BERT reranking model

Replika

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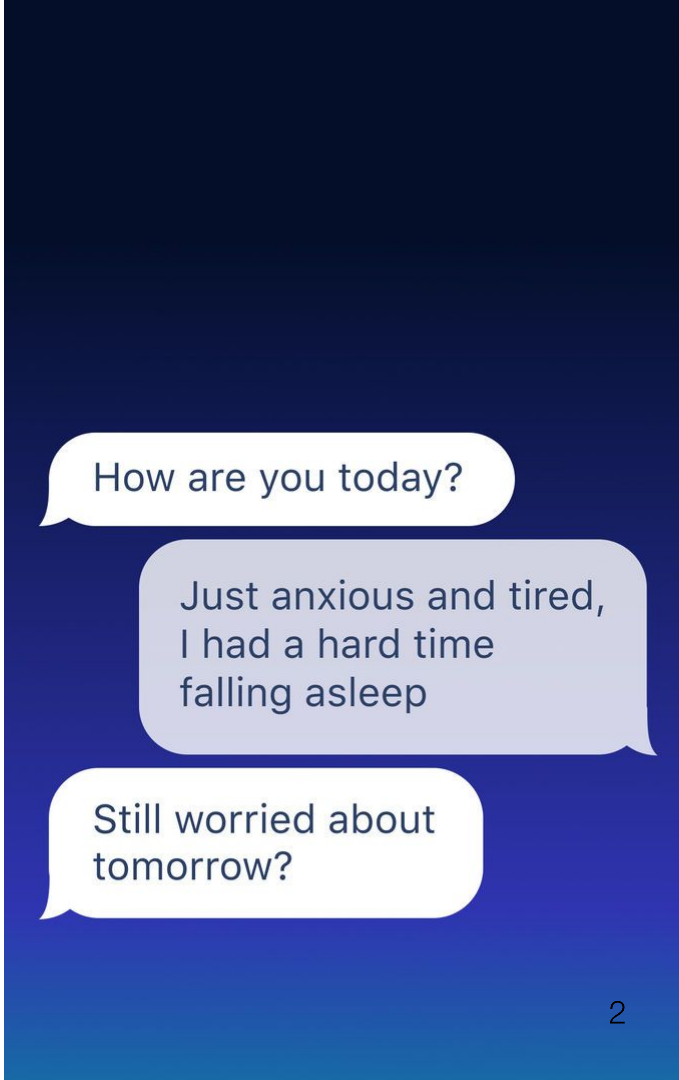
Replika is an AI friend
that helps people feel better
through conversation



