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5 Linking and Access Structures

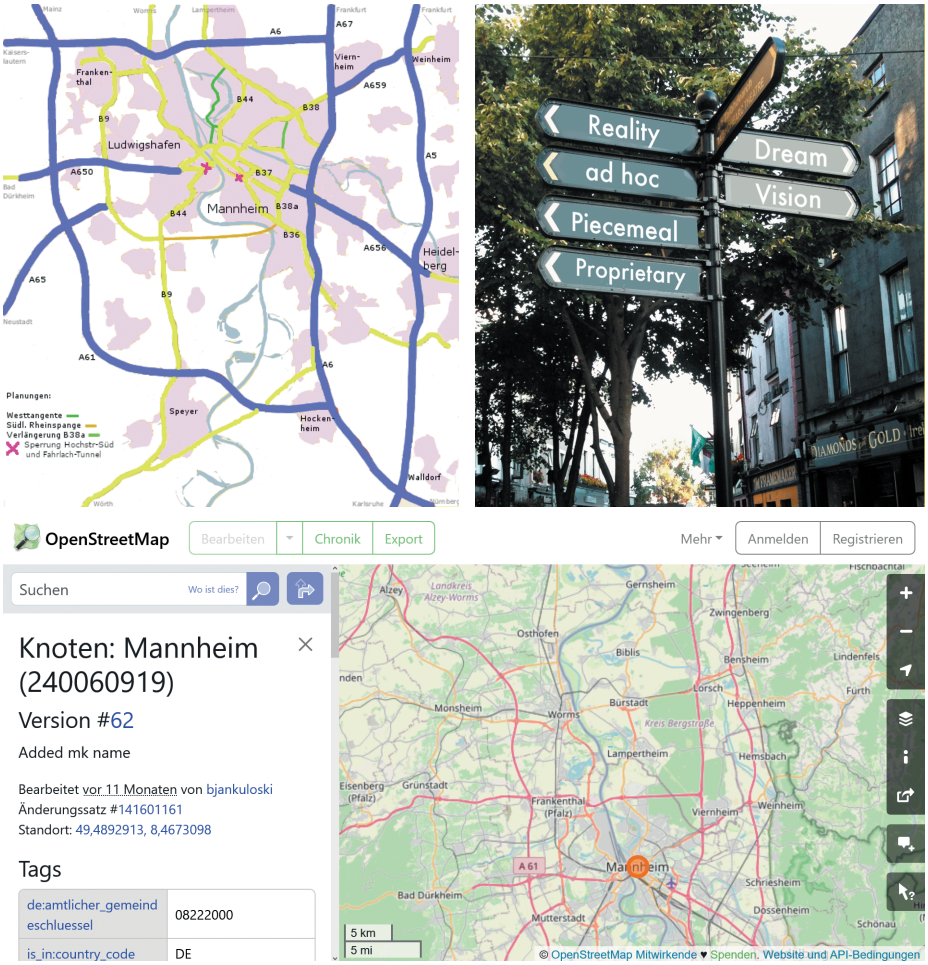

Fig. 5.1: Maps, town plans, and street signs.

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Lexicographic content interlinked within and between Internet dictionaries can be thought of as a network of streets. The streets connect different pieces of content in Internet dictionaries, thus forming the digital street network between different dictionary entries. The links in the user interface of a dictionary, from one headword to its associated synonyms for example, play an important role here as the main signposts by which users arrive, ideally, directly at their destination. Admittedly, this is not quite the same as reading a signpost in a street (cf. also Blumenthal et al. 1988). If you want to look up a place in an atlas, this can be done very conveniently online nowadays with the search function in digital maps. Direct access to dictionary content works in the same way. Here, there is a wide range of options for dictionary users to access individual pieces of lexicographic content.

5.1 Introduction

This chapter describes linking and access structures in Internet dictionaries. Linking refers to the navigation routes through a dictionary created by lexicographers. Hence, in many language dictionaries, headwords that can be used as synonyms in certain contexts are linked to one another, such as *smart* with *intelligent* or *bright*. This linking of content is mostly realised as hyperlinks, through which users are able to arrive directly at the destination of the networked connection. There have always been cross-references in print dictionaries; what is new in Internet dictionaries is that, in the best case, we only have to click once in order to reach our goal, instead of spending time leafing through pages. Whether in print or online, it is important for users of dictionaries to be able to find particular information in a direct way and as quickly as possible. Indeed, what all reference works have in common is that they are not read in a linear way, but that information is sought selectively. In this regard too, the digital medium offers a whole spectrum of possibilities.

This chapter is intended to provide insights into the whole field of linking and access structures. In the process, our aim is not to provide an exhaustive overview but rather to demonstrate, by way of example, which basic possibilities exist. In the first section, we explain what can be understood by linking in Internet dictionaries and how the level of data management differs from the presentational level. In the second part, we present the options for both semasiological (→ Section 5.3.1) and onomasiological access structures (→ Section 5.3.2). Finally, in → Section 5.4, we show what new impulses electronic cross-linking and access structure can offer for modern dictionary research.

5.2 Linking structures

The vocabulary of a language does not consist of individual words that exist as independent units, detached from one another. Rather, all of the elements of the lexicon are interconnected in multiple ways. Some words are used frequently with one another (like *dog* and *leash* or *smart* and *choice*); they can have (almost) the same meaning (like *smart* and *intelligent*) or are typically used in particular constructions (like *to make a smart move*). Yet, this web of words and the connections between them are difficult to represent in a general language dictionary, especially in two-dimensional print space. For that reason, the practice has developed over the centuries that in so-called semasiological dictionaries, the graphical form of individual words forms the access structure: that is, if you want to know something about the meaning of *smart move*, you know that, as a rule, you should look under either *smart* or *move* – at least in a general, monolingual print dictionary. In this way, the content relationships between the words are depicted by cross-references between individual dictionary entries (cf. Nielsen 1999; Engelberg/Lemnitzer 2009: 177f.). This type of organisation is not necessarily the "natural order of things" but rather a form of cultural practice.

While semasiological dictionaries start from individual words or groups of words, onomasiological dictionaries sit at the opposite end of the spectrum as they proceed from concepts or objects. For this kind of reference work, an alphabetically arranged index of words has to provide access to the concepts, at least if the work exists in print form. In Internet dictionaries, these different ways of accessing content are generally implemented digitally as search options. Hence, we will return to the distinction between semasiological and onomasiological access structures again in → Section 5.3.

The content-based relationships in the lexicon are represented in a language dictionary through cross-references based on the dictionary object. The term 'dictionary object' refers to the language and subsection of the language described by the dictionary (cf. Engelberg/Lemnitzer 2009: 272). These cross-references arise very frequently in print lexicography since, for reasons of space, some information is only marked in one place in the dictionary, even though it would be relevant in many places (cf. Wiegand 2002: 173). These formal cross-referencing requirements should occur relatively rarely in Internet dictionaries since the space for presenting data is substantially less restricted. Another type of cross-references is based on the intended dictionary functions (cf. Tarp 1999; Wiegand 2001).

All aspects of cross-referencing phenomena in print dictionaries are treated under the heading of *mediostructure* in dictionary research (Wiegand/Smit 2013). For digital dictionaries, we talk more generally of the linking structure (Müller-Spitzer 2007: 169f.; Meyer 2014). As a rule, the mediostructure of print dictionaries is analysed

by inspecting example entries from one or more dictionaries.[1] The basis of the data for this kind of analysis is a printed book from which information is gathered and classified by reading and cognitive analysis. The analysis of dictionary structure often proceeds in a similar way for digital dictionaries.[2] For example, this kind of research analyses which types of cross-references appear in a particular dictionary and how these are presented in the user interface, etc. However, it can also proceed in a completely different way when the basis of the data is formed of the entire digital database of a dictionary and when this data is evaluated using statistical methods. We show a brief example of this in our "Outlook" (→ Section 5.4).

The prerequisites for how many cross-references can be presented in an Internet dictionary are set in its data modelling (→ Chapter 4). Already at the end of the 1980s, the two different levels – data modelling and presentation – were illustrated in an essay using the analogy of maps vs road signs (Blumenthal et al. 1988: 356f.). In this analogy, data modelling is equivalent to drawing a map, that is, to defining, on an abstract level, which elements can be linked at all. Individual cross-references in the actual dictionary are then the individually placed signposts.

Cross-references are mostly rendered by links on the user interface. For the most part, we do not distinguish between the terms *link* (the element of an Internet site that can be activated) and *hyperlink* (the connection between this element and other content, managed by the computer). However, when analysing linking structures, it is often useful to be able to distinguish terminologically between these two uses of a link. For this purpose, we use the term *link marker* for the element that can be activated on the presentational level, the term *link target* for the element the link marker points to, and the term *link relation* for the computer connection between the content (text) units on the data modelling level. The link relation is not visible on the user interface. On the presentational level, we can only see the link markers that can be activated with a mouse, a keyboard, or a touchpad/touchscreen in order to call up other units of information (for further information, cf. Storrer 2013).

Consider an example. In the article *smart* in MERRIAM-WEBSTER, various link markers to synonyms can be found under the different subsenses of the word (and under the heading "Synonyms of smart"). In this dictionary, these are rendered in small capitals and in blue font colour. Underneath the keyword, however, there is another form of link marker: a loudspeaker icon, which takes the user to audio examples of the keyword. As such, link markers need not necessarily be units of written language; other graphical elements can also function as link markers. Various types of data also come into play as link targets in Internet dictionaries – text and images as well as audio and video data. In the online entry for *smart*, there are entries in the left sidebar with yet another form of

1 Cf. Kammerer (1998: 325); for other examples of this kind of study, cf. Lindemann (1999) or Müller (2002).

2 Cf., for example, Mann (2010: 28f., 36f.); on questions of the possible transferability of concepts, cf., among others, Tarp (2008: 102) and Müller-Spitzer (2013).

link: “synonyms” and “example sentences”, etc. will each lead the user to different groups of information pertaining to the headword. These kinds of links will be referred to as *structural links* and belong to the so-called internal access structure: in other words, they serve to provide access to individual parts of the word entry. By contrast, we refer to cross-references to synonyms, audio examples, or translations as *content links* since the connection is motivated by properties of the dictionary object.

At least in the form in which they are shown in → Fig. 5.2, structural links are part of the internal access structure of an entry. The external structure in Internet dictionaries is realised through search functions. These are the subject of the following section.

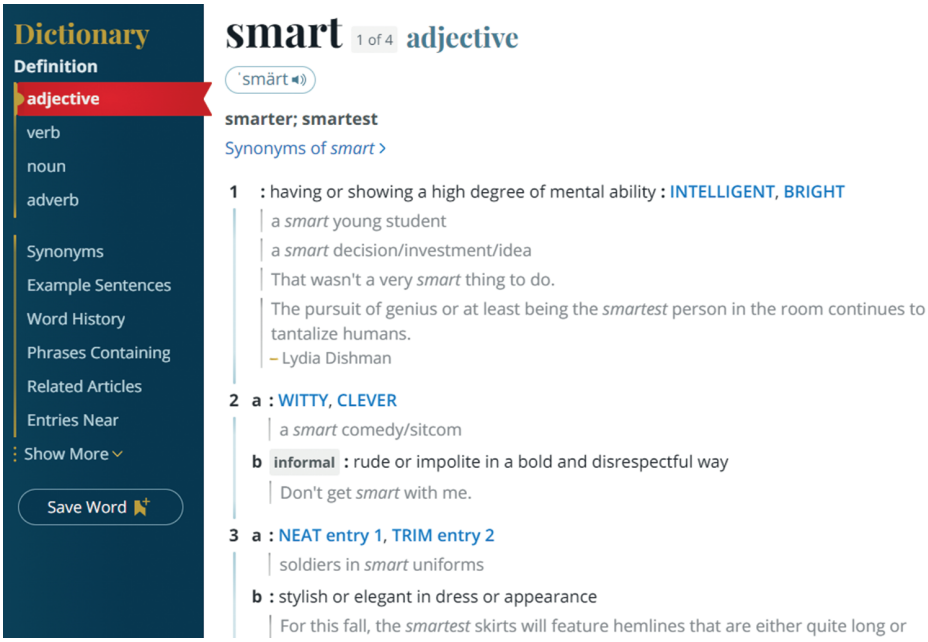


Fig. 5.2: Link markers in the field for related words in the entry for the lemma *smart* in MERRIAM-WEBSTER.

5.3 Access structures

The linking structures described in the previous section make it possible for dictionary users to use a cross-reference to move from any given entry in the dictionary to another with which the former has a connection. However, a variety of access structures stand at the user’s disposal to facilitate their access to the dictionary “from the outside” so that they can find relevant entries in the first place. Typically, this involves different kinds of searches.

In a print dictionary, there are two principal types of search: first, a semasiological search in an alphabetical dictionary by means of successively flicking through pages, forwards and backwards, until the location is found; second, an onomasiological search shaped from a content perspective, for example, in a hierarchically structured ontology. This division is reflected in the two following sections, which present the access structures in Internet dictionaries.

