Dialogue moves and information states*

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Abstract

We present an experiment in annotating a dialogue using a stripped down variant of Ginzburg's (1996a, 1996b, 1998) view of the dialogue game board, including questions under discussion (QUD). The aim is to try to develop a method of annotation that might be useful to a dialogue system developer in specifying a system that could deal with a certain type of dialogue. In this first experiment we annotated a task oriented dialogue with as simple a notion of information state as we could imagine would be able to illuminate the dynamics of QUD management. We found that a number of interesting issues were raised by the annotation and that there were interesting possibilities for defining dialogue moves in terms of transitions between these information states.

Keywords: Information states, dialogue moves, questions under discussion, dialogue annotation

1 Introduction

In this paper we present an experiment in annotating a dialogue using a stripped down variant of Ginzburg's (1996a, 1996b, 1998) view of the dialogue game board, including

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questions under discussion (QUD). The aim is to try to develop a method of annotation that might be useful to a dialogue system developer in specifying a system that could deal with a certain type of dialogue. We do not think that the annotation that we have could lead to the kind of general coding scheme which could be given to naive coders with a manual and achieve a level of reliability. But we do feel that the kind of annotation we are proposing could be useful to expert coders who wish to investigate the nature of a class of dialogues that are to serve as models for a system. In this first experiment we annotated an Autoroute dialogue[1] with as simple a notion of information state as we could imagine would be able to illuminate the dynamics of QUD management. We also took as limited a notion as possible of the actions that dialogue participants could perform and also of the formal operations that could be performed on information states. Nevertheless, we found that a number of interesting issues were raised by the annotation and that there were interesting possibilities for defining dialogue moves in terms of transitions between these information states.

2 Characterizing the information states

We represent information states informally using an informal version of typed records as discussed in Cooper (1998a, 1998b). We use the notation $a : T$ to represent the judgement that a is of type T. The basic idea of typed records is that if $a_1 : T_1, a_2 : T_2, \ldots, a_n : T_n$ then the record in (1a) is of the record type in (1b).

(1) a.
$$\begin{bmatrix} l_1 & = & a_1 \\ l_2 & = & a_2 \\ \ldots & & \\ l_n & = & a_n \end{bmatrix}$$

b.
$$\begin{bmatrix} l_1 & : & T_1 \\ l_2 & : & T_2 \\ \ldots & & \\ l_n & : & T_n \end{bmatrix}$$

In our annotation of the autoroute dialogue we limited ourselves to representing information states for a dialogue participant by records of the type in (2).

(2)
$$\begin{bmatrix} \text{Private} & : & \begin{bmatrix} \text{Bel} & : & \text{Set(Prop)} \\ \text{Agenda} & : & \text{Stack(Action)} \end{bmatrix} \\ \text{Common} & : & \begin{bmatrix} \text{Bel} & : & \text{Set(Prop)} \\ \text{QUD} & : & \text{Stack(Question)} \end{bmatrix} \end{bmatrix}$$

[1] We are grateful to the Speech Research Unit of the Defence Evaluation and Research Agency, Malvern, UK, for making the Autoroute dialogues available to the Trindi project.

That is, we made a division between Private and Common information. The Private information consisted of a set of private beliefs (a set of propositions). In the particular annotation we did this was treated as a static field. It was not modified as a result of the dialogue moves. As with many aspects of this annotation, this was a simplification that we thought worth pursuing as long as it would hold but that we felt probably would not hold up with a more detailed annotation or a similar annotation of a more complex dialogue. Our overall analytical strategy is to use as simple means as possible until it becomes clear what phenomena motivate additional complexity.

Propositions are represented as English sentences with deictics referring to the dialogue participants replaced by the labels A and B. At the level of detail we were aiming at in this analysis it did not seem relevant to commit to one particular formal semantic theory. We are more interested in the dynamic modifications to the various fields in the information state rather than the exact formal representation of the objects.

The second private field is an Agenda which is a stack of actions which the agent is to perform. The idea here is that the Agenda represents very local actions. More general goals that the agent wishes to achieve with the conversation (or her life) would, on the simple view presented here, be included in the private beliefs. (This feels like it should be an oversimplification and that it will be necessary to have a separate field for goals.) In contrast to goals, Agenda items are actions that should in general be performed in the next move. Agenda items are introduced as a result of the previous move.

We tried to make minimal assumptions about what actions could be put on the Agenda (i.e. what actions could be performed by the dialogue participants). We characterize possible actions informally by the following inference rules, assuming that we have a type *Question* and a type *Prop(osition)*.

(3) $$\frac{q\text{:Question}}{\text{respond}(q)\text{:Action}} \quad \frac{q\text{:Question}}{\text{raise}(q)\text{:Action}} \quad \frac{p\text{:Prop}}{\text{instruct}(p)\text{:Action}}$$

That is, dialogue participants may either raise questions (put them on QUD), respond to questions (which are maximal in QUD) or give an instruction to the other dialogue participant. We are trying here the experiment of doing as much as possible in terms of raising or responding to questions.

The first Common field in the information state is again for a set of beliefs (i.e. a set of propositions). It is something of a misnomer to call this beliefs since it is meant to represent what has been established for the sake of the conversation and we do not really mean that this necessarily represents a committment on the part of the dialogue participants to the common propositions. The common beliefs represent rather what has been established as part of the conversational record, assumptions according to which the rest of the dialogue should proceed. This can, of course, be distinct from what the dialogue participants "really

think".

The second Common field is QUD, a stack of questions under discussion. Like the Agenda, this is meant to be a local affair, representing question(s) that should be addressed more or less in the next turn and not general issues that have been raised by the conversation so far or issues that the agent feels to be generally relevant.

