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COURSE RECOMMENDER SYSTEM

Final Project Report submitted in partial fulfillment of the requirements of the Degree of Bachelor of Science in Computer Science

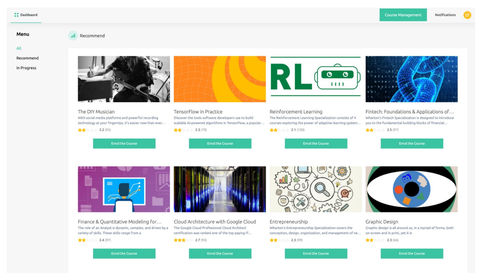
INTRODUCE

We now live in an era of information explosion, and online studying is becoming an essential part. We aim to build an e-learning system with a recommender system. Thus recommender systems are playing an important role in getting the user's attention in recent years; Especially, recommender systems are successfully applied in many applications like Netflix and Amazon and primarily used in recommending a product or item in which users may be interested.

We use hybrid techniques to implement the hybrid recommender system to extract the information and recommend courses. The hybrid recommender system is combining Matrix Factorisation, and Bayesian average algorithms can make a recommendation with ranking popularity and personalized items.

Objectives

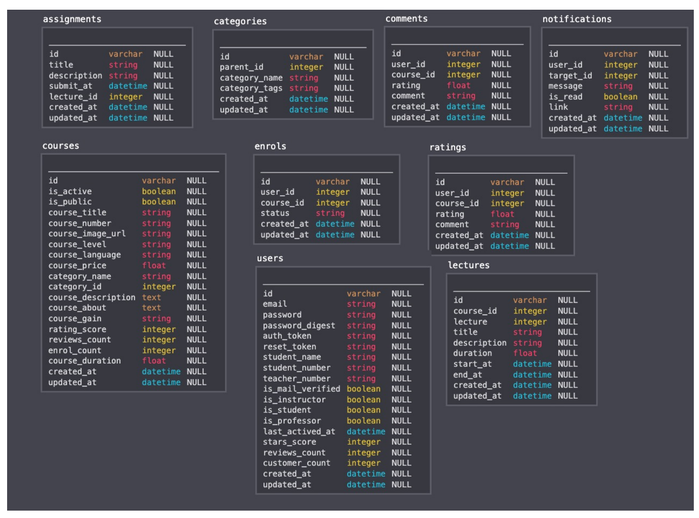
The general goal is to build an online studying application with APIs. The application allows users to create accounts and interact with the course and will show personalised recommendations to users in which users would be interested.



Recommender System

The primary objective is to implement a course recommender system is to provide a comfortable and user-friendly interface where students can see the recommendation and choose an attractive course. We have devised our course recommender system with the hybrid recommender system, which is involving objective functions of matrix factorisation, k-Nearest Neighbours, singular value decomposition, popularity algorithm, correlation thresholding, and also explored neural network for collaborative filtering.

