Our experimental results incorporate heatmaps to visually represent the performance of both collaborative (ALS and BPR) and content-based (ONTO) recommendation algorithms. Within the hybrid model, the ultimate score assigned to each item in the test set is achieved by fusing scores from the collaborative filtering and the content-based. This fusion involves a weighted methodology, wherein the components are assigned weights based on four distinct metrics. Specifically, M_1 denotes the multiplication of scores from both CF and CB approaches, as per Eq. (1). Similarly, M_2 signifies the mean of scores for the guidelines above, by Eq. (2). Additionally, M_3 corresponds to the quadratic mean of scores from the same methods, as illustrated in Eq. (3). Lastly, M_4 designates the harmonic mean derived from the same approaches, as represented in Eq. (4).

$$M_1 = S_{CF} \times S_{CB} \tag{1}$$

$$M_2 = \frac{S_{CF} + S_{CB}}{2} \tag{2}$$

$$M_3 = \frac{\sqrt{S_{CF}^2 + S_{CB}^2}}{2} \tag{3}$$

$$M_4 = 2/\Big(\frac{S_{CF} + 1}{S_{CB}}\Big) \tag{4}$$

The metrics for evaluation of the datasets are of two types, Classification Accuracy Metrics (CAMet) and Rank Accuracy Metrics (RAMet). For CAMet we use Precision (Eq. 5), Recall (Eq. 6), while for RAMet we use Mean Reciprocal Rank (MRR) (Eq. 7), normalised Discount Cumulative Gain (nDCG) (Eq. 9).

$$Precision@k = \frac{relevant\_items@k}{k} \tag{5}$$

$$Recall@k = \frac{relevant\_items@k}{all\_relevant\_items} \tag{6}$$

$$MRR = \frac{1}{n\_users} \sum_{i=1}^{n\_users} \frac{1}{rank_i} \tag{7}$$

$$DCG = \sum_{i=1}^{n} \frac{relevance_i}{log_2(i+1)} \tag{8}$$

$$nDCG = \frac{DCG}{iDCG} \tag{9}$$

The Precision@k metric provides a measure of items recommended in the top@k list. Meanwhile, Recall@k measures the number of relevant items suggested in the top@k list. The Mean Reciprocal Rank (MRR) determines the

position of the first relevant item's appearance. Lastly, the normalised Discounted Cumulative Gain (nDCG) is an evaluation approach that compares the ideal ranking of a test set (iDCG) with the ranking assigned by the recommendation algorithm.

These heatmaps offer valuable insights into the effectiveness of the algorithms by showcasing their respective strengths and weaknesses.

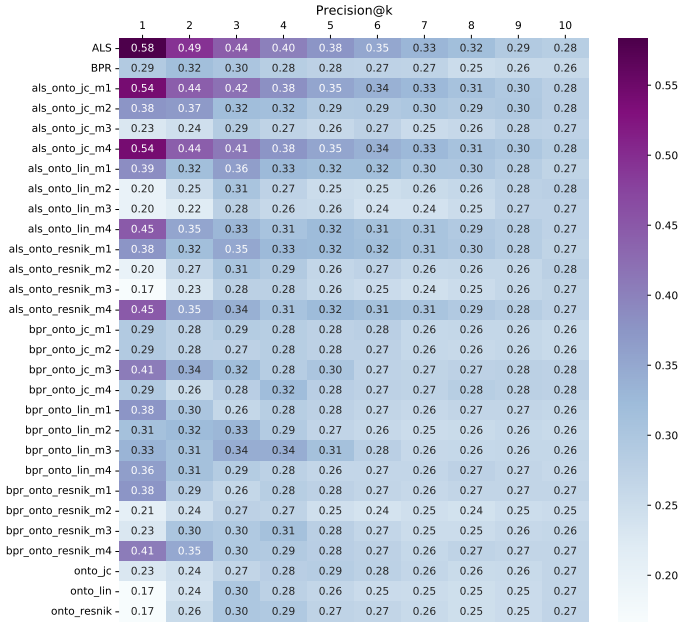

Figure 1: A list of top@10 Precision results from Med4EMC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

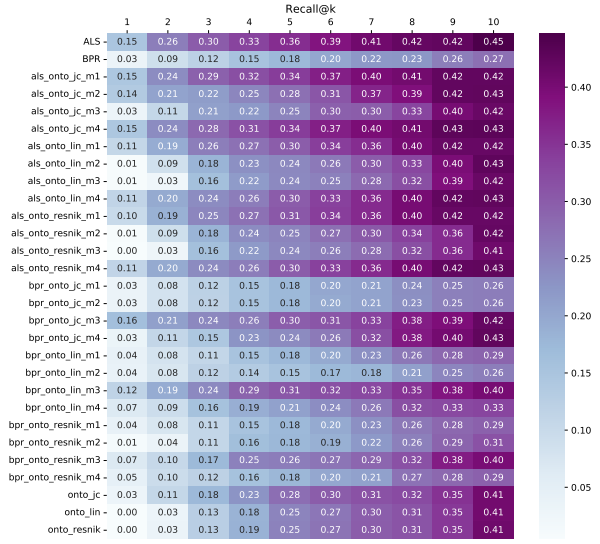

Figure 2: A list of top@10 Recall results from Med4EMC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

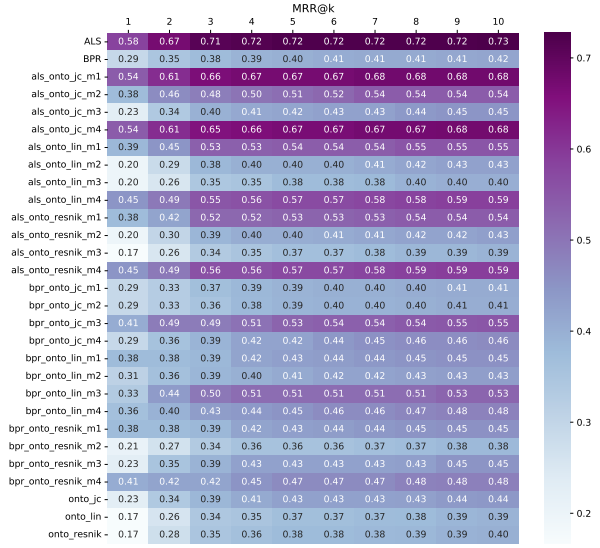

Figure 3: A list of top@10 MRR results from Med4EMC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

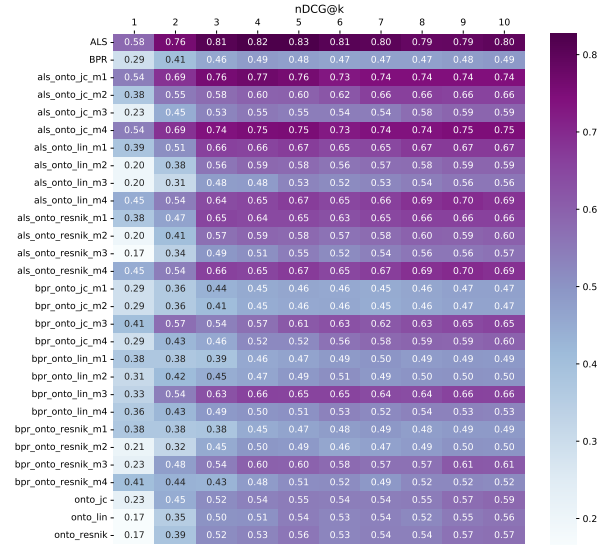

Figure 4: A list of top@10 nDCG results from Med4EMC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

