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SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Multimedia services

Metadata for an intelligent question answering service

Recommendation ITU-T F.746.7

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Recommendation ITU-T F.746.7

Metadata for an intelligent question answering service

Summary

Recommendation ITU-T F.746.7 describes metadata for the intelligent question answering service (IQAS) framework specified in Recommendation ITU-T F.746.3. This Recommendation specifies metadata and service flow for different functions to support the IQAS, which provides advanced functions to generate answers for user questions in natural language. The scope of this Recommendation covers metadata for a natural language processing function, question analysis function, candidate answer generation function, answer inference/generation function, as well as an input and output function. This Recommendation also describes general information flows to describe how metadata are used in the (IQAS.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.746.7	2018-08-29	16	11.1002/1000/13658

Keywords

Intelligent system, natural language processing, question answering, QA, QA metadata

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Metadata for an intelligent question answering service

1 Scope

This Recommendation describes metadata related to the intelligent question answering service (IQAS). The IQAS framework in [ITU-T F.746.3] already identifies some elements and attributes related to an IQAS; however, it does not define all elements needed to provide the basic features of an IQAS. This Recommendation specifies metadata for the following IQAS features as well as the general information flows to describe how metadata are used in the IQAS.

– information for natural language processing;

– information for question analysis;

– information for candidate answer generation;

– information for answer inference/generation;

– information for input and output.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T F.746.3] Recommendation ITU-T F.746.3 (2015), *Intelligent question answering service framework*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 co-reference resolution [ITU-T F.746.3]: A function that detects the preceding referents of the pronouns which replace the noun phrases of the input sentences.

3.1.2 named entity recognition [ITU-T F.746.3]: A function that recognizes named entities such as PLO entities which are people, locations and organizations from the sentences. The PLO can be decomposed into more detailed named entities depending on the applications.

3.1.3 natural language processing [ITU-T F.746.3]: A method that analyses text in natural languages through several processes such as part-of-speech recognition, syntactic analysis and semantic analysis.

3.1.4 part-of-speech recognition [ITU-T F.746.3]: A function that recognizes parts of speech (POS) in the sentences and assigns relevant POS tags considering contextual meaning of the target sentences.

3.1.5 semantic analysis [ITU-T F.746.3]: A function that recognizes the semantic relations among the words around predicates that exist in the same sentence. The semantic analysis function then generates a semantic predicate argument structure (PAS).

3.1.6 speech [b-ITU-T H.703]: Speech is the vocalized form of human communication.

3.1.7 syntactic analysis [ITU-T F.746.3]: A function that analyses sentence structures and generates dependency relations among words based on dependency grammars.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 CV_occupation: A named entity tag belonging to the civilization (CV) category that indicates a person's occupation. (e.g., scientist).

3.2.2 CV_prize: A named entity tag belonging to the civilization (CV) category that indicates a prize. (e.g., Nobel prize).

3.2.3 IsA relation: A hierarchical relation between two words in such a way that the meaning of one word includes that of the other.

3.2.4 knowledge base (KB): A collection of knowledge resources that consists of structured and unstructured data. The knowledge base is used to provide information to the various applications that are related to information provisioning such as question answering (QA) systems and search systems.

3.2.5 question answering (QA): A system that provides answers in natural language to questions in natural language form by analysing the questions and all the knowledge resources that are available to the system.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DB	Database
ID	Identifier
IQAS	Intelligent Question Answering Service
KB	Knowledge Base
LAT	Lexical Answer Type
NE	Named Entity
NLP	Natural Language Processing
NLU	Natural Language Understanding
NNG	Noun, General
NNP	Noun, Proper
NP_OBJ	Noun Phrase Objective
NP_SBJ	Noun Phrase Subjective
PAS	Predicate Argument Structure
PLO	People, Location, Organization
POS	Part Of Speech
QA	Question Answering
SRL	Semantic Role Labelling
TV	Television
URL	Uniform Resource Locator

VP Verb Phrase

VV Verb

WSD Word Sense Disambiguation

XSV Auxiliary Suffix from Verb

5 Conventions

None.

6 Overview

An intelligent question answering service (IQAS) is an advanced function to generate answers for user questions in natural language. Figure 1 illustrates the concept of QA system in the digital signage domain, where a user requests information about shoe stores to the QA system at the mall.

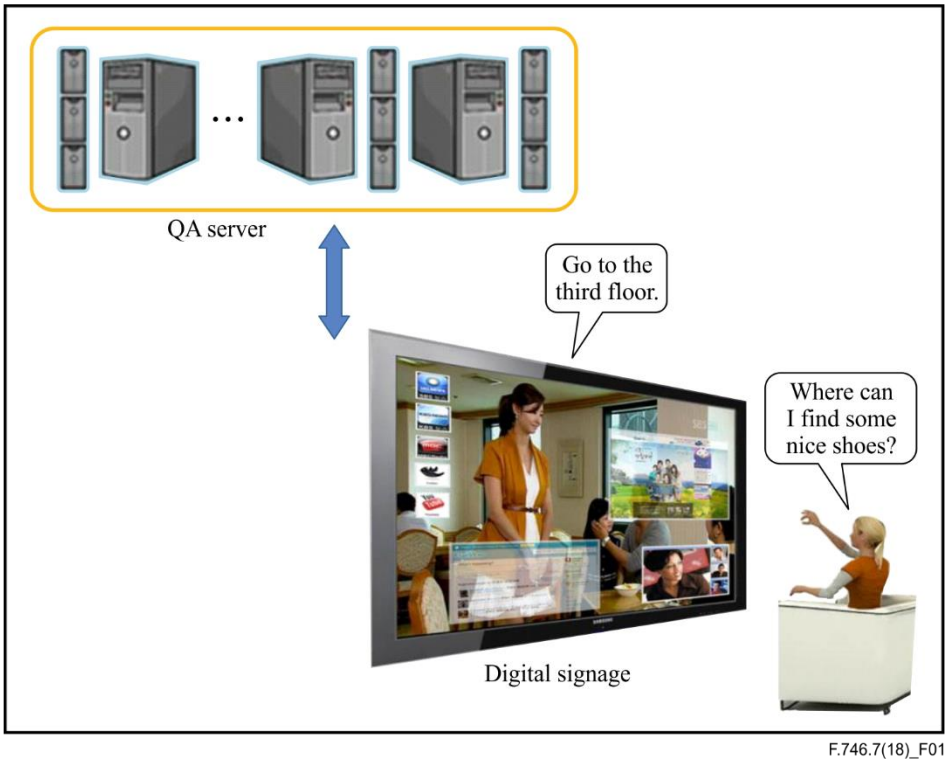

Figure 1 – Digital signage with question answering function: At the mall

Figure 2 presents an example of QA architecture. The QA system consists of several functional blocks: those for natural language processing, question analysis, candidate answer generation, answer inference and generation.

