BDA 6-4

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Hello everyone, I am Haiying Che, from Institute of Data Science and knowledge Engineering

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in last session we learned 3 main Recommendation System Algorithms,

User-based filtering, Item-based filtering and Content-Based Filtering, and

in this session we will learn a typical Latent **Factor model, Matrix Factorization.**

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Let’s watch a video “How Recommender Systems Work (NetflixAmazon)

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From the video we know there is hidden patterns in the Rating Matrix,

We want to Find some character the items may have.

And we Decompose the rating matrix into item-character rating & user-character rating.

Moreover, we don’t want to know the meaning of characters. Which is Abstract model, we just suppose the number of characters.

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In linear algebra, the singular value decomposition (SVD) is a factorization of a real or complex matrix.

It generalizes the eigen decomposition of a square normal matrix with an orthonormal eigen basis to any m\*n matrix.

It is related to the polar decomposition.

Specifically, the singular value decomposition of an m\*n complex matrix M is a factorization of the form U,

where UΣV\*, where U is an m\*m complex unitary matrix,

Σ is an m\*n rectangular diagonal matrix with non-negative real numbers on the diagonal,

and V is an n\*n complex unitary matrix.

If M is real, U and V can also be guaranteed to be real orthogonal matrices.

In such contexts, the SVD is often denoted  UΣ(V transpose)

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SVD requires dense matrix, that is the matrix doesn’t have missing values.

Evidently, user-item rating matrix has lots of missing values.

So, use Matrix Decomposition to replace SVD.

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Decompose the matrix into two matrix, that is , where is user-item rating matrix, is user-LF(Latent factor ) matrix, and is item-LF(Latent factor ) matrix.

For u-user and i-item, their rating is:

If get two dense matrix , from we can predict the missing value in .

So how to calculate ?

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Define cost function as showed in the formula, and use the cost function to evaluate the better choice of P and Q. We only calculate cost function with the already given rating values by the users.

The first part in the cost function is the MSE of the predict rating value Rui hat and true value Rui.

And the second part in the cost function is regular value, which prevent overfitting.

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We do the iteration to minimize the cost function.

Two ways to minimize cost function:

1) using ALS (Alternating Least Square) to minimize cost function :which means fix P, compute Q to make c min; then, fix Q, compute P to make c min;

End until reach max iteration or c satisfies threshold condition.

Compute partial derivative of C with respect to Pu, and make the formula equals to 0, get .

Similarly get .

2) using Gradient Descent to minimize cost function, which means Compute partial derivative of C with respect to Pu

and partial derivative of C with respect to Qi.

then Do Iteration using the formula in the slide (where is step size)

After each iteration, the Pu and Qi are updated until the end, until reach max iteration or c satisfies threshold condition.

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To understand the recommendation system, A series of experiments were designed,

it includes User-based filtering recommendation and Matrix Decomposition.

In User-based filtering recommendation, it consist preprocessing and Collaborative Filtering.

In 1.1 preprocessing, it includes load the data and relate the two original tables, and create a new data.csv file, and make a dictionary by deleting the duplicate records.

In 1.2 Collaborative Filtering, first compute the user similarity, and then list top 10 similar users to the current user, and make the recommendation.

For matrix decomposition experiment, we need import the library surprise, the used data set includes 100,000 user’s ratings on movies.

The related models include Funk or Bias SVD, Grid Search for training.

The goal is to Train and test on the best model and Get the best parameters for SVD,

The process will be

1）Import library

2）import data

3）Grid search SVD training

4）Use the best parameters obtained by grid search for raining and prediction

And finally visualize the Result.

All the experiments material including the manual and codes are provided on the platform, which can help you to do the hands-on.

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In this session, we learned a typical Latent Factor model, Matrix Factorization.

thank you for your attention, if you have any question, feel free to contact me.