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Semantics of a Propositional Network

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Setting

- Semantics of SNePS 3
- Builds on previous versions of SNePS and predecessor systems
- Ideas evolved from pre-1968 to current.

Kind of Graph

- Directed Acyclic Graph
- With Labeled Edges (arcs)
- Cf. Relational graphs
- No parallel arcs with same label
- Allowed: parallel arcs with different labels
- Allowed: multiple outgoing arcs
  - With same or different labels
  - To multiple nodes
  - Each node identified by a URI

Basic Notions 1

- Network represents conceptualized mental entities of a believing and acting agent.
- Entities include
  - Individuals
  - Classes
  - Properties
  - Relations
  - Propositions
  - Acts
  - etc…

Basic Notions 2

- 1-1 relation between entities and nodes.
  - Every node denotes a mental entity.
    - Arbitrary and Indefinite Terms replace variables.
  - Every mental entity denoted by one node.
  - No two nodes with same arcs to same nodes.
- Some, not all, proposition-denoting nodes are asserted.

Contexts

- Delimit sub-graph of entire network.
- Contain and distinguish
  hypotheses and derived propositions.
- Organized as a rooted DAG
  for inheritance
  of asserted propositions.

Top-Level Domain Ontology

- Entity
  - Proposition
  - Act
  - Policy
  - Thing
- Use many-sorted logic.

Syntactic Hierarchy

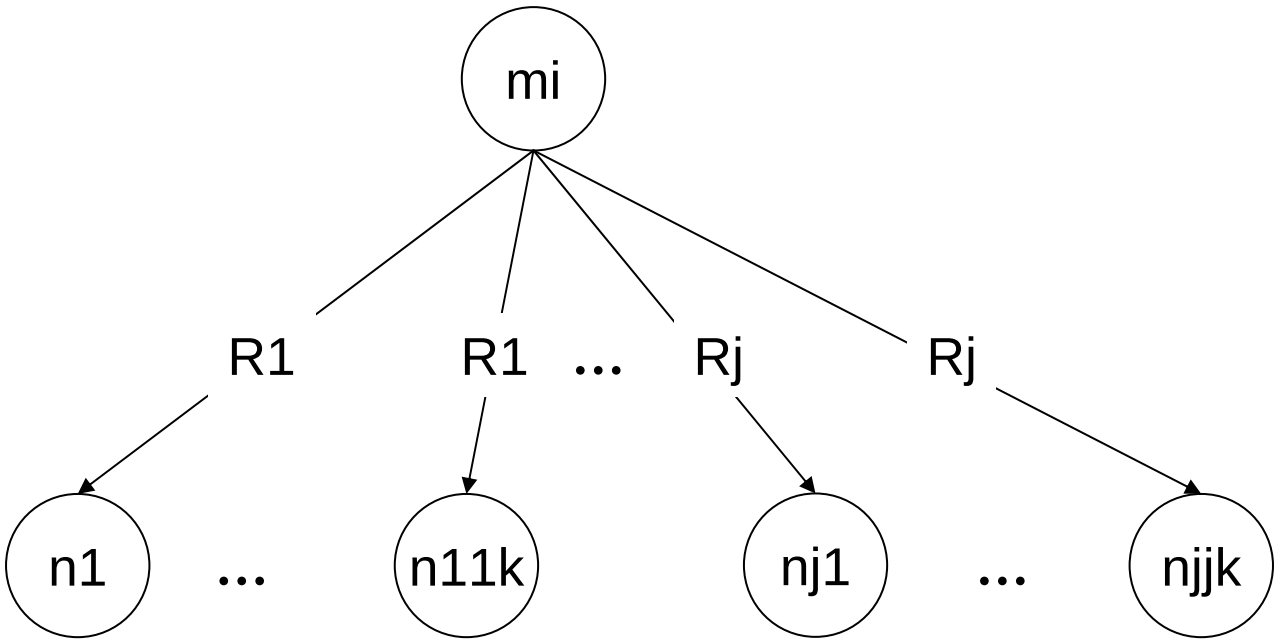
- Node
  - Atomic
    - Base (Individual constants)
    - Variable
      - Arbitrary
      - Indefinite
  - Molecular
    - Generic
    - …

Semantics of Individual Constants

- Base node, n_i
  - No outgoing arcs
- Denotes some entity e_i
- n_i is created because
  - When e_i is conceived of no other node "obviously" denotes it.

