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ARTICLE

Approaching a National Film History through Data. Network Analysis in German Film History

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The present paper is an attempt at importing network analysis as a method and applying it to a field that has hitherto been examined in different ways: the study of national cinema. The approach was motivated by the perceived conundrum in the existing studies of German cinema that filmhistorical and political history usually do not match. The aim is to open up another perspective on the problem of periodization by looking at the data of film production, more specifically of collaboration. By using a comprehensive data set which is made availavable by the Filmportal, the central internet platform on German film, the approach in this paper is to look at the key creatives involved in the production of a film in the period from 1919 to 1939 and to conceptualize collaboration and connectivity in a (national) film culture through the use of network research methods.

As more data sets in good quality become available, as tools that help us understand big data are developed and gain traction, as researchers acquire knowledge and experience about meaningful methods for using large pools of information, we are faced with the task of testing our hypotheses in new ways. Of course, the "datafication" of film studies is a complex process that has institutional as well as economical impact, it requires us to rethink methods as well as study programmes (because students need new skills), it calls for new introductions and reflections (Arnold and Tilton). At the same time, we need to take the risk of breaking new ground in our research methods which implies the possibility of failure. The present paper is an attempt at importing a method – network analysis – and applying it to a field that has hitherto been examined in different ways: the study of national cinema. As certain misunderstandings are rather common, it is important to note at the start that this paper does not propose an ultimately better way of doing film history nor does it imply a replacement of existing approaches, but it rather ventures down a different path. By using a comprehensive data set and reverting to methods of network analysis, our paper is trying to break new ground for the study of national cinema. The approach was motivated by the perceived conundrum in the existing studies of German cinema that filmhistorical and political history usually do not match.

Of course, there is a larger question looming behind the question what can be considered a national cinema which cannot be addressed here in total. Film studies has a tradition of critical engagement with the concept of national cinema, its vicissitudes and pitfalls (see e.g. Higson; Vitali; Christie). There are, of course, many good reasons why traditional film histories that most often rely on the unquestioned triad of nation, work, and author – as conventional national film histories did – have gone out of fashion. And we certainly do not want to attempt a rescue mission of these approaches from the dustbin of history. Yet again, approaching a national film history as a whole can be attempted on the basis of the available data which is what this essay proposes. Whether this is the entirety (or even totality) of a national cinema is a different question, but it is – in terms of data – at least a more comprehensive base on which we are building.

Break or continuity – how to periodize German film history?

> *The disasters of German history this century have left their mark on the cinema, and even more so on the image and idea we have of it.*
>
> Thomas Elsaesser (1995, 172)

In recent decades, there have been few attempts to consider German film history in its entirety. The last major attempt with a claim to providing a general overview of German film history, written in German, has not been updated for 20 years (Jacobsen et al.). More recent publications focusing on German film history as a whole have not only been written without exception in English, they announce their reservations and limited scope already in their titles. One title proclaims the book to be a "critical history" (Brockmann), even if the classic canon is worked through. A similar approach, offering a series of analyses of canonical films, can be found in another anthology (Garncarz and Ligensa). A third publication is announced as a "new history" (Kapczynski and Richardson) because conceptually the texts are oriented rather towards events and discourses than towards works and persons. This limited claim also applies to other studies as well: one anthology immediately places history in the plural and relates these "histories" to genre development (Fisher), while another collection proposes multiple approaches to historical, as well as aesthetic and theoretical questions of German cinema, making it more of a scholarly compendium (Bergfelder et al.). All of these books are similar insofar as they take a limited sample (usually a small group of films, sometimes persons or events) and consider this as a representative subset of the whole.

Besides the question of comprehensiveness (the data basis), there is also the question of internal periodization. German film history has often been divided into periods according to the political ruptures and the frequent system changes that have characterized the history of the country over the

20th Century. What is still the most canonical film history in German (Jacobsen et al.), has chapters on German film history up to 1918 (the imperial period), on Weimar film culture (1919-33), on Nazi film (1933-45), on postwar cinema divided between East and West and, in the case of the Federal Republic, further subdivided according to decades (1945-89), and, in the second edition, it also contains a final chapter on post-Wall cinema (1989 to present).[1] Of course, these political breaks are important and I am certainly not denying the impact of political transformations and system change on the cinema sector in general and filmmaking specifically. At the same time, there are other temporal markers in existence which are often connected to the development of film as a medium that do not map exactly onto these political dates, but are in conflict with them. The most significant film-historical events that would imply a different periodization compared to the major political ruptures are probably the following: the introduction of the long feature film which happened in the early to mid-1910s during the imperial period and before World War I; sound film was introduced in Weimar Germany between 1928 and 1930; cinema attendance peaked in the mid-1950s and then declined until the 1980s, a period in which the competition with television provided the constant background noise. These decisive moments could also be applied to divide German film history into temporal slices.[2] It is therefore a conceptual decision to give the (legal) take-over of government by the National Socialists in early 1933 more weight than the introduction of sound a couple of years before. We are certainly not arguing that sound film is more important (for film history) than the Nazis coming to power, we simply want to highlight the unspoken assumptions inherent in such periodization that are only seldomly discussed. Turning to a data-driven approach, one can test the existing assumptions such as the correlation (or even causal link) of cinema and political history which undergirds much writing on German film history. In the analysis that follows we wish to open up another perspective on this problem of periodization by looking at the data of film production, more specifically of collaboration.

Films and/as networks

> *Film history is always a phenomenon of the in-between, of the relation and of the context.*
>
> Lorenz Engell (10)

1 To be fair, one should add that these chapters following the political logic of German history are complemented by texts on experimental and documentary film, on feminism and censorship, on criticism and the relationship of film to television that cut across the periodization.

2 In fact, US film history is more often conceptualized by dates relevant to the medium; the introduction of sound in the late 1920s is usually seen as an epochal break, just as the Paramount decision by the Supreme court, forcing the studios in the late 1940s to divest themselves off their cinema chains, thereby effectively ending vertical integration. See for an early example (Altman), and for a more current one, the *History of the American Cinema*-series (University of California Press) which follows a film historical periodisation until the introduction of sound (the volumes are divided as follows: up to 1907; 1907-1915; 1915-1928; 1926-1931), then turns to decades as the organizing principle.

