

Advanced Dialogue Modeling for Practical Applications
Hauptseminar , WS 2008/09

Conflict Resolution in Collaborative Planning Dialogues^[1]

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Outline

- Conflicts!
- Modeling Collaboration in CORE
- Dialog Model
- Conflict Detection
- Conflict Resolution
- Conclusion
- Questions

Conflicts!

- Collaboration : two or more participants coordinate their actions towards achieving shared goals[2].
 - Approach: Collaborative Discourse Theory, SharedPlans
- Collaborative Environments
 - e.g. COLLAGEN, TRIPS
 - Agents
 - autonomous and heterogeneous
 - domain knowledge and beliefs
 - Discrepancies in belief's -> conflicts during planning!
 - Then what?
 - Stop talking? or Ignore and leave? or Non-corporation ? or Attempt to resolve?
- Negotiation
 - Seeking own goal; Agreements or resolving disputes; might trade off between one's own goals or shared agendas; dynamically change in goals and strategy [3].
- Collaborative Negotiation Subdialogs!

Collaborative Negotiation

- In a collaborative negotiation subdialogue
 1. Agents are open and honest
 2. Doesn't insist on winning an argument and given convincing evidence -> may change their beliefs
 3. Share own beliefs with others
- **Motto:** “What really is best for the agents as a group”
- Example
 - Me : Here is 1 euro for this 500 ml bottle of water.
 - Arl : 1.75 euros please!
 - Me : Why? It should not cost more then 50 cents.
 - Arl : things are usually expensive at Midways and Gas stations.
 - Me : Ahem! [paid 75 cents more]
 - Arl : thanks!

Modeling Collaboration

- Corpus analysis of TRAINS 91 dialogues.
- Proposal/acceptance and Proposal/rejection sequence [Sidner 1994, Walker, 1996]
- Observation:
 - a *proposal* is not discarded for entirety, but is modified.
- **CORE** for conflict detection and conflict resolution during collaborative planning activities.
 - A proposal
 - Evaluate the proposal to detect conflicts
 - Validity and optimality of proposal
 - Truth of proposed beliefs
 - Resolution of conflict
 - Initiate negotiation subdialogues with the user
 - Multiple conflicts -> selects most effective aspects for resolution using
 - its private domain beliefs and its model of user's belief

Framework

- Modeling behavior of collaborative agents as ***Propose-Evaluate-Modify***

(10) S: I was going to say two [courses] this time and then three next time.
[proposal]

(11) A: And if you take two and then don't pass one, you also would be slightly behind. *[evaluates 10, based upon own beliefs, decides to modify 10, and proposes in 11]*

(12) S: Right. *[acknowledges 11]*

(13) But then if I take two, the probability is much higher that I'll do well in both of them. *[evaluates 11, provides evidence to support 10]*

(14) Whereas if I take three...*[attempts to modify A's belief]*

(15) A: Right. *[evaluates S's proposal in light of evidences]*

(16) People do take two, so...*[accepts S's initial proposal]*

Modeling Actions and Intentions

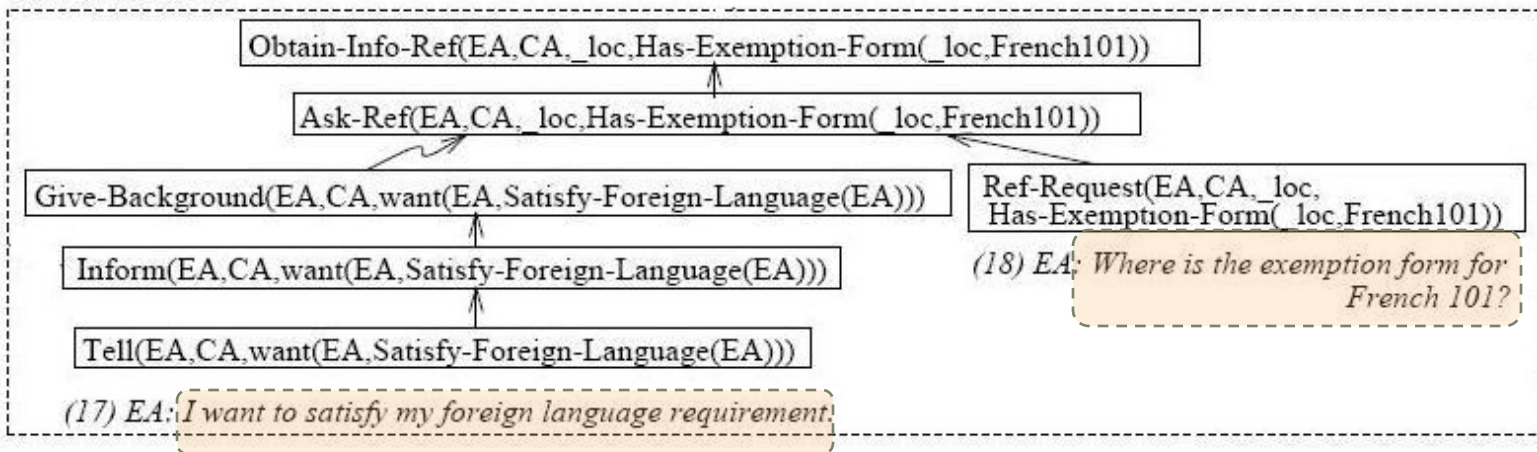
- Collaborative planning
 - Determining domain actions for Shared plan
 - Collaborate on strategies to construct domain plan
 - Alternative plans or investigate plans in parallel
 - Establish mutual beliefs
 - Communication actions to exchange information
- Capturing current intentions of dialogue participants
 - Dialogue Model
 - Domain level
 - Problem-Solving level
 - Belief level
 - Discourse level

