Wissensrepräsentation

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Sommersemester 2003

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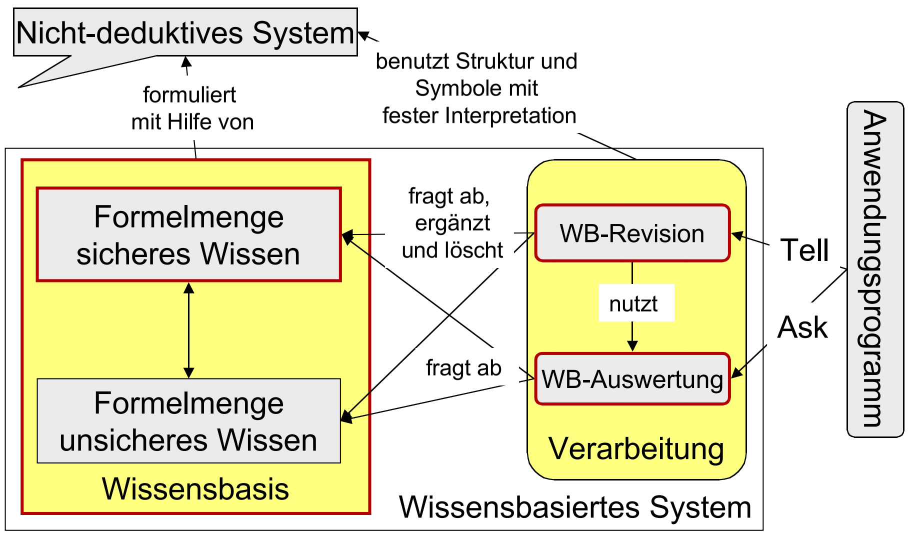
Sitzung 14: Vererbung / Inheritance

- Vererbung
- Pfadbasiertes Schliessen
- Vererbungsnetze

Wissensbasiertes System mit nicht-deduktiver Wissensbasis



Literatur

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Insbesondere

J. Horty. Some direct theories of nonmonotonic inheritance. In D. Gabbay, C. Hogger, and J. Robinson (eds.), Oxford University Press (1994), pp. 111 - 187.

D. Touretzky. (1986). The mathematics of inheritance systems. Morgan Kaufmann, Los Altos, Ca., 1986.

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Vererbung (Inheritance)

When thinking object-centered, hierarchy is a natural way to view the world

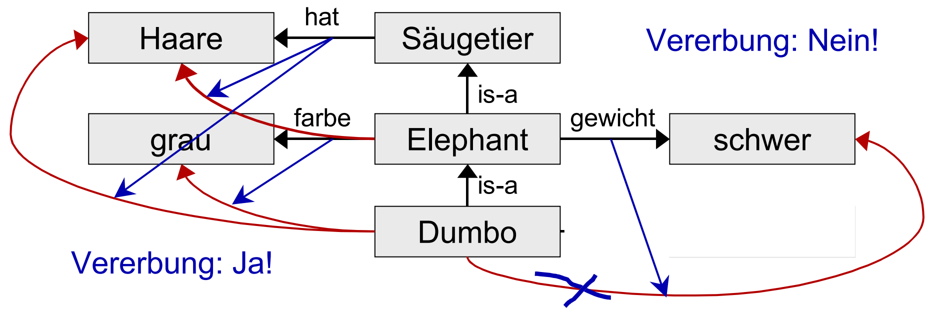
- importance of abstraction in remembering and reasoning
  - groups of things share properties in the world (e.g., mammals, seafood)
  - don't have to repeat representations (e.g., sufficient to say that "elephants are mammals" to know a lot about them)

z.B. Frames, Semantische Netze, Beschreibungslogik (description logics)

