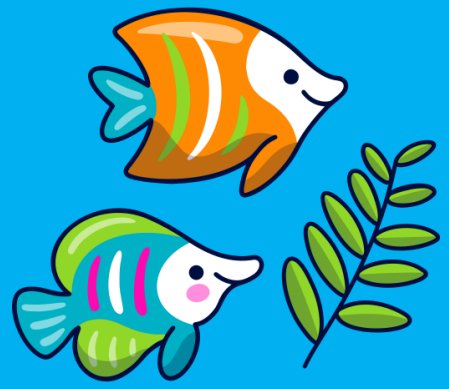
613 373 9423 Pathompong Muangthong





# Social Recommendation Based on Weighted Graph

## วิธีแนะนำทางสังคมบนพื้นฐานของกราฟแบบถ่วงน้ำหนัก

Images by Flaticon

# Related Works 

 Background and Rationale

 Related Knowledge

 Objective

 Methodology

 Result and Conclusion

**Background and Rationale**

**Related Knowledge**

Objective

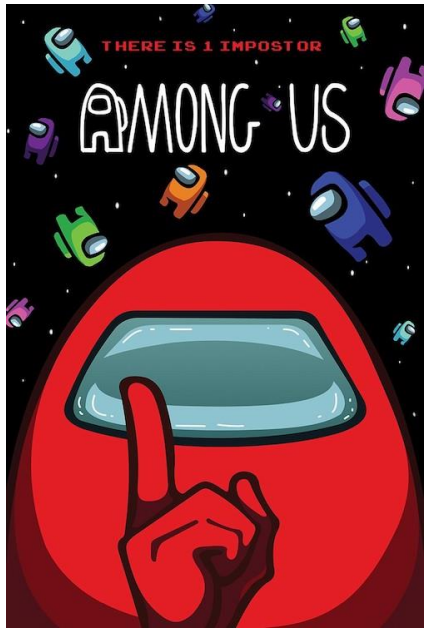
Methodology

Result and Conclusion

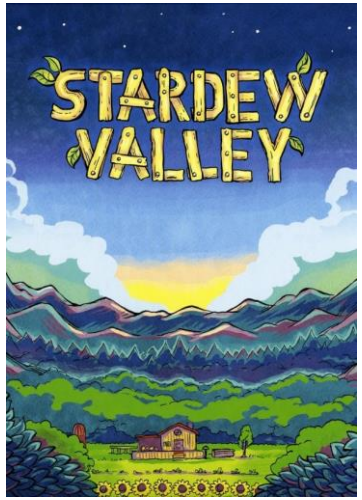
Images by Flaticon

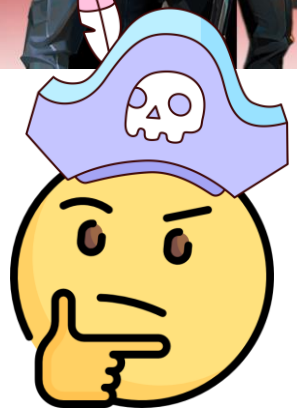
# Recommender System



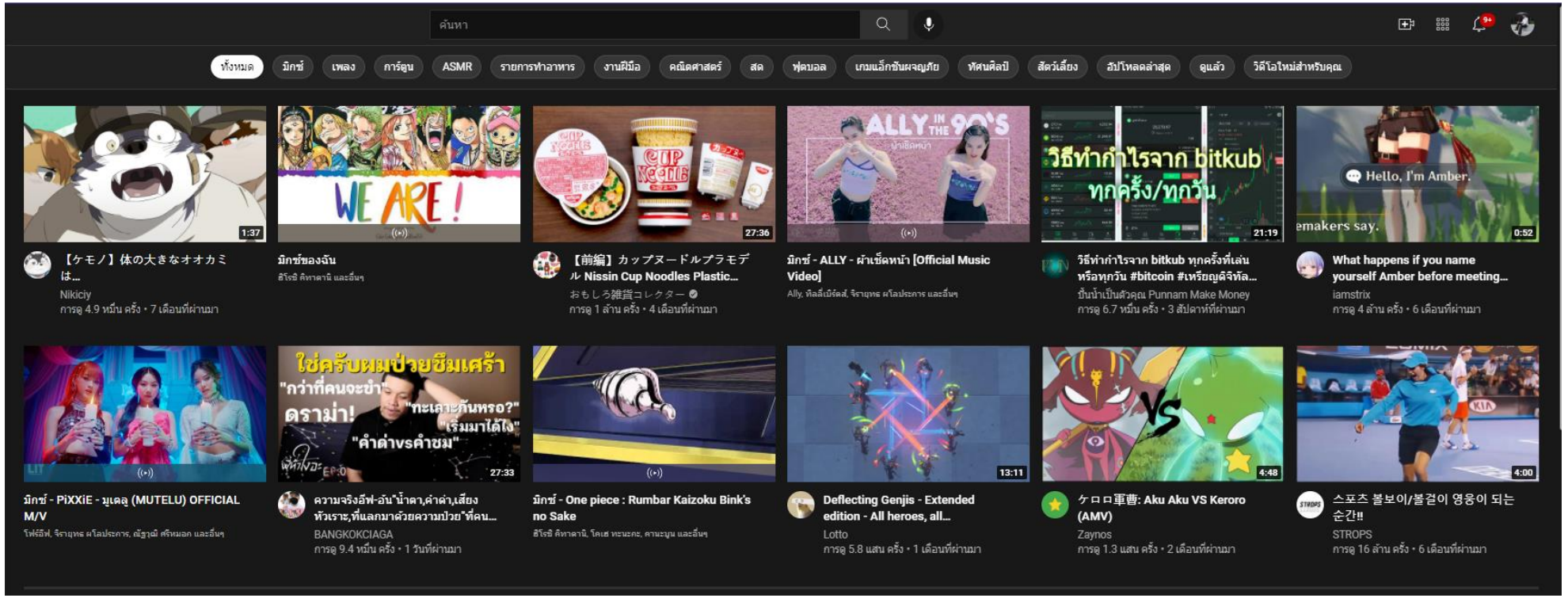






# Recommender System



# Recommender System

Early Black Friday
$22.59 – $52.99
Up to 60% off Anne Klein Watches
Ends in 23:30:09

Early Black Friday
$5.73 – $36.79
20% off Pet Toys from Outward Hound and more
Ends in 23:30:09

Early Black Friday
$22.39 – $366.40
Up to 30% off Zinus Bed Frames, Sofa and More
Ends in 23:30:09

Early Black Friday
$5.07 – $27.97
Up to 30% off Burt's Bees Family Pajamas
Ends in 23:30:09


$99.00
List Price: $169.00 41% off
Honeywell Home Wifi Smart Thermostats
★★★★½ 10,010

$99.99
List Price: $149.99 33% off
Up to 33% Off Samsung Buds +

$15.49 – $568.17
Up to 50% off Watches from Invicta, Timex, Tommy Hilfiger, and more

$134.10 – $2,800.75
Up to 30% off on Casper mattresses and more

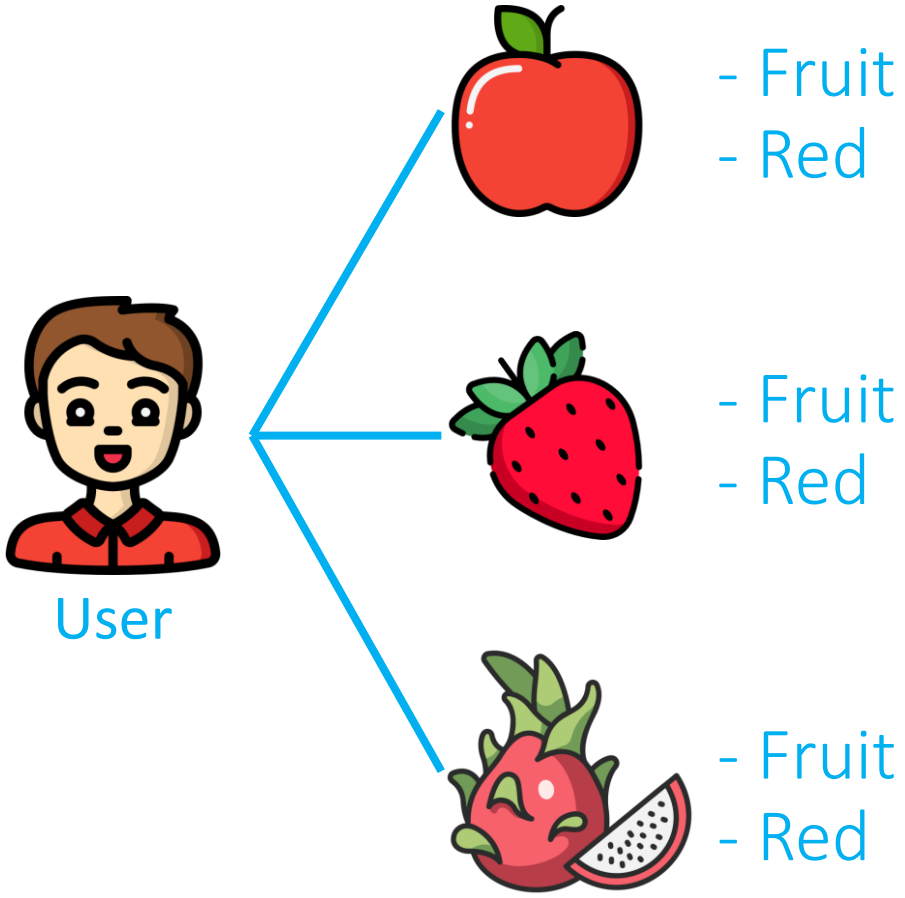
$69.00 – $177.80
Save up to 50% off select Ray-Ban and Oakley Sunglasses

$199.99
List Price: $269.99 26% off
TP-Link Deco WiFi 6 Mesh WiFi System(Deco X20) - Covers up to 5800 Sq.Ft. , Replaces...
★★★★½ 5,427

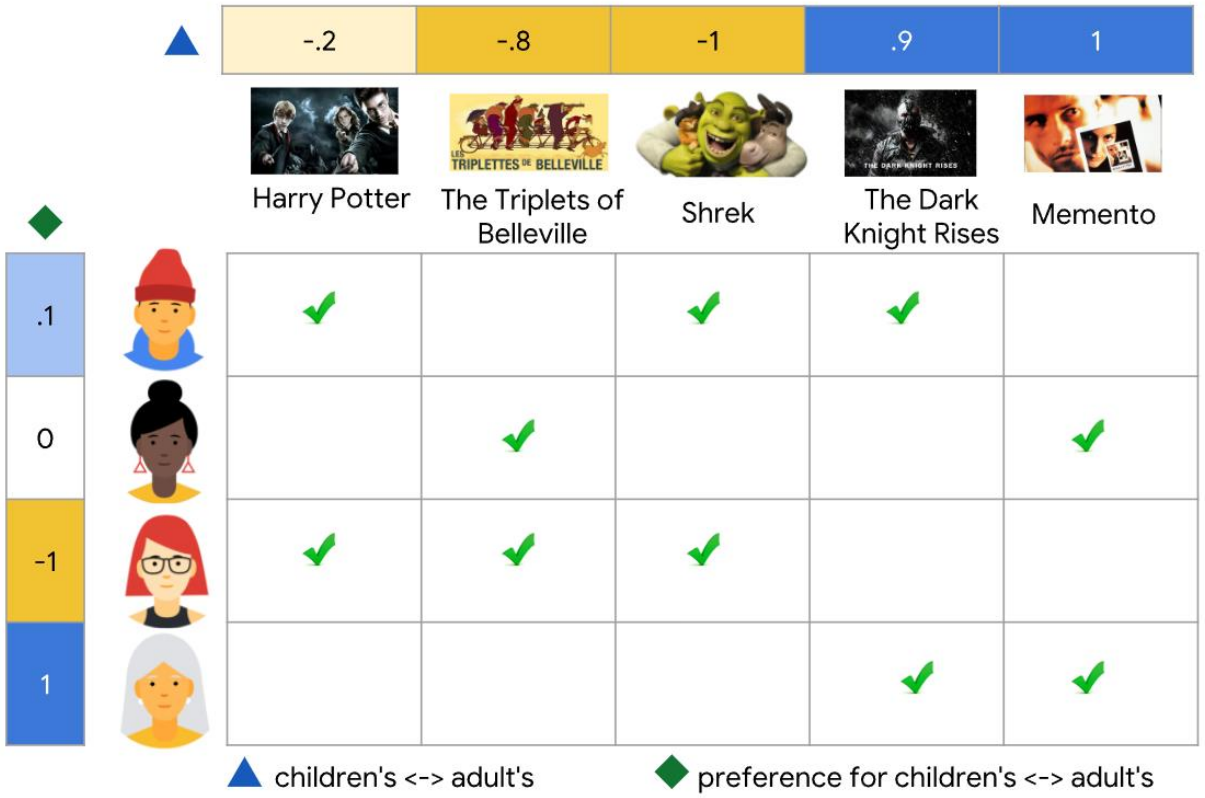
$7.64 – $50.10
Up to 15% Off Amazon Basics Kids Bedding

$25.49 – $55.24
Save on Thanksgiving Tablecloth

# Content-Based Filtering



# Collaborative Filtering




Resource: Collaborative Filtering | Recommendation Systems | Google Developers. (2022). Retrieved 25 April 2022, from https://developers.google.com/machine-learning/recommendation/collaborative/basics

# Collaborative Filtering

| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 4 | | | 3 | | 1 | |
| U2 | | 5 | | | | | 1 |
| U3 | | | 3 | | | | 2 |
| U4 | 5 | | | | 1 | 3 | |
| U5 | | | 4 | | | | |
| U6 | 4 | | | | 3 | 2 | |
| U7 | | 4 | | 4 | | | 2 |

## User-based

# Collaborative Filtering

| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 4 | | | 3 | | 1 | |
| U2 | | 5 | | | | | 1 |
| U3 | | | 3 | | | | 2 |
| U4 | 5 | | | | 1 | 3 | |
| U5 | | | 4 | | | | |
| U6 | 4 | | | | 3 | 2 | |
| U7 | | 4 | | 4 | | | 2 |

## User-based

# Collaborative Filtering

| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 4 | | | 3 | | 1 | |
| U2 | | 5 | | | | | 1 |
| U3 | | | 3 | | | | 2 |
| U4 | 5 | | | | 1 | 3 | |
| U5 | | | 4 | | | | |
| U6 | 4 | | | | 3 | 2 | |
| U7 | | 4 | | 4 | | | 2 |

## User-based

# Collaborative Filtering

Similar user

| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 4 | | | 3 | | 1 | |
| U2 | | 5 | | | | | 1 |
| U3 | | | 3 | | | | 2 |
| U4 | 5 | | | | 1 | 3 | |
| U5 | | | 4 | | | | |
| U6 | 4 | | | | 3 | 2 | |
| U7 | | 4 | | 4 | | | 2 |