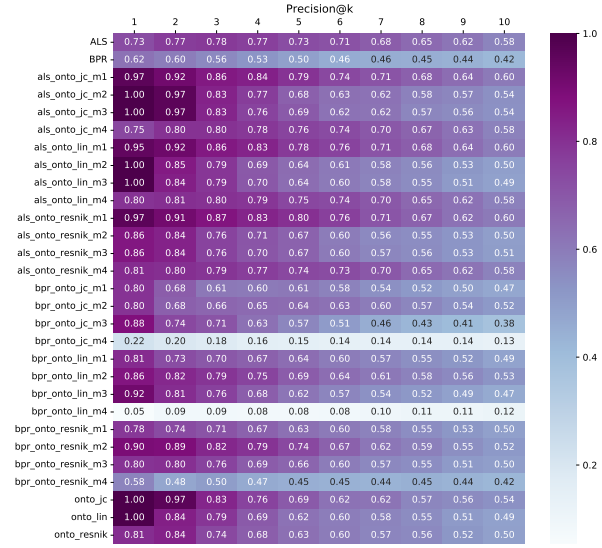

Figure 5: A list of top@10 Precision results from Med4EMC-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

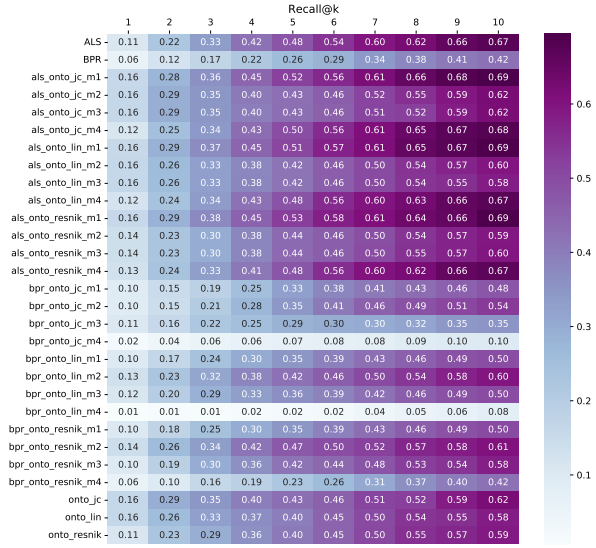

Figure 6: A list of top@10 Recall results from Med4EMC-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

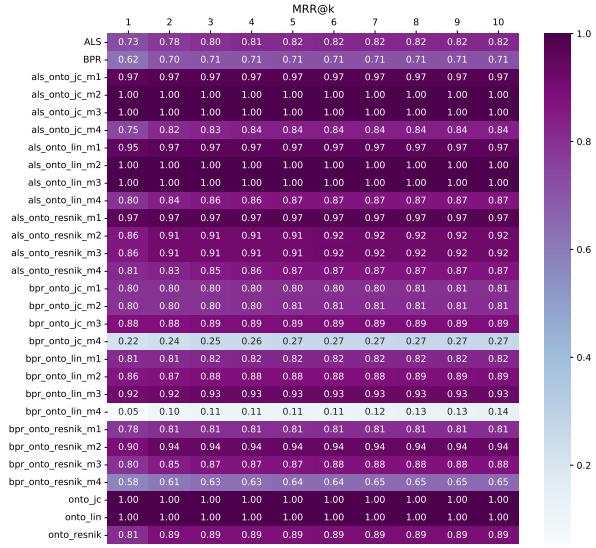

Figure 7: A list of top@10 MRR results from Med4EMC-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

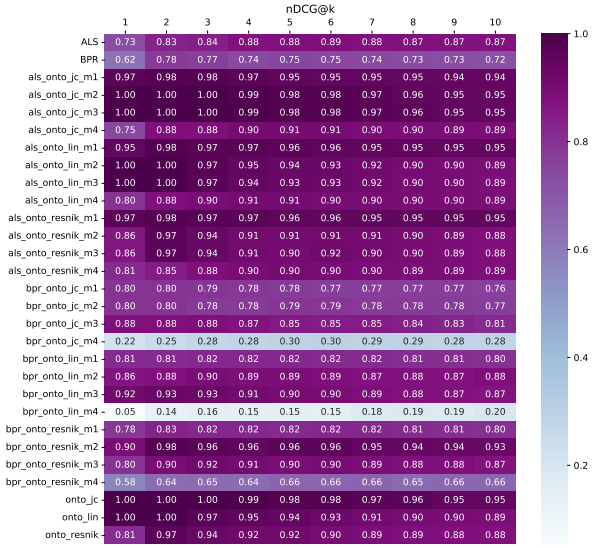

Figure 8: A list of top@10 nDCG results from Med4EMC-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

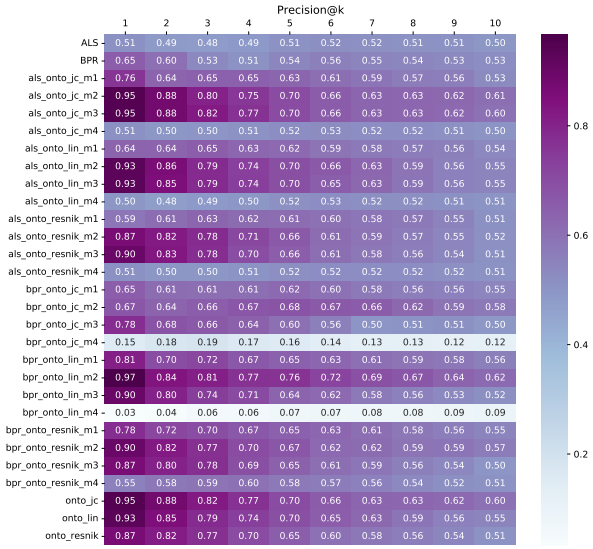

Figure 9: A list of top@10 Precision results from Med4EMC-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

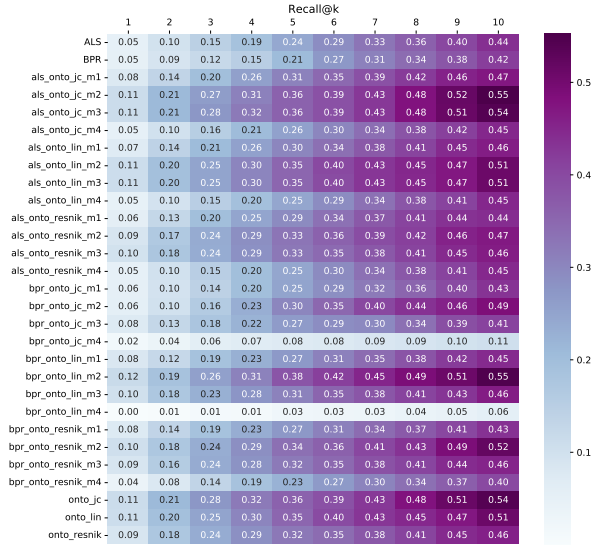

Figure 10: A list of top@10 Recall results from Med4EMC-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