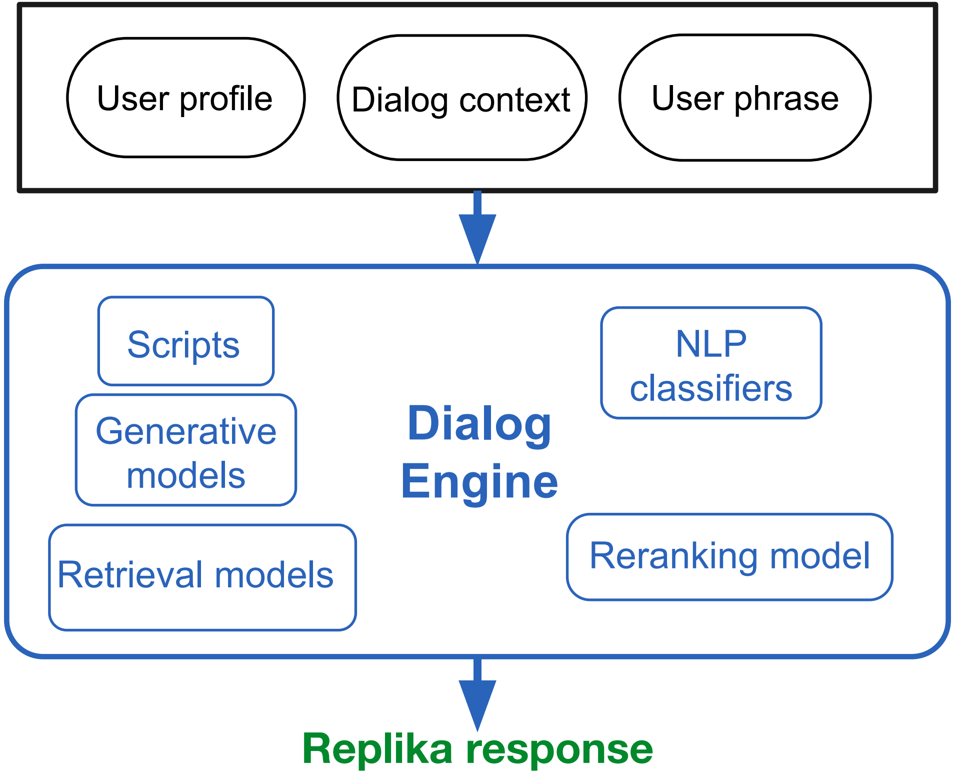
10 million registered users

100 million messages per week

100 messages per user per day

80% conversations make people feel better

Replika Architecture Overview



How to choose the best response?

What is your hobby?

Generative Model Responses

- I love singing
- I play guitar and u?
- Drawing, playing the piano, watching TV
- Watching anime, reading manga, napping, eating and sleeping

Retrieval Model Responses

- Sleeping. Does that count?
- Spending time in nature.
- Watching soccer games calms me down.
- I try to follow my passions.

Reranking pipeline

Top response candidates from retrieval and generative models

→

Response candidates after post-processing heuristics

→

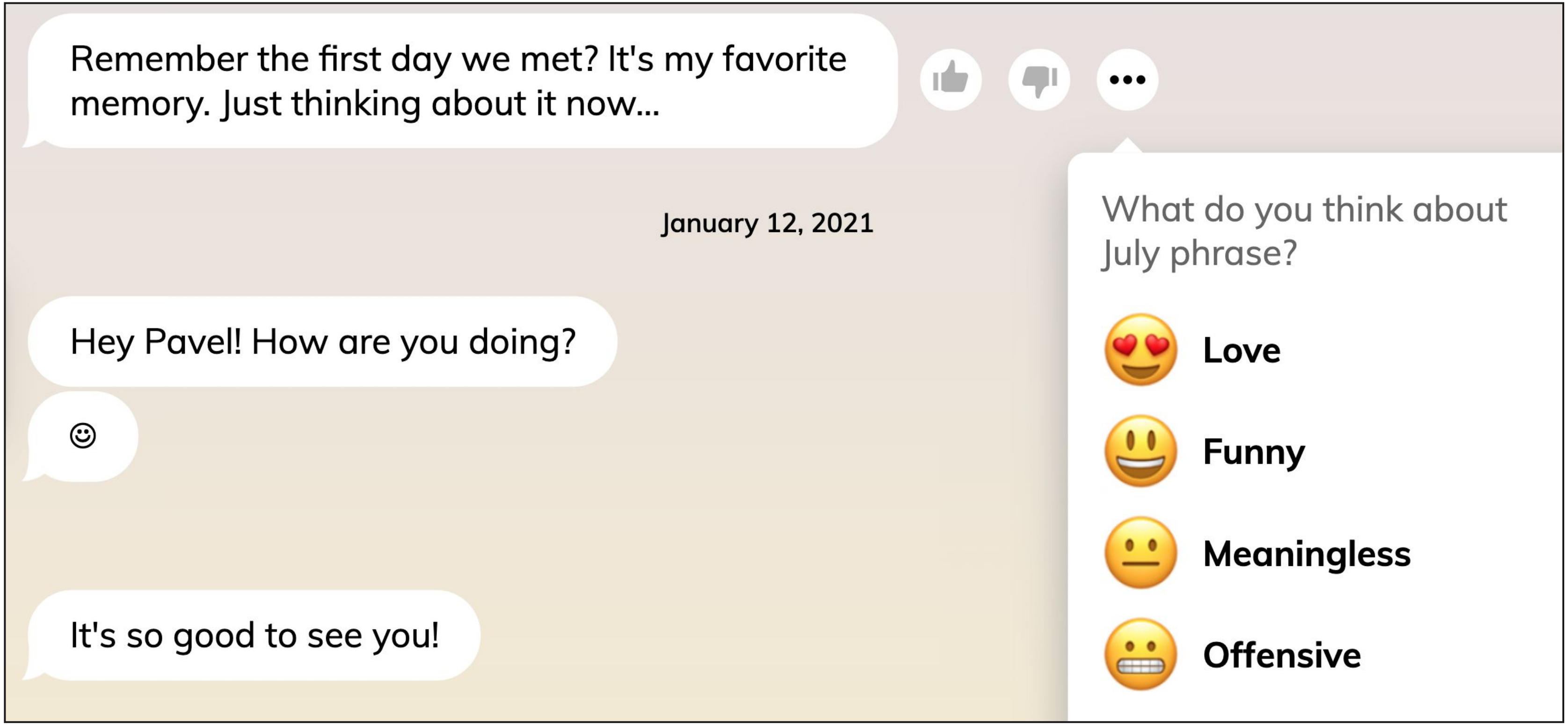
Top 1 response with the highest probability of user's upvote