## User-based

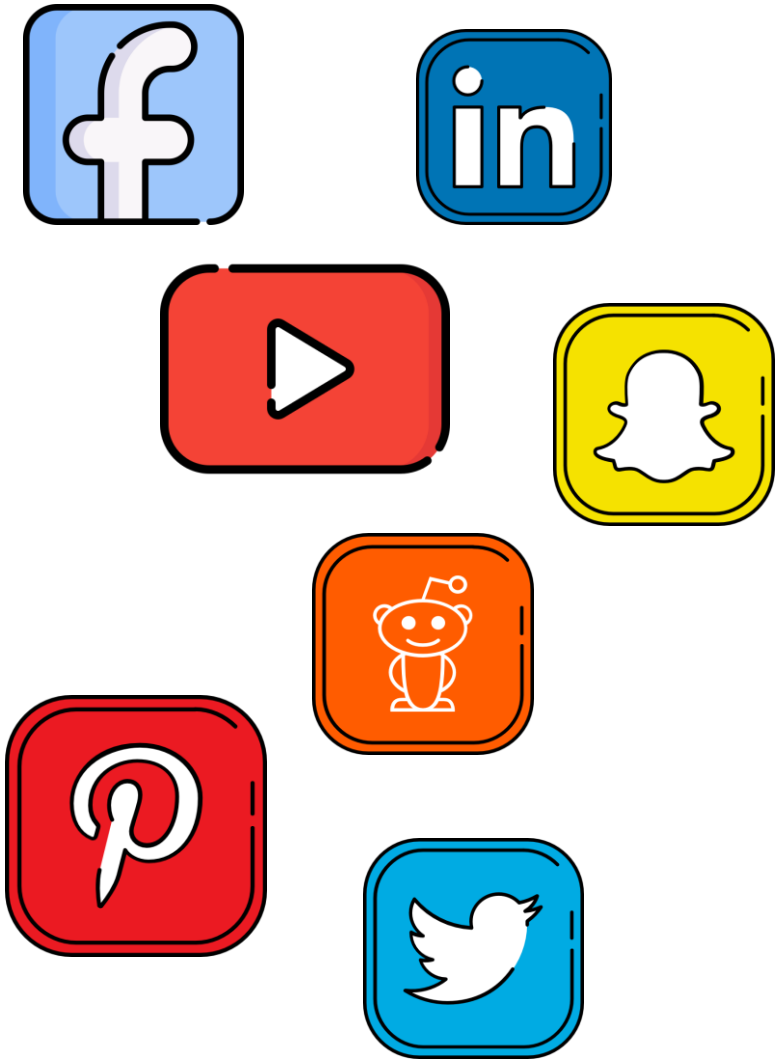
# Collaborative Filtering

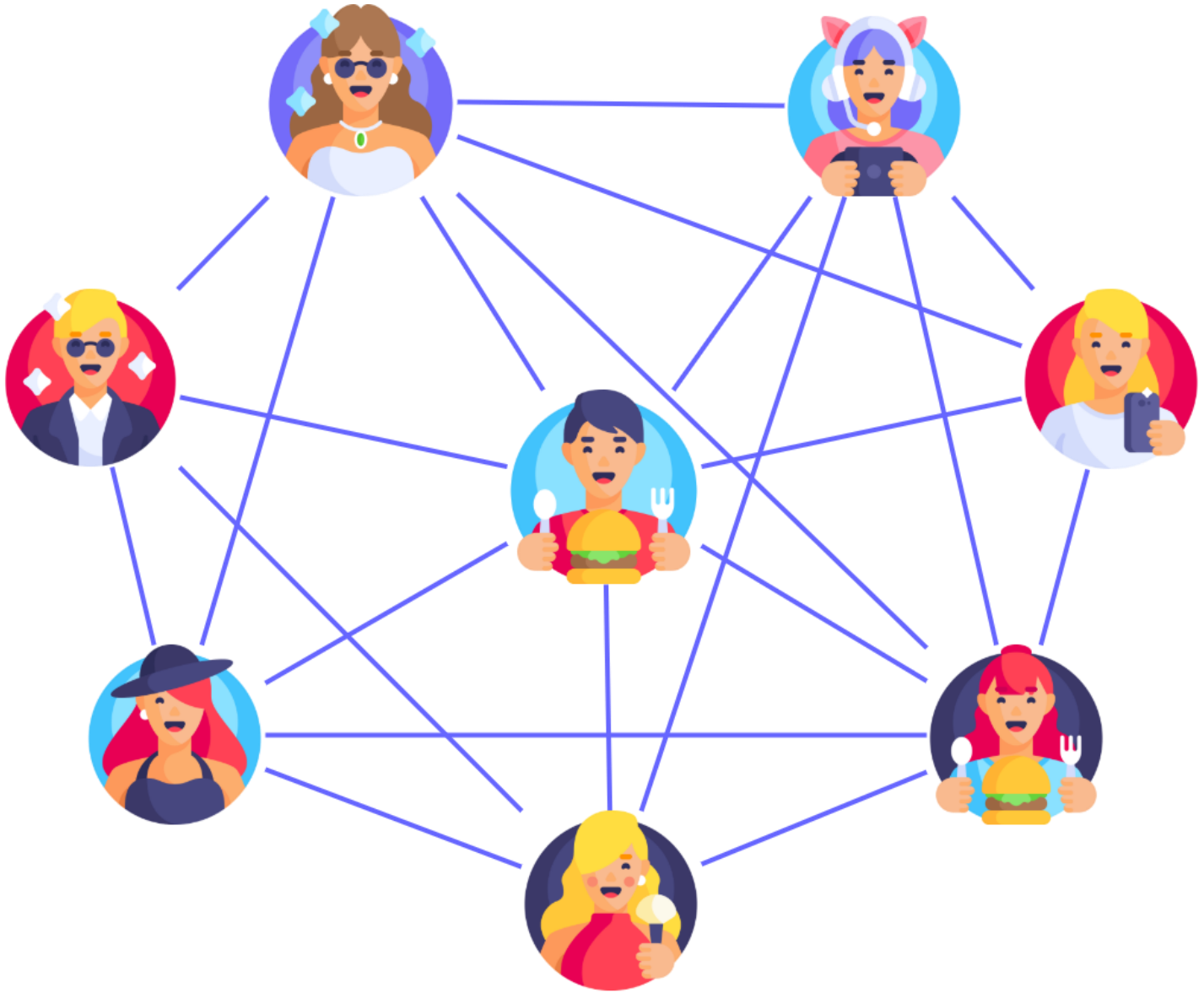
## ข้อด้อย

- ข้อมูลเบาบาง

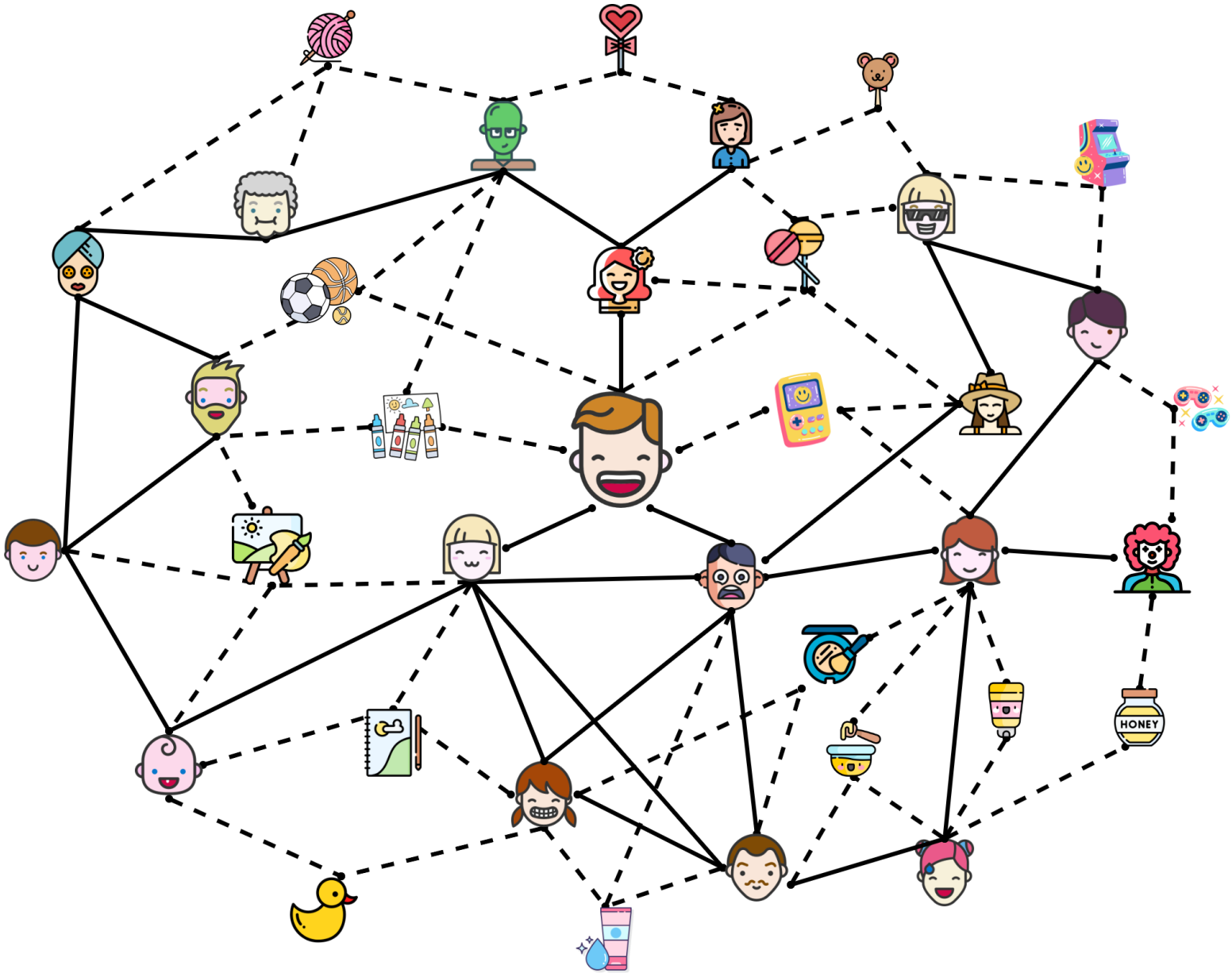
| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 4 | | | 3 | | 1 | |
| U2 | | 5 | | | | | 1 |
| U3 | | | 3 | | | | 2 |
| U4 | 5 | | | | 1 | 3 | |
| U5 | | | 4 | | | | |
| U6 | 4 | | | | 3 | 2 | |
| U7 | | 4 | | 4 | | | 2 |

# Social Network



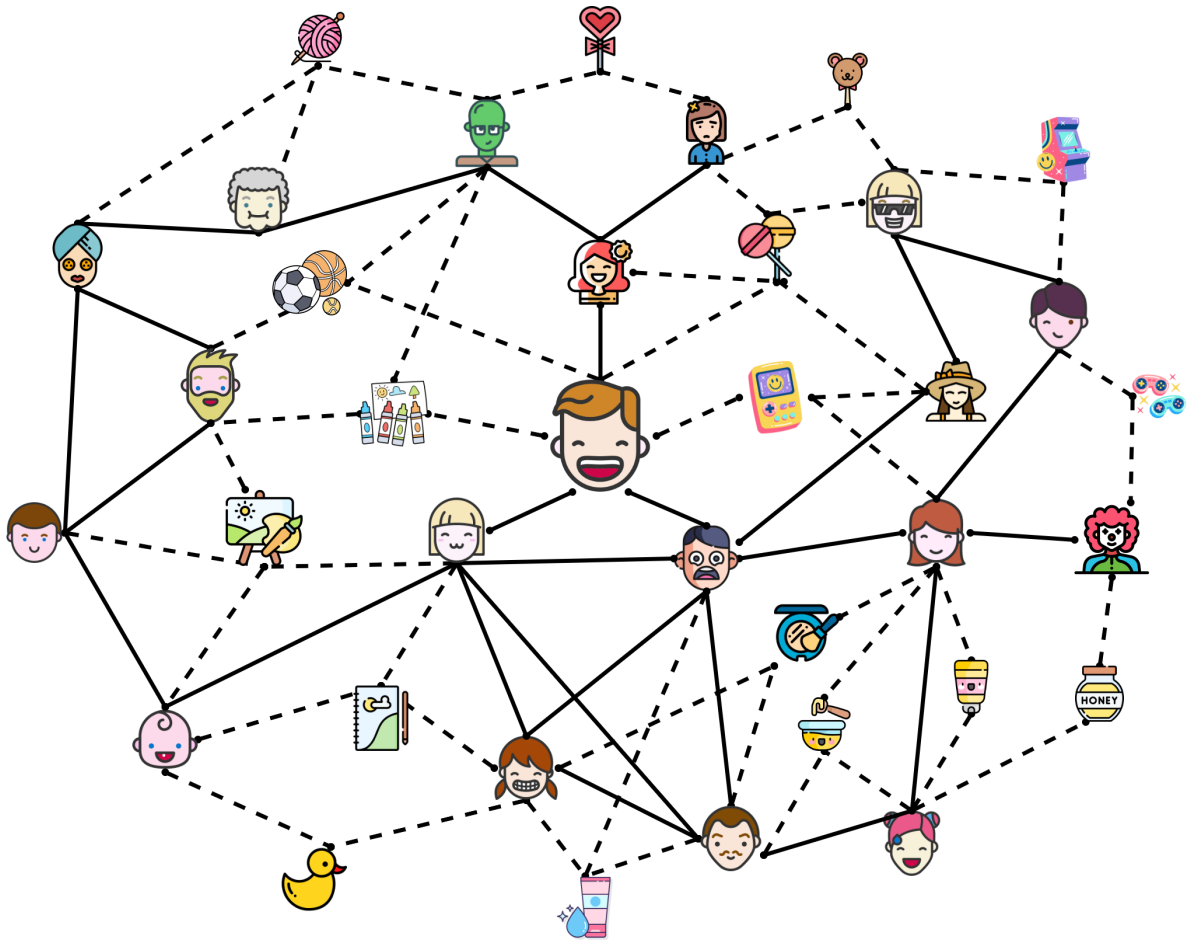


# Social Network



# Social Network

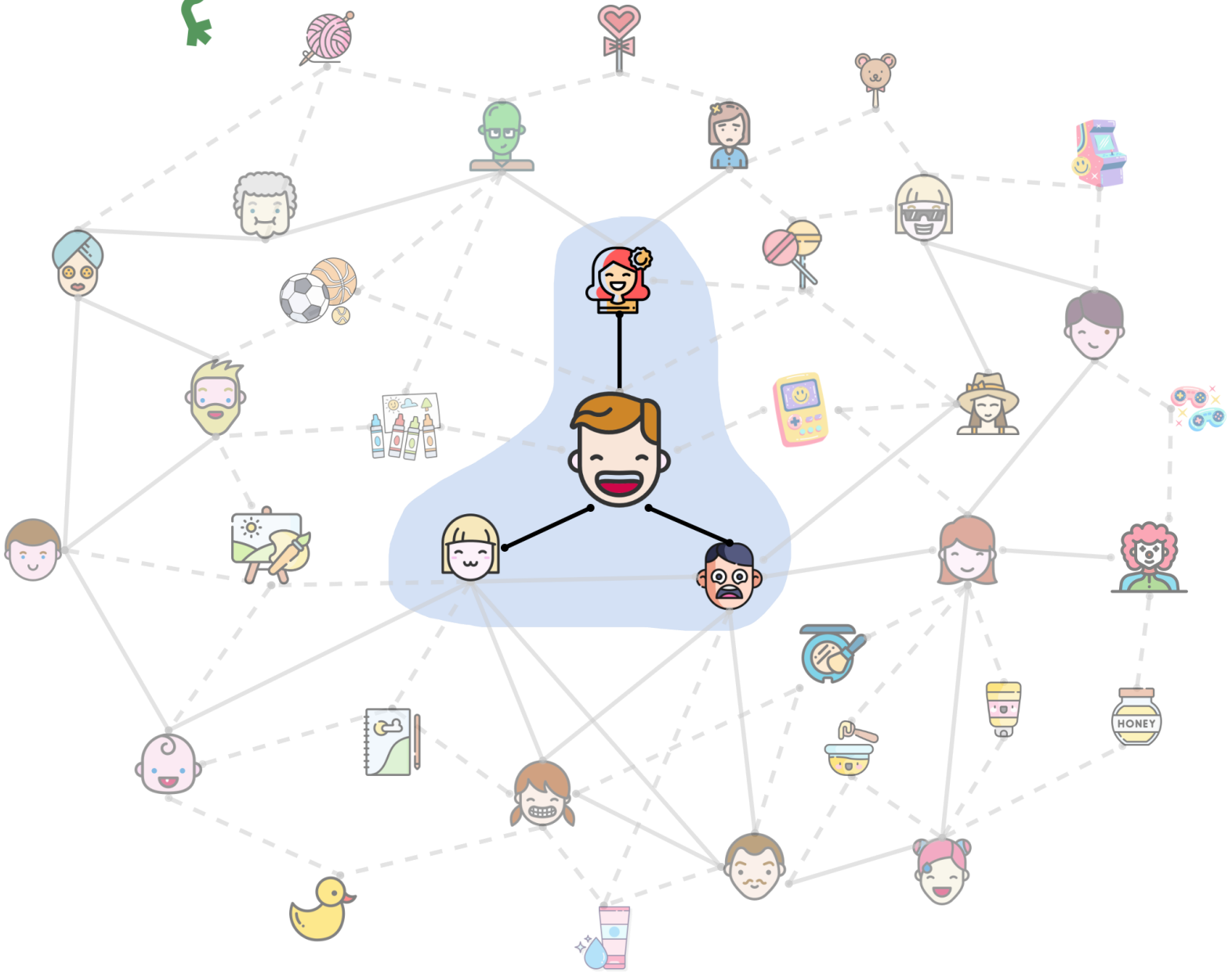
| users \ items | i1 | i2 | i3 | i4 | i5 | i6 | i7 |
|---|---|---|---|---|---|---|---|
| U1 | 1 | | | 1 | | 1 | |
| U2 | | 1 | | | | | 1 |
| U3 | | | 1 | | | | 1 |
| U4 | 1 | | | | 1 | 1 | |
| U5 | | | 1 | | | | |
| U6 | 1 | | | | 1 | 1 | |
| U7 | | 1 | | 1 | | | 1 |



