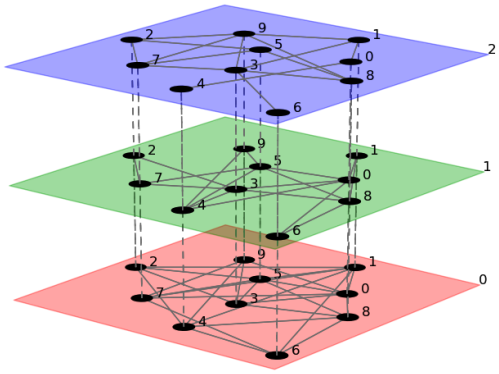
MULTIDIMENSIONAL NETWORKS FOR RECOMMENDER SYSTEMS



1. MULTIDIMENSIONAL GRAPHS

A multidimensional network is represented by a triple ***G = (V, E, D)***, where

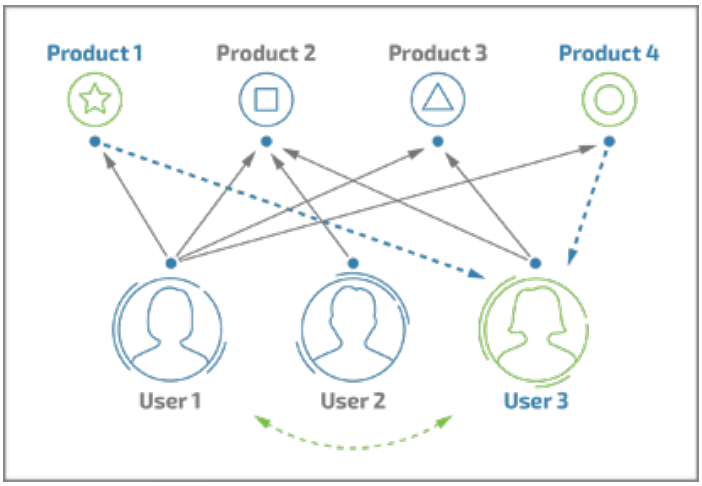
> ***V*** is the set of nodes
> ***D*** is a set of dimensions (or layers), each member of which is a different type of link
> ***E*** is the set of links between the nodes in the form of triples ***(u,v,d)*** with ***u,v*** in ***V*** and ***d*** in ***D***

Adjacent figure consists of a 3-dimensional graph with D = { 0,1,2 }

2. MODEL COMBINING USER-BASED & ITEM-BASED COLLABORATIVE FILTERING

2.1 ABSTRACT

By employing the underlying basic *similarity of user interests to dictate recommendation* assumption of collaborative filtering, the proposed model combines the user and item-based approaches in different dimensions of a multidimensional graph and by setting appropriate threshold parameters ø and μ on similarly measures extrapolates the user-item weights in a separate dimension to thereafter recommend new items to users.



2.2 DIMENSIONS OF MULTILAYER RECOMMENDER NETWORK

- The multilayer recommender network ***G = (V, E, D)*** consists of two kinds of nodes/vertices - user nodes ***U*** and item nodes ***I*** which form partitions of set of vertices ***V.***
- There are three dimensions represented by ***D = { 0, 1, 2, }***.
- Dimension ***0*** consists of edges only between nodes from ***U*** with weights representing cosine similarity/Euclidean distance between users represented by their corresponding rating vectors. Unknown ratings are considered to be 0 causing them to effectively drop out of the numerator.

$$s(u,v) = \frac{\mathbf{r}_u \cdot \mathbf{r}_v}{\|\mathbf{r}_u\|_2 \|\mathbf{r}_v\|_2} = \frac{\sum_i r_{u,i} r_{v,i}}{\sqrt{\sum_i r_{u,i}^2} \sqrt{\sum_i r_{v,i}^2}}$$

- Dimension ***1*** employs Amazon's item-to-item algorithm to determine cosine similarity between items and arranges nodes from ***I*** with edge weights representing the similarity measure.
- ***ø*** and ***μ*** set thresholds in dimensions ***0*** and ***1*** respectively to determine the number of nearest neighbours (users and items respectively) to be considered to evaluate the user-item edge weights/ratings of dimension ***2.*** Varying the parameters with the data set allows averaging out the result over values with greater confidence and thus combines the advantages of both the user and item-based approaches by reducing dependence on estimated missing data values.
- Dimension ***2*** consists of edges between sets ***I*** and ***U*** with edge weights representing the extrapolated user ratings as average edge weights of edges determined by ***ø*** and ***μ*** along with a bit to represent whether the item was bought or not, to facilitate making the next prediction.

2.3 RECOMMENDATION MECHANISM

To make a recommendation to user ***u*** in ***U*** we consider all edges of the form ***(u, i, 2 , < x , b >)*** where ***u*** is the concerned user, for every ***i*** ∈ ***I***, ***2*** represents the dimension, ***x*** is the extrapolated user rating and ***b*** bit indicates whether the item is bought or not by 1 and 0 respectively. The next recommended item will the ***i1*** ∈ ***I*** st ***x*** is maximum and ***b = 0***.