Mind Maps Automation System

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Abstract- *Natural language processing has many applications that always make it one of the most active research areas. Application can include text summarization, headline generation, question answering system _--, etc. Our work here has a novel application to represent. Actually it has the leadership to be the first contribution. This comes as the first contribution in this area covering Mind Maps automation (MMA) process; this paper includes the overall structure of mind maps automation system and contributed algorithms in different stages of the MMA System. It also covers previous contributions in NLP that work as essential components in MMA system. This paper simply helps a big dream exist in the real life.*

1. Introduction

The brain's potential is infinite, we know that it contains vast power waiting to be unleashed .We have been limiting the brain's potential by forcing it to use limited modes of expression. These methods have resulted in problems relating to our ability to learn, remember and organize information to our fullest capacity.

1.1.Linear presentation- bad for the brain

"Linear note taking has served as one of the greatest impediments to learning", says the leading author, Tony Buzan, President of The Brain Foundation. There are several reasons why linear note taking has been limiting our brain's potential, on top of which is that it failed to stimulate the brain's creatively. The linear presentation of standard notes prevents the brain from making associations, thus counteracting creativity and memory. In addition, especially when faced with list-style notes, the brain constantly has the sense that it has 'come to an end' or 'finished'. The false sense of completion acts almost like a mental narcotic, slowing and stifling the process of thinking.

1.2 How does our brain work?

First, our brain is divided into two halves

1) *The left half:* This is responsible for words, calculations, logic, numbers and thinking.
2) *The right half:* This is responsible for all colors, imagination, drawing, voice, music and feelings.

The logical left side is easily bored by lack of input and tends to "doze off" during some activities .The right brain is then able to "sneak" into our consciousness, filling our minds with emotional and visual vignettes and freely associated images. Hence we can see that reading of linear notes as an activity will not make use of our capabilities of right half rather than the left half. As the right half does not have a good lead in the linear context.

Second, the information is processed into our brains much better and quicker and it would be memorized much easier, if the information was in the form of the neural cell.

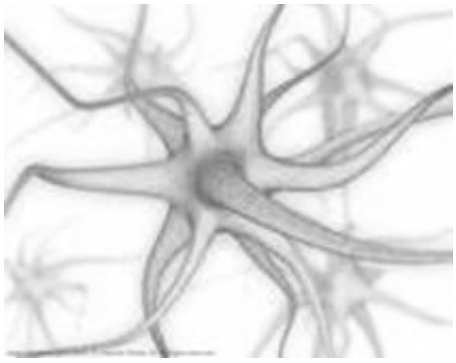


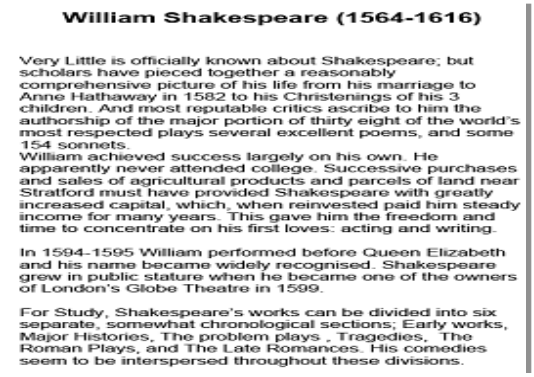
Fig. 1: neural cell

When the information is processed in traditional linear notes, it is similar to putting a cup of tea on a ball. For sure it cannot be stable, also people always remember the faces of persons and forget their names and that's because the brain loves pictures and does not easily forget it, so the best way of using your brain should allow using the 2 halves of our brain, presenting the information in the shape of the neural cell and using pictures.

1.3 Mind mapping - An evolutionary breakthrough

Mind mapping is a technique that was developed by Tony Buzan in the 1960's. It is a powerful graphic technique which provides a universal key to unlocking the potential of the brain. Mind Maps were designed based on the examination of how our brains actually work.

Figure 2 and figure 3 represents linear text of Shakespeare's life, and its corresponding mind map respectively.



