An Analysis on Critical Questions for Plan Proposals

Rolando Medellin-Gasque, Katie Atkinson, and Trevor Bench-Capon

University of Liverpool, Department of Computer Science, Liverpool UK
{medellin,katie,tbc}@liverpool.ac.uk

Abstract. In order to create a comprehensive dialogue game for autonomous agents to engage in rational debate over plans we present in this report a list of critical questions that match an argumentation scheme for plan proposals. Questions are grouped in seven categories that focus on the level of detail of the plan proposal. The critical questions are formalized in terms of an Action-based Alternating Transition system where applicable.

Key words: plan proposal, argumentation schemes, critical questions.

1 Introduction

Argumentation schemes are stereotypical patterns of defeasible reasoning used in everyday argumentation and conversation. In an argumentation scheme, arguments are presented as general inference rules where under a given set of premises a conclusion can be presumptively drawn [7]. Artificial Intelligence has become increasingly interested in argumentation schemes due to their potential for making significant improvements in the reasoning capabilities of artificial agents [3] and for automation of agent interactions. In [8], Walton explains: "*...arguments need to be examined within the context of an ongoing investigation in dialogue in which questions are being asked and answered*".

Critical questions are a way to examine the acceptability of arguments. Depending on the nature of the critical question, these questions can be used to evaluate several aspects of the argument. Usually, critical questions provide pointers which would make the argumentation scheme inapplicable or could lead to a valid way to attack the argument, either defeating the argument on one of its premises or on its presumptive conclusion. Depending on the nature of the dialogue game in which the critical questions are posed they could aim to search for further information or present sources of disagreement from to create an attach on a dialogue. We build on a previous list presented in [5] and refine it based on an ongoing implementation.

The remain of the paper is structured as follows: Section 2 presents our argumentation scheme for plan proposals and section 3 present the critical questions together with the conflict that generates them. Section 4 presents examples of questions given a travel situation and a couple of example dialogues. Section 5 concludes and gives future research paths.

2 Argumentation scheme for a plan proposal

Our plan proposal is based on the proposal for actions in [1] which is defined as follows: In the current circumstances R,we should perform action A to achieve new circumstances S which will realize some goal G which will promote some value v.

Our plan proposal modifies this action proposal and takes it to the level of a plan where a plan is a set of combined actions. Our proposal ASP is as follows:

Given a social context X [1] *in the current circumstances* q_0 *holding preconditions* $\pi(q_0)$*, plan* p *should be performed to achieve new circumstances* q_x*, that will hold postconditions* $\pi(q_x)$ *which will realize the plan-goal* G *which will promote value(s)* V_G.

The valid instantiation of the scheme pre-supposes the existence of a regulatory environment or a social context X in which the proponent has some rights to engage in a dialogue with the co-operating agent. Current circumstances are represented by an initial state q_0. The agent acting as the proponent proposes plan p as a finite set of linked action-combinations. If executed successfully ,the plan leads to a state in which propositions $\pi(q_x)$ and the plan-goal G is achieved and a non-empty set of values associated with the plan is promoted. We use Action-based Alternating Transition Systems (AATS) as introduced in [6] as a basis for our formalism to represent action and plan proposals. AATS models define joint-actions that may be performed by agents in a state and the effects. In particular, an AATS model defines semantic structures useful to represent joint-actions for multiple agents, their preconditions and the states that will result from the transition. Table 1 presents the plan proposal and its AATS representation.

Table 1. Plan Proposal Argumentation Scheme ASP

Plan Proposal	**as an AATS model**
Given a social context X, in the current circumstances q_x holding preconditions $\pi(q_x)$ plan p should be performed to achieve new circumstances q_y that will hold postconditions $\pi(q_y)$ which will realize the plan-goal G which will promote value(s) V_G.	Given context Δ , In the initial state $q_0 = q_x \in Q$, where $\pi(q_0)$, agents $a, b \in Ag$ should execute plan p, where p is a finite set of joint-actions j_n such that $p = \{j_0, .., j_n\}$ and $\{j_0, .., j_n\} \in J_{Ag}$ and $j_n = \{\alpha_i, .., \alpha_j\}$ with transition given by $\tau(q_x, p)$ is q_y , where $\tau(q_0, \{j_1, .., j_n\}) = \tau(\tau(q_0, j_1), (j_2, ..j_n))$ and $\tau(q_x, \{\}) = q_x$ to reach $G \in \pi(q_y)$ such that $p_a \in \pi(q_x)$ and $p_a \notin \pi(q_y)$ where $G = p$ and ($V_G \subseteq V$ such that $v_1 \in V_G$ iff $\delta(q_x, q_y, v_1)$ is $+$) and $V_G \neq \emptyset$

[1] The social context was an extension to the argumentation scheme AS1 introduced in [2] for the purposes of specifying a multi-agent dialogue protocol for command dialogues.

