Slovenian mathematicians

analysis of bibliographic networks from OpenAlex

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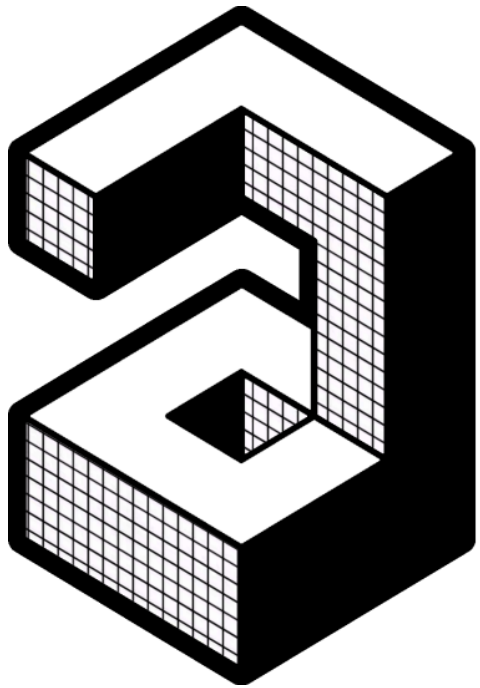
Outline



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Current version of slides (September 12, 2025 at 02:53): slides PDF
https://github.com/bavla/OpenAlex/tree/main/ex/SImat

Bibliographic services and OpenAlex

Web of Science (WoS) – selection of (high) quality journals, mostly in English, bias towards natural sciences, paid access

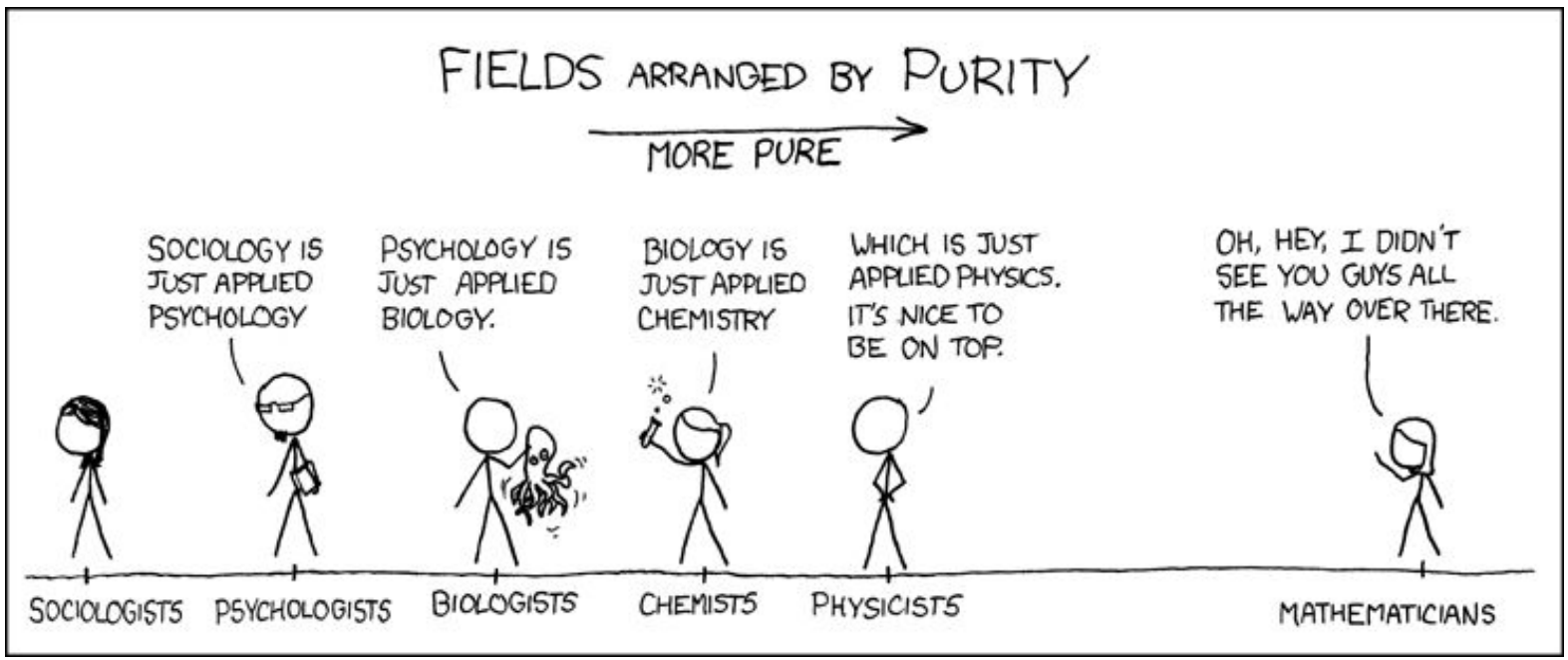
Scopus – slightly wider selection than WoS, paid access

COBISS – data on Slovenian researchers, no data on references (lists of sources)

OpenAlex (OA) – much wider selection of journals, accessible IDs of individual units, free access (API)

OpenAlex2Pajek [9]

Who is a mathematician?



Data

Determining the initial set of works W:

1. In OA we determine all works with at least one co-author from SI (SI $\in$ `authorships.countries`) and dealing with mathematics (26 $\in$ `topics.field`). Saved to `worksMatSI.csv` (6528).
2. Using `OpenAlex2PajekAll` we create the corresponding bibliographic networks. From `matSIWA.csv` we retrieve the list of authors and save to `authors.csv` (7274).
3. We collect data on authors (name, aID, ORCID, scopus, countries) from OA and create a sublist `SIauthor.csv` (2121). OA, API.
4. We add data on Slovenian mathematicians from Sicris and Wikipedia. In Sicris, we select `advanced search` and then `select from list`. We get a little over 700 hits. For both lists, the names that are in OA (have aID) are added to the list `SIauthor.csv`. The extended list is in the file `SImatOA.csv`.

Slovenian mathematicians

5. Some authors may have multiple aIDs (Josip Plemelj: A5053689990, A5007473069, A5037884930). These are collected in the file `joinSImat.csv`.
6. Same aID – different persons (A5055260770 Igor Kononenko: FRI, UA, KPI).
7. Data on Slovenian mathematicians are supplemented with data from Wikidata.
8. The initial set of works W consists of all works in OA by authors from `SImatOA.csv` (140978).

We take the term Slovenian mathematician in a (very) broad sense – someone registered in OA who has published a work of mathematical content as a member of a Slovenian institution or is listed among mathematicians in Sicris or on Wikipedia.

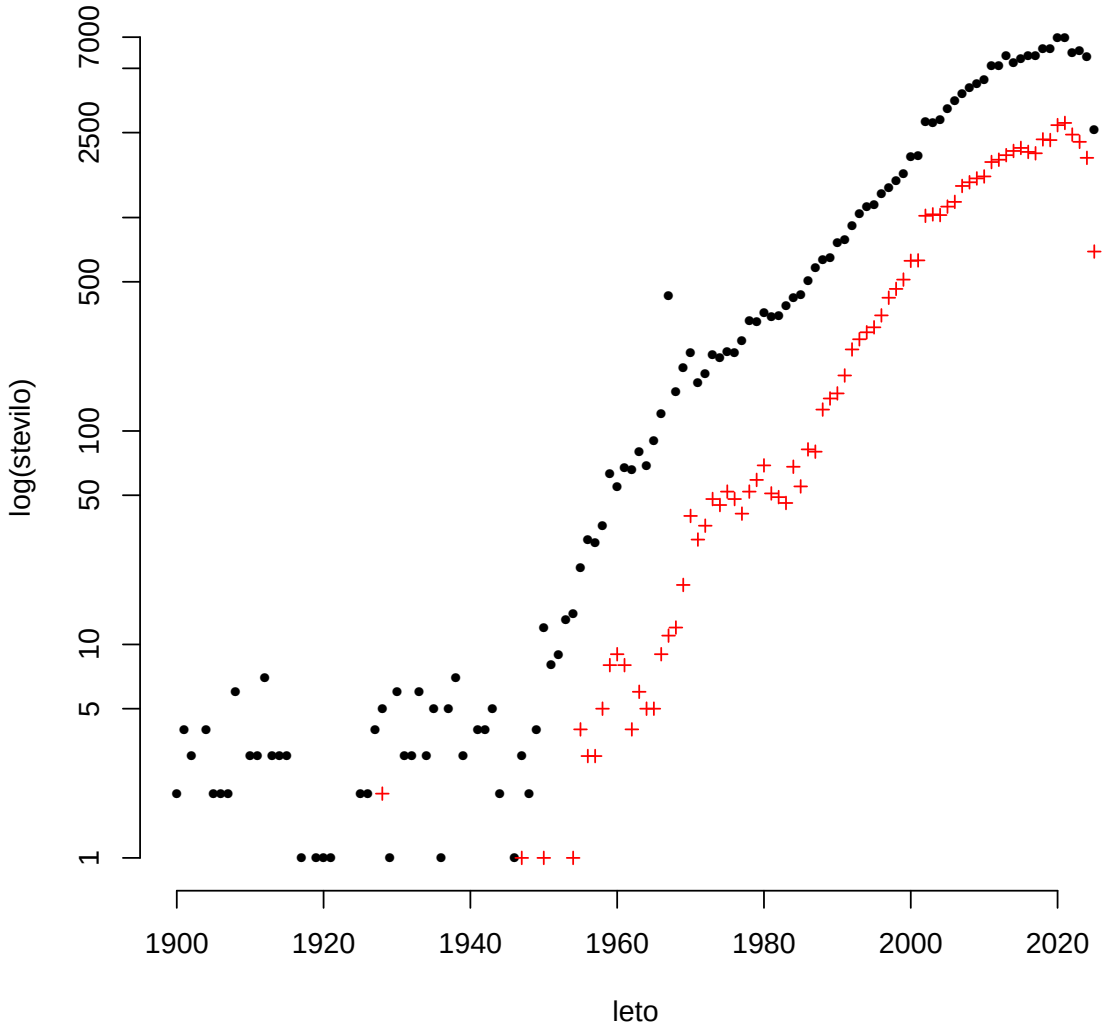
Slovenian mathematicians

For works from W with `OpenAlex2PajekAll` we create networks (Ci, WA, WJ, WC, WK) and properties. $|W| = 1471778$, $|A| = 224749$, $|J| = 14547$.
[1] [4] [3]

Additionally, we create a property (vector) DC ($DC[w] = 1$ – work $w \in W$ is a hit; $DC[w] = 0$ – work w appears only in reference lists.

The figure on the next slide shows the growth in the number of works. The black dot indicates the number of those with $DC = 1$ (for $DC = 0$ we do not have data on the affiliation of the authors). From MatSIWC, we obtain all works with a Slovenian co-author – they are marked with a red cross.

