A Primer on Argument

(Overarching Properties Edition)

version 1.2
(modified 2021-05-07)

C. Michael Holloway
NASA Langley Research Center

Kimberly S. Wasson
Federated Safety, LLC.

The purpose of this document is to establish for the Overarching Properties Working Group (OPWG) a common understanding of the terms, concepts, principles, and uses of argument. It emphasizes the practical over the theoretical and the simple over the complicated.

Mr. Holloway's work on this document was partially funded through an Interagency Agreement between NASA Langley Research Center and the FAA William J. Hughes Technical Center (NASA IA1-30333 / FAA IA NO. 692M15-19-T-00029) for Aviation Software and Electronics Research, specifically NASA Annex 1 / FAA Task Order 692M15-19-F-00697 Streamlining Assurance Via Overarching Properties. Dr. Wasson's work on this document was partially funded by Joby Aero Inc., 340 Woodpecker Ridge, Santa Cruz, CA, 95060 in support of applied research and development in argumentation and certification for assured autonomy.

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1 Preliminaries

Humans have been studying argument for a long time, for several millennia in fact before anyone conceived of "safety cases" or "assurance cases." The literature on the subject is deep and wide and growing (see for example [2] & [8]). Nothing we present here is new in any fundamental sense. We are not trying to contribute to the general philosophical or legal literature of argument, nor to the specific literature of the assurance case community with this document, but only synthesizing and (we hope) simplifying the ideas that are directly applicable to creating and assessing arguments relating to whether a system possesses the Overarching Properties.

Readers who are familiar with the assurance / safety case work over the last couple of decades will notice some differences here[1]. 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[2]. We are only establishing *a* common understanding from which the OPWG can proceed forward.

The structure is as follows. Section 2 identifies and defines the primitives (*aka* terms) necessary to speak and reason coherently about arguments. Section 3 presents the precepts we believe should be kept clearly in mind as the OPWG's work proceeds. Section 4 enumerates several practical matters that are also important to keep in mind. Section 5 wraps everything up. Throughout, to distinguish between explanatory text and the things you need to remember forever,

> we narrow the margins around the "you must remember this" [4] material, and collect it all in Appendix A

2 Primitives

In this section, we are going against type. Rather than providing the OED-like, lexicographically precise definitions we relish, we will stick to the rather informal-ish

[1] Even from some previous papers and presentations we ourselves have given. Michael is in the process of revising his *Understanding Assurance Cases* [3] to comply more closely with the ideas presented in this document.

[2] 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.

(but nevertheless adequately precise) language Michael developed a while back for reasons initially unrelated to Overarching Properties or even to his NASA job.

Although we make full use of colors as an aid to identifying and distinguishing among specific defined terms, the colors have no meaning, and are not necessary. ***Bold text*** also identifies the defined terms. 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.

2.1 argument, believe, conclusion

We begin, as you probably suspected we would, with ***argument***[3]:

> An ***argument*** **is** an attempt to convince others to ***believe*** a ***conclusion*** through ***reasoning*** and one or more ***premise***s.

In general an ***argument*** may be oral or written, but for OPWG purposes we will be almost exclusively concerned with written ***argument***s[4]. An ***argument*** may also be ***atomic*** or ***compound.*** We'll explain the distinction shortly, but let's first consider ***believe***, ***conclusion***, ***premise***, and ***reasoning*** in that order.

The basic word 'believe' is one of those frequently used words for which nearly everyone believes they have a correct understanding, but which has many subtly (and some not so subtly) different senses, some of which are mutually contradictory. Philosophers have been known to have battles over 'believe' at least as intense as the battles engineers have over probabilities of failure. As fascinating as these battles are, OPWG's work does not require participating in them, or even picking sides. For our purposes, we can rest content with this very simple definition:

> To ***believe*** is to accept as true.

But, someone may ask, "What is truth?" To which we reply, paraphrasing Justice Potter Stewart, "You know it when you see it." [6] Within the context of arguments

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[3] Michael is compelled to insert this footnote identifying the corresponding relevant sense (#4) of the term as given in the OED [1]: "A connected series of statements or reasons intended to establish a position (and, hence, to refute the opposite) …"

[4] For our purposes, *written* encompasses arguments that are recorded, e.g. via analog or digital documentation, and expressed using text, graphical, tabular, or other representations. All such representations are *notational variants* for expressing and elaborating the primitives described herein.

about whether a product possesses the Overarching Properties, the existential question of the meaning of truth will never arise. The questions will always be about *whether* a specific statement is true (or not).

