

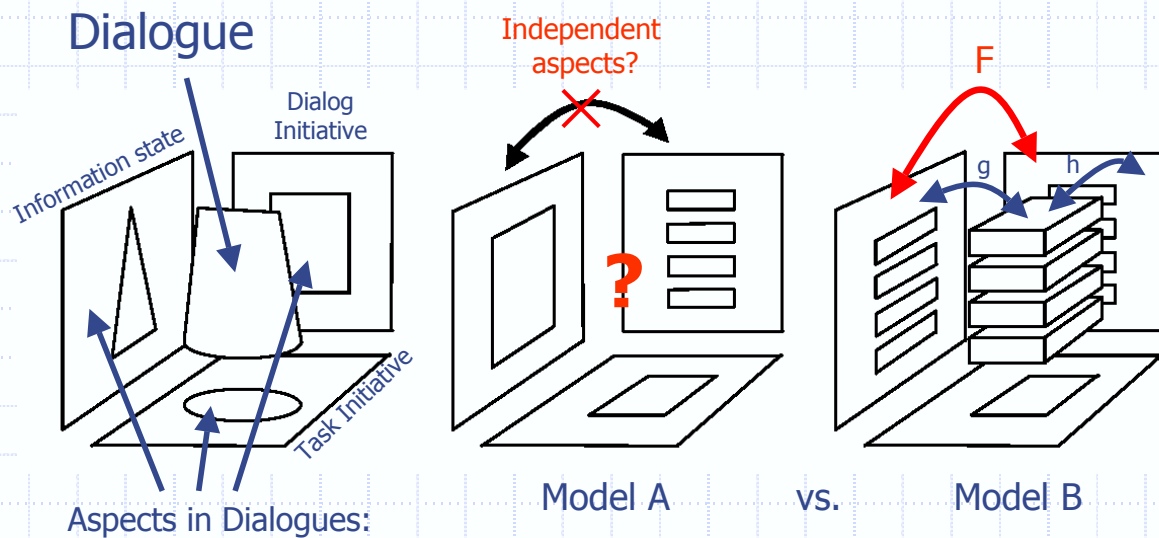
Dialogue Initiative and Task Initiative in Dialogues

Referent: Harald Lochert

Introduction - Questions about Dialogues

- ◆ WHAT, WHEN, WHY and HOW should the system speak in a dialogue?
 - What are the relevant aspects in a dialogue?
 - Are these aspects interdependent or independent?
 - Can these aspects determine the outcome of dialogues?

Introduction - Aspects in Dialogues



Aspects in Dialogues:

- Dialogue Initiative
- Task Initiative
- Information State
- Information Flow
- Participant Roles
- etc.

Model B seems to be more plausible than Model A.

Introduction - Demands on Dialog Systems

- ◆ problem solving
- ◆ maintain and use information garnered from the dialogue
- ◆ maintain and use a user model and pass control arbitrarily from one subdialogue to another
- ◆ vary initiative in dialogues
- ◆ perform appropriate strategies (e.g. didactical, pedagogical, instructional etc.)

Introduction - Fraser and Gilbert (1991)

“ The designer is caught in a vicious circle – it is necessary to know the characteristics of dialogues between people and automata in order to be able to build the system, but it is impossible to know what such dialogues would be like until such a system has been built. ”

- ◆ **Question:** Is their claim true?

Introduction - Overall view of the talk

- ◆ „Missing Axiom Theory“ (Ronnie W. Smith)
 - Fundamentals, Properties
 - Example: “The Circuit Fix-It Shop”
- ◆ A Model for Tracking Initiative (Chu-Carroll, Brown)
 - Task Initiative vs. Dialogue Initiative
 - Cues, Examples
 - Dempster-Shafer Theory
- ◆ Tutorial Dialogue (Core, Moore, Zinn)

