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Uncertainty in Argumentation Schemes: Negative Consequences and Basic Slippery Slope*

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Abstract. This study is an approach to encompass uncertainty in the well-known Argumentation Scheme from Negative Consequences and in the more recent "Basic Slippery Slope Argument" proposed by Douglas Walton. This work envisages two new kinds of uncertainty that should be taken into account, one related to time and one related to the material relation between premises and conclusion. Furthermore, it is argued that some modifications to the structure of these Argumentation Schemes or to their Critical Questions could facilitate the process of Knowledge Extraction and modeling from these two argumentative patterns. For example, the study suggests to change the premises of the Basic Slippery Slope related to the Control and the Loss of Control.

Keywords: Argumentation Schemes · Uncertainty · Argumentation.

1 Introduction

In this first introductory Section, after a brief introduction to the theory of Argumentation Schemes and their associated Critical Questions, some conceptual issues related to the Basic Slippery Slope and Negative Consequences arguments are reported, such as the problem of designing a unique and definitive scheme that can represent all the types of Slippery Slope arguments, and the relation between the two schemes. We then introduce the problem and the importance of modelling Natural Language uncertainty in Argumentation Schemes. Moreover, we target some theoretical limitations and non-uniformity and suggest some potential way to tackle them. In Section 2, we briefly introduce the Argumentation Scheme from Negative Consequences, its structure and Critical Questions. In Section 3, a modelling for encompassing the uncertainty of this scheme is proposed following the approach of Baroni et al. [1] and suggesting the presence of a kind of uncertainty defined as "Equal-Opposite Material Relation Uncertainty" and another one related to time. We also propose a different formalization of the

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Critical Questions that could enhance the uniformity of the scheme. In Section 4, we describe the Basic Slippery Slope Argument, its structure and its Critical Questions. Then, in the Section 5, we apply a formalization for encompassing the uncertainty of the scheme suggesting, also in this case, the presence of the two above-mentioned kinds of uncertainty. We also argue that a different formalization of the scheme could be advisable for both theoretical and practical reasons. The Section 6 concludes the paper.

1.1 Argumentation Schemes and Critical Questions

Before proceeding with our analysis, we briefly describe the concept of Argumentation Scheme and Critical Question following the theories of Walton et al. [10]. According to these theories, Argumentation Schemes describe stereotypical patterns of reasoning and can be seen as structures of inferential connections composed by premises supporting a conclusion.

Following this model, the two Argumentation Schemes analyzed in the present work, namely the Negative Consequence and the Basic Slippery Slope, will be represented as a set of *linked* premises [10] (for a the distinction between linked and convergent argument see Freeman [3]). The connection of these premises is thus described with a conjunction of the various semantic relations (see Figure 1). For a more precise description of the concept of material (or semantic) relation, please refer to Macagno et al. [6].

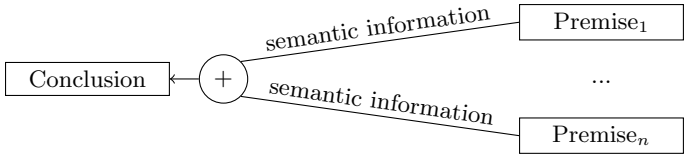


Fig. 1. Structure of an Argumentation Scheme

Although all the premises of an Argumentation Scheme provide semantic information (causal, definitional, and so on), some schemes contain *major* and *minor* premises, which seems to suggest the existence of a internal hierarchical order, with some premises having a stronger role in the inferential connection between premises and conclusion. In any case, all the Argumentation Schemes have a warranting function which enables the main inference to be drawn from the set of premises to the conclusion [6]. The warrant can be found in explicit or implicit premises [10] and it usually contains the main semantic relation. In this paper, we will follow the idea that the semantic connection between premises and conclusion, and the warranting function of the schemes, can be thought as an aggregate result of the actions of all the premises.

An Argumentation Scheme can be attacked in three ways [6], namely by arguing that:

– the premises are not true;
– the conclusion does not follow from the premises;
– the conclusion is false.

In other words, an attack can target premises, conclusions and the inferential connections. Moreover, the notion of attacking an Argumentation Scheme can be seen also from the point of view of its Critical Questions, since each Argumentation Scheme has a set of Critical Questions associated to it which aims at criticizing the scheme itself.

As explained by Walton et al. [10], the nature of Critical Questions may be somehow controversial, since they can sometimes target implicit premises, while other times they can be used as the starting point for an attack to a specific point of the scheme, requiring a further burden of proof. A clarification has been offered by Verheij [8], according to which critical questions have four roles:

– Questioning whether a premise holds;
– Pointing to exceptional situations in which the scheme defaults;
– Framing conditions for the correct use of a scheme;
– Indicating other arguments that might be used to attack the scheme.

1.2 The Basic Slippery Slope and the Negative Consequences arguments

A common misunderstanding is that of confusing the Slippery Slope Argument and the Argument from Negative Consequences. We follow the idea that the first one is a subspecies of the second one, having its own characteristics [9]. These two argumentative patterns are conceptually similar, since their aim is similar: showing that an action may (will) result in a negative outcome. However, as will be described in Section 4, the Basic Slippery Slope argument proposed by Walton has a peculiar set of premises and if one these premises is missing, then we are not dealing with a Basic Slippery Slope, but with a different instance or subspecies of a Negative Consequences argument (notice that sometimes premises can be implicit, and if they are implicit they should not be considered missing) [9].

