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Exhibiting the Exhibitors: Spatial Visualization for Heterogeneous Cinema Venue Data

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Cinema data is characteristically complex, heterogeneous and interlinked. Rather than relying on simple information retrieval techniques, researchers are increasingly turning to the creative exploration and reapplication of data in order to more fully explore the meaning of newly available and diverse data sets. In this context, the cinema historian becomes the creator of visual texts which can be assessed for both their interpretive insight and their aesthetic qualities. This paper presents four research projects that use different spatio-temporal visualization techniques to understand the industrial dynamics of post-war film exhibition and distribution in Australia. The research integrates work by a group of inter-disciplinary investigators into the effectiveness of techniques such as dendritic mapping, Circos circular visualizations, animation, cartogram mapping, and multivariate visualization for the study of cinema circuits and operations at a number of scales.

Keywords: Geovisualization, australian cinema, cartograms, historic data

INTRODUCTION

Working with information that is historical, geographical, and cinematic in focus creates opportunities for new and interesting interdisciplinary research. Changing the focus of cinema studies to concepts of geographical influence, spatial analysis, and data visualization can lead to new insights and creative investigative methods.

Recent developments within the broad framework of the humanities have encouraged such collaborations by embracing the vast changes in technology, methodological frameworks, and research sources and scope. Increases in the adoption of the use of data to lead evidence based research and to explore previously ignored areas of research has in turn created an environment in which the humanities are also turning digital. To work with data you need ways of collecting data, storing data, accessing and analysing data, and interpreting and finding outcomes with data. Developments in the humanities have therefore manifested into databases, statistical analysis, data mining, big data, visual analytics, and visualization; all with a cultural focus.

Humanities data within a spatial context requires the application of geospatial technologies and mapping. Whilst traditionally used in the physical sciences, more recently non-traditional disciplines largely embedded in the humanities have seen the benefits that arise from investigating geographic patterns in their data such as literature (Moretti, 2007; Piatti *et al.*, 2008; Roberts, 2012), and the social sciences (DeBats, 2008; Donahue, 2008; Gregory and Henneberg, 2010; Knowles and Healey, 2006; Skinner *et al.*, 2000) in a move sometimes described as the 'Spatial Turn'.

For cinema studies, this 'turn' has found its place in a range of academic practices such as the study of map use in films (Caquard and Taylor, 2009; Lukinbeal, 2004a; Conley, 2007), the representation of locations (Arrowsmith *et al.*, 2010; Klenotic, 1998, 2001; Dibbets, 2010; Maltby and Walsh, 2011; Verhoeven and Arrowsmith, 2013; Verhoeven *et al.*, 2009), mapping film diffusion (Verhoeven *et al.*, 2013), and in the analysis of geographical patterns of cinema operation and influence (for example see Caquard, 2009, Caquard and Fiset, 2013; Verhoeven *et al.* 2009). It is particularly within this last topic that the application of spatial technologies and techniques has played a big role; developing new approaches to collaborative research and new ways of analyzing and communicating information and results.

This paper extends this work and will focus on a number of recent studies which look at cinema from an inter-disciplinary perspective, one that considers the role of geovisualization of the geographical distribution of cinema venues. Whilst Klenotic (2011), Lukinbeal (2004b),

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Hallam (2014) and Caquard *et al.* (2014) consider the other facets of film and cinema–going such as audience, film content and venue location, we extend some of that work in presenting alternative geovisualization methods for representing cinema venue activity. In this respect we focus on what Roberts and Hallam (2014) identify as the theme of 'mapping of film production and consumption' and in particular the complex spatial and temporal dimensions of film diffusion. This interest falls within Roberts and Hallam's three 'orientations' of 'spatial historiography', where spatial methods are used to 'explore the historical geographies of film production and exhibition' and also touches on the 'spatial ontologies' of spatial data querying and analyses (Roberts and Hallam, 2014, p. 8).

CINEMA AND VISUAL REPRESENTATION

It has been noted that humanities data is characterized as being highly complex, heterogeneous, interlinked, and often incomplete and imprecise (Verhoeven, 2012). Film distribution data is particularly rich and multifaceted. As Verhoeven has noted, films only exist in order to be transported through space and time to audiences (Verhoeven, 2011). With the added complexity of spatial and temporal components, humanities data cannot always be handled by the more conventional cartographic techniques as these are not always the best solution for understanding or interpreting findings within the data. Instead, working with such data has led to the adaption of other analytic techniques beyond conventional cartographic methods. The research presented here has developed over a number of years, evolving as our interdisciplinary experience grows, and with the capacity and willingness to take advantage of the new opportunities presented by these developments. The questions that we ask of the sources collected cannot be addressed simply by interrogating lists of data; the data needs to be in a format that is accessible and approachable at any scale. Visualizing the data enables us to explore the data that is hidden away in tables and records, and also allows us to incorporate the spatial element that is often inherent in such datasets. All approaches and subsequent visualizations handle the spatial, historical, and cinematic aspects differently. As the questions we ask for each project and the nature of the data investigated are different, each approach in terms of method, analysis, and visualization needs to be tailored to the individual project.

Each project will be briefly outlined, highlighting the ways in which data is accessed and outcomes of applying such methods and visualizations.

Film movement

'Are there spatial patterns of film movement from one venue to the next for Greek cinema in Australia'.

Greek cinema developed in Australia in the post-war period, coinciding with significant Greek immigration into Australian cities and changes in both the Australian and Greek film industries (Verhoeven, 2007). It has been anecdotally noted that the patterns of movement of films within the Greek cinema circuit during this period were determined by the provenance of the films, in particular the identity of the production company (Verhoeven *et al.*, 2009). Was this in fact the case? We have adopted several methods for analyzing and displaying patterns of physical film movement from one venue to the next. The data collected included film title, production company, date of screenings, venue name, and address, including city of venue. Data was sourced from archival newspaper and oral history research as well as government records, including censorship documents, and theatre licence and company records. Not only is it important for the data to capture film movement, it is also important that a time profile for movements are also incorporated to give an indication as to the frequency of movement for specific films.