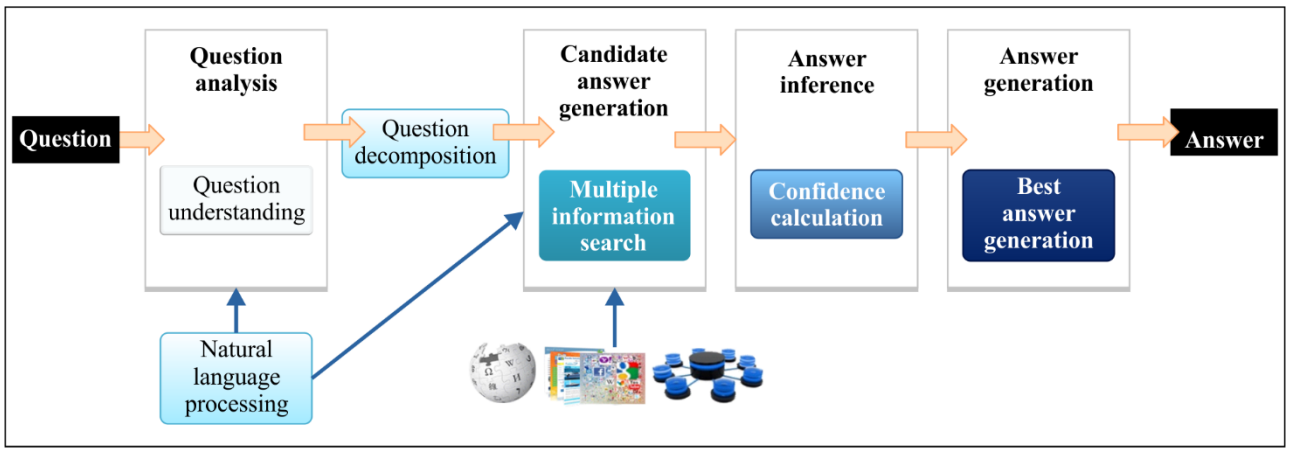

Figure 2 – Example of a question answering architecture in accordance with [ITU-T F.746.3]

This Recommendation addresses metadata related to the IQAS to present details of content and service information. [ITU-T F.746.3] has specified some elements that are applicable to IQASs.

This Recommendation selects basic elements/attributes from these specifications that are applicable to the IQAS. Names of elements/attributes are quoted as they are in the specifications, in order to keep clear the relationship between them.

7 Functional components and information flow of the intelligent question answering service

IQAS functional components are basically composed of natural language processing, question analysis, candidate answer generation, answer inference and answer generation functional blocks, as follows.

– **Natural language processing functional block**: supports natural language processing on the QA server.

– **Question analysis functional block**: supports question analysis on the terminal.

– **Candidate answer generation functional block**: supports candidate answer generation by searching information in various databases (DBs).

– **Answer inference/generation functional block**: supports answer inference based on feature normalization and ranking of candidate answers and best answer generation on the terminal.

See Figure 3.

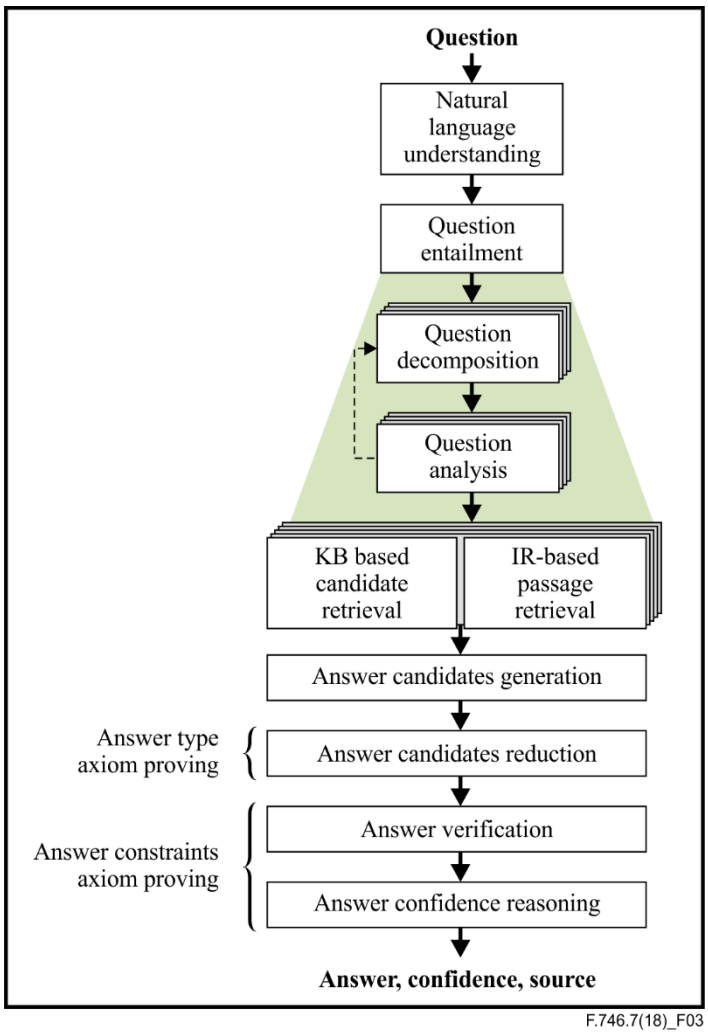

Figure 3 – Information flow of functional blocks in an intelligent question answering service

8 Information for natural language processing

This clause describes the metadata for natural language processing (NLP) information elements. The NLP module consists of the natural language understanding (NLU) function and the linguistic knowledge learning and extraction function. The NLU function analyses user questions as well as target documents for knowledge extraction using the semantic and syntactic analysis technology. The linguistic knowledge learning and extraction functions extract semantic relations among words and time/location information in the documents and acquire linguistic knowledge.

The information flow of natural language processing is described in Figure 4 as sequentially connected submodules that analyse input documents to generate one best main result for each processing submodule. To prevent error propagation from this sequential processing method, a subsidiary language analyser, which consists of the same submodules as the main NLP module, generates several analysis results for the submodules. A central controller operates on the multiple NLP analysers using an algorithm with a non-transitory storage device to prevent error propagation along with an analysis result amender. When errors occur in the main analysis result, the analysis result amender acquires multiple subsidiary analysis results that correspond to the main analysis result where the error occurred. It then transmits a substitute main analysis result with the subsidiary analysis result, and re-performs a main language analysis.