Dialogue Model 1/5

- **Discourse Level**

- Communicative actions initiated to achieve the mutual beliefs.
- User Utterances are mapped to Discourse actions.
- Discourse actions can contribute to other discourse actions.
- Agents can't disagree about discourse actions (execution along with utterance).

Discourse Level



Dialogue Model 2/5

- **Belief Level**

- Mutual beliefs pursued during the planning process in order to further the problem solving intentions (proposed)
- Agent beliefs can't become shared until accepted, therefore it is still a **Proposed Belief Level** (private)
- Agreed mutual beliefs are part of **Existing Belief level** (shared)

Proposed Belief Level

MB(EA,CA,want(EA,Satisfy-Foreign-Language(EA)))

Mknowref(EA,CA, loc.Has-Exemption-Form(loc.French101))

Discourse Level

Obtain-Info-Ref(EA,CA, loc.Has-Exemption-Form(loc.French101))

Ask-Ref(EA,CA, loc.Has-Exemption-Form(loc.French101))

Give-Background(EA,CA,want(EA,Satisfy-Foreign-Language(EA)))

Ref-Request(EA,CA, loc, Has-Exemption-Form(loc.French101))

Inform(EA,CA,want(EA,Satisfy-Foreign-Language(EA)))

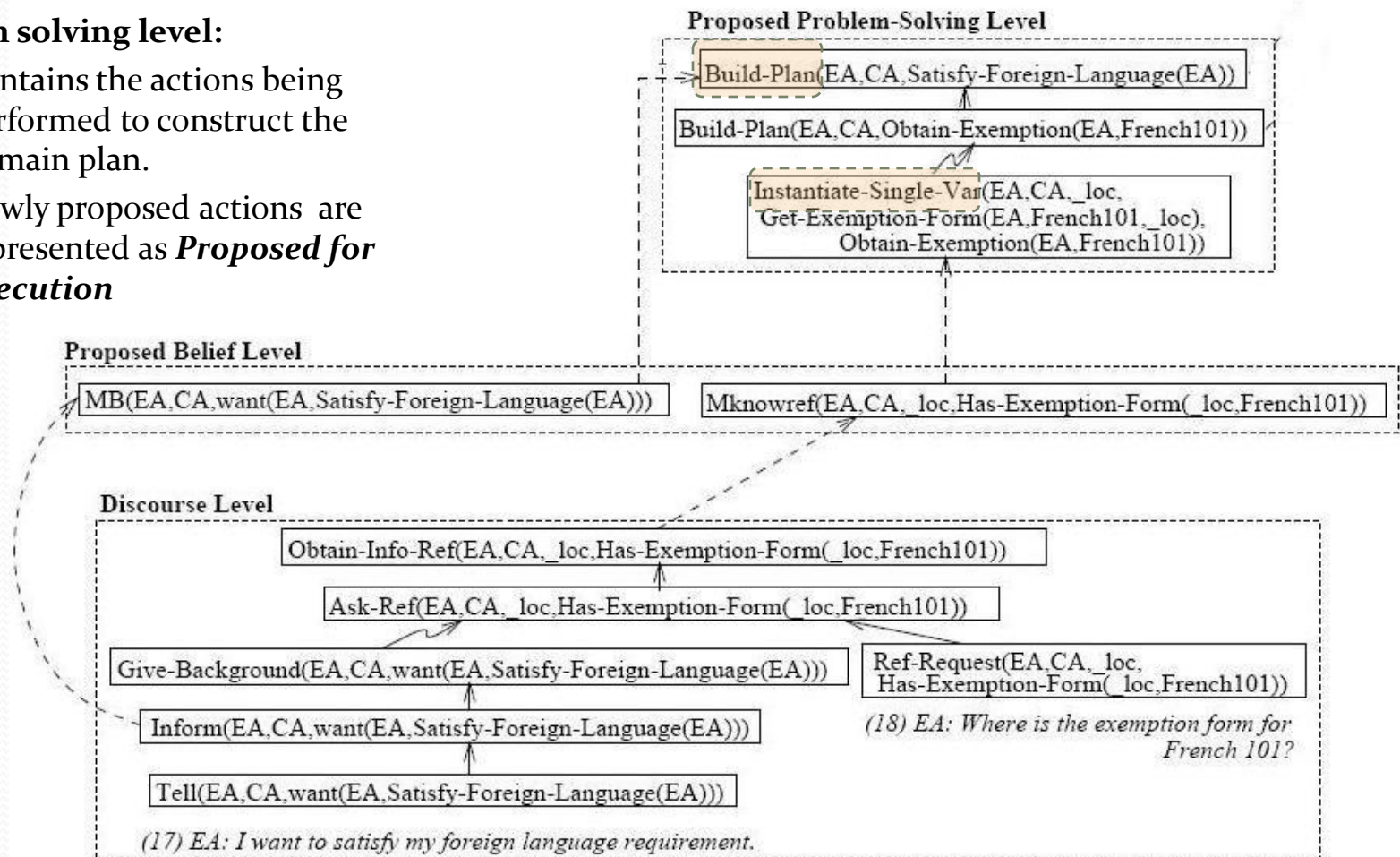
(18) EA: Where is the exemption form for French 101?

