Analisi e modellizzazione dei Poli di innovazione in Toscana

Multidimensional networks emerging in a regional policy programme

Margherita Russo*, Annalisa Caloffi^, Federica Rossi§, Valentina Fiordelmondo*, Stefano Ghinoi*, Riccardo Righi*, Simone Righi*

* Department of Economics, University of Modena and Reggio Emilia, Italy
^ Department of Economics and Management, University of Padua, Italy
§ Department of Management, Birkbeck College, University of London, United Kingdom

Contact: margherita.russo@unimore.it

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Multidimensional networks emerging in a regional policy programme
lessons learned from the empirical analysis of Tuscany’s innovation poles to enhance regional innovation systems

Outline

0. *motivation*
1. Intermediaries : their role in innovation processes and policies
2. Innovation policy in Tuscany 2011-2014: innovation poles
3. Structure, conduct and performance of the innovation poles
4. From the individual poles to the regional innovation system: issues in the analysis of multidimensional networks
5. Further developments

intermediaries

- Role of intermediary organizations to **support firm-level and collaborative innovation** (Howells, 2006; Lazaric et al, 2008)
  - provide a range of knowledge-intensive services

- Innovation intermediaries can also **contribute to the success of innovation policies** (see e.g. Kauffeld-Monz and Fritsch, 2013).
  - policies targeting micro firms and SMEs: intermediaries may facilitate the exchange of knowledge and competencies with other organizations (large firms, universities and research centres) that have different languages, organizational cultures, decision-making horizons, systems of incentives and objectives (Howells, 2006; Russo and Rossi, 2009; Caloffi et al, 2015).
  - examples: are the regional competitiveness poles in France, the Innovation Networks in Denmark, the Strategic Centres for Science, Technology and Innovation in Finland, the Catapult Centres in the UK.

Innovation poles in the Tuscany regional policy 2011-2014

Tuscany's industrial structure includes a large number of SMEs having relatively few connections with universities and other regional research hubs

Goal of the policy

- to strengthen the regional innovation system
- to support the development of a range of knowledge-intensive services
- to encourage technology transfer and stimulate the innovation capabilities of regional small and medium-sized enterprises (SMEs)

Policy mesasures

for three years, funding of 12 innovation poles specialized in different technological domains

Innovation poles in the Tuscany regional policy 2011-2014

poles	Domains of specialization
OPTOSCANA	Optoelectronics for manufacturing and aerospace
INNOPAPER	Paper
OTIR 2020	Fashion (textiles, apparel, leather, shoes, jewellery)
VITA	Life science
PIETRE	Marble
PENTA	Shipbuilding and maritime technology
POLIS	Technologies for sustainable cities
NANOXM	Nanotechnologies
CENTO	Furniture and interior design
PIERRE	Renewable energies and energy saving technology
POLO12	Mechanics, particularly for automotive and transport
POLITER	ICT and robotics

Source: our elaborations using data provided by Tuscany's Regional government

Innovation pole [pole] in Tuscany regional policy 2011-2o14

structure

- Each pole is a temporary association of organizations forming a consortium
- It is managed by one ore more organizations constituting a temporary consortium. These organizations can participate also to other pole-consortia
- Among the consortium's participants there is a leading organization. It can be leader only of one pole
- Each pole consortium’s participant may share with the pole: its employees, laboratories, incubators
- Each pole offers membership to companies in the region (a condition to have access to a pool of specialized services offered through the consortium’s participants of the pole)

Innovation pole [pole] in Tuscany regional policy 2011-2o14

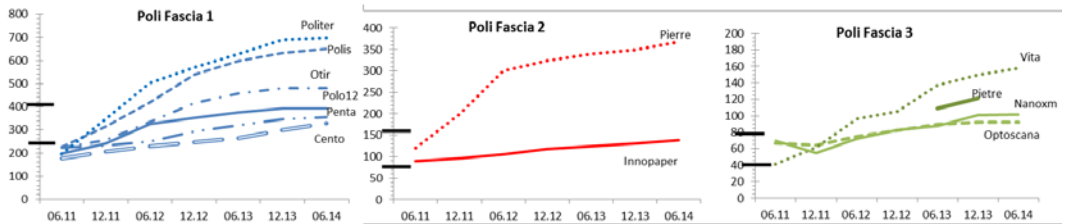
activities

- **marketing**, to recruit new members to the pole, including scouting activities to encourage companies to demand knowledge-intensive services and to invest in innovation;
- participation in **R&D projects** at regional, national and European levels;
- management of the pole's open access infrastructures such as its **laboratories**;
- organization of knowledge transfer programmes, workshops and seminars to **facilitate knowledge sharing and networking** between members.
- Through the consortium's participants, the innovation pole **supplies advanced services to companies members** of the pole
- Through **collaboration agreements** the poles may start new projects with other diverse partners (also other poles)

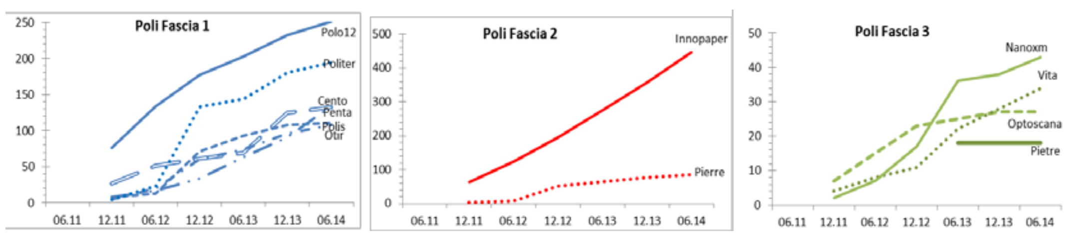
Innovation pole [pole] in Tuscany regional policy 2011-2014

- performance

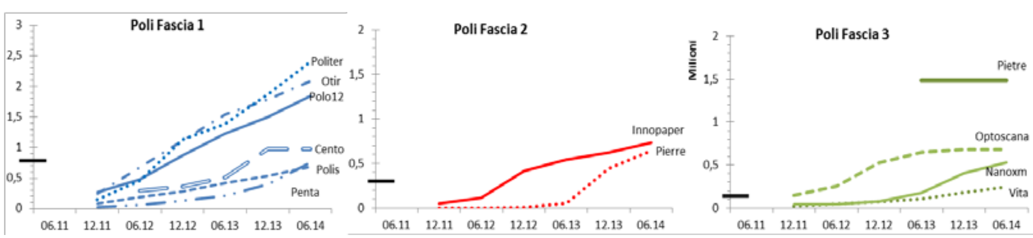
Number of members



Number of services supplied



Turnover (mln euro)



Source: our elaborations using data provided by Tuscany's Regional government

Innovation pole [pole] in Tuscany regional policy 2011-2014

Number of «nodes» in the 12 innovation poles

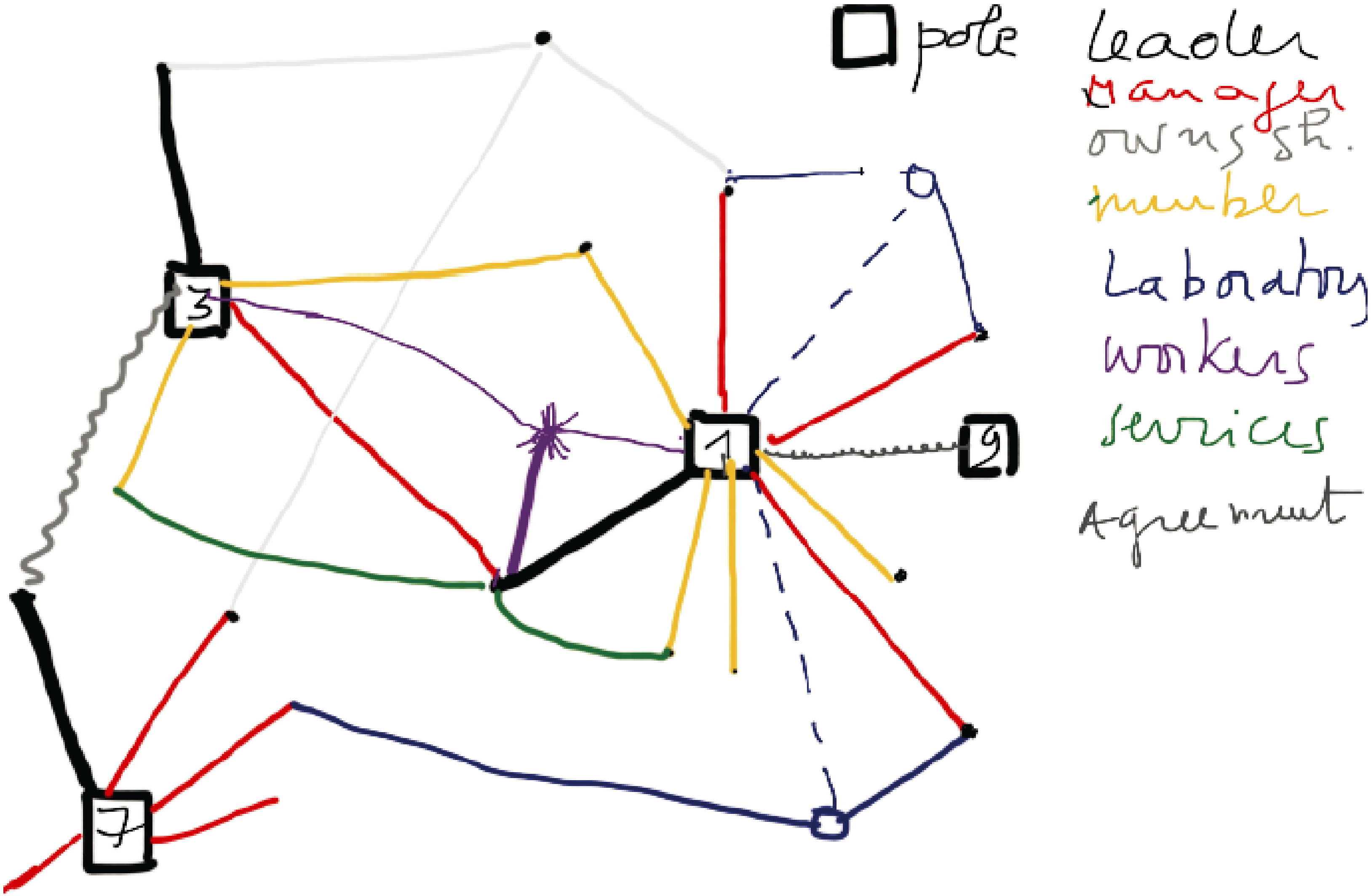
pole	consortium's participants (including leader)	members	Participants' employees working for the pole	advisors	laboratories
OPTOSCANA	3	92	29	1	14
INNOPAPER	1	139	24	20	4
OTIR 2020	11	501	43	18	6
VITA	8	158	26	2	2
PIETRE	4	122	22	0	3
PENTA	5	352	25	38	3
POLIS	8	645	54	0	>100
NANOXM	7	129	25	1	4
CENTO	7	322	34	17	12
PIERRE	13	371	56	3	23
POLO12	6	394	37	3	9
POLITER	15	700	84	2	17
Total # of presences	*88*	*3.925*	*459*	*105*	*>197*
Total # of nodes	**46**	**3.154**	**280**	**67**	

Source: our elaborations using data provided by Tuscany's Regional government

From the individual poles to the regional innovation system

	1 Pole	2 Poles	3 Poles	4 Poles	5 Poles	Total
consortium's particpants	26	13	2	4	1	46
Laboratories	>100*	43	8	1	0	>100
member companies	2.599	411	140	16	1	3.154

nodes, linkages, layers



Network promoting the innovation poles system

- Organization leading a pole-consortium
- Organization managing the pole-consortium
- Organization/institutions owing shares of a pole consortium's member

Network of competences

- Organization leading a pole-consortium
- Organization managing the pole-consortium
- Pole or pole's leader/participant or other organiz. signing a coll. agreement
- Consortium member/leader whose workers are employed in the pole
- Worker employed by a pole consortium's member working for the pole
- Pole-consortium member owing a laboratory
- Laboratory supplying services to pole's members
- Pole-consortium's member supplying services

multilayers

Rosvall and Bergstrom (2007, PNAS) introduced a method based on information theory to reveal comunities

- It solves the main problems with Newman and Girvan (2004) expecially in indentifying communities of very different sizes.
- Operates by Minimizing the description length of a network and the loss of information due to the clustering.

