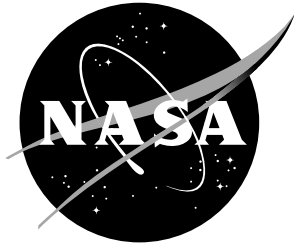NASA/TM–20230004423

The Friendly Argument Notation (FAN): 2023 Version

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December 2023

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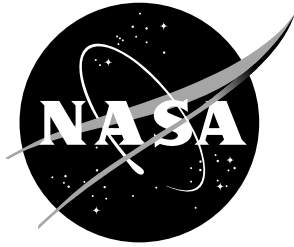
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Acknowledgments

Abstract

This document constitutes the official description of the current iteration of the Friendly Argument Notation (FAN). This new version provides several enhancements to the original 2020 instantiation, while maintaining essential compatibility with it. Specifically, the new version enables distinguishing between deductive and non-deductive arguments, removes the requirement for always providing an explicit statement of reasoning, and relaxes the rules for when labels may be used. The primary intended use of FAN is unchanged: creating and evaluating arguments about safety-critical systems, specifically the types of arguments common within safety and assurance cases.

Preface

Since its unfurling in June 2020 [1], the Friendly Argument Notation (FAN) has been used successfully, both in projects involving its creator in some capacity [2,3] and in entirely independent projects in both industry[1] and academia [4]. Happily, no change-demanding deficiencies in the notation have been identified; but, also happily, a handful of potentially efficacious enhancements have.

This paper documents those enhancements. To make the paper self-contained, freeing readers from the burden of referring to the original paper, the enhanced notation is described in full as if it were brand new. To comfort those folks who read and liked the original paper, the same structure and method of exposition used in it are used here. Well, almost the same; this paper includes an sneak peek not included in the original. To reward the curious readers who want to know how the current version of FAN differs from the original, Appendix A summarizes the differences.

1 Introduction

This document constitutes the official description of the current iteration of the Friendly Argument Notation (FAN)[2] The emphasis here is on showing what FAN looks like to someone who is using it manually to develop or assess arguments. A later document will provide a more precise definition suitable for use by tool developers[3]

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[1]I am aware of at least five different organizations currently using FAN internally. These uses have thus far remained proprietary and thus are uncitable.

[2]When necessary to distinguish between this version and the original, the expressions FAN_{2023} and FAN_{2020} will be used. FAN always refers to the current version.

[3]In opposition to the commonly expressed belief that tools are so crucial that they must be developed right away, and thus developing them should be a priority in NASA aeronautics research, I consider tools to be secondary or tertiary in importance, trailing getting the ideas right by a substantial margin. Also, I believe based on the experiences so far FAN can be used effectively without any specialized tools. Existing editors and version control programs for text work well. If other folks want to develop tools, I will be happy to consult with them as time permits.

1.1 Terminology

FAN aims to promote clarity, understanding, and communication with and among ordinary engineers and managers, while maintaining consistency with the long-existing common terminology about argument in philosophy and law. To that end, the notation uses the simple primitives and definitions[4] described in *A Primer on Argument* [5]:

- ARGUMENT: an attempt to convince others to BELIEVE a CONCLUSION through REASONING and one or more PREMISES.

- BELIEVE: accept as true.

- CONCLUSION: the statement you want your audience to BELIEVE.

- PREMISE: a statement you think your audience BELIEVES.

- REASONING: states why you think the PREMISES should cause your audience to BELIEVE your CONCLUSION.

- BINDING: an association between a term used in an ARGUMENT and the real-world information to which that term refers.

- DEFEATER: 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.

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

1.2 Organization

The rest of this document is organized as follows.

- Section 2 provides four examples of valid FAN$_{2023}$ arguments as a sneak peek into the changes made since FAN$_{2020}$.

- Section 3 explains and illustrates the syntax rules.

- Section 4 explains and illustrates the semantic rules.

- Section 5 provides exercises for the reader.

- Section 6 wraps everything up.

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[4]To make clear which words are primitives and which are not, primitives are displayed here in SMALL CAPS. The convention is not necessary in the remainder of the text.

- Appendix A summarizes the changes between FAN$_{2020}$ and FAN$_{2023}$.

- Appendix B lists all of the FAN rules on one page (front and back).

- Appendix C provides examples of using FAN that are longer than the examples and exercises in the main text.

2 Sneak Peek

The original FAN description jumped immediately into an explanation of the syntax rules. Not until five pages in did the reader see a complete, valid FAN$_{2020}$ argument. In retrospect, that approach seems a tad unfriendly. I want to be friendly this time, hence here are four short examples of atomic arguments expressed in FAN$_{2023}$.

Example 1. An example that is valid in FAN$_{2020}$, too

> Believing
>
>> Socrates is mortal.
>
> is justified by applying
>
>> AAA-1 Syllogism
>
> to these premises
>
>> All humans are mortal.
>> Socrates is a human.

Example 2. The "Socrates" argument using FAN$_{2023}$'s required by construct to indicate the argument is deductive

> Believing
>
>> Socrates is mortal.
>
> is required by applying
>
>> AAA-1 Syllogism
>
> to these premises
>
>> All humans are mortal.
>> Socrates is a human.

Example 3. The "Socrates" argument using FAN$_{2023}$'s required by construct and implicit reasoning

Believing

Socrates is mortal.

is required by these premises

All humans are mortal.

Socrates is a human.

Example 4. An example[5] using implicit, non-deductive reasoning.

Believing

Aircraft-level hazards have been identified and adequately characterized.

is justified by these premises

Aircraft Functional Hazard Assessment (AFHA) has been conducted.

The AFHA was conducted according to standard practice by appropriate personnel.

The aircraft and air operation details assumed during the AFHA are accurate.

Assumptions about crew mitigations of hazardous aircraft states are accurate.

The AFHA process has been endorsed by relevant aviation regulators.

3   Syntax

The syntax of FAN is directly based on the primitives just described. This section explains the syntax by stating the seven rules that define a valid FAN expression of an argument and by giving examples of valid applications and violations of the rules. The following conventions are used with the rules:

- *SMALLCAP ITALIC* denotes words or phrases with special meaning within the rules.