Importantly, this study must mention the existence of an extended debate about the uniqueness of the Slippery Slope Argument. The fact that the very existence of the Slippery Slope as a unique and definitive Argumentation Scheme is a topic of debate shows the non-triviality of analyzing the characteristics of this argumentative pattern. In this regard, Walton [11] identified four types of Slippery Slope Argument: one depending on causality, one depending on precedents, one depending on vagueness, and one that is a mixture of the previous ones. However, this study failed in finding common elements among those four types of Slippery Slope Argument. In fact, the problem of the Slippery Slope arguments is that they have a structure that can be difficult to understand and that can make it difficult to define a single, basic scheme embracing all the possible types and sub-types of Slippery Slope. For this reason, some scholars have argued that there is not such a unique and definitive structure that can include

all these argumentative patterns [5]. A proposal of a "Basic Slippery Slope Argument" that could include all the typologies of Slippery Slope arguments has been proposed in Walton [9].

Following the formalization proposed in Baroni et al. [1], the present study proposes a modeling of the uncertainty of both the Basic Slippery Slope scheme and the Negative Consequences scheme.

1.3 The problem of uncertainty and why it is useful

Baroni et al. [1] suggested the presence of at least three kinds of uncertainty that can be found in natural language:

- Uncertainty related to the presence and credibility of a source (e.g. expression referring to sources such as "According to professor Mario Rossi, ...") [U_1];
- Uncertainty about the commitment (related to how the agents involved into an argument express their commitment, generally through the use of linguistic indicators) [U_2];
- Uncertainty within the use of language (mostly related to the vagueness or ambiguity of some linguistic modifiers) [U_3].

These three uncertainties are presented as a starting point for further extensions. The study suggests to investigate further to assess which kinds of uncertainty can be related to specific Argumentation Schemes.

Importantly, sometimes the source is not explicitly mentioned in the Argumentation Scheme, however we assume that any Argumentation Scheme has a source. If we consider Argumentation Schemes as patterns of reasoning that agents use to express and support their arguments, we assume that there is at least one basic source for any Argumentation Scheme: the arguer itself.

Baroni et al. [1] aimed at proposing a formalization for encompassing these kinds of natural language uncertainty directly within Argumentation Schemes. In this regard, they offer two examples: the Argumentation Scheme from Cause to Effect and the Argumentation Scheme from Position to Know, showing how to encompass Natural Language uncertainty into these two Argumentation Schemes. Finding a way to encompass uncertainty into Argumentation Schemes can be useful to evaluate argument strength and acceptability, because they can be "ranked" depending on their uncertainties, following the idea of the *preference-dependent* attack in Baroni et al. [2]. Interestingly, this way of encompassing uncertainty from Natural Language means that we can extract, from Natural Language, elements that can then be used within semi-formal and formal argumentation layers of evaluation. In other words, this methodology could be considered part of a broader approach in which linguistic indicators coming from Natural Language and Natural Arguments can provide elements of formal evaluation into Abstract Argumentation. This goes into the direction of building a common ground where Abstract Argumentation and Structured Argumentation can cooperate smoothly.

The ability to encompass uncertainty into Argumentation Schemes it is not only an elegant way to tighten the connection between Abstract Argumentation,

NLP and Structured Argumentation; it can be useful also for practical purposes and applications: for example, in the legal domain, where modelling Legal Knowledge from Argumentation Schemes can be used to assess weakness and strength of legal argumentation [7]. Furthermore, this approach can be useful for several other applications of Formal Argumentation [4].

1.4 Theoretical limitations and the problem of non-uniformity

In order to encompass uncertainty, this study suggests that some Argumentation Schemes should be reformulated. In some cases, in fact, the Argumentation Schemes formalized by Walton et al. [10] are not uniform. Particularly, these non-uniformities can be found in:

- How linguistic elements of uncertainty are used within the definition of Argumentation Schemes;
- How Critical Questions encompass uncertainty.

This is a long-term research goal which partially depends on the theoretical background. For example, it is not clear how the semantic links and the inferential warrants of Argumentation Schemes are inherited by their sub-types. Moreover, it is not always clear why some Critical Questions are targeting specific aspects of their scheme while the Critical Questions of other Argumentative Schemes seems focused on other aspects.

For example, similarly to Baroni et al. [1], we wonder why the Argumentation Scheme from Position to Know has two Critical Questions attacking the semantic information channeled by the two premises, while the Argumentation Scheme from Cause to Effect does not. As can be seen in Table 1, a further Critical Question could be added (as suggested by Baroni et al. [1]) targeting Premise 2 of the Cause to Effect argument. This could be something like "Does A actually occur?"

Table 1. An example of non-uniformity in the design of Critical Questions (CQs).

