

# Mapping Literature: Visualisation of Spatial Uncertainty in Fiction

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*The interdisciplinary project 'A Literary Atlas of Europe' aims to develop an interactive atlas as a research tool for spatial analysis of literature. The central questions of where do stories take place and what interactions exist between literary spaces and the real space are answered by means of cartographical visualisation. This paper provides an overview of an extensive systematic evaluation of the literary space and proposes a practical implementation of literary spatial data into a database. In this process, specific properties of literary spaces are identified: the narrated spaces are fragmentary; they have vague boundaries and are often hard to localize, if at all. Furthermore, they can be transformed and remodelled by the author and can be linked to any time period. Considering these properties of fictional data, it becomes clear that visualisation of inherent uncertainty is necessary. The main challenge of this research is developing appropriate visualisation methods that visually satisfy those above-mentioned inherent rules of individual literary places. Therefore, visualisation methods for several specific properties are suggested and subsequently implemented to allow automatic map generation.*

**Keywords:** uncertainty visualisation, vagueness, literary geography, literary cartography, cartographic information system

## INTRODUCTION

Fictional worlds consist of three core elements: protagonists, actions and the space(s) the plot unfolds in (Kayser, 1960). Since it is impossible to tell a story without one or more settings, the spatial dimension is essential to fiction. Besides the sometimes entirely imaginary settings, common to genres such as Science Fiction and Fantasy, writers often link their stories to existing, recognisable places. As Malcolm Bradbury puts it: '[A] very large part of our writing is a story of its roots in a place: a landscape, region, village, city, nation or continent' (Bradbury, 1996). Some authors are even inseparably connected to a geographic area, for example, Wordsworth with the Lake District, Dickens with London, Balzac with Paris, Storm with Northern Frisia, the Brontë sisters with Yorkshire, Turgenjev with the wide plains of Russia, Faulkner with South America, and Steinbeck with California, to name just a few.

The analysis of such fictional geographies and topographies requires specific tools and methods. One productive approach is mapping. The first scientifically motivated experiments in mapping literature date back more than 100 years (for a draft of the development and a range of map samples, see Piatti, 2008 and Döring, 2009). During this time, two questions were critical, the first, why do we map literature and the second, how do we map literature? Two different methodological approaches exist: on the one

hand, maps depict individual texts in order to get a deeper, analytical insight into the spatial structure of a story; on the other hand, maps focus on a group of features and for example indicate the literary geography described by an individual author, or of a genre, a motif or an epoch. The latter follows a quantitative approach, to answer statistical queries such as: Where and when do landscapes and cities emerge on the literary map?; Are there geographic areas that are entirely undocumented by literature?; How does a region become gradually 'fictionalized', over a period of decades or even centuries?; How densely populated by fictional works is a particular space?; and What variations can be detected if several authors use the same geospatial extract as a backdrop for their plots?

What gradually emerges from such maps is the (imaginary) space of literature, with its own dimensions and functions according to its own rules, but which is anchored in the 'reality' of existing spaces and places. Through this process, not only could the literary resources of single regions be illuminated, but also fictionalized landscapes and cities across Europe could be examined comparatively, in the sense of a literary-geographical system.

Whenever literary scholars screen, read, interpret and compare such maps, they do what is regarded as their core competence: writing map annotations and carefully consider ambiguities, contextualize and shed light on historical

references or juxtapose several readings. Consequently, those map annotations allow making the decisive last step: what questions are posed by the maps – and which answers can be found?

With some rare exceptions, such as the ‘Mapping the Lakes’ project (Cooper and Gregory, 2011), the majority of literary critics tried and still try to design such maps by themselves and hence were tied to conventional, static, printed mapping products. In order to explore the multi-dimensional geography of literature, it is essential to exploit the capabilities of database-enhanced, digital, interactive cartography. This challenge was undertaken through the interdisciplinary ‘A Literary Atlas of Europe’ project, based on collaboration between ETH Zurich (CH), Georg August University, Goettingen (D), and Charles University, Prague (CZ), and supported by the Swiss National Science Foundation.

After this introduction that briefly sketches the extent to which a literary cartography should be developed, the paper continues with the breakdown of the spatial structure of literary texts into individual spatial entities. We then give an overview of what additional data should be depicted to investigate the geography of literature. To do so, three opposing, literarily renowned model regions were chosen: Prague (Czech Republic), Northern Frisia (Germany) and Lake Lucerne (Switzerland). After a short overview of different literary map products, the main section concentrates on the actual mapping of literature with respect to the inherent rules of fictional geographies. Therefore, appropriate uncertainty visualisations are introduced including diffuse boundaries, animation and several compound line symbols. Finally, examples of ‘single spatial object maps’ demonstrate the spectrum of digital, interactive literary maps.

#### SPATIAL ENTITIES OF FICTIONAL TEXTS

To map fictional spaces and to analyse the interaction between these fictional spaces and their corresponding counterparts in the ‘real world’, first, the spatial structure of the fictional text has to be broken down into individual spatial entities. Within the context of our project, the geography of literature is composed of five main categories: SETTING, PROJECTED SPACE, ZONE OF ACTION, MARKER and ROUTES, as suggested by Piatti (2008). Table 1 lists the five categories and offers definitions for each spatial entity.

These definitions of literary geographical concepts of spatial entities within a fictional text serve as a starting point for

analysing space and place in the literature. Every topographic or geographic reference within a story can be associated with one of these categories. Literary settings follow their own rules, which we describe below. There are at least five aspects that make fictional spaces unique. Consequently, it is difficult to collect the data and visualize it appropriately:

First, fictional spaces are fragmentary. The spatial dimension in fiction is constructed by the power of words; it has to be completed and developed through the imagination of the reader. Second, and as a consequence to the first issue, spatial entities have uncertain, vague boundaries, neither physical nor natural nor administrative, man-made boundaries. Authors describe spaces more or less precisely by narrating the surrounding in which the characters are acting and moving. Third, fiction is sometimes difficult to localize; a setting can be set in an indeterminate location. Often a setting is relatively small geographical space, like a building, but this building is located within a larger geographical area, for instance, a suburb, a valley or a country. In those cases, determining the location is only possible imprecisely. Hurni and Sell’s (2010) statement about cartographic uncertainty methodology clarifies the challenge of mapping literature: ‘the available data are often rather coarse’ and thus, for visualisation, they ‘must be converted to sharply delineated data; so it could be said, that a non-existing precision is assumed’. Literary geography, however, is looking for visualisation of data in a very sensitive way, which respects the rules of literary settings. Fourth, the ‘real-world counterpart’ of a setting can lie in any time epoch. Texts that are set or were written in the past do not refer to today’s geographical reality. It is also possible that a single text is referring to changes of the geospace (the real, existing space the described textual space is referring to), whether changes of political borders, changes of coastal lines, sunken islands or the growth of a town. Fifth and finally, spaces in narrations can be transformed or remodelled by the author; this ranges from simple renaming of places to the combination or relocation of places to totally invented places without an obvious counterpart in the geospace.

The distinction of these literary spatial entities is not realized by the topographical objects to which they refer, but by the function the entity is used for within fiction. That means: settings, projected spaces, routes and markers can be all kind of topographical objects, both natural and man-made objects, covering the whole range of (map) scales. For instance, a place of action can be, on the one hand, inside of a building or a city, but on the other hand, this building or city might only be roughly located somewhere within a given region like in the mountains or

Table 1. Spatial entities that compose the geographical space within a fictional text

Spatial entity	Definition
Setting	The location where the action takes place – characters are present
Projected space	Characters are not present in this location, but they dream of, remember, or long for it
Zone of action	Several settings or projected spaces combined by the scholar
Marker	A location that is only mentioned. It has no significance for the story or the character. Markers indicate the geographical range and horizon of the fictional space
Route	Along which characters move; connections between several settings or projected spaces

Ein literarischer Atlas Europas  
Schauplätze – Handlungsräume – Raumphantasien

Karten  
Aktualisieren  
Autor(in)  
Text  
Handlungsraum  
Schauplätze  
Projizierte Räume  
Wege & Grenzen  
Marker & Topol  
Kommentare  
Einführung  
Validierung  
Statistiken  
Texttabelle PRG  
Texttabelle 4WA  
Texttabelle NFR  
Eingabe absenden

