

**Digital Literary Mapping I:
Visualising and Reading Graph Topologies as Maps for Literature**

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ABSTRACT

This paper is the first of two linked pieces that emerge out of the AHRC-funded *Chronotopic Cartographies* project for the mapping of place and space in Literature. The paper aims to establish the value of a topological approach for the mapping of literary texts. It is centred on Bakhtin’s concept of the “chronotope” or “time-space” as the basis for digitally mapping spatial meaning in literary works. The paper begins by contextualising our work in relation to the field of Literary Geography and Cartography. It then makes a clear distinction between mapping to the real-world using GIS (as is common in fields such as History or Geography) and mapping relatively, using topologies, which we argue is essential for the mapping of fictional place and space. The current digital models that are closest to this project concern social network analysis and its adaptation to the mapping of character networks in literary texts. After contextualising our work in relation to this research, we aim to provide a rationale for the use of topological models in literary mapping. A range of topological forms and their meaning for literature is examined with reference to particular examples from the *Chronotopic Cartographies* project. A full analytical method emerging from this is presented in a second paper: “Digital Literary Mapping II”.

KEYWORDS: Literary Mapping; Topology; chronotope; space; time; text; map.

Digital Literary Mapping I: Visualising and Reading Graph Topologies as Maps for Literature

“The chronotope is the place where the knots of narrative are tied and untied.” (Bakhtin 1981, 250)

The research presented in this paper concerns the use of digitally-generated topological graphs in relation to the mapping of place and space in literary texts.¹ This work is situated at the opposite end of the spectrum from large-scale quantitative projects. It aims to map spatiality deeply within individual texts, or across a small corpus, using mixed methods and manual mark-up as opposed to fully automated tools. It articulates a new form of literary mapping for the representation of place and space found in imaginative writing and releases itself from referential GIS by use of the relative spatial forms of topology. As such it finds its interdisciplinary origins in literary geography but is also positioned in relation to recent DH work that seeks to adapt social networking models to the needs of Literary Studies. Unlike these, however, it is *not* centred upon character-networks but upon the mapping of place, space and movement within and across the fictional text.

Literary Geography, Cartography and Digital Literary Mapping

We need to begin by contextualising our research in relation to the larger history of interdisciplinary work between the fields of Geography, Cartography and Literary Studies and the deployment of “cartography as an analytical tool for mapping real/fictional literary settings” (Rossetto 2014, 516). Here the foundational figure is Franco Moretti. Originally drawing upon early atlases and maps from the mid-twentieth century field of Literary Geography, Moretti took a relationship between map and text that was inherent, but latent, and developed a model for the thematic mapping of literary data in which visualisation of the map became part of the argument, with maps used “as intellectual tools” (Moretti 1998, 4). Moretti’s explicit mapping techniques were intended to bring to the fore that which was previously treated as “background” or “setting” with a primary aim to “make the connection between geography and literature explicit” by means of a map – here defined as “a connection made visible” (Moretti 1998, 3). His overarching purpose in *Atlas of the European Novel* was to use maps to uncover “how geography shapes the narrative structure of the European novel” (Moretti 1998, 7). In seeking to show that the spatial is a vital and

intrinsic part of literature, Moretti argued that maps are linked to plot action (as we would expect) but also that we need to understand that “Space acts upon style” (Moretti 1998, 43) and – drawing implicitly but heavily upon Bakhtin’s account of the chronotope – that genre itself is strongly spatialised: “Each genre possesses its own space, then – *and each space its own genre*: defined by a spatial distribution – by a map – which is unique to it” (Moretti 1998, 35).

Our approach for digital mapping (outlined below) differs from Moretti’s in a number of fundamental ways: in being much more explicitly indebted to Bakhtin; in questioning the apparent objectivity and absoluteness of the map; in generating maps directly out of texts; in seeking to integrate textual and map analysis fully; in wanting to find an interpretative method for literature that combines visual and verbal interpretation. Nonetheless, it shares his core beliefs about the centrality of space to literary meaning, form and structure and it explicitly acknowledges and develops Bakhtin’s work in spatialising genre.

In 2011 the “Literary Atlas of Europe” led by Piatti, Reuschel and Hurni, took Moretti’s work into the digital domain by means of a more explicitly scientific and systematic project.² This emerged from the Institute of Cartography at ETH Zurich and as such had as its starting point: “the assumption that a large part of fiction indeed refers to the physical/real world . . . by using an almost infinite variety of options to do so” (Piatti and Hurni 2011, 2018). Literary Geography was redetermined as Literary Cartography centred upon (digital) and referential map-making. The project mapped three distinct areas of Europe with dense literary settings across a range of authors with the hope that:

creating maps based on the elements the author used to build up his fiction will not only better show where fiction takes place . . . it will also demonstrate new correlations between these two worlds (Piatti and others 2009, 2).

Again, then, as in Moretti’s maps there is a degree of conflation here between real world and literary geographies and the project is premised upon the value of mapping fictional space by overlay onto the real. Fiction is mapped through five geographical components (setting; zone of action; projected space; route; marker). Piatti states that “Every topographic or geographic mention within the story belongs to one of these categories” (Piatti and others 2009, 2). These primary elements are then further broken down into attributes and categories. So, “setting” exists in terms of a point; a line; a polygon; but the system also allows for different uses of setting within literature such as: simple scenery; thematic scenery; mythical/symbolic; physical protagonistical; protagonistical-psychic. Piatti also allows for indeterminate space and developed graphic methods “to represent uncertainty” (Piatti and others 2009, 17) as well

as acknowledging that “some aspects of literary geography remain unmappable, for example completely imaginary spaces” (Piatti and others 2009, 11). The detailed level of spatial attributes fed into the database enables the generation of a wide range of maps, with the next stage as “implementation of the second approach, using statistical methods for analysing literary elements from different texts” (Piatti and others 2009, 10).

While this project was ground-breaking (and provides an invaluable template for later work) from a literary-critical point of view, such an approach is also inherently self-limiting. The digital model that emerges from it tends to rely technically on referential GIS (using tools such as ArcGIS) and this creates three problems. First, counter to Piatti’s claim that “One of literary cartography’s traditional starting points is the assumption that a large part of fiction refers to the mappable world” (Piatti 2016, 89) only a relatively small proportion of literary works and genres *have* direct correspondence to real world places – which means that the model is not applicable to many literary genres (sci-fi; fantasy; adventure; many forms of poetry etc.). Second, even where a literary text *appears* to correspond to the real-world, this is a false correlation and leads to the kind of referential confusion evidenced by literary touristic desires for “accuracy”. The apparent realism of the realist novel, for example, is misleading because it creates a false relation between literary world and real world as if the literary is referential when by its very nature it cannot be (because it exists only in the form of language). The very term “Literary Geography” encourages this slippage – as does Moretti when he denotes “Geography as the foundation of narrative form” (Moretti 1998, 38). Still, in digital mapping terms, the major problem with the referential model is that it determines almost the *entire* approach for literary cartography whereas it should only apply to *certain kinds* of text, or acts of mapping. We can surely imagine a mixed model that combines GIS mapping with other forms of mapping to permit greater complexity. Third, it forces Humanities scholars to rely on, or adapt, science-based models rather than creating tools that are designed to meet the needs of their disciplines. Our alternative topological model seeks to address all of these self-limiting elements for the mapping of literature.

As the field has developed, the terms “Literary Geography” and “Literary Cartography” have become increasingly hard to pin down because they encompass a relationship that can be developed in a range of ways. We use instead the term “Literary Mapping” to denote the making of maps out of literature in a fully integrated process. Our definition of what constitutes a “map” for literature is broad and corresponds to that given by Harley and Wood in volume I of *History of Cartography*: “Maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human

world” (Harley and Wood 1987, xvi). Of course what we are here describing as “maps” could also be called “diagrams” and are, literally, graphs. However, our primary focus is on the *function* of these graphs in relation to spatial meaning within the literary text from which they are derived and they function to visualise and spatialise that verbal representation. Literally speaking then, they “map” the text to which they correspond.

The kind of work we seek to undertake aligns itself with recent studies in the field. In the highly influential *Spatiality* (2012) Robert T. Tally Jr. employs three terms – “literary cartography”; “literary geography”; “geocriticism” – to structure his study, each referring to specific ways of understanding and responding to literary place and space. For him, literary cartography concerns the writer as map-maker “the act of writing might be considered a form of mapmaking or a cartographic activity” (Tally 2012, 45); literary geography relates only to the critic as reader “the critical reader becomes a kind of geographer” (Tally 2012, 79); and geocriticism (*pace* Bernard Westphal) concerns spatial and cultural theory as “itself a crucial domain of spatiality” (Tally 2012, 112). In contrast, for Sheila Hones, in *Literary Geographies* everything is embraced by the term “Literary Geography”. She articulates three kinds of literary-geographical space: the “fictional space generated in the event of the text”; “intertextual literary space”; and “the socio-spatial dimension of the collaboration of author, editor, publisher, critic and reader” (Hones 2016, 8). (Such a model we might note is itself highly Bakhtinian in highlighting text as event, inter-text and social space.) Although our topological model is primarily centred upon mapping place and space represented within the text, we develop a self-conscious critical method and remain alert to aspects of writerly and readerly meaning.

From Social Networks to Character Networks

Having established the larger interdisciplinary context for the mapping of literature we now need to consider the context for DH work in the Humanities as it bears upon the field of Literary Studies more broadly and on literary mapping in particular. For the last fifteen years or so, projects on the digitising of texts have been strongly centred upon Big Data, drawing upon large collections of material and driven by quantitative methods of data mining.³ This has been highly effective in Literary Studies when undertaken for a major writer with a substantial body of work (e.g. Shakespeare) or in relation to the creation of databases for particular periods or forms of literature.⁴ Such projects undertake quantitative analysis of the

whole in order to answer data-driven questions, which can then be pursued further in qualitative ways. A convincing methodological case can also be made here that the computer is able to find meanings and patterns that cannot otherwise be identified, thus providing a strong rationale for the use of such tools in the Digital Humanities (since the “reading” act they perform exceeds the capabilities of the human reader).

A secondary element of such data mining concerns the way in which findings are *presented* and here one of the dominant visual models is that of the network: “networks have become the de facto diagram of the Big Data age” (Bounegru and others 2016, 690). One aspect of such networks with direct application to the Humanities is that of the social network and corresponding social network theory – which long precedes the use of graphs as digital visualisation tools but comes to fruition through such a form. In social network theory, interest is centred upon the inter-relations between entities and forms of connection that enable exploration of areas such as: friendship networks, disease transmission, forms of social exchange, etc. Individual actors within the network are represented by nodes (vertices). The connections between them are represented by ties or links (edges) which may be weighted to show a strong or a weak connection or greater degree of interaction. Traditionally, those working in the field of social network analysis start with the node as an example of “an actor” and an “ego network” centred upon that node and work out from here. However, as sociologists Robert A. Hanneman and Mark Riddle remind us: “Actors are described by their relations, not by their attributes. And the relations themselves are just as fundamental as the actors they connect” (Hanneman and Riddle, 2005).⁵ In other words: “Rather than thinking about how an actor’s ties with other actors describes the attributes of ‘ego’ network analysis instead see a structure of connections, within which the actor is embedded” (Hanneman and Riddle, 2005). The primary use of such a model for literature emerges from this social interaction since it equally determines the structure of dialogic connection between characters in literary works.

In one of the earliest examples from social studies, psychiatrist J. L. Moreno used graph forms to depict the “evolution of group organisation” (Moreno, 1934) and determine the underlying structures that informed that evolution, centred upon the position of an individual within a group.⁶ He undertook tests to examine social groupings and isolated individuals in U.S. schools from Kindergarten up to 8th Grade, that could identify potentially “at risk” individuals. Moreno’s nodes concerned gender groups with different styles of circle symbol for females (double circle for adults) and triangle symbol for males (a double triangle for an adult male) resulting in a number of different node/connection forms. He weighted his edges

(connections) between individuals in terms of “attraction”; “repulsion” and “indifference” (see *Figure 1*).

FIGURES 1 and 2 HERE

Figure 1. J. L. Moreno: Who Shall Survive: Key to Charts p.30

Figure 2. J. L. Moreno: Who Shall Survive. Charts showing the position occupied by a typical leader (left) and depicting an isolated individual (right) p. 52-3

These resulted in images such as *Figure 2*, which depicts the centrality and attractiveness of a boy identified as a “leader” (Moreno 1934, 52) on the left, and the social antipathy shown towards the “isolated individual” (Moreno 1934, 53) on the right.⁷ The simple 1930s style of the graph images belies their predictive effectiveness as data visualisations of social observation – since Moreno’s work successfully identified individuals who *did* go on to abscond from school as a consequence of that social isolation.

Moreno’s use of network models to depict positive and negative social bonds finds a much more recent equivalent in the popular social concept of “six degrees of separation”. In the *Six Degrees of Francis Bacon* project (created by data-mining the *Oxford Dictionary of National Biography* for 1500-1700) this idea is applied retrospectively onto the Early Modern period.⁸ The site “currently identifies more than 13,000 individuals and highlights approximately 200,000 relationships”.⁹ It also allows for continual growth by crowdsourcing and uses the colour of the networks to help advance it.¹⁰

Since 2009-10 researchers have begun to explore the potential of social network models (and the graph structures that underpin them) for visualisation work that relates not to real-world social connections as above, but to those found within forms of literary representation. Here, the use of networks bears a closer resemblance to Moreno than to the gigantic structures of Big Data. Two early, influential, papers (by Elson and others 2010 and Rydberg-Cox 2011) are key here, whilst the concept was also made more widely known to Literary Studies through Moretti’s (2011) paper on the subject.

