TEMPORAL QUESTION ANSWERING SYSTEM: A SURVEY

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Abstract : **Question Answering (QA) system is a field of Natural language processing, which allows users to ask questions using the natural language sentence and return a brief answer to the users rather than a list of documents. One type of QA systems is Temporal Question Answering system. Time is an important dimension in any information system. Time-specific information embedded in document in the form of temporal expressions. Temporal expressions are words or phrases that describe a point, duration in time. Extraction of these expressions from raw text is used for a wide range of information retrieval tasks such as Summarization, Question Answering and other tasks. In this paper we give a survey of Temporal Question Answering system which focuses on answering temporal questions posted by humans in natural language.**

Index Terms - Information Retrieval, Temporal Question Answering.

I. INTRODUCTION

Question Answering (QA) system can automatically and accurately answer the questions posed in natural language. The end user of this system is interested to receive direct answer to an information need. The sources of information for QA system are documents, audio, text, files or databases.

The QA system may be broadly classified as Restricted Domain Question Answering (RDQA) and Open Domain Question Answering (ODQA). RDQA systems answer questions posed by users in a specific domain which rely on manually constructed data or some knowledge sources. ODQA focuses on answering questions apart from the subject domain which extracts from a large corpus of textual documents which may be semi-structured or unstructured [9].

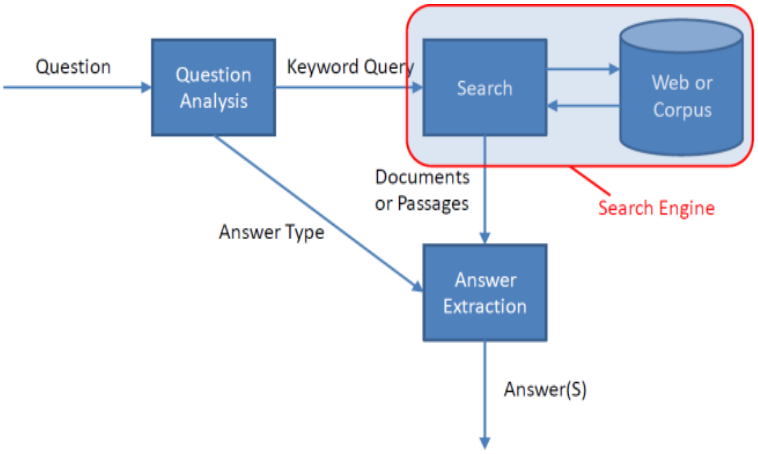

Fig: 1 Architecture of ODQA system

Fig. 1 shows the architecture of Open Domain Question Answering system (ODQA). The architecture of ODQA system consists of three components. 1. Question Analysis, 2. Information retrieval/Search Engine, 3.Answer extraction.

Question Analysis: In this block, keywords of the question are extracted. The question type is identified by the "interrogated/question words" like *What, Where, Why, etc.*, Question is classified as factoids, list, definition, hypothetical, causal, relationship, procedural and confirmation question. A factoid question is a question, which starts with a Wh-interrogated word (What, When, Where, Who) and requires a fact expressed in the text as an answer. A list question is a question, which requires list of facts or entities as an answer. A list question usually starts as List and Name. A definition question is a question, which requires the definition of the specific term in the question and usually starts with 'What is'. The opinion question focuses the opinion about an entity or an event. A hypothetical question is a question, which requires information about a hypothetical event and has the form of 'What would happen if'. A causal question requires explanation of an event, like why. A relationship question asks about a relation between two entities. A procedural question is a question, which requires as an answer a list of instructions for performing the task mentioned in the question. A confirmation question is a question, which requires a Yes or No as an answer to an event expressed in the question [9].

The Information retrieval component extracts the passages and documents which is relevant to the question keyword. The answer extraction component takes the input from Question Analysis component which suggests the type of answer expected. The answer is extracted from the passage with the keywords available in the question and type of answer expected.

"What is the capital of India?" is an example of the factual questions. The answer expected is the name of a city. The "wh" word *What* is used for identifying the type of answer. The keywords like "capital" and "India" are given to the search engine to get the document relevant to the keywords supplied. With the relevant document and type of answer expected, answer is extracted from the passage.

Research has moved forward from simple question answering to complex question answering system, especially complex temporal question answering system [17].