Brachman&Levesque - ch.10, f.1

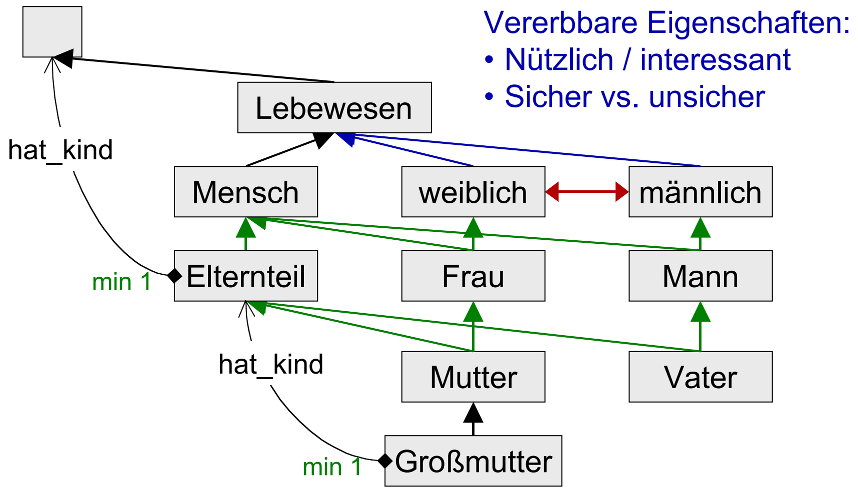
Semantische Netze

- Repräsentationen für Konzept-Wissen
- Graphen mit Knoten für Konzepte und Individuen und beschriftete Pfeilen für binäre Relationen
- Definiert über Bilder, keine klare Semantik, keine spezifizierten Verarbeitungsmechanismen



Beispiel: Konzeptsysteme

Gruppen-diskussion



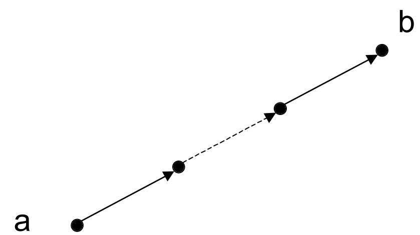
Vererbbare Eigenschaften:
- Nützlich / interessant
- Sicher vs. unsicher

Inheritance

"Inheritance" is the result of transitivity reasoning over paths

- for strict networks, *modus ponens* in graphical form
- does *a* inherit from *b*?

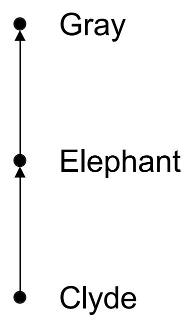
  ≡ is b in the transitive closure of IS-A (or subsumption) from a?



Brachman&Levesque - ch.10, f.1

Pfad-basiertes Schliessen

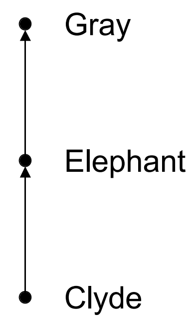
Focus just on inheritance and transitivity
- many interesting considerations in looking just at where information comes from in a network representation
- abstract descriptions, and properties into *nodes* in graphs, and just look at reasoning with paths and the conclusions they lead us to



Brachman&Levesque - ch.10, f.2

Pfad-basiertes Schliessen (cont‘d)

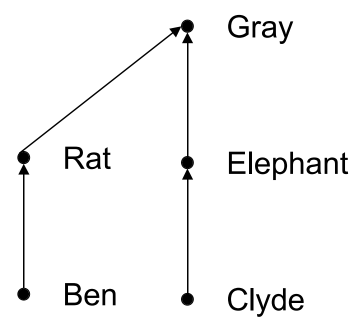
- edges in the network:
  Clyde—Elephant, Elephant—Gray
- paths included in this network:
  {Clyde—Elephant—Gray},
  plus edges
  - in general, a path is a sequence of 1 or more edges
- conclusions supported by the paths:
  Clyde → Elephant; Elephant → Gray;
  Clyde → Gray



Brachman&Levesque - ch.10, f.2

Vererbungsnetze (1)

