Natural Language Processing approach to NLP Meta model automation

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***Abstract*— Neuro Linguistic Programming (NLP) is one of the most utilised approaches for personality development and Meta model is one of the most important techniques in this process. Usually, when one speaks about a problem or a situation, the words that one chooses will delete, distort or generalize portions of their experience. Meta model, which is a set of specific questions or language patterns, can be used to understand and recover the information hidden behind the words used. This technique can be adopted to understand other people's problems or enable them to understand their own issues better. Applying the Meta Model, however, requires a great level of skill and experience for correct identification of deletion, distortion and generalization. Using the appropriate recovery questions is challenging for NLP practitioners and Psychologists. Moreover, the efficiency and accuracy of existing methods on the Meta model can potentially be hindered by human errors such as personal judgment or lack of experience and skill. This research aims to automate the process of using the Meta Model in conversation in order to eliminate human errors, thereby increasing the efficiency and accuracy of this method. An intelligent software has been developed using Natural Language Processing, with the ability to apply the Meta model techniques during conversation with its user. Comparisons of this software with performance of an established NLP practitioner have shown increased accuracy in identification of the deletion and generalization processes. Recovery of information has also been more efficient in the software in comparison to an NLP practitioner.**

Keywords—Neuro Linguistic Programming, Natural Language Processing, Meta Model, Personality Development, NLP

I. Introduction

A. History of Neuro Linguistic Programming

Neuro Linguistic Programming (NLP) is a powerful practical approach to personal development [1] which emphasizes on how an individual's brain connects to the surrounding world and the influence of this connection on the one's behaviour [2]. Andreas and Faulkner [1] explain that "Neuro" refers to the nervous system and the mental pathways of the five senses of hearing, sight, touch, taste, and smell. "Linguistic", on the other hand, refers to the use of language and how specific words and phrases mirror the mental scene. This word also refers to the "silent language" of gestures, body language and habits that reveal further. The term "Programming" is borrowed from the field of computer science, to suggest that our thoughts, feelings, and actions are simply habitual programs that can be changed by upgrading the "mental software". NLP techniques have been used in a variety of fields such as business, education, sales and healthcare. Supplementary to the influence this technique provides for an NLP practitioner in assisting clients, it can also enable individuals to reach in and embark on personal development [3, 7]. NLP consists of a variety of techniques and escalating levels of processes to aid personal development in clients and oneself, one of the most significant techniques being the Meta model.

B. Background of Meta Model

The Meta model is the first formal model in NLP that was first described by Richard Bandler and John Grindler in the first edition of their book, 'Structure of Magic' published in 1975. They had observed the use of certain language patterns and essential questions by successful therapists that enabled them to correctly and efficiently identify and address the issues of their clients. The Meta model is now established as the identification of language patterns to detect generalization, distortion and deletion of information in speech with the aid of specific questions to recover the information not presented through language [4, 6]. As people speak about a problem or a situation, the words that they choose, may distort, delete and generalize portions of the presented concept. Thus, by considering these language patterns, the information concealed behind the words can be identified and recovered [4].

The discrepancy in the information presented by language was in fact, identified to be rooted in the processing of information acquired through the senses. It has been recognized that the nervous system uses deletion, distortion and generalization of the raw sensory input in order to process reality more readily and into a more manageable version [5]. Fig. 1 shows how information input may be developed through this process.

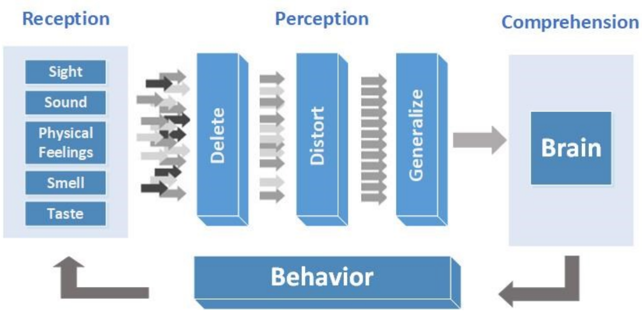

Fig. 1. Reception, perception and comprehension processes

Deletion refers to the portions of the mental map which do not appear in the verbal expression due to being eliminated. These gaps of information are recognized by the NLP practitioner and retrieved in conversation [6, 8]. Distortion, on the other hand, is about alteration of the information from its initial form. Upon detection, this is explored in conversation and the original information is recovered [6]. Carroll [8] defines distortion as "the process of representing parts of the model differently to how they were originally represented." Finally, generalisation is about simplification of information through which concepts may be merged. The practitioner then retrieves lost information via reaching specification throughout the conversation [6]. Fig. 2 shows how the Meta model deals with these processes.