One particular type of statement about which these questions will arise is the ***conclusion*** of an ***argument***, because

> The ***conclusion*** is the statement you want your audience to ***believe.***

2.2 premise, reasoning

To convince your audience, you will make use of things you think they *already* ***believe***. Calling each of those things by the term first recorded in written English in 1398 [5], we say

> A ***premise*** is a statement you think your audience ***believe***s.

Many traditional explanations of argumentation stop here, separating an ***argument*** into only two parts, ***conclusion*** and ***premise***s. Most explanations of assurance cases do not use the word ***premise*** at all. We think both of these approaches are less clear than they ought to be.

A simple bifurcation is less clear than it needs to be because it leaves to the audience the task of either figuring out *why* the given ***premise***s are adequate to justify the ***conclusion,*** or deciding *which* of the specific ***premise***s explains why the others provide sufficient justification. We free the audience from this burdensome and risky task by requiring an explicit statement in the ***argument***.

> Your ***reasoning*** states why you think the ***premise***s should cause your audience to ***believe*** your ***conclusion.***

A ***premise***-free explanation is also problematic because it falsely suggests that an assurance case is something different in kind from a traditional ***argument***. Recognizing, however, that some of the assurance case community's alternate terms may have some value to some people in some situations, we adapt two of those common terms to fit nicely as follows:

> ***Evidence*** is the name you *may* give to a ***premise*** you're certain your audience ***believe***s.[5]

> ***Assumption*** is the name you *may* give to a ***premise*** you are not prepared to justify if your audience does not ***believe*** it.

[5] The use of the term 'evidence' is highly problematic. We reluctantly use it here because of its current ubiquity and put off until another day a serious attempt to address the problems.

Neither ***evidence*** nor ***assumption***s are anything more (or less) than ***premise***s. Whether the terms are used is a matter of style not of substance.

We have now explained all of the primitives that constitute an ***argument***: ***conclusion***, ***reasoning***, ***premise***(s), and ***believe***. A ***conclusion*** alone is not an ***argument***. ***Reasoning*** alone is not an ***argument***. A ***premise*** or several ***premise***s is not an ***argument***. Several ***premise***s and some ***reasoning*** do not an ***argument*** make***.*** And even a ***conclusion*** with ***reasoning*** and one or more ***premise***s is not an ***argument***, unless it is being offered for the purpose of trying to convince someone to ***believe*** the ***conclusion.***

2.3 binding, defeater

As much as the reader may wish we were, we are not quite done. There are two more primitives and three helpful terms we need to introduce. First, the additional primitives.

Sometimes understanding an ***argument*** requires more information than can be conveniently expressed in the ***conclusion***, ***reasoning***, or ***premise***s. We borrow a term from programming language theory to use ***binding*** as the primitive for information of this form.

> 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. Any OP-related ***argument*** will almost certainly include ***binding***s corresponding to one or more of the definitions from the OP description. Other examples of ***binding***s are references to external documents or other artifacts in which relevant information is contained.

One more primitive to go. It is called a ***defeater.***

> A ***defeater*** is a statement that may cause your audience to *not* ***believe*** your ***conclusion***.

Whereas a ***premise*** provides support for ***believing*** the ***conclusion***, a ***defeater*** provides support for *not* ***believing*** it Or, at least for not believing that the given ***argument*** compels ***belief***[6].

[6] Within the philosophical literature, distinguishing between two or sometimes more types of defeaters is common. We do not think those distinctions are necessary or even helpful for the OPWG, and follow the approach (but not the language; he uses 'rebuttal') of Toulmin [8].

2.4 atomic, compound, cogent

That's it for the primitives, but we further introduce two *almost*-primitives to facilitate unambiguous conversations by providing a way to distinguish between ***argument***s with one level of depth and those with multiple levels:

> An ***atomic argument*** consists of a single ***conclusion*** together with its immediate ***reasoning***, ***premise***s, ***binding***s (if present), and ***defeater***s (if present).
>
> A ***compound argument*** is an ***argument*** consisting of more than one ***atomic argument.***

Finally, we introduce an adjective to describe good ***argument***s.

> An ***argument*** is called ***cogent*** if it rationally justifies ***believing*** its ***conclusion*** to the required standard of confidence.

Consider, for example, the legal system of the United States. The required standard 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" standard of confidence. An ***argument*** that is ***cogent*** for a civil action may well not be ***cogent*** in a criminal trial.

A complete listing of all terms and definitions described in this section is given in Appendix A. With a clear, sufficient vocabulary established and explained, we move on to enumerating precepts for guiding the development and assessment of OP-related arguments (OPRA) by the OPWG.

