Annex: Dataset Recommendation for Heterogeneous and Dynamic Scholarly Graphs via Multimodal Representation Learning

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1 Results

In this section, we expand the analysis by presenting a more comprehensive set of results. Specifically, we compare the performance of MM-SAN against the baselines at three different cutoff levels: 5, 10, and 20. We also evaluate the models using a broader range of metrics, including hits, recall (R), precision (P), F1-score (F1), and MRR. In the original paper, we reported results at cutoff 5 using NDCG and recall, as these were representative of the model's overall performance. On the other hand, in this extended analysis, we provide a more detailed evaluation to better capture the model's behavior across different recommendation depths and performance dimensions.

We report two sets of tables. The first set, Tables 1,3,5, 2, 4,6 reports the performances of GAT, SAGE, HAN, HGT and MM-SAN on MES and PubMed datasets. The evaluation metrics considered are nDCG, precision, recall, F1, hits and mean reciprocal rank. We evaluated the methods effectiveness in transductive, semi-inductive and fully inductive setups, in different metadata conditions: with full datasets metadata available (ideal condition) and with 75%, 50%, 25% available metadata. The results confirm the considerations done in the original paper: All models, including MM-SAN, perform best in the transductive setting when full metadata is available (100% row. However, this scenario is least representative of real-world academic contexts. MM-SAN maintains reliable performance even in more challenging semi-inductive and full-inductive settings, where predictions are made for previously unseen nodes. Under more realistic conditions, where metadata availability is limited, MM-SAN, like other models, experiences a slight decline in performance as the proportion of datasets with metadata decreases (from 75% to 25%). This trend underscores the importance of text-based features for enhancing recommendation accuracy and highlights MM-SAN's flexibility in handling situations with sparse metadata.

In the second set of experiments, we present the performance results for SAGE, GAT, HGNN, their enhanced versions (where the original sampling method is replaced with ours), and MM-SAN. For each baseline and its enhanced version, we report the percentage gain to highlight the impact of our sampling method on each baseline. We observe a significant improvement across all methods when replacing the original sampling approach with ours. This improvement is attributed to our method's focus on enhancing heterogeneity and selecting the most representative nodes of the target. In contrast, methods like SAGE and GAT, which are designed for homogeneous graphs, sample neighboring nodes randomly, potentially leading to less representative samples.

2 Baselines

We applied grid search to systematically tune the hyperparameters of each baseline model for fair comparison. In Table 13, we report the specific choices and value ranges explored for each hyperparameter and each baseline.

3 Sampling Analysis

In this set of experiments, we investigate the performance of MM-SAN when replacing the original random walk-based sampling method with random sampling. We explored the effect of random sampling at different hop distances (k-hops) to evaluate how sampling neighbors from progressively deeper levels influences the results. The results for MES and PubMed datasets at cutoff 5 are shown in Tables 14, 15 respectively.

We observe that MM-SAN, in its original implementation using random walk-based sampling, outperforms random sampling at every selected hop. However, there are two important observations to make. The first is that as the sampling depth (k-hop) increases, the performance of random sampling improves. This is reasonable because we increase the heterogeneity of the sample. The second is that MM-SAN does not significantly outperform random sampling, especially when the setup is either ideal (transductive, 100%) or entirely realistic (25% inductive). In fact, we see that when only 25% of the nodes are well described, there is no longer a marked difference between sampling at hop-1 or hop-3. This is related to the fact that nodes without textual features are being sampled, making them less representative of the target. Moreover, we see that across all settings — transductive, semi-inductive, and fully inductive — and regardless of the portion of the dataset with complete metadata, sampling neighbors at greater depths consistently improves performance. This improvement is expected, as deeper sampling increases the heterogeneity of the sampled neighborhood. Nonetheless, the methods we proposed in our pipeline, based on random walks, yield superior results.

4 Augmentation Analysis

In this section, we expand on the component-based analysis presented in the original paper and report results on the MES and PubMed datasets in Tables 16 and 17. We evaluate five graph-based baselines—GAT, SAGE, HAN, HGT, and HGNN—along with modified versions that incorporate our sampling strategy (denoted as GAT-RW, SAGE-RW, and HGNN-RW).

Consistent with findings from the original study, we observe that the augmentation phase improves the performance of HGNN and MM-SAN. This improvement can be attributed to their sensitivity to sample heterogeneity; the inclusion of new node types enhances their ability to capture complex relationships. In contrast, the original implementations of SAGE and GAT do not benefit from node augmentation, likely because they are designed for homogeneous graphs and struggle to exploit the added heterogeneity.

Table 1: Recall@5 (R@5), nDG@5 (N@5), Precision@5 (P@5), f1-score (f1@5), Mean reciprocal rank (MRR@5), Hits@5 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The best-performing method is indicated in boldface.

MES	Setting	Metric	GAT	SAGE	HAN	HGT	HGNN	MM-SAN
100%	Tran	R@10	0.748	0.715	0.008	0.023	0.656	**0.796**
		N@10	0.641	0.573	0.009	0.020	0.455	**0.566**
		P@10	0.020	0.045	0.001	0.001	0.069	**0.084**
		F1@10	0.085	0.126	0.002	0.003	0.124	**0.151**
		Hits@10	0.765	0.794	0.010	0.033	0.660	**0.803**
		MRR@10	0.473	0.469	0.010	0.011	0.392	**0.493**
	Semi	R@10	0.773	0.712	0.000	0.007	0.655	**0.799**
		N@10	0.528	0.504	0.000	0.003	0.439	**0.551**
		P@10	0.074	0.042	0.000	0.000	0.066	**0.083**
		F1@10	0.111	0.110	0.000	0.000	0.120	**0.147**
		Hits@10	0.692	0.720	0.000	0.009	0.659	**0.811**
		MRR@10	0.523	0.485	0.000	0.002	0.370	**0.472**
	Ind	R@10	0.716	0.738	0.000	0.000	0.658	**0.743**
		N@10	0.526	0.519	0.000	0.000	0.447	**0.538**
		P@10	0.045	0.031	0.000	0.000	0.067	**0.086**
		F1@10	0.127	0.110	0.000	0.000	0.122	**0.137**
		Hits@10	0.726	0.767	0.000	0.000	0.658	**0.743**
		MRR@10	0.439	0.437	0.000	0.000	0.379	**0.472**
75%	Tran	R@10	0.568	0.522	0.008	0.022	0.534	**0.704**
		N@10	0.454	0.422	0.006	0.011	0.363	**0.480**
		P@10	0.020	0.019	0.000	0.000	0.057	**0.074**
		F1@10	0.057	0.096	0.000	0.000	0.103	**0.164**
		Hits@10	0.565	0.594	0.010	0.033	0.544	**0.707**
		MRR@10	0.395	0.324	0.001	0.002	0.309	**0.408**
	Semi	R@10	0.480	0.505	0.000	0.000	0.598	**0.723**
		N@10	0.442	0.393	0.000	0.000	0.369	**0.441**
		P@10	0.041	0.023	0.000	0.000	0.061	**0.127**
		F1@10	0.022	0.022	0.000	0.000	0.110	**0.132**
		Hits@10	0.577	0.509	0.000	0.000	0.598	**0.727**
		MRR@10	0.349	0.398	0.000	0.000	0.295	**0.405**
	Ind	R@10	0.510	0.525	0.000	0.000	0.562	**0.701**
		N@10	0.434	0.426	0.000	0.000	0.397	**0.455**
		P@10	0.048	0.007	0.000	0.000	0.057	**0.071**
		F1@10	0.042	0.088	0.000	0.000	0.104	**0.129**
		Hits@10	0.596	0.509	0.010	0.020	0.566	**0.704**
		MRR@10	0.344	0.381	0.000	0.000	0.347	**0.383**
50%	Tran	R@10	0.312	0.317	0.007	0.015	0.473	**0.639**
		N@10	0.308	0.234	0.006	0.012	0.329	**0.405**
		P@10	0.020	0.028	0.000	0.000	0.050	**0.067**
		F1@10	0.040	0.049	0.000	0.000	0.090	**0.120**
		Hits@10	0.322	0.265	0.010	0.020	0.476	**0.646**
		MRR@10	0.303	0.196	0.002	0.001	0.286	**0.334**
	Semi	R@10	0.320	0.397	0.000	0.000	0.527	**0.670**
		N@10	0.253	0.304	0.000	0.000	0.333	**0.404**
		P@10	0.020	0.010	0.000	0.000	0.053	**0.067**
		F1@10	0.008	0.063	0.000	0.000	0.096	**0.122**
		Hits@10	0.347	0.382	0.000	0.000	0.530	**0.674**
		MRR@10	0.293	0.244	0.000	0.000	0.273	**0.322**
	Ind	R@10	0.363	0.347	0.000	0.000	0.543	**0.625**
		N@10	0.272	0.236	0.000	0.000	0.367	**0.409**
		P@10	0.010	0.020	0.000	0.000	0.055	**0.063**
		F1@10	0.001	0.000	0.000	0.000	0.100	**0.115**
		Hits@10	0.360	0.352	0.000	0.000	0.546	**0.632**
		MRR@10	0.238	0.221	0.000	0.000	0.315	**0.345**
25%	Tran	R@10	0.164	0.159	0.003	0.007	0.376	**0.595**
		N@10	0.134	0.107	0.002	0.007	0.225	**0.371**
		P@10	0.010	0.000	0.000	0.000	0.039	**0.061**
		F1@10	0.036	0.000	0.000	0.000	0.071	**0.111**
		Hits@10	0.189	0.138	0.003	0.008	0.388	**0.599**
		MRR@10	0.139	0.089	0.003	0.008	0.181	**0.300**
	Semi	R@10	0.181	0.206	0.000	0.000	0.466	**0.561**
		N@10	0.148	0.170	0.000	0.000	0.307	**0.344**
		P@10	0.020	0.020	0.000	0.000	0.047	**0.057**
		F1@10	0.002	0.002	0.000	0.000	0.085	**0.103**
		Hits@10	0.210	0.180	0.000	0.000	0.470	**0.561**
		MRR@10	0.180	0.107	0.000	0.000	0.259	**0.275**
	Ind	R@10	0.134	0.207	0.000	0.000	0.451	**0.536**
		N@10	0.146	0.158	0.000	0.000	0.270	**0.322**
		P@10	0.020	0.009	0.000	0.000	0.045	**0.054**
		F1@10	0.040	0.000	0.000	0.000	0.082	**0.098**
		Hits@10	0.184	0.205	0.000	0.000	0.454	**0.539**
		MRR@10	0.187	0.124	0.000	0.000	0.216	**0.255**

Interestingly, in the methods implementing our sampling mechanism – with the suffix -RW, we see that the augmentation improves the overall performances, suggesting that our method allows these

Table 2: Recall@5 (R@5), nDG@5 (N@5), Precision@5 (P@5), f1-score (f1@5), Mean reciprocal rank (MRR@5), Hits@5 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The best-performing method is indicated in boldface.