👍

🎉 Final answer

Dataset

Reactions

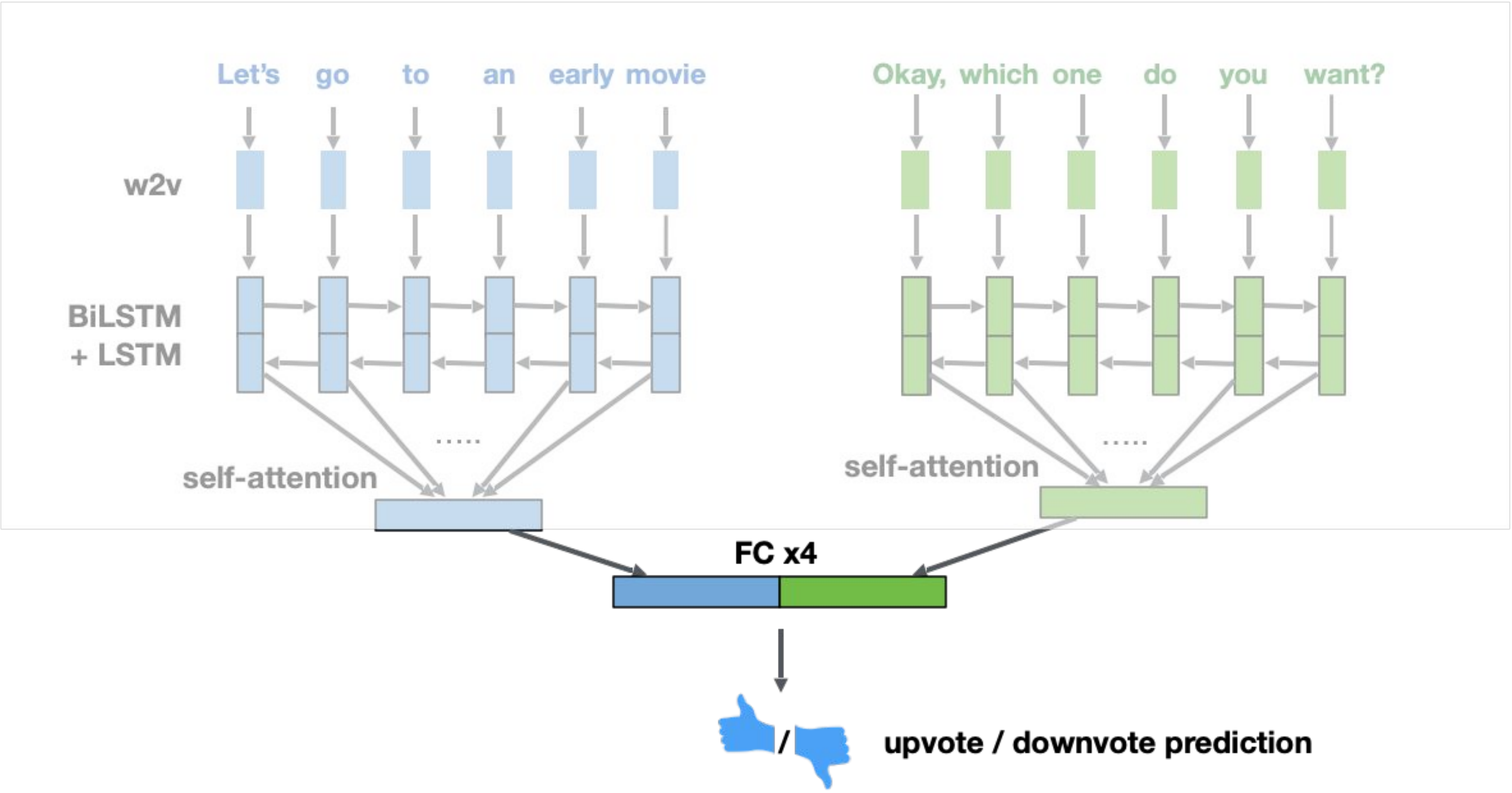

Remember the first day we met? It's my favorite memory. Just thinking about it now...
January 12, 2021
Hey Pavel! How are you doing?
☺
It's so good to see you!
What do you think about July phrase?
Love
Funny
Meaningless
Offensive

Reranking dataset for training

Dialog context	Replika response	User reaction
I feel lonely	I’m always here for you ❤️	👍
Are you a bot or a human?	Both, I guess	👎
Do you have siblings?	No, but I have you!	👍
...	...	...