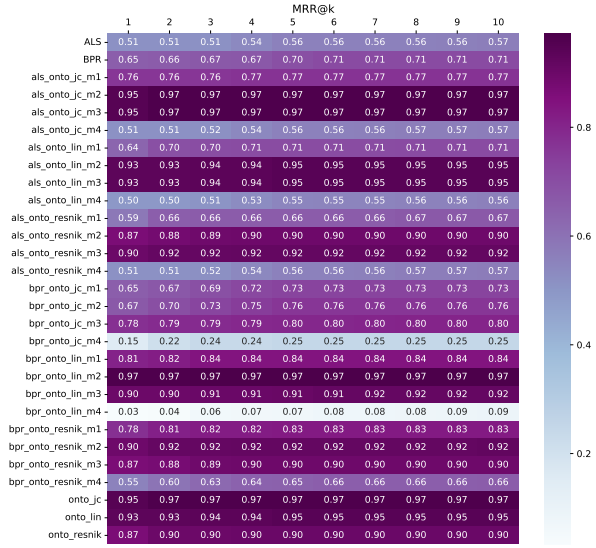

Figure 11: A list of top@10 MRR results from Med4EMC-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

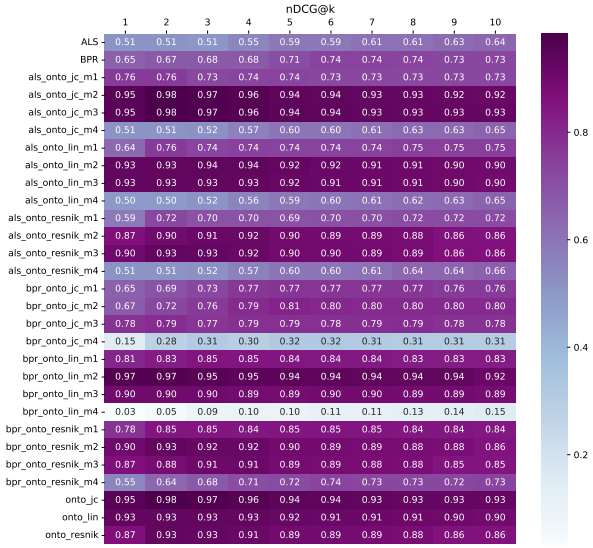

Figure 12: A list of top@10 nDCG results from Med4EMC-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

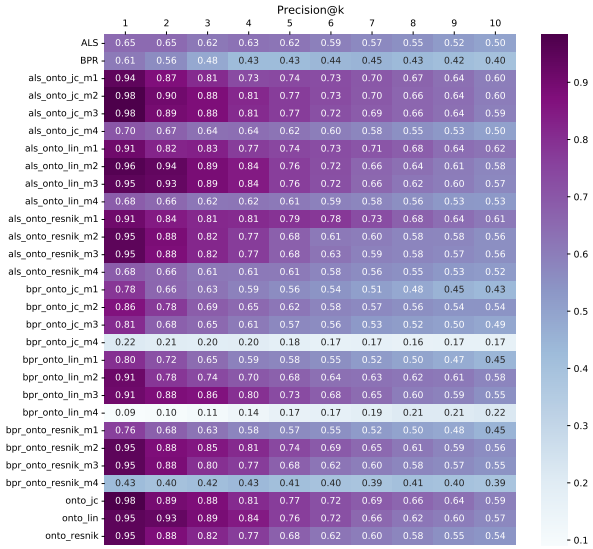

Figure 13: A list of top@10 Precision results from Med4EMC-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

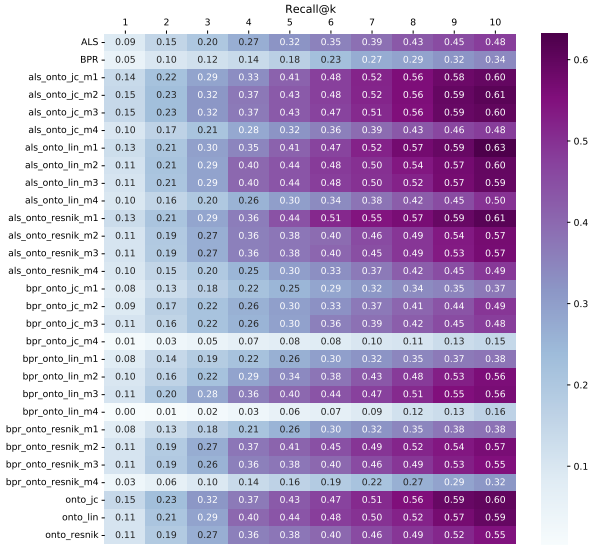

Figure 14: A list of top@10 Recall results from Med4EMC-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

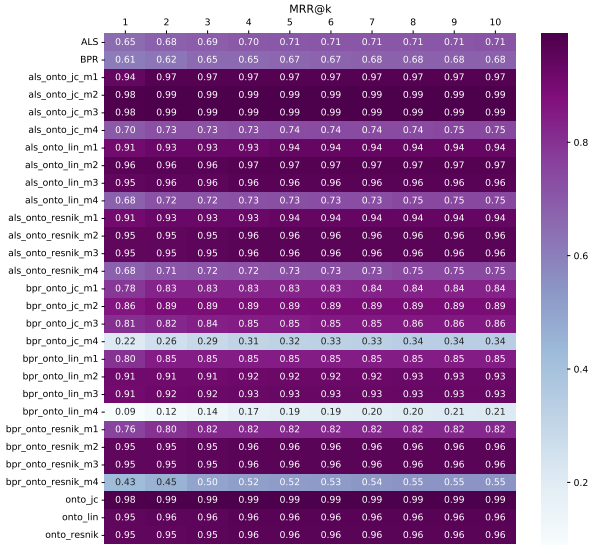

Figure 15: A list of top@10 MRR results from Med4EMC-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

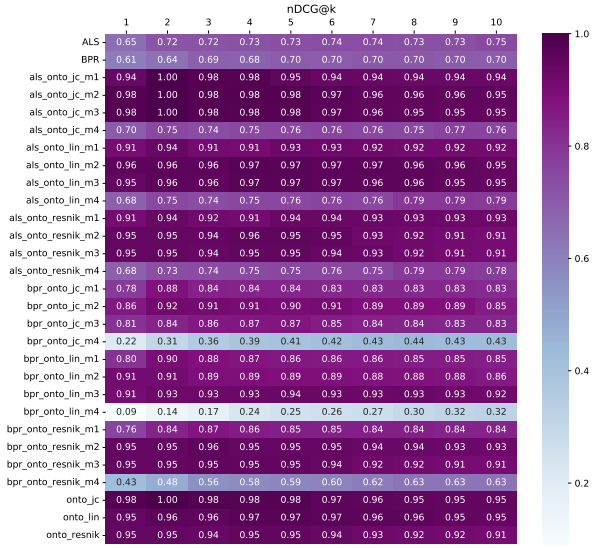

Figure 16: A list of top@10 nDCG results from Med4EMC-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

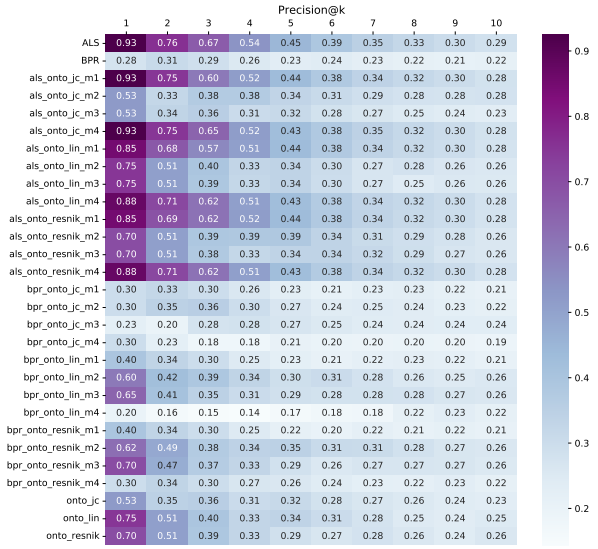

Figure 17: A list of top@10 Precision results from Med4EMC-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