To answer a "when" question the system needs to temporally anchor the event, and to answer a "how long" question the system needs to measure the duration of the event [18]. Effective treatment of temporal expressions has a strong impact on the capability of a system to deal with specific classes of questions, such as those asking for the DATE of a particular event. Current QA system would suffer to answer questions like "When Dr. M.G.R. sworn in as Chief Minister for the first time?", "When does the seminar take place?" [12]. Processing this sort of questions is usually performed by identifying explicit temporal expressions in questions and relevant documents, in order to gather the necessary information to answer the queries.

Answering questions like "What Dr. Abdul Kalam did after he served as scientific adviser to the defence minister?" is even more complex than the previous examples.

To answer this type of questions Temporal Question Answering systems were developed by the researchers. Temporal Question Answering system focuses mainly on answering temporal questions given by users in natural language.

Temporal QA Systems: Temporal QA implies answering questions such as listing which events happened after some event or time, inferring when some event occurred in time or with respect to other events, etc [7].

Given a text in natural language, understanding the temporal information requires anchoring and ordering the events of the text in time. Anchoring of events requires the development of annotations schemes and the construction of annotated corpora.

Processing questions that involve temporal inference relies on (1) the recognition of events/states and of entities that participate in them; (2) the relative ordering of events in the question and in the texts; (3) the temporal properties of the entities being questioned; and (4) identification of the expected answer and its relations to temporal expressions mentioned in the question or candidate answers [8].

1.1 Temporal Expressions

Temporal expression can be grouped into four types: date, time, duration and set.

Date Expressions: A date expression refers to a point in time of the granularity "day" (e.g. "June18, 2015" or any other coarser granularity, like "month" (e.g., "June 2015") or "year" (e.g., "2015"). In other words these can be calendar dates (e.g. "January 4") and other verbal expressions which can be mapped to calendar dates (e.g. "Last week", "This month", "next Friday", or "this time").

Time Expression: A time expression refers to a point in time of any granularity smaller than "day" such as a part of a day (e.g., "Friday morning") or time of a day (e.g., "3:30 pm"). In another words TIME is used for specific time points within a day, for instance, "4.05 AM", or can be relative "20 minutes ago".

Duration: A duration expression provides information about the length of an interval i.e. The amount of intervening time between the two end-points of a time interval. Example of Duration expressions are "ten hours", "last 5 months".

Set/Frequency Expression: A set expression refers to the periodical aspect of an event, For e.g. "every Friday", "thrice a day"). Medical Documents like discharge summaries have various frequency terms denoted by Latin abbreviations such as, "tid (thrice a day)" , "q4h (every four hours)".

Occurrences of Temporal expressions

Documents contain implicit and explicit temporal information that can be utilized in the retrieval process. An explicit temporal expression given in a document can be mapped directly to a time point or interval, such as dates or years on the Gregorian calendar (eg: "July 4, 2014" and "January 1, 2015"). An implicit temporal expression is given in a document as an imprecise time point or interval. For example, "Independence Day 2014" and "New Year's Day 2015" are implicit expressions that can be mapped to "August 15, 2014" and "January 1, 2015" respectively. A relative temporal expression occurring in a document can be resolved to a time point or interval using a time reference, either an explicit or implicit temporal expressions mentioned in a document or the publication date of the document itself. For example, the expressions "this Monday" and "next month" are relative expressions, where their exact dates can be determined using the publication date of the document [11].

Furnishing the fundamental information that is needed for Temporal Question Answering System the paper has been organised as section I which gives the introduction about Question Answering System. Section II gives the related works in Temporal Question Answering System. Finally section III describes about discussions and future work.

II. Temporal Question Answering System

Estela Saquete et. al. (2004) [17] presented a system with a multilayered architecture which improves the system to handle the complex questions. This system focuses decomposition of complex questions. The main components of the Temporal Question Answering System are top-down: Question Decomposition Unit, General purpose Q.A. system and Answer Recomposition Unit. *The Question Decomposition Unit* performs three main tasks. Firstly, the recognition and resolution of temporal expressions in the question. Secondly, the type of the question need to be identified. After that, types 3 and 4 complex questions are splitted into simple ones. This simple question are used as the input of a General Purpose Question-Answering system. The complex questions split into two simple questions by means of the detection of temporal signals. For example consider, what happened to the world oil prices after the Iraqi annexation of Kuwait? In this example, there is no transformation in the first simple question. But the

latter one needs to be transformed. This can be done by adding the words when did.....occur?. So it also changed to a simple question as When did Iraqi annexation occur?. Simple factual questions which are generated, are processed by a General Purpose Question Answering system. Any Question Answering system could be used._ *The Answer Recomposition Unit* is the last stage in the process. This unit finds the answer to the original question from the answers to the sub-questions and the temporal information extracted from the questions (temporal signals or temporal expressions). From this, the correct answer to the original question is returned. The performance of splitting complex questions into simple questions, shown in terms of precision and recall 85% and 75% respectively.

