16

Formal representation and extraction of perspectives

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16.1 Abstract

Perspectivisation is a pervasive cognitive phenomenon, and the current state of the Web and virtual communication intensifies its personal and social consequences, requiring appropriate modeling to be studied at scale, computationally. A perspective is also an entity we need to talk about as soon as a knowledge graph of facts is perspectivised, and new facts/perspectives are extracted e.g. from discourse or a movie. This chapter describes a landscape of perspective research, presents a formal ontology of *Cognitive Perspectivisation* (CP) based on frame semantics and multilayered knowledge graphs, and shows how to operationalise CP with respect to viewpoints in political spinning. A discussion of the current techniques to automate the pipeline of extraction, representation, and reasoning with CP and hybrid methods concludes the work.

16.2 Viewpoints and perspectives: a landscape

Humans tend to process multimodal input within stories, as a tool to make sense of complex environmental and internal information, and their interaction. Narratological and social cognition research Enfield and Levinson (2006) Boyd (2009) Dancygier et al. (2016) has relevant results on the role played by narratives, and viewpoint occupies a central place Verhagen (2016):

> In processing narrative discourse, listeners/readers construct conceptualizations of the ways [...] different viewpoints are connected into a meaningful fabric, and moreover connect it to their own point of view, thus adding a further dimension of meaning.

The scale of the Web has changed the way we make research on cognitive phenomena, and requires that we model perspectival discourse so that we can

use computation to study it. In computer science, and especially semantic technologies (including e.g. knowledge representation, knowledge extraction and natural language processing), we aim at understanding human conceptualization as the optimal way to understand system requirements and the domain in which they apply. Since human viewpoint conceptualization is so widespread, we need to treat viewpoints as first-order entities in our semantic representation of the world. The work so far has scratched the surface of global phenomena such as bias in news Ma and Yoshikawa (2009) and viewpoints in opinionated text Paul et al. (2010). There have been multiple attempts to provide a context semantics to knowledge representation Hayes (2012) Klarman and Gutierrez-Basulto (2016), but the most successful has been in adding syntactic facilities to boost knowledge graphs Noy et al. (2019) with annotations of statements, whose semantics is however entirely left to the user. The recent introduction of RDF* Olaf Hartig (2021) helps in reducing the required syntactic overload for linked data.

Since viewpoints/perspectives occupy such a central role in cognition, they escape a simple way of identifying a closed set of semiotic features. Orderly encoding of viewpoints exists in Direct and Indirect Discourse structures (as in the sentences *I am lost*, *he said he was fainting*), where the provenance of a fact or judgment is explicit. But when multiple viewpoints are reported, things can get complicated. Furthermore, as described in pioneering work by Jakobson Jakobson (1957), viewpoints are often contained within Free Indirect Discourse (neither Direct nor Indirect), which "mixes" the provenance of reported facts (so inducing an epistemological quagmire), as in the sentence *She was lost in thought*, where we can only unsafely assume that the author of the text is the holder of the perspective on *she*'s state of mind.

Beyond natural language, perspectives are the primary tool for visual narratives in photography and video, as with the Kuleshov Effect Mobbs et al. (2006), which also evidences multimodal interferences in originating interpretive perspectives. Perspectives are also present in data, typically in the form of provenance declarations[a] or when alternative datasets or models on a same topic are integrated.

Far from being only a matter of provenance, perspectives arise from multiple dimensions. In natural language, a plethora of subtle lexical, modal, mood, deictic, as well as discourse markers and cues, require attention in order to interpret viewpoints. In data, even when provenance is given, different conceptual schemas, *views* or queries on data can generate different ontologies

[a] http://www.w3.org/TR/prov-dm/#dfn-provenance

(world representations), and e.g. different infographics may eventually lead to biased or distorted interpretations by readers Krauss (2012).

A central issue in perspective research is about what makes a perspective emerge, i.e. *perspective generators*. As a quick list of cases in perspectival semantics, we provide the following sentences, images, videos, as well as complex communication phenomena. Far from being complete, we classify them by the kind of *perspective generator* they feature:

- discourse markers: *a cat is on the mat* vs. *that cat is again on the mat*
- lexical frames: *your building is on the hill* vs. *your building hangs over the city*
- attitudes: *I hate speaking in public*, *I am happy he has been condemned*
- patternicity: use of commonplaces, idioms, sayings, to interpret a situation, e.g. *Queen is a fake rock band*, *The Procrustean bed of crisis: the momentum of a conflict and its analytical fixation inexorably escape each other*
- culturally sensible framing: biases as emotionally laden framing used against certain people or topics, e.g. the *migrants are invaders* framing in political discourse from U.S., Hungary, Italy in 2018
- alternative framing and storytelling: political talk, e.g. *conservatives claim that we need tax relief* vs. *democrats claim that taxes are investments*, see also the neurocognitive reconstruction of framing and storytelling cases in Lakoff (2008)
- explicit multimodal framing on a neutral fact: the Kuleshov Effect Mobbs et al. (2006). Kuleshov noticed the multiple meanings emerging out of the contrast and ordering of images in the films of Russian formalists in the early 20th century
- explicit alternative narratives: Akira Kurosawa's Rashomon movie, Escher's *stairways* graphics, the CAMEO ontology Event Data Project Department (2012) in the political, diplomatic and military mediation and conflict domain, alternative reconstructions of facts and causality in science, Law, economics, etc.
- silencing: Cancel (or Call-Out) culture, e.g. completely ignoring or suppressing the communication/expertise of those who infringe a taboo in social media (or more traditionally, in social circles), e.g. attacking a beloved or influential person, defending criminals, committing a hateful crime, behaving against the currently accepted practices, etc.