Argumentation Scheme "Position to Know"		
Component	**Sentence**	**Targeted by:**
Premise 1	α is in position to know in domain S containing preposition A.	**CQ1** Is α in position to know?
Premise 2	α asserts that A (in domain S) is true (false).	**CQ3** Did α assert that A is true?
Argumentation Scheme "Cause to Effect"		
Component	**Sentence**	**Targeted by:**
Premise 1	If A occurs, then B occurs.	**CQ1** How strong is the causal generalization?
Premise 2	In this case, A occurs.	**MISSING**

Moreover, why some Critical Questions explicitly target the main semantic relation of the inferential connection between premises and conclusion, while other schemes (even those sharing the same kind of main semantic relation) do not? For example, as will be described later, the Negative Consequence argument has a Critical Question targeting its causal relation, while the Slippery Slope argument (which is a sub-type of Negative Consequence argument) does not.

In this sense, it could be useful to harmonize the design of the Critical Questions or, at least, to clarify their scope (e.g., whether it is targeting an inferential connection, an explicit premise, an implicit premise, the semantic information of one premise, an aggregated semantic information, the whole inferential structure, and so on).

2 The Argumentation Scheme from Negative Consequences

The Argumentation Scheme from Negative Consequences is an argumentative pattern which points out the negative consequences of an action. For example, it is used by arguers who try to discourage people from bringing about specific actions, by claiming that those actions would have "bad consequences". Although there is also a positive counterpart (the Positive Consequences scheme), this work will focus only on the negative one, for reasons of space.

2.1 Structure of the Argumentation Scheme from Negative Consequences

The structure of this Argumentation Scheme is relatively straightforward:

Premise 1: If the agent α brings about (doesn't bring about) A, then B will occur.
Premise 2: B is a bad outcome (from the point of view of α's goals).
Conclusion: α should not bring about A.

As can be seen from the previous description, the scheme has a combination of two semantic connections: the causal relation of Premise 1 (in the form *if A then B*) and a definitional relation coming from Premise 2 (in the form *B is good/bad*) which aims at classifying the result of the previous causal relation.

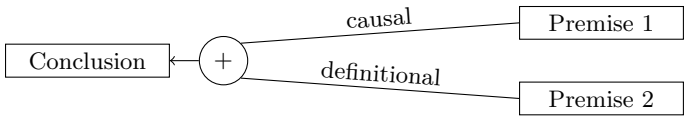


Fig. 2. Structure of the Negative Consequences Argumentation Scheme

Therefore, the inferential connection between premises and conclusion can be described as the aggregation of these two semantic connections (See Figure 2). As already stated before, an Argumentation Scheme can be attacked in three ways: rebutting the conclusion of the Scheme, undermining a premise of the Scheme, undercutting the inferences between premises and conclusions. Regarding the ways of attacking an Argumentation Scheme from Negative Consequences, Walton at al. [10] propose three main Critical Questions:

Critical Question 1
How strong is the likelihood that the cited consequences will (may, must) occur?
Critical Question 2
What evidence supports the claim that the cited consequences will (may, must) occur, and is it sufficient to support the strength of the claim adequately?
Critical Question 3
Are there other opposite consequences (bad as opposed to good, for example) that should be taken into account?

3 Encompassing the uncertainty of the Argumentation Scheme from Negative Consequences

The uncertainty of the Argumentation Scheme from Negative Consequence could be encompassed in the following way:

Premise 1:
{If the agent α brings about (doesn't bring about) A, then B will occur}[U_1,U_t].
Explanation:
The assumption that if α brings (doesn't bring) about A, then B will occur may have a source. For this reason, there is an uncertainty U_1. Furthermore, we introduce a specific type of uncertainty that we call U_t, related to the use of the modal "will". A justification for adding this kind of uncertainty is that there are specific linguistic elements in Natural Language that are connected to the idea of time and can discriminate among different kinds of Negative Consequence arguments: for example, words such as "future" or verbal forms indicating an hypothetical results (e.g. "would") can be crucial to differentiate a Slippery Slope argument from a bare Negative Consequence argument [9].

Premise 2:
{B is a bad outcome (from the point of view of α's goals)}[U_1].
Explanation:
The assumption that B is a bad outcome (from the point of view of α's goals) may have a source. For this reason, there is an uncertainty U_1.

Conclusion: {α should not bring about A}.[DU]
Explanation:
This is the Derived Uncertainty (DU).

3.1 Modelling the Critical Questions of the Argumentation Scheme From Negative Consequences

The Critical Questions of the scheme could be modelled as follows:

Critical Question 1
{How strong is the likelihood that the cited consequences will (may, must) occur?}[U_3,U_t]
Explanation:
The word "strong" implies a linguistic uncertainty (U_3). Also in this case, we suggest the presence of an uncertainty U_t, related to the use of the modals "will", "may" or "must".

Critical Question 2
{What evidence supports the claim that the cited consequences will (may, must) occur?}[U_1,U_t] {and is it sufficient to support the strength of the claim adequately?}[U_3]
Explanation:
This Critical Question explicitly questions the source (evidences) that can support the argument. This can be considered an uncertainty about the source U_1, while we consider the verbal uncertainty related to the use of the modals "will", "may" or "must" as U_t. The second part refers again to the "strength" of the claim, so it is U_3.