Tell(EA,CA,want(EA,Satisfy-Foreign-Language(EA)))

(17) EA: I want to satisfy my foreign language requirement.

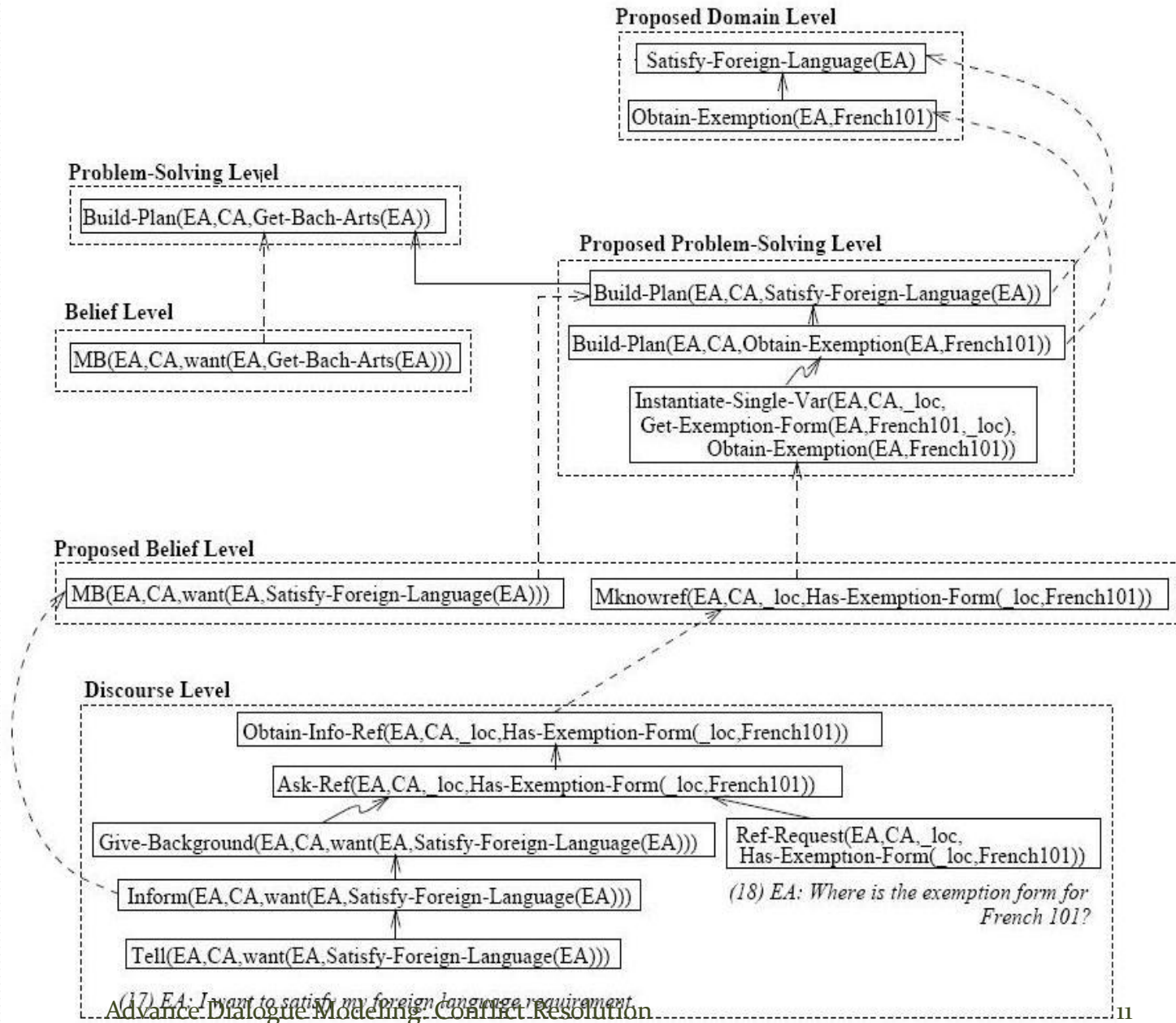
Dialogue Model 3/5

- **Problem solving level:**
 - Contains the actions being performed to construct the domain plan.