For the purposes of pattern extraction we adopted a statistical process referred to as Markov Chain Analysis (Kemeny and Snell, 1976). Markov Chains provide a powerful technique for analyzing time series events where an initial condition results in a number of alternative outcomes (see Arrowsmith and Verhoeven, 2011). For this particular case study we restricted our research period to the years between 1956 and 1963, and two particularly well-known and popular Greek film production companies, Finos and Anzervos Films. Each cinema venue was assigned a letter and each film investigated for sequence patterns was given a number. By looking at the sequence of time and venue that these films were shown it was possible to identify a number of patterns which can then be mapped in the form of a tree-graph as shown in Figures 1 and 2. For each of the movements a probability was calculated.

The graphic representation of film distribution as a Markov Chain demonstrates spatial discontinuities through individual venues, the production of temporal divergence, emphasizing the passage of time between screenings, and the multiplicity of simultaneous events, emphasizing synchronous releases. Using Markov Chains we can see how film diffusion and therefore film history moves both forwards and sideways at once from a singular point of origin (Moretti, 2007).

Figures 1 and 2 show portions of pathways for the sequence of movements of a film from one venue to the next. Each film is shown as a four digit number. The numbers in parenthesis indicate the number of films following a particular pathway, whilst the decimal numbers beneath the venue code gives the conditional probability of following a path to that venue. From Figures 1 and 2, it can be seen that the key difference between pathway patterns for Anzervos and Finos films is in the number of cinemas that films were shown at, which is generally greater for Finos (29 films screening at 18 different venues) than for Anzervos (24 films at 16 venues). The number of different venues at which films were permitted to launch was also greater for Finos (8) than for Anzervos (6). In addition, there are many more 'bifurcations' for the Finos 'trees' which indicates that these films were more likely to screen at a greater number of cinemas through the course of their release whilst for Anzervos these movements are generally more linear and do not persist throughout a 'circuit' to the same degree. For example, the maximum number of alternative pathways a single circuit can move is three for Anzervos, where the film circuit BCBCA can move in one

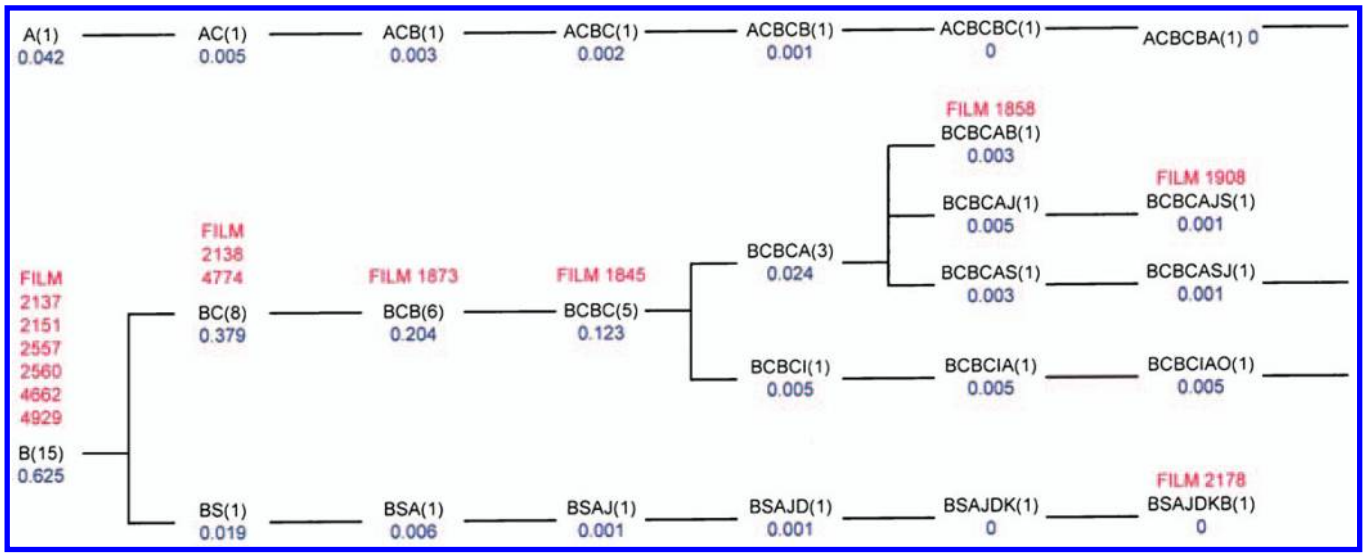

Figure 1. Portion of sequence of movements for Anzervos Films 1956–1963

of three ways. For Finos circuits, a maximum of six alternate pathways can be taken for the circuit commencing BC. This bifurcation also occurs much earlier in the circuit indicating that more current films were shown more extensively throughout the Greek cinema network and that the distributors of Finos Films had working relationships with a greater number of film venues.

Another approach was to look at this question through a technique known as Circos diagrams (see Figure 3). Circos is one of a number of visualization software packages that can be used to show relationships in a circular layout (http://circos.ca/). Circos was developed originally for identifying and analyzing similarities and differences in genome structure and the sequencing of multiple genomes