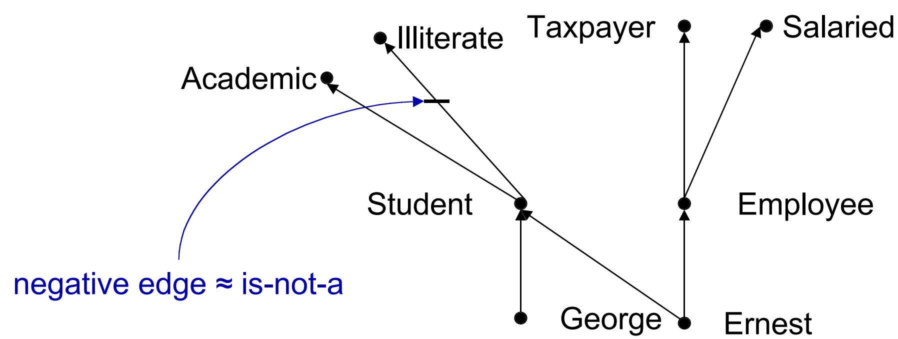
Strict inheritance in trees
- as in description logics
- conclusions produced by complete transitive closure on all paths (any traversal procedure will do);
  all reachable nodes are implied



Brachman&Levesque - ch.10, f.3

Vererbungsnetze (2)

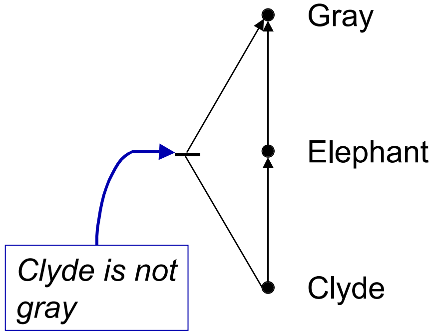
Strict inheritance in DAGs
- as in DL’s with multiple AND parents
- same as above: all conclusions you can reach by any paths are supported



Brachman&Levesque - ch.10, f.3

Defeasible inheritance (1)

- inherited properties do not always hold, and can be *overridden* (defeated)
- conclusions determined by searching upward from "focus node" and selecting first version of property you want

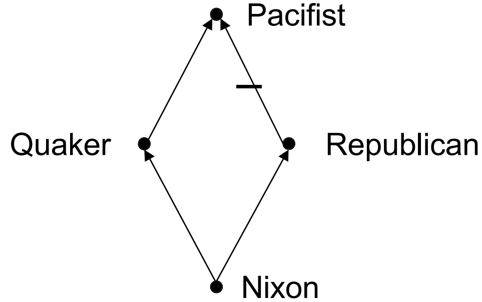


- *defeasible*
  - *anfechtbar*
  - *annullierbar*
- „Polarität" von Kanten
  - positiv is / is-a
  - negative is-not / is-not-a

Brachman&Levesque - ch.10, f.4

Defeasible inheritance (2): Nixon Diamond

- Mehrere Vererbungen möglich, die sich aber widersprechen können. (ambigous net)
- Welche Eigenschaft soll hier zugesprochen werden?
- Welche Strategien für die Entscheidung zwischen den Vererbungs-möglichkeiten?



Defeasible Inheritance

Gruppen-diskussion

Konzeptsystem der Wochentage etc.

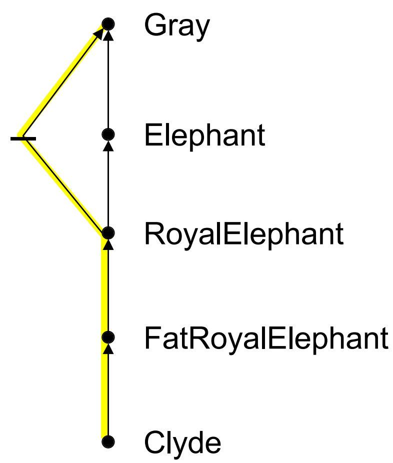
- Werktage, Samstag, Sonntag
- Sonn- und Feiertage
- Spezifische Feiertage:
  - Neujahr
  - Karfreitag, Ostern
  - Himmelfahrt
  - Pfingsten
  - 3. Oktober
  - Weihnachten, Sylvester

- Welche Vererbungs-Netze?
- Welche Strategien für Konflikte?

