1000 random graphs of 100 vertices comparison to pivot algorithm (20 tries)

ordered pivot compared to pivot

Probability of + edge	average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
005	-20.7412	1.1364	14.1596	2.6839
01	-24.0648	0.8315	28.904	3.11
02	-22.8061	0.6679	36.4357	3.7254
03	-18.7686	0.6144	28.3339	4.0466
04	-13.2291	0.591	11.5044	4.8137
05	-7.9899	0.4553	-11.5319	4.6059
055	-8.9587	0.7428	-23.4402	4.6322
06	-15.491	1.339	-35.1557	4.2137
07	-33.1673	1.3765	-49.7841	3.8829
08	-46.917	1.3182	-56.7646	4.0543
09	-57.2115	1.7591	-55.8987	3.774
095	-61.4312	2.4481	-51.0811	3.3752

semi ordered pivot compared to pivot

Probability of + edge	average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
005	-20.7397	1.152	14.1343	2.5496
01	-24.0725	0.8299	28.9384	3.0362
02	-22.8114	0.6659	36.3456	3.6502
03	-18.7695	0.6106	28.517	4.0912
04	-13.2302	0.5916	11.5179	4.6536
05	-7.9779	0.4506	-11.4252	4.8825
055	-8.9603	0.7492	-23.5371	4.7692
06	-15.4819	1.3416	-35.0892	4.5287
07	-33.1454	1.3899	-49.5269	3.8619
08	-46.9713	1.331	-56.9584	4.1422
09	-57.2167	1.6978	-55.9142	3.7486
095	-61.4186	2.4207	-51.0451	3.3119

concurrent clusters compared to pivot

Probability of + edge	average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
005	-22.1331	1.1108	9.315	2.5843
01	-25.19	0.8045	24.4037	3.0033
02	-24.2026	0.6501	33.2308	3.501
03	-20.6334	0.575	27.476	3.8588
04	-15.6697	0.5654	11.4857	4.6786
05	-10.3899	0.458	-12.3749	4.5484
055	-9.2615	0.4242	-24.8928	4.5259
06	-12.0134	1.1328	-36.3918	4.2326
07	-29.9181	2.0156	-50.4435	3.8079
08	-45.8853	1.6675	-56.9436	4.0917
09	-57.0191	1.8406	-55.9945	3.8204
095	-61.4038	2.4704	-51.1906	3.2237

1000 random graphs of 100 vertices comparison between the algorithms

Probability of + edge	average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
005	-0.001	0.3426	0.0298	1.4358
01	0.0104	0.2215	-0.0139	1.684
02	0.007	0.1943	0.0841	1.9718
03	0.0012	0.2048	-0.1078	2.5969
04	0.0015	0.227	0.0332	3.2051
05	-0.0125	0.3206	-0.0087	4.3699
055	0.0026	0.3876	0.2738	5.2212
06	-0.0084	0.6914	0.1508	6.6785
07	-0.0261	1.1123	-0.0793	9.381
08	0.1139	1.4649	1.1903	12.1084
09	0.0266	1.9995	0.5096	9.8774
095	0.0002	2.7298	0.1577	6.9474

ordered compared to semi ordered pivot

average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
-1.7551	0.4231	-4.2335	1.421
-1.4812	0.2747	-3.4782	1.5818
-1.8087	0.2254	-2.3279	1.899
-2.2951	0.2181	-0.6377	2.3104
-2.8124	0.2332	0.0397	3.1996
-2.6078	0.3642	-0.8672	4.1118
-0.3278	0.7102	-1.7547	5.291
4.1254	1.1046	-1.7008	6.5095
4.8672	2.371	-0.8715	9.3385
1.955	2.4106	0.2607	11.7929
0.472	2.4355	0.2686	9.9846
0.1119	2.9728	0.0484	7.1421

concurrent clusters compared to ordered pivot

average cost difference (in%)	cost diff std (%)	diff in nb of clust (%)	nb of clust std (%)
-1.7566	0.4334	-4.2153	1.3925
-1.4711	0.2839	-3.5049	1.6067
-1.802	0.2249	-2.2652	1.8776
-2.2941	0.2177	-0.7766	2.3887
-2.8112	0.228	0.019	3.1239
-2.6205	0.3641	-0.959	4.3703
-0.3259	0.7219	-1.6281	5.1063
4.1139	1.0793	-1.7493	6.8145
4.8347	2.4285	-1.3878	9.2478
2.0606	2.4321	0.7941	12.4446
0.476	2.3216	0.2734	9.7608
0.0723	2.884	-0.05	6.8954

concurrent clusters compared to semi-ordered pivot

On 100 random graphs of 200 nodes
(20 tries)

