Bibliometric analysis of a scientific journal based on OpenAlex data

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Abstract

We are developing an R package, OpenAlex2Pajek, for creating bibliographic networks from the OpenAlex database. The basic package version supports the collection of data on selected topics. In this contribution, we present an extension, the function OpenAlexSources, that creates a list of works related to a selected journal (all papers published by the chosen journal and all works citing/cited by these papers). Since units (works, authors, sources, keywords, etc.) in networks are identified by their OpenAlex IDs, another function, unitsInfo, provides the user with additional information about the units appearing in the analysis results. We applied the new functions to create bibliographic networks for the journals Advances in Methodology and Statistics / Metodološki zvezki (S4210169332) and Ars Mathematica Contemporanea (S61442588). We present some basic results of their analyses.

Keywords: R package, OpenAlex, bibliometrics, networks, scientific journal, derived network

1. OpenAlex

OpenAlex (`https://docs.openalex.org/`) is a fully open catalog of the global research system. It's named after the ancient Library of Alexandria and was made by the nonprofit OurResearch. OpenAlex launched in January 2022 with a web GUI, free API, and data snapshot (Priem et al., 2022, see Figure 1). It is a free alternative to commercial bibliographic services such as Web of Science and Scopus. Through its API, it provides programming access to bibliographic data, enabling complex analyses and the development of higher-order bibliographic services.

OpenAlex solves several important questions for the analysis of bibliographic data:
1. identification of bibliographic units (IDs, disambiguation)
2. free access (share derived data, download all data to your computer)
3. improving content through user participation (submit a request)

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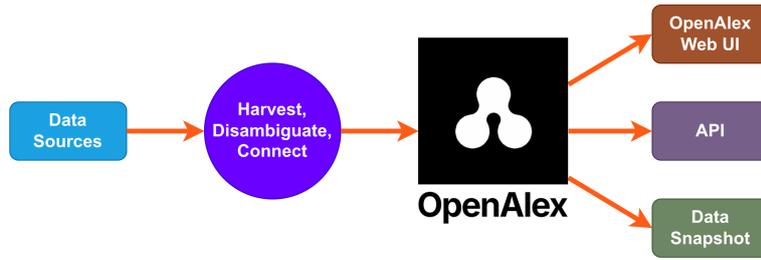
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Figure 1. OpenAlex dataflow

OpenAlex is based on 7 types of units or entities (Figure 2): **W**(ork), **A**(uthor), **S**(ource), **I**(nstitution), **C**(oncept), **P**(ublisher), or **F**(under).
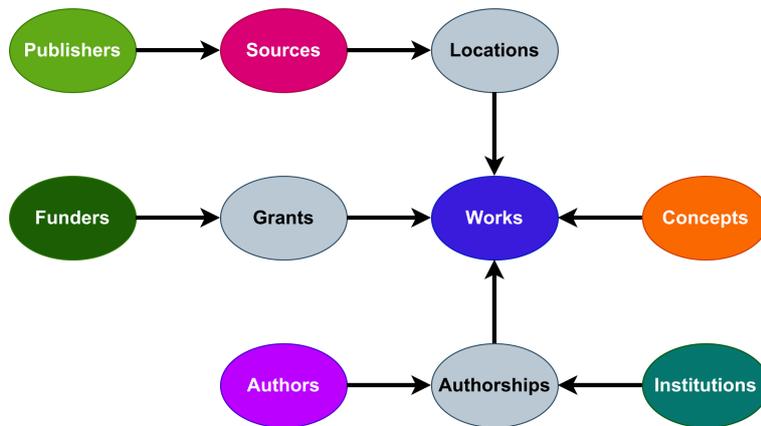

Figure 2. Types of bibliographic units

Usually, the first step of analysis is to prepare a list of interesting works. In the second step, for the works from this list, we create a corresponding collection of bibliographic networks. The collection contains the citation network **Ci** (w **Ci** z ≡ work w cites work z) and two-mode networks: authorship **WA** (w **WA** a ≡ person a is a (co-)author of work w), sources **WJ** (w **WJ** j ≡ work w was published in source j), keywords **WK**, countries **WC**, and work properties: publication year, type of publication, the language of publication, cited by count, countries distinct count, and number of referenced works. We continue with the analysis of the obtained networks.

We are developing an R package, `OpenAlex2Pajek`, for creating bibliographic networks from the OpenAlex database (Batagelj, 2025; OpenAlex, 2024). The basic package version supports the collection of data on selected topics.

In this paper, we present an extension, the function `OpenAlexSources`, that creates a list of works relevant for a selected journal (all papers published by the chosen journal and all works citing/cited by these papers). Since units (works, authors, sources, keywords, etc.) in networks are identified by their OpenAlex IDs, another function, `unitsInfo`, provides the user with additional information about the units appearing in the analysis results.

We applied the new functions to create bibliographic networks for two Slovenian scientific journals Advances in Methodology and Statistics / Metodološki zvezki (AMS/MZ, S4210169332) and Ars Mathematica Contemporanea (AMC, S61442588).

In the paper, for both journals, we present basic analyses of the corresponding collection of networks.

2. Sources

First, let's show that we can retrieve the desired data using the OpenAlex API.

In the following, we will use the following icons: ♣ – in the PDF version of the article, clicking on this icon triggers the use of OpenAlex API from a web browser; ⓡ *n* – see R code *n* in the appendix; 🕷 *n* – see the sequence of Pajek commands *n* in the appendix.

Some strings are longer than a line of text and need to be "broken". The character » at the end of a line means that the string continues on the next line. It is not part of the string.

2.1. Collecting works – API request patterns

If you open these examples in a web browser, they will look much better if you have a browser plug-in such as JSONVue installed.

A. List of works published by a given source (journal) ♣

```
https://api.openalex.org/works?filter=primary_location.source.id:»
S4210169332&select=id,title,type,cited_by_count,publication_year
```

B. List of works citing a given work ♣

```
https://api.openalex.org/works?filter=cites:W4206962290&select=»
id,title,type,cited_by_count,publication_year&per_page=200&page=1
```

C. List of works cited by a given work ♣

```
https://api.openalex.org/works?filter=openalex:W4205437711|»
W4206962290|W2096252182|W4206003933&select=id,title,»
publication_year,referenced_works
```

2.2. Creating the set of relevant works W_r and networks

Let *j* be the selected source (journal). Determine (using **A**) the set W_j of works published in the journal *j*. Now we can determine

- the set W_I of works citing some work from W_j – for each $k \in W_j$ determine (using **B**) the set W_k of works citing the work *k*. The set W_I is the union of all W_ks.
- the set W_O of works cited from some work from W_j – for each $k \in W_j$ determine (using **C**) the set W_k' of works cited by the work *k*. The set W_O is the union of all W_k's.
- the set of relevant works is $W_r = W_I \cup W_j \cup W_O$. To get networks, apply the procedure `OpenAlex2PajekAll` on W_r.

Note that for sources different from *j* only the citations from/to *j* are complete. Other citations consider only cases where at least one end-node is related to a work from the source *j*. The obtained networks can be used to determine the set of relevant sources *J*.

The programming of support for the collection of the selected source data resulted in two functions: `OpenAlexSources`, that creates a list of works relevant for a selected journal (all papers published by the chosen journal and all works citing/cited by these papers), and `unitsInfo`, that provides the user with additional information about the units appearing in the analysis results.

To build networks for a selected source `sID` is now simple. First, we create a list *W* of all works from `sID`, works citing them, and works cited by them. We save the list *W* in a `csv` file. To get the networks, we apply `OpenAlex2PajekAll` on *W*.