Film is a cultural form that is, in most cases, created in collectives (Mayer et al.). Films are usually made in creative networks of individual actors (Jones), some of whom are considered to be creative individuals (so called "above the line"-workers or head of departments), while others are rather seen as craftspeople, service providers or subworkers ("below the line").[3] Even though the director is most often credited with being the author of a specific work[4], most experts would agree that there is usually a group of creative professionals involved in the making of a film. If a film has a shared vision and is perceived to be of a piece, the creative individuals need to work closely together because cultural objects cannot be produced on the drawing board, but they need to be individualized and created collectively. By concentrating on these collaborative networks, we are putting an emphasis on relationships, not on individuals or singular works. Historically, the production of films has been most frequently organized as freelance work in project teams. Factory-like division of labour has played a role both in mainstream filmmaking[5] as well in other forms of film production (e.g. commissioned and educational films), while non-collective, artisanal filmmaking by individuals proved to be an alternative for experimental filmmakers, but the most common form of organization remains the project team that is assembled for each production anew. Even though teams are regrouped with each new film, the composition of such teams is not arbitrary, but often professionals work in relatively stable networks of co-workers. In a network analysis of film production in Hungary, Juhász et al. have shown how the positioning in networks can be decisive for success, measured in terms of awards won (Juhász et al.). Our take is to follow a specific aspect of this approach, namely seeing the shifting networks of collaboration as central to the workings of the industry. The approach in this essay is to look at the key creatives involved in the production of a film: the heads of departments and the main actors/actresses. We decided to specifically extract the data for director, producer, screenwriter, director of photography, editing, set design, and music, plus six actors/actresses. With the view towards the selection of the material, the aim of this study is to consider the whole field in a comprehensive way, not just the famous examples. This does not necessarily produce better or more valuable results, but such research on the basis of larger and comprehensive data sets might highlight aspects that have gone unnoticed so far.

Data preparation

> *...the translation of the social into data involves a process of abstraction that compels certain compromises to be made as the data are generated, selected and analysed*

3 For a critical and ethnographic look at the "below the lines"-workers see Caldwell.

4 For important overviews of this approach from different time periods see Caughie, Grant Jeong and Szaniawski.

5 For the most iconic example, the classical Hollywood studio system, see the seminal study Bordwell et al.

van Es and Schäfer (13)

This being an exploratory study, the time period – and therefore the data pool – had to be limited, even though the amount of data we worked on remained rather large when compared to many other network analyses in the field of Digital Humanities.[6] Initially, we wanted to concentrate on the time period from 1919 to 1962 which would have encompassed a number of different political systems. This time frame would have included the cinema of the Weimar Republic and the reign of the Nazis, as well as the immediate post-war period up to the Oberhausen Manifest (in February 1962) in the West which ushered in the Young German Film (and therefore another period in film history) and the building of the Berlin wall (August 1961) in the East, thus anchoring for both East and West Germany the time frame with historical events. Of course, such temporal boundaries are always to a certain extent arbitrary, yet our aim was to have a number of ruptures within the examined period and not to claim any primacy or specific significance for this particular periodisation. When preparing the data though, we realized that the amount of data would not only have taken a lot more time to process than anticipated, but also given us so much material that we would be overwhelmed. So, for the purpose of this article, we limited the time frame to the 21-year-period from 1919 to 1939, concentrating on the immediate interwar period. This choice encompasses the transition to sound, but not the shift to the long feature film in the mid 1910s or the peak in cinema going in the 1950s.

We used the data available and curated at *Filmportal*, the central internet platform on German film, a non-profit project run by the German Film Institute in Frankfurt and financed by national as well as regional cultural funding. The service has been online since 2005 and arguably provides the best data, in terms of credits and technical information, publicly available on German cinema from the beginning to today.[7] As a way to limit the amount of data and to make it processable, we decided to concentrate on feature films; therefore, short subjects, documentaries, "useful cinema" (Acland and Wasson), such as films that are being shown in schools, universities, administrations or companies, amateur films and others were excluded. For each film we collected the following data: director, producer, writer, director of photography, editor, production designer, and composer, as well as six actors/actresses (those with top billing). There is no widespread consensus on what the key contributors in terms of creative input are to a film production. Jan-Christopher Horak, for example, has argued that exile films are films made outside Germany by émigres who were working in the German-

6 The data can be found here: Hagener, Malte; Blaschke, Theresa, 2024, "Approaching a National Film History through Data", https://doi.org/10.7910/DVN/C80HD1, Harvard Dataverse"

7 See https://www.filmportal.de/seite/die-geschichte-von-filmportal.de (17.8.2023) for a brief overview. Thanks to David Kleingers and the team at the DFF for their helpful assistance and collaboration.

speaking film industry prior to their migration; and he defined the key position as director, writer and producer. We deliberately chose a more encompassing model of creative work which included the main crafts involved in the production of a film. Of course, decisions what to include and what to exclude are to a certain extent always arbitrary. Why did we not include sound design, make-up or costume? There are two reasons for the exclusion of additional categories: First of all, we can find data for most of the films for the creative positions chosen, while other crafts are often not listed. This fact already demonstrates a certain contemporary significance. Secondly, our aim was to show networks of people working together over time and how these networks shift or remain stable. In order to do that, we had to construct a data model and apply it which is necessarily an abstraction from historical reality. Adding a category or two would not have changed the results in decisive ways.

We created a unimodal network[8] based on persons which were conceptualised as nodes and on films which connected two persons (edge) that worked on the same film. In our case, we wanted to understand temporal change within the network and therefore we built a separate network for each year. In effect, we ended up with 21 networks which we compared and contrasted in different ways. In these networks, persons were conceptualized as nodes, whereas connections are established if they work together on a film. As a result, a film would usually create thirteen connections (direction, production, screenwriting, camera, editing, set design, music, six actors/actresses), sometimes more if the technical positions were occupied by more than one person, sometimes less if not all of the positions were known or occupied. We worked with CSV-files to process the data and used Gephi, a popular and well-known program, as a tool to calculate the metrics and visualize the networks. Once the dataset was cleaned and corrected, it contained a total of 22.132 nodes, that is persons with credits in the relevant categories, and 6.046 films over the 21-year-period. Since many persons show up more than once in the same or in subsequent years, we counted 8.101 unique professionals that worked in the relevant categories on German films between 1919 and 1939. Which information does this network actually contain? It provides a certain image of the industry, as it shows how much in demand professionals were that worked in creative positions on film. What flows in these networks is reputation and the dynamics of the industry. More importantly, the structure of the network also shows patterns of collaboration. As the following observations will be concerned with the density and centrality within the network and with changes over time, the specific focus is on closeness and distance, on collaboration and transformation.

