NGUARD: A Game Bot Detection Framework for NetEase MMORPGs

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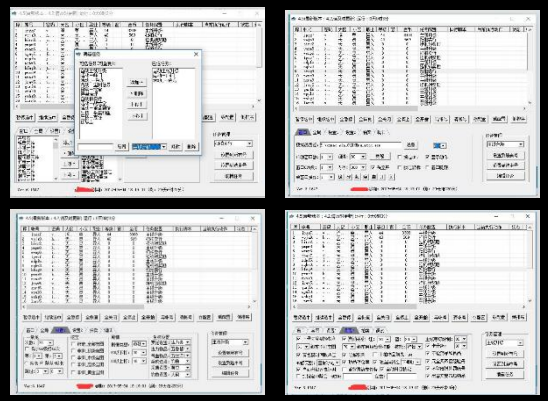
MMORPG反外挂背景

MMORPG
大型多人在线角色扮演游戏

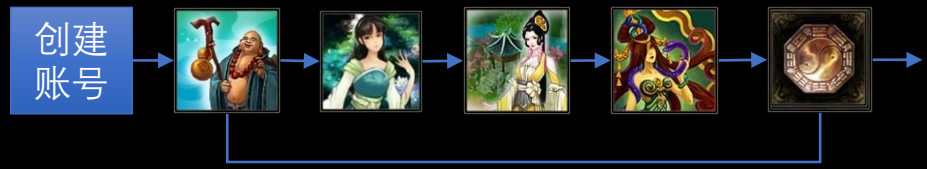
游戏外挂客户端截图



游戏外挂脚本界面

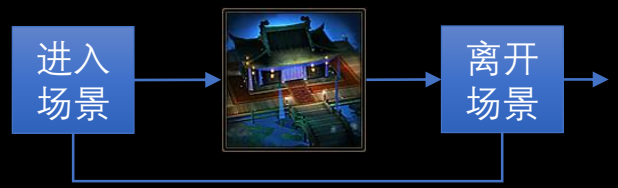
外挂严重破坏游戏的生态圈
降低游戏的公平性和可玩性

Main quest

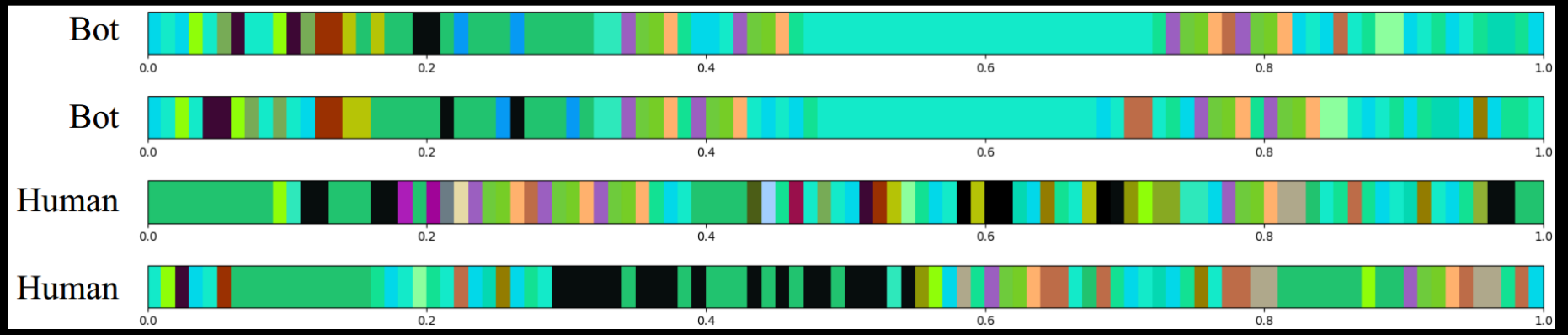