3 Critical Questions for plan proposals

A benefit of having critical questions associated with an argument scheme is that the questions enable dialogue participants to seek points of challenge in a debate or locate premises in an instantiation of the argument scheme that can be recognized as questionable.

Our set of critical questions is based on the set of critical questions developed for action proposals in command dialogues presented in [2]. We classify our set of critical questions in 7 layers. Each layer groups questions according to the level of plan-detail on which they focus. At the highest level, the critical questions are all those which are independent of the way in which actions are composed inside the plan *i.e*. the way in which actions are combined. This classification allows us to separate questions regarding the planning process, the proposal or the time in which they should be executed. This classification gives us elements to create a strategy to choose a critical question in a dialogue. An agent may want to start with elements that are not part of the view of his world and question a particular element to get more information about it. On another level an agent may want to deal with specific questions about the plan, given he accepts the proposal elements. A strategy on how to choose a particular question will be left for future work. The seven layers are the following:

- Layer 1: The action and its elements.
- Layer 2: The timing of a particular action.
- Layer 3: The way actions are combined.
- Layer 4: The plan proposal overall.
- Layer 5: The timing of the plan proposal.
- Layer 6: Side effects not considered.
- Layer 7: Alternative options

Apart from the layers, we identify three types of questions:

- Suitability Questions). These questions challenge the plan or action on the premises or assumptions taken for it to be performed.
- Challenging Questions. These questions lead to challenge the argument questioning the validity or possibility of the argument.
  Possibility could be addressed in 2 ways: either the action is not possible at all or the action is not possible at a point in time. For our purposes we consider the first to be a question of validity.
- Option Questions. - Questions search for a better alternative.

We present now the complete list of questions together with the conflict situation that cause the question and a formalization (where possible) in terms of the AATS proposal presented above.

3.1 Layer 1. Critical Questions for an arbitrary action and its elements (16 questions)

CQA-01. Is the action valid? ($j_n \notin J_{AG}$ where $j_n = \alpha^i_n$)
A missing action specification lead to discard action j_n or provide action specification.

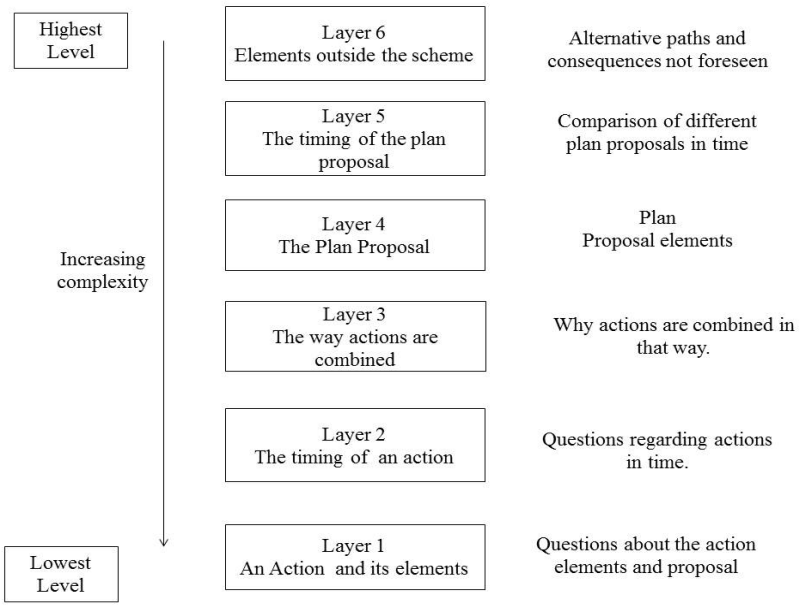

Fig. 1. Action Proposal Representation.

