

A Primer on Argument Assessment

Version 1.0

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1 Introduction

This paper follows up *A Primer on Argument* [1] by providing introductory information about how to assess arguments. The same warning from the earlier *Primer* continues to apply:

Readers who are familiar with the assurance / safety case work over the last couple of decades will notice some differences here. Most of these differences are rooted in our emphasis on harmony with the mature principles of argument over harmony with the adolescent ideas of assurance cases. None of the differences should be interpreted as us saying the other stuff is necessarily erroneous.¹ We are only [seeking to establish] *a* common understanding from which [to] proceed forward.

The structure is as follows. The remainder of this section identifies and summarizes prerequisite information a reader needs to understand to understand this document. Section 2 introduces a way (but not the *only* way) to assess atomic arguments.² Section 3 does the same for compound arguments. Section 4 wraps everything up.

For readers to comprehend this document without first reading two other documents, we summarize the essential material here. Presumably the truly interested readers will eventually choose to read the other documents, too, but doing so is not intended to be a prerequisite for understanding this one. Here we summarize material from *A Primer on Argument* [1] and *The Friendly Argument Notation* (FAN) [2].

1.1 What you need to know about argument

A Primer on Argument identified a collection of primitives, precepts, and practical considerations important for discussing, creating, and assessing ARGUMENTS. To the extent that any of the precepts or practical considerations are needed, they will be introduced at the point in this document where they are needed. Here, we concentrate on the primitives (which, if you prefer, you may also call ‘terms’).

Contrary to the conventions of the original *Primer*, we use SMALL CAPS alone (without colors) as an aid to identifying and distinguishing among specific defined terms.³ All terms not specifically defined are assumed to have a meaning consistent with their use in ordinary English, and which can be unambiguously determined from the context. We present the definitions without discussion.

- An ARGUMENT is an attempt to convince others to BELIEVE a CONCLUSION through REASONING and one or more PREMISES.
- To BELIEVE is to accept as true.
- The CONCLUSION is the statement you want your audience to BELIEVE.
- A PREMISE is a statement you think your audience BELIEVES.
- REASONING is the statement of why you think the PREMISES should cause your audience to BELIEVE your CONCLUSION.

These primitives express the goal of an ARGUMENT (BELIEF) and encompass the necessary elements of an ARGUMENT: CONCLUSION, REASONING, PREMISE(S). A CONCLUSION alone is not an ARGUMENT.

¹ There is a bunch of erroneous stuff out there, but not all of it is, and we’re not trying to separate the chaff from the wheat in this document.

² If you do not already recognize the phrases ‘atomic argument’ and ‘compound argument’ do not worry. You will soon.

³ All forms of the term are also set in SMALL CAPS. For example, BELIEVED, BELIEF, PREMISES, COGENCY.

REASONING alone is not an ARGUMENT. A PREMISE or several PREMISES is not an ARGUMENT. Several PREMISES and some REASONING do not an ARGUMENT make. And even a CONCLUSION with REASONING and one or more PREMISES is not an ARGUMENT, *unless* it is being offered for the purpose of trying to convince someone to BELIEVE the CONCLUSION.

In addition to the above essential terms there are two more primitives and three helpful terms that are used throughout this document.

- A BINDING is an association between a term used in an ARGUMENT and the real-world information to which that term refers. One example of a BINDING is a definition, through which the meaning of a particular word or phrase in the ARGUMENT is constrained. Other examples of BINDINGS are references to external documents or other artifacts in which relevant information is contained.
- A DEFEATER is a statement that may cause your audience to *not* BELIEVE your CONCLUSION.
- An ATOMIC ARGUMENT consists of a single CONCLUSION together with its immediate REASONING, PREMISES, BINDINGS (if present), and DEFEATERS (if present).
- A COMPOUND ARGUMENT is an ARGUMENT consisting of more than one ATOMIC ARGUMENT.

Finally,

- An ARGUMENT is called COGENT if it rationally justifies BELIEVING its CONCLUSION to the required standard of confidence.

The terms, definitions, and descriptions just given above are consistent with⁴ the common, historic, orthodox vocabulary of ARGUMENT within philosophy and related disciplines.

1.2 What you need to know about FAN

The Friendly Argument Notation (FAN) was developed to facilitate the creation, understanding, and assessment of structured ARGUMENTS [2], particularly, but not exclusively, ARGUMENTS about safety-critical systems. FAN intentionally corresponds closely to traditional ARGUMENT concepts. It is designed to be efficient to write and read, with sufficient semantic and syntactic rigor to capture the necessary distinctions. We use it here specifically for its minimalist nature.

Anyone interested in the formal rules that fully define FAN should read [2]. However, the examples in this section provide enough detail to allow the reader to understand FAN's use in this document. These examples are intentionally simple in hopes of maximizing the likelihood that readers concentrate solely on FAN itself, and not on the content of the ARGUMENTS.

The first example will be the ARGUMENT equivalent of the canonical “hello world” example for programming languages. It is the famous, ancient ARGUMENT for Socrates' mortality. Given the two PREMISES, `All men are mortal` and `Socrates is a man`, we conclude that `Socrates is mortal`. In FAN, this ARGUMENT might look like this:

```
Believing
  Socrates is mortal
is justified by applying
  the AAA-1 syllogism
to these premises
  All men are mortal
  Socrates is a man
```

⁴ Consistency does not imply identicalness. As explained in [1], we have departed a bit from strict orthodoxy in some minor ways based on previous experiences.

This example illustrates how the CONCLUSION, REASONING, and PREMISES are expressed in FAN.

- The CONCLUSION follows a line containing the keyword **Believing**.
- The REASONING follows a line containing “**is justified by applying**”.⁵
- The PREMISES follow the phrase “**to these premises**”, with each PREMISE starting on its own line and being visually distinguishable from any other PREMISES. This visual distinction may be done in a variety of ways, such as using blank lines, numbering, or trailing backslashes.

For some audiences, this FAN ARGUMENT will be understandable as written. But for some other audiences the REASONING (the **AAA-1 syllogism**) may be incomprehensible. To remedy difficulties of this sort, FAN provides a means for expressing BINDINGS (recall the definition of BINDING from above), as shown below.

```
Believing
  Socrates is mortal
is justified by applying
  the <AAA-1 syllogism>
to these premises
  All men are mortal
  Socrates is a man.
with
  <AAA-1 syllogism>: see https://en.wikipedia.org/wiki/Syllogism
```

The keyword **with** begins a BINDING section, and in the example the provided BINDING tells the reader of the ARGUMENT where to go to know what is meant by **AAA-1 syllogism**. In this document each bound phrase is surrounded by angle brackets (< >) to identify it as such. Different conventions (such as **mortal**, *mortal*, or mortal) are also allowed, so long as they are used consistently. As many BINDINGS as are needed may be provided, as shown in the following:

```
Believing
  Socrates is <mortal>
is justified by applying
  the <AAA-1 syllogism>
to these premises
  All men are <mortal>
  Socrates is a man
with
  <AAA-1 syllogism>: see https://en.wikipedia.org/wiki/Syllogism
  <mortal>: subject to death
```

FAN allows DEFEATERS to be expressed following the keyword **unless**. Unless the accepted wisdom about how logic works is wrong, there are no plausible DEFEATERS for our example. To be pedantically explicit about this fact, we could rewrite the ARGUMENT in FAN as follows.

```
Believing
  Socrates is <mortal>
is justified by applying
```

⁵ The FAN definition is a bit less restrictive than this sentence implies. Any text whatsoever may follow the initial keyword **is**. This document always uses the longer phrase **is justified by applying**. Similarly, to identify the beginning of PREMISES, FAN only requires the single keyword **to**, but the longer **to these premises** is used consistently here.

```
    the <AAA-1 syllogism>
to these premises
    All men are <mortal>
    Socrates is a man
with
    <AAA-1 syllogism>: see https://en.wikipedia.org/wiki/Syllogism
    <mortal>: subject to death
unless
    The accepted wisdom about how logic works is wrong
```

To express a COMPOUND ARGUMENT in FAN, one need only to write sequentially each of its constituent ATOMIC ARGUMENTS. FAN facilitates understanding and navigating COMPOUND ARGUMENTS in three ways:

1. allowing statements to be labeled;
2. treating BINDINGS as having global scope; and
3. permitting a FAN COMPOUND ARGUMENT to begin with a free-standing BINDING section.

The following example illustrates these aspects of FAN⁶.

```
with
    <national champion>: winner of NCAA sanctioned tournament
    <reigning>: most recent
Believing
    UVa is the <reigning> <national champion> in two sports
is justified by applying
    conjunction
to these premises
    UVa is the <reigning> <national champion> in women's swimming {wswm}
    UVa is the <reigning> <national champion> in men's lacrosse {mlax}

Believing
    UVa is the <reigning> <national champion> in women's swimming {wswm}
is justified by applying
    the definition of <reigning>
to these premises
    UVa is the 2020-21 <national champion> in women's swimming
    The 2021-2022 women's swimming season has not begun

% The following illustrates the use of a label

Believing
    {mlax}
is justified by applying
    the definition of <reigning>
to these premises
    UVa is the 2021 <national champion> in men's lacrosse
```

⁶ For some readers additional bindings may be needed to enable full comprehension. For example: <UVa>: The University of Virginia, specifically its athletic department (see <https://www.virginiasports.com/>) and <NCAA>: The National Collegiate Athletic Association, which sponsors United States championships in a variety of sports.

The 2022 men's lacrosse season has not started

The material just provided should be enough to enable a reader not previously familiar with FAN to understand its use throughout this document. Just because we use FAN here does not mean that it is the only reasonable notation to use. To the contrary, any notation that adequately expresses ARGUMENTS may be considered a legitimate choice. We chose FAN to minimize to the extent possible the likelihood of notational nuances getting in the way of important basic ideas about ARGUMENT assessment.

