

1 Supplementary Material

1.1 Class Hierarchy in Yago

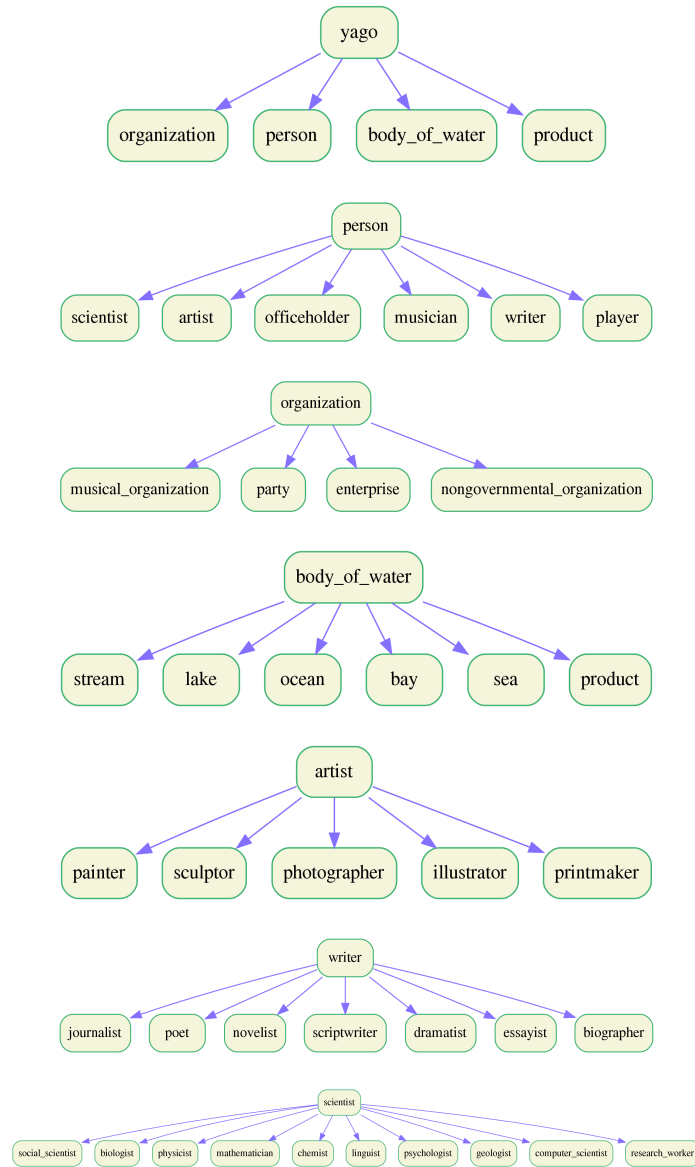


Fig. 1: Examples of Yago Class Hierarchy at Levels 1 to 3

1.2 Results of pre-trained embedding models

Table 1: Best performance of all models for Yago3-10 dataset

	MRR	Hits@1	Hits@3	Hits@10
ComplEx	.551	.476	.596	.682
TransE	.390	.273	.459	.612
RESCAL	.310	.223	.344	.479
ConvE	.506	.419	.557	.666
DistMult	.542	.456	.595	.696

1.3 SDType Precision-Recall curves

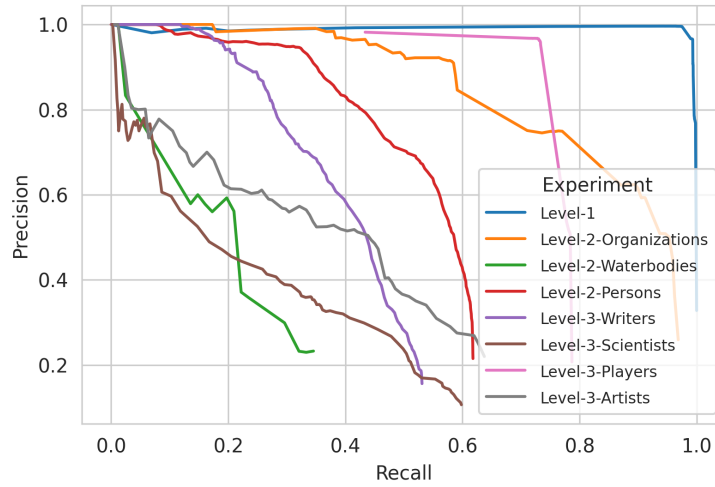


Fig. 2: Precision-Recall Curves for SDType on Yago.