V **Projizierte Räume**

V. projizierte Räume

Toponymie	Topographische Einheit	Koordinaten	Referenzierung	Handlung	
<input checked="" type="radio"/> aktuell <input type="radio"/> historisch <input type="radio"/> fremdsprachlich <input type="radio"/> verschwunden <input type="radio"/> neu erfunden <input type="radio"/> umbenannt/ verschleiert <input type="radio"/> umschrieben/ namenlos <input type="radio"/> zusammengefasst nähere Ortsbeschreibung:	<input type="radio"/> Kontinent <input type="radio"/> Teilkontinent <input type="radio"/> Land/Staat <input type="radio"/> Region <input checked="" type="radio"/> Stadt/Dorf <input type="radio"/> Stadtteil <input type="radio"/> Strasse/Platz <input type="radio"/> Gebäude	<input checked="" type="radio"/> POINT(8.586416 46.975) <input type="radio"/> synthetisierter Raum <input type="radio"/> verschobener Raum	<input checked="" type="radio"/> direkt <input type="radio"/> indirekt <input type="radio"/> nicht ref.	<input type="radio"/> mit Handlung <input checked="" type="radio"/> ohne dlung	
<input type="radio"/> aktuell <input type="radio"/> historisch <input type="radio"/> fremdsprachlich <input type="radio"/> verschwunden <input checked="" type="radio"/> neu erfunden <input type="radio"/> umbenannt/ verschleiert <input type="radio"/> umschrieben/ namenlos <input type="radio"/> zusammengefasst nähere Ortsbeschreibung:	<input type="radio"/> Kontinent <input type="radio"/> Teilkontinent <input type="radio"/> Land/Staat <input checked="" type="radio"/> Region <input type="radio"/> Stadt/Dorf <input type="radio"/> Stadtteil <input type="radio"/> Strasse/Platz <input type="radio"/> Gebäude	<input checked="" type="radio"/> POLYGON(9.580078 47. <input type="radio"/> synthetisierter Raum <input type="radio"/> verschobener Raum	<input checked="" type="radio"/> direkt <input type="radio"/> indirekt <input type="radio"/> nicht referenzierbar	<input checked="" type="radio"/> präzise <input type="radio"/> zonal <input type="radio"/> unbestimmt <input checked="" type="checkbox"/> oberirdisch <input type="checkbox"/> unterirdisch <input type="checkbox"/> unter Wasser <input type="checkbox"/> in der Luft <input type="checkbox"/> Innenraum <input type="checkbox"/> unbestimmt <input type="radio"/> importiert <input type="radio"/> transformiert <input checked="" type="radio"/> fingiert Kontrafaktischer "Reiz" <input type="radio"/> imaginär <input type="radio"/> unentschieden	<input checked="" type="checkbox"/> erinnertes Ort <input type="checkbox"/> Traumort <input type="checkbox"/> Sehnsuchtsort <input type="checkbox"/> evozierter Ort <input checked="" type="radio"/> mit Handlung <input type="radio"/> ohne Handlung löschen

Handlung

mit Handlung  
ohne  
dlung

Figure 1. Online submission form with digitizing tool

in the tidelands (as it is often the case in our two model-regions Lake Lucerne and Northern Frisia). Furthermore, characters travel through countries, regions and cities, or dream of the ocean, long for the 'far off America' (the continent of unlimited opportunities and freedom) or remember places of their childhood (combined zones of action). Consequently, we are dealing with heterogeneous data concerning topographical elements (such as building, town, country, continent, etc.) and basic geometrical elements (point, line and polygon) that are described by supplementary attributes.

#### DATA ACQUISITION – FROM FICTION TO GEODATA

To facilitate extensive data acquisition, an online data submission form was developed, specially tailored to the needs of the literary scholars. Data entered into the form (Figure 1) are automatically evaluated and transferred into the data model. The data model connected to the form is implemented through a relational database management system. Note that the complex data model of the uncertain literary (geo)data and the realisation of the submission form is not part of this paper (detailed information is in Reuschel *et al.*, 2009). On the basis of different current map material and satellite images, the experts are asked to digitize the approximate extension or, if possible, a precise location of the fictionalized spaces. They can depict the space as point,

line or polygon geometry. Table 2 indicates all possible thematic variables that are analysed during the data acquisition process and provides some examples from the text analysis.

In general, a complete data acquisition of an individual text can be structured into four parts:

- **information about the text:** general data such as year of publishing, genre, original language, quotations and a summary of the story are collected and the text is assigned to the depicted model region. In addition to that, the function and the meaning of the text's literary space are submitted (see Table 2 for content-related attributes);
- **data about the author:** biographical facts and the author's relation to the (model) region they are writing about are collected (Were they born there or have they lived there? Have they ever visited in the region?);
- **time:** the temporal context of the text is recorded (What timeframe covers the main story? What points in time are integrated through flashbacks or flashforwards?). Additionally, pivotal historical events, which took place in the model region, can be specified if the text refers to them;
- **spatial entities:** each spatial occurrence is categorized using the schema described in Table 1. A location is digitized and its precision is recorded ('position-related'

Table 2. An overview about content-related attributes. Those can be related to settings (S), projected spaces (P) or the text as a whole (T)

Term	Definition	Example	Relation
<b>Relations between literary space and real space</b>			
Imported	The setting corresponds with the geographical reality by realistically portraying the surrounding	Libuše Moníková 'Verklärte Nacht' (1996): <i>Moníková's figures stroll through Prague, each specific place is linked to a specific event or history. The reader is very well orientated within the town</i>	(S) (P)
Transformed	The setting is transformed; this includes techniques of remodelling, renaming, relocation or a synthesis of several places	K. von der Eider 'Antje Möller. Eine Eiderstedter Binnerdeern' (1911): <i>Secondary literature verifies a lot of renaming and remodelling of settings within this story</i>	(S) (P)
Invented	An invented setting within familiar geographical reality	Wilhelm Lobsien: 'Der Halligpastor' (1914): <i>One of the central settings of the story, a Hallig called 'Westeroog' neighbouring to 'Hoogeroog', does not exist in reality</i>	(S) (P)
Imagined	There is no hint at all about the position of the setting, it is located 'somewhere', with no real-world counterpart, only existing within the narration. Consequently, it is not possible to assign coordinates	L. Frank Baum: 'The Wonderful wizard of Oz' (1900): <i>The 'Land of Oz' is an autonomous geography surrounded by a desert, without any link to the real world</i>	(S) (P)
Synthesized places	Special form of a literary transformation technique: Within the text, two or more spaces are synthesized to a new, third space	Theodor Storm: 'Aquis submersus' (1877): <i>The description of the village church is a combination of four different churches from surrounding villages</i>	(S) (P)
Shifted places	Special form of a literary transformation technique: An existing place is shifted to a new location, in a new geographical context	Theodor Storm: 'Der Schimmelreiter' (1911): <i>A tavern placed on a dike is shifted in order to allow the consecutive travel of the character</i>	(S) (P)
<b>Function and meaning of literary space</b>			
Simple scenery	The scenery is theoretically replaceable, it only serves as background, and it does not play an important role for the story	Max Frisch: 'Wilhelm Tell für die Schule' (1971): <i>A typical alp of Central Switzerland serves as an example for the landscape and the waste living on such an alp</i>	(S) (P) (T)
Thematic scenery	The scenery is essential for the plot and is described plastically (portrayal of landscapes, architecture and atmosphere). Thus, the scenery is not replaceable	Ossip Schubin: 'Holunderblüten' (1909): <i>The stereotype of the Jewish town Josefov is used: dark, foul-smelling, musty and dirty</i>	(S) (P) (T)
Protagonistical physical	The setting takes physical action, usually in terms of natural phenomena or natural hazard events like avalanches, landslides or floods	Paul Leppin: 'Das Gespenst der Judenstadt' (1914): <i>The buildings are acting and talking</i>	(S) (P) (T)
Protagonistical psychological	The setting influences the mind of the characters, for example, by causing a feeling of being trapped or threatened; also positive feelings like freedom are possible	Wilhelm Lobsien: 'Der Halligpastor' (1914): <i>The remoteness of the Hallig causes a feeling of loneliness</i>	(S) (P) (T)

Table 2. Continued

Term	Definition	Example	Relation
Mythical connotation	The setting has obvious mythical atmosphere or meaning	Gustav Frenssen: 'Jörn Uhl' (1901): <i>Setting of the legend in which the 'people from the underground' are brought across the river during the night</i>	(S) (P) (T)
Allegorical, symbolical connotation	The setting has an obvious metaphoric or symbolic connotation	Albert Camus: 'Der glückliche Tod' (1971): <i>The abbey symbolises timelessness, the sense of time is of central significance</i>	(S) (P) (T)
<b>Modus of projected spaces</b>			
Place of remembering	The character is remembering a place he was in the past, e.g. a childhood place	Zikmund Winter: 'Mister Kampanus' (1907): <i>Within the historical fiction the figures remember places of political interest</i>	(P)
Place of dreaming	The character is literally dreaming of a place	Siegfried Lenz: 'Deutschstunde' (1968): <i>The protagonist has a dream that takes place on a small island off the coast of Schleswig-Holstein</i>	(P)
Place of longing	What is meant here is the active longing for a place, either for one that the character already knows or for one that has been unattainable so far	Wilhelm Jensen 'Posthuma' (1872): <i>The female protagonist often longs for this small island: part of her family and the man she loves live there</i>	(P)
Place of evocation	A place is evoked, but none of the three categories can be applied	Theodor Storm: 'Ein Bekenntnis' (1888): <i>The narration is constructed as a story within a story, so the places become projected spaces</i>	(P)

attributes: Can the location be captured precisely or just zonally?). Additionally, the locations are interpreted with respect to their function and meaning ('content-related' attributes) and with reference to their relation to the real space (Table 2).

The fictional texts are analysed by literary scholars who are also experts in the history of the region they are examining. Good general knowledge of the region is essential to separate places that no longer exist from those that have been invented or modified by the author.

