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The Friendly Argument Notation (FAN)

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1. Introduction

This document defines and explains through examples the Friendly Argument Notation (FAN). FAN builds on previous work investigating text-based ways to express arguments [2, 3]. Its primary intended use is for creating and evaluating arguments about safety-critical systems, especially the types of arguments common within safety and assurance cases [4], but nothing in its design constrains its use to that domain. Compared to existing notations commonly used within this domain (for example [6]), FAN corresponds more closely to traditional argument concepts (for example [1]), allows greater flexibility in expression, provides for including counter-arguments, and requires less knowledge of computer-science-specific concepts. Only time and use will determine how beneficial these differences are in practice.

This paper concentrates on showing how FAN looks to someone who is using it manually to develop or assess arguments. A later document will concentrate on providing the information necessary for software tools to be created for FAN.

2. Terminology

To promote clarity, understanding, and communication, FAN is based on a small number of terms, which we'll call primitives from now on. To facilitate FAN's use for assurance case arguments by ordinary engineers, the meaning of each primitive is given informally, but with sufficient precision as to leave no reasonable doubt about what is intended. For the purposes of this document, these definitions are simply stated. An upcoming paper will provide a detailed explanation for why these definitions were chosen and how they fit into the multi-millennia history of the study of argument. To make clear which words are primitives and which are not, primitives are written in **bold face** below. The convention is not necessary in the remainder of the text.

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**.

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 for the rules and examples:

- *SMALLCAP ITALIC* denotes words or phrases with special meaning within the rules.
- San serif denotes FAN text.

Rule 1. FAN is not case-sensitive.

Example 1. ‘Believing’, ‘believing’, ‘beLieVING’ are equivalent.

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 2. 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.

13 – 9 was the score of the 2019 men’s lacrosse championship

$\sin(x) + \sin(y) > \cos(z)$

All arguments that matter are necessarily informal

Rule 3. The words **believing, is, to, with, unless,** and **end** are keywords, with special meaning whenever they appear at the *BEGINNING OF A CHUNK*. Any additional text on the *CHUNK* after the keyword is ignored.

Example 3. Each *CHUNK* below contains a keyword:

Believing

is justified by applying

to
to these premises
to this evidence
unless my arm falls off
unless
with
END it all

Example 4. No *CHUNK* below contains a keyword (only *BEGINNING OF A CHUNK* words can be keywords):

Don't stop believing
A cat is a better pet than a dog
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 keyword **believing** followed by a single *CHUNK*.

Example 5. 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 6. An invalid *CONCLUSION BLOCK* (no keyword)

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

Example 7. An invalid *CONCLUSION BLOCK* (multiple lines)

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

Rule 4.b. A *REASONING BLOCK* consists of a *CHUNK* containing the keyword **is** followed by a single *CHUNK*.

Example 8. A valid *REASONING BLOCK* (note the allowed text after the keyword)

is justified by applying
The requirements for Presidential eligibility in the Constitution

Example 9. An invalid *REASONING BLOCK* (no keyword)

because of
The requirements for Presidential eligibility in the Constitution

Example 10. An invalid *REASONING BLOCK* (multiple lines)

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

Rule 4.c. A *PREMISE BLOCK* consists of a *CHUNK* containing the keyword **to** followed by one or more *CHUNKS*. The *PREMISE BLOCK* ends before the first appearance of the keywords **with**, **unless**, **end**, or **believing**.

Example 11. A valid *PREMISE BLOCK* (3 premises)

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

Example 12. A valid *PREMISE BLOCK* (with extraneous but perhaps useful text after **to**)

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 ...

Example 13. An invalid *PREMISE BLOCK* (no keyword)

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

Example 14. An invalid *PREMISE BLOCK* (empty)

to these premises
end

Rule 4.d. A *BINDING BLOCK* consists of a *CHUNK* containing the keyword **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 keywords **unless**, **end**, or **believing**.

Example 15. A valid *BINDING BLOCK* (1 binding, which is a definition)

```
with
    Innocuity: Any part of the implementation that is not \
    required by the defined intended behavior has no \
    unacceptable impact.
end
```

Example 16. A valid *BINDING BLOCK* (including extra text, a definition, and a reference)

```
with this definition and context
    eligible: regarded as fulfilling the necessary criteria or qualifications
    constitution: see https://constitutioncenter.org/interactive-constitution/
unless ...
```

Example 17. An invalid *BINDING BLOCK* (no keyword)

```
definitions
    eligible: regarded as fulfilling the necessary criteria or qualifications
end
```

Example 18. Invalid *BINDING BLOCKS* (empty, no colon, no text after colon)

```
with these definitions
end

with
    eligible is defined as fulfilling the necessary criteria or qualifications
end

with
    eligible:
end
```

Rule 4.e. A *DEFEATER BLOCK* consists of the keyword **unless** followed by one or more *CHUNKS*. The *BINDING BLOCK* ends before the first appearance of the keywords **with**, **end** or **believing**.