A theory for public perspectivisation practices that have huge effects on societies is emerging from work in social cognition and cognitive neuroscience,

with Lakoff's work Lakoff (2008) being an interesting attempt towards a unified account: framing works in order to provide individual counterparts to reality, (see also Gangemi (2020)) and becomes activated in biological mechanisms such as neural binding, emotional paths, somatic markers and mirror neurons. Neural binding allows to "connect the pieces" that come from perception, recall, abstraction, and imagination. Neural binding works according to emotional paths (dopaminergic, noradrenergic), and is linked to narratives and frames. Mirror neurons activate the same circuitry for actual perception, recall of perception, abstraction of perception, and imagination of new perceptions.

We are far from an explanatory and predictive theory that spans from semiotics to neural activation, social cognition and public behaviour, however, the bits and pieces of biological and phenomenological evidence are promising, and make us feel entitled to propose a formal contribution to jointly study perspectivisation phenomena.

16.3 What is a perspective?

This initial landscape analysis of perspective/viewpoint research shows how challenging it is to formally represent perspectives, as well as to single out one or more sets of features that can used for extracting perspectives. A general definition of viewpoint in language Dancygier et al. (2016) is that it is "present when an expression represents a person's judgement or when that person is responsible for the expression". This definition hints at viewpoint holders as provenance points for either an expression, or a judgment. But a judgment is itself conveyed in an expression. We clearly need a more precise definition before proposing a formal/computational treatment of perspectives.

Perspective is typically understood as an attitude, as in the Oxford Dictionary definition:

> a particular attitude towards or way of regarding something; a point of view.

Its etymology goes back to *perspicere*, Latin for "looking through", which links the attitude notion back to a metaphoric account of understanding in terms of perceiving, as exemplified e.g. in the MetaNet repository of English metaphors: `Understanding is Perceiving`. However, the notion of "through" seems to imply an effort to disentangle something, in order to give it a view.

The two notions of analysing and having an attitude towards something can

be made formal by using two rhetorical devices. Firstly, we need to detach ourselves from the thing analysed (*having an attitude*). Then, we need to analyse the thing, and tell a story that puts some part of the analysed thing under the focus of our scrutiny, apparently revealing a less known or obscure aspect, or creating a previously blurred relation, asserting a judgment, or simply creating a spotlight on one of the analysed parts or aspects.

We call this complex rhetorical device *cognitive perspectivisation*. In fact, differently from the act of taking a perspective (or viewpoint, standpoint, vantage point, etc., which all seem metaphorical parts of the `Perceiving` frame) on a physical object or scene, in cognitive perspectivisation we always assume a situation as constructed (perceived, judged, negated, inferred, etc.) by someone, typically in contrast to some other perspective, e.g. as part of an argumentation.

This contrastive nature of perspectivisation seems coherent with its storytelling nature. Even in rigorous domains such as medicine or jurisprudence, perspectivisation is a major reasoning tool, and emerges as soon as two descriptions of a same case are taken into account. As argued in Gangemi et al. (2004); Gangemi et al. (2001); Gangemi et al. (2005), the expertise used to evaluate alternative diagnostic hypotheses on a patient's situation, or to assess conflicting norms to be applied on a same legal state of affairs, requires to reason at both intensional (conceptual) and extensional (factual) levels, albeit such levels can be recursively expanded, as with meta-norms (on top of alternative norms), epistemological principles (on top of diagnostic hypotheses), etc.

Perspectives can then be the target of epistemological practices introduced as regulatory and/or coordination measures: scientific methods, objectivity practices, fact checking, control of bias, sentiment, emotion, etc.).

As with the contrasting sentences: *family is the place of love* vs. *love is the place of family*, perspectivisation happens when at least two views could be selected from a ground situation (e.g. *location* + *love* + *family*). This also means that we need to postulate the existence of at least two perspectives, either implicit or explicit, in order for one of them to be considered (e.g. the family-oriented one in the example). In other words, perspectivisation always entails comparative reasoning. In everyday life however, this often goes unnoticed. Political spins for example exploit rhetorical means (as in the location+love+family example) in order to make one perspective preferred in the understanding of an audience.

In order to implement perspectivisation, a situation should be known, or simply expected to be known (this is the *background*), although only some *aspect* (or *cut* in cinematics language) of the background is shared, and appropriate control constructs (e.g. the location roles in the example sentence) are

introduced as a *lens* to observe that aspect. The control constructs reflect the *attitude* of the *conceptualiser*, i.e. the perspective holder, as well as its *values*, norms, goals, etc.

This implementation can be preliminarily represented as a conceptual frame Fillmore (1982) or knowledge pattern Clark et al. (2000) Gangemi and Presutti (2010). A `Perspective` frame includes roles for *eventualities*, their `background`, a `cut` on them, appropriate `lenses`, possible `attitudes`, and of course a `conceptualiser` that holds the perspective. We may imagine though that additional roles may be active: `recipient`, `time`, `provenance`, `trustworthiness`, `community support`, etc. We can also imagine relations between perspectives, as well as between perspectives and values, ethical principles, norms, political ideology, etc.

It is remarkable that this definition includes in practice most of our discourse productions, even in presence of elliptical sentences such as "*wow!*" (requiring substantial context to reconstruct the perspectival situation), or with *In* Lu (2017) constructions such as *I have him in the car* or *I have him in the loop*, where a Langacker's Perspective Taking mechanism Langacker (1987) is exemplified: in order to have someone in some place, it requires a vantage point by the perspective holder, who shares the same (physical, social, or abstract) space with the situation addressed by the perspective.

In fact, in cognitive linguistics perspectivisation is assumed as a comprehensive process of meaning production Verhagen (2007):

> a viewpoint is regarded as the cognitive mechanism of construal of an object in discourse from the point of view of the speaker (conceptualiser). The act of construal is performed by the speaker to influence the cognitive state of the listener.