#### LITERARY MAPS – CARTOGRAPHICAL IMPLEMENTATION

All literary maps are built on the above-described data, collected and stored in the database. By querying this relational database, it is theoretically possible to represent the data in any desired configuration. The result is a collection of fictional spatial entities that are finally available for further mapping processes. The following map topics are possible: maps of individual texts, maps of a single author or a group of authors, maps of a certain genre, of a certain epoch or a particular topic (one of the content-related attributes in Table 2). Even the fictionalisation process over time can be depicted. All kinds of combinations are possible as well: for instance, maps of all projected places of longing during a specific historical event. In order to analyse the results on a map, one can choose between two different map types (see below for details): '*maps showing single spatial objects*' and '*maps showing statistical surfaces*'.

#### Maps showing single spatial objects

On a 'single spatial object map', the function of each of the individual objects can be read directly from the map: is the place used as setting with acting characters, as projected space of longing, is it part of a route or just mentioned? Symbols and labels give indications about the dimension and preciseness of the settings: does the action take place inside an existing, confined area (e.g. a building) or can it only be located approximately? Colours indicate the relationship between literary space and real space, i.e. the divergence of the literary setting from geographical reality. Via zoom and navigation tools, one can examine the complete geographical distribution of all single objects. Thus, it is possible to analyse a widespread range of places of action: from the detailed microcosm, such as individual buildings, to spacious, regional or even worldwide macrocosm. Content represented on the map is scale-dependent. Finally, the selection of individual objects delivers additional information. Single-object maps are easily and intuitively interpreted based on the original digitized objects giving the user the ability to access additional information about each single element. However, if there are too many single objects overlapping, the presentation of individual spatial objects is inappropriate, as map readability suffers. See map examples for single spatial objects in Figures 9–12.

#### Maps showing statistical surface

Here, individual settings recede into the background, in favour of the general question about the density of the fictionalized spaces. In order to receive a meaningful statistical result, the calculation of statistical surfaces is

based on bounded (model) regions and assumes a statistically significant number of literary places. This map type shows hotspots (frequently fictionalized spaces) and blank spots (places never to be found in fiction). For visualisation, density values are classified and colour-coded, using a sequential colour scale. Compared with single spatial object maps, the readability of density maps is assured, but the acquisition of the geometry (the actual shape and extent), as well as the functionality and further information of a single spatial object, is obfuscated. Altogether, interpreting maps showing statistical surfaces requires careful analysis to avoid misinterpretation. Please find map examples for statistical surfaces in Bär and Hurni (2011).

In the Literary Atlas of Europe, it should be possible to switch between both single-object and statistical map types. Depending on the distribution and the quantity of the resulting data, one representation will be more appropriate. In either case, literary geography is much more than mere cartographic illustration or a support to scholarly writing. Literary maps are meant to be tools for interpretation and inspiration and powerful analytical instruments. Their purpose is to show something that has not been evident before. As Moretti (1998) stated in his 'Atlas of the European Novel', 'Placing a literary phenomenon in its specific space – mapping it – is not the conclusion of geographical work; it's the beginning. After which begins in fact the most challenging part of the whole enterprise: one looks at the map, and thinks'. One should also not underestimate that in many cases, a literary map itself has analytical character, since often settings could only be localized by exploring secondary literature. So, the individual literary map has already provided spatial information about a text in a way that goes beyond the usual scholarly reading of a text. The next step now is to reasonably combine and compare spatial literary data to analyse resulting patterns, distributions or developments.

In the following section, we focus only on the visualisation of single, uncertain spatial objects. Details for the generation and visualisation of statistical surfaces can be found in Bär and Hurni (2011).

## UNCERTAINTY INHERENT TO FICTIONAL SPACES

### Definition of uncertainty

Information uncertainty is a complex concept with many interpretations across knowledge domains and application contexts (MacEachren *et al.*, 2005). Within the disciplines of geographic information sciences (GIScience), the term and concept of 'uncertainty' is not uniformly defined. In fact, it is used for the characterisation of the conceptualisation of phenomena, the measurements of those phenomena as well as the resulting predictions made from them. Goodchild defines the general term 'spatial uncertainty' in the Encyclopedia of GIS (2008) as 'the difference between the contents of a spatial database and the corresponding phenomena in the real world'. When talking about the notion 'uncertainty' in the context of 'vagueness', many authors (Erwig and Schneider, 1997; Bittner and Stell, 2002; Montello *et al.*, 2003; Evans and Waters, 2007;

Bennett, 2001) suggest the introduction of 'broad boundaries, whose crisp boundaries are replaced by an area expressing the boundary's uncertainty'. The latter allows recording information about uncertainty together with the data by adding a three-valued indeterminacy of location. Those values are 'false', 'maybe' and 'true' (Clementini, 2008).

In the context of this research, uncertainty can be understood as a combination of subjectivity, vagueness and ambiguity (caused by the conceptualisation of literary places) on the one hand, and averaging, completeness and continuousness (resulting through the acquisition method of those literary objects) on the other hand.

### Sources of uncertainty in literary geography

During the process of converting textual fictions into geodata and finally into map products, different sources contribute to the total uncertainty. Below we identify relevant sources of uncertainty within literary geography. We distinguish between five sources of uncertainty: uncertainty occurring through (I) artistic freedom, (II) linguistic concepts, (III) geographical concepts, (IV) interpretation and (V) visualisation.

#### *Uncertainty through artistic freedom*

'There are no limits set on the poetic variations of using space within literary texts. Fictional spaces are never merely mimetic copies of the reality', as Piatti (2009) stated in 'Die Geographie der Literatur. Schauplätze, Handlungsräume, Raumphantasien' (The geography of literature. Settings, fictional spaces, spatial fantasies). She observes that the creation of spatial uncertainty within literary texts is often done on purpose by methods such as the alienation effect, the simple renaming of places or the combination of real existing places and fictional places. Artistic freedom and subjectivity is also found in cartography, or as Hurni (1999) puts it, 'cartography creates new realities'. He argues with a statement of the Swiss cartographer Eduard Imhof that 'maps in fact even represent their own realities by creating new "terrae", which are up to a certain point independent from the "real world"'.

#### *Uncertainty in linguistic concepts*

The fictional location to be investigated is already an interpretation of reality, decorated and even camouflaged through the imagination of the author and made accessible by written words and by natural language. Apart from the transformations of textual space already performed by the author, the text usually does not provide distinct information about places. As Auger and Roy (2008) suggested in a study about linguistic data, 'ambiguity, uncertainty, and vagueness are inherent to natural language'. There are words whose meaning 'implicitly involves fuzziness', e.g. 'more or less', 'roughly', 'almost', 'practically', 'actually', 'likely', 'close to', 'may', 'should' and 'could'. Egenhofer and Mark (1995) pointed out that 'the way people think and reason [and in our case write about it and capture it] about geographic space and time may appear trivial to us, but it is extremely difficult to formalize in order to implement it on a computer system'. They present some

elements as examples for this statement. For instance, people disregard the Earth's curvature; the great circle is not part of common-sense knowledge for most people. Additionally, distances are asymmetric; people see distances as a measure for how long it takes from one place to another. Even if a person is taking the same path in both directions, the perceived distance may not be the same.

#### *Uncertainty in geographical concepts*

One may argue that the notion of 'downtown' is a distinct concept and therefore more precise than just naming the town. The same applies to 'at the end of the valley' and 'coastal tideland' versus 'valley' and 'tideland', respectively. When it comes to the depiction of these spaces, it is not possible to have a one-to-one definition or a precise boundary for these spaces. Exceptions are clearly defined administrative borders (like in the case of countries and states) or obvious natural borders (in the case of islands). But even those can change over time, and this needs to be considered when working with fictional texts from different epochs. Many GIScientists are concentrating on probabilistic concepts concerning the question of finding the best way to capture, conceptualize or visualize vague regions. They differentiate areas by attributes (of differing numbers) where the segmentation suits their purpose. Erwig and Schneider (1997) uses a trisection of vague regions (kernel, boundary and outside parts), while Bennett (2001) differentiates between seven different categories (from arguable to reliable). Further, Montello *et al.* (2003) are averaging a number of binary surfaces, obtained from a number of users, to calculate a 'subjectivist'. In this context, Goodchild (2008) noticed that 'many spatial databases are based on definitions of terms, classes, and values that are vague, such that two observers may interpret them in different ways'.

#### *Uncertainty of the interpreters/readers*

No two readers are alike; each person would define a region that is only described by words slightly different. On the one hand, this subjectivity is influenced by the personal imagination, the knowledge about the space, additional details in secondary literature and the generalisation of settings. On the other hand, it is influenced by the base map in general (satellite image or map), the input scale and available digitizing tools. Therefore, the literary scholars need to mark clearly which data have been retrieved directly from the text's surface (such as explicit toponyms) and which data are already part of the interpretation (Piatti, 2009).

#### *Uncertainty in visualisation*

Once the literary locations are available as geometries and have information attached to them, they can be presented as cartographic visualisations. Here, the scholars requested a method of visualisation of the inherent rules and imprecise character of literary geography. Uncertainty due to subjectivity is also found in cartography: 'The only objectiveness or truth does not exist', argued Hurni (1999). To some degree, cartographers make use of 'fuzzy', 'subjective' methods in order to produce maps (such as generalisation). There are always several aspects that must

be considered such as precision, completeness, resemblance to nature (realism) and others. Another important factor is 'the personality of the editor (...). Usually there is not only one good [cartographic] solution, but there are several suitable possibilities' (Baumgartner, 1990).

