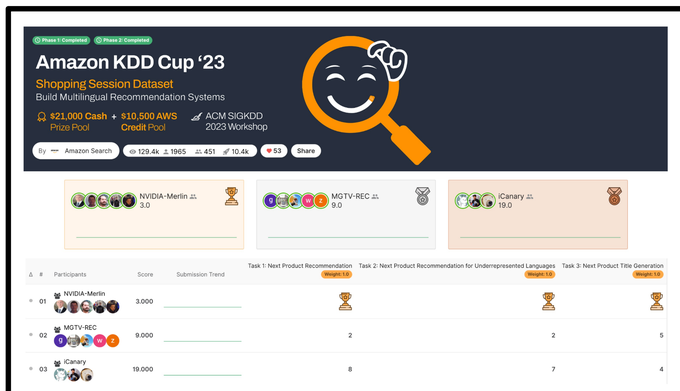
Winning Amazon KDD Cup'23

Recommender Two Stage Model

Task 1 & 2 Stage One

Task 1 & 2 Stage Two

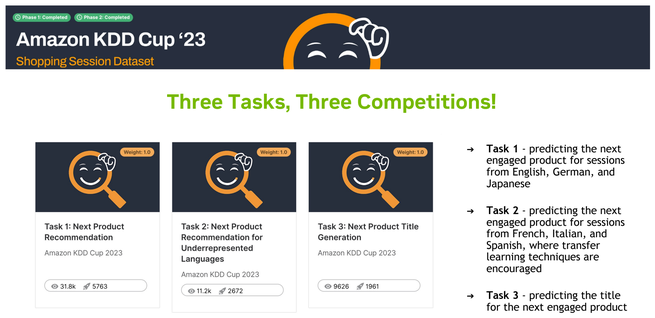
Task 3



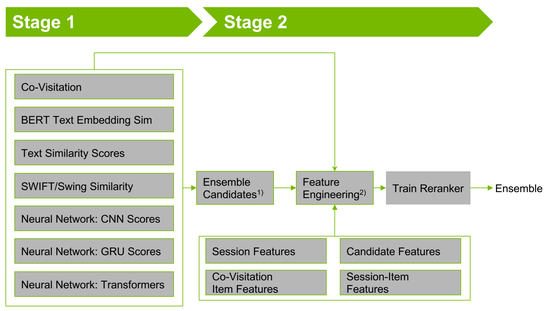
1st Place Team NVIDIA-Merlin

4x KAGGLE GRANDMASTERS OF NVIDIA (KGMON)
1x Nvidia Merlin Recommender Systems

Benedikt Schifferrer · Chris Deotte · Kazuki Onodera · Gilberto Titericz · Jean-Francois Puget

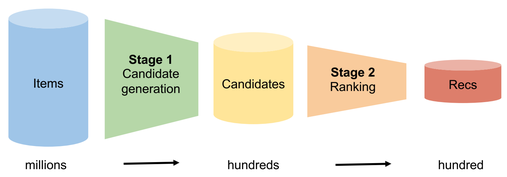


- **Task 1** - predicting the next engaged product for sessions from English, German, and Japanese
- **Task 2** - predicting the next engaged product for sessions from French, Italian, and Spanish, where transfer learning techniques are encouraged
- **Task 3** - predicting the title for the next engaged product

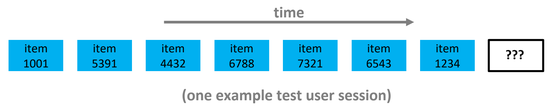


1) Final candidates can use a subset of all potential candidates from stage 1 depending on the solution
2) Scores from candidate generation can be used as session-item features

Two Stage Recommender Pipeline



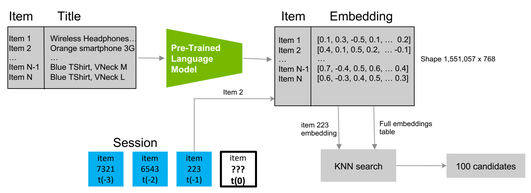
Session-based recommendation Question - What Will Users do in Future?



