US008180629B2

(12) **United States Patent**
Rehberg

(10) **Patent No.: US 8,180,629 B2**
(45) **Date of Patent: May 15, 2012**

(54) **AUTOMATIC PATTERN GENERATION IN NATURAL LANGUAGE PROCESSING**

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(73) Assignee: **Trigent Softward Ltd.**, Bangalore (IN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 978 days.

(21) Appl. No.: **12/170,433**

(22) Filed: **Jul. 10, 2008**

(65) **Prior Publication Data**

US 2010/0010800 A1 Jan. 14, 2010

(51) **Int. Cl.**
G06F 17/27 (2006.01)

(52) **U.S. Cl.** **704/9**; 704/257; 704/10

(58) **Field of Classification Search** 704/1–10, 704/270, 270.1, 251, 257, 255, 272, 274
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,346,490 B2 * 3/2008 Fass et al. 704/7
7,962,326 B2 * 6/2011 Tsourikov et al. 704/9

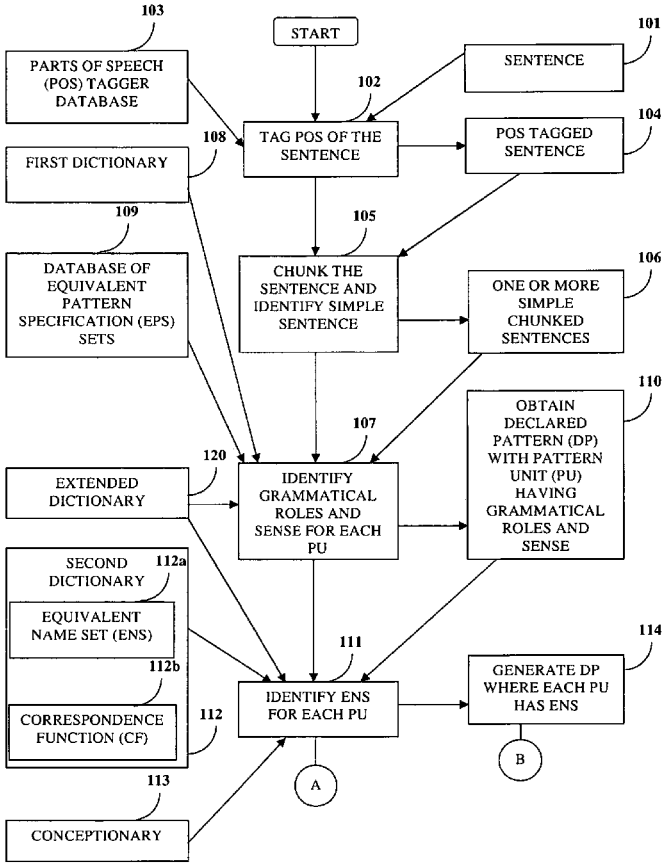
* cited by examiner

Primary Examiner — Huyen X. Vo
(74) *Attorney, Agent, or Firm* — Ash Tankha; Lipton, Weinberger & Husick

(57) **ABSTRACT**

Disclosed herein is a computer implemented method and system of generating declared patterns from components of a sentence. Parts of speech in the sentence are tagged for identifying parts of speech of each word and phrase in the sentence. Sentence chunking is then performed using the identified parts of speech of each word and phrase to generate pattern units. A first dictionary and a database of equivalent pattern specification sets are then applied to identify grammatical roles and senses of the generated pattern units. A second dictionary and a conceptionary are then applied to identify an equivalent name set for each of the generated pattern units. The declared patterns are then generated for the sentence using the identified equivalent name set for each of the generated pattern units.

12 Claims, 22 Drawing Sheets



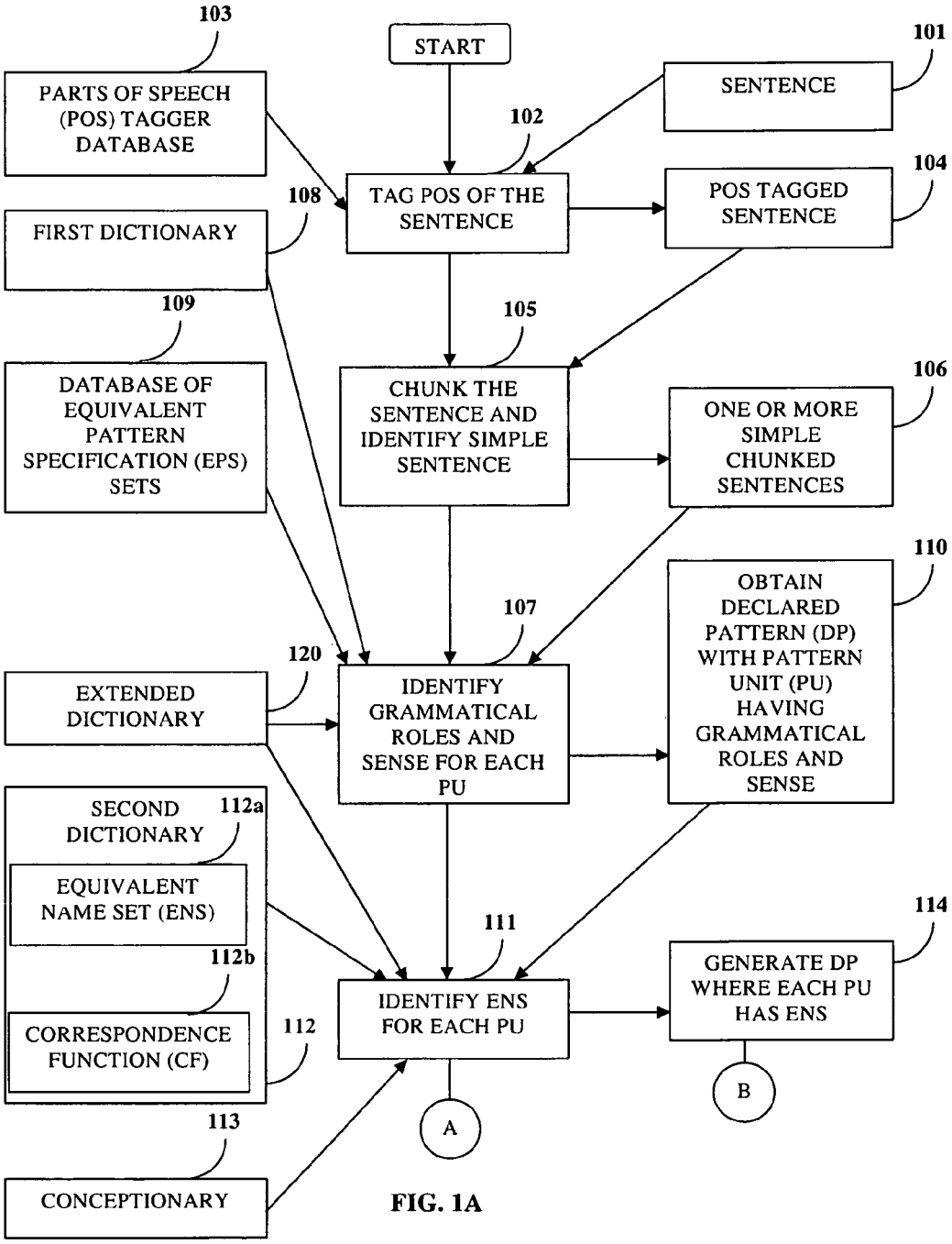

103
START
101
PARTS OF SPEECH (POS) TAGGER DATABASE
SENTENCE
102
TAG POS OF THE SENTENCE
104
POS TAGGED SENTENCE
108
FIRST DICTIONARY
109
105
DATABASE OF EQUIVALENT PATTERN SPECIFICATION (EPS) SETS
CHUNK THE SENTENCE AND IDENTIFY SIMPLE SENTENCE
106
ONE OR MORE SIMPLE CHUNKED SENTENCES
110
OBTAIN DECLARED PATTERN (DP) WITH PATTERN UNIT (PU) HAVING GRAMMATICAL ROLES AND SENSE
107
120
EXTENDED DICTIONARY
IDENTIFY GRAMMATICAL ROLES AND SENSE FOR EACH PU
SECOND DICTIONARY
112a
EQUIVALENT NAME SET (ENS)
112b
111
114
GENERATE DP WHERE EACH PU HAS ENS
CORRESPONDENCE FUNCTION (CF)
112
IDENTIFY ENS FOR EACH PU
B
A
113
CONCEPTIONARY

FIG. 1A

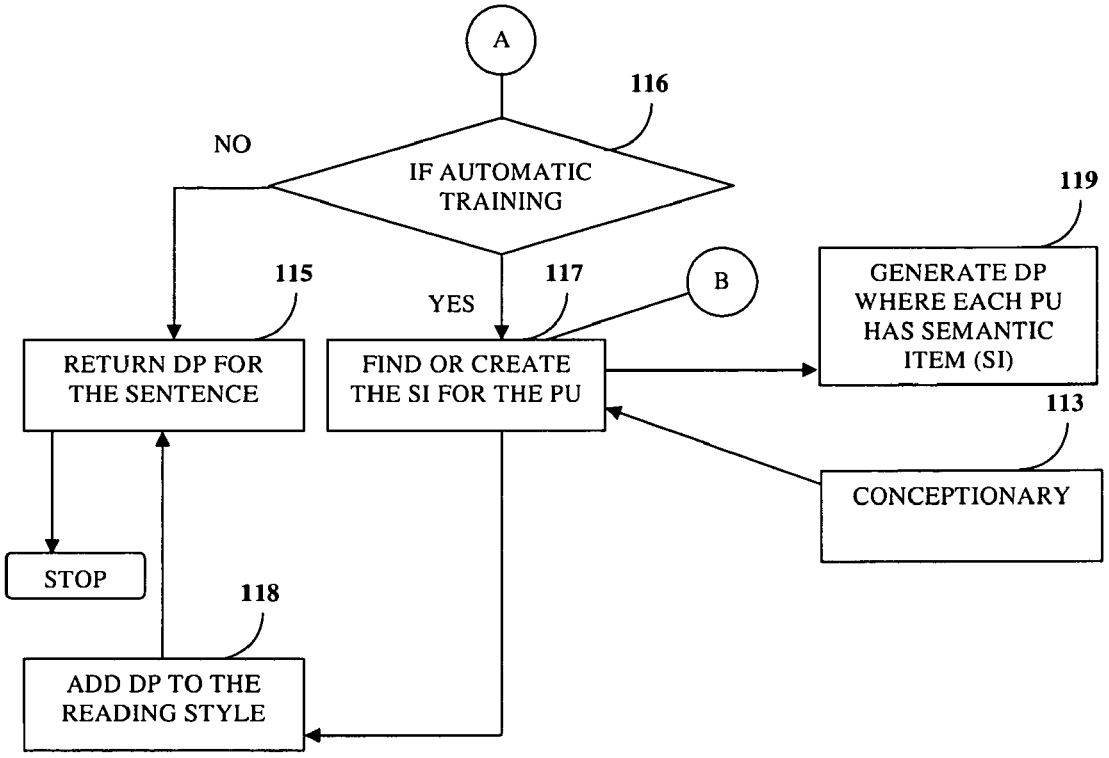

A
116
NO
IF AUTOMATIC TRAINING
119
115
117
YES
B
GENERATE DP WHERE EACH PU HAS SEMANTIC ITEM (SI)
RETURN DP FOR THE SENTENCE
FIND OR CREATE THE SI FOR THE PU
113
CONCEPTIONARY
STOP
118
ADD DP TO THE READING STYLE

FIG. 1B

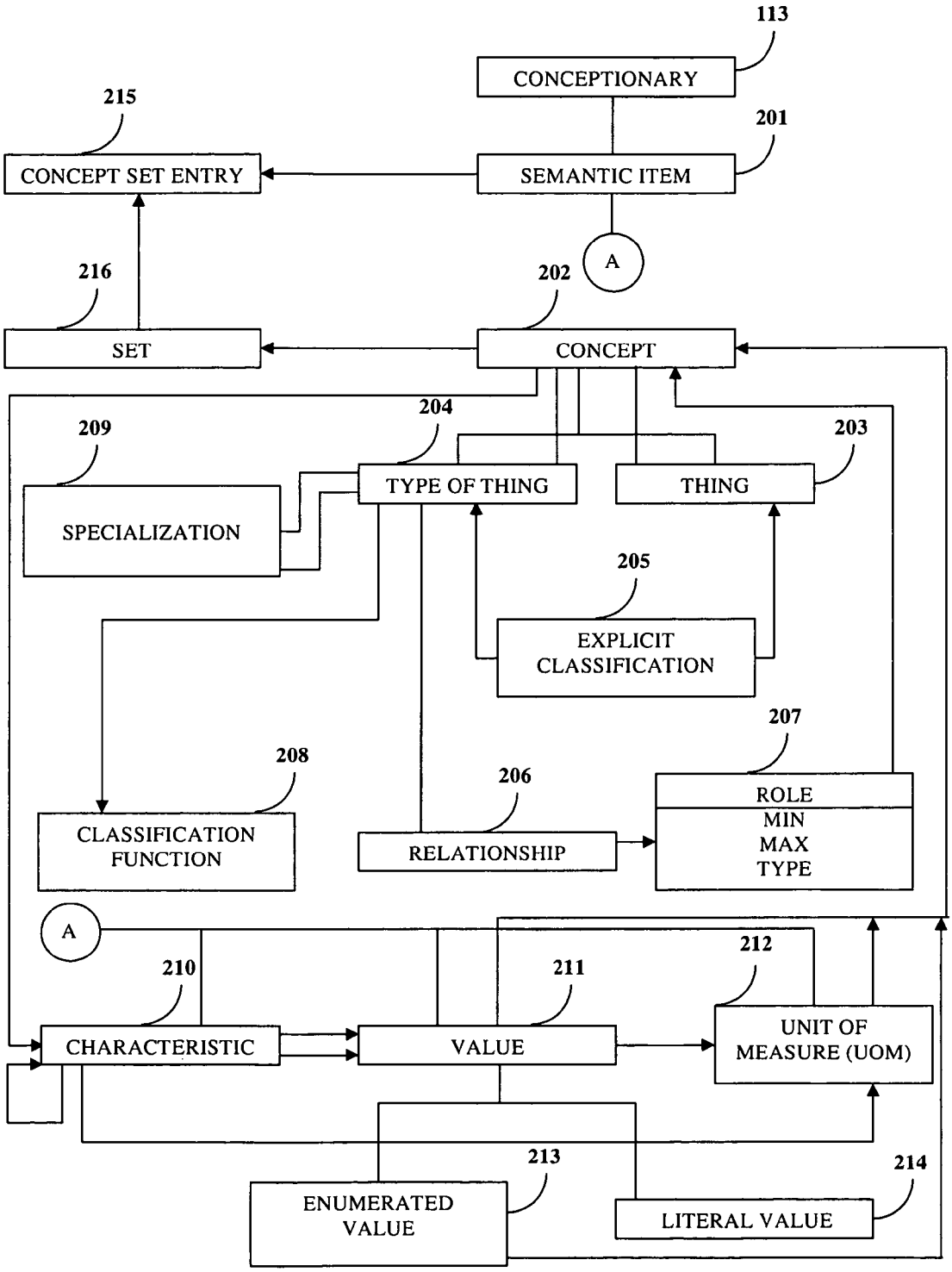

113
CONCEPTIONARY
215
201
CONCEPT SET ENTRY
SEMANTIC ITEM
A
216
202
SET
CONCEPT
204
209
203
TYPE OF THING
THING
SPECIALIZATION
205
EXPLICIT CLASSIFICATION
207
208
206
ROLE
MIN
MAX
TYPE
CLASSIFICATION FUNCTION
RELATIONSHIP
A
212
210
211
CHARACTERISTIC
VALUE
UNIT OF MEASURE (UOM)
213
214
ENUMERATED VALUE
LITERAL VALUE

FIG. 2A

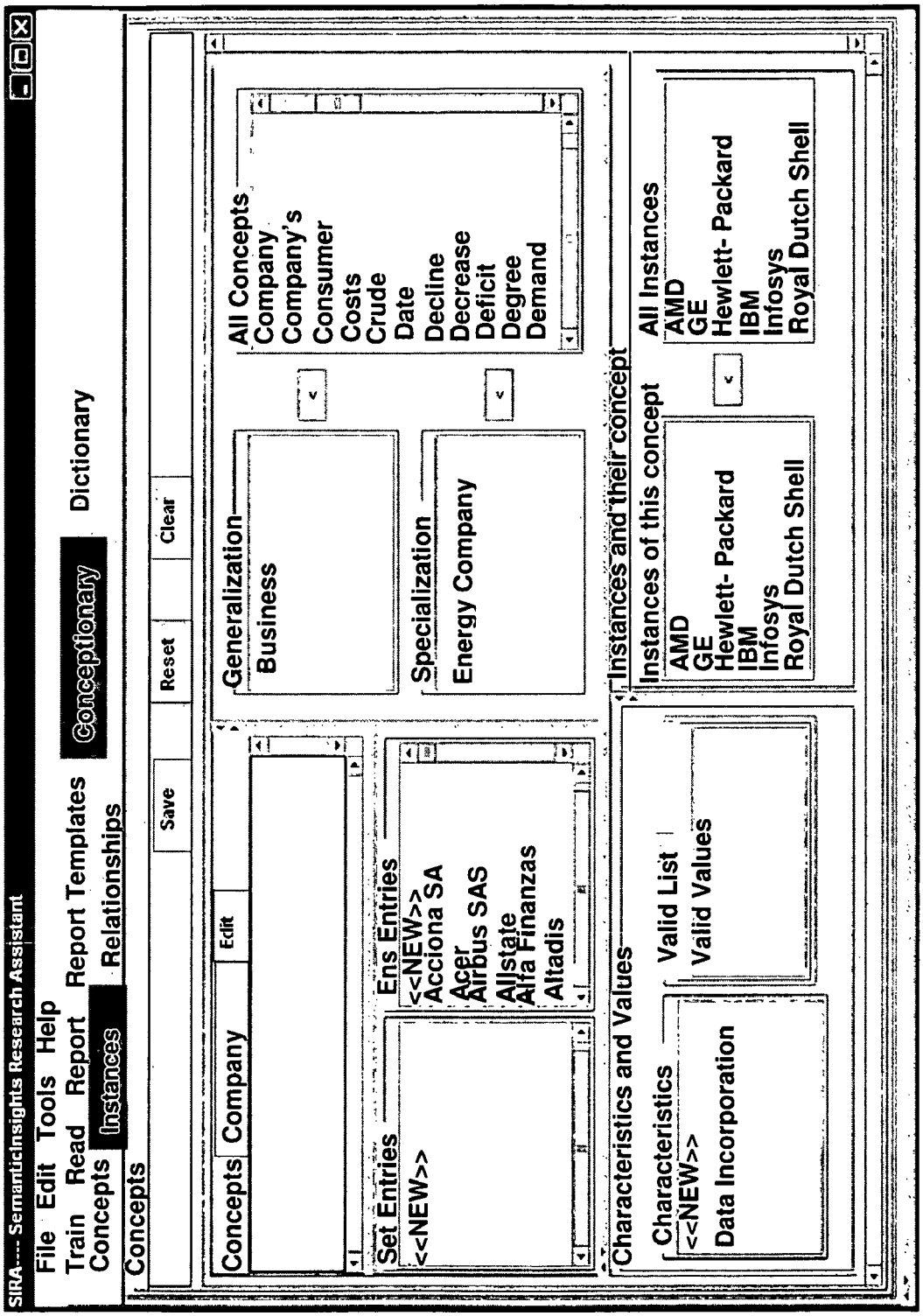

SIRA --- SemanticInsights Research Assistant
File Edit Tools Help
Train Read Report Report Templates Conceptionary Dictionary
Concepts Instances Relationships
Concepts
Save
Reset
Clear
Concepts Company
Edit
Set Entries
<<NEW>>
Ens Entries
<<NEW>>
Acciona SA
Acer
Airbus SAS
Allstate
Alfa Finanzas
Altadis
Generalization
Business
Specialization
Energy Company
All Concepts
Company
Company's
Consumer
Costs
Crude
Date
Decline
Decrease
Deficit
Degree
Demand
Instances and their concept
Characteristics and Values
Characteristics
<<NEW>>
Data Incorporation
Valid List
Valid Values
Instances of this concept
AMD
GE
Hewlett- Packard
IBM
Infosys
Royal Dutch Shell
All Instances
AMD
GE
Hewlett- Packard
IBM
Infosys
Royal Dutch Shell

