A Review of the Various Approaches for Text to Text Machine Translations

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ABSTRACT
Machine translation (MT) is defined as a subfield of computational linguistics that investigates the use of computer software to translate text or speech from one natural language to another. It is a key application in the field of natural language processing. At its basic level, MT performs simple substitution of words in one natural language for words in another. Effort to access documents from one language to another leads to the development of machine translation system which involves lots of heterogeneous features and its implementations. Approaches to machine translations are different and each of this approach has its own benefits and drawbacks. This study looks at the various approaches to machine translations and future needs in order to provide more robust and sensible system in the area of natural language processing which will be resistant and impervious to failure regardless of users' inputs. It is hopeful that researchers in the area of language processing can make use of our valuable improvement and suggestions.

General Terms
Machine Translations

Keywords
Machine Translation, Direct-Based, Rule-Based, Statistical-Based, Hybrid Approach, Natural Language Processing

1. INTRODUCTION
The only means by which human beings abstract reality is through language. Language is an efficient and effective medium of communication which explicitly represents the ideas and expressions of the human mind. Over 5000 languages exist in the world today and this gives evidence of the linguistic diversity. It is difficult for an individual to know and understand all the languages of the world. Hence methodology of translation has been adopted to communicate messages from one language to another [16]. Translation is the transfer of the meaning of a text from one language to another for a new relationship. This implies that translation is not always a straight forward case of substituting word(s) in the source language (SL) with the equivalent word(s) in the target language (TL). The translated text must convey the same meaning as the original text meaning. That is, the translator must understand the message that the author of the original text is trying to convey [1]. A complete translation system must have a very good knowledge of the language from which it is translating, a very good knowledge of the grammatical features of the target language, familiarity with the subject matter of the text being translated as well as a profound understanding of the syntax and grammatical features of the two languages involved and their vocabularies. Developing a machine translation system, that accurately produces a good translation system between human languages has been the target of machine translation [1].

Machine Translation is a subfield of computational linguistics that investigates the use of computer software to translate text or speech from one natural language to another. At its basic level, machine translation performs simple substitution of words in one natural language for words in another [11].

Machine translation systems are needed to translate literary works from any language into native languages. The literary work is usually fed into the machine translation system and translation is done. Such systems can break language barriers by making available rich sources of literature to people across the world [11].

Machine translation mainly deals with the transformation from one natural language to another [15]. Natural language Interface provides the user freedom to interact with the computer in a natural language used for day to day communication. One of the important goals of computational linguistics is a fully automatic machine translation between such natural languages. This is important because communication between people from different linguistic backgrounds still constitute a major problem [15].

Machine translation of natural languages is a very difficult task. It can be perceived as the simple substitution of words in one natural language for words in another. Yet it is not so simple because of the complexity of some natural languages. Many words have various meanings in some languages and so they can be translated in different ways. Also, sentences might be ambiguous and have various meanings. Grammatical relations can vary depending on the languages, and translating sentences from languages having different relations means reformulating the sentence. Besides, problems due to the associated world knowledge may be encountered and these are usually difficult to solve [13].

2. MACHINE TRANSLATIONS APPROACHES
Accuracy and speed of translation are the two main measures to evaluate the performance of machine translation tools. However, various approaches to machine translations have been proposed and each of this approach has its major benefits and drawbacks. These various approaches that have been proposed in literatures are: direct approach, rule-based approach which is further divided into transfer-based and Interlingua approaches respectively, the corpus-based which is also divided into statistical and example-based approaches

respectively, and the knowledge based approach to translations. In addition to these classifications, researchers have used various other methods like neural networks, fuzzy logic, genetic algorithms, and hidden Markov models among others in different domains or languages for achieving better organization, rules and better accuracy [18].

2.1 The Direct Approach (DBMT)

The direct approach to machine translation is considered to be the most primitive or the original approach of all, carrying out replacement of the words in the source language with words in the target language which is carried out in the same sequence and without much linguistic analysis and processing. The major resource used by this approach is a bilingual dictionary and this is why it is known as dictionary-driven machine translation [18].