Daily quest

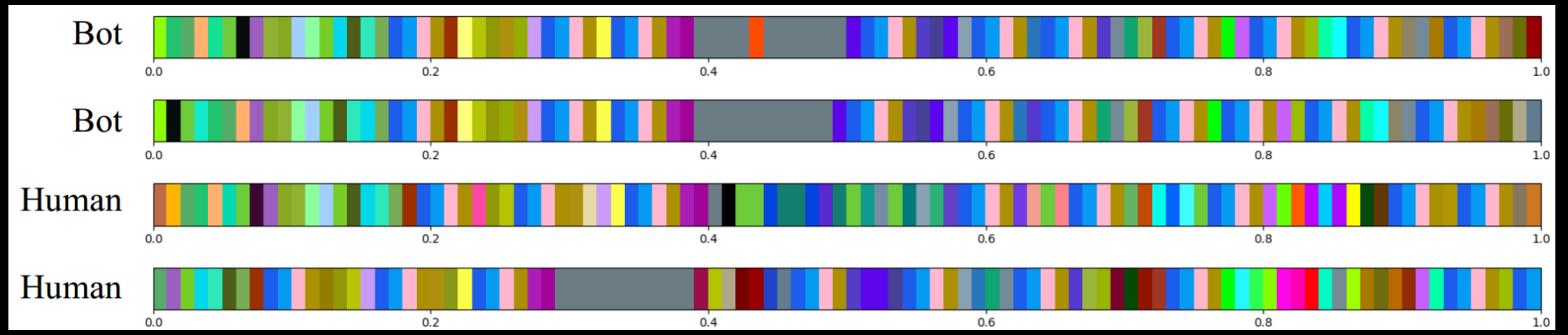
Instanced quest



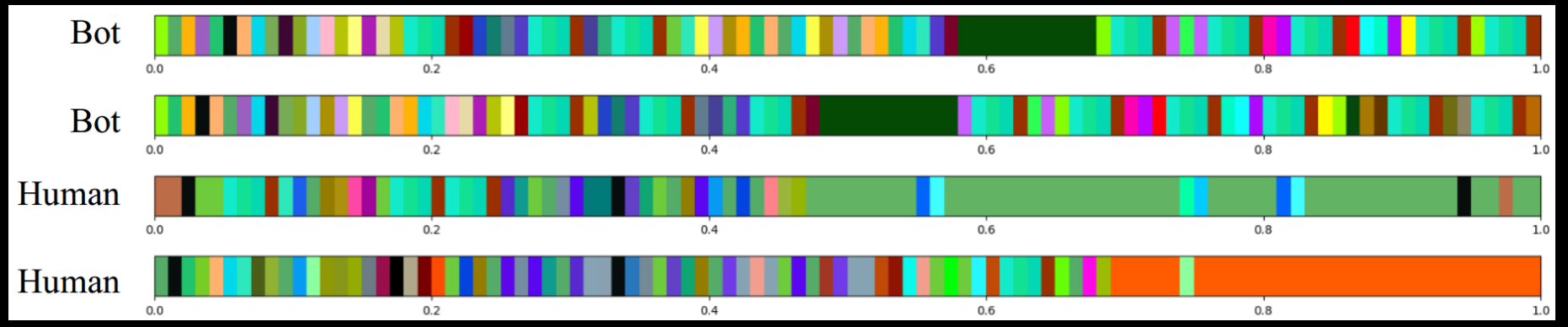
Main quest



Daily quest



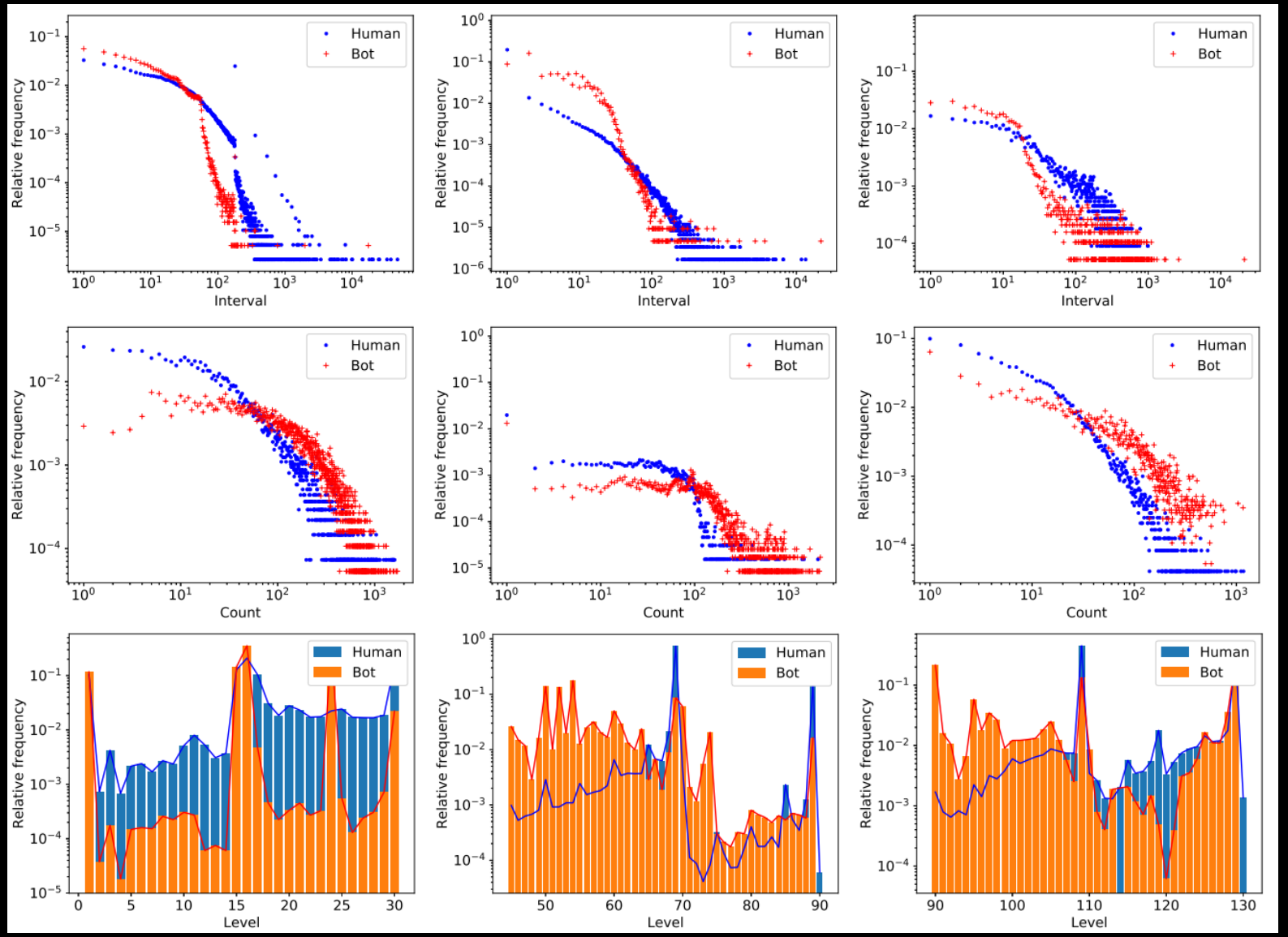
Instanced quest



Interval

Count

Level

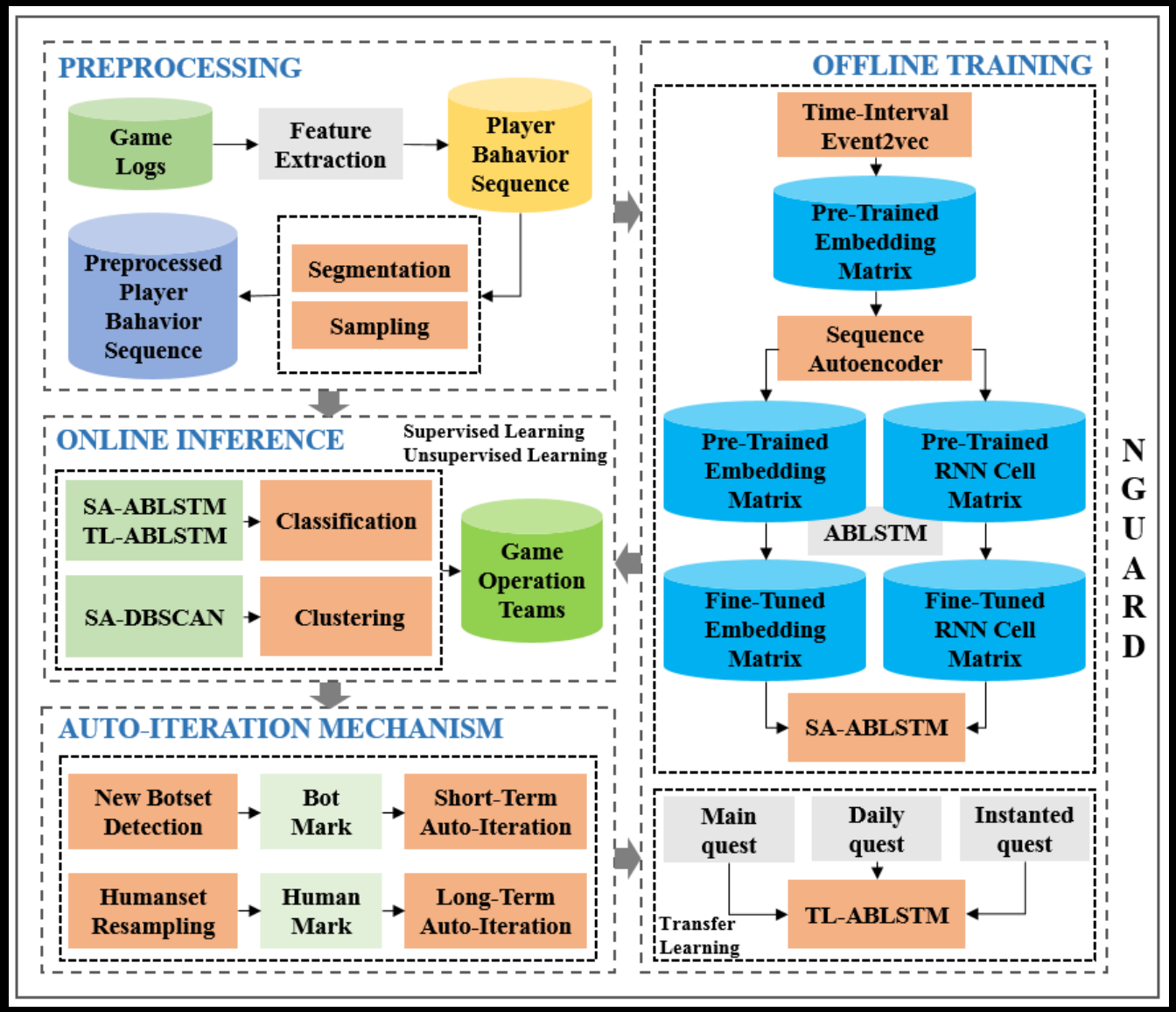


Main quest

Daily quest

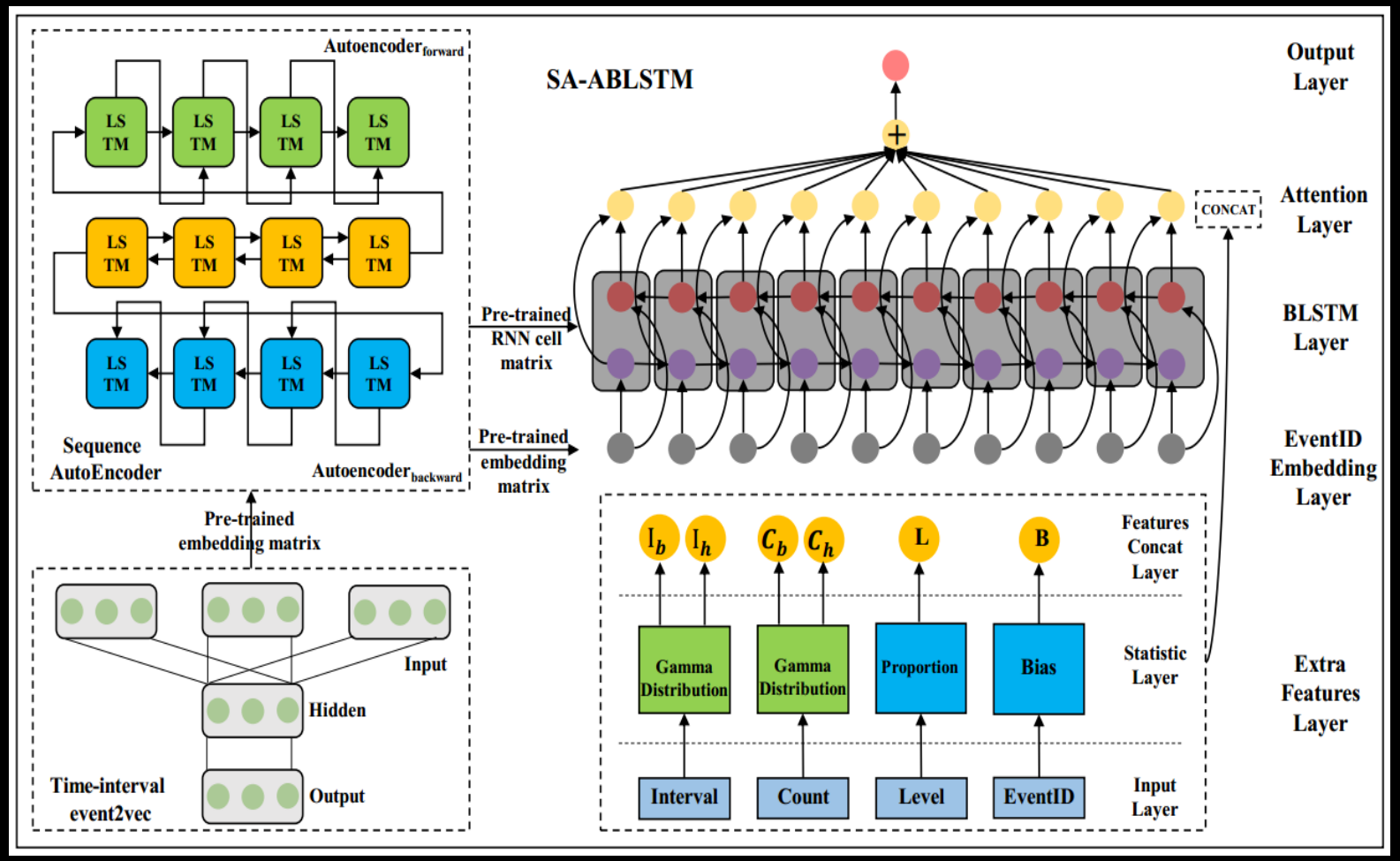
Instanced quest

