

# Digital Approaches

Christoph Purschke

## 6.1 Introduction

The story of digitality and its impact on culture has been told many times. Often, the focus is on society in the digital age (Reckwitz 2017) or digital culture (Miller 2020), on specific aspects of practice like online dating (Rudder 2016), affordances of social media networks (boyd 2010), constructions of the self online (Turkle 1997) or via self-tracking and quantification (Lupton 2016), or the development of surveillance capitalism (Zuboff 2018). For linguistics, Léon (2021) has shown how the development of computation has led to the rise of computational approaches to linguistic analysis, including present-day applications like chatbots or machine translation.

In sociolinguistics, there are two approaches to digitality, in close contact with Computational Linguistics and Linguistic Anthropology. On the one hand, countless studies examine digital communication often concerning English (Page et al. 2022). On the other hand, “Computational Sociolinguistics” (Nguyen et al. 2016) has developed into a methodological approach investigating social aspects of language use computationally. A third perspective on digitality engages with quantification as a cultural technique, focusing on categorization and establishing cultural “orders,” for example, in scientific or everyday taxonomies (Bowker and Leigh Star 2000). This is also linked to the quantification and datafication of culture (Kitchin 2014).

In what follows, I use all three aspects of digitality as starting points for discussing digital approaches and ways to approach the digital in Linguistic Landscape (LL) research. In doing so, I understand *digitality* as:

- a) *practical*: an *object of investigation for research* (e.g., online social practices and their mediatization through digital platforms),
- b) *methodological*: a *resource for research methodology* (e.g., the development of digital tools for data collection and visualization), and
- c) *analytical*: a *cultural technique of categorizing phenomena* (e.g., analytical taxonomies for researching social practices).

Digitality as a perspective on human culture (Stalder 2019; Noller 2022) is also linked to auto-reflexive access of society to its latent or manifest structures (Nassehi 2019). From an analytical perspective, the concept represents a particular case of the functional paradigm: “We thus do

not recognize ‘the objects’—as if they were already previously and independently given and *determined as objects*—but we recognize *objectively* by creating certain demarcations within the uniform course of experiential contents and by fixing certain permanent elements and linking contexts” (Cassirer 2000: 328; markup in original; my translation).

Digitality can thus be described as a form of practice that, socially as well as technically, produces digital (and digitizable) structures, is grounded in the use of socio-technical artifacts while establishing them as a means of analyzing its social and technical preconditions. As such, the functionalist paradigm aligns with an understanding of the social world as a “mediated construction” (Couldry and Hepp 2017), that is, constructed by humans through socio-technical media. In the same vein, the scientific analysis of human practice is conditioned by the cultural and technical requirements for manufacturing measuring instruments (Janich 2015), for example, digital tools and taxonomies for data analysis.

A functional approach can be aligned with the theoretical foundations of LL research, for instance regarding the interactional and material forms of “linguistic place-making” (Scollon and Scollon 2003), the role of the audience for “meaning-making” (Spolsky 2009; Ben-Rafael, Shohamy, and Barni 2010), or the understanding of LL as “semiotic landscape” (Jaworski and Thurlow 2010). It also highlights the fundamental importance of form-induced *salience* and purpose-driven *pertinence* for the individual engagement with the LL (Purschke 2021) and extends it to its epistemological (re)construction.

## 6.2 Evolution of the field

The engagement of LL research with forms of digitality has taken place in several waves. First, the development of methodological tools for data collection, processing, and analysis runs parallel to their technological foundations (Halfpenny and Procter 2015), for example, digital photography, mobile communications, geolocation tracking, and geostatistical mapping. Large parts of LL research have only become possible due to the ubiquity of digital devices that collect, store, and transmit LL photography and metadata. The second form of digitality, namely categorization systems for classifying observations, has unfolded since the beginning of the study of LL, with an increased interest in taxonomies since the early 2010s. In contrast, engagement with practical forms of digitality has played little role in research referring to the term LL.