3 Precepts

Through study and experience, we have collected a number of observations that, turned into guiding principles, support a consistent theory and practice of ***argument*** development and assessment. We will refer to these collectively as the Precepts, and introduce them here.

3.1 Locality

We have differentiated between ***atomic*** and ***compound argument***s above because these structural levels have relevance in ***argument*** construction and assessment, Specifically, the ***premise***s of one ***atomic argument***, if requiring further rationale for their believability, themselves become ***conclusion***s of supporting ***argument***s. Linked together in chains or hierarchies, these ***atomic argument***s comprise an integrated ***compound argument***. However, while a ***conclusion*** of any complexity requires a ***compound argument*** to organize its rationale, each ***conclusion*** at the atomic levels must be worthy of belief for the ***conclusion*** of the ***compound argument*** to also be worthy of belief.

> The precept of ***Locality*** reminds us that *the* ***cogency*** *of a* ***compound argument*** *never exceeds the* ***cogency*** *of its weakest* ***atomic argument.***

Applying this precept[7] to figuring out how best to assess an ***argument*** (as the A Team is charged with doing) tells us we can (well, really *must*) focus assessment at the ***atomic argument*** level. That is, when assessing whether ***believing*** a particular ***conclusion*** is justified, we assume its ***premise***s are true, and consider only whether their truth and the stated ***reasoning***, in the context created by any ***binding***s and ***defeater***s, provides the necessary justification. We do not look elsewhere within the ***argument.*** To assess a ***compound argument***, one assesses iteratively each ***atomic argument*** contained therein.

3.2 Depth

Since a ***premise*** of one ***atomic argument*** can become a ***conclusion*** of a supporting ***argument***, we can infer that ***argument***s may in theory descend ad infinitum. In

[7] The name of the precept originated in Michael's mantra, "All arguments are local." He coined the statement long ago based on the saying, "All politics is local," which was used most famously by (but was not original to) former Speaker of the U.S. House of Representatives (1977-1987) Tip O'Neill. We originally stated the precept in Michael's original words, but have revised it as shown here to be consistent with the more recent compound / atomic distinction.

practice, we obviously don't do this. In order to be of genuine practical use, ***argument*** decomposition must descend far enough to serve stakeholder objectives, and not so far as to unnecessarily consume resources, create distraction, or put into an ***argument*** something that is better expressed in some other form. It was easy to write that; it is harder to do, and we'll return to this in forthcoming discussions. Nonetheless,

the precept of ***Depth*** reminds us to *descend no deeper than necessary*.

3.3 Certainty

As it was more straightforward to *describe* a target ***depth*** of decomposition than to *find* it, it is similarly more straightforward to describe a target level of precision or ***certainty*** in documenting ***argument*** components than it is to accomplish it. Since the ***argument***s with which we are concerned are *informal*[8], we are searching not for a property of mathematical precision in specifying ***argument*** elements, but rather for one of *pragmatic sufficiency*. That is, in stating a ***premise***, ***conclusion***, ***reasoning***, or other component of an ***argument***, we recognize that we can never achieve absolute formality of precision or ***certainty.*** However, we target with mindful attention a level that is pragmatically sufficient to the purposes at hand. As with ***depth***, we will revisit operational guidance for such decisions during our ensuing group work.

The precept of ***Certainty*** reminds us that *certainty is certainly not possible*.

3.4 Change

Any ***argument*** of the type with which we are concerned is constructed in the context of a real world state, including the respective states of entities over which it argues, as well as the respective states of knowledge and understanding of those contributing to its documentation. Even ***argument***s considered some form of "final" for system lifecycle purposes are still subject to change, for example, in light of post-deployment experience. Importantly, ***argument***s themselves have lifecycles, and go through stages of development with implications that (1) must be attended to, and (2) can be leveraged. That is, irrespective of process codification including configuration management, change management, and other conventions of complex development processes, we recognize that any discrete snapshot of an argument represents a point in a continuously changing space described by a large

[8] See the precept of ***Induction*** for more on informality.

number of informal variables. We discretize this space to some degree in order to manage development processes, for systems *and* for arguments. But what an argument says, and to what it applies, is under refinement throughout its development, and subject to change even afterward should new need or knowledge arise.

> The precept of ***Change*** reminds us that ***argument****s are living structures*.