PubMed	Setting	Metric	GAT	SAGE	HGT	HAN	HGNN	MM-SAN
100%	Tran	R@5	0.241	0.239	0.016	0.030	0.284	**0.380**
		N@5	0.181	0.179	0.017	0.023	0.202	**0.270**
		P@5	0.069	0.076	0.003	0.005	0.058	**0.077**
		F1@5	0.121	0.121	0.005	0.007	0.096	**0.127**
		HIT@5	0.300	0.267	0.016	0.030	0.286	**0.381**
		MRR@5	0.233	0.304	0.019	0.023	0.209	**0.234**
	Semi	R@5	0.231	0.221	0.006	0.010	0.246	**0.374**
		N@5	0.171	0.161	0.005	0.008	0.198	**0.267**
		P@5	0.070	0.075	0.003	0.005	0.055	**0.076**
		F1@5	0.123	0.125	0.005	0.007	0.091	**0.126**
		HIT@5	0.254	0.297	0.015	0.022	0.273	**0.376**
		MRR@5	0.222	0.254	0.009	0.013	0.222	**0.232**
	Ind	R@5	0.196	0.187	0.000	0.000	0.271	**0.344**
		N@5	0.134	0.133	0.000	0.000	0.199	**0.246**
		P@5	0.062	0.069	0.003	0.005	0.050	**0.070**
		F1@5	0.109	0.115	0.005	0.007	0.083	**0.116**
		HIT@5	0.289	0.209	0.014	0.021	0.301	**0.347**
		MRR@5	0.301	0.213	0.009	0.013	0.187	**0.214**
75%	Tran	R@5	0.201	0.183	0.006	0.012	0.241	**0.319**
		N@5	0.149	0.139	0.005	0.009	0.171	**0.227**
		P@5	0.052	0.062	0.003	0.005	0.048	**0.064**
		F1@5	0.094	0.104	0.004	0.006	0.079	**0.107**
		HIT@5	0.300	0.298	0.013	0.019	0.252	**0.319**
		MRR@5	0.196	0.196	0.008	0.012	0.149	**0.197**
	Semi	R@5	0.186	0.174	0.000	0.007	0.237	**0.318**
		N@5	0.140	0.133	0.000	0.007	0.174	**0.228**
		P@5	0.052	0.062	0.003	0.005	0.048	**0.065**
		F1@5	0.093	0.103	0.004	0.006	0.080	**0.107**
		HIT@5	0.296	0.202	0.013	0.019	0.289	**0.319**
		MRR@5	0.198	0.198	0.008	0.012	0.150	**0.199**
	Ind	R@5	0.145	0.136	0.000	0.000	0.202	**0.295**
		N@5	0.104	0.097	0.000	0.000	0.199	**0.210**
		P@5	0.047	0.057	0.002	0.003	0.043	**0.060**
		F1@5	0.084	0.094	0.003	0.005	0.072	**0.099**
		HIT@5	0.273	0.199	0.010	0.015	0.215	**0.297**
		MRR@5	0.182	0.190	0.007	0.011	0.135	**0.183**
50%	Tran	R@5	0.156	0.145	0.005	0.007	0.203	**0.272**
		N@5	0.116	0.111	0.005	0.007	0.140	**0.192**
		P@5	0.034	0.044	0.002	0.003	0.041	**0.055**
		F1@5	0.062	0.072	0.004	0.006	0.069	**0.091**
		HIT@5	0.206	0.216	0.011	0.017	0.206	**0.274**
		MRR@5	0.155	0.163	0.007	0.011	0.131	**0.166**
	Semi	R@5	0.144	0.129	0.000	0.001	0.201	**0.268**
		N@5	0.110	0.100	0.000	0.002	0.142	**0.190**
		P@5	0.031	0.041	0.002	0.003	0.040	**0.054**
		F1@5	0.059	0.068	0.004	0.006	0.066	**0.090**
		HIT@5	0.200	0.206	0.011	0.017	0.243	**0.270**
		MRR@5	0.140	0.150	0.005	0.007	0.124	**0.164**
	Ind	R@5	0.096	0.057	0.000	0.000	0.129	**0.246**
		N@5	0.086	0.079	0.000	0.000	0.120	**0.140**
		P@5	0.010	0.020	0.002	0.003	0.029	**0.041**
		F1@5	0.024	0.034	0.003	0.005	0.048	**0.068**
		HIT@5	0.091	0.101	0.008	0.012	0.144	**0.204**
		MRR@5	0.063	0.073	0.005	0.007	0.087	**0.121**

models to better accommodate heterogeneous graph structures. As a result, the incorporation of diverse node types becomes beneficial, further validating the effectiveness of our sampling approach.

Table 3: Recall@10 (R@10), nDG@10 (N@10), Precision@10 (P@10), f1-score (f1@10), Mean reciprocal rank (MRR@10), Hits@10 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. Methods with the -RW suffix indicate that their original sampling mechanism has been replaced by our proposed sampling strategy. The best-performing method is indicated in boldface.

MES	Setting	Metric	GAT	SAGE	HAN	HGT	HGNN	MM-SAN
100%	Tran	R@10	0.748	0.715	0.000	0.023	0.656	**0.796**
		N@10	0.641	0.573	0.000	0.020	0.455	**0.566**
		P@10	0.020	0.045	0.000	0.001	0.069	**0.084**
		F1@10	0.085	0.126	0.000	0.003	0.124	**0.151**
		Hits@10	0.765	0.794	0.000	0.033	0.660	**0.803**
		MRR@10	0.473	0.469	0.000	0.011	0.392	**0.493**
	Semi	R@10	0.773	0.712	0.000	0.007	0.655	**0.799**
		N@10	0.528	0.504	0.000	0.003	0.439	**0.551**
		P@10	0.074	0.042	0.000	0.000	0.066	**0.083**
		F1@10	0.111	0.110	0.000	0.000	0.120	**0.147**
		Hits@10	0.692	0.720	0.000	0.009	0.659	**0.811**
		MRR@10	0.523	0.485	0.000	0.002	0.370	**0.472**
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		N@10	0.526	0.519	0.000	0.000	0.447	**0.538**
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		Hits@10	0.726	0.767	0.000	0.000	0.658	**0.743**
		MRR@10	0.439	0.437	0.000	0.000	0.379	**0.472**
75%	Tran	R@10	0.568	0.522	0.000	0.022	0.534	**0.704**
		N@10	0.454	0.422	0.000	0.011	0.363	**0.480**
		P@10	0.020	0.019	0.000	0.000	0.057	**0.074**
		F1@10	0.057	0.096	0.000	0.000	0.103	**0.164**
		Hits@10	0.565	0.594	0.000	0.033	0.544	**0.707**
		MRR@10	0.395	0.324	0.001	0.002	0.309	**0.408**
	Semi	R@10	0.480	0.505	0.000	0.000	0.598	**0.723**
		N@10	0.442	0.393	0.000	0.000	0.369	**0.441**
		P@10	0.041	0.023	0.000	0.000	0.061	**0.127**
		F1@10	0.022	0.022	0.000	0.000	0.110	**0.132**
		Hits@10	0.577	0.509	0.000	0.000	0.598	**0.727**
		MRR@10	0.349	0.398	0.000	0.000	0.295	**0.405**
	Ind	R@10	0.510	0.525	0.000	0.000	0.562	**0.701**
		N@10	0.434	0.426	0.000	0.000	0.397	**0.455**
		P@10	0.048	0.007	0.000	0.000	0.057	**0.071**
		F1@10	0.042	0.088	0.000	0.000	0.104	**0.129**
		Hits@10	0.596	0.509	0.010	0.020	0.566	**0.704**
		MRR@10	0.344	0.381	0.002	0.000	0.347	**0.383**
50%	Tran	R@10	0.312	0.317	0.002	0.015	0.473	**0.639**
		N@10	0.308	0.234	0.006	0.012	0.329	**0.405**
		P@10	0.020	0.028	0.000	0.003	0.050	**0.067**
		F1@10	0.040	0.049	0.002	0.006	0.090	**0.120**
		Hits@10	0.322	0.265	0.010	0.020	0.476	**0.646**
		MRR@10	0.303	0.196	0.002	0.001	0.286	**0.334**
	Semi	R@10	0.320	0.397	0.000	0.000	0.527	**0.670**
		N@10	0.253	0.304	0.000	0.000	0.333	**0.404**
		P@10	0.020	0.010	0.000	0.000	0.053	**0.067**
		F1@10	0.008	0.063	0.000	0.000	0.096	**0.122**
		Hits@10	0.347	0.382	0.010	0.020	0.530	**0.674**
		MRR@10	0.293	0.244	0.002	0.000	0.273	**0.322**
	Ind	R@10	0.363	0.347	0.000	0.000	0.543	**0.625**
		N@10	0.272	0.236	0.000	0.000	0.367	**0.409**
		P@10	0.010	0.020	0.000	0.000	0.055	**0.063**
		F1@10	0.001	0.000	0.000	0.000	0.100	**0.115**
		Hits@10	0.360	0.352	0.010	0.000	0.546	**0.632**
		MRR@10	0.238	0.221	0.002	0.000	0.315	**0.345**
25%	Tran	R@10	0.164	0.159	0.000	0.007	0.376	**0.595**
		N@10	0.134	0.107	0.000	0.008	0.225	**0.371**
		P@10	0.010	0.000	0.000	0.000	0.039	**0.061**
		F1@10	0.036	0.000	0.000	0.000	0.071	**0.111**
		Hits@10	0.189	0.138	0.003	0.008	0.388	**0.599**
		MRR@10	0.139	0.089	0.003	0.008	0.181	**0.300**
	Semi	R@10	0.181	0.206	0.000	0.000	0.466	**0.561**
		N@10	0.148	0.170	0.000	0.000	0.307	**0.344**
		P@10	0.020	0.020	0.000	0.000	0.047	**0.057**
		F1@10	0.002	0.002	0.000	0.000	0.085	**0.103**
		Hits@10	0.210	0.180	0.000	0.000	0.470	**0.561**
		MRR@10	0.180	0.107	0.000	0.000	0.259	**0.275**
	Ind	R@10	0.134	0.207	0.000	0.000	0.451	**0.536**
		N@10	0.146	0.158	0.000	0.000	0.270	**0.322**
		P@10	0.020	0.009	0.000	0.000	0.045	**0.054**
		F1@10	0.040	0.000	0.000	0.000	0.082	**0.098**
		Hits@10	0.184	0.205	0.000	0.000	0.454	**0.539**
		MRR@10	0.187	0.124	0.000	0.000	0.216	**0.255**

Table 4: Recall@10 (R@10), nDG@10 (N@10), Precision@10 (P@10), f1-score (f1@10), Mean reciprocal rank (MRR@10), Hits@10 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. Methods with the -RW suffix indicate that their original sampling mechanism has been replaced by our proposed sampling strategy. The best-performing method is indicated in boldface.

MES	Setting	Metric	GAT	SAGE	HAN	HGT	HGNN	MM-SAN
100%	Tran	R@10	0.393	0.435	0.016	0.023	0.342	**0.466**
		N@10	0.215	0.266	0.017	0.020	0.224	**0.298**
		P@10	0.046	0.000	0.003	0.001	0.035	**0.047**
		F1@10	0.047	0.069	0.005	0.003	0.063	**0.085**
		Hits@10	0.406	0.458	0.016	0.033	0.342	**0.467**
		MRR@10	0.185	0.235	0.019	0.011	0.187	**0.245**
	Semi	R@10	0.348	0.349	0.000	0.007	0.335	**0.442**
		N@10	0.227	0.214	0.000	0.003	0.221	**0.289**
		P@10	0.000	0.033	0.000	0.000	0.034	**0.045**
		F1@10	0.038	0.068	0.000	0.000	0.062	**0.081**
		Hits@10	0.352	0.388	0.000	0.009	0.336	**0.444**
		MRR@10	0.229	0.219	0.000	0.002	0.185	**0.242**
	Ind	R@10	0.413	0.392	0.000	0.000	0.302	**0.426**
		N@10	0.269	0.250	0.000	0.000	0.196	**0.273**
		P@10	0.000	0.025	0.000	0.000	0.031	**0.043**
		F1@10	0.051	0.009	0.000	0.000	0.056	**0.078**
		Hits@10	0.344	0.342	0.000	0.000	0.304	**0.428**
		MRR@10	0.184	0.235	0.000	0.000	0.163	**0.225**
75%	Tran	R@10	0.328	0.404	0.008	0.022	0.289	**0.406**
		N@10	0.186	0.173	0.006	0.011	0.188	**0.255**
		P@10	0.000	0.000	0.003	0.000	0.029	**0.041**
		F1@10	0.013	0.000	0.004	0.006	0.053	**0.075**
		Hits@10	0.352	0.360	0.010	0.009	0.290	**0.408**
		MRR@10	0.117	0.127	0.008	0.156	0.156	**0.209**
	Semi	R@10	0.310	0.316	0.000	0.000	0.295	**0.391**
		N@10	0.234	0.207	0.000	0.000	0.190	**0.252**
		P@10	0.000	0.031	0.000	0.000	0.030	**0.040**
		F1@10	0.000	0.067	0.000	0.000	0.054	**0.072**
		Hits@10	0.330	0.349	0.010	0.000	0.296	**0.393**
		MRR@10	0.152	0.160	0.008	0.000	0.157	**0.209**
	Ind	R@10	0.289	0.295	0.000	0.000	0.262	**0.366**
		N@10	0.157	0.176	0.000	0.000	0.169	**0.233**
		P@10	0.000	0.016	0.000	0.000	0.027	**0.037**
		F1@10	0.016	0.031	0.000	0.000	0.041	**0.058**
		Hits@10	0.351	0.287	0.010	0.000	0.263	**0.368**
		MRR@10	0.118	0.154	0.007	0.000	0.141	**0.192**
50%	Tran	R@10	0.266	0.278	0.005	0.015	0.247	**0.353**
		N@10	0.150	0.191	0.005	0.012	0.158	**0.218**
		P@10	0.022	0.000	0.002	0.003	0.025	**0.036**
		F1@10	0.000	0.008	0.004	0.006	0.045	**0.065**
		Hits@10	0.348	0.336	0.011	0.017	0.248	**0.354**
		MRR@10	0.163	0.118	0.007	0.011	0.130	**0.176**
	Semi	R@10	0.281	0.266	0.000	0.000	0.251	**0.340**
		N@10	0.199	0.204	0.000	0.000	0.164	**0.213**
		P@10	0.000	0.000	0.000	0.024	0.025	**0.034**
		F1@10	0.058	0.057	0.000	0.043	0.046	**0.062**
		Hits@10	0.261	0.266	0.011	0.234	0.253	**0.342**
		MRR@10	0.130	0.075	0.005	0.168	0.137	**0.174**
	Ind	R@10	0.281	0.248	0.000	0.000	0.223	**0.317**
		N@10	0.182	0.136	0.000	0.000	0.139	**0.194**
		P@10	0.000	0.000	0.000	0.023	0.023	**0.032**
		F1@10	0.015	0.031	0.000	0.041	0.041	**0.058**
		Hits@10	0.290	0.228	0.000	0.226	0.224	**0.319**
		MRR@10	0.064	0.064	0.000	0.146	0.114	**0.155**
25%	Tran	R@10	0.277	0.236	0.003	0.007	0.193	**0.311**
		N@10	0.112	0.115	0.002	0.007	0.120	**0.184**
		P@10	0.015	0.000	0.000	0.000	0.020	**0.031**
		F1@10	0.015	0.000	0.000	0.000	0.035	**0.057**
		Hits@10	0.258	0.240	0.003	0.008	0.194	**0.312**
		MRR@10	0.122	0.111	0.003	0.008	0.097	**0.145**
	Semi	R@10	0.264	0.228	0.000	0.024	0.187	**0.293**
		N@10	0.128	0.109	0.000	0.000	0.117	**0.174**
		P@10	0.000	0.000	0.000	0.000	0.019	**0.030**
		F1@10	0.000	0.000	0.000	0.022	0.034	**0.054**
		Hits@10	0.275	0.288	0.000	0.121	0.189	**0.295**
		MRR@10	0.093	0.105	0.000	0.080	0.095	**0.138**
	Ind	R@10	0.223	0.234	0.000	0.003	0.182	**0.270**
		N@10	0.144	0.063	0.000	0.000	0.113	**0.162**
		P@10	0.000	0.000	0.000	0.011	0.019	**0.027**
		F1@10	0.028	0.000	0.000	0.000	0.034	**0.050**
		Hits@10	0.225	0.175	0.008	0.012	0.184	**0.272**
		MRR@10	0.080	0.102	0.005	0.007	0.093	**0.130**