The digital medium and digital methods for processing lexical information multiply the possible ways of accessing dictionary content. Some of these new access structures cannot be classified unambiguously as either semasiological or onomasiological. These are the subject of → Section 5.3.3.[3]

5.3.1 Semasiological access structures

In the following, we characterise the different types of searches in Internet dictionaries. To this end, lexicographical Internet searches are considered according to four criteria, each of which relate to aspects of the search action. These four aspects are (1) the starting point of the search action, (2) the type of search action, (3) the complexity of the search action, and (4) the target of the search action (→ Fig. 5.3).

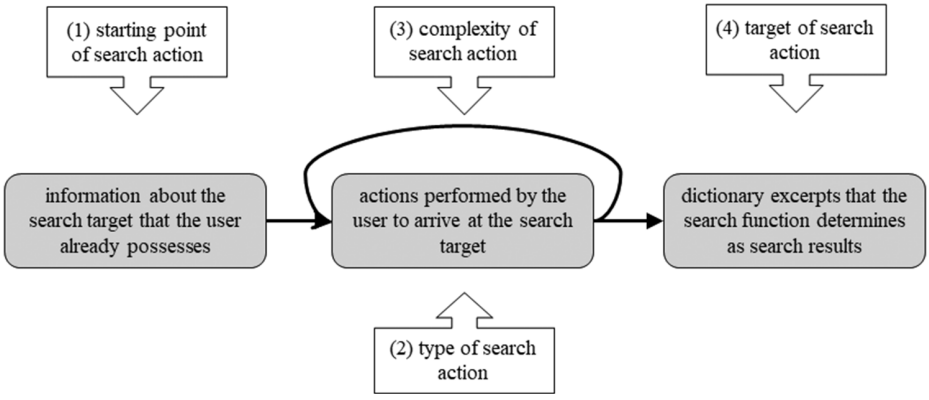


Fig. 5.3: The search action.

(1) *Starting point of the search action.* In order to find a needle in a haystack, you can take the haystack apart, stalk by stalk, until the needle turns up. However, searching in a dictionary does not normally involve such a time-consuming path through the whole

3 For overviews of search functions in electronic dictionaries cf. Engelberg/Lemnitzer (2009: 99f.), Lew (2012), Dziemianko (2018: 667ff.), Pastor/Alcina (2022), Klosa-Kückelhaus/Michaelis (2022: 416f.). See Giacomini (2015) on access structures in LSP lexicography.

search space; rather, it takes as its starting point certain information about the goal of the search that is already at the user's disposal. This information could relate to the written form of the lemma symbol that is being sought, its sound form, its (intensional) meaning, or its typical objects of reference (extensional meaning). As is the case for a print dictionary, a search that starts with the written or spoken form of a linguistic sign is referred to as a semasiological search, and one that starts with the intensional or extensional meaning of a linguistic sign is referred to as an onomasiological search. → Section 5.3.2 is devoted to the latter; here, we concentrate on semasiological searches.

Searches by written form are implemented in as good as every Internet dictionary and represent by far the most common form of dictionary search. In what follows they are presented in detail. Conversely, the option to search by spoken form is realised much more rarely (cf. Lew 2012: 346; Dziemianko 2018: 669). In principle, the latter can take two forms: in a search based on phonetic transcription, the user chooses the transcription symbols (e.g., IPA) that correspond to the sound form of the lemma symbol as the search term; in a speech-input search, the search proceeds from the inputting of spoken language which is then processed by a speech recognition module. A transcription-based search is possible, for example, in the Trésor de la langue française informatisé (TLFi) (→ Fig. 5.4).

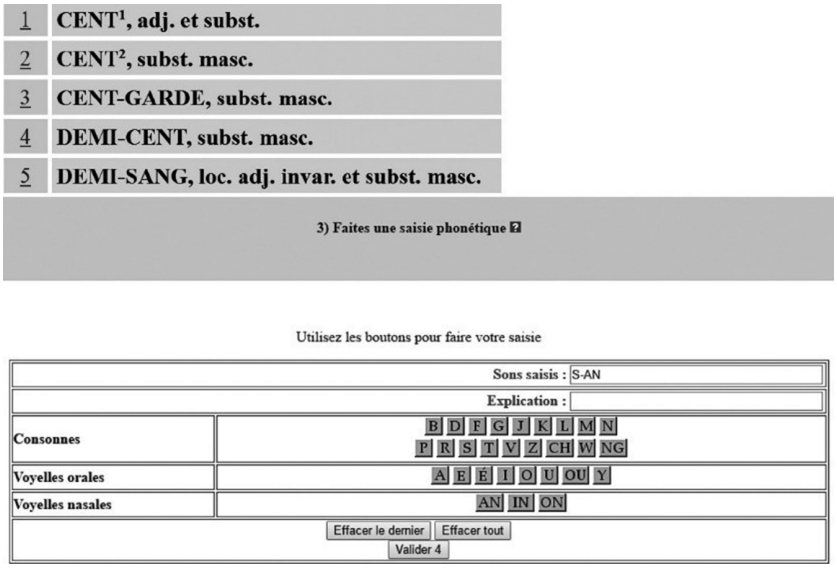


Fig. 5.4: Search based on sound form in the TLFi.

Voice input options are now widely used in all kinds of systems, such as speech-to-text conversion or automatic translation, and they are also used in lexicographic products, especially in dictionary apps for mobile devices.

(2) *Type of search action*. Basic search actions are oriented towards the medium and are familiar from other Internet-based forms of communication. Above all, they are based on inputting text, clicking on links, or moving the cursor. The basic lexicographic Internet search actions include:

- typing in a search term (input-based search);
- clicking on a linguistic expression, for which a corresponding dictionary entry can be found (index-based search);
- clicking on a selection field or making a selection from a drop-down menu in order to limit the volume of hits (filter-based search);
- reading a linguistic expression for which a corresponding dictionary entry can be found, for example, using the scanning function of a mobile phone (scanner-based search);
- the spoken inputting of a search term already mentioned above (speech input search).

There are some particular aspects of input-based, index-based, and filter-based searches that are worth mentioning now. An input-based search by means of typing into a search field is often supported by a series of specific options:

- When a search term begins to be entered, suggestions are made to complete it that can be selected; these correspond to the characters already entered and to lemmas in the dictionary (incremental search, type-ahead search) (cf. Engelberg et al. 2020: 64f.; Lew 2012: 351f.).
- An option is available to decide whether the search should be case sensitive or not (case-sensitive search).
- In order to offer a suitable target search term for users who are uncertain about spelling, lemmas are shown that are similar phonetically or graphemically to the search term (fuzzy search, spelling-tolerant, or phonetic search) (cf. Engelberg/Lemnitzer 2009: 106f.; Lew 2012: 347f.).
- Parts of the search term are kept variable by certain operators; these placeholders can stand for individual letters or for a chain of letters (placeholder search); in this way, for example, all the entries can be found that describe lemma symbols with particular morphological elements, such as all words ending in the German suffix *-ung* or all words with the component part *-moon-* (cf. Pastor/Alcina 2022: 96).
- The inflected form of a word is entered into the search field, which leads back to the root form by automatic lemmatisation and for which the corresponding lemma is then sought (search by inflected form) (cf. Pastor/Alcina 2022: 97).

An index-based search involves lemmas being searched by means of lemma lists and lemma range indicators.[4] Searching in lemma lists usually involves navigating through moving lemma lists, in which the required lemma can be chosen by clicking. Navigating in lemma lists is often supported by lemma range indicators, i.e., letter bars or lemmas listed by their start sequences, which limits the range of lemmas within which the required lemmas can be located (→ Fig. 5.5). Here, the search often involves successive navigation from wider to narrower ranges of lemmas. At the end of navigation via lemma range indicators, there is normally a section of a lemma list within which the required lexeme can be found.

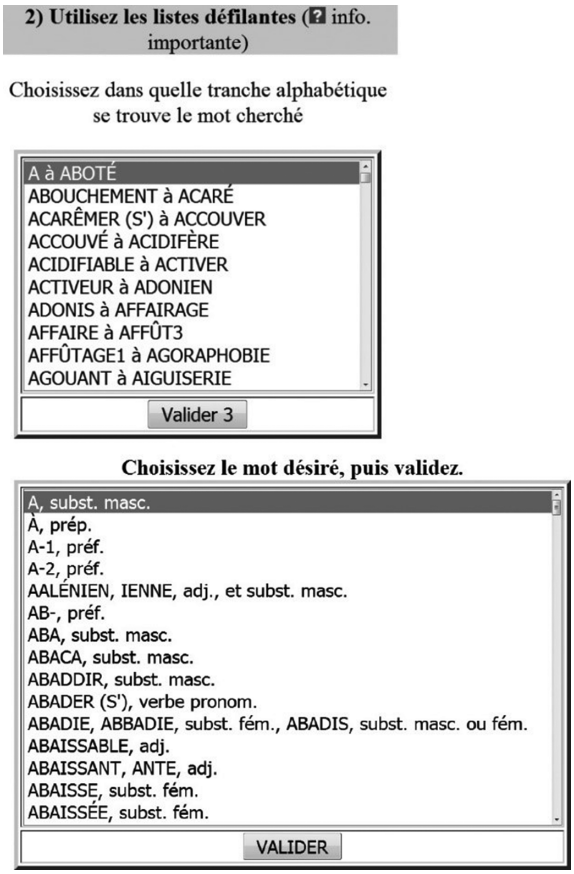


Fig. 5.5: Lemma range indicator in the TLFi.

4 A lemma range is an uninterrupted sequence of entries in a dictionary. They can be referred to in the form of lemma range indicators, e.g., by giving the first and last lemma of the range.

Navigating by clicking on particular expressions is also the basis for two other forms of search. In a text-based search, it is not lemmas that are clicked from the dictionary's lemma list but rather words from electronic texts external to the dictionary (→ Fig. 5.6). Then, potentially following automatic lemmatisation, the clicked word is matched against the dictionary's lemma list. In this way, the user can call up a dictionary entry directly from the text editor or text display. The scanner-based search mentioned above is also a form of text-based search. In the ideal case, connecting a text-based search with context-sensitive analysis even makes it possible to identify the specific interpretation of the word (Seretan/Wehrli 2013).

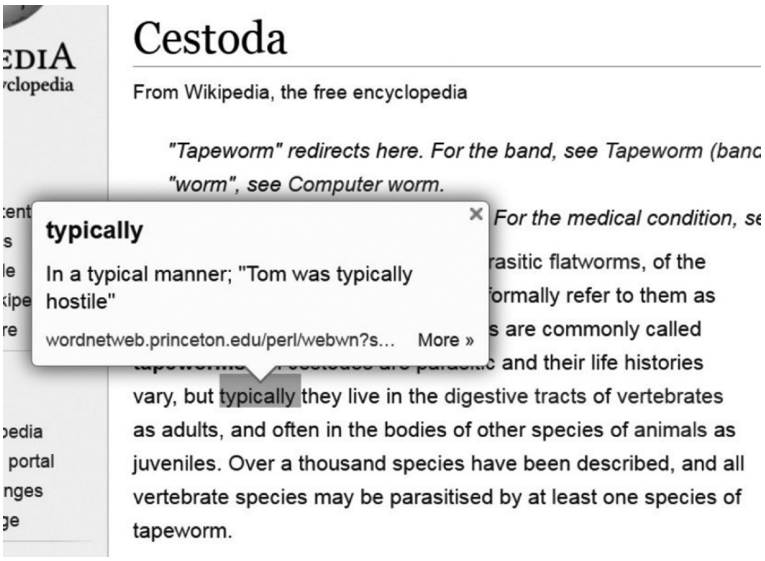


Fig. 5.6: Text-based search in the GOOGLE dictionary (starting from a WIKIPEDIA article).

A filter-based search is particularly suitable when it is not an individual word that is being sought but rather a number of lemmas, sublemmas, compound words listed for a lemma within a dictionary entry, or semantically related words. This makes it possible to filter out those lemmas with particular properties (formal, semantic, etymological). Here, the search process can include clicking on checkboxes or selecting from a drop-down menu (→ Fig. 5.7). A particular type of filter-based searches is a faceted search. It allows a progressive refinement of a search using one filter after the other while the search output is continuously reduced (cf., e.g., Porta-Zamorano 2018: 926f., Engelberg et al. 2020: 61f.).

