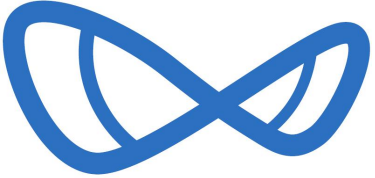

An Effective Ensemble Framework with Multichannel Time Series for User Retention Prediction

Zhiruo Li, Zhihui Cui, Shunyao Wu

Qingdao University

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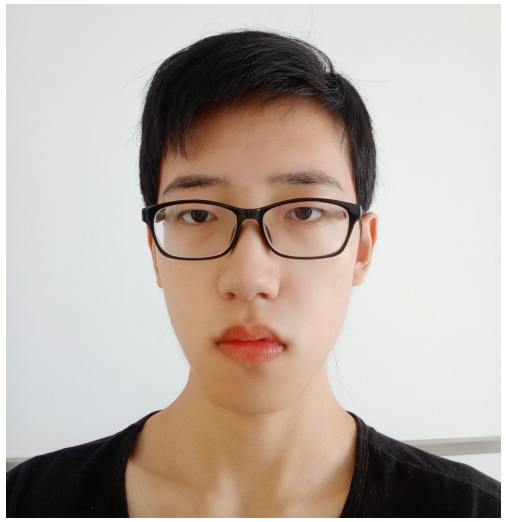
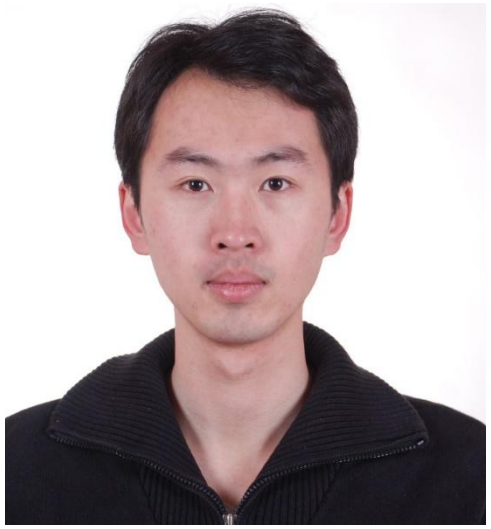
QDU Team Profile

Bioinformatics Group
Qingdao University

Zhiruo Li
Graduate Student
at Qingdao University,
major in applied statistics



Zhihui Cui
Pre-final Year Student
at Qingdao University



Shunyao Wu
Assistant Professor
at Qingdao University

QDU achieved top rankings in 5 data mining competitions, e.g.

- ✓ Ranked 1st in *CIKM AnalytiCup 2019*
- ✓ Ranked 6th in *KDD CUP 2020*

Problem Understanding

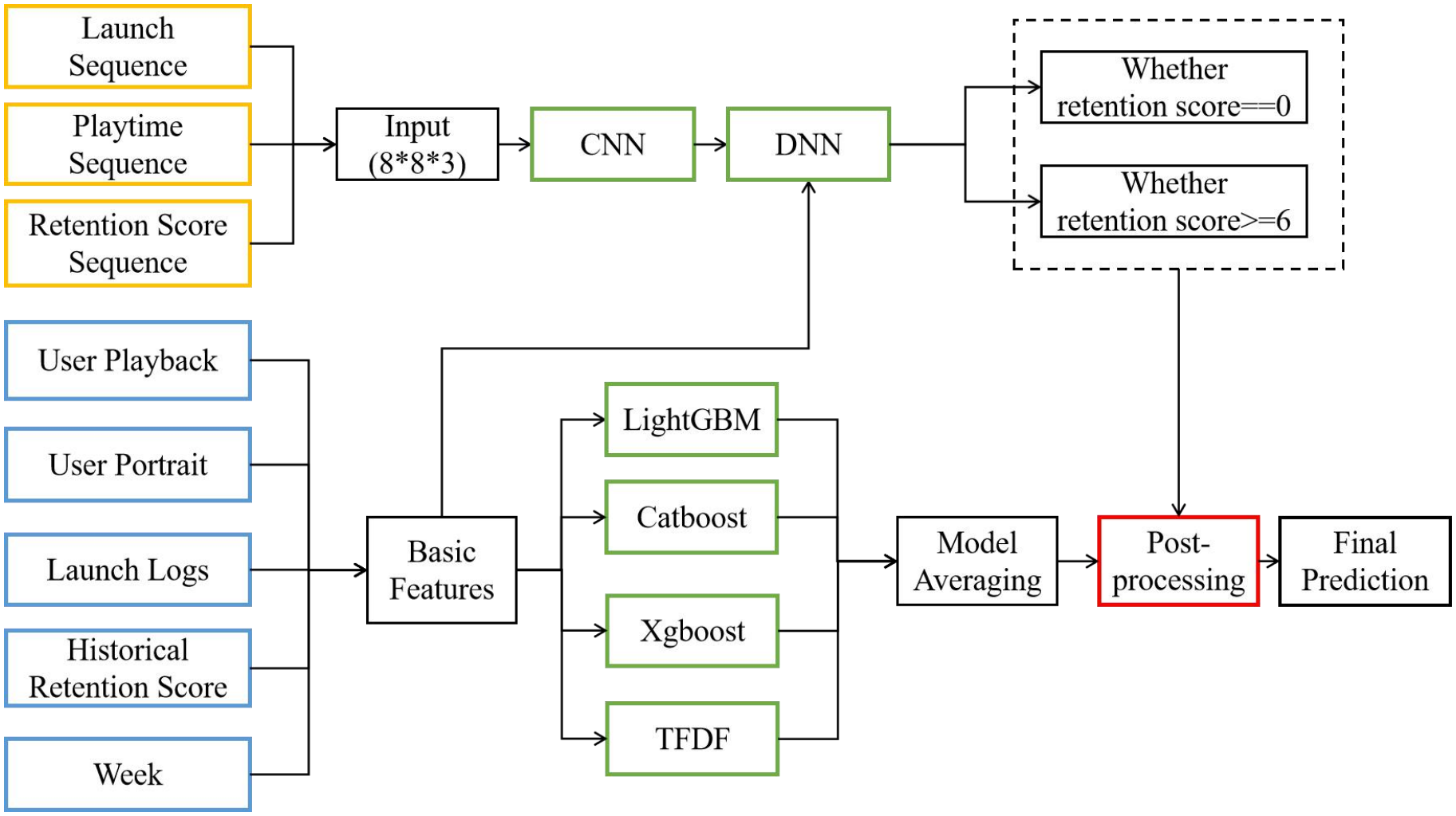
- **Task:** Predict the 7-day retention score of any user
- **Evaluation Metric**