Example 19. A valid *DEFEATER BLOCK* (1 single defeater)

```
unless
    Sam has been twice elected to the office of President of the USA
end
```

Example 20. 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 21. An invalid DEFEATER BLOCK (no keyword)

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

Example 22. An invalid DEFEATER BLOCK (empty)

unless
end

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.

Example 23. Using a word defined within a *BINDING BLOCK*

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

Rule 6. A valid FAN argument consists of a *CONCLUSION BLOCK*, followed by a *REASONING BLOCK*, followed by a *PREMISE 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 24. 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
end

Example 25. 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 this definition and context

eligible: regarded as fulfilling the necessary criteria or qualifications

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

end

Example 26. A valid FAN argument with the *BINDING BLOCK* beginning the document

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

end

Example 27. A valid FAN argument with a BINDING BLOCK and 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
 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
end

Example 28. 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 this definition and context
 eligible: regarded as fulfilling the necessary criteria or qualifications
 constitution: see \
 <https://constitutioncenter.org/interactive-constitution/the-constitution>
end

Believing
 Sam was born in the Commonwealth of Virginia
is justified by applying
 Inspection by a qualified document expert
to
 A certificated copy of Sam's birth certificate is available
end

Example 29. An invalid FAN argument (missing REASONING BLOCK and PREMISES BLOCK)

Believing
 Sam is eligible to run for President of the United States
is justified by nothing
end

Example 30. An invalid FAN argument (missing *REASONING BLOCK*)

Believing
Sam is eligible to run for President of the United States
is justified by these premises
Sam is 57 years old
Sam was born in the Commonwealth of Virginia
Sam has never been outside of the United States
end

Example 31. 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
unless
Sam has been twice elected to the office of President of the US
end

Example 32. An invalid FAN argument (*DEFEATER BLOCK* in wrong order)

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
Sam was born in the Commonwealth of Virginia
Sam has never been outside of the United States
with
eligible: regarded as fulfilling the necessary criteria or qualifications
constitution: see <https://constitutioncenter.org/interactive-constitution/the-constitution>
end

Rule 7. Each *CHUNK* not beginning with a keyword may end with an optional label within curly braces. The label provides a way to refer to a *CHUNK* elsewhere within an argument.

Example 33. All of the following are valid labels:

{1}
{alpha}
{cmh-label}
{COVID_19}
{198,319,791,961}
{P1}
{Con1}

Example 34. None of the following are valid labels:

[1]
alpha dog
{}
198.31
{who
P1
false premise

Example 35. A validly labeled argument

Believing
Socrates is mortal {1}
is justified by applying
AAA-1 syllogism {2}
to
All men are mortal {3}
Socrates is a man {4}

Example 36. An invalidly labeled argument (label attached to keyword chunk)

Believing {1}
Socrates is mortal
is justified by applying {2}
AAA-1 syllogism
to
All men are mortal {3}
Socrates is a man {4}

These seven rules fully define the syntactic boundaries of FAN arguments.

4. Semantics

FAN's semantic rules are fewer in number and less constraining than its syntactic rules. Automating enforcement of these semantic rules would be quite difficult, which is appropriate for a notation that is intended for expressing arguments of any variety concerning any subject.

Rule A. The non-keyword *CHUNK* in a *CONCLUSION BLOCK* must be a proposition (that is, a statement to which attributing a truth value is appropriate).

Example 37. All of the following *CHUNKS* are acceptable for a *CONCLUSION BLOCK*

Socrates is a man

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 reigning men's basketball champions

George Washington was the 22nd President of the United States

Example 38. None of the following *CHUNKs* is acceptable for a *CONCLUSION BLOCK*

Socrates

0.000001 failures per hour

Twas brillig, and the slithy tove Did gyre and gimble in the wabe

Remember the Titans

<https://bit.ly/cmhpubs>

Is the system safe enough to be used in Seattle?

Rule B. Each non-keyword *CHUNK* in a *PREMISE BLOCK* and in a *DEFEATER BLOCK* must be a proposition.

Example 39. Acceptable *CHUNKs* in a *PREMISE* or *DEFEATER BLOCK*

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 40. Unacceptable *CHUNKs* for a *PREMISE* or *DEFEATER BLOCK*

Twas brillig, and the slithy tove Did gyre and gimble in the wabe

the test results report

139

Justice Jackson

cool beans

Rule C. The non-keyword *CHUNK* in a *REASONING BLOCK* should explain why the content of the *PREMISE BLOCK* provides sufficient justification for believing the content of the *CONCLUSION BLOCK*. (See Section 5 for examples.)

Rule D. For each non-keyword *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 to an entity in the real world described or referenced by the *RHS*.
- (3) The *RHS* provides a reference to an external document in which the *LHS* is defined or described.

We have already seen an example of a D(1) compliant binding (*eligible*) and a D(2) compliant binding (*constitution*). Examples of D(3) compliant bindings are contained in *Example 46* below.

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.

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

5. Longer Examples

This section presents three examples of FAN expressions of arguments. The first example 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 [2]. The third example is of recent vintage; it puts forth a snippet of an argument that might appear as part of an attempt to show possession of the Overarching Properties [5].