Critical Question 3
{Are there other opposite consequences (bad as opposed to good, for example) that should be taken into account?}[U_{eomr}]
Explanation:
Here we formulate the presence of an uncertainty that we call "Equal-Opposite Material Relation". Baroni et al. [1] detected an analogous uncertainty within the Argumentation Scheme from Cause to Effect. In that case, Baroni et al. wondered what kind of uncertainty it was. We are attempting to give an answer to this question here. We argue that: when the main semantic (or "material") relation of an Argumentation Scheme (e.g. a causal relation [3]) produces effects that have an equal nature (i.e. they derive from the same material relation, e.g. a causal relation) but go towards an opposite direction w.r.t. the the inferential connection of the Argumentation Scheme (i.e. these effects undercut the inference between premises and conclusion), we have an "Equal-Opposite Material Relation" (EOMR). Whenever an Argumentation Scheme is questioned in this way, there is an "Equal-Opposite Material Relation" (EOMR).

While we argue that the existence of a EOMR can be plausibly considered true, we underline that its theoretical usefulness in the analysis of Argumentation Schemes is not in the scope of this work and should be further investigated.

Following the ideas of Verheij [8], it seems that the role of the first Critical Question is to question whether Premise 1 holds. More precisely, it questions how

strong is the probability that the causal information channeled by Premise 1 (i.e. the causal connection between the action A and the result B) occurs. While the role of the first Critical Question is clear, the second Critical Question seems somehow redundant and is split in two parts. In fact, while the first Critical Question is about *how strong is the likelihood* of the causal relation between A and B, the second one is about *what evidence supports* the same causal relation. Although, this appears as a partially redundant attack on the first premise, the role of the second Critical Question seems slightly different if we consider that it requires a burden of proof. This is made explicit in the second part of the question: "is [the evidence] sufficient to support the strength of the claim that *if A then B*?". Finally, the role of the third Critical Question, is to point to exceptional situations in which the scheme defaults. This means that this Critical Question is somehow related to the causal semantic information channelled by Premise 1.

Another aspect that should be mentioned is related to the definition of additional Critical Questions designed to reject each premise of the Scheme. This is a suggestion proposed by Baroni et al. [1], which aims at both uniforming the formulation of the Critical Questions and facilitating the modelling of their uncertainty. The Critical Questions 1 and 2 partially do it with regard to Premise 1, but they don't question the basic assumption that the agent is really bringing about (or not bringing about) the action A. In other words, the basic semantic information is not challenged. Furthermore, Premise 2 is not questioned at all. This means that we could add two new Critical Questions directly targeting the semantic information provided by the two premises:

Critical Question 4
{Is the agent α bringing about A?}$[U_1]$
Explanation:
This is undermining Premise 1; namely, it is as an uncertainty about the source's assumption that the agent α is bringing about A (U_1).

Critical Question 5
{Is B really a bad outcome from the point of view of α's goals?}$[U_1]$
Explanation:
This is undermining Premise 2; namely, it is an uncertainty about the source's assumption that B is a bad outcome from the point of view of α's goals (U_1).

4 The Basic Slippery Slope Argument

The Basic Slippery Slope Argument can be considered a general Argumentation Scheme designed to include all the types of Slippery Slope arguments that can be found in Natural Argumentation. As suggested by Walton [9], it can be considered a particular sub-type of the Argumentation Scheme from Negative Consequence, but with a more complex structure that span over a temporal sequence of events. This temporal sequence can be explicitly mentioned or it can

be "compressed" by using special words that implicitly involve time spans (e.g. the word "future"). We will come back to this temporal aspect in the Section 4.1, which describe a proposal to encompass natural language uncertainties within the Basic Slippery Slope Argumentation Scheme.

Before describing the scheme, it is important to underline the difference with the Argumentation Scheme from Negative Consequences and the Slippery Slope arguments. The main conceptual difference between these two Schemes is that the Slippery Slope arguments have a sequence of actions that go in and out an undetermined "gray zone". In other words, the negative outcome must pass through a sequence of steps which has an undetermined nature.

4.1 The structure of Basic Slippery Slope Argument

The general structure of the Basic Slippery Slope Argument described by Walton [9] is the following:

Initial Premise: An agent α is considering carrying out an action A_0.
Sequential Premise: Carrying out A_0 would lead to A_1, which would in turn lead to carrying out A_2, and so forth, through a sequence A_2, ... , A_x, ... A_y, ..., A_n.
Indeterminacy Premise: There is a sequence A_0, A_1, A_2, ... , A_x, ... A_y, ..., A_n that contains a sub-sequence A_x, ... A_y called "the gray zone" where x and y are indeterminate points.
Control Premise: α has control over whether to stop carrying out the actions in the sequence until α reaches some indeterminate point in the gray zone A_x, ... A_y.
Loss of Control Premise: Once α reaches the indeterminate point in the gray zone A_x, ... A_y, α will lose control and will be compelled to keep carrying out actions until he/she reaches A_n.
Catastrophic Outcome Premise: A_n is a catastrophic outcome that should be avoided if possible.
Conclusion: A_0 should not be brought about.

Being a sub-type of the Negative Consequences argument, it can be noticed that the Sequential Premise is an evolution of Premise 1 of the Negative Consequences argument, while the Catastrophic Outcome Premise is an evolution of Premise 2 of the Negative Consequences argument. At the same time, it seems that the main semantic relation of the super-type, which is a causal relation (channeled by Premise 1) is preserved not only in the Sequential Premise, but also in the Loss of Control Premise (See Figure 3). All the other premises, instead, seem to convey a definitional/classificatory value. In any case, also in the case of the Basic Slippery Slope, the final inferential strength connecting premises and conclusion can be described as the aggregation of the semantic information conveyed by the six linked premises.