Missing Axiom Theory

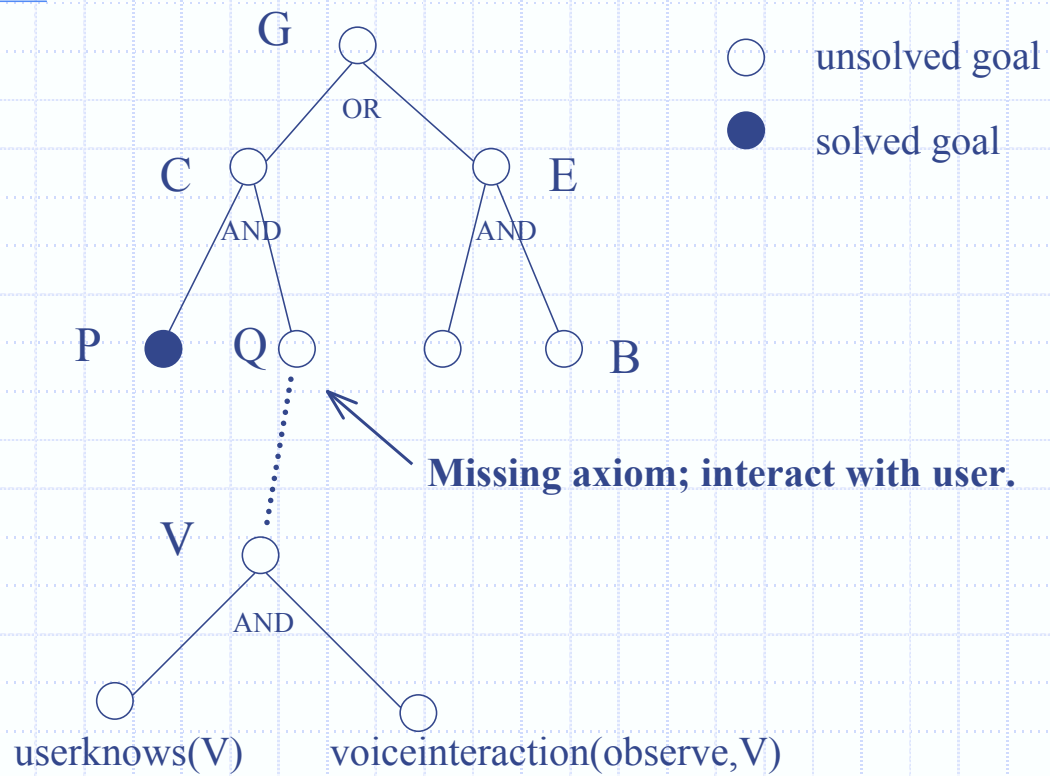
- ◆ Integrated Model of dialog processing
 - Dynamic theorem proving is used to determine when goals are completed
 - Language is used to acquire missing axioms that may inhibiting proof completion
 - A dialogue controller controls and reasons about resources

Missing Axiom Theory

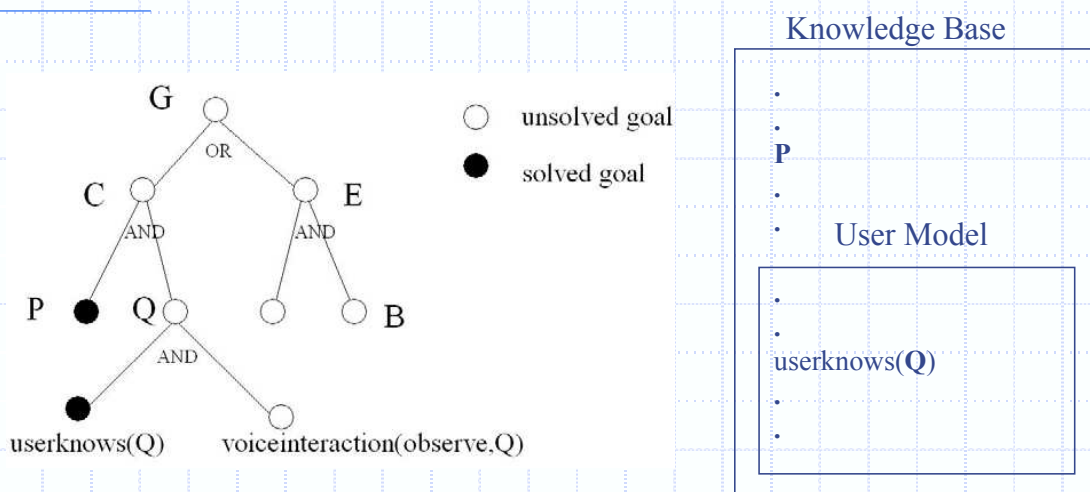
Properties of the Missing Axiom Theory:

- ◆ problem solving
- ◆ model of resources
- ◆ coherent subdialogue movement
- ◆ user model usage
- ◆ expectation usage
- ◆ variable initiative behaviour

Missing Axiom Theory - Discourse Model



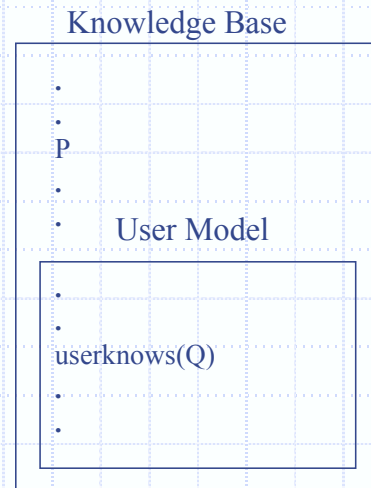
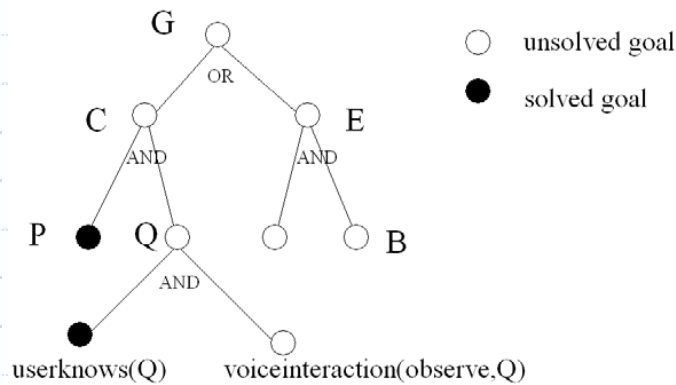
Missing Axiom Theory - Discourse Model (2)



C: *Is the switch up?*

U: Yes.

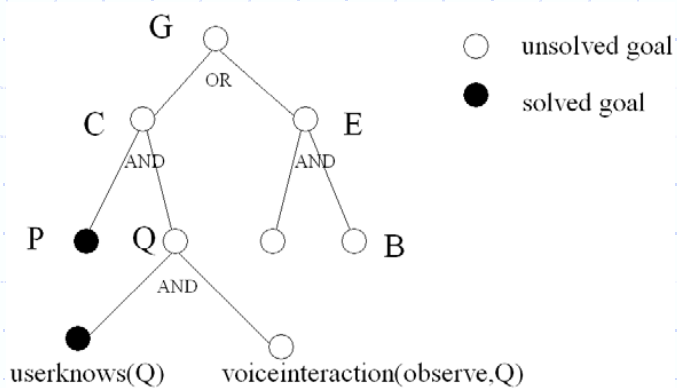
Missing Axiom Theory - Initiative



C: *Is the switch up?*

U: Is B true?

Missing Axiom Theory - Expectation

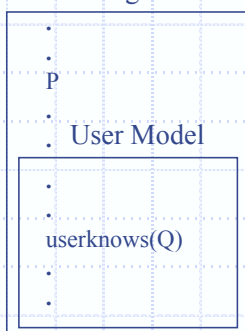


Expectations

Local:
 answer(affirmative)
 state(switch, up)
 state(switch, down)
 query(location(switch,X))