Rast števila objav

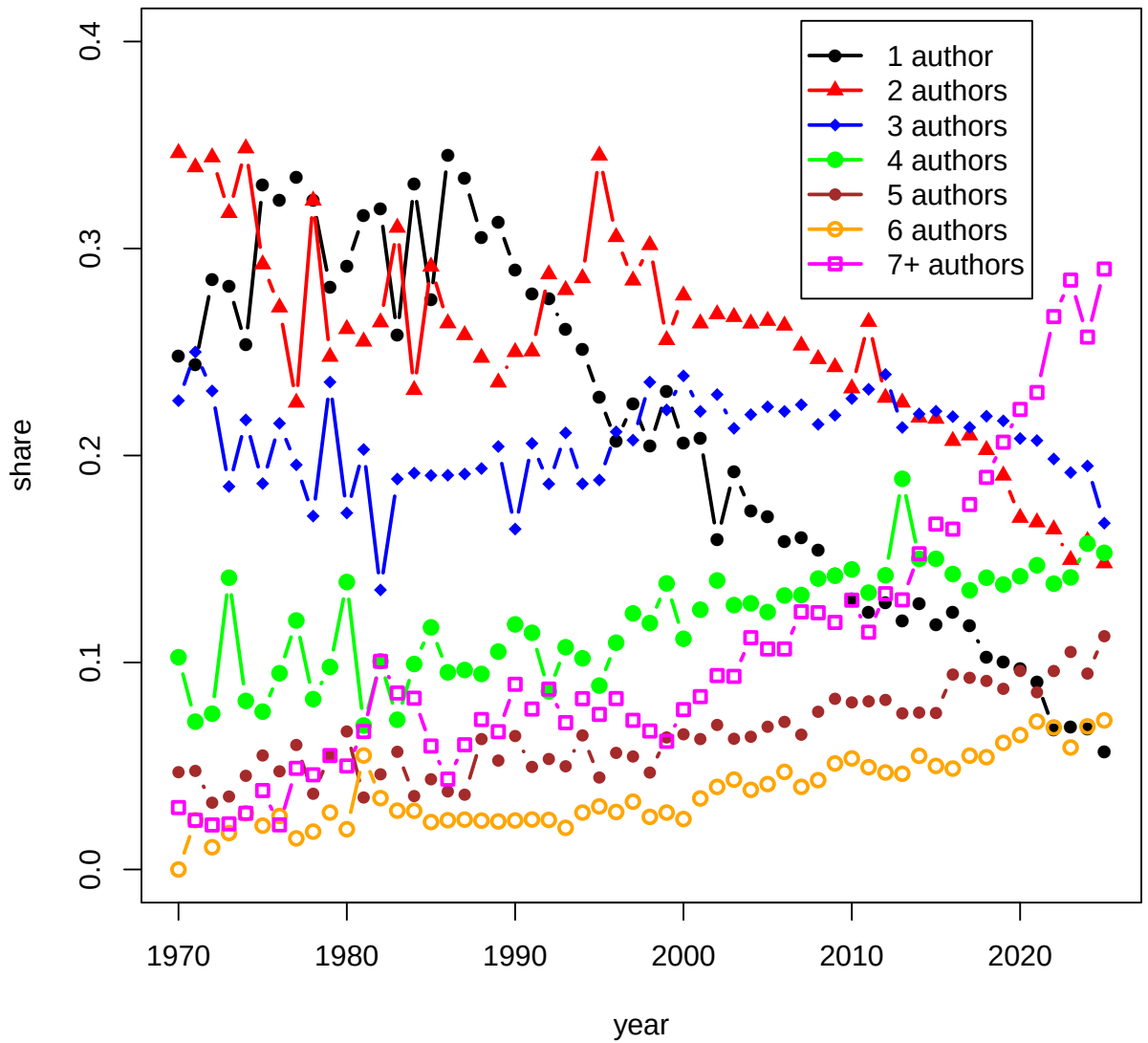


The annual share of works with 1–7+ authors

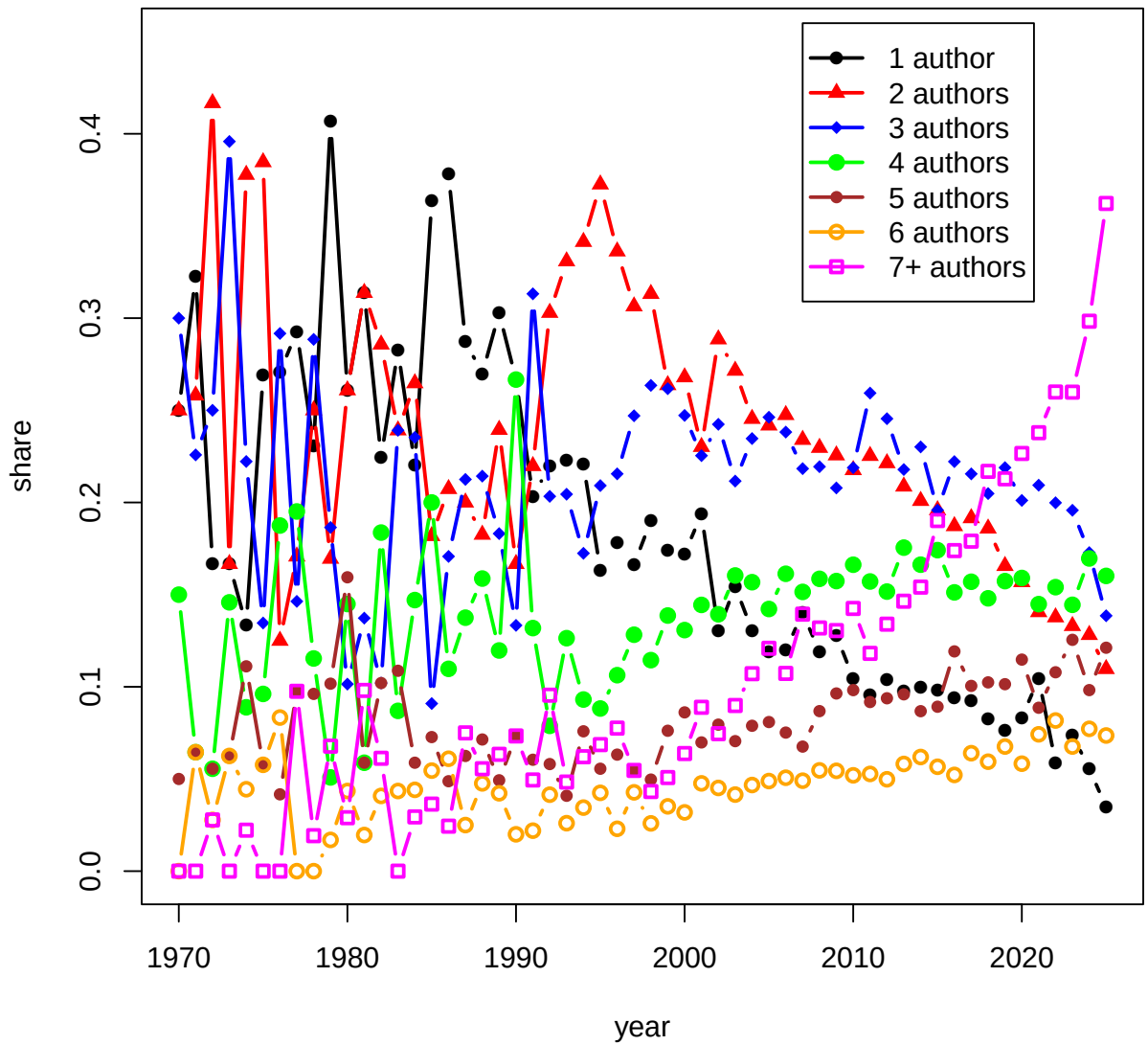
In recent decades, the "culture of publishing" has changed considerably. More and more works are being produced through co-authorship. For example, in the field of network analysis, in the period 1980 – 2020, the share of works with a single author fell from 68% to 12%, while the share of works with 6 or more authors increased from 0.8% to 12.4% [6].

The following figures show the annual share of works with 1–7+ authors for the period 1970-2025 for $DC = 1$ and SI authors.

The annual share of works with 1–7+ authors / DC



The annual share of works with 1–7+ authors / SI



Comments

- applied disciplines (physics, chemistry, electronics, biology, etc.) work in labs supported by a group of researchers
- evaluation rules for research(ers) - publish or perish (WP, Harzing) and salami slicing / Goodhart's law [8].

In OpenAlex we found two works W3135829537 and W3194033501 with 16162 co-authors

- COVIDSurg Collaborative and GlobalSurg Collaborative: Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study. Anaesthesia 2021, 76, 748–758
- COVIDSurg Collaborative and GlobalSurg Collaborative: SARS-CoV-2 infection and venous thromboembolism after surgery: an international prospective cohort study. Anaesthesia 2022, 77, 28–39

See also: Guinness. (2021). Guinness world record 653537: The most authors on a single peer-reviewed academic paper.

Fractional approach

The citation network **Ci** is based on the relation $w\,\mathbf{Ci}\,z \equiv$ work w cites work z; or in other words: work z is in the list of references of work w.

The input degree $\mathrm{ideg}(w)$ of work w counts how many works cite work w.

When measuring the importance/impact of works with input degree, works with a long list of references are given more weight. This can be fixed with a *fractional* approach where each work has 1 "vote", which is (equally) distributed among its sources – each link $(w, z) \in \mathbf{Ci}$ gets a weight

$$cin(w, z) = \frac{1}{\mathrm{odeg}(w)}$$

Then the importance of the works can be measured by a weighted input degree

$$\mathrm{wideg}(w) = \sum_{z\,\mathbf{Ci}\,w} cin(z, w)$$

Most cited works

wid – OpenAlex work Id; ideg – in-degree; wideg – weighted in-degree; cbc – cited by count; lab – Garfield style work's label; tit – title

The first 40 rows contain the works (sources) that have the highest fractional contribution. Rows 41–50 contain the works with the highest input degree. Rows 51–60 contain the works from our topic that have the highest input degree relative to the entire OA data.

We can see that most of the most cited works are books. The main topics are graph theory and algebra (group theory). In addition to mathematics, the following fields are present: physics, chemistry, artificial intelligence, computer science, medicine and law.