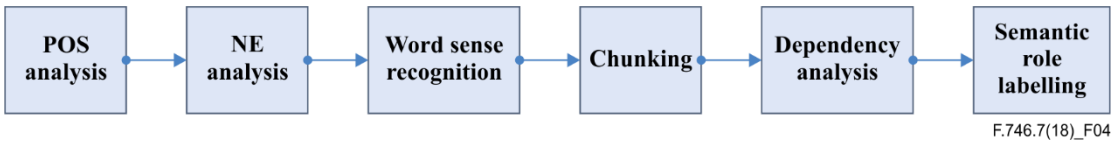

Figure 4 – Information flow of natural language processing

The analysis result amender performs the substitution as follows. The amender:

– determines whether there is a contradiction between the main analysis results;

– in response to such a detection, determines whether an error in the language processing modules is causing the contradiction;

– acquires a subsidiary analysis result that is different from the main analysis result; and

– transmits the subsidiary analysis result to the language processing modules of the main language analyser.

A set of elements/attributes for NLP information are shown in Tables 1 to 12.

Table 1 – Natural language processing information elements/attributes – Document

Element/attribute	Description	Type
N_DOC	Wrapper object of the NLP result	object
Title	Title object of a document for NLP which contains text and a named entity (NE)	object
text	Title text of the document	String
NE	NE of the title, e.g., person, location, organization	String
Category	Category of the document	string
Category_weight	Reliability of the categorization of document for NLP between 0 and 1	double
Doc_id	Identifier (ID) of the document	integer
DCT	Document creation time	String
Other_metaInfo	Other metadata information about the document that is saved as a key-value e.g., { "URL" : "http://ko.wikipedia.org/wiki/Cicano" }	Map<String, String>

Table 2 – Natural language processing information elements/attributes – Sentence

Element/attribute	Description	Type
Sentence	Result of the NLP which includes ID and original text	object
text	Title text of the document	String
NE	NE of the title, e.g., person, location, organization	String
Category	Category of the document	string
Category_weight	Reliability of the categorization of document for NLP between 0 and 1	double
Doc_id	ID of the document	integer
DCT	Document creation time	String

Table 2 – Natural language processing information elements/attributes – Sentence

Element/attribute	Description	Type
Other_metaInfo	Other metadata information of document that are saved as key-value, e.g., { "URL" : "http://ko.wikipedia.org/wiki/Cicano" }	Map<String, String>

Table 3 – Natural language processing information elements/attributes – Morphological analysis (POS)

Element/attribute	Description	Type
Morp	Result of part of speech (POS) analysis	object
id	ID of POS (starts from 0)	integer
lemma	Target of the POS, usually a word	String
type	POS tag, e.g., Desk(word): NOUN(POS tag)	string
position	Byte position in a sentence	integer
weight	Reliability of POS analysis from 0 to 1	double
amended	Indicates the result is the amended one or not	boolean

See Figure 5.

An example of morphological analysis:

```
{"morp" : [
           {"id" : 0, "lemma" : "JeongHyun Park", "type" : "NNP", "position" : 0,
"weight" : 1},
           {"id" : 1, "lemma" : "President", "type" : "NNG", "position" : 10, "weight" :
1 },
           {"id" : 2, "lemma" : "i", "type" : "JKS", "position" : 19, "weight" : 1},
           {"id" : 3, "lemma" : "minister", "type" : "NNG", "position" : 23, "weight" : 1
},
           {"id" : 4, "lemma" : "lul", "type" : "JKO", "position" : 29, "weight" : 1},
           {"id" : 5, "lemma" : "appoint", "type" : "NNG", "position" : 33, "weight" : 1
},
           {"id" : 6, "lemma" : "do", "type" : "XSV", "position" : 39, "weight" : 1 },
           {"id" : 7, "lemma" : "n-da", "type" : "EF", "position" : 39, "weight" : 1},
           {"id" : 8, "lemma" : ".", "type" : "SF", "position" : 45, "weight" : 1 }
     ]}

(President Park appoints Prime Minister.)
```

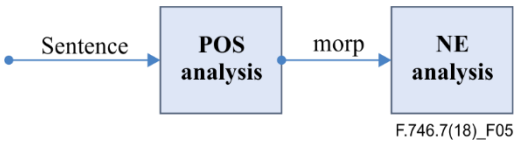

Figure 5 – Information flow for POS analysis

Table 4 – Natural language processing information elements/attributes – Named entity analysis

Element/attribute	Description	Type
NE	Result of NE analysis	object
id	ID of a word (starting from 0 in a sentence)	integer
text	Text of a word	string
type	NE type, e.g., river, person, organization	string
begin	ID of the first POS tag in word	integer
end	ID of the last POS tag in a word	integer
weight	Reliability of word sense disambiguation (WSD) analysis from 0 to 1	double
Common_noun	Specify if it is common noun (1) or proper noun (0)	0 or 1
amended	Indicates the result is the amended one or not	boolean

See Figure 6.

An example of an NE analysis:

```
{"NE" : [
{"id" : 0, "text" : " JeongHyun Park ", "type" : "PS_NAME", "begin" : 0, "end" : 0,
"weight" : 0.752954, "common_noun" : 0, "amended" : "TRUE" },
{"id" : 1, "text" : "president", "type" : "CV_POSITION", "begin" : 1, "end" : 1, "weight"
: 0.528416, "common_noun" : 0, "amended" : "FALSE" },
{"id" : 2, "text" : "minister", "type" : "CV_POSITION", "begin" : 3, "end" : 3, "weight"
: 0.431414, "common_noun" : 0, "amended" : "TRUE" }
     ]}

(President Park appoints Prime Minister.)
```

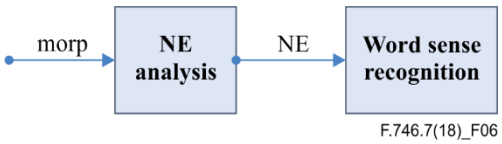

Figure 6 – Information flow for a named entity analysis

Table 5 – Natural language processing information elements/attributes – Word sense recognition

Element/attribute	Description	Type
WSD	Result of word sense disambiguation (recognition)	object
id	ID of WSD target word	integer
text	Target of WSD	String
type	POS tag of the text, e.g., Desk(word): NOUN(POS tag)	string
scode	Sense number in a predefined list or standard dictionary	integer
position	Byte position in a sentence	integer
weight	Reliability of WSD analysis from 0 to 1	double
begin	ID of the first POS tag in a target word	string
end	ID of the last POS tag in a target word	string
amended	Indicates the result is the amended one or not	boolean

See Figure 7.