FIG. 2B

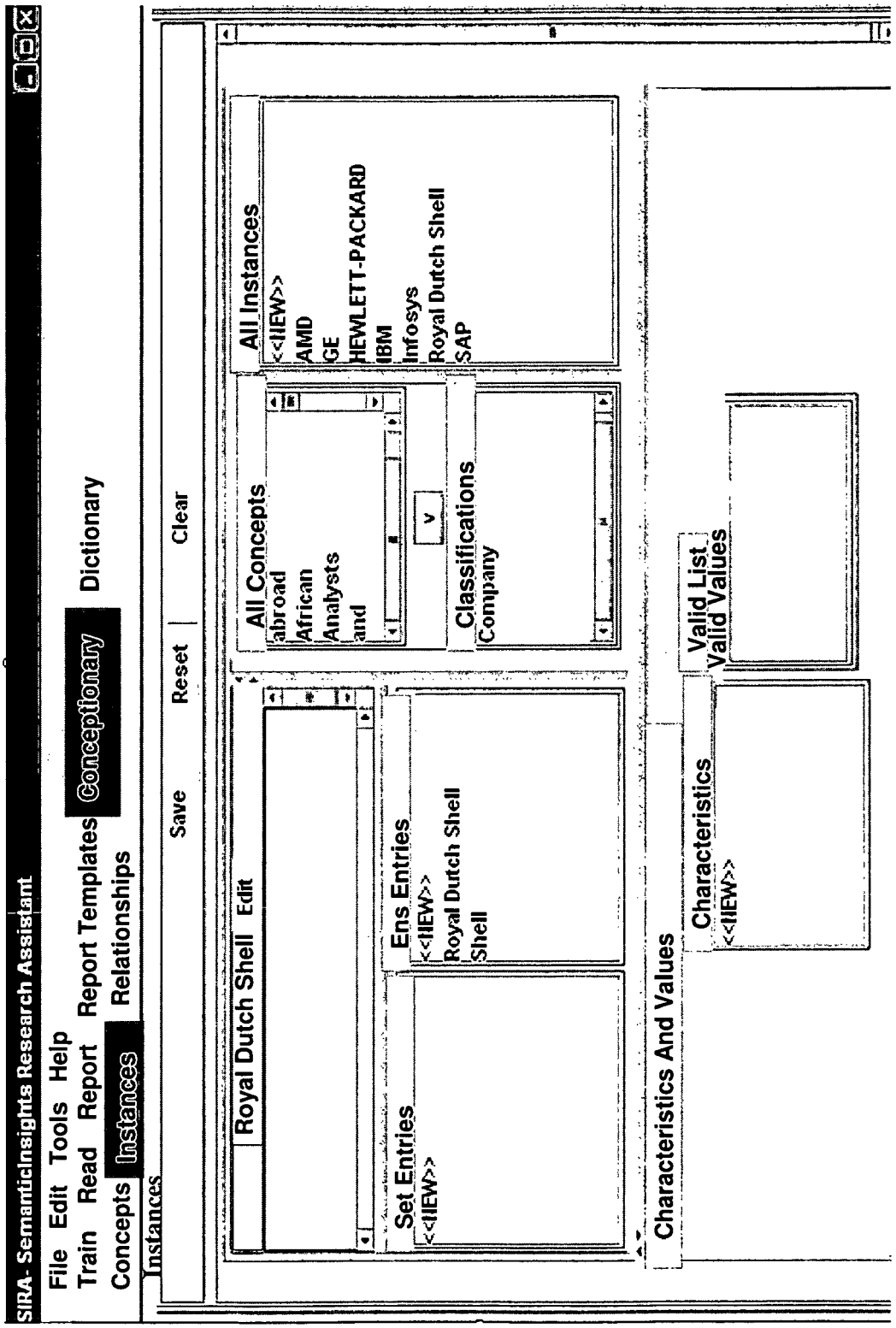

SIRA- SemanticInsights Research Assistant
File Edit Tools Help
Train Read Report Report Templates Conceptionary Dictionary
Concepts Instances Relationships
Instances
Save Reset Clear
Royal Dutch Shell Edit
All Concepts
abroad
African
Analysts
and
All Instances
<<NEW>>
AMD
GE
HEWLETT-PACKARD
IBM
Infosys
Royal Dutch Shell
SAP
Set Entries
<<NEW>>
Ens Entries
<<NEW>>
Royal Dutch Shell
Shell
Classifications
Company
Characteristics And Values
Characteristics
<<NEW>>
Valid List
Valid Values

FIG. 2C

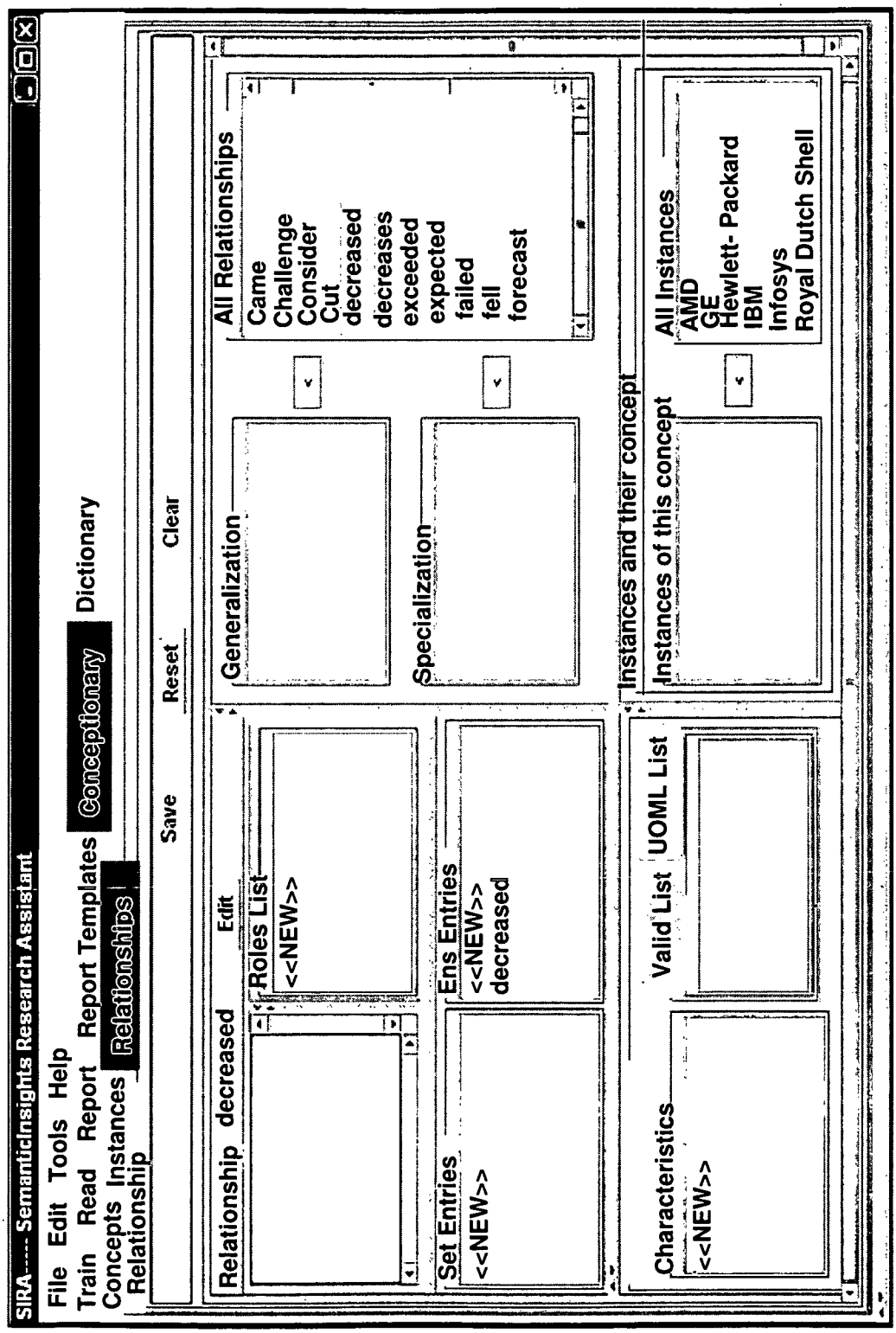

SIRA---- SemanticInsights Research Assistant
File Edit Tools Help
Train Read Report Report Templates
Concepts Instances
Relationship
Conceptionary
Dictionary
Relationships
Save
Reset
Clear
Relationship decreased
Edit
Roles List
<<NEW>>
Set Entries
<<NEW>>
Ens Entries
<<NEW>>
decreased
Generalization
Specialization
All Relationships
Came
Challenge
Consider
Cut
decreased
decreases
exceeded
expected
failed
fell
forecast
Instances and their concept
Characteristics
<<NEW>>
Valid List
UOML List
Instances of this concept
All Instances
AMD
GE
Hewlett- Packard
IBM
Infosys
Royal Dutch Shell

FIG. 2D

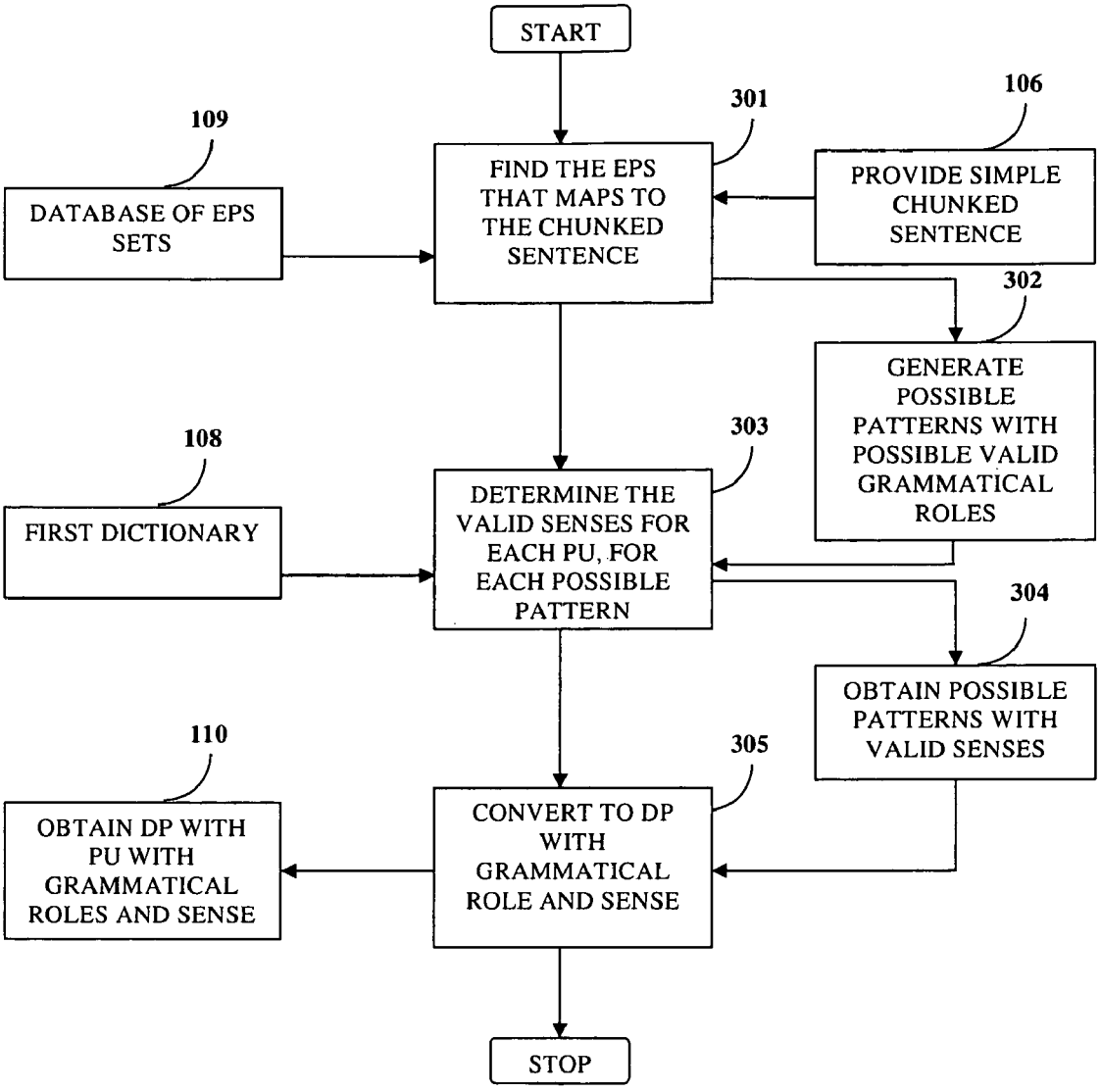

START
109
DATABASE OF EPS SETS
301
FIND THE EPS THAT MAPS TO THE CHUNKED SENTENCE
106
PROVIDE SIMPLE CHUNKED SENTENCE
302
GENERATE POSSIBLE PATTERNS WITH POSSIBLE VALID GRAMMATICAL ROLES
108
FIRST DICTIONARY
303
DETERMINE THE VALID SENSES FOR EACH PU, FOR EACH POSSIBLE PATTERN
304
OBTAIN POSSIBLE PATTERNS WITH VALID SENSES
110
OBTAIN DP WITH PU WITH GRAMMATICAL ROLES AND SENSE
305
CONVERT TO DP WITH GRAMMATICAL ROLE AND SENSE
STOP

FIG. 3

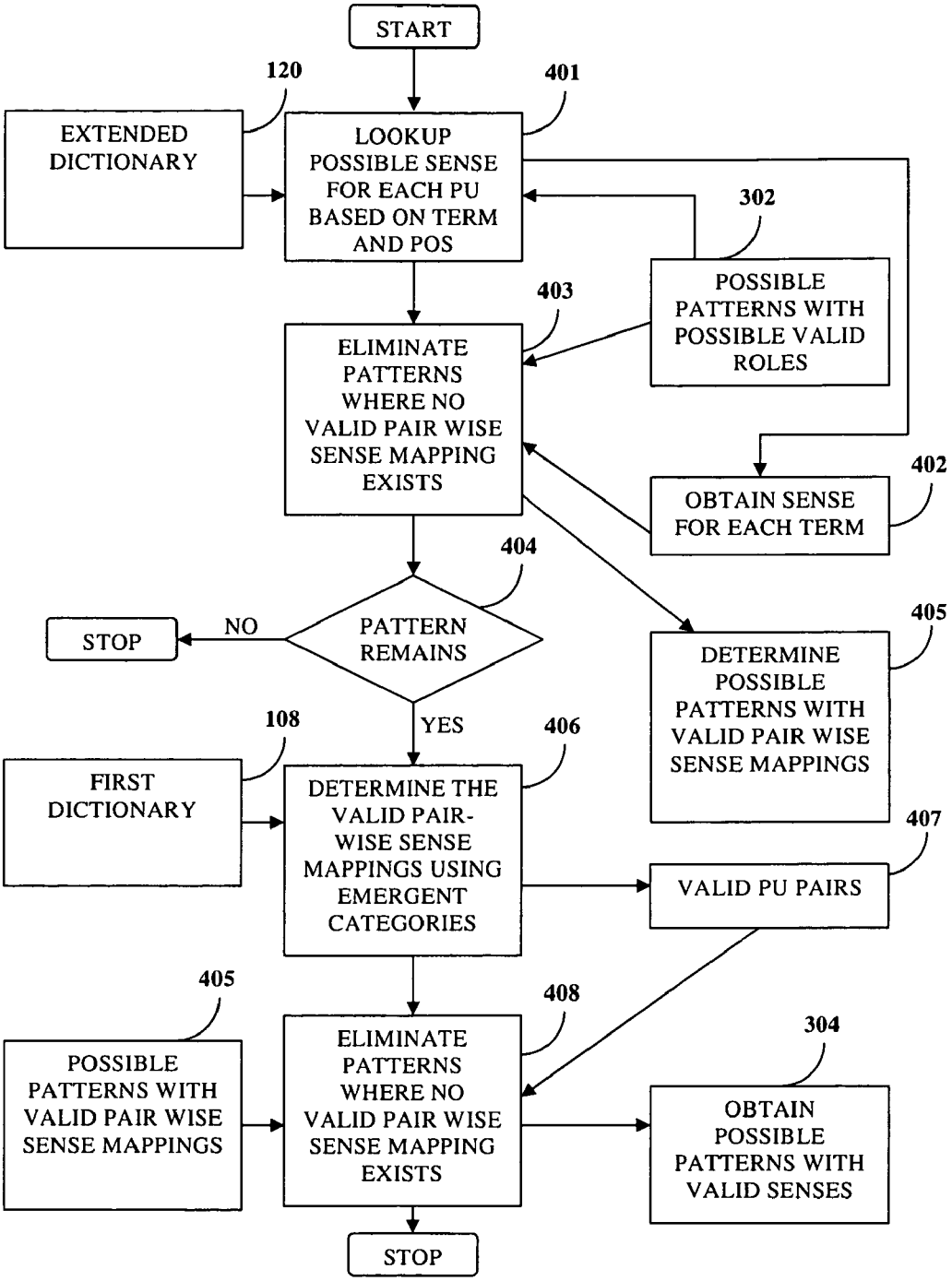

START
120
401
EXTENDED DICTIONARY
LOOKUP POSSIBLE SENSE FOR EACH PU BASED ON TERM AND POS
302
POSSIBLE PATTERNS WITH POSSIBLE VALID ROLES
403
ELIMINATE PATTERNS WHERE NO VALID PAIR WISE SENSE MAPPING EXISTS
402
OBTAIN SENSE FOR EACH TERM
404
PATTERN REMAINS
NO
STOP
405
DETERMINE POSSIBLE PATTERNS WITH VALID PAIR WISE SENSE MAPPINGS
YES
108
406
FIRST DICTIONARY
DETERMINE THE VALID PAIR-WISE SENSE MAPPINGS USING EMERGENT CATEGORIES
407
VALID PU PAIRS
405
408
304
POSSIBLE PATTERNS WITH VALID PAIR WISE SENSE MAPPINGS
ELIMINATE PATTERNS WHERE NO VALID PAIR WISE SENSE MAPPING EXISTS
OBTAIN POSSIBLE PATTERNS WITH VALID SENSES
STOP