(one example test user session)

- Above is 1 example user session
- Train data from past. Test data in the future.
- Train data has 3.6 million unique user sessions!
- Train data has 1.4 million unique items (i.e. products)!
- Each item has 11 properties including Title, Brand, Color, Price, etc
- Task 1 & 2 Metric is MRR@100
- Task 3 Metric is BLEU

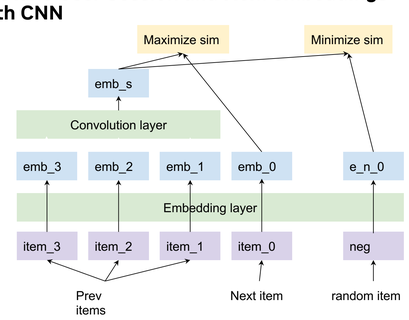
Stage 1 - BERT Embeddings & Text Similarity Scores



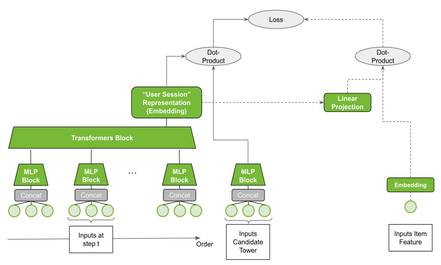
1. Concatenate product, title, price, locale and all other properties.
2. Use a pretrained LLM to extract vector embeddings from the last layer.
3. Use Nearest Neighbors search to find top 100 most similar items of last item in a session.

Stage 1 - Finetune User Session and Item embeddings with CNN

- Transfer Learning:
  - Embedding table is initialized with a pretrained model
- This pattern is shifted to the left
  - Predict last prev item from previous ones
- 4000 random samples are used as negatives for each predicted embedding



Stage 1 - Finetune User Session and Item embeddings with NVIDIA Merlin Transformers4Rec[1)]



- Merlin Transformers4Rec provide an easy-to-use integration for Hugging Face for recommender systems with ~64 different architectures
- The XLNet architecture was trained with **MLM masking** strategy
- The **input were item_id, item_features (e.g. brand, color) and BERT text embeddings processed** by a 1-layer MLP without activation function
- One variant was **multi-task learning**, where the model had to predict the masked item and the masked item features (e.g. brand)
- Different combination of two variants were trained (total 4)
  - Previous Item Only vs. Previous Item + Next Item
  - Single Task vs. Multi-Task

1) https://github.com/NVIDIA-Merlin/Transformers4Rec/

Stage 1 - LLM Transfer Learning Scores

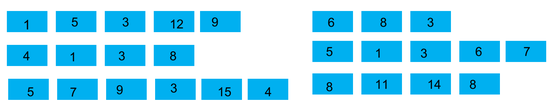
MRR@100	UK	DE	JP	FR	IT	ES
Allenai-specter	0.196	0.196	0.149	0.258	0.241	0.259
Distiluse-base-multilingual-cased-v2	0.197	0.196	0.212	0.251	0.236	0.254
Bert-base-multilingual-uncased	0.195	0.195	0.214	0.255	0.239	0.256
Clip-ViT-B-32-multilingual-v1	0.197	0.195	0.212	0.252	0.236	0.254
Stsb-xlm-r-multilingual	0.194	0.192	0.212	0.247	0.232	0.249

Combining the 5 LLM embeddings scores (MRR@100):

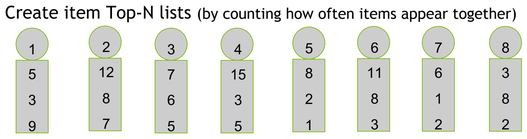
- Task1 trainset score: 0.209 / LB: 0.226
- Task2 trainset score: 0.261 / LB: 0.278

Stage 1 - Covisitation Matrices

- Use all train user sessions

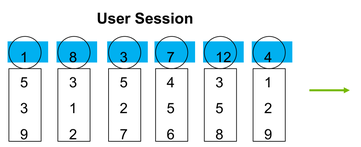


- Create item Top-N lists (by counting how often items appear together)