1.3 The rest of the paper

The remainder of this paper provides general information about the assessment of ARGUMENTS, specifically by giving guidance about how to determine if an ARGUMENT is COGENT. That is, we present an approach to determining whether an ARGUMENT rationally justifies BELIEVING its CONCLUSION to a required standard of confidence. Philosophers, theologians, lawyers, and others have thought about ARGUMENT COGENCY for thousands of years, creating myriad approaches and ways of talking about these approaches. In recent years, assurance case researchers have added to the ideas, unfortunately often without understanding what has gone before. The material in this paper ignores those additions, instead resting firmly on well-established foundations (as described in [4] & [5] in particular).

For simplicity we begin by explaining a (but not the *only*) systematic way⁷ to assess ATOMIC ARGUMENTS. We then expand on the material to explain a (but not the *only*) systematic way to assess COMPOUND ARGUMENTS.

As an aid to exposition (and retention), we shall call the person who assesses ARGUMENTS “Ashley”. “Cameron” will be the person who created the ARGUMENTS for Ashley to assess⁸. Also, as an aid to retention and as a matter of style, we use interrogative sentences (aka questions) to express the guidelines and frame each question so that an affirmative answer is the good response. Using declarative sentences (aka criteria) is equally acceptable.⁹ Converting from questions to criteria is not difficult; we leave doing so as an exercise for interested readers.

2 Assessing ATOMIC ARGUMENTS – SPRY

One (but not the only) way Ashley might assess the COGENCY of an ATOMIC ARGUMENT is to ask and answer the following four questions:

1. Is the **Syntax** proper?
2. Are the **PREMISES** acceptable?
3. Is the **REASONING** acceptable?

⁷ In a research paper we would spend several pages summarizing many of the different instantiations of assessment approaches that have been propounded over the centuries. Doing so here, however, is more likely to confuse than to enlighten, especially because most of the differences are quite subtle. Keep in mind that we present just one instantiation of one approach. In doing so we are not asserting that the presented approach is necessarily optimal. Nor are we asserting that it has already been applied as is on an actual project. We are asserting that it is suitable for trial in an appropriate case study.

⁸ These names were chosen because they are gender neutral, Ashley and assess both begin with the letter ‘a’ pronounced in the same way in both words, and Cameron and construct both begin with the letter ‘c’ pronounced similarly.

⁹ Well, maybe. Without any empirical basis for thinking so, our intuition is that a criteria-based exposition may be more likely to encourage the dreaded “checklist mentality” than a question-based exposition. That intuition is another reason we chose to use questions here.

4. Is saying “**Yes**” to the CONCLUSION justified?

Whimsically, we may refer to a COGENT ATOMIC ARGUMENT as a *spry*¹⁰ one and call these questions the ‘SPRY’ questions.

We consider each of the four questions in turn.

2.1 Is the Syntax proper?

Evaluating the syntax of an ATOMIC ARGUMENT is primarily an objective activity, the results of which should not vary from one assessor to another. To examine an ATOMIC ARGUMENT’s syntax Ashley needs only to ask and answer these seven questions¹¹:

- a. Is there a single CONCLUSION that is stated in the form of a proposition?
- b. Is there a statement of REASONING?
- c. Is there at least one PREMISE?
- d. Is each PREMISE stated in the form of a proposition?
- e. If there are DEFEATERS, is each stated in the form of a proposition?
- f. Does a BINDING exist for each term or phrase used in the CONCLUSION, REASONING, PREMISES, and (if any) DEFEATERS that does not have a well-known, unambiguous definition?
- g. Does a proper BINDING exist for each reference to an external artifact?

The wording of these questions is intended to be straightforward to understand for anyone who already understands the foundational documents¹², with only one potential subtlety. This subtlety arises with the inclusion of ‘proper’ in question g but not question f. The word is included in question g because determining whether a BINDING to an external artifact references the right artifact (for example, the current configuration-controlled version rather than an outdated version) can be done without knowing anything about the content of the artifact. Thus, it can legitimately be called a syntactic determination. The word is excluded in question f because determining whether a definition is ‘proper’ is, by definition, a semantic determination, not a syntactic one.

A negative answer to any of these questions reveals a syntactic flaw in the ARGUMENT. If the reason for a negative answer is minor and an easy fix is possible, then Ashley may feel comfortable making the fix to the ARGUMENT (subject to any process and configuration management protocols not considered here) and continuing the assessment. One example of an easily fixable minor flaw in syntax is writing a CONCLUSION (or PREMISE) as an imperative statement (`Testing must reveal no errors`) instead of as a proposition (`Testing reveals no errors`).

¹⁰ “Active, nimble, smart, brisk; full of health and spirits.” *spry*, *adj.* and *adv.* OED Online, Oxford University Press, March 2021, www.oed.com/view/Entry/187907. Accessed 26 April 2021. As silly as it may seem to some, the primary reason Michael chose to use ‘syntax’ instead of ‘form’ in this question (in conjunction with the wording of the fourth question) is to enable the questions to be remembered as a single word.

¹¹ The questions are mostly independent of the notation used for expressing the ARGUMENT. So long as there exists a mapping from the elements of the notation to the ARGUMENT primitives, all these questions are relevant. For simplicity of exposition, FAN is used for the examples. As a reminder, the term proposition as used throughout this document refers to a statement that is capable of truth or falsity, consistent with its usage for centuries.

¹² Someone who does not understand the foundational documents might misunderstand some of the questions. For example, the phrase ‘a statement’ in question b might be thought to require the REASONING to be written as a complete sentence. Understanding [1] precludes such a thought.

If the cause of a negative answer is not minor, or an easy fix does not come to mind quickly (for example, if no REASONING is given), then Ashley's best course of action is to tell Cameron about the problem and wait for Cameron to fix it before continuing assessment.

Here are six examples¹³ of ATOMIC ARGUMENTs expressed in FAN. Check your understanding of this section by asking the seven questions of each example to determine whether the syntax is proper.

Exercise 1:

Believing
Socrates is mortal
is justified by applying the reasoning
AAA-1 syllogism
to these premises
All men are mortal
Socrates is a man

Exercise 2:

Believing
A counterfactual account of causality
is justified by applying
Reading
to
David Lewis gave a plausible counterfactual account
David Hume gave a plausible counterfactual account

Exercise 3:

Believing
It is raining outside
is justified by applying
Personal observation
to this premise
I see water streaming down my windows

Exercise 4:

Believing
At least one counterfactual account of causality is plausible
is justified by
Reading many books and articles on causality

Exercise 5:

Believing
Traveling by plane is safer than traveling by automobile
is justified by these premises
Airplane travel averages fewer fatalities per mile traveled

¹³ It is very difficult (some might say impossible) to develop exercises that are appropriate for an audience consisting of people with a wide range of knowledge and expertise. Some folks with deep knowledge may find some of our exercises (here and throughout) to not have enough information for making a decision. But if we included that information, some (perhaps many) people with less knowledge would find the exercises too complicated and confusing. We hope (and optimistically believe) the balance we have struck here will please significantly more people than it will annoy.

Airplanes crash less often than automobiles

Exercise 6:

Believing
It is raining outside
is justified by applying
Personal observation
to these premises
Operating windshield wipers
Deployed umbrellas
unless
Sprinklers

How did you do? Were you able to focus exclusively on assessing syntactic validity? If there were terms you did not recognize, did that distract you from assessing syntax alone? Do you want to know the right answers? If so, read this footnote¹⁴.

2.2 Are the PREMISES acceptable?

The acceptability of PREMISES compromises two concepts, each of which may be expressed in terms of a question Ashley should ask about each PREMISE:

- a. Is the PREMISE BELIEVABLE?
- b. Is the PREMISE relevant to the CONCLUSION?

Some readers are surely wondering why these two questions are written in this order instead of in the opposite, suspecting that assessing BELIEVABILITY is more difficult than establishing relevance¹⁵. But the ordering is not based on difficulty; it is based on objectiveness. Writing objective general criteria for assessing BELIEVABILITY turns out to be feasible, whereas doing so for relevance is not.

2.2.1 *Is the PREMISE BELIEVABLE?*

To decide whether a PREMISE is BELIEVABLE Ashley needs only to determine whether it falls into one of these categories:

- (a) expresses a proposition that is ‘universally’ accepted as true
- (b) expresses a proposition that is accepted as true within the relevant domain
- (c) is supported by an ARGUMENT (provisionally presumed to be COGENT)

¹⁴ Ashley says that Exercise 3 has proper syntax, Exercise 1 may or may not have proper syntax depending on the intended audience, and the other four do not. If Exercise 1’s audience consists only of people who have studied categorical logic, then its syntax is proper; otherwise, a BINDING is needed for <AAA-1 syllogism>. Exercise 2 does not have a CONCLUSION stated in the form of proposition. Exercise 4 does not have at least one PREMISE. Exercise 5 has no REASONING. Finally, neither the PREMISES nor the DEFEATER in Exercise 6 are stated in the form of propositions. Cameron regretfully admits that Ashley’s assessment is correct for all six cases, and vows to come back soon with syntactically correct revisions.

¹⁵ Some other readers may be wondering why we have included relevance as a sub-condition for acceptability, instead of elevating it to the same level (as Govier does in her famous ARG criteria [4]). We have done so based on personal observations over more than a decade of what resonates with the larger number of people. For more folks than not, acceptability seems to be a broad term which easily encompasses relevance. Once again, we emphasize that the approach put forward here is one way but not the only way to effectively assess ARGUMENT COGENCY.

- (d) is supported by external artifacts that are accepted within the domain as being sufficient to establish its truth
- (e) will fall into category (c) or (d) at a later stage of argument development
- (f) is an assumption accepted by all stakeholders and clearly identified as such

“Wait a minute,” a philosophically minded reader screams, “How can you be so naive as to think anything belongs in (a)? There’s not a single proposition that is universally accepted as true! Including this one.”