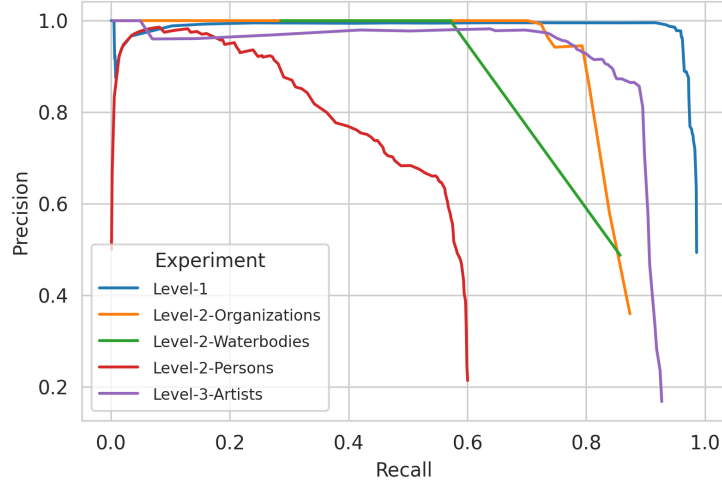


Fig. 3: Precision-Recall Curves for SDType on Freebase.

1.4 Full Experiment Results for Yago3-10 and FB15k-237

Table 2: Classification results for Yago3-10 on Level-1

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	99.2	99.1	99.1	99.0	98.2	98.6	94.8	93.2	93.7
RESCAL	99.5	99.5	99.5	99.4	98.7	98.9	99.4	99.4	99.4
ComplEx	99.3	99.1	99.2	99.2	99.1	99.1	96.0	95.6	95.6
DistMult	99.5	99.4	99.4	97.8	96.4	97.0	98.3	97.9	98.1
ConvE	99.4	99.4	99.4	99.2	98.9	99.1	76.5	78.7	72.7
RDF2Vec	97.7	97.6	97.6	98.0	97.2	97.4	97.1	97.1	97.1

Table 3: Classification results for Yago3-10 on Level-2-organization

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	77.6	73.2	75.3	93.1	60.4	70.8	75.4	60.4	65.6
RESCAL	86.9	81.6	84.1	95.7	72.6	81.3	87.6	81.9	84.2
ComplEx	86.4	81.9	84.1	90.6	65.7	72.5	73.0	44.9	45.4
DistMult	85.6	84.7	85.1	85.0	61.4	69.6	80.0	73.8	75.3
ConvE	84.4	81.0	82.5	94.0	66.0	74.4	46.0	25.5	23.8
RDF2Vec	76.6	75.2	75.6	86.3	62.7	69.9	77.2	71.8	73.3

Table 4: Classification results for Yago3-10 on Level-2-body_of_water

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	73.4	61.7	66.5	66.0	44.4	52.5	68.0	63.0	64.3
RESCAL	70.8	63.0	66.2	78.3	55.6	60.9	70.0	66.7	67.0
ComplEx	70.3	69.1	69.6	87.5	49.4	57.4	65.8	64.2	64.3
DistMult	73.8	66.7	70.0	83.4	64.2	68.3	76.8	67.9	70.7
ConvE	64.0	56.8	59.7	79.3	45.7	54.2	43.2	37.0	37.2
RDF2Vec	63.3	60.5	61.3	72.9	50.6	57.4	60.7	63.0	61.1

Table 5: Classification results for Yago3-10 on Level-2-person

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	66.3	69.0	67.6	85.9	52.1	63.1	74.3	67.7	70.6
RESCAL	72.9	73.7	73.2	85.9	68.5	76.0	81.5	73.3	77.1
ComplEx	66.3	68.0	67.2	86.5	51.3	62.0	71.7	52.2	54.3
DistMult	76.9	74.9	75.8	84.0	43.7	54.3	78.2	69.1	72.3
ConvE	75.4	73.2	74.3	87.7	58.9	69.2	43.5	34.5	28.6
RDF2Vec	72.1	69.3	70.6	78.1	65.2	70.6	72.6	66.3	69.2

Table 6: Classification results for Yago3-10 on Level-3-person-writer

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	53.5	54.4	53.9	55.9	38.2	40.7	62.8	47.5	53.3
RESCAL	61.6	60.7	61.1	78.3	49.5	52.8	69.2	57.5	60.6
ComplEx	56.3	57.4	56.8	72.7	43.7	47.0	66.3	42.3	40.1
DistMult	64.6	61.3	62.7	57.1	40.4	41.8	72.8	56.9	61.0
ConvE	61.4	60.0	60.5	57.1	40.2	43.0	45.7	39.7	34.3
RDF2Vec	56.6	53.3	54.4	65.3	41.3	45.1	60.0	49.6	52.4