De Domenico et al. (2015, PRX) extends the setup to multiplex networks, showing that by taking into account the multilayer structure of networks one can see new features emerging from nodes interacting in the different layers

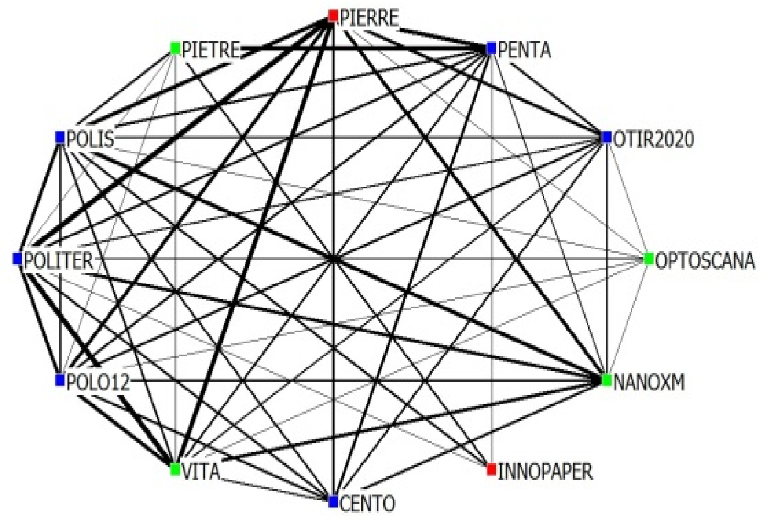
- communities maximizes the probability of remaining into a cluster when starting from one of the nodes in that community..
- A random walker is used to compute flows among nodes in the same layers. With some probability (r=0.15) the random walker jumps across layers (such as the teleportation in the PageRank algorithm).
- If two nodes in two different layers tends to be visited with similar patters they are associated to the same community that becomes an multi-layer community.
- thus the algorithm is able to identify both communities identified in one single layer and communities identified on multiple layers.

As layers are themselves informative the outcome is a more realistic and informative clustering.

NETWORK PROMOTING THE INNOVATION POLES

Poles, consortia's leaders and participants,
organiz./institutions owing shares of a pole consortium's participant

	OPTOSCANA	INNOPAPER	OTIR2020	VITA	PIETRE	PENTA	POLIS	NANOXM	CENTO	PIERRE	POLO12	POLITER
OPTOSCANA	**3**		2	1			2	1		1	2	3
INNOPAPER		**12**			4	2	5					1
OTIR2020	2		**49**	3		4	3	3	4	7	6	3
VITA	1		3	**26**	1	4	6	7	3	12	9	13
PIETRE		4		1	**31**	8	4				1	2
PENTA		2	4	4	8	**94**	5	3	7	9	5	5
POLIS	2	5	3	6	4	5	**39**	8	4	9	6	9
NANOXM	1		3	7		3	8	**88**	4	10	5	7
CENTO			4	3		7	4	4	**92**	7	5	6
PIERRE	1		7	12		9	9	10	7	**93**	10	13
POLO12	2		6	9	1	5	6	5	5	10	**39**	8
POLITER	3	1	3	13	2	5	9	7	6	13	8	**47**

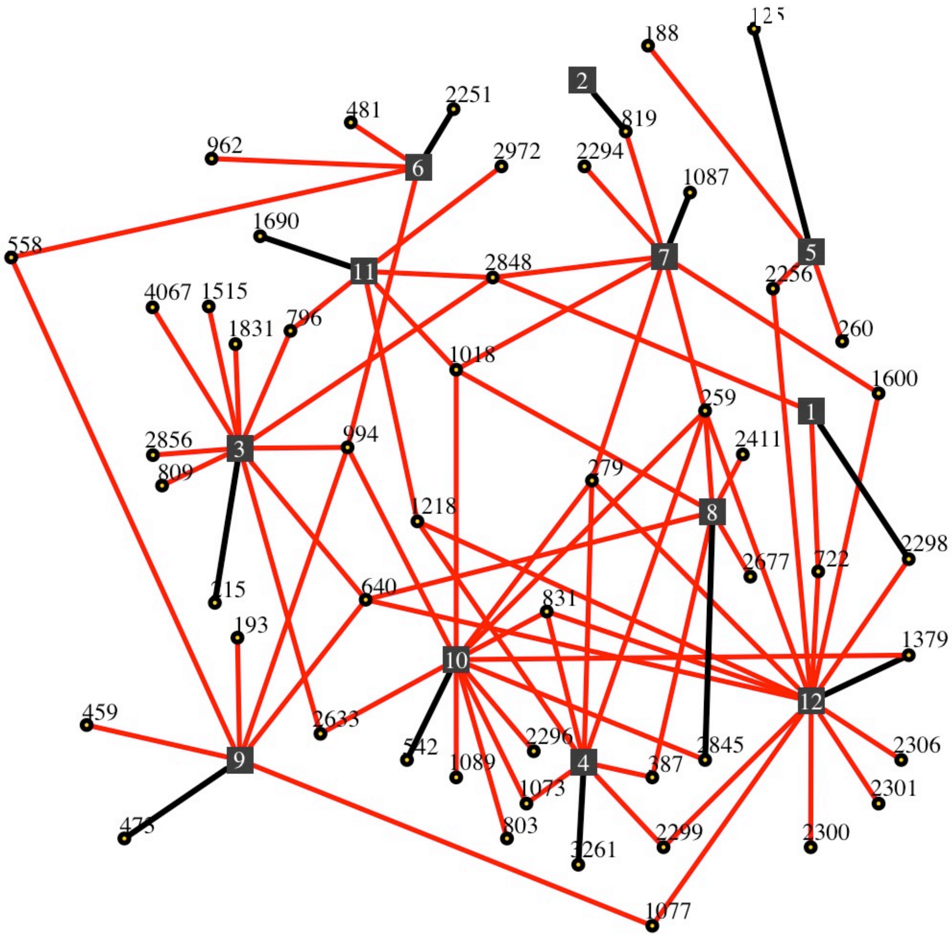


	Degree	Bonacich Power	Closeness	Eigenvectors	Betweenness
OPTOSCANA	8	1675.23	15	0.25	0.00
INNOPAPER	5	885.42	18	0.13	0.00
OTIR2020	10	2075.48	13	0.30	0.29
VITA	11	2206.92	12	0.32	1.34
PIETRE	7	1322.71	16	0.19	0.50
PENTA	11	2129.03	12	0.31	2.63
POLIS	12	2295.24	11	0.34	3.67
NANOXM	10	2075.48	13	0.30	0.29
CENTO	9	1909.27	14	0.28	0.00
PIERRE	10	2075.48	13	0.30	0.29
POLO12	11	2206.92	12	0.32	1.34
POLITER	12	2295.24	11	0.34	3.67

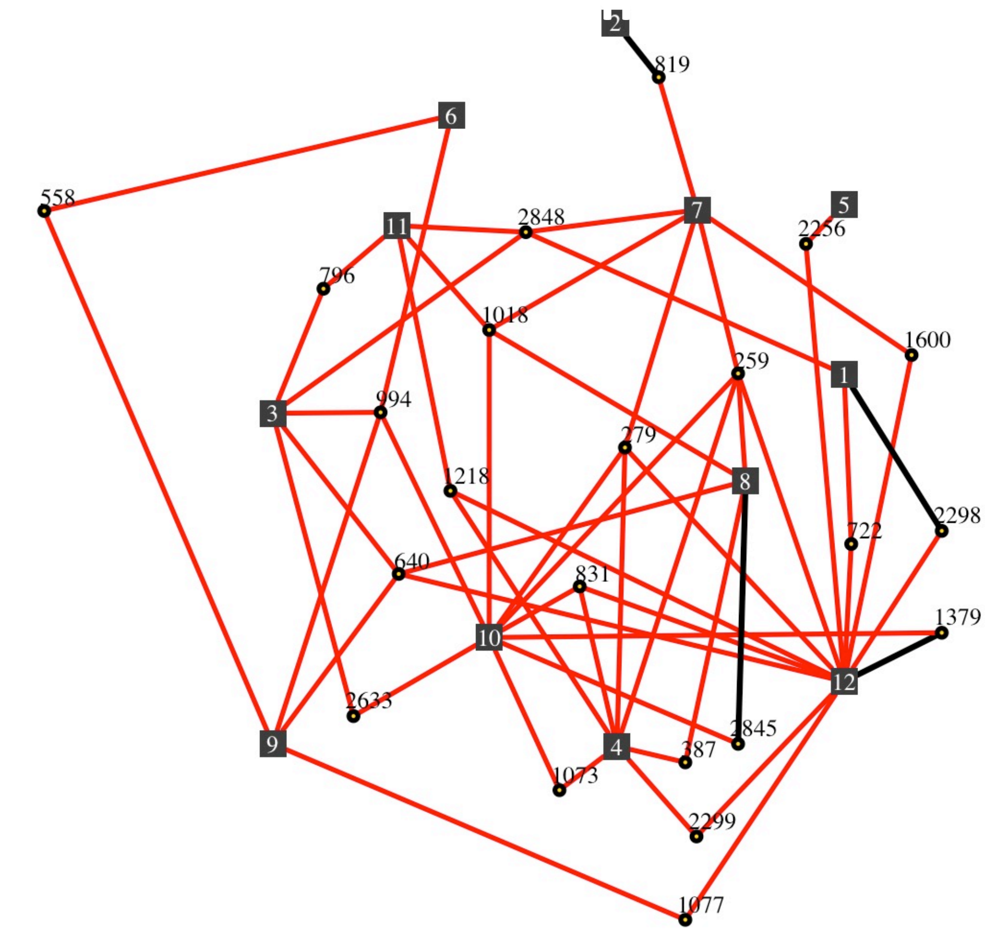
Legenda:
blue = band 1 >160 members
red = band 2 > 80 members
green = band 3 > 40 members

