A Bayesian approach to Argumentation within Language

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Abstract This paper addresses the question of the linguistic correlates of argumentation. Studies on argumentation have discussed normative aspects arguments (i.e. what should convince vs. what does convince), structural aspects of arguments (e.g. through the study of arguments schemes) and how the content of the arguments are taken into account in their evaluation (by treating argumentation as one form of reasoning). Little attention has however been given to the linguistic form of arguments, e.g. how the choice of particular linguistic items or constructions affects the evaluation of an argument. This paper examines different claims about the ties between language and argumentation and interprets them in a Bayesian perspective on argumentation. It is shown how most of these insights directly follow from a probabilistic interpretation of argumentation coupled with generally assumed principles about the semantics of natural language. This is illustrated by showing how to account for the argumentative effects of a number of discourse markers.

Keywords: Argumentation, Bayesian approach, Probability, Discourse connectives

The formal study of argumentation goes back at least to the works of Plato and Aristotle. One of their goals was to find a way to set apart acceptable arguments from those that looked convincing but should not be: fallacies and sophisms. Aristotle's *Sophistic Refutations* is (among other things) an attempt to set up a way to determine whether an argument is *valid*, and, in case it is not, explain why the argument should not be accepted not matter how convincing it may sound. While critical of Sophists, Plato and Aristotle were nevertheless fascinated by them and recognized the powerful rhetoric power behind sophistry and the general cogency of sophisms. Aristotle even went so far as to include an inventory of sophist techniques for the aspiring rhetorician (Hamblin 1970).

In the psychology of reasoning the efficiency of logical fallacies has been studied in detail e.g. by Hahn & Oaksford (2006, 2007), Hahn et al. (2009), Zenker (2013). A key concept is that what makes a *good*, i.e. persuasive or cogent, argument is not its structure, i.e. whether the argument scheme is valid or not, but whether it is *effective*, where effectiveness is measured by how much the argument affects the degrees of belief of the agents involved.

These studies focus on the study of argumentative situations characterized by the *contents* of the arguments in play, but they do not take into account the *linguistic form* of the arguments. Language is however strongly tied to argumentation. The choice of lexical items and linguistic construction affects how an argument is perceived, and part of the toolbox of a good rhetorician is knowing how to couch one's point in the most effective form. Such aspects are not however typical concerns in formal approaches to the semantics and pragmatics of natural language.

One exception is the, mostly French, tradition of studying the semantics and pragmatics of natural language from an argumentative angle (Anscombre & Ducrot 1983). This theory of "*Argumentation dans la langue*" (Argumentation within Language, *AwL*) postulates that the meaning of an utterance cannot be reduced to propositional, truth conditional elements, but conveys an argumentative component that is central to its interpretation. Although the theory has received some exposure in the semantics and pragmatics literature in English (Horn 1989, Nyan 1998, Iten 2000, Plantin 2002, Winterstein 2012b, van Eemeren et al. 2014), there has been few attempts to try and articulate its observations and claims with other approaches in the field.

The aim of this paper is to address this situation. First, it proposes to shed more light on the relation between language and argumentation. This is done by introducing the theory of argumentation within language, highlight its key observations and hypotheses, and relate them to other non-linguistic approaches to argumentation. It will be argued that a complete model of argumentative reasoning has to take the linguistic form of the arguments into account. The model I defend is a probabilistic one based on a Bayesian interpretation of probability. I intend to show that, unlike what is claimed by Anscombre and Ducrot, it is possible to reconcile the key observations of *AwL* with current approaches in formal semantics and pragmatics based on the widely held assumption that natural language expressions convey informational content, i.e. content related to the state of the world. I claim that information layering plays an important role in the evaluation of the argumentative profile of an utterance and illustrate this with the study of a series of linguistic markers which all have argumentative correlates and show how these argumentative properties can be accounted for.

Section 1 gives an overview of the issues and core concepts of argumentation studies. Section 2 is an introduction to *AwL*, and section 3 discusses the insights of *AwL* under a probabilistic interpretation of the notion of argumentation. Section 4 discusses different natural language expressions which have been identified as argumentative operators and shows how to interpret their contributions in probabilistic terms. Section 5 concludes the paper.

1 Argumentation studies

This section gives a general overview of argumentation studies. It first defines what is behind the concept of *argument* and then focuses on normative aspects of argumentation, i.e. what constitutes an acceptable, or good, argument.

1.1 What is an argument?

Unlike in French (and other languages) the English terms derived from the verb *to argue* can refer to two different activities (Plantin 2002, van Eemeren et al. 2014). The first one is necessarily dialogic and deals with dispute. It involves some form of hostility, a certain degree of expressivity and emotion, and an absence of cooperation or even willingness to listen to the other party. The second one relates to situations in which a speaker is presenting statements that support a conclusion. While this is usually done with an audience in mind, the situation is not necessarily dialogic. Those communicative situations are also not necessarily hostile: the addressees might be neutral or even already partially committed to the truth of the conclusion targeted by the speaker and are supposed to rationally (in a broad sense) respond to the speaker's discourse. This work focuses on the latter understanding of the term which is the one matching the meaning of the term *argument* in French and other languages (although some authors consider that argumentation necessarily involves a difference in opinion, e.g. van Eemeren et al. 2014).

One can find various definitions of argumentation, out of a great variety of disciplines: psychology (van Eemeren et al. 1996, Mercier & Sperber 2011, Zenker 2013), computer science and artificial intelligence (Besnard & Hunter 2008, Prakken 2010), linguistics (Anscombre & Ducrot 1983, Merin 1999), and "argumentation studies" proper (van Eemeren et al. 2014). These fields all approach argumentation with different agendas in mind, but there is some consistency in the features they attribute to the notion of argumentation. The crucial ones are the following:

- Argumentation is an act aimed at *persuasion*. It is performed by an agent and targets an audience. The goal of the agent performing the argumentation is to convince the audience of something by the means of their argument. The goal targeted by the agent can be the truth of a proposition, the interest of pursuing a particular course of action or anything else related to the *beliefs* of the audience.
- An argument has the following features:
  - A conclusion, or goal, which is what the target audience should be convinced of after receiving the argument. The fact that the audience

has to be convinced somehow presupposes that there is a difference of opinion between speaker and addressee about the conclusion (i.e. there is no need to be "preaching to the choir"). That conclusion is often a proposition which the agent wants the audience to believe, but it can be of other types, e.g. a question as in erotetic arguments (Wiśniewski 1991), or courses of action which can be analyzed in a way parallel to imperatives. Here, I will be mostly concerned with propositional goals.

  - A set of premises which serve as the basis of the argument, i.e. which are the elements presented by the speaker as supporting the conclusion they target and for which the speaker is accountable.[1]

- There are good and bad arguments: there is an intuitive form of strength inherent in an argument that measures its potential to convince. Arguments can be compared and may supersede each other.

- There exists a mechanism explaining how to go from the premises to the conclusion. I will refer to this as *argumentative reasoning*. The nature and inner workings of this reasoning works is a point which distinguishes approaches within argumentative studies.XX

Depending on the approach, an argument might be an entirely verbal construction or involve extra linguistic elements. For example, advertisement can be seen as a (sometimes very effective) form of argument that rests on non-verbal communication. Here, the focus will be on verbal communication, but this should not be taken as an indication that argumentation is necessarily linguistic, even though it will be argued that language entertains strong ties with argumentation and that language often, if not always, has an argumentative dimension.

It should be kept in mind that, while they are constitutive of argumentation, the elements introduced above are sometimes missing in some instances of argumentation, i.e. arguments can be incomplete. First, they might often be lacking some of the premises that are necessary in order to get to the conclusion. Such arguments are called enthymemes.[2] For example, in (1) the argument lacks a premise, namely that Socrates is a man, to warrant the conclusion that Socrates is mortal.

(1) a. All men are mortal.

1 The term *argument* is often used metonymically to refer only to the set of premises used in the argument, or more specifically to the sole premise used by a speaker to argue in favor of the conclusion. I will use the term in both ways, making it clear which meaning I have in mind when the context does not.

2 Burnyeat (1994) argue that this is a misunderstanding of what Aristotle meant by enthymeme. Whatever the intentions of Aristotle actually were, I stick to the usual interpretation of the term here.

b. Therefore Socrates is mortal.

In other cases, the conclusion is not explicit, and it is up to the audience to understand the agenda of the speaker. Some authors go even as far as claiming that this is one of the main goals of natural language interpretation (Merin 1999). Thus in (2), B's answer could be taken both as a *no* (because B works too much they are tired and do not want to go to a party) or a *yes* (because B wants to take some time off their work).

(2) A: You want to come to the party?
B: I'm working too much these days.

1.2 What is a good argument?

While most approaches agree on the set of defining features for argumentation presented above, they usually differ when they consider the question of what is a *good* or *acceptable* argument. This question is related to the normative question of the validity of an argument and the importance it is given in evaluating an argument. The way it is handled mirrors the prescriptivist/descriptivist distinction in linguistics: some approaches are concerned with which arguments should be accepted or not, while others focus on the *effectiveness* of arguments.

The first camp takes its roots in the classical approach to argumentation fostered by Aristotle. It firmly equates the value of an argument with its *validity* and tries do delineate the conditions under which a given argument is logically acceptable. What "logically acceptable" varies greatly from one approach to the other. Probably, one of the most influential contributions of Aristotle in this work is the definition of *syllogisms* (of which (1) is a typical instance) and the determination of which types of syllogisms are valid, based on whether they allow a valid deduction or induction.

In those approaches, the notion of *fallacy* is a central one. What makes a good argument is essentially the fact that is not fallacious. Properly defining what is a fallacy is however not straightforward, and attempts usually run into various problematic issues (Hamblin 1970).

This stance is also found in most of the works on argumentation done in some strict implementations of argumentation systems in computer science. These approaches have a practical agenda of devising complex logic systems able to automatically analyze and generate arguments. These systems also need to be able to evaluate the differences between conflicting arguments and take appropriate decisions. For example, Prakken (2010) defines an abstract framework in which three distinct mechanisms can be used to attack arguments depending on which part of the argument is targeted. The way to resolve attacks depends on the types of attacks, and on preference orderings about which elements should or can be abandoned.

Even though strict logical validity is considered to be the hallmark of good and irrefutable argumentation, most approaches in the field of computer science leave room for invalid, yet effective, arguments. One way to do this is to consider that argumentation is instantiated in a variety of *schemes* which specify the type of their premises and conclusion (e.g. see Toulmin 1958, van Eemeren & Grootendorst 1984, van Eemeren et al. 1996, Walton 1996, Walton et al. 2008). These schemes structurally resemble valid syllogisms, but they do not rely on proper deduction or induction. Rather, they are described as *presumptive* which means that their conclusions are *defeasible*. A distinction is therefore made between logically valid argumentation schemes, the conclusion of which are irrefutable, and the presumptive ones. This entails that logically valid arguments are better arguments than the presumptive ones, while leaving room to acknowledge the efficiency of non-deductive reasoning.

This normative nature of logical arguments is found in other works reported by Mercier & Sperber (2011). They mention experiments which showed that when agents reason in groups, they usually come up with better solutions to the problems they face than when participants reason on their own. It is claimed that, from the social point of view, one of the functions of argumentation is to optimize problem solving in groups. What is observed in the experiments is that when a logically sound solution to a problem is found, it ends up being favored by the group (Davis 1973). This, again, points toward a correlation between the logical soundness of arguments and their effectiveness and value.

