(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 April 2015 (16.04.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/053607 A1

(51) International Patent Classification:
*G06F 17/27* (2006.01)

(21) International Application Number:
PCT/MY2014/000182

(22) International Filing Date:
12 June 2014 (12.06.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI 2013701910 10 October 2013 (10.10.2013) MY

(71) Applicant: **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(72) Inventors: **ARUN, Anand Sadanandan**; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **KOW, Weng Onn**; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **CHU MIN XIAN, Benjamin**; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **DICKSON, Lukose**; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **BAHLS, Daniel**; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(74) Agent: **H. A. RASHID, Ahmad Fadzlee**; Ipvolusi Sdn Bhd, A-3-3A, Centrio Pantai Hillpark, No.1, Jalan Pantai Murni, 59200 Kuala Lumpur (MY).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

*[Continued on next page]*

(54) Title: SYSTEM AND METHOD FOR SEMANTIC-LEVEL SENTIMENT ANALYSIS OF TEXT

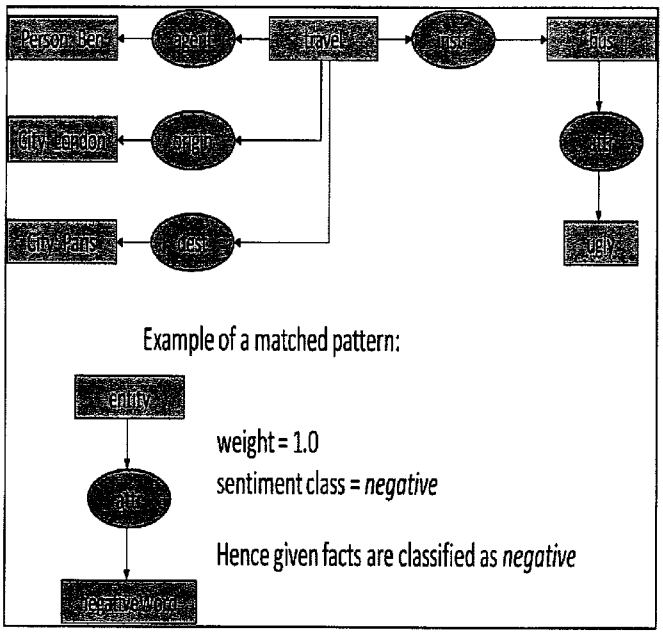


FIG. 4 (b)

(57) Abstract: The present invention relates to a system and method for semantic level sentiment analysis. The system (100) comprises of a graph generator component (10), a semantic sentiment analyser component (20), a sentiment processor component (30), a sentiment dictionary (40), a sentiment taxonomy (50), a semantic sentiment patterns repository (60) and a propagation rules repository (70). The system (100) accepts text data as input and analyses sentiment in the text. The method enables semantically valid sentiment in terms of the entire text as well as the individual entities in the text.

WO 2015/053607 A1

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17**:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

**Published**:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

# SYSTEM AND METHOD FOR SEMANTIC LEVEL SENTIMENT ANALYSIS

## FIELD OF INVENTION

The present invention relates to a system and method for semantic level sentiment analysis.

## BACKGROUND OF THE INVENTION

Sentiment analysis uses natural language processing which aims to determine the attitude of a speaker or writer about some topic or the overall contextual polarity of a document. Natural language processing deals with the actual text element and transforms it into a machine usable format. By using sentiment analysis, it allows a system to track products, brands and also people to determine whether they are viewed positively or negatively.

Sentiment analysis is important as it allows a system to track any new product or brand perception besides tracking business reputations. It also allows individuals to get an opinion or review on something on a global scale. Recently, a lot of researches have been carried out to improve the sentiment analysis of text.

An example of a system and method for sentiment analysis is disclosed in United States Patent No. 2011/0137906. It involves the steps of extracting a snippet related to a subject from a content database; calculating a sentiment score for the snippet; classifying the snippet into sentiment category and classifying the snippets as positive, negative or neutral.

The common existing sentiment analysis techniques only classify whole chunks of text with respect to certain sentiment classes. There is no disclosure of finding out the sentiment towards the entities contained in the text. Therefore, there is a need to provide a system and method that addresses the above mentioned drawbacks of the existing sentiment analysis techniques.

## SUMMARY OF INVENTION

The present invention relates to a system (**100**) and method for semantic level sentiment analysis. The system (**100**) comprises of a graph generator component (**10**) for constructing conceptual representation of a text; a sentiment

dictionary (**40**); a sentiment taxonomy (**50**); and a propagation rules repository (**70**), wherein the system (**100**) is further characterised in that a semantic sentiment analyser component (**20**) for semantically analysing the conceptual structures and generates sentiments; a sentiment processor component (**30**) for receiving results from the semantic sentiment analyser component (**20**) and processing the received results; and a semantic sentiment patterns repository (**60**) which is a library of sentiment patterns stored as graph.

The method for semantic sentiment analysis is characterised by the steps of constructing conceptual representation of a text by a graph generator component (**10**); loading a terminology-box which consists of concepts and relations, concept-hierarchy and relation-hierarchy by a semantic sentiment analyser component (**20**); performing classification of the entire fact graph by the semantic sentiment analyser component (**20**); performing classification of objects involved in the fact graph by the semantic sentiment analyser component (**20**); performing in-graph attribute propagation graph by the semantic sentiment analyser component (**20**); processing the classification results graph by the semantic sentiment analyser component (**20**); and performing sentiment processing by a sentiment processor component (**30**).

Preferably, performing classification of the entire fact graph by the semantic sentiment analyser (**20**) includes the steps of selecting pattern from the sentiment patterns repository (**60**); projecting the fact graph onto a pattern graph; extracting sentiment weight of the pattern graph; identifying the number of pattern graphs projected that the project graph can project to if no more patterns are found; and determining the classification of the entire fact graph by calculating the weighted majority vote.

Preferably, performing classification of objects involved in the fact graph by the semantic sentiment analyser (**20**) includes the steps of selecting all predefined classification targets; selecting sub-graphs involving the classification targets; determining sentiment classification of the sub-graphs by calculating the weighted majority vote; repeating the step of performing classification of the entire fact graph by the semantic sentiment analyser (**20**); and using the results of the sentiment classification to annotate the fact graph in creating a modified fact graph.

Preferably, performing in-graph attribute propagation graph by the semantic sentiment analyser (**20**) includes the steps of selecting propagation rules from a propagation rules repository (**70**); selecting the matching rules based on the concepts in the modified fact graph; and applying rule to assign sentiment classification to the corresponding concepts.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

**FIG. 1** illustrates a system (**100**) for semantic level sentiment analysis according to an embodiment of the present invention.

**FIG. 2 (a)** illustrates a flow chart of a conceptual structure generation from text according to an embodiment of the present invention.

**FIG. 2 (b)** illustrates an example of a conceptual structure generation from text.

**FIG. 3** illustrates a flow chart of a semantic sentiment analysis process according to an embodiment of the present invention.

**FIG. 4 (a)** illustrates a flow chart of the sentiment classification of the entire fact graph according to an embodiment of the present invention.

**FIG. 4 (b)** illustrates an example of the sentiment classification of the entire fact graph.

**FIG. 5 (a)** illustrates a flow chart of the sentiment classification of objects involved in the fact graph according to an embodiment of the present invention.

**FIG. 5 (b)** illustrates an example of the sentiment classification of objects involved in the fact graph.

**FIG. 5 (c)** illustrates the result of the example from **FIG. 5 (b)**.

**FIG. 6 (a)** illustrates a flow chart of the in-graph attribute propagation according to an embodiment of the present invention.

