Truth Maintenance Systems

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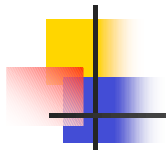- Literature

some knowledge

Knowledge representation:

1) Idea of ontology (organizes everything in the world into a hierarchy of categories)

2) Reasoning about the results of actions

3) Reasoning systems for representation uncertain and changing knowledge.

more knowledge (2)

- Agents until now have beliefs and can deduce new beliefs
- Looking for having agents with knowledge about beliefs and about deduction

... TMS

then....

! problem : when are contradictions and it is not that "simple" to retract in the KB, what to do?

Suggested solution:

Truth Maintenance Systems (TMS)

tracking the order in which sentences are told to the knowledge base by numbering them, this implies that the KB will be consistent.

TMS (2)

- justification-based TMS (JTMS)
- assumption-based TMS (ATMS)
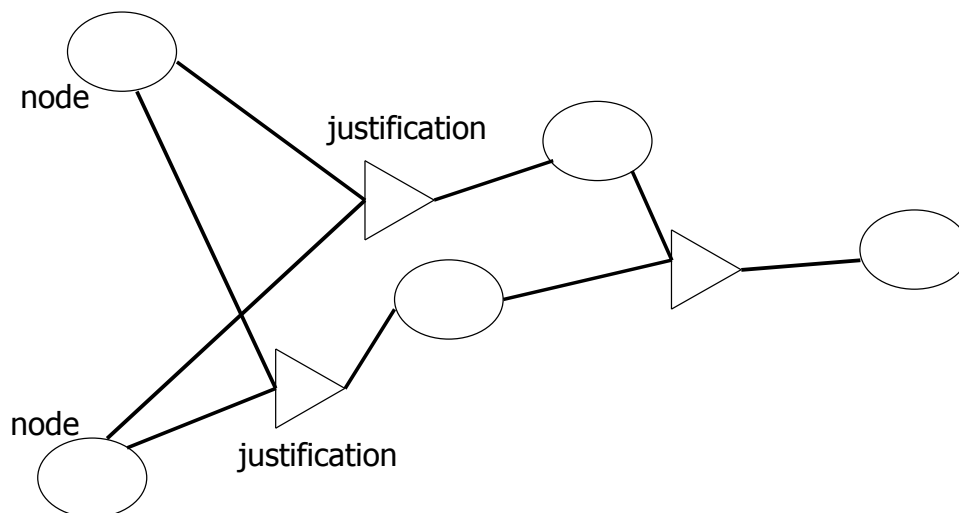- logic-based TMS (LTMS)

JTMS

- one element of a TMS design space
- simplest
- good model for most dependency systems
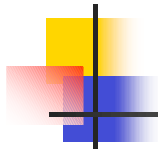- can quickly focus on how to use it

JTMS representation

node

justification

node

justification

JTMS nodes

- each belief represented by a TMS node
- nodes are associated 1:1 with assertions
- the label of a node represents the belief status of the corresponding problem solver fact
- the relationships between beliefs are expressed by the justifications it participates in

JTMS Labels

- every assertion is either IN or OUT
  - IN = "believed"
  - OUT = "not believed"
- Warning: IN does not mean TRUE

	P in	P out
(not p) in	Contradiction	(not p) true
(not p) out	p true	Don't know

JTMS Justifications

- Must be Horn clauses
  - Horn clause
- Nomenclature
  - Consequent is the node whose belief is supported by the justification
  - Antecedents are the beliefs which, when IN, support the consequent
  - Informant records information from external systems

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JTMS

- efficient: keeps justification records of conclusions and retracts only relevant conclusions
  - **P=>Q, Tell(P)->justifications{P,P=>Q} for Q**
  - **Retract(P)->check only justifications**
- sentences marked IN or OUT (avoid deleting)
- can also be used to analyze multiple hypothetical situations efficiently

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Enforcing constraints between beliefs

- A node is IN when either:
    - it is an enabled assumption or promise
    - there exists a justification for it whose antecedents are all IN
- Assumptions underlying a belief can be found by backchaining through supporting justifications
- JTMS operations must preserve well-founded support

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ATMS

ATMS is a general search - control mechanism, that can be coupled with domain-specific problem to solve a wide range of problem

- Start with a JTMS
- Label become more complex than: in, out

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ATMS data structures

- Assumption
- Environments
- Labels

Justifications

Justifications is a relationships among assumptions and nodes

$$1 \quad l_1 \wedge l_2 \wedge \mathrm{K} \wedge l_n \rightarrow n$$

$$2 \quad l_1 \wedge l_2 \wedge \mathrm{K} \wedge l_n \rightarrow \perp$$
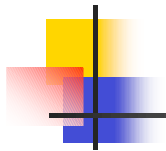
where:

1 – truth of the node

2-inconsistensy

New Definitions

Environments = set of assumption

Label = set of environments

Type of labels

- *Sound* - All assumptions in any environment within the label of a node being true is a sufficient condition to derive that node:

- *Consistent* - No environment in the label of a node, other than the nogood node, describes an impossible world:

- *Minimal* - The label does not contain possible worlds that are less general than one of the other possible worlds it contains (i.e. environments that are supersets of other environments in the label):

- *Complete* - The label of each node, other than the nogood node, describes all possible worlds in which that node can be inferred:
  -

LTMS

- **Logic Truth Maintenance Systems**

  ideal for real time propositional reasoning

- **LTMS database summatory**

  contains clauses describing component behaviour in each mode

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Conclusions

- JTMS is used to maintain well fondness and assumption based TMS (ATMS) for coherence
- No possible to tell which TMS is the best without analysing the problem at hand and the resources available
- TMS in general handle knowledge, updates and revisions efficiently
- TMS can be used to speed up the analysis of multiple hypothetical situations.

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