FIG. 4

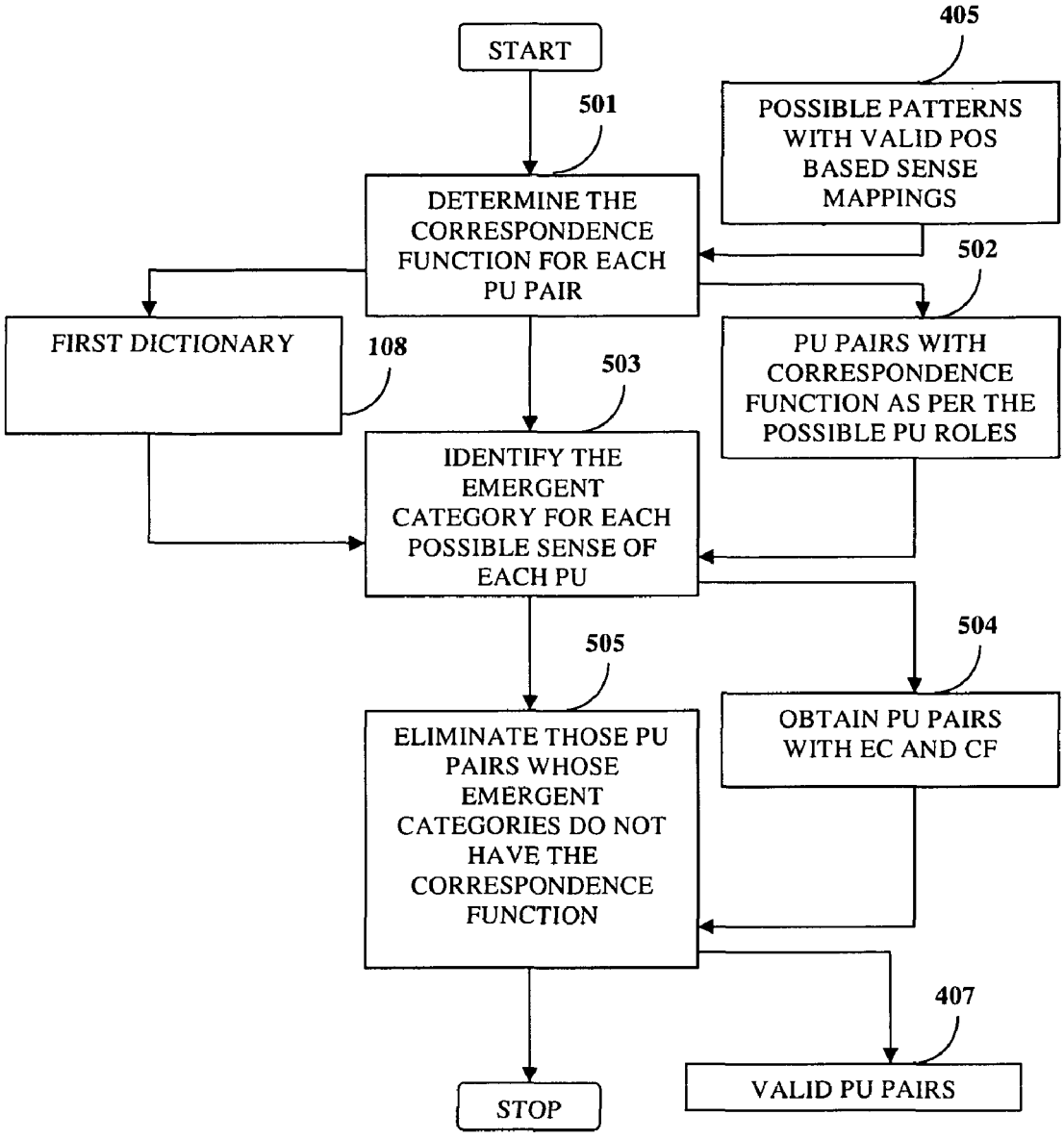

START
501
DETERMINE THE CORRESPONDENCE FUNCTION FOR EACH PU PAIR
405
POSSIBLE PATTERNS WITH VALID POS BASED SENSE MAPPINGS
502
FIRST DICTIONARY
108
PU PAIRS WITH CORRESPONDENCE FUNCTION AS PER THE POSSIBLE PU ROLES
503
IDENTIFY THE EMERGENT CATEGORY FOR EACH POSSIBLE SENSE OF EACH PU
504
505
OBTAIN PU PAIRS WITH EC AND CF
ELIMINATE THOSE PU PAIRS WHOSE EMERGENT CATEGORIES DO NOT HAVE THE CORRESPONDENCE FUNCTION
407
STOP
VALID PU PAIRS

FIG. 5A

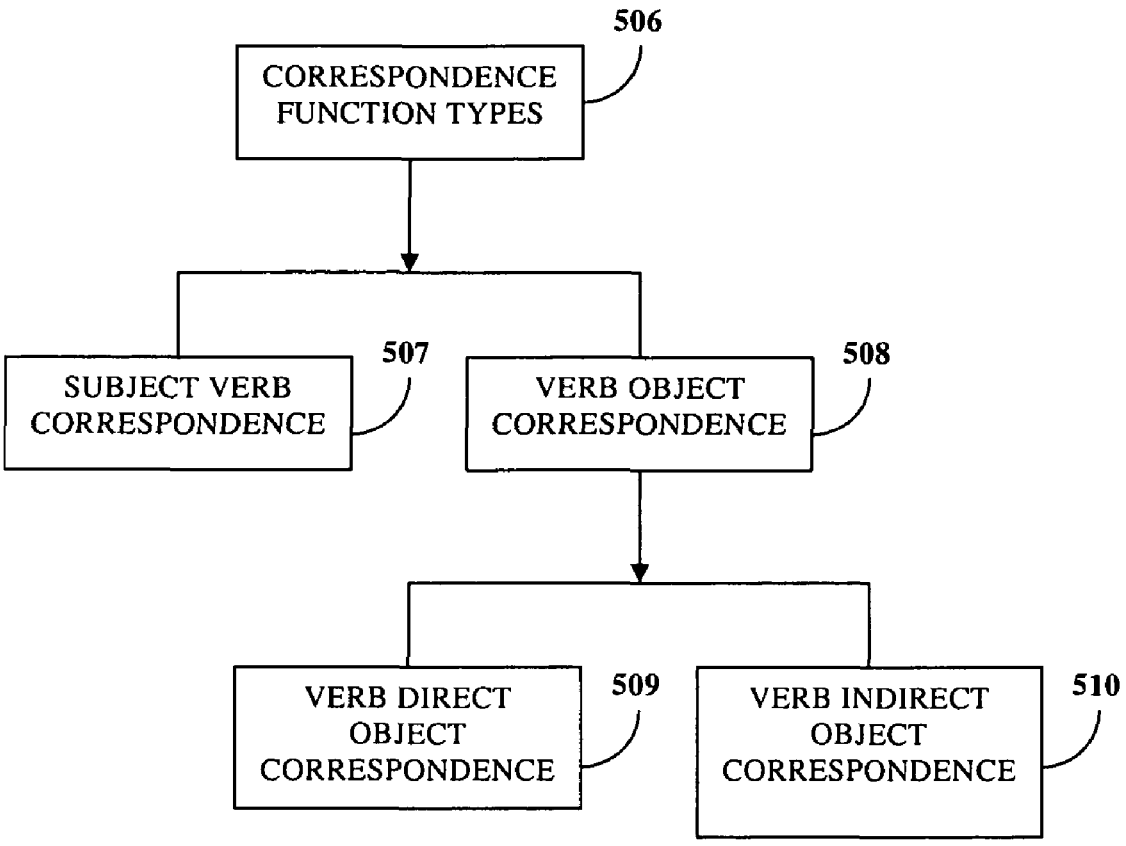

506
CORRESPONDENCE FUNCTION TYPES
507
SUBJECT VERB CORRESPONDENCE
508
VERB OBJECT CORRESPONDENCE
509
VERB DIRECT OBJECT CORRESPONDENCE
510
VERB INDIRECT OBJECT CORRESPONDENCE

FIG. 5B

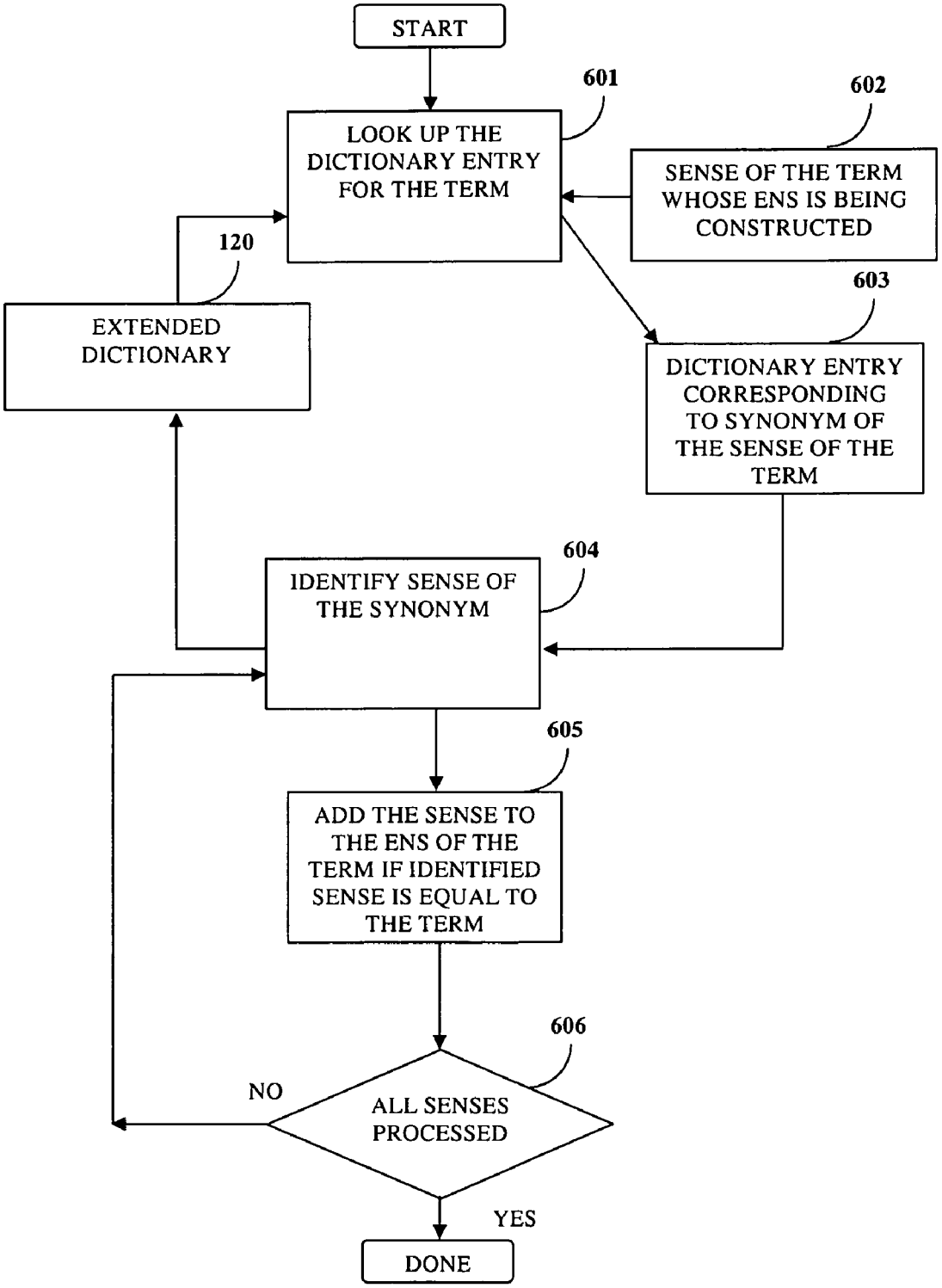

START
601
LOOK UP THE DICTIONARY ENTRY FOR THE TERM
602
SENSE OF THE TERM WHOSE ENS IS BEING CONSTRUCTED
120
EXTENDED DICTIONARY
603
DICTIONARY ENTRY CORRESPONDING TO SYNONYM OF THE SENSE OF THE TERM
604
IDENTIFY SENSE OF THE SYNONYM
605
ADD THE SENSE TO THE ENS OF THE TERM IF IDENTIFIED SENSE IS EQUAL TO THE TERM
606
ALL SENSES PROCESSED
NO
YES
DONE

FIG. 6A

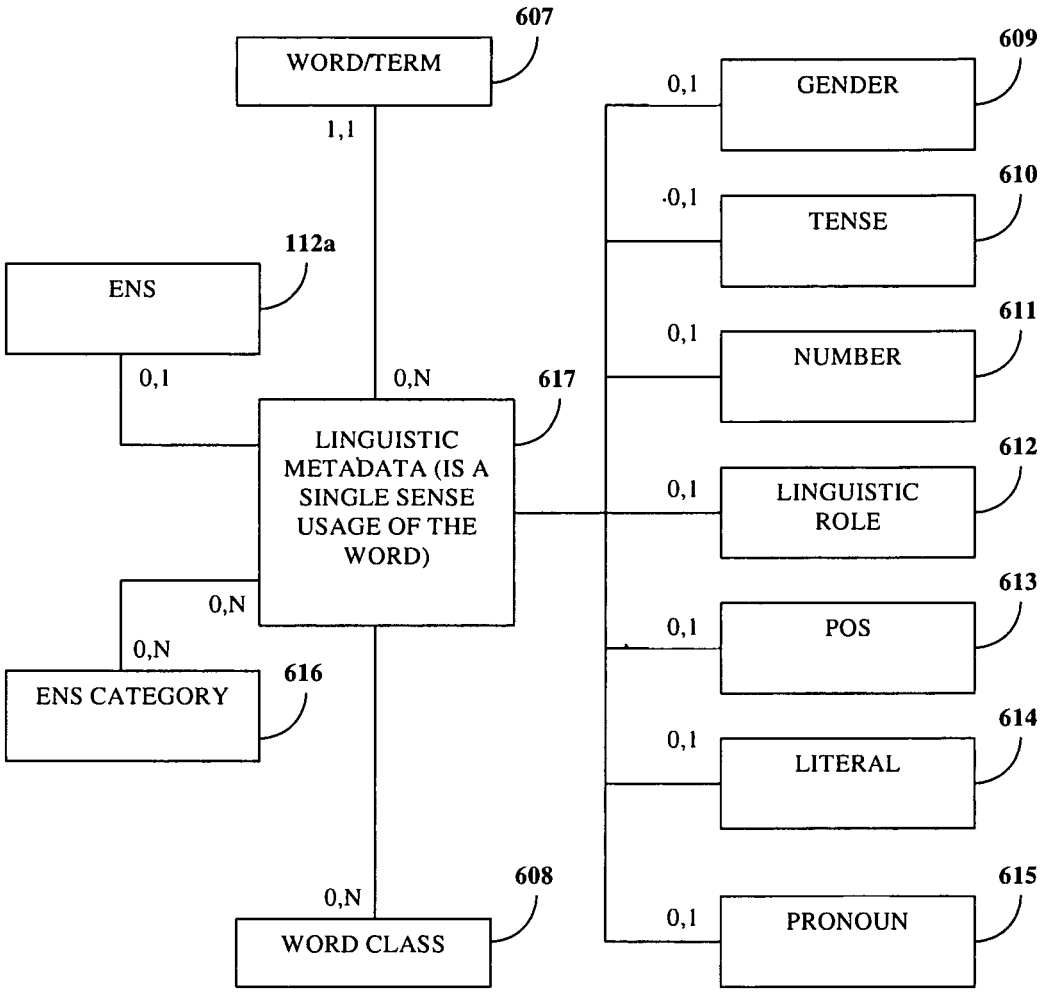

607
WORD/TERM
1,1
609
0,1
GENDER
610
0,1
TENSE
112a
ENS
0,1
0,N
617
611
0,1
NUMBER
LINGUISTIC METADATA (IS A SINGLE SENSE USAGE OF THE WORD)
612
0,1
LINGUISTIC ROLE
0,N
613
0,1
POS
0,N
616
ENS CATEGORY
0,1
614
LITERAL
0,N
608
615
0,1
PRONOUN
WORD CLASS

FIG. 6B

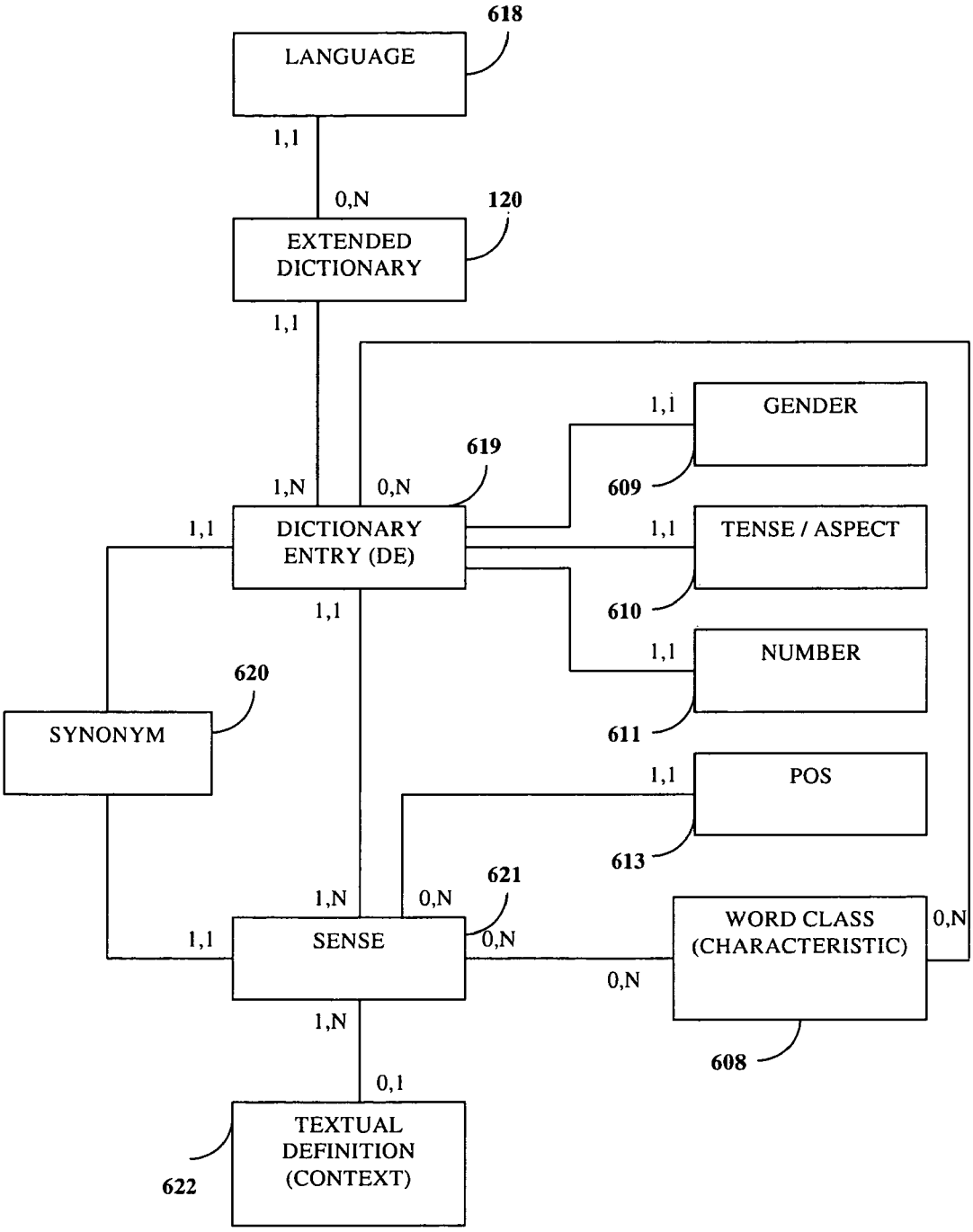

618
LANGUAGE
1,1
0,N
120
EXTENDED DICTIONARY
1,1
1,1
GENDER
619
1,N
0,N
609
1,1
DICTIONARY ENTRY (DE)
1,1
TENSE / ASPECT
610
1,1
NUMBER
620
611
SYNONYM
1,1
POS
613
621
1,N
0,N
1,1
SENSE
0,N
WORD CLASS (CHARACTERISTIC)
0,N
0,N
1,N
608
0,1
TEXTUAL DEFINITION (CONTEXT)
622