The philosophically minded reader’s objection is well taken in theory (hence the quotes around ‘universally’), but rather silly in practice (hence the existence of the category). Within any conceivable real-life context for an ARGUMENT, there exist many propositions that legitimately belong in category (a). Here are three examples:

`28 > 0`

`Lift is created by pressure differences`

`Plane geometry and spherical geometry define a line differently`

Category (b) encompasses propositions that may not be well known to people from outside the domain(s) about which the ARGUMENT is concerned, but which are accepted as true within it. Here are three examples:

`Complying with D0-178C is an acceptable means for showing compliance with the applicable airworthiness regulations for software aspects of airborne systems and equipment`

`Compilers are not error free`

`Saying “MCDC coverage” is analogous to saying “PIN number”16`

Category (c) includes every PREMISE whose truth is further supported by an ATOMIC ARGUMENT of its own. When initially evaluating an ATOMIC ARGUMENT containing a category (c) PREMISE, Ashley simply should assume the PREMISE is true, and continue asking the remaining SPRY questions based on that assumption. Thoughts such as, “If I believed PREMISE-1, then I’d believe the CONCLUSION, but I’m unsure of PREMISE-1, so I’m unsure of the CONCLUSION,” must be banished from Ashley’s mind *at this stage*. Determining whether PREMISE-1 is actually true will take place when Ashley assesses the separate ATOMIC ARGUMENT for which PREMISE-1 is the CONCLUSION. (See section 3 for the details.)

Category (d) encompasses PREMISES that include references to non-definitional BINDINGS. Here are two examples of such PREMISES:

`The Overarching Properties are defined in <UtOPs>
with
<UtOPs>: https://hdl.handle.net/2060/20190029284`

`The <plans> are specified in sufficient detail
with
<plans>: the Plan for Software Aspects of Certification document`

¹⁶ Saying “MCDC coverage” is the same as saying “Modified Condition Decision Coverage coverage”. Saying “PIN number” is the same as saying “Personal Identification Number number.” The two phrases are thus analogously redundant.

Category (e) applies *only* when assessing ARGUMENTS during the construction phase. Perhaps a PREMISE will eventually be supported by a separate ATOMIC ARGUMENT, but the ATOMIC ARGUMENT is not yet constructed. Or a PREMISE refers to an external artifact that does not yet exist but will by the time approval is sought. During the ARGUMENT construction phase, such PREMISES should be deemed BELIEVABLE. No category (e) PREMISES should be left by the time of final assessment.

Finally, category (f) allows for PREMISES that express assumptions, so long as those assumptions are explicitly identified as such and are agreed by all stakeholders. Three examples of PREMISES that might belong in category (f) are

The device will not be used underwater

Recently enacted regulation 8645.11.3.(e) does not apply

Qualified personnel are available to perform inspections

2.2.2 Is the PREMISE relevant?

In contrast to these specific objective criteria for BELIEVABILITY, the criteria for assessing the relevance of a PREMISE can only be expressed generally. Here is one way¹⁷ to express it:

A PREMISE is relevant if BELIEVING it increases at least a little bit the likelihood of BELIEVING the CONCLUSION.

Providing general guidelines, particularly objective ones, for determining relevance is not simple. The lack of simplicity arises in part from the common dependence of relevance to the domain and circumstances of each specific ARGUMENT. Speaking generally, perhaps the only general guideline is to look out for the category of informal fallacies known as fallacies of relevance.¹⁸

Although providing general guidelines for determining PREMISE relevance is hard, in practice determining whether a PREMISE is relevant will likely to be quite straightforward most of the time. And if an irrelevant PREMISE happens to slip through undetected, no great harm occurs so long its existence does not otherwise affect the assessment of the ARGUMENT.

2.2.3 Exercises

For those who want to try out their understanding of this section, here are three exercises. For each PREMISE, determine whether it is BELIEVABLE and whether it is relevant to the CONCLUSION. To avoid any confounding issues, we include only one PREMISE in each exercise and leave out specifying the REASONING (which is discussed in the next section) altogether in these exercises.

Exercise 7:

Believing

California has more inhabitants than New York

... premise

¹⁷ This description of relevance is based on the description provided in [4], with the language changed a bit to correspond to our terminology. We require a premise to increase the likelihood of BELIEF, rather than just alter it, because of the explicit allowance for DEFEATERS. A relevant DEFEATER will decrease the likelihood of BELIEF.

¹⁸ A cottage industry has risen aimed at identifying, categorizing, and giving examples of a whole slew of informal fallacies, which is the name that has come to be accepted for the collection of categories of **non-COGENT** ARGUMENTS. For example, see [3] for an example of such a collection targeted specifically to ARGUMENTS about safety-critical systems. We concentrate on avoiding fallacies as the salient aspect of relevance in this *Primer* because the concept of relevance has been and remains quite controversial among philosophers.

The land area of California is bigger than that of New York

Exercise 8:

Believing

California has more inhabitants than New York

... premise

The 2020 Census shows California has more people than NY

Exercise 9:

Believing

California has more inhabitants than New York

... premise

Joseph personally counted all the people in both states

If you are interested, compare your answers to Ashley's answers¹⁹ before continuing.

2.3 Is the REASONING acceptable?

Two questions encapsulate our method for assessing the acceptability of the REASONING:

- a. Is the REASONING relevant?
- b. Is the REASONING consistent with current knowledge?

We consider both questions in turn.

2.3.1 *Is the REASONING relevant?*

Some of what is written above about PREMISE relevance applies here, too²⁰. REASONING relevance is often domain dependent. Giving objective general guidelines for evaluating relevance is difficult. But unlike an irrelevant PREMISE, irrelevant reasoning is not only likely to be harmful, it is highly likely to be fatal to COGENCY.

One general statement that can be made about REASONING relevance is that any REASONING that is already known to be deficient is not relevant. Over thousands of years, people have identified and collected many deficient ways of reasoning. Only within the last several decades, however, has free, easy access to these collections been possible. Helpfully, for this subject at least, the Wikipedia entry is a good place to start [6]. Even more helpfully, requiring an explicit statement of REASONING as the *Primer* requires, instead of just allowing it to be implied or embedded among the PREMISES, may make it more difficult to get away with employing known fallacies.

Consider as an example the fallacy of division, which occurs when someone claims that something true of the whole must be true of each of the parts. Committing this fallacy is easy with normal prose. Joe is an excellent baseball player because he plays on an excellent team, for example. Some people may spot the fallacy right away; others may not. But how would one express this in FAN?

¹⁹ For Exercise 7 Ashley decides the PREMISE is category (a) BELIEVABLE, but irrelevant to the CONCLUSION absent an ARGUMENT establishing a relationship between size and population. The Exercise 8 PREMISE is both category (a) BELIEVABLE and relevant. Finally, Ashley recognizes that the PREMISE in Exercise 9 is relevant but not BELIEVABLE.

²⁰ Especially applicable is the footnote about the controversial nature of the subject among philosophers, who, as discussed in [1] usually do not make the distinction between reasoning and premises that we do here, and thus consider relevance as a single question.

Believing
Joe is an excellent baseball player
is justified by applying
???
to this premise
Joe plays on an excellent baseball team

Other than “the fallacy of division” what could the REASONING be?

That is all we will say in general terms about relevance here.

2.3.2 Is the REASONING consistent with current knowledge?

Just because the REASONING is relevant to the ARGUMENT does not mean that it is acceptable. It needs to embody ideas that are consistent with current knowledge. This current knowledge may derive from approved practices within the domain for which the ARGUMENT has been created. Or it may be based on the received wisdom within the relevant community(ies). Or it may employ new ideas from state-of-the-art research that has been deemed to be sufficiently mature to be treated as BELIEVABLE.

We cannot overemphasize the reliance on *current* knowledge. There is no other option besides it, but consequently, the acceptability of REASONING is not necessarily static. REASONING that was once considered acceptable may become unacceptable because of changes in knowledge. The aviation domain is full of examples of this phenomenon. An accident happens. The investigation reveals that the causal complex leading to the accident included an event, or an interaction among systems, or an environmental condition, or something else that heretofore had been considered sufficiently unlikely as to be dismissible. From that time forward, whether REASONING is given explicitly or only implicitly, no REASONING will be considered consistent with current knowledge if it permits dismissing the possibility of that event, interaction, condition, or something happening.

2.3.3 Exercises

For those who want to try out their understanding of this section, here are three exercises. For each statement of REASONING determine whether it is acceptable. To avoid any confounding issues, you may assume the PREMISES in each exercise have already been assessed as acceptable and the meaning of all words is understood by everyone who needs to understand (hence no BINDINGS are needed).

Exercise 10:

Believing
Sam is eligible to run for President of the United States
is justified by applying
The eligibility requirements mentioned on talk radio
to these premises
Sam was born in the Commonwealth of Virginia
Sam is 61 years old
Sam has lived in Charlottesville her entire life

Exercise 11:

Believing
 $X > Z$
is justified by applying
transitivity of $>$ for integers
to these premises
 X , Y , and Z are positive integers

X > Y

Y > Z

Exercise 12:

Believing

Sharon is more introverted than Chuck
is justified by applying
a study of Myers-Briggs personality profile results
to these premises
Chuck's M-B profile is ENFJ
Sharon's M-B profile is INFP

If you are interested, compare your answers to Ashley's answers²¹ before continuing.

2.4 Is saying “Yes” to the CONCLUSION justified?

Ashley needs only ask this question after obtaining affirmative answers to the previous three questions. Thus, Ashley knows the ATOMIC ARGUMENT has (1) proper syntax, (2) acceptable PREMISES, and (3) acceptable REASONING. Thus, all that is left to assess is whether REASONING applied to the PREMISES yields a good enough level of confidence to BELIEVE the CONCLUSION.

One way²² to make that assessment is to address two subsidiary questions:

- a. Is the required level of confidence known?
- b. Does the ARGUMENT engender the required level of confidence?

In keeping with the practice established earlier, we consider these questions in turn.

2.4.1 *Is the required level of confidence known?*

Opening a can of worms. Jumping down a rabbit hole. Going off on a tangent. Running off the rails. Going sideways. All these metaphors and more besides may aptly apply to just about any discussion about the general concept of “confidence”, whether the discussion is in terms of “levels”, “degrees”, “standards”, or any other similar expression.²³ For the purposes of this overview, however, we think we can avoid these bad things by avoiding any general discussion. Instead, we provide only one specific example of two explicit (but historically non-quantified) levels of confidence from one domain, and then make a few suggestions about how to extrapolate from that domain to others.