A more pragmatic answer to the question of what makes a good argument is to consider that good arguments are convincing ones, no matter how they manage to convince people. This is the defining feature of non-normative argumentative studies, i.e. those focusing on the effectiveness of arguments. Zenker (2013) summarizes it in the following way: "[. . .] what does persuade need not be coextensive with what *should* persuade." Thus, even though some arguments are instances of fallacies, they are nevertheless very persuasive (which was the trademark of the Sophists), and, even though they are logically valid, some arguments can fail to convince.

Informal logic (Johnson & Blair 2002, Johnson 2006, Blair 2011) is one field which studies argumentation in this way. It identifies three necessary and jointly sufficient conditions for an argument to be acceptable (the *RSA*: Relevance, Sufficiency and Acceptability conditions). First, the premises should be relevant to the conclusion, i.e. they should positively affect the belief, or commitment, in the conclusion. Second, the premises should provide sufficient support to the conclusion. Finally, the premises should be acceptable, i.e. they should be plausible enough to be accepted as premises. There is thus a notion of validity of arguments, but empirically founded rather than resting on *a priori* considerations on what should be convincing.

Other approaches focusing on the effectiveness of arguments are inspired by work on reasoning in psychology, e.g. work on Wason's selection task (Wason 1966). Just as Oaksford & Chater (2007) showed how the apparent errors in Wason's selection task could be explained as the optimal output of probabilistic reasoning, scholars proposed probabilistic analyses for a number of classical fallacies such as the argument from ignorance, the circular argument, the slippery slope argument, the appeal to popularity, or the *ad hominem* argument (Korb 2004, Oaksford & Hahn 2004, Hahn & Oaksford 2006, 2007, Hahn et al. 2009, Zenker 2013). What these authors show is that the way an argument is evaluated strongly depends on elements such as the prior beliefs of the agents about the targeted conclusion and the credibility of the source of the argument rather than on the form and structure of the argument.

In section 3, I introduce in detail the probabilistic approach to argumentation and use it as a the formal background against which I analyze a series of linguistic markers of argumentation. Here it suffices to notice that this approach is not incompatible with other, less formal, approaches to argumentation. For example, Godden & Zenker (2016) provide a probabilistic interpretation of the RSA conditions of the informal logic approach to argumentation, and of how to approach the notion of cogency, which is a key concept of the informal stand.

2 Argumentation in language

Although they differ in many respects, the works mentioned in the previous section have one thing in common: none of them seems to consider the linguistic form of an argument as an element which might affect its validity, cogency or effectiveness. Of course, the use of some argumentative schemes and the status of utterances as premises or conclusions can be signaled by some specific markers such as *therefore* or *because*, but even in such cases, the linguistic form of the premises does not matter. All these approaches focus on their content, irrespective of how that content is formulated and conveyed. For example, if one looks at the formalization of the RSA conditions proposed by Godden & Zenker (2016), the content of the premises which is used for belief update is represented as a single, monolithic, proposition.

This raises a number of issues for the linguist interested in argumentation.

The first one deals with the fact that a single utterance conveys meaning in different ways. Since the works of Grice (1989) on implicatures and those dealing with presupposition (dating as far back as Aristotle, or more recently Frege, cf. Frege 1892 and Karttunen 2016) it is customary to distinguish different ways by which an utterance conveys meaning. Some meaning is conventional, some comes about from reasoning about the utterance, for example by considering conversational principles such as Grice's maxims. Different authors might disagree about how many layers of

information should be distinguished, but all would probably agree that the meaning of an utterance is complex and manifold.

Regarding the way an argument is evaluated, one might then ask which of these various layers of meaning are taken into account in the calculi behind argumentative reasoning. It seems reasonable to assume that part of the conventional meaning conveyed by an utterance plays a role in argumentation, but which one? If one sees presuppositions as preconditions for felicitous assertion, then it might seem sensible that they do not carry argumentative force. But what about other type of conventional content such as conventional implicatures? These questions are addressed in Sec. 4 and in (Winterstein 2013, 2015). There, I argue that not all the conventional information conveyed by an utterance plays a role in its argumentative profile, and that the notion of *at-issueness* plays a key role in its evaluation.

A second issue deals with the observation that utterances which share the same content seem to have different argumentative profiles, i.e. cannot be used as premises to support the same set of conclusions. This observation is the cornerstone of *AwL*, initially fostered by Anscombre and Ducrot. This section introduces elements of this approach, first through a series of examples on which the theory was built (Sec. 2.1) then by introducing the model in a more systematic way (Sec. 2.2). I close the section with a discussion of the observables of *AwL* (Sec.2.3).

2.1 Foundations

Anscombre & Ducrot (1983) summarize the foundations of their study of linguistic argumentation as follows:

> a speaker argues when he presents an utterance E_1 (or a set of utterances) as the grounds for *admitting* another (or a set of others) E_2. For an utterance E_1 to be given as an argument in favor of an utterance E_2, it is [...] not enough for E_1 to give reasons to acknowledge E_2. The linguistic structure of E_1 must satisfy certain conditions so that it is apt to constitute, in a discourse, an argument for E_2
>
> The observation which triggered our research is the following: some utterances E_1, while giving the best reasons in the world to admit other utterances E_2, are nevertheless incapable, in a discourse, to serve as arguments in favor of E_2.
>
> [...]
>
> The argumentative possibilities in a discourse are tied to the global linguistic structure of the utterances and not just to the content they convey.

Anscombre & Ducrot (1983: p. 8–9)[3]

Here, I present a few examples which illustrate their point.

A first example is the pair in (3) (translated from a French political debate mentioned by Anscombre & Ducrot 1983).

(3) a. The state gained as much as the individual consumers.
b. The individual consumers gained as much as the state.

Valéry Giscard d'Estaing (then French president) used (3a) as a counter-argument to a previous claim by François Mitterand (his opponent in the debate) who argued that a state-backed bond scheme was too advantageous for the individual consumers, and hence ruinous for the state. A&D observe that in that situation it would have been impossible for Giscard d'Estaing to use (3b), even though it seems to assert exactly the same thing as (3a), or at least, on the face of it, to convey the same informational value: each group gained the same thing.

Another example is given in (4) which compares two possible versions of a slogan to advertise some subscription plan.

(4) a. At least 9.99$ a month.
b. Starting at 9.99$ a month.

Looking at advertisements, one is bound to find arguments of the form of (4b), whereas (4a) does not sound like a very cogent argument. Yet, here again, both convey exactly the same thing: at the end of the month, the subscriber will pay 9.99$ or more.

A final example, initially due to A&D and discussed in most presentations of *AwL*, deals with the different effects of the adverbs *barely* and *almost*. The former entails the truth of its scope and the latter denies it, e.g. (5a) entails (5b) and (6a) entails (6b).

(5) a. John was barely on time.

3 Translated from the original:

un locuteur fait une argumentation lorsqu'il présente un énoncé E_1 (ou un ensemble d'énoncés) comme destiné à en faire admettre un autre (ou un ensemble d'autres) E_2. Pour qu'un énoncé E_1 puisse être donné comme argument en faveur d'un énoncé E_2, il ne suffit pas en effet que E_1 donne des raisons d'acquiescer à E_2. La structure linguistique de E_1 doit de plus satisfaire à certaines conditions pour qu'il soit apte à constituer, dans un discours, un argument pour E_2.

L'observation qui a déclenché nos recherches est la suivante: certains énoncés E_1, tout en fournissant les meilleures raisons du monde d'admettre d'autres énoncés E_2, sont cependant incapables, dans un discours, de servir d'arguments en faveur de E_2.

[. . .]

Les enchaînements argumentatifs possibles dans un discours sont liés à la structure linguistique des énoncés et non aux seules informations qu'ils véhiculent.

b. ⇝ John was on time.

(6) a. John was almost on time.
b. ⇝ John was not on time.

However, only (6a) can be used as a praise for John (among other possible conclusions), even though in the situation described by (6a) John is objectively more late than in the one corresponding to (5a). This, A&D argue, shows that the truth-conditions of an utterance and their (argumentative) discursive properties are independent and should be distinguished. This is the foundation on which they built *AwL*.

2.2 The *AwL* model

Tracing the exact contours of A&D's theory is a difficult task because it evolved a lot since its inception in the early 70's until later works in the 90's and even more recent developments. Initially, the theory considered argumentative content to co-exist along truth-conditional content, each possibly affecting the other. This period is best represented by Ducrot (1980a) where the concept of argumentative scales and various discourse laws are introduced. Moeschler (1989) calls this period "weak argumentativism". Later on, the theory took a more radical turn, claiming that linguistic expressions only encode argumentative content, and that informational and truth-conditional content is derived from these. This is already suggested towards the end of (Anscombre & Ducrot 1983) and fully developed with the introduction of the concept of *argumentative topoi* (Anscombre 1989, Ducrot 1993, Anscombre 1995). This period is referred to as "radical (or strong) argumentativism". Later Carel (1992, 2011) challenged the topoi-based approach to propose a theory of *semantic blocks* that further rejects truth-conditions and any informative aspect in the semantics of natural language.

I will not try to give a comprehensive description of the evolution of the theory, and the reasons for a move from weak to strong argumentativism, especially because that move was gradual and continuous, and many later works in the framework still use early elements of the theory such as the recourse to some argumentative discourse laws. The interested reader can consult the following sources in English for more thorough presentation (although most of them are biased in a way). Iten (2000) proposes an overview of the whole theory, which, although it turns out to be rather critical of *AwL*, gives an idea of how and why it evolved. Plantin (2002) offers an overview of the theory in a historical perspective on the place of rhetorical studies in French academia. van Eemeren et al. (2014: chap. 9) also offers an introduction to *AwL* in a comparative perspective with other approaches in the field of argumentation studies.

Here, I will limit myself to introducing the core components of *AwL* which will be reinterpreted in the light of the probabilistic interpretation of argumentation. It can already be noted at this stage that such a reinterpretation goes against one of the main tenets of *AwL*. For A&D, argumentation is a primitive notion which cannot be decomposed, analyzed and above all cannot and should not be deduced from the truth-conditional or informational content of an utterance. This separation of the informative and argumentative sides of an utterance is behind the two major shifts in *AwL* mentioned above, and each time the shift was towards a starker detachment from anything like truth-conditional content. In contrast, my proposal attempts to explain how to derive all of the observations of *AwL* from the postulate that linguistic expressions convey an informative probabilistic meaning, i.e. meaning related to beliefs about the external state of things (cf. Sec. 3).

2.2.1 Argumentative orientation and scales

In *AwL*, the relation of argumentative orientation stands between two utterance types, which I will refer to as sentences. The kind of argumentative relations that *AwL* deals with are thus not *hic et nunc* ones which might arise out of specific contexts, but ones which exhibit some regularity, and will take place unless special circumstances arise. An utterance U will be considered to argue in favor of a conclusion C iff U can felicitously be used in a discourse to support C. What "felicitous" means, and how to observe a relation of argumentation are discussed in more details in Sec.2.3. What is of importance to A&D lies in the relationship between utterances which argue for the same conclusion. If U_1 and U_2 both argue for C, then they belong to the same *argumentative class*.

