheth says "*spot*" in another speech too..

```
<SPEECH>
  <SPEAKER>LADY MACBETH<<SPEAKER;>
  <LINE>Yet here's a spot.</LINE>
</SPEECH>
```

These "*spot*"s are in "PLAY\ACT\SCENE\SPEECH\LINE"
In XML we not only have a parent/child ancestry of nodes but we also have within nodes a linear ordered relationship. One letter follows the next and one word follows the other. In the above example "*Yet*" precedes "*here's*" and "*a*" follows after and finishing with "*spot*". We have order and at at least a qualitative (intuitive) notion of distance.
One could then specify an inclusion (within the same unnamed or named field or path), an order and even a character (octet) metric.

We have not attempted to implement a word metric as the concept of word is more complicated then commonly held. Is edz@bsn.com a single word? Two words? One word? Maybe even 3? What about a URL? Hyphenation as in "auto-mobile"? Two words? On the other hand what does such a distance mean?
Our metric of distance is defined as the file offsets (octets) as the record is stored on the file system. This too is less than clear cut as the render from HTML of Überzeugung and Überzeugung are equivalent but their lengths are different.

```
zum Thema Präsentieren und Überzeugen
```

The file system offsets between the word "Thema" and "und" depends upon how "Präsentieren" was encoded. As UTF-7, UTF-8, UTF-32, Latin-1 or with entities ¨ and &;Uuml; or &#nnn form. Does one, instead, treat the rendered level? This too is misleading since different output devices might have quite different layouts. What about columns? And the tags?

Tags are, of course, even worse with words since we have started to associate a semantics for distance. Look at an XML fragment like

```
<name>Edward C. Zimmermann</name><company>NONMONOTOMIC Lab</company>
```

What is the word distance between "Lab" and "Edward" keeping in mind that XML markup is equivalent if NAME is specified before or after COMPANY?

```
<company>NONMONOTOMIC Lab</company><name>Edward C. Zimmermann</name>
```

These are equivalent content and the word distance? That's right.. its not well defined (that is why the XML people came out withe xs:sequence for Schemas to denote in applications when order matters)! Leaving order aside, do we count “name” and “company” as words?
Order and inclusion do make sense, even some rough guide to distance but words? We are, of course, open to convincing examples!
We instead can say the distance between “Zimmermann” and “NONMONOTONIC” in the first example is 17 and in the second 30. The guiding force is not how the data is represented in an internal model but in how the data was provided in the input.

Counting containers

We can also count containers using C++ (or one of the language bindings).

```
GetNodeOffsetCount(GPTYPE HitGp, STRING FieldNameorPath= "", FC *Fc= NULL)
```

where HitGp is the address of a hit, FieldNameofPath the name, resp. path, of the container we are interested in and Fc (optional) is its calculated start/end coordinates.
This is useful to be able to determine which page (paragraph or line) a hit is on but may also be used in an abstract sense.
Example:

```
 <ingredients>
   <item>Chocolate</item>
   <item>Flour</item>
   <item>Butter</item>
   <item>eggs</item>
 </ingredients>
```

The ***order*** is the order in the mark-up. Chocolate might be the 25th item in the document but its the first item in the particular instance of INGREDIENTS. This is possible since we can check the count of the instance of INGREDIENTS and can look at the previous we can count also the offset of ITEM.

Comparison of the re-Isearch language to CQL

CQL query consist, like the re-Isearch language, of either a single search clause or multiple search clauses connected by boolean operators. It may have a sort specification at the end, following the 'sortBy' keyword. In addition it may include prefix assignments which assign short names to context set identifiers.

IB Expression (re-Isearch language)	**CQL Expression**
dc.title/fish	dc.title any fish
dc.title/fish dc.creator/sanderson OR	dc.title any fish or dc.creator any sanderson

Ranking and Normalization

Ranking

We support many models of sorting result sets:

- By Record Key
- By order as indexed
- By an external sort
- By Score
- By Adjuncted Score
- By number of different term matches
- By Date (either forward or reverse)
- By Category
- By Newsrank (a heuristic that combines "score" with a function of chonology). The idea behind "Newsrank" is that newer stories are more significant than older ones.

Score

Score is the product of normalization of hits and there are several models.

Spatial Ranking

Spatial searches are scored according to the work "*A spatial overlay ranking method for a geospatial search of text objects*"[6], Lanfear, Kenneth J. & U.S. Geological Survey, 2006, USGS Reston, Va.. The spatial overlay score tries to correlate how well an object's footprint matches the search's spatial extent (defined by a bounding box).

Normalization

The re-Isearch engine supports many models of normalization. These may be chosen at search time:

- No normalization.
- Cosine normalization (TD-IDF): Despite being many decades old, still seems to be among the best. It is a bag-of-words retrieval function that ranks a set of documents based on the query terms appearing in each document, regardless of their proximity within the document. Its main drawback (beyond the need to create full sets) is that it tends to be biased towards shorter records, finding them more frequently than alone the linear distribution of lengths might suggest. This has led to the development of the Okapi system with a number of variants such as BM1, BM11, BM15, BM25 and others. At their heart (beyond using some empircal values for weighing parts of their metric) a comparison of document length with the average document length.
- Log Normalization: A cosine variant normalized (dampened) according to the log of document length.
- Max Normalization: Normalized to favor those with more different hits.
- Bytes Normalization: Various document length normalization models have been proposed to address the bias of Cosine Normalization towards shorter records. They, however, nearly always tend to overly penalize long records—including BM25. With Byte Normalization a middle ground approach is taken: the cosine model is slightly modified to also take document length distribution into consideration.
- Euclidean Normalization: Yet another variant of Cosine Normalization. The byte metric distance between "hits" (multiple term searches) is used to favor records where these are closer. Since hits are typically

6 http://pubs.usgs.gov/of/2006/1279/2006-1279.pdf

closer in shorter records given their lesser maximum distance, we limit ourselves to the minimum of all the distances rather than an average and adjust.

- One may extend the engine with custom normalizations.

Notice that as of August 2021 we don't support Okapi (BM25) normalization. This was a decision—that may be revised—based upon the belief that it is not wholly suitable to the underlying search paradigm. BM25 adjusts the cosine metric with a guesstimate parameters ***K*** and a weight ***b***. The weight b applies to a kind of linear weighting of the function according to a result's length with respect to the average result length in a result set. It does not consider the proximity of hits within the record. It only factors the frequency, record length, size of the result set and average size of records therein. Following a query we have a set that includes the hits and their location as well as a pointer to the record it is contained in. We, however, don't yet resolve particular information about the record's length. That information is contained in another data structure. We could look it up but it is an additional cost that seems, at this time, unwarranted. Our own tests using TREC data found Euclidean Normalization to more generally outperform BM11 and BM15—BM25 is just a weight factor that mixes these two algorithms.

Another overriding design issue is the question: should the result be a segment of a record what length should be used?. The whole record or that length of the segment? Recall we don't always want to just retrieve the whole record that contains the hit but perhaps the relevant elements. Since larger result segments are generally selected because they are "more relevant" any weighting against an average would degrade their rank. This results in having "more relevant" items lesser scored.

Part of our work was inspired by AF1. See the paper "Toward Better Weighting of Anchors", David Hawking et. al.[7]

> "Okapi BM25 scoring of anchor text surrogate documents has been shown to facilitate effective ranking in navigational search tasks over web data. We hypothesize that even better ranking can be achieved in certain important cases, particularly when anchor scores must be fused with content scores, by avoiding length normalisation and by reducing the attentuation of scores associated with high tf.
>
> …
>
> A more refined version of AF1 is likely to include better weighting of term coordination, weighting of proximity/adjacency of query terms, separate treatment of individual pieces of incoming anchor text and the proportion of anchor text consisting of the query words"

Score Bias

Scores can in turn be "biased" according to "priority" (a per record scalar), "category" (a per-record predicate) and temporal (date metadata). The skew can be used to "boost" or downgrade scores. In IBU News (a news analysis site that was operated by BSn until 2011) priority was calculated as a value to represent a number of features of the information source (such as data quality).

7https://david-hawking.net/pubs/hawking_sigirposter04.pdf

Magnetism

The re-Isearch engine also features a unique feature called magnetism. It allows (set via per-index parameters) to allow items in a result list to "attract" to one another (or repel) allowing them to fall into segmented clusters.

Central to the “magnetism” algorithm is the “category” of records. By boosting scores (either positively or negatively) on the basis of their category results within the same category can be more readily clustered.

XII. Isearch Command Line Tool

The Isearch command line tool is a simple utility to perform some searches on an index. It is not a replacement for a proper application written in one of the support languages but still has a myriad of uses.

Options

As one might expect it has a large number of options:

```
Isearch -d db [options] term...
options:
  -d (X)           // Search database with root name (X).
  -cd (X)          // Change working directory to (X).
  -id (X)          // Request document(s) with docid (X).
  -D (X)           // Load Result Set from file (X).
  -p (X)           // Present element set (X) with results.
  -P (X)           // Present Ancestor (X) content for hits.
                   // where X may be as (X)/(Y) where (X) is an ancestor
                   // and (Y) is a descendant of that ancestor.
  -c               // Sort results Chronologically.
  -cr              // Sort result from oldest to newest.
  -s               // Sort results by Score (Relevant Ranked).
  -sc              // Sort results by Score modified by Category.
  -smag (NN.NN)    // Sort results by Score/Category with Magnetism factor NN.NN
  -scat            // Sort results by Category.
  -snews           // Sort results by News Rank.
  -h               // Sort results by different matches (see -joint).
  -k               // Sort results by Key.
  -n               // Don't sort (By indexing order).
  -cosine_norm     // Cosine Normalization (default).
  -euclidean_norn  // Euclidean Normalization.
  -max_norm        // Max. normalization.
  -log_norm        // Log Normalization.
  -bytes_norm      // Bytes Normalization.
  -no_norm         // Don't calculate scores or normalize
  -sort B[entley]|S[edgewick]|D[ualPivot] // Which variation of QuickSort to use
  -show            // Show first hit neighborhood.
  -summary         // Show summary/description.
  -XML             // Present Results in XML-like structure.
  -H[TML]          // Use HTML Record Presentation.
  -q[uiet]         // Print results and exit immediately.
  -t[erse]         // Print terse results.
  -tab             // Use Terse tab format.
  -scan field      // scan service.
  -shell           // Interactive mode.
```

```
-rpn             // Interpret as an RPN query.
-infix           // Interpret as an InFix-Notation query.
                 //   Additional Unary Ops:  ! for NOT, field/  for WITHIN:field
-words           // Interpret as words.
-smart field     // Fielded Smart search.
-regular         // Regular Query (fields, weights etc. but no operators).
-syn             // Do synonym expansion.
-priority (NN.NN)// Over-ride priority factor with NN.NN
-scale (NN)      // Normalize score to 0-(NN) (scale).
-max (NN)        // Max. NN hits
-clip (NN)       // Clip at NN.
-common (NN)     // Set common words threshold at NN.
-reduce          // Reduce result set (MiniMax of different matches).
-reduce0         // Same as -h -reduce
-drop_h (NN)     // Drop all results with less than NN different matches.
-drop_a (NN)     // Drop all results with absolute score less than NN.
-drop_s (NN)     // Drop all results with scaled score less than NN.
-prefix (X)      // Add prefix (X) to matched terms in document.
-suffix (X)      // Add suffix (X) to matched terms in document.
-headline (X)    // Use alternative headline display using element (X).
-filename        // Filenames ONLY.
-filesystem      // Same as -q -filename -byterange
-hits            // Show total matches per record.
-joint           // Show joint total (different matches) per record.
-score           // Show unnormalized scores.
-date            // Print date.
-datemodified    // Print date modified.
-key             // Print Record Key.
-doctype         // Print Record doctype.
-byterange       // Print the byte range of each document within
                 // the file that contains it.
-range (X)[-(Y)] // Show the (X)th to (Y)th result in set
-daterange (X)   // Limit search to records in the range (X)
                 // Specified as YYYY[MM[DD]][-YYYY[MM[DD]]] or
                 // YYYY[MM[DD]]/[[YYYY]MM]DD
                 // Example: 2005 would return all records of the year 2005
                 // Note: The date here is the 'date of the record'
                 // in contrast to ordinary date fields.
                 // Note2: -daterange limits ALL searches to the range. The unary
                 // operator WITHIN:<daterange> applies to a search set.
-startdoc (NN)   // Display result set starting with the (NN)th
                 // document in the list.
-enddoc (NN)     // Display result set ending with the (NN)th document
                 // in the list.
-o (X)]          // Document type specific option.
-table (X)       // Save Result Set into file (X)
-level (NN)      // Set message level to NN (0-255).
-debug           // Load of debug messages.
-bench           // Show rusage
-pager (EXE)     // Use program EXE to page results (e.g. more).
-more            // Same as -pager /bin/more
(...)            // Terms (X), (Y), .. or a query sentence.
                 // If -rpn was specified then the sentence is expected to be in RPN.
                 // If -infix then the conventional in-fix notation is expected.
                 // If -words or -regular then OR'd.  Default is Smart search.
```

✗ Examples:

```
 Isearch -d MAIL NGI projects
 Isearch -d SHAKESPEARE to be or not to be
 Isearch -d POETRY truth 'beaut*' urn:2
 Isearch -d FTP -headline L C++
 Isearch -d WEBPAGES title/library
 Isearch -d WEBPAGE  -rpn library WITHIN:title
 Isearch -d WEBPAGES library WITHIN:title
 Isearch -d STORIES -rpn title/cat title/dog OR title/mouse OR
 Isearch -d STORIES -infix title/(cat or dog or mouse)
 Isearch -d POETRY -rpn speaker/hamlet line/love AND:scene
 Isearch -d POETRY -infix (speaker/hamlet and:scene line/love)
 Isearch -d POETRY -infix act/(speaker/hamlet and:scene line/love)
 Isearch -d MAIL -H -infix from/edz AND 'subject/"Isearch Doctypes"'
 Isearch -d KFILM -XML -show -rpn microsoft NT AND windows NOT
 Isearch -d BILLS -rpn vendor/BSn price<100 AND
 Isearch -d NEWS  -rpn unix WITHIN:2006
 Isearch -d SHAKESPEARE -P SPEECH/SPEAKER -rpn out spot PEER
```

```
Note: "Built-in" Elements for -p and -headline: F for Full, B for Brief and S for Short.
Additional Special elements: R for Raw, H for Highlight, L for location/redirect and M
for metadata.
```

Interactive Shell Mode

The -shell flag puts the tool into “shell modus”. This provides a kind of minimalist interactive search shell.

In the most simplistic form:

```
Isearch -d BART -shell
```

The response from the shell is the prompt:

```
Enter Query (=), [un]set option, range first-last or Select file #:
```

By using set or unset one can set command line flag options. The `set` command without an option shows the query mode set. Using = one can submit a query to be processed.

It contains a minimal help sub-system:

```
Enter Query (=), [un]set option, range first-last or Select file #: help
# Help: set/unset or NNN[,<ELEMENT>], NNN,<Ancestor>/<Descendant> or =<Query
Expression>
```

The command to exit the shell is: `quit.`

Using -shell and either -XML or -tab one can easily construct a search daemon it sit on a port.

Example: -tab -shell

```
edz@icebear$Isearch -d BART -tab -shell
# Process time: 2 ms. (2) Search: 0 ms.
```

```
# 0    1-0    0      0

Enter Query (=), [un]set option, range first-last or Select file #: =buy jewels
# Process time: 11 ms. (2) Search: 8 ms. (4.1 ms/term)
# 1    1-1    1      1
1.     100    Love's Labour's Lost

Enter Query (=), [un]set option, range first-last or Select file #:
```

Example: -XML -shell -show

```
edz@icebear$ ../bin/Isearch -d /BART -XML  -shell -show
<?xml version='1.0' encoding='iso-8859-1' standalone='yes'?>
<!-- Process time: 2 ms. (2) Search: 0 ms.-->
<RESULTS NUMBER="0" HITS="0" MATCHES="0">
<TITLE>BART</TITLE>
<MAINTAINER NAME='Edward C. Zimmermann,,,' ADDRESS='edz@nonmonotonic.netr'/>
<QUERY></QUERY>
</RESULTS>
<!--
 Enter Query (=), [un]set option, range first-last or Select file #: =buy jewels
Process time: 11 ms. (2) Search: 8 ms. (4.1 ms/term)-->
<RESULTS NUMBER="1" HITS="1" MATCHES="1">
<TITLE>BART</TITLE>
<MAINTAINER NAME='Edward C. Zimmermann,,,' ADDRESS='edz@icebear'/>
<QUERY>"buy" "jewels" PEER</QUERY>
<RESULT ID="1" CHARSET="iso-8859-1" LANGUAGE="en">
<SCORE ABSOLUTE="0.110432" SCALE="100">100</SCORE>
<FILE PATH="/home/edz/ib/ib2/build/data/" NAME="shakespeare.xml" START="3990175"
END="4204407"/>
<DOCTYPE>PLAY</DOCTYPE>
Isearch [Error]: URL: No Resource Path defined
<KEY>I$0000UHtF0GC2-00FEAV--Bhd</KEY>
<DATE>20071108T04:33:32Z</DATE>
<HEADLINE>Love's Labour's Lost</HEADLINE>
<HIT TERM="jewels">As <MATCH CONTAINER_NAME="PLAY\ACT\SCENE\SPEECH\LINE">jewels</MATCH>
in crystal for some prince to buy;</HIT>
<HITS UNITS="characters" NUMBER="2">
  <CONTAINER NAME="PLAY\ACT\SCENE\SPEECH\LINE" TYPE="" FC="(4047349,4047392)">
    <LOC POS="57177" LEN="6"/>
    <LOC POS="57214" LEN="3"/>
  </CONTAINER>
</HITS>

</RESULT>

</RESULTS>
<!--
Enter Query (=), [un]set option, range first-last or Select file #:
```

Example: -t -shell -show

```
edz@icebear$ Isearch -d BART -t -shell -show

Enter Query (=), [un]set option, range first-last or Select file #: =buy jewels

   1.   100  Love's Labour's Lost
```

```
Hit: As jewels in crystal for some prince to buy;

Enter Query (=), [un]set option, range first-last or Select file #:
```

Shell on Inetd (Internet Service Daemon)

inetd is a super-server daemon on many Unix systems that provides Internet services. For each configured service, it listens for requests from connecting clients. Requests are served by spawning a process which runs the appropriate executable, but simple services such as echo are served by inetd itself. External executables, which are run on request, can be single- or multi-threaded. It is generally located at /usr/sbin/inetd.

This makes it easy to put up a Isearch shell on a port to listen to requests.

The list of services that will be serviced is given in a configuration file, usually /etc/inetd.conf. The daemon may need a signal in order to re-read its configuration. For an example, Isearch can be configured as follows:

```
isearch-web stream tcp6 nowait ibadmin /opt/nonmonotonic/bin/Isearch Isearch
-d /var/index/WEB -shell -tab
```

The first word, isearch-web, is the official name of the service. It is resolved using the system database to map port numbers and protocols to service names. In this case, /etc/services could (using port 1234) contain:

isearch-web 1234/tcp

The second and third words describe the type of socket and underlying protocol respectively. The /etc/protocols database is consulted.

The fourth word is the wait/nowait switch. A single-threaded server expects inetd to wait until it finishes reading all the data. Otherwise inetd lets the server run and spawns new, concurrent processes for new requests.

The fifth word is the user name, from the /etc/passwd database, that the service program should run as. Here we are using the “ibadmin” account.

Finally, the path and the arguments of an external program are given. As usual, the first argument is the program name. In the example, inetd is told to launch the program with the command line arguments -d /var/index/WEB -shell -tab. inetd automatically hooks the socket to stdin, stdout, and stderr of the server program.

Generally TCP sockets are handled by spawning a separate server to handle each connection concurrently. UDP sockets are generally handled by a single server instance that handles all packets on that port.

Presentation Elements and Methods

One of the design goals of re-Isearch was to facilitate implementation of the ISO 23950 (ANSI/NISO Z39.50) Information Retrieval Protocol services standard. Z39.50 makes it easier to use large information databases by standardizing the procedures and features for searching and retrieving information.

ISO 23950 has the concepts of record syntax and record elements.

Presentation Elements (Metadata)

Presentation is requested of a record by its element name and its preferred record syntax.

- The element names specifies whether the client wants full records ("f"), brief records ("b") one of of the available fields (or a combination thereof).
- The preferred record syntax specifies the format of retrieval. It can be USMARC, SUTRS, GRS-1 or some other format. The values which may be set for this option must be taken from an enumerated set which is specified by the binding.

Element Name	Element	Description
Brief	B	Brief description of records (typ. Title or Headline)
Full	F	A "Non-brief" description, typically the full viewable record (not always the complete stored record). Views may depend upon user privileges and rights which different users getting different "full record" presentations.
Metadata	M	A metadata record describing the record
Location	L	Location (often URI) to access the record.

The elements "B" and "F" are mandated by the ISO23950/Z39.50 standard. re-Isearch reserves the 1-letter element space for extensions and special derived record elements.

Ancestors and Descendants

In re-Isearch one can select the name ancestors (via name or path) for hits. One can also request a named descendant of such an ancestor.

Lets look a bit closer by example of XML fragments (from SGML/XML markup of Shakespeare's works by Jon Bosak):

```
<SPEECH>
 <SPEAKER>LADY MACBETH</SPEAKER>
 <LINE>Out, damned spot! out, I say!--One: two: why,</LINE>
 <LINE>then, 'tis time to do't.--Hell is murky!--Fie, my</LINE>
 <LINE>lord, fie! a soldier, and afeard? What need we</LINE>
 <LINE>fear who knows it, when none can call our power to</LINE>
 <LINE>account?--Yet who would have thought the old man</LINE>
 <LINE>to have had so much blood in him.</LINE>
</SPEECH>
```

The words "*out*" and "*spot*" are in the same node (with path ...\SPEECH\LINE). Its named SPEECH ancestor is the above speech--- the only speech in all of Shakespeare's works to have the words "out" and "spot" in the same LINE. The SPEAKER descendant of that SPEECH is "LADY MACBETH".

These elements are specified as

```
AncestorPath[/DescendantPath]
```

Examples:

- *SPEECH* (or *PLAY\ACT\SCENE\SPEECH*) would return the content (markup) of (all) the speeches that contain the hits

- *SPEECH/SPEAKER* (or *PLAY\ACT\SCENE\SPEECH/SPEAKER* or *SPEECH/PLAY\ACT\SCENE\SPEECH\SPEAKER* or ...) would return their speakers.

If, on the other hand, we wanted to know the different speakers in the act where Lady Macbeth said "*Out, damned spot! out, I say*" we would request *SCENE/PLAY\ACT\SCENE\SPEECH/SPEAKER) (or SCENE/SPEAKER). This would yield of list including "Doctor" and "Gentlewoman" alongside the guilt ridden Lady.*

XIII. *Presentation Syntax*

In re-Isearch we may distinguish between the format that a record was created or stored and the format requested from a search.

Record Syntaxes

Record Syntax	Description
RAW	Raw. As stored on the file system. The whole record is just read into the system as stored.
SUTRS	Simple unstructured text plain text. This might be--- but must not be--- the same as RAW but may be rendered.
HTML	Provide a Web version for view using a contemporary browser. This might not be in HTML markup but may contain the HTTP MIME header followed by the binary stream for some forms of context (such as PDF).
SGML	Provide a SGML version of a metadata record for the resource.
XML	An XML version of metadata.

Record Syntax OIDs

Object Identifier	Name	Usage	Reference
1.2.840.10003.5.**100**	Explain	Explain Records	REC.1
1.2.840.10003.5.**100.1**	Revised Explain Syntax definition to support ZSQL query	Explain Records	ZSQL additions to Explain
1.2.840.10003.5.**101**	SUTRS	simple, unstructured text	REC.2
1.2.840.10003.5.**102**	OPAC	OPAC Records	REC.3
1.2.840.10003.5.**103**	Summary	Summary Records	REC.4
1.2.840.10003.5.**104**	GRS-0	(superceded by GRS-1)	
1.2.840.10003.5.**105**	GRS-1	structured information	REC.5
1.2.840.10003.5.**106**	ESTaskPackage	Extended Services	REC.6
1.2.840.10003.5.**107**	fragment	fragmentation	FragmentSyntax
1.2.840.10003.5.**108**	(not used)	(previously assigned to HTML; superceded by 1.2.840.10003.5.109.3)	
1.2.840.10003.5.**109**	✗ IANA mime types	(see note following this table)	
1.2.840.10003.5.**109.1**	pdf	mime type application/pdf	Portable Document Format Reference; Manual, Adobe Systems, Inc, Addison-Wesley Publishing Co. ISBN 0-201-62628-4, 1993.
1.2.840.10003.5.**109.2**	postscript	mime type application/postscript	rfc 1341
1.2.840.10003.5.**109.3**	html	mime type text/html	rfc 1866
1.2.840.10003.5.**109.4**	tiff	mime type image/tiff	Tag Image File Format (TIFF) class F, revision 6.0
1.2.840.10003.5.**109.5**	~~pdf~~ **error, should be gif**	mime type image/gif	rfc 1341
1.2.840.10003.5.**109.6**	jpeg	mime type image/jpeg	rfc 1341

1.2.840.10003.5.**109.7**	png	mime type image/png	Internet-Draft draft-boutell-png-spec-04.txt, "Png (Portable Network Graphics) Specification Version 1.0" Informational RFC; see item 11 of the IESG minutes from meeting of 7-11-96.
1.2.840.10003.5.**109.8**	mpeg	mime type video/mpeg	rfc 1341
1.2.840.10003.5.**109.9**	sgml	mime type text/sgml	rfc 1874
1.2.840.10003.5.**109.10**	xml (no specific version)	mime type text/xml	RFC 2376
1.2.840.10003.5.**109.10.1.0**	xml version 1.0		
1.2.840.10003.5.**109.10.1.1**	xml version 1.1		
1.2.840.10003.5.**109.11**	(*not used*)		
1.2.840.10003.5.**110**	✗ Z39.50 mime types	(see note following this table)	
1.2.840.10003.5.**110.1**	tiff-b		
1.2.840.10003.5.**110.2**	wav		
1.2.840.10003.5.**111**	SQL-RS	SQL	Z+SQL Profile
1.2.840.10003.5.**112**	xml-b	XML record according to the schema or definition identified by the element set name.	Implementor agreement: Requesting XML Records
1.2.840.10003.5.**1000**	✗ locally registered syntaxes		
1.2.840.10003.5.**1000.3.1**	Latin-1	locally registered by Lucent Technologies	
1.2.840.10003.5.**1000.3.2**	TIFF	locally registered by Lucent Technologies	
1.2.840.10003.5.**1000.3.3**	Postscript	locally registered by Lucent Technologies	
1.2.840.10003.5.**1000.6.1**	GRS-0	locally registered by CAS	also registered as 1.2.840.10003.5.104
1.2.840.10003.5.**1000.6.2**	CXF	locally registered by CAS	
1.2.840.10003.5.**1000.147.1**	ADF	locally registered by Astrophysics Data System (Smithsonian Astrophysical Observatory)	

A mime type may be registered as a Z39.50 mime type when there is no current appropriate iana type. When a mime type is so registered it is with the understanding that that registration will be depricated if and when an appropriate mime type is defined by iana, and it will be superceded by a subsequent registration in the iana category.