²¹ For Exercise 10 Ashley decides the REASONING is not relevant because it instantiates the informal fallacy of appeal to an inappropriate authority. Ashley assesses the Exercise 11 REASONING as both relevant and consistent with existing knowledge. Finally, Ashley recognizes that the REASONING in Exercise 12 likely would have been considered consistent with existing knowledge several decades ago but that many of relevant professionals no longer accept it.

²² Some people may prefer a different second question that explicitly invokes the notion of sufficiency; the following poses a version: Do the PREMISES and REASONING provide sufficient grounds for BELIEVING the CONCLUSION? Either version may be used, so long as it is used consistently within a given assessment undertaking.

²³ Michael is compelled, however, to open one can, namely the can of quantification worms. There exist people who believe that quantifying (that is, attaching numerical values, usually in the form of probabilities or percentages, to) confidence is a worthy and feasible endeavor. One day perhaps somebody might discover a mathematical theory for confidence, but that day is not today, and that theory is not probability.

Our example comes from the legal systems in the United States²⁴. The required level of confidence for a judge or jury to convict a criminal defendant is (with some slight variations in wording depending on the state) “beyond a reasonable doubt.” In contrast, to find for the plaintiff in a civil action, the judge or jury need only reach a “more likely than not” level of confidence. An ARGUMENT that is COGENT for a civil action may well not be COGENT for a conviction in a criminal trial.

Let us consider using these two different levels of confidence to assess the COGENCY of the following (very simple) ARGUMENT²⁵.

Believing
Jeremiah chose a number less than 12
is justified by applying
conjunction
to this premises
Jeremiah was asked to pick a number between 1 - 20 inclusive
Jeremiah followed the instructions

If the necessary level of confidence is “more likely than not”, then Ashley should conclude that saying “Yes” to the CONCLUSION is justified. If, however, the necessary level of confidence is “beyond a reasonable doubt”, then Ashley should surely answer, “No.” With this exact ARGUMENT, the answers for both levels of confidence are obvious.

More interesting is considering what simple changes (if any) to the numbers in the example would result in a COGENT argument for the “beyond a reasonable doubt” standard.²⁶ Certainly, changing 12 to 21 in the CONCLUSION would do it. Would changing 12 to 20? or 19? What if we change 20 to 2,000,000,000,000,000 in the first PREMISE, what does 12 need to be changed to in the CONCLUSION? What if we eliminate the second PREMISE?

2.4.2 Does the ARGUMENT engender the required level of confidence?

Obviously, the standards of confidence within almost any aviation context will be different from these two simple standards, and the ARGUMENTs involved will rarely be simple ATOMIC ones, but the general principle is the same. COGENCY depends on how much confidence is needed and whether the ARGUMENT engenders at least that much confidence in the truth of its CONCLUSION.

ARGUMENT COGENCY also depends in part on two of the argument precepts laid down in the *Primer*: INDUCTION and CERTAINTY. The precept of INDUCTION reminds us that the ARGUMENTs with which we will concern ourselves within the aviation domain are *almost uniformly* *INDUCTIVE ARGUMENTS*²⁷. As a result, the precept of CERTAINTY reminds us that *certainty is certainly not possible*.

²⁴ Some other countries have substantially similar standards of confidence; some have rather different ones. We chose the U.S. solely because we know more about it than we do any other country.

²⁵ An astute reviewer pointed out that the discussion here assumes there is no outside-the-ARGUMENT information. If, however, such information exists (suppose Jeremiah knows the distribution of answers is not uniform and is skewed heavily towards 13), then the justified confidence in the COGENCY of the ARGUMENT may be different.

²⁶ The difficulty in answering questions like this is one of the reasons legal systems have (almost) universally resisted any attempts to quantify or further constrain the meaning of “beyond a reasonable doubt.”

²⁷ Recall we are using the phrase *inductive ARGUMENTS* as a catch-all to include any ARGUMENT that is not *deductive* (That is, one with a CONCLUSION that can be proven using a formal logic). Recall further that in doing so we risk our standing among our philosopher friends, because philosophers of logic usually speak of additional categories or sub-categories such as analogical, abductive, explanatory, and defeasible ARGUMENTS. In saying that we are almost universally concerned with *inductive ARGUMENTS*, we are not saying that *deductive ARGUMENTS* have no place in

Knowing these precepts, Ashley realizes that in assessing the answer to the final question, the reasoning is not evaluated against certainty but against pragmatic sufficiency. Acceptable REASONING applied to acceptable PREMISES may not (in reality, almost never will in practice) *guarantee* the truth of the CONCLUSION, so Ashley does not expect a guarantee. Ashley just expects to be able to have sufficient confidence in the truth of the CONCLUSION to enable BELIEVING it. Although these particular terms are rarely used, an analogous concept is routinely applied throughout all engineering disciplines.²⁸ The phrase “engineering judgment” is an embodiment of the concept. Determining whether an ARGUMENT engenders the required level of confidence requires exercising “ARGUMENTATION judgment.”

One (but not the only) way Ashley might choose to systematize “ARGUMENTATION judgment” in this phase of assessment is by carefully considering whether it is possible to come up with plausible DEFEATERS for the ARGUMENT being assessed²⁹. If it is possible to do so, and if the BELIEVABILITY of those DEFEATERS exceeds the required level of confidence, then the ARGUMENT as given should be assessed as *not* engendering the required level of confidence. In such a case Ashley should return the ARGUMENT to Cameron for possible correction.

Providing concrete, yet general, guidelines about how to obtain and apply “ARGUMENTATION judgment” is well beyond the scope of this introductory primer.

2.4.3 Exercises

Despite the unavoidable lack of specificity in this section, see if you reach the same answers to the Y questions as Ashley does for the following three exercises. Assume the syntax is proper, the PREMISES are acceptable, and the REASONING is acceptable. And, of course, assume all the words are understood.³⁰ Your task is to decide whether saying “Yes” to the CONCLUSION is justified.

Exercise 13: The required level of confidence is “beyond a reasonable doubt”.

Believing

Linda is a better student than Joe
is justified by applying
inspection of college transcripts
to these premises

Linda’s Grade Point Average is 3.76

Joe’s Grade Point Average is 3.60

Joe and Linda are 3rd year chemical engineering majors

Exercise 14:

Believing

engineering. Engineering rests on the foundation of the quintessential domain of deduction: mathematics. But there is no need to use FAN or any other ARGUMENT notation or tool to express mathematical formulae, equations, or results. Standard practice works just fine.

²⁸ And in normal, everyday life, too. Am I certain that my breakfast cottage cheese has not been poisoned? No, but I believe it hasn’t with sufficient confidence to eat it without having my hand poised to dial 9-1-1 (or 9-9-9 if I happen to be eating breakfast in the UK, or 1-1-2 if I am calling on most mobile networks worldwide).

²⁹ Obviously, if the ARGUMENT already includes one or more DEFEATERS, then part of the job of coming up with them has already been done. Some readers have likely been wondering when DEFEATERS would be mentioned. You need wonder no longer.

³⁰ Making these assumptions will be easier for some of the exercises than for others for everyone, and easier in general for some people than others. One of us can easily share the pain of those for whom it is hard. One of us finds it a bit more difficult. Readers are welcome to guess which of us is which.

The software is suitable for installation on the aircraft
is justified by applying
current approval practices
to these premises
The software complies with D0-178C
The safety assessment of the aircraft satisfies regulations

Exercise 15: The required level of confidence is “enough to sign an approval certificate”

Believing
The system is suitable for installation on the aircraft
is justified by applying
the Overarching Properties
to these premises
The system possesses the Intent property
The system possesses the Correctness property
The system possesses the Innocuity property

Ashley’s answers are available for your comparison.³¹

3 Assessing COMPOUND ARGUMENTS: **iTest**

Armed with introductory knowledge about how to assess ATOMIC ARGUMENTS, we can now tackle assessing COMPOUND ARGUMENTS. ‘Tis an easy tackle, which we describe in this section.

3.1 The main steps of **iTest**

To guide the assessing of a COMPOUND ARGUMENT, we recommend applying a simple process:

- I. **Isolate** one ATOMIC ARGUMENT.
- II. **Interrogate** it as an ATOMIC ARGUMENT using the guidelines from section 2.
- III. **Iterate** until all ATOMIC ARGUMENTS have been assessed.

For the visually inclined, this process, which we affectionately call **iTest**, looks like this graphically³²:

³¹ For Exercise 13 Ashley decides that the difference in Grade Point Average (GPA) is too small to justify BELIEVING beyond a reasonable doubt that Linda is a better student than Joe, even if one assumes that GPA is a reasonable measure of how good a student someone is. Ashley recognizes that without a specified required level of confidence for Exercise 14, assessing whether the ARGUMENT justifies the CONCLUSION is not possible. She also recognizes that even with a specified level of confidence, the ARGUMENT has some problems. What is one such problem? Don’t worry if you can’t think of one. Exercise 15 is better because it specifies a required level of confidence. Ashley recognizes that the ARGUMENT encapsulates the philosophy undergirding the Overarching Properties but is nevertheless unwilling to deem it COGENT. Surely at least one additional PREMISE is needed. What is it? Something indicating that an appropriate authority has accepted showing possession of the OPs as a means for obtaining approval.

³² As you’ll see shortly, the three-step description and illustration shown here are slightly simplified for presentation purposes; keep reading for the fourth step and an enhanced illustration.

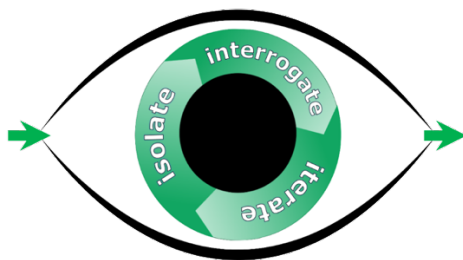


Figure 1: iTTest visual (simple)

Steps I and III are simple enough to be described together.