# Multi-Hops

## 1 Hop

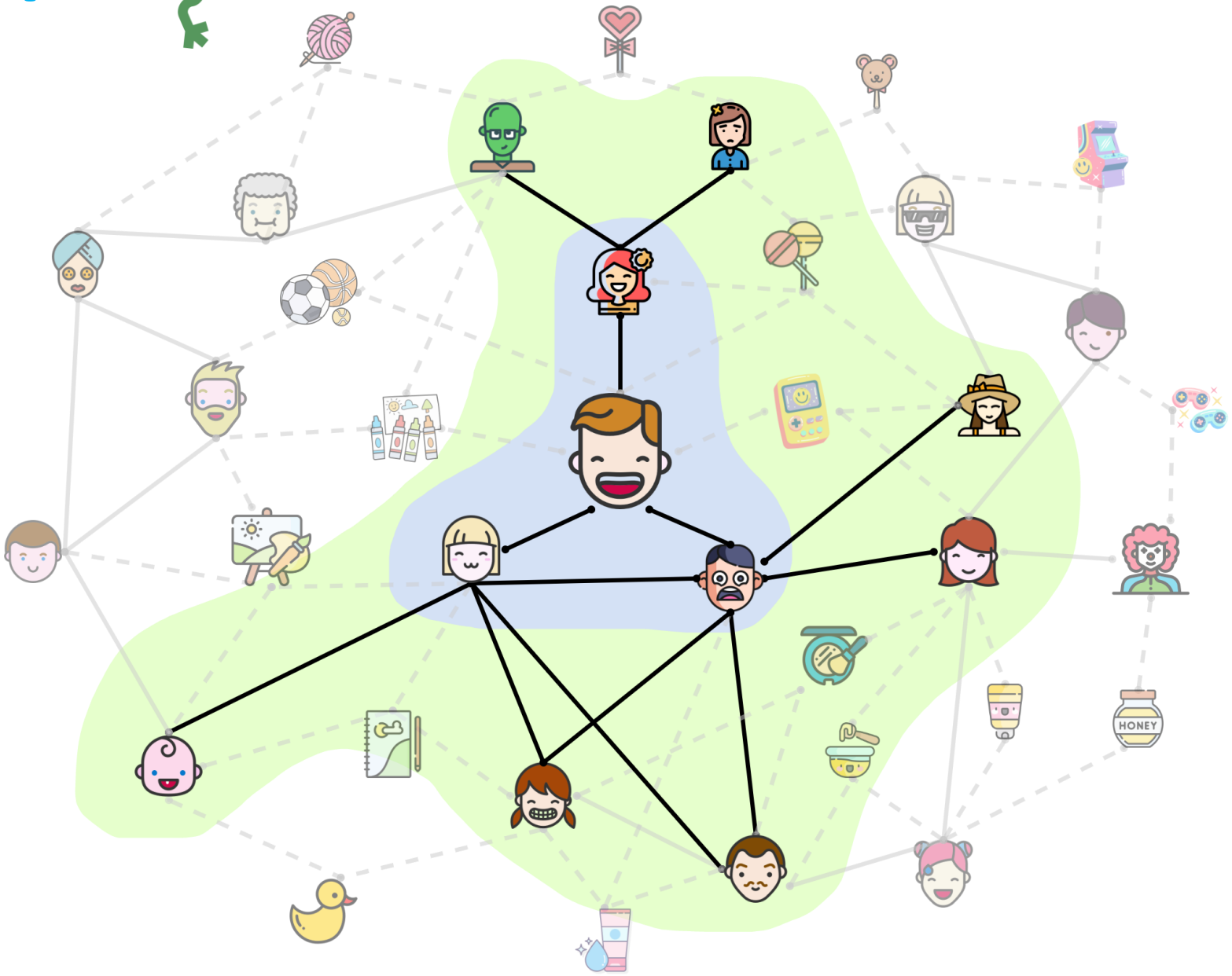
เพื่อนบ้านลำดับที่ 1



# Multi-Hops

## 2 Hops

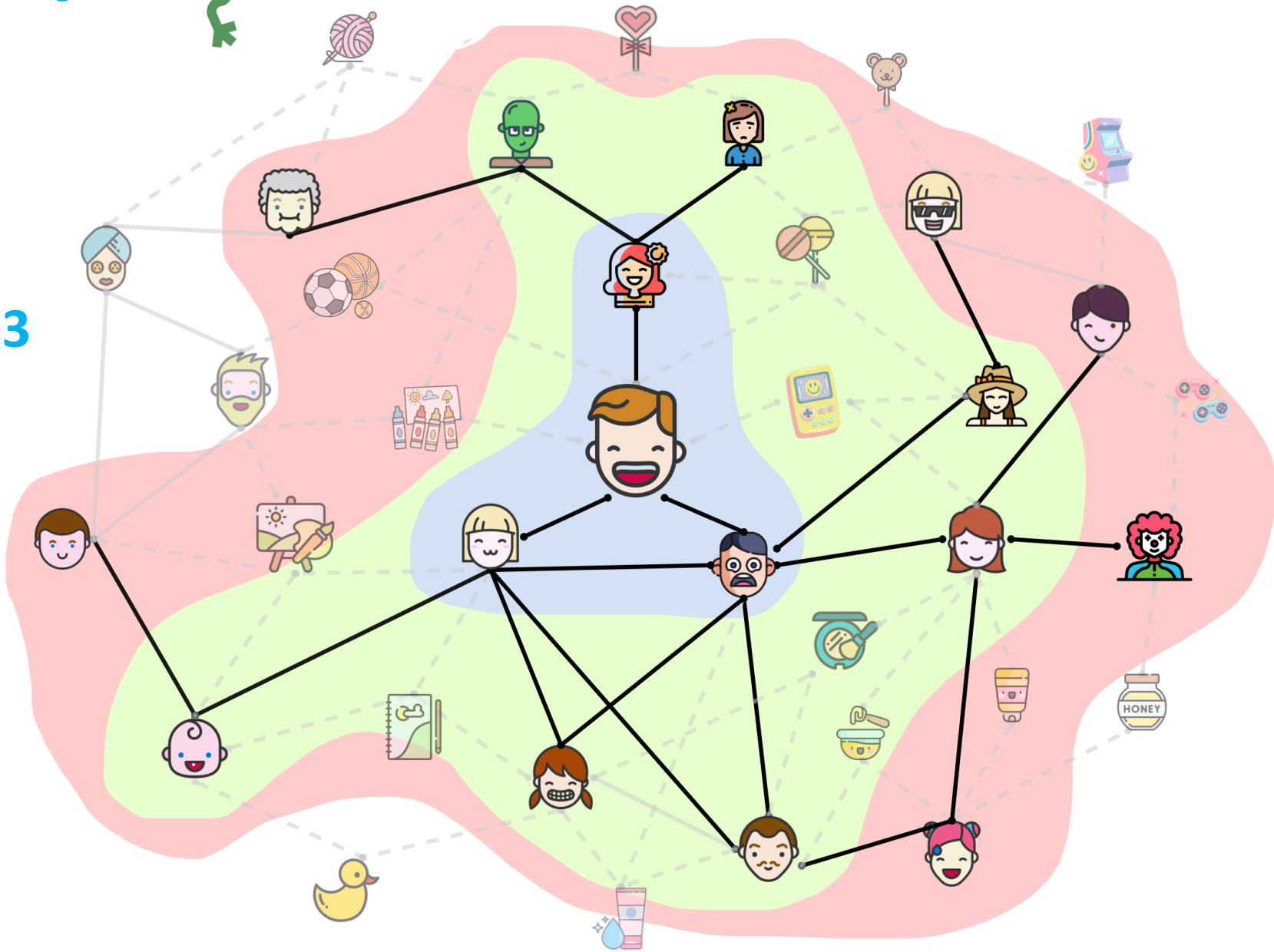
เพื่อนบ้านลำดับที่ 2



# Multi-Hops

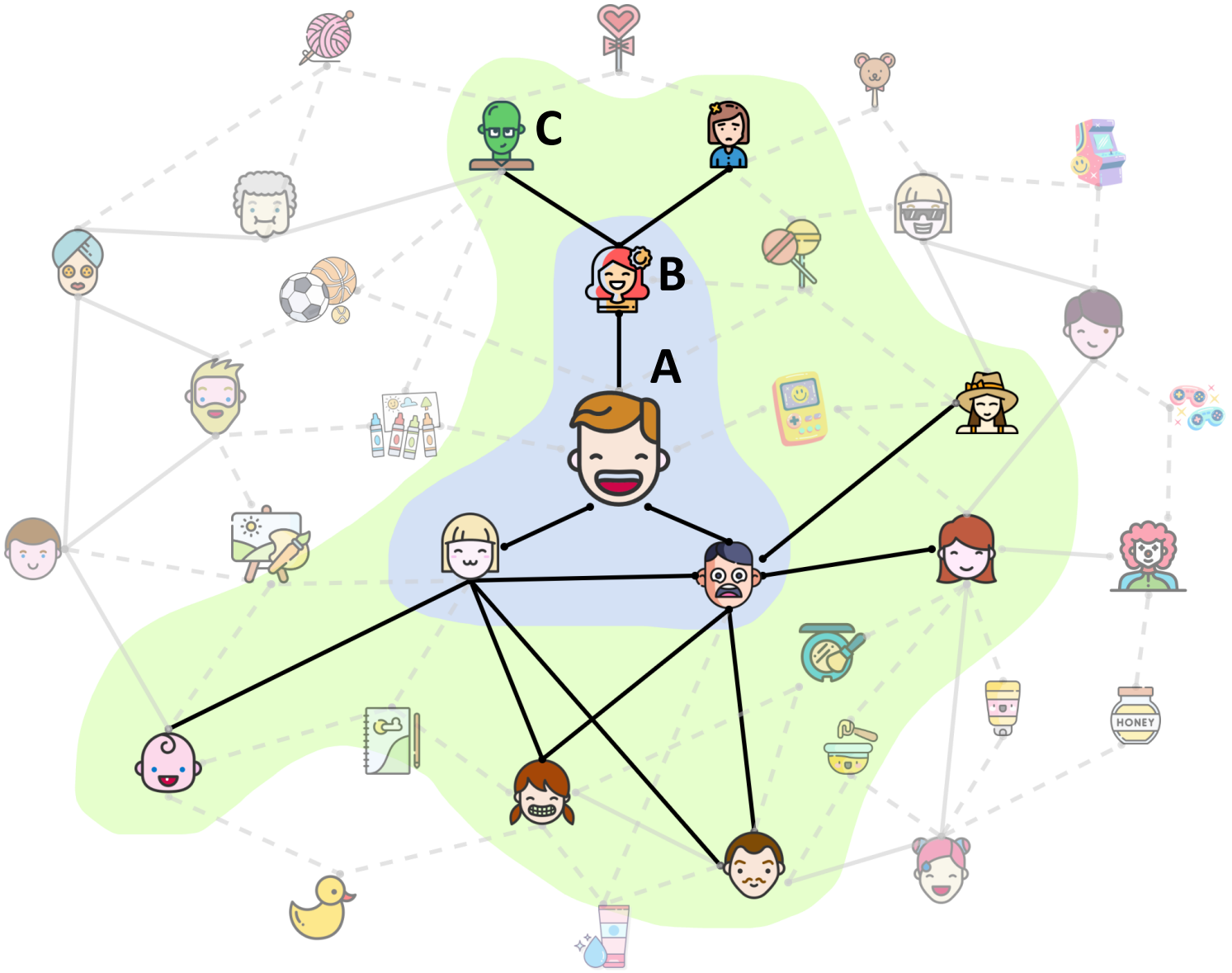
## 3 Hops

เพื่อนบ้านลำดับที่ 3

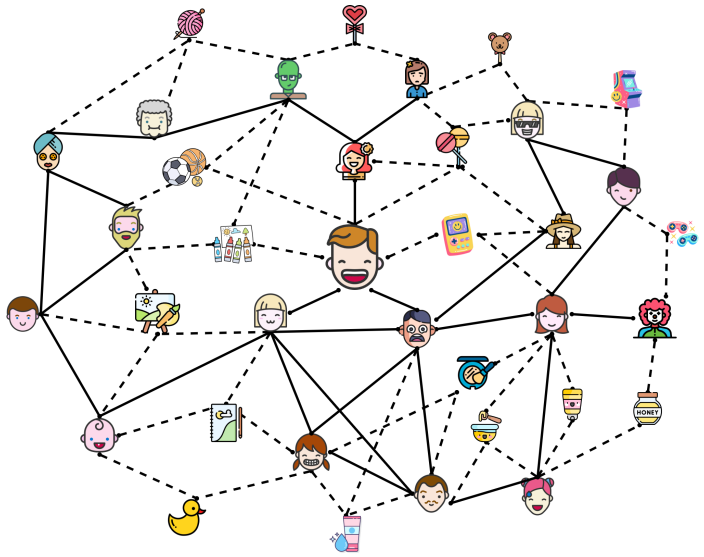


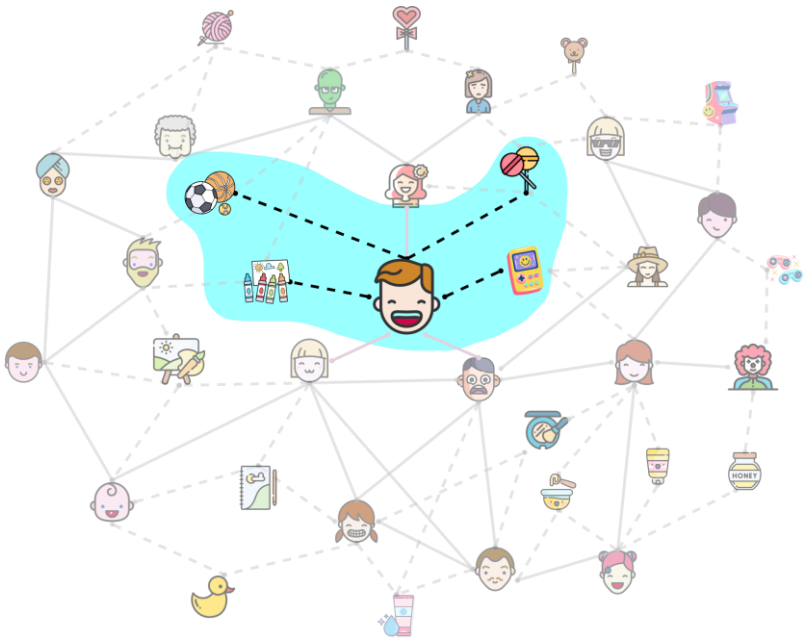
users

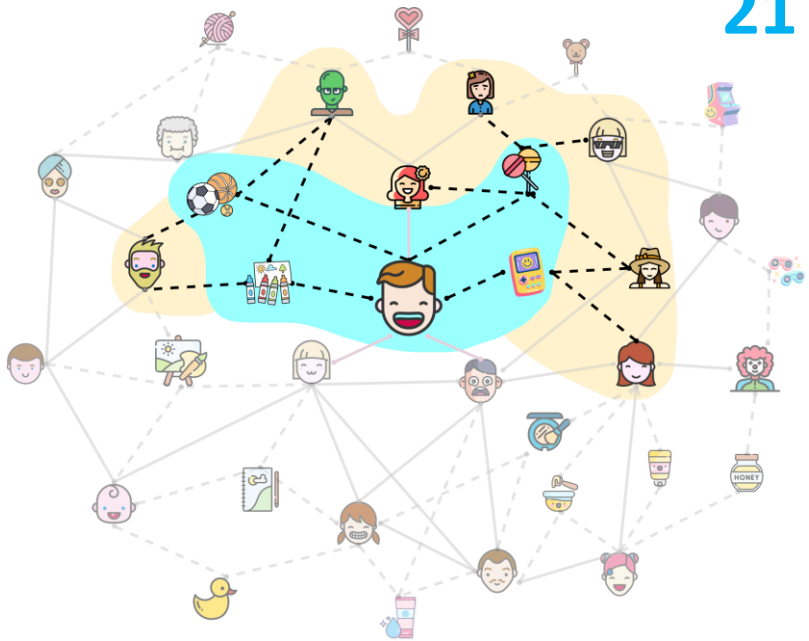
| users | | | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 1 | 1 | | |
| | | | | | 1 | 1 |
| | | | | 1 | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