Most cited works

i	wId	ideg	wideg	cbc	lab	tit
1	W1493071618	449	37.9	0	Haynes_TW(2013)BK	Fundamentals of Domination in Graphs
2	W2153929644	609	35.1	1378	Abashian_A(2002)479:117	The Belle detector
3	W2799004609	346	28.2	0	Harary_F(1969)BK	Graph theory
4	W1977133864	522	27.1	0	Kurokawa_S(2003)499:1	Overview of the KEKB accelerators
5	W1976677460	454	26.3	0	Bosma_W(1997)24:235	The Magma Algebra System I: The User L
6	W2011039300	442	24.5	0	Garey_MR(1979)BK	Computers and Intractability: A Guide to t
7	W1545231783	267	23.5	0	Todeschi_R(2000)BK	Handbook of Molecular Descriptors
8	W2490805901	339	23.1	1030	Hammack_RH(2011)BK	Handbook of Product Graphs
9	W2890747390	227	21.7	0	Trinajst_N(2018)BK	Chemical Graph Theory
10	W2798943694	309	20.2	0	Mortimer_B(1996)BK	Permutation Groups
11	W1581552469	240	19.5	0	Haynes_TW(1998)BK	Domination in graphs : advanced topics
12	W3004024615	188	19.3	0	Abragam_A(1961)29:860	The Principles of Nuclear Magnetism
13	W2051170661	286	18.8	0	Haimo_F(1966)73:800	Finite Permutation Groups.
14	W2318794083	416	18.6	0	Wiener_H(1947)69:17	Structural Determination of Paraffin Boilin
15	W2582743722	626	17.2	0	Team_RC(2014)1:	R: A language and environment for statisti
16	W71943752	246	16.9	865	Imrich_W(2000)BK	Product Graphs: Structure and Recognitio
17	W1558273801	224	15.3	1537	**Pisanski_T**(2003)BC	Topological Graph Theory
18	W2108625605	203	15.2	645	Naschie_ME(2003)NA	A review of E infinity theory and the mass
19	W2021229217	336	15.0	3501	Randić_M(1975)97:6609	Characterization of molecular branching
20	W2113076747	168	14.9	0	Bezdek_JC(1981)BK	Pattern Recognition with Fuzzy Objective
21	W2066196783	251	14.7	0	Gennes_PGD(1995)48:70	The Physics of Liquid Crystals
22	W1479863711	206	14.4	0	West_DB(2010)BC	Introduction to Graph Theory
23	W648463323	183	14.3	741	Mikhalev_AA(1995)BK	Rings with Generalized Identities
24	W2125055259	266	14.0	0	Quinlan_JR(1992)BK	C4.5: Programs for Machine Learning
25	W2917893419	212	13.8	0	Wielandt_H(1964)BK	Finite Permutation Groups
26	W1484040084	179	13.6	0	Bondy_JA(1976)BK	Graph Theory with Applications
27	W2018756269	137	13.6	0	Gutman_I(1986)BK	Mathematical Concepts in Organic Chemis
28	W2490728539	196	13.6	0	Huppert_B(1967)BK	Endliche Gruppen I
29	W2798588639	188	13.1	0	Diestel_R(1997)BK	Graph Theory
30	W1515707356	212	13.1	0	Biggs_N(1974)BK	Algebraic Graph Theory

Most cited works

i	wId	ideg	wideg	cbc	lab	tit
31	W1595159159	287	12.6	0	Storn_R(1997)11:341	Differential Evolution – A Simple and
32	W1631356911	117	12.5	0	Nielsen_MA(2002)70:558	Quantum Computation and Quantum
33	W1589331344	165	12.4	0	Cvetkovi_D(1995)BK	Spectra of graphs : theory and applica
34	W560340026	176	12.4	433	Henning_MA(2013)BK	Total Domination in Graphs
35	W623814603	185	12.4	1321	Deviller_J(2000)BK	Topological Indices and Related Descri
36	W1578352082	136	12.2	0	Fowler_PW(1995)BK	An atlas of fullerenes
37	W2610857016	163	12.2	0	Horn_RA(1985)BK	Matrix Analysis
38	W2911964244	364	12.1	0	Breiman_L(2001)45:5	Random Forests
39	W12766527	214	11.9	0	Wilson_RA(1985)BK	ATLAS of Finite Groups
40	W1585649433	140	11.8	0	Clifford_AH(1964)BK	The algebraic theory of semigroups
48	W2162542540	383	8.1	0	Moffitt_TE(1993)100:674	Adolescence-limited and life-course-per
50	W4301308134	350	7.1	0	Gottfred_MR(1990)BK	A General Theory of Crime
51	W2108718991	32	0.6	20051	Schloss_PD(2009)75:7537	Introducing mothur: Open-Source, Pla
52	W1563088657	88	3.9	13760	Cristian_N(2000)BK	An Introduction to Support Vector Ma
53	W1565746575	159	5.0	10750	**Demšar_J**(2006)7:1	Statistical Comparisons of Classifiers o
54	W3193598686	23	0.6	9470	Mcdonagh_TA(2021)42:3599	2021 ESC Guidelines for the diagnosis
55	W3021842026	75	1.8	8508	Perk_J(2012)33:1635	European Guidelines on cardiovascular
56	W3084106382	64	2.2	7552	Patrigna_C(2016)40:100001	Review of Particle Physics
57	W2899140785	45	1.3	6914	Tanabash_M(2018)98:	Review of Particle Physics
58	W2252578136	136	6.9	6790	Eidelman_S(2004)592:1	Review of Particle Physics
59	W1510073064	82	4.4	6714	**Shawe-Ta_J**(2004)BK	Kernel Methods for Pattern Analysis
60	W4238591275	187	9.1	6114	Godsil_C(2001)BK	Algebraic Graph Theory

41 = 15, 42 = 2, 43 = 4, 44 = 5, 45 = 1, 46 = 6, 47 = 14, 49 = 38.

Co-authorships

The relationship between works and their authors is described by a two-way *authorship* network **WA**

$$w\ \mathbf{WA}\ a \equiv \text{ person } a \text{ is a (co)author of work } w$$

The output degree $\mathrm{odeg}(w)$ counts the number of authors of work w; the input degree $\mathrm{ideg}(a)$ counts the number of works for which a is a (co)author.

The *co-authorship* network **Co** is obtained by multiplying the networks (the product of the associated matrices) $\mathbf{Co} = \mathbf{WA}^T \cdot \mathbf{WA}$. $co(a, b) =$ number of works where a and b are co-authors [2].

The weight co is not a "fair" measure of collaboration between authors – works with many co-authors have too much influence. Again, we use the fractional approach and introduce weights (ordinary and strict/Newman normalization) [7]

$$wan(w, a) = \frac{1}{\max(1, \mathrm{odeg}(w))} \quad \text{in} \quad was(w, a) = \frac{1}{\max(1, \mathrm{odeg}(w) - 1)}$$

Co-authorships

The weighted input degree windeg(a) in the network **WAn** is equal to the fractional contribution of author a.

Fractional co-authorship networks are again obtained by multiplying:
ordinary $\mathbf{Cn} = E(\mathbf{WAn}^T \cdot \mathbf{WAn})$ and
strict $\mathbf{Cs} = E(D_0(\mathbf{WAn}^T \cdot \mathbf{WAs}))$.

$D_0(\mathbf{N})$ removes all loops from the network **N** (sets the diagonal of the matrix to 0).

$E(\mathbf{N})$ transforms the directed network **N** into an undirected one – replacing the pairs of opposite arcs (u, v) and (v, u) with an edge $(u : v)$ with a weight equal to the sum of the weights of both arcs.

Strict co-authorship only considers co-authorship between different authors – works with zero or a single author are not considered.

Co-authorships

i	ald	name	windeg	ideg	cbc
1	A5091549348	Slavoj Žižek	692.8374	813	33787
2	A5076762560	David P. Farrington	580.4625	1271	83478
3	A5111857036	M.S. El Naschie	518.0833	544	12078
4	A5059383361	Nikolaos S. Papageorgiou	407.0444	768	8262
9	A5043525348	Cheryl E. Praeger	326.5783	773	8524
10	A5089473322	Michael A. Henning	320.2764	740	10267
12	A5052317325	R. Blinc	310.5514	1163	30618
17	A5110334725	Alexandrù T. Balaban	272.1644	663	16321
18	A5005993212	**Bojan Mohar**	267.4052	546	11259
19	A5081252768	Milan Randić	265.9955	474	20270
20	A5031333422	**Dušan Repovš**	257.2326	632	6262
21	A5112203336	Herbert S. Wilf	241.4312	353	10319
22	A5047980012	**John Shawe-Taylor**	236.0920	661	60107
23	A5049148828	**Sandi Klavžar**	235.1119	651	11239
24	A5044431363	Matjaž Perc	234.7540	761	48948
27	A5043857437	**Franc Forstnerič**	212.1111	285	3664
29	A5030623629	Janez Grum	204.0615	329	3618
30	A5006528801	Rudolf Podgornik	198.9827	514	14616
35	A5055891902	Tomaž Prosen	187.4857	421	16845
36	A5064609702	Sašo Džeroski	187.3779	611	19403
38	A5028811495	Mirjam Cvetič	175.1328	419	20786
44	A5006396219	**Matej Brešar**	168.7524	262	6379
51	A5040973605	Amrit Šorli	159.1265	226	609
52	A5071211846	Damijan Miklavčič	158.6122	601	29397
63	A5013049879	Diego Klabjan	138.4695	354	5283
65	A5008674617	Matej Pavšič	137.2417	162	2047
67	A5007749653	**Josip Globevnik**	132.1667	149	1372
68	A5057908726	**Peter Šemrl**	132.0833	209	4996
69	A5001676164	**Vladimir Batagelj**	129.2208	271	13416
70	A5085971943	Aleš Leonardis	128.7034	461	17557

Co-authorships

i	aId	name	windeg	ideg	cbc
72	A5075795523	Marko Robnik	127.3119	239	4381
74	A5029196867	S. Žumer	126.0043	400	16151
76	A5012442974	Iztok Fister	123.0236	271	6040
78	A5060174190	**Nada Lavrač**	122.2524	385	10869
79	A5076766961	N. Mankoč-Borštnik	122.1433	203	1170
80	A5040998302	Igor Škrjanc	121.8630	333	5782
81	A5089379545	**Janez Žerovnik**	121.2869	241	1595
82	A5052945164	Gorazd Meško	120.9082	268	2268
83	A5088568164	Aleksander Aristovnik	120.6082	220	4481
85	A5083674096	**Riste Škrekovski**	119.6667	325	3603
86	A5030203098	Robert Jeraj	119.5360	477	9906
89	A5009207700	**Tomaž Pisanski**	118.1518	310	4657
93	A5019807187	Božidar Šarler	113.6308	289	4631
96	A5015052144	**Igor Kukavica**	110.8625	230	3811
101	A5042165141	Zvonko Jagličić	106.0667	669	6886
102	A5020641117	Ivan Bratko	105.9136	247	7864
106	A5108705492	V. Žitko	103.4548	189	4533
107	A5062790218	Mario Poljak	102.4685	538	15861
108	A5068406372	Zdravko Kravanja	102.2530	328	7915
110	A5005875450	Igor Grabec	102.1548	202	3082
111	A5006257741	P. Prelovšek	102.0218	243	7059
112	A5108743163	Milan Vodopivec	101.0678	190	2874
113	A5055260770	Igor Kononenko	100.0703	232	15763
118	A5082272086	Gregor Serša	98.7847	512	17436
121	A5065490876	Patrick Doreian	97.4982	182	5414
122	A5028549991	**Dragan Marušič**	96.4671	235	5189
126	A5000636578	Borut Peterlin	94.3968	462	8041
127	A5036485959	Bosiljka Tadić	94.3024	203	3678
131	A5077686752	Franc Solina	92.1005	220	3007
135	A5027970574	**Martin Milanič**	91.0904	290	1728