Framework



- **Preprocessing**
  segment
  sampling
- **Offline Training**
  training the models offline
- **Online Inference**
  online service
- **Auto-iteration mechanism**
  short-term
  long-term

Offline Training



- **Pre-training**
  Time-interval Event2vec
  Sequence Autoencoder
- **Modeling**
  SA-ABLSTM
- **Transfer-learning**

Time-interval Event2vec

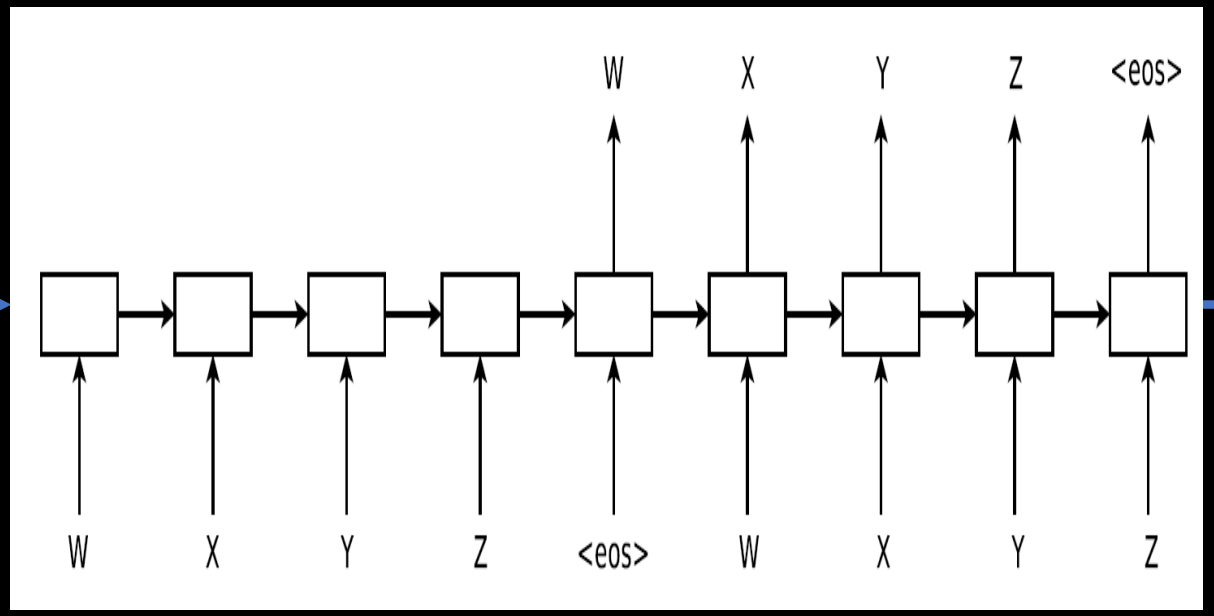
Time-interval Event2vec	Word2vec
Event Sequence	Sentence
Weight of event is different	Weight of word is the same

- **Time-interval Event2vec considers the time elapsed between two events.**
- **The event within shorter time gaps to the target event should contribute more in predicting the target event.**