3. Advances in Methodology and Statistics / Metodološki zvezki

Metodološki zvezki (MZ) began to be published in book form in 1987. They contained the proceedings of the *Blejsko metodološko srečanje / Bled Methodological Meeting* and its successor *Developments in ....* A total of 21 volumes were published, among them several stand-alone books. The founding editors are Anuška Ferligoj and Andrej Mrvar. In 2004, MZ became a journal with the English title *Advances in Methodology and Statistics* (AMS). It is an open-access journal that focuses on advancing scientific methodology and research through the use of quantitative, qualitative, and mixed methods. It is indexed in SCOPUS, EBSCO, ECONIS, STMA-Z Statistical Theory, PROQUEST, and COBISS. OpenAlex contains data on publications in the journal and some book volumes.

The OpenAlex ID for the *Metodološki zvezki* resource is $sID = S4210169332$. Applying the previously described procedure to it, we get $|W_j| = 238$, $|W_I| = 1423$, and $|W_O| = 4490$, for a total of $|W_r| = 5323$ relevant works. The OpenAlex2PajekAll function expands it into the set W with 157 256 works created by 10 268 authors (including 120 anonymous) and published in 1776 sources. It creates a one-mode citation network **Ci** and two-mode networks **WA** (Authorship), **WJ** (Sources), **WC** (Countries), and **WK** (Keywords). In addition, the node properties include publication year, type of publication, language of publication, cited by count, countries distinct count, and number of referenced works [R A.1].

Before analyses, in Pajek, we first clean the networks **Ci**, **WA**, **WJ**, ..., removing multiple links and loops [B.1]. We obtain networks with $|W| = 157256, |J| = 1776, |A| = 10268$, $m_{Ci} = 233191, m_{WJ} = 5294, m_{WA} = 13491$, etc.

3.1. Works citing/cited by the journal MZ

Citation is a kind of voting. Therefore, it is interesting to determine
- works from the MZ that are most frequently cited – the most notable works published in MZ
- works that are most frequently cited by works from the MZ – indicate areas that the MZ deals with

First, we compute the set W_j of all works published by the journal j

$$W_j = \{w \,:\, WJ[w, j] > 0\}.$$

Let $\mathbf{w}_j$ be its characteristic vector – the j's column in the network matrix **WJ**. In Pajek, we obtain it as the 1-in-neighbors of node j in the network **WJ** [B.2].

Using W_j, we can extract the corresponding years from the year partition and obtain the frequency distribution of MZ works in OpenAlex per year, as presented in Figure 3 [B.3]. It seems that the journal MZ has had occasional problems obtaining articles over the last decade.

The most frequently cited works published in the journal MZ can be identified as the top works in $\mathbf{d}_j$ – the input degrees vector of citation network **Ci** restricted to the works W_j [B.2]. In Pajek, we inspect the vector $\mathbf{d}_j$ and list the largest 50 nodes [+50]. We can check selected works – for example ♣ W2096252182. We copy the selected top lines into a text editor (TextPad) and further extract the Value and Id columns and save them to a CSV file dI.csv [B.4].

In R, we collect additional information about the selected works from OpenAlex. It turns out that the authors' names are not directly accessible as a data field; they are contained within the field authorships. To extract them, we use the function authors [R A.2]. Now we are ready to get the information about the selected works. Some data (authors and title) can be very long. To get a readable report, we truncate them [R A.3].

Table 1. Most frequently cited works published in the journal MZ.

|	wID	year	dj	authors	title
1	W2096252182	2006	122	M Vuk	ROC curve, lift chart and calibration plot
2	W4205437711	2021	93	J Stare, D Maucort-Boulch	Odds ratio, hazard ratio and relative risk
3	W4206281730	2004	50	A Žiberna, N Kejžar, P Golob	Comparison of different approaches to hierarchical clus
4	W4206003933	2019	49	D Fink-Hafner, T Dagen, M Doušak, M Nov	Delphi method
5	W4205792358	2004	33	M Pohar Perme, M Blas, S Turk	Comparison of logistic regression and linear discrimina
6	W3163535942	2011	33	A Göktaş, Ö İşçi Güneri	Comparison of the most commonly used measures of associ
7	W2182964678	2009	29	V Hlebec, M Mrzel, T Kogovšek	Social support network and received support at stressfu
8	W4205589890	2014	29	K Lozar Manfreda, V Vehovar, V Hlebec	Collecting ego-centred network data via the Web
9	W2181453067	2004	23	V Vehovar, E Belak, Z Batagelj, S Čikić	Mobile phone surveys
10	W2188947830	2005	22	AS Göritz	Contingent versus unconditional incentives in WWW-studi
11	W2181703841	2004	21	RD Tortora	Response trends in a national random digit dial survey
12	W4285417151	2021	19	FN Nwobi, F Akanno	Power comparison of ANOVA and Kruskal-Wallis tests when
13	W4205243627	2006	16	K Faust	Comparing social networks
14	W2181744505	2008	15	N Lavrač, D Jesenovec, N Trdin, N Mramo	Mining spatio-temporal data of traffic accidents and sp
15	W2182840202	2005	15	V Hlebec, T Kogovšek	Hypothetical versus actual support providers in compara
16	W2187948374	2006	15	SS Yahaya, AJ Othman, HJ Keselman	Comparing the "typical score" across independent groups
17	W4206431867	2013	14	A Žiberna	Generalized blockmodeling of sparse networks
18	W2186792288	2005	14	T Kogovšek, V Hlebec	Effects of limitation of number of alters and time fram
19	W4206744517	2012	13	D Karagöz, C Hamurkaroğlu	Control charts for skewed distributions
20	W4256052055	2021	13	J Mali, V Grebenc	Researching long-term care for older people using the R
21	W4254418209	2006	13	T Kogovšek	Reliability and validity of measuring social support ne
22	W2183723159	2005	13	M Sever, J Lajovic, B Rajer	Robustness of the Fisher's discriminant function to ske
23	W4206962290	2015	12	A Ferligoj	How to improve statistical literacy?
24	W4205150564	2004	12	D DeLange, F Agneessens, H Waege	Asking social network questions
25	W4205784087	2014	11	P Doreian, A Mrvar	Testing two theories for generating signed networks usi
26	W4205451374	2009	11	A Žiberna	Evaluation of direct and indirect blockmodeling of regu
27	W2188452501	2006	10	JHP Hoffmeyer-Zlotnik, U Warner	Methodological discussion of the income measure in the
28	W2183777063	2012	9	A Žnidaršič, P Doreian, A Ferligoj	Absent ties in social networks, their treatments, and b
29	W2113917668	2004	9	A Mrvar, V Batagelj	Relinking marriages in genealogies
30	W2105720724	2004	9	A Petrucci, N Salvati, C Seghieri	Autologistic regression model for poverty mapping and a
31	W2184576020	2009	9	T Kogovšek, V Hlebec	Stability of typologies produced on the basis of repeat
32	W2188310091	2009	9	JHP Hoffmeyer-Zlotnik, U Warner	Private household concepts and their operationalisation
33	W2160098819	2004	8	JM Batista-Foguet, G Coenders, WE Saris	Simultaneous estimation of indirect and interaction eff
34	W2185288456	2007	8	C Quintano, R Castellano, G Punzo	Estimating poverty in the Italian provinces using small
35	W4206364318	2021	8	N Berzelak, V Vehovar	Mode effects on socially desirable responding in web su
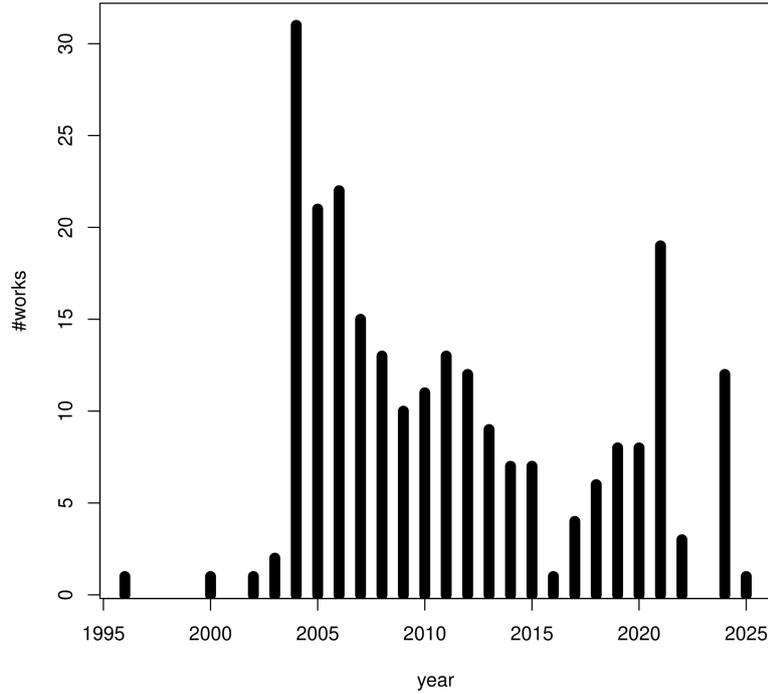
Figure 3. Number of MZ works in OpenAlex per year