16.4 Representing and extracting perspectives

Based on the conceptual frame that we have sketched for a broad notion of perspective, we can start suggesting a formal treatment.

Firstly, we assume a general knowledge representation (KR) style that is widely used in academy, industry and government, i.e. *knowledge graphs* Noy et al. (2019). We make use in particular of RDF graphs with OWL2 schemas Motik et al. (2009), but they can be straightforwardly converted into graph databases, conceptual models, or other KR languages. In the text, we use first-order logic for general accessibility.

Secondly, we assume a knowledge pattern framework such that, given the *background knowledge* about an *eventuality*[b] *cognitive perspectivisation* re-

[b] An eventuality is a catch-all class including events, event types, factoids, and situations, cf. the

describes that eventuality by providing multiple lenses in the form of *constructions*[c], narratives, stories, and *principles*[d] to tailor a *cut* within the background eventuality, revealing the *attitude* held by the *conceptualiser* towards the cut, and, by extension, to the overall eventuality, typically in contrast to alternative cuts held by others.

For example, assuming the previous *localization+family+love* example as an eventuality with its background knowledge of frames such as *being a couple*, *mutual love*, and *marriage*, a typical conservative politician would make a cut using a localization metaphor as a lens that puts love situations in the "family as place". On the contrary, a typical progressive perspectivisation would rather cut it with a same lens, but inverting it, i.e. putting family situations in the "love as place". Of course, this cut is supported by different value lenses: the conservative one depending on the *tradition* value lens that favors marriage, the progressive on a *self-direction* value lens that favors tolerance to alternative institutions to marriage, since it prioritises a more general *openness to change* value over the *conservation* value.[e]

This assumption is formalised as a `CognitivePerspectivisation` (`CP`) *n-ary* relation holding between a conceptualiser producing a cut of an eventuality on its background knowledge, by using one or more lenses. Figure 16.1 shows a Graffoo Falco et al. (2014) diagram that summarizes the OWL2 Motik et al. (2009) axioms from the CP ontology.

Due to the polymorphism of the `CP` relation (other arguments can be considered such as time, location, provenance, etc.), it is specified here as a multigrade relation Oliver and Smiley (2004); Gangemi (2020), represented as a *SuperDuper* knowledge pattern Gangemi and Presutti (2016), also known as *Descriptions & Situations*. A super-duper pattern allows (a) to reify the relation both as a class of *situations*, and an intensional *description* (a.k.a. *frame*), (b) to reify its instance relationships as individual situations, and (c) to project all its arguments as both binary relations, and intensional concepts. This solution provides a first-order representation for both the intension of a perspective (its roles, types, relations to other perspectives, etc.), and its extension (its situations). In OWL2 we use *punning* to grant a double intepretation to the same

DOLCE-Zero ontology at
`http://www.ontologydesignpatterns.org/ont/d0.owl`

[c] A construction may be a linguistic, visual, cinematic, gestural, or even multi-modal pattern)

[d] Principles can be individual, social and cultural values, norms, social practices, stereotypes, biases, etc.

[e] We are using here the circumplex model of Schwartz' Schwartz (2012) as a reference for those values.