$$Score = 100 * (1 - \frac{1}{n}\sum_{t=1}^{n}\frac{|F_t - A_t|}{7})$$

F_t : forecast value, A_t: actual value

- **Data**
  - user playback data
  - user protrait date
  - video related data
  - app launch logs
  - user interaction data

Our Framework



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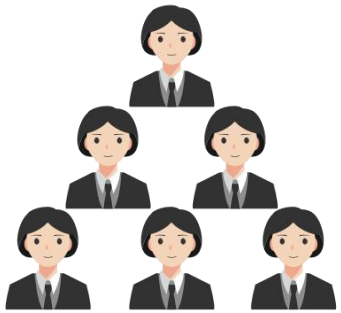
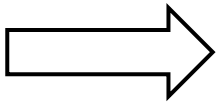
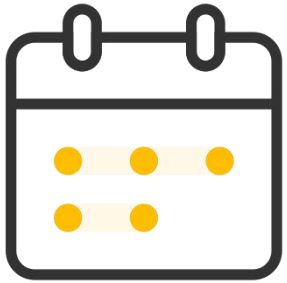
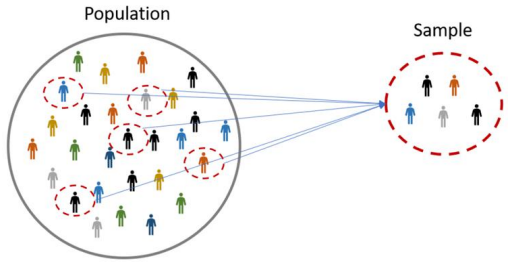
Preprocessing









Training Set

Select Users

only users from the online test set

Extend Dates

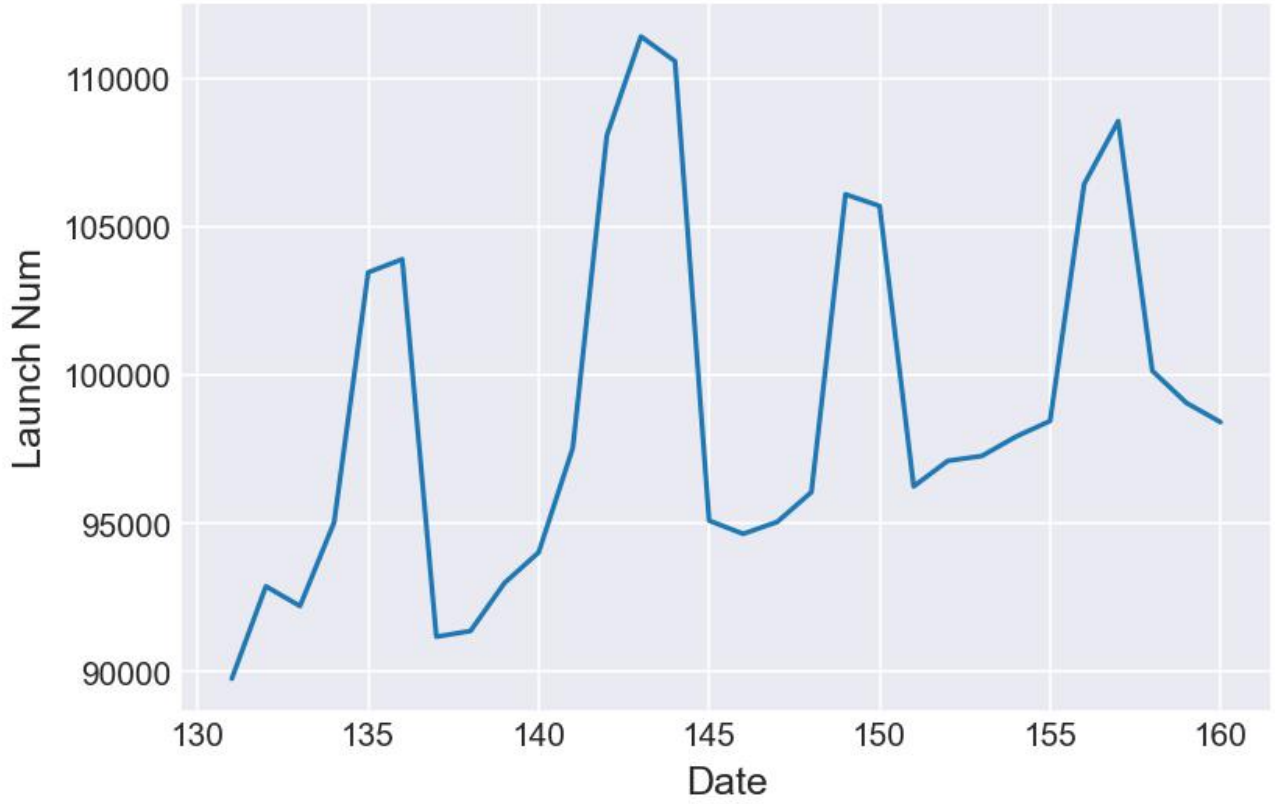
all available dates, i.e. $[date\_min, date\_max - 7] \cup [131, 153]$