 - Newly proposed actions are represented as *Proposed for execution*



Dialogue Model 4/5

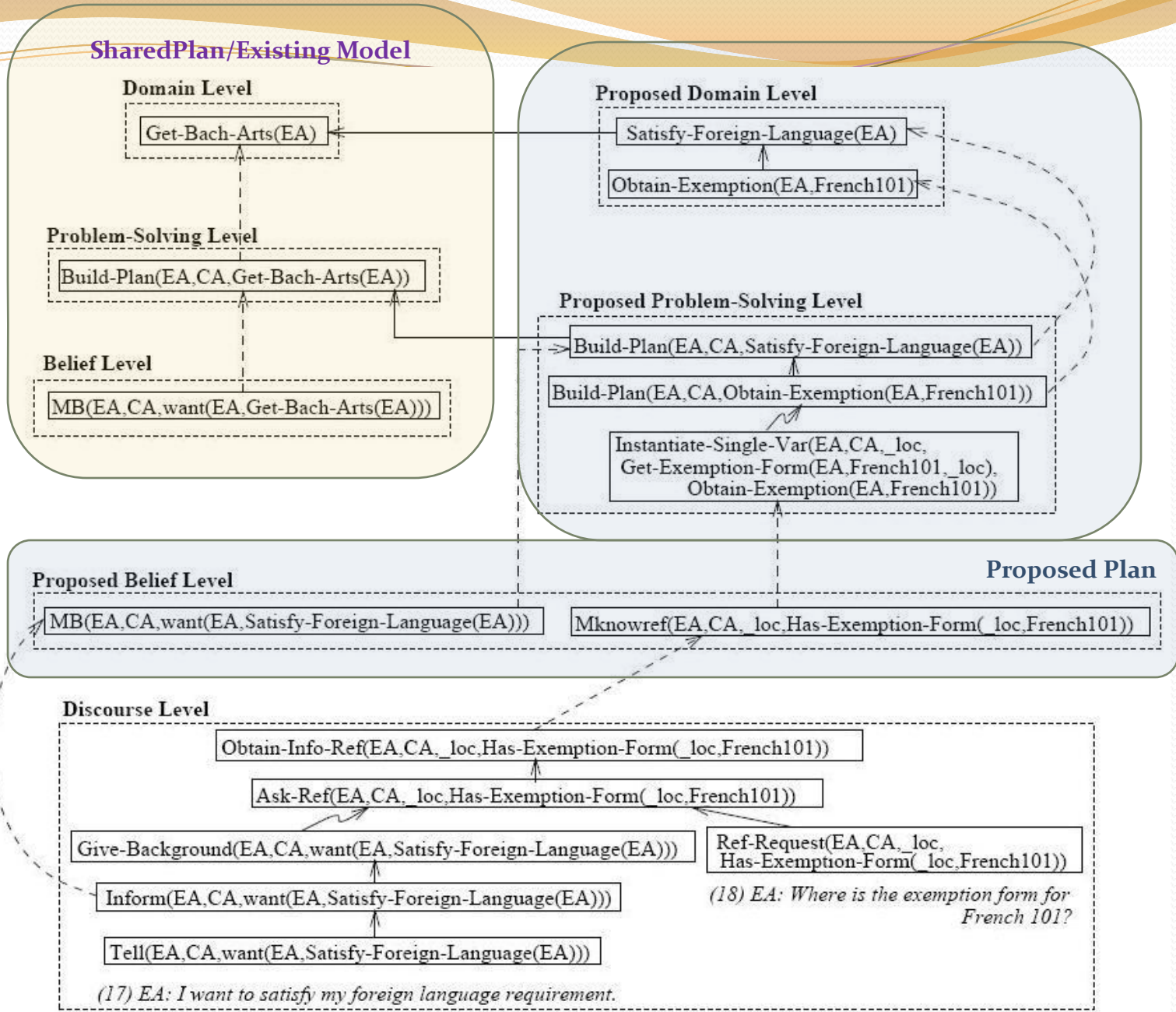
- **Domain Level** consists of the domain plan being constructed to achieve the agents' *shared domain* goal.
- Agents collaborate on determining which domain action to include in their shared plan.