An example of WSD result:

```
{"WSD" : [
     {"id" : 0, "text" : " JeongHyun Park ", "type" : "NNP", "scode" : "00", "weight" :
1, "position" : 0, "begin" : 0, "end" : 0, "amended" : "TRUE" },
     {"id" : 1, "text" : "president", "type" : "NNG", "scode" : "00", "weight" : 1,
"position" : 10, "begin" : 1, "end" : 1, "amended" : "TRUE" },
     {"id" : 2, "text" : "i", "type" : "JKS", "scode" : "00", "weight" : 1, "position" :
19, "begin" : 2, "end" : 2, "amended" : "FALSE" },
     {"id" : 3, "text" : "minister", "type" : "NNG", "scode" : "01", "weight" : 1,
"position" : 23, "begin" : 3, "end" : 3, "amended" : "TRUE" },
     {"id" : 4, "text" : "lul", "type" : "JKO", "scode" : "00", "weight" : 1, "position"
: 29, "begin" : 4, "end" : 4, "amended" : "FALSE" },
     {"id" : 5, "text" : "appoint", "type" : "VV", "scode" : "03", "weight" : 1,
"position" : 33, "begin" : 5, "end" : 6, "amended" : "TRUE" },
     {"id" : 6, "text" : "n-da", "type" : "EF", "scode" : "00", "weight" : 1, "position"
: 39, "begin" : 7, "end" : 7, "amended" : "FALSE" },
     {"id" : 7, "text" : ".", "type" : "SF", "scode" : "00", "weight" : 1, "position" :
45, "begin" : 8, "end" : 8, "amended" : "TRUE" }
]}
(President Park appoints Prime Minister.)
```

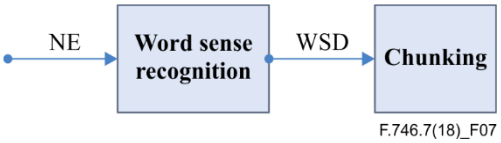

Figure 7 – Information flow for word sense recognition

Table 6 – Natural language processing information elements/attributes – Chunking

Element/attribute	Description	Type
chunk	Result of chunking	object
id	ID of chunking unit (starting from 0 in a sentence)	integer
text	Text of chunking result (restored from POS result)	string
type	Chunking type, e.g., river, person, organization	string
begin	ID of the first POS tag in a chunk	integer
end	ID of the last POS tag in a chunk	integer
weight	Reliability of POS analysis from 0 to 1	double
amended	Indicates whether the result is the amended one	boolean

See Figure 8.

An example of chunking:

```
{"chunk" : [
          {"id" : 0, "text" : " President JeongHyun Park ", "type" : "NP", "begin" : 0,
"end" : 2, "weight" : 1, "amended" : "TRUE"},
          {"id" : 1, "text" : "minister", "type" : "NP", "begin" : 3, "end" : 4,
"weight" : 1, "amended" : "FALSE" },
          {"id" : 2, "text" : "appoint", "type" : "VP", "begin" : 5, "end" : 8, "weight"
: 1, "amended" : "TRUE"}
     ]}
 (President Park appoints Prime Minister.)
```

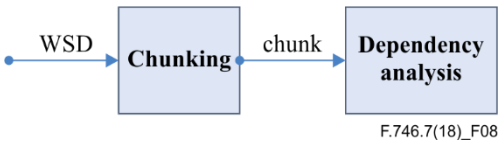

Figure 8 – Information flow for chunking process

Table 7 – Natural language processing information elements/attributes – Dependency analysis

Element/attribute	Description	Type
dependency	Result of dependency analysis	object
id	ID of a word (starting from 0 in a sentence)	integer
text	Text of a word	string
head	ID of a parent word in a dependency graph	string
label	Dependency relation, e.g., noun phrase objective (NP_OBJ), noun phrase subjective (NP_SBJ)	string
mod	ID of a child word in a dependency graph	string
weight	Reliability of dependency analysis	double
amended	Indicates the result is the amended one or not	boolean

See Figure 9.

An example of dependency analysis:

```
{"dependency" : [
          {"id" : 0, "text" : " JeongHyun Park ", "head" : 1, "label" : "NP", "mod" :
[], "weight" : 0.7696, "amended" : "TRUE"},
          {"id" : 1, "text" : "president", "head" : 3, "label" : "NP_SBJ", "mod" : [0],
"weight" : 0.561622, "amended" : "TRUE"},
          {"id" : 2, "text" : "minister", "head" : 3, "label" : "NP_OBJ", "mod" : [],
"weight" : 0.486835, "amended" : "TRUE"},
          {"id" : 3, "text" : "appoint", "head" : -1, "label" : "VP", "mod" : [1, 2],
"weight" : 0.163655, "amended" : "FALSE"}
     ]}
 (President Park appoints Prime Minister.)
```

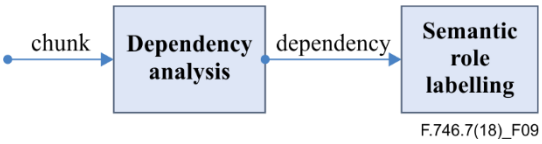

Figure 9 – Information flow for dependency analysis

Table 8 – Natural language processing information elements/attributes – Semantic role labelling

Element/attribute	Description	Type
SRL	Result of semantic role labelling	object
Verb	Target verb which is a predicate of a sentence	string
sense	Sense number of the target verb	Integer
Word_id	ID of the verb word	integer
weight	Reliability of SRL result	double
argument	Semantic argument information of a verb	object

Table 8 – Natural language processing information elements/attributes – Semantic role labelling

Element/attribute	Description	Type
type	Argument type	string
text	Text of a word in an argument	string
Word_id	ID of a word in an argument	integer
weight	Reliability of argument analysis	double
amended	Indicates the result is the amended one or not	boolean

See Figure 10.

An example of semantic role labelling:

```
{ "SRL":[
       {"verb":"appoint","sense":1, "word_id":3, "weight":0.154974, "argument":[
       {"type":"ARG0","word_id":1, "text":"president", "weight":0.170862},
       {"type":"ARG1", "word_id":2, "text":"minister", "weight":0.139087},
       { "amended":"TRUE"}]}
   ] }
 (President Park appoints Prime Minister.)
```

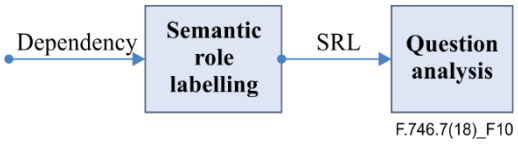

Figure 10 – Information flow for semantic role labelling

9 Information for question analysis

This clause describes metadata for user question analysis information. The question analysis module in Figure 11 analyses questions that are input in a natural language by users, understands their intention, and recognizes various pieces of information in the answers that should be presented as the output of the IQAS. In the natural language question answering system, a query axiom is generated from an input question through a textual entailment recognition process, in which additional questions are extracted from the original question based on its meaning. For the question analysis, the following metadata elements are used. A set of elements/attributes for user question analysis information is shown in Table 9 for question information and Table 10 for answer information. See Figure 12.