Sampling

70% of Retention score 0

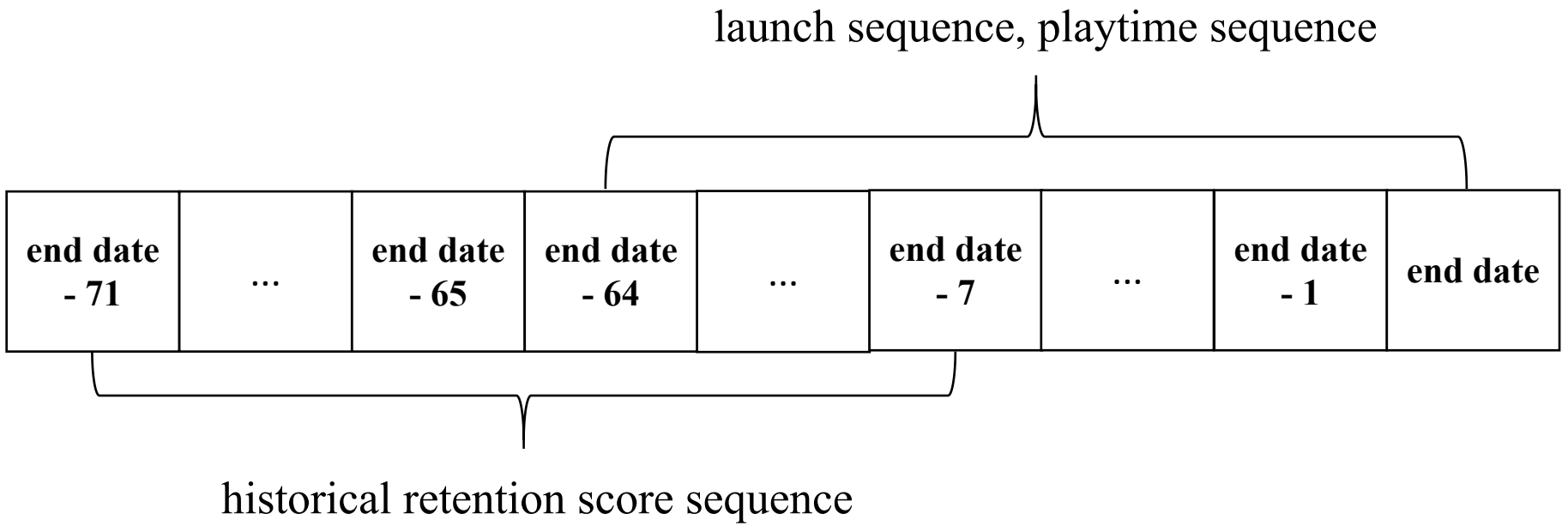
Exploratory Data Analysis

- Cyclical pattern, every week
- Example
  - ✓ date 143: Saturday
  - ✓ date 144: Sunday
  - ✓ date 145: Monday