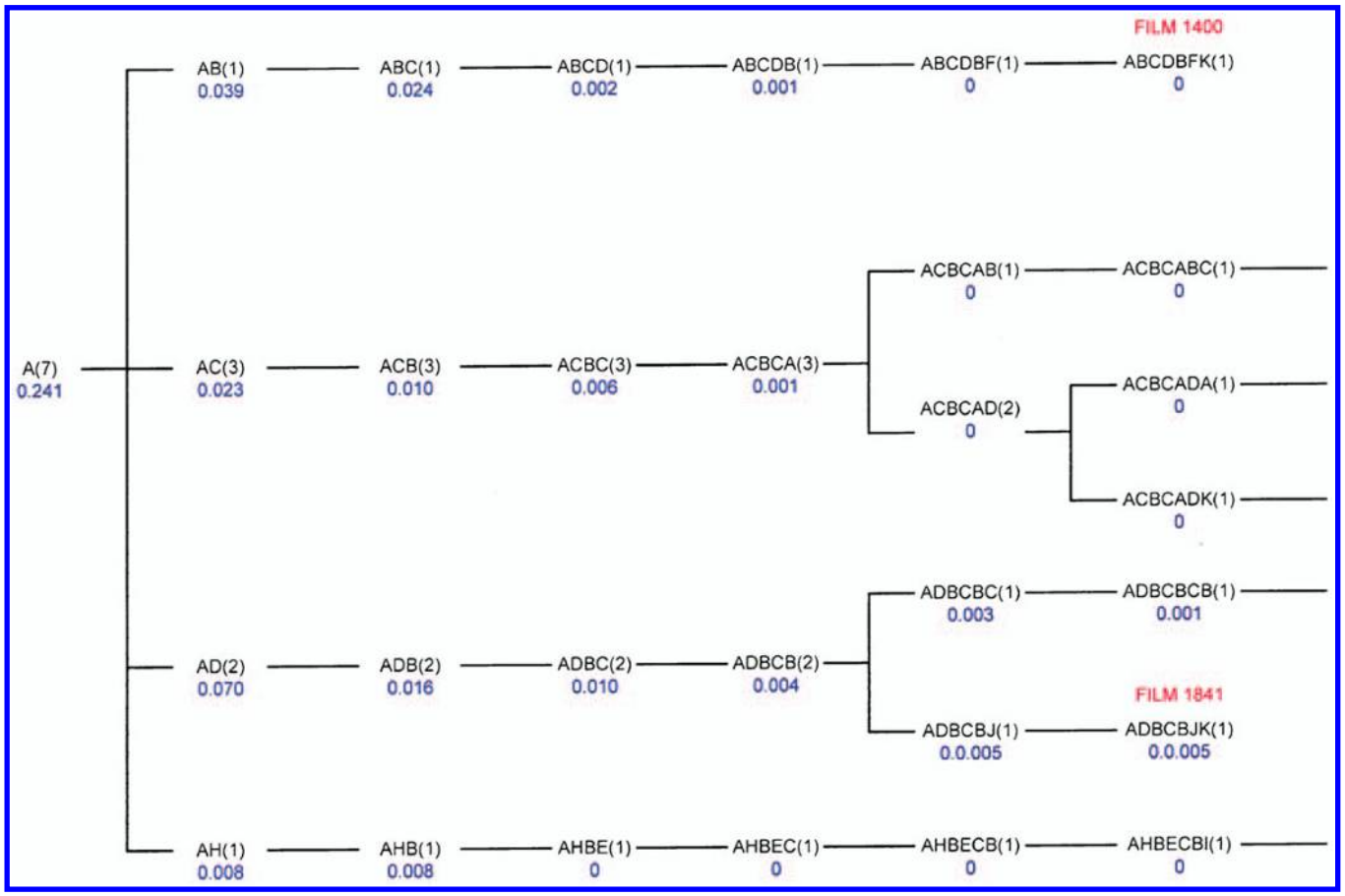

Figure 2. Portion of sequence of movements for Finos Films 1956–1963

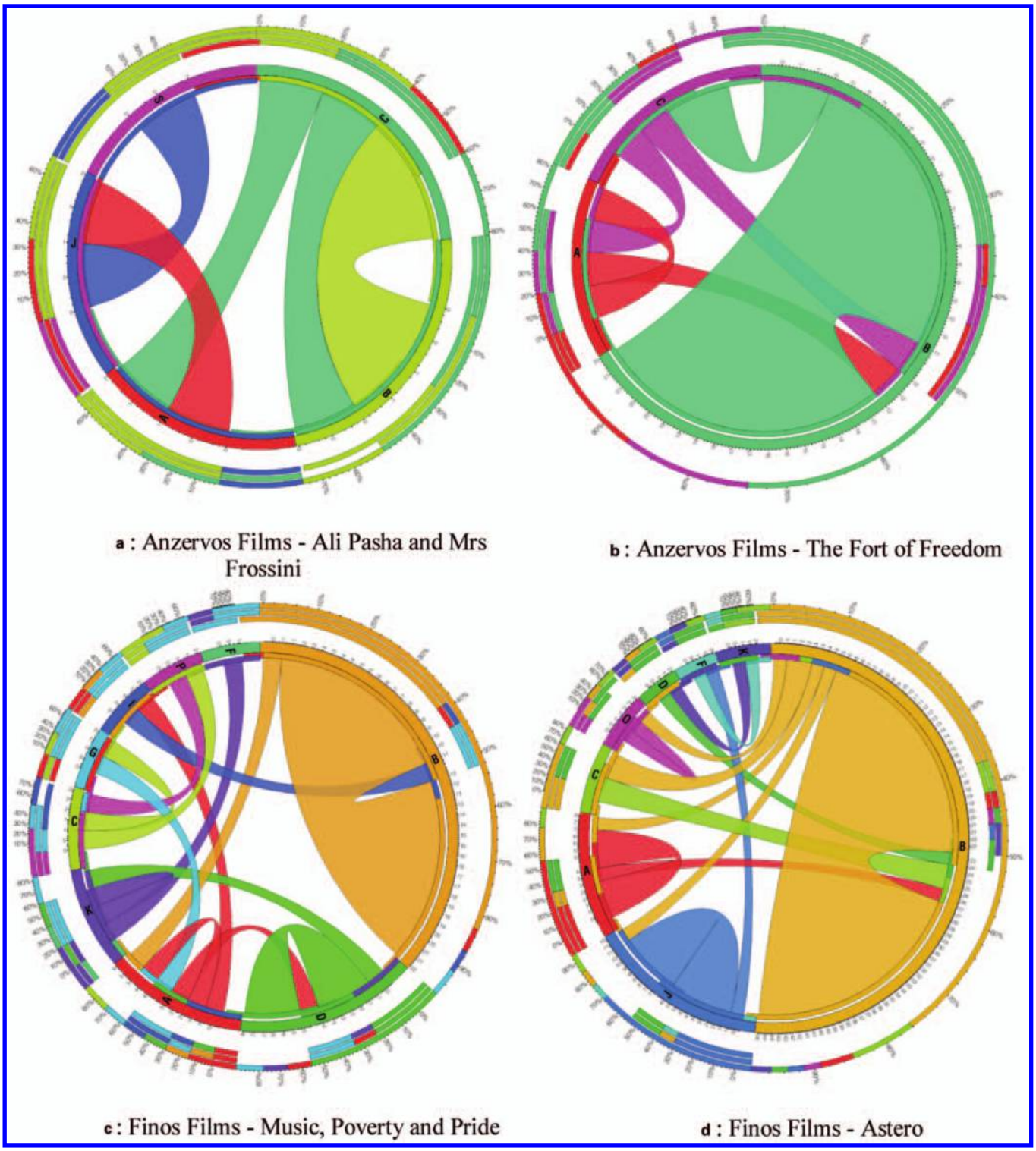

Figure 3. (a) Anzervos Films – Ali Pasha and Mrs Frossini, (b) Anzervos Films – The Fort of Freedom, (c) Finos Films – Music, Poverty and Pride and (d) Finos Films – Astero

