

# Arguing from Definition to Verbal Classification: The Case of Redefining 'Planet' to Exclude Pluto

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**Abstract:** The recent redefinition of 'planet' that excludes Pluto as a planet led to controversy that provides a case study of how competing scientific definitions can be supported by characteristic types of evidence. An argumentation scheme from Hastings is used to analyze argument from verbal classification as a form of inference used in rational argumentation. The Toulmin-style format is compared to more recently developed ways of modeling such cases that stem from advances in argumentation technology in artificial intelligence. Using these tools, it is shown how argumentation schemes, in particular argument from verbal classification and argument from definition to verbal classification, apply to cases of scientific argumentation.

**Resumé:** La redéfinition récente de « planète » qui fait sortir Pluton de la classe des planètes a créé une controverse qui nous donne une étude de cas sur la façon que différents types de preuves appuient des définitions scientifiques rivales. À partir d'un schème d'argumentation de Hastings, une analyse des arguments fondés sur une classification verbale présente ceux-ci comme une forme d'inférence employée dans l'argumentation rationnelle. On compare le format de Toulmin aux façons récentes de représenter des cas qui proviennent des progrès de la technologie d'argumentation dans l'intelligence artificielle. On emploie ces outils pour démontrer comment les schèmes d'argumentation, en particulier, les arguments fondés sur une classification verbale ou sur une réflexion qui va de la définition à la classification, s'appliquent aux cas d'argumentation scientifique.

**Keywords:** scientific definition; classification; decisions about definitions; competing definitions; argumentation schemes; arguments based on classifications; defeasible ontologies; artificial intelligence.

## 1. Introduction

The useful study of arguments from or to verbal classifications and definitions or redefinition of the term has in the past often been made to seem impossible because of a dichotomy about matters of definition. On the one hand they are often seen by the public as trivial matters of mere

words, or decisions that are merely arbitrary. On the other hand, they have been portrayed by philosophers in the past as inquiries into the absolute essence of the concept to be defined, suggesting to many a metaphysical question with infinite answers (Schiappa, 2003, p. 103). The examples studied in this paper show that this polarization can be overcome by showing how certain forms of argument (called argumentation schemes) that support definitions and verbal classifications of kinds commonly used in both law and science can be objectively identified, analyzed and evaluated. It is shown how a verbal classification based on a redefinition of a scientific concept can be extremely controversial, both within and outside the science in which the concept falls, and how the arguments both pro and contra can be modeled within argumentation theory is having a particular structure that is valuable for us to know about and study. It is important to recognize that such arguments can be extremely powerful and significant, because their consequences can be enormously important, not only in science, but in politics, business, national affairs and law. Arguments about definitions can be disputed at great length, and in some instances, at great cost, in the courts. In such cases especially, it is important to be aware that the method for analyzing and evaluating such arguments is to raise critical questions based on the argumentation scheme for argument from verbal classification.

The main example studied in this paper is the redefinition of the term 'planet' recently approved by the General Assembly of the International Astronomical Union (IAU) to define a planet as something that must satisfy three conditions: it must be in orbit around the sun, it must be big enough to assume a roughly spherical shape, and it must have cleared the neighborhood around its orbit of other objects. As a consequence of this new definition, Pluto was demoted to the status of being a dwarf planet. Many in the field of astronomy were unhappy with the new definition, and argued against it. Although the new definition has been now officially set in place by IAU rules, leading scientists have organized a petition against it, and argued that a better definition is needed.

Section 1 is an outline of the Pluto case. Section 2 presents the standard classification of the main different types of definitions. Section 3 discusses the general pragmatic approach to argumentation employed in the following sections to analyze and evaluate arguments based on definitions and verbal classifications. Section 4 introduces the reader to argument from verbal classification by using some examples. Section 5 presents argumentation schemes for both arguments from classification and arguments that proceed from a definition to a verbal classification. Section 6 analyses the argumentation in the Pluto case, using the argumentation schemes from the previous section. Section 7 shows how new argumentation technology can be applied to some special features of arguments from verbal classification. Section 8 draws some conclusions about arguments based on definitions and verbal classifications, based on lessons drawn from the case.

## 2. Redefinition of the term ‘planet’ in 2006

The planet Pluto was discovered in 1930 by astronomer Clyde Tombaugh, and was added to the eight other planets, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, making the total of nine planets that all of us learned in school. Pluto is by far the smallest of the nine, even smaller than earth’s moon. It is too faint to be seen without the aid of the telescope. This conventional view of our solar system was changed in 2006 when the International Astronomical Union (IAU) redefined the traditional concept of planet in a manner that excluded Pluto, leaving only eight planets. Because of the way it changed the conventional view, the IAU definition has attracted considerable interest and controversy, not only among astronomers and other scientists, but among the general public as well. The new definition has not been accepted by all astronomers, even though it was put in place by a majority vote at a Congress of the IAU, and groups of dissenters have offered criticisms and alternative definitions (Carlidge, 2006, p. 11). Thus this example remains a central case of argumentation from classification and definition and will continue to be controversial. The best source for precise information is the IAU website<sup>1</sup>, but in the summary account presented below an attempt is made to describe the main outlines of the redefinition in non-specialized terminology.

The conventional definition of a planet was “a body that orbits a star, shines by reflecting the star’s light and is larger than an asteroid” (Soter, 2007, p. 1).<sup>2</sup> Since 1930, when Pluto was discovered, the solar system was taken to have nine planets. Since 2000, however, three other bodies were discovered, Quaoar, Sedna and Eris<sup>3</sup>, that are similar to Pluto in size in orbit. These and other observations from telescopes on earth and in space led to growing concerns about the conventional definition. In particular, Eris, because it is larger than Pluto, would appear to deserve being classified as a planet, if Pluto is so classified. This led to a situation where, in order to preserve consistency, either these bodies would have to be classified as planets or Pluto would have to be reclassified as not being a planet. This was the controversy that led to a debate within the IAU. In 2006 the IAU presented a definition laying down three criteria for a celestial body to count as being a planet (Soter, 2007, p. 1). First, it has to be in orbit around the sun (the orbit criterion). Second, it has to have sufficient mass so that it has formed into a nearly round shape (the roundness criterion). Third, it has to have cleared the neighborhood

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<sup>1</sup> <http://www.iau.org/iau0601.424.0.html>

<sup>2</sup> Part of the traditional definition of a star is based on the object’s ability to fuse hydrogen in its core. This definition itself has been subject to challenge because of the existence of brown dwarf planets that are too small to sustain hydrogen fusion, but have been granted star status on their ability to fuse deuterium (Wikipedia, 2006, p. 7).

<sup>3</sup> Eris used to be called Xena (Carlidge, 2006, p. 11).

around its orbit (the sufficient clearance criterion). A body fulfilling only the first two criteria, but not the third one, is reclassified by the new definition as a dwarf planet. In other words, according to the new definition, a dwarf planet is not a planet (without qualifications), in the proper sense of the term.<sup>4</sup> Many variants on this definition were debated by the IAU, before the final form was voted on by the General Assembly and accepted on August 24, 2006, in Prague. Of the over 9,000 members of the IAU, over 2,700 astronomers attended the conference, and about 800 were present on the day the vote was taken, but when the count was taken, only 424 votes were cast. Within five days of the acceptance of the new definition, a petition was signed by over 300 scientists opposing the new definition (Wikipedia, 2006, p. 2; Cartlidge, 2006, p. 11).