The direct machine translation approach is a unidirectional approach and access only one language pair at a time. A word to word translation of the output text is performed and the result is obtained in the form of output text [2].

DBMT carries out word by word translation with the help of a bilingual dictionary usually followed by some syntactic rearrangement and re-ordering. The DBMT system starts with morphological analysis which removes morphological inflections from the words to get the root word from the source language words. The next step is bilingual dictionary lookup in which a bilingual dictionary is looked up to get the target-language words corresponding to the source-language words. This approach is designed for unidirectional translation or word for word translations between one pair of languages, and it is not conducive to genuine multilingual machine translation design [11].

2.2 The Rule-Based Approach (RBMT)

Another approach to machine translation is the rule-based approach to machine translation which involves the application of morphological, syntactic and semantic rules in the analysis of the source language text and the synthesis of the target-language text. It is further divided into transfer-based and Interlingua machine translations respectively. In this approach, a database of translation rules is used to translate text from source to target language [10].

This approach deals with the word-order problem and since it uses linguistic knowledge, the produced errors can be traced.

RBMT parses the source text and produces an intermediate representation which may be a parse tree or some abstract representation. The target text is generated from the intermediate representation. These systems rely on the specification of rules for morphology, syntax, lexical selection and transfer, semantic analysis and generation. It identifies the relationship between source-language words and their structural representations. However, this approach requires a lot of human efforts and dedication [6].

Of the two rule-based methods, transfer based systems are more flexible and it can be extended to language pairs in a multilingual environment. In this translation system, a database of translation rules is used to translate text from source to target language. Whenever a sentence matches one of the rules or examples, it is translated directly using a bilingual dictionary. It uses contrastive knowledge of two languages [8].

The Interlingua based systems can be used for multilingual translation. The Interlingua MT converts words into a universal language that is created for the machine translation simply to translate it to more than one language. SL text converted into a language independent or 'universal' abstract representation Transformed into several target languages [9].

2.3 The Corpus-Based Approach

The corpus-based is classified into statistical machine translation (SMT) and example-based machine translations (EBMT). SMT requires less human effort to undertake translation. SMT is a MT paradigm where translations are generated on the basis of statistical models. These statistical models parameters are derived from the analysis of bilingual text corpora. Statistical-based MT uses purely statistical based methods in aligning the words and generation of texts. SMT is based on the view that every sentence in a language has a possible translation in another language. That is every sentence in the target language is a possible translation of the input sentences. This approach requires minimal human effort and can be created for any language pair that has enough training data. However, it requires large sentence aligned parallel text for each language pair and this approach cannot be employed where these corpora are not available [9].

EBMT use previous translation examples to generate translations for an input provided. When an input sentence is presented to the system, it retrieves a similar source sentence from the example-based and its translation. The system then adapts the example translation to generate the translation of the input sentence. EBMT systems use variety of linguistic resources such as dictionaries to translate text [16].

2.4 Knowledge-Based Approach

Early machine translation systems are characterized by the use of syntax. There was little semantic analysis. The synthesis and analysis is restricted in early MT systems to sentence level. Semantic-based approaches to language analysis have been introduced by artificial intelligence researchers. The approaches require a large knowledge based that includes both ontological and lexical knowledge, uses extensive semantic and pragmatic knowledge and the ability to reason about concepts, highly modular and multilingual, difficult to produce a universal representation of all languages and only capable of demonstrating prototypes [11].

2.5 The Hybrid Approach

Hybrid approach leverages the strengths of statistical and rule-based translation methodologies. This approach involve rules post-processed by statistics: in which translations are performed using rules based engine and statistics are used in an attempt to adjust and correct the output from the rules engine and also, statistics guided by rules in which rules are used to preprocess data in an attempt to better guide the statistical engine [18].