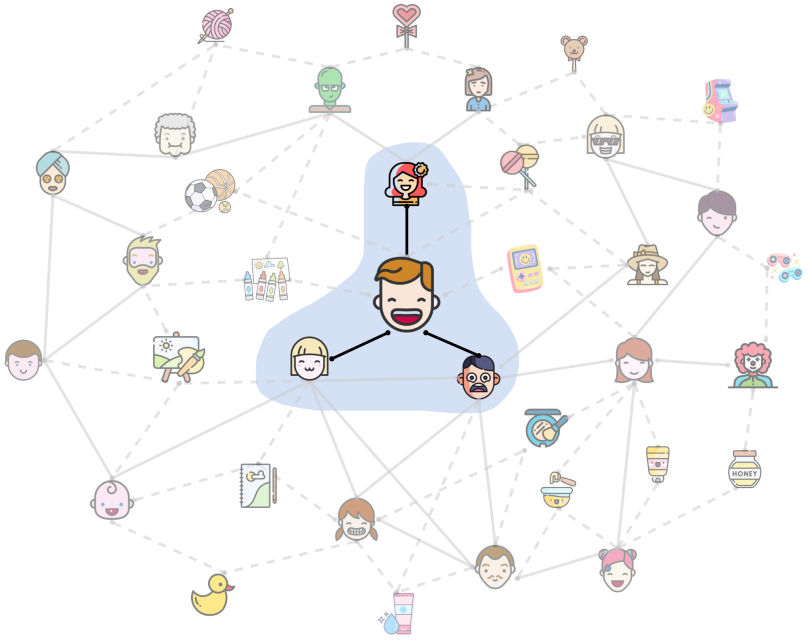


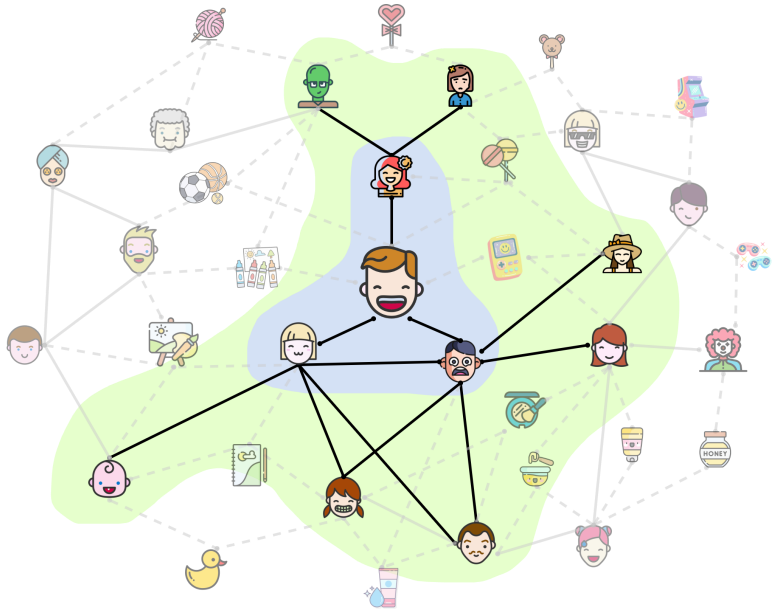
# Graph



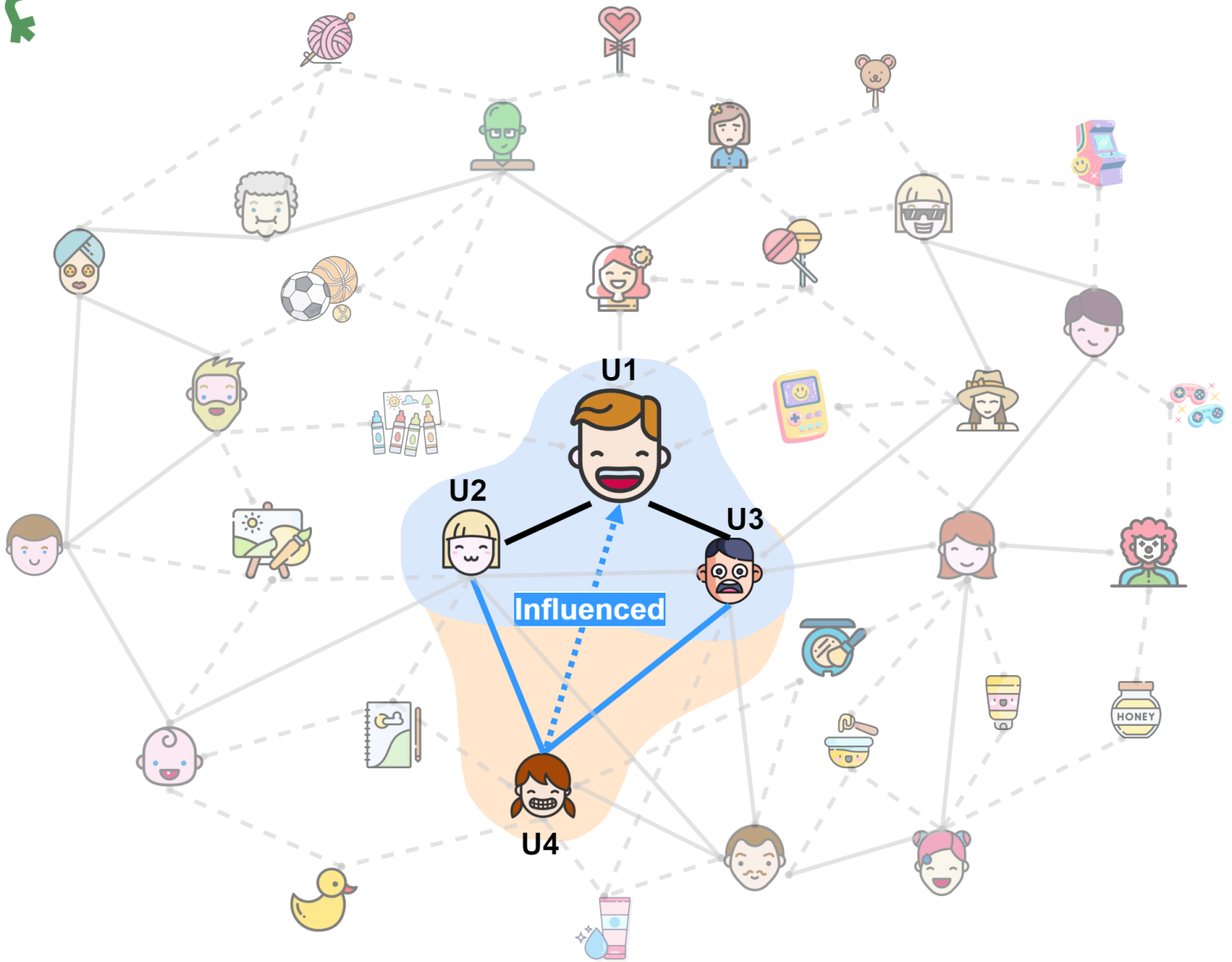






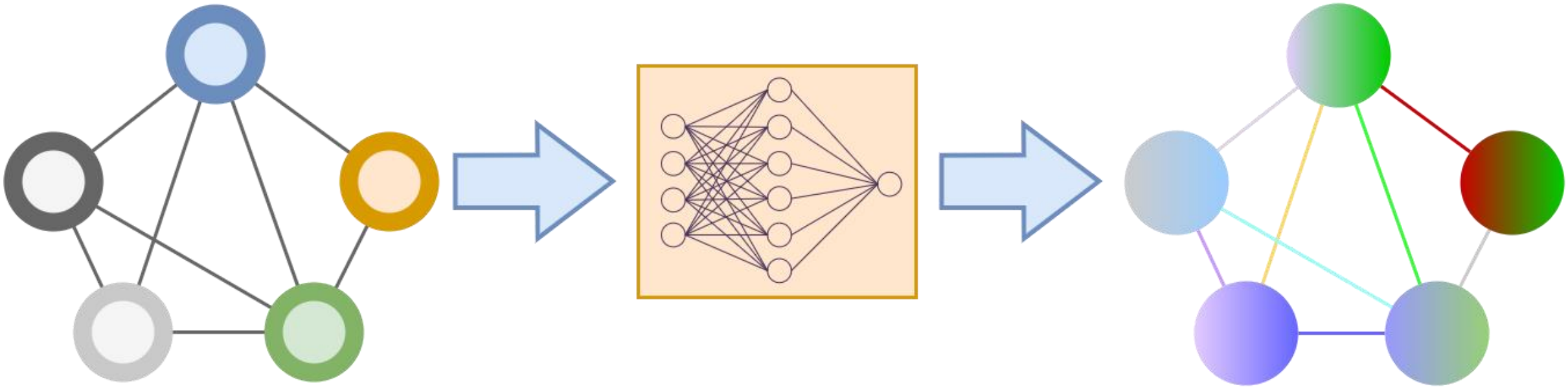


# Graph



# Graph-based Recommendation

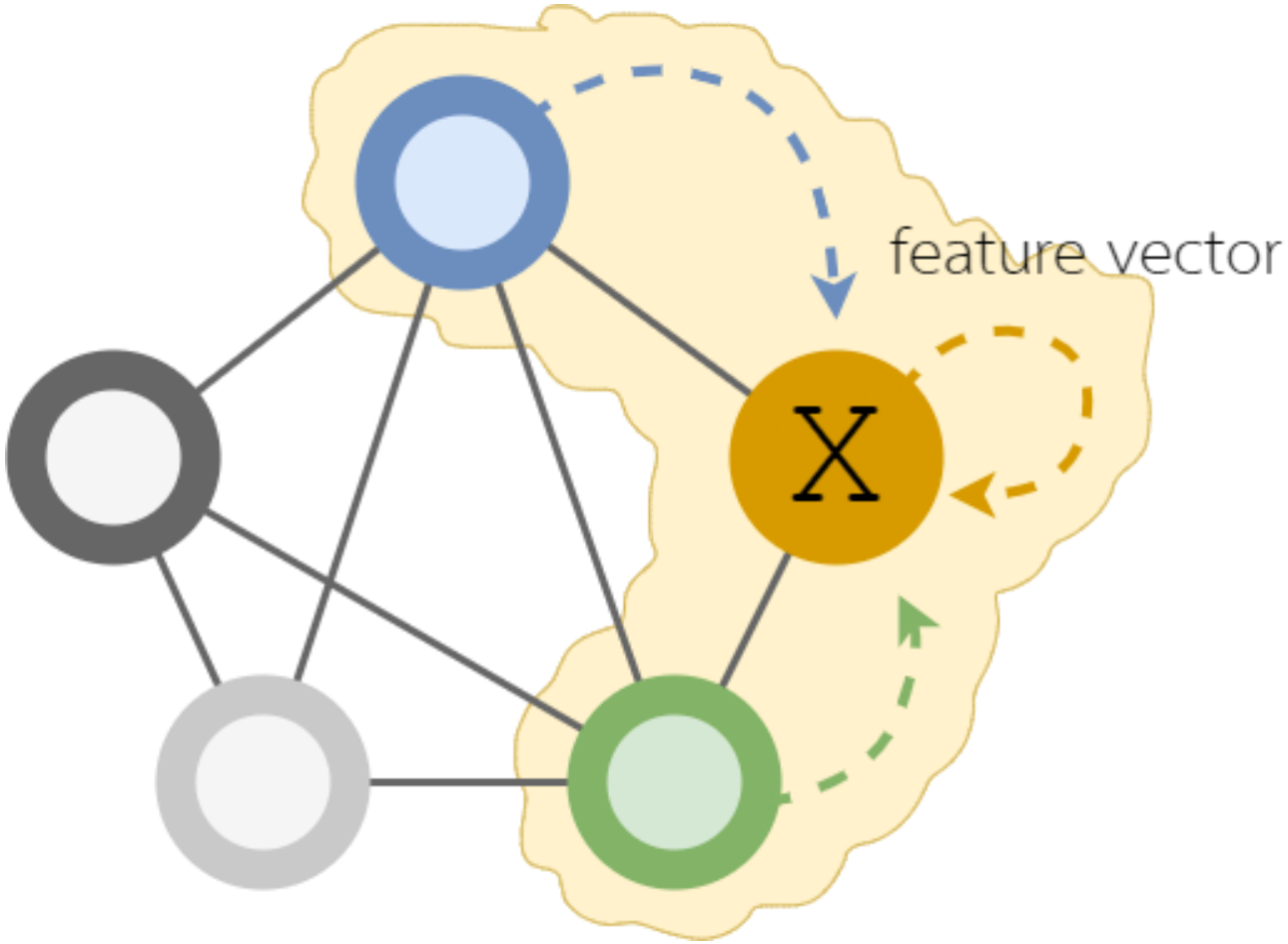
Graph Neural Network **GNN**



# Graph-based Recommendation

Graph Neural Network **GNN**

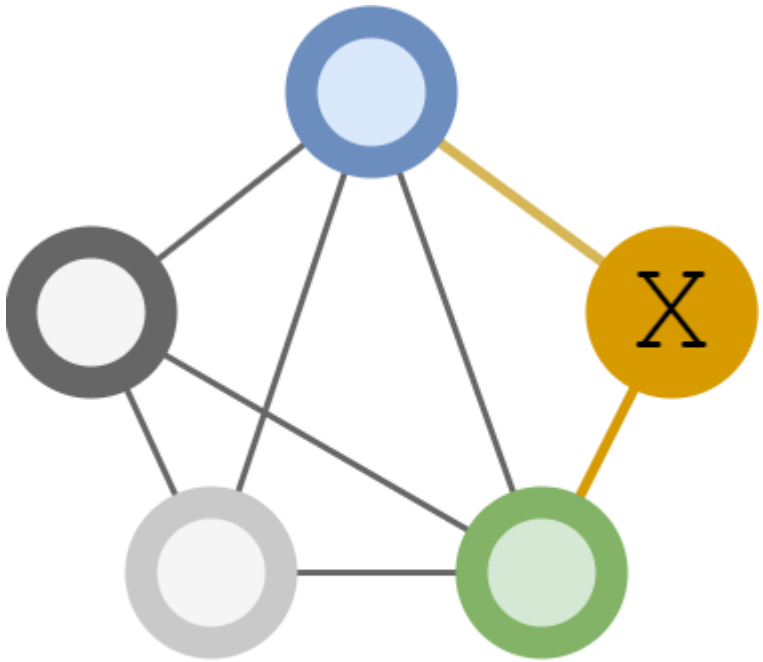
Message Passing



# Graph-based Recommendation

Graph Neural Network **GNN**

Message Passing

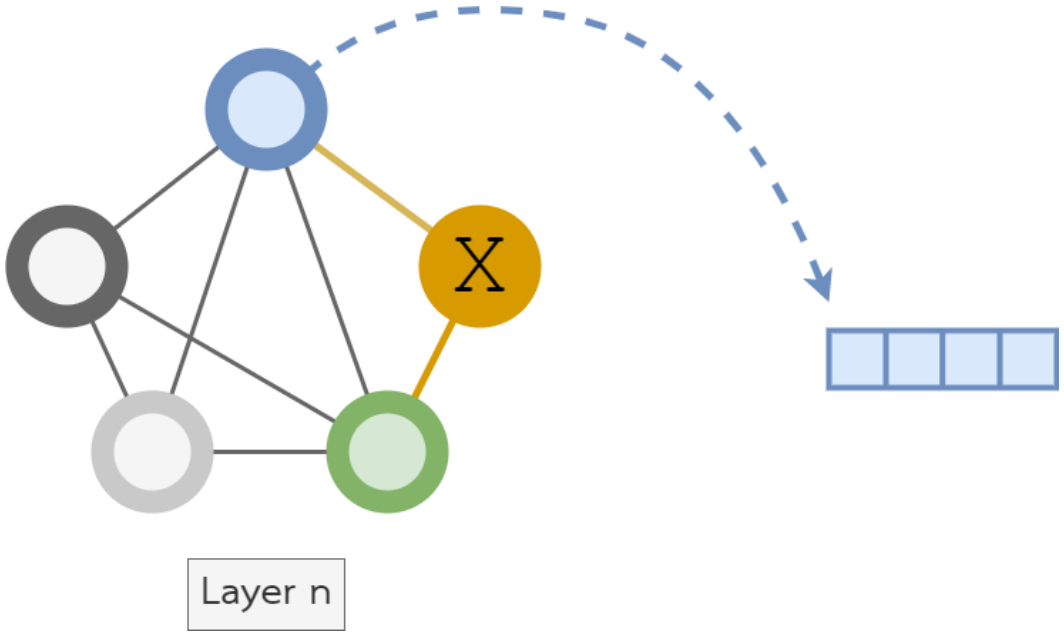



Layer n

# Graph-based Recommendation

Graph Neural Network **GNN**

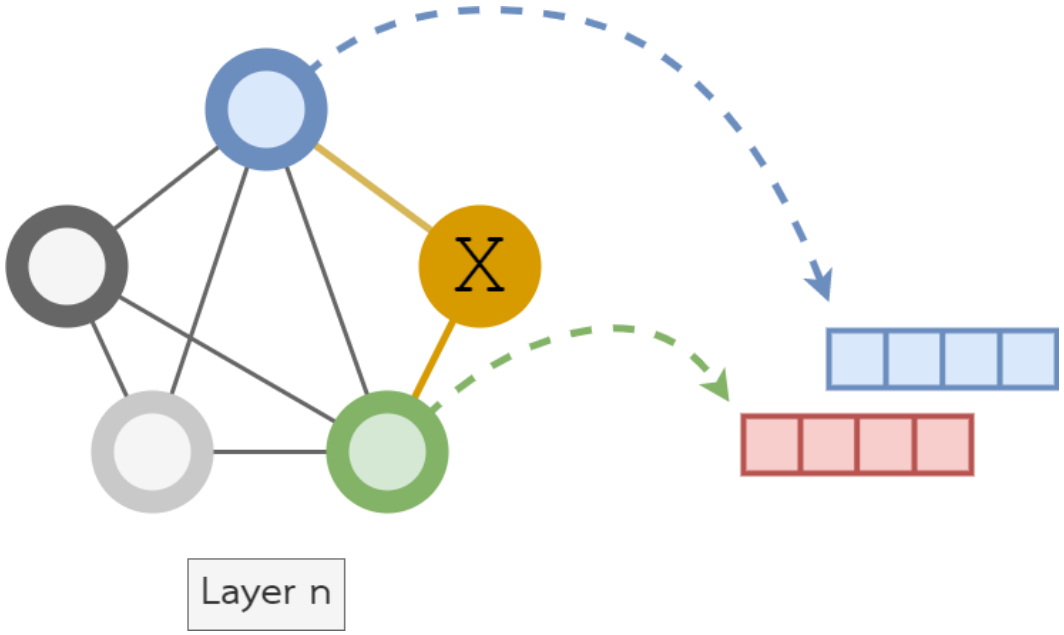
Message Passing



# Graph-based Recommendation

Graph Neural Network **GNN**

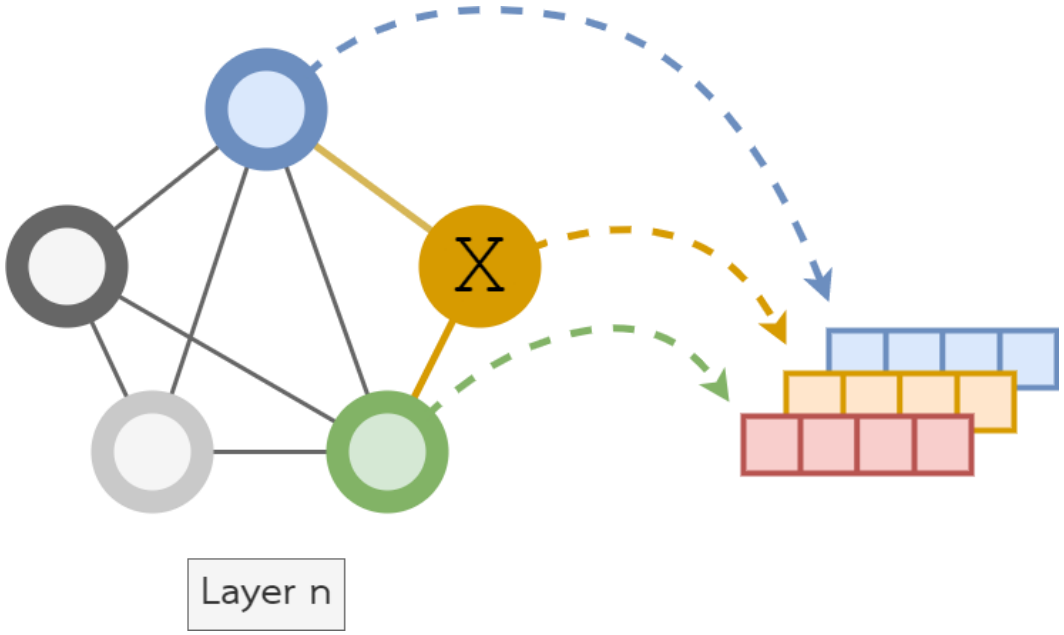
Message Passing



# Graph-based Recommendation

Graph Neural Network **GNN**

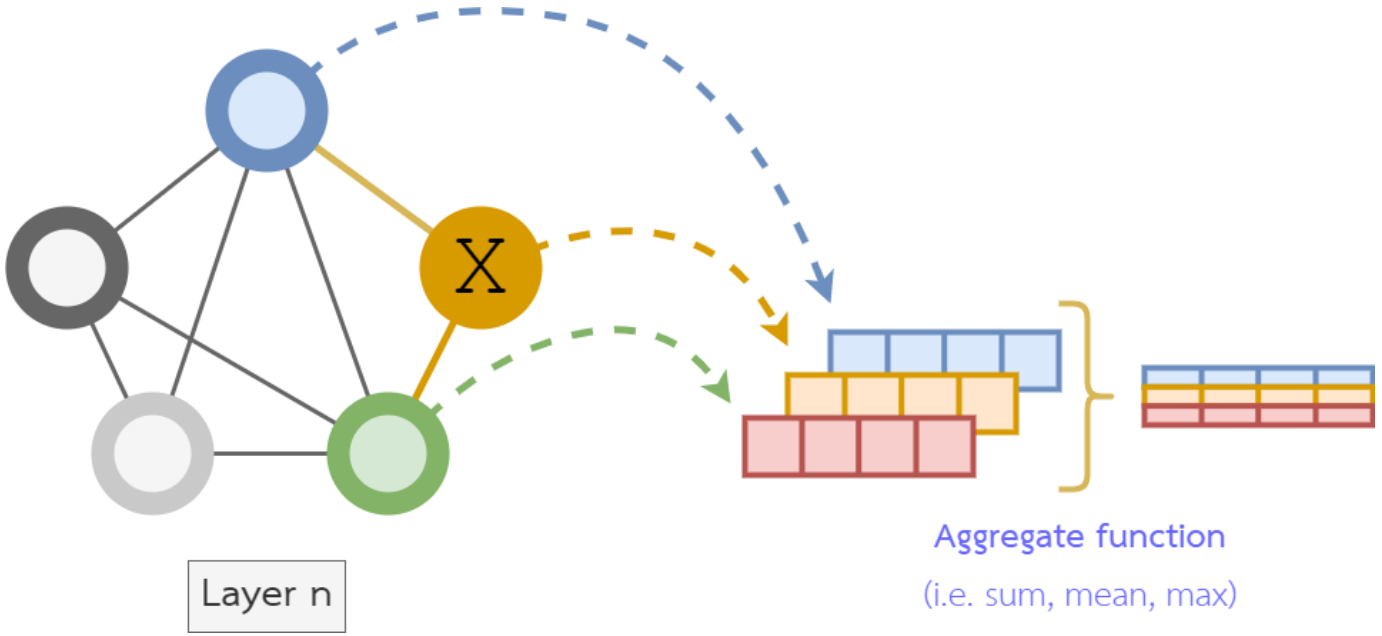
Message Passing



# Graph-based Recommendation

Graph Neural Network **GNN**

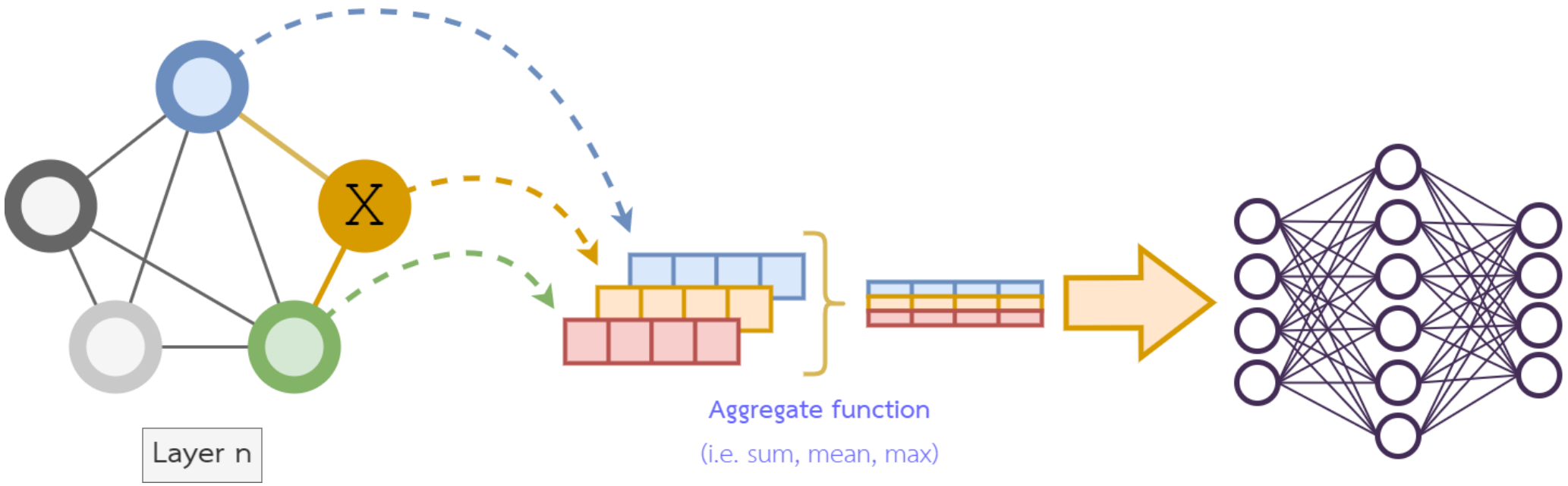
Message Passing



# Graph-based Recommendation

Graph Neural Network **GNN**

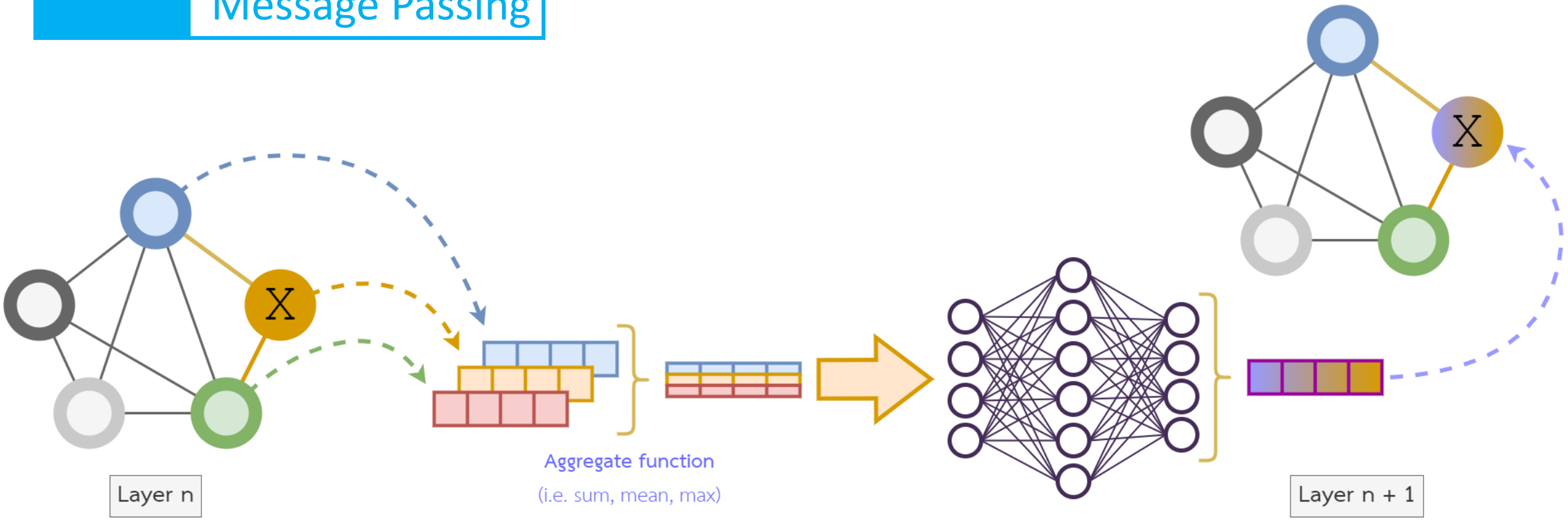
Message Passing



# Graph-based Recommendation

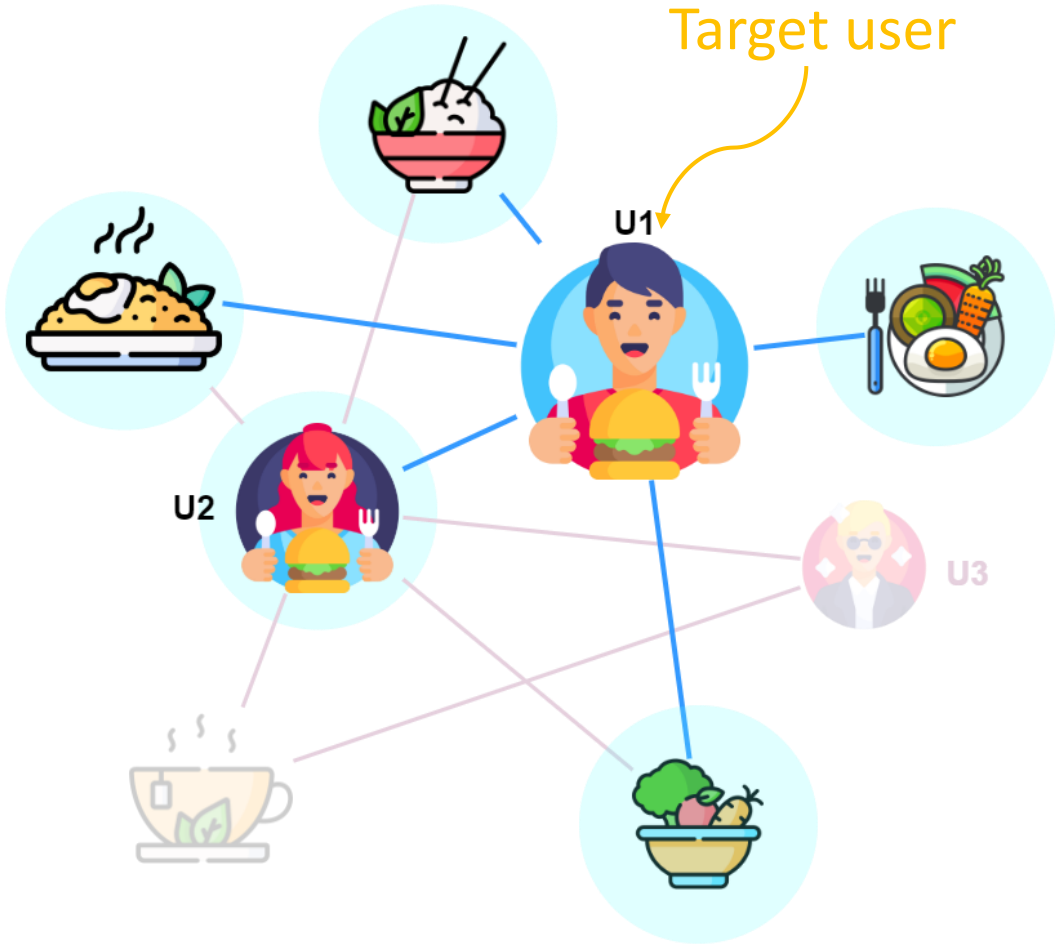
Graph Neural Network **GNN**

Message Passing

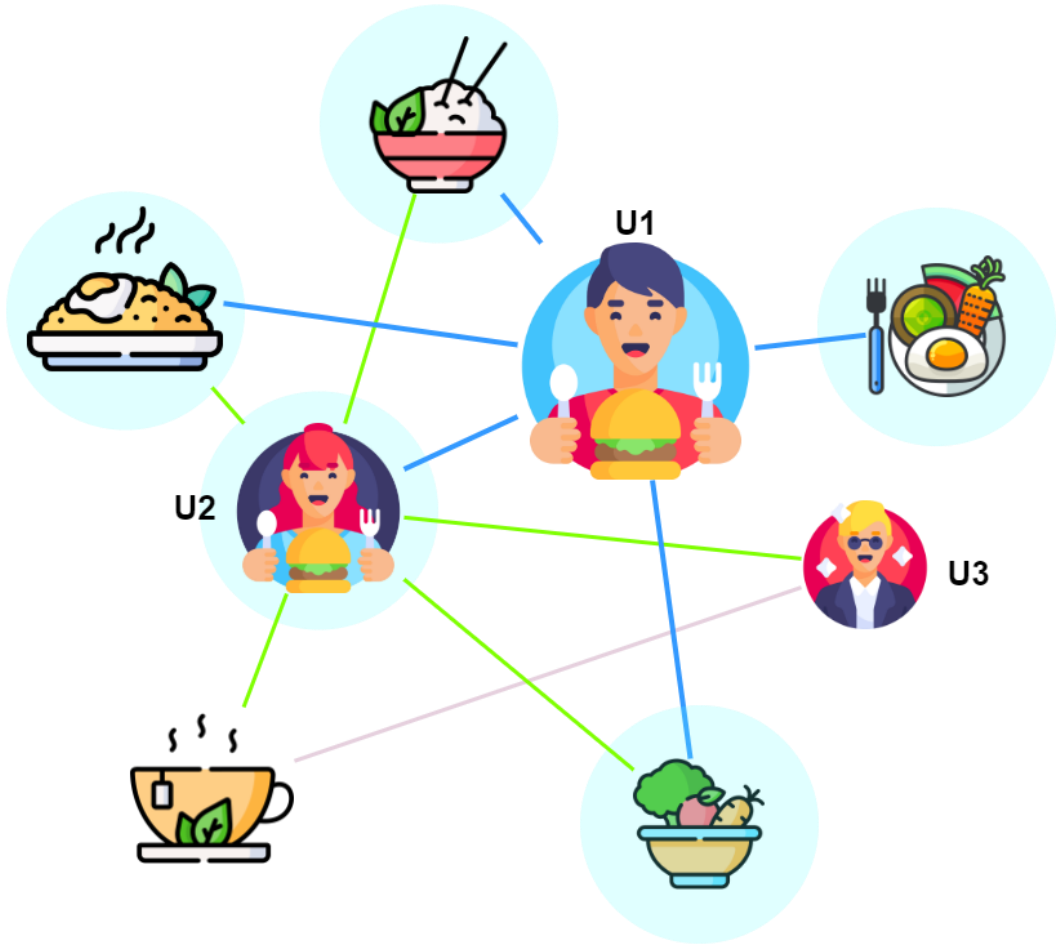


# Graph-based Recommendation

Graph Convolutional Network **GCN**




Iteration 1 (Hop1)