Emerging out of Classical Studies, Jeff Rydberg-Cox’s paper on “Social Networks and the Language of Greek Tragedy” notes that: “because the number of characters who appear on stage in Greek tragedy is limited, most of these social network diagrams fall into a few basic types” (Rydberg-Cox 2011, 1). This leads him immediately into a model that functions at a different scale from that of larger network projects. Instead, Rydberg-Cox recognises the need for a localised model which he describes as:

a middle ground between the emerging distance reading approach adopted by many digital humanists and a close reading approach traditionally adopted by students and scholars in the humanities. (Rydberg-Cox 2011, 1)

He defines four essential network types for Greek tragedy in a way that subsequent papers (including this one) draw upon:

one type appears in plays where a central character occupies the stage and a series of characters appear in-turn to speak to that person . . . (Rydberg-Cox 2011, 3)

The second type occurs when all the characters occupy the stage at essentially the same time and all speak to each other . . . (Rydberg-Cox 2011, 3)

The third type appears when groups of characters appear on stage in turn and speak to each other with no central character . . . (Rydberg-Cox 2011, 4)

The fourth type appears when there are textual difficulties or anomalies . . . (4)

The advantage for Rydberg-Cox is that, because he is dealing with early models from Ancient Greece, his types for drama have an immediate cultural authority. The disadvantage is that the model only covers relations between people and in one literary form (Greek drama). In his definitions above, we can see that the first type corresponds to a strong focus on the ego network for social network analysis and that the model is a little like Moreno's social groupings – concerning the centrality or otherwise of key individuals. More recent research draws on this in two different ways. So Venturini and others (2017) take his definitions and enlarge these four into five “narrative reading types” for journalistic storytelling; while Luczak-Roesch, Grener and Fenton (2018) draw out the implications of the concept of “the middle ground” in a paper entitled “Not-so-distant Reading” .

While Rydberg-Cox's work uses the stage itself and appearances on it by actors to determine points of contact, the work of Elson, Dames and McKeown is centred upon an attempt to “derive the networks from dialogue interactions” and includes automated “components for finding instances of quoted speech, attributing each quote to a character, and identifying certain characters who are in conversation” (Elson and others 2010, 139). They work across sixty novels from the Nineteenth Century seeking to explore the relationship between urban and rural settings and the number of interactions between characters. This leads them to conclude, counter to expectations, that “the important element of social networks in nineteenth-century fiction is not where the networks are set, but from what

standpoint they are imagined or narrated” (Elson and others 2010, 146). Elson, Dames and McKeown’s work draws upon that of Raymond Williams, Terry Eagleton and Franco Moretti and a similar model is then explored by Moretti himself in his Stanford LitLab pamphlet “Network Theory, Plot Analysis.”(Moretti 2011). Here, Moretti draws a direct equivalence between *plot* and network – although plot is determined in terms of character rather than narrative: “A network is made of vertices and edges; a plot of characters and actions: characters will be the vertices of the network, interactions the edges” (Moretti 2011, 2). Moretti also adopts a dialogue-based model in which “two characters are linked if some words have passed between them: an interaction, is a speech act” (Moretti 2011, 2) and he then plays with a series of visualisations to see, for example, what happens if Hamlet is removed from *Hamlet*: “what happens is that the network almost splits in half” (Moretti 2011, 210).

Whilst he has been credited as an early practitioner of the character-network model by those seeking to develop it in automated ways, what has *not* been acknowledged or further developed is the skeletal interpretative model that Moretti also presents here. Implicitly rather than explicitly, Moretti touches upon key structures for interpretation of the network that we will return to below and in the second paper: part vs. whole “they make visible specific ‘regions’ within the plot as a whole: subsystems” (Moretti 2011, 3); the importance of the central node corresponding to the protagonist; but also the distinction between stability (Hamlet) and centrality (Claudius); the emergence of opposing fields (of power between legitimate and illegitimate sovereigns); the significance of marginalised figures. Unlike others, Moretti is able to draw out the potential literary significance of these structures. So, for example, he considers the networked marginality of Horatio, as a character with “a function . . . but not a motivation” (Moretti 2011, 6). From this he draws an initial hypothesis that language on the edge of the network is designed to communicate simply and clearly whereas “as we move towards the center . . . Figureality rises” (Moretti 2011, 6).

Moretti’s participation in this debate, then, is highly distinctive for his self-questioning alertness to the usefulness or otherwise of the network model for literature, and also in being willing to consider the limitations of it: “As I have often been asked when presenting the paper in public: Did I really need it, to speak about Horatio and the State?” (Moretti 2011, 10). His conclusion:

No, I did not need network *theory*; but I probably needed networks. I had been thinking about Horatio for some time – but I had never ‘seen’ his position within Hamlet’s field

of forces until I looked at the network of the play. ‘Seen’ is the keyword here. What I took from network theory were less concepts than visualization. (Moretti 2011, 10) In fact – despite this work being reproduced as the final chapter of *Distant Reading* (2013) – what Moretti undertakes is *not* what is commonly understood to be “distant reading” at all, since it concerns narrow analysis of single texts using a non-automated method (his networks are “made by hand” (2)).¹¹ What he *does* do, far more effectively than anyone else, is to show the interpretive potential of networks in relation to literature.

More recent research in this area, such as that by Min and Park, or Argawal, Corvalan, Jensen and Rambow, takes Elson and others’ and Moretti’s approach for exploring character interaction and moves towards a *dynamic* model.¹² Argawal and others (2012) aim to create “dynamic networks . . . (to) build a fuller picture of how each character works in a literary text” (Argawal and others 2012, 12). They distinguish between two simple kinds of social event in *Alice in Wonderland* (“interaction” and “observation”) to create a simple comparative model for how characters engage with each other over time. Min and Park use character timelines for co-appearance:

To build the network of characters in a narrative, we start by representing it using a set of character timelines, the record of a character’s appearances in the narrative. Time can be measured in narrative units such as scenes and chapters. . . Based on the timelines, one can build the network of characters by connecting the characters who meet (co-appear) in a narrative unit . . . (Min and Park 2019).

They combine sentiment analysis and topic modelling with use of the network in an attempt to create a dynamic model that can trace changes over time and assess fluctuations in Sentiment Polarity Indices for ten characters across Victor Hugo’s *Les Misérables*. This is an impressive attempt, yet even here the researchers conclude by acknowledging that “Bridging the aforementioned gap between narratives and scientific methods so that we do not inadvertently reduce the process of understanding narratives with all its complexity into sets of plots is a challenge” (Min and Park 2019).¹³

A number of concerns that emerge from these papers are also of interest to our project. First, there is a common desire to define forms and create models that can function in a more localised way than Big Data allows and that can represent elements of literary meaning that are essential to understanding and analysis of texts. This is currently centred on “character” but needs to apply to more complex areas as well (e.g. setting, narrative, event, plot, agency). Second, there is a need for networks to be *dynamic*, and allow for the passage of time, since static maps are too limited an equivalence for a representational form that is sequentially

experienced (the reading of a literary work) and constitutes an unfolding narrative. So, for example, Lukzac-Roesch, Grener and Fenton aim to “treat the text as a diachronically evolving information system” (Luczak-Roesch, Grener and Fenton 2018, 30). In their model “the source text is broken into ‘slices’ of 1,000 words . . . so each node represents exactly one of those slices with the node identifier reflecting the chronological order” (Luczak-Roesch, Grener and Fenton 2018, 31). Argawal and others similarly remind us that: “Literature is, after all, built in layers, with successive scenes stacking up on each other. Texts reveal information not all at once, like a network, but in spurts” (Argawal and others 2012, 89). Third, in terms of a method of analysis and interpretation, some new form of reading is needed that situates itself somewhere between so-called “distant” and “close” reading and allows for *other* ways of interpreting the visualisations. To be more specific, it needs to allow for the visualisations to be *an active part of interpretation* rather than merely illustrative of project findings. (Fully defining and illustrating such a method is the focus of our second paper: “Digital Literary Mapping II”).

Even in the best of the social networking papers considered above, the assumption that literature is “about” character is problematic for the field of Literary Studies since it appears to be premised upon an understanding of the discipline that is out of date. To some extent this is unfair – since any study of network structures in literature surely must be at least partly about social relations – but the major issue here is that the desire to automate reading is at odds with the complexities of language and meaning held in a literary text. This is not a problem when functioning in terms of Big Data – where the computer *can* “read” much faster than the human mind and with the capacity to see patterns and meanings at scale. However, as soon as those methods are applied in relation to much smaller data sets, or individual novels, then the reading ability of the human mind easily exceeds that of the computer. Much time and effort is then spent in creating models that only serve to tell us what we were already able to grasp in reading the text. We are back with Moretti and Horatio: “There needs no ghost, my lord, come from the grave, /To tell us this” (*Hamlet*, Act I, scene v. lines 124-5). This is a key issue in terms of articulating a convincing method for visualising and mapping literary relations in ways other than for large data sets. As a first step, we propose that, rather than think in terms of a *network*, we think in terms of a *topology*.

What is Literary Topology?

Topology concerns a geometric object that has a continuous form: “It is the study of continuity: beginning with the continuity of space, or shapes, it generalizes, and then by analogy leads into other kinds of continuity”(Barr 1964, 2).¹⁴ A topological form can be deformed into other shapes but still preserve its internal properties (a famous and easily understood example is the Möbius strip). Thus, the topologist “is interested in those properties of a thing that, while they are in a sense geometrical, are the most permanent – the ones that will survive distortion and stretching” (Barr 1964, 3). The primary focus of topology is on “shape, connection, relative position compared with that of geometry (or geography) which are about more rigid notions such as distance angle and area” (Earl 2019, 2-3).

FIGURES 3, 4 and 5 HERE

Figure 3: Euler’s solution to the Seven Bridges Problem (NOTE: not a Eulerian path)

Figure 4: A Eulerian Cycle

Figure 5: Topological Types

Topology is, therefore, fundamentally concerned with three properties: *continuity*, *connectedness* and *compactness* (contained space) or alternatively: “connectivity; relationality and dimensionality” (Shields 2012, 48). It assumes a set of related points, each with a field (neighbourhood) around it. Underlying axioms then link point and region to each other. So a topological approach is concerned to a large extent with variations within, and the relationship between, part and whole, with the added advantage that deformation can occur to the whole without the loss of integral meaning in the parts (allowing for dynamic change over time). When used to map things out, then, we can define topology as a form of *relative* rather than *absolute* mapping.

According to the *OED* the term “topology” used in relation to mathematics was first employed by J. B. Lister in 1847 and translated into English in 1883.¹⁵ This reflects the fact that topology is a relatively recent form of mathematics dating from the early Nineteenth Century. As is well-known, it finds its origins in the need to visualise a real-world spatial problem that was solved in this way by Leonard Euler in 1735. “The Seven Bridges of Königsburg” was a puzzle posed by its inhabitants asking: can a person cross all seven bridges around the island city only once? Euler solved the problem by creating an abstract geometric model for the space in which a-f are the bridges and A-D the land supporting the

bridges (A being an island, see *Figure 3*). This led first to the concept of the “Eulerian path” and “cycle” and later to the “Euler characteristic” of 1758.¹⁶

In a recent article, Rob Shields considers the value of Euler’s solution for a topological approach to social and cultural studies. Shields makes clear the value of topology as an alternative to other forms of mapping culture and society in ways that are directly relevant here when he states:

Topology sets aside the privilege granted to Euclidean space in lay understandings of the social to problematize even the spatio-temporal ironies and anomalies we do recognise in everyday life. (Shields 2012, 48)

Shields embraces the possibility of the “intertopological” (Shields 2012, 53) allowing for multiple topologies and the ability of the whole to shift over time whilst maintaining a necessary connection between parts. Here he points towards its potential for use in a range of ways in the Humanities:

This can usefully be compared to other things that change yet are held to remain the same, such as a family or community or group – virtualities, that is, intangible-but-real-entities that remain despite turnover in membership. (Shields 2012, 47)

For Shields, the value of topology lies in its malleability, which enables it to be dynamic, as well as in the privileging of *relational* over *absolute* meaning that also means this kind of visualisation can be played off against other forms. This is a key point in relation to the issue of dynamic maps. Topology offers an alternative potential model for representing static maps over time, through the changing form of the relations between parts, which will affect the form of the whole – resulting in a morphing topological structure.