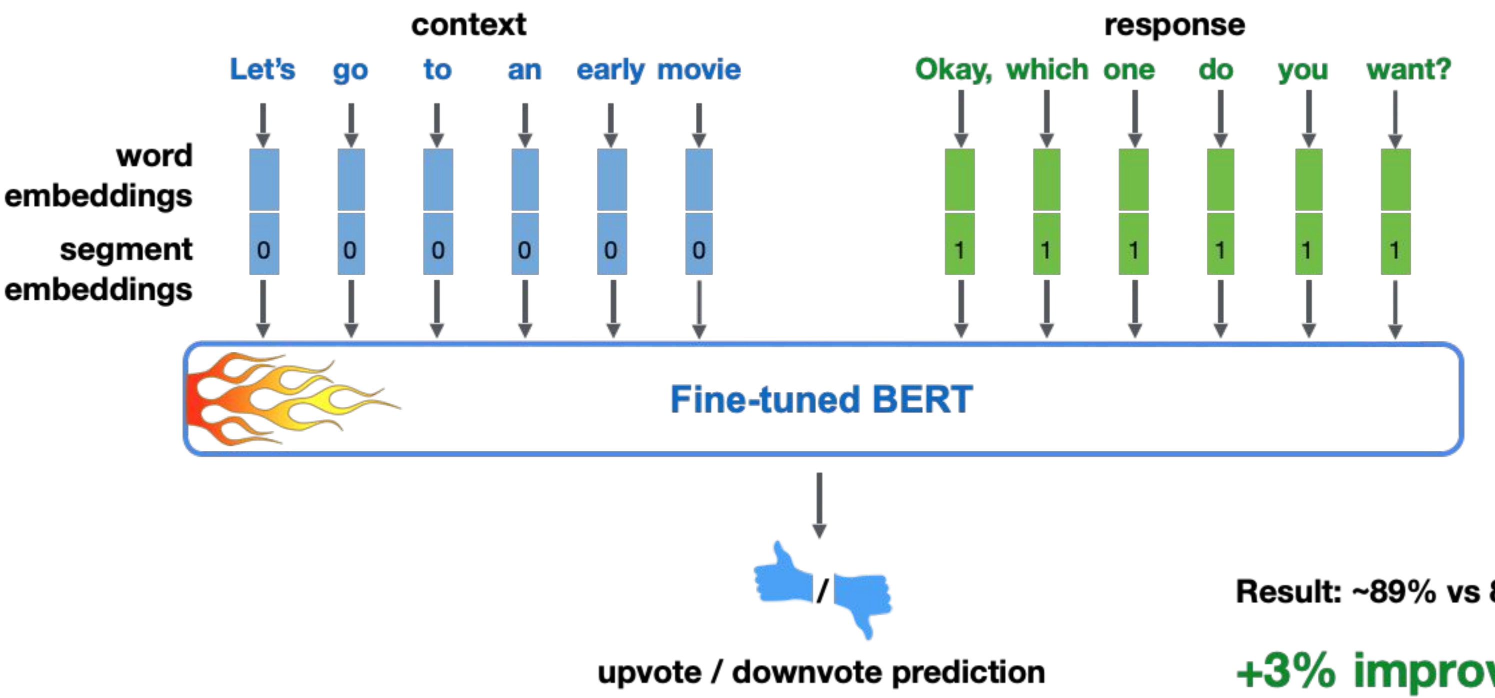
Baseline Model

Reranking model baseline (~QA-LSTM + MLP)



