

# 推荐系统用户行为预训练与迁移学习

报告人：原发杰（西湖大学，PI of REPL Lab）

报告日期：2021/12/17

## Bio

- 2021.04-: Assistant professor (PI) at Westlake University
- 2018.10-2021.04: Senior researcher at Tencent
- 2014.10-2018.10: Phd at University of Glasgow, UK  
supervised by Prof. Joemon Jose

招聘研究员，副研究员，助理研究员，博士后等若干名。

直博，没有准免资格的本科生也可以通过直接招入（无需考试）。  
优秀博士生有新生发展奖学金。

高分子合成，多肽，纳米药物，基因递送，细胞靶向

化学，材料，药学，医学，生物，生物，化工

## Representative work

- F. Yuan, G. Zhang, A. Karatzoglou, X. He, J. Jose, B. Kong, Y. Li.  
One Person, One Model, One World: Learning Continual User Representation without Forgetting. SIGIR, 2021.
- F. Yuan, X. He, A. Karatzoglou, L. Zhang.  
Parameter-Efficient Transfer from Sequential Behaviors for User Modeling and Recommendation. SIGIR, 2020.
- F. Yuan, X. He, H.Jiang, G. Guo, J. Xiong, Z. Xu, Y. Xiong  
Future Data Helps Training: Modelling Future Contexts for Session-based Recommendation. WWW, 2020
- F. Yuan, A. Karatzoglou, I. Arapakis, J. Jose, X. He  
A Simple Convolutional Generative Network for Next Item Recommendation. WSDM, 2019
- F. Yuan, X. Xin, X. He, G. Guo, W. Zhang, T. Chua, J. Jose  
fBGD: Learning Embeddings From Positive Unlabeled Data with BGD. UAI, 2018
- F. Yuan, G. Guo, J. Jose, L. Chen, H. Yu, W. Zhang  
LambdaFM: Learning Optimal Ranking with Factorization Machines Using Lambda Surrogates. CIKM, 2016

chengjianjun@westlake.edu.cn 电话 : 18051756851

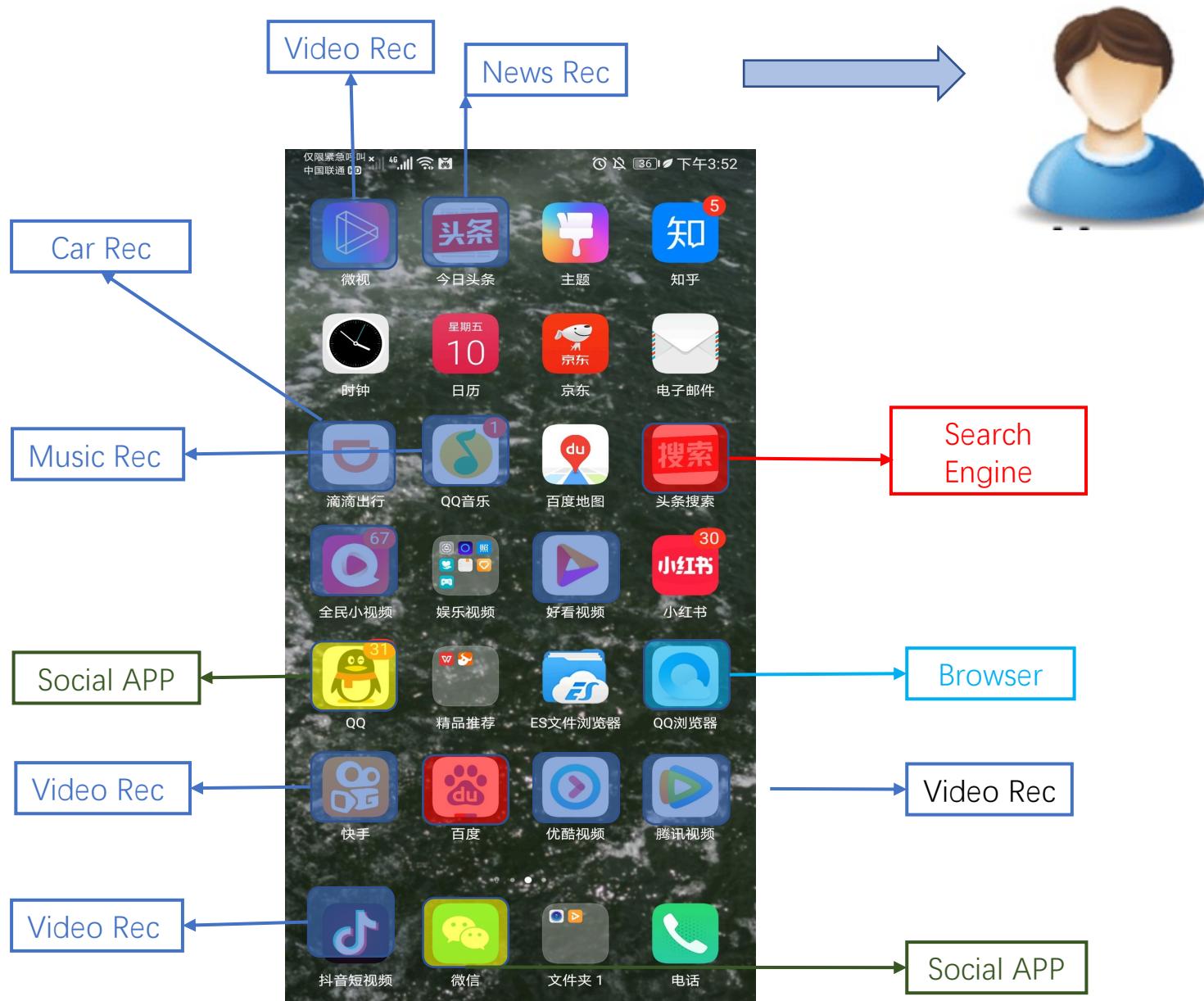
# Outlines

- Background
- Related Work
- Behavior Models
- Pre-training & Transfer Learning

# Feeds Recommendation



## Background



### Example:

QQ音乐

腾讯视频

腾讯新闻

腾讯看点

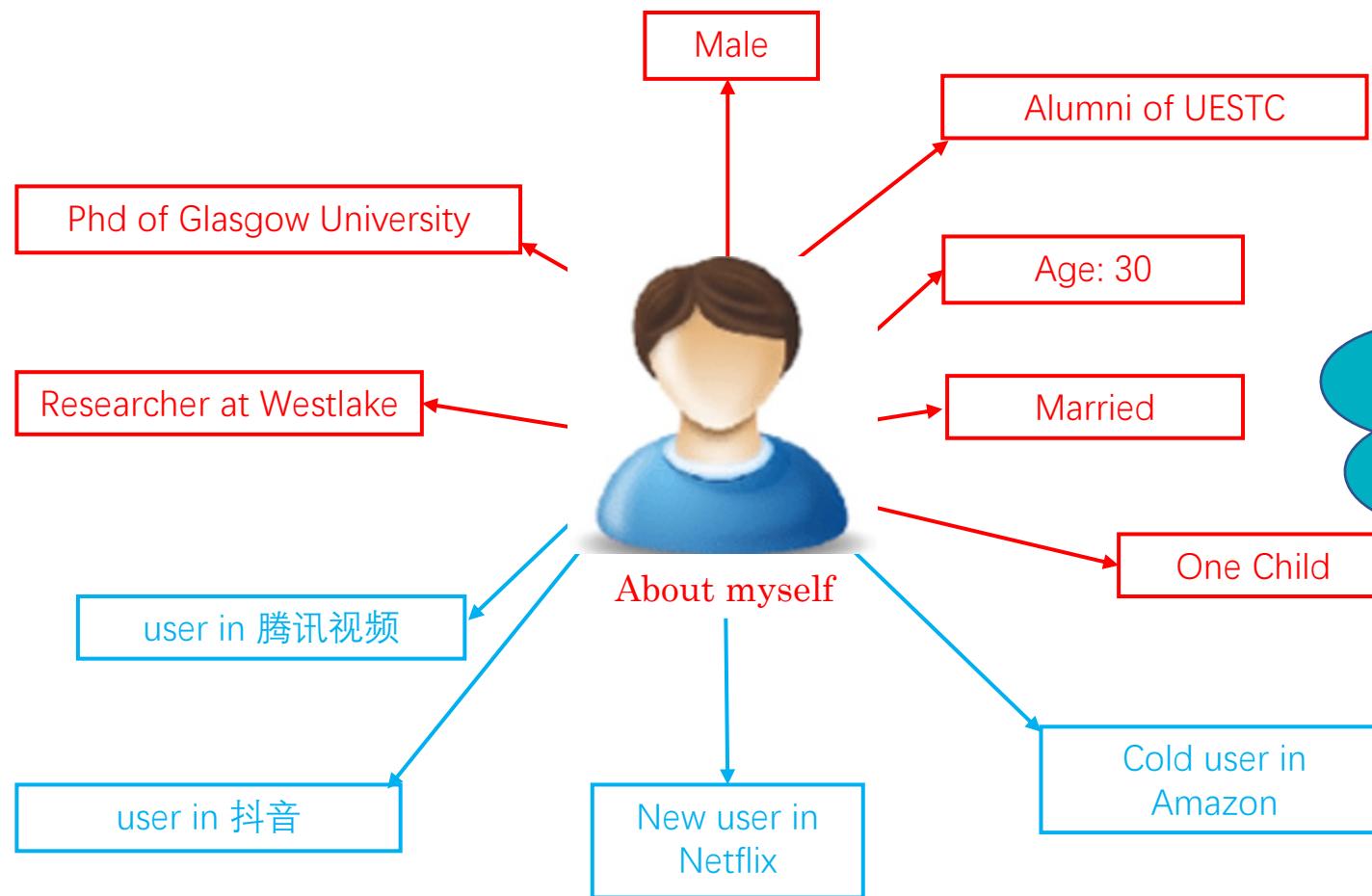
全民K歌

微视

微信

QQ

快手

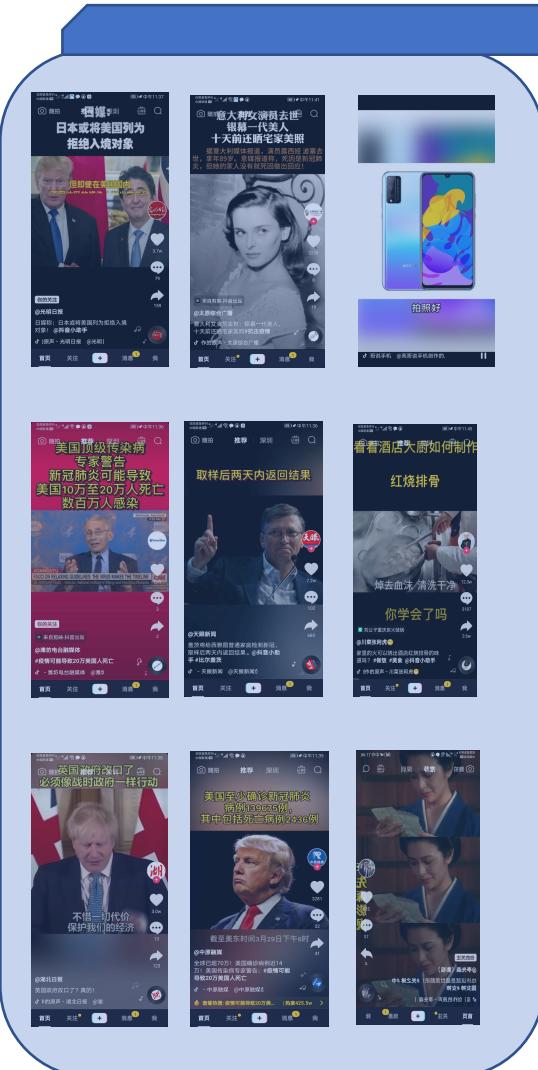


## Research Motivation

A person has different roles to play in life !  
But all these roles may have some commonalities, such as personalization, habits, preference.

user profile  
‘一人一世界’ SIGIR2020 | 2021

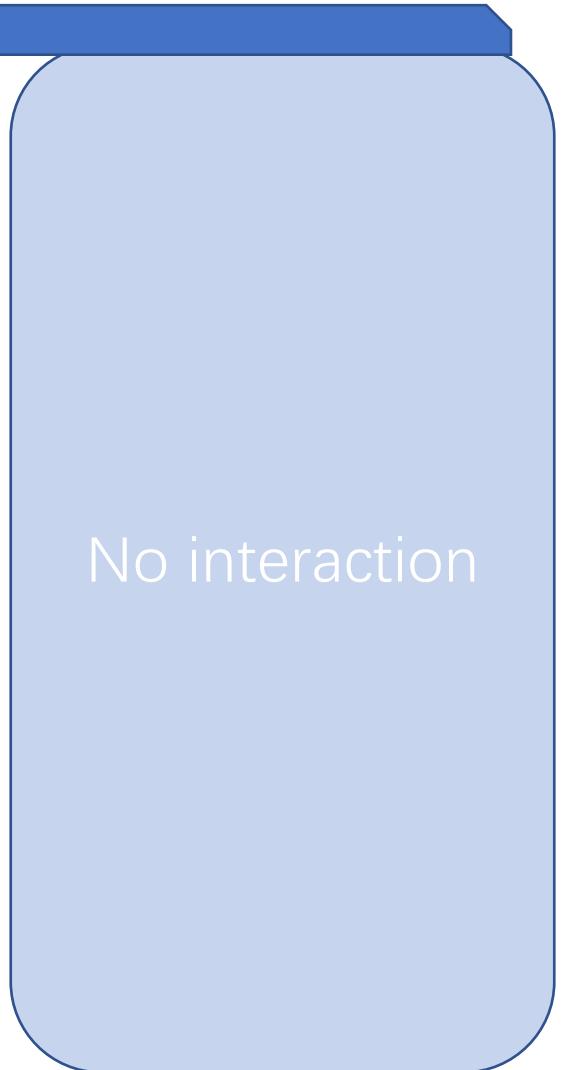
## Background



抖音-- warm user



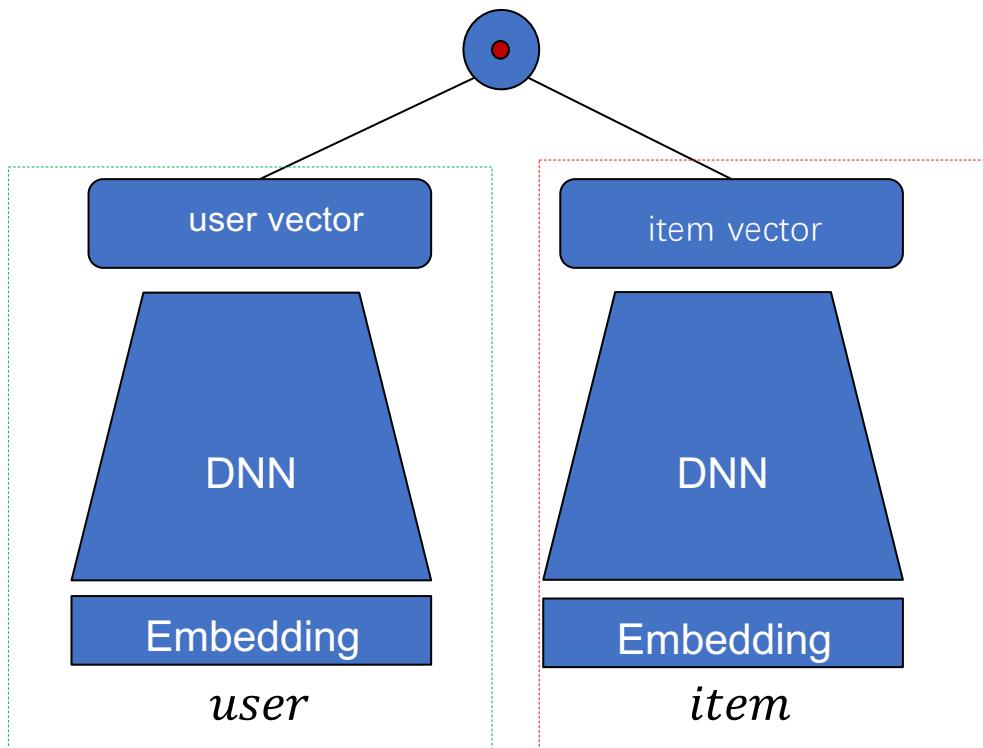
微视 -- cold users



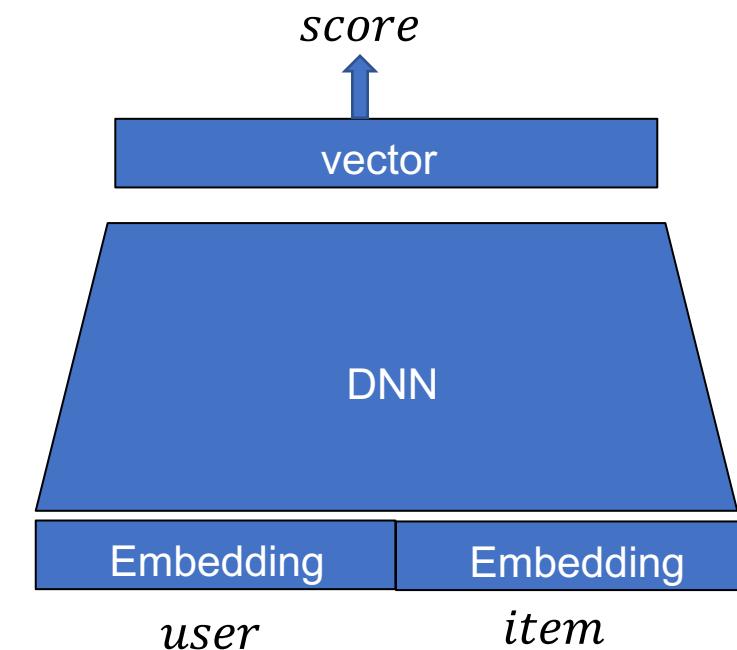
广告 --- new users

# Outlines

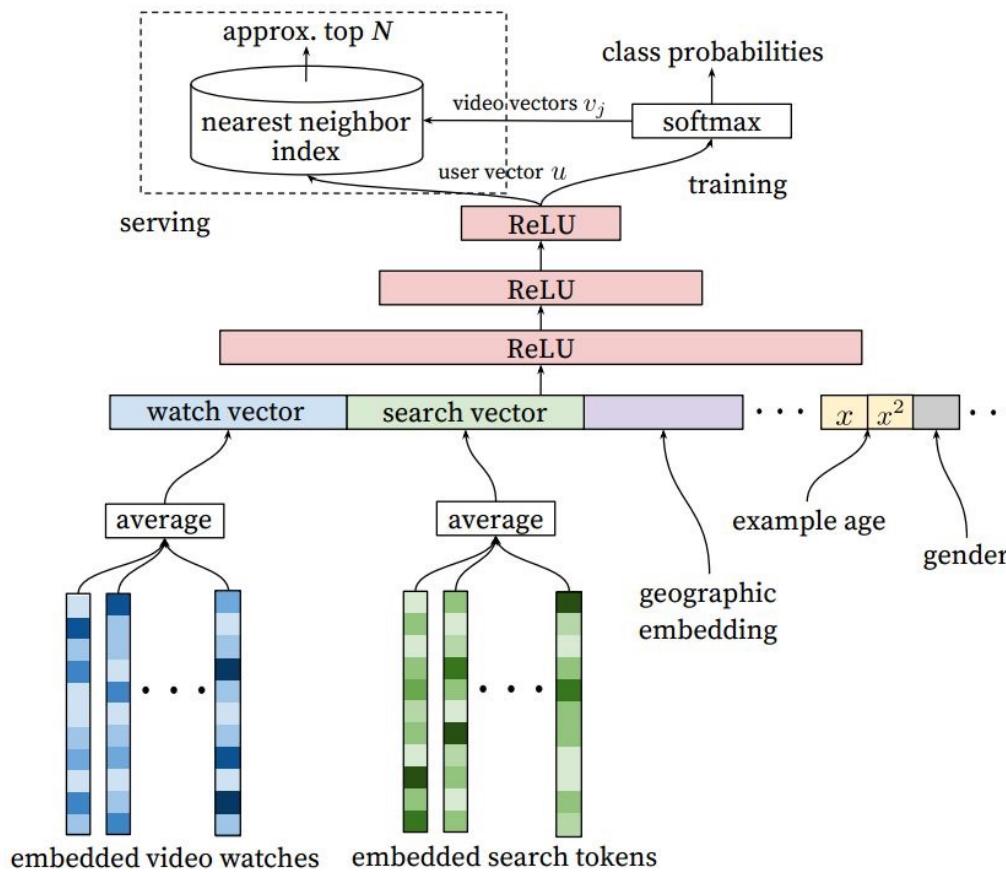
- Background
- Related Work
- Behavior Models
- Pretraining and Transfer Learning