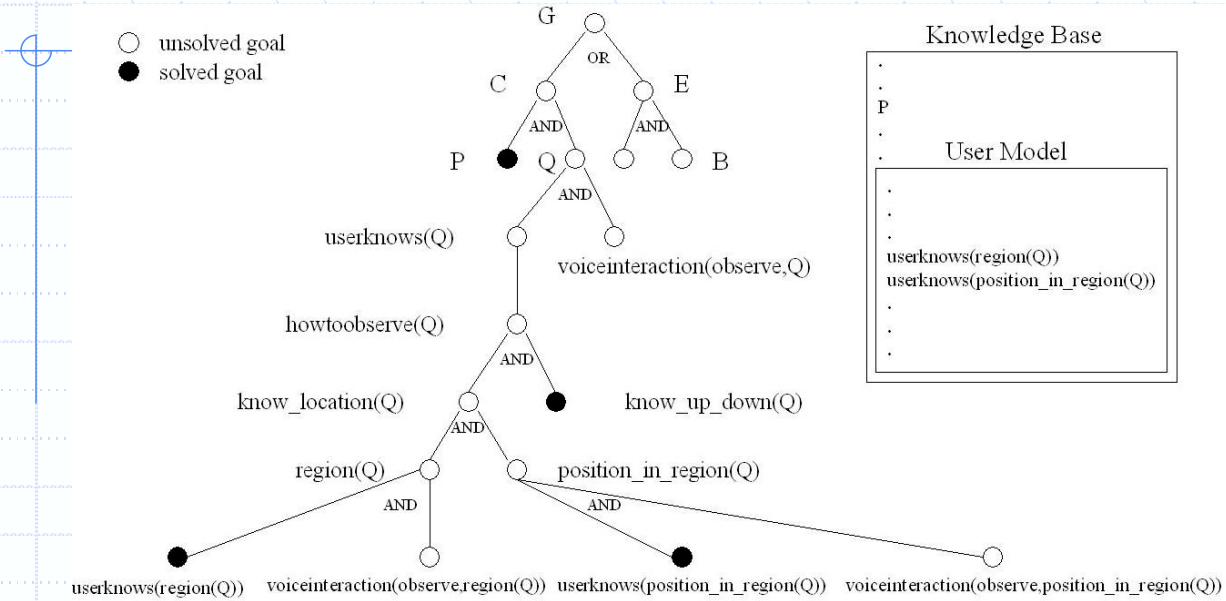
Level 1

Knowledge Base



C: *Is the switch up?*

Missing Axiom Theory - User Modeling



C: *Is the switch up?*

U: Yes.

C: *There is a switch right in the middle.*

U: I see it.

C: *Is the switch up?*

U: Yes.

The Circuit Fix-It Shop - An Application

- (1) C: *Is there a wire between connector 84 and connector 99?*
- (2) U: It is not there.
- (3) C: *Add a wire between connector 84 and connector 99.*
- (4) U: I need help.
- (5) C: *Obtain a wire.*
- (6) U: Done.
- (7) C: *Connect metal of one free end of the wire to connector 84.*
- (8) U: How?
- (9) C: *Bend back connector 84.*
- (10) U: Done.
- (11) C: *Insert free end of wire into connector 84.*
- (12) U: Wire between 84 and 99 is connecting.
- (13) C: *What is the LED displaying?*

MAIN GOAL 1

fact(wire(84,99),exist,X)) X=absent

missing axiom (utt. 1)

“It is not there”
(utt. 2)

INFER
userknows(loc(84))
userknows(loc(99))

do(action(add,wire(84,99)))

MAIN GOAL 2

missing axiom (utt. 3)

“wire between 84 and 99 is
connecting”
(utt. 12)

learn to do add (“I need help”)
(utt. 4)

connect(end2,99)
(proof never started)

locate 84

locate 99

obtain wire

connect(end1,84)

user model
axiom
userknows(loc(84))

user model
axiom
userknows(loc(99))

missing axiom
(utt. 5)

“done”
(utt. 6)

missing axiom
(utt. 7)

learn to do (“How?”)
(utt. 8)

bend 84

insert(end1,84)

missing axiom (utt. 9)

missing axiom
(utt. 11)

“done” (utt. 10)

MAIN GOAL 3

fact(LED,display,X))

missing axiom (utt. 13)

Levels of Initiative - Dialog Modes

- ◆ **Directive:** The computer has complete dialogue control, and allows no interruptions to other subdialogues.
- ◆ **Suggestive:** The computer still has dialogue control, but will allow minor interruptions to closely related subdialogues.
- ◆ **Declarative:** The user has dialogue control and can interrupt to any desired subdialogue.
- ◆ **Passive:** The user has complete dialogue control