Sequence Autoencoder

Time-interval Event2vec

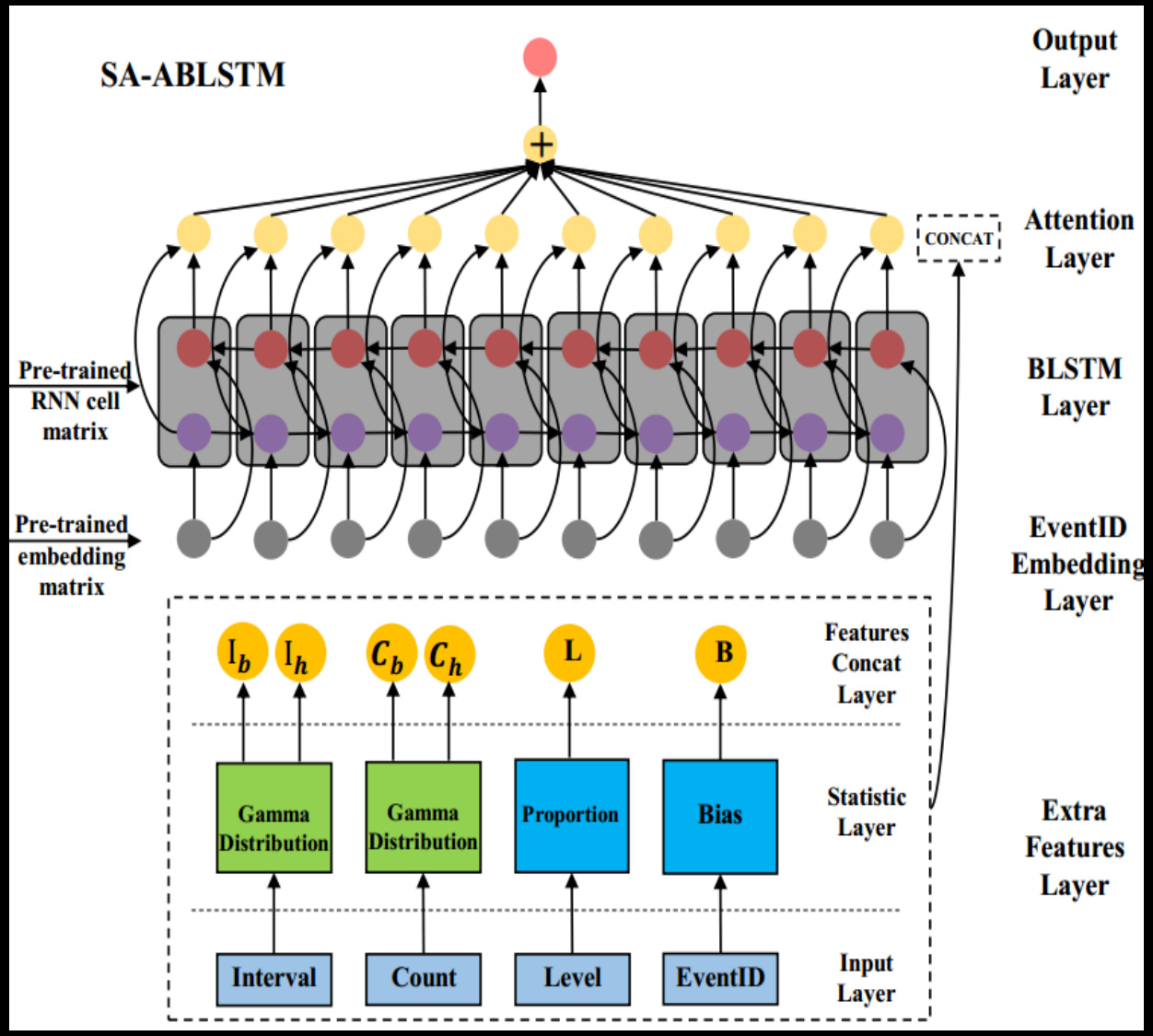
Pre-trained event embedding matrix



Pre-trained event embedding matrix (Fine-tuned)

Pre-trained RNN cell weight

SA-ABLSTM



- **Input**
  Event sequence $\{E_1,\ldots,E_n\}$
  Extra features: Interval, Count, Level
- **Bi-LSTM for Event sequence**
- **Knowledge-based method for extra features**

Knowledge-based method for extra features

- **Interval**

Gamma distribution : $Interval_h \sim \Gamma(\alpha_{i,h}, \beta_{i,h})$ $Interval_b \sim \Gamma(\alpha_{i,b}, \beta_{i,b})$

$$I_{i,h} = f(t_i; \alpha_{i,h}, \beta_{i,h}) \ , \ I_{i,b} = f(t_i; \alpha_{i,b}, \beta_{i,b})$$

- **Count**

Gamma distribution : $Count_h \sim \Gamma(\alpha_{c,h}, \beta_{c,h})$ $Count_b \sim \Gamma(\alpha_{c,b}, \beta_{c,b})$

$$C_{i,h} = f(c_i; \alpha_{c,h}, \beta_{c,h}) \ , \ C_{i,b} = f(c_i; \alpha_{c,b}, \beta_{c,b})$$

- **Level**

$$L_i = P(l_i) = \frac{N_{bot}^{l,e}}{N_{bot}^{l,e} + N_{human}^{l,e}}$$

- **bias**

$$B_i = P(e_i) = \frac{N_{bot}^{e}}{N_{bot}^{e} + N_{human}^{e}}$$

- **Output of Bi-LSTM: $H=[h_1, \ldots, h_n]$**
- **Concat H with the statistical values:**

$$h_i' = h_i \circ I_{i,h} \circ I_{i,b} \circ C_{i,h} \circ C_{i,b} \circ L_i \circ B_i$$

- **Self-attention:**

$$a_i = softmax(w_i{}^T H' + b_i) \ , \ r_i = a_i \odot h_i'$$

Online Inference

- **Supervised solution**
  Classification: SA-ABLSTM

- **Unsupervised solution**
  Clustering: SA-DBSCAN
  1. Extract the vector representation of event sequences from the well-trained Sequence Autoencoder
  2. Perform DBSCAN on the vector representation of event sequence

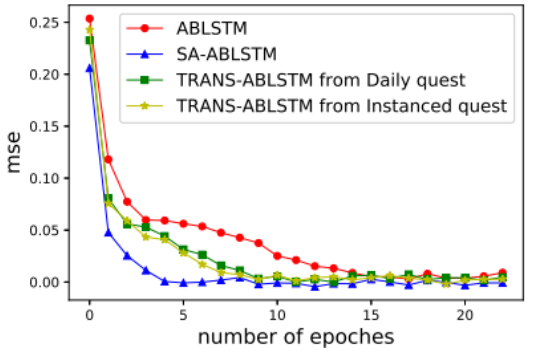
Auto-iteration Mechanism

- **Humanset Resampling**
- **New Botset Detection**
  Known game bots, Mutated game bots, Unknown game bots
  clusters of SA-DBSCAN
- **Short-term Auto-iteration**
  ABLSTM
- **Long-term Auto-iteration**
  SA-ABLSTM