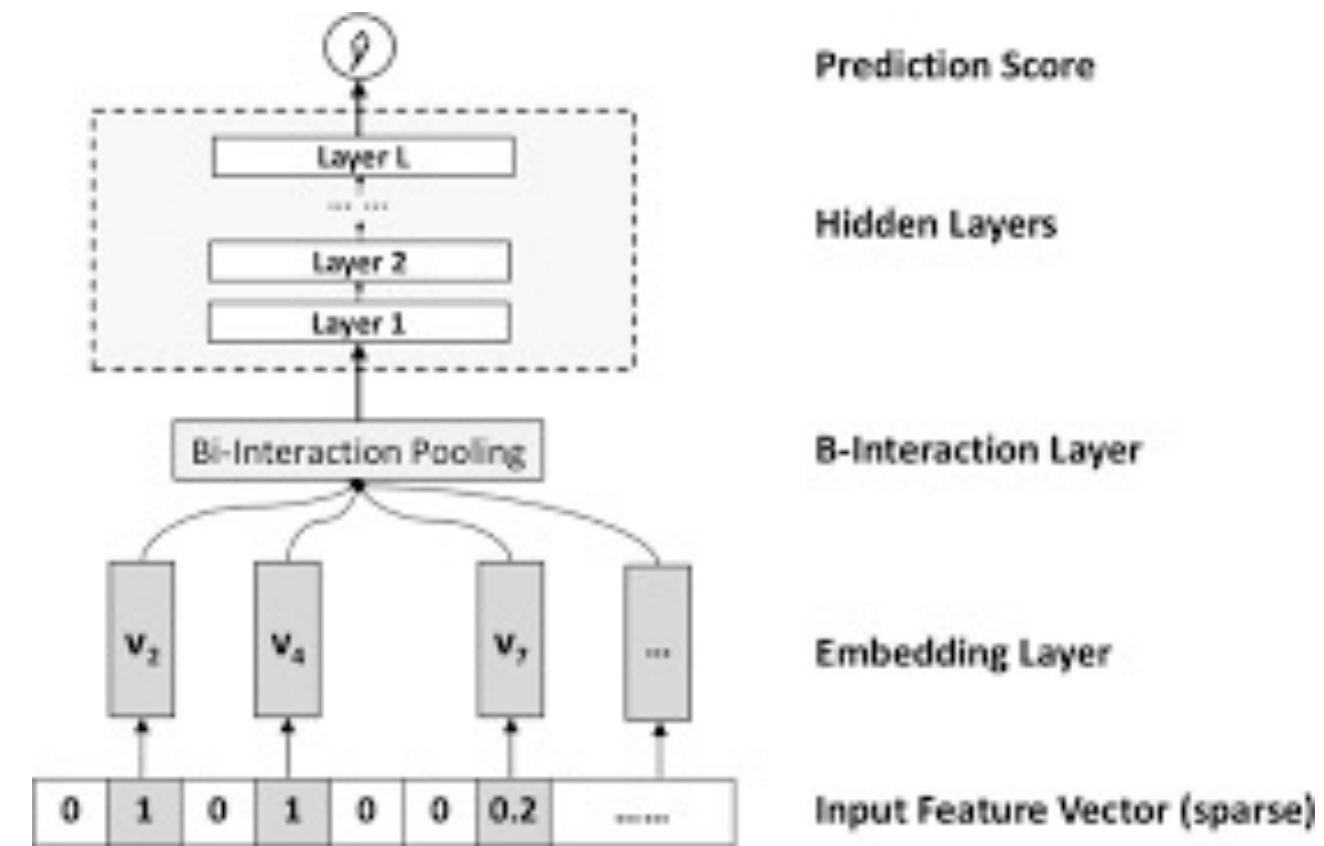
DSSM-two tower



MMOE/NFM-single tower

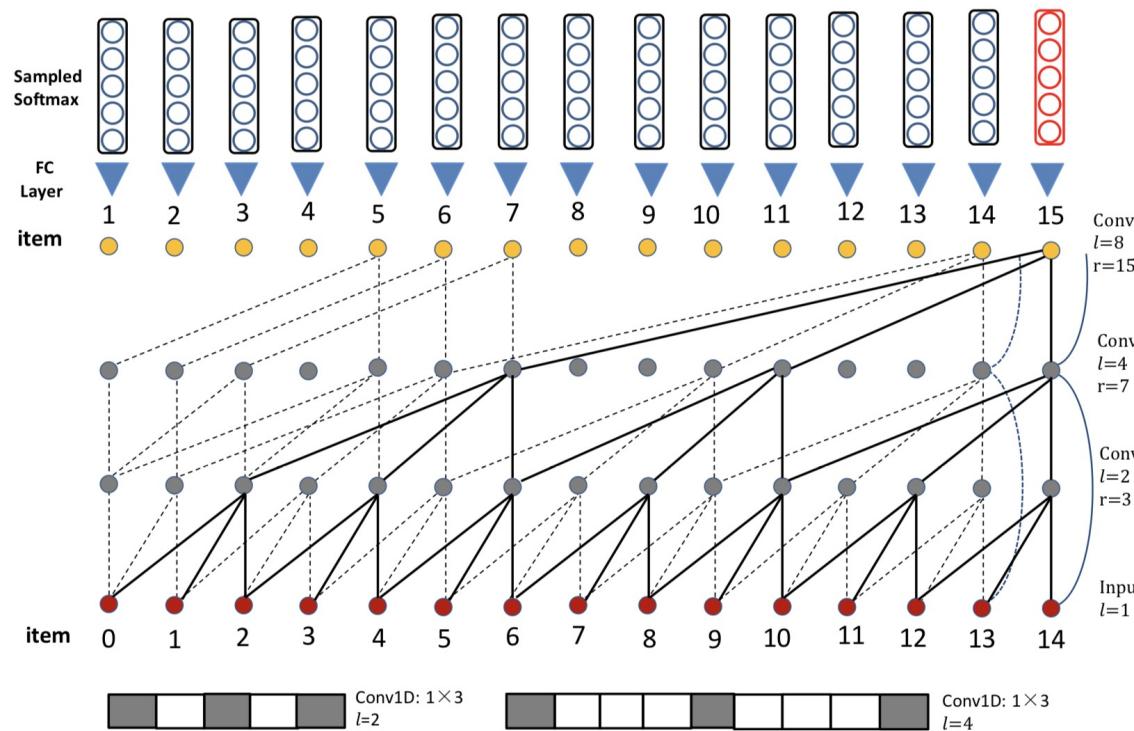


**Youtube DNN (2016) 双塔**

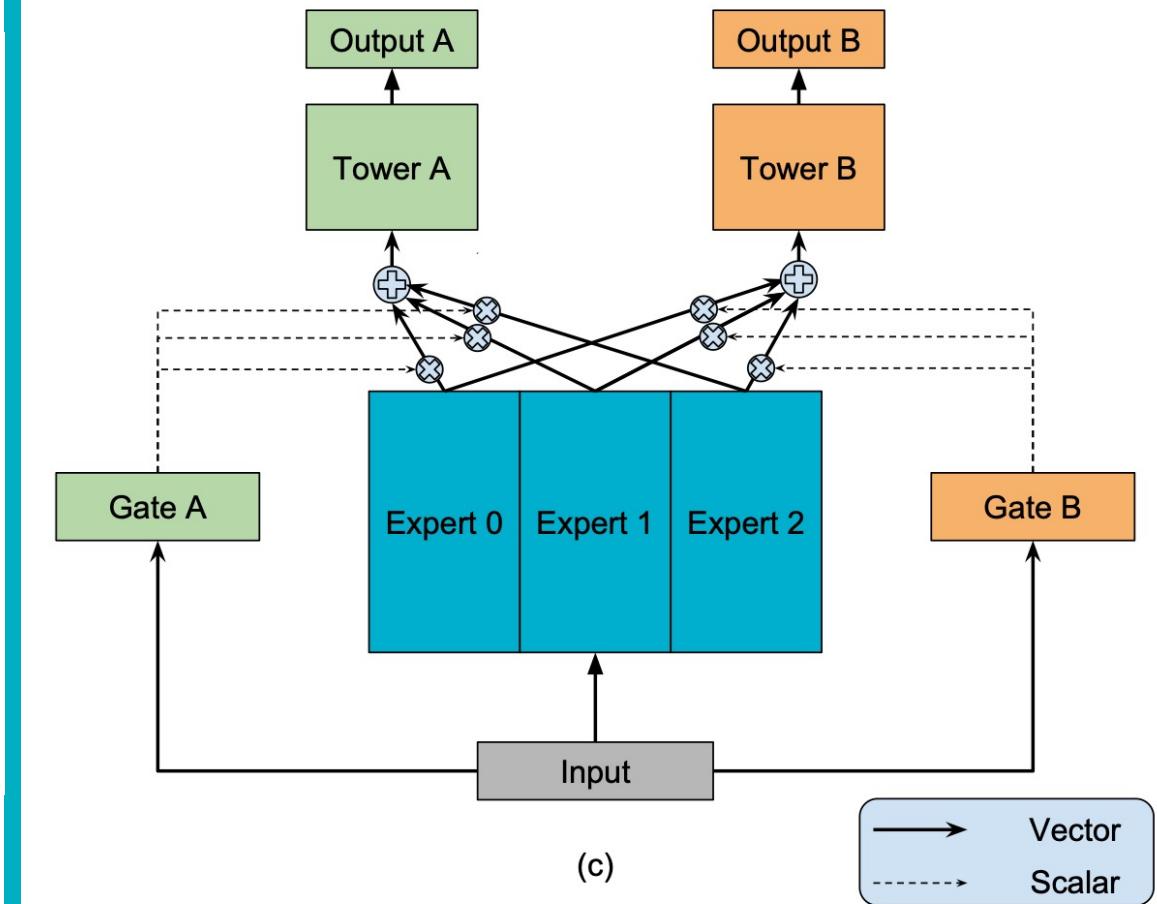


**Neural FM (2017) 单塔**

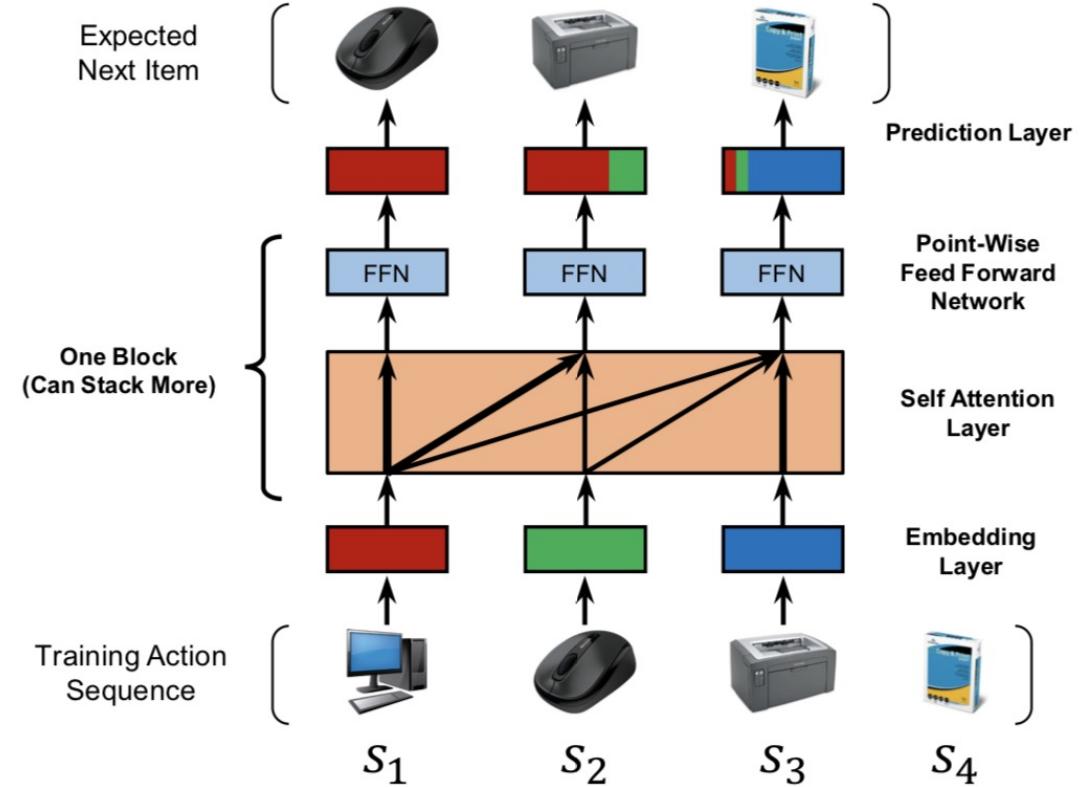
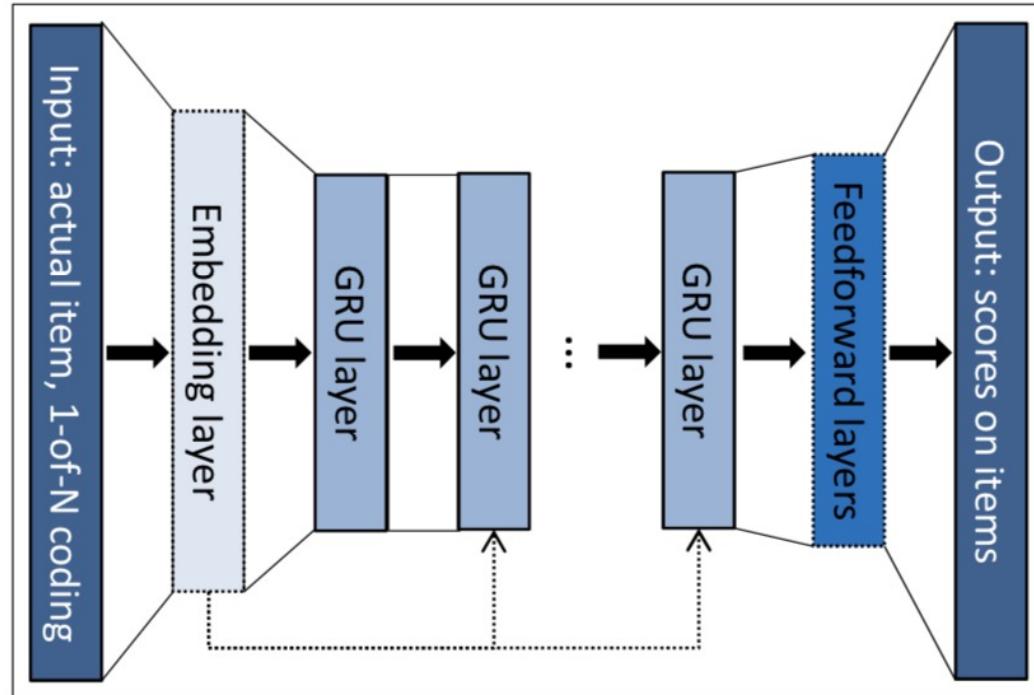
## Related Work + Behavior Models

