

Decomposing Concepts with Frames

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Riga 2006



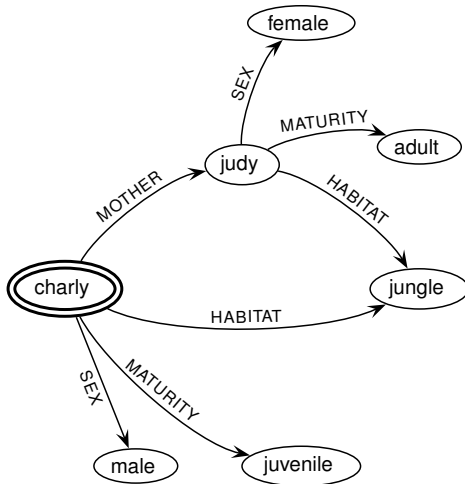
outline

- 1 Introduction
- 2 Concept Classes
- 3 Frames
- 4 Outlook

my hypotheses

- 1 Concepts are complex cognitive structures
- 2 Concepts can be decomposed in frames
- 3 Frames of sortal concepts decompose them into functional concepts

How do frames look like?



Why am I here?

International Symposium of Cognition, Logic
and Communication

Oswald Külpe

Aspects of a Qualitative Science

What I found in Külpe's work

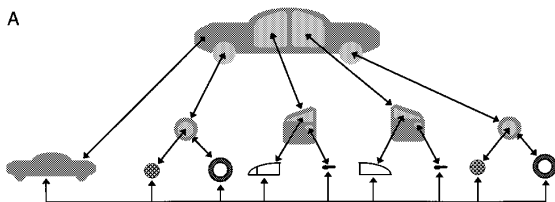
- Experimental method of “Kundgabe”
- Concentration on higher mental processes

Oswald Külpe: Kundgabe

*“Die Versuchspersonen begannen in der **Sprache** des Lebens **zu reden** und den Vorstellungen nur eine untergeordnete Bedeutung für ihre Innenwelt beizulegen. Sie wußten und dachten, urteilten und verstanden, ergriffen den Sinn und deuteten die Zusammenhänge, ohne eine wirkliche Unterstützung durch gelgentlich auftauchende Versinnlichungen dabei zu erhalten.”*

(Külpe 1912)

Barsalou 1999: Perceptual Symbol Systems



Oswald Külpe: higher mental processes

“Es ist dem Denken in der früheren Psychologie meist nicht die genügende Beachtung geschenkt worden.

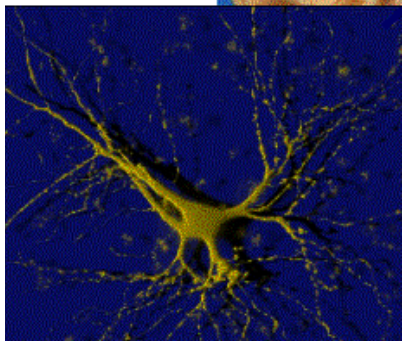
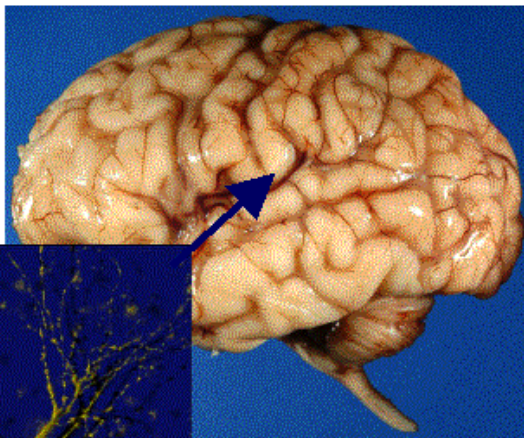
[...] Von der naturwissenschaftlichen Erfahrung her waren sie [die experimentellen Psychologen] auf Sinnesreize und Empfindungen, auf Nachbilder, Kontrasterscheinungen und phantastische Veränderungen der Wirklichkeit eingerichtet. Was solchen Charakter nicht an sich trug, schien einfach nicht vorhanden zu sein.”