**FIG. 6 (b)** illustrates an example of the in-graph attribute propagation.

**FIG. 6 (c)** illustrates the result of the example from **FIG. 6 (b)**.

**FIG. 7** illustrates a flow chart of the sentiment processing according to an embodiment of the present invention.

**DESCRIPTION OF THE PREFFERED EMBODIMENT**

A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well known functions or constructions are not described in detail since they would obscure the description with unnecessary detail.

Reference is made initially to **FIG. 1** which illustrates a system (**100**) for semantic level sentiment analysis according to an embodiment of the present invention. The system (**100**) accepts text data as input and analyses sentiment in the text. It generates semantically valid sentiment in terms of the entire text as well as the individual entities in the text. The system (**100**) comprises of a graph generator component (**10**), a semantic sentiment analyser component (**20**), a sentiment processor component (**30**), a sentiment dictionary (**40**), a sentiment taxonomy (**50**), a semantic sentiment patterns repository (**60**) and a propagation rules repository (**70**).

The graph generator component (**10**) is used to construct conceptual representation of the text. The semantic sentiment analyser component (**20**) semantically analyses the conceptual structures and generates sentiments. The sentiment processor component (**30**) receives the results from the semantic sentiment analyser component (**20**) and processes the received results.

The sentiment dictionary (**40**) comprises of an enriched list if keywords that are associated to polarity values. Each keyword is mapped to one or more sentiment categories such as positive, negative, sad, angry, happy, confident, etc. The list may

be enhances with synonyms which are extracted from a lexical database. The sentiment taxonomy (**50**) comprises of taxonomical representation of common terms to describe sentiments.

The semantic sentiment pattern repository (**60**) is a library of sentiment patterns stored as graphs. These sentiment patterns tell how sentiment terms are related to a particular noun. A generated annotated semantic sentiment graph is composed of a conceptual graph query, g; a sentiment class, $c \in C$; and a weight, $w \in \mathbb{R}+$. A collection of these graphs are stored in the semantic sentiment patterns repository (**60**). Finally, the propagation rules repository (**70**) comprises of a set of propagation rules representing how the sentiment classes may be assigned to related concepts.

Referring now to **FIG. 2 (a)**, it illustrates a flow chart of the conceptual structure generation from text according to an embodiment of the present invention. Initially the graph generator component (**10**) accepts text as input as in step **101** before it generates conceptual representation of the text as in step **102**. An example of a text and its corresponding conceptual representation is shown in **FIG. 2 (b)**. Since the text "Mary gave John a boring book" contains a set of facts, a fact graph is generated to represent the conceptual structure.

Moving on to **FIG. 3**, it illustrates a flow chart of a sentiment analysis process according to an embodiment of the present invention. After the conceptual structure is constructed in step **102**, the system (**100**) loads a terminology-box from the semantic sentiment analyser component (**20**) which comprises of concepts and relations, concept-hierarchy and relation-hierarchy as in step **210**. It then selects the conceptual representation i.e. the fact graph generated in step **102** to be analysed from multiple dimensions as in step **220**. The semantic sentiment analyser component (**20**) initially performs classification of the entire fact graphs as in step **230**, wherein the entire fact graph is analysed to determine the sentiment classification before it performs classification of objects involved in the fact graph as in step **240**. Next, the semantic sentiment analyser component (**20**) performs in-graph attribute propagation as in step **250** by propagating sentiments which are associated with a particular concept to other concept that are related. Lastly, the semantic sentiment analyser component (**20**) sends the three classification results

i.e. the sentiment classification of the entire fact graph, the sentiment classification objects involved in the fact graph and the sentiment classification by the in-graph attribute propagation to the sentiment processor component (**30**) for further processing as in step **260**.

**FIG. 4 (a)** illustrates a flow chart of the sentiment classification of the entire fact graph according to an embodiment of the present invention which further explains step **230** of **FIG. 3**. In analysing the entire fact graph to determine the sentiment classification, the fact graph is projected on to the sets of graphs in the semantic sentiment pattern repository (**60**) as in step **231**, wherein the sets of graphs are the sentiment patterns which are stored as graphs. This is achieved through graph projection technique which results in one or more pattern graphs, p that match the fact graph as in step **232**. The graph projection technique measures the similarity between two graphs, wherein if a graph can be projected fully on to another graph or vice versa, it is defined as very similar. When a graph can be partially projected, it is defined as a partial match.

The weight of the pattern graph, w is retrieved from each of the matched pattern graph as in step **233**, wherein the matched pattern graphs are the results of the graph projection technique which can either be fully projected or partially projected. If more patterns are found as in step **234**, the steps are repeated from step **231** until no more patterns are found. The numbers of projections, f found are then identified for each pattern graph as in step **235**. Finally, the sentiment classification of the input graph is determined using the equation below,

$$c_{facts} = \arg\max_{j \in C} \left\{ \sum_{i=1}^{n} w_i f_i \right\}$$

where c represents the classification of the fact graph, w represents the weight of the pattern graph and f represents the number of projections or matches found as in step **236**.

An example of this process is shown in **FIG. 4 (b)** wherein the example graph represents the sentence "Ben travelled from London to Paris in an ugly bus." Upon projecting this graph on to the semantic sentiment pattern repository, a matching pattern i.e. entity->attr->ugly is found. In other words, the attribute of the concept "entity" is ugly. By using the sentiment class and weight, the entire graph can be

classified as negative. Entities are the objects of interest and each entity instance is described by a set of attributes that define its qualities, characteristics or properties.

The step **240** of **FIG. 3** is further described in **FIG. 5 (a)**, which illustrates a flow chart of the sentiment classification of objects involved in the fact graph according to an embodiment of the present invention. In this step, the sentiment classification is performed on the sub-graphs in the fact graph where a sub-graph is composed of at least one concept. Initially, a set of predefined classification target is selected as in step **241**. For instance, in the case of *entity* being a classification target, the process is conducted to determine the sentiment classification of all the entities found in the fact graph, by determining the sub-graphs that represent the classification targets as in step **243**. Sub-graphs are smaller graphs which are derived from the fact graph. These sub-graphs are extracted by selecting the classification target and the concepts that are directly linked to it. Next, the sentiment classification process is repeated from step **231** to step **236** until all the pattern graphs in the semantic sentiment patterns repository (**60**) are processed to identify the classification of that particular sub-graph. Finally, the results of the sentiment classification are used to annotate the fact graph in creating a modified fact graph as in step **244**, wherein a modified fact graph is a fact graph that is associated with a sentiment classification.

An example of this process is shown in **FIG. 5 (b)**. The conceptual graph for the sentence "The beautiful Anna travelled in an uncomfortable and ugly bus" is used as projection. Assuming that *entity* is a classification target, multiple pattern graphs can be identified and used for determining the sentiment classification. The results of the classification are shown in **FIG. 5 (c)** where it can be seen that the sentiments related to the entity *Bus* are negative i.e. ugly and uncomfortable whereas the one related to the entity *Anna* is positive i.e. beautiful.

Referring now to **FIG. 6 (a)** which illustrates a flow chart of the in-graph attribute propagation according to an embodiment of the present invention, it further describes step **250** of **FIG. 3**. For this step, sentiment classifications are applied automatically by propagation based on propagation rules which are used to perform the in-graph attribute propagation as in step **251**. There are no restrictions as to what properties are to be used in the propagation rule. It can use any of the properties in

the relation hierarchy. For example in **FIG. 6 (b)**, if concepts A and B are linked together with a "hasPart" relation, then the sentiment for B is assigned to A as well.