(Krzywinski *et al.*, 2009). These circular visualizations show how films moved from one venue to the next, and enable us to estimate the proportion of discrete movements made. For example, 'The Fort of Freedom' (Figure 3b), whilst making a number of moves from venue B to venue C, the vast majority of screenings occurred at venue B (that is indicating a sequence or 'movement from B to B). Finos Films (Figure 3c and d), although demonstrating a similar B to B screening sequence, show a number of other apparently more specialized moves, say from J to F or B to J for Astero or C to P or G to A for Music, Poverty and Pride. Hence it could be concluded that Finos Films had a much

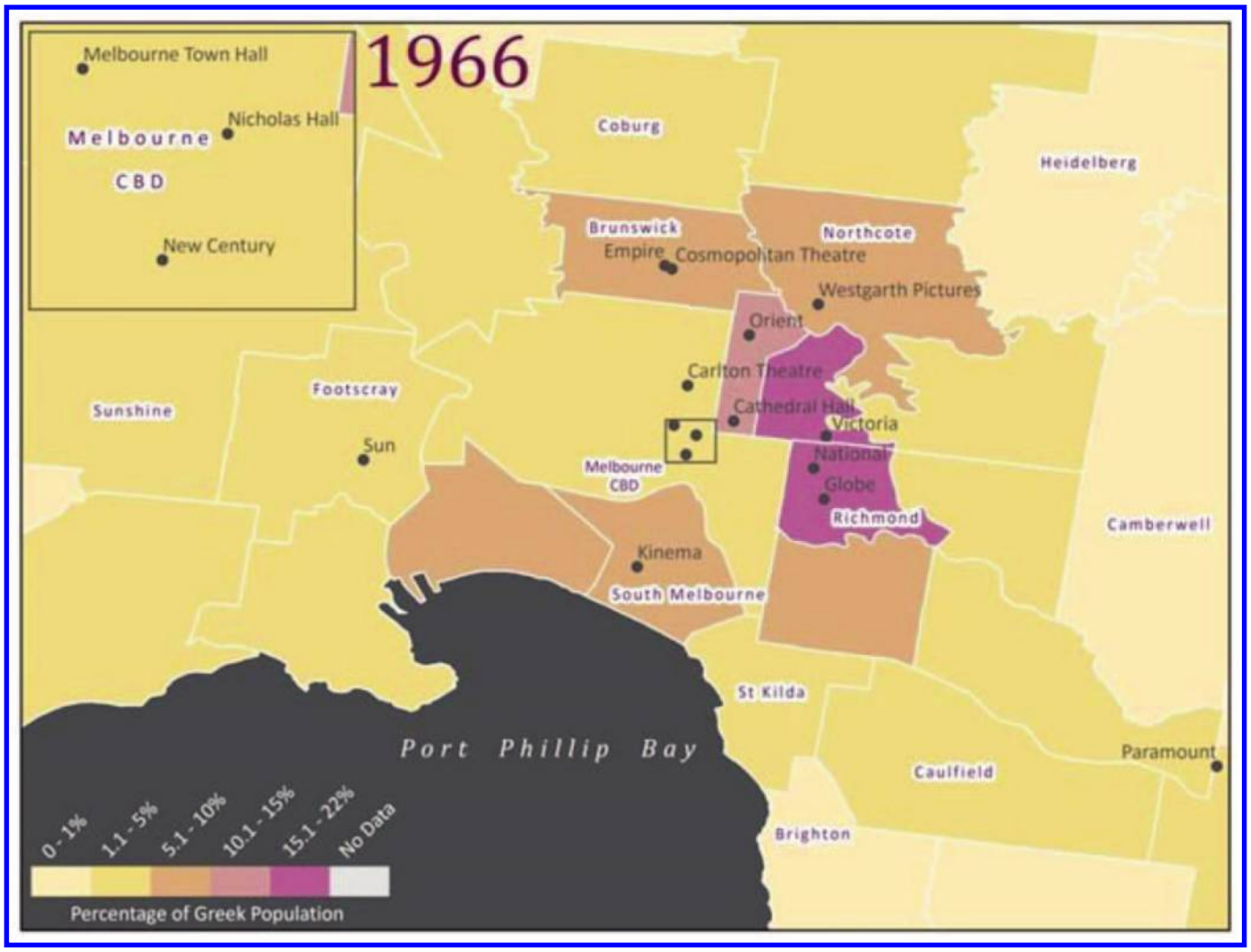

Figure 4. Snapshot of Greek Cinema Animation

broader, or eclectic, venue repertoire than did Anzervos, who were more constrained to venues A, B and C.

Cinema and demographics

'What is the relationship between cinema location and target audience location?'

This study focuses again on Greek cinema using the same set of data collected for the Markov Chain analysis described in the previous example, this time concentrating on the city of Melbourne. The primary focus of this study was to address the question of how a migrant venue operation supports the immediate surrounding population. Were Greek cinema venues found in areas where the Greek migrant population was also high or was it that the venue pre-dated the Greek population? By combining demographic and cinema venue data it was possible to assess this relationship (Figure 4). Greek population data was taken from the Australian national census starting in 1947 through to 1981; a total of seven census collection dates within this period. Data concerning the operation of Greek cinema venues in Melbourne were collected using dates of screenings and cinema venue ownership – such data was sourced from archival newspapers and magazines, government records, and theatre licence and company records.

When this data is combined within a GIS in order to map the results, the temporal nature of the data is lost in a series of static census defined images. Creating an animation of interpolated years from the data for each year between 1947 and 1981 it was possible to change our understanding of the relationship between population and cinema operation. Examining this animation revealed a number of points that were previously hidden in tables, lists, and static images.

The most significant finding from the animation was that Greek cinema venues predated the Greek population and perhaps acted as a catalyst for growth in the immigrant population.

Dynamics of cinema venue operation

'What was the impact of the introduction of television on cinema venue openings and closures?'

In this project we investigated changes evident in the cinema industry in the period following the Second World War.