Co-authorships

i	ald	name	windeg	ideg	cbc
136	A5043419128	Matjaž Gams	90.6873	257	3777
137	A5103154620	**Primož Potočnik**	90.1675	226	4170
138	A5070642269	Sanja Fidler	89.6110	403	32412
139	A5087189787	Milan Batista	88.5778	120	1264
140	A5057446742	Mitja Lainščak	88.2815	478	35330
149	A5089443562	**Boštjan Brešar**	84.0976	238	2803
151	A5044306350	Marko Žnidarič	83.1667	131	6901
152	A5067280644	Boris Kryštufek	82.8513	236	4899
155	A5069300318	Marko Hočevar	82.1445	315	5871
156	A5111892770	Miha Drofenik	82.0802	260	6507
157	A5054450044	Mitja Kovač	81.1172	123	387
161	A5009382799	J. Strnad	80.3333	100	393
162	A5081908263	Janez Kopač	80.1393	210	6553
164	A5032053768	Miroslav Verbič	79.8833	166	1685
165	A5034923438	**Sergio Cabello**	79.4698	190	2097
167	A5080451202	Tadej Bajd	78.2790	263	3997
172	A5020021079	Marko Robnik-Šikonja	76.0900	220	6286
175	A5079914130	Roman Trobec	75.5879	214	2063
180	A5033383250	Damjan Zazula	74.6747	182	2746
185	A5030526764	Jurij Avsec	73.0903	166	1452
191	A5022550124	Andrej Trkov	72.0719	251	8831
197	A5042418492	Jure Zupan	71.2679	166	6672
200	A5019105855	**Joso Vukman**	70.2024	108	2027
201	A5112303330	Franjo Pernuš	70.1898	272	5392
202	A5066290998	Polona Tominc	69.9329	207	1574
203	A5062380534	Rok Žitko	69.9217	192	4135
204	A5055222513	Roman Jerala	69.7864	358	11467
206	A5038286229	Ivan Kuščer	69.5333	143	1550
209	A5026962152	Matija Vidmar	69.0833	84	340
210	A5034807634	B. Žekš	68.9947	228	9244
214	A5039271966	Enes Pašalić	68.3623	187	2819

Co-authorships

Given a network $\mathbf{N} = (V, L, w)$ – V is the set of nodes, L is the set of links, and $w : L \to \mathbb{R}$ is the weight. A *cut* at threshold t from a network $\mathbf{N}$ is a subnetwork $\mathbf{C}_t = (V_t, L_t, w_t)$ where $L_t = \{e \in L : w(e) \geq t\}$, V_t is the set of endpoints from L_t and w_t is the restriction of the weight w to L_t.

For the analysis, we chose the strict co-authorship network **Cs** ($n = 224692$, $m_A = 53137974$). After examining the distribution of weight values, we chose a threshold of $t = 2$ ($m(0.0000, 1.0024] = 53133034$). The resulting cut $\mathbf{C}_2$ has $n = 3101$ nodes and $m_E = 2661$ edges. It is decomposed into 549 connected subnetworks. Their size distribution is

351	156	125	64	45	42	29	27	26	23	22	19	18	17	16
1	1	1	1	1	1	1	1	1	2	2	2	1	1	1

15	14	13	12	11	10	9	8	7	6	5	4	3	2
2	3	5	2	8	7	16	9	15	29	45	74	90	226

Co-authorships

What are the characteristics of each cluster? We can find these by considering data on sources (journals), countries, and keywords. Let's see which journals the cluster members publish in the most.

A given partition $\mathcal{C} = \{C_1, C_2, \ldots, C_k\}$ of the set $\mathcal{A}$ into clusters can be represented as a two-mode network. $\mathbf{AC} = ((\mathcal{A}, \mathcal{C}), \mathcal{L})$ such that

$$\forall a \in \mathcal{A} : (a \in C(a) \in \mathcal{C} \Rightarrow (a, C(a)) \in \mathcal{L})$$

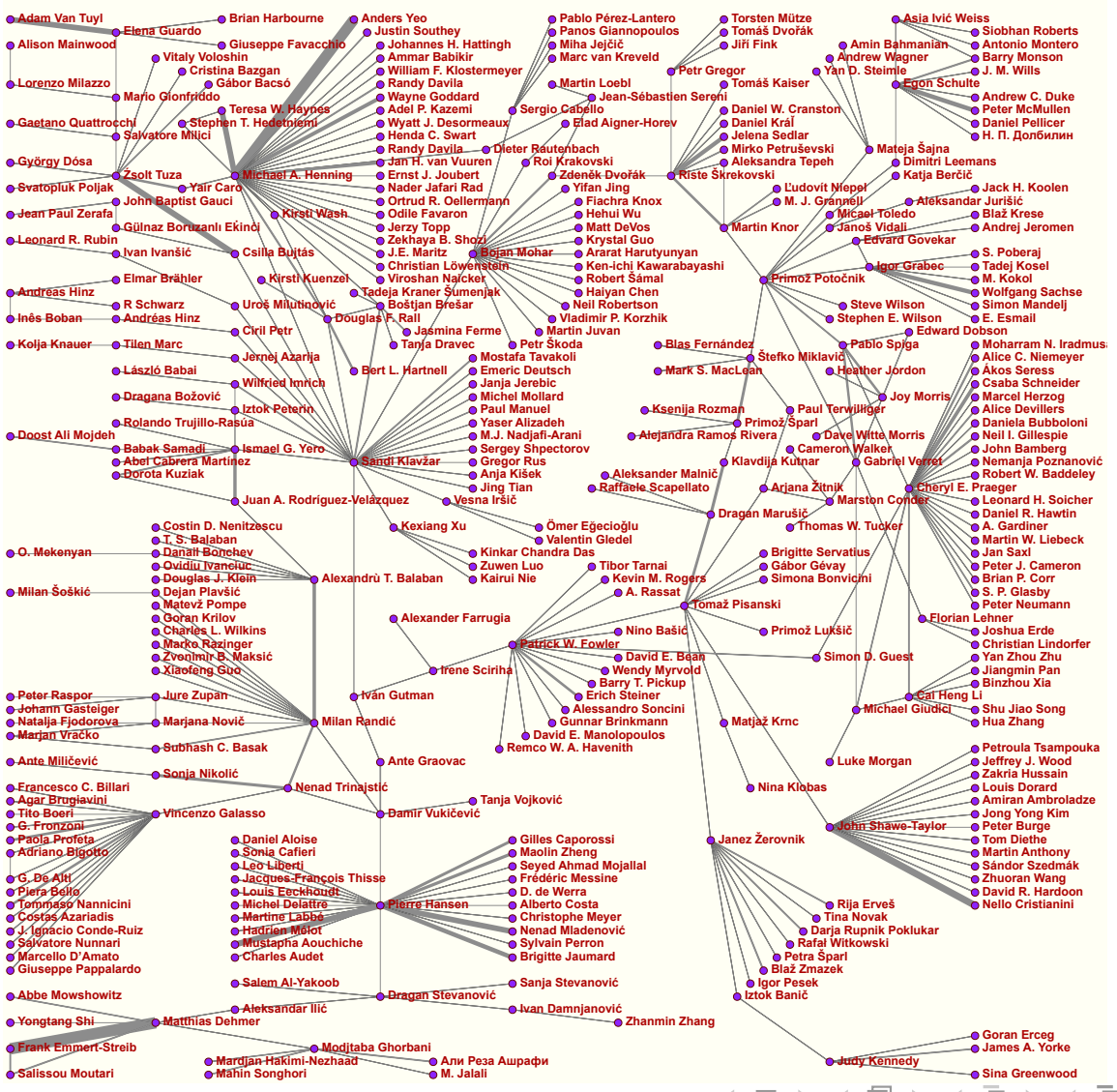
Note that also **WJ** is a partition matrix. We get the author's fractional contribution to a journal by $\mathbf{AJn} = n(\mathbf{WA})^T \cdot \mathbf{WJ}$. Let **AC** be the weak component decomposition matrix of the link cut. Then we get the fractional contribution of each cluster to a journal as

$$\mathbf{CJ} = \mathbf{AC}^T \cdot \mathbf{AJn}$$

$cj[c, j]$ = fractional contribution of authors from cluster c to journal j

Co-authorships

Discrete mathematics



Journals

Discrete mathematics

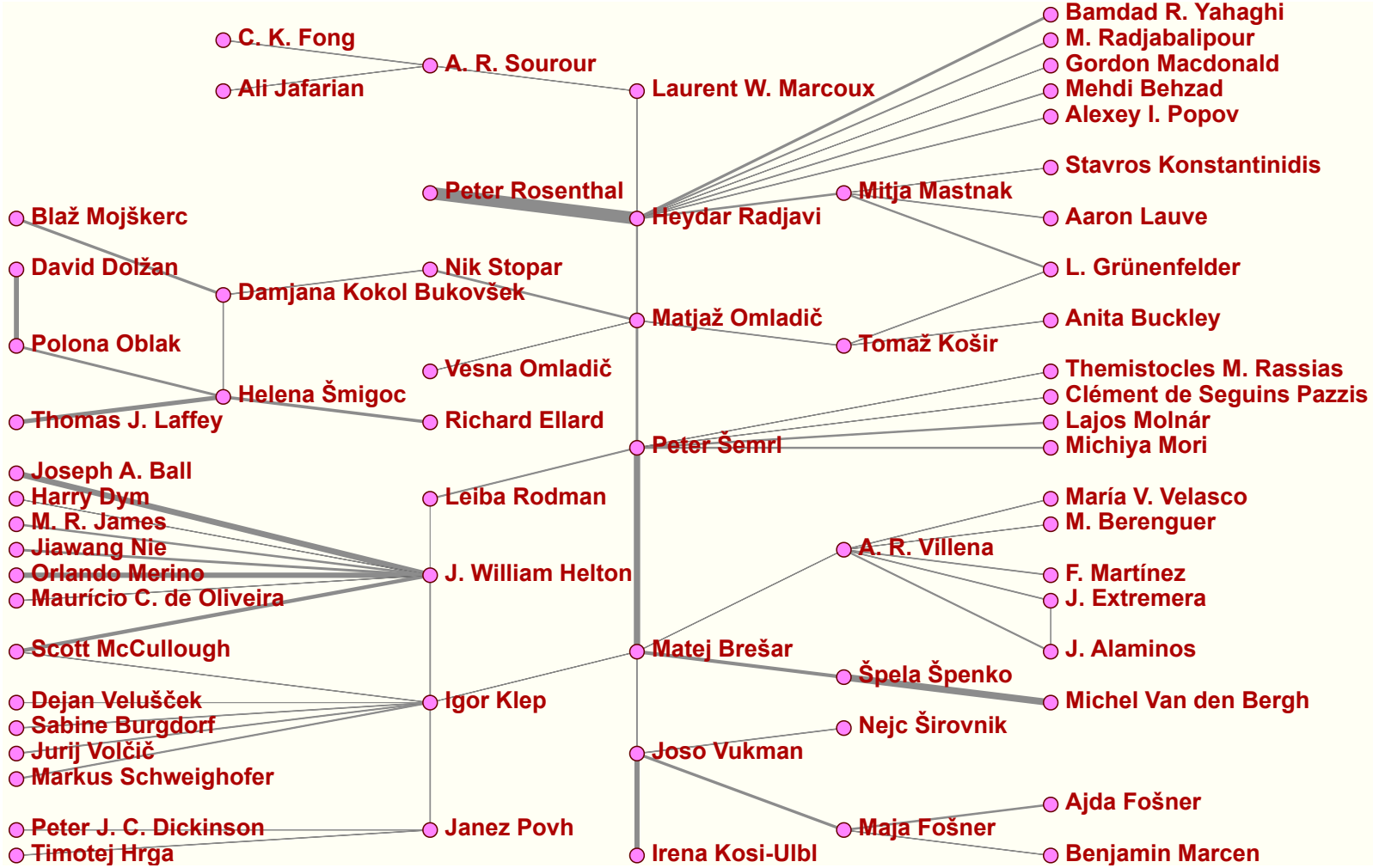
```
> R1 <- journals(1,C=weak)
Cluster 1 with 351 nodes
 [1] "Douglas F. Rall"      "Pierre Hansen"        "Alberto Costa"
 [4] "Leo Liberti"          "Modjtaba Ghorbani"    "M. Jalali"
 [7] "Sandi Klavžar"        "Alexandrù T. Balaban" "Sonja Nikolić"
[10] "Brigitte Jaumard"
```