William Shakespeare (1564-1616)

Very Little is officially known about Shakespeare; but scholars have pieced together a reasonably comprehensive picture of his life from his marriage to Anne Hathaway in 1582 to his Christenings of his 3 children. And most reputable critics ascribe to him the authorship of the major portion of thirty eight of the world's most respected plays several excellent poems, and some 154 sonnets.
William achieved success largely on his own. He apparently never attended college. Successive purchases and sales of agricultural products and parcels of land near Stratford must have provided Shakespeare with greatly increased capital, which, when reinvested paid him steady income for many years. This gave him the freedom and time to concentrate on his first loves: acting and writing.

In 1594-1595 William performed before Queen Elizabeth and his name became widely recognised. Shakespeare grew in public stature when he became one of the owners of London's Globe Theatre in 1599.

For Study, Shakespeare's works can be divided into six separate, somewhat chronological sections; Early works, Major Histories, The problem plays , Tragedies, The Roman Plays, and The Late Romances. His comedies seem to be interspersed throughout these divisions.

Fig. 2: A linear presentation of William Shakespeare

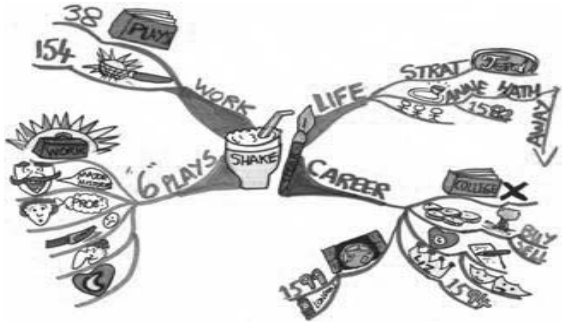


Fig. 3 : A mind map of William Shakspear's life

Some of the Advantages of using mind maps

• It accelerates the learning capacity.
• It instantly reveals connections and links between different subjects.
• It develops effective brainstorming techniques.
• It helps the mind become a powerful generator of ideas.
• It provides quickly gain insight into the big picture of any project.
• It increases the ability of memorizing and remembering.

2. Previous work

Mind maps automation system is similar to some tasks in natural language processing such as automatic summarization, Machine translation, question answering, and text simplification.

2.1.How to make a mind Map

There are two ways of making a mind map:

1) Manually by using a paper, pens and colors but it couldn't be drawn until the drawer read the text, understand it well and design the mind map on his mind.
2) Using existing software that just serves as an editing canvas where user can insert pictures and create relations between them (i.e. manually) examples include "I mind , Nova mind".

2.2. Natural language processing front end

NLP front end refers to common stages in many NLP applications. These stages include morphological analysis, parsing, syntax analysis, discourse analysis and word sense disambiguation.

Morphological analysis: Concerns how words are constructed from more basic meaning units called morphemes. It gets all possible morphs for each word in the text. For example: Friendly (Adj.) = friend (n.) + Ly (suffix) [1].

Parsing: is the process in which all possible parse trees of a sentence are built. It consists of 3 parts

1. The English lexicon: WordNet 2.1.
2. The grammar: The details mentioned in [2].
3. The algorithm: Top-down chart parsing is the strategy that is used to parse English plain text.

Syntax Analysis: Is the module which produces the final correct parse trees of the input text. Filtering is done based on a score given to each parse tree and its internal structure.

Discourse Analysis: This task is concerned with assigning each pronoun to the noun which it refers to. The algorithm used in MMA is the RAP algorithm (Resolution of Anaphora Procedure) .the details are mentioned in [3] and [4].

Word Sense Disambiguation (WSD): This Task is concerned with assigning the most proper sense (meaning) for each word according to the formulation of the sentence. The details of Word Sense Disambiguation algorithm used in our system mentioned in [5, 9, and 10].It's hybrid technique that depends on adaptive lesk [6] WSD algorithm and other semantic relatedness measures.

These NLP front end stages "As illustrated in figure 4"are part of the implementation of Mind maps automation system

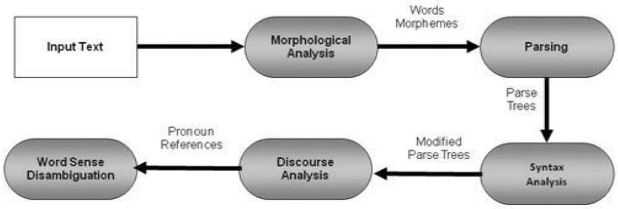


Fig. 4: the stages of NLP front end

2.3. Ontology

Ontology is the study or concern about what kinds of things exist. In artificial intelligence, ontology is the specification of conceptualizations, used to help programs and humans share knowledge. In this usage, an ontology is a set of concepts - such as things, events, and relations - that are specified in some way (such as specific natural language) in order to create an agreed-upon vocabulary for exchanging information. The details mentioned in [8], [9].