This was a period of significant change in the Australian cinema industry. In the lead up to television, there were

both social and economic shifts driven by post-war suburbanization, immigration and consumerism. With the introduction of home-based technologies such as television in Australia in 1956, initially into Sydney and Melbourne, and later into Adelaide in 1959, this research sought to identify the spatial differences that emanated from that introduction. The objectives of this study were to investigate the ways in which the cinema industry responded to demographic, social and cultural changes in the study period, and to develop geospatial methods to build digital historical maps to help explain cinema survival and closure.

Using GIS, a geodatabase of cinema venues for the time period from 1948 through to 1971 was constructed. Data was sourced from the 'Film Weekly' summaries that were scanned and digitized. Data attributes collected from this source included cinema location, the town name, theatre name, exhibitor and seating capacity. Cartograms were created where a thematic variable, in this case changes in cinema numbers for each state, are substituted for land area (see Figure 5).

These cartograms were based on changes in cinema venue numbers by state, where relative changes for the period were used as a factor for enlarging or reducing the area for each state. Therefore what can be seen in Figure 5, is that relatively large numbers of openings in Queensland and New South Wales during the period 1948–1953, were essentially offset by widespread closures throughout the period 1958 to 1968. During 1968–1971 the enlargement of Queensland is associated with relatively large numbers of closures, compared to the rest of Australia. Whilst the eastern states of New South Wales and Victoria have the larger number of cinema venues it can be seen from Figure 5 that their reductions in numbers were greatest during the period from 1963 through to 1968 before finding a small resurgence in 1971. In Figure 6, the numbers of country cinemas, defined as more than 20 km from a major city, lost or gained, by postcode, using conventional choropleth maps is shown.

One important consideration in reviewing these maps is to consider the size of the postcode area. For example, in rural regions towards the centre of the continent, very few cinemas exist and those that do service a large geographic area. Any change in cinema venue numbers will result in large scale areal changes on the map and these changes could be construed to show more significant change that what is actually taking place. However, from Figure 6, it can be seen that there appear to be spatial clusters of closures through the study period. For example during the periods from 1958 to 1963 and 1963 to 1968 some clustering can be detected in northern Victoria and rural NSW, towards the south-eastern coast.

Spatial clustering can also be investigated using Moran's Index. Moran's Index or Moran's I, is a measure of spatial autocorrelation based on feature locations and attribute values (Lloyd, 2010; Longley *et al.*, 2011). Moran's I examines whether or not values of similar values occur close to each other, or whether features with similar values are randomly dispersed. Rather than using postcode polygon areas to show change, the use of point symbols to represent venue change across an area of variable population density gives a less biased picture.

In Figure 7, a 'hot-spot' analysis based on the Getis-Ord method (Getis and Ord, 1992) shows regions of change both in colour and size. In these maps data have been normalized to show change for five year periods from 1948 through to 1971, proportional to the starting number of venues for each postcode.

In Figure 7 the Z-scores, equal to the numbers of standard deviations above or below the mean in change in venue numbers are displayed, where large blue points indicate values less than 2.58 times the standard deviation, and large red points indicate values greater than 2.58 times the standard deviation at the 95% confidence level for that period. These could be regarded then, as hot spots of red where a greater number of venues were opened (or less numbers of closures took place where only closures occurred), or cold spots of blue where there was a greater number of closures (or less than the average number of openings took place).

Therefore Figure 7 shows across Victoria, southern New South Wales and into South Australia there were fewer openings of venues during 1948 to 1953 and again in 1958 to 1963. This pattern extends into northern New South Wales in 1963 to 1968. What is evident is that change occurs across state boundaries in a regional, rather than a state constrained pattern.

Exploring spatial aspects of cinema businesses

'How successful were large cinema companies between 1946 and 1986 in Melbourne, and what were the characteristic, spatial, and temporal differences between the different companies'

Whilst some of the techniques demonstrated here have challenged the epistemic and methodological precepts of humanities research, they have not necessarily extended or challenged cartographic techniques themselves. The following technique however, is an innovative approach to handling spatial data that has a strong temporal aspect as well as multiple variables that change over time. Creative visualizations, called Petal diagrams were produced in order to explore and analyze historical, multivariate, and spatial data in a single view.

The visualizations were developed in order to understand the relative importance of the many factors affecting cinema sustainability during a period of intense technological, commercial and social disruption. The post-war period in Australia witnessed the closure of large numbers of cinemas and the emergence of new business models for the film industry. The two major players in the cinema industry in the 1950s in Melbourne were *Hoyts Theatres* and *Greater Union Theatres*, originally starting in 1909 and 1911 respectively (Bertrand, 1987). Our analysis found that during this time there was also a strong presence of *Cosmopolitan Theatres*, *Kirby's Theatres*, and a number owned by *Robert McLeish Theatres*. The majority of cinema venues, especially in the suburbs, were under independent control; however these large cinema chains still dominated the industry and owned or built the majority of prominent cinema venues in Melbourne. In 1954, *Village Cinemas* was founded and would go on to become a dominant chain in the cinema industry of Melbourne (Village Roadshow, 2013).