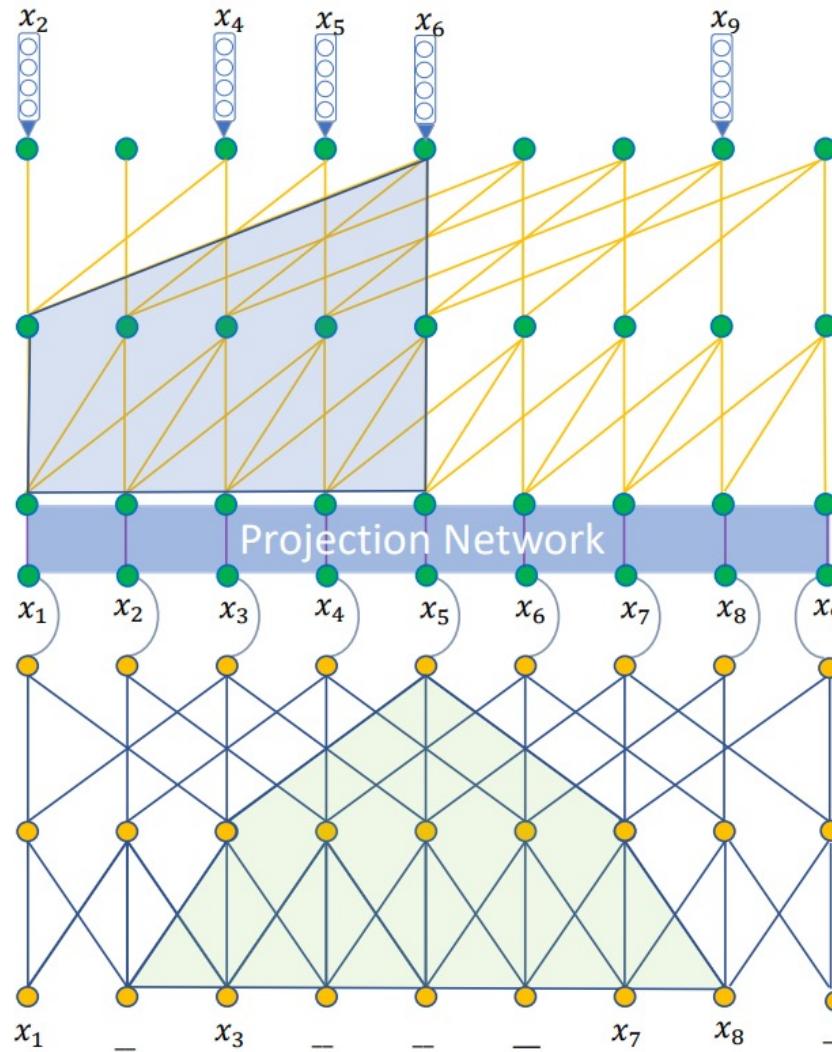


NextItNet (2019) 双塔

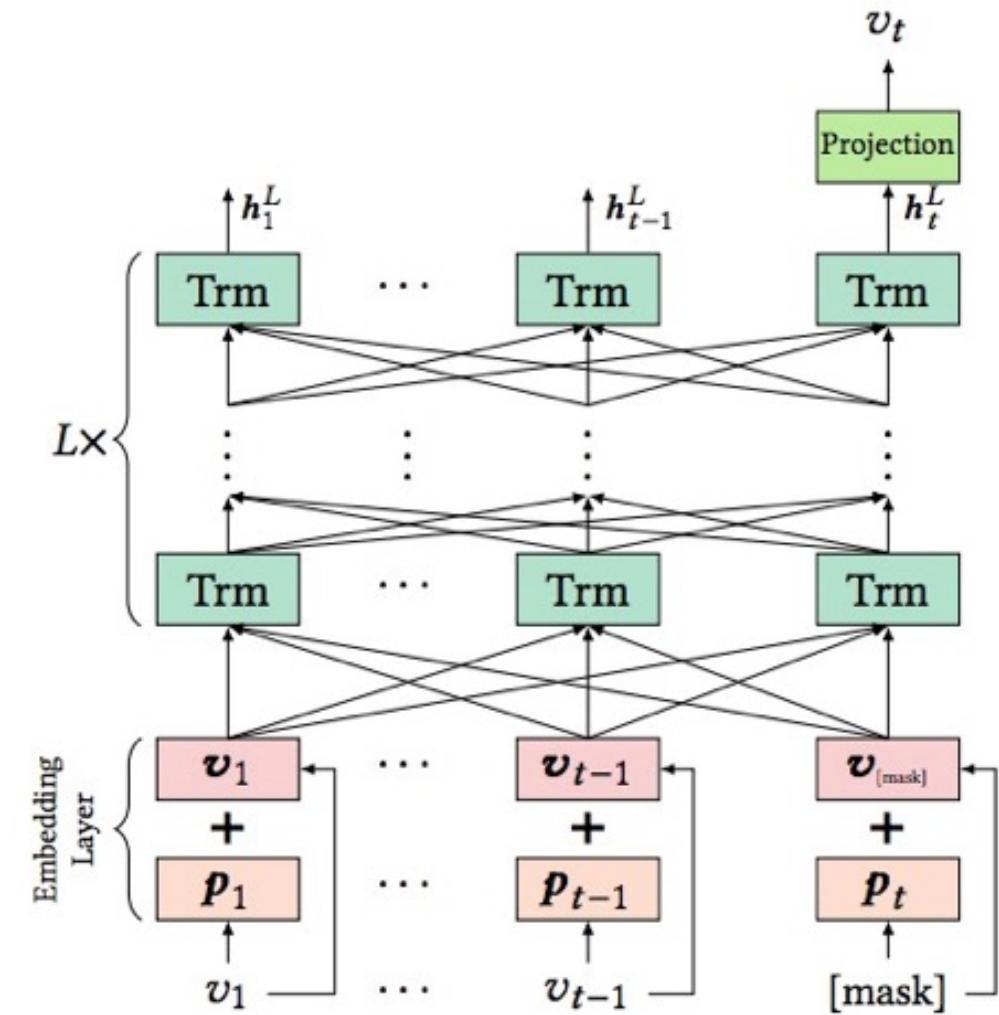


MMOE (2018) 单塔



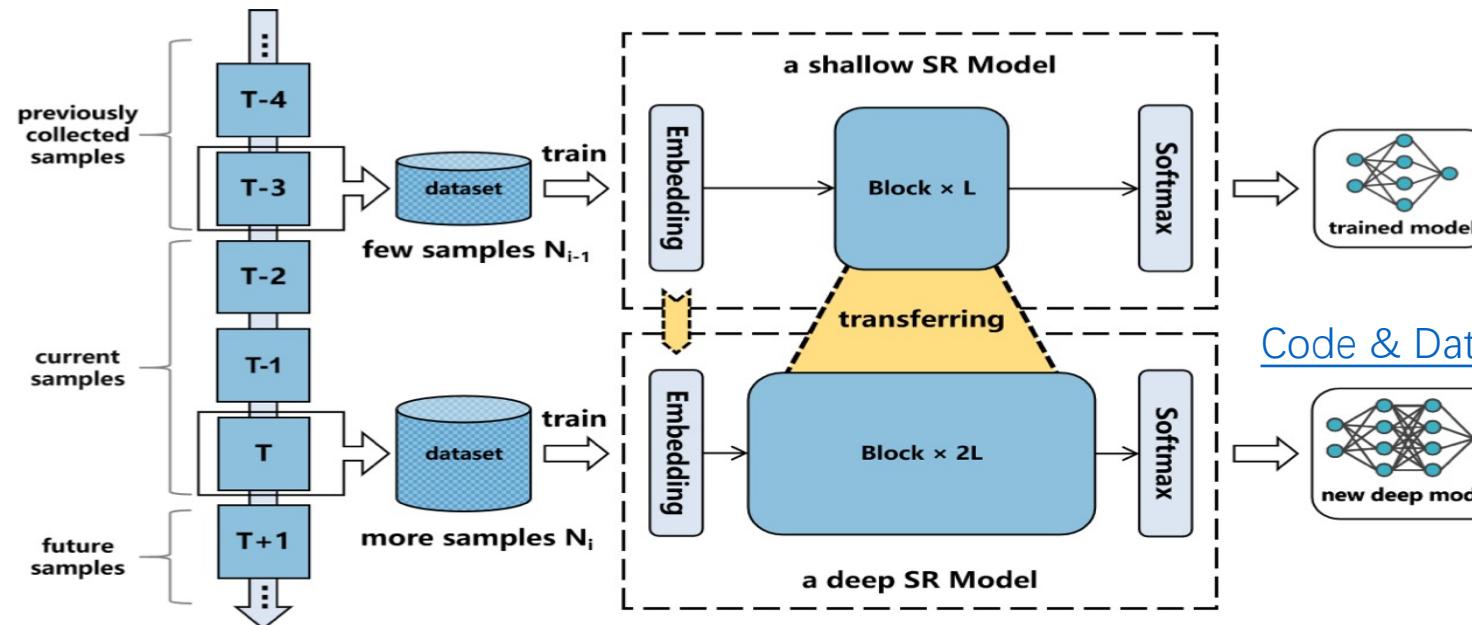


GRec (WWW 2020) 双塔



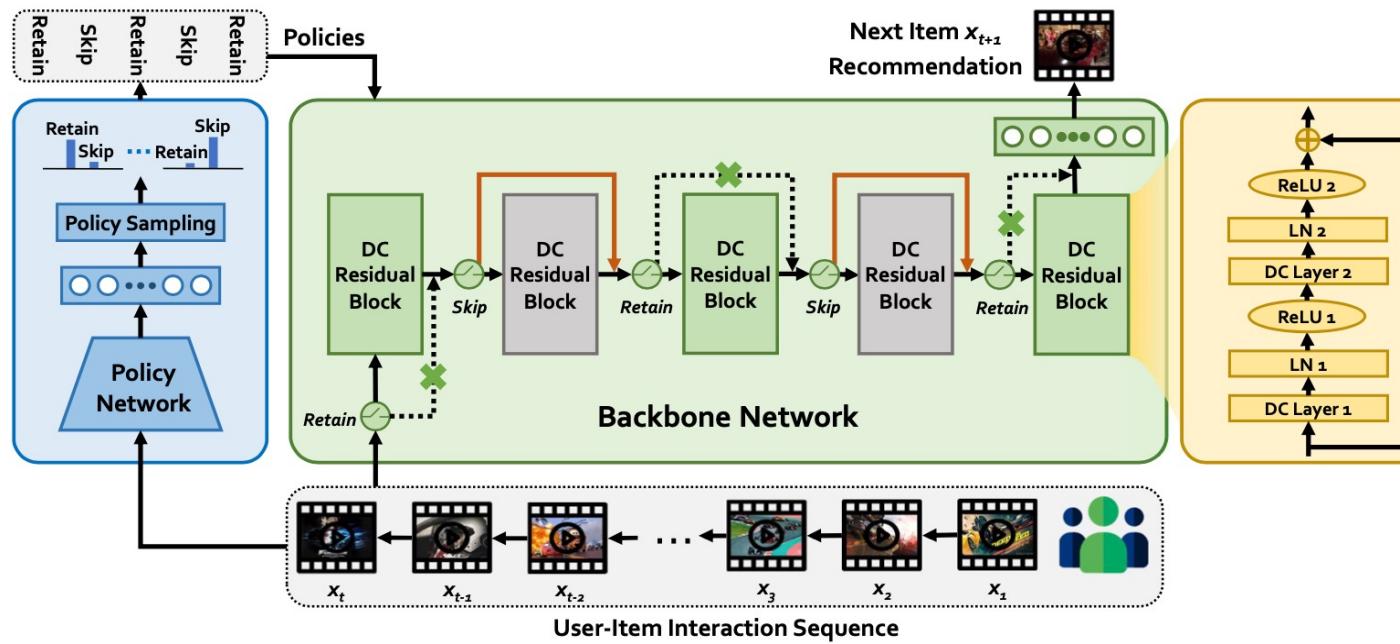
BERT4Rec (CIKM 2019) 双塔

## Related Work + Behavior Models



**StackRec (SIGIR 2021) 128层**

Code & Data <https://github.com/wangjiaochun0426/StackRec>

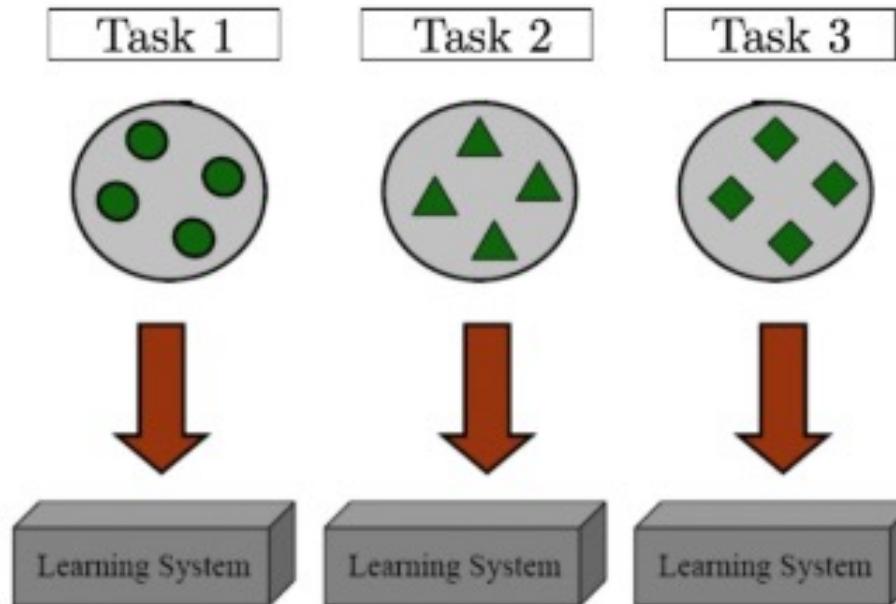


**SkipRec (AAAI 2021) 128层**

# Outlines

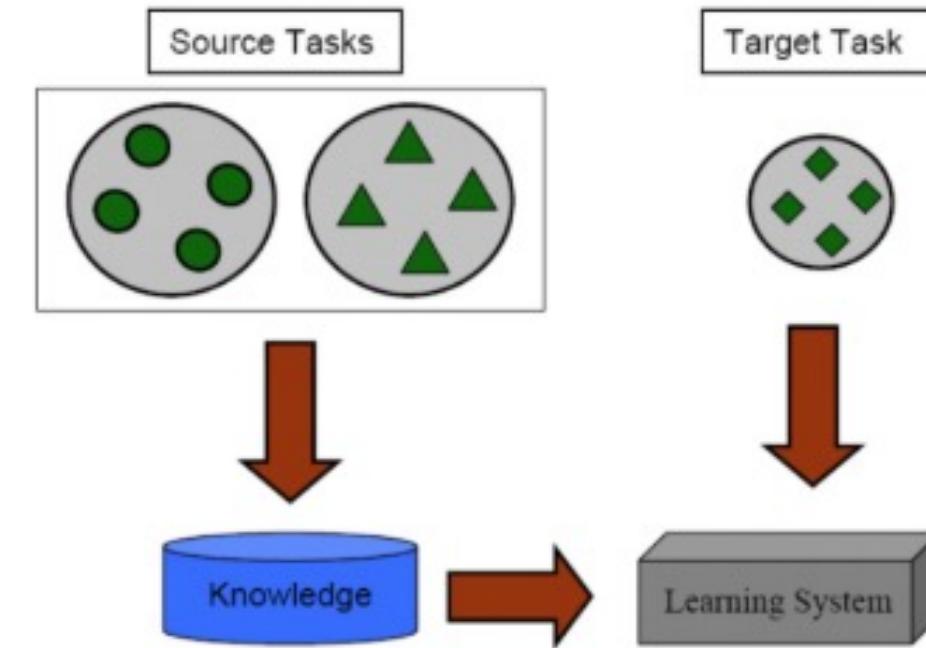
- Background
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Learning Process of Traditional Machine Learning



(a) Traditional Machine Learning

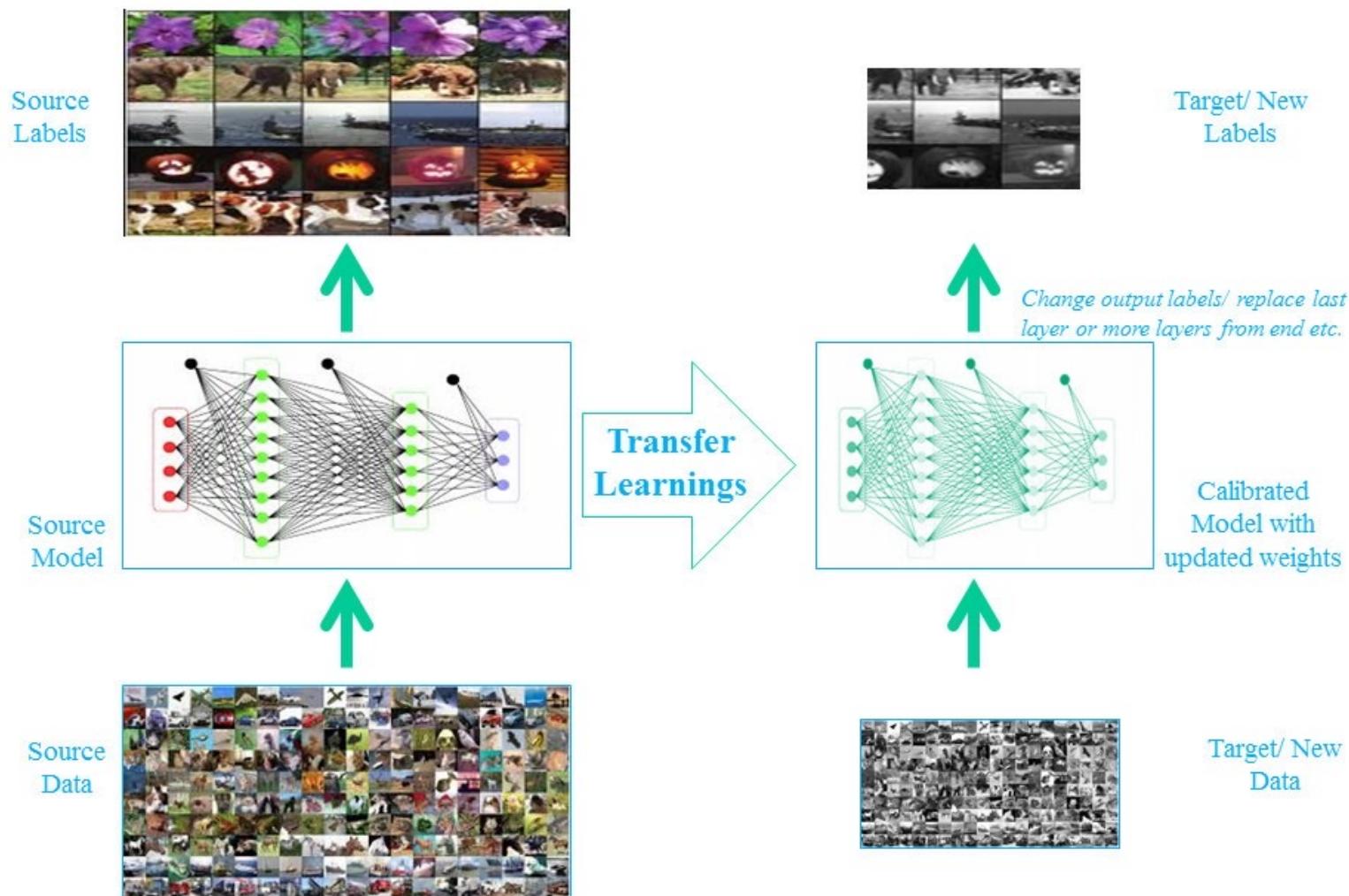
Learning Process of Transfer Learning

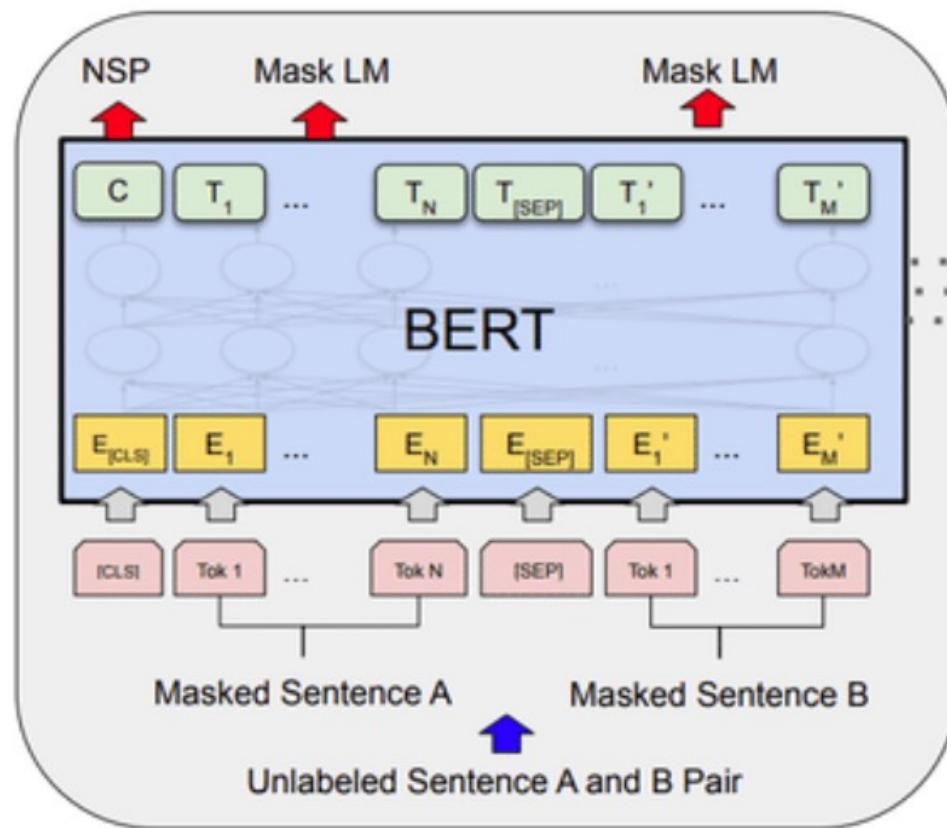


(b) Transfer Learning

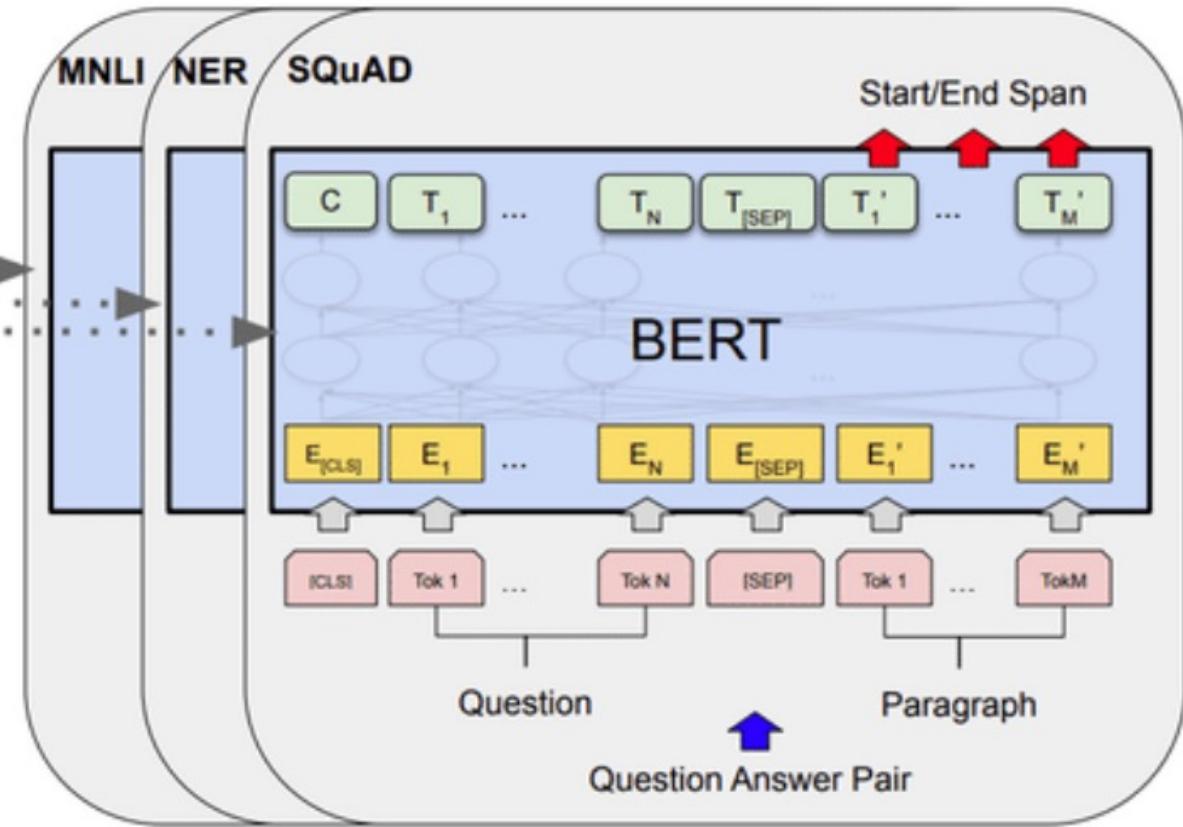
## Transfer Learning

## Pre-training &amp; Transfer Learning

**ImageNet Supervised Transfer Learning**



Pre-training



Fine-Tuning

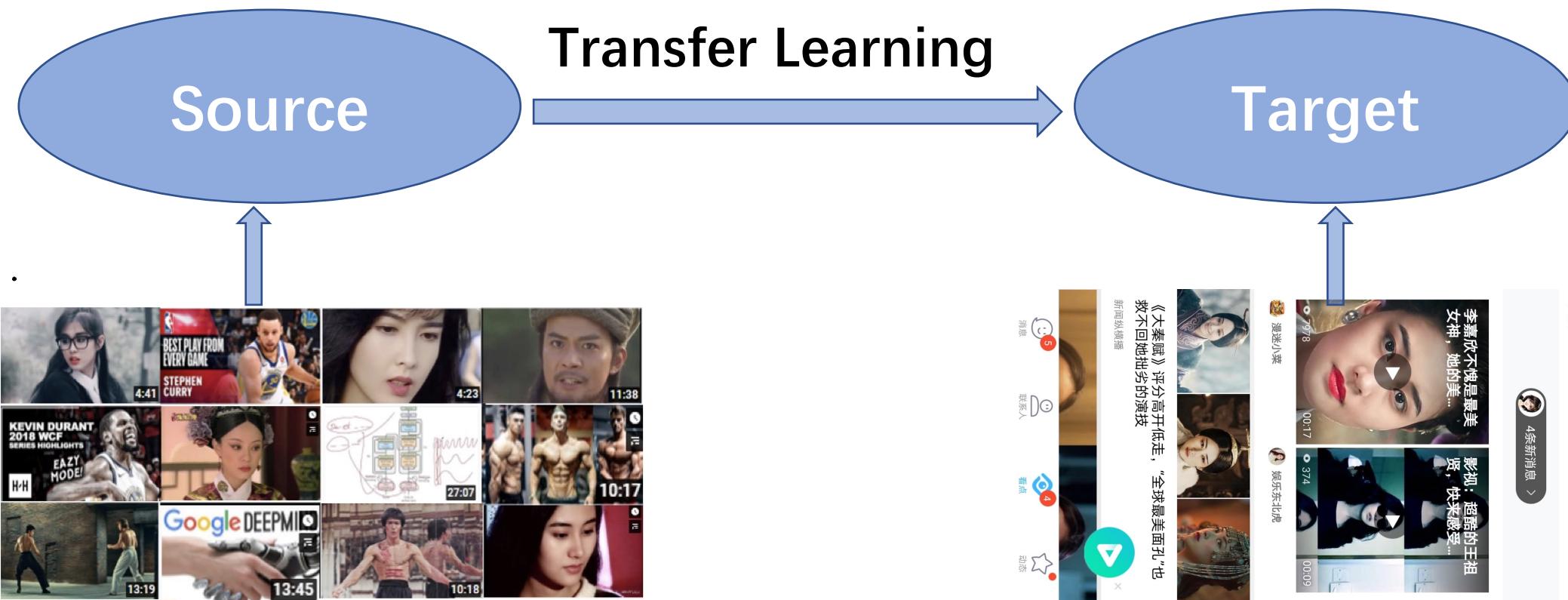
**Bert Self-supervised Transfer Learning**