ordered pivot compared to pivot
on 1000 graphs of 100 nodes

-20.7412	1.1364	14.1596	2.6839
-24.0648	0.8315	28.904	3.11
-22.8061	0.6679	36.4357	3.7254
-18.7686	0.6144	28.3339	4.0466
-13.2291	0.591	11.5044	4.8137
-7.9899	0.4553	-11.5319	4.6059
-8.9587	0.7428	-23.4402	4.6322
-15.491	1.339	-35.1557	4.2137
-33.1673	1.3765	-49.7841	3.8829
-46.917	1.3182	-56.7646	4.0543
-57.2115	1.7591	-55.8987	3.774
-61.4312	2.4481	-51.0811	3.3752

p

005	-25.5921	0.5199	39.8162	2.668	-25.5921	0.5223	39.6947	2.7739	-26.2277	0.5048	35.4379	2.6304
01	-26.7303	0.4363	61.7932	2.925	-26.7392	0.4429	61.8408	3.0598	-27.3452	0.4306	57.695	2.751
02	-23.9462	0.3751	70.7402	3.0876	-23.9431	0.3778	70.8411	3.5466	-24.7953	0.3721	69.7796	3.441
03	-19.0603	0.331	54.7319	4.4944	-19.0684	0.3347	54.4264	3.9467	-20.2524	0.3249	56.8604	4.4644
04	-12.6811	0.3472	25.5079	3.9034	-12.6858	0.3462	25.41	3.841	-14.3622	0.3202	28.3697	4.2646
05	-6.3545	0.2182	-11.6023	4.0216	-6.3318	0.2037	-11.5681	4.2751	-8.0238	0.2109	-11.3812	4.1419
06	-17.5842	0.7946	-41.9904	3.6832	-17.6082	0.7732	-42.0592	3.3938	-12.8312	0.9583	-42.6943	2.9455
07	-35.4755	0.7151	-55.8836	3.1482	-35.4994	0.7387	-56.0055	3.5811	-33.3869	1.1822	-56.3312	3.2116
08	-48.5033	0.7554	-61.6411	3.2695	-48.55	0.721	-62.1719	3.3883	-47.9468	0.9396	-62.2432	3.7218
09	-58.331	0.9584	-60.6242	3.3397	-58.3894	0.8891	-61.1669	2.5262	-58.1592	1.1038	-60.1852	3.5831
095	-62.0029	1.7228	-54.534	3.5386	-62.0601	1.6675	-54.7104	3.7435	-62.086	1.6594	-55.1372	3.183

ordered pivot compared to pivot   semi ordered pivot compared to pivot   concurrent clusters compared to pivot

100 random graphs of 200 nodes (20 tries)

p

005	0.0001	0.1276	0.0944	1.0919
01	0.0123	0.0722	-0.021	1.1639
02	-0.004	0.074	-0.0429	1.4641
03	0.0101	0.0775	0.2051	1.8438
04	0.0053	0.0936	0.1132	2.717
05	-0.0242	0.1574	0.0559	4.0018
06	0.0298	0.4283	0.349	7.1736
07	0.0392	0.5854	0.8233	9.8284
08	0.0929	0.7994	2.1381	11.9801
09	0.1426	1.0627	1.7598	10.2781
095	0.1557	1.4584	0.6632	7.0013

ordered compared to semi ordered pivot

005	-0.854	0.1424	-3.1264	1.0584
01	-0.8393	0.0941	-2.5247	1.1896
02	-1.1165	0.0837	-0.5566	1.4336
03	-1.4728	0.081	1.3959	1.9305
04	-1.925	0.0937	2.31	2.7417
05	-1.7823	0.1992	0.3083	3.5987
06	5.7699	0.9441	-0.9665	6.0075
07	3.2411	1.7087	-0.5433	9.9202
08	1.0834	1.3036	-1.0247	11.591
09	0.4155	1.5307	1.7379	11.4848
095	-0.1984	1.6304	-1.0258	7.0949

concurrent clusters compared to ordered pivot

005	-0.854	0.1445	-3.0399	1.1301
01	-0.8271	0.1063	-2.553	1.0863
02	-1.1204	0.0816	-0.6118	1.2911
03	-1.463	0.083	1.5848	1.8283
04	-1.9198	0.1001	2.3834	2.555
05	-1.8062	0.1992	0.2975	3.9408
06	5.8006	0.9643	-0.8437	6.534
07	3.2791	1.6628	-0.2173	9.7647
08	1.1764	1.4727	0.5904	13.1343
09	0.5493	1.2692	2.8069	9.9471
095	-0.0565	1.4404	-0.6394	6.6073

