ISSI Newsletter

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CONTENTS

EDITORIAL

"NEVER SAY NEVER AGAIN..."

WOLFGANG GLÄNZEL

SARAH HEEFFER

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Roughly one year ago, I heavy-heartedly decided to leave my position of the Editor of the ISSI Newsletter. The board of the ISSI Society decided not to completely relinquish the endeavour of publishing this e-zine but to search for a new format and platform to enhance society communication without leaving the popular features of the e-zine. Although we have made

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progress in planning the “transfer”, important, topical and even urgent events have forced us to edit, in the meantime, a special issue in the traditional format. From time to time, we may revive the e-zine as special issues, whenever we have to communicate a bundle of important issues.

To begin with, we must bewail a severe loss to our community again. And so we have the sad duty now to report the passing away of a great researcher personality and friend, the first President of the ISSI Society, Hildrun Kretschmer (1947–2024). She was also the founder of the COLLNET network, the Global Interdisciplinary Research Network for the Study of all Aspects of Collaboration in Science and in Technology, which was headed by her for almost 25 years. Shortly after her death, the annual COLLNET meeting was held in Strasbourg (France) in December 2024. This event was overshadowed by the loss of its founder and leader.

We will therefore open this special issue with an obituary, which will be followed by a report of the COLLNET meeting.

After reflecting on these current events, we will devote the second part of this special issue to burning issues in research and science policy.

The Society Board decided on publishing a short note on the ongoing debate on the reform of the research assessment practices. The note will present the response of ISSI to the CoARA reform. This note is authored by the collective of the board members.

As it always was our wont, we give scientists the opportunity to present their views, opinions, and new results as being part of society communication. This time, longstanding members of ISSI in cooperation with their colleague from the National Science Library of the Chinese Academy of Sciences present a piece on a novel approach to core-periphery studies relevant for bibliometric network analysis.

To conclude, we sincerely hope that all members of the Society will actively participate in the board elections starting soon this spring, and we look forward to meeting you in high number at the ISSI Conference in Yerevan (Armenia) in late June 2025.

HILDRUN KRETSCHMER (1947 – 2024)

AN OBITUARY BY

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Hildrun Kretschmer passed away after a long and incurable illness in November 2024. She was an outstanding researcher and among the first German scientists to devote their lives to scientometric studies. She became a well-known scholar of world-wide recognition in our field.

She was born in 1947 in East Germany and started up her career in the field of social psychology but moved as early as in the late 1970s to quantitative studies of patterns and phenomena of research collaboration. One of her favourite research topics was the comparative study of social stratification in co-authorship networks of invisible colleges and institutionalised communities, where she could benefit from her knowledge in social psychology as well. Social equality in science reflected by gender and age structures of co-authorship and webometric networks have become

more recent topics of her research. She was able to create and maintain an impressive co-authorship network reaching from the US over Europe to India and China.

She was not only active as researcher since she also turned theory into practice: she founded COLLNET, the Global Interdisciplinary Research Network for the Study of all Aspects of Collaboration in Science and in Technology in 2000, alongside Liming Liang and Ramesh Kundra. This global interdisciplinary research network aimed to expand collaborative relations between Germany, India, and China internationally. Under her leadership, COLLNET grew into a thriving community, organizing annual conferences and establishing the COLLNET Journal of Scientometrics and Information Management (CJSIM).

The COLLNET Journal with Hildrun Kretschmer as Founding Editor, has made a not inconsiderable contribution to raising the public profile of the research achievements of the COLLNET community in its almost 20 years of publication. The maiden issue of the journal was launched on the eve of the 8th COLLNET conference held in New Delhi 2007 and has published peer reviewed articles presented at COLLNET conferences held in different parts of the globe, besides publishing original articles submitted by scholars from various countries.

Hildrun Kretschmer's vision integrated bibliometric and scientometric approaches with related fields to analyse international cooperation. Her work fostered a diverse network of experts, addressing challenges in data-intensive science and global scholarly communication. Hildrun's legacy continues to shape scientometric research by her engagement in the creation of the necessary institutions and infrastructures.

Hildrun Kretschmer co-founded WISELab at Dalian University of Technology (China) jointly with Liu Zeyan in 2005. WISELab has since become a flagship of Scientometrics in China, inspiring generations of young researchers and stimulating innovative research in the field with the invitation of several international researchers in the framework of the Chinese Sea-Sky program. Her positions held at WISELab, at Henan Normal University, Xinxiang (China) expressed her strong personal international engagement in research and education, and her tireless commitment to mentoring emerging scholars and promoting scholarly innovation has left an enduring legacy. Hildrun played a vital role in the life of our scientometrics and informetrics community.

She strongly advocated the foundation of an international association bringing scholars and practitioners together to represent and support the community in the field of scientometrics and informetrics with the aim to advance research and application, to stimulate education and public communication, including policy discussions. She acted as the first president of the International Society for Informetrics and Scientometrics (ISSI) that was founded in 1994 after she had organised the 4th International Conference on Bibliometrics, Informetrics and Scientometrics in Berlin, the first one of a series that is associated with this Society.

With her passing, our scientific community has lost one of its great personalities, but we also celebrate her outstanding and long-lasting contributions, as well as her impact on the worldwide Scientometrics community.

