**What is BERT-FlowDelta?**
- A multiturn question and answer model that captures human conversation more accurately than single turn models
  - The flow of human conversation (i.e. how topics change) is captured by passing the difference of two previous hidden states
- The Modular Annotation team, built a tool to produce data to further fine-tune the model in the future

**Model Improvements**
- Originally, when provided with user-generated questions containing word negations, the model provided nonsensical and inaccurate responses
  - To improve this, we gave the model user-generated questions that contained negations, validated model answer output, and formatted the answer output to be used as training data

**Improvement Process**
- Created question and answer pairs (annotations) from Lincoln Aviator Ford manual
- Fine-tuned using annotations which validated model answer output and formatted model response to be used as training data
- Fine-tuned the model response accuracy (F1 score) of 66.4 using Ford Data to an overall score of 70.7 in the fine-tuned model
- Expanded model capabilities by integrating NL2SQL to provide model responses from vehicle manual tables
- Code was readily accessible online with multiple published papers discussing the effectiveness of the model
- Relatively high rank on both CoQA and QuAC Datasets compared to other NLP models

**Integrating NL2SQL with BERT-FlowDelta**

**Motivation:**
- Ability to generate answers from the tables inside the Lincoln Aviator Manual

**Requirements:**
- Database: A collection of 176 tables extracted from the Lincoln Aviator Manual
- Metadata table with entities that reference all other tables by a unique identifier (uuid)
- Natural Language question
- The corresponding SQL query (generated by X-SQL model)

**Updated Question/Answer System Pipeline**

1. **Question:** A user generates a question, and that question gets fed into the IR system.
2. **IR System:** The IR system uses encoding to narrow down the owner manual by returning only the most relevant paragraphs.
3. **X-SQL:** If a table identification is returned, the X-SQL model generates an SQL statement based on the question input which then will query the information from that table.
4. **Answer:** Information that is returned by the SQL query becomes the newly updated answer outputted to the user. If X-SQL was not used, the IR system will highlight the part of the Ford Owner Manual text that was used as the answer from BFD.

**Future Goals**
- Merge the Modular Annotation Tool with BERT-FlowDelta
- SQL Query rejection model integration

**Model Improvement Results and Conclusions**

**Fine-tuning Results**
- Assigned a score to the performance of the model question-response accuracy (F1 score).
- Base model (3 epochs):
  - Ford F1: 36.7
  - Overall F1: 56.4
- Fine-tuned model (3 epochs):
  - Ford F1: 66.4
  - Overall F1: 70.7

**Conclusion**
- The F1 score of the base model (pre-training data), fine-tuned model, and overall scores shows that the model was considerably improved due to the data produced by our team. In addition, the NL2SQL integration will help the model answer customers’ questions better by gathering information from both the main text and the tables inside the Lincoln Aviator Manual.

**Future Goals**
- Merge the Modular Annotation Tool with BERT-FlowDelta
- SQL Query rejection model integration

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