3.5 Induction

Related closely to the precept of ***Change*** is the precept of ***Induction***. In stating that even a "final" ***argument*** is subject to update, we have implied that new ***premise***s can affect ***belief*** in a ***conclusion***. This is true for the ***argument***s with which we are concerned, and differentiates these from another type. The study of argument differentiates ***conclusion***s that can be *proven* through the application of formal logic to sufficient ***premise***s (deductive arguments), and those that are in contrast ***believe****able* through the application of any other type of reasoning (inductive arguments)[9]. All ***argument***s with which we are concerned refer to real world state that cannot be formalized.

> The precept of ***Induction*** reminds us that *the* ***argument****s with which we will concern ourselves are uniformly*[10] *inductive* ***argument****s*.

3.6 Plausibility

In an ideal world, everyone would assess in the same way whether a particular ***argument*** (even an inductive one) is ***cogent***. Even without the possibility of ***certainty***, consensus about ***cogency*** seems both desirable and feasible (well, at least a consensus among those with sufficient subject-area and argumentation knowledge). In the real world, agreement does not always happen.

Many different theories have been proposed over the centuries to explain why equally qualified people sometimes assess differently the ***cogency*** of an ***argument***. These theories may be combined and summarized by as follows: The propositions,

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[9] We are simplifying things a little bit here, as modern philosophers of logic often speak of additional categories or sub-categories such as analogical, explanatory, and defeasible arguments. Most of the arguments likely to apply to showing OP possession would properly fit into the defeasible category. We shall not speak of this again.

[10] Note a compound *inductive* argument might include occasional nested *deductive* arguments, which does not change the fact that at the relevant level of abstraction, it is still an *inductive* argument.

ideas, perceptions, conjectures, beliefs, etc., a person treats as true, whether explicitly or subconsciously, *before* evaluating an ***argument*** establish in advance the boundaries within which that person will judge the ***cogency*** that ***argument***. Or in fewer words:

> The precept of ***Plausibility*** reminds us that *presuppositions predetermine plausibility*.

If, for example, Teresa and Joyce (both smart and knowledgeable people) assess the ***cogency*** of an ***argument*** differently, their different assessment may have nothing to do with the ***argument*** itself. Rather the differences may rest in conflicting opinions about the truth of matters that are (necessarily) implicit in the ***argument.***

An implication of this precept is that arguments developed exclusively by people with similar backgrounds and areas of areas of expertise may have shortcomings that arguments developed by people with more diverse backgrounds and areas of expertise would not. This applies similarly for evaluation: a homogenous collection of evaluators may fail to spot some flaws that a diverse collection of evaluators would find.

These six precepts — ***Locality***, ***Depth***, ***Certainty***, ***Change***, ***Induction***, and ***Plausibility*** — should be kept continually in mind throughout the ongoing work of the OPWG. Also, if either the A Team or the E Squad finds need to add to the precepts, they should let the other group know immediately.

4 Practicalities

The material so far has laid down a consistent and elegant intellectual foundation for proceeding forward with the OPWG's work. This section addresses some practical issues that are sure to arise, just as they (or close variants thereto) have arisen in previous discussions over the lifetime of the OPWG.

4.1 Concerning adding to primitives and precepts

The primitives and precepts presented here establish a core working lexicon and set of relationships to anchor and unify the more complex discussions, constructions, and assessments the OPWG will undertake. As our objectives grow more advanced, we will necessarily provoke consideration of additional concepts, meaning distinctions, and options for representation. We as a working group shall endeavor

to resist the tendency to multiply primitives or precepts. We shall try to be disciplined in maintaining traceability to the foundations. And we shall document, discuss between both the A Team and E Squad, and justify if and when we determine extension is necessary.

4.2 Concerning notations

When the time comes to document working arguments, we will necessarily need to choose one or more representations to accomplish this. As described earlier, all analog and digital records of arguments captured via text, graphical, tabular, or other data, are *notational variants* of each other and more importantly of the primitives. We will in all likelihood land on one choice for convenience; however, our position is that the integrity of the primitives takes precedence over the notation.

Further, any notation has the power to facilitate or impede expression and reception of the primitives, and conventional use of some familiar notations in the community has muddied this water. When we choose a representation, we shall at that time document alignment to the primitives, and any constraints on use and interpretation needed in order to maintain integrity of the primitives. To be precise:

> For any notation we choose, we will modify its language to the extent needed to conform to the primitives defined in this document.