“The Seven Bridges of Königsburg” sounds like the title of a nineteenth-century novel – but if it *were* a novel, what would be of interest? Certainly far more than the geometric puzzle of how to cross all the bridges only once (impossible, as Euler’s topological analysis proved). Instead we would be interested in what we might call: *lived* geometry. This still concerns geometric points and relative positions within the whole, but points relating to spatio-temporal meaning and lived spatial meaning (spatiality). We could map encounters, routes, intersections across and between the bridges statically or dynamically over time. Who met whom, where, by which route and with what motivation? Does the object of the bridge function as a threshold space as we might expect – a crossing point from one state into another – or does it function as a road; part of a journey? Is it the focus of a dramatic event – say, tragic – a character jumping off it to end his, or her, life; or romantic – one character falling in love with another at a key point on a bridge? We might want to know what kind of

chronotopic space each bridge represents metaphorically or symbolically as well as literally. Does a bridge stay firmly located within the real or is it a place of dreams, of dislocation? Adopting a Latourian approach – which respects human and non-human equally – we might give equal validity to the bridges themselves as agents along with the human.¹⁷

In *Poetry, Language, Thought*, Heidegger asks “what is the relationship between location and space . . . between man and space?” (Heidegger 1971, 155). To address this question he dwells specifically upon the object of the bridge, which:

does not just connect banks that are already there. The banks emerge as banks only as the bridge crosses the stream. The bridge designedly causes them to lie across from each other. One side is set off against the other by the bridge. Nor do the banks stretch along the stream as indifferent border strips of the dry land. With the banks, the bridge brings to the stream the one and the other expanse of the landscape lying behind them. It brings stream and bank and land into each other’s neighborhood. The bridge *gathers* the earth as landscape around the stream. (Heidegger 1971, 152)

What is the “bridge-ness” of a bridge? A phenomenological account of place and space mapped onto topology reminds us that place is made meaningful holistically, while at the same time each part (re)determines the whole. So literary – unlike mathematical or even cultural – topology concerns the vital interlinking of space and time with lived experiences and with human and even object agency.¹⁸ And the equal weighting of the topology, or the possibility of generating multiple topologies, embedded at different levels, from the same section of a text, allows for the same spatiality to be understood through multiple perspectives – human and non-human – and dynamically. In *The Topological Imagination*, Angus Fletcher distinguishes between topology and geometry as “radically different in spirit” and notes that: “topology is concerned with perceived shapes, while geometry is concerned only with measured shapes” (Fletcher 2016, 11). He continues: “Topology looks at the world and asks where and how things are placed, how are they actually situated . . . what pragmatic (and finally aesthetic) consequences follow from placement” (Fletcher 2016, 12). This kind of approach begins to make clear the value of topology in relation to mapping out elements within the literary text.

Relative Literary Mapping

A necessary question to address at this point, then, is what is the *difference* between network theory and topology in relation to the mapping out of literary meaning? Certainly what we

are here calling “literary topology” bears a strong relationship to social network analysis since it draws upon the same core structure of vertices (nodes) and edges (connections). The main difference lies in the focus of investigation and in what that structure is being used to reveal or enable. What was notable, in all prior attempts by researchers in the Digital Humanities to move towards a more intimate exploration of a small group of texts or a single text, was that the method adopted was not *fundamentally* any different from that of Big Data. That is to say, those approaches remained primarily concerned with identifying patterns within a network that revealed something – albeit at a smaller scale with fewer elements. This therefore also often came down to the defining of types. At this point of the paper, we want to move *beyond* the network to explore more fully what core topological forms might mean for literature. This will still involve defining types, but we move towards a fuller account of what those types mean for spatial analysis of Literature and their impact on interpretation which will be articulated fully in our second paper.

We need to turn to some of the topological graphs generated from the *Chronotopic Cartographies* project (graphs that function as “maps” in relation to literary texts) and briefly summarise the project aims and principles in order for these to make sense.¹⁹ As a team, our positioning is perhaps unusual in that we operate out of an English Literature department, drawing upon subject-specific digital expertise, rather than out of a Computer Science department, reaching across to the Humanities. Much that is distinctive about our approach follows from this. Our ultimate aim is to create map-generation tools that can be employed widely by literary critics and thus to fully integrate DH use within the discipline. This is only achievable if those tools are extremely user-friendly and if it is clear to literary scholars that the resulting method is capable of yielding results that are of use in relation to complex forms of analysis. Our core principles might therefore be simply stated as:

1. To create easy-to-use tools and a method that can be employed widely within our discipline
2. To assume the need for manual mark-up since automated methods produce results that are too crude (although where possible a mixed-method should be moved towards)
3. To create a model that allows for scaling up and scaling down. It must be possible to drill down into the text
4. To create a model that combines static and dynamic visualisations
5. To articulate a method using these tools that convincingly illustrates their value to experts in Literary Studies

Our starting point also positions us somewhat tangentially in relation to other projects that adapt the social networking model for literature. This is because we did not *start* with graphs but chose this model as a means of solving a problem for literary mapping: how to generate a base map for a text with no real-world reference. So our immediate context was referential real-world mapping in GIS, and the need for a counter-model, rather than networks or graph theory, and our focus was on the representation of place/space and movement between them.

From a literary-cartographic perspective, topological graphs release us into a model of *relative* rather than *absolute* mapping of different aspects of literary spatiality. Also from this perspective the dominant focus is on the spatial rather than the human (although it is important to note that place is explored in and through narrative voice, which strongly colours certain chronotopes). Thus, our project is distinct from all others in that all of them use topology to explore relationships between characters, whereas our project uses topology to represent relationships between place and spaces across the text.²⁰ It is also important to note that a topological model *can* span both Euclidean / Cartesian forms of mapping place (as enabled by standard GIS tools) and non-Euclidean forms. Because of the malleable nature of the topology it is able to exist in its relative form or be laid onto a “map” for literature at two levels; in terms of a literary map as given at the front of a book (e.g. *Treasure Island*) or in terms of supposedly underlying “real-world” referential topography (e.g. the “Wessex” of Thomas Hardy’s novels).

This is not the place for a full explanation of the Bakhtinian underpinnings of the *Chronotopic Cartographies* project, but a brief overview is necessary. The project is concerned with exploring the interfused nature of space and time within literary works by using the concept of the “chronotope” (time-space) as its central means of chunking out the text. There are five spatio-temporal groupings with 5-6 texts in each and a wide range of texts across all periods of literature, since this was a scoping project intended to test the universality of the model.²¹ The *nodes* on the map (graph) correspond to key chronotopic chunks within the text that occur in a particular place and have both a spatial identity (framename) and a chronotopic identity (type). E.g. “Geneva”/“Public Square” or “Geneva/Castle”.

The *connections* between nodes denote the way in which the text moves between chronotopes and different kinds of movement between nodes are signalled by different *connection styles* (e.g. “direct”; “indirect”; “jump” etc. see *Table 2* below). These styles are normally in colour to aid differentiation but we present them in black and white within this paper. The size of the chronotope symbol denotes the amount of text dedicated to it within

the literary work. The *toporefs* for a chronotope correspond to places that are named within the text at that point (other places referenced out of the current topos).

The names for chronotopes are derived substantially from Bakhtin's essay on the chronotope to which we wished to remain true. This means that they can sound quite dated (e.g. "parlour") but, rather than modernise them, we provide a full definition for each that makes their identity clear (see *Table 1*). We have also necessarily supplemented Bakhtin by adding the spatial type "metanarrative" to describe purely textual spaces or relations which link the text in question to other texts in a range of ways. Our maps (graphs that *function* as maps in relation to the text to which they correspond) are generated from the XML mark-up.

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Table 1: Chronotopic Symbols and Descriptions













Symbol	Name	Description
	Encounter	An unexpected happening, sudden shift, any meeting. Can occur anywhere, but frequently on the road.
	Road	Paths, travel, journey, options, coming and going, wandering.
	Castle	Confinement, imprisonment, stasis, discomfort, dark, visible traces of the past.
	Idyll	Familiarity, comfort, happiness, pleasure, peace, respite, self-contained, unified, stable, homely, known.
	Idyllic Wilderness	The wild, openness, freedom, untouched, the earth, the natural world, unity.
	Anti-Idyll	Dystopias, post-apocalyptic settings, mechanical, the idyll destroyed, invaded, or made alien. Can be exterior or interior.
	Threshold	The hall, the corridor, the staircase, the street, docks, stations, liminal spaces, emotionally charged, intense, sublime, excess, a place of contrasts.
	Parlour	Interior, room, defined, bounded, hosting guests, where the public and private merge, where dialogues happen, a site of political and commercial intrigue.
	Provincial Town	Community, locality, rustic, petty-bourgeois, specific locales, quaint little houses and rooms of the town, sleepy streets.
	Public Square	Dynamic, crowd, forum, metropolitan, the internal externalized (the private/intimate becomes public), theatrical (place of the clown, the rogue, the fool).
	Distortion	Elsewhere, miraculous, bewitched, dreams, hallucinations.
	Metanarrative	For sections of text without a concrete sense of space, which could be internal (e.g. commentary, direct address to the reader) or external (e.g. glosses, framing statements, contained texts; authorial/editorial notes, etc) to the narrative. See metatextual / paratextual / intratextual connection types.

Table 2: Connection Types and Styles

Symbol	Name	Description
————	Direct	Where frames are physically connected and the narrative shifts seamlessly between two related topoi.
-----	Indirect	Where topoi which are not immediately reachable from the current frame are referenced. E.g. points viewed from afar.
- - - -	Projection	Where the narrative movement is conducted through imagination, memory, dreams, etc.
-----	Interrupt	Where the narrative movement reverts to a previous state after a tangent or diversion.
-----	Jump	Where the narrative movement is disconnected, or broken by interrupts.
-----	Metatextual	Where the narrative refers externally to a pre-existing work.
-----	Paratextual	Where the narrative contains a sub-narrative that is linked but could be separated from it.
-----	Intratextual	Where the narrative addresses the reader directly or draws attention to its own fictionality.

Table 3: Map Types Generated From the Markup

Map Format	Description
Complete	A full map of a text showing the topoi (nodes), their associated toporefs (place-names referenced also as a node), and the connections between them (arrowed lines).
Topoi	This shows the topoi (framenames) and the connections between them privileged over the chronotopes and without the associated toporefs
Syuzhet	This shows the topoi and their connections as they appear sequentially across the text in the order in which the tale is told.
Fabula	Corresponding to the "Syuzhet" above, the "Fabula" map shows the topoi and connections in the order in which events actually occurred (not the order as told)
Topoi and Chronotopic Archetypes	This shows the relationship between the topoi and the underlying chronotopic types. For many texts this graph appears as disconnected clusters. However, where topoi change chronotope over the course of a text when a place changes identity (e.g. an "Idyll" becomes a "Castle"), the clusters become interlinked.
Chronotopic Archetypes and Toporefs	This shows the relationship between the core chronotopic form and the toporefs nested within them.
Deep Chronotope	This is the simplest map to understand. It represents each chronotope as a single node, with the scale reflecting the percentage of the text dedicated to each and how they relate to one another.

FIGURE 6

Figure 6: Colour and Black and White Key for Maps

of the spatial schema using Gephi to generate the network structure (with algorithm Force Atlas 2) and Python to produce the final visualisation with symbology. Finally, it is also necessary to understand that a *series* of maps is generated out of the single marked-up text (see *Table 3*). Depending on the spatial meaning, or approach to the text, different maps within the series come to the fore.

Interpreting Literary Topological Forms

Having established the background required to read the information presented on the maps, we can now draw upon examples from the project to illustrate the major topological forms for literature and their interpretative potential. In a general sense, topological forms consist of four core structures: *star*; *mesh*; *ring*; *bus* with a fifth *hybrid* type allowing for combination of the other base forms, (e.g. *tree*; *knot*).²² Unsurprisingly, social networks adapted to character-relations also correspond to some of these forms. So, for example, in relation to Rydberg-Cox's distinction between four types of Greek tragedy we can see that the first would correspond to a star topology and the second to a mesh. In such a model the topological form essentially corresponds to a different structure of communication determined by the relative amount of text or speech for each character. However, there is no reason why topological forms should not be used to correspond to a much wider range of meanings held within the text and capable of spatialization. They could relate to a theme such as power – since they are a form of hierarchisation or de-hierarchisation as Shields suggests (Shields 2013, 153-55). Equally, as Graham Alexander Sack points out, in his work on narrative generation: “there is a close association between narrative structure and network structure” (Sack 2013, 187). In the chronotopic model we have adopted for exploring spatio-temporal meaning, the nodes represent chronotopic sites (spatio-temporal zones) while the connections are used to show different kinds of movement *between* chronotopic sites within the text. What we also find in our model is that the same text produces different topological structures across the generated map series. So, for example, the deep chronotopic map always shows up as a *mesh* structure of some sort because the chronotopic spaces are fully integrated.

FIGURE 7 HERE

Figure 7: Star Topology from Topoi/ Chronotope map for *To the Lighthouse*
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/lighthouse/chronotopes/>

It is necessary to consider carefully what these topological forms might mean in relation to literary texts and how we can employ them as a visual form in relation to analysis of content and language (as we do in the second paper on this subject). We can begin with the *star* topology as the most easily identifiable. In this topology, a central “hub” provides the sole link to the other nodes in the network. Every satellite can only communicate through the hub. Sack describes just such a form for Dickens’s *David Copperfield*: “The network is highly centralized with an obvious star-shape, reflecting an egocentric focus on its protagonist” (Sack 2013, 187). Although our approach is primarily centred upon place rather than character (whilst bearing in mind that place is described through the narration and thus implicitly linked to narratorial perspective and voice) the same topological forms apply. In fact in our map types, the map that shows the Bakhtinian chronotopes (road; parlour, castle etc.) in conjunction with the named places within the text often assumes a loosely connected star-like form – (or that of its more complex hybrid cousin, the snowflake). This is because the graphs foreground the chronotope, and therefore loosely prioritise form over content. Some texts will have more distinct or disconnected stars/snowflakes than others – for example, if there is a dominant and stable narrative voice/style/focalisation. Other, multi-focalised novels, are more likely to have connected snowflakes because of broader subjectivity/ propensity for change (i.e. a single topos shifts from castle to idyll or from road to encounter repeatedly).