#### UNCERTAINTY VISUALISATION OF SPATIAL LITERARY ENTITIES

Having highlighted the uncertainty of fictional geographies, the resulting question is how to visualize spatial uncertainty derived from the fictional text. A considerable number of visual variables and visualisation techniques were proposed in the literature to communicate spatial uncertainty. Most of the techniques investigate the usability of the visual variables introduced by Bertin (1983) and explore new suitable graphic variables and techniques. Concerning Bertin's visual variables, Trau and Hurni (2007) suggest 'colour hue', 'colour saturation', 'colour value', 'texture' and 'size' for the depiction of uncertainty in connection with natural hazard assessment, while the variables 'location', 'shape' and 'orientation' were therefore found to be unsuitable. MacEachren (1992) and MacEachren *et al.* (2005) propose for an extended set of visual variables to depict uncertainty and emphasize the potential of the following four 'straight-forward' methods to indicate uncertainty: *crispness* (a strategy of making the edges fuzzy), *transparency* (highly transparent objects indicate a figment of one's imagination), *colour saturation* (the greying out of a colour) and *resolution* (reducing the resolution of geographical details to the depicted data precision of the thematic information). Further complex techniques to visualize uncertainty were introduced by Pang *et al.* (1997) including methods of adding glyphs (compound point symbols) or adding geometry (e.g. using isolines), modifying attributes of geometry (e.g. using shading or manipulating the surface, similar to bump mapping), as well as using animation (e.g. speed, duration and motion blur).

In the field of literary cartography, uncertainty visualisation is used as a cartographic styling device to respond to the particular character of literary spaces. Pang (2001) observed in his studies on uncertainty visualisations: 'uncertainty comes in a variety of forms [e.g. concepts including error, accuracy, completeness and reliability] and representations, and requires different techniques for presentation together with the underlying data'. Besides that, in literary geography, different graduations are conceivable: literary spaces with very high precision and distinct boundaries, extensive literary spaces with vague boundaries, literary spaces that can only roughly be located and finally unmappable literary spaces. We explore different visualisations of literary spaces in the following section.

#### Literary spaces with vague boundaries and indeterminate locations

Applying a 'contour crispness', as MacEachren (1992) suggested, is the most obvious way to present uncertain information. He introduced this uncertainty visualisation metaphor as possibly the 'ideal way to depict uncertainty'. Evidence that contour crispness is intuitively understandable for representing uncertainty can be seen in many maps

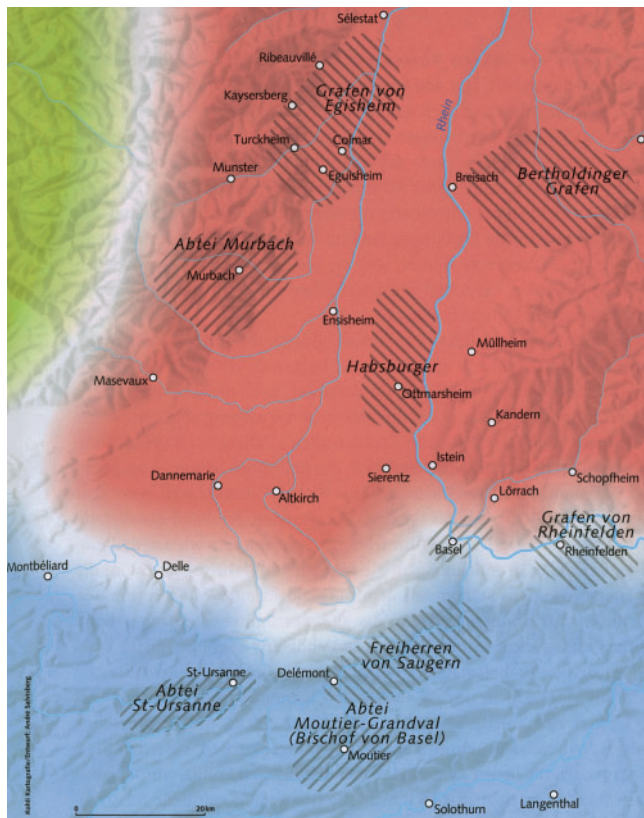


Figure 2. Example of uncertain visualisation in historical maps: Dukedoms around AD 1000 (© Christoph Merian Verlag, Kohli Kartografie/Concept: André Salvisberg; published in Salvisberg, 2010)

and graphics. One example can be seen in Figure 2 taken from the ‘Historischer Atlas der Region Basel. Geschichte der Grenzen’ (The historical atlas of the region Basel. Stories of the borders) (Salvisberg, 2010). The uncertainty visualisation is used to show ambiguous borders of the individual historical dukedoms around AD 1000.

Consequently, and according to MacEachren’s former recommendation, the visual implementation of literary spaces with uncertain boundaries is realized with ‘fuzzy shapes’. It is implemented by area-filling the depicted

geometry so that the fill fades as distance from the centre increases. Additionally, transparency is added so that the topographical information of the base map is still visible. As described initially, settings and projected places can be depicted as polygons (e.g. regions, such as a valley, a suburb or the countryside) as well as lines (e.g. streets or coastal strips) and points (such as continents, countries, towns – locations beyond our model regions are depicted as points for small-scale overview maps). For each of the geometries, the cartographic representation has to be adapted.

Settings and projected places depicted as points are assigned a specific radius concerning their geographical entity and they are transformed into ‘fuzzy points’ (Figure 3, left). In this way, the user can assign the point symbol to the geographical region on the base map. A suitable line width for line geometries was chosen with the help of the base map: lines within a town do not exceed the street width and lines on the coast are displayed as narrow ‘fuzzy band’ along the coast or along a river. Fictional locations depicted as polygons keep their shape through the blur and are visually defined with a ‘fuzzy contour’. Figure 3 provides an overview of how each vector geometry (indicated in grey) is represented. The visualisation is performed using a Gaussian blur filter with a pre-assigned amount of blur.

Piatti *et al.* (2009) argued that, ‘if settings denote a specific location rather than an area, fuzzy shapes are no longer an appropriate means of representation’. The following example reiterates the different character of locations with vague boundaries on the one hand and indeterminate locations on the other hand: a fictional setting might be a mountain hillside or even the whole mountain range and might not be defined more precisely. The dimension of the fictional location is only vaguely delimited and cannot be estimated, like an open space without clear boundaries. Here, the spatial focus lies on the entire region. Indeterminate locations, however, are located somewhere within a broader region, but this time the spatial focus lies on a relatively small, limited object like a hut and the whole story is located inside it. A typical example would be ‘in a hut somewhere on the mountain hillside’. The visual implementation of indeterminate