8 A unimodal network only contains one kind of node and one kind of edge without further specification or direction of the edge. For the possibilities and risks inherent in networks in the humanities see Weingart which has been important for our reasoning here.

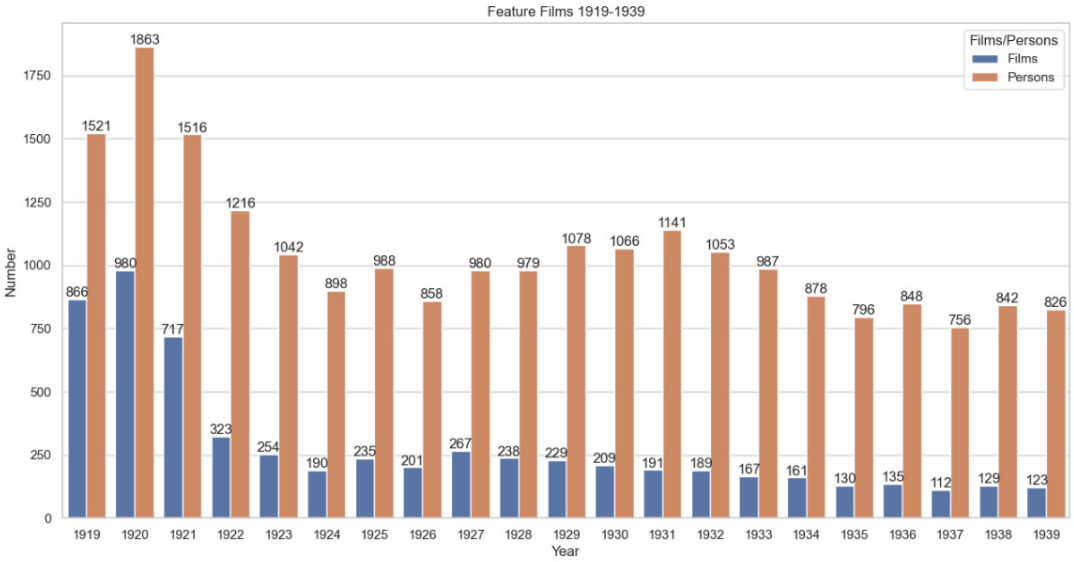

Illustration 1. number of films and number of participants per year

Results

One of the first things we noticed already during the preparation of the data was the rather wide fluctuation in the number of films produced in each year (see fig. 1). In the beginning of the period under consideration, nearly 1000 films were made in a single year (1919: 866; 1920: 980; 1921: 717). There are a number of reasons one can find for this phenomenon, among them the fluctuating economy which made a highly speculative industrial sector such as film production attractive to potential investors, as well as the weakness of the currency which made exports very profitable and therefore potential earnings higher (Spiker). Most important were probably the expectations towards films (in terms of return on investment) and the generally low degree of professionalization of the industry – it was relatively easy to enter the industry which would also explain the rather high oscillation of the key creative professionals involved in the production (see next paragraph). As the years went on, it became costlier to make a film and it required more expertise to enter the industry, so fewer films were made and more stability was achieved. The number of films produced annually soon settled at a much lower average of 230 films (calculated over the years 1923 to 1929) and even lower, if we look at the sound film period with 154 films produced annually (the average of the years 1930 to 1939). Given the capital necessary for film production, the rising production costs and the access to professionals and equipment, this development is not surprising. At least the number of films produced annually was a parameter well known before (Prinzler).

We were specifically interested in the stability of the network (as a whole) over time, so we tried to zoom in a bit on those persons that leave the network from one year to the next. The first thing that struck us – even

though it did not quite surprise us – was that those people had a much lower average participation in productions than those that stayed in the network.[9] Those that left the network from one year to another were involved in 1,3 to 1,6 productions in the preceding year, with 1,44 as the average. These numbers remained rather stable over the whole period under investigation. Since 1,0 is the lowest possible value here (because the person has to have at least one credit in the preceding year), an average of 1,3 to 1,6 is pretty low, especially if we look at the numbers for those remaining in the network. The number of productions that the people remaining in the network from one year to the next participated in fluctuated between 4,96 (nearly five productions on average; in 1921) and 2,33 (in 1938) with the average of the whole time period (1919-39) being 3,3. Of course, with the huge difference in the number of films produced each year, it is only logical that these number decline over time. For the 1920s, the average is 3,7 films, while for the 1930s it is 2,9, echoing the general trend of fewer films produced per year. Most probably, this also has to do with the average production time that an individual was occupied with on any project. Films at the beginning of the 1920s, on average, were produced faster and also with fewer participants. Here, an approach based on network analysis is productive because it shows wider trends based on the entirety of available data, not just a section or part thereof.

The next thing we noticed was the rather wide fluctuation of personnel each year. Each person that receives a credit in a given year is represented by a node; one to two thirds of all the nodes of a given year (i.e. persons) do not show up in the network of the next year. The highest numbers of people leaving the network (not being present in the following year) are to be found in the early years of the Weimar Republic. In the early 1920s about two thirds of the professionals active in a given year did not receive a credit on a feature film in the following year (1921: 66,3%; 1922: 68,5%; 1923: 64,3%), so it seems that the industry was at a most volatile state. When looking more closely – and beyond the immediate post-war situation – at the data, we noticed that one of the largest percentage of people not showing up the next year in credits can be observed from 1933 to 1934 (60,3%), i.e. exactly at the point in time, when – after the National socialists came to power – a great number of professionals belonging to persecuted groups (Jews, political activists, open opponents of the fascists, queers and other minoritarian groups) were forced out of the film industry. If we ignore the early years of the Weimar Republic as a short spell of turmoil and disorder, then the percentage of persons not showing up in next year's credits is usually below 50%. It is only twice decisively over 55% - in 1927 and in 1934. The peak in 1927 is harder to explain than the one in

9 Mainly for reasons of operationalization, we only looked at participation from year to year. We did not take into account that some professionals do not show up one year and then have a credit again in the year after. Of course, one could model the data in such a way that participation in the network has a half-life period of more than one year. Yet again, this being an exploratory study, we were more interested in getting to know and exploring the data than in modelling only one particular question.