The modified fact graph generated from step **244** is analysed further by applying matching rules from the propagation rules repository (**70**) as in step **252**. The rules are matched based on the concepts present in the fact graph. Upon applying the rules, further concepts other than the previously tagged ones can be classified as in step **253**. Special markers, which are labels to indicate whether a particular concept is a target concept, are used to determine "Target" placeholders, wherein a target concept is a concept to which propagation rules are to be applied. The system uses these special markers to decide what should be carried forward or where to find the sentiment in the match i.e. the "Sentiment Class" and to which object it should be propagated to i.e. the "target."

An example of the attribute propagation is shown in **FIG. 6 (b)** while the results of applying the above mentioned propagation rule on an annotated facts are shown in **FIG. 6 (c)**. The concept storyline is annotated as positive according to step **240**. Referring now to **FIG. 6 (c)**, it can be deducted that "Movie A" can also be classified as positive by using the propagation rule due to the "hasPart" property.

Finally, **FIG. 7** illustrates a flow chart of the sentiment processing according to an embodiment of the present invention. Initially, the sentiment processor component (**30**) receives the results from the semantic sentiment analyser as in step **301**. It then consolidates the results to show the sentiment classification in terms of the whole sentence as well as for objects of interest in the sentence to produce the multidimensional sentiment analysis results as in step **302**.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specifications are words of description rather than limitation and various changes may be made without departing from the scope of the invention.

**CLAIMS**

1. A system (**100**) for semantic level sentiment analysis comprises of:
   a) a graph generator component (**10**) for constructing conceptual representation of a text;
   b) a sentiment dictionary (**40**);
   c) a sentiment taxonomy (**50**); and
   d) a propagation rules repository (**70**),

   wherein the system (**100**) is further characterised in that:
   i. a semantic sentiment analyser component (**20**) for semantically analysing the conceptual structures and generates sentiments;
   ii. a sentiment processor component (**30**) for receiving results from the semantic sentiment analyser component (**20**) and processing the received results; and
   iii. a semantic sentiment patterns repository (**60**) which is a library of sentiment patterns stored as graph.

2. A method for semantic sentiment analysis is characterised by the steps of:
   a) constructing conceptual representation of a text by a graph generator component (**10**);
   b) loading a terminology-box which consists of concepts and relations, concept-hierarchy and relation-hierarchy by a semantic sentiment analyser component (**20**);
   c) performing classification of the entire fact graph by the semantic sentiment analyser component (**20**);
   d) performing classification of objects involved in the fact graph by the semantic sentiment analyser component (**20**);
   e) performing in-graph attribute propagation graph by the semantic sentiment analyser component (**20**);
   f) processing the classification results graph by the semantic sentiment analyser component (**20**); and
   g) performing sentiment processing by a sentiment processor component (**30**).

3. The method as claimed as claim **2**, wherein performing classification of the entire fact graph by the semantic sentiment analyser (**20**) includes the steps of:
    a) selecting pattern from the sentiment patterns repository (**60**);
    b) projecting the fact graph onto a pattern graph;
    c) extracting sentiment weight of the pattern graph;
    d) identifying the number of pattern graphs projected that the project graph can project to if no more patterns are found; and
    e) determining the classification of the entire fact graph by calculating the weighted majority vote.

4. The method as claimed as claim **2**, wherein performing classification of objects involved in the fact graph by the semantic sentiment analyser (**20**) includes the steps of:
    a) selecting all predefined classification targets;
    b) selecting sub-graphs involving the classification targets;
    c) determining sentiment classification of the sub-graphs by calculating the weighted majority vote;
    d) repeating the step of performing classification of the entire fact graph by the semantic sentiment analyser (**20**); and
    e) using the results of the sentiment classification to annotate the fact graph in creating a modified fact graph.

5. The method as claimed as claim **2**, wherein performing in-graph attribute propagation graph by the semantic sentiment analyser (**20**) includes the steps of:
    a) selecting propagation rules from a propagation rules repository (**70**);
    b) selecting the matching rules based on the concepts in the modified fact graph; and
    c) applying rule to assign sentiment classification to the corresponding concepts.

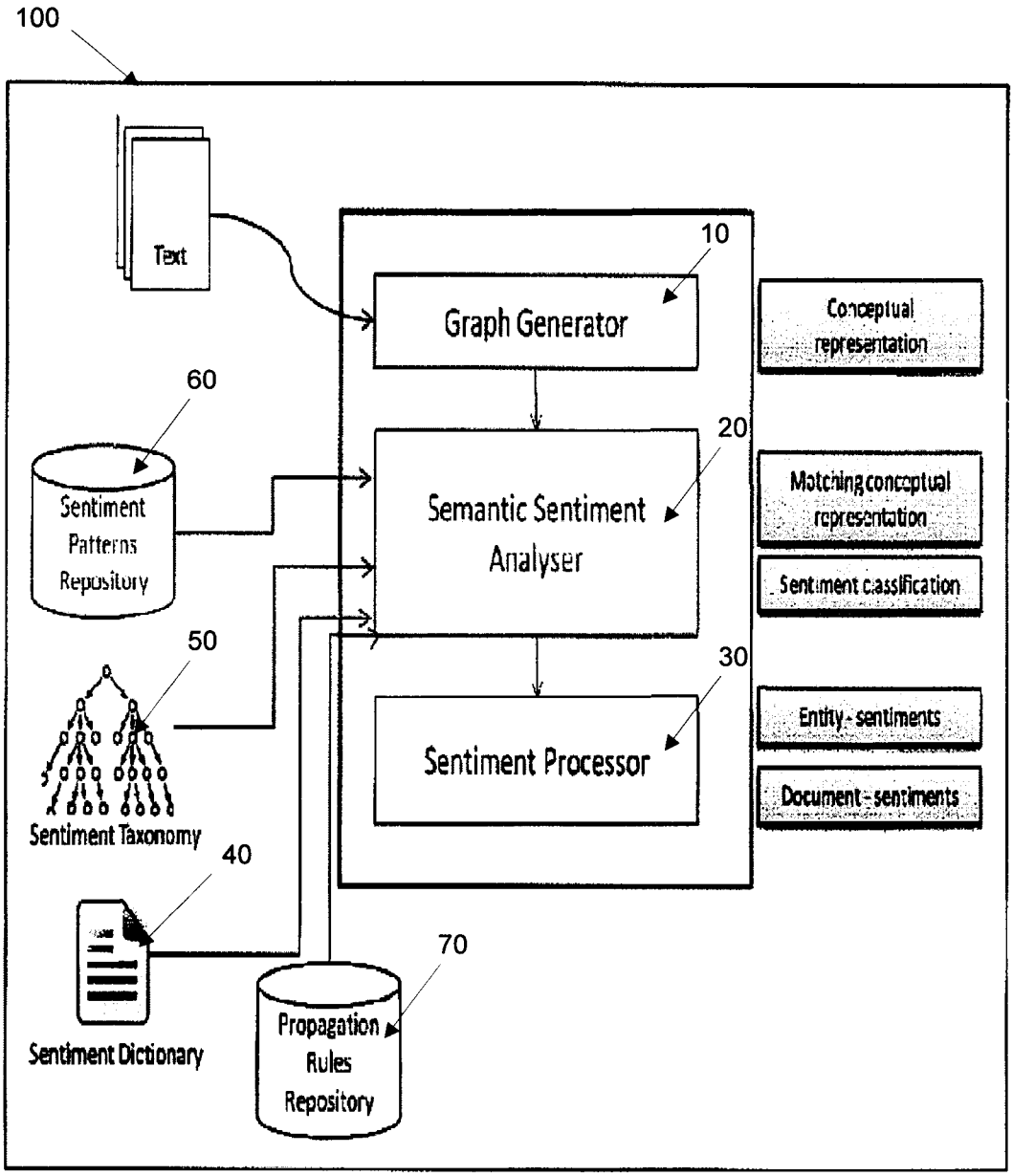
100
Text
10
Graph Generator
Conceptual representation
60
Sentiment Patterns Repository
20
Semantic Sentiment Analyser
Matching conceptual representation
Sentiment classification
50
30
Sentiment Taxonomy
Sentiment Processor
Entity - sentiments
Document - sentiments
40
70
Sentiment Dictionary
Propagation Rules Repository