(3) *Complexity of the search action*. One-dimensional search actions only require a single one of the search processes outlined above, or a short sequence of them: that is, entering a single search term, clicking one lemma in a lemma list, or applying a single filter. Multidimensional search actions, in contrast, combine several individual actions simul-

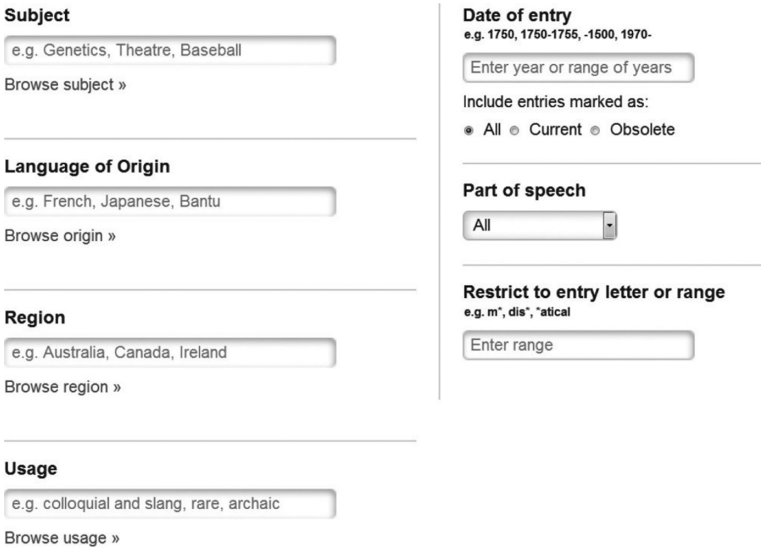


Fig. 5.7: Filter-based search in the Oxford English Dictionary (OED) via the selected entry of a term (e.g., "subject", "region"), selecting a radio button (e.g., "all/current/obsolete"), or making a selection in a drop-down menu ("part of speech").

taneously into a complex search query. For the most part, they do not serve to locate a single lemma but rather a number of expressions that satisfy particular criteria. This applies, for example, to the "advanced search" in the OED (→ Fig. 5.7).

Individual academic language platforms sometimes allow searches in dictionaries using query languages like SPARQL or CQP, e.g., BABELNET or LILA, a knowledge base of linguistic resources for Latin (→ Fig. 5.8).

(4) *Target of the search action.* The target of a search action can be a specific lemma, a number of lemmas, or a particular information item in one or more dictionary articles: for example, all of the sense items whose paraphrase contains a particular content word. The most common case is, indisputably, a search for an individual lemma and its associated dictionary entry. Most one-dimensional search actions lead to this kind of result. Conversely, complex search actions, and also some simple placeholder or filter searches, serve for the most part to identify a number of lemmas that satisfy particular syntactic (→ Fig. 5.9), morphological, semantic-pragmatic (→ Fig. 5.21), etymological, or other criteria. Searches of this kind lead either directly to a dictionary entry or to a lemma, which is then clicked to reach the entry.

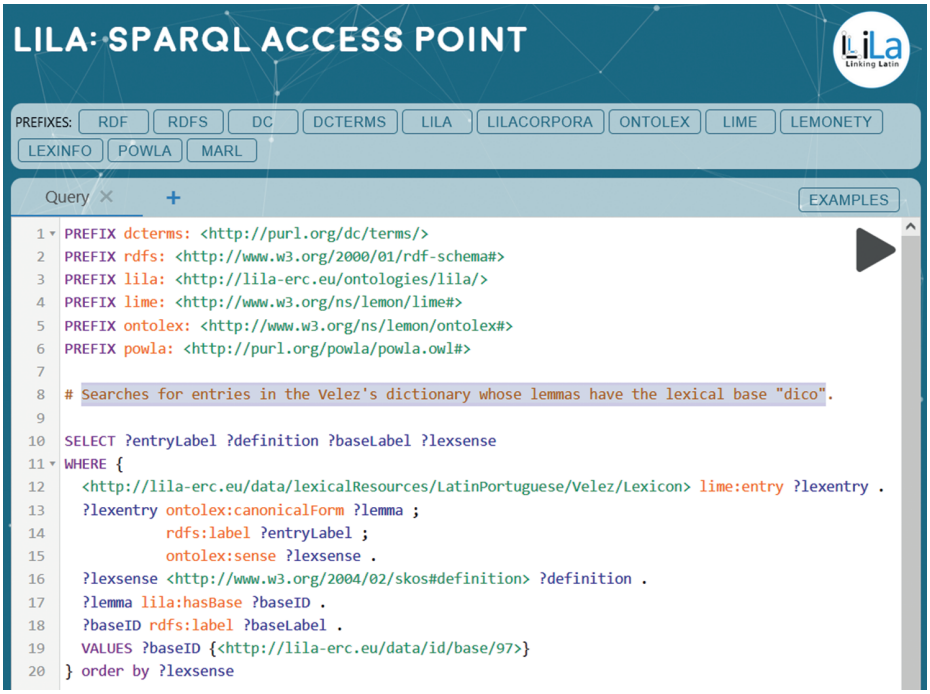


Fig. 5.8: Searches in the Latin knowledge base LiLa for entries in one of the included dictionaries whose lemmas have the lexical base “dico”, using SPARQL as a query language.

5.3.2 Onomasiological access structures

Semasiological dictionary access proceeds from linguistic forms and leads to information about the meaning and use of these forms. By contrast, *onomasiological dictionary access* has its starting point in a meaning (an idea, a concept, a piece of content) and refers to associated linguistic forms. Onomasiological access structures can be helpful for productive dictionary use, for example, when the dictionary is being used to help write a text, but also when a language learner wants to open up and explore a section of foreign language vocabulary or specialised terminology.

As a rule, onomasiological access structures exist in addition to semasiological structures, that is, as a complement or supplement to them: printed illustrated dictionaries normally contain an alphabetical keyword index that cross-refers back from the linguistic form to the content depicted in pictorial form. Digital dictionaries open up new, extended ways to provide onomasiological access structures. For one thing, being liberated from the print form facilitates notably more flexible forms of presentation. If dictionary data are first modelled separately from their form of presentation, according to purely content-based aspects (→ Chapter 4), the individual components of the dictionary

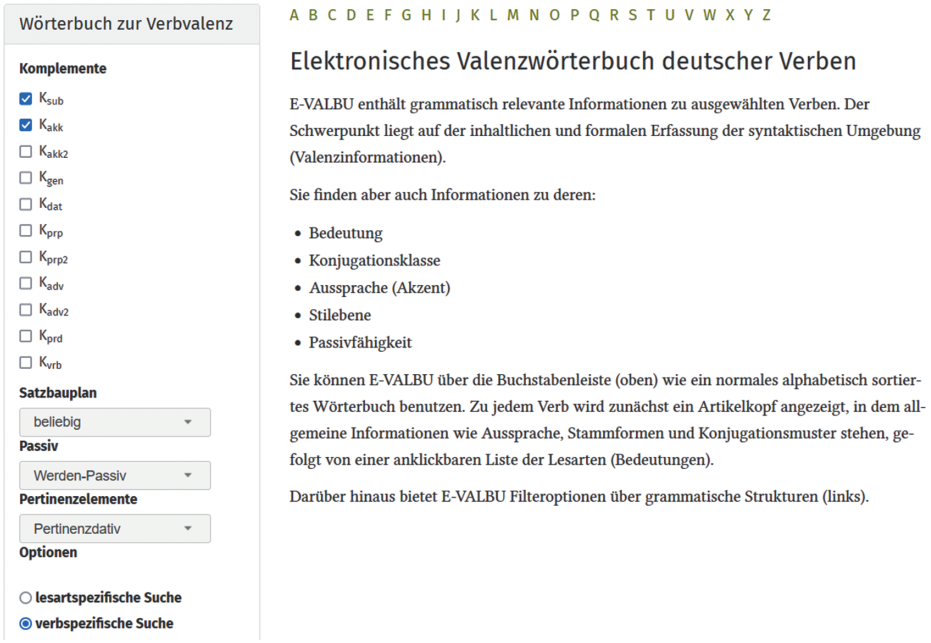


Fig. 5.9: Multidimensional filter-based search in the E-VALBU ("Electronic Valency Dictionary of German Verbs"); the search is for all verbs that require an obligatory accusative object in addition to a subject and that also allow a dative of possession and a *werden*-passive.

can be assembled and (re)organised according to any criteria at all for presentational purposes.[5] In this way, one or more onomasiological access options (e.g., in the form of an image or a hierarchically organised ontology) can be set alongside an alphabetical lemma list (as the classic semasiological access structure), both of which point to the same dictionary entries. For another, the multimedia capabilities of computers open up new possibilities for presenting and illustrating the content aspects of an expression for the user. In addition to static images, which could already be used as the starting point for an onomasiological approach to accessing a dictionary in the print medium (albeit at a relatively high cost), moving images (video clips) can also be integrated into the dictionary in the digital medium to illustrate an action or audio data (audio clips) to illustrate sounds.

When it comes to semasiological access structures (→ Section 5.3.1), orthography acts as a system familiar to almost all dictionary users for representing linguistic forms. This system is not only standardised as widely as possible and applicable across the entire lexicon (every word has an orthographic form) but it also includes a distinct system for order-

5 Meyer/Tu (2021) show how an onomasiological search can be implemented post hoc based on existing word senses and multilingual pre-trained word embeddings.

ing different forms by placing them in relationships with one another (the alphabet and the classification of root forms and inflected forms). This is fundamentally different for onomasiological access structures. First of all, it is not at all obvious how a given meaning (an idea, a concept, a piece of content) can be presented as the starting point for onomasiological access on the part of dictionary users, and there is no distinct system by which the different meanings can be organised exhaustively and put into relationships with one another. While pictures, for example, might often be a suitable way of representing concrete objects, involving the part-whole relationship (partonymy) as an inherent organisational system (→ Fig. 5.10), the meanings of more complex actions (e.g., "exmatriculate") or more abstract content (e.g., "shy") cannot be illustrated well through images.

The basis of onomasiological access structures is thus more diverse and less clearly defined than for semasiological structures; furthermore, any given onomasiological access structure often does not cover the whole lexicon but only the part of it for which that particular form of representing meaning is well suited. Fillmore (1978) argues that it can be entirely adequate to select the access structures in this way, dependent on "semantic domains":

> I think that semantic theory must reject the suggestion that all meanings need to be described in the same terms. I think, in fact, that semantic domains are going to differ from each other according to the kind of 'definitional base' which is most appropriate to them. (p. 148)

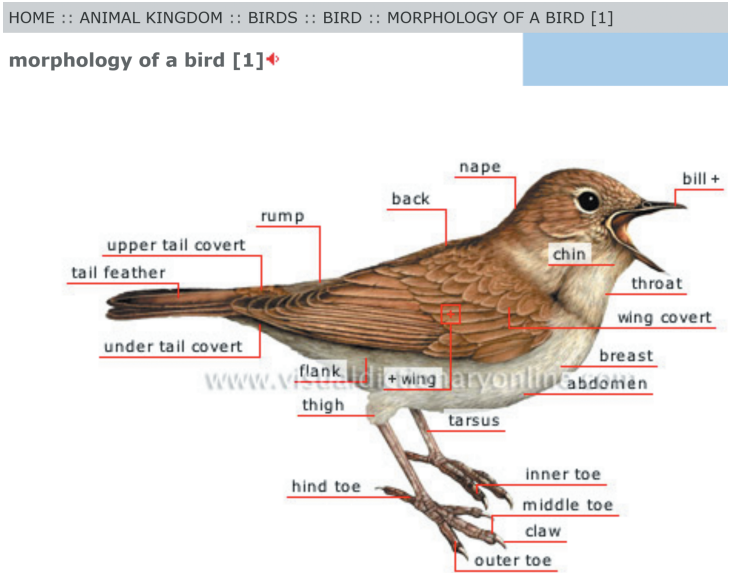


Fig. 5.10: *Bird* in the Merriam-Webster Visual Dictionary (MWVDO).

As far as the presentation of meanings for onomasiological access is concerned, we can initially draw an essential distinction between linguistic and non-linguistic forms.

When it comes to linguistic representation, (intensional) meanings are described by linguistic forms: for example, if verbs – as in the dictionary of verbs of communication (KOMMUNIKATIONSVERBEN) in OWID (→ Fig. 5.11) – are collected into paradigms listed according to the semantically dominating verb, if terms relating to linguistically named concepts are assigned to an ontology (see below) (cf. Pastor/Alcina 2022: 113f.),

Kommunikationsverben

versprechen-Paradigma

(Kommissive.versprechen.versprechen)

Paradigmenübersicht »

Bezugssituationstyp: Kommissive.versprechen.versprechen

Propositionaler Gehalt:	Mitteilungsgehalt: P
Geschehenstyp:	Handlung
Zeitbezug:	zukünftig
Rollenbezug:	Sprecher
Kommunikative Einstellung von S	
Propositionale Einstellung von S:	S will: P tun
Sprecherabsicht:	S will: H erkennt: propositionale Einstellung von S
Vorannahmen von S:	im Interesse von H: P

Mitglieder im Paradigma

versprechen · versichern · zusichern
geloben · schwören

Lexikalische Merkmale

Verben	Merkmale							
	Semantische Rollen	Argument Struktur	Passiv	Resultativität	Bewertung	Polysemie	Performativität	stilistische Markiertheit
versprechen	H (fak)	NP<Dat>	+	-	-	-	+	-
	P (obl)	NP<Akk> SE Inf NPKorrSE						
versichern	H (fak)	NP<Dat>	+	-	-	+	+	-
	P (obl)	NP<Akk> SE Inf NPKorrSE						
zusichern	H (fak)	NP<Dat>						

Fig. 5.11: Verbs belonging to the paradigm of verbs of promise (German: *versprechen*) in the dictionary of verbs of communication (KOMMUNIKATIONSVERBEN) in OWID containing information about their valency and semantic-pragmatic features.

or if – as in the Algemeen Nederlands Woordenboek (ANW; → Fig. 5.12) – the meaning of a lexeme is described by semagrams with linguistically named properties. Meanings are also represented in linguistic form in a full-text search in a dictionary, which, as outlined above, can equally be seen as an onomasiological form of access.