Estela Saquete et. al. (2006) [18] presented a method of event ordering based on temporal information resolution. This system consists of three main units: temporal expression recognizing, resolution of the coreference introduced by these expressions, and event ordering. The texts are tagged with lexical and morphological information and this information is given as the input to the temporal parser. Once the parser recognizes the TEs in the text, these are introduced into the resolution unit, which will update the value of the reference according to the date it is referring and generate the XML tags for each expression. The event ordering module runs over the text building a matrix with the complete information from the XML tags. This matrix includes the columns ID, VALDATE1, VALTIME1, VALDATE2, VALTIME2, and VALORDER. The system will assign a sequential order number to every TE in the matrix, having the same order number for concurrent TEs. Then, the document is re-tagged including this order number in the VALORDER attribute for every XML tag. Although the results are high, this system does not use semantic or context information. And also, it is not able to resolve well known event in temporal expressions like "two days before the Olympic games".

Harabagiu and Bejan's work (2005) [8] build Question Answering system that involves all types of inference. First, inferring the relation between the temporal expressions and the events. Second, semantic inference to match the terms in the question and the document. Third, temporal inference to find the answer for temporal questions. In this system, semantic inference plays major role in finding the answer for the questions accurately.

Estela Saquete et. al. (2009) [1] presented a system with multilayered architecture which enhanced the capabilities of current QA systems. A specialized layer is designed with two steps: (i) Complex question decomposition Unit - Questions are decomposed into simple questions (sub-questions) based on the temporal signal which relates the events. The first sub-question (Q-Focus) gives the type of information the user needs to retrieve. The answer to the second sub-question (Q-Restriction) establishes the temporal restrictions on the list of answers given by the Q-Focus. The question (Q-Focus) and the question (Q-Restriction) are the input of a QA system (ii) Question recomposition Unit - Answers to the Q-Focus and Q-Restriction, given by the QA system, are filtered and compared and found the final complex answer. The Multilayered QA system obtained an overall F-measure of approximately 65% for English

Naushad UzZaman et al. (2012) [4] implemented to perform temporal reasoning. This system developed mainly to evaluate automated temporal information understanding. It can be used to answer temporal questions like factoid, list and yes/no about any document which are annotated in TimeML annotation scheme. These questions are answered only through Timegraph which is constructed from temporal relations. The results concluded that the performance of the system increases only by Temporal reasoning.

Sanampudi S.K., Guda V. (2013) [19] designed a model which is integrated with search system for specific time relevant questions. This model defines functionality process into two major steps with respect to the process of adequate response. The question is processed by decomposition unit to identify important components in the question. Answers are extracted and integrated to eruct the final answer for a given question.

Zeineb Neji et. al.(2016) [20] proposed a methodology to compute temporal inference for QA system for Arabic language. This approach involves three main modules. They are (1) question processing for interpreting the question, its temporal requirements and selecting candidate answers, (2) document processing, which includes indexation based on temporal information, finally (3) answer processing, where temporal inference is used to get the answer.

Zhen Jia et al. (2018) [21] created a Temp questions corpus containing 1,271 questions with answers which are temporal in nature. This questions are developed from Free917,Web questions and Complex Questions. This brings a benchmark for Temporal Question Answering.

III. DISCUSSION

This study presents a survey on Temporal Question Answering System. Most of the systems worked in temporal annotation to extract temporal information from raw text. Only some of the systems concentrated on Temporal Question answering system. In that, few worked with the raw text as input and remaining with annotated features. In this context, we can see some of the issues faced in temporal question answering system.

(i) General purpose QA system like START cannot answer the complex questions compared to Temporal QA system [1].
(ii) To identify the event occurrence correctly in the text, we need semantic information or context in the text [18].
(iii)Well known event in the temporal expression need to be resolved [18].
(iv) Question ambiguities : for example: "What did Besson work on before his marriage to Jovovich?" could be interpreted as asking about the movie Besson working on or all movies he was working on before his marriage. It is difficult to understand the natural language questions with such ambiguities [21].
(vi) Identifying Temporal relations in the text is more difficult. Some of the systems dealt only with 3 relations like before, after, vague [8].

The following issues need to be considered while the system answering the temporal questions. As future work the performance of the system can be improved by identifying the temporal relations accurately in the document. Still the system needs deep understanding of temporal structures in document.

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