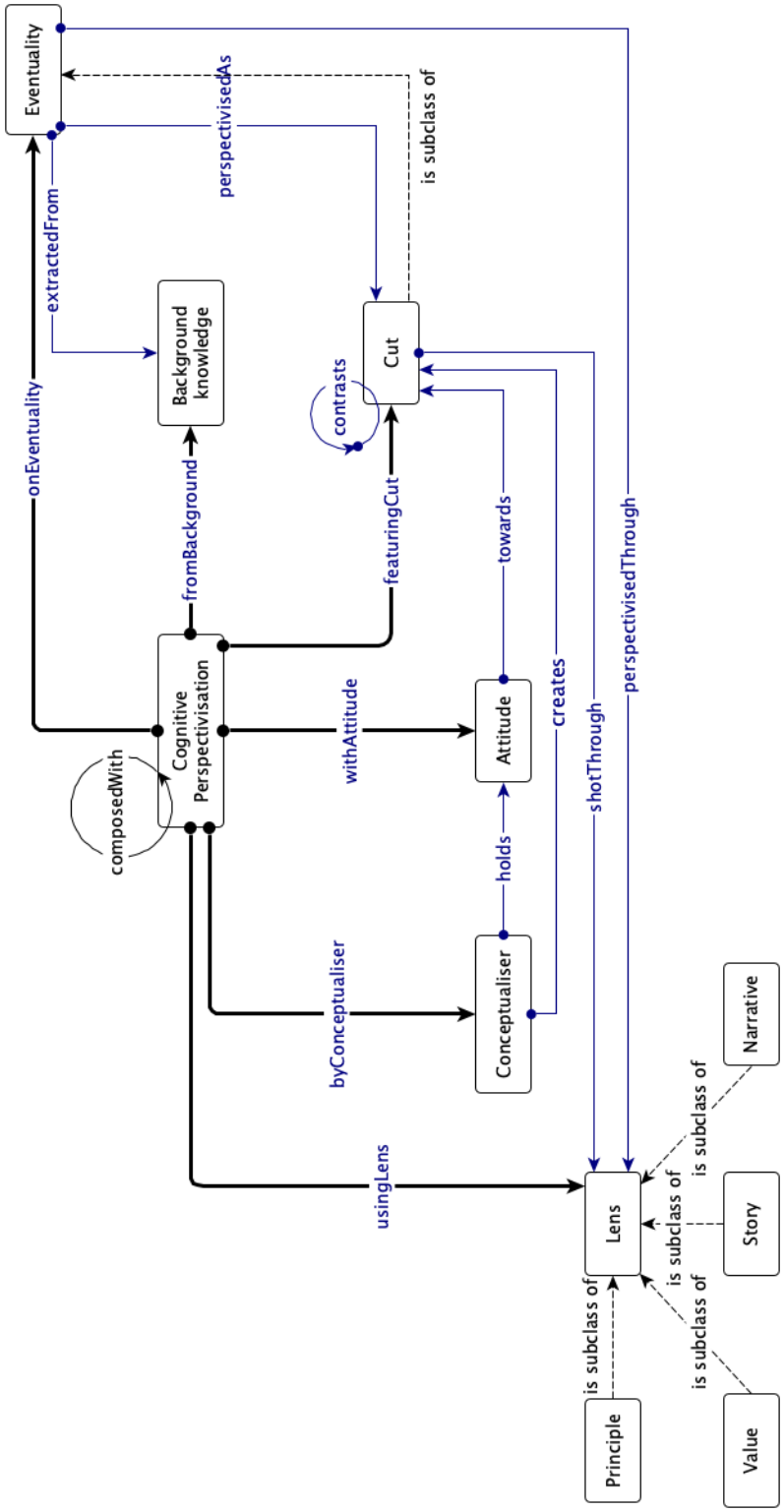

Figure 16.1 A diagrammatic summary of the Cognitive Perspectivisation knowledge pattern. Bold arrows denote the main arguments of the CP relation, the others are projection or subsumption relations.

constant used as an individual (a CP frame), and as a class of situations (the CP frame occurrences).

We provide here a first-order axiomatisation of the CP knowledge pattern. We then provide a frame-based treatment of its intensional part. Each frame from linguistics literature is also represented as a knowledge pattern, following the approach described in Nuzzolese et al. (2011), and implemented in the large Framester knowledge graph Gangemi et al. (2016). We finally exemplify it with a perspectivisation case.

Axiomatisation of CP. The CP relation (Axioms (1.1)(1.2)) can be formally described as follows: a situation s, in which a conceptualiser c has an attitude a towards a cut ct of an eventuality e, jointly with its background knowledge b, shot by means of a lens l, possibly in contrast[f] to some other (either explicit or implicit) cut ct_1 that addresses at least part of the same background b (e.g. a same set of facts with causal relations among them), but possibly with a different lens l_1. Axiom 1.1 is the extensional part of CP, while axiom 1.2 provides the intensional types. Axioms 1.3 and 1.4 provide the semantic types for the ranges of semantic roles.

$$\forall(s)\,\texttt{CP}(s) \rightarrow \texttt{occurrenceOf}(s, CP) \wedge \tag{16.1}$$

$$\exists(c, e, b, l, a, ct)\,\texttt{conceptualiser}(s, c) \wedge \texttt{eventuality}(s, e) \wedge \texttt{background}(s, b) \wedge \texttt{lens(s,l)} \wedge \texttt{attitude}(s, a) \wedge \texttt{cut}(s, ct) \rightarrow \texttt{CP}(s) \rightarrow \texttt{Frame}(\texttt{CP}) \wedge \tag{16.2}$$

$$\texttt{hasProjection}(\texttt{CP}, r) \wedge \texttt{SemanticRole}(r),\ r \in \{\texttt{lens}, \texttt{cut}, \texttt{eventuality}, \texttt{conceptualiser}, \texttt{background}, \texttt{attitude}\}\ (r(s, y) \wedge r \neq \texttt{conceptualiser}) \rightarrow \texttt{Situation}(y) \tag{16.3}$$

$$\texttt{conceptualiser}(s, y) \rightarrow \texttt{Agent}(y) \tag{16.4}$$

The argument projections of CP shown in Figure 16.1 can be axiomatized as in Axioms 1.5-1.11 (assuming previous axioms). A contrast relation between

[f] A contrast is not necessarily a source of conflict: contrast relations are a matter of research, which should be investigated empirically, e.g. from distributional evidence and psychological testing.

cuts that are not related by subsumption is defined in Axiom 1.12.

$$\forall(s,e,b)\,(\texttt{eventuality}(s,e) \wedge \texttt{background}(s,b)) \rightarrow \texttt{extractedFrom}(e,b) \quad (16.5)$$

$$\forall(s,e,ct)\,(\texttt{eventuality}(s,e) \wedge \texttt{cut}(s,ct)) \rightarrow \texttt{perspectivisedAs}(e,ct) \quad (16.6)$$

$$\forall(s,e,l)\,(\texttt{eventuality}(s,e) \wedge \texttt{lens(s,l)}) \rightarrow \texttt{perspectivisedThrough}(e,l) \quad (16.7)$$

$$\forall(sl,ct)\,(\texttt{lens(s,l)} \wedge \texttt{cut}(s,ct)) \rightarrow \texttt{shotThrough}(ct,l) \quad (16.8)$$

$$\forall(s,c,a)\,(\texttt{conceptualiser}(s,c) \wedge \texttt{attitude}(s,a)) \rightarrow \texttt{holds}(c,a) \quad (16.9)$$

$$\forall(s,a,ct)\,(\texttt{attitude}(s,a) \wedge \texttt{cut}(s,ct)) \rightarrow \texttt{toward}(a,ct) \quad (16.10)$$

$$\forall(s,c,a,ct)\,(\texttt{holds}(c,a) \wedge \texttt{toward}(a,ct)) \rightarrow \texttt{creates}(c,ct) \quad (16.11)$$

$$\forall(ct,ct_1)\,(\texttt{shotThrough}(ct,l) \wedge \texttt{shotThrough}(ct_1,l_1) \wedge \neg((\texttt{subsumes}(l,l_1) \cup \texttt{subsumes}(l_1,l)) \leftrightarrow \texttt{contrasts}(ct,ct_1)) \quad (16.12)$$

$$\forall(e,l)\,\texttt{perspectivisedThrough}(e,l) \leftrightarrow e \otimes l = ct \quad (16.13)$$