edges width proportional to the number of nodes belonging to the two poles

Poles, consortia's leaders and participants



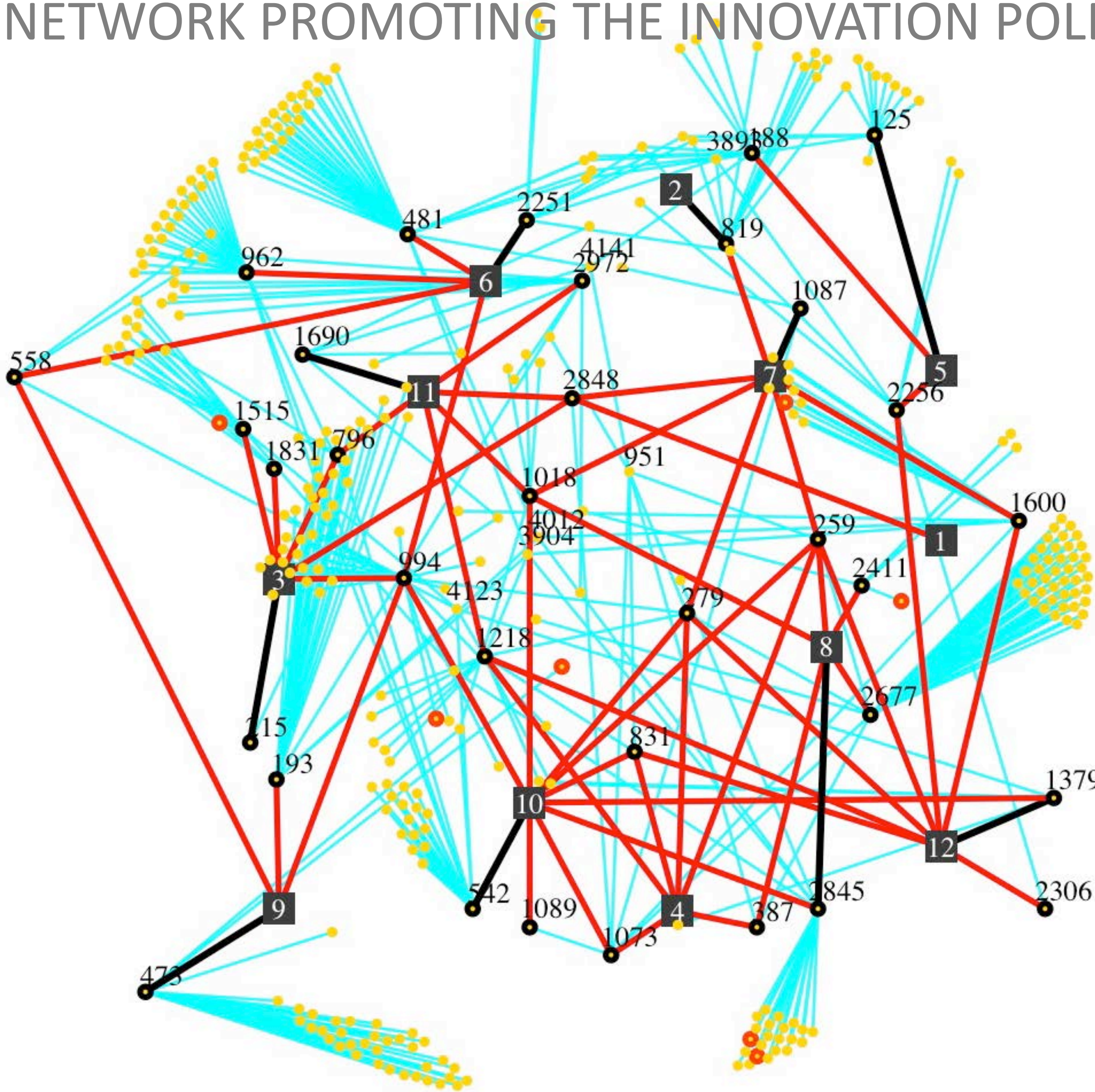
Poles, consortia’s leaders and participants



Degree > 2

Poles, consortia's leaders and participants, organiz./institutions owing shares of a pole consortium's participant

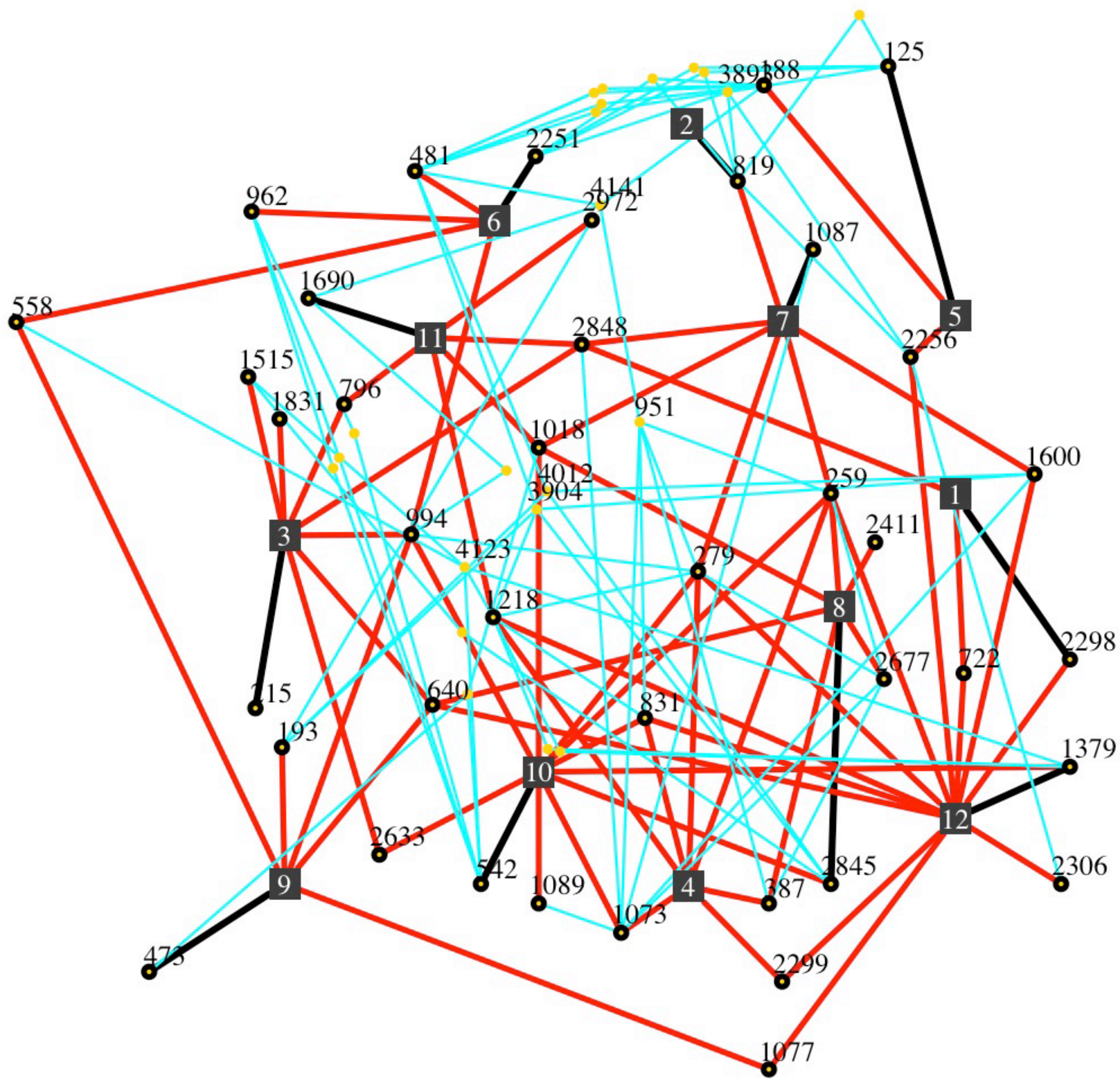
→NETWORK PROMOTING THE INNOVATION POLES



Poles, consortia’s leaders and participants, organiz./institutions owing shares of a pole consortium's participant