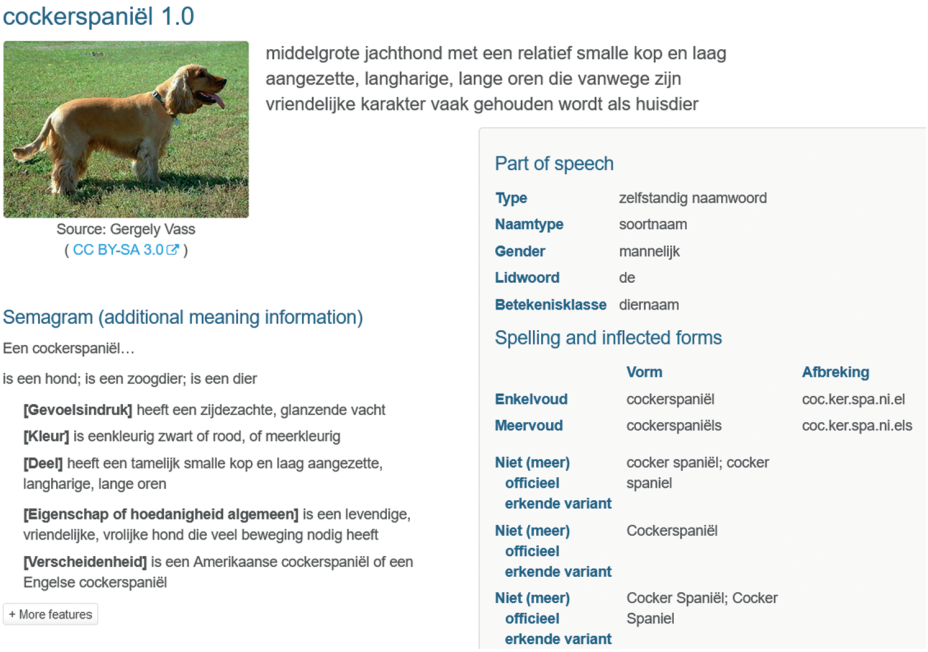


Fig. 5.12: Semagram for Dutch *cockerspaniël* ('cocker spaniel') in the ANW.

By contrast, images serve to describe (extensional) meanings in a non-linguistic representation. Examples for this kind of illustration-based representation can be found in → Fig. 5.10 and → Fig. 5.12, in which a typical reference object is represented for each in either a drawing (*bird*) or a photograph (*cockerspaniël*). Schematic drawings or moving images (or potentially sounds) are other conceivable methods for representing or illustrating meanings in non-linguistic form. For example, KICKTIONARY (→ Fig. 5.13) makes use of diagrams and video clips, among other things, in order to show users the meaning of actions ("scenes") in football matches.

However, in order to facilitate onomasiological access to a dictionary, it is not sufficient to make individual meanings available as the starting point for locating linguistic forms. Rather, these individual meanings have to be organised and related to one another in a comprehensible way so that the user is in a position to find them in the first place as the starting point for an onomasiological search in the dictionary.

In terms of the form of this organisation, we can distinguish between hierarchical and non-hierarchical structures and between top-down and bottom-up processes for

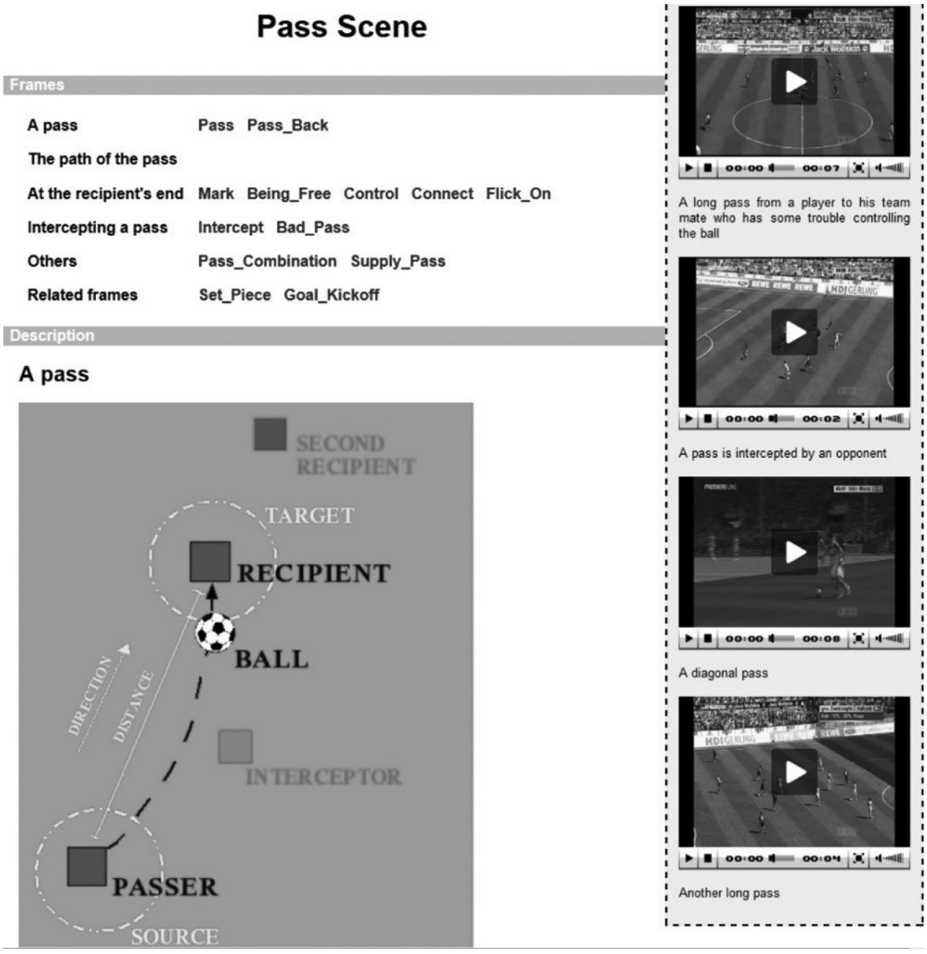


Fig. 5.13: "Pass scene" in KICKTIONARY.

constructing them. In the following, this will be explained using four examples of onomasiological access structures.

Example 1 (Pictorial dictionary MWVDO): The basic components of onomasiological access (that is, images or linguistic signs, etc. that stand for a given meaning) are often organised in a hierarchical structure. For example, the Merriam-Webster Visual Dictionary (MWVDO) (→ Fig. 5.14) initially starts with 17 different thematic areas that are then each subdivided into further subareas on multiple levels (here: animal kingdom > insects and arachnids > butterfly > morphology of a butterfly) until the actual linguistic forms appear as the caption for an image at the lowest level.

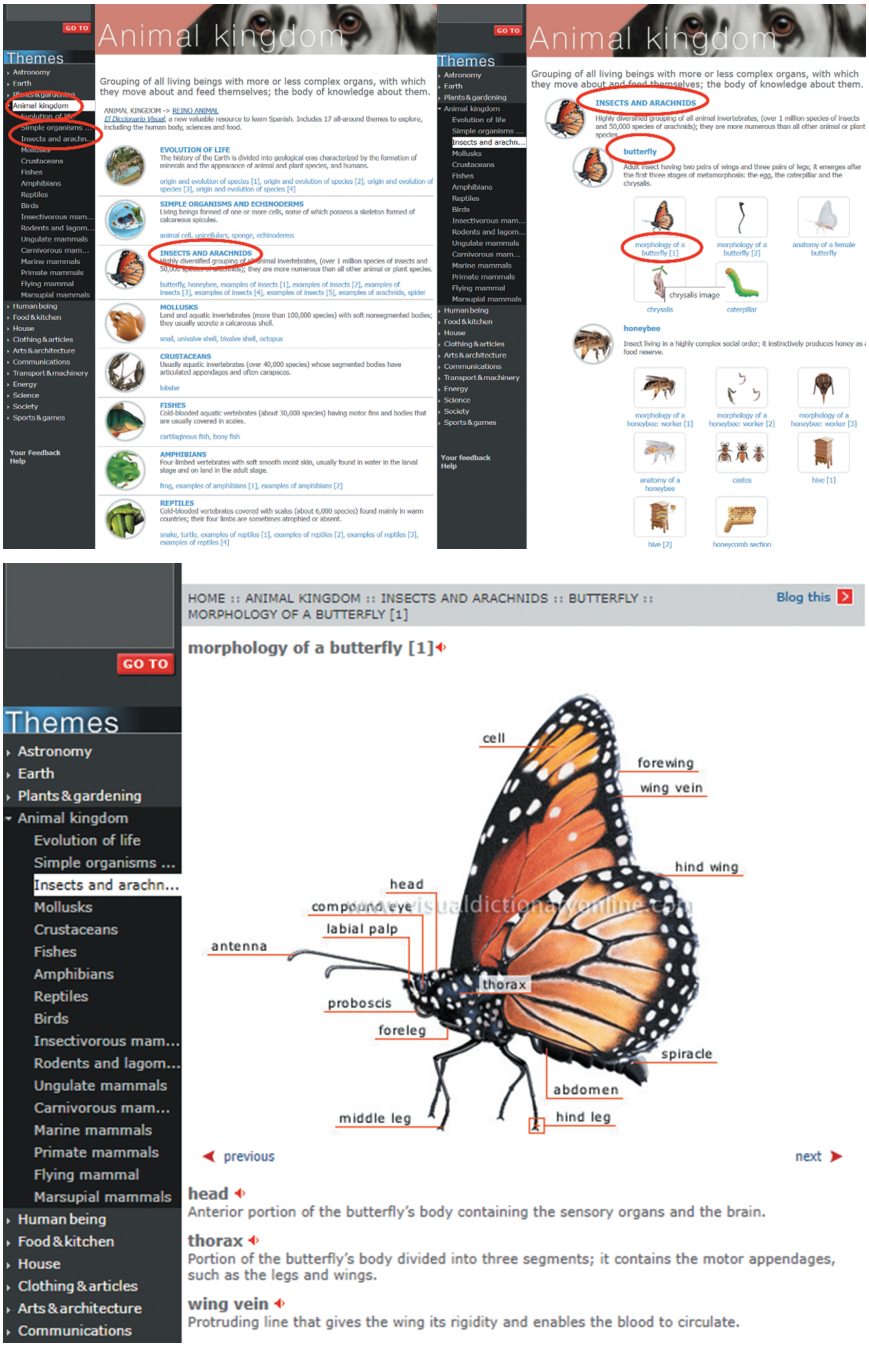


Fig. 5.14: Hierarchical construction of a pictorial dictionary (exemplified by Merriam-Webster Visual Dictionary; MWVDO).

Example 2 (Semantic Relations in KICKTIONARY): The so-called concept hierarchies in KICKTIONARY are also organised hierarchically; however, meanings are not represented pictorially but directly through synonyms or the linguistic forms of translation equivalents. The relationship between the individual entries in the hierarchy is a semantic relation like the ones used in the organisation of wordnets (e.g., WORDNET or GERMANET) (Schmidt 2009).

In this way, there is synonymy between entries from the same language at a particular level, such as *goalkeeper, keeper, custodian* (all = 'goalkeeper'). The entirety of synonymous forms is referred to as a SynSet (→ Chapter 4.4.2) and represents the meaning they have in common. In KICKTIONARY this principle also extends across languages: along with {*Torwart, Torhüter, Schlussmann*} for German and {*gardien de but, gardien, portier*} for French, the result is a multilingual SynSet that stands for the meaning (the "concept") 'goalkeeper'.

Further semantic relations can exist between SynSets, which then lead to the hierarchies that are depicted in the dictionary. The hierarchy shown in → Fig. 5.15 is based on the semantic relation of hyponymy (or its converse, hyperonymy), which denotes the relationship between a subordinate and superordinate term – if X is a type of Y (a goalkeeper is a player, a sweeper is a defender), then X is a hyponym of Y, and the SynSet containing X is subordinate to the SynSet containing Y. The hierarchy shown below in → Fig. 5.15 is based on the semantic relation of partonymy (converse: holonymy), which denotes a part-whole relationship. If X is a part of Y (a goalkeeper is part of the lineup, the lineup is part of the team), then X is a partonym of Y. In this way, a dictionary user can start with a meaning and arrive at various linguistic forms that denote this meaning, and they can also navigate in the relevant hierarchy to find linguistic forms which have a related (i.e., more general or more specific) meaning.

Example 3 (Frames in the Berkeley FRAMENET): A notably more complex onomasiological organisation is used in dictionaries based on frames. Here, the frame is the starting point for the dictionary's structure – a structure in which knowledge about prototypical courses of action and their actors and objects is represented.

For example, the frame *Commerce buy* from FRAMENET in → Fig. 5.16 provides a structure in which different linguistic expressions to do with buying (*buy*, *purchase*, *buyer*) can be organised. The definition explains the relevant action in an abstract way and specifies the so-called frame elements involved (in this case, among others, a buyer, a seller, goods, and money). The description of individual linguistic elements ("lexical units", e.g., the verb *buy*) can then have recourse to this superordinate structure, for example by annotating the frame elements with corresponding labels in an example sentence. In this way, different linguistic forms can be assigned to a common meaning, thereby facilitating onomasiological access. Additional possible forms of dictionary navigation arise because individual frames are assigned to one another in frame-to-frame relations. For example, the frame *Rent* constitutes a special case of the frame *Commerce_buy* and thereby "inherits" its properties. Likewise, *Commerce_buy*

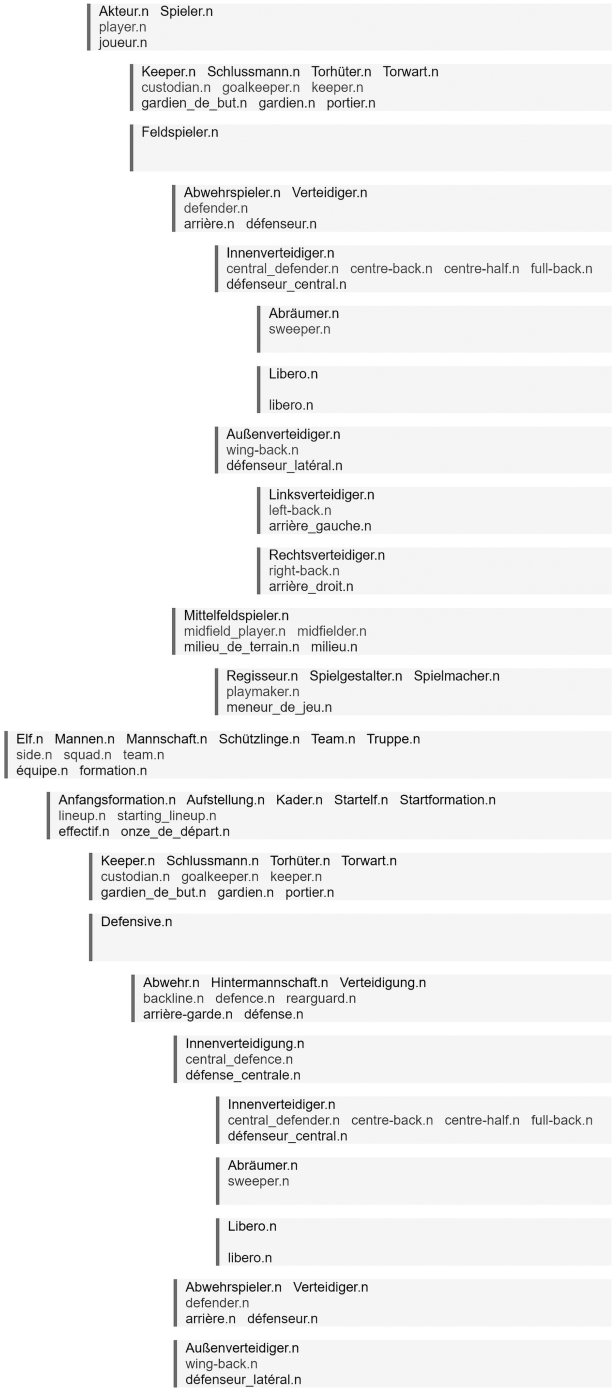
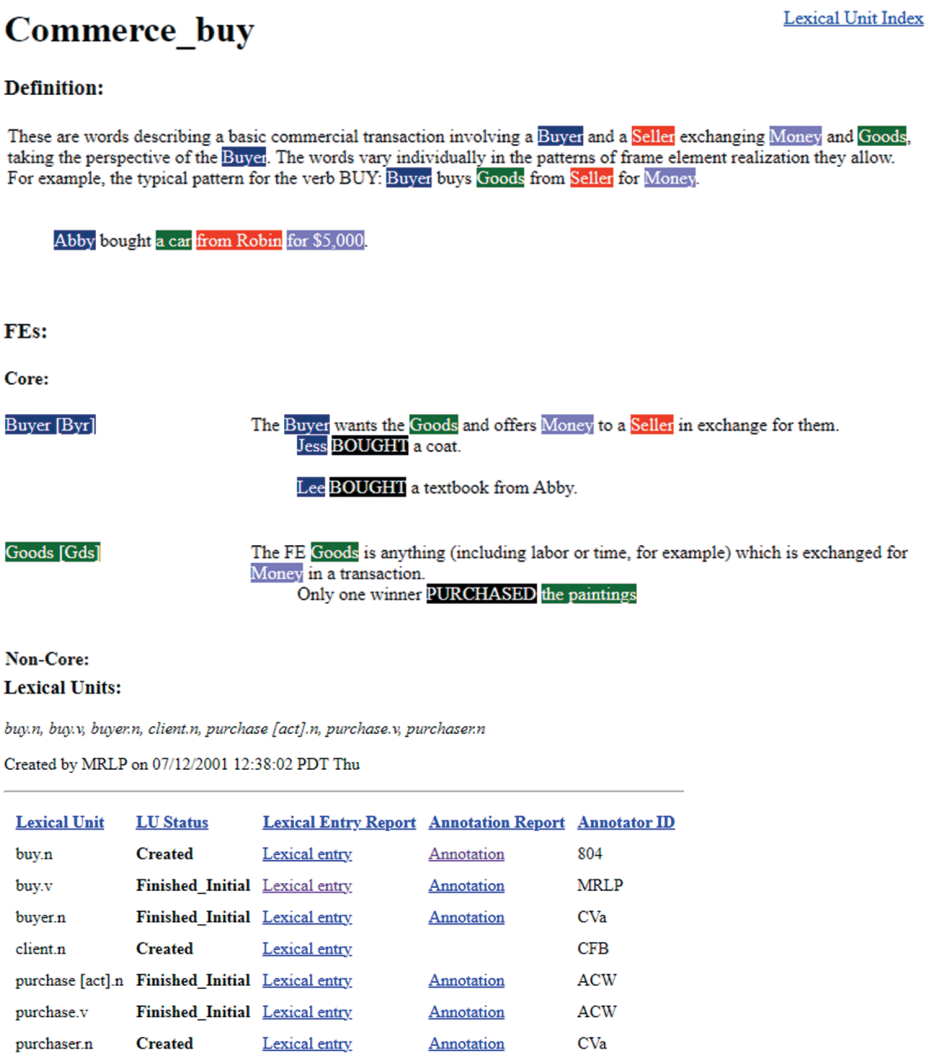


Fig. 5.15: Concept hierarchies in KICKTIONARY.

and *Commerce_sell* constitute opposing perspectives on the same superordinate frame *Commerce_goods-Transfer* and therefore share its core frame elements. In this way, a complex network of frames related to one another develops (→ Fig. 5.17), which makes it possible for the dictionary user to explore relationships between meanings and the linguistic forms that belong to them.



Commerce_buy

Lexical Unit Index

Definition:

These are words describing a basic commercial transaction involving a Buyer and a Seller exchanging Money and Goods, taking the perspective of the Buyer. The words vary individually in the patterns of frame element realization they allow. For example, the typical pattern for the verb BUY: Buyer buys Goods from Seller for Money.

Abby bought a car from Robin for $5,000.

FEs:

Core:

Buyer [Byr] — The Buyer wants the Goods and offers Money to a Seller in exchange for them.
Jess BOUGHT a coat.
Lee BOUGHT a textbook from Abby.

Goods [Gds] — The FE Goods is anything (including labor or time, for example) which is exchanged for Money in a transaction.
Only one winner PURCHASED the paintings

Non-Core:

Lexical Units:

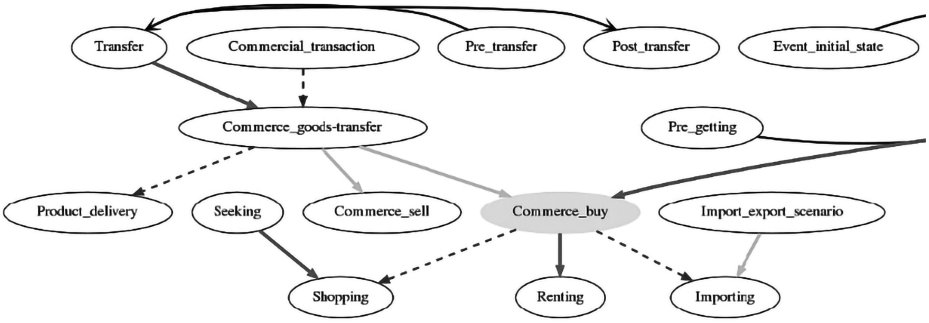
buy.n, buy.v, buyer.n, client.n, purchase [act].n, purchase.v, purchaser.n

Created by MRLP on 07/12/2001 12:38:02 PDT Thu

Lexical Unit	LU Status	Lexical Entry Report	Annotation Report	Annotator ID
buy.n	**Created**	Lexical entry	Annotation	804
buy.v	**Finished_Initial**	Lexical entry	Annotation	MRLP
buyer.n	**Finished_Initial**	Lexical entry	Annotation	CVa
client.n	**Created**	Lexical entry		CFB
purchase [act].n	**Finished_Initial**	Lexical entry	Annotation	ACW
purchase.v	**Finished_Initial**	Lexical entry	Annotation	ACW
purchaser.n	**Created**	Lexical entry	Annotation	CVa

Fig. 5.16: Description of the frames *Commerce_buy* (above) with the associated lexical units (below) in FrameNet.

Example 4 (Semagrams in the ANW): While pictorial dictionaries and frames explicitly create onomasiological access structures as a macrostructure – a lexicographer selects



Frame-frame Relations:

Inherits from: Getting
Is Inherited by: Renting
Perspective on: Commerce_goods-transfer
Is Perspectivized in:
Uses:
Is Used by: Importing, Shopping
Subframe of:
Has Subframe(s):
Precedes:
Is Preceded by:
Is Inchoative of:
Is Causative of:
See also:

Fig. 5.17: Frame-Frame relations in FRAMENET.

images or defines frames to which linguistic forms are then assigned – in the case of concept hierarchies, they result implicitly from mediostructural elements, namely the relations of linguistic forms to one another. The former method can be classed as "top-down" since it specifies the superordinate structures that are then "filled" with lexical units; the latter are classed as "bottom-up" because here the superordinate categories result from the information which is assigned to the lexical units – in this case, the superordinate categories are "emergent".

The semagrams in the ANW constitute a further bottom-up method for constructing onomasiological access structures (cf. Tiberius/Declerck 2017). A semagram represents knowledge that belongs to a word:

> A semagram is the representation of knowledge associated with a word in a frame of 'slots' and 'fillers'. 'Slots' are conceptual structure elements which characterise the properties and relations of the semantic class of a word meaning. (Moerdijk et al. 2008: 19)

As shown in → Fig. 5.12, for example, semagrams belonging to the word *cockerspaniël* ('cocker spaniel') record superordinate and subordinate terms ("dog" or "English cocker spaniel") for this word but also those that denote particular characteristics of this species (e.g., "spotted").

Fig. 5.18: Semagram-based search in the ANW.

Semagrams provide dictionary users with a way to navigate through the dictionary based on meanings: for example, to display all of the words to which the semagram "spotted" is assigned. As illustrated in → Fig. 5.18, it is possible, for example, to search in the superordinate category "animal" for the keyword "gevlekt" ('spotted'), which returns the hits *pos*

('chub'), *steenuil* ('little owl'), and *zandhagedis* ('sand lizard') as responses as well as *cockerspaniël*.

Onomasiological searches can take very different forms. Some Internet dictionaries provide the option of filtering hits semantically. In this way, the "advanced search" in ELEXIKO allows the user to restrict the desired lemmas to those in particular semantic classes, in → Fig. 5.19, for instance, to words that denote actions.

Fig. 5.19: "Advanced search" in ELEXIKO, searching for words denoting actions ("Handlungsprädikator").

The full text search is actually conceived in its core function as a semasiological search but when used skilfully and verbalised consistently in the entry texts it can also be employed as an onomasiological search (Engelberg et al. 2020: 61; Pastor/Alcina 2022: 98f., 108f.). Here, the entries in which the search term corresponds to the lemma are not sought but rather the entries in which the search term appears in the entry text or its meaning. For example, the OWID dictionary portal allows a "search in meaning paraphrases" in all its integrated dictionaries; for the search term "Computer", this would list all of the entries that stand in a semantic relationship with the German word *Computer* (→ Fig. 5.20).