- Sans serif denotes FAN text.

3.1   Rules

---

[5]Taken from [6]. Readers interested in exploring further how to make sense of the concept of evidence within arguments are invited to read this paper.

> **Rule 1: FAN is not case-sensitive.**

Example 5. The following are all equivalent.

> Believing
>
> believing
>
> beLieVING
>
> BELIEVING

> **Rule 2. In these rules the word CHUNK denotes a single distinct bit of text. The manner of separation of CHUNKS depends on the form of the document. Where typesetting features are available, whitespace may be used to separate CHUNKS. In plain text files, lines might be terminated by a backslash (\) character to indicate that they are part of a CHUNK that includes the subsequent line. BEGINNING OF A CHUNK denotes the first non-whitespace character.**

Example 6. Each of the following constitute one CHUNK.

> Socrates is mortal.
>
> The modus ponens inference rule.
>
> The 'T' in word 'The' is the beginning of this chunk.
>
> The Constitution of the United States lists the qualifications to be eligible to run for President as being at least 35 years old, a natural born citizen and 'fourteen Years a Resident within the United States'.
>
> This is a long sentence in which we use a backslash \
> to indicate that we are continuing it on multiple lines \
> even in the absence of text formatting such as was \
> in preceding chunk.
>
> 13 − 9 was the score of the 2019 men's lacrosse championship
>
> sin(x) + sin(y) > cos (z)
>
> You need argument only when you need argument!

> **Rule 3. The words and phrases believing, with, unless, end, is justified by applying, is required by applying, to these premises, is justified by these premises, and is required by these premises are keyphrases. Keyphrases have special meaning whenever they appear at the BEGINNING OF A CHUNK. Any additional text in the CHUNK after a keyphrase is ignored.**

Example 7. Each CHUNK below contains a keyphrase.

Believing

is justified by applying

to these premises

unless

with

is required by these premises

unless my arm falls off

END of an era

Example 8. No CHUNK below contains a keyphrase (only BEGINNING OF A CHUNK words can be keyphrase).

Don't stop believing

A cat is a better pet than a dog

required

Jonathan and I went to the baseball game with Tim

No! I won't do it, unless you give me $85.77

And now we come to the end of this example

Rule 4.a. A CONCLUSION BLOCK consists of a CHUNK containing the keyphrase believing followed by a single CHUNK.

Example 9. Two valid CONCLUSION BLOCKS

Believing

Sam is eligible to run for President of the United States

Believing

Argument-based methods provide the best way to show possession of the Overarching Properties

Example 10. An invalid CONCLUSION BLOCK (no keyword).

I believe Sam is eligible to run for President of the United States

Example 11. An invalid CONCLUSION BLOCK (multiple propositions).

Believing

Sam is eligible to run for President of the United States
Sam is eligible to run for Governor of Virginia

4.b.1. An *Explicit Reasoning Block* consists of a *Chunk* beginning with either the keyphrase is justified by applying or the keyphrase is required by applying followed by a single *Chunk*.

Example 12. Two valid *Explicit Reasoning Blocks*.

> is justified by applying
>
>> The requirements for Presidential eligibility in the Constitution
>
> is required by applying
>
>> modus ponens

Example 13. An invalid Explicit Reasoning Block (no keyphrase).

> because of
>
> The requirements for Presidential eligibility in the Constitution

Example 14. An invalid Explicit Reasoning Block (multiple *Chunks*).

> is justified by applying
>
>> The requirements in Article II Section I of the US Constitution
>> The additional requirements in the 25th amendment

Rule 4.b.2. An *Implicit Reasoning Block* consists of a *Chunk* beginning with either the keyphrase is justified by these premises or the keyphrase is required by these premises followed by one or more *Chunks*. The *Implicit Reasoning Block* ends before the first appearance of the keyphrases with, unless, end or believing.

Example 15. Two valid Implicit Reasoning Blocks.

> is justified by these premises
>
>> Presuppositions predetermine plausibility
>> Certainty certainly is not possible
>> All arguments are local
>
> is required by these premises
>
>> If Michael is old his memory is degrading
>> Michael is old

Example 16. An invalid Implicit Reasoning Block (a non-propositional statement).

is justified by these premises

> Blue is a more attractive color than maroon
>
> Orange is an exciting color
>
> Go Hoos!

Rule 4.c. A *PREMISE BLOCK* consists of a *CHUNK* containing the keyphrase **to these premises** followed by one or more *CHUNK*s. The *PREMISE BLOCK* ends before the first appearance of the keyphrases **with, unless, end** or **believing**.

Example 17. A valid PREMISE BLOCK.

> to these premises
>
> > Sam is 57 years old
> >
> > Sam was born in the Commonwealth of Virginia
> >
> > Sam has never been outside of the United States

Example 18. An invalid PREMISE BLOCK (empty).

> to these premises

Example 19. An invalid PREMISE BLOCK (wrong keyphrase).

> to these propositions
>
> > One is the loneliest number
> >
> > A cord of three strands is not easily broken

Rule 4.d. A *BINDING BLOCK* consists of a *CHUNK* containing the keyphrase **with** followed by one or more *CHUNK*s, with each following *CHUNK* containing text, a colon (:), and more text. The *BINDING BLOCK* ends before the first appearance of the keyphrases **unless, end,** or **believing**.

Example 20. A valid *BINDING BLOCK* (1 binding, which is a definition).

> with these bindings
>
> > $<$Innocuity$>$: Any part of the implementation that is not required by the defined intended behavior has no unacceptable impact.

Example 21. A valid *BINDING BLOCK* (a definition and a reference).

> with these bindings

<eligible> : regarded as fulfilling the necessary criteria or qualifications

<constitution> : see https://constitutioncenter.org/interactive-constitution

Example 22. An invalid Binding Block (no keyword).

definitions:

<eligible> : regarded as fulfilling the necessary criteria or qualifications

Example 23. An invalid Binding Block (no colon).

with these bindings

eligible is defined as fulfilling the necessary criteria or qualifications

---

Rule 4.e. A *Defeater Block* consists of the keyphrase unless followed by one or more *Chunks*. The *Defeater Block* ends before the first appearance of the keyphrase with, end, or believing.