Shortest Path Heuristic

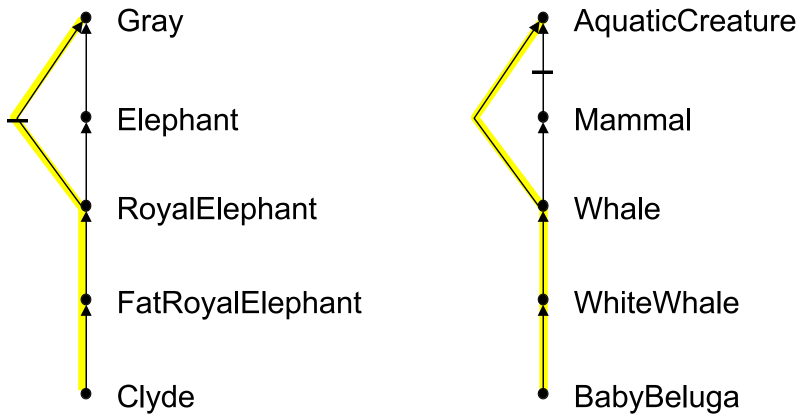
Defeasible inheritance in DAGs
- links have polarity (positive or negative)
- use shortest path heuristic to determine which polarity counts

➢ Zugrundeliegende Idee: Berücksichtige das spezifischste subsumierende Konzept.



Brachman&Levesque - ch.10, f.5

Shortest Path Heuristic



→Clyde ist nicht grau.

→ BabyBeluga ist ein im Wasser lebendes Tier.

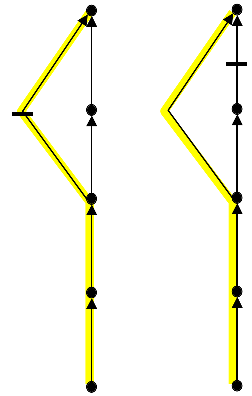
Brachman&Levesque - ch.10, f.5

Shortest Path Heuristic

Pfade im Vererbungsnetzwerk
- fungieren als Argumente
- stützen Schlussfolgerungen

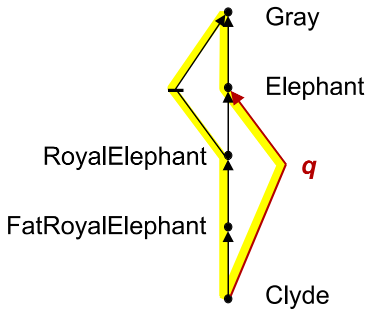
- Einige Pfade werden von anderen verhindert (are "preempted")
- Andere sind zulässig (are "admissible")

➢ Das Vererbungsproblem ist das Problem, die zulässigen Pfade zu bestimmen.

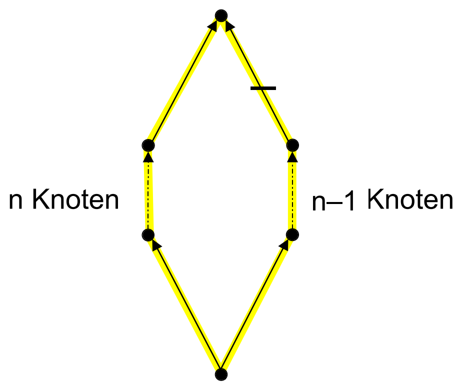


Probleme mit der Kürzeste-Wege-Heuristik

Redundante Kanten beeinflussen das Ergebnis, z.B. eine zusätzliche direkte Verbindung, etwa durch einen „gespeicherten Schluss"



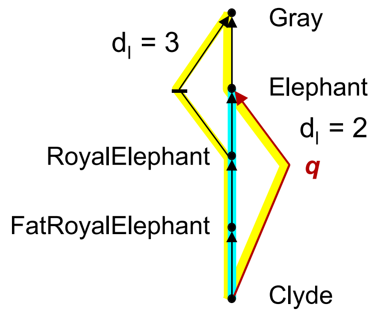
Irrelevante Kanten können das Ergebnis beeinflussen, z.B. bei grosser Pfadlänge



