



Figure 1: Sensitivity of ℓ_1 LD-CTGR to the number of bins on the US Legis. data set. We change the number of bins in the interval $[96, 104]$ and fix other hyperparameters. ℓ_1 LD-CTGR shows robust AUC scores to this change.

Table 1: Performance of different methods for network reconstruction (in-sample) across diverse data sets. TCL and GraphMixer are two new compared methods from (Yu et al., 2023), while Can. Parl. and US Legis. are two new data sets from (Poursafaei et al., 2022). We also double the initial relative distance parameter in Synthetic- α to generate more outliers for experiments, shown as “Synthetic- α (More Outliers)”. In this setting, ℓ_1 LD-CTGR significantly outperforms GRASSP.

Data Set		Node2Vec	CTDNE	HTNE	PIVEM	TCL	GraphMixer	GRASSP	ℓ_1 LD-CTGR
Synthetic- α	ROC	0.627	0.518	0.573	0.554	0.550	0.431	0.724	0.687
		± 0.004	± 0.006	± 0.009	± 0.002	± 0.021	± 0.084	± 0.004	± 0.006
	PR	0.629	0.568	0.545	0.567	0.567	0.503	0.756	0.643
		± 0.006	± 0.011	± 0.008	± 0.003	± 0.020	± 0.034	± 0.005	± 0.008
Synthetic- β	ROC	0.541	0.493	0.535	0.531	0.528	0.448	0.843	0.610
		± 0.006	± 0.008	± 0.008	± 0.006	± 0.061	± 0.006	± 0.015	± 0.021
	PR	0.545	0.557	0.591	0.536	0.621	0.573	0.756	0.554
		± 0.004	± 0.006	± 0.006	± 0.006	± 0.054	± 0.016	± 0.011	± 0.017
Contacts	ROC	0.674	0.508	0.555	0.539	0.594	0.539	0.589	0.676
		± 0.011	± 0.021	± 0.011	± 0.012	± 0.007	± 0.012	± 0.013	± 0.016
	PR	0.657	0.570	0.563	0.567	0.616	0.614	0.634	0.676
		± 0.016	± 0.019	± 0.013	± 0.009	± 0.016	± 0.013	± 0.019	± 0.021
HyperText	ROC	0.589	0.486	0.619	0.560	0.602	0.662	0.607	0.694
		± 0.006	± 0.014	± 0.011	± 0.004	± 0.010	± 0.006	± 0.006	± 0.011
	PR	0.569	0.542	0.624	0.572	0.627	0.663	0.580	0.691
		± 0.008	± 0.013	± 0.007	± 0.004	± 0.007	± 0.003	± 0.009	± 0.014
Infectious	ROC	0.781	0.501	0.851	0.613	0.811	0.804	0.738	0.861
		± 0.003	± 0.009	± 0.011	± 0.005	± 0.001	± 0.001	± 0.018	± 0.021
	PR	0.742	0.566	0.819	0.630	0.812	0.801	0.708	0.832
		± 0.008	± 0.011	± 0.009	± 0.007	± 0.004	± 0.001	± 0.016	± 0.019
Facebook	ROC	0.506	0.473	0.445	0.482	0.510	0.5	0.5	0.612
		± 0.002	± 0.005	± 0.003	± 0.002	± 0.002	± 0.009	± 0.000	± 0.004
	PR	0.515	0.489	0.481	0.625	0.520	0.53	0.5	0.588
		± 0.004	± 0.005	± 0.003	± 0.003	± 0.001	± 0.006	± 0.000	± 0.004
NeurIPS	ROC	0.433	0.489	0.431	0.510	0.635	0.634	0.548	0.528
		± 0.004	± 0.011	± 0.011	± 0.009	± 0.001	± 0.001	± 0.018	± 0.009
	PR	0.476	0.541	0.448	0.525	0.580	0.578	0.506	0.501
		± 0.004	± 0.015	± 0.008	± 0.008	± 0.004	± 0.006	± 0.025	± 0.008
US Legis.	ROC	0.493	0.478	0.490	0.525	0.750	0.766	0.662	0.767
		± 0.003	± 0.011	± 0.017	± 0.012	± 0.005	± 0.014	± 0.012	± 0.014
	PR	0.510	0.524	0.576	0.561	0.515	0.700	0.588	0.712
		± 0.004	± 0.013	± 0.020	± 0.012	± 0.004	± 0.008	± 0.018	± 0.012
Can. Parl.	ROC	0.701	0.479	0.583	0.508	0.687	0.761	0.593	0.826
		± 0.004	± 0.009	± 0.011	± 0.009	± 0.004	± 0.009	± 0.013	± 0.004
	PR	0.649	0.542	0.643	0.527	0.634	0.743	0.614	0.793
		± 0.004	± 0.009	± 0.015	± 0.014	± 0.005	± 0.005	± 0.008	± 0.003
Synthetic- α (More Outliers)	ROC	0.524	0.550	0.535	0.567	0.281	0.300	0.577	0.793
		± 0.013	± 0.016	± 0.021	± 0.018	± 0.042	± 0.038	± 0.028	± 0.038
	PR	0.538	0.555	0.602	0.642	0.400	0.412	0.509	0.708
		± 0.023	± 0.027	± 0.019	± 0.016	± 0.009	± 0.027	± 0.029	± 0.039