## Task description

Source :  $(u, x^u)$ , where  $x^u = \{x_1^u, x_2^u, \dots, x_n^u\}$ ,

where  $x_t^u$  denotes the  $t$ -th interacted item of user  $u$

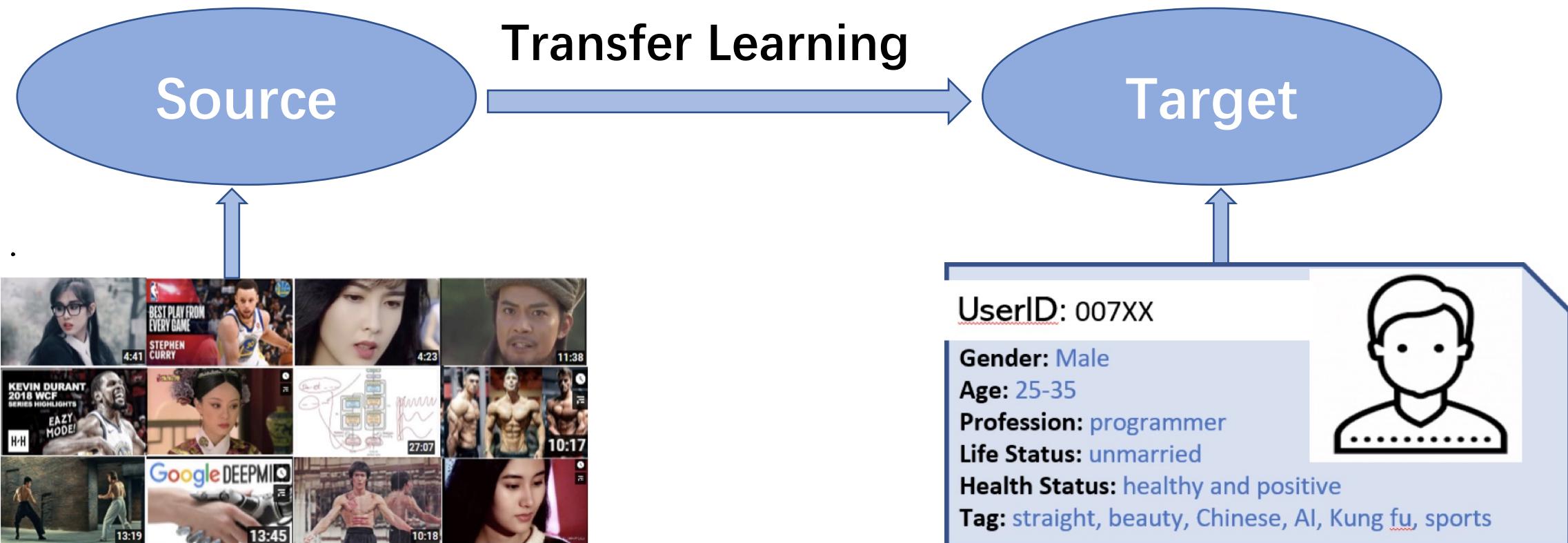
Target :  $(u, y)$  where  $y$  is the supervise label in the target dataset

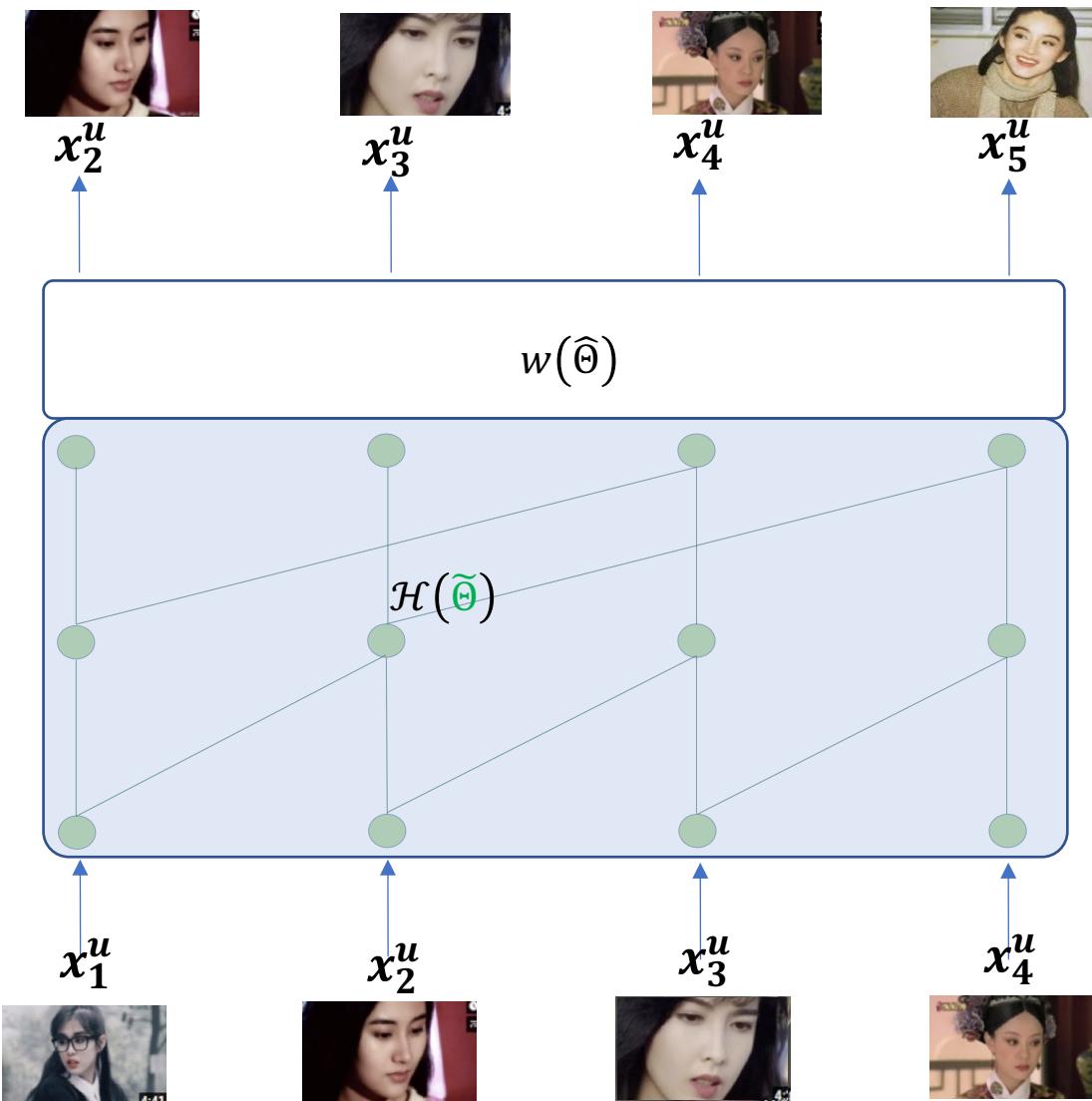


## Task description

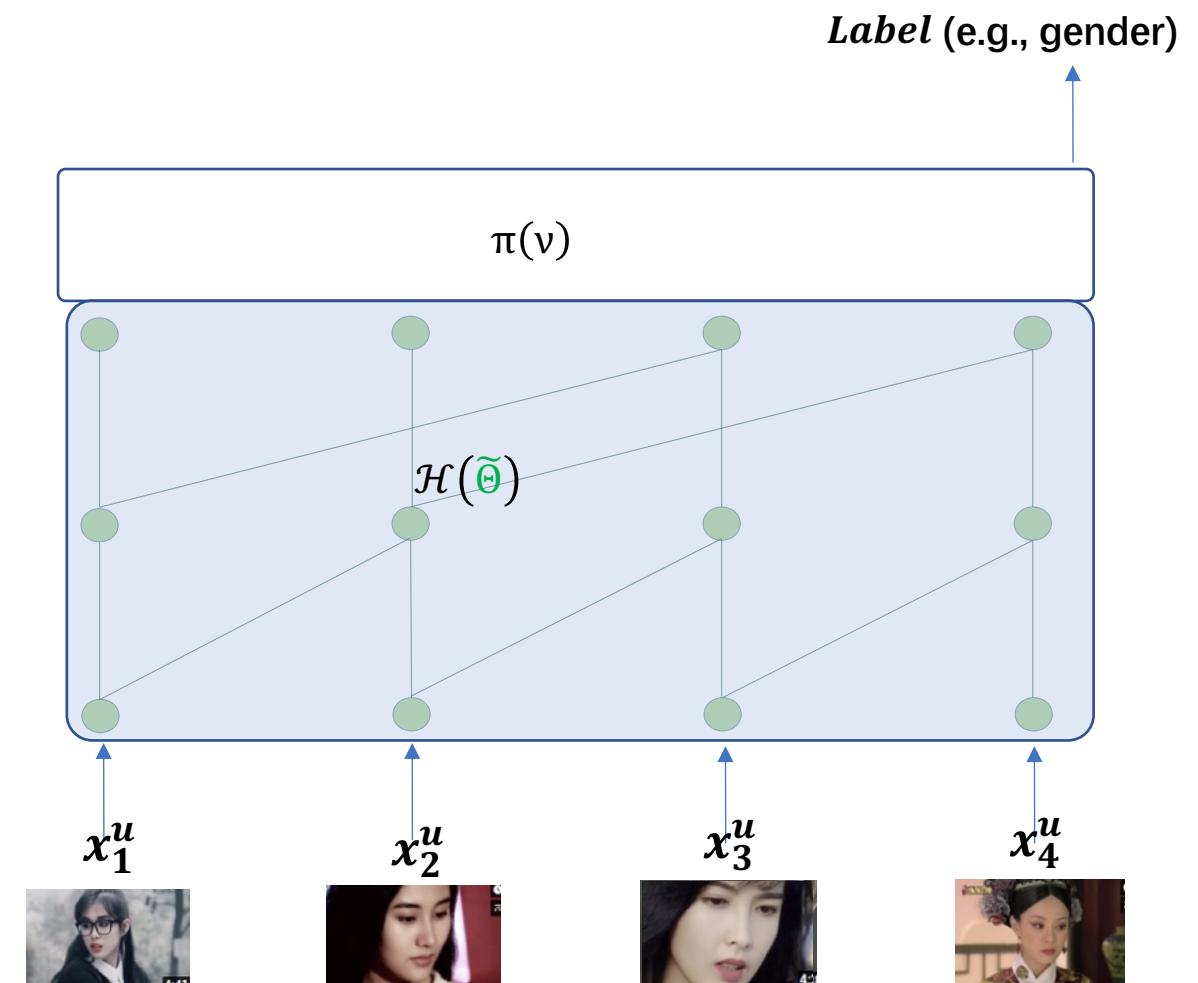
Source :  $(u, x^u)$ , where  $x^u = \{x_1^u, x_2^u, \dots, x_n^u\}$ ,  
where  $x_t^u$  denotes the t-th interacted item of user u

Target :  $(u, y)$  where y is the supervise label in the target dataset





(a) pre-training on 腾讯视频 data

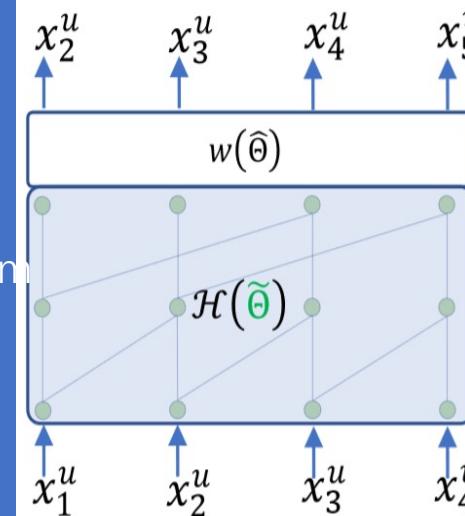


(b) fine-tuning on user profile dataset

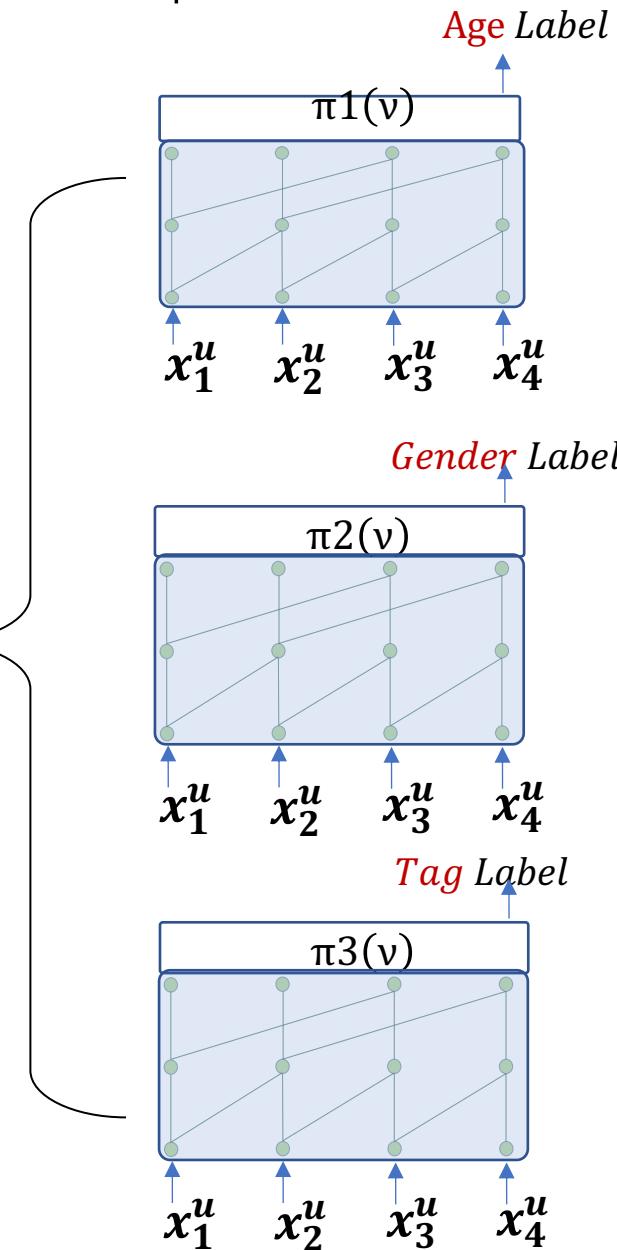
Problems we meet when a number of tasks are required.

Training a separate model for each downstream task is parameter-inefficient since both pretraining & finetuning models are very large.

The number of finetuned models is as many as the number of downstream tasks.  
100 tasks=100 finetuned models

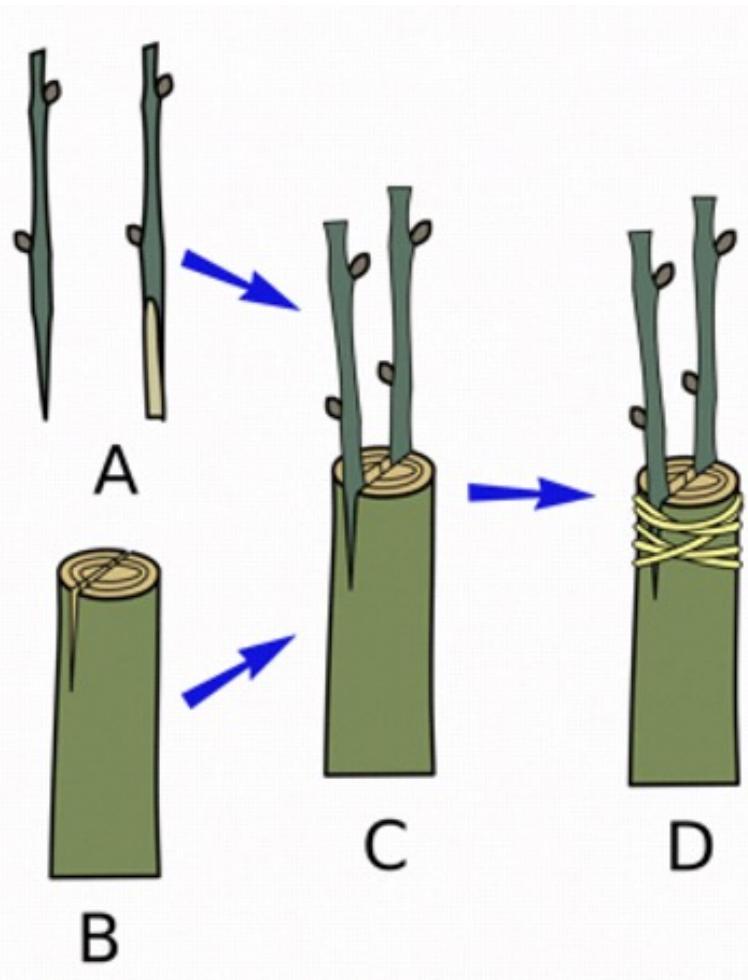


pretraining



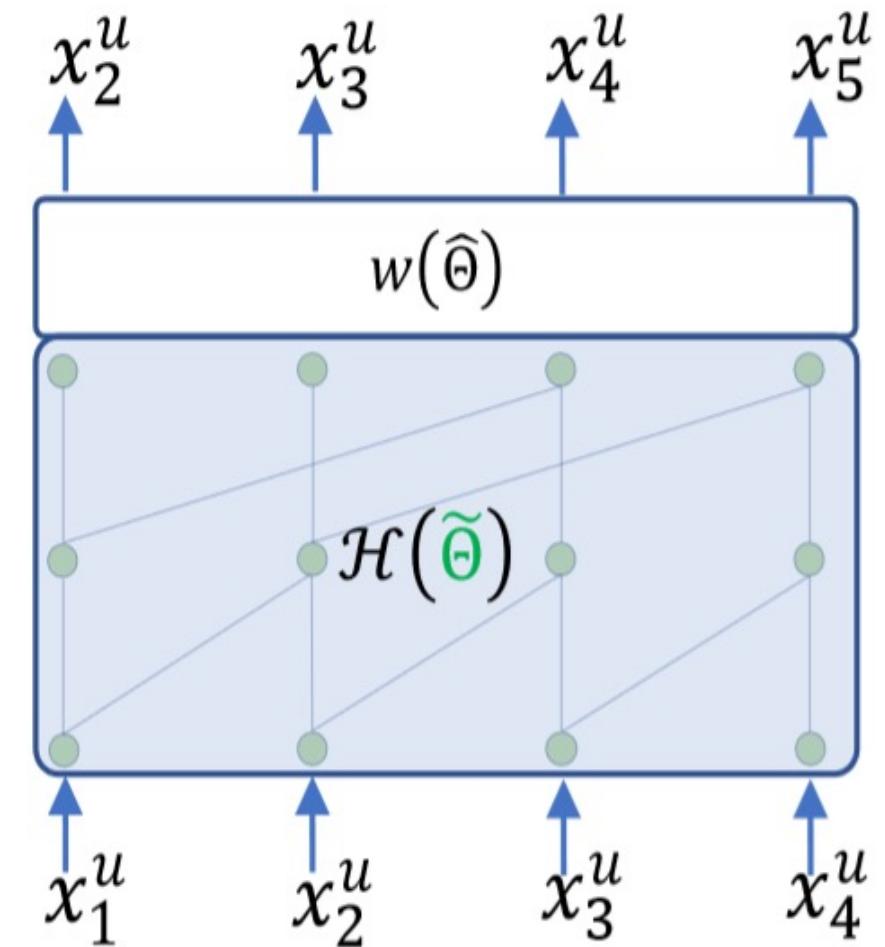
腾讯:

有100种以上的画像预测任务  
50个以上推荐系统业务。



- A: branch of plum  
 B: Tree of peach  
 C: insertion  
 D: grow together

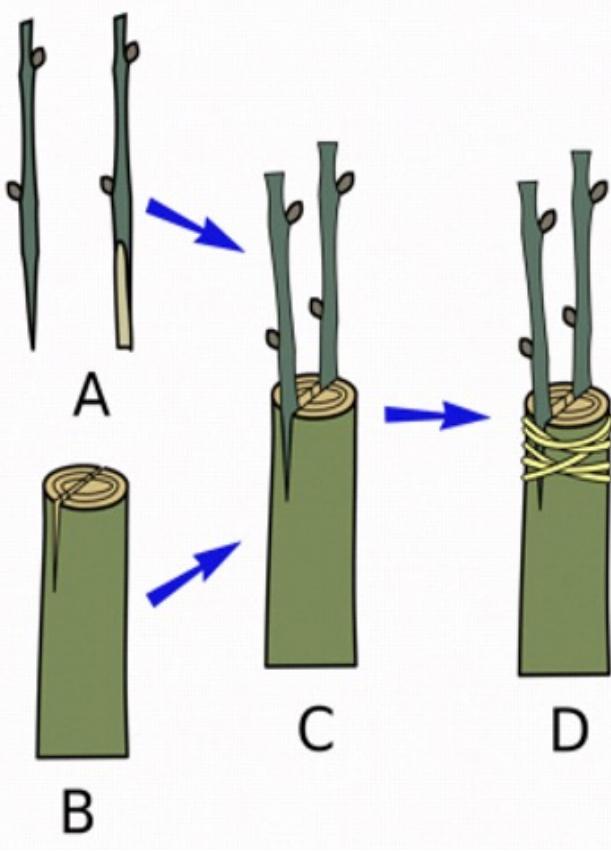
Tree



Pre-trained model

Pretrained model is treated as the peach Tree.

## Grafting for plants.



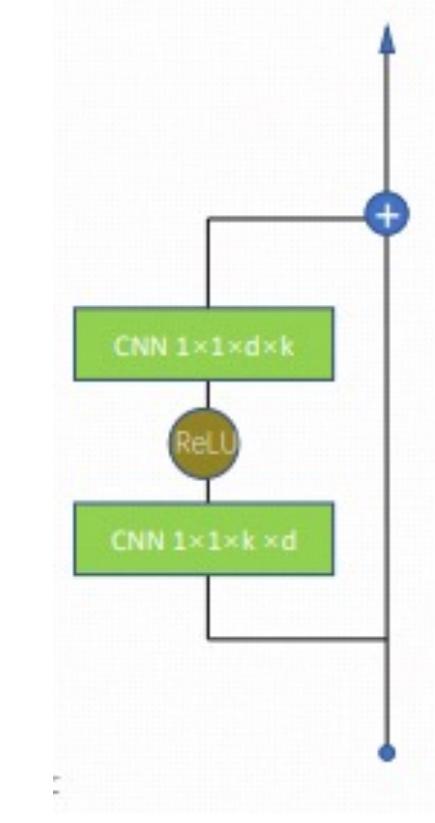
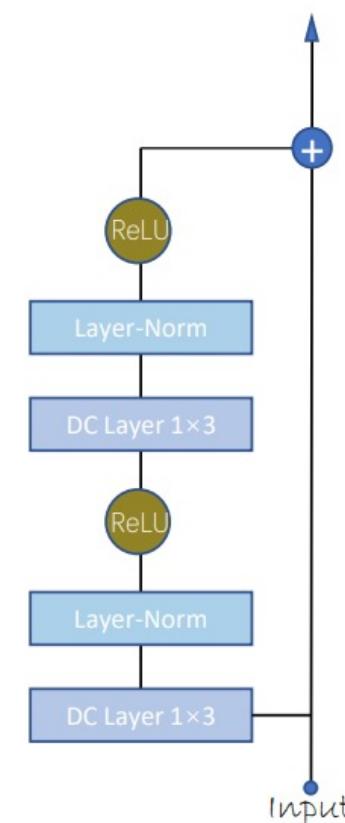
A: branch of plum vs MP

B: Tree of peach vs pre-trained model

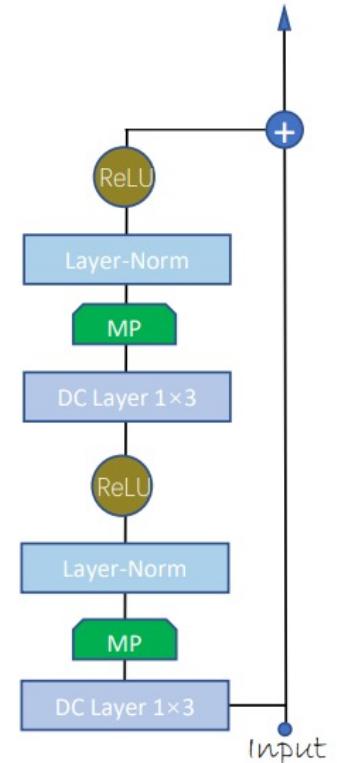
C: insertion vs insertion

D: grow together vs fine-tuning

Original resnet block

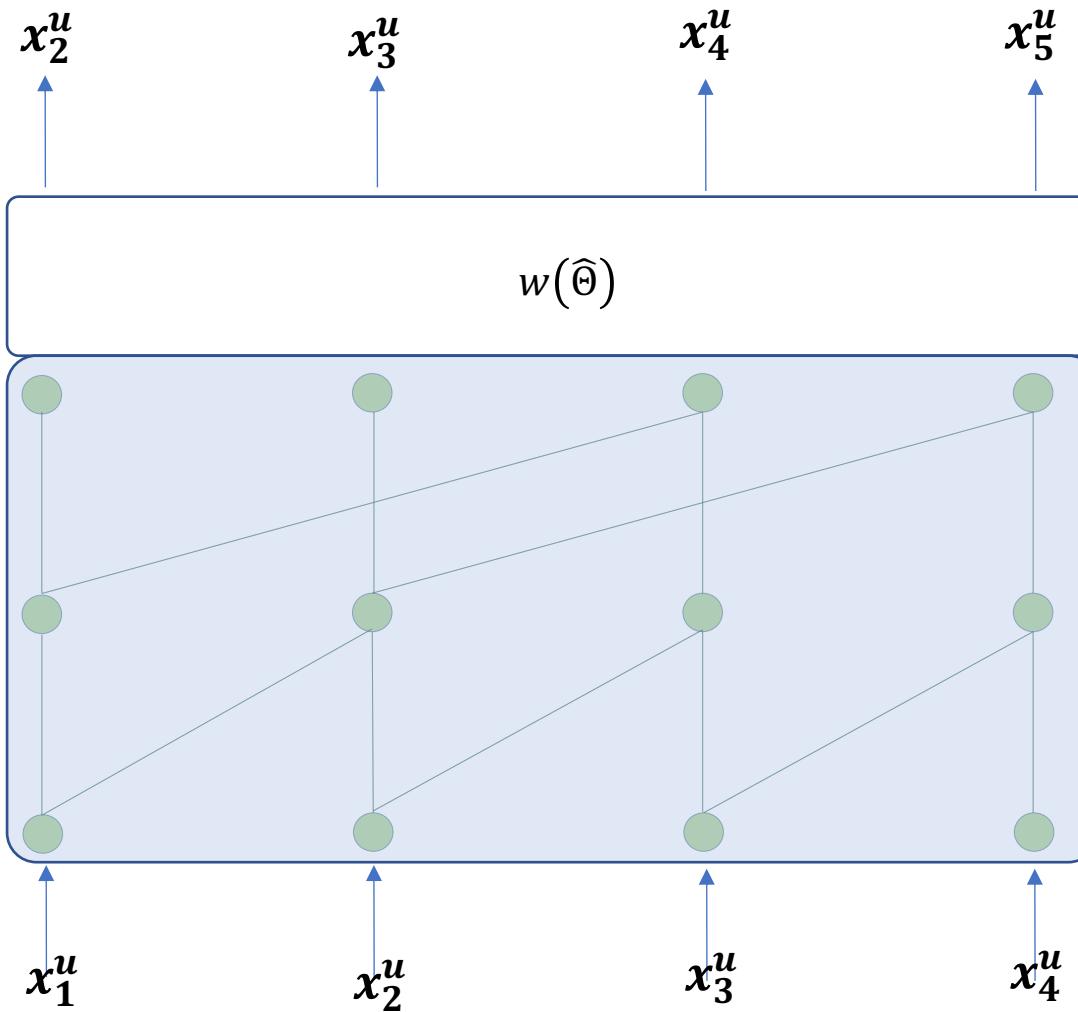


MP

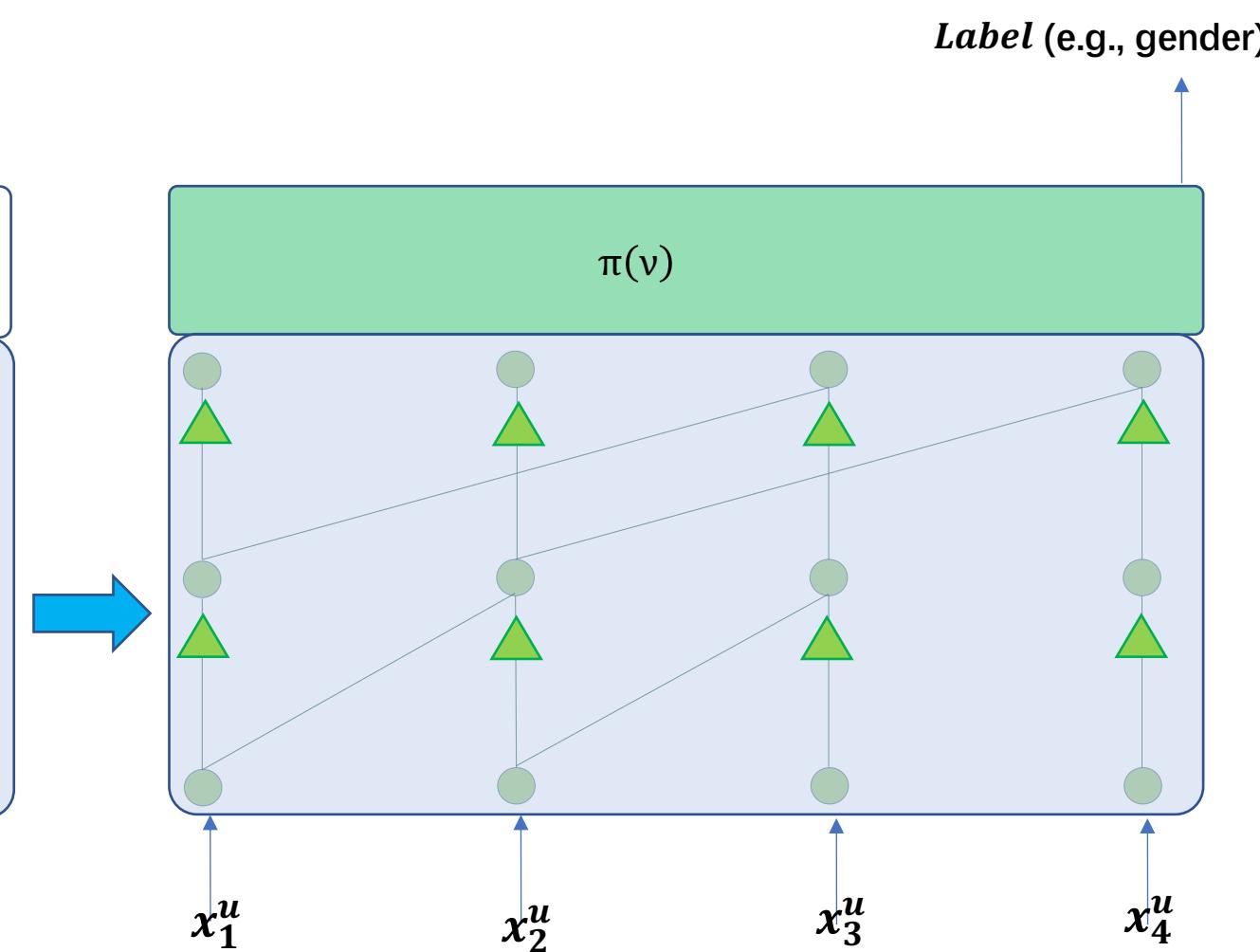


insertion

# PeterRec Architecture

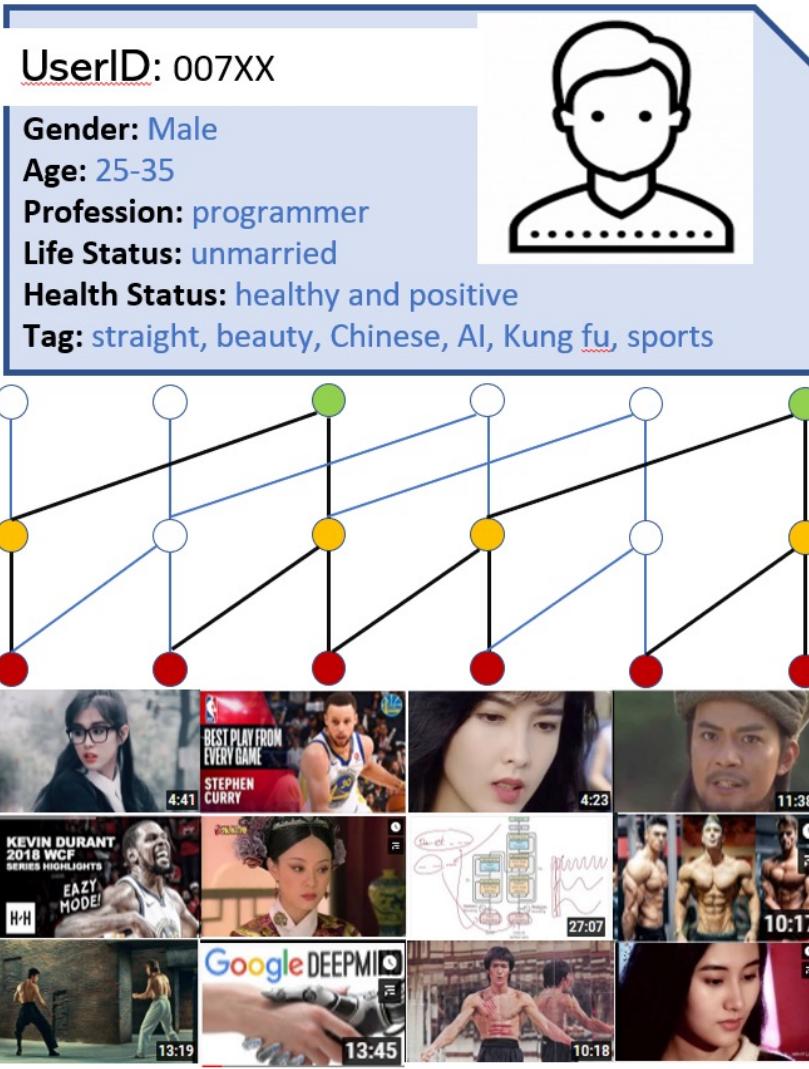


(a) pre-training on QQ Browser data

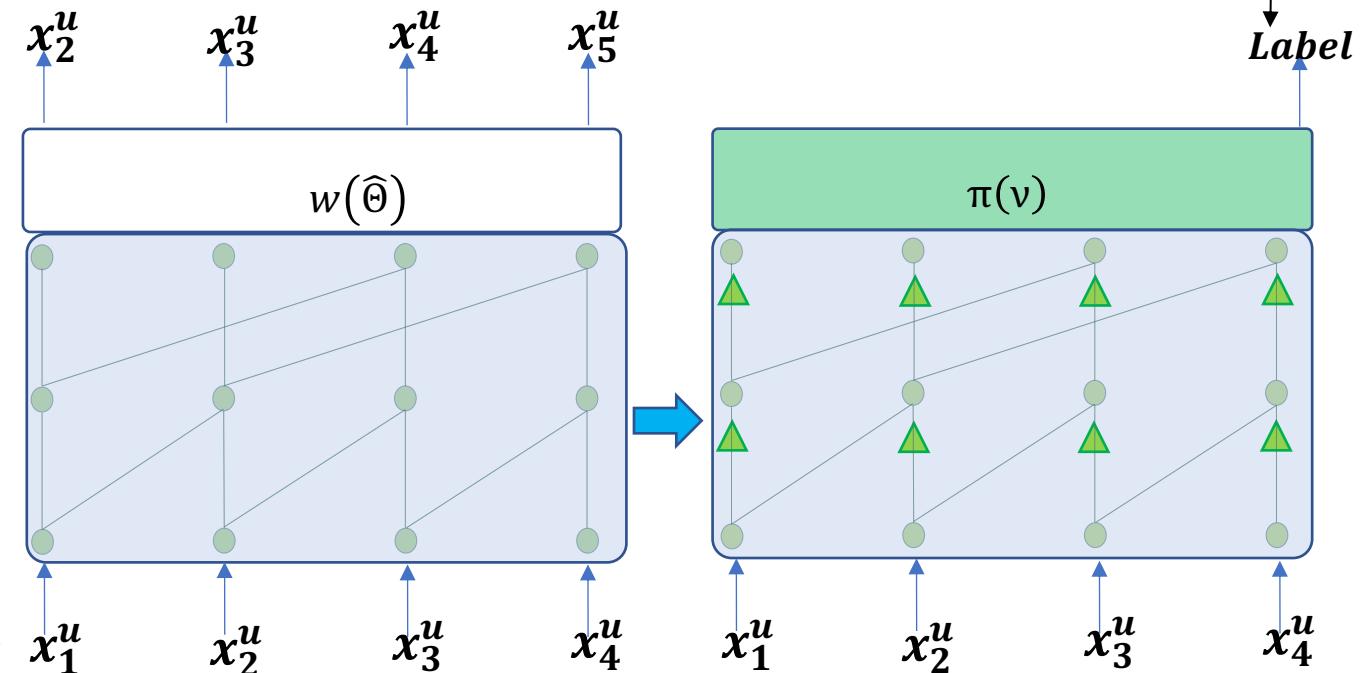


(b) fine-tuning on user profile dataset

▲ : Model patch



Adolescent mental health - for parents  
Payment capacity - for bank  
Advertising – for company  
Dating site