In line with all approaches to argumentation, A&D confer an argumentative strength to premises, i.e. argumentative classes can be (semi)-ordered by how well their members argue for their conclusion. This is how *argumentative scales* are formed. More precisely, two utterances U_1 and U_2 form an argumentative scale for a conclusion C where U_1 is higher on the scale if and only if using U_2 as an argument for C entails that the speaker would also be willing to use U_1 in favor of C, but not necessarily vice-versa. In line with the notation used for pragmatic scales in general (Horn 1989), I will write this as $\langle U_1, U_2 \rangle_C$.

Many of the linguistic expressions described in *AwL* as argumentative operators indicate relations involving argumentative classes and scales. For example, *almost* is described as forcing the orientation of its host utterance to be the same as its prejacent, but weaker, i.e. there is an argumentative scale of the form $\langle p, \mathit{almost}\ p \rangle_C$. A selection of operators of this sort is given in Sec. 4.

2.2.2 (Argumentative) Discourse laws

To account for the effect of some linguistic expressions and for general principles of discourse interpretation, a number of discourse laws (*lois de discours*) are postulated within *AwL*. Some of these laws play a role which is comparable to Grice (1989)'s maxims of conversation in that they are principles which allow an enrichment of the sense of an utterance-type in a given situational context. Other laws are behind the mechanism of *centering* (*centrage*) which handles the compositionality aspect of argumentation. Centering combines the argumentative orientation of simple propositions with argumentative laws and the effect of operators to produce the final argumentative profile of an utterance.

There is no fixed inventory of all the discourse laws postulated in *AwL*, and it is even more difficult to determine which of these laws are assumed at some particular point in the development of the theory. An overview (in French) of these laws is presented in (Moeschler & Reboul 1994: chap. 7,10) who highlight that they are typical of the early versions of *AwL*, before the introduction of topoi but note that later works still occasionally refer to some of them.

In this work, I will focus on those laws which explicitly deal with the argumentative properties of an utterance or have a direct link with the probabilistic interpretation of argumentation I will examine later. Most of these laws are postulated based on the observation of argumentative regularities or on rationality considerations about how argumentation should behave in a discourse. Most laws deal with scalar considerations on argumentation and the behavior of argumentative properties with negation. In section 3.3 I introduce and examine these laws in details and show that some of them can be derived from probabilistic considerations rather than being postulated, and that one other law is not general, as claimed by A&D, but only holds under specific conditions related to the speaker's beliefs.

2.2.3 Argumentative topoi

A later addition to *AwL* is the concept of argumentative *topos* which is inspired by the Aristotelian concept, but rather distinct from it. The introduction of topoi is motivated by two main considerations. First, A&D observe that in some circumstances the informational content of an utterance can only be understood after having considered its argumentative value. For example, in (7), the value of *almost 10%* depends on the aim of the speaker. If they want to argue that the communist party is losing ground, then that quantity will be slightly above 10%, if on the other hand they argue that this party is gaining traction, then that quantity will understood to be slightly under 10%.

(7) The communist party reached almost 10% in the last polls.

A&D generalize such cases and take a radical step with the introduction of topoi: they claim that all conventional meaning is argumentative. Informational and truth-conditional content are derived from it through the application of certain rules (notably the process of *delocutivité* Benveniste 1966, Anscombre 1979).

Topoi represent general principles which are assumed to be part of the socio-cultural background of a linguistic community. The lexical meaning of a linguistic expression is the set of topoi it is associated with (Anscombre 1995). These topoi are later affected by the argumentative operators used by the speaker in their utterance and subject to some of the argumentative laws already mentioned. A topos always relates one quantity to another, therefore it is intrinsically gradable. This gradability is necessary and desirable since argumentation is also gradable, and under the assumptions of strong argumentativism all meaning is argumentative.

An example of topos is given in (8). It is associated with linguistic items such as *book* and *to read* (and conceivably others which are lexically related to them).

(8) The more books by an author were read by someone, the more the reader knows about the author.

From (8) one can trivially derive the following "converse" topos:

(9) The less books by an author were read by someone, the less the reader knows about the author.

The topos in (8) can be used to account for the fact that (10b) is a better argument than (10a) for (10), i.e. that there is an argumentative scale at play in their interpretation.

(10) John knows about Chomsky.
   a. He read some of his books.
   b. He read all of his books.

The role of topos is to offer a path from premises to conclusions, e.g. how to go from (10a) to (10). To that extent they could be taken as representations of both world knowledge and argumentative reasoning.[4]

I will not follow the path of strong argumentativism here, as I consider that topoi present too many theoretical issues and rather aim at reconciling *AwL* with approaches based on informational content.

For one, the question of the origin of topoi remains rather open. For example Anscombre (1989) argues that French (and possibly other languages) have the following topoi (along with their converse):

4 This turns out to be one of the main criticism of Carel (1992, 2011) who argues that this reduces argumentation to a question of truth-conditional relations, and thus contradicts the spirit of *AwL*.

(11) a. The more time one has, the less they have to hurry.
b. The more time one has, the more they have to hurry.

Anscombre argues that the topoi in (11) are natural sounding and "commonly used", but one might wonder whether this is really the case for (11b) which appears much less obvious than its counterpart and contradicts it. To address this issue, Anscombre (1989) argues that proverbs offer a trace of the existence of topoi in a language, and support the claim that contradictory topoi can usually be entertained at the same time. As an illustration, the two following sayings are regularly called up when discussing human relationships:

(12) a. Opposites attract.
b. Birds of a feather flock together.

While I agree that proverbs certainly offer an insight into the common values and beliefs of a community, they cannot account for the immense amount of topoi that *AwL* postulates: all of our shared knowledge is assumed to be accessible as a topos. Thus the problem is to have an external criterion to determine whether a given topos exist. The answer of A&D is that these can be observed in language, but this is tantamount to circular reasoning (cf. next section on the question of the observables of *AwL*).

Another problematic side of topoi is the claim that they are scalar in nature and always relate the increase (or decrease) of a property to the increase (or decrease) of another. There are however non-scalar properties which have clear argumentative properties. For example, the property of being nuclear is not scalar, but argues for dangerosity. But to account for an example like (13), *AwL* would need to postulate a topos of the form *the more something is nuclear, the more dangerous it is* which makes little sense.

(13) This power plant is nuclear, but not dangerous.

The same applies when the conclusion being targeted is not scalar, i.e. a topos like *the more radioactive material are used, the more nuclear the plant is* does not make sense either since *nuclear* is not scalar.

Thus, in the remainder of this work I will not consider topoi as a key theoretical concept. That being said, I will have a way to access the information supposed to be encoded in topoi. Rather than postulating that topoi exist as independent entities, I will take them to be mere paraphrases of degrees of belief and beliefs about causal relations between different properties, gradable or not. These are typically represented via joint probabilities, or expressible in the form of Bayesian Belief Networks (Pearl 2009).

2.3 Observing argumentation in language

Although I do not assume with A&D that argumentation is a primitive component of meaning, the question of what are the observable correlates of (linguistic) argumentation remains relevant. There is a very intuitive sense in considering that an utterance U argues for a conclusion C, but one would ideally like to use more precise tests to be able to decide whether a relation of the type "*argues for*" stands between some premise(s) and a conclusion. The formal apparatus of probability which I will rely on is of little use here since we do not have access to our internal belief representations (although assuming that we entertain probabilistic beliefs gives a basis on which one can design quantitative experiments).

A&D rarely address that question head on. They mostly answer it by considering that the relation of argumentation is intrinsically discursive and can thus be observed by observing the felicity of various discourses. They then consider the use of the conjunction *therefore* to be the hallmark of an argumentation relation (Carel & Ducrot 1999). Thus a premise P will be considered to argue for a conclusion C if and only if one can construct felicitous discourse of the form *P therefore C*.

Taking (3) as an example, one can see that only the first version argues for the conclusion *the scheme was advantageous for the state*.

(14) a. The state gained as much as the individual consumers, therefore the scheme was advantageous for the state.
b. #The individual consumers gained as much as the state, therefore the scheme was advantageous for the state.

Thus, the main observable is the acceptability of a discourse which involves a discourse marker such as *therefore*. Beyond that connective, A&D consider other markers which they take as encoding basic argumentative constraints, such as the connective *but* which indicates an argumentative opposition between its two conjuncts. Similarly the adverb *even* is taken to indicate that its prejacent is higher on an argumentative scale than its antecedent.[5]

This might give a sense of circularity of A&D's approach to argumentation. On one hand, they postulate that there exists an argumentative dimension of meaning which is separate from truth-conditions, and that there are linguistic markers whose function is to mark argumentation. On the other hand, to show that there are argumentative effects in language, they rely on a set of markers which they describe as markers of argumentation based on an intuitive understanding of the relation of argumentation.

5 Section 4 gives a more complete overview of the set of argumentative markers and the details behind the semantics of some of them.

That being said, acceptability judgments certainly give insights about the possible argumentative properties of a given sentence.

The way I will get round this issue is by rejecting A&D's assumption that argumentation is a primitive, irreducible, notion. Rather, adopting a probabilistic interpretation of it lends us quantitatively testable ways to test whether a given utterance affects the belief attributed to some conclusion. Thus, when discussing argumentative markers I refer to elements which influence the process of belief update, either by structuring information in a specific way or by directly encoding probabilistic constraints. In Sec. 3, I provide more details about that probabilistic interpretation of argumentation.

Besides such acceptabilities, other measures are available to study argumentation. One is a measure of the convincingness of arguments. This follows works by Hahn & Oaksford (2007), Hahn et al. (2009) and boils down to introducing situations that involve different agents are engaged in conversation and asking the participants to evaluate how much one of the agent is convincing by what another tells him. Measuring convincingness is a way to compare features of arguments (like their orientation or strength) that does not rely on postulating that specific markers encode certain properties, for example that *even* encodes argumentative superiority (which turns out to be wrong, as shown in section 4.3). It is also a way to validate the predictions made by the Bayesian treatment of argumentation about how the content of an argument bears on its cogency (which is at the core of Hahn and colleagues' work, and some work on argumentative operators mentioned in section 4).

3 Arguing for a probabilistic treatment of argumentation in language

This section introduces the probabilistic (or Bayesian) view on argumentation. I first introduce the general probabilistic model (Sec. 3.1), then discuss its relationships with Anscombre and Ducrot's take on argumentation and the link between argumentative reasoning and inference (Sec. 3.2). Section 3.3 shows how the probabilistic model can be used to predict some of the argumentative discourse laws postulated by A&D.

Our goal is not to provide an introduction to probability, nor to engage in a detailed technical discussion of the probabilistic model. The works cited in this section already provide these, notably Jeffrey (2004) or Godden & Zenker (2016). I will mostly provide a general introduction of the model and its links to the postulates of *AwL*.

3.1 The probabilistic view on argumentation

3.1.1 The probabilistic model

The probabilistic approach to argumentation can be traced at least as far back as the works of Ramsey (1926) and Carnap (1950) on probability. As mentioned in the previous chapter, this approach enjoyed a renewed interest in the domain of psychology, as an alternative way to approach argumentative reasoning (see among others Hahn & Oaksford 2007, Zenker 2013, Godden & Zenker 2016 or Hahn & Hornikx 2016). On the linguistics side, Merin (1999) first took inspiration from the works or Ramsey and Carnap as a way to model *AwL*.

The cornerstone of the probabilistic stance is rather simple and summarized in (15).