The example given here in black and white (*Figure 7*) is from Virginia Woolf’s *To The Lighthouse* in which loosely connected stars illustrate the decentred nature of the Modernist text. Places are fixed internally (in the shifting consciousness of implied narrators) rather than externally. The physically present places of the novel (e.g. “the lawn”) are fairly limited, reflecting the way in which the novel is loosely grounded in a represented real-world place. Unusually, it is a topos (location/place) not a chronotope (spatio-temporal form) that dominates the map – the house and its environs – because the contents of this place (human and non-human) are the focal entities in the novel. While main sites on this map are subject to change (“drawing-room”, “dining-room”, “lawn”, “terrace”) because they are physically occupied by, and filtered through, multiple characters’ experience of them, other places are

disconnected because they are brought into play only through a single subjectivity (e.g. “a Hall” is held only in Lily Briscoe’s memory/imagination). What we also see is a limited number of connections because of the limited scope of settings and because characters tend to be physically (though not mentally) static. Again these reflect the shift into an internalised mode for the Modernist novel.

We can compare our reading of this topological map to Graham Alexander Sack’s observations in relation to a character network structure for *Mrs Dalloway*:

the character network for Mrs Dalloway contrasts noticeably with the others. While mid-Victorian novels often featured sprawling casts, the network for Mrs Dalloway, . . . is delimited. . . . The focus is on psychological depth rather than sociological breadth. . . . The network, correspondingly, does not have a pronounced center. (Sack 2013, 187)

This example then draws attention to the way in which, on the one hand, interpretation of a literary topological map corresponds to other generic or period-based elements that are more familiar to literary critics. That is to say, fragmentation is a self-conscious element of early twentieth-century Modernism – reflecting the cultural and societal mode of the day and affecting all elements: plot, character, voice, theme, image. This *also* affects the spatio-temporal meanings of the text since these are generated out of those elements. Conversely, the model could also work to bring out connections hidden by the tyranny of genre and the literary canon. Such an example points towards the potential of the model for comparative analysis. Do all, or most, Modernist texts correspond to this kind of spatio-temporal form? Can we start to denote spatial identities for particular forms of the novel or poetry that correspond to their generic or sub-generic categories?

A second form – the *mesh* topology – in which each node is connected to every other node directly, creates a pentagram or similar star shape within the nodes. The advantage of this formation is that each point has its own link to every other point. It is a model of tight interconnectedness. In the deep chronotopic map example from our project given here for *Gawain and the Green Knight* (Figure 8) the **star mesh** topology forms a near-perfect pentagram between the chronotopes of parlour/ castle (positive and negative internal spaces) and the interactive journey chronotopes of threshold and encounter with the fifth point provided by the space-time of idyll-wilderness. This underlying geometry proves to be astonishingly appropriate for a poem in which the pentagram has multiple symbolic meanings.

Within the corresponding text much is made of the symbol of the pentangle as a badge of Gawain's perfection as a knight (a perfection that the narrative will challenge and undermine, compelling him to learn greater self-awareness and humility). As he arms himself, to set off on his journey, attention is drawn to the design on his shield:

It is a symbol that Solomon once set in place
And is taken to this day as a token of fidelity,
For the form of the figure is a five-pointed star
And each line overlaps and links with the last
So is ever-eternal, and when spoken of in England
Is known by the name of the endless knot.
So it suits this soldier in his spotless armour,
Fully faithful in five ways five times over.²³

FIGURE 8 HERE

Figure 8: Mesh Topology from Deep Chronotope Map for Gawain and the Green Knight
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/sir-gawain-and-green-knight/harrison-deep-chronotopic-map/>

The choice of symbol relates directly to the unity and intertwinedness of its geometric form ("the endless knot") which is then embodied in Gawain himself. This model of exactness, balance and perfection determines (over-determines?) his model of behaviour and internalised standards of chivalry:

Five things

Which meant more to Gawain than to most other men.
So these five sets of five were fixed in this knight,
Each linked to the last through the endless line,
A five-pointed form which never failed,
Never strong to one side or slack at the other,
But unbroken in its being from beginning to end . . .
(Lines 654-660)

In the text there is a degree of ambiguity in the core description of the pentangle that is "fixed in this knight". Is this a good or a bad thing and to what extent is it within the control of the character – or is he subject to forces beyond his understanding? The presence of this underlying geometric form for the whole work (invisible and unknown until now) reveals that at a deeper level the underlying form and structure of the text as a whole corresponds to its

surface symbolism, but also raises questions about the working out of that structure through the human agent. The text fulfils its symbolic identity of absolute unity in a way that the hero himself does not. Here we also see the value of mapping *beyond* character and into the depths of underlying form. It is also important to note, however, that the pentangle form is not unique to this map. In fact, most of the deep chronotopic maps (showing the weighting given to each chronotope across the work as a whole) form a mesh pattern or a hybrid mesh/star. Nonetheless, the fact that it emerges so distinctively for this text *is* striking once we undertake visual-verbal interpretation of the text alongside the image from which it is generated.

The third topological form to consider here is that of a *ring topology*. As its name implies, a circle is formed, with each node connected only to the two nodes on either side of it. What this suggests for literature is a strong linearity within the narrative. Such a form is not commented upon by those working on character networks because it does not naturally emerge out of a conversation structure. (For this to be the case one character would have to say something to the person next to them, who would say something to the person next to them and so on – the traditional game of “Chinese Whispers” – which would make for quite an odd literary form.) However, when mapping spatially the ring form is quite common.

A simple, but striking, example of the ring topology occurs for Samuel Taylor Coleridge’s 1798 poem, “The Rime of the Ancyent Marinere”. This ballad begins with a frame narrative in which the old sailor takes hold of a guest about to go into a wedding and – in a unique dialogic situation of doubled compulsion – forces him to listen to the retold story of his own cursed voyage. In his book on Coleridge, Seamus Perry argues for “unity and division as fundamental” to Coleridgean poetics and to this poem (Perry 1999, 281). In many ways this tension between “the relative virtues of oneness and multiplicity” (281) might be said to be uniquely suited to the form of topological mapping since it exemplifies the unity of the whole at the same time as it allows for constant mapping within that whole. Such a construct is uniquely Coleridgean in any case since he defines a “legitimate poem” on the grounds that “it must be one, the parts of which mutually support and explain each other” and as a form “proposing to itself such delight from the whole, as is compatible with distinct gratification from each component part” (Engell and Bate, 1981, 131).

When the “Rime” is mapped in terms of the core narratological distinction between *fabula* (actual chronological order of events) and *syuzhet* (the telling of the tale) the second map is almost an inversion of the first, or *vice versa* (Figures 9 and 10). The *fabula* map reconstructs the physical route of the mariner’s journey (registering the amount of text dedicated to each

chronotope in font size) as a neat loop away and back home to the chronotopic location of “the Harbour”. Essentially this corresponds to the Mariner’s own internalised cognitive map, externalised and retold as a narrative. However, in contrast, the *syuzhet* map presents an entirely different structure that spatialises the story as it repeatedly jumps back to the moment of utterance: “The Wedding”. The dialogic power of the speaker over the listener in the poem functions spatially like the spokes of a wheel connecting to the outer rim; the circular form of the narrated journey.²⁴

How do we read the relationship between these two maps? Are they interlocking or opposed? At one and the same time they “mutually support” each other, and yet in their lack of connection they also almost cancel each other out. They spatialise the still point of the telling – a singularity that is also an endless repetition – but this also emphatically reminds us **FIGURES 9, 10, 11 and 12 HERE**

Figure 9: Fabula Map for Rime of the Ancyent Marinere (1798)

Figure 10. Syuzhet Map for Rime of the Ancyent Marinere (1798)

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancyent-marinere/1817-fabula-syuzhet/>

Figure 11: Complete map with Gloss for Rime of the Ancient Mariner (1817)

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancyent-marinere/1817-map-with-gloss/>

Figure 12: Colour version (Gloss only) for Rime of the Ancient Mariner (1817)

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancyent-marinere/1817-map-with-gloss/>

that all the geographical/ physical movement happens within the secondary narrative (the retold tale) so that it is equally possible that the mariner has gone nowhere and the entire poem is his own subjective nightmare (as various critics have postulated).²⁵

In the later 1817 version of the text Coleridge (responding to negative criticism of the lack of unity or sense in the poem) added a marginal “Gloss” in an attempt to illuminate understanding (essentially narrating it as a Christian allegory). At a textual level the gloss tries to impose a singularity of meaning onto a text that is resolutely multiple while at the same time, materially, it functions in the margins. However, when we generate a map for *this* version of the poem, and one for the Gloss alone, we see that the added text functions centrally to connect *fabula* and *syuzhet* together into one unified whole, resembling (appropriately enough) the species of sea urchin known as a sand dollar (see *Figures 11* and

12). Thus we could argue that what the Gloss sets out to do in *one* way (through language) it achieves in *another* – spatially harmonising the whole. This simple poetic example also illustrates the value of generating a map *series* for a single text and then selecting the most helpful map from across the series in relation to the unique spatial identity of the text itself. In the case of “Rime” the *syuzhet/fabula* maps stand out because they are so opposed to each other. However, for another text where the narrative is told chronologically, these two maps would be identical, thus rendering *fabula* redundant.

The final topological form to be considered here is that of the *bus topology* involving a linear layout with all nodes connected, not to each other, but in a line off a single core connection that functions as the “backbone”. At a character or character/dialogue level, again, this is likely to be uncommon. However, in terms of narrative structure and spatio-temporal meaning it corresponds to a narrative with a dominant itinerary structure but with stopping points or digressions along the way. The *syuzhet* map for *Jekyll and Hyde* (Figure 13) tends towards this form (combining bus and star) because direct lines of movement between police-station, Utterson’s house and Lanyon’s house create the “spine” of reliable trustworthy movement by the investigators (in search of the hidden threat) which is also the dominant trajectory of the narrative, told in the third-person. Other ordinary places (“house”; “laboratory”) are direct (in purple on the colour map) nodes off from the spine whereas indirect jumps (in orange) signal a move by respectable Jekyll into the alternate realm of the sinister Hyde as well as a shift in narration from third to first person and from Utterson

FIGURES 13, 14, 15 and 16 HERE

Figure 13: *Bus Topology from Syuzhet Map for Jekyll and Hyde*

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/jekyll-and-hyde/syuzhet/>

Figure 14: *Bus Topology from Syuzhet Map for The Idiot Boy*

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/idiot-boy/deep-chronotopic-maps/>

Figure 15: *Tree / Jellyfish Topology from Toporef and Chronotopic Archetype Map for Frankenstein*

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/frankenstein/toporefs-chronotopic-achetypes/>

Figure 16: *Near Figure-of-eight from Complete Map for The Wasteland*

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/waste-land/complete-map/>

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(investigator) to Hyde (subject of investigation).²⁶ The topology signals a spatial doubleness that reflects the deeply psychological duality running throughout this semi-allegorical novel. It also signals how the main narrative, based on travelling between and reading “real” external places (e.g. the outside of Hyde’s house), is disrupted by first-person narratives based on journeys inward as letters and diaries enclose and mystify space. These narratives appear as a series of interruptions to the base narrative: the event Enfield retells is retrospective; Lanyon’s narrative is set even further back in time and Jekyll’s – further enclosed within Lanyon’s – returns to the beginning of the narrative. The narratives give alternative perspectives, occurring in tandem to the main. The topology thus spatialises layered voices and spaces of the text and shows how different narrative voices occur in tandem to the dominant third person narrator.

A simpler example of the bus topology occurs for Wordsworth’s ballad: “The Idiot Boy” (*Figure 14*). This touching comic poem describes the night-time journey of simple “Johnny” on his horse as he ambles about the moonlit lanes instead of doing what he should be doing: racing urgently from Betty Foy’s to the doctor’s house on a rescue mission. Again, the topology of the syuzhet map is linear, with a central backbone largely corresponding to the route that *should* be taken, while imaginary and undetermined sites that are visited during Johnny’s night-ramble function as nodes off this route. In both cases (here and for *Jekyll and Hyde*) the bus topology plays a formal (objective? denotative?) primary mode of movement off against a secondary (subjective? connotative?) way of experiencing the world. Even though the topology is such a different form of mapping from the Cartesian, then, this inherent doubleness in the map as a form of representation, remains.

Finally, it is worth considering some hybrid forms. The *tree topology* offers a particular kind of hybrid model that effectively combines *bus* and *star*. It assumes a hierarchical form – a dominant node with secondary nodes coming off it. Superficially, we use this form throughout the project to depict the relationship between a place within the text (topos) and the place-names referred to from that place (toporefs). However, these are not hierarchised in themselves and for the most part places and chronotopes are not hierarchised in relation to one another but given equal status. As a result we have few true “tree” forms but quite a lot of “jellyfish” types – where multiple toporefs (place-names) emanate from a single topos or chronotope – as in the extreme example from *Frankenstein* (*Figure 15*) – where multiple sites emanate from the chronotope of “the road” (bottom left) or “encounter” (top right).