A cut ct can also be viewed as an occurrence of a composition of an eventuality with a lens: the cinematic metaphor here well describes the Kuleshov conceptual effect at work in perspectivisation. Axiom 1.13 uses a compositional operator $\otimes$ between situations, as a consequence of the cut notion as a perspectivisation result on an eventuality, shot through a lens. The `CP` frame has been implemented in OWL2, and aligned to the Framester schema.[g]

Aligning `CP` to known frames and the emergence of compositionality. Most newly introduced frames/KP can be aligned to existing ones. On one hand, the FrameNet lexical resource Baker et al. (1998) has been the first to (informally) systematise known frames, followed by other linguistic resources, and eventually addressing also *frame matching* problems as with metaphors, e.g. with MetaNet David et al. (2014). On the other hand, formal ontology, ontology engineering, and the Semantic Web, even without explicitly adopting Fillmore's frame semantics, have eventually formalised a huge amount of knowledge patterns (see e.g. the Ontology Design Patterns Repository[h] as well as examples of KPs that underlie foundational ontologies such as DOLCE

[g] http://www.ontologydesignpatterns.org/ont/persp/perspectivisation.owl

[h] http://www.ontologydesignpatterns.org

Presutti and Gangemi (2016)), which also constitute precedents to any newly proposed frame. A formal integration of the different sources for frames, KPs, lexical resources, etc. is provided by resources such as Framester Gangemi et al. (2016)[i] and Premon Rospocher et al. (2019). Framester is used here, because its semantics fully integrates data semantics and lexical semantics.

In the case of Cognitive Perspectivisation, we can look for the FrameNet frames, to which we can align the `CP` frame, and then we may wonder whether that alignment can help us operationalising the `CP` by assisting semantic technologists in using e.g. joint data and text information to reason on perspectivisation.

Firstly, frame alignment provides new potential axioms that could enrich, or induce a refactoring of, a proposed frame. Frame alignment works by detecting the closest frames in FrameNet, which match the roles from `CP` (see below), and aligning them.

Secondly, frame composition can help us operationalizing `CP`. We start with a minimal theory of frame composition Gangemi (2020). Axiom (1.14) introduces a $\otimes$ compositional binary operator stating that any two frames f and g are composed if and only if at least one role r from f and one role s from g are composed. When two roles are composed, their filler x in a frame composition occurrence (an eventuality $e^l \neq e$) is the same (Axiom 1.15). A composition creates a new frame/role (Axiom 1.16).

$$\forall(f,g)(f \otimes g) \leftrightarrow \exists(r,s)(\texttt{hasRole}(f,r) \wedge \texttt{hasRole}(g,s) \wedge (r \otimes s)) \tag{16.14}$$

$$\forall(r,s)(r \otimes s) \leftrightarrow \exists(e)(\texttt{r.F}(e,x) \wedge \texttt{s.G}(e,x)) \tag{16.15}$$

$$\forall(x,y)(x \otimes y)(\texttt{Frame}(x) \wedge \texttt{Frame}(y) \rightarrow \exists(z)(\texttt{Frame}(z)) \cup (\texttt{Role}(x) \wedge \texttt{Role}(y)) \rightarrow \exists(z)(\texttt{Role}(z))) \tag{16.16}$$

For example, when `CP` is aligned to its closest matches from Framester, perspectives seem to depend at least on the following FrameNet frames: `Attributed_information` (for the conceptualisation part), `Mental_property` (for the attitude part), `Scrutiny` (for the cut part), and `Differentiation` (for the contrasting/similarity part):

- `Regarding` and `Representing` approximate the lens part of CP. An Entity represents some Phenomenon through its existence and/or defining

[i] The Framester knowledge graph can be queried from `http://etna.istc.cnr.it/framester2/sparql` while its ontology schema is available at `https://w3id.org/framester/schema/`

characteristics. Entity corresponds to the CP cut, Phenomenon to the eventuality.

- AttributedInformation has the following given roles: Proposition, Speaker, Text: a Proposition is attributed to a Speaker or directly to a Text (as a provenance attribution). Speaker corresponds to the CP conceptualiser, the Proposition to the lens, and the Text to the background.
- Mental_property has the following given roles: Judge, Behavior, Protagonist, Degree, Manner, Practice, and Domain; the core ones that are at stake in CP are Judge, Manner and Behavior. Judge corresponds to the conceptualiser, Manner to the attitude, and Behavior to the cut.
- Scrutiny has the following given roles: Cognizer, Phenomenon, Purpose, Time, Medium, Means, Degree, Direction, Ground, Manner, Instrument, with Cognizer, Manner and Phenomenon corresponding to the CP conceptualiser, attitude and eventuality respectively. Differentiation has the following given roles: Cognizer, Phenomena, Quality, Degree, Means, Manner, Circumstances, Depictive, with Cognizer, Phenomenon1, Phenomenon2, Circumstances corresponding to the conceptualiser, cut, and background respectively.