Table 5: Recall@20 (R@20), nDG@20 (N@20), Precision@20 (P@20), f1-score (f1@20), Mean reciprocal rank (MRR@20), Hits@20 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. Methods with the -RW suffix indicate that their original sampling mechanism has been replaced by our proposed sampling strategy. The best-performing method is indicated in boldface.

MES	Setting	Metric	GAT	SAGE	HAN	HGT	HGNN	MM-SAN
100%	Tran	R@20	0.769	0.747	0.016	0.023	0.707	**0.867**
		N@20	0.563	0.570	0.017	0.020	0.468	**0.584**
		P@20	0.039	0.041	0.003	0.001	0.037	**0.046**
		F1@20	0.031	0.043	0.005	0.003	0.070	**0.086**
		Hits@20	0.811	0.824	0.016	0.033	0.714	**0.871**
		MRR@20	0.486	0.491	0.019	0.011	0.395	**0.498**
	Semi	R@20	0.730	0.768	0.000	0.007	0.723	**0.886**
		N@20	0.568	0.542	0.000	0.003	0.457	**0.573**
		P@20	0.004	0.000	0.000	0.000	0.037	**0.045**
		F1@20	0.080	0.077	0.000	0.000	0.070	**0.086**
		Hits@20	0.735	0.777	0.000	0.009	0.727	**0.886**
		MRR@20	0.476	0.476	0.000	0.002	0.375	**0.477**
	Ind	R@20	0.738	0.778	0.000	0.000	0.711	**0.809**
		N@20	0.554	0.554	0.000	0.000	0.460	**0.555**
		P@20	0.030	0.013	0.000	0.000	0.036	**0.041**
		F1@20	0.033	0.009	0.000	0.000	0.069	**0.078**
		Hits@20	0.758	0.766	0.000	0.000	0.711	**0.809**
		MRR@20	0.436	0.472	0.000	0.000	0.383	**0.477**
75%	Tran	R@20	0.558	0.540	0.008	0.022	0.609	**0.765**
		N@20	0.444	0.449	0.006	0.011	0.381	**0.495**
		P@20	0.000	0.000	0.003	0.000	0.032	**0.040**
		F1@20	0.000	0.000	0.004	0.006	0.061	**0.076**
		Hits@20	0.605	0.532	0.010	0.009	0.619	**0.769**
		MRR@20	0.411	0.400	0.008	0.003	0.314	**0.412**
	Semi	R@20	0.569	0.556	0.000	0.000	0.674	**0.818**
		N@20	0.410	0.393	0.000	0.000	0.388	**0.466**
		P@20	0.022	0.000	0.000	0.000	0.034	**0.041**
		F1@20	0.021	0.046	0.000	0.000	0.065	**0.079**
		Hits@20	0.516	0.542	0.000	0.000	0.674	**0.826**
		MRR@20	0.360	0.327	0.000	0.000	0.300	**0.361**
	Ind	R@20	0.613	0.617	0.000	0.000	0.658	**0.799**
		N@20	0.479	0.436	0.000	0.000	0.422	**0.480**
		P@20	0.000	0.000	0.000	0.000	0.034	**0.040**
		F1@20	0.041	0.016	0.000	0.000	0.064	**0.077**
		Hits@20	0.594	0.568	0.000	0.000	0.658	**0.803**
		MRR@20	0.388	0.383	0.000	0.000	0.354	**0.477**
50%	Tran	R@20	0.313	0.337	0.005	0.015	0.561	**0.779**
		N@20	0.263	0.217	0.005	0.012	0.351	**0.440**
		P@20	0.000	0.000	0.000	0.000	0.030	**0.041**
		F1@20	0.027	0.011	0.004	0.006	0.056	**0.077**
		Hits@20	0.340	0.345	0.011	0.017	0.565	**0.789**
		MRR@20	0.230	0.201	0.007	0.011	0.292	**0.344**
	Semi	R@20	0.349	0.382	0.000	0.024	0.629	**0.758**
		N@20	0.291	0.333	0.000	0.000	0.360	**0.427**
		P@20	0.014	0.000	0.000	0.000	0.032	**0.039**
		F1@20	0.021	0.041	0.000	0.000	0.061	**0.073**
		Hits@20	0.357	0.333	0.011	0.000	0.629	**0.758**
		MRR@20	0.218	0.212	0.005	0.000	0.280	**0.328**
	Ind	R@20	0.321	0.290	0.000	0.000	0.582	**0.691**
		N@20	0.270	0.213	0.000	0.000	0.376	**0.426**
		P@20	0.000	0.000	0.000	0.000	0.026	**0.035**
		F1@20	0.001	0.012	0.000	0.000	0.049	**0.062**
		Hits@20	0.321	0.169	0.000	0.000	0.513	**0.651**
		MRR@20	0.199	0.169	0.000	0.000	0.317	**0.349**
25%	Tran	R@20	0.113	0.150	0.000	0.000	0.460	**0.667**
		N@20	0.132	0.066	0.000	0.000	0.247	**0.389**
		P@20	0.033	0.000	0.000	0.000	0.024	**0.051**
		F1@20	0.040	0.000	0.000	0.000	0.046	**0.065**
		Hits@20	0.139	0.126	0.003	0.008	0.563	**0.667**
		MRR@20	0.129	0.064	0.003	0.008	0.187	**0.305**
	Semi	R@20	0.160	0.196	0.000	0.000	0.530	**0.705**
		N@20	0.112	0.121	0.000	0.000	0.324	**0.381**
		P@20	0.022	0.008	0.000	0.000	0.027	**0.036**
		F1@20	0.040	0.000	0.000	0.026	0.051	**0.068**
		Hits@20	0.245	0.176	0.000	0.000	0.530	**0.705**
		MRR@20	0.125	0.141	0.000	0.000	0.264	**0.285**
	Ind	R@20	0.217	0.134	0.000	0.000	0.513	**0.645**
		N@20	0.147	0.129	0.000	0.000	0.286	**0.350**
		P@20	0.010	0.010	0.000	0.000	0.026	**0.033**
		F1@20	0.015	0.012	0.000	0.000	0.049	**0.062**
		Hits@20	0.184	0.169	0.000	0.000	0.513	**0.651**
		MRR@20	0.118	0.087	0.000	0.000	0.220	**0.263**

Table 6: Recall@20 (R@20), nDG@20 (N@20), Precision@20 (P@20), f1-score (f1@20), Mean reciprocal rank (MRR@20), Hits@20 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] **indicates the percentage of datasets having textual metadata. Methods with the -RW suffix indicate that their original sampling mechanism has been replaced by our proposed sampling strategy. The best-performing method is indicated in boldface.**

PubMed	Setting	Metric	GAT	SAGE	HAN	HGT	HGNN	MM-SAN
100%	Tran	R@20	0.513	0.505	0.016	0.023	0.396	**0.528**
		N@20	0.303	0.300	0.017	0.020	0.238	**0.313**
		P@20	0.011	0.000	0.003	0.001	0.020	**0.027**
		F1@20	0.032	0.016	0.005	0.003	0.038	**0.077**
		Hits@20	0.596	0.556	0.016	0.033	0.398	**0.529**
		MRR@20	0.248	0.242	0.019	0.011	0.191	**0.290**
	Semi	R@20	0.506	0.484	0.000	0.007	0.388	**0.511**
		N@20	0.264	0.264	0.000	0.003	0.234	**0.307**
		P@20	0.019	0.000	0.000	0.000	0.020	**0.026**
		F1@20	0.022	0.001	0.000	0.000	0.037	**0.049**
		Hits@20	0.521	0.497	0.000	0.009	0.390	**0.513**
		MRR@20	0.226	0.216	0.000	0.000	0.189	**0.247**
	Ind	R@20	0.439	0.416	0.000	0.000	0.352	**0.496**
		N@20	0.280	0.267	0.000	0.308	0.209	**0.291**
		P@20	0.014	0.022	0.000	0.000	0.018	**0.025**
		F1@20	0.043	0.039	0.000	0.000	0.034	**0.048**
		Hits@20	0.453	0.480	0.000	0.000	0.394	**0.499**
		MRR@20	0.235	0.235	0.000	0.259	0.167	**0.230**
75%	Tran	R@20	0.312	0.301	0.000	0.000	0.342	**0.486**
		N@20	0.260	0.182	0.000	0.000	0.201	**0.276**
		P@20	0.021	0.000	0.000	0.000	0.017	**0.025**
		F1@20	0.023	0.002	0.000	0.000	0.033	**0.047**
		Hits@20	0.401	0.387	0.000	0.000	0.343	**0.488**
		MRR@20	0.149	0.140	0.000	0.000	0.160	**0.214**
	Semi	R@20	0.327	0.286	0.000	0.000	0.335	**0.462**
		N@20	0.228	0.213	0.000	0.000	0.200	**0.290**
		P@20	0.008	0.000	0.000	0.000	0.017	**0.023**
		F1@20	0.041	0.010	0.000	0.000	0.032	**0.045**
		Hits@20	0.329	0.284	0.000	0.000	0.335	**0.463**
		MRR@20	0.205	0.205	0.000	0.000	0.160	**0.234**
	Ind	R@20	0.320	0.267	0.000	0.000	0.306	**0.427**
		N@20	0.225	0.194	0.000	0.000	0.180	**0.249**
		P@20	0.002	0.000	0.000	0.000	0.016	**0.025**
		F1@20	0.017	0.000	0.000	0.000	0.030	**0.037**
		Hits@20	0.410	0.328	0.000	0.000	0.309	**0.429**
		MRR@20	0.136	0.111	0.000	0.000	0.144	**0.197**
50%	Tran	R@20	0.290	0.170	0.000	0.000	0.305	**0.424**
		N@20	0.153	0.109	0.000	0.000	0.173	**0.236**
		P@20	0.016	0.011	0.000	0.000	0.015	**0.051**
		F1@20	0.018	0.012	0.000	0.000	0.029	**0.051**
		Hits@20	0.272	0.195	0.000	0.000	0.306	**0.426**
		MRR@20	0.097	0.062	0.000	0.000	0.134	**0.182**
	Semi	R@20	0.367	0.168	0.000	0.000	0.294	**0.415**
		N@20	0.210	0.161	0.000	0.000	0.175	**0.232**
		P@20	0.002	0.000	0.000	0.000	0.015	**0.021**
		F1@20	0.031	0.000	0.000	0.000	0.028	**0.040**
		Hits@20	0.413	0.213	0.000	0.000	0.296	**0.418**
		MRR@20	0.096	0.095	0.000	0.000	0.140	**0.179**
	Ind	R@20	0.281	0.107	0.000	0.000	0.269	**0.382**
		N@20	0.113	0.094	0.000	0.000	0.151	**0.210**
		P@20	0.008	0.000	0.000	0.000	0.014	**0.019**
		F1@20	0.031	0.000	0.000	0.000	0.026	**0.037**
		Hits@20	0.186	0.154	0.000	0.000	0.270	**0.385**
		MRR@20	0.159	0.136	0.000	0.000	0.117	**0.160**
25%	Tran	R@20	0.202	0.101	0.000	0.000	0.236	**0.382**
		N@20	0.192	0.061	0.000	0.000	0.131	**0.202**
		P@20	0.001	0.000	0.000	0.000	0.012	**0.019**
		F1@20	0.023	0.000	0.000	0.000	0.023	**0.037**
		Hits@20	0.144	0.037	0.003	0.008	0.237	**0.383**
		MRR@20	0.051	0.000	0.003	0.008	0.100	**0.150**
	Semi	R@20	0.293	0.049	0.000	0.000	0.226	**0.370**
		N@20	0.145	0.067	0.000	0.000	0.126	**0.194**
		P@20	0.004	0.000	0.000	0.000	0.011	**0.019**
		F1@20	0.023	0.004	0.000	0.000	0.022	**0.036**
		Hits@20	0.242	0.097	0.000	0.000	0.228	**0.372**
		MRR@20	0.070	0.040	0.000	0.000	0.098	**0.144**
	Ind	R@20	0.120	0.107	0.000	0.000	0.224	**0.345**
		N@20	0.119	0.004	0.000	0.000	0.124	**0.181**
		P@20	0.003	0.000	0.000	0.000	0.011	**0.017**
		F1@20	0.031	0.000	0.000	0.000	0.022	**0.033**
		Hits@20	0.342	0.029	0.000	0.000	0.226	**0.346**
		MRR@20	0.010	0.000	0.000	0.000	0.095	**0.135**