Table 7: Classification results for Yago3-10 on Level-3-person-scientist

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	49.1	44.4	46.3	52.2	7.8	13.0	61.1	39.5	43.6
RESCAL	56.7	52.2	54.2	69.1	18.9	27.9	66.6	42.9	50.8
ComplEx	52.2	45.6	48.6	69.2	10.7	17.9	64.5	23.2	29.9
DistMult	62.9	53.0	57.3	61.3	6.3	11.2	74.8	48.6	57.6
ConvE	58.6	50.5	54.0	60.8	9.5	16.1	40.0	9.2	9.5
RDF2Vec	33.5	29.0	30.8	33.2	5.9	8.9	39.5	20.1	24.9

Table 8: Classification results for Yago3-10 on Level-3-person-artist

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	48.0	46.0	46.6	42.9	28.4	32.9	40.3	40.9	36.4
RESCAL	53.0	48.3	49.7	59.0	34.1	39.8	65.7	50.0	53.6
ComplEx	51.3	40.3	43.7	42.3	32.4	36.5	29.3	16.5	18.3
DistMult	57.8	49.4	52.1	44.1	30.1	35.5	50.4	42.6	44.6
ConvE	50.8	47.2	48.1	43.6	32.4	36.7	30.9	33.5	29.9
RDF2Vec	52.0	45.7	48.4	49.3	35.3	41.0	50.3	41.0	43.0

Table 9: Classification results for Yago3-10 on Level-3-person-player

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	89.8	90.1	89.9	96.8	86.8	88.1	95.8	87.9	90.0
RESCAL	90.9	90.7	90.8	97.8	88.6	90.8	96.3	89.3	91.6
ComplEx	89.9	90.5	90.2	96.0	85.9	86.4	96.0	87.5	90.0
DistMult	92.6	90.8	91.6	96.4	84.3	83.8	95.8	88.0	90.4
ConvE	91.0	90.5	90.7	95.8	86.7	87.4	91.3	84.4	84.4
RDF2Vec	89.9	87.5	88.3	94.7	85.2	85.3	89.7	85.9	86.2

Table 10: Classification results for FB15k-237 on Level-1

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	98.6	98.8	98.7	99.0	96.8	97.9	98.3	98.2	98.3
RESCAL	99.0	98.8	98.9	99.0	98.3	98.6	98.3	98.2	98.2
ComplEx	98.7	98.3	98.5	98.8	98.0	98.4	98.3	98.1	98.2
DistMult	98.6	98.5	98.5	98.7	98.2	98.4	98.4	98.3	98.3
ConvE	98.6	98.5	98.6	98.9	98.3	98.6	98.8	98.8	98.8
RDF2Vec	98.3	98.1	98.2	98.7	97.6	98.1	98.0	97.6	97.8

Table 11: Classification results for FB15k-237 on Level-2-person

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	80.7	76.6	78.5	78.8	75.1	73.1	79.3	79.8	79.2
RESCAL	81.7	79.0	80.2	81.5	74.3	74.7	82.1	76.8	78.8
ComplEx	82.1	79.1	80.3	80.7	77.0	76.6	82.8	75.0	78.1
DistMult	82.1	78.8	80.3	84.1	77.2	77.9	82.9	74.1	77.6
ConvE	81.7	80.1	80.9	83.9	77.7	78.9	82.2	79.3	80.4
RDF2Vec	74.0	73.8	73.7	74.8	74.6	70.9	74.1	75.3	74.1

Table 12: Classification results for FB15k-237 on Level-2-organization

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	94.1	95.3	94.4	92.2	79.1	82.7	95.2	95.3	95.1
RESCAL	93.2	91.9	92.0	90.8	84.9	86.9	92.5	91.9	91.9
ComplEx	95.1	94.2	94.3	92.2	82.6	85.0	92.0	89.5	89.6
DistMult	97.4	96.5	96.7	94.8	83.7	87.6	92.3	84.9	86.3
ConvE	93.8	93.0	93.2	92.9	89.5	90.8	86.5	88.4	87.4
RDF2Vec	88.9	82.6	85.6	94.5	77.9	85.3	88.2	79.1	83.3