One last hybrid form of interest worth mentioning is that of the knot. In topology a knot is a form in which the ends are joined together so it cannot be undone.²⁷ The key area of interest is the “crossing” where one line crosses over the other. What is happening within a literary text when such a form is created? In spatio-temporal terms we can assume that the crossing relates to a point where there is a shift of some kind temporally and /or spatially – a move outward and then a looping back. One map that approaches a knot is the map for T. S. Eliot’s *The Wasteland* (Figure 16) where an overlap between two central loops is clearly seen – entirely counter to what we might expect from what is generally considered to be a fragmentary text. Here, the splitting of the poem into linked topoi (spatial regions) creates a distinct figure-of-eight consisting of two spatial clusters. This produces, on the left, spaces largely suggestive of abstract or archetypal spatial types: “the mountains”, “the voice of thunder”, “the shore”, “Ganga”, “the Waste Land” itself. Conversely, the topoi on the right-hand side are more specific – “the Thames”, “the City of London” – or interior: the domestic spaces of the typist’s home and the room in which the conversation of “A Game of Chess” occurs. “London” in topological terms is the most connected node on the network and functions as the point of articulation between the two groupings; the crossing point at the centre of the knot. In this visual reading, London thus serves as the mediating space through which the mythic and concrete elements of the poem are synthesised, connecting external non-specific spaces to more grounded, everyday realities.

Conclusions

What we hope that the paper has shown is, first, that the adaptation of networks to literary texts need not be limited to relationships between characters but can easily be extended into other areas – in our project to the mapping out of place, spatial meaning and time within a fictional text. Second, that the standard topological forms (maps) that emerge from our marked-up text are easily subject to analysis in terms of literary elements such as narrative, structure, plot and event and even to more abstract literary elements such as symbolism, imagery, psychological states. Third, we have begun to suggest that such visualisations are capable of integrated interpretation with detailed analysis of the text at multiple levels.

If we reflect more broadly upon what the topological form offers to literature, we can begin to consider that it is not merely a preferable option to the limitations of GIS mapping but that it is inherently more suited to the needs of *literary* mapping. In *The Topological Imagination* Angus Fletcher goes so far as to suggest that the imagination itself functions as a

kind of topology when he states that, “creativity depends upon imagined links *between seemingly disjunctive fields of thought*” (Fletcher 2016, 41) or claims that, “At least within the Romantic orbit of organicist creativity, the imagination on its higher levels of thought and feeling attains a topological phase-change” (Fletcher 2016, 57). We feel something of this in relation to the maps for Coleridge’s “Rime”. Whether or not we agree with this, we can immediately see that the kind of pull towards unity – or the interplay between part-whole meaning – that underpins topology is also fundamentally important for literary works.

In fact inherent in Moretti’s own mapping model was a valuing of relative over absolute meaning in his acts of mapping. This was made explicit in *Graphs Maps Trees* where he gave a response to an earlier critique, on the grounds that his maps were not actually maps but diagrams, and that his interest was not in geography but geometry. Moretti replies:

The diagrams look like maps, yes because they have been “superimposed on a cartographic plane” but their true nature emerges unmistakably from the way I analyse them, which disregards the specificity of the various locations to focus almost entirely on their mutual relations . . . (Moretti 1999, 54)

He then goes on to make a comparative core statement about the nature of mapping *literary* place and space as an activity that renders “Relations among locations as more significant than locations as such . . . but for geography, locations as such *are* significant” (Moretti 1999, 55). In a sense then, literary mapping was *never* actually about correspondence to the real but always implicitly about topology (relative mapping within the whole).²⁸

What remains to be done in the next paper is to fully articulate an integrated method of spatial analysis for literary criticism drawing upon topology through a visual/verbal approach. This needs to include: the mapping of part and whole; the making of multiple maps (embedded topologies); the layering of one kind of map meaning onto another; the valuing of the process of graph generation; different kinds of dynamic model. Thus, the conclusion of this paper is not really a conclusion at all, since what we have attempted here is only the first step towards a full method of visual-verbal analysis on which our second paper will elaborate.

References

- Agarwal, Apoorv and Augusto Corvalan, Jacob Jensen, Owen Rambow. 2012. "Social Network Analysis of *Alice in Wonderland*." *Workshop on Computational Linguistics for Literature*: 88-96.
- Armitage, Simon. 2007. Trans. *Gawain and the Green Knight*. London: Faber and Faber.
- Bakhtin, M. M. 1981. "Forms of Time and Chronotope in the Novel." *The Dialogic Imagination: Four Essays by M. M. Bakhtin*. Ed. Michael Holquist, trans. Caryl Emerson and Michael Holquist. Austin: University of Texas Press. 184-258.
- Bostetter, Edward. 1962. "The Nightmare World of The Ancient Mariner," *Studies in Romanticism*: 351-98.
- Bounegru, Liliana. Tommaso Venturini, Mathieu Jacomy Jonathan Gray. 2016. "Narrating Networks: Exploring the Affordances of Networks as Storytelling Devices in Journalism." *Digital Journalism* 5: 699-730.
- Coleridge, Samuel Taylor. 1983. *The Collected Works of Samuel Taylor Coleridge: Biographia Literaria*. Volume VII. II. Eds. James Engell and Walter Jackson Bate Princeton: Princeton University Press.
- "Digging For Data Challenge": <https://diggingintodata.org/>
- Earl, Richard. 2019. *Topology: A Very Short Introduction* Oxford: Oxford University Press.
- Elson, David K. Nicholas Dames, Kathleen R. McKeown. 2010. "Extracting Social Networks from Literary Fiction." Proceedings of the 48th Annual Meeting of the Association for Computational Linguistics Uppsala Sweden: 138-147.
- Fletcher, Angus. 2016. *The Topological Imagination: Spheres, Edges and Islands*. Cambridge, Mass. Harvard University Press.

The Folger Shakespeare: <https://shakespeare.folger.edu/>

Hanneman, Robert A. and Mark Riddle. 2005. "Introduction to Social Networks Methods." <https://faculty.ucr.edu/~hanneman/nettext/>

Harley, J. B. and David Woodward. 1987. "Preface." *History of Cartography, vol. 1: Cartography in Prehistoric, Ancient and Medieval Europe and the Mediterranean*. Chicago: University of Chicago Press.

Heidegger, Martin. 1971. *Poetry, Language, Thought* trans. Albert Hofstadter. Harper & Row Publishers.

Hones, Sheila. 2018. *Literary Geographies: Narrative Space in Let the Great World Spin*. Basingstoke: Palgrave Macmillan.

Latour, Bruno. 2005. "Objects Too Have Agency." *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford University Press.

Law, John. 1999. "After ANT: Complexity, Naming and Topology." *Actor Network Theory and After*. Eds. John Law and John Hassard. Oxford: Blackwells Publishers.

Luczac-Roesch, Markus and Adam Grener and Emma Fenton. 2018. "Not-so-Distant Reading: A Dynamic Network Approach to Literature." *Information Technology* 60: 29-40.

Min, Semi and Juyong Park. 2019. "Modelling Narrative Structure and Dynamics with Networks, Sentiment Analysis and Topic Modelling." *PLOS ONE* 14: e0226025. <https://doi.org/10.1371/journal.pone.0226025>.

Moreno, J. L. 1934. *Who Shall Survive: A New Approach to the Problem of Human Relations* Nervous and Mental Disease Series Monograph, 58.

Moretti, Franco. 1997. *An Atlas of the European Novel 1800-1900*. London: Verso.

---. 2015. *Distant Reading*. London: Verso.

---. 1999. *Graphs, Maps, Trees*. London: Verso.

Moretti, Franco. 2011. "Network Theory, Plot Analysis." Literary Lab: Pamphlet 2.

<https://litlab.stanford.edu/pamphlets/>

Perry, Seamus. 1999. *Coleridge and the Uses of Division*. Oxford: Oxford University Press.

Piatti, Barbara. 2016. 'Mapping Fiction: The Theories, Tools and Potentials of Literary Cartography.' *Literary Mapping in the Digital Age*. Eds. David Cooper, Christopher Donaldson and Patricia Murrieta-Flores (London: Routledge, 2014). 88-101.

Piatti, Barbara, H. R. Bär, A.K. Reuschel, L. Hurni, and W. Cartwright. 2009. "Mapping Literature: Towards a Geography of Fiction." Special Issue: *Cartography and Art*. Berlin, Heidelberg: Springer. 1-16.

Piatti, Barbara and Lorenz Hurni, 2011. "Editorial: Cartographies of Fictional Worlds." *The Cartographic Journal* 48 (2011): 218-19.

Propp, V. J. 1968. *Morphology of the Folktale*. Eds. L. Scott and L. A. Wagner. Austin: University of Texas Press.

Rossetto, Tania. 2014. "Theorizing Maps with Literature." *Progress in Human Geography* 38: 513-30.

Rydberg-Cox, Jeff. 2011. "Social Networks and the Language of Greek Tragedy." *Journal of the Chicago Colloquium on Digital Humanities and Computer Science* 1:

<http://jdhcs.uchicago.edu/>

Sack, Graham Alexander. 2013. "Character Networks for Narrative Generation: Structural Balance Theory and the Emergence of Proto-Narratives." *Workshop on Computational Models of Narrative*: 183-197.

- Shelley, Mary. 1996. *Mary Shelley: Frankenstein, The 1818 Text*. Ed. J. Paul Hunter. W. W. Norton & Co. New York and London.
- Shields, Rob. 2012. "Cultural Topology: The Seven Bridges of Königsburg, 1736." *Theory, Culture & Society* 29 (4/5): 43-57.
- . 2013. *Spatial Questions: Cultural Topologies and Social Spatialisations*. London: Sage.
- Six Degrees of Separation Project. <http://www.sixdegreesoffrancisbacon.com>
- Tally, Robert. *Spatiality*. London: Routledge, 2012.
- Text-Mining the Novel <http://novel-tm.ca>
- Venturini, Tommaso, Liliana Bounegru, Mathieu Jacomy Jonathan Gray. 2017. "How to Tell Stories with Networks: Exploring the Narrative Affordances of Graphs with the Iliad." <https://hal.archives-ouvertes.fr/hal-0167229>. Accessed April 4th, 2020.
- Woolf, Virginia (1927) 1992. *To the Lighthouse*. Ed. M. Drabble. Oxford: Oxford University Press.
- Wordsworth, William and Coleridge, Samuel Taylor. *Lyrical Ballads: 1798 and 1802*. 2013. Ed. F. J. Stafford. Oxford: Oxford University Press.

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² <http://www.literaturatlas.eu/en/>

³ Data mining essentially involves the extraction of knowledge in the form of patterns of meaning through automated tools that rely on dependency and correlation (NLP; NEP and so on). See for example, funded projects in the “Digging For Data Challenge”: <https://diggingintodata.org/>

⁴ See The Folger Shakespeare: <https://shakespeare.folger.edu/>; Text-Mining the Novel <http://novel-tm.ca>; Early Modern Print: <https://earlyprint.org/lab/>

⁵ Robert A. Hanneman and Mark Riddle. 2005. *Introduction to Social Networks Methods*. Available at: <https://faculty.ucr.edu/~hanneman/nettext/>

⁶ J.L. Moreno. 1934. *Who Shall Survive: A New Approach to the Problem of Human Relations* (Nervous and Mental Disease Series Monograph 58) 23. Thanks to Venturini and others. for drawing our attention to Moreno in their paper: Tommaso Venturini, Liliana Bounegru, Mathieu Jacomy Jonathan Gray. 2017. “How to Tell Stories with Networks: Exploring the Narrative Affordances of Graphs with the Iliad.” Available at: <https://hal.archives-ouvertes.fr/hal-0167229>. p. 11.

⁷ In these simple but effective diagrams, short red lines = “attraction towards”; full red lines = “reciprocal attraction”; short black lines indicate “antipathy towards”; full black lines indicate “mutual antipathy”.

⁸ <http://www.sixdegreesoffrancisbacon.com>. This concept was first articulated by Frigyes Karinthy in a short story (“Chains” 1929), popularised more recently by John Guares in his play “Six Degrees of Separation” (1990).

⁹ <https://www.cmu.edu/news/stories/archives/2015/october/francis-bacon-launch.html>

¹⁰ So, for example, nodes in red represent under-researched individuals (often women) and this directly encourages users to enlarge the model independently.

¹¹ The term “distant reading” is defined quite loosely by Franco Moretti in *Graphs, Maps, Trees* as: “a process of deliberate reduction and abstraction. . . where distance is however not an obstacle, but a specific form of knowledge” (Moretti 1999, 8).

¹² Semi, Min and Juyong Park. 2019. “Modelling Narrative Structure and Dynamics with Networks, Sentiment Analysis and Topic Modelling,” PLOS ONE 14: e0226025. Available at:

<https://doi.org/10.1371/journal.pone.0226025>; Apoorv Agarwal, Augusto Corvalan, Jacob Jensen, Owen Rambow. 2012. “Social Network Analysis of *Alice in Wonderland*,” *Workshop on Computational Linguistics for Literature*: 88-96.