Dialogue Model 5/5

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Conflict Detection

- Proposal Evaluation
 - Whether or not to make a **proposed plan/belief** part of **shared plan/belief**?
 - Algorithm should:
 - recognize *intentions* that does not comprise a *correct means* of achieving one's goals.
 - ascribes *erroneous beliefs* that a Executing Agent (EA) might be holding.
 - Evaluation in two parts:
 - Evaluation of proposed action
 - Evaluation of proposed belief

Part 1 – Domain and PS actions

- Proposals consists of a chain of actions inferred from an agent's *utterances*
 - *Child* action 'A' contributing to *Parent* action 'B' if
 - *goal* of 'A' satisfies a precondition of 'B' (see: Recipes)
 - *A is a subaction of B*
- Top-down evaluation that detects
 - Invalid as well as
 - Sub-optimal Plans
- Address highest-level action that agents disagree about
 - Evaluation terminates as soon as a conflict is detected

Part 1 – Domain and PS actions

- Invalid Plan
 - One of its actions is Infeasible, if
 - EA can't perform this action. For this, check if
 - applicability conditions of the recipe are satisfiable?
 - Pre-conditions can be satisfied?
 - Ill-formed
 - Child action do not *contribute* to the parent action as intended.
 - Contribute relationship between a pair of action holds
 - e.g. slide 12,
 - CORE thinks action A contributes to B
 - But *contributes* fails as applicability condition of action A is not satisfiable.

Part 1 – Domain and PS actions

- Suboptimal plans
 - CA should propose better alternative to a proposal.
 - Agents might differ on what defines a ‘high-quality plan’.
 - EA’s preferences have a major impact
 - Attribute-Value preference with *strength*
 - Stronger preference e.g. *_Course.Prof: Dr. Smith*
 - Weaker Preferences e.g. *_Course.Time: 14:00*
 - *Strength* is not always a clear cut preference, so *closeness of match*
 - e.g. *_Course.Level :Moderate* is close to *Easy* then *Difficult*
 - CA must consider *strength* of EA’s preference as well as *closeness* of preferred and actual attrib-values of the alternative instantiations.

Ranking Advisor

- Best instantiation of a action parameter, given EA's preferences (EA's model maintained by CORE)
- Actual values: system's knowledge
- Preferred values: from system's model of EA (maintained incrementally)
- **Weighted additive rule**^[4] to keep *strength* and *closeness* in view as in human-decision making for ranking.
 - based upon their importance *attributes* are assigned *weight*
 - *values* are assigned *scores* depending upon closeness with EA's preference
- Sum over the product of (weight * score) for all attributes of parameter *object*. Pick that object with max sum.
- Scale for measurement *weight*=6 values, and *score* =4 values for EA's preferences from EA's model.

Example

Domain Knowledge:

CS883:

Professor(CS883,Brown)
Meets-At(CS883,14:00-15:15)
Difficulty(CS883,moderate)
Workload(CS883,light)
Offered(CS883)

CS889:

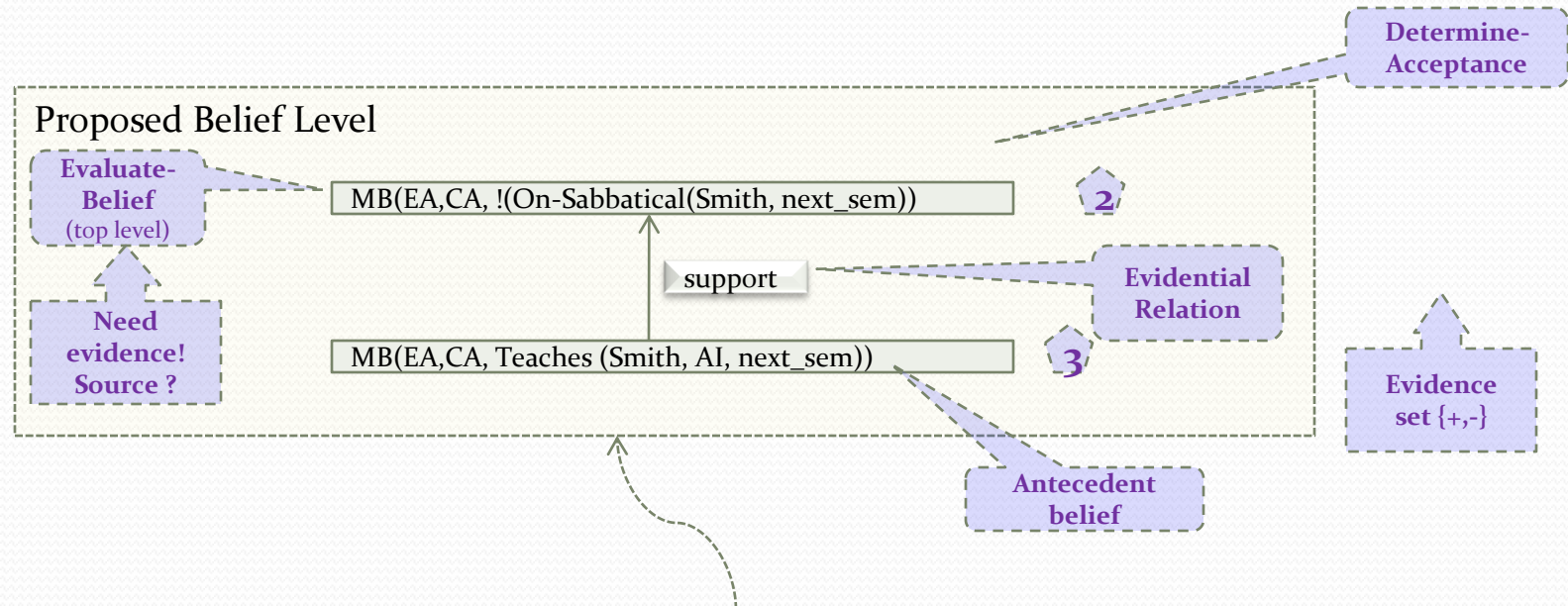
Professor(CS889,Smith)
Meets-At(CS889,10:30-11:45)
Difficulty(CS889,easy)
Workload(CS889,moderate)
Offered(CS889)

User Model Information:

Prefers(EA,Professor(_course,White),Take-Course,strong(neg))
Prefers(EA,Meets-At(_course,before(12:00),Take-Course,low-moderate(pos))
Prefers(EA,Difficulty(_course,easy),Take-Course,high-moderate(pos))

Relevant Domain Knowledge and EA Preferences

Part 2- Evaluating Proposed Belief



Conflicts

- During evaluation process conflicts might arise with
 - Validity of a proposition represented by a node
 - *infeasibility* of a proposed action or
 - *rejection* of a proposed belief
 - Validity of relationship between two nodes in the proposal
 - a proposed *contribute* relationship between two actions or
 - a proposed *supports* relationship between two beliefs doesn't hold
 - Optimality of a proposed plan:
 - a better *alternative* plan exists. e.g. parameter instantiations.
- Then what? Collaborative agents must work on *resolution*

Collaborate to *resolve*

- Shall agents simply reject others' proposals at conflict?
 - Collaborative participants should
 - communicate detected conflicts *asap* (i.e. at levels)
 - attempt to resolve conflicts (hint: Propose-Evaluate-*Modify*)
- Should an agent modify proposals single handedly?
 - Uncooperative; against the spirit of collaboration
 - Convey desire to *modify* the proposal
 - Agents should first agree on *proposal* for modification.
 - Leads to *collaborative negotiation subdialogue* for a shared goal at hand, resolving the current *conflict(s)*

Recipe: *Modify-Proposal*

- Three specializations
 - Correct-Node
 - Infeasible action or
 - not accepted belief
 - Correct-Relation
 - Ill-formed contribute relation
 - Improve-parameter
 - Better instantiation of a parameter

Action:	Correct-Node (_agent1, _agent2, <u>{_elem}</u> , _proposed)
Type:	Decomposition
Appl Cond:	believe(_agent1, ¬acceptable(_prop)) believe(_agent2, acceptable(_prop))
Const:	elem-type(_elem, node) prop-in(_prop, _elem)
Body:	Modify-Node(_agent1, _agent2, _proposed, _prop) Insert-Correction(_agent1, _agent2, _proposed)
Goal:	acceptable(_proposed)
Action:	Modify-Node (_agent1, _agent2, _proposed, _prop)
Type:	Specialization
Precond:	MB(_agent1, _agent2, ¬acceptable(_prop))
Body:	<u>Remove-Node</u> (_agent1, _agent2, _proposed, _prop) Alter-Node(_agent1, _agent2, _proposed, _prop)
Goal:	modified(_proposed)