### 6.2.1 Digital approaches to data collection and analysis

Since the beginning of LL research, photography has played a central role. This is especially true for quantitative approaches that often assemble large corpora of images. For example, Backhaus (2007) conducted large-scale photo collection in the surroundings of subway stations in Tokyo. The advent of digital cameras and, later, mobile phones with ever-increasing storage space, high-speed data connections, and capable onboard cameras, has paved the way for digital data collection (see Barni 2008 for an early account). Additionally, cameras and phones are usually equipped with GPS modules enabling instant localization. The launch of *Google Street View* in 2007 marked the first global network of street-level images that can be harnessed for analysis (Curtis et al. 2013; Hong 2020). While most studies in LL research are based on pictures, there are also attempts to use video (Troyer and Szabó 2017) or mobile eye-tracking (Vingron et al. 2017).

The availability of digital photography, GPS-based localization, and digital databases has decisively expanded the spectrum of methods. This concerns the online curation of large-scale collected corpora, for example, in participatory projects (see Section 6.2.3), but also geostatistical mapping for data analysis (Buchstaller and Alvenides 2017). Thanks to modern machine learning (ML), text extraction and analysis tools are also available for image processing (Gilles and Ziegler 2021).

### ***6.2.2 Digitizing the LL through analytical taxonomies***

Quantitative approaches have a long tradition in LL research (Gorter 2013) but are losing ground in recent years to more qualitative and ethnographically informed approaches (Blommaert and Maly 2014). In contrast, the specific analytical potential of quantifying approaches must be considered (Lyons 2020). Blackwood (2015) argues for combining qualitative and quantitative methods, and Gorter and Cenoz (2023) give a detailed methodological account. Quantitative methods seem primarily suited for exploratory analysis and macro-level modeling of datasets. Especially in projects with large image collections, the statistic assessment of the data is an appropriate means to provide an overall view and identify trends in the dataset. At the same time, qualitative approaches bring advantages for in-depth analysis of smaller datasets. The same distinction applies to the data types that can be easily combined with the respective approach.

What qualitative and quantitative methods have in common is that they mainly operate based on categorizations which are derived differently depending on the methodological approach, that is, explicitly using predefined analytical taxonomies (quantitative default) or implicitly through content analysis (qualitative default). Theoretically, the difference between these methodological poles can be seen as one of “methodological order” (Dingler 1987) in establishing categorizations for analysis either by using variable-based models that abstract from individual cases (quantitative default) or case-based models that abstract from individual characteristics (qualitative default; Borgstede and Scholz 2021). In this sense, categorization can be seen as a form of “digitizing” the LL by establishing an analytic grid used to capture and explain the variation found.

Research in LL has seen many attempts to develop analytical taxonomies, mainly against the backdrop of quantitative methodology, to categorize different aspects of the appearance, emplacement, or social embedding of signs. While some taxonomies are well established in the literature, stemming from studies like Scollon and Scollon (2003), Reh (2004), Ben-Rafael et al. (2006) or Backhaus (2007), there are also newer attempts to extend the analytical lens. For example, Auer (2010) introduces a functional differentiation, Blommaert (2013) focuses on sociocultural aspects, Schmitz and Ziegler (2016) analyze “visual discourses,” Amos (2017) examines hierarchies in signs, and Wachendorff (2021) introduces typographical aspects to the analysis of LL.

### ***6.2.3 Digital practices and spaces as an object of investigation***

Studying digital social practices and virtual spaces has played a subordinate role in LL research so far. The interest in digital culture and linking online and offline practices began comparatively late. Ivkovic and Lotherington (2009) use the label “virtual linguistic landscapes” for the description of the digital equivalent of physical LL. Troyer (2012) coins the term “linguistic netscape” using the example of multilingual Thai online newspapers to extend the notion of LL to the online world. And Kallen, Ní Dhonnacha, and Wade (2020) discuss the blurry boundaries

between online and offline language identity work in the “online linguistic landscape.” Other studies like Reershemius (2018) and Bloomaert and Maly (2019) investigate the interplay of offline and online aspects in the LL, for example, QR codes or URLs in public signage.