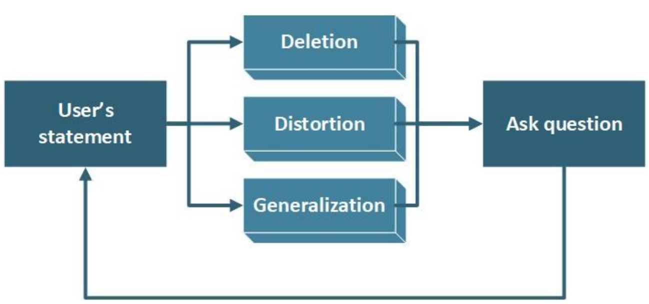

Fig. 2. The Meta model mechanism

The main focus in identifying the process of deletion, has five important elements. These are (1) unspecified nouns, (2) simple deletions, (3) comparative deletions, (4) unspecified verbs and (5) "Ly" adverbs [5].

Nouns included in a sentence, which are not specifically referred to in the statement, can be categorized as unspecified nouns. The missing information may be deleted completely or it may be replaced with an unspecified pronoun [5]. Simple deletions, on the other hand, refer to the missing elements of a sentence which are key to the statement being made. While in the case of unspecified nouns, the sentence has an object which is merely unspecified, in simple deletion, it would be a case of information missing entirely [10]. Davis [5] mentions that "simple deletions are where part of the meaning is left out or lost and you can notice them in a sentence with "it" and "that" and also when referring to missing descriptions (adjectives)." Comparative deletion happens when the person uses hypnotic words to make a comparison, but does not explain what is being compared and hence it will be left unstated [10]. Unspecified verbs are verbs that do not describe the action completely nor are they fully informative with regards to the statement. In this case, one may fill in the gap with their own experience. This process is called "mind reading" [9]. Finally, "Ly" Adverbs are words that end with "Ly" such as "slowly" or "creatively". Stoker [11] points out that the problem with "Ly" adverbs is that they give a judgment which tends to be accepted by other people without questioning whether it is true or not. This may cause a problem because people can forget to ask about the judgment and it secretly slips under the radar.

The second major process in the Meta model is distortion which focuses on five important language patterns; (1) mind reading, (2) lost performative, (3) cause effect pattern, (4) complex equivalence and (5) linguistic Presuppositions [8].

Mind reading would happen when it is assumed that you know what the other person is thinking or feeling without checking. It can mean that one may take an action, or withhold an action, because you think that you know how the other person would react [6]. Lost performatives happen when a person is talking about a personal belief, but presents it like a universal truth which can lead people to accept it as the truth without questioning [5]. Cause effect patterns, on the other hand, implies a relationship in time, which suggests that in the case of one event taking place, a second event will automatically follow [6, 9]. The fourth important language pattern in distortion is complex equivalence which happens when there are two experiences, ideas, objects or their meanings interpreted as being synonymous [8]. Finally, the fifth language pattern in distortion is linguistic presupposition, which is one of the most powerful aspects of the Meta model language patterns. It refers to statements where unstated elements must be assumed to be true, for the statement to make sense [12]. These statements are, hence, merely presuppositions. Linguistic presuppositions are categorized into four groups. These are (1) linguistic presuppositions of awareness, (2) linguistic presuppositions of time, (3) linguistic presuppositions of order and (4) adverbs and adjectives [5].

The third phase of the Meta model is generalization. Identification of this process consists of two important elements; (1) modal operators and (2) universal quantifiers [13]. Modal operators refer to one's feelings regarding carrying out a task. Examples of this would be the difference in one's mood regarding a task you enjoy, and a task you have to do regardless [5]. Modal operators are categorized into two groups; (1) necessity and (2) possibility. Modal operators of necessity define rules that must be followed and there are undefined consequences in case of breaking these rules. On the other hand, modal operators of possibility reduce your flexibility by creating some limits on what you can or cannot do and they define arbitrary barriers [13]. Universal quantifiers are another type of generalization which take a single case or situation and apply it to all cases or at all times [6].