FIG. 1

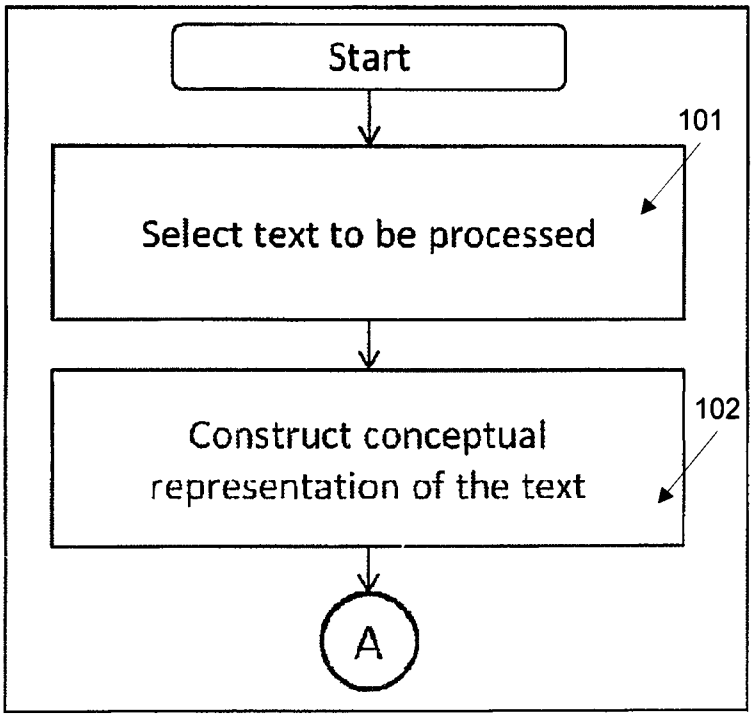
Start
101
Select text to be processed
Construct conceptual representation of the text
102
A

FIG. 2 (a)

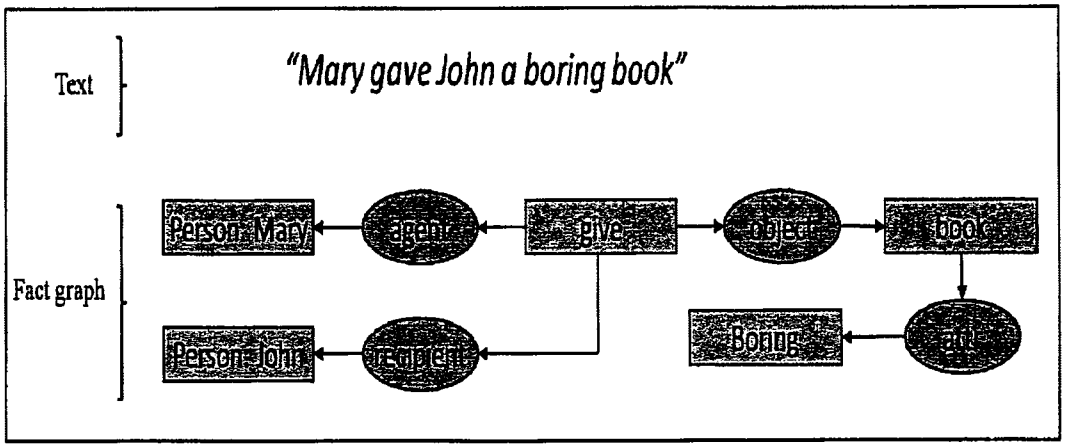
Text
"Mary gave John a boring book"
Fact graph
Person-Mary
agent
give
object
book
Person-John
recipient
Boring
adj

FIG. 2 (b)

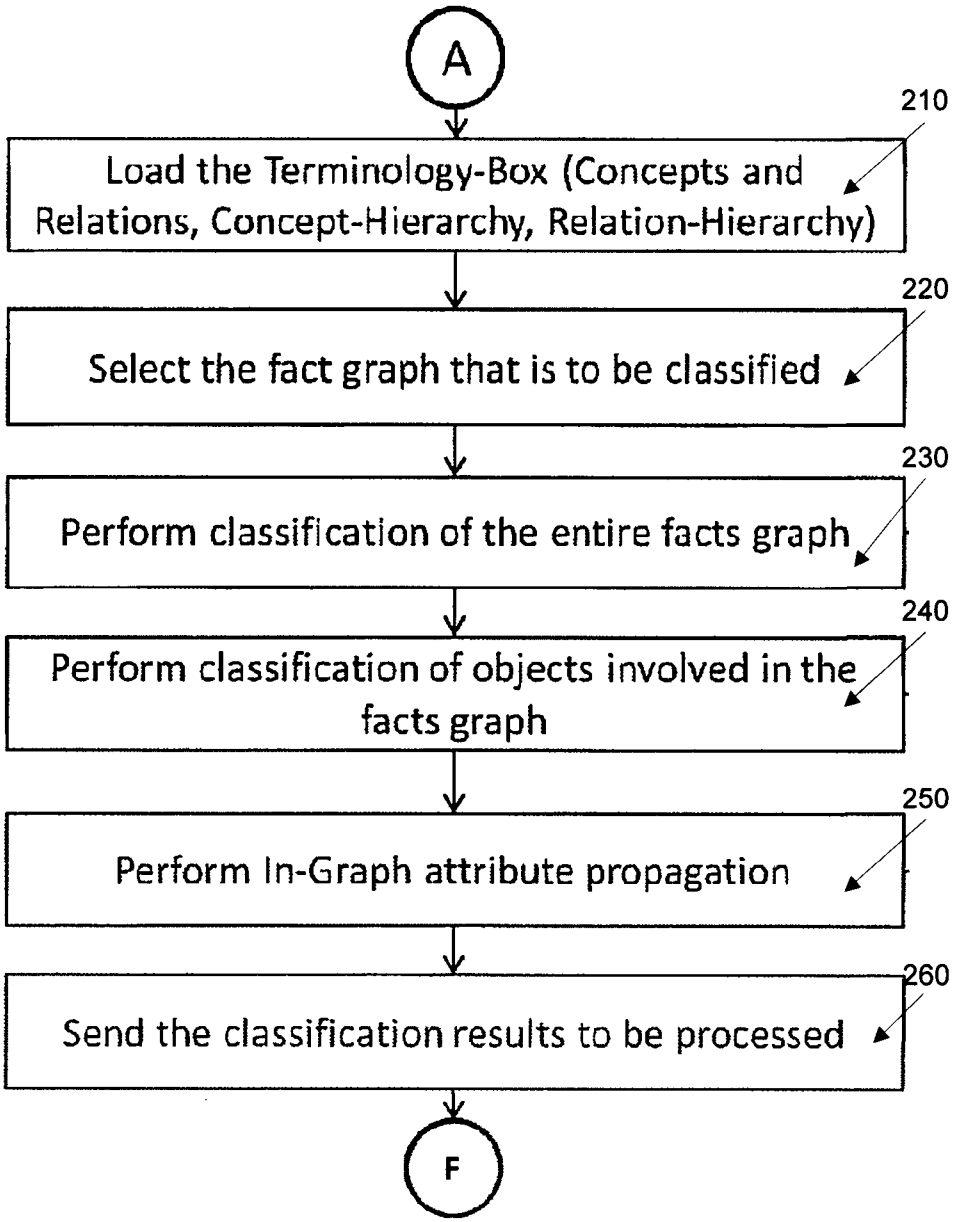
A
210
Load the Terminology-Box (Concepts and Relations, Concept-Hierarchy, Relation-Hierarchy)
220
Select the fact graph that is to be classified
230
Perform classification of the entire facts graph
240
Perform classification of objects involved in the facts graph
250
Perform In-Graph attribute propagation
260
Send the classification results to be processed
F