Online place-making discourses represent another line of investigation, for example, the Mission District in San Francisco and its digital representation in Instagram posts, for which Lyons (2019) proposes the term “phygital” as blending of physical and digital aspects of social practices, or Blackwood (2019) using the example of the Paris Orly airport as a source for online self-representations. Other researchers examine the intertwining of online and offline practices in political contexts such as the “Unite Cyprus Now” protests (Themistocleus 2021) or the “Occupy Wallstreet” movement (DeLuca, Lawson, and Sun 2012). Theoretical extensions can be found at interfaces with other fields, for example, in Computer-Mediated Communication (Androutsopoulos 2014), Discourse Studies (Sergeant and Giaxoglou 2020), or Digital Ethnography (Yao 2023). Beyond LL research, the analysis of digital and online practices has developed into a mainstream paradigm of scholarly work, be it in Digital Anthropology with a focus on the social, political, and ideological implications of digitality (Horst and Miller 2012), Computational Linguistics and NLP that primarily harness statistical computing methods for data modeling and the analysis of online interactions (Farzindar and Inkpen 2015), or in related disciplines like Sociology that explore the structural interplay of social practices and the affordances of digital media (Lupton 2015).

## **6.3 Main research methods**

### **6.3.1 Digital (visual) data collection methods**

Arguably the primary method of collecting data for LL research is using digital devices, either cameras or smartphones, to capture images. This applies to both strongly quantitative (Soukup 2016) and qualitative approaches, which often combine ethnographic methods and photo data (Hayik 2017). In this way, large-scale corpora can be assembled to document and analyze a LL’s socio-semiotic complexity (Ziegler et al. 2018). Participatory projects using mobile research apps also work with images as a means of communication with the public (see Section 6.3.3), partly because this type of data is relatively easy to collect through crowdsourcing. Methodologically, all these approaches are linked through using digital devices to capture still images, optionally with or without GPS localization. Data are stored digitally, either locally on storage media or in private or public image repositories. In addition, databases are used for sorting, tagging, and analyzing the images, either for project-specific purposes (Mühlán-Meyer and Lützenkirchen 2017) or via a public repository (Purschke 2020).

With the development of commercial social media platforms such as *Instagram* or *flickr*, additional sources of data have emerged that can be harnessed using computational methods and analyzed, for example, in the context of posts about places of tourist interest (Lyons 2018). In addition, interactive virtual representations of LL in commercial applications such as *Google Street View* provide opportunities to collect and analyze images worldwide without visiting the relevant locations. Manual data extraction methods via screenshots are used (Low 2022), also extending to teaching contexts (Yusuf 2022). Still, automated image extraction for a defined geographic area is also possible (Scamehorn 2017). This method also opens new possibilities for the systematic analysis of the temporal dynamics of LL, despite limitations regarding the quality of the available images.

Other forms of visual input material have yet to be considered systematically in LL research. Troyer and Szabó (2017) discuss using videography as a methodological means against a theoretical framework of “visual representation.” Leimgruber, Vingron, and Titone (2020) report on using mobile eye-tracking devices to capture LL perceptions in field experiments. And Heyd (2014) explores folk-linguistic photo blogging as a source for researching online practices of enregistering language ideologies.

### 6.3.2 *Geolocation and mapping*

Tools for mapping, visualizing, and analyzing datasets form the second strand of digital applications. The term “mapping” is ambiguous in the field in that it not only refers to the geographical projection of data points onto a spatially defined plane using different means of visualization and based on a thematic interest (Hake, Grünreich, and Men 2002) but is also used as a collective term for different types of descriptive analysis (Nikolaou 2017). In the following, I will only discuss the first notion. To be remembered is the analysis of research data using statistical software such as *Microsoft Excel*, *SPSS*, or *r Studio*, which are particularly suitable for larger corpora, that is, for creating tables with frequency distributions or diagrams for trend visualization.