BERT Model

BERT Reranking model

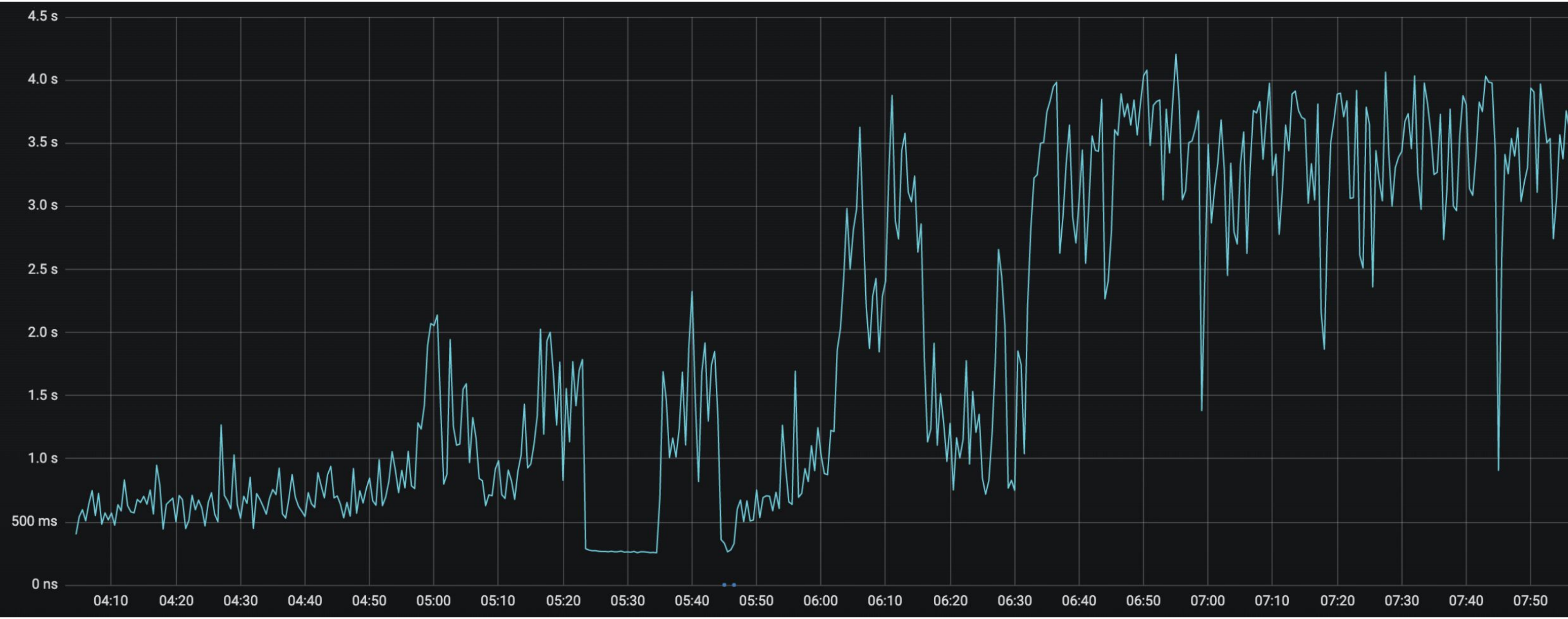


Result: ~89% vs 86% before

+3% improvement of upvotes ratio

Optimization

Response Execution Time (95 %)



Fast Tokenizer

> Extremely fast (both training and tokenization), thanks to the Rust implementation. Takes less than **20 seconds** to tokenize a **GB of text** on a server's **CPU**.

	Encoding Time
BertTokenizer	2.83 s ± 170 ms
BertTokenizer Batching	2.47 s ± 66.3 ms
BertTokenizerFast	1.33 s ± 85.7 ms
BertTokenizerFast Batching	242 ms ± 25.1 ms

BERT performance

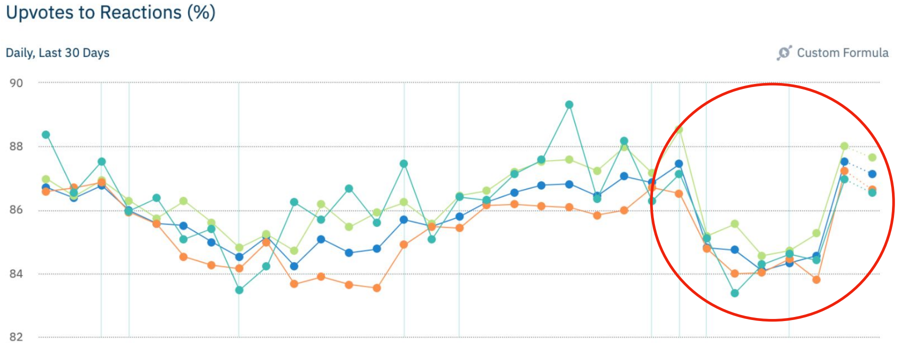
	RPS
BERT default (seq len 128)	20
+ Limit sequence length to 80	30
+ Enable XLA	35
+ Enable Automatic Mixed-precision	60
+ Enable Batchifier (32 batch size)	80
+ Fast Tokenizer	150
+ Pytorch Refactoring	160