The list of the most cited MZ works is presented in Table 1. For a given work, `wID` is its OpenAlex ID, `year` is its publication year, and `dj` is its input degree.

The product $\mathbf{u} = \mathbf{A} \cdot \mathbf{v}$ of the network $\mathbf{A}$ with the vector $\mathbf{v}$ is defined as

$$u_i = \sum_{j\,:\,(i,j)\in L} A_{ij} \cdot v_j$$

The vectors $\mathbf{d}_I = \mathbf{Ci} \cdot \mathbf{w}_j$ and $\mathbf{d}_O = \mathbf{Ci}^T \cdot \mathbf{w}_j$

$$d_I(i) = \sum_k Ci[i,k] \cdot w_j(k) = \sum_{k \in W_j} Ci[i,k] \quad \text{and}$$

$$d_O(i) = \sum_k Ci^T[i,k] \cdot w_j(k) = \sum_k Ci[k,i] \cdot w_j(k) = \sum_{k \in W_j} Ci[k,i]$$

count: $d_I(i)$ - how many works from W_j are cited by the work i; and $d_O(i)$ - how many works from W_j are citing the work i [🕷 B.4].

Vector $\mathbf{d}_I$ is not particularly interesting, while vector $\mathbf{d}_O$ answers the second question from the beginning of this subsection – the top works cited by the journal MZ (see Table 2). For a given work, `wID` is its OpenAlex ID, `cby` is its cited by count (number of citations in OpenAlex), `dO` is the number of works from MZ that cite it, and `year` is its publication year. The most cited work by the MZ journal is the R software package, which is the basic tool for data analysis. Most of the remaining works in the table deal with network analysis and measurements (surveys, reliability, and validity).

Similarly, vector $\mathbf{a}_j$ provides us with information about the most *frequent authors in the source j*

$$\mathbf{a}_j = \mathbf{WA}^T \cdot \mathbf{w}_j$$

$a_j(a) = $ # of works in the journal j co-authored by the author a (see Table 3) and the set $A_j = \{a \in A : a_j(a) > 0\}$ of *authors with works published in the source j.*

Table 2. The top works cited by the journal MZ

	wID	cby	dO	year	authors	title
1	W2582743722	352806	19	2000	R Core Team	R: A Language and Environment for Statistical Comp
2	W2061901927	18140	10	2019	S Wasserman, K Faust	Social network analysis methods and applications
3	W977705565	470	9	2004	P Doreian, V Batagelj, A Ferligoj	Generalized Blockmodeling
4	W2023723604	128	9	1992	V Batagelj, A Ferligoj, P Doreian	Direct and indirect methods for structural equival
5	W2116814842	67	8	2002	T Kogovšek, A Ferligoj, G Coenders, WE+	Estimating the reliability and validity of persona
6	W1987455866	265	7	1973	PW Holland, S Leinhardt	The structural implications of measurement error i
7	W2017099446	1664	7	1971	F Lorrain, HC White	Structural equivalence of individuals in social ne
8	W2001947224	103	7	1992	V Batagelj, P Doreian, A Ferligoj	An optimization approach to regular equivalence
9	W4205589890	28	6	2014	KL Manfreda, V Vehovar, V Hlebec	Collecting ego-centred network data via the Web
10	W2182840202	15	6	2005	V Hlebec, T Kogovšek	Hypothetical versus actual support providers in co
11	W2186748749	15	6	2006	P Ziherl, H Iglič, A Ferligoj	Research Groups' Social Capital: A Clustering Appr
12	W1893868194	14	6	2006	LC Soler	Social networks and performance in knowledge creat
13	W2151243887	85	6	2006	A Žiberna	Generalized blockmodeling of valued networks
14	W2054720216	109	6	1999	A Ferligoj, V Hlebec	Evaluation of social network measurement instrumen
15	W1556604050	1109	6	1989	A Vaux	Social support: theory, research, and intervention
16	W2133011836	357	6	1983	DR White, K Reitz	Graph and semigroup homomorphisms on networks of r
17	W1981385379	198	6	2004	P Doreian, V Batagelj, A Ferligoj	Generalized blockmodeling of two-mode network data
18	W2109278577	1397	6	1999	V Batagelj, A Mrvar	Pajek – Program for Large Network Analysis
19	W1873057782	4472	5	2000	R Tourangeau, LJ Rips, KA Rasinski	The Psychology of Survey Response
20	W2186792288	14	5	2005	T Kogovšek, V Hlebec	Effects of limitation of number of alters and time
21	W2103535733	9	5	2007	AMC Artigues, LC Soler, A Ferligoj, U+	Networks of PhD Students and Academic Performance:
22	W2065231053	4000	5	2000	RS Burt	The Network Structure Of Social Capital
23	W4245436919	3201	5	1963	JH Ward	Hierarchical Grouping to Optimize an Objective Fun
24	W2010398643	2268	5	1991	JA Krosnick	Response strategies for coping with the cognitive
25	W2040622755	1589	5	1995	S Sudman, NM Bradburn, N Schwarz	Thinking About Answers: The Application of Cogniti
26	W1997733761	1864	5	1987	PV Marsden	Core Discussion Networks of Americans
27	W1967398990	220	5	1999	S Bailey, PV Marsden	Interpretation and interview context: examining th
28	W2057126414	519	5	1978	L McCallister, CS Fischer	A Procedure for Surveying Personal Networks
29	W2107592916	809	5	2005	ED de Leeuw	To mix or not to mix data collection modes in surv
30	W4300534085	606	5	2003	PP Biemer, L Lyberg	Introduction to Survey Quality
31	W1987971958	19137	4	1987	PJ Rousseeuw	Silhouettes: A graphical aid to the interpretation