FIG. 6C

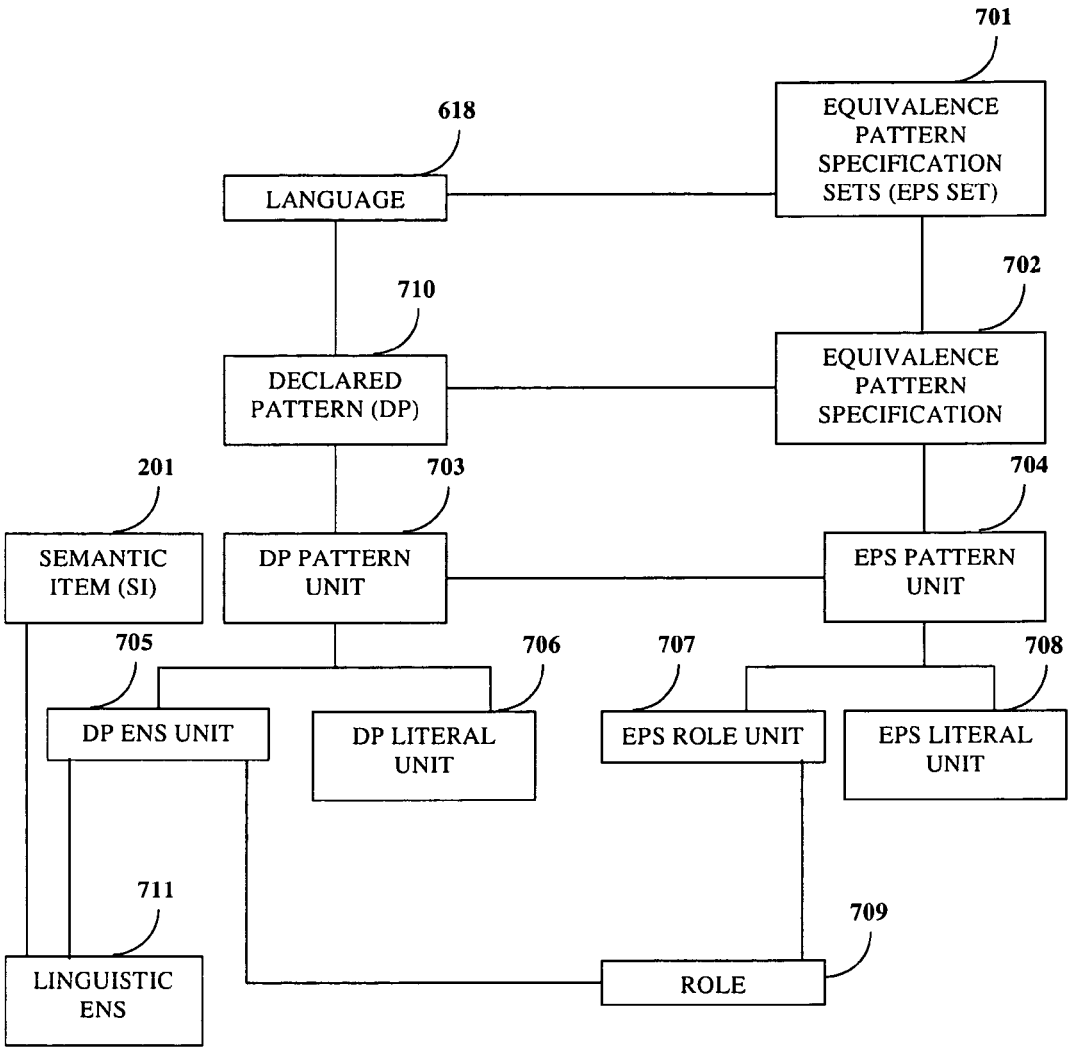

701
EQUIVALENCE PATTERN SPECIFICATION SETS (EPS SET)
618
LANGUAGE
702
EQUIVALENCE PATTERN SPECIFICATION
710
DECLARED PATTERN (DP)
201
SEMANTIC ITEM (SI)
703
DP PATTERN UNIT
704
EPS PATTERN UNIT
705
DP ENS UNIT
706
DP LITERAL UNIT
707
EPS ROLE UNIT
708
EPS LITERAL UNIT
711
LINGUISTIC ENS
709
ROLE

FIG. 7

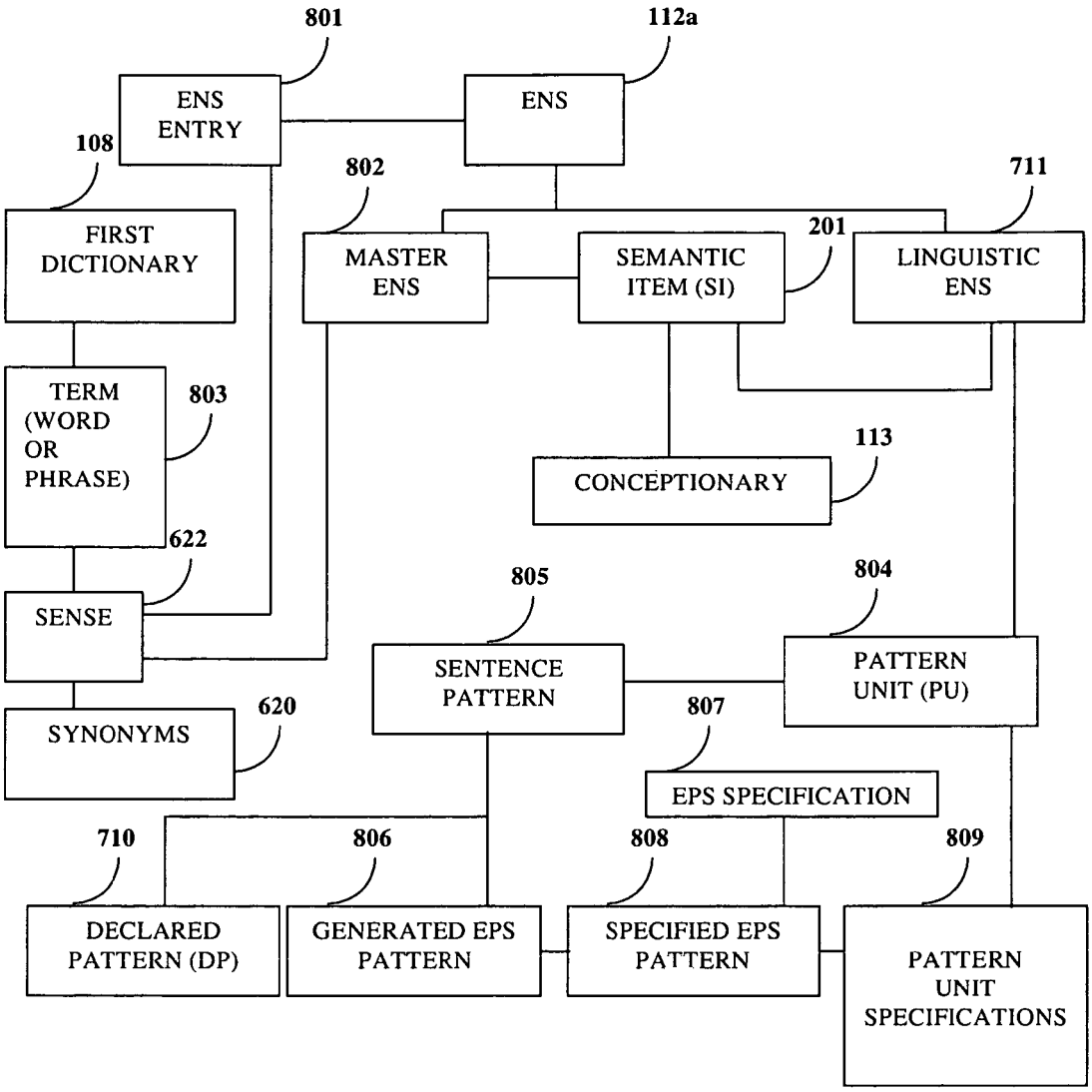

801
112a
ENS ENTRY
ENS
108
802
711
FIRST DICTIONARY
MASTER ENS
201
SEMANTIC ITEM (SI)
LINGUISTIC ENS
TERM (WORD OR PHRASE)
803
113
CONCEPTIONARY
622
805
804
SENSE
SENTENCE PATTERN
PATTERN UNIT (PU)
620
807
SYNONYMS
EPS SPECIFICATION
710
806
808
809
DECLARED PATTERN (DP)
GENERATED EPS PATTERN
SPECIFIED EPS PATTERN
PATTERN UNIT SPECIFICATIONS

FIG. 8A

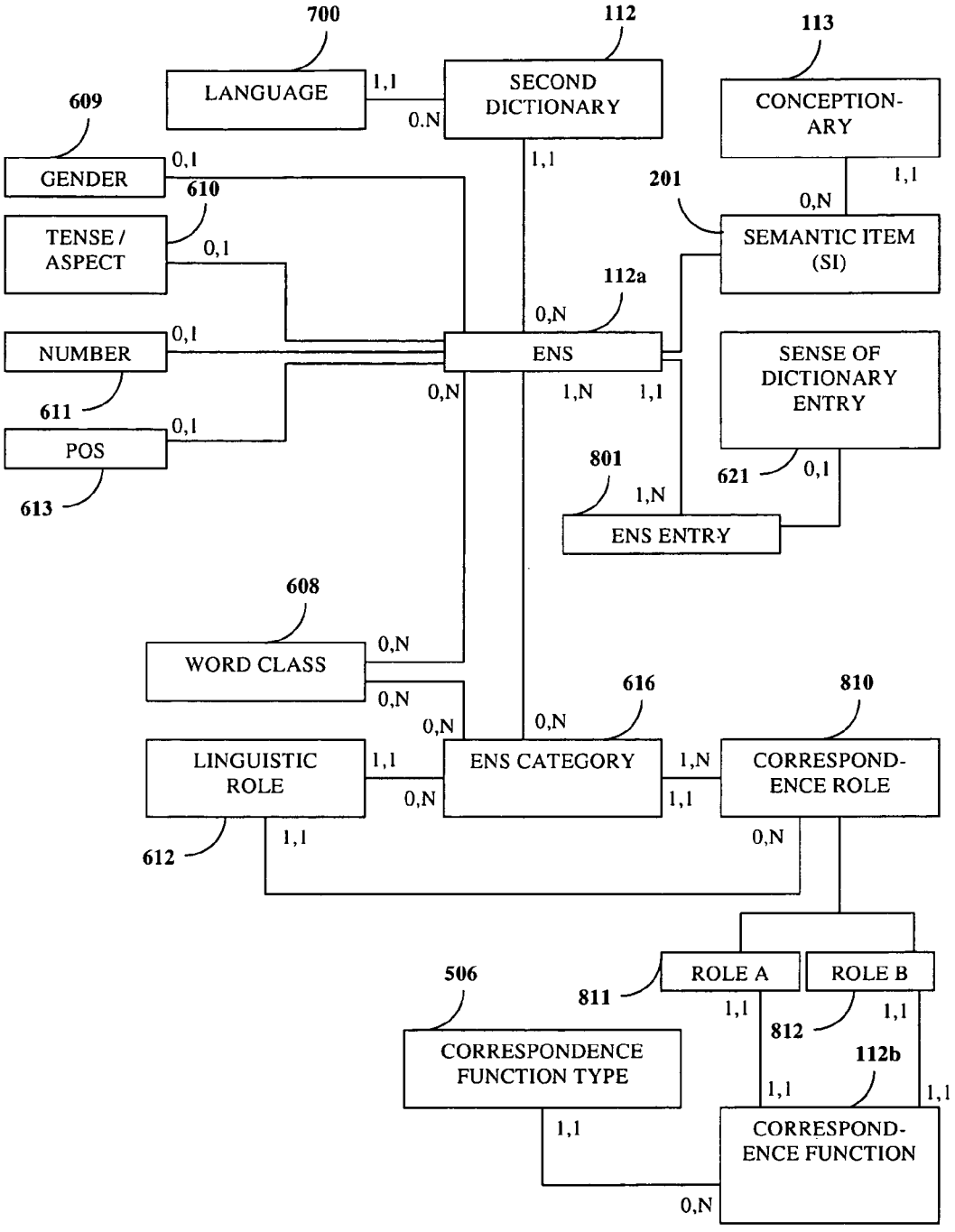

700
LANGUAGE
1,1
0,N
112
SECOND DICTIONARY
113
CONCEPTION-ARY
609
GENDER
0,1
610
TENSE / ASPECT
0,1
NUMBER
0,1
611
POS
0,1
613
1,1
201
0,N
1,1
SEMANTIC ITEM (SI)
112a
0,N
ENS
0,N
1,N
1,1
SENSE OF DICTIONARY ENTRY
621
0,1
801
1,N
ENS ENTRY
608
WORD CLASS
0,N
0,N
0,N
616
0,N
810
LINGUISTIC ROLE
1,1
0,N
ENS CATEGORY
1,N
1,1
CORRESPOND-ENCE ROLE
612
1,1
0,N
506
811
ROLE A
ROLE B
1,1
812
1,1
CORRESPONDENCE FUNCTION TYPE
112b
1,1
1,1
1,1
CORRESPOND-ENCE FUNCTION
0,N

FIG. 8B

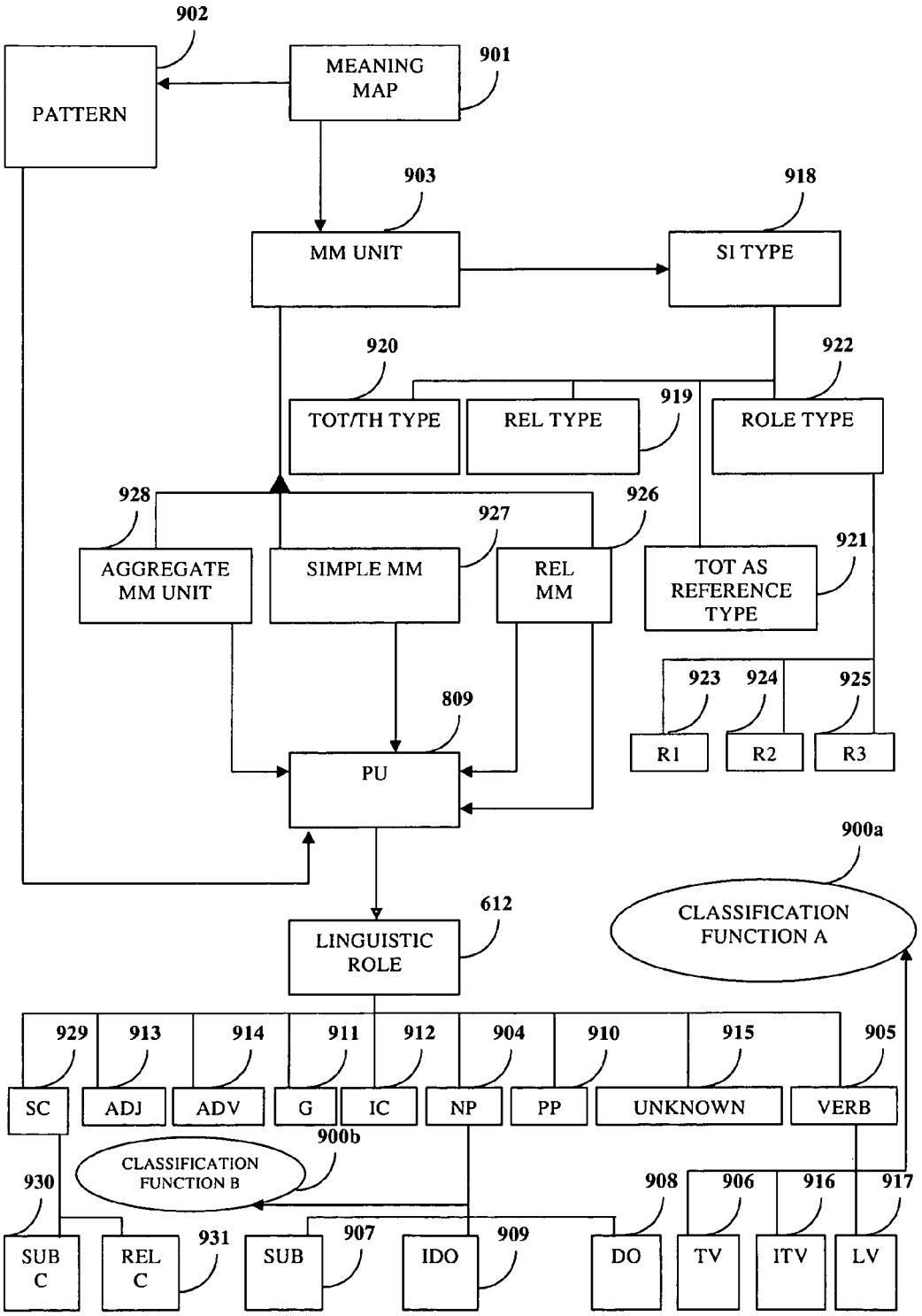

902
PATTERN
MEANING MAP
901
903
MM UNIT
918
SI TYPE
920
TOT/TH TYPE
REL TYPE
919
ROLE TYPE
922
928
AGGREGATE MM UNIT
927
SIMPLE MM
926
REL MM
TOT AS REFERENCE TYPE
921
923
924
925
R1
R2
R3
809
PU
900a
CLASSIFICATION FUNCTION A
612
LINGUISTIC ROLE
929
913
914
911
912
904
910
915
905
SC
ADJ
ADV
G
IC
NP
PP
UNKNOWN
VERB
900b
CLASSIFICATION FUNCTION B
930
908
906
916
917
SUB C
REL C
931
SUB
907
IDO
909
DO
TV
ITV
LV