However, despite decades of great efforts to develop machine translations for languages, efficient methods for machine translation continue to be a challenging task. Although, efforts on machine translations from one language to another have been in existence for long, a fully-automatic general purpose high quality machine translation system (FGH-MT) is still extremely difficult to build. Infact, there is no system in the world of any pair of languages which qualifies to be called FGH-MT [17].

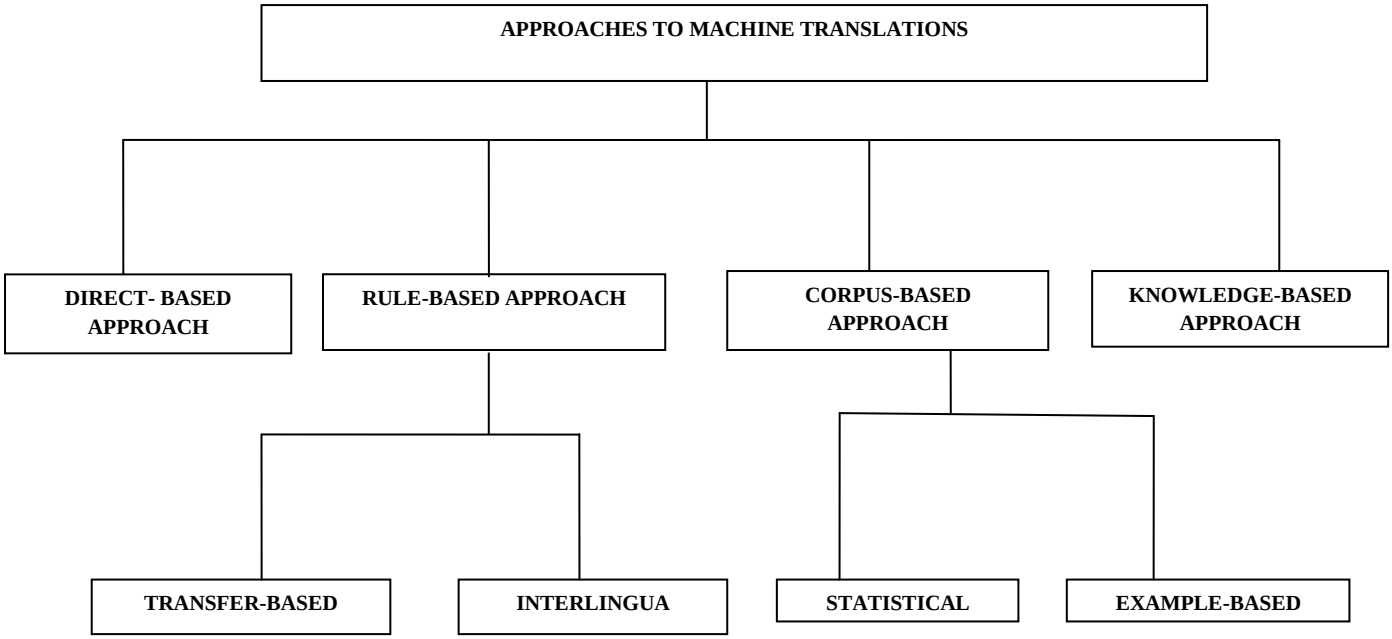

Fig 1: Approaches to Machine translations

3. PROBLEMS IN MACHINE TRANSLATIONS

There are several structural and stylistic differences among languages which make automatic translation a difficult task. Some of them are:

3.1 Word Order: word order in some languages differs. Some languages have the order SVO (Subject Verb and Object) in a sentence. While others have word order as SOV (Subject Object and Verb). When two languages have different word order, word to word translation is usually difficult in such cases.

3.2 Word Sense: In some languages, the same word may have different senses when being translated. The selection of right word specific to the context is important for example bank means river as well as financial institution in English language. Likewise, different word senses will likely translate into different words in another language

3.3 Pronoun Resolution: the problem of not resolving the pronominal references is important for machine translation. Unresolved references can lead to incorrect translation for example, translators should know when to use `she' or `he' or `it'?