FIG. 3

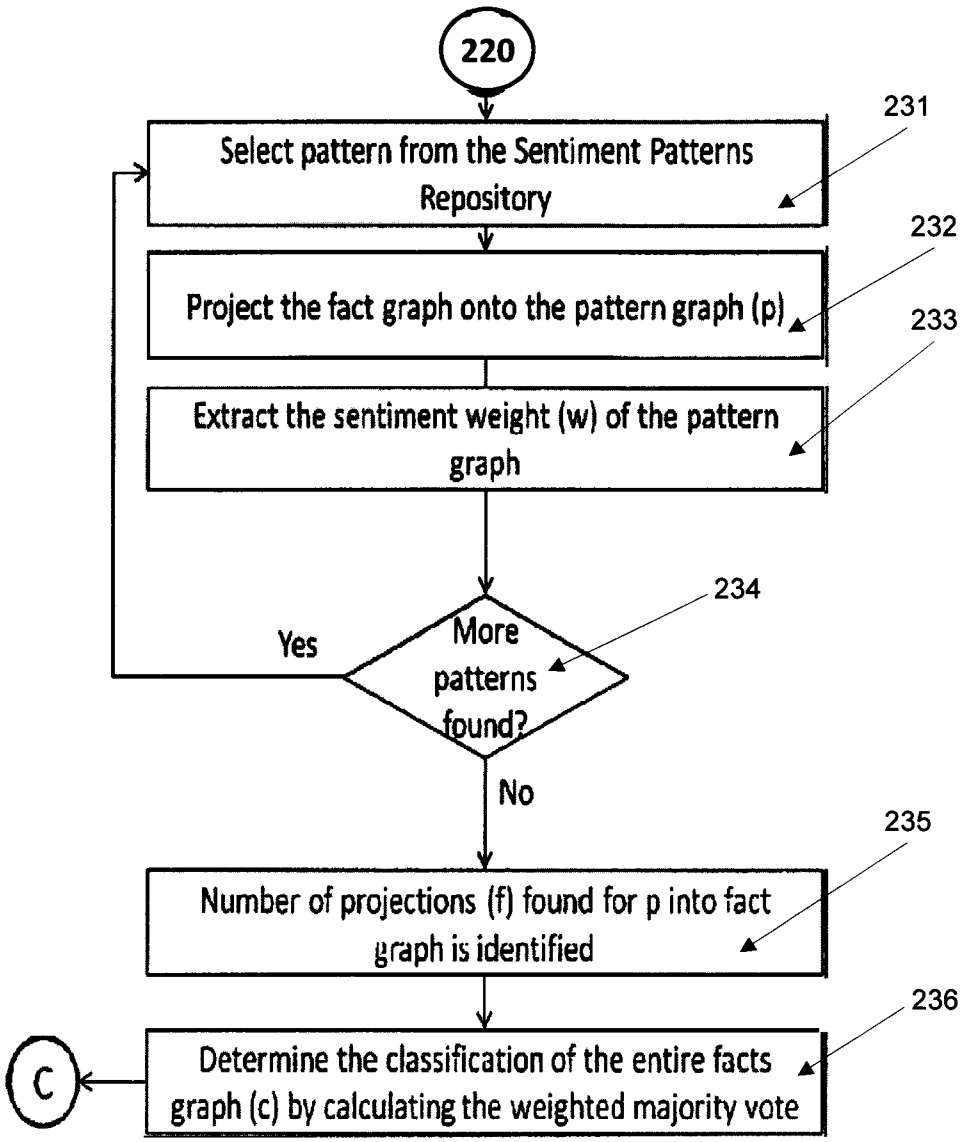
220
231
Select pattern from the Sentiment Patterns Repository
232
Project the fact graph onto the pattern graph (p)
233
Extract the sentiment weight (w) of the pattern graph
234
More patterns found?
Yes
No
235
Number of projections (f) found for p into fact graph is identified
236
Determine the classification of the entire facts graph (c) by calculating the weighted majority vote
C

FIG. 4 (a)

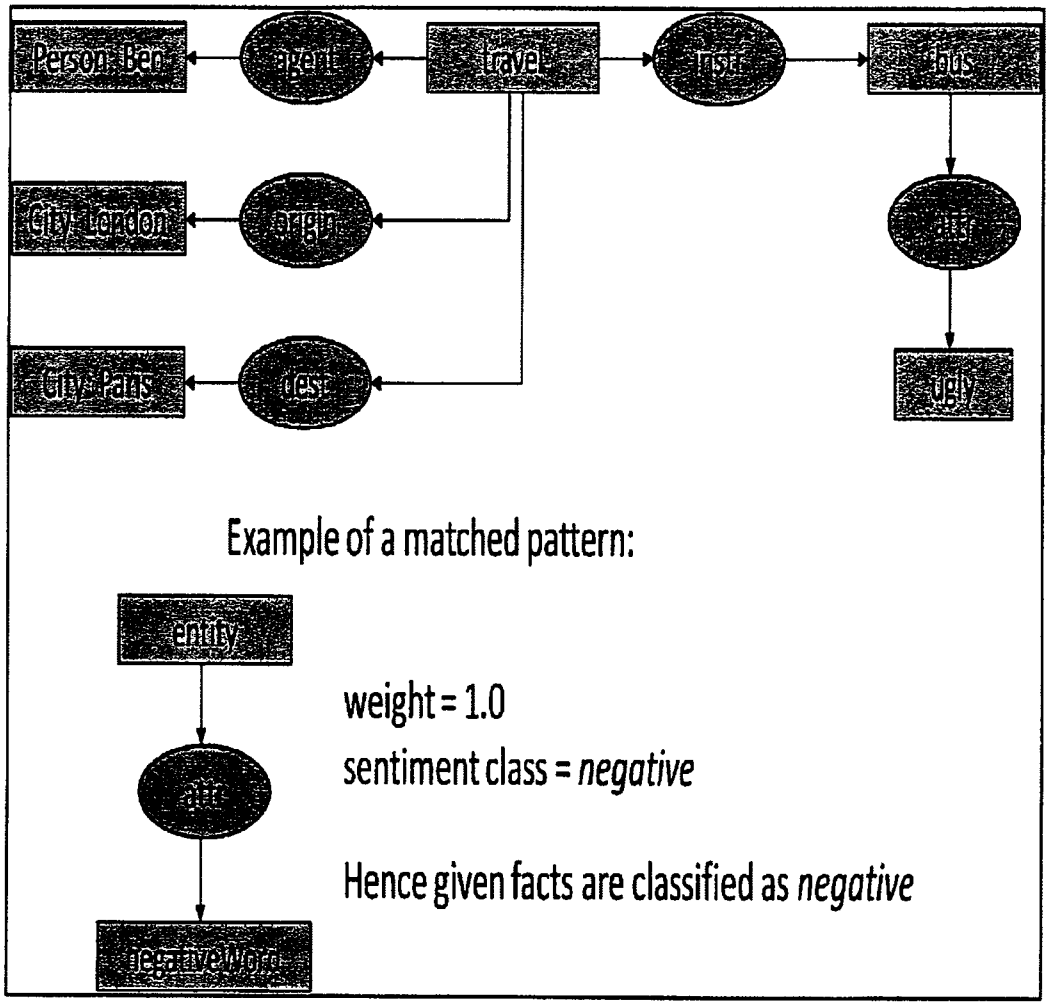
Person_Ben
agent
travel
first
bus
City_London
origin
att
City_Paris
dest
ugly
Example of a matched pattern:
entity
att
negativeWord
weight = 1.0
sentiment class = negative
Hence given facts are classified as negative