Example 23. A valid Defeater Block (a single defeater)[6].

unless

Sam has been twice elected to the office of President of the USA

Example 24. A valid Defeater Block (2 defeaters).

unless

Sam has been twice elected to the office of President of the USA
Sam is an elephant

Example 25. An invalid Defeater Block (no keyword).

but Sam has been twice elected to the office of President of the USA

Example 26. An invalid Defeater Block (empty).

unless

---

[6]Readers unfamilar with but interested in the concept of defeaters may wish to read [7] after finishing this paper.

> **Rule 5.** A word or phrase that appear to the left of a colon (:) in a *Binding Block* is written everywhere else in a way that distinguishes it from other text. **Note: Where typesetting features are available, this might be accomplished with italicization or underlining. In plain text, such phrases might appear between slash (/) characters or be surrounded by angled brackets (<>).**

Note to pendants: Rule 5 is intended to be applied using common sense, not unthinking literalism. I will rewrite it to make this more clean when I think of how to do it.

Example 27. A proper use of a word defined within a *Binding Block*.

Sam is <eligible> to run for President of the United States

Example 28. An improper use of a word defined within a *Binding Block* (it is not distinguished visually).

Sam is eligible to run for President of the United States

> **Rule 6.** A valid FAN argument consists of a *Conclusion Block*, followed by either (1) an *Explicit Reasoning Block* followed by a *Premise Block* or (2) an *Implicit Reasoning Block*; followed optionally in either order by a *Binding Block* and a *Defeater Block*. More than one FAN argument may be contained in the same document. Also, a document may begin with a *Binding Block*

Example 29. A valid FAN argument without a *Binding Block* or *Defeater Block*.

Believing

Sam is eligible to run for President of the United States

is justified by applying

The requirements for Presidential eligibility in the Constitution

to these premises

Sam is 57 years old

Sam was born in the Commonwealth of Virginia

Sam has never been outside of the United States

Example 30. A valid FAN argument with a *Binding Block* but no *Defeater Block*.

Believing

Sam is *eligible* to run for President of the United States

is justified by applying

The requirements for Presidential eligibility in the *Constitution*

to these premises

Sam is 57 years old

Sam was born in the Commonwealth of Virginia

Sam has never been outside of the United States

with these bindings

<eligible> : regarded as fulfilling the necessary criteria or qualifications

<constitution> : see https://constitutioncenter.org/interactive-constitution

Example 31. A valid FAN argument with initial Comment Blocks and a Binding Block.

% This argument was initially created in 2015
% as an example for teaching youngsters about arguments

with these bindings

<eligible> : regarded as fulfilling the necessary criteria or qualifications

<constitution> : see https://constitutioncenter.org/interactive-constitution

Believing

Sam is *eligible* to run for President of the United States

is justified by applying

The requirements for Presidential eligibility in the *Constitution*

to these premises

Sam is 57 years old

Sam was born in the Commonwealth of Virginia

Sam has never been outside of the United States

Example 32. A valid FAN argument with a SMALL-CAPS BINDING BLOCK and SMALL-CAPS DEFEATER BLOCK.

Believing

    Sam is <eligible> to run for President of the United States

is justified by applying

    The requirements for Presidential eligibility in the <Constitution>

to these premises

    Sam is 57 years old

    Sam was born in the Commonwealth of Virginia

    Sam has never been outside of the United States

with these bindings

    <eligible> : regarded as fulfilling the necessary criteria or qualifications

    <constitution> : see https://constitutioncenter.org/interactive-constitution

unless

    Sam has been twice elected to the office of President of the USA

Example 33. Two valid FAN arguments together in the same file.

Believing

    Sam is <eligible> to run for President of the United States

is justified by applying

    The requirements for Presidential eligibility in the <Constitution>

to these premises

    Sam is 57 years old

    Sam was born in the Commonwealth of Virginia

    Sam has never been outside of the United States

with these bindings

    <eligible> : regarded as fulfilling the necessary criteria or qualifications

<constitution> : see https://constitutioncenter.org/interactive-constitution

Believing

Sam was born in the Commonwealth of Virginia

is justified by applying

Inspection by a qualified document expert

to these premises

A certificated copy of Sam's birth certificate is available

Example 34. A valid FAN argument with implicit (non-deductive) reasoning.

Believing

Sam was born in the Commonwealth of Virginia

is justified by these premises

A copy of Sam's birth certificate is available
A qualified document inspector verifies the certificate

Example 35. An invalid FAN argument (missing either type of REASONING BLOCK and a PREMISES BLOCK).

Believing

Sam is eligible to run for President of the United States

is justified
unless

Sam has been twice elected to the office of President of the USA
Sam is an elephant

Example 36. An invalid FAN argument (missing PREMISE BLOCK).

Believing

Sam is eligible to run for President of the United States

is justified by applying

The requirements for Presidential eligibility in the Constitution

Example 37. An invalid FAN argument (DEFEATER BLOCK in wrong order).

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Believing

> Sam is <eligible> to run for President of the United States

is justified by applying

> The requirements for Presidential eligibility in the <Constitution>

unless

> Sam has been twice elected to the office of President of the US

to these premises

> Sam is 57 years old   % (well, she's 63 now)
>
> Sam was born in the Commonwealth of Virginia
>
> Sam has never been outside of the United States

with these bindings

> <eligible> : regarded as fulfilling the necessary criteria or qualifications
>
> <constitution> : see https://constitutioncenter.org/interactive-constitution

---

Rule 7. Each *Chunk* not beginning with a keyphrase may end with an optional label within curly braces. A label may be used elsewhere as a shorthand for the content of the *Chunk*.

Example 38. All of the following are valid labels.