After each conversational move we annotate the information state of each participant. Here is a typical example of an information state after utterance 8 made by A:

U8 A <Where would you like to go.>

8.

$$\left[\begin{array}{lll} A & = & \left[\begin{array}{lll} \text{Private} & = & \left[\begin{array}{lll} \text{Bel} & = & \text{7.A.Private.Bel} \\ \text{Agenda} & = & < \begin{array}{l} \text{raise}(\textit{What time does B want to make the journey?}), \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} > \end{array}\right] \\ \text{Common} & = & \left[\begin{array}{lll} \text{Bel} & = & \text{7.A.Common.Bel} \\ \text{QUD} & = & <\textit{Where does B want to go?}> \end{array}\right] \end{array}\right] \\ B & = & \left[\begin{array}{lll} \text{Private} & = & \left[\begin{array}{lll} \text{Bel} & = & \text{7.B.Private.Bel} \\ \text{Agenda} & = & <\text{respond(fst(B.Common.QUD))}> \end{array}\right] \\ \text{Common} & = & \left[\begin{array}{lll} \text{Bel} & = & \text{7.B.Common.Bel} \\ \text{QUD} & = & <\textit{Where does B want to go?}> \end{array}\right] \end{array}\right] \end{array}\right]$$

At several points pathnames in the information state associated with utterance 7 are given (e.g. *7.A.Private.Bel*) in order to make the notation more compact. Note that B's Agenda contains the action to respond to the first item on B's QUD.

Note that the Common fields are not shared between the two dialogue participants. They may have different views about what has been established in the dialogue and what is currently under discussion. Such differences may arise because of genuine misunderstanding. But they may also arise because of the general dialogue strategy pursued by the participants which lead to mismatches which would not be intuitively construed as misunderstandings. Such mismatches arise, for example, as a result of the "optimistic" strategy we describe below. The Common fields may be glossed as that which the dialogue participant believes (optimistically) to have been established or under discussion in the conversation.

Transitions between information states which are occasioned by a dialogue contribution are defined in terms of a restricted set of operations. Again, this is probably more restricted than is ultimately needed, but we want to start small and then see what motivation there is for making additions. The operations we have used in this coding are:

Stack: push, pop
Set: add an element
Resetting values of Common fields to those of a previous state

In order to make clear what changes are taking place in the transition from one information state to another we represent the operations resulting from the preceding dialogue contribution in the annotation before the resulting information state. This exercise gives some indication of how a dialogue system should be specified according to the assumptions of the annotation. Thus the operations associated with utterance 8 above are:

pop(A.Private.Agenda)
push(*Where does B want to go?*, A.Common.QUD)

push(respond(fst(B.Common.QUD)), B.Private.Agenda)
push(*Where does B want to go?*, B.Common.QUD)

3 Optimism – an overall dialogue strategy

Optimism means that participants assume that their contributions have been understood and entered in both participants' common beliefs or QUDS as soon as they have been uttered. If grounding fails, for example because there is a clarification, they have to retract. A consequence of this is that you need to keep around information from previous turn(s) in order to reinstate previous information.

The overall basic strategy which regulates the flow of information between the Agenda and QUD is as follows:

- if a dialogue participant A has *raise(q)* on the agenda, then A should use her turn to utter a question which expresses q and push q onto QUD.
- if a dialogue participant A notices that q has been pushed onto QUD by the other dialogue participant then A also pushes q onto QUD and pushes *respond(fst(A.Common.QUD))* onto her agenda
- if a dialogue participant A has *respond(fst(A.Common.QUD))* on top of the agenda and q on the top of QUD then A should use her turn to utter an appropriate response to q, pop the Agenda and the QUD and add the response to Common Beliefs.
- if a dialogue participant A notices that the other dialogue participant has responded to a question with p then A should attempt to integrate p with her Private and Common Beliefs. If the integration is successful then A should add p to the Common

Beliefs and pop QUD. If the integration is unsuccessful then A pushes an action to raise a clarifying question q' onto her Agenda. (Her Common Beliefs and QUD remain unchanged.)

A final state is one in which all participants' Agenda and QUD are empty.

This basic strategy embodies optimism. As soon as A has uttered something as a response to a question, she enters the response into Common Beliefs. As soon as A raises a question, the question is entered into QUD. A cautious strategy would wait until there is some kind of feedback (which may involve simply continuing with another relevant utterance) before entering the common information. We are not sure what the consequences of pursuing an optimistic or a cautious strategy are. We think that the kind of annotation we are pursuing would allow us to experiment with annotations for different strategies and see if there are any empirical consequences (i.e. dialogue phenomena that can be accounted for by one strategy but not the other) or consequences involving computational efficiency (in terms of the number of operations that have to be performed overall).

4 Annotating for information states in GATE

Annotating for information states by editing LaTeX documents is not a particularly quick business, even given the simple information states we have in our current example (and it requires LaTeXnical stamina). To make the annotation process easier a set of scripts have been implemented to facilitate annotation using the MAT (Manual Annotation Tool) in GATE. Also, two MAT annotation schemes have been designed for annotating updates to information states. The **infostate** scheme has the following attributes:

- **Participant**: The participant whose information state is updated.
- **Operation**: This is the type of operation to be performed, e.g. `push`, `pop` (for stacks), `add` and `delete` (for sets).
- **Field**: The fields are shorthand names for paths in the information state record, such as `qud` (for *common.qud*), `agenda` (for *private.agenda*) etc.
- **Content**: The value of this attribute is a reference to an annotation produced by the **content** scheme. Contents are currently sentences of natural language. Eventually, one might want want to complement this with a more formal represantation of content.
- **Action**: This attribute is used only for pushes to the agenda, as in `push(A.private.agenda, raise(content-12))`. The actions are `raise`, `respond` and `instruct`.

- **Order** is a natural number indicating when an update is to be performed in relation to other updates caused by a single utterance (segment). It is used in cases where a single segment is annotated with several order-dependent updates. For example, if an utterance is annotated with several `push`es to `A.shared.qud`,the resulting information state depends on the order in which these are executed.