¹³ <https://doi.org/10.1371/journal.pone.0226025>

¹⁴ Stephen Barr. (1964) 1989. *Experiments in Topology*. New York: Dover Publications, Inc. 2.

¹⁵ Definitions: German *topologie* in *Gottinger Studien* 1.814. 1847; English in *Nature* 316/2 1st February, 1883: “The term “Topology” was introduced by Listing to distinguish what may be called qualitative geometry from the ordinary geometry in which quantitative relations chiefly are treated”. Available at: <https://www-oed-com.ezproxy.lancs.ac.uk/view/Entry/203426>

¹⁶ A Eulerian path visits every edge once. A Eulerian cycle occurs if the path starts and ends at the same point (vertex). This can only happen if all the vertices are of even degree. The Euler characteristic is the formula: $x = V - E + F$, where V = vertices; E = edges and F = faces.

¹⁷ Defining Actor-Network theory, John Law states: “it tells that entities take their form and acquire their attributes as a result of their relations with other entities. In this scheme of things entities have no inherent qualities . . . truth and falsehood. Large and Small. Agency and structure. Human and non-human. Before and after” (John Law, 1999. “After ANT: Complexity, Naming and Topology” *Actor Network Theory and After* eds. John Law and John Hassard. Oxford: Blackwells Publishers, 1-15); 3. He also reminds us that it is: “a term which embodies a *tension*. It is intentionally oxymoronic, a tension which lies between the centred ‘actor’ on the one hand and the decentred ‘network’ on the other” (Law 1999, 5). See also “Objects Too Have Agency” in Bruno Latour. 2005. *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford: OUP) 63-86.

¹⁸ See also Venturini and others who allow for Latour in their model.

¹⁹ For more information on the on the *Chronotopic Cartographies* project go to:

<https://www.lancaster.ac.uk/chronotopic-cartographies/>

²⁰ It is worth noting however, that Bounegru and others start to draw close to our model when they employ the use of “panorama”; “vantage position” and so on to define different types of network story.

²¹ The five spatio-temporal groupings are: correspondent places (referential to the real); indefinite spaces; nested worlds; fantasy and bridge worlds; lost worlds (no longer existing or incapable of return).

²² Available at: <https://www.comparitech.com/net-admin/network-topologies-advantages-disadvantages/>

²³ *Gawain and the Green Knight*. 2007. Trans. Simon Armitage, (London: Faber and Faber) lines 625-632.

²⁴ “The Rime of the Ancyent Marinere,” *Lyrical Ballads 1798 and 1802*. 2013. Ed. Fiona Stafford (Oxford: OUP).

²⁵ See for example, Edward Bostetter. 1962. “The Nightmare World of The Ancient Mariner,” *Studies in Romanticism* I: 351-98.

²⁶ In both *Frankenstein* and *Jekyll and Hyde* shifts of narrative voice are not explicitly marked within the complete map which is superficially misleading. This is a point where sub-topologies are needed at a secondary level to create a separate comparable representation of different voices within the text and the spaces they occupy and to acknowledge the nature of the embedded narrative (tale within a tale). We explore these in paper II.

²⁷ See also Shields 2013, 118-119.

²⁸ Moretti knew this at one level yet somehow missed it at another since the “graphs” of *Graphs Maps Trees* are one dimensional (line graphs) rather than being represented in the plane and as topologies.

DRAFT

FIGURES for Digital Literary Mapping I

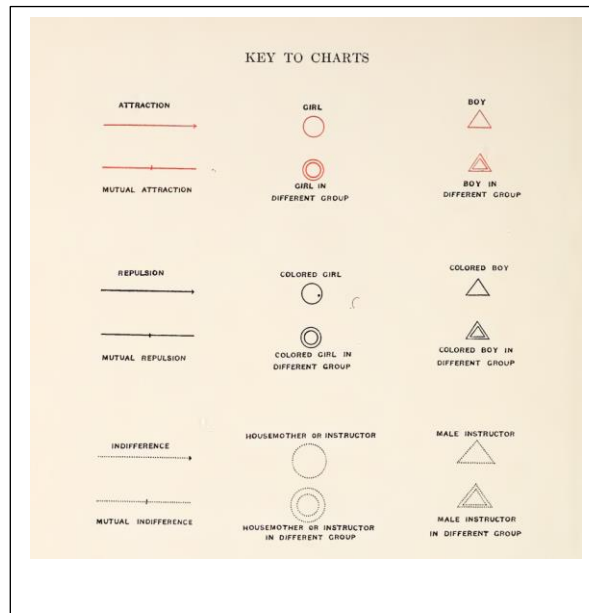


Figure 1. J. L. Moreno: *Who Shall Survive: Key to Charts* p.30

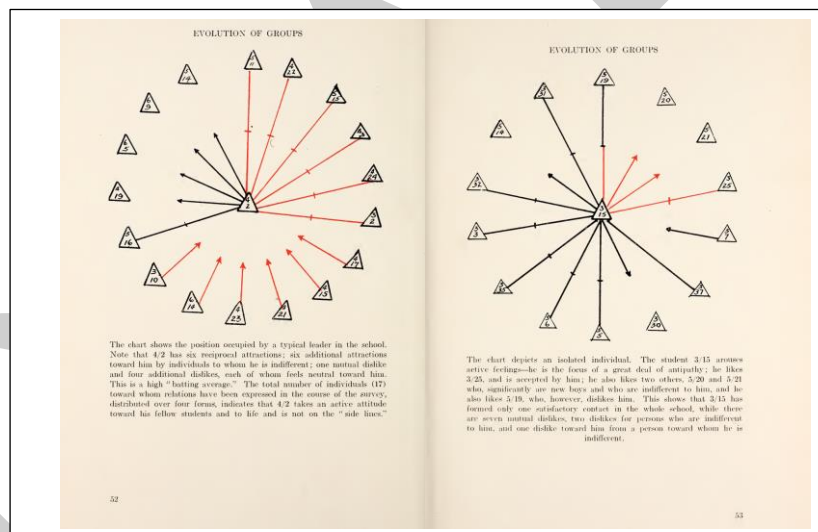


Figure 2. J. L. Moreno: *Who Shall Survive*. Charts showing the position occupied by a typical leader (left) and depicting an isolated individual (right) p. 52-3.

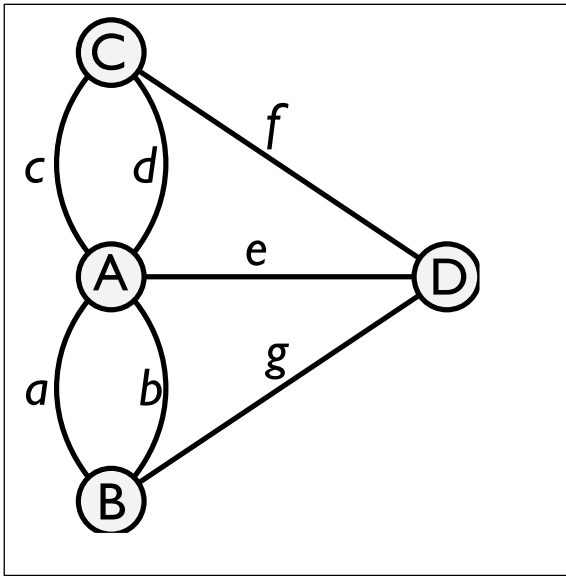


Figure 3: Euler's solution to the Seven Bridges Problem (NOTE: not a Eulerian path)

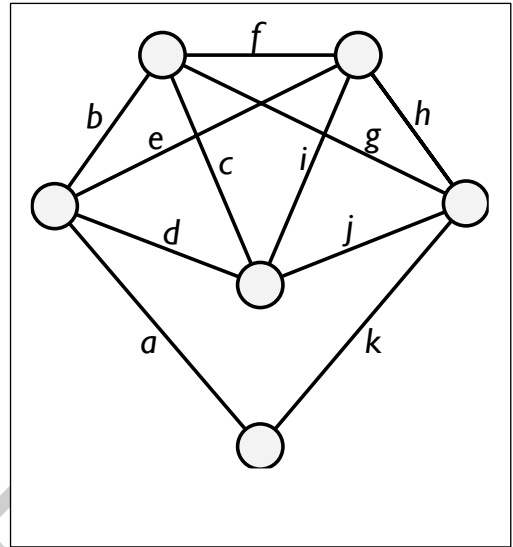


Figure 4: A Eulerian Cycle

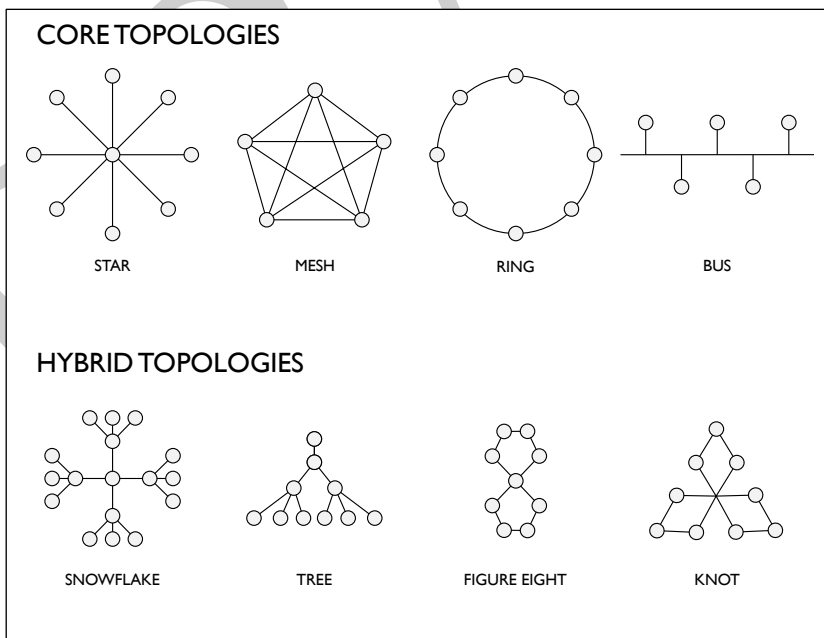


Figure 5: Topological Types

Chronotopes		Connections		Chronotopes		Connections	
	Anti-Idyll		Direct		Anti-Idyll		Direct
	Castle		Indirect		Castle		Indirect
	Distortion		Interrupt		Distortion		Interrupt
	Encounter		Jump		Encounter		Jump
	Idyll		Projection		Idyll		Projection
	Metalepsis		Metatextual		Metalepsis		Metatextual
	Parlour		Paratextual		Parlour		Paratextual
	Public Square		Intratextual		Public Square		Intratextual
	Road				Road		
	Threshold				Threshold		
	Provincial Town				Provincial Town		
	Wilderness				Wilderness		

Figure 6: Colour and Black and White Key for Maps

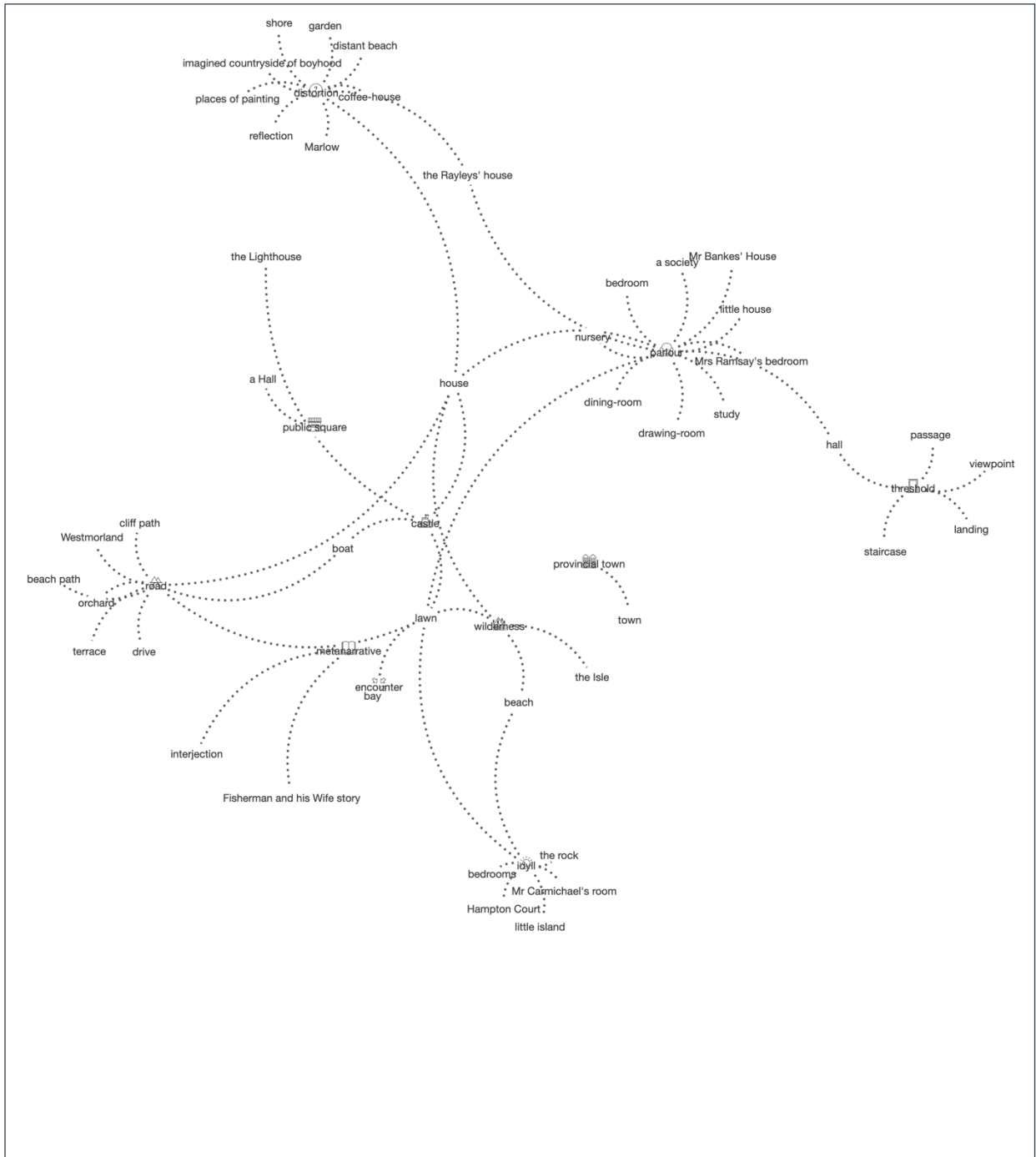


Figure 7: Star Topology from Topoi/ Chronotope map for *To the Lighthouse*
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/lighthouse/chronotopes/>