Highlighting and hit context

The engine provides a wide range of highlighting methods inclusive of support of Adobe's PDF Highlighting. Hit context exploits the document structure to text within its own container. The context for a hit for "Edward" in `<name>Edward Zimmermann</name><address>NONMONOTONIC...` *contains, for example, the name Edward Zimmermann but not NONMONOTONIC. Algorithms are provided to select both the context of individual "hits" with a record but also to calculate an "optimal" context based around a measure of hit distance metrics.*

XIV. Centroids (Meshes and P2P)

The re-Isearch engine is not just about search but about what we have called “re-search”, a recursive model of search where one searches first for where to search rather than just demanding a list of records.
One of the approaches developedto enable this within a distributed network is a so-called “bag of words” centroid. Each target (index) can be viewed as a potential node withing a search mesh or peer-to-peer network. Here one searches not for specific records but for databases that might have the data one is looking for: targets with content (terms) in specific fields that meets a query rather than for document or records.
To make this possible one can generate a so-called “Centroid” file for a target. It is a file (using a kind-of XMLish format) that lists each field (path) and its included terms (and their frequency).

Here is a fragment of the file generated for an index of the complex works of Shakespeare:

```
<?xml version="1.0" encoding="utf-8" standalone="yes"?>
        <!-- generator="re-Isearch 4.0a x86_64 GNU/Linux" -->
        <!DOCTYPE Locator SYSTEM "centroid.dtd">
<centroid src="/var/opt/nonmonotonic/indexes/bart/BART" version="0.1">
 <words slots="22945" slot_length="28" source_charset="iso-8859-1">
  <word freq="37">0</word>
  <word freq="40">1</word>
  <word freq="1">10</word>
….
</words>
 <fields count="77">
  <ACT type="string" elements="22819">
    <word freq="1">10</word>
    <word freq="1">2d</word>
    <word freq="2">2s</word>
….
    <word freq="1">zone</word>
    <word freq="21">zounds</word>
    <word freq="1">zwaggered</word>
  </ACT>
….
<PLAY type="string" elements="22911">
    <word freq="1">10</word>
    <word freq="74">1992</word>
    <word freq="37">1994</word>
    <word freq="37">1996</word>
    <word freq="74">1999</word>
…
 </fields>
</centroid>
```

Searching for a terms like “zounds” in an ACT element would here turn up the target BART where the word occurs 21 times. Searching BART a searcher could then see that the terms occurs in 6 plays of Shakespeare and most prominently in the `The First Part of Henry the Fourth' (occurring 10 times) but also occurring only once in

both the `The Tragedy of Titus Andronicus' ( 'Zounds, ye whore! is black so base a hue?) and `The Life and Death of King John' (Zounds! I was never so bethump'd with words) .

XV. Scan Service

Instead of searching for records or content that meets the demands of some query sometimes one might want to search for terms or queries themselves. This is called “scan”. With it one can browse indexes to view a list of the words or phrases included. Scan supports searching into structure and since it allows for all the magic of of term search once can use it to find specific words to search rather than wildcards to keep noise down.
Example instead of “cheap*” (in the collected works of Shakespeare) once could see that we had also the term cheapside alongisde cheapen, cheapest and cheapy. Cheapside is a street in the City of London, the historic and modern financial centre of London. It was for a long time one of the most important streets in London. Shakespeare used Cheapside as the setting for several bawdy scenes in Henry IV, Part I. In Henry VI, Part II, the rebel Jack Cade: "all the realm shall be in common; and in Cheapside shall my palfrey go to grass".

Searching (the collected works of Shakespeare again) for “jew*” one would see that “jewel” occurs in many more plays (29) than “jew” (7 plays) but is less frequent (an incidence of 69 times in `The Merchant of Venice') or “jewish” (which occurs twice in `The Merchant of Venice' but no where else). Jewel, by contrast, was most frequent in `The Life of Timon of Athens' but there it occurred only 8 times.

The scan facility can be used to develop other search interfaces such as facets.

XVI.Facets

Faceted search is a popular strategy for *information exploration* to assist the searcher

- Discover relationships or trends between contents.
- To enable dynamic classified browsing.
- Help users who don't know precisely what they can find or what to search for (exploration and discovery).

From the perspective of the information provider they

- Allow one to push searches (navigate them) into specific areas (define top-down narratives).
- Create an aura of relevance.

The primary design goal is to allow users to move through large information spaces in a flexible manner both refining and expanding the queries, while maintaining a consistent representation of the collection's structure and "not getting lost".

Effective faceted search depends on well organized taxonomies. Many organizations, unfortunately, have not done the upfront classification work needed to fully leverage facets for search and guided navigation. The “let’s just use what we have and see what happens” approach may sometimes provide some benefit but nearly always miss their potential and often mislead and navigate users into the wrong direction. Our experience is that the cost of "bad navigation" can be— especially in eCommerce applications— very high. Even with well defined taxonomies we've found that only in homogeneous well-defined settings with shared semantics (men, women, boys, girls, pants, skirts, tops etc.) can they be effective.

Typical implementations of faceted search is via (db intensive) relational database calls. With indexing applied to fields this still tends to limit them to sites with a relatively small number of items (nodes), low update frequency (inserts to indexed fields demand re-indexing) and with comparatively low traffic.
re-Isearch handles things differently. Information is de-coupled from the RDMS and off-loaded. Faceted search is implemented in re-Isearch via cacheable search calls including:

- Field/Path faceting: the counts for all terms, or just the top terms in any given field or path.
- Path Fragement Faceting: Like field/path faceting but is a relative path (in the document tree) via the field/path instance where a given query found a match.
- Query faceting: the number of documents in the current search results that also match the given query.
- Date faceting: the number of documents that fall within certain date ranges.
- Data faceting: the number of documents that fall with a numerical range in a *specific numerical field*, geospatial bounding box etc.

Like Search and Scan, **Faceted Search** its offloaded from the application front end (CMS etc.) and provided as services via the server.

XVII. Programming Languages

Since the internal representation of a query is a RPN stack and we have a number of programming interfaces (C++, Python, Java, PHP, Tcl, etc.) we have the tremendous power to express and store what we wish. At current we don't have a SQL or SPARQL interface but it should be relatively easy for a contributor to write in Python (or one of the other languages).

Python

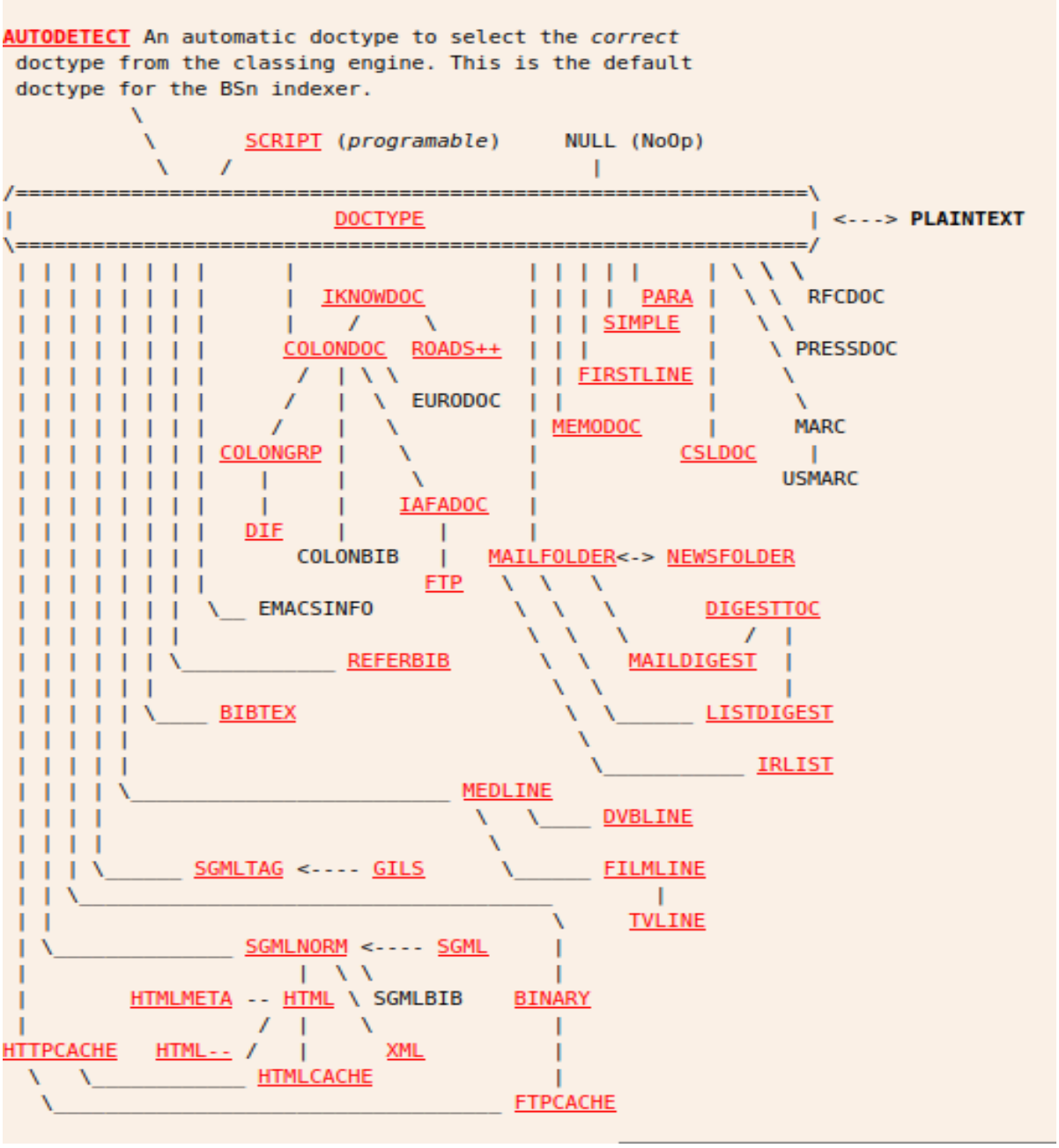
In Python one can build a query like:

```
query = "beschaffungsmanagement:3 OR beschaffungsmarketing:3 OR
beschaffungsmarkt:3 OR beschaffungsplanung:3 OR beschaffungsprozesse:3 OR
(deterministische:3 FOLLOWS beschaffung:3) OR einkaufspolitik:3 OR
(stochastische:3 FOLLOWS beschaffung:3) OR strategien:2 OR strategie OR (c:3
FOLLOWS teilemanagement:3) OR beschaffungsmarktforschung:3 OR (double:4 FOLLOWS
sourcing:4) OR (global:4 FOLLOWS sourcing:4) OR (modular:4 FOLLOWS sourcing:4)
OR (multiple:4 FOLLOWS sourcing:4) OR (single:4 FOLLOWS sourcing:4) OR
sourcing:3 OR methoden:2 OR methode OR lieferant:3 OR lieferanten:2 OR
logistikdienstleister:3 OR rahmenvertraege:3 OR tul:4 OR spediteur:3 OR
spediteure:2 OR spediteuren:2 OR spediteurs:2 OR stammlieferant:3 OR vertraege:3
OR vertrag:2 OR vertraegen:2 OR vertrages:2 OR vertrags:2 OR zulieferpyramide:3
OR partner:2 OR partnern OR partners OR beschaffungskosten:3 OR
einkaufscontrolling:3 OR einkaufsverhandlungen:3 OR incoterms:3 OR
wiederbeschaffungszeit:3 OR zahlungskonditionen:3 OR konditionen:2 OR kondition
OR einfuhr:3 OR einfahre:2 OR einfahren:2 OR einfahrend:2 OR einfahrest:2 OR
einfahret:2 OR einfahrt:2 OR einfuehrt:2 OR einfuehre:2 OR einfuhren:2 OR
einfueren:2 OR einfuehrest:2 OR einfuehret:2 OR einfuhrst:2 OR einfuhrt:2 OR
eingefahren:2 OR einzufahren:2 OR eust:4 OR einfuhrumsatzsteuer:3 OR inbound:3
OR jis:4 OR (just:3 FOLLOWS in:3 FOLLOWS sequence:3) OR jit:4 OR (just:3 FOLLOWS
in:3 FOLLOWS time:3) OR sendungverfolgung:3 OR stapler:3 OR staplern:2 OR
staplers:2 OR we:4 OR wareneingang:3 OR wa:4 OR warenausgang:3 OR
wareneingangskontrolle:3 OR zoll:3 OR zoelle:2 OR zoellen:2 OR zolles:2 OR
zolln:2 OR zolls:2 OR gezollt:2 OR zolle:2 OR zollen:2 OR zollend:2 OR zollest:2
OR zollet:2 OR zollst:2 OR zollt:2 OR zollte:2 OR zollten:2 OR zolltest:2 OR
zolltet:2 OR zollware:3 OR transport:2 OR transporte OR transporten OR
transportes OR transports"
db_path="/var/opt/nonmonotonic/NEWS";
pdb = IDB(db_path); ## Open the index
squery = SQUERY(query); # Build the query
irset = pdb.Search(squery, ByScore); # Run the query
## The resulting irset is a set which we can perform operations upon or combine with another irset
## from another search using the operators in the tables above—for example Or, Nor, And, ….
irset = irset1.And(irset2); ## This is like irset = irset1 AND irset2
```

As one can see it is relatively straightforward to build alternative query languages to run.

XVIII. Doctypes

This is an old (historic) map of the doctypes



Some, like script, have been abandoned and instead supplemented by using the engine within a script language—instead of embedding Python into the engine, the engine is embedded into Python as a module. Many others are similar just in name only.

What has not changed is that the root class of all document handlers is the “DOCTYPE” class—vastly expanded since that map. Every other class is a descendant. Some like AUTODETECT are not true document handlers but managers for detecting which document format to use to handle some document. Others like SGMLNORM are master document types useful in themselves for handling SGML document but also to provide parser services for XML documents. The XML class (child of SGMLNORM itself child of DOCTYPE) has a child XMLBASE. It adds special handling for heirarchical fields. XMLBASE itself has a number of children like XMLREC and GILSXM. GILSXML too has children like NEWSML. Some handlers are not purely hierarchical but as a family pass work to their children (rather than the always the other way around). A good example is MAILFOLDER, a handler designed for folders of mail (RFC822) messages (a child of PTEXT). Since mails can sometimes have other formats like mailing lists it like AUTODETECT but on mail messages tries to detect the format. If it looks like a digest it gets passed to the MAILDIGEST class (a child of MAILFOLDER) which in turn might pass it to LISTDIGEST (a child of MAILDIGEST) or even AOILLIST (which is designed for AOL's RFC-noncompliant Listserver Mail Digests).

The current collection (August 2021):

```
Available Built-in Document Base Classes (v28.8):
        AOLLIST           ATOM     AUTODETECT       BIBCOLON
         BIBTEX         BINARY            CAP       COLONDOC
       COLONGRP         CSVDOC       DIALOG-B            DIF
           DOCX        DVBLINE        ENDNOTE      EUROMEDIA
       FILMLINE         FILTER    FILTER2HTML    FILTER2MEMO
    FILTER2TEXT     FILTER2XML      FIRSTLINE            FTP
           GILS        GILSXML        HARVEST           HTML
         HTML--      HTMLCACHE       HTMLHEAD       HTMLMETA
     HTMLREMOTE       HTMLZERO        IAFADOC       IKNOWDOC
         IRLIST        ISOTEIA           JIRA          LATEX
     LISTDIGEST     MAILDIGEST     MAILFOLDER       MARKDOWN
        MEDLINE           MEMO        METADOC       MISMEDIA
     NEWSFOLDER         NEWSML            OCR            ODT
        ONELINE       OZSEARCH         PANDOC        PAPYRUS
           PARA            PDF      PLAINTEXT             PS
         PTEXT            RDF       REFERBIB            RIS
        ROADS++         RSS.9x           RSS1           RSS2
     RSSARCHIVE        RSSCORE           SGML       SGMLNORM
        SGMLTAG         SIMPLE           SOIF            TSV
         TSVDOC        XBINARY        XFILTER            XML
        XMLBASE         XMLREC      YAHOOLIST
External Base Classes ("Plugin Doctypes"):
  RTF:               // "Rich Text Format" (RTF) Plugin
  ODT:               // "OASIS Open Document Format Text" (ODT) Plugin
  ESTAT:             // EUROSTAT CSL Plugin
  MSOFFICE:          // M$ Office OOXML Plugin
  USPAT:             // US Patents (Green Book)
  ADOBE_PDF:         // Adobe PDF Plugin
  MSOLE:             // M$ OLE type detector Plugin
  MSEXCEL:           // M$ Excel (XLS) Plugin
  MSRTF:             // M$ RTF (Rich Text Format) Plugin [XML]
  NULL:              // Empty plugin
  MSWORD:            // M$ Word Plugin
  PDFDOC:            // OLD Adobe PDF Plugin
  TEXT:              // Plain Text Plugin
  ISOTEIA:           // ISOTEIA project (GILS Metadata) XML format locator records
```

NOTE: *The version built and/or distributed may have a list that differs from the one above as the "real" documentation is always the built-in list and NOT this handbook.*

NOTE: Every built-in doctype can be extended to have its own options by using the CHILD:PARENT convention, e.g. IDISS:XMLREC to define a document format IDISS that will use the XMLREC handler. The specific behavior is set by the options.

✗ General Options:

The various doctypes has a number of options allowing them to be used generically in a wider range of applications and for a larger class of document. **All the options set-able in a parent doctype can be set by its children.**

In the **`[doctype]`** section of the DB.ini (where doctype is the name of the doctype handler) one can specify a number of options specific to the database—versus in the doctype.ini configuration file where the options are set specific to the doctype in its **`[general]`** section-- as **`Key=Value`**

Key	Value
Headline	<Headline format to over-ride default Brief record> The format is %(FIELD1)...text...%(FIELD2) ... where the %(X) declarations get replaced by the content of field (X). The declaration %(X?:Y) may be used to use the content of field (Y) should field (X) be empty or undefined for the record.
Headline/<RecordSyntax OID>	<Headline format for Record Syntax>
Summary	<Format to define a Summary> # See Headline
Summary/<RecordSyntax OID>	<Format to define a Summary> # See Headline
Content-Type	<MIME Content type for the doctype>
FieldType	<file to load for field definitions> # default <doctype>.fields
DateField	<Field name to use for date of record>
DateModifiedField	<Date Modified field for record>
DateCreatedField	<Date of record creation field>
DateExpiresField	<Date of record expiration>
TTLField	<Time to live in minutes: Now+TTL = DateExpires>
LanguageField	<Field name that contains the language code>
KeyField	<Field name that contains the record key>
MaxWordLength	<Number, words longer than this won't get indexed>
Help	<Help text>

Each doctype in turn has its own doctype.ini configuration file where a number of its parameters are set.

[Fields]	Field=Field1 # Map fields into others
[FieldTypes]	Field=<FieldType>
[External/<RecordSyntax OID>]	Field=<program> # e.g. F=cat would pipe the record for full element presentation to cat
[Present <Language-Code>]	Field=<Display format name for Field when the record has language>
[Defaults]	Field=<Default Value> Default value for Field if not in record.

In the <db.ini> some of these can be embedded as

[Defaults <Doctype name>]	Field=<Default Value> Default value for Field if not in record.
[<Uppercase Doctype Name>]	The general options in the table abve

AUTODETECT

Lets start off the with AUTODETECT type as it's often the go-to default. Class Tree:

DOCTYPE (Generic Document Type)

v

AUTODETECT

AUTODETECT is a special kind of doctype that really isn't a doctype at all. Although it is installed from the viewpoint of the engine as a doctype in the doctype registrary, it does not handle parsing or presentation and only serves to map and pass responsibility to other doctypes. It uses a complex combination of file contents and extension analysis to determine the suitable doctype for processing the file.

The identification algorithims and inference logic have been designed to be smart enough to provide a relatively fine grain identification. The analysis is based in large part upon content analysis in contrast to purely magic or file extension methods. The later are used as hints and not for the purpose of identification. These techniques allow the autodetector to distinguish between several different very similar doctypes (for example MEDLINE, FILMLINE and DVBLINE are all based upon the same basic colon syntax but with slightly different features). It allows one to index whole directory trees without having to worry about the selection of doctype. It can also detect many doctypes where there are, at current, no suitable doctype class available or binary files not probably intended for indexing (these include misc files from FrameMaker, SoftQuad Author/Editor, TeX/METAFONT, core files, binaries etc). At current ALL doctypes available are identified. For doctypes that handle the same document formats but for different functions (eg. HTML, HTML-- and HTMLMETA) given that being logical does not mean it can read minds. For these one must specify the document parser or the most general default parser would be chosen (eg. HTML for the entire class of HTML files).

Should the document format not be recognized by the internal logic it then appeals to, should it have been built with it (its optional) libmagic. That library has a user editable magic file for identification. If the type is identified as some form of "text", viz. not as some binary or other format, then it is associated with the PLAINTEXT doctype.

Since it has proved accurate, robust and comfortable it is the default doctype.

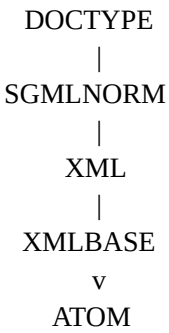
✗ Options in .ini:

```
[General]
Magic=<path>     # Path of optional magic file
ParseInfo=[Y|N]  # Parse Info for binary files (like images)

[Use]
<DoctypeClass>=<DoctypeClassToUse> # example HTML=HTMLHEAD
<DoctypeClass>=NULL  # means don't index <DoctypeClass> files
```

ATOM

Supports various flavors of the IETF Atom 1.0 Syndication Forma (AtomPub)t. The format is an XML language used for web feeds envisioned as a replacement for RSS. Its last release as a standard was in 2007. The Atom Syndication Format was issued as a Proposed Standard in IETF RFC 4287 in December 2005. The co-editors were Mark Nottingham and Robert Sayre. This document is known as atompub-format in IETF's terminology. The Atom Publishing Protocol was issued as a Proposed Standard in IETF RFC 5023 in October 2007. Two other drafts have not been standardized



Example:

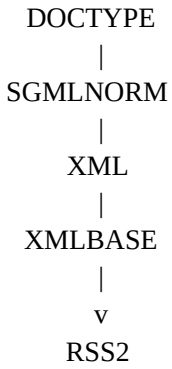
```
<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">
       <title>Example Feed</title>
       <subtitle>A subtitle.</subtitle>
       <link href="http://example.org/feed/" rel="self" />
       <link href="http://example.org/" />
       <id>urn:uuid:60a76c80-d399-11d9-b91C-0003939e0af6</id>
       <updated>2003-12-13T18:30:02Z</updated>
       <entry>
              <title>Atom-Powered Robots Run Amok</title>
              <link href="http://example.org/2003/12/13/atom03" />
              <link rel="alternate" type="text/html"
href="http://example.org/2003/12/13/atom03.html"/>
              <link rel="edit" href="http://example.org/2003/12/13/atom03/edit"/>
              <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
              <updated>2003-12-13T18:30:02Z</updated>
              <summary>Some text.</summary>
              <content type="xhtml">
                     <div xmlns="http://www.w3.org/1999/xhtml">
                            <p>This is the entry content.</p>
```

```
                </div>
            </content>
            <author>
                <name>John Doe</name>
                <email>johndoe@example.com</email>
            </author>
        </entry>
</feed>
```

The Atom format is, like RSS, still deployed by many sites but its use in the mainstream storefront has been widely upstaged by JSON. In the backend, AtomPub continues to have a strong presence via the OASIS OData protocol.

> *"A REST-based protocol, OData builds on HTTP, AtomPub, and JSON using URIs to address and access data feed resources. It enables information to be accessed from a variety of sources including (but not limited to) relational databases, file systems, content management systems, and traditional Web sites. OData provides a way to break down data silos and increase the shared value of data by creating an ecosystem in which data consumers can interoperate with data producers in a way that is far more powerful than currently possible, enabling more applications to make sense of a broader set of data. Every producer and consumer of data that participates in this ecosystem increases its overall value." – "OASIS Open Data Protocol (OData) TC | OASIS".*

RSS2



RSS2 is the Really Simple Syndication 2.0.(XML) format handler. Websites usually use RSS feeds to publish frequently updated information, such as blog entries, news headlines, episodes of audio and video series, or for distributing podcasts. An RSS document includes full or summarized text, and metadata, like publishing date and author's name. RSS formats are specified using a generic XML file.

RSS verus ATOM:

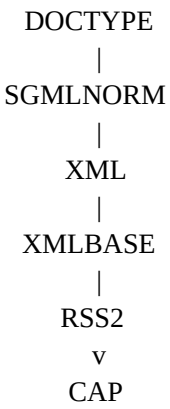
RSS 2.0	Atom 1.0
author	author*
category	category
channel	feed
copyright	rights
—	subtitle
description*	summary and/or content
generator	generator
guid	id*

image	logo
item	entry
lastBuildDate (in channel)	updated*
link*	link*
managingEditor	author or contributor
pubDate	published (subelement of entry)
title*	title*
TTL	—

Note: default special extension is "etag" field for key.