RESPONSE OF THE INTERNATIONAL SOCIETY FOR SCIENTOMETRICS AND INFORMETRICS (ISSI) TO THE CoARA REFORM

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In 2022, the Coalition for Advancing Research Assessment (CoARA) was established with the goal of overhauling research evaluation practices. An agreement was formulated for potential members to endorse, incorporating the principles and pledges underpinning the reform initiative (CoARA, 2022). The CoARA vision is that *"the assessment of research, researchers and research organisations recognises the diverse outputs, practices and activities that maximise the quality and impact of research. This requires basing assessment primarily on qualitative judgment, for which peer review is central, supported by responsible use of quantitative indicators"* (CoARA, n.d.).

The International Society for Scientometrics and Informetrics (ISSI), which brings together a community of renowned researchers and experts of quantitative research assessment methods and bibliometric indicators for over 30 years, aims to present its perspective on research assessment reform to both CoARA and the broader research community. The objective is to offer evidence-based insights and recommendations for (quantitative) research assessment rooted in scientific principles while steering clear of personal or ideological biases. For a more in-depth analysis of the CoARA initiative, we refer the reader to Abramo (2024).

We concur with CoARA regarding the understanding that research outputs extend beyond publications catalogued in bibliographic databases, acknowledging that researchers engage in activities that may not always culminate in publications. However, the ability of peer review to extend assessment to research outputs beyond indexed publications does not imply that peer review, in practice, can ultimately assess products better than bibliometrics. Therefore, we find it challenging to align with a consequential assertion such as, "this necessitates primarily relying on qualitative judgement, with peer review as a central component." There are two main reasons for that.

First, we contend that there is not inherently a superior methodology for assessing research, as both peer review and bibliometrics possess their own limitations and shortcomings (Bornmann, 2011; Gingras, 2016; Horrobin, 1990; Lee et al., 2013; MacRoberts & MacRoberts, 1996; Moxam & Anderson, 1992). The choice of a methodology should follow a thorough examination of

i. the objectives of the research assessment,

ii. the intended use of its outcomes,

iii. the technical specifications (e.g., scale, disciplinary variations, granularity, timeliness, deadlines, minimum acceptable accuracy thresholds, etc.),

iv. the available financial resources,

v. the data accessibility, and

vi. the cultural context (e.g., ethical considerations, gender equity, incentive frameworks, etc.).

Only then, would it be possible to determine whether to adopt peer-review, bibliometrics or a hybrid approach.

Second, CoARA argues that research assessment should center on qualitative methods and asserts that "peer review is the most robust method known for assessing quality." However, this statement does not hold true when considering individual research works, as evidenced by the not infrequent discrepancies in evaluations by divergent reviewers (Ancaiani et al., 2015; Bertocchi et al., 2015; Bornmann et al., 2010). This discrepancy is even more pronounced when assessing research units, where quality scores and rankings fluctuate depending on the number of works evaluated by peers in large-scale assessments (Abramo et al., 2010).

Peer review stands as the conventional method for evaluating research. We recognize situations where peer review remains the sole viable option:

i. within the arts and humanities, where bibliographic databases lack comprehensive coverage, hindering reliable quantitative assessments of researchers and research institutions (Aksnes & Sivertsen, 2019; Larivière et al., 2006);

ii. in national research systems where a significant portion of research output remains unindexed; and

iii. when the assessment scale is small yet pivotal, such as in recruitment and career advancement evaluations.

However, the challenge lies in the practical feasibility of peer review in all instances

of assessing research, including organisations and countries. Researchers serving as reviewers face an overwhelming demand from journal editors, with the number of articles published in 2022 soaring by 47% compared to 2016, surpassing the modest growth in the number of active scientists (Dance, 2023; Hanson et al., 2023). Additionally, the diminishing marginal benefits and escalating marginal costs for scientists engaged in further reviews for hiring committees, tenure review panels, funding agencies, and research assessment bodies exacerbate the issue. In addition to the sheer volume of assessments required for individual manuscripts, grant proposals, and application packages, conducting assessments of all diverse research outputs, practices, and activities at the meso (e.g., academic institutions) and macro (e.g., countries) levels is nearly impossible and economically unviable using qualitative methods.

The selection of an assessment methodology should thus entail a thorough examination of the objectives of the research assessment, the intended use of its outcomes, technical specifications (e.g., scale, disciplinary variations, granularity, timeliness, deadlines, minimum acceptable accuracy thresholds, etc.), available financial resources, data accessibility, and cultural context (e.g., ethical considerations, gender equity, incentive frameworks, etc.). Subsequently, it would be more logical to determine whether and, if so, how to integrate peer review, bibliometrics, or a hybrid approach based on these considerations.

The recommendation by CoARA to "move away from using metrics like the Journal Impact Factor (JIF), Article Influence Score (AIS), and h-index as proxies for quality and impact" (CoARA, 2022, p. 6) reflects criticisms regarding the prevalent and undesirable misuse of metrics, which has been discussed in our field for years. In fact, the concerns about the limitations of using bibliometric indicators are almost as old as the metrics themselves (Rushforth, & Hammarfelt, 2023). However, beyond the simplistic metrics like JIF and h-index, there exists a range of bibliometric indicators and methods that can shed light on publication and collaboration behaviour as well as scholarly impact, which, in the context of suitable benchmarks, can indicate national or institutional research activities.