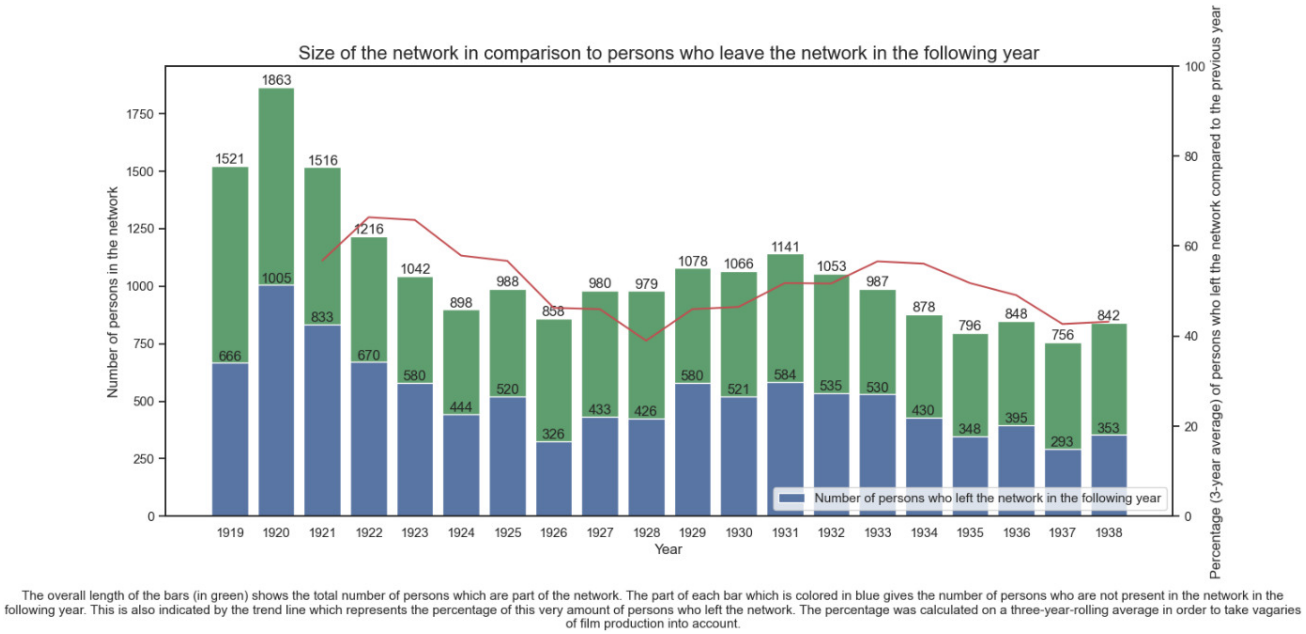

Illustration 2. percentage of participants not active in the following year (with 3-year-rolling-average)

1934, but it could be due to the economic slump which hit the film industry in 1926 (Kremeier 146–57), a kind of delayed reaction to the economic crisis and inflation of 1923. The overall development becomes more apparent when one calculates and works with a three-year-rolling average to account for the time it takes from the conception of a project via the production to the film coming into cinemas. Films usually take a year or two along this path, so using a three-year average is an attempt to take vagaries of film production into account. Here, a clear second climax (beside the one in the post-World War One period) is visible in the years 1933 and 1934 which clearly demarcates that the exodus from the German film industry is a result of the Nazis coming to power, as some professionals were anticipating the political changeover, while the trend intensified in 1933 and the following years.

One of the most striking results is the noticeable increase in network density over time. Network density is measured as the ratio between the potential and the actual edges (connections) in the network. A network density of one (1,0) would indicate that the full potential is realized, i.e. every node is connected to all other nodes. Translated to our case at hand, such a state would indicate that every person (node) in the network would work on every production. The lower the network density, the more spread out is the participation in films among the creative personnel. Or, put differently – a higher number in network density indicates a smaller group working on more productions, thus a more tightly knit group of creative professionals. The lowest density of

the network as a whole, thus also the highest average path length[10], is visible in the early years of the Weimar republic (1919: 0,011; 1920: 0,010; 1921: 0,012; 1922: 0,014; 1923: 0,015). The value then increases noticeably and remains rather close to 0,030 throughout the whole period under investigation. The development of the average path length which stays clearly above 3 until 1925 and then oscillates around 2,7 for the rest of the period appears structurally to be very similar. As time goes on, therefore, the network is structured more densely, the industry is increasingly tightly knit, but it remains rather stable in this respect all through the period under investigation.

These findings about the development of the network are corrobated by the results in network diameter which show a similar development and echo the findings just mentioned. The diameter is the longest chain in the whole network that you are forced to travel along to get from one node to another or, simply put, the longest distance between any two nodes. As a measurement, it indicates how densely interconnected the nodes are or, conversely, how spread out or loose the network is. Whereas the early years of Weimar filmmaking (1919-23) shows a diameter of between 7 and 9, this measurement later settles between 5 and 6. Superficially, this means that the two persons furthest apart in the network, i.e. film industry, have to traverse less nodes/people in later years. Yet again, the significance of the results goes beyond the degree of separation of the film industry, as it illustrates a higher degree of concentration in the industry. This concentration is indicative of the interpersonal, but also of the economic state of the industry which tends in the 1920s towards concentration (see also Spiker 34ff). Moreover, these findings cannot simply be put down to the higher number of films being produced in the early years: In 1923, when 254 films are being made, the diameter of the network is seven, whereas in 1927 more films are made (267) and the diameter is noticeably smaller (five). The stability – and above all, the connectivity – that is achieved in 1924, after the inflation and the crash of the economy, shows how this sector had settled on a relatively stable base from which it then operated. This is maybe one of the key findings: despite a rather large fluctuation of personnel (see above), the industry had achieved a measure of structural stability by the mid-1920s which remained intact until the late 1930s. Yet again, despite this structural consolidation, a rather large number of professionals were forced out of the industry around the National socialist take-over of power in 1933.