CAP

Supports a variant of the OASIS Standard CAP-V1.1, October 2005 and CAP-V1.2, July 2010 in an RSS2 news feed.
Class Tree:



The Common Alerting Protocol (CAP) is an XML-based data format for exchanging public warnings and emergencies between alerting technologies. CAP allows a warning message to be consistently disseminated simultaneously over many warning systems to many applications, such as Google Public Alerts and Cell Broadcast. CAP increases warning effectiveness and simplifies the task of activating a warning for responsible officials.

Standardized alerts can be received from many sources and configure their applications to process and respond to the alerts as desired. Alerts from the Department of Homeland Security, the Department of the Interior's United States Geological Survey, and the United States Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and state and local government agencies can all be received in the same format by the same application. That application can, for example, sound different alarms, based on the information received.

By normalizing alert data across threats, jurisdictions, and warning systems, CAP also can be used to detect trends and patterns in warning activity, such as trends that might indicate an undetected hazard or hostile act. From a procedural perspective, CAP reinforces a research-based template for effective warning message content and structure.

Example:

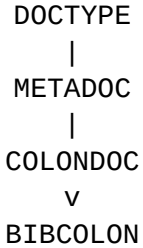
```
<?xml version="1.0"  encoding="UTF-8"?>
<rss version="2.0">
<channel>
<title>Alerts Posted by ACMAD</title>
<link>http://www.acmad.org/alerts/rss.xml</link>
<description>Alerts posted by ACMAD (African Centre of Meteorological Applications for
Development)</description>
<language>en-us</language>
<copyright>public domain</copyright>
<pubDate>Fri, 14 Oct 2011 15:13:22 +0000</pubDate>
<docs>http://blogs.law.harvard.edu/tech/rss</docs>
<item>
<title>Geomagnetic Storm Alert</title>
<link>http://www.acmad.org/alerts/20111014150503.xml</link>
<description>There is likely to be a major geomagnetic storm and possible auroral
activity over the next few days. Space W eather sources at NOAA/NASA indicate that major
solar flares and a coronal mass ejection (CME) were observed at 9:30 a.m. Eastern Time on
June 6.</description>
<author>echristian@usgs.gov</author>
<category>Met</category>
<guid>http://www.acmad.org/alerts/20111014150503.xml</guid>
<pubDate>2011-10-14T15:05:03-00:00</pubDate>
</item>
</channel>
</rss>
```

CAP feeds are typically available via RSS, Atom and ASN.1

See: http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2.html

BIBCOLON

COLONDOC for bibliographies



Special fields are:

```
  Template: Class   // First field (mandatory)
  Handle: UniqueID  // 2nd field (mandatory)
  Name:             // Name associated with record
  Organization:     // Associated organization for name above
  Email:            // Internet email for name above
```

The UniqueID passed in Handle is used for the record key.

BIBTEX

DOCTYPE
^
BIBTEX

The native BIBTEX doctype class is for BibTeX bibliographic databases as used by the LaTeX package for the TeX-typesetting program.

The BIBTEX doctype supports TeX macro encodings of European characters, string substitution and hypertext links to "crossref" entries.

BibTeX is reference management software for formatting lists of references. The BibTeX tool is typically used together with the LaTeX document preparation system. Within the typesetting system, its name is styled as B I B T E X {\displaystyle {\mathrm {B{\scriptstyle {IB}}\!T\!_{\displaystyle E}\!X} }} {\mathrm {B{\scriptstyle {IB}}\!T\!_{\displaystyle E}\!X} }. The name is a portmanteau of the word bibliography and the name of the TeX typesetting software.
BibTeX has become one of the standard formats to store and share bibliographic data. Each BibTeX reference consist of three parts: the entry type, citekey, key-value pairs storing the bibliographic data.

NOTE: The engine does not support the @STRING construction.
`@String{inst-LASL = "Los Alamos Scientific Laboratory"}`
during fielded search but gets resolved in presentation, e.g. an element using inst-LASL as value needs to be searched as such rather than “Los Alamos”.. during the presentation, however, the abbreviation does get resolved. This was a design decision. Should one wish to have searches for "Los Alamos Scientific Laboratory" find also inst-LASL one can use the thesaurus facility. A script to process @STRING abbreviations into thesaurus entries should be quite trivial to implement.

✗ Example of a book:

```
@book{Robinson:1966,
      author    = "Robinson, Abraham, 1918-1974",
      title     = "Non-standard analysis",
      series    = “Studies in logic and the foundations of
mathematics”,
      publisher = "North-Holland Pub. Co.",
      address   = "Amsterdam, NL",
      year      = 1966
    }
```

✗ Example of an article:

```
@Article{Finerman:1979:F,
  author =       "Aaron Finerman",
```

```
  title =        "Foreword",
  journal =      j-ANN-HIST-COMPUT,
  volume =       "1",
  number =       "1",
  pages =        "3--3",
  month =        jul # "\slash " # sep,
  year =         "1979",
  CODEN =        "AHCOE5",
  ISSN =         "0164-1239",
  ISSN-L =       "0164-1239",
  bibdate =      "Fri Nov 1 15:29:16 MST 2002",
  bibsource =
"http://www.math.utah.edu/pub/tex/bib/annhistcomput.bib",
  URL =
"http://dlib.computer.org/an/books/an1979/pdf/a1003.pdf;
                 http://www.computer.org/annals/an1979/a1003abs.htm",
  acknowledgement = ack-nhfb,
  fjournal =     "Annals of the History of Computing",
  journal-URL =  "http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?
punumber=5488650",
}
```

✗ BibTeX features 14 entry types:

Entry Type	**Description**
article:	Any article published in a periodical like a journal article or magazine article
book:	Book with designated published
booklet:	like a book but without a designated publisher
conference:	a conference paper
inbook:	Section or chapter in a book
incollection:	Article in a collection
inproceedings:	Conference paper (same as the conference entry type)
manual:	Technical manual
masterthesis:	Masters thesis
misc:	used if nothing else fits
phdthesis:	PhD thesis
proceedings:	whole conference proceedings
techreport:	technical report, government report or white paper
unpublished:	work that has not yet been officially published

Standard field types

- **address**: address of the publisher or the institution
- **annote**: an annotation
- **author**: list of authors of the work
- **booktitle**: title of the book
- **chapter**: number of a chapter in a book
- **edition**: edition number of a book
- **editor**: list of editors of a book
- **howpublished**: a publication notice for unusual publications
- **institution**: name of the institution that published and/or sponsored the report
- **journal**: name of the journal or magazine the article was published in
- **month**: the month during the work was published
- **note**: notes about the reference
- **number**: number of the report or the issue number for a journal article
- **organization**: name of the institution that organized or sponsored the conference or that published the manual
- **pages**: page numbers or a page range
- **publisher**: name of the publisher
- **school**: name of the university or degree awarding institution
- **series**: name of the series or set of books
- **title**: title of the work
- **type**: type of the technical report or thesis
- **volume**: volume number
- **year**: year the work was published

The BibTeX parser supports a number of additional keywords.

Currently recognizes the following keywords: `"ISBN", "ISSN", "LCCN", "URL", "abstract", "acknowledgement", "address", "affiliation", "annote", "availability", "author", "bibdate", "booktitle", "classification", "chapter", "coden", "confdate", "conflocation", "confsponsor", "copyright", "crossref", "edition", "editor", "howpublished", "institution", "journal", "key", "keywords", "language", "month", "note", "number", "organization", "pages", "pageswhole", "price", "publisher", "review", "school", "series", "subject", "thesaurus", "title", "type", "uniform", "volume" and "year"`

NOTE: The keyword “`key`” is quite special and unique to the engine in that it sets the record key.

This doctype can be used like the IKNOWDOC and ROADS++ doctypes for Whois++ services.
The MIME type for "Raw" records is "Application/X-BibTeX".

REFERBIB

"REFERBIB": Refer bibliographic record format (used by several systems).

DOCTYPE
v

REFERBIB

The default field parser recognizes the extended names used by many systems including EndNote, Papyrus and the HCI extensions.

PAPYRUS

Class Tree:

```
DOCTYPE
   |
REFERBIB
   V
PAPYRUS
```

ENDNOTE

Class Tree:

```
DOCTYPE
   |
REFERBIB
   v
ENDNOTE
```

BINARY

The BINARY doctype has been designed for the management of multimedia files (audio/graphics), CAD drawings and non-textual databases whose content we don’t want to try to directly index.

```
DOCTYPE
   v
BINARY
```

A "binary" file consists of 2 (two) components, a plain text description and the binary file itself. Looks for a file ,info that contains the text information (eg. for "x.tar" looks for "x.tar,info").

The first sentence in the ,info file is used to construct the "Title" field—as in FIRSTLINE. The Rest of the document is stored under the "Description" field.

The fields Title, Description and the whole document (Any Field) are searchable.

In the Presentation:

Title returns the first line.

The FULLTEXT ("F") attribute returns the binary file.
The field FULLPATH returns the complete path to the file.
The field BASENAME returns the basename of the binary file.
The Key is a unique name based on the basename of the binary file.

The default headline consists of the title and the type of the file in ().
The MIME type for depends upon the type of the binary file.

Built-in MIME bindings

Extension	MIME type	Extension	MIME type
NoExtension	*/*	.mpe	video/mpeg
Default	Application/Octet-Stream	.mpeg	video/mpeg
.ai	application/postscript	.mpg	video/mpeg
.aif	audio/aiff	.nvd	application/x-navidoc
.aifc	audio/aiff	.nvm	application/x-navimap
.aiff	audio/aiff	.pbm	image/x-portable-bitmap
.ani	application/x-navi-animation	.pdf	application/pdf
.arc	application/x-arc	.pgm	image/x-portable-graymap
.art	image/x-art	.pic	image/pict
.au	audio/basic	.pict	image/pict
.avi	video/x-msvideo	.pnm	image/x-portable-anymap
.bibtex	application/x-bibtex	.ps	application/postscript
.bin	application/x-macbinary	.qt	video/quicktime
.bmp	image/bmp	.ra	audio/x-pn-realaudio
.btx	application/x-bibtex	.ram	audio/x-pn-realaudio
.cpio	application/x-cpio	.ras	image/x-cmu-raster
.csv	application/csv	.refer	application/x-refer
.dcr	application/x-director	.rgb	image/x-rgb
.doc	application/x-msword	.rtf	application/rtf
.dir	application/x-director	.sgm	text/sgml
.dll	application/octet-stream	.sgml	text/sgml
.dp	application/commonground	.sit	application/x-stuffit
.dtd	text/sgml	.snd	audio/basic
.dvb	application/x-dvbline	.so	application/octet-stream
.dvi	application/x-dvi	.sql	application/x-sql
.dxr	application/x-director	.stl	application/x-navistyle
.eml	text/plain	.tar	application/x-tar
.eps	application/postscript	.tcl	text/plain
.exe	application/octet-stream	.tex	application/x-tex
.gif	image/gif	.text	text/plain
.gz	application/x-compressed	.tgz	application/x-compressed
.hqx	application/mac-binhex40	.tif	image/tiff
.htm	text/html	.tiff	image/tiff
.html	text/html	.txt	text/plain
.latex	application/x-latex	.voc	audio/basic
.lha	application/x-lharc	.xbm	image/x-xbitmap
.ltx	application/x-latex	.xpm	image/x-xpixmap

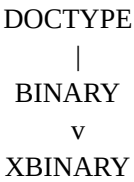
.java	application/x-java	.vrml	x-world/x-vrml
.jfif	image/jpeg	.wav	audio/x-wav
.jpe	image/jpeg	.wp4	application/x-wp4
.jpg	image/jpeg	.wp5	application/x-wp5
.jpeg	image/jpeg	.wks	application/x-lotus123
.js	application/x-javascript	.wrl	x-world/x-vrml
.ls	application/x-javascript	.xls	application/x-excel
.map	application/x-navimap	.Z	application/x-compressed
.mif	application/x-mif	.zip	application/x-zip-compressed
.mocha	application/x-javascript	.zoo	application/x-zoo
.mov	video/quicktime		

If compiled with the optional libmagic library it will, should it not have resolved the MIME type use it to try to determine an appropriate MIME type.

NOTE: The reason we look at the extension first is to allow for type spoofing as is commonly practiced by formats that use archivers such as ZIP (e.g. .jar files).

XBINARY

The XBINARY doctype is intended for indexing binary files.



While the BINARY doctype uses plain text “,info” files to describe a resource (considered a “binary” file to indicate that its content is not being parsed for data), it instead, expects an “,info.xml” file. These files, encoded in XML, contain a description (metadata) of the file resource. The format of the XML file to describe the metadata is relatively free and up to the application. The only assumption is that there should be a “TITLE” element to describe the resource—an alternative element that would proxy as TITLE can, of course, be remapped to TITLE during indexing. The class allows a free choice of what XMLish doctype to use for parsing the ,info.xml” file—one can even use the FILTER2XML doctype to have a script (“filter”) create or modify the data passed to the parser.

- Uses the field TITLE for the default headline
- Uses the extension (as does BINARY) to determine the MIME type

Options:

```
   XMLPATHS specifies if these should be stored (Default ON)
   USECLASS specifies an alternative BASE class (default XML)
```

Note: XMLPATHS off sets the BASE class to XML. On set it to GILSXML which also handles TYPE= defines (see the documentation).

COLONDOC

Colon tagged documents are among the most commonly used form of ASCII markup. Field names are defined by, you guessed it, ':'.

COLONDOC Class Tree:

DOCTYPE
|
METADOC
v
COLONDOC

"COLONDOC": Colon document format files. Like "METADOC" but the default sep is ':'.

COLONDOC is not really (intended to be) a document type but a parent for this "major" class of document formats. The COLONDOC class has been designed to provide a convenient base class for the development of user document types.

Examples of children are: BIBCOLON, IADADOC, IKNOWDOC and through its child COLONGRP a number of other types such as DIF.

Colon Records:

```
TAG1: ...
.....
TAG2: ...
TAG3: ...
...
....
```

1. Fields are continued when the line has no tag
2. Field names **may NOT contain white space**. Although not explicitly required it is *recomended* that all field names use characters restricted to the the set of 7-bit ASCII characters excluding %(*per-cent*), $ (*dollar*) and +(*plus*).
3. *Field names* are currently *case independent*, viz. *From*, *FROM* and *from* are all considered to name the same field.
4. The space BEFORE field names MAY contain white space
5. Between the field name and the ':' NO white space is allowed.
6. There is a compile time options to NOT allow white space before the start of the field name. While this makes life easier for continuation (one need not worry about formatting to prevent bogus fields) it forces a more rigid format.

7. There is no specific limitation on the length of a line. The maximal line and field length is given by the maximal size of a memory block defined by the O/S on the host platform. On most 32-bit Unix platforms this is around 2 GB.
8. Should the document contain several records the user must specify the record separator via a option to the Indexer (eg. -s " *****" for *Ziff CD* records)

Although the **COLONDOC** format is ill-suited to hierarchical data its COLONGRP child is.

COLONGRP

COLONGRP is a master colondoc doctype that supports some structure (sub-tags). If it inspired by, as well as parent of, DIF.

```
COLONGRP Class Tree:
                                        DOCTYPE
                                           |
                                        METADOC
                                           |
                                       COLONDOC
                                           v
                                       COLONGRP
```

The contents of the *first field* should be *unique*. It is used as a *unique* identification string for the record

The Field Name `Group` is a *reserved name*. It supports some structure via *Groupings*.

```
Group: GroupName
        Field:  Value
        Field:  Value
        Field:  Value
End_Group
```

Groups may contains groups. For each `Group` one must specify `End_Group` to inform the parser where the end of the group is.

```
Field: Value
Field: Value
Group: GroupName
       Field:  Value
       Field:  Value
       Group: GroupName
              Field:  Value
              Field:  Value
              Field:  Value
       End_Group
End_Group
```

Its probably best understood by looking at the example fragment below.

```
Entry_ID: 1013DS-A.cdf
```

```
Group:  Technical_Contact
        First_name:  Frances
        Middle_name:  S.
        Last_name:  Hotchkiss
        Phone:  508-457-2242
        Phone:  FAX 508-457-2310
        Group:  Address
                384 Woods Hole Road
                Quissett Campus
                Woods Hole, MA  02543-1598
                USA
        End_Group
End_Group
```

`Entry_ID`
: 1013DS-A.cdf would specify `1013DS-A.cdf` as the *unique key* for the record.

`Technical_Contact`
: contains everything from `First_name` to the `End_Group` in Address.

`First_name`
: contains `Frances`

`Middle_name`
: contains `S.`

`Last_name`
: contains `Hotchkiss`

`Phone`
: contains `508-457-2242` and `FAX 508-457-2310`

`Address`
: contains everything from `384 Woods Hole Road` to `USA`

Compared to SGML/XML:

Group: Level1
  Group: Level2
  tag1: tag1_value
  End_Group
End_Group
	<Level1>
	 <Level2>
	  <tag1>tag1_value</tag1>
	 </Level2>
	</Level1>

The MIME type for *Raw Records* is `Application/X-COLONGRP`.

CSVDOC

The native CSVDOC doctype class is for "Comma Separated Values" such as those exported from Claris FileMaker Pro (Merge), MS Access, Excel and other popular PC programs. Like its ancestors COLONDOC and METADOC it is a key-value type but, in contrast to them, defined along the colon rather than row.

```
CSVDOC Class Tree:
                                        DOCTYPE
                                           |
                                        METADOC
                                           |
```

COLONDOC
v
CSVDOC

The doctype is especially well suited to the export of metadata records from PCs to provide GILS and other network services. Although many US Federal agencies, especially the smaller less budgeted institutions, tend to deploy personal computers (Windows, Win'95, WinNT and Mac) these platforms are ill-suited to network services. It is also desirable for security to de-couple the data collection from the Internet. The CSVDOC doctype allows for the continued use of familiar PC tools but with more robust, secure and powerfull Z39.50 and WWW services.

A CSLDOC looks like

```
Field0;Field1;Field2
"Field0";"Field1";"Field2"
```

i. The first line contains the field names.
ii. The following lines contain the contents of each field.
iii. The content lines may or may not have ""
iv. The field seperator may be some other character or even sequences of characters. Whatever they are they are consistent.

Example (From Claris FileMaker Pro):

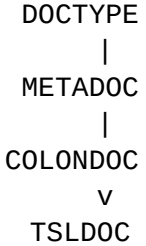
```
ID;Artistpage;Sortiername;Artist;Artistphoto;Kuenstlername;LebenD;LebenE;AtelierD;Atelier
E;EinzelaustellungD;EinzelaustellungE;OefentlicheArbeitenD;OefentlicheArbeitenE
"A139";"K";"Aenderungsatelier Schweitzer & Stemmer";"Žnderungsatelier Schweitzer &
Stemmer";"";"Žnderungsatelier Schweitzer & Stemmer";"";"";"";"";"";"";""
"A104";"K";"Amey, Paul";"Amey, Paul";"";"Paul Amey";"";"";"";"";"";"";""
"A115";"K";"Doubrawa, Reinhard";"Doubrawa, Reinhard";"";"Reinhard
Doubrawa";"";"";"";"";"";"";""
"A124";"K";"Droese, Felix";"Droese, Felix";"";"Felix  Droese";"";"";"";"";"";"";""
"A183";"K";"Dumas, Marlene";"Dumas, Marlene";"";"Marlene Dumas";"";"";"";"";"";"";""
"A184";"K";"Emin, Tracey";"Emin, Tracey";"";"Tracey Emin";"";"";"";"";"";"";""
"A185";"K";"Esser, Uwe";"Esser, Uwe";"";"Uwe Esser";"";"";"";"";"";"";""
"A186";"K";"Eubel, Edgar A.";"Eubel, Edgar A.";"";"Edgar A.
Eubel";"";"";"";"";"";"";""
"A187";"K";"Fabro, Luciano ";"Fabro, Luciano ";"";"Luciano Fabro";"";"";"";"";"";"";""
"A188";"K";"Fairhurst, Angus";"Fairhurst, Angus";"";"Angus
Fairhurst";"";"";"";"";"";"";""
"A108";"K";"Fischer, Urs";"Fischer, Urs";"";"Urs Fischer";"";"";"";"";"";"";""
"A189";"K";"Fischli, Peter/ Weiss David";"Fischli, Peter/ Weiss David";"";"Peter Fischli/
David Weiss";"";"";"";"";"";"";""
"A129";"K";"Flinzer, Jochen";"Flinzer, Jochen";"";"Jochen
Flinzer";"";"";"";"";"";"";""
"A191";"K";"Frank, Dinah";"Frank, Dinah";"";"Dinah Frank";"";"";"";"";"";"";""
"A192";"K";"Friedmann Gloria";"Friedmann Gloria";"";"Gloria
Friedmann";"";"";"";"";"";"";""
"A193";"K";"Fritsch, Katharina";"Fritsch, Katharina";"";"Katharina
Fritsch";"";"";"";"";"";"";""
"A194";"K";"Gabriel, Twin";"Gabriel, Twin";"";"Twin Gabriel";"";"";"";"";"";"";""
"A195";"K";"Geldmacher, Klaus";"Geldmacher, Klaus";"";"Klaus
Geldmacher";"";"";"";"";"";"";""
```

```
"A196";"K";"Gilbert & George";"Gilbert & George";"";"Gilbert &
George";"";"";"";"";"";"";""
"A197";"K";"Gillick, Liam";"Gillick, Liam";"";"Liam Gilick";"";"";"";"";"";"";""
"A198";"K";"Gober, Robert";"Gober, Robert";"";"Robert Gober";"";"";"";"";"";"";""
"A199";"K";"Gonschior, Kuno";"Gonschior, Kuno";"";"Kuno
Gonschior";"";"";"";"";"";"";""
"A201";"K";"Gormly, Antony";"Gormly, Antony";"";"Antony Gormly";"";"";"";"";"";"";""
"A200";"K";"Gostner, Martin";"Gostner, Martin";"";"Martin
Gostner";"";"";"";"";"";"";""
"A202";"K";"Granda, Alonso /M. Elena";"Granda, Alonso /M. Elena";"";"Alonso Granda /Elena
M.";"";"";"";"";"";"";""
"A203";"K";"Groá, Sabine";"Groá, Sabine";"";"Sabine Groá";"";"";"";"";"";"";""
"A204";"K";"Grubinger, Eva";"Grubinger, Eva";"";"Eva Grubinger";"";"";"";"";"";"";""
"A215";"K";"Hurst, Annette";"Hurst, Annette";"";"Annette Hurst";"";"";"";"";"";"";""
"A131";"K";"Ingold Airlines ";"Ingold Airlines";"";"Ingold
Airlines";"";"";"";"";"";"";""
"A126";"K";"Innocente";"Innocente";"";"Innocente";"";"";"";"";"";"";""
"A216";"K";"Irwin";"Irwin";"";"Irwin";"";"";"";"";"";"";""
"A217";"K";"Jaxi, Constantin";"Jaxi, Constantin";"";"Constantin
Jaxi";"";"";"";"";"";"";""
"A218";"K";"Kabakov, Ilya";"Kabakov, Ilya";"";"Ilya Kabakov";"";"";"";"";"";"";""
"A219";"K";"Kane, Alan";"Kane, Alan";"";"Alan Kane";"";"";"";"";"";"";""
"A220";"K";"Katase, Kazuo";"Katase, Kazuo";"";"Kazuo Katase";"";"";"";"";"";"";""
"A222";"K";"Keikeik";"Keikeik";"";"Keikeik";"";"";"";"";"";"";""
"A272";"K";"Schmidt, Enno";"Schmidt, Enno";"";"Ennno Schmidt";"";"";"";"";"";"";""
"A273";"K";"Schmidt, Pavel";"Schmidt, Pavel";"";"Pavel Schmidt";"";"";"";"";"";"";""
"A274";"K";"Schneider, Rolf";"Schneider, Rolf";"";"Rolf
Schneider";"";"";"";"";"";"";""
"A275";"K";"Schnyder, Achim";"Schnyder, Achim";"";"Achim
Schnyder";"";"";"";"";"";"";""
"A276";"K";"Scholz, Norbert";"Scholz, Norbert";"";"Norbert
Scholz";"";"";"";"";"";"";""
"A305";"K";"West, Franz";"West, Franz";"";"Franz West";"";"";"";"";"";"";""
"A306";"K";"Whiteread, Rachel";"Whiteread, Rachel";"";"Rachel
Whiteread";"";"";"";"";"";"";""
"A307";"K";"Wiegand, Suse";"Wiegand, Suse";"";"Suse Wiegand";"";"";"";"";"";"";""
"A313";"K";"Zangs, Herbert";"Zangs, Herbert";"";"Herbert Zangs";"";"";"";"";"";"";""
```

Since the CSV file format is not fully standardized the CSVDOC tries to be clever and determine the CSV format. The format is closely related to a number of other delimiter-separated formats that use other field delimiters such as tab characters and semicolons. A delimiter such as tab that is not present in the field data allows simpler format parsing. See the TSLDOC format.

TSLDOC

Class Tree:



TSLDOC is a base class for Tab Separated List (Tab delimited) files:

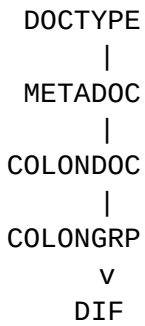
- Each line is a record
- Each line contain fields separated from each other by TAB characters (horizontal tab, HT, Ascii cc 9).
- "Field" means here just any string of characters, excluding TABs.
- Each line must contain the same number of fields.
- The first line may contain the names for the fields (on all lines), i.e. column headers.

It supports the following options:

```
[General]
 TabFields=Comma separated list of field names (e.g. field1,field2,field3)
   alternatively in the doctype.ini to define the "column" field names.
   If the option "UseFirstRecord" is specified (True) it is used
   as the fieldnames.
   If no TabFields are specified and UseFirstRecord was not specified
   True of False then UseFirstRecord will be assumed as True.
 CategoryField=<Field contains an integer for record category>
 PriorityField=<Field contains an integer to skew scores for record>
   For priority to have an effect one must define in "Db.ini"'s
   [DbInfo] PriorityFactor=NN.NN (a floating point number)
Alternatively in the "Db.ini" file [Doctype] section
```

DIF

Class Tree:



The Directory Interchange Format (DIF) is a de-facto standard used to create directory entries which describe a group of data. Its use is wide spread among US government agencies. A DIF record consists of a collection of fields which detail specific information about the data.
From the point of view of syntactical structure it is a heirarchical COLONDOC-based document format. The DIF class has been implemented as a child of COLONGRP.