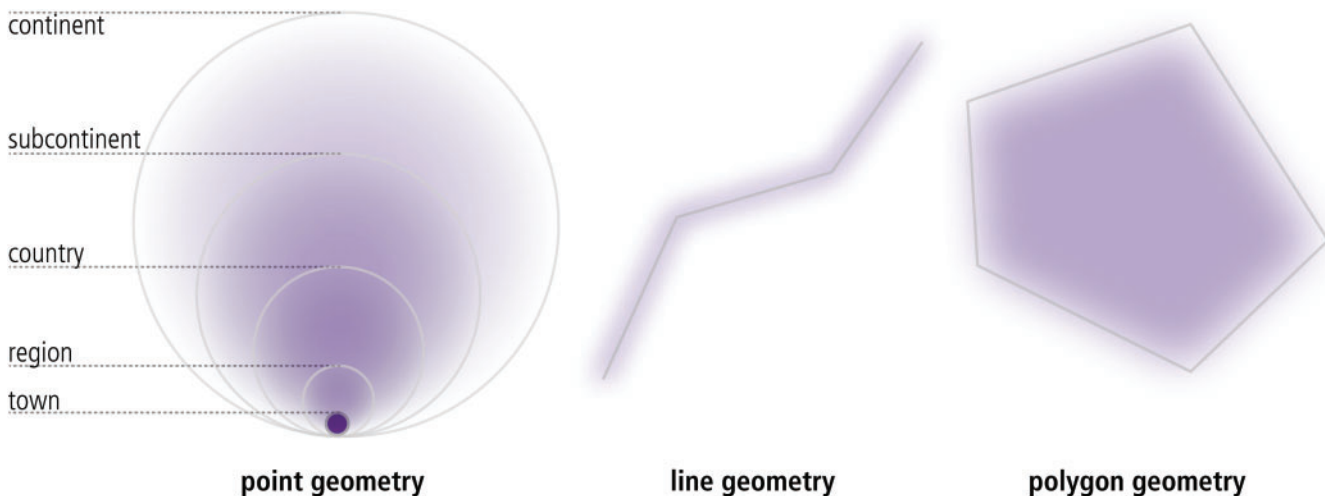


Figure 3. Adaptation of fuzzy shapes for single vector geometries



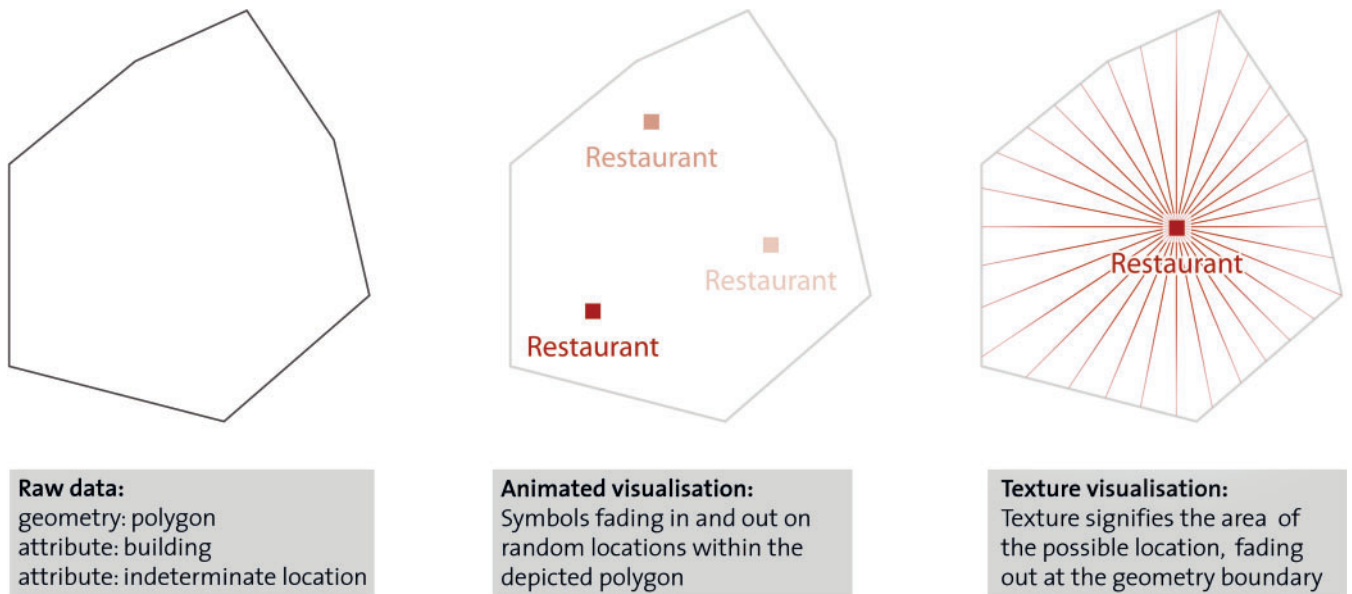


Figure 4. Animated and static visualisation methods of settings with an indeterminate location, based on the same raw data

locations (buildings within large scale maps and towns within small scale maps) is done using an animated or alternatively a specially developed static approach. Both visualisations are based on the same input data, indicated in Figure 4 (left): a polygon that outlines the location and attributes that signify the topographical entity (building) and the location (indeterminate).

The use of animation techniques is a common approach for uncertainty visualisation using variables such as speed or duration, motion blur, and range or extent of motion (Pang, 1997). Zhang *et al.* (2008) applied animation in complex planning maps in order to communicate the uncertainty of the location, boundary, orientation, size and shape of planning objects. They argue that an 'effective animated cartographic symbol depends on ways in which the dynamic visualization variables are linked to graphic variables'. In our project, we use animation to represent locational uncertainty. In order to do this, the graphic variables 'location' and 'transparency', as well as the dynamic visualisation variables '(irregular) speed' and 'duration', were carefully tailored against each other. We implement the animated approach by having labelled symbols (e.g. houses or towns) fade in and out at random locations within the depicted indeterminate region (see Figure 4, centre). To determine the optimal amount of animated fading, several parameters were tested, such as duration, velocity of fading and movement, as well as a number of symbols. We suggest increasing the animation period to at least eight seconds for each symbol. A sine wave modulates the opacity of the symbols to ensure smooth fading. In order to not lose focus, several symbols of the same literary place overlap temporally such that the symbol fades in at a new location before it has faded out from the previous location (as illustrated in Figure 4, centre). Furthermore, because there is sometimes more than one animated literary place, a temporal delay is added to achieve a slightly different movement for each animation.

The idea of the static alternative to the animated visualisation can be seen in Figure 4 (right). Here, the label

of the setting is placed in the centre of the depicted polygon. Starting from the centre, thin radial lines fade out to the border of the bounding polygon. The number of radial lines varies as a function of the extent of the polygon. Due to the increasing angular separation of the lines towards the periphery, it is necessary to use lines in an interval of  $11.25^\circ$  resulting in 32 lines for relatively large areas. However, in relatively small areas, it is sufficient to use lines in an interval of  $22.5^\circ$  resulting in 16 lines. In order to reduce the visual significance of the centre and to emphasize the uncertain location of the setting, a transparent white border frames the actual symbol. Thus, the user gets the impression of a limited setting located within a broad vague area.

The advantage of an animated approach is the theoretically equal probability of the symbol to appear in each position within the area (Figure 4, centre). However, it is not possible to instantly perceive the extent of its possible location especially on relatively large areas. Furthermore, there are often a large number of ambiguously located settings within a single fiction, which causes adverse overlapping movement. This could lead to lose sight of the animated symbols. The advantage of the static approach is the instantaneous recognition of the depicted area. Moreover, a separation of several overlapping symbols is feasible, because the orientation towards a centre avoids irritating patterns. Those so-called 'moiré patterns' are caused by narrow hatching or adverse overlapping of regular patterns (Bollmann and Koch, 2002). However, the disadvantage of the static visualisation remains the assumption of a determined centre.

#### Schematized and interpreted routes

The depiction and visualisation of routes characters are moving along, which is one of the most challenging categories within literary geography. Vague, uncertain locations meet vague or even unknown routes. The actual start or end of a route is often untraceable, since characters often shown up 'out of nowhere', or the path dissipates 'into nowhere'. Furthermore, there is almost always more than

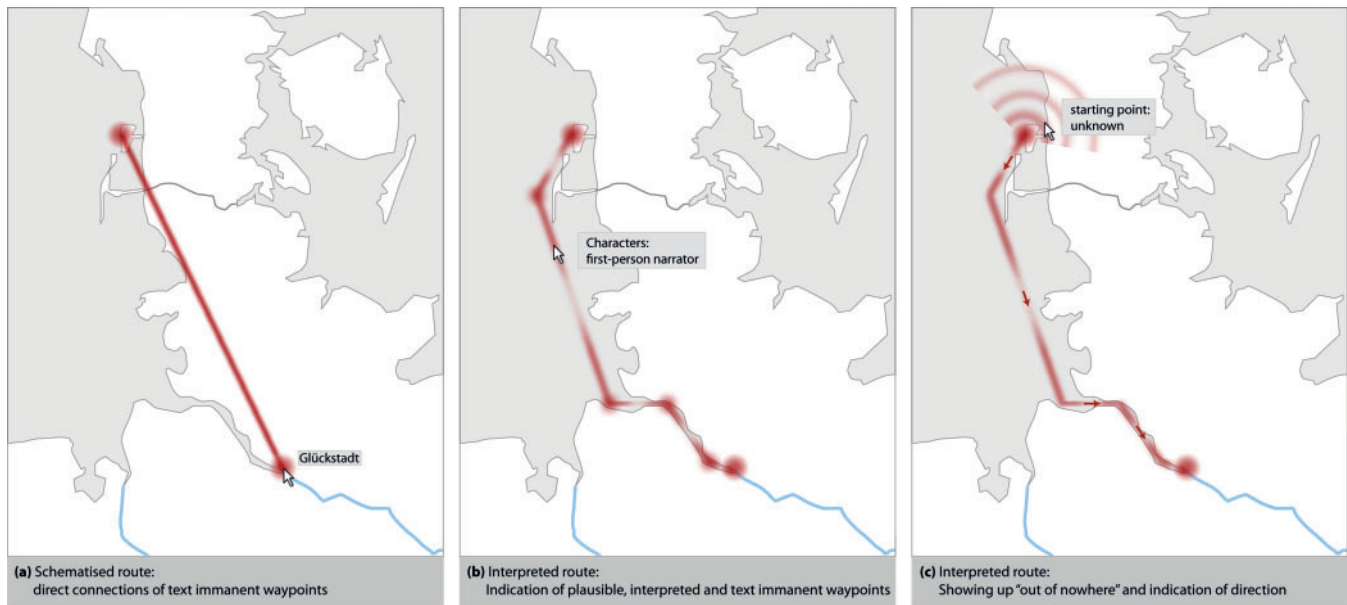


Figure 5. Overview of the detailed route visualisation

one alternative route that connects two places. The problem of determining difficult (sometimes impossible) route tracing and creating a satisfying depiction of fictional routes in combination with using an appropriate visualisation is particularly evident. In order to approach the problem, each waypoint is classified during data acquisition as either 'text immanent' (directly mentioned in the text), 'plausible' (every other possibility can be excluded) or 'interpreted' (the most probable possibility according to the interpretation of the scholar). The information of an unknown start or an unknown end is also stored as attribute into the database since the depicted linestring will only contain the explicitly mentioned part of the route. Figure 5 demonstrates route visualisation with an example showing an exemplar route by ship where only two stations of the journey are described within the text. The map user can switch between two different modes: a schematic and an interpreted mode. The schematized route will show all the waypoints directly mentioned in the text (Figure 5a). These are connected with straight lines and represent the movement described within the text. To emphasize the vague character of a route, the waypoints, as well as the connecting lines, are drawn with a diffuse Gaussian boundary. The interpreted route additionally encloses plausible and interpreted waypoints and therefore, shows a more detailed interpretation of where the character could have moved along. This is represented by adding route segments that are fading out with increasing distance from the waypoints (Figure 5b). Optionally, interpreted and plausible points can be visualized by adding small fuzzy points (Figure 5b). Further information, like the direction of the movement, is shown with small arrows as soon as the route segment is long enough (Figure 5c). An unknown start or end (the character appears or disappears) is represented with three concentric circular arcs that spread orthogonally to the route (Figure 5c). Additional interactivity enables information retrieval about who is making the journey and the text immanent points provide more information about each visited location.

