Exploring the Potential of Using Transfer Learning with Google T5 Model for Text-to-SQL Tasks

Department of Computer Science, Babes-Bolyai University

Emanuel-Vasile Putura

Computer Science Student

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Motivation

Figure 1: The vast majority of our data is stored in relational DBs

- widely useful model because the vast majority of data in our lives is stored in relational database

- healthcare, financial services, and sales industries exclusively use the relational databases

- writing SQL queries can be prohibitive to non-technical users

- even Bill Gates noticed this problem and he himself(!) wrote down 105 questions that he wants a machine to be able to answer given enterprise databases
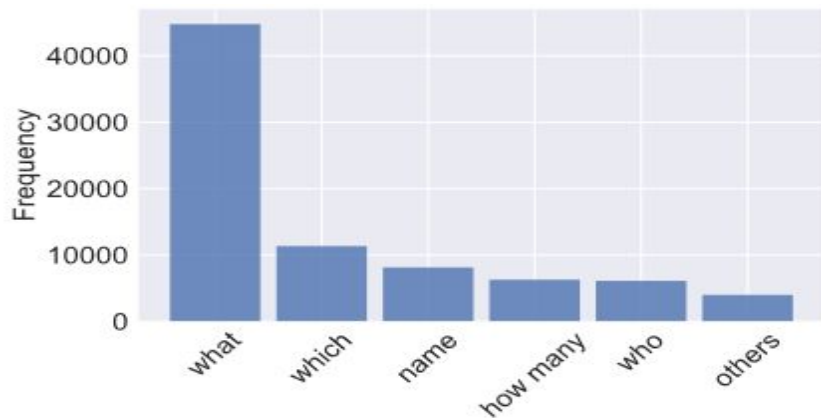
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Data

Figure 2: Distribution of questions in WikiSQL

- WikiSQL consists of approximatively 80k questions and corresponding SQL queries for different tables, making it one of the first and largest datasets for this task

- there are about 24K different tables associated with this dataset

- WikiSQL constrained the problem by two factors: each question is only addressed by a single table, and the table is known

- this constrained setting has guided research to focus on the core elementary proble

- even though the scope is constrained, the dataset is still very challenging because the tables and questions are very diverse

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Google T5 Model
Text-To-Text Transfer Transformer (T5)

→

Text-to-SQL Model
Obtained after applying transfer learning to T5

- **One of promising approaches for text-to-SQL is using transfer learning with pre-trained models, such as Google T5**

- **Google T5 is a neural network model that was trained on a diverse range of tasks using the text-to-text transfer learning framework. This allows T5 to be fine-tuned for a wide variety of tasks, making it a suitable candidate for text-to-SQL.**

- **The T5 model is based on the transformer architecture, which is an attention-based neural network that can handle long-term dependencies and large amounts of input data.**

- **T5 has been shown to achieve state-of-the-art performance on several natural language understanding tasks.**

- **We use transfer learning on Google's T5 model and fine tune it for the text-to-SQL task, using the WikiSQL dataset**

- **We attempt to experiment with certain hyperparameters and training arguments of the model, to improve its performance.**

- **We use different metrics to evaluate each of the experiments we perform**

- **Our findings suggest that transfer learning with T5 may be a promising approach for text-to-SQL tasks in the future**

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Google T5 Model
Text-To-Text Transfer Transformer (T5)