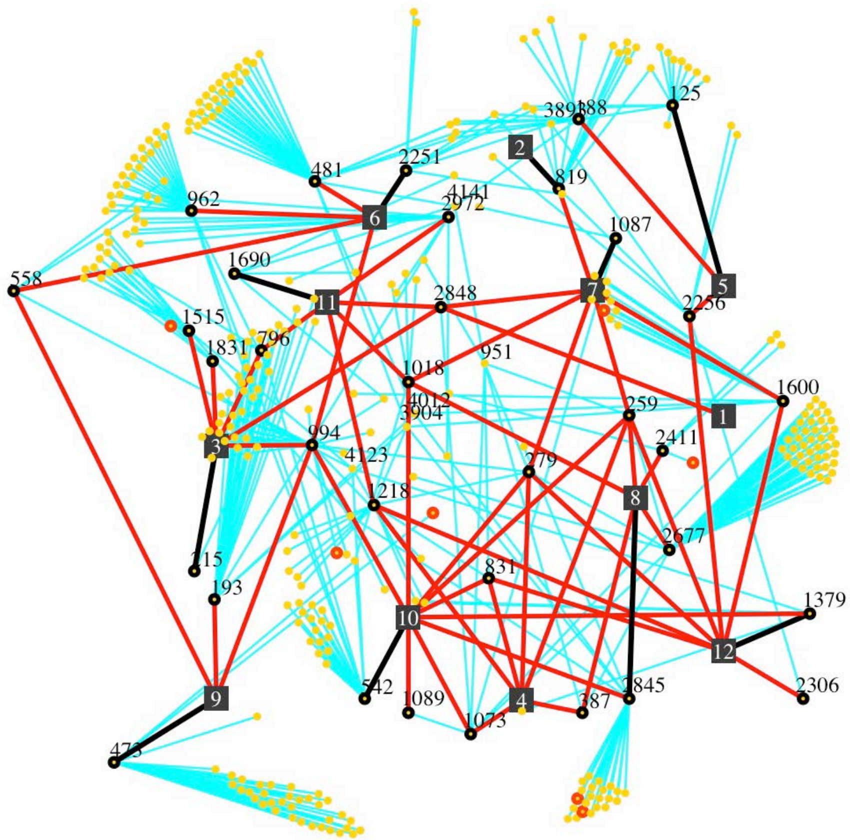
→NETWORK PROMOTING THE INNOVATION POLES

Degree > 2

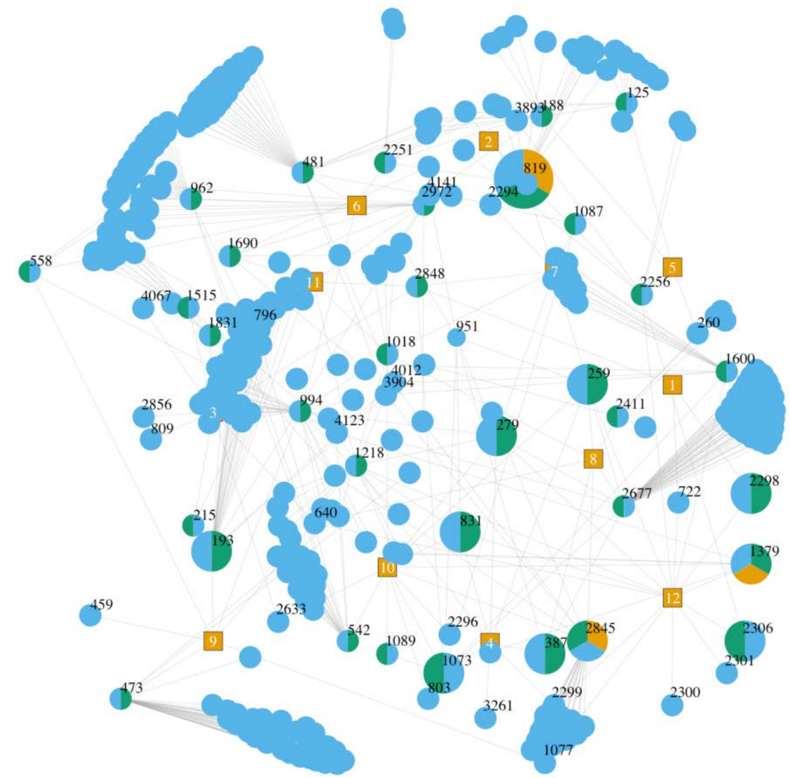


NETWORK PROMOTING THE INNOVATION POLES

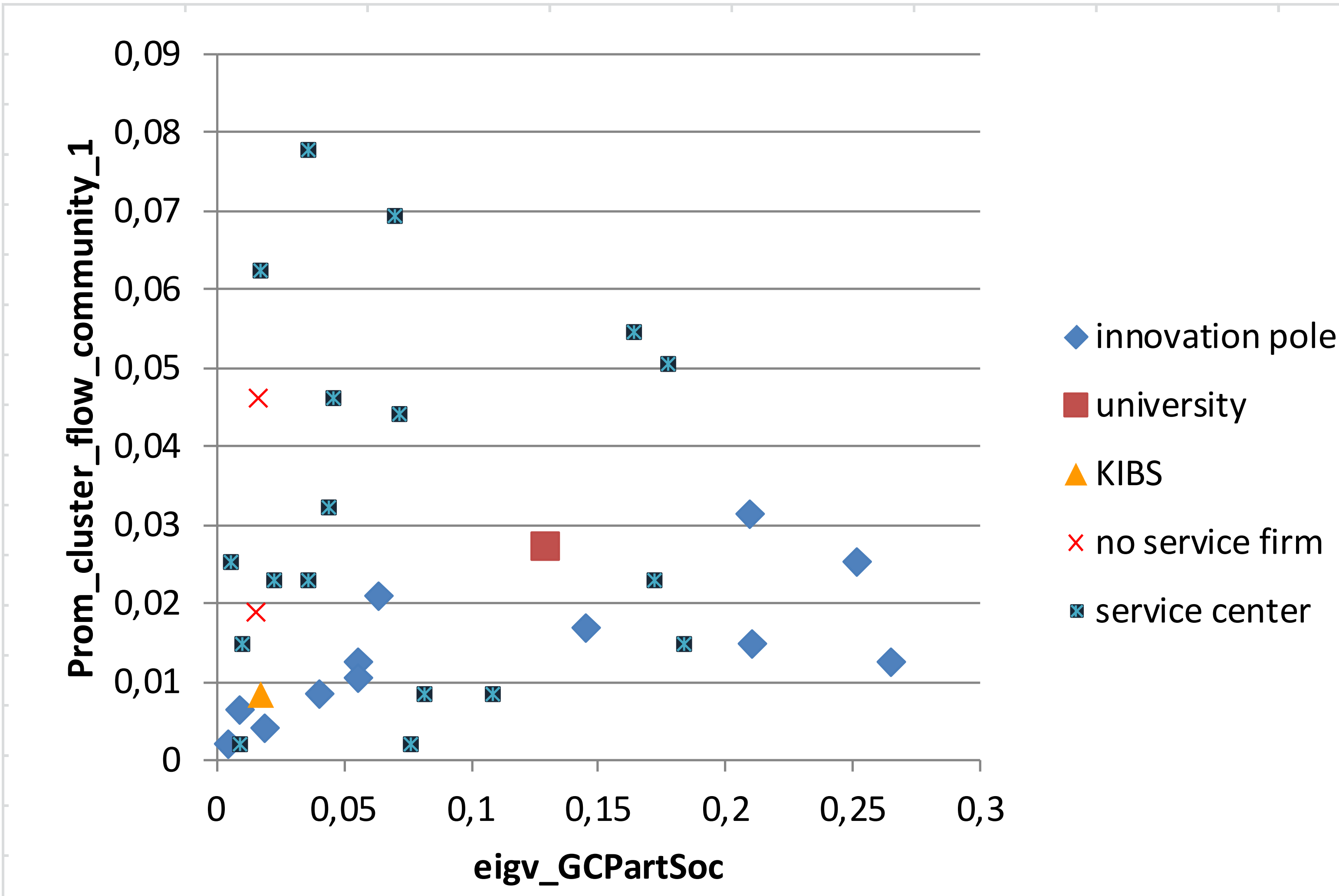
Three layers mapping



Multilayer communities

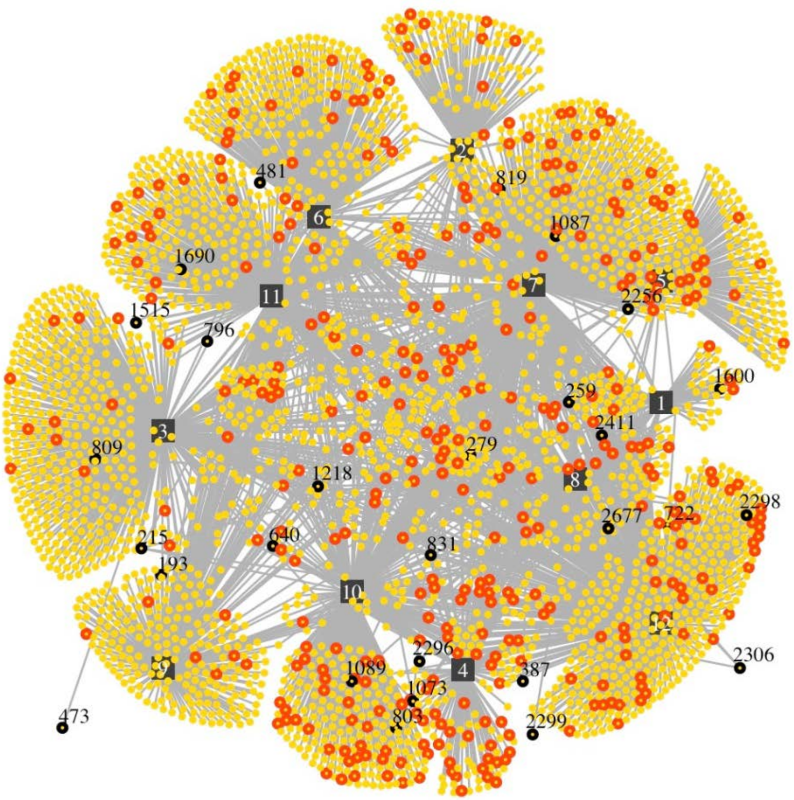


NETWORK PROMOTING THE INNOVATION POLES
eigenvector and information flow within the community_1



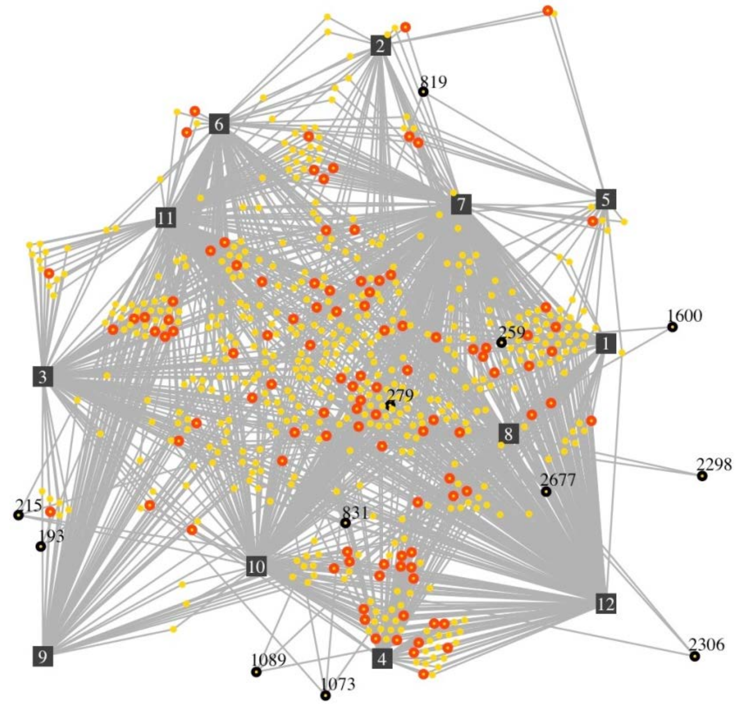
Poles and companies members of the poles

_A



_A2
nodi con almeno 2 gradi

Degree > 2



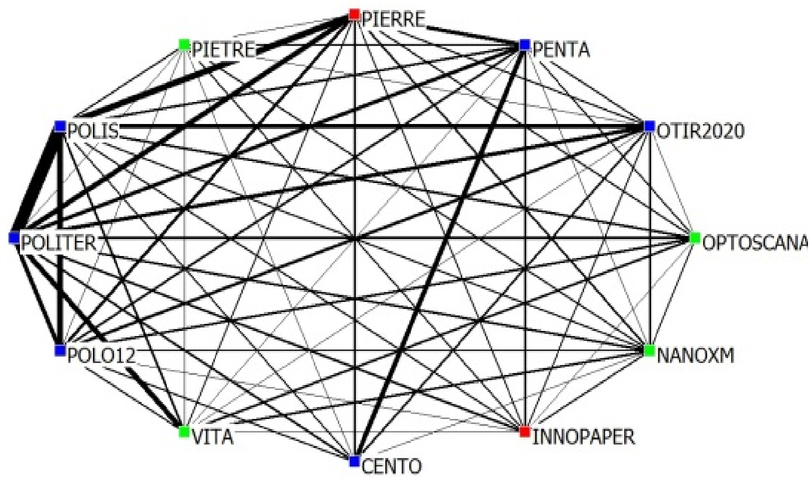
Legenda _accCollGC e _accCollGC2
vertex: black square: pole; black border: consortium participant or leader; orange border: kibs; yellow: other members; figures: id
edges: grey: from member to pole

Poles and companies members of the poles

Number of members for each pole (on diagonal) and in common between poles

	OPTOS CANA	INNOP APER	OTIR2 020	VITA	PIETRE	PENTA	POLIS	NANO XM	CENTO	PIERRE	POLO 12	POLITE R
OPTOSCANA	**92**	1	2	13		5	16	6		5	13	22
INNOPAPER	1	**139**	6	1	5	14	9	5		6	3	14
OTIR2020	2	6	**501**	4	3	9	33	17	16	8	19	27
VITA	13	1	4	**158**	1	1	18	17		5	5	44
PIETRE		5	3	1	**122**	7	6	6	2	1	1	2
PENTA	5	14	9	1	7	**352**	13	4	42	26	13	26
POLIS	16	9	33	18	6	13	**643**	11	10	56	50	114
NANOXM	6	5	17	17	6	4	11	**128**	3	13	10	14
CENTO			16		2	42	10	3	**322**	14	9	16
PIERRE	5	6	8	5	1	26	56	13	14	**368**	20	43
POLO12	13	3	19	5	1	13	50	10	9	20	**390**	38
POLITER	22	14	27	44	2	26	114	14	16	43	38	**697**