Another important measure in networks is the so called "Eigenvector centrality" which calculates the centrality of specific nodes by looking at neighboring nodes. A high score in Eigenvector centrality indicates that a node is connected to numerous nodes which have high values (and therefore also many connections to other high-scoring nodes). One of the most famous

10 The average path length is the average number of steps along the shortest path for all possible pairs of network nodes.

Table 1. network density, average path length, diameter (1919-39)

Year	Density	Average Path Length	Diameter
1919	0,011	3,202	7
1920	0,01	3,196	8
1921	0,012	3,182	9
1922	0,014	3,097	7
1923	0,015	3,101	7
1924	0,018	3,084	6
1925	0,019	3,001	6
1926	0,026	2,644	6
1927	0,026	2,568	5
1928	0,024	2,665	5
1929	0,021	2,709	6
1930	0,022	2,827	6
1931	0,022	2,746	5
1932	0,025	2,706	5
1933	0,025	2,689	5
1934	0,028	2,745	6
1935	0,03	2,719	5
1936	0,027	2,731	5
1937	0,029	2,795	6
1938	0,027	2,784	5
1939	0,028	2,718	5

cases of Eigenvector centrality is the Google PageRank which calculates the value of web pages by looking at the incoming links.[11] In our case, value flows in both directions, as highly sought after professionals bestow value to a production, but being part of an important film (with other respected professionals) also increases the prestige of a person. Therefore, our edges were undirected (not distinguishing between incoming and outgoing links). The results are meaningful for calculating the real and symbolic value of film workers that connect with others and therefore have a more central position in the network. First of all, we specifically looked at the Eigenvector centrality of those people that fell out of the network from one year to another to find out how centrally they were positioned in the network. In the first years, when the industry was highly volatile, the value was around 0,045, as compared to values around 0,15 for those remaining in the network (0,137 for 1920; 0,177 for 1921; 0,144 for 1922[12]). People remaining in the film business had a much higher involvement in the industry (number of productions they were involved in), roughly by the factor of three. The issue at hand here is the structural composition of the industry; being marginal to

11 Google is just interested in incoming links because the value (of web pages) has to be generated from the outside, otherwise a web page could score high just by linking to central pages without anyone noticing it.

12 We could not calculate the value for 1919 because we did not have the data for 1918 which would have been necessary to ascertain who remained and who left the network.

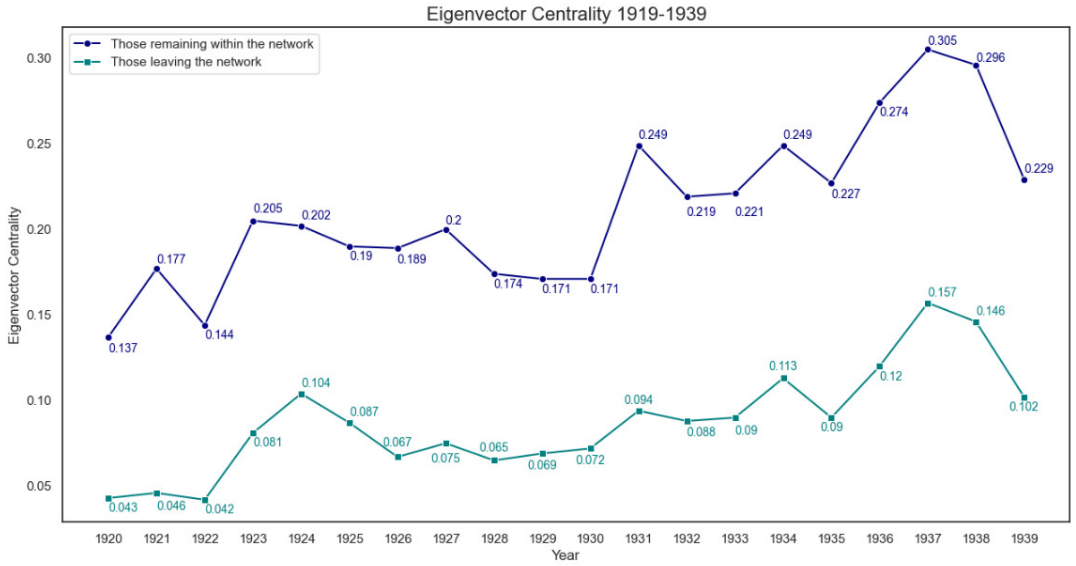

Illustration 3. Eigenvector Centrality (1919-39)

the network (i.e. having a lower Eigenvector centrality) significantly increases the likelihood of not working again on any film in the following year. From 1923 until the early 1930s, the Eigenvector Centrality of the people dropping out of the network fluctuates between 0,07 and 0,1, while the Eigenvector Centrality of the ones that stay in the network moves slightly up and down around 2,0. A marked increase in Eigenvector Centrality of those falling out of the network can be noticed in 1934, when it jumps to 0,112, indicating that more people that were central to the network in the year before do not show up anymore. Of course, we see here again the direct result of the Nazi purges in the film sector after 1933, as up to 2000 people (Horak 101) had to leave the industry.

Yet again, Eigenvector Centrality seems to be on a steady increase all through the period in focus. If we take five year averages for those leaving the network and those remaining we get 0,063 and 0,173 (1920-24), 0,072 and 0,185 (1925-29), 0,091 and 0,222 (1930-34), 0,123 and 0,266 (1935-39). The measurement roughly doubles over the twenty years, both for those remaining within the network, as well as for those leaving the network. What remains stable is the relation between those not being employed in the following year and those finding employment again (the factor oscillates between 3 and 2,5). The increase confirms the observation that the industry is getting more tight and more intensely connected over the years, but the ratio of openness (new people entering the industry, established people leaving the industry) to closeness (hiring always established experts) remains rather stable. One hypothesis might be that a creative industry such as filmmaking requires a certain relation between openness (hiring new and unknown people) and closure (relying on tested professionals).