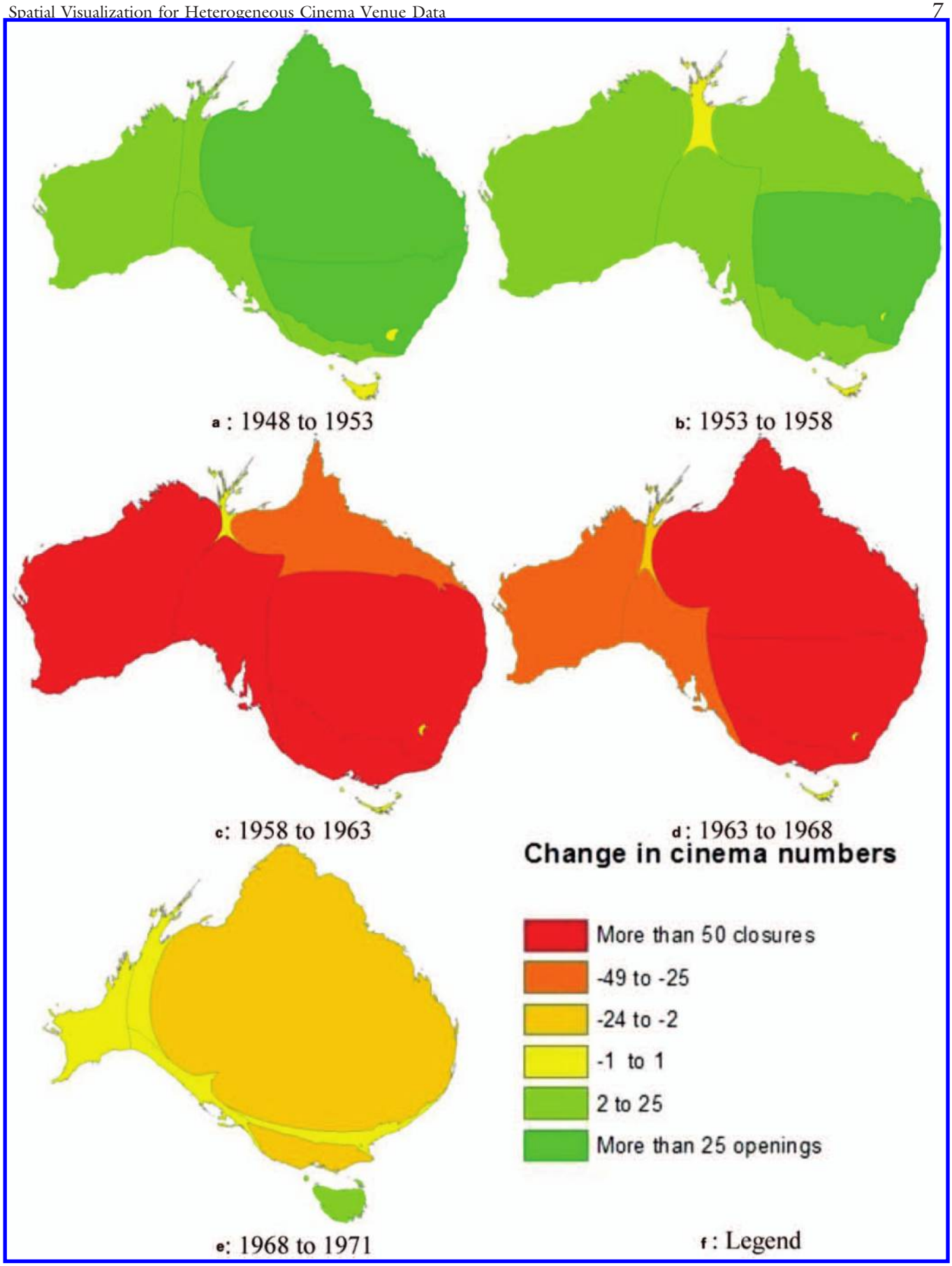

Figure 5. Cartograms based on cinema numbers by state from 1948 through to 1971: (a) 1948 to 1953, (b) 1953 to 1958, (c) 1958 to 1963, (d) 1963 to 1968, (e) 1968 to 1971, (f) Legend

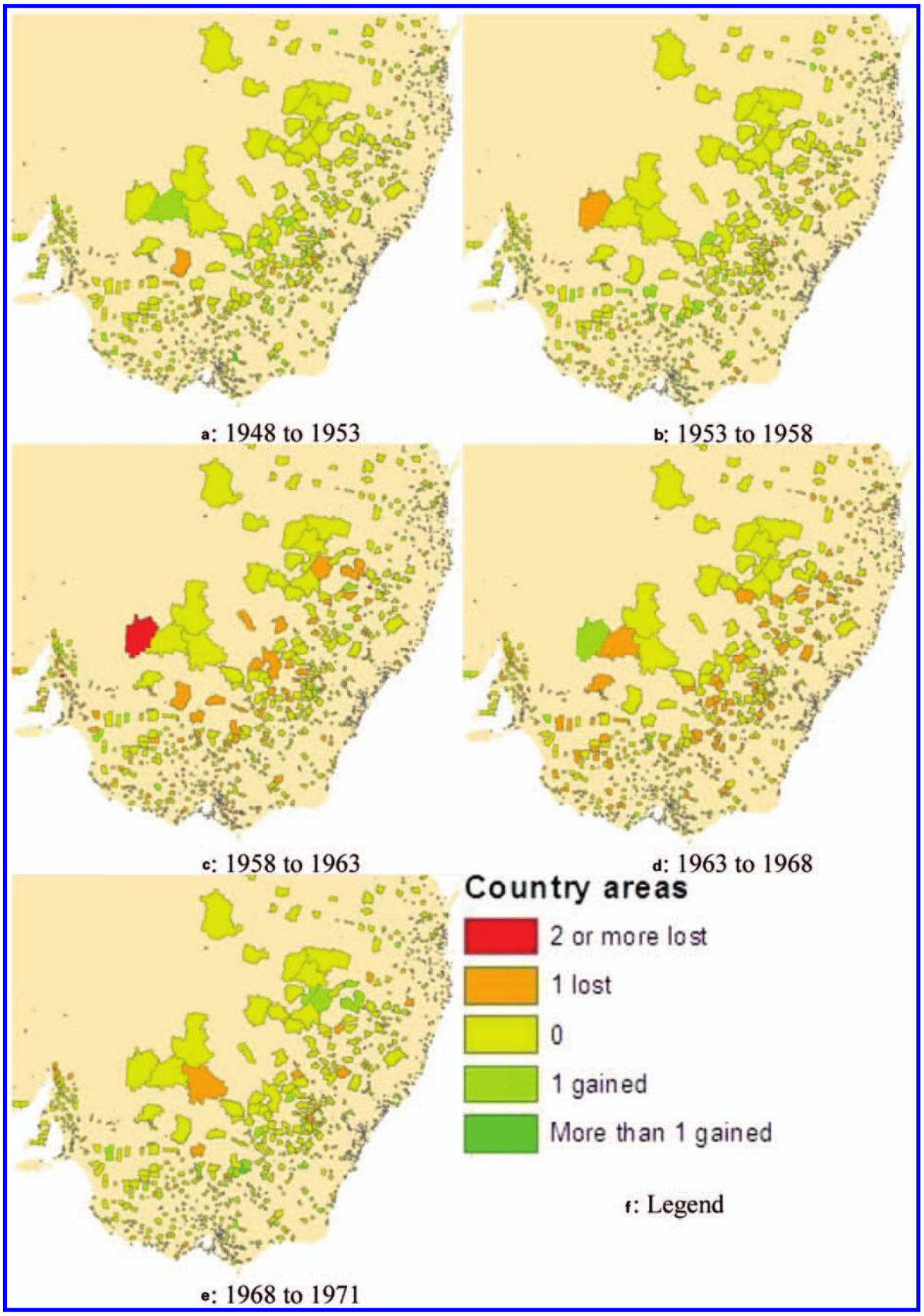

Figure 6. Cinema changes by postcode for rural south-eastern Australia: (a) 1948 to 1953, (b) 1953 to 1958, (c) 1958 to 1963, (d) 1963 to 1968, (e) 1968 to 1971, (f) Legend