Walton also suggested the possible presence of some contextual factors, called "drivers". A driver is described as a "catalyst that helps to propel the argument

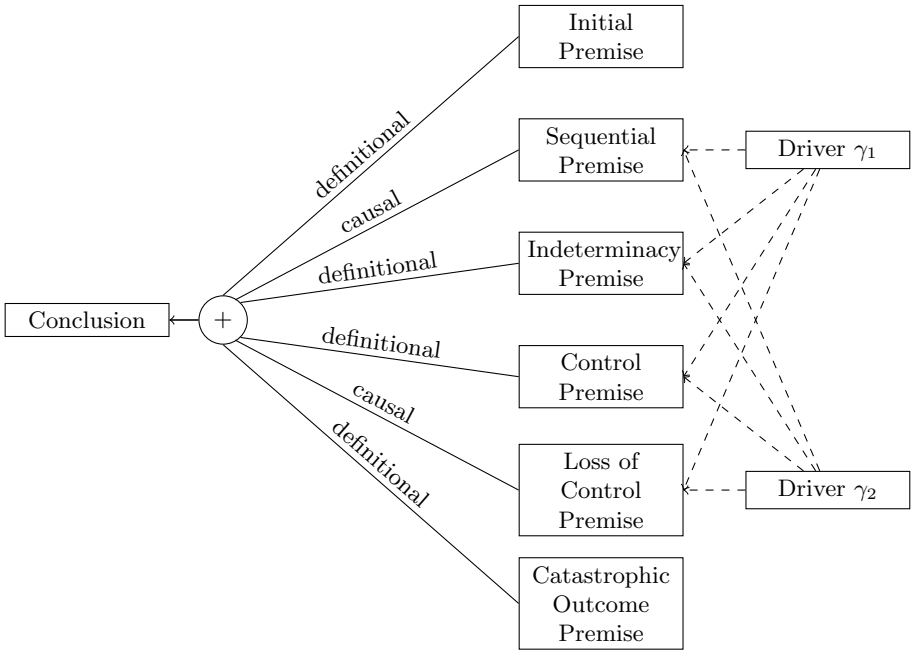


Fig. 3. Structure of the Basic Slippery Slope, dashed connections are optional links.

along the sequence in the argument, making it progressively harder for the agent to resist continuing" [9].

Walton chose not to clarify the nature of drivers in depth, maybe because a driver is an element that can be closely related to the peculiarities of the context where the argument takes place. Since the formulation of the Basic Slippery Slope Argument aims at designing a general model suitable for all the types of Slippery Slope argument, being too specific about the nature of drivers is probably not advisable. However, we may consider them as some sort of factors that can influence the main agent α either directly (influencing the actions of the agent α) or indirectly (perhaps, operating on the contextual environment).

Plausibly enough, we could even consider them as some sort of pseudo-agents, in some more specific instances of the Basic Slippery Slope argument. In this sense, the choice of the word "compelled" in the *Loss of Control Premise* is flexible enough to open the door for the possibility that the control (which is progressively lost by the agent α) flows towards some other drivers. In some more specific instances of Slippery Slope argument, a driver acquiring control over the sequence of actions could be, in our view, equivalent to consider that driver not anymore as a mere contextual factor, but as a proper agent involved into the sequence of the events of the slippery slope. For this reason, we may consider drivers as pseudo-agent or potential agents.

In any case, for the more general Basic Slippery Slope Argument, the drivers should be considered just as contextual factors that contribute in making the sequence flow towards the catastrophic result A_n. In such general instance of Slippery Slope argument, Walton suggest to model them as additional (optional) premises that can support some of the main premises of the scheme [9]. Intuitively, drivers are more likely to be connected with premises related to the sequence, and premises related to the control (see Figure 3).

Following the Argumentation Scheme above, we can summarize the components of the Basic Slippery Slope Argument according to the Table 2.

Table 2. Components of the Basic Slippery Slope Argument.

Component	**Comment**
Agent α	Targeted agent
The critic β	Source agent
The drivers $\gamma_x \subseteq \Gamma$	Optional
A starting action A_0	
A catastrophic result A_n	
A sequence A_0, A_1, A_2, ... , A_x, ... A_y, ... , A_n (containing an indeterminate sub-sequence A_x, ... A_y)	The indeterminate sub-sequence is the "gray zone"

According to Walton, the main way of attacking a Slippery Slope is by asking if there is a bright line of separation in the so-called "gray zone". In other words, it is an attack to the Indeterminacy Premise and, indirectly, also to the premises related to the control and its loss. For this reason, the Basic Slippery Slope Argument has the following main Critical Question:

Main Critical Question
Is there a bright line in the gray zone?

In fact, if a bright line can be found into the allegedly "indeterminate gray zone", it means that the Slippery Slope does not exist at all.