Finally, we believe that the CoARA principles should acknowledge that bibliometric methods remain a valid, accurate, functional, and efficient means of assessing research in certain contexts, particularly on the meso and macro levels of analysis, such as assessment of institutions or countries, supplementing peer review effectively, and at times making them more transparent and evidence-based. There are also several convincing arguments for the use of a hybrid approach in which bibliometric indicators can be used to inform and improve peer review and panel-based evaluations (van den Besselaar & Sandström, 2020).

Recalling that science, in principle, should not be driven by ideology or personal interests, we urge research managers and policymakers to have the argument in favour of peer review, while outrightly rejecting bibliometric methods, thoroughly discussed and considered before deciding to follow the CoARA recommendations.

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REFLECTING ON COLLNET 2024

A LEGACY FOR HILDRUN KRETSCHMER:

INSIGHTS FROM THE 18th INTERNATIONAL WIS CONFERENCE IN STRASBOURG

A MEETING REPORT BY

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The enchanting city of Strasbourg, known as the "Capitale de Noël" (Capital of Christmas), set the perfect stage for the 18th International Conference on Webometrics, Informetrics, and Scientometrics (WIS) & 23rd COLLNET Meeting. Held from December 12-14, 2024, at the MISHA (Maison Interuniversitaire des Sciences de l'Homme), University of Strasbourg, this hybrid event welcomed global participants both in-person and online.

Conference poster. Credits: B. Markscheffel.

A MOMENT OF REFLECTION:

HONORING PROF. HILDRUN KRETSCHMER

This year's conference carried a profound sense of remembrance as it was the first COLLNET event following the passing of its founder, Prof. Hildrun Kretschmer. Her

Opening speech & obituary. Photo courtesy of © V. Batagelji

legacy as a pioneer in scientometric research and her visionary contributions to COLLNET were deeply honored throughout the conference. Many attendees began their presentations with heartfelt tributes, with the opening statement by General Chair Dr. Bernd Markscheffel titled: "Prof. Hildrun Kretschmer's Legacy to the Scientific World" setting a reflective and respectful tone for the event.

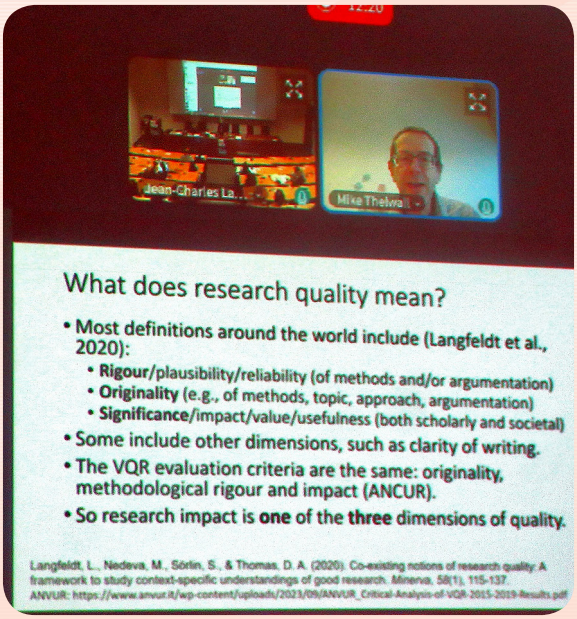
A GLOBAL GATHERING OF MINDS

The conference brought together researchers, academics, and practitioners from diverse corners of the globe, fostering meaningful discussions and collaborations. With 23 in-person presentations featuring experts from India, China, Germany, France, Japan, Estonia, Philippines, Taiwan, Slovenia and the USA, and 11 online talks from South Korea, Canada, Belgium, Great Britain, and India, the event demonstrated impressive international participation.

This year's program was carefully curated through a rigorous review process, selecting the presented talks from over 80 contributions, ensuring a high standard of academic excellence and relevance.

KEY HIGHLIGHTS

The conference delivered engaging keynote sessions from renowned figures in scientometric research:



Mike Thelwall's keynote speech. Photo courtesy of © V. Batagelji

- **Mike Thelwall (UK):**

  "Can Large Language Models Replace Citation Data for Research Quality Indicators?"

- **Grant Lewison (UK):**

  "Research Evaluation in an Age of Collaboration"

- **Marc Bertin (France):**

  "Analysis of Citation Contexts: Past, Present and Future"

- **Wolfgang Glänzel (Belgium):**

  "Challenges in Measuring Interdisciplinarity – On Concepts, Methods, and Caveats"

Interactive Q&A sessions ensured active engagement across both in-person and virtual attendees, while topics such as scholarly profiling, bibliometric advancements, and interdisciplinary research evaluation sparked lively discussions.

CELEBRATING EXCELLENCE: BEST PAPER AWARDS

This year, two outstanding papers received the spotlight:

- **Fang Cheng et al.:**

  "Research on Scholar Profiling Based on Generative Pre-trained Language Model."

  This groundbreaking paper addresses the challenges of extracting scholar information from unstructured internet sources by introducing an innovative attribute-entity extraction method based on generative pre-trained language models. The proposed approach achieves unprecedented accuracy in scholar profiling, outperforming existing models across all 12 types of scholars' attribute entities with a remarkable 99.34% F1 score, while significantly improving the extraction of complex attributes like "research direction."

- **Aparna Basu et al.:**

  "International Scientific Collaboration: Core-Periphery Structure in the Regional South Asian Network of Countries."