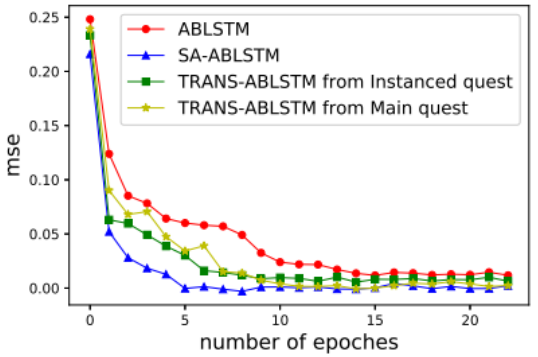
Experiments

Comparisons of supervised solutions

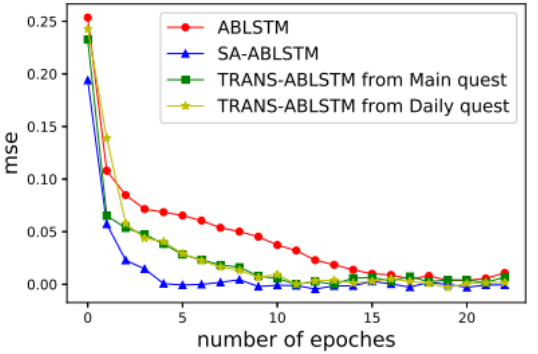
Type of game bot	Model	Precision	Recall	F1
Main quest	MLP	0.9618	0.9773	0.9694
	CNN	0.9721	0.9807	0.9764
	Bi-LSTM	0.9809	0.9865	0.9837
	ABLSTM	0.9851	0.9882	0.9866
	TL-ABLSTM from Daily quest	0.9893	0.9906	0.9902
	TL-ABLSTM from Instanced quest	0.9878	0.9896	0.9881
	SA-ABLSTM	**0.9904**	**0.9912**	**0.9908**
Daily quest	MLP	0.9528	0.9609	0.9568
	CNN	0.9633	0.9712	0.9672
	Bi-LSTM	0.9709	0.9728	0.9718
	ABLSTM	0.9716	0.9774	0.9745
	TL-ABLSTM from Main quest	0.9771	0.9742	0.9785
	TL-ABLSTM from Instanced quest	0.9736	0.9721	0.9763
	SA-ABLSTM	**0.9838**	**0.9861**	**0.9815**
Instanced quest	MLP	0.9441	0.9571	0.9506
	CNN	0.9552	0.9643	0.9597
	Bi-LSTM	0.9612	0.9732	0.9672
	ABLSTM	0.9674	0.9786	0.973
	TL-ABLSTM from Daily quest	0.9698	0.9801	0.9742
	TL-ABLSTM from Main quest	0.9704	0.9808	0.9753
	SA-ABLSTM	**0.9721**	**0.9816**	**0.9768**