A DIF record starts with a `Entry_ID:` followed by a **unique** identification string for the record (Handle), eg:
Entry_ID: 1013DS-A.cdf
The Field Name `Group` is a reserved name. It supports some structure via Groupings.

```
Group: GroupName
        Field:  Value
        Field:  Value
```

```
        Field:  Value
End_Group
```

Groups may contains groups. For each `Group` one must specify `End_Group` to inform the parser where the end of the group is.

Its probably best understood by looking at the example record below.

```
Group:  Technical_Contact
        First_name:  Frances
        Middle_name:  S.
        Last_name:  Hotchkiss
        Phone:  508-457-2242
        Phone:  FAX 508-457-2310
        Group:  Address
                384 Woods Hole Road
                Quissett Campus
                Woods Hole, MA  02543-1598
                USA
        End_Group
End_Group
```

✗ The fields

`Technical_Contact`
: contains: everything from First_name to the End_Group in Address.

`First_name`
: contains: Frances

`Middle_name`
: contains: S.

`Last_name`
: contains: Hotchkiss

`Phone`
: contains: 508-457-2242 and FAX 508-457-2310

`Address`
: contains: everything from 384 Woods Hole Road .. to .. USA

The Brief_Record (Headline) is the contents of the Entry_Title field.

The MIME type is: `Application/X-DIF`

DVBLINE

`DVBLINE Class Tree:`

```
                                    DOCTYPE
                                       |
                                    MEDLINE
                                       v
                                    DVBLINE
```

DVBLINE is a Medline family document format based upon a molestation of `Filmline` 1.x.

It provides the basic interchange format for the DVB pilot, a project to develop a cooperative model for database record-ship amongst the independent state German language media clearing houses.

The DVB software was developed for the Landesmedienzentrale (State Media Central Authority) Koblenz under contract of the State of Rheinland-Pfalz back in the mid 1990s.

In addition to the features of the `FILMLINE` Document handler it also supports sub-tags and "automatic" generation of a hypertext Web around the embeded background documents.

Sub-tags are specified with colon notation such as that provided by `COLONDOC`.

The Key for the record is derived from the DVB-Id number of the record.

A multiple-platform GUI workplace for the workflow has been developed in wxPython. This script driven program handles communication (flow) with a WWW workflow server, assists and shields the user from the details of the format (metarecord authorship), provides validation services and allows for import/export of other formats used in German education by decentral authorities.

DVBLine "tag" semantics

Field Tag	Attribute (Descriptive Name)	German Attribute Name
AB	abstract	Abstract
AD	audience	Adressat
AU	author	Buch
AW	awards	Awards
CG	camera	Kamera
CL	clue	Verl.Schluessel
CO	country	Produktionsland
CR	critics	Critics
CS	Character Set	CharacterSet
DA	date collected	+Datum-Erfassung
DE	description	Beschreibung
DI	director	Regie
DK	documentation	Dokumentation
DT	distribution	Vertrieb
ED	editor	Editor
FP	fee purchase	Kaufpreis
FR	fee rent	Mietpreis
GE	genre	Genre
GM	fee GEMA	GEMA
I0	DVB Record Status (Internal)	Status
I1	record author (Internal)	+Erschliesser
I2	Expert (Internal)	+Potentieller.Erschliesser

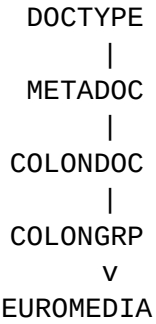
I3	external_links_exist (Internal Boolean)	+B.Hintergrunddok
I4	record_technical_author (Internal)	+Zustaendiger.Facherschliesser
I5	parallel_title	Paralleltitel
I6	agency	Auftraggeber
I7	local-collection	+Kaeufer
I8	FWU-call-id	FWU-Signatur
I9	FRG-Unified-call-id	BundesSig
IB	remarks	Bemerkung
IC	size	Anzahl
IE	external_links_public (Supplementary Material)	Hintergrunddok
IF	external_links (Secret)	+Hintergrunddok.geheim
IG	writers	Weitere-Urheber
KW	keywords	Schlagwoerter
LA	code-language	Sprache
LN	length	Laufzeit
LO	location	Standort
LT	lit_author	Vorlage
MD	color	Farbe
MM	media	Media
MU	music	Musik
NA	thesaurus-motbis	MOTBIS
NB	thesaurus-tee	TEE
PO	parent	Sammelmedien
PR	producer	Realisator
PS	commentary	Beurteilung
PU	publisher	Herausgeber
RA	ratings (FSK)	FSK
SA	collections	Sammlung
SD	sound	Ton
SE	series titel	Serientitel
SH	sort_title	Sortierhaupttitel
SI	local-call-id	ID-Nummer
SL	see also languages	Sprachfassungen
SM	see also media	Einzelmedien
SO	See Also	Kontextmedien
SS	series_sort_title	Sortierserientitel
ST	other-credits	Mitwirkende
SU	sort_subtitel	Sortieruntertitel
SY	systematic	Sachgebiete
TD	technical_data	Technische-Angaben
TE	title-uniform	Haupttitel
TI	title-cover	Wahrer-Titel
TO	original language title	Originaltitel
TU	title-caption	Untertitel
UA	UDC	Klassifikation-UDC
UB	Dewey	Klassifik-Dewey
VL	volume	Volume
VT	Synchronisation (Dub)	Synchronisation

YR	date-of-publication	Produktionsjahr
ZC	ILL-Code	ILL-Code
ZL	Language.Code	Language.Code
ZR	date-last-modified	CDAT
ZU	URL	URL
ZZ	misc	Verschiedenes

The MIME type for Raw is "`Application/X-DVBLine`"

EUROMEDIA

EUROMEDIA is multinational mediagraphic format based upon COLONGRP originally used to create and exchange national language multimedia metarecords within the EU-sponsored EUROMEDIA project.



Since the project had participating partners in Germany, France, Italy and Spain with record languages of, resp., German, French, Italian and Spanish it was designed to be both multi-lingual (supporting a national language) and fully human readable. The conversions from/to national language is handled via the “Unified Field” architecture which allows field names (and paths) can to be mapped during indexing to alternative names. During presentation using the requested language code these records (created on-the-fly) can have their keys remapped to names in a local vocabulary.

From the point of view of syntactical structure it is a heirarchical colondoc-based document format. The `EUROMEDIA` class has been implemented as a child of COLONGRP.

A `EUROMEDIA` record starts with a Local_number: followed by a unique 8-digit identification number for the record (Handle), eg:

```
Local_number: 00000024
```

Although the doctype supports any other unique key, the workflow solution and charter specify an 8-digit number. The Field Name Group is a reserved name. It supports some structure via Groupings.

```
Group: GroupName
        Field:  Value
        Field:  Value
        Field:  Value
End_Group
```

Groups may contains groups. For each Group one must specify End_Group to inform the parser where the end of the group is.

Default Language Field is `'Code_language'`
Default Date Field is `'Date_last_modified'`

The Brief Record (Headline) is defined, by default, by ‘Title’ (if not then ‘Title_Series’ then ‘Title_other_variant’).

Since it is multinational it supports alongside the `Dewey_classification number`, `Subject_TEE`, `Subject_MOTBIS` (as is widely used in French Education currently enriched and updated by Réseau Canopé) and `Local_subject_index`.

MISMEDIA

DOCTYPE
|
METADOC
|
COLONDOC
|
COLONGRP
v
MISMEDIA

MIS (Rheinland-Pfalz) colondoc mediagraphic records. This is an enhanced version of DVBLINE.

FILMLINE

```
DOCTYPE
   |
MEDLINE
   v
FILMLINE
```

The FILMLINE doctype is for filmline v 1.x records (version 2.x is based upon a XML/SGML DTD). It was developed by BSn and JFF (JFF - Institut für Medienpädagogik in Forschung und Praxis / JFF – Institute for Media Research and Media Education) for interchange of mediagraphic records and as a basis for database publishing for their printed film catalogue. It was based heavily upon the Medline format.

FILMLINE 1.x is currently being used in several European mediagraphic projects. In a modified form it also provides the interchange format for the German National DVB project as DVBLINE.

Filmline 1.x "tag" semantics

Field Tag	Attribute (Descriptive Name)
AB	abstract
AD	address
AU	author
AW	awards
CG	camera
CL	clue
CO	country
CR	critics
CS	charset
DA	date_collected
DE	description
DI	director
DK	documentation
DT	distribution
ED	editor
FD	distribution
FP	fee-purchase
FR	fee-rent
GE	genre
GM	GEMA
LA	language
KW	keywords
LN	length
LT	lit_author
MD	media-type
MM	Content-type
MU	music
PO	parent
PR	producer
PS	ps
PU	publisher
RA	ratings
SA	collections
SE	series
SH	sort-title
SS	series-title
SI	signature
SL	alt_lang
SM	children
SO	other-source
ST	other-credits
SU	subtitle
SY	systematic
TD	technical-data
TE	title-uniform
TI	title-cover

TU	title-caption
VL	volume
VT	sync
YR	date
ZU	URL

The MIME type: "Application/X-Filmline"

MEDLINE

Medline (txt) Document Type

DOCTYPE
v
MEDLINE

The MEDLINE format is a tagged field format originally developed for medical journals by the US National Library of Medicine. These days there are now two MEDLINE formats. In the context of the NIH "Medline" is used as a synonym for "Medline (XML)" while "MedlinePlain" is used as a synonym for "Medline (txt)".

Many reference management tools can accept MEDLINE (txt) format as an input.

Example:

```
    JT - Journal of Personality and Social Psychology
    TA - J Pers Soc Psychol
    DP - 1986
    VI - 51
    IP - 6
    IS - 0022-3514
    TI - The moderator-mediator variable distinction in social psychological research:
conceptual, strategic, and statistical considerations.
    PG - 1173-1182
    AU - Baron,RM
    AU - Kenny,DA
    PT - JOURNAL ARTICLE
    DO - DOI:10.1037/0022-3514.51.6.1173
    SO - J Pers Soc Psychol. 1986;51(6):1173-1182.
```

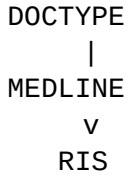
Out of the box the parser understands the following maps (to Unified names)

```
  {"AA",  "Author-Address"},
  {"AB",  "Abstract"},
  {"AD",  "author-address"},
  {"AN",  "Accession-Number"},
  {"AR",  "Access-Restrictions"},
  {"AT",  "Article-Title"},
  {"AU"   "Author"},
  {"CA",  "Corporate-Author"},
  {"CD",  "Coden"},
  {"CI",  "Column-inches"},
  {"CL",  "Column-number"},
```

```
{"CP",  "Captions"},
{"DP",  "Date-of-publication"},
{"DT",  "Document-Type"},
{"DY",  "Day-of-the-week"},
{"ED",  "Edition"},
{"FR",  "Frequency"},
{"GC",  "Geographic-Code"},
{"GD",  "Government-Document-Num"},
{"GI",  "GPO-Item-Num"},
{"IB",  "ISBN"},
{"IL",  "Illustrations"},
{"IP",  "Issue-part"},
{"IS",  "Issue"},
{"JA",  "Jo.Author"},
{"JO",  "Journal"},
{"JT",  "Item-Title"},
{"LA",  "Language"},
{"LC",  "LCCN"},
{"LO",  "Location"},
{"LT",  "Linked-PE"},
{"MH",  "Keywords"},
{"MK",  "Musical-Key"},
{"MN",  "Music-Publisher-Num"},
{"MO",  "Month"},
{"MT",  "Title-Main"},
{"NR",  "issue-num"},
{"NT",  "Notes"},
{"OE",  "Other-Entries"},
{"OR",  "Organization"},
{"OT",  "Other-Titles"},
{"OW",  "Ownership"},
{"PA",  "Personal-author"},
{"PG",  "Pagination"},
{"PH",  "History"},
{"PL",  "Place"},
{"PN",  "Producer-Num"},
{"PU",  "Publisher"},
{"RE",  "Reprint"},
{"RF",  "Reference"},
{"RN",  "Report-Numb"},
{"RT",  "Related-Titles"},
{"SB",  "Subfile"},
{"SD",  "Std-Ind-code"},
{"SE",  "Series"},
{"SL",  "Scale"},
{"SO",  "Source"},
{"SR",  "Series-added"},
{"SS",  "ISSN"},
{"ST",  "Stock-Num"},
{"SU",  "Subject"},
{"TA",  "Title-Abbrev"},
{"TD",  "Technical-Details"},
{"TH",  "Thematic"},
{"TI",  "Title"},
{"UI",  "Journal-code"},
```

```
  {"UT",  "Uniform-Title"},
  {"UR",  "URL"},
  {"VN",  "Vendor-Num"},
  {"VO",  "Volume"},
  {"VO",  "issue-vol"},
  {"YE",  "Year"},
  {"XX",  "Message"},
  {"ZZ",  "End-of-Record"}
```

RIS



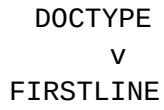
RIS is a standardized tag format developed by Research Information Systems, Incorporated (the format name refers to the company) to enable citation programs to exchange data. It is supported by a number of reference managers. Many digital libraries, like IEEE Xplore, Scopus, the ACM Portal, Scopemed, ScienceDirect, SpringerLink, Rayyan, Accordance Bible Software, and online library catalogs can export citations in this format. Citation management applications such as BibDesk, RefWorks, Zotero, Citavi, Papers, Mendeley, and EndNote can export and import citations in this format.

Example:

```
TY  - JOUR
AU  - Shannon, Claude E.
PY  - 1948
DA  - July
TI  - A Mathematical Theory of Communication
T2  - Bell System Technical Journal
SP  - 379
EP  - 423
VL  - 27
ER  -
```

FIRSTLINE

FIRSTLINE Class Tree:



An extremely simple but also extremely useful and flexible document format. We often have fully unstructured text files that we want to index and search and for their indentification use the first (or some other specified) line or sentence to identify them in results. For the Brief Record (Headline) it uses the Nth line or sentence as specified.

Index-time options:

```
  Startline N    Specifies which line or sentence to use (default is 1)
```

FILTER

The re-Isearch engine can be extended to support the widest range of data inputs through the use of external programs, so called filters. There programs should take a single argument as the path to the input file and should write their output in the specific format to standard output (stdout).

```
filter_path filename_path
```

Out-of-the box the engine provides doctypes to handle filtering to HTML, MEMO, TEXT and XML formats. The most generic is the FILTER doctype.

FILTER uses an external filter to process input to any DOCTYPE.

Class Tree:

DOCTYPE
v
FILTER

Options:

FILTER Specifies the filter program to use
CLASS Specifies which doctype class to use to handle the filtered records

Note:
Filters must take single arguments of the form: filter filename
and write to stdout. For output one should also define External/ filters (see DOCTYPE class)

FILTER2HTML

FILTER2HTML uses an external filter that converts the input file into HTML type files. It has similar goals to FILTER where the class was set to pass processing to HTMLMETA.

```
Class Tree:
                                    DOCTYPE
                                       |
                                    METADOC
                                       |
                                   COLONDOC
                                       |
                                   HTMLMETA
                                       |
                                   HTMLHEAD
                                       v
                                 FILTER2HTML
```

Options:

```
   Filter        Specifies the program to use.
   Content-type  Specifies the MIME content-type of the original.
```

These are defined in the "filter2html.ini" [General] or <Db>.ini [FILTER2HTML] sections.

Filters should take a single argument as the path to the (binary) input file and should write their output (HTML) to standard output (stdout)

FILTER2MEMO

FILTER2MEMO uses an external filter that converts the input file into MEMO type files. It has similar goals to FILTER where the class was set to pass processing to MEMODOC.

```
DOCTYPE
   |
 PTEXT
   |
MEMODOC
   v
FILTER2MEMO
```

Options:

```
   Filter        Specifies the program to use.
   Content-type  Specifies the MIME content-type of the original.
```

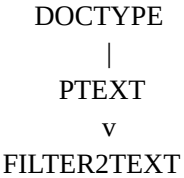
These are defined in the "filter2memo.ini" [General] or <Db>.ini [FILTER2MEMO] sections.

Filters should take a single argument as the path to the (binary) input file and should write their output (MEMO) to standard output (stdout)

FILTER2TEXT

FILTER2TEXT uses an external filter that converts the input file into TEXT (PTEXT) type files. It has similar goals to FILTER where the class was set to pass processing to PTEXT.

Class Tree:



Options:

```
   Filter        Specifies the program to use.
   Content-type  Specifies the MIME content-type of the original.
```

These are defined in the "filter2text.ini" [General] or <Db>.ini [FILTER2TEXT] sections.

Filters should take a single argument as the path to the (binary) input file and should write their output (PTEXT) to standard output (stdout)

FILTER2XML

FILTER2XML uses an external filter that converts the input file into XML type files. It has similar goals to FILTER where the class was set to pass processing to XML.

```
Class Tree:
                                        DOCTYPE
                                           |
                                        SGMLNORM
                                           |
                                          XML
                                           v
                                      FILTER2XML
```

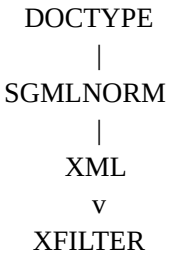
Options:

```
   Filter        Specifies the program to use.
   Content-type  Specifies the MIME content-type of the original.
```

These are defined in the "filter2xml.ini" [General] or <Db>.ini [FILTER2XML] sections.

Filters should take a single argument as the path to the (binary) input file and should write their output (XML) to standard output (stdout)

XFILTER



Uses an external filter that converts input file into XML type files. Its functionality is quite similar to FILTER2XML. Its main function is to provide a reference.

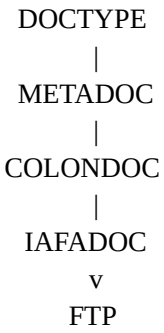
Options:

```
   Filter  Specifies the program to use (default "pandoc").
   Options Specifies the options for Filter (default "-s -t docbook5").
   Content-type  Specifies the MIME content-type of the original.
```

These are defined in the "xfilter.ini" [General] or <Db>.ini [XFILTER] sections.

Suitable filters must write their output (XML) to standard output (stdout)

FTP



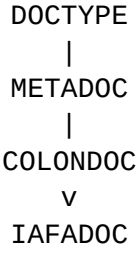
While FTP archives are no only that widely used their management is still important. That is where the FTP doctype comes in.

The FTP doctype has been designed to support the distribution of binary data (via Z39.50 or HTTP) from FTP archives that adhere to the guidelines for FTP publication from the IAFA-WG. Like the BINARY doctype it has been designed to manage software archives, CAD drawings and non-textual information. The FTP document model offers much more control than the Binary model, but is a bit more complicated.

A "FTP" file consists of 2 (two) components, a IAFA (Internet Anonymous FTP Archives) metadata and the binary file itself. Looks for a file .iafa that contains the text information (eg. for "x.tar" looks for "x.tar.iafa"). All the fields in the IAFA description are searchable.

The FULLTEXT ("F") attribute returns the binary file.
The MIME type for Raw is specified in the IAFA file with the field Content-type. If not defined the default is "`Application/Octet-Stream`".

IAFADOC



P. Deutsch, A. Emtage, M. Koster and M. Stumpf, *Publishing Information on the Internet with Anonymous FTP (IAFA Templates)*, IETF IAFA WG Internet Draft, January 1995, <URL:ftp://nic.merit.edu/documents/internet-drafts/draft-ietf-iiir-publishing-03.txt>.

IAFA is colon type document format—colon separated key value pairs—where the tags (keys) define metadata elements. The Internet Engineering Task Force (IETF) Working Group on Internet Anonymous FTP Archives

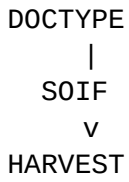
(IAFA), later called IIIR, produced the IAFA templates Internet Draft back in 1995. It defined a range of indexing information that can be used to describe the contents and services provided by anonymous FTP archives.
The standard provided a rich range of templates, attributes and values that can be used to describe common and useful elements. Their goal was to create a basis to enable an efficient indexing of archives. One or more data elements are collected into templates which have a single Template-Type field to describe the type of the basic template. Multiple templates can be collected in index files by separating with blank lines. The attributes can be structured in several ways:

While FTP has fallen from favor as an anonymous file transport and the standard has more or less obsoleted by RDF and a host other XML and JSON based formats, IAFA continues to be an interesting format due to its combination of human readability and its extreme machine readable simplicity.

HARVEST / SOIF

SOIF format files and points to resource.

HARVEST Class Tree:



HARVEST was an integrated set of tools to gather, extract, organize, and search information across the Internet.

SOIF

```
The SOIF (Summary Object Interchange Format) Grammar is as follows:
    SOIF            ::=  OBJECT SOIF | OBJECT
    OBJECT          ::=  @ TEMPLATE-TYPE { URL ATTRIBUTE-LIST }
    ATTRIBUTE-LIST  ::=  ATTRIBUTE ATTRIBUTE-LIST | ATTRIBUTE
    ATTRIBUTE       ::=  IDENTIFIER {VALUE-SIZE} DELIMITER VALUE
    TEMPLATE-TYPE   ::=  Alpha-Numeric-String
    IDENTIFIER      ::=  Alpha-Numeric-String
    VALUE           ::=  Arbitrary-Data
    VALUE-SIZE      ::=  Number
    DELIMITER       ::=  ":<tab>"
```

Some common fields

Abstract
: Brief abstract about the object.

Author
: Author(s) of the object.

Description
: Brief description about the object.

File-Size
: Number of bytes in the object.

Full-Text

Entire contents of the object.

Gatherer-Host
: Host on which the Gatherer ran to extract information from the object.

Gatherer-Name
: Name of the Gatherer that extracted information from the object. (eg. Full-Text, Selected-Text, or Terse).

Gatherer-Port
: Port number on the Gatherer-Host that serves the Gatherer's information.

Gatherer-Version
: Version number of the Gatherer.

Update-Time
: The time that Gatherer updated the content summary for the object.

Keywords
: Searchable keywords extracted from the object.

Last-Modification-Time
: The time that the object was last modified.

MD5
: MD5 16-byte checksum of the object.

Refresh-Rate
: The number of seconds after Update-Time when the summary object is to be re-generated. Defaults to 1 month.

Time-to-Live
: The number of seconds after Update-Time when the summary object is no longer valid. Defaults to 6 months.

Title
: Title of the object.

Type
: The object's type.

SOIF is an alternative to IAFA. It, like IAFA, has been widely replaced by RDF but a number of projects still use it.

ROADS++

Extended IAFA documents.

DOCTYPE
v
ROADS++

The overall objective of the ROADS project was to design and implement a user-oriented resource discovery system. It investigated the creation, collection and distribution of resource descriptions, to provide a transparent means of searching for, and using resources. The object was not to create an individual and idiosyncratic system but to draw on, and help create, standards of good practice which could be widely adopted by subject communities to aid and automate the process of resource organisation and discovery. A primary goal was interworking with other national and international services, and partners are active in Internet Engineering Task Force working groups and UK and international consensus-making bodies at technical, service and organisational levels.

RESOURCE

DOCTYPE
|

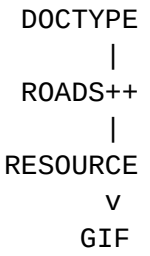
ROADS++
v
RESOURCE

The resource doctype is designed to allow for the pairing of a metadata record and and a resource record.

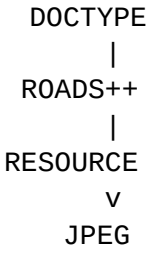
✗ IMAGE Formats

The following image formats are supported

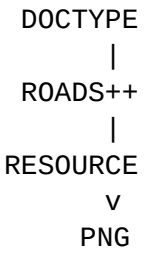
GIF



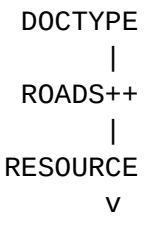
JPEG



PNG



TIFF



HTML

The re-Isearch engine contains a number of doctypes suitable for indexing HTML. For general use most projects will use the doctypes focusing on the metadata rather than the tags and elements in the body of the HTML document as these tend to convey little information.

The HTML Doctype is for special documents marked-up using the Hypertext Markup Language of the World Wide Web (WWW). For general indexing of HTML document the HTMLHEAD doctype is strongly advised.

Although the HTML doctype is a subclass of SGMLNORM it does not require normalized HTML and handles most all HTML Markup (tag normalized or not) and entities, e.g. Ü (Ü), &amp (&), &#177 (±) etc.
The doctype was designed to support HTML 0.9, 2.0, 3.0, HTML 3.2, W3O's Cougar (4.0) as well as *many* vendor extensions, kludges and abuses. Most common incorrect uses of HTML markup are also correctly handled. It has been tested against a very large random sample of several gigabytes of HTML data from thousands of sites and has been used to in the field to index many terabytes of HTML pages at hundreds of sites. It does not handle CSS, Javascript and some HTML 5 constructs that build around it (like Canvas).

By default it indexes *all* fields that *represent content* (*container tags*) in an HTML document. Descriptive markup, such as <I> ,<B>,<TT> etc. are ignored.

Parser Levels

The parser knows several levels:

Basic (5)
: Accept only a few tags and combine into some simple groups with plain english names. This level is for robots and web services.

Valid (4)
: Accept only valid HTML, make less assumptions and complain.

Strict (3)
: Accept only known HTML tags, complain about bogus use.

Normal (2)
: Accept only known HTML tags

Maximal (1)
: Accept all tags except some descriptive markup.

Full (0)
: Accept anything.

Antihtml (-1)

Use HTML-- for processing.

The level is specified as a *doctype option* (eg. -o LEVEL=*Level*) or via *LEVEL* in the .ini *HTML* section. Either the long name or number can be specified.