5 Encompassing the Uncertainty of the Basic Slippery Slope Argument

Considering the Argumentation Scheme above and the formalization of Baroni et al. [1], we attempt to model the uncertainty behind each premise of the Basic Slippery Slope Argument. Also, we propose to reformulate some of the premises to eliminate some non-uniformities and because it seemed more appropriate for the modelling of uncertainty.

Initial Premise: {An agent α is considering carrying out an action A_0}$[U_1, U_2]$.

Explanation:
The observation "α is considering carrying out an action" has a source (the critic), for this reason there is an uncertainty connected to the source (U_1), which is to say, to the critic β.
The word "considering" could be seen as an uncertainty about the commitment (U_2) of the agent α.

Sequential Premise: {Carrying out A_0 would lead to A_1, which would in turn lead to carrying out A_2, and so forth, through a sequence A_2, ..., A_x, ... A_y, ..., A_n}[U_1,U_t]
Explanation:
The assumption "A_0 would lead to A_1 (...)" has a source, the critic β. For this reason, there is a source uncertainty U_1.
Similarly to the Negative Consequence argument, we introduce a specific type of uncertainty that we call U_t, related to the temporality of the sequence. A justification for adding this kind of uncertainty is that there are linguistic elements in Natural Language that are connected to the idea of time and can discriminate among different kinds of Slippery Slope Argument: words such as "future" or verbal forms indicating an hypothetical results (e.g. "would") can be crucial to detect, for example, the so-called "Compressed" Slippery Slope Argument [9]. Since temporality is an element that discriminates not just between Slippery Slope and non-Slippery Slope Arguments but also between different kinds of Slippery Slope arguments (e.g. the "Compressed" one), we argue that it is also important to model temporal expressions as a type uncertainty.

Indeterminacy Premise: {There is a sequence A_0, A_1, A_2, ... , A_x, ... A_y, ..., A_n that contains a sub-sequence A_x, ... A_y called "the gray zone" where x and y are indeterminate points}[U_1, U_3].
Explanation:
The assumption that there is a "gray zone" where x and y are not recognizable has a source (the critic β). So, also in this case there is an instance of uncertainty related to the source (U_1).
The expression "indeterminate" can be considered as a linguistic uncertainty (U_3).

Control Premise:* {α has control over whether to stop carrying out the actions in the sequence until α reaches some indeterminate point in the gray zone A_x, ... A_y}[U_1, U_3].
Explanation:
The assumption that α will has control only until a certain point has a source (the critic β) and for this reason, there is an uncertainty U_1.
The expression "indeterminate" can be considered as a linguistic uncertainty (U_3).

Loss of Control Premise:* {Once α reaches the indeterminate point in the gray zone A_x, ... A_y, α will lose control}[U_1,U_3] {and will be compelled to keep carrying out actions until he/she reaches A_n}[U_1,U_3].

Explanation:
The assumption that α will lose control has a source (the critic β) and for this reason, there is an uncertainty U_1.
Moreover, the expression "indeterminate" can be considered as a linguistic uncertainty (U_3).
Interestingly, this premise can be considered as a group of two premises: the first one seems concerned with the concept that α will lose the control and can be considered partially overlapped with the previous premise, while the second one seems concerned with the direction of this loss (i.e. the direction of the loss is the catastrophic result A_n) and also with the existence of some not explicit compelling factors.
Always in the second part, we should consider the word "compelled" as linguistic uncertainty (U_3). A justification for this, is the fact that behind this word there is a potential crucial element in the definition of the drivers: why is the agent α compelled? What factors contribute to this condition? This definition, in fact, could be determinant in the definition of some more specific instance of Slippery Slope argument. So, we argue that also the general Basic Slippery Slope argument should encompass this element.

Catastrophic Outcome Premise: $\{A_n$ is a catastrophic outcome that should be avoided if possible$\}[U_1]$.
Explanation:
The assumption that A_n is catastrophic has a source (the critic β) and for this reason, there is an uncertainty U_1.

Conclusion: $\{A_0$ should not be brought about$\}$[DU].
Explanation:
This is the Derived Uncertainty (DU).

As already suggested above, the Sequential Premise might be considered a derivation from the super-type's Premise 1, while the Catastrophic Outcome can be considered a derivation from the super-type's Premise 2. Interestingly, the premises of the sub-type (i.e., the premises of the Basic Slippery Slope argument) seems to reflect the same kinds of uncertainty of the super-type's premises (i.e., the premises of the Negative Consequence argument). In fact, U_1 and U_t seems to be inherited by the Sequential Premise from Premise 1, while U_1 is inherited by the Catastrophic Premise from Premise 2.

A similar phenomenon can be observed with the Critical Questions conveying the main semantic relation (which is a causal relation in the case of the two schemes analyzed in this work). In fact, the uncertainties U_1 and U_t seem to be inherited by the Critical Question 3 of the Basic Slippery Slope (i.e. the Critical Question related to the main causal relation) from the first two Critical Questions of the Negative Consequence Argument (i.e. the two Critical Questions focused on Premise 1, which we considered as partially redundant).

5.1 The problem of the non-uniformity

It is important to underline that there is a potential non-uniformity between the Control Premise and the Loss of Control Premise (for this reason, they have been marked with an asterisk).[3] It seems that the former wants to describe the fact of having control, while the latter is focused on the loss of control. However, the first one already says that the control exists *just until a specific point*, which implicitly means that the control is lost after reaching that point. In other words, the Control Premise is already about *losing* control (not just about *having* control).