(Külpe 1912)

higher mental processes

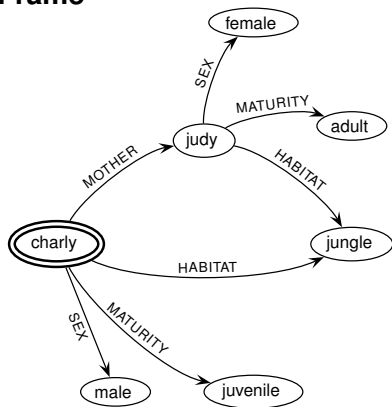


higher mental processes



higher mental processes

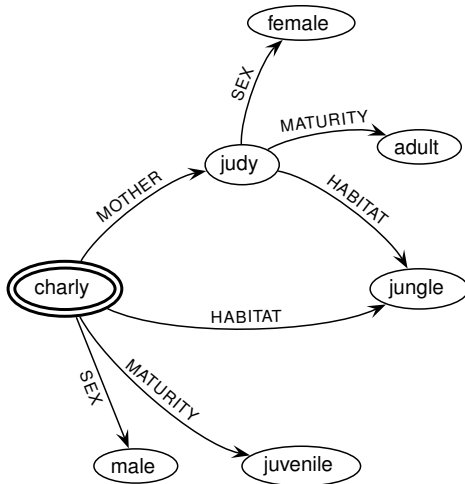
Frame



Feature List

(juvenile,
male,
jungle inhabitant)

concept names used in the Charly-frame



classifying concepts

	no unique reference	unique reference
arity:1	ape, chimpanzee, jungle	Charly, Judy, sun, pope
arity:>1	brother, argument, entrance	mother, age, sex, spouse

classifying concepts

	no unique reference	unique reference	
arity:1	ape, chimpanzee, jungle	Charly, Judy, sun, pope	
arity:>1	brother, argument, entrance	mother, age, sex, spouse	relational

classifying concepts

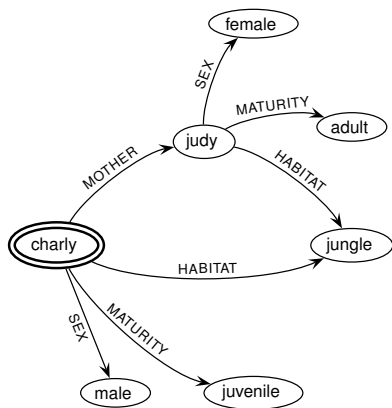
	no unique reference	unique reference	
arity:1	ape, chimpanzee, jungle	Charly, Judy, sun, pope	
arity:>1	brother, argument, entrance	mother, age, sex, spouse	relational
		identificational	

4 concept classes (Löbner)

	no unique reference	unique reference	
arity:1	SC: sortal concept	IC: individual concept	
arity:>1	RC: (proper) relational concept	FC: functional concept	relational

identificational

frames



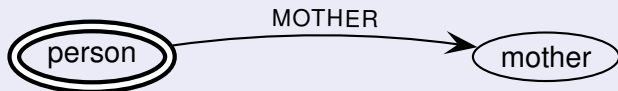
Definition (Frame)

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

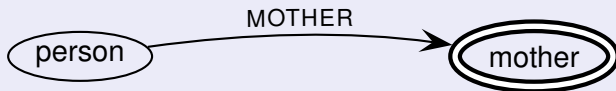
frames of functional concepts

frame 'person' (with attribute 'mother')



$$\lambda x : \text{person}(x) \wedge (\exists y : \text{mother}(y) \wedge \text{MOTHER}(x) = y)$$

