Assignment 3

- 1. Using your favorite software for finding eigenvectors of matrices, construct the Laplacian and the modularity matrix for this small network:
 - a. Find the eigenvector of the Laplacian corresponding to the second smallest eigenvalue and perform a spectral bisection of the network into two equally sized parts.
 - b. Find the eigenvector of the modularity matrix corresponding to the largest eigenvalue and divide the network into two communities.
- 2. Generate random networks using random.graph.game, measure their metrics (such as clustering coefficient, degree distribution, ...), and discuss the disagreements between random networks and real networks. Please use the table in the next page for the discussion.
- <u>Deadline: Feb. 6, 2012(Mon) 13:20</u>

metrics in real networks S: the size of the largest component as a fraction of total network size

	network	type	n	m	z	l	α	$C^{(1)}$	$C^{(2)}$	r	Ref(s).	S
social	film actors	undirected	449913	25516482	113.43	3.48	2.3	0.20	0.78	0.208	20, 416	0.980
	company directors	undirected	7673	55392	14.44	4.60	_	0.59	0.88	0.276	105, 323	0.876
	math coauthorship	undirected	253339	496489	3.92	7.57	_	0.15	0.34	0.120	107, 182	0.822
	physics coauthorship	undirected	52909	245300	9.27	6.19	_	0.45	0.56	0.363	311, 313	0.838
	biology coauthorship	undirected	1520251	11803064	15.53	4.92	_	0.088	0.60	0.127	311, 313	0.918
	telephone call graph	undirected	47000000	80 000 000	3.16		2.1				8, 9	-
	email messages	directed	59912	86 300	1.44	4.95	1.5/2.0		0.16		136	0.952
	email address books	directed	16881	57029	3.38	5.22	-	0.17	0.13	0.092	321	0.590
	student relationships	undirected	573	477	1.66	16.01	_	0.005	0.001	-0.029	45	0.503
	sexual contacts	undirected	2810				3.2				265, 266	
information	WWW nd.edu	directed	269504	1497135	5.55	11.27	2.1/2.4	0.11	0.29	-0.067	14, 34	1.000
	WWW Altavista	directed	203549046	2130000000	10.46	16.18	2.1/2.7				74	0.914
	citation network	directed	783339	6716198	8.57		3.0/-				351	-
	Roget's Thesaurus	directed	1022	5103	4.99	4.87	_	0.13	0.15	0.157	244	0.977
	word co-occurrence	undirected	460902	17000000	70.13		2.7		0.44		119,157	1.000
technological	Internet	undirected	10697	31992	5.98	3.31	2.5	0.035	0.39	-0.189	86, 148	1.000
	power grid	undirected	4 941	6594	2.67	18.99	-	0.10	0.080	-0.003	416	1.000
	train routes	undirected	587	19603	66.79	2.16	-		0.69	-0.033	366	1.000
	software packages	directed	1439	1 723	1.20	2.42	1.6/1.4	0.070	0.082	-0.016	318	0.998
	software classes	directed	1377	2213	1.61	1.51	_	0.033	0.012	-0.119	395	1.000
	electronic circuits	undirected	24097	53248	4.34	11.05	3.0	0.010	0.030	-0.154	155	1.000
	peer-to-peer network	undirected	880	1296	1.47	4.28	2.1	0.012	0.011	-0.366	6, 354	_ 0.805
biological	metabolic network	undirected	765	3686	9.64	2.56	2.2	0.090	0.67	-0.240	214	0.996
	protein interactions	undirected	2115	2240	2.12	6.80	2.4	0.072	0.071	-0.156	212	0.689
	marine food web	directed	135	598	4.43	2.05	_	0.16	0.23	-0.263	204	1 000
	freshwater food web	directed	92	997	10.84	1.90	_	0.20	0.087	-0.326	272	1.000
	neural network	directed	307	2359	7.68	3.97	-	0.18	0.28	-0.226	416, 421	0.967

TABLE II Basic statistics for a number of published networks. The properties measured are: type of graph, directed or undirected; total number of vertices n; total number of edges m; mean degree z; mean vertex-vertex distance ℓ ; exponent α of degree distribution if the distribution follows a power law (or "-" if not; in/out-degree exponents are given for directed graphs); clustering coefficient $C^{(1)}$ from Eq. (3); clustering coefficient $C^{(2)}$ from Eq. (6); and degree correlation coefficient r, Sec. III.F. The last column gives the citation(s) for the network in the bibliography. Blank entries indicate unavailable data. M. Newman "The structure and function of complex networks"

http://arxiv.org/abs/cond-mat/0303516

Instructions for submission (1)

- Submit your assignment to 5-8 report box at the passage on the third floor between A4 s West8E and West8W buildings
- Use A4 size papers
- Please staple in the upper left corner
- Write your name and student ID number
- Electronic submission (sending by email) is allowed for the students from Suzukakedai.



Submit to the right box



Instructions for submission (2)

 Students from Suzukakedai campus are allowed to submit this assignment by email. Attach PDF or MS Word file and sent it to cn@ai.cs.titech.ac.jp. Size of the attached file should be less than 2MB. Subject of the email should be "[cn]".