Finally, we wanted to zoom in, so we examined in more detail some individuals and their development over time. Eigenvector Centrality appeared to us as the most important measurement of centrality in our network, therefore we looked at the ten most highly ranked nodes (individuals) in each year. Of course, centrality correlates to a certain degree with productivity – with more productions, a node has more edges and therefore it becomes more likely that the position is more central. Being engaged in many productions implies that a person is sought after and thus occupies a position of centrality. The top ten for each year gives us a list of those individuals with the highest scores in Eigenvector Centrality in the network, i.e. the strongest neighboring nodes. In these lists, actors and actresses dominate at first almost exclusively, in the period 1919-24 they make up 72,5% of the list. By the mid-1920s composers show up in surprising numbers (in the half-decade from 1925-29 they even form the biggest group in the list with 38%), probably due to the fact that they are now permanently employed by big production companies to write sheet music for the cinemas. This task can be done relatively quickly, so that the composers can work on many different productions in one year which gives them a lot of connections. In the five years after the introduction of sound (1930-34), they make up 18% and then drop back to 4% in the years leading up to World War Two (1935-39), a decline that is not so easily explained. Directors and producers show up only very seldomly in these lists, as they are usually occupied for longer periods of time with one project. A lower overall number of credits means less connected nodes and therefore less potential to be in direct vicinity to high-scoring nodes.

In 1930, no actor/actress is in the list (the only year in the whole period in which acting personnel is absent from the top ten-list), but a number of three screenwriters, the highest number in the whole time period under investigation. Most likely, sound film increased the significance of the writing (i.e. the dialogue), so they occupy about 10% of the positions in the list after 1930, whereas before they were far less significant. This could be seen as an indication that indeed the filmhistorical transition to sound film is a significant turning point for the structure of the film industry. The central role of cinematography and set design in German filmmaking which has been discussed repeatedly in existing scholarship (Esser; Betz et al.; Bartels; Block) can be seen by the relatively steady presence of cameramen and set designers all through the period – each group usually makes up around 10%. In the half-decade 1935-39 this number even increases to 22% for set design and to 14% for cinematography. On the other hand, editing is completely absent from this list; no editor makes the top ten in these 21 years. This would indeed also corrobate existing scholarship in which editing has not played a major role so far.

Table 2. Top Ten nodes (individuals) with highest Eigenvector Centrality (1919-39) per year

1919			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Reinhold Schünzel	acting/direction	26	1
Olga Engl	acting	28	0.961043
Magnus Stifter	acting	15	0.779291
Kurt Richter	production design	21	0.773576
Eduard von Winterstein	acting	15	0.737371
Frida Richard	acting	12	0.672176
Leopold von Ledebur	acting	18	0.634464
Harry Liedtke	acting	13	0.629112
Emil Rameau	acting	13	0.622357
Paul Hartmann	acting	13	0.61175
1920			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Conrad Veidt	acting/direction	18	1
Hermann Vallentin	acting	20	0.967256
Rudolf Lettinger	acting	12	0.949705
Wilhelm Diegelmann	acting	16	0.929771
Frida Richard	acting	14	0.917065
Eduard von Winterstein	acting	16	0.889449
Robert Neppach	production design	14	0.813694
Carl Hoffmann	cinematography	14	0.802799
Charles Willy Kayser	acting/direction	23	0.781542
Bernhard Goetzke	acting	22	0.776206
1921			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Wilhelm Diegelmann	acting	21	1
Robert Neppach	production design/ screenwriting	22	0.784435
Erich Kaiser-Titz	acting	21	0.759334
Albert Steinrück	acting	14	0.639941
Robert Scholz	acting	18	0.604983
Olga Engl	acting	12	0.58635
Charles Willy Kayser	acting/direction	20	0.565821
Ilka Grüning	acting	12	0.564551
Alfred Abel	acting/direction	10	0.508669
Hermann Picha	acting	11	0.507694
1922			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Wilhelm Diegelmann	acting	15	1
Alfred Abel	acting	12	0.97597

Eduard von Winterstein	acting	12	0.969536
Ilka Grüning	acting	11	0.956453
Robert Scholz	acting	14	0.937518
Margit Barnay	acting	13	0.934813
Hermann Picha	acting	13	0.923251
Frida Richard	acting	10	0.829949
Fritz Arno Wagner	cinematography	7	0.752948
Kurt Lande	cinematography	10	0.743246
1923			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Eduard von Winterstein	acting	11	1
Hermann Vallentin	acting	10	0.979716
Hans Dreier	production design	11	0.837996
Erich Kaiser-Titz	acting	10	0.739235
Alexander Granach	acting	6	0.72093
Guido Seeber	cinematography	5	0.711151
Wilhelm Diegelmann	acting	13	0.687974
Anton Edthofer	acting	5	0.6753
Erich Waschneck	cinematography	5	0.651439
Alfons Fryland	acting	7	0.642457
1924			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Frida Richard	acting	9	1
Erich Pommer	production	7	0.75678
Robert Scholz	acting	8	0.737897
Albert Steinrück	acting	8	0.698131
Margarete Kupfer	acting	9	0.687788
Olga Engl	acting	7	0.678675
Otto Erdmann	production design	6	0.672148
Hans Sohnle	production design	6	0.672148
Mutz Greenbaum	cinematography	8	0.639005
Gustave Preiß	cinematography	7	0.631136
1925			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Frida Richard	acting	15	1
Hans Behrendt	screenwriting/acting/ direction	12	0.729216
Margarete Kupfer	acting	8	0.697692
Robert Liebmann	screenwriting	13	0.685088
Hermann Picha	acting	10	0.682415
Willy Schmidt-Gentner	music	9	0.668048
Jacek Rotmil	production design	10	0.627568
Wilhelm Diegelmann	acting	11	0.619729