The **contents** scheme is used to annotate the dialogue transcription with (natural language) paraphrases of the contents. These paraphrases (and all other annotations) are assigned indexes, which can then be used as values of the **content** attribute of the **infostate** scheme. For example, the annotation for the utterance

```
A       <Where would you like to start your journey.>
```

might look something like this:

```
ID      TYPE            START   END     ATTRIBUTES
19      contents                        (string:Where does B want to start?)
37      infostate       164     209     (field:agenda) (operation:pop) (participant:A)
39      infostate       164     209     (content:19) (field:qud)
                                        (operation:push) (participant:A)
40      infostate       164     209     (action:respond) (content:19) (field:agenda)
                                        (operation:push) (participant:B)
41      infostate       164     209     (content:19) (field:qud) (operation:push)
                                        (participant:B)
```

(Note that the contents annotation has no specific range.) The number 19 in the **content** fields are references to the ID number of the **contents** annotation. When the annotation is finished, the next step is to translate the annotation to Prolog format, using the script `tipster2prolog`. A second script is then used to produce a LaTeX file from the Prolog-format annotation file and the transcription file. The above annotation produces the following output:

(6)
(Pause: 1)
A <Where would you like to start your journey.>

pop(a.private.agenda)
push(a.shared.qud, *Where does B want to start?*)
push(b.private.agenda, respond(*Where does B want to start?*))

push(b.shared.qud, *Where does B want to start?*)

$$
\left[\begin{array}{lll}
\text{a} = & \left[\begin{array}{lll}
\text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Where does B want to go?}) \\ \text{raise}(\textit{What time does B want to make the journey?}) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{Where does B want to start?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & \left[\begin{array}{lll}
\text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Where does B want to start?}) \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{Where does B want to start?} \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

5 Defining dialogue moves in terms of information states

From a more theoretical perspective, we are interested in characterizing moves (such as those used in the Map Task, Carletta *et al.*, 1996, or DRI, Allen and Core, ms) in terms of transitions between information states, in a reasonably precise way without committing to a particular semantic theory. The particular preliminary formulation we present here builds on the kinds of moves used in the Map Task but with the addition of arguments indicating the agents and the contents of the utterances involved. What one notices when one begins to look at the information states that the kind of division that seems natural when one is only thinking in terms of moves perhaps should be refined when one derives one's moves from information state transition types. For example, there is no real motivation to distinguish between *query-w* (wh-query) and *query-yn* (according to the assumptions under which we have done this particular annotation) since the operations on information states are exactly similar except for the fact that for *query-w* it is a precondition that q is a *wh*-question whereas for *query-yn* there is a precondition that q is a yes-no-question. On the other hand some move types have to be broken down into various subtypes such as successful and unsuccessful (depending on whether the hearer accepts the other agent's response or not), suggesting perhaps that a neater analysis of moves would break them down into smaller units, including silent moves in which an agent tries to integrate the information from the last move in her information state.

query-w(A, B, q) "A asks B q"

Preconditions

fst(A.Private.Agenda) = raise(q)
whq(q)

Effects

pop(A.Private.Agenda)
push(q, A.Common.QUD)

push(respond(fst(B.Common.QUD)), B.Private.Agenda)
push(q, B.Common.QUD)

reply-w(A, B, q, p) – **successful** "A replies to B with p as a response to question q"

Preconditions

fst(A.Private.Agenda) = respond(fst(A.Common.QUD))
fst(A.Common.QUD) = q
whq(q)

Effects

pop(A.Private.Agenda)
add(p, A.Common.Bel)
pop(A.Common.QUD) # Should be: pop all questions from top of QUD to which q is an answer.

add(p, B.Common.Bel)
pop(B.Common.QUD) # Should be: pop all questions from top of QUD to which q is an answer.

reply-w(A, B, q, p, q') – **unsuccessful** "A responds to B concerning question q with response p, which B fails to integrate, generating a clarification question q' on B's Agenda"

Preconditions

fst(A.Private.Agenda) = respond(fst(A.Common.QUD))
fst(A.Common.QUD) = q

Effects

pop(A.Private.Agenda)
add(p, A.Common.Bel)

pop(A.Common.QUD) # Should be: pop all questions from top of QUD to which q is an answer.

push(raise(q', B.Private.Agenda))

query-yn(A, B, q) "A asks q of B"

Preconditions

fst(A.Private.Agenda) = raise(q)
ynq(q)

Effects

pop(A.Private.Agenda)
push(q, A.Common.QUD)

push(respond(fst(B.Common.QUD)), B.Private.Agenda)
push(q, B.Common.QUD)

reply-y(A, B, q, p) – **successful** "A responds to B concerning q with p"

Preconditions

fst(A.Private.Agenda) = respond(fst(A.Common.QUD))
fst(A.Common.QUD) = q
ynq(q)
p = yes(q)

Effects

pop(A.Private.Agenda)
add(p, A.Common.Bel)
pop(A.Common.QUD) # Should be: pop all questions from top of QUD to which q is an answer.

add(p, B.Common.Bel)
pop(B.Common.QUD) # Should be: pop all questions from top of QUD to which q is an answer.

6 Conclusion

We regard this as only a preliminary formulation which opens up a number of important issues about the basic mechanics of information state management in dialogue. However, we feel that it is suggestive of tools that could be useful in refining issues concerning the nature of information states in dialogue and transitions between them. We think it could be useful to implement an interpreter which would take moves defined as above and an information state and returning a new information state. This would at the same time provide a useful tool for experimenting with different definitions of moves and computing their predictions for the content of information states and (coupled with a translation of information states to LaTeX) an automatic way of generating the kind of annotation we give here in the appendix. Furthermore the code needed to do this might be regarded as a preliminary stage in building a dialogue system.

References

Allen, J. and Core, M. (ms) Draft of DAMSL: Dialog Act Markup in Several Layers.