#### Reference to reality

As previously described, some spatial entities (settings, projected spaces and zones of action) are analysed with regard to their strong or faint reference towards geospace (see also Table 2: relations between literary space and real space). Four main categories: imported, transformed, invented or imagined, are applied along one scale. These categories indicate how closely the fictional space depends on the geospace (based on Zipfel, 2001, conceptualized by Piatti, 2008). The quadripartite concept of close and far according to 'close to reality', 'transformed reality', 'far from reality' and 'no relation to reality', is realized by using colours as shown in Figure 6. Taking the idea of distance literally, one finds similar attempts in defining colour schemes for relief maps within the cartographic research field. In his major book *Cartographic Relief Presentation*, Imhof (2007) argues that 'an impression of far and near or high and low is induced by depicting colours by their intensity, brightness and contrast.' Furthermore he noticed, 'Yellow is the brightest colour. [...] Every other colour, even saturated red, appears darker'. He refers to a familiar natural phenomenon, the so-called effect of aerial perspective, where the surface hues in the foreground are very rich in contrast and colour. 'With increasing distance, however, [...] contrasts become weaker and weaker, the hazy appearance of all colour tones rises'. According to Imhof's insights, bright colours should be selected for far objects. We developed two colour sets in order to distinguish between settings (where the character is present and real) and projected spaces (spaces which a character thinks of, without being physically present, just mental). We chose dark, saturated colours with high contrast for close objects and bright, saturated colours with low contrast for distant objects. The colours of both scales for settings and projected places (Figure 6:  $x$ -axis) should be visually equidistant so that the individual colours are visually classified to the same reference layer (Figure 6:  $y$ -axis).

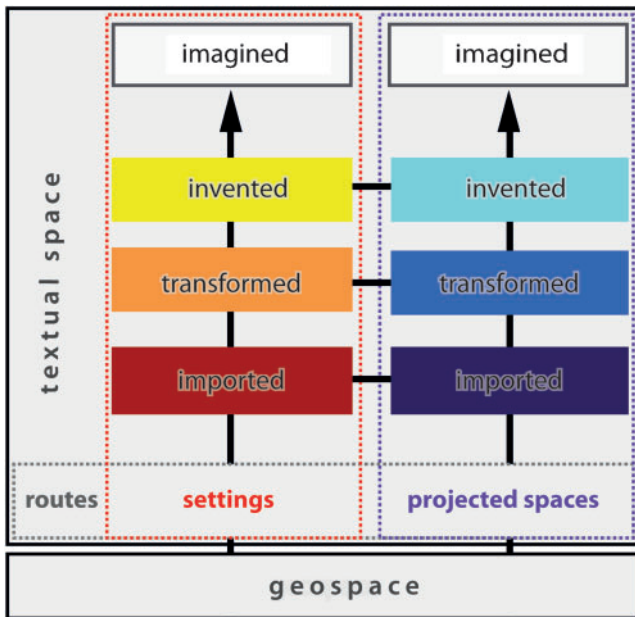


Figure 6. Colour coding scheme indicating the level of abstraction between geospace and textual space

Since we are already using transparency and gradations for the visualisation of uncertainty, we now require different colour hues. These should allow a clear distinction between both colour scales and the three levels of abstraction. The Munsell colour scale provides a sound basis to approach this problem. Albert H. Munsell developed a perceptual colour scale, which is based on how we see differences in relative light and not on a strict set of mathematical values. In his system, the colours are arranged perceptually uniform, i.e. the distances between each neighbour colour are perceived equally (Stromer, 2002). Based on the Munsell scale, two bright colours (yellow and cyan), arranged on the upper end of his colour tree, are chosen to represent invented places, far off reality. In just the same way, two colours (red and purple) were chosen from Munsell’s scale for imported places, representing the ‘closeness to the reality’ (arranged on the

lower end of Munsell’s tree) with very rich contrast as Imhof noted. Finally, for the abstraction level ‘transformed places within fiction’, we chose orange and blue, two intermediate colours approximately equidistant from the previously selected extremes. Of course, it is not possible to localize and consequently show imagined places on the map at all, so for the sake of completeness and in order to follow the logic, we accordingly added a category with ‘no colour’ (white). The theory of colour psychology distinguishes between ‘warm colours’, red–orange–yellow and ‘cold colours’, purple–blue–cyan. Thereby, warm colours stand for closeness, reality and tangibility, whereas cold colours stand for remoteness, mental activity and intangibility (Heller, 2005). Here again, the chosen colours can be assigned to literary objects in a metaphorical sense: the figure is present (close, real) within settings (warm colour scale), whereas figures are only thinking of a place with a spatial distance (far, mental) within projected places (cold colour scale). Furthermore, the colour system (Figure 6) also determines the colour for routes. Routes are simplified to have either a projected nature when the character is following a route in their mind (purple colour) – or, it has the nature of a setting (red colour) if the character is actually travelling on this route.

In fiction, there are a large number of different examples where the author transformed the real geospace. We now describe visualisation strategies for shifted and synthesized spaces. A shifted place is a fictional space that has a real counterpart, but has been shifted to a new location. Synthesized spaces are complex spatial constructs, which are created by the author by synthesizing two or more spaces to a new, third space (see Table 2 for example). In both cases, it is necessary to assign two or even more geometries to such an individual setting: the location where it is set within the story and the real-world counterpart. The visual implementation of shifted places is shown in Figure 7 (left). Both geometries are shown on the map using the symbolism described previously (fuzzy shapes and indeterminate locations). Thereby, it is possible that a place can be depicted precisely in the reality, whereas in the text, the new position is only given as uncertain, indeterminate location (such as a well-known building that

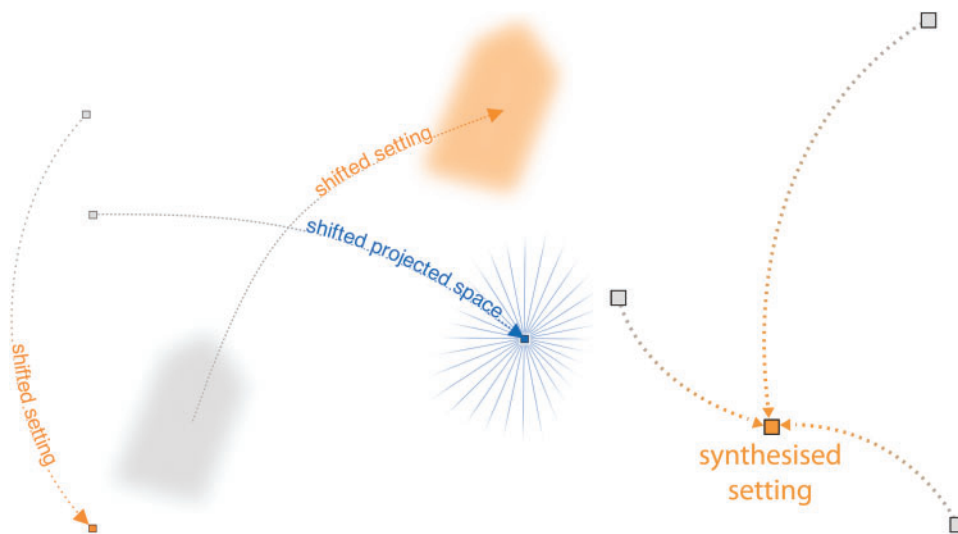


Figure 7. Visualisation of spaces that are shifted (left) or synthesized (right) in relation to their real-world counterpart

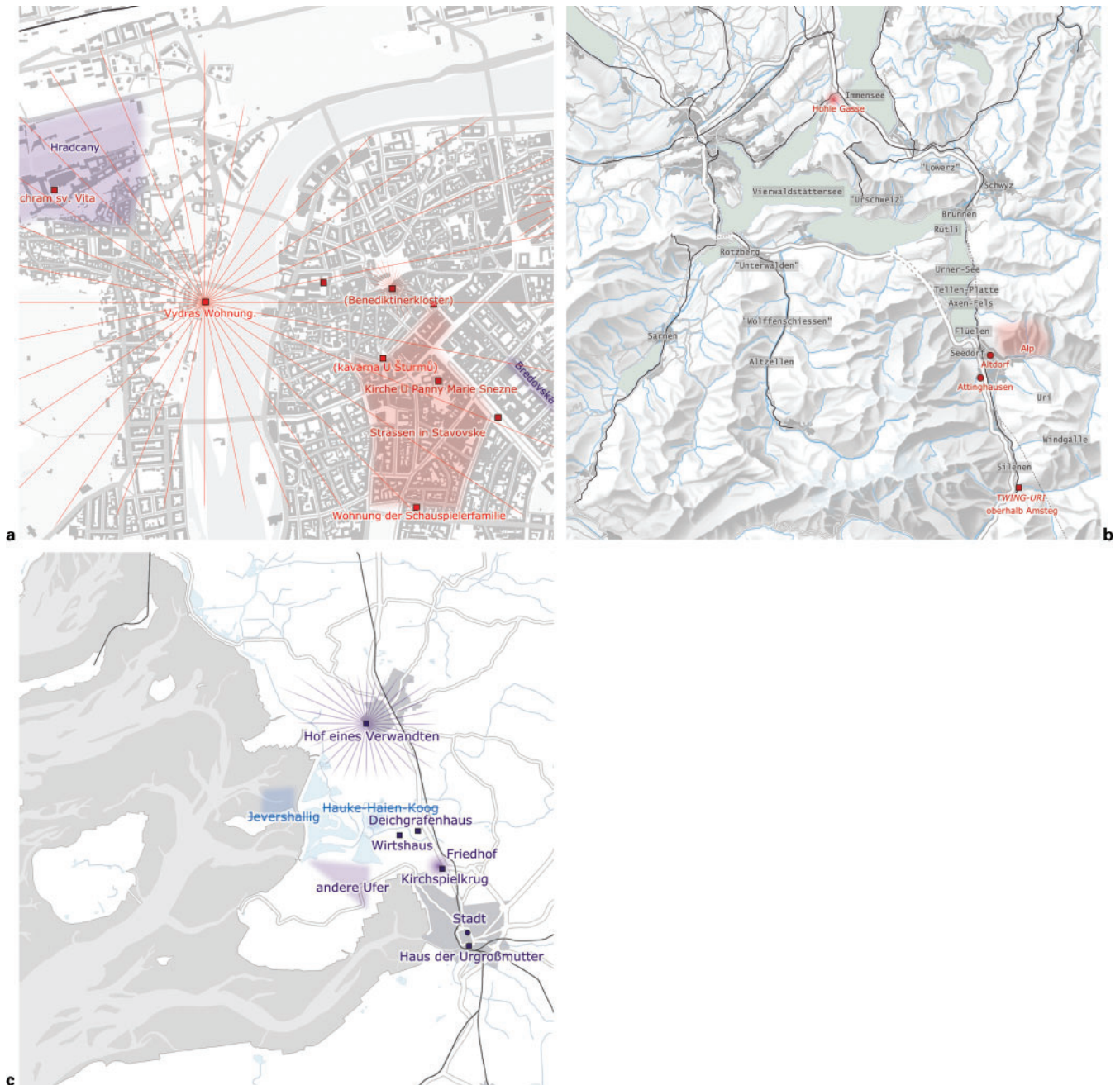


Figure 8. Single-object maps of individual texts of all three model regions: (a) historical fiction: Alois Jirasek: 'F.L.Vek' (1907) (main settings in model region Prague), (b) epic: Max Frisch: 'Wilhelm Tell für die Schule' (Wilhelm Tell: a School Text) (1971) (main settings in model region Lake Lucerne), (c) novella: Theodor Storm 'Der Schimmelreiter' (The Rider on the White Horse) (1888) (main settings in model region Northern Frisia) (literary text analysis carried out by M. Frolíková, B. Piatti and K. Winkler)

is shifted to a new town district). According to the colour coding system, the transformed space's location geometry is depicted in orange (for a setting), or blue (for a projected space). In contrast, the counterpart within geospace to which the shifted location within the textual space refers, receives a grey tone like the base map for guidance. In order to illustrate the connection between both spaces, a directed Bezier curve is drawn from the geospace to the fictional place, which is labelled and drawn with a colour gradient from grey to orange/blue. The visual implementation of synthesized spaces is done similarly. However, instead of a single directed

line, it displays a net with a central point towards which all the Bezier curves run together (Figure 7, right).

#### EXAMPLES OF SINGLE TEXT MAPS AND SPECIFIC TOPICS

The above-described visualisations are implemented into a web-based atlas information system, the *Literary Atlas of Europe*. It can also be referred to as a Multimedia Atlas Information System (MAIS), since it fulfils most of the

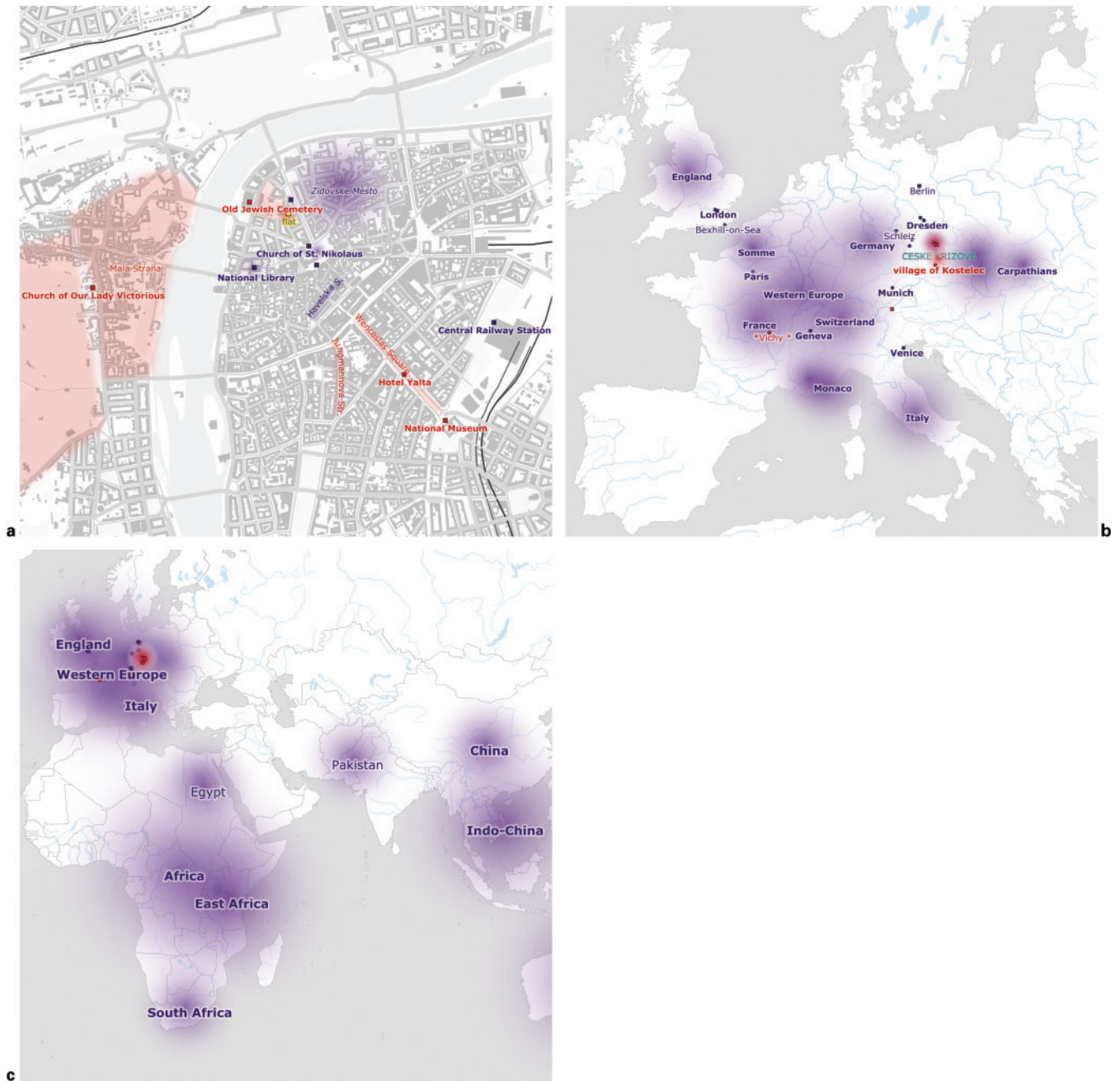


Figure 9. Scale-dependent single object map of the novella 'Utz', Bruce Chatwin (1988): (a) detailed distribution of literary spaces in Prague, (b) European wide distribution of literary spaces, (c) part of the worldwide distribution of literary spaces (literary text analysis carried out by M. Frolíková)

characteristics of MAIS as it is defined by Hurni (2008): 'systematically targeted collection of spatially related knowledge in electronic form and allows a user-oriented communication for information purposes. Furthermore, [...] it mainly consists of a harmonised collection of maps with different topics, scales and from different regions. It disposes of special interactive functions for geographic and thematic navigation, querying, analysis and visualisations in 2D and 3D. Unlike in many geographic information systems (GIS) applications, the data in MAIS is cartographically edited and the functionality is intentionally limited in order to provide a user-targeted set of data as well as adapted analysis and visualisation functions'.