Table 2: Performance of different methods for network completion (out-of-sample) across diverse data sets. TCL and GraphMixer are two new compared methods from (Yu et al., 2023), while Can. Parl. and US Legis. are two new data sets from (Poursafaei et al., 2022). We also double the initial relative distance parameter in Synthetic- α to generate more outliers for experiments, shown as “Synthetic- α (More Outliers)”. In this setting, ℓ_1 LD-CTGR significantly outperforms GRASSP.

Data Set		Node2Vec	CTDNE	HTNE	PIVEM	TCL	GraphMixer	GRASSP	ℓ_1 LD-CTGR
Synthetic- α	ROC	0.696	0.536	0.339	0.522	0.541	0.540	0.630	0.750
		± 0.003	± 0.006	± 0.013	± 0.002	± 0.029	± 0.033	± 0.011	± 0.008
	PR	0.681	0.557	0.485	0.534	0.528	0.550	0.687	0.695
		± 0.008	± 0.007	± 0.011	± 0.003	± 0.008	± 0.020	± 0.011	± 0.009
Synthetic- β	ROC	0.656	0.507	0.377	0.542	0.550	0.564	0.612	0.661
		± 0.007	± 0.009	± 0.009	± 0.007	± 0.011	± 0.043	± 0.018	± 0.013
	PR	0.694	0.569	0.578	0.566	0.556	0.563	0.540	0.641
		± 0.007	± 0.011	± 0.004	± 0.009	± 0.010	± 0.043	± 0.024	± 0.018
Contacts	ROC	0.517	0.489	0.461	0.557	0.610	0.621	0.670	0.680
		± 0.021	± 0.029	± 0.025	± 0.009	± 0.001	± 0.002	± 0.016	± 0.017
	PR	0.526	0.553	0.509	0.579	0.602	0.687	0.714	0.724
		± 0.019	± 0.031	± 0.023	± 0.017	± 0.003	± 0.001	± 0.025	± 0.028
HyperText	ROC	0.570	0.498	0.613	0.554	0.641	0.658	0.619	0.671
		± 0.011	± 0.015	± 0.014	± 0.015	± 0.016	± 0.001	± 0.011	± 0.012
	PR	0.595	0.554	0.651	0.571	0.645	0.652	0.591	0.672
		± 0.013	± 0.017	± 0.008	± 0.008	± 0.001	± 0.001	± 0.024	± 0.015
Infectious	ROC	0.681	0.534	0.651	0.578	0.728	0.724	0.728	0.756
		± 0.004	± 0.009	± 0.018	± 0.003	± 0.000	± 0.001	± 0.029	± 0.017
	PR	0.632	0.585	0.611	0.592	0.731	0.723	0.711	0.779
		± 0.011	± 0.008	± 0.016	± 0.004	± 0.001	± 0.003	± 0.028	± 0.017
Facebook	ROC	0.529	0.340	0.463	0.482	0.533	0.571	0.5	0.572
		± 0.002	± 0.005	± 0.003	± 0.002	± 0.002	± 0.004	± 0.000	± 0.004
	PR	0.572	0.501	0.511	0.608	0.549	0.620	0.5	0.687
		± 0.004	± 0.005	± 0.003	± 0.003	± 0.001	± 0.002	± 0.000	± 0.004
NeurIPS	ROC	0.355	0.455	0.222	0.469	0.503	0.467	0.360	0.533
		± 0.002	± 0.018	± 0.026	± 0.014	± 0.000	± 0.001	± 0.031	± 0.022
	PR	0.355	0.435	0.289	0.468	0.504	0.536	0.468	0.559
		± 0.002	± 0.022	± 0.028	± 0.027	± 0.000	± 0.002	± 0.026	± 0.019
US Legis.	ROC	0.393	0.490	0.492	0.510	0.749	0.770	0.656	0.776
		± 0.003	± 0.009	± 0.014	± 0.010	± 0.006	± 0.015	± 0.013	± 0.013
	PR	0.486	0.534	0.542	0.529	0.684	0.707	0.587	0.725
		± 0.004	± 0.014	± 0.016	± 0.011	± 0.005	± 0.013	± 0.015	± 0.012
Can. Parl.	ROC	0.675	0.509	0.473	0.529	0.734	0.801	0.678	0.810
		± 0.003	± 0.010	± 0.011	± 0.012	± 0.008	± 0.014	± 0.009	± 0.009
	PR	0.616	0.568	0.538	0.545	0.692	0.739	0.709	0.761
		± 0.004	± 0.013	± 0.016	± 0.010	± 0.002	± 0.012	± 0.008	± 0.010
Synthetic- α (More Outliers)	ROC	0.459	0.489	0.542	0.578	0.602	0.619	0.559	0.817
		± 0.009	± 0.021	± 0.019	± 0.030	± 0.020	± 0.016	± 0.024	± 0.030
	PR	0.471	0.493	0.574	0.562	0.590	0.586	0.527	0.813
		± 0.013	± 0.019	± 0.020	± 0.027	± 0.016	± 0.011	± 0.021	± 0.031