On the other hand, while the Loss of Control Premise (which should be focused on the loss of the control) starts by mentioning the loss explicitly, it seems also focused on the description of another aspect: in fact, the second part of this premise (starting with "and will be compelled ...") seems more focused on the direction of the loss, rather than on the loss itself.

The partial overlapping between the Control Premise and the Loss of Control Premise (regarding the loss of control) along with the fact that the Loss Premise also mention a different concept (the direction of the Loss towards the catastrophic event A_n), could be a non-uniformity issue that can potentially affect the attempt to model knowledge starting from the this Argumentation Scheme.

For this reason, we argue that it is advisable to solve this non-uniformity. In this direction, we suggest a possible solution to reformulate the two premise avoid repetitions and ambiguities of the premises' scope. The solution could be that of having a premise for the loss of the control ("Loss of Control Premise") and another for the direction of the loss ("Slope Premise" or "Direction of the Loss Premise"). There is probably no need to create a premise which is just dedicated to the fact that the agent α have control until the point A_x.

Moreover, a "Direction of the Loss Premise" formulated in this way would give more importance and conceptual room to the potentialities behind the word "compelled" which is the only linguistic element referring to the potential existence of drivers.

Briefly, our suggestion can be described as follows:

> **Loss of Control Premise:** {α has control over whether to stop carrying out the actions in the sequence until α reaches some indeterminate point in the gray zone A_x, where the control is lost ... A_y}[U_1, U_3].
> **Explanation:**
> The assumption that α will have control only until a certain point has a source (the critic β) and for this reason, there is an uncertainty U_1.
> The expression "indeterminate" can be considered as a linguistic uncertainty (U_3).
>
> **Direction of the Loss Premise:** {α is compelled to keep carrying out actions until he/she reaches A_n}[U_1,U_3].

[3] Also Baroni et al. [1] noticed a similar issue and suggested a different formulation for the Argumentation Schemes analyzed in their work and for the related Critical Questions.

Explanation:
The assumption that α is compelled to keep carrying out actions has a source (the critic β) and for this reason, there is an uncertainty U_1.
We should consider the word "compelled" as linguistic uncertainty (U_3), as already specified before.

As partially argued before, the fact of mentioning that the agent α has the control, before losing it, seems not necessary both from a logical point of view (losing it already imply having had it) and from the point of view of the practical implementation of the scheme in a real example: to instantiate a Basic Slippery Slope scheme there is no need to mention the fact of *having control* in a dedicated premise; on the contrary, to reach the theoretical purposes of the scheme, it should be sufficient to mention that the agent α lost it. This changes are not a mere linguistic change. We think that they can be useful for a better modelling of the knowledge and uncertainty within the Basic Slippery Slope Argumentation Scheme.

5.2 Modelling the Critical Questions of the Basic Slippery Slope Argumentation Scheme

As described by Baroni et al. [1], the Critical Questions can be used in the formulation of the uncertainty in the premises. For this reason, we can model the main Critical Questions of the Basic Slippery Slope Argument as follow:

Critical Question 1
{Is there a bright line in the gray zone?}[U_1]
Explanation:
This Critical Question can directly undermine the source's assumption that there is a Slippery Slope. For this reason there is an uncertainty U_1.

In the above-mentioned Critical Question, the "bright line" should be considered as a distinctive point in the sequence from A_0 to A_n where *agent α understands that it is time to stop*. It should be mentioned, however, that answering to this question is not simple, because the answer can depend on at least two points of view: the ability of α and the condition of the context (drivers included). In this sense, mentioning a "bright line" in the Critical Question is a good metaphorical resort, which however risks to hide the direction where the answers should be searched for. In fact, if the point of view is only on the "ability of α" to stop before the slope, the origin of the uncertainty would be intrinsically related with the agent. However, watching at the context (e.g. at the drivers involved into the sequence from A_0 to A_n), we may find that the origin of the uncertainty can be related to how drivers influence the slope. This distinction is not merely aesthetical. For example, if we wanted to investigate the presence of uncertainty related to the "bright line" in the gray zone directly within Natural Language sentences, we should consider not only those sentences in which the ability of the agent is mentioned, but also the sentences referred to contextual

elements or drivers. This can be even more important in more specific instances of Slippery Slope arguments, where drivers could play a more defined role.

Also in this case, for uniformity, some Critical Questions may be explicitly formulated to attack the existence of each premise. This would produce other six Critical Questions:

Critical Question 2
{Is α considering carrying out A_0?}[U_1, U_2]
Explanation:
Questioning that A_n is considering carrying out A_0 would undermine the source's assumption that we are in a context of Slippery Slope (U_1).
While the verb "considering" can be seen as a U_2 (uncertainty about the commitment of the agent α).

Critical Question 3
{Is A_0 leading towards A_n?}[U_1, U_t]
Explanation:
Questioning that A_0 leading towards A_n would undermine the source assumption that we are in a context of Slippery Slope (U_1).
Moreover, since the sequence that would "lead" from A_0 to A_n is located into an indeterminate span of time, there could be an uncertainty connected to time also in this case (U_t).

