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Network analysis of the competence centres in Slovenia

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Contribution of the research

We apply state of the art network analysis methods to networks spanned by research groups included in three out of seven approved competence centres.

We rely on high quality data about research output of institutions included in the study which is based on two central publically available and well maintained databases.

Our approach can be easily extended to consider other type of research output, other network analysis methods and other research policy measures.

Data sources

Slovenian Current Research Information System (SICRIS)

Co-operative Online Bibliographic System and Services (COBISS)

Competence centres:

1. “Devices supported by cloud computing” (CC CLASS);
2. “Competence centre for biotechnological development and innovations (CC BRIN)”;
3. “Advanced systems of effective use of electrical energy” (CC SURE).

Compared Factors

Size of networks, measured by:

the number of research groups included in the network of the particular CC.

Productivity, measured by :

(i) number of publications where authors come from at least two member groups of the same CC

(ii) number of publications where authors come from the profit and non-profit member groups of the same CC.

Connectivity, measured by :

density,
average degree,
diameter,
number of connected components,
clustering coefficient.

Parameters

Network size

$$n = |V|$$
$$m = |E|.$$

Network Density

$$D = \frac{2m}{n(n-1)}.$$

Avarage degree

$$d(G) = \frac{1}{n}\sum_{v \in V} d(v).$$

Number of connected components

Diameter

$$diam(G) = \max_{u,v \in V} d(u,v).$$

Clustering Coeficient

$$C_v = \frac{2e_v}{d(v)(d(v)-1)}.$$

$$C(G) = \frac{1}{n}\sum_{v \in V} C_v.$$

The productivity

Table 1: Size of network (number of active research groups)

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\overline{S}$
ALL	1073	1137	1165	1192	1214	1228	1231	1237	1243	1247	1252	1255	1257	**1.33**
CC CLASS	86	122	146	163	196	215	254	275	306	324	348	357	373	**13.01**
CC BRIN	96	122	129	144	162	175	188	207	218	228	238	250	258	**8.59**
CC SURE	101	136	162	179	203	222	236	271	280	289	308	318	336	**10.54**

Source: [SICRIS; own research]

The productivity

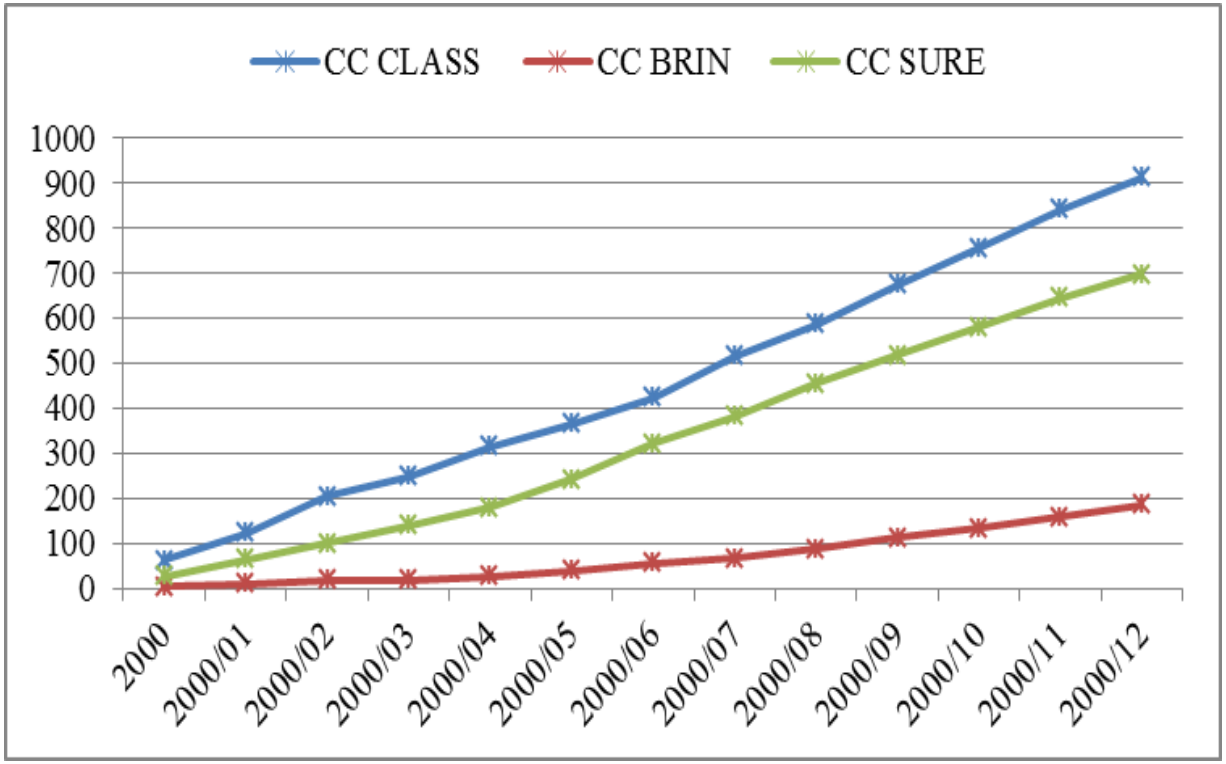
Table 2: Growth of the number of co-authored publications

