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Notes:

- The actual research work will be referred to as ‘this research paper’, ‘this study’, or ‘this work’ throughout this document.
- The below abstract tries to answer some of the basic research questions as a comprehensive story with technical and real-world examples.
- The outline includes details of what content will be presented in the final research paper. There could be additions or modifications to the headings listed in the final research paper.

TOPIC

SmartRec - Smart Conversational Recommendation System using Semantic Knowledge Graphs

ABSTRACT

Conversational recommendation systems (CRS) intend to return the best recommendations to users through a multi-turn interactive conversation. CRS allows users to provide their feedback during the conversation, unlike the traditional recommendation systems. CRS can combine the knowledge of the predefined user profile with the current user requirements to output custom yet most relevant recommendations or suggestions [1]. Covid-19 pandemic has undoubtedly accelerated the pace at which many E-commerce platforms will adapt conversational agents for highly available customer support. This ongoing demand calls for the need to implement more generic and efficient conversational agents and recommendation engines that can provide customers with the required information at every stage of the conversation during the purchasing and issue-resolving cycle. This study will implement a Smart Conversational AI-based recommendation system - SmartRec. SmartRec can have a multi-turn conversation [2] with the user to understand the context and semantics behind their product requirement or issue reporting. SmartRec can generate appropriate recommendations or natural language response text suggestions based on the user queries. Although the diverse study is in progress for improving CRS [3], there are multi-faceted gaps that remain open for research. State-of-the-art CRS suffers from three main issues. Firstly, lack of proper contextual understanding of the user inclinations. (e.g., what is the current user goal when booking a vacation). Second, inaccurate semantic mapping of user preferences in natural language to the interested item attributes. Third, rely only on current conversation and suffer from data sparsity [4] by not incorporating historical user interactions for understanding the user profile. To overcome these issues, SmartRec will encompass a *context-aware semantic knowledge graph* that captures the current conversation,

past conversations, and product attributes to produce relevant and semantically meaningful responses to user queries. On top of this intelligent knowledge graph, this study will integrate a collaborative recommendation framework [5] and a dialog component [6]. This study will conduct experiments to evaluate machine learning, system performance, and user experience and compare them against best-in-class CRS [7]. State-of-the-art knowledge graph-based CRS's trained on large-scale multi-domain data but do not generalize well for a specific domain, lack features that can assist interactive conversations, and do not include historical user-item interactions. This work envisions building a novel CRS utilizing semantic knowledge graph and machine learning components, incorporating a hybrid response model which combines the ability to list product recommendations with suggestions for the reported customer issue. This work will curate a novel large-scale, domain-relevant, integrated dataset from different sources such as Airbnb tagged data from Twitter and Quora, public data released by Airbnb, including listings, user reviews, FAQs for experiments. Our CRS will incorporate preference understanding by current context, historical user interactions, and user engagement. This work intends the proposed system architecture to be generic and thus easy to train with data for different domains and adapted to a broad range of AI-enhanced customer service applications. The current study will be limited to textual conversation in English. Future extensions of this solution can incorporate image and video interactions, voice-based, and multi-lingual CRS, expanding the potential footprint of the solution to an even a broad range of applications and users.

OUTLINE

1. **Introduction**

   This section will present a general introduction to the problem area and the solution, the scale of the impact of this problem on the general public, real-life examples stressing the need for this study. The section will also highlight what part of the problem will be solved, the high-level technical details, and the advantages of the proposed system compared to the existing solution. This header will also present the organization of the rest of the paper.

2. **Related works**

   This section will provide an insight into the proposed solution and comparisons of existing research on conversational recommendation systems and semantic knowledge graphs.

3. **Project Justification**

This section will detail the justification of the proposed solution in this research and stress the innovative nature of the proposed methodologies with supporting arguments.

4. **Technical Aspects**

This section describes the technical aspects of the proposed algorithm and methodologies. This section will also go in-depth into the system design, explaining the functionalities of different components of the system and the corresponding input and output interfaces.

5. **Results**

This section will record the experiments conducted, settings and configuration parameters for re-running the experiments, and the results obtained. This section will also tabulate a comparison of the results obtained with the state-of-the-art CRS results.

6. **Conclusion**

This section will provide an overall conclusion of the approaches studied with an overview of the expected outcome, shortcomings, future extensions, and the application of the solution in customer service chatbots.