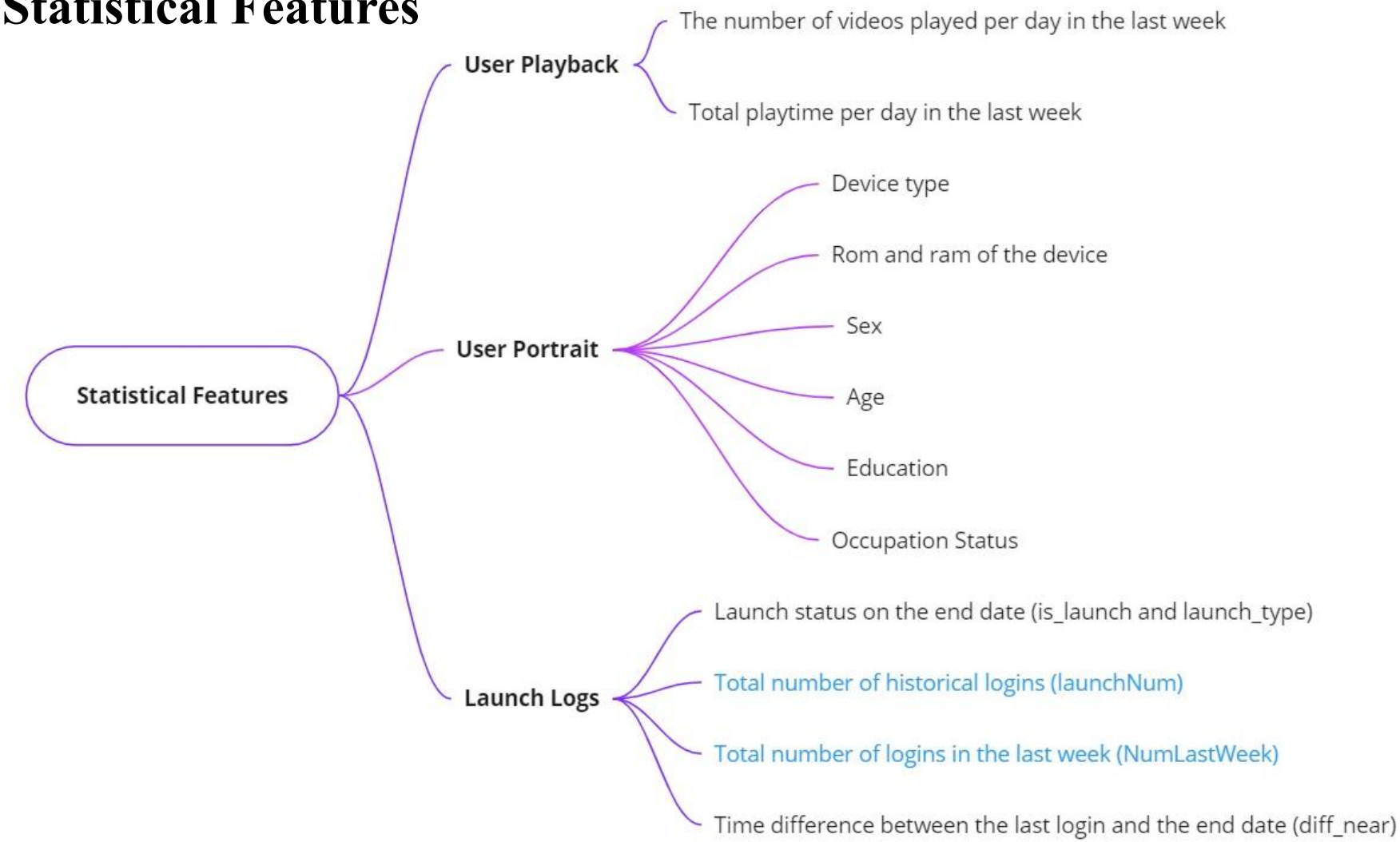
Feature Engineering

➢ Multichannel Sequences



Feature Engineering

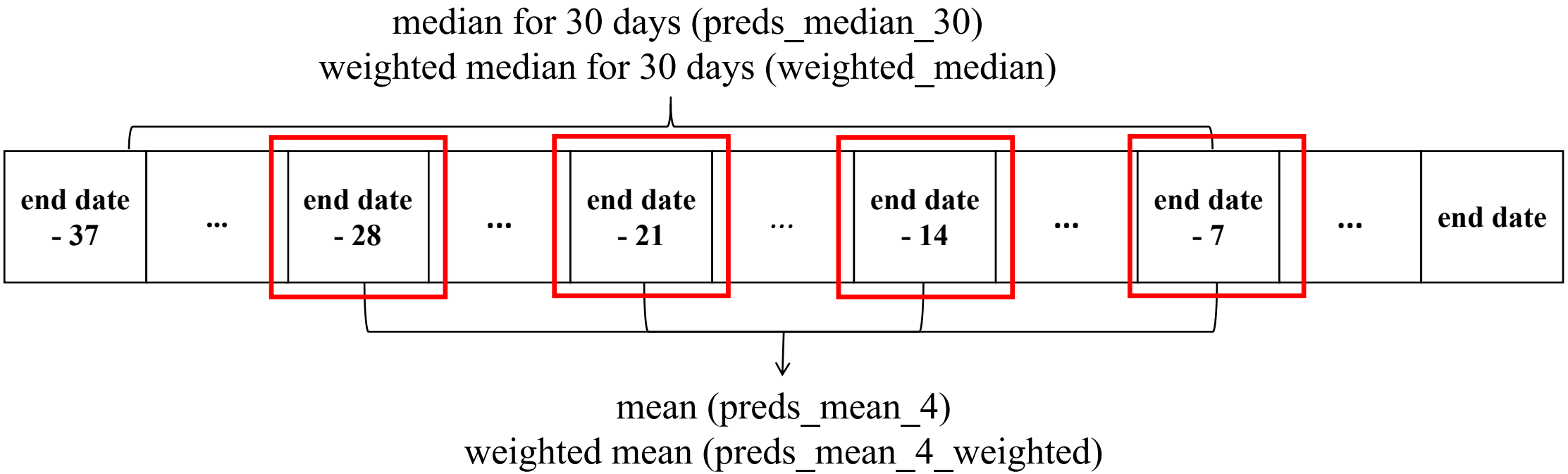
➢ Statistical Features



Feature Engineering

➢ Statistical Features

✓ Historical Retention Score



Feature Engineering

➢ Statistical Features

✓ Historical Retention Score

Feature Name	Stage A	Stage B
preds_mean_4	84.522	84.581
preds_mean_4_weighted	**84.994**	**85.013**
preds_median_30	83.778	83.906
weighted_median	83.123	83.268