FIG. 4 (b)

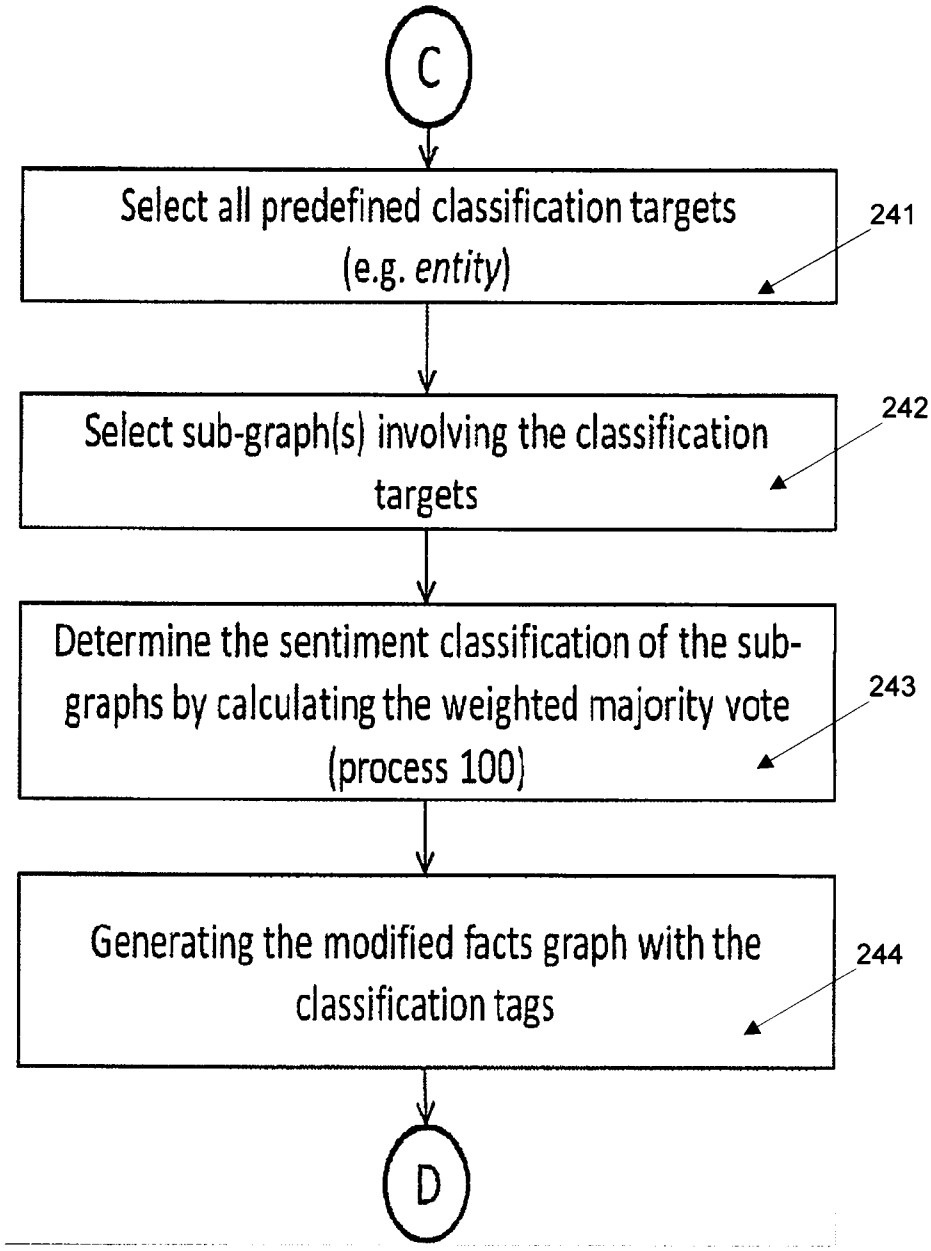
C
Select all predefined classification targets (e.g. *entity*)
241
Select sub-graph(s) involving the classification targets
242
Determine the sentiment classification of the sub-graphs by calculating the weighted majority vote (process 100)
243
Generating the modified facts graph with the classification tags
244
D

FIG. 5 (a)

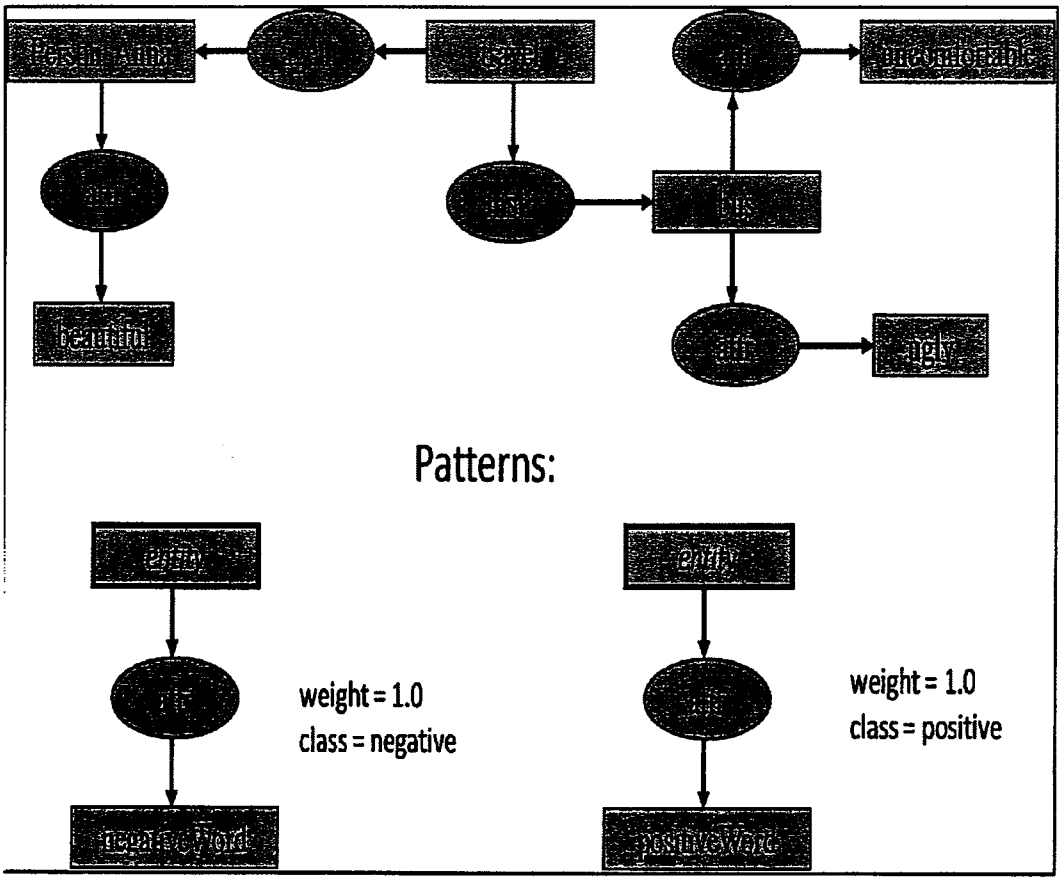
Patterns:
weight = 1.0
class = negative
weight = 1.0
class = positive

