Frames 3.0 – Are all human concepts frames?

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Collaborative Research Centre 991
„The structure of representations in language, cognition, and science“
Heinrich Heine University Duesseldorf

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1. The Frame Hypothesis
2. Examples from everyday life
3. Towards a definition of “frame”
4. Applications in linguistics
5. Challenges

1. The Frame Hypothesis

Frame – a notion from psychology and artificial intelligence

Knowledge unit for a complex condition involving several components with defined relationships.

Lawrence W. Barsalou (1992): Frame Hypothesis
Frames constitute the universal format of concepts in human cognition.

Concepts – Any mental representations of individual objects, categories, events, properties, states, etc. etc. Arbitrary knowledge units in the cognitive system.
2. Examples of descriptions in frame format from everyday life

2.1 Passport

Description grid of the passport bearer

1. Name
2. Given names
3. Nationality
4. Date of birth
5. Sex
6. Place of birth
10. Signature of bearer
11. Residence
12. Height
13. Color of eyes

[without number and designation: ] Photograph of the face

Frame embedding

Passport

Type: P
Code: D
Passport No.: A12BC345D
Authority: Stadt Mönchengladbach
Date of issue: 28.04.2016
Date of expiry: 27.04.2026

Bearer

Name: XXXXX
Given names: YYYYY ZZZ
Nationality: deutsch...
2. Examples of descriptions in frame format from everyday life

2.1 Passport

Frame embedding

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>P</td>
</tr>
<tr>
<td>Code</td>
<td>D</td>
</tr>
<tr>
<td>Passport No.</td>
<td>A12BC345D</td>
</tr>
<tr>
<td>Authority</td>
<td>Stadt Mönchengladbach</td>
</tr>
<tr>
<td>Date of issue</td>
<td>28.04.2016</td>
</tr>
<tr>
<td>Date of expiry</td>
<td>27.04.2026</td>
</tr>
<tr>
<td>Bearer.Name</td>
<td>XXXXX</td>
</tr>
<tr>
<td>Given names</td>
<td>YYYYY ZZZ</td>
</tr>
<tr>
<td>Nationality</td>
<td>deutsch</td>
</tr>
</tbody>
</table>

2.2 Library catalogue entry

Title: Cognitive psychology : an overview for cognitive scientists
Author: Barsalou, Lawrence W.
Subjects: Cognitive psychology; introduction
Similar titles: FBsprv200; psyf300
Related titles: Cognitive science series : Tutorial essays in cognitive science
Publisher: Hillsdale, NJ [u.a.] : Erlbaum
Creation date: 1992
Holdings: Zentralbibl. / Lesesaal 3. Etage : psyf300.b282
Verbundbibliothek Geisteswissenschaften : sprv200.b282
Source: DUE 01 aleph

(sources: http://katalog.ulb.hhu.de/)

2.3 Scientific objects: elementary particles

<table>
<thead>
<tr>
<th>Particle</th>
<th>Mass (GeV/c²)</th>
<th>Spin</th>
<th>Charge</th>
<th>Interaction mediated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photon</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Electromagnetism</td>
</tr>
<tr>
<td>Z⁺-Boson</td>
<td>91.2</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>W⁺-Boson</td>
<td>80.4</td>
<td>1</td>
<td>1</td>
<td>Weak interaction</td>
</tr>
<tr>
<td>W⁻-Boson</td>
<td>80.4</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gluon</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Strong interaction</td>
</tr>
<tr>
<td>(Graviton)</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>Gravitation</td>
</tr>
</tbody>
</table>

(Sources: https://de.wikipedia.org/wiki/Schwache_Wechselwirkung

3. Towards a definition of ‘frame’

3.1 Attributes and their values

Description / Representation of an object by assigning attributes and their values. The specification of the values can be more or less precise; often just a range of possible values is specified. Values need not be describable in words.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type of value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearer.NAME</td>
<td>a linguistic expression that is admissible as a name</td>
</tr>
<tr>
<td>Bearer.DATE OF BIRTH</td>
<td>a date of a day</td>
</tr>
<tr>
<td>Bearer.SIGNATURE</td>
<td>a written shape</td>
</tr>
<tr>
<td>Bearer.[FACE]</td>
<td>a photographic picture of a human face</td>
</tr>
<tr>
<td>Bearer.HEIGHT</td>
<td>a measure of body height</td>
</tr>
<tr>
<td>Passport.TYPE</td>
<td>one out of five possible passport types (abstract)</td>
</tr>
<tr>
<td>Passport.CODE</td>
<td>a country code (letter sequence)</td>
</tr>
<tr>
<td>Passport.PASSPORT-NO.</td>
<td>a normed sequence of letters and numbers</td>
</tr>
<tr>
<td>Passport.DATE OF EXPIRY</td>
<td>the date of issue</td>
</tr>
</tbody>
</table>
3. Towards a definition of ‘frame’