META

The *META* tag is used to embed metadata in a HTML document. It belong in the *HEAD* of the document (since much HTML is non-comformant the HTML parser will accept it anywhere).
In HTML 2.0 the *META*s may occur anywhere in the *HEAD*

```
<!ENTITY % head.content "TITLE & ISINDEX? & BASE? %head.extra">

<!ELEMENT HEAD O O  (%head.content) +(META|LINK)>
```

But in HTML 3.2 all the *META*s must be grouped together.

```
<!ENTITY % head.content "TITLE & ISINDEX? & BASE? & STYLE? &
                         SCRIPT* & META* & LINK*">

<!ELEMENT HEAD O O  (%head.content)>
```

HTML 4.0 specified META as a complex empty tag via a name/value pair: *NAME* and *CONTENT*.

```
<!ELEMENT META - O EMPTY>
<!ATTLIST META
        HTTP-EQUIV  NAME    #IMPLIED
        NAME        NAME    #IMPLIED
        CONTENT     CDATA   #REQUIRED    >
```

The HTML document type definition offers very little content structure making the development of structured databases difficult. The *META*-tag mechanism offers some relief.
Meta tags, <META NAME="AUTHOR" CONTENT="Elmer Fudd"> are *searchable* (in versions >1.9) as META.AUTHOR

```
  <META NAME="AUTHOR" CONTENT="Elmer Fudd"> -->
     META@        := NAME="AUTHOR" CONTENT="Elmer Fudd"
     META@NAME    := "CONTENT"
     META@CONTENT := "Elmer Fudd"
  Version > 1.9
     META.AUTHOR  := "Elmer Fudd"
```

In Version >1.10 <META HTTP-EQUIV="AUTHOR" CONTENT="Elmer Fudd">

```
  <META HTTP-EQUIV="AUTHOR" CONTENT="Elmer Fudd"> -->
     META@        := HTTP-EQUIV="AUTHOR" CONTENT="Elmer Fudd"
     META@NAME    := "CONTENT"
     META@CONTENT := "Elmer Fudd"
     AUTHOR       := "Elmer Fudd"
```

Versions based upon SGMLNORM >1.8 support *Schema* and *Type* specified in content, viz. `<META NAME="LANGUAGE" CONTENT="(Schema=ISO6639)en">` searchable under *META.LANGUAGE(ISO6639)*.
The keywords *Schema*, *Scheme* and *Type* are currently supported.

- `<META NAME="AAA" CONTENT="(Schema=BBB)DDD>` maps to *META.AAA(BBB)*.
- `<META NAME="AAA" CONTENT="(Type=CCC)DDD>` maps to *META.AAA.CCC*.
- `<META NAME="AAA" CONTENT="(Schema=BBB)(Type=CCC)DDD>` maps to *META.AAA.CCC(BBB)*.
- `<META NAME="AAA" CONTENT="(Schema=BBB)(Type=CCC)(Schema=DDD)EEE>` maps to *META.AAA.CCC(BBB.DDD)*.
- `<META NAME="AAA" CONTENT="(Type=BBB)(Type=CCC)DDD>` maps to *META.AAA.BBB.CCC*.

HTML 4.x extends *META* to:

```
<!ATTLIST META
  %i18n;                              -- lang, dir for use with content string --
  http-equiv  NAME       #IMPLIED  -- HTTP response header name  --
  name        NAME       #IMPLIED  -- metainformation name --
  content     CDATA      #REQUIRED -- associated information --
  scheme      CDATA      #IMPLIED  -- select form of content -- >
```

The definition of `Scheme=` overrides the specification of Scheme in Content, eg. `CONTENT="(Scheme=..)..."`.
This allows the development of interfaces to search for HTML pages based on meta-data, viz. content that HTML has no container for.
See also: META HTTP-EQUIV and NAME equivalences.

BASE

The doctype option or environment variable `WWW_ROOT` is used to synthesize— should it *not* have been defined— the value for <BASE HREF="..." ... >. This enables CGI interfaces (or clients) to "derive" a fully-qualified URL to the original document and resolve relative hypertext references.
In Version >1.10:

1. The .dbi/.ini file is examined for a *Pages* entry in the *HTTP* section.
2. else if the doctype option *WWW_ROOT* is defined it is used
3. else if the doctype option *HTTP_PATH* is defined it is used
4. else if the doctype option *HTTP_PATH* it is used
5. else if the doctype option *HTDOCS* is defined it is used
6. else the environment is checked for the above variables, processed in that order.

Should the path specified in `<BASE HREF=`*`path`*`>` have a trailing /, then the filename is concatinated. This way one may specify the same `BASE` for all files in the same directory.
The `URL` is searchable via the `BASE` field. Since binary data such as images, audio and video files *often* have descriptive names, eg. `ElmerFudd.au`, this can also provide a pragmatic basis for search of multimedia information.
In Version >1.10 one can also specify the name/port of the WWW server. This is designed to support multiple virtual hosts or mapping to PURL (Persistant URL) resolver.

1. The .dbi/.ini file is examined for a *Server* entry in the *HTTP* section. A URL of type `http://www.bsn.com:8080` is expected.
2. If the .dbi/.ini file does not contain an entry then a *HTTP_Server* doctype option is expected.
3. If this is not defined then the standard HTTP Server environment variables *SERVER_NAME* and *SERVER_PORT* are used to build the URL. If these are undefined then one is probably not running under a HTTPD and a `file:///` method based URL is contructed (only HTML).

An interesting option is to set the *Server* to point to a PURL resolver instead of the Web server. This way the resource URL can persist beyond, or be de-coupled from, the URL structure within a web.

LINK

The complex values of LINK are, like META stored. The REV and REL values can be used to model external flows to and from the HTML document instance.

I18N

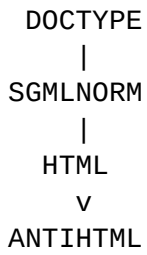
Support for i18n

```
<!ENTITY % i18n
 "lang        NAME       #IMPLIED  -- RFC 1766 language value --
  dir         (ltr|rtl)  #IMPLIED  -- default directionality --" >
```

is not yet available. It is currently in development (it may already be available but was not yet ready at the time this handbook section was being authored).

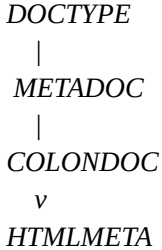
Notes:
The HTML Doctype is NOT a validator and makes many assumptions. It tries to guess the intent of some of the HTML kludges in common use. It is, none-the-less, advisable to validate HTML pages and to adhere to a content model.

HTML-- / ANTIHTML:



Like HTML but not indexing the standard tags but only meta and title elements. In general the HTMLHEAD or HTMLZERO are the preferred document handlers but there are some use cases where HTML-- is called for.

HTMLMETA



Metadata is data *about* an information resource. It is generally structured into a number of elements. There are many different attribute sets and standards for metadata. The HTMLMETA Doctype has been designed to help create and manage meta-databases derived from documents marked-up with Meta-data using the Hypertext Markup Language (HTML) of the World Wide Web (WWW).

The point of embeding the meta data record into the HTML source is that it is scalable from simplistic low cost solutions up to full blown sophisticated editorial systems. The issue is pragmatics and encoding the meta record in HTML holds the chance of being widely accepted.
From the viewpoint of gathering meta-records there is little difference (other than cost and data consistency) between human coded and machine produced copy.

The **HTMLMETA** doctype has been designed to support a flexible model for the encapsulation of generic metadata and is equally well suited to Dublin Core, GILS, EAD and other standards.
The documents processed by the doctype are HTML with meta-information embeded in the `<HEAD>...</HEAD>` of a document using attribute tags rather than container element content. This form is compatible with the HTML standards. The main difference between HTMLMETA and HTML doctypes are:

i. Only the fields in `<HEAD>` are processed.
ii. The field names are processed differently.
iii. Different Presentation.

- The content in <META NAME="Foo" Content="Bar"> are searchable in HTMLMETA (default behaviour) under FOO. The HTML and -- doctypes, by contrast, map the content to META.FOO.
- The presentation is the extracted record of meta-data and not the document.
- Similiar to the HTML-- doctype nearly all HTML-tags are ignored. The exception are the BASE, META and LINK EMPTY tags.
  HTMLMETA does not process *user tags*. While HTML-- would store the content of `<AUTHOR>Elmer Fudd</AUTHOR>` under *AUTHOR*, the HTMLMETA doctype would *ignore the field*.

The parser does not enforce the use of any particular attribute set. Using the GILS core attribute set, for instance, the HTMLMETA doctype can be used to *automatically* create GILS-compliant Z39.50 servers to HTML data resources.
The default (RAW) data format produced is an **experimental** XMLformat suitable for export, remote meta-indexing, whois++ (distributed), X.500/LDAP or import into another re-Isearch database using the XML or GILS document handlers.

Mark-up Conventions

An HTML file containing the fragement:

```
<META NAME="AUTHOR" CONTENT="Elmer Fudd">
<META NAME="COMPANY" CONTENT="Acme Inc.">
<META NAME="ADDRESS" CONTENT="Looney Place 4, Acme Acres">
<META NAME="VERSION" CONTENT="%Z%%Y%%M% %I% %G% %U% BSN;">
```

Contains the fields *AUTHOR*, *COMPANY*, *ADDRESS* and *VERSION*. Each are fully searchable and mappable to attribute OIDs.

The above example would produce SUTRS Presentation fragment:

AUTHOR: Elmer Fudd

COMPANY:	Acme Inc.
ADDRESS:	Looney Place 4, Acme Acres
VERSION:	@(#)HTMLMETA.html 1.11 11/27/2008 23:19:35 BSN (1)
LOCATION:	*URL to the original HTML (2)*

1) If document was processed by sccs-get to resolve the %?% symbols.
2) "The URL to the original HTML" is derived from the <BASE ... > or synthetically derived. For a GILS or other meta-search facility it can point to PURL (Persistant URL) resolver elsewhere, such as gils.org, that, in turn, maps to the resource. The later is of particular relevance for maintaining links to resources for robots and other page gatherers. See HTML BASE processing.

The *XML* representation would be:

```
<!ENTITY LOCATION CDATA "URL" -- Indexed Document -->
<AUTHOR>Elmer Fudd</AUTHOR>
<COMPANY>Acme Inc.</COMPANY>
<ADDRESS>Acme Inc.</ADDRESS>
<VERSION>@(#)HTMLMETA.i.html 1.11 11/27/98 23:19:35 BSN</VERSION>
```

An entity notation has been chosen instead of:

```
<LOCATION>http://www.your.org/blah</LOCATION>
```

or

```
<LOCATION HREF="http://www.your.org/blah"/>
```

so as not to break emerging DTDs.

Note: The name for the *LOCATION* as well as the XML notation is *subject to change* in future versions.
In Content, if following the '`"' is a (Keyword=YYY)... it is specially processed. At current there are handlers for two keywords: Schema and Type. If the keyword is not in this set of registered words (with handlers) it is considered part of content, eg.`
`<META NAME="AUTHOR" CONTENT="(Fudd)"> is read as <AUTHOR>(Fudd)</AUTHOR>.`

Specifying Complex Attributes

To specify a *schema* (for container data typing) one includes it in *CONTENT* as
`<META NAME=Attribute CONTENT="(Schema=Type)Content">`
The (more intuitive) alternative: `<meta name="Attribute(Type)" content="Content">` is not valid HTML given the '`(`'. It is, none-the-less, in the *HTML tradition*, accepted.
In the presentation *both* are mapped to: `<Attribute Schema="Type">`
Example:

- `<meta name="date" content="(SCHEMA=ISO)1996-04-19">`
- `<meta name="date(ISO)" content="1996-04-19">`

Which would produce an XML of: `<DATE SCHEMA="ISO">1996-04-19</DATE>`
In the above example the content data would be stored under the field *DATE(ISO)*

```
<!ATTLIST META
  %i18n;                    -- lang, dir for use with content string --
```

```
  http-equiv  NAME  #IMPLIED  -- HTTP response header name  --
  name        NAME  #IMPLIED  -- metainformation name --
  content     CDATA #REQUIRED -- associated information --
  scheme      CDATA #IMPLIED  -- select form of content --
  <
```

HTMLMETA interprets as equivalent:

i. `<META NAME="DATE(ISO)" CONTENT="1996-04-19>`
ii. `<META NAME="DATE" CONTENT="(SCHEMA=ISO)1996-04-19>`
iii. `<META NAME="DATE" SCHEME="ISO" CONTENT="1996-04-19>`

Marking Up Hierarchical Data

To represent heirarchical data the *HTMLMETA framework* uses the '`.`' (*dot-notation*), as
`<META NAME="`*`Tag0.Tag1...`*`" CONTENT="`*`Content`*`">` eg.
`<META NAME="AUTHOR.NAME" CONTENT="Elmer Fudd">`
`<META NAME="AUTHOR.AGE" CONTENT="60">`
Produces:
`<AUTHOR><NAME>Elmer Fudd</NAME><AGE>60</AGE></AUTHOR>`
By extending to several levels of '.' one can define a simple heirarchical model of meta-data suitable for the development of sophisticated models and services.
The order of the METAs is ***significant***. To markup:

```
<TITLE>A Title
<NAME>A Name</NAME>
</TITLE>
```

One enters:

```
<META NAME="TITLE" CONTENT="A Title">
<META NAME="TITLE.NAME" CONTENT="A Name">
```

By contrast, the *META* markup:

```
  <META NAME="TITLE" CONTENT="A Title">
  <META NAME="NAME" CONTENT="A Name">
  <META NAME="TITLE.NAME" CONTENT="Another Name">
```

Would produce:

```
  <TITLE>A Title</TITLE>
  <NAME>A Name</NAME>
  <TITLE><NAME>Another Name</NAME></TITLE>
```

The convention is somewhat different from the one originally proposed at *W3C Distributed Indexing and Searching Workshop, May 28-29, 1996*:

`<META NAME= "`*`schema_identifier.element_name`*`" CONTENT="`*`string data`*`">`
In general HTML documents marked-up with this convention will be correctly interpreted. The major difference between it and the semantics of the HTMLMETA framework occurs when the element_name includes '`.`':
`<META NAME="GNU.FOO.BAR" CONTENT="Aardvarks">`.

HTMLMETA framework
field *BAR* as a sub-element of *FOO* under *GNU*

W3C Workshop framework
: field *FOO.BAR* within the *named schema* GNU. This can be viewed as *FOO.BAR* under *GNU*. The order of the *META* tags is invariant.

Another common model and typical among *Dublin Core* implementations is:
`<META NAME="schema_identifier.element_name" CONTENT="(Type=element_type)Content">`. In the HTMLMETA framework it would be *interpreted* as:
`<META NAME="schema_identifier.element_name.element_type" CONTENT="Content">`
The advantages of the HTMLMETA framework are:

- Explicit heirarchical meta model
- Better support of existing *META* markup.

Although many document/data models can be *"flattened"*, especially for S/R services a heirarchical model can provide advantages. Examine, for example, the following GILS attributes:

```
<!ELEMENT Contact-Name               - O (#PCDATA)>
<!ELEMENT Contact-Organization       - O (#PCDATA)>
<!ELEMENT Contact-Street-Address     - O (#PCDATA)>
<!ELEMENT Contact-City               - O (#PCDATA)>
<!ELEMENT Distributor-Name           - O (#PCDATA)>
<!ELEMENT Distributor-Organization   - O (#PCDATA)>
<!ELEMENT Distributor-Street-Address - O (#PCDATA)>
<!ELEMENT Distributor-City           - O (#PCDATA)>
```

Using something like this, instead:

```
<!ELEMENT Name           - O (#PCDATA)>
<!ELEMENT Organization   - O (#PCDATA)>
<!ELEMENT Street-Address - O (#PCDATA)>
<!ELEMENT City           - O (#PCDATA)>
<!ENTITY % address "NAME & ORGANIZATION & STREET-ADDRESS & CITY">
<!ELEMENT CONTACT O O  (%address)>
<!ELEMENT DISTRIBUTOR O O  (%address)>
```

has the advantage that the kind of content is more clearly defined as an object.
On would then markup as:
`<META NAME="Distributor.City" CONTENT="Munich, Germany">`
Mapping to a heirarchical DTD with *ORGANIZATION*, *STREET-ADDRESS* and *City* as subelements of *CONTACT* and *DISTRIBUTOR* allows for an *implicit and interoperable* search for *ORGANIZATION* which would **include** a search of both *CONTACT* and *DISTRIBUTOR*.

Real world example

The following example illustrates the use of Dublic Core Metadata in HTML.

```
<-- Ripped out from http://info.ox.ac.uk/~lou/wip/metadata.syntax.html -->
<meta name="title" content="A syntax for Dublin core Metadata:
 Recommendations from the second Metadata Workshop">
<meta name="author" content="Lou Burnard">
<meta name="author" content="Eric Miller">
<meta name="author" content="Liam Quin">
<meta name="author" content="C. M. Sperberg-McQueen">
<meta name="subject" content="metadata">
```

```
<meta name="subject" content="Second Metadata Workshop (Warwick, U.K.)">
<meta name="date" content="1996">
<meta name="date" content="(Schema=ISO)1996-04-19">
<meta name="object-type" content="article">
<meta name="form" content="HTML 2.0">
<meta name="form" content="(Schema=IMT)text/html">
<meta name="identifier"
      content="(Schema=URL)http://info.ox.ac.uk/~lou/wip/metadata.syntax.html">
<meta name="identifier"
      content="(Schema=URL)http://www.uic.edu/~cmsmcq/tech/metadata.syntax.html">
<meta name="source" content="(none)">
<meta name="language" content="(Schema=ISO6639)en">
```

The Meta-record fragment would be:

```
<!ENTITY LOCATION  CDATA "http://info.ox.ac.uk/~lou/wip/metadata.syntax.html">
<author>Lou Burnard</author>
<author>Eric Miller</author>
<author>Liam Quin</author>
<author>C. M. Sperberg-McQueen</author>
<subject>metadata</subject>
<subject>Second Metadata Workshop (Warwick, U.K.)</subject>
<date>1996</date>
<date SCHEMA="ISO">1996-04-19</date>
<object-type>article</object-type>
<form>HTML 2.0</form>
<form SCHEMA="IMT">text/html</form>
<identifier SCHEMA="URL">
        http://info.ox.ac.uk/~lou/wip/metadata.syntax.html</identifier>
<identifier SCHEMA="URL">
        http://www.uic.edu/~cmsmcq/tech/metadata.syntax.html</identifier>
<source>(none)</source>
<language SCHEMA="ISO639>en</language>
```

As with all the doctypes it includes an autodetection of implied hyperlinks, URLs and email addresses.
Note: The *LOCATION* refers to the derived URL of the document being indexed and this might be different from the encoded URL identifier. The later is the *more definitive* source and can well have a different encoded meta-record (different version).

Meta Level Grain

The HTML presentation, in turn, also contains Metadata and link information about the resource record derived from the <LINK...> content in the original resource.
The `<LINK REL="BASE" HREF=URL>` encodes the link from the meta record to the original HTML that contained the meta.
HTTP-EQUIV metadata for DATE-MODIFIED and EXPIRATION are transfered from the original resource to the meta-record. Rating system information such as PICS is also reflected in the META record.
`<META http-equiv="PICS-Label" content='(PICS-1.0 "http://www.classify.org/safesurf/" l on "1997.05.02T13:23-0100 r (SS~~000 1)'>` Is a simple PICS classification for a HTML resource. While this PICS lable refers to the resource and might not apply to the metarecord it is still transfered.
The <HEAD> would contain:

```
<META http-equiv="PICS-Label" content='(PICS-1.0
"http://www.classify.org/safesurf/" l on "1997.05.02T13:23-0100 r (SS~~0 00
```

1)'>
And the content would contain:

PICS-Label: (PICS-1.0 "http://www.classify.org/safesurf/" l on "1997.05.02T13:23-0100 r (SS~~000 1)

or as XML:
<PICS-Label>(PICS-1.0 "http://www.classify.org/safesurf/" l on "1997.05.02T13:23-0100 r (SS~~000 1)</PICS-Label>
The *LINK* attributes are transfered to the HTML and mapped into the XML as:
`<LINK Type=Name TITLE=TITLE HREF=URL>`
To `<Type NAME=Name TITLE=Title HREF=URL/>` , eg. tags *REV* and *REL*.
The `<LINK REL="META" SRC="...">` and `<LINK REV="META" SRC="...">` are *special*! They are used to provide *external* meta-record definitions to a HTML resource. There are no definitive standards yet.
The `<LINK REL="SCHEMA.XXX" HREF="..." and <LINK REL="DTD.XXX" HREF="..."`
are used to define the descriptive schema and the DTD for the structure.
Lets look at a more complicated, "real-world", example:

```
<!-- Dublin Core Metadata Package -->
<META NAME="DC.title" CONTENT="Proposed Encodings for Dublin Core Metadata">
<META NAME="DC.author.name" CONTENT="Dave Beckett">
<META NAME="DC.author.email" CONTENT="D.J.Beckett@ukc.ac.uk">
<META NAME="DC.subject.keyword" CONTENT="metadata, dublin core">
<META NAME="DC.identifier.URL"
CONTENT="http://www.hensa.ac.uk/pub/metadata/dc-encoding.html">
<META NAME="DC.form.imt" CONTENT="text/html">
<META NAME="DC.language" CONTENT="en">
<LINK REL="SCHEMA.dc" TITLE="Dublin Core"
HREF="http://purl.org/metadata/dublin_core_elements">
<LINK REL="DTD.dc" TITLE="-//OCLC//DTD Dublin Core 1.0//EN"
HREF="http://purl.org/metadata/dublin.dtd">
```

The LINK specifies the schema used for the METAs whence is a kind of meta-DTD model about the structure of the meta-record. The DTD.dc refers to the DTD for the model, so one has a

```
<?XML ENCODING="Charset (IANA Name)" VERSION="1.0"?>
<!DOCTYPE DC PUBLIC "-//OCLC//DTD Dublin Core 1.0//EN"
"http://purl.org/metadata/dublin.dtd">
<!ENTITY LOCATION  CDATA "http://www.bsn.com/blah/blah/blah">
<DC NAME="Dublin Core" SCHEMA="http://purl.org/metadata/dublin_core_elements">
<TITLE>Proposed Encodings for Dublin Core Metadata"</TITLE>
<AUTHOR>
  <NAME>Dave Beckett</NAME>
  <EMAIL>D.J.Beckett@ukc.ac.uk</EMAIL>
</AUTHOR>
<SUBJECT>
  <KEYWORD>metadata, dublin core</KEYWORD>
</SUBJECT>
<INDENTIFIER>
  <URL>http://www.hensa.ac.uk/pub/metadata/dc-encoding.html&;lt;/URL>
</INDENTIFIER>
<FORM>
 <IMT>text/html</IMT>
</FORM>
```

```
<LANGUAGE>en</LANGUAGE>
</DC>
```

Since meta-data markup conventions are in flux and the HTML should survive past the next change, via the doctype option *MAPPING* one can specify a map file to map the container specified in *<META NAME=..>* to an alternative name. This feature has been provided to allow for the unification of field names between collections— eg. to interpret `<META NAME="DC.form.imt" CONTENT="text/html">` and `<META NAME="DC.form" CONTENT="(Schema=imt)text/html">`— and doctypes.
The XML produced is *NOT VALIDATED* but is assumed to have been correct. It is the duty of the HTML authors to confirm the correctness of the mark-up.
If `<LINK REL="DTD.dc" ...>` is not defined then the XML record produced would be without the doctype declaration.

XSpace Meta Content Framework (MCF)

In addition the HTML presentation contains a:
`<EMBED SRC="URL.mcf">`
as a link to a MCFified view of the hyper-content of the original document. This dynamic reference is a catalog of the links from the document *external* to the document and meta-record. The MCF file format is originally from Apple Research's ProjectX.

http://www.guha.com/mcf/mcf_spec.html

The MIME type for the MCF is: `Content-type: image/vasa`
Together with a MCFed Web one has the possibility to create a VRML-like geometric navigation model. It is easily reproduced from a HyTime model.

HTMLHEAD

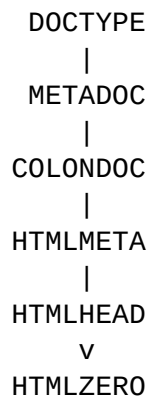
This is a variant of the HTMLMETA doctype intended for use by spinders and crawlers.

```
HTMLHEAD Class Tree:
                                DOCTYPE
                                   |
                                METADOC
                                   |
                               COLONDOC
                                   |
                               HTMLMETA
                                   v
                               HTMLHEAD
```

Processes META, TITLE and LINK elements in <HEAD>...</HEAD> or <METAHEAD>...</METAHEAD>

HTMLZERO

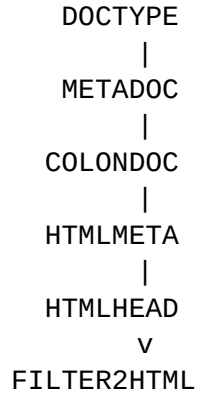
A HTMLHEAD variant that does not treat 'most' tagnames as words.



In contrast to rendered HTML it still supports fielded search all the metadata and allows one to use HTML comments to supplement documents with searchable but not 'visible' information.

FILTER2HTML

```
Class Tree:
```



The FILTER2HTML is a special variant of the HTMLHEAD doctype. Instead of processing files directly it us designed to use an external filter to convert the input file into HTML type files for processing by the HTMLHEAD document handler.

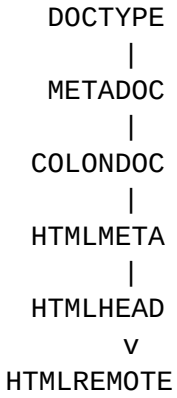
Options:

```
 Filter        Specifies the program to use.
Content-type  Specifies the MIME content-type of the original.
```

These are defined in the "filter2html.ini" [General] or <Db>.ini [FILTER2HTML] sections. Filters should take a single argument as the path to the (binary) input file and should write their output (HTML) to standard output (stdout).