Carletta, J. , A. Isard, S. Isard, J. Kowtko, G. Doherty-Sneddon (1996) HCRC dialogue structure coding manual, Technical Report HCRC/TR-82.

Cooper, Robin (1998a) Mixing Situation Theory and Type Theory to Formalize Information States in Dialogue Exchanges, in *Proceedings of TWLT 13/Twendial '98: Formal Semantics and Pragmatics of Dialogue.* Also available as GPCL 98-2 at `http://www.ling.gu.se/publications/GPCL.html`.

Cooper, Robin (1998b): Information States, Attitudes and Dialogue, *Proceedings of ITALLC-98*. Also available as GPCL 98-5 at `http://www.ling.gu.se/publications/GPCL.html`.

Ginzburg, Jonathan (1996a) Dynamics and the Semantics of Dialogue, in Seligman and Westerståhl (1996).

Ginzburg, Jonathan (1996b) Interrogatives: Questions, Facts and Dialogue in Lappin (1996).

Ginzburg, Jonathan (1998) Clarifying Utterances, *Proceedings of TwenDial 98, 13th Twente workshop on Language Technology*, ed. J. Hulstijn and A. Nijholt, Twente University.

Lappin, Shalom, ed., (1996) *The Handbook of Contemporary Semantic Theory*, Blackwell, Oxford.

Seligman, Jerry and Dag Westerståhl, eds (1996) *Logic, Language and Computation, Vol. 1*, CSLI Publications, Stanford.

A Full annotation

(1)
Dialogue 127
%—**start**—-%

push(a.private.agenda, raise(*What does B want?*))
push(a.private.agenda, respond(*Does B have A's attention?*))
add(a.shared.bel, *A has B's attention*)
push(a.shared.qud, *Does B have A's attention?*)
add(b.shared.bel, *B wants assistance*)
add(b.shared.bel, *A has B's attention*)
push(b.shared.qud, *Does B have A's attention?*)

$$\left[\begin{array}{lcl} \text{a} & = & \left[\begin{array}{lcl} \text{private} & = & \left[\begin{array}{lcl} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \begin{array}{l} \text{respond}(\textit{Does B have A's attention?}\ ) \\ \text{raise}(\textit{What does B want?}\ ) \end{array} \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lcl} \text{bel} & = & \left\{ \textit{A has B's attention} \right\} \\ \text{qud} & = & \left\langle \textit{Does B have A's attention?} \right\rangle \end{array}\right] \end{array}\right] \\ \text{b} & = & \left[\begin{array}{lcl} \text{private} & = & \left[\begin{array}{lcl} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lcl} \text{bel} & = & \left\{ \begin{array}{l} \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \left\langle \textit{Does B have A's attention?} \right\rangle \end{array}\right] \end{array}\right] \end{array}\right]$$

(2)

A <Welcome to the Route Planning Service.>

pop(a.shared.qud)
add(a.shared.bel, *B has A's attention*)
add(b.shared.bel, *B has A's attention*)
pop(b.shared.qud)
pop(a.private.agenda)

$$\left[\begin{array}{lcl} \text{a} & = & \left[\begin{array}{lcl} \text{private} & = & \left[\begin{array}{lcl} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \text{raise}(\textit{What does B want?}\ ) \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lcl} \text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\ \text{b} & = & \left[\begin{array}{lcl} \text{private} & = & \left[\begin{array}{lcl} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lcl} \text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \end{array}\right]$$

(3)

<How can I help you.>

pop(a.private.agenda)
push(a.shared.qud, *How can A help B?*)
push(b.private.agenda, respond(*What does B want from A?*))
push(b.shared.qud, *How can A help B?*)
push(b.shared.qud, *What does B want from A?*)

$$\left[\begin{array}{lll} & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \left\langle \textit{How can A help B?} \right\rangle \end{array}\right] \end{array}\right] \\ \text{a} = & \\ & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \text{respond}(\textit{What does B want from A?}) \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \left\langle\begin{array}{l} \textit{What does B want from A?} \\ \textit{How can A help B?} \end{array}\right\rangle \end{array}\right] \end{array}\right] \\ \text{b} = & \end{array}\right]$$

(4)

(Pause: 1)
B <A route please.>

pop(b.private.agenda)
pop(b.shared.qud)
pop(b.shared.qud)
push(a.shared.qud, *What does B want from A?*)
add(b.shared.bel, *B wants a route from A*)

$$\left[\begin{array}{lll} & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \left\langle\begin{array}{l} \textit{What does B want from A?} \\ \textit{How can A help B?} \end{array}\right\rangle \end{array}\right] \end{array}\right] \\ \text{a} = & \\ & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\ \text{b} = & \end{array}\right]$$

(5)

pop(a.shared.qud)
pop(a.shared.qud)
push(a.private.agenda, raise(*Does B want the quickest or shortest route?*))
push(a.private.agenda, raise(*What time does B want to make the journey?*))
push(a.private.agenda, raise(*Where does B want to go?*))
push(a.private.agenda, raise(*Where does B want to start?*))

$$\left[\begin{array}{lll} & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Where does B want to start?}\ ) \\ \text{raise}(\textit{Where does B want to go?}\ ) \\ \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\ \text{a} = & & \\ \text{b} = & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] & \end{array}\right]$$

(6)
(Pause: 1)
A <Where would you like to start your journey.>

pop(a.private.agenda)
push(a.shared.qud, *Where does B want to start?*)
push(b.private.agenda, respond(*Where does B want to start?*))
push(b.shared.qud, *Where does B want to start?*)

$$\left[\begin{array}{lll} & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Where does B want to go?}\ ) \\ \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} & = & \left\langle \textit{Where does B want to start?} \right\rangle \end{array}\right] \end{array}\right] \\ \text{a} = & & \\ \text{b} = & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \text{respond}(\textit{Where does B want to start?}\ ) \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \left\langle \textit{Where does B want to start?} \right\rangle \end{array}\right] \end{array}\right] & \end{array}\right]$$