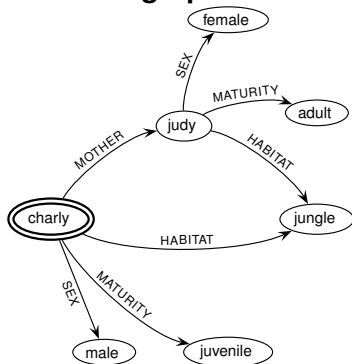
frame 'mother'



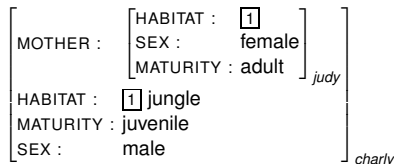
$$\lambda y : \text{mother}(y) \wedge (\exists x : \text{person}(x) \wedge \text{MOTHER}(x) = y)$$

two ways of representing frames

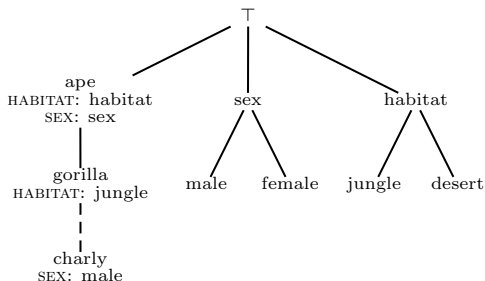
Charly-frame represented as graph



Charly-frame represented as AVM



types are organized in type signatures



$$\left[\begin{array}{l} \text{HABITAT : } \mathit{habitat} \\ \text{SEX : } \mathit{sex} \end{array} \right]_{\mathit{ape}} \sqsubseteq \left[\begin{array}{l} \text{HABITAT : } \mathit{jungle} \\ \text{SEX : } \mathit{sex} \end{array} \right]_{\mathit{gorilla}} \sqsubseteq \left[\begin{array}{l} \text{HABITAT : } \mathit{jungle} \\ \text{SEX : } \mathit{male} \end{array} \right]_{\mathit{gorilla}}$$

Notice the strange duplication of the attributes!

excluding bad attributes

[HEIGHT : 6 feet
HIT : mary]_{john}

Wood's Linguistic Test

Y is a value of the attribute A of X if we can say that Y is a A of X (or *the* A of X).

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 functional concepts

denotational interpretation

A functional concept denotes a set of entities:

$$\delta : \mathcal{R} \rightarrow 2^{\mathcal{U}}$$

$$\delta(\text{mother}) = \{m \mid m \text{ is the mother of someone}\}$$

relational interpretation

A functional concept has also a relational interpretation:

$$\varrho : \mathcal{R} \rightarrow 2^{\mathcal{U} \times \mathcal{U}}$$

$$\varrho(\text{mother}) = \{(p, m) \mid m \text{ is the mother of } p\}$$

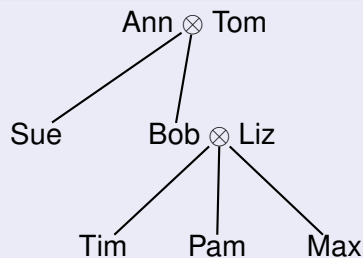
consistency postulate (Guarino, 1992)

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

If $(p, m) \in \varrho(\text{mother})$, then $m \in \delta(\text{mother})$.

example

example family



'mother' denotational

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

'mother' relational ('mother of')