CQA-02. Is the action α_i possible?
CQA-03. Are the preconditions valid? $(not\ \pi(q_x))$
Missing condition leads to discard action j_n or assert condition.
CQA-04. Are the preconditions possible?
Different preconditions lead to discard action j_n or argue over difference.
CQA-05. Are the start effects valid?
Start effect missing in action specification lead to discard action j_n or assert start effect.
CQA-06. Are the start effects possible?
Action specification different in start effects lead to discard action $\rfloor_n$ or argue over difference.
CQA-07. Are the invariants conditions valid?
Invariant Condition missing in action specification lead to discard action or assert condition.
CQA-08. Are the invariants conditions possible?
Action specification different in invariant conditions lead to discard action $\rfloor_n$ or argue over difference.
CQA-09. Are the termination conditions valid?
Termination condition missing in action specification lead to discard action or provide condition.
CQA-10. Are the termination conditions possible?
Action specification different in termination conditions lead to discard action $\rfloor_n$ or ar-

gue over difference.
CQA-11. Are the end effects valid?
End effect missing in action specification lead to discard action j_n or assert end effect.
CQA-12. Are the end effects described possible?
Action specification different in end effects lead to discard action $\rfloor_n$ or argue over difference.
CQA-13. Does the new circumstances already pertain? ($q_0 = q_y$)
CQA-14. Can the desired sub-goal be realized?
CQA-15. Is the value a legitimate one? ($v_n \notin V$)
CQA-16. Is the value promoted by the execution of the action?

3.2 Layer 2. Critical Questions for the timing of an action (9 questions).

CQAT-01. Is the action possible with the specified duration?
Conflict in action duration lead to discard action argue over difference.
CQAT-02. Is the action possible at the specified start time?
Conflict in scheduling specification lead to modify start time or discard action.
CQAT-03. Is the action possible to finish at the specified time?
Conflict in scheduling specification lead to modify end time or discard action.
CQAT-04. Could the action start time point be earlier?
Conflict in scheduling specification lead to modify start time or discard action.
CQAT-05. Could the action start time point be later?
Conflict in scheduling specification lead to modify start time or discard action.
CQAT-06. Could the action duration be less?
Conflict in action duration lead to discard action argue over difference.
CQAT-07. Could the action duration be longer?
Conflict in action duration lead to discard action argue over difference.
CQAT-08. Could the end time point be sooner?
CQAT-09. Could end time point be later?

3.3 Layer 3. Critical Questions for way actions are combined (10 questions)

For sequential actions
CQAC-01. Could actions j_m and j_n be performed concurrently at some point?
Conflict in the plan specification lead to plan modification.
CQAC-02. Could the order of the actions be changed?
Conflict in the action specification lead to plan modification.
For concurrent actions
CQAC-03. Is there a conflict in any of the invariant conditions of the actions?
Conflict in the plan specification lead to action dismissal.
CQAC-04. Is there a conflict in the start effects of the actions?
Conflict in the action specification lead to plan modification.
CQAC-05. Is there a conflict in the end effects of the actions?
Conflict in the action specification lead to plan modification.

CQAC-06. Is there a maximum duration for actions to perform concurrently?
Conflict in the plan specification lead to plan modification.
CQAC-07. Is there a minimum duration for actions to perform concurrently?
Conflict in the action specification lead to plan modification.
CQAC-08. If actions start at the same time, is there a conflict in any of the preconditions or start effects of the actions?
Conflict in the action specification lead to plan modification.
CQAC-09. If actions end at the same time, is there a conflict in any of the termination condition or end effects of the actions?
Conflict in the action specification lead to plan modification.
CQAC-10. If action α is embedded in action β, is there a conflict between the any of the conditions or effects j_m and the invariant conditions of $\rfloor_m$.