pole members

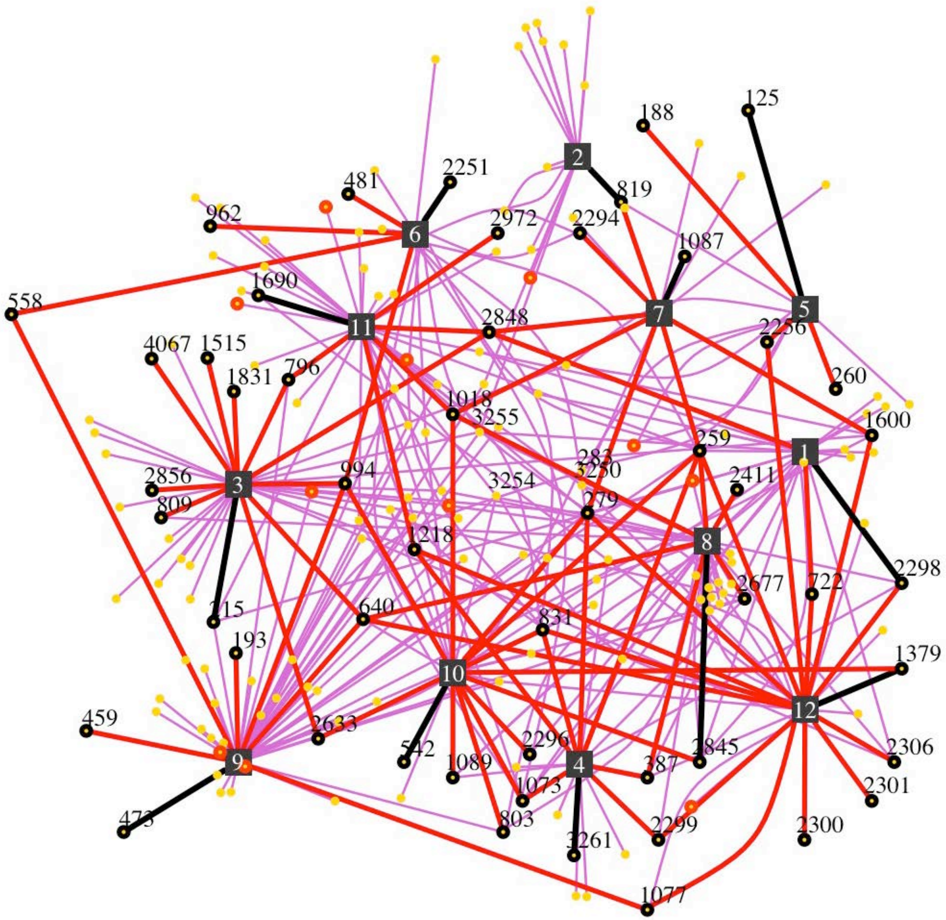


Legenda:
blue = band 1 >160 members
red = band 2 > 80 members
green = band 3 > 40 members

edges width proportional to the number of nodes belonging to the two poles

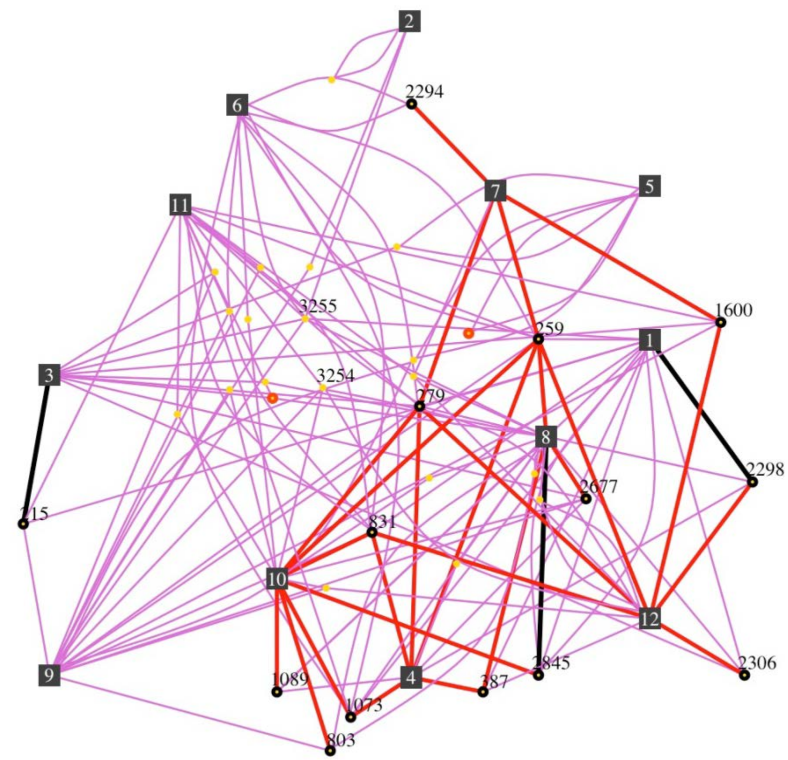
Poles, consortia's leaders and participants, other organizations signing collaboration agreements

_accCollGC



_accCollGC2

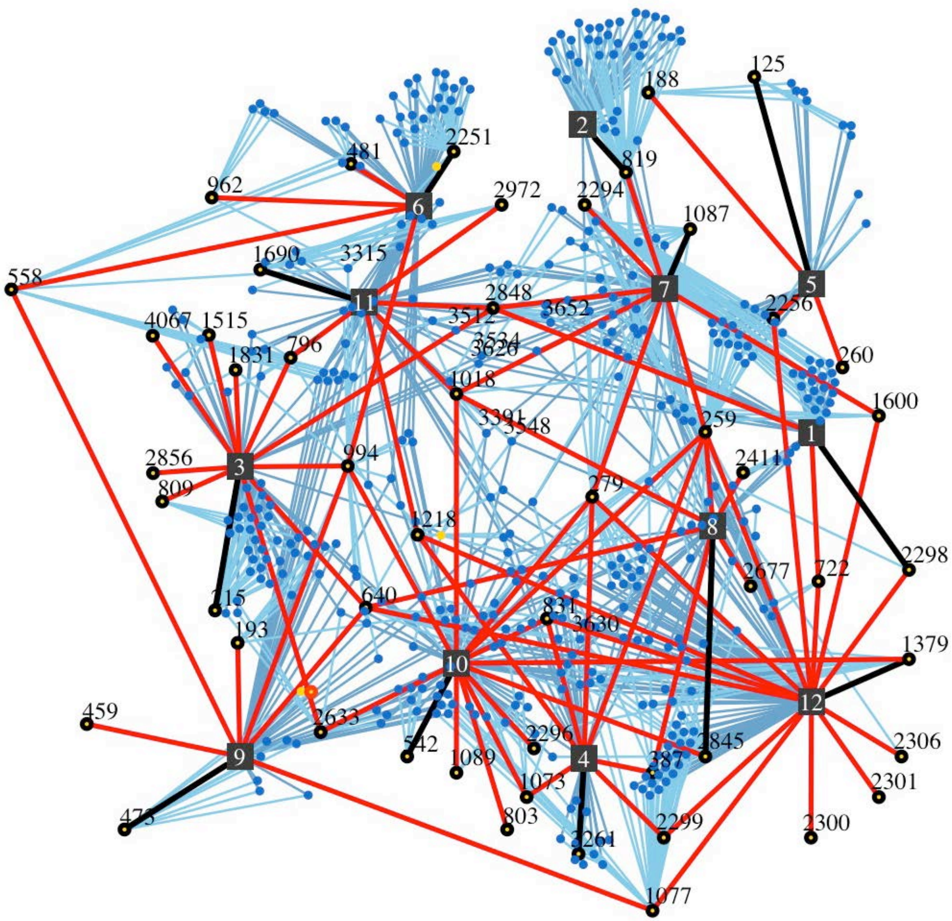
Degree > 2



Legenda _accCollGC e _accCollGC2
vertex: black square: pole; black border: consortium participant or leader; orange border: kibs; orange: other mebers; figures: id
edges: lilac: collaboration agreement

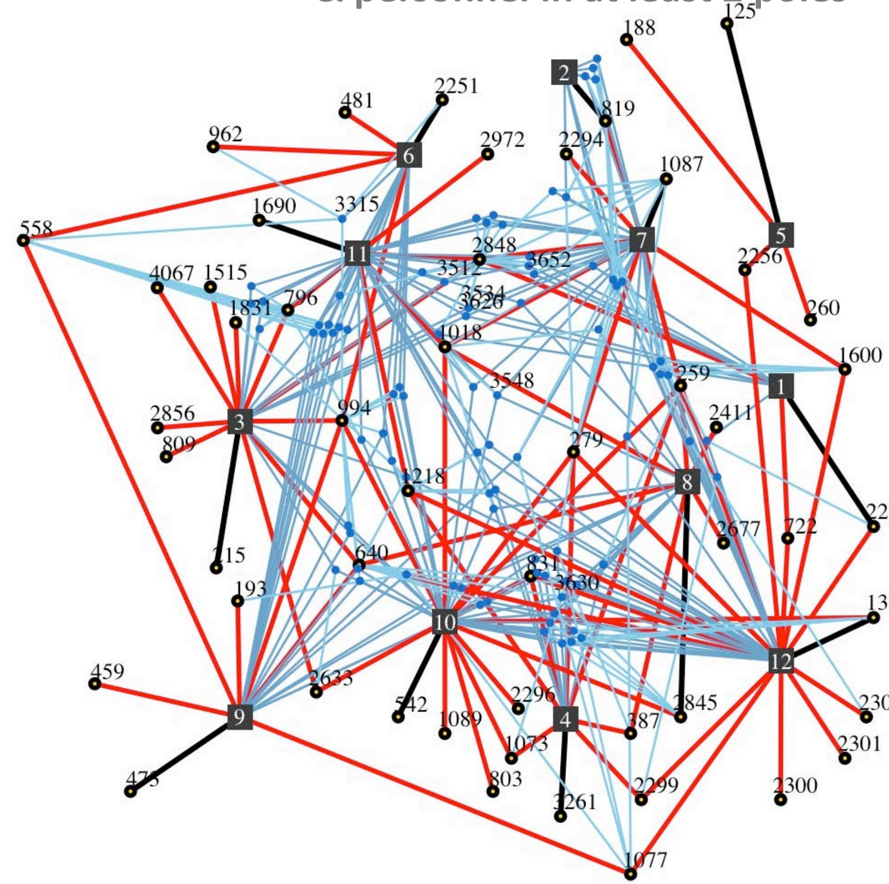
Poles, consortia's leaders and participants, personnel (employees and consultants)

_Pers



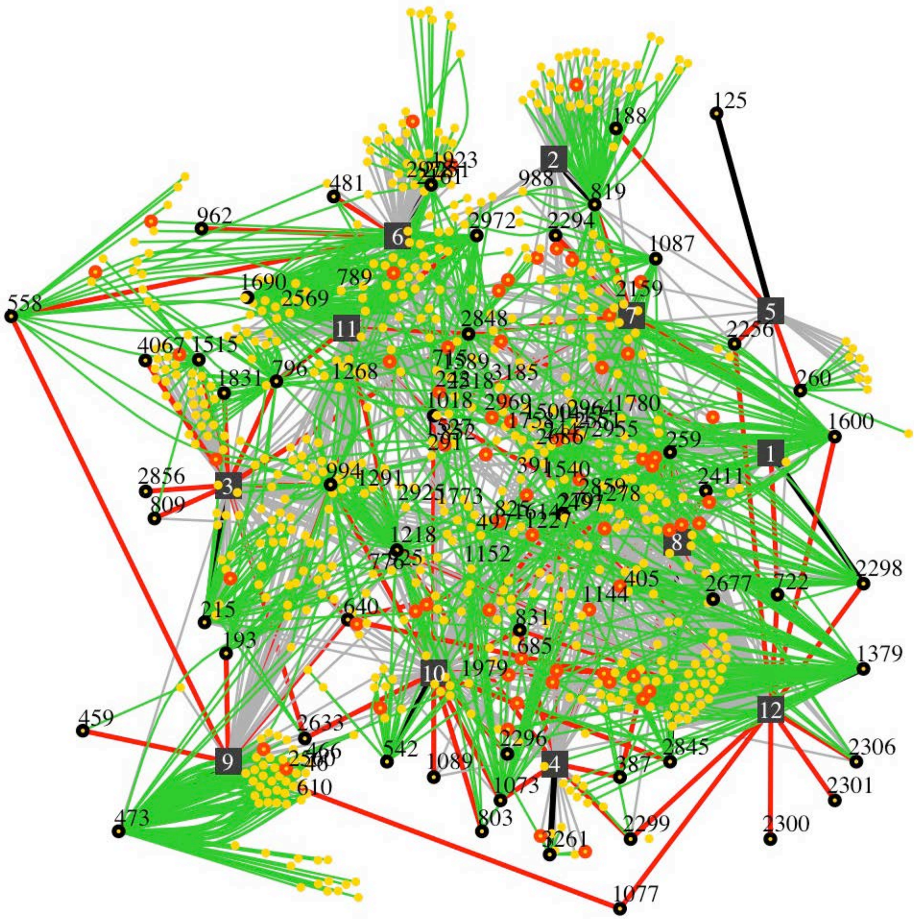
_Pers2

Degree > 2
& personnel in at least 2 poles



Poles, consortia's leaders and participants and member companies demanding advanced services