FIG. 5 (b)

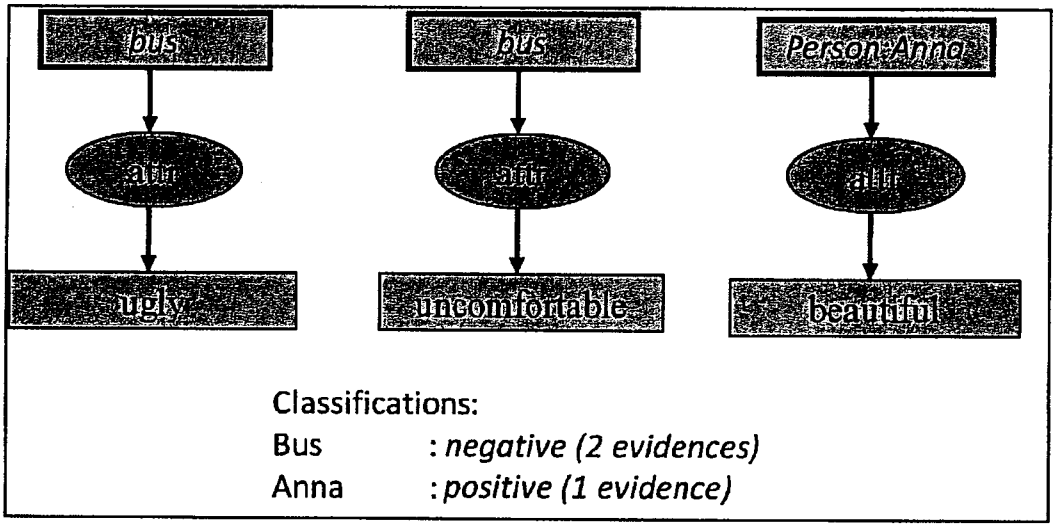
bus
bus
Person:Anna
ugly
uncomfortable
beautiful
Classifications:
Bus : negative (2 evidences)
Anna : positive (1 evidence)

FIG. 5 (c)

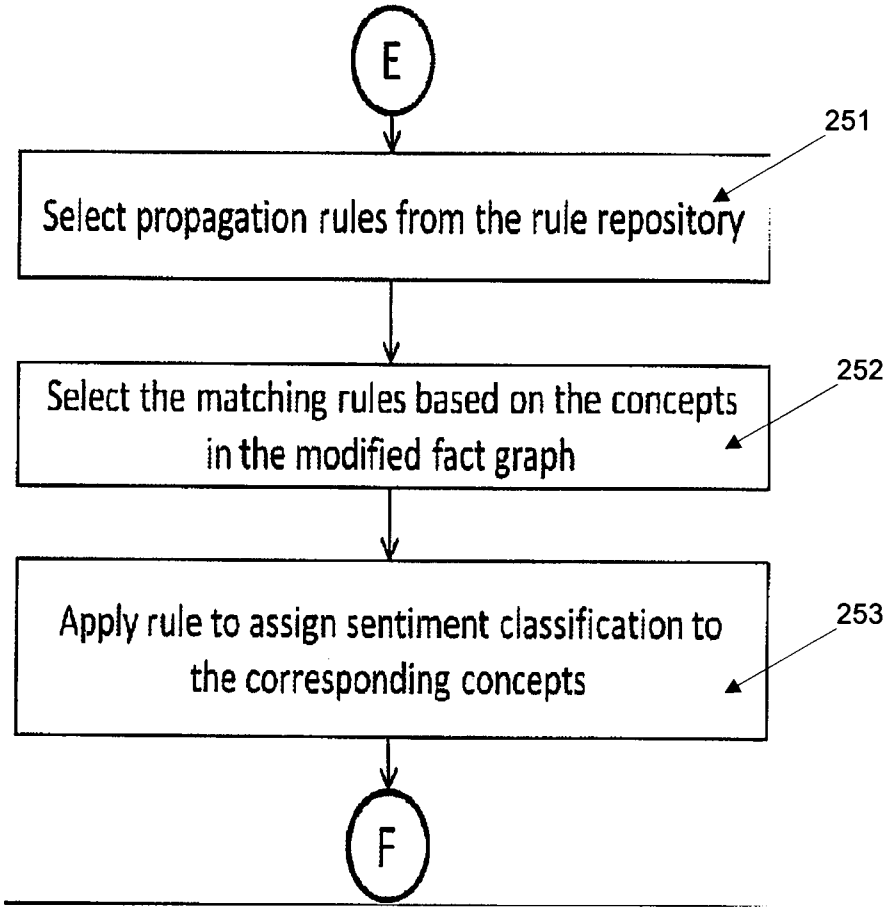
E
251
Select propagation rules from the rule repository
252
Select the matching rules based on the concepts in the modified fact graph
253
Apply rule to assign sentiment classification to the corresponding concepts
F

FIG. 6 (a)

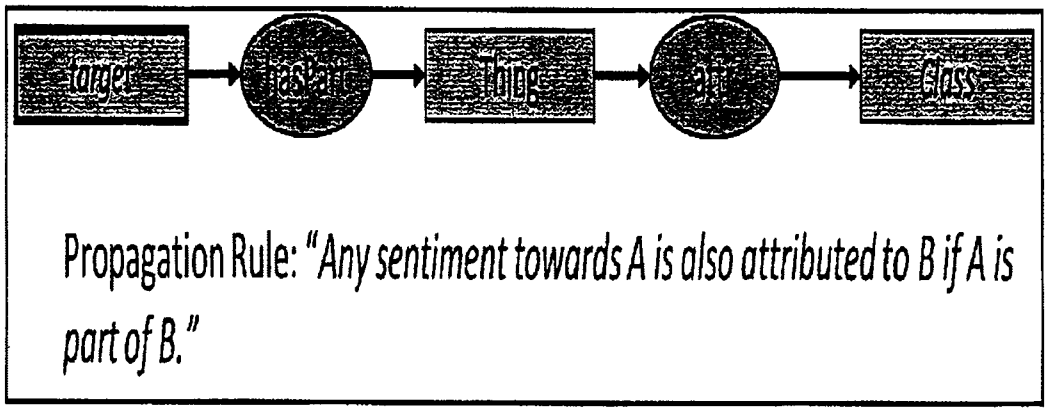
target
has part
Things
is a
Class
Propagation Rule: "Any sentiment towards A is also attributed to B if A is part of B."