3.1 Attributes and their values

<table>
<thead>
<tr>
<th>Kind of attribute</th>
<th>Person</th>
<th>Guitar</th>
<th>Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>For parts</td>
<td>FACE</td>
<td>NECK</td>
<td>PREFACE</td>
</tr>
<tr>
<td>For correlates</td>
<td>PLACE OF BIRTH</td>
<td>OWNER</td>
<td>AUTHOR</td>
</tr>
<tr>
<td>For properties</td>
<td>SEX</td>
<td>TYPE</td>
<td>PRICE</td>
</tr>
<tr>
<td>For related actions and events</td>
<td>BIRTH</td>
<td>PURPOSE</td>
<td>PRINTING</td>
</tr>
</tbody>
</table>

Attributes have a **domain** and a **range of possible values**, e.g. COLOR: domain = visible objects, range of values = the color space.

3.2 Structural conditions on Barsalou-Frames

**Recursivity**

The values of attributes can themselves carry attributes with values, and so on.

Objects, attributes and values are often represented by a network, where the represented object and attribute values are nodes (vertices) connected by arcs that represent the attributes.

- Every node can carry an attribute only once.
- An attribute links a node to exactly one value node.
- The network of nodes and attribute arcs must be connected (coherent).

⇒ The attributes in the network represent **functional**.

3.3 A Barsalou frame für wine

![Diagram of a Barsalou frame for wine](image-url)
4. Applications in linguistics
4.1 Syntax: Syntactic trees can be read as frame representations

The child got a pink duck.
4. Applications in linguistics

4.2 Semantics (1): different types of concepts

**Sortal noun**: central node for the referent with a fan of attributes

**Functional noun**: attribute concept – argument node, referent node

**Verb**: Case frame – node for the event referent, arguments of the verb as attributes

**Relational noun**: nodes for referent and possessor argument
4. Applications in linguistics

4.2 Semantics (1): different types of concepts

**Adjective**: no referent node, 1 argument node

![Diagram of open argument]

4. Applications in linguistics

4.3 Semantics (2): Composition

(1) *red pencil*

>`pencil` : sortal concept

>`red` : adjective concept

Unification 1

![Diagram of red pencil and COLOR]
4. Applications in linguistics
4.3 Semantics (2): Composition

(1) *red pencil*

Unification 1

(2) *yellow ballpen / blue ballpen*
4. Applications in linguistics

4.3 Semantics (3): Composition and decomposition

Modeling lexical meaning ("decomposition"): nouns, verbs, adjectives

- composition as compounding of frames
- more fine-grained analysis of composition: detailed modeling of the interaction of meanings/concepts
- modeling conceptual meaning shifts: metonymy, mass-count shifts, and others
- modeling semantic processes of word formation (e.g. derivation of nouns from verbs, noun-noun compounds)

5. Challenges

- Can all types of concepts be modeled as a network of attributes and values?
- How to model temporal, spatial, and causal relations in verb concepts, scripts, narrations etc.?
- Can arbitrary conceptual relations be analyzed in terms of functional attributes?
- If all concept formation is in terms of attributes – What are admissible / cognitively plausible attributes to be used in frame analysis?
- How can frame contents be empirically assessed?

6. History

Frames 1.0

Bundles of attributes and values (‘slots and fillers’), often not recursively organized. Primarily sortal nouns and verbs.


Sequential models of complex sequences of events:

Frames 2.0


6. History

Frames 3.0

Current developments in the Duesseldorf research community: development of a formal frame theory. Applications in linguistics, philosophy, science. Psychological and neurological research.


Visit the CRC homepage for more publications and ongoing work:
http://www.sfb991.uni-duesseldorf.de/

Thank you very much for your attention!