Iteration 2 (Hop2)

Images by Flaticon

# DiffNet++

## A Neural Influence and Interest Diffusion Network for Social Recommendation

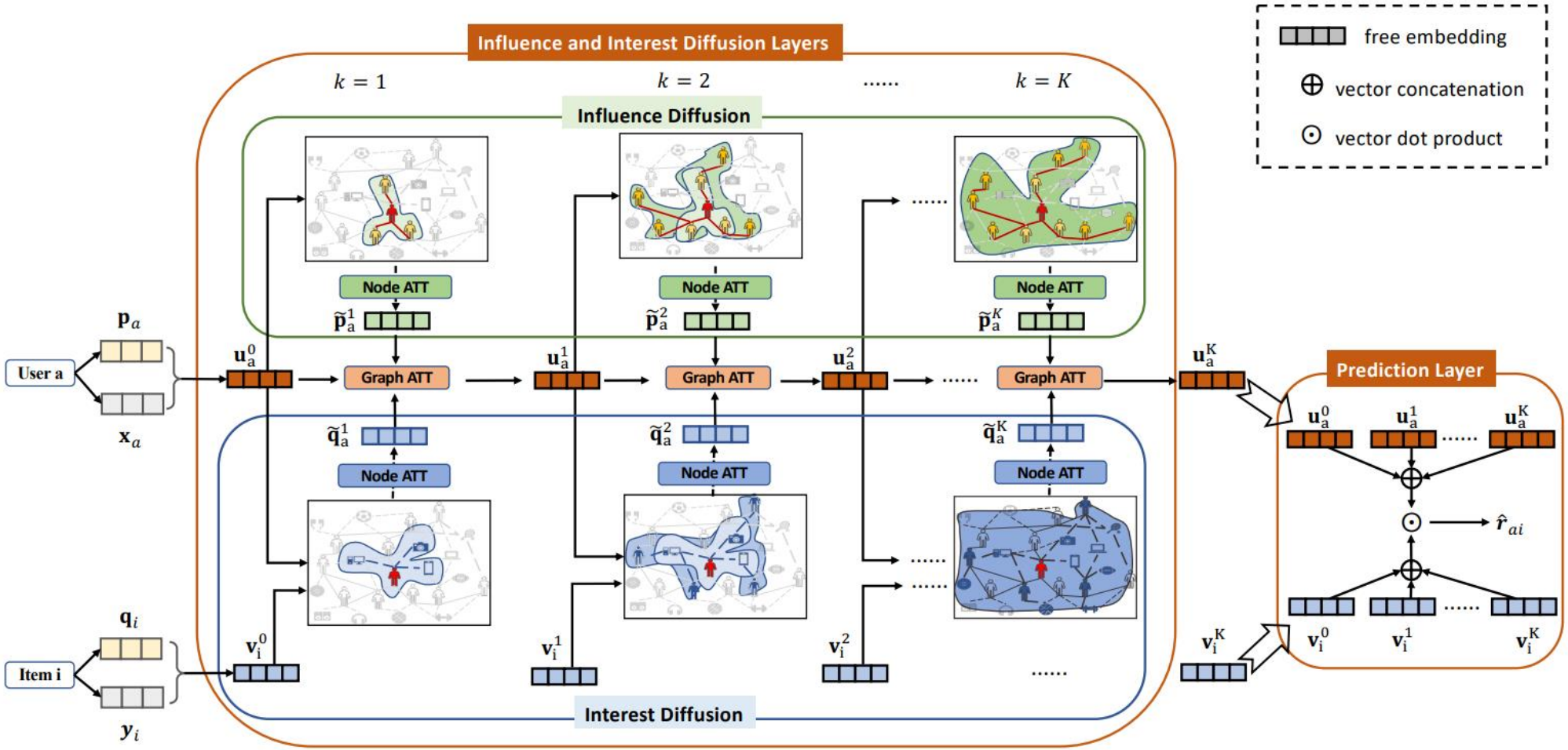



Figure from L. Wu, J. Li, P. Sun, R. Hong, Y. Ge and M. Wang, "DiffNet++: A Neural Influence and Interest Diffusion Network for Social Recommendation," in IEEE Transactions on Knowledge and Data Engineering.

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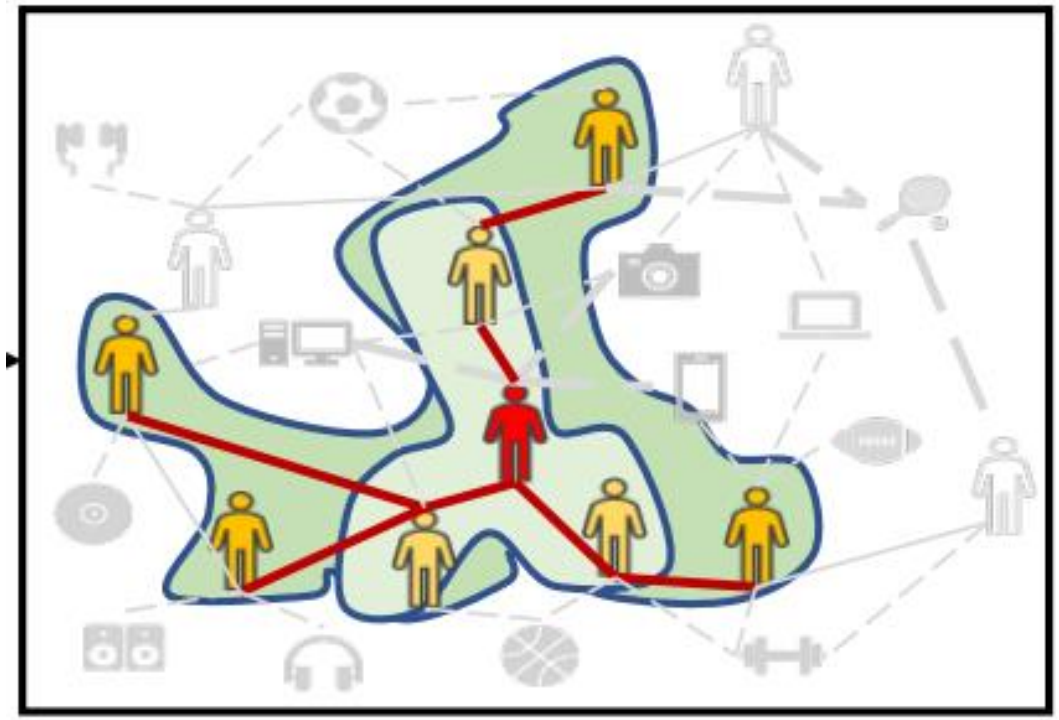
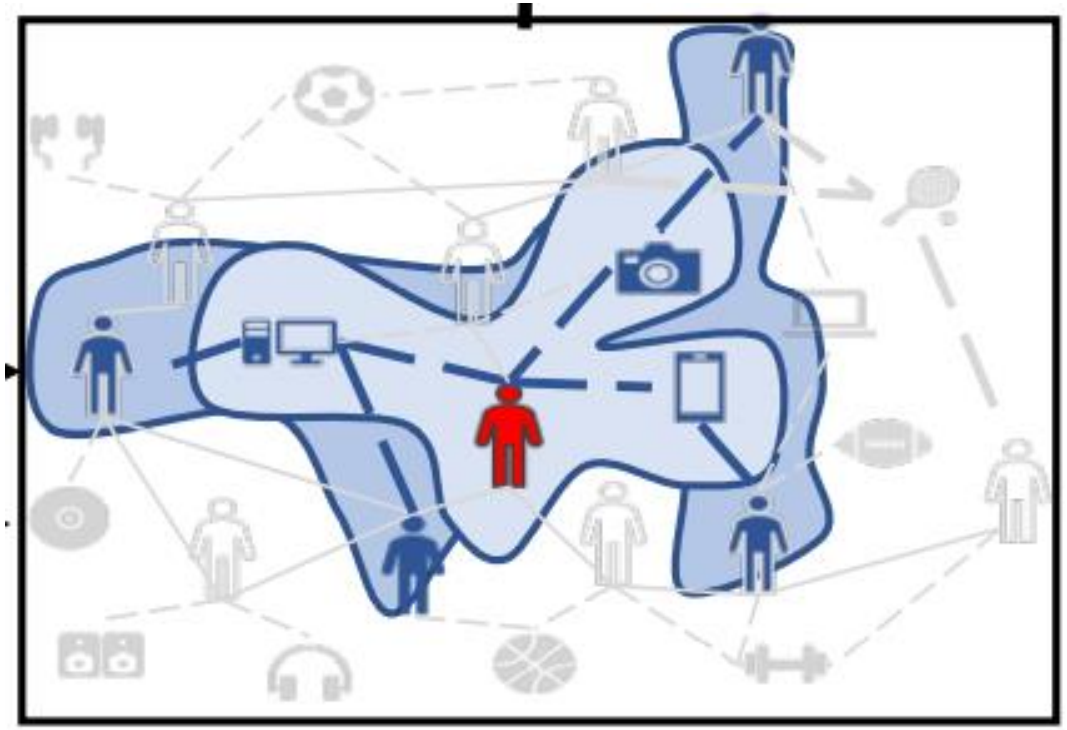


กราฟด้านอิทธิพล

(User-based CF)



กราฟด้านรสนิยม

(Content-based Filtering)

# DiffNet++

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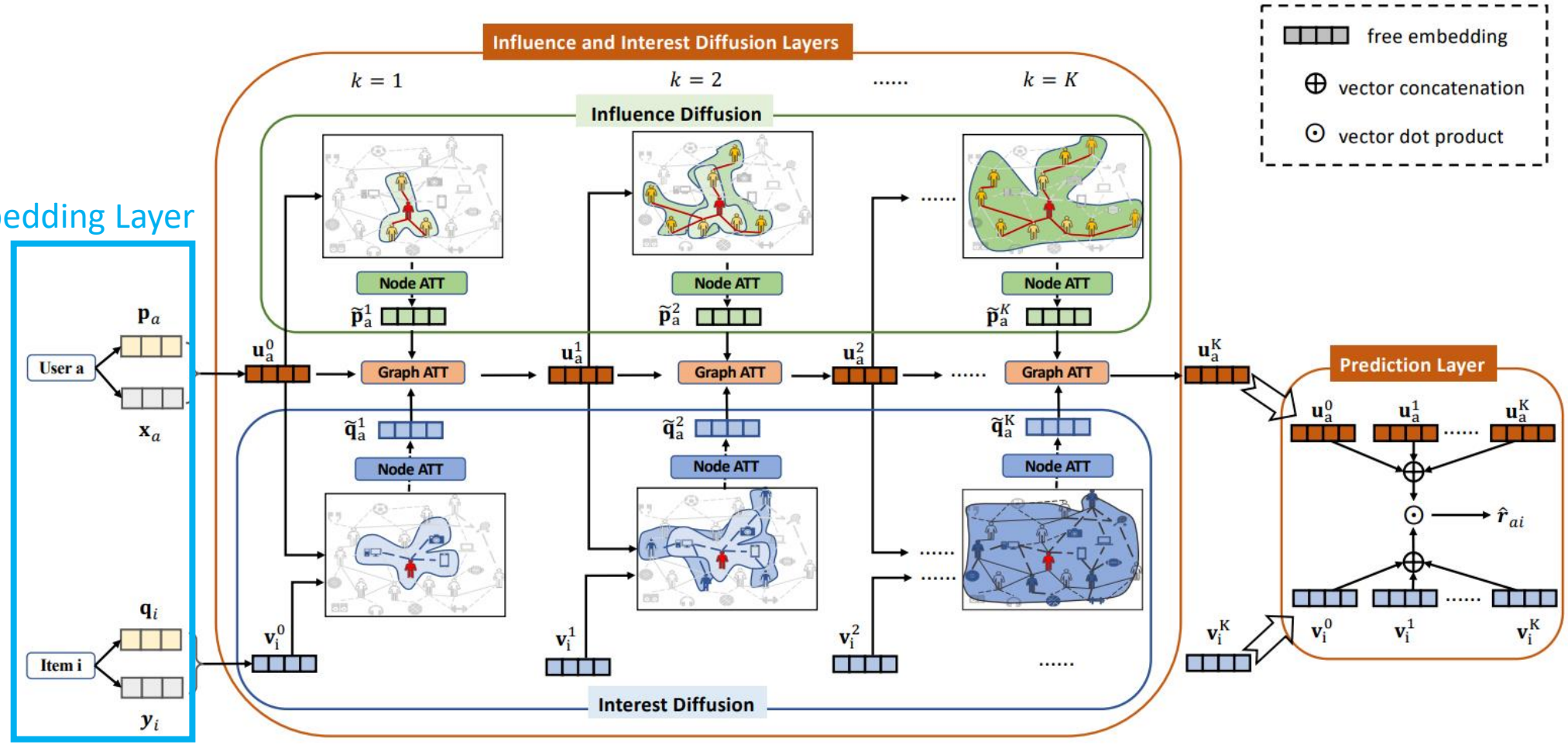


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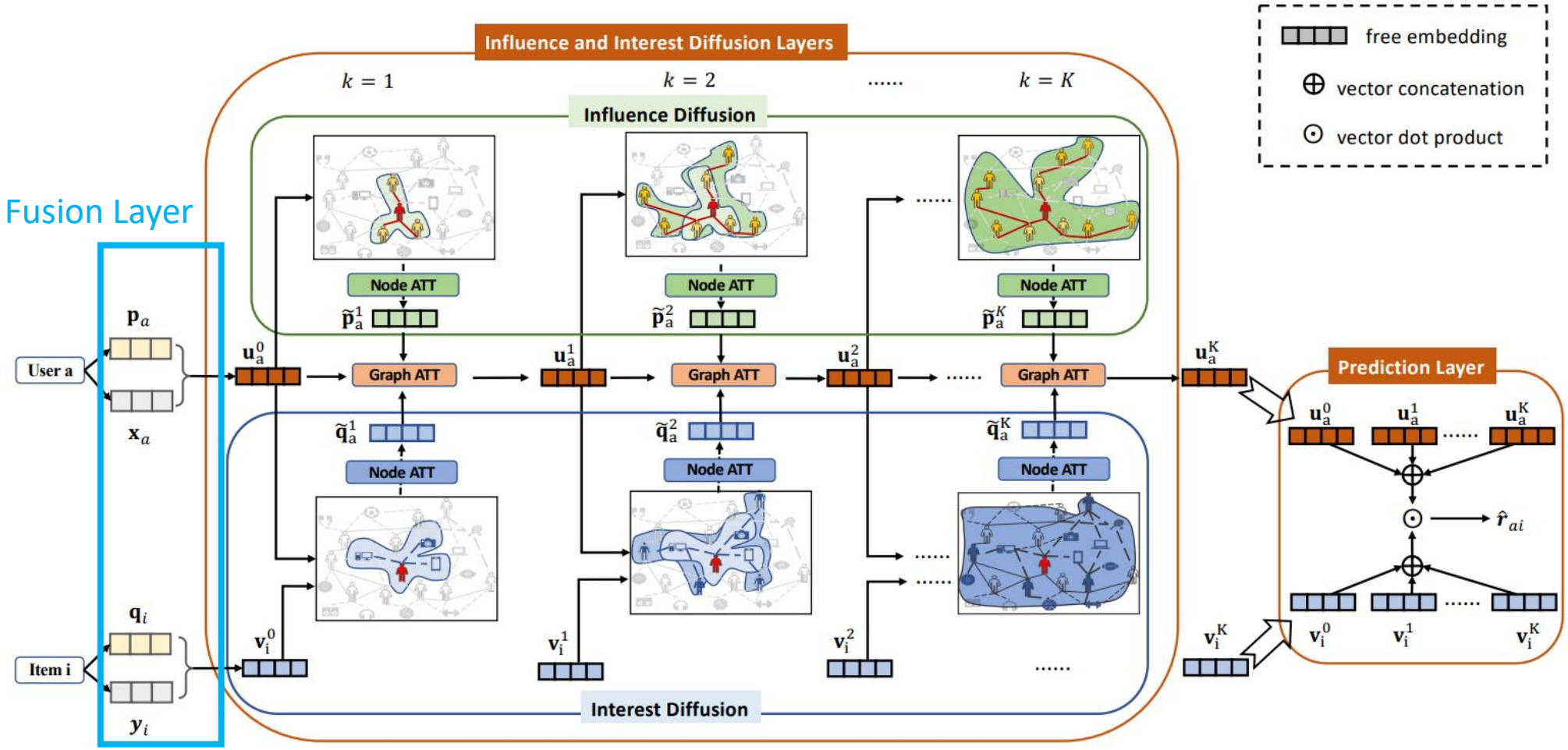


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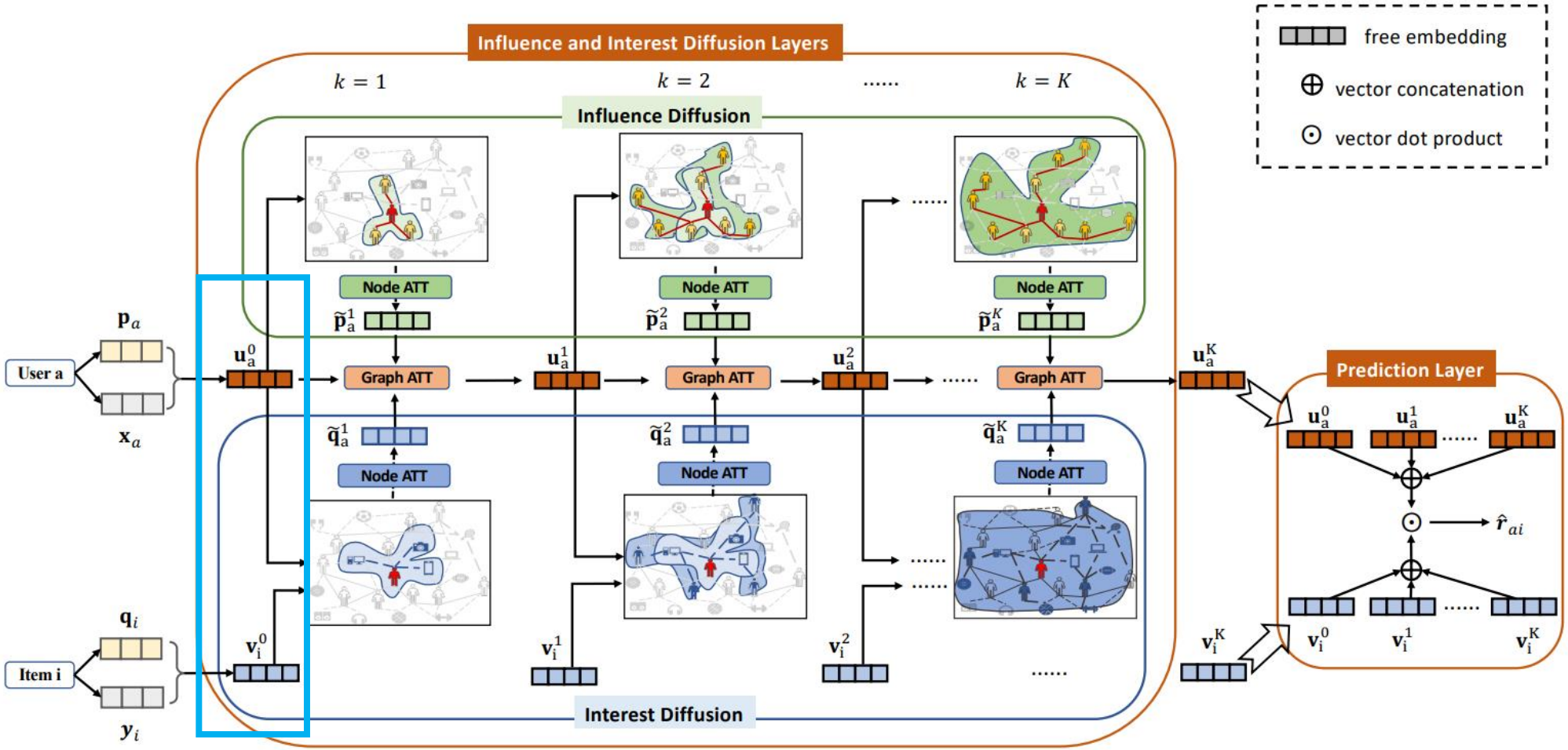