(7)

B <Malvern.>

push(a.private.agenda, raise(*Does B want to start the journey in great Malvern?*))
pop(b.private.agenda)
add(b.shared.bel, *B wants to start the journey in Malvern*)
pop(b.shared.qud)

$$\left[\begin{array}{lll} & \left[\begin{array}{lll} & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Does B want to start the journey in great Malvern?}\ ) \\ \text{raise}(\textit{Where does B want to go?}\ ) \\ \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle \end{array}\right] \\ \text{private} & = & \\ & & \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} & = & \left\langle \textit{Where does B want to start?} \right\rangle \end{array}\right] \end{array}\right] \\ \text{a} = & & \\ & & \\ & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ & & \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\ \text{b} = & & \\ & & \end{array}\right]$$

(8)

A <Starting in Great Malvern.>

pop(a.private.agenda)
push(a.shared.qud, *Does B want to start the journey in great Malvern?*)
push(b.shared.qud, *Where does B want to start?*)
delete(b.shared.bel, *B wants to start the journey in Malvern*)
push(b.shared.qud, *Does B want to start the journey in great Malvern?*)
push(b.private.agenda, respond(*Does B want to start the journey in great Malvern?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
 & \text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Where does B want to go?}) \\ \text{raise}(\textit{What time does B want to make the journey?}) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} \right\rangle
\end{array}\right] \\
\text{a} = & & \\
 & \text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \begin{array}{l} \textit{Does B want to start the journey in great Malvern?} \\ \textit{Where does B want to start?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right] \\
 & \left[\begin{array}{lll}
 & \text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Does B want to start the journey in great Malvern?}) \right\rangle
\end{array}\right] \\
\text{b} = & & \\
 & \text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \left\langle \begin{array}{l} \textit{Does B want to start the journey in great Malvern?} \\ \textit{Where does B want to start?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(9)

(Pause: 1)
B <Yes.>

pop(a.shared.qud)
pop(a.shared.qud)
pop(b.private.agenda)
pop(b.shared.qud)
pop(b.shared.qud)
add(a.shared.bel, *B wants to start the journey in Great Malvern*)
add(b.shared.bel, *B wants to start the journey in Great Malvern*)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
 & \text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Where does B want to go?}) \\ \text{raise}(\textit{What time does B want to make the journey?}) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} \right\rangle
\end{array}\right] \\
\text{a} = & & \\
 & \text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
 & \left[\begin{array}{lll}
 & \text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{b} = & & \\
 & \text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(10)

A <Where would you like to go.>

pop(a.private.agenda)
push(a.shared.qud, *Where does B want to go?*)
push(b.private.agenda, respond(*Where does B want to go?*))
push(b.shared.qud, *Where does B want to go?*)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{Where does B want to go?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
\text{b} = & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Where does B want to go?}\ ) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{Where does B want to go?} \right\rangle
\end{array}\right]
\end{array}\right] &
\end{array}\right]
$$

(11)

B <Edwinstowe.>

push(a.private.agenda, raise(*Does B want to go to Edwinstowe?*))
pop(b.private.agenda)
add(b.shared.bel, *B wants to go to Edwinstowe*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Does B want to go to Edwinstowe?}\ ) \\ \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{Where does B want to go?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
\text{b} = & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] &
\end{array}\right]
$$

(12)

(Pause: 1)
A <Edwinstowe.>

pop(a.private.agenda)
push(a.shared.qud, *Does B want to go to Edwinstowe?*)
delete(b.shared.bel, *B wants to go to Edwinstowe*)
push(b.private.agenda, respond(*Does B want to go to Edwinstowe?*))
push(b.shared.qud, *Where does B want to go?*)
push(b.shared.qud, *Does B want to go to Edwinstowe?*)

$$
\left[\begin{array}{lll}
\text{a} = & \left[\begin{array}{lll}
\text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \begin{array}{l} \textit{Does B want to go to Edwinstowe?} \\ \textit{Where does B want to go?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & \left[\begin{array}{lll}
\text{private} = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Does B want to go to Edwinstowe?}\ ) \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \left\langle \begin{array}{l} \textit{Does B want to go to Edwinstowe?} \\ \textit{Where does B want to go?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(13)

B <Yes.>

push(a.private.agenda, instruct(*B waits*))
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B wants to go to Edwinstowe*)
pop(b.shared.qud)
pop(b.shared.qud)

$$
\begin{bmatrix}
 & \begin{bmatrix}
 & \text{private} = & \begin{bmatrix} \text{bel} = \{\} \\ \text{agenda} = \left\langle \begin{array}{l} \text{instruct}(\textit{B waits}) \\ \text{raise}(\textit{What time does B want to make the journey?}) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} \right\rangle \end{bmatrix} \\
\text{a} = & \\
 & \text{shared} = & \begin{bmatrix} \text{bel} = \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} = \left\langle \textit{Where does B want to go?} \right\rangle \end{bmatrix}
\end{bmatrix} \\
 & \begin{bmatrix}
 & \text{private} = & \begin{bmatrix} \text{bel} = \{\} \\ \text{agenda} = \langle\rangle \end{bmatrix} \\
\text{b} = & \\
 & \text{shared} = & \begin{bmatrix} \text{bel} = \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} = \langle\rangle \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

(14)