  This innovative study investigates the international research collaboration network among SAARC countries in South Asia, uncovering a distinct core-periphery structure with significant implications for regional scientific cooperation. The analysis, based on co-authorship data from Web of Science (2016-2019), reveals a regional sub-core formed by India and the USA, while other countries occupy positions ranging from Outer Core to Near and Outer Periphery, demonstrating stronger ties to global core countries than intra-regional collaborations.

BEYOND THE CONFERENCE HALLS

Strasbourg's magical holiday charm added a unique cultural dimension to the event. At-

Fang Chen's talk. Photo courtesy of © V. Batagelji

"Capitale de Noël". Photo courtesy of © B. Markscheffel.

Prof. Jean Charles Lamirel taking over his Lifetime Achievement Award . Photo courtesy of © D. Begum.

tendees explored the iconic Christmas markets, strolled through beautifully illuminated streets, and soaked in the festive atmosphere. The conference dinner at Salamboo Amilkar, a renowned Tunisian restaurant, provided a cozy setting for relaxed conversations and networking over delicious cuisine.

Dinner in "Salambôo Amilkar". Photo courtesy of © B. Markscheffel.

CLOSING CEREMONY AND FUTURE PLANS

The conference concluded with a memorable Closing Ceremony, where Prof. Jean Charles Lamirel was honored with the Lifetime Achievement Award in recognition of his outstanding contributions to the field of Scientometrics and Informetrics.

Additionally, Dr. PK Jain officially announced the next edition of the conference: the 19th International Conference on Webometrics, Informetrics, and Scientometrics (WIS) & 24th COLLNET Meet-

Strasbourg Christmas Market. Photo courtesy of © B. Markscheffel.

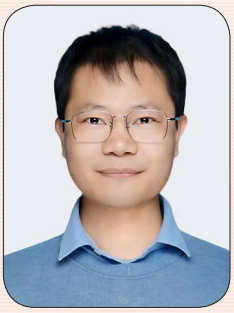
ing, scheduled to take place in New Delhi, India, from September 19-21, 2025, at the prestigious Institute of Economic Growth.

LOOKING AHEAD

The COLLNET 2024 conference reaffirmed its position as a premier platform for global knowledge exchange and collaboration in the fields of Webometrics, Informetrics, and Scientometrics. The General Chair concluded the conference by emphasizing the importance of maintaining the professional connections established during the conference. He expressed their heartfelt gratitude to all speakers, participants, and staff for their dedication and contributions, their vibrant discussions, inspiring presentations, and the sense of community that has filled our time here accompanied by the hope that the participants would continue the dialogues initiated during the event and actively seek collaborative opportunities that could potentially result in significant scientific or professional advancements. Furthermore, the speaker warmly invited attendees to participate in the upcoming event in the conference series.

As the curtains close on this memorable gathering, participants eagerly anticipate the next COLLNET conference 2025 in Delhi at Institute of Economic Growth, ready to continue advancing research and fostering cross-border collaborations in these dynamic fields. Stay tuned for updates on COLLNET's future events and initiatives!

SPIDER NETWORKS AND CORE-PERIPHERIES STUDIES



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ABSTRACT: In this investigation, we study a family of networks, called spiders, which covers a range of networks going from chains to complete graphs. These spiders are characterized by three parameters: the number of nodes in the core, the number of legs at each core node, and the length of these legs. We propose spiders as a model for core-periphery studies.

Keywords: networks; spiders

1. INTRODUCTION

Let G = (*V*,*E*) be an undirected network (or graph), where $V = (v_k)_{k=1,\ldots,N}$ denotes the set of nodes or nodes and *E* denotes the set of links or edges. For general terminology on networks and network indicators we refer to (Rousseau et al., 2018; Wasserman & Faust, 1994).

We recall for further use the definition of the following three basic networks. The chain, the star and the extended star, see Fig. 1.

A chain is a graph G consisting of alternating nodes and edges, beginning and ending with nodes and in which each edge is incident with the two nodes immediately preceding and following it. A chain will be described through its number of edges.

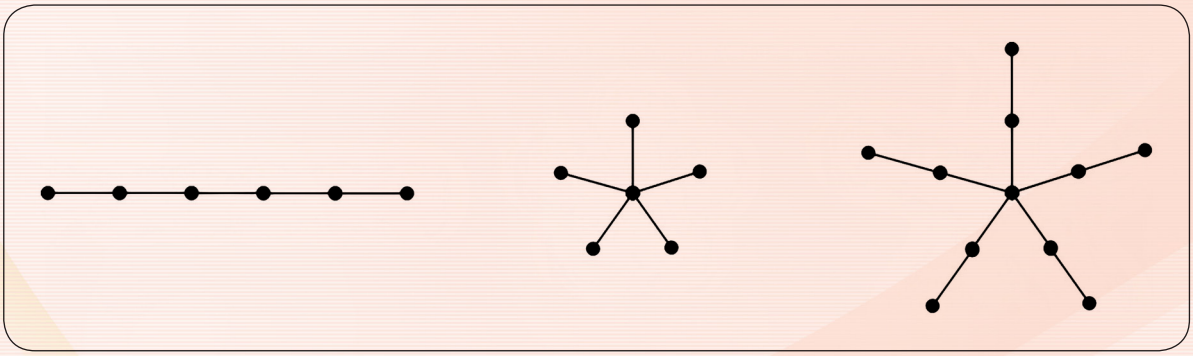

Fig.1 A chain, a star and an extended star

Hence an N chain has N + 1 nodes. This description corresponds with the idea of six degrees of separation, where there are 6 links connecting 7 actors. A star is a graph consisting of a central node and some, say K, terminal nodes, connected only to the central node. Finally, an extended star has one node between each terminal node and the central node. Hence, when there are K terminal nodes, there are 2K edges, and in total N = 2K + 1 nodes.