Table 3. The top authors by the number of works in the journal MZ

	aID	ORCID	wc	cby	papers	name
1	A5038897789	0000-0002-3691-7959	160	2391	18	Valentina Hlebec
2	A5049753566	0009-0001-4355-8608	60	642	14	Tina Kogovšek
3	A5029499420	0000-0002-3682-6854	139	2740	12	Anuška Ferligoj
4	A5039511070	0000-0002-5204-6882	153	3696	10	Germà Coenders
5	A5040950908	<NA>	65	2024	8	Katarina Košmelj
6	A5083575454	0000-0002-3253-7959	145	4129	6	Vasja Vehovar
7	A5023248667	<NA>	59	217	6	Uwe Warner
8	A5010863389	0000-0003-1534-6971	41	443	6	Aleš Žiberna
9	A5068940001	<NA>	51	3063	5	Katja Lozar Manfreda
10	A5025019965	0000-0001-6461-3007	86	661	5	Rosalia Castellano
11	A5002890522	0000-0001-7851-6216	109	678	4	Jana Mali
12	A5044693419	0000-0003-0769-0633	79	1179	4	Lluís Coromina
13	A5019207040	0000-0002-2564-8781	70	3835	4	Janez Stare
14	A5033311124	0000-0001-8557-4692	100	8835	4	Andrej Mrvar
15	A5001676164	0000-0002-0240-9446	271	13374	4	Vladimir Batagelj
16	A5046373528	0000-0002-2248-1517	68	376	4	Irena Ograjenšek
17	A5041301436	0000-0003-3069-9863	66	743	4	Nataša Kejžar
18	A5022627222	<NA>	160	1316	4	JHP Hoffmeyer-Zlotnik
19	A5052875930	0000-0001-7906-0580	1024	13664	4	Darío Gregori
20	A5102781233	0000-0002-5550-7007	131	401	4	Malgorzata Graczyk
21	A5025045918	0000-0002-5395-1593	113	280	4	Bronislaw Ceranka
22	A5011534481	<NA>	28	102	3	Anton Cedilnik
23	A5065490876	0000-0002-3301-7840	182	5385	3	Patrick Doreian
24	A5055592225	0000-0001-6861-9553	68	579	3	Gennaro Punzo
25	A5084724910	0000-0003-4261-8928	89	1241	3	Giuseppe Scandurra

For a given author, `aID` is his/her OpenAlex ID, `ORCID` is his/her Open Researcher and Contributor ID, `wc` is his/her work count (number of works in OpenAlex), `cby` is his/her cited by count (number of citations in OpenAlex), `papers` is the number of his/her works published in MZ, and `name` is the author's name. The top authors in MZ come from the Faculty of Social Sciences, University of Ljubljana (the initial publisher of MZ), participants in statistical meetings in Preddvor and Ribno, collaborators of IRMCS (International Research group on Methodology and Comparative Survey research, led by Willem Saris), and teachers at the postgraduate study of statistics at the University of Ljubljana.

3.2. Citations between authors (and journals)

Network multiplication is defined by multiplying the associated matrices. In network analysis, it allows us to introduce *derived* networks. For example, the network $\mathbf{AJ} = \mathbf{WA}^T \cdot \mathbf{WJ}$ connects authors to sources – $AJ[a, j]$ = number of works by author a published in source j (Batagelj, 2020; Batagelj & Cerinšek, 2013; Batagelj & Maltseva, 2020).

In our analysis, we will look at the derived *network of citations between authors*

$$\mathbf{ACiA} = \mathbf{WA}^T \cdot \mathbf{Ci} \cdot \mathbf{WA}$$

$ACiA[a, b]$ = number of times author a cites author b ≡ number of citations of a work of author a to a work of author b. [🕷 B.6].

and the *network of citations between sources*

$$\mathbf{JJ} = \mathbf{WJ}^T \cdot \mathbf{Ci} \cdot \mathbf{WJ}$$

$JJ[i, k]$ = number of times journal i cites journal k ≡ number of citations of a work from journal i to a work from journal k.

For MZ networks, the network **ACiA** has $n_{ACiA} = 10268$ nodes, $m_{ACiA}^A = 119301$ links, and 701 loops. Using `Network/Info/Line values`, we select the threshold $t = 15$. We make
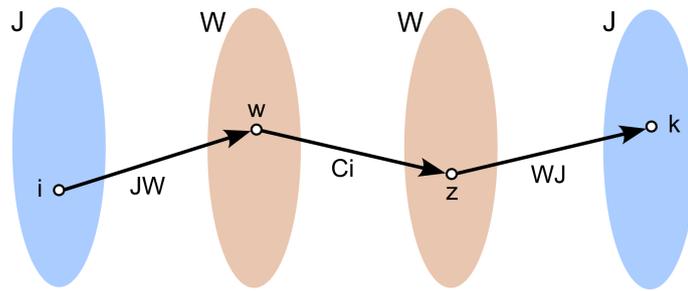
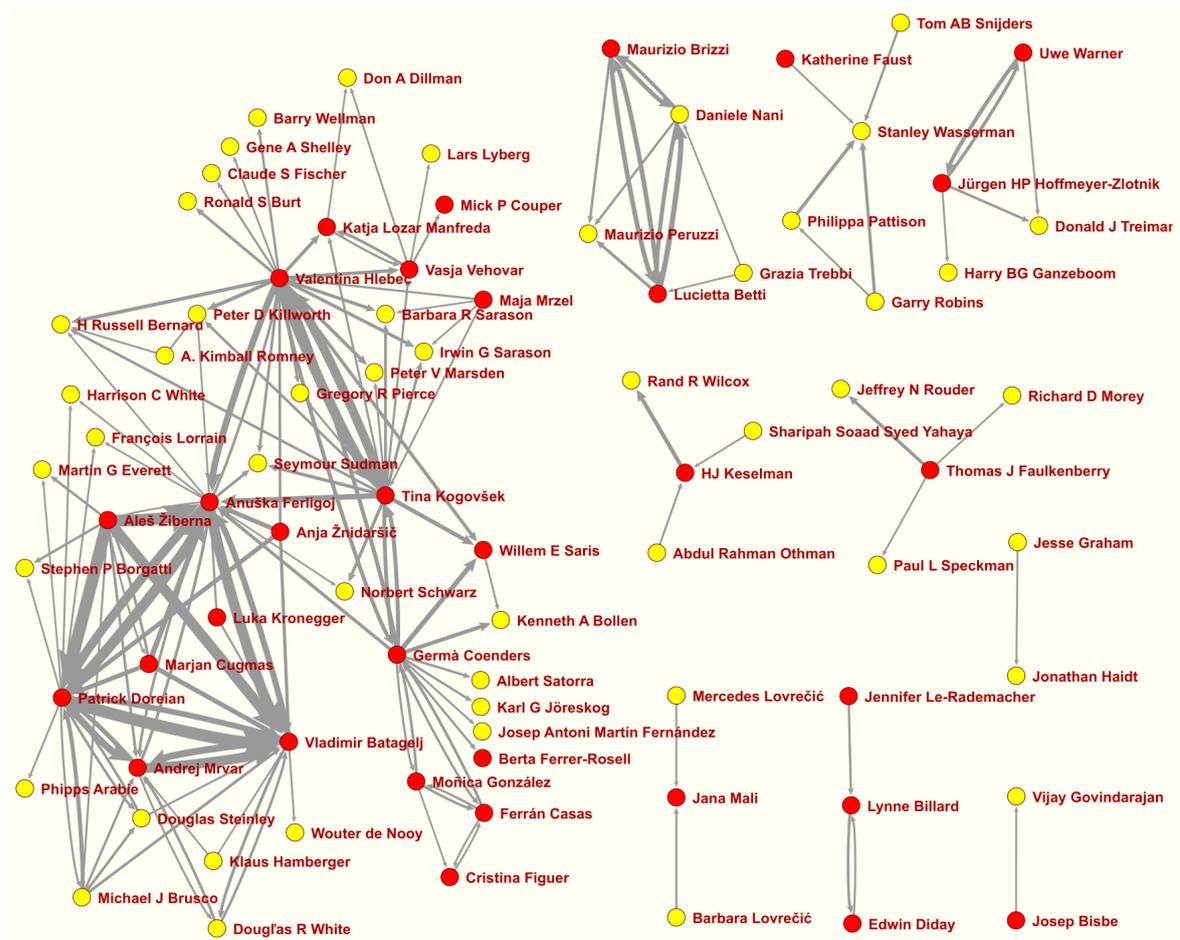**Figure 4.** Derived network of citations between authors