The original definition that had been proposed during the debates before August 24 would have contained only the orbit criterion and the roundness criterion, but not the sufficient clearance criterion. There was considerable controversy in the IAU about this earlier definition (Wikipedia, 2006, p. 2). This definition would have led to the acceptance of three other celestial bodies, as well as Pluto being recognized as planets, and a further twelve or more bodies were also possible candidates to join the list (Wikipedia, 2006, p. 2). Some argued that the new definition was ambiguous, or was not necessary. The addition of the sufficient clearance criterion excluded these candidates, and became part of the new definition that gained the upper hand among the members attending before August 24. As noted above, according to this new position there would only be eight major planets, and Pluto would be downgraded to a dwarf planet. One of the main bones of contention was whether or not a body's orbital characteristics should be included among the definition criteria. There was also controversy about borderline cases of double planet systems. The debate was said to be still open, and private meetings were held before the final vote held on August 24 (Wikipedia, 2006, p. 2). After the final vote on August 24, an IAU process was established for the purpose of assigning borderline objects into the dwarf planet category or other categories.

The new definition has been criticized as arbitrary and confusing, and a petition has been circulated among astronomers who oppose it, arguing that it should be changed again. One of their arguments is that earth, Mars and Jupiter and Neptune have not properly cleared the neighborhoods around their orbit, and therefore should not properly be considered planets under the IAU definition. Harold Weaver of the Johns Hopkins University Applied Physics Laboratory in Maryland pointed out that Neptune's orbit is crossed by a number of objects, including Pluto (Cartlidge, 2006, p. 11). This objection can be countered by bringing in a

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<sup>4</sup> According to the IAU definition, a dwarf planet is a celestial body that is in orbit around the sun, has sufficient mass to overcome rigid body forces so that it assumes a nearly round shape, has not cleared the neighborhood around its orbit, and is not a satellite (Wikipedia, 2006, p. 4).

technical definition (Soter, 2007, p. 7) of ‘clearing the neighborhood’, but it has been argued in reply that the concept of neighborhood in this technical definition is still ambiguous (Wikipedia, 2006, p. 5).<sup>5</sup> The IAU definition has another limitation, in that it applies only to objects in our own solar system. Consideration of planets in orbit around other stars was excluded as too complex an issue to be resolved by the congress. However, the proposed redefinition will need to accommodate new challenges posed by these planets eventually, showing that the new definition may still be a work in progress.

There was a petition organized against the new definition organized by Mark Sykes, director of the Planetary Science Institute in Arizona, and Alan Stern, executive director of the Space Science and Engineering Division of the Southwest Research Institute in Colorado (Cartlidge, 2006, p. 7). The petitioners stated that they did not agree with the IAU’s definition of a planet, that they would not use it, and that a better definition is needed. Harold Weaver of the Johns Hopkins University put forward two arguments as objections (Cartlidge, 2006, p. 11). His first objection was to posit a scientific counter-example, by pointing out that Neptune’s orbit is crossed by a number of objects, but it is still classified as a planet by the new definition. His second objection was that the concept of a planet clearing its neighborhood is risky because it’s “based on a theoretical construct that is only approximate best” (Cartlidge, 2006, p. 11).

One aspect of the case that is very interesting is that it is clear that the new definition is seen as subject to disputation. Indeed, the proposed definition is seen as defeasible, meaning that its acceptance is tentative, is subject to further argumentation, and could be overturned in the future. Under the IAU rules, the new definition will remain in place for at least the next three years, and its opponents are putting on an international online forum that they hope to lead to an alternative definition based on a consultation of scientists (Cartlidge, 2006, p. 11).

### 3. Types of definitions

Distinctions are often drawn in logic textbooks between different kinds of definitions. One such textbook (Hurley, 2000, pp. 93-99) cites five types of definitions: stipulative, lexical, précising, theoretical and persuasive.

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<sup>5</sup> Soter (2007, p. 5) suggested a numerical cut off value that specified the degree of clearing required to qualify a body as a planet. According to this definition, a body in our solar system is a planet only if it accounts for more than 99% of the mass in its orbital zone. However, Soter argued that the exact value of this cutoff is not critical, and other numerical values that could be specified would have the same effect. He proposed the general definition that a planet is a body that has “swept up or scattered away most of the mass from its orbital zone” (p. 5).

1. A stipulative definition is said to assign a meaning to a word for the first time (Hurley, 2000, pp. 93-94). A stipulative definition is one that is invented, as opposed to representing an established or widely accepted meaning (Shepard, 1973). For example, the term 'quark' was introduced in physics to name a special type of subatomic particle. Or in economics, a recession may be stipulatively defined as two quarters of negative growth in GNP.
2. A lexical definition is said to report the meaning that a word already has in a language (Hurley, 2000, p. 94). For example, a dictionary definition reports or explains the meaning of an existing term used in a language.
3. A precisising definition is said to fix borderline cases where a word is vague, so that it is not possible to tell whether the word applies to a specific instance or not (p. 95).
4. A theoretical definition assigns a meaning to a word by placing it within a theory, like a scientific theory. For example, the term 'heat', is scientifically defined as random motion of molecules.
5. A persuasive definition assigns a value-laden meaning to a term in order to take a stance towards what is denoted by that term on an issue with two sides (p. 97). For example, the pro-life side in the abortion dispute might define 'abortion' as the killing of a person, while the pro-choice side might define 'abortion' as a surgical procedure whereby a woman is relieved of an unwanted burden. Certain terms, like the term 'wetland', have proved to be highly controversial, not only in the political arena, but have even been subject to extensive litigation (Schiappa, 1996). In such cases it is appropriate to bring in the notion of a persuasive definition.

Defining a term can be seen as a special kind of speech act, often used to support or attack an argument, or series of arguments. In such cases the party who puts forward the definition does it in the expectation of getting the other party to accept an argument based on the definition. However, the five different types of definition listed above show that the putting forward of definitions can be used to support argumentation in several different ways. There is not enough space here to show how each of the five types of definition contains problems and puzzles that need analysis as special types of speech acts that can be used to base arguments on.

It is a good question which category the new definition of 'planet' fits into. Stipulative definitions are often reasonable in science. For example, stipulative definitions are very common in mathematics. But it seems improbable that proposing a purely stipulative scientific definition of the term 'planet' would be appropriate, in light of the Pluto case described above. Some scientific terms would not appear to be definable in a purely

stipulative way, because substantive arguments, not only scientific ones but ones relating to values, financial matters and politics, have been marshaled for and against the proposed definition. But the redefinition of the term ‘planet’ above does not appear to really fit this category either. It is not a lexical definition, either, although it may partly fit that category. It appears to fit best as either *précising* definition or a theoretical definition. Perhaps it fits into both of these categories.