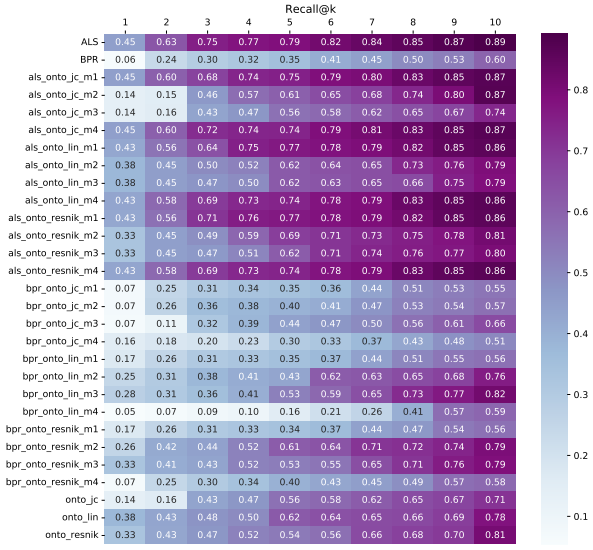

Figure 18: A list of top@10 Recall results from Med4EMC-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

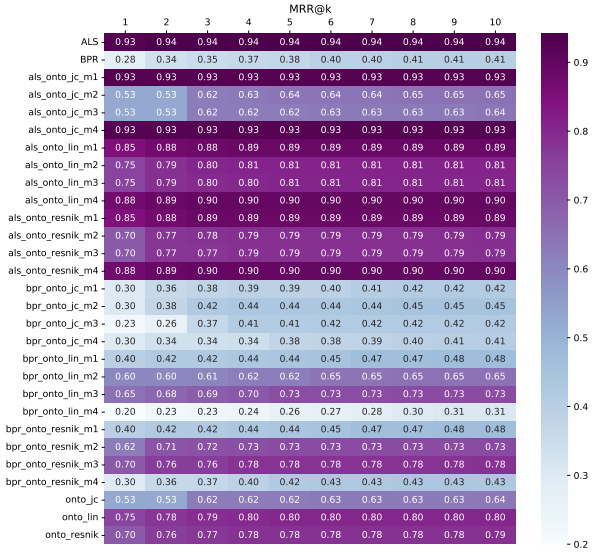

Figure 19: A list of top@10 MRR results from Med4EMC-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

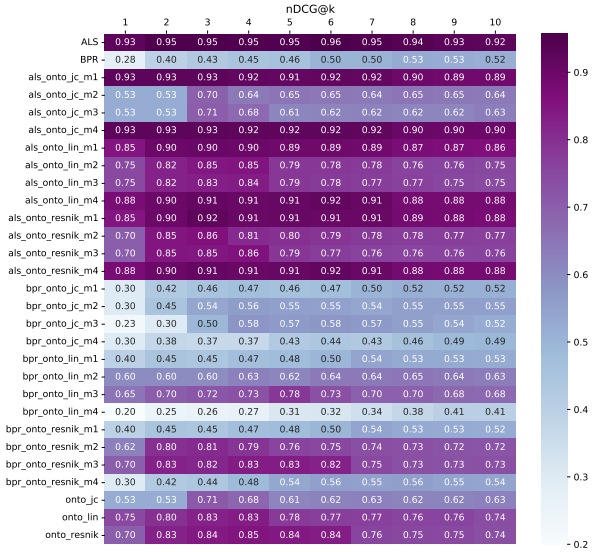

Figure 20: A list of top@10 nDCG results from Med4EMC-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

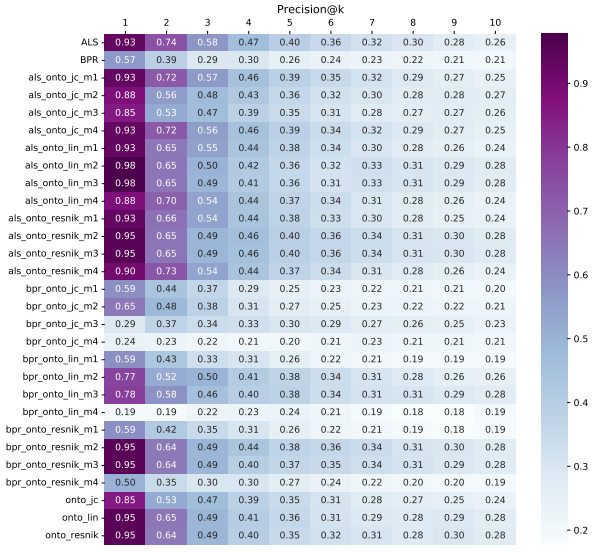

Figure 21: A list of top@10 Precision results from Med4EMC-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

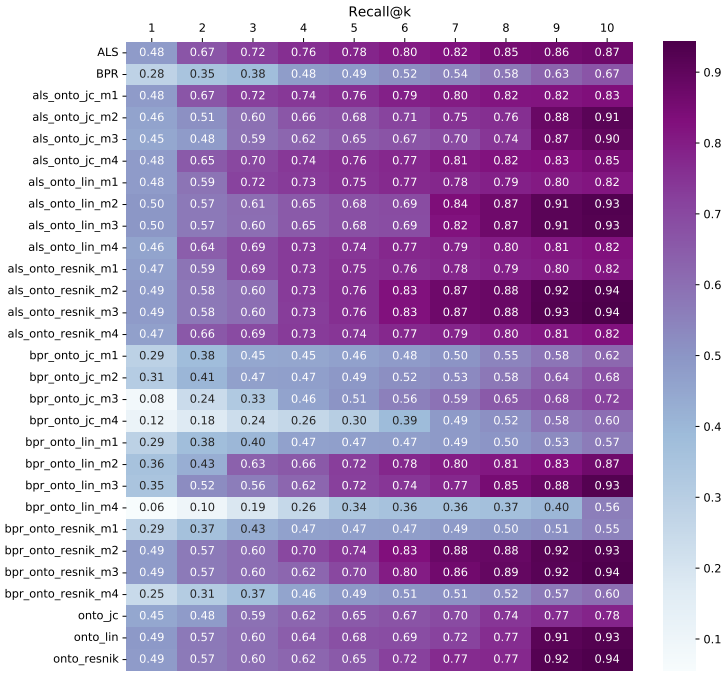

Figure 22: A list of top@10 Recall results from Med4EMC-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

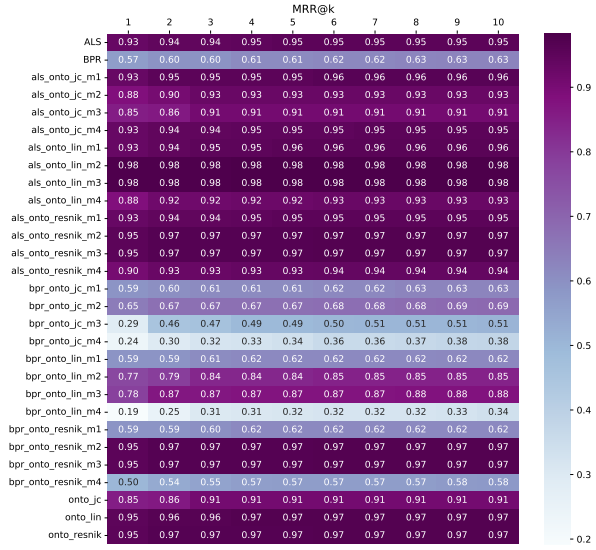

Figure 23: A list of top@10 MRR results from Med4EMC-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