_GCAComm

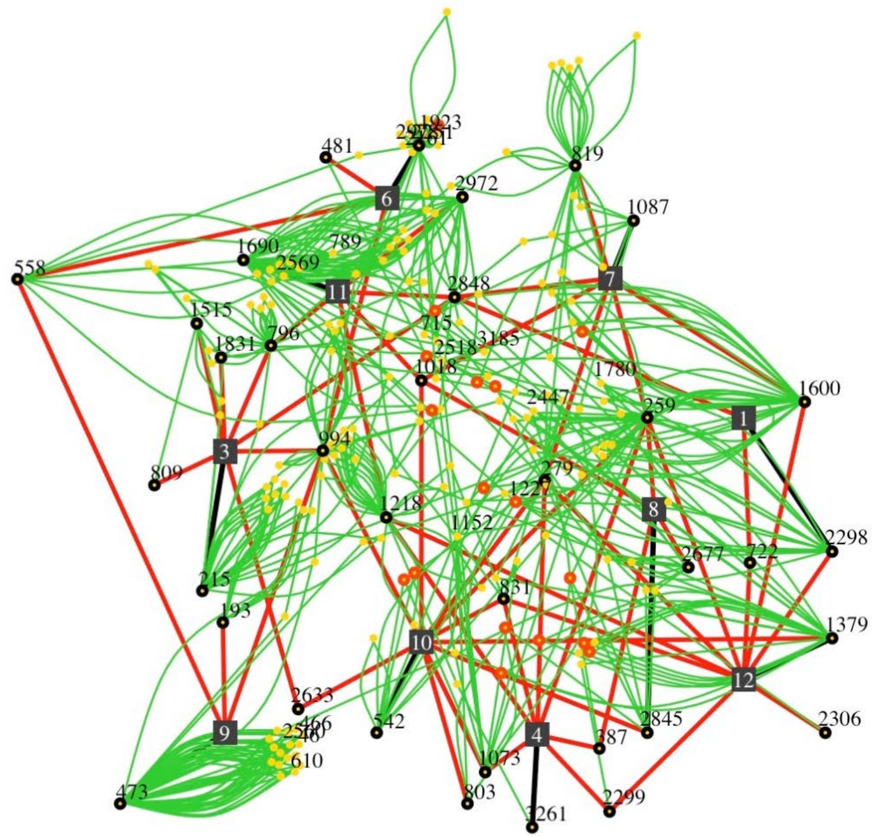


_GCComm

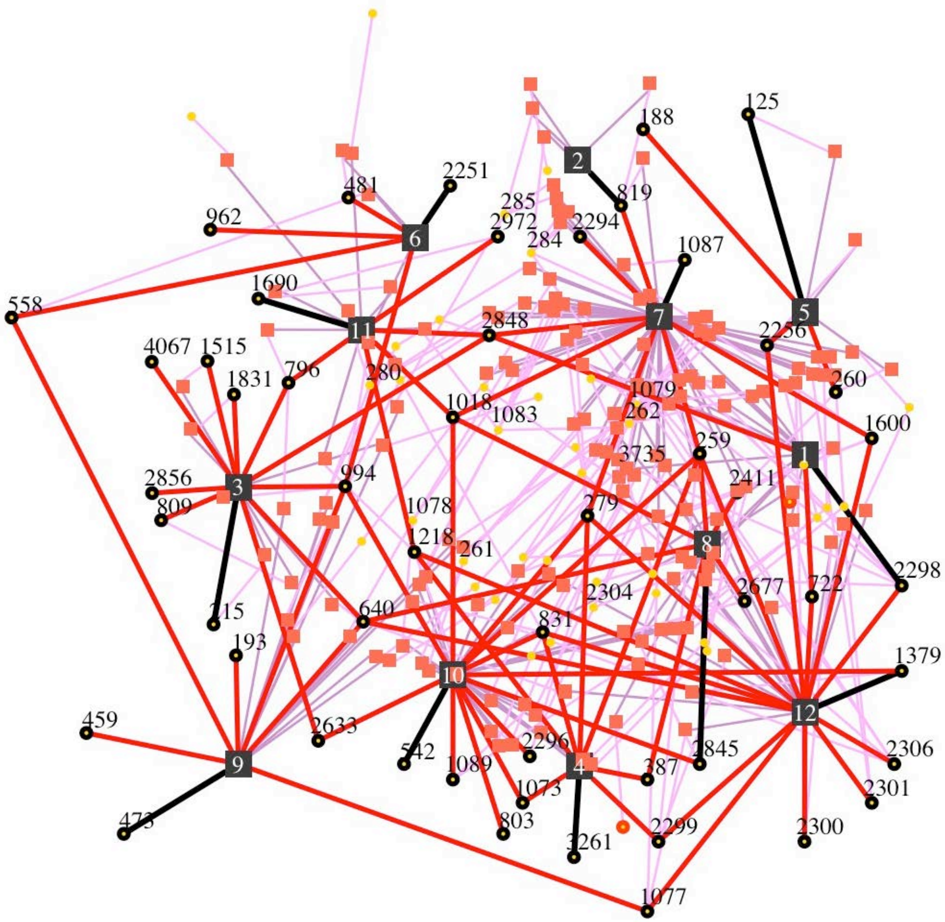
nodi che hanno ricevuto almeno 1 servizio

nodi che sono stati almeno una volta gestori/capofila

Degree > 2



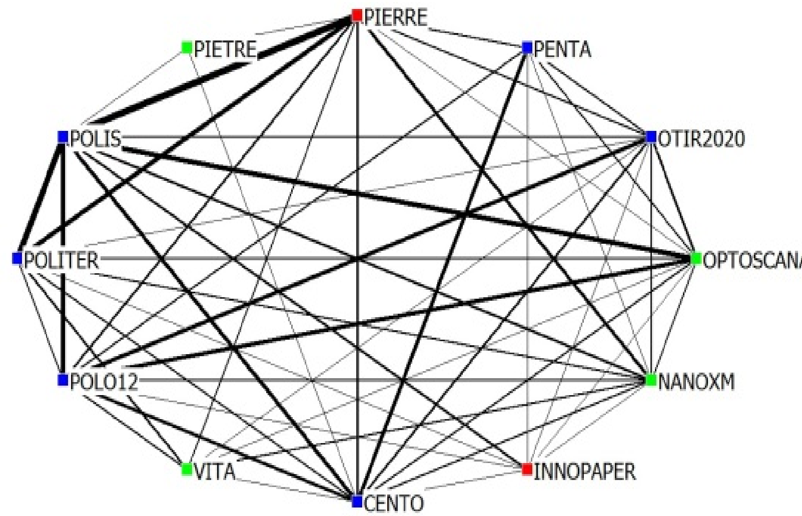
Poles, consortia's leaders and participants and laboratories



COMPETENCE NETWORKS

Organization leading a Pole-consortium | Organization member of the Pole-consortium managing the pole | Collaboration agreement | Consortium member/leader providing workers to be emplyed in the pole | Worker of a consortium member working for the pole | Pole-consortium member owing a laboratory | Laboratory supplying services to pole's members | Pole-consortium member supplying of services |

	OPTO SCAN A	INNO PAPE R	OTIR2 020	VITA	PIETR E	PENT A	POLIS	NAN OXM	CENT O	PIERR E	POLO 12	POLIT ER
OPTOSCANA	**69**	1	7	1		4	18	5	6	1	13	4
INNOPAPER	1	**65**	1			1	9	1	2		1	1
OTIR2020	7	1	**98**	1		4	5	4	9	6	16	2
VITA	1		1	**45**				3	1	3	5	8
PIETRE					**35**		2		1	1		
PENTA	4	1	4			**86**		2	15	7	4	
POLIS	18	9	5		2		**168**	9	14	29	19	25
NANOXM	5	1	4	3		2	9	**69**	5	11	6	5
CENTO	6	2	9	1	1	15	14	5	**117**	10	10	4
PIERRE	1		6	3	1	7	29	11	10	**107**	9	19
POLO12	13	1	16	5		4	19	6	10	9	**86**	7
POLITER	4	1	2	8			25	5	4	19	7	**127**



Centrality indexes of innovation poles

	Degree	Bonacich Power	Closeness	Eigenvectors	Betweenness
OPTOSCANA	11	2219.67	12	0.32	0.89
INNOPAPER	9	1845.50	14	0.27	0.29
OTIR2020	11	2219.67	12	0.32	0.89
VITA	8	1679.87	15	0.25	0.00
PIETRE	4	697.14	19	0.10	0.00
PENTA	8	1656.94	15	0.24	0.13
POLIS	10	1959.23	13	0.29	2.29
NANOXM	11	2219.67	12	0.32	0.89
CENTO	12	2289.19	11	0.33	4.05
PIERRE	11	2106.80	12	0.31	3.26
POLO12	11	2219.67	12	0.32	0.89
POLITER	10	2055.82	13	0.30	0.44

Legenda:
blue = band 1 >160 members
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green = band 3 > 40 members