	i	f	id	journal
1	1	1452.967	S4306400194	arXiv (Cornell University)
2	2	436.038	S18902827	Discrete Mathematics
3	3	240.402	S171741597	Discrete Applied Mathematics
4	4	186.695	S4306518497	Les Cahiers du GERAD
5	5	150.821	S204851967	European Journal of Combinatorics
6	6	143.822	S61442588	Ars Mathematica Contemporanea
7	7	140.230	S193368155	Journal of Graph Theory
8	8	136.894	S171559003	Journal of Chemical Information and Computer Sc...
9	9	117.652	S2939117604	Journal of Combinatorial Theory Series B
10	10	93.956	S2738357781	Discussiones Mathematicae Graph Theory
11	11	91.433	S44567922	Chemical Physics Letters
12	12	90.767	S4306463937	Springer eBooks
13	13	89.561	S50372074	Applied Mathematics and Computation
14	14	86.350	S184147796	Journal of Algebra
15	15	86.306	S36275936	Croatica Chemica Acta
16	16	85.917	S186126824	Graphs and Combinatorics
17	17	85.694	S41354064	ChemInform
18	18	84.167	S38448739	The Electronic Journal of Combinatorics
19	19	74.667	S4306462995	Cambridge University Press eBooks
20	20	74.105	S106296714	Lecture notes in computer science
21	0	646.812	Sunknown	Unknown source

Cluster 2 / 156 : Dušan Repovš (+ Matija Cencelj)
Cluster 3 / 125 : Physicists: R. Blinc, Tomaž Prosen, Mitja Rosina, Rudolf Podgornik, S. Žumer, Bosiljka Tadić, etc.

Co-authorships

Analysis



Journals

Analysis

```
> R4 <- journals(4,C=weak)
Cluster 4 with 64 nodes
 [1] "Joso Vukman"       "A. R. Sourour"     "J. William Helton" "Irena Kosi-Ulbl"
 [5] "Matej Brešar"      "Peter Šemrl"       "Maja Fošner"       "Leiba Rodman"
 [9] "Orlando Merino"    "F. Martínez"
    i       f          id                                                journal
1   1 290.324 S4306400194                                arXiv (Cornell University)
2   2 114.233  S159544283                        Linear Algebra and its Applications
3   3  96.900 S4210226894         Proceedings of the American Mathematical Society
4   4  44.575  S150125562                           Linear and Multilinear Algebra
5   5  39.250  S184147796                                        Journal of Algebra
6   6  34.864   S54953690                           Journal of Functional Analysis
7   7  32.300  S151579836 Journal of Mathematical Analysis and Applications
8   8  31.850    S7365561                                        Studia Mathematica
9   9  24.417   S53865935                                Communications in Algebra
10 10  21.100   S76385772                  Integral Equations and Operator Theory
11 11  19.875 S4306463937                                       Springer eBooks
12 12  19.500   S28609967                                     Glasnik Matematicki
13 13  19.333   S60030702 Transactions of the American Mathematical Society
14 14  18.238  S141318850   Bulletin of the Australian Mathematical Society
15 15  18.000 S4210236142                                          Universitext
16 16  17.767    S4805881                     Journal of Pure and Applied Algebra
17 17  17.667  S150892397                           Aequationes Mathematicae
18 18  15.433   S75897683                                       Semigroup Forum
19 19  15.333  S131268793                        Canadian Journal of Mathematics
20 20  15.200  S196210972                  Indiana University Mathematics Journal
21  0 108.776    Sunknown                                       Unknown source
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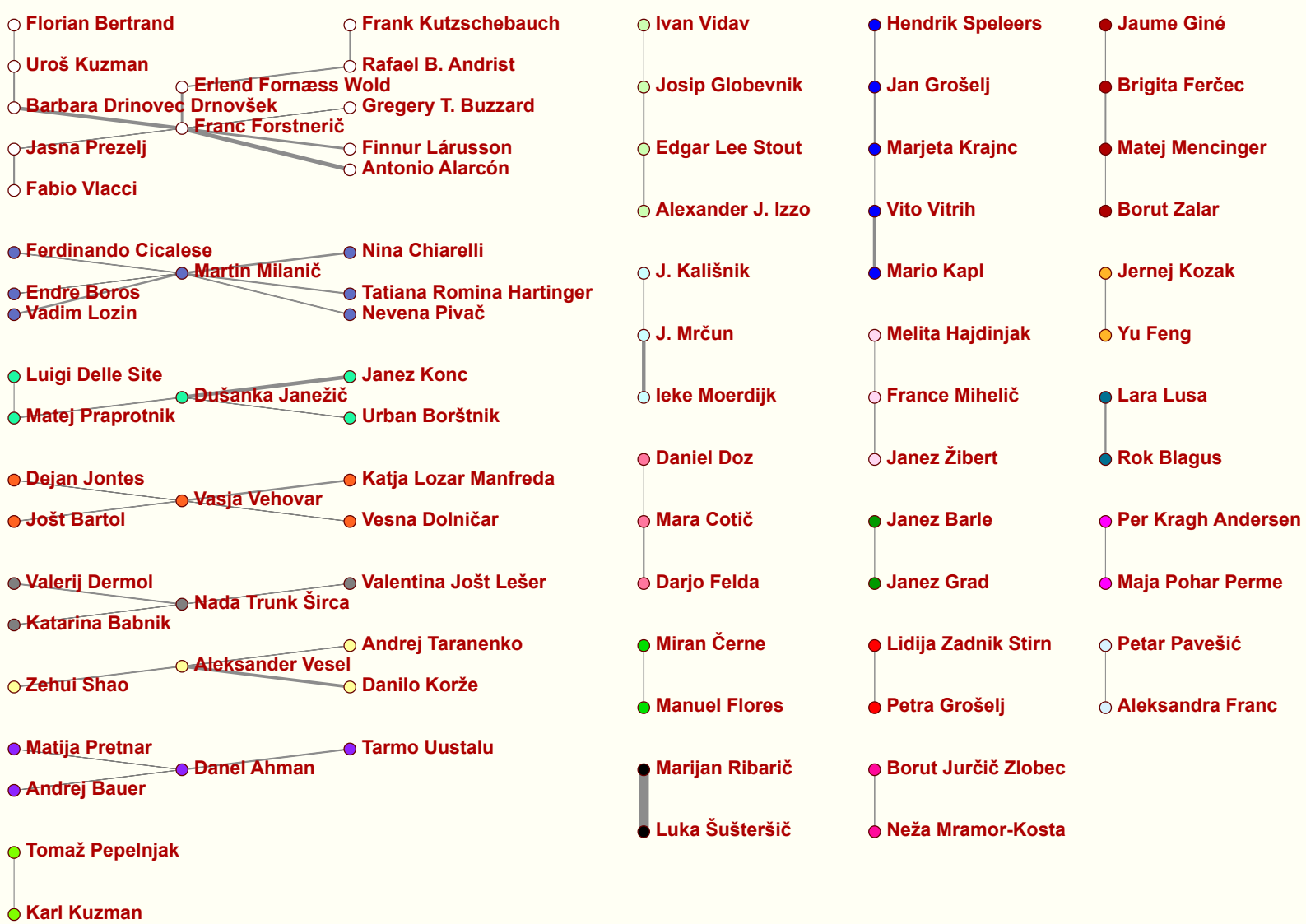
Co-authorships

Mixed



Journals

Analysis 2