With the rise of digital photography and geographic information systems (GIS), LL research quickly picked up on these techniques. The work of Barni and Bagna (2006, 2009) represents an early example of combining digital cameras with a laptop running dedicated GIS software for localizing and annotating images directly in the field. With the advent of powerful computers and smartphones and the development of digital and social media, the conditions for digital methods have changed decisively. Even complex geostatistical applications can be operated on standard PCs, and smartphones have all the necessary prerequisites for capturing, processing, and displaying LL data in large quantities.

In recent years, there has been an increasing effort to incorporate digital technologies in LL projects. Buchstaller and Alvanides (2017) use geostatistical mapping to study remote LL on the Marshall Islands. Low (2022) collects street-level photos from *Google Street View* to examine the LL of a road in East Thailand, while Grzech and Dohle (2018) introduce a user-generated map of language items in the LL for use in Critical Discourse Analysis, and Väisänen et al. (2022) combine the analysis of social media data from Twitter with population register data for the Helsinki metropolitan area to map linguistic diversity. Similarly, Lu, Martens, and Sayer (2022) examine the intersection of multilingualism and social class in Columbus, Ohio, combining GIS and census data to increase representativeness. In a multi-method approach, Saiz de Lobado García and Revilla Guijarro (2019) combine the analysis of press corpora with geostatistical mapping via *Google Maps* and the use of story maps that allow the enrichment of localized items with narrative and multimedia elements. And Buchstaller et al. (2020) explore the language–ideology–power nexus in Annaberg-Buchholz, Germany, via combining spatiotemporal analysis and visualization techniques with ethnographic interviews and Critical Discourse Analysis.

### 6.3.3 *Crowdsourcing and participatory research apps*

In the last ten years, a participatory paradigm has emerged in linguistics that uses crowdsourcing (Brabham 2013) and Citizen Science (Strasser et al. 2019) to collect data. At the same time, many projects also explore participatory approaches in direct exchange with the public (Leemann and Hilton 2021). In LL research, two participatory projects have paved the way for the crowdsourced

collection of LL data with mobile research apps and analysis via digital means, *LinguaSnapp* (Gaiser and Matras 2016) and *Lingscape* (Purschke 2017a).<sup>1</sup>

Both projects offer dedicated mobile apps that researchers and the public can use to upload images to a platform with annotations. In doing so, they differ regarding their methodological purposes (local vs. global focus, complex vs. simple data model, focus on analysis vs. focus on user activity). Purschke (2017b) compares the two projects and discusses the Citizen-Science rationale of *Lingscape*. Both projects use geostatistical mapping to display and analyze the collected data interactively. At the same time, the projects differ in terms of their technical infrastructure. *LinguaSnapp* is available as a stand-alone application for reuse that has seen some satellite projects in Jerusalem, St. Petersburg, Melbourne, Estonia, and Hamburg (Gaiser and Matras 2021; Androutsopoulos 2021). Contrary to this, *Lingscape* is designed as a central platform and image repository and has enabled more than 250 satellite projects since its launch (see, e.g., Clausen 2018; Kalocsányiová, Essex and Poulter 2021; Carreira et al. 2022). For every satellite project, an individual set of analytical taxonomies and language labels can be selected, as well as specific settings for image visibility and moderation of contributions.

From a methodological perspective, app-based approaches to LL research offer several advantages and challenges (see Purschke (2021) for a discussion). For example, in addition to high-resolution cameras and fast data connections, modern smartphones offer automatic image localization. Hence, with the help of mobile research apps, data processing can already partly be done during fieldwork. Participatory projects also allow for diverse perspectives in collaboratively (re)constructing the LL of specific locations or can serve as a didactic tool in the classroom for exploring multilingual environments (Purschke 2018). However, material preparation, participant outreach, and the dissemination of results require significant time and effort. Maintaining participant motivation and addressing data quality and reliability concerns are crucial. Balancing user-friendliness with data optimization, and personalization while ensuring data privacy are ongoing considerations. Additionally, project work might be impacted by open-access policies and self-financing. On top of the crowdsourced data analysis, one exciting addition is the possibility of analyzing user participation patterns and individual spatial orientation strategies when using a mobile research app for data collection (Purschke 2020).

