NL2SQL: NLI Matching Model

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Introduction

Summarizing SQL patterns from training data, identify which pattern matches the input question and construct SQL with question and pattern.

What is a Pattern?

A SQL stripped down to skeleton. For example:

Question: "**Find the name of customers who are living in Colorado.**"

```
SELECT t1.customer_name FROM
customers AS t1 JOIN
customer_addresses AS t2 ON
t1.customer_id  =  t2.customer_id
JOIN addresses AS t3 ON
t2.address_id  =  t3.address_id
WHERE t3.state_province_county  =
"Colorado"
```

SQL

```
SELECT {COLUMN}
WHERE {COLUMN} = {VALUE}
```

Pattern

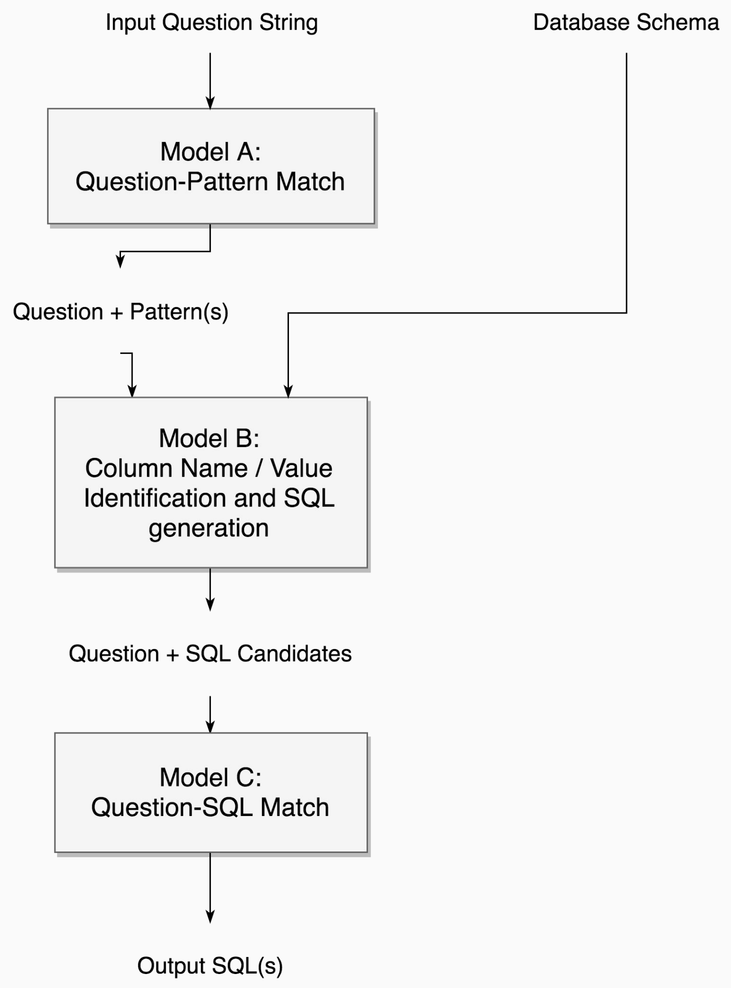
```
select where equals
```

Pattern (Simplified and Naturalized)

How many patterns are there?

Out of the 5000+ preprocessed SQLs that we are having right now, there are around **70** to **400** patterns depending on the level of simplification, and these should cover the vast majority of all SQLs in real life.

Model Structure



Model A: Question-Pattern Match

Given a question, predict which pattern would be the best fit for this question.

- Using existing Natural Language Inference (NLI) models
- Like paraphrase identification
- Instead of "contradiction" / "entailment" etc., use "match" and "not match"

Training Model A

We used an NLI model by Zhiguo Wang, Wael Hamza and Radu Florian: ***Bilateral Multi-Perspective Matching for Natural Language Sentences*** (BiMPM).

- Generate training data by
  a. random mismatch of training question-pattern pairs
  b. slightly tweaking a correct pair (to capture details)
- Changed the evaluation metric
  a. from "correctly identifying match/mismatch"
  b. to "correctly identify the pattern out of all patterns"

Model B: SQL Generation

Given:

1. Question
2. Predicted pattern of the corresponding query of that question
3. Database schema

Generate the **most likely SQLs that would retrieve the answer to this question**.

We can potentially reuse any other models in this project for Model B.

Model C: Question-SQL Matching

Given a question and a list of SQL candidates, identify which one among them would be the one that could correctly answer the question.

- Potentially another NLI model
- Could be trained just like model A

Pros and Cons

Pros:

- Intuitive, analogous to the way humans learn and write SQL
- Simple and straightforward

Cons:

- Cannot guarantee 100% SQL pattern coverage

Potential Byproduct: Data Augmentation

1. Strip SQLs to skeleton, leaving behind replacements tokens
   - Like `{COLUMN NAME}` and `{VALUE}`
2. Use the non-keyword stripped from SQL to strip questions
   - Non-keywords: either column names or values
   - With other statistical approaches like word frequency
3. (Possibly) Hand pick some reusable high-quality Question-Pattern-SQL-Pattern pairs
4. Deduct column types statistically
   - E.g. can column `order_type` be `GROUP BY`'ed over?
5. Generate new Question-SQL pairs