> {1}
>
> {alpha}
>
> {cmh-label}
>
> {COVID_19}
>
> {198,319,791,961}
>
> {P1}
>
> {This-is-a-very-long-impractical-but-valid-label}
>
> {false_premise}

Example 39. None of the following are valid labels.

[1]

alpha dog

{}

198.31

{who

This-is-a-very-long-impractical-and-invalid-label

false premise

Example 40. A validly labeled argument.

Believing

    Socrates is mortal {Socrates-will-die}

is justified by applying

    AAA-1 syllogism {AAA-1}

to these premises

    All men are mortal {P1}
    Socrates is a man {P2}

Example 41. An invalidly labeled argument (label attached to keyword chunk).

Believing {Socrates-will-die}

    Socrates is mortal

is justified by applying

    AAA-1 syllogism {AAA-1}

to these premises

    All men are mortal {P1}
    Socrates is a man {P2}

Example 42. Properly referencing a label within an argument.

Believing

    Numbers are evil {Evil-Numbers}

is justified by applying

    History and Experience

to these premises

> Many accidents have been attributed to improper use of estimated probabilities of failures {Numbers-Cause-Accidents}

> Not everyone who calculates numbers was an A student in mathematics {DK}

Believing

> {Numbers-Cause-Accidents}

is justified by these premises

> "Incorrectly calculated probabilities of failure" was among the causal and contributing factors identified for twelve accidents in the US over the last two decades

> "Incorrectly calculated probabilities of failure" was among the causal and contributing factors identified for seven accidents in the UK over the last two decades

unless

> The investigators incorrectly identified "Incorrectly calculated probablities of failure" as a causal or contributing factor in all of those accidents

3.2 Summary

The seven rules defined and illustrated above fully delineate the syntactic boundaries of FAN arguments. For ease of future reference, they are listed together below.

Rule 1. FAN is not case-sensitive.

Rule 2. In these rules the word *Chunk* denotes a single distinct bit of text. The manner of separation of *Chunks* depends on the form of the document. Where typesetting features are available, whitespace may be used to separate *Chunks*. In plain text files, lines might be terminated by a backslash ($\backslash$) character to indicate that they are part of a *Chunk* that includes the subsequent line. *Beginning of a Chunk* denotes the first non-whitespace character.

Rule 3. The words and phrases **believing**, **with**, **unless**, **end**, **is justified by applying**, **is required by applying**, **to these premises**, **is justified by these premises**, and **is required by these premises** are keyphrases. Keyphrases have special meaning whenever they appear at the *Beginning of a Chunk*. Any additional text in the *Chunk* after a keyphrase is ignored.

Rule 4.a. A *Conclusion Block* consists of a *Chunk* containing the keyphrase **believing** followed by a single *Chunk*.

Rule 4.b.1. An *Explicit Reasoning Block* consists of a *Chunk* beginning with either the keyphrase **is justified by applying** or the keyphrase **is required by applying** followed by a single *Chunk*.

Rule 4.b.2. An *Implicit Reasoning Block* consists of a *Chunk* beginning with either the keyphrase **is justified by these premises** or the keyphrase **is required by these premises** followed by one or more *Chunks*. The *Implicit Reasoning Block* ends before the first appearance of the keyphrases **with**, **unless**, **end** or **believing**.

Rule 4.c. A *Premise Block* consists of a *Chunk* containing the keyphrase **to these premises** followed by one or more *Chunks*. The *Premise Block* ends before the first appearance of the keyphrases **with**, **unless**, **end** or **believing**.

Rule 4.d. A *Binding Block* consists of a *Chunk* containing the keyphrase **with** followed by one or more *Chunks*, with each following *Chunk* containing text, a colon (:), and more text. The *Binding Block* ends before the first appearance of the keyphrases **unless**, **end**, or **believing**.

Rule 4.e. A *Defeater Block* consists of the keyphrase **unless** followed by one or more *Chunks*. The *Defeater Block* ends before the first appearance of the keyphrase **with**, **end**, or **believing**.

Rule 5. A word or phrase that appear to the left of a colon (:) in a *Binding Block* is written everywhere else in a way that distinguishes it from other text. Note: Where typesetting features are available, this might be accomplished with italicization or underlining. In plain text, such phrases might appear between slash (/) characters or be surrounded by angled brackets (<>).

Rule 6. A valid FAN argument consists of a *Conclusion Block*, followed by either (1) an *Explicit Reasoning Block* followed by a *Premise Block* or (2) an *Implicit Reasoning Block*; followed optionally in either order by a *Binding Block* and a *Defeater Block*. More than one FAN argument may be contained in the same document. Also, a document may begin with a *Binding Block*

Rule 7. Each *Chunk* not beginning with a or keyphrase may end with an optional label within curly braces. A label may be used elsewhere as a shorthand for the content of the *Chunk*.

4   Semantics

FAN has five semantics rules. Currently there are no plans to work on ways to au-

tomate enforcement of these rules[7]. Rather, enforcement for now is done manually. This choice seems appropriate for a notation that is intended for expressing arguments of any variety concerning any subject.

4.1 Rules

> **Rule A. The non-keyphrase *Chunk* in a *Conclusion Block* must be a proposition (that is, a statement to which attributing a truth value is appropriate).**

Example 43. All of the following *chunks* are acceptable for a *Conclusion Block*.

Socrates is a cat

The reliability of the switch is 0.000001 failures per hour

The product possesses the Overarching Properties

Sam is 57 years old

Attaching a GPS tracking device to an automobile without obtaining a warrant is a violation of the 4th Amendment as applied to the states by the 14th Amendment

The University of Virginia is the three-time reigning women's swimming and diving champion

George Washington was the 22nd President of the United States

Some people do not like me

Example 44. None of the following *chunks* is acceptable for a *Conclusion Block*.

Socrates

0.000001 failures per hour

Oh

Remember the Titans

https://bit.ly/cmhpubs

Go Johnny Go. Go. Go. Go.

Is the system safe enough to be used by your child?

> **Rule B. Each non-keyphrase *Chunk* in a *Premise Block*, *Implicit Reasoning Block*, and *Defeater Block* must be a proposition.**

Example 45. Each of these *chunks* is acceptable in a *Premise*, *Implicit Reasoning Block*, or *Defeater Block*.