Sue \curvearrowright Ann

Bob \curvearrowright Ann

Tim \curvearrowright Liz

Pam \curvearrowright Liz

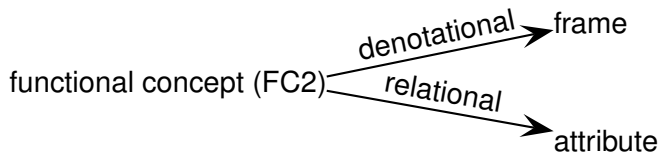
Max \curvearrowright Liz

attributes in frames

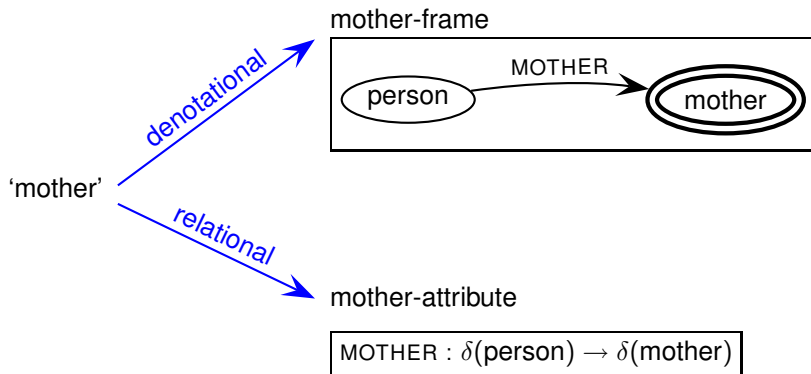
Thesis:

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



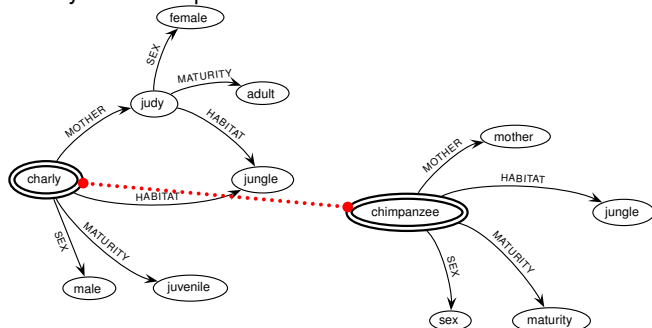
attributes in frames



first ideas about a frame-based logic

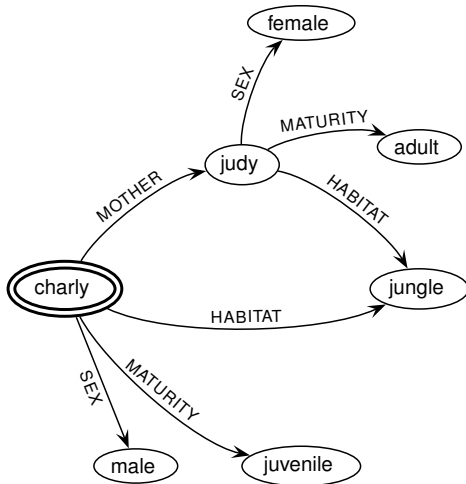
“Charly is an chimpanzee” modeled in **PL1**: $\text{Chimp}(c)$
 true iff $\llbracket c \rrbracket \in \llbracket \text{Chimp} \rrbracket$, i.e. ‘Charly’ $\in \{x \mid x \text{ is an chimpanzee}\}$

“Charly is an chimpanzee” modeled with **Frames**:



true iff the unification of the two frames succeeds, i.e. there exists a unique most general frame which subsumes both frames

reference shifting



advertisement

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

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

Invited speakers:

- Lawrence W. Barsalou
- Friedemann Pulvermueller
- Peter Gaerdenfors
- Barbara Partee
- Xiang Chen
- Nicola Guarino
- William McGregor
- Jeff Pelletier
- Charles Fillmore
- Peter Simons
- Vladimir Borshev

Submission deadline: March 1st 2007

literature

- Barsalou (1992)** Frames, Concepts, and Conceptual Fields. In Lehrer and Kittay (eds.): Frames, Fields, and Contrasts.
- Guarino (1992)** Concepts, attributes and arbitrary relations — some linguistic and ontological criteria for structuring knowledge bases. Data Knowl. Eng. 8, 249-261
- Löbner (2005)** FFF — Forschergruppe “Funktionalbegriffe und Frames”, DFG-Antrag.
- Petersen & Werning (submitted)** Conceptual Fingerprints: Lexical Decomposition by Means of Frames.

the binding problem