#### 6.3.4 Other digital approaches

There are also attempts to apply methods from ML to LL research. So far, these have played a minor role but they hold great potential for data annotation and analysis. This concerns harnessing social media data for geospatial analysis (Hiippala et al. 2019), combining it with a classical LL data collection (Lyons and Soukup, this volume), or the automatic recognition of text and objects in images to make them accessible for large-scale analysis (Gilles and Ziegler 2021).

ML methods hold great potential, especially for large collections of LL images, for example, for model-based annotation and image content analysis (Bhuyan 2019). While the current state of the art in computer vision reaches high levels of accuracy for language detection and optical character recognition, object detection, semantic analysis, and especially feature classification still face substantial challenges, despite rapid progress in ML. From a LL perspective, one avenue to explore could be using richly annotated datasets to train a model for classifying LL items. This could also be achieved through crowdsourced annotations, for example, in participatory projects.



On a smaller scale, the use of mobile phone technology already allows the identification of text in images, making it possible to perform tasks like language detection and translation during data collection.

## 6.4 Original research

In this section, I will use the example of the *Lingscape* data collected for the Vienna and Luxembourg LLs to demonstrate how the project digitizes LL research in three ways: (1) *methodologically* through the use of digital tools for processing data, (2) *analytically* through the use of taxonomies for data categorization, and (3) *practically* in the form of (re)constructions of LLs through a multitude of individual perspectives.

### 6.4.1 Digitizing the LL 1: The *Lingscape* app and platform

The *Lingscape* project is built around a free mobile research app for iOS and Android. The app has three core functions: an overview map, a photo upload process, and a project mode. Access to and use of the app are open and anonymous; no personal login is required, nor is any personal data collected. The in-app map shows all publicly available photos on the platform with metadata (languages and potential annotations). The photo upload function allows users to add new images to the map and annotate their uploads with additional information such as location, languages, or comments. Uploads are immediately published on the map to give users direct feedback and moderated ex post to ensure that no inappropriate material is publicly accessible. Users can also create nicknames in the app to claim authorship over their contributions.

A public photo repository is the second pillar of the project fulfilling two functions. First, all images and metadata are collected here and made available to the public. Second, the platform serves to manage satellite projects. Registered users can administer projects on the platform, including a customized list of languages, tailored annotation categories, working groups, and access passwords for participants. Project data can be publicly accessible or only visible to participants. Additionally, all publicly available data is published on an interactive web map using the geostatistical mapping service *CARTO*,<sup>2</sup> with analysis widgets that can dynamically visualize the data. For satellite projects, individual data maps can be generated for reuse in websites or publications.

### 6.4.2 Digitizing the LL 2: The role of analytical taxonomies

Per default, *Lingscape* uses a straightforward data schema that requires only basic information about each image (location, languages). However, individual annotation categories can be defined for projects where more detailed information is necessary. This refers to the list of available languages that can be adapted, as well as the use of additional taxonomies for annotation. Many of the taxonomies on the platform originate from the available literature (see Section 6.3.2); others have been created specifically for *Lingscape*.<sup>3</sup> New taxonomies for satellite projects can be created upon request. Given the central position of the platform and the fact that it offers a predefined yet flexible analytical grid to satellite projects, taxonomies are developed as universally as possible to ensure consistency across projects.

The role of these categories for defining the object of investigation can be illustrated by the language list. To have stable basis, *Lingscape* uses the ISO 639-3 standard, which represents languages via three-digit codes. It allows a relatively fine-grained systematization of linguistic

diversity up to the distinction of small varieties such as *Upper* and *Lower Sorbian*. Nevertheless, a standard by design excludes other varieties, for example, in the case of the German regional languages, of which only some (e.g., *Bavarian* and *Low German*) have their own codes. Additionally, the ISO labels often do not correspond to the names common in the population (Purschke and Trusch 2021). Similarly, satellite projects might handle the labeling of closely related languages differently, for example, for the South Slavic languages in Vienna, either the individual codes plus the generic label *AMB* (*Ambilinguistic*) for cross-linguistic items or the collective label *HBS* (*Serbo-Croatian*) are used.