Our work actually is mixture of the two items (NLP front end and ontology) mentioned above, and the details of how to use ontology and NLP as a pre-requisite for the automation of mind map will be covered in the next section.

3. MMA System

Making mind maps manually for a text requires reading and understanding the text well which takes much time and effort in addition to the fact that not all people are creative enough to draw mind maps, so generating mind maps automatically could be a very useful idea as it would save a lot of time and effort.

The MMA system *is the first system that creates mind maps automatically*.

Figure 5 is system description to illustrate all the steps of the MMA system.

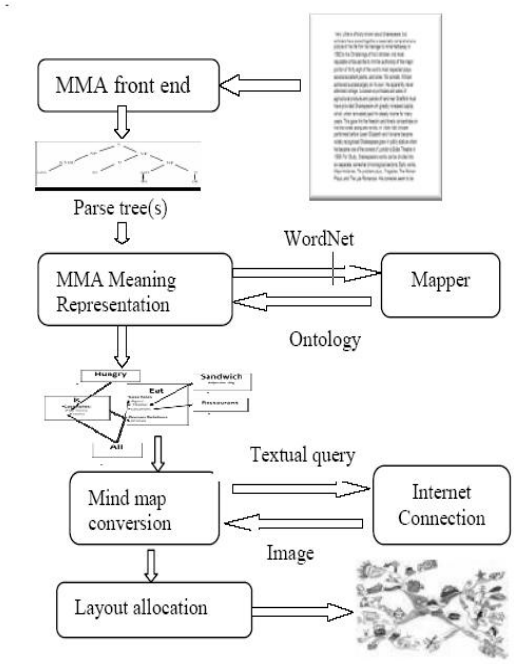


Fig. 5: The implementation Phases of the MMA system with the Inputs and Outputs.

3.1. MMA front end (Natural Language Processing)

It is the first phase in the MMA system which is responsible for understanding the input text "detailed in previous work".

3.2. MMA Meaning Representation

It is responsible for putting the text in a form that best represents its meaning, as it makes the computer able to understand the meaning of all the words and the relations between the words of the whole text. For example:

"Ali ate a big red apple in the club". The target of the meaning representation is to make the computer able to understand that :

- Ali: the person who ate the apple.
- Apple: Is a→Tree fruit.
- Big: is the size of the apple.
- Red: is the color of the apple.
- Club: is the location of eating the apple.

This is done by starting with the verb as it is the main part of the sentence. At first, make action frame for each verb and noun (party) frame for each noun in the sentence, then through some English rules we could know if the statement is negative or affirmative, active or passive, the verb is transitive or intransitive_--, etc, to be able to fill the roles and the relations which the meaning representation could be built through filling them.

- Filling the Roles:
  Case Role: Agent, Theme / Co-theme, Accompanier, Beneficiary**,** Experiencer, Source, Destination, Path, Means, Manner, Purpose.
  Circumstantial roles: Location, Time.
- Filling the relations :
  - Domain relations: represent connections between events, states or objects in the text.
  - Temporal relations: indicate the relative timing of one event in the text in relation to another.
  - Textual relations: A relation between textual elements reflecting the organization of a document as well as discourse structure.

Example*:* Ali ate a big sandwich in the restaurant because he was hungry.