Levels of Initiative - Directive Mode

1. C: *This is the circuit fix it shop. How may I help you?*
2. U: Rs111 is not working.
3. C: *I am familiar with that circuit. The LED is supposed to be displaying alternately flashing one and seven.*
4. U: The LED is off.
5. C: *What is the switch at when the LED is off?*
6. U: The switch is down.
7. C: *Put the switch up.*
8. U: Okay.
9. C: *Put the knob to one zero.*
10. U: Okay.
11. C: *What is the LED displaying?*
12. U: LED is displaying only a flashing seven.
13. C: *Is there a wire between connector eight four and connector nine nine?*

Levels of Initiative - Declarative Mode

1. C: *This is the circuit fix it shop. How may I help you?*
2. U: Rs111 is not working.
3. C: *I am familiar with that circuit. The LED is supposed to be displaying alternately flashing one and seven.*
4. U: There is no wire from connector nine nine to connector eight four.
5. C: *There is supposed to be a wire between connector nine nine and connector eight four.*

Missing Axiom Theory - Advantages

- ◆ The language-directed theorem proving process minimizes backtracking
- ◆ The paradigm facilitates the following tasks during dialog processing:
 - maintaining and using of a model of the dialogue
 - maintaining and using a model of the user
 - handling movement between different subdialogues

Missing Axiom Theory - Problems

- ◆ miscommunications between user and system
- ◆ physical breakdown
- ◆ occurrences of a situation outside the systems knowledge
- ◆ socially unacceptable dialogues shift timings

Initiative in Dialogue Interactions

- ◆ **Hypothesis 1:**

Initiative shifts in a primarily principled fashion

- signalled by
 - ◆ linguistic cues
 - ◆ prosodic cues
- in face-to-face interactions by
 - ◆ eye gaze
 - ◆ gestures

Initiative in Dialogue Interactions

◆ **Hypothesis 2:**

A dialog system must be able to track initiative shifts dynamically during interaction

- by recognizing the users cues for initiative shifts
- by providing appropriate cues in it's responses to user utterances

Initiative in Dialogue Interactions

◆ **Views of Initiative:**

- Single factor/thread Models of Initiative
- Multi-factor Models of initiative

◆ **Three Classes of Models:** Models that investigate

- behaviour in mixed-initiative dialogues
- causes of initiative shifts and their effects
- initiative interactions

Initiative in Dialogue Interactions

- ◆ **Chu-Carroll, Brown (1998):**
 - **Initiative-point-of-view:**
View differences between alternative responses as difference between Levels of Initiative
 - They distinguish two types of Initiative:
 - ◆ **Dialogue Initiative (DI)**
 - ◆ **Task Initiative (TI)**
 - Distinctions between responses are modelled by the distribution of DI and TI

Task Initiative vs. Dialogue Initiative

- ◆ **Task Initiative (TI):**
An agent A is said to have the TI, if his utterance is directing how the agents' task should be accomplished, i.e. the utterance proposes
 - Domain Actions
 - Problem-Solving Actions
- ◆ Example 1: "*Why don't we couple engine E2 to the boxcar that's at Elmira, and send it to Corning?*"
- ◆ Example 2: "*Let look at the first [domain problem] first. I think the are separate.*"

Task Initiative vs. Dialogue Initiative

- ◆ **Dialogue Initiative (DI):**

An agent A is said to have the DI, if he keeps or takes over the conversational lead in order to establish mutual beliefs between the agents about:

- a piece of domain knowledge
- the validity of a proposal

- ◆ Example: *"We can't go by Damsville because we've got engine E1 going on that track."*

Task Initiative vs. Dialogue Initiative

(1) C: I need some money.

(2) C: How much do I have in my 6-month CD?

(3a) T: *You have \$5,000 in that CD.*

[C keeps DI and TI]

(3b) T: *You have \$5,000 in that CD, but that CD will not mature for another 3 months.*

[C keeps TI, but T overtakes DI]

(3c) T: *You have \$5,000 in that CD, but that CD will not mature for another 3 months. However, you have \$3,000 in another CD that will be available next week.*

[T overtakes DI and TI]

Task Initiative vs. Dialogue Initiative

Relationships between TI and DI:

TI implies DI **but** DI does NOT imply TI

Revising the preceding example:

(3b) T: *You have \$5,000 in that CD, but that CD will not mature for another 3 months.*

[C keeps TI, but T overtakes DI]

(3c) T: *You have \$5,000 in that CD, but that CD will not mature for another 3 months. However, you have \$3,000 in another CD that will be available next week.*

[T overtakes TI and therefore also overtakes DI]

Cues for Shifts in Initiative

Class	Cuetype	Subtype	effects	Initiative
explicit	explicit requests	give up task	TI + DI	hearer
		give up dialogue	DI	hearer
		take over task	TI + DI	speaker
		take over dialogue	DI	speaker
discourse	end silence	repetitions	TI + DI	hearer
			TI + DI	hearer
	no new info	prompts	TI + DI	hearer
			DI	speaker
	questions	domain	DI	hearer
		evaluation	DI	hearer
obligation fulfilled	task	TI + DI	hearer	
	discourse	DI	hearer	
analytical	invalidity	action	TI + DI	hearer
		belief	DI	hearer
	suboptimality	action	TI + DI	hearer
			TI + DI	hearer
	ambiguity	action	TI + DI	hearer
		belief	DI	hearer

Cues for Shifts - Explicit Cues

Example 1:

(4) U: Yeah, so go to Bath and pick up the boxcar, bring it back to Corning and then bring it back to Elmira.”

(5) S: *Okay, well that's 8 hours, so you're not gaining anything by doing that.*

→ (6) U: Okay [2sec] [sigh] [3sec] **Any suggestions?**

(7) S: *Well, there's a boxcar at Dansville and you can use that.*

or

(7') S: *(Sorry,) but it's your responsibility to make a proposal.*

Cues for Shifts - Explicit Cues (2)

Example 2:

(8) U: So you can start making OJ and then when the OJ is ready you load it up into the tanker car and bring it back to Avon.

→ (9) U: Okay, **summarize the plan at this point system!**

(10) S: *Okay, lemme make sure I got all this. You wanna link the boxcar at Elmira to E2 ...*

Cues for Shifts - Discourse Cues

Example 1:

(11) U: Can we please send engine E1 over to Dansville to pick up a boxcar and then send it right back to Avon. [3 sec]

(12) S: *Okay, it'll get back to Avon at 6.*

Example 2:

(13) U: Grab the tanker, pick up oranges, go to Elmira, make em into orange juice.

→ (14) S: *Okay, then we go to Elmira, we make orange juice, okay.*

(15) U: And then send the orange juice back to Avon.

Cues for Shifts - Analytical Cues

Example 1:

(25) U: *Let's get the tanker car to Elmira and fill it with OJ.*

(26) S: *You need to get oranges to the OJ factory.*

OR

(26') S: *You don't have OJ in Elmira.*

Temporary Summary

- ◆ mixed-initiative model: task and dialog initiative switch back and forth between the dialogue participants
- ◆ initiative indicates an agent's higher level of involvement in directing the planning process
- ◆ initiative shifts are triggered by several types of cues

Some Missing Features

- ◆ some cues provide stronger evidence for initiative shifts than others → weighted cues
- ◆ initiative shifts are endemic → track cues dynamically
- ◆ initiative prediction → probabilistic approach
- ◆ user/system modelling
- ◆ different dialog modes (tutorial, advice, request, etc.)