#### 6.4.3 Digitizing the LL 3: How *Lingscape* users construct the unit of analysis

To properly frame the discussion of the data collected in *Lingscape*, it is vital to consider not only the quantitative aspects of their collection annotation. In addition, their qualitative relation to the object of study is essential. Since *Lingscape* relies on the support of a large group of (scientifically trained and untrained) contributors, special methodological conditions apply:

1. The data comprises many individual contributions, into which the respective purposes of satellite projects enter, as well as the personal perspectives of participants.
2. The composition of the data is dynamic and highly dependent on the specific research interest of satellite projects.
3. The epistemic structuring of the data partly depends on the annotation logic used in satellite projects, that is, on the taxonomies and language labels selected for data collection.

Since the resulting digital LLs are not true-to-life representations of a LL, Purschke (2020, 2021) introduces the term “linguistic crowdscape” (LC) for the collaborative (re)construction of LLs in participatory projects.

To illustrate how LCs can interest LL research, I will undertake a three-step analysis of the Vienna LC. First, I compare two snapshots of the crowdscape in terms of their linguistic shape to illustrate its composition and temporal dynamics. Second, I examine the corpus regarding the underlying concept of a prototypical sign. And last, I will compare the Vienna data with a snapshot of the Luxembourg City data in this regard.

a) *Composition and temporal dynamics*: In April 2019, we took a snapshot of the Vienna data for a comparative study examining the Luxembourg City and Vienna LC (Purschke 2020). In July 2022, a new snapshot of the Vienna data was taken. In this way, we can trace the composition of an LC in *Lingscape* over time. Table 6.1 shows the key figures for the structuring of the Vienna LC in 2019 and 2022.

The Vienna LC has changed in several ways, first purely quantitatively regarding the total number of images (increase of 54.3 percent in images with language labels). The average number of language labels per unit has moved slightly upwards. In contrast, there is a significant increase in the number of active satellite projects, both quantitatively and in terms of the qualitative changes associated with them. This can be seen in the presence of the most common languages: while the overall structure of the Vienna LC remains the same with a predominance of *German* and *English*, the contribution of secondary languages to the LC has changed drastically.



**Table 6.1** The Vienna LC Recorded in 2019 and 2022

|                                                                                                            | 2019                                                                                                                                                                   | 2022                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Images total</b>                                                                                        | 2,689                                                                                                                                                                  | 4,158                                                                                                                                            |
| —with language labels                                                                                      | 2,472                                                                                                                                                                  | 3,814                                                                                                                                            |
| <b>Active satellite projects</b>                                                                           | 8                                                                                                                                                                      | 15                                                                                                                                               |
| <b>Language labels per sign</b>                                                                            | 1.27                                                                                                                                                                   | 1.38                                                                                                                                             |
| <b>Most frequent languages</b><br>(of labeled signs, including languages<br>present in multilingual signs) | <i>German</i> (84.4%)<br><i>English</i> (26.6%)<br><i>French</i> (3.4%)<br><i>Italian</i> (3.0%)<br><i>Other language</i> (1.8%) <sup>4</sup><br><i>Turkish</i> (1.5%) | <i>German</i> (77.1%)<br><i>English</i> (27%)<br><i>Serbian</i> (10%)<br><i>French</i> (8.4%)<br><i>Croatian</i> (8.3%)<br><i>Bosnian</i> (6.4%) |