#### 4. Absolutistic *versus* pragmatic approaches

The traditional approach in philosophy has been to pose the question asking for a definition in the form, ‘What is X?’, for example, ‘What is a tree?’, ‘What is death?’ or ‘What is marriage?’ (Robinson, 1950, p. 190). This approach has often been characterized as the quest for a real definition, because it attempts to define what things really are (Robinson, 1950). The absolutistic metaphysical way of seeing definitions comes from our Platonic and Aristotelian heritage. In one of its more extreme forms, asking the question ‘What is X?’ is taken to be a quest for the so-called essence of the thing X, meaning what makes the thing X an X.<sup>6</sup> Essentialism has long been discredited as a view of definitions to be taken seriously, but still, the absolutistic metaphysical quest for real definitions has retained a strong hold on modern philosophy.<sup>7</sup> Schiappa (2003, p. xi) has argued for a pragmatic approach, instead of the traditional approach that seeks a so-called real definition, by reformulating the question as, ‘How ought we to use the word X?’ Such an approach is rightly said to be pragmatic, because the classification of one term in relation to another is based on the form of definition ‘X counts as Y in context C’ (p. xi). On such a pragmatic account, the definition needs to be evaluated in light of the purpose for which it was put forward.

It is an important corollary of this pragmatic approach that a legal definition, for example, might have a different purpose from a scientific definition of the same term, or that either of these might have a different purpose from the definition of the term in ordinary conversational usage, or for that matter, from a definition of it offered in a work of philosophy. When addressing the definitional issues involved in the abortion dispute, the Supreme Court has sidestepped questions of the form ‘What is X?’. For example, the philosophical question ‘What is a person?’ was reformulated by the Supreme Court as the question ‘What counts as a person with respect to the Constitution?’ (Schiappa, 2003, p. 103). Legal

<sup>6</sup> Robinson (1950, p. 190) described the question ‘What is X?’ as “the vaguest of all forms of questions except the inarticulate grunt”.

<sup>7</sup> Schiappa (2003, p. 43) suggested that even though real definitions have now been set aside by most professional philosophers, examples suggest that the language of metaphysical realism, with its absolutistic approach to definitions, persists outside the realm of professional philosophy.

definitions often make their pragmatic approach explicit by stating something like, "For the purposes of this agreement, an X is defined as such-and-such".

Part of Schiappa's pragmatic approach is that, in place of the absolutistic view that sees definitions as set in place by fiat, he puts forward a view that sees them as argumentative in nature. This view implies that definitions not only have argumentative force on issues subject to disputation, but are themselves based on arguments. Schiappa has presented some detailed case studies featuring terms that have been central to recent legal cases, like 'wetland', 'death' and 'rape'. For example, whether a given piece of land that developers want to build on can be classified as a wetland can have significant consequences, and both sides to such a case will marshal what they take to be strong arguments supporting their claims. There has been other work that supports the pragmatic viewpoint of these cases studies by studying the use of persuasive definitions in prominent public policy arguments (Zarefsky, Tutzauer and Tutzauer, 1984; Zarefsky 1997; McGee, 1999; Titsworth, 1999; Walton 2005).

These studies suggest that arguments from a definition to a verbal classification of a term are important to study, but before we can get a clearer and more accurate grasp of how such arguments work, and how they ought to be evaluated as weaker or stronger, we need to have some analysis of their logical form as inferences from premises to a conclusion. The pragmatic approach sees them as defeasible arguments, that is, as holding generally as reasonable arguments, but as subject to attack and even defeat by reasonable counter-arguments or critical questioning of the right kind.

## **5. Argument from verbal classification**

Argument from verbal classification concludes that a particular thing has a certain property on the grounds that this thing can be classified under a general category of things that have this property. A simple example is the following argument.

All dolphins are classified as mammals.  
Flipper is a dolphin.  
Therefore, Flipper is a mammal.

In this case, the classification of dolphins as mammals is determined by the science of biology. To the extent that the classification of all dolphins as mammals is not subject to exceptions, or to borderline cases, the inference in this example may be classified as deductively valid.

Hastings (1969, p. 36) offered the following example (p. 36):



In voluntary health insurance you generally get a poor return for your money because overhead and profits of the insurance company eat up huge chunks of the premiums you pay. On individual policies these companies spend for overhead and profits an average of about 60% of what you pay them and only about 40 cents of your premium dollar goes for benefits to policyholders. Obviously such insurance is a mighty poor buy.

In contrast with a previous case, which appears to be deductively valid and have true premises, this example seems to be open to possible exceptions. What is or is not a poor return can vary considerably, depending on the economic circumstances of the time. Still, the argument given strongly suggests that buying voluntary health insurance does generally yield only a poor return as an investment. This example shows how additional arguments can back up a proposed classification on which the deriving of a conclusion depends. What is shown is how a proposed classification of one concept within another can be an essential part of the chain of argumentation in which several arguments are marshaled to prove a conclusion at issue. The example suggests how common such arguments are in reasoning about making financial and business decisions, and also that they are often not as straightforward or trivial as the dolphins example and others like it may appear to suggest.

Another example can be used to show how arriving at a conclusion on how to classify something is far from the trivial process, and may involve significant argumentation on both sides of the disputed issue. In this example, a boy rode his bike through a park and was cited for violating a rule prohibiting vehicles in the park (Gordon, 2007, p. 2). This example is a variation on Hart's famous example concerning the open texture of the legal concept of a vehicle. As pointed out by Gordon (2007, p. 2) this problem is known as the subsumption problem in German legal theory, the problem of finding in a particular case whether a particular action or thing fits under the general legal concept. According to Gordon (2007), arriving at such a finding requires interpretation rules needed to apply the general concept to the specific case that issue. The problem of how to apply such rules to a specific case requires significant argumentation on both sides of the issue, because one can always question whether or not the interpretation is legally valid and defensible.

The following case was cited in the logic textbook (Copi and Cohen, 2005, p. 281) as an example of an enthymeme, an argument with an implicit premise or conclusion. The example was taken from a Supreme Court opinion in which federal legislation regulating interstate violence was applied to cases of violence motivated by gender falling under the Violence against Women Act. According to the Supreme Court opinion, classifying violence motivated by gender under federal legislation was ruled unconstitutional on the grounds that crimes motivated by gender should not properly be so classified. The ruling was that the commerce clause of the constitution regulates interstate activity only when that activity is economic in nature. Since the kind of violence motivated by gender at issue was not taken to be economic in nature, the implied

conclusion was that it should not be classified under the federal legislation regulating interstate criminal activity.

To portray the argumentation in this example as an enthymeme, Copi and Cohen (2005, p. 281), put it in syllogistic form, as follows.

- Explicit premise 1: all activities that may be regulated by Congress under the rule of Supreme Court cases are economic activities.
- Explicit premise 2: no interstate gender motivated crimes of violence are economic activities.
- Conclusion: no interstate gender motivated crimes of violence may be regulated by Congress under the rule of Supreme Court cases.

Copi and Cohen evaluated this syllogistic argument as valid on the ground that it has a valid AEE form. In many cases an argument is classified as an enthymeme because it has a missing (unstated) premise. They used this example to illustrate the case of an enthymeme that has an implicit conclusion, a missing statement that needs to be inserted before the argument can be tested for validity.