(15) A (set of) premise(s) (or reasons) R is an argument for a conclusion C iff $P(C|R) > P(C)$, i.e. if and only if the probability of C after learning that R is true (the *posterior* probability) is higher than it was before learning that R is true (the *prior* probability).

In (15), probabilities are understood as representing the subjective *degrees of belief* of the participants in the discourse, rather than objective measurements coming from the observation of frequencies. One way to understand degrees of belief is as *dispositions to act*, e.g. in betting situations (Ramsey 1926, Jeffrey 2004). This view of probabilities is sometimes referred to as the *Bayesian* interpretation of probabilities.

The definition in (15) lends itself to a rich array of interpretation if one considers Bayes' rule, which explicitly relates the prior and posterior probabilities. In its most common forms, Bayes' rule is as follows (the second version is obtained via the application of the law of total probability to the denominator):

(16) **Bayes' rule**: $P(C|R) = \dfrac{P(R|C) \times P(C)}{P(R)} = \dfrac{P(R|C) \times P(C)}{P(C) \times P(R|C) + P(\neg C) \times P(R|\neg C)}$

In (16), $P(R|C)$ is called the *likelihood* that R is true given that C is true. In our case, this can be interpreted as the likelihood that the premises used in the argument are true assuming that the conclusion they target is indeed true.

The Bayesian perspective offers a way to measure how good an argument is. Intuitively, the more a set of reasons R augments the posterior probability of the targeted conclusion, the better the argument. A simple way to measure this is simply to consider the quantities $P(C|R) - P(C)$ or $\dfrac{P(C|R)}{P(C)}$ which can be expressed using (16) (see Godden & Zenker 2016 for considerations). More complex measures have

been proposed, notably Good's weight of evidence (Good 1950) which corresponds to the natural logarithm of the odds factor of the conclusion to the reasons. One advantage of this measure is that it is not sensitive to whether the prior and posterior probabilities lay at the lower or higher end of the probability spectrum. It thus provides a better way to assess the information gain provided by *R* about *C* (Good 1979, Jeffrey 2004). This measure is the one used by Merin (1999) to model the *relevance* of *R* to *C* (cf. infra).

There is a straightforward correspondence between the probabilistic take on argumentation and recent Bayesian-inspired proposals in semantics and pragmatics Franke & Jäger (2016), Zeevat & Schmitz (2015), Goodman & Lassiter (2015) for example discuss various domains in semantics and pragmatics where adopting a probabilistic approach provides new insights into some complex phenomena: from reference resolution to quantity implicatures and indirect speech acts. These applications are Bayesian in a strong sense: they fully use Bayes' rule to explain phenomena related to natural language interpretation and production (see also Zeevat 2014 for another example). Other works are Bayesian because they assume that meaning is best treated as probabilistic (e.g. Jayez 2010, Colinet 2012, Lassiter 2010, Yalcin 2010 or Lassiter 2012). They do not necessarily involve a Bayesian process of interpretation, but they remain compatible with it, and so is the model that I assume here.

3.1.2 Some features of the model

The outline of the model just described raises a number of questions and issues.

First, in (15) it is assumed that the probability of *R* is 1, i.e. that *R* is certain as soon as it has been uttered by the speaker. This is implausible in the case of natural language communication. Just because a speaker makes a claim *R* does not mean that addressees will immediately consider that *R* is true and add it to their common ground (otherwise why bother arguing? the speaker could just go straight for the conclusion *C* they are arguing for). Aspects like the speaker's reliability (McCready 2015) or the prior belief in the claim all affect how much an audience is ready to accept a claim that *R* is true and further update their belief or act on it.

One way to deal with belief update on uncertain information is to use Jeffrey Conditionalization (JC) (Jeffrey 1983) instead of the standard one used in (15). In virtually all the cases I will be concerned with, updating beliefs on certain information or with JC will yield the same results, i.e. if a piece of information *R* argues for a conclusion *C* using standard update, then it will also raise the probability of *C* under JC, as long as the posterior probability of *R* is higher than its prior (see proof in Appendix A.3 and Godden & Zenker (2016) for more details about JC in the argumentative perspective). I take this last requirement to be generally true: when

a speaker asserts a content R, it will usually not lead to a decrease of belief in R among the discourse participants (except in the borderline case of a well-known pathological liar, but in such a case the conditions of rational conversations are not met).

A second question is how to approach the persuasiveness of an argument. This question is related to normative considerations, i.e. knowing when an argument should or should not be accepted. Godden & Zenker (2016) propose a probabilistic interpretation of the RSA criteria postulated by informal logic approaches to model the cogency of an argument (cf. Sec. 1.2). They are summarized as follows:

- Premises need to be *positively relevant* to the conclusion, i.e. $P(C|R) > P(C)$
- Premises need to be *inferentially sufficient*: they must raise the posterior probability of the conclusion above a contextual threshold of acceptability above the prior belief in C, i.e. $P(C|R) \geq t_s > P(C)$. Note that this condition entails the relevance condition.
- Premises need to be *acceptable*, i.e. they need to be sufficiently plausible to warrant an inferential update: $P(R) \geq t_a$, where t_a is a contextual threshold of premise acceptability.

Informal logicians consider that these conditions are necessary to justify inferential update on the premises (although Godden & Zenker 2016 dispute this). In parallel, Hahn & Hornikx (2016) argue that approaching the question of argument quality only from the angle of argumentative schemes is insufficient (in line with previous observations by Walton et al. 2008). They show how the Bayesian approach to argumentation provides a way to address these issues, and generally argue for an approach to argument quality which uses features coming from both the Bayesian approach and the argumentative scheme-based one.

A third, more general, question is to know where the probability measure comes from, i.e. how speakers assign probabilities to propositions in the first place, especially given how difficult it is to consciously assign probabilities to propositions and how most people are prone to "errors" when dealing with probabilistic reasoning (cf. the literature on representativity bias stemming from Kahneman et al. 1982).

Regarding the second point, even though humans may make mistakes when asked to consciously reason about probabilities, it has also been shown how Bayesian reasoning can account for a range of very rich and robust inferences made on the basis of sparse evidence (Tenenbaum et al. 2011) and that infants are already capable of Bayesian reasoning (Xu & Garcia 2008). This suggests that seeing reasoning as a Bayesian process is not an implausible hypothesis.

Regarding the question of where the probabilities come from, the probability distributions are not assumed to be specific to language related activities. Probabilis-

tic beliefs are assumed to be accessible for all cognitive activities from reasoning to vision or natural language understanding (Kersten et al. 2004, Oaksford & Chater 2010, Zeevat 2014). The question of what the initial probabilities distributions should be, i.e. what agents "start with" (purely uniform distributions or more biased ones) remains an open one, but it can be addressed and evaluated in both qualitative and quantitative ways (Qing & Franke 2015).

3.1.3 Example

Here I show how to apply the Bayesian treatment to one of the most basic forms of argumentation: an information is presented as being relevant to some conclusion. This corresponds to the *argument from sign* identified in the literature on argument schemes (Walton et al. 2008), i.e. where some observation is taken to be the indication that a certain conclusion is warranted. I will briefly review the case of (17), which is discussed in more details by Hahn & Hornikx (2016).

(17) London is a tourist destination because there are a large number of people with digital cameras on the street.

In (17), the conclusion is C_{touristy} ="*London is a tourist destination*" and the premise, or reason, is R_{cameras} ="*there are a large number of people with digital cameras on street*". Using (16) we see that the posterior belief in C_{touristy} after learning R_{cameras} depends on the following.

- The prior belief in C_{touristy}. If that belief is already high, the argument may not sound like a very good one. This is because an argument needs to have an effect (i.e. raise the probability of the conclusion and produce a change in beliefs).
- The likelihood that there would be people in digital cameras on the street if London is a tourist city. This factor is also called *sensitivity* in signal detection because it measures how good an indicator the premise is for the conclusion. It reflects the rate of false negatives, i.e. the chance that the premise is false even though the conclusion is not (the higher the sensitivity, the less false negatives).
- The false positive rate $P(R_{\text{cameras}}|\neg C_{\text{touristy}}) = 1 - P(\neg R_{\text{cameras}}|\neg C_{\text{touristy}})$, where $P(\neg R_{\text{cameras}}|\neg C_{\text{touristy}})$ is called the *specificity*. It measures how characteristic of the conclusion the premise is, i.e. how much one expects not to see digital cameras in non-touristy places.

Depending on these different quantities, one can evaluate the quality of the argument, for example by considering the RSA criteria already mentioned above.

3.2 *AwL* and probability

Having laid out the basic tenets of the Bayesian approach to argumentation, I now turn to the relationship between the Bayesian approach and *AwL*.

Merin (1999) was the first to explicitly connect a probabilistic approach to argumentation and the insights of *AwL*. His starting point is basically the same as the approaches described above.Merin describes several argumentative operators using probabilistic descriptions, typically centered on the relevance of the host utterance to the conclusion which the speaker aims at (see below and Sec. 4 for examples).

Merin's system goes beyond assuming that meaning is probabilistic. It offers a decision theoretic approach to adversary conversation, i.e. exchanges which involve agents whose preferences are opposed and have little, if any, incentive to fully cooperate. Merin uses his approach to explain, among other things, how to derive quantity implicatures and interpret presuppositions. Here, I will not expound this facet of this work. Essentially it is because this view is not perfectly in line with the spirit of *AwL* as described by Anscombre and Ducrot. A&D do not claim that argumentative phenomena are typical of adversary discourse. Rather, their claim is more general: they assume that every utterance is oriented towards a conclusion, irrespective of the context in which it is uttered, be it cooperative or not. Essentially, they seek to describe a grammar of discourse which rests upon argumentative terms (and, as mentioned before, in the later incarnations of *AwL*, argumentative terms are the only terms semantics should consider).[6]

One aspect in which the probabilistic formalization behind *AwL* differs from other approaches to argumentation is that it makes little to no reference to the quality of arguments: the relation of argumentation is confounded with that of relevance. If knowing R augments the belief in C, i.e. $P(C|R) > P(C)$, then R argues in favor of C. This contrasts with the other Bayesian approaches to argumentation which place the persuasiveness of arguments at the core of their research agenda. Typically, the informal logic approaches consider that an argument is acceptable only if it raises the probability of its conclusion above a certain level. If not, it will not be treated as an argument.

This does not mean that the strength of an argument is not a relevant feature in *AwL*. On the contrary, many operators are supposed to be sensitive to this dimension. But there are no normative conditions on that strength for an argument to be acceptable. To evaluate how strongly premises R affect a conclusion C, Merin (1999) uses a measure of relevance. As mentioned above, his measure of relevance corresponds to Good's weight of evidence, which smooths differences between probabilities at different ends of the value spectrum (Jeffrey 2004).

6 That being said, there are cases for which considering that the speaker and addressee are at odds is explanatory useful, but I will not discuss these here.

(18) **Relevance**: $rel(R,C) \triangleq log\left(\frac{P(R|C)}{P(R|\neg C)}\right)$

This measure is a continuous monotone increasing function of other measures of relevance such as the difference or the ratio between priors. This means that the precise choice of measure has little import, apart from practical advantages (among these, Merin 1999 mentions the additivity of *rel* provided conditional independence and the fact that *rel* values all cases of entailment among contingent propositions in the same way).

