This Graph-based Self-Adaptive Conversational Agent

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Abstract

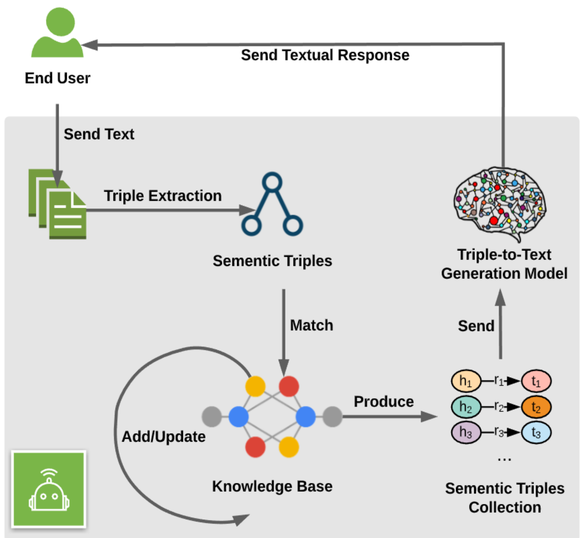
we propose a graph-based adaptive conversational agent model which is capable of learning knowledge from human beings and adapting the knowledge-base according to human-agent interactions. Studies to evaluate the proposed model are conducted and presented, which compare the responses from the proposed adaptive agent model and a conventional agent.

Introduction

To address the limitations of existing Conversational Agents, we propose a novel conversational agent model, named Graph-based Self-adaptive Conversational Agent (GSCA). The proposed model enables the agents to learn from the human-agent interactions, continuously enriching the knowledge base. We represent agents' knowledge base as a dynamic and transparent knowledge graph, where the nodes denote key entities and links that describes the semantic relationship. On top of that, to obtain appropriate responses, we develop a temporal-based triple extraction algorithm for GSCA, where Google T5 has been utilized for text generation.

Advantages of GSCA

- GSCA is capable of retaining and recalling knowledge obtained from the conversations.
- GSCA has the automatic adaptive skill; notably, it carries memory and knowledge, also consider the time-series context.
- GSCA's knowledge base can be revise and updated without retraining.



GSCA Framework

Semantic triples will be extracted using information extraction techniques. Triples $F = \{f_1, f_2, ..., f_n\}, n \in \mathbb{N}$ can be represented as a collection of facts, and each fact comprises three entities ε, i.e., $f_x = (hx, rx, tx), f_x \in F$, where $h_x, rx,$ and t_x represent head, relation and tail of f_x, respectively. In GSCA, each entity $\varepsilon \in \{h, r, t\}$, has been granted with enriched features, including the last accessed time $\tau\varepsilon$, frequency of being visited $\omega\varepsilon$ and attention degree $\eta\varepsilon$. Specifically, the attention degree of any entity $\eta\varepsilon$ can be derived by using a time decay function, i.e., $\eta\varepsilon = e^{-\alpha \Delta\tau}$, $\alpha > 0$, where $\Delta\tau = \tau\varepsilon - \tau no\ w$ and α describes a constant controlling the degree of decay.

Conversation Examples

Topic	Input Sentence	Retrieved Triple	Reply Text
Artist	Aaron turner is a friend of Billy.	"aaron turner" "be friend of" "aaron deer"	Aaron turner was a friend of Aaron Deer.
Artist	Hip hop music is very popular.	"hip hop music" "be genre of" "rap music"	Hip hop music is a genre of rap music.
Artist	Billy performs rap music.	"Billy" "perform" "hip hop music."	Billly performs hip hop music.
Food	Almond is brown colour	"almond" "be" "flowering plant"	Almond is a flowering plant.
Food	Almond has colour	"Almonds" "be from" "rosaceae family"	Almonds are from the rosaceae family.
Food	Almonds is food.	"sandwich" "be" "food"	The sandwich is a food.

Temporal-based Triple Retrieval (TTR) Algorithm

- Vectorized entities of a fact:
  $f_{x'} = v(h_x), v(r_x), v(t_x))$

where v (.) indicates a function, converting a token into a vector.

- Estimate the distance between the hypothesis triple and existing triples:
  $$dis(f_i, f_j) = \sum_{\varepsilon \in \{h,r,t\}} w_\varepsilon \cdot sim(v(\varepsilon_i), v(\varepsilon_j))$$

Where $sim(\varepsilon_i, \varepsilon_j)$ denotes the cosine similarity between ε_i and ε_j :

$$sim(\varepsilon_i, \varepsilon_j) = \frac{v(\varepsilon_i) \cdot v(\varepsilon_j)}{||v(\varepsilon_i)|| \times ||v(\varepsilon_j)||}$$

While w_ε balances the trade-off among h , r and t. With a restriction of $\sum_{\varepsilon \in \{h,r,t\}} w_\varepsilon = 1$.

- The agent identifies potential answer triples with extracted triples and the connected siblings. Given hypothesis triple f_i , the confidence score of an identified triple. $f_j = (h_j, r_j, t_j)$ can be derived from distance $dis(f_i, f_j)$, normalized frequency of being accessed $\omega\hat{}\varepsilon$ and attention degree of the entity $\eta\varepsilon$, where. $\varepsilon \in \{h_j, r_j, t_j\}$.

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