edges width proportional to the number of nodes belonging to the two poles

COMPETENCE NETWORKS

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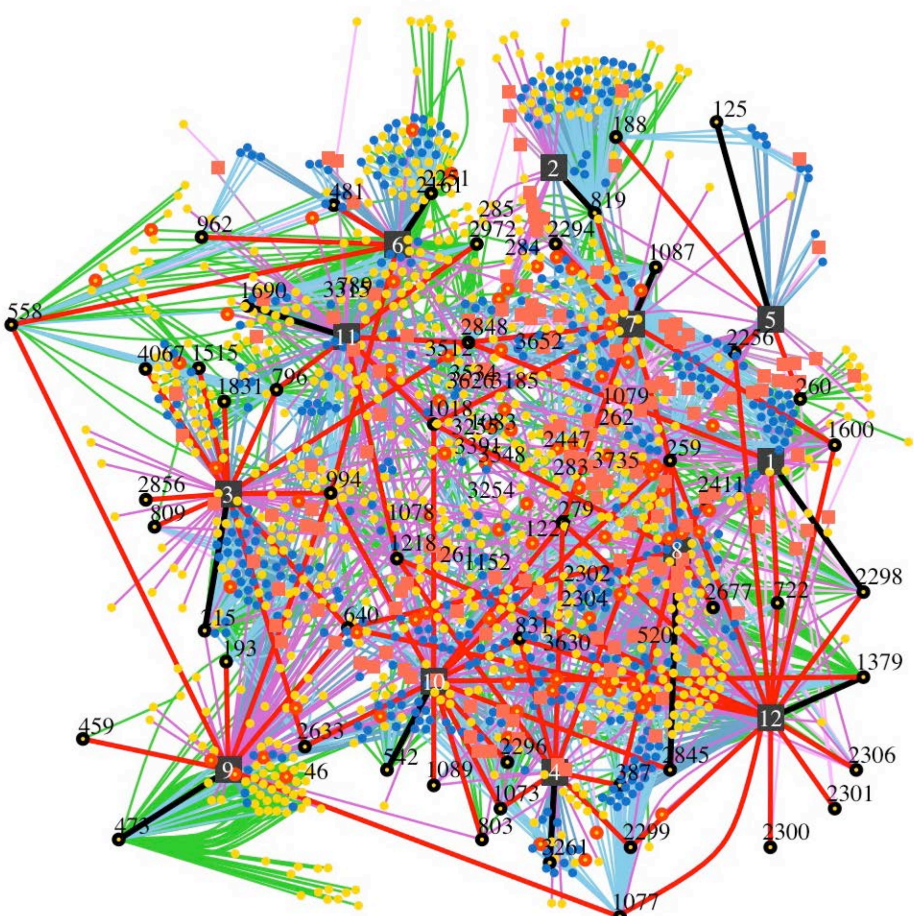
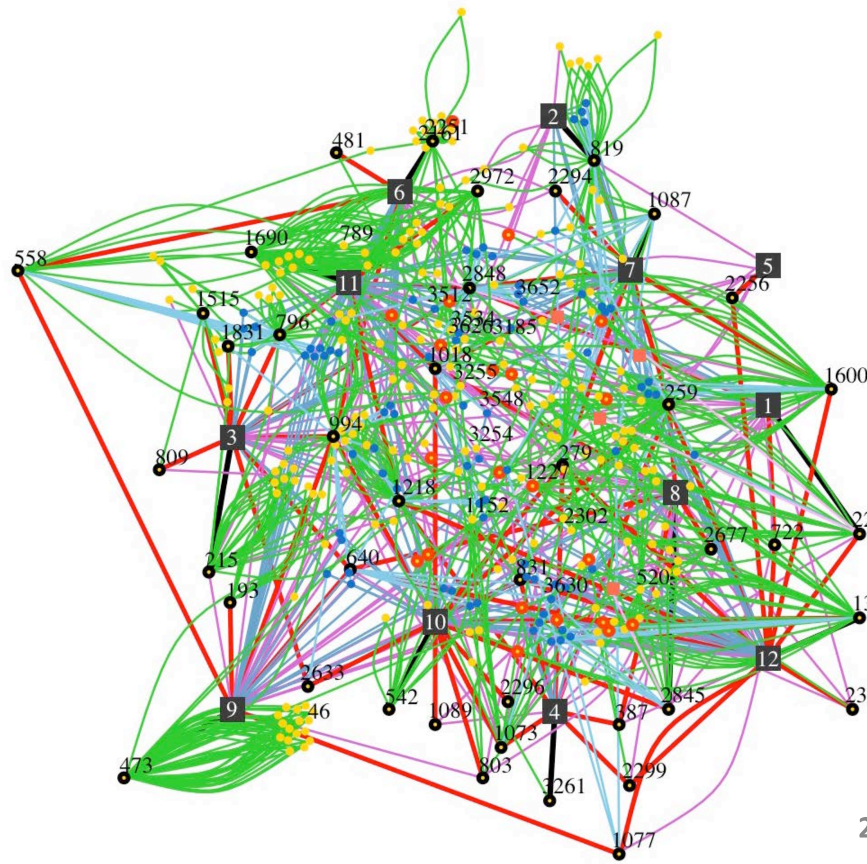
_Competence



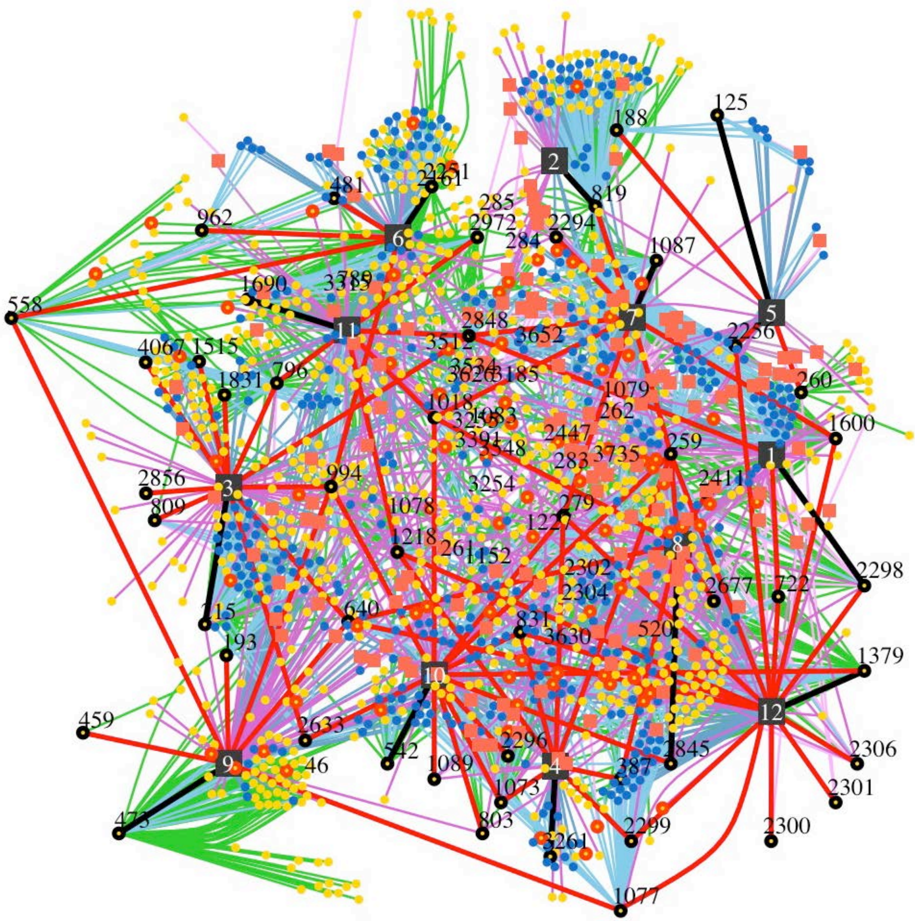
Restricted
Degree > 2
Personnel on more than one pole
More than two types of services



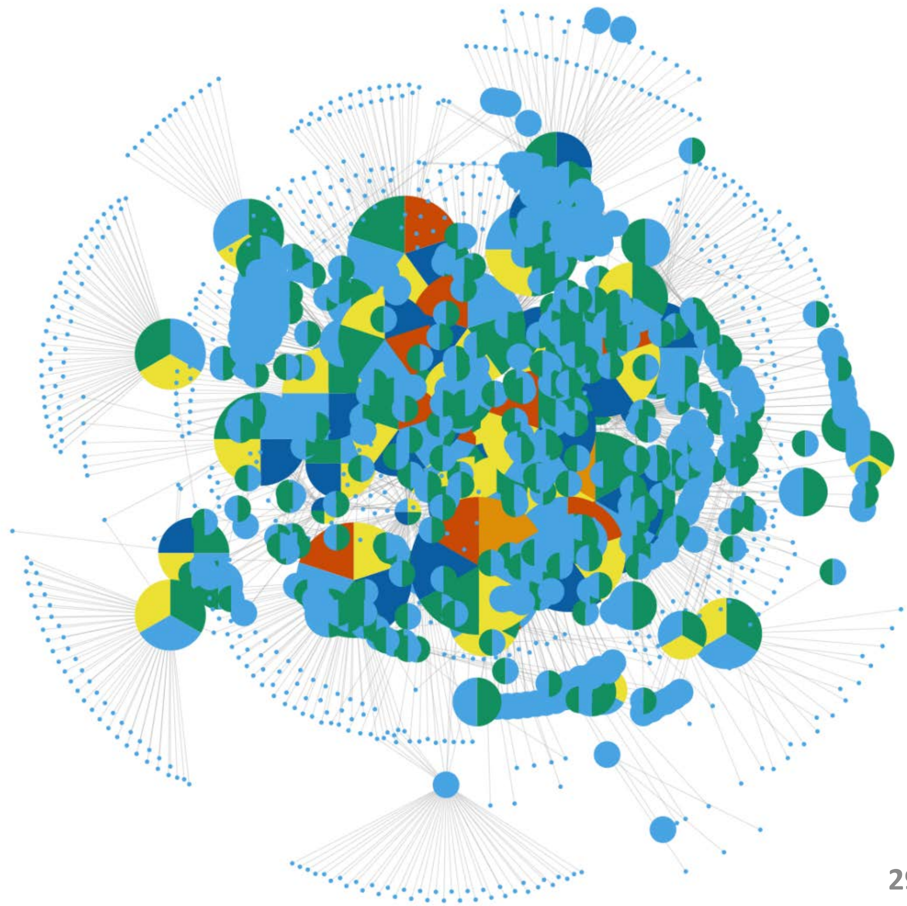
COMPETENCE NETWORKS

Organization leading a Pole-consortium | Pole-consortium participants managing the pole | Collaboration agreement | Consortium participants whose workers are employed in the pole | Worker of a consortium's participant working for the pole | Pole- consortium's participant owing a laboratory | Laboratory supplying services to pole's members | Pole-consortium member supplying services |