Database

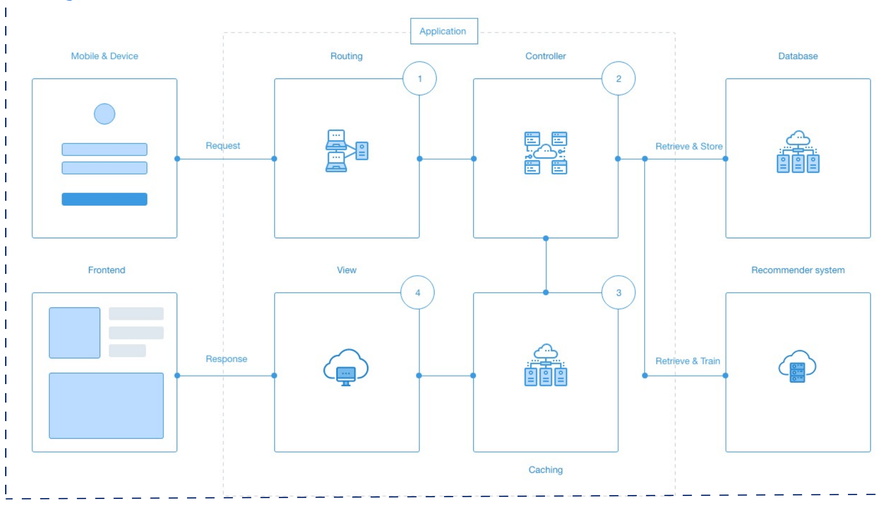


ACKNOWLEDGEMENTS

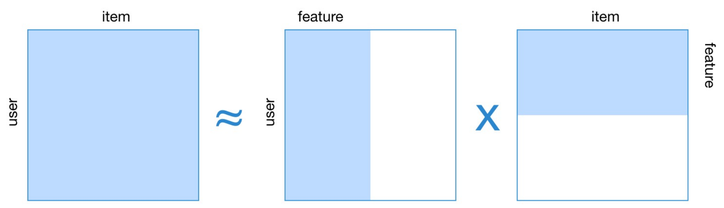
I would like to express my sincere gratitude to my Academic Supervisor Prof. Yuan Wu, for providing their invaluable guidance, comments, and suggestion in this project.

In the idea decision stage, we have a common meeting with Prof. Yuan Wu to ask his professional opinions. Prof. Yuan Wu has sent a lot of material which can rich our idea. I feel thankful for Prof. Yuan Wu helping.

System Architecture



Matrix Factorisation (MF) models



The basic idea behind matrix factorisation is to find a matrix R by multiplied together between two matrices X and Y. It is intuitive and straightforward for finding the hidden structure behind the information with machine learning methods. MF is to discover latent features between two embeddings (user and item features) through user-item matrix decomposition and dimensionality reduction from a high level of massive sparsity. However, there is a particular class of problems that caused in reducing and decomposing a large matrix. To solve it, Singular Value Decomposition and Principal Component Analysis are well-known models for applying in Matrix Factorisation. Both two methods are excellent flexibility and scalability and can identify latent factors in the field of information retrieval.

Singular Value Decomposition (SVD)

SVD decomposes a massive matrix into a lower-dimensional feature space, exposing the original matrix's valuable properties. The basic idea of SVD is to factorize matrix R into three other matrices. For example: Let the matrix R as an input, and it gives you M, Σ, and U where R is equal to the product. Both matrices M and U are orthogonal, and matrix Σ is diagonal.

$$R = M\Sigma U^T$$

Error function

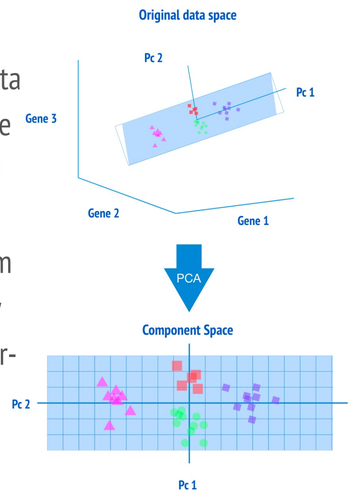
For predicting unknown ratings with reasonable accuracy, the model is computing by fitting the previously observed rating matrix until the model can get a lower error value e by subtracting the original rating value by the dot product. Also, the system should control the extend of regularization to avoid overfitting by regularizing the learned parameters λ.

$$\min_{q^*,p^*} \sum_{(u,i)\in K} (r_{ui} - q_i^T p_u)^2 + \lambda(\|q_i\|^2 + \|p_u\|^2)$$

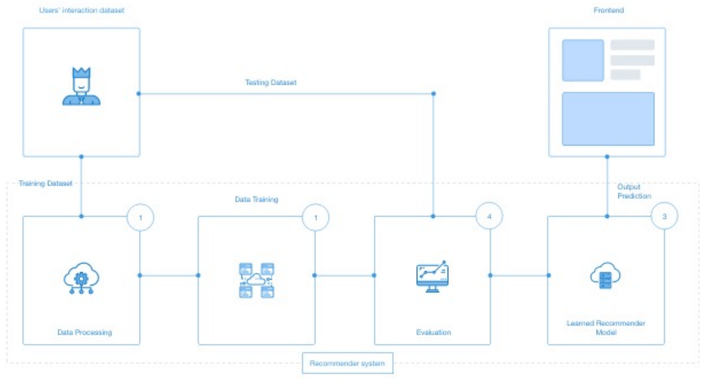
Principal component analysis (PCA)

PCA is a statistical technique used in the dimensionality reduction approach. An orthogonal transformation to transform a set of observations of correlated variables into values through several linear combinations without losing original properties.