There are defined outlines for psychologists and NLP practitioners for using the Meta model during counselling or therapy. Many human limiting factors are, however, bound to contribute to this process such as lack of experience or skill, personal judgment, and inaccuracy which may have a direct or indirect impact on the outcome of using the Meta Model. In the literature review of this research, it has been understood that the process of using the Meta Model has always been considered as a face-to-face technique during conversation and there have been no attempts to automate this process or use computers to improve this process.

C. *Natural Language Processing as a tool for automation*

Natural language processing is defined as a computerized approach, based on the use of a variety of theories and technologies to analyze the human language. This enables the language input to be processed and understood while the same natural language can be generated by the system in order to communicate with the user [14, 15]. Natural Language Processing is, in fact, a multidisciplinary field of study, covering computer science, linguistics, psychology and artificial intelligence, focusing on the interaction between computers and natural language of the user [14]. According to Liddy [15] there are seven levels in natural language processing; (1) phonology, (2) morphology, (3) lexical, (4) syntactic, (5) semantic, (6) discourse and (7) pragmatic.

The phonology level deals with interpretation of sound in speech to identify words and will be applied only if the text origin is speech [16]. Nugues [17] states that "morphology is the study of how root words and affixes are composed to form words". It is, hence, about analyzing and identifying the structure of words [14, 17]. Lexical analysis, on the other hand, is about understanding the position of words in a sentence, their meaning and their relation to other words in that sentence [16]. Syntactic analysis focuses on analyzing the words with regards to the grammatical structure of the sentence. The structural dependency relationships between the words in a sentence will also be recognized in the following step of processing [15]. In the semantic analysis stage, the focus is on the interactions among word-level meanings in a sentence and the way that lexical meaning is combined morphologically and syntactically to form the meaning of the statement [15, 18]. Following this stage, discourse level looks at the connections between sentences in a text and deals with the properties of the whole statement in conveying meaning [15]. This is to take into account the dependence of each sentence on the previous and following sentences for conveying its meaning [14]. Finally, pragmatic analysis focuses on the use of language in context, deriving the purposeful use of the language in different situations [18]. After considering the stages of analysis through natural language processing, it was determined that this system would be an ideal tool for automating the process of using the Meta model in the human-computer conversation.

Based on the presented information above, this is the first time that the process of using the Meta model in a conversation is being automated whereby Natural Language Processing is being used for this purpose. This research intends to create a new methodology for implementing the Meta model in order to increase the success rate of this method. This is carried out by an attempt to increase the accuracy, reliability and efficiency of this method through intelligent automation. As a result, the contributing human factors and errors such as lack of skill and experience, personal judgment and opinion, inaccuracy or mistakes of psychologists and NLP practitioners are eliminated from the process. The software created in this research thereby aims to provide a more effective alternative for implementation of the Meta model branch of NLP for personal development.

II. Software development procedure

A. *Software structure*

In this software three language patterns from the deletion process: (1) unspecified nouns, (2) comparative deletions (3) "Ly" adverbs; two language patterns from the distortion process: (1) mind reading (2) linguistic presuppositions; and two language patterns from the generalization process: (1) universal quantifiers and (2) modal operators will be considered.

The software would start the conversation by asking the first of ten set question. The theme of the questions in this study had been regarding the user's work environment. The software would continue the conversation with the user based on the user's answers. The software would be identifying the language patterns used in the user's response and follow up by asking the relevant Meta model recovery questions to clarify any obscured information. The user will be informed about the missing information and issues identified in the conversation. Additionally, clarifications or explanations about the presented issues will be provided by software.

B. *Programming language and the relevant library*

Python, a powerful programming language for processing linguistic data and NLTK, a useful library for natural language processing in Python, were used to develop this software. NLTK provides basic classes for representing the data relevant to the natural language as well as convenient interfaces for performing tasks such as text classification, syntactic parsing and part-of-speech tagging [19].

C. *Asking a question*

In the first step of software development, an input statement has been used to ask the first question from the user and the user's answer will be recorded in the relevant variable. This answer will be analyzed in next steps. Input statements are used for asking the continuing questions.