From the point of view of *AwL*, relevance and argumentation are similar because the focus of *AwL* is not on what makes a convincing argument, but rather what makes a linguistically sound argument, e.g. one which does not violate the discursive argumentative constraints conveyed by its elements. These constraints are expressed in terms of strength and orientation. An utterance argues for or against a conclusion, with more or less strength. This is precisely captured by the measure of relevance. Issues such as those covered by the RSA criteria fall beyond the scope of *AwL*. What *AwL* has to offer for the study of argument cogency is, for example, a description of markers which are used by speakers to signal that their argument is a strong one, or a stronger one than a previous one (cf. the discussion of *even* and related operators in Sec. 4.3.2).

The use of the term *relevance* evokes Relevance Theory (RT) (Sperber & Wilson 1986, Wilson & Sperber 2004) with which *AwL* has much in common. Iten (2000) argues in favor of (but does not detail) a reformulation of the insights of *AwL* in terms of RT, and Wilson & Sperber (2004) mention that *rel* is a formal quantitative version of the notion of Relevance which is central to their account. Merin (1999) on the other hand clearly argues against such a move and is highly critical of the whole enterprise of RT. While I share some of Iten's criticism, especially regarding the radical view about language being purely argumentative, I will not attempt to interpret *AwL* in terms of RT. This is because I believe there is more to gain by adopting a Bayesian perspective. Furthermore, in (Winterstein 2012b, 2013) I discussed some problems encountered by RT when dealing with argumentative markers such as the adversative *but*. Specifically, RT does not really distinguish between argumentative effects and inferences such as conversational implicatures. This creates over-generation problems for RT when dealing with connectives such as *but* (Winterstein 2012b).

3.3 Argumentative discourse laws

To close this section we examine the argumentative discourse laws introduced in Sec. 2.2.2 from the Bayesian angle. The aim is to determine whether these laws

can be directly derived from the probabilistic framework I assume, or whether additional assumptions need to be made. Most of the laws and their interaction are fully described by Ducrot (1980a) and later Anscombre & Ducrot (1983).

3.3.1 Negation law (*loi de négation*)

The negation law is a description of how the argumentative orientation of an utterance is affected by standard descriptive negation (as opposed to metalinguistic negation). A formulation is given in (19).

(19) **Negation law**: if an utterance of content R argues for a conclusion C, then an utterance of content $\neg R$ argues for $\neg C$. (Ducrot 1980a)[7]

This law matches intuition and its effects are illustrated in (20): adding a negation to (20a) changes its argumentative orientation.

(20) a. This ring is nice. $\underset{arg}{\rightsquigarrow}$Speaker will buy the ring.
b. This ring is not nice. $\underset{arg}{\rightsquigarrow}$Speaker will not buy the ring.

The negation law follows directly from the probabilistic interpretation of argumentation.[8] The proof is given in Appendix A.1.

3.3.2 Lowering law (*loi d'abaissement*)

The lowering law is related to the observation that there is often a match between scalar expressions, their argumentative orientation and strength and the way negation affects it. For example, if one considers the scale of temperature, there is a general tendency for argumentative strength to follow an increase or decrease of temperature. On the scale of coldness, both (21a) and (21b) are arguments in favor of (21), and (21b) appears to be a better argument than (21a), while referring to a temperature higher on the scale of cold.

(21) You need to dress warmly.
a. It's cool outside.
b. It's very cold outside.

An additional observation A&D make is that using a negation with such scalar predicates means "lower than", e.g. (22) means it is necessarily warmer than "cool"

7 Eggs (1978) notes that the law can actually be traced back to Aristotle.
8 Merin (1999) already observed this result (Fact 4 in his paper).

outside (rather than it being very cold). What is negated then are the terms situated higher up on the argumentative scale.

(22) It's not cool outside.

This behavior of negation with gradable predicates is the essence of the lowering law. To account for this data, A&D postulate the lowering law which essentially states that the ordinary descriptive negation of a scalar predicate means *less than* (Moeschler & Reboul 1994).

So far, these observations match those made by Kennedy & McNally (2005) about the semantics of gradable adjectives. In their approach, gradable expressions are normally treated as encoding a lower bound on a scale. Applying a negation to that lower bound naturally turns it in an upper-bound limiting expressions, which can be paraphrased by *less than*.

A&D however insist that the positive version of the adjective does not encode a lower bound on the scale, but rather denotes a precise point on it. Their argumentation is a bit fuzzy on these points (especially when discussing the interaction with the exhaustivity law) and I will not review it.

The point here is that, assuming the by now relatively standard view that gradable adjectives encode a lower bound on a (possibly contextually) oriented scale, then the effect of negation (and thus the lowering law) naturally come about. There is thus no need to postulate such a law. While this does not have a probabilistic interpretation *per se*, it will have important consequences when discussing the inversion law.

3.3.3 Inversion law (*loi d'inversion*)

Another discourse law related to the effect of negation and postulated by A&D is the inversion law. A formulation is given in (23).

(23) **Inversion law**: if an utterance of content R is a stronger argument for a conclusion C than an utterance of content R' is for C, then $\neg R'$ will be a better argument for $\neg C$ than $\neg R$.

As stated in (23), the law matches the description given by Ducrot (1980a). Later on, Anscombre & Ducrot (1983: p. 104–111) make it more complex by considering distinct goals C and C' for R and R'. Several authors (e.g. Iten 2000) have noted that the inversion law is difficult to interpret in the more general case since it is not straightforward to compare the strengths of two arguments for different conclusions. Moeschler & Reboul (1994) only consider the version where $C = C'$, and in most of their writings it seems that A&D focus on this case as well. I will follow them in that respect and only consider the case of a unique conclusion for both R and R'.

The inversion law appears justified based on cases such as (24) (adapted from Anscombre & Ducrot 1983).

(24) a. Peter is very polite, he helped to clear the table and above all cleaned the dishes.
b. Peter is not very polite, he didn't clean the dishes and above all didn't help clear the table.

In (24a), R' =*Peter helped to clear the table* is presented as an argument in favor of C =*Peter is very polite*, and R =*Peter cleaned the dishes* is also an argument in favor C, and a stronger one than R', as shown by the fact that the expression *above all* can be used to mark it as superior.[9] If R and R' are negated, they both argue against C, but now $\neg R'$ appears to be more convincing than $\neg R$: Peter did not have even the minimal courtesy of helping to clear the table.

While the law seem to have empirical support, it cannot be directly derived using the probabilistic interpretation of argumentation. Instead it can be shown that the inversion law holds if and only if the following condition is met (proof given in Appendix A.2):[10]

- $P(C,R') > P(C,R)$, i.e. $P(R'|C) > P(R|C)$, which means the *sensitivity* of R' is higher than that of R; if C is true, it is more likely that R' is true than R being true.
- If the conditions stated in (23) are true, then the condition above entails $P(R') > P(R)$.

The proof also predicts that in case the likelihood of R is higher than that of R', the opposite effect of the inversion law should be observed. A case like (25) seems to support this prediction.

(25) a. Conference X is very attractive. You get a nice conference hat, and above all the organizers invited interesting keynote speakers.
b. Conference X is not very attractive. They do not offer any hat, and above all the invited speakers are not interesting.

9 A&D used French *même* (*even*) in their example, but I will argue in Sec. 4.3.2 that the argumentative value of this item is more complex than merely showing argumentative superiority, while the description is correct for *above all*.

10 Merin (1999: pp. 24–25) provides a proof of the law based on the idea that linguistic expressions of different force partition the semantic space, i.e. are mutually exclusive. This is in-line with A&D, but I do not follow his approach here, and my conclusions do not match his either since he seems to consider that the law is true in the general case, contrary to what I propose here.

In (25), the likelihood that conference X has interesting keynote speakers (R) if it's an attractive one is higher than it offering a nice hat (R'). Arguably, R is also a better argument than R' for the conclusion C that conference X is attractive (but R' remains an argument in favor of the conference). Yet, contrary to A&D's prediction, the negation of R is a better argument against the conference being attractive than the negation of R', which intuitively does not seem to carry a lot of argumentative weight (or any weight at all).

As a last remark about the inversion law, I turn again to the case of scalar predicates and their associated argumentative scales. When discussing the lowering law, I mentioned that scales formed out of gradable expressions often correspond to argumentative scales. When the elements in the scale are related by relations of logical entailment, then the conditions for the inversion law to apply are automatically verified. Taking the case of (21) again, under the assumption that scalar predicates encode a lower bound, then (21b) (R) entails (21a) (R'). From the probabilistic point of view this entails that $P(R') > P(R)$. The condition $P(R'|C) > P(R|C)$ similarly holds: in all situations such that C (*need to dress warmly*) and R are true, then R' is also true but not vice-versa.

Most of the examples discussed by A&D about the inversion law involve an entailment scale of the sort discussed here which probably explains why they formulated the law as absolute, rather than depending on the properties (likelihood and prior belief) of the premises.

3.3.4 Weakness law (*loi de faiblesse*)

The last law I will mention here is the weakness law which states that:

(26) **Weakness law**: if an utterance of content R argues in favor of C but is a *weak* argument in favor of C (i.e. is low on the scale associated with C), then, under appropriate circumstances, R can be used as an argument for $\neg C$.

Ducrot (1980a) paraphrases the law as follows: "to assert a quantity which happens to be small [amounts to] assert the smallness of this quantity". This second part is what allows the counter-oriented argumentation.

The law is at play in examples like (27).

(27) a. You won't get ruined, the ticket costs 5 dollars.
b. You won't get ruined, the ticket does not cost 5 dollars.

In (27) the same premise (R: *the ticket costs 5 dollars*) and its negation are used to argue in favor of the same conclusion. This indicates that R can be used to argue

both for and against the conclusion *C you won't get ruined*, seemingly violating the negation law introduced above.

At first sight, the weakness law is incompatible with the probabilistic angle. It is not possible for the same set of reasons to be an argument for both C and its negation $\neg C$: $P(C|R) > C$ necessarily entails $P(\neg C) > P(\neg C|R)$. As suggested by Ducrot's paraphrase, this law, if empirically founded, should result from Gricean-like considerations on the meaning of an utterance, i.e. if the speaker had a better argument in favor of their conclusion they would have used it. From there, one can infer that no stronger argument holds, which amounts to arguing against the conclusion.

That approach is essentially the one adopted by Harris et al. (2009) when discussing the argument of being "damned by faint praise", which corresponds to the cases covered by the weakness law. These authors also argue that these cases seem to be *prima facie* counterexamples to a Bayesian approach to argumentation. They go on by proposing an account of these examples which rests on the considerations of alternative (stronger) arguments which could have been used, and offer experimental evidence which supports their model.

4 Argumentative elements

Having set the formal background against which I reinterpreted the insights of *AwL*, I will now discuss how to describe and account for the properties of different argumentative markers.

I will consider three types of argumentative elements:

i. Monadic elements which modify the argumentative profile of an utterance because of the way they affect information *packaging*, i.e. whether they convey information in an at-issue or non at-issue way (Sec. 4.1).

ii. Monadic elements which directly affect the argumentative value of an utterance, i.e. carry an intrinsically probabilistic/argumentative component (Sec. 4.2)

iii. Dyadic elements (connectives) which impose constraints on the orientation of the elements in their scope and their antecedents. These elements are also intrinsically argumentative (Sec. 4.3).