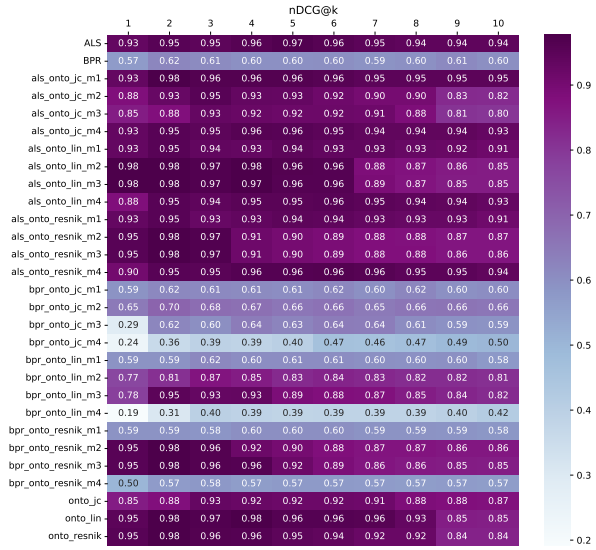

Figure 24: A list of top@10 nDCG results from Med4EMC-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

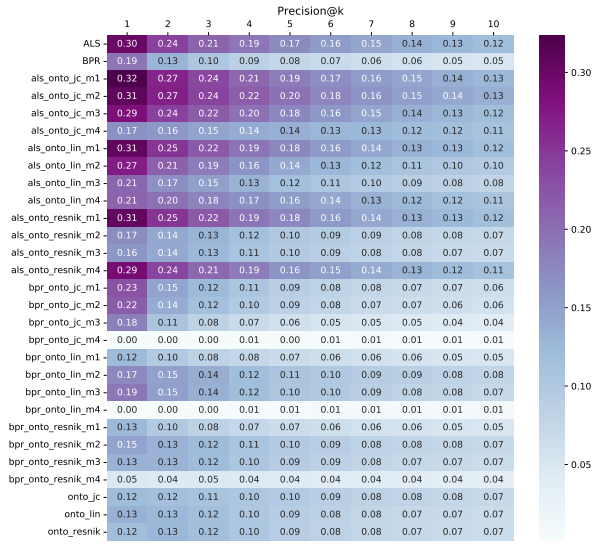

Figure 25: A list of top@10 Precision results from Med4DB, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

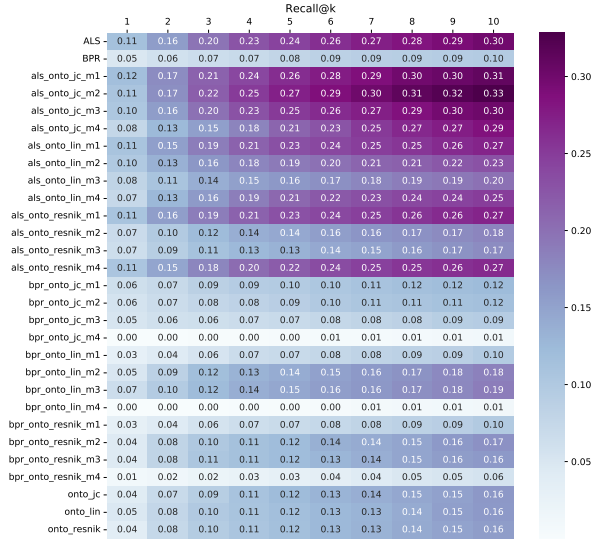

Figure 26: A list of top@10 Recall results from Med4DB, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

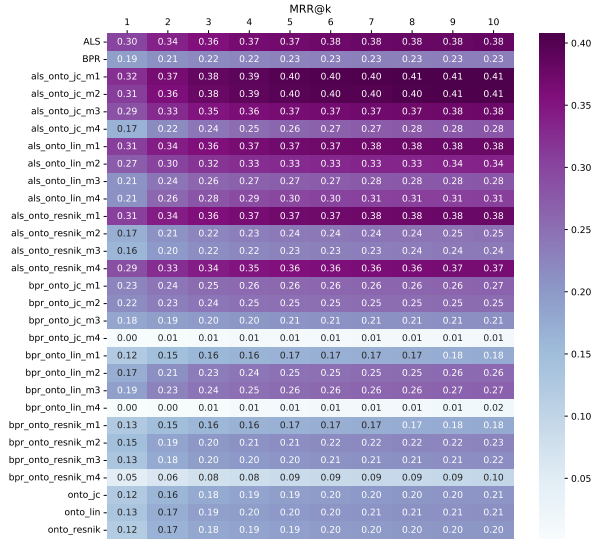

Figure 27: A list of top@10 MRR results from Med4DB, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

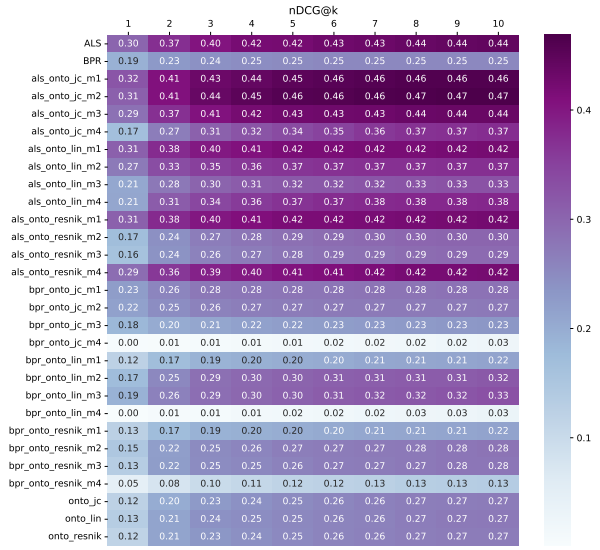

Figure 28: A list of top@10 nDCG results from Med4DB, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

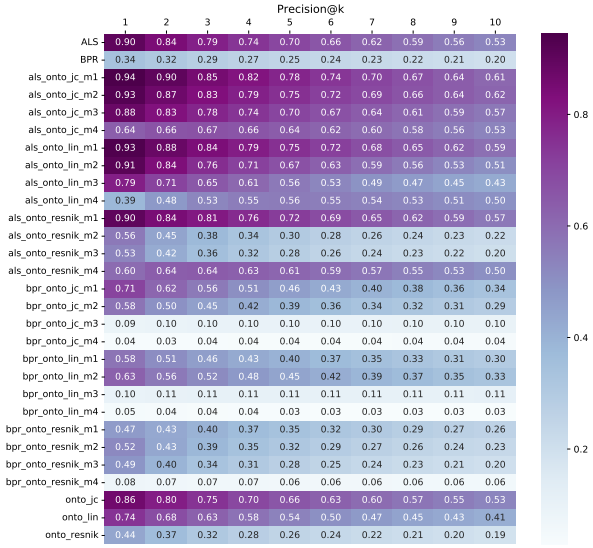

Figure 29: A list of top@10 Precision results from Med4DB-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