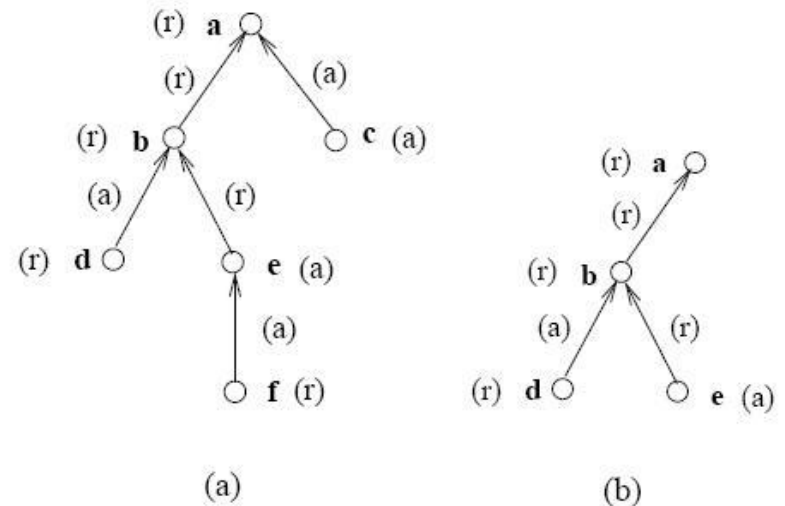
The *Correct-Node* and *Modify-Node* Recipes

_elem?

- Domain or PS level: a action *node* or a *contribute* relation
- Rejection of top-level proposed belief (and *evidences*) requires
 - Modifying agent's belief. For this
 - provide evidence against top-belief itself or
 - about the rejected *children* or
 - addressing both of the above
- But in a ***belief-tree*** which beliefs and evidences to refute?
 - Identify those which if refuted, *might* resolves the agents' conflict (i.e. make agent change its original belief)
 - *Focus of modification*
 - *minimal subset* : subset among these to *explicitly* refute

Candidate foci tree

- rejected top-level proposed belief : 'a'
- evidences: {b, c, d, e, f}
 - Rejected by the system
 - Support a rejected belief
 - Weaken support for top-level by refutation through transitivity
- What to refute explicitly?
 - Belief: implicit closing of dialog
 - Evidence:
 - discussion is open to dialog, and
 - disagreement to belief as well as invalid support, which strengthens its acceptance
- Refute evidences!! (minimally sufficient subset)



An Evaluated Belief Tree and Its Corresponding Candidate Foci Tree

Belief Revision

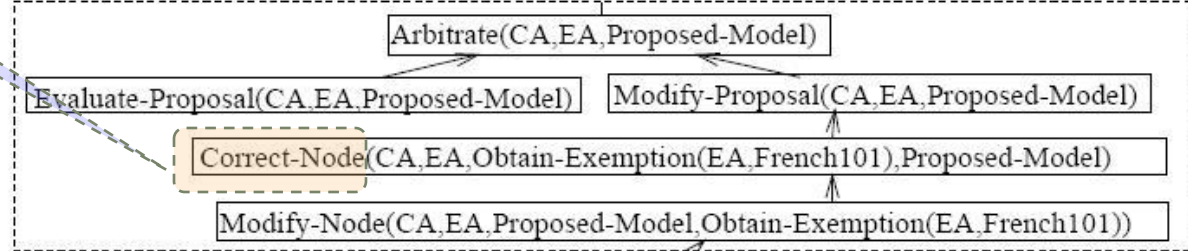
- Two steps to successfully refute a belief:
 - Sufficient *justification* to prove the rejected evidence invalid
 - Would this be *enough* to cause agent to change its belief.
- **Select-Focus-Modification** (`_bel`)
 - identifies whether to refute belief or evidences, or refute both
 - **Predict**: predicts hearer's belief
 - Belief revision mechanism [Galliers, 1992] to predict Hearer's belief
 - Speaker's belief about hearer's evidence pertaining to belief
 - Evidence presented by speaker to hearer
 - **Select-Min-Set**: check if `_evid1` is sufficient, or two piece of evidence,....*n* piece evidence
 - At the end, *negation* of beliefs is proposed by the system as MB