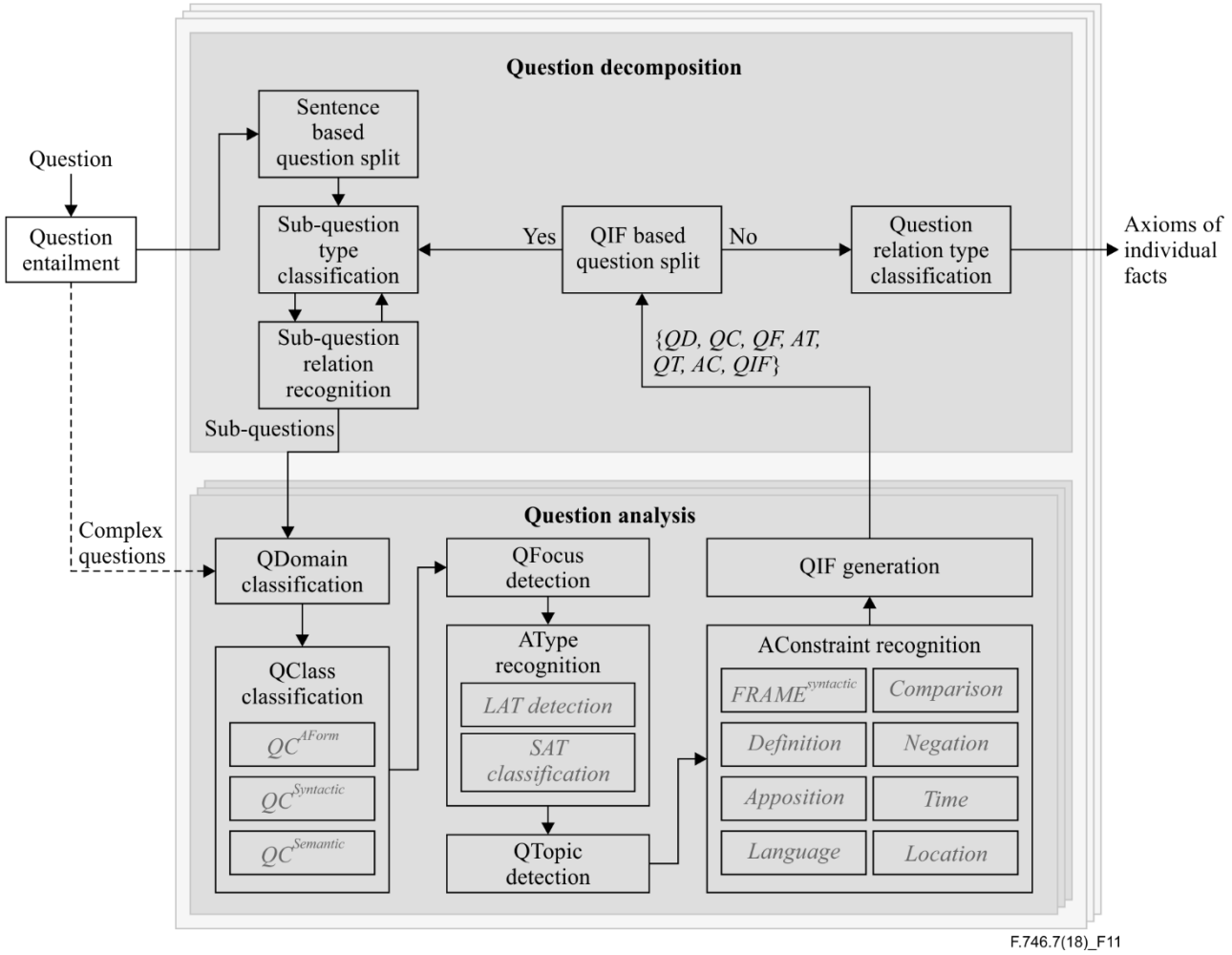

Figure 11 – Submodules for question analysis

Table 9 – Metadata for question analysis information – Question

Element/attribute	Description	Type
Q_tagged	Question tagged with question focus and LAT (lexical answer type)	string
Q_class	Object for question classification	object
QC_atype	Question classification according to the way the answer is presented, e.g., simple answer vs. complex answer	string
QC_semantic	Question classification based on the meaning of the question, e.g., request for attributes vs. request for terminology	string array
QC_syntactic	Question classification based on the structure of the question, e.g., fill in the blank vs. statement type	string array
Q_domain	Domain of the question, e.g., science, health, history …	string array
Q_level	Difficulty of the question	string
Q_complexity	Complexity of the question sentence, e.g., single sentence, complex sentence structure, multiple sentences …	string
Q_focus	Array of the question focus, e.g., what, who, what policy…	string array
Q_SAT	Array of semantic answer type in the question based on NE classification, e.g., Person_actor, Location_river…	string array

Table 9 – Metadata for question analysis information – Question

Element/attribute	Description	Type
Q_LAT	Array of lexical answer type in the question, e.g., nationality, chemical, person …	string array
Q_topic	Array of question topics. Question topic is the object or event that the question is about, e.g., Q_topic is King Lear in "Who is the author of King Lear?"	string array
Q_reltype	Question relation type	string
Q_decomp	Object array of sub-questions	object array
SubQ_id	ID of sub-question. Number is assigned sequentially from 1	integer
SubQ_string	Content of sub-question	string
SubQ_type	Question type of the sub-question	string
SubQ_complexity	Sentence complexity of the sub-question	string
Q_quotation	Quotation phrase for "filling in the blank" type question in a quiz	string
Q_constraint	Answer constraint information object	object
Q_SF	Syntactic frame object for answer constraint	object
Q_NEG	Negation question type, e.g., Which day does the shop not open?	string
Q_LAN	Language constraint information of answer, e.g., Chinese character in the question	string
Q_APP	Question apposition information for answer constraint. It provides the same meaning of a word which constrains an answer, e.g., What is "snow" in Portuguese? (In this question, snow is marked as Q_APP)	string
Q_DEF	Definition information for answer constraint	string
Q_COM_MOD	Comparison by modifier for answer constraint	object
Q_COM_ADVERB	Adverbial comparison object for answer constraint	object
Q_TE	Expressive time constraint information	string
Q_TI	Implied time constraint information	string
Q_SE	Expressive location constraint information	string
Q_SI	Implied location constraint information	string