HTMLREMOTE

Class Tree:

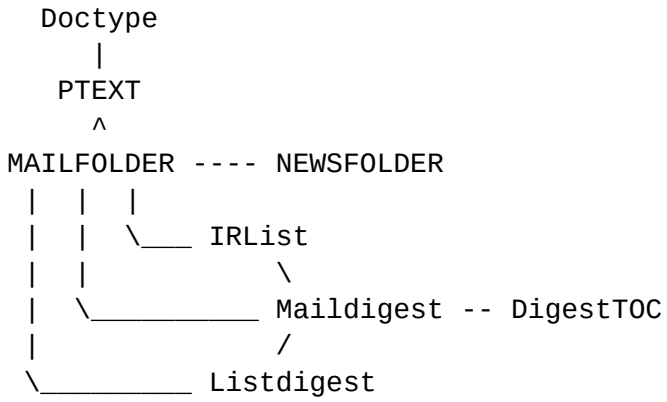


The HTMLREMOTE doctype is intended for processing Web pages retrieved from remote sites. Its main additional feature over HTMLHEAD is that it can resolve local paths to URLs. This way a retrieval can return a URL to the remote document rather than retrieve the local cached copy.

Search time Options:

BASE Specifies the base of the HTML tree (root) This can also be specified in the doctype.ini as BASE=dir in the [General] section.

MAIL DOCTYPES



The mail doctypes have been designed to accept and correctly handle nearly anything that ends up in a mailfolder.

The MAILFOLDER, NEWSFOLDER, IRLIST, MAILDIGEST, LISTDIGEST and DIGESTTOC doctypes are all intimately intertwined into one another.

The AUTODETECT class knows how to identify these files, basically those with mail headers and those with news headers. All these files are passed to the MAILFOLDER doctype. It in turn understands the different types of mail and passes the records to the suitable doctype. These doctypes are also equiped with identification logic and can pass the doctype to yet another class.

In practice this means that: a folder can contain a mixture of all the kinds of mail that arrive in ones mailbox, even mixed with newsfolders. Due to this design it is well suited for use as part of an automatic list or behind a incoming mail filter.

MAILFOLDER Message Parsing

The MAILFOLDER mail parser understand a number of header tag keywords in mails including some non-standard X- elements such as "X-No-Archive", "X-OriginalArrivalTime", "X-Original-Date", "X-Supersedes", "X-To", "X-UID" and "X-Url". It importantly uses the “Message-Id” keyword value to define a key (the value is encoded into an ASCII alphanumeric string safe for transmission) for the record since they are by-definition unique identifiers.

> *“The "Message-ID:" field provides a unique message identifier that refers to a particular version of a particular message. The uniqueness of the message identifier is guaranteed by the host that generates it (see below). This message identifier is intended to be machine readable and not necessarily meaningful to humans. A message identifier pertains to exactly one version of a particular message; subsequent revisions to the message each receive new message identifiers.”* – IETF RFC5322 Internet Message Format[8]

Should multiple messages be encountered with the same Message-Id the handler will detect this and create an alternative key and typically mark the duplicate as “deleted”. This can happen when the same message is cross posted to numerous mailing lists and these lists are indexed together.

Note that according to the RFC it “SHOULD be present” but may not be present (should versus must).

The parser uses the Document-Id to not only assign unique record keys but also to resolve mail threads—messages referring to other messages especially using the "In-Reply-To:" and "References:" fields.

The other special keyword in email is “Expires”. The value of this field is a date defined as the “time at which a message loses its validity”. We use it to set the expiration date for the record. Depending upon configuration the record, once past its expiration date, will be either automatically deleted when the AutoDeleteExpired key is set to true (easily set using the Iutil tool with -autodelete) or manually triggered for deletion (available also via the Iutil command line tool via the -del_expired).

Limitations

Base 64 encoded messages and multipart messages are not deep processed. To do so would require that the attachments and components be decoded. Mails are processed as-in in the transport. Multipart boundaries are by-design not understood as multipart boundaries. This means that HTML and other encodings are not understood as such. Beyond the header elements there is the body and it is processed as text.

Should deep processing be demanded by an application, indexing its full content, one would need a pre-processing external filter to process the electronic messages into one or more records encoded in a manner more suitable. A mail, for example, containing a binary attachment can be processed into two records: one the mail body and the other the attachment. The attachment could then be indexed with an appropriate doctype and the mail could have a hyper-reference to said record.

8 https://datatracker.ietf.org/doc/html/rfc5322

DIGESTTOC

Internet Mail Digest (RFC1173, Listserver, Lyris and Mailman) Table of Contents

NEWSFOLDER

Newsfolders parsed by the `MAILFOLDER` document handler are "automaticaly" set with the `NEWSFOLDER DOCTYPE`. This is mainly to get the right MIME type for binding external applications such as a newsreader.
The MIME type for "Raw" records is "message/news".

MAILDIGEST

Internet mail digest file format per RFC 1153. This is the most common mail digest format. The `MAILDIGEST` is for single digests only. To process a folder of digests one should use the MAILFOLDER doctype. That doctype has been designed to identify RFC1153 digests and will pass the individual messages to the `MAILDIGEST` doctype.
The MIME type for "Raw" records is "Application/X-MailDigest". See also `MAILFOLDER`.

LISTDIGEST

Listserver mail digest file format. As with the `MAILDIGEST` doctype it is designed for single digests only. The `MAILFOLDER` doctype will identify `LISTDIGEST` messages and segment a folder into individual digests as records.
The MIME type for "Raw" records is "Application/X-ListDigest". See also MAILFOLDER.

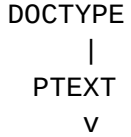
IRLIST

Yet another mail digest format. The MIME type for "Raw" records is "Application/X-IRList".

This is a "helper" class for `MAILDIGEST` and `LISTDIGEST`. It handles the creation of a Table of Contents (with HyperLinks in HTML) for the contents of a digest. The Hyperlinks and Table of Contents is created "on-the-fly" during the Presentation. See
Digest TOC Example (HTML)
Digest TOC Example (SUTRS)
Raw Source.
The MIME type for "Raw" records is "message/rfc822". See also `MAILFOLDER`.

MEMODOC

`MEMODOC Class Tree:`



MEMODOC

The MEMODOC doctype is designed to support a class of ASCII memos. The fields/tags are, like COLONDOC, defined by a : (Colon), eg. <Field Name>: <Field Value>

These pairs are parsed untill a boundary-seperator is encountered. This seperator is a combination of several _-+= characters (at least 4) or an empty line. The contents from the separator until the end-of-record is defined as the Memo-Body. In generic memos one would just format COLONDOC type lines with a blank line to separate to the body. In the text-body since it is a child of PTEXT it also tries to detect pages, paragraphs, lines and sentences as well as the first instances thereof as a unique field.

The Default Headline is contructed from, should they exist, a combination of the FROM and SUBJECT fields as: Memo from <From value>: <Subject value>

Example:

```
Field_name: Content of the field
Field_name2: Content of the 2nd field

Here is the content of the "MEMODOC-Body" field. It is handled by the PTEXT
document handler. If so specified it will get parsed into sentences,
paragraphs and pages. This is the forth sentence.

This, for example, is the 2nd paragraph.

And here is the third paragraph.
```

Options:

```
[General]
ParseMessageStructure=Yes|No // specifies if the message line/sentence/paragraph
                             // structure should be parsed (Default: YES)
AutodetectFieldtypes=Yes|No  // specified if we should guess fieldtypes (default:YES).
```

METADOC

Class Tree:

```
DOCTYPE
   v
METADOC
```

The METADOC doctype is a major base for a whole class of text style meta-document format files, especially COLONDOC and its family.

The format defines a set of a key-value pairs by default using the = and left (key) to right (value): e.g. key=value.

Example:

```
First_name=Frances
Middle_name=S.
Last_name=Hotchkiss
Phone=508-457-2242
Phone=FAX 508-457-2310
```

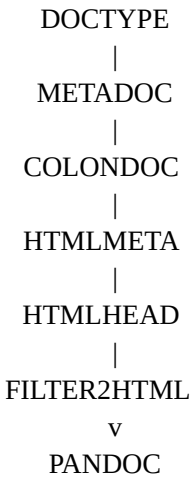
Indexing options (defined in .ini):

```
 [General]

 Style=List|Table // To use Lists or Tables for HTML presentations.
 AllowWhiteBeforeField=True|False // Allow leading white space.
 AutodetectFieldtypes=True|False // Guess fieldtypes
 IgnoreTagWords=True|False        // Store tag names as searchable words?
 SepChar=Character specified as Character or
      <space> (for ' '), <equals> (for '='),    <tab> (for the horizontal tab
      character), \nnn (octal number for character)  or xNN (hexidecimal). If
not   specified the default is '='.
```

These options are definable in all children of METADOC.

PANDOC



Option: format=<format>

It uses the program pandoc. Pandoc is a free and open-source document converter. It was created by John MacFarlane, a philosophy professor at the University of California, Berkeley.

For conversion it runs 'pandoc -s -t HTML -f <format>' (where <format> is the name that pandoc recognizes for an input format). If format is no specified (the default) it will execute: 'pandoc -s -t HTML'. Here pandoc will attempt to guess it from the extensions of the input filenames. If the input files' extensions are unknown, the input format will be assumed to be markdown.

Pandoc understands a number of useful markdown syntax extensions, including document metadata (title, author, date); footnotes; tables; definition lists; superscript and subscript; strikeout; enhanced ordered lists (start number

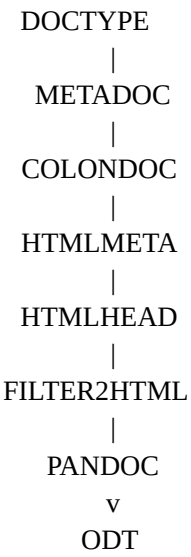
and numbering style are significant); running example lists; delimited code blocks with syntax highlighting; smart quotes, dashes, and ellipses; markdown inside HTML blocks; and inline LaTeX. If strict markdown compatibility is desired, all of these extensions can be turned off.

Among the standard formats pandoc understands are: `biblatex bibtex commonmark commonmark_x creole csljson csv docbook docx dokuwiki epub fb2 gfm haddock html ipynb jats jira json latex man markdown markdown_github markdown_mmd markdown_phpextra markdown_strict mediawiki muse native odt opml org rst t2t textile tikiwiki twiki vimwiki`

The command to get the input list from pandoc: `pandoc –list-input-formats`

The following formats uses pandoc for processing:

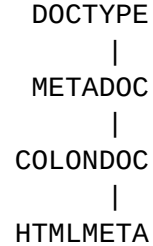
ODT

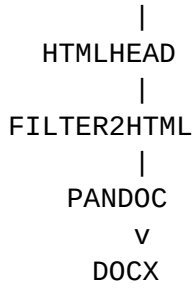


Uses the program 'pandoc -s -t HTML -f ODT' to convert the input file from ODT into HTML.

`Option: format=<format> (default: ODT)`

DOCX

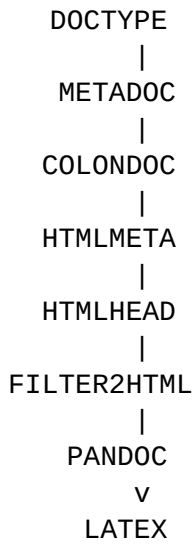




Uses the program 'pandoc -s -t HTML -f DOCX' to convert the input file from DOCX into HTML.

`Option: format=<format> (default: DOCX)`

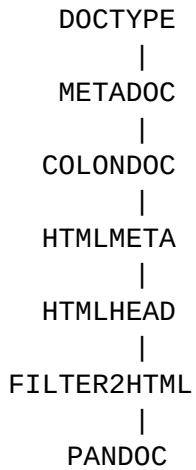
LATEX



Uses the program 'pandoc -s -t HTML -f LATEX' to convert the input file from LATEX into HTML.

`Option: format=<format> (default: LATEX)`

MARKDOWN

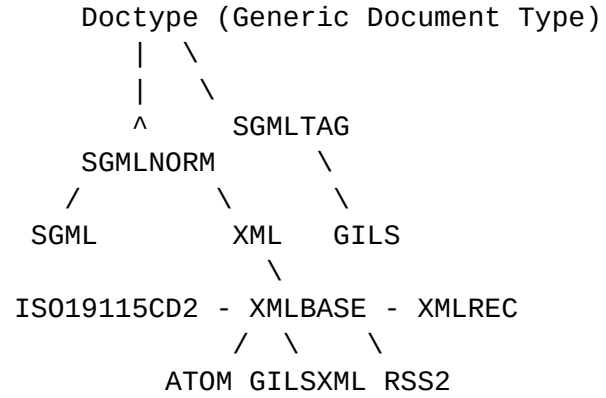


v
MARKDOWN

Uses the program 'pandoc -s -t HTML -f MARKDOWN' to convert the input file from MARKDOWN into HTML.

Option: format=<format> (default: MARKDOWN)

SGML DOCTYPES



The base for most of the SGMLish formats is SGMLNORM (there is another DOCTYPE called SGMLTAG that is designed for simple SGML-like taged documented) but not for SGML or XML documents).

SGMLNORM

Handles SGML-type documents with "normalized" tags and entities, viz. end-tags and entity replacement.

- It is not a validating SGML parser and is not in complete adherence to *15.3* of the ISO standard.
- It has been designed to provide the basic parsing and presentation services for heirarchical data for the Isearch engine, within the limitations and constraints of the Isearch architecture,
- The DTD is not processed and need not even be available on the indexing platform. Although the input is assumed to have Each non-empty tag (container) defines a field.
- In addition to storing tags values as a field it also stores the values of (complex) attributes to allow for a relatively complete search and retrieval of document content.
  In: <ONE TWO="Three">Four</ONE> Four is stored as the value of ONE Three is stored as the values for ONE@ and ONE@TWO
- SGML comments and declarations are correctly ignored. *Note:* Version 1.8 corrects a bug handling nested declaration.
- Empty tags per SGML Handbook Annex C.1.1.1, p.68 are also supported. The "null end tag" (*NET*), p.69, with the *short-tag feature* used in markup such as <tag/hello world/ is supported.
- Te parser also correctly processes XML conventions, viz. <EMPTY/> for empty containers.

The MIME type (for CGI applications) is: `text/sgml`
Index time Options:

```
Complex arg    // Takes 0 (ignore), 1 (accept) [default is 1]
IgnoreTagWords arg   // as above, store tag names or ignore them?
These can also be specified in the doctype.ini [General] section as
Complex=0 or 1.
IgnoreTagWords=0 or 1
```

Search time Options:

In the section [<DTD Name>] (example `[-//Free Text Project//DTD Play//EN]`)

`Headline=<Headline format>.`

In the section `[Catalog]` the DTDs can be maped as `DTD=useDTD`

References:

- C. F. Goldfarb. ``The SGML Handbook." Y. Rubinsky, Ed., Oxford University Press, 1990.
- ISO 8879. Information Processing -- Text and Office Systems - Standard Generalized Markup Language (SGML), 1986.

- See Also
  - ISO/IEC JTC1/SC18/WG8
  - A Gentle Introduction to SGML

SGML

The Standard Generalized Markup Language (SGML; ISO 8879:1986) is a standard for defining generalized markup languages for documents.

The SGML doctype is a **full** validating SGML parser. It works in 2 (two) passes. In the first pass the document is parsed, validated and normalized into a cannonical form and placed into a persistant cache. In the second pass the cannonical document is parsed and processed by the SGMLNORM doctype handler.

While XML has greatly replaced SGML one continues to encounter some applications:

- Text Encoding Initiative (TEI) is an academic consortium that designs, maintains, and develops technical standards for digital-format textual representation applications.
- DocBook is a markup language originally created as an SGML application, designed for authoring technical documentation; DocBook currently is an XML application.
- CALS (Continuous Acquisition and Life-cycle Support) is a US Department of Defense (DoD) initiative for electronically capturing military documents and for linking related data and information
- HyTime defines a set of hypertext-oriented element types that allow SGML document authors to build hypertext and multimedia presentations.
- EDGAR (Electronic Data-Gathering, Analysis, and Retrieval) system effects automated collection, validation, indexing, acceptance, and forwarding of submissions, by companies and others, who are legally required to file data and information forms with the US Securities and Exchange Commission (SEC).
- LinuxDoc. Documentation for Linux packages has used the LinuxDoc SGML DTD and Docbook XML DTD.
- AAP DTD is a document type definition for scientific documents, defined by the Association of American Publishers.
- ISO 12083, a successor to AAP DTP, is an international SGML standard for document interchange between authors and publishers.
- SGMLguid was an early SGML document type definition created, developed and used at CERN.

Prerequisite for the proper functioning of the SGML doctype are the tools “sgmlnorm” and “jade” from James Clark.

> http://www.jclark.com/sp/sgmlnorm.htm
> It prints on the standard output a normalized document instance for the SGML document contained in the concatenation of the entities with system identifiers sysid....
>
> http://www.jclark.com/jade/
> Jade is an implementation of the DSSSL style language. The current version is 1.2.1.

The doctype must be configured to be able to find an execute these tools.

Options:

```
Sgmlnorm=<path> // Path to an alternative SGML normalizer
Jade=<path>     // Path to the Jade program executable
Catalog=<path>  // Path to the SGML catalog
DSSSL=<path>    // Path to the DSSSL specification
```

These may also be specified in the sgml.ini (or xxx.ini for xxx=sgml) as Catalog=path and DSSSL=path in the [General] section.

The default SGML catalog is "sgml_catalog"
The default DSSSL specification is "dsssl_spec"

```
The MIME type (for HTTP applications) is: text/sgml
```

XML

The Extensible Markup Language (XML) is a language derived from SGML. XML has been designed to retain most of the power of SGML but with a substantially more simple grammar that is suited to tools such as yacc and lex.

The motivation for XML was to provide:

- A structured open document type for distributed applications working on large-scale networks such as the Internet.
- A simple language *compatible* with SGML
- An easy to author (even by hand) document format.
- An inter-operable basis for push delivery models.

The most significant features of XML are:

- A document can be processed without need of the DTD.
- All container tags are normalized
- Unicode character (UTF) set support via `&#nnnn;` style entities.
- Empty tags are explicit using a `<tag/>` markup convention.

The XML handler does not provide any significant language validation and since it is a child of SGMLNORM it also supports several SGML constructs that are not, and were never intended to be, part of the standard.

Note: For the autodetect mechanism to work correctly one *must* either use the .xml (or .XML) file name extension or specify <?XML VERSION="*Version*"?> (only the <?XML is significant) in the document declaration. Since the XML document will be correctly parsed by the SGMLNORM doctype the major effect of *incorrect identification* would be in the MIME type for the *Raw record*.

✗ SGML-like formats

SGMLTAG

Handles documents with SGML-like markup. It is NOT intended for SGML documents.

In v2.0+ of the doctype suite the SGMLTAG doctype is tuned to the needs of GILS documents. The headline is constructed from the 2nd level tag.

The MIME type (for CGI applications) is

Application/X-SGMLTAG-<level-1>

Example: `<Rec> <Title> Personnel Action System </Title> <Originator>U.S. Geological Survey </Originator>`

For the above example: `Application/X-SGMLTAG-Rec`.
And the *Headline*: `Personnel Action System`.

GILS

Handles documents with SGML-type markup for use in GILS systems. It is NOT intended for SGML documents. It uses SGMLTAG.

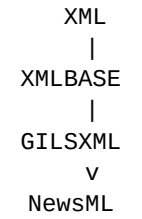
The MIME type (for CGI applications) is

Application/X-GILS-<level-1>

NEWSML

The doctype is designed to handle the newsml XML format from the International Press Telecommunications Council (IPTC), an organization established by a group including the Alliance Européenne des Agences de Presse, ANPA (now NAA), FIEJ (now WAN) and the North American News Agencies (a joint committee of Associated Press, Canadian Press and United Press International) to safeguard the telecommunications interests of the world's press.
http://www.newsml.org / https://iptc.org/

```
NEWSML Class Tree:
        DOCTYPE
           |
        SGMLNORM
           |
```

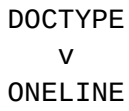


The format is basically XML but it also understands a few details about NewsML such as that elements "DateAndTime", "DateId", "DateLabel", "DateLineDate", "FirstCreated" and "ThisRevisionCreated" are date datatypes.

As default for the record key it uses the value of Duid from <NewsML Duid=”key..”>. For the date of the record itself it uses NewsML\\NewsEnvelope\\DateAndTime. For date created it uses "FirstCreated" and for date modified it uses "ThisRevisionCreated". Since news has a expiration date the engine uses for date expires “EndDate”;

ONELINE

```
Each line is a record (unfielded)
```

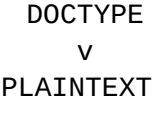


The ONELINE doctype is quite basic but both convenient and powerful for suitable use cases (such as simple telephone books). Lines are delineated by newline character. There are no fields whence also no special handling for headlines.

The result is the whole record. This can be used for great benefit by using an external filter to handle presentation which, in turn, can parse the record and trigger a number of events.

```
[External/<RecordSyntax OID>]
  Field=<program> # e.g. F=cat would pipe the record for full element
presentation to cat
```

PLAINTEXT



The PLAINTEXT doctype is the absolute most basic doctype presenting an archetypal fulltext keyword search . The entire document is viewed as a single record. There are no fields whence also no special handling for headlines and the result is the whole document.

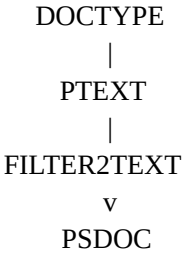
There are use cases and this doctype can be used for great benefit by using an external filter to handle presentation which, in turn, can parse the record and trigger a number of events.

```
[External/<RecordSyntax OID>]
  Field=<program> # e.g. F=cat would pipe the record for full element
presentation to cat
```

Since the record is the whole document another popular use is to exploit its path on the disk to reconstruct a URL for a remote resource. Example: map //var/opt/data/www.nonmonotonic.net/def/document1 to http://www.nonmonotonic.net/def/document1

PS (PostScript)

Postscript Indexing via (external PS to Text) filter



Option:

```
   Filter   Specifies the program to use (default “pstotext” or “ps2ascii”)
```

By default it looks for “*pstotext*” in its executable path and if it does not find it it sets “*ps2ascii*” as the default program (filter) to use for conversion to text.

The program *ps2ascii* comes with the Ghostscript package and is generally bundled on many Linux platforms. It uses gs to extract ASCII text from PostScript or Adobe Portable Document Format (PDF) files. The default ps2ascii doesn't look at font encoding, and isn't very good at dealing with kerning, so one may want to consider installing *pstotext*.

The program *pstotext* is similar to the *ps2ascii* program. The output of *pstotext* is however better than that of ps2ascii, because pstotext deals better with punctuation and ligatures.

There are, however, other options. One can, for example, use Adobe’s Distiller to convert PS files. Given that PostScript files are generally legacy artefacts (replaced by variants of PDF) the functionality of *pstotext* tends to be sufficient.

PTEXT

Plaintext with "Page", "Paragraph", "Sentence" and "Line" fields as well as "firstParagraph", "firstSentence" and "firstLine" fields for the resp. first incidences of these fields.

PTEXT Class Tree:

DOCTYPE
v
PTEXT

Example:

```
Here is the content of the first sentence field. This is the second sentence
and the first line contains bits of the first and second sentence. If so
specified it will get parsed into sentences, lines, paragraphs and pages.
This is the forth sentence as well as the forth line.

This, for example, is the 2nd paragraph.

And here is the third paragraph.

^L If it sees a Ctrl-L character  (FF, Form-feed, defined by a value of 12)
it recognizes what follows as the next page.
```

A "Headline" field is, by default, set to the longer of "firstLine" or "firstSentence". If "Headline" is set to empty (<ignore>) then no "Headline" field will be created during indexing. The <ignore> value can be used to disable individually the line, sentence, paragraph and page detection.

These options are defined in the `Doctype.ini` [Fields] section.

Additional `DB.ini` Options:

[General]

```
ParseBody=Y|N       # To parse the body for the above "fields"
ZeroLengthPages=Y|N # Allow for empty pages to be stored (for page count)
Headline=<Fieldname>
```

The algorithm for line, sentence, paragraph and page detection is relatively straightforward and reflects European tradition.

Line
: The contents between two lines (defined by line feeds or carriage returns).

Sentence
: The contents between the demarcation of the end-of-sentence punctuation.

Paragraph
: The contents between block of text with some extra whitespace between their end and the start of the next block

Page
: Text between emissions of the page character.

NOTE: Elements Line and sentence may overlap. A line can contain parts of a sentence or wholly one or more sentences. A sentence may be within a single line or spread across multiple lines. A paragraph can consist of a single line or single sentence but never can a sentence contain more than one paragraph.

XMLREC

The XMLREC doctype is a special child of the XML document types used to “slice and dice” an XML document with multiple items into, from the perspective of re-Isearch, multiple records each containing a single item.

DOCTYPE
|
SGMLNORM
|
XML
|
XMLBASE
v
XMLREC

In order to slice-and-dice it needs to know what element is used for the “cut”. It is defined as the RecordSeperator option. When it encounters the <Seperator ...> it triggers a new record event. The entire content from the < in <Seperator .. until the > in </Seperator > is viewed as a single record. The declaration and whatever was before the first instance of the element is ignored just as the content in-between and after the closing last instance of the element.

Options:

```
[XML]
 RecordSeperator=<tag>
 Preface=<XML preface fragment including declaration>
 Tail=<XML tail fragment>
```

In order to be XML compliant on presentation it needs two additional items configured:

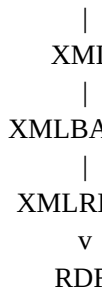
(a) Preface: the preface is all the verbage including the document declaration.
(b) Tail: whatever XML should be inserted at the end.

TIP: In order to have multiple sets of prefaces and tails for different document types under the RECXML banner one uses the doctype child specification convention: NAME:RECXML where name is a unique identifier for the format. In its NAME.ini configuration file (in the usual places) or in the DB.ini under the NAME section one would have the preface, tail and record separator defined..

RDF

RDF-like record format.

DOCTYPE
|
SGMLNORM



The Resource Description Framework (RDF) is a W3C standard for describing resources on the Web.

RDF is a framework for describing Web resources, such as the title, author, modification date, content, and copyright information of a Web page.

Uses element name to slice-and-dice records by default `<rdf:Description>`.