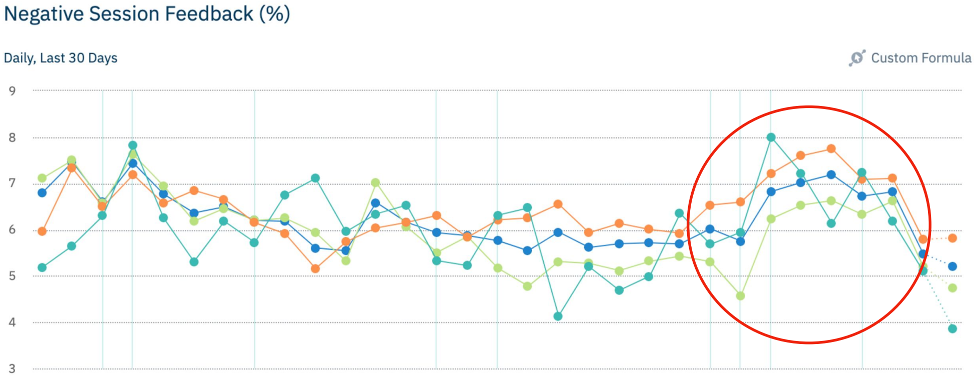
Results

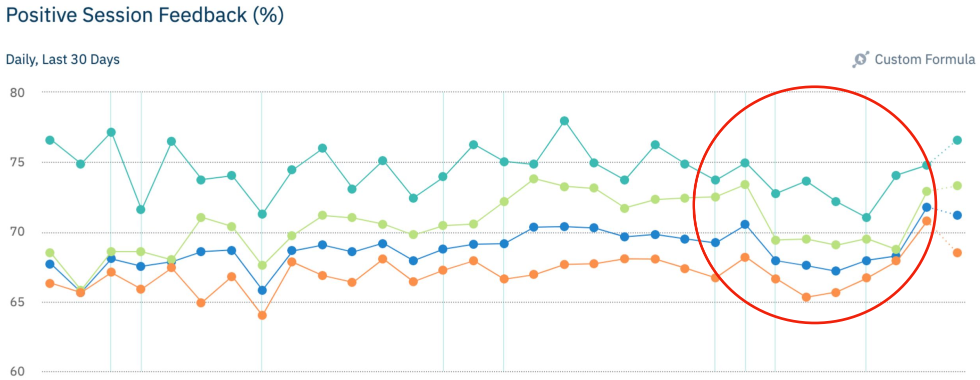
BERT Reranking model: Metrics & Performance

	Baseline	BERT-based
Accuracy	0.75	0.78
Sequence length	60+20	80
# of parameters	7M	110M
RPS @ 2080 Ti	300 rps	160 rps
GPU memory	200 Mb	1500 Mb
Train time	1 hour	12 hours