3.4 Idioms: Idioms exist in every language and they are not taken literally and because of idioms developing translators for languages may be difficult. In many languages an idiomatic expression may convey a different meaning than what is evident from its words. For example an idiom in English language, "the ball is in your court" would not convey the intend meaning when translated to other language.

3.5 Ambiguity: in computational linguistics, word sense disambiguation (WSD) is an open problem of NLP, which governs the process of identifying which sense of a word (that is meaning) is used in a sentence, when the word has multiple meanings.

4. RELATED WORKS

Web-Based English to Yoruba Noun-Phrases Machine Translation System was proposed by [1]. She was motivated by the need to reduce the extinction threat of the Yoruba language which is one of the major indigenous languages in Nigeria, by providing a global platform for the language and the need to have an automated machine translation system for the language. Rule-based approach was used and the formulated rules were specified using context-free grammar, then finite state automata was used to formulate computational model and also for recognizing the grammar of the language. The approach used was rule-based.

Telugu to English translation using direct machine translation approach was proposed by [18]. They were motivated by the fact that, there are many translation systems for translating from English to Indian Languages but very few for vice-versa, and also by the need to convert Telugu sentences to its equivalent English sentence and expand grammatical usage of the language. The use of direct machine translation, a primitive approach for the development. The development was based on dictionary entries, where words are translated as they are by a dictionary. The method employed does not require human post-editing in most cases. A limited dictionary of Telugu to English with over 2000 words was developed with the direct approach.

English to Yoruba Translation system using rule-based approach to machine translations was developed by [3]. He was motivated with the need to contribute to knowledge in machine translations by experimenting with an African language the Yoruba language, and the need to address problems of English to Yoruba machine translator and make information available to a global audience. Text corpora were collected from home domain, context-free grammars were used to model the two languages, re-write rules and parse tree were also used. Automata theory was used to recognize the computational problem underlining the translation process. The approach used was rule-based.

Designed and development of a Malayalam to English Translator a Transfer Based Approach was proposed by [9]. Motivated by the need to use a more flexible machine translation approach to develop Malayalam to English translator and the need to improve on existing machine translation works. Transfer approach developed on a rule-based architecture combined with linguistic knowledge components of both Malayalam and English was used. The system includes preprocessor for splitting the compound words, morphological parser for context disambiguation and chunking and a bilingual dictionary. The technique of artificial intelligence was also employed in the development. The System was rule-based.

Using statistical machine translation as a language tool for understanding the Yoruba language was proposed by [19]. They were motivated by the fact that a lot of research has been done on machine translations but little or no attention has been paid to local languages of developing countries like Nigeria, and the need to provide tools that could tackle the problem of language translation between English and Yoruba, lack of parallel corpus for English to Yoruba and the lack of SMT translator for English to Yoruba. In this work, translations were generated on the basis of statistical models whose parameters were derived from the analysis of bilingual text corpora. Language model and translation model for the system involved the use morphological analyzer. Lexical dictionaries were also used. English to Yoruba Bible was used for corpus and bilingual text aligner was also used. Moses open source toolkit was used as decoder. The system was evaluated with BLEU and NIST metrics. The approach was Statistical-based.

A Review on a Web-Based Punjabi to Hindi Statistical machine translation was developed by [2], they were motivated by the need to improve on existing approaches of translating Punjabi to Hindi and the need to remove barrier of communication between Punjabi and Hindi. Statistical machine translation approach which is based on statistical models and in which a word is translated to one of a number of possibilities based on probabilities was used in the development. The whole process was performed by dividing sentences to N-grams. Statistical system analyzed the position of N-grams in relation to one another within sentences. The approach was Statistical-based

An Efficient Machine Translation System for English to Indian Languages using Hybrid Mechanism was proposed by [15]. They were motivated by the following: complexity of automatic translation of Indian languages, failure of the rule-based approach to attain satisfactory performance for large scale application and the need to have a more robust and sensible system which will be resistant or impervious to failure regardless of user's inputs. In this work, rule-based approach was used to form linguistic rules of the source language, context free grammars (CFG) were used in generation of the language structures and then the errors in the translated sentences were corrected by applying a statistical technique. The proposed hybrid machine translation system was evaluated using BLEU and NIST evaluation metric. The approach was hybrid-based.

