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1 Annex I - Mathematical Notations

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- Let $U = \{u_1, \dots, u_n\}$ be a set of *users*, where u_i represents the i th user and n the number of users, $|U| = n$.
- Let $P = \{p_1, \dots, p_m\}$ be a set of *products* or *items* for recommendation, where p_j is the j th product and m the number of items, $|P| = m$. Depending on the recommender algorithm, P will be the whole set of products or a subset of them.
- Let R be the *Utility* or *Rating Matrix*; defined as an $n \times m$ matrix of *ratings* or *degrees of preference* $r_{i,j}$, with $i \in \{1, \dots, n\}$ and $j \in \{1, \dots, m\}$. Values come from an ordered set (e.g., integers 1–5, representing the number of stars that the user gave as a rating for that item). We assume that the matrix is **sparse**, meaning that most entries are “unknown.” An unknown rating implies that we have no explicit information about the user’s preference for the item. If a certain user i has not rated an item j , the corresponding matrix entry $r_{i,j}$ remains empty.
- *Sparsity problem*: In any recommender system, the number of ratings already obtained is usually very small compared to the number of ratings that need to be predicted.