Table 7: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@5 (R@5), nDG@5 (N@5), Precision@5 (P@5), f1-score (f1@5), Mean reciprocal rank (MRR@5), Hits@5 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.

MES	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MMSAN
0%	Tran	R@5	0.625	0.700	12.000	0.489	0.610	24.700	0.581	0.700	20.500	**0.727**
		N@5	0.475	0.520	9.500	0.398	0.510	28.100	0.438	0.520	18.800	**0.546**
		P@5	0.145	0.150	3.400	0.142	0.148	4.200	0.120	0.145	20.800	**0.152**
		F1@5	0.240	0.246	2.500	0.236	0.244	3.400	0.198	0.240	21.200	**0.250**
		Hits@5	0.711	0.721	1.400	0.719	0.735	2.200	0.580	0.725	25.100	**0.741**
		MRR@5	**0.482**	0.490	1.600	0.448	0.470	4.900	0.378	0.480	26.900	0.484
	Semi	R@5	0.621	0.700	12.700	0.446	0.600	34.400	0.587	0.700	19.300	**0.719**
		N@5	0.479	0.490	2.300	0.316	0.400	37.800	0.417	0.510	22.300	**0.524**
		P@5	0.141	0.145	2.800	0.155	0.160	3.200	0.118	0.138	16.900	**0.145**
		F1@5	0.242	0.241	0.400	0.236	0.238	0.800	0.197	0.230	16.700	**0.242**
		Hits@5	0.723	0.721	0.300	0.716	0.710	0.900	0.591	0.720	21.900	**0.727**
		MRR@5	0.454	0.456	0.400	0.447	0.455	1.800	0.362	0.450	24.400	**0.461**
	Ind	R@5	0.590	0.622	5.400	0.439	0.512	16.700	0.582	0.634	8.900	**0.687**
		N@5	0.442	0.513	16.000	0.315	0.346	18.700	0.422	0.475	12.600	**0.519**
		P@5	0.123	0.136	10.700	0.133	0.145	9.200	0.118	0.120	1.700	**0.149**
		F1@5	0.226	0.232	2.600	0.225	0.230	2.200	0.196	0.202	3.100	**0.232**
		Hits@5	0.611	0.627	2.600	0.607	0.631	3.900	0.586	0.644	9.900	**0.691**
		MRR@5	0.434	0.437	0.700	0.437	0.438	0.200	0.370	0.377	1.800	**0.466**
75%	Tran	R@5	0.481	0.511	6.200	0.352	0.372	5.700	0.573	0.593	3.500	**0.623**
		N@5	0.370	0.391	5.700	0.294	0.314	6.900	0.356	0.387	8.600	**0.447**
		P@5	0.118	0.132	11.900	0.119	0.123	3.400	0.101	0.103	2.100	**0.128**
		F1@5	0.198	0.204	3.000	0.193	0.202	4.700	0.164	0.172	4.900	**0.210**
		Hits@5	0.484	0.518	7.000	0.472	0.478	1.300	0.556	0.598	7.600	**0.659**
		MRR@5	0.491	**0.499**	1.600	0.451	0.493	9.300	0.300	0.309	3.000	0.495
	Semi	R@5	0.483	0.501	3.700	0.332	0.393	18.400	0.515	0.545	5.800	**0.598**
		N@5	0.404	0.434	7.400	0.247	0.306	23.800	0.373	0.387	3.800	**0.442**
		P@5	0.101	0.109	7.900	0.106	**0.111**	4.700	0.103	0.102	1.000	0.106
		F1@5	0.173	0.181	4.600	0.180	0.184	2.300	0.172	0.181	5.300	**0.187**
		Hits@5	0.516	0.525	1.700	0.449	0.503	11.900	0.515	0.552	7.200	**0.630**
		MRR@5	0.393	0.398	1.300	0.377	0.391	3.700	0.283	0.292	3.200	**0.398**
	Ind	R@5	0.409	0.432	5.600	0.325	0.354	9.100	0.523	0.549	5.000	**0.598**
		N@5	0.324	0.338	4.300	0.235	0.241	2.400	0.383	0.385	0.500	**0.468**
		P@5	0.111	0.114	2.700	0.110	0.116	5.500	0.096	0.098	1.700	**0.116**
		F1@5	0.183	0.191	4.400	0.186	0.192	3.200	0.159	0.163	2.500	**0.192**
		Hits@5	0.458	0.476	3.900	0.463	0.502	8.400	0.580	0.599	3.300	**0.609**
		MRR@5	0.443	**0.449**	1.300	0.383	0.417	8.900	0.336	0.355	5.600	0.368
50%	Tran	R@5	0.361	0.399	10.600	0.286	0.309	8.100	0.443	0.453	2.300	**0.539**
		N@5	0.319	0.337	5.600	0.212	0.260	22.600	0.324	0.367	13.300	**0.398**
		P@5	0.069	0.071	2.900	0.066	0.072	9.100	0.083	0.093	11.900	**0.102**
		F1@5	0.111	0.116	4.500	0.117	0.118	0.800	0.136	0.139	2.200	**0.168**
		Hits@5	0.337	0.360	6.800	0.400	0.401	0.300	0.451	0.460	2.000	**0.563**
		MRR@5	0.311	0.337	8.400	0.282	0.292	3.600	0.276	0.292	5.800	**0.340**
	Semi	R@5	0.349	0.380	8.900	0.240	0.263	9.600	0.484	0.500	3.300	**0.518**
		N@5	0.277	0.302	9.100	0.209	0.256	22.400	0.352	0.371	5.400	**0.359**
		P@5	0.069	0.076	10.100	0.075	0.083	10.800	0.077	0.081	5.100	**0.108**
		F1@5	0.123	0.126	2.400	0.130	0.139	6.900	0.129	0.130	0.800	**0.179**
		Hits@5	0.372	0.389	4.600	0.414	0.417	0.700	0.486	0.502	3.300	**0.538**
		MRR@5	0.302	0.303	0.300	0.295	0.296	0.300	0.253	0.257	1.600	**0.303**
	Ind	R@5	0.321	0.376	17.100	0.196	0.211	7.600	0.434	0.457	5.300	**0.526**
		N@5	0.258	0.276	7.000	0.150	0.177	18.100	0.339	0.357	5.300	**0.391**
		P@5	0.063	0.067	6.300	0.059	0.066	12.000	0.092	0.100	7.400	**0.099**
		F1@5	0.108	0.111	2.800	0.100	0.109	9.000	0.153	0.157	2.500	**0.164**
		Hits@5	0.333	0.386	15.900	0.380	0.399	5.000	0.461	0.471	2.100	**0.558**
		MRR@5	0.273	0.281	2.900	0.243	0.281	15.700	0.304	0.306	0.700	**0.326**
25%	Tran	R@5	0.230	0.278	21.000	0.190	0.201	5.800	0.336	0.357	6.300	**0.467**
		N@5	0.203	0.203	0.000	0.165	0.165	0.000	0.242	0.242	0.000	**0.329**
		P@5	0.032	0.039	21.900	0.030	0.038	26.700	0.060	0.064	6.600	**0.095**
		F1@5	0.063	0.064	1.600	0.060	0.062	3.300	0.098	0.100	2.000	**0.157**
		Hits@5	0.245	0.281	14.700	0.331	0.340	2.800	0.340	0.375	10.100	**0.473**
		MRR@5	0.250	0.260	4.000	0.200	0.232	16.000	0.169	0.173	2.400	**0.283**
	Semi	R@5	0.206	0.282	37.100	0.145	0.190	31.000	0.367	0.401	9.200	**0.454**
		N@5	0.172	0.191	11.100	0.125	0.189	51.100	0.270	0.301	11.400	**0.306**
		P@5	0.042	0.047	11.900	0.045	0.047	4.400	0.074	0.079	6.800	**0.086**
		F1@5	0.070	0.078	11.400	0.072	0.078	8.600	0.123	0.129	4.900	**0.144**
		Hits@5	0.235	0.330	40.300	0.292	0.320	9.400	0.371	0.410	10.600	**0.462**
		MRR@5	0.177	0.181	2.300	0.186	0.198	6.500	0.247	0.256	4.100	**0.256**
	Ind	R@5	0.159	0.176	10.700	0.075	0.075	0.000	0.322	0.367	13.900	**0.453**
		N@5	0.128	0.128	0.000	0.069	0.069	0.000	0.233	0.233	0.000	**0.321**
		P@5	0.035	0.042	20.000	0.035	0.043	22.900	0.058	0.063	8.600	**0.088**
		F1@5	0.060	0.070	16.700	0.063	0.072	14.300	0.096	0.103	7.300	**0.147**
		Hits@5	0.203	0.211	3.900	0.214	0.217	1.400	0.340	0.378	11.100	**0.441**
		MRR@5	0.186	0.190	2.100	0.174	0.188	8.100	0.194	0.201	3.500	**0.241**

Table 8: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@5 (R@5), nDG@5 (N@5), Precision@5 (P@5), f1-score (f1@5), Mean reciprocal rank (MRR@5), Hits@5 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.