Frame View of Molecular Nodes

Multiple arcs with same label forms a set.



mi:(R1 (n1 … n11k) … Rj (nj1 … njjk))

Set/Frame View Motivates Slot-Based Inference

E.g.

From

(member (Fido Lassie Rover)
  class (dog pet))

To

(member (Fido Lassie) class dog)

Slot-Based Inference & Negation

From
(not (member (Fido Lassie Rover) class (dog pet)))
To
(not (member (Fido Lassie) class dog))
OK.

From
(not (siblings (Betty John Mary Tom)))
To
(not (siblings (Betty Tom)))
Maybe not.

Relation Definition Controls Slot-Based Inference

- Name
- Type (of node(s) pointed to)
- Docstring
- Positive
  - Adjust (expand, reduce, or none)
  - Min
  - Max
- Negative
  - Adjust (expand, reduce, or none)
  - Min
  - Max
- Path

Example: member

- Name: member
- Type: entity
- Docstring: “Points to members of some category.”
- Positive
  - Adjust: reduce
  - Min: 1
  - Max: nil

(member (Fido Lassie Rover) class (dog pet))
├ (member (Fido Lassie) class dog)

- Negative
  - Adjust: reduce
  - Min: 1
  - Max: nil

(not (member (Fido Lassie Rover) class (dog pet)))
├ (not (member (Fido Lassie) class dog))

Example: siblings

- Name: siblings
- Type: person
- Docstring: "Points to group of people."
- Positive
  - Adjust: reduce
  - Min: 2
  - Max: nil
- Negative
  - Adjust: expand
  - Min: 2
  - Max: nil

(siblings (Betty John Mary Tom))
├ (siblings (Betty Tom))

(not (siblings (Betty John Mary)))
├ (not (siblings (Betty John Mary Tom))

Case Frames

- Function "symbols" of the SNePS logic.
- Denote nonconceptualized functions in the domain.