4.3 Concerning speaking about assurance cases

In the April 2019 meeting, the OPWG informally and without much discussion tacitly accepted the phrase “Assurance Case for the Overarching Properties (ACOP)” as the label to describe that for which we are working to provide guidance. The A Team is tasked with developing guidance for assessing ACOPs, and the E Squad is tasked with developing guidance for creating examples of them. So far, this document has intentionally avoided talking about ACOPs (and, for the most part, assurance cases in general). Here’s why.

Our experience and observations have suggested the phrase “assurance case” (or any of its close variants) tends to complicate rather than facilitate conversations about the fundamental ideas. The reasons for the complications vary. Some people seem unable to think of assurance cases as anything other than big diagrams in (usually) the Goal-Structuring Notation (GSN); they often entirely miss the centrality of argument. Some people, particularly those of a certain mathematical bent, seem to think the only legitimate goal for assurance cases is to embody formal, deductive

arguments exclusively. Some other people, mostly computer scientists or engineers, think exclusively in terms of tool support, including tools to quantify confidence.

But the most essential reason we have concentrated on ***argument*** and not cases is because it is in creating and assessing the ***arguments*** that the need for guidelines and examples is most acute. Arranging the OP-related arguments into an ACOP is not the hard part. Creating the OPRAs and ensuring they are ***cogent*** are the hard parts, and the parts on which the E Squad and A Team need to focus right now.

> Creating ***argument***s and ensuring they are ***cogent*** are the hard parts.

5 Prognosis

This document has established for the Overarching Properties Working Group (OPWG) a common understanding of the terms, concepts, principles, and uses of argument. By doing so it

- provides a firm foundation from which the A Team and E Squad can proceed forward in accomplishing their assigned tasks efficiently and efficaciously;
- reduces the likelihood of either group introducing language or concepts that are incompatible with the other; and
- increases the likelihood the products of both groups will be consistent with well-accepted ancient and modern ideas and practices of argumentation.

With apologies to the great J. R. R. Tolkien[11] we close with an admonition. Go back? No good at all! Go sideways? Impossible! Go forward? Only thing to do! Let us go on with our hearts all of a patter and a pitter.

[11] See [7] (or any other edition) for the original words.

6 Precedents

[1] "argument, n." OED Online, Oxford University Press, March 2020, www.oed.com/view/Entry/10663. Accessed 31 March 2020.

[2] Govier, Trudy. 2010. *A Practical Study of Argument*. 7th edition. Belmont, CA: Cengage Learning.

[3] Holloway, C. Michael. 2018. *Understanding Assurance Cases: An Educational Series in Five Parts*. https://shemesh.larc.nasa.gov/arg/uac.html

[4] Hupfeld, Herman. 1931. "As Time Goes By." Made famous by Dooley Wilson as Sam in Warner, Jack L., *et al.* 1942. *Casablanca*. Warner Bros. Pictures, Inc., 1942.

[5] "premise, n." OED Online, Oxford University Press, March 2020, www.oed.com/view/Entry/150302. Accessed 9 April 2020.

[6] Stewart, Justice Potter. *Jacobellis v. Ohio*. 378 US 184, 197, 1963.

[7] Tolkien, J.R.R. *The Hobbit.* Houghton Mifflin Harcourt. Kindle Edition. p. 69.

[8] Toulmin, Stephen E. 2003 (1958). *The Uses of Argument*. Cambridge, UK: Cambridge University Press.

Appendix A - "you must remember this"

An ***argument*** is an attempt to convince others to ***believe*** a ***conclusion*** through ***reasoning*** and one or more ***premise***s.

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 ***believe***s.

Your ***reasoning*** states why you think the ***premise***s should cause your audience to ***believe*** your ***conclusion.***

Evidence is the name you *may* give to a ***premise*** you're certain your audience ***believe***s.

Assumption is the name you *may* give to a ***premise*** you are not prepared to justify if your audience does not ***believe*** it.

A ***binding*** is an association between a term used in an ***argument*** and the real-world information to which that term refers.

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***, ***premise***s, ***binding***s (if present), and ***defeater***s (if present).

A ***compound argument*** is an ***argument*** consisting of more than one ***atomic argument.***

An ***argument*** is called ***cogent*** if it rationally justifies ***believing*** its ***conclusion*** to the required standard of confidence.

The precept of ***Locality*** reminds us that *the* ***cogency*** *of a* ***compound argument*** *never exceeds the* ***cogency*** *of its weakest* ***atomic argument***.

The precept of ***Depth*** reminds us to *descend no deeper than necessary*.

The precept of ***Certainty*** reminds us that *certainty is certainly not possible*.

The precept of ***Change*** reminds us that ***argument****s are living structures*.

