Material Suplementar - Inferência de Redes de Regulação Gênica a partir de Séries Temporais via Meta-heurísticas

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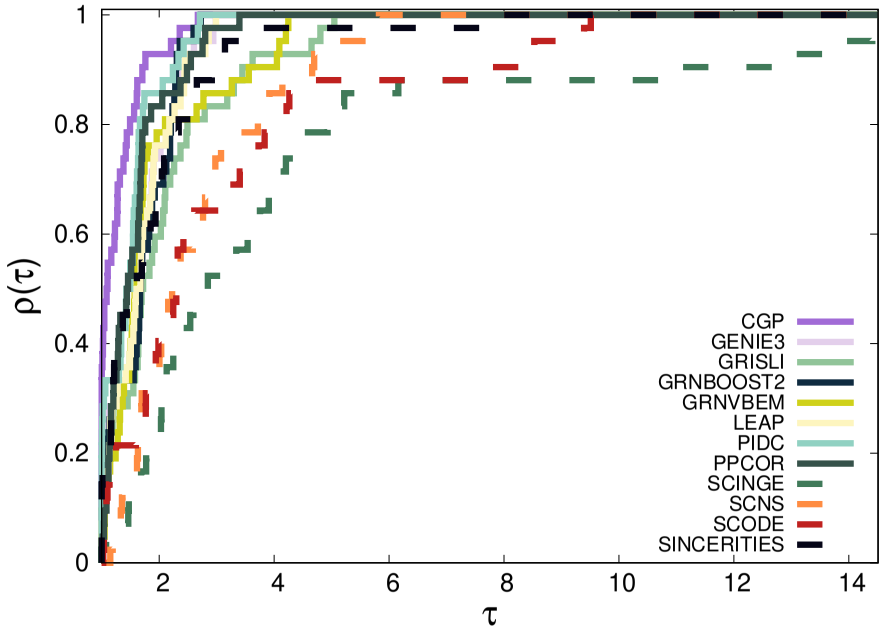
Este material suplementar apresenta detalhes adicionais, perfis de desempenho, resultados tabulares adicionais, redes reconstruídas e *boxplots* do método proposto aplicado aos problemas *benchmark*.

1 *Performance Profiles*

Figura 1: Performance profiles considerando os valores de mediana para BEELINE AUPRC e AUROC.

(a) Performance Profiles dos valores de mediana da BEELINE AUPRC considerando os 12 algoritmos.



(b) Performance Profile dos valores de mediana da BEELINE AUROC considerando os 12 algoritmos.

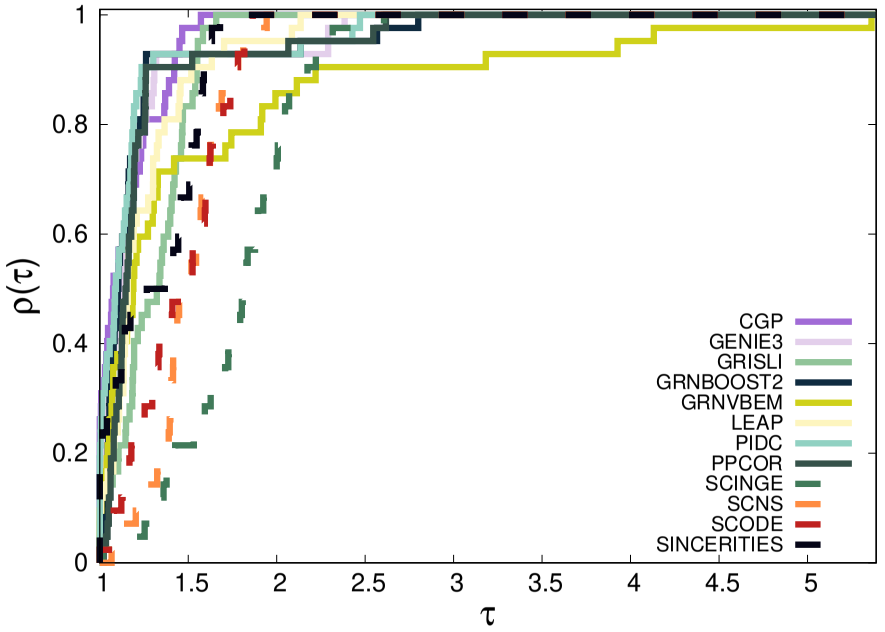
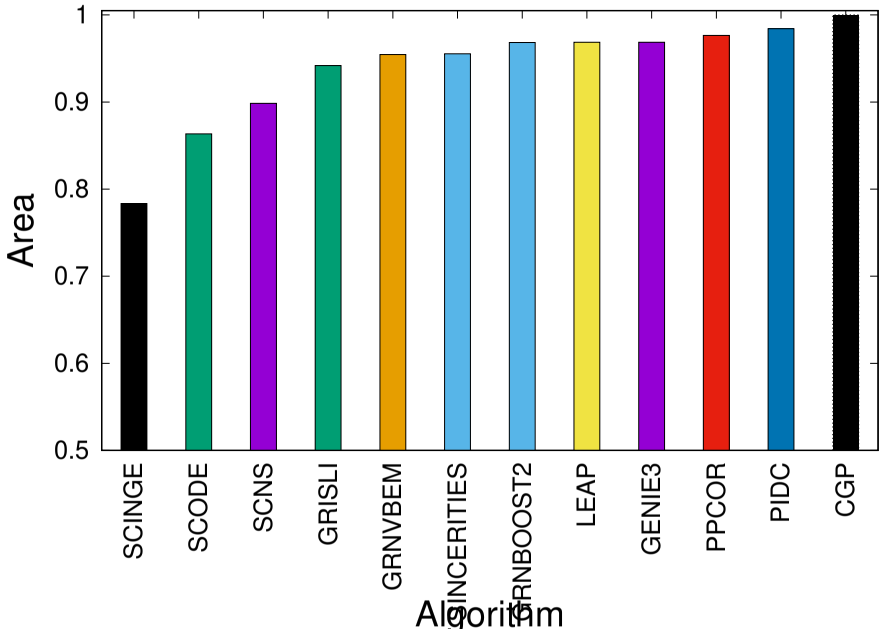


Figura 2: Gráfico de barras considerando os valores de mediana para BEELINE AUPRC e AUROC.

(a) Gráfico de barras da área dos valores de mediana para BEELINE AUPRC considerando os 12 algoritmos.



(b) Gráfico de barras da área dos valores de mediana para BEELINE AUROC considerando os 12 algoritmos.

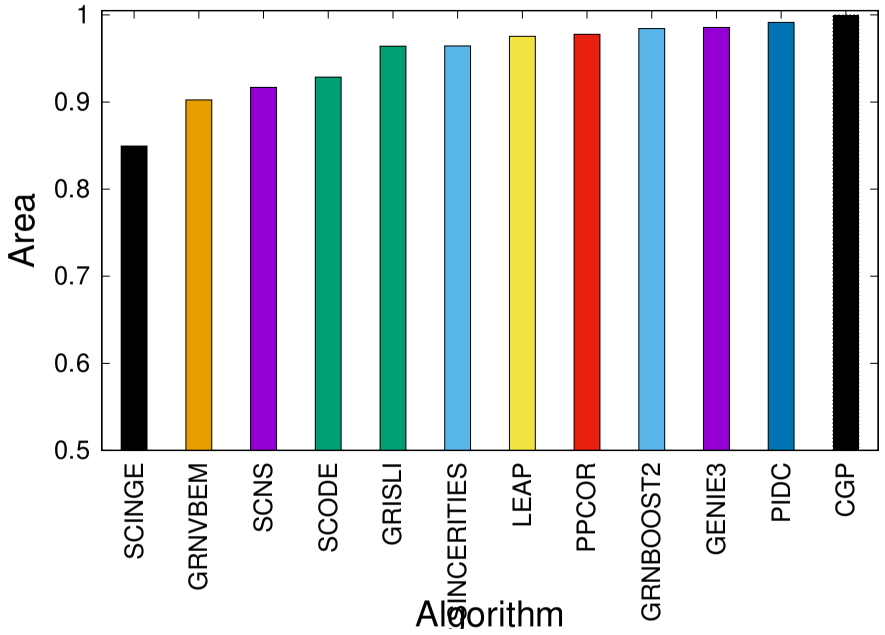
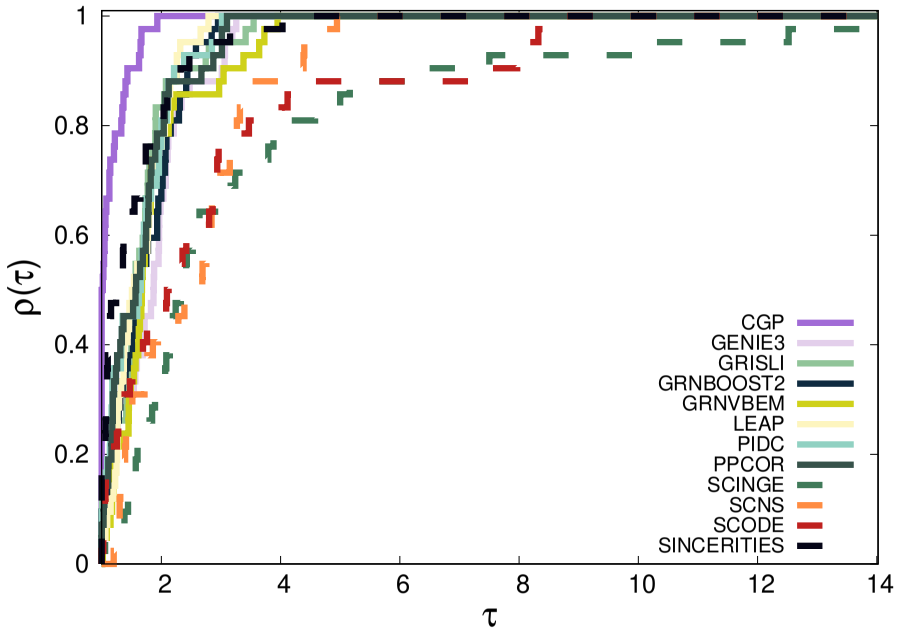


Figura 3: *Performance profiles* considerando os valores de melhor para BEELINE AUPRC e AUROC.

(a) Performance Profiles dos valores de melhor para BEELINE AUPRC considerando os 12 algoritmos.



(b) Performance Profiles dos valores de melhor para BEELINE AUROC considerando os 12 algoritmos.

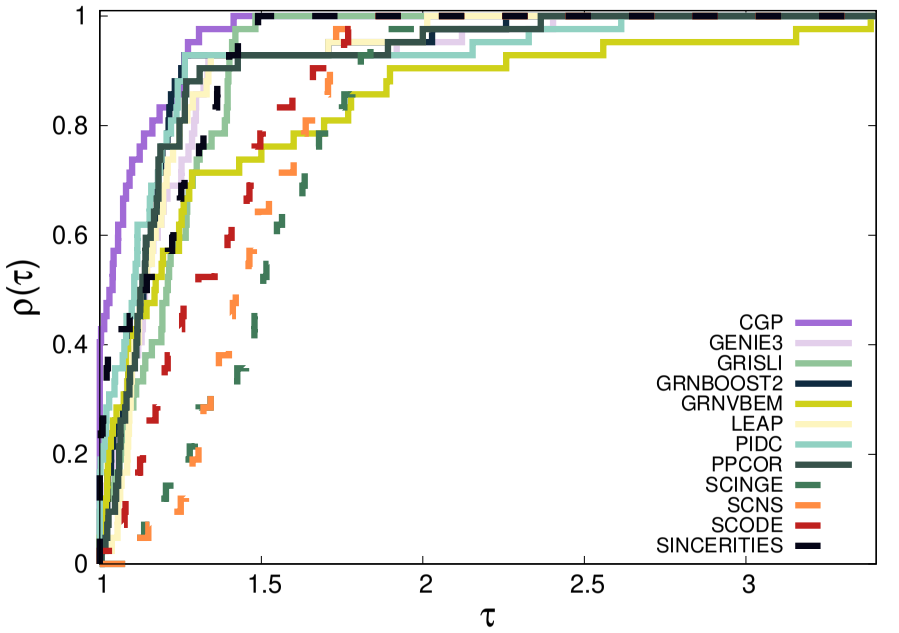
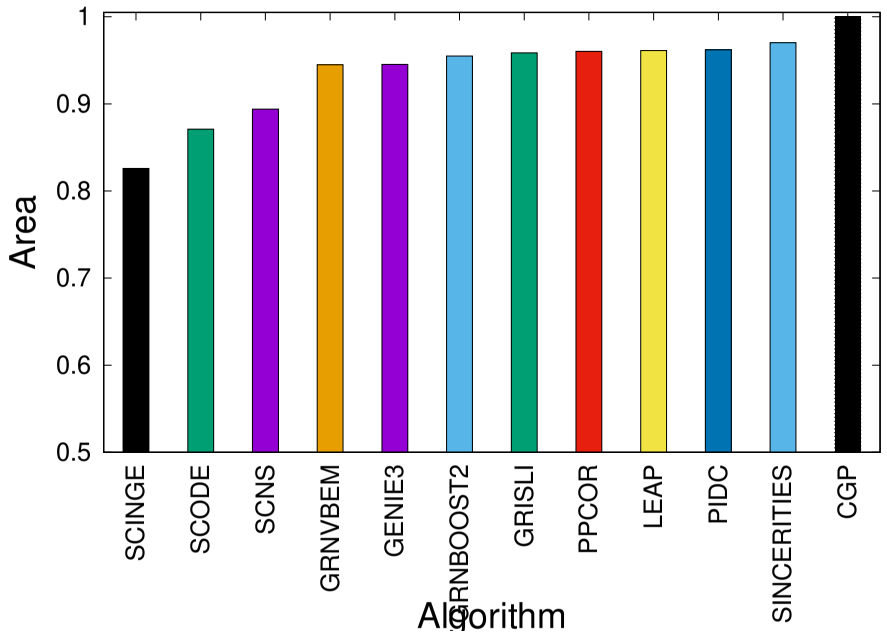
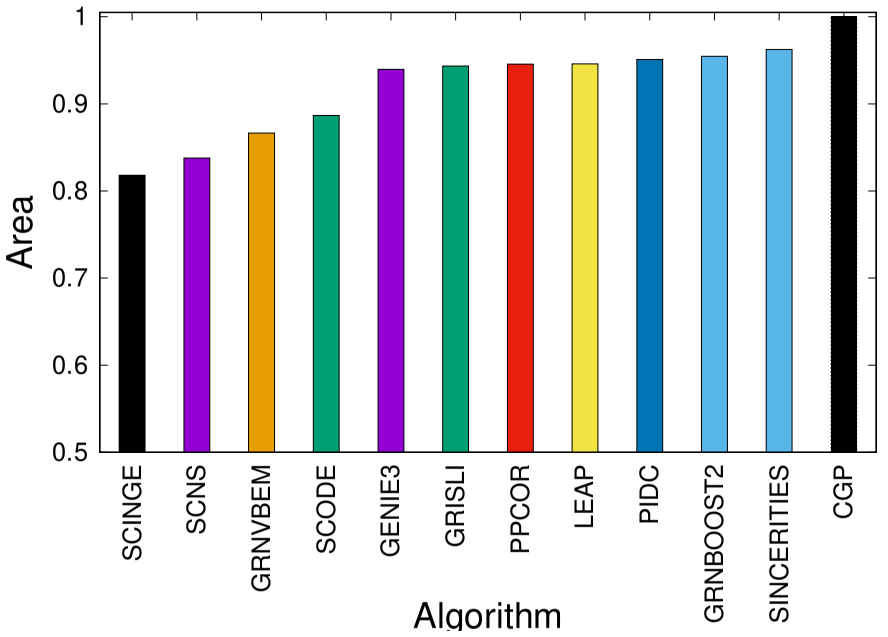


Figura 4: Gráfico de barras considerando o valor de melhor para BEELINE AUPRC e AUROC.

(a) Gráfico de barras da área dos valores de melhor para BEELINE AUPRC considerando os 12 algoritmos.



(b) Gráfico de barras da área dos valores de melhor para BEELINE AUROC considerando os 12 algoritmos.

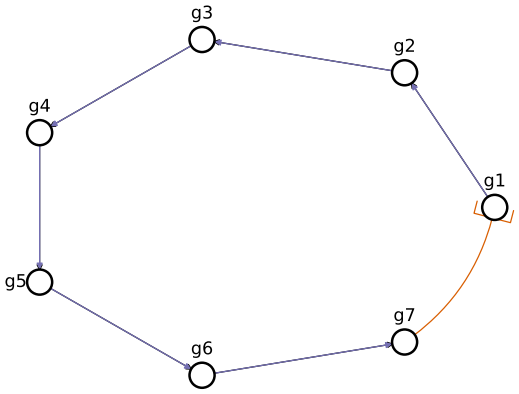


2 Linear

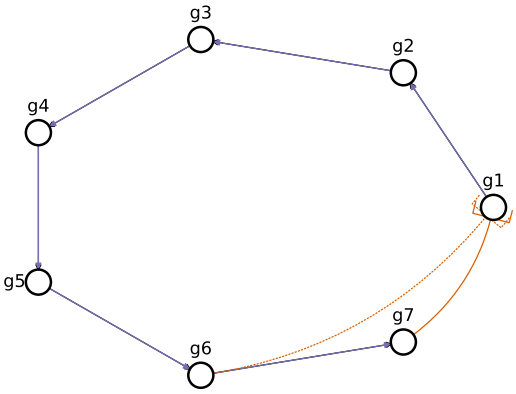
O problema Linear consiste de 7 genes e um *pseudotime*. CGP não conseguiu reconstruir a rede completamente. As seguintes tabelas apresentam os resultados para BEELINE AUPRC (Tabelas 1 a 5) e BEELINE AUROC (Tabelas 6 a 10), respectivamente. As redes *ground-truth* e reconstruídas são apresentadas na Figura 5.

Figura 5: Redes Linear *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



2.1 AUPRC

Tabela 1: AUPRC LI-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9809**	0.6561	0.4592	0.4458	0.2699	0.5611	0.2087		-
SCNS	0.3280	0.3129	0.3017	0.2373	0.1827	0.2778	0.0495		7.38E-04
PIDC	0.5000	0.4727	0.418	0.4045	0.3939	0.4371	0.0383		4.76E-01
GRNVBEM	0.7821	0.6811	0.6191	0.5696	0.4316	0.6187	0.0922		3.29E-01
GENIE3	0.5367	0.4507	0.4044	0.3507	0.3152	0.4099	0.0731		1.90E-01
GRNBOOST2	0.4244	0.3971	0.3467	0.3196	0.2858	0.3541	0.0443		3.08E-02
PPCOR	0.4762	0.4617	0.3982	0.3982	0.3088	0.4111	0.051		2.29E-01
SCODE	0.3313	0.2328	0.2054	0.1902	0.1505	0.2155	0.0486	2.01E-14	4.46E-05
SINCERITIES	0.3971	0.3513	0.2152	0.1776	0.1368	0.2509	0.0969		2.30E-04
LEAP	0.7814	**0.7218**	**0.6512**	**0.5888**	**0.5219**	**0.654**	0.0817		2.12E-01
GRISLI	0.8403	0.693	0.5415	0.3632	0.1963	0.5336	0.204		7.92E-01
SCINGE	0.2142	0.1748	0.1666	0.1536	0.1216	0.165	**0.0241**		1.10E-06

Tabela 2: AUPRC LI-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9809**	0.6994	0.4458	0.4458	0.4360	0.5883	0.1918		-
SCNS	0.3115	0.3038	0.2417	0.1810	0.1745	0.2418	0.0601		8.57E-05
PIDC	0.4689	0.4599	0.4552	0.4515	0.3939	0.447	**0.0244**		3.93E-01
GRNVBEM	0.6588	0.6318	0.6255	0.6137	**0.5078**	0.6133	0.0415		4.11E-01
GENIE3	0.4819	0.4599	0.3894	0.3453	0.3219	0.3985	0.0592		9.34E-02
GRNBOOST2	0.4057	0.3288	0.315	0.3062	0.2857	0.3270	0.0400	3.82E-16	3.52E-03
PPCOR	0.5092	0.4666	0.4326	0.3906	0.3557	0.4276	0.0474		1.77E-01
SCODE	0.3426	0.2255	0.1873	0.1719	0.1401	0.2113	0.0648		2.93E-05
SINCERITIES	0.5639	0.3862	0.3169	0.2017	0.1644	0.3182	0.1240		4.31E-03
LEAP	0.7743	0.7131	0.6600	0.5348	0.4686	0.6306	0.1055		3.78E-01
GRISLI	0.8137	**0.7982**	**0.7184**	**0.6168**	0.4332	**0.6831**	0.1278		2.66E-01
SCINGE	0.2428	0.1532	0.1440	0.1401	0.1259	0.1577	0.0354		7.18E-07

Tabela 3: AUPRC LI-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9809**	**0.8091**	0.4458	0.4458	0.4101	0.6148	0.2266		-
SCNS	0.3090	0.3004	0.2892	0.2068	0.1626	0.2578	0.0581		8.13E-05
PIDC	0.5000	0.4774	0.4708	0.4618	0.4123	0.4657	**0.0273**		4.52E-01
GRNVBEM	0.8060	0.7563	0.6341	0.5755	0.5083	0.6546	0.1035		3.65E-01
GENIE3	0.5000	0.4115	0.3865	0.3752	0.3478	0.3993	0.0407		3.50E-02
GRNBOOST2	0.4543	0.3552	0.3463	0.3417	0.3108	0.3555	0.0359	1.29E-15	5.48E-03
PPCOR	0.4762	0.4606	0.4341	0.4176	0.3881	0.4353	0.0285		1.59E-01
SCODE	0.2337	0.2097	0.1785	0.1621	0.1444	0.1849	0.0296		5.01E-06
SINCERITIES	0.9157	0.6638	0.4474	0.3408	0.1900	0.5192	0.2328		3.22E-01
LEAP	0.7768	0.7077	**0.6660**	**0.5911**	**0.5725**	**0.6596**	0.0685		3.35E-01
GRISLI	0.8912	0.7292	0.6430	0.5584	0.4353	0.6543	0.1366		4.29E-01
SCINGE	0.2526	0.2085	0.1652	0.1412	0.1138	0.1744	0.0421		2.45E-06

Tabela 4: AUPRC LI-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9809**	**0.9112**	0.4458	0.4458	0.4360	0.6310	0.2412		-
SCNS	0.3001	0.2847	0.2719	0.1735	0.1627	0.2383	0.0566		9.79E-05
PIDC	0.4904	0.4762	0.4708	0.4644	0.4456	0.4695	**0.0115**		5.69E-01
GRNVBEM	0.5385	0.5104	0.4955	0.4707	0.4313	0.4911	0.0302		8.88E-01
GENIE3	0.4719	0.3818	0.3762	0.3638	0.3520	0.3818	0.0329		2.53E-02
GRNBOOST2	0.5079	0.3918	0.3473	0.3369	0.2987	0.3722	0.0626	5.45E-15	1.80E-02
PPCOR	0.5488	0.4856	0.4660	0.4437	0.4252	0.4707	0.0348		4.70E-01
SCODE	0.3097	0.1964	0.1783	0.1677	0.1423	0.1982	0.0554		3.78E-05
SINCERITIES	0.9211	0.8931	0.6548	0.4761	0.3767	0.6684	0.2123		5.04E-01
LEAP	0.7746	0.7201	0.6622	**0.5613**	**0.5436**	0.6501	0.0846		1.73E-01
GRISLI	0.8886	0.8793	**0.7608**	0.5413	0.4656	**0.7143**	0.1655		1.75E-01
SCINGE	0.4705	0.1831	0.1735	0.1421	0.1237	0.1940	0.0954		4.72E-05

Tabela 5: AUPRC LI-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9809	**0.9809**	0.5741	0.4458	0.4458	0.6855	0.2523		-
SCNS	0.3142	0.2940	0.2771	0.1970	0.1528	0.2522	0.0580		3.77E-05
PIDC	0.5000	0.4958	0.4803	0.4629	0.4551	0.4785	**0.0167**		4.11E-01
GRNVBEM	0.5482	0.4643	0.4568	0.4368	0.4313	0.4609	0.0324		1.67E-01
GENIE3	0.4719	0.3825	0.3696	0.3649	0.3535	0.3833	0.0332		7.78E-03
GRNBOOST2	0.4354	0.3684	0.3600	0.3534	0.3168	0.3633	0.0295		2.17E-03
PPCOR	0.5488	0.5000	0.4693	0.4373	0.4121	0.4716	0.0423		2.45E-01
SCODE	0.2429	0.2188	0.1975	0.1846	0.1561	0.1993	0.0273	1.66E-17	7.66E-06
SINCERITIES	**1.0000**	0.8977	**0.8253**	**0.6975**	0.4882	**0.7906**	0.1567		2.12E-01
LEAP	0.7733	0.7258	0.6555	0.5465	0.5298	0.6452	0.0941		5.50E-01
GRISLI	0.8179	0.7635	0.7190	0.5868	**0.5593**	0.6863	0.0918		3.75E-01
SCINGE	0.2728	0.1429	0.1340	0.1277	0.1206	0.1497	0.0433		3.43E-07

2.2 AUROC

Tabela 6: AUROC LI-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9959**	0.8306	0.7429	0.7306	0.6367	0.7865	0.0994		-
SCNS	0.6204	0.5852	0.5837	0.5485	0.5286	0.5749	**0.0301**		1.08E-03
PIDC	0.9000	0.8633	0.7816	0.7551	0.6878	0.8004	0.0672		6.83E-01
GRNVBEM	0.9469	**0.9357**	**0.9163**	**0.8898**	**0.802**	**0.9065**	0.0414		2.42E-02
GENIE3	0.8816	0.8735	0.8531	0.8102	0.7388	0.8367	0.0448		3.07E-01
GRNBOOST2	0.8735	0.7633	0.7327	0.6878	0.6449	0.7441	0.0732		4.85E-01
PPCOR	0.8429	0.7306	0.7286	0.7286	0.6143	0.7290	0.0571		3.28E-01
SCODE	0.7265	0.6480	0.5592	0.5388	0.4449	0.5763	0.0894	3.02E-14	1.45E-03
SINCERITIES	0.6816	0.6291	0.6041	0.5265	0.4286	0.5735	0.0794		1.48E-03
LEAP	0.9061	0.8520	0.8265	0.7918	0.7612	0.8259	0.0432		4.14E-01
GRISLI	0.9306	0.8531	0.7673	0.7051	0.5102	0.7608	0.1241		7.53E-01
SCINGE	0.6367	0.5429	0.5010	0.4612	0.3449	0.5061	0.0795		1.09E-04

Tabela 7: AUROC LI-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9959**	0.8367	0.7429	0.7429	0.7327	0.8008	0.0850		-
SCNS	0.5837	0.5704	0.548	0.525	0.4653	0.5433	0.0342		6.26E-04
PIDC	0.8592	0.8469	0.8102	0.7878	0.7122	0.8086	0.0439		6.53E-01
GRNVBEM	0.9571	**0.9383**	**0.9255**	**0.848**	**0.8286**	**0.9002**	0.0493		2.46E-02
GENIE3	0.8735	0.8429	0.8265	0.8214	0.7755	0.8306	**0.0262**		2.90E-01
GRNBOOST2	0.849	0.7684	0.7367	0.7133	0.6612	0.7412	0.0567		2.82E-01
PPCOR	0.8429	0.7872	0.7837	0.7286	0.6714	0.7671	0.0524		5.96E-01
SCODE	0.6653	0.6286	0.5776	0.5153	0.4367	0.5702	0.0734	3.36E-14	1.35E-03
SINCERITIES	0.8224	0.6724	0.6092	0.5296	0.4592	0.6198	0.1124		1.28E-02
LEAP	0.8367	0.8077	0.8031	0.7770	0.7490	0.7963	0.0271		9.72E-01
GRISLI	0.9020	0.8622	0.8367	0.8122	0.6571	0.8245	0.0641		3.14E-01
SCINGE	0.6653	0.5071	0.4612	0.4056	0.3857	0.4849	0.0981		9.15E-05

Tabela 8: AUROC LI-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9959**	0.8888	0.7429	0.7429	0.7367	0.8190	0.1030		-
SCNS	0.5755	0.5612	0.5276	0.5051	0.4612	0.5271	0.0370		1.09E-03
PIDC	0.9000	0.8755	0.8633	0.8388	0.7449	0.8469	0.0508		2.38E-01
GRNVBEM	0.9714	**0.9454**	**0.9327**	**0.9097**	**0.8367**	**0.9218**	0.0403		9.14E-03
GENIE3	0.8776	0.8724	0.8673	0.8418	0.8122	0.8555	0.0222		1.32E-01
GRNBOOST2	0.8449	0.8265	0.8143	0.7949	0.7061	0.8041	0.0371		9.72E-01
PPCOR	0.8429	0.8378	0.7816	0.7699	0.7163	0.7910	0.0445	8.52E-13	7.24E-01
SCODE	0.6735	0.6061	0.5367	0.4857	0.4571	0.5478	0.0685		1.71E-03
SINCERITIES	0.9755	0.8883	0.7949	0.7622	0.5653	0.8122	0.1138		8.40E-01
LEAP	0.8327	0.8204	0.8051	0.7929	0.7673	0.8039	**0.0208**		8.37E-01
GRISLI	0.9551	0.8898	0.8143	0.7755	0.7388	0.8327	0.0702		6.00E-01
SCINGE	0.6612	0.6133	0.5173	0.4551	0.3061	0.5186	0.1067		1.09E-03

Tabela 9: AUROC LI-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9959**	0.9577	0.7429	0.7429	0.7327	0.8278	0.1141		-
SCNS	0.5531	0.5143	0.5112	0.4944	0.449	0.5053	0.0301		1.07E-03
PIDC	0.8918	0.8735	0.8633	0.8469	0.8102	0.8576	0.0233		2.38E-01
GRNVBEM	0.9143	0.8985	0.8908	**0.8816**	0.8041	0.8829	0.0288		3.76E-02
GENIE3	0.8694	0.8571	0.8469	0.8367	**0.8163**	0.8461	**0.0161**		4.54E-01
GRNBOOST2	0.8776	0.8429	0.8286	0.7939	0.7714	0.8212	0.0326		9.95E-01
PPCOR	0.8918	0.8745	0.8449	0.7908	0.7694	0.8347	0.0436	7.76E-13	6.41E-01
SCODE	0.6000	0.5867	0.5551	0.5276	0.4653	0.5469	0.0466		4.96E-03
SINCERITIES	0.9714	**0.9602**	**0.9112**	0.826	0.7714	**0.8949**	0.0722		5.79E-02
LEAP	0.8327	0.8153	0.8041	0.7694	0.7367	0.7945	0.0309		4.23E-01
GRISLI	0.9388	0.9051	0.8673	0.8112	0.7755	0.8624	0.0564		2.11E-01
SCINGE	0.6735	0.5827	0.5041	0.4423	0.3673	0.5092	0.0910		1.31E-03

Tabela 10: AUROC LI-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9959	**0.9959**	0.7929	0.7429	0.7429	0.8541	0.1194		-
SCNS	0.5776	0.5449	0.4949	0.4842	0.4224	0.5063	0.0459		2.84E-04
PIDC	0.9000	0.8959	0.8796	0.8429	0.8102	0.8673	0.0305		4.22E-01
GRNVBEM	0.9184	0.8816	0.8694	0.8286	0.7857	0.8561	0.0396		6.57E-01
GENIE3	0.8735	0.8602	0.8531	0.8418	**0.8367**	0.8522	**0.0109**		8.02E-01
GRNBOOST2	0.8490	0.8439	0.8265	0.7980	0.7755	0.8200	0.0257		4.23E-01
PPCOR	0.9020	0.8980	0.8480	0.8020	0.7612	0.8433	0.0540	9.89E-14	9.00E-01
SCODE	0.6531	0.6235	0.5980	0.5449	0.4776	0.5833	0.0540		1.76E-03
SINCERITIES	**1.000**	0.9786	**0.9551**	**0.9082**	0.8224	**0.9380**	0.0529		3.31E-02
LEAP	0.8286	0.8112	0.7898	0.7418	0.7224	0.7798	0.0373		9.03E-02
GRISLI	0.9347	0.8918	0.8653	0.8459	0.7918	0.8657	0.0436		5.16E-01
SCINGE	0.5612	0.4658	0.4122	0.3939	0.3592	0.4312	0.0562		2.93E-05

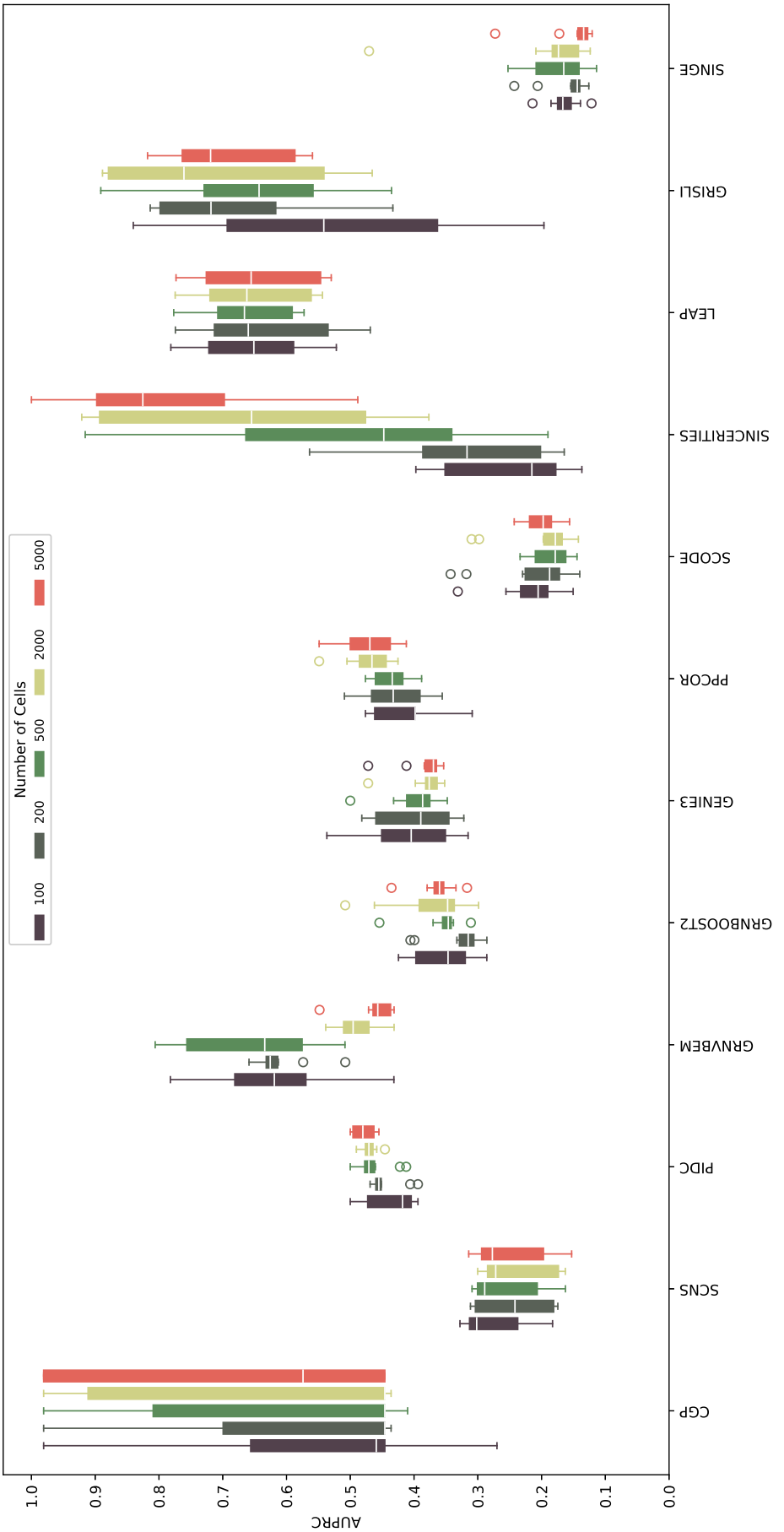


Figura 6: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema Linear.

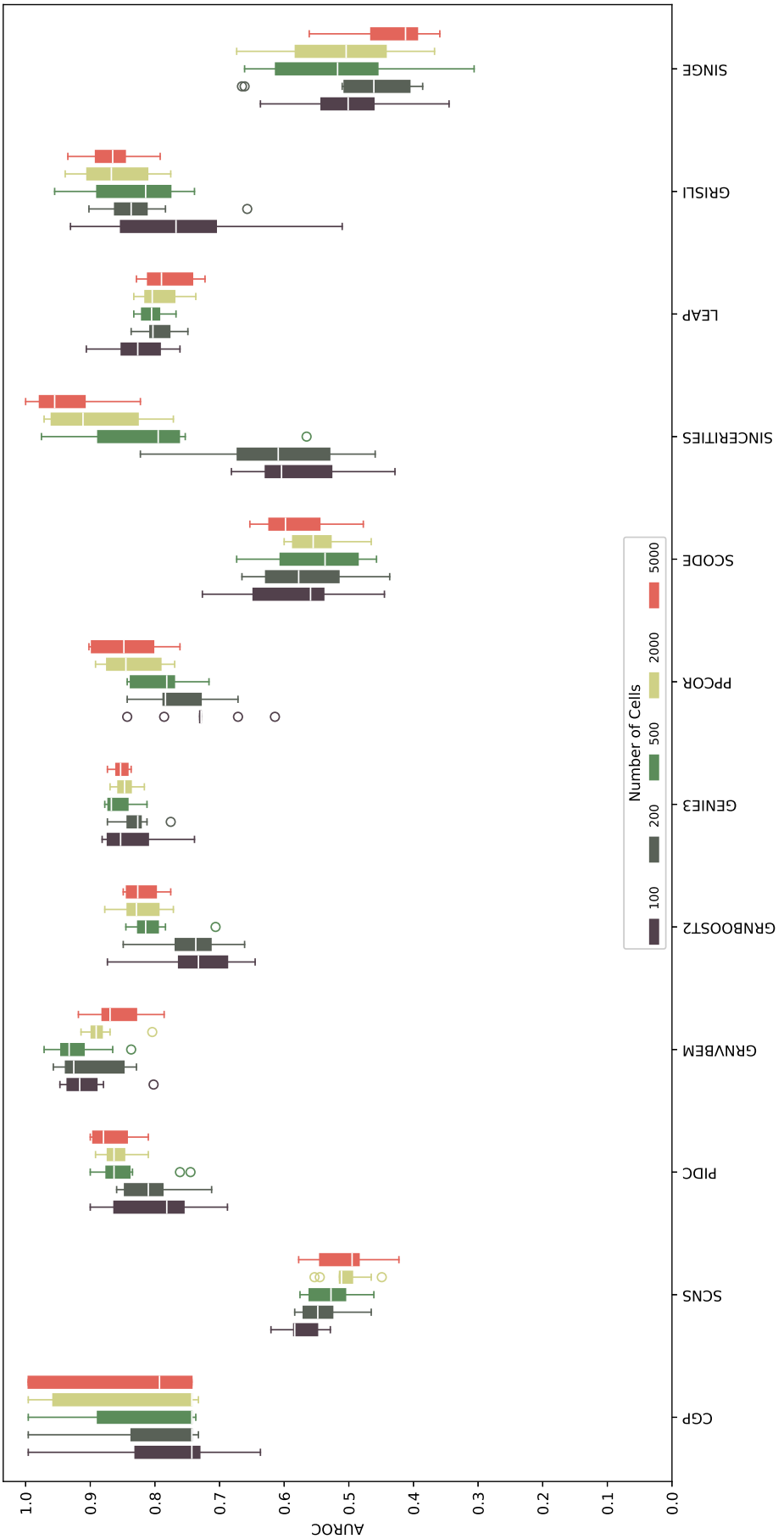


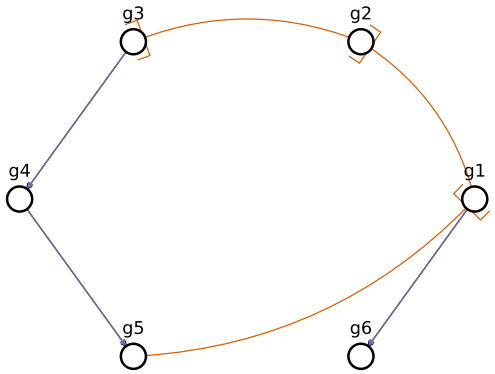
Figura 7: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema Linear.

3 *Cycle*

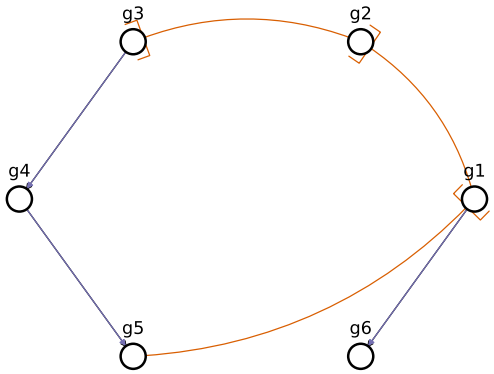
O problema *Cycle* consiste de 6 genes e um *pseudotime*. A CGP conseguiu reconstruir a rede completamente. As tabelas seguintes apresentam os resultados para BEELINE AUPRC (Tabelas 11 a 15) e BEELINE AUROC (Tabelas 16 a 20), respectivamente.

Figura 8: Redes *Cycle ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



3.1 AUPRC

Tabela 11: AUPRC CY-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.000**	**0.8773**	**0.7357**	**0.6897**	**0.4210**	**0.7536**	0.1717		-
SCNS	0.2900	0.2618	0.2391	0.1961	0.1693	0.2313	0.0374		1.66E-08
PIDC	0.4519	0.3712	0.3287	0.3028	0.2866	0.3452	0.0509		1.48E-02
GRNVBEM	0.4643	0.3812	0.2656	0.2232	0.1769	0.295	0.0972		8.58E-05
GENIE3	0.3266	0.3172	0.3117	0.3036	0.2803	0.3081	**0.0132**		8.11E-04
GRNBOOST2	0.3389	0.3239	0.3121	0.2861	0.2706	0.3071	0.0223		7.39E-04
PPCOR	0.4706	0.3989	0.2961	0.2721	0.2514	0.3317	0.0736		1.90E-03
SCODE	0.4804	0.3655	0.3201	0.2397	0.1935	0.3107	0.0843	2.46E-10	6.27E-04
SINCERITIES	0.4301	0.2682	0.2339	0.1895	0.1656	0.2457	0.0737		1.85E-07
LEAP	0.4742	0.3481	0.3243	0.3107	0.2794	0.3416	0.0549		1.13E-02
GRISLI	0.5924	0.4036	0.351	0.3345	0.2247	0.3763	0.0988		3.79E-02
SCINGE	0.2635	0.1924	0.1687	0.1487	0.1372	0.1773	0.0375		2.87E-11

Tabela 12: AUPRC CY-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.9173**	**0.7814**	**0.5901**	**0.563**	**0.7689**	0.1632		-
SCNS	0.3572	0.2264	0.2090	0.1809	0.1561	0.2155	0.0534		8.41E-09
PIDC	0.4193	0.3292	0.3221	0.3028	0.2998	0.3260	0.0333		6.54E-03
GRNVBEM	0.4525	0.3122	0.2947	0.2202	0.1503	0.2802	0.0815		2.08E-05
GENIE3	0.3259	0.3131	0.2999	0.2930	0.2705	0.3010	**0.0152**		2.13E-04
GRNBOOST2	0.4068	0.3828	0.3500	0.2959	0.2742	0.3418	0.0465		1.71E-02
PPCOR	0.3741	0.3382	0.3062	0.2806	0.2772	0.3142	0.0362		1.10E-03
SCODE	0.3441	0.2956	0.2216	0.1982	0.1748	0.2438	0.0611	6.89E-08	6.72E-07
SINCERITIES	0.4760	0.4201	0.3417	0.2120	0.1957	0.3254	0.1025		2.12E-03
LEAP	0.3581	0.3495	0.3202	0.3046	0.2727	0.3211	0.0284		4.36E-03
GRISLI	0.5250	0.3262	0.2799	0.2294	0.2173	0.3127	0.1048		1.98E-04
SCINGE	0.4181	0.2677	0.1924	0.1440	0.1334	0.2176	0.0871		1.02E-08

Tabela 13: AUPRC CY-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.8053**	**0.7524**	**0.5901**	**0.5630**	**0.7385**	0.1448		-
SCNS	0.3898	0.2427	0.1921	0.1740	0.1614	0.2233	0.0683		2.40E-08
PIDC	0.3315	0.3315	0.3221	0.3054	0.2998	0.3192	0.0133		4.44E-03
GRNVBEM	0.2682	0.2288	0.1839	0.1711	0.1529	0.1983	0.0380		4.13E-10
GENIE3	0.3134	0.3019	0.2979	0.2927	0.2721	0.2956	0.0117		4.33E-05
GRNBOOST2	0.3515	0.3318	0.3261	0.3169	0.2603	0.3173	0.0279		4.67E-03
PPCOR	0.3315	0.3261	0.3174	0.3100	0.2998	0.3174	**0.0104**	1.95E-09	2.62E-03
SCODE	0.3403	0.2976	0.2211	0.1878	0.1725	0.2398	0.0633		8.45E-07
SINCERITIES	0.6452	0.5204	0.3886	0.3116	0.2712	0.4236	0.1217		6.23E-02
LEAP	0.4422	0.3742	0.3169	0.2925	0.2734	0.3379	0.0554		5.76E-03
GRISLI	0.5760	0.4777	0.3018	0.2298	0.1569	0.3404	0.1419		8.09E-04
SCINGE	0.3789	0.3306	0.2314	0.1907	0.1533	0.2560	0.0802		7.89E-06

Tabela 14: AUPRC CY-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9444**	**0.9235**	**0.8727**	**0.7922**	**0.563**	**0.8194**	0.1370		-
SCNS	0.3954	0.2509	0.2347	0.1878	0.1614	0.2362	0.0630		1.02E-07
PIDC	0.3315	0.3221	0.3221	0.3116	0.2998	0.3174	0.0108		1.13E-02
GRNVBEM	0.2795	0.2267	0.2075	0.1910	0.1568	0.2103	0.0317		3.74E-09
GENIE3	0.3132	0.3032	0.2922	0.2868	0.2817	0.2950	**0.0099**		1.88E-04
GRNBOOST2	0.3874	0.3420	0.3204	0.3003	0.2771	0.3219	0.0311		9.57E-03
PPCOR	0.3289	0.3237	0.3116	0.3004	0.2978	0.3124	0.0116		5.06E-03
SCODE	0.3371	0.2414	0.1984	0.1898	0.1625	0.2184	0.0473	3.49E-12	2.49E-08
SINCERITIES	0.9296	0.7986	0.7258	0.5942	0.3688	0.6835	0.1596		7.00E-01
LEAP	0.4458	0.3206	0.3049	0.2830	0.2689	0.3184	0.0507		1.60E-03
GRISLI	0.5329	0.3780	0.2644	0.2074	0.1830	0.3029	0.1140		1.27E-04
SCINGE	0.3890	0.3073	0.2325	0.1919	0.1435	0.2493	0.0754		2.96E-06

Tabela 15: AUPRC CY-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	0.8913	**0.8611**	**0.7806**	0.5630	0.8083	0.1360		-
SCNS	0.3511	0.2086	0.1833	0.1623	0.1569	0.1999	0.0550		2.89E-08
PIDC	0.3315	0.3292	0.3221	0.3221	0.2998	0.3205	0.0111		4.35E-02
GRNVBEM	0.2532	0.2334	0.2027	0.1913	0.1679	0.2092	0.0271		1.26E-07
GENIE3	0.3070	0.2996	0.2926	0.2781	0.2705	0.2897	0.0132		5.97E-04
GRNBOOST2	0.3873	0.3433	0.3315	0.3103	0.2852	0.3305	0.0285		6.41E-02
PPCOR	0.3315	0.3228	0.3125	0.3086	0.2975	0.3148	**0.0109**	1.61E-15	2.40E-02
SCODE	0.2488	0.2199	0.2042	0.1856	0.1736	0.2048	0.0218		8.85E-08
SINCERITIES	0.9410	**0.9093**	0.8479	0.7532	**0.5954**	**0.817**	0.1091		9.85E-01
LEAP	0.3760	0.3080	0.2881	0.2788	0.2572	0.2996	0.0336		2.31E-03
GRISLI	0.6627	0.4019	0.2703	0.2083	0.1612	0.3271	0.1575		4.59E-04
SCINGE	0.2000	0.1997	0.1746	0.1690	0.1614	0.1818	0.0151		1.29E-09

3.2 AUROC

Tabela 16: AUROC CY-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.9149**	**0.8906**	**0.8828**	0.7292	**0.8892**	0.0776		-
SCNS	0.6250	0.5938	0.5521	0.5295	0.4514	0.5549	0.0484		9.32E-07
PIDC	0.8194	0.7778	0.7639	0.7500	**0.7361**	0.7667	0.0247		2.03E-01
GRNVBEM	0.6250	0.5920	0.5208	0.4878	0.4167	0.5306	0.0662		1.50E-07
GENIE3	0.7708	0.7569	0.7500	0.7448	0.7083	0.7479	**0.017**		6.45E-02
GRNBOOST2	0.7917	0.7639	0.7604	0.7326	0.7083	0.7514	0.0256		9.27E-02
PPCOR	0.7639	0.7500	0.7066	0.6623	0.6076	0.7000	0.0548	3.79E-15	7.13E-03
SCODE	0.6181	0.5590	0.5243	0.5087	0.4236	0.5285	0.0517		1.13E-07
SINCERITIES	0.7361	0.5938	0.5451	0.4253	0.3819	0.5344	0.1152		4.06E-07
LEAP	0.8889	0.7925	0.7691	0.7535	0.7222	0.7830	0.0476		3.07E-01
GRISLI	0.8056	0.7257	0.6736	0.5868	0.5417	0.6681	0.0869		1.90E-03
SCINGE	0.6458	0.5156	0.4097	0.3576	0.3090	0.4385	0.1022		9.52E-10

Tabela 17: AUROC CY-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.9766**	**0.8837**	**0.8125**	**0.7917**	**0.8948**	0.0800		-
SCNS	0.5903	0.5686	0.5521	0.4896	0.4167	0.5288	0.0557		8.68E-08
PIDC	0.8056	0.7882	0.7778	0.7535	0.7500	0.7736	0.0187		2.10E-01
GRNVBEM	0.6667	0.5703	0.5069	0.4618	0.3681	0.5122	0.0820		1.85E-08
GENIE3	0.7778	0.7552	0.7431	0.7361	0.7083	0.7451	**0.0179**		3.00E-02
GRNBOOST2	0.8472	0.8177	0.7847	0.7396	0.7083	0.7812	0.0461		2.10E-01
PPCOR	0.8021	0.7708	0.7361	0.6762	0.6667	0.7285	0.0478	1.08E-15	1.83E-02
SCODE	0.5556	0.5122	0.5000	0.4792	0.4167	0.4944	0.0358		1.84E-09
SINCERITIES	0.7986	0.6311	0.5868	0.5234	0.5069	0.5955	0.0841		1.31E-05
LEAP	0.8021	0.7665	0.7622	0.7370	0.7222	0.7566	0.0228		6.27E-02
GRISLI	0.7153	0.6927	0.6319	0.5590	0.5000	0.6222	0.0761		2.73E-05
SCINGE	0.6597	0.5781	0.5104	0.3351	0.2778	0.4764	0.1360		1.37E-08

Tabela 18: AUROC CY-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.9444**	**0.8958**	**0.8125**	**0.7917**	**0.8903**	0.0739		-
SCNS	0.6562	0.6146	0.4948	0.4661	0.4375	0.5330	0.0773		3.91E-08
PIDC	0.7917	0.7917	0.7778	0.7569	0.7500	0.7750	0.0173		1.91E-01
GRNVBEM	0.5903	0.5486	0.4670	0.4514	0.3958	0.4882	0.0623		1.47E-09
GENIE3	0.7569	0.7431	0.7431	0.7378	0.7153	0.7396	**0.0117**		3.10E-03
GRNBOOST2	0.7986	0.783	0.7778	0.7587	0.6875	0.7625	0.0346		8.54E-02
PPCOR	0.7917	0.7856	0.7691	0.7613	0.7500	0.7715	0.0147	4.43E-16	1.21E-01
SCODE	0.5694	0.5000	0.4931	0.4670	0.4375	0.4965	0.0409		7.02E-09
SINCERITIES	0.7882	0.7543	0.7222	0.6997	0.6389	0.7229	0.0430		2.35E-03
LEAP	0.8750	0.8168	0.7708	0.7396	0.6944	0.7809	0.0549		8.48E-02
GRISLI	0.7431	0.6944	0.6458	0.5417	0.4028	0.6083	0.1088		2.22E-06
SCINGE	0.7014	0.5955	0.5243	0.4488	0.3819	0.5247	0.1007		2.09E-08

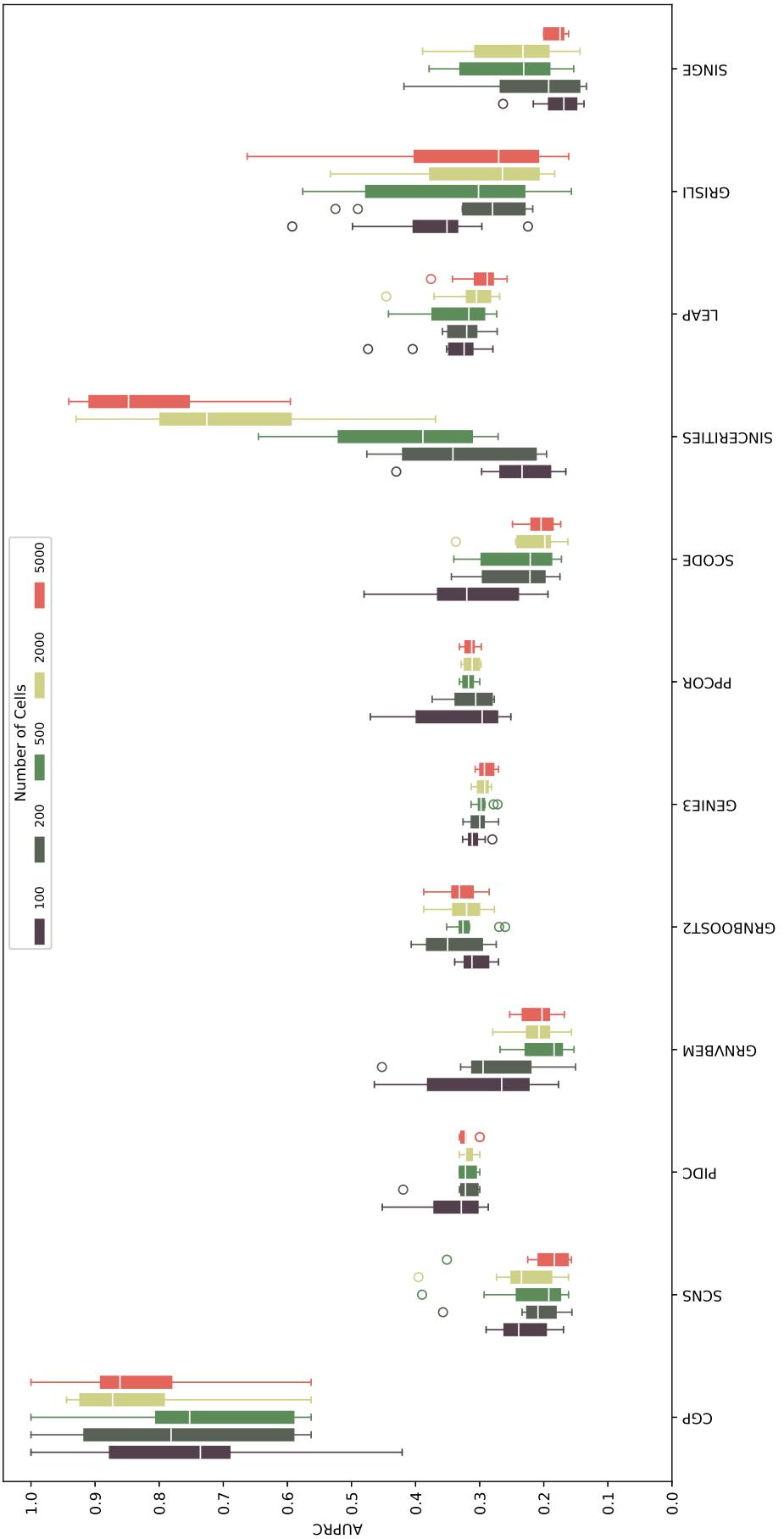
Tabela 19: AUROC CY-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9826**	**0.9757**	**0.9618**	**0.8854**	**0.7917**	**0.9198**	0.0722		-
SCNS	0.6354	0.6024	0.5677	0.5069	0.4375	0.5538	0.0592		1.78E-07
PIDC	0.7917	0.7778	0.7778	0.7639	0.7500	0.7722	0.0142		8.14E-02
GRNVBEM	0.5556	0.5104	0.4826	0.4740	0.3958	0.4861	0.0409		1.16E-09
GENIE3	0.7569	0.7431	0.7431	0.7292	0.7222	0.7382	**0.0112**		9.73E-04
GRNBOOST2	0.8125	0.7830	0.7708	0.7431	0.7222	0.7653	0.0269		2.84E-02
PPCOR	0.7882	0.7769	0.7639	0.7509	0.7465	0.7649	0.0141	8.04E-16	3.87E-02
SCODE	0.5556	0.5469	0.5174	0.4948	0.4236	0.5104	0.0409		1.07E-08
SINCERITIES	0.9722	0.9219	0.8524	0.8099	0.7500	0.8611	0.0717		5.54E-01
LEAP	0.8750	0.7743	0.7552	0.7318	0.7153	0.7656	0.0477		1.48E-02
GRISLI	0.7708	0.6632	0.6076	0.5312	0.4653	0.5993	0.0912		2.52E-06
SCINGE	0.7778	0.6094	0.4757	0.4418	0.3542	0.5233	0.1289		3.40E-08

Tabela 20: AUROC CY-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**1.0000**	**0.9688**	**0.9583**	0.8958	0.7917	0.9198	0.0711		-
SCNS	0.6528	0.5486	0.4931	0.4392	0.4132	0.5031	0.0731		3.03E-08
PIDC	0.7917	0.7882	0.7778	0.7778	0.7500	0.7764	0.0145		1.32E-01
GRNVBEM	0.5625	0.5373	0.5017	0.4332	0.4167	0.4892	0.0529		1.44E-08
GENIE3	0.7500	0.7361	0.7326	0.7240	0.7083	0.7292	**0.0124**		1.43E-03
GRNBOOST2	0.8194	0.7847	0.7812	0.7535	0.7292	0.7757	0.0267		1.04E-01
PPCOR	0.7917	0.7778	0.7639	0.7613	0.7465	0.7681	0.0148	1.61E-17	6.69E-02
SCODE	0.5694	0.5469	0.5139	0.4878	0.4514	0.5132	0.0402		1.32E-07
SINCERITIES	0.9792	0.9670	0.9444	**0.9062**	**0.8576**	**0.9309**	0.0429		8.98E-01
LEAP	0.8264	0.7595	0.7361	0.7240	0.6910	0.7469	0.0379		9.74E-03
GRISLI	0.7639	0.6927	0.6181	0.5747	0.4306	0.6215	0.0924		3.18E-05
SCINGE	0.5069	0.5000	0.4792	0.4583	0.4375	0.4778	0.0226		4.69E-09

Figura 9: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema Cycle.



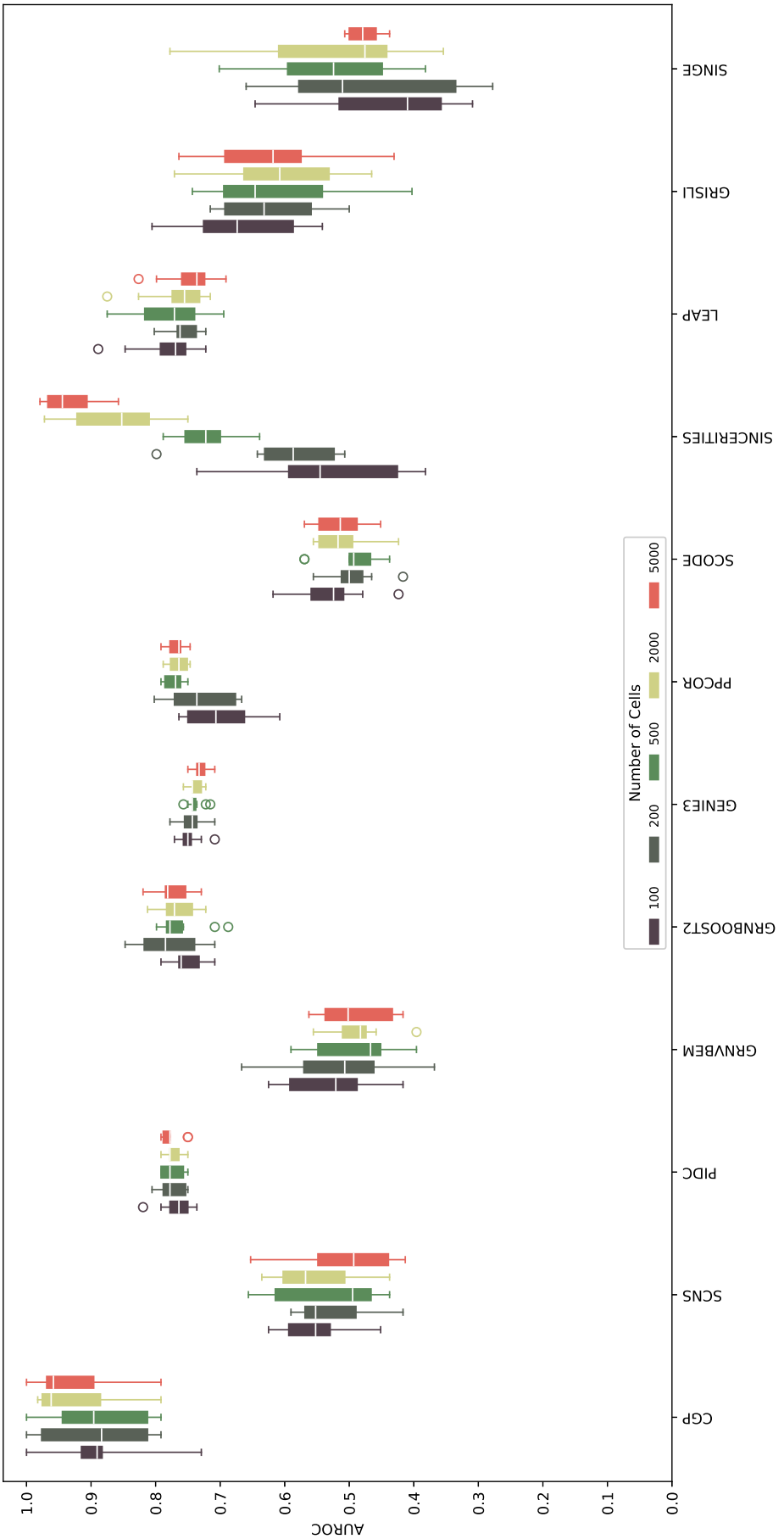


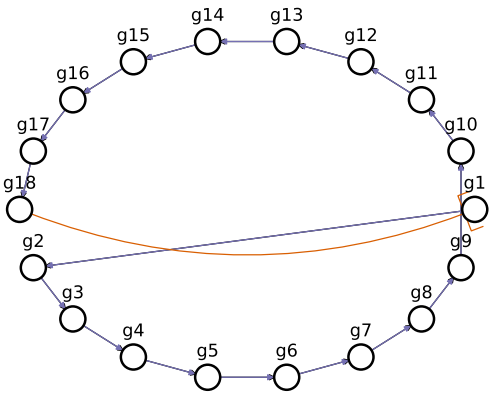
Figura 10: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema *Cycle*.

4 Linear Long

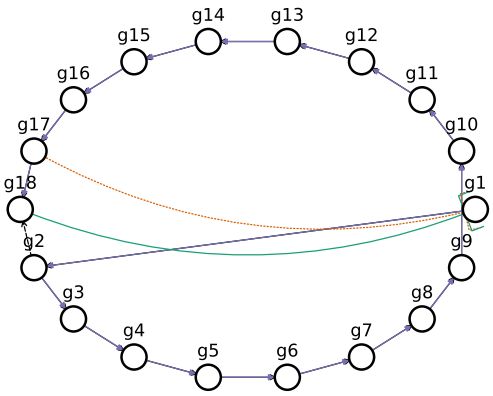
O problema *Linear Long* consiste de 18 genes e um *pseudotime*. A CGP não conseguiu reconstruir a rede completamente, como apresentado na Figura 11b. As tabelas seguintes apresentam os resultados para BEELINE AUPRC (Tabelas 21 a 25) e BEELINE AUROC (Tabelas 26 a 30), respectivamente.

Figura 11: Redes Linear Long *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



4.1 AUPRC

Tabela 21: AUPRC LL-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.7863**	**0.6655**	**0.6207**	**0.5902**	**0.4522**	**0.6213**	0.0892		-
SCNS	0.1700	0.1286	0.1066	0.0853	0.0727	0.1098	0.0289		2.53E-07
PIDC	0.4715	0.4621	0.4370	0.3645	0.3146	0.4142	0.0536		1.59E-01
GRNVBEM	0.6843	0.5373	0.4849	0.4336	0.2214	0.4716	0.1188		3.22E-01
GENIE3	0.4611	0.4114	0.3549	0.3452	0.2808	0.368	0.0534		3.67E-02
GRNBOOST2	0.3810	0.3108	0.2833	0.2718	0.2275	0.2942	0.0461		4.06E-03
PPCOR	0.2535	0.1995	0.1828	0.1515	0.1138	0.1800	0.0451		4.85E-05
SCODE	0.0987	0.0922	0.0795	0.0750	0.0714	0.0831	**0.0099**	1.04E-17	5.53E-09
SINCERITIES	0.1950	0.1278	0.0816	0.0680	0.0578	0.1019	0.0429		3.00E-08
LEAP	0.5707	0.4197	0.4121	0.3800	0.3541	0.4179	0.0596		1.41E-01
GRISLI	0.2865	0.2082	0.1292	0.1045	0.0888	0.1604	0.0708		8.92E-06
SCINGE	0.1242	0.0627	0.0568	0.0500	0.0427	0.0614	0.0221		1.93E-11

Tabela 22: AUPRC LL-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8536**	**0.7598**	**0.7023**	**0.6286**	**0.4666**	**0.6896**	0.1028		-
SCNS	0.1946	0.1448	0.1400	0.1060	0.0623	0.1281	0.0355		2.50E-08
PIDC	0.4906	0.4827	0.4694	0.4207	0.3135	0.4466	0.0529		1.94E-01
GRNVBEM	0.5856	0.4809	0.4486	0.3626	0.308	0.4359	0.0819		9.72E-02
GENIE3	0.4556	0.4171	0.3745	0.3352	0.3079	0.3794	0.0484		1.43E-02
GRNBOOST2	0.4266	0.3695	0.3186	0.2959	0.2303	0.3281	0.0535		1.17E-03
PPCOR	0.4183	0.3545	0.3418	0.3088	0.2922	0.3418	0.0387		2.46E-03
SCODE	0.0983	0.0886	0.0824	0.0791	0.0635	0.0836	**0.0096**	3.65E-17	2.98E-10
SINCERITIES	0.2707	0.2114	0.1984	0.1193	0.0813	0.1749	0.0606		4.66E-07
LEAP	0.5828	0.4679	0.4174	0.3643	0.3306	0.4309	0.0815		8.97E-02
GRISLI	0.3791	0.2450	0.2037	0.1580	0.0983	0.2195	0.0892		9.19E-06
SCINGE	0.1138	0.0685	0.0554	0.0465	0.0437	0.0617	0.0202		7.26E-12

Tabela 23: AUPRC LL-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8536**	**0.853**	**0.7648**	**0.6879**	**0.4744**	**0.7479**	0.1153		-
SCNS	0.1986	0.1804	0.1381	0.1127	0.0657	0.1419	0.0401		5.00E-08
PIDC	0.5000	0.4963	0.4756	0.4543	0.4219	0.4721	0.0252		1.69E-01
GRNVBEM	0.5201	0.5124	0.4648	0.3969	0.3915	0.4571	0.0533		9.09E-02
GENIE3	0.4294	0.3602	0.3481	0.3383	0.2937	0.3545	0.0362		2.36E-04
GRNBOOST2	0.5269	0.4112	0.3602	0.3446	0.2277	0.3695	0.0810		1.43E-03
PPCOR	0.4768	0.4459	0.4114	0.3837	0.2756	0.4043	0.0544		8.56E-03
SCODE	0.1055	0.0944	0.0897	0.0758	0.0744	0.0870	**0.0102**	1.04E-16	4.15E-10
SINCERITIES	0.4906	0.4276	0.3868	0.2526	0.0914	0.3473	0.1246		1.20E-03
LEAP	0.5664	0.5277	0.4798	0.4437	0.3467	0.4760	0.0645		1.46E-01
GRISLI	0.3051	0.2267	0.1644	0.1155	0.1058	0.1792	0.0679		3.21E-07
SCINGE	0.0840	0.0671	0.0531	0.0501	0.0439	0.0589	0.0124		5.29E-12

Tabela 24: AUPRC LL-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8536**	**0.7878**	**0.7598**	**0.7183**	**0.7031**	**0.7635**	0.0531		-
SCNS	0.1941	0.1848	0.1630	0.1072	0.0556	0.1463	0.0471		2.89E-08
PIDC	0.5000	0.5000	0.4936	0.4410	0.4095	0.4709	0.0360		1.39E-01
GRNVBEM	0.5100	0.4724	0.4512	0.4308	0.3837	0.4510	0.0338		6.32E-02
GENIE3	0.3849	0.3741	0.3359	0.3233	0.3109	0.3451	0.0277		1.74E-04
GRNBOOST2	0.4122	0.3665	0.3354	0.3238	0.2641	0.3435	0.0423		1.78E-04
PPCOR	0.4794	0.4664	0.4461	0.4156	0.3556	0.4327	0.0423		2.75E-02
SCODE	0.1163	0.0861	0.0799	0.0736	0.0654	0.0832	0.0143	5.01E-17	3.51E-10
SINCERITIES	0.7901	0.6941	0.5553	0.2733	0.1851	0.5014	0.2218		4.63E-02
LEAP	0.4832	0.4516	0.4415	0.4078	0.3173	0.4213	0.0510		1.43E-02
GRISLI	0.2500	0.1929	0.1505	0.1301	0.1194	0.1663	0.0459		1.18E-07
SCINGE	0.0682	0.0568	0.0526	0.0459	0.0403	0.0523	**0.0083**		3.06E-12

Tabela 25: AUPRC LL-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.9141**	**0.7932**	**0.7616**	**0.7315**	**0.5498**	**0.7564**	0.0859		-
SCNS	0.1848	0.1848	0.1838	0.1137	0.0587	0.1477	0.0476		1.45E-08
PIDC	0.5000	0.5000	0.4930	0.4486	0.4363	0.4768	0.0267		1.18E-01
GRNVBEM	0.4754	0.4595	0.4496	0.4491	0.1508	0.4247	0.0917		1.34E-02
GENIE3	0.3693	0.3297	0.3255	0.3186	0.3113	0.3282	0.0153		2.51E-05
GRNBOOST2	0.4518	0.4025	0.3673	0.3238	0.2556	0.3644	0.0583		2.77E-04
PPCOR	0.4979	0.4715	0.4539	0.4144	0.3576	0.4413	0.0448		2.18E-02
SCODE	0.1098	0.0857	0.0811	0.075	0.0660	0.0824	0.0113	7.46E-15	6.00E-10
SINCERITIES	0.6735	0.6506	0.5301	0.2708	0.1886	0.4689	0.1874		3.06E-02
LEAP	0.4777	0.4699	0.4021	0.3781	0.3154	0.4105	0.0564		6.00E-03
GRISLI	0.2576	0.2338	0.2100	0.1862	0.1625	0.2100	0.0475		2.69E-03
SCINGE	0.0655	0.0596	0.0546	0.0466	0.0424	0.0541	**0.0079**		3.36E-12

4.2 AUROC

Tabela 26: AUROC LL-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9117	0.8977	0.8513	0.8492	0.7860	0.8607	0.0392		-
SCNS	0.6883	0.6614	0.6415	0.6104	0.5570	0.6321	0.0417		2.17E-03
PIDC	0.9610	**0.9552**	0.9406	0.8650	0.7948	0.9080	0.0635		2.89E-01
GRNVBEM	**0.9633**	0.9435	0.9008	0.8855	0.7338	0.8981	0.0625		3.82E-01
GENIE3	0.9562	0.9477	**0.9417**	**0.9160**	**0.8463**	**0.9270**	0.0319		1.73E-01
GRNBOOST2	0.8848	0.8589	0.8500	0.7462	0.6873	0.8084	0.0692		5.25E-01
PPCOR	0.6751	0.6437	0.6188	0.5962	0.5815	0.6236	0.0320		1.09E-03
SCODE	0.6512	0.6276	0.6148	0.5959	0.5675	0.6108	**0.0238**	7.50E-17	3.97E-04
SINCERITIES	0.7067	0.6710	0.6087	0.5607	0.5031	0.6121	0.0663		6.27E-04
LEAP	0.9061	0.8919	0.8705	0.8278	0.7797	0.8584	0.0401		9.85E-01
GRISLI	0.8493	0.7447	0.7042	0.6687	0.6343	0.7120	0.0599		6.99E-02
SCINGE	0.5598	0.5380	0.4757	0.4570	0.3738	0.4811	0.0603		8.20E-07

Tabela 27: AUROC LL-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9132	0.9106	0.8799	0.8526	0.7818	0.8721	0.0434		-
SCNS	0.7183	0.7115	0.6825	0.6159	0.5245	0.6592	0.0607		9.31E-04
PIDC	**0.9653**	**0.963**	**0.9485**	0.8865	0.8322	0.9248	0.0461		1.41E-01
GRNVBEM	0.9579	0.9269	0.9183	0.9009	0.8025	0.9076	0.0395		3.22E-01
GENIE3	0.9522	0.9493	0.9456	**0.9257**	**0.9109**	**0.9377**	**0.0153**		7.50E-02
GRNBOOST2	0.9331	0.9230	0.8800	0.8075	0.7292	0.8609	0.0669		9.74E-01
PPCOR	0.9074	0.8481	0.7933	0.7370	0.7248	0.7974	0.0600		1.50E-01
SCODE	0.6582	0.6445	0.6236	0.5879	0.5602	0.6155	0.0365	3.78E-16	1.74E-04
SINCERITIES	0.8426	0.7787	0.7495	0.6968	0.5469	0.7255	0.0908		1.31E-02
LEAP	0.8891	0.8747	0.8611	0.8387	0.7935	0.8558	0.0278		6.95E-01
GRISLI	0.8463	0.8178	0.7942	0.7390	0.5965	0.7660	0.0726		5.22E-02
SCINGE	0.5858	0.5153	0.4768	0.4180	0.3919	0.4780	0.0659		3.80E-06

Tabela 28: AUROC LL-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9406	0.9132	0.9105	0.8836	0.8080	0.8965	0.0341		-
SCNS	0.7213	0.6913	0.6786	0.6483	0.5344	0.6590	0.0533		8.89E-04
PIDC	**0.9688**	**0.9668**	**0.9531**	0.9153	0.8723	**0.9391**	0.0324		1.18E-01
GRNVBEM	0.9615	0.9216	0.9176	0.8831	0.8425	0.9070	0.0351		6.30E-01
GENIE3	0.9512	0.9457	0.9434	**0.9339**	**0.9032**	0.9366	**0.0148**		1.45E-01
GRNBOOST2	0.9456	0.9389	0.9087	0.8131	0.7286	0.8735	0.0746		8.35E-01
PPCOR	0.9630	0.9100	0.8796	0.8513	0.6948	0.8674	0.0725	3.04E-14	6.30E-01
SCODE	0.6659	0.6431	0.6254	0.6004	0.5795	0.6226	0.0270		2.19E-04
SINCERITIES	0.9549	0.9407	0.9153	0.8432	0.6356	0.8723	0.0944		9.95E-01
LEAP	0.8877	0.8740	0.8586	0.8458	0.7976	0.8541	0.0287		2.50E-01
GRISLI	0.8708	0.8179	0.7503	0.7296	0.5681	0.7590	0.0805		1.86E-02
SCINGE	0.6092	0.5397	0.4730	0.4437	0.3763	0.4887	0.0700		7.44E-06

Tabela 29: AUROC LL-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9132	0.9114	0.9112	0.8872	0.8542	0.8967	0.0231		-
SCNS	0.7214	0.7113	0.6950	0.6474	0.4808	0.6677	0.0695		4.40E-03
PIDC	0.9688	0.9688	0.9659	0.8869	0.8333	0.9300	0.0517		1.39E-01
GRNVBEM	0.9689	0.9552	0.9234	0.9099	0.8954	0.9312	0.0260		2.39E-01
GENIE3	0.9485	0.9457	0.9436	**0.9339**	**0.9205**	**0.9387**	**0.0100**		1.83E-01
GRNBOOST2	0.9539	0.9468	0.9423	0.8683	0.8289	0.9114	0.0503		4.77E-01
PPCOR	0.9611	0.9569	0.9391	0.8560	0.7950	0.9058	0.0617	5.06E-15	4.39E-01
SCODE	0.6892	0.6727	0.6150	0.5923	0.5268	0.6217	0.0509		9.74E-04
SINCERITIES	**0.9873**	**0.9802**	**0.9722**	0.8897	0.7627	0.9250	0.0760		1.18E-01
LEAP	0.8802	0.8631	0.8461	0.8176	0.8053	0.8424	0.0250		3.22E-01
GRISLI	0.8156	0.7867	0.7860	0.7642	0.6759	0.7708	0.0368		3.44E-02
SCINGE	0.5372	0.4805	0.4377	0.4100	0.3384	0.4422	0.0581		5.56E-05

Tabela 30: AUROC LL-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.9702	0.9391	0.9117	0.9115	0.8247	0.917	0.0360		-
SCNS	0.6968	0.6950	0.6950	0.6767	0.4942	0.6617	0.0646		3.00E-03
PIDC	0.9688	0.9688	0.9653	0.9284	0.8634	**0.9406**	0.0378		1.91E-01
GRNVBEM	0.961	0.9362	0.9198	0.9155	0.6253	0.8990	0.0925		9.67E-01
GENIE3	0.9462	0.944	0.9423	**0.9372**	**0.9203**	0.9391	**0.0075**		4.65E-01
GRNBOOST2	0.9614	0.9544	0.9475	0.8761	0.8017	0.9127	0.0553		6.85E-01
PPCOR	0.9667	0.9565	0.9487	0.8674	0.7948	0.9121	0.0585	1.06E-12	6.54E-01
SCODE	0.6537	0.6321	0.5983	0.5552	0.5154	0.5888	0.0477		5.47E-04
SINCERITIES	**0.9836**	**0.9801**	**0.9699**	0.9113	0.7993	0.9386	0.0584		1.68E-01
LEAP	0.8771	0.8582	0.8415	0.8151	0.7898	0.8371	0.0262		9.56E-02
GRISLI	0.8260	0.8212	0.8165	0.8117	0.8069	0.8165	0.0095		2.42E-01
SCINGE	0.5457	0.5067	0.4738	0.4207	0.3708	0.4647	0.0533		2.43E-05

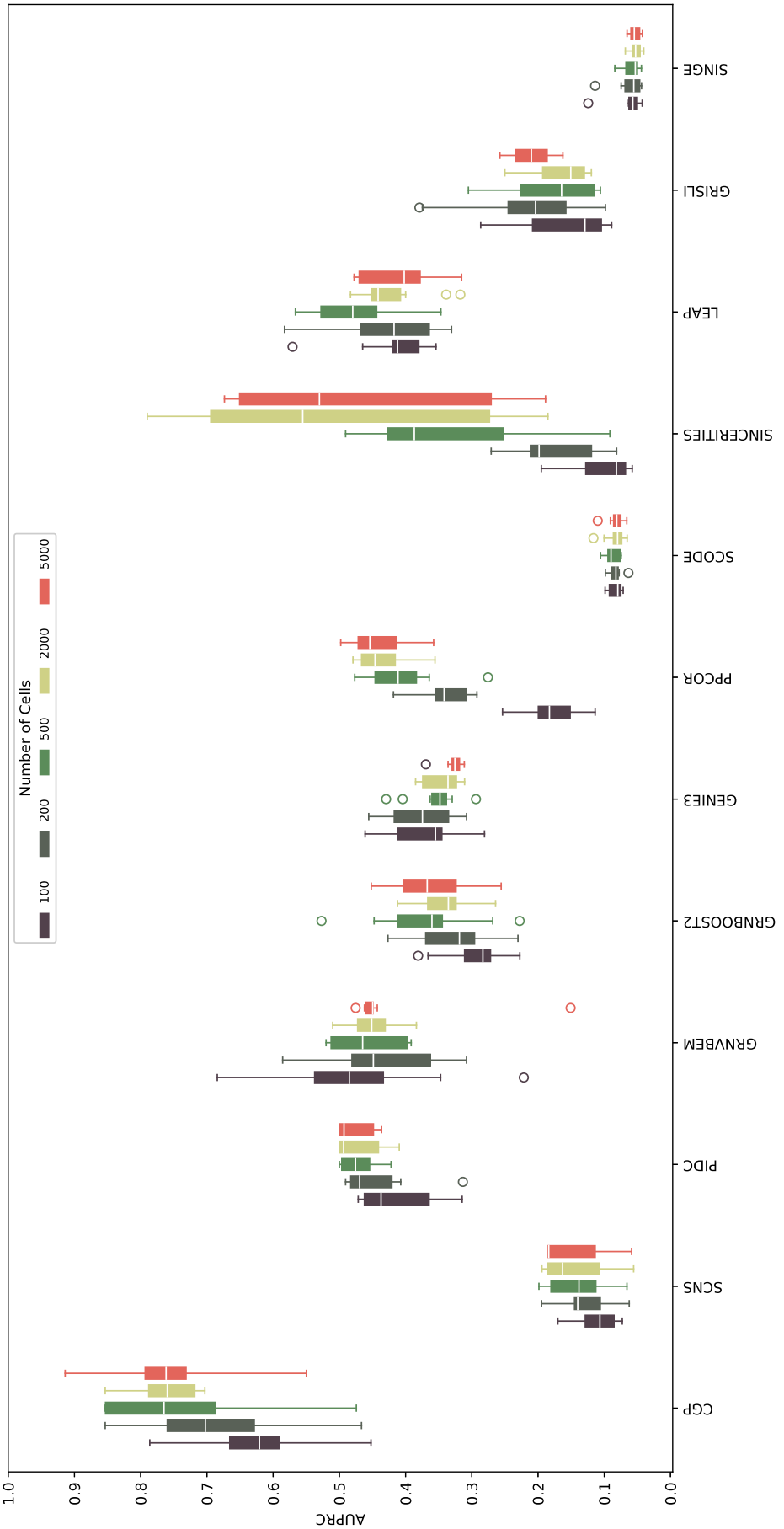


Figura 12: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema Linear Long.

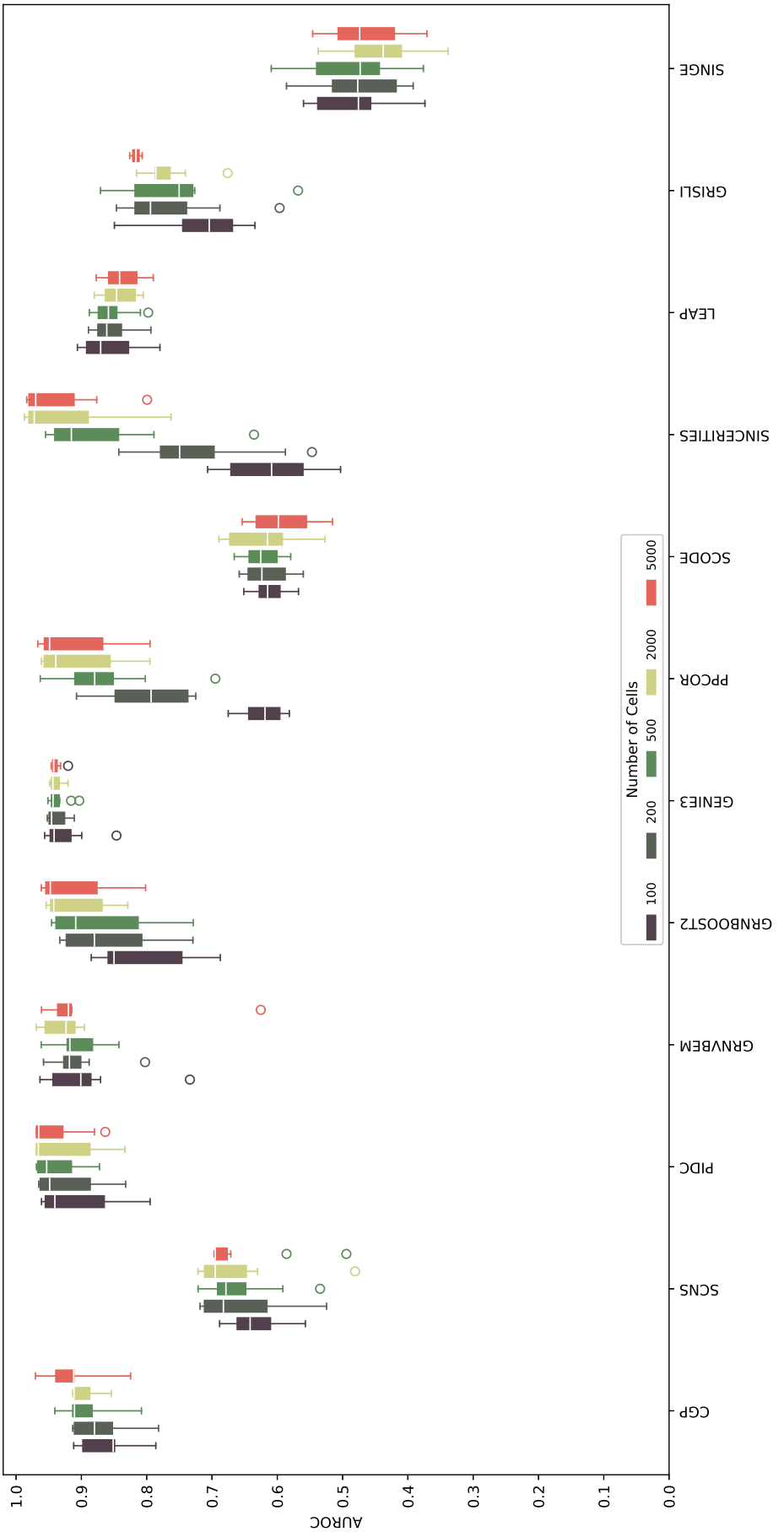


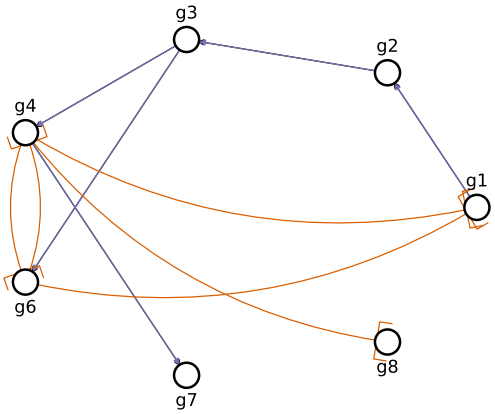
Figura 13: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema Linear Long.

5 Bifurcating

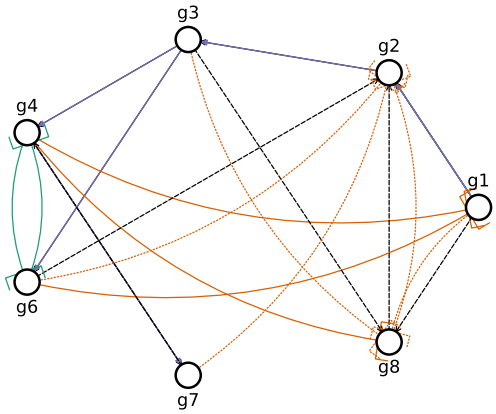
O problema *Bifurcating* consiste de 7 genes e dois *pseudotimes*. A CGP não conseguiu reconstruir a rede completamente, como apresentado na Figura 14b. As tabelas seguintes apresentam os resultados para BEELINE AUPRC (Tabelas 31 a 35) e BEELINE AUROC (Tabelas 36 a 40), respectivamente.

Figura 14: Redes *Bifurcating ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída..



5.1 AUPRC

Tabela 31: AUPRC BF-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8352**	**0.5764**	**0.4968**	**0.4584**	**0.4266**	**0.5406**	0.1161		-
SCNS	0.3017	0.2791	0.2684	0.2564	0.2149	0.2648	**0.0236**		1.14E-06
PIDC	0.3953	0.3798	0.3471	0.3147	0.2941	0.3459	0.0365		1.29E-02
GRNVBEM	0.4560	0.4096	0.3579	0.3250	0.2548	0.3615	0.0592		2.98E-02
GENIE3	0.3780	0.3608	0.3088	0.2767	0.2705	0.3184	0.0425		9.10E-04
GRNBOOST2	0.4003	0.3358	0.3023	0.2659	0.2562	0.3067	0.0449	1.61E-08	2.88E-04
PPCOR	0.6238	0.4097	0.3949	0.3483	0.3117	0.4132	0.0954		1.46E-01
SCODE	0.5516	0.3496	0.2480	0.2173	0.1670	0.2923	0.1137		1.03E-05
SINCERITIES	0.4319	0.3836	0.3082	0.2840	0.1965	0.3168	0.0746		8.89E-04
LEAP	0.3605	0.3250	0.2958	0.2550	0.2091	0.2916	0.0472		3.89E-05
GRISLI	0.5921	0.3763	0.2448	0.2270	0.1952	0.3107	0.1192		5.42E-05
SCINGE	0.3588	0.2097	0.1914	0.1765	0.1454	0.2091	0.0577		7.66E-10

Tabela 32: AUPRC BF-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6151	**0.5334**	**0.5108**	**0.4577**	0.3307	**0.4927**	0.0730		-
SCNS	0.3343	0.2727	0.2433	0.2278	0.1942	0.2532	0.0399		9.67E-07
PIDC	0.4887	0.4187	0.3932	0.3618	0.3172	0.3937	0.0490		2.66E-01
GRNVBEM	0.3732	0.3338	0.3171	0.2871	0.2727	0.3148	**0.0304**		3.59E-03
GENIE3	0.3846	0.3475	0.3055	0.2743	0.2528	0.3124	0.0433		2.31E-03
GRNBOOST2	0.4151	0.3440	0.2833	0.2735	0.2719	0.3118	0.0488		1.56E-03
PPCOR	**0.6495**	0.4287	0.3859	0.3723	**0.3378**	0.4167	0.0834	1.25E-08	3.89E-01
SCODE	0.4409	0.3679	0.2758	0.2181	0.1806	0.2952	0.0928		1.57E-04
SINCERITIES	0.5898	0.4120	0.2561	0.2186	0.1808	0.3214	0.1389		2.48E-04
LEAP	0.5198	0.2965	0.2771	0.2530	0.2335	0.2986	0.0795		1.28E-04
GRISLI	0.3771	0.3102	0.2967	0.2312	0.1915	0.2835	0.0593		8.13E-05
SCINGE	0.2897	0.2586	0.2397	0.1851	0.1529	0.2249	0.0483		3.61E-08

Tabela 33: AUPRC BF-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6399	**0.5706**	**0.5182**	**0.4924**	**0.4008**	**0.5202**	0.0750		-
SCNS	0.3584	0.2694	0.2435	0.2225	0.1800	0.2504	0.0451		2.36E-07
PIDC	0.5720	0.4020	0.3869	0.3755	0.3056	0.4046	0.0737		1.99E-01
GRNVBEM	0.3943	0.3315	0.3042	0.2605	0.2394	0.3015	0.0464		2.96E-04
GENIE3	0.3391	0.3199	0.3119	0.2945	0.2726	0.3075	**0.0185**		9.53E-04
GRNBOOST2	0.4923	0.4197	0.3040	0.2967	0.2737	0.3513	0.0768		1.15E-02
PPCOR	**0.6662**	0.4601	0.4042	0.3725	0.3222	0.4420	0.1063	2.26E-11	3.58E-01
SCODE	0.3934	0.3504	0.2929	0.2524	0.1818	0.2953	0.0658		1.74E-04
SINCERITIES	0.5757	0.4773	0.4369	0.2992	0.2396	0.4058	0.1105		7.93E-02
LEAP	0.3665	0.3204	0.2756	0.2663	0.2535	0.2917	0.0374		9.54E-05
GRISLI	0.3509	0.3017	0.2460	0.2235	0.1947	0.2630	0.0525		2.38E-06
SCINGE	0.3108	0.2195	0.2040	0.1820	0.1619	0.2084	0.0411		1.24E-09

Tabela 34: AUPRC BF-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6049	0.5572	0.5225	0.4844	**0.4491**	0.5222	0.0543		-
SCNS	0.3978	0.3078	0.2637	0.2498	0.2131	0.2842	0.0616		6.60E-06
PIDC	0.5061	0.4193	0.4040	0.3806	0.3245	0.4035	0.0446		1.45E-01
GRNVBEM	0.3745	0.3167	0.3118	0.2943	0.2704	0.3130	**0.0309**		2.88E-04
GENIE3	0.4300	0.3329	0.3187	0.3066	0.2868	0.3276	0.0376		1.71E-03
GRNBOOST2	0.4880	0.4310	0.3227	0.3029	0.2821	0.3626	0.0762		9.40E-03
PPCOR	0.6601	0.4917	0.4138	0.3826	0.3236	0.4549	0.1098		3.13E-01
SCODE	0.5451	0.3629	0.3292	0.2681	0.2030	0.3387	0.0984	3.92E-13	1.53E-03
SINCERITIES	**0.6838**	**0.6604**	**0.5368**	**0.5056**	0.4111	**0.5658**	0.0891		8.07E-01
LEAP	0.3685	0.3201	0.2784	0.2694	0.2605	0.2967	0.0371		3.02E-05
GRISLI	0.3586	0.2995	0.2792	0.2488	0.1848	0.2709	0.0503		2.61E-06
SCINGE	0.3310	0.2027	0.1885	0.1689	0.1571	0.1992	0.0476		2.44E-09

Tabela 35: AUPRC BF-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6372	0.6049	0.5499	0.5161	0.4491	0.5495	0.0626		-
SCNS	0.4076	0.3276	0.2552	0.2440	0.2311	0.2854	0.0559		1.00E-05
PIDC	0.5440	0.4076	0.4049	0.3817	0.3671	0.4103	0.0477		1.41E-01
GRNVBEM	0.3391	0.3126	0.3097	0.2831	0.2631	0.3027	0.0234		9.05E-05
GENIE3	0.3470	0.3333	0.3240	0.3088	0.2997	0.3223	**0.016**		9.53E-04
GRNBOOST2	0.5001	0.4612	0.3251	0.3099	0.2870	0.3720	0.0814	1.61E-13	1.09E-02
PPCOR	0.6900	0.4813	0.4212	0.3822	0.3153	0.4591	0.1162		2.95E-01
SCODE	0.5203	0.4231	0.3797	0.2425	0.1907	0.3461	0.1106		2.36E-03
SINCERITIES	**0.7202**	**0.6281**	**0.606**	**0.5428**	**0.4800**	**0.5899**	0.0682		7.63E-01
LEAP	0.3494	0.3175	0.2784	0.2690	0.2585	0.2922	0.0322		2.55E-05
GRISLI	0.3518	0.3309	0.2680	0.2303	0.2159	0.2792	0.0517		9.18E-06
SCINGE	0.2727	0.1983	0.1712	0.1599	0.1560	0.1894	0.0401		7.06E-10

5.2 AUROC

Tabela 36: AUROC BF-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8672**	**0.7977**	**0.7805**	**0.7352**	**0.7172**	**0.7764**	0.0440		-
SCNS	0.5938	0.5820	0.5570	0.5289	0.4719	0.5480	**0.0413**		9.96E-07
PIDC	0.7312	0.6984	0.6469	0.6312	0.5000	0.6512	0.0625		2.68E-02
GRNVBEM	0.7969	0.7148	0.6531	0.6227	0.5531	0.6645	0.0712		4.12E-02
GENIE3	0.7750	0.6797	0.6344	0.5898	0.5469	0.6369	0.0651		6.86E-03
GRNBOOST2	0.7531	0.6578	0.6187	0.6062	0.5875	0.6384	0.0496	9.42E-09	1.11E-02
PPCOR	0.7609	0.7129	0.6711	0.6102	0.5687	0.6669	0.0615		5.38E-02
SCODE	0.7938	0.6547	0.5625	0.4977	0.2750	0.5584	0.1383		3.28E-05
SINCERITIES	0.7859	0.6121	0.5656	0.5082	0.3984	0.5647	0.1036		2.65E-05
LEAP	0.7562	0.6980	0.6000	0.5680	0.4594	0.6205	0.0874		1.94E-03
GRISLI	0.7469	0.5766	0.5328	0.4824	0.4328	0.5425	0.0836		1.40E-06
SCINGE	0.6641	0.4574	0.4156	0.3523	0.1891	0.4198	0.1240		2.29E-09

Tabela 37: AUROC BF-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8406**	**0.8121**	**0.7414**	**0.7086**	**0.6458**	**0.7536**	0.0643		-
SCNS	0.6531	0.5805	0.5203	0.4969	0.4297	0.5364	0.0666		2.82E-06
PIDC	0.7812	0.7297	0.7156	0.6953	0.6062	0.7025	0.0505		4.48E-01
GRNVBEM	0.7344	0.6332	0.6094	0.5945	0.5500	0.6158	0.0495		2.49E-03
GENIE3	0.7125	0.6695	0.6422	0.6070	0.5687	0.6419	0.0428		2.32E-02
GRNBOOST2	0.7062	0.6930	0.6375	0.6203	0.6094	0.6538	**0.0369**	4.30E-09	4.92E-02
PPCOR	0.7953	0.7090	0.6547	0.6414	0.6141	0.6823	0.0625		2.08E-01
SCODE	0.7000	0.6617	0.5719	0.4883	0.3500	0.5619	0.1107		1.74E-04
SINCERITIES	0.7641	0.6070	0.5422	0.4875	0.3688	0.5586	0.1220		6.37E-05
LEAP	0.7750	0.6484	0.6219	0.5578	0.5250	0.6202	0.0773		4.58E-03
GRISLI	0.6922	0.5867	0.5484	0.5160	0.4219	0.5483	0.0725		7.43E-06
SCINGE	0.6469	0.5246	0.4766	0.3973	0.2250	0.4512	0.1253		6.19E-08

Tabela 38: AUROC BF-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8656**	**0.8375**	**0.7992**	**0.7781**	**0.6641**	**0.7903**	0.0595		-
SCNS	0.6344	0.5684	0.5266	0.4723	0.3875	0.5208	0.0676		1.58E-07
PIDC	0.7500	0.7375	0.7219	0.7062	0.6000	0.7094	0.0442		2.36E-01
GRNVBEM	0.6906	0.6836	0.6281	0.5984	0.5453	0.6311	0.0525		1.48E-03
GENIE3	0.7156	0.6727	0.6516	0.6383	0.5844	0.6534	0.0323		6.29E-03
GRNBOOST2	0.7250	0.6867	0.6750	0.6695	0.6375	0.6772	**0.0213**	7.77E-13	3.64E-02
PPCOR	0.8266	0.7750	0.7195	0.6984	0.6250	0.7277	0.0629		3.04E-01
SCODE	0.7281	0.6484	0.6125	0.5562	0.3312	0.5834	0.1100		9.28E-05
SINCERITIES	0.7922	0.7453	0.7000	0.6102	0.5453	0.6811	0.0811		4.81E-02
LEAP	0.7438	0.7062	0.6000	0.5672	0.5406	0.6275	0.0751		1.34E-03
GRISLI	0.6141	0.5418	0.5141	0.4688	0.4156	0.5142	0.0589		6.79E-08
SCINGE	0.5297	0.4648	0.4258	0.3691	0.2906	0.4102	0.0747		2.86E-10

Tabela 39: AUROC BF-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8656	0.8445	0.8047	0.7906	**0.7375**	0.8088	0.0412		-
SCNS	0.6094	0.5762	0.5258	0.5023	0.4797	0.5375	0.0432		1.43E-07
PIDC	0.7625	0.7469	0.7344	0.7016	0.6375	0.7219	0.0365		1.59E-01
GRNVBEM	0.7000	0.6383	0.6242	0.5961	0.5531	0.6222	0.0406		1.72E-04
GENIE3	0.7188	0.6867	0.6562	0.6422	0.6313	0.6644	**0.027**		5.93E-03
GRNBOOST2	0.7406	0.7016	0.6922	0.6648	0.6500	0.6884	0.0272	5.99E-15	3.28E-02
PPCOR	0.8313	0.8059	0.7406	0.6730	0.6187	0.7350	0.0739		2.09E-01
SCODE	0.7438	0.6953	0.6344	0.5656	0.4625	0.6275	0.0876		7.47E-04
SINCERITIES	**0.9000**	**0.8684**	**0.8281**	**0.8160**	0.7063	**0.8308**	0.0507		7.85E-01
LEAP	0.7672	0.6969	0.6062	0.5758	0.5594	0.6370	0.0707		6.72E-04
GRISLI	0.6422	0.5973	0.5789	0.5039	0.3812	0.5422	0.0823		8.20E-07
SCINGE	0.5531	0.4320	0.4000	0.3258	0.2531	0.3919	0.0829		4.06E-10

Tabela 40: AUROC BF-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8750	0.8656	0.8344	0.8000	0.7375	0.8247	0.0463		-
SCNS	0.6422	0.5836	0.5359	0.4969	0.4750	0.5420	0.0523		4.50E-07
PIDC	0.7563	0.7469	0.7344	0.7172	0.7000	0.7312	**0.0183**		1.86E-01
GRNVBEM	0.6375	0.6297	0.6125	0.5652	0.5281	0.5970	0.0403		2.00E-05
GENIE3	0.7063	0.6773	0.6594	0.6484	0.6438	0.6662	0.0203		4.49E-03
GRNBOOST2	0.7406	0.7156	0.6969	0.6727	0.6562	0.6959	0.0265	5.18E-15	2.79E-02
PPCOR	0.8609	0.8039	0.7383	0.6969	0.5938	0.7384	0.0804		1.34E-01
SCODE	0.7781	0.7453	0.7141	0.5008	0.3719	0.6297	0.1463		3.27E-03
SINCERITIES	**0.9125**	**0.8805**	**0.8695**	**0.8461**	**0.8266**	**0.8691**	0.0269		5.80E-01
LEAP	0.7437	0.6883	0.6016	0.5773	0.5531	0.6309	0.0662		3.60E-04
GRISLI	0.6578	0.6340	0.5648	0.5188	0.4984	0.5739	0.0607		6.11E-06
SCINGE	0.5047	0.3781	0.3336	0.2820	0.2609	0.3484	0.0767		3.10E-10

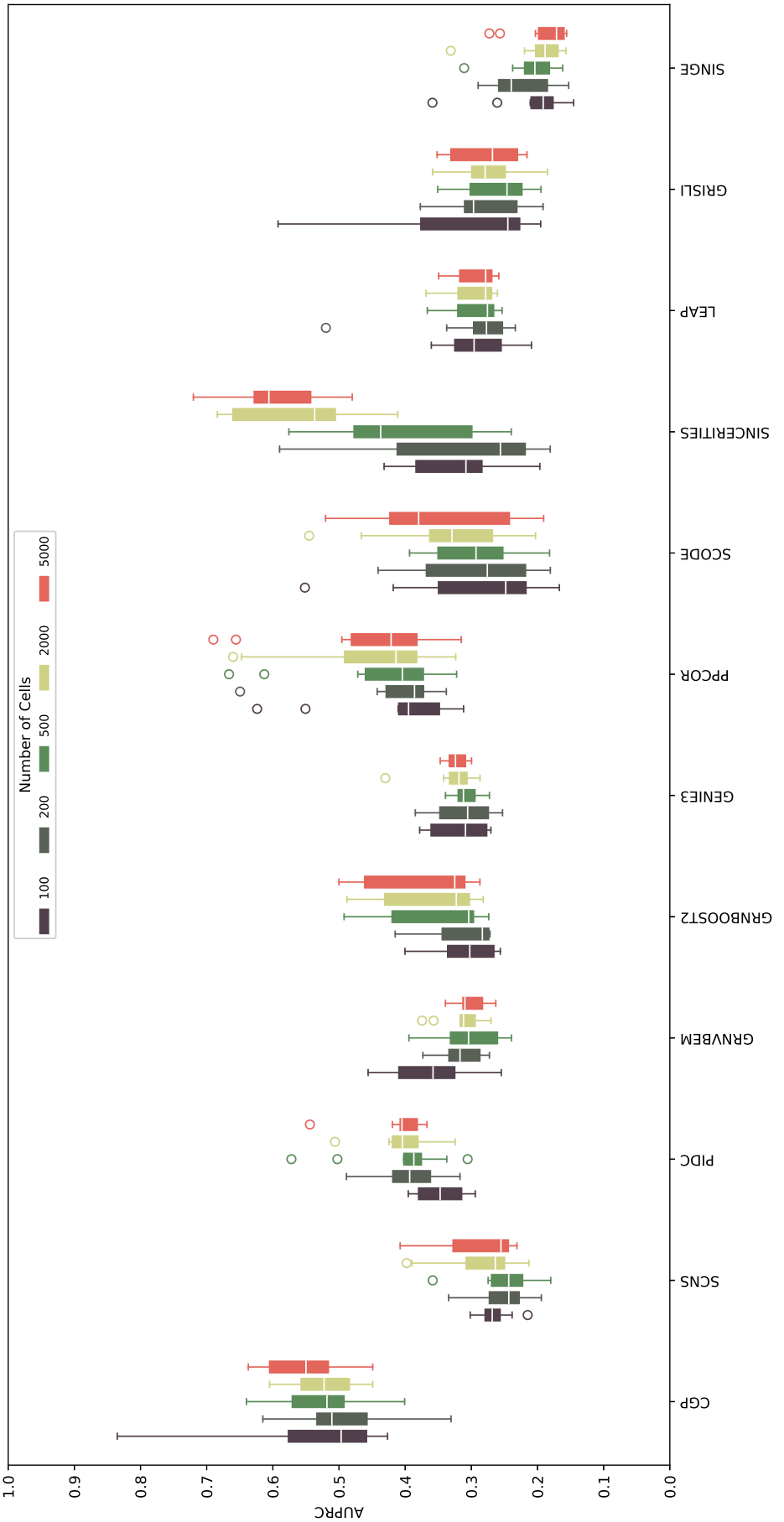


Figura 15: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema *Bifurcating*.

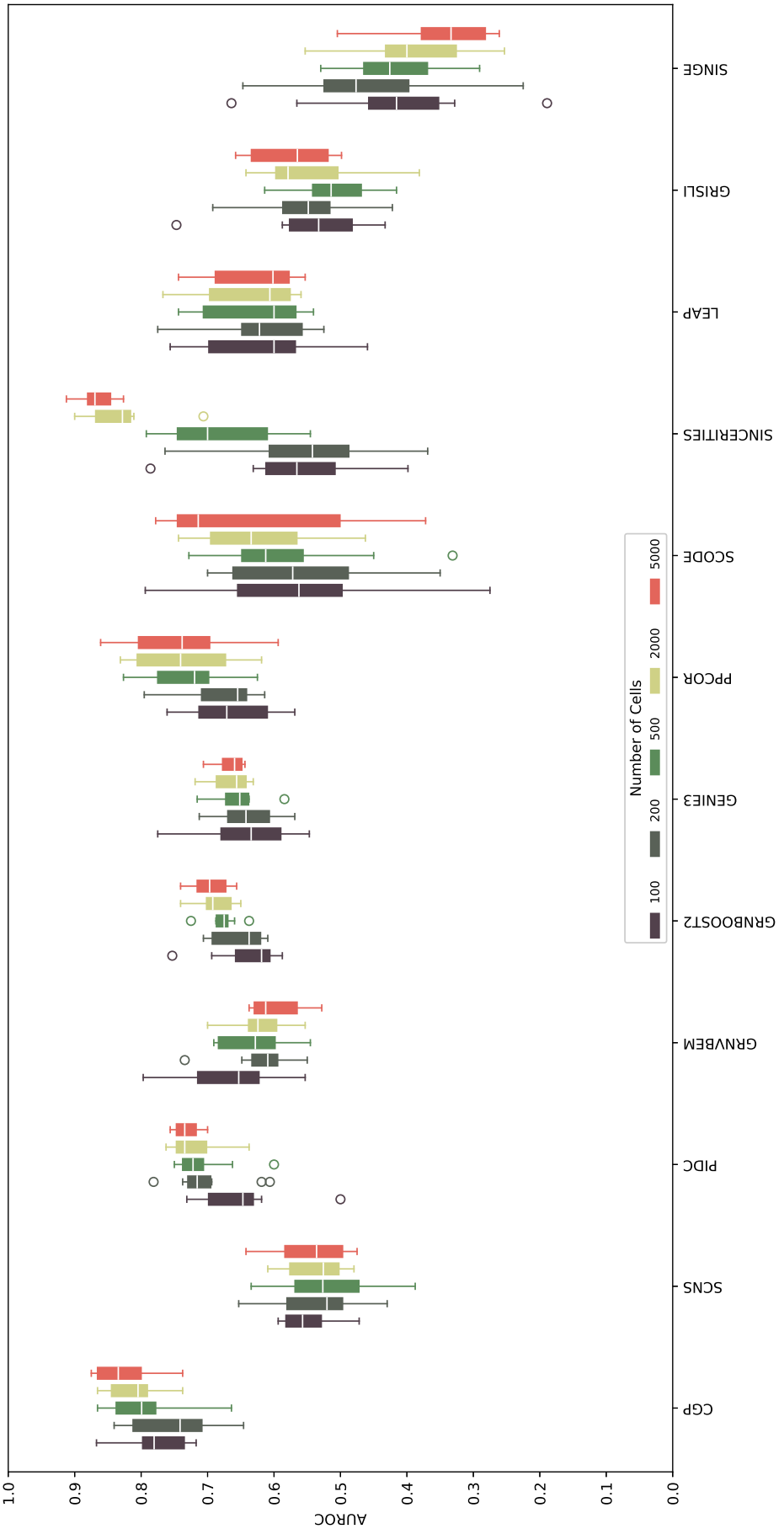


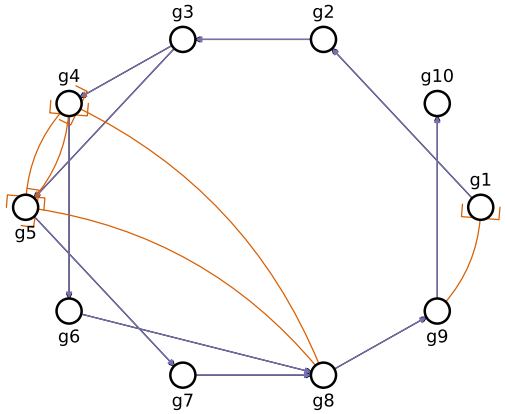
Figura 16: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema *Bifurcating*.

6 *Bifurcating Converging*

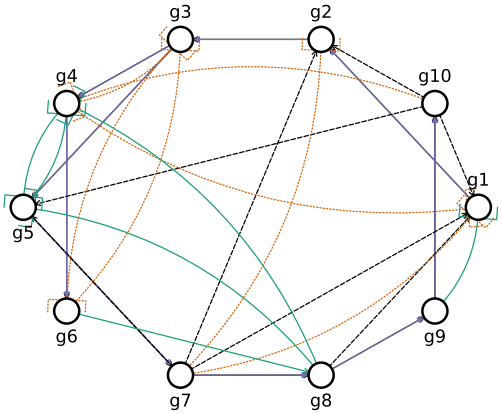
O problema *Bifurcating Converging* consiste de 10 genes e dois *pseudotimes*. A CGP não conseguiu reconstruir a rede completamente, como apresentado na Figura 17b. As tabelas seguintes apresentam os resultados para BEELINE AUPRC (Tabelas 41 a 45) e BEELINE AUROC (Tabelas 46 a 50), respectivamente.

Figura 17: Redes *Bifurcating Converging ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



6.1 AUPRC

Tabela 41: AUPRC BFC-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.6848**	**0.5721**	0.5022	0.4476	0.2667	0.5031	0.1170		-
SCNS	0.2995	0.2771	0.2359	0.228	0.2234	0.2505	0.0291		2.41E-05
PIDC	0.5111	0.3369	0.3155	0.2914	0.2168	0.3228	0.0741		2.17E-02
GRNVBEM	0.6721	0.5503	**0.5253**	**0.4486**	**0.3211**	**0.5053**	0.0897		8.12E-01
GENIE3	0.3642	0.3406	0.3171	0.2965	0.2778	0.3186	**0.0279**		3.61E-02
GRNBOOST2	0.3545	0.3305	0.3127	0.2784	0.2349	0.3032	0.0380		1.05E-02
PPCOR	0.4486	0.3629	0.3075	0.2904	0.2472	0.3249	0.0604		3.23E-02
SCODE	0.2939	0.2581	0.2283	0.2034	0.1975	0.2340	0.0326	2.61E-14	3.57E-06
SINCERITIES	0.2528	0.1869	0.1801	0.1591	0.1525	0.1868	0.0342		2.16E-08
LEAP	0.4767	0.4111	0.3519	0.3114	0.2905	0.3650	0.0606		2.05E-01
GRISLI	0.4393	0.3425	0.3196	0.2727	0.2388	0.3166	0.0579		1.96E-02
SCINGE	0.2165	0.1892	0.1572	0.1320	0.1112	0.1614	0.0340		1.64E-09

Tabela 42: AUPRC BFC-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.6589**	**0.5653**	**0.5352**	**0.4909**	**0.464**	**0.5361**	0.0582		-
SCNS	0.2391	0.2379	0.2279	0.2219	0.2081	0.2278	**0.0104**		7.43E-08
PIDC	0.4056	0.3331	0.3069	0.2809	0.2709	0.3192	0.0447		1.31E-03
GRNVBEM	0.5467	0.4412	0.4058	0.3950	0.3570	0.4295	0.0603		4.76E-01
GENIE3	0.3526	0.3348	0.3291	0.3212	0.3028	0.3277	0.0154		3.45E-03
GRNBOOST2	0.3770	0.3257	0.3156	0.3111	0.2975	0.3247	0.0238	1.07E-15	1.95E-03
PPCOR	0.3898	0.3738	0.3670	0.3473	0.2968	0.3590	0.0251		5.38E-02
SCODE	0.2675	0.2329	0.2210	0.1982	0.1897	0.2205	0.0243		1.72E-08
SINCERITIES	0.3231	0.2547	0.2033	0.1788	0.1368	0.2136	0.0548		1.33E-08
LEAP	0.4967	0.3515	0.3419	0.3174	0.3007	0.3492	0.0533		1.09E-02
GRISLI	0.4400	0.3733	0.3160	0.2451	0.1904	0.3124	0.0779		9.75E-04
SCINGE	0.2033	0.1708	0.1487	0.1187	0.1124	0.1482	0.0302		7.59E-12

Tabela 43: AUPRC BFC-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6828	0.4594	0.4347	**0.409**	**0.3821**	**0.4648**	0.0905		-
SCNS	0.2702	0.2316	0.2214	0.2140	0.2076	0.2260	0.0178		1.36E-07
PIDC	0.4169	0.3725	0.3316	0.3046	0.2795	0.3378	0.0442		4.06E-03
GRNVBEM	0.5326	0.4735	0.4213	0.3766	0.3679	0.4293	0.0549		6.62E-01
GENIE3	0.3716	0.3473	0.3392	0.3228	0.2980	0.3380	0.0215		2.17E-03
GRNBOOST2	0.4086	0.3707	0.3534	0.3363	0.3132	0.3559	0.0297		1.46E-02
PPCOR	0.4157	0.4070	0.3969	0.3934	0.3722	0.3975	**0.0122**	1.45E-12	4.00E-01
SCODE	0.3000	0.2727	0.2374	0.2214	0.1917	0.2436	0.0328		6.09E-07
SINCERITIES	**0.7263**	**0.4906**	**0.4440**	0.3666	0.1541	0.4161	0.1568		2.22E-01
LEAP	0.4709	0.3695	0.3472	0.3277	0.3130	0.3581	0.0447		1.54E-02
GRISLI	0.4960	0.4288	0.3731	0.3306	0.2886	0.3826	0.0650		8.26E-02
SCINGE	0.3309	0.2044	0.1691	0.1338	0.1153	0.1823	0.0621		1.14E-08

Tabela 44: AUPRC BFC-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5557	0.4445	0.4415	0.3723	0.3387	0.4233	0.0622		-
SCNS	0.2398	0.2322	0.2263	0.2234	0.2143	0.2278	**0.0074**		1.13E-05
PIDC	0.4140	0.3796	0.3707	0.3453	0.2610	0.3533	0.0472		1.05E-01
GRNVBEM	0.4618	0.4254	0.3790	0.3523	0.3055	0.3831	0.0510		3.41E-01
GENIE3	0.3777	0.3432	0.3370	0.3327	0.3063	0.3389	0.0180		9.76E-03
GRNBOOST2	0.4884	0.4010	0.3782	0.3634	0.3437	0.3939	0.0458		5.08E-01
PPCOR	0.4573	0.4411	0.4261	0.4066	**0.3790**	0.4233	0.0259	1.81E-14	7.24E-01
SCODE	0.2773	0.2603	0.2331	0.2210	0.1855	0.2354	0.0291		2.21E-05
SINCERITIES	**0.796**	**0.6954**	**0.6087**	**0.4934**	0.3394	**0.5862**	0.1495		2.39E-01
LEAP	0.4481	0.3622	0.3403	0.3327	0.3254	0.3587	0.0387		4.99E-02
GRISLI	0.5211	0.4233	0.3925	0.3736	0.3454	0.4032	0.0473		7.04E-01
SCINGE	0.2658	0.1763	0.1447	0.1247	0.1118	0.1575	0.0440		3.32E-07

Tabela 45: AUPRC BFC-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5210	0.4851	0.4442	0.3731	0.3151	0.4337	0.0706		-
SCNS	0.2454	0.2271	0.2241	0.2136	0.1997	0.2222	**0.0133**		7.23E-06
PIDC	0.4082	0.3780	0.3484	0.3232	0.2482	0.3476	0.0452		5.14E-02
GRNVBEM	0.4311	0.3754	0.3422	0.3098	0.2759	0.3443	0.0457		3.97E-02
GENIE3	0.3676	0.3481	0.3388	0.3335	0.3095	0.3401	0.0149		2.37E-02
GRNBOOST2	0.4416	0.4163	0.3934	0.3694	0.3474	0.3931	0.0313		5.16E-01
PPCOR	0.4531	0.4397	0.4296	0.4087	0.3896	0.4235	0.0209		9.33E-01
SCODE	0.2481	0.2406	0.2325	0.2069	0.1909	0.2253	0.0198	1.09E-15	1.24E-05
SINCERITIES	**0.8608**	**0.8041**	**0.7190**	**0.5519**	**0.4438**	**0.6823**	0.1436		1.08E-01
LEAP	0.4008	0.3671	0.3401	0.3266	0.3095	0.3467	0.0267		3.50E-02
GRISLI	0.4781	0.4512	0.3928	0.3504	0.2500	0.3905	0.0682		4.79E-01
SCINGE	0.1668	0.1593	0.1377	0.1281	0.1224	0.1420	0.0165		6.92E-08

6.2 AUROC

Tabela 46: AUROC BFC-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8373	0.8023	**0.7869**	**0.7711**	0.6800	0.7822	0.0400		-
SCNS	0.7067	0.6558	0.6460	0.6368	0.6236	0.6540	**0.027**		3.83E-04
PIDC	0.7773	0.6956	0.6680	0.6556	0.5658	0.6797	0.0576		7.28E-03
GRNVBEM	**0.8978**	**0.8202**	0.7804	0.7543	**0.7067**	**0.788**	0.0540		9.08E-01
GENIE3	0.7920	0.7718	0.7489	0.7247	0.6676	0.7448	0.0343		3.40E-01
GRNBOOST2	0.7698	0.7447	0.7062	0.6536	0.5564	0.6920	0.0632		1.62E-02
PPCOR	0.7560	0.6791	0.6460	0.6129	0.5929	0.6553	0.0512		5.00E-04
SCODE	0.7360	0.6578	0.6320	0.6042	0.5973	0.6401	0.0423	1.56E-13	8.81E-05
SINCERITIES	0.6289	0.5692	0.5431	0.4948	0.4609	0.5352	0.0492		9.44E-09
LEAP	0.8236	0.7602	0.7307	0.6879	0.6409	0.7265	0.0518		1.28E-01
GRISLI	0.7444	0.7054	0.6638	0.6221	0.5911	0.6628	0.0485		1.04E-03
SCINGE	0.5964	0.5384	0.4556	0.3968	0.2796	0.4592	0.0957		8.64E-10

Tabela 47: AUROC BFC-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8596**	**0.8312**	**0.8216**	**0.8023**	0.7098	**0.8109**	0.0388		-
SCNS	0.6787	0.6640	0.6462	0.6330	0.5991	0.6454	**0.0236**		3.36E-06
PIDC	0.7702	0.7302	0.6964	0.6693	0.6298	0.6988	0.0450		2.21E-03
GRNVBEM	0.8311	0.7857	0.7636	0.7347	0.6707	0.7600	0.0430		1.99E-01
GENIE3	0.8124	0.7907	0.7493	0.7296	**0.7218**	0.7594	0.0338		2.02E-01
GRNBOOST2	0.7867	0.7531	0.7458	0.7076	0.6569	0.7324	0.036		4.32E-02
PPCOR	0.7644	0.7293	0.7276	0.6997	0.6698	0.7177	0.0275		1.14E-02
SCODE	0.6827	0.6431	0.6147	0.5962	0.5813	0.6215	0.0316	6.41E-14	3.21E-07
SINCERITIES	0.6889	0.6084	0.5640	0.4886	0.4316	0.5552	0.0808		1.40E-08
LEAP	0.8129	0.7847	0.7193	0.6778	0.6569	0.7300	0.0565		3.67E-02
GRISLI	0.7933	0.7672	0.6764	0.6564	0.5462	0.6934	0.0740		2.05E-03
SCINGE	0.5587	0.5177	0.4338	0.3426	0.3049	0.4303	0.0940		6.96E-11

Tabela 48: AUROC BFC-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8933**	0.8151	0.7747	0.7414	0.7258	0.7840	0.0497		-
SCNS	0.7142	0.6583	0.6291	0.6237	0.5956	0.6413	0.0347		2.36E-04
PIDC	0.8129	0.7604	0.6982	0.6644	0.6227	0.7101	0.0594		4.16E-02
GRNVBEM	0.8702	**0.8463**	**0.8331**	**0.8117**	**0.7929**	**0.8309**	0.0243		1.03E-01
GENIE3	0.8124	0.7869	0.7698	0.7613	0.7324	0.7727	0.0226		8.05E-01
GRNBOOST2	0.8213	0.8016	0.7689	0.7576	0.7324	0.7761	0.0273		8.75E-01
PPCOR	0.8004	0.7963	0.7838	0.7727	0.7516	0.7809	**0.0172**	7.46E-12	9.97E-01
SCODE	0.7218	0.6953	0.6644	0.6431	0.5858	0.6609	0.0435		8.39E-04
SINCERITIES	0.8693	0.8070	0.7422	0.7273	0.4738	0.7307	0.1175		3.40E-01
LEAP	0.8613	0.8132	0.7344	0.6981	0.6773	0.7547	0.0635		4.25E-01
GRISLI	0.8258	0.7320	0.7131	0.6878	0.6422	0.7195	0.0506		5.58E-02
SCINGE	0.5369	0.4911	0.4538	0.3842	0.3258	0.4400	0.0667		1.14E-06

Tabela 49: AUROC BFC-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8756	0.7884	0.7842	0.7734	0.7280	0.7868	0.0373		-
SCNS	0.6524	0.6377	0.6349	0.6267	0.6222	0.6344	**0.0091**		2.71E-04
PIDC	0.7880	0.7356	0.7293	0.7093	0.6333	0.7220	0.0434		5.58E-02
GRNVBEM	0.8511	0.8231	0.8062	0.7808	0.7556	0.8031	0.0298		4.50E-01
GENIE3	0.8053	0.7842	0.7778	0.7729	0.7547	0.7785	0.0138		7.90E-01
GRNBOOST2	0.8204	0.8000	0.7849	0.7676	0.7556	0.7868	0.0216		9.59E-01
PPCOR	0.8431	0.8338	0.8258	**0.8197**	**0.8004**	0.8248	0.0129	1.51E-14	8.32E-02
SCODE	0.7191	0.6873	0.6516	0.6404	0.5973	0.6569	0.0369		1.51E-03
SINCERITIES	**0.9387**	**0.9109**	**0.8676**	0.8170	0.7129	**0.8538**	0.0691		1.14E-01
LEAP	0.8480	0.8144	0.7644	0.7211	0.6658	0.7650	0.0561		6.07E-01
GRISLI	0.7862	0.7711	0.7553	0.7026	0.6484	0.7350	0.0470		1.15E-01
SCINGE	0.5342	0.4879	0.4060	0.3704	0.2996	0.4208	0.0753		7.11E-06

Tabela 50: AUROC BFC-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8498	0.8224	0.7860	0.7749	0.7062	0.7892	0.0405		-
SCNS	0.6516	0.6371	0.6324	0.6108	0.5738	0.6236	0.0215		1.34E-04
PIDC	0.7809	0.7276	0.7036	0.6769	0.6511	0.7092	0.0411		2.35E-02
GRNVBEM	0.8653	0.7979	0.7716	0.7377	0.6844	0.7741	0.0511		5.76E-01
GENIE3	0.8116	0.7818	0.7751	0.7640	0.7458	0.7748	0.0171		4.12E-01
GRNBOOST2	0.7964	0.7953	0.7880	0.7789	0.7769	0.7869	**0.0080**		9.67E-01
PPCOR	0.8347	0.8284	0.8271	0.8247	0.7920	0.8240	0.0111	2.48E-15	1.90E-01
SCODE	0.6924	0.6680	0.6493	0.6242	0.5884	0.6449	0.0310		5.43E-04
SINCERITIES	**0.9662**	**0.9502**	**0.9160**	**0.9002**	**0.8089**	**0.9148**	0.0437		2.40E-02
LEAP	0.8320	0.8237	0.7693	0.7022	0.6676	0.7609	0.0606		4.74E-01
GRISLI	0.7924	0.7886	0.7742	0.7563	0.6267	0.7559	0.0498		2.80E-01
SCINGE	0.5258	0.4522	0.4082	0.3879	0.3316	0.4221	0.0580		2.70E-06

Figura 18: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema *Bifurcating Converging*.

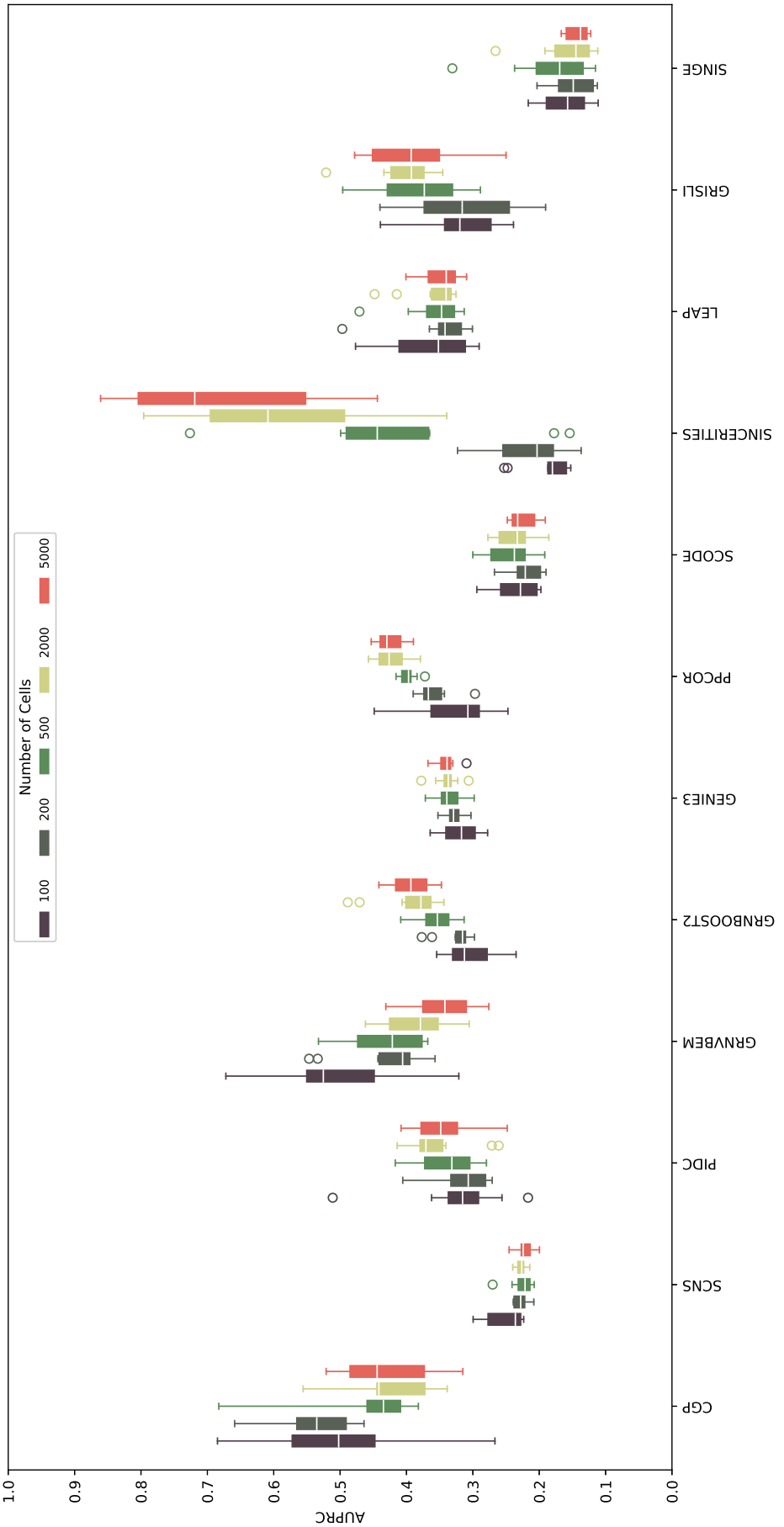
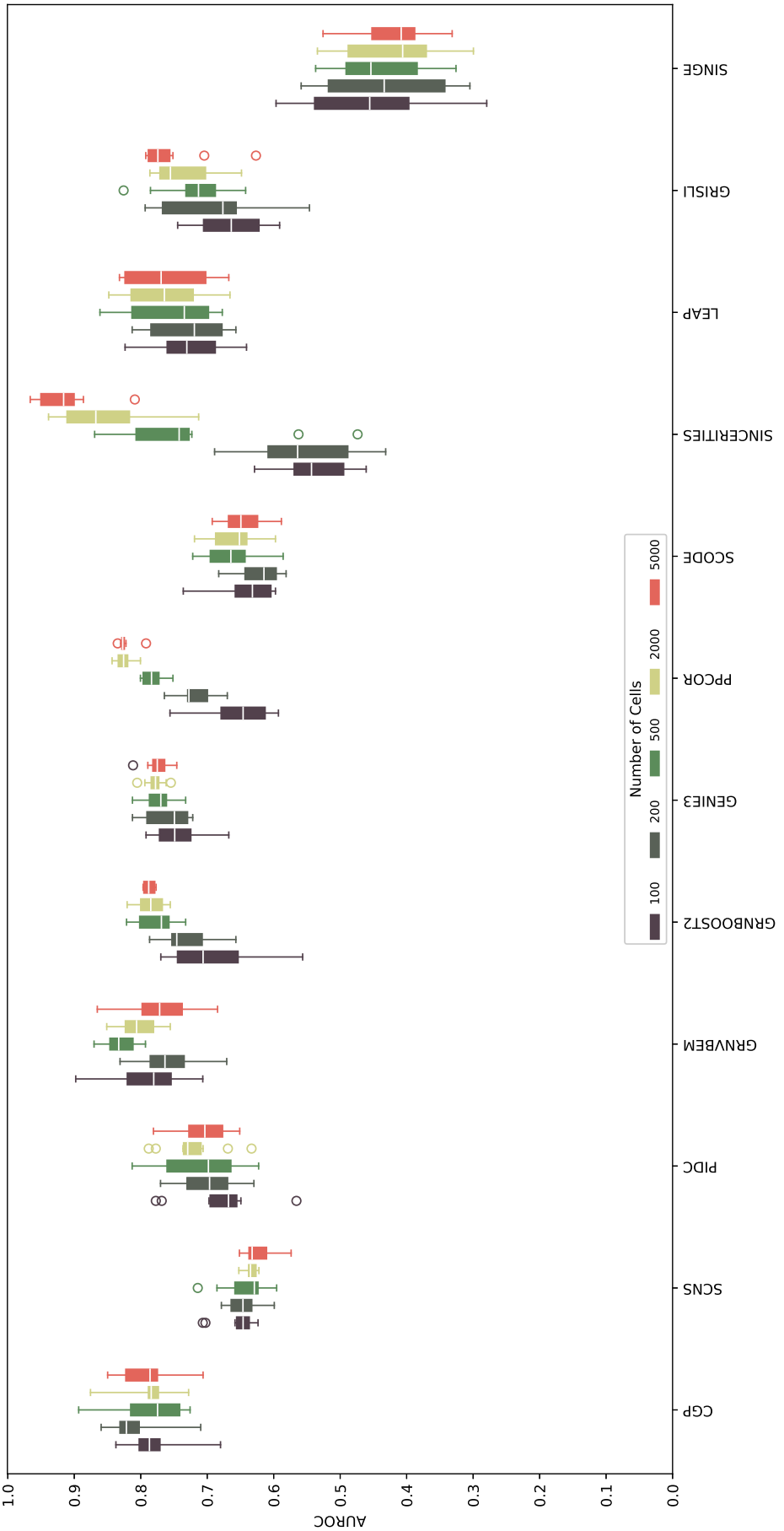


Figura 19: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema *Bifurcating Converging*.

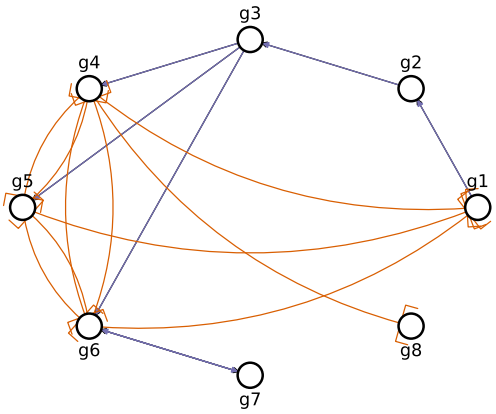


7 Trifurcating

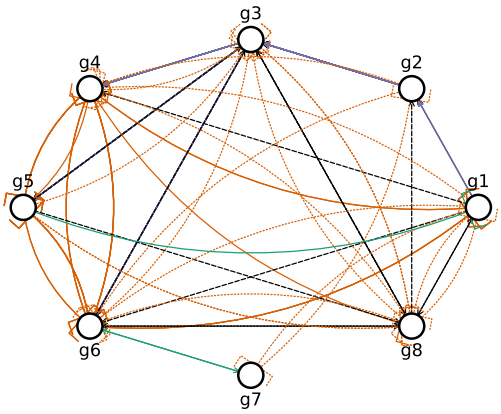
O problema *Trifurcating* consiste de 8 genes e três *pseudotimes*. A CGP não conseguiu reconstruir a rede completamente, como apresentado na Figura 20b. As tabelas seguintes apresentam os resultados para BEELINE AUPRC (Tabelas 51 a 55) e BEELINE AUROC (Tabelas 56 a 60), respectivamente.

Figura 20: Redes *Trifurcating ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



7.1 AUPRC

Tabela 51: AUPRC TF-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6848	0.5688	0.5288	0.4747	0.4481	0.5403	0.0783		-
SCNS	0.5671	0.4382	0.3933	0.3607	0.3186	0.4156	0.0802		2.84E-02
PIDC	0.6934	0.5867	**0.5357**	**0.5026**	**0.4852**	**0.5545**	0.0631		6.57E-01
GRNVBEM	0.5074	0.4676	0.4308	0.3805	0.2966	0.4190	0.0622		1.96E-02
GENIE3	0.5972	0.5581	0.5244	0.4938	0.4534	0.5277	0.0444		9.69E-01
GRNBOOST2	0.6590	0.5674	0.5174	0.4890	0.4483	0.5319	0.0585		9.90E-01
PPCOR	0.5630	0.5351	0.5123	0.4957	0.4398	0.5097	**0.0342**	3.26E-12	7.33E-01
SCODE	0.3982	0.2798	0.2694	0.2635	0.2566	0.2878	0.0436		2.96E-06
SINCERITIES	0.5405	0.3375	0.3154	0.2989	0.2579	0.3326	0.0753		1.78E-04
LEAP	**0.7386**	**0.6113**	0.5275	0.4771	0.3383	0.5466	0.1170		9.59E-01
GRISLI	0.4269	0.3616	0.3389	0.3098	0.2407	0.3325	0.0496		1.49E-04
SCINGE	0.5123	0.4071	0.3180	0.3003	0.2605	0.3514	0.0778		5.18E-04

Tabela 52: AUPRC TF-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.6894**	**0.6259**	0.5230	0.5105	0.4401	0.5511	0.0801		-
SCNS	0.5323	0.4037	0.3446	0.2862	0.2383	0.3529	0.0836		5.18E-04
PIDC	0.6003	0.5644	0.5435	0.4705	0.4327	0.5210	0.0570		7.38E-01
GRNVBEM	0.5725	0.4845	0.4407	0.3880	0.2864	0.4435	0.0831		5.79E-02
GENIE3	0.6175	0.556	0.5397	0.5033	0.4584	0.5392	0.0476		9.64E-01
GRNBOOST2	0.6188	0.5498	0.5215	0.4900	**0.4606**	0.5242	0.0445	7.72E-13	7.58E-01
PPCOR	0.6213	0.5229	0.4958	0.4486	0.4174	0.4954	0.0563		3.25E-01
SCODE	0.5191	0.3315	0.2790	0.2431	0.2110	0.3043	0.0905		1.81E-05
SINCERITIES	0.4777	0.3342	0.3125	0.2797	0.2513	0.3202	0.0617		6.21E-05
LEAP	0.6476	0.5962	**0.5782**	**0.5194**	0.4140	**0.5540**	0.0689		7.53E-01
GRISLI	0.4391	0.3961	0.3533	0.3080	0.2566	0.3519	0.0542		4.27E-04
SCINGE	0.3733	0.3019	0.2789	0.2505	0.2262	0.2828	**0.0439**		2.87E-06

Tabela 53: AUPRC TF-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.7351**	**0.6663**	0.5494	0.4837	0.4584	**0.5713**	0.0984		-
SCNS	0.4857	0.3817	0.3390	0.2765	0.2336	0.3413	0.0758		9.29E-05
PIDC	0.6236	0.5973	**0.5754**	**0.5308**	0.4652	0.5615	0.0477		7.09E-01
GRNVBEM	0.4681	0.4445	0.4211	0.3949	0.3196	0.4092	0.0476		4.58E-03
GENIE3	0.5893	0.5713	0.5352	0.4914	0.4485	0.5285	0.0494		7.38E-01
GRNBOOST2	0.5602	0.5385	0.5217	0.4904	0.4509	0.5135	0.0366		5.16E-01
PPCOR	0.5385	0.5325	0.5144	0.4966	**0.4671**	0.5107	**0.0237**	4.75E-14	4.60E-01
SCODE	0.3465	0.3208	0.2964	0.2605	0.2289	0.2930	0.0370		1.57E-06
SINCERITIES	0.5419	0.3074	0.2758	0.2624	0.2456	0.3138	0.0882		1.16E-05
LEAP	0.6124	0.5881	0.5465	0.5053	0.4216	0.5340	0.0642		8.37E-01
GRISLI	0.4937	0.3615	0.3510	0.3415	0.3135	0.3610	0.0469		6.12E-04
SCINGE	0.4075	0.3735	0.3244	0.2742	0.2157	0.3222	0.0622		2.27E-05

Tabela 54: AUPRC TF-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.7374**	0.6001	0.5725	0.4850	0.3801	0.5489	0.0982		-
SCNS	0.4244	0.3506	0.3047	0.2798	0.2625	0.3190	0.0509		7.71E-05
PIDC	0.6456	**0.6069**	**0.5743**	**0.5579**	0.4872	**0.5715**	0.0497		5.37E-01
GRNVBEM	0.4277	0.4123	0.3849	0.3662	0.3080	0.3833	0.0354		2.52E-03
GENIE3	0.5795	0.5565	0.5386	0.5257	0.4597	0.5344	0.0325		8.22E-01
GRNBOOST2	0.5733	0.5496	0.5041	0.4712	0.4221	0.5055	0.0474		3.68E-01
PPCOR	0.6102	0.5468	0.5298	0.5053	**0.4934**	0.5355	0.0367	4.01E-14	8.07E-01
SCODE	0.3130	0.2845	0.2557	0.2416	0.2356	0.2646	**0.0276**		1.43E-06
SINCERITIES	0.6586	0.5958	0.4775	0.3981	0.2920	0.4852	0.1188		2.72E-01
LEAP	0.6411	0.5820	0.5426	0.4944	0.4809	0.5443	0.0515		9.59E-01
GRISLI	0.5113	0.4152	0.3956	0.3620	0.3272	0.3977	0.0552		5.17E-03
SCINGE	0.3398	0.2870	0.2453	0.2361	0.2077	0.2631	0.0431		1.10E-06

Tabela 55: AUPRC TF-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.7299	0.5687	0.5411	0.4970	0.4722	0.5582	0.0797		-
SCNS	0.4966	0.3816	0.3603	0.3434	0.2559	0.3646	0.0576		7.92E-04
PIDC	0.6194	**0.6057**	**0.5873**	0.5026	0.4712	**0.5616**	0.0581		6.25E-01
GRNVBEM	0.4388	0.4034	0.3856	0.3650	0.3011	0.3795	0.0389		1.95E-03
GENIE3	0.5724	0.5600	0.5298	**0.5260**	0.4508	0.5341	0.0331		9.23E-01
GRNBOOST2	0.5851	0.5192	0.5051	0.4845	0.4618	0.5072	0.0336		3.58E-01
PPCOR	0.5803	0.5613	0.5415	0.5093	**0.5066**	0.5379	0.0263		9.79E-01
SCODE	0.3487	0.3033	0.2552	0.2443	0.2285	0.2727	0.0396	6.07E-15	1.47E-06
SINCERITIES	**0.7302**	0.5721	0.5540	0.4907	0.4318	0.5500	0.0892		9.13E-01
LEAP	0.6682	0.5804	0.5219	0.4974	0.4632	0.5415	0.0595		9.03E-01
GRISLI	0.4650	0.3688	0.3612	0.3402	0.3155	0.3614	0.0392		5.43E-04
SCINGE	0.2888	0.2761	0.2616	0.2490	0.2218	0.2610	**0.0186**		1.21E-06

7.2 AUROC

Tabela 56: AUROC TF-100

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8205	**0.7958**	**0.7598**	**0.7306**	0.5641	**0.7488**	0.0708		-
SCNS	0.7104	0.6702	0.6312	0.5848	0.5483	0.6288	0.0526		1.61E-02
PIDC	0.7971	0.7270	0.6870	0.6380	0.5920	0.6834	0.0635		2.29E-01
GRNVBEM	0.7866	0.7195	0.6290	0.5560	0.4962	0.6394	0.1006		2.96E-02
GENIE3	0.7873	0.7130	0.6750	0.6154	0.5928	0.6736	0.0645		1.55E-01
GRNBOOST2	0.8386	0.7436	0.6923	0.6312	**0.6124**	0.6968	0.0703		3.22E-01
PPCOR	0.6735	0.6510	0.6384	0.6161	0.5814	0.6351	**0.0266**		2.51E-02
SCODE	0.6063	0.4977	0.4676	0.4540	0.3680	0.4858	0.0661	7.78E-12	5.24E-07
SINCERITIES	0.6953	0.5377	0.4800	0.4568	0.4027	0.5037	0.0796		2.27E-06
LEAP	**0.8537**	0.7954	0.7549	0.6908	0.5799	0.7440	0.0810		8.40E-01
GRISLI	0.5762	0.5434	0.5207	0.4661	0.4103	0.5052	0.0490		1.76E-06
SCINGE	0.6357	0.5202	0.4962	0.4402	0.4329	0.5051	0.0713		2.74E-06

Tabela 57: AUROC TF-200

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8831**	0.7756	0.7632	0.7189	**0.7074**	**0.7637**	0.0510		-
SCNS	0.6742	0.6608	0.5581	0.4840	0.3989	0.5600	0.0951		1.98E-04
PIDC	0.7911	0.7360	0.7142	0.6576	0.6041	0.7033	0.0585		2.42E-01
GRNVBEM	0.7413	0.6978	0.6621	0.6465	0.5324	0.6600	0.0565		4.06E-02
GENIE3	0.7617	0.7334	0.6735	0.6290	0.5973	0.6801	0.0594		1.03E-01
GRNBOOST2	0.8175	0.7602	0.7466	0.7281	0.6833	0.7454	**0.0353**		7.80E-01
PPCOR	0.7730	0.6422	0.6120	0.5884	0.5475	0.6257	0.0597		5.43E-03
SCODE	0.7722	0.5830	0.4827	0.4005	0.2881	0.4922	0.1396	1.67E-13	8.52E-06
SINCERITIES	0.5928	0.5468	0.5068	0.4425	0.3952	0.4977	0.0615		1.62E-06
LEAP	0.8273	**0.8018**	**0.7692**	**0.7345**	0.6629	0.7630	0.0479		9.28E-01
GRISLI	0.6327	0.5956	0.5234	0.4891	0.4367	0.5355	0.0684		2.06E-05
SCINGE	0.5973	0.5074	0.4223	0.3712	0.3333	0.4425	0.0818		9.03E-08

Tabela 58: AUROC TF-500

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8544**	**0.8292**	0.7598	0.7130	0.7006	**0.7698**	0.0578		-
SCNS	0.6523	0.6154	0.5566	0.4749	0.3846	0.5429	0.0844		2.06E-05
PIDC	0.8303	0.7655	0.7217	0.6757	0.6312	0.7253	0.0623		4.14E-01
GRNVBEM	0.7285	0.6963	0.6821	0.6167	0.5581	0.6601	0.0531		1.85E-02
GENIE3	0.7134	0.7044	0.6780	0.6225	0.6109	0.6664	0.0412		3.00E-02
GRNBOOST2	0.7768	0.7534	0.7466	0.7251	**0.7074**	0.7422	**0.0209**	3.67E-14	7.72E-01
PPCOR	0.7549	0.7236	0.6603	0.6120	0.5498	0.6644	0.0665		3.28E-02
SCODE	0.6305	0.5618	0.4925	0.4276	0.3635	0.4985	0.0893		1.29E-06
SINCERITIES	0.7179	0.5403	0.4687	0.4191	0.4042	0.5007	0.0985		1.76E-06
LEAP	0.8100	0.7994	**0.7873**	**0.7313**	0.6802	0.7634	0.0452		9.82E-01
GRISLI	0.6131	0.5758	0.5366	0.5196	0.4729	0.5413	0.0443		8.27E-06
SCINGE	0.6199	0.5471	0.4940	0.4408	0.3077	0.4876	0.0857		5.70E-07

Tabela 59: AUROC TF-2000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.8703	**0.8162**	0.7651	0.7097	0.5965	0.7572	0.0764		-
SCNS	0.6071	0.5577	0.5045	0.4851	0.4548	0.5216	0.0512		1.35E-05
PIDC	0.8213	0.8017	0.7187	0.6908	0.6674	0.7398	0.0582		7.67E-01
GRNVBEM	0.7134	0.6718	0.6546	0.6020	0.5158	0.6371	0.0573		1.15E-02
GENIE3	0.7089	0.6927	0.6652	0.6440	0.6350	0.6682	0.0259		4.77E-02
GRNBOOST2	0.7934	0.7579	0.7436	0.7089	0.6863	0.7370	0.0331	1.65E-14	7.36E-01
PPCOR	0.8137	0.7304	0.6938	0.6499	0.6003	0.6971	0.0613		2.01E-01
SCODE	0.5566	0.4985	0.4404	0.3918	0.3590	0.4459	0.0612		3.21E-07
SINCERITIES	**0.8884**	0.7643	0.6912	0.6282	0.4925	0.6919	0.1100		1.82E-01
LEAP	0.8077	0.7945	**0.7790**	**0.7581**	**0.7308**	**0.7747**	**0.0253**		5.94E-01
GRISLI	0.6365	0.6016	0.5803	0.5354	0.4713	0.5667	0.0497		1.74E-04
SCINGE	0.6116	0.4768	0.4050	0.3897	0.2813	0.4327	0.0924		3.44E-07

Tabela 60: AUROC TF-5000

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	**0.8959**	**0.8013**	0.7768	0.7310	0.6599	**0.7735**	0.0636		-
SCNS	0.6388	0.5747	0.5528	0.5403	0.4419	0.5532	0.0513		1.58E-05
PIDC	0.8273	0.7994	0.7519	0.6863	0.6704	0.7462	0.0571		6.12E-01
GRNVBEM	0.7112	0.6744	0.6599	0.6207	0.5068	0.6392	0.0601		2.95E-03
GENIE3	0.7029	0.6946	0.6614	0.6459	0.6259	0.6662	0.0267		8.56E-03
GRNBOOST2	0.7738	0.7500	0.7406	0.7266	0.7059	0.7410	**0.0208**	1.81E-15	5.02E-01
PPCOR	0.7851	0.7568	0.7244	0.6427	0.6229	0.7064	0.0598		1.59E-01
SCODE	0.6124	0.5430	0.4389	0.4042	0.3575	0.4673	0.0863		2.17E-07
SINCERITIES	0.8884	0.7470	0.7410	0.7245	0.6817	0.7495	0.0536		6.05E-01
LEAP	0.8235	0.7994	**0.7817**	**0.7455**	**0.7127**	0.7732	0.0330		7.82E-01
GRISLI	0.7051	0.5924	0.5558	0.5194	0.4736	0.5627	0.0668		3.78E-05
SCINGE	0.5121	0.4915	0.4529	0.4284	0.3379	0.4527	0.0497		7.83E-08

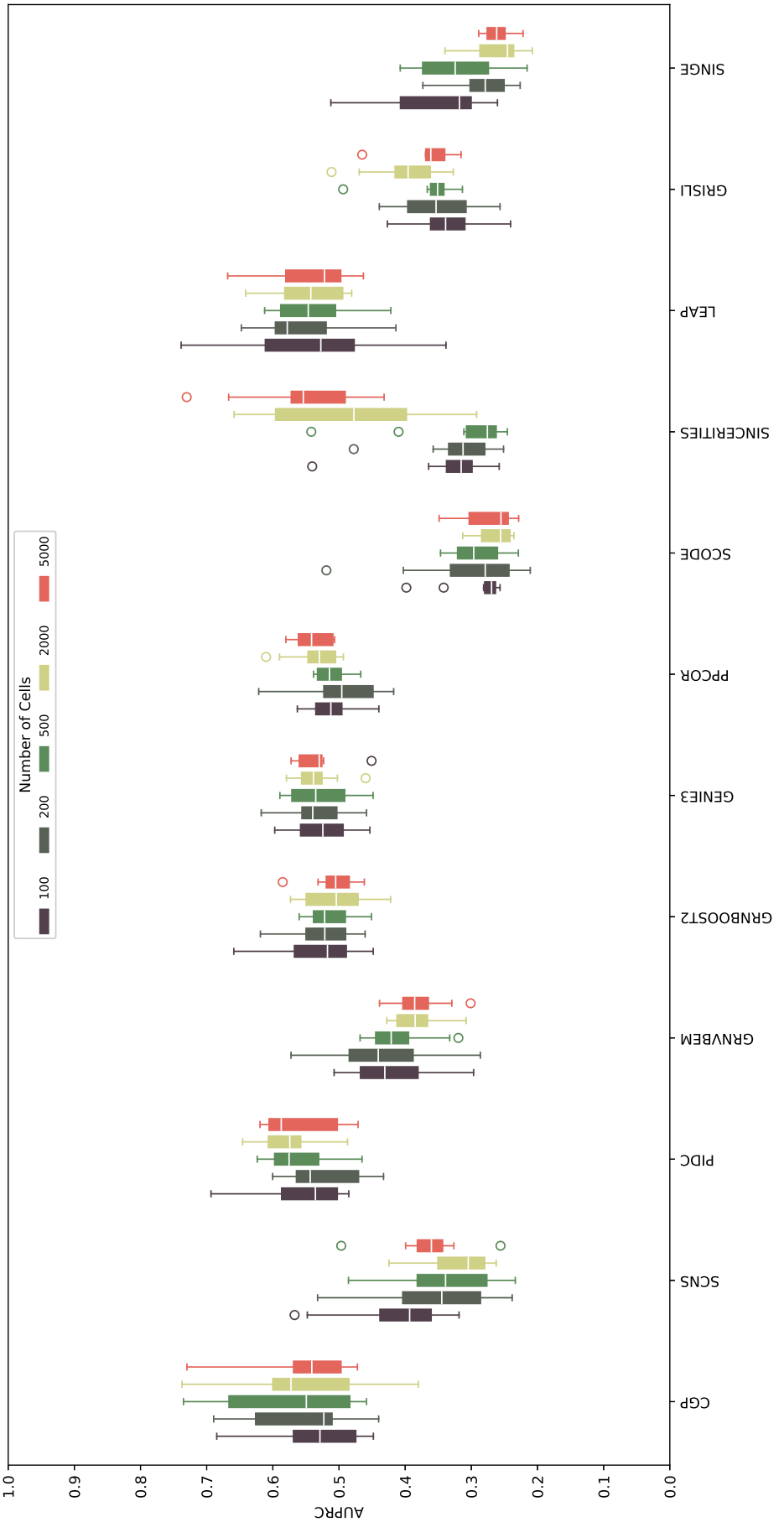


Figura 21: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema *Trifurcating*.

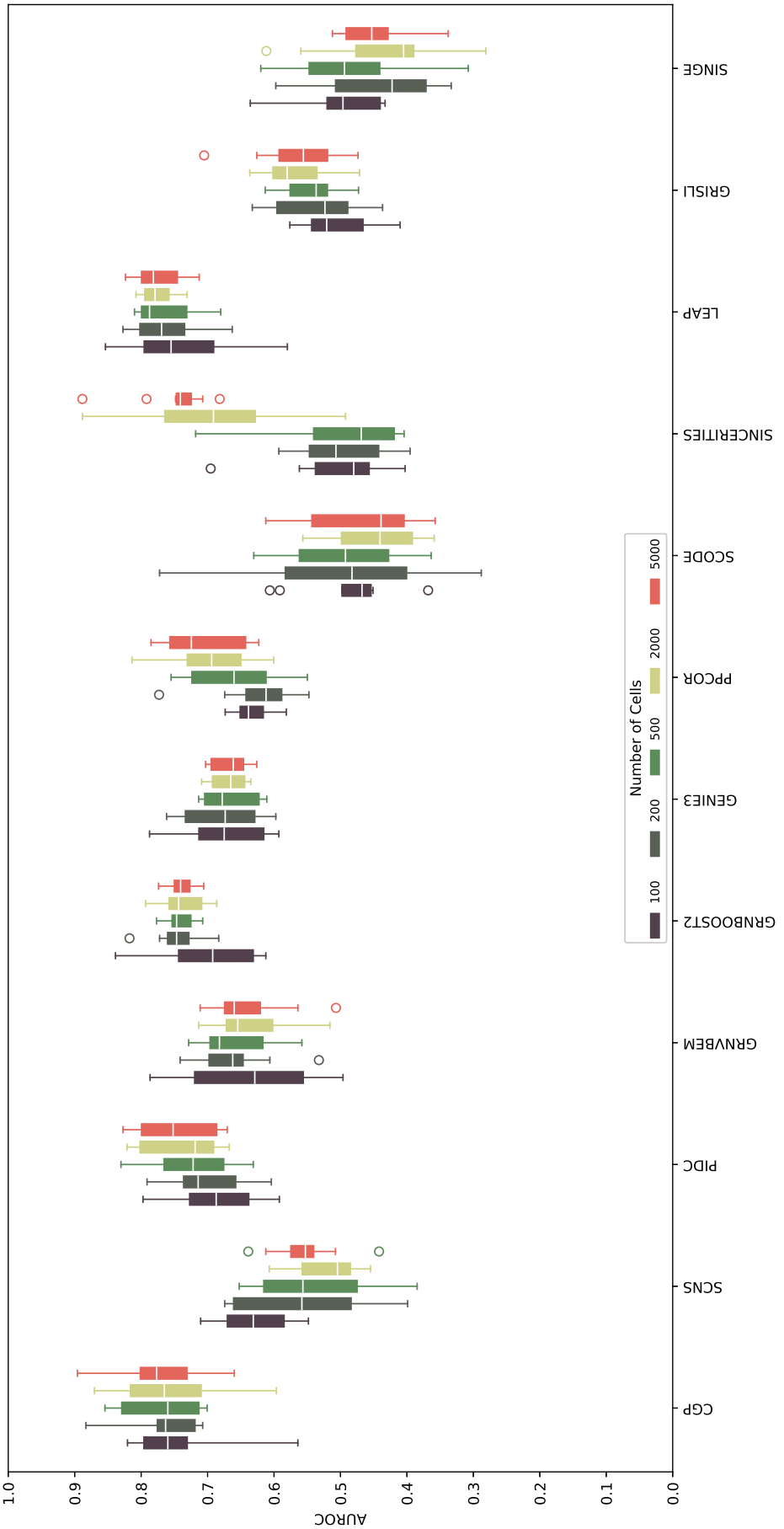


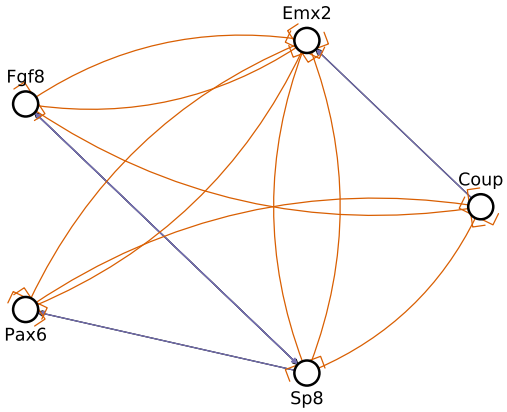
Figura 22: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema *Trifurcating*.

8 mCAD

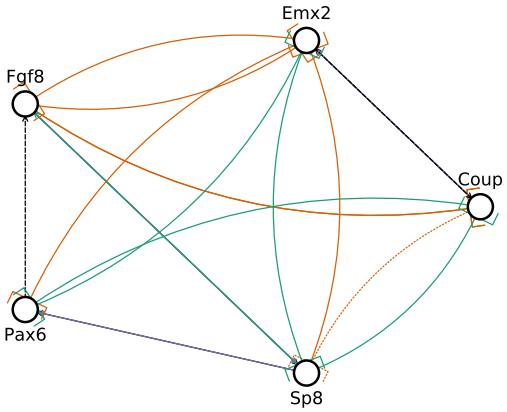
O modelo de desenvolvimento da área cortical de mamíferos (mCAD) [1] contém cinco fatores de transcrição conectados por 14 interações, com dois *steady-states*.

Figura 23: Redes mCAD *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



8.1 AUPRC

Tabela 61: AUPRC mCAD-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.7508	0.7508	0.6452	0.5719	0.5291	0.6540	0.0865		-
SCNS	0.6894	0.6355	0.6170	0.6123	0.5692	0.6222	0.0360		7.97E-01
PIDC	0.5426	0.5347	0.5166	0.5137	0.5110	0.5224	0.0123		1.36E-02
GRNVBEM	0.5191	0.5057	0.4915	0.4781	0.4726	0.4931	0.0163		5.71E-05
GENIE3	0.5264	0.5189	0.5147	0.5147	0.5136	0.5174	**0.004**		9.76E-03
GRNBOOST2	0.5413	0.5102	0.5089	0.5044	0.4855	0.5074	0.0142		3.97E-04
PPCOR	0.5506	0.5288	0.5017	0.4947	0.4928	0.5120	0.0221		1.07E-03
SCODE	0.8504	0.8099	0.7976	0.7929	**0.7314**	0.7976	0.0333	5.51E-17	8.15E-02
SINCERITIES	0.7936	0.6972	0.6833	0.6317	0.4943	0.6613	0.0776		9.23E-01
LEAP	0.5668	0.5513	0.5472	0.5409	0.5338	0.5471	0.0095		1.73E-01
GRISLI	**0.9054**	**0.8725**	**0.8494**	**0.7978**	0.7168	**0.8302**	0.0616		3.78E-02
SCINGE	0.8558	0.8278	0.7714	0.7521	0.6771	0.7802	0.0561		1.28E-01

Tabela 62: AUPRC mCAD-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.7624	0.6926	0.6452	0.5766	0.5596	0.6466	0.0713		-
SCNS	0.6697	0.6275	0.6088	0.5774	0.5681	0.6104	0.0358		7.43E-01
PIDC	0.5261	0.5168	0.5046	0.5004	0.4934	0.5076	**0.0103**		2.52E-03
GRNVBEM	0.5203	0.4927	0.4816	0.4760	0.4713	0.4873	0.0148		3.68E-05
GENIE3	0.5571	0.5371	0.5131	0.5083	0.5042	0.5232	0.0188		1.83E-02
GRNBOOST2	0.5523	0.5316	0.4982	0.4861	0.4755	0.5078	0.0261	1.15E-16	1.71E-03
PPCOR	0.5524	0.5382	0.4996	0.4818	0.4781	0.5082	0.0293		1.43E-03
SCODE	0.8485	0.8402	0.8031	0.7904	**0.7523**	0.8102	0.0307		5.46E-02
SINCERITIES	0.7977	0.7310	0.6775	0.6089	0.5188	0.6635	0.0913		9.54E-01
LEAP	0.5973	0.5305	0.5196	0.5154	0.5080	0.5287	0.0244		3.79E-02
GRISLI	**0.8720**	0.7527	0.7254	0.7191	0.6565	0.7462	0.0582		2.86E-01
SCINGE	0.8684	**0.8455**	**0.8237**	**0.7935**	0.7391	**0.8174**	0.0376		4.56E-02

Tabela 63: AUPRC mCAD-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6561	0.6561	0.6403	0.6081	0.5515	0.6281	0.0331		-
SCNS	0.6910	0.6226	0.6110	0.5849	0.5692	0.6149	0.0374		8.47E-01
PIDC	0.5534	0.5350	0.5263	0.5062	0.4989	0.5234	**0.0174**		2.46E-03
GRNVBEM	0.5474	0.5147	0.4663	0.4556	0.4445	0.4851	0.0362		1.09E-04
GENIE3	0.5739	0.5539	0.5405	0.5179	0.5062	0.5379	0.0218		1.51E-02
GRNBOOST2	0.5791	0.5340	0.5226	0.5025	0.4781	0.5226	0.0281	3.33E-16	2.62E-03
PPCOR	0.5633	0.5605	0.5377	0.5124	0.5021	0.5359	0.0234		1.26E-02
SCODE	0.8468	0.8169	0.7826	**0.7534**	**0.7263**	**0.7841**	0.0401		3.34E-02
SINCERITIES	0.7778	0.7197	0.6387	0.5854	0.5485	0.6522	0.0784		8.47E-01
LEAP	0.6461	0.6267	0.5736	0.5414	0.5331	0.5830	0.0433		2.83E-01
GRISLI	**0.8834**	**0.8277**	**0.8140**	0.6818	0.6294	0.7689	0.0844		5.54E-02
SCINGE	0.8254	0.7800	0.7551	0.7347	0.6576	0.7526	0.0481		7.93E-02

8.2 AUROC

Tabela 64: AUROC mCAD-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6264	0.6264	0.5165	0.3750	0.3242	0.4978	0.1220		-
SCNS	0.5000	0.4670	0.4505	0.4396	0.3956	0.4495	0.0329		7.53E-01
PIDC	0.3132	0.3132	0.3022	0.2912	0.2912	0.3022	**0.0110**		4.22E-03
GRNVBEM	0.2418	0.206	0.1868	0.1538	0.1319	0.1835	0.0358		2.73E-06
GENIE3	0.3407	0.3187	0.3077	0.3077	0.3077	0.3154	**0.0110**		1.49E-02
GRNBOOST2	0.3626	0.2940	0.2857	0.2692	0.2088	0.2802	0.0391		4.69E-04
PPCOR	0.3462	0.3091	0.2802	0.2582	0.2527	0.2879	0.0336	1.66E-17	1.25E-03
SCODE	0.7582	0.6786	0.6538	0.6401	0.5604	0.6538	0.0504		1.11E-01
SINCERITIES	0.6264	0.5055	0.4505	0.4162	0.2418	0.4451	0.1017		5.54E-01
LEAP	0.4066	0.3709	0.3516	0.3407	0.3132	0.3538	0.0256		1.65E-01
GRISLI	**0.8187**	**0.7541**	**0.7335**	**0.6964**	**0.6484**	**0.7275**	0.0513		2.74E-02
SCINGE	0.7198	0.6195	0.5852	0.5453	0.5055	0.5929	0.0656		3.32E-01

Tabela 65: AUROC mCAD-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6319	0.5412	0.5055	0.4135	0.3626	0.4934	0.0899		-
SCNS	0.4780	0.4643	0.4478	0.4052	0.3791	0.4357	0.0331		6.81E-01
PIDC	0.3352	0.3077	0.2802	0.2692	0.2473	0.2868	**0.0256**		2.68E-03
GRNVBEM	0.2473	0.1799	0.1676	0.1497	0.1429	0.1736	0.0312		4.43E-06
GENIE3	0.4066	0.3489	0.3022	0.2885	0.2747	0.3198	0.0424		1.62E-02
GRNBOOST2	0.3846	0.3516	0.2473	0.2253	0.1868	0.2791	0.0701		2.36E-03
PPCOR	0.3901	0.342	0.2720	0.2184	0.2033	0.283	0.0701	3.31E-17	2.62E-03
SCODE	**0.7802**	0.7225	**0.6923**	0.6511	**0.6264**	0.6923	0.0464		7.50E-02
SINCERITIES	0.6374	0.5137	0.4890	0.3805	0.3132	0.4621	0.0985		6.97E-01
LEAP	0.3901	0.3379	0.3242	0.3146	0.2967	0.3330	0.0296		4.81E-02
GRISLI	**0.7802**	**0.728**	**0.6923**	**0.6772**	0.5879	**0.6973**	0.0490		5.79E-02
SCINGE	0.7088	0.6992	0.6813	0.6387	0.5495	0.6599	0.0536		1.36E-01

Tabela 66: AUROC mCAD-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5440	0.5440	0.4863	0.4286	0.3352	0.4736	0.0749		-
SCNS	0.5165	0.4698	0.4451	0.4272	0.3956	0.4495	**0.0339**		9.10E-01
PIDC	0.3571	0.3352	0.3242	0.2747	0.2692	0.3132	0.0340		4.72E-03
GRNVBEM	0.3407	0.2871	0.1291	0.0907	0.0549	0.1791	0.1041		8.01E-05
GENIE3	0.3626	0.3269	0.3022	0.2857	0.2418	0.3033	0.0345		2.26E-03
GRNBOOST2	0.4505	0.3489	0.3242	0.2665	0.1868	0.3154	0.0727		8.47E-03
PPCOR	0.4066	0.3709	0.3352	0.2788	0.2363	0.3253	0.0553	2.16E-16	1.25E-02
SCODE	0.7143	0.6731	0.6429	0.5852	**0.5604**	0.6341	0.0499		4.19E-02
SINCERITIES	0.5824	0.5316	0.4313	0.3736	0.3407	0.4495	0.0850		7.41E-01
LEAP	0.4505	0.4396	0.4066	0.3777	0.3242	0.4044	0.0393		3.82E-01
GRISLI	**0.7692**	**0.7349**	**0.6923**	**0.6195**	0.5165	**0.6714**	0.0758		2.23E-02
SCINGE	0.6978	0.6319	0.5797	0.5453	0.5220	0.5918	0.0558		1.15E-01

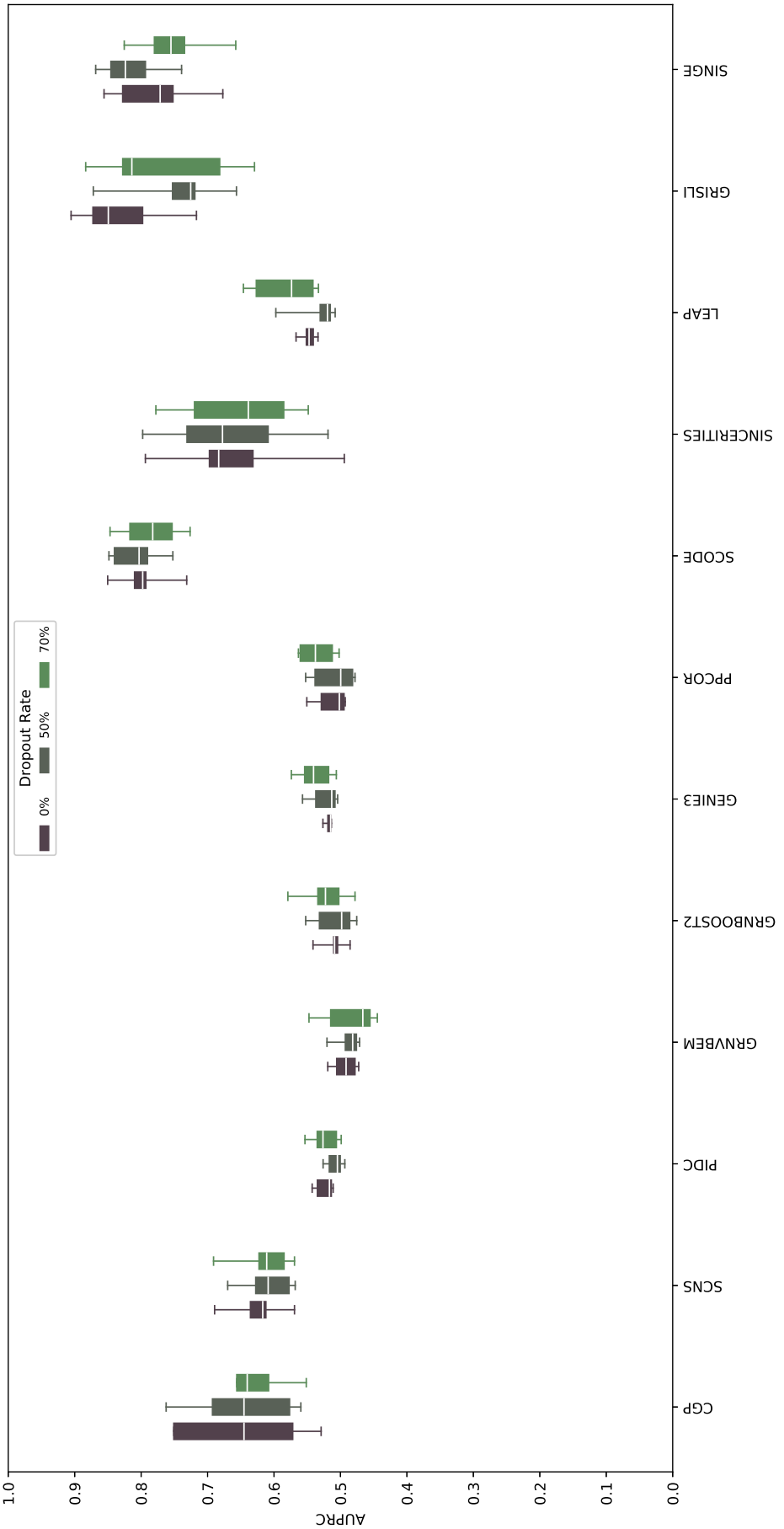
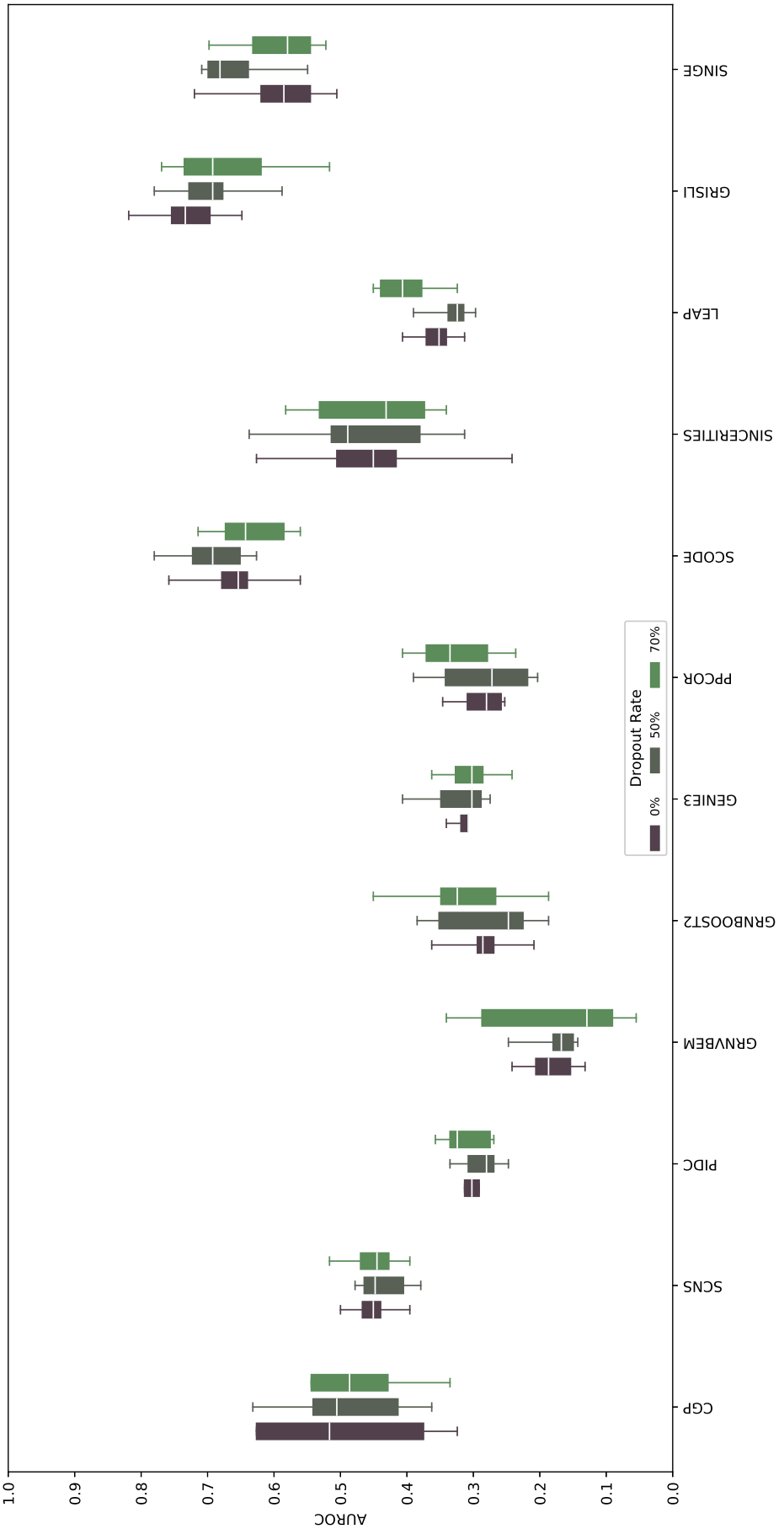


Figura 24: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema mCAD.

Figura 25: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema mCAD.

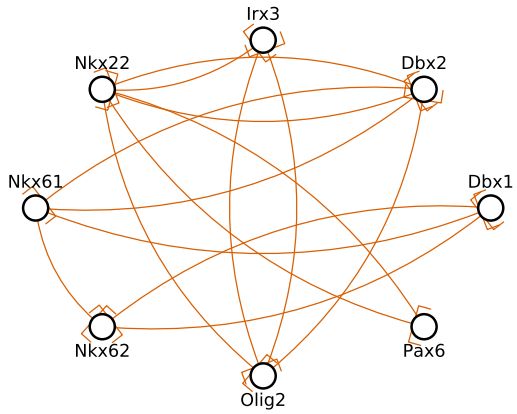


9 VSC

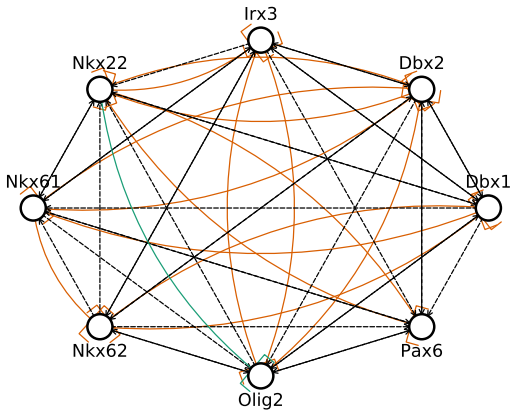
O modelo de desenvolvimento da medula espinhal ventral (VSC) [2] consiste de 8 fatores de transcrição e contém 15 interações, todas de inibição, e 5 *steady-states*.

Figura 26: Redes VSC *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



9.1 AUPRC

Tabela 67: AUPRC VSC-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.4683	0.3287	0.3138	0.2789	0.2338	0.3217	0.0667		-
SCNS	0.2679	0.2679	0.2679	0.2679	0.2679	0.2679	**0.0000**		2.12E-01
PIDC	0.7603	0.7363	0.7295	0.6921	0.6604	0.7167	0.0298		6.55E-04
GRNVBEM	0.2091	0.1850	0.1827	0.1760	0.1684	0.1842	0.0118		4.30E-03
GENIE3	0.7530	**0.7421**	**0.7401**	**0.7357**	**0.7256**	**0.7386**	0.0074		7.67E-05
GRNBOOST2	**0.7614**	0.7229	0.7197	0.7111	0.6975	0.7227	0.0196		7.71E-04
PPCOR	0.6139	0.5892	0.5739	0.5519	0.5456	0.5741	0.0232		2.21E-02
SCODE	0.4325	0.3616	0.3037	0.2720	0.2481	0.3217	0.0627	4.07E-17	9.85E-01
SINCERITIES	0.3563	0.2981	0.2786	0.2530	0.2185	0.2796	0.0375		4.18E-01
LEAP	0.3374	0.2734	0.2640	0.2370	0.2102	0.2621	0.0335		1.81E-01
GRISLI	0.4173	0.3567	0.3375	0.2926	0.2600	0.3300	0.0458		6.95E-01
SCINGE	0.4755	0.4697	0.3846	0.3223	0.2834	0.3893	0.0742		2.98E-01

Tabela 68: AUPRC VSC-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.4671	0.4395	0.3431	0.3069	0.2457	0.3607	0.0750		-
SCNS	0.2679	0.2679	0.2679	0.2679	0.2679	0.2679	**0.0000**		4.84E-02
PIDC	**0.7790**	**0.7628**	**0.7568**	**0.751**	**0.6851**	**0.7489**	0.0269		1.37E-04
GRNVBEM	0.2558	0.2219	0.2126	0.201	0.1945	0.2169	0.0204		1.46E-03
GENIE3	0.6311	0.5972	0.5823	0.5285	0.4565	0.5599	0.0584		3.28E-02
GRNBOOST2	0.6288	0.5972	0.5840	0.5723	0.5587	0.5869	0.0208		2.48E-02
PPCOR	0.6568	0.6535	0.6264	0.6177	0.6111	0.6331	0.0180		2.16E-03
SCODE	0.6096	0.3636	0.3257	0.2890	0.2738	0.3607	0.1017	3.42E-16	9.49E-01
SINCERITIES	0.3923	0.3134	0.2928	0.2708	0.2540	0.3035	0.0450		2.89E-01
LEAP	0.3880	0.3596	0.3110	0.2715	0.2119	0.3129	0.0544		4.14E-01
GRISLI	0.4384	0.3370	0.3058	0.2721	0.2425	0.3117	0.0546		3.61E-01
SCINGE	0.4110	0.3932	0.3821	0.2938	0.2755	0.3518	0.0523		9.44E-01

Tabela 69: AUPRC VSC-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.3730	0.3071	0.2590	0.2275	0.1938	0.2709	0.0532		-
SCNS	0.2679	0.2679	0.2679	0.2679	0.2679	0.2679	**0.0000**		8.72E-01
PIDC	**0.7208**	**0.7139**	**0.6925**	**0.6553**	**0.6384**	**0.6852**	0.0300		7.91E-08
GRNVBEM	0.2426	0.2235	0.2122	0.2058	0.1977	0.2149	0.0136		1.31E-01
GENIE3	0.3677	0.3656	0.3634	0.3600	0.3531	0.3621	0.0043		1.48E-02
GRNBOOST2	0.4675	0.4396	0.4352	0.4297	0.4179	0.4358	0.0128		1.45E-04
PPCOR	0.6187	0.5903	0.5760	0.5636	0.5428	0.5776	0.0208		2.29E-06
SCODE	0.4439	0.4261	0.3916	0.3605	0.2944	0.3842	0.0491	1.18E-15	5.05E-03
SINCERITIES	0.4912	0.3373	0.2958	0.2839	0.2728	0.3227	0.0614		1.94E-01
LEAP	0.3892	0.3317	0.2825	0.2551	0.2233	0.2945	0.0520		5.50E-01
GRISLI	0.4605	0.3069	0.2919	0.2580	0.2072	0.2958	0.0639		5.46E-01
SCINGE	0.4936	0.3920	0.3394	0.3239	0.2262	0.3526	0.0684		4.28E-02

9.2 AUROC

Tabela 70: AUROC VSC-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6805	0.628	0.5541	0.5014	0.4211	0.5608	0.0778		-
SCNS	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	**0.0000**		2.10E-01
PIDC	**0.8528**	0.8171	0.8008	0.7894	0.7715	0.8037	0.0223		4.69E-04
GRNVBEM	0.3333	0.2663	0.2553	0.2382	0.2033	0.2607	0.0380		4.22E-03
GENIE3	0.8163	0.8057	0.7967	0.7878	0.7854	0.7974	0.0101		1.02E-03
GRNBOOST2	0.8439	**0.826**	**0.8122**	**0.8028**	**0.7967**	**0.8154**	0.0148	4.35E-16	8.77E-05
PPCOR	0.7252	0.7209	0.7057	0.6841	0.6707	0.7020	0.0192		2.72E-02
SCODE	0.6797	0.6203	0.5325	0.5207	0.4537	0.5595	0.0706		9.54E-01
SINCERITIES	0.6179	0.5370	0.5114	0.4807	0.413	0.5144	0.0573		3.85E-01
LEAP	0.6846	0.5717	0.5354	0.4697	0.4033	0.5289	0.0775		5.80E-01
GRISLI	0.6561	0.5963	0.5740	0.5490	0.4789	0.5696	0.0532		8.37E-01
SCINGE	0.7106	0.6065	0.5817	0.5319	0.5098	0.5865	0.0618		5.65E-01

Tabela 71: AUROC VSC-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.7707	0.6929	0.613	0.5583	0.4593	0.6199	0.0913		-
SCNS	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	**0.0000**		1.40E-02
PIDC	**0.8659**	**0.8488**	**0.8366**	**0.8195**	**0.8138**	**0.8369**	0.0174		5.41E-04
GRNVBEM	0.4561	0.4059	0.3768	0.3207	0.3081	0.3728	0.0515		4.58E-04
GENIE3	0.7854	0.7610	0.7504	0.7411	0.7252	0.7520	0.0165		3.38E-02
GRNBOOST2	0.8309	0.8159	0.8138	0.8057	0.7967	0.8125	0.0094	2.51E-16	3.23E-03
PPCOR	0.7415	0.7346	0.7228	0.6945	0.6886	0.7167	0.0203		1.37E-01
SCODE	0.7350	0.5850	0.5691	0.5195	0.4049	0.5608	0.0795		3.82E-01
SINCERITIES	0.6350	0.5697	0.5309	0.5197	0.4634	0.5446	0.0460		2.25E-01
LEAP	0.6724	0.6124	0.5744	0.5429	0.3967	0.5706	0.0718		5.33E-01
GRISLI	0.6724	0.5965	0.5488	0.5118	0.4480	0.5521	0.0682		2.83E-01
SCINGE	0.6691	0.6492	0.5866	0.5543	0.4911	0.5917	0.0598		6.71E-01

Tabela 72: AUROC VSC-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6854	0.5742	0.5272	0.4280	0.3415	0.5113	0.1013		-
SCNS	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	**0.0000**		5.78E-01
PIDC	**0.8561**	**0.8447**	**0.8285**	**0.8211**	**0.8138**	**0.8317**	0.0141		8.98E-07
GRNVBEM	0.4537	0.4067	0.3919	0.3665	0.3333	0.3902	0.0389		5.10E-02
GENIE3	0.6407	0.6390	0.6350	0.6313	0.6228	0.6340	0.0057		1.59E-02
GRNBOOST2	0.7984	0.7801	0.7764	0.7711	0.7642	0.7784	0.0102	5.37E-16	8.42E-05
PPCOR	0.8366	0.7998	0.7809	0.7746	0.7447	0.7872	0.0262		3.36E-05
SCODE	0.6748	0.6366	0.6016	0.5837	0.5756	0.6122	0.0317		6.00E-02
SINCERITIES	0.6374	0.6041	0.5683	0.5486	0.5236	0.5741	0.0360		3.10E-01
LEAP	0.6407	0.5522	0.5073	0.4724	0.4390	0.5141	0.0588		9.23E-01
GRISLI	0.7171	0.5665	0.4996	0.4913	0.3902	0.5311	0.0858		9.64E-01
SCINGE	0.6911	0.6382	0.6089	0.5423	0.4577	0.5937	0.0678		1.32E-01

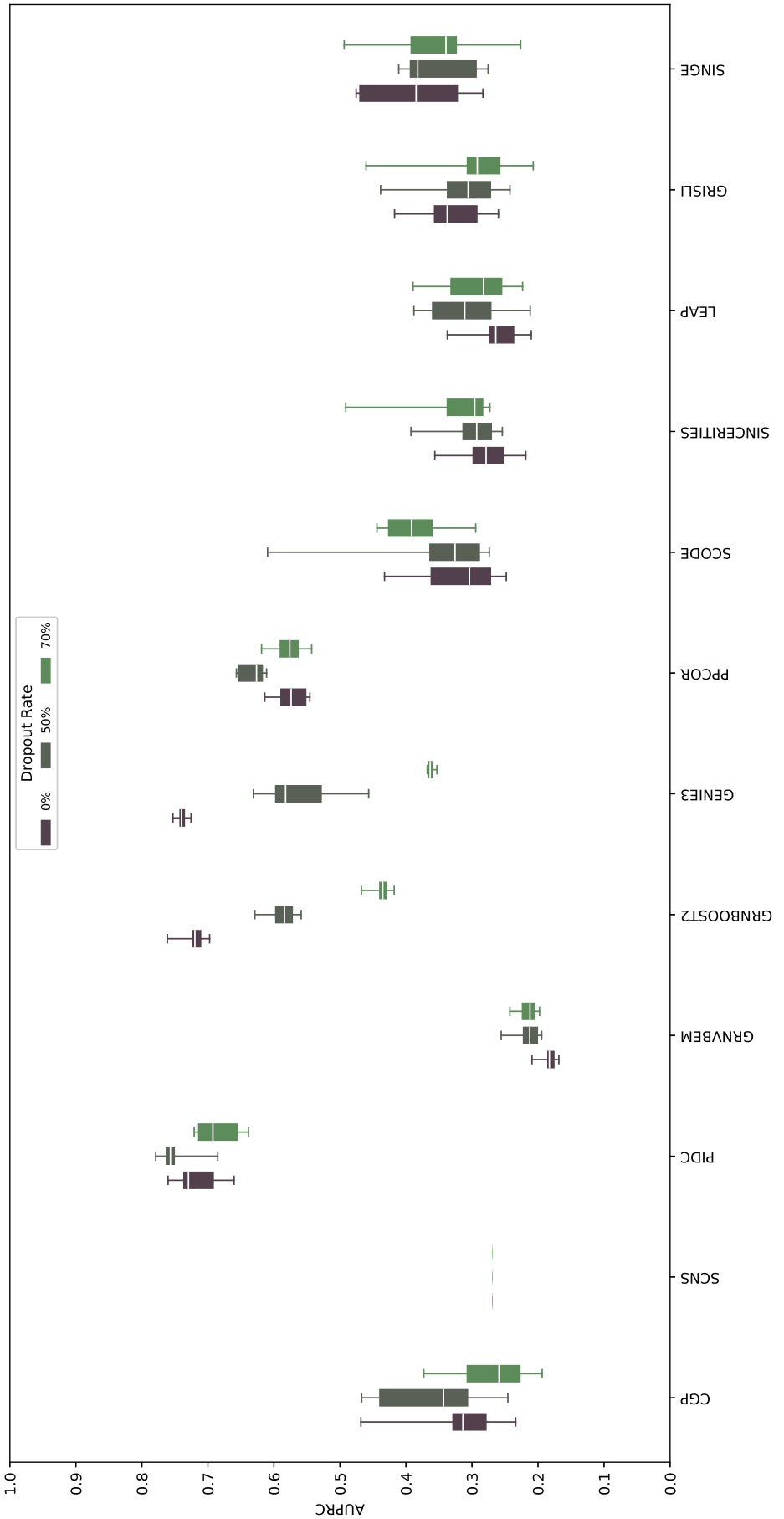


Figura 27: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema VSC.

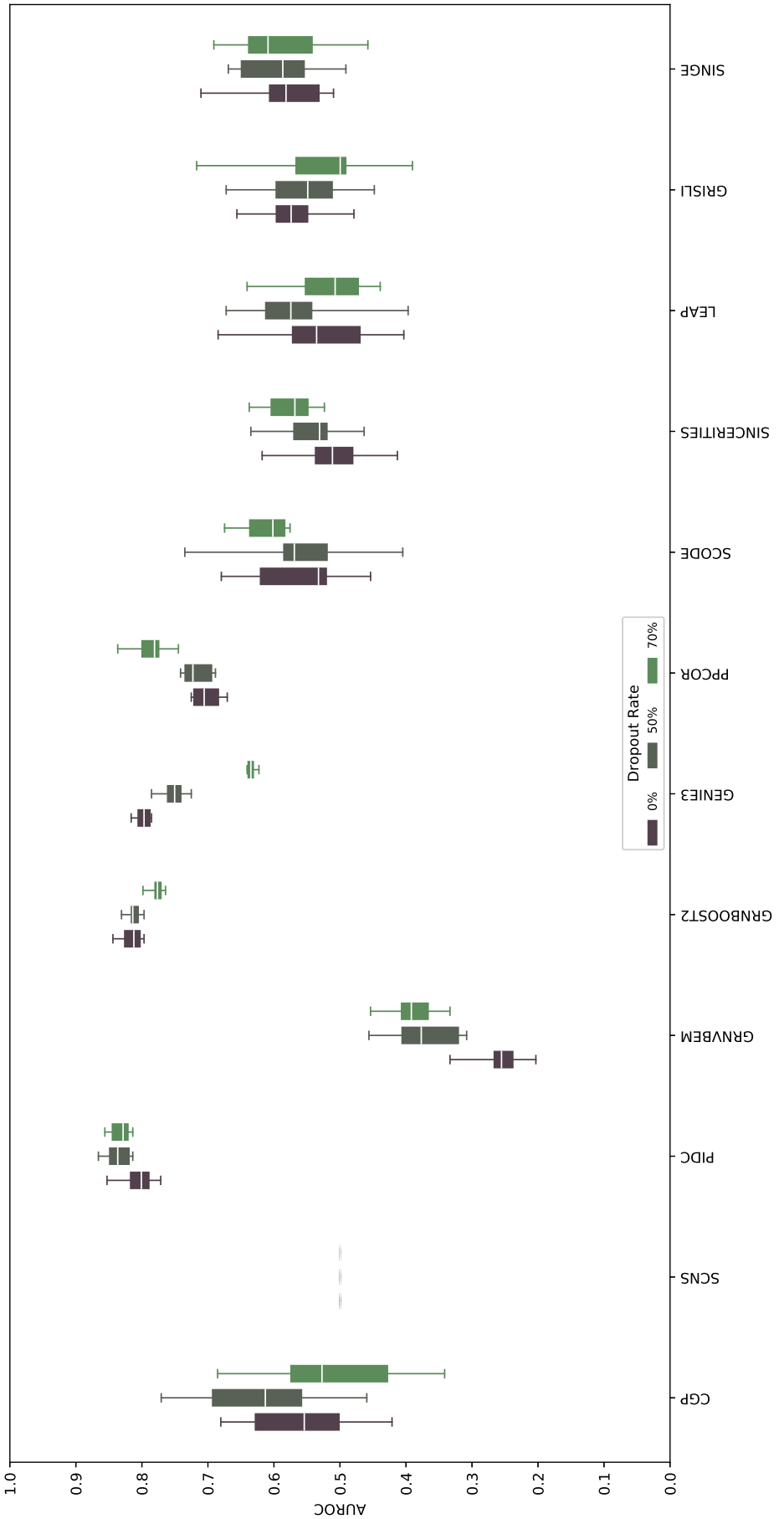


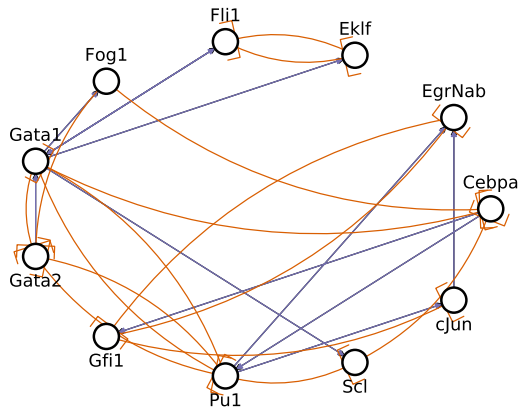
Figura 28: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema VSC.

10 HSC

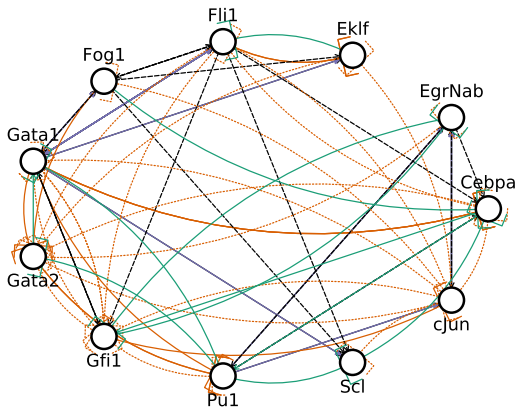
O modelo de diferenciação da célula-tronco hematopoiética (HSC) [3] consiste de 11 fatores de transcrição, 30 interações das quais 15 são ativações e 15 são inibições, com quatro *steady-states*.

Figura 29: Redes HSC *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



10.1 AUPRC

Tabela 73: AUPRC HSC-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.4032	0.3198	0.2658	0.2535	0.2241	0.2901	0.0563		-
SCNS	0.3803	0.3378	0.2806	0.2650	0.2547	0.3008	0.0453		7.28E-01
PIDC	0.4897	0.4806	0.4667	**0.4646**	**0.4556**	**0.4707**	**0.0109**		1.01E-04
GRNVBEM	0.3302	0.3217	0.3116	0.2977	0.2792	0.3088	0.0160		4.25E-01
GENIE3	0.4968	0.4808	0.4665	0.4524	0.4353	0.4661	0.0188		1.74E-04
GRNBOOST2	**0.5357**	**0.4973**	**0.4682**	0.4556	0.3736	0.4663	0.0468		1.83E-04
PPCOR	0.4512	0.4238	0.4091	0.3877	0.3676	0.4067	0.0256		2.21E-02
SCODE	0.4698	0.4340	0.4254	0.3972	0.3368	0.4147	0.0394	1.77E-17	1.07E-02
SINCERITIES	0.3241	0.2648	0.2550	0.2280	0.2015	0.2535	0.0371		3.93E-01
LEAP	0.2986	0.2884	0.2749	0.2646	0.2233	0.2713	0.0217		8.37E-01
GRISLI	0.2580	0.2383	0.2262	0.2176	0.2043	0.2280	0.0157		1.15E-01
SCINGE	0.2215	0.2005	0.1981	0.1890	0.1808	0.1969	0.0113		1.36E-02

Tabela 74: AUPRC HSC-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.3502	0.2979	0.2857	0.2714	0.2462	0.2915	0.0325		-
SCNS	0.3313	0.2927	0.2647	0.2576	0.2484	0.2791	0.0292		6.90E-01
PIDC	0.4803	0.4584	**0.4472**	**0.4318**	**0.417**	**0.4458**	0.0195		7.05E-04
GRNVBEM	0.3179	0.2891	0.2843	0.2749	0.2554	0.2840	0.0175		9.44E-01
GENIE3	0.4609	0.4443	0.4361	0.4217	0.3949	0.4314	0.0198		2.86E-03
GRNBOOST2	**0.4902**	**0.4643**	0.4426	0.4205	0.3925	0.4426	0.0313	2.51E-17	1.25E-03
PPCOR	0.4210	0.4017	0.3844	0.3731	0.3270	0.3844	0.0255		8.61E-02
SCODE	0.4371	0.4027	0.3937	0.3816	0.3498	0.3937	0.0255		5.38E-02
SINCERITIES	0.2969	0.2538	0.2185	0.2167	0.1770	0.2306	0.0344		4.16E-02
LEAP	0.2727	0.2503	0.2350	0.2278	0.2007	0.2385	0.0206		7.29E-02
GRISLI	0.3004	0.2636	0.2383	0.2324	0.2209	0.2485	0.0246		1.59E-01
SCINGE	0.2376	0.2236	0.2121	0.2043	0.1915	0.2140	**0.0155**		7.49E-03

Tabela 75: AUPRC HSC-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.4167	0.3876	0.3527	0.2998	0.2509	0.3440	0.0528		-
SCNS	0.3203	0.2843	0.2549	0.2508	0.2390	0.2676	0.0252		3.85E-02
PIDC	0.4360	0.4185	**0.4119**	**0.4071**	0.3863	**0.4121**	0.0145		3.50E-02
GRNVBEM	0.3010	0.2847	0.2785	0.2650	0.2544	0.2770	0.0146		9.85E-02
GENIE3	0.4127	0.4085	0.4023	0.3977	**0.3903**	0.4021	**0.0073**		9.72E-02
GRNBOOST2	**0.4369**	**0.4200**	0.4039	0.3869	0.3491	0.4023	0.0254	3.02E-16	7.60E-02
PPCOR	0.3710	0.3678	0.3627	0.3420	0.3238	0.3538	0.0174		9.03E-01
SCODE	0.4209	0.3917	0.3573	0.3290	0.3120	0.3625	0.0372		5.76E-01
SINCERITIES	0.3369	0.2907	0.2393	0.2111	0.2038	0.2527	0.0442		8.09E-03
LEAP	0.2601	0.2500	0.2460	0.2179	0.2085	0.2359	0.0185		1.53E-03
GRISLI	0.3066	0.2768	0.2451	0.2325	0.2038	0.2528	0.0290		8.40E-03
SCINGE	0.2627	0.2159	0.2028	0.1900	0.1864	0.2078	0.0222		6.38E-05

10.2 AUROC

Tabela 76: AUROC HSC-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6376	0.5951	0.5413	0.516	0.4531	0.5517	0.0554		-
SCNS	0.6158	0.5574	0.5308	0.5204	0.4794	0.5385	0.0371		8.07E-01
PIDC	0.7958	0.7768	0.7637	0.7473	0.7326	0.7621	0.0190		9.29E-05
GRNVBEM	0.6724	0.6478	0.6043	0.5975	0.5907	0.6213	0.0291		1.83E-01
GENIE3	0.8008	**0.7879**	**0.7853**	**0.7771**	**0.7688**	**0.7841**	**0.0097**		6.03E-06
GRNBOOST2	**0.804**	0.7831	0.7541	0.7399	0.7248	0.7607	0.0259	4.40E-18	7.30E-05
PPCOR	0.7351	0.6972	0.6856	0.6656	0.6348	0.6847	0.0291		9.06E-03
SCODE	0.7092	0.6812	0.6664	0.6525	0.6355	0.6672	0.0223		2.00E-02
SINCERITIES	0.5742	0.5249	0.5037	0.492	0.4299	0.5031	0.0415		3.10E-01
LEAP	0.6326	0.6216	0.6033	0.5616	0.4975	0.5878	0.0428		5.00E-01
GRISLI	0.5664	0.5317	0.5072	0.4835	0.4663	0.5095	0.0299		3.58E-01
SCINGE	0.4789	0.4485	0.4378	0.4041	0.3883	0.4310	0.0288		2.79E-02

Tabela 77: AUROC HSC-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6172	0.5912	0.5488	0.5171	0.4966	0.5552	0.0414		-
SCNS	0.5591	0.5497	0.5312	0.5124	0.4567	0.5258	0.0304		5.04E-01
PIDC	0.7701	0.7601	0.7546	0.7276	0.7024	0.7442	0.0219		1.49E-04
GRNVBEM	0.6307	0.6118	0.5847	0.5640	0.5053	0.5825	0.0364		5.25E-01
GENIE3	**0.7857**	**0.7742**	**0.7633**	**0.7505**	**0.7326**	**0.7602**	0.0172		2.77E-05
GRNBOOST2	0.7674	0.7412	0.7303	0.7160	0.6941	0.7304	0.0228	4.51E-17	4.07E-04
PPCOR	0.7285	0.6828	0.6787	0.6523	0.6376	0.6739	0.0257		1.59E-02
SCODE	0.6868	0.6693	0.6538	0.6488	0.6401	0.6589	**0.0143**		3.23E-02
SINCERITIES	0.6225	0.5328	0.4912	0.4528	0.3622	0.4953	0.0739		2.24E-01
LEAP	0.5847	0.5573	0.5259	0.4944	0.4421	0.5229	0.0446		4.88E-01
GRISLI	0.6207	0.5569	0.5366	0.5143	0.4785	0.5402	0.0379		7.28E-01
SCINGE	0.5087	0.4697	0.4594	0.4480	0.4201	0.4592	0.0240		2.70E-02

Tabela 78: AUROC HSC-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.6827	0.6465	0.6197	0.5684	0.5039	0.6097	0.0547		-
SCNS	0.5685	0.5327	0.5019	0.4865	0.4505	0.5079	0.0341		2.33E-02
PIDC	**0.7509**	**0.7365**	**0.7221**	0.7012	0.6914	0.7208	0.0202		6.94E-03
GRNVBEM	0.5881	0.5788	0.5438	0.5299	0.5140	0.5515	0.0260		2.09E-01
GENIE3	0.7440	0.7284	0.7207	**0.7155**	**0.7138**	**0.723**	**0.0091**		5.49E-03
GRNBOOST2	0.7445	0.7175	0.7070	0.7007	0.6827	0.7091	0.0178	8.04E-17	2.25E-02
PPCOR	0.7056	0.6835	0.6600	0.6526	0.6337	0.6671	0.0228		2.46E-01
SCODE	0.7202	0.6686	0.6394	0.6339	0.6076	0.6528	0.0313		3.84E-01
SINCERITIES	0.6090	0.5506	0.5002	0.4526	0.3707	0.5015	0.0703		2.64E-02
LEAP	0.5643	0.5525	0.5459	0.4904	0.4645	0.5250	0.0366		7.24E-02
GRISLI	0.5918	0.5797	0.5306	0.5262	0.4501	0.5418	0.0413		1.44E-01
SCINGE	0.5103	0.4524	0.4439	0.4199	0.4105	0.4459	0.0299		4.94E-04

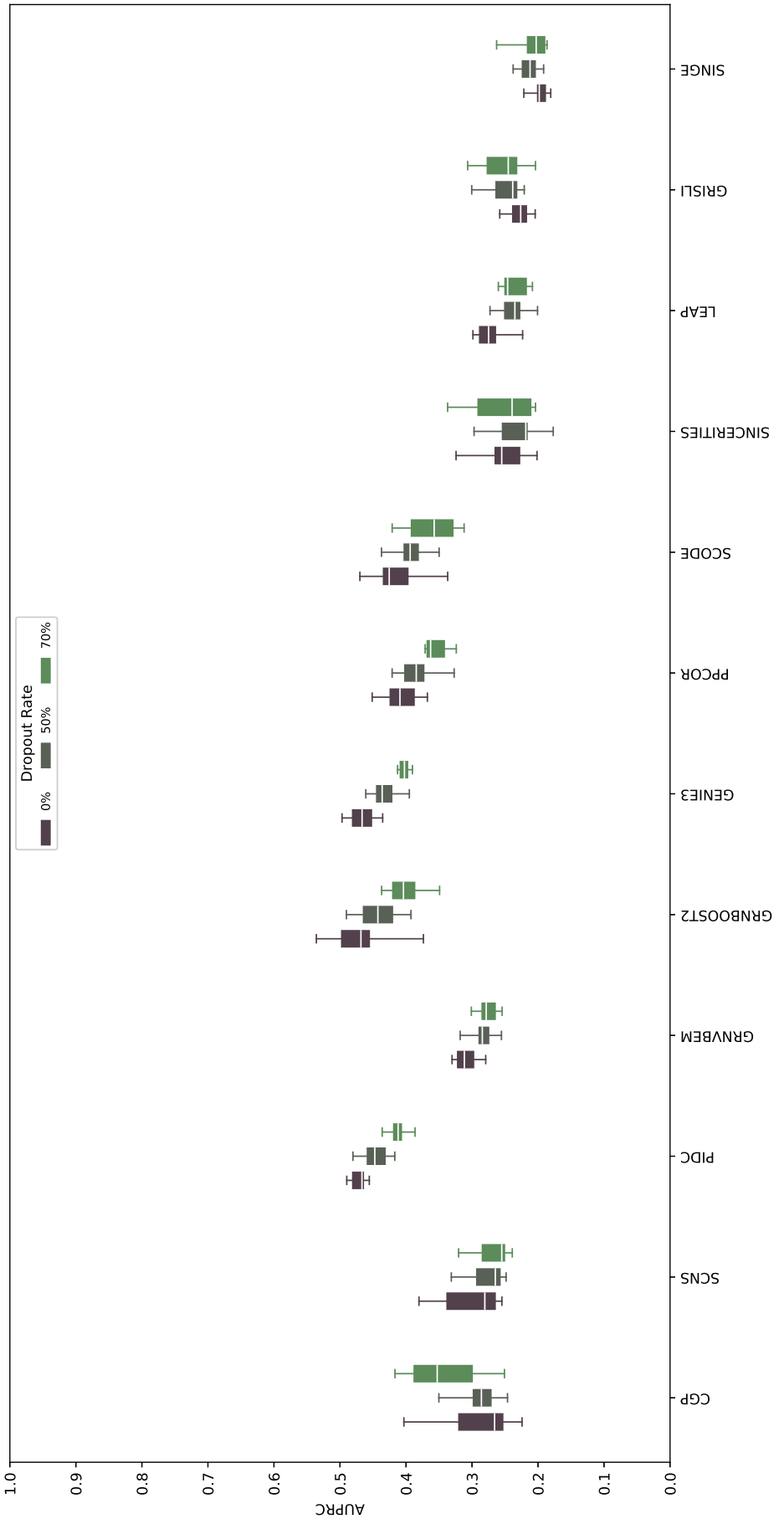
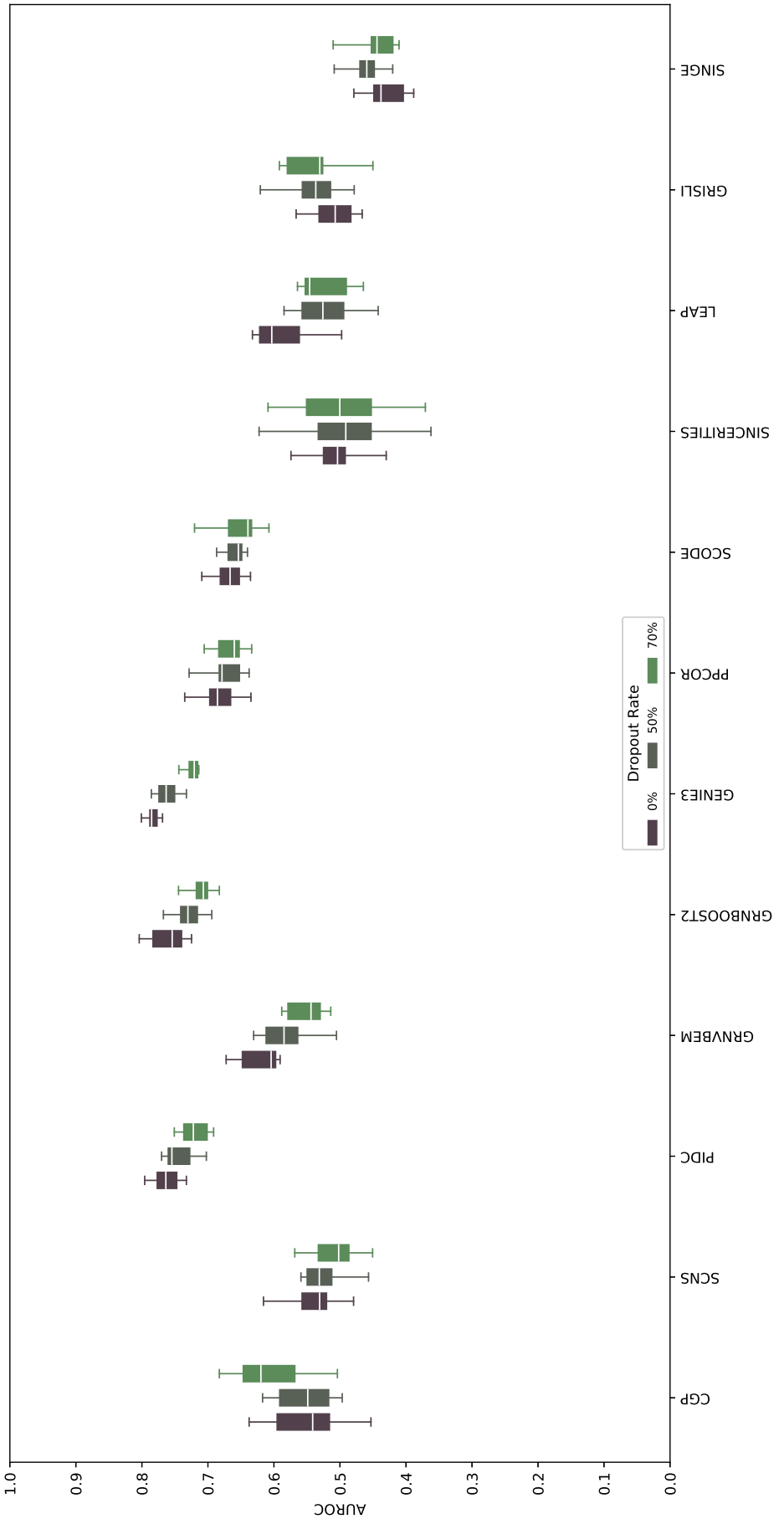


Figura 30: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema HSC.

Figura 31: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema HSC.

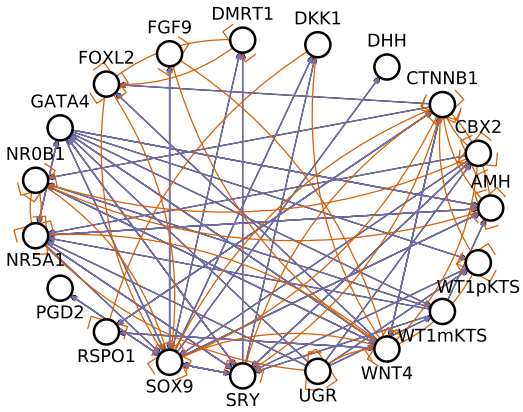


11 GSD

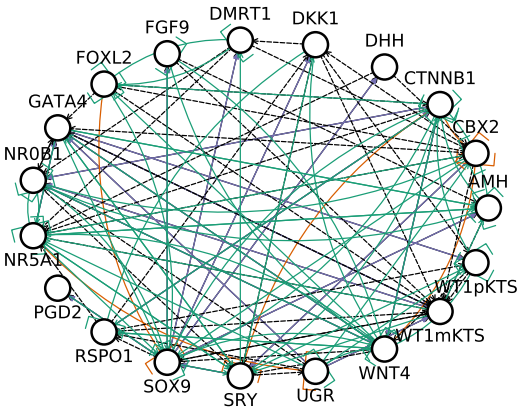
O modelo de determinação de sexo gonadal (GSD) [4] consiste de 19 fatores de transcrição e contém 86 interações, 27 ativações e 59 inibições, com dois *steady-states*.

Figura 32: Redes GSD *ground-truth* e reconstruídas. Linhas azuis representam ativação e linhas laranjas, inibição. Linhas sólidas são relações corretas e linhas tracejadas são relações regulatórias obtidas apenas pela proposta. Linhas verdes são relações regulatórias da rede *ground-truth* que não foram encontradas pela proposta.

(a) Rede *ground-truth*.



(b) Rede reconstruída.



11.1 AUPRC

Tabela 79: AUPRC GSD-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.2630	0.2552	0.2480	0.2399	0.2073	0.2453	0.0156		-
SCNS	0.2575	0.2526	0.2482	0.2470	0.2418	0.2491	0.0048		9.90E-01
PIDC	0.3018	0.2949	0.2934	0.2896	0.2856	0.2929	0.0044		4.85E-05
GRNVBEM	0.3056	0.2971	0.2854	0.2712	0.2603	0.2848	0.0155		8.89E-04
GENIE3	0.2814	0.2804	0.2785	0.2769	0.2716	0.2780	0.0029		9.23E-03
GRNBOOST2	0.2930	0.2872	0.2836	0.2713	0.2660	0.2804	0.0095		3.45E-03
PPCOR	0.3232	0.3125	**0.3053**	**0.2973**	**0.2864**	0.3046	0.0109		1.97E-06
SCODE	0.3402	**0.3310**	0.2925	0.2644	0.212	0.2909	0.0418		1.04E-03
SINCERITIES	0.2888	0.2571	0.2508	0.2435	0.2294	0.2510	0.0160		7.28E-01
LEAP	0.2615	0.2599	0.2583	0.2569	0.2547	0.2583	**0.002**		3.38E-01
GRISLI	**0.3589**	0.3286	0.3041	0.2809	0.2623	**0.305**	0.0299		2.94E-05
SCINGE	0.2284	0.2055	0.1895	0.1869	0.1827	0.1977	0.0144		1.54E-01

Tabela 80: AUPRC GSD-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.2772	0.2665	0.2288	0.2125	0.1854	0.2355	0.0304		-
SCNS	0.2509	0.2494	0.2448	0.2432	0.2421	0.2459	**0.0034**		9.79E-01
PIDC	0.2972	0.2939	0.2891	**0.2835**	**0.2786**	**0.2886**	0.0060		1.38E-04
GRNVBEM	0.3323	**0.2993**	**0.2916**	0.2715	0.2237	0.2855	0.0270		5.43E-04
GENIE3	0.2963	0.2835	0.2820	0.2709	0.2579	0.2791	0.0111		3.90E-03
GRNBOOST2	0.2933	0.2900	0.2790	0.2595	0.2514	0.2754	0.0161		9.58E-03
PPCOR	0.3280	0.2922	0.2866	0.2780	0.2484	0.2864	0.0192	1.42E-09	7.38E-04
SCODE	**0.3386**	0.2942	0.2689	0.2413	0.2054	0.2692	0.0426		3.85E-02
SINCERITIES	0.3110	0.2740	0.2504	0.2353	0.2211	0.2553	0.0279		3.13E-01
LEAP	0.2760	0.2618	0.2585	0.2503	0.2421	0.2569	0.0099		4.00E-01
GRISLI	0.3143	0.2884	0.2812	0.2742	0.2573	0.2836	0.0169		2.17E-03
SCINGE	0.2291	0.2107	0.1982	0.1906	0.1804	0.2004	0.0150		1.18E-01

Tabela 81: AUPRC GSD-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.2960	0.2541	0.2319	0.2176	0.1986	0.2398	0.0311		-
SCNS	0.2533	0.2516	0.2466	0.2391	0.2384	0.2456	**0.006**		9.95E-01
PIDC	0.2924	0.2891	0.2826	0.2653	0.2561	0.2774	0.0135		1.78E-03
GRNVBEM	0.2806	0.2711	0.2540	0.2497	0.2221	0.2558	0.0182		2.29E-01
GENIE3	**0.3045**	**0.2897**	**0.2835**	**0.2686**	**0.2625**	**0.2814**	0.0134		5.18E-04
GRNBOOST2	0.2820	0.2657	0.2619	0.2550	0.2449	0.2612	0.0095		7.93E-02
PPCOR	0.3039	0.2869	0.2729	0.2666	0.2452	0.2744	0.0169		3.98E-03
SCODE	0.2848	0.2445	0.2267	0.2196	0.1898	0.2339	0.0273	6.54E-10	6.48E-01
SINCERITIES	0.2973	0.2622	0.2517	0.2444	0.2192	0.2525	0.0207		3.89E-01
LEAP	0.3039	0.2474	0.2465	0.2340	0.2315	0.2476	0.0200		8.32E-01
GRISLI	0.3026	0.2833	0.2671	0.2581	0.2544	0.2721	0.0163		6.42E-03
SCINGE	0.2202	0.2012	0.1937	0.1900	0.1775	0.1975	0.0128		2.25E-02

11.2 AUROC

Tabela 82: AUROC GSD-0

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5479	0.5362	0.5291	0.5216	0.4803	0.5262	0.0185		-
SCNS	0.5784	0.5717	0.5652	0.5638	0.5621	0.5678	0.0053		8.26E-02
PIDC	**0.637**	**0.6283**	**0.6181**	**0.6132**	**0.6043**	**0.6201**	0.0100		5.53E-10
GRNVBEM	0.6228	0.5966	0.5797	0.5663	0.5550	0.5831	0.0221		1.86E-03
GENIE3	0.6046	0.6020	0.6010	0.5996	0.5944	0.6004	**0.0027**		1.52E-06
GRNBOOST2	0.6075	0.6035	0.5931	0.5859	0.5825	0.5943	0.0093		3.20E-05
PPCOR	0.6064	0.5928	0.5828	0.5723	0.5644	0.5838	0.0140	1.04E-12	1.34E-03
SCODE	0.5994	0.5864	0.5730	0.5583	0.4802	0.5658	0.0320		3.03E-02
SINCERITIES	0.6047	0.5928	0.5670	0.5553	0.5465	0.5722	0.0210		1.90E-02
LEAP	0.6031	0.5948	0.5919	0.5901	0.5876	0.5934	0.0047		6.55E-05
GRISLI	0.6279	0.6129	0.5759	0.5512	0.5393	0.5805	0.0315		2.26E-03
SCINGE	0.5451	0.4702	0.4488	0.4380	0.4340	0.4621	0.0341		5.41E-01

Tabela 83: AUROC GSD-50

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5508	0.5435	0.5070	0.4875	0.4408	0.5099	0.0349		-
SCNS	0.5674	0.5651	0.5547	0.5507	0.5494	0.5573	**0.0072**		1.46E-01
PIDC	0.6244	**0.6117**	**0.6049**	**0.6015**	**0.5974**	**0.6070**	0.0076		5.32E-09
GRNVBEM	0.6077	0.5847	0.5656	0.5585	0.5212	0.5684	0.0228		8.09E-03
GENIE3	0.6043	0.6016	0.5994	0.5881	0.5796	0.5954	0.0086		7.68E-07
GRNBOOST2	0.5951	0.5764	0.5682	0.5617	0.5538	0.5701	0.0115	2.01E-12	1.07E-02
PPCOR	0.5799	0.5765	0.5750	0.5675	0.5237	0.5682	0.0157		9.40E-03
SCODE	0.5803	0.5764	0.5654	0.5436	0.4725	0.5487	0.0396		6.99E-02
SINCERITIES	**0.6527**	0.6009	0.5817	0.5476	0.5150	0.5782	0.0378		1.20E-03
LEAP	0.5950	0.5869	0.5852	0.5755	0.5547	0.5807	0.0124		3.26E-04
GRISLI	0.6238	0.6020	0.5893	0.5866	0.5435	0.5891	0.0208		1.97E-05
SCINGE	0.5106	0.4811	0.4563	0.4423	0.4153	0.4613	0.0297		4.83E-01

Tabela 84: AUROC GSD-70

Método	Máx.	3Q	Mediana	1Q	Min.	Média	DP	p_{kw}	p_d
CGP	0.5827	0.5336	0.5113	0.4941	0.4680	0.5178	0.0340		-
SCNS	0.5774	0.5717	0.5501	0.5476	0.5467	0.5577	0.0131		3.55E-02
PIDC	0.6076	0.5919	**0.5867**	**0.579**	**0.5675**	**0.5867**	0.0113		2.48E-05
GRNVBEM	0.5442	0.5267	0.5185	0.5044	0.4817	0.5170	0.0186		6.76E-01
GENIE3	0.5916	0.5833	0.5789	0.5683	0.5631	0.5772	**0.0096**		3.60E-04
GRNBOOST2	0.5648	0.5552	0.5484	0.5414	0.5258	0.5477	0.0105		1.67E-01
PPCOR	0.6004	0.5836	0.5621	0.5359	0.5304	0.5624	0.0260	2.08E-12	1.54E-02
SCODE	0.5688	0.5416	0.5196	0.4971	0.4320	0.5115	0.0411		8.93E-01
SINCERITIES	0.6344	0.5955	0.5797	0.5701	0.5201	0.5788	0.0325		9.53E-04
LEAP	0.5809	0.5500	0.5436	0.5326	0.5279	0.5443	0.0151		2.58E-01
GRISLI	**0.6365**	**0.5992**	0.5820	0.5655	0.5543	0.5849	0.0246		1.49E-04
SCINGE	0.5283	0.4714	0.4524	0.4469	0.3902	0.4578	0.0342		1.05E-01

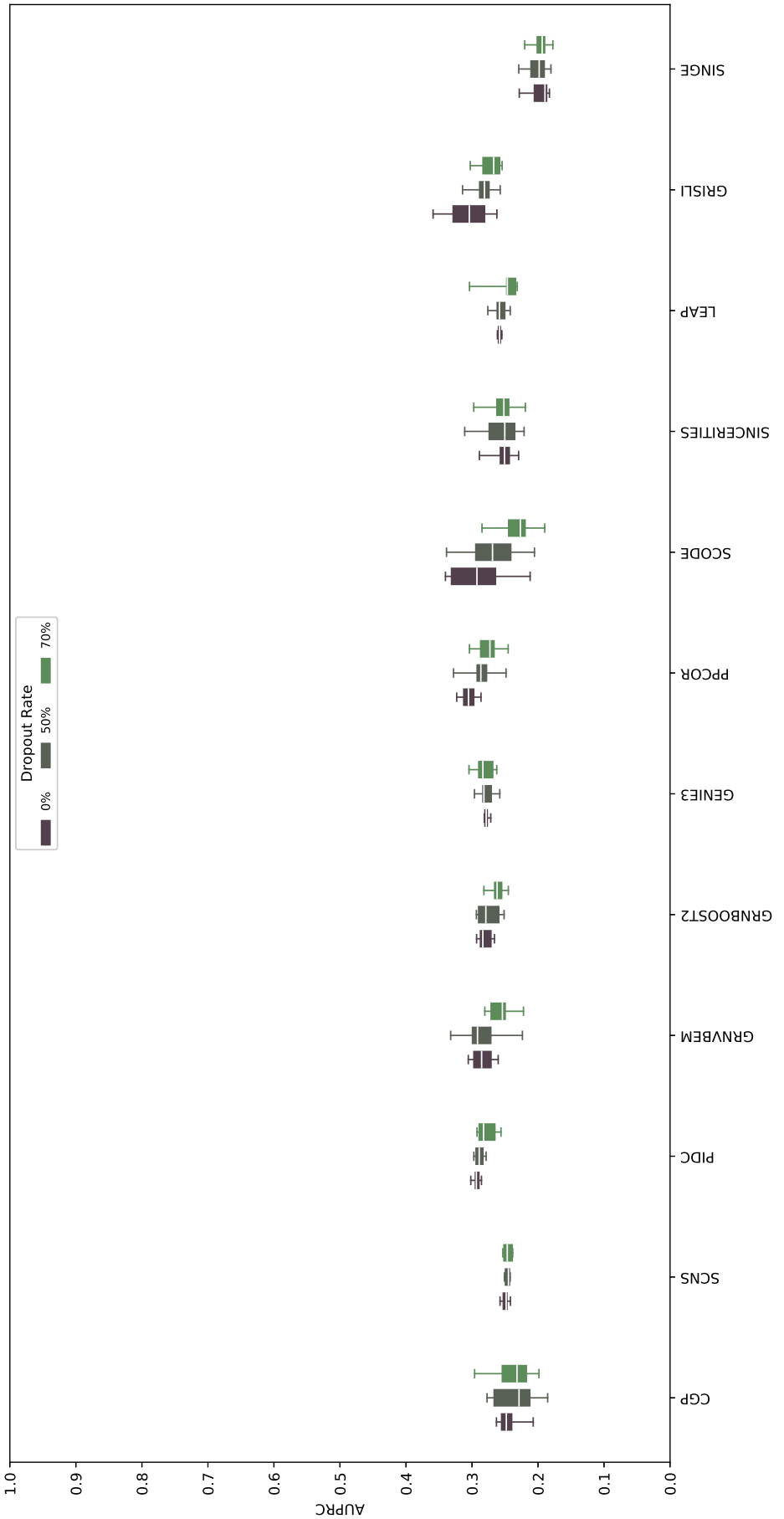


Figura 33: *Boxplots* para BEELINE AUPRC considerando os 12 algoritmos para o problema GSD.

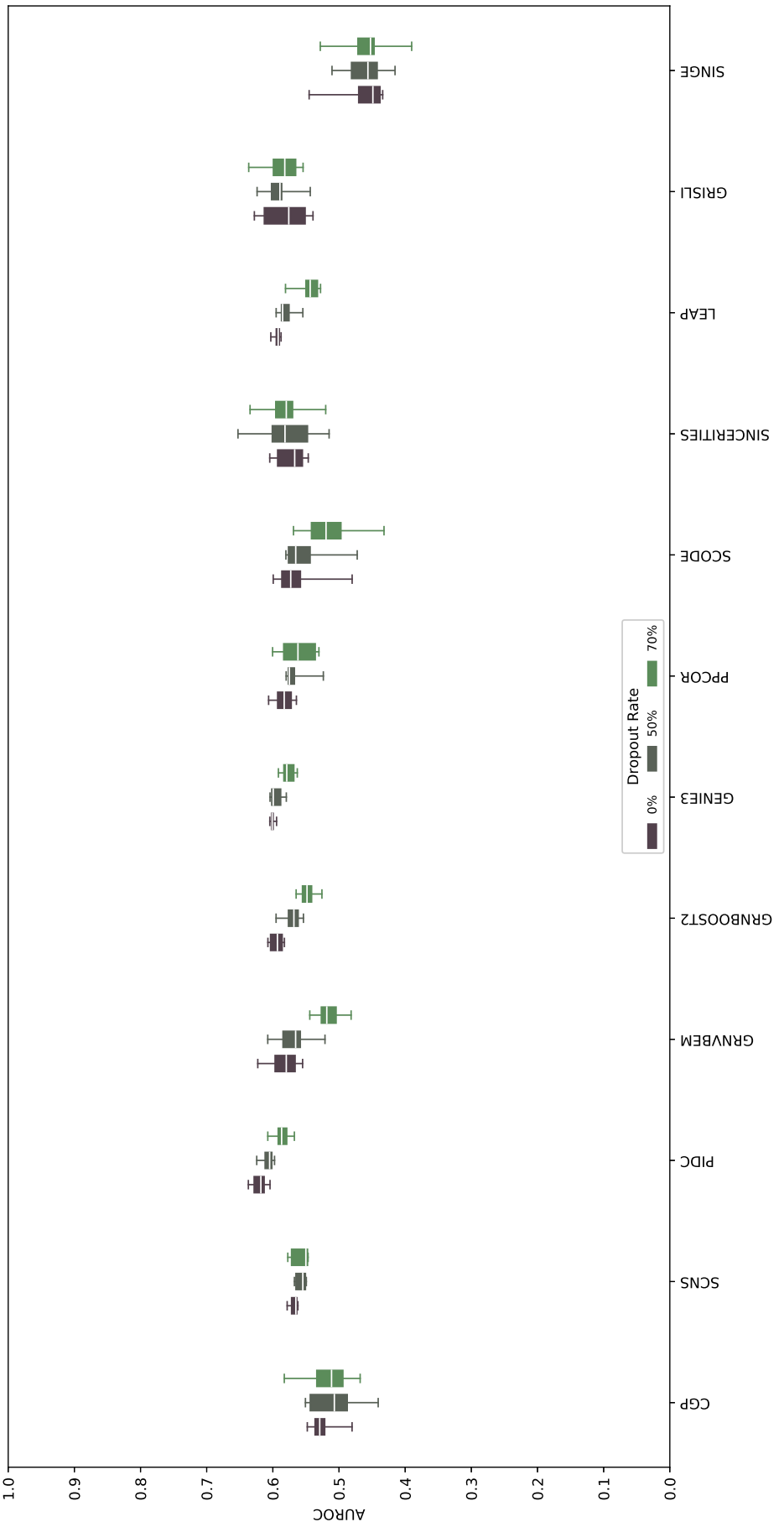


Figura 34: *Boxplots* para BEELINE AUROC considerando os 12 algoritmos para o problema GSD.

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