(a) Main quest



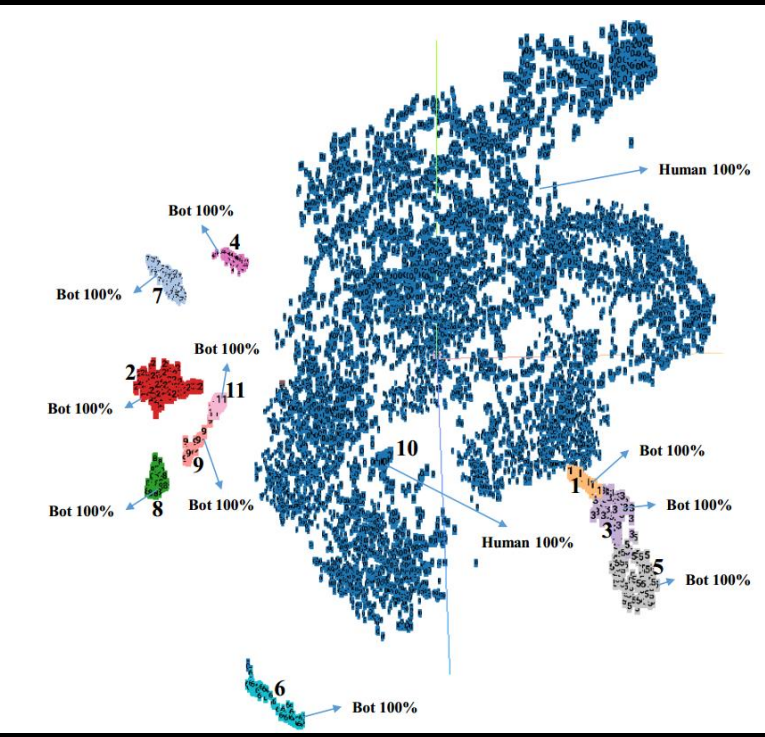
(b) Daily quest



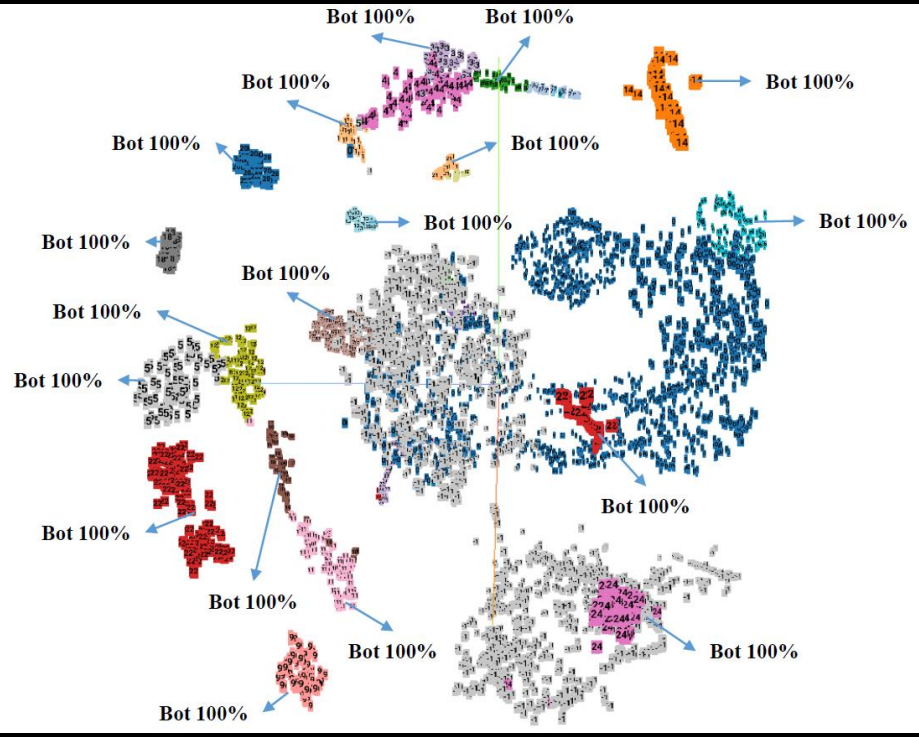
(c) Instanced quest

Experiments

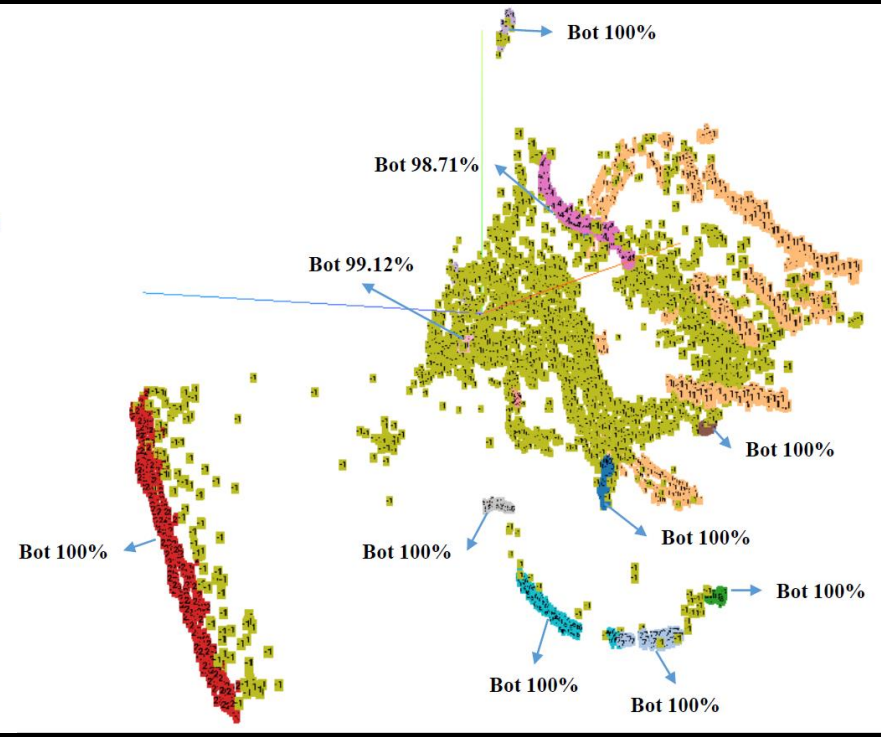
Evaluations of unsupervised solution: SA-DBSCAN