---

[7]If you are someone who *is* interested in doing such work, please let me know.

Sam is 57 years old

The University of Virginia is the reigning men's lacrosse national champion

The scoreboard reads 85-77

Article III of the Constitution defines the judicial power

The company's Plan for Software Aspects of Certification is incomplete

Example 46. Each of these CHUNKS is unacceptable in a *Premise, Implicit Reasoning Block,* or *Defeater Block.*

the test results report

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Justice Jackson

cool beans

Rule C.a. The non-keyphrase *Chunk* in an *Explicit Reasoning Block* should explain why the content of the *Premise Block* provides sufficient justification for believing the content of the *Conclusion Block*.

Rule C.b. In both *Implicit* and *Explicit Reasoning Blocks*, the word required signifies that true premises are believed to guarantee the truth of the conclusion. Whereas the word justified signifies that the truth of the premises does not necessarily guarantee the truth of the conclusion.

Example 47. An argument using explicit, non-deductive reasoning.

Believing

This is a cool proposition. {Cool}

is justified by applying

non-deductive reasoning

to these premises

This is a proposition everyone believes. {E}
This is a proposition most people believe. {M}

Example 48. An argument using implicit, non-deductive reasoning.

Believing

This is a cool proposition. {Cool}

is justified by these premises

This is a proposition everyone believes. {E}

This is a proposition most people believe. {M}

Example 49. An argument using explicit, deductive reasoning.

Believing

Socrates is mortal. {S-mortal}

is required by applying

AAA-1 Syllogism

to these premises

All humans are mortal. {All-mortal}

Socrates is a human. {S-human}

Example 50. An argument using implicit, deductive reasoning.

Believing

Socrates is mortal. {S-mortal}

is required by these premises

All humans are mortal. {All-mortal}

Socrates is a human. {S-human}

Rule D. For each non-keyphrase Chunk in a Binding Block the relationship between the text to the left of the colon (*LHS*) and the text to the right of the colon (*RHS*) should satisfy one of these constraints: (1) The *RHS* provides a definition or description for the *LHS*; (2) The *LHS* provides a name for an entity in the real world described or referenced by the *RHS*; or (3) The *RHS* provides a reference to an external document in which the *LHS* is defined or described.

We have already seen a D(1) compliant binding (*eligible* in Examples Y-X), a D(2) compliant binding (*constitution* in Examples x-8, and Examples of D(3) compliant binding in Examples 4-9.

Rule E. A binding applies not only to the argument in which it first appears, but also to all arguments in the same document. If a given LHS appears in more than one Binding Block in a document, it must be bound to the same RHS each time.

Example 51. An example of improper repetition of a binding.

with these bindings

    <correctness> : One of the three Overarching Properties defined in [8]

Believing

    My system possesses <Correctness>

is justified by applying

    examination of test results

to these premises

    All planned tests were conducted {tests-planned}
    The test results are available for review

Believing

    {tests-planned}

is justified by these premises

    Tests were created to ensure <correctness>

with these bindings

    <correctness> : complying with expected results

4.2   Summary

That is it for the current semantic rules for FAN. It is likely that as FAN's usage continues to increase, additions to these rules will be indicated and incorporated into the definition.

Rule A. The non-keyphrase *Chunk* in a *Conclusion Block* must be a proposition (that is, a statement to which attributing a truth value is appropriate).

Rule B. Each non-keyphrase *Chunk* in a *Premise Block*, *Implicit Reasoning Block*, and *Defeater Block* must be a proposition.

Rule C.a. The non-keyphrase *Chunk* in an *Explicit Reasoning Block* should explain why the content of the *Premise Block* provides sufficient justification for believing the content of the *Conclusion Block*.

Rule C.b. In both *Implicit* and *Explicit Reasoning Blocks*, the word **required** signifies that true premises are believed to guarantee the truth of the conclusion.

Whereas the word **justified** signifies that the truth of the premises does not necessarily guarantee the truth of the conclusion.

Rule D. For each non-keyphrase *Chunk* in a *Binding Block* the relationship between the text to the left of the colon (*LHS*) and the text to the right of the colon (*RHS*) should satisfy one of these constraints: (1) The *RHS* provides a definition or description for the *LHS*; (2) The *LHS* provides a name for an entity in the real world described or referenced by the *RHS*; or (3) The *RHS* provides a reference to an external document in which the *LHS* is defined or described.

Rule E. A binding applies not only to the argument in which it first appears, but also to all arguments in the same document. If a given LHS appears in more than one *Binding Block* in a document, it must be bound to the same RHS each time.

5 Exercises

Readers are encouraged to try the exercises that follow. The answers are not provided in this paper, but may be obtained by sending e-mail to the author.

5.1 Valid or Invalid?

For all the following exercises, your sole challenge is to decide whether the FAN text is valid or invalid.

Exercise 1.

> Believing
>
>> I am
>
> is justified by these premises
>
>> I think
>
> unless
>
>> Descartes was wrong

Exercise 2.

> Believing
>
>> <Politics> affects standards committees
>
> is justified by these premises
>
>> Some people make objectively false statements in standards committees

The people making the statements know they are objectively false

<Politics> explains why someone knowingly makes an objectively false statement

with these bindings

<politics> : see https://ahdictionary.com/word/search.html?q=politics (sense 5)

unless

The concept of "objectively false" is meaningless

Exercise 3.

Believing

The abbreviation "AI" stands for "Artificial Intelligence"

unless

The abbreviation appears in an article about basketball .

Exercise 4. (from [6])

Believing

The window was broken by a rock. {Y}

is justified by these premises

There is a rock on the floor beyond the broken window. {Y}

The rock was not in that exact position before the breaking of the window. {B1}

There are no other objects in the vicinity of the window that would cause it to break if launched at it. {B2}

Exercise 5.