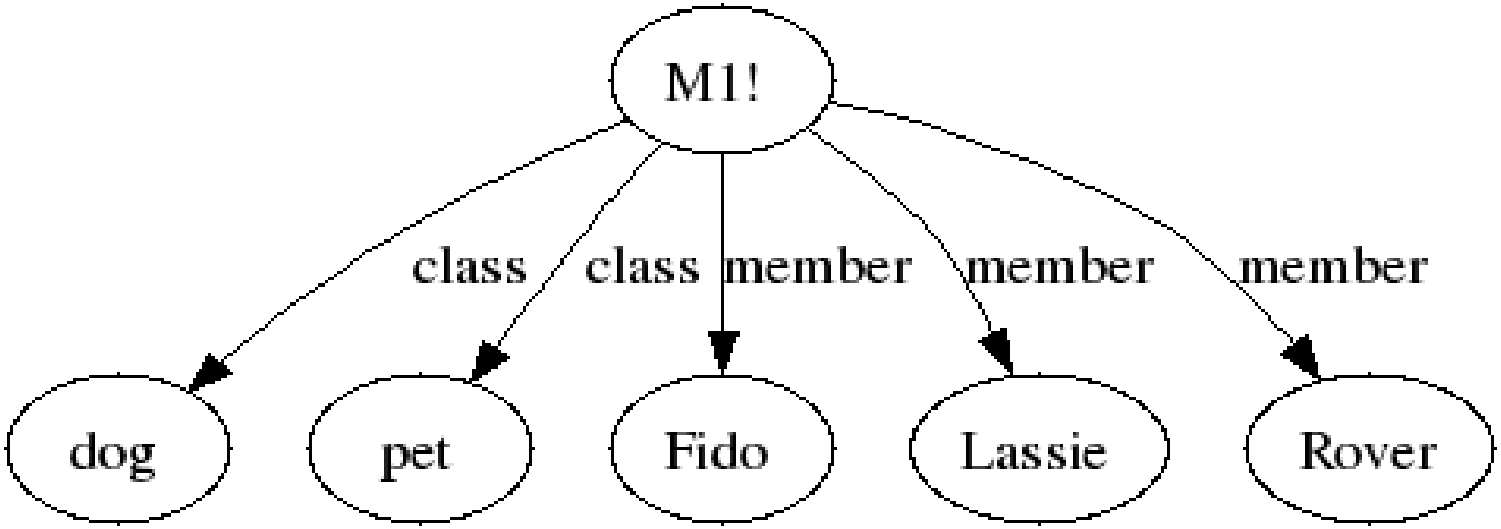
Case Frame Definition

- Type (of created node)
- Docstring
- KIF-mapping
- Relations

Example Case Frame

- Type: proposition
- Docstring:
  "the proposition that [member] is a [class]"
- KIF-mapping: ('Inst member class)
- Relations: (member class)