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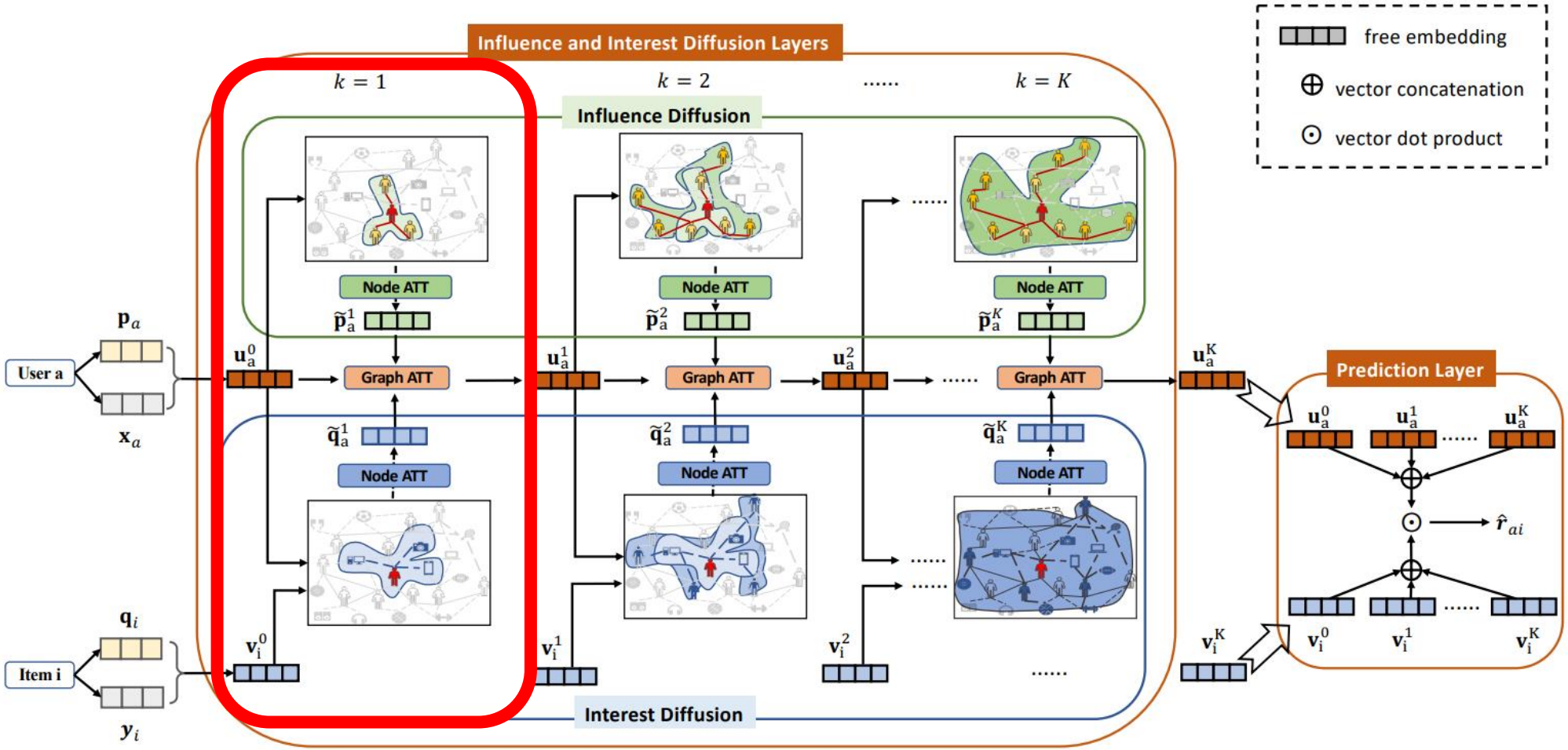


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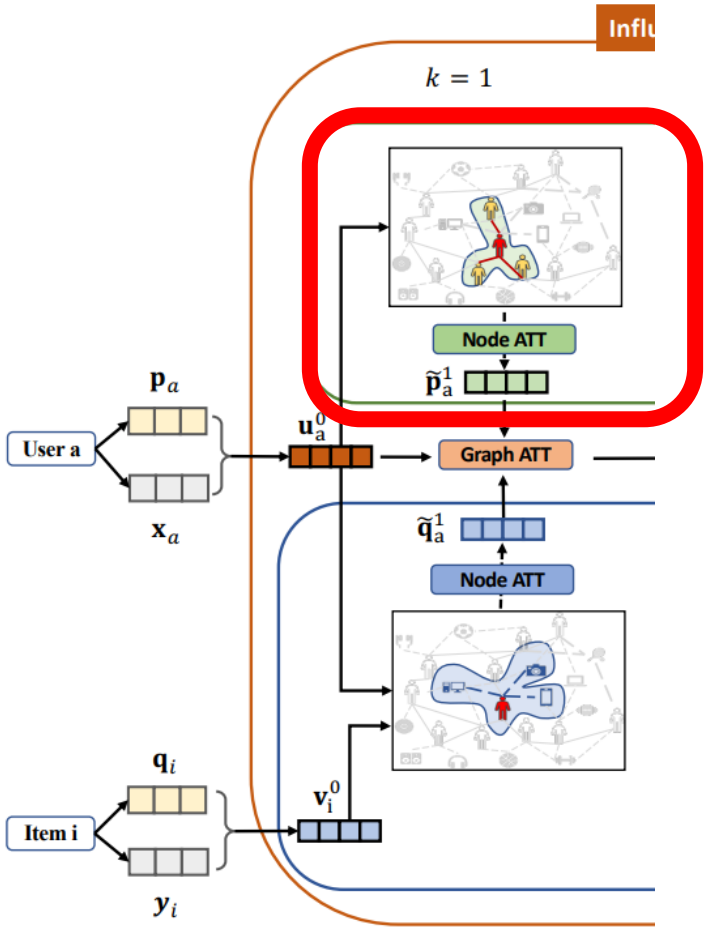



Interest of user a

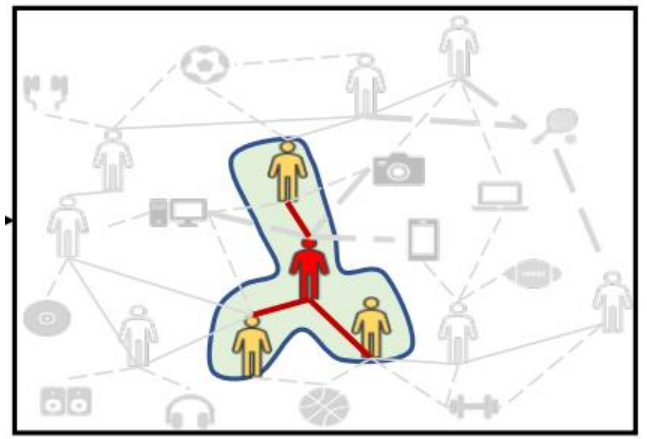
Neighbors influenced to user a

Previous user a embedding

$$\mathbf{u}_a^{k+1} = \mathbf{u}_a^k + (\gamma_{a1}^{k+1}\tilde{\mathbf{p}}_a^{k+1} + \gamma_{a2}^{k+1}\tilde{\mathbf{q}}_a^{k+1})$$

$$\tilde{\mathbf{p}}_a^{k+1} = \sum_{b \in S_a} \alpha_{ab}^{k+1}\mathbf{u}_b^k,$$

Neighbors user



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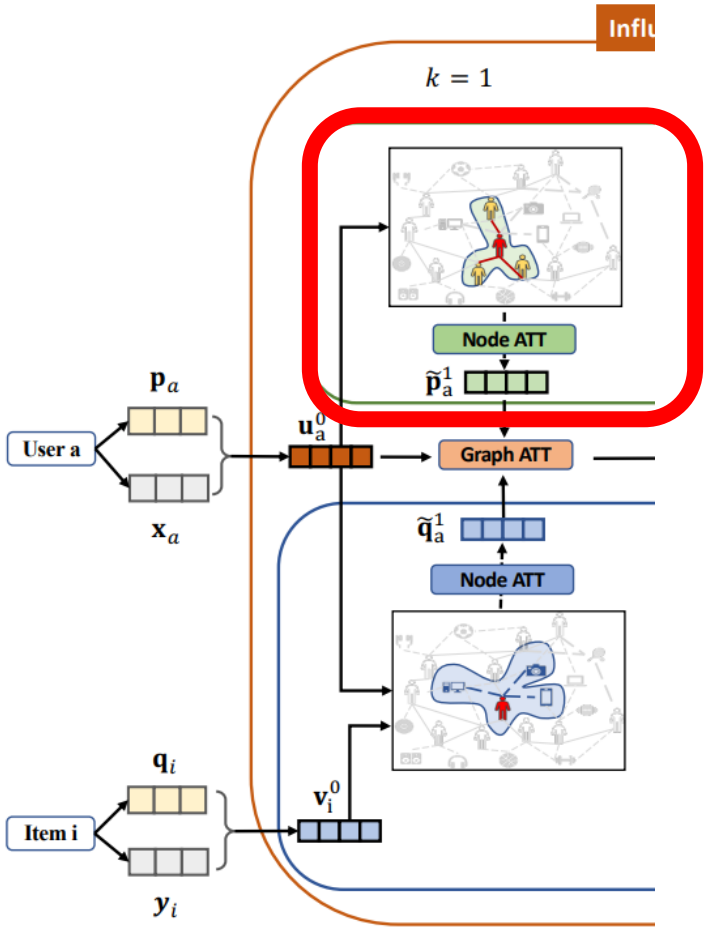
# DiffNet++

## A Neural Influence and Interest Diffusion Network for Social Recommendation




Interest of user a

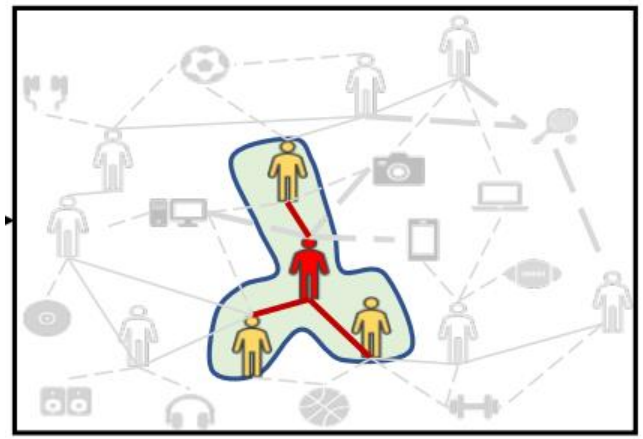
Neighbors influenced to user a

Previous user a embedding

$$\mathbf{u}_a^{k+1} = \mathbf{u}_a^k + (\gamma_{a1}^{k+1}\tilde{\mathbf{p}}_a^{k+1} + \gamma_{a2}^{k+1}\tilde{\mathbf{q}}_a^{k+1})$$

$$\tilde{\mathbf{p}}_a^{k+1} = \sum_{b \in S_a} \alpha_{ab}^{k+1}\mathbf{u}_b^k,$$

Neighbors user



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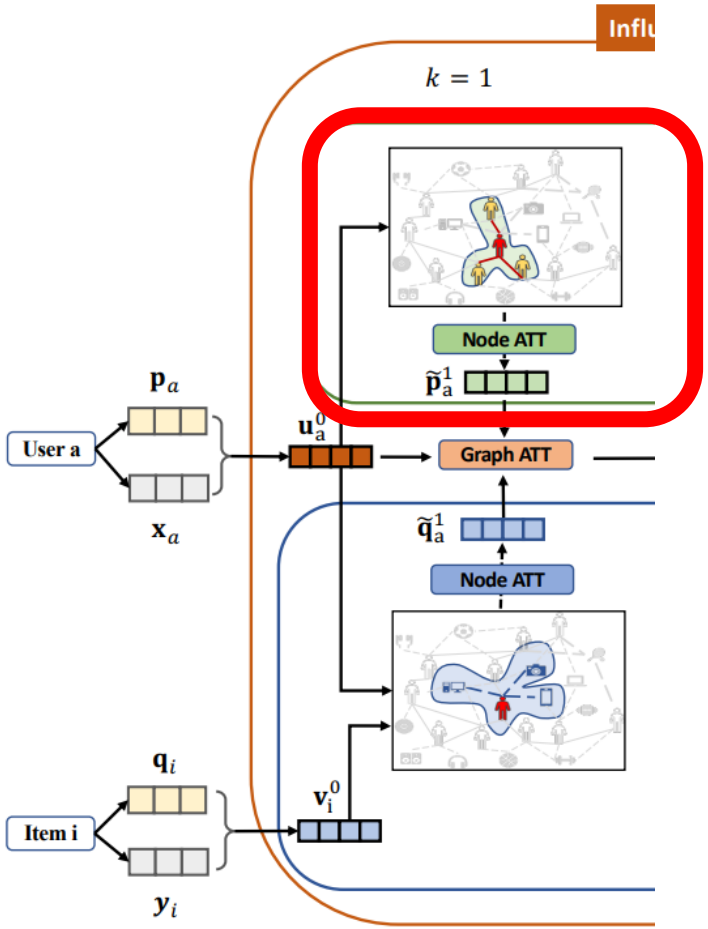


Interest of user a

Neighbors influenced to user a

Previous user a embedding

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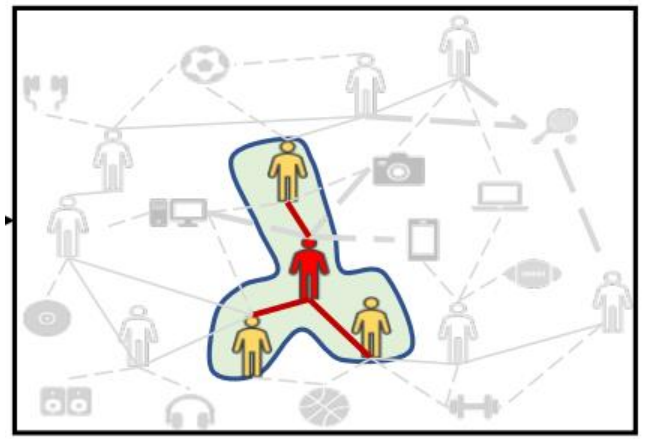
Weighted sum of all users interacted with user a

$$\tilde{\mathbf{p}}_a^{k+1} = \sum_{b \in S_a} \alpha_{ab}^{k+1}\mathbf{u}_b^k,$$

Neighbors user



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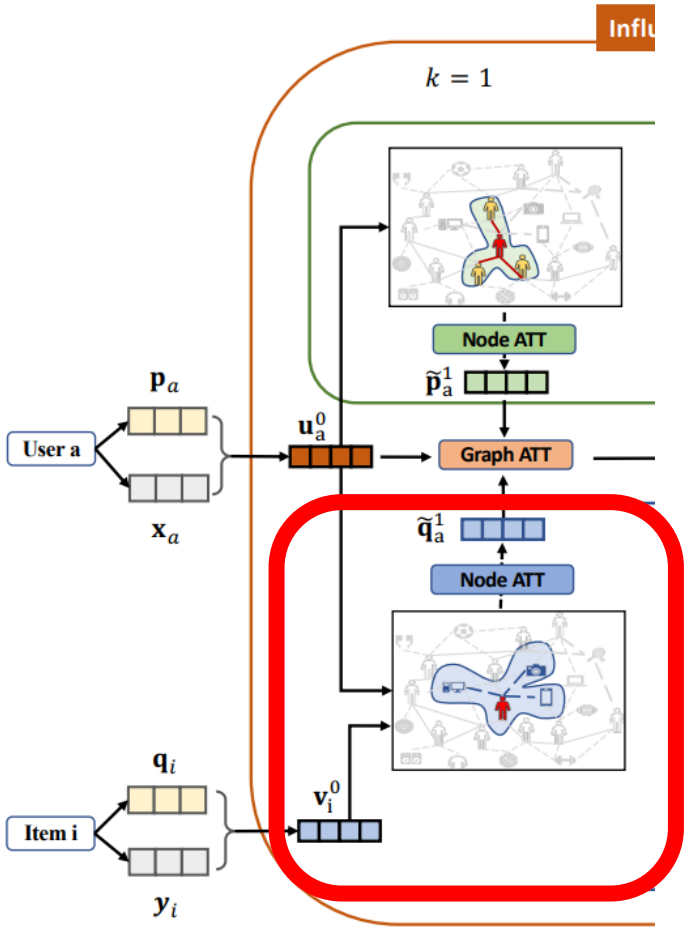


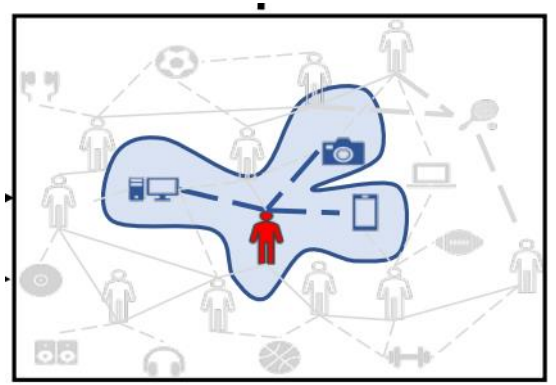

item i's aggregated embedding from its neighbor users

Neighbor users

$$\tilde{\mathbf{v}}_i^{k+1} = AGG_u(\mathbf{u}_a^k, \forall a \in R_i) = \sum_{a \in R_i} \eta_{ia}^{k+1} \mathbf{u}_a^k,$$

aggregation weight

$$\eta_{ia}^{k+1} = MLP_1([\mathbf{v}_i^k, \mathbf{u}_a^k]),$$

$$\mathbf{v}_i^{k+1} = \tilde{\mathbf{v}}_i^{k+1} + \mathbf{v}_i^k,$$

Previous embedding

Weighted sum of all users interacted with item i

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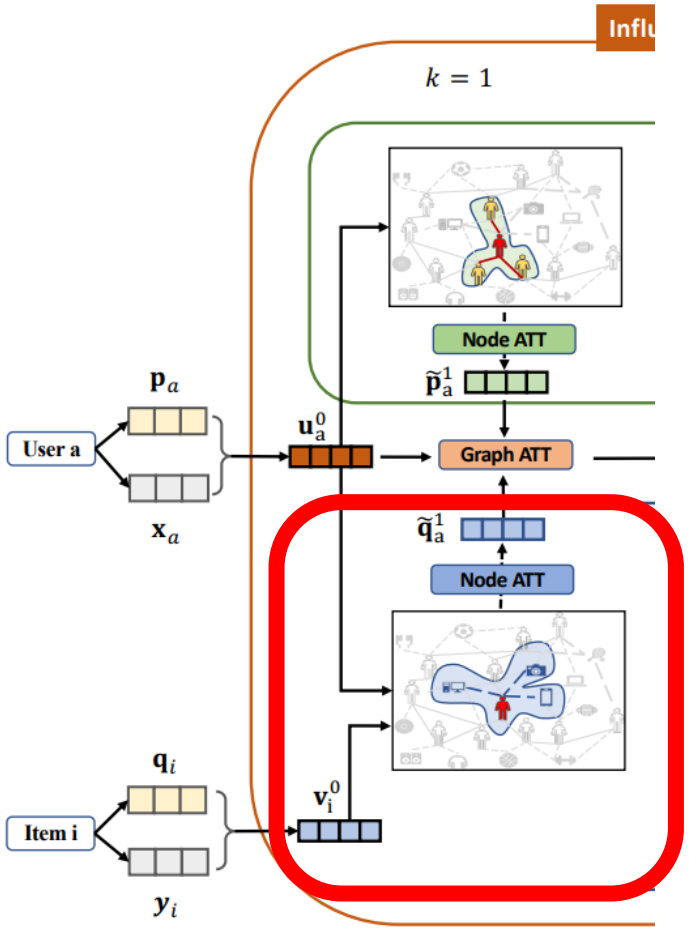


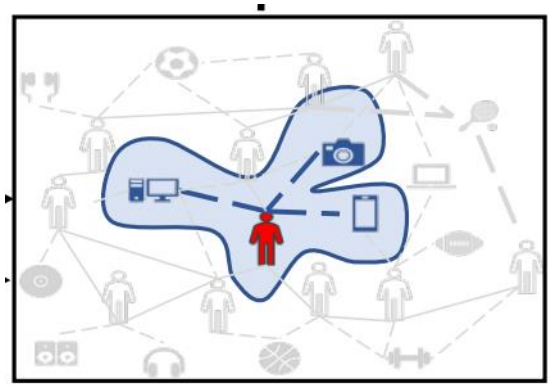

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Previous embedding

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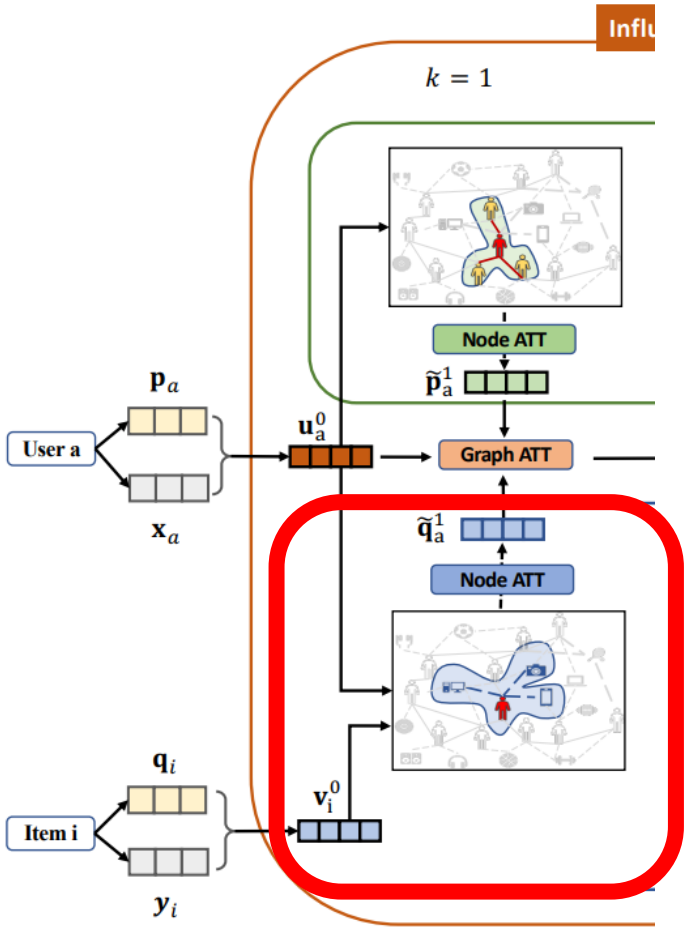
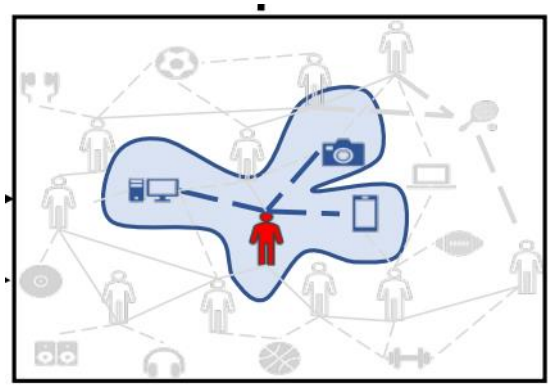