Table 10 – Metadata for question analysis information - Answer

Element/attribute	Description	Type
A_ans	Answer string	string
A_synonym	String array of synonym answers (of similar meaning)	string array
A_type	Classified answer meaning which corresponds to NE type, e.g., person, location, animal, date, organization	string
Passage	Objects to provide answer evidence, e.g., sentences that provide answer evidence	object array
A_domain	Answer domain, e.g., literature, science, health	string array
A_level	Difficulty level of the answer inference, e.g., very difficult, difficult, not difficult	string array
AP_sent	Sentences that contain the answer	string
AP_title	Title of a document that contains the answer	string
AP_origin	Document title of the answer source, e.g., wiki	string
AP_URL	Uniform resource locator (URL) of the answer source	URL

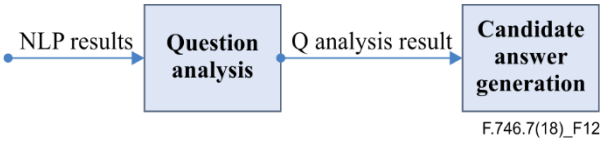

Figure 12 – Information flow for question analysis

10 Information for candidate answer generation

This clause describes metadata for the candidate answer generation module. The candidate answer generation module performs index and search functions on document collections and generates candidate answers from the input query using search results and various databases, such as a structured/unstructured KB.

A set of elements/attributes for candidate answer generation module are shown in Table 11.

Table 11 – Metadata for candidate answer generation

Element/attribute	Description	Type
IR_result	Result of information search	object
docid	Document ID	string
domain	Domain of the candidate answer resource	string
cpname	Type of search engine	string
doc_title	Document title	string
description	Contents of the search result sentence	string
weight	Search weight	double
ranking	Ranking of the search results	integer
qType	Search question	string
Candidates	Result of the candidate answer generation	object
ranking	Ranking of the candidate answer	integer
answer	Candidate answer	string

Table 11 – Metadata for candidate answer generation

Element/attribute	Description	Type
type	Type of the candidate answer	string
NEType	NE type of the candidate answer	string
resource	Information on the search result sentence	string
cpname	Type of search engine	string
source	Search location	string
docID	Document ID	string
sentID	Sentence ID	string
IRranking	Ranking of the search	integer
IRsource	Search resource	string
qType	Search question	string

See Figure 13.

An example of candidate answers:


```
{"IR_result": [
          {"docid":"003476500000000", "domain":"wiki", "cpname":"wiki_definition",
"page_struct":"Tibet", "description":" Tibet Tibet (, ) is located in central Asia and is
the traditional homeland of the Tibetan people. Tibet is the highest region on Earth with
an average elevation of 4 900 m. Thus it is called "Roof of the world." The highest
elevation in Tibet is Mount Everest, Earth's highest mountain, rising 8 848 m above sea
level. ", "weight":91.257285, "ranking":1, "qType":"original question"},
          {"docid":"053471700000000", "domain":"wiki", "cpname":"wiki_definition",
"page_struct":"Mountain Mitchell", "description":" Mount Mitchell Mount Mitchell is the
highest peak of the Appalachian Mountains and the highest peak in mainland eastern North
America. It is located near Burnsville in Yancey County, North Carolina, in the Black
Mountain subrange of the Appalachians, and about 19 miles (31 km) northeast of Asheville.
It is protected by Mount Mitchell State Park and surrounded by the Pisgah National
Forest. Mount Mitchell's elevation is 6 684 feet (2 037 m) above sea level.",
"weight":87.192415, "ranking":2, "qType":" original question"}]}

{"Candidates": [
          {"ranking":1, "answer":"Tibet", "type":"NE", "NEType":"LCP_COUNTRY",
"resource":
                [
                     {"cpname":"wiki_definition", "source":"[definition]Content",
"docID":"003476500000000", "sentID":0, "qType":"original question", "IRranking":1,
"IRsource":"wiki_definition"},
                     {"cpname":"wiki_definition", "source":"[definition]Content",
"docID":"003476500000000", "sentID":0, "qType":" original question ", "IRranking":1,
"IRsource":"wiki_definition"}
                ]
          },
          {"ranking":2, "answer":"Mount Mitchell", "type":"NE", "NEType":"LCG_MOUNTAIN",
"resource":
                [
                     {"cpname":"wiki_definition", "source":"[definition]Title",
"docID":"053471700000000", "sentID":0, "qType":" original question ", "IRranking":2,
"IRsource":"wiki_definition"},
                     {"cpname":"wiki_definition", "source":"[definition]Content",
"docID":"053471700000000", "sentID":0, "qType":" original question ", "IRranking":2,
"IRsource":"wiki_definition"},
                     {"cpname":"wiki_passage", "source":"[passage]Content",
"docID":"008264100000000", "sentID":5, "qType":" original question ", "IRranking":5,
"IRsource":"wiki_passage"}
                ]
          },
```

```
          {"ranking":3, "answer":"Kyonggi do", "type":"NE", "NEType":"LCP_PROVINCE",
"resource":
                [
                     {"cpname":"wiki_definition", "source":"[definition]Content",
"docID":"066405400000000", "sentID":0, "qType":" original question", "IRranking":3,
"IRsource":"wiki_definition"},
                     {"cpname":"wiki_definition", "source":"[definition]Content",
"docID":"066405400000000", "sentID":0, "qType":" original question", "IRranking":3,
"IRsource":"wiki_definition"}
                ]
          }]
}
```


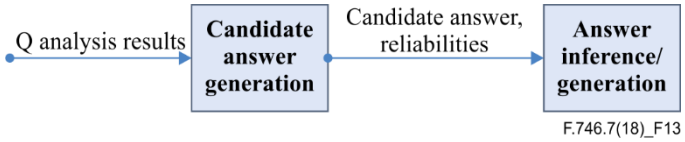

Figure 13 – Information flow for candidate answer generation

11 Information for answer inference/generation

The function of the answer inference and generation module is to decide and generate the best answer by measuring reliabilities of the candidate answers using the query axiom, the filtered candidate answers, the reasoned candidate answers as features to determine ranks of the candidate answers, based on the calculated reliability. The candidate answers are filtered and reasoned out based on a similarity between the query axiom and the candidate answers and by using an inductive, deductive or an abductive reasoning.