This example is also interesting, however, because it illustrates how argument from classification is used in legal cases, and is important because it is the fundamental argumentation structure on which the reasoning in the case turns. Of course, the case is interesting as well because it links argument from classification to the concept of the enthymeme, a notion that is also fundamentally important in logic. Argument from classification is frequently overlooked in everyday conversational reasoning. Perhaps because we're so familiar with it, and so commonly use it in everyday argumentation practices, we fail to notice that it is a distinctive form of reasoning in its own right on which the structure of an argument depends.

Another especially interesting aspect of this particular example is that it is an instance of the use of negative argument from classification in which some property is held to be excluded from a particular category. The argument is to the effect that the constitution requires that criminal cases be classified under the heading of interstate activity only when that activity is economic in nature. The other premise, premise 2 of the argument, states that gender motivated crimes of violence are not generally economic activities. The conclusion drawn is the negative one that gender motivated crimes of violence should not be regulated under the classification of interstate activity. Although many of the most familiar cases of argument from classification proceed from positive classifications of one concept under another, this example is an instance of negative argument from classification in which one property is excluded from being classified under another.

## 6. Schemes for arguments from classification and definition

Hastings (1969) was the first to give a systematic account of the structure of argumentation based on verbal classifications and definitions, to present argumentation schemes representing these forms of argument, and to set a list of critical questions corresponding to each scheme. To analyze the voluntary health insurance example presented above, Hastings (1969 p. 36) represented the argument in the example in the Toulmin format (Toulmin, 1964, p. 101), as shown in figure 1.

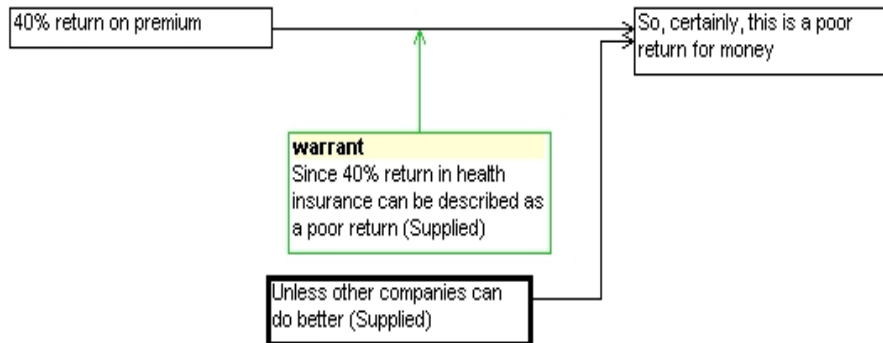


Figure 1: Hastings' Poor Return example shown in the Toulmin format

The premise is the statement that 40% is the return on the premium. The warrant is the statement that a 40% return on health insurance can be described as a poor return. The conclusion is that this is a poor return for the money. The exception is the qualifier, 'unless other companies can do better'. By using the Toulmin format, Hastings showed how argument from a verbal classification is defeasible.

As his method for evaluating the argument from criteria to a verbal classification, Hastings presented the following seven critical questions.

1. What is the implicit definition being used? (p. 42)
2. Is the definition acceptable; are the criteria acceptable as a definition of the classification? (p. 43)
3. Are there exceptions or qualifications to the definition and criteria? (p. 43)
4. Are other criteria necessary for an adequate definition? (p. 43)
5. Do the characteristics described meet the criteria? (p. 44)
6. Are enough characteristics described to justify inclusion in this category? (p. 44)

7. Could the event fit better into another category, or be classified differently on the basis of its characteristics? (p. 45)

The structuring of argumentation from verbal classification in this format, with an argumentation scheme expressed using the Toulmin model, and a set of questions matching the argumentation scheme, was an important step forward. It showed for the first time how such arguments have a definite structure of the defeasible kind, and how sets of critical questions can be used as tools to analyze and evaluate such an argument in a given case.

A more recent analysis of the argumentation scheme for argument from verbal classification has been presented in (Walton 1996, p. 54). On this account, the argument from verbal classification is said to have the following general form, where  $a$  is an individual entity,  $x$  is a variable ranging over such entities, and  $F$  is a property.

#### **Argumentation scheme for Argument from Verbal Classification**

Individual Premise:  $a$  has property  $F$ .

Classification Premise: for all  $x$ , if  $x$  has property  $F$ , then  $x$  can be classified as having property  $G$ .

Conclusion:  $a$  has property  $G$ .

The critical questions appropriate for this version of the argument from verbal classification are the following (Walton, 1996, p. 54).

1. Does  $a$  definitely have property  $F$ , or is there room for doubt?
2. Can the verbal classification (in the second premise) be sent to hold strongly, or is it one of those weak classifications that is subject to doubt?

Analyzed in this manner, argument from a verbal classification can be seen as an inherently reasonable form of argument that shifts the burden of proof from one side to another in a dialogue. In many of the most typical cases, it is best seen not as a deductive or inductive form of argument, but as a defeasible form of argument that can be shown to be weak, or even to fail, if the right critical questions are asked, and failed to be answered adequately. However, it is also extremely useful to know that such arguments can be used in some cases in a way that falls short of standards of reasonable argumentation.

An important thing about argument from verbal classification is that this type of argument is frequently used in an aggressive way to bring pressure to bear against an opponent by the use of an argument that is

biased to one side of a dialogue.<sup>8</sup> Suppose, for example that two people are having a theological dialogue on the issue of whether God is a trinity or a unity, and the proponent of the trinity thesis argues against the unity defender using the following argument.

Your thesis is heresy.  
Therefore, your thesis is wrong.

This use of argument from a verbal classification seems to have the unity defender on the ropes, assuming (as seems plausible perhaps to the disputants) that anything that can be classified as heresy sounds pretty bad, and must have something wrong with it. This implication could stem from the negative connotations of the term ‘heresy’ - it sounds like something bad. But it should be questioned, by asking the first critical question above, whether the thesis in question really can be classified as heresy. And even if it can, it should be questioned, by asking the second critical question above, whether all heresy is really all that bad. After all, ‘heresy’ seems to be stipulatively defined as any view that is against church dogma. What needs to be recognized is then that ‘heresy’ is a kind of biased term, as used in the theological dialogue above. For any view that departs from the trinity arguer’s view in the dialogue above can be classified as heresy. ‘Heresy’ is not only a derogatory term, or at least it is meant to be, by the proponent of the argument in the dialogue above. But any view opposed to his own (the official church view) is thereby automatically classified as heresy, permitting no opposition to this view in the dialogue. What a respondent needs to do is to challenge the classification of his thesis under this derogatory term by questioning the biased use of this stipulative term.

Finally, it should be noted that Hastings, in addition to recognizing argument from criteria to a verbal classification, also recognized a different type of argument closely related to it called argument from definition to characteristics. The important thing for our purposes here is that Hastings recognized that argument from definition to a classification is often used to support argument from a verbal classification, the type of argument being used to offer evidence to support the latter type. The following version of the scheme for this type of argument is from (Walton, Reed and Macagno, 2007).

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<sup>8</sup> Bentham (1824; 1969, p. 337) drew a contrast between what he called eulogistic terms like “generosity” and “gratitude” and dyslogistic terms like “lust and “avarice”, to label and classify objects. He pointed out that the use of such terms can deceptively conceal an argument by building a bias into the language used.