3.4 Layer 4. Critical questions for the plan proposal overall (11 questions)

CQPP-01. Is the plan p possible?
Conflicts could be several at various levels. This question leads to argue at different plan levels.
CQPP-02. Is the current social context valid?
Conflict in social context representation lead to dismiss proposal.
CQPP-03. Is the initial state valid? ($q_0 \neq q_x$ and $q_0 \in p(\alpha_i)$)
Different initial state representation leads to dismiss proposal or align initial state.
CQPP-04. Is the initial state possible? ($q_x \in Q$)
Different initial state representation leads to dismiss proposal or align initial state.
CQPP-05. Does the new circumstances already pertain? ($q_x = q_y$)
New circumstances equal to current, conflict in initial state specification lead to proposal dismissal.
CQPP-06. Assuming initial state is valid, will the plan bring about the desired state? ($\tau(q_x, p)$ is not q_y).
Conflict in new circumstances planning engine outputs a different result, leads to proposal dismissal.
CQPP-07. Assuming all of these, will the plan p bring about the desired goal G? ($G \notin \pi(q_y)$)
Conflict in goal specification, leads to proposal dismissal.
CQPP-08. Can the desired goal G be realized?
CQPP-09. Are the values in V_G legitimate values? (for some $v_n \in V_G$ there is a value v_n such that $v_n \notin V$).
Values not specified lead to plan dismissal.
CQPP-10. Is the value v_n promoted by the execution of the plan p? ($\delta(q_x, q_y, v)$ is not $+$).
Plan specification different, value not involved lead to plan dismissal.
CQPP-11. Can the value v_n be promoted?
Conflict in finding a plan for value v , plan specification different lead to plan dismissal.

3.5 Layer 5. Critical Questions for the timing of the plan proposal (10 questions)

CQPPT-01. Is the start time-point for the plan p fixed?
The start time-point is not possible lead to change start time-point.
CQPPT-02. If the starting point is not fixed not, what is the range allowed?
Information seeking question lead to change staring point.
CQPPT-03. If the plan duration is not fixed, what is the range allowed?
Conflict in the plan duration lead to change plan duration.
CQPPT-04. Is the plan p possible with the specified duration?
Conflict in the plan duration leads to dismiss plan proposal.
CQPPT-05. Can the duration be less?
Information seeking question lead to change duration on actions.
CQPPT-06. Can the duration be longer?
Information seeking question lead to change duration on actions.
CQPPT-07. Is the plan p possible at the specified time?
Information seeking question lead to change staring point.
CQPPT-08. Is the plan p possible to finish at the specified time? Conflict in the duration lead to dismiss the proposal.
CQPPT-09. What is the earliest time the plan p can end?
Conflict.- Time constraint in plan specification.
CQPPT-10. What is the latest time the plan p can end? Conflict.- Time constraint in plan specification.

3.6 Layer 6. Critical questions for side effects. (4 questions)

CQSE-01. Does performing the plan p have a side effect which demotes the value v_n ? ($\tau(q_x, p)$ s.t. $p_b \in \pi(q_y)$ s. t. q_x, q_y, v_n is -)
Extra effects may interfere with agents local values. Question lead to dismiss current plan.
CQSE-02. Does performing the plan p have a side effect which demotes some other value v_n? ($\tau(q_x, p)$ s.t. $p_b \in \pi(q_y)$ s. t. q_x, q_y, v_u is -.)
Extra effects may interfere with agents local value specification. Question lead to dismiss current plan.
CQSE-03. Does performing the plan p promote some other value v_u?
CQSE-04. Does performing the plan p preclude doing some other action which would promote some other value v_u? (there is some other plan p_x s.t. $\tau(q_x, p_x)$ is q_z s.t. $\delta(q_x, q_z, v_u)$ is +, where $v_u \neq v_n$).
Extra effects may interfere with agents local value specification answer leads to dismiss current plan.

3.7 Layer 7. Alternative paths (5 questions)

CQAO-01. Is there an alternative plan p_x to promote the same value v_n? ($\tau(q_x, p_x)$ s.t. $\delta(q_x, q_y, v_n)$).

A more efficient plan is available leads to dismiss current plan.
CQAO-02. Is there an alternative plan p_x to realize the same new circumstances? ($\tau(q_x, p_x)$ is q_y).
A more efficient plan is available to reach the same circumstances leads to dismiss current plan.
CQAO-03. Is there an alternative plan p_x to realize the same goal G? ($\tau(q_x, p_x)$ is q_y s.t. $G \in \pi(q_y)$).
A more efficient plan is available to reach the same goal leads to dismiss current plan.
CQAO-04. Is there another agent that could perform a particular action α? ($j_n = (\alpha_i, .., \alpha_k)$).
Another agent can perform action more efficient leads to change action specification.
CQAO-05. Is there another action that could be performed with the same result? ($\tau(q_x, p_x)$ where $p_x = \{j_0, ..j_m\}$).
Another action can be performed more efficient leads to change action specification in the plan.