The default prefix (see XMLREC), should one not be defined, is:
`<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:s="http://description.org/schema/">`

And the default tail is: `</rdf:RDF>`

Both of these can be over-ridden using the options (see XMLREC).

RDF example:

```
<?xml version="1.0"?>

<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:cd="http://www.recshop.fake/cd#">

<rdf:Description
 rdf:about="http://www.recshop.fake/cd/Empire Burlesque">
  <cd:artist>Bob Dylan</cd:artist>
  <cd:country>USA</cd:country>
  <cd:company>Columbia</cd:company>
  <cd:price>10.90</cd:price>
  <cd:year>1985</cd:year>
</rdf:Description>

<rdf:Description
 rdf:about="http://www.recshop.fake/cd/Hide your heart">
  <cd:artist>Bonnie Tyler</cd:artist>
  <cd:country>UK</cd:country>
  <cd:company>CBS Records</cd:company>
  <cd:price>9.90</cd:price>
  <cd:year>1988</cd:year>
</rdf:Description>
.
.
.
</rdf:RDF>
```

```
Just to examine.. We index.. and lets examine the fields


edz@icebear$Iutil -d /tmp/R -vf
Iutil [Info]: Iutil 4.0a (x86_64 GNU/Linux)
The following fields are defined in this database: '.' 'CD:ARTIST' 'CD:COMPANY'
'CD:COUNTRY' 'CD:PRICE' 'CD:YEAR' 'RDF:DESCRIPTION' 'RDF:DESCRIPTION@'
'RDF:DESCRIPTION@RDF:ABOUT' 'RDF:DESCRIPTION\CD:ARTIST' 'RDF:DESCRIPTION\CD:COMPANY'
'RDF:DESCRIPTION\CD:COUNTRY' 'RDF:DESCRIPTION\CD:PRICE' 'RDF:DESCRIPTION\CD:YEAR'
'RDF:DESCRIPTION\'
Iutil [Info]: Done.


edz@icebear$Isearch -d /tmp/R -p cd:year tyler
Process time: 2 ms. (1) Search: 1 ms.
Query: "tyler"

1 record of 2 matched your query, 1 record displayed.
HeadlineElement:= cd:year

       Score  File
   1.   100  /home/edz/ib/ib2/build/example.rdf
`1988'

edz@icebear:$Isearch -d /tmp/R -p "RDF:DESCRIPTION@RDF:about" empire
Process time: 3 ms. (1) Search: 2 ms.
Query: "empire"

1 record of 2 matched your query, 1 record displayed.
HeadlineElement:= RDF:DESCRIPTION@RDF:about

       Score  File
   1.   100  /home/edz/ib/ib2/build/example.rdf
`http://www.recshop.fake/cd/Empire Burlesque'
```

Another example (here about resource discovery, e.g. like SOIF):

```
<?xml version="1.0"?>
 <rdf:RDF>
  <rdf:Description about="http://x.org/packages/X11">
    <s:DistributionSite>
      <rdf:Alt>
        <rdf:li resource="ftp://ftp.x.org"/>
        <rdf:li resource="ftp://ftp.cs.purdue.edu"/>
        <rdf:li resource="ftp://ftp.eu.net"/>
      </rdf:Alt>
    </s:DistributionSite>
  </rdf:Description>
</rdf:RDF>
```

XIX. Extending re-Isearch with Doctype Plugins

The re-Isearch engine is designed to be extended with both internal “built-in” doctypes but also “plugins”. The latter are loadable at run-time. These loadable plug-ins can handle all or just partial services and are not just descendents of a built-in document handler class but also can pass control to other types not immediately in its class path.

While the re-Isearch “built-in” doctypes are fullly open source and licensed according to the same license and conditions as the rest of the engine, the “plugin-in” types allow for independent distribution and may be covered by other licenses such as GPL or even closed source and proprietary.

Developing a plug-in

Plug-ins are developed in C++ and are quite simple in structure.
The following example PLUGIN “NULL” does not do anything but shows the format.

```
/*@@@
File:           null.cxx
Version:        1.00
Description:    Class NULL
@@@*/
#include "doctype.hxx"

#ifndef _WIN32
# define __declspec(dllexport)
#endif

class IBDOC_NULL : public DOCTYPE {
public:
   IBDOC_NULL(PIDBOBJ DbParent, const STRING& Name);
   const char *Description(PSTRLIST List) const;

   ~IBDOC_NULL();
};

static const char myDescription[] = "Empty plugin";

// Stubs for dynamic loading
extern "C" __declspec(dllexport) {
  IBDOC_NULL *  __plugin_null_create (IDBOBJ * parent, const STRING& Name)
  {
    return new IBDOC_NULL (parent, Name);
  }
  int          __plugin_null_id  (void) { return DoctypeDefVersion; }
  const char * __plugin_null_query (void) { return myDescription; }
}

IBDOC_NULL::IBDOC_NULL(PIDBOBJ DbParent, const STRING& Name) : DOCTYPE(DbParent, Name)
{ }

const char *IBDOC_NULL::Description(PSTRLIST List) const
{
  List->AddEntry (Doctype);
  DOCTYPE::Description(List);
  return myDescription;
}

IBDOC_NULL::~IBDOC_NULL() {
}
#ifdef _WIN32
```

```
int WINAPI DllMain (HINSTANCE hInstance, DWORD fdwReason, PVOID pvReserved)
{
  return TRUE;
}
#endif
```

The important elements to be registered are the symbols:

```
int          __plugin_<name>_id
const char * __plugin_<name>_query
IBDOC_NULL * __plugin_<name>_create
```

In the above example building a NULL DOCTYPE:

```
int          __plugin_null_id
const char * __plugin_name_query
IBDOC_NULL * __plugin_null_create
```

(notice the case).

Key to the functioning of the interface is the observation that the DOCTYPE base class has the methods we'll "override" as "virtual". C++ uses a lookup table (vtable) of functions to resolve the function calls in a dynamic/late binding manner. We are creating here just more pointers.

When the engine is fired-up and the doctype registery is initiated it sets as default search path for plugins (under Unix): `"~/.ib/plugins:/var/opt/nonmonotonic/ib/lib/plugins:~asfadmin/lib/plugins:~ibadmin/lib/plugins:/opt/nonmonotonic/ib/lib/plugins:."`

The algorithm to see if a plugin exists and loads it:

1. Look for a shared library. The file name of a plugin is upper-case letters for the class followed by the extension .sob.
2. Look for the symbol __plugin_xxx_id. The id function returns the version of the plugin.
3. Confirm that the value returned by a call to the _id function matches the version expected.
4. Construct the class using the create function call.

The registry support routine looks for a _create symbol and fetches a pointer to the class:

```
static inline dt_constr_t Creator(HINSTANCE handle, const STRING &module)
{
  dt_constr_t create = NULL;
  if (handle)
    {
      STRING symbol (PluginSymbolPrefix);
      symbol += module;
      symbol += "_create";
      logf (LOG_DEBUG, "Symbol '%s' load", symbol.c_str());
      create = (dt_constr_t) dlsym (handle, symbol.c_str());
    }
  return create;
}
```

The call to dlsym obtains the address of a symbol in a shared object. Notice that we expect it to be void so we can call it without arguments. In the case of the _create we expect a pointer—with _id we expect and int and with _query we expect a C-style 0 terminated array of characters.

Note: __plugin_xxx_query where xxx is the name of the doctype class returns the description of the plugin. Recall every doctype is designed to carry with it some of its own documentation. This is also available from plugins.

Plugins are internally represented with their name followed by the ':' character. The above NULL plugin would be seen as "NULL:". This is compared to the notation for a based class and its child: CHILD:CLASS—for example RSS:RSS2.

Plug-in doctypes should have names that distinguish themselves without regard to case from the names of any of built-in doctypes. Name clashes may result in needlessly unpredictable results. Since the names are unique one can typically call a plug-in without the ':'.

For development consult the doctype.hxx file and examine the methods available. There are method hooks available to prepare and create records to index:

```
  virtual void BeforeIndexing();
  virtual void AddFieldDefs();
  virtual void ParseRecords(const RECORD& FileRecord);
  virtual void SelectRegions(const RECORD& Record, FCT* FctPtr);
```

There are methods to handle decoding the stream of text in a record and creating the addresses to the words in the buffer:

```
 virtual GPTYPE ParseWords(UCHR* DataBuffer, GPTYPE DataLength,
        GPTYPE DataOffset, GPTYPE* GpBuffer, GPTYPE GpLength);
 virtual size_t ParseWords2(const STRING& Buffer, WORDSLIST *ListPtr) const;
```

Then parsing fields and anything to do after indexing:

```
virtual void ParseFields(RECORD* NewRecordPtr);
virtual void AfterIndexing();
```

Then there are methods to handle searching:

```
  virtual void BeforeSearching(QUERY* QueryPtr);
  virtual IRSET *AfterSearching(IRSET* ResultSetPtr);
```

And creating the result sets (RSET):

```
  virtual void BeforeRset(const STRING& RecordSyntax);
  virtual void AfterRset(const STRING& RecordSyntax);
```

There are many many other methods.. But the above gives a hint.. Best to study some of the built-in doctypes to understand the vast possibilities.

Sample Plugins

EXIF:

The engine supports a number of image formats. Some types like JPEG that contain within their contents metadata can have their metadata automatically extracted using the EXIF data.

EXIF is short for Exchangeable Image File, a format that is a standard for storing interchange information in digital photography image files. While the Japan Electronic Industries Development Association (JEIDA) produced the initial definition of Exif, it is today is supported by almost all camera manufacturers.

The metadata tags defined in the Exif standard cover a broad spectrum:

- Date and time information. Digital cameras will record the current date and time and save this in the metadata.
- Camera settings. This includes static information such as the camera model and make, and information that varies with each image such as orientation (rotation), aperture, shutter speed, focal length, metering mode, and ISO speed information.
- Descriptions
- Copyright information.
- GPS information (where the photo was taken).
- Photo identification: a unique ID to the photograph.

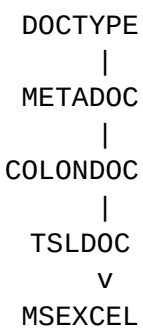
Not all cameras (and configurations) provide or store all the possible metadata.

The EXIF plugin is perhaps the most complicated sample plugin-in. It is provided to demonstrate how to build plugins using other files and even libraries. All the other plugins are self-contained.

It can be used to index JPEG and TIFF files (as well as other files that contain EXIF metadata).

MSEXCEL:

M$ Excel (XLS) Plugin. Uses an external filter to TSLDOC.



Options:

```
   FILTER   Specifies the program to use (Default 'xls2tsl')
   ONELINE  Yes/No specifies if each line should be a record (Default Yes)
```

```
xls2tsl is based on xls2csv and reads MS-Excel file and puts its content as
tab, rather than comma, separated data on standard output
```

MSRTF:

```
RTF (Rich Text Format) Plugin. Uses an external filter to convert to XML.
```

```
DOCTYPE
   |
SGMLNORM
   |
  XML
   v
 MSRTF
```

```
Options:
   FILTER   Specifies the program to use (Default 'unrtf')
```

UnRTF is a command-line program from the GNU prokject. It is written in C and converts documents in Rich Text Format (.rtf) to HTML, LaTeX, troff macros, and RTF itself. Converting to HTML, it supports a number of features of Rich Text Format:

MSWORD:

M$ Word Plugin. Uses an external filter to convert Word .doc files (pre-2007) to MEMODOC.

DOCTYPE
|
PTEXT
|
MEMODOC
v
MSWORD

Options:
FILTER Specifies the program to use (Default 'catdoc')

catdoc behaves much like cat(1) but it reads MS-Word file and produces human-readable text on standard output.

NOTE: ***This is for handling the now obsolete pre OOXML (DOCX) MS Word format.***

ODT:

DOCTYPE
|
PTEXT
|
FILTER2TEXT
v
ODT

This doctype is a stop-gap pending a better ODF doctype to index "*OASIS Open Document Format Text*" (ODT) files. It does not directly index ODT files but uses an external filter convert ODT to a format suitable for the PTEXT doctype.

`Options:`

```
  FILTER   Specifies the program to use (Default 'odt2txt')
```

By default it uses *`odt2txt`* which is a simple converter that extracts the text out of OpenDocument Texts produced by LibreOffice, OpenOffice, StarOffice, KOffice and others into plain text.

odt2txt can also extract text from some file formats similar to OpenDocument Text, such as OpenOffice.org XML, which was used by OpenOffice.org version 1.x and older StarOffice versions. To a lesser extent, odt2txt may be useful to extract content from OpenDocument spreadsheets and OpenDocument presentations.

The other alternative is to use ODF:XFILTER and pandoc to convert, for example, to the Docbook5 XML format or FILTER2HTML and defining as filter `"pandoc -s t HTML"`. The later is handled by the ODT builtin doctype.

Both pandoc and odt2txt have their significant limitations. In the future we hope to have a significantly better solution for ODF. To this aim we are working with members of the OASIS ODF TC.

USPAT:

US Patents (Green Book Style) doctype plugin.

DOCTYPE
v
USPAT

NOTE: ***This is for handling the now obsolete Green Book format.***
From 1976 - 2001 the US Patents and Trademark Office's Automated Patent System (APS) format used the Green Book standard.
https://bulkdata.uspto.gov/data/patent/grant/redbook/fulltext/1993/PatentFullTextAPSDoc_GreenBook.pdf

Since MAR 15, 2001 the USPTO switched to an XML format in accordance with the Patent Application Version 4.4 International Common Element (ICE) Document Type Definition (DTD).

XX. Custom Ranking and Sorting Algorithms

Against a fixed sort (External)

```
[External Sort]
<nn>=<path> # <nn> is number, path is to the external sort file
            # if not defined it looks for <DB>.__<nn>
```

If the file exists it will offload the sorting to the external sort defined therein. The internal index number is the number of the record in the index. The index file contains a 4-byte sort index number that associates a fixed rank to the internal index, e.g. we seek in the External sort file to

```
index_id.GetMdtIndex()*sizeof(_index_id_t)
```

and read an `_index_id_t` value. This value we use as the value for the sort.

To visualize imagine an index with only 2 records. The fist record would have its sort at offset 0. The second would have its value at offset 1*sizeof(_index_id_t) or, given 4-bytes for the size of _index_id_t, at offset 4. If the value stored in the file at offset 0 is 1 and at offset 4 its 0 then the sort would be exactly opposite the sort if we were to just use the internal indexing order as sort.

Motivation

Often we have the need (or desire) to have relevant records sorted by an external, pre-set, criteria. One of the most famous of these is "PageRank" which according to Google "*works by counting the number and quality of links to a page to determine a rough estimate of how important the website is. The underlying assumption is that more important websites are likely to receive more links from other websites*". As one can see the PageRank can be calculated and determined prior to search as the intrinsic sort defined therein is independent from the query. Other well-known ranking are the TrustRank and Hit Algorithm.

In the context of cognitive search the external sort, albeit so simplistic, opens a vast range of new applications. By analyzing text and creating a number of different ranking according to specific criteria (such as sentiment, bias, interests, etc.) one can create more personalized ranking. Here one maps the searcher into a class of rankings.

Combine with other record features

One can combine the external sort with priority and magnetism to effect a bias upon the fixed external sort but to allow for intrinsic, also pre-search, features of records to effect sort across all the external sorts.

Programmatic

In the source file "*ranking.c*" one can define `__Private_IRSET_Sort` and `__Private_RSET_Sort` to enable a number of different private sorting methods. In this file one can also implement custom modification of News Ranking and Distance Ranking.

The `__Private_` functions are called by IRSET and RSET sorting methods:

Called by IRSET sorts:

```
void atomicIRSET::SortByPrivate(int n)
{
  if (Sort != (ByPrivate+n))
    {
      if (__Private_IRSET_Sort)
        __Private_IRSET_Sort(Table, (int)TotalEntries, Parent, n, userData);
      else
        SortByScore();
```

```
      Sort = (enum SortBy)(ByPrivate+n);
    }
}
```

and RSET sorts:

```
void RSET::SortByPrivate(int n)
{
  if (Sort != (ByPrivate+n))
    {
      if (__Private_RSET_Sort)
        __Private_RSET_Sort(Table, (int)TotalEntries, n);
      else
        SortByScore();
      Sort = (enum SortBy)(ByPrivate+n);
    }
}
```

for private sorting. The integer n parsed from “private” in SORTBY:private<number> (e.g. private3 → 3) or via the enums in `ByPrivate, ByPrivateLocal1, ByPrivateLocal2, ByPrivateLocal3, ...`

By default they are NOT defined:

```
int (* __Private_IRSET_Sort) (void *, int, void *, int, void *) = 0;
int (* __Private_RSET_Sort)  (void *, int, int) = 0;
```

This mechanism allows one to install a number of bespoke sorting (normalization) methods.

The compiled objects from c*type.c*, *ranking.c and extras.c* are put into an individual .so shared library that can be swapped out without effecting the engine.

XXI. SRU/W

SRU/CQL

SRU- Search/Retrieve via URL - is a standard XML-based protocol for search queries, utilizing CQL - Contextual Query Language - a standard syntax for representing queries. See http://www.loc.gov/standards/sru/sru-2-0.html

SRU (Search & Retrieve URL Service) is a URL-based alternative to SRW. Messages are sent via HTTP using the GET method and the components of the SRW SOAP request are mapped to simple HTTP parameters. The response to an SRU request is identical to the response to an SRW request, with the SOAP wrapper removed.

SRW

The SRW (Search & Retrieve Web Service) initiative is part of an international collaborative effort to develop a standard web-based text-searching interface. It draws heavily on the abstract models and functionality of Z39.50,

but removes much of the complexity. SRW is built using common web development tools (WSDL, SOAP, HTTP and XML) and development of SRW interfaces to data repositories is significantly easier than for Z39.50. In addition, such arcane record formats as MARC and GRS-1 have been replaced with XML.

SRW is a variation of SRU. Messages are conveyed from client to server, not by a URL, but instead using XML over HTTP via the W3C recommendation SOAP, which specifies how to wrap an XML message within an XML envelope. The SRW specification tries to adhere to the Web Services Interoperability recommendations.

XXII. Configuration

Input

Map field names

During indexing one can map field names (paths) to another names. This allows one to unify names as part of a strategy to map semantically aligned fields to syntactically aligned names.

Output

Map field names

```
[Present <Language-Code>]
Field=<Display format name for Field when the record has language>
```

This is used to map internal fieldname (which may have been mapped from the name used in the source via the field unification framework) to a presentation name. This is useful for on-the-fly conversions of field names to long and descriptive names in a national langauge.

Example: To have a field name TITLE converted to TITEL in German.

```
[Present DE]
TITLE=TITEL
```

We use standard language codes. See tables above.

Convert Formats

```
[External/<RecordSyntax OID>]
Field=<program> # e.g. F=cat would pipe the record through cataloged
```

Each OID (record syntax) can have its own program. HTML, for example, would need a different processor than plain text.

To, for example, have a plain text message converted to HTML (when HTML is requested) by some text2HTML program:

```
[External/1.2.840.10003.5.109.3]
```

`Field=text2HTML`

Notice that we use OIDs rather than names

```
  {UnimarcRecordSyntax,                 "1.2.840.10003.5.1"},
  {IntermarcRecordSyntax,               "1.2.840.10003.5.2"},
  {CCFRecordSyntax,                     "1.2.840.10003.5.3"},
  {USmarcRecordSyntax,                  "1.2.840.10003.5.10"},
  {UKmarcRecordSyntax,                  "1.2.840.10003.5.11"},
  {NormarcRecordSyntax,                 "1.2.840.10003.5.12"},
  {LibrismarcRecordSyntax,              "1.2.840.10003.5.13"},
  {DanmarcRecordSyntax,                 "1.2.840.10003.5.14"},
  {FinmarcRecordSyntax,                 "1.2.840.10003.5.15"},
  {MABRecordSyntax,                     "1.2.840.10003.5.16"},
  {CanmarcRecordSyntax,                 "1.2.840.10003.5.17"},
  {SBNRecordSyntax,                     "1.2.840.10003.5.18"},
  {PicamarcRecordSyntax,                "1.2.840.10003.5.19"},
  {AusmarcRecordSyntax,                 "1.2.840.10003.5.20"},
  {IbermarcRecordSyntax,                "1.2.840.10003.5.21"},
  {CatmarcRecordSyntax,                 "1.2.840.10003.5.22"},
  {MalmarcRecordSyntax,                 "1.2.840.10003.5.23"},
  {ExplainRecordSyntax,                 "1.2.840.10003.5.100"},
  {SUTRSRecordSyntax,                   "1.2.840.10003.5.101"},
  {OPACRecordSyntax,                    "1.2.840.10003.5.102"},
  {SummaryRecordSyntax,                 "1.2.840.10003.5.103"},
  {GRS0RecordSyntax,                    "1.2.840.10003.5.104"},
  {GRS1RecordSyntax,                    "1.2.840.10003.5.105"},
  {ESTaskPackageRecordSyntax,           "1.2.840.10003.5.106"},
  {fragmentRecordSyntax,                "1.2.840.10003.5.107"},
  {PDFRecordSyntax,                     "1.2.840.10003.5.109.1"},
  {postscriptRecordSyntax,              "1.2.840.10003.5.109.2"},
  {HtmlRecordSyntax,                    "1.2.840.10003.5.109.3"},
  {TiffRecordSyntax,                    "1.2.840.10003.5.109.4"},
  {jpegTDRecordSyntax,                  "1.2.840.10003.5.109.6"},
  {pngRecordSyntax,                     "1.2.840.10003.5.109.7"},
  {mpegRecordSyntax,                    "1.2.840.10003.5.109.8"},
  {sgmlRecordSyntax,                    "1.2.840.10003.5.109.9"},
  {XmlRecordSyntax,                     "1.2.840.10003.5.109.10"},
  {applicationXMLRecordSyntax,          "1.2.840.10003.5.109.11"},
  {tiffBRecordSyntax,                   "1.2.840.10003.5.110.1"},
  {wavRecordSyntax,                     "1.2.840.10003.5.110.2"},
  {SQLRSRecordSyntax,                   "1.2.840.10003.5.111"},
  {Latin1RecordSyntax,                  "1.2.840.10003.5.1000.3.1"},
  {PostscriptRecordSyntax,              "1.2.840.10003.5.1000.3.3"},
  {CXFRecordSyntax,                     "1.2.840.10003.5.1000.6.2"},
  {SgmlRecordSyntax,                    "1.2.840.10003.5.1000.34.2"},
  {ADFRecordSyntax,                     "1.2.840.10003.5.1000.147.1"},

  // Private Exensions
  {DVBHtmlRecordSyntax,                 "1.2.840.10003.5.1000.34.3"}, // Private
  {TextHighlightRecordSyntax,           "1.2.840.10003.5.1000.34.4.1"}, // Private
  {HTMLHighlightRecordSyntax,           "1.2.840.10003.5.1000.34.4.2"}, // Private
  {XMLHighlightRecordSyntax,            "1.2.840.10003.5.1000.34.4.3"}, // Private
```

XXIII. System Administration

System wide installation

By default the engine expects its binaries and libraries to be installed in either the user accounts “ibadmin” or “asfadmin”. Alternative locations are in

```
/opt/nonmonotonic/lib
/var/opt/nonmonotonic/ib
```

Note: If the software has NOT been installed in /opt/nonmonotonic please confirm that you have created either a user "asfadmin" (if you are running ASF) or "ibadmin" whose HOME directory points to where the software has been installed.

User “`ibadmin`” (or “asfadmin”)

It is common best practice to create an account to run a daemon, service, or other system software. Technically, it makes no difference if the software is installed as a special user or in a standard global location. There are, however, long term benefits in keeping user and software accounts in separate parts of the numeric space. Since some indexes depend on access to files and the right to execute them, this is best managed through user accounts.

In Ubuntu Linux you can create this account by: `$ sudo adduser ibadmin`

Enhanced Security

Chroot

A chroot on Unix operating systems is an operation that changes the apparent root directory for the current running process and its children. A program that is run in such a modified environment cannot name (and therefore normally cannot access) files outside the designated directory tree. The term "chroot" may refer to the chroot(2) system call or the chroot(8) wrapper program. The modified environment is called a chroot jail.

To have a functional chroot environment in Linux, the kernel virtual file systems and configuration files also have to be mounted/copied from host to chroot.

```
# Mount Kernel Virtual File Systems
TARGETDIR="/mnt/chroot"
mount -t proc proc $TARGETDIR/proc
mount -t sysfs sysfs $TARGETDIR/sys
mount -t devtmpfs devtmpfs $TARGETDIR/dev
mount -t tmpfs tmpfs $TARGETDIR/dev/shm
mount -t devpts devpts $TARGETDIR/dev/pts

# Copy /etc/hosts
```

/bin/cp -f /etc/hosts $TARGETDIR/etc/

Copy /etc/resolv.conf
/bin/cp -f /etc/resolv.conf $TARGETDIR/etc/resolv.conf

Link /etc/mtab
chroot $TARGETDIR rm /etc/mtab 2> /dev/null
chroot $TARGETDIR ln -s /proc/mounts /etc/mtab

Containers

Solaris Zones and Docker Containers. Containers enable developers to easily pack, ship, and run any application as a lightweight, portable, self-sufficient packages which can run virtually anywhere.

TO BE CONTINUED

XXIV. Engine Tuning

To be written.

XXV. C++ API

Although the re-Isearch engine is written in a subset of C++ one generally does not— except for callbacks and ranking algorithms where ultimate execution speed are demanded— develop applications in c or C++ but typically one of the script languages

- Python
- Tcl
- Perl
- Ruby
- Java
- PHP

These languages are convenient for application development beyond even rapid prototyping and provide excellent performance and robustness. For most developers they are the first choice.