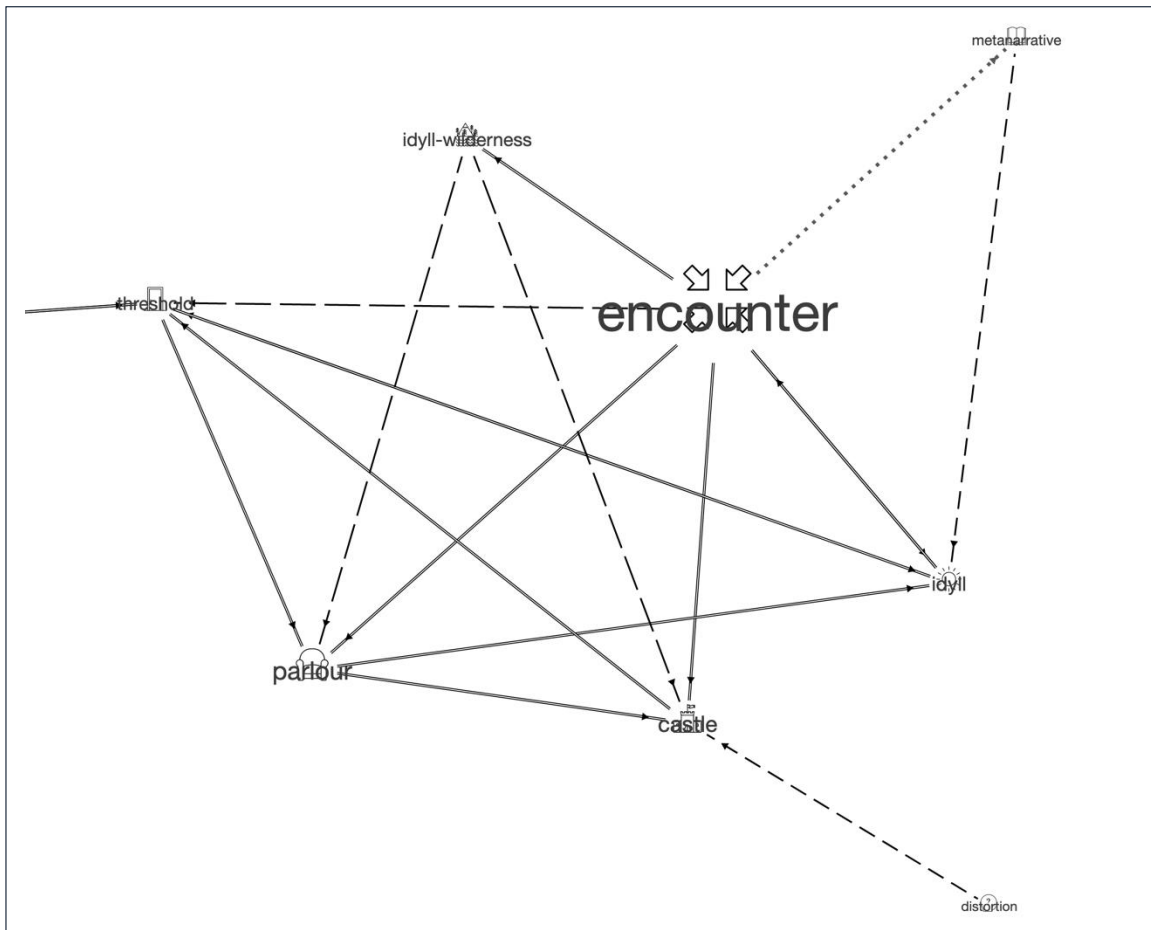


Figure 8: Mesh Topology from Deep Chronotope Map for Gawain and the Green Knight
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/sir-gawain-and-green-knight/harrison-deep-chronotopic-map/>

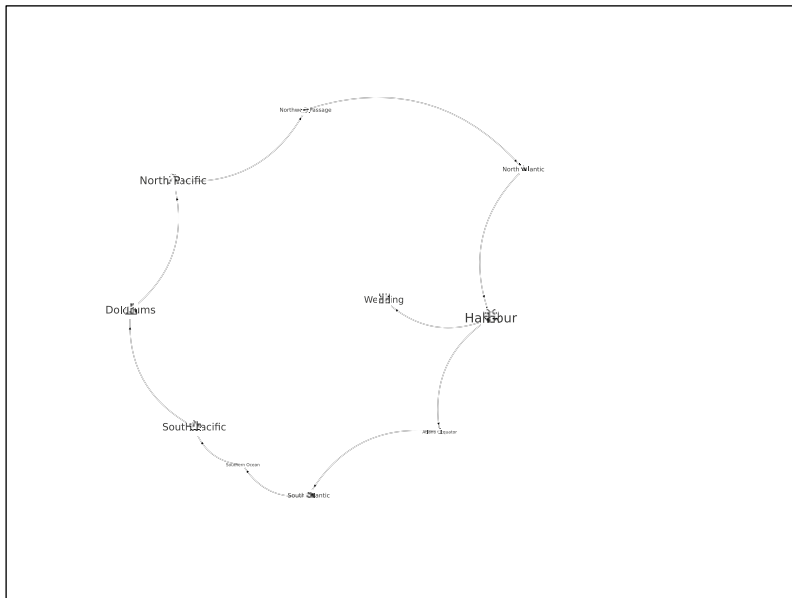


Figure 9: Fabula Map for Rime of the Ancient Mariner (1798)

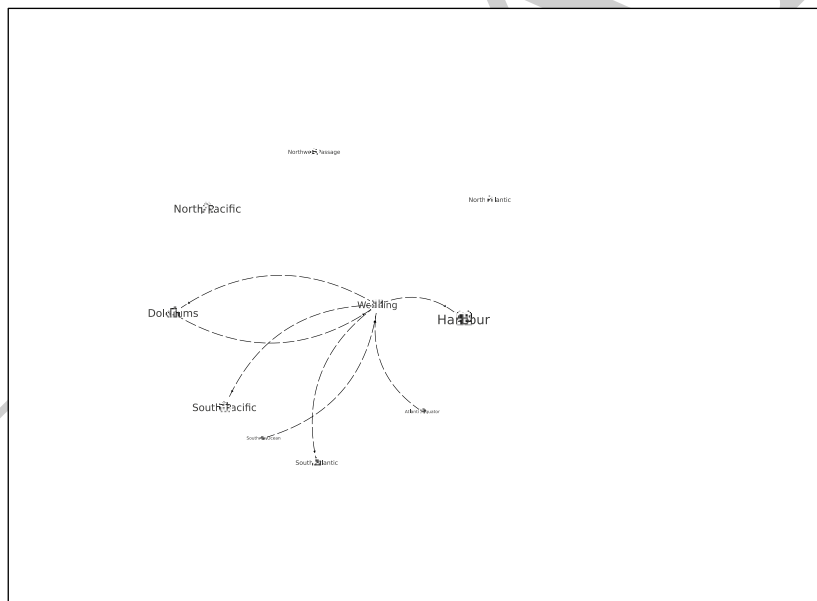


Figure 10. Syuzhet Map for Rime of the Ancient Mariner (1798)

<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancient-mariner/1817-fabula-syuzhet/>

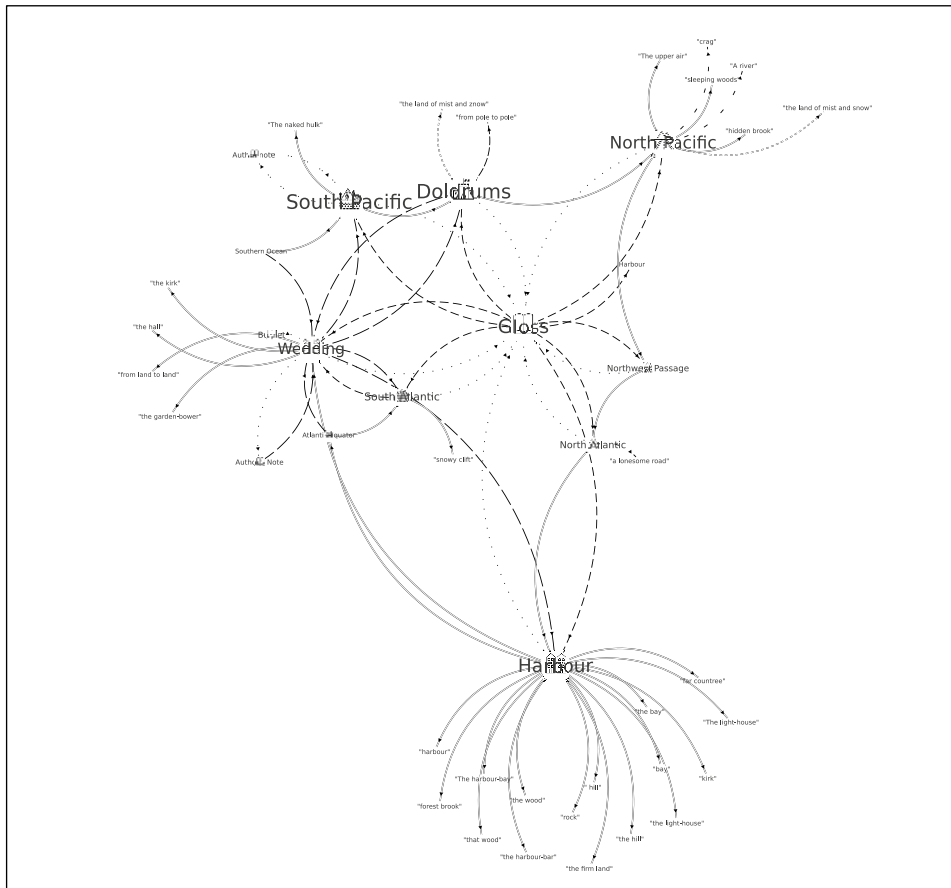


Figure 11: Complete map with Gloss for Rime of the Ancient Mariner (1817)
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancient-mariner/1817-map-with-gloss/>

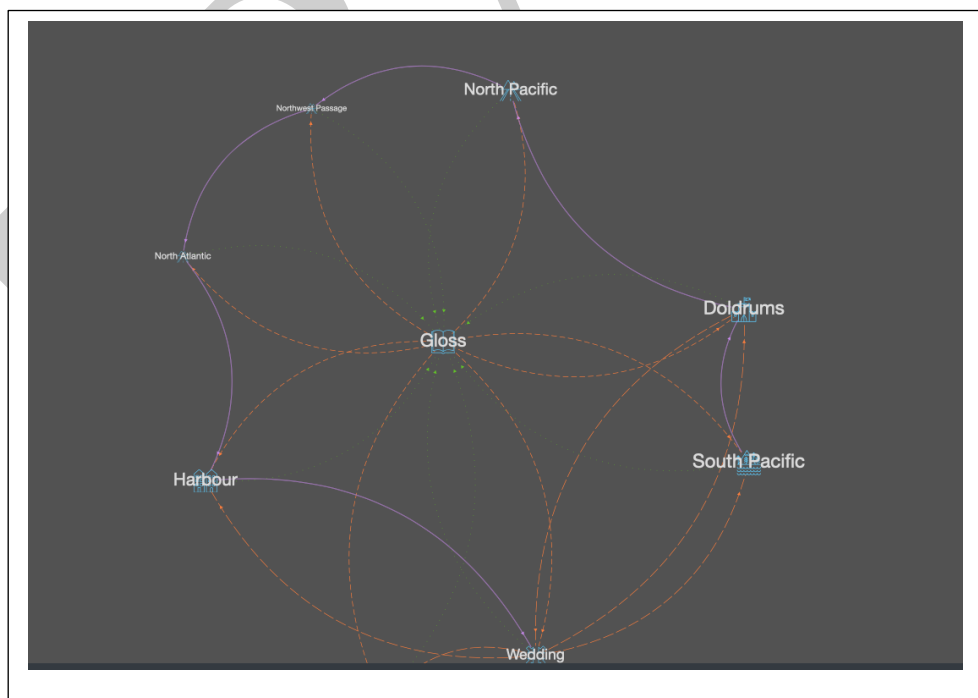


Figure 12: Colour version (Gloss only) for Rime of the Ancient Mariner (1817)
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/rime-ancient-mariner/1817-map-with-gloss/>