```
> j <- weak$C1[which(Nams=="Franc Forstnerič")]
> R <- journals(j,C=weak)
Cluster 30 with 12 nodes
 [1] "Fabio Vlacci"              "Jasna Prezelj"             "Rafael B. Andrist"
 [4] "Erlend Fornæss Wold"       "Florian Bertrand"          "Uroš Kuzman"
 [7] "Franc Forstnerič"          "Finnur Lárusson"           "Frank Kutzschebauch"
[10] "Barbara Drinovec Drnovšek"
    i       f          id                                                journal
1   1 138.633 S4306400194                                arXiv (Cornell University)
2   2  21.000 S4210201681   Ergebnisse der Mathematik und ihrer Grenzgebiete
3   3  16.167 S4210226894   Proceedings of the American Mathematical Society
4   4  15.833    S6775291                        Journal of Geometric Analysis
5   5  13.500  S104894821                            Mathematische Zeitschrift
6   6  12.083  S192217950                               Mathematische Annalen
7   7   8.250   S60030702  Transactions of the American Mathematical Society
8   8   7.500  S151579836  Journal of Mathematical Analysis and Applications
9   9   6.667 S4210234235                 Springer monographs in mathematics
10 10   6.000   S78118978                      Annales de l'institut Fourier
11 11   6.000  S126920787                      Mathematical Research Letters
12 12   5.500  S141396939                                Arkiv för matematik
13 13   5.000   S77333429          Complex Variables and Elliptic Equations
14 14   4.500  S196210972            Indiana University Mathematics Journal
15 15   4.000  S171170845                            Duke Mathematical Journal
16 16   3.500 S2764899347 Contemporary mathematics - American Mathematica...
17 17   3.500 S4210174540                           Indagationes Mathematicae
18 18   3.500 S2477993565                                    Analysis & PDE
19 19   3.000   S98347115                          Inventiones mathematicae
20 20   3.000  S111381568        International Mathematics Research Notices
21  0   9.333    Sunknown                                    Unknown source
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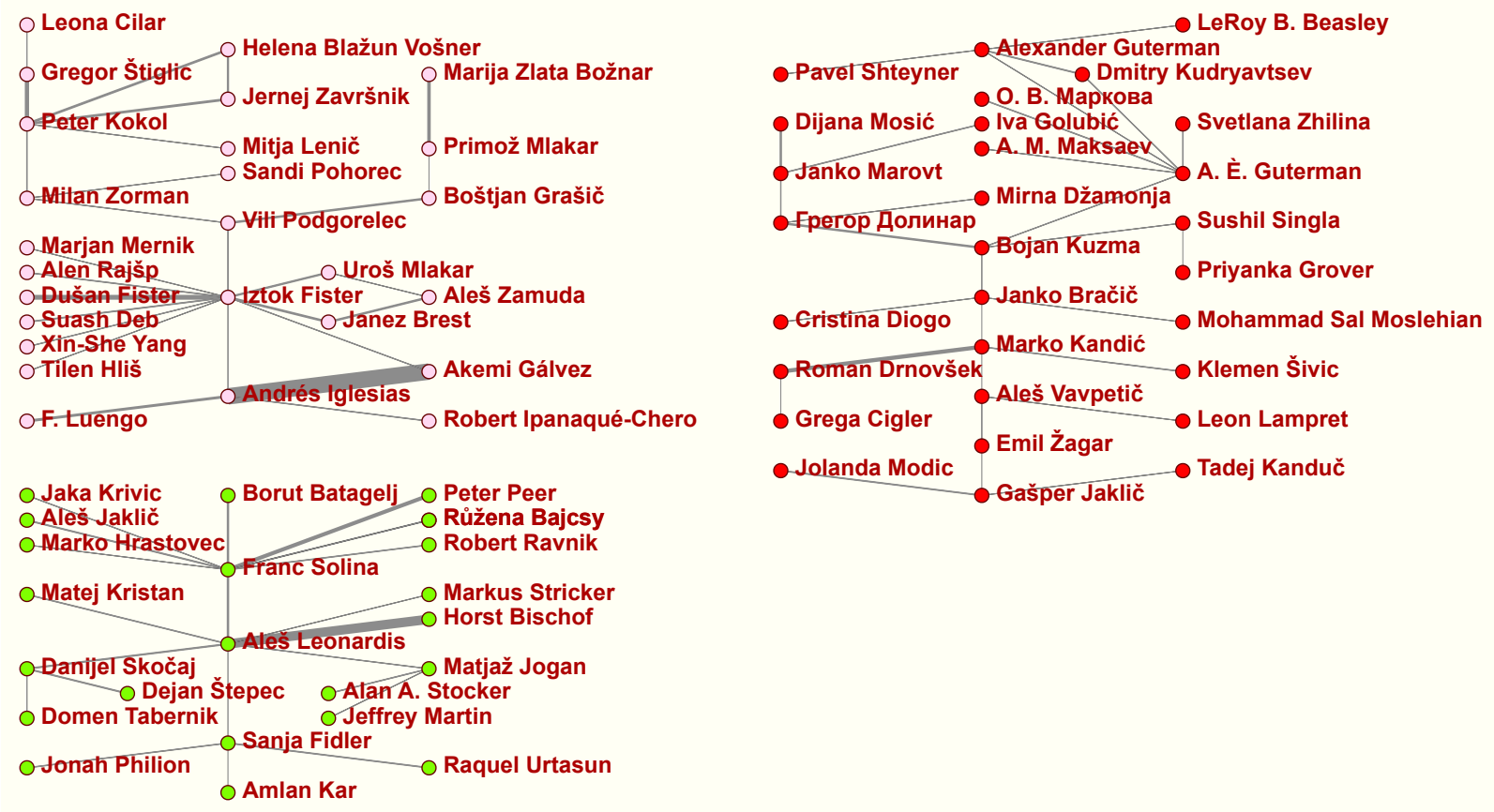
Co-authorships

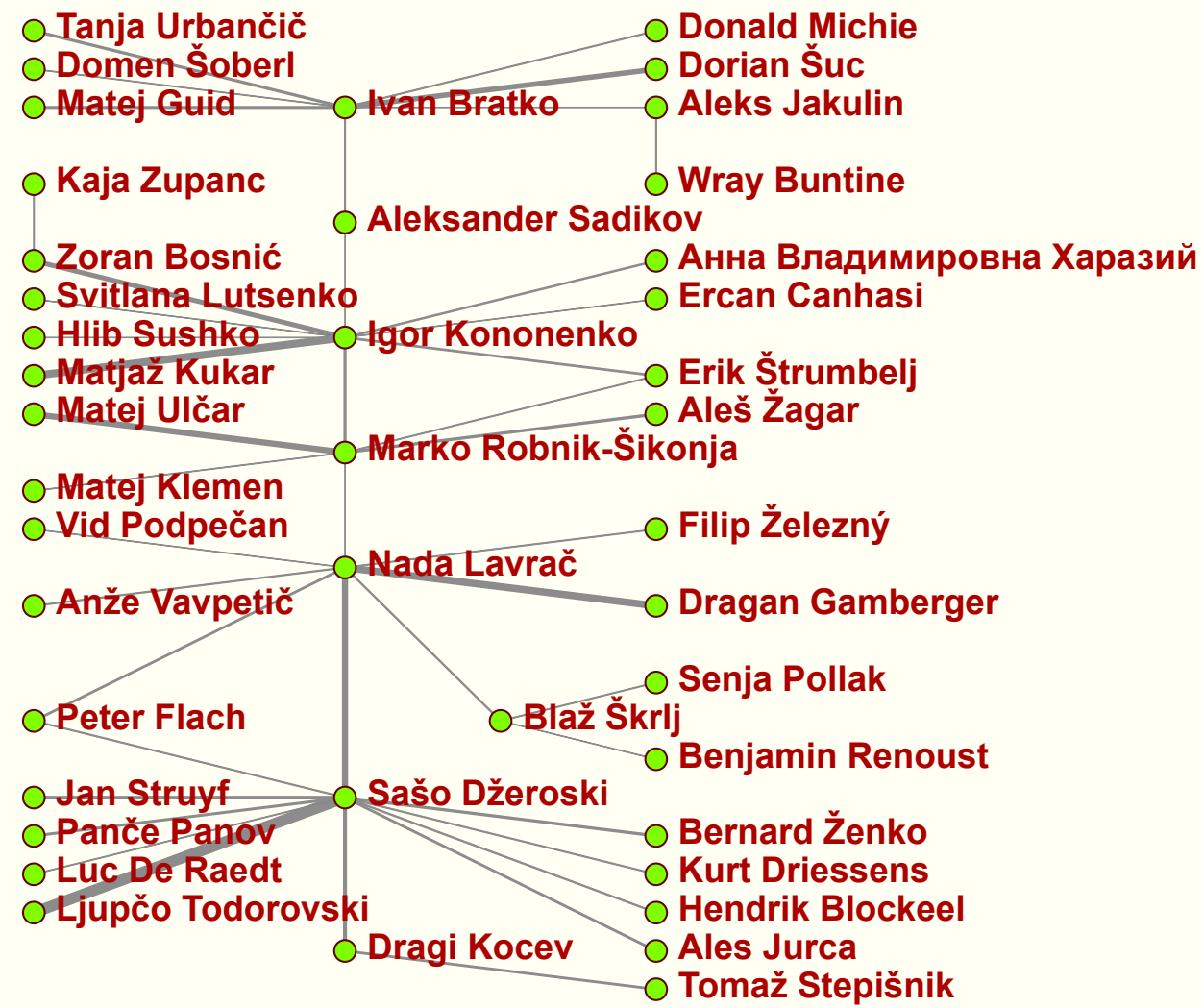
Mixed



Cluster 9 / 26 : Genetic + Evolutionary computing
Cluster 10 / 23 : Pattern recognition, Computer vision
Cluster 7 / 29 : (Linear) Algebra

Co-authorships

Artificial intelligence



Journals

Artificial intelligence

```
> j <- weak$C1[which(Nams=="Ivan Bratko")]
> R <- journals(j,C=weak)
Cluster 6 with 42 nodes
 [1] "Nada Lavrač"        "Igor Kononenko"     "Zoran Bosnić"       "Tanja Urbančič"
 [5] "Ivan Bratko"        "Ljupčo Todorovski"  "Sašo Džeroski"      "Peter Flach"
 [9] "Aleksander Sadikov" "Aleks Jakulin"
    i       f          id                                                journal
1   1 166.800  S106296714                        Lecture notes in computer science
2   2  64.761 S4306400194                               arXiv (Cornell University)
3   3  50.971 S4306463937                                      Springer eBooks
4   4  34.979   S62148650                                     Machine Learning
5   5  21.333 S4306463230                                      Elsevier eBooks
6   6  16.377   S88315673                                  Ecological Modelling
7   7  11.650 S4306463409                                     IGI Global eBooks
8   8  11.617   S57195646                                           Informatica
9   9  11.067 S4306419644             International Conference on Machine Learning
10 10  10.683   S13144211                         Expert Systems with Applications
11 11   8.817   S42468263                       Artificial Intelligence in Medicine
12 12   8.667 S4210169997                                    Cognitive technologies
13 13   8.229 S4306400562 Zenodo (CERN European Organization for Nuclear ...
14 14   8.167   S36033921                Journal of Intelligent Information Systems
15 15   8.033 S4306418308            European Conference on Artificial Intelligence
16 16   7.333   S30686695                                           ICGA Journal
17 17   7.333 S4210176598                       ACM SIGKDD Explorations Newsletter
18 18   7.000 S4210184905                       SpringerBriefs in computer science
19 19   6.700 S2498839158                                 Intelligent Data Analysis
20 20   6.667 S2764476468 Eastern-European Journal of Enterprise Technolo...
21  0 143.396    Sunknown                                         Unknown source
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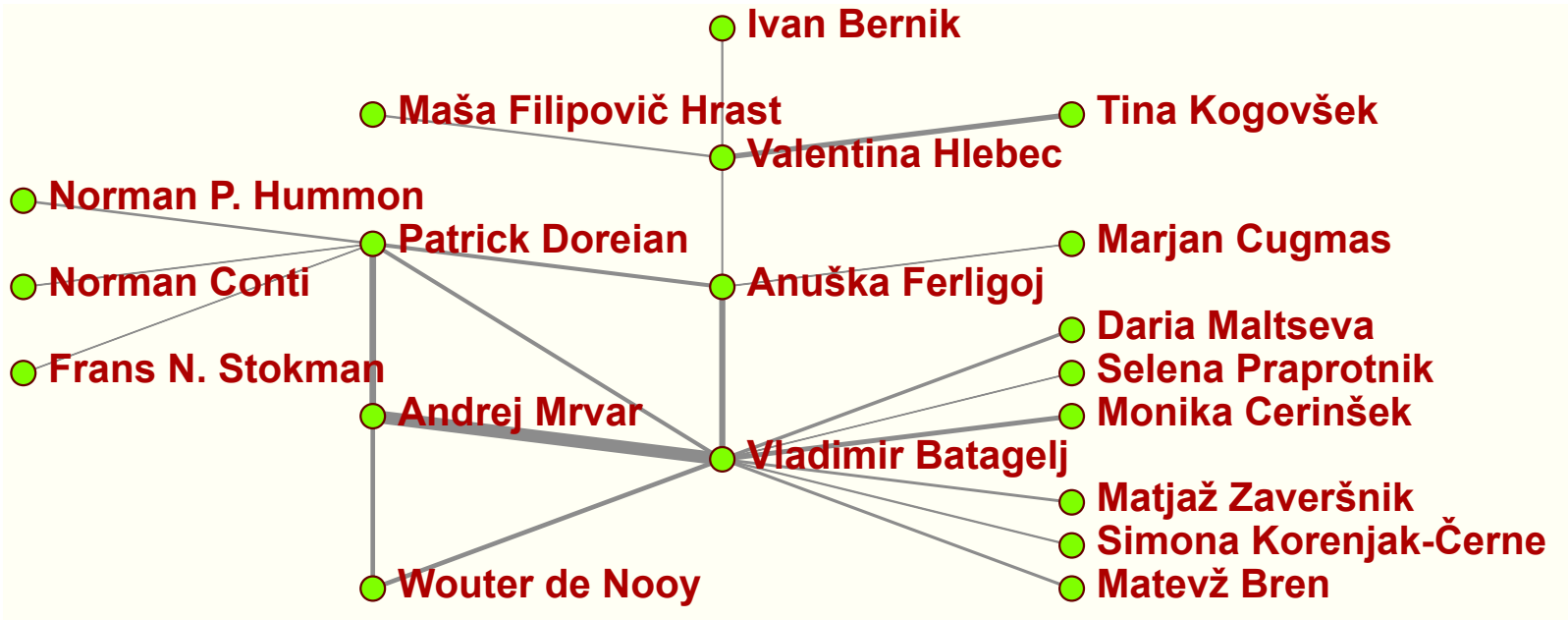
Co-authorships

Data analysis and network analysis



Journals

Data analysis and network analysis