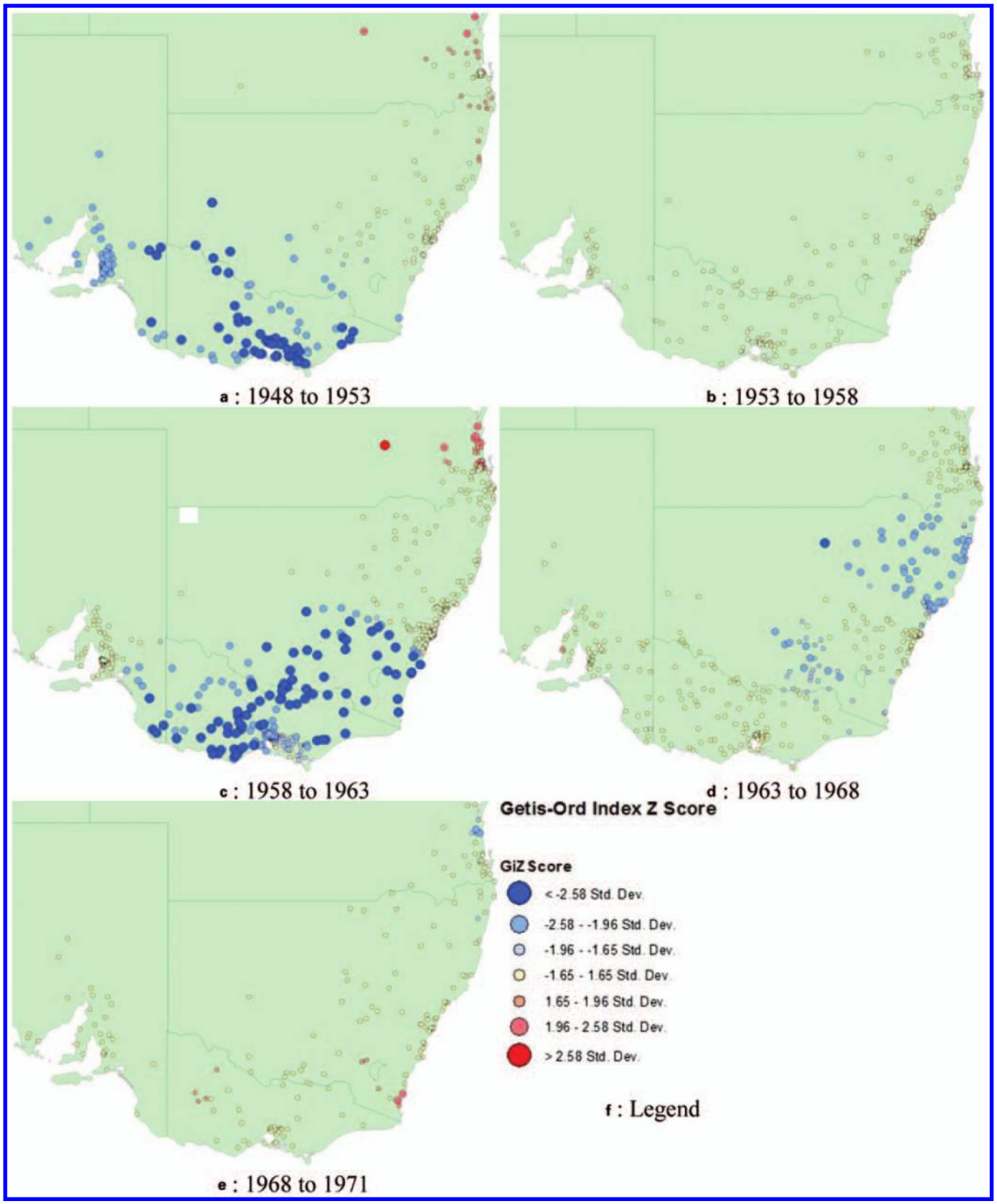

Figure 7. Getis-Ord hot spot analysis: (a) 1948 to 1953, (b) 1953 to 1958, (c) 1958 to 1963, (d) 1963 to 1968, (e) 1968 to 1971, (f) Legend

Data came from the Cinema and Audiences in Australia Research Project (CAARP) database (Verhoeven, 2013). This consisted of all known venues that screened films along with their spatial location (address and latitude and longitude), in addition associated variables of name, opening and closing dates, seating capacity, management and