For those elements that conventionally encode an argumentative constraint, this one is best viewed as a species of ancillary meaning. A&D argued that they are instances of presuppositions. However, one can use the tests proposed by Potts (2007) and McCready (2010) to distinguish conventional implicatures (CI) and presuppositions to show that argumentative content is more related to CI, in spite of

Potts' rejection of the use of the term to describe the contribution of elements like *but*. We do not delve into these details here, but assume that the compositionality rules of a system like $\mathscr{L}_{CI}^{+}$ (Potts 2005, McCready 2010) correctly captures the way argumentative effects compose in an utterance.

I will not discuss all operators that were described in the *AwL* literature, but this section with a table enumerating these elements.

4.1 Information layering operators

I start by considering operators which affect the argumentative properties of their host, not because they convey an explicitly argumentative probabilistic constraint, but because of the way they package the information conveyed by the utterance. In doing so, I thus go against one of the main tenets of *AwL*, according to which informational values come second after argumentative orientation. My goal is to show that not all operators should be considered as encoding argumentative constraints, even though they have argumentative effects.

I discuss two operators: the exclusive adverb *only*, as well as the adverb *almost* which involves a conventional implicature.

4.1.1 Exclusive markers: *Only*

The argumentative effect of *only* is described by Ducrot (1973b) as one of reversal: if an utterance of content *R* argues for *C*, then *only R* will argue against *C*, i.e. in favor of ¬*C*. Thus (28a) is a felicitous discourse, whereas (28b) is not, even though Ritchie's diploma is the same in both cases.

(28) a. Ritchie is quite competent, he has a master's degree.
b. #Ritchie is quite competent, he only has a master's degree.

Rather than postulate that *only* directly encodes this reversal, Winterstein (2012a, 2015) argues that this argumentative behavior can be predicted if it is assumed that only the at-issue content of *only* is considered in its argumentative profile. Although there are many conflicting analyses of the precise contribution of *only* (see e.g. Coppock & Beaver 2013 for a review), most agree that a sentence of the form *only R* conveys:

- a negative, asserted/at-issue content, according to which *R* is the only proposition which is true (among a set of alternatives contextually determined, by taking into account the associate of *only*)
- a positive, not at-issue content, which conveys the truth of *R*

Formal analyses differ in how they determine the set of alternatives, whether these form a scale or not, and on the status of the positive component as a presupposition (Rooth 1992, Krifka 1999), conventional implicature (Beyssade 2010) or more complex proposals (Ippolito 2008, Zeevat 2009).

Whatever the status of the positive content, Winterstein (2012a) proposes that the argumentative profile of *only* is based on its asserted content alone, i.e. that the positive part is ignored in the calculation of the argumentative orientation of an utterance using *only*. The argumentative reversal effect is then explained by considering that the negative part negates propositions which are belong to the same argumentative class as the prejacent of *only* and are placed higher on the corresponding argumentative scale.

Winterstein (2015) presents experimental evidence which shows that the argumentative profile of *only* is identical to that of *no more than* when *only* modifies a quantified noun phrase. This supports the idea that only the negative, at-issue content plays a role in the evaluation of the argumentative effect of an utterance involving *only*. More generally, this suggests that non at-issue, backgrounded meaning is ignored in argumentative computations. This is in line with the characterization of presuppositions as preconditions for assertions, and also consonant with observations by A&D who argue that presupposed content does not enter into the semantics of argumentative operators.

4.1.2 *Almost*

We already mentioned the observation, dating as far back as Ducrot (1972), that an utterance of the form *almost R* has the same argumentative orientation as an utterance *R*, even though it actually entails $\neg R$. An additional observation is that *almost R* is a weaker argument than *R*, i.e. both form a scale on which *R* has a higher position.

As for *only*, there is no attempt within *AwL* to derive these argumentative constraints on the basis of the informational content of *almost*. These constraints are assumed to be part of the meaning postulate of *almost*. In contrast to that position, Jayez & Tovena (2008) (J&T) propose an account of how to derive the argumentative properties of *almost* based on its at-issue content.[11]

Essentially, they propose that modifying a property *P* with *almost* conveys two meaning components. One is at an at-issue content which conveys that the actual value denoted by *almost P* is superior to a "left-threshold" of *P*, where a left-threshold is defined as a point which determines a zone of indiscernibility on the left side of a value.

11 Other approaches to *almost* and *barely* are mentioned by Horn (2002) and Verhagen (2005).

To illustrate, consider (29).

(29) Almost half the students failed the quiz.

There the quantity q_f of students who failed is such that $q_f > q_t$, where q_t is such that $q_t < 0.5$ but is contextually indiscernible from the value 0.5 for a conclusion C (which corresponds to the argumentative goal the speaker is aiming at).

The other component is a conventional implicature according to which the actual value P' is 'below' P on the relevant scale. In the case of (29) this means that $q_f < 0.5$.

Just like for *only* the argumentative properties of *almost* are explained on the basis of its at-issue contribution, and by assuming that its non at-issue component, here a conventional implicature, is ignored. J&T note that Ducrot (1972) already observed that presupposed material is not available for subsequent discursive attachment (Ducrot called it the "linking law"). This property explains the impossibility of building an argumentation which exploits presupposed material. J&T propose to extend it to all non-asserted, including the conventional implicature conveyed by *almost*. Thus, as for the case of *only* the argumentative profile of an *almost*-utterance is only calculated on the basis of its asserted content.

Note that in some cases the conventional implicature of *almost* cannot be ignored for argumentative purposes. A case in point is given in (30).

(30) This is perfect exercise in the morning. When you almost break a sweat riding your bike to work.

In (30) the point of the speaker is that the perfect amount of exercise is to work out as much as possible without reaching the point of sweating, i.e. the speaker's point hinges on the negative conventional implicature.

On way to account for this behavior is to consider that the conventional implicature is actually at-issue in (30). This hypothesis is backed up by the observation that if the addressee denies (30), their denial can bear on the conventional implicature:

(31) No you're wrong, sweating is an ideal way to start the day.

Thus, the proper characterization for the way information enters argumentative calculations indeed goes along the at-issue/not at-issue distinction rather than on the informational layer at which it is conveyed (CI, presupposition etc.) Anything which is at-issue is considered in the probabilistic update which determines argumentative effects, the rest is ignored.

4.2 Other monadic argumentative operators

Here we discuss operators that have argumentative effects that are not tied to the way they package information. These elements give an indication about the relevance of their hosts to some argumentative goal. Typically they either mark their prejacent as a strong or weak argument.

4.2.1 Argumentative weakeners: epistemic modals

Anscombre (1989) describes French *peut-être* (≈*maybe*) as downtoning the argumentative strength of his host. More formally: if $rel(R,C) > 0$, then $rel(R,C) > rel(\text{maybe}(R),C) > 0$, i.e. *maybe* keeps the argumentative orientation of its scope, but reduces its argumentative strength.[12]

Yalcin (2010), Lassiter (2010) propose that an element like *maybe* (and other gradable epistemic modals) should directly be associated with the scale of standard numerical probability. This dovetails naturally with the Bayesian interpretation of argumentation and also allows to directly derive their argumentative profile.

When an epistemic modal like *maybe/peut-être* is used with a content R as its scope, the ensuing belief update is done not by considering the absolute truth of R, but a lower probability $P_f(R)$ such that $0 < P_f(R) < 1$.

In many cases, especially monologues, we can assume a more precise constraint: $P_f(R) > P_i(R)$, where P_i is the prior probability measure. In dialogical situations, when *maybe* is used as a reply, this does not have to be the case (cf. infra). To handle the kind of belief update that follows an uncertain assertion, I use Jeffrey Conditionalization (JC, cf. 3.1.2). Doing so, we can compare the different impacts of full conditionalization (i.e. assuming that $P_f(R) = 1$) and JC to show that full conditionalization yields a higher impact term than JC, meaning that the use of a modal indeed downtones the argumentative strength (where the impact term measures how much the posterior and prior beliefs differ):

- Full conditionalization impact term: $I_f = \dfrac{P(R|C)}{P(R)}$
- Jeffrey conditionalization impact term: $I_{JC} = \dfrac{P(R|C)}{P(R)}P_f(R) + \dfrac{P(\neg R|C)}{P(\neg R)}P_f(\neg R)$
- $I_f - I_{JC} = (1 - P_f(R))\dfrac{P(R|C)}{P(R)} - \dfrac{P(\neg R|C)}{P(\neg R)}P_f(\neg R)$

12 Here I only deal with the adverbial *maybe* which takes a propositional object as its argument. The analysis I propose also applies to the bare *maybe* that can be used as a reply in dialogue. Whenever relevant I will mention this case.

- $I_f - I_{JC} = P_f(\neg R)\left(\frac{P(R|C)}{P(R)} - \frac{P(\neg R|C)}{P(\neg R)}\right)$
- $I_f - I_{JC} = P_f(\neg R)\left(\frac{P(C|R)}{P(C)} - \frac{P(C|\neg R)}{P(C)}\right)$ (via Bayes' rule)
- If R argues for C, then $P(C|R) > P(C) > P(C|\neg R)$, meaning $I_f - I_{JC} > 0$

The calculation above shows that JC always yields a lower impact term than full conditionalization. In section 3.1.2 I showed that the JC impact term is positive if and only if $P_f(R) > P_i(R)$. Thus, whenever that condition is met we have: $P_i(C|R) > P_f(C) > P_i(C)$ which corresponds to the case described by Anscombre: the use of *maybe* downtones the argumentative strength, but keeps the orientation. However when the prior belief in $P_i(R)$ is higher than $P_f(R)$ it is predicted that the argumentative orientation will be reversed. This is what I assume happens in cases like (32) (where *might* is considered to have a contribution similar to *maybe*).

(32) a. *A:* I'm so happy Lemmy will be on stage tonight.
b. *B:* He said he might be on stage, so don't get your hopes too high.

The semantics outlined here might appear completely trivial and vacuous since as a rule most non-tautological and non-contradictory propositions should be assigned a probability between 0 and 1. One way to understand the use of *maybe* in discourse is thus with regards to the prior probability P_i. For monologues, I argued in section 3.1.2 that a speaker usually asserts a content in order to increase its probability, so we get the downtoning effect. When that assumption does not hold, we expect *maybe* to have different effects.

4.2.2 Argumentative strengtheners

Here I discuss different elements whose presence indicate that the speaker considers that they have a strong argument in favor of their conclusion. Generally, this can be captured by saying that the relevance of the prejacent (or its diagnosticity) is higher than some contextually determined threshold which corresponds to a strong argument (cf. the discussion on the RSA conditions in Sec. 3.1.2).

In English, one potential candidate for such a strengthener would be the adverb *even* in its monadic uses, i.e. when it is not used with a clear need to find an antecedent. Given that the semantics and status of *even* gave rise to a rich and complex literature, I will not consider it here (see Sec. 4.3.2 for more details). Instead, I will briefly introduce the case of the Cantonese sentence final particle *tim1*. This particle has an intricate meaning, ranging from a pure additive meaning similar to *too* to a

mirative reading indicating a form of surprise from the speaker (Lee & Pan 2010, Winterstein et al. 2018).

Winterstein et al. (2018) argue that the mirative reading can be analyzed as a mark of high relevance of its host relative to the goal targeted by the speaker. The argument is based on the observation that the mirative *tim1* can be used to indicate that the speaker is either surprised about the fact they are reporting or about the relationship between that content and some other proposition. In addition, and in contradistinction with the additive *tim1*, the mirative usage is not anaphoric in any way. Thus an example like (33) can be understood in two ways under the mirative reading.