2. CORE AND PERIPHERY IN SCIENCE AND INFORMETRICS: A SHORT OVERVIEW

2.1 THE CORE-PERIPHERY IDEA

The core-periphery idea assumes that there are two classes of nodes in a network. The first consists of a cohesive core in which the nodes are highly interconnected, and the second is made up of a peripheral set of nodes that are loosely connected to the core.

One of the best-known core-periphery studies is Krugman and Venables' work (Krugman & Venables, 1995) on manufacturing and the role of transportation costs. They find that when transport costs fall below a critical value, a core-periphery spontaneously forms, and nations that find themselves in the periphery suffer a decline in real income. Other examples of studies on core-periphery structures can be found e.g., in biogeography (Channell & Lomolino, 2000), the film industry (Cattani & Ferriani, 2008), online social networks and disaster mitigation (Kim & Hastak, 2018), or city regions and globalization (Scott, 2001). Within the field of education, Altbach (2007) described the role of research universities in peripheral countries compared with mainstream countries. He notes, among other things, that "Globalisation subjects all participants to the pressures of an unequal global knowledge system dominated by the wealthy universities, and imposes the norms and values of those institutions on all (Altbach, 2004).

Within the field of bibliometrics, we see that already in the seventies Moravcsik (1978) paid attention to peripheral countries (at that time referred to as less developed countries), and in the eighties Arunachalam and his collaborators used the term "periphery" in scientometrics studies (Arunachalam & Garg, 1986; Arunachalam & Manorama, 1988) to refer to India and ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand). He noted that these countries mainly published in low-impact journals and were generally rarely cited. He further noted that for India peripherality is not uniform, but some areas like astronomy and to some extent physics are closer to mainstream science than others.

Later, Latin-American colleagues Narvaez-Berthelemot and Russell (2001) studied the social sciences literature, focussing on the scientific periphery using the DARE Unesco database. Inspired by Belver Griffith's work, Pamela E. Sandstrom (2001) studied the field of human behavioral ecology and was interested in understanding how schol-

ars discover and use information originating from the core as well as the periphery.

Leydesdorff and Wagner (2008) studied international collaboration and found that during the period 2000–2005, the network of global collaborations reinforced the formation of a core group of the fourteen most cooperative countries. They note that countries at the periphery may be disadvantaged by the increased strength of this core. Choi (2012) observed that, although the core-periphery pattern persists, new rising stars, such as Korea and Türkiye, have emerged in the scientific co-authorship network.

Zelnio (2012) proposed a methodology to find the core-periphery structure for different scientific fields by considering the power law structure of articles and the degree centrality of countries. Among others, he identified stark differences between technology and non-technology-intensive fields. In a study on the influence of core-periphery thinking in the Chinese humanities and social sciences, Xu (2020) described the periphery as successively positioned away from the center with decreasing power and scope to affect the global research agenda.

Finally, using patent analysis Gao et al. (2011), a block model analysis showed that the interregional knowledge exchange network of China began to show a core-periphery structure in which the most advanced provinces formed a core of most active knowledge exchangers (as measured through co-inventorships), while the members of the peripheral block from less favored regions showed few or no local and extra-local knowledge exchange.

2.2 CORE-PERIPHERY MODELS

In an ideal core-periphery system, core nodes are adjacent to other core nodes and some peripheral nodes while peripheral nodes are not connected with other peripheral nodes (Borgatti & Everett, 1999). This ideal, in the adjacency matrix representation, consists of an upper square block of ones (except possibly the diagonal), while the square describing the other columns and rows consists of zeros (again with the diagonal as a possible exception). The remaining rectangles can have any number of zeros and ones. Borgatti and Everett (1999) provide, among other examples, a bibliometric case, namely Baker's work (Baker, 1992) of co-citations among social work journals. His data consisted of the number of citations from one journal to another journal during a one-year period 1985–1986, but Borgatti and Everett conveniently dichotomized the data, ignoring reflexive ties (citations of a journal to itself). The results of analyzing the data led to a core of five journals and gave a Pearson correlation of 0.54, indicating a strong but far from perfect fit with the ideal. Here the correlation is calculated between the observed adjacency matrix, considered row by row, and the ideal case.

3. THE SPIDER FAMILY: (M,K,L)

Here we introduce spiders (see Egghe, 2024): these networks consist of a core of $M > 0$ nodes, with on each node $K \geq 0$ "legs" of length $L \geq 0$. M, K, and L are natural numbers.

Construction of a spider, denoted as $sp_{M,K,L}$: a complete network on M nodes acts as the core; then, to each of these M nodes K chains are attached of length L. Informally, we refer to such a set of K chains as a bundle. Hence the number of nodes $N = M + M*K*L$ and the number of (undirected) links is

$$\frac{M(M-1)}{2} + MKL$$

If $M = 1$ and $L = K = 0$ then there are no links. The next figure (Fig.2) shows some spiders.