FIG. 9

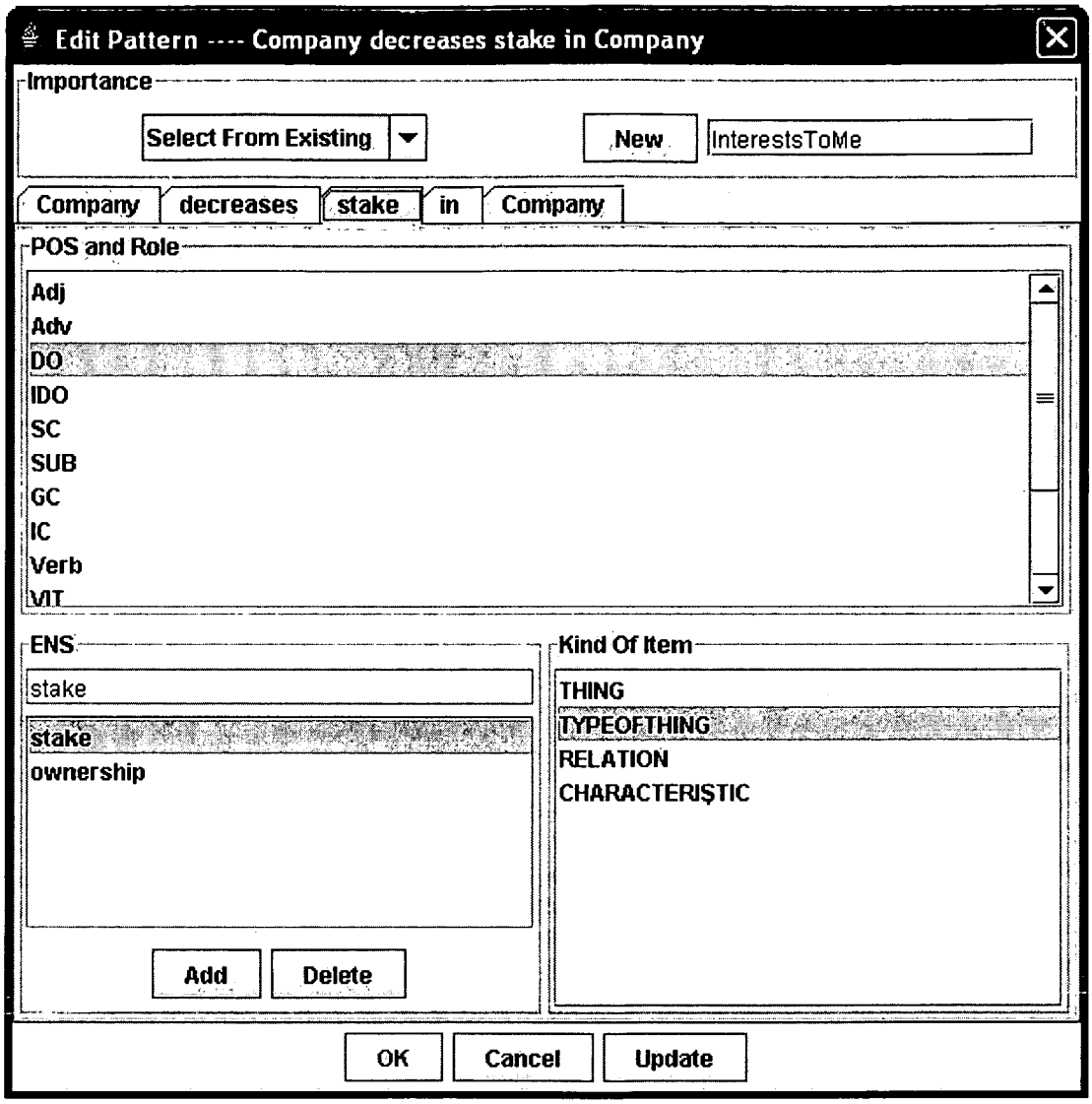

Edit Pattern ---- Company decreases stake in Company
Importance
Select From Existing
New
InterestsToMe
Company
decreases
stake
in
Company
POS and Role
Adj
Adv
DO
IDO
SC
SUB
GC
IC
Verb
VIT
ENS
stake
stake
ownership
Add
Delete
Kind Of Item
THING
TYPEOFTHING
RELATION
CHARACTERISTIC
OK
Cancel
Update

FIG. 10A

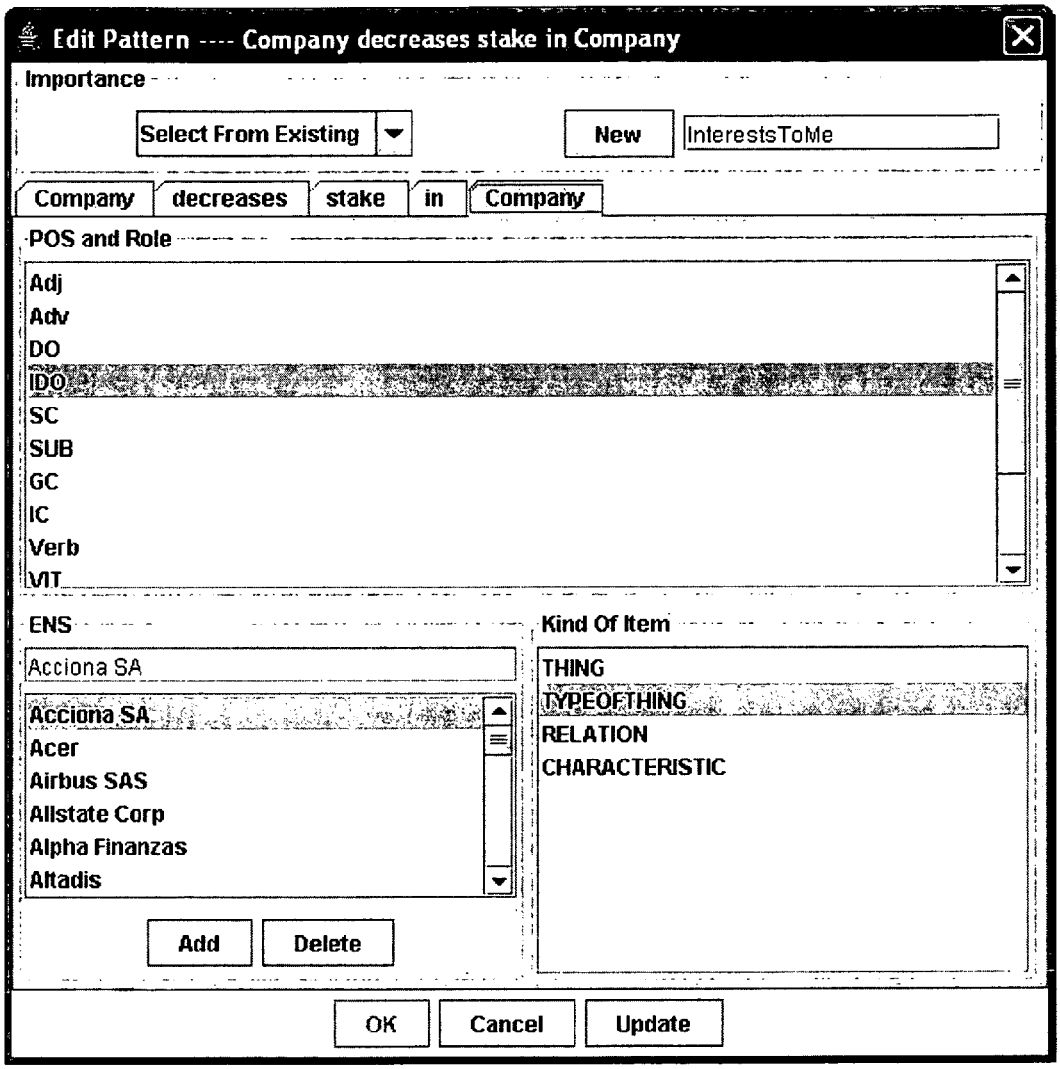

Edit Pattern ---- Company decreases stake in Company
Importance
Select From Existing
New
InterestsToMe
Company
decreases
stake
in
Company
POS and Role
Adj
Adv
DO
IDO
SC
SUB
GC
IC
Verb
VIT
ENS
Acciona SA
Acciona SA
Acer
Airbus SAS
Allstate Corp
Alpha Finanzas
Altadis
Add
Delete
Kind Of Item
THING
TYPEOFTHING
RELATION
CHARACTERISTIC
OK
Cancel
Update

FIG. 10B

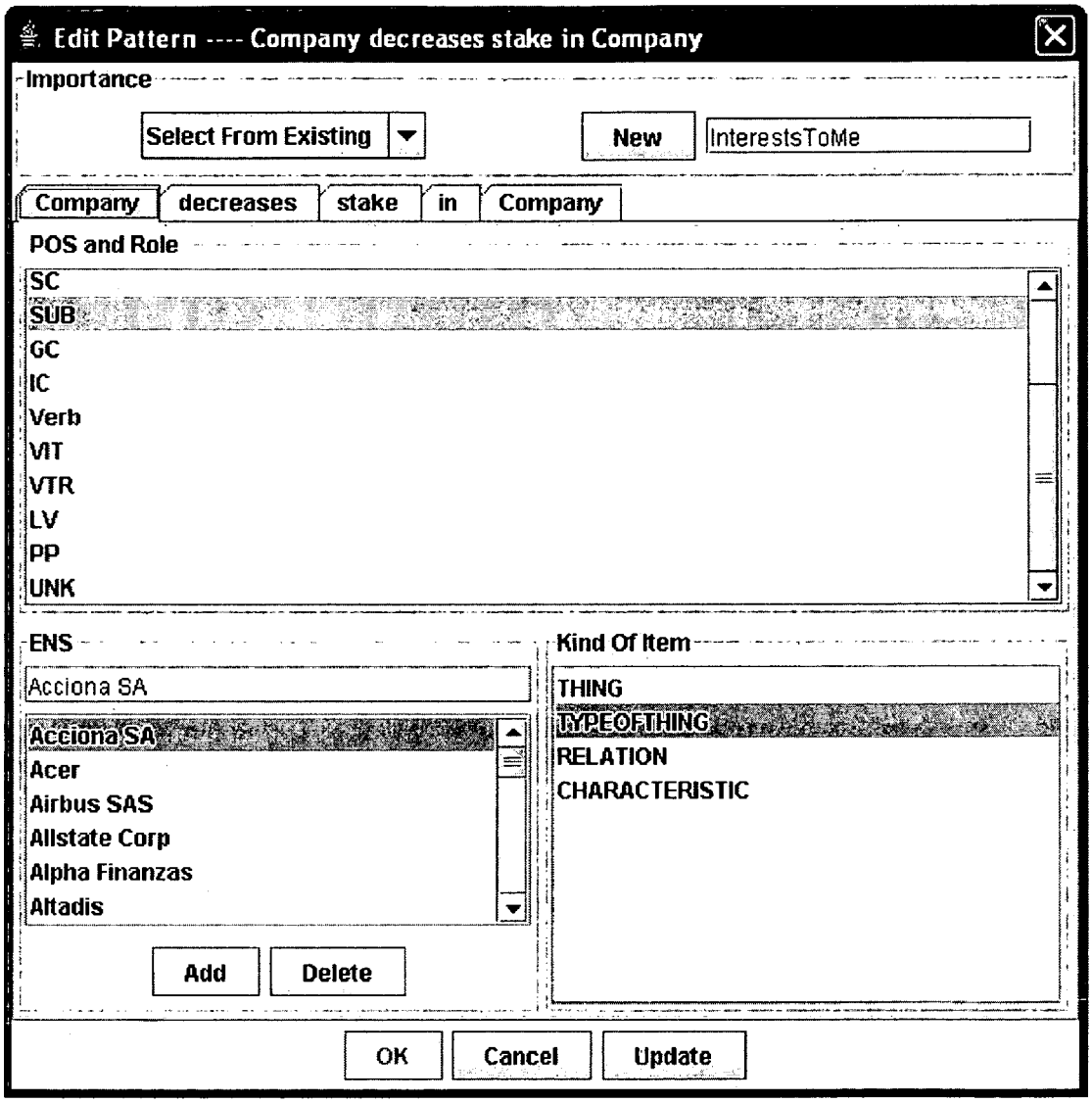

Edit Pattern ---- Company decreases stake in Company
Importance
Select From Existing
New
InterestsToMe
Company
decreases
stake
in
Company
POS and Role
SC
SUB
GC
IC
Verb
VIT
VTR
LV
PP
UNK
ENS
Acciona SA
Acciona SA
Acer
Airbus SAS
Allstate Corp
Alpha Finanzas
Altadis
Add
Delete
Kind Of Item
THING
TYPEOFTHING
RELATION
CHARACTERISTIC
OK
Cancel
Update

FIG. 10C

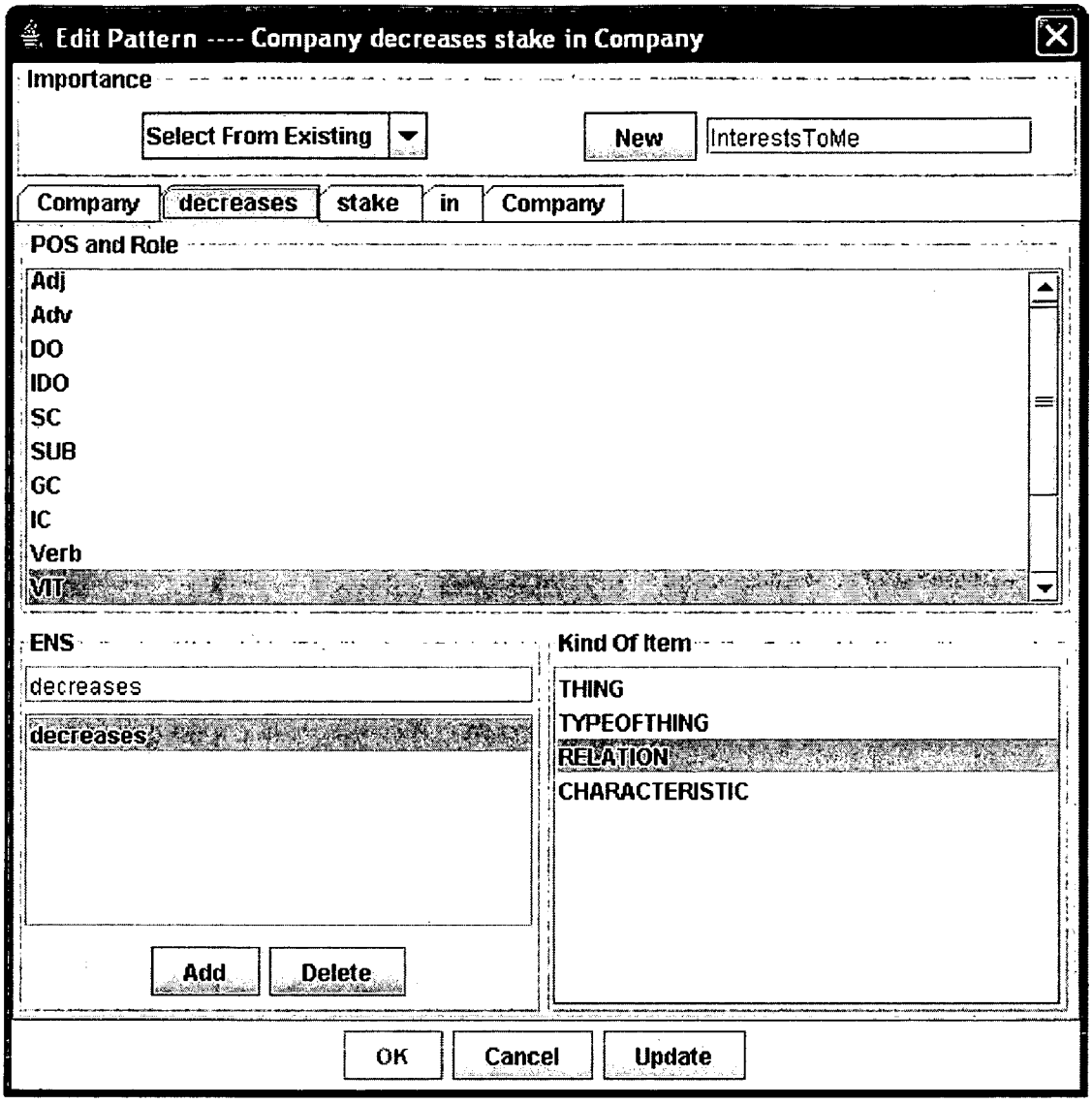

Edit Pattern ---- Company decreases stake in Company
Importance
Select From Existing
New
InterestsToMe
Company
decreases
stake
in
Company
POS and Role
Adj
Adv
DO
IDO
SC
SUB
GC
IC
Verb
VIT
ENS
decreases
decreases
Add
Delete
Kind Of Item
THING
TYPEOFTHING
RELATION
CHARACTERISTIC
OK
Cancel
Update

FIG. 10D

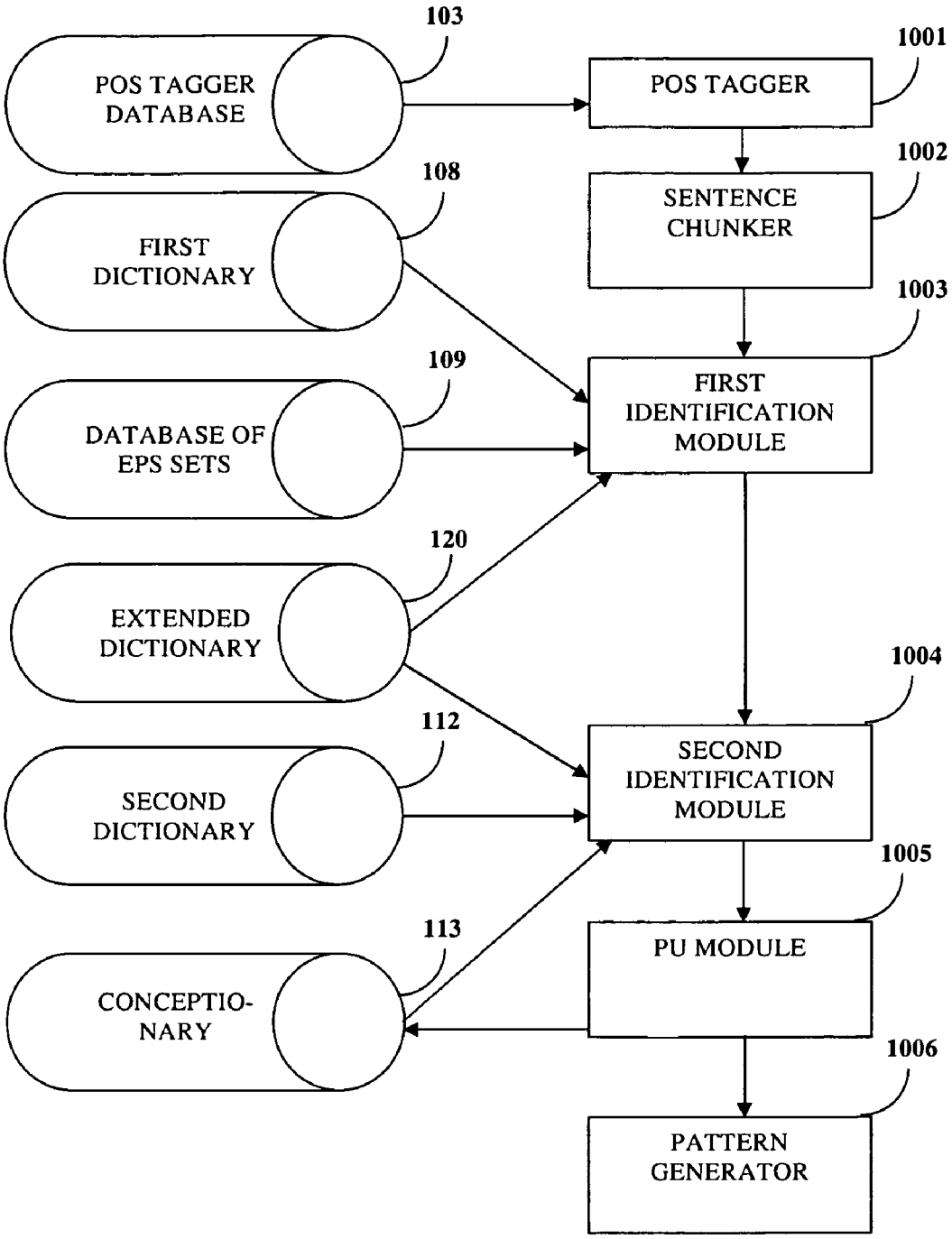

103
POS TAGGER DATABASE
1001
POS TAGGER
1002
SENTENCE CHUNKER
108
FIRST DICTIONARY
1003
FIRST IDENTIFICATION MODULE
109
DATABASE OF EPS SETS
120
EXTENDED DICTIONARY
1004
SECOND IDENTIFICATION MODULE
112
SECOND DICTIONARY
1005
PU MODULE
113
CONCEPTIO-NARY
1006
PATTERN GENERATOR

FIG. 11

AUTOMATIC PATTERN GENERATION IN NATURAL LANGUAGE PROCESSING

BACKGROUND

This invention, in general, relates to a method of linguistic analysis and in particular relates to a method of determining the appropriate sense of words used in a sentence.