Figure 5. MZ citations between authors (link cut at level 15, loops removed)
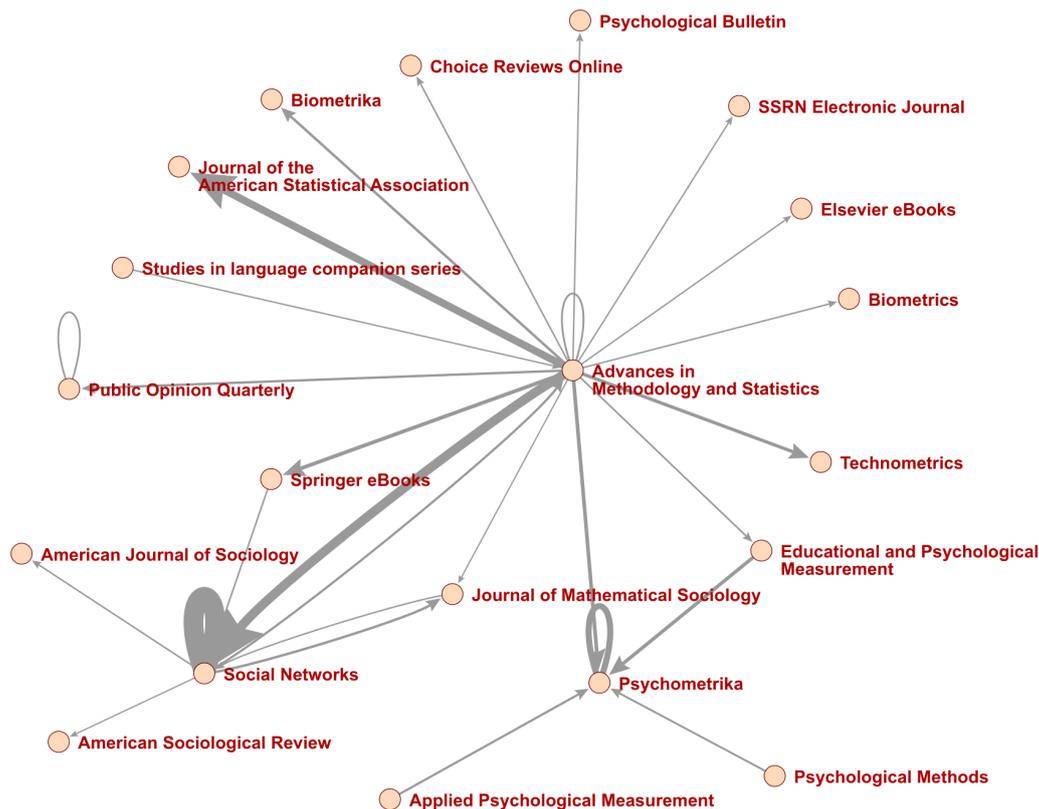
Figure 6. MZ citations between journals (link cut at level 30, Sunknown removed)

a link cut at level *t*. [🕷 B.7]. See Figure 5. In the layout of the link cut, the MZ authors are presented with red circles, and the rest with yellow. The cut consists of several (connectivity) components. The largest consists of authors in the field of network analysis, which is also the topic of the members of the Katharine Faust component. Maurizio Brizzi was a regular participant in the meetings in Preddvor and Ribno. Jürgen HP Hoffmeyer-Zlotnik was a member of the IRMCS group. The members of the Lynne Billard component worked on symbolic data analysis.

For journals, we get $n_{JJ} = 1776$ nodes, $m_{JJ}^A = 8382$ links, and 141 loops. Using Network/Info/Line values, we select the threshold $t = 30$. We make a link cut at level *t*. The display of citations between journals in Figure 6 shows that the main areas on which the journal MZ (Advances in Methodology and Statistics) relies are network analysis (Social Networks), statistics (Journal of the American Statistical Association), psychology (Psychometrika, Psychological Bulletin, Educational and Psychological Measurement), biometrics (Biometrika, Biometrics), and sociology (Public Opinion Quarterly, Journal of Mathematical Sociology).

4. Ars Mathematica Contemporanea

Ars Mathematica Contemporanea (AMC) is an open-access journal established in 2008. The founding editors are Dragan Marušič and Tomaž Pisanski. It aims to publish peer-reviewed, high-quality articles in contemporary mathematics that arise from the discrete and concrete mathematics paradigm. It favors themes that combine at least two different fields of mathematics. It is indexed in MathSciNet, zbMATH, COBISS, SCOPUS, SCIE, Web of Science, ISI Alerting Service, CC/PC & ES, DBLP, dLib.si, DOAJ, and OpenAlex.

In Slovenia, graph theory (especially topological and algebraic) and combinatorics gained importance in the 1980s (Pisanski, Marušič, Mohar, Batagelj). They were connected within
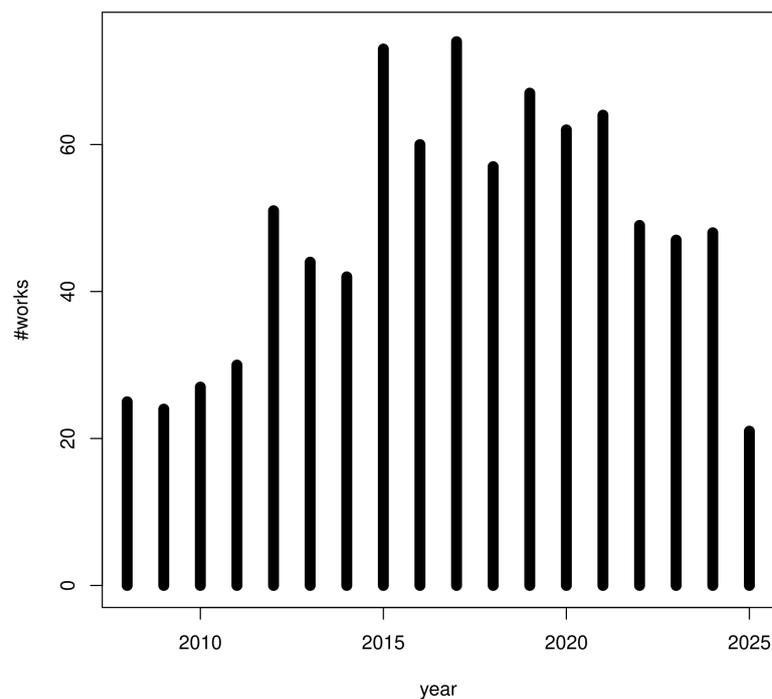
Figure 7. Number of AMC works in OpenAlex per year

Yugoslavia (Cvetković, YU seminar, Math/Chem/Comp) and internationally - Leoben (Imrich, Leoben-Ljubljana seminar), Bratislava (Škoviera), and beyond (Slovenian Conference on graph theory). In the 1990s, a group was formed at the University of Maribor (Klavžar), and in the 2000s, another group was formed in Koper at the University of Primorska (Marušič).

When analyzing the AMC journal networks, we follow the same steps as when analyzing the MZ journal. The OpenAlex ID of the AMC journal is sID = S61442588. The trace of the construction of the AMC network collection is shown in Section A.4.

For the cleaned AMC networks **Ci**, **WA**, and **WJ** we get $|W| = 137751$, $|J| = 1192$, $|A| = 10849$, $m_{Ci} = 290906$, $m_{WJ} = 12691$, and $m_{WA} = 28153$.

The frequency distribution of AMC works per year is presented in Figure 7. At least 20 articles are published in AMC every year, sometimes even more than 60. The list of the most cited AMC works is presented in Table 4.