SPECIAL CASES

Real spiders (biological spiders have eight legs, usually with seven segments): Hence $M = 8$, $K = 1$, $L = 7$, or $M = 1$, $K = 8$, $L = 7$, depending on

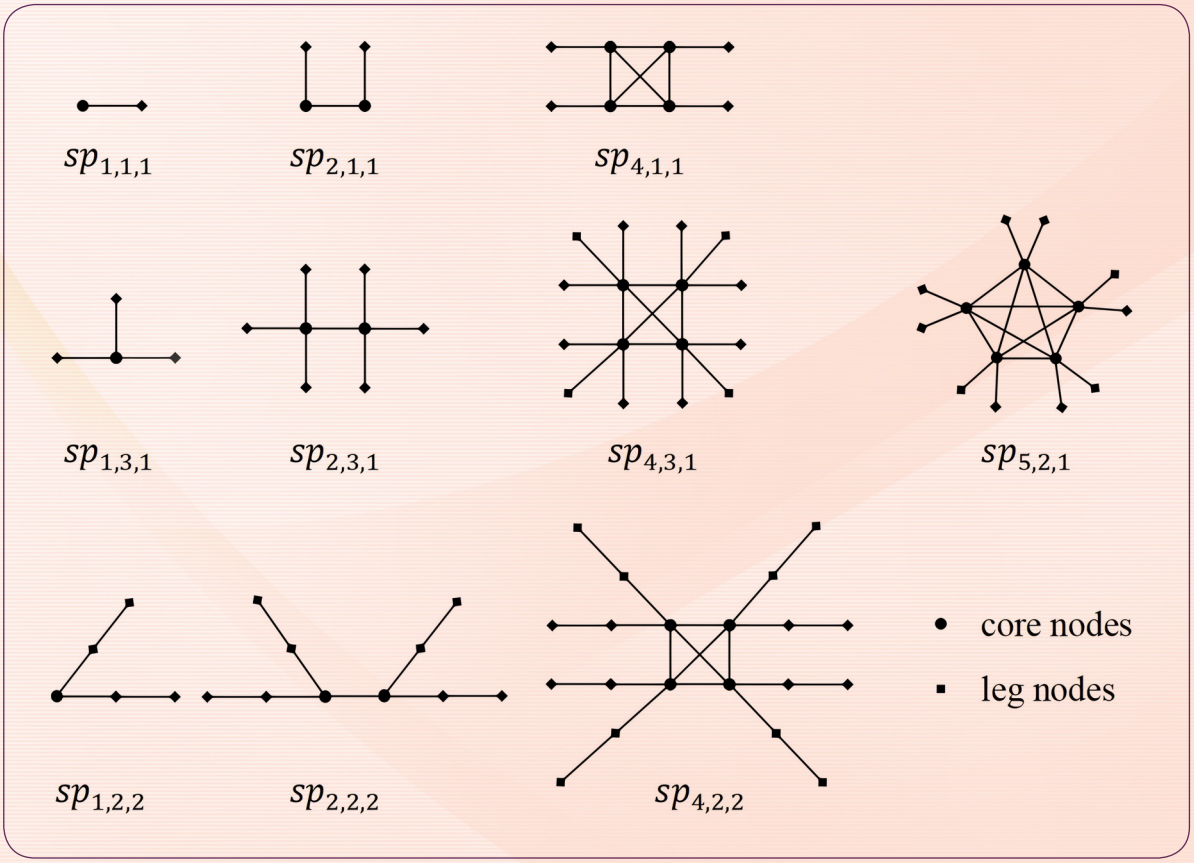

Figure 2: spiders

how one sees its main body (as a tightly knit construction, or as an abstract "ball").

If K = 0, or equivalently L = 0, we have a complete network.

If M = 1 and L = 1 then we have a star (for all K > 0).

If M = 1 and L > 1 we have an extended star (for all K > 0).

The case M = 1, K = 1, and any L > 0 yields a chain.

Interpretation: the complete network represents the core, while the chains attached to it represent peripheries closer or further away from the core. Adapting the length of a leg leads to the near or far periphery, as in the terminology used in (Arunachalam & Manorama, 1988).

Indicators and arrays related to spider networks, including small-world properties, are studied in (Egghe et al., 2024) to which we refer the reader.

4. FEEDBACK TO THE CORE-PERIPHERY MODEL

We think that some spider networks are excellent models for theoretical core-periphery studies. Yet, one may consider the opposite question: "Given a network, which spider best describes it?". Remembering the Borgatti-Everett (1999) study which used correlations, the following heuristic reasoning can be applied. The core is the essential part of a spider, hence one must try to find the best approximation of a complete network. We opt for a k-shell approach (Seidman, 1983; Malliaros et al., 2019). As in the Borgatti-Everett case, one can use correlations to determine the fit. A pseudo-code to do this is given in the appendix.

EXAMPLE 1.

A, B, C, D, K1, K2, K3, K4, K5, K6, K7, and K8 co-authored nine papers. The detailed co-authorship relationships are shown in Table 1 and Figure 3. This leads to a perfect spider.