A <Please wait.>

pop(a.private.agenda)
push(a.private.agenda, raise(*Is Edwinstowe Edwinstowe in Nottingham?*))

$$
\begin{bmatrix}
 & \begin{bmatrix}
 & \text{private} = & \begin{bmatrix} \text{bel} = \{\} \\ \text{agenda} = \left\langle \begin{array}{l} \text{raise}(\textit{Is Edwinstowe Edwinstowe in Nottingham?}) \\ \text{raise}(\textit{What time does B want to make the journey?}) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}) \end{array} \right\rangle \end{bmatrix} \\
\text{a} = & \\
 & \text{shared} = & \begin{bmatrix} \text{bel} = \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} = \left\langle \textit{Where does B want to go?} \right\rangle \end{bmatrix}
\end{bmatrix} \\
 & \begin{bmatrix}
 & \text{private} = & \begin{bmatrix} \text{bel} = \{\} \\ \text{agenda} = \langle\rangle \end{bmatrix} \\
\text{b} = & \\
 & \text{shared} = & \begin{bmatrix} \text{bel} = \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} = \langle\rangle \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

(15)

(Pause: 5)
<Is that Edwinstowe in Nottingham.>

pop(a.private.agenda)

push(a.shared.qud, *Is Edwinstowe Edwinstowe in Nottingham?*)
delete(b.shared.bel, *B wants to go to Edwinstowe*)
push(b.shared.qud, *Where does B want to go?*)
push(b.shared.qud, *Does B want to go to Edwinstowe?*)
push(b.private.agenda, respond(*Is Edwinstowe Edwinstowe in Nottingham?*))
push(b.shared.qud, *Is Edwinstowe Edwinstowe in Nottingham?*)

$$
\left[\begin{array}{ll}
 & \left[\begin{array}{ll}
\text{private} = & \left[\begin{array}{ll}
\text{bel} = & \{\} \\
\text{agenda} = & \left\langle \begin{array}{l} \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{ll}
\text{bel} = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} = & \left\langle \begin{array}{l} \textit{Is Edwinstowe Edwinstowe in Nottingham?} \\ \textit{Where does B want to go?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{ll}
\text{private} = & \left[\begin{array}{ll}
\text{bel} = & \{\} \\
\text{agenda} = & \left\langle \text{respond}(\textit{Is Edwinstowe Edwinstowe in Nottingham?}\ ) \right\rangle
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{ll}
\text{bel} = & \left\{ \begin{array}{l} \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} = & \left\langle \begin{array}{l} \textit{Is Edwinstowe Edwinstowe in Nottingham?} \\ \textit{Does B want to go to Edwinstowe?} \\ \textit{Where does B want to go?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$

(16)

B <Yes.>

add(a.shared.bel, *B wants to go to Edwinstowe in Nottingham*)
pop(a.shared.qud)
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B wants to go to Edwinstowe in Nottingham*)
pop(b.shared.qud)
pop(b.shared.qud)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{What time does B want to make the journey?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(17)

(Pause: 2)
A <What time would you like to make your journey.>

push(a.shared.qud, *What time does B want to make the journey?*)
pop(a.private.agenda)
push(b.shared.qud, *What time does B want to make the journey?*)
push(b.private.agenda, respond(*What time does B want to make the journey?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{What time does B want to make the journey?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{What time does B want to make the journey?}\ ) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{What time does B want to make the journey?} \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(18)

B <Six p.m.>

push(a.private.agenda, raise(*Does B want to leave at 6 p.m.?*))
pop(b.private.agenda)
add(b.shared.bel, *B wants to make the journey at 6 p.m.*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Does B want to leave at 6 p.m.?}\ ) \\ \text{raise}(\textit{Does B want the quickest or shortest route?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle\ \textit{What time does B want to make the journey?}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(19)

(Pause: 1)
A <Leaving at six p.m.>

pop(a.private.agenda)
push(a.shared.qud, *Does B want to leave at 6 p.m.?*)
delete(b.shared.bel, *B wants to make the journey at 6 p.m.*)
push(b.shared.qud, *What time does B want to make the journey?*)
push(b.shared.qud, *Does B want to leave at 6 p.m.?*)
push(b.private.agenda, respond(*Does B want to leave at 6 p.m.?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{raise}(\textit{Does B want the quickest or shortest route?}) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle\begin{array}{l}
\textit{Does B want to leave at 6 p.m.?} \\
\textit{What time does B want to make the journey?}
\end{array}\right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Does B want to leave at 6 p.m.?}) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \left\langle\begin{array}{l}
\textit{Does B want to leave at 6 p.m.?} \\
\textit{What time does B want to make the journey?}
\end{array}\right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(20)

B <Yes.>

add(a.shared.bel, *B wants to make the journey at 6 p.m.*)
pop(a.shared.qud)
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B wants to make the journey at 6 p.m.*)
pop(b.shared.qud)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{raise}(\textit{Does B want the quickest or shortest route?}) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(21)

(Pause: 4)
A <Would you like the quickest or the shortest route.>

pop(a.private.agenda)
push(a.shared.qud, *Does B want the quickest or shortest route?*)
push(b.shared.qud, *Does B want the quickest or shortest route?*)
push(b.private.agenda, respond(*Does B want the quickest or shortest route?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \left\langle\ \textit{Does B want the quickest or shortest route?}\ \right\rangle \end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle\ \text{respond}(\textit{Does B want the quickest or shortest route?}\ )\ \right\rangle \end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \left\langle\ \textit{Does B want the quickest or shortest route?}\ \right\rangle \end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$

(22)

B <Quickest.>

push(a.private.agenda, instruct(*Wait while route from Malvern to Edwinstowe is calculated*))
add(a.shared.bel, *B wants the quickest route*)
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B wants the quickest route*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{instruct}(\textit{Wait while route from Malvern to Edwinstowe is calculated}) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(23)

(Pause: 2)
A <Please wait> <while your route from Malvern to Edwinstowe is calculated.>

pop(a.private.agenda)
push(a.shared.qud, *How long is the quickest route and how long will it take?*)
push(a.private.agenda, respond(*How long is the quickest route and how long will it take?*
))
push(b.shared.qud, *How long is the quickest route and how long will it take?*)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{How long is the quickest route and how long will it take?}) \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle \textit{How long is the quickest route and how long will it take?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \left\langle \textit{How long is the quickest route and how long will it take?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(24)