The top works cited by the journal AMC are listed in Table 5. The works most cited from the AMC journal are *The Magma Algebra System I* and *Topological Graph Theory*. The other works in the table deal with topological and/or algebraic graph theory, (finite) group theory, graph theory, and combinatorics.

Most of the authors with the largest number of works in AMC in Table 6 are either Slovenian graph theorists or their international collaborators.

In the network of citations between authors, we select the threshold $t = 75$ and produce a link cut at level t. See Figure 8. Unlike MZ, this display is dominated by red nodes – most of the authors shown publish in AMC. The largest component has Dragan Marušič at its center, and the second has Sandi Klavžar.

In the network of citations between journals, we select the threshold $t = 50$. We make a link cut at level t. The network of citations between journals for MZ is tree-like. For the journal AMC (Ars Mathematica Contemporanea) in Figure 9, it is much more intertwined. The main sources for AMC are journals Discrete Mathematics, J Combinatorial Theory – Series B, J Graph Theory, European J Combinatorics, Discrete Applied Mathematics, and

Table 4. Most frequently cited works published in the journal AMC

	wID	year	dj	authors	title
1	W1901228607	2008	208	T Došlić	Vertex-weighted Wiener polynomials for composite graphs
2	W1820867527	2009	74	B Grünbaum	A catalogue of simplicial arrangements in the real projec
3	W1718680046	2014	57	P Potočnik, P Spiga, G Verret	A census of 4-valent half-arc-transitive graphs and arc-t
4	W2303469705	2016	51	V Andova, F Kardoš, R Škrekovski	Mathematical aspects of fullerenes
5	W1914506312	2008	50	MO Albertson	Chromatic number, independence ratio, and crossing number
6	W1921033683	2012	48	KC Das, DW Lee, A Graovac	Some properties of the Zagreb eccentricity indices
7	W1928275852	2013	45	D Korže, A Vesel	On the packing chromatic number of square and hexagonal l
8	W2115067923	2014	45	G Huang, M Kuang, H Deng	The expected values of Kirchhoff indices in the random po
9	W2164875551	2010	43	M DeVoss, K Kawarabayashi, B Mohar, +	Immersing small complete graphs
10	W1708699344	2014	43	D Dimitrov, R Škrekovski	Comparing the irregularity and the total irregularity of
11	W2108501738	2009	42	G Indulal	Distance spectrum of graph compositions
12	W2601058736	2017	39	G Košmrlj	Domination game on paths and cycles
13	W2982375418	2020	38	D Bartoli, C Zanella, F Zullo	A new family of maximum scattered linear sets in PG(1,q6^
14	W1947309533	2008	37	S Wilson	Rose window graphs
15	W1808614301	2014	37	M Conder, P Potočnik, P Šparl	Some recent discoveries about half-arc-transitive graphs
16	W2127740732	2009	37	M Petkovšek, H Zakrajšek	Enumeration of I-graphs: Burnside does it again
17	W2101890136	2011	36	M Muzychuk, I Ponomarenko	On pseudocyclic association schemes
18	W1899495372	2009	35	D Leemans, E Schulte	Polytopes with groups of type PGL_2(q)
19	W1851229946	2009	35	T Pisanski, J Žerovnik	Edge-contributions of some topological indices and arbore
20	W2145289104	2014	33	D Stevanović, I Gutman, MU Rehma	On spectral radius and energy of complete multipartite gr
21	W1847899263	2015	33	S Praprotnik, V Batagelj	Spectral centrality measures in temporal networks
22	W2567105523	2016	32	MR Oboudi	Characterization of graphs with exactly two non-negative
23	W2602072253	2019	32	NJ Cavenagh, JH Dinitz, D Donovan, +	The existence of square non-integer Heffter arrays
24	W2128139669	2012	32	D Pellicer	Developments and open problems on chiral polytopes
25	W1936736521	2012	31	A Devillers, W Jin, CH Li, CE Praeger	Line graphs and geodesic transitivity
26	W2962759531	2018	30	JA Rodríguez-Velázquez	On the k-metric dimension of metric spaces
27	W1930124199	2011	29	K Choo, G MacGillivray	Gray code numbers for graphs
28	W1911731259	2008	29	Irene Sciriha	Coalesced and embedded nut graphs in singular graphs
29	W1784030948	2013	29	P Moravec	Unramified Brauer groups and isoclinism
30	W1919033776	2011	29	I Kovács, R Nedela	Decomposition of skew-morphisms of cyclic groups
31	W2613505588	2017	28	M Pilšniak	Improving upper bounds for the distinguishing index
32	W2969487462	2019	28	Z Stanić	Integral regular net-balanced signed graphs with vertex d
33	W2962686173	2016	27	C Godsil, K Meagher	An algebraic proof of the Erdős-KO-Rado theorem for inter

Table 5. The top works cited by the journal AMC

	wID	year	cby	d0	authors	title
1	W1558273801	2003	1449	45	T Pisanski, P Potočnik, J Chen, +	Topological Graph Theory
2	W1976677460	1997	7113	45	W Bosma, J Cannon, C Playoust	The Magma Algebra System I: The User Language
3	W4298236575	1989	2073	29	AE Brouwer, AM Cohen, A Neumaier	Distance-Regular Graphs
4	W2490805901	2011	1006	25	RH Hammack, W Imrich, S Klavžar	Handbook of Product Graphs
5	W51037165	2002	429	22	P McMullen, E Schulte	Abstract Regular Polytopes
6	W1480793893	2009	159	22	B Grünbaum	Configurations of Points and Lines
7	W3138922280	2013	256	21		Topological Graph Theory
8	W2917893419	1964	1274	21		Finite Permutation Groups
9	W2051170661	1966	1663	21	F Haimo, H Wielandt	Finite Permutation Groups
10	W2060397425	1978	325	20	GA Jones, D Singerman	Theory of Maps on Orientable Surfaces
11	W2798943694	1996	1412	20	B Mortimer, JD Dixon	Permutation Groups
12	W247697463	2001	4813	17	C Godsil, G Royle	Algebraic Graph Theory
13	W1855706715	1996	271	16	MO Albertson, KL Collins	Symmetry Breaking in Graphs
14	W2117862969	1998	282	16	M Xu	Automorphism groups and isomorphisms of Cayley digraphs
15	W2490728539	1967	5120	16	B Huppert	Endliche Gruppen I
16	W4234295943	1996	877	16	J D. Dixon, B Mortimer	Permutation Groups
17	W1515707356	1974	2981	16	N Biggs	Algebraic Graph Theory
18	W4300303686	1977	3016	15	E Kay, JA Bondy, USR Murty	Graph Theory with Applications
19	W1493071618	2013	3279	15	TW Haynes, ST Hedetniemi, PR Slater	Fundamentals of Domination in Graphs
20	W2318794083	1947	4018	14	H Wiener	Structural Determination of Paraffin Boiling Points
21	W2052414950	1972	1494	14	HSM Coxeter, WOJ Moser	Generators and Relations for Discrete Groups
22	W2126209209	2007	3371	13	NJA Sloane	The On-Line Encyclopedia of Integer Sequences
23	W2963223390	2012	93	13	P Potočnik, P Spiga, G Verret	Cubic vertex-transitive graphs on up to 1280 vertices
24	W2023601405	1981	301	13	C Godsil	On the full automorphism group of a graph
25	W1581293664	1984	714	12	E Sakauchi, T Ito	Algebraic combinatorics I : association schemes
26	W2138033161	2011	1995	12	AE Brouwer, WH Haemers	Distance-Regular Graphs
27	W2068845873	2000	160	12	A Malnič, R Nedela, M Škoviera	Lifting Graph Automorphisms by Voltage Assignments
28	W71943752	2000	815	12	W Imrich, S Klavžar	Product graphs: structure and recognition
29	W2094583082	2002	126	11	CH Li	On isomorphisms of finite Cayley graphs–a survey
30	W2063976358	1993	317	11	CE Praeger	An O'Nan-Scott Theorem for Finite Quasiprimitive Permutat
31	W1997799442	1964	331	11	G Sabidussi	Vertex-transitive graphs
32	W594463866	2001	854	11	B Mohar, C Thomassen	Graphs on Surfaces
33	W2141456319	1977	183	11	L Babai	Isomorphism problem for a class of point-symmetric struct
34	W2798588639	1997	5021	11	R Diestel	Graph Theory
35	W599531250	2012	69	10	T Pisanski, B Servatius	Configurations from a Graphical Viewpoint