3.1.1 iTTest: Isolate & Iterate

The application of iTTest begins by choosing a single ATOMIC ARGUMENT from among the set contained in the COMPOUND ARGUMENT being assessed. An assessor who tends to think from the general to the concrete is likely to choose the top-level ATOMIC ARGUMENT first. By contrast, an assessor who tends to think from the concrete to the general may be more likely to begin with an ATOMIC ARGUMENT at the lowest level of the hierarchy. Contrarians (or others) may start somewhere in the middle. None of these choices is wrong. None of these choices is right. The important thing is simply to choose.

Once an ATOMIC ARGUMENT is chosen, then it is interrogated as described in the next section. Once it is interrogated and the results of the interrogation recorded, the assessor moves to the next iteration (choose another ATOMIC ARGUMENT and interrogate it) and continues iterating until all ATOMIC ARGUMENTS have been assessed.

3.1.2 iTTest: Interrogate

Each instance of the Interrogate step involves using the Spry questions for assessing the COGENCY of the chosen ATOMIC ARGUMENT. The content of these questions, and guidelines about how to ask and answer them, were described in detail in section 2. Figure 2 provides a summary of the questions.

1. Is the **Syntax** proper?
 - a. Is there a single CONCLUSION that is stated in the form of a proposition?
 - b. Is there a statement of REASONING?
 - c. Is there at least one PREMISE?
 - d. Is each PREMISE stated in the form of a proposition?
 - e. If there are DEFEATERS, is each stated in the form of a proposition?
 - f. Does a BINDING exist for each term or phrased used in the CONCLUSION, REASONING, PREMISES, and (if any) DEFEATERS that does not have a well-known, unambiguous definition?
 - g. Does a proper BINDING exist for each reference to an external artifact?
2. Are the **PREMISES** acceptable?
 - a. Is each PREMISE BELIEVABLE? To be BELIEVABLE it must fall into one of these categories:
 - (a) expresses a proposition that is ‘universally’ accepted as true
 - (b) expresses a proposition that is accepted as true within the relevant domain
 - (c) is supported by an ARGUMENT (provisionally presumed to be COGENT)
 - (d) is supported by external artifacts that are accepted within the domain as being sufficient to establish its truth
 - (e) will fall into category (c) or (d) at a later stage of ARGUMENT development
 - (f) is an assumption accepted by all stakeholders and clearly identified as such

- b. Is each PREMISE relevant to the CONCLUSION?
3. Is the **REASONING** acceptable?
 - a. Is the REASONING relevant?
 - b. Is the REASONING consistent with current knowledge?
4. Is saying “**Yes**” to the CONCLUSION justified?
 - a. Is the required level of confidence known?
 - b. Does the ARGUMENT engender the required level of confidence?

Figure 2: The Spry questions for an ATOMIC ARGUMENT

Interrogating an ATOMIC ARGUMENT isolated from within a COMPOUND ARGUMENT is identical to assessing a free-standing ATOMIC ARGUMENT. The same questions are asked, and the same sort of answers are desired. In practice, as some readers may have already surmised, isolated ATOMIC ARGUMENTS may be somewhat more likely than free-standing ones to have PREMISES that fall into BELIEVABILITY categories (c), (e), or (f). What to do with such PREMISES will be discussed shortly in section 3.2.1.

3.1.3 A concrete abstract example – part 1

As noted earlier, ‘tis no easy task to construct examples that illustrate relevant points without introducing extraneous complications. The task is made even harder when the intended audience spans a wide range of knowledge and, more importantly, of coordinates in the abstract/concrete thinker spectrum. The example presented here is concrete in its ARGUMENT *structure* but abstract in the *content* of those ARGUMENTS. Probably no one will be fully pleased with it, but perhaps no one will be fully disgusted with it either.

Exercise 16: Cameron presents Ashley with a COMPOUND ARGUMENT having the following structure.

Believing
Prop1
is justified by applying
conjunction
to these premises
Prop2
Prop3
Prop4

Believing
Prop2
is justified by applying
Reas1
to these premises
Prop5
Prop6

Believing
Prop3
is justified by applying
Reas2
to these premises
BelProp1
BelProp2

Believing
Prop4
is justified by applying
Reas2
to these premises
BelProp3
Prop7

Believing
Prop5
is justified by applying
conjunction
to these premises
BelProp4
Prop8

Believing
Prop6
is justified by applying
inspection of results
to these premises
The results in Arti1 support Prop6

Even without knowing the content of the ARGUMENT, by adopting certain conventions, you should be equipped to apply **iTest** to begin conducting a partial assessment. These conventions are as follows:

- a. Prop1 – Prop8 represent propositions whose BELIEVABILITY by the audience is not known.
- b. ARGUMENTS for Prop7 and Prop8 will be provided at a later stage of development.
- c. BelProp1 – BelProp4 represent propositions that the audience BELIEVES.
- d. Arti1 represents an artifact for which an appropriate binding is provided (despite it not being shown here), and which is accepted within the relevant domain as adequate for purpose.
- e. All REASONING is known to be relevant and consistent with current knowledge.

Taking these conventions into account, use **iTest** to answer these five questions:

- (1) What is the first step you will take in assessing this ARGUMENT?
- (2) How many ATOMIC ARGUMENTS does the COMPOUND ARGUMENT comprise?
- (3) Which ATOMIC ARGUMENT will you assess first?
- (4) What is the first step you will take in assessing it?
- (5) In what BELIEVABILITY category (a) – (f) does Prop6 belong? Refer to Figure 2 if needed.

That's all you need to do at this stage. Your answers to (1), (2), (4), and (5) should be the same as Ashley's; but your answer to (3) may differ³³.

³³ Ashley's answers are as follows: (1) Isolate (pick an ATOMIC ARGUMENT to assess); (2) six; (3) the ARGUMENT for Prop6; (4) ask the Spry questions beginning with "Is the syntax proper?"; and (5) Prop6 is in category (d).

3.2 The fourth step of **iTest**: Integrate

After all ATOMIC ARGUMENTS have been assessed, one step remains³⁴:

III. **Integrate** the individual assessments by answering these questions:

- A. Are all ATOMIC ARGUMENTS assessed as COGENT?
- B. Does every path through the COMPOUND ARGUMENT terminate in BELIEVED PREMISES?

An **iTest** graphic incorporating the Integrate step looks like this



Figure 3: *iTest* visual (enhanced)

We discuss the final two questions separately³⁵.

3.2.1 **Are all ATOMIC ARGUMENTS assessed as COGENT?**

A “Yes” answer permits moving on to the final question. What to do with a “No” answer depends on the purpose of the assessment. If the sole purpose is to do nothing more than decide whether the COMPOUND ARGUMENT is COGENT, then stopping at this point and writing (perhaps in big, red letters) “not COGENT” will satisfy the purpose.

If, as will likely be the case most often, the purpose is to identify flaws in the ARGUMENT to help repair it, then further examining the non-COGENT ATOMIC ARGUMENTS will be warranted. One way, but not the only way, to conduct such an examination is to follow these five steps:

1. For each non-COGENT ATOMIC ARGUMENT, list its CONCLUSION.
2. For each listed CONCLUSION, find all ATOMIC ARGUMENTS for which it serves as a PREMISE. Note that each such PREMISE will have been identified as falling into BELIEVABILITY category (c).
3. Change the PREMISE’S BELIEVABILITY from category (c) to “No.”
4. Reassess the COGENCY of the ARGUMENT in which the PREMISE appears.
5. Repeat until no new non-COGENT ARGUMENTS are revealed.

The result of completing these steps will be a comprehensive enumeration of the aspects of the COMPOUND ARGUMENT that need to be repaired before it can³⁶ be accepted as justifying confidence in its top-level CONCLUSION.

³⁴ Although IV is the most common Roman numeral expression used today for four, IIII was also used by the Romans.

³⁵ The task of answering these questions may be made easier by support from well-designed software tools, or it may be made harder by poorly designed tools. Regardless of tool availability and quality, any person responsible for assessing ARGUMENTS needs to understand how to conduct a manual assessment.

³⁶ Whether it *should* be accepted after the repairs are made is, as anyone familiar with the possibility of unintended consequences of changes realizes, uncertain until after a reassessment is made of the changed COMPOUND ARGUMENT.

3.2.2 Does every path terminate in BELIEVED PREMISES?

Answering this question is necessary only when the answer to the previous question is affirmative. Answering the question is, thankfully, straightforward³⁷. One need only look at the BELIEVABILITY category for every terminal PREMISE, where a terminal PREMISE is one that does not also appear as a CONCLUSION in a different ATOMIC ARGUMENT). The answer to the question is “Yes” if every terminal PREMISE resides in BELIEVABILITY category (a), (b), (d), or (f). A “Yes” answer to this final question justifies awarding the assessed COMPOUND ARGUMENT with the coveted title of COGENT ARGUMENT. Different assessors are likely to choose different ways to award the title. Ashley uses the specially designed sticker (for printed ARGUMENTS) / graphic (for electronic ARGUMENTS) shown here.



If any terminal PREMISE falls into BELIEVABILITY category (c) or (e), then whether the answer to the question is “No” or “Not yet” depends on whether the COMPOUND ARGUMENT has been presented to the assessor as the final ARGUMENT (the answer is “No”) or as a preliminary ARGUMENT for which further development is planned (the answer is “Not Yet.”).

3.2.3 A concrete abstract example – part 2

For the final exercise of this *Primer*, we return to the FAN text in Exercise 16, add two more ATOMIC ARGUMENTS to it, and ask three questions.

Exercise 17. Cameron presents Ashley with a COMPOUND ARGUMENT with the same structure as the one used in Exercise 16 (reproduced below in a space-saving format).

