

CPSC 599.27 Term Project Milestone Report: Reverse Jeopardy!

SHAEMUS MELVIN* and VALERIE KIM*, University of Calgary, Canada

ACM Reference Format:

Shaemus Melvin and Valerie Kim. 2023. CPSC 599.27 Term Project Milestone Report: Reverse Jeopardy!. 1, 1 (December 2023), 2 pages.
<https://doi.org/10.1145/nnnnnnn.nnnnnnn>

1 INTRODUCTION

The project being developed is a clue generation model in the style of the game show Jeopardy! The main area of NLP that the project is relevant to is Question Answering (QA), with a twist in that in the Jeopardy! format, the clue is phrased in the form of an answer, and contestants are expected to respond in the form of a question. Since the problem of training a model to respond to Jeopardy! clues has been covered by IBM's Watson, the Reverse Jeopardy! project aims to develop Jeopardy! clues when given a Jeopardy! style response (e.g. when given "What is Ireland?", the model would respond with "This island nation west of Great Britain has a green, white, and orange flag"), which could be seen as going full circle using the Jeopardy! model, simply answering questions in a very specific format.

2 SOLUTION

The data set being used is a list of every Jeopardy! clue from September 1984 to October 2021. It was retrieved from a list of NLP datasets provided on d2l¹, originally published on the r/datasets subreddit², hosted on Google Drive³, and was originally sourced from j-archive⁴. It comprises 216,930 total clue/response pairs (along with other data), and totals 53 MB. The values given in each question are category, air date, clue, value, response, round, and show number. Strictly speaking, the only data that is needed from these fields is clue and response, however there is also great value in a lot of the categories (often they follow a theme outlined by the category name, for example in the language of the show, a letter in the category name being in quotation marks signifies that all responses in the category will have that letter somewhere in the word(s)), and there are certain responses that are dependent on the time period the clue was given (e.g. until 1997 the Democratic Republic of the Congo was called "Zaire"), so at the very least 4 fields should be used in the training data. Dollar amounts and round are also relevant to the difficulty of the questions, however that's an extra layer of complexity that's not relevant to the base functionality of the model, so will be retained as a stretch goal. Show number and air date convey nearly the exact same information, so air date will be included but not show number.

*Both authors contributed equally to this research.

¹<https://d2l.ucalgary.ca/d2l/le/content/500684/viewContent/5727476/View>

²https://www.reddit.com/r/datasets/comments/1uyd0t/200000_jeopardy_questions_in_a_json_file/

³https://drive.google.com/file/d/0BwT5wj_P7BKXb2hfM3d2RHU1ckE/view?usp=sharing

⁴<http://www.j-archive.com>

Authors' address: Shaemus Melvin, shaemus.melvin@ucalgary.ca; Valerie Kim, minjae.kim1@ucalgary.ca, University of Calgary, 2500 University Dr SW, Calgary, Alberta, Canada, T2N 1N4.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

© 2023 Association for Computing Machinery.

Manuscript submitted to ACM

The project is being built by fine-tuning a pre-trained language model (which itself is a fine-tuning of a pre-trained model). The specific pre-trained model that is being used is the DistilBERT base cased distilled SQuAD, by HuggingFace⁵. Its training is based on the DistilBERT training (done on BookCorpus⁶), with fine-tuning for this specific model done on the Stanford Question Answering Dataset (SQuAD⁷). The model has 6 layers, and 66 million parameters⁸. No extra layers are going to be added, however some layers will be frozen both for the purposes of preserving functionality of the model and in order to make training more efficient.

To train on DistilBERT, the input data requires at minimum two of: question, answer and context. The jeopardy data set currently lacks context in the traditional sense, and the question and answer data is fairly unusual compared to BERT and SQuAD training data. A unique loss function must also be defined as the preexisting loss functions assumed the existence of a context. For preprocessing, a pre-trained tokenizer provided by the model pipeline is being used. Since the project uses the cased version of the model, text is not lowercased before tokenization to assist in better Named Entity recognition. It seems that part of the tokenization pipeline also involves randomized masking. This may conflict with the fact that the responses are incredibly short, so a way to tokenize it while disabling masks may be mandatory. Another solution to the context issue could be to group clues together by response (e.g. all clues with the response "Ireland" would be grouped together) and use the collective set of clues as a context. Towards the edges of the frequency curve (i.e. responses which have only occurred once, or responses that have occurred hundreds of times) the context would be less useful, but in general it should generate usable contexts.

3 CHALLENGES

Low-parameter-count (relatively speaking) QA models typically generate an answer for a question out of a context (typically a section of text that either contains the information being asked of or just some context) rather than simply "knowing" what the answer to a question is (which is typically only done by huge models like GPT-3). Given that our "context" in this case is the set of all Jeopardy! clues ever written, it is going to be difficult to get the model to creatively generate clues from responses without simply retrieving an old clue and outputting it. Theoretically, this shouldn't be an issue since the model being trained is a fine-tuned language generation model (so should have some degree of creativity) rather than an information extraction model, however it is something to be aware of. The most obvious solution if it does come up is to prepend a dropout layer between the dataset and the model (and since the dataset is large enough, there should still be an appropriate amount of information on any given topic).

Another challenge has been configuring a way to train the model given the subjectivity of the desired output. Any significant use of an error/loss function would inevitably lead to overfitting, so the pre-configured training functions which require a loss function to train are difficult to use. This is somewhat related to the issue of training data being difficult to use due to the difficulty of validation given the fuzzy relationship between the input and the output (e.g. there are a million different ways to generate a clue for "What is Ireland", so validating clues generated from that response within the framework of a traditionally-trained neural network is difficult). As mentioned in the proposal document, this could potentially be resolved by feeding the output of the model which is being trained into a separate pre-trained QA model that is trained to respond to Jeopardy! clues. Alternatively, it could be deemed tolerable, at least as an intermediate stage, that the model just regurgitates old Jeopardy! clues.

No significant changes have been made to the project design since the project proposal.

⁵<https://huggingface.co/distilbert-base-cased-distilled-squad>

⁶<https://yknzhu.wixsite.com/mbweb>

⁷<https://rajpurkar.github.io/SQuAD-explorer/>

⁸https://github.com/huggingface/transformers/blob/main/examples/research_projects/distillation/README.md