Functional Concepts in Frames and Functional Concepts as Frames

Wiebke Petersen

Heinrich-Heine-Universität Düsseldorf
Research group on “Functional Concepts and Frames”
www.phil-fak.uni-duesseldorf.de/~petersen/
1 Functional Concepts
   - Research Unit on Functional Concepts and Frames
   - Concept Types

2 Frames
   - Definition of Frames
   - Interpretation of Relational Concepts
   - Attributes in Frames

3 Conclusion
1. Functional Concepts
   - Research Unit on Functional Concepts and Frames
   - Concept Types

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   - Definition of Frames
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1. **Functional Concepts**
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Forschergruppe Funktionalbegriffe und Frames

FFF is a research unit with

- speaker: Prof. Dr. Löbner
- begin: August, 2005
- location: Düsseldorf (and Frankfurt)
- 9 projects from:
  - General Linguistics
  - Computational Linguistics
  - Romance Linguistics
  - Philosophy
  - Medicine History
  - Cognition Science
classifying concepts

- person, pope, house, verb, sun, Mary, wood, brother, mother, meaning, distance, spouse, argument, entrance
classifying concepts: arity

<table>
<thead>
<tr>
<th>arity: 1</th>
<th>person, pope, house, verb, sun, Mary, wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>arity: &gt;1</td>
<td>brother, mother, meaning, distance, spouse, argument, entrance</td>
</tr>
</tbody>
</table>
### Concept Types

**classifying concepts: uniqueness of reference**

<table>
<thead>
<tr>
<th>Arity</th>
<th>No unique reference</th>
<th>Unique reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arity: 1</td>
<td>person, house, verb, wood</td>
<td>Mary, pope, sun</td>
</tr>
<tr>
<td>Arity: &gt;1</td>
<td>brother, argument, entrance</td>
<td>mother, meaning, distance, spouse</td>
</tr>
</tbody>
</table>
## Concept Types

<table>
<thead>
<tr>
<th>Arity: 1</th>
<th>arity: &gt;1</th>
<th>relational</th>
</tr>
</thead>
<tbody>
<tr>
<td>no unique reference</td>
<td>unique reference</td>
<td></td>
</tr>
<tr>
<td>person, verb, wood</td>
<td>Mary, pope, sun</td>
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</tbody>
</table>
### Concept Types

<table>
<thead>
<tr>
<th>Arity</th>
<th>Unique Reference</th>
<th>Relational Identificational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arity: 1</td>
<td>Person, house, verb, wood</td>
<td>Mary, pope, sun</td>
</tr>
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The table shows different concept types based on their arities. Unique reference concepts include person, house, verb, wood, and Mary, pope, sun. Relational identificational concepts include brother, argument, entrance, and mother, meaning, distance, spouse.
### Concept Types

#### 4 concept types (Löbner)

<table>
<thead>
<tr>
<th>Arity</th>
<th>SC: Sortal Concept</th>
<th>IC: Individual Concept</th>
<th>RC: Relational Concept</th>
<th>FC: Functional Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>no unique reference</td>
<td>unique reference</td>
<td>(proper) relational concept</td>
<td>relational</td>
</tr>
<tr>
<td>&gt;1</td>
<td>SC: sortal concept</td>
<td>IC: individual concept</td>
<td>RC: relational concept</td>
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</tr>
</tbody>
</table>

**Relational**

**Identificational**
## 4 concept types: linguistic realization

<table>
<thead>
<tr>
<th>SC: sortal concept</th>
<th>IC: individual concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEFINITE</td>
<td>DEFINITE</td>
</tr>
<tr>
<td>person, house, verb, wood</td>
<td>Mary, pope, sun</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RC: (proper) relational concept</th>
<th>FC: functional concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEFINITE + POSSESSIVE</td>
<td>DEFINITE + POSSESSIVE</td>
</tr>
<tr>
<td>brother, argument, entrance</td>
<td>mother, meaning, distance, spouse</td>
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3 Conclusion
Barsalou’s frames


- Frames provide the fundamental representation of knowledge in human cognition.
- At their core, frames contain **attribute-value sets**.
- Frames further contain a variety of relations.
  - **Structural invariants** in a frame capture relations in the world that tend to be relatively constant between attributes.
  - **Constraints** capture systematic patterns of variability between attribute values.
Barsalou’s vacation frame
Definition of Frames

typed feature structures

Typed feature structures model sortal and individual concepts!
types can be organized in type signatures