Feature Engineering

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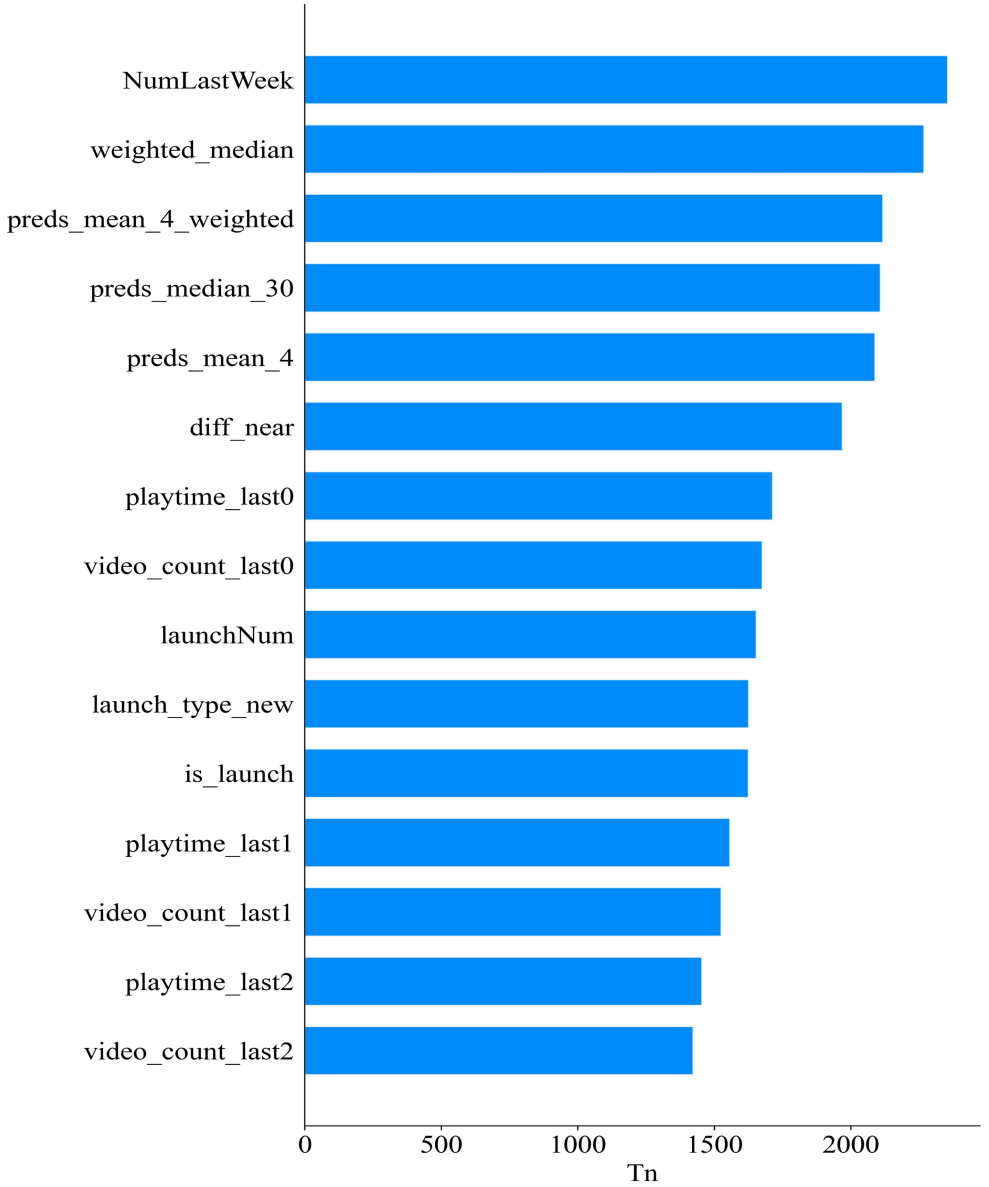
➢ Feature Selection

- ✓ Mean variance test (MvTest)
- ✓ Distribution free test of Independence
- ✓ Test statistic:

$$T_n = n\widehat{MV}(X|Y)$$
$$= \sum_{r=1}^{R} \sum_{i=1}^{n} \widehat{p_r} * [\widehat{F_r}(X_i) - \widehat{F}(X_i)]^2$$