The inference and generation module compares a threshold value with a reliability ratio of a best candidate answer to the second best candidate answer, readjusting the determined ranks according to a result of the comparison, and detecting the best candidate answer, determined through the readjustment, as a final answer of the QA service.

A set of elements/attributes for answer inference/generation module are shown in Table 12.

Table 12 – Metadata for answer inference/generation

Element/attribute	Description	Type
AnsUnit_TotalCnt	Total number of the final candidate answers	integer
AnsUnit	Information on final candidate answers	object
rank	Ranking of the final candidate answers	integer
answer	Final candidate answer	string
kb_weight	Weight of KB query	double
ir_weight	Weight of search (information retrieval)	double
Tot_weight	Weight total	double
CI_feature	Type and constraint inference feature	object
type	Type of the final candidate answer	string
NEType	NE type of the final candidate answer	string
CIweight	Reliability for constraint on final candidate answers	double
TyCor_vec	Type and constraint inference feature	vector
	0: type reliability	double
	1: wordnet feature	double

Table 12 – Metadata for answer inference/generation

Element/attribute	Description	Type
	2: word distance feature	double
	3: semantic network feature	double
	4: word sense network feature	double
	5: Wikipedia category feature	double
	6: IsA feature	double
	7: class/instance relation feature	double
	8: location similarity feature	double
	9: time similarity feature	double
	10: linguistic constraint feature	double
	11: cultural asset constraint feature	double
	12: proverb constraint feature	double
	13: number constraint feature	double
	14: work constraint feature	double
	15: entity frequency feature	double
	16: quotation constraint feature	double
	17: integrated answer constraint feature	double
AnsSent	Information on evidence search	object
AnsSent_totalCnt	Number of evidence search	integer
ASent	Sentence information on evidence search	object
docID	Document ID	string
sentID	Sentence ID	string
DIRweight	Weight of the evidence search	double
CD_vec	Evidence inference information	vector
source	Location of evidence search	string
cpname	Evidence search engine	string
domain	Kind of the resource	string
qType	Question for evidence search	string
IRranking	Ranking of evidence search	integer
IRsource	Source of evidence search	string
sent	Evidence sentence	string
CD_feature	Information on evidence inference	vector
	1: integrated reliability	double
	2: word similarity feature	double
	3: expanded word similarity feature	double
	4: word sense similarity feature	double
	5: location & time similarity feature	double
	6: word layout similarity feature	double
	7: word order similarity feature	double
	8: expanded sentence structure similarity feature	double

Table 12 – Metadata for answer inference/generation

Element/attribute	Description	Type
	9: expanded semantic relation similarity feature	double
	10: quotation similarity feature	double
	11: semantic frame similarity feature	double
	12: definition/negation similarity feature	double
Ans_Feature	Information on reliability feature	object
TyCor_score	Combined type feature	double
Ln_score	Language feature	double
SEM_score	Semantic feature	double
CONS_score	Constraint feature	double
IR_score	Search feature	double
IR_score2	Evidence search feature	double
KB_score	KBQ feature	double
confidence	Reliability of final answer	double
src_ENGINE	Kind of Search (Search or Evidence Search)	string

See Figure 14.

An example of final answers:


```
{"AnsUnit_TotalCnt": 31,
      "AnsUnit": [
            {"rank":1, "answer":"John Hancock Center", "kb_weight":0.0000,
"ir_weight":0.9040, "tot_weight":0.4976,
             "CI_feature": {
                "type":"NE", "NEType":"OGG_ECONOMY", "CIweight": 0.0800, "TyCor_vec":
[0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.4200, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.2500, 0.0000, 0.2500]
                },
             "AnsSent": {
                "AnsSent_TotalCnt":2,
                "ASent":[
                      {"docID":"126269100000000", "sentID":9, "DIRweight":16.1910,
"CD_vec":[0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000], "source":"[passage]Title",
"cpname":"doosan_passage","domain":"", "qType":" org", "IRranking":1,
"IRsource":"doosan_passage", "sent":" The 44th-floor sky lobby of John Hancock Center
features America's highest indoor swimming pool. "},
                      {"docID":"096386600000000", "sentID":10, "DIRweight":17.5910,
"CD_vec":[0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000], "source":"[passage]Title",
"cpname":"naver_all_passage","domain":"", "qType":" org", "IRranking":1,
"IRsource":"naver_all_passage", "sent":" In the 44th-floor of John Hancock Center is
located America's highest indoor swimming pool."},
                      {"docID":"096386600000000", "sentID":10, "DIRweight":86.2560,
"CD_vec":[0.2570, 1.0000, 0.0000, 0.0400, 0.0300, 0.5000, 1.0000, 0.5190, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000], "source":"evidence_new",
"cpname":"naver_all_passage","domain":"", "qType":"org", "IRranking":1, "IRsource":"Just
go Sightseeing Guide", "sent":" In the 44th-floor of John Hancock Center there is also
the America's highest indoor swimming pool. "}

                      ]
                }
             ,"CD_feature":[0.5288, 0.5010, 0.0000, 0.8000, 1.0000, 1.0000, 0.2857,
0.8522, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000]
             ,"Ans_Feature": {
```

```
                "TyCor_score":0.0000, "Ln_score":0.0000, "SEM_score":0.0800,
"CONS_score":0.0920, "IR_score":0.9040, "IR_score2":0.9466, "KB_score":0.0000,
"confidence":0.4976,
                "src_ENGINE":"", "evidence_str":""
                }}]}
```


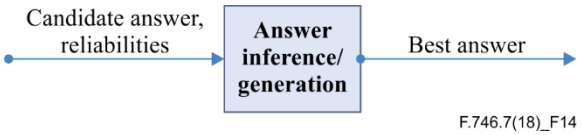

Figure 14 – Information flow for answer inference/generation

Appendix I

Example of named entity types

(This appendix does not form an integral part of this Recommendation.)

Named entity types

The NE types used for a NE recognizer are presented in Table I.1. At the top level, the NE tag set is composed of 15 NE types: person (PS), academic field (FD), theory (TR), artificial object (AF), organization (OGG), location (LC), culture/civilization (CV), date (DT), time (TI), quantity (QT), event (EV), animal (AM), plant (PT), material (MT) and terminology (TM). The sub-level NE types are total 146. NE types are important information and so are used in different modules in a QA system. NE types are changed and easily adaptable depending on the purpose of the NE recognizer and various applications.