Table 6. The top authors by the number of works in the journal AMC

	aID	ORCID	wc	cby	papers	name
1	A5009207700	0000-0002-1257-5376	310	4639	38	Tomaž Pisanski
2	A5028549991	0000-0002-8452-3057	235	5157	27	Dragan Marušič
3	A5083674096	0000-0001-6851-3214	324	3542	17	Riste Škrekovski
4	A5036402562	0000-0002-9836-6398	124	877	12	Klavdija Kutnar
5	A5061875089	0000-0002-0256-6978	241	3016	12	Marston Conder
6	A5011391021	0000-0002-8353-896X	176	1412	11	Jin-Xin Zhou
7	A5103154620	0000-0001-5028-3545	159	2987	10	Primož Potočnik
8	A5081540165	0000-0002-3734-723O	74	427	9	Monika Pilśniak
9	A5000602953	0000-0002-5901-7646	220	2813	9	Jozef Širáň
10	A5078908489	0000-0002-4439-502X	184	1130	9	Dimitri Leemans
11	A5004612329	0000-0002-4949-4203	198	1037	9	Zoran Stanić
12	A5025392880	0000-0002-0157-7405	343	1703	9	Pablo Spiga
13	A5013070295	0000-0003-4245-9226	78	1472	9	Aleksander Malnič
14	A5085576668	0000-0003-3214-0609	224	2309	8	Yan-Quan Feng
15	A5101478915	0000-0002-2564-9530	162	5093	8	Jonathan L. Gross
16	A5036070439	0000-0003-1766-4834	130	690	8	Gabriel Verret
17	A5043525348	0000-0002-0881-7336	770	8480	8	Cheryl E. Praeger
18	A5009892196	0000-0003-2416-669X	147	818	7	Joy Morris
19	A5089379545	0000-0002-6041-1106	239	1581	7	Janez Žerovnik
20	A5039728806	0000-0002-5477-6803	92	927	7	Irene Sciriha
21	A5101686757	0000-0002-7082-7025	226	3198	7	Gareth A. Jones
22	A5083411825	0000-0002-8326-513X	136	2103	7	Tomislav Došlić
23	A5037896222	0000-0002-0475-9335	170	4124	7	Wilfried Imrich
24	A5049148828	0000-0002-1556-4744	647	11134	7	Sandi Klavžar
25	A5066245855	0000-0002-9826-704X	151	1949	7	Roman Nedela
26	A5059638892	0000-0002-2878-0745	98	556	7	Štefko Miklavič
27	A5071017819	0000-0001-5412-4656	386	4954	6	Michael Giudici
28	A5066088171	0000-0002-9082-7647	183	3747	6	JA Rodríguez-Velázquez
29	A5113798192	\<NA\>	134	759	6	Dave Witte Morris
30	A5047753351	0000-0003-2106-1104	447	14010	6	Patrick W. Fowler
31	A5022919726	0000-0002-7868-6925	104	2911	6	Thomas W. Tucker
32	A5089473322	0000-0001-8185-067X	735	10163	6	Michael A. Henning
33	A5054789661	0000-0003-0935-5724	64	175	6	Leah Wrenn Berman
34	A5075057406	0000-0002-1034-3993	129	2899	6	Brian Alspach
35	A5033117907	0000-0002-2108-7518	139	1830	6	Martin Škoviera
36	A5034441122	0000-0001-9689-9302	57	331	5	Nico Van Cleemput
37	A5058613293	0000-0001-7682-3917	53	187	5	I. A. Mednykh
38	A5069872796	0000-0002-5147-9344	14	149	5	Imran F. Khan
39	A5006147730	\<NA\>	67	600	5	Shaofei Du
40	A5085909262	0000-0002-4190-7050	279	1484	5	Vadim E. Levit

Figure 8. AMC citations between authors (link cut at level 75, loops removed)
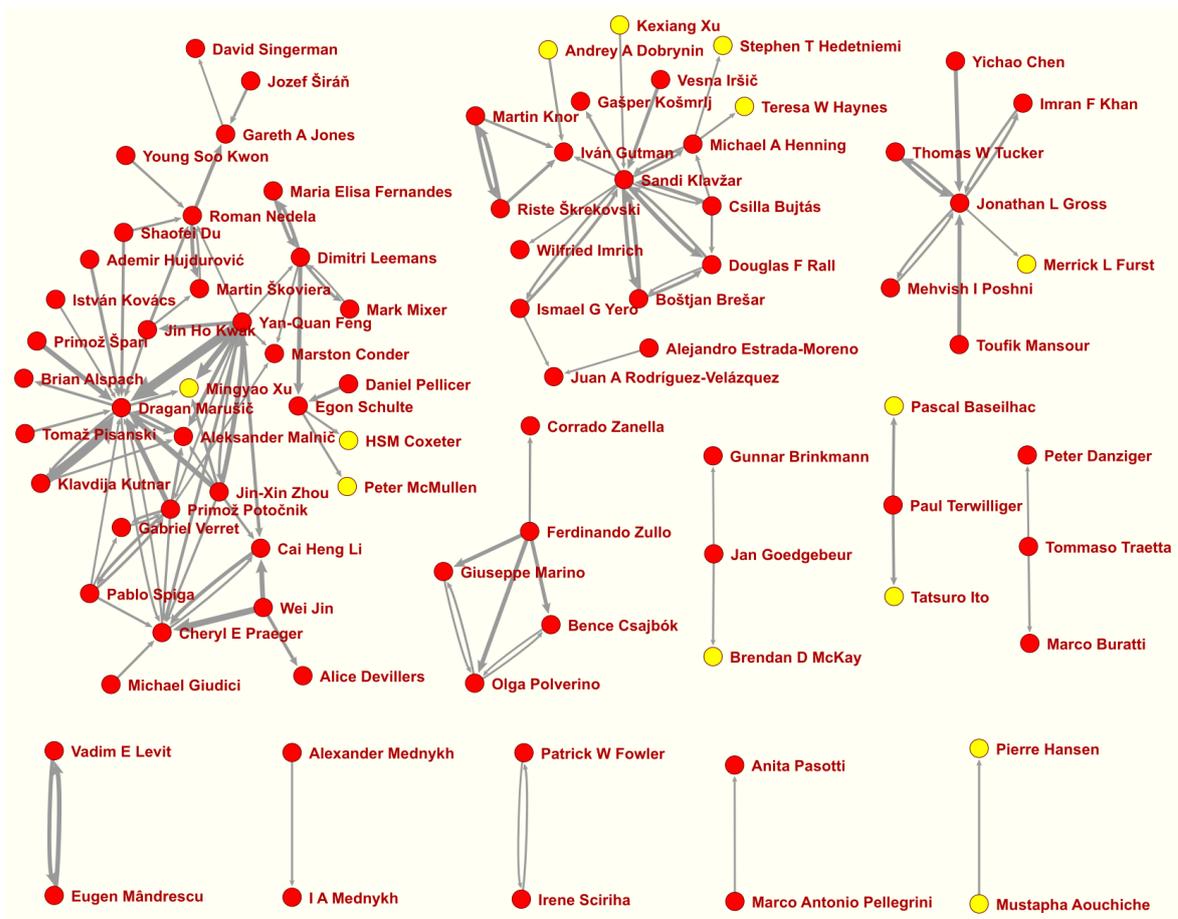
Figure 9. AMC citations between journals (link cut at level 50, loops and Sunknown removed)

The Electronic J Combinatorics. Other journals include fields such as algebra, geometry, computer science, coding and cryptography, and chemistry.