Table 3: Performance of different methods for network prediction (across-sample) across diverse data sets. TCL and GraphMixer are two new compared methods from (Yu et al., 2023), while Can. Parl. and US Legis. are two new data sets from (Poursafaei et al., 2022). We also double the initial relative distance parameter in Synthetic- α to generate more outliers for experiments, shown as “Synthetic- α (More Outliers)”. In this setting, ℓ_1 LD-CTGR significantly outperforms GRASSP.

Data Set		Node2Vec	CTDNE	HTNE	PIVEM	TCL	GraphMixer	GRASSP	ℓ_1 LD-CTGR
Synthetic- α	ROC	0.748	0.517	0.606	0.602	0.588	0.493	0.901	0.912
		± 0.005	± 0.007	± 0.009	± 0.006	± 0.059	± 0.108	± 0.013	± 0.018
	PR	0.673	0.562	0.641	0.614	0.579	0.531	0.913	0.881
		± 0.011	± 0.015	± 0.013	± 0.005	± 0.078	± 0.049	± 0.011	± 0.011
Synthetic- β	ROC	0.514	0.491	0.593	0.588	0.456	0.363	0.861	0.864
		± 0.003	± 0.012	± 0.006	± 0.006	± 0.008	± 0.056	± 0.014	± 0.014
	PR	0.578	0.555	0.639	0.598	0.503	0.465	0.829	0.831
		± 0.007	± 0.018	± 0.005	± 0.006	± 0.009	± 0.035	± 0.014	± 0.016
Contacts	ROC	0.738	0.509	0.604	0.493	0.681	0.676	0.763	0.767
		± 0.009	± 0.016	± 0.003	± 0.011	± 0.013	± 0.004	± 0.016	± 0.018
	PR	0.687	0.565	0.601	0.497	0.691	0.692	0.714	0.721
		± 0.015	± 0.017	± 0.004	± 0.010	± 0.003	± 0.001	± 0.020	± 0.018
HyperText	ROC	0.552	0.491	0.501	0.516	0.513	0.525	0.607	0.568
		± 0.003	± 0.011	± 0.019	± 0.006	± 0.005	± 0.001	± 0.007	± 0.005
	PR	0.518	0.552	0.502	0.516	0.525	0.537	0.569	0.576
		± 0.011	± 0.005	± 0.018	± 0.004	± 0.008	± 0.004	± 0.009	± 0.009
Infectious	ROC	0.869	0.508	0.730	0.517	0.867	0.859	0.898	0.901
		± 0.002	± 0.006	± 0.017	± 0.008	± 0.003	± 0.003	± 0.015	± 0.016
	PR	0.875	0.555	0.771	0.602	0.866	0.852	0.861	0.888
		± 0.007	± 0.014	± 0.013	± 0.009	± 0.007	± 0.005	± 0.017	± 0.016
Facebook	ROC	0.489	0.503	0.468	0.483	0.493	0.472	0.491	0.528
		± 0.002	± 0.005	± 0.003	± 0.002	± 0.001	± 0.004	± 0.006	± 0.004
	PR	0.513	0.517	0.462	0.491	0.512	0.517	0.498	0.535
		± 0.006	± 0.005	± 0.009	± 0.003	± 0.001	± 0.002	± 0.006	± 0.003
NeurIPS	ROC	0.445	0.504	0.510	0.507	0.5	0.5	0.761	0.778
		± 0.004	± 0.009	± 0.018	± 0.014	± 0.000	± 0.000	± 0.010	± 0.011
	PR	0.470	0.569	0.517	0.505	0.5	0.5	0.675	0.723
		± 0.004	± 0.011	± 0.022	± 0.012	± 0.000	± 0.000	± 0.019	± 0.013
US Legis.	ROC	0.475	0.466	0.490	0.463	0.482	0.469	0.565	0.754
		± 0.003	± 0.011	± 0.017	± 0.012	± 0.011	± 0.015	± 0.012	± 0.014
	PR	0.496	0.513	0.593	0.481	0.505	0.505	0.537	0.711
		± 0.004	± 0.013	± 0.020	± 0.012	± 0.008	± 0.013	± 0.018	± 0.012
Can. Parl.	ROC	0.654	0.504	0.512	0.504	0.569	0.582	0.678	0.715
		± 0.005	± 0.012	± 0.016	± 0.010	± 0.008	± 0.014	± 0.010	± 0.010
	PR	0.597	0.565	0.527	0.496	0.548	0.557	0.609	0.651
		± 0.004	± 0.009	± 0.011	± 0.005	± 0.005	± 0.009	± 0.008	± 0.008
Synthetic- α (More Outliers)	ROC	0.486	0.511	0.575	0.588	0.420	0.446	0.875	0.922
		± 0.003	± 0.019	± 0.016	± 0.014	± 0.015	± 0.066	± 0.020	± 0.018
	PR	0.491	0.495	0.614	0.502	0.454	0.510	0.819	0.890
		± 0.012	± 0.019	± 0.020	± 0.017	± 0.011	± 0.014	± 0.019	± 0.019

Table 4: Average running time (in seconds) per epoch of GRASSP and ℓ_1 LD-CTGR on different data sets (mean \pm STD). The training criterion of GRASSP is followed, which is a three-stage 300-epoch procedure. Results are conducted on a device with an Intel(R) Xeon(R) Gold 6330 CPU, 1 TB RAM, and eight NVIDIA A100 GPUs. ℓ_1 LD-CTGR shows the same order of computational time as that of GRASSP.

Data Set	GRASSP	ℓ_1 LD-CTGR
Synthetic- α	$1.85E-4 \pm 8.89E-6$	$1.79E-4 \pm 8.77E-6$
Synthetic- β	$1.64E-4 \pm 7.15E-6$	$1.66E-4 \pm 7.81E-6$
Contacts	$3.21E-3 \pm 1.60E-4$	$3.09E-3 \pm 1.45E-4$
HyperText	$6.18E-3 \pm 2.98E-4$	$6.22E-3 \pm 2.90E-4$
Infectious	$6.15E-3 \pm 3.00E-4$	$6.15E-3 \pm 2.79E-4$
Facebook	$4.49 \pm 2.18E-1$	$4.55 \pm 2.33E-1$
NeurIPS	$2.74E-1 \pm 1.41E-2$	$2.77E-1 \pm 1.37E-2$
US Legis.	$1.86E-2 \pm 9.39E-4$	$1.76E-2 \pm 9.10E-4$
Can. Parl.	$2.49E-2 \pm 1.20E-3$	$2.44E-2 \pm 1.31E-3$
Synthetic- α (More Outliers)	$1.93E-4 \pm 8.97E-6$	$1.94E-4 \pm 9.44E-6$