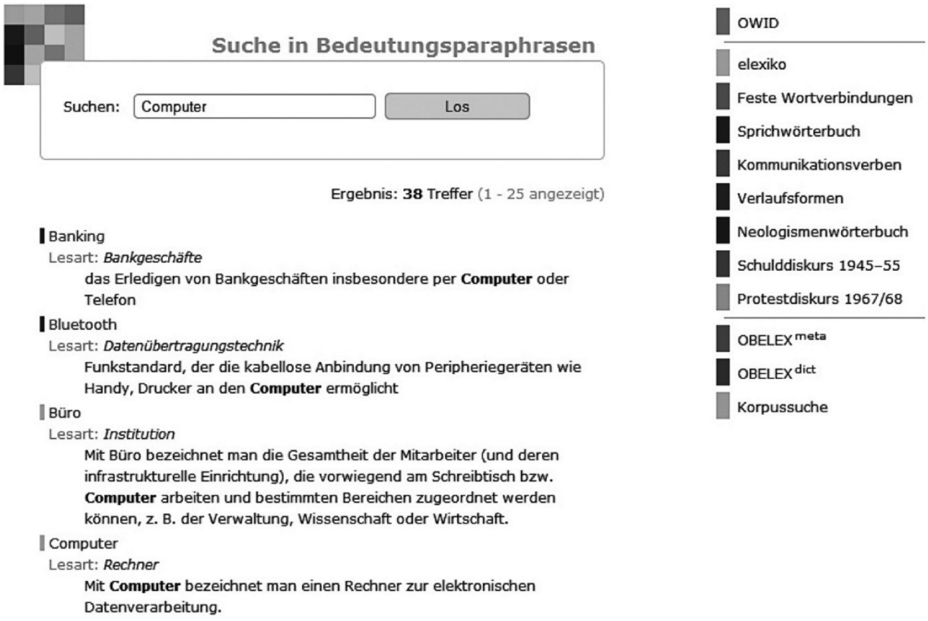


Fig. 5.20: "Search in meaning paraphrases" in OWID.

As in a semasiological search, navigating through successive clicks also plays a role in onomasiological searches, when, for example, the user navigates through thematic trees and ontologies. Using a pictorial dictionary, for instance, as in → Fig. 5.14, requires first of all navigating through the thematic tree for "animal kingdom" to "butterfly", before a lemma is chosen by clicking in the illustration. This is referred to as illustration-based searches.

The representation of meaning relationships in graphs (also → Section 5.3.3) can facilitate access to onomasiological structures. For example, various lexemes that have a semantic relation to the adjective "happy" are represented in a graph in → Fig. 5.21.

5.3.3 Other access structures

Graph-based searches represent a new form of visually supported access to dictionary data that cannot always be classified clearly as semasiological or onomasiological. Here, a graph which represents relations to other lemmas is produced and visualised for a particular lemma. It is possible to access the lemmas visualised in the graph by clicking (→ Fig. 5.22 and → Fig. 5.23), or the user can display a compact form of the article by hovering the mouse over it (→ Fig. 5.21 and → Fig. 5.23) (cf. Meyer 2013, Pastor/Alcina 2022: 116f.; Torner/Arias-Badia 2019 on collocation networks in dictionaries).

Fig. 5.21: Graph representing semantic relations in the VISUAL THESAURUS using the option of a graph-based search.

In addition to graph-based search structures, further access structures that are based on various visual associations of lexemes have been popular. So, for example, it is possible to call up lemmas by clicking in word clouds that are generated from co-occurrence analyses (→ Fig. 5.24).

Finally, the boundaries between accessing dictionaries and accessing other types of Internet-based language resources, particularly corpora, become blurred in the digital medium (→ Chapter 2). After all, input-based searches are used not only in dictionary searches but also in corpus queries. In advanced digital lexical systems, individual input-based search queries are used to reach not only dictionary entries but also an array of corpus examples. These searches are realised in both the monolingual DWDS (→ Fig. 5.25) and the bilingual LINGUEE dictionaries (→ Fig. 5.26).[6]

Finally, it also has to be mentioned that the apparently paradoxical form of arbitrary searching has also been realised in Internet lexicography. In this way, it is possible to have an entry chosen for you by a random generator in the WIKTIONARY dictionaries. This is more comparable to randomly exploring dictionary content than the targeted accessing of information.

6 Cf. also Granger/Paquot (2015, pp. 134f.). A dictionary that provides direct access to a corpus of spoken language is described in Meliss et al. (2019).

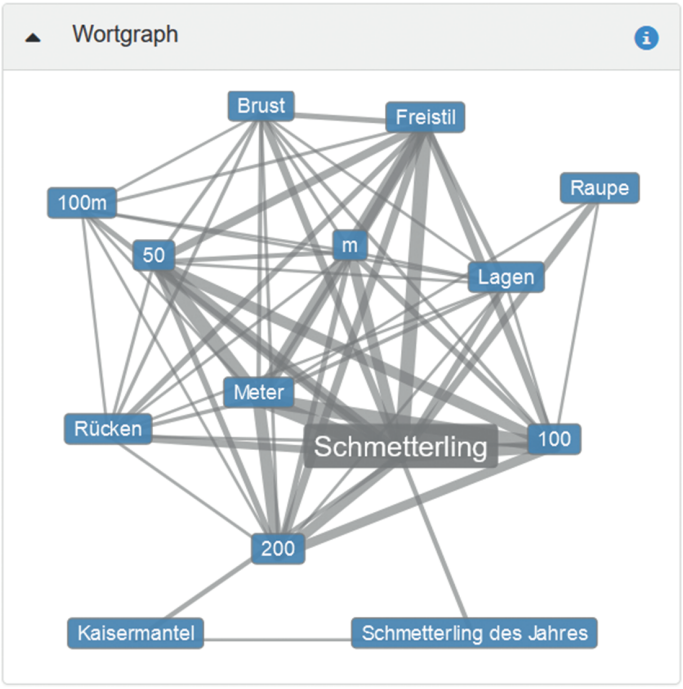


Fig. 5.22: Graph representing co-occurrence relationships of the German word *Schmetterling* 'butterfly' in WORTSCHATZ using the option for graph-based searches.

5.4 New perspectives for dictionary research

The strengths of the digital medium are the possibilities for linking data and the options available to access it in a targeted way. This is reflected in the multiple forms of linking and access structures in Internet dictionaries. However, this not only offers increased room for manoeuvre on the part of dictionary users; it also opens up new perspectives for dictionary research. At the outset, we wrote that it was possible to analyse the linking of data in Internet dictionaries in a similar way to the mediostructures of print dictionaries, in other words by inspecting individual entries as examples. However, we can also proceed in a completely different way when the whole digital basis of data of a dictionary provides the underlying data and when these data are analysed using statistical methods. At the end of this contribution, therefore, we present an example of this kind of novel analysis of the "linking roadmap" for an Internet dictionary using the example of paradigmatic information in the German WIKTIONARY (cf. in more detail Müller-Spitzer/Wolfer 2015) about synonyms, antonyms, hyponyms, hyperonyms, and words related in terms of reference or meaning.

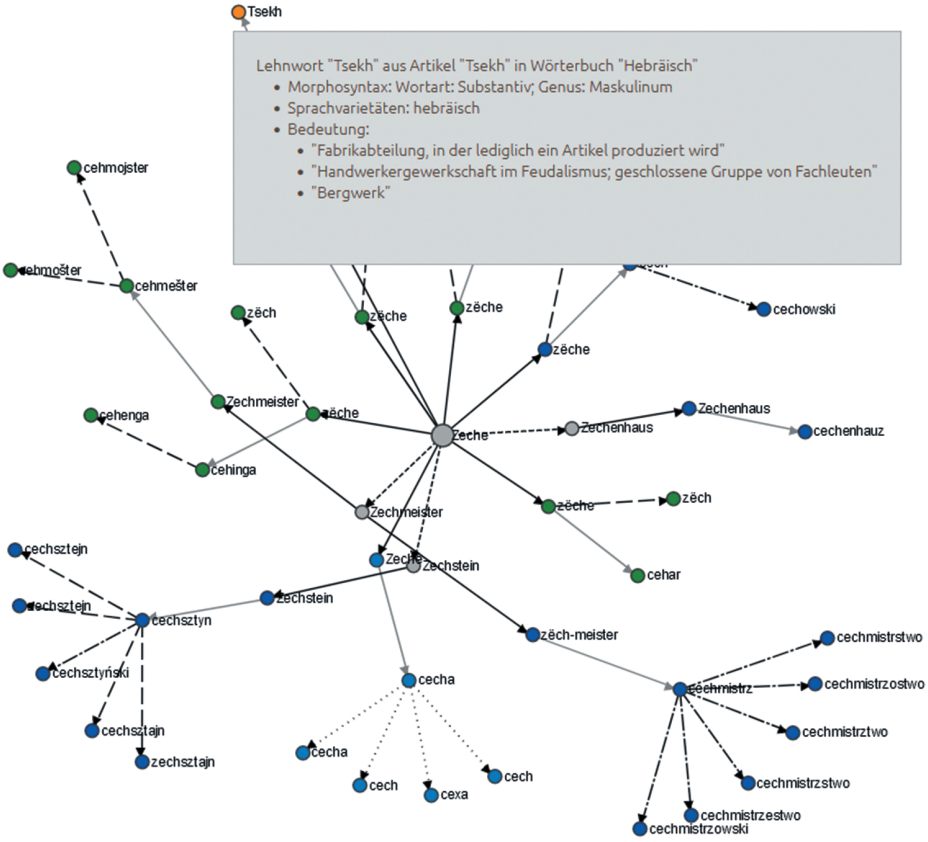


Fig. 5.23: Graph representing loanword relationships and morphological relationships in the LWPD using the option of graph-based searches; article for Hebrew *Tsekh* as a borrowing from German *Zeche* ('mine').

It is possible to download the entire basis of data of WIKTIONARY and, thus, to analyse it as a whole body of data.[7] For example, it is possible to visualise all of the relevant information about paradigmatic linking in WIKTIONARY in a single overall representation, drawing an atlas, as it were, of the paradigmatic information in the dictionary (→ Fig. 5.27). The basis for → Fig. 5.27 is provided by all of the incoming and outgoing edges for all five of the relevant classes of information (synonyms, antonyms, factually related words and words related by meaning, superordinate terms, and subordinate terms), represented as a single graph. To aid clarity, only the nodes (keywords) and not the connections between them (edges) are represented. In the process, three clear groups emerge: verbs, nouns, and adjectives. Here, nouns are the largest group. The visualisation routine that is used to create the graph organises the headwords with many con-

7 https://dumps.wikimedia.org/ [last access: October 14, 2023].

Fig. 5.24: Word cloud with automatically derived collocations for the German lexeme *laufen* ('run') in the DWDS; corresponding dictionary articles are called up by clicking on words.

nections between them close to one another spatially. As we would expect, the whole graph shows that paradigmatic linking exists above all between headwords from the same word class. Furthermore, the image as a whole makes it possible to see that a large group of headwords are positioned at the periphery of the graph. These are headwords that are only linked in a very weak way with other headwords. This is the case, for example, when two headwords are connected with one another, but no connection exists in the rest of the graph. A digital version of this graph has been made available online, which allows enlarged sections to be viewed by "zooming in".[8] This kind of global map does not make it possible to see any details of linking, but it offers a completely different view of the linking structure of the dictionary.

Furthermore, the analysis of the whole basis of data makes it possible to determine their quantitative distributions. Are there more cross-references to synonyms or antonyms? On average, how many nouns, verbs, or adjectives are reported? In this study, for example, we learn that around 25% of the whole inventory of headwords in the German WIKTIONARY are linked paradigmatically, that these linkages exist above all among headwords of the same class, and that the overwhelming majority of instances of paradigmatic information are in entries for nouns, while for verbs the average number of relational partners is higher than for nouns.

In addition, this kind of global analysis of all of the paradigmatic linking makes it possible to detect particularly strongly linked groups of headwords, for example, by analysing whether there is a group of headwords in the graph where all of the mem-

8 http://www.ids-mannheim.de/fileadmin/lexik/bilder/all.links.pdf [last access: October 14, 2023).