**Argumentation scheme for Argument  
from Definition to Verbal Classification**

DEFINITION	<i>a</i> fits definition <i>D</i> .
PREMISE:	
CLASSIFICATION	For all <i>x</i> , if <i>a</i> fits definition <i>D</i> ,
PREMISE:	then <i>x</i> can be classified as having property <i>G</i> .
CONCLUSION:	<i>a</i> has property <i>G</i> .

The critical questions appropriate for this version of the argument from verbal classification are the following (Walton, Reed and Macagno, 2007, chapter 9).

- CQ<sub>1</sub>: What evidence is there that *D* is an adequate definition, in light of other possible alternative definitions that might exclude *a*'s having *G*?
- CQ<sub>2</sub>: Is the verbal classification in the classification premise based merely on a stipulative or biased definition that is subject to doubt?

Here there is little space to go into the very broad topic of theories of definition, and all the literature in that area (Robinson, 1950; Schappa, 2003). We merely note that argument from definition represents an important argumentation scheme in its own right, and that such arguments are often employed to support arguments from a verbal classification.

The precise relationships between argument from verbal classification and argument from definition to verbal classification remain to be explored. Applying these schemes to realistic cases of argumentation involves many complexities, because there is a great variety of ways in which such arguments can be supported and attacked by offering evidence of various kinds. The best we can do in this short space is to present the general format explaining how such sequences of argumentation fall into a common pattern. This general pattern of argumentation is displayed in figure 2.

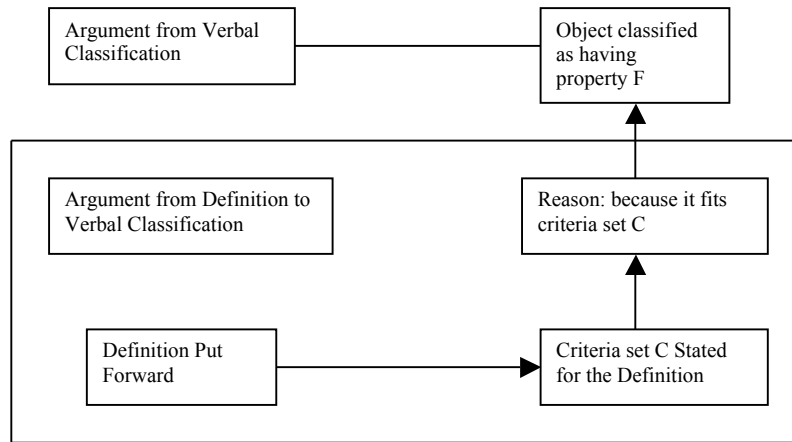


Figure 2: How a verbal classification is based on supporting arguments

At the top of figure 2, in the part outside the rectangle, the common kind of situation is shown in which an object is classified as having a particular property F, based on argument from verbal classification. The assumption is that the object can be classified as an F on the grounds of an argument from verbal classification. In the argumentation scheme for argument from verbal classification, an individual object is said to have a property on the grounds of our ability to classify it. Such arguments commonly appear to be very simple on the surface. It often seems trivial that some object can be classified as having a certain property simply on the basis of common usage. This initial argument could be described as the part of the iceberg visible from the surface. However, the part of figure 2 within the rectangle could be described as the part of the iceberg lurking under the surface. It shows how such a simple classification can be based on an argument from a prior definition to the verbal classification. To back up the part of the argument outside the rectangle, various kinds of evidence shown inside the rectangle can be marshaled. For example, it can be argued that the classification is legitimate because it fits criteria for a definition. The definition itself may be put forward. And then an argument from the definition to the verbal classification can be built. So the sequence of argumentation within the rectangle is labeled as argument from definition to verbal classification.

For example, in Hart's case of the vehicle in the park, a particular definition of the term 'vehicle' might be put forward as an argument for classifying a bicycle as a vehicle, or for that matter an opposed argument might be put forward for not classifying a bicycle as a vehicle. Note that in figure 2 we have displayed for purposes of illustration and explanation how a supporting chain of argumentation works, but it is just as common to find arguments from definition used to attack a verbal classification.

The next step is to provide an interesting current example that is more complex, but simple enough to show how this structure of argumentation works in practice. As a basis for studying in more depth how these two

kinds of arguments are related to each other, and how arguments from definition can be used to support arguments from verbal classification, we now return to the Pluto case.

## **7. Dialectical structure of the Pluto case**

In this case it is clear how the disagreement arose. Mike Brown and his colleagues at the California Institute of Technology discovered what appeared to be a tenth planet Eris (Xena). This planet is larger than Pluto, and its classification as a planet could have led to a kind of slippery slope in which many more small bodies in the solar system would now have to be called planets. This situation had to be resolved. Should all these bodies be classified as planets, which would appear to be necessary if astronomy were to stick with the traditional definition, or should some stricter and more precise definition be proposed that would head off the slippery slope? A problem is that the new definition that was proposed, while it had the desired effect of heading off many problematic situations where other bodies might have to be classified as planets, had the consequence that Pluto was no longer classified as a planet. This decision seemed counterintuitive to the public, long used to classifying Pluto as a planet, and to many astronomers, who were also unhappy with the new definition.

The situation was characteristic of one that posed a conflict of opinions needing to be resolved by argumentation. Although many definitions were put forward in a new discussion phase as means to resolve the conflict, as the argumentation preceded, at some point it became clear that the debate had polarized to two proposed definitions. Contrasting with the IAU definition with its three criteria, the opposed definition that was considered was based only on the first two criteria but excluding the third. Let's call this the alternative definition, meaning that it was seen as the leading alternative to the IAU definition. Thus the argumentation in the Pluto case can be dialectically structured as reaching a confrontation stage where the two proposals were opposed, and where the argumentation on both sides took the form of arguments for or against each of these proposals in turn. This dialectical structure is shown in figure 1. At the first stage, there was the traditional definition of the concept of a planet representing the state of scientific knowledge at that time. Next, there was a stage over time of the discovery of several new bodies that could be classified as planets under the traditional definition. These discoveries posed a problem that had to be resolved. Some decision had to be made on whether these bodies should be classified as planets or not. This problem posing stage led to a proliferation of new definitions being considered. During this stage two leading competing definitions came to the fore, and a central conflict arose between them. Next there was an argumentation stage in which arguments were brought forward on both sides to support their respective



definitions. Ultimately, in the Pluto case, the conflict was tentatively resolved by moving to the new definition accepted by the IAU.

Figure 3 shows the sequence of argumentation on the left, and the various stages that the argumentation reached at each level are shown on the right. This format represents the classical structure of argumentation proceeding through a series of stages from an opening stage to a closing stage.