Giuseppe Becce	music	8	0.619376
Hans Mierendorff	acting	8	0.610501
1926			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Willy Schmidt-Gentner	music	16	1
Felix Bartsch	music	16	0.976383
Henry Bender	acting	11	0.796366
Harry Liedtke	acting	12	0.796077
Otto Kanturek	cinematography	11	0.787772
Hans May	music	11	0.743387
Maly Delschaft	acting	11	0.702722
Wilhelm Dieterle	acting	11	0.702592
Jacek Rotmil	production design	10	0.687149
Willi A. Herrmann	production design	13	0.678468
1927			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Felix Bartsch	music	29	1
Willy Schmidt-Gentner	music	25	0.894267
Hans May	music	23	0.821943
Walter Ulfig	music	18	0.681393
Jacek Rotmil	production design	16	0.647645
Gustav A. Knauer	production design	16	0.644136
Pasquale Perris	music	14	0.615632
Albert Steinrück	acting	12	0.597605
Harry Liedtke	acting	13	0.558995
Hermann Picha	acting	12	0.546915
1928			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Hansheinrich Dransmann	music	22	1
Paul Dessau	music	16	0.821566
Willy Schmidt-Gentner	music	12	0.661269
Walter Ulfig	music	14	0.652854
Hans Junkermann	acting	12	0.640975
Hans Sohnle	production design	13	0.623562
Otto Erdmann	production design	13	0.623562
Curt J. Braun	screenwriting	13	0.621407
Fritz Kampers	acting	13	0.605992
Georg Alexander	acting	11	0.599367
1929			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Werner Schmidt-Boelcke	music	23	1

Willy Schmidt-Gentner	music	20	0.844957
Bernhard Homola	music	17	0.784801
Gustav A. Knauer	production design	20	0.784567
Willy Schiller	production design	18	0.751045
Hansheinrich Dransmann	music	14	0.696112
Pasquale Perris	music	13	0.683074
Fritz Kampers	acting	13	0.682755
Georg C. Klaren	screenwriting	10	0.632767
Albert Paulig	acting	12	0.624331
1930			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Willi A. Herrmann	production design	18	1
Willy Schmidt-Gentner	music	12	0.982412
Hans H. Zerlett	screenwriting	9	0.959955
Otto Stransky	music	9	0.957903
Franz Schroedter	production design	14	0.951228
Robert Stolz	music	15	0.937058
Walter Wassermann	screenwriting	10	0.881921
Friedl Behn-Grund	cinematography	9	0.875069
Walter Reisch	screenwriting	15	0.87041
Friedrich Hollaender	music	9	0.862193
1931			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Willi A. Herrmann	production design	16	1
Otto Wallburg	acting	12	0.94901
Paul Hörbiger	acting	10	0.872025
Artur Guttmann	music	11	0.837794
Willy Goldberger	cinematography	11	0.827073
Ralph Arthur Roberts	acting	10	0.826337
Bobby E. Lüthge	screenwriting	9	0.801761
Fritz Schulz	acting	9	0.768044
Julius Falkenstein	acting	8	0.762298
Lucie Englisch	acting	9	0.757352
1932			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Paul Hörbiger	acting	15	1
Ida Wüst	acting	13	0.855504
Jakob Tiedtke	acting	9	0.846241
Willi A. Herrmann	production design	14	0.806304
Anton Pointner	acting	10	0.797539
Oskar Sima	acting	8	0.764021
Willy Goldberger	cinematography	12	0.760103

Georg Alexander	acting	9	0.701724
Erich Pommer	production	16	0.676079
Carl Drews	cinematography	9	0.658408
1933			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Otto Wallburg	acting	11	1
Georg Alexander	acting	7	0.948205
Walter Wassermann	screenwriting	11	0.946106
Carl Boese	direction/screenwriting/ production	14	0.9406
Paul Hörbiger	acting	10	0.930068
Eduard Künneke	music	10	0.917699
Ida Wüst	acting	9	0.912042
Fritz Kampers	acting	13	0.908362
Franz Grothe	music	12	0.886449
Liane Haid	acting	9	0.877544
1934			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Adele Sandrock	acting	13	1
Jakob Tiedtke	acting	11	0.99822
Theo Lingen	acting	11	0.953203
Paul Hörbiger	acting	10	0.881102
Will Meisel	music	9	0.849884
Fritz Odemar	acting	9	0.842207
Erich Czerwonski	production design	12	0.801936
Willy Winterstein	cinematography	11	0.76921
Paul Henckels	acting	8	0.724451
Franz Grothe	music	9	0.699177
1935			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Lothar Philipp August Mayring	screenwriting	9	1
Adele Sandrock	acting	10	0.9876
Theo Lingen	acting	8	0.973672
Paul Hörbiger	acting/production	8	0.94581
Philipp Lothar Othello Mayring	screenwriting	8	0.91582
Ida Wüst	acting	7	0.895015
Albrecht Schoenhals	acting	6	0.857265
Erich Zander	production design	7	0.856674
Willi Depenau	production design	7	0.856674
Bruno Mondi	cinematography	7	0.818872
1936			

Persons	Craft	Number of participations in film productions	Eigenvector Centrality
Ewald Daub	cinematography	7	1
Alfred Bütow	production design	8	0.982821
Willi A. Herrmann	production design	8	0.982821
Fritz Maurischat	production design	8	0.902362
Fritz Kampers	acting	6	0.892411
Theo Lingen	acting	5	0.878123
Gustav Fröhlich	acting	6	0.854081
Grethe Weiser	acting	6	0.849666
Hans Leibelt	acting	6	0.834836
Rudolf Platte	acting	7	0.804879
1937			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Leo Leux	music	6	1
Herbert Körner	cinematography	6	0.915335
Artur Günther	production design	7	0.888683
Otto Wernicke	acting	6	0.882058
Friedl Behn-Grund	cinematography	6	0.86962
Oskar Sima	acting	6	0.838815
Georg Alexander	acting	7	0.83415
Bobby E. Lüthge	screenwriting	6	0.829794
Hilde Körber	acting	6	0.829431
Georg Jacoby	direction	5	0.824909
1938			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Lothar Philipp August Mayring	screenwriting	9	1
Philipp Lothar Othello Mayring	screenwriting	9	1
Georg Alexander	acting	9	0.853298
Karl Weber	production design	7	0.705906
Erich Zander	production design	7	0.705906
Alfred Bütow	production design	9	0.697357
Willi A. Herrmann	production design	9	0.680621
Herbert Hübner	acting	6	0.680146
Hans Schneeberger	cinematography	8	0.666173
René Deltgen	acting	6	0.650699
1939			
Persons	**Craft**	**Number of participations in film productions**	**Eigenvector Centrality**
Paul Hörbiger	acting/production	13	1
Hans Brausewetter	acting	6	0.667036
Werner Bochmann	music	8	0.636867