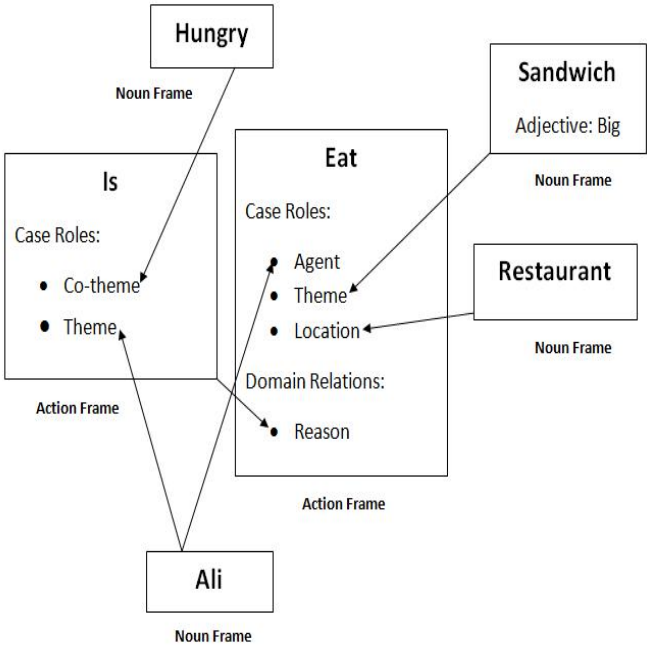


Fig. 6: the meaning representation output of the statement "Ali ate a big sandwich in the restaurant because he was hungry."

After filling the roles, in order to build a good meaning representation, a lot of properties must be filled to make the computer as in the previous example able to know that

- Apple: Is a→Tree fruit.
- Big: is the size of the apple.
- Red: is the color of the apple.

That is done by using Ontology. But there was a problem that is the Lexicon used in the "MMA Front End" step to get the senses of the words is the "WordNet ". But the Lexicon used in the Ontology to get the senses of the words which is under the concepts is the" Ontology lexicon" which is neither known nor available. Hence, we do not have the senses of the ontology words and in the case of having a word with more than one sense we want to use its ontology concept properties. Then, we will face this problem because we will not be able to determine the correct Concept of the word. Example to clarify the problem: if we have a statement like: "Ali played football."And we want to fill any properties of the word 'play' which are in the ontology. But "play" has more than one meaning. We have the correct sense of "play" in this statement from the WordNet as the output of "MMA front end" phase. But in the ontology there is more than concept represent the word "play" as the word play has many senses and we know none of them "As shown in figure 7

Concept: Playing a game Map-lex: Play, -----, ----- Properties: ----------	Concept: Playing an instrument Map-lex: Play, -----, ----- Properties: ----------

Fig. 7: example of two concepts in the ontology, each one of them has the word "play" under its map-lex.

So we can't determine which concept is the correct concept to fill its properties. From here came the idea of the *Ontology Mapper*.

Ontology Mapper

It is the idea of generating a data base which contains "the ontology concepts, the words represent each concept, and the corresponding WordNet sense" *automatically* by using the *"Map-Lex"* property included in each concept, which is the set of words that represent each concept in the ontology. The idea is to use the "word sense disambiguation "algorithm with the "WordNet" lexicon on all of the *"Map-lex"* words for each concept on the ontology, which will produce only one meaning for each word in the" map-lex" of each concept, hence we can add it to the database. As shown in figure 8 an example of the database columns.

Word	its meaning in the WordNet	Its concept in the ontology

Fig. 8: example of the database columns.

3.3. Mind maps conversion

Image generation

It represents the meaning with an appropriate picture; that is done by generating Google image search with a concept associated with its fillers (e.g. small red ball is the text to be searched for ball concept that have small and red as its properties.)

Layout Allocation

It is responsible for Drawing and organizing the mind map on the screen according to the size of the mind map and the size of the screen. Microsoft Automatic Graph Layout can be used to layout the graph.

3.4. MMA system walks through example

"Shakespeare is a great writer in the history of literature. He had 3 children."

MMA Front End output

- *Syntax Analysis output*

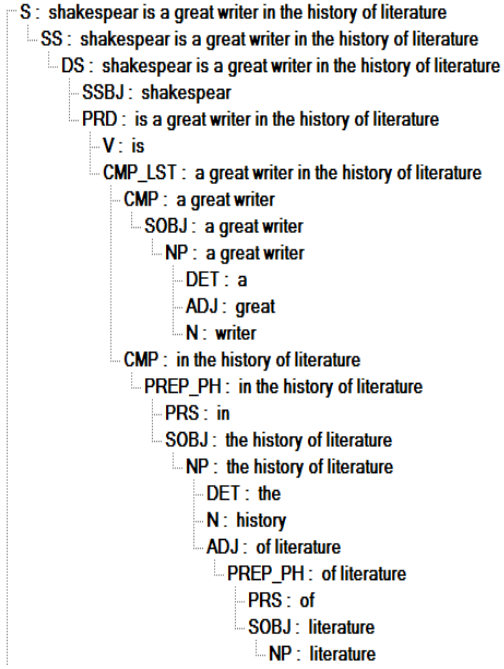


Fig.9: The syntax Analysis output of the first sentence.