Weighted sum of all items interacted by user a

$$\tilde{\mathbf{q}}_a^{k+1} = \sum_{i \in R_a} \beta_{ai}^{k+1} \mathbf{v}_i^k,$$



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Neighbor users

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Previous embedding

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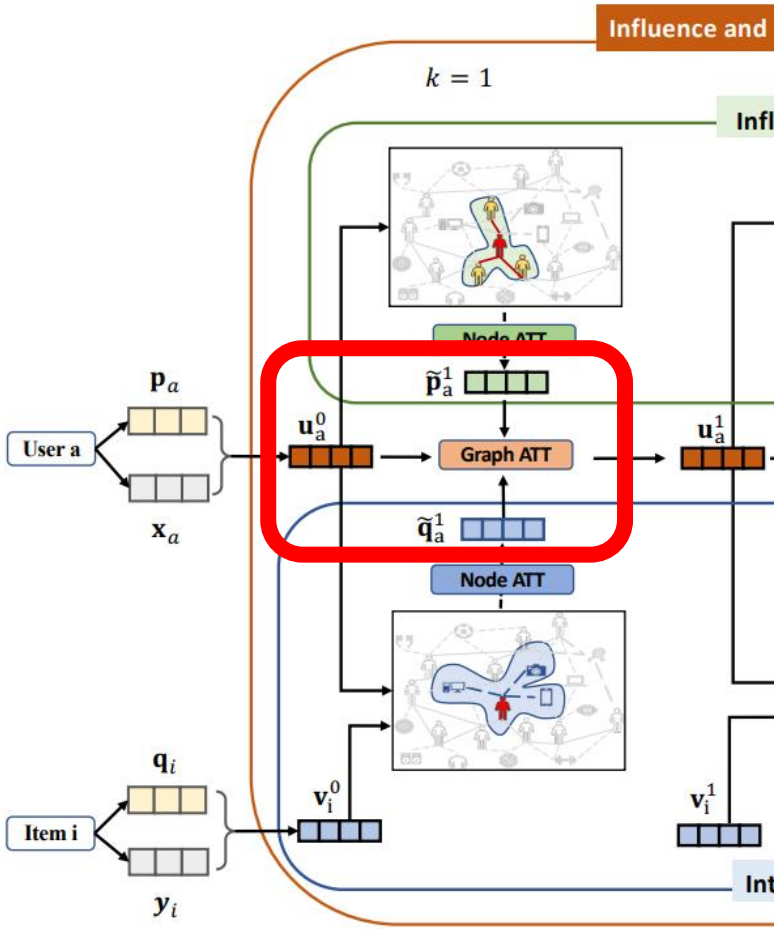


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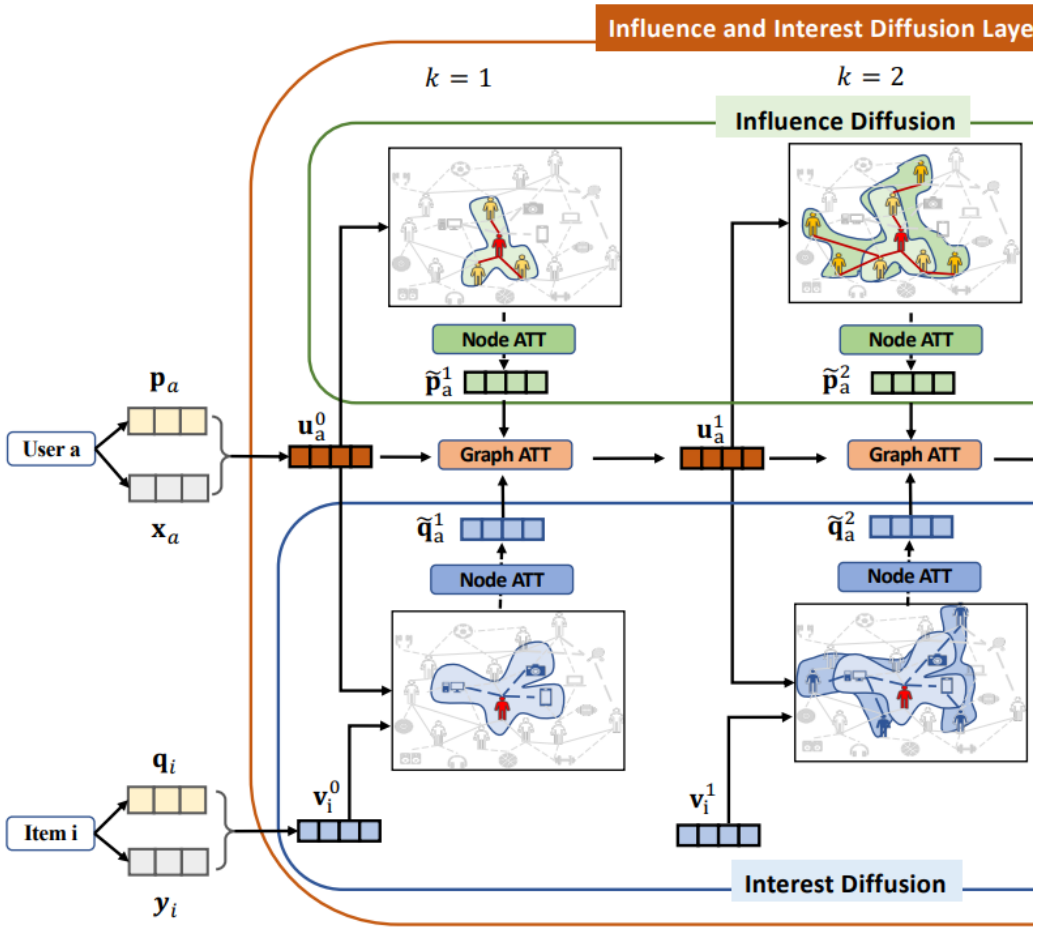


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# DiffNet++

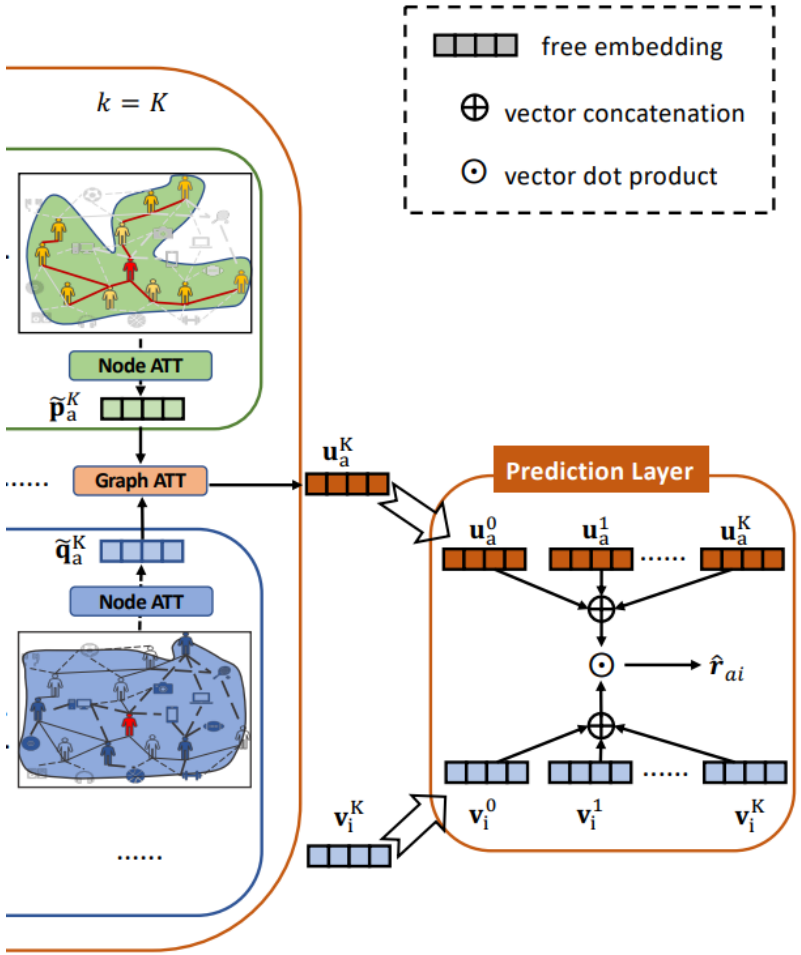
## A Neural Influence and Interest Diffusion Network for Social Recommendation

Rating that user a will be given to item i

Concatenation of item i embedding from every hops

$$\hat{r}_{ai} = [\mathbf{u}_a^0||\mathbf{u}_a^1||...||\mathbf{u}_a^K]^T[\mathbf{v}_i^0||\mathbf{v}_i^1||...||\mathbf{v}_i^K].$$

Concatenation of user a embedding from every hops

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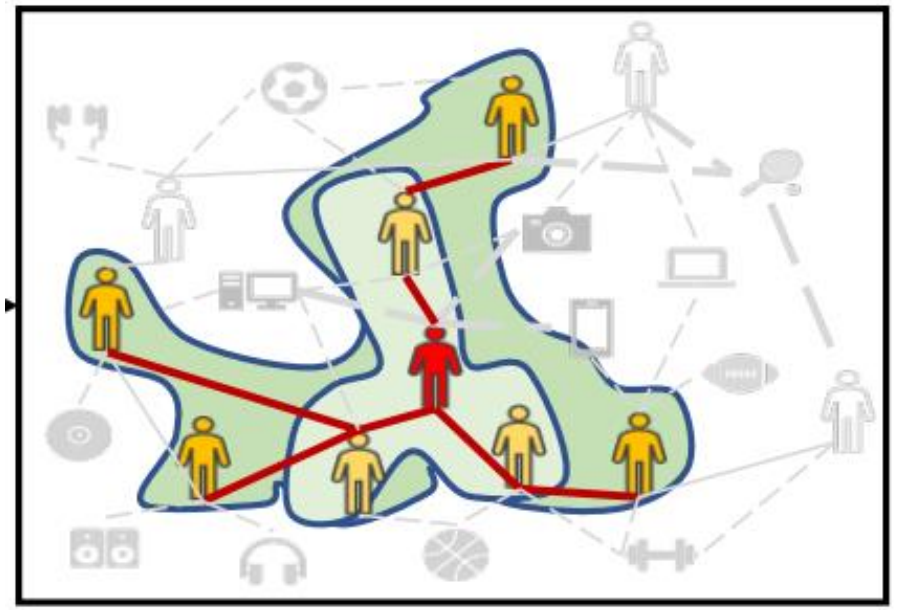
# DiffNet++

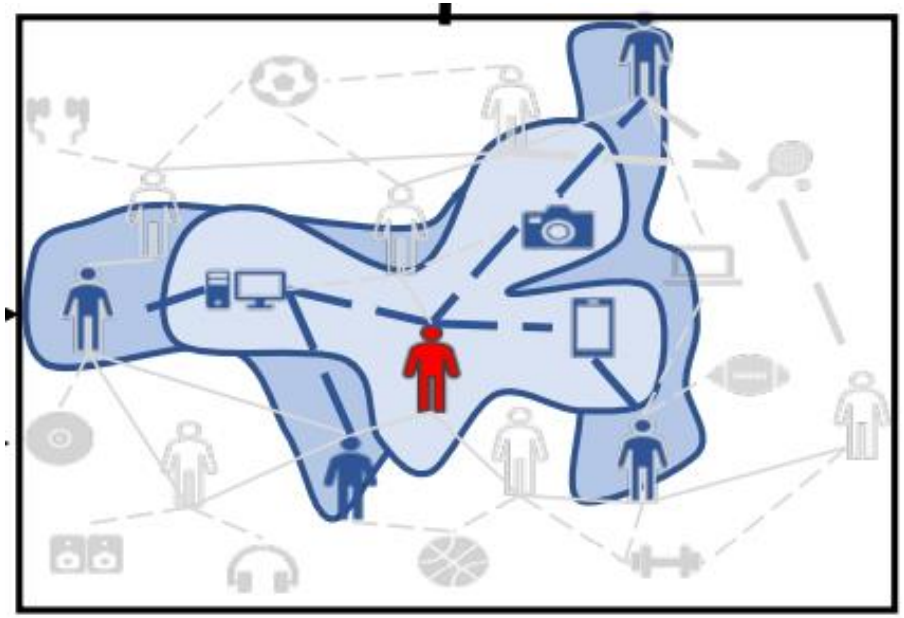
## A Neural Influence and Interest Diffusion Network for Social Recommendation

**ข้อด้อย**

- DiffNet++ มองความสัมพันธ์แต่ละความสัมพันธ์เท่ากัน



ด้านอิทธิพลระหว่างผู้ใช้



ด้านรสนิยมของผู้ใช้

# DiffNet++

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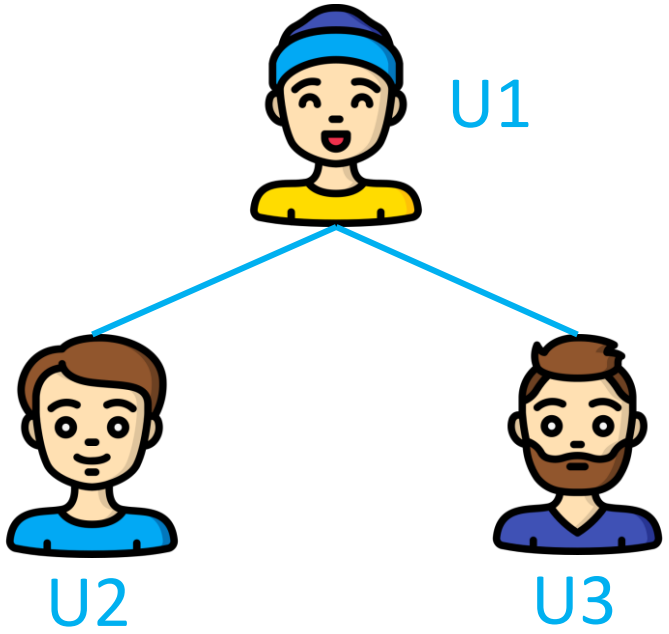

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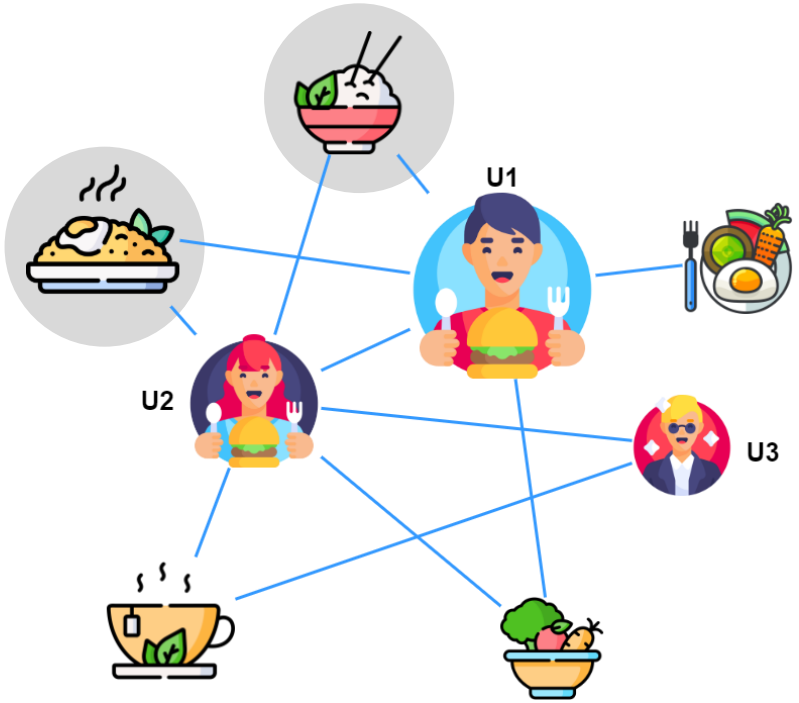
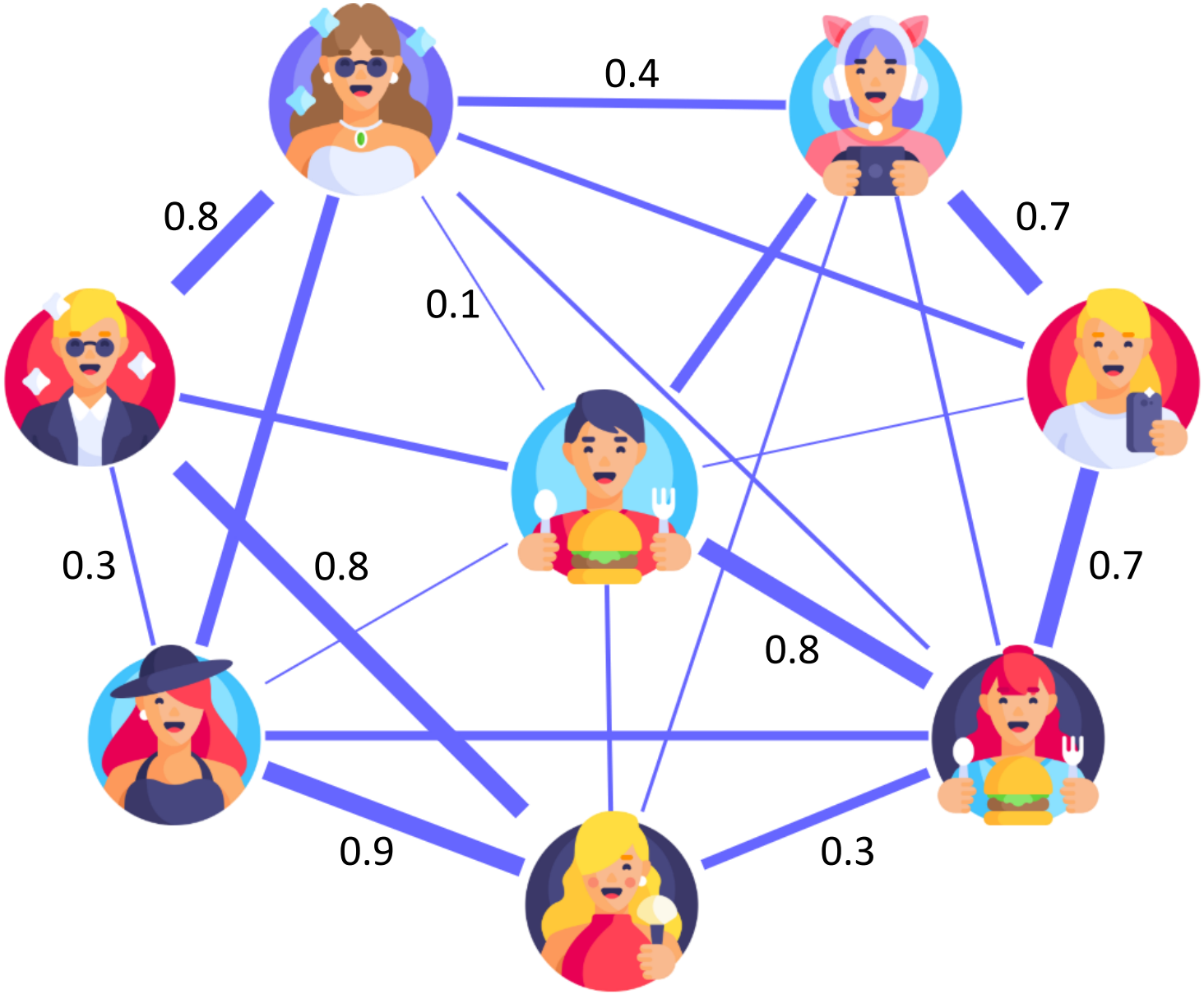