Johannes Riemann	acting	6	0.607806
Ernst Waldow	acting	6	0.584665
Willy Winterstein	cinematography	6	0.57952
Grethe Weiser	acting	6	0.573184
Hilde Hildebrand	acting	5	0.569003
Eduard Hoesch	cinematography	7	0.562098
Heinrich Richter	production design	6	0.561561

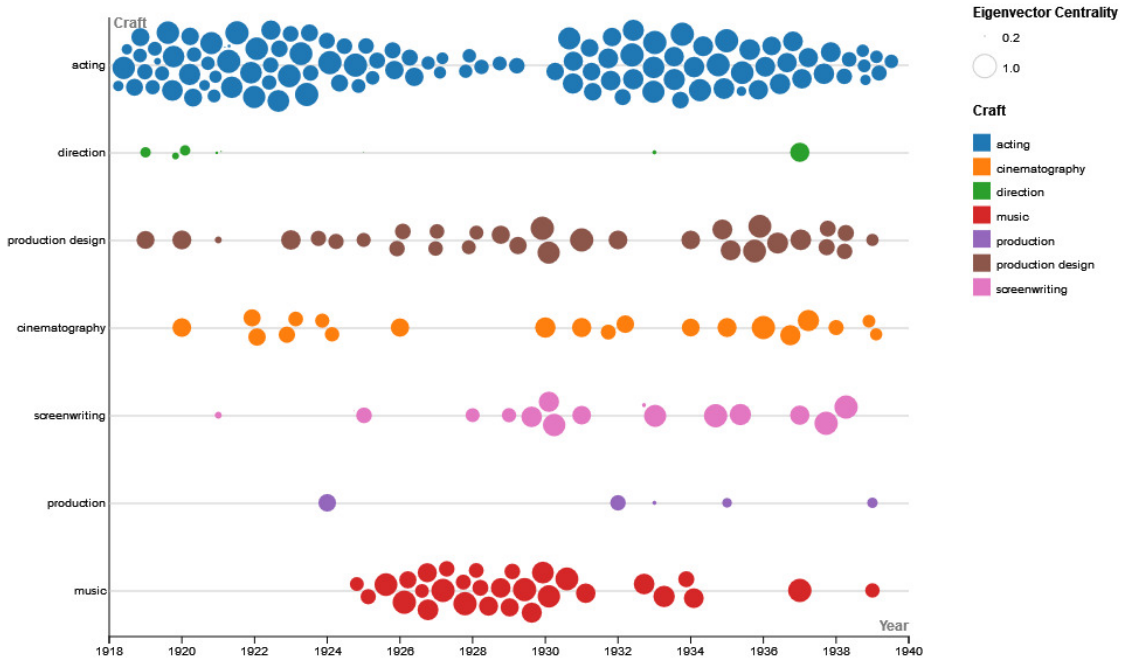

Illustration 4. craft group as represented in the top ten-list of professionals with the highest Eigenvector Centrality (1919-24; 1925-29; 1930-34; 1935-39)

Conclusion

This has been an exploratory study which investigates the use value of network analysis as a method for conceptualizing collaboration and connectivity in a (national) film culture. While network analysis has been used as a tool in many fields of the humanities (Barabási; Ahnert et al.) it is rather new to film studies. With this methodological adoption, the present study does not claim to offer a better approach or the ultimate solution to an old problem, but it rather proposes to use the data and digital methods at our disposal for an alternative look at some of the issues that film history has grappled with in the past. At the same time, this study also wants to contribute to answering the question of what new insights might become possible through the systematic application of network research methods in a specific field.

In film history, the focus has traditionally been on single-work analyses and relatively stable categories such as author, national cinema, or genre, which have been examined according to established methods. Shifting the focus to network research means to open up a different perspective. This transition from fixed entities to linkages which network research necessitates stresses relationality and relativity. Since nodes and edges are mutually dependent, the primacy of objects as fixed entities no longer applies; rather, changing relations provide for constant repositioning within a wider web of references. Thus, instead of being viewed in isolation as a monument, a network-based approach emphasizes the embeddedness and interconnectedness of entities such as films or filmmakers. This allows new perspectives on structures or influences to be derived, and possibilities and limits of agency are once again configured differently than in many conventional studies because networks of relationships become the focus of attention. The dynamic nature of networks, especially when read historically on a temporal axis, requires an approach that is interested in the constitution of groups and their always fuzzy boundaries (because social groups always include connections beyond the internal structure).

We do not use data to test a fixed and stable hypothesis which are then either confirmed or falsified (as, for example, clinical studies do). We rather follow the lead of "exploratory data analysis" (Tukey; Arnold and Tilton 50ff), as data and hypotheses stand in a relation of mutual interconnectedness. We look at data in order to verify or falsify hypotheses, but data also often give rise to new hypotheses; as we find trends and outliers that we did not notice before. Thus, we need to take the mutual interdependence of data and hypotheses into account. In this respect, we have to constantly remind ourselves that data is always modelled, as it is an abstraction from reality. Yet again, modelling also happens in approaches that study a specific national cinema through a small number of films, as the sample implicitly claims that it is representative of the larger whole.

The engagement with subject-specific research data as well as the consistent acquisition and application of data skills enables the opening up of new perspectives in film studies. In particular, the innovative use of collected data resources in relation to existing and new research questions supports a re-contouring of the field. Using data-based methods, comparative studies can be carried out, because previously unpublished or unnoticed data holdings on the history of cinema are made accessible and used consistently for the first time. In this way, questions that have already been asked frequently come into view in such a way that they can open up data-based paths to other insights - and especially to new models of thought. This is by no means to say that the large amounts of available data - "big data" in the sense of the Californian ideology - finally enable us to find better or even true answers, but rather that it is about the productivity of a new perspective that is able to frame certain questions differently. Among the questions to be answered in such

studies are: To what extent can thematic foci and multiple relationships and collaborations within German film historiography be illustrated with the help of network research? Which aspects of cinema research that are particularly interested in popular culture allow for a network-based approach?

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