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\overline{S}$
ALL	8331	16728	25753	35079	45482	56521	67701	79865	92495	105094	117712	130898	143673	**26.78**
CC CLASS	63	122	205	249	315	366	423	516	587	674	756	841	912	**24.95**
CC BRIN	5	10	18	18	26	40	57	67	88	112	133	158	185	**35.11**
CC SURE	26	65	100	139	179	243	321	382	454	518	580	645	698	**31.54**

Source: [SICRIS; own research]

The productivity

Growth of the number of co-authored publications



Source: [SICRIS; own research]

The productivity

Table 3: Growth of the number of profit/non-profit co-authorships

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\bar{S}$
ALL	2125	4443	6918	9435	12073	14882	17694	20752	23915	26789	29680	32433	35096	**26.33**
CC CLASS	0	0	0	0	4	5	5	5	5	6	8	12	17	/
CC BRIN	0	0	2	2	7	9	16	18	27	30	33	36	43	/
CC SURE	0	0	2	5	5	5	7	8	9	9	9	9	10	/

Source: [SICRIS; own research]

The connectivity

Table 4: Dynamics in network density

	2000	2000 / 2001	2000 / 2002	2000 / 2003	2000 / 2004	2000 / 2005	2000 / 2006	2000 / 2007	2000 / 2008	2000 / 2009	2000 / 2010	2000 / 2011	2000 / 2012	$\bar{S}$
ALL	0.006	0.008	0.009	0.011	0.012	0.014	0.016	0.018	0.02	0.02	0.02	0.02	0.03	**14.35**
CC CLASS	0.07	0.07	0.06	0.06	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.06	**-1.28**
CC BRIN	0.1	0.11	0.12	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	**2.21**
CC SURE	0.1	0.08	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	**-5.61**

Source: [SICRIS; own research]

The connectivity

Table 5: Dynamics in average degree

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\bar{S}$
ALL	6.54	9.1	11.22	13.11	15.19	17.34	19.74	22.54	24.79	26.75	28.42	30.36	32.12	**14.18**
CC CLASS	5.93	8.2	8.78	9.08	10.6	12.29	14.5	15.82	16.95	18.32	19.24	20.1	20.9	**11.07**
CC BRIN	9.73	13.39	15.1	16.6	18.1	21.3	23.45	24.9	26.6	27.6	28.31	31.86	34.53	**11.13**
CC SURE	10.22	10.5	10.42	11.33	11.86	12.7	13.74	14.45	15.34	15.7	16.5	17.1	18.26	**4.96**

Source: [SICRIS; own research]

The connectivity

Table 6: Dynamics in number of connected components

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\overline{S}$
ALL	172	149	126	119	105	93	84	73	65	61	61	57	52	**-9.49**
CC CLASS	3	2	2	2	2	2	2	2	2	2	2	2	2	**-3.32**
CC BRIN	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**
CC SURE	6	5	2	2	2	1	1	1	1	1	1	1	1	**-13.87**

Source: [SICRIS; own research]

The connectivity

Table 7: Dynamics in diameter

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\bar{S}$
ALL	10	9	8	8	7	7	7	6	7	6	6	6	6	**-4.17**
CC CLASS	6	6	6	6	6	5	5	5	5	4	4	4	4	**-3.32**
CC BRIN	6	6	5	5	5	4	4	4	4	3	3	3	3	**-5.61**
CC SURE	6	6	6	6	6	6	6	5	5	5	5	5	5	**-1.51**

Source: [SICRIS; own research]

The connectivity

Table 8: Dynamic in clustering coefficient

	2000	2000/ 2001	2000/ 2002	2000/ 2003	2000/ 2004	2000/ 2005	2000/ 2006	2000/ 2007	2000/ 2008	2000/ 2009	2000/ 2010	2000/ 2011	2000/ 2012	$\overline{S}$
ALL	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,39	0,38	0,38	0,38	0,39	**0.22**
CC CLASS	0,77	0,73	0,72	0,73	0,69	0,67	0,65	0,62	0,61	0,6	0,59	0,57	0,56	**-2.62**
CC BRIN	0,75	0,74	0,7	0,67	0,62	0,62	0,6	0,6	0,57	0,58	0,57	0,57	0,59	**-1.98**
CC SURE	0,84	0,79	0,75	0,71	0,69	0,64	0,64	0,62	0,61	0,59	0,58	0,56	0,54	**-3.61**

Source: [SICRIS; own research]

Discussion and conclusion

Used method can be indirectly used for evaluation of certain public policy which has measurable results as product of social interaction/networking.

Establishment of competence centres did not significantly boost co-authored publications in any of three cases compared to the whole population.

Networking potential of competence centres measured by joint publications prior and after establishment of competence centres, did not change.

Joint publications did not disproportionally increase with establishment/financing of competence centres.