The precept of ***Induction*** reminds us that *the* ***argument****s with which we will concern ourselves are uniformly inductive* ***argument****s*.

The precept of ***Plausibility*** reminds us that *presuppositions predetermine plausibility*.

For any notation we choose, we will modify its language to the extent needed to conform to the primitives defined in this document.

Creating ***argument***s and ensuring they are ***cogent*** are the hard parts.

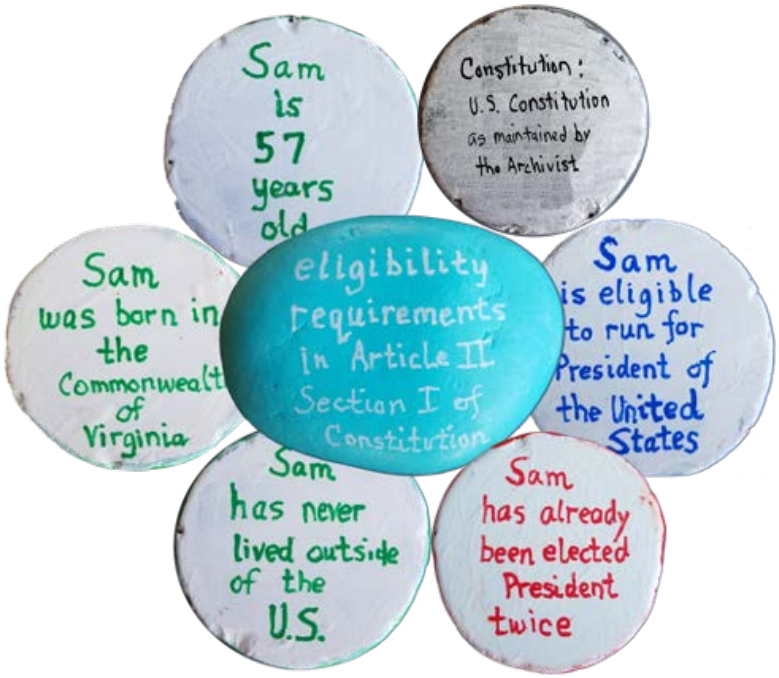
Appendix B - Example Arguments

Here is a series of simple examples illustrating the meaning of the primitives explained in Section 2. We present the examples in a notation (painted rocks) we believe is self-explanatory but also clearly not a notation the OPWG should use, and on a subject no one will think is biased towards hardware or software.