4 Example

We use an example to illustrate the use of the critical questions and the selection process in a simulated dialogue. The example presents the problem of choosing between different routes (plans) for 2 agents (John and Paul) attending a conference in Paris. Two agents having different representations of the situation need to agree on the best plan to reach Paris from Inverness. The actions that could be combined to reach the goal are: $taketrain()$, $takePlane()$ and $takecoach()$. Each city has restrictions on the availability of the train station, airport and coach station. The values involved are $v_1 = moneysaving$, $v_2 = timetravel$, $v_3 = friendship$, $v_4 = pleasure$.

4.1 Question examples

We now formulate example questions for each layer to illustrate how questions could be instantiated with no particular order. Before each question we indicate if the question is (V)alidity question, a (P)ossibility question, a (S)uitability question or a question that considers (A)lternate options.

Questions Layer 1. Action elements

- CQA-01. (V) Is the action $takeCoach()$ valid?
- CQA-02. (P) Is the action $takePlane()$ possible?
- CQA-03. (V) Are the preconditions for $takePlane(Inverness, day(Tuesday))$ valid?
- CQA-04. (P) Are the preconditions for $takeTrain(Inverness)$ possible?
- CQA-05. (V) Are the start effects $reading$ valid?
- CQA-06. (P) Are the start effects $reading$ possible?

- CQA-07. (V) Are the invariant conditions $agentIn(Transit, A, B)$ valid?
- CQA-08. (P) Are the invariant conditions $reading$ possible with action $takePlane()$?
- CQA-09. (V) Are the termination conditions $agentIn(Paris, Thursday)$ valid?
- CQA-10. (P) Are the termination conditions $agentIn(Paris, Thursday)$ possible?
- CQA-11. (V) Are the end effects $agentIn(Paris, Thursday)$ valid?
- CQA-12. (P) Are the end effects $agentIn(Paris, Thursday)$ possible?
- CQA-13. (S) Does the new circumstances, $agentIn(London, Wednesday)$ already pertain?
- CQA-14. (S) Can the desired sub-goal $agentIn(Manchester, Wednesday)$ be realized?
- CQA-15. (V) Are the values in V_G legitimate values?
- CQA-16. (S) Is the value $v_1 = moneysaving$ promoted by the execution of the action ?

Questions Layer 2. The timing of an action.

- CQAT-01. (P) Is the action $takeTrain(Inverness, Manchester, Tuesday)$ possible in the specified 3 hours?
- CQAT-02. (P) Is the action $takeTrain(Inverness, Manchester, Tuesday)$ possible at the specified 9AM?
- CQAT-03. (P) Is the action $takeTrain(Inverness, Manchester, Tuesday)$ possible to finish at 12PM?
- CQAT-04. (S) Could the start time for $takeTrain(Inverness, Manchester, Tuesday)$ be at 8.30AM (earlier)?
- CQAT-05. (S) Could the start time for $takeTrain(Inverness, Manchester, Tuesday)$ be at 8.30PM (later)?
- CQAT-06.(S) Could the action $takeTrain(Inverness, Manchester, Tuesday)$ duration be (less) 2 hours (to promote $v = comfort$)?
- CQAT-07. (S) Could the action $takeTrain(Inverness, Manchester, Tuesday)$ duration be (longer) 4 hours longer?
- CQAT-08. (S) Could the end time for $takeTrain(Inverness, Manchester, Tuesday)$ be sooner?
- CQAT-09. (S) Could end time for $takeTrain(Inverness, Manchester, Tuesday)$ be later?

Questions Layer 3. The way actions are combined.

- CQAC-01.(S) Could actions $takeTrain()$ and $takePlane()$ be performed concurrently at some point?
- CQAC-02.(S) Could the order of the actions $takeTrain()$ and $takePlane()$ be changed?
- CQAC-03.(P) Is there a conflict in any of the invariant conditions of the actions $takeTrain$ and $readbook()$?
- CQAC-04.(P)Is there a conflict in the start effects of the actions $takeTrain()$ and $readbook()$?