Recipe to Correct Action Proposal

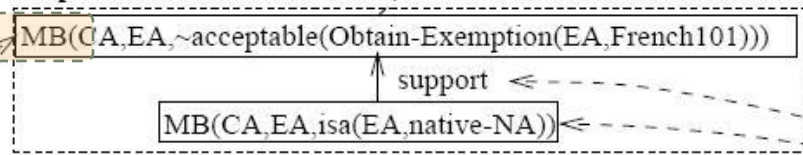
Example: Correcting Invalid Proposals

Dialogue Model in Figure 2

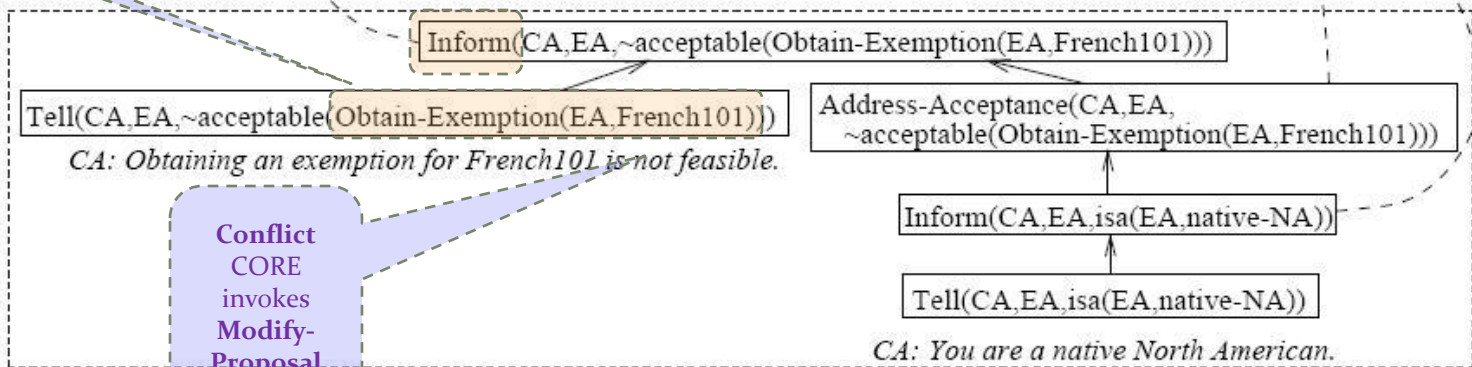
Proposed Problem-Solving Level



Proposed Belief Level



Discourse Level



Focus-of-Modification

Conflict CORE invokes Modify-Proposal

Responding to Implicitly-Conveyed Conflicts

CORE

- Domain knowledge
 - Objects in domain (attribute-values)
 - e.g. _course-CS881
 - Hierarchy of concepts
 - e.g. (Computer = {Hardware,Software})
 - Evidential inferences
 - e.g. sabbatical -> not teaching
- User Models for EA (incrementally updated)
 - EA's preferences to actions in a domain
 - EA's particular circumstances and characteristics in a domain
 - CORE's belief about EA's domain knowledge

Conclusion

- Collaborative Agents must be able to deal with conflicts.
- Evaluate proposal based on private beliefs to detect conflicts
- Resolving Conflict requires communication among agents the detected conflicts, with evidences and desire to modification proposals.
- Recursive cycle of Propose-Evaluate-Modify
- Why questions are sometimes never answered even in the most cooperative of environments. (superfluous)

References

- 1. Chu-Carroll, Jennifer and Sandra Carberry. “*Conflict Resolution in Collaborative Planning Dialogues.*” *International Journal of Human-Computer Studies*, 53(6) pp.~969-1015, 2000.
- 2. Rich, C.; Sidner, C.L.; Lesh, N.B., “*COLLAGEN: Applying Collaborative Discourse Theory to Human-Computer Interaction*”, *Artificial Intelligence Magazine*, Winter 2001, Vol 22, Issue 4, pps 15-25 (AI Magazine)
- 3. [Traum et al. 2008] David Traum , Stacy Marsella , Jonathan Gratch , Jina Lee , and Arno Hartholt, “*Multi-party, Multi-issue, Multi-strategy Negotiation for Multi-modal Virtual Agents*” to appear in 8th International Conference on Intelligent Virtual Agents, September 2008.
- 4. Ralph L. Keeney and Howard Raiffa. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. Cambridge University Press, 1993.

Questions

- "Collaborative negotiation" Vs "Argument".
- About agent's changing his/her opinion.
- Why does 'S' engages this conversation at all? [Alexander](#)
- How does CA actually learns about EA's preferences? Is the Model static? Measuring preference relative or generic? [Miroslav](#)
- Re-evaluate plans and actions if a belief turns out to be wrong during the ongoing dialogue? [Lisa](#)
- How do we measure if child actions are contributing to their parent "as intended" [Faisal](#)
- [Elahi](#) :
 - Collaborative negotiation, argumentation and non collaborative negotiation.
 - How these abstract issues be modeled mentioned in the system. In the paper agent's preference is assigned by strength?
 - In ranking advisor, how weight is assigned to a attribute related to agent's decision making?
 - What is the endorsement process?
 - Agent's conflict on top level proposed belief
 - The process is complicated if the reason for rejection is in belief level.
 - What is the subset of rejected belief and how it resolve the agent's conflict on top level proposed belief?
- How are the agent's character, mood and emotions modeled in the system and how do they influence what the agents say? [Fabian](#)