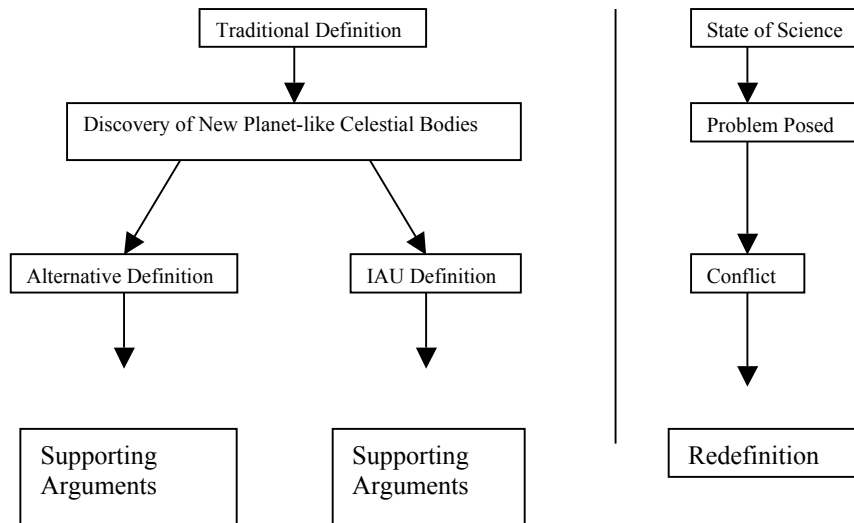


Figure 3: Dialectical structure of the disagreement in the Pluto case

The facts of the case presented in section 1 made clear how the problem arose, demanding a resolution. By only using the first two criteria, and excluding the orbital clearance criterion, we would have the three new planets, as well as Pluto, classified as planets. We were also told that, in addition to these three celestial bodies and Pluto, there were a further twelve or more bodies that were possible candidates to be classified as planets under the alternatives definition. As noted in section 1, if Pluto is classified as a planet, Eris, because it is larger than Pluto, would also have to be classified as a planet. The problem posed, in the sequence shown in figure 3, is one of an apparent inconsistency. An inconsistency in a scientific system of classification is a problem.

Another aspect of the problem is that sticking with the old definition may lead to a worrisome widening of the definition of ‘planet’. Having many additional planets could be an outcome of accepting the alternative definition. What is suggested here as well is that because such an outcome seems somehow worrisome, argumentation from negative consequences is a possibility. It may even be suggested that the opened nature of the alternative definition, with its potentially expansionary consequences, could pose a kind of slippery slope or opening of the Pandora’s box type of argument. Probing into the nature of the disagreement a little more deeply, one might ask exactly what is

wrong with having three, or even fifteen additional planets. The case study data doesn't give us information on this question. It is uncertain whether problem of having so many additional planets is more of a scientific one or one of the public to deal with such a serious revision of the traditional view of the planets. We're told that many other definitions were debated as well, before the IAU definition was accepted on August 24, 2006 in Prague. But we were also told that many variants on this definition were debated by the IAU before that time. In the case study description above, we're not told all the details of the reasons for and against these definitions that were given during the debate. However, even based on the short description of the case presented above, we can get an idea of some of the leading arguments offered on both sides.

One of the arguments stated in the case study was that the new definition was criticized as arbitrary and confusing by the group of astronomers who opposed it. One of their arguments cited was that earth, Mars, Jupiter and Neptune have not properly cleared the neighborhoods around their orbit. According to this argument, therefore, these four bodies should not be classified as planets on the grounds that they, like Pluto, do not fit the orbital clearance criterion. Therefore, the conclusion is that they should not properly be considered planets under the IAU definition. This is an argument against the IAU definition, and in particular, an argument contending that this definition does not apply to the planets in the way contended by its defenders.

The structure of this argument against the IAU definition is displayed on the argument diagram in figure 4. The double arrow shown between the two boxes at the top of the diagram indicates that the statement shown in the darkened box is meant to be a refutation of the IAU definition, shown in the box on the right. This means that the statement that the IAU definition is arbitrary and confusing is put forward as an attack on the definition. The argumentation scheme for argument from definition to verbal classification is shown as applying to two arguments in figure 3. At the top of the diagram, the IAU definition is used as an argument to support the conclusion that plateau should no longer be classified as a planet. The borderline around this argument labeled as argument from definition to verbal classification shows how the conclusion is drawn from the premise by this argumentation scheme. Further below, on the left part of the diagram, it is shown how two premises are linked together to support the conclusion that earth, Mars, Jupiter and Neptune should not be classified as planets on the IAU definition. This argument is an instance of negative use of argument from definition to verbal classification.

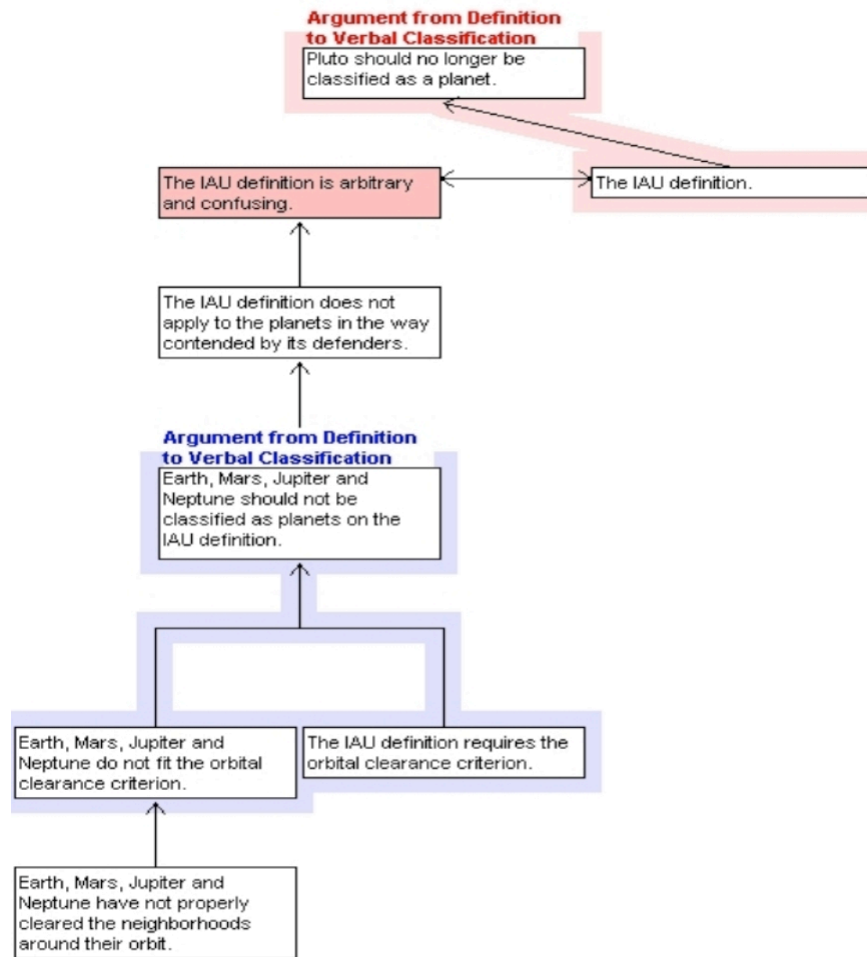


Figure 4: Argument diagram for argument against the IAU definition

An especially interesting aspect of this analysis of the argument is that it shows how one argument based on argument from definition to verbal classification is opposed by another argument based on the same argumentation scheme. It is an interesting kind of refutation argument in which the very same kind of argument is used to refute a given argument. Sometimes this kind of argumentation is called the *tu quoque* argument in the literature. This kind of argument that uses a counterargument to stand a given argument on its own head was beloved by the sophists in the ancient world.