English to Malayalam Machine Translation using the hybrid approach was proposed by [12]. Their motivations were: low availability of machine translators for English to Malayalam language pair and low availability of electronic resources for Malayalam language. A statistical machine translator performs translation by applying machine learning techniques on the corpus. The translation memory caches the recently performed translations in memory and eliminates the need for performing redundant translations. The system is implemented and evaluated using BLEU score and precision measure and the hybrid approach is found to improve the performance of the translator. Open source tools such as IRSTLM, GIZA++, Moses decoder etc. were used in this work for implementing the proposed system. The tools were installed in Ubuntu 10.04 operating system environment. The approach was hybrid-based.

Towards a Hybrid Rule-Based and Statistical Arabic-French Machine Translation was developed by Fatiha [4], motivated by the need to build the first Arabic-French phrase–based machine translation system, the need to carry out pre-processing of the source language in order to improve the quality of translation and the need to deal with the complexity and ambiguity of the source language to boost the efficiency of the translation system. The proposed SMT system used a simple stemming algorithm based on finite-state automata to split Arabic words into prefixes, stem and suffixes. The introduced morphological rule was to reduce the morphology of Arabic to a level that makes it closer to that of the French language. Method for POS tagging and segmentation of Arabic texts showed a significant improvement in terms of BLEU score.

Chinese-to-Spanish Rule-Based machine Translation System was proposed by [6]. They were motivated by the need to develop the first freely available Chinese to Spanish machine translation system due to the interest of companies, tourists, students etc for translation system between these two of the most spoken languages in the world and also due to the fact that, few works are available in academic research on these pair of languages. The work was based on rule-based machine translation in which the translation process was divided into: analysis, transfer and generation. The analysis and generation cover mainly the morphological and semantic variations of the languages. The transfer phase is in charge of the grammatical aspect.

Rule-Based Statistical Hybrid Machine was developed by [14]. They were motivated by the need to analyze the difficulties that lead to low performance of the available English to Tamil Machine Translation System and the need to improve on the output of the existing English to Tamil machine translation system. Statistical approach that dynamically generates the grammar rules without language expert and bilingual dictionary was used. Statistical approach with translation, language models and decoders. The approach was statistical-based.

Rule-Based Machine Translation of Noun-Phrases from Punjabi to English was developed by [7]. They were motivated by the need to provide text to text automatic translations of noun-phrases from Punjabi to English which will be machine based and in which the degree of accuracy will be measure. The system uses a rule-based approach which involve the transfer architecture which not only translates at the lexical level like the direct architecture but also syntactically and sometimes semantically. The steps involved are pre- processing, tagging, ambiguity resolution, translation and synthesis of words in target language, morphological analyzing and tagging, the use of bilingual dictionary. The system is based on the transfer approach, with three main components: an analyzer, a transfer component, and a generation component. The approach was rule-based.

Rule-Based Breton to French Machine Translation System was proposed by [5]. He was motivated by the fact that, there

is need to provide intelligible translations into French of texts published in the Breton language media and the need to translate everything published in Breton to French so as to produce gisting translations for better understanding. The system uses a rule-based approach which involved the development of morphological analyzer, bilingual dictionary and some transfer rules, a new analyzer was developed for Breton and also a gisting translation for Breton to French. The approach was rule-based.

English to Hindi Statistical Machine Translation System was developed by [11]. Motivated by the language barrier in the sidelines of digital age and the fact that, most of the contents available in digital format are in English language. Software available in Linux was used to develop language, translation model and decoder, SRILM for language model, Giza ++ for translation model and Moses for decoding. The language model computes the probabilities with respect to the target language; the translation model computes the probabilities regarding the substitution of target language words with source language words. The system was statistical-based.

