

Figure 1: Sensitivity of  $\ell_1$ LD-CTGR to number of bins on the US Legis. data set. We change the number of bins in the interval [96, 104] and fix other hyperparameters.  $\ell_1$ LD-CTGR shows robust AUC scores to this change.

		Node2Vec			PIVEM	TCL	GraphMixer	GRASSP	
									CTGR
Synthetic- $\alpha$	ROC	0.627	0.518	0.573	0.554	0.550	0.431	0.724	0.687
	1100	±0.004	±0.006	±0.009	±0.002	±0.021	$\pm 0.084$	±0.004	±0.006
Symmetre as	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
	ROC	0.541	0.493	0.535	0.531	0.528	0.448	0.843	0.610
Synthetic- $\beta$	NOC	$\pm 0.006$	$\pm 0.008$	$\pm 0.008$	$\pm 0.006$	$\pm 0.061$	±0.006	$\pm 0.015$	$\pm 0.021$
	PR	0.545	0.557	0.591	0.536	0.621	0.573	0.756	0.554
	110	$\pm 0.004$	$\pm 0.006$	$\pm 0.006$	$\pm 0.006$	$\pm 0.054$	±0.016	$\pm 0.011$	$\pm 0.017$
_	ROC	0.674	0.508	0.555	0.539	0.594	0.539	0.589	0.676
Contacts	KUC	±0.011	$\pm 0.021$	±0.011	$\pm 0.012$	$\pm 0.007$	±0.012	±0.013	±0.016
Contacts	PR	0.657	0.570	0.563	0.567	0.616	0.614	0.634	0.676
	PK	±0.016	±0.019	$\pm 0.013$	$\pm 0.009$	±0.016	±0.013	±0.019	$\pm 0.021$
_	DOC	0.589	0.486	0.619	0.560	0.602	0.662	0.607	0.694
	ROC	±0.006	±0.014	±0.011	$\pm 0.004$	±0.010	±0.006	±0.006	±0.011
HyperText	DD.	0.569	0.542	0.624	0.572	0.627	0.663	0.580	0.691
	PR	±0.008	±0.013	±0.007	±0.004	±0.007	±0.003	±0.009	±0.014
_	ROC	0.781	0.501	0.851	0.613	0.811	0.804	0.738	0.861
T 0		±0.003	±0.009	±0.011	±0.005	±0.001	±0.001	±0.018	±0.021
Infectious	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
_	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
Facebook	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
-	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
NeurIPS	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
-		0.493	0.478	0.490	0.525	0.750	0.766	0.662	0.767
US Legis.	ROC	±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	$\pm 0.004$	±0.008	±0.018	±0.012
-		0.701	0.479	0.583	0.508	0.687	0.761	0.593	0.826
Can. Parl.	ROC	±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- $\alpha$	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
(More Outliers)	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

, , , ,		Node2Vec			PIVEM	TCL	GraphMixer	GRASSP	$\ell_1 LD$ -
									CTGR
	DOG	0.696	0.536	0.339	0.522	0.541	0.540	0.630	0.750
Synthetic- $\alpha$	ROC	$\pm 0.003$	$\pm 0.006$	$\pm 0.013$	$\pm 0.002$	±0.029	±0.033	$\pm 0.011$	$\pm 0.008$
	DD	0.681	0.557	0.485	0.534	0.528	0.550	0.687	0.695
	PR	$\pm 0.008$	$\pm 0.007$	$\pm 0.011$	$\pm 0.003$	$\pm 0.008$	±0.020	$\pm 0.011$	$\pm 0.009$
-	ROC	0.656	0.507	0.377	0.542	0.550	0.564	0.612	0.661
0 -41 -41 - 0		$\pm 0.007$	$\pm 0.009$	$\pm 0.009$	$\pm 0.007$	±0.011	±0.043	$\pm 0.018$	$\pm 0.013$
Synthetic- $\beta$	DD	0.694	0.569	0.578	0.566	0.556	0.563	0.540	0.641
	PR	$\pm 0.007$	$\pm 0.011$	$\pm 0.004$	$\pm 0.009$	±0.010	±0.043	$\pm 0.024$	$\pm 0.018$
_	DOC	0.517	0.489	0.461	0.557	0.610	0.621	0.670	0.680
Cantanta	ROC	$\pm 0.021$	$\pm 0.029$	$\pm 0.025$	$\pm 0.009$	±0.001	±0.002	$\pm 0.016$	$\pm 0.017$
Contacts	DD	0.526	0.553	0.509	0.579	0.602	0.687	0.714	0.724
	PR	$\pm 0.019$	$\pm 0.031$	$\pm 0.023$	$\pm 0.017$	$\pm 0.003$	±0.001	$\pm 0.025$	$\pm 0.028$
_	DOC	0.570	0.498	0.613	0.554	0.641	0.658	0.619	0.671
II	ROC	$\pm 0.011$	$\pm 0.015$	$\pm 0.014$	$\pm 0.015$	±0.016	±0.001	$\pm 0.011$	$\pm 0.012$
HyperText	PR	0.595	0.554	0.651	0.571	0.645	0.652	0.591	0.672
		$\pm 0.013$	$\pm 0.017$	$\pm 0.008$	$\pm 0.008$	$\pm 0.001$	±0.001	$\pm 0.024$	$\pm 0.015$
=	ROC	0.681	0.534	0.651	0.578	0.728	0.724	0.728	0.756
Infactions		$\pm 0.004$	$\pm 0.009$	$\pm 0.018$	$\pm 0.003$	$\pm 0.000$	±0.001	$\pm 0.029$	$\pm 0.017$
Infectious	PR	0.632	0.585	0.611	0.592	0.731	0.723	0.711	0.779
		$\pm 0.011$	$\pm 0.008$	$\pm 0.016$	$\pm 0.004$	$\pm 0.001$	±0.003	$\pm 0.028$	$\pm 0.017$
-	ROC PR	0.529	0.340	0.463	0.482	0.533	0.571	0.5	0.572
Facebook		$\pm 0.002$	$\pm 0.005$	$\pm 0.003$	$\pm 0.002$	$\pm 0.002$	$\pm 0.004$	$\pm 0.000$	$\pm 0.004$
racebook		0.572	0.501	0.511	0.608	0.549	0.620	0.5	0.687
		$\pm 0.004$	$\pm 0.005$	$\pm 0.003$	$\pm 0.003$	$\pm 0.001$	±0.002	$\pm 0.000$	$\pm 0.004$
<del>-</del>	ROC	0.355	0.455	0.222	0.469	0.503	0.467	0.360	0.533
NeurIPS		$\pm 0.002$	$\pm 0.018$	$\pm 0.026$	$\pm 0.014$	$\pm 0.000$	±0.001	$\pm 0.031$	$\pm 0.022$
Neulifs	PR	0.355	0.435	0.289	0.468	0.504	0.536	0.468	0.559
		$\pm 0.002$	$\pm 0.022$	$\pm 0.028$	$\pm 0.027$	$\pm 0.000$	±0.002	$\pm 0.026$	$\pm 0.019$
_	ROC	0.393	0.490	0.492	0.510	0.749	0.770	0.656	0.776
US Legis.	ROC	$\pm 0.003$	$\pm 0.009$	±0.014	±0.010	$\pm 0.006$	±0.015	±0.013	$\pm 0.013$
	PR	0.486	0.534	0.542	0.529	0.684	0.707	0.587	0.725
		$\pm 0.004$	$\pm 0.014$	±0.016	±0.011	$\pm 0.005$	±0.013	$\pm 0.015$	$\pm 0.012$
Can. Parl.	ROC PR	0.675	0.509	0.473	0.529	0.734	0.801	0.678	0.810
		±0.003	±0.010	$\pm 0.011$	$\pm 0.012$	$\pm 0.008$	±0.014	$\pm 0.009$	$\pm 0.009$
		0.616	0.568	0.538	0.545	0.692	0.739	0.709	0.761
	ı ıx	±0.004	±0.013	±0.016	±0.010	±0.002	±0.012	$\pm 0.008$	$\pm 0.010$
Synthetic- $\alpha$	ROC	0.459	0.489	0.542	0.578	0.602	0.619	0.559	0.817
	NOC	±0.009	±0.021	±0.019	±0.030	±0.020	±0.016	$\pm 0.024$	$\pm 0.030$
(More Outliers)	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- $\alpha$  to generate more outliers for experiments, shown as "Synthetic- $\alpha$  (More Outliers)". In this setting,  $\ell_1$ LD-CTGR significantly outperforms GRASSP.

Node2	s) . In this setting, e	122 01				PIVEM	TCL	GranhMiver	GRASSP	ℓ.I D.
Synthetic-α			140dc2 vcc	CIDNL	IIIIIL	I I V LIVI	ICL	Graphivnixer	OKASSI	
Synthetic-a   PR			0.748	0.517	0.606	0.602	0.588	0.493	0.901	
Note	Synthetic- $\alpha$	ROC								
Synthetic-β         PR         ±0.011         ±0.015         ±0.013         ±0.005         ±0.078         ±0.049         ±0.011         ±0.014           Synthetic-β         ROC         0.514         0.491         0.593         0.588         0.456         0.363         0.861         0.864           PR         ±0.007         ±0.018         ±0.005         ±0.006         ±0.009         ±0.035         ±0.014         ±0.016           Contacts         PR         ±0.007         ±0.018         ±0.000         ±0.001         ±0.013         ±0.014         ±0.016         ±0.016           Contacts         ±0.009         ±0.016         ±0.003         ±0.011         ±0.013         ±0.004         ±0.016         ±0.017           HyperText         #0.687         0.565         0.601         0.497         0.691         0.692         0.714         0.712           HyperText         #0.003         ±0.011         ±0.004         ±0.003         ±0.011         ±0.003         ±0.015         ±0.003         ±0.016         ±0.003         ±0.017         ±0.000         ±0.007         ±0.007         ±0.006         ±0.007         ±0.007         ±0.007         ±0.007         ±0.006         ±0.007         ±0.006         <										
Note		PR								
Synthetic-β   PR   0.578   0.555   0.639   0.598   0.503   0.465   0.829   0.831     PR   0.578   0.555   0.639   0.598   0.503   0.465   0.829   0.831     PR   0.738   0.509   0.604   0.4093   0.681   0.676   0.763   0.767     PR   0.687   0.565   0.601   0.497   0.691   0.692   0.714   0.721     PR   0.687   0.565   0.601   0.497   0.691   0.692   0.714   0.721     PR   0.552   0.491   0.501   0.516   0.693   0.725   0.607   0.568     PR   0.518   0.552   0.502   0.516   0.693   0.735   0.607   0.568     PR   0.518   0.552   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.552   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.552   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.552   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.555   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.555   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.555   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.518   0.555   0.502   0.516   0.705   0.730   0.569   0.576     PR   0.889   0.508   0.730   0.517   0.667   0.859   0.898   0.901     PR   0.513   0.555   0.771   0.602   0.866   0.852   0.861   0.888     PR   0.513   0.517   0.462   0.491   0.512   0.517   0.491   0.528     PR   0.470   0.569   0.510   0.507   0.5   0.5   0.761   0.778     PR   0.470   0.569   0.517   0.505   0.5   0.5   0.761   0.778     PR   0.470   0.569   0.517   0.505   0.5   0.5   0.5   0.761     PR   0.496   0.513   0.593   0.481   0.500   ±0.001   ±0.001   ±0.011     PR   0.496   0.513   0.593   0.481   0.500   ±0.010   ±0.011   ±0.012     PR   0.496   0.513   0.593   0.481   0.505   0.505   0.537   0.711     PR   0.496   0.504   0.512   0.504   0.509   ±0.015   ±0.012   ±0.014     PR   0.496   0.513   0.593   0.481   0.505   0.505   0.537   0.711     PR   0.496   0.513   0.593   0.481   0.505   0.505   0.537   0.711     PR   0.496   0.504   0.501   ±0.010   ±0.008   ±0.014   ±0.015   ±0.016   ±0.016     PR   0.496   0.513   0.597   0.	-									
PR		ROC								
Property	Synthetic- $\beta$									
ROC   0.738   0.509   0.604   0.493   0.681   0.676   0.763   0.767   0.018   0.681   0.676   0.687   0.565   0.601   0.497   0.691   0.692   0.714   0.721   0.692   0.692   0.714   0.721   0.692   0.692   0.714   0.721   0.692   0.692   0.714   0.721   0.692   0.692   0.714   0.721   0.692   0.693		PR								
Contacts   PR	-									
PR	_	ROC								
HyperText   PR	Contacts									
HyperText   ROC   0.552   0.491   0.501   0.516   0.693   0.725   0.607   0.568   20.003   20.005   20.005   20.001   20.007   20.005   20.005   20.001   20.007   20.005		PR								
HyperText	-									
PR	**	ROC								
$ \text{Infectious} \\ \text{Infectious} \\ \text{Infectious} \\ \text{ROC} \\ \frac{0.869}{\pm 0.002} & 0.508 & 0.730 & 0.517 & 0.867 & 0.859 & 0.898 & 0.901 \\ \pm 0.002 & \pm 0.006 & \pm 0.017 & \pm 0.008 & \pm 0.003 & \pm 0.003 & \pm 0.015 & \pm 0.016 \\ \pm 0.002 & \pm 0.006 & \pm 0.017 & \pm 0.008 & \pm 0.003 & \pm 0.003 & \pm 0.015 & \pm 0.016 \\ \textbf{PR} \\ \pm 0.007 & \pm 0.014 & \pm 0.013 & \pm 0.009 & \pm 0.007 & \pm 0.005 & \pm 0.017 & \pm 0.016 \\ \textbf{Eacebook} \\ \textbf{PR} \\ \frac{10.007}{\pm 0.002} & \pm 0.005 & \pm 0.003 & \pm 0.002 & \pm 0.001 & \pm 0.005 & \pm 0.017 & \pm 0.016 \\ \textbf{PR} \\ \pm 0.002 & \pm 0.005 & \pm 0.003 & \pm 0.002 & \pm 0.001 & \pm 0.004 & \pm 0.006 & \pm 0.004 \\ \pm 0.002 & \pm 0.005 & \pm 0.003 & \pm 0.002 & \pm 0.001 & \pm 0.004 & \pm 0.006 & \pm 0.004 \\ \pm 0.006 & \pm 0.005 & \pm 0.009 & \pm 0.003 & \pm 0.001 & \pm 0.002 & \pm 0.006 & \pm 0.003 \\ \pm 0.004 & \pm 0.005 & \pm 0.009 & \pm 0.003 & \pm 0.001 & \pm 0.002 & \pm 0.006 & \pm 0.003 \\ \pm 0.004 & \pm 0.009 & \pm 0.018 & \pm 0.014 & \pm 0.000 & \pm 0.000 & \pm 0.006 & \pm 0.011 \\ \textbf{PR} \\ \pm 0.004 & \pm 0.011 & \pm 0.022 & \pm 0.012 & \pm 0.000 & \pm 0.000 & \pm 0.010 & \pm 0.011 \\ \pm 0.003 & \pm 0.011 & \pm 0.012 & \pm 0.011 & \pm 0.015 & \pm 0.012 & \pm 0.014 \\ \pm 0.003 & \pm 0.011 & \pm 0.017 & \pm 0.012 & \pm 0.011 & \pm 0.015 & \pm 0.012 & \pm 0.014 \\ \pm 0.004 & \pm 0.013 & \pm 0.022 & \pm 0.012 & \pm 0.008 & \pm 0.013 & \pm 0.012 & \pm 0.014 \\ \pm 0.004 & \pm 0.013 & \pm 0.020 & \pm 0.012 & \pm 0.008 & \pm 0.013 & \pm 0.012 & \pm 0.014 \\ \pm 0.004 & \pm 0.013 & \pm 0.020 & \pm 0.012 & \pm 0.008 & \pm 0.013 & \pm 0.018 & \pm 0.012 \\ \pm 0.004 & \pm 0.013 & \pm 0.020 & \pm 0.012 & \pm 0.008 & \pm 0.014 & \pm 0.010 & \pm 0.010 \\ \pm 0.005 & \pm 0.012 & \pm 0.011 & \pm 0.008 & \pm 0.014 & \pm 0.010 & \pm 0.010 \\ \pm 0.005 & \pm 0.012 & \pm 0.011 & \pm 0.008 & \pm 0.014 & \pm 0.010 & \pm 0.010 \\ \pm 0.005 & \pm 0.012 & \pm 0.010 & \pm 0.008 & \pm 0.014 & \pm 0.010 & \pm 0.008 \\ \pm 0.005 & \pm 0.012 & \pm 0.011 & \pm 0.005 & \pm 0.009 & \pm 0.008 & \pm 0.018 \\ \pm 0.005 & \pm 0.012 & \pm 0.011 & \pm 0.005 & \pm 0.009 & \pm 0.008 & \pm 0.018 \\ \pm 0.004 & \pm 0.009 & \pm 0.011 & \pm 0.005 & \pm 0.009 & \pm 0.008 & \pm 0.018 \\ \pm 0.004 & \pm 0.009 & \pm 0.011 & \pm 0.005 & \pm 0.009 & \pm 0.008 & \pm 0.018 \\ \pm 0.004 & \pm 0.009 & \pm 0.011 & \pm 0.015 & \pm 0.066 & \pm 0.020 & \pm 0.018 \\ \pm 0.004 & \pm 0.015 & \pm $	HyperText	DD								
Infectious $\begin{array}{c ccccccccccccccccccccccccccccccccccc$		PK								
Infectious	=	DOG	0.869							
PR   $\frac{0.875}{\pm 0.007}   \frac{0.555}{\pm 0.014}   \frac{0.771}{\pm 0.013}   \frac{0.602}{\pm 0.007}   \frac{0.866}{\pm 0.005}   \frac{0.852}{\pm 0.005}   \frac{0.861}{\pm 0.017}   \frac{0.888}{\pm 0.016}   \frac{0.888}{\pm 0.007}   \frac{1.0017}{\pm 0.016}   \frac{1.0017}{\pm 0.016}   \frac{1.0017}{\pm 0.016}   \frac{1.0017}{\pm 0.005}   \frac{1.0017}{\pm 0.005}   \frac{1.0017}{\pm 0.005}   \frac{1.0017}{\pm 0.005}   \frac{1.0017}{\pm 0.005}   \frac{1.0017}{\pm 0.006}   1.0017$	T C .:	ROC				±0.008				
Facebook  ROC	Infectious	PR	0.875	0.555	0.771	0.602	0.866		0.861	
Facebook $PR$ $0.002$ $0.005$ $0.003$ $0.002$ $0.001$ $0.004$ $0.006$ $0.006$ $0.004$ $0.006$ $0.005$ $0.006$ $0.005$ $0.009$ $0.003$ $0.001$ $0.002$ $0.002$ $0.498$ $0.535$ $0.006$ $0.006$ $0.006$ $0.005$ $0.009$ $0.003$ $0.001$ $0.002$ $0.006$ $0.006$ $0.003$ $0.003$ $0.001$ $0.002$ $0.006$ $0.006$ $0.003$ $0.003$ $0.001$ $0.002$ $0.006$ $0.006$ $0.003$ $0.003$ $0.001$ $0.002$ $0.006$ $0.006$ $0.003$ $0.003$ $0.001$ $0.002$ $0.000$ $0.000$ $0.000$ $0.000$ $0.001$			±0.007	±0.014	±0.013	±0.009	$\pm 0.007$	±0.005	±0.017	±0.016
Facebook $PR$ $0.513$ $0.517$ $0.462$ $0.491$ $0.512$ $0.517$ $0.498$ $0.535$ $\pm 0.006$ $\pm 0.006$ $\pm 0.005$ $\pm 0.009$ $\pm 0.003$ $\pm 0.001$ $\pm 0.002$ $\pm 0.006$ $\pm 0.003$ $\pm 0.001$ $\pm 0.012$ $\pm 0.001$ $\pm 0.001$ $\pm 0.013$ $\pm 0.011$ $\pm 0.012$ $\pm 0.011$ $\pm 0.012$ $\pm 0.011$ $\pm 0.012$ $\pm 0.011$ $\pm 0.012$ $\pm 0.012$ $\pm 0.012$ $\pm 0.013$ $\pm 0.013$ $\pm 0.012$ $\pm 0.014$ $\pm 0.013$ $\pm 0.014$ $\pm 0.014$ $\pm 0.015$ $\pm 0.014$ $\pm 0.015$ $\pm 0.015$ $\pm 0.016$ $\pm 0.010$ $\pm 0.008$ $\pm 0.014$ $\pm 0.010$ $\pm 0.0$	-	ROC	0.489	0.503	0.468	0.483	0.493	0.472	0.491	0.528
NeurIPS $ \begin{array}{c} PR \\ \pm 0.006 \\ \pm 0.006 \\ \pm 0.005 \\ \pm 0.009 \\ \pm 0.003 \\ \pm 0.003 \\ \pm 0.001 \\ \pm 0.001 \\ \pm 0.002 \\ \pm 0.000 \\ \pm 0.003 \\ \pm 0.001 \\ \pm 0.002 \\ \pm 0.006 \\ \pm 0.006 \\ \pm 0.003 \\ \pm 0.000 \\ \pm 0.000 \\ \pm 0.000 \\ \pm 0.000 \\ \pm 0.010 \\ \pm 0.011 \\ \pm 0.011 \\ \pm 0.002 \\ \pm 0.000 \\ \pm 0.010 \\ \pm 0.011 \\ \pm 0.011 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.000 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.000 \\ \pm 0.010 \\ \pm 0.011 \\ \pm 0.013 \\ \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \pm 0.013 \\ \pm 0.013 \\ \pm 0.014 \\ \pm 0.015 \\ \pm 0.005 \\ \pm 0.008 \\ \pm 0.0$	Easebast		±0.002	±0.005	±0.003	±0.002	$\pm 0.001$	±0.004	±0.006	$\pm 0.004$
NeurIPS $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	racebook	PR	0.513	0.517	0.462	0.491	0.512	0.517	0.498	0.535
NeurIPS $ \begin{array}{c} \text{ROC} \\ \pm 0.004 \\ \text{PR} \\ \begin{array}{c} 0.470 \\ \pm 0.004 \\ \end{array} \begin{array}{c} \pm 0.009 \\ 0.569 \\ \end{array} \begin{array}{c} \pm 0.018 \\ 0.517 \\ \end{array} \begin{array}{c} \pm 0.000 \\ 0.505 \\ \end{array} \begin{array}{c} \pm 0.000 \\ 0.505 \\ \end{array} \begin{array}{c} \pm 0.000 \\ \end{array} \begin{array}{c} \pm 0.000 \\ \end{array} \begin{array}{c} \pm 0.001 \\ \end{array} \begin{array}{c} \pm 0.011 \\ \pm 0.002 \\ \end{array} \begin{array}{c} \pm 0.000 \\ \pm 0.000 \\ \end{array} \begin{array}{c} \pm 0.000 \\ \pm 0.000 \\ \end{array} \begin{array}{c} \pm 0.010 \\ \end{array} \begin{array}{c} \pm 0.013 \\ \end{array} \begin{array}{c} \pm 0.013 \\ \end{array} \\ \begin{array}{c} \pm 0.004 \\ \end{array} \begin{array}{c} \pm 0.011 \\ \pm 0.011 \\ \end{array} \begin{array}{c} \pm 0.022 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.000 \\ \pm 0.000 \\ \end{array} \begin{array}{c} \pm 0.019 \\ \pm 0.013 \\ \end{array} \begin{array}{c} \pm 0.013 \\ \end{array} \begin{array}{c} \pm 0.011 \\ \pm 0.011 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.011 \\ \pm 0.015 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.014 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.011 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.010 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.012 \\ \pm 0.012 \\ \pm 0.012 \\ \end{array} \begin{array}{c} \pm 0.0$			$\pm 0.006$	$\pm 0.005$	$\pm 0.009$	±0.003	$\pm 0.001$	±0.002	$\pm 0.006$	$\pm 0.003$
NeurIPS $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	<del>-</del>	ROC	0.445	0.504	0.510	0.507	0.5	0.5	0.761	0.778
$ \text{US Legis.} \begin{array}{c} \text{PR} \\ \frac{\pm 0.004}{\pm 0.004} \\ \frac{\pm 0.011}{\pm 0.011} \\ \frac{\pm 0.022}{\pm 0.012} \\ \frac{\pm 0.000}{\pm 0.000} \\ \frac{\pm 0.000}{\pm 0.000} \\ \frac{\pm 0.019}{\pm 0.013} \\ \frac{\pm 0.013}{\pm 0.011} \\ \frac{\pm 0.011}{\pm 0.017} \\ \frac{\pm 0.012}{\pm 0.011} \\ \frac{\pm 0.011}{\pm 0.015} \\ \frac{\pm 0.012}{\pm 0.011} \\ \frac{\pm 0.012}{\pm 0.012} \\ \frac{\pm 0.012}{\pm 0.$	MaurIDC		$\pm 0.004$	$\pm 0.009$		±0.014	$\pm 0.000$	$\pm 0.000$	±0.010	$\pm 0.011$
US Legis. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Neulli 3	DD	0.470	0.569	0.517	0.505	0.5	0.5	0.675	0.723
US Legis. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		ΓK	$\pm 0.004$	±0.011	±0.022	±0.012	$\pm 0.000$	$\pm 0.000$	±0.019	$\pm 0.013$
US Legis. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	US Legis.	POC		0.466	0.490	0.463	0.482	0.469	0.565	0.754
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		ROC								
Can. Parl. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		PR		0.513	0.593	0.481			0.537	
Can. Parl. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$										
Can. Parl. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Can. Parl.	ROC								
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$										
Synthetic- $\alpha$ ROC $\frac{0.486}{\pm 0.003}$ $\frac{0.511}{\pm 0.003}$ $\frac{0.575}{\pm 0.003}$ $\frac{0.588}{\pm 0.003}$ $\frac{0.420}{\pm 0.015}$ $\frac{0.446}{\pm 0.066}$ $\frac{0.875}{\pm 0.020}$ $\frac{0.922}{\pm 0.018}$ (More Outliers) PR $\frac{0.491}{\pm 0.495}$ $\frac{0.495}{\pm 0.495}$ $\frac{0.614}{\pm 0.502}$ $\frac{0.502}{\pm 0.454}$ $\frac{0.510}{0.510}$ $\frac{0.819}{0.890}$		PR								
Synthetic- $\alpha$ ROC $\pm 0.003$ $\pm 0.019$ $\pm 0.016$ $\pm 0.014$ $\pm 0.015$ $\pm 0.066$ $\pm 0.020$ $\pm 0.018$ (More Outliers) PR 0.491 0.495 0.614 0.502 0.454 0.510 0.819 <b>0.890</b>										
$\pm 0.003 \pm 0.019 \pm 0.016 \pm 0.014 \pm 0.015 \pm 0.066 \pm 0.020 \pm 0.018$ (More Outliers) PR 0.491 0.495 0.614 0.502 0.454 0.510 0.819 <b>0.890</b>	Synthetic- $\alpha$	ROC								
(More Chiffiers) PR		NOC								
$\pm 0.012$ $\pm 0.019$ $\pm 0.020$ $\pm 0.017$ $\pm 0.011$ $\pm 0.014$ $\pm 0.019$ $\pm 0.019$	(More Outliers)	PR								
			±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  $\ell_1 LD$ -CTGR on different datasets (mean  $\pm$  STD). Results are conducted with a device equipped with an Intel(R) Xeon(R) Gold 6330 CPU, 1TB RAM, and 8 NVIDIA A100 GPUs in parallel.  $\ell_1 LD$ -CTGR shows the same order of computational time as that of GRASSP.

Dataset	GRASSP	$\ell_1 \text{LD-CTGR}$
Synthetic- $\alpha$	$1.85E - 4 \pm 8.89E - 6$	$1.79E - 4 \pm 8.77E - 6$
Synthetic- $\beta$	$1.64E - 4 \pm 7.15E - 6$	$1.66E - 4 \pm 7.81E - 6$
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- $\alpha$ (More Outliers)	$1.93E - 4 \pm 8.97E - 6$	$1.94E - 4 \pm 9.44E - 6$