Believing

'Twas <brillig>, and the <slithy> <toves> Did <gyre> and <gimble> in the <wabe>

is justified by applying

examination of available data

to these premises

Suzy reports being struck by a <tove> in the <wabe>

Three local television stations broadcast videos depicting <slithy> <toves> <gryeing>

with these bindings

<brillig> : windy (above 30 mph sustained winds)

<slithy> : coated with silver paint

<toves> : desiccated oranges

<gryre> : swirl about in the air

<gimble> : occasionally strike passers by

<wabe> : public park

Exercise 6.

Believing

Anything Don says

is justified by applying

Personal experience

to these premises

I want Don's statements to be true

Humans find it easy to believe what they want to be true

Exercise 7.

Believing

Quarrels over the <age> of the earth are fruitless

is justified by these premises

No one has ever come up with a cogent definition of time

Discussing the <age> of something is fruitless without a cogent definition of time

with these bindings

<age> : the length of time that has passed between the beginning of something and now

Exercise 8.

Believing

The software is written in Ada

is required by these premises

The software is written in either Ada or Scheme

The software is not written in Scheme

5.2   What's wrong?

In each of the following exercises, the FAN text is invalid. Your challenge is to explain why.

Exercise 9.

Believing

The proposed procedure for disposing of the toxic waste is unlikely to harm anyone

is justified by these premises

the environmental impact statements

the hazard identification

the hazard analysis

Exercise 10.

is justified by applying

Observation

to these premises

The road is wet.

Everyone is carrying an umbrella or wearing a raincoat

Puddles have formed in the low areas of the yard

Believing

It is raining outside right now {Raining}

Exercise 11.

Believing

This statement is the conclusion {My Conclusion}

is required by these premises

Definition

Exercise 12.

Believing

At least twelve people are <lapidroids>

is justified by applying

enumeration of examples

to these premises

Four people avidly support cubification
Four people think everyone should return to the office
Four people believe InLook is a good mail server

unless

The same four people are referred to in all three premises

Exercise 13.

with these bindings

<survey> : the survey sent to employees by e-mail on 2023-04-01

Believing

Legitimate conclusions may be drawn from the <survey>

unless

The <survey> was determined to be badly designed by a team of world-renowned experts

Exercise 14.

Believing

<SAM> possesses the <Overarching Properties>

is justified by these premises

<SAM> possesses <Intent> {pIntent}
<SAM> possesses <Correctness> {pCorrectness}
<SAM> possesses <Innocuity> {pInnocuity}

Exercise 15.

Believing

Claims unsupported by data or reasoning

Exercise 16.

with these bindings

<UtOPs> : https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190029284.pdf

<SAM> : the system for which approval is sought

<Intent> : defined in <UtOPs>

<Correctness> : defined in <UtOPs>

<Innocuity> : defined in <UtOPs>

<Overarching Properties> : <Intent>, <Correctness>, and <Innocuity>

<DIB> : abbreviation for <Defined Intended Behavior>

<DeB> : abbreviation for <Desired Behavior>

6   Final Remarks

The Friendly Argument Notation is intended to provide an easy to write, easy to understand, and computer-system independent way to express arguments. As noted in the Preface, experience so far suggests the intent is being met. This document has provided the official definition of the current version of the notation, examples of its use, and exercises with which readers can test their understanding.

Happy **FAN**ning!

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Appendix A: Summary of changes from FAN$_{2020}$ version

Rules 1, 2, D, and E are **unchanged**.

The following rules were only **edited**, either for clarity or for conformance to the enhanced rules: 4.a, 4.c, 4.d, 4.e, 5, 7, A. The following differences resulted:

- In rules 4.a, 4.c, 4.d, 4.e, 7, and A the word "keyphrase" replaced "keyword", so as to conform to the new terminology introduced in enhanced rule 3.

- In rule 5, the clause "or be surrounded by angled brackets ($<>$)" was added to the end. Angled brackets were allowed by the original rules but not explicitly mentioned.

- The last sentence in rule 7 was replaced by a new sentence: "The label may be used as a shorthand for the content of the *CHUNK* anywhere the *CHUNK* itself can appear." The original sentence permitted the use of labels in inappropriate places.

These rules were **enhanced** to provide the additional desired expressiveness: 3, 4.b, 6, B, C.

- The enhanced Rule 3 (1) eliminates **is** as a keyword; (2) changes "keyword" to "keyphrase"; and (3) adds the following to the list of keyphrases: **is justified by applying**, **is required by applying**, **to these premises**, **is justified by these premises**, **is required by these premises**

- Rule 4.b is separated into two parts.

  4.b.1 renames the original *REASONING BLOCK* to *EXPLICIT REASONING BLOCK* and changes the keyphrase indicator of such a block from textbfis to either **is justified by applying** or **is required by applying**

  4.b.2. introduces the *IMPLICIT REASONING BLOCK*, which provides for immediate listing of premises without a statement explaining why the premises support the conclusion.

- Rule 6 expands the definition of a valid FAN argument to include using an *IMPLICIT REASONING BLOCK*.

- Rule B adds *IMPLICIT REASONING BLOCK* to the list of BLOCKS in which all *CHUNKS* but the first must be propositions.

- Rule C is divided into two parts.

  C.a is equivalent to the original C (except for using "keyphrase" instead of "keyword").

  C.b explains the difference in meaning between **is required by** and **is justified by**.

Appendix B: FAN$_{2023}$ Rules on One[8] Page

Rule 1. FAN is not case-sensitive.

Rule 2. In these rules the word *Chunk* denotes a single distinct bit of text. The manner of separation of *Chunks* depends on the form of the document. Where typesetting features are available, whitespace may be used to separate *Chunks*. In plain text files, lines might be terminated by a backslash (\\) character to indicate that they are part of a *Chunk* that includes the subsequent line. *Beginning of a Chunk* denotes the first non-whitespace character.

Rule 3. The words and phrases **believing**, **with**, **unless**, **end**, **is justified by applying**, **is required by applying**, **to these premises**, **is justified by these premises**, and **is required by these premises** are keyphrases. Keyphrases have special meaning whenever they appear at the *Beginning of a Chunk*. Any additional text in the *Chunk* after a keyphrase is ignored.