Web-Based Hindi to Punjabi Machine Translation System was proposed by [17]. The motivation of this work was to digitize the existing traditional dictionaries and build an exhaustive lexicon consisting of Hindi words along with its corresponding translated version of Punjabi and extend the lexicon with large Hindi corpus. The system uses a direct approach to machine translation which involves word for word translations of Hindi word to Punjabi and was able to provide up to 95% accuracy.

Statistical Machine Translation Based Punjabi to English Transliteration System for Proper Nouns was proposed by [13]. They were motivated by the need to remove the language barrier for communication by using Statistical Machine Translation System to transliterate proper nouns in Punjabi to its equivalent in English. The system uses Statistical Machine Translation to transliterate proper nouns with the help of n-gram approach which include the use of unigram, bi-gram, tri-gram, four-gram, five-gram and six-gram respectively for transliteration. **T**ransliteration of proper nouns of Gurumukhi script into English was done and the overall accuracy of the system was good.

Table 1: Tabular View of the Summary of Reviewed Works on Machine Translation Approaches

S/N	Researcher (s)	Motivation (s)	Approach
1.	Adeoye (2012)	Need to reduce the extinction threat of Yoruba language by providing a platform for the language.	Rule-Based
2.	Amarpreet Kaur et al (2014)	The need to remove barrier of communication between Punjabi and Hindi.	Statistical-Based
3.	Eludiora (2014),	Need to contribute to knowledge in machine translations by experimenting with an African language (Yoruba language).	Rule-Based
4.	Fatiha (2013),	The need to build the first Arabic-French phrase–based machine translation system,	Statistical-Based
5.	Folajimi et al(2012)	A lot of research has been done on machine translations but little or no attention has been paid to local languages of developing countries like Nigeria.	Statistical-Based
6.	Francis, (2010)	Need to provide intelligible translations into French of texts published in the Breton language	Rule-Based
7.	Jordi et al (2014)	The need to develop the first freely available Chinese to Spanish machine translation system	Rule-Based
8.	Kamaljeet et al (2010)	The need to provide text to text automatic translations of noun-phrases from Punjabi to English which will be machine based	Rule-Based
9.	Latha et al (2012)	Need to improve on existing machine translation works by the use of a more flexible machine translation approach to develop Malayalam to English translator.	Transfer-Based
10.	Nakul Sharma (2011).	The language barrier in the sidelines of digital age. Most of the contents available in digital format are in English language.	Statistical-Based
11.	Nithya et al, (2013)	The low availability of machine translators for English to Malayalam language pair and low availability of electronic resources for Malayalam language.	Hybrid Approach
12	Pankaj et al (2013)	They were motivated by the need to remove the language barrier for communication	Statistical-Based
13.	Priyanga et al (2013)	The need to improve on the output of the existing English to Tamil machine translation system.	Statistical-Based
14.	Sangeetha et al, (2014)	The need to have a more robust and sensible system which will be resistant or impervious to failure regardless of user's inputs.	Hybrid Approach
15.	Venkateswara et al (2013)	Many translation systems for translating from English to Indian Languages but very few for vice-versa.	Direct Approach
16.	Vishal et al (2010)	Need to digitize the existing traditional dictionaries and build an exhaustive lexicon consisting of Hindi words along with its corresponding translated version of Punjabi.	Direct Approach

5. CONCLUSION

From our reviewed works, researchers working on machine translations have approached it in various ways which are: direct approach, rule-based, statistical and hybrid. The two major goals in any translation system development work are accuracy and speed of translations. However most researchers failed to evaluate the accuracy and speed of their systems. Accuracy and speed of these systems must therefore be put into considerations by future researchers. Also, translation works for languages can further be enhanced by researchers if they can endeavor to combine two or more approaches so as to be able to achieve more robust systems and these systems can also be made mobile application based to allow for effective usage and dissemination.

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