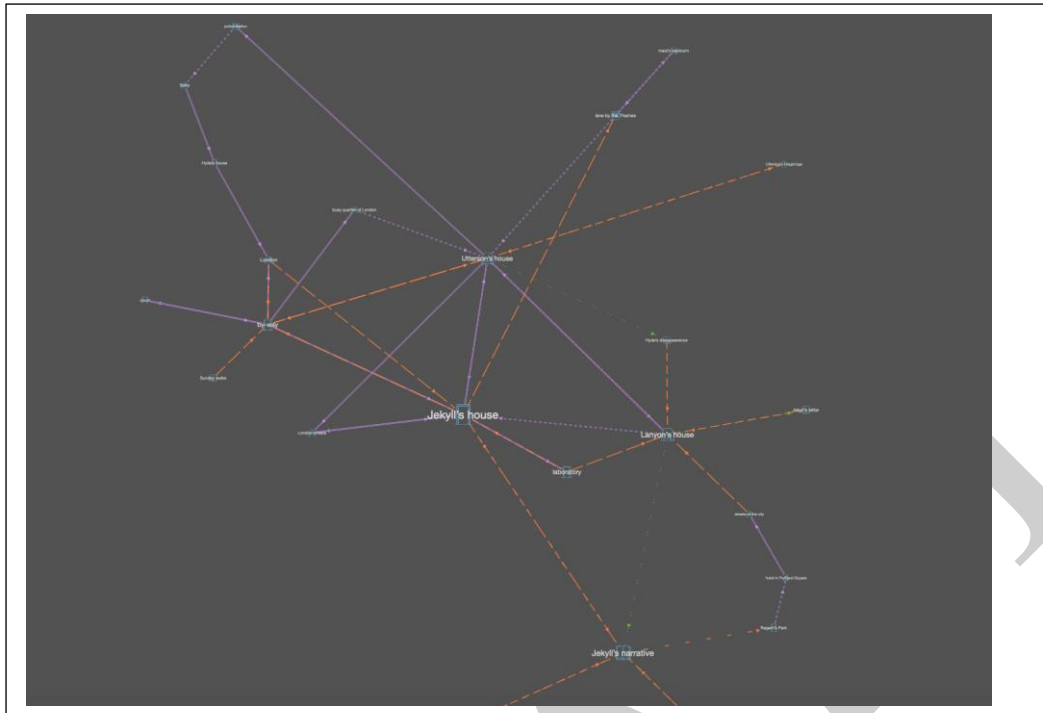


Figure 13: Bus Topology from Syuzhet Map for Jekyll and Hyde
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/jekyll-and-hyde/syuzhet/>

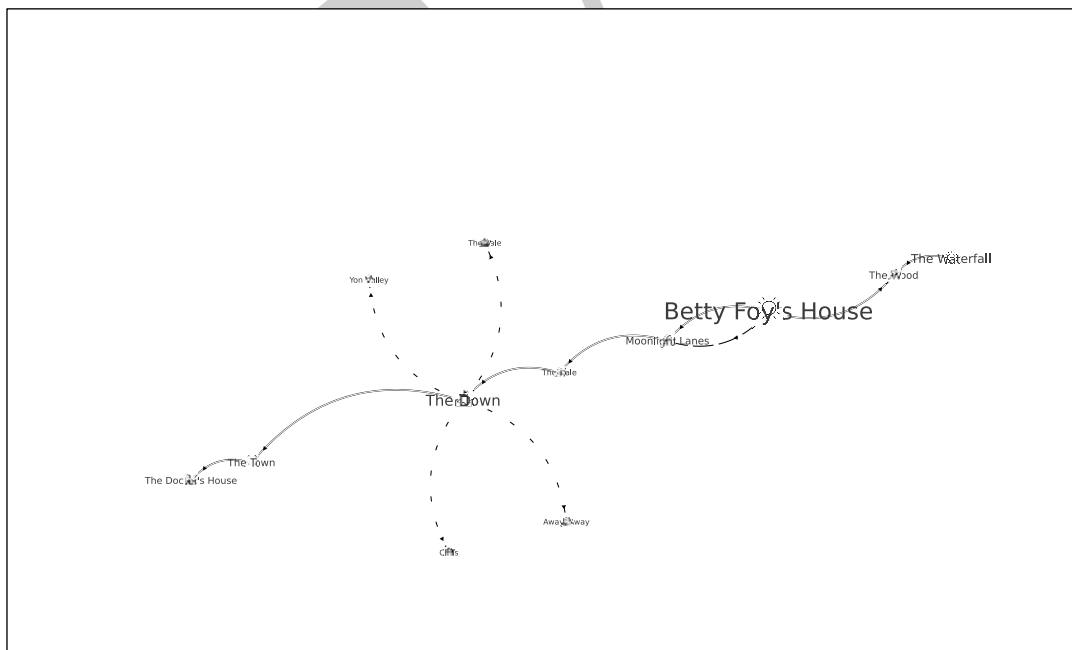


Figure 14: Bus Topology from Syuzhet Map for The Idiot Boy
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/idiot-boy/deep-chronotopic-maps/>

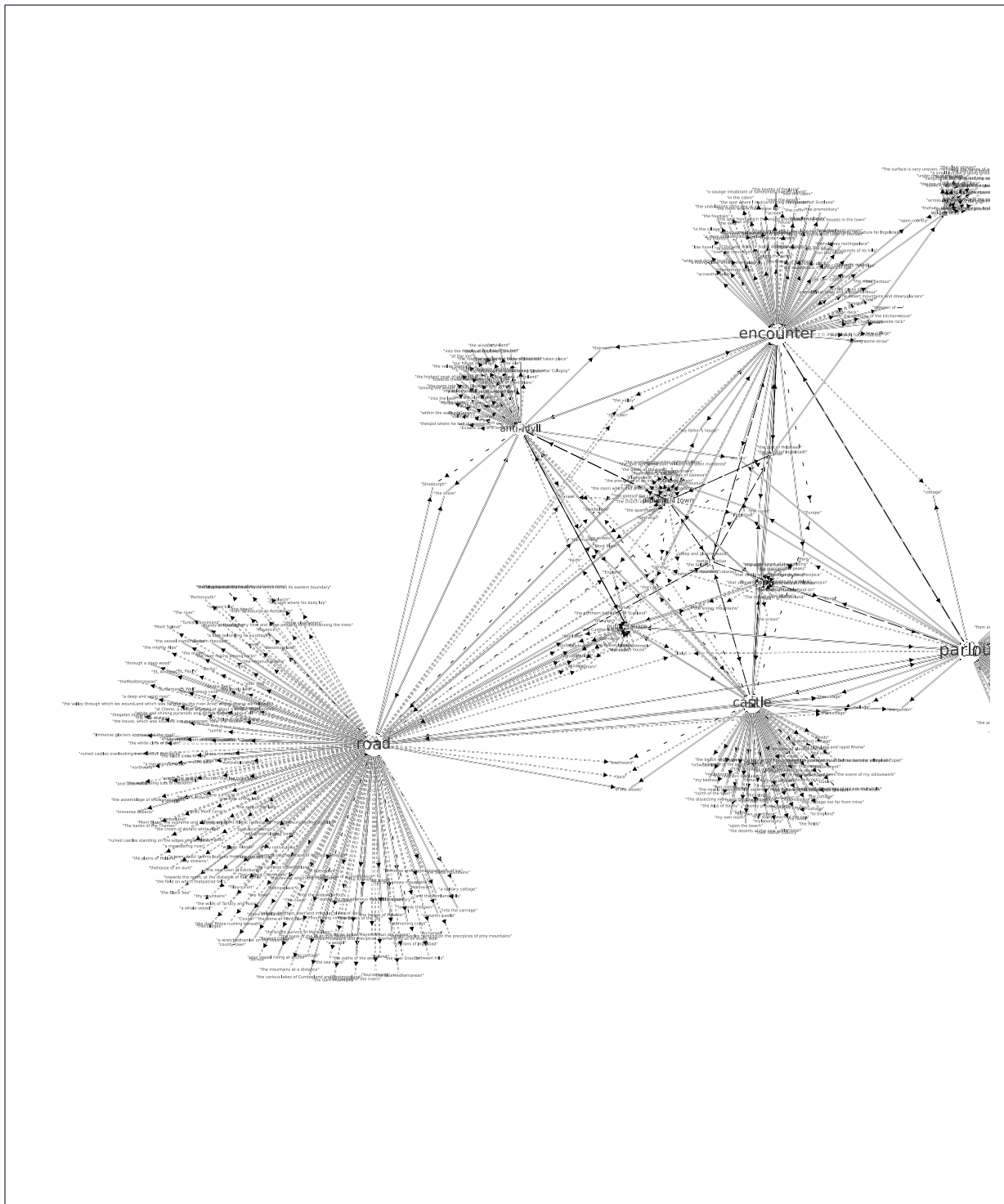


Figure 15: Tree / Jellyfish Topology from Complete Chronotope/ Toporef Map for Frankenstein
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/frankenstein/toporefs-chronotopic-achetypes/>

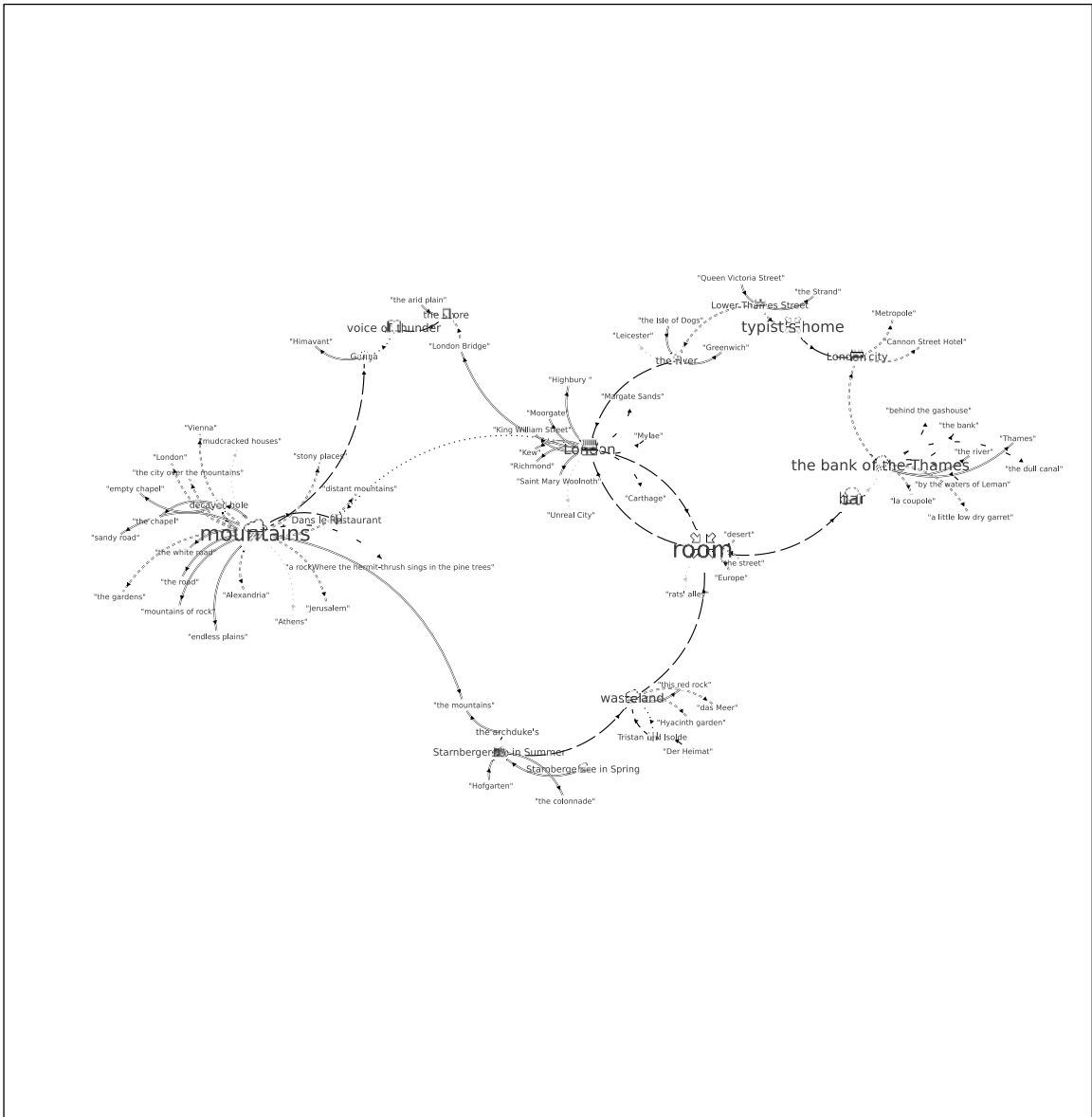


Figure 16: Near Figure-of-eight from Complete Map for The Wasteland
<https://www.lancaster.ac.uk/chronotopic-cartographies/visualisations/waste-land/complete-map/>