Believing
Prop1
is justified by applying
conjunction
to these premises
Prop2
Prop3
Prop4

Believing
Prop2
is justified by applying
Reas1
to these premises
Prop5
Prop6

Believing
Prop3
is justified by applying
Reas2
to these premises
BelProp1
BelProp2

Believing
Prop4
is justified by applying
Reas2
to these premises
BelProp3
Prop7

Believing
Prop5
is justified by applying
conjunction
to these premises
BelProp4
Prop8

Believing
Prop6
is justified by applying
inspection of results
to these premises
The results in Arti1 support Prop6

Cameron also adds three additional ATOMIC ARGUMENTS with the following structure:

Believing
Prop7
is justified by applying
Reas3
to these premises
Prop9
The results in Arti2 support Prop7

Believing
Prop8

³⁷ Designing a simple tool to answer this question would also be straightforward. It could be as simple as a shell script searching for the presence of certain text.

is justified by applying

Reas4

to these premises

BelProp5

Prop10

Believing

Prop9

is justified by applying

inspection of results

to these premises

The results in Arti3 support Prop9

The following conventions apply:

- a. Prop1 - Prop9 represent propositions whose BELIEVABILITY by the audience is not known. Prop10 represents a proposition accepted by all stakeholders.
- b. Prop2 - Prop10 represent propositions known to be relevant.
- c. BelProp1, BelProp3, BelProp5 represent propositions that are BELIEVED universally and are known to be relevant.
- d. BelProp2 and BelProp4 represent propositions that are BELIEVED within the relevant domain for the ARGUMENT and are known to be relevant.
- e. Arti1 - Arti3 represent artifacts for which an appropriate binding is provided (despite them not being shown here), and which are accepted within the relevant domain as adequate for purpose.
- f. Arti2 represents an artifact for which the binding refers to a non-current version.
- g. The REASONING (Reas1 - Reas3, conjunction, and inspection of results) is known to be relevant and consistent with current knowledge.
- h. Reas4 is known to be relevant but whether it is consistent with current knowledge is not known.
- i. The required level of confidence is known.
- j. When applied to BELIEVED PREMISES, Reas1, Reas2, conjunction, and inspection of results are known to be sufficient to engender the needed level of confidence.

Taking these conventions into account, apply **iTest**, then answer these three questions:

- (1) In what BELIEVABILITY category (a) – (f) does Prop4 belong? Refer to Figure 2 if needed.
- (2) Did you answer, “No” to the S question for any ATOMIC ARGUMENTS? If so, which one(s)?
- (3) Of the nine ATOMIC ARGUMENTS how many did you assess as COGENT before you started the Integrate step?

After completing the exercise compare your answers to Ashley’s answers³⁸. For your further study, Ashley’s complete application of **iTest** is provided in Appendix B.

4 Concluding Remarks

This paper has explained and illustrated one approach for determining if an ARGUMENT is COGENT. That is, whether the ARGUMENT rationally justifies BELIEVING its CONCLUSION to a required level of confidence. The suggested approach is intended to be consistent with approaches traditionally espoused in the ARGUMENTATION literature, while also being usable by people without any knowledge of that literature and whose interest in ARGUMENT assessment is primarily practical rather than theoretical. Whether this intent

³⁸ For question (1), Ashley answered category (c); for question (2), “No”; and for question (3), eight.

will be met in practice is yet to be determined. We close with a final graphical representation of the approach, which may assist some readers in remembering the material in this paper.

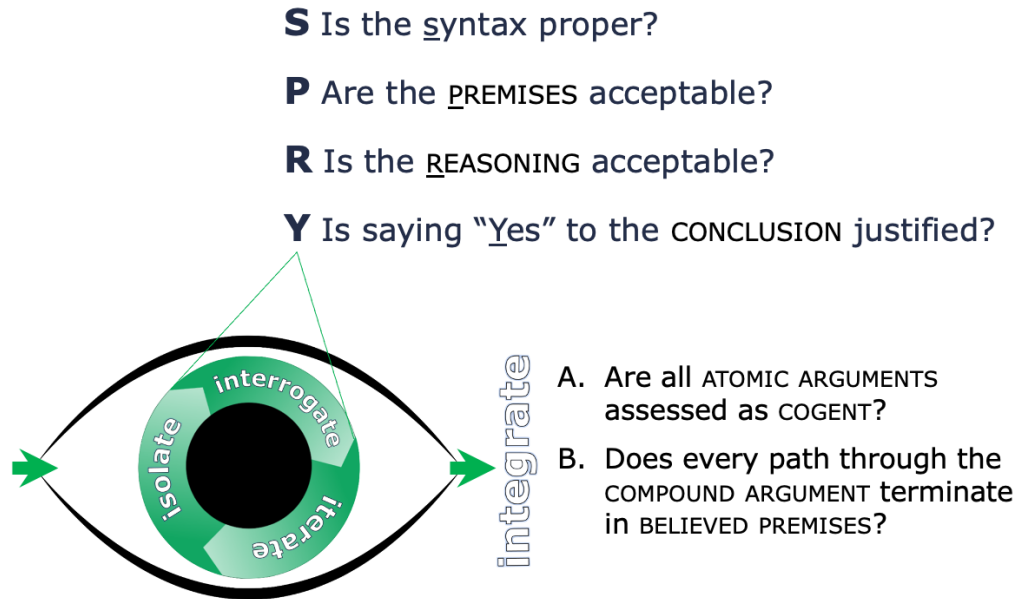


Figure 4: iTTest – The Interrogate & Integrate questions

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Appendix A – “you must remember this”

One way, to assess the COGENCY of an ATOMIC ARGUMENT is to answer the **SPRY** questions:

1. Is the **Syntax** proper?
2. Are the **PREMISES** acceptable?
3. Is the **REASONING** acceptable?
4. Is saying “**Yes**” to the **CONCLUSION** justified?

One way to answer the **S** question is to answer these additional questions:

- a. Is there a single **CONCLUSION** that is stated in the form of a proposition?
- b. Is there a statement of **REASONING**?
- c. Is there at least one **PREMISE**?
- d. Is each **PREMISE** stated in the form of a proposition?
- e. If there are **DEFEATERS**, is each stated in the form of a proposition?
- f. Does a **BINDING** exist for each term or phrased used in the **CONCLUSION**, **REASONING**, **PREMISES**, and (if any) **DEFEATERS** that does not have a well-known, unambiguous definition?
- g. Does a proper **BINDING** exist for each reference to an external artifact?

One way to answer the **P** question is to answer these additional questions:

- a. Is each **PREMISE BELIEVABLE**? To be **BELIEVABLE** it must fall into one of these categories:
 - (a) expresses a proposition that is ‘universally’ accepted as true
 - (b) expresses a proposition that is accepted as true within the relevant domain
 - (c) is supported by an **ARGUMENT** (provisionally presumed to be **COGENT**)
 - (d) is supported by external artifacts that are accepted within the domain as being sufficient to establish its truth
 - (e) will fall into category (c) or (d) at a later stage of **ARGUMENT** development
 - (f) is an assumption accepted by all stakeholders and clearly identified as such
- b. Is each **PREMISE** relevant to the **CONCLUSION**?

One way to answer the **R** question is to answer these additional questions:

- a. Is the **REASONING** relevant?
- b. Is the **REASONING** consistent with current knowledge?

One way to answer the **Y** question is to answer these additional questions:

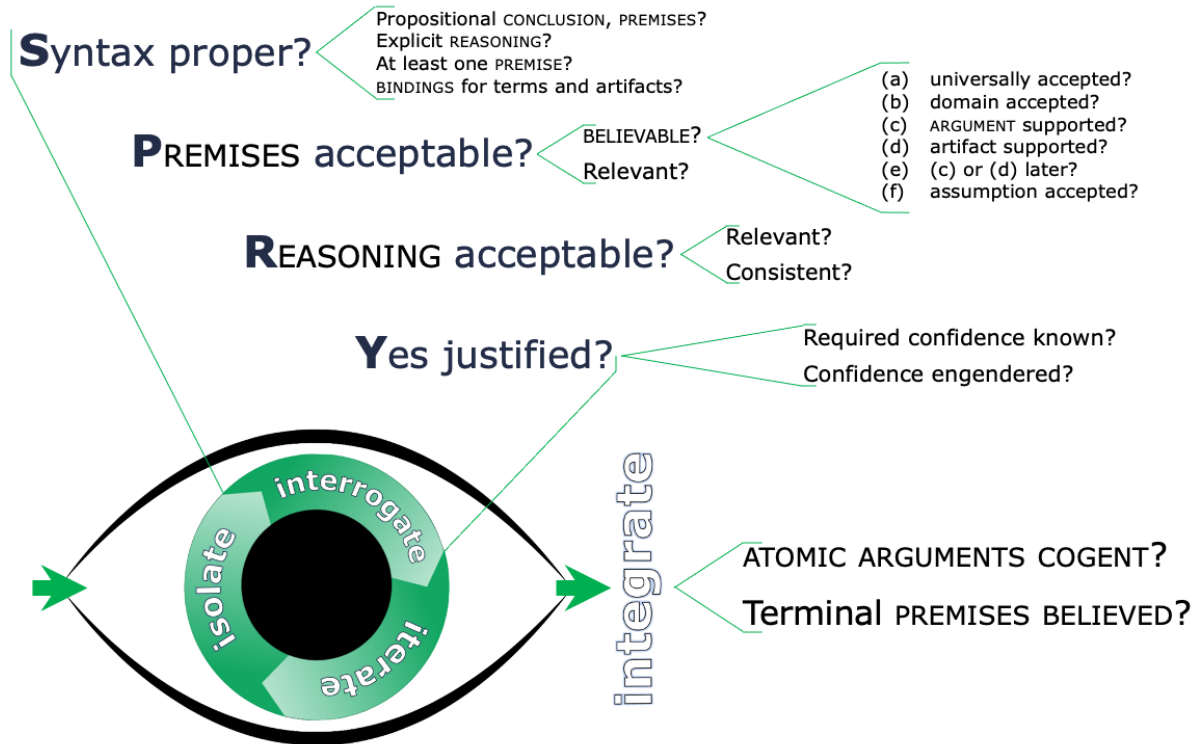
- a. Is the required level of confidence known?
- b. Does the **ARGUMENT** engender the required level of confidence?

One way, but not the only way, to assess the cogency of a **COMPOUND ARGUMENT** is to apply **iTest**.