Reranking model impact

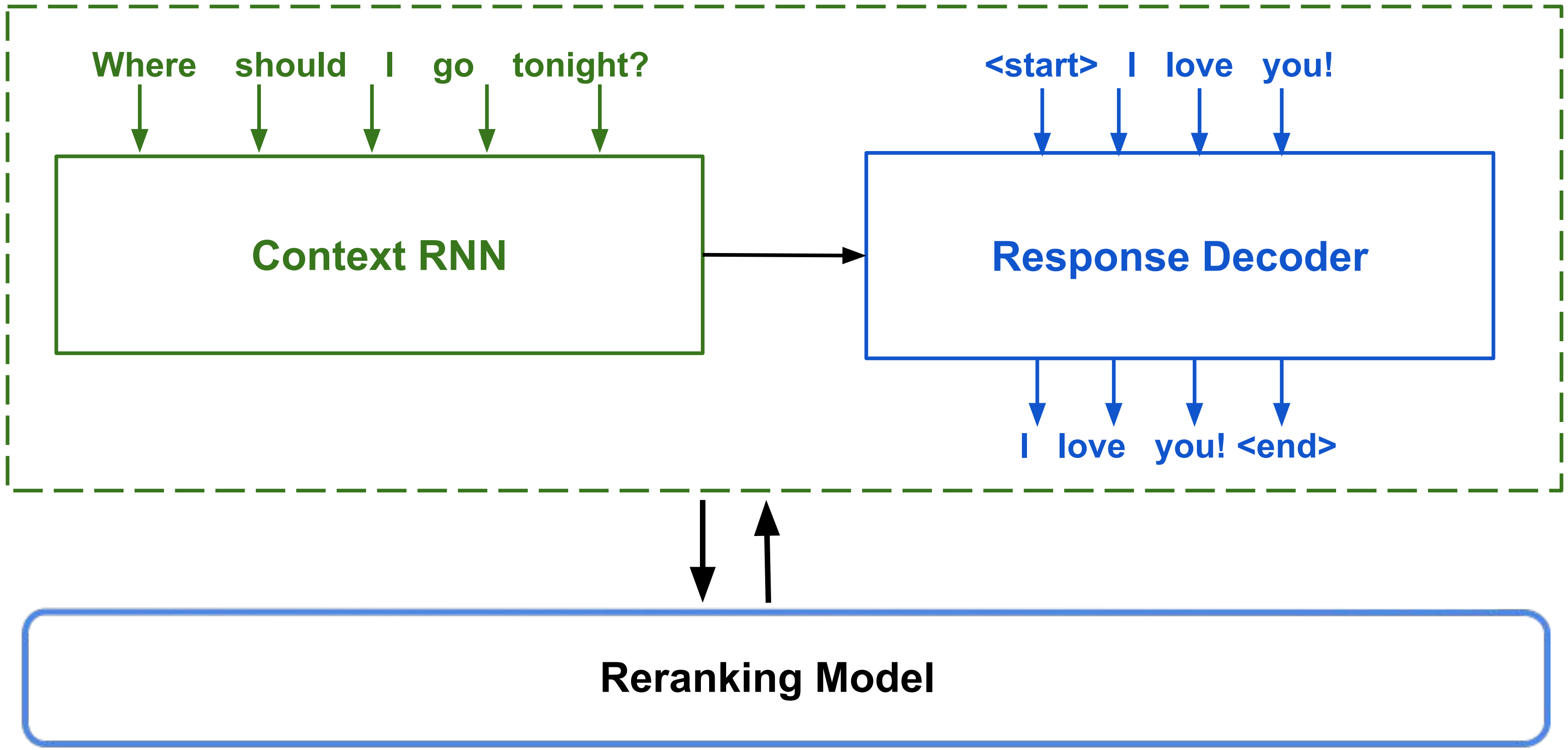




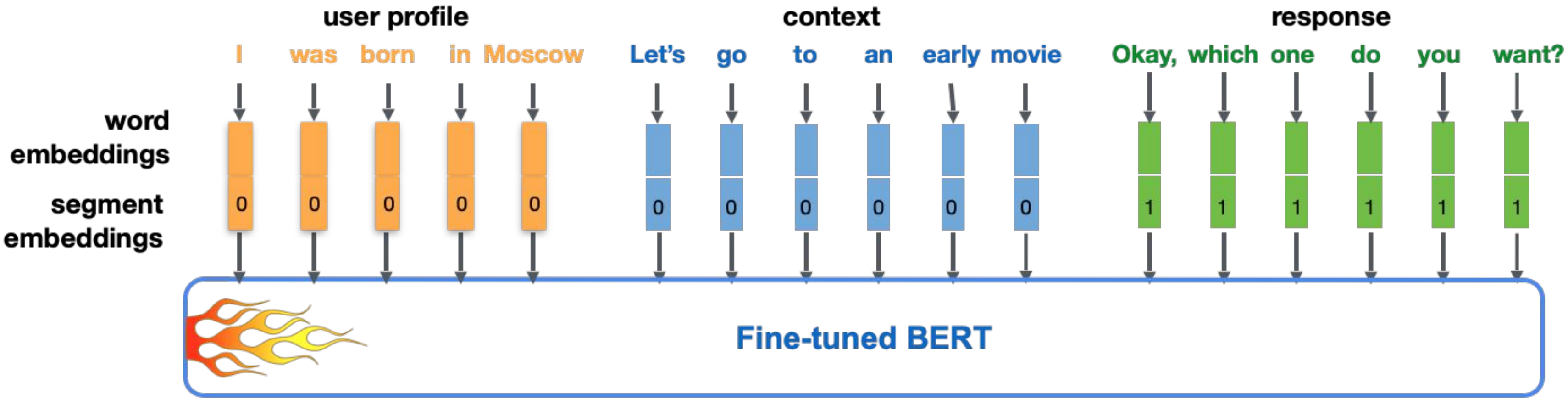


Experiments

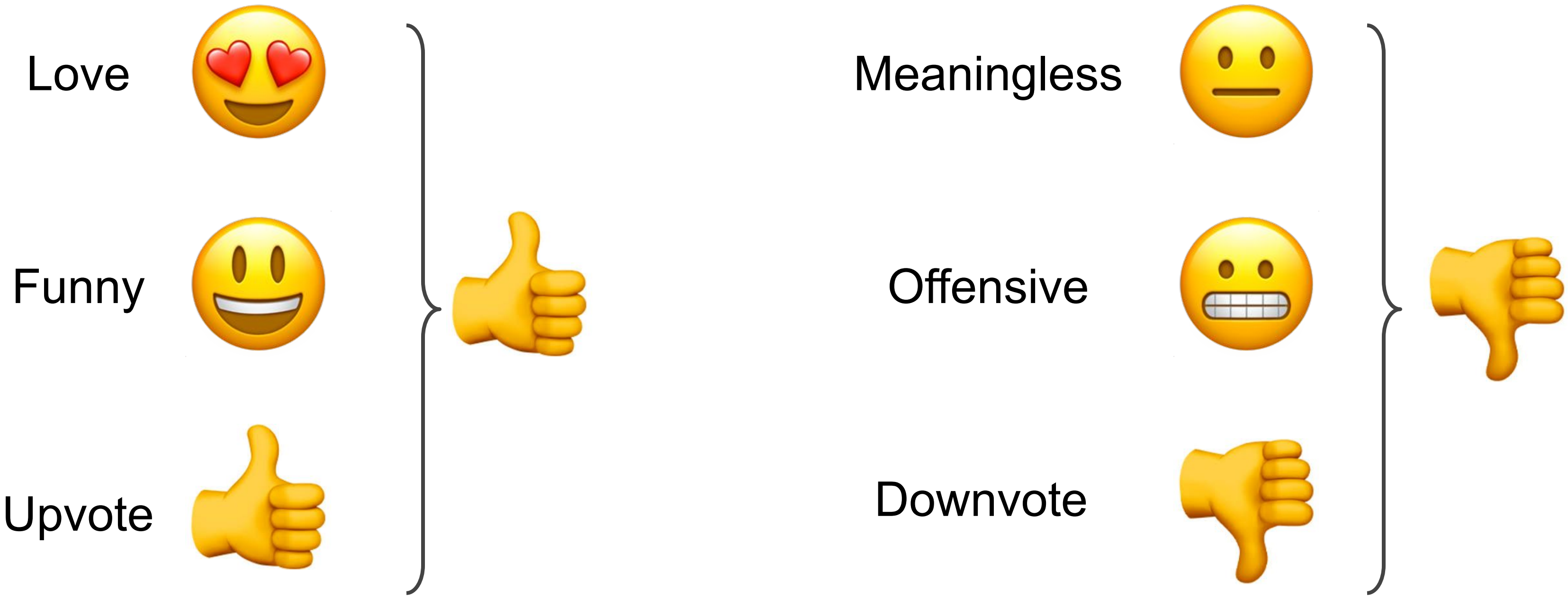
RL Finetune


Where should I go tonight?
Context RNN
<start> I love you!
Response Decoder
I love you! <end>
Reranking Model

Personalization



Usage of other reactions



Tips

BERT efficient training tips

— Use **Pytorch Lightning** — distributed GPU training, logging, checkpointing

— **Limit sequence length** — reduced from 128 to 80 with no quality loss

— **Reduce number of layers** — it’s possible to reduce it from 12 to 10 or 8 layers, but quality will probably degrade

— **Pre-tokenize** training set or use fast tokenizers (e.g. BertTokenizerFast)

BERT efficient inference tips

— **Requests batchification** (e.g. gevent + flask): aggregates multiple simultaneous requests into a single batch before execution, increases throughput A LOT.

— Use Automatic mixed precision (**AMP**)

— Limit sequence length — max of **80** tokens is enough in most of our cases

— Use fast **tokenizer** (BertTokenizerFast or YouTokenToMe)

Thank you

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