D. Defining the key words

Eight lists have been created for this software which include specific key words or identifiers that would be used in different steps of the Meta model process. They are about personal pronouns, determiners, necessity identifiers, impossibility identifiers and universal quantifiers, explained previously. Tables 1 shows the content of these lists.

TABLE 1 CONTENT OF THE CREATED LISTS

Lists	Content of the lists	
Personal Pronouns 1	he she him her	they them his their
Personal Pronouns 2	It	
Determiners 1	this that	these those
Determiners 2	there	
Necessity identifiers	has to have to had to	need to must should
Unnecessity identifiers	do not have to did not have to don't have to didn't have to does not have to doesn't have to should not shouldn't	do not need to don't need to did not need to didn't need to does not need to doesn't need to must not mustn't
Impossibility identifiers	cannot can't impossible is not possible isn't possible	could not couldn't not possible
Universal quantifiers	Never ever	always all

E. Tokenization process

In response to the user's answers, the software will use the "Tokenization" technique. In this step, the user's answer will be recorded as a string which would be divided into different sentences and each sentence would be analyzed separately. All sentences will be recorded in a list and each sentence will be divided into different words, which would form a second list.

F. Lexical and Syntactic anlysis

Following the tokenization process, Part-Of-Speech tagging or the POS tagging technique will be used and the role of each word in each sentence or in other words, all verbs, nouns, adjectives, adverbs and other relevant elements in each sentence will be recognized. There are several approaches for building a POS tagger, but supervised and unsupervised tagging are the most common approaches [20]. Both of these tagging approaches have three sub-types. These are (1) rule based, (2) stochastic based and (3) neural network based. Hidden Markov model (HMM) is the most common stochastic tagging technique [20]. This technique was used to build the POS tagger. There are a variation of tag sets which could be used in this process. Penn treebank tag set was employed in this research.

Eq. (1) will be used to find out the tag sequence that is most probable given the observation sequence of n words:

$$\hat{t}_1^n = \arg\max_{t_1^n} P(t_1^n | w_1^n) \quad (1)$$

Eq. (2) is Bayes' theorem which describes the probability of an event, based on knowledge of conditions previously associated to the event. In other word, Eq. (2) can be used to derive the probability of X given Y when you know the probability of Y given X:

$$P(x|y) = \frac{P(y|x)P(x)}{P(y)} \quad (2)$$

Bayes' theorem will be applied to Eq. (1) in its application for tag probability:

$$\hat{t}_1^n = \arg\max_{t_1^n} \frac{P(w_1^n|t_1^n)P(t_1^n)}{P(w_1^n)} \quad (3)$$

Eq. (3) is simplified by dropping the denominator $P(w_1^n)$:

$$\hat{t}_1^n = \arg\max_{t_1^n} P(w_1^n|t_1^n)P(t_1^n) \quad (4)$$

Two further simplifying assumptions will be made by HMM taggers in order to allow estimation of the probability of tag sequences given word sequences. The first simplifying assumption is that the probability of a word appearing depends only on its own tag and that it is independent of neighboring words and tags:

$$P(w_1^n|t_1^n) \approx \prod_{i=1}^n P(w_i|t_i) \quad (5)$$

The second simplifying assumption is that the probability of a tag is solely dependent on the previous tag, as opposed to the entire tag sequence:

$$P(t_1^n) \approx \prod_{i=1}^n P(t_i|t_{i-1}) \quad (6)$$

Plugging in the simplifying assumptions from Eq. (5) and Eq. (6) into Eq. (4) leads to formation of the below equation for the most probable tag sequence from a bigram tagger.

$$\hat{t}_1^n \approx \arg\max_{t_1^n} \prod_{i=1}^n P(w_i|t_i)P(t_i|t_{i-1}) \quad (7)$$

$P(w_i|t_i)$ in Eq. (7) corresponds to the emission probability and $P(t_i|t_{i-1})$ corresponds to the transition probability.

Following the POS tagging process, the software creates two different lists; the first list consists of the pronouns in each sentence as they may be indicative of missing information. The second list is of the adverbs in each sentence. Each one of these lists will be created by using a loop and checking the POS tags for each word in each sentence. Thus, if the relevant POS tag existed in the sentence, that specific word will be recorded in the relevant list and these lists will be used for the comparison process in the next step.