PubMed	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MM-SAN
100%	Tran	R@5	0.241	0.298	23.654	0.239	0.278	16.412	0.284	0.301	5.963	**0.380**
		N@5	0.181	0.202	11.629	0.179	0.201	12.345	0.202	0.256	26.731	**0.270**
		P@5	0.069	0.076	10.145	0.076	0.076	0.000	0.058	0.070	20.690	**0.077**
		F1@5	0.121	0.125	3.289	0.121	0.126	4.090	0.096	0.106	10.417	**0.127**
		HIT@5	0.300	0.310	3.333	0.267	0.301	12.727	0.286	0.309	8.036	**0.381**
		MRR@5	0.233	0.254	9.024	0.304	0.369	21.228	0.209	0.255	22.021	**0.234**
	Semi	R@5	0.231	0.242	4.762	0.221	0.253	14.457	0.246	0.271	10.204	**0.374**
		N@5	0.171	0.205	19.886	0.161	0.182	13.211	0.198	0.201	1.523	**0.267**
		P@5	0.070	0.075	7.143	0.075	0.075	0.000	0.055	0.072	30.000	**0.076**
		F1@5	0.123	0.125	1.626	0.125	0.125	0.000	0.091	0.125	37.360	**0.126**
		HIT@5	0.254	0.301	18.627	0.297	0.311	4.716	0.273	0.309	13.213	**0.376**
		MRR@5	0.222	0.245	10.351	0.254	0.302	18.633	0.222	0.243	9.423	**0.232**
	Ind	R@5	0.196	0.240	22.448	0.187	0.239	27.747	0.271	0.320	18.073	**0.344**
		N@5	0.134	0.186	38.806	0.133	0.201	51.127	0.199	0.267	34.151	**0.246**
		P@5	0.062	0.069	11.290	0.069	0.069	0.000	0.050	0.069	37.093	**0.070**
		F1@5	0.109	0.115	5.514	0.115	0.115	0.000	0.083	0.115	5.221	**0.116**
		HIT@5	0.289	0.299	3.448	0.209	0.265	26.629	0.301	0.321	6.668	**0.347**
		MRR@5	0.301	0.319	5.985	0.213	0.274	28.662	0.187	0.221	18.216	**0.214**
75%	Tran	R@5	0.201	0.240	19.404	0.183	0.198	8.207	0.241	0.267	10.771	**0.319**
		N@5	0.149	0.167	12.083	0.139	0.145	4.337	0.171	0.193	12.831	**0.227**
		P@5	0.052	0.063	21.154	0.062	0.063	0.000	0.048	0.063	31.250	**0.064**
		F1@5	0.094	0.106	12.765	0.104	0.106	1.923	0.079	0.106	34.177	**0.107**
		HIT@5	0.300	0.318	6.000	0.298	0.310	4.033	0.252	0.278	10.267	**0.319**
		MRR@5	0.196	0.196	0.000	0.196	0.196	0.000	0.149	0.170	13.781	**0.197**
	Semi	R@5	0.186	0.201	8.064	0.174	0.199	14.377	0.237	0.258	8.854	**0.318**
		N@5	0.140	0.167	19.286	0.133	0.167	25.379	0.174	0.192	10.345	**0.228**
		P@5	0.052	0.064	23.077	0.062	0.064	3.226	0.048	0.064	33.333	**0.065**
		F1@5	0.093	0.106	13.978	0.103	0.106	2.921	0.080	0.100	25.000	**0.107**
		HIT@5	0.296	0.318	7.432	0.202	0.265	31.619	0.289	0.295	2.083	**0.319**
		MRR@5	0.198	0.198	0.000	0.198	0.198	0.000	0.150	0.184	22.667	**0.199**
	Ind	R@5	0.145	0.175	20.690	0.136	0.190	39.706	0.202	0.232	14.851	**0.295**
		N@5	0.104	0.165	58.654	0.097	0.102	5.154	0.145	0.188	29.828	**0.210**
		P@5	0.047	0.059	25.532	0.057	0.059	3.509	0.050	0.059	18.000	**0.060**
		F1@5	0.084	0.098	16.667	0.094	0.098	4.255	0.072	0.098	26.389	**0.099**
		HIT@5	0.273	0.288	5.510	0.199	0.229	15.083	0.215	0.227	5.581	**0.297**
		MRR@5	0.132	0.145	9.848	0.142	0.155	9.157	0.135	0.150	11.111	**0.183**
50%	Tran	R@5	0.156	0.198	27.027	0.145	0.168	15.862	0.203	0.213	4.933	**0.272**
		N@5	0.116	0.124	6.897	0.111	0.139	25.232	0.140	0.166	18.571	**0.192**
		P@5	0.034	0.053	55.882	0.044	0.053	20.455	0.041	0.053	29.268	**0.055**
		F1@5	0.062	0.075	21.000	0.072	0.083	15.277	0.069	0.089	28.986	**0.091**
		HIT@5	0.206	0.248	20.370	0.216	0.229	6.018	0.206	0.235	14.084	**0.274**
		MRR@5	0.155	0.163	5.161	0.163	0.163	0.000	0.131	0.159	21.427	**0.166**
	Semi	R@5	0.144	0.165	14.583	0.129	0.132	2.325	0.201	0.210	4.474	**0.268**
		N@5	0.110	0.122	10.909	0.100	0.130	30.000	0.142	0.139	0.000	**0.190**
		P@5	0.031	0.054	74.194	0.041	0.054	31.707	0.040	0.054	35.000	**0.054**
		F1@5	0.059	0.071	20.340	0.069	0.090	30.435	0.066	0.090	28.904	**0.090**
		HIT@5	0.200	0.224	12.000	0.206	0.249	21.008	0.243	0.273	12.343	**0.270**
		MRR@5	0.140	0.165	17.857	0.150	0.175	16.667	0.124	0.165	33.064	**0.164**
	Ind	R@5	0.096	0.132	37.500	0.097	0.122	25.773	0.167	0.199	19.212	**0.246**
		N@5	0.086	0.101	17.441	0.079	0.098	24.051	0.120	0.140	16.667	**0.170**
		P@5	0.030	0.049	63.333	0.040	0.049	22.500	0.035	0.049	40.000	**0.050**
		F1@5	0.056	0.070	25.000	0.066	0.082	24.242	0.058	0.082	41.379	**0.083**
		HIT@5	0.189	0.213	12.672	0.199	0.229	15.076	0.215	0.227	5.887	**0.247**
		MRR@5	0.132	0.145	9.848	0.142	0.155	9.157	0.135	0.150	11.111	**0.183**
25%	Tran	R@5	0.113	0.167	47.787	0.108	0.119	10.185	0.156	0.199	27.500	**0.234**
		N@5	0.084	0.100	19.048	0.089	0.099	11.236	0.108	0.123	13.888	**0.159**
		P@5	0.010	0.021	110.000	0.020	0.046	130.000	0.030	0.046	53.846	**0.047**
		F1@5	0.024	0.063	162.500	0.034	0.060	76.471	0.049	0.077	60.870	**0.078**
		HIT@5	0.120	0.132	10.000	0.110	0.129	17.273	0.140	0.153	9.286	**0.235**
		MRR@5	0.063	0.099	57.143	0.073	0.091	24.658	0.091	0.102	12.155	**0.135**
	Semi	R@5	0.098	0.109	11.224	0.096	0.102	6.250	0.152	0.167	10.666	**0.211**
		N@5	0.077	0.091	18.181	0.075	0.089	18.667	0.107	0.111	3.738	**0.147**
		P@5	0.011	0.026	136.364	0.021	0.042	100.000	0.029	0.042	44.828	**0.043**
		F1@5	0.024	0.067	179.167	0.034	0.060	76.471	0.048	0.070	66.667	**0.071**
		HIT@5	0.178	0.199	11.801	0.155	0.178	14.838	0.205	0.230	12.195	**0.213**
		MRR@5	0.101	0.107	5.940	0.078	0.105	34.615	0.090	0.114	26.079	**0.127**
	Ind	R@5	0.053	0.089	68.868	0.057	0.077	35.088	0.129	0.134	3.883	**0.202**
		N@5	0.038	0.088	131.579	0.043	0.063	46.512	0.090	0.100	10.526	**0.140**
		P@5	0.010	0.022	120.000	0.020	0.034	70.000	0.029	0.040	37.931	**0.041**
		F1@5	0.024	0.063	162.500	0.034	0.045	70.588	0.048	0.067	45.833	**0.068**
		HIT@5	0.091	0.140	53.846	0.101	0.137	35.643	0.144	0.189	31.944	**0.204**
		MRR@5	0.063	0.112	77.778	0.073	0.118	61.643	0.087	0.117	34.483	**0.121**

Table 9: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@10 (R@10), nDG@10 (N@10), Precision@10 (P@10), f1-score (f1@10), Mean reciprocal rank (MRR@10), Hits@10 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] **indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.**

MES	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MM-SAN
100%	Tran	R@10	0.748	0.786	5.089	0.715	0.778	8.817	0.656	0.670	2.141	**0.796**
		N@10	0.641	0.666	3.907	0.573	0.632	10.290	0.455	0.466	2.415	**0.566**
		P@10	0.040	0.065	62.000	0.045	0.085	88.889	0.069	0.081	17.391	**0.084**
		F1@10	0.085	0.153	79.531	0.126	0.153	21.428	0.124	0.127	2.424	**0.151**
		Hits@10	0.765	0.789	3.122	0.794	0.800	0.756	0.660	0.683	3.439	**0.803**
		MRR@10	0.473	0.523	10.573	0.469	0.478	1.910	0.392	0.484	23.470	**0.493**
	Semi	R@10	0.773	0.785	1.552	0.712	0.778	9.259	0.655	0.685	4.854	**0.799**
		N@10	0.528	0.546	3.409	0.504	0.536	6.349	0.439	0.479	9.115	**0.551**
		P@10	0.074	0.082	10.811	0.042	**0.083**	97.619	0.066	0.071	7.578	0.081
		F1@10	0.111	0.139	25.314	0.110	0.141	28.182	0.120	0.135	12.786	**0.147**
		Hits@10	0.692	0.711	2.747	0.720	0.800	11.111	0.659	0.668	1.364	**0.811**
		MRR@10	0.523	0.567	8.421	0.485	0.564	16.331	0.370	0.383	3.513	**0.472**
	Ind	R@10	0.716	0.733	2.376	0.738	0.740	0.270	0.658	0.699	6.232	**0.743**
		N@10	0.526	0.533	1.333	0.519	0.530	2.114	0.447	0.529	18.338	**0.538**
		P@10	0.045	0.080	77.778	0.061	0.078	27.800	0.067	0.081	20.895	**0.086**
		F1@10	0.124	0.127	2.362	0.110	0.132	20.000	0.122	0.130	6.557	**0.137**
		Hits@10	0.726	0.783	7.841	0.767	0.770	0.391	0.658	0.697	5.923	**0.743**
		MRR@10	0.439	0.445	1.364	0.437	0.446	2.062	0.379	0.441	16.353	**0.472**
75%	Tran	R@10	0.568	0.605	6.514	0.522	0.616	17.929	0.534	0.583	9.168	**0.704**
		N@10	0.454	0.474	4.409	0.422	0.473	11.151	0.363	0.442	21.778	**0.480**
		P@10	0.050	0.065	30.000	0.049	0.065	32.105	0.057	0.070	22.808	**0.074**
		F1@10	0.057	0.076	37.509	0.096	0.117	22.917	0.103	0.161	56.341	**0.164**
		Hits@10	0.565	0.612	8.319	0.594	0.619	4.211	0.544	0.617	13.416	**0.707**
		MRR@10	0.395	0.401	1.518	0.324	0.369	13.580	0.309	0.366	18.452	**0.408**
	Semi	R@10	0.480	0.580	20.833	0.505	0.580	14.850	0.598	0.631	5.504	**0.723**
		N@10	0.440	0.442	0.452	0.393	0.448	13.994	0.369	0.433	17.300	**0.441**
		P@10	0.041	0.059	43.902	0.043	0.059	37.143	0.061	**0.127**	107.377	0.073
		F1@10	0.022	0.037	68.364	0.022	0.024	9.090	0.110	0.123	11.818	**0.132**
		Hits@10	0.577	0.583	1.042	0.509	0.583	14.541	0.598	0.620	3.670	**0.727**
		MRR@10	0.349	0.403	15.468	0.398	0.406	2.016	0.295	0.381	29.103	**0.405**
	Ind	R@10	0.510	0.609	19.412	0.525	0.602	14.714	0.562	0.583	3.733	**0.701**
		N@10	0.434	0.451	3.913	0.426	0.455	6.796	0.397	0.444	11.837	**0.455**
		P@10	0.048	0.062	29.167	0.007	0.008	14.429	0.057	0.070	22.807	**0.071**
		F1@10	0.042	0.112	166.667	0.088	0.111	26.136	0.104	0.120	15.384	**0.129**
		Hits@10	0.596	0.612	2.690	0.509	0.605	18.843	0.566	0.611	7.954	**0.704**
		MRR@10	0.344	0.355	3.196	0.381	0.421	10.512	0.347	0.417	20.222	**0.383**
25%	Tran	R@10	0.164	0.195	19.018	0.159	0.188	18.739	0.376	0.458	21.847	**0.595**
		N@10	0.134	0.158	17.910	0.107	0.152	41.682	0.225	0.308	36.944	**0.371**
		P@10	0.010	0.011	10.000	0.015	0.020	25.000	0.039	0.54	37.510	**0.061**
		F1@10	0.036	0.038	5.556	0.000	0.037	0.000	0.071	0.125	76.923	**0.111**
		Hits@10	0.189	0.204	7.946	0.138	0.197	42.393	0.388	0.480	23.759	**0.599**
		MRR@10	0.139	0.153	10.145	0.089	0.147	65.167	0.181	0.187	3.315	**0.300**
	Semi	R@10	0.181	0.250	38.078	0.206	0.250	21.847	0.466	0.489	4.925	**0.561**
		N@10	0.148	0.200	35.135	0.170	0.205	20.588	0.307	0.402	31.001	**0.344**
		P@10	0.020	0.026	30.000	0.020	0.026	30.000	0.047	0.141	33.333	**0.057**
		F1@10	0.002	0.003	50.000	0.002	0.004	100.000	0.085	0.092	8.353	**0.103**
		Hits@10	0.210	0.250	19.048	0.180	0.250	38.889	0.470	0.489	3.809	**0.561**
		MRR@10	0.180	0.183	1.667	0.107	0.192	79.907	0.259	0.350	35.221	**0.275**
	Ind	R@10	0.134	0.217	61.940	0.207	0.217	4.831	0.451	0.474	5.099	**0.536**
		N@10	0.146	0.194	32.877	0.158	0.192	21.523	0.270	0.370	37.037	**0.322**
		P@10	0.020	0.022	10.000	0.009	0.022	144.444	0.045	0.061	44.444	**0.054**
		F1@10	0.040	0.040	0.000	0.040	0.000	0.000	0.082	0.091	11.500	**0.098**
		Hits@10	0.184	0.224	21.739	0.205	0.224	9.756	0.454	0.511	12.509	**0.539**
		MRR@10	0.187	0.189	1.070	0.124	0.186	50.000	0.216	0.299	38.725	**0.255**