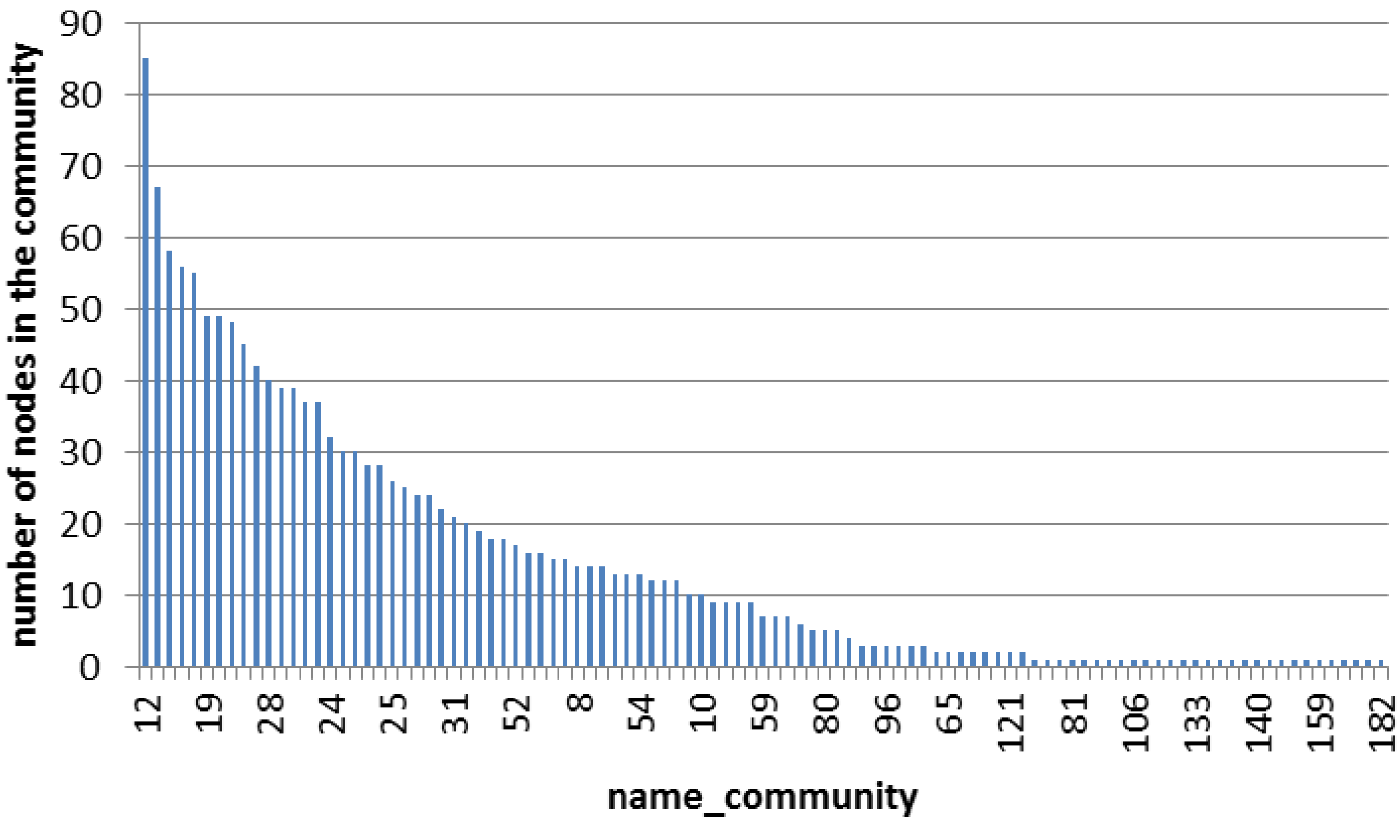
_aggregated competence networks



_multilayer communities in the competence networks

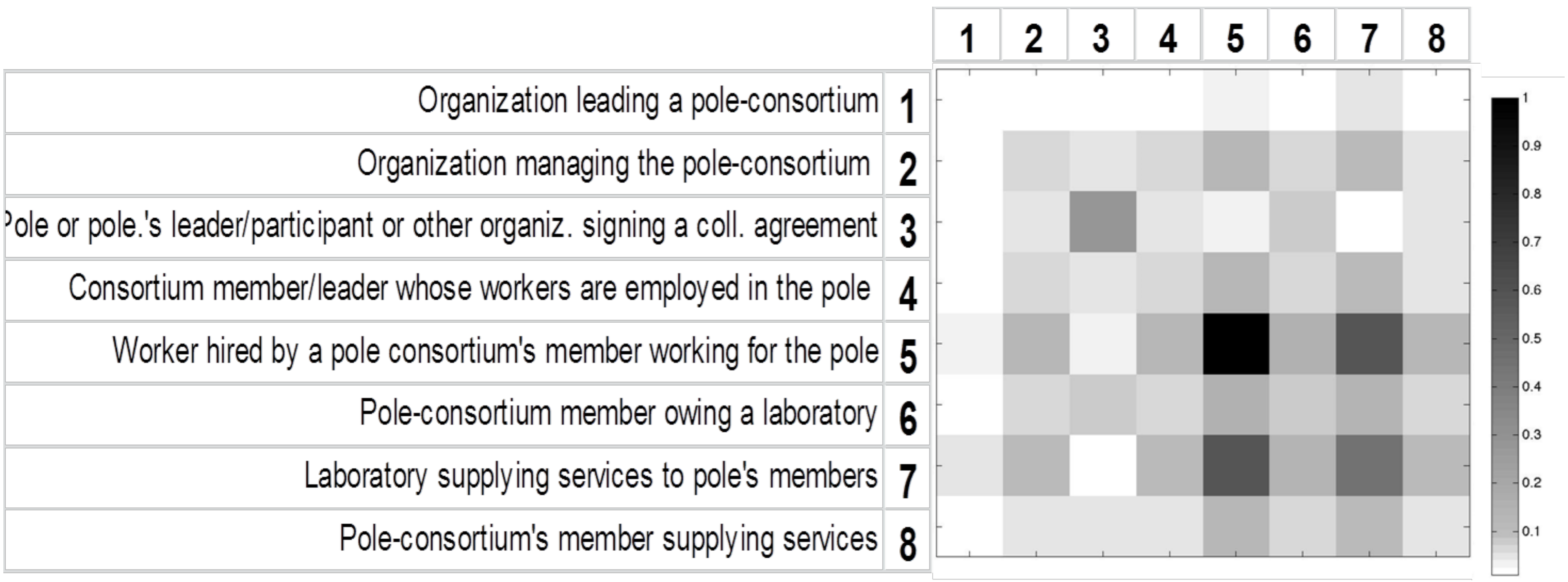


COMPETENCE NETWORKS
communities



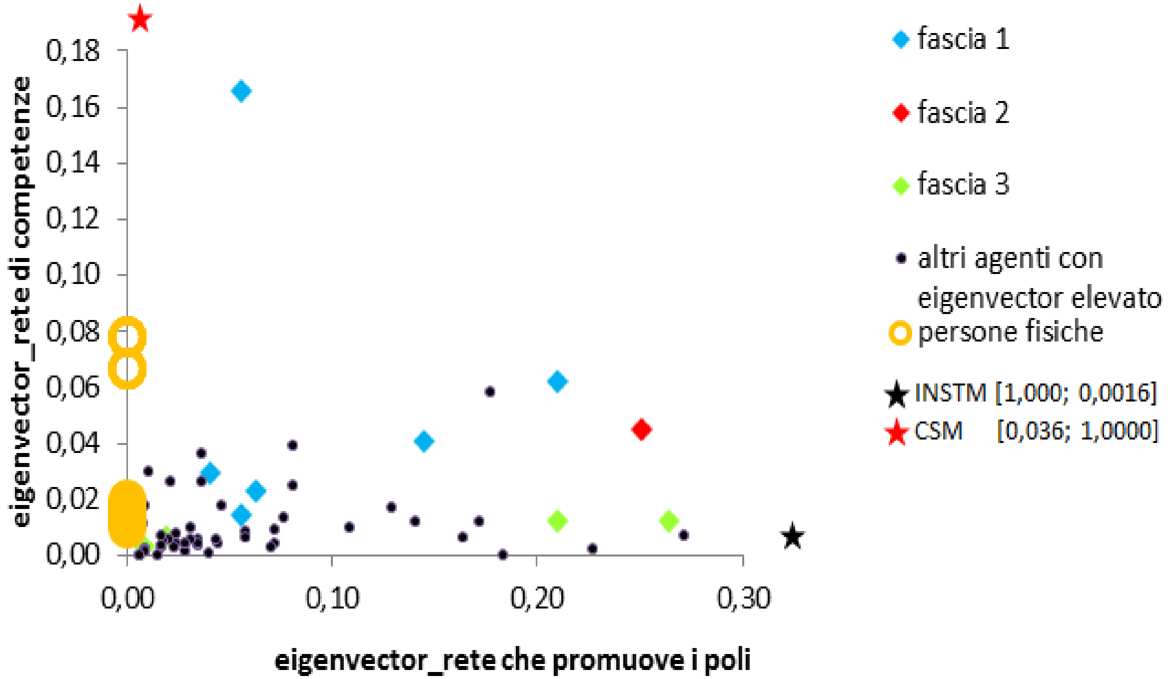
COMPETENCE NETWORKS
similarities between network layers

The map shows the similarities between network layers, measured as the fraction of nodes in different network layers that are assigned to the same communities

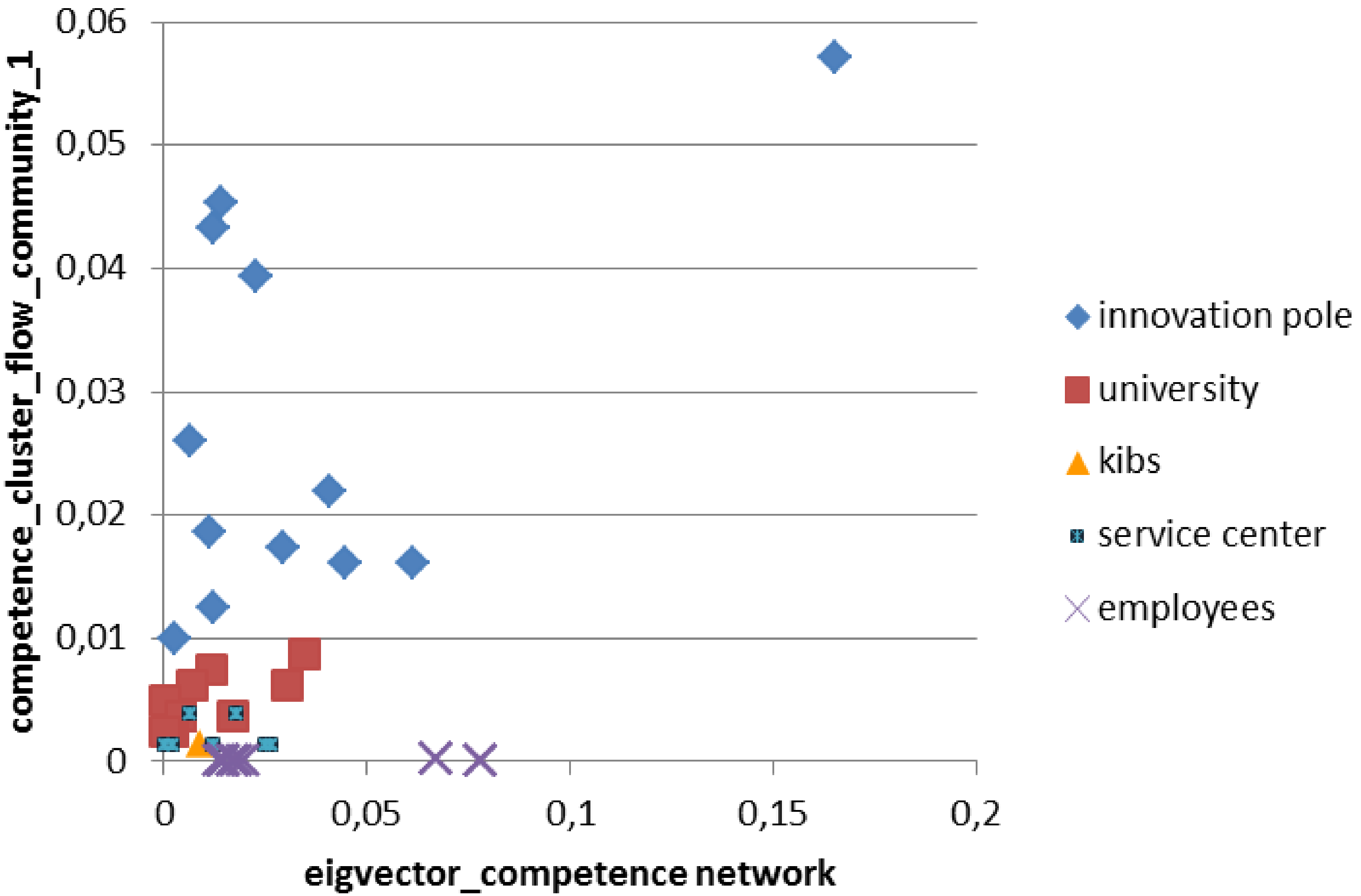


Normalized_number_overlappin_comunities_competenze.jpg

Subnetworks:
agents promoting poles and competence network



COMPETENCE NETWORK
eigenvector and information flow within the community_1



lessons

- Innovation intermediaries: multidimensional entities
- Agents' centrality measures highlight some relevant aspects of the nodes in the system

  →for each layer and in the aggregate network: different ranking
- Different layers bring specific «values» to the system
- A systemic perspective can benefit from analysis of community detection

  →who are the agents (universities, public research centers, service centers, etc)

  acting with whom

  in which roles

  and activities

Further developments

With regard to our case study

- Improving the metrics of each layer (weights)
- One multilayer network vs the two we have analyzed
- Add the virtual layers
- Detecting the multilayers communities, characterizing agents by type and location

Further research

- Using multilayer network:
- from analysis to policy assessment and policy design

Questions?