## 8. Current argumentation technology

Much has changed in the field of argumentation since 1969, and among the most important developments has been the advent of argumentation technology (Reed and Norman, 2003), especially the development of

automated tools to assist in argument diagramming, like the system used to construct the diagrams in figure 1 and figure 4. Here we bring out some important lessons by briefly showing how this new technology for argumentation representation can be used to display some special features of the structure of arguments from verbal classification. As shown in figure 1, Hastings used the Toulmin layout to display the structure of argumentation from verbal classification. According to this layout (Hastings, 1969, p. 17), there are six elements in the argument: the claim representing the conclusion of the argument, the data representing the premises of the argument, the warrant asserting that the conclusion follows from the premises, the backing or evidence that supports the warrant, the qualifier that leaves room for exceptions to the warrant, and the rebuttal or refutation, a statement that cites an exception or qualifying condition that can defeat the application of the argument in special circumstances. The Toulmin layout is a valuable tool for argument analysis, but there are many aspects of it that are controversial, and have proved hard to define in a precise enough way to be suitable for developing argumentations tools of the kind that might be used in artificial intelligence, and that might also be automated in a way that would make them useful for purposes of argument identification, analysis and evaluation. New computational models supporting argument diagramming tools have been specifically developed to model argumentation schemes along with the sets of critical questions matching each scheme (Walton and Gordon, 2006).

The tool used to construct the argument diagrams shown in figures 1 and 4 is called *Araucaria* (Reed and Rowe, 2006). It aids a user when constructing a diagram of the structure of an argument using a simple point-and-click interface, which may be then saved in a portable format called AML, or Argument Markup Language, based on XML (Reed and Walton, 2005). The user inserts the text to be analyzed as a text document into *Araucaria*. She can then use the cursor to highlight each explicit premise or conclusion in the argument. Next she can insert implicit premises or conclusions and draw in arrows from each premise or set of premises to each conclusion it supports. The same statement can be used as a conclusion in one argument and then again as a premise in a next argument joined to the first one (as shown in the example in figure 4). Once she has analyzed the whole argument to a level she is satisfied with, the user can produce an argument diagram connecting all the premises and conclusions in one large diagram. This diagram appears on the screen and can be exported or printed. Such an argument can be represented in standard format, as shown in figure 4, but it can also be represented in other formats, including the Toulmin format. The one format can then automatically be converted to the other. In the standard format, each statement (premise or conclusion in the argument) is represented in a text box that appears on the screen. As shown in the example in figure 4, argumentation schemes, like that for argument from

definition to verbal classification, can be identified as applying to certain arguments in a chain of argumentation, and shown on the diagram.

In figure 5, an *Araucaria* diagram representing Hastings' example is shown. The conclusion is the statement shown in the box at the top. The two statements in the boxes with borders just below the conclusion are two premises. One states that a 40% return on health insurance can be described as a poor return. It is prefaced by the word 'since', a premise indicator word. The other premise links with this one by stating the alleged fact that the return on the premium in this case is one of 40%. These two premises function together to form a linked argument to support the conclusion that this is a poor return for money. The argumentation scheme is indicated above the conclusion.

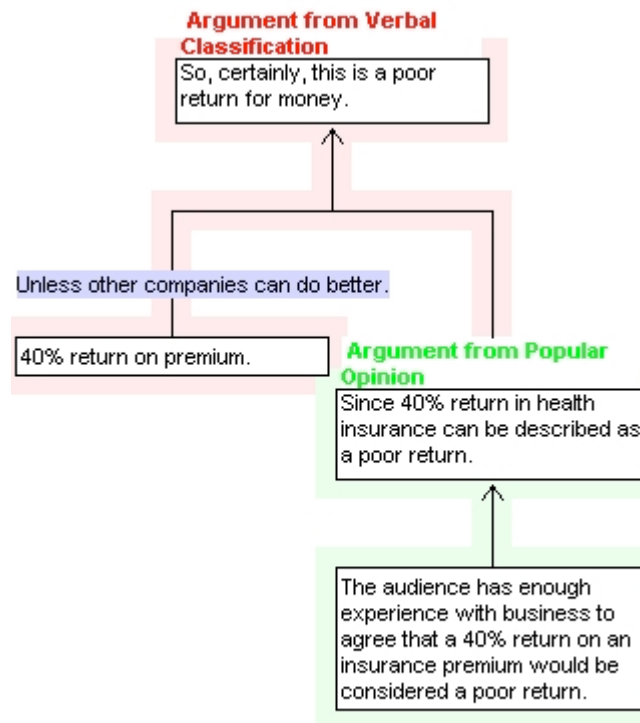


Figure 5: Araucaria diagram for Hastings' example

In this representation, the argumentation schemes are displayed on the diagram, showing how the premises support the conclusion in the argument in virtue of a particular argumentation scheme. One can also note some other features displayed in figure 5. The exception, 'unless other companies can do better' is displayed on the linked argument. Another argumentation scheme is shown in the bottom right hand segment of the diagram. Explanation of this scheme will be given below, after a general explanation of how schemes are applied to arguments in *Araucaria*.

The schemes are selected from a list that can be found in one of a number of scheme sets that the user can access. For example, 26 common schemes are contained in the Walton scheme set. The user opens such a scheme set, and then having identified a particular argument represented on the diagram, a particular scheme can be selected and applied to the argument. The screen shot displayed in figure 6 shows how a particular scheme is selected from the menu. The particular scheme chosen here is that for argument from verbal classification.

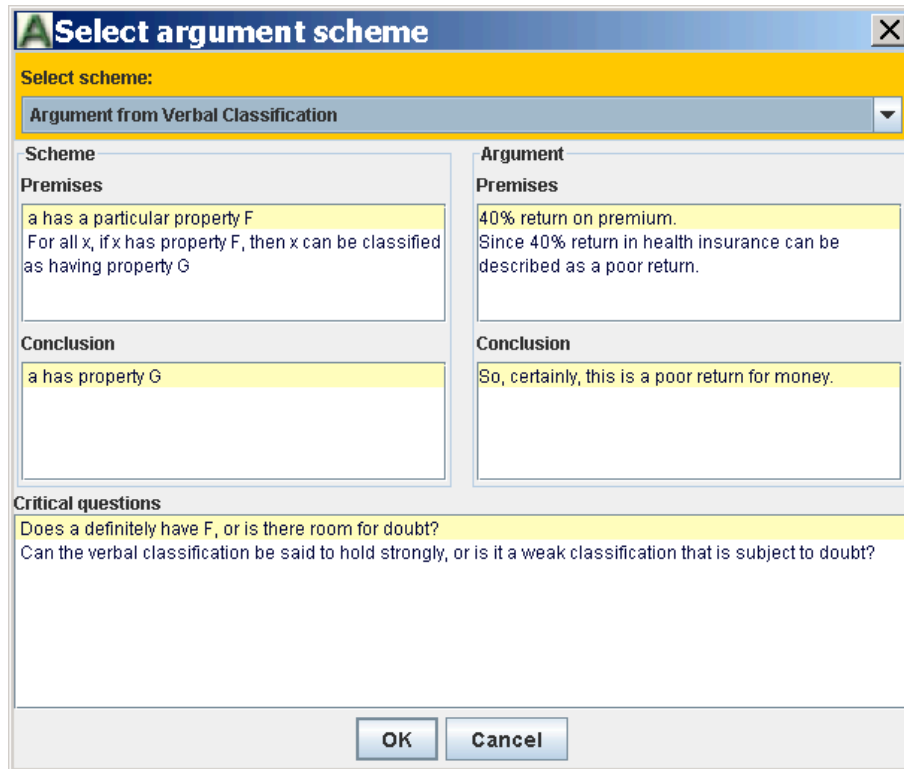


Figure 6: Screen shot of the schemes menu

Figure 6 shows how the premises and the conclusion of the scheme are represented generally, on the left, and how the particular example to which the scheme is being applied, in this instance Hastings’ example, fits the scheme. In the box at the bottom, the critical questions matching the scheme are displayed.