concurrent clusters compared to semi-ordered pivot

Average cost / nb of clusters difference
on all grahs of 3-9 nodes

```
conc vs pi :
 [-18.4288 -11.5704]
ord vs pi :
 [-11.3334 -10.3412]
conc vs ord :
 [-9.4875 -0.9764]
ord vs semi :
 [-1.7339  0.4133]
```

```
-53.6612    8.0528   -7.4237    3.5427        2.204   17.8962  -0.0018   1.1878]
-53.0352    5.9878  -12.6565    4.2634        2.3157  13.3343   0.0243   1.7683]
-50.8707    4.5387  -19.9015    3.9534        2.9163  10.0448  -0.1256   2.6167]
-47.5714    3.4106  -26.1211    3.7665        3.2512   7.5202  -0.2734   3.6177]
-40.4035    2.572   -26.9938    3.4998        3.1081   5.4046  -1.5325   4.7248]
-28.6952    1.8103  -14.9363    3.9897        1.5042   3.0876  -2.1198   4.9219]
-14.2877    0.592    11.4578    4.322        -0.0029   0.4885  -0.2705   3.2283]
-10.3667    0.8352  -27.3683    4.4443       -0.0027   0.4671   0.0335   5.3057]]

-53.9966    7.9226   -7.4144    3.571       -11.0221  12.717   -0.1908   1.0847
-53.7335    5.7039  -12.6636    4.2734      -12.2104   9.712   -0.5115   1.6295
-52.0658    4.0947  -19.7673    4.0782      -13.6029   7.2111  -1.24     2.3057
-49.0941    3.2144  -25.8671    3.8372      -14.3957   5.1291  -2.8281   3.1641
-42.123     2.4394  -25.7677    3.6475      -14.6051   3.6909  -5.747    4.0526
-29.718     1.841   -12.9824    4.131       -11.5629   2.4567  -9.0519   4.3101
-14.2842    0.6043   11.813     4.1879       -3.5138   0.5282  -1.9759   3.2014
-10.3632    0.8456  -27.279     4.6295        0.8876   0.7551  -1.6998   5.2692

-59.3621    5.8756   -7.6076    3.4882      -10.4368  12.5097  -0.1995   1.0956
-59.1419    4.1306  -13.1158    4.2176      -10.98     9.3912  -0.5034   1.5923
-57.7741    2.996   -20.9158    3.9098      -11.5614   6.6321  -1.3968   2.3519
-55.2429    2.1173  -28.2547    3.528       -11.8549   5.1088  -3.1537   3.2613
-49.1726    1.7436  -31.2566    3.2218      -12.0684   3.8879  -7.2933   4.1051
-36.9649    1.5808  -22.723     3.6232      -10.27     2.6245 -11.0883   4.2862
-17.3006    0.5811    9.1988    4.2619       -3.5176   0.5414  -2.2898   3.2658
 -9.5762    0.5039  -28.699     4.4609        0.8839   0.7638  -1.7891   5.5613
```

Comparison on perfectly clustered with flipped edges

Ord vs pi
Semi ord vs pi
Conc vs pi
Ord vs semi ord
Conc vs ord
Conc vs semi ord

F = 25, 50, 100, 200, 400, 750, 1500, 3000

average on 1000 perfectly clustered graphs with 100 nodes and 5 clusters (20 tries)

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
pivot	25.149	152.149	69.355	36.084	5.	6.697	5.45	0.568]
ord	25.	82.109	31.689	15.653	5.	5.54	5.038	0.134]
semi	25.	76.9	31.451	14.661	5.	5.544	5.038	0.136]
conc	25.	56.225	27.788	8.118	5.	5.43	5.028	0.104]

F = 25

58.139	243.137	136.997	49.128	5.003	7.39	5.833	0.754]
50.	137.227	63.917	24.439	5.	5.847	5.082	0.238]
50.	127.096	62.94	22.123	5.	5.851	5.082	0.238]
50.	93.109	55.604	12.496	5.	5.671	5.056	0.177]

F = 50

151.619	401.786	265.736	65.316	5.061	8.32	6.483	0.931]
100.	239.993	130.117	38.923	5.	6.198	5.181	0.385]
100.	218.99	126.958	33.598	5.	6.239	5.189	0.398]
100.	164.396	111.823	19.236	5.	5.999	5.115	0.296]

F = 100

356.601	665.529	504.334	80.079	5.547	9.261	7.349	1.017]
200.043	420.649	264.044	60.249	5.	6.825	5.418	0.591]
200.155	392.867	256.374	51.827	5.	6.899	5.437	0.61]
200.	299.198	225.417	28.884	5.	6.383	5.262	0.465]

F = 200

738.472	1071.018	903.512	86.079	6.345	10.034	8.225	1.007]
413.318	733.197	538.18	86.738	5.001	7.862	5.997	0.867]
411.12	712.446	522.653	79.82	5.001	8.089	6.097	0.918]
400.66	568.68	458.958	45.974	5.	7.219	5.646	0.707]

F = 400

min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
[1266.103	1549.443	1409.594	73.109	6.852	10.563	8.673	1.009]
[836.108	1185.883	1004.908	93.632	5.445	9.619	7.372	1.13]
[828.167	1178.426	990.49	94.269	5.555	9.898	7.541	1.166]
[778.055	1036.918	888.315	68.665	5.113	8.677	6.697	0.976]
[1941.068	2114.173	2023.765	44.683	6.424	9.888	8.093	0.939]
[1678.403	1773.656	1734.608	24.544	7.462	10.731	9.015	0.889]
[1678.221	1774.15	1734.681	24.856	7.514	10.749	9.044	0.883]
[1614.129	1718.777	1673.612	27.215	7.288	10.494	8.833	0.866]
[2386.841	2533.895	2461.393	38.102	4.296	7.125	5.637	0.772]
[2150.992	2270.361	2206.188	31.146	2.992	5.423	4.091	0.698]
[2150.127	2272.08	2206.275	31.471	3.	5.419	4.096	0.692]
[2163.562	2285.952	2225.655	31.818	2.968	5.287	4.017	0.676]

F = 750

F = 1500

F = 3000

Max on 1000 perfectly clustered graphs with 100 nodes and 5 clusters (20 tries)

Row order (Pivot ordered semi-ord conc): Pivot, ordered, semi-ord, conc

25 flipped

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
Pivot	44.	287.	103.65	66.616	5.	9.	6.3	1.054
ordered	25.	295.	49.1	58.82	5.	7.	5.2	0.477
semi-ord	25.	214.	48.4	43.944	5.	7.	5.2	0.51
conc	25.	131.	38.15	24.838	5.	7.	5.2	0.477

50 flipped

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
Pivot	112.	406.	183.65	77.888	6.	10.	6.8	1.299
ordered	50.	315.	102.75	66.891	5.	8.	5.4	0.654
semi-ord	50.	299.	88.35	59.782	5.	8.	5.35	0.766
conc	50.	173.	69.6	29.614	5.	7.	5.35	0.572

100 flipped

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
Pivot	219.	567.	320.8	101.968	6.	10.	7.65	1.536
ordered	100.	494.	163.5	89.04	5.	8.	5.6	0.781
semi-ord	100.	437.	160.9	103.815	5.	8.	5.55	0.921
conc	100.	253.	127.85	37.718	5.	8.	5.45	0.792

200 flipped

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
Pivot	455.	871.	575.05	120.963	7.	11.	8.4	1.652
ordered	219.	638.	323.8	121.819	5.	9.	6.	1.122
semi-ord	233.	694.	313.35	111.908	5.	10.	6.	1.187
conc	200.	465.	251.95	59.919	5.	9.	5.7	0.97

400 flipped

	min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
Pivot	862.	1305.	972.25	153.436	8.	12.	9.3	1.687
ordered	483.	1034.	602.75	148.656	6.	10.	6.95	1.359
semi-ord	468.	926.	608.95	134.456	6.	11.	6.95	1.83]
conc	433.	781.	494.4	79.207	5.	9.	6.35	1.161]

min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
1371.	1704.	1490.45	116.754	8.	13.	9.8	1.718
952.	1345.	1067.3	144.092	7.	12.	8.45	1.83
944.	1330.	1075.05	152.028	7.	14.	8.7	2.012
848.	1188.	944.1	106.816	6.	12.	7.75	1.545

750 flipped

min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
2044.	2226.	2092.6	75.485	8.	13.	9.2	1.568
1750.	1861.	1798.45	55.037	9.	13.	10.5	1.431
1750.	1843.	1803.7	59.125	9.	13.	10.25	1.388
1683.	1785.	1729.9	55.789	9.	13.	10.2	1.53

1500 flipped

min cost	max cost	avg cost	cost std	min nb clust	max nb clust	avg nb clust	clust std
2445.	2608.	2500.3	66.883	5.	9.	6.3	1.179
2216.	2347.	2257.25	51.239	4.	8.	4.85	1.241
2223.	2355.	2252.	50.872	4.	7.	5.1	1.114
2217.	2370.	2256.3	61.981	4.	7.	4.95	1.135

3000 flipped