Example Proposition

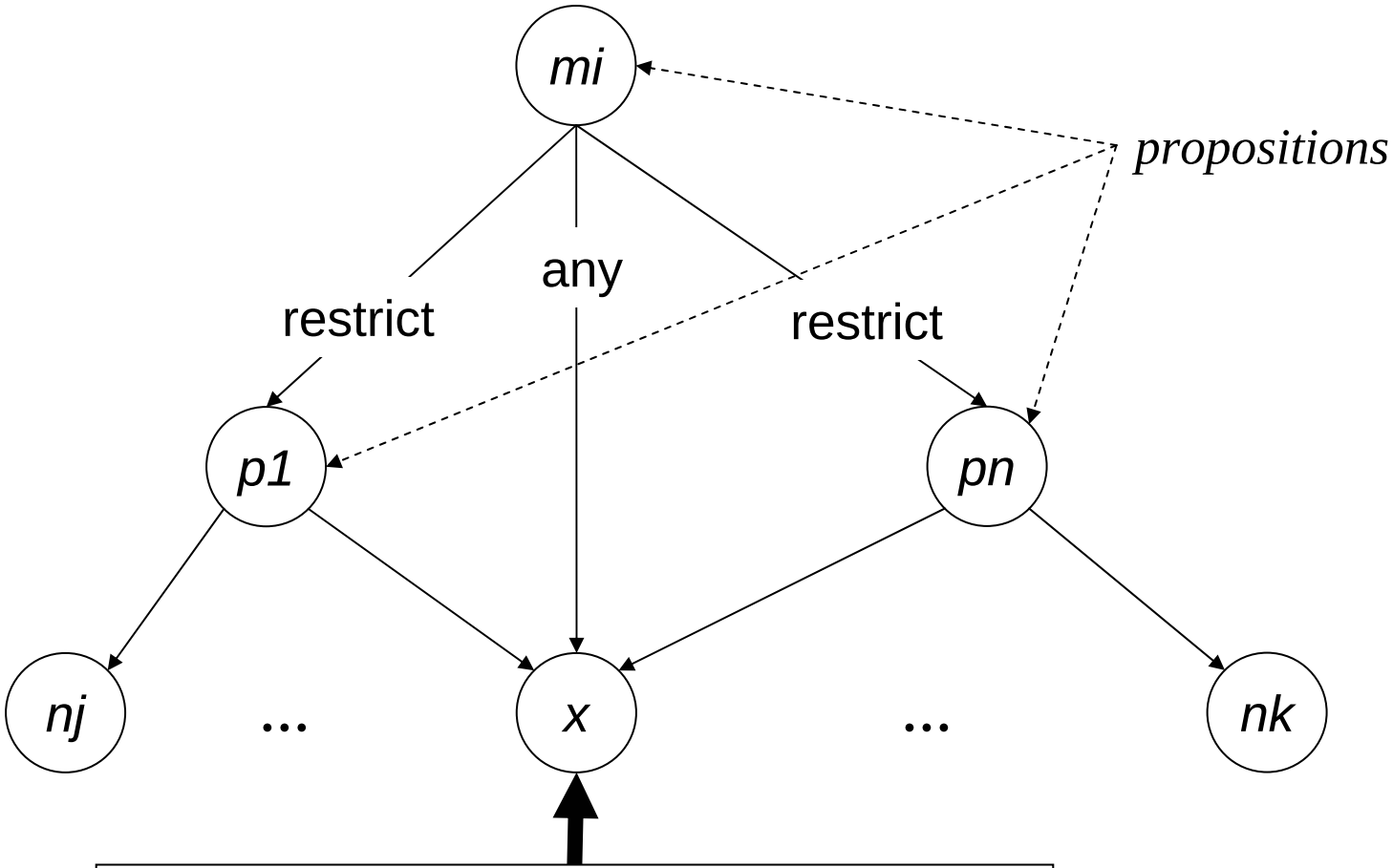


M1!:(member (Fido Lassie Rover) class (dog pet))

(Inst (setof Fido Lassie Rover) (setof dog pet))

The proposition that Rover, Lassie, and Fido is a pet and dog.

Arbitrary Terms

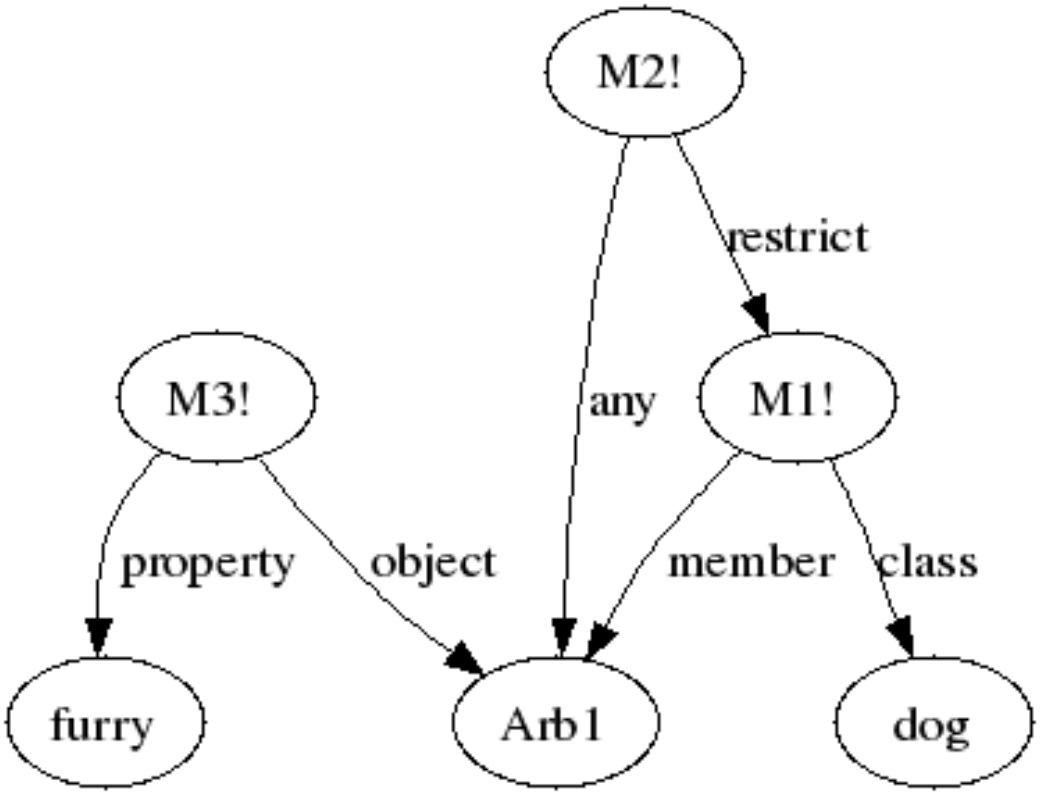


(any *x* restrict *p1 … pn*)

No two that are just renamings.