(Pause: 3)
<The quickest route is one hundred and thirteen miles and will take two hours eight minutes.>

pop(a.private.agenda)
push(a.private.agenda, raise(*Would B like to see the instruction*))
add(a.shared.bel, *The quickest route is 113 miles and will take 2 hrs 8 mins*)
pop(a.shared.qud)
add(b.shared.bel, *The quickest route is 113 miles and will take 2 hrs 8 mins*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle\ \text{raise}(\textit{Would B like to see the instruction})\ \right\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \\ \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] \\
\text{b} = & & \\
\end{array}\right]
$$

(25)

(Pause: 1)
<Would you like me to send the instructions to you.>

pop(a.private.agenda)
push(a.shared.qud, *Would B like to see the instruction*)
push(b.shared.qud, *Would B like to see the instruction*)
push(b.private.agenda, respond(*Would B like to see the instruction*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Would B like to see the instruction}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle\ \text{respond}(\textit{Would B like to see the instruction})\ \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Would B like to see the instruction}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$

(26)

B <No.>

push(a.private.agenda, raise(*Does B require any further information?*))
add(a.shared.bel, *B would not like A to send the instructions*)
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B would not like A to send the instructions*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle\ \text{raise}(\textit{Does B require any further information? })\ \right\rangle \end{array}\right] \end{array}\right. & \\
 & \left.\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] & \\
\text{a} = & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \end{array}\right. & \\
 & \left.\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \langle\rangle \end{array}\right] \end{array}\right] &
\end{array}\right]
$$

(27)

(Pause: 2)
A <Do you require any further information now.>
B

pop(a.private.agenda)
push(a.shared.qud, *Does B require any further information?*)
push(b.shared.qud, *Does B require any further information?*)
push(b.private.agenda, respond(*Does B require any further information?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Does B require any further information?}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle\ \text{respond}(\textit{Does B require any further information?})\ \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Does B require any further information?}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$

(28)
B <No.>

add(a.shared.bel, *B does not require any further information*)
pop(a.shared.qud)
push(a.private.agenda, raise(*What is B's location?*))
push(a.private.agenda, raise(*What is B's name?*))
add(b.shared.bel, *B does not require any further information*)
pop(b.private.agenda)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{What is B's name?}\ ) \\ \text{raise}(\textit{What is B's location?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(29)

(Pause: 1)
A <Can I have your name please.>

pop(a.private.agenda)
push(a.shared.qud, *What is B's name?*)
push(b.shared.qud, *What is B's name?*)
push(b.private.agenda, respond(*What is B's name?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\ \text{raise}(\textit{What is B's location?}\ )\ \rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \langle\ \textit{What is B's name?}\ \rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\ \text{respond}(\textit{What is B's name?}\ )\ \rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \langle\ \textit{What is B's name?}\ \rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$

(30)

(Pause: 1)
B <Mr Smith>

push(a.private.agenda, raise(*Is B's name mr. Smith?*))
pop(b.private.agenda)
add(b.shared.bel, *B's name is mr. Smith*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \begin{array}{l} \text{raise}(\textit{Is B's name mr. Smith?}\ ) \\ \text{raise}(\textit{What is B's location?}\ ) \end{array} \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\
\text{qud} & = & \left\langle \textit{What is B's name?} \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{ \begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(31)

(Pause: 1)
A <Mr Smith>

pop(a.private.agenda)
push(a.shared.qud, *Is B's name mr. Smith?*)
delete(b.shared.bel, *B's name is mr. Smith*)
push(b.shared.qud, *What is B's name?*)
push(b.shared.qud, *Is B's name mr. Smith?*)
push(b.private.agenda, respond(*Is B's name mr. Smith?*))

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\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{raise}(\textit{What is B's location?}) \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\}
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{qud} & = & \left\langle \begin{array}{l} \textit{Is B's name mr. Smith?} \\ \textit{What is B's name?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right] \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle \text{respond}(\textit{Is B's name mr. Smith?}) \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & \left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\}
\end{array}\right] \\
\text{shared} = & \left[\begin{array}{lll}
\text{qud} & = & \left\langle \begin{array}{l} \textit{Is B's name mr. Smith?} \\ \textit{What is B's name?} \end{array} \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(32)

B <Yes=>

add(a.shared.bel, *B's name is mr. Smith*)
pop(a.shared.qud)
pop(a.shared.qud)
pop(b.private.agenda)
add(b.shared.bel, *B's name is mr. Smith*)
pop(b.shared.qud)
pop(b.shared.qud)

$$
\begin{bmatrix}
 & \begin{bmatrix} \text{private} & = & \begin{bmatrix} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\ \text{raise}(\textit{What is B's location?})\ \rangle \end{bmatrix} \end{bmatrix} \\
\text{a} = & \begin{bmatrix} \text{shared} & = & \begin{bmatrix} \text{bel} & = & \left\{ \begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{bmatrix} \end{bmatrix} \\
 & \begin{bmatrix} \text{private} & = & \begin{bmatrix} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{bmatrix} \end{bmatrix} \\
\text{b} = & \begin{bmatrix} \text{shared} & = & \begin{bmatrix} \text{bel} & = & \left\{ \begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array} \right\} \\ \text{qud} & = & \langle\rangle \end{bmatrix} \end{bmatrix}
\end{bmatrix}
$$

(33)

A <=And your location please.>

pop(a.private.agenda)
push(a.shared.qud, *What is B's location?*)
push(b.shared.qud, *What is B's location?*)
push(b.private.agenda, respond(*What is B's location?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \end{array}\right] \\
\text{a} = & \left[\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \left\langle \textit{What is B's location?} \right\rangle \end{array}\right] \end{array}\right] \\
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \text{respond}(\textit{What is B's location?}) \right\rangle \end{array}\right] \end{array}\right] \\
\text{b} = & \left[\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \left\langle \textit{What is B's location?} \right\rangle \end{array}\right] \end{array}\right]
\end{array}\right]
$$