```
> j <- weak$C1[which(Nams=="Andrej Mrvar")]
> R <- journals(j,C=weak)
Cluster 14 with 19 nodes
 [1] "Anuška Ferligoj"       "Patrick Doreian"       "Vladimir Batagelj"
 [4] "Valentina Hlebec"      "Matevž Bren"           "Wouter de Nooy"
 [7] "Andrej Mrvar"          "Simona Korenjak-Černe" "Matjaž Zaveršnik"
[10] "Maša Filipovič Hrast"
    i      f          id                                                journal
1   1 47.500 S4306462995                 Cambridge University Press eBooks
2   2 37.500   S26186134                                   Social Networks
3   3 23.083 S4306463937                                   Springer eBooks
4   4 22.843 S4210169332             Advances in Methodology and Statistics
5   5 20.367 S4306400194                       arXiv (Cornell University)
6   6 16.967  S148561398                                    Scientometrics
7   7 12.000  S102399824                             Quality & Quantity
8   8 11.750 S4306508438                          Družboslovne razprave
9   9 11.083   S81521204                 Journal of Mathematical Sociology
10 10 10.417 S4210194094 Studies in classification, data analysis, and k...
11 11  5.750   S18902827                              Discrete Mathematics
12 12  5.000 S2739014637                Slovenian Journal of Public Health
13 13  4.833    S9536269                   Sociological Methods & Research
14 14  4.729   S73028643                          Journal of Classification
15 15  4.333 S4210226991 Bulletin of Sociological Methodology/Bulletin d...
16 16  3.917 S4306526029                                Revija Varstvoslovje
17 17  3.667 S4317411217                                     Deleted Journal
18 18  3.500  S186480540                                       Psychometrika
19 19  3.500 S4306463762                                Policy Press eBooks
20 20  3.417 S4306401280     DOAJ (DOAJ: Directory of Open Access Journals)
21  0 90.848    Sunknown                                        Unknown source
```

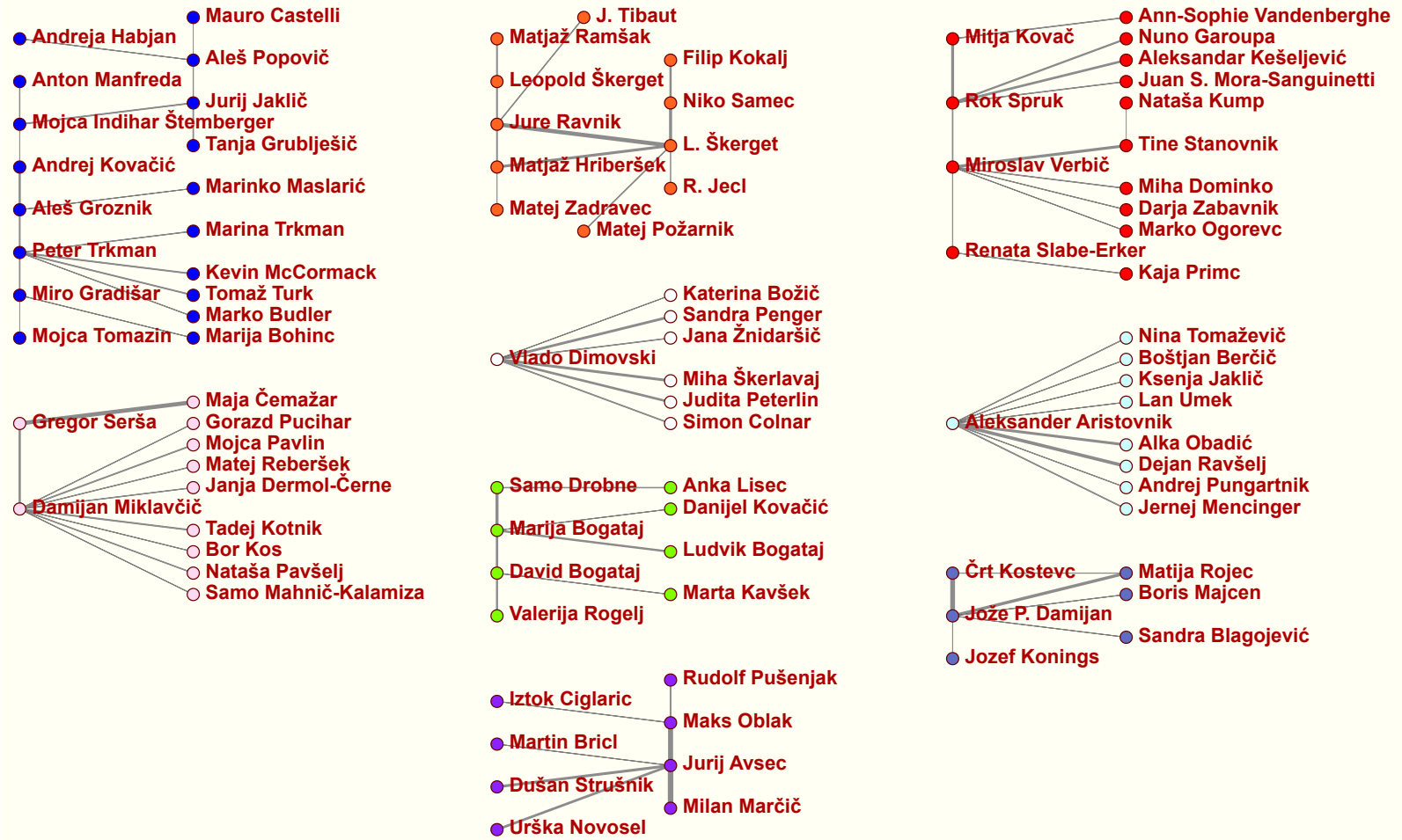
Co-authorships

Informatics, AI, Physics

Cluster 52 / 9 : Bioinformatics, Medical Informatics, AI
Cluster 37 / 11 : Physics, Biosystems
Cluster 92 / 6 : Informatics, AI
Cluster 214 / 4 : Informatics, Computer Science
Cluster 57 / 9 : Chemical Physics, Mathematical Physics

Co-authorships

Economics, electrical engineering, mechanical engineering



References between authors