Applying **iTest** involves completing the following steps:

- I. **Isolate** one **ATOMIC ARGUMENT**.
- II. **Interrogate** it as an **ATOMIC ARGUMENT** using the **SPRY** questions.
- III. **Iterate** until all **ATOMIC ARGUMENTS** have been assessed
- IIII. **Integrate** the individual assessments by answering these questions:
 - A. Are all **ATOMIC ARGUMENTS** assessed as **COGENT**?
 - B. Does every path through the **COMPOUND ARGUMENT** terminate in **BELIEVED PREMISES**?

Here is a more compact, abbreviated, visual representation of the same information.



Appendix B – Exercise 17 as completed by Ashley

For recording the application of **iTest** Ashley developed a simple notational convention based on numbering ATOMIC ARGUMENTS according to the order in which they are assessed, identifying **iTest** steps using its own roman numeral scheme, and identifying the SPRY questions by the appropriate S-P-R-Y and lower-case letter.

Ashley began the assessment of Exercise 17's ARGUMENT by Isolating the top-level ATOMIC ARGUMENT and recording the work as shown below. All text except that enclosed within square brackets is text produced by Ashley.

I. **Isolate** ARGUMENT 1 - the ARGUMENT for Prop1.

Believing
Prop1
is justified by applying
conjunction
to these premises
Prop2
Prop3
Prop4

II. **Interrogate** using SPRY questions.

1 S: Yes. The syntax is proper because the answers to all questions (a) – (g) are affirmative.

1 P.a: Yes. All three PREMISES fall into BELIEVABILITY category (c).

1 P.b: Yes. All three PREMISES are relevant by convention b.

1 R.a: Yes. By convention g **conjunction** is relevant REASONING.

1 R.b: Yes. By convention g **conjunction** is consistent with current knowledge.

1 Y.a: Yes. By convention i the required level of confidence is known.

1 Y.b: Yes. By convention j applying **conjunction** to the three provisionally BELIEVED PREMISES engenders the required level of confidence.

1 Assessment: ARGUMENT for Prop1 is **COGENT** (subject to COGENCY of the ARGUMENTS for Prop2, Prop3, and Prop4.)

[Although Ashley is a a-word-equals-a-thousand-pictures person, Leslie, one of folks who will be reading the assessment, is a-picture-equals-a-thousand-words person. Hence Ashley expends extra time to create some graphical representations for Leslie. Here is the first one.]

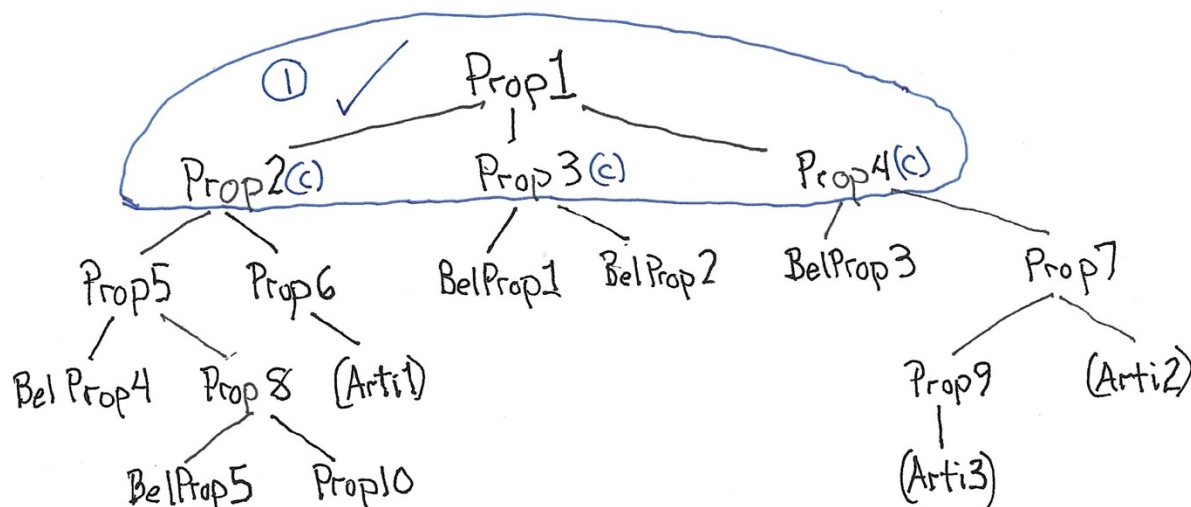


Figure 5: State of assessment after the first iteration

[Ashley decided to jump to the last ATOMIC ARGUMENT for the next iteration. If your preferences are less eclectic, you may have chosen the ARGUMENT for Prop2 for your second iteration. Also, continuing with the appeal to Leslie’s visual nature, Ashley also creates a graphic to denote the second isolated ATOMIC ARGUMENT.]



III. Iterate and I. Isolate ARGUMENT 2 - the ARGUMENT for Prop9.

Believing
 Prop9
 is justified by applying
 inspection of results
 to these premises
 The results in Arti3 support Prop9

II. Interrogate using the SPRY questions.

2 S: Yes. The syntax is proper.

2 P.a: Yes. By convention e the sole PREMISE is in BELIEVABILITY category (d).

2 P.b: Yes. By implication from conventions e and j the PREMISE is relevant.

2 R.a: Yes. By convention g inspection of results is relevant.

2 R.b: Yes. By convention g inspection of results is consistent with current knowledge.

2 Y.a: Yes. By convention i the required level of confidence is known.

2 Y.b: Yes. By convention j and the answers to 2 P.a – 2.Ya the ARGUMENT engenders the required level of confidence to justify believing Prop9.

2 Assessment: ARGUMENT for Prop9 is **COGENT**.

[From this point forward, Ashley began using shortcuts to record the assessment results.]

III/I 3 – ARGUMENT for Prop2

Believing
Prop2
is justified by applying
Reas1
to these premises
Prop5
Prop6

II. 3

3 S: Yes.

3 P.a: Y. Prop 5 and Prop6 BELIEVABILITY category (c).

3 P.b: Y. convention b.

3 R.a: Y. Reas1 conv. g.

3 R.b: Y. Reas1 conv. g.

3 Y.a: Y. conv. i.

3 Y.b: Y. conv. j.

3 Assessment: ARGUMENT for Prop2 is **COGENT** (subject to COGENCY of ARGUMENTS for Prop5 and Prop6).

III/I 4 – ARGUMENT for Prop3.

Believing
Prop3
is justified by applying
Reas2
to these premises
BelProp1
BelProp2

II. 4

4 S: Y.

4 P.a: Y. BelProp1 category (a) by conv. c. BelProp2 category (b) by conv. d.

4 P.b: Y. BelProp1 conv. c. BelProp2 conv. d.

4 R.a: Y. Reas2 conv. g.

4 R.b: Y. Reas2 conv. g.

4 Y.a: Y. conv. i

4 Y.b: Y. conv. j

4 Assessment: ARGUMENT for Prop3 is **COGENT**.

III/I 5 - ARGUMENT for Prop4.

Believing
 Prop4
 is justified by applying
 Reas2
 to these premises
 BelProp3
 Prop7

II. 5

5 S: Y.

5 P.a: Y. BelProp3 cat (a), conv. c. Prop7 cat (c), conv. b.

5 P.b: Y. BelProp3 conv. c. Prop7 conv. b.

5 R.a: Y. conv. g.

5 R.b: Y. conv. g.

5 Y.a: Y. conv. i.

5 Y.b: Y. conv. j.

5 **Assessment:** ARGUMENT for Prop4 is **COGENT** (subject to COGENY of the ARGUMENT for Prop7).

[Ashley inserted another graphical representation for the benefit of Leslie.]

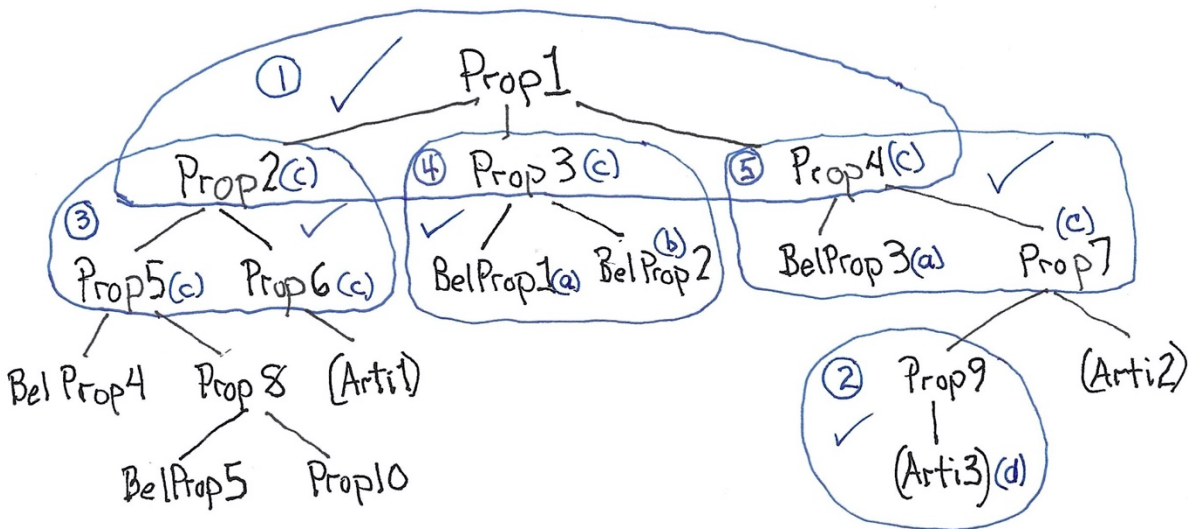


Figure 6: State of assessment after the fifth iteration

[Ashley chose to next isolate the argument for Prop7. Some folks may make a different choice.]

III/I 6 – ARGUMENT for Prop7.

Believing

Prop7
is justified by applying
Reas3
to these premises
Prop9
The results in Arti2 support Prop7

II. 6

6 S: Y.

6 P.a: Y. Prop9 cat. (c). The results in Arti2 support Prop7. cat (d).

6 P.b: Y. Prop9. conv. c. No. The results in Arti2 support Prop7. By convention f, Arti2 is BOUND to a non-current version; hence, it is not relevant.