- person
  - AGE: age
  - ADDRESS: address
  - SEX: sex

- child
  - AGE: < 18

- woman
  - SEX: female

- girl

- address

- sex
  - female
  - male
frames as extended typed feature structures

**Definition (Frame)**

Frames are connected, directed graphs with:
- one central / referential node
- nodes labeled with types
- edges labeled with attributes
- no node with two equally labeled outgoing edges
- (one root node)
Definition of Frames

**Example**

frame ‘person’ (with attribute ‘mother’)

\[ \lambda x : \text{person}(x) \land (\exists y : \text{mother}(y) \land \text{MOTHER}(x) = y) \]

frame ‘mother’

\[ \lambda y : \text{mother}(y) \land (\exists x : \text{person}(x) \land \text{MOTHER}(x) = y) \]
Definition of Frames

Example

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Frame 'mother'

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Defining Frames

**Attributes in Frames**

- **Barsalou, 1992**
  
  “I define an attribute as a **concept** that describes an aspect of at least some category member.”
  
  “Values are subordinate concepts of an attribute.”

- **Guarino, 1992: Concepts, attributes and arbitrary relations**
  
  “We define attributes as **concepts** having an associate relational interpretation, allowing them to act as conceptual components as well as concepts on their own.”
Interpretation of Relational Concepts

denotational and relational interpretation

denotational interpretation
A relational concept denotes a set of entities:

\[ \delta : \mathcal{R} \rightarrow 2^U \]

\[ \delta(\text{son}) = \{ s \mid s \text{ is a son of somebody} \} \]

relational interpretation
A relational concept has also a relational interpretation:

\[ \rho : \mathcal{R} \rightarrow 2^{U \times U} \]

\[ \rho(\text{son}) = \{ (\rho, s) \mid s \text{ is a son of } \rho \} \]
denotational and relational interpretation

**denotational interpretation**
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**Consistency Postulate (Guarino, 1992)**

Any value of an relationally interpreted relational concept is also an instance of the denotation of that concept.

If \((p, s) \in \rho(\text{son})\), then \(s \in \delta(\text{son})\).

**Consequences**

- relationally interpreted relational concept: relation with
  1. argument: possessor argument
  2. argument: referring argument
- relational interpretation of a functional concept: function: possessor \(\rightarrow\) referent

If \((c, m_1), (c, m_2) \in \rho(\text{mother})\), then \(m_1 = m_2\).
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example family

Ann ⊗ Tom

Sue
Bob ⊗ Liz

Tim
Pam
Max

‘s’on’ denotational

\[ \delta(\text{son}) = \{ \text{Max, Tim, Bob} \} \]

‘s’on’ relational (‘son of’)

Ann ↾ Bob
Tom ↾ Bob
Bob ↾ Max, Bob ↾ Tim
Liz ↾ Max, Liz ↾ Tim
**Interpretation of Relational Concepts**

**example family**

```
example family

Ann ⊗ Tom

Sue

Bob ⊗ Liz

Tim
Pam
Max
```

**‘mother’ denotional**

\[ \delta(\text{mother}) = \{\text{Ann, Liz}\} \]

**‘mother’ relational (‘mother of’)**

- Sue ↾ Ann
- Bob ↾ Ann
- Tim ↾ Liz
- Pam ↾ Liz
- Max ↾ Liz
Attributes in Frames are relationally interpreted functional concepts!

- Attributes are not frames themselves.
- Attributes are unstructured.
- Each attribute has an associated frame.
- The possible values of an attribute are subconcepts of the denotationally interpreted functional concept.
attributes in frames

mother-frame

\[
\text{MOTHER} : \delta(\text{person}) \rightarrow \delta(\text{mother})
\]
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concluding remarks

- Frames can be seen as slightly extended feature structures.
- Sortal and individual concepts can be analyzed by typed feature structures.
- Functional concepts can be analyzed by (functional) frames.
- Attributes in frames are relationally interpreted functional concepts.
how to proceed?

**a fragmentary todo list**

- How do frames of relational concepts look like?
- How to benefit practically of our frames? How to compute with them?
- How to define type signatures for frames (redefinition)?
- How to deal with scale-valued attributes and how to implement constraints on them?

...
further information

Conference on
Concept Types and Frames
in Language, Cognition, and Science
Düsseldorf, August 20-22, 2007

organized by

FFF
Forschergruppe
“Funktionalbegriffe und Frames”

www.phil-fak.uni-duesseldorf.de/FFF


origin of the pictures

- picture frames (titlepage):

- German ID card:

- Barsalou’s vacation frame: Barsalou 1992, p. 38