Rule 4.a. A *Conclusion Block* consists of a *Chunk* containing the keyphrase **believing** followed by a single *Chunk*.

Rule 4.b.2. An *Implicit Reasoning Block* consists of a *Chunk* beginning with either the keyphrase **is justified by these premises** or the keyphrase is required by these premises followed by one or more *Chunks*. The *Implicit Reasoning Block* ends before the first appearance of the keyphrases **with**, **unless**, **end** or **believing**.

Rule 4.c. A *Premise Block* consists of a *Chunk* containing the keyphrase **to these premises** followed by one or more *Chunks*. The *Premise Block* ends before the first appearance of the keyphrases **with**, **unless**, **end** or **believing**.

Rule 4.d. A *Binding Block* consists of a *Chunk* containing the keyphrase **with** followed by one or more *Chunks*, with each following *Chunk* containing text, a colon (:), and more text. The *Binding Block* ends before the first appearance of the keyphrases **unless**, **end**, or **believing**.

Rule 4.e. A *Defeater Block* consists of the keyphrase **unless** followed by one or more *Chunks*. The *Defeater Block* ends before the first appearance of the keyphrase **with**, **end**, or **believing**.

Rule 5. Whenever a word or phrase that appears to the left of a colon (:) in a *Binding Block* is written everywhere else in a way that distinguishes it from other text. Note: Where typesetting features are available, this might be accomplished with italicization or underlining. In plain text, such phrases might appear between slash (/) characters or be surrounded by angled brackets (<>).

---

[8]Or two if you don't print using both the front and back of the paper.

Rule 6. A valid FAN argument consists of a *Conclusion Block*, followed by either (1) an *Explicit Reasoning Block* followed by a *Premise Block* or (2) an *Implicit Reasoning Block*; followed optionally in either order by a *Binding Block* and a *Defeater Block*. More than one FAN argument may be contained in the same document. Also, a document may begin with a *Binding Block*

Rule 7. Each *Chunk* not beginning with a keyphrase may end with an optional label within curly braces. A label may be used elsewhere as a shorthand for the content of the *Chunk*.

Rule A. The non-keyphrase *Chunk* in a *Conclusion Block* must be a proposition (that is, a statement to which attributing a truth value is appropriate).

Rule B. Each non-keyphrase *Chunk* in a *Premise Block*, *Implicit Reasoning Block*, and *Defeater Block* must be a proposition.

Rule C.a. The non-keyphrase *Chunk* in an *Explicit Reasoning Block* should explain why the content of the *Premise Block* provides sufficient justification for believing the content of the *Conclusion Block*.

Rule C.b. In both *Implicit* and *Explicit Reasoning Blocks*, the word **required** signifies that true premises are believed to guarantee the truth of the conclusion. Whereas the word **justified** signifies that the truth of the premises does not necessarily guarantee the truth of the conclusion.

Rule D. For each non-keyphrase *Chunk* in a *Binding Block* the relationship between the text to the left of the colon (*LHS*) and the text to the right of the colon (*RHS*) should satisfy one of these constraints: (1) The *RHS* provides a definition or description for the *LHS*; (2) The *LHS* provides a name for an entity in the real world described or referenced by the *RHS*; or (3) The *RHS* provides a reference to an external document in which the *LHS* is defined or described.

Rule E. A binding applies not only to the argument in which it first appears, but also to all arguments in the same document. If a given LHS appears in more than one *Binding Block* in a document, it must be bound to the same RHS each time.

Appendix C - Three longer examples

This section presents three examples of FAN expressions of compound arguments. The first two are identical to the first two presented in [1], updated to use the FAN$_{2023}$ extensions. The first is based on an argument with a multi-year history in presentations that I have given. The second example has an even longer history; it also served as the primary example in [9]. The third example is based on section 3.4.4.5 in [3].

6.1 Sam Running for President

We begin with a simple argument, purporting to convince someone to believe that Sam can run for President.

> Believing
>
> > Sam is eligible to run for President of the United State
>
> is justified by applying
>
> > The requirements for Presidential eligibility in the Constitution
>
> to these premises
>
> > Sam is 57 years old
> >
> > Sam was born in the Commonwealth of Virginia
> >
> > Sam has never been outside of the United States

After a bit of thought, we decide to provide a definition for 'eligible' and a link to the U.S. Constitution.

> Believing
>
> > Sam is <eligible> to run for President of the United State
>
> is justified by applying
>
> > The requirements for Presidential eligibility in the <Constitution>
>
> to these premises
>
> > Sam is 57 years old
> >
> > Sam was born in the Commonwealth of Virginia
> >
> > Sam has never been outside of the United States
>
> with these bindings

> <eligible> : regarded as fulfilling the necessary criteria or quali-
> fications
>
> <Constitution> : see https://constitutioncenter.org/interactive-
> constitution/the-constitution

Satisfied with these additions, we seek review from a Constitutional expert. She recognizes a problem with the argument, and annotates it with a defeater that encapsulates the problem.

> Believing
>
>> Sam is <eligible> to run for President of the United State
>
> is justified by applying
>
>> The requirements for Presidential eligibility in the <Constitution>
>
>
> to these premises
>
>> Sam is 57 years old
>>
>> Sam was born in the Commonwealth of Virginia
>>
>> Sam has never been outside of the United States
>
> with these bindings
>
>> <eligible> : regarded as fulfilling the necessary criteria or quali-
>> fications
>>
>> <Constitution> : see https://constitutioncenter.org/interactive-
>> constitution/the-constitution
>
> unless
>
>> Sam has been twice elected to the office of President of the US

Our expert helpfully suggests two additional premises we can include in order to defeat the stated defeater and a defeater that was not stated, too. We decide to add labels to the premises, also, recognizing we'll need to provide argument to justify each of them, if we want to end up with a cogent argument.

> Believing
>
>> Sam is <eligible> to run for President of the United State
>
> is justified by applying
>
>> The requirements for Presidential eligibility in the <Constitution>

to these premises

> Sam is 57 years old {OldEnough}
>
> Sam was born in the Commonwealth of Virginia {NaturalBorn}
>
> Sam has never been outside of the United States {LivedHere}
>
> Sam has never been President {notPresident}
>
> Sam has never been disqualified from holding federal office {noDisqual}

with these bindings

> <eligible> : regarded as fulfilling the necessary criteria or qualifications
>
> <Constitution> : see https://constitutioncenter.org/interactive-constitution/the-constitution

Interested readers are invited to try to complete the argument by justifying the believing each of the premises. If you accept the invitation please send your effort to the author.

6.2 Tim Driving Jon to the Game

The primary running example used in [9] concerns whether the father of Jon (a teenager not yet of driving age) will allow him to ride in a car with Tim (a college student known well by Jon's family) to a game.

with these bindings

> <safe enough> : at least as safe as Jon's dad
>
> <special danger> : a problem safe driving cannot overcome

Believing

> Tim is a <safe enough> driver to take Jon to the game {TimTakeJon}

is justified by applying

> Five independent sources of support for Tim's ability to drive
> safely are good enough for Jon's dad

to these premises

> Tim has satisfied all legal requirements for driving {TimLegal}
>
> Tim has not been in an accident {TimNoAcci}
>
> Nothing untoward is going on in Tim's life that might cause him to
> drive less well than usual {TimOkay}
>
> Tim has a good reputation for driving {TimGoodRep}

Tim's car does not pose any <special danger> {CarOkay}

Believing

{TimLegal}

is justified by these premises

Tim has a driver's license

unless

The license is a fake {FakeLicense}

Believing

{TimNoAcci}

is justified by applying

Three available sources of accident information

to these premises

Common knowledge says Tim hasn't been in an accident
DMV records do not show any accidents for Tim
Tim's insurance records are accident-free

Believing

{TimOkay}

is justified by these premises

Tim is not currently in any fights or quarrels with friends or class-mates
Tim's academic life will not affect his driving
Tim has no big life decisions that may distract him

Believing

{TimGoodRep}

is justified by applying

inferring a positive from the absence of a negative

to these premises

Neither Jon nor Jon's parents have heard any negative comments about Tim's driving

Believing

> {CarOkay}

is justified by applying

> Jon's dad's knowledge of cars

to these premises

> The model of the car has a superior reliability rating
>
> The car is 3 years old
>
> The car has been regularly serviced according to the manufacturer's recommendations

6.3 An Incomplete OPRA

with these bindings

> <UtOPs> : The document "Understanding the Overarching Properties", NASA/TM-2019-220292
>
> <MDSS> : Maneuver determination subsystem as defined by specified development artifacts (which must eventually be named)
>
> <Intent> : "The defined intended behavior is correct and complete with respect to the desired behavior" as defined in <UtOPs>
>
> <Correctness> : "The <implementation> is correct with respect to its defined intended behavior, under foreseeable operating conditions" as defined in <UtOPs>
>
> <Innocuity> : "Any part of the <implementation> that is not required by the <defined intended behavior> has no <unacceptable impact>" as defined in <UtOPs>
>
> <DIB> : abbreviation for <defined intended behavior>
>
> <DeB> : abbreviation for <desired behavior>
>
> <desired behavior> : "Needs and constraints expressed by the stakeholders (this includes those needs and constraints identified by the <safety assessment> and those mandated by regulations)" as defined in <UtOPs>
>
> <defined intended behavior> : "The record of the desired behavior" as defined in <UtOPs>
>
> <implementation> : "<item> or combination of inter-related <item>s for which acceptance or approval is being sought" as defined in <UtOPs>
>
> <foreseeable operating conditions> : "External and internal conditions in which the system is used, encompassing all known normal and abnormal conditions" as defined in <UtOPs>

<unacceptable impact> : as defined in <UtOPs>

<Correct-wrt-DIB> : <implementation> is shown through specified acceptable methods to meet specified acceptable satisfaction criteria (which must both eventually be named)

<safety assessment> : see description in <UtOPs>

<item> : see description in <UtOPs>

Believing

<MDSS> possesses the <Overarching Properties> {pOPs}

is justified by these premises

<MDSS> possesses <Intent> {pIntent}

<MDSS> possesses <Correctness> {pCorrectness}

<MDSS> possesses <Innocuity> {pInnocuity}

Believing

{pIntent}

is justified by applying

The definition of <Intent>

to these premises

<MDSS> <DIB> is correct with respect to its <DeB> {DIBcorrect}

<MDSS> <DIB> is complete with respect to its <DeB> {DIBcomplete}

Believing

{pCorrectness}

is justified by applying

The definition of <Correctness>

to these premises

<MDSS> <implementation> is correct with respect to its <DIB> {ImpcrtDIB}

<Foreseeable operating conditions> are accounted for in the <DIB> {FOCinDIB}

Believing

{pInnocuity}

is justified by applying

The definition of <Innocuity>

to these premises

Every part of <MDSS> <implementation> is required by its <DIB>
{impReq}

Believing

{DIBcorrect}

is justified by these premises

BelProp1   % believed universally and relevant
BelProp2   % believed in domain and relevant

% Skipping some of the arguments given in the original

Believing

{FOCinDIB}

is justified by these premises

The <DIB> accounts for everything in <prevFOC> {DIBprevFOC}

<MDSS> has the same <foreseeable operating conditions> as its
predecessor {SameFOC}

with these bindings

<prevFOC> : the collection of <foreseeable operating conditions>
developed for the predecessor to <MDSS>

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14. ABSTRACT

This document constitutes the official description of the current iteration of the Friendly Argument Notation (FAN). This new version provides several enhancements to the original 2020 instantiation, while maintaining essential compatibility with it. Specifically, the new version enables distinguishing between deductive and non-deductive arguments, removes the requirement for always providing an explicit statement of reasoning, and relaxes the rules for when labels may be used. The primary intended use of FAN is unchanged: creating and evaluating arguments about safety-critical systems, specifically the types of arguments common within safety and assurance cases.

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