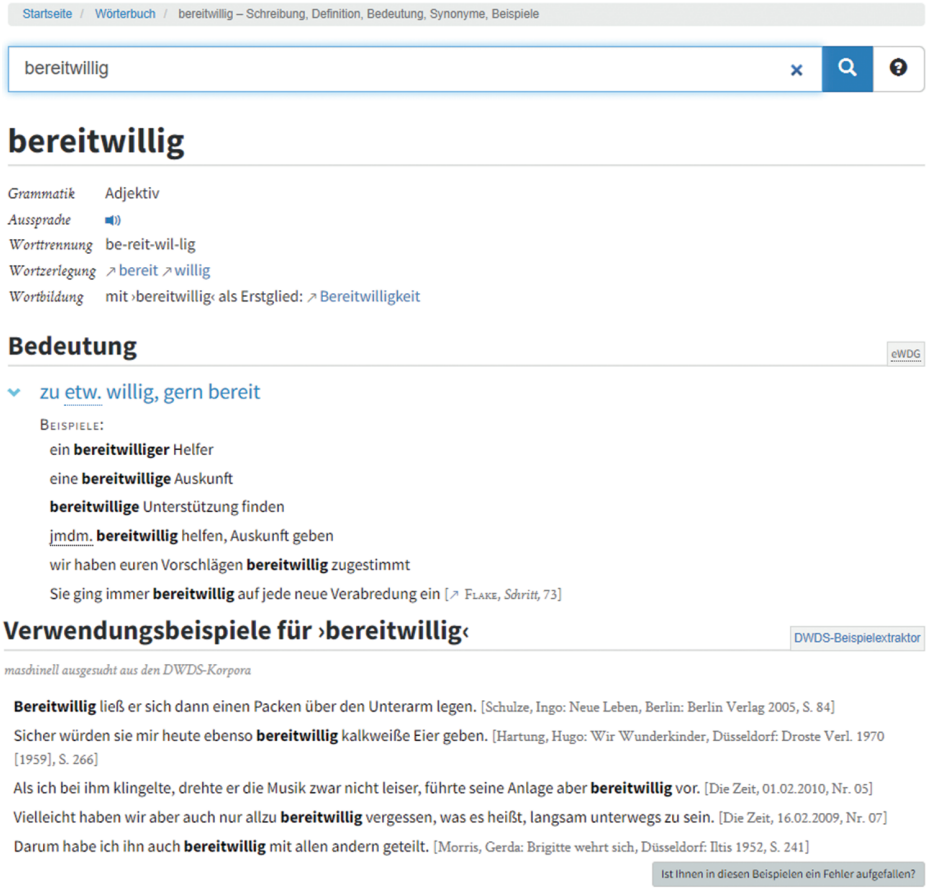


Fig. 5.25: Search for German *bereitwillig* ('willing') in the DWDS and in its integrated corpora.

bers of that group are linked with all of the other members. For instance, this was the case in the German WIKTIONARY for the causal connectors around *deswegen* ("therefore"), where all of the members of the headword group were connected with all of the others (→ Fig. 5.28). In a second step, this kind of data can be pulled together with further (meta)data about these words. For example, we investigated whether paradigmatically linked words are also frequently looked up. The results for the headword group around *deswegen* can be seen in → Fig. 5.29: here, it is above all the headword *ergo* that is looked up particularly frequently (cf. Müller-Spitzer 2015).[9]

9 We thank Sascha Wolfer for providing us with these figures in printable quality.

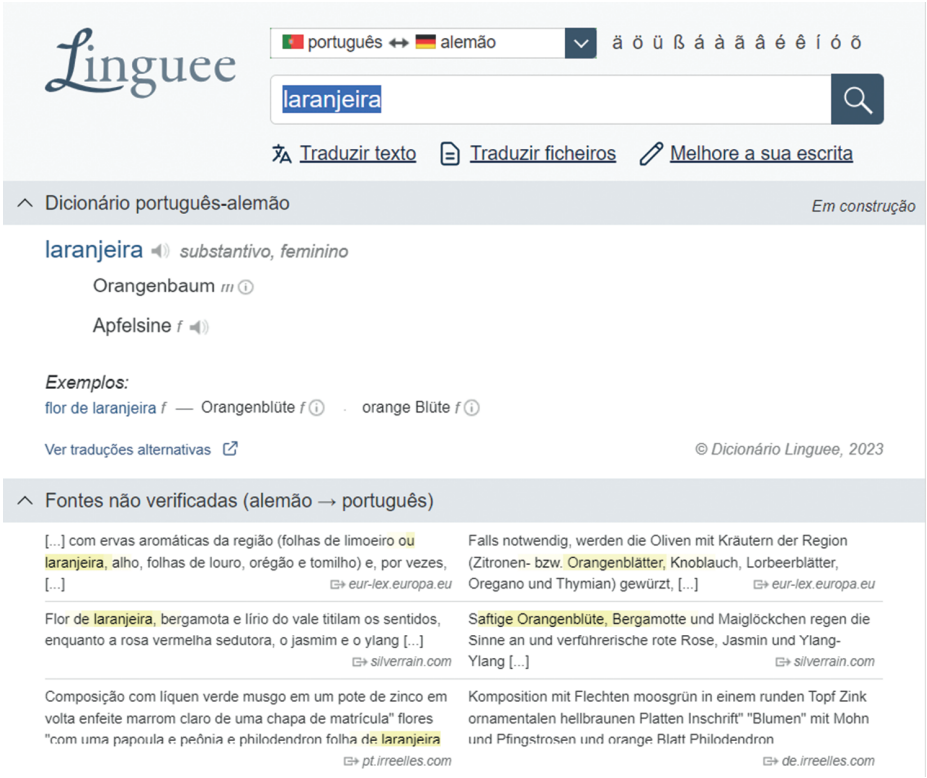


Fig. 5.26: Search for Portuguese *laranjeira* ‘orange tree’ in the Portuguese-German LINGUEE and in its parallel corpus.

This kind of new approach to analysing linking structures may not only provide new impetus for describing linking structures but may also be used to create new access structures. For example, users could have the option to be shown groups of keywords that are closely linked paradigmatically and to be able to access them directly (which may be more useful than showing words that are close to each other in the alphabet, as in printed dictionaries). This is just one example for the way in which so much could still change in the field of linking and access structures.

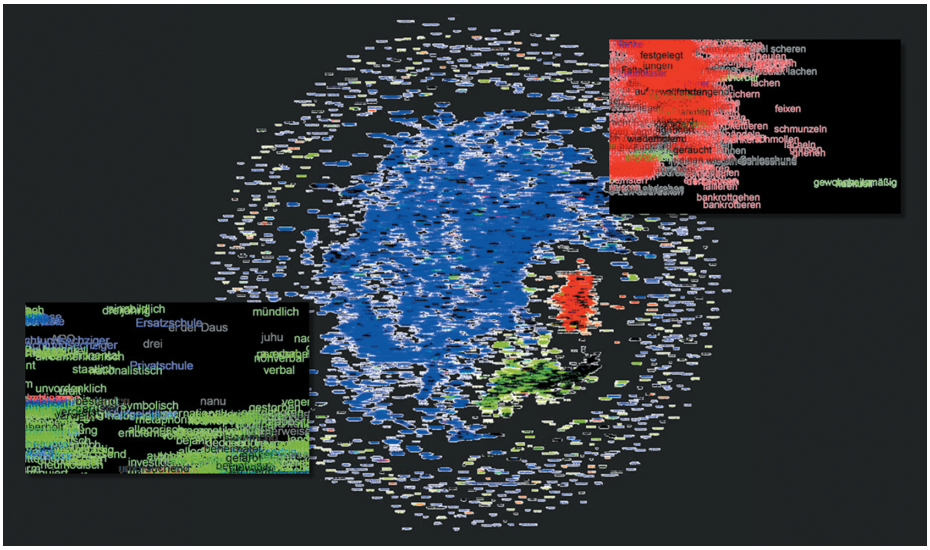


Fig. 5.27: Paradigmatic linking in the German WIKTIONARY as a complete graph; colours indicate different parts of speech.

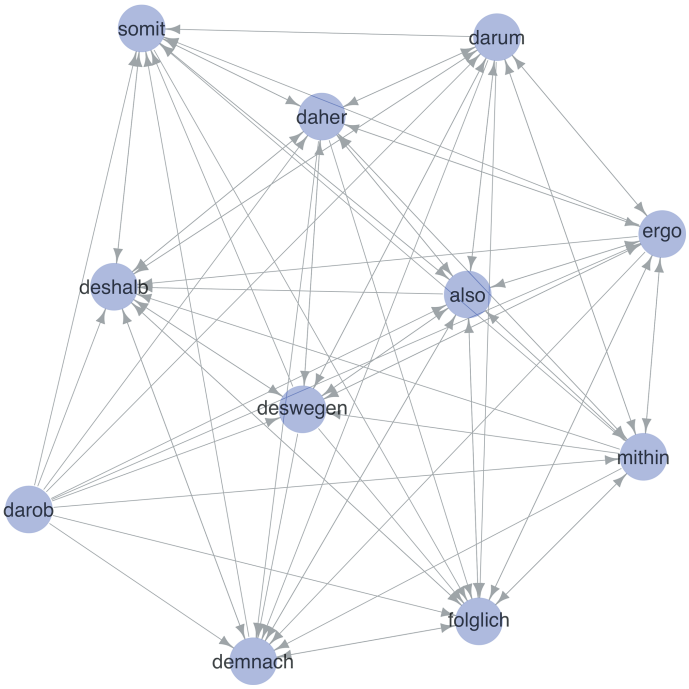


Fig. 5.28: Clique *deswegen*.

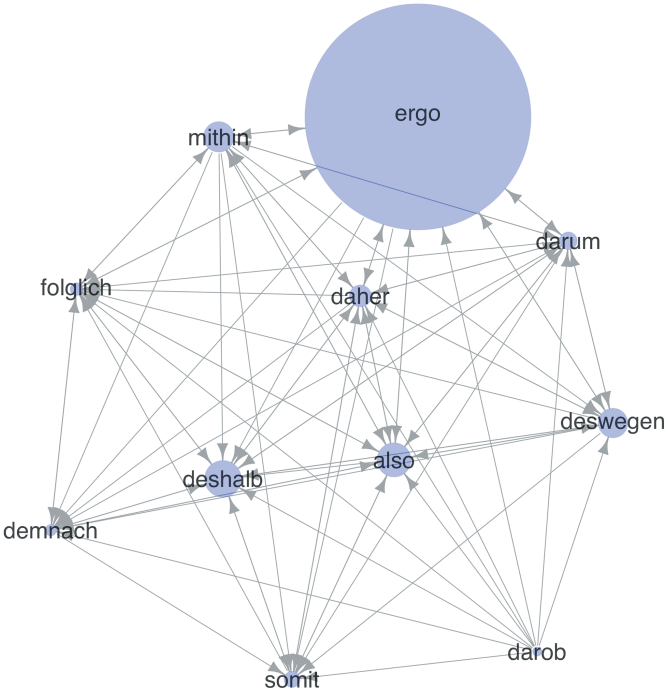


Fig. 5.29: Clique *deswegen*, labelled for frequency of consultation (the size of the circle indicates the frequency of consultation in 2014).

Bibliography

Further reading

Gouws, Rufus H. (2018): Internet lexicography in the 21st century. Berlin/Boston: de Gruyter. In: Engelberg, Stefan/Kämper, Heidrun/Storjohann, Petra (eds.): *Wortschatz: Theorie, Empirie, Dokumentation*, 215–236. https://doi.org/10.1515/9783110538588-010 [last access: April 27, 2024]. *This article relates questions of linking and access structure in digital dictionaries to structural features of printed dictionaries, thus providing a helpful (terminological) link to earlier metalexicographic research.*

Pastor, Verónica/Alcina, Amparo (2022): Researching the use of electronic dictionaries. In: Jackson, Howard (ed.): *The Bloomsbury Handbook of Lexicography*. London et al.: Bloomsbury Academic, 89–124. *This article also provides an overview of linking and access structures, but with a particular focus on developing a standardised nomenclature for describing the different types of searches found in different dictionaries.*

Literature

Academic literature

Blumenthal, Andreas/Lemnitzer, Lothar/Storrer, Angelika (1998): Was ist eigentlich ein Verweis? Konzeptionelle Datenmodellierung als Voraussetzung computerunterstützter Verweisbehandlung. In: Harras, Gisela (ed.): *Das Wörterbuch. Artikel und Verweisstrukturen. Jahrbuch 1987 des Instituts für deutsche Sprache*. Düsseldorf: Schwann, 351–373.

Dziemianko, Anna (2018): Electronic dictionaries. In: Pedro A. Fuertes-Olivera (ed.): *The Routledge Handbook of Lexicography*. London/New York: Routledge, Taylor & Francis, 663–681.

Engelberg, Stefan/Klosa-Kückelhaus, Annette/Müller-Spitzer, Carolin (2020): Internet lexicography at the Leibniz-Institute for the German Language. In: *K Lexical News* 28, 54–77.

Engelberg, Stefan/Lemnitzer, Lothar (2009): *Lexikographie und Wörterbuchbenutzung*. 4., überarb. Aufl. Tübingen: Stauffenburg.

Fillmore, Charles J. (1978): On the Organization of Semantic Information in the Lexicon. In: Farkas, Donka/Jacobsen, Wesley M./Todrys, Karol W. (eds.): *Papers from the Parasession on the Lexicon*. Chicago: Chicago Linguistic Society, 148–173.

Giacomini, Laura (2015): Macrostructural properties and access structures of LSP e-dictionaries for translation: the technical domain. In: *Lexicographica* 31, 90–117.

Granger, Sylviane/Paquot, Magali (2015): Electronic lexicography goes local: Design and structures of a needs-driven online academic writing aid. In: *Lexicographica* 31, 118–141.

Kammerer, Matthias (1998): Die Mediostruktur in Langenscheidts Großwörterbuch Deutsch als Fremdsprache. In: Wiegand, Herbert Ernst (ed.): *Perspektiven der pädagogischen Lexikographie des Deutschen. Untersuchungen anhand von "Langenscheidts Großwörterbuch Deutsch als Fremdsprache"*. Tübingen: Niemeyer, 315–330.

Klosa-Kückelhaus, Annette/Michaelis, Frank (2022): The design of internet dictionaries. In: Howard Jackson (ed.): *The Bloomsbury Handbook of Lexicography*. London et al.: Bloomsbury Academic, 405–421.

Lew, Robert (2012): How can we make electronic dictionaries more effective? In: Granger, Sylviane/Paquot, Magali (eds.): *Electronic Lexicography*. Oxford: Oxford University Press, 343–361.

Lindemann, Margarete (1999): Mediostrukturen in modernen italienischen Wörterbüchern. In: *Lexicographica* 15, 38–65.

Mann, Michael (2010): Internet-Wörterbücher am Ende der "Nullerjahre": Der Stand der Dinge. Eine vergleichende Untersuchung beliebter Angebote hinsichtlich formaler Kriterien unter besonderer Berücksichtigung der Fachlexikographie. In: *Lexicographica* 26, 19–45.

Meliss, Meike/Möhrs, Christine/Ribeiro Silveira, Maria/Schmidt, Thomas (2019): A corpus-based lexical resource of spoken German in interaction. In: Kosem, Iztok, et al. (eds.): *Electronic Lexicography in the 21st Century: Smart Lexicography. Proceedings of the eLex 2019 conference, Sintra, Portugal, 1–3 October 2019*. Brno: Lexical Computing CZ s.r.o., 783–804.

Meyer, Peter (2013): Advanced graph-based searches in an Internet dictionary portal. In: Kosem, Iztok, et al. (eds.): *Electronic lexicography in the 21st century: thinking outside the paper. Proceedings of the eLex 2013 conference, 17–19 October 2013, Tallinn, Estonia*. Ljubljana/Tallinn: Trojina, Institute for Applied Slovene Studies/Eesti Keele Instituut, 488–502.

Meyer, Peter (2014): Meta-computerlexikografische Bemerkungen zu Vernetzungen in XML-basierten Onlinewörterbüchern – am Beispiel von elexiko. In: Abel, Andrea/Lemnitzer, Lothar (eds.): *Vernetzungsstrategien, Zugriffsstrukturen und automatisch ermittelte Angaben in Internetwörterbüchern*. Mannheim: Institut für Deutsche Sprache, 9–21. https://pub.ids-mannheim.de/laufend/opal/opal14-2.html [last access: April 27, 2024].

Meyer, Peter/Tu, Ngoc Duyen Tanja (2021): A word embedding approach to onomasiological search in multilingual loanword lexicography. In: Kosem, Iztok, et al. (eds.): *Electronic Lexicography in the 21st Century. Proceedings of the eLex 2021 conference. 5–7 July 2021, virtual*. Brno: Lexical Computing CZ, s.r.o., 78–91.

Moerdijk, Fons/Tiberius, Carole/Niestadt, Jan (2008): Accessing the ANW dictionary. In: *Proceedings of the workshop on Cognitive Aspects of the Lexicon (COGALEX '08)*. Association for Computational Linguistics, Stroudsburg, PA, USA, 18–24.

Müller, Peter O. (2002): Die Mediostruktur im De Gruyter Wörterbuch Deutsch als Fremdsprache. In: Wiegand, Herbert Ernst (ed.): *Perspektiven der pädagogischen Lexikographie des Deutschen II*. Tübingen: Niemeyer, 485–496.

Müller-Spitzer, Carolin (2007): *Der lexikografische Prozess. Konzeption für die Modellierung der Datenbasis*. Tübingen: Narr.

Müller-Spitzer, Carolin (2013): Textual structures in electronic dictionaries compared with printed dictionaries. A short general survey. In: Gouws, Rufus H., et al. (eds.): *Dictionaries. An International Encyclopedia of Lexicography. Supplementary Volume: Recent Developments with Focus on Electronic and Computational Lexicography.* Berlin/Boston: De Gruyter, 367–381.

Müller-Spitzer, Carolin/Wolfer, Sascha (2015): Vernetzungsstrukturen digitaler Wörterbücher. Neue Ansätze zur Analyse. In: *Lexicographica* 31, 173–199.

Nielsen, Sandro (1999): Mediostructures in Bilingual LSP Dictionaries. In: *Lexicographica* 15, 90–113.

Pastor, Verónica/Alcina, Amparo (2022): Researching the use of electronic dictionaries. In: Jackson, Howard (ed.): *The Bloomsbury Handbook of Lexicography*. London et al.: Bloomsbury Academic, 89–124.

Porta-Zamorano, Jordi (2018): Exploratory and text searching support in the Dictionary of the Spanish Language. In: Čibej, Jaka et al. (eds.): *Proceedings of the XVIII EURALEX International Congress: Lexicography in Global Contexts*. Ljubljana: Ljubljana University Press, Faculty of Arts, 925–929.

Schmidt, Thomas (2009): The Kicktionary – A multilingual lexical resource of football language. In: Boas, Hans C. (ed.): *Multilingual Frame-Nets in Computational Lexicography*. Berlin/Boston: De Gruyter, 101–132.

Seretan, Violeta/Wehrli, Eric (2009): Context-sensitive look-up in electronic dictionaries. In: Gouws, Rufus H., et al. (eds.): *Dictionaries. An International Encyclopedia of Lexicography. Supplementary Volume: Recent Developments with Focus on Electronic and Computational Lexicography.* Berlin/Boston: De Gruyter, 1056–1062.

Storrer, Angelika (2013): Representing (computational) dictionaries in hypertextual form. In: Gouws, Rufus H. et al. (eds.): *Dictionaries. An International Encyclopedia of Lexicography. Supplementary Volume: Recent Developments with Focus on Electronic and Computational Lexicography*. Berlin/Boston: De Gruyter, 1244–1253.

Tarp, Sven (1999): Theoretical foundations of the so-called crossreference structures. In: *Lexicographica* 15, 114–137.

Tarp, Sven (2008): *Lexicography in the Borderland between Knowledge and Non-Knowledge. General Lexicographical Theory with Particular Focus on Learner's Lexicography*. Tübingen: Niemeyer.

Tiberius, Carole/Declerck, Thierry: A lemon model for the ANW Dictionary. In: Kosem, Iztok, et al. (eds.): *Electronic Lexicography in the 21st Century. Proceedings of the eLex 2017 conference. 19–21 September 2017, Leiden, Netherlands*. Brno: Lexical Computing CZ, s.r.o., 237–251.

Torner, Sergi/Arias-Badia, Blanca (2019): Visual networks as a means of representing collocational information in electronic dictionaries. In: *International Journal of Lexicography* 32, 3, 270–295.

Wiegand, Herbert Ernst (2001): Was eigentlich sind Wörterbuchfunktionen? Kritische Anmerkungen zur neueren und neuesten Wörterbuchforschung. In: *Lexicographica* 17, 217–248.

Wiegand, Herbert Ernst (2002): Altes und Neues zur Mediostruktur in Printwörterbüchern. In: *Lexicographica* 18, 168–252.

Wiegand, Herbert Ernst/Smit, Maria (2013): Mediostructures in printed dictionaries. In: Gouws, Rufus H., et al. (eds.): *Dictionaries. An International Encyclopedia of Lexicography. Supplementary Volume: Recent Developments with Focus on Electronic and Computational Lexicography*. Berlin/Boston: De Gruyter, 214–253.

Dictionaries and other reference works

ANW = *Algemeen Nederlands Woordenboek*. Leiden: Instituut voor de Nederlandse Taal. https://anw.ivdnt.org/search [last access: April 27, 2024].

BabelNet = *BabelNet. Version 5.2*. https://babelnet.org [last access: April 27, 2024].

DWDS = *Digitales Wörterbuch der deutschen Sprache*. Berlin-Brandenburgische Akademie der Wissenschaften. http://www.dwds.de [last access: April 27, 2024].

elexiko = elexiko. In: *OWID – Online Wortschatz-Informationssystem Deutsch*. Mannheim: Leibniz-Institut für Deutsche Sprache. http://www.owid.de/wb/elexiko/start.html [last access: April 27, 2024].

e-VALBU = Das elektronische Valenzwörterbuch deutscher Verben. In: *Grammis*. Mannheim: Leibniz-Institut für Deutsche Sprache. http://hypermedia.ids-mannheim.de/evalbu/index.html [last access: April 27, 2024].

FrameNet = *FrameNet*. Berkeley: International Computer Science Institute. http://framenet.icsi.berkeley.edu/ [last access: April 27, 2024].

GermaNet = *Germanet*. *A Lexical-semantic Net for German*. Universität Tübingen, Allgemeine Sprachwissenschaft und Computerlinguistik. www.sfs.uni-tuebingen.de/GermaNet/index.shtml [last access: April 27, 2024].

Google = *Google Dictionary*. Google Inc. [available as an app for Chrome; otherwise integrated into the Google search engine].

Kicktionary = Schmidt, Thomas: *Kicktionary*. *Mehrsprachiges digitales Wörterbuch zur Fachsprache des Fußballs*. http://www.kicktionary.de/index_de.html [last access: April 27, 2024].

Kommunikationsverben = Kommunikationsverben. In: *OWID – Online Wortschatz-Informationssystem Deutsch*. Mannheim: Leibniz-Institut für Deutsche Sprache. http://www.owid.de/docs/komvb/start.jsp [last access: April 27, 2024].

LiLa = *LiLa: Linking Latin*. *Building a Knowledge Base of Linguistic Resources for Latin*. Milan: Università Cattolica del Sacro Cuore. https://lila-erc.eu [last access: April 27, 2024].

Linguee = *Linguee Wörterbuch*. Köln: Linguee GmbH. http://www.linguee.de [last access: April 27, 2024].

LWPD = Meyer, Peter/Engelberg, Stefan: *Lehnwortportal Deutsch*. Unter Mitarbeit von Friederike Appel, Frank Michaelis und Simona Štavbar. Mannheim: Leibniz-Institut für Deutsche Sprache. Online: http://lwp.idsmannheim.de/ [last access: April 27, 2024].

Merriam-Webster = *Merriam.Webster*. Springfield: Merriam-Webster Inc. https://www.merriam-webster.com/ [last access: April 27, 2024].

MWVDO = *Merriam-Webster Visual Dictionary Online*. QA International. https://www.visualdictionaryonline.com [last access: April 27, 2024].

OED = *Oxford English Dictionary*. Oxford: Oxford University Press. http://www.oed.com/ [last access: April 27, 2024].

OWID = *OWID – Online Wortschatz-Informationssystem Deutsch*. Mannheim: Leibniz-Institut für Deutsche Sprache. http://www.owid.de/.

TLFi = *Trésor de la langue française informatisé*. Nancy: ATILF. http://atilf.atilf.fr/ [last access: April 27, 2024].

Visual Thesaurus = *Thinkmap Visual Thesaurus*. New York: Thinkmap, Inc. http://www.visualthesaurus.com [last access: April 27, 2024].
Wikipedia = *Wikipedia, die freie Enzyklopädie*. San Francisco, CA: Wikimedia Foundation. https://www.wikipedia.org [last access: April 27, 2024].
Wiktionary = *Wikitionary, das freie Wörterbuch*. https://de.wiktionary.org/wiki/Wiktionary:Hauptseite [last access: April 27, 2024].
WordNet = *WordNet*. Princeton, NJ: Princeton University. https://wordnet.princeton.edu/ [last access: April 27, 2024].
Wortschatz = *Wortschatz-Portal*. Universität Leipzig. http://wortschatz.uni-leipzig.de/ [last access: April 27, 2024].

Images

Fig. 5.1 Mannheim-Straßenverkehr: https://upload.wikimedia.org/wikipedia/commons/c/c7/Mannheim-Strassenverkehr.png?uselang=de> Knoten Mannheim: OpenStreetMap <http://www.openstreetmap.org/node/240060919#map=11/49.4898/8.4670 Frank, Wikimedia Commons, licenced under CreativeCommons-Lizenz BY-SA 3.0, URL: https://creativecommons.org/licenses/by-sa/3.0/legalcode. Straßenschild: Street sign with ideas https://upload.wikimedia.org/wikipedia/commons/3/33/Street_Sign_with_ideas.jpg. Tom Murphy, Wikimedia Commons, licenced under CreativeCommons-Lizenz BY-SA 3.0, URL: https://creativecommons.org/licenses/by-sa/3.0/legalcode.