G. *Comparison process*

There are four different lists related to specific pronouns and determiner words that have been defined for the software previously. These lists will be used during the comparison process to be compared with the created list about the pronouns in each sentence in the previous step. Hence, the created list in the lexical and syntax analyses will be compared to each one of those four lists one by one. Detection of similarity between each of the two lists, leads the specific words to be recorded in a new list, as the final list.

The software will also create four other lists which are about necessary identifiers, unnecessary identifiers, impossibility identifiers and universal quantifiers. The strategy for creating these lists will be the same in being created using a loop. However, the POS tags are not necessary in this case and instead, each word in each sentence will be compared to the words recorded in the relevant list, as defined and explained previously.

As a result, there will be six lists as the final lists to be used in the following step of checking the conditions and the decision making process.

H. *Decision making process*

In this step, the software would check the conditions and in the case of any words recorded in any of the final lists, the software would ask a specific relevant recovery question from the user. For instance, if the user has written one paragraph, the format of a recovery question would be as follows:

> You said: "……..(The sentence that includes missing information will be repeated in here)……..".
> The relevant question word (Who/What/Which/Where) exactly? Could you explain further?

Hence, the software would encourage the user to expand on the missing information and to clarify the meaning of the made statement. The user's answer to the recovery questions would be recorded to be used in next steps.

The list about adverbs, on the other hand, created during the lexical and syntax analyses would be used in checking the condition process. If this list was empty and there were no "Ly" adverb used in the user's sentences, the software would continue the conversation in the standard format. If the list was not empty, however, a recovery question would be asked from the user, such as:

> You said: "…….(The sentence that includes the intended adverb will be repeated in here)……".
> (The intended adverb) than what? / Why (The intended adverb)? / How (The intended adverb)?

Thus, the user's expansion on his/her statement via the recovery question would be recorded to be used in future steps. This process would be repeated for all answers to the recovery questions provided by the user. If there were any remaining missing information, the software will continue asking recovery questions to clarify the statement.

I. *Informing the person*

After each recovery question, the user will be informed about the issue in his/her sentence and then the clarification or explanation that he/she made, after responding to the recovery question. The format will be as follows:

> You said: "……..(The sentence that includes missing information, changed information or generalized information, will be repeated in here)……..".
> The issue in your sentence was …… (The relevant issue. For instance, unspecified noun which is an element of deletion process in the Meta model)
> Your clarification or explanation for this issue is: "…..(The user's answer to the recovery question)…..".

J. *Repetition process*

The user's answers to any of the set questions based on his/her work environment will be analyzed for any ambiguity which the Meta model could be used for in order to clarify the statement for the computer. Following clarification, with the use of the Meta model questions, or in the case of no need for clarification, the user is presented with the next of the ten set questions.

The steps of the Meta model analysis will be executed inside the body of a function which will be used in a 'for loop' to be repeated for all answers provided by the user, ensuring clarification of every statement.

K. *Data gathering procedure*

This software has been tested on 50 participants with a variation of age, professional background and lifestyle. Participants were fully informed about the function of the software and they were aware that the information provided will not be shared with any third parties and will remain private and confidential. They were also aware that there are no risks of mental or physical harm in participation, and that they were not in risk of financial loss or impact on their professional or personal life. The estimated time for this test ranged between 20 to 30 minutes depending on their typing speed and the length of their answers.

III. Results of Comparing the Performance of the Software and Human

After the data gathering process, the conversations between the software and participants were analyzed by a NLP practitioner (human). The results were compared to the software for examining the accuracy of the software's results and evaluating its performance. The software identified 904 deletions, 328 distortions and 452 generalizations. The number of deletions identified by the NLP practitioner, on the other hand, were 703, in addition to 542 distortions and 351 generalization. In other words, 54% of the recovery questions by the software were related to deletion, 19% were related to distortion and 27% were related to generalization, as demonstrated in Fig. 3.