Main quest



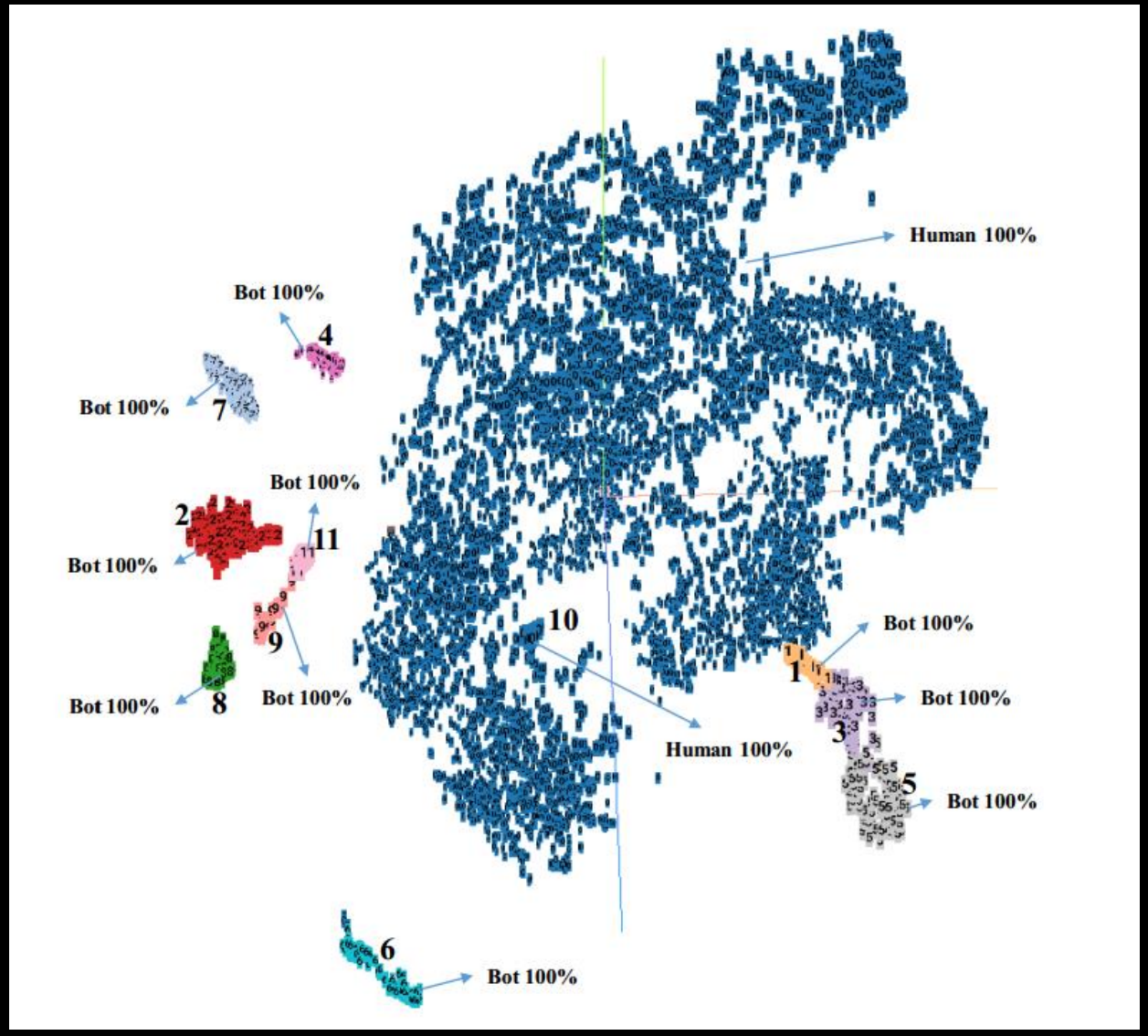
Daily quest

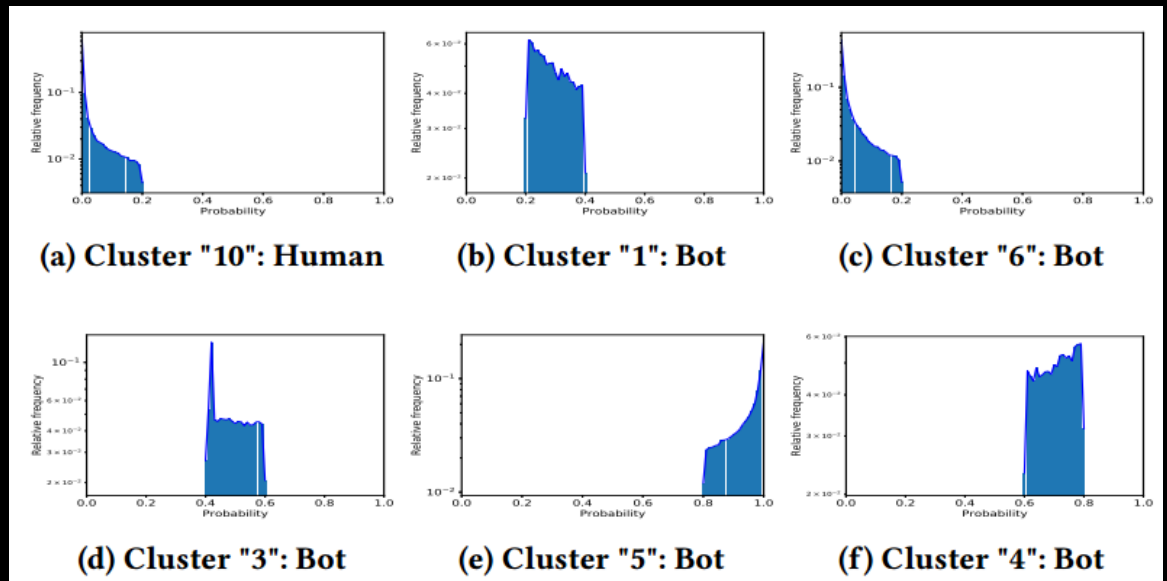


Instanced quest

Experiments

The necessity of the auto-iteration mechanism

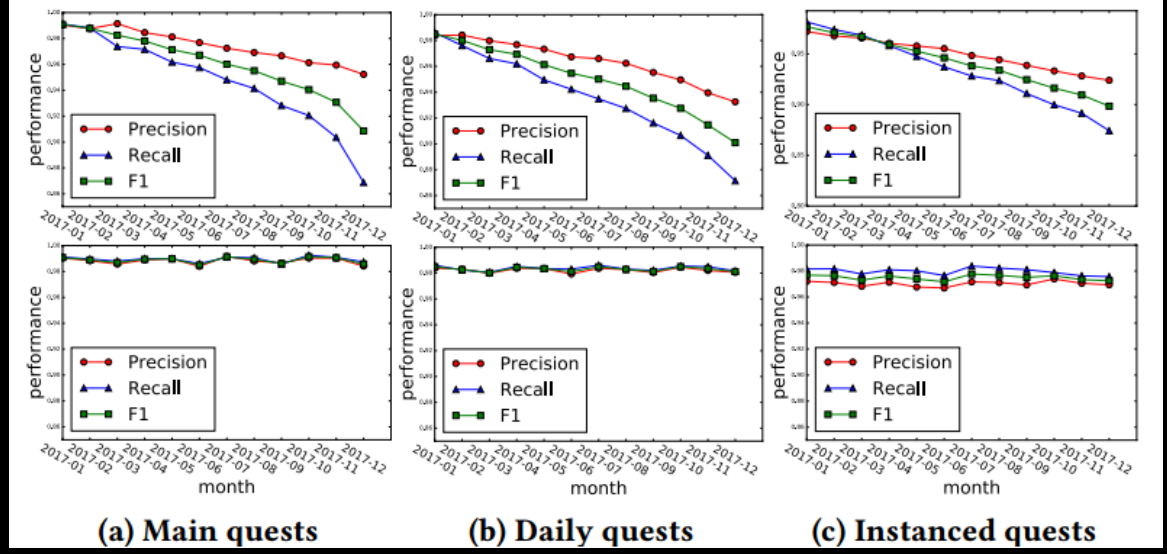




(a) Cluster "10": Human (b) Cluster "1": Bot (c) Cluster "6": Bot

(d) Cluster "3": Bot (e) Cluster "5": Bot (f) Cluster "4": Bot

Figure 8: Clusters' probability distribution in Figure 7(a)



(a) Main quests (b) Daily quests (c) Instanced quests

谢谢