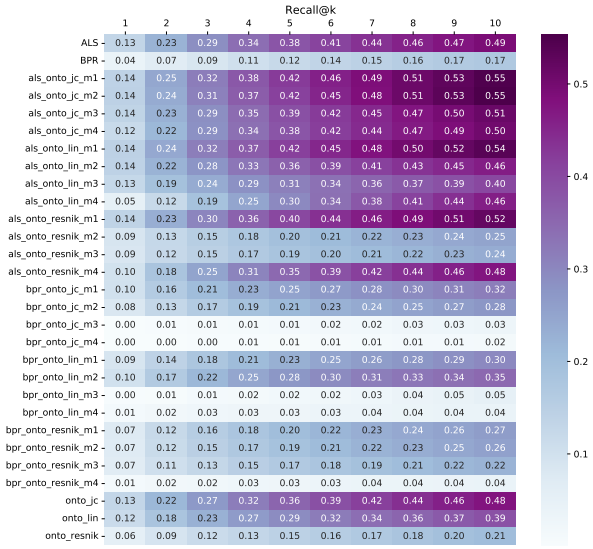

Figure 30: A list of top@10 Recall results from Med4DB-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

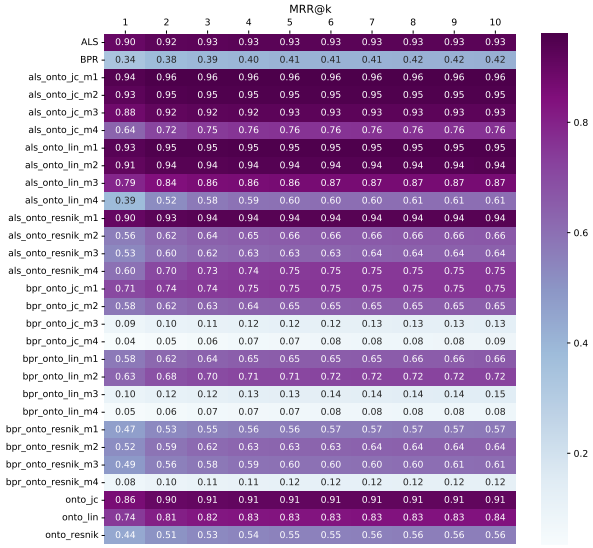

Figure 31: A list of top@10 MRR results from Med4DB-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

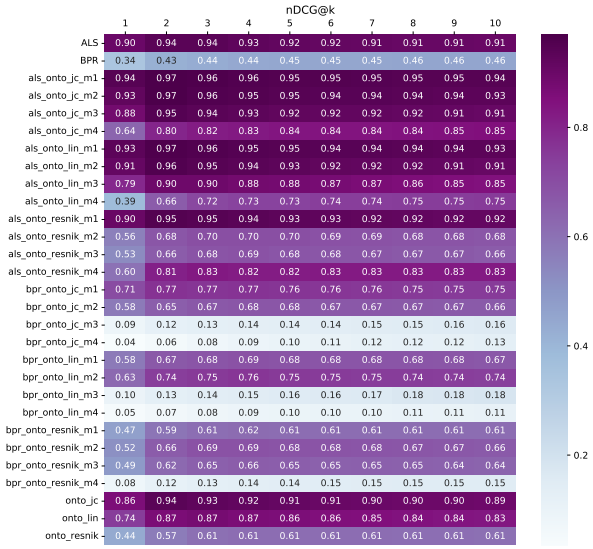

Figure 32: A list of top@10 nDCG results from Med4DB-KG-Resnik, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

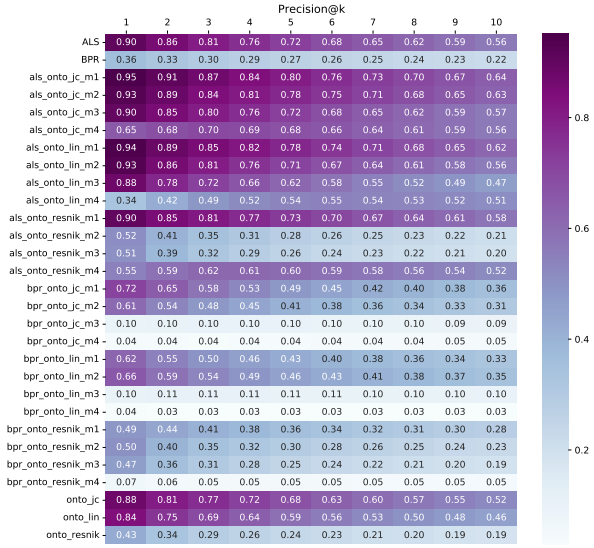

Figure 33: A list of top@10 Precision results from Med4DB-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

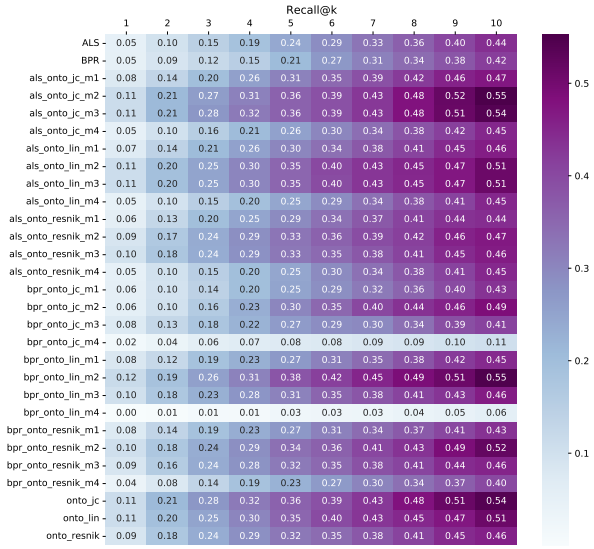

Figure 34: A list of top@10 Recall results from Med4DB-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

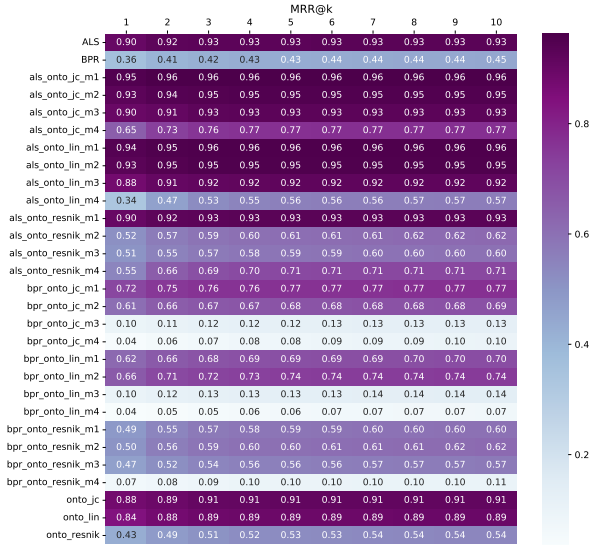

Figure 35: A list of top@10 MRR results from Med4DB-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