6 R.a: Y. Reas2 conv. g.

6 R.b: Y. Reas2 conv. g.

6 Y.a: Y. conv. i.

6 Y.b: No. The second PREMISE fails P.b.

6 Assessment: ARGUMENT for Prop7 is **not COGENT**. Potentially may be made COGENT by correcting the BINDING of Arti2 and reassessing.

III/I 7 – ARGUMENT for Prop8.

Believing
Prop8
is justified by applying
Reas4
to these premises
BelProp5
Prop10

II. 7

7 S: Y.

7 P.a: Y. BelProp5. cat (a), conv. c. Prop10. cat (f), conv. b. (Note: this proposition should be clearly marked in some way to show it is an assumption accepted by all stakeholders. Following the naming convention for this concrete abstract example, it could be called AssumProp1.)

7 P.b: Y. BelProp5. conv. c. Prop10. conv. b.

7 R.a: Y. Reas4. conv. h.

7 R.b: ?. Convention h. says it is not known whether Reas4 is consistent with current knowledge.

7 Y.a: Y. conv. i.

7 Y.b: ? Must know more about Reas4 to answer R.b.

7 Assessment: The COGENCY of the ARGUMENT for Prop8 is **unknown** until adequate information is obtained about Reas4 to assess whether it is consistent with current knowledge. If so, then the ARGUMENT is COGENT; otherwise, the ARGUMENT is **not** COGENT.

III/I 8 - ARGUMENT for Prop5.

Believing
Prop5
is justified by applying
conjunction
to these premises
BelProp4
Prop8

II. 8

8 S: Y.

8 P.a: Y. BelProp4. cat. (b) conv. d. Prop8. cat. (c). [Note: because Ashley has already assessed the COGENCY of the ARGUMENT for Prop8 and found it questionable, resisting the temptation to mark Prop8 as not BELIEVABLE at this point is difficult. Ashley resists to illustrate the proper functioning of the iTest Integrate step.]

8 P.b: Y. BelProp4. conv. d. Prop8. conv. b

8 R.a: Y. conv. g.

8 R.b: Y. conv. g.

8 Y.a: Y. conv. i.

8 Y.b: Y conv. j.

8 Assessment: ARGUMENT for Prop5 is **COGENT** (subject to the COGENCY of the ARGUMENT for Prop8)

III/I 9 – ARGUMENT for Prop6.

Believing
Prop6
is justified by applying
inspection of results
to these premises
The results in Arti1 support Prop6

II. 9

9 S: Y.

9 P.a: Y. cat (d), conv. e.

9 P.b: Y. conv. e.

9 R.a: Y. conv g.

9 R.b: Y. conv. g.

9 Y.a: Y. conv. i.

9 Y.b: Y. conv. j.

9 Assessment: ARGUMENT for Prop9 is **COGENT**.

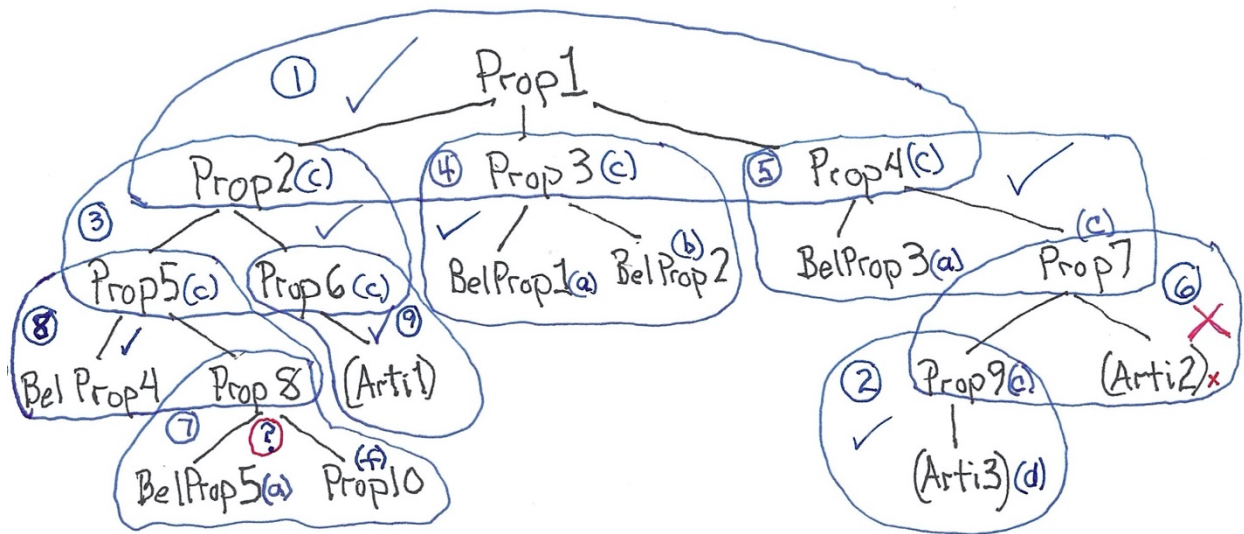


Figure 7: State of assessment after the final iteration

III. Integrate ATOMIC ARGUMENT assessments.

A. Are all ATOMIC ARGUMENTS assessed as COGENT?

No. ARGUMENT 6 is assessed as not COGENT. ARGUMENT 7 is assessed as having unknown COGENCY.

[Ashley's numbering scheme for the steps comes from the description of steps in section 3.2.1 for propagating non-COGENCY.]

1. ARGUMENT 6 conclusion is Prop7
2. Prop7 is a PREMISE in ARGUMENT 5
3. Change Prop7's BELIEVABILITY category from (c) to "No"
4. This changes ARGUMENT 5's assessment from COGENT to non-COGENENT.

1. ARGUMENT 7 CONCLUSION is Prop8
2. Prop8 is a PREMISE in ARGUMENT 8
3. Change Prop8's BELIEVABILITY category from (c) to "No"
4. This changes ARGUMENT 8's assessment from COGENT to non-COGENENT.

5. Next iteration

1. ARGUMENT 5 CONCLUSION is Prop4
2. Prop4 is a PREMISE in ARGUMENT 1

This paper will be updated whenever experience warrants.

3. Change Prop4's BELIEVABILITY category from (c) to "No"
4. This changes ARGUMENT 1's assessment from COGENT to non-COGENT.

1. ARGUMENT 8 CONCLUSION is Prop5
2. Prop5 is a PREMISE in ARGUMENT 3
3. Change Prop5's BELIEVABILITY category from (c) to "No"
4. This changes ARGUMENT 3's ASSESSMENT from COGENT to non-COGENT

5. Next iteration

1. ARGUMENT 3 CONCLUSION is Prop2
2. Prop2 is a PREMISE in ARGUMENT 1
3. Change Prop2's BELIEVABILITY category from (c) to "No"
4. ARGUMENT 1 assessment has already changed from COGENT to non-COGENT.

[For Leslie's benefit, Ashley shows the following drawing.]

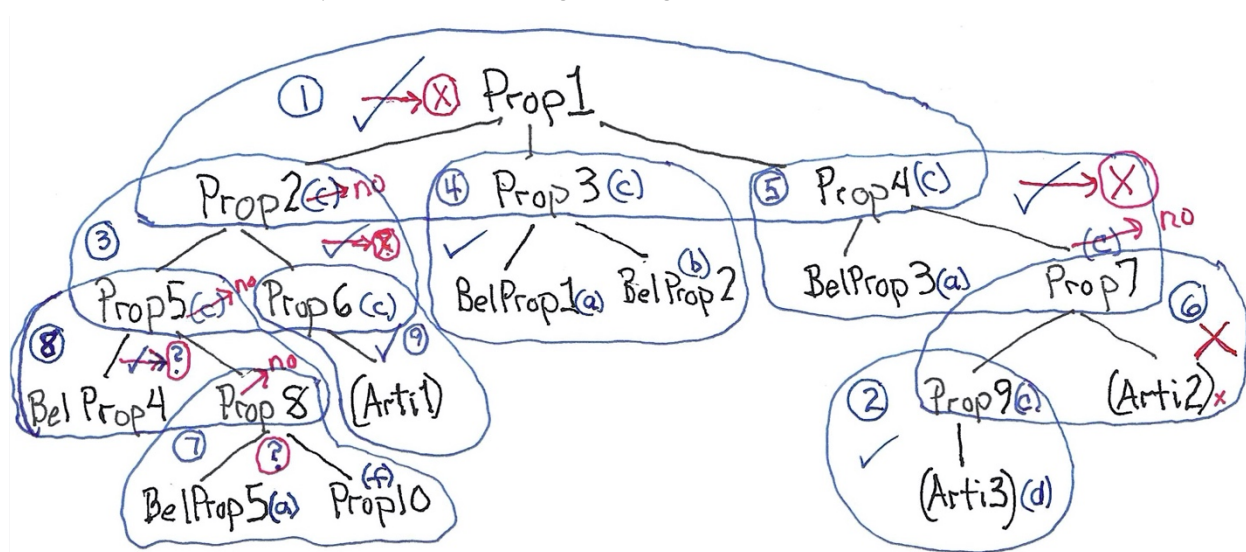


Figure 8: State of assessment after integration

B. Does every path through the COMPOUND ARGUMENT terminate in BELIEVED PREMISES?

This question does not have to be asked for the flawed argument in exercise 17.

[For illustrative purposes, Ashley proposes two changes to the exercise conventions, which would result in all the ATOMIC ARGUMENTS being assessed as COGENT, and thus also the answer to Integrate question A becoming "Yes" and asking Integrate question B becoming relevant.]

This paper will be updated whenever experience warrants.

If we alter the conventions for exercise 17 by changing convention g to include **Reas4** and remove conventions f and h, then all nine ATOMIC ARGUMENTS will be COGENT. The terminal PREMISES and their BELIEVABILITY categories will be as follows:

- (a): BelProp1, BelProp3, BelProp5
- (b): BelProp2, BelProp4
- (d) : The results in Arti3 support Prop9, The results in Arti1 support Prop6, The results in Arti2 support Prop7
- (f): Prop10

Thus, with those changes, the compound argument is cogent.