- CQAC-05.(P) Is there a conflict in the end effects of the actions $takeTrain()$ and $readbook()$?
- CQAC-06.(S) Is there a maximum duration for actions $takeTrain()$ and $readbook()$ to perform concurrently?
- CQAC-07.(S) Is there a minimum duration for actions $takeTrain()$ and $readbook()$? to perform concurrently?
- CQAC-08.(P) If actions start at the same time, is there a conflict in any of the preconditions or start effects of the actions $takeTrain()$ and $readbook()$?
- CQAC-09.(P) If actions end at the same time, is there a conflict in any of the termination condition or end effects of the actions $takeTrain()$ and $readbook()$?
- CQAC-10.(P) If action $readbook()$ is embedded in action $takeTrain()$, is there a conflict between the any of the preconditions,start effects,termination condition or end effects of $readBook()$ and the invariant conditions of $takeTrain()$?

Questions Layer 4. Plan proposal.

- CQPP-01.(P) Is the plan p_1 possible?
- CQPP-02(V). Is the current social context Δ believed to be as stated by proponent?
- CQPP-03.(V) Is the initial state $agentIn(Inverness, Tuesday)$ valid?
- CQPP-04.(P) Is the initial state $agentIn(Inverness, Tuesday)$ possible?
- CQPP-05.(P) Is the agent already in Paris? Agent already in Paris $agentIn(Paris, Thursday)$
- CQPP-06.(P) Assuming the initial state is valid, will the plan p bring about the desired state $agentIn(Paris, Thursday)$?
- CQPP-07.(P) Assuming all of these, will the plan p_1 bring about the desired goal $g = agentIn(Paris, Thursday)$?
- CQPP-08.(S) Can the desired goal $g = agentIn(Paris, Thursday)$ be realized? The goal $agentIn(Paris, Thursday)$ cannot be realized. There is no valid plan to reach the goal.
- CQPP-09.(V) Are the values in V_G legitimate values?
- CQPP-10.(S) Is the value $v_2 = friendship$ promoted by the execution of the plan p_1?
- CQPP-11.(S) Can the value $v_2 = friendship$ be promoted?

Questions Layer 5. Plan proposal in time.

- CQPPT-01.(S) Is the start time-point for the plan pl_1 fixed? Information seeking question.
- CQPPT-02.(S) If the starting point is not fixed not, what is the range allowed? Information seeking question.
- CQPPT-03.(S) If the plan p_1 duration is not fixed, what is the range allowed? Information seeking question.
- CQPPT-04.(P) Is the plan p_1 possible in 3 days?
- CQPPT-05.(S) Can the duration of plan p_1 be 2 days (less)?
- CQPPT-06.(S) Can the duration be 5 days (longer)?
- CQPPT-07.(P) Is the plan p_1 possible at Saturday morning?
- CQPPT-08.(P) Is the plan p_1 possible to finish at the specified time?

– CQPPT-09.(S) What is the earliest time the plan p_1 can end? Information seeking question.
– CQPPT-10. (S) What is the latest time the plan p_1 can end?

Questions Layer 6. Plan side effects.

– CQSE-01.(S) Does performing the plan pl_1 have a side effect which demotes the value $v_2 = friendship$?
– CQSE-02.(S) Does performing the plan pl_1 have a side effect which promote some other value v_u?
– CQSE-03.(S) Does performing the plan pl_1 preclude doing action $writeThesis()$ which would promote some other value $hapiness$?
– CQSE-04.(S) Does performing the plan pl_1 preclude doing action $writeThesis()$ which would demote value $progress$?

Questions Layer 7. Alternative options

– CQAO-01.(A) Is there an alternative plan p_2 to promote the same value $money_saving$?
– CQAO-02.(A) Is there an alternative plan p_2 to realize the same new circumstances?
– CQAO-03.(A) Is there an alternative plan p_2 to realize the same goal g?
– CQAO-04.(A) Is there another agent ag that could perform action $takeTrain()$?
– CQAO-05.(A) Is there another action that could be performed with the same result?

4.2 Dialogue Examples

Tables 2 - 5 present examples on how a dialogue might develop using the critical questions presented.

5 Conclusions

We believe this analysis enable plan proposals to be questioned in a comprehensive way in order to be justified. Critical questions could be used to create Dialogue Games for agents where the proponents may put forward arguments instantiating the argumentation scheme and opponents to the argument challenge it through critical questions. Argumentation-based dialogues are used to formalize dialogues between autonomous agents based on theories of argument exchange. Examples of argumentation-based dialogue protocols that use critical questions are presented in [1, 2, 4].