Inferential distance

Consider "inferential distance": not linear distance, but
- topologically based – a node a is nearer to node b than to node c if there is a path from a to c through b

➢ idea: conclusions from b preempt those from c



Inheritance Hierarchy (Formalization L. A. Stein)

An inheritance hierarchy Γ = <V,E> is a directed, acyclic graph with

	intended to denote	depicted as
• positive edges	"(normally) is-a"	a — x
and		
• negative edges,	"(normally) is not-a"	a — ¬x

A sequence of edges is a path:

- a positive path is a sequence of positive edges
  a —… — x
- a negative path is a sequence of positive edges followed by a single negative edge
  a —… —v — ¬x

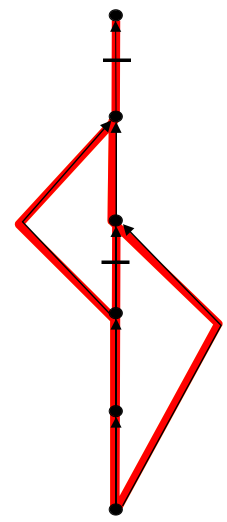
Vererbungspfade als Argumente

A path (or argument) supports a conclusion:

- a —… — x
  supports the conclusion
  a→x (a is an x)
- a —… —v — ¬x
  supports
  a-/->x (a is not an x)

Note: a conclusion may be supported by many arguments

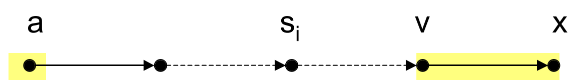
However: not all arguments are equally believable...



Zulässigkeit von Pfaden (Admissibility)

An edge v —(¬)x is admissible in Γ = <V,E> w.r.t. a if there is a positive path a —$s_1 \ldots s_n$ — v (n ≥0) in E and

1. each edge in a —$s_1 \ldots s_n$ — v is admissible in Γ w.r.t. a (recursively);
2. no edge in a —$s_1 \ldots s_n$ — v is redundant in Γ w.r.t. a (see below);
3. no intermediate node a,$s_1,\ldots,s_n$ is a preemptor of v —(¬)x w.r.t. a (see below).



Support & Admissibility

Γ= <V,E> supports a path a —$s_1 \ldots s_n$—(¬)x if the corresponding set of edges {a—s_1,…, s_n—(¬)x} is in E, and it is admissible.

- The hierarchy supports a conclusion a → x (or a -/-> x) if it supports some corresponding path

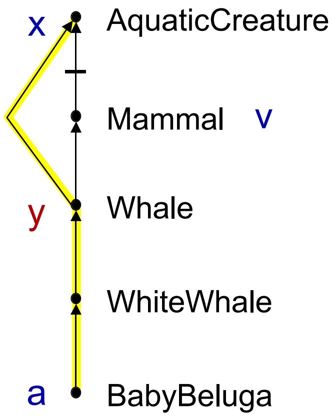
A path is admissible if every edge in it is admissible.

Preemption (Verhinderung)

A node y along path
a —...y...—v is a preemptor
of $v — x$ ($v —\neg x$) w.r.t a

if y —¬x ∈ E ($y — x$ ∈ E)

Existenz eines Preemptors schliesst Pfade als zulässig aus (Bed. 3).



Redundanz

A positive edge b—w is redundant in Γ w.r.t. node a if

there is some positive path $b—t_1 \ldots t_m—w \in E$ ($m \geq 1$), for which

1. each edge in $b—t_1 \ldots t_m$ is admissible in Γ w.r.t. a;
2. there are no c and i such that $c—\neg t_i$ is admissible in Γ w.r.t. a;
3. there is no c such that c—¬w is admissible in Γ w.r.t. a.

The definition for a negative edge b—¬w is analogous