FIG. 6 (b)

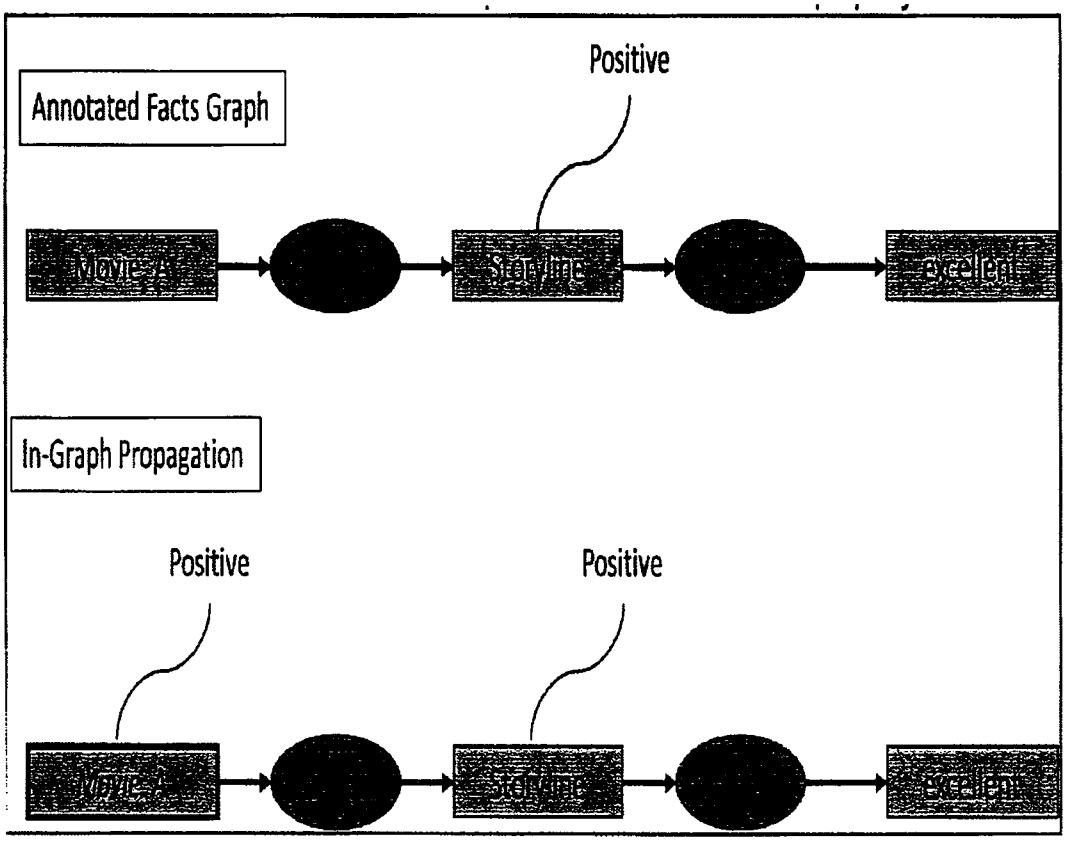
Annotated Facts Graph
Positive
Movie A
Storyline
excellent
In-Graph Propagation
Positive
Positive
Movie A
Storyline
excellent

FIG. 6 (c)

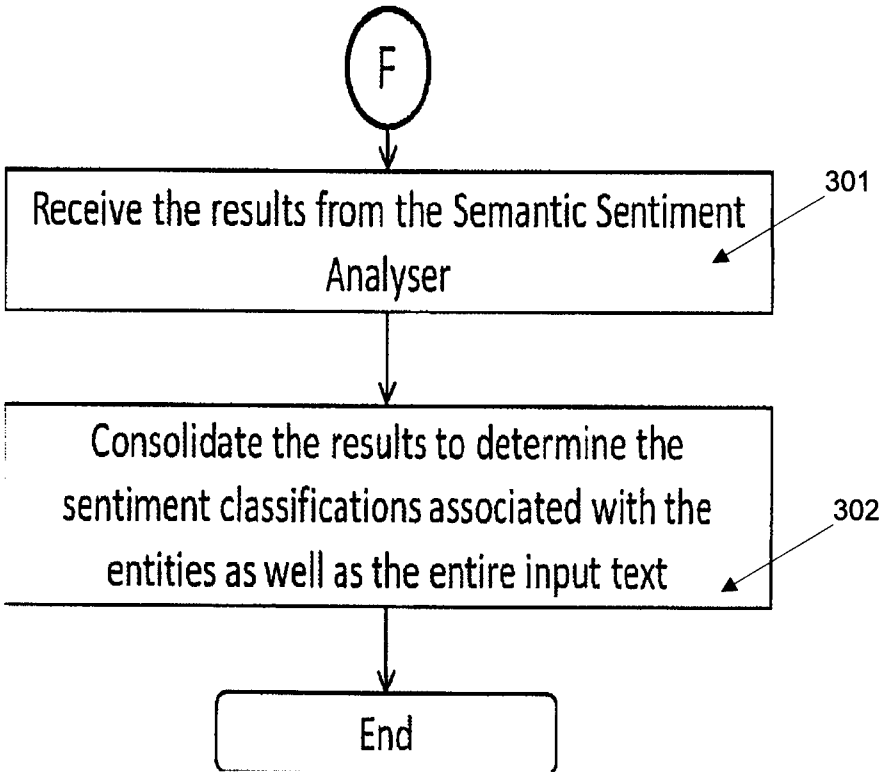
F
Receive the results from the Semantic Sentiment Analyser
301
Consolidate the results to determine the sentiment classifications associated with the entities as well as the entire input text
302
End

FIG. 7

# INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000182

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F17/27
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GUANG QIU ET AL: "Opinion word expansion and target extraction through double propagation", COMPUTATIONAL LINGUISTICS, vol. 37, no. 1, March 2011 (2011-03), pages 9-27, XP058000002, ISSN: 0891-2017, DOI: 10.1162/COLI_A_00034 Sections 1, 3 and 4 ----- | 2 |
| X | LILI ZHAO ET AL: "Ontology Based Opinion Mining for Movie Reviews", 25 November 2009 (2009-11-25), KNOWLEDGE SCIENCE, ENGINEERING AND MANAGEMENT, SPRINGER BERLIN HEIDELBERG, BERLIN, HEIDELBERG, PAGE(S) 204 - 214, XP019135000, ISBN: 978-3-642-10487-9 Section 3, 3.3.-3.5 ----- | 1,2 |
| | -/-- | |

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 4 March 2015 | 10/03/2015 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Alt, Susanne |

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X,P | Valentina Presutti ET AL: "Sentilo: Semantic Web-based Sentiment Analysis", , 21 October 2013 (2013-10-21), XP055173066, Retrieved from the Internet: URL:http://challenge.semanticweb.org/2013/submissions/swc2013_submission_9.pdf [retrieved on 2015-03-02] Sections 1-3; figure 3 ----- | 1,2 |
| T | THANH TUNG NGUYEN ET AL: "A Sentiment Analysis Model Using Ontology- enriched Conceptual Graph and Operational Rules", INTERNATIONAL CONFERENCE ON ADVANCES IN COMPUTING, ELECTRONICS AND ELECTRICAL TECNOLOGY - CEET 2014, 20 December 2014 (2014-12-20), XP055173074, Sections I-IV ----- | 1-5 |

1