Table I.1 – Named entity types

Named entity subtypes	Description
PS_NAME	– name of person
LC_OTHERS	– other location
LCP_COUNTRY	– country name
LCP_PROVINCE	– area, county, state name
LCP_COUNTY	– town, street name
LCP_CITY	– city name
LCP_CAPITALCITY	– capital name
LCG_RIVER	– river, pond, lake name
LCG_OCEAN	– ocean, see name
LCG_BAY	– peninsula, bay
LCG_MOUNTAIN	– mountain, hill
LCG_ISLAND	– island, archipelago name
LCG_CONTINENT	– continent name
LC_TOUR	– tour attractions
LC_SPACE	– space name, celestial bodies
OG_OTHERS	– other organization
OGG_ECONOMY	– organization related with economy
OGG_EDUCATION	– educational organization and groups
OGG_MILITARY	– military related organization and groups
OGG_MEDIA	– media organization and companies
OGG_SPORTS	– sports organization and groups
OGG_ART	– art related organization and groups
OGG_MEDICINE	– medical organization
OGG_RELIGION	– religion organization/association/group
OGG_SCIENCE	– organization/association/group related with science
OGG_LIBRARY	– library related organization/association/group
OGG_LAW	– organization/association/group related with laws

Table I.1 – Named entity types

Named entity subtypes	Description
OGG_POLITICS	– government, public organization, political organization/association/group
OGG_FOOD	– Food company and organization/association/group
OGG_HOTEL	– organization/association/group related with hotel accommodation
AF_CULTURAL_ASSET	– Cultural assets such as building/books/art pieces
AF_BUILDING	– buildings, apartment, bridge, light house, fountain, playground
AF_MUSICAL_INSTRUMENT	– name of a musical instrument
AF_ROAD	– road name, railroad name
AF_WEAPON	– name of weapons
AF_TRANSPORT	– transportation/cars/ship model and types, rides
AF_WORKS	– art works/other works
AFW_DOCUMENT	– books – maps/books related with geology – medical books – religion books/bibles – philosophy related books – literature name such as poems/novels/play – history books – other books
AFW_PERFORMANCE	– dance name, dance works, dance types – play, performance, Drama, opera
AFW_VIDEO	– movie name – television (TV) programme name
AFW_ART_CRAFT	– art work, painting name
AFW_MUSIC	– music work name
AF_WARES	– product name
DT_OTHERS	– other date types
DT_DURATION	– period/duration
DT_DAY	– date/subdivisions of the seasons
DT_MONTH	– month
DT_YEAR	– year
DT_SEASON	– season
DT_GEOAGE	– geological period
DT_DYNASTY	– dynasty
TI_OTHERS	– other time related terms
TI_DURATION	– duration time
TI_HOUR	– hour
TI_MINUTE	– minute
TI_SECOND	– second
CV_NAME	– culture/civilization name

Table I.1 – Named entity types

Named entity subtypes	Description
CV_TRIBE	– name of nationality/tribe/race
CV_SPORTS	– Name of sports/reports/leisure
CV_SPORTS_INST	– sports instruments/tools
CV_POLICY	– name of policy/system
CV_TAX	– name of tax
CV_FUNDS	– name of pension, funds, capital
CV_LANGUAGE	– name of a language
CV_BUILDING_TYPE	– name of architectural style
CV_FOOD	– food name/ food ingredients
CV_DRINK	– name of drinks
CV_CLOTHING	– name of clothes, fabrics
CV_POSITION	– position/title/name sports position
CV_RELATION	– relation names among people
CV_OCCUPATION	– name of occupation
CV_CURRENCY	– name of currency
CV_PRIZE	– prize and medals
CV_LAW	– name of law
CV_FOOD_STYLE	– type of food
AM_OTHERS	– other animal names
AM_INSECT	– insects
AM_BIRD	– birds
AM_FISH	– fish
AM_MAMMALIA	– mammals
AM_AMPHIBIA	– amphibian
AM_REPTILIA	– reptilian
AM_TYPE	– animal types
AM_PART	– part of an animal (body part name)
PT_OTHERS	– name of other plants
PT_FRUIT	– name of fruit (edible plant fruit)
PT_FLOWER	– name of flower
PT_TREE	– name of a tree
PT_GRASS	– name of a grass
PT_TYPE	– plant type
PT_PART	– name for a part of a plant
QT_OTHERS	– other quantity
QT_AGE	– age
QT_SIZE	– size/width
QT_LENGTH	– distance, length, height
QT_COUNT	– count/frequency

Table I.1 – Named entity types

Named entity subtypes	Description
QT_MAN_COUNT	– number of people
QT_WEIGHT	– weight
QT_PERCENTAGE	– percentage, rate, ratio, strength
QT_SPEED	– speed
QT_TEMPERATURE	– temperature
QT_VOLUME	– volume
QT_ORDER	– order, order related expressions
QT_PRICE	– price
QT_PHONE	– phone number
QT_SPORTS	– quantity related with sports
QT_CHANNEL	– TV/radio channel number
QT_ALBUM	– quantity related with album
QT_ZIPCODE	– postal code
FD_OTHERS	– other field of study
FD_SCIENCE	– field of study related with science
FD_SOCIAL_SCIENCE	– field of study and school related with social science
FD_MEDICINE	– field of study and school related with medicine
FD_ART	– field of study and school related with art
FD_PHILOSOPHY	– field of study and school related with philosophy
TR_OTHERS	– other theory/axiom/principals
TR_SCIENCE	– theory/method/principles/idea/study related with science
TR_SOCIAL_SCIENCE	– social science theory/method/principles/idea, politics
TR_ART	– art theory/method/principles/idea
TR_PHILOSOPHY	– philosophical theory
TR_MEDICINE	– medical treatments
EV_OTHERS	– other events
EV_ACTIVITY	– social movement and declaration
EV_WAR_REVOLUTION	– war/revolution
EV_SPORTS	– event related to sports/leisure
EV_FESTIVAL	– festival name
MT_ELEMENT	– element name
MT_METAL	– metal material
MT_ROCK	– name of the rocks
MT_CHEMICAL	– chemical material
TM_COLOR	– colour
TM_DIRECTION	– direction
TM_CLIMATE	– climate area name
TM_SHAPE	– shape/figure name
TM_CELL_TISSUE	– cells/organs/tissues(invisible outside)

Table I.1 – Named entity types

Named entity subtypes	Description
TMM_DISEASE	– symptoms/disease
TMM_DRUG	– drug names
TMI_HW	– IT hardware terms
TMI_SW	– IT software terms
TMI_SITE	– URL address
TMI_EMAIL	– email address
TMI_MODEL	– model names and part names
TMI_SERVICE	– IT service terms
TMI_PROJECT	– project name
TMIG_GENRE	– game genre
TM_SPORTS	– terms for sports and leisure activity (names for technique/rules)

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