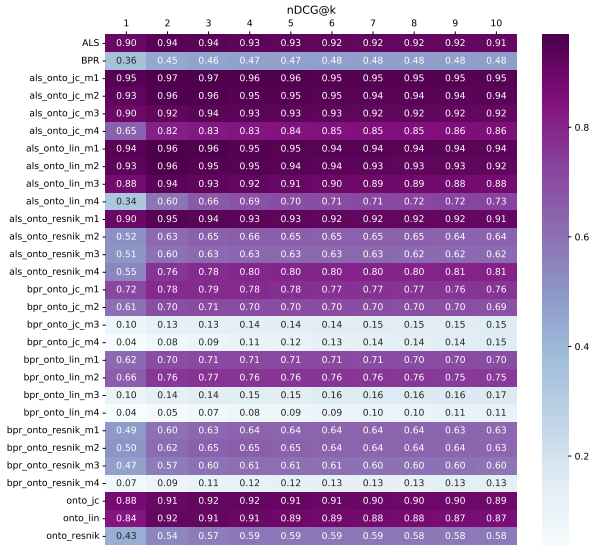

Figure 36: A list of top@10 nDCG results from Med4DB-KG-JC, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

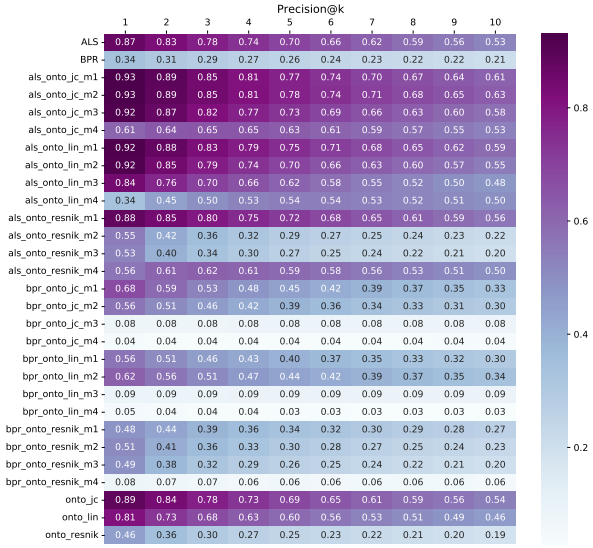

Figure 37: A list of top@10 Precision results from Med4DB-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

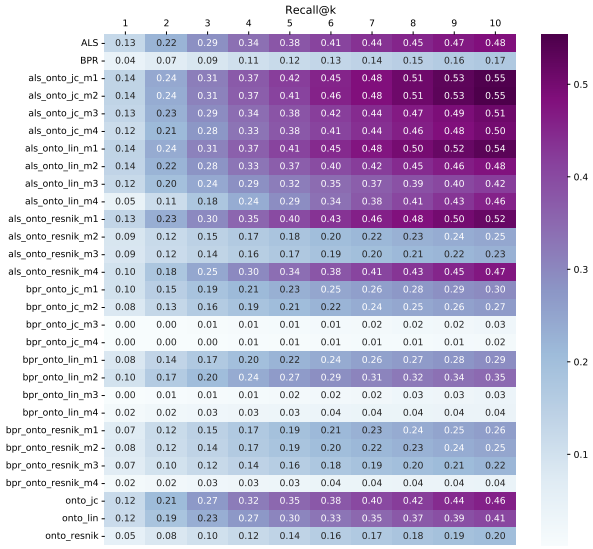

Figure 38: A list of top@10 Recall results from Med4DB-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

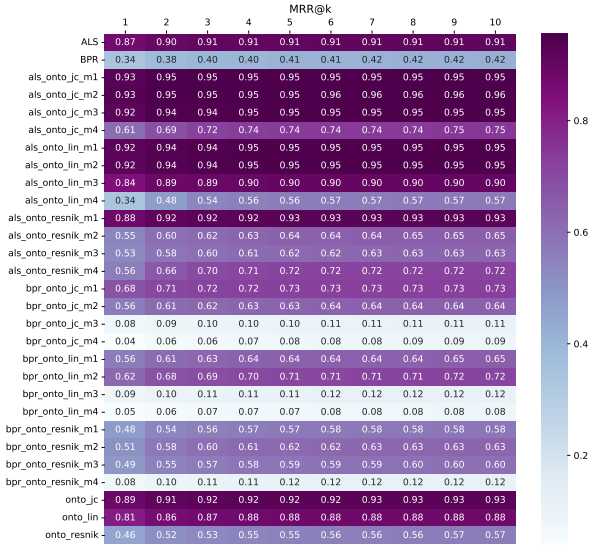

Figure 39: A list of top@10 MRR results from Med4DB-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

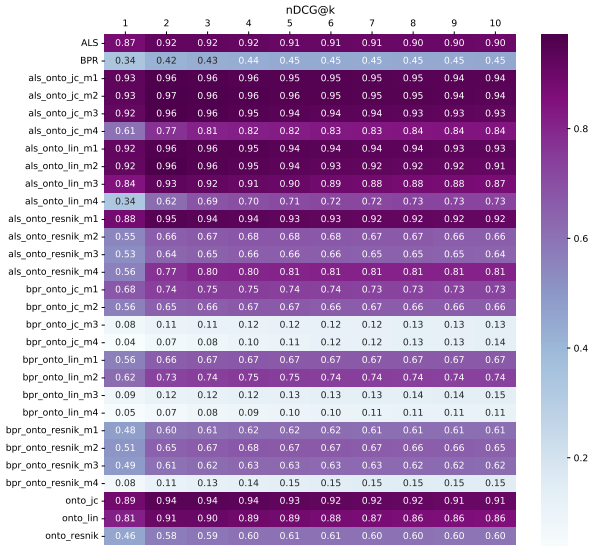

Figure 40: A list of top@10 nDCG results from Med4DB-KG-Lin, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

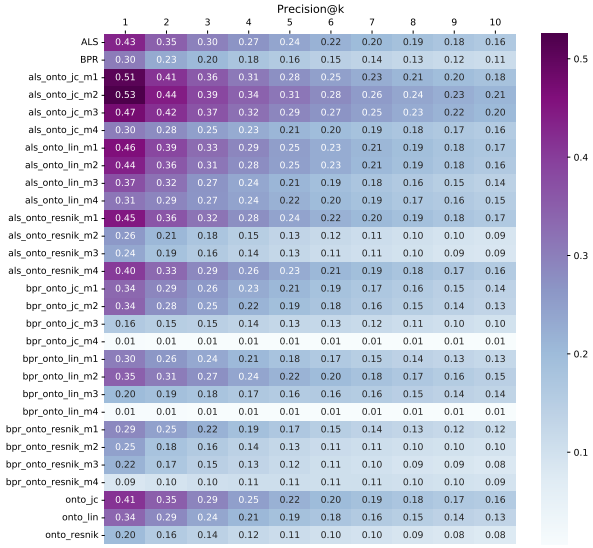

Figure 41: A list of top@10 Precision results from Med4DB-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

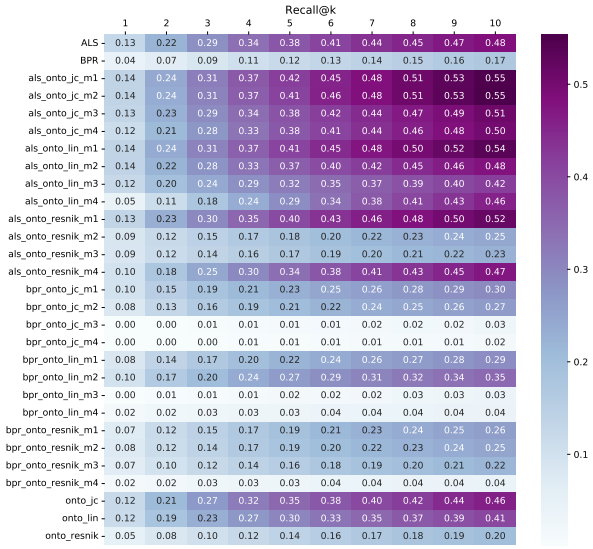

Figure 42: A list of top@10 Recall results from Med4DB-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