These higher level directly accessed classes execute quickly (as fast as native development since they are native) and are easy to use. For example in Python:

```
import sys
import string
from Isearch import *

query='chain test OR'

Db="WEB";
pdb = VIDB(Db);
print "This is PyISearch version %s/%s" % (string.split(sys.version)[0],
pdb.GetVersionID());
print "Copyright (c) 1999 Basis Systeme netzwerk/Munich";
```

```
if not pdb.IsDbCompatible():
  raise ValueError, "The specified database '%s' is not compatible with this version. Re-
index!" % `Db`
elements = pdb.GetTotalRecords();
print "Database ", Db, " has ", elements, " elements";
total = 10;
if elements > 0:
        rset = pdb.VSearchRpn(query, ByScore, 300, total); # RPN Query
```

At the core is a C++ API to which the interfaces are generated using SWIG and the following interface classes:

```
// Search Statistics
class IDB_STATS {
public:
  IDB_STATS();
  ~IDB_STATS();
  void SetHits(size_t nHits);
  void SetTotal(size_t nTotal);
  size_t GetTotal() const;
  size_t GetHits() const;
  void   Clear();
  void   SetName(const STRING newName);
  STRING GetName() const;
};

class VIDB_STATS {
public:
  VIDB_STATS();
  ~VIDB_STATS();
  void Clear();
  IDB_STATS operator[](size_t n) const;
  void SetTotal(size_t i, size_t total);
  void SetHits(size_t i, size_t total);
  void SetName(size_t i, const STRING Name);
};

class IDBOBJ {
public:
  IDBOBJ();
  ~IDBOBJ();

  bool getUseRelativePaths() const;
  bool setUseRelativePaths(bool val=1);

  STRING RelativizePathname(const STRING Path) const;
  STRING ResolvePathname(const STRING Path) const;
};
```

TO BE CONTINUED

IDB Class

This is the class where we create or open an index. In its simplist creator:
  IDB(const STRING& DBName. bool SearchOnly = false);

Example:

IDB *pdb = new IDB(“/tmp/Web”);

This will open, resp. create if not existing, an index in */tmp.* Class IDB can be used for both indexing and searching.

If we were just searching and wanted to support also virtual databases we instead use the class VIDB. In its simplist creator:

VIDB(const STRING& DBName);

A number of class instances to manage many of the other files that contain information in the database are managed through the IDB class. In particular:

- the main index: MainIndex, class INDEX
- the field data: MainDfdt, class DFDT
- the doctype registry: DocTypeReg, class DTREG
- the options registry: MainRegistry. Class REGISTRY
- metadata defaults: MetaDefaults, Class METADATA

Result sets

The engine has two classes for result sets: RSET and IRSET. IRSET is lighter weight and faster. It is what search returns.

IRSET: At its core is an array of IRESULT objects and a pointer to the IDB class parent.

IRESULT: The data in these are a number of ints, a few double ints, date (in tern a few ints), a class of linked objects to hit addresses (each 2 long ints).

Operations like AND, OR (all the binary and unary operations), sorting etc. act on IRSETs.

RSET: At its core is an array of RESULT objects.

RESULT: The data here has been resolved to get things like paths, dates, etc. and are not tied to the search or database classes.

When we search and want to present we must resolve IRSETs into RSETs. Generally we don’t resolve the entire IRSET but only the parts we immediately want such as for a result page.

One of the IRSET methods for this is GetRset(size_t Start, size_t End). It returns a pointer to a ready to use RSET. The other method is Fill(size_t Start, size_t End = 0, RSET *set = NULL)

Joining Result sets

We have two indexes and run searches on each and want to “somehow” connect the two using common keys:

In the query language ee support 3 variantions to join two result sets:

JOIN	Join, a set containing elements shared (common record keys) between both sets.
JOINL	Join left, a set containing those on the right PLUS those on the left with common keys
JOINR	Join right, a set containing those of the left PLUS those on the right with common keys

On the level of the API we have a single method: Join.

```
OPOBJ *Join (const OPOBJ& OtherIrset);
OPOBJ *Join (OPOBJ *OtherIrset);
```

```
case OperatorJoinR:
        // Like AND but NOT symetric
        { POPOBJ Op = Op1; Op1 = Op2; Op2 = Op; }
case OperatorJoinL:
        // Like AND but NOT symetric
        Stack << (Op1->Join (*Op2));
        break;
```

The work for Join is done in the method:
OPOBJ *atomicIRSET::Join (const OPOBJ& OtherIrset)

We don't support arbitary elements at search time for the key to use for joins but use the record keys which were defined (or created) at index time as that demands RSETs while the result of a search is, at first, IRSETs (which are much faster and lighter weight).

For an example let's look at the following:

from index1:

```
<document>
 <name>"Edward Zimmermann</name>
 <org>Nonmonotonic Networks</org>
...
```

from index2:

```
<document>
 <name>Nonmonotonic<name/>
 <field>machine learning</field>
…
```

```
// Open the two indexes
IDB *pdb1 = new IDB ("Index1");
IDB *pdb2 =  new IDB ("Index2");
```

Let's assume in this example that the first index contains records about people and the second contains intelligence about organizations.

Now I'm interested in searching for an "Edward" that is working in an organization is is active in "machine learning".

Since the second index is about activity we search it for records where the field contains “machine learning” (field/”machine learning”).

```
SQUERY squery(“field/\”machine learning\””);
RSET *rs2 =  pdb2→VSearch(squery); // Use Vsearch which resolves the IRSET into an RSET
```

In this result set we use the value of the name field and use that to search in index1 as the value for org. Using the field for name will give us a result set listing the relevant names.

```
size_t found = rs2→GetTotalFound();

ATTRLIST atributes;
attributes.SetFieldName(“org”);

for (size_t i = 0: i < found: i++) {
  const RESULT result = rs2→GetEntry(i);
  STRING value = pdb2->Present (result, “name”);
  if (!value.IsEmpty()) {
     SQUERY q
     q.SetLiteralPhrase(value); // We do a
     q.SetAttributes(attributes);
     RSET *rs1 = pdb1→Vsearch(q);
     …
  }
}
```

This approach is not only more flexible and more powerful it is also potentially much more performant than generic foreign key joins as the intermediate sets will often be significantly smaller (average sort performance is O(n log n) where n is the number of results while the search itself is O(p log m) where m is the number of unique terms in the index and p is the number of terms in the query so as n grows it tends to dominate the limiting performance).

TO BE CONTINUED

Compatibility with the XML:DB API paradigm

General Requirements	
Language Independence - The API MUST NOT preclude the usage with more than one language binding.	Re-Isearch provides a large number of languages bindings including C++, Tcl, Python, Perl, PHP, Ruby, Java, C#)
Textual Interface - The API MUST provide a textual representation of XML result sets.	Yes.
XML-API Interface - The API SHOULD provide a SAX or DOM based representation of XML result sets.	A SAX or DOM based representation of the XML result sets is available via loading the XML representation of the result sets into DOM

XXVI. Python API

The Python interface is generated by SWIG and is designed to map to the C++ API. The Python module with the bindings is called “IB”.

Creating the loadable extensions (language bindings)

The Python extension as well as the other extensions are created with the SWIG (Simplified Wrapper and Interface Generator) system. SWIG is an interface compiler that connects programs written in C and C++ with scripting languages such as Perl, Python, Ruby, and Tcl. It works by taking the declarations found in C/C++ header files and using them to generate the wrapper code that scripting languages need to access the underlying C/C++ code.

The necessary files for building the interface are in the swig/ directory. Central are the .i (interface files). These define the classes, methods and interfaces. We, for example, have our own string handling class (a superset variant of std:string) called STRING. In my_typedefs.i we provide some of the “hacks” to work around to create a good glue to a number of bindings (including Java). It also provides maps from its own structures to some familiar in some of the binding languages.

We, for example, to “convert” an FCT (the engines class for a table of FC or pair coordinates)

```
PyObject* PyList_FromFCT(const FCT Fct)
{
  PyObject     *listPtr = PyList_New ( Fct.GetTotalEntries() );
  const FCLIST *fclist  = Fct.GetPtrFCLIST();
  int i = 0;
  for (const FCLIST *p = fclist->Next(); p != fclist; p = p->Next())
    PyList_SetItem(listPtr, i++,  FCasTuple(p->Value()) );
  return listPtr;
}
```

We have a class called ArraySTRING that is basically an array of STRING (STRING being again our own string class). To pass these off as Python list objects:

```
PyObject * PyList_FromArraySTRING(const ArraySTRING& array)
{
  const size_t  count = array.Count();
  PyObject *listPtr = PyList_New ( count );
  for (size_t i=0; i < count; i++)
    PyList_SetItem(listPtr, i, PyString_FromString(array[i].c_str()) );
  return listPtr;
}
```

Going, for example, the other way: Python list to ArraySTRING:

```
ArraySTRING *ArraySTRING_FromPyList(PyObject* source) {
    if (!PyList_Check(source))
      {
        PyErr_SetString(PyExc_TypeError, err_not_a_list);
      }
    else
      {
    const int count = PyList_Size(source);
        ArraySTRING *temp = new ArraySTRING(count);
        for (int x=0; x<count; x++) {
          PyObject* o = PyList_GetItem(source, x);
```

```
          if (! PyString_Check(o)) {
            PyErr_SetString(PyExc_TypeError, "Expected a list of strings.");
            delete temp;
            return NULL;
          }
          temp->Add(  PyString_AsString(o) );
        }
        return temp;
      }
    return NULL;
}
```

Building the Python bindings

These is a convienient Makefile in swig/ directory. This is a feed forward to the makefiles for the various bindings.

To build the Python bindings we do a: `make Python`

This calls `make -f Makefile.py`

The Makefile.py contains a number of items that need configuration. These are mainly:

```
################################################################

################################################################
#### This is the configuration stuff  ######################

SWIG=swig-2
INCLUDE=/usr/include/python$(PYVERSION)
#OPT= -DSWIG -O5 -march=pentiumpro
MOPT= -DSWIG -O5 -march=athlon64 -mtune=k8 $(OPT)
MOPT= -DSWIG



PIC=-fpic
```

This should build both the IB.py (the Python interface) as well as the shared library (.so)-- as well as some symbollic links. In the swig/ directory there are a few Python test scripts which as part of the larger sample collections found in lib/tests/python

At the time of writing the directory contained more than 30 test scripts to explore the test the Python interface to the API. These files are a good starting place to study the API.

Loading the Python Module extension

```
import string
import sys
sys.path.append('/opt/nonmonotonic/lib/python%s.%s' % (sys.version_info[0:2]))
import IB
```

Replace *opt/nonmonotonic/lib/* with wherever the library module is installed. This will allow Python to properly load the IB module. Note the re-Isearch module is called IB!

In ib.i we specified the module names as IB:
`%module IB`

Should another name be desired it needs to be changed here. The name IB was kept for historical reasons. Since the use of the "-" character in extension names is not always acceptable we elected to keep things short. One can use the import as contruct to map to any name one desires anyway!

Opening an Index to search to add files

```
db1=/opt/nonmonotonic/data/nonmonotonicWEB";
pdb = IDB(db1);
print "This is PyIB version %s/%s" % (string.split(sys.version)[0], pdb.GetVersionID());
if not pdb.IsDbCompatible():
  raise ValueError, "The specified database '%s' is not compatible with this version. Re-
index!" % `db1`
```

Here we opened the index defined in "/opt/nonmonotonic/data/nonmonotonicWEB".
Notice we used the IDB class. There is also the VIDB class. It supports virtual collections of indexes. IDB is, however, the only class that provides indexing services. VIDB can't since it maps to multiple indexes and it can't know which index to add to.

Simplistic Search (using VIDB)

```
db1="/opt/nonmonotonic/data/nonmonotonicWEB";
query = sys.argv[1:] and sys.argv[1] or 'chain test OR'

pdb = VIDB(db1);

if not pdb.IsDbCompatible():
  raise ValueError, "The specified database '%s' is not compatible with this version. Re-
index!" % `db1`

elements = pdb.GetTotalRecords();

print "Database ", db1, " has ", elements, " elements";

total = 10;
if elements > 0:

        rset = pdb.VSearchRpn(query, ByScore, 300, total); # RPN Query
        print type(rset);
        print rset;
        rset = pdb.VSearchRpn(query, ByScore); # RPN Query
        total = rset.GetTotalEntries();
        print "Searching for: ", query;
```

```
        print "Got = ", total, " Records";

        # Print the results....
        for i in range(1,total+1):
          result = rset.GetEntry(i);
          area = pdb.Context(result, "___", "____") ;
          datum = result.GetDate();

          score  = result.GetScore();
          hits   = result.GetHitTable();
          print "[", i , "] ", rset.GetScaledScore(score, 100), " ", score, " ",
pdb.Present(result, ELEMENT_Brief);
          print "\tFormat: ", result.GetDoctype();
          print "\tFile:", result.GetFullFileName(), "  [", result.GetRecordStart(), "-",
result.GetRecordEnd(), "]";
          print "\tDate: ", datum.RFCdate();
          print "\tMatch: ", area;

pdb = None; # Delete
```

Explained:

Notice that the call to VIDB (aka Virtual IDB class) to perform an RPN search returned a RSET object. This called called “Result Set” has all the elements resolved to their paths etc. so one can directly read them. We just loop through the elements and print the format, path, matching context, record date, hit score and hit table. We requested the ELEMENT_Brief. This is a short element defined by the document format and is typically considered a suitable headline.

Let us look at another Search:

```
import string
from IB import *

##############################################################################
##
##
##############################################################################

query = sys.argv[1:] and sys.argv[1] or 'ba-nking'
db1="/opt/nonmonotonic/data/REUTERS2";
pdb = VIDB(db1);
print "This is PyIB version %s/%s" % (string.split(sys.version)[0], pdb.GetVersionID());
if not pdb.IsDbCompatible():
  raise ValueError, "The specified database '%s' is not compatible with this version. Re-
index!" % `db1`

elements = pdb.GetTotalRecords();

print "Database ", db1, " has ", elements, " elements";

if elements > 0:
```

```
        p = pdb.GetIDB(1);
        print "IDB =", p;
        mdt = p.GetMainMdt();
        print "MDT = ", mdt;
        irset = pdb.SearchSmart(query);
        rset = None;
        total = 0;
        if irset != None:
                rset = irset.GetRset(20);
                total = rset.GetTotalEntries();
        print "Searching for: ", query;
        print "Got = ", total, " Records";

        # Print the results....
        for i in range(1,total+1):
          result = rset.GetEntry(i);
          area = pdb.Context(result, "___", "____") ;
          datum = result.GetDate();

          score  = result.GetScore();
          hits   = result.GetHitTable();
          print "[", i , "] ", rset.GetScaledScore(score, 100), " ", score, " ",
pdb.Present(result, ELEMENT_Brief);
          print "\tFormat: ", result.GetDoctype();
          print "\tFile:", result.GetFullFileName(), "  [", result.GetRecordStart(), "-",
result.GetRecordEnd(), "]";
          print "\tDate: ", datum.RFCdate();
          print "\tMatch: ", area;
```

Notice that instead of going directly to RSET we asked for an IRSET. This set is lighter weight and not fully resolved.

See: Result sets (RSET and IRSET classes): C++ API Result Sets

More sophisticated

```
#!/user/bin/python
#-------------------------------------------------
#ident  "%Z%%Y%%M%  %I% %G% %U% nonmonotonic"

import sys
import string
import array
from IB import *


class HIT:
    def __init__(self, speaker, line):
        self.speaker  = speaker
        self.line     = line
    def Speaker(self):
        return self.speaker
    def Line(self):
        return self.line
```

```
    def __repr__(self):
        return self.speaker+": "+ self.line;

#############################################################################
##
##
#############################################################################
shakespeare = "SHAKESPEARE";
query = sys.argv[1:] and sys.argv[1] or 'out spot PEER'
bard="/usr/index/"+shakespeare+"/"+shakespeare;

foo = 0, IDB(bard);
for i in range(1, 10) :
  print "Open", i;
  array2 = i, IDB(bard);
  foo += array2;

print foo;

raise ValueError, "Foo"

pdb = IDB(bard);
if not pdb.IsDbCompatible():
  raise ValueError, "The specified database '%s' is not compatible with this version. Re-
index!" % `bard`

print "# IB Index '"+shakespeare+"' has ", pdb.GetTotalRecords(), " plays";

#log_init(255);

squery = SQUERY(query);
irset = pdb.Search(squery, ByScore);
total = irset.GetTotalEntries();
print "# Searching for: ", query;

rset = irset.Fill(1,total);

MainMdt = pdb.GetMainMdt();

# Print the results....
rec = 0;
for i in range(1,total+1):
  result = rset.GetEntry(i);

  key = result.GetKey();
  entry = MainMdt.LookupByKey(key);
  mdtrec = MainMdt.GetEntry( entry );
  offset = mdtrec.GetGlobalFileStart() + mdtrec.GetLocalRecordStart();
 score  = result.GetScore();
  print "[", i , "] ", rset.GetScaledScore(score, 100), " ", score, " ",
pdb.Headline(result);

  hits = result.GetHitTable();
  hit_total = len(hits);

  hitTable = [];
```

```
  old_lfc = FC(0,0);
  for k in range(0, hit_total):
        fcl = hits[k];
        fc = FC(fcl[0] + offset,fcl[1]+offset);
        lfc = pdb.GetAncestorFc (fc, "SPEECH");
        if (lfc.GetFieldStart() == old_lfc.GetFieldStart()):
                continue;
        if (lfc.GetLength() == 0) :
                continue;
        old_lfc = lfc;

        fct = pdb.GetDescendentsFCT (lfc, "SPEAKER");
        if (len(fct) == 0):
                continue;
        speaker =  pdb.GetPeerContent(FC(fct[0][0], fct[0][1]));

        node =  pdb.GetPeerNode(FC(fct[0][0], fct[0][1]));
        print "SPEAKER NODE: ", node.Name() ;

        line_fc = pdb.GetAncestorFc (fc, "LINE");
        if (line_fc.GetLength() == 0):
                continue;
#       if (fc.GetFieldStart() < line_fc.GetFieldStart()) :
#               continue;
        line  = pdb.GetPeerContent(line_fc);

        trueHit = HIT(speaker, line);
        hitTable.append(trueHit);

  count = len(hitTable);
  if (count > 1):
        print "       -- ",count,"relevant lines:";
  for l in range(0, count):
        print "      ", hitTable[l];
```

TO BE CONTINUED

XXVII. Appendium

Semantic Revelation

The engine has been designed to allow for the implementation of a novel remarkably powerful yet simple paradigm of retrieval that we've called "*semantic revelation*". The basic idea is that clusters of associations define their own implicit semantics for terms. Folksonomies (the current fashion of social tagging) assume everyone is speaking the same language with the same shared background. They don't. Everything is NOT Miscellaneous (as David Weinberger suggests). Words derive their commonality in meaning from those that associate with one another. We don't know what the words mean but might assume that if people are talking to one another that they have shared semantics. That's the basics of normative communication. Throwing everything into a big bag of words allows one to only find similar utterances but not similar meaning.

John Searle introduced the notion of an 'indirect speech act' as a kind of indirect 'illocutionary' act: "In indirect speech acts the speaker communicates to the hearer more than he actually says by way of relying on their mutually shared background information, both linguistic and nonlinguistic, together with the general powers of rationality and inference on the part of the hearer." Our model goes backwards.. It first asks.. "Who is talking to each other". And "who do I want to talk with". Its guilt by association.

The point is: We don't care what a word or sentence means. We just "assume" that when people talk they understand, more or less, each other but neither is everyone talking with each another nor do they even want to..

When there is no dialogue between listeners, the same words and phrases as spoken by a speaker can mean different things. Search is also searching for dialogue. Its all, of course, not de-coupled from ranking..

This approach increases the accessibility and visibility of information in the Internet and at the same time allows for people to individually define their own thresholds for what kinds of conversations that they don't want to see. Search after all is about helping people find what they are looking for AND NOT what they don't want to find!

See also: the collaborative works on Multipolar Search: EXODVS Cross Search Presentation @ ISEA 2008. National Museum of Singapore.

Semantic Spheres

The keys to cognitive search is a segmentation of the pool of inputs into spheres of communication. We call these semantic spheres. In the context, for example, of social networks this is not the islands of “filter bubbles” but also the dialog between them. The actors in these bubbles have often various degrees of leakage, being more or less prone to interaction, and more or less and open to information coming from “outside”.

Within a polarized mainstream media—a phrase itself tainted by actors within the mainstream media to de-legitimatize opposing voices as “Lügenpresse” or “Fake News”— the same story and syntactically nearly identical utterances may have quite opposing semantics. The most radical voices speak in codes to their listeners. When members of the LaRouche movement, for example, speak of England and “the Queen” in the context of conspiracy they are not talking about England but what they see as a global “Jewish Cabal” with overtones reminiscent of “The Protocols of the Elders of Zion“. While some of the language might on the surface align with anti-Monarchists and anti-colonialists their message is completely different. The same with David Icke and his reptilian conspiracy. In Russian publications words like “individualism” and “cosmopolitan” are semantically quite remote from their meaning to most Americans. Both the self-identified left and right share similar expressions of anti-global expressions but quite different intents. The phrase “free and fair elections” means quite different things in contemporary America depending upon ones political sentiment. “Summer of Love” meant quite something different in 1967 in San Francisco's neighborhood of Haight-Ashbury than it did in 2015 when Soa Aids Nederland launched their “Summer of Love” campaign or in 2021 Portland when the Proud Boys, a self-proclaimed chauvinist Neo-fascist movement, announced their “Summer of Love”.

Words indeed only have meaning in context but that context is often extraneous to the text within which they are included. One needs to examine the cybernetic structures, especially the patterns of communication and control. There are a large number of algorithms developed over the past half century to analyze these communication networks and model these spheres. At ISEA 2008 we showed one.

Though the use of target virtualization (see "Virtual Databases") one can combine these segments into larger groups and re-arrange then, as needed, on-the-fly. Each segment can have its own thesauri.

Comparison Medline (txt), Medline (XML) and RIS

Field	Medline (txt)	Medline (XML)	RIS
Abstract	**AB**	**Abstract / AbstractText**	**AB**
Affiliation	**AD**		
Article Date		**ArticleDate**	
Article Identifier	**AID**	**Article**	
Article Title		**ArticleTitle**	
Author	**AU**	**AuthorList**	**AU/A1**
Author Identifier	**AUID**		
Book Title	**BTI**		**BT**
Chemical List		**ChemicalList**	
Citation Subset		**CitationSubset**	
Collection Title	**CTI**		
Collaborators			**A3**
Comments Corrections List		**CommentsCorrectionsList**	
Corporate Author	**CN**		
Copyright Information		**CopyrightInformation**	
Create Date	**CRDT**		
Country		**Country**	
Data Bank List		**DataBankList**	
Date Completed	**DCOM**	**DateCompleted**	

Date Created	**DA**	**DateCreated**	
Date Last Revised	**LR**	**DateRevised**	
Date of Electronic Publication	**DEP**		
Date of Publication	**DP**		**Y2**
Delete Citation		**DeleteCitation**	
DOI			**DOI**
Edition	**EN**		
Editor and Full Editor Name	**FED**		**ED**
End			**ER**
End Page			**EP**
Entrez Date	**EDAT**		
Full Author	**FAU**		
Full Personal Name as Subject	**FPS**		
Gene Symbol	**GS**		
General Note	**GN**	**GeneralNote**	
Grant List		**GrantList**	
Grant Number	**GR**		
Investigator Name and Full Investigator Name	**IR/FIR**		
Investigator List		**InvestigatorList**	
ISO Abbreviation		**ISOAbbreviation**	
ISBN	**ISBN**		**SN**
ISSN	**IS**	**ISSN**	
ISSN Linking		**ISSNLinking**	

Issue	**IP**	**Issue**	**IS**
Journal Issue		**JournalIssue**	
Journal Title	**JT**	**Journal**	**JO/JF/JA**
Journal Title Abbreviation	**TA**		
Keywords		**KeywordList**	**KW**
Language	**LA**	**Language**	
Location Identifier	**LID**		
Manuscript Identifier	**MID**		
Medline Title Abbreviation		**MedlineTA**	
Medline Date		**MedlineDate**	
MeSH Date	**MHDA**		
Mesh Heading List		**MeshHeadingList**	
MeSH Terms	**MH**		
Misc			**M1-M3**
NLM Unique ID	**JID**	**NlmUniqueID**	
Note			**N1**
Number of References	**RF**		
Other Abstract and other abstract language	**OAB/OABL**	**OtherAbstract**	
Other Copyright Information	**OCI**		
Other ID	**OID**	**OtherID**	
Other Term	**OT**		
Other Term Owner	**OTO**		
Owner	**OWN**		
Pagination	**PG**	**Pagination**	

Personal Name as Subject	**PS**		
Personal Name as Subject List		**PersonalNameSubjectList**	
Place of Publication	**PL**		
Publication History Status	**PHST**		
Publication Status	**PST**		
Publication Type	**PT**		
Publication Type List		**PublicationTypeList**	
Publisher			**PB**
Publishing Date		**PubDate**	
Publishing Model	**PUBM**		
PubMed Central Identifier	**PMCR**		
PubmMed Unique Identifier	**PMID**	**PMID**	
Registry Number	**RN**		
Reprint			**RP**
Start Page			**SP**
Substance Name	**NM**		
Supplemental Mesh List		**SupplMeshList**	
Secondary Source ID	**SI**		
Source	**SO**		
Space Flight Mission	**SFM**		
Status	**STAT**		
Subset	**SB**		
Title	**TI**	**Title**	**TI/T1**

Transliterated Title	**TT**		
Type			**TY**
URL			**UR**
User Text			**U1-U3**
Volume	**VI**	**Volume**	**VL**
Volume Title	**VTI**		
Vernacular Title		**VernacularTitle**	
Year			**PY/Y1**

BM25 Normalization

BM25 is really just a combination of BM11 and BM15. Where b is selected as a constant from the interval [0,1]

$$\mathcal{B}_{i,j} = \frac{(K_1 + 1) f_{i,j}}{K_1 \left[(1 - b) + b \frac{len(d_j)}{avg\_doclen} \right] + f_{i,j}}$$

$f_{i,j}$ is the frequency of term within document d_j

The Value for K_1 and b are empirically chosen. Each document collection probably needs their own K value. Notice: If b = 0 → BM15, if b = 1 → BM11. A popular value for b is 0.75 given that B11 seems to generally outperform B15.

$$sim_{BM25}(d_j, q) \sim \sum_{k_i [q, d_j]} \mathcal{B}_{i,j} \times \log \left(\frac{N - n_i + 0.5}{n_i + 0.5} \right)$$