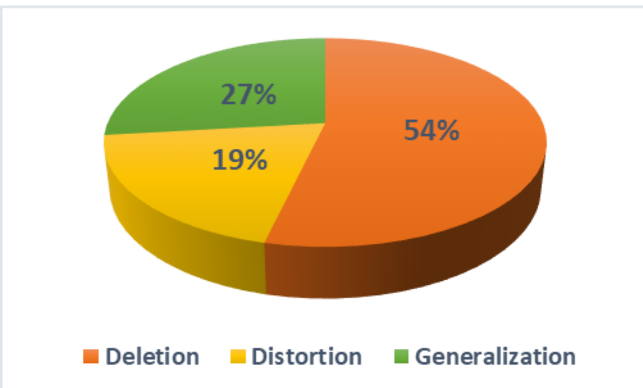

Fig. 3. Number of recovery questions about deletion, distortion and generalization, asked by the software

For the identified processes by the NLP practitioner, 23% were related to deletion, 29% were related to distortion and 48% were related to generalization. This is shown in Fig. 4.

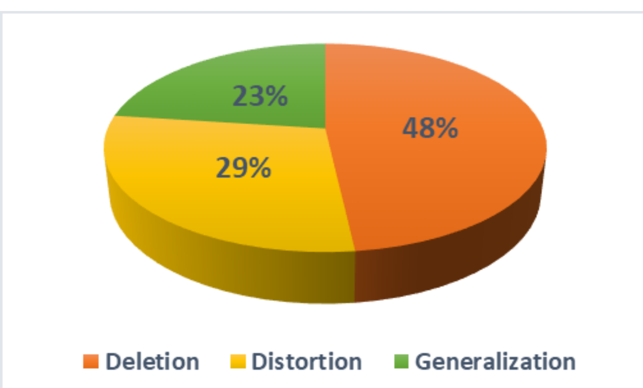

Fig. 4. Number of recovery questions about deletion, distortion and generalization, asked by human

The number of identified deletions, distortions and generalizations by the software were compared to the NLP practitioner, as shown in Fig. 5.

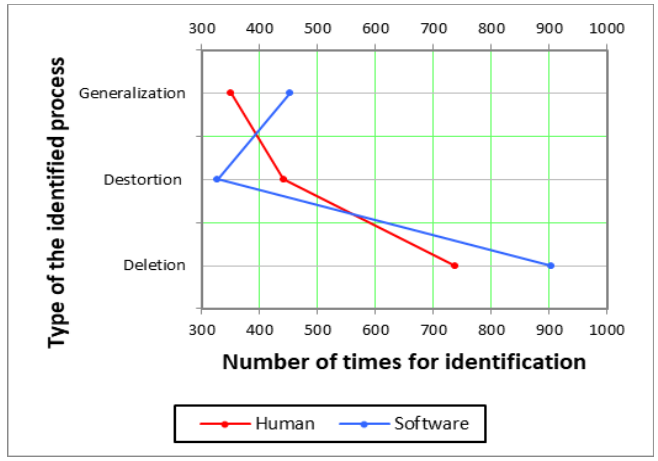

Fig. 5. Comparing the number of Deletion, Destortion and Generalization, identified by the human and software

According to Fig. 5, the software had a better performance than the NLP practitioner, in identifying the deletion processes. Table 2 shows that the software's performance in this regard was 6% better than that of the NLP practitioner. Fig. 5 also shows, however, that the software was not as successful as the NLP practitioner in identifying the distortion processes by 10%, as seen in Table 2. Finally, the software was also more effective with regards to identifying the generalization processes. Table 2, demonstrates this difference to be by 4%.

TABLE 2 Comparing the Performance of the Software and Human

	The identified process		
	Deletion	***Distortion***	***Generalization***
Software	54%	19%	27%
Human	48%	29%	23%
Difference	6%	-10%	4%

The number of recovery questions related to each category of the deletion, distortion and generalization processes were also recorded. Fig. 6 shows that 398 questions were related to unspecified nouns, 202 questions were related to comparative deletions and 304 questions were related to "Ly" adverbs in the user-software conversation. On the other hand, 278 questions were related to unspecified nous, 167 questions related to comparative deletions and 293 questions related to "Ly" adverbs in the case of our NLP practitioner.