Example 1: an ***atomic argument***

Example 2: an ***atomic argument*** with a ***binding***

Example 3: an ***atomic argument*** with a ***binding*** and a ***defeater***

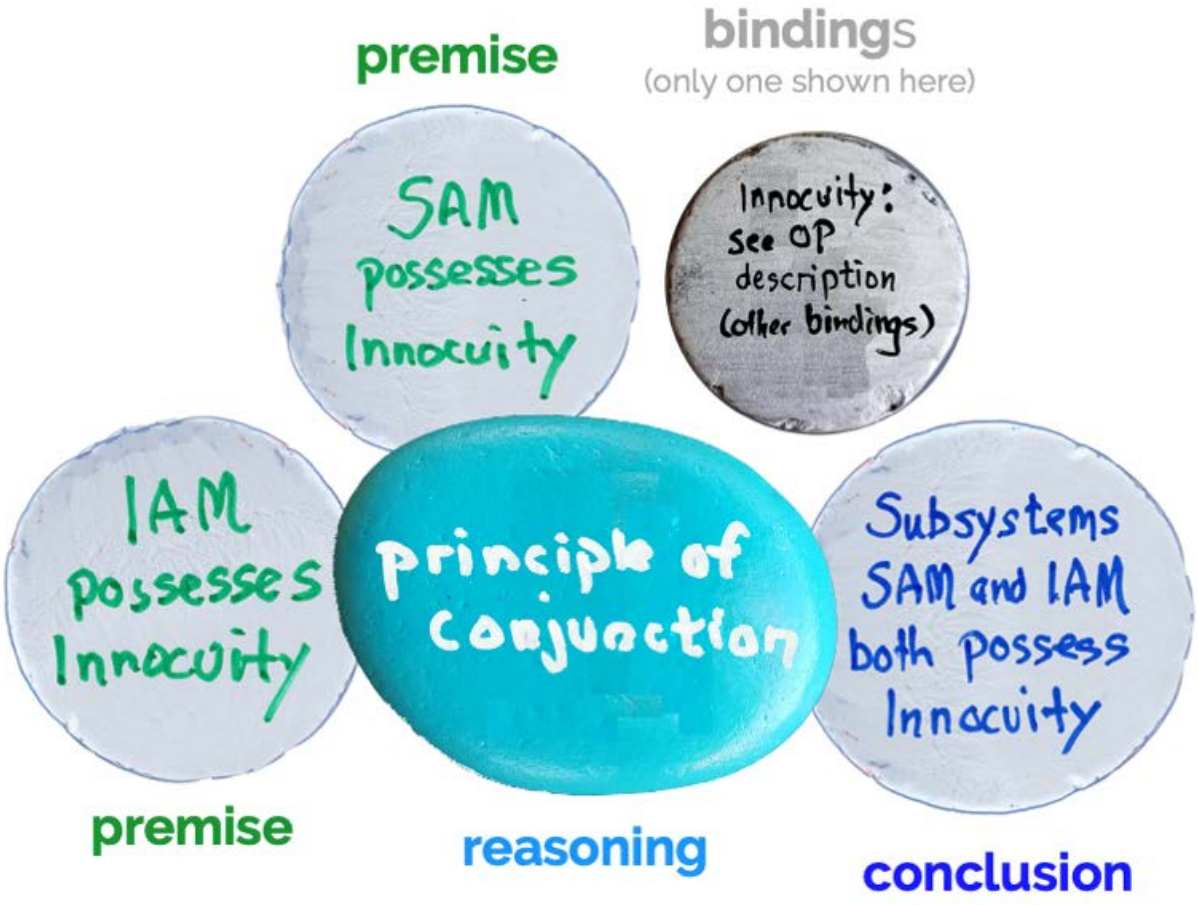


Example 4: an ***atomic argument*** modified to eliminate the ***defeater***

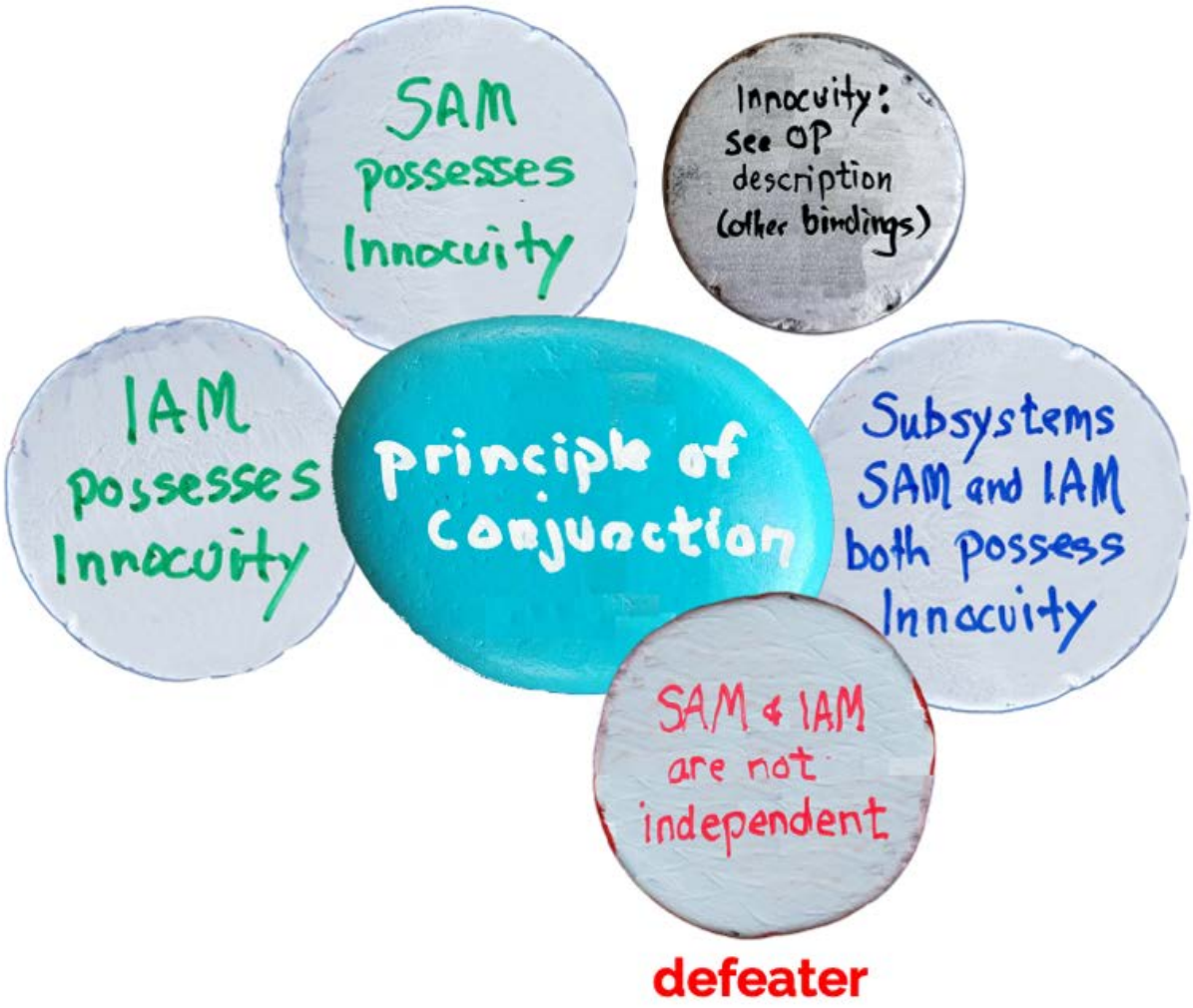
Example 5: a ***compound argument***