In 2019, the common secondary languages for a major city in the German-speaking world can be found (*French, Italian, Turkish*), mainly in commercial, specifically gastronomic contexts. Additionally, there are several images labeled as *Other language* that primarily show graffiti tags or nonlinguistic symbols. For the 2022 snapshot, it is noticeable that the secondary languages have been almost completely replaced, namely by *Serbian, Croatian, and Bosnian*. In methodological terms, it is the effect of two satellite projects that specialized in South Slavic languages in Vienna which documented primarily or exclusively such signs. At the same time, these projects highlight a part of public writing that had received little attention in the 2019 data. Compared to the secondary languages in 2019, South Slavic languages are mainly found in transgressive contexts, that is, on stickers, graffiti, or posters. However, the collection activity in these projects leads to a certain overrepresentation of these languages in the dataset compared to the actual urban picture. This is shown by the comparison of the Vienna LC with the data from the *ELLVIA* project (Soukup 2020), which, with a total of 11,408 items in the survey area, has, in addition to the primary languages *German* (67.7 percent) and *English* (30.7 percent), the expected secondary languages *French* (2.1 percent), *Italian* (1.8 percent), *Japanese* (1.0 per cent), and *Spanish* (0.9 percent), again mainly in commercial communication. Thus, the image of an LC in *Lingscape* is highly dependent on the contributions of the participating projects and does not necessarily give a representative picture of the underlying LL.

b) *The prototypical unit of analysis*: To develop a more precise understanding of the qualitative basis of the Vienna LC, I now analyze at the contributions of the participants involved in its creation. I am concerned with what constitutes the prototypical *unit of analysis* (Gorter and Cenoz 2023: 113–17) for the users of the *Lingscape* platform. To this end, I created a randomly drawn subsample of 415 images from the 2022 snapshot (10 percent of the data). About half of these stem from the app’s public photo collection (204 images) and half from specialized satellite projects (211 images). All images were analyzed manually and concerning the following characteristics:

- *Singular versus multiple items*: images that depict either a single (e.g., a sticker, a traffic sign) or multiple signs (e.g., various stickers on a streetlight);

- *Simple versus complex items*: distinguishes images that depict one or more spatially separate items (e.g., two posters on a canvas) or items with multiple layered elements (e.g., two stickers on a street sign);
- *Monolingual versus multilingual items*: images with one or more represented language(s);
- *Figure-ground relations*: images that show either the motif only (e.g., a street sign without background), a motif in context (e.g., street sign on a fence), or a context with embedded motifs (e.g., street view with several signs scattered across the image area).

Based on this analytical matrix, the following characteristics of a prototypical sign in the Vienna LC can be determined. Single items are depicted in 82.4 percent of the images, and only 17.6 percent contain multiple items, regardless of the content and form of the respective signs. A similar picture emerges for the simple and complex items: only 8.2 percent of the images show complex signs in which different signs are superimposed; 91.8 percent of the photos show simple items. Regarding the language distribution, two-thirds of all images show monolingual signs (68.9 percent); bilingual (20.5 percent), trilingual (3.9 percent), and multilingual (5.8 percent) signs make up the last third. The analysis of figure-ground relations in the sample shows that most images contain only the respective motif (88.0 percent); motifs with context (7.9 percent) and contexts with motifs (4.1 percent), in contrast, account for only about 12 percent of the dataset.

Regarding the question of what constitutes a prototypical unit of analysis in the Vienna LC, it can be stated: first and foremost, they are monolingual or bilingual signs that are recorded individually (no collages), without overlapping signs and without context. Thus, the Vienna LC is based on a comparatively simple concept of the unit of analysis, which only partially considers the spatial boundedness of signs, forms of semiotic layering, or sign assemblages. In part, this finding can be attributed to the technical options available in the app, for example, the option to crop selected motifs during upload. In addition, project-related specifications for the selection of motifs are also likely to play a role. Concerning multilingualism, the sociolinguistic makeup of Vienna as a German-speaking city is also expected to play a role in official writing and regarding the default language for other forms of writing.

c) *Factors influencing the prototypical sign*: This is evidenced, for example, by comparing the Vienna LC with the data for Luxembourg City. Identical to the Vienna dataset, a randomly sampled subset of 10 percent ( $n=192$ ) images from Luxembourg City was created (as of July 2022) and annotated using the same analytical matrix. Despite its smaller size, the Luxembourg data also differ regarding the urban area covered (smaller city size), the number of satellite projects involved ( $n=5$ ; 35 images), and the societal multilingualism of the underlying LL (French, German, and Luxembourgish as official languages).