Table 10: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@10 (R@10), nDG@10 (N@10), Precision@10 (P@10), f1-score (f1@10), Mean reciprocal rank (MRR@10), Hits@10 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.

MES	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MM-SAN
100%	Tran	R@10	0.393	0.394	0.254	0.435	0.455	4.609	0.342	0.382	11.759	**0.466**
		N@10	0.215	0.236	9.767	0.266	0.321	20.684	0.224	0.265	18.408	**0.298**
		P@10	0.026	0.046	48.000	0.030	0.046	44.000	0.035	0.040	14.280	**0.047**
		F1@10	0.038	0.047	19.148	0.069	0.083	20.290	0.063	0.075	19.048	**0.085**
		Hits@10	0.406	0.456	12.319	0.456	0.458	0.435	0.342	0.392	14.706	**0.467**
		MRR@10	0.185	0.242	30.302	0.235	0.279	18.723	0.187	0.198	5.856	**0.245**
	Semi	R@10	0.348	0.388	11.494	0.349	0.447	28.032	0.335	0.382	13.873	**0.442**
		N@10	0.227	0.247	8.817	0.214	0.324	51.401	0.221	0.258	16.724	**0.289**
		P@10	0.020	0.032	60.000	0.033	0.045	36.364	0.034	0.054	58.588	**0.045**
		F1@10	0.038	0.054	42.105	0.068	0.082	20.588	0.062	0.064	3.226	**0.081**
		Hits@10	0.352	0.425	20.732	0.388	0.448	15.573	0.336	0.351	4.463	**0.444**
		MRR@10	0.229	0.231	0.873	0.219	0.285	30.145	0.185	0.224	21.108	**0.242**
	Ind	R@10	0.413	0.457	10.677	0.392	0.418	6.633	0.302	0.417	38.413	**0.426**
		N@10	0.269	0.272	3.344	0.250	0.294	17.647	0.196	0.234	19.387	**0.273**
		P@10	0.010	0.019	90.000	0.025	0.042	68.000	0.031	0.061	100.000	**0.043**
		F1@10	0.051	0.063	94.118	0.009	0.017	100.556	0.056	0.080	36.000	**0.078**
		Hits@10	0.344	0.352	1.736	0.342	0.421	23.106	0.304	0.341	12.114	**0.428**
		MRR@10	0.184	0.220	19.565	0.130	0.256	96.923	0.163	0.167	2.448	**0.225**
75%	Tran	R@10	0.328	0.390	18.902	0.404	0.439	12.646	0.289	0.384	32.893	**0.406**
		N@10	0.186	0.189	1.613	0.173	0.256	47.950	0.188	0.250	33.620	**0.255**
		P@10	0.000	0.000	0.000	0.036	0.040	12.300	0.029	0.040	11.976	**0.041**
		F1@10	0.013	0.030	102.000	0.030	0.065	101.000	0.053	0.059	11.797	**0.075**
		Hits@10	0.320	0.352	9.091	0.354	0.360	1.667	0.290	0.381	31.414	**0.408**
		MRR@10	0.117	0.150	28.205	0.127	0.225	76.775	0.133	0.156	14.744	**0.209**
	Semi	R@10	0.310	0.313	1.290	0.316	0.349	10.426	0.295	0.366	24.151	**0.391**
		N@10	0.234	0.286	23.936	0.207	0.254	22.715	0.190	0.195	2.632	**0.252**
		P@10	0.000	0.000	0.000	0.036	0.000	0.000	0.030	0.036	23.452	**0.040**
		F1@10	0.002	0.005	100.000	0.067	0.074	4.493	0.054	0.072	77.778	**0.072**
		Hits@10	0.330	0.375	13.636	0.349	0.350	0.286	0.296	0.310	4.735	**0.393**
		MRR@10	0.152	0.165	24.342	0.160	0.225	40.625	0.157	0.162	3.189	**0.209**
	Ind	R@10	0.289	0.359	24.207	0.295	0.326	10.517	0.262	0.358	36.518	**0.366**
		N@10	0.157	0.220	40.761	0.176	0.235	33.333	0.169	0.180	6.526	**0.233**
		P@10	0.000	0.000	0.000	0.023	0.000	0.000	0.023	0.025	15.203	**0.032**
		F1@10	0.016	0.043	43.750	0.031	0.041	32.258	0.048	0.085	69.583	**0.067**
		Hits@10	0.351	0.372	5.397	0.287	0.329	14.674	0.263	0.341	29.680	**0.368**
		MRR@10	0.118	0.176	49.152	0.154	0.207	34.481	0.141	0.180	29.577	**0.225**
25%	Tran	R@10	0.277	0.303	9.379	0.236	0.245	10.847	0.193	0.298	54.438	**0.311**
		N@10	0.112	0.160	42.857	0.115	0.185	60.000	0.120	0.138	15.385	**0.184**
		P@10	0.015	0.030	100.000	0.006	0.012	100.000	0.020	0.035	75.000	**0.031**
		F1@10	0.015	0.030	100.000	0.000	0.021	40.000	0.035	0.048	37.142	**0.057**
		Hits@10	0.258	0.295	14.355	0.240	0.310	50.000	0.194	0.298	53.333	**0.312**
		MRR@10	0.122	0.157	19.672	0.111	0.143	32.432	0.097	0.153	45.360	**0.145**
	Semi	R@10	0.264	0.294	15.151	0.228	0.262	47.368	0.187	0.195	4.274	**0.293**
		N@10	0.128	0.138	7.812	0.109	0.123	12.650	0.117	0.160	36.557	**0.174**
		P@10	0.000	0.000	0.000	0.012	0.030	106.000	0.010	0.019	50.000	**0.030**
		F1@10	0.000	0.000	0.000	0.022	0.000	0.000	0.034	0.052	43.294	**0.054**
		Hits@10	0.275	0.277	1.091	0.288	0.320	57.634	0.253	0.322	27.295	**0.342**
		MRR@10	0.053	0.091	45.565	0.080	0.105	23.810	0.048	0.095	49.474	**0.138**
	Ind	R@10	0.223	0.254	13.874	0.234	0.261	11.448	0.182	0.246	35.209	**0.270**
		N@10	0.144	0.161	11.111	0.063	0.083	31.746	0.113	0.132	16.817	**0.162**
		P@10	0.000	0.000	0.000	0.011	0.000	0.000	0.019	0.030	28.124	**0.027**
		F1@10	0.028	0.042	50.000	0.000	0.020	100.000	0.026	0.034	23.529	**0.050**
		Hits@10	0.225	0.229	1.778	0.175	0.182	36.000	0.184	0.232	26.087	**0.272**
		MRR@10	0.080	0.111	38.750	0.102	0.175	46.470	0.093	0.120	60.215	**0.130**

Table 11: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@20 (R@20), nDG@20 (N@20), Precision@20 (P@20), f1-score (f1@20), Mean reciprocal rank (MRR@20), Hits@20 scores over the MES dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] **indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.**