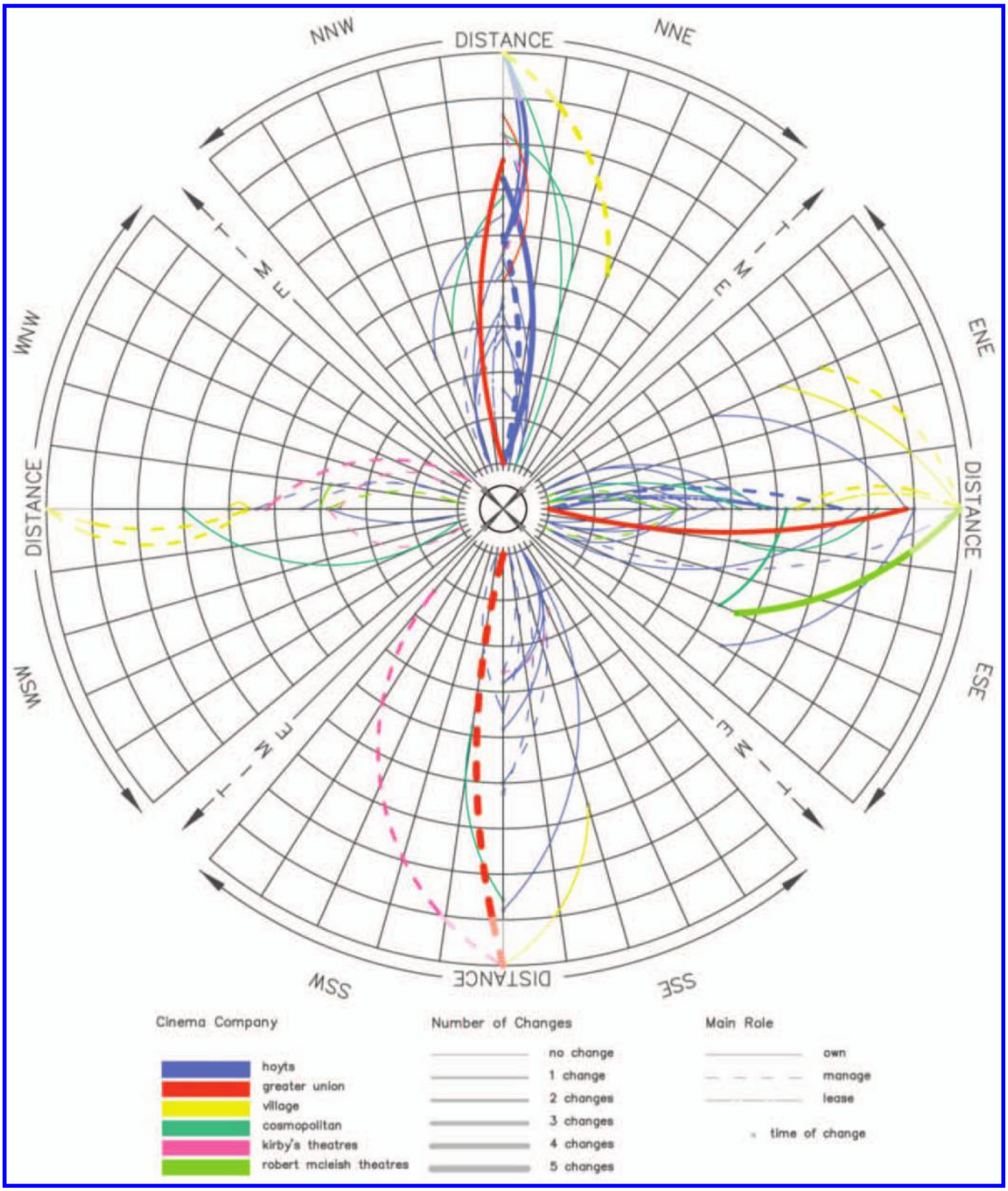

Figure 8. Visualizing Large Cinema Companies in Melbourne, Australia

ownership, primary purpose, and screen numbers. The online database is event driven, and therefore considers each change in a cinema venue to be an event and attributes a time stamp for each change to a cinema variable so the dynamics of cinema venue operation can be captured. This data is complex not only because of the large number of records, but because it encompasses a large spatial scale, has multiple venue variables, and includes an important

temporal aspect. The temporal aspect is important for two main reasons: one, the geographic distribution of cinema venues changes dramatically over time as new one open and others close; and two, cinema venues variables such as seating capacity and ownership often change many times during a cinema's operation. The challenge therefore is to combine data that is historical, geographic, and thematically changing in an approach to visual representation that could aid in exploring and understanding the relationships between different variables both geographically and over time (see Davidson *et al.*, 2011 for a full description).

Figure 8 shows a visualization technique designed to handle such data; a *Petal* diagram. The visualization is a flexible structure where the temporal period, number of cinema venues, and associated variables can be selected by the user and displayed using choice of visual variables. The flexibility of the visualization is important as it can then be used as a tool for exploration of the data. Within this one image it is possible to visually analyze the operation of the large cinema venue chains in Melbourne, dating from 1946 to 1986, based on geography, including distance and direction from the centre of Melbourne, the name of the cinema chain, the number of changes that occurred to each cinema in this period, and whether it was owned, managed, or leased by the chain (for a full scale version of the visualization see Davidson, 2013).

From Figure 8, it can be seen that from the sheer number of closures of venues since 1946 that had occurred; only a handful of these venues lasted past 1986. Clusters of new venues opening between 1965 and 1975 have occurred, distributed mainly in the east and north of the city. The lack of new cinemas opening in the west outside of the city centre is clearly shown. In fact, there are no large cinema chains operating in this area past 1975. The dominance of the blue curves is indicative of the dominance of *Hoyts* cinema venues. The large numbers of *Hoyts* cinemas are found throughout Melbourne and at varying distances from the centre of the city. However, the majority of these cinemas do not survive past 1970, and those that do experience some form of change indicated by the width of the line. This suggests that a *Hoyts* cinema operating in 1946 would most likely not remain open after 1970 unless they made adjustments to their cinema such as adding another screen or decreasing seating capacity.

Comparisons between certain attributes can be made more effectively with the use of the selection/querying capabilities within the visualization technique. This can be useful simply in eliminating unwanted information. For example, comparing results from two particular classes of distance is possible by placing two snapshots side by side or by only including the relevant information in the one visualization. By eliminating all other venues, this approach ensures that the focus can be given to the relevant data and comparisons can be made more readily.

CONCLUSION

What we have established in our ongoing research is that cinema data, whilst linked by location, is complex and heterogeneous. This collection of studies has shown that data relating to cinema comes from multiple sources. Often these sources are digital, but, and particularly so for historic data, are in hardcopy format. Whilst this presents many issues and obstacles, it also presents many opportunities for interesting and interdisciplinary research. Visualizations of such data take sources from tables, lists, and narrative text, and transforms them to a format that is interrogative and insightful for historical and cultural analysis. Without this mode of communication, these findings would not have been possible.

BIOGRAPHICAL NOTES

Colin Arrowsmith is Associate Professor in the School of Mathematical and Geospatial Sciences at RMIT University. He holds a Doctor of Philosophy from RMIT as well as two masters' degrees and a bachelor's degree from the University of Melbourne, and a Graduate Diploma of Education from Hawthorn Institute of Education. Colin has authored more than 40 refereed publications and 6 book chapters in the fields of geographic information systems (GIS), tourism analysis and in film studies. Colin's research interests include the application of geospatial information systems, including GIS, geospatial science education, investigating the impact of tourism on nature-based tourist destinations, tourist behaviour, as well as investigating the issue of managing micro-historical data within GIS utilizing cinema data.

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