References

[1] Y. Zhang, X. Chen, Q. Ai, L. Yang and W. Croft, "Towards Conversational Search and Recommendation", *in Proceedings of the 27th ACM International Conference on Information and Knowledge Management,* 2018. Available: 10.1145/3269206.3271776 [Accessed: September 29, 2021].

The chosen work [3] is a research article from *ACM Journal Proceedings* targeted to benefit the general public, e-commerce. The paper proposes an innovative approach to recommend products based on the multi-turn interactive conversation with the user. My proposed scope of work will adopt this approach to implement multi-turn interaction to extract the user preferences.

[2] G. Li, J. Wang, C. Li and J. Feng, "Supporting efficient top-k queries in type-ahead search", in *Proceedings of the 35th international ACM SIGIR conference on Research and development in information retrieval - SIGIR '12*, 2012. Available: 10.1145/2348283.2348333 [Accessed: September 29, 2021].

The chosen work [4] is a research article from *ACM Journal Proceedings* that can benefit general search mechanisms, educators, students. The paper proposes an efficient approach to retrieve suggestions within milliseconds to complete typing based on the previously typed words. My proposed scope of work will adapt this technique to help the customers with different language fluency to help frame their questions.

[3] K. Zhou, W. Zhao, S. Bian, Y. Zhou, J. Wen and J. Yu, "Improving Conversational Recommender Systems via Knowledge Graph based Semantic Fusion", in *Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining*, 2020. Available: 10.1145/3394486.3403143 [Accessed: September 29, 2021].

The chosen paper [1] is a research article from ACM Journal Proceedings targeted to benefit the general public, e-commerce. The paper introduces a novel approach to enhance conversational recommendations by incorporating a semantic understanding between user-product preferences and product attributes using knowledge graphs. My defined scope of work will be to try to incorporate the semantic fusion approach proposed by the chosen paper to build the data intelligence into the recommendation and dialog engine.

[4] C. Wong et al., "Improving Conversational Recommender System by Pretraining Billion-scale Knowledge Graph", in *2021 IEEE 37th International Conference on Data Engineering (ICDE)*, 2021. Available: 10.1109/icde51399.2021.00291 [Accessed: September 29, 2021].

The chosen paper [2] is a research article from the *IEEE Internal Conference* targeted to benefit the general public, e-commerce. This paper introduces a novel approach to incorporate billion-scale data intelligence into conversational recommendation systems. My proposed scope of work will consider the chosen paper's training approach to train the machine learning models with large-scale data.

[5] X. He, L. Liao, H. Zhang, L. Nie, X. Hu and T. Chua, "Neural Collaborative Filtering", in *Proceedings of the 26th International Conference on World Wide Web*, 2017. Available: 10.1145/3038912.3052569 [Accessed: September 29, 2021].

The chosen work [6] is a research article from *ACM Journal Proceedings* that can benefit the general public, e-commerce. This paper details the efficiency of the deep neural collaborative filtering approach for recommendation systems. My scope of work will try

to adopt this technique to train the recommendation component via a collaborative filtering approach using neural networks.

[6] J. Gao, M. Galley and L. Li, "Neural Approaches to Conversational AI", in *The 41st International ACM SIGIR Conference on Research & Development in Information Retrieval*, 2018. Available: 10.1145/3209978.3210183 [Accessed: September 29, 2021].

The chosen work [5] is a research article from *ACM Journal Proceedings* that can benefit the general public, e-commerce. The paper surveys the state-of-the-art neural approaches to implement different types of conversational AI systems. This survey provides a comprehensive understanding of some of the drawbacks of state-of-the-art AI systems and gives a good direction towards my proposed work.

[7] "A novel deep hybrid recommender system based on auto-encoder with neural collaborative filtering", *Big Data Mining and Analytics*, vol. 1, no. 3, pp. 211-221, 2018. Available: 10.26599/bdma.2018.9020019 [Accessed: September 29, 2021].

The chosen work [7] is a research article from the *IEEE Journal & Magazines* that can benefit the general public, e-commerce. This paper introduces a novel approach to build a hybrid recommendation model using collaborative filtering and a content-based approach. My proposed work will try to extend this system to model a hybrid recommendation cum customer support system.