Text-to-SQL Model
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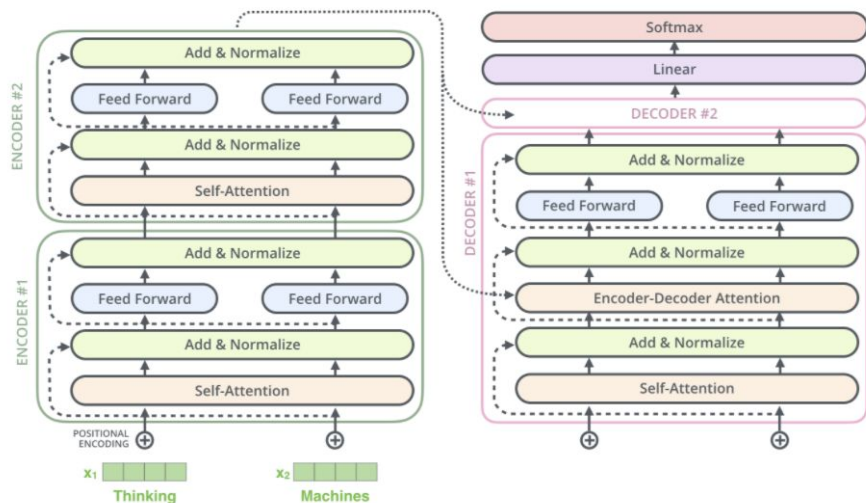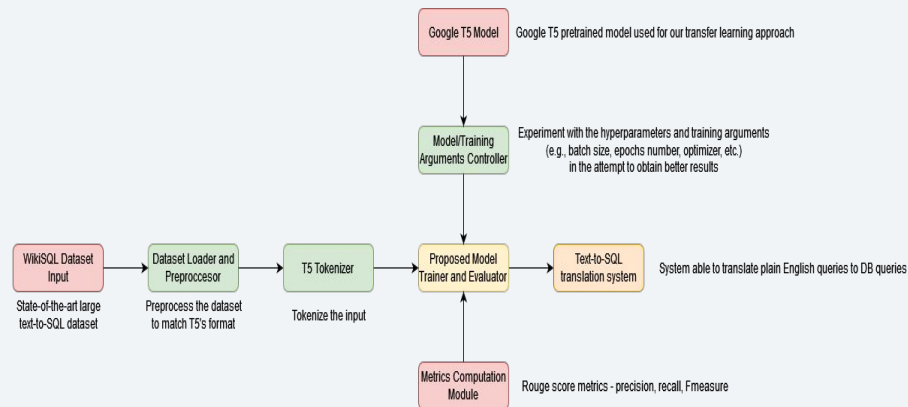Figure 3: Google T5 arhitecture

Figure 4: Our model's arhitecture

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Evaluation

Training Loss	Epoch	Step	Validation Loss	Rouge2 Precision	Rouge2 Recall	Rouge2 Fmeasure
0.2718	1.0	2025	0.2103	0.7551	0.6695	0.7026
0.2172	2.0	4050	0.1762	0.7779	0.6893	0.7237
0.1982	3.0	6075	0.1608	0.7918	0.7014	0.7369
0.183	4.0	8100	0.1504	0.8006	0.71	0.7456
0.1702	5.0	10125	0.1433	0.8052	0.7137	0.7497
0.1631	6.0	12150	0.1378	0.8086	0.7166	0.7529
0.1575	7.0	14175	0.1336	0.8123	0.7203	0.7566
0.152	8.0	16200	0.1300	0.8154	0.7234	0.7597
0.1458	9.0	18225	0.1266	0.8171	0.7251	0.7613
0.1422	10.0	20250	0.1242	0.8193	0.7267	0.7631

Figure 5: Evaluation results for 10 epochs

- we can see that our model has an acceptable precision, compared to the existing models. While there are today state-of-the-art models that perform better, our model still outperforms some of the state-of-the-art models from a few years ago, which might still be a promising result

- these findings suggest that transfer learning with T5 may be a promising approach for text-to-SQL tasks in the future

Model Output Example

```
translate to SQL: what's the new south wales with crop (kilotonnes) being canola
Predict. :SELECT New South Wales FROM table WHERE Crop (Kilotonnes) = Canola
Expected: SELECT New South Wales FROM table WHERE Crop (kilotonnes) = Canola
================================

translate to SQL: If % lunsford is 51.82% what is the % mcconnell in Letcher?
Predict. :SELECT % McConnell FROM table WHERE % Lunsford = 51.82%
Expected: SELECT % McConnell FROM table WHERE % Lunsford = 51.82%
================================

translate to SQL: What is the percentage of the Shivalik Zone where the percentage of the Mid-Hill Zone is 10%?
Predict. :SELECT Shivalik Zone FROM table WHERE Mid-Hill Zone = 10%
Expected: SELECT Shivalik Zone FROM table WHERE Mid-Hill Zone = 10%
================================

translate to SQL: How many episodes in season 6 titles "Poppin' Tags"?
Predict. :SELECT COUNT Season 6 FROM table WHERE Title = "Poppin' Tags"
Expected: SELECT COUNT No. in season FROM table WHERE Title = "Poppin' Tags"
================================
```

Thank You

The code for our model is publicly available:

https://github.com/EmanuelPutura?tab=repositories

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