We may briefly exemplify an application of CP alignment with Axiom 1.17, which associates CP with the Attributed_information frame by composing some of the roles introduced in Axiom 1.1.

$$\begin{aligned} \forall(s,p,a,ct,b)\,\texttt{CP}(s,p,a,ct,b) \rightarrow \\ \texttt{conceptualiser.CP}(s,p) \leftrightarrow \texttt{speaker.AI}(s,p) \wedge \\ \texttt{cut.CP}(s,ct) \leftrightarrow \texttt{proposition.AI}(s,ct) \wedge \\ \texttt{background.CP}(s,b) \leftrightarrow \texttt{text.AI}(s,b) \end{aligned} \tag{16.17}$$

Frame evocation with cognitive perspectivisation. As described, frame alignment and composition techniques can now be applied for:

1. extracting frame-based knowledge graphs from text with FRED Gangemi et al. (2017) machine reader, which automatically parses, logically shapes, and links the knowledge expressed by the sentence to public knowledge graphs;
2. anchoring the extracted graph to perspectival knowledge through the large frame-based Framester's knowledge graph.

Framester frames and roles are automatically associated to FRED knowledge

graphs via the FRED2Framester API[j] and when a perspectivisation hint is detected in the graph, the `CP` frame is used to overload the knowledge graph with perspectival knowledge. We call that overload *super-dupering*, cf. Sect. 16.4.

We exemplify this operationalization with respect to a classic perspectivisation example from Sect. 16.2, used by spin doctors to explain storytelling techniques: *Conservatives claim that we need relief from taxes* vs. *Democrats claim that taxes are investments for us*.

We apply the approach as sketched at the beginning of this section, by firstly parsing the sentences with a frame-based approach, and extracting two knowledge graphs KG_c and KG_d. Then we apply the double intensional/extensional modelling to the extracted frames, and align them to the CP frame. Finally, we analyse the compositionality resulting from aligning the super-dupered knowledge graphs to public semantic resources.

Frame-based knowledge extraction. We pass the two sentences to the FRED machine reader API[k], obtaining two knowledge graphs. FRED graphs contain RDF triples expressing:

- the concepts expressed in the sentences: Claim, Need, Relief, Tax, Investment
- the anonymous referents of those concepts (claims, needs, reliefs, investments, taxes)
- individual entities and facts: Conservatives, Democrats, anonymous persons (we, us) denoted in the sentences
- the roles (agent, experiencer, etc.) evoked by the words in the syntactically dominant frames (Claim, Need)
- the automatically linked entities and concepts from public repositories, which can be used to extend the graph automatically with public background knowledge (e.g. individuals, concepts and frames related to Claim, Need, Tax, Investment, Conservatism, etc.)

From the first sentence, we extract KG_c, expressible in first-order logic as the existential axiom 1.18. From the second sentence, we extract KG_d, expressed

[j] http://wit.istc.cnr.it/stlab-tools/fred_api/
[k] A web application for testing is also available at http://wit.istc.cnr.it/stlab-tools/fred/

in axiom 1.19:

$$\exists(x,c,p,n,h,r,t)(\texttt{Conservative}(x) \wedge \texttt{Claim}(c) \wedge \texttt{Person}(p) \wedge \texttt{Need}(n) \wedge \texttt{Have}(h) \wedge \texttt{Relief}(r) \wedge \texttt{Tax}(t) \wedge \texttt{agent.Claim}(c,x) \wedge \texttt{theme.Claim}(c,n) \wedge \texttt{experiencer.Need}(n,p) \wedge \texttt{theme.Need}(n,h) \wedge \texttt{agent.Have}(h,p) \wedge \texttt{patient.Have}(h,r) \wedge \texttt{from.Need}(n,t)) \tag{16.18}$$

$$\exists(x,c,p,s,t)(\texttt{Democrat}(x) \wedge \texttt{Claim}(c) \wedge \texttt{Person}(p) \wedge \texttt{Situation}(s) \wedge \texttt{Tax}(t) \wedge \texttt{agent.Claim}(c,x) \wedge \texttt{theme.Claim}(c,s) \wedge \texttt{involves}(s,t) \wedge \texttt{involves}(s,p) \wedge \texttt{Investment}(t) \wedge \texttt{for}(t,p)) \tag{16.19}$$

For an intuitive rendering of the semantic subgraphs produced by FRED,[l] cf. Figure 16.2 and 16.3, which also include the entity linking axioms not shown in the FOL axioms.

[l] FRED produces two linked subgraphs, the first annotates textual fragments with semantic and syntactic knowledge, the second (the semantic subgraph) is a frame-based knowledge graph including both a schema and the data extracted from the sentence, aligned to public resources (WordNet, VerbNet, FrameNet, schema.org, DBpedia, etc.)