We now present some examples from a written-in-stone argument that is OP-related, albeit quite incomplete.

Example 6: an initial ***atomic argument***

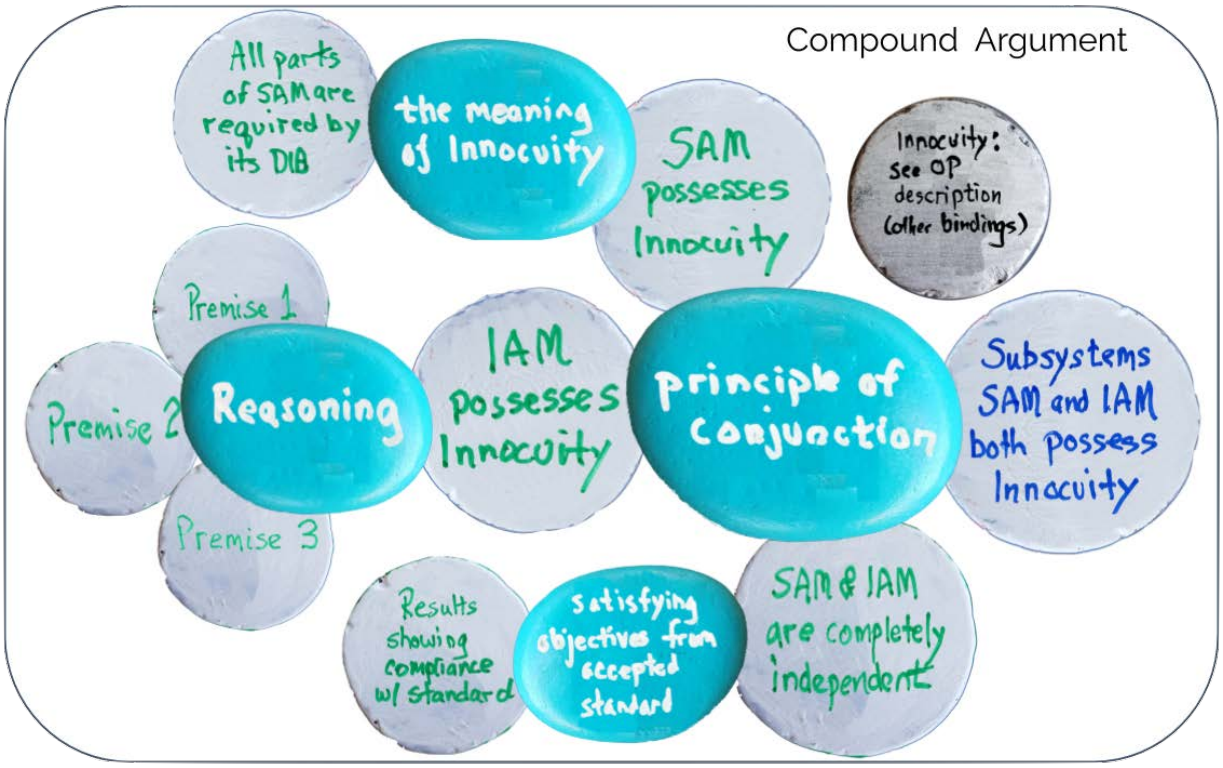


Example 7: a ***defeater*** discovered



Example 8: the ***defeater*** defeated

Example 9: the ***argument*** expanded



Example 10: the 4 constituent ***atomic argument***s