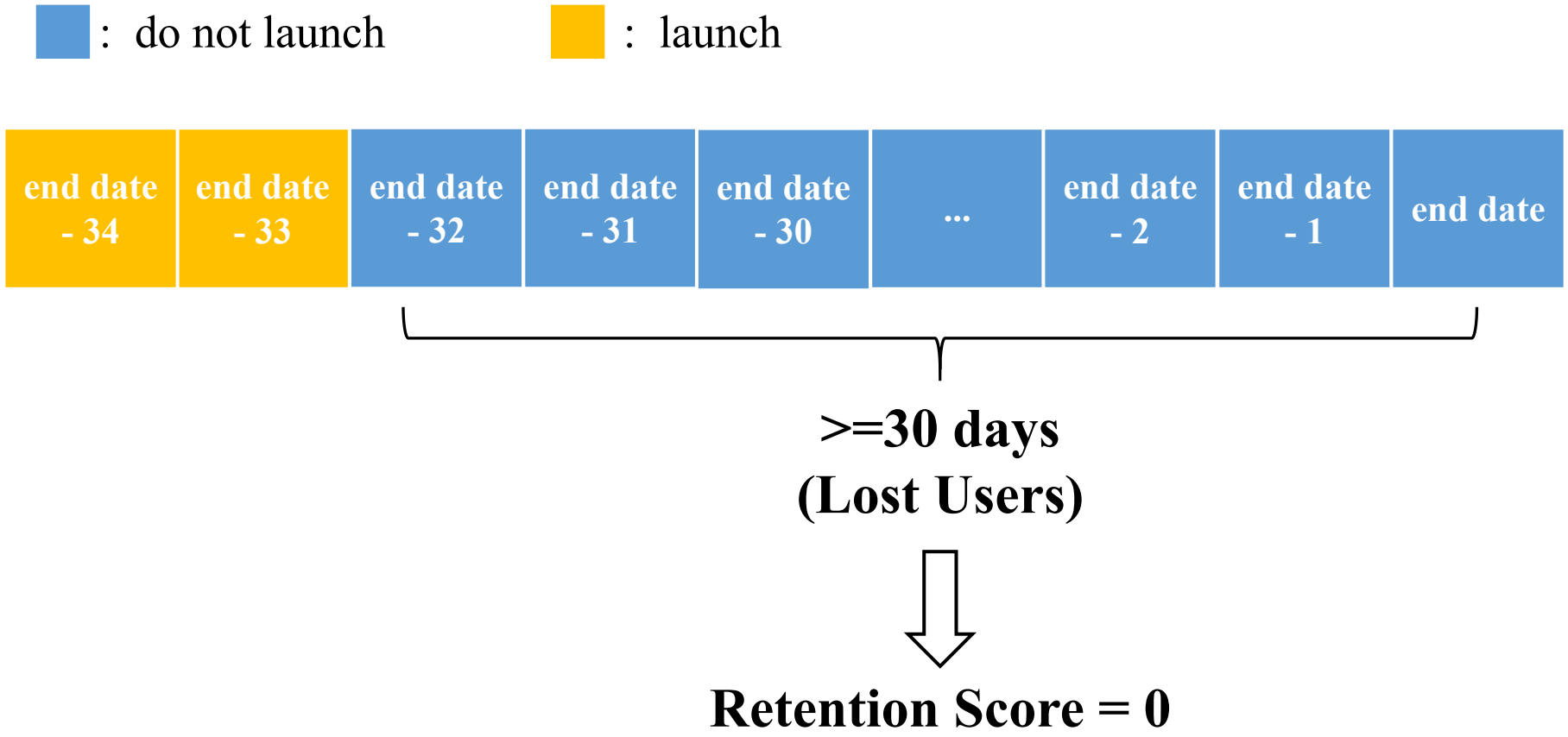


Model Averaging

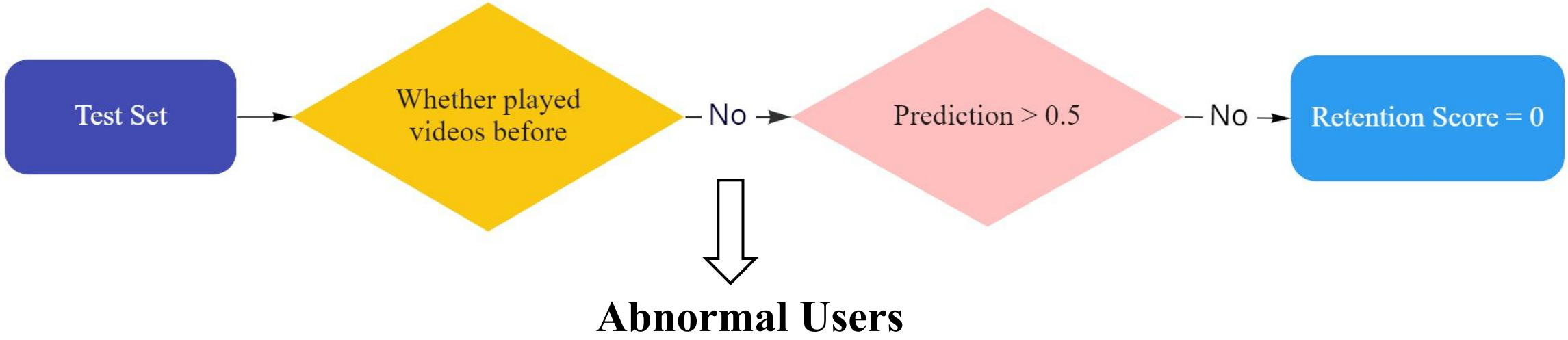
- Assemble 4 tree-based models by the harmonic mean
  - ✓ LightGBM
  - ✓ Catboost
  - ✓ Xgboost
  - ✓ Tensorflow Decision Forest (TFDF)

$$\hat{y} = \frac{4}{\frac{1}{\hat{y}_{lgb} + 0.00001} + \frac{1}{\hat{y}_{cbt} + 0.00001} + \frac{1}{\hat{y}_{xgb} + 0.00001} + \frac{1}{\hat{y}_{tfdf} + 0.00001}}$$

Post-processing

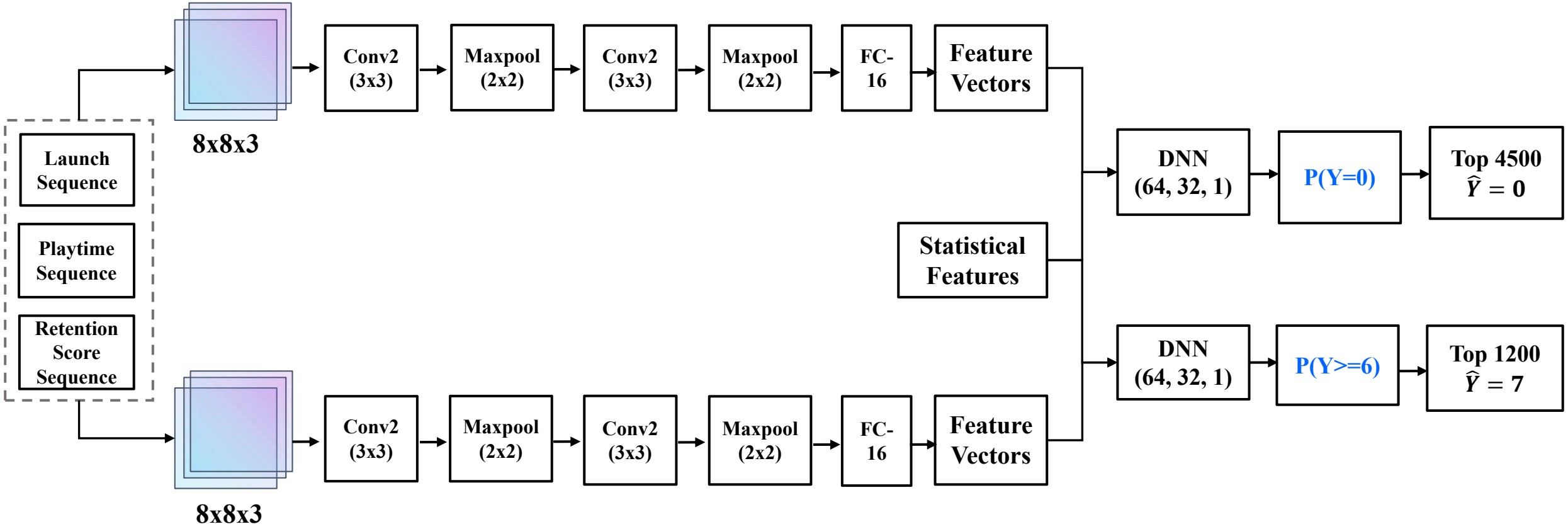


Post-processing



Post-processing

- CNN models, adjust predictions

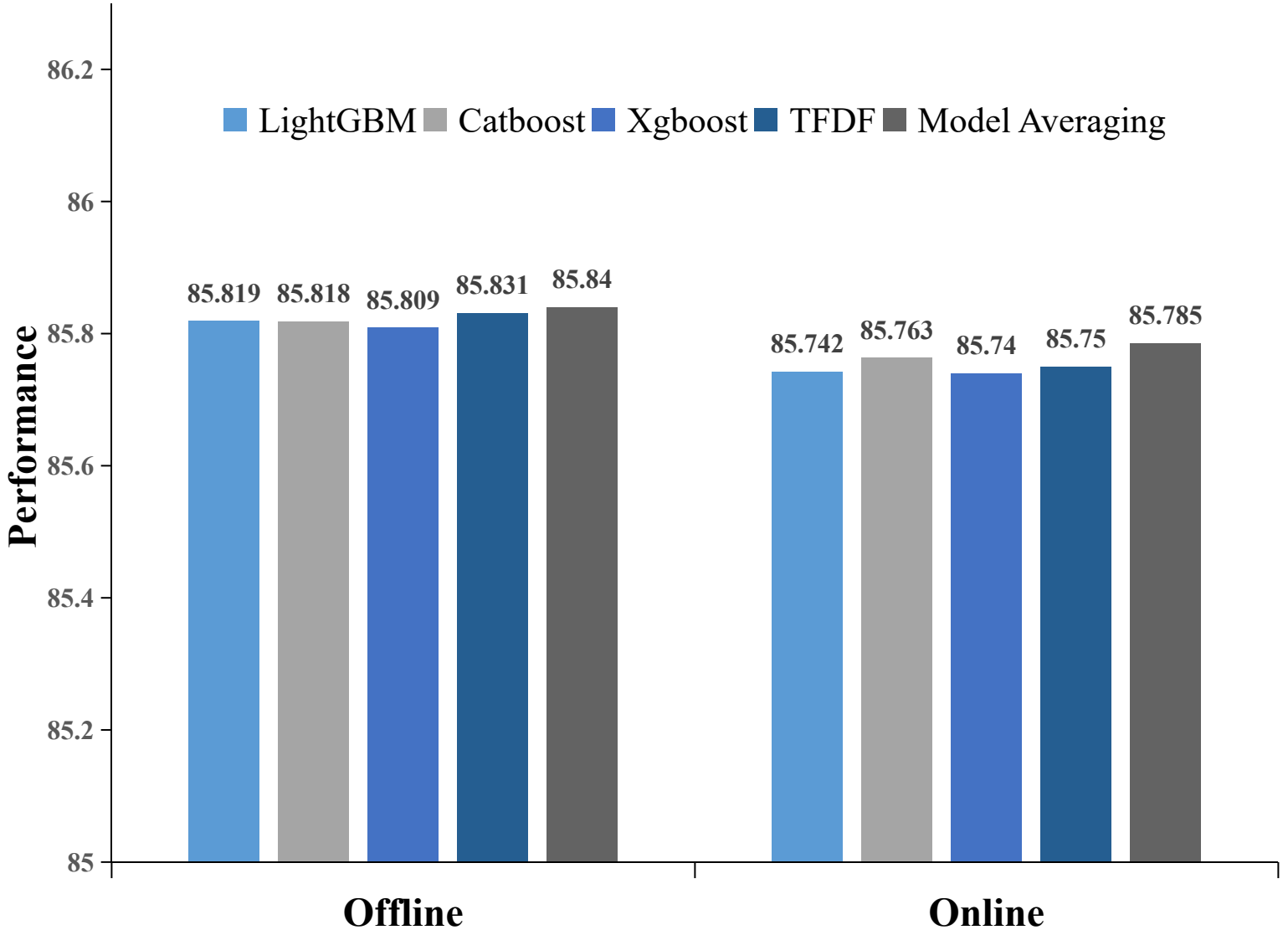


Post-processing

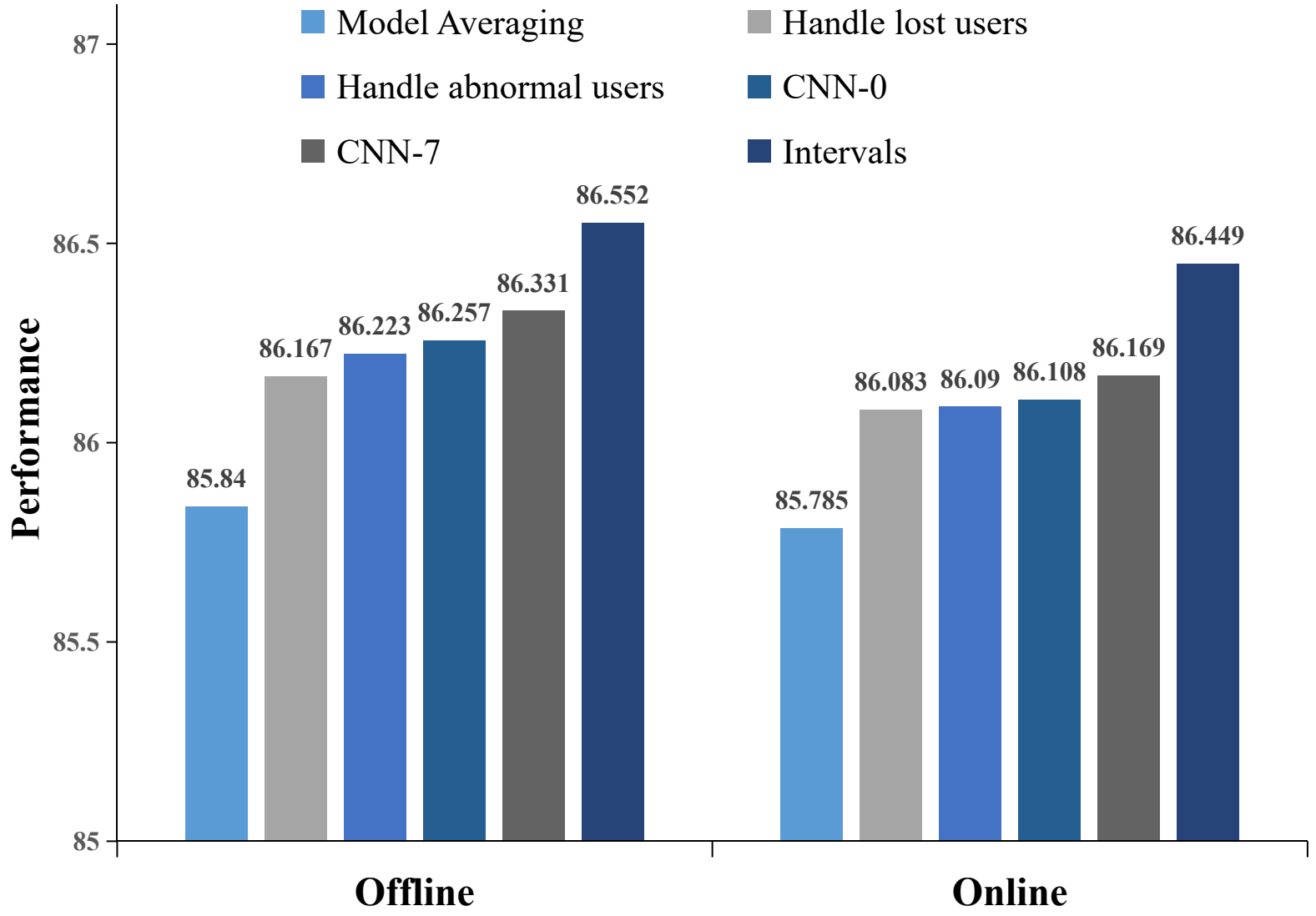
- Adjust the predictions by intervals

Interval	Adjusted Prediction
(0, 0.5)	0
(0.6, 1.4)	1
(1.55, 2.4)	2
(2.55, 3.4)	3
(3.55, 4.4)	4
(4.55, 5.2)	5
(5.55, 6.2)	6

Performance



Performance



Thank you !

If you would like to join us for a master's or doctoral degree, please contact the Founding Director Prof. Xiaoquan Su (suxq@qdu.edu.cn).