Table 2. Example Dialogue 1

Agent	**Dialogue**	
$Paul$	Plan is to take a flight to Paris on Thursday, that will promote the value of $traveltime$	Proposal 1.
$John$	There is no available airport at Inverness.	**CQPP-05**. Possibility of the initial state.
$Paul$	OK.	Acknowledge information
$Paul$	Could you find another way to promote $traveltime$?	**CQAO-03**. Alternate plan
$John$	Yes. Take a train to Manchester Wednesday, then take a plane to Paris on Wednesday	Proposal 2.
$Paul$	There is no flight from Manchester Airport on Wednesday.	**CQA-04**. Possibility of action preconditions.
$John$	OK.	
$John$	If there is no way to promote $traveltime$ let's promote $moneysaving$	Change value order.
$Paul$	I have a plan for that. Take a train from Inverness to Manchester on Tuesday. On Wednesday take a train to London and then take a flight to Paris the same day. Arrive Wednesday	Proposal 3.
$John$	Does the plan promote the value $moneysaving$?	**CQPP-10**. Value promotion question.
$Paul$	Yes. 50 less than other plans. Total is 200.	Assert post-conditions with more information.
$John$	The plan does not promote $moneysaving$.	Reject previous assertion.
$John$	The total cost is 300 considering the hotel.	Backup rejection with new information.
$Paul$	OK.	
$John$	Do you know the cost of the train from London to Paris on Thursday?	Information seeking
$Paul$	Yes, 50	Assert information.
$John$	I found a plan to promote $moneysaving$. Take train Inverness Manchester on Wednesday, same day take train Manchester-London, then Thursday take the train to Paris. Total cost 250. Less than other plans	Proposal 3 modified.
$Paul$	Does the plan demotes the value $friendship$?	**CQSE-01**. Value demotion question
$John$	The plan promotes the value	Assert new information.
$Paul$	OK. I agree on that plan.	Proposal 3 accepted.

Table 3. Example Dialogue 2

Agent	**Dialogue**	
$Paul$	The initial state agents are in Inverness and the goal is that agents have to be Paris by Thursday	Initial state and goal statement
$Paul$	The plan is to take a flight to Manchester on Wednesday and a train to London on Thursday and a train to Paris on Thursday to promote $friendship$ and $progress$	Proposal 1.1
$John$	I agree on the flight to Manchester but no on the rest of the plan. Trains to London are not possible on Thursday	Accept one action reject the rest **CQPP-01** , **CQA-04**
$Paul$	OK	
$Paul$	The new plan the is to take a flight to Paris from Manchester on Thursday.	Proposal 1.2
$John$	The action is not suitable since the flights are too expensive	**CQA-17**
$John$	I propose to take a flight to London from Manchester and then the train to Paris.	Proposal 1.3
$Paul$	I agree on the flight but no on the train. There is a strike and trains might not be available from London	Agree on one action reject the last one **CQA-04**
$Paul$	I propose take a coach	Proposal 1.4
$John$	A coach would take 12 hours that demotes the value comfort and does not reach the goal	**CQAT-06 , CQA-20**
$Paul$	Then take a flight to Paris	Proposal 1.5
$John$	I agree on that.	All actions accepted.

Table 4. Example Dialogue 3

Agent	Dialogue	
$Paul$	The initial state agents are in Inverness and the goal is that agents have to be Paris by Thursday	Initial state and goal statement
	Suitability Questions	
$John$	The goal cannot be realized at all. There is no possible plan to arrive to Paris in time.	**CQPP-08**
$Paul$	Yes, I have a plan.	
	Plan Validity	
$John$	Are the values in V_G legitimate values?	**CQPP-09**
$Paul$	Yes it is, Inverness in Scotland.	
	Action Suitability	
$John$	Could the start time for action $takeTrain(9AM)$ be earlier?	**CQAT-04**
$Paul$	Yes, there is a train at 8.30	
	Action Validity	
$John$	Is the action $takeTrain()$ valid?	**CQA-01**
$Paul$	Action $takeTrain()$ is valid	
	Action Possibility	
$John$	Are the preconditions for $takeTrain()$ in Inverness possible?	**CQA-04**
$Paul$	Yes, all the preconditions are possible	
$John$	Is there a conflict in the start effects of actions $takeTrain()$ and $readBook()$	**CQAC-05**
$Paul$	No, there is no conflict	
	Plan Possibility	
$John$	Assuming the preconditions and the plan are correct, the plan wont bring about the desired goal (in Paris by Thursday).	**CQPP-06**
$Paul$	The plan indeed takes us to Paris by Thursday	
	Alternative actions	
$John$	Is there another action that could be performed with the same result?	**CQAO-05**
$Paul$	No action available	
	Alternative plans	
$John$	OK, the plan is good but I have a better plan that promotes the same value.	**CQAO-01**
$Paul$	Your plan is no better than mine.	
$John$	OK, I accept the plan.	**CQAO-01**