MES	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MM-SAN
100%	Tran	R@20	0.769	0.833	8.319	0.747	0.840	12.465	0.707	0.773	9.339	**0.867**
		N@20	0.563	0.583	3.550	0.570	0.580	1.754	0.468	0.470	0.426	**0.584**
		P@20	0.039	0.044	12.821	0.041	0.044	7.317	0.037	0.045	21.622	**0.046**
		F1@20	0.031	0.083	167.741	0.043	0.084	95.327	0.070	0.082	17.143	**0.086**
		Hits@20	0.811	0.837	3.211	0.824	0.844	2.422	0.714	0.726	1.679	**0.871**
		MRR@20	0.486	0.490	0.823	0.491	0.495	0.816	0.395	0.410	3.797	**0.498**
	Semi	R@20	0.730	0.833	14.113	0.768	0.867	13.001	0.723	0.764	5.658	**0.886**
		N@20	0.568	0.572	0.701	0.542	0.559	3.134	0.457	0.466	1.975	**0.573**
		P@20	0.004	0.042	950.000	0.020	0.044	100.000	0.037	0.044	18.920	**0.045**
		F1@20	0.080	0.081	1.250	0.077	0.084	9.092	0.070	0.083	18.571	**0.086**
		Hits@20	0.735	0.833	13.333	0.777	0.871	12.062	0.727	0.760	4.536	**0.886**
		MRR@20	0.476	0.486	2.105	0.476	0.487	2.313	0.375	0.387	3.200	**0.477**
	Ind	R@20	0.738	0.808	9.495	0.778	0.806	3.594	0.711	0.717	0.843	**0.809**
		N@20	0.554	0.554	0.000	0.554	0.612	10.477	0.460	0.491	6.452	**0.555**
		P@20	0.030	0.040	33.333	0.013	0.041	215.385	0.036	0.040	11.111	**0.041**
		F1@20	0.033	0.077	133.333	0.009	0.079	777.778	0.069	0.077	11.594	**0.078**
		Hits@20	0.758	0.808	6.603	0.766	0.816	6.537	0.711	0.773	8.703	**0.809**
		MRR@20	0.436	0.446	2.294	0.472	0.479	1.479	0.383	0.454	18.502	**0.477**
75%	Tran	R@20	0.558	0.636	14.027	0.540	0.622	15.185	0.609	0.697	14.457	**0.765**
		N@20	0.444	0.454	2.248	0.449	0.495	10.225	0.381	0.471	23.642	**0.495**
		P@20	0.000	0.034	3400.000	0.000	0.033	0.000	0.032	0.039	21.429	**0.040**
		F1@20	0.000	0.064	6400.000	0.040	0.062	48.000	0.061	0.075	22.951	**0.076**
		Hits@20	0.605	0.639	5.626	0.532	0.626	17.675	0.619	0.718	16.001	**0.769**
		MRR@20	0.411	0.411	0.000	0.400	0.410	2.500	0.314	0.317	0.955	**0.412**
	Semi	R@20	0.569	0.598	5.098	0.556	0.614	10.400	0.674	0.740	9.797	**0.818**
		N@20	0.410	0.450	9.756	0.393	0.457	16.283	0.388	0.465	19.872	**0.466**
		P@20	0.022	0.031	40.909	0.000	0.031	3100.000	0.034	0.040	17.647	**0.041**
		F1@20	0.021	0.042	100.000	0.046	0.060	30.435	0.065	0.078	20.000	**0.079**
		Hits@20	0.516	0.598	15.917	0.542	0.614	13.302	0.674	0.762	13.083	**0.826**
		MRR@20	0.360	0.360	0.000	0.327	0.407	24.475	0.300	0.360	20.000	**0.361**
	Ind	R@20	0.613	0.622	1.469	0.617	0.641	3.880	0.658	0.736	11.855	**0.799**
		N@20	0.479	0.479	0.000	0.436	0.475	8.973	0.422	0.426	0.949	**0.480**
		P@20	0.020	0.032	43.000	0.000	0.033	0.000	0.034	0.039	14.706	**0.041**
		F1@20	0.041	0.060	46.341	0.016	0.062	287.500	0.069	0.077	11.594	**0.078**
		Hits@20	0.594	0.625	5.214	0.568	0.645	13.531	0.711	0.773	8.718	**0.809**
		MRR@20	0.388	0.388	0.000	0.383	0.424	10.688	0.383	0.454	18.574	**0.477**
50%	Tran	R@20	0.313	0.374	19.472	0.337	0.395	17.215	0.561	0.653	16.359	**0.779**
		N@20	0.263	0.331	26.042	0.217	0.311	43.249	0.351	0.374	6.550	**0.440**
		P@20	0.018	0.020	11.000	0.000	0.021	0.000	0.030	0.040	33.333	**0.041**
		F1@20	0.027	0.037	37.037	0.011	0.039	254.545	0.056	0.076	34.667	**0.077**
		Hits@20	0.340	0.381	12.000	0.345	0.401	16.230	0.565	0.577	2.124	**0.789**
		MRR@20	0.230	0.321	39.565	0.201	0.289	43.286	0.292	0.318	8.849	**0.344**
	Semi	R@20	0.349	0.436	25.030	0.382	0.458	20.000	0.629	0.696	10.648	**0.758**
		N@20	0.291	0.337	15.822	0.333	0.336	0.900	0.360	0.426	18.333	**0.427**
		P@20	0.014	0.022	57.143	0.000	0.023	0.000	0.032	0.038	19.847	**0.039**
		F1@20	0.021	0.042	100.000	0.041	0.044	7.317	0.061	0.072	18.032	**0.073**
		Hits@20	0.357	0.439	23.029	0.409	0.462	13.008	0.629	0.697	10.783	**0.758**
		MRR@20	0.218	0.310	42.227	0.212	0.300	41.509	0.280	0.322	15.000	**0.328**
	Ind	R@20	0.321	0.368	14.622	0.290	0.368	26.897	0.582	0.623	7.042	**0.691**
		N@20	0.270	0.304	12.593	0.213	0.290	36.148	0.376	0.425	13.021	**0.426**
		P@20	0.000	0.019	1900.000	0.000	0.019	0.000	0.030	0.034	13.333	**0.035**
		F1@20	0.004	0.006	20.000	0.026	0.036	38.462	0.049	0.060	22.449	**0.062**
		Hits@20	0.321	0.395	23.049	0.377	0.375	-0.531	0.586	0.625	6.667	**0.697**
		MRR@20	0.199	0.287	44.178	0.169	0.267	58.588	0.317	0.348	9.772	**0.349**
25%	Tran	R@20	0.113	0.209	85.840	0.150	0.209	39.333	0.460	0.507	10.217	**0.667**
		N@20	0.132	0.162	22.727	0.066	0.157	137.879	0.247	0.330	33.541	**0.389**
		P@20	0.033	**0.051**	54.545	0.000	0.011	0.000	0.024	0.033	37.500	0.034
		F1@20	0.040	0.061	52.500	0.000	0.021	47.222	0.046	0.064	39.167	**0.065**
		Hits@20	0.139	0.218	56.788	0.126	0.218	73.015	0.563	0.569	0.536	**0.667**
		MRR@20	0.129	0.154	19.385	0.064	0.148	131.250	0.187	0.234	25.066	**0.305**
	Semi	R@20	0.160	0.258	61.250	0.196	0.265	35.327	0.530	0.621	17.170	**0.705**
		N@20	0.112	0.202	80.357	0.121	0.209	73.553	0.324	0.380	17.213	**0.381**
		P@20	0.022	0.033	50.000	0.008	0.014	75.000	0.027	0.035	29.630	**0.036**
		F1@20	0.040	0.055	37.500	0.000	0.026	150.000	0.051	0.067	31.429	**0.068**
		Hits@20	0.245	0.258	5.316	0.176	0.265	51.137	0.530	0.567	7.021	**0.705**
		MRR@20	0.125	0.184	47.200	0.141	0.193	36.957	0.264	0.284	7.575	**0.285**
	Ind	R@20	0.217	0.230	5.990	0.134	0.217	62.314	0.513	0.578	12.719	**0.645**
		N@20	0.147	0.197	34.015	0.129	0.192	48.440	0.286	0.290	1.418	**0.350**
		P@20	0.010	0.022	120.000	0.010	0.011	10.000	0.026	0.032	23.077	**0.033**
		F1@20	0.015	0.022	46.667	0.012	0.021	75.000	0.049	0.060	22.448	**0.062**
		Hits@20	0.184	0.237	28.804	0.169	0.224	32.456	0.513	0.537	4.684	**0.651**
		MRR@20	0.118	0.190	61.864	0.087	0.186	113.793	0.220	0.262	19.091	**0.263**

Table 12: We report the performances of SAGE, GAT, HGNN, their enhanced versions with our sampling strategy, and MM-SAN. We report recall@20 (R@20), nDG@20 (N@20), Precision@20 (P@20), f1-score (f1@20), Mean reciprocal rank (MRR@20), Hits@20 scores over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. 100% indicates that all the datasets have textual metadata. [75%, 50%, 25%] indicates the percentage of datasets having textual metadata. The columns Gain indicate the percentage gain achieved from the original implementation and its enhanced version with our sampling strategy. In boldface we report the highest performances for each setting and metric.

PubMed	Setting	Metric	GAT	GAT-RW	Gain (GAT)	SAGE	SAGE-RW	Gain (SAGE)	HGNN	HGNN-RW	Gain (HGNN)	MM-SAN
100%	Tran	R@20	0.513	0.525	2.335	0.505	0.516	2.178	0.396	0.427	7.831	**0.528**
		N@20	0.303	0.304	0.330	0.300	0.336	12.000	0.238	0.267	12.167	**0.313**
		P@20	0.011	0.026	136.364	0.010	0.026	210.000	0.020	0.041	105.000	**0.027**
		F1@20	0.032	0.034	6.250	0.016	0.050	212.500	0.038	0.077	102.632	**0.051**
		Hits@20	0.596	0.650	7.718	0.556	0.567	7.030	0.398	0.472	18.184	**0.529**
		MRR@20	0.248	0.249	0.403	0.242	0.283	17.000	0.191	0.194	1.576	**0.290**
	Semi	R@20	0.506	0.510	0.792	0.484	0.493	1.860	0.388	0.391	0.774	**0.511**
		N@20	0.264	0.295	11.702	0.264	0.335	27.021	0.234	0.297	26.923	**0.307**
		P@20	0.019	0.021	10.526	0.010	0.025	250.000	0.020	0.042	110.000	**0.026**
		F1@20	0.022	0.037	68.182	0.021	0.048	470.000	0.037	0.073	97.297	**0.049**
		Hits@20	0.521	0.552	5.945	0.497	0.503	1.205	0.390	0.475	21.795	**0.513**
		MRR@20	0.226	0.228	0.885	0.216	0.288	33.333	0.189	0.252	33.510	**0.247**
	Ind	R@20	0.439	0.457	4.100	0.416	0.473	13.705	0.352	0.440	25.000	**0.496**
		N@20	0.280	0.284	1.429	0.267	0.308	15.343	0.209	0.210	0.478	0.291
		P@20	0.014	0.020	42.857	0.022	0.024	9.091	0.018	0.076	322.222	**0.025**
		F1@20	0.043	0.045	4.651	0.039	0.046	17.949	0.034	0.086	153.333	**0.048**
		Hits@20	0.453	0.487	7.507	0.480	0.495	3.125	0.394	0.461	16.987	**0.499**
		MRR@20	0.235	0.235	0.000	0.235	0.259	10.213	0.167	0.221	32.312	**0.230**
75%	Tran	R@20	0.312	0.485	55.206	0.301	0.399	32.241	0.342	0.370	8.088	**0.486**
		N@20	0.260	0.262	0.769	0.182	0.267	46.708	0.201	0.250	24.388	**0.276**
		P@20	0.021	0.024	14.286	0.000	0.020	0.000	0.017	0.079	363.158	**0.025**
		F1@20	0.023	0.024	4.348	0.012	0.038	300.000	0.033	0.042	27.177	**0.047**
		Hits@20	0.401	0.485	21.009	0.387	0.399	3.105	0.343	0.370	7.883	**0.488**
		MRR@20	0.149	0.177	18.872	0.140	0.208	48.571	0.160	0.214	33.750	**0.214**
	Semi	R@20	0.327	0.335	2.448	0.286	0.382	33.679	0.335	0.429	28.434	**0.462**
		N@20	0.228	0.264	15.789	0.213	0.263	23.506	0.200	0.280	40.000	**0.290**
		P@20	0.008	0.020	150.000	0.010	0.019	90.000	0.017	0.020	17.647	**0.023**
		F1@20	0.041	0.042	2.439	0.010	0.037	270.000	0.032	0.040	25.000	**0.045**
		Hits@20	0.329	0.417	26.740	0.284	0.382	34.646	0.335	0.379	13.170	**0.463**
		MRR@20	0.205	0.210	2.439	0.205	0.227	10.732	0.160	0.213	33.125	**0.234**
	Ind	R@20	0.320	0.331	3.438	0.267	0.358	34.114	0.306	0.370	21.008	**0.427**
		N@20	0.225	0.239	6.222	0.194	0.243	25.257	0.180	0.198	10.000	**0.249**
		P@20	0.002	0.004	100.000	0.010	0.013	30.000	0.016	0.043	168.750	**0.019**
		F1@20	0.017	0.030	76.471	0.011	0.035	218.182	0.030	0.041	37.500	**0.041**
		Hits@20	0.410	0.411	0.244	0.328	0.361	10.048	0.309	0.388	25.532	**0.429**
		MRR@20	0.136	0.145	6.618	0.111	0.209	88.288	0.144	0.209	45.208	**0.197**
25%	Tran	R@20	0.202	0.232	14.851	0.101	0.128	26.730	0.236	0.284	20.339	**0.382**
		N@20	0.192	0.200	4.167	0.061	0.088	44.262	0.131	0.208	58.024	**0.202**
		P@20	0.001	0.003	200.000	0.001	0.002	100.000	0.012	0.073	508.333	**0.019**
		F1@20	0.023	0.023	0.000	0.012	0.000	0.000	0.023	0.030	30.435	**0.037**
		Hits@20	0.144	0.228	58.333	0.037	0.130	251.351	0.237	0.310	30.712	**0.383**
		MRR@20	0.051	0.142	178.431	0.000	0.076	100.000	0.100	0.108	8.000	**0.150**
	Semi	R@20	0.293	0.316	7.856	0.049	0.125	155.102	0.226	0.276	22.125	**0.370**
		N@20	0.145	0.164	13.103	0.067	0.091	35.820	0.126	0.174	38.888	**0.194**
		P@20	0.004	0.010	150.000	0.000	0.006	50.000	0.011	0.014	27.273	**0.019**
		F1@20	0.023	0.026	13.043	0.004	0.012	200.000	0.022	0.030	34.788	**0.036**
		Hits@20	0.242	0.289	19.508	0.097	0.126	29.897	0.228	0.243	6.579	**0.372**
		MRR@20	0.070	0.080	14.286	0.040	0.081	102.500	0.098	0.137	40.816	**0.144**
	Ind	R@20	0.120	0.171	42.500	0.107	0.119	11.214	0.224	0.234	4.464	**0.345**
		N@20	0.119	0.160	34.454	0.044	0.086	50.000	0.124	0.157	26.667	**0.181**
		P@20	0.003	0.008	166.667	0.000	0.006	100.000	0.011	0.032	54.545	**0.017**
		F1@20	0.031	0.032	3.225	0.000	0.011	100.000	0.022	0.026	18.182	**0.033**
		Hits@20	0.342	0.342	0.000	0.029	0.120	314.482	0.226	0.310	37.168	**0.346**
		MRR@20	0.030	0.053	43.000	0.098	0.115	23.469	0.095	0.134	41.053	**0.135**

Table 13: Hyperparameters tested via grid search for each baseline. We put "-" when the hyperparameter does not apply to the method.