In this transformation, a linear projection of high dimensional data into a lower-dimensional subspace with maximized variance retained and minimized the least-square reconstruction error. Its central aim is to overcome the dimensionality of the problem and output a lower-dimensional matrix suitable for calculation.

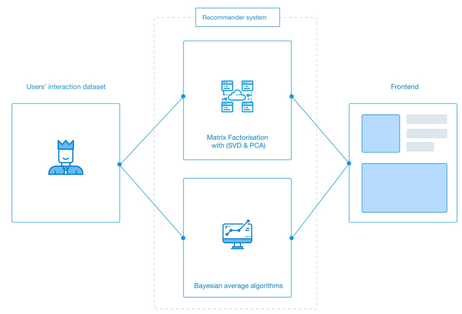


Architecture



Hybrid implementation

The recommender systems derive the user preferences from analysing the implicit and explicit features regarding users' demographic information and the properties of items. The hybrid recommending is combining Bayesian average algorithms and MF models. Bayesian average algorithm is used to calculate the popularity weighted. We can rank the weighted to suggest a new user which solve the cold-start problem. After the new user interacts on the platform, we can use MF models to learn the user's performance and behaviour and make a high accuracy recommendation.



Evaluation

Statistical Accuracy Metrics

Mean Absolute Error (MAE)

$$|\bar{E}| = \frac{\sum_{i=1}^{n}|y_i - x_i|}{n}$$

Root Mean Absolute Error (RMAE)

$$\left|\sqrt{\bar{E}^2}\right| = \sqrt{|\bar{E}^2|} = \sqrt{\frac{\sum_{i=1}^{n}|y_i - x_i|^2}{n}}$$

Decision Support Accuracy Metrics

Precision

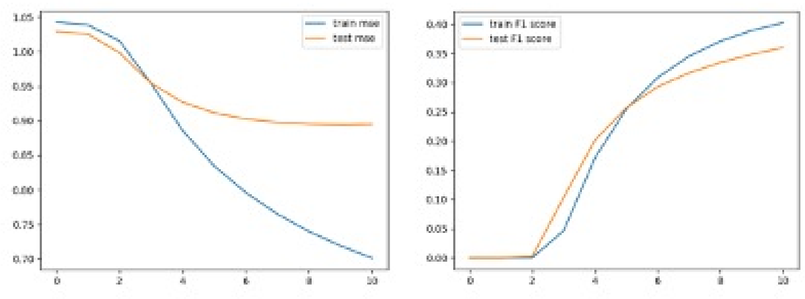
$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive} = \frac{True\ Positive}{Actual\ Results}$$

Recall

$$Recall = \frac{True\ Positive}{True\ Positive + False\ Negative} = \frac{True\ Positive}{Predicted\ Results}$$

F1 Score

$$F1\ Score = 2 * \frac{Precision * Recall}{Precision + Recall}$$



MAE decreases significantly as the number of epochs increases. The more we iterate, the result gets better. Also, F1 score gets higher. F1 score is defined as the harmonic mean.

Conclusion

In this project, we successfully implemented an online course platform with a hybrid recommender system that employed matrix factorisation (MF) and bayesian average algorithms. We choose to use Ruby on Rails to develop the web application.

Although the result is as good as we expect, we wish to employ the recurrent neural network (RNN) successfully in our recommender system in future work. In addition, we want to build an automatic workflow with the data distribution system which can handle the schedule jobs and automatically trigger the event for training and evaluation under the diversity models.

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