Table 5. Example Dialogue 4

Agent	Dialogue	
$Paul$	The initial state agents are in Inverness and the goal is that agents have to be Paris by Thursday	Initial state and goal statement
$Paul$	The plan is to take a flight to Manchester on Wednesday and a flight to Paris on Thursday to promote $comfort$	Plan proposal
	Suitability Questions	
$John$	Does the plan promote all the values intended ?	**CQPP-10**
$Paul$	All the values are promoted by the actions	
$John$	Can the duration of plan be less?	**CQPPT-06**
$Paul$	The duration is fixed, it cant be less.	
	Plan Validity	
$John$	Value $moneysaving$ is not legitimate ?	**CQPP-09**
$Paul$	The values are legitimate	
	Action Suitability	
$John$	The sub-goal, -agent in Manchester- cannot be achieved?	**CQA-17**
$Paul$	Action specification applied to the initial state specifies that goal could be achieved	
	Action Validity	
$John$	Are the start effects of the action $takePlane()$ valid?	**CQA-05**
$Paul$	The start effects are valid	
	Action Possibility	
$John$	Is the action $takePlane()$ possible from Paris ?	**CQA-02**
$Paul$	The action is possible from Paris, there was a strike but its over now.	
	Alternative actions	
$John$	Is there another action that could be performed with the same result?	**CQAO-05**
$Paul$	The action takeTrain() would be suitable but it does not promote the values intended	
	Plan Possibility	
$John$	Assuming the initial state is valid, will the plan bring about the desired state?	**CQPP-06**
$Paul$	The plan is possible	
	Alternative plans	
$John$	Is there an alternative plan to realize the same goal ?	**CQAO-03**
$Paul$	No	

References

1. K. Atkinson, T. Bench-Capon, and P. McBurney. A dialogue game protocol for multi-agent argument over proposals for action. *Autonomous Agents and Multi-Agent Systems*, 11(2):153–171, 2005.
2. K. Atkinson, R. Girle, P. McBurney, and S. Parsons. Command Dialogues. In I. Rahwan and P. Moraitis, editors, *Argumentation in Multi-Agent Systems*, Fifth International Workshop, pages 93–106, Berlin, Heidelberg, 2009. Springer-Verlag.
3. F. Bex, H. Prakken, C. Reed, and Douglas Walton. Towards a formal account of reasoning about evidence: argumentation schemes and generalisations. *Artificial Intelligence Law*, 11(2-3):125–165, 2003.
4. S. Heras, M. Rebollo, and V. Julián. A dialogue game protocol for recommendation in social networks. In Emilio Corchado, Ajith Abraham, and Witold Pedrycz, editors, *Hybrid Artificial Intelligence Systems*, volume 5271 of *Lecture Notes in Computer Science*, pages 515–522. Springer Berlin / Heidelberg, 2008. 10.1007/978-3-540-87656-4_64.
5. R. Medellin-Gasque, K. Atkinson, P. McBurney, and T. Bench-Capon. Critical Questions for Plan Proposals. Technical Report ULCS-11-003, Department of Computer Science, University of Liverpool, UK, March 2011.
6. W. van der Hoek, M. Roberts, and M. Wooldridge. Social laws in alternating time: Effectiveness, feasibility, and synthesis. *Synthese*, 156:1–19, 2007.
7. D. N. Walton. *Argumentation Schemes for Presumptive Reasoning*. Lawrence Erlbaum Associates, Mahwah, NJ, USA, 1996.
8. D. N. Walton. Justification of argumentation schemes. *Australasian Journal of Logic*, 3, 2005.