There is an unmet need using a computer implemented system to adequately identify the appropriate senses of words used in a sentence. For example, consider the two sentences "the table ate the pie" and "the dog ate the pie". Linguistically, a subject verb object organization exists in both the sentences. Linguistically both sentences are correct, however semantically the first sentence does not make sense. There is a need for a computer implemented method and system to determine the correct correspondence of the senses of the terms used in a sentence.

Effective information retrieval requires a strong understanding of the content of the underlying information, i.e., the components of the sentences comprising the information. There exists a need for a system to improve information search and retrieval based on an understanding of the components of a sentence.

SUMMARY OF THE INVENTION

This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description of the invention. This summary is not intended to identify key or essential inventive concepts of the claimed subject matter, nor is it intended for determining the scope of the claimed subject matter.

Disclosed herein is a computer implemented method and system for generating declared patterns from components of a sentence. A pattern derived from a sentence is herein referred to as a "declared pattern". The computer implemented method and system disclosed herein automatically generates declared patterns (DP) from the components of a sentence. A declared pattern is a sequence of pattern units, each of which corresponds to a portion of text in the sentence. The method and system of automatic generation of declared patterns employ the following units: a conceptionary, a parts of speech tagger database, a dictionary extended with declared and emergent categories, herein referred to as a "first dictionary", where emergent semantic categories determine which sense of the word is valid in the sentence. Other components employed in the system disclosed herein are the following: a database of equivalent pattern specification sets that, for a given language, represent different ways of saying the same thing, and a second dictionary of an equivalent name set which is used to identify the equivalent senses for each pattern unit. The equivalent name set refers to a set of senses which can be considered to have the same meaning.

For each sentence in a document corpus, the parts of speech tagger database is used to tag the sentence in terms of the parts of speech. The method of parts of speech tagging identifies the parts of speech of each word and phrase in the sentence. Sentence chunking is performed using the identified parts of speech of each word and phrase to generate pattern units. The first dictionary with emergent categories, together with database of the equivalent pattern specification sets is then applied to determine the grammatical roles and the senses of the generated pattern units. The second dictionary and conceptionary are used to identify the equivalent name sets for the generated pattern units. A declared pattern is generated by identifying a valid combination of the generated pattern units.

Automatically generated declared patterns together with reading styles may be applied in automated keyword search string refinement applications.

Automatically generated declared patterns may be used to enhance the reading style of a user. As used herein, a user's reading style is a formal mapping of sentence structure and content to their conceptionary. Worldview of the user comprises the reading style, equivalent name sets and private ontology, i.e. conceptionary of the user. The worldview reflects the logic and structure with which a user comprehends a document. Indian patent application No. 1819/CHE/2005 filed in the Indian patent office on Dec. 13, 2005, and its counterpart U.S. patent application Ser. No. 11/451,198, which is herein incorporated in its entirety by reference illustrates a method of capturing the reading style of a user, wherein the reading style is a set of one or more declared patterns.

The computer implemented method and system disclosed herein enhances the reading style. The reading style can be applied in determining the information of interest from the document corpus in a target language.

The computer implemented method and system disclosed herein determines equivalent terms of the components of a given sentence. These equivalent terms may be used to broaden the search criteria in an information retrieval process and may be used to provide a more comprehensive set of results. In the computer method and system disclosed herein, the equivalent terms are called pattern units and when these pattern units occur in predefined strings, the pattern units are called a declared pattern.

The computer implemented method and system disclosed herein can be used to create reading styles and conceptionary on the fly, which can be applied to the discovery of content and the relationships within contents.

BRIEF DESCRIPTION OF DRAWINGS

The foregoing summary, as well as the following detailed description of the invention, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, exemplary constructions of the invention are shown in the drawings. However, the invention is not limited to the specific methods and instrumentalities disclosed herein.

FIGS. **1**A-**1**B illustrate a computer implemented method of generating declared patterns from components of a sentence.

FIG. **2**A exemplarily illustrates the architecture of a conceptionary.

FIG. **2**B exemplarily illustrates a conceptionary editor.

FIG. **2**C exemplarily illustrates a screen shot of instances in the conceptionary.

FIG. **2**D illustrates a screen shot of relationships in the conceptionary.

FIG. **3** exemplarily illustrates a method of identifying grammatical roles and senses of pattern units.

FIG. **4** exemplarily illustrates a method of determining valid senses for generated pattern units.

FIG. **5**A exemplarily illustrates a method of using emergent categories to determine the valid pair wise senses.

FIG. **5**B illustrates the correspondence function types.

FIG. **6**A exemplarily illustrates a method of identifying equivalent name sets for senses.

FIG. **6**B illustrates linguistic metadata.

FIG. **6**C is an exemplary illustration of one embodiment of an extended dictionary.

FIG. **7** exemplarily illustrates a block diagram of equivalent pattern sets.

FIG. **8**A exemplarily illustrates a block diagram of equivalent name sets.

FIG. **8**B exemplarily illustrates an equivalent name set (ENS) and an ENS category.

FIG. **9** exemplarily illustrates the block diagram of a meaning map.

FIGS. **10**A-**10**D exemplarily illustrate an example of generating declared pattern from a sentence.

FIG. **11** exemplarily illustrates a computer implemented system for automatic declared pattern generation.

DETAILED DESCRIPTION OF THE INVENTION

The definitions of the technical terms used herein are provided below.

Declared pattern (DP): A declared pattern is a sequence of pattern units, each of which corresponds to a portion of text in the sentence. A declared pattern is a mapping between natural language grammar and semantic items in the conceptionary.

Pattern unit (PU): A pattern is a relative sequence of pattern units. A pattern unit is a mapping between a role in a sentence and its equivalent name set.

Conceptionary: A conceptionary is a language independent representation of ontology. The conceptionary is a knowledge representation of items. The items represent concepts, instances, relationships of different kinds, characteristics, values, units of measure, and sets and aggregations of these items.

Reading style: The reading style is a set of one or more declared patterns. A declared pattern contains a set of source components. A pattern identifies a specific semantic item. The user declares patterns from source components and thereby captures the reading style. There are different kinds of source components such as sentences, paragraphs, etc.

Worldview: The worldview of the user comprises the reading style, ENS repository, reading plan, and private ontology, i.e. the conceptionary of the user. The worldview reflects the logic and structure with which a user comprehends a document.

Semantic item: A semantic item is one of the following: a thing, a type of thing, a characteristic, or a relationship between things and types of things. The conceptionary comprises semantic items.

Equivalent name set (ENS): Identifies a set of senses for words which mean the same and also provides a set of words that have the same meaning for a given language. For a given language, each semantic item maps to a single ENS. The ENS contains multiple items, i.e., multiple entries.

ENS category: An ENS Category identifies a set of one or more ENS.

Equivalent pattern specification (EPS) sets: Sets of equivalent pattern specifications that for a given language represent different ways of saying the same thing. An equivalent pattern (EP) is a sequence of pattern units (PU). A PU specifies the linguistic metadata needed to match a term in a language. Each of the EPS sets is a set of EP where each EP represents grammatically different ways that possibly represent the same semantics. The EP in an EPS comprises the same number of PU representing an occurrence of an ENS. Each EPS includes a meaning map that describes a single semantic pattern involving one or more of the PU in the EP.

Emergent categories: Emergent semantic categories are used to determine which sense of the word or phrase is valid in the sentence relative to other words or phrases of a sentence.

Correspondence function (CF): Identifies a relationship between two senses, where the relationship includes a linguistic correspondence. A CF identifies a correspondence involving two ENS each with a different linguistic role. The linguistic roles include subject, transitive verb, intransitive verb, linking verb, direct object, indirect object, etc. A CF asserts that when each ENS fills the identified linguistic roles, that combination of ENS is considered to be semantically valid.

Meaning maps: A meaning map is a set of meaning map units (MMU) that establishes a correspondence between PU and semantic item types (SIT) in the conceptionary. Each MMU establishes a part of the semantic representation in terms of SIT one or more of the PU in the EP.

Parts of speech tagger: parts of speech tagger is a unit that determines the part of speech of the different terms of a sentence as subject, verb, object etc.

FIGS. **1**A-**1**B illustrates a computer implemented method of generating declared patterns from components of a sentence **101**. The method disclosed herein provides a confectionary **113**, a parts of speech (POS) tagger database **103**, a first dictionary **108** comprising declared categories and emergent categories, a database **109** comprising equivalent pattern specification (EPS) sets, and a second dictionary **112** comprising an equivalent name set (ENS) **112***a*. The conceptionary **113** is a knowledge representation of items. The items represent concepts, instances, relationships of different kinds, characteristics, values, units of measure, and sets and aggregations of these items. Reference is made to the copending patent application Ser. No. 11/451,198 titled "Capturing Reading Style," filed Jun. 10, 2006, wherein conceptionary **113** is also defined as a library that contains information on how words or phrases in one or more given languages are related to concepts. As used herein, the term "concept" means a general idea derived from specific instances. "types of things" and "concepts" are equivalent terms used in the description.

The POS tagger database **103** may be a readily available off-the-shelf POS database **103**. The sentence **101** from a document corpus is provided as input to the POS tagger **1001**. The POS **613** in the sentence **101** are tagged **102** for identifying POS **613** of each word **607** and phrase in the sentence **101**. Each term in the POS tagged sentence **104** is tagged with the term's part of speech. The POS tagged sentence **104** is given as input for sentence chunking **105**.

The POS tagged sentence **104** is then chunked **105** using the identified POS **613** of each word **607** and phrase to generate pattern units. Consider the example: "Joe and Bob bought a Mercedes". The sentence **101** is identified as a complex sentence and can be chunked into the following two simple sentences: Joe bought a Mercedes and Bob bought a Mercedes. "Joe bought a Mercedes" is chunked as Joe bought Mercedes=>(Noun Phrase) (Verb Phrase) (Noun Phrase), and "Bob bought a Mercedes" is chunked as=>(Noun Phrase) (Verb Phrase) (Noun Phrase). The output of chunking is one or more simple chunked sentences **106**. Sentence chunking occurs as an iterative process where the number of iterations depends on the extent up to which the sentence **101** can be simplified. For example, in the sentence **101** "Joe wished he went to California", "Joe wished" is chunked as '(Noun Phrase) (Verb Phrase)' and "he went to California" is a sentential compliment. Next "he went to California" is chunked to (Noun Phrase) (Verb Phrase) (Noun Phrase). Each constituent of a simple chunked sentence becomes a potential pattern unit (PU) **804** in a declared pattern (DP) **710**. After a PU **804** is generated, the grammatical role and sense **621** for each PU **804** is identified **107**. Identification of the grammatical roles and senses of the PU **804** is illustrated in FIG. **3**.

The sense **621** of a word **607** is the meaning of the word **607** as applicable to the context in which the word **607** is used in the sentence **101**. For example consider the sentence **101**: "Joe ran for the office". The word **607** "ran" may have forty different senses. In the above sentence **101**, "ran" have two different senses, either hurried or campaigned. i.e. "Joe hurried to the office" or "Joe campaigned for the office". The context or the environment in which the word **607** is used in the sentence **101** determines the sense **621** of the word **607**. The first dictionary **108** and a database **109** of EPS sets are applied to identify **107** grammatical roles and senses of the generated pattern units. The first dictionary **108** comprises dictionary entries of words and phrases. Each of the dictionary entries is a term composed of single words and phrases and specifies individual senses of the term.

An extended dictionary **120** is a database containing terms that are words and phrases with an associated list of senses, where each sense **621** includes a definition and a set of categories, where some categories are declared categories such as POS **613**, and some categories are emergent categories. The emergent categories describe how senses associate with other senses. Emergent categories constrain the sense **621** of a PU **804** in a given sentence **101**, i.e., emergent categories limit the various senses of a word **607** to only those senses that are appropriate in the given context. For example, consider the sentence **101**: "peel the orange". In the above example, the emergent category identifies correspondence between words, and identifies valid sense pairings, and is used to determine the sense **621** of the word **607** "orange", as used herein is a fruit and not a color. Emergent semantic categories are used to determine which sense **621** of the term is valid in the sentence **101**.

For example consider the following two sentences:

Sentence 1: Joe runs for the bus.

Sentence 2: Joe runs for the office.

Both of the above sentences have the same linguistic pattern, i.e., the subject verb object pattern. However the emergent semantic categories will determine which senses of the words in the above sentences correctly correspond to one another.

As another example, consider the sentence **101**: "Joe ran a company". In this sentence **101**, the sense **621** of the words needs to be determined and the relationship **206** between the senses clearly established using emergent semantic categories. For example, the word **607** "ran" in the sense **621** of management must be related to "leading", in the sentence **101** wherein the word **607** "company" is used in the sense **621** of an organization. This correspondence of senses is indicated by the emergent categories.

The EPS sets **701** provide mappings of the grammatical roles of the simple chunked sentences **106**. The mappings are checked against the EC to find valid corresponding senses of the pattern units. After the sense **621** and grammatical role of each pattern unit PU **804** has been identified, PU **804** with their identified grammatical role and senses are obtained **110**. The second dictionary **112** and a conceptionary **113** are then applied to identify **111** an ENS **112***a* for each of the generated pattern units. The ENS **112***a* is a set of words that have same meaning. If ENS **112***a* for some sense **621** does not exist, then ENS **112***a* for that sense **621** is constructed. A method of identifying the ENS **112***a* is illustrated in FIG. **6**A.

Declared patterns with identified grammatical role and senses **110** are generated **114** using the identified ENS **112***a* for each of the generated pattern units.

A DP **710** is a mapping between natural language grammar and semantic items in the conceptionary **113**. The semantic item **201** for the PU **804** is found or created **117** if there is a DP **710** with each PU **804** comprising an ENS **112***a*. The ENS **112***a* maps a concept **202** to an equivalent term. The DP **710** is returned **115** to a user as the derived DP **710** for the inputted sentence. The DP **710** provides a sequence that is used to map to a set of semantic items in a conceptionary **113**, if the DP **710** is found in the sentence **101**. The mapping is defined by meaning maps. There is a need to identify the semantic item **201** for the ENS **112***a*. The conceptionary **113** is looked up based on the meaning maps, and on the basis of the structure of the PU **804**, the ENS **112***a* found is mapped to the semantic item **201** in the conceptionary **113**.

For each of the generated pattern units, the ENS **112***a* is obtained and further whether or not a matching semantic item **201** with the ENS **112***a* exists for the given language **618** in the conceptionary **113** is determined. The DP **710** is determined if some or all the PU **804** include semantic items. If there are no pattern units with semantic items, then new semantic items for pattern units are created. Further, the new semantic item **201** is added to the conceptionary **113**. The new semantic item **201** is then related to other semantic items in the conceptionary **113** via relationships indicated between the generated pattern units in the declared patterns.

If automatic training is not implemented, then return the DP **710** with or without the missing semantic item **201** for the PU **804**. If automatic training is implemented, check if there are any missing semantic items. Test if there are declared patterns where some or all pattern units have semantic items. If some or all pattern units have semantic items, then create semantic items for the PU **804**. Derive declared patterns where all pattern units have semantic items. Add the DP **710** to the reading style.

The method of deriving declared patterns may further include the step of automatic training **116**. The step of automatic training **116** enables addition of the sense **621** of new words to ENS **112***a*, addition of new semantic item **201** in the conceptionary **113** and the update of the reading style. Automatic training therefore updates the conceptionary **113** and the reading style. For a new pattern unit, a semantic item **201** is created **117**, if not found in the conceptionary **113**. The semantic item **201** is then added to the conceptionary **113** referencing the identified ENS **112***a* for each pattern unit, if the identified ENS **112***a* is not already referenced in the conceptionary **113**.

A DP **710** is generated **119** and the conceptionary **113** is updated based on this DP **710**, where each PU **804** includes the semantic item **201**. The semantic item **201** is one of the following: a thing **203**, a type of thing **204**, a characteristic **210**, or a relationship **206** between things and types of things. Declared patterns with new semantic items are added **118** to the conceptionary **113** and reading style. For example, if the user performing training comes across the sentence **101**: "He is a fly guy". If the meaning (i.e. sense) of the term "fly guy" (meaning a "cool guy") is not represented as a concept **202** in the conceptionary **113**, although the concepts representing "fly" and "guy" individually are, the new concept "fly guy" gets added to the conceptionary **113**.

The reading style is a set of one or more declared patterns. The DP **710** contains a set of source components. The DP **710** identifies a specific semantic item **201**. The user declares patterns from source components and thereby captures the reading style. There are different kinds of source components such as sentences, paragraphs, etc. The process of capturing and applying the reading style includes the following activities: capturing and applying the reading style of the user, creating a worldview of the user using the reading style, applying the worldview to a document corpus, determining the information of interest, and displaying the desired infor-

mation to the user in the form of a report. The worldview of the user is constructed from the reading style, reading plan and private ontology of the user. Optionally, the user can choose to include a predetermined external ontology to create the worldview. Co-pending U.S. application Ser. No. 11/451,239 titled "Pattern Generation" generates equivalent patterns that include the manifestations of the DP **710** of an end user's reading style, thereby providing the ability to comprehensively and accurately determine the information of interest from an information source.