The network of references between authors is obtained by multiplying $\mathbf{Ci_A} = \mathbf{WA}^T \cdot \mathbf{Ci} \cdot \mathbf{WA}$ and it holds that

$$ci_A(a, b) = \text{ number of references of author } a \text{ to author } b$$

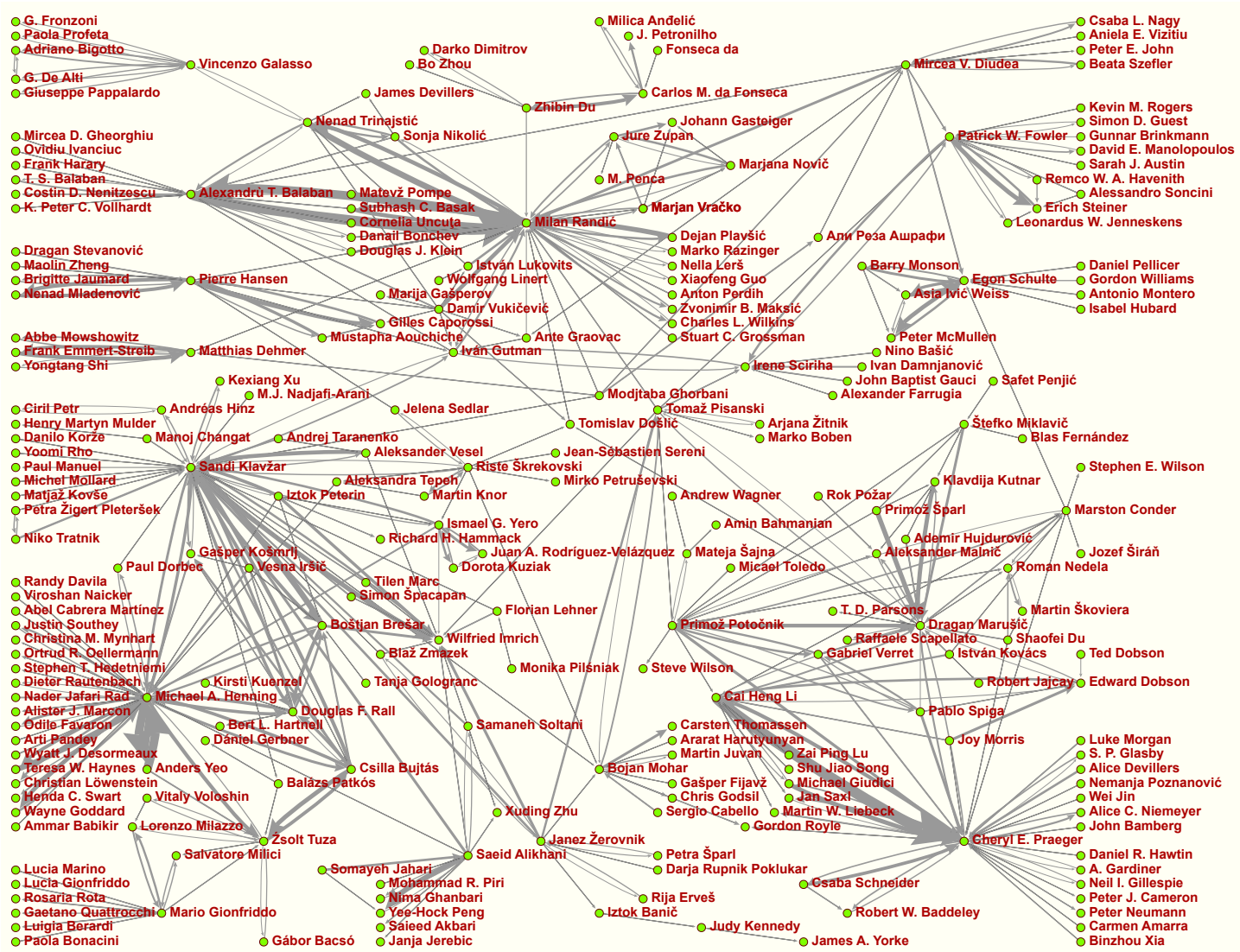
or more precisely: the number of cases when the work of author a references the work of author b.

The corresponding fractional network is obtained by multiplying the normalized versions of the networks $\mathbf{Ci_An} = \mathbf{WAn}^T \cdot \mathbf{Cin} \cdot \mathbf{WAn}$. Each work has a value of 1, which is distributed over the links of the network $\mathbf{Ci_An}$.

Again, we chose the fractional network $\mathbf{Ci_An}$ for analysis and determined a cut in it at the threshold $t = 1$.

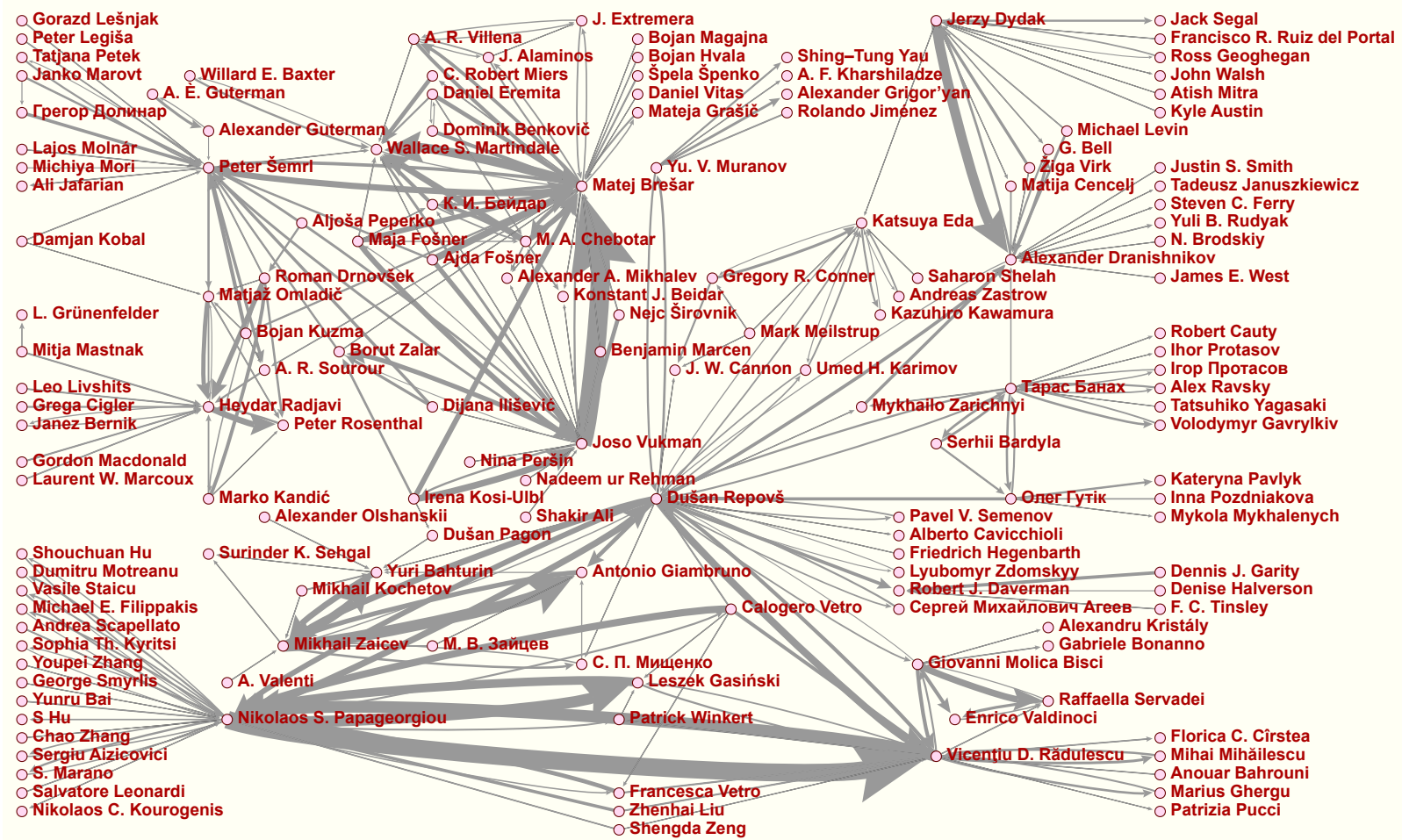
References between authors

Discrete mathematics



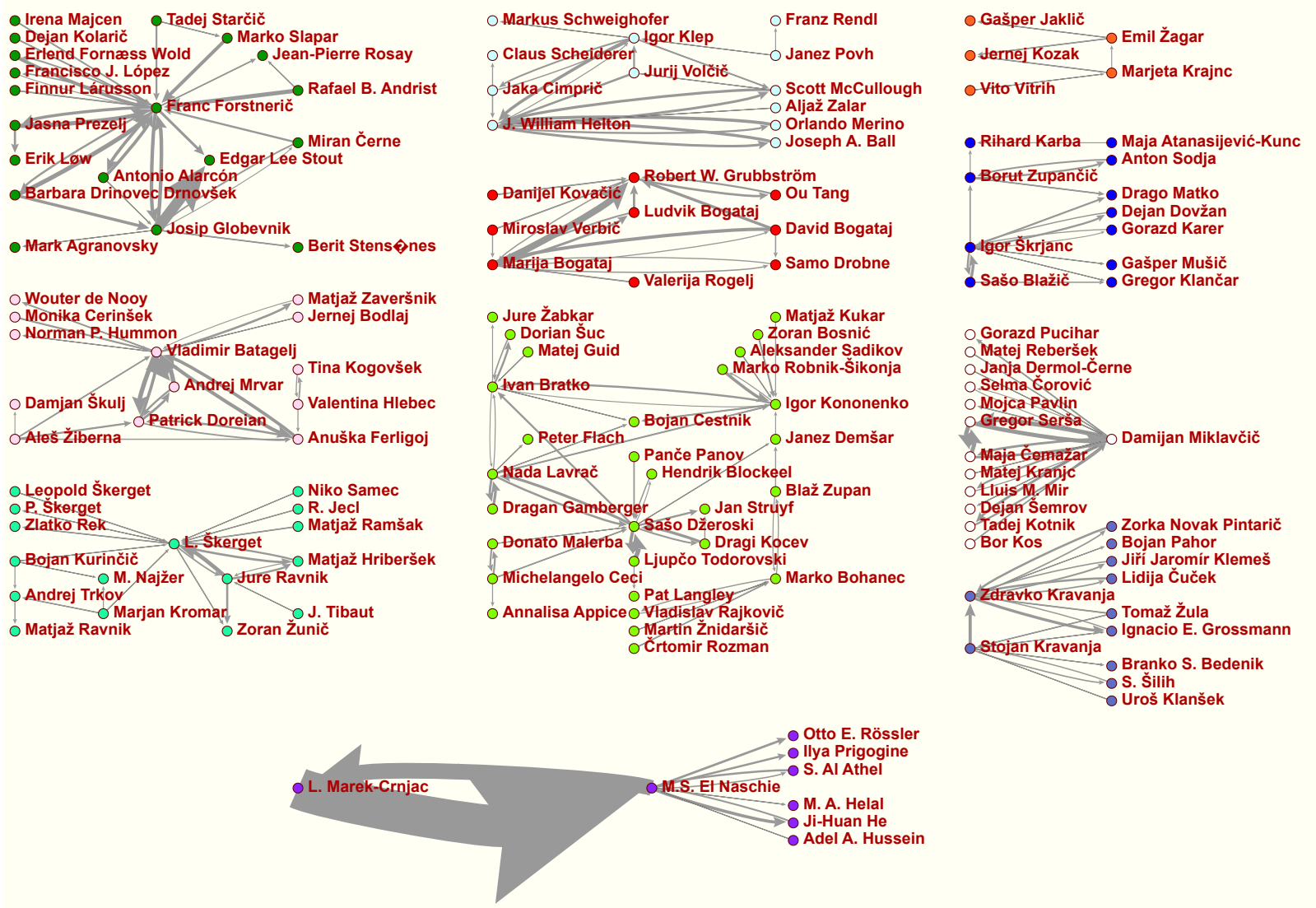
References between authors

Analysis



References between authors

Mixed



Mohamed El Naschie [10]; A5050116618, A5054934738

Conclusions

1. In the 16th-19th centuries (and even today), the development of mathematics was strongly influenced by physics, which led to the development of mathematical analysis.
2. In the 20th century, the need for mathematization also appeared in other fields. New fields also appeared.
3. The development of computers and computer science, which strongly stimulated the development of discrete mathematics, has a special influence on this.

Acknowledgments

The computational work reported in this presentation was performed using R and Pajek [5]. The code and data are available at GitHub/Vlado.

This work was partially supported by the Slovenian Research Agency (research program P1-0294 and research project J5-4596) and was prepared within the framework of COST action CA21163 (HiTEc).

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Daria Maltseva and Vladimir Batagelj. 2022. Collaboration between authors in the field of social network analysis. *Scientometrics*, 127, 6, 3437–3470.

References II

Mark EJ Newman. 2001. Scientific collaboration networks. ii. shortest paths, weighted networks, and centrality. *Physical review E*, 64, 1, 016132.

Tomaž Pisanski, Vladimir Batagelj, and Jan Pisanski. 2024. Open Science and Goodhart's Law. In *Proceedings of Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia*.

Vladimir Batagelj. 2025. OpenAlex2Pajek. https://github.com/bavla/OpenAlex/tree/main/OpenAlex2Pajek. [Online; accessed 15-August-2025]. (2025).

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