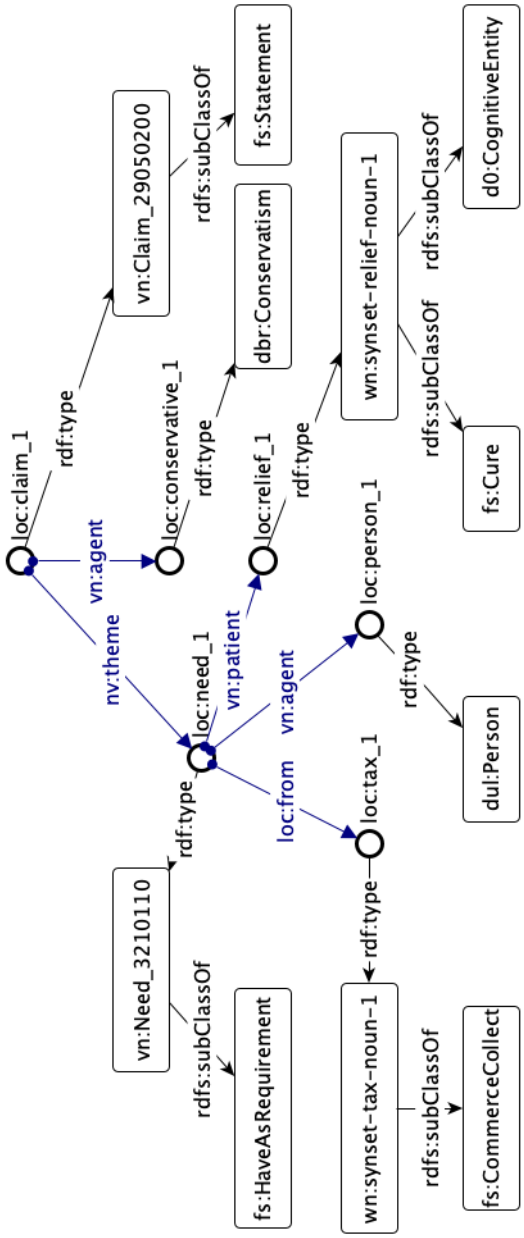

Figure 16.2 A diagram showing the semantic subgraph produced by FRED for the sentence *Conservatives claim that we need relief from taxes*. Circles denote classes, diamonds denote individuals. Prefixes: loc: for local resources, vn: for VerbNet senses, wn: for WordNet synsets, dbr: for DBpedia entities, dul: for DOLCE, d0: for DOLCE-Zero.

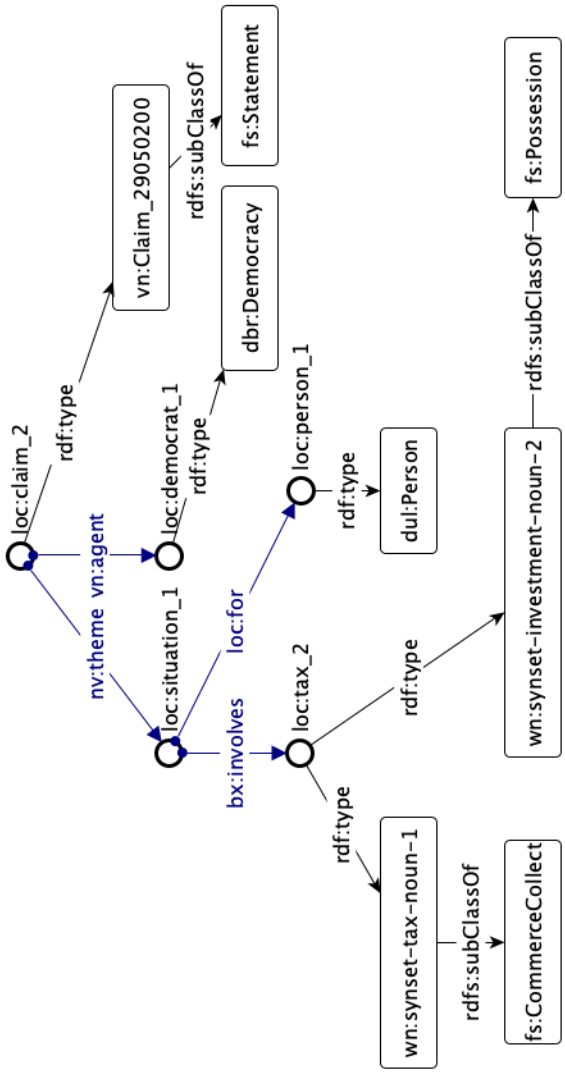

Figure 16.3 A diagram showing the semantic subgraph produced by FRED for the sentence *Democrats claim that taxes are investments for us*.

SuperDupering knowledge graphs with the perspectivisation frame. In the running example, the task of extracting perspectives is quite straightfor-

ward, because many arguments of CP can be filled with values from the extracted graphs. In other words, perspectivisation is explicit in the sentences, e.g. the *claim* frame points directly at a perspectivisation. In more complex cases, perspectivisation hints might be subtler. Axioms 1.20 through 1.24 show how the SuperDupering operates on CP occurrences:

$$KG_c \uparrow \exists(e_1, w)(\texttt{CP}(e_1) \wedge \texttt{TaxKG}(w) \wedge \texttt{conceptualiser}(e_1, \texttt{Conservative}) \wedge \texttt{background}(e_1, w) \wedge \texttt{attitude}(e_1, \texttt{Need}) \wedge \texttt{lens}(e_1, \texttt{Relief}) \wedge \texttt{eventuality}(e_2, \{\texttt{Tax}\}) \tag{16.20}$$

$$\texttt{background}(e_1, w) \wedge \texttt{attitude}(e_1, \texttt{Need}) \wedge \texttt{lens}(e_1, \texttt{Relief}) \wedge \texttt{eventuality}(e_2, \{\texttt{Tax}\} \rightarrow \texttt{cut}(e_2, \{\texttt{Tax} \otimes \texttt{Relief}\}) \tag{16.21}$$

$$KG_d \uparrow \exists(e_2, w)(\texttt{CP}(e_2) \wedge \texttt{TaxKG}(w) \wedge \texttt{conceptualiser}(e_2, \texttt{Democrat}) \wedge \texttt{background}(e_2, w) \wedge \texttt{attitude}(e_2, s) \wedge \texttt{lens}(e_2, \texttt{Investment}) \wedge \texttt{eventuality}(e_2, \{\texttt{Tax}\}) \tag{16.22}$$

$$\texttt{background}(e_1, w) \wedge \texttt{attitude}(e_1, \texttt{s}) \wedge \texttt{lens}(e_1, \texttt{Investment}) \wedge \texttt{eventuality}(e_2, \{\texttt{Tax} \rightarrow \texttt{cut}(e_2, \{\texttt{Tax} \otimes \texttt{Investment}\}) \tag{16.23}$$

$$KG_c \otimes KG_d \uparrow \texttt{contrasts}(\{\texttt{Tax} \otimes \texttt{Relief}\}, \{\texttt{Tax} \otimes \texttt{Investment}\}) \tag{16.24}$$