FIG. **2**A exemplarily illustrates the architecture of the conceptionary **113**. The conceptionary **113** is a language **618** independent representation of ontology. The conceptionary **113** is composed of semantic items. A semantic item **201** is one of the following: a thing **203**, a type of thing **204**, a characteristic **210**, or a relationship **206** between things and types of things, and concepts **203**. As used herein, the term "concept" means a general idea derived from specific instances. A concept **202** can be a thing **203**, or a type of thing **204**. A thing **203** or a type of thing **204** is an explicit classification **205** of concepts **203**. Explicit classification **205** does not require a classification function **208** to be defined. E.g. "Antarctica is at the south pole" is considered as an explicit classification **205**. Explicit classification **205** allows a thing **203** to be an instance of a type of thing **204**. Instances of concepts have relationship **206** between them. The relationship **206** can have different types of roles **207**. The role has a type and a minimum and maximum value. For example, consider the sentence **101**: "Joe has a wife". The role **709** in this sentence **101** is "wife". The minimum and maximum values a role **709** can attain are zero and one respectively in a monogamous society. Type of thing **204** includes a computed classification providing the classification function **208**. The classification function **208** may be computed on basis of the information that the sentence **101** provides about the type of thing **204**. For example, if the sentence **101** states: "That insect is crawling on the wall and spinning a web and the insect has six legs". The classification function **208** classifies the type of thing **204** as a spider. The specialization **209** defines specialization **209** of a thing **203** with respect to its sense **621**. For example, consider the word "you". "You" can have different senses; it can signify a male or a female, depending upon the sense **621** of its usage. Therefore, there is a need for specialization **209**.

Each semantic item **201** in the conceptionary **113** may contain characteristic **210**, values **211** and units of measure **213**. For example, consider the sentence **101**: "He is six feet tall". In this example, six is the value **211**, feet is the unit of measure **212** and tall is an indicator of height; therefore height is a characteristic **210**. Values are further classified as enumerated value **213** and literal value **214**. The literal value **214** is an absolute value, like the number six in the above example while an enumerated value **213** is again the concept **202**. Semantic items are members of concept set entry **215**. Occasionally the concept **202** may represent a set of other concepts or set of other semantic items. For example, for the concept **202** of a "family", the concept **202** can represent a set of members of a family which could include parents and children and grandparents and so forth, the concept **202** of two or three of the members of the family may represent a set **216** with entries in the concept set entry **215**.

FIG. **2**B exemplarily illustrates a conceptionary editor. The conceptionary editor allows a user to make and save changes to the conceptionary **113**. The concept **202** is first selected in the concept panel. Click on "New", a prompt will appear to input a name of the concept, i.e. for a label for the concept. In FIG. **2**B, the concept **202** is labeled as a company. The generalization box provides a super class of the concept. The current concept **202** is listed under the generalization "business". The specialization **209** is a further refinement of the generalization. The concepts selected from the box "All concepts" can be moved to the generalization or specialization box. FIG. **2**B illustrates how instances of the concepts are captured.

The ENS **112***a* entries are other name for 'company', such as enterprise, concern etc. The ENS **112***a* entries can be created by double clicking on "New entries" and further entering a term or searching an entry for a new term. The ENS **112***a* identifies the equivalent name for the particular sense **621** of the word **607**. The concept **202** represents a set of other concepts or relationships that it stands for. For example the concept **202** could be United Nations (UN), and the set entries would include the countries who are members of the UN. A characteristic **210** is a property of a concept **202**. In FIG. **2**B, property comprises a label called "date of incorporation". The interface shown in FIG. **2**B allows a user to relate the characteristic **210** to the concept **202** in the conceptionary **113**. The valid values list provides the value **211**. In FIG. **2**D, the valid value **211** is a numerical representation of the date of incorporation.

FIG. **2**C exemplarily illustrates a screen shot of instances in the conceptionary **113**. The "V" button allows a user to select concepts in the all concepts window and send the selected concept **202** to the classification window. For each of the classifications, their characteristics also get placed in the characteristics box.

FIG. **2**D illustrates a screen shot of relationships in the conceptionary **113**. The user interface in FIG. **2**D allows a user to describe a relationship **206** between concepts and concepts, between concepts and instances, and between instances and instances.

If the relationship **206** represents a term, for example 'given' or 'to give', then, role 1 may indicate a participant in the relationship **206** as the giver, role 2 may indicate what was given and role 3 may indicate the person who received. When a role **709** is created, the following relationships are derived: relationship **206** between concepts and concepts, between concepts and instances, and between instances and instances. The relationships can have characteristics and valid values. For example, for a relationship **206** called "decrease", an instance of when the decrease happened can be captured.

FIG. **3** exemplarily illustrates a method of identifying grammatical roles and senses of pattern units. Simple chunked sentences **106** are provided to generate DP **710** with PU **804** comprising grammatical roles and senses **110**. The EPS **702** that could possibly map to the simple chunked sentences **106** is then found **301**. The database **109** of EPS sets are then looked up to identify the EPS **702** that could possibly map to the simple chunked sentences **106**. The possible pattern units with possible valid grammatical roles are then generated **302**. Consider the patterns with possible valid roles in conjunction with the inputs from the first dictionary **108**. For each possible pattern, the valid senses for each PU **804** are determined **303**. A method of determining valid senses for each of the generated pattern units is illustrated in FIG. **4**. Further the pattern units with valid senses are obtained **304**. The possible patterns with valid senses are converted **305** to declared patterns with grammatical roles and senses. Thus, the DP **710** with the PU **804** with identified grammatical roles and senses is obtained **110**.

A. The steps below provide a method of generating CF **112***b* from the DP **710**:

1. A DP **710** identifies linguistic roles for each PU **804**.

2. The PU **804** for specific corresponding pairs of linguistic roles can be identified. For example, if present, the respective PU **804** for the subject-transitive verb pair can be identified.
3. In addition, each PU **804** identifies either a specific ENS **112***a* or literal **614**.
4. When two PU **804**, each identifying an ENS **112***a*, also have linguistic roles for a valid CF **112***b* Type, a new CF **112***b* can be generated.
5. The ENS Category **616** containing each identified ENS **112***a* can be determined by:
   a) For each of the two ENS **112***a*
      (1) For each ENS Category **616** for this ENS **112***a*
         (a) If the CF **112***b* for this ENS Category **616** has the correct roles and the other ENS **112***a* is in the other ENS Category **616** then
            (i) CF **112***b* was found
            (ii) Done
      (2) If no appropriate CF **112***b* was found, then
         (a) Create a new CF **112***b* with the corresponding linguistic roles.
         (b) Create a new ENS Category **616** for each ENS **112***a*.
         (c) Associate the ENS Category **616** with the new CF **112***b* in their respective linguistic roles.
         (d) Done.

B. Generation of New CF **112***b* and ENS Categories through reasoning by analogy:

1. ENS category aggregation with CF **112***b* Generation
   a. If A←X→B and C←X→B then
      (1) Let D={A, C}
      (2) Create D←X→B
   b. If A←X→E and C←X→E then
      (3) Since D={A, C}
      (4) Create D←X→E
   c. If D←X→B and D←X→E then
      (5) Let F={B, E}
      (6) Create D←X→F
2. Evident ENS category aggregation
   a. Q={A, C, G, H}
   b. R={B, E, I, J}
   c. If Q←X→R and S←X→E and S←X→B and S←X→I and S←X→J then
      (1) Q={A, C, G, H, S}
3. Imputed ENS category aggregation
   a. Note: With analogy match function threshold>=75%
   b. Q={A, C, G, H}
   c. R={B, E, I, J}
   d. If Q←X→R and S←X→E and S←X→B and S←X→I then
      (1) Assert: S←X→J
      (2) Therefore: Q={A, C, G, H, S}

C. Generating DP **710** using CF **112***b:*

1. During training:
   a. Use POS Tagger **1001** to identify linguistic metadata **617**
   b. Use sentence chunker **1002** to enable identification of EPS **702**
   c. For each EPS **702** match for each PU **804**
      (1) Find or create ENS **112***a*
      (2) Identify corresponding Role **709**
2. During reading:
   a. Use second dictionary **112** to identify sets of possible linguistic metadata **617** and ENS **112***a* for each term
   b. Use database **109** of EPS to identify possible EPS **702** matches
   c. Use linguistic metadata **617** and EPS **702** matches to identify possible roles
3. Both:
   a. Use second dictionary **112** to find ENS Categories for each ENS **112***a*
   b. Use CF **112***b* DB to find or create CF **112***b* for each ENS category pair
   c. Use CF **112***b* to identify valid ENS **112***a* combinations
   d. Select the valid EPS **702** matches from previous EPS **702** matches with valid ENS **112***a* combinations
   e. Generate a DP **710** for each set of valid ENS **112***a* mappings for each valid EPS **702** match.

FIG. **4** exemplarily illustrates a method of determining valid senses for each of the generated pattern units. The computer implemented method disclosed herein elaborates the step of determining the valid senses for each PU **804** for each possible pattern pair occurring in the process of identifying grammatical roles of pattern units.

An extended dictionary **120** is provided with part of speech for each sense **621**. The possible senses for each PU **804** are looked for **401** based on term and POS **613** for patterns with possible valid roles **302**. Herein, the terms "term" and "word" are used interchangeably. The possible senses for PU **804** are looked for based on terms and POS **613** to obtain **402** senses for each term. The patterns where no valid POS **613** based sense mapping exists are then eliminated **403**. The possible patterns which have valid POS **613** based sense mapping are then determined **405**. The elimination process is repeated **404** as long as a pattern remains. The valid pair-wise sense mapping of the PU **804** is then determined **406** using the first dictionary **108** with emergent categories. A method of using emergent categories to determine the valid pair wise senses is exemplarily illustrated in FIG. **5**A.

The valid pattern unit pairs are then obtained **407** and further used to eliminate **408** patterns where no valid sense based mapping exists. The possible patterns with valid senses are then obtained **304**. For example, in the sentence **101** "run to the store," 'run' is a verb; whereas 'run' is a noun in the sentence **101** "please bring me that run", where 'run' could be a run of paperwork. The former sentence **101** will have a possible sense **621** based on POS **613** in a dictionary. The latter sentence **101** may or may not have a possible sense **621** based on POS **613** in the dictionary. Patterns are not eliminated just because a possible sense **621** is not identified in the dictionary. In these cases, emergent categories are used to determine whether a pattern is valid or not.

FIG. **5**A exemplarily illustrates a method of using emergent categories to determine the valid pair wise senses. The possible patterns with valid POS **613** based sense mapping are provided and the correspondence function (CF) **112***b* is determined **501** for each pattern unit pair. Apply a dictionary with declared emergent categories based on the CF **112***b*. The CF **112***b* is defined as relationship **206** between two sets of senses. For example, the CF **112***b* may relate a subject **907** and a verb **905**, a subject **907** and a direct object **908**, or a subject **907** and an indirect object **909**, etc. The pattern unit pairs with the CF **112***b* are obtained which are pairings for a possible valid sense **621**.

The emergent category for each possible sense **621** of each PU **804** in the pair is identified **503** for pattern unit pairs with correspondence functions per the possible pattern unit roles **502**. The pattern unit pairs with emergent categories and correspondence functions are then obtained **504**. The pattern unit pairs whose emergent categories do not have a correspondence function **112***b* are then eliminated **505**. Then the valid pattern unit pairs are obtained **407**. For example, "my dog ate

my homework" is a valid pair wise sense, but "the table ate my homework" is not a valid pair wise sense.

FIG. **5**B illustrates the correspondence function types **506**. Correspondence functions fall into two types: Subject verb correspondence **507**, e.g. the correspondence in "Dog ate my homework," and verb object correspondence **508**. Verb object correspondence **508** can be a verb direct object correspondence **509**, for e.g. "Joe gave Bob the ball" and a verb indirect object correspondence **510**, for e.g. "Joe took a beating". Correspondence functions are not specific to a kind of thing **203**; however, correspondence functions are specific to emergent categories.

FIG. **6**A illustrates a method of identifying ENS **112***a* for senses. The FIG. **6**A elaborates the step of identifying ENS **112***a* for each PU **804** when the ENS **112***a* for a sense **621** does not exist in the second dictionary **112** with ENS **112***a* for each sense **621**. A dictionary with senses **120** along with synonyms for each sense **621** is provided. Each sense **621** of a word **607** includes a corresponding ENS **112***a*. For example, consider the word **607** "run". The word **607** "run" has different senses in different sentences. The word **607** "run" means "manage" when it occurs in the sentence **101**: "Joe runs a company.", whereas the same word **607** means "to hurry" when it occurs in the sentence **101** "Joe ran for office". Thus, "hurry" and "manage" are synonyms for run but they have different senses and for each sense **621** of the word **607** "run", i.e., "hurry" and "manage" there exists an ENS **112***a*.

The method of determining ENS **112***a* for senses comprises the following steps. For each sense **621** of the term whose ENS **112***a* is being constructed **602**, the dictionary entry (DE) **619** for the term is looked for **601**. The dictionary entries corresponding to synonyms of the sense **621** of the term whose ENS **112***a* are being constructed is determined **603**. The senses of the synonyms are identified **604**. The identified sense **621** of the synonym **620** to the ENS **112***a* being constructed is added **605** to the ENS **112***a* if the identified sense **621** of the synonym **620** is equal to the term. The process is repeated till the senses of the synonym **620** of the term are processed **606**.

FIG. **6**B illustrates linguistic metadata **617**. A word or term **607** can comprise any number of linguistic metadata **617** associated with it. A word or term **607** is or is associated with a gender **609**, a tense **610**, a number **611**, a linguistic role **612**, parts of speech (POS) **613**, literal **614**, and a pronoun **615**. Linguistic metadata **617** includes a word class **608** associated with it. Linguistic metadata **617** also comprises zero or many ENS category **616** to determine which sense **621** of the word **607** to be used. Linguistic metadata **617** further comprises an ENS **112***a* that provides a set of words or terms, which among themselves have close enough meaning to be considered equivalent in a given language **618** and context.

FIG. **6**C is an exemplary illustration of one embodiment of an extended dictionary **120** with senses. Each language **618** comprises multiple extended dictionaries **120** with senses. Each of the extended dictionaries **120** with senses comprises many dictionary entries **619**. Each of these dictionary entries **619** refers to a gender **609**, a tense or aspect **610**, and a number **611**. Each dictionary entry **619** comprises one or many senses **621**. The sense **621** identifies the POS **613**. The sense **621** also identifies word classes (characteristic), where a word class **608** is a way of identifying the sense **621** of a dictionary entry **619** as belonging to other dictionary entry senses. A word class **608** can identify many senses. A sense **621** of a dictionary entry **619** can comprise a synonym **620**. Each sense **621** may comprise a textual definition **622**.

FIG. **7** illustrates the block diagram of EPS sets **701**. Each of the EPS sets **701** corresponds to a specific language **618**. Each language **618** has potentially zero or many declared patterns **710**. Each of the EPS sets **701** comprises a multiplicity of equivalent pattern specifications **702**. Each of the equivalent pattern specifications **702** comprises zero or many EPS pattern unit **704**. Each DP **710** comprises zero or many declared pattern units. Each declared pattern unit **703** may comprise one or more matching pattern units, i.e. EPS pattern unit **704**. Each EPS pattern unit **704** may comprise zero or many declared pattern unit **703**. Each declared pattern unit **703** may be one of two continents, i.e. either a DP ENS unit **705** or a DP literal unit **706**. If the declared pattern unit **703** is of kind DP ENS unit **705**, then the declared pattern unit **703** must contain a linguistic ENS **711**. Each linguistic ENS **711** corresponds to zero or one semantic item **201**. Further, each DP ENS unit **705** must have a role **709** that connects the DP ENS unit **705** to the EPS role unit **707**. Each EPS pattern unit **704** may be either one or one of two components: EPS role unit **707** or EPS literal unit **708**.

FIG. **8**A illustrates the block diagram of an ENS **112***a*. An ENS **112***a* comprises one of two kinds; master ENS **802** and linguistic ENS **711**. Each ENS **112***a* comprises zero or many ENS entries **801**. Each ENS entry **801** corresponds to zero or one senses. Each sense **621** is a sense **621** for any term. A term is a word **607** or a phrase **803**. Each term **803** is listed in the first dictionary **108**. Each sense **621** may have zero or many synonyms. Each semantic item **201** comprises one master ENS **802**. Each semantic item **201** may have zero or many linguistic ENS **711**. The conceptionary **113** comprises zero or many semantic items. A sentence pattern **805** comprises zero or many pattern units **804**. Each PU **804** comprises one linguistic ENS **711**. A sentence pattern **805** is one of the following two types: a DP **710** or a generated EPS pattern **806**. A generated EPS pattern **806** arises from a specified EPS pattern **808**. The specified EPS pattern **808** includes one pattern found in an EPS specification **807**. The PU **804** comprises pattern unit specifications **809**.

If the ENS **112***a* of a sense **621** is to be constructed, then the ENS entries **801**, along with all the terms **803** referred to, have to be considered. The master ENS **802** which contains all the terms of the word **607** is created. A linguistic ENS **711**, a subset of the master ENS **802** is provided to determine the appropriate linguistic sense **621** of a word **607**. For example, in the German language, one can call "you" as "Sie" or "du". But "Sie" is used in a formal manner of addressing a person while "du" is used in an informal manner of addressing a person. Thus, even if the master ENS **802** allows both "Sie" and "du" as ENS for "you", the linguistic ENS **711** provides only the correct ENS for the given language **618** and culture. The linguistic ENS **711** further condenses the output of master ENS **802** to provide an appropriate usage of the word **607**. For example, if a certain word **607** includes thirty senses, the word **607** has thirty master ENS **802**, one for each sense **621**. However, there may be much less than thirty linguistic ENS **711**.

FIG. **8**B exemplarily illustrates ENS **112***a* and ENS category **616**. Each ENS corresponds to a language **618**. Each ENS **112***a* consists of one or many ENS entries **801**. Each ENS entry **801** corresponds to zero or one sense **621**. Each semantic item **201** includes an ENS **112***a*. The conceptionary **113** comprises zero or many semantic items. An ENS **112***a* is further associated with a gender **609**, a tense or aspect **610**, a number **611** and POS **613**.

ENS category **616** participates in a number of correspondence functions **112***b*. Correspondence roles participate in correspondence functions as either role A **811** or role B **812**, i.e. role A argument or role B argument in the CF **112***b*. For example, role A **811** could be a subject role, or role B **812**

could be the role played by the object. Each ENS category **616** plays one or the other of these roles within a given CF **112***b*. The CF **112***b* could be one of the correspondence function types **506** described in FIG. **5**B. Each ENS category **616** can participate in a number of word classes, and word classes can have a number of ENS categories. An ENS category **616** fulfills one and only one linguistic role **612**. Each correspondence role **810** also refers to the same linguistic role **612**.

