Improved Automatic Speech Recognition by Co-embedding Voice Queries and Voice Query Refinements

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Improving Automatic Speech Recognition by Co-embedding Voice Queries and Voice Query Refinements

ABSTRACT

Automatic speech recognition (ASR) models are used to recognize voice commands or queries from users in hardware products such as smartphones, smart speakers/displays, as well as applications that enable speech interaction, e.g., virtual assistant applications. However, the query abandonment rates for voice queries continue to be much higher than text queries which is often due to incorrect interpretation of the spoken query. This disclosure describes techniques to improve the performance of recognition of spoken queries by combining user specific phonetic variations and session specific contextual signals, obtained with specific user permission.

KEYWORDS

- Automatic Speech Recognition (ASR)
- Natural Language Understanding (NLU)
- Phonetic refinement
- Query rewriting
- Collaborative filtering
- Deep Neural Network (DNN)
- Virtual assistant
- Smart speaker
- Voice query
- Spoken query
- Speech transcription
BACKGROUND

Automatic speech recognition (ASR) models are used to recognize voice commands or queries from users in hardware products such as smartphones, smart speakers/displays, as well as applications that enable speech interaction, e.g., virtual assistant applications. However, the query abandonment rates for voice queries continue to be much higher than text queries which is often due to incorrect interpretation of the spoken query. For example, the voice query ‘Play tutorial of Hidden Markov Model’ might get recognized as ‘Play tutorial of hiccup half a poodle,’ resulting in the user abandoning the voice query and switching to text input.

Automatic speech recognition is a complex problem that requires correct processing of the acoustic and semantic signals from the voice input. A typical ASR system includes an acoustic model that transforms the audio signal into a feature vector, and a language model that uses the features to obtain a meaningful utterance by referring to a language and context specific vocabulary. The acoustic model is designed to account for the variation in pronunciation across users and languages, while the language model is designed to account for the semantic differences across contexts within a language.

Prior queries made by a user within a session are useful in determining the context within which the subsequent queries are likely to be made. However, such information is hard to incorporate in conventional ASR models.

DESCRIPTION

This disclosure describes techniques to improve the performance of recognition of spoken queries by combining user specific phonetic variations and session specific contextual signals, obtained with specific user permission. For example, contextual signals can include the successful and abandoned queries earlier in the session. The solution described in this disclosure
employs a two tower deep neural network architecture, which is a generalization of collaborative filtering.

One of the DNN towers represents the user, while the other tower represents the current session. The user tower includes successful queries issued by the user in previous sessions and multiple phonetic refinements of these queries. The query tower includes data from the queries issued by the user in the current session. For all queries in the current session, the query tower captures whether the query was successful or abandoned. For an abandoned query, the query tower also captures the successful query that follows it.

![Diagram of query interpretation process](image)

**Fig. 1: Example process to correct query interpretation based on phonetic replacement and past ASR data**
Fig. 1 illustrates an example process for improvement in automatic speech recognition, per techniques of this disclosure. User permission is obtained to utilize data such as past queries by the user for the specific purpose of query refinement. If the user denies permission, or restricts permission to certain data, only such data as permitted by the user are used for query interpretation.

When a new user query is received (102), an initial interpretation of the audio signal (104) is generated. In the example shown in Fig. 1, the user’s query “Play Beyonce song Spirit” (shown in blue) is incorrectly interpreted as “Play beyond song Spirit” (shown in red). The initial interpretation is then further analyzed using a two tower deep neural network (DNN) to generate a refined query interpretation.

User specific features including the user’s past queries and their phonetic refinement are obtained (106) from the user tower, to generate the user context (108). Session specific information including prior abandoned queries in the session are obtained (110) from the query tower to generate the session specific query embedding (112).

Using the user context and session specific query embedding, collaborative filtering techniques (e.g., weighted average least squares - WALS) are applied (114) are applied to generate the refined query interpretation. In the illustrated example, the refined query interpretation (shown in green) matches the original user query. Nearest neighbor refinement may be obtained based on past queries in the session and used to rewrite the query. Per the described techniques, the context signals and query refinements are in the same embedding space.
Training of the model is performed using query pairs that include an abandoned voice query that is followed by a successful query. Such query pairs of training data are utilized with specific user permission.

The described techniques for query interpretation can be utilized in any application, e.g., a virtual assistant activated by voice, a media application that accepts voice input, that is provided on a device such as a computer, smart speaker, smart display/TV, smartphone, or other smart appliance. Reduction in speech recognition errors can help improve the user experience and increase user engagement for such applications.

Further to the descriptions above, a user is provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information (e.g., information about a user’s spoken input such as queries or commands, whether a query was successful or not, a user’s preferences), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user’s identity may be treated so that no personally identifiable information can be determined for the user. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques to improve the performance of recognition of spoken queries by combining user specific phonetic variations and session specific contextual signals, obtained with specific user permission.
REFERENCES