The data reveal striking differences to the Vienna data. Regarding the distribution of simple (90.1 percent) and complex (9.9 percent) items, both datasets are very similar. Looking at single and multiple signs, however, the first differences become apparent: 71.3 percent of the Luxembourg images depict single items, while 28.6 percent contain multiple items, 20 percent more than in the Vienna sample. The figure-ground relations also show clear differences: while in the Vienna data, almost 90 percent of the images showed only the motif, in the Luxembourg sample, there are significantly more motifs with context (39.6 percent) and fewer motifs without context (55.7

percent) with a similar number of contexts with signs (4.7 percent). Finally, the differences are also clear in the language distribution, with 49.5 percent monolingual, 28.6 percent bilingual, 15.1 percent trilingual, and 6.8 percent multilingual signs in the Luxembourg City sample.

Regarding language distribution, the picture from the comparison of the two crowdscares in 2019 is confirmed (Purschke 2020): the Luxembourg LC is characterized by a significantly higher proportion of bi- and multilingual signs (50.5 percent) than the Vienna LC (21.1 percent). This reflects the difference between a primarily German-speaking city with many secondary languages (Vienna) and Luxembourg City, the capital of a country with complex societal multilingualism. This indicates a strong influence of the respective sociolinguistic situation on the prototypical sign of a crowdscape.

The other differences between the datasets point to influencing factors that are individually or project-specifically motivated. While the Viennese participants focus more strongly on single units and record them without context, the Luxembourg data show a stronger orientation toward images with multiple signs and an inclusion of the respective context, and this with an identical distribution of simple and complex signs. Without further information about the concerned projects and participant motivations, it seems difficult to identify causes for these different orientations (e.g., instructions given in the project, technical possibilities of the app, individual preferences when taking photos). Nevertheless, the comparison results clearly show that the orientation horizon for the unit of analysis in the collaborative (re)construction of a LC varies significantly depending on the context.

## 6.5 Conclusions

The study of LLs is directly connected to the history of digitality and its opportunities for data collection, analysis of digital practices, and classification in taxonomies. The discussion has shown how the development of digital analysis methods, particularly for image capture, geolocation, and mapping, parallels the development of digital technology. This parallelism is particularly evident in the development of digital photography.

The example of the *Lingscape* project illustrates how digitality provides an epistemological basis for work in several ways, that is, as a resource for providing digital research infrastructure for the project, in the form of taxonomies and categories for annotation, and in terms of the collaborative co-construction of digital “linguistic crowdscares.” It is possible to show how the prototypical unit of analysis of participants varies between different groups and in different sociolinguistic contexts, while still reflecting a traditional idea of *sign*.

Starting from here, potential extensions arise for LL research, primarily through the connection to neighboring disciplines such as Computational Linguistics, Discourse Studies, and Digital Ethnography. There are various points of contact, especially for the study of digital practices, as well as their interconnection with offline practices. For example, to the best of my knowledge, that are to date no studies that engage with *Virtual* or *Augmented Reality* as new sources of blended practices in the online–offline nexus. One possible new field of inquiry would be digital game worlds or “gamescares” (Magnet 2006), for example, regarding narrative (Jenkins 2006), ideological (Murray 2018), or linguistic (Kajszczarek 2023) aspects. The ideological grounding of discourses about online gaming (Smith 2016) in LL could also be fruitful as a line of investigation.

## Notes

- 1 <http://linguasnapp.manchester.ac.uk>, <https://lingscape.uni.lu>.
- 2 <https://carto.com>.
- 3 The complete list of taxonomies can be found at <https://lingscape.uni.lu/taxonomies/>.
- 4 The label *Other language* is used for signs where a user cannot determine the given language(s), where the sign contains languages not yet present in the app or where the sign does contain non-identifiable writing, for example, graffiti tags.

## Suggestions for further reading

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