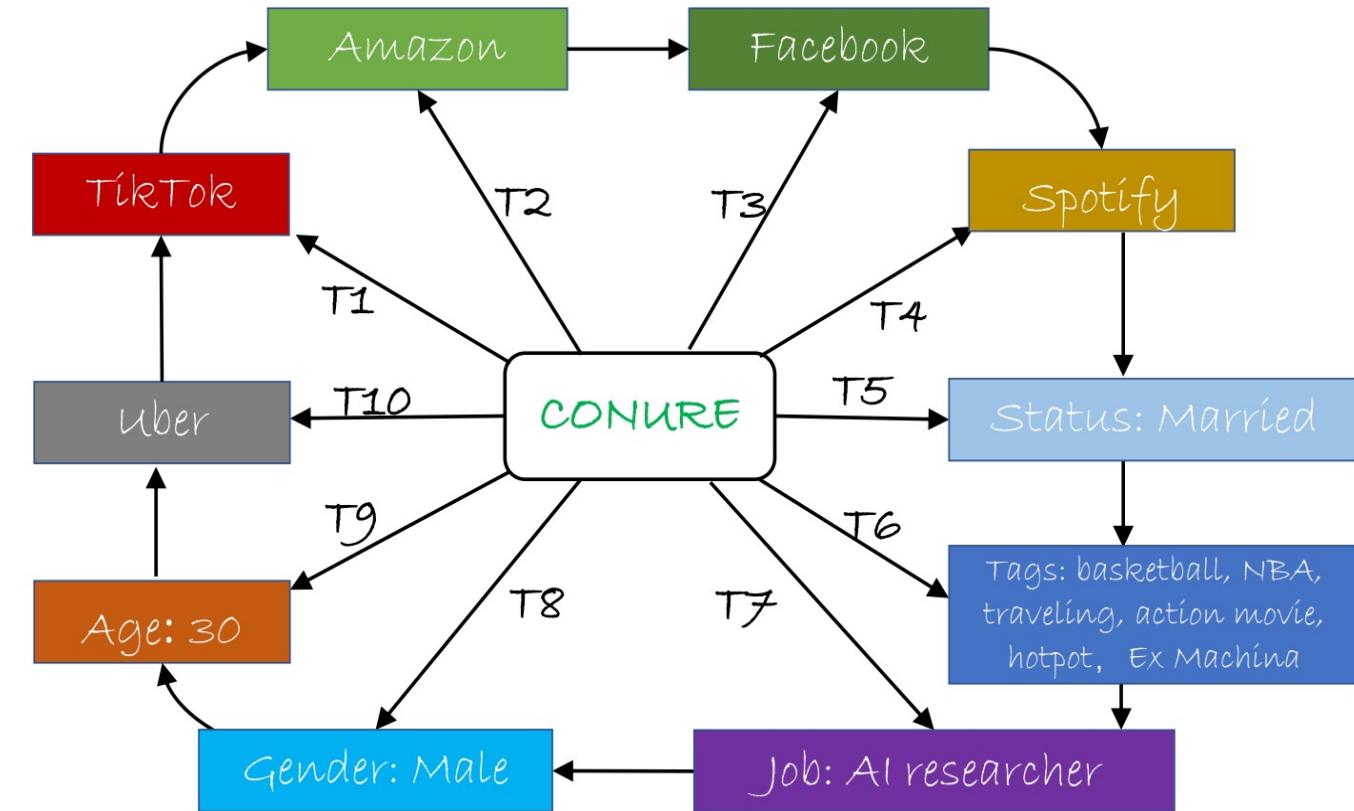


Example : if we have the video watch behaviors of a teenager, we may know whether he has depression or propensity for violence by PeterRec without resorting to much feature engineering and human-labeled data.

# Our Motivation

‘一人一世界’

A person has different roles to play in different life scenes ! But all these roles may have some commonalities, such as personalization, habits, preference.

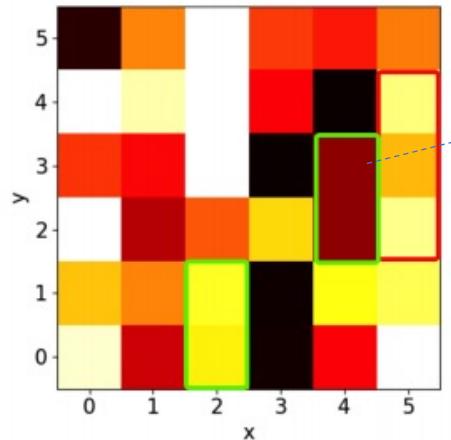
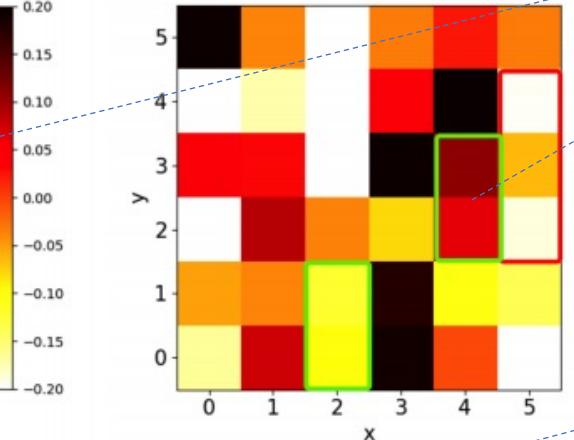


Our Focus:

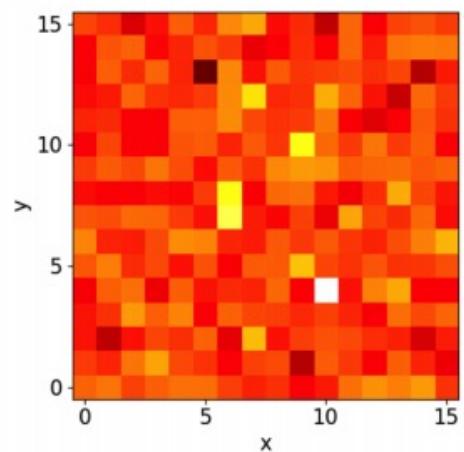
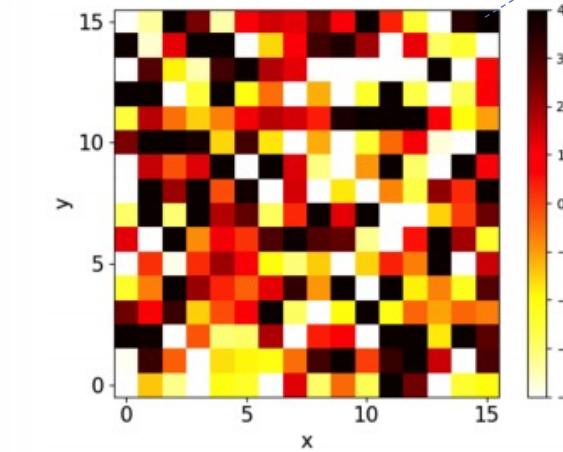
Whether we can build a user representation model that could keep continual learning throughout all these tasks without forgetting

One Person, One Model, One World

## Forgetting :

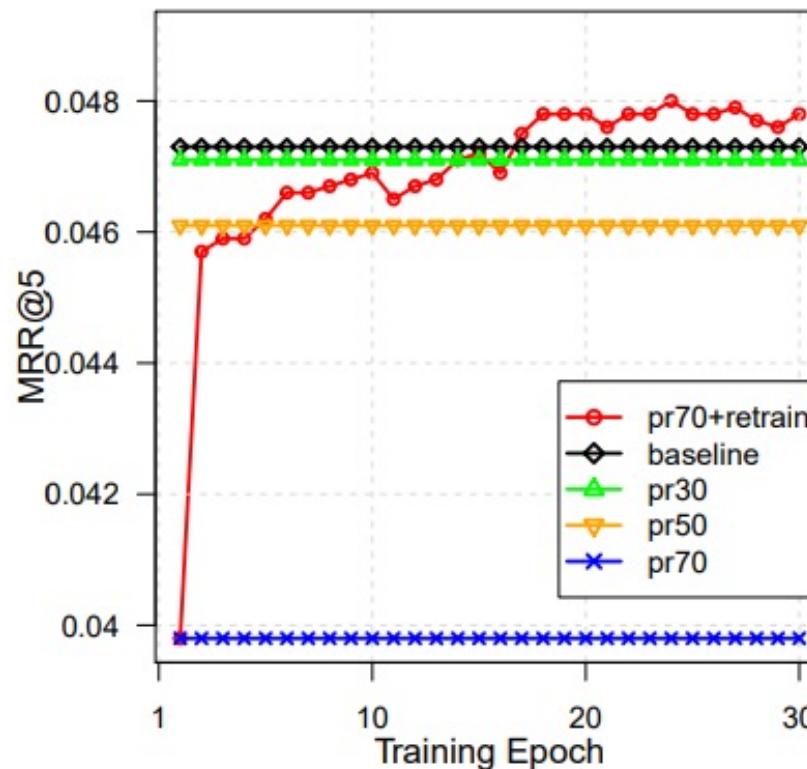
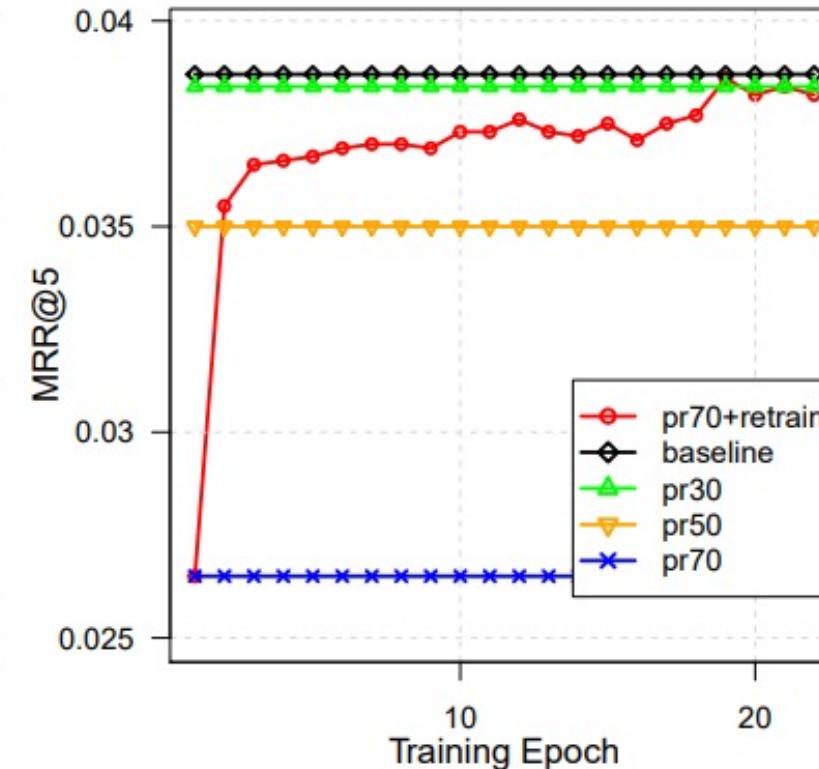
(a) Only training  $T_1$ (b) After Training  $T_2$ 

Parameter  
Changes

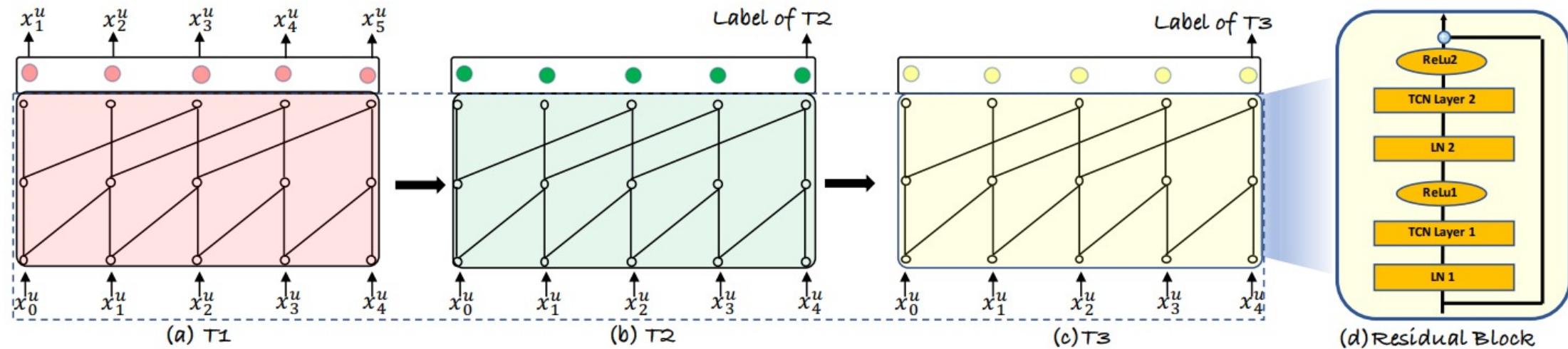
(c) Only training  $T_1$ (d) After training  $T_2$ 

Last hidden  
Vector Changes

## Over-parameterization:

(a)  $f = 256$  with 16 CNN layers(b)  $f = 64$  with 8 CNN layers

- (1) the more parameters are pruned, the worse it performs
- (2) performing retraining on the pruned network (i.e., “pr70+retrain”) regains its original accuracy quickly
- (3) smaller models (i.e., (b)) are also highly over-parameterized



Input : user interaction sequence.

Task1:

input  $x_0^u, x_1^u, x_2^u, x_3^u, x_4^u$

output  $x_1^u, x_2^u, x_3^u, x_4^u, x_5^u$

Task2:

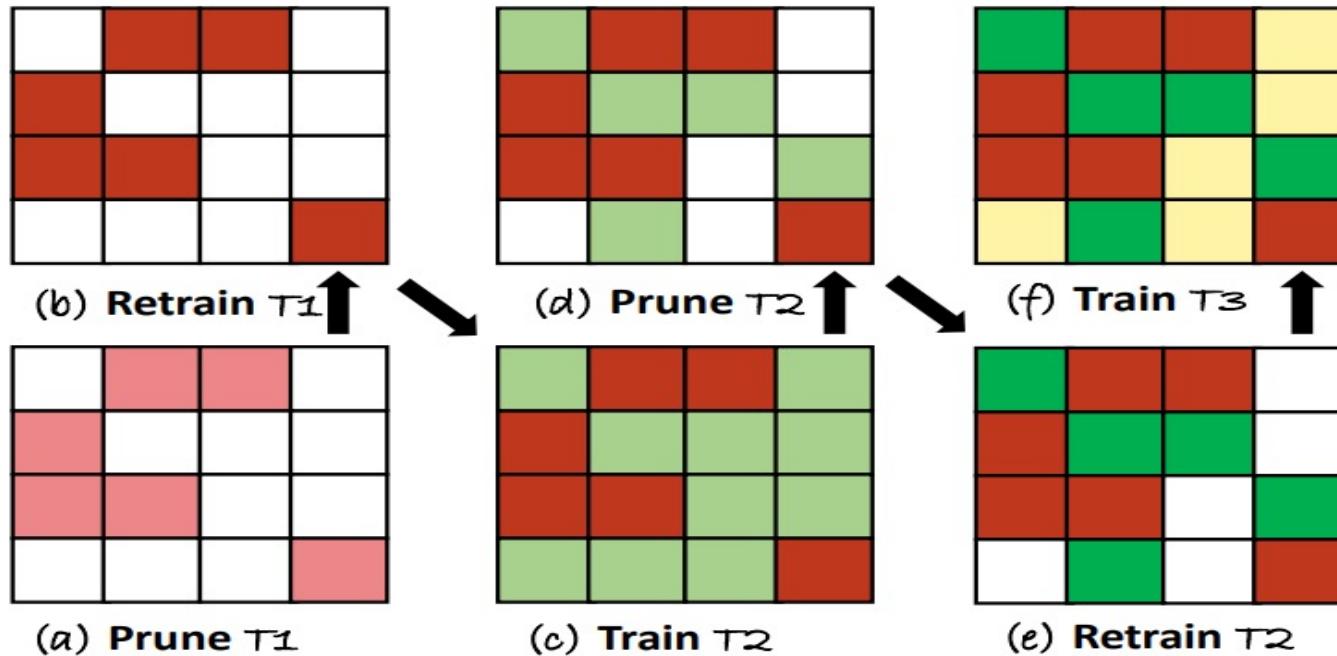
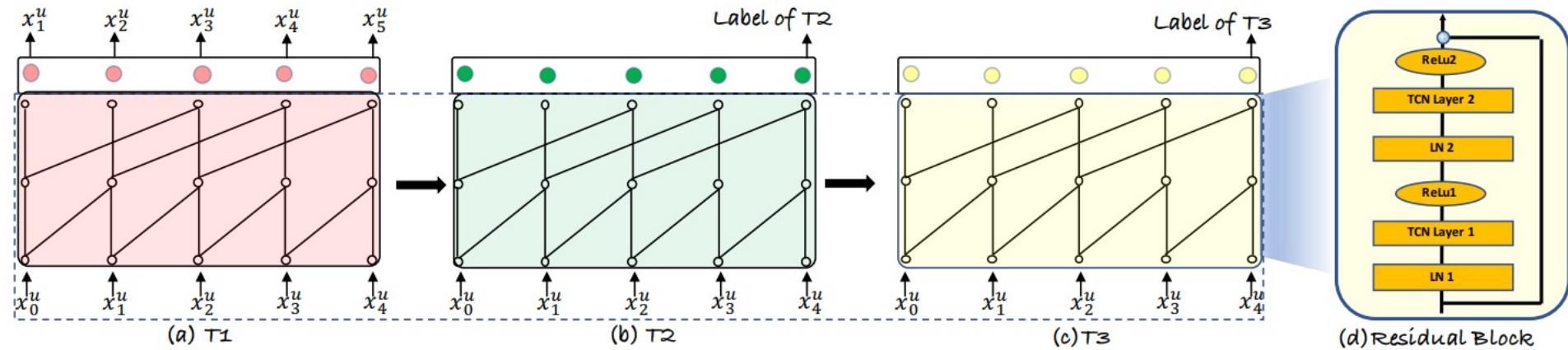
input  $x_0^u, x_1^u, x_2^u, x_3^u, x_4^u$

output  $y$

Task3:

input  $x_0^u, x_1^u, x_2^u, x_3^u, x_4^u$

output  $y$



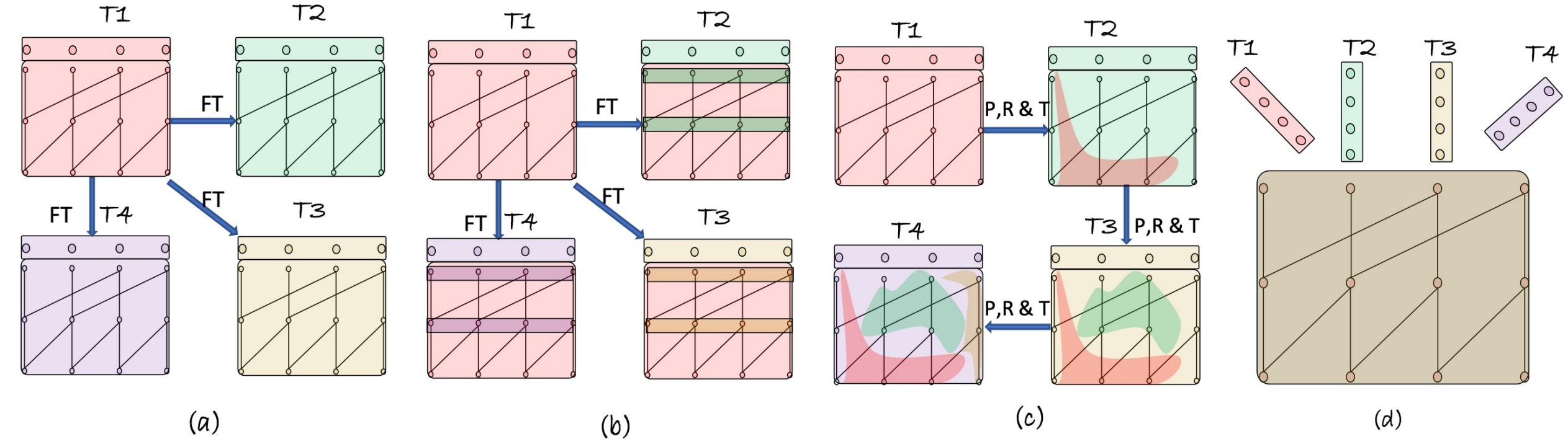
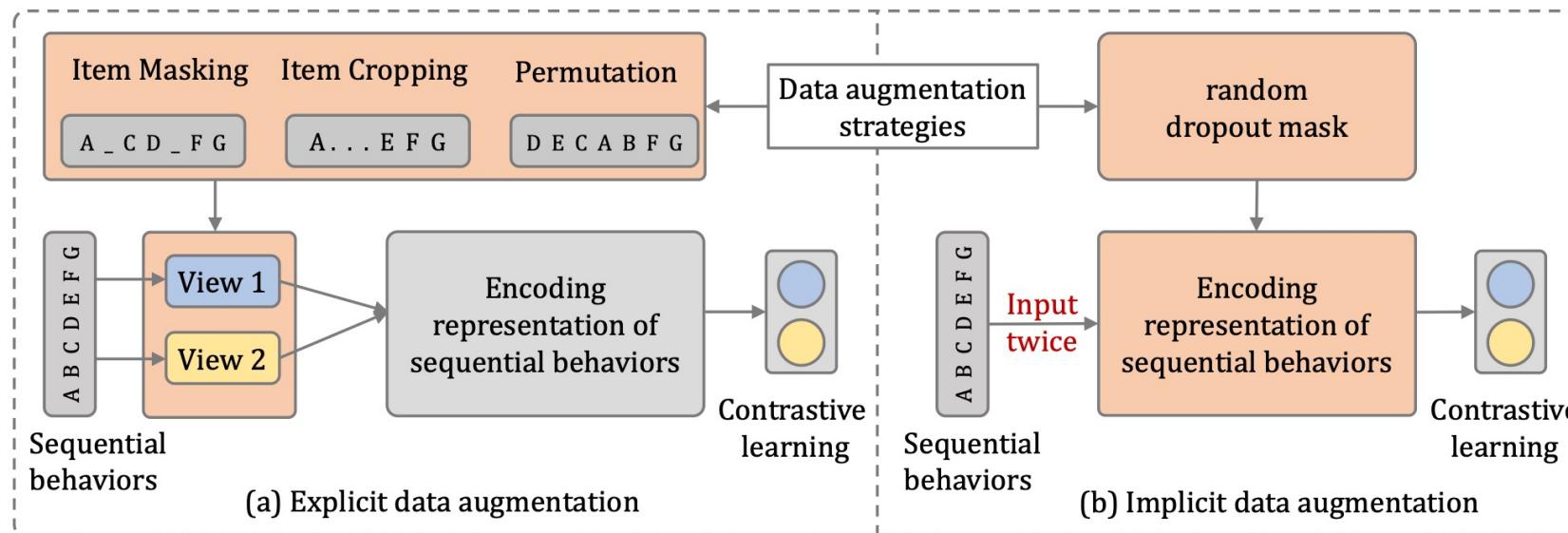
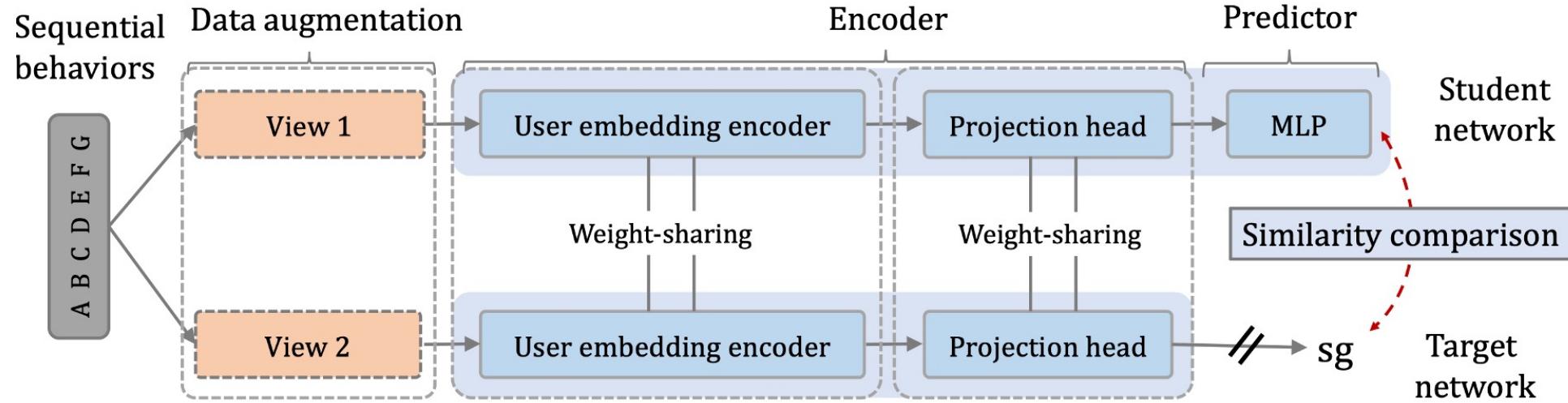
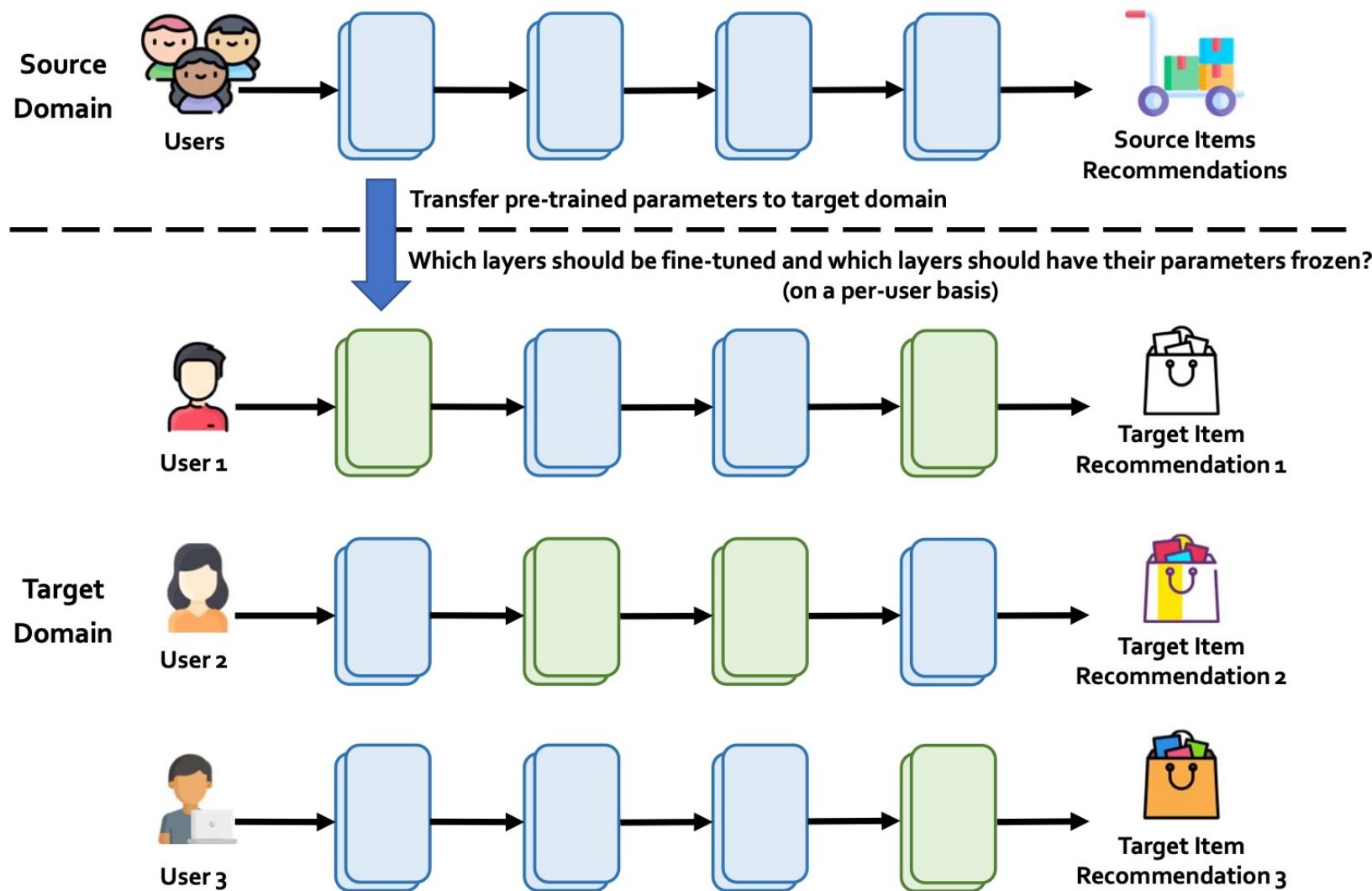


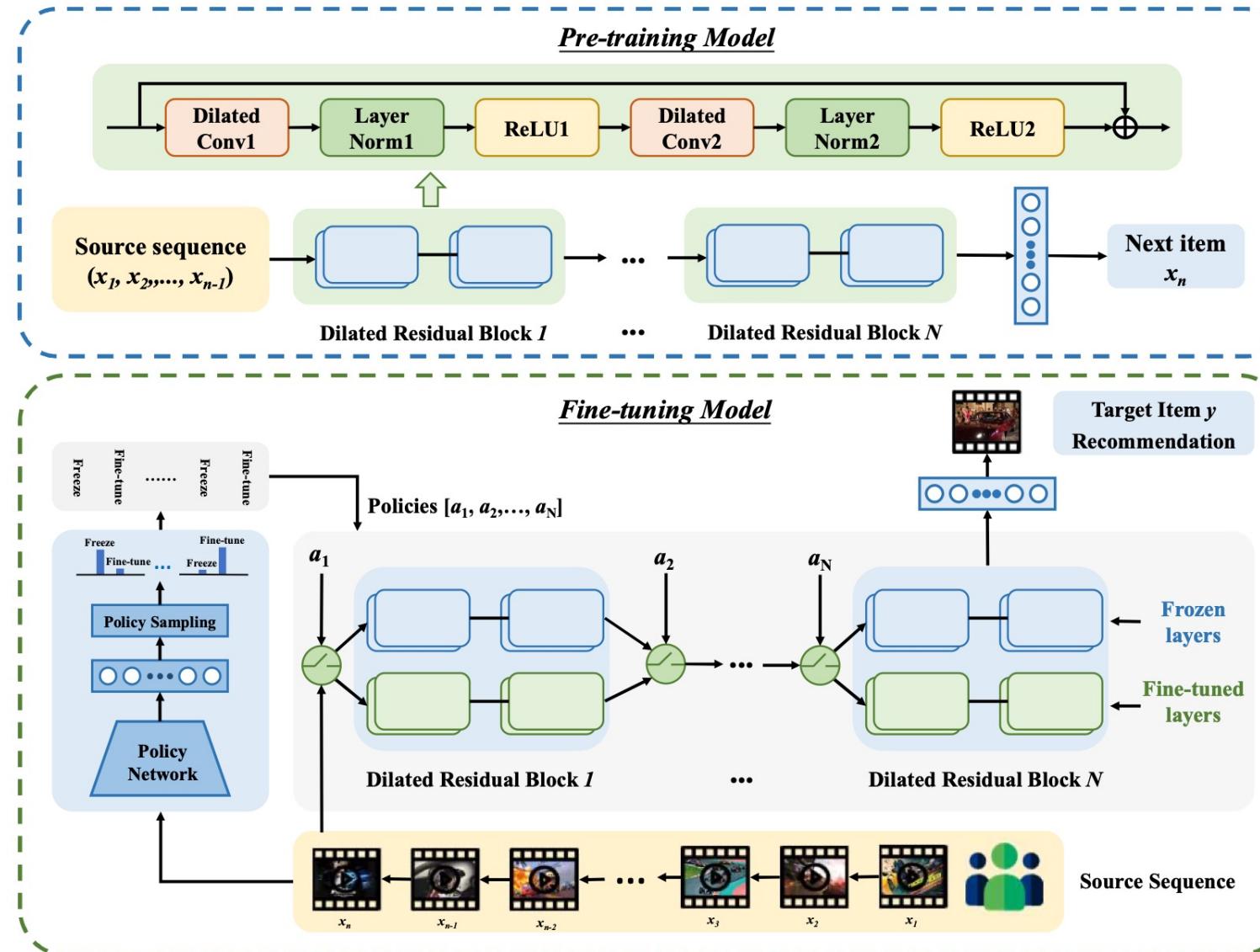
Figure 5: Model Comparison: (a) standard transfer learning; (b) PeterRec; (c) Conure ; (d) multi-task learning (MTL). Parameters of  $T_1$ ,  $T_2$ ,  $T_3$ and  $T_4$ are respectively represented by red, green, yellow and purple colors.

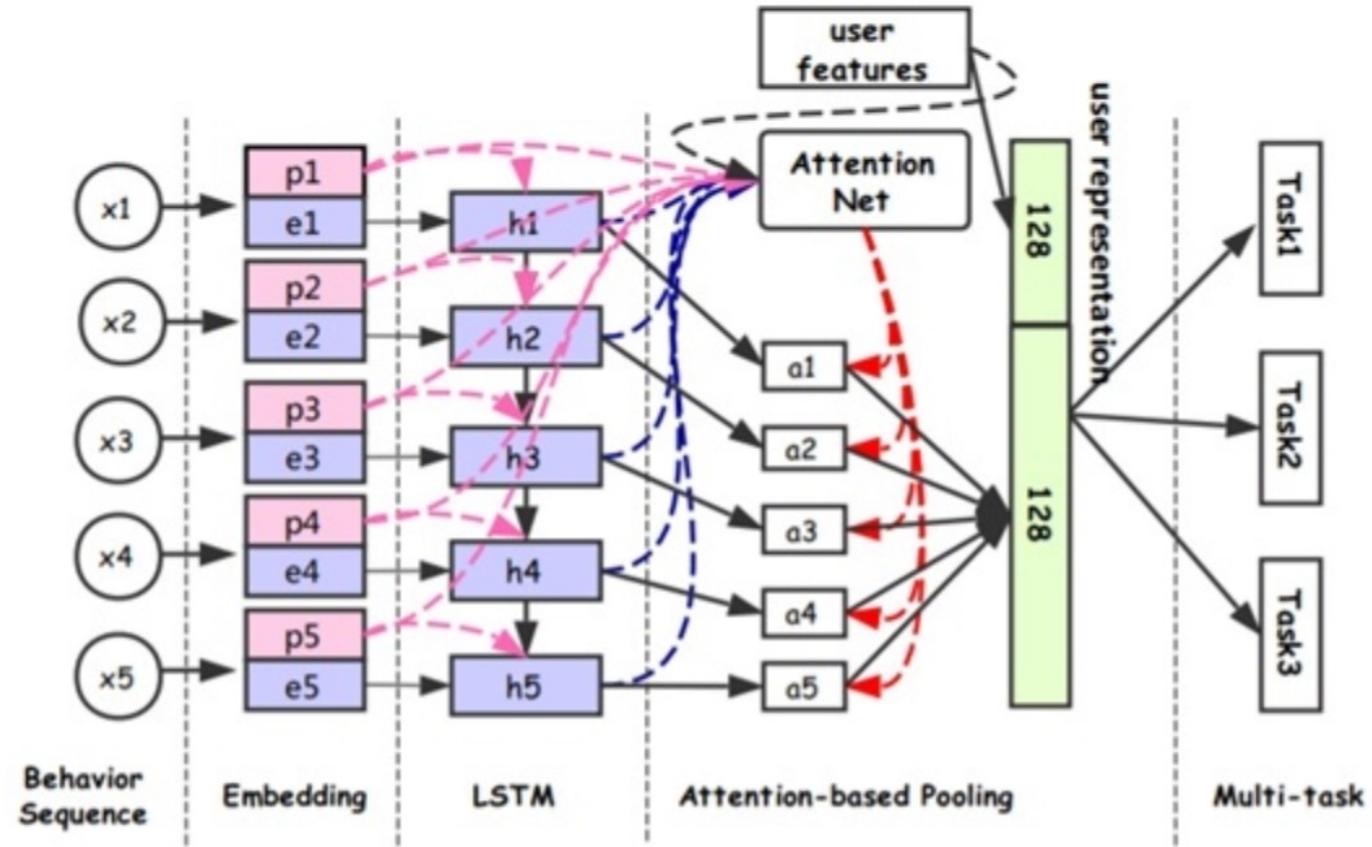
**Table 2: Accuracy comparison. #B is the number of backbone networks. The left and right of ‘||’ represent TTL and ML, respectively. *Conure-* denotes *Conure* that has not experienced the pruning operation after training on the current task. The worse and best results are marked by ‘▽’ and ‘△’, respectively.**

Model	$T_1$	$T_2$	$T_3$	$T_4$	$T_5$	$T_6$	#B	$T_1$	$T_2$	$T_3$	#B
DNN	0.0104	0.0154	0.0231	0.7131	0.8908	0.6003	<b>6</b>	0.0276	0.0175	0.0313	<b>3</b>
SinMo	0.0473	0.0144	0.0161	0.7068	0.8998	0.5805▽	<b>6</b>	0.0637	0.0160	0.0259▽	<b>3</b>
SinMoAll	0.0009▽	0.0079 ▽	0.0124▽	0.5640▽	0.7314▽	0.6160	<b>1</b>	0.0038▽	0.0145▽	0.0310	<b>1</b>
FineSmax	0.0473	0.0160	0.0262	0.6798	0.8997	0.6070	<b>1</b>	0.0637	0.0150	0.0262	<b>1</b>
FineAll	0.0473	0.0172	0.0271	0.7160△	0.9053	0.6132	<b>6</b>	0.0637	0.0189	0.0325	<b>3</b>
PeterRec	0.0473	0.0173	0.0275	0.7137	0.9053	0.6156	<b>1</b>	0.0637	0.0182	0.0308	<b>1</b>
MTL	-	0.0151	0.0172	0.7094	0.8979	0.6027	<b>1</b>	-	0.0167	0.0276	<b>1</b>
<i>Conure-</i>	0.0473	0.0174	<b>0.0286</b>	0.7139	0.9051	0.6180	-	0.0637	0.0183	<b>0.0347</b>	-
<i>Conure</i>	0.0480△	0.0177△	0.0287△	0.7146	0.9068△	0.6185△	<b>1</b>	0.0656△	0.0197△	0.0353△	<b>1</b>