- *Discourse Analysis* output
  HE→SHAKESPEAR

- *Word Sense Disambiguation output*

Be: have the quality of being (copula used with an adjective or a predicate noun. *Writer*: writes (books, stories, articles) for pay.

Fig. 10: Part of the word sense disambiguation's output "the sense of each word".

MMA Meaning Representation output

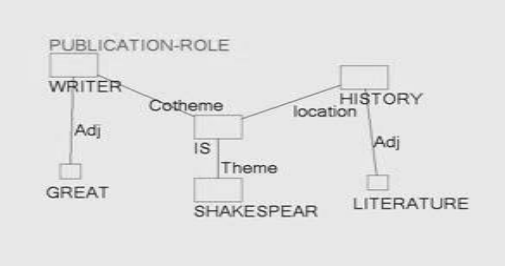


Fig. 11: the meaning representation of the first sentence.

As it is shown the system could recognize the theme(s), co-theme(s), Adj. and the location--;then to know the meaning of the word "writer", the mapper is used to get the ontology concept that represents the word writer to get a lot of properties about this word from it, as shown in fig.11 "writer" is a 'publication role'.

Mind Map Conversion, Lay out Allocation output

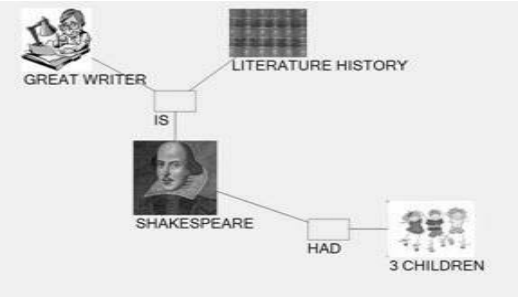


Fig. 12: The Output Mind Map

4. Experimental results

The Mapper algorithm "mentioned in MMA SYSTEM part "has been implemented and successfully mapped 17294 word sense to their ontology concepts, the quality of the algorithm has been evaluated by taking random samples of 100 records from the database and verify them manually, hence the algorithm is proved to be 95% of accuracy.

Meaning representation has been proved by implementing samples of roles, relations and fillers (properties) .then by applying a set of 10 test cases as input; in the field of normal life; each test case is a paragraph between 100-150 words. This proved 91% of accuracy.

The MMA system can work with the same accuracy on any other field simply by using ontology related to this field, also the system was tested with short paragraphs, because the target is to prove the methodology. If it works on the small scale, it will be working on a larger scale simply if the MMA system ontology and meaning representation have been enriched.

Currently the size of the input text is limited to 200 words so that it can be allocated on the monitor. If the text exceeds the limit, it will be better to build levels of mind map which is accounted by us a future work challenge.

3. Conclusion

- The Mind Maps can be applied to every aspect of life where improved learning and clearer thinking will enhance human performance.
- Mind maps take a long time & effort to be made manually.
- The automation of making mind maps is the best solution to enjoy the mind maps' privileges without passing throws the difficulties of making it.
- Mind maps automation system:
  - MMA front end
  - MMA meaning representation
  - Mind Maps conversion
  - Layout Allocation

5. Future work

- *Multi-Level Mind Maps* To build hierarchy of mind maps. Such that an element in parent level can be expanded to child mind map tilling reaching a leaf mind map.
- *Developing an Arabic version of the MMG* To generate mind maps automatically for Arabic texts.
- *Meaning Representation Binary Operations Manipulator* operations between two text documents.
  a) *UNION*: Builds up meaning representation that hold the knowledge of both given 1st document and 2nd as semantics document.
  b) *INTERSECTION*: semantically correlates knowledge in text documents.
  c) *SUBTRACTION*: represent knowledge represented in at document that has no relation with another.

6. References

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