Table 1: Twelve authors co-authored nine papers ($sp_{4,2,1}$, M=4, K=2, L=1)

PAPER	AUTHORS
P1	A, B, C, D
P2	A, K1
P3	A, K2
P4	B, K3
P5	B, K4
P6	C, K5
P7	C, K6
P8	D, K7
P9	D, K8

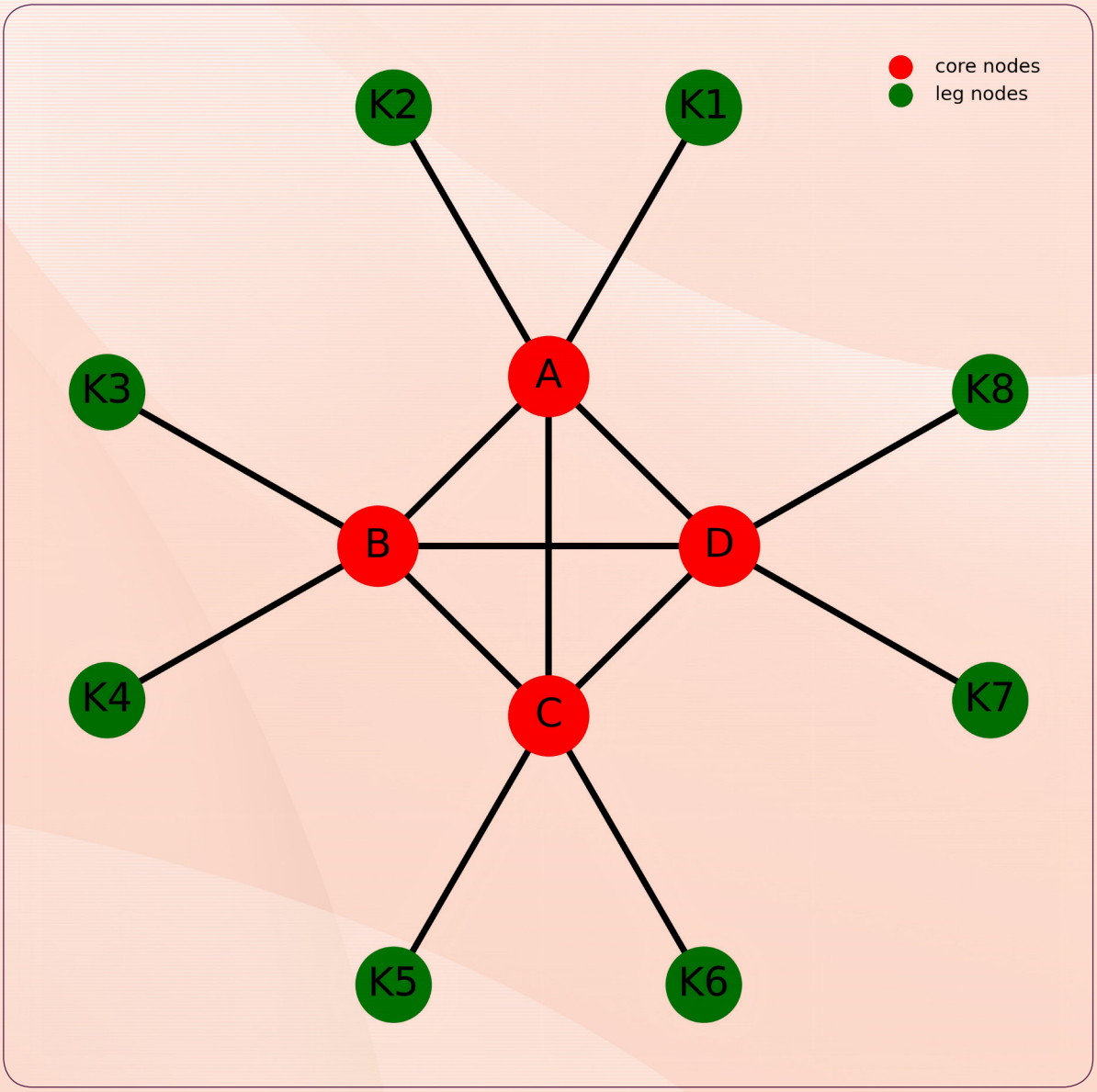

Figure 3. Perfect co-authorship spider

Table 2: Twelve authors co-authored nine papers ($sp_{4, 1.75, 1.14}$, M=4, K=1.75, L=1.14)

PAPER	AUTHORS
P1	A, B, C, D
P2	A, K1
P3	B, K2
P4	K2, K3
P5	C, K4
P6	C, K5
P7	C, K6
P8	D, K7
P9	D, K8

$$M = 4\ , \quad K = \frac{1+1+3+2}{4} = 1.75\ , \quad L = \frac{1+2+3+2}{7} = 1.14$$