Dempster-Shafer Theory (DST)

- ◆ Operates over a set of possible outcomes ("frame of discernment", θ)
- ◆ Elements in θ are assumed to be mutual exclusive and exhaustive (Source of potential problems?)
- ◆ Each piece of evidence is associated with a "Basic Probability Assignment" (BPA), $1 \geq BPA \geq 0$
- ◆ The BPA represents the impact of a piece of evidence on a subset of θ :
 - 1= highest weight
 - 0= lowest weight

Tracking Initiative with DST

- ◆ each dialogue participant is associated with a task and dialog initiative index
- ◆ task initiative indices measure the level of involvement in the planning process
- ◆ dialog initiative indices measure the level of involvement in determining the discourse focus
- ◆ uses basic probability assignments represent the effect of cues
- ◆ a combination rule calculates a new probability from two existing ones

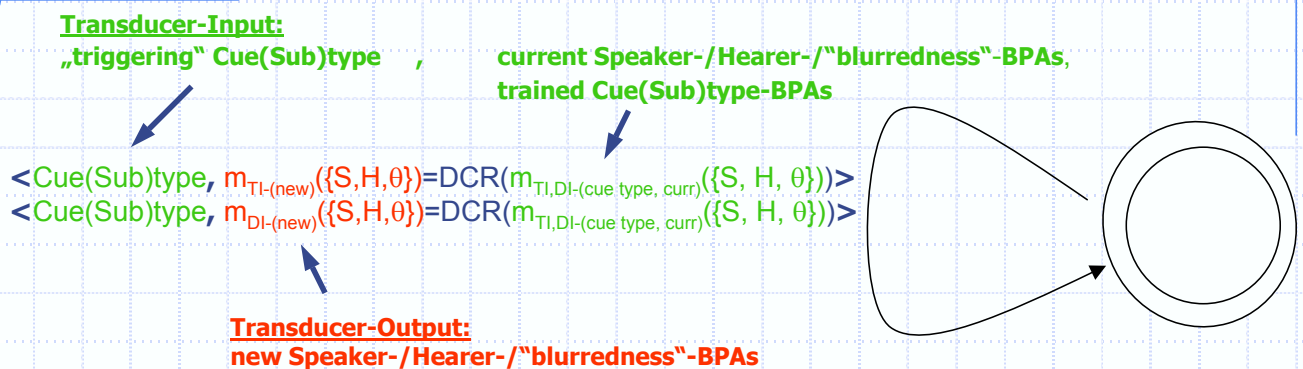
Tracking Initiative with DST

- initiative indices are represented by BPAs, e.g.

$$m_{\text{TI-(turn)}}(\{\text{Speaker}\}) = 0.3, \quad m_{\text{DI-(curr-turn)}}(\{\text{Hearer}\}) = 0.5$$

- at the end of each dialogue turn new initiative indices are computed by the "Dempster combination rule" (DCR)
- appropriate values for the cues are determined during a training phase

DST as one-state transducer



Example: Values of „give up task“-BPAs

Class	Cuetype	Subtype	Trained BPA
explicit	explicit requests	give up task (gut)	$m_{\text{TI-(gut)}}(\{H\}) = 0.35$ $m_{\text{DI-(gut)}}(\{H\}) = 0.65$ $m_{\text{TI-(gut)}}(\{\theta\}) = 0.35$ $m_{\text{DI-(gut)}}(\{\theta\}) = 0.65$

Initiative Tracking - Summary

Questions and Shortcomings:

- ◆ Is the DST an appropriate framework? (DI and TI are not mutual exclusive!)
- ◆ No adjustment of dialog modes (tutorial, advice, etc.)
- ◆ No cue history or a look-back function - cue effects are simply accumulated
- ◆ No explicit user/system relationship modelling
- ◆ Interdependencies between DI and TI remain opaque
- ◆ Limited explanatory power: DST describes but does not explain differences in initiative

Tutorial Dialogues - An Extension

- ◆ **Motivation:**
Collaborative dialogues between tutor and student promote learning.
- ◆ **“Extended” Initiative Model:**
 - initiative recognition
 - initiative control
 - TI, DI + **Pedagogical Initiative (PI)**

Tutorial Dialogues

Pedagogical Initiative:

- ◆ Taking over PI means to control the learning strategy:
 - Change the current set of learning goals
 - Determine when and how those goals are being addressed
 - Control and conduct the topic of the conversation
- ◆ Student performance can be derived from the student model and dialogue history

Tutorial Dialogues - Summary

Questions and Shortcomings:

- ◆ same problems like in Chu-Carroll, Brown's Model
- ◆ no relevance check of dialogue participants contributions
- ◆ the paper is lacking a student model