5.1 Sam Running for President

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

Example 41. Initial try at showing Sam is eligible

```
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

end
```

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

Example 42. Addition of bindings to showing Sam is eligible

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/the-constitution>

end

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.

Example 43. A defeater attacks Sam’s eligibility

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/the-constitution>

unless

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

end

Our expert helpfully suggests two additional premises we can include in order to defeat the defeater.

Example 44. The defeater defeated

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

Sam has never been President

Sam has never been disqualified from holding office

with these bindings

eligible: regarded as fulfilling the necessary criteria or qualifications

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

end

Obviously, this example can be expanded, but we will not do so here.

5.2 Tim Driving Jon to the Game

A running example throughout [4] and one of the two primary examples used in [2] concerns whether the father of Jon (a teenager not yet of driving age) will allow him to ride a car with Tim (a college student known well by Jon's family) to a game. We present the example without commentary, but note that it should be considered only as an example of using FAN, and not as an example of a complete, cogent argument.

Example 45. Tim & Jon

Believing

Tim is a /safe enough/ driver to take Jon to the game {1}

is justified by applying

Five independent sources of support for Tim's ability to drive safely \ are good enough for Jon's dad {2}

to these premises

Tim has satisfied all legal requirements for driving {3}

Tim has not been in an accident {4}

Nothing untoward is going on in Tim's life that might cause him to \ drive less well than usual {5}

Tim has a good reputation for driving {6}

Tim's car does not pose any /special danger/ {7}

with

safe enough: at least as safe as Jon's dad {8}

special danger: a problem safe driving cannot overcome {9}

Believing

Tim has satisfied all legal requirements for driving {3}
is justified by applying
Having a driver's license is sufficient evidence of legality {10}
to these premises
Tim has a driver's license {11}
unless
The license is a fake. {12}

Believing

Tim has not been in an accident {4}
is justified by applying
Three available sources of accident information {13}
to these sources of information
Common knowledge says Tim hasn't been in an accident {14}
DMV records do not show any accidents for Tim {15}
Tim's insurance records are accident-free {16}

Believing

Nothing untoward is going on in Tim's life that might cause him to \
drive less well than usual {5}
is justified by applying
The belief that something untoward would show up in relationships, \
academics, or distractions {17}
to these premises
Tim is not currently in any fights, disagreements, or arguments with \
friends or classmates {18}
Tim's academic life will not affect his driving {19}
Tim has no big life decisions that may distract him {20}

Believing

Tim has a good reputation for driving {6}
is justified by
inferring a positive from the absence of a negative {21}
to
Neither Jon nor Jon's dad nor Jon's mom have heard any negative \
comments about Tim's driving {22}

Believing

Tim's car does not pose any /special danger/ (7)
is justified by
Jon's dad's knowledge of cars {23}
to the premises
The model of the car has a superior reliability rating {24}
The car is 3 years old {25}
The car has been regularly serviced according to the manufacturer's \
recommendations {26}
end

5.3 SAM and IAM Doing no Harm

The final example arose from trying to create a simple, nearly realistic illustration of what a partial argument related to the Overarching Properties [5] might look like. Its sole purpose here is to illustrate the use of FAN as it might occur during development. Note the current incompleteness of the arguments. Much remains to be done, such as expanding the *BINDING BLOCKS*, determining some of the reasoning, figuring out some necessary premises, and providing additional arguments. As with the previous example, this one is presented without additional commentary.

Example 46. SAM and IAM are harmless

Believing

Subsystems SAM and IM both possess /Innocuity/ {1}

is justified by applying

the principle of conjunction {2}

to

SAM possesses /Innocuity/ {3}

IAM possesses /Innocuity/ {4}

SAM and IAM are /independent/ {5}

with

Innocuity: definition in the OP description \

<<https://hdl.handle.net/2060/20190029284>> {6}

independent: to be defined {7}

Believing

SAM possesses /Innocuity/ {3}

is justified by applying

the meaning of /Innocuity/ {8}

to

All parts of SAM are required by the /DiB/ {9}

with this binding

DiB: abbreviation for "defined intended behavior" in \

OP description <https://hdl.handle.net/2060/20190029284> {10}

Believing

IAM possesses Innocuity {4}

is justified by applying

Yet to be determined reasoning {10}

to an unknown number of premises but we'll say three for now

Premise-1 {11}

Premise-2 {12}

Premise-3 {13}

Believing

SAM and IAM are /independent/ {5}

is justified through

Satisfying independence objectives from /standard/

to this premise

Results show compliance with chosen /standard/

with

standard: see <https://abc.def.com/the-standard>

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. This document has provided the official definition of the notation, and several examples of its use. Happy FANning!

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14. ABSTRACT

This document defines and explains through examples the Friendly Argument Notation (FAN). FAN provides a concise, easy to understand, expressive notation for writing arguments. Its primary intended use is for creating and evaluating arguments about safety-critical systems, specifically the types of arguments common within safety and assurance cases. Compared to existing notations, FAN corresponds more closely to traditional argument concepts, allows greater flexibility in expression, provides for including counter-examples, and requires less knowledge of computer-science specific concepts.

15. SUBJECT TERMS

argument, premise, conclusion, reasoning

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