Stage 1 - Covisitation Matrices

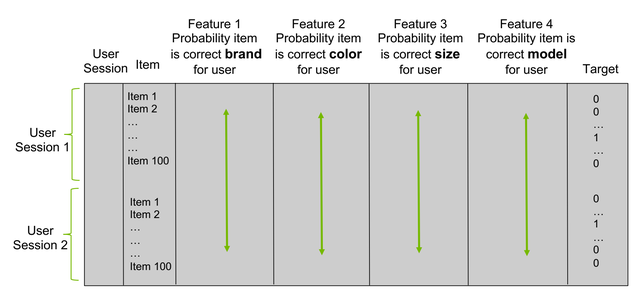
- Generate user session candidates by Applying Top-N lists to each user session item



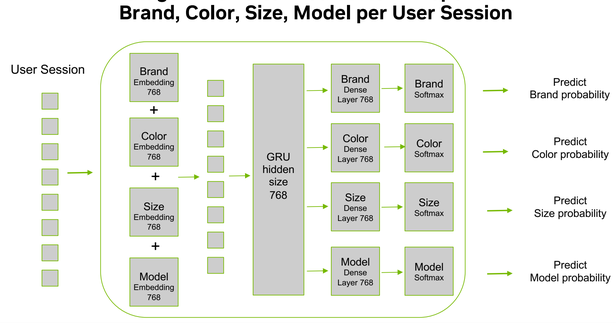
Candidate Items

Item	Count
5	4
3	3
2	3
1	2
9	2
7	1
4	1
6	1
8	1

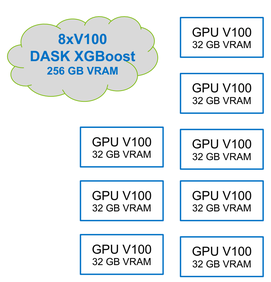
Stage 2 - GBT Reranker Example Feature Engineering



Stage 2 - GRU to Predict Item Properties Brand, Color, Size, Model per User Session



Stage 2 - Train GBT Reranker using 8xV100 GPU!



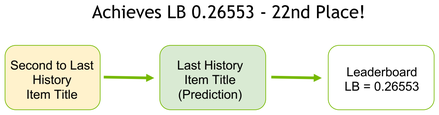

```
import xgboost as xgb

X_train = candidates[FEATURES]
y_train = candidates[TARGET]
dtrain = xgb.dask.DaskQuantileDMatrix(
    client, X_train, y_train
)

model = xgb.dask.train(
    client, XGB_PARAMS, dtrain=dtrain
)
```

Train 360 million rows with ~150 features using 8xV100 DASK XGBoost for +0.002 MRR boost !!

Task 3 Baseline

Submitting User's Last History Item Title

Achieves LB 0.26553 - 22nd Place!



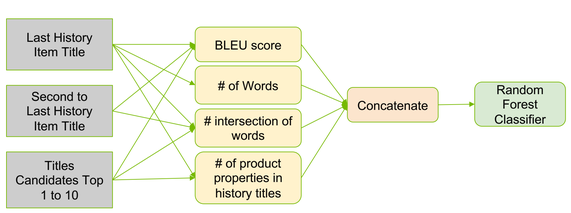
BLEU score = $\sqrt[4]{P_{1-gram}(y,\hat{y}) * P_{2-gram}(y,\hat{y}) * P_{3-gram}(y,\hat{y}) * P_{4-gram}(y,\hat{y})} * BP(y,\hat{y})$

** Geometric mean of 1-gram, 2-gram, 3-gram and 4-gram precision scores.*
BP = Brevity Penalty

Task 3 - Model One

Last Two Titles Classifier

Achieves LB 0.26673 (+0.00120) - 13th Place!



Task 3 - Model Two

Removing Last Word Classifier using LLM

Achieves LB 0.27152 (+0.00480) - 1st Place!

Train XLM-RoBERTa-base to choose:

```
model = TFAutoModel.from_pretrained('xlm-roberta-base')
outputs = model(ids,attention_mask=att)[0]
outputs = tf.keras.layers.GlobalAveragePooling1D()(outputs)
outputs = tf.keras.layers.Dense(1, activation='sigmoid')(outputs)
```

ZOEON Clothing for Baby Doll, Outfits with Hat for 14-16 inches Dolls (35-43 cm) (Pink) ???

Predict Binary Classification if removing last word improves BLEU metric

NVIDIA