Table 13: Classification results for FB15k-237 on Level-3-person-artist

	MLP			Random Forest			KNN		
	P	R	F1	P	R	F1	P	R	F1
TransE	94.4	92.9	93.5	91.8	91.4	91.0	96.5	92.9	93.0
RESCAL	93.6	93.2	93.1	90.7	91.1	89.8	97.4	92.6	93.4
ComplEx	95.5	92.9	93.9	91.0	91.7	90.6	95.7	93.5	93.6
DistMult	94.8	93.5	93.6	91.3	91.7	90.7	94.3	93.5	93.3
ConvE	94.5	92.9	93.4	91.2	91.7	91.1	94.6	92.9	92.8
RDF2Vec	92.7	89.9	90.7	92.7	90.2	89.9	90.4	89.9	89.1

Table 14: Clustering results for FB15k-237 on Level-1

	Kmeans				Optics				Hierarchical				Spectral			
	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI
TransE	.84	.67	.75	.72	.23	.11	.16	-.024	.78	.70	.74	.76	.52	.68	.59	.50
RESCAL	.83	.62	.71	.60	.22	.11	.16	.005	.84	.63	.72	.61	.57	.76	.66	.70
ComplEx	.86	.69	.77	.74	.28	.11	.18	-.002	.84	.74	.79	.84	.55	.69	.62	.53
DistMult	.85	.75	.80	.85	.26	.11	.17	.009	.82	.71	.76	.82	.44	.82	.60	.43
ConvE	.85	.64	.74	.64	.30	.11	.18	-.003	.88	.72	.80	.78	.85	.83	.84	.89
RDF2Vec	.40	.32	.35	.26	.14	.11	.12	.003	.53	.44	.48	.36	.54	.71	.62	.51

Table 15: Clustering results for FB15k-237 on Level-2-person

	Kmeans				Optics				Hierarchical				Spectral			
	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI
TransE	.2	.099	.141	.087	.206	.067	.117	-.014	.216	.113	.156	.086	.1	.131	.115	.03
RESCAL	.184	.091	.13	.083	.15	.069	.101	.001	.19	.095	.135	.081	.19	.136	.161	.151
ComplEx	.2	.099	.141	.087	.199	.066	.114	-.019	.183	.091	.129	.069	.136	.163	.149	.178
DistMult	.2	.099	.141	.089	.184	.07	.113	-.001	.194	.109	.145	.119	.137	.161	.148	.18
ConvE	.207	.104	.147	.084	.206	.069	.119	-.014	.164	.082	.116	.069	.158	.18	.169	.211
RDF2Vec	.108	.056	.078	.027	.1	.071	.084	.011	.114	.06	.083	.031	.096	.077	.086	.013

Table 16: Clustering Results for FB15k-237 on Level-2-organization

	Kmeans				Optics				Hierarchical				Spectral			
	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI
TransE	.73	.692	.71	.74	.243	.244	.243	.039	.734	.709	.722	.763	.671	.715	.693	.661
RESCAL	.718	.677	.679	.715	.21	.227	.218	.02	.688	.645	.666	.682	.643	.705	.673	.641
ComplEx	.696	.654	.675	.69	.312	.261	.285	.067	.684	.643	.663	.685	.574	.666	.619	.579
DistMult	.689	.646	.668	.678	.309	.259	.283	.069	.705	.661	.683	.691	.579	.677	.626	.589
ConvE	.66	.711	.685	.655	.301	.229	.263	.031	.66	.711	.685	.655	.647	.7	.673	.646
RDF2Vec	.374	.454	.412	.367	.286	.198	.238	.022	.358	.447	.04	.372	.474	.532	.503	.495

Table 17: Clustering results for FB15k-237 on Level-3-person-writer

	Kmeans				Optics				Hierarchical				Spectral			
	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI	H	C	NMI	ARI
TransE	.251	.146	.191	.059	.245	.11	.164	-.039	.228	.14	.178	.074	.203	.171	.186	.181
RESCAL	.221	.13	.169	.062	.16	.107	.13	-.044	.235	.139	.181	.084	.223	.199	.211	.266
ComplEx	.27	.16	.21	.11	.22	.10	.15	-.037	.22	.13	.17	.07	.20	.25	.22	.34
DistMult	.263	.154	.201	.093	.173	.101	.132	-.059	.225	.135	.174	.064	.202	.281	.238	.383
ConvE	.24	.14	.18	.05	.24	.11	.17	-.013	.25	.15	.19	.10	.24	.2	.22	.22
RDF2Vec	.16	.09	.12	.03	.13	.12	.12	.01	.165	.1	.128	.047	.193	.128	.157	.0173