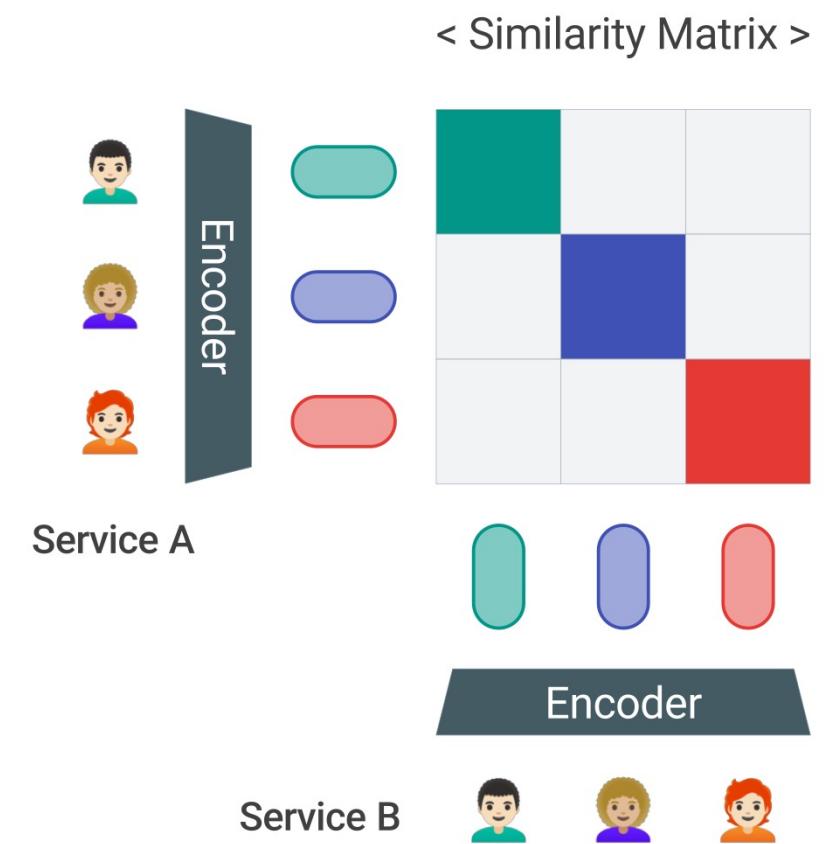
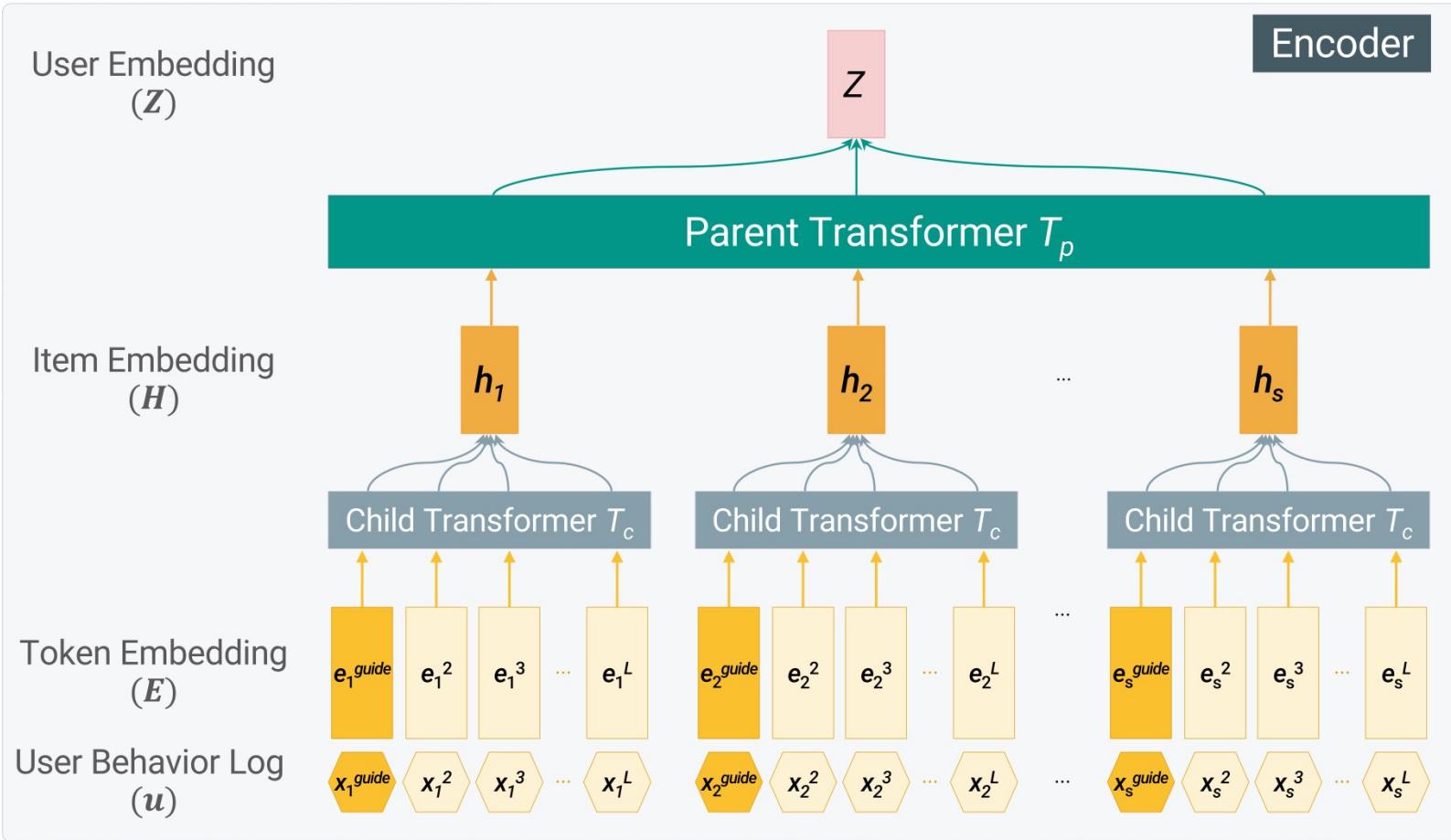


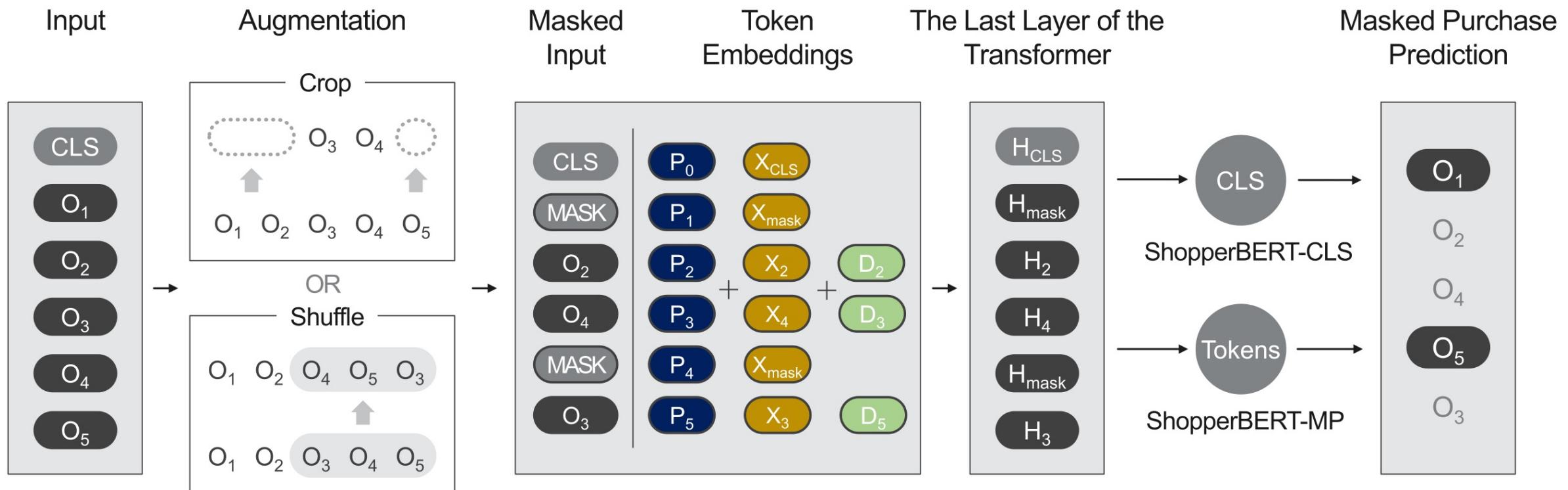




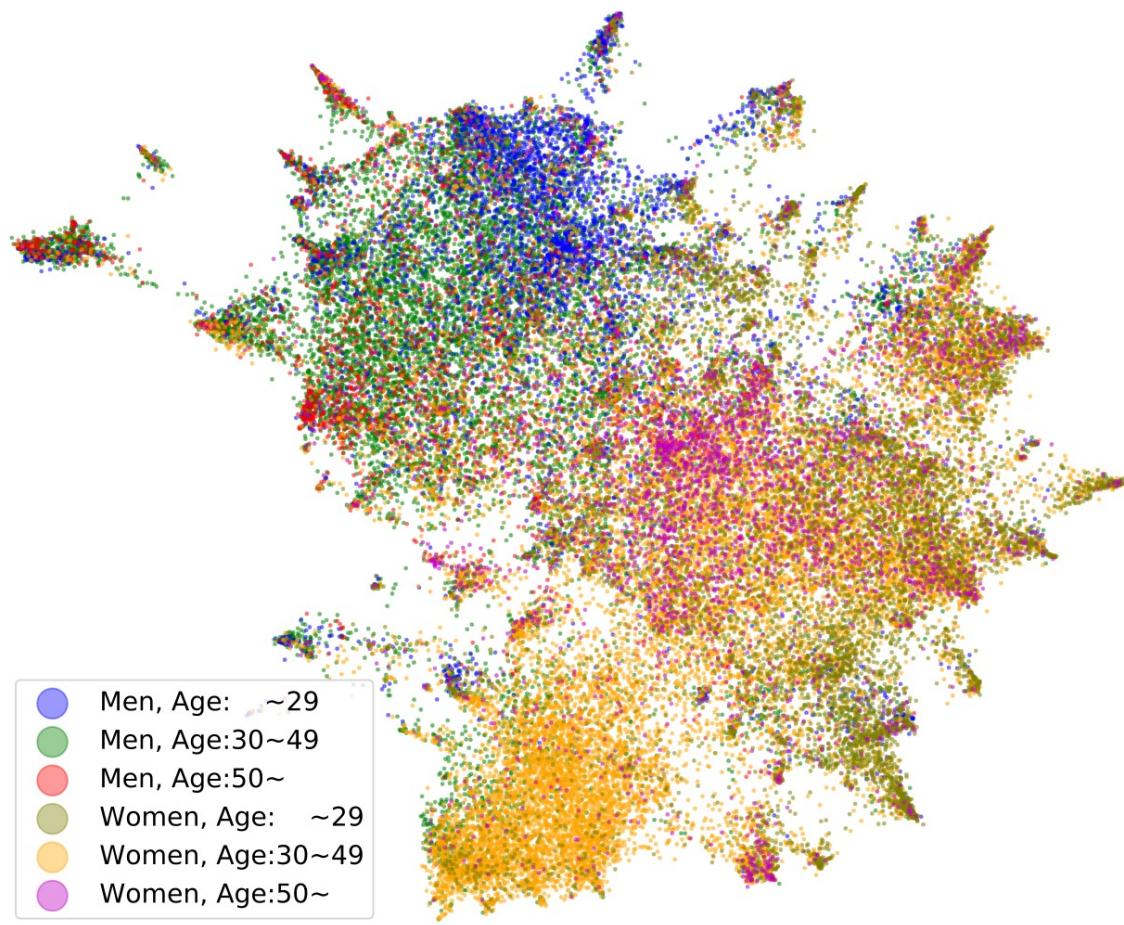
**Figure 2: General Model Architecture. Color of lilac denotes**

Perceive Your Users in Depth: Learning Universal User Representations from Multiple E-commerce Tasks.  
KDD2018.

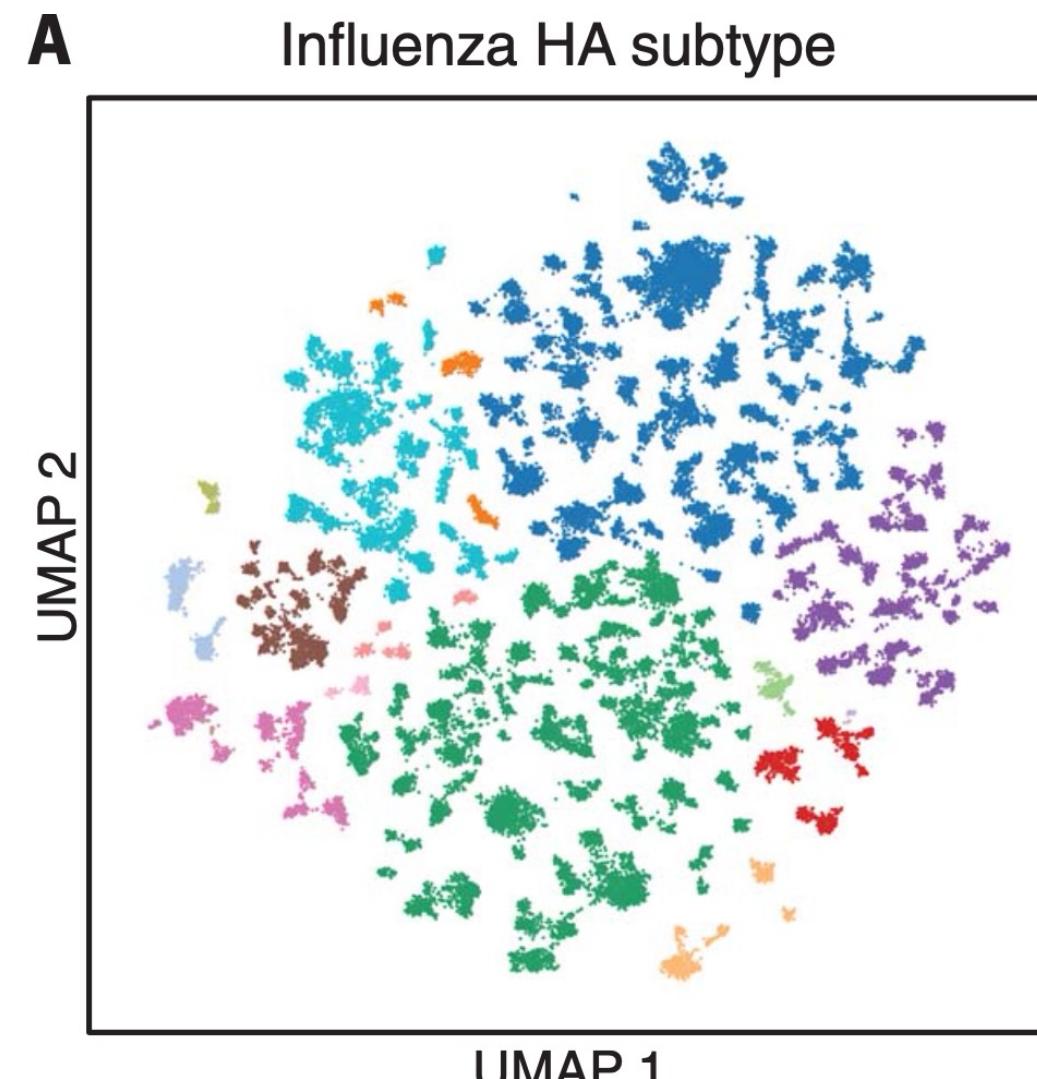




**Figure 1: Overall pre-training procedure of ShopperBERT. This figure illustrates the case of shuffle augmentation. We put the**



**Figure 2: UMAP visualization of the user representations**



One4all User Representation for Recommender Systems in E-commerce.  
Learning the language of viral evolution and escape. Science 2021

| 大龙八部：乔峰的演技有多好？看看这段你就明白了，多少人竖起了拇指！ : 015f597eae221ah:1268

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| 联盟谁有资格单换詹皇？波波维奇：8年前有一个，5年后有好多个：0495fab3f21305ah:8347  
| 18年詹姆斯离开骑士，联盟其他29支球队都是什么反应？:9365f99630d585ah:2201  
| 这球打的开挂了吧！詹姆斯与浓眉哥10大残暴时刻，死亡隔扣打服字母哥：1755fc9f77d561ah:2510  
| 詹姆斯这球让字母哥目瞪口呆 你以前开推土机的吧？:4245fc3b6d1208bk:3144  
| 进攻万花筒！枸杞哥厉害了，训练师晒维金斯单挑集锦，勇士这下稳了：3615fa9d358568ah:1614  
| 4日《长暂停》韦少体面挥笔分手信 底薪男扬言三分虐库里：8155fc9fb49469ah:4281  
| 白威亚斯真正见悟展现天赋时！对于看到也只能无奈摊手了！:6655fb86b/d7/bk:1819  
| 詹姆斯生涯过大赏：灭死神过科比，能用脑子决不靠身体！:6645fc44ac7166ah:3555  
| 詹姆斯vs欧文！2019-20赛季湖人对阵篮网詹姆斯、欧文高光表现！:1945fc5ee2d888ah:865  
| 再见兄弟！比小冰清告别尔尔：回顾奇才从烂队到最强一战：5555fc1a11d10ah:1175  
| 经典回顾：詹皇欧文同砍41分攻陷勇士，吹响史诗逆袭号角：4815fc226cc490ah:3890  
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| 《令人心动的offer》第一季实习生现状揭秘，律政精英究竟凭什么？: 0495f9ead5a18/ah:6770  
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| 令人心动的offer：学霸英语必须好？看了何运晨就知道，规矩是可以破的：9125fab3919269ah:6366  
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| 令人心动的offer，替换实习生面试开始，首批实习生成气氛紧张：0305fc78ad9113ah:7361  
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| 李浩源堪称行走的敦煌百科，汪涵都被圈粉了！: 9445fb4ede2325ah:3737  
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| 瞿泽林曝一直住寄宿学校，吃饭都在亲戚家，却未曾提及父母！: 7405fc08efb154ah:2371  
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Offer：斯坦福学霸竟没拿过奖学金！王晓学费自出，何运晨该拿的都拿了：6535fb7e81386ah:7274  
| Offer：君合VS锦天城，两大顶尖律所工资大爆料，徐灵菱年收入近千万：9685fb22a0f563ah:7741  
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| offer：两季高级合伙人气场PK！直呼带教律师全名，地位一眼看出：8165fc99a4b127ah:9218  
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| 令人心动的offer：郭旭蔡昆廷甜蜜互动小瞬间，磕到了！: 6115f9ea9ea550ah:5665  
| 在湖南电视台食堂吃饭，谢娜全程刷脸，遭海涛吐槽！: 7735fa10532551ah:8477  
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| 为什么范丞丞后来不pick詹秋怡了？原来是她的一句话，伤了丞丞子的心：7695fbf4a5a121ah:8844  
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| 3403217297 原来全家都是高颜值, 5om127vnkllpt2k  
| 3403217297 就属宋晓峰最丑! :e3072yxnw30, c306491volo  
| 3403217297 2014-04-17我为喜剧狂:5om127vnkllpt2k, t0806q1tmwo  
| 3403217297 文松打出“一张4”, d0846mvvohb  
| 3403217297 宋晓峰直接出“大王”, i0820kb867c  
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| 赵本山上台领奖太搞笑: 硬把颁奖现场弄成相声大会, 逗乐全场大咖:0195fbdb01c949ah:11659  
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| <https://v.qq.com/x/page/1675f5706b0115ah.html>:1675f5706b0115ah:6543  
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| <https://v.qq.com/x/page/2935f9fd88c009ah.html>:2935f9fd88c009ah:12629  
| 江疏影, 独一无二的嘟嘴, 这是被谁气到啦?: 0875fa4d521497bk:2247  
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| 影视: 朱德被污蔑, 周总理直接请示伟大领袖危机顿时解除, 真是太厉害了!:8945faa5a94327ah:4067  
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| <https://v.qq.com/x/page/1285f926155577ah.html>:1285f926155577ah:5664  
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| <https://v.qq.com/x/page/0585fba0735224ah.html>:0585fba0735224ah:6085  
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| 中国又一好消息，南海30万吨黄土涌出海面？西方直言：太厉害了！ :655fbdff62042ah:8493  
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| 美国卫星路过中国沙漠，发现了“神秘”黑点，科学家们坐不住了 :8055fc0d6f0067ah:8951  
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| 偷学来的电线接头绝活，手法专业又牢固，又不用缠胶布，长见识了 :1815f5f62c3187ah:10164  
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| 中央军委主席—立就器张，不料女军官千般—炮直接毙了，团长看傻眼。 :6105f832e90427ah:5125  
| 毛主席会见美国代表人，主席抽着香烟，神情自若的说了一段话！ :8055fd92c9884ah:6469  
| 中国湖南有位“峭壁飞人”，专门帮人上龙头香，一天能赚上万元！ :9385fb79082475ah:7010  
| 普京表示，我从不这么等人而你是第一个，这个人会是谁呢：6815fab756031ah:8253  
| <https://v.qq.com/x/page/8675fbacd2e423ah.html>:8675fbacd2e423ah:6834  
| <https://v.qq.com/x/page/8215fc0cff792ah.html>:8215fc0cff792ah:7254  
| <https://v.qq.com/x/page/8395fc6f249698ah.html>:8395fc6f249698ah:5029  
| 全球最罕见的现象，堪称百年难遇，科学家至今都无法解释！ :2555fc0c4cb838ah:7400  
| 云南惊现“悬浮山”，村民凑近一看吓得拔腿就跑，牛顿坐不住了！ :3015fb62b95488ah:6847  
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| 20米坠桥事故完整视频来了，原因反转了，结果也反转了 :2365fb719f3921ah:10831  
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| 男子将野猪和家猪关在一起，没想到意外发生了，视频记录全过程！ :3545fb5ddd4351ah:6805  
| 我国“打穿”喜马拉雅山，尼泊尔举国欢庆，印度人却不乐意了！ :0795fb7897a757ah:4009  
| 这才是软线和硬线的正确接法，看不懂，原来以前都接错了 :2915f75c5e2824ah:6602  
| 马拉多纳最离谱一球，如果不是镜头记录下来，国足绝不信这是真的 :8165fb8bcf3a112ah:11844  
| 农民工的新发明，在果园里真实用啊，快收藏起来 :1165fb48fd2881ah:5273  
| <https://v.qq.com/x/page/0655fbdbb9d288ah.html>:0655fbdbb9d288ah:2440  
| 凶残野狼追杀驼鹿，驼鹿机智跳入水里，下一秒太激烈了！ :8065fbdf8a3782ah:1010  
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### 原发杰的联系方式

[yuanfajie@westlake.edu.cn](mailto:yuanfajie@westlake.edu.cn) 电话：15626510956



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