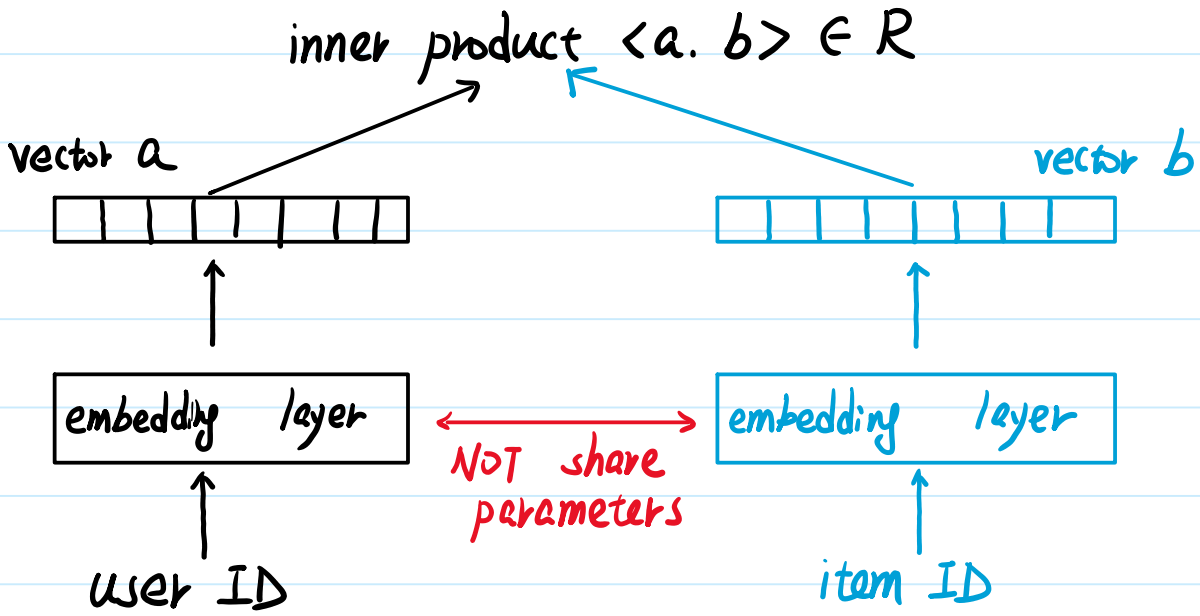
Matrix Completion

Tuesday, February 27, 2024 2:45 PM

Matrix completion model:



Model Training:

① user embedding matrix:

$A = \begin{bmatrix} \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$ u^{-th} column: user u : $\vec{a}_u$

② item embedding matrix:

$B = \begin{bmatrix} \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$ i^{-th} column: item i : $\vec{b}_i$

③ inner product: $\langle \vec{a}_u, \vec{b}_i \rangle$: u's interest on i

④ learn A and B such that $\langle \vec{a}_u, \vec{b}_i \rangle$ is close to actual interest score.

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Dataset:

tuple: (userID, itemID, actual interest score)

Objective:

$$\min_{A,B} \sum_{(u,i,y)\in\Omega} \left(y - \langle \vec{a}_u, \vec{b}_i \rangle\right)^2$$

Intution: why call "matrix completion"?

$$\begin{bmatrix} 0 & 1 & 3 & 4 \\ x & 2 & x & 0 \\ 1 & x & 3 & 0 \end{bmatrix}$$

3 users x 4 items.

missing: user 2 on item 1
user 2 on item 3
user 3 on item 2

learn to fill missing.

limitations:

① pure use userID and itemID; do not use user and item properties

② negative samples are NOT selected correctly

③ training method is NOT good:

③.1 inner product is worse then cosine similarity

③.2 squared error loss is worse than cross entropy. (from regression to classification)

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Offline storage:

① matrix A and B (after training)

② index from userID to its column $\vec{a_u}$ in A

③ index related to B (complicated)

Online inference:

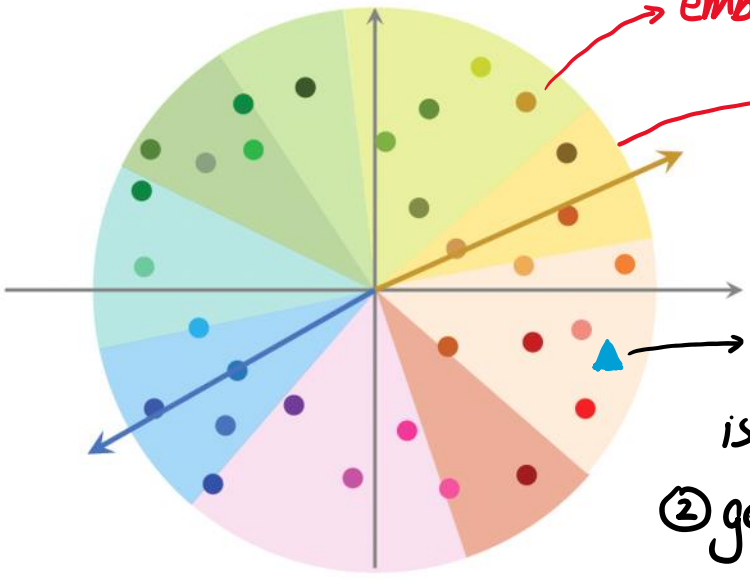
① given user ID. get its embedding vector $\vec{a_u}$

② find top k items by $<\vec{a_u}, \vec{b_i}>$ result ranking

(Not possible to calculate $<\vec{a_u}, \vec{b_i}>$ for each item)

"Approximate" Nearest Neighbor Search:

Example: embedding vector has a dimenson of 2.



(Picture from Shusen Wang on Youtube/Bilibili)