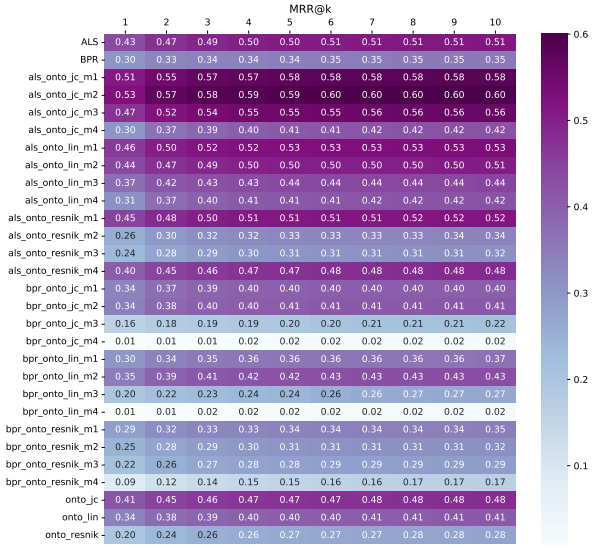

Figure 43: A list of top@10 MRR results from Med4DB-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

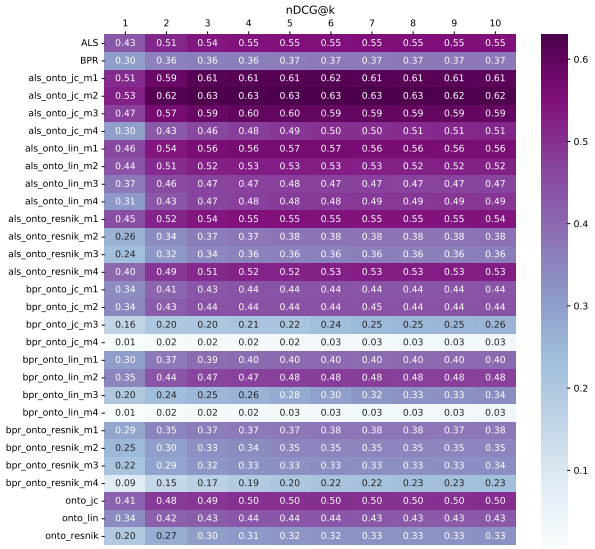

Figure 44: A list of top@10 nDCG results from Med4DB-KG-Morgan, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

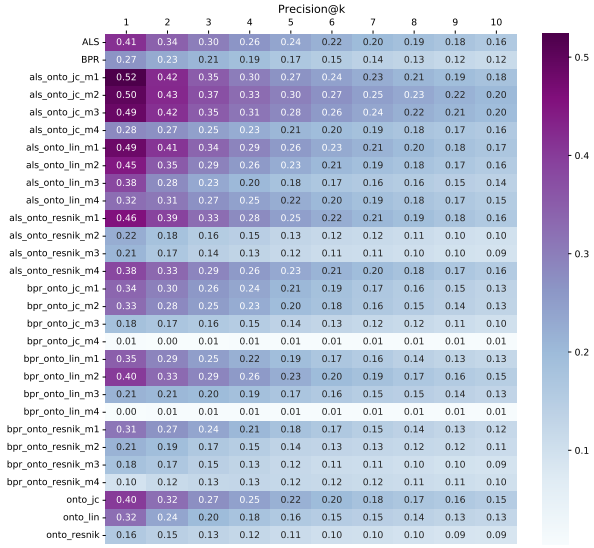

Figure 45: A list of top@10 Precision results from Med4DB-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

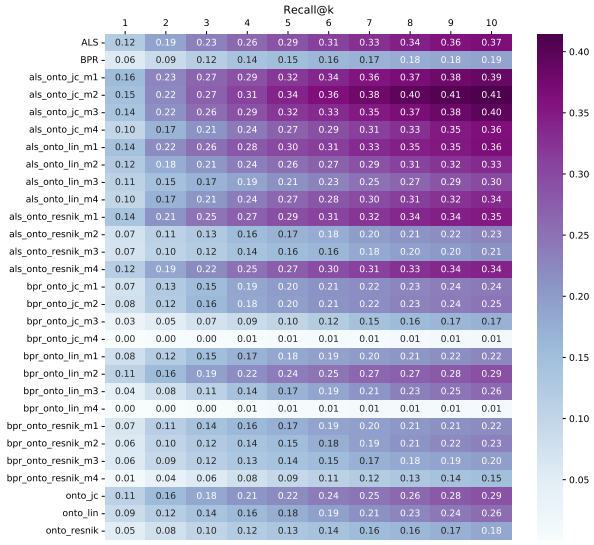

Figure 46: A list of top@10 Recall results from Med4DB-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

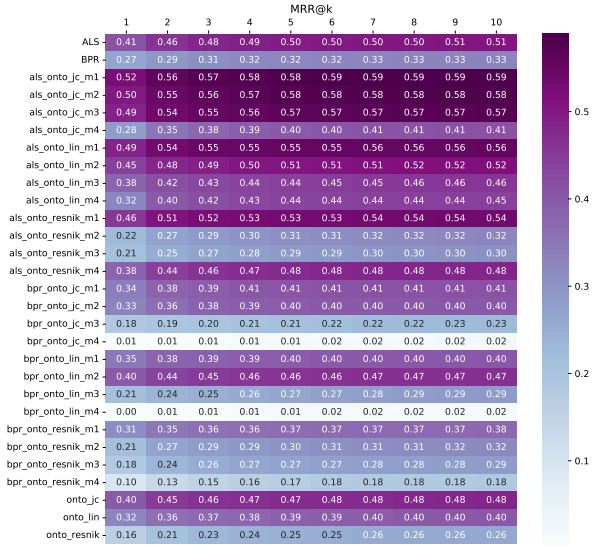

Figure 47: A list of top@10 MRR results from Med4DB-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.

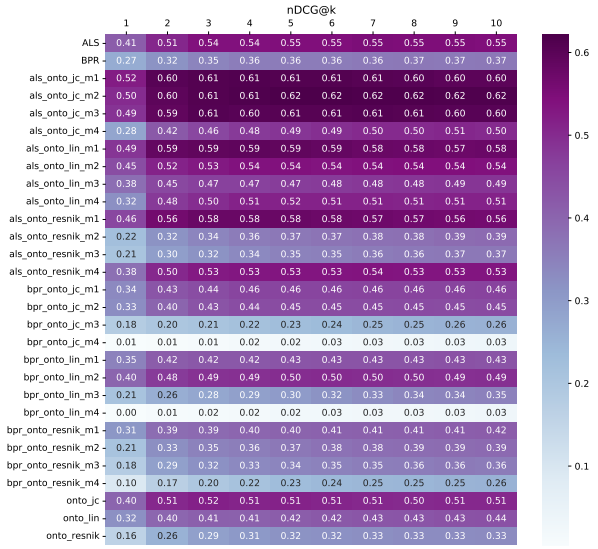

Figure 48: A list of top@10 nDCG results from Med4DB-KG-Tanimoto, including ALS, BPR, ONTO, and hybrids, obtained by using the 5 most similar items in calculating the ONTO scores.