In the following, a small selection of map examples were chosen to demonstrate our visualisation techniques and to show an overview of the different model regions and map scales. These automatically rendered maps are integrated into the MAIS, enabling geographical and thematic map navigation, as well as interactive functionality to provide all attribute information for each spatial entity. Figure 8 shows a representative map example of each model region with settings of a single text. The literary spaces within the model regions are depicted in detail, so scholars can compare different literary texts within the same model region. To allow investigation of the complete spatial expansion of a text, the user can change the zoom level and obtain a

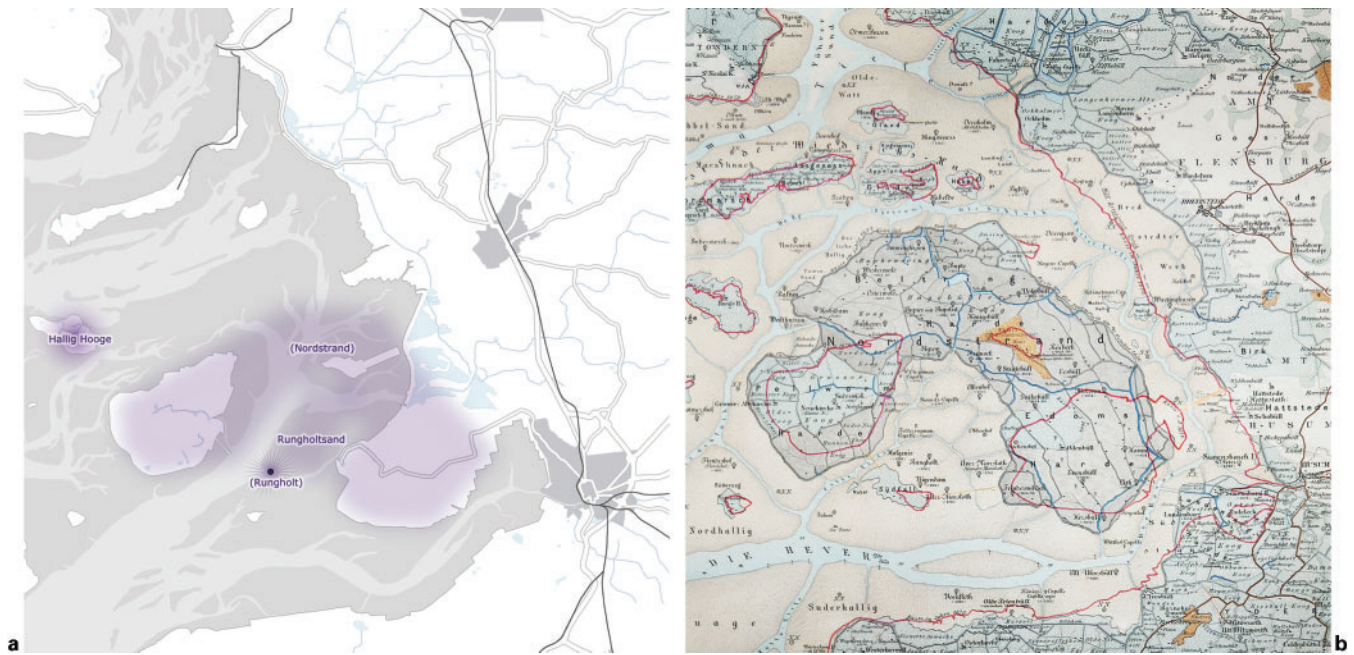


Figure 10. (a) Epic: Ernst Adolf Willkomm 'Erzählung eines Wattenschiffers' (Narrations of a mudflat skipper) (1860) (literary text analysis carried out by K. Winkler), (b) historical map (map during 1643–1646 with an overlay of the coastlines in red from 1878)

different level of detailed, up to world maps. Figure 9 shows three zoom levels of the same novella 'Utz' written by Bruce Chatwin in 1988, with its scenes distributed across the world. To realize different map scales, objects are depicted through an attribute that approximately indicates the geographical entity, such as continent, country, region, town/island, suburb/street and building. As the geospace has changed significantly over the last centuries, it is necessary to use historical map data to analyse historical texts. The short epic 'Erzählung eines Wattenschiffers' by Ernst Albert Willkomm for instance, which is written in 1860, talks about the historical, disappeared island 'Nordstrand'. A contemporary map could misdirect the map-reader, although brackets around the toponym indicate the disappearance of the location (Toponym 'Nordstrand' in Figure 10a). A comparison with historical maps needs to be done in such cases. For this reason, several historical maps from all three model regions were collected and georeferenced. The user can interactively select the required historical map, for instance, from the time the story is set or from the time the author worked on the fiction (Figure 10b).

A further step towards a complex analytic evaluation of spatial literary data can be seen in Figures 11 and 12. Here, the maps do not show the spatial situation of a single text, but compilations of spaces with the same attribute, taken from different texts and different authors. Figure 11 shows spaces in the region of Northern Frisia with protagonistal-physical properties from all entered data. Every fictional space, without exception, is located close to or on the water. Only by means of this map-result, a clear statement can be made: within the coastal model region, the strength of the water plays a crucial role in literary texts and often also leads to the death of the characters. Figure 12 shows a composition of all spaces used by Theodor Storm (based on 35 analysed texts). Analysing the map, one can observe that

this author often refers to the same spaces within his novellas and short stories and concentrates on a small, local radius. This example also demonstrates the limits of the presentation of single-object maps: single objects overlap and obscure each other. As soon as a large accumulation occurs at a certain location, a statistical approach is necessary to be able to draw conclusions about the frequency and density of a literary space. This approach results in literary maps showing statistical surfaces.



Figure 11. Protagonistical – physical spaces within the model region Northern Frisia

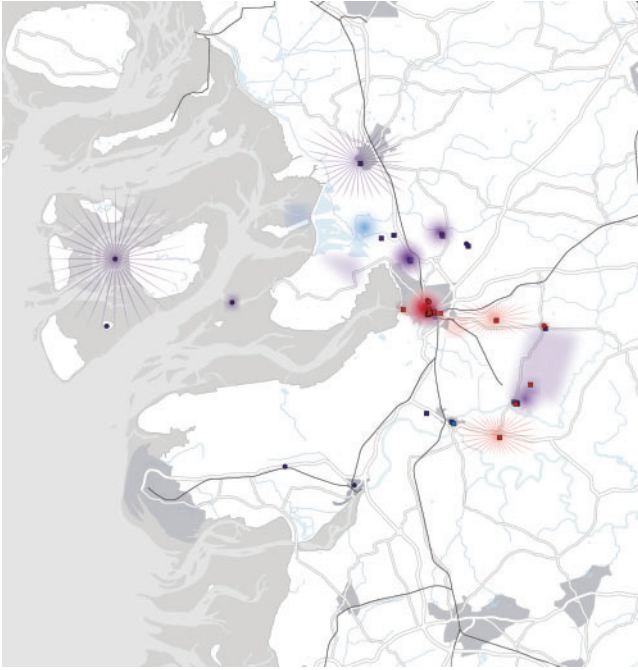


Figure 12. Distribution of all fictional spaces within texts of Theodor Storm, model region Northern Frisia

### SUMMARY AND CONCLUSION

Fictional space is the spatial element within literary texts and the object of research in literary geography studies. By means of literary cartography, patterns and tendencies of the entire text corpus, of an author, of a genre, a motif or an epoch can be explored, detected and communicated. By using cartographic visualisations, it is possible to meet the needs of the scholars and develop appropriate implementations for data capturing and visualisation methods that reflect the inherent rules of narrated settings: these are fragmentary, have uncertain boundaries or even an indeterminate location and are sometimes transformed or remodelled by the author.

To achieve this goal, we first detailed how individual spatial entities are defined and which data are collected in order to visualize the settings and to provide a substantial, extensive data analysis functionality. After having stated the variety of uncertainty sources in literary geography, the necessity of using uncertainty visualisation for achieving appropriate visualisation methods is evident. Uncertainty visualisation was thereupon tested on several spatial entities, and aims to present the characteristic of the literary spaces intuitively. Subsequently, the suggested uncertainty visualisations were implemented and led to digital, automatically rendered and interactive single spatial objects maps. As a result, an MAIS is now available, where the entered data can immediately be presented on an interactive map or integrated into the spatial analysis.

Even when almost every fictional text is linked to an existing, recognisable place, the development of standardized categories and automated visualisations for the Literary Atlas of Europe was a significant challenge. The different functionality of fictional places (just mentioned versus main-setting of the plot) and the different accuracy

(realistic, indicated or even camouflaged) are not always clearly determinable. Additionally, the range of varied extents of places that are used reaches from detailed descriptions of houses that are used reaches from varied descriptions of places that are used reaches from vague indications of large regions, countries or continents. This means that the visualisation of all different kind of data is not possible in a single map scale, on one single view. A user always needs to be able to adapt the map-scale interactively. Fictional places that could not be classed into one of the defined references to reality or those that could not be grasped with coordinates remain uncategorized or even unvisualized. It may even happen that whole fictional texts remain unmappable. In such cases, the scholars cannot utilize a detailed spatial breakdown of the fictional space. Not all of the recognized characteristics could be integrated so far. For instance, it is often the case that a spatial object changes its function throughout a text. At the beginning, a place is just mentioned (marker), then serves as place of action (setting) and finally appears again in the memory of a character (projected place). In our current implementation, only one of the functions can be visualized at the same time. Overall, we can conclude that with the current differentiation and specification of spatial objects, the Literary Atlas of Europe takes a pioneering role. Supported by the uncertainty visualisation, quite detailed conclusions can be drawn to the individual original text and enables further investigations concerning the coherences between the literary geography, the real space, the individual authors and natural, historical or political influences.

### BIOGRAPHICAL NOTES



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