Critical Question 4
{Does the sequence $A_0...A_n$ contain the indeterminate sub-sequence?}[U_1, U_3]
Explanation:
Questioning that the sequence from A_0 to A_n contain the indeterminate sub-sequence would undermine the source assumption that we are in a context of Slippery Slope (U_1).

Critical Question 5
{What elements indicate that α may lose the control?} [U_1, U_3, U_t] {Are these elements strong enough to support the claim?}[U_3]
Explanation:
This Critical Question targets the potential presence of elements indicating that α could lose the control, undermining the existence of the Argumentation Scheme itself (U_1). While the word "strong" can be considered a linguistic uncertainty (U_3) and the word "may" can be referred to an uncertainty related to time (U_t).

Critical Question 6
{What elements indicate that α may be compelled to go towards A_n?}[U_1, U_3,U_t] {Are these elements strong enough to support the claim?}[U_3]
Explanation:
This Critical Question targets the potential presence of elements indicating that α could be compelled to go towards A_n, undermining the existence of the Argumentation Scheme itself (U_1). While the word "strong"

can be considered a linguistic uncertainty (U_3) and the word "may" can be referred to an uncertainty related to time (U_t).

Critical Question 7
{What elements indicate that A_n may be a catastrophe?} [U_1,U_3,U_t] {Are these elements strong enough to support the claim?}[U_3]
Explanation:
This Critical Question targets the potential presence of elements indicating that A_n is a catastrophe, undermining the existence of the Argumentation Scheme itself (U_1). While the word "strong" can be considered a linguistic uncertainty (U_3) and the word "may" can be referred to an uncertainty related to time (U_t).

It should be noted that the Critical Questions 5, 6 and 7 are the most exposed to the problem of the time, basic characteristic element of the Slippery Slope Arguments. In fact, these questions could be not answerable, since their answers could be just arbitrary predictions on future events. For these reasons, they are formulated in terms of "What elements indicate that X may be true". Finally, it could be useful to underline that attacking the existence itself of the Argumentation Scheme is considered as an attack to the source of the argument (U_1).

At this point, it seems natural to envisage the existence of a Critical Question indicating the existence of a U_{eomr}, similarly to the Critial Question 3 of the super-type. In this sense, there would be another Critical Question questioning the existence of other factors (e.g. other consequences or even drivers) which despite being related to the same causal relation could go towards the opposite direction w.r.t the inference from premises to the conclusion.

Critical Question 8
{Are there other consequences or factors to be considered, which may be triggered through the sequential process from A_0 onward?}[U_{eomr}, U_t]
Explanation:
In this case, the main semantic relation (i.e. a causal relation) may produce effects or factors having an equal nature (i.e. they derive from the same causal material relation) but an opposite direction w.r.t. the the inferential connection of the Argumentation Scheme, undercutting the inference between premises and conclusion (U_{eomr}). However, since these effects are in the future, there is an uncertainty related to time (U_t), channelled by the word "may".

6 Conclusions

In this paper, we encompassed the uncertainty of both the famous Argumentation Scheme from Negative Consequence and the novel Basic Slippery Slope Argument following the methodology proposed in Baroni et al. [1].

Noticeably, we described the presence of two potentially new kinds of uncertainty: one related to time (defined as U_t), and one related to the main semantic relation in the inferential connection between premises and conclusion, which we defined as "Equal-Opposite Material Relation" uncertainty (U_{eomr}).

Regarding the Argumentation Scheme from Negative Consequences, we suggested a partial reformulation of current model adding two more Critical Questions which target the semantic information channeled by the two premises of the scheme.

Regarding the Basic Slippery Slope Argument, we also suggested a reformulation of two premises in order to solve some non-uniformity that could affect the attempts to model knowledge from this Argumentation Scheme. Namely, we intervened in the two premises related to the loss of control to avoid redundancies. Moreover, similarly to the Negative Consequence argument, we suggested to add a new Critical Question for each premise, targeting the relative semantic information. Finally, we added another Critical Question which is related to the U_{eomr} uncertainty and is meant to target the potential existence of factors which may undercut the inferential connection between premises and conclusion despite being originated by the same main semantic relation of the scheme's inferential connection (i.e. the same causal relation).

In future research we will follow the suggestion of Baroni et al. [1] to use the modelled Argumentation Schemes with uncertainty together with Natural Language uncertainties in order to reach the "semi-formal argumentation with uncertainty". In this sense, some classifiers could be trained using NLP techniques in order to automatically evaluate the presence of uncertainty directly within Natural Language sentences.

This is a long-term research path which is strictly dependent on the formalization choices and on the theoretical background. In this regard, further studies on the philosophical side of the the Argumentation Scheme theory can be crucial for a successful implementation of the present approach. For example, a more in-depth clarification about how the semantic links and the inferential warrants of an Argumentation Scheme are inherited by its sub-types could be useful for modeling uncertainty in a more appropriate way. Moreover, a further standardisation of the types (and sub-types) of Argumentation Schemes and Critical Questions is strongly advisable. We think that there is the need to reinforce the theoretical background designing Critical Questions in a more uniform way, making clear, and possibly unambiguous, what is the target of a Critical Question; for example, whether it is targeting an inferential connection, a (possibly implicit) premise, a semantic information, the whole inferential structure, and so on.

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