Images by Flaticon

# Weighted Graph



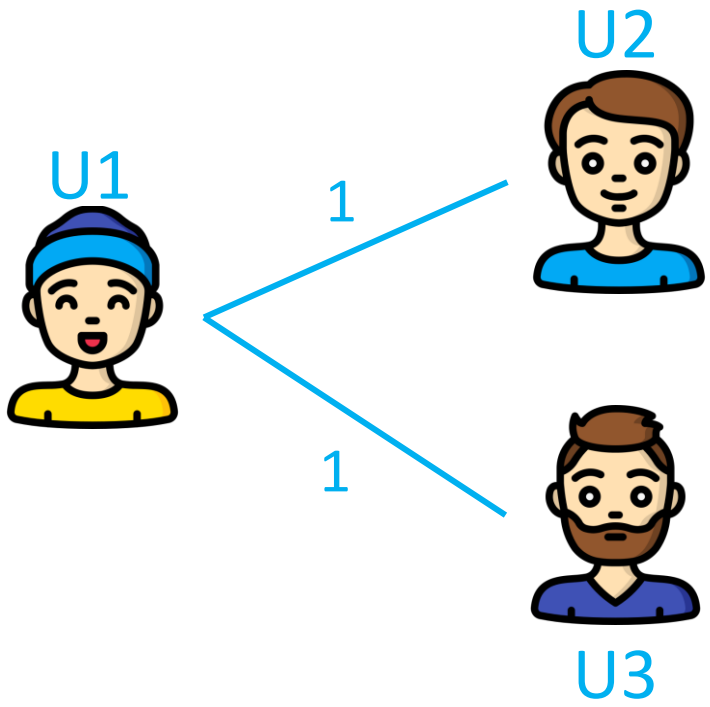

Images by Flaticon

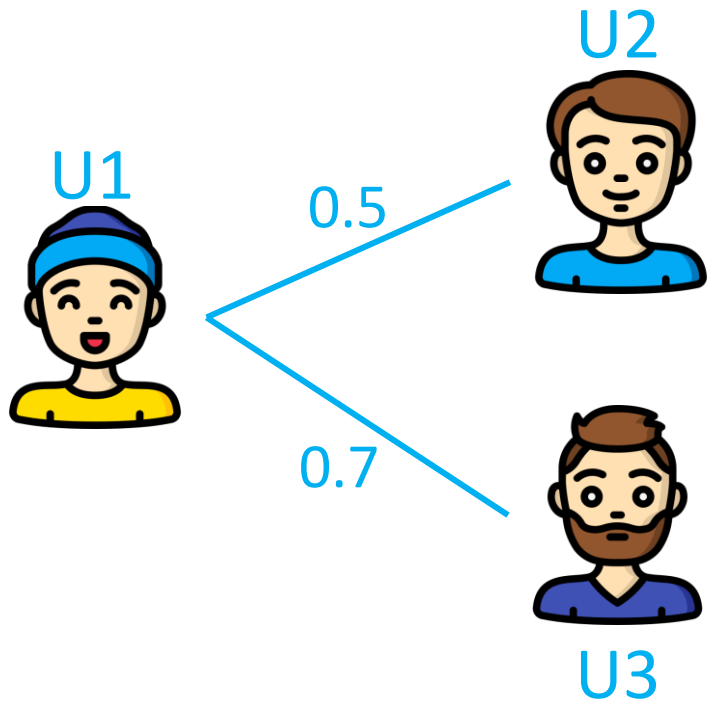
# Weighted Graph

DiffNet++

ด้านอิทธิพล

ความเป็นจริง



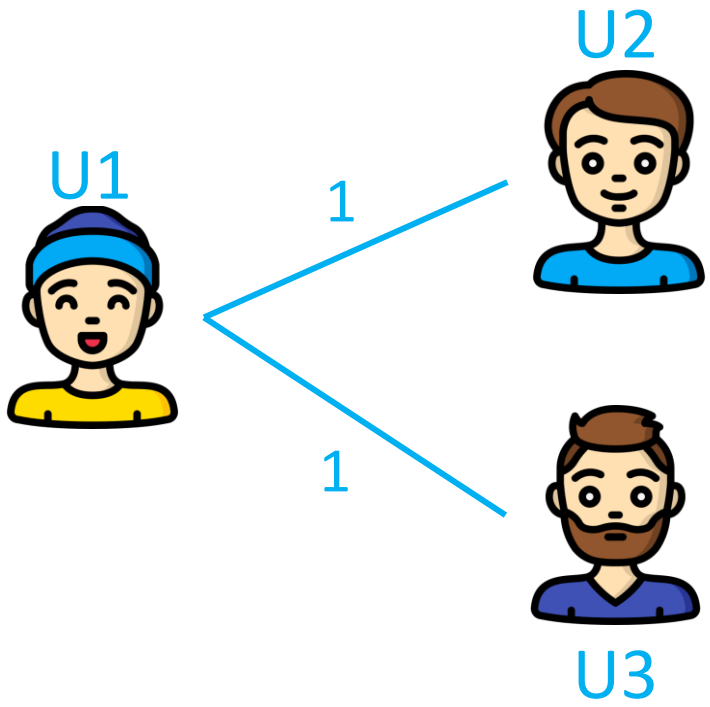



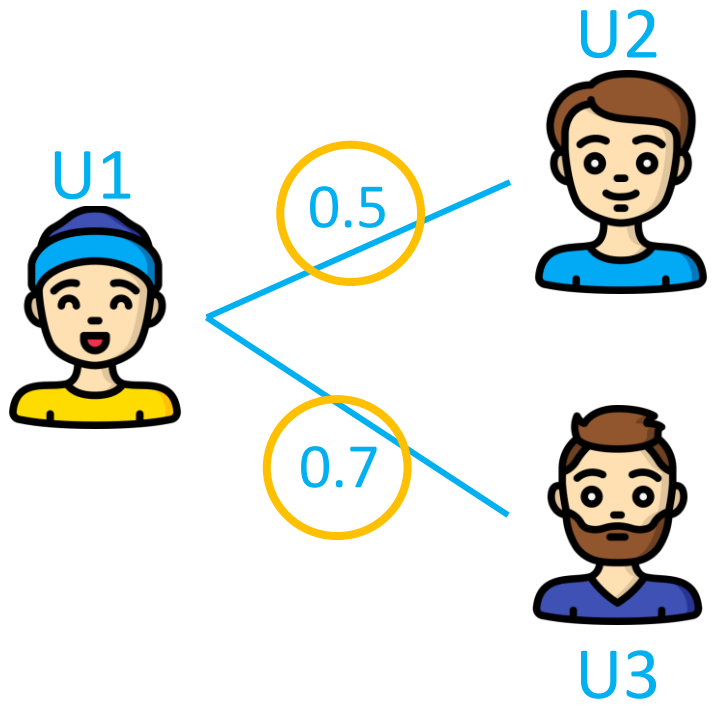
# Weighted Graph

DiffNet++

ด้านอิทธิพล

ความเป็นจริง

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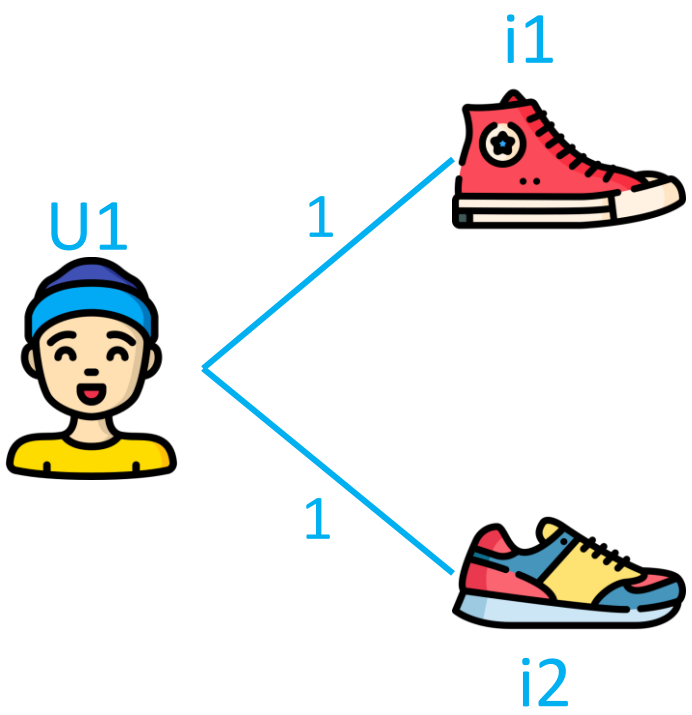
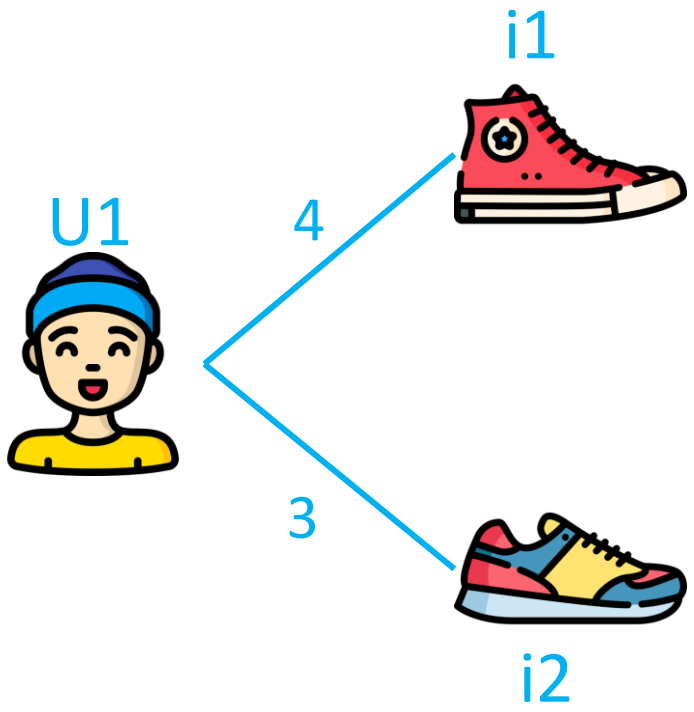
# Weighted Graph

DiffNet++




ด้านรสนิยม

ความเป็นจริง



Background and Rationale

Related Knowledge

**Objective**

Methodology

Result and Conclusion

Images by Flaticon

# Objective

## วัตถุประสงค์

เพื่อเสนอวิธีแนะนำทางสังคมบนพื้นฐานของกราฟแบบถ่วงน้ำหนัก จากแหล่งข้อมูลดังนี้

1. กราฟฝั่งอิทธิพลผู้ใช้ต่อผู้ใช้ โดยจะมีค่าของระดับของความอิทธิพลที่ส่งผลจากผู้ใช้หนึ่งไปยังอีกผู้ใช้หนึ่งเป็นน้ำหนักของเส้นเชื่อมระหว่างผู้ใช้กับผู้ใช้

2. กราฟฝั่งรสนิยมของผู้ใช้ต่อรายการ โดยจะมีค่าที่แสดงถึงระดับของความน่าสนใจที่รายการมีต่อผู้ใช้เปรียบเทียบกับรายการอื่นๆเป็นน้ำหนักของเส้นเชื่อมระหว่างผู้ใช้กับรายการ

# ขอบเขตของโครงงาน

1. เปรียบเทียบกับวิธีการ DiffNet++ บนคลังข้อมูล Yelp เท่านั้น
2. ใช้จำนวนผู้ใช้ไม่ต่ำกว่า 5,000 ผู้ใช้ และรายการไม่ต่ำกว่า 40,000 รายการ
3. การแทนผู้ใช้จะสร้างมาจากกราฟอิทธิพลระหว่างผู้ใช้ และกราฟรสนิยมของผู้ใช้

# ขั้นตอนการดำเนินการ

**ตารางเวลาการดำเนินการ**

| ขั้นตอนการดำเนินการ | ปี 2564 | | | | | ปี 2565 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ส.ค. | ก.ย. | ต.ค. | พ.ย. | ธ.ค. | ม.ค. | ก.พ. | มี.ค. | เม.ย. |
| 1. ศึกษาและค้นคว้าข้อมูลที่เกี่ยวกับระบบ และวิธีแนะนำแบบต่างๆ | ■ | ■ | | | | | | | |
| 2. ศึกษาและค้นคว้าข้อมูลแบบวิธีต่างๆ ที่มีการใช้กราฟ | | ■ | ■ | | | | | | |
| 3. ทำการนำแบบวิธีพื้นฐานมาใช้ | | | ■ | ■ | ■ | | | | |
| 4. ทำการพัฒนาวิธีแนะนำ | | | | | ■ | ■ | ■ | | |
| 5. ทดสอบและวัดประสิทธิภาพของวิธีที่พัฒนา | | | | | | ■ | ■ | ■ | |
| 6. ปรับปรุงวิธีเพื่อเพิ่มประสิทธิภาพ | | | | | | | ■ | ■ | |
| 7. สรุปผลการดำเนินงาน ข้อเสนอแนะ และการจัดทำเอกสาร | | | | | | | | ■ | ■ |

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**Methodology**

Result and Conclusion

# DiffNet++

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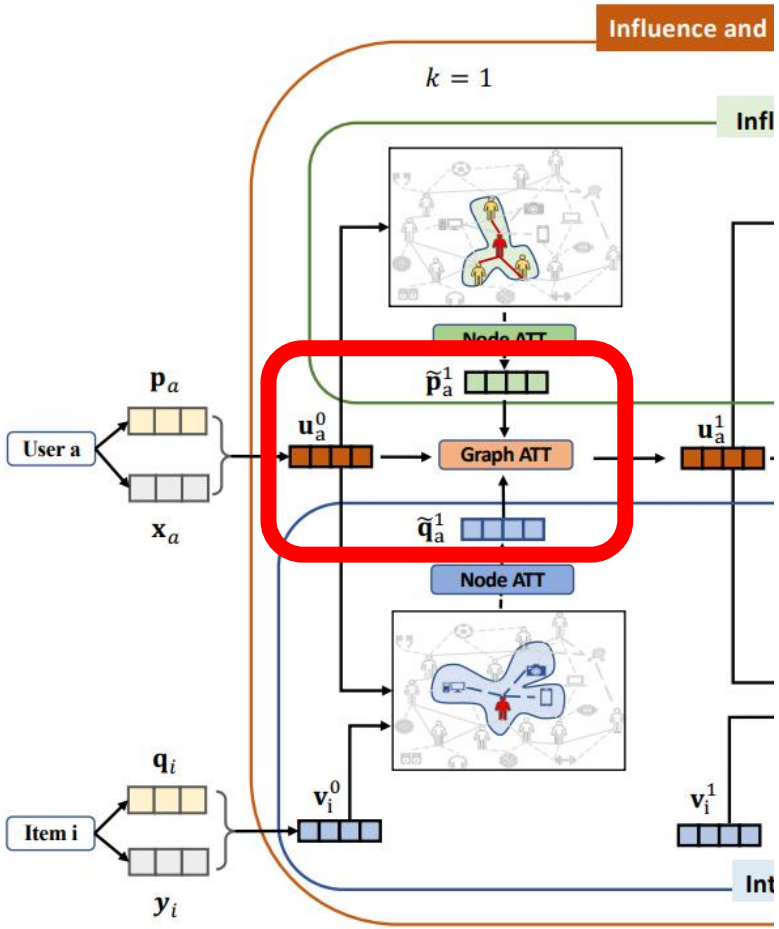


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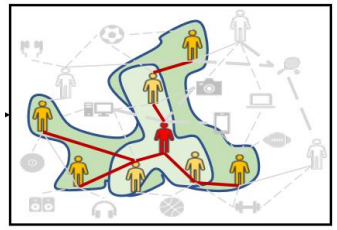
$$\tilde{\mathbf{p}}_a^{k+1} = \sum_{b \in S_a} \alpha_{ab}^{k+1}\mathbf{u}_b^k,$$

← User embedding from social influence graph (user-user)



$$\tilde{\mathbf{q}}_a^{k+1} = \sum_{i \in R_a} \beta_{ai}^{k+1}\mathbf{v}_i^k,$$

← User embedding from item interest graph (user-item)

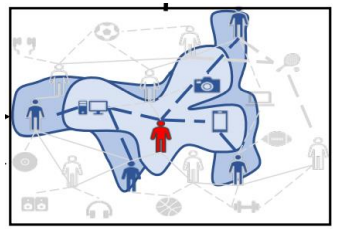


Figure from L. Wu, J. Li, P. Sun, R. Hong, Y. Ge and M. Wang, "DiffNet++: A Neural Influence and Interest Diffusion Network for Social Recommendation," in IEEE Transactions on Knowledge and Data Engineering.

# GCN in DiffNet++ (baseline)

$$H^{[i+1]} = \sigma(W^{[i]} H^{[i]} A^*)$$

Feature representation for layer i+1

Activation Function

Weight

Normalized Adjacency Matrix
A* = DA

$\frac{1}{\#user's\ neighbors}$ →

Example of Degree Matrix (D)

| | | | |
|---|---|---|---|
| 0.16 | 0 | 0 | 0 |
| 0 | 0.11 | 0 | 0 |
| 0 | 0 | 0.02 | 0 |
| 0 | 0 | 0 | 0.21 |

x

Example of Adjacency Matrix (A)

| | | | |
|---|---|---|---|
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |

=

Example of Normalized Adjacency Matrix (A*)

| | | | |
|---|---|---|---|
| 0 | 0.16 | 0 | 0.16 |
| 0.11 | 0 | 0 | 0.11 |
| 0.02 | 0.02 | 0 | 0 |
| 0 | 0.21 | 0.21 | 0 |

# Social Neighbor Embedding (user-user)

$$\tilde{p}_a^{k+1} = \sigma(W^k \tilde{p}_a^k A_1^*)$$

Feature representation for layer k+1 from social influence graph (user-user)

Activation Function

Weight

#user x #user

Weighted Adjacency Matrix

| | | | |
|---|---|---|---|
| 0 | 0.14 | 0 | 0.08 |
| 0.12 | 0 | 0 | 0.15 |
| 0.06 | 0.02 | 0 | 0 |
| 0 | 0.11 | 0.21 | 0 |

$$w_a = \frac{E_a}{\sum_{b \in a's\ neighbors} E_b}$$

#user a's edges

User a's weight

#User a's neighbor edges

$$w_{ab} = \frac{\frac{E_b}{\sum_{c \in b's\ neighbors} E_c}}{\frac{E_a}{\sum_{b \in a's\ neighbors} E_b}} = \frac{w_b}{w_a}$$

# Consumed Item Embedding (user-item)

$$\tilde{q}_a^{k+1} = \sigma(W^k \tilde{q}_a^k A_2^*)$$

Feature representation for layer k+1 from item interest graph (user-item)

Activation Function

Weight

#user x #item

Weighted Adjacency Matrix

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.28 | 0 | 0.18 | 0.11 | 0 | 0 | 0 |
| 0 | 0 | 0.09 | 0.15 | 0 | 0 | 0.06 |
| 0.05 | 0.08 | 0 | 0 | 0.12 | 0 | 0 |
| 0.15 | 0 | 0 | 0.20 | 0 | 0.10 | 0 |

$$w_{ai} = \frac{r_{ai}}{\sum_{k \in R_a} r_{ak}}$$

user a's rating given to item i

Relation weight between user a and item i

Background and Rationale

Related Knowledge

Objective

Methodology

**Result and Conclusion**

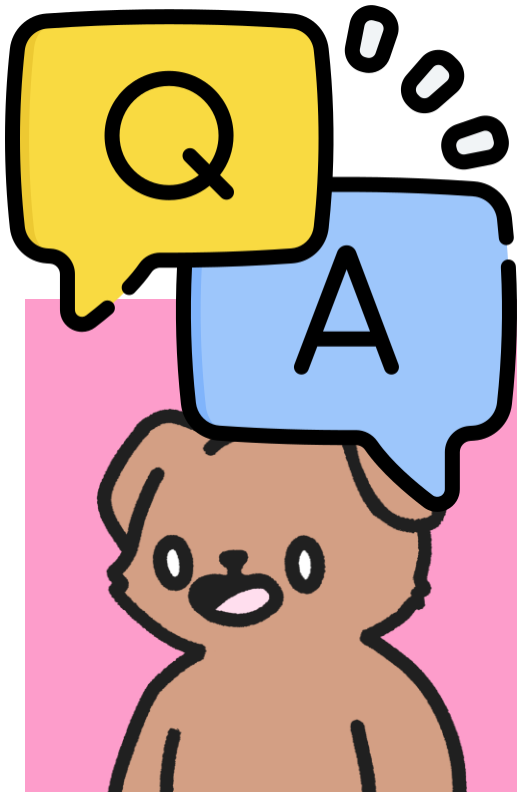
Images by Flaticon

# Result and Conclusion

Comparison between baseline and with weighted graph on Yelp

| Model | Yelp | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | HR (D=64) | | | | NDCG (D=64) | | | |
| | N=5 | N=10 | N=15 | N=30 | N=5 | N=10 | N=15 | N=30 |
| DiffNet++ (baseline) | **0.3781** | 0.4464 | 0.4954 | 0.5912 | 0.3407 | 0.3645 | 0.3806 | 0.4104 |
| DiffNet++ with weighted graph | 0.3771 | **0.4492** | **0.5000** | **0.5936** | **0.3430** | **0.3678** | **0.3844** | **0.4136** |


Images by Flaticon

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