Based on the CP frame and its axioms, Axioms 1.20 and 1.22 represent the overdescription of the two FRED graphs with CP: a conceptualiser holds an attitude towards a lens applied to a background eventuality, producing a certain cut that makes a blend emerge out of the role composition (lens $\otimes$ cut), as shown in axioms 1.21 and 1.23. SuperDupering (denoted as $\uparrow$) operates on each knowledge graph, assigning the CP roles to individuals or concepts from the graph whenever possible, else introducing new individuals. This happens for:

- the CP-ed situations (e_1 and e_2);
- the background w, i.e. the TaxKG knowledge graph, automatically extracted from the dbpedia Tax graph thanks to the FRED linking, including e.g. Tax_policy, Tax_revenue, Tax_avoidance, etc., which are not explicit

in the sentences. The construction of the TaxKG is a result of the semiotic drifting (cf. next paragraph);
- the `conceptualiser` role "superdupers" conservatives and democrats;
- the `attitude` role superdupers the claims, i.e. *need* for Conservatives, and the asserted situation for Democrats;
- the `lens` role superdupers the `Relief` frame for conservatives, and the `Investment` frame for democrats;
- `cut` roles superdupers the `Tax`⊗`Relief` frame for conservatives, and the `Tax`⊗`Investment` for democrats;
- finally, Axiom 1.24 shows the composition of the two knowledge graph, which superdupers a contrast between the two different cuts, which are not related explicitly in the Framester knowledge graph;[m]
- in this example, the `eventuality` role filler coincides with the `background` one, because the claims are about a general value, and no specific time is expressed, which could distinguish tax knowledge in general, from current circumstances.

Semiotic drifting. At this point, we have got two superdupered graphs KG_c^s and KG_d^s. We have used the alignment functionalities of FRED's to disambiguate the concepts and named individuals, and then we have queried the Framester knowledge graph hub to collect all the frames evoked by the sentences, so generating a richer composition. Axioms 1.20 and 1.22 show a sample of those alignments, which exemplify a method used in knowledge extraction, which we call *semiotic drifting*, consisting of dynamically expanding a graph g with relevant knowledge as soon as some part of g gets aligned to other knowledge. Expansion can be guided by requirements, opportunity, or just serendipity, and can be implemented with off-the-shelf graph traversal algorithms. Since the amount of alignments can get really huge after a couple of iterations, we show here just a few.

Conservatives and Democrats are easily matched to public DBpedia or Wikidata entities, while the Claim, Need, Relief, Tax, Investment concepts are aligned to WordNet, VerbNet, FrameNet, and ultimately to Framester core frames: VerbNet's `Claim_29050200` (leading to the `Statement` frame) and `Need_32010110` (leading to the `Needing` frame), WordNet's `synset-relief-noun-1` (metaphorically leading to the `Cure` frame by reusing the Framester extension to MetaNet frame-based metaphors, now represented in the Amnestic Forgery knowledge graph Gangemi et al. (2018)), DBpedia's `Conservatism` and `Democracy` (leading to the

[m] I.e., each of them does not subsume, use, etc. the other.

PeopleAlongPoliticalSpectrum frame), Tax (leading to the EarningsAndLosses frame), and Investment (leading to the Possession frame).

Rule-based superdupering The superdupered mapping of extracted entities and concepts to the CP roles is currently performed in a rule-based form, e.g. the attitude role is associated with modal expressions, the conceptualiser role with agents of perspectivisation frames (e.g. *verba dicendi*), the background role with semiotic drifting (see below), the lens role is e.g. assigned in contrast to the *eventuality* role, according to role chains of frame composition in discourse. Finally, the cut role is differentially established according to the composition of explicit frames.

However, the superdupered mapping of extracted entities and concepts to the CP roles needs further research, in order to design or learn rules that have enough variability to deal with complex perspective networks. Rhetorical Structure Theory Ji and Smith (2017) and Argumentation Mining Stede and Schneider (2018) might provide some heuristics, as well as a large-scale exploration starting with e.g. the training of an LSTM to recognize patterns of CP roles.

Extraction strategies: a generalisation. Existing text mining approaches that deal with viewpoints address biases Ma and Yoshikawa (2009), opinions Paul et al. (2010), etc., but they hardly attack the problem analytically (an exception is Gangemi et al. (2014)); even smaller literature targets multimodal perspectives (a recent work is Zadeh et al. (2017)). Because of the variety of multimodal expressions that can evoke a perspective, we barely need methodological hybridisation, which can maximise recall in detecting or discovering perspectivisation with inductive techniques.

On the other hand, we are injecting semantics into feature engineering, e.g. by using techniques such as graph embeddings over knowledge graphs Goyal and Ferrara (2018) Ristoski and Paulheim (2016). The SuperDuper approach proposed here, jointly with a hybrid semiotic drifting, can provide a healthy feedback loop in both discovering and formally reasoning over features. CP-like frames can also be used as know-how repositories for experiments over perspectival thinking.

16.5 Conclusions

In this chapter we have presented a brief assessment of current linguistic, cognitive and computational literature on perspectivisation, as well as a pragmatic method to extract and represent perspectival knowledge.

The major difficulty in making computational sense of perspectives is that they are (1) widespread in communication; (2) multimodal; (3) only interpretable with respect to implicit, indirect, or nuanced contextual knowledge. The differences between the many types of perspectivisation phenomena seem huge, but, inspired by cognitive linguistics, frame semantics, and pattern-based ontology design, we have proposed a SuperDuper approach to perspective representation, which admits multilayered framing that can be used across multiple types of perspectivisation.

Our main intention is to show the feasibility of SuperDuper-ing knowledge representation without adding logical complexity, and also retaining the basic expressivity that can be employed in both scalable knowledge engineering methods, and feature engineering methods for machine learning.

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