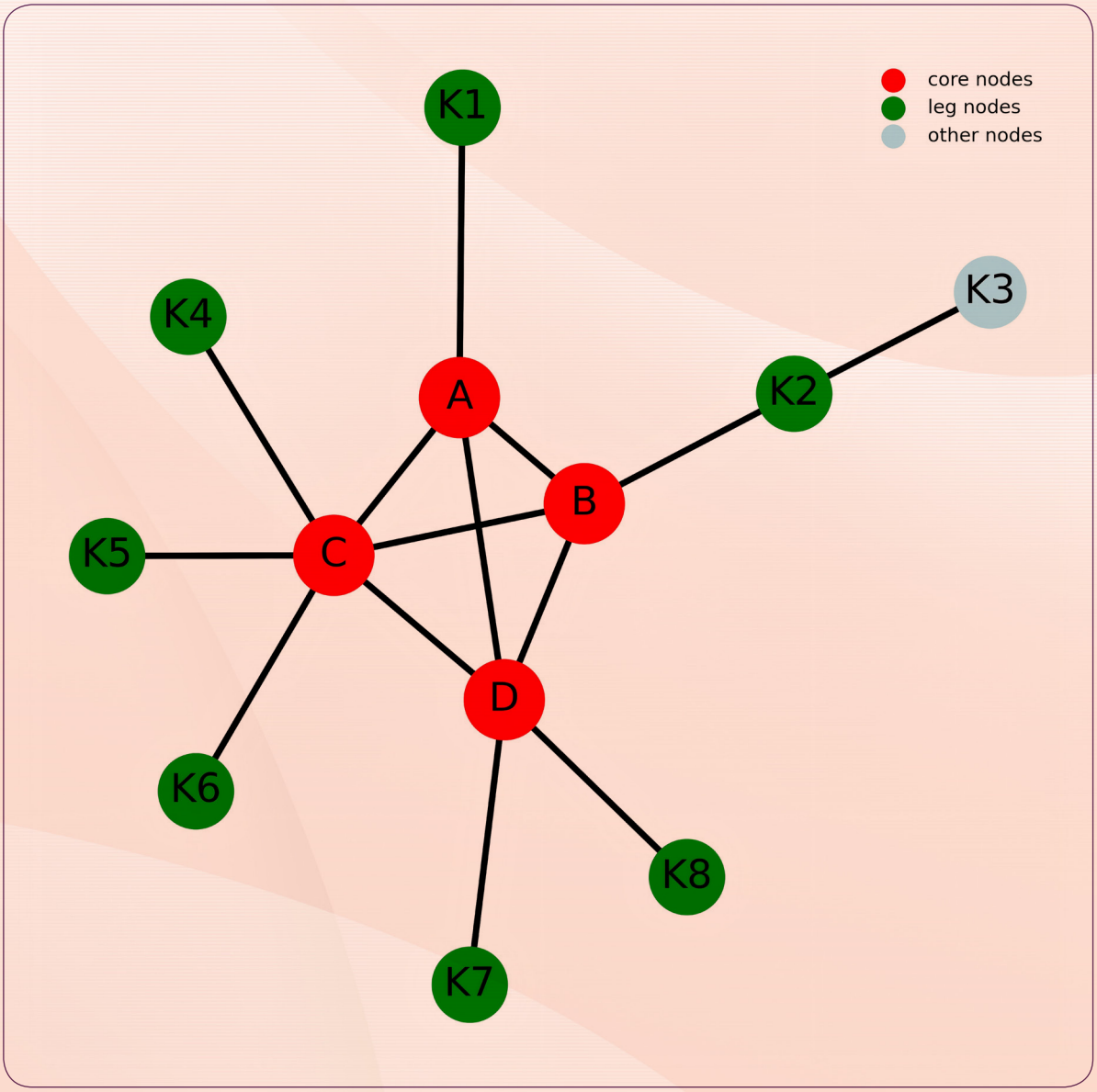

Figure 4. A core-periphery structure approximating a spider network

EXAMPLE 2.

Most networks exhibiting a core-periphery structure are not perfect spiders. Another example shows a case of twelve authors who co-authored another nine papers. The detailed co-authorship relationships are shown in Table 2 and Figure 4. We replaced the numbers M, K and L by their observed averages.

5. CONCLUSION

Besides as a model for core-periphery networks, spiders are also interesting examples in more formal network studies as they provide a fluent transition between two extreme situations, namely chains and complete networks.

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APPENDIX

PSEUDOCODE FOR ESTIMATING SPIDER MODEL PARAMETERS

(1) K-shell Decomposition

- The graph is decomposed into different k-shells, and the nodes in the highest k-shell are identified as core nodes.

(2) Identifying Core and Leg Nodes

- All direct neighbors of each core node that are not core nodes themselves are identified as leg nodes.

(3) Calculating Leg Lengths

- For each core node, compute the shortest-path distances to its leg nodes using BFS or Dijkstra, while skipping (i.e., ignoring) any edge that connects two core nodes during the search.
- Record the maximum distance (leg length) for each core node. The average of these maximum distances across all core nodes is the average leg length L.

Input:

- (G): A graph((V, E))

Output:

- (M): Number of core nodes
- (K): Average number of legs per core node
- (L): Average length of the legs

```
Initialization
Core_Nodes = ∅
Direct_Leg_Nodes = ∅
Leg_Counts = []
Leg_Lengths = []
## (1) K-shell Decomposition
Perform K-shell decomposition on G
Max_Shell = maximum k value from the decomposition
Core_Nodes = all nodes in Max_Shell
M = size(Core_Nodes)
## (2) Identifying Core and Leg Nodes
for each node in Core_Nodes do
    Neighbors = direct neighbors of node in G
    Legs = Neighbors - Core_Nodes
    Leg_Counts.append( size(Legs) )
    Direct_Leg_Nodes = Direct_Leg_Nodes ∪ Legs
end for
K = average( Leg_Counts )
## (3) Calculating Leg Lengths
for each core_node in Core_Nodes do
    distance_map = BFS_or_Dijkstra(
        start = core_node,
        graph = G,
        ignore_edge_if = (u, v in Core_Nodes)
    )
# In BFS/Dijkstra: do not traverse edges connecting two core nodes
    max_length_core = 0
    for each leg_node in Direct_Leg_Nodes do
        if distance_map[leg_node] ≠ ∞ and
        distance_map[leg_node] > max_length_core then
            max_length_core = distance_map[leg_node]
    end for
    Leg_Lengths.append( max_length_core )
end for
L = average( Leg_Lengths )
Output M, K, L
```