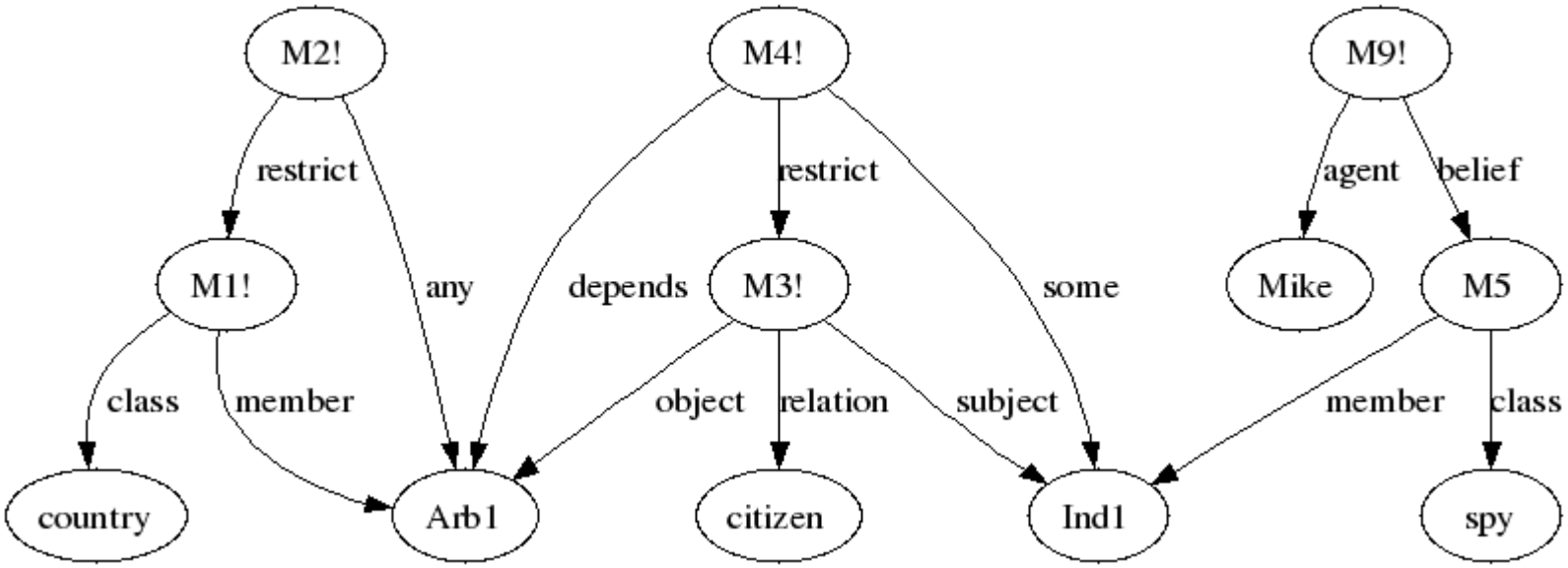
[Shapiro KR'04]

Example: Dogs are furry.



M3!:(object (any x restrict (member x class dog))
property furry)