(33) A3-Wai4 zung2 wa2 hou2 zung1ji3 ngo5 tim1.
A-Wai even say very like me TIM1
'A-Wai said he likes me!'

On one hand the particle *tim1* can indicate the surprise of the speaker at the news of A-Wai liking them. On the other hand, the sentence is also compatible with a situation in which the speaker is already aware that A-Wai likes them, but realizes only now the consequences of this information, for example after learning that A-Wai has a history as a stalker (what Aikhenvald 2004 calls a *deferred realization*).

This ambiguity of the mirative *tim1* is captured by the constraint of high relevance, i.e. higher than some contextually assumed threshold for strong arguments (see Winterstein et al. 2018 for details). High relevance can come from:

- A low prior belief in R, the prejacent, i.e. a low value of $P(R)$. This deals with the speaker surprise reading of *tim1*.
- A high value of $P(C|R)$ or $P(R|C)$, i.e. the establishment of a strong causal link between the conclusion C and R. This deals with the deferred realization aspect.

Generally speaking, the class of discourse particles, and especially sentence final particles is prone to contain elements which can be analyzed as monadic markers of argumentation. This is because these elements are often non-anaphoric, and place their contribution at a non truth-conditional level. A common way to treat most of these particles is in terms of modal operators of some sort. In the probabilistic framework we assume, most modal operations can be interpreted probabilistically, which makes these markers good examples of monadic argumentative markers.

4.3 Argumentative connectives

To conclude we present argumentative connectives which take two elements as their arguments and impose constraints on their argumentative profiles (strength and/or orientation). We begin by briefly mentioning the case of *but* which has already been given a probabilistic treatment, then discuss the contribution of *even*, another emblematic argumentative marker.

4.3.1 Adversatives: *but*

Within *AwL* the adversative connective *but* (or its French near equivalent *mais*) is described as a marker of argumentative opposition (Anscombre & Ducrot 1977, Merin 1999, Winterstein 2010, 2012b). Its contribution can be summarized as in (34) (using the $\diamond$ operator introduced by McCready (2010) to conjoin at-issue and non at-issue meaning).

(34) $\quad [\![\text{but}]\!] = \lambda Q \lambda P.P \wedge Q \diamond \lambda Q \lambda P.\text{rel}(P,C) > 0 > \text{rel}(Q,C)$

In prose this means that *but* conveys the truth of its two conjuncts and imposes that the first one argues for some conclusion C while the second one argues against it. This analysis naturally deals with all uses of *but* described as involving concession or denials of expectation (Lakoff 1971, Sanders et al. 1992). More problematic are cases that involve semantic opposition, for example between antonyms. Winterstein (2012b) discusses these points, and shows how the above probabilistic description of *but* accounts for all readings of *but*, including the semantic opposition ones. For reasons of space I do not discuss these aspects.

The description given in (34) departs from that of A&D in one respect: it does not explicitly mark the second conjunct as decisive, i.e. as argumentatively stronger than the first one. A&D add that decisiveness constraint to their description of *mais/but* after observing than any discourse continuation can only bear of the second conjunct, which they interpret as an indication that the second argument superseded the first one. However this fact can also be interpreted as a discursive constraint such as the right frontier constraint, which is independently justified (Polanyi 1985, Asher 1993).

4.3.2 Additive connectives: *even*

Additive connectives are dual to adversative ones. Instead of indicating that the elements in their scope are in argumentative opposition, they indicate their co-orientation. Here we will focus on the case of *even* and other elements in the class of

scalar additives (Gazdar 1979, Krifka 1999).[13] Here we follow Greenberg (2016, 2017) in focusing on the question of the scale on which *even* bears, rather than on its nature as an NPI, or whether it comes with an existential presupposition. These issues are of course crucial to a full account of *even*, but would take us too far afield.

The main claim of *AwL* is that *even* indicates not just the co-orientation, but also the argumentative superiority of its host compared to its antecedent (Ducrot 1980a, Anscombre & Ducrot 1983).[14] Example (35) illustrates this: the use of *even* in the last segment indicates that Lemmy's coming on stage is a stronger argument for the quality of the concert than Brian playing a song.

(35) The concert was a success. Brian played a song. Lemmy even came on stage.

However, the description given by *AwL* is not tenable, and needs to be amended. *Even* cannot be used in example (36a) (adapted from (25)), even though having interesting keynote speakers is a better argument in favor of the conference than offering nice hats. The reverse order in (36b) appears much more natural (note that *above all* would work in (36a), suggesting that this marker does encode argumentative superiority, unlike *even*).

(36) a. #Conference X is very attractive. You get a nice conference hat, and the organizers even invited interesting keynote speakers.
b. Conference X is very attractive. The organizers invited interesting keynote speakers and you even get a nice conference hat.

An alternative way to describe the scale on which *even* bears is to assume it is a scale of likelihood (see a.o. Karttunen & Peters 1979, Chierchia 2013): the prejacent of *even* is supposed to be more unlikely than its antecedent (or than any other salient proposition). The obvious way to interpret that scale is to identify likelihood with probability: A is more unlikely than B iff $P(A) < P(B)$. The data in (36a)–(36b) are easily explained by such an analysis: offering hats is more unlikely than having keynote speakers, independently of their relevance to the quality of the conference.

However, Greenberg (2016, 2017) discusses a number of problematic examples for the likelihood approach (which we will not review here). The gist of her argument is that assuming a simple comparison of the bare likelihood of prejacent and an-

13 An argumentative treatment of non-scalar additives can be found in (Winterstein 2011, Winterstein & Zeevat 2012)

14 A&D actually describe *même*, the French near equivalent of *even*. Differences between the two items are not relevant for the discussion here.

tecedent is too broad and leads to both under and over generation cases. Greenberg's proposal then goes along the following lines:[15]

> . . . [*even*] requires that with respect to *x*, a nonfocused element in the prejacent of *even*, *p* [the prejacent], and *G*, a contextually supplied gradable property, the following two conditions hold: (a) *x*'s maximal degree on the scale associated with *G* is higher in all accessible *p* worlds than in all accessible *q*-and-not-*p* worlds, and (b) in the latter kind of worlds *x*'s degree on *G* is at least as high as the standard of *G*. (Greenberg 2017: p. 11)

For (35), this boils down to saying that the concert was successful in all accessible worlds, and more successful in the worlds in which Lemmy came on stage than the ones in which he did not. The case laid out by Greenberg for introducing a contextual scale in the semantics is solid, and I will not dispute it here. Rather, I propose to interpret her proposal in argumentative terms. As mentioned above, A&D's proposal for *even* is problematic in some cases, but it can be amended. The upshot of such a move is that it gives a principled manner by which the *even*-scale is construed: it is related to the argumentative goal, and the abduction of this goal is guided by the set of argumentative constraints at play in the discourse, the assumed stance of the speaker in the discourse. . . all of which conspire to restrict the set of possible hypotheses for the goal.

First, rather than following Greenberg and assume that the degree of *x* is above the standard in all worlds, including the ones in which the prejacent is false but the antecedent true, I propose a constraint of argumentative co-orientation: both the prejacent and antecedent of *even* need to be arguments for the same conclusion. Such a constraint is also at play in the semantics of non-scalar additives (Winterstein 2011, Winterstein & Zeevat 2012), and given how many scalar additives evolved from non-scalar ones (Winterstein et al. 2018), this seems like a desirable parallel between the semantics of these two classes of elements. This also has the benefit of avoiding some potential issues of Greenberg's proposal for an example like (37) which involves the predicate *dry* which has an absolute maximal standard (Kennedy & McNally 2005), i.e. something is dry iff its degree of dryness is maximal.

(37) [Towels were put out to dry. None of them is dry yet.]
A: Which one is the most dry?
B: This one is already half dry, and this one is even more dry.

15 Greenberg offers more complex versions of the meaning postulate for cases involving contrastive topics and two degrees of comparisons. We eschew these details here, but see Winterstein (2011) for related considerations about the semantics of *too*.

If the scale at play in (37) is one of dryness, then Greenberg's account makes the wrong predictions: the degree of dryness of the towels is under the standard in all worlds. Of course, her account leaves room around this issue by simply assuming that the relevant scale is not that of dryness, but rather one related to the needs of speaker A. In our view, this corresponds to considering an argumentative scale. Given the mapping between degree scales and argumentative scales, it also accounts for the interpretation and use of *even* with gradable predicates.

Second, we have seen that simply stating a constraint of argumentative superiority on that scale does not work. Instead I propose that the scalar constraint of *even* bears on the likelihoods of the prejacent and antecedent, where the notion of likelihood is understood in its technical Bayesian sense, i.e. relative to a conclusion. Precisely, *even* imposes the following constraint: $P(R|C) < P(A|C)$, where R is the antecedent of *even* and A its antecedent. Taken with the constraint of argumentative co-orientation mentioned above, this gives the following set of constraints for *even*, where R is the part of the prejacent that enters argumentative reasoning, A is the equivalent in the antecedent, and C is the conclusion targeted by the speaker.[16]

(38) a. *Co-orientation*: $P(C|R) > P(C)$ and $P(C|A) > P(C)$
b. *Scalar constraint*: $P(R|C) < P(A|C)$

Note that between themselves these constraints do **not** entail $P(R) > P(A)$, thus avoiding the problems of the "pure" likelihood approach mentioned by Greenberg. What the scalar constraint conveys is that, assuming the conclusion is true, then the prejacent is less likely to be true than the antecedent in the same conditions, which correctly rules out an example like (36a).

Taking stock, I proposed to adopt Greenberg's analysis for *even*, and interpreted it in an argumentative perspective. Besides improving the original description of *AwL*, this move also offers a way to restrict the process by which one abducts the scale postulated by Greenberg for the semantics of *even*.

4.4 Summary: argumentative markers

The few markers in this section only give a overview of the elements that affect the argumentative profile of an utterance. Table 1 summarizes most of the known/purported markers or families of markers in English with appropriate references when they exist (sometimes about their French equivalents). The table indicates a short description of the argumentative effect of markers, their arity, examples of linguistic items that convey these effects and references to the literature.

16 In cases contrastive topics are involved, the contents of A and R should be modified to substitute alternatives in the way detailed by Greenberg. We stick to the simple cases here.

Value	Arity	Marker(s)	References
Inversion	1	negation, *less than, at most*, polar interrogatives	(Anscombre & Ducrot 1983, Merin 1999)
Inversion + convey prejacent	1	*only*, *barely*	(Ducrot 1973b, 1980a, Anscombre & Ducrot 1983, Winterstein 2012a, 2015)
Weakening	1	*maybe*	(Anscombre & Ducrot 1983, Anscombre 1989)
Weakening + convey negation of prejacent	1	*almost*	(Ducrot 1980a, Anscombre & Ducrot 1983, Jayez & Tovena 2008)
Strengthening	1	*even*, *tim1* (Cantonese)	(Winterstein et al. 2018)
Opposite arg. orientations	1	*few* vs. *a few*	(Ducrot 1973a)
Argues for higher values	2	equality (*as X as*)	(Anscombre & Ducrot 1983)
Parallelism	2	*too*	(Winterstein & Zeevat 2012)
Independence	2	*and*, *d'ailleurs (FR)*	(Ducrot 1980b, Jayez & Winterstein 2013)
Opposition	2	*but*, *yet, even though*	(Anscombre & Ducrot 1977, Merin 1999, Winterstein 2012b)
Inferiority	2	*en tout cas (FR)*	(Ducrot 1980a: p. 74)
Lower likelihood	2	*even*	here, (Anscombre 1973, Ducrot 1980a)
Arg. superiority	2	*above all*	here
Argues for	2	*if, so, because*	(Ducrot 1980a, Carel & Ducrot 1999)

Table 1 Argumentative markers

As mentioned several times already, these markers modify the argumentative profile of an utterance by different means. Minimally we distinguished those that do it by separating information in at-issue and non at-issue layers, others that encode a probabilistic constraint but not one that directly makes reference to the conclusion targeted by the speaker, and those that encode a constraint hinging on that goal. The

latter ones are argumentative markers in the strong sense: their argumentative effect is not derived, but part of their core semantics. They are thus the prime examples of what A&D called argumentation within language.