5. Conclusions

In this article, we present the results of some basic analyses of bibliographic networks of Slovenian journals MZ (Metodološki zvezki – Advances in Methodology and Statistics) and AMC (Ars Mathematica Contemporanea). The presented approach can be applied to any journal indexed by OpenAlex. The analyses can be further extended, for example, by keyword analysis (Maltseva & Batagelj, 2020), by using the fractional approach (Batagelj, 2020), and by temporal analyses (Batagelj & Maltseva, 2020).

The data in the OpenAlex database is not completely error-free. Most errors can be considered as noise – important units will float to the surface. If the error is serious and is reflected in the final result (for example, units with multiple OpenAlex IDs), we correct it accordingly in networks and repeat the analysis. We can also contribute to the quality of the data in the OpenAlex database by informing the database maintainers about errors.

6. Acknowledgments

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A. R code

A.1. ® *Creating bibliographic networks for MZ*

Creating networks for *Advances in Methodology and Statistics – Metodološki zvezki*

```
> setwd(wdir <- "C:/test/OpenAlex/sources/MZ")
> library(httr); library(jsonlite)
> bavla <- "https://raw.githubusercontent.com/bavla/"
> source(paste0(bavla,"Rnet/master/R/Pajek.R"))
> source(paste0(bavla,"OpenAlex/main/code/OpenAlex2Pajek.R"))
> sID <- "S4210169332"
> R <- OpenAlexSources(sID,step=250)
OpenAlex2Pajek / Sources Mon May 26 05:08:49 2025
  238 source S4210169332 works collected Mon May 26 05:08:50 2025
 1423 citing works collected Mon May 26 05:10:29 2025
 4490 cited works collected Mon May 26 05:10:31 2025
 5323 different works Mon May 26 05:10:31 2025
> csv <- file("worksMZ.csv","w",encoding="UTF-8")
> write(R,sep="\n",file=csv)
> close(csv)
> OpenAlex2PajekAll(NULL,name="MZ",listF="worksMZ.csv")
OpenAlex2Pajek / All - Start Mon May 26 05:12:37 2025
*** OpenAlex2Pajek / All - Process Mon May 26 05:12:37 2025
...
*** OpenAlex2Pajek / All - Data Collected Mon May 26 05:46:36 2025
hits: 5323 works: 157256 authors: 10268 anon: 120 sources: 1776
>>> Citation Cite
>>> publication year, type of publication, language of publication
>>> cited by count, countries distinct count, referenced works
>>> Authorship WA, Sources WJ, Countries WC, Keywords WK
*** OpenAlex2Pajek / All - Stop Mon May 26 05:47:50 2025
```

A.2. ® *Function authors*

```
authors <- function(L) {
  A <- L$authorships; k <- length(A); N <- rep("",k)
  for (i in 1:k) N[i] <-
    paste(A[i][[1]]$author$display_name,collapse=", ")
  return(N)
}
```

A.3. ® *Get information about selected works*

```
> LI <- read.table("dI.csv",head=FALSE,sep="")
> selW <- paste0("id,language,countries_distinct_count,cited_by_count,",
+     "relevance_score,publication_year,title,authorships")
> RW <- unitsInfo(IDs=LI$V2,units="works",select=selW,order="input")
> rep <- data.frame(id=RW$id,cdc=RW$countries_distinct_count,
+ cby=RW$cited_by_count,dI=LI$V1,year=RW$publication_year,
+ authors=substr(authors(RW),1,50),title=substr(RW$title,1,60))
> rep
```

A.4. ® *Creating bibliographic networks for AMC*

```
> OpenAlex2PajekAll(NULL,name="AMC",listF="worksAMC.csv")
OpenAlex2Pajek / All - Start Mon May 26 06:10:05 2025
*** OpenAlex2Pajek / All - Process Mon May 26 06:10:05 2025
...
*** OpenAlex2Pajek / All - Data Collected Mon May 26 07:20:44 2025
hits: 12758 works: 137751 authors: 10849 anon: 185 sources: 1192
*** OpenAlex2Pajek / All - Stop Mon May 26 07:21:54 2025
```

B. Pajek commands

B.1. 🕷 *Cleaning a network*

```
read or select the network
Network Info button
Network/Create New Network/Transform/Remove/Loops
Network/Create New Network/Transform/Remove/Multiple Lines/Single Line
File/Network/Change label [newName]
```

B.2. 🕷 *The set W_j of all works published by the source j*

```
read or select the network WJ
Network/Create Partition/k-neighbors/input [S4210169332,1]
Partition/Binarize Partition [1]
Network/2-mode Network/Partition into 2-modes
select 2-mode as the Second and binarized as the First
Partitions/Extract Subpartition [1]
File/Partition/Change label [Wj]
```

If needed, we can get the index j of the node representing MZ in the set of journals J by applying the Pajek command `Info/Vertex label -> Vertex number [S4210169332]` on the network **WJ**. We get $j = 157398 - |W| = 142$.

B.3. 🕷 *Number of works per year*

```
select the partition Wj as the Second
read partition MZyear.clu
Partitions/Extract Subpartitions [1]
Partition Info button
```

Copy columns Cluster and Freq into the file `MZpubYear.csv`. Draw the frequency distribution using R.

B.4. 🕷 *The most frequently cited works from MZ*

```
read or select the network Ci
select the partition Wj
Network/Create Vector/Centrality/Degree/Input
Operations/Vector+Partition/Extract Subvector [1]
Operations/Network+Partition/Extract/Subnetwork [1]
Vector Info button [+50]
```

B.5. 🕷 *Computing vector $\mathbf{d}_I$*

```
select partition Wj
Partition/Copy to Vector
File/Vector/Change Label [wj]
select Ci as the First network
Operations/Network+Vector/Network*Vector [1]
File/Vector/Change Label [dI]
```

Vector $\mathbf{d}_O$ is computed similarly.

```
select Ci as the First network
Network/Create new network/Transform/Transpose [yes]
File/Network/Change label [CiT]
select wj as the First vector
Operations/Network+Vector/Network*Vector [1]
File/Vector/Change Label [dO]
```

B.6. 🕷 *Computing network* **ACiA**

```
select Ci as the First network
Network/Create new network/Transform/1-mode to 2-mode
select WA as the First network
Network/2-mode/Transpose
File/Network/Change label [AW]
select 2-mode Ci as the Second network
Networks/Multiply networks
select WA as the Second network
Networks/Multiply networks [yes]
File/Network/Change label [ACiA]
```

B.7. 🕷 *Link cut at level 15 in network* **ACiA**

```
Network/Create new network/Transform/Remove/Loops
Network/Create new network/Transform/Remove/Lines with value/lower than [15]
Network/Create Partition/Degree/All
Operations/Network+Partition/Extract/Subnetwork [1-*]
File/Network/Change label [Link cut 15]
read or select Wj as the First partition
Partition/Copy to Vector
select AW as the First network
Operations/Network+Vector/Network*Vector
select degree partition as the First
Operations/Vector+Partition/Extract Subvector [1-*]
Vector/Make Partition/by intervals/Selected thresholds [0.5]
File/Partition/Change label [Type]
```