FIG. **9** exemplarily illustrates the block diagram of a meaning map **901**. The meaning map **901** is composed of zero or many meaning map unit **903**. Each meaning map unit **903** refers to one semantic item (SI) type **918**. Each meaning map (MM) unit **903** may be one of three kinds; aggregate MM **928**, simple MM **927**, and REL MM **926**. Each pattern **902**, for example an EPS specification **807**, includes one or many pattern units **804**. A simple MM **927** refers to one pattern unit. A PU **804** may reference zero or many simple MM **927**. An aggregate MM **928** is composed of one or many pattern units **804**. A REL MM **926** refers to one and only one PU **804** and refers from one PU **804**. Each PU **804** includes a single linguistic role **612**. Each linguistic role **612** is one of the following kinds; sentential complement **929**, adjective **913**, adverb **914**, gerund clause **911**, infinite clause **912**, noun phrase **904**, prepositional phrase **910**, unknown **915**, and verb phrase **905**. Each sentential complement **929** is one of two kinds; subordinate clause **930** or relative clause **931**. Each noun phrase **904** is one of three kinds: a subject **907**, an indirect object **909**, or a direct object **908**. Each verb phrase **905** is one of three kinds: transitive verb **906**, intransitive verb **916**, or linking verb **917**. Classification function A **900***a* is used to determine whether the verb **905** is one of transitive verb **906**, intransitive verb **916**, or linking verb **917**. A different classification function B **900***b* is used to differentiate or distinguish the kinds of noun phrase **904**. The SI type **918** is one of four different types: REL type **919**, TOT/TH. type **920**, role type **922**, and TOT as reference type **921**. Each role type **922** is either a R**1** **923**, R**2** **924**, or R**3** **925**.

The meaning map **901** maps a PU **804** to an SI Type **918** in the conceptionary **113**. Ontology as defined herein is a set of semantic items and their inter-relationships. If a semantic item **201** with an ENS **112***a* is not present in the conceptionary **113**, the semantic item **201** is created in the conceptionary **113** using meaning maps.

There are different patterns in which PU **804** occur in a sentence **101**. For example, a subject may occur with a verb, a subject may occur with a noun, etc. Accordingly there are different patterns **902** such as subject-verb, subject-noun, verb-object, etc. For example, the PU **804** can be a noun phrase **904** which may be a subject **907**, a direct object **908**, or an indirect object **909**. The PU **804** can also be a preposition phrase **910**, a gerund clause (GC) **911**, an infinitive clause (IC) **912**, an adjective **913**, an adverb **914** or may be of an unknown **915** type. These are the various linguistic roles the PU **804** may have. The listing of linguistic roles in FIG. **9** is exemplary and not meant to be limiting.

To exemplarily illustrate the different constituents of the meaning map **901**, consider the example: "Joe gave the ball." In this example, the PU **804** for "Joe" is a noun phrase which is also a subject. The word **607** "gave" is a verb **905** of a transitive verb **906** type and "ball" is another noun phrase **904**. Similarly, the verb **905** may also be of intransitive verb **916** or linking verb (LV) **917** types. The meaning map unit **903** provides the SI type **918**. SI type **918** can further be of the following types: relation (REL) type **919**, type of thing or thing (TOT/TH) type **920**, type of thing (TOT) as reference type **921** and role type **922**. The different semantic item types may be explained using the example considered above. In this example, "Joe" and "ball" are a type of thing or thing type **920**. "Gave" is the REL type **919** which maps directly to the things "Joe" and "ball" present in the sentence **101**. There exists a role **709** between the type of thing or thing type **920** and REL type **919**. The relationship **206** between "Joe" and "gave" is that of a giver. Therefore, the relationship **206** between the PU **804** "Joe" and the PU **804** "gave" is mapped in the relationship meaning map called the REL MM **926**. The role type **922** connects the relationship **206** to the related concepts **203**. The relationship **206** and role type **922** have been defined for connecting the concepts "Joe" and "ball". "Joe" is assigned the role **709** of a giver to express that the relationship **206** is not a reflexive relationship. Role types **922** are of the following three types: R**1** **923**, R**2** **924** and R**3** **925**. R**1** **923** may be the relation between subject **907** and verb **905**. R**2** **924** may be the relation between verb **905** and direct object **908**. R**3** **925** may be the relation between verb **905** and indirect object **909**. The definition of role type, **922** R**1** **923**, R**2** **924** and R**3** **925** provided above are exemplary, and not used herein in a limiting sense **621**.

The classification function **208** may be computed on basis of the information that the sentence **101** provides about the type of thing **204**.

The meaning map unit **903** map to one of the following types of meaning maps: aggregate meaning map **928**, simple meaning map **927** and relationship meaning map (REL MM) **926**. Simple meaning map **927** contains references of all pattern units **804** that have been decomposed into simple terms and comprise only singular terms. Aggregate meaning map **928** contains pattern units **804** that comprise a plurality of terms.

For example, consider the following two sentences:

Sentence 1. Wake up the person.

Sentence 2. Wake the person up.

In sentence 1, the terms "wake" and "up" occur as consecutive terms. While in sentence 2, the terms "wake" and "up" do not occur as consecutive terms. However the two sentences convey the same meaning. Thus, aggregate meaning map **928** comprises aggregate terms whose combined meaning has a meaning different from a simple combination of the meanings of the individual parts.

Sentential complement (SC) **929** is a type of linguistic role **612** comprising subordinate clause (SUB C) **930** and relative clause (REL C) **931**. For example, consider the two sentences below:

Sentence 1. If Joe goes to California, he will return on Monday.

Sentence 2. Joe wished he went to California.

In sentence 1, "goes to California" and "return on Monday" are two concepts, related to each other forming a relative clause (REL C) **931**. In sentence 2, "went to California" is subordinate to the related "wishing". Hence, "went to California" is of the subordinate clause (SUB C) **930** type.

FIGS. **10**A-**10**D exemplarily illustrate an example of generating a DP **710** from a sentence **101**. The sentence **101** considered in the example is "Company decreases stake in Company." In FIG. **10**A, "stake" is identified as a direct object in the sentence **101**, which is the role **709** the word **607** is playing in the pattern. In FIG. **10**B, "company" (second occurrence) is identified as an indirect object. In FIG. **10**C, "company" is identified as the subject in the sentence **101**. In FIG. **10**D, "decreases" is identified as an intransitive verb (VIT). Thus, the input sentence "Company decreases stake in company" is processed to arrive at the DP **710** as exemplified in the FIGS. **10**A-**10**D.

FIG. **11** illustrates a computer implemented system for automatic DP **710** generation. The parts of speech (POS)

Tagger **1001** accesses the POS tagger database **103** and then sends the POS tagged sentence **104** to the sentence chunker **1002**. The sentence chunker **1002** sends the chunked sentence to a first identification module **1003** that identifies the grammatical roles and senses for each PU **804**. The first identification module **1003** accesses the first dictionary **108**, extended dictionary **120**, and the database **109** of EPS sets to identify the grammatical roles and senses for each PU **804**. The sentences with the rules and senses for each PU **804** identified are then sent to a second identification module **1004** that identifies the ENS **112***a* for each PU **804**. The second identification module **1004** accesses the second dictionary **112**, extended dictionary **120**, and the conceptionary **113** to identify the ENS **112***a* for each PU **804**. The pattern units with each ENS **112***a* identified are then sent to find or create the semantic items for PU module **1005**. The PU Module **1005** then updates the conceptionary **113** with new semantic items. A pattern generator **1006** generates the declared patterns for the sentence using the identified ENS **112***a*.

Examples of industrial applications of the method and system disclosed herein are provided below.

Automatically generated declared patterns may be applied in keyword search engines. Automatic generation of declared patterns provide a method for analyzing the terms composing a sentence **101**, and expressing the meaning of the terms in the context of that sentence **101** thereby enriching the reading experience of the user. Declared patterns have equivalent terms and have a meaning closely associated to the provided search string. Therefore, declared patterns help in providing effective search results while searching information of interest from a document corpus since the results are concentrated around the senses of the word **607** in which it occurs in the search pattern.

In another industrial application, automatically generated declared patterns may be used to enhance the reading style and reading experience of a user. As defined herein, a user's reading style is a formal manifestation of his/her worldview. The worldview of the user comprises the reading style and private ontology of the user. The worldview reflects the logic and structure with which a user comprehends a document. Patent application No. 1819/CHE/2005 filed in the Indian Patent Office on Dec. 13, 2005 illustrates a method of capturing the reading style of a user, wherein the reading style is a set of one or more declared patterns. The method disclosed herein provides a method of applying the reading style of a user for analyzing sentences.

The method and system disclosed herein, employing a reading style can be applied in determining the information of interest from a document corpus in a target language **618**. The method and system of automatic generation of declared patterns and matching declared patterns to the document corpus to determine which document(s) contain sentences that match the original declared patterns helps in providing document(s) as the information of interest to the user.

The method and system disclosed herein hastens up the search results by filtering and concentrating the search results around only those declared patterns that match the sense **621** of the search word **607** in the context in which it occurs in the search pattern.

The method and system disclosed herein generates synonyms of a word **607** and provides the synonyms which are semantically closest and also match the environment in which the word **607** is being put into use.

It will be readily apparent to a person with skill in the art that the various methods and algorithms described herein may be implemented as computer readable medium, e.g., appropriately programmed general purpose computers and computing devices. Typically a processor, for example, one or more microprocessors will receive instructions from a memory or like device, and execute those instructions, thereby performing one or more processes defined by those instructions. Further, programs that implement such methods and algorithms may be stored and transmitted using a variety of media, for e.g., computer readable media in a number of manners. In some embodiments, hard-wired circuitry or custom hardware may be used in place of, or in combination with, software instructions for implementation of the processes of various embodiments. Thus, embodiments are not limited to any specific combination of hardware and software. A "processor" means any one or more microprocessors, Central Processing Unit (CPU) devices, computing devices, microcontrollers, digital signal processors, or like devices. The term "computer-readable medium" refers to any medium that participates in providing data (e.g., instructions) that may be read by a computer, a processor or a like device. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media include, for example, optical or magnetic disks and other persistent memory volatile media include Dynamic Random Access Memory (DRAM), which typically constitutes the main memory. Transmission media include coaxial cables, copper wire and fiber optics, including the wires that comprise a system bus coupled to the processor. Transmission media may include or convey acoustic waves, light waves and electromagnetic emissions, such as those generated during Radio Frequency (RF) and Infrared (IR) data communications. Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, any other magnetic medium, a Compact Disc-Read Only Memory (CD-ROM), Digital Versatile Disc (DVD), any other optical medium, punch cards, paper tape, any other physical medium with patterns of holes, a Random Access Memory (RAM), a Programmable Read Only Memory (PROM), an Erasable Programmable Read Only Memory (EPROM), an Electrically Erasable Programmable Read Only Memory (EEPROM), a flash memory, any other memory chip or cartridge, a carrier wave as described hereinafter, or any other medium from which a computer can read. In general, the computer-readable programs may be implemented in any programming language. Some examples of languages that can be used include C, C++, C#, or JAVA. The software programs may be stored on or in one or more mediums as object code. A computer program product comprising computer executable instructions embodied in a computer-readable medium comprises computer parsable codes for the implementation of the processes of various embodiments.

Where databases are described, such as the POS tagger database **103** and the database **109** of EPS sets, it will be understood by one of ordinary skill in the art that (i) alternative database structures to those described may be readily employed, and (ii) other memory structures besides databases may be readily employed. Any illustrations or descriptions of any sample databases presented herein are illustrative arrangements for stored representations of information. Any number of other arrangements may be employed besides those suggested by, e.g., tables illustrated in drawings or elsewhere. Similarly, any illustrated entries of the databases represent exemplary information only; one of ordinary skill in the art will understand that the number and content of the entries can be different from those described herein. Further, despite any depiction of the databases as tables, other formats (including relational databases, object-based models and/or distributed databases) could be used to store and manipulate the data types described herein. Likewise, object methods or

behaviors of a database can be used to implement various processes, such as described herein. In addition, the databases may, in a known manner, be stored locally or remotely from a device that accesses data in such a database.

The present invention can be configured to work in a network environment including a computer that is in communication, via a communications network, with one or more devices. The computer may communicate with the devices directly or indirectly, via a wired or wireless medium such as the Internet, Local Area Network (LAN), Wide Area Network (WAN) or Ethernet, Token Ring, or via any appropriate communications means or combination of communications means. Each of the devices may comprise computers, such as those based on the Intel® processors, AMD® processors, Sun® processors, IBM® processors etc., that are adapted to communicate with the computer. Any number and type of machines may be in communication with the computer.

The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present method and system disclosed herein. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitations. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspect.

I claim:

1. A computer implemented method of generating declared patterns from components of a sentence, wherein each of said declared patterns is a sequence of pattern units, wherein each of said pattern units corresponds to a portion of text in said sentence, comprising:

providing a computer-readable memory tangibly embodying said method as a computer program, wherein execution of the computer program in a computer comprising one or more processors is configured to:

providing a conceptionary, wherein said conceptionary is a knowledge representation of items, wherein said items represent concepts, instances, relationships, characteristics, values, units of measure, and sets and aggregations of the items; providing a parts of speech tagger database;

providing a first dictionary comprising dictionary entries of words and phrases, wherein said first dictionary further comprises declared categories and emergent categories, further wherein each of said dictionary entries is a term composed of single words and phrases and specifies individual senses of said term;

providing a database of equivalent pattern specification sets for a given language, wherein said equivalent pattern specification sets represent different ways of saying the same thing in said given language;

providing a second dictionary in a target language comprising an equivalent name set for each sense of a word, wherein said equivalent name set is a set of terms that are semantically close in meaning;

for each sentence in a document corpus;

tagging parts of speech in the sentence for identifying parts of speech of each word and phrase in the sentence;

chunking the sentence using said identified parts of speech of each word and phrase to generate pattern units;

identifying grammatical roles and senses of said generated pattern units by applying said first dictionary and said database of equivalent pattern specification sets;

identifying an equivalent name set for each of the generated pattern units by applying said second dictionary and the conceptionary; and

generating the declared patterns for the sentence using said identified equivalent name set for each of the generated pattern units.

2. The computer implemented method of claim **1**, further comprising the steps of:

obtaining an equivalent name set for each of the generated pattern units and determining whether or not a matching semantic item with said equivalent name set exists for the given language in the conceptionary;

creating a new semantic item representing each of the generated pattern units if said matching semantic item does not exist for a pattern unit; and adding said new semantic item to the conceptionary;

relating the new semantic item to other semantic items in the conceptionary via relationships indicated between the generated pattern units in the declared patterns; and adding a semantic item to the conceptionary referencing the identified equivalent name set for each said pattern unit, if the identified equivalent name set is not already referenced in the conceptionary.

3. The computer implemented method of claim **1**, wherein said step of identifying said grammatical roles and said senses of the generated pattern units, comprises the steps of:

finding an equivalent pattern specification set that maps to said chunked sentence; generating pattern units with valid grammatical roles from said equivalent pattern specification set;

determining valid senses for each of said generated pattern units; obtaining pattern units with said valid senses; and converting said obtained pattern units with the valid senses to the declared patterns.

4. The computer implemented method of claim **3**, wherein said step of determining the valid senses for each of the generated pattern units, comprises the steps of:

providing an extended dictionary with a parts of speech for each of the senses; looking up the valid senses for each of the generated pattern units based on terms and parts of speech using said extended dictionary;

obtaining senses for said terms; determining valid pair wise sense mapping for the generated pattern units using the first dictionary; and obtaining pattern units with valid senses and eliminating pattern units where no said valid pair wise sense mapping exists.

5. The computer implemented method of claim **4**, wherein said step of determining the valid pair wise sense mapping for the generated pattern units, comprises the steps of:

determining a correspondence function representing a pair of grammatical roles, for each sense of each entry in the extended dictionary;

obtaining pattern unit pairs with said correspondence function which are pairings for a possible valid sense;

identifying an emergent category for said possible valid sense of each of said pattern unit pairs;

obtaining pattern unit pairs with said emergent category based on the correspondence function; and

eliminating one or more of said obtained pattern unit pairs whose emergent category does not have the correspondence function, to finally obtain valid pattern unit pairs.

6. The computer implemented method of claim **1**, further comprising a step of constructing an equivalent name set for a term in absence of said equivalent name set for said term in said second dictionary, wherein said construction of the equivalent name set of the term comprises the steps of:

providing an extended dictionary with senses, wherein each of said senses has synonyms;

looking up dictionary entry for the term in said extended dictionary with the senses and identifying dictionary entries corresponding to said synonyms of said senses of the term;

identifying senses of each of the synonyms from the extended dictionary with the senses; and

adding said identified senses to the equivalent name set of the senses of the term whose equivalent name set is being constructed, if identified senses are equal to the term.

7. The computer implemented method of claim **1**, wherein each of said individual senses identifies membership in said declared categories.

8. The computer implemented method of claim **1**, wherein said each sense of said word is an entry in the equivalent name set.

9. A computer implemented system for generating declared patterns from components of a sentence in a document corpus, wherein each of said declared patterns is a sequence of pattern units, wherein each of said pattern units corresponds to a portion of text in said sentence, comprising:

a computer comprising one or more processors; and

a storage device comprising a computer-readable medium in communication with said processors, said computer-readable medium storing instructions adapted to be executed by the processors, causing said computer to implement:

a parts of speech tagger for tagging parts of speech in the sentence to identify parts of speech of each word and phrase in the sentence iteratively;

a sentence chunker for chunking said parts of speech tagged sentence, wherein said chunked sentence is called a pattern unit;

a first identification module for identifying grammatical roles and senses for each said pattern unit using a first dictionary with declared categories and emergent categories and a database of equivalent pattern specification sets, wherein each dictionary entry in said first dictionary specifies senses of the words and phrases, wherein each of said equivalent pattern specification sets is a set of equivalent pattern specifications, that for a given language, represent different ways of saying the same thing;

a second identification module for identifying an equivalent name set for each said pattern unit using a conceptionary and a second dictionary comprising an equivalent name set for each sense of a word; and

a pattern generator for generating the declared patterns for the sentence using said identified equivalent name set.

10. The computer implemented system of claim **9**, wherein said conceptionary is updated by adding a semantic item to the conceptionary referencing the identified equivalent name set for each pattern unit, if the identified equivalent name set is not previously referenced in the conceptionary.

11. The computer implemented system of claim **9**, wherein automatically generated declared patterns are used for matching declared patterns to said document corpus to determine which documents contain sentences that match the declared patterns and providing said documents as information of interest to a user.

12. A computer program product comprising computer executable instructions embodied in a non-transitory computer-readable medium, wherein said computer program product comprises:

a first computer parsable program code for tagging parts of speech in a sentence to identify said parts of speech of each word and phrase in said sentence;

a second computer parsable program code for chunking the sentence using said identified parts of speech of each word and phrase to generate pattern units;

a third computer parsable program code for identifying grammatical roles and senses of said generated pattern units by applying a first dictionary and a database of equivalent pattern specification sets;

a fourth computer parsable program code for identifying an equivalent name set for each of the generated pattern units by applying a second dictionary and a conceptionary; and

a fifth computer parsable program code for generating declared patterns for the sentence using said identified equivalent name set for each of the generated pattern units.

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