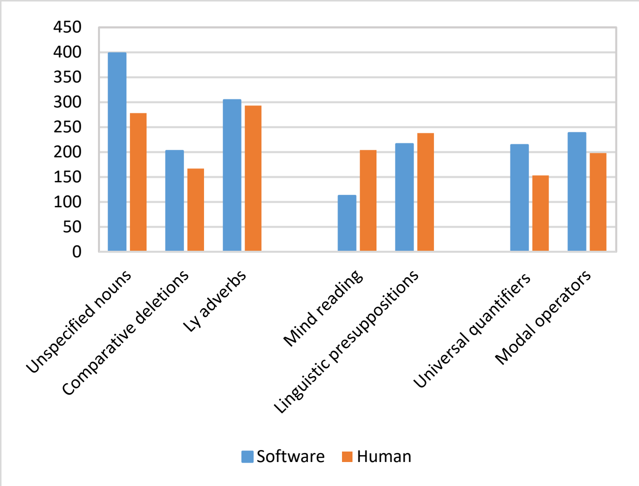

Fig. 6. Comparing the number of recovery questions related to each category of deletion, distortion and generalization processes, asked by the software and human.

According to Table 3, there is a 6% difference between the performance of the software and the NLP practitioner, in favor of the software. Table 3 also shows that there is no difference between the result of the software and the practitioner regarding comparative deletions' identification but the performance of the practitioner was 6% better than the software regarding the recognition of "Ly" adverbs.

TABLE 3 COMPARING THE NUMBER OF RECOVERY QUESTIONS RELATED TO EACH DELETION CATEGORY ASKED BY THE SOFTWARE AND HUMAN

	Deletion		
	Unspecified nouns	***Comparative deletions***	***Ly adverbs***
Software	44%	22%	34%
Human	38%	22%	40%
Difference	6%	0%	-6%

The number of recovery questions relating to the distortion process were analyzed where Fig. 6 and Table 4 demonstrate that 112 (34%) recovery questions asked by the software were related to mind reading in the distortion process while 216 (66%) questions were related to the linguistic presuppositions. This is while the practitioner asked 204 (46%) questions in relation to mind reading and 238 (54%) questions related to linguistic presuppositions. According to table 4, the software performed better than the practitioner regarding identification of mind reading but the practitioner performed better than the software in relation to identification of the linguistic presuppositions.

TABLE 4 COMPARING THE NUMBER OF RECOVERY QUESTIONS RELATED TO EACH DISTORTION CATEGORY ASKED BY THE SOFTWARE AND HUMAN

	Distortion	
	Mind reading	***Linguistic presuppositions***
Software	34%	66%
Human	46%	54%
Difference	-12%	12%

Finally, the generalization recovery questions were analyzed which demonstrated 214 questions related to universal quantifiers and 238 questions relating to modal operators. This is while the practitioner asked 153 questions relating to universal quantifiers and 198 questions relating to modal operators. Table 5 shows that performance of the practitioner was 12% better than software in recognizing modal operators while performance of the software was 12% better than the practitioner in recognizing universal quantifiers.

TABLE 5 COMPARING THE NUMBER OF RECOVERY QUESTIONS RELATED TO EACH GENERALIZATION CATEGORY ASKED BY THE SOFTWARE AND HUMAN

	Generalization	
	Modal operators	***Universal quantifiers***
Software	53%	47%
Human	56%	44%
Difference	-12%	12%

The average time for the software to process and analyze the participants' statements and respond accordingly did not surpass 1 second. This reflects the increased efficiency of the software in comparison to the manual alternative, where the practitioner would require more time to read and comprehend the participants' statements in order to respond appropriately.

Availability of some participants was a limitation that could have influenced this study. As described, the software was tested on 50 participants. Although the outlined outcome is comprehensive but 100 or more participants may have improved the result.

IV. CONCLUSION

This research has automated the process of using the Meta model in a human-computer interaction. Natural language processing was used as a tool for the automation process of this system. As a result, an intelligent software has been developed which is able perform as a competent NLP practitioner or psychologist. The software has been tested on 50 participants with a good variety backgrounds. The conversations and answers from participants were recorded in separate files and given to an experienced NLP practitioner to be analyzed. Finally, obtained results by the software were compared to the obtained results by the practitioner. A more efficient performance of the software, with a high level of accuracy and reliability, was observed in comparison to the practitioner. Based on the results, it can be concluded that the proposed software is more successful with regards to the deletion and generalization processes in comparison to an experienced NLP practitioner. The software, however, is slightly less successful for clarifying the distortion processes compared to the practitioner. The methodology presented in this research paper could successfully improve the accuracy and reliability of using the Meta model in a conversation through automation of the process. Human errors such as lack of experience, personal judgment, effect of the practitioners' level of skill and other human errors were effectively eliminated from the process and the relevant inaccuracies significantly decreased.

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