(34)

B <T (.) 43>

push(a.private.agenda, raise(*Is B's location T 43?*))
pop(b.private.agenda)
add(b.shared.bel, *B's location is T 43*)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle\ \text{raise}(\textit{Is B's location T 43?}\ )\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} \quad = & & \\
 & \left[\begin{array}{lll}
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right. \\
\text{qud} & = & \left\langle\ \textit{What is B's location?}\ \right\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} \quad = & & \\
 & \left[\begin{array}{lll}
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right. \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

(35)

A <T 43>

pop(a.private.agenda)
push(a.shared.qud, *Is B's location T 43?*)
delete(b.shared.bel, *B's location is T 43*)
push(b.shared.qud, *What is B's location?*)
push(b.shared.qud, *Is B's location T 43?*)
push(b.private.agenda, respond(*Is B's location T 43?*))

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \langle\rangle \end{array}\right] \end{array}\right] \\
\text{a} = & \left[\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \end{array}\right\} \\ \text{qud} & = & \left\langle\begin{array}{l} \textit{Is B's location T 43?} \\ \textit{What is B's location?} \end{array}\right\rangle \end{array}\right] \end{array}\right] \\
 & \left[\begin{array}{lll} \text{private} & = & \left[\begin{array}{lll} \text{bel} & = & \{\} \\ \text{agenda} & = & \left\langle \text{respond}(\textit{Is B's location T 43?}) \right\rangle \end{array}\right] \end{array}\right] \\
\text{b} = & \left[\begin{array}{lll} \text{shared} & = & \left[\begin{array}{lll} \text{bel} & = & \left\{\begin{array}{l} \textit{B's name is mr. Smith} \\ \textit{B does not require any further information} \\ \textit{B would not like A to send the instructions} \\ \textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\ \textit{B wants the quickest route} \\ \textit{B wants to make the journey at 6 p.m.} \\ \textit{B wants to go to Edwinstowe in Nottingham} \\ \textit{B wants to start the journey in Great Malvern} \\ \textit{B wants a route from A} \\ \textit{B has A's attention} \\ \textit{A has B's attention} \\ \textit{B wants assistance} \end{array}\right\} \\ \text{qud} & = & \left\langle\begin{array}{l} \textit{Is B's location T 43?} \\ \textit{What is B's location?} \end{array}\right\rangle \end{array}\right] \end{array}\right]
\end{array}\right]
$$

(36)

B <Yes.>

add(a.shared.bel, *B's location is T 43*)
pop(a.shared.qud)
pop(a.shared.qud)
push(a.shared.qud, *Can A and B release attention?*)
push(a.shared.qud, *Are the purposes of the conversation met?*)
push(a.private.agenda, respond(*Are the purposes of the conversation met?*))
pop(b.private.agenda)
add(b.shared.bel, *B's location is T 43*)
pop(b.shared.qud)
pop(b.shared.qud)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle\ \text{respond}(\textit{Are the purposes of the conversation met? })\ \right\rangle
\end{array}\right] \\
 & & \left[\begin{array}{lll}
 & & \left\{\begin{array}{l}
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle\begin{array}{l}
\textit{Are the purposes of the conversation met?} \\
\textit{Can A and B release attention?}
\end{array}\right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
 & & \left[\begin{array}{lll}
 & & \left\{\begin{array}{l}
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(37)

A <OK.>

pop(a.private.agenda)
pop(a.shared.qud)
push(a.private.agenda, respond(*Can A and B release attention?*))
add(a.shared.bel, *The purposes of the conversation are met*)
push(b.shared.qud, *Are the purposes of the conversation met?*)
add(b.shared.bel, *The purposes of the conversation are met*)
pop(b.shared.qud)
push(b.shared.qud, *Can A and B release attention?*)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \left\langle\ \text{respond}(\textit{Can A and B release attention?})\ \right\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The purposes of the conversation are met} \\
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B has A's attention} \\
\textit{A has B's attention}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Can A and B release attention?}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The purposes of the conversation are met} \\
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B has A's attention} \\
\textit{A has B's attention} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \left\langle\ \textit{Can A and B release attention?}\ \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = & &
\end{array}\right]
$$

(38)
(.) <Thank you for calling.>
(Pause: 2)
<Goodbye.>

pop(a.private.agenda)
pop(a.shared.qud)
pop(b.shared.qud)
delete(a.shared.bel, *B has A's attention*)
delete(a.shared.bel, *A has B's attention*)
delete(b.shared.bel, *B has A's attention*)
delete(b.shared.bel, *A has B's attention*)

$$
\left[\begin{array}{lll}
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The purposes of the conversation are met} \\
\textit{B's location is T 43} \\
\textit{B's name is mr. Smith} \\
\textit{B does not require any further information} \\
\textit{B would not like A to send the instructions} \\
\textit{The quickest route is 113 miles and will take 2 hrs 8 mins} \\
\textit{B wants the quickest route} \\
\textit{B wants to make the journey at 6 p.m.} \\
\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{a} = & \\
 & \left[\begin{array}{lll}
\text{private} & = & \left[\begin{array}{lll}
\text{bel} & = & \{\} \\
\text{agenda} & = & \langle\rangle
\end{array}\right] \\
\text{shared} & = & \left[\begin{array}{lll}
\text{bel} & = & \left\{\begin{array}{l}
\textit{The purposes of the conversation are met} \\
\textit{B's location is T 43} \\
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\textit{B wants to go to Edwinstowe in Nottingham} \\
\textit{B wants to start the journey in Great Malvern} \\
\textit{B wants a route from A} \\
\textit{B wants assistance}
\end{array}\right\} \\
\text{qud} & = & \langle\rangle
\end{array}\right]
\end{array}\right] \\
\text{b} = &
\end{array}\right]
$$