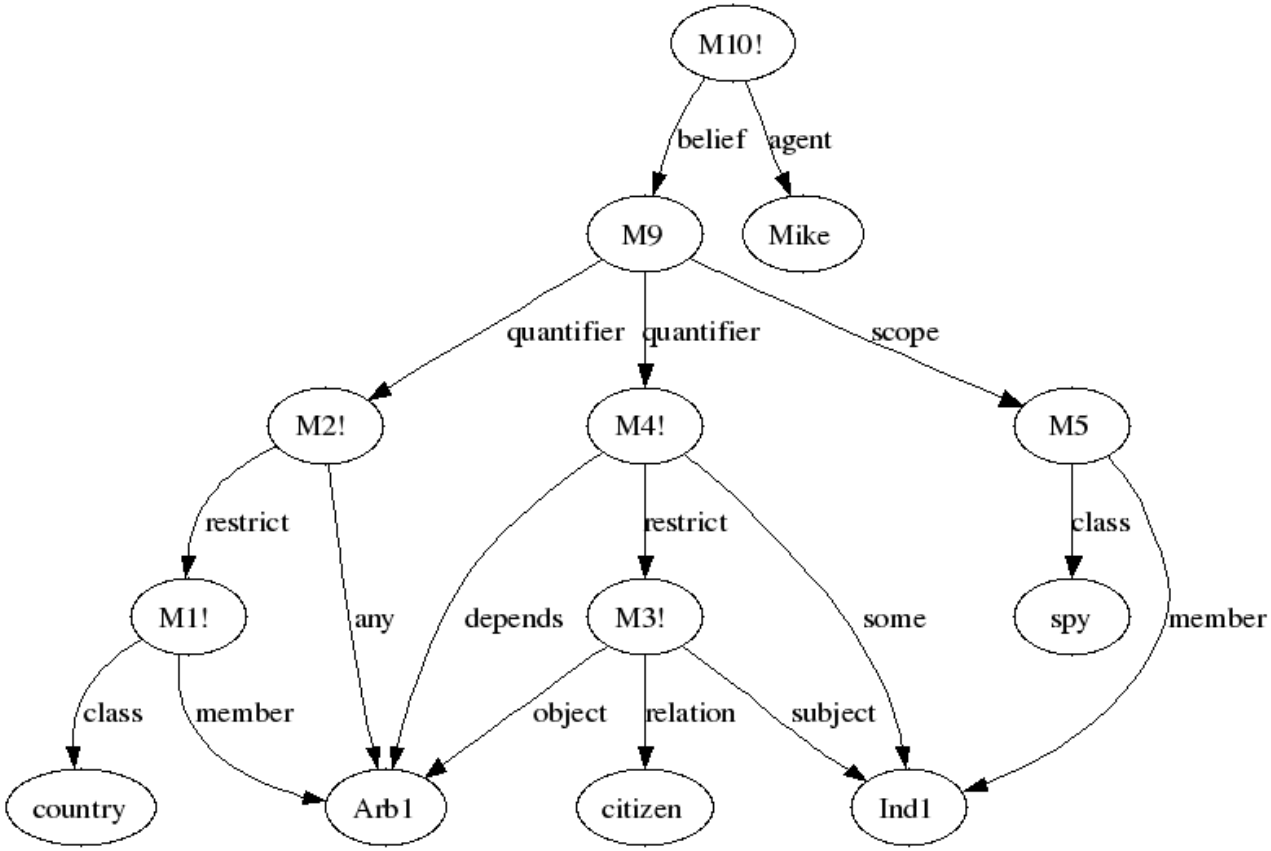
Indefinite Terms, Example



There's some citizen of every country whom Mike believes is a spy.

M9!:(agent Mike
belief (member (some x ((any y (member y class country)))
(relation citizen subject x object y))
class spy))

Closed Indefinite Terms, Example



Mike believes that some citizen of every country is a spy.

M15!:(agent Mike
belief (close (member (some x ((any y (build member y class country)))
(relation citizen subject x object y))
class spy)))

Other Topics

- Logical Connectives
  - (andor (*i j*) *P1* … *Pn*)
  - (thresh (*i j*) *P1* … *Pn*)
  - (*i*=> (setof *A1* … *An*) (setof *C1* … *Cn*))
- Supports for ATMS

Summary

- Nodes denote mental entities.
  - Individual constants.
  - Arbitrary and Indefinite terms.
  - Functional terms, including:
    - Atomic Propositions;
    - Nonatomic Propositions.
    - Some propositions are asserted.
- Labeled arcs indicate argument position.
- Case Frames denote nonconceptualized functions.