Model	Learning Rate	Hidden Dimensions	Layers	Heads	Neighbors
GraphSAGE	{1e-6, 1e-5, 5e-5, 1e-4, 1e-3, 1e-2}	{64, 128, 256}	{2, 3}	-	{5,10, 15}
GAT	{1e-6, 1e-5, 5e-5, 1e-4, 1e-3, 1e-2}	{64, 128, 256}	{2, 3}	-	{5,10, 15}
HGT	{1e-6, 1e-5, 5e-5, 1e-4, 1e-3, 1e-2}	{64, 128, 256}	{2, 3}	{1,2,4,8}	-
HAN	{1e-6, 1e-5, 5e-5, 1e-4, 1e-3, 1e-2}	{64, 128, 256}	{2, 3}	{1,2,4,8}	-
HGNN	{1e-6, 1e-5, 5e-5, 1e-4, 1e-3, 1e-2}	{64, 128, 256}	{2, 3}	{1,2,4,8}	{5,10,15}

Table 14: Random sampling component-based analysis. Evaluation metrics over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. Metrics include Recall@5 (R@5), nDG@5 (N@5). 100% indicates full textual metadata; [75%, 50%, 25%] indicate partial metadata availability. RS-*i* refers to Random Sampling at *i*-th depth.

MES	Setting	Metric	RS-1	RS-2	RS-3	MMSAN
100%	Tran	R@5	0.602	0.637	0.644	**0.727**
		N@5	0.434	0.471	0.475	**0.546**
		P@5	0.127	0.135	0.145	**0.152**
		F1@5	0.208	0.221	0.221	**0.250**
		Hits@5	0.605	0.646	0.653	**0.741**
		MRR@5	0.413	0.419	0.428	**0.484**
	Semi	R@5	0.669	0.677	0.702	**0.719**
		N@5	0.519	0.527	**0.535**	0.524
		P@5	0.138	0.143	0.145	**0.145**
		F1@5	0.230	0.232	0.237	**0.242**
		Hits@5	0.669	0.697	0.712	**0.727**
		MRR@5	0.429	0.440	0.456	**0.461**
	Ind	R@5	0.651	0.635	0.662	**0.687**
		N@5	0.494	0.452	0.465	**0.519**
		P@5	0.132	0.128	0.128	**0.149**
		F1@5	0.219	0.212	0.222	**0.232**
		Hits@5	0.658	0.638	0.662	**0.691**
		MRR@5	0.443	0.452	0.462	**0.466**
75%	Tran	R@5	0.602	0.615	0.619	**0.623**
		N@5	0.513	0.513	**0.515**	0.447
		P@5	0.122	0.120	0.127	**0.128**
		F1@5	0.203	0.205	0.207	**0.210**
		Hits@5	0.605	0.617	0.635	**0.659**
		MRR@5	0.475	0.482	0.493	**0.495**
	Semi	R@5	0.576	0.627	**0.630**	0.598
		N@5	0.402	0.437	0.438	**0.442**
		P@5	0.113	0.131	0.145	**0.146**
		F1@5	0.222	0.224	0.222	**0.227**
		Hits@5	0.577	0.628	0.630	**0.630**
		MRR@5	0.333	0.344	0.372	**0.398**
	Ind	R@5	0.515	0.525	0.598	**0.598**
		N@5	0.407	0.410	0.430	**0.468**
		P@5	0.111	0.111	0.116	**0.116**
		F1@5	0.191	0.190	0.191	**0.192**
		Hits@5	0.579	0.575	0.609	**0.609**
		MRR@5	0.312	0.313	0.330	**0.365**
50%	Tran	R@5	0.407	0.425	0.439	**0.539**
		N@5	0.310	0.310	0.358	**0.358**
		P@5	0.124	0.136	0.132	**0.137**
		F1@5	0.205	**0.224**	0.218	0.208
		Hits@5	0.502	0.507	0.516	**0.538**
		MRR@5	0.408	0.404	0.402	**0.416**
	Semi	R@5	0.616	0.623	**0.636**	0.518
		N@5	0.413	0.414	**0.458**	0.359
		P@5	0.118	0.131	0.137	**0.138**
		F1@5	0.229	0.230	0.232	**0.239**
		Hits@5	0.619	0.627	0.636	**0.638**
		MRR@5	0.409	**0.455**	0.399	0.403
	Ind	R@5	0.525	0.525	0.531	**0.535**
		N@5	0.438	0.442	0.451	**0.465**
		P@5	0.126	0.136	0.154	**0.199**
		F1@5	0.110	0.150	0.160	**0.164**
		Hits@5	0.625	0.622	**0.672**	0.558
		MRR@5	0.256	0.285	0.286	**0.326**
25%	Tran	R@5	0.431	0.418	0.429	**0.467**
		N@5	0.337	0.371	**0.391**	0.328
		P@5	0.088	0.090	0.090	**0.095**
		F1@5	0.140	0.143	0.147	**0.157**
		Hits@5	0.439	0.426	0.419	**0.473**
		MRR@5	0.218	0.253	0.223	**0.283**
	Semi	R@5	0.425	0.427	0.429	**0.454**
		N@5	0.236	0.221	0.271	**0.306**
		P@5	0.082	0.075	0.072	**0.086**
		F1@5	0.119	0.124	0.120	**0.144**
		Hits@5	0.429	0.427	0.429	**0.462**
		MRR@5	0.197	0.172	0.109	**0.256**
	Ind	R@5	0.409	0.428	0.438	**0.453**
		N@5	0.256	0.281	0.252	**0.321**
		P@5	0.078	0.072	0.080	**0.088**
		F1@5	0.105	0.121	0.100	**0.147**
		Hits@5	0.412	0.434	0.439	**0.441**
		MRR@5	0.206	0.224	0.203	**0.241**

Table 15: Random sampling component-based analysis. Evaluation metrics over the PubMed dataset in transductive (Tran), semi-inductive (Semi), and inductive (Ind) settings. Metrics include Recall@5 (R@5), nDG@5 (N@5). 100% indicates full textual metadata; [75%, 50%, 25%] indicate partial metadata availability. RS-*i* refers to Random Sampling at *i*-th depth.

PubMed	Setting	Metric	RS-1	RS-2	RS-3	MM-SAN
100%	Tran	R@5	0.314	0.313	0.295	**0.380**
		N@5	0.243	0.225	0.212	**0.270**
		P@5	0.063	0.063	0.060	**0.077**
		F1@5	0.105	0.105	0.099	**0.127**
		Hits@5	0.315	0.314	0.295	**0.381**
		MRR@5	0.220	0.197	0.184	**0.234**
	Semi	R@5	0.301	0.307	0.290	**0.374**
		N@5	0.231	0.217	0.207	**0.267**
		P@5	0.061	0.062	0.059	**0.076**
		F1@5	0.101	0.103	0.098	**0.126**
		Hits@5	0.302	0.309	0.294	**0.376**
		MRR@5	0.208	0.189	0.181	**0.232**
	Ind	R@5	0.256	0.271	0.251	**0.344**
		N@5	0.191	0.190	0.179	**0.246**
		P@5	0.052	0.055	0.051	**0.070**
		F1@5	0.086	0.091	0.084	**0.116**
		Hits@5	0.258	0.274	0.253	**0.347**
		MRR@5	0.170	0.164	0.156	**0.214**
75%	Tran	R@5	0.317	0.318	**0.318**	0.314
		N@5	0.145	0.130	0.137	**0.159**
		P@5	0.064	0.064	0.064	**0.067**
		F1@5	0.106	**0.107**	0.106	0.098
		Hits@5	0.319	**0.319**	0.318	0.317
		MRR@5	0.204	0.204	0.214	**0.216**
	Semi	R@5	0.281	0.259	0.285	**0.292**
		N@5	0.132	0.122	0.127	**0.151**
		P@5	0.061	0.063	0.062	**0.065**
		F1@5	0.101	0.104	0.103	**0.104**
		Hits@5	0.305	0.311	0.308	**0.326**
		MRR@5	0.211	0.196	0.204	**0.211**
	Ind	R@5	0.281	0.299	**0.302**	0.262
		N@5	0.133	0.129	0.133	**0.142**
		P@5	0.061	0.063	0.062	**0.065**
		F1@5	0.102	**0.105**	0.103	0.104
		Hits@5	0.302	0.301	0.318	**0.321**
		MRR@5	0.209	0.186	0.201	**0.210**
50%	Tran	R@5	0.312	0.311	0.312	**0.317**
		N@5	0.233	0.220	0.232	**0.235**
		P@5	0.062	0.062	0.062	**0.052**
		F1@5	**0.104**	0.103	0.104	0.096
		Hits@5	0.312	0.311	0.312	**0.317**
		MRR@5	**0.220**	0.192	0.206	0.196
	Semi	R@5	0.292	0.308	0.300	**0.316**
		N@5	0.223	0.222	0.222	**0.225**
		P@5	0.060	0.062	0.061	**0.071**
		F1@5	0.099	0.103	0.101	**0.104**
		Hits@5	0.293	0.309	0.301	**0.318**
		MRR@5	**0.201**	0.192	0.196	0.196
	Ind	R@5	0.270	0.265	0.268	**0.277**
		N@5	0.200	0.191	0.198	**0.202**
		P@5	0.055	0.054	0.055	**0.058**
		F1@5	0.091	0.089	0.090	**0.092**
		Hits@5	0.271	0.266	0.269	**0.278**
		MRR@5	0.180	0.158	0.169	**0.185**
25%	Tran	R@5	0.221	0.220	0.221	**0.230**
		N@5	0.244	0.236	0.240	**0.246**
		P@5	0.064	0.064	0.064	**0.068**
		F1@5	**0.107**	0.106	0.107	0.098
		Hits@5	0.321	0.320	0.321	**0.322**
		MRR@5	0.224	0.213	0.219	**0.231**
	Semi	R@5	0.215	0.214	0.210	**0.217**
		N@5	0.232	0.231	0.231	**0.239**
		P@5	0.062	0.063	0.063	**0.067**
		F1@5	0.103	0.105	0.104	**0.110**
		Hits@5	0.306	0.316	0.311	**0.319**
		MRR@5	**0.212**	0.204	0.208	0.188
	Ind	R@5	0.217	0.217	0.212	**0.217**
		N@5	0.183	0.182	0.188	**0.189**
		P@5	0.053	0.055	0.054	**0.056**
		F1@5	0.087	0.091	0.089	**0.092**
		Hits@5	0.267	0.278	0.273	**0.279**
		MRR@5	0.163	0.165	0.164	**0.166**

Table 16: Recall@5 (R@5) and nDG@5 (N@5) scores over the MES dataset in transductive and 100% metadata available setting. The column "no augmentation" refers to the models run excluding topics and entities; "augmentation" reports the results on the enriched graph.

Method	Augmentation		No Augmentation	
	R@5	N@5	R@5	N@5
GAT	0.578	0.422	0.625	0.475
GAT-RW	0.710	0.506	**0.700**	0.432
SAGE	0.472	0.312	0.489	0.398
SAGE-RW	0.655	0.519	0.614	0.510
HGT	0.020	0.020	0.023	0.020
HGNN	0.601	0.488	0.581	0.438
HGNN-RW	0.711	0.531	0.700	**0.520**
HAN	0.008	0.009	0.008	0.009
MM-SAN	**0.727**	**0.546**	0.642	0.496

Table 17: Recall@5 (R@5) and nDG@5 (N@5) scores over the PubMed dataset in transductive and 100% metadata available setting. The column "no augmentation" refers to the models run excluding topics and entities; "augmentation" reports the results on the enriched graph.

Method	Augmentation		No Augmentation	
	R@5	N@5	R@5	N@5
GAT	0.228	0.165	0.241	0.181
GAT-RW	0.314	0.219	0.298	0.202
SAGE	0.217	0.172	0.239	0.179
SAGE-RW	0.288	0.218	0.278	0.201
HGNN	0.294	0.222	0.284	0.202
HGNN-RW	0.321	0.267	0.301	0.256
HGT	0.014	0.015	0.016	0.017
HAN	0.026	0.021	0.030	0.023
MM-SAN	**0.380**	**0.272**	**0.361**	**0.261**