5 Conclusion

In this paper I have discussed different aspects of the theory of argumentation within language and shown how to interpret them in a Bayesian perspective on the semantics and pragmatics of natural language. The overarching goal of this discussion is to show the descriptive and theoretical merits of the insights of *AwL*, and cast them in formal terms that makes them compatible with current research in the field. It is also an attempt at bringing argumentative studies and formal semantics and pragmatics closer by highlighting the non trivial ways in which language choice affects the way an argument is evaluated. In doing so, the account of argumentation within language I gave departs from most of the work in the framework of that theory: rather than assuming that all semantic meaning is argumentative, I show how many argumentative effects are best seen as effects stemming from the assumption that meaning is probabilistic.

Having done so, many questions remain open. One pertains to the nature of argumentative goals, the fundamental elements of the theory around which all argumentative effects are evaluated. In some respects these goals resemble inferences: they come about as the result of some calculations based on what a speaker said, and the alleged intentions of the speaker. However, goals differ from inferences in many ways. The most obvious difference comes from the negation law which states that $p \underset{arg}{\rightsquigarrow} q \equiv \neg p \underset{arg}{\rightsquigarrow} \neg q$ (cf. Sec. 3.3.1). This property is trivially false in the case of entailment relations, and generally not a property expected of inferences. Winterstein (2013) discusses the case of quantity implicatures and shows that these inferences cannot serve as argumentative goals, setting the two notions further apart. In addition, the process of abduction of the goal also needs to be properly spelled out. Anscombre & Ducrot (1983) claim that when implicit, the argumentative goal is "easily restored", whereas Merin (1999) goes as far as saying that restoring it is what conversation is all about. Between these two extremes one can imagine adopting a Bayesian perspective which selects the most likely goal to be targeted by the speaker given their utterance and prior beliefs about the goals the speaker is likely to target. This is left to future work.

As a final word, one might wonder what the status of argumentation within language is. A&D's claim that everything in semantics is argumentative has already been challenged. Beyond this, many discussions in this paper are not language specific. In particular, the argumentative laws apply in principle to all cases of argumentation, verbal or not. To my knowledge these laws have not been discussed

outside of the linguistic domain, probably because they are usually seen as laws governing the well-formedness of discourses. But nothing in their formulation forbids seeing them as rules for all forms of argumentation, e.g. in pictorial form as used in advertisements. What is thus truly linguistic in argumentation is found in the various markers I described. Argumentation offers a principled way of describing the semantics of some of these elements and of describing the contextual elements that enter their interpretation. Furthermore, if one assumes with Mercier & Sperber (2011) that argumentation played a key role in the development of language, it should come as no surprise to find elements directly bearing on that dimension of communication.

A Proofs

A.1 Negation law

We want to show that if a content R argues for a conclusion C, i.e. $P(C|R) > P(C)$, then $\neg R$ argues for $\neg C$, i.e. $P(C|R) < P(C)$.

Proof.

$$
\begin{aligned}
& P(C|R) > P(C) && \\
\equiv & \frac{P(C,R)}{P(R)} > P(C) && \text{Def. of conditional prob.} \\
\equiv & \frac{P(C) - P(C,\neg R)}{P(R)} > P(C) && \text{Law of total probability} \\
\equiv & P(C) - P(C,\neg R) > P(R)P(C) && \\
\equiv & P(C,\neg R) < P(C)(1 - P(R)) && \\
\equiv & P(C,\neg R) < P(C)P(\neg R) && \\
\equiv & \frac{P(C,\neg R)}{P(\neg R)} < P(C) && \\
\equiv & P(C|\neg R) < P(C) &&
\end{aligned}
$$

□

A.2 Inversion law

Let R, R', C be such that:

(39) $P(C|R) > P(C|R') > P(C)$

The inversion law postulates that the following is also true:

(40) $\quad P(\neg C|\neg R') > P(\neg C|\neg R) > P(\neg C)$

Proof. Observe that $P(\neg C|\neg R) = 1 - P(C|\neg R)$. So,

$$P(C) > P(C|\neg R) > P(C|\neg R')(40)$$

The first part of the inequalities was proven with the negation law.

The rest is not a consequence of (39), but it is true under certain conditions defined by the following system of inequalities:

$$\begin{cases} P(C|R) > P(C|R') \\ P(C|\neg R) > P(C|\neg R') \end{cases}$$

$$\equiv \begin{cases} \dfrac{P(C,R)}{P(R)} > \dfrac{P(C,R')}{P(R')} \\ \dfrac{P(C,\neg R)}{P(\neg R)} > \dfrac{P(C,\neg R')}{P(\neg R')} \end{cases} \qquad \text{Def. of conditional prob.}$$

$$\equiv \begin{cases} P(R') > P(R)\dfrac{P(C,R')}{P(C,R)} \\ 1 - P(R') > \dfrac{P(\neg R)P(C,\neg R')}{P(C,\neg R)} \end{cases}$$

$$\equiv \begin{cases} P(R') > P(R)\dfrac{P(C,R')}{P(C,R)} \\ 1 - P(R') > \dfrac{(1-P(R))P(C,\neg R')}{P(C,\neg R)} \end{cases}$$

$$\equiv \begin{cases} P(R') > P(R)\dfrac{P(C,R')}{P(C,R)} \\ 1 - \dfrac{(1-P(R))P(C,\neg R')}{P(C,\neg R)} > P(R') \end{cases}$$

$$\equiv \begin{cases} P(R') > P(R)\dfrac{P(C,R')}{P(C,R)} \\ \dfrac{P(C,\neg R) - (1-P(R))P(C,\neg R')}{P(C,\neg R)} > P(R') \end{cases}$$

$$\equiv \begin{cases} P(R') > P(R)\dfrac{P(C,R')}{P(C,R)} \\ P(R)\dfrac{P(C,\neg R')}{P(C,\neg R)} + \dfrac{P(C,\neg R) - P(C,\neg R')}{P(C,\neg R)} > P(R') \end{cases}$$

Taken together these give:

$$
\begin{aligned}
& P(R)\frac{P(C,\neg R')}{P(C,\neg R)} + \frac{P(C,\neg R) - P(C,\neg R')}{P(C,\neg R)} > P(R)\frac{P(C,R')}{P(C,R)} \\
\equiv & P(R)\frac{P(C,\neg R')}{P(C,\neg R)} + \frac{P(C,\neg R) - P(C,\neg R')}{P(C,\neg R)} - P(R)\frac{P(C,R')}{P(C,R)} > 0 \\
\equiv & P(R)\left(\frac{P(C,\neg R')}{P(C,\neg R)} - \frac{P(C,R')}{P(C,R)}\right) + \frac{P(C,\neg R) - P(C,\neg R')}{P(C,\neg R)} > 0 \\
\equiv & P(R)\left(\frac{P(C,\neg R')P(C,R) - P(C,\neg R)P(C,R')}{P(C,\neg R)P(C,R)}\right) + \frac{P(C,\neg R) - P(C,\neg R')}{P(C,\neg R)} > 0 \\
\equiv & P(R)\left(\frac{(P(C) - P(C,R'))P(C,R) - (P(C) - P(C,R))P(C,R')}{P(C,R)}\right) + P(C,\neg R) - P(C,\neg R') > 0 \\
\equiv & P(R)\left(\frac{P(C)(P(C,R) - P(C,R'))}{P(C,R)}\right) + P(C,\neg R) - P(C,\neg R') > 0 \\
\equiv & P(R)\left(\frac{P(C)(P(C,R) - P(C,R'))}{P(C,R)}\right) + P(C) - P(C,R) - P(C) + P(C,R') > 0 \\
\equiv & P(R)\left(\frac{P(C)(P(C,R) - P(C,R'))}{P(C,R)}\right) - (P(C,R) - P(C,R')) > 0 \\
\equiv & (P(C,R) - P(C,R'))\left(\frac{P(R)P(C)}{P(C,R)} - 1\right) > 0
\end{aligned}
$$

Besides:

$$
\begin{aligned}
& P(C|R) > P(C) && \text{by assumption} \\
\equiv & \frac{P(C,R)}{P(R)} > P(C) \\
\equiv & P(C,R) > P(C)P(R) \\
\equiv & 1 > \frac{P(R)P(C)}{P(C,R)} \\
\equiv & \left(\frac{P(R)P(C)}{P(C,R)} - 1\right) < 0
\end{aligned}
$$

Therefore: $P(C,R') > P(C,R)$.

□

A.3 Argumentation under Jeffrey Conditionalization

We will show that if a content R argues for C under full conditionalization, then R also argues for C under Jeffrey Conditionalization if and only if the posterior belief in R is higher than the prior belief in R.

Let P_i be the prior probability measure and P_f the posterior probability measure after R has been uttered.

Proof. We are interested in the difference between $P_f(C)$ and $P_i(C)$.

$$
\begin{aligned}
& P_f(C) - P_i(C) \\
=& P_i(C|R)P_f(R) + P_i(C|\neg R)P_f(\neg R) - P_i(C) && \text{Def. of JC} \\
=& P_i(C|R)P_f(R) + P_i(C|\neg R)P_f(\neg R) - P_i(C|R)P_i(R) - P_i(C|\neg R)P_i(\neg R) && \text{Law of total probability} \\
=& P_i(C|R)\left(P_f(R) - P_i(R)\right) + P_i(C|\neg R)\left(P_f(\neg R) - P_i(\neg R)\right) \\
=& P_i(C|R)\left(P_f(R) - P_i(R)\right) - P_i(C|\neg R)\left(P_f(R) - P_i(R)\right) && \text{cf.} P(\neg R) = 1 - P(R) \\
=& \left(P_i(C|R) - P_i(C|\neg R)\right)\left(P_f(R) - P_i(R)\right)
\end{aligned}
$$

Therefore $P_f(C) - P_i(C) > 0$ if and only if

$$
\begin{aligned}
\left(P_i(C|R) - P_i(C|\neg R)\right) > 0 \text{ and } \left(P_f(R) - P_i(R)\right) > 0 \\
\text{or } \left(P_i(C|R) - P_i(C|\neg R)\right) < 0 \text{ and } \left(P_f(R) - P_i(R)\right) < 0
\end{aligned}
$$

We assumed that R argues for C under full conditionalization: i.e.:

$$
\begin{aligned}
& P_i(C|R) > P_i(C) > P_i(C|\neg R) > 0 \\
\rightarrow & P_i(C|R) - P_i(C|\neg R) > 0
\end{aligned}
$$

Therefore from the above:

$$
\begin{aligned}
& P_f(C) - P_i(C) > 0 \\
\equiv & P_f(R) - P_i(R) > 0
\end{aligned}
$$

□

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