We now return to figure 5 to explain how the scheme for argument from popular opinion appeared in that diagram. Hastings (1969, p. 17), discussing how his example fits the Toulmin format, asked what justification can be given for the assumption that 40% return in health insurance can be classified as a poor return. His answer was: “The audience is expected to have had enough experience with business and commercial dealings to agree that a 40% return on insurance premium is lower than it should be, and this would be considered a poor return” (p. 17). It was this answer that suggested diagramming the argument as

shown in figure 5. The analysis uses the argumentation scheme for argument from popular opinion by choosing this scheme from the Walton scheme set in *Araucaria* and applying it to Hastings' example. So analyzed, the diagram in figure 5 shows how this example can be diagrammed as a chain of argumentation in which two arguments are connected together and each is based on a separate argumentation scheme.

Finally, it can be shown how Hastings' analysis of his example argument using the Toulmin layout would be represented in *Araucaria*. This is shown in figure 7.

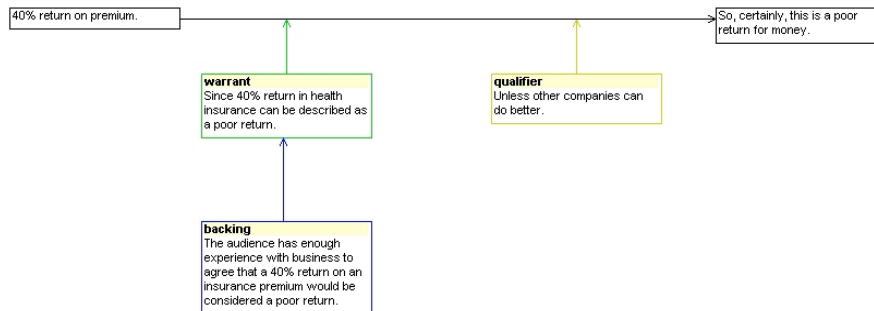


Figure 7: Toulmin diagram for Hastings' example in *Araucaria*

Note the difference between figure 7 and figure 1. In figure 1 the exception, 'unless other companies can do better' was applied to the conclusion of the argument. This represents one approach to exceptions, showing them as rebutting the conclusion of the argument if it can be shown that the exception obtains. However, the standard way of diagramming exceptions in *Araucaria* is to draw the exception or qualifier in a box leading by an arrow that joins the main arrow going from the data to the claim. These two ways of visualizing exceptions represent two approaches to modeling defeasibility using structures like Toulmin layouts and argument diagrams.

## 9. Conclusions

Only a few basic facts about the Pluto case were assembled, mainly from three sources, and the analysis based on these assumptions provides a sufficiently complete account of the case to support the inferences drawn from claims made about the argumentation in it. Given the space limitations of this paper, and the use of the case to study certain specific aspects of the argumentation in it, the length and detail of the case have been limited to what was presented. Further work could proceed by expanding the details of the case, and by examining the structure of the argumentation on both sides in more detail. The comparable cases

studied by Zarefsky (1997) and Schiappa (2003) could be used as models. The Pluto example can be used as a classic case in further work on how definitions are made and supported by evidence in scientific reasoning.

The analysis of the Pluto case was presented above in a way comparable to the pragmatic approach of Schiappa (2003). The reader will recall from section 3 that Schiappa (2003, p. xi) advocated a pragmatic approach that reformulates the question from 'What is X?' to 'How ought we to use the word X?' According to Schiappa (2003, p. 168), seeking a real definition by putting the question in the former way is problematic because it is based on the metaphysical idea of identifying an unchanging essence of the term to be defined. This absolutistic approach was shown in the foregoing study of the Pluto case to go against the defeasibility of the argumentation schemes for argument from verbal classification and argument from definition to classification. However, in certain other respects, the approach taken in the analysis above may not fit with Schiappa's approach. Schiappa (2003, p. xi) wrote that his approach is rightly said to be pragmatic because he advocates thinking of one appropriate form of definition as 'X counts as Y in context C' (p. xi). We consider this expression not as a form of definition, but as part of the argumentation scheme for argument from verbal classification. However, as has been shown, this form of argument is closely connected to definitions because the schemes for argument from verbal classification and argument from definition to verbal classification are closely related.

The analysis of the Pluto case presented above is dialectical as well as pragmatic, for two reasons. One is that the analysis shows how the need to put forward an alternative to an existing definition can arise at a particular stage of a discussion where a conflict is posed. The argumentation then put forward attempts to resolve this conflict by offering reasons to support the new definition versus the old one, and also reasons that might be given to support the old definition versus the new one. This dialectical aspect of such arguments was shown in figure 3. The other is that the analysis above has concentrated more on argumentation supporting definitions and argumentation based on definitions than it has on the concept of definition itself, the latter being a much broader topic of interest in its own right. This approach agrees with the remark of Schiappa (2003, p. 169) that when such a conflict occurs, of the sort that Schiappa calls a "definitional rupture", the process of definition itself becomes an issue, so that "the persuasive dimensions of arguments *from* and *by* definition are equally important". It is this aspect of definition and classification that has been brought out in the analysis of the Pluto case above.

Argumentation put forward in real cases needs to be evaluated within a dialectical framework with respect to how that argument was used for some purpose, for example to resolve a conflict of opinions. This dialectical aspect is very much evident in the Pluto case. The purpose of



putting the new definition forward was to confront the problem posed by the inconsistency between the new scientific findings and the previously accepted definition. The goal of the argumentation was to solve this problem. The new definition did solve the problem, at least on a defeasible basis, by assembling the new evidence and assessing the arguments on both sides. The combination of the empirical evidence with the arguments put forward by the participants in the discussions can be structured in a dialogue format, as shown above, in which the reasons on both sides are presented, questioned, and evaluated as strong or weak arguments. The context is one of a scientific investigation, and the purpose is not merely to consider the arguments on both sides, or to judge which ones are stronger or weaker, but also to solve a specific problem that was posed. In such a scientific investigation, there is always a burden of proof, and there are also standards of proof that have to be met before the move can be made from a previously accepted hypothesis to a new one. Thus underlying the argumentation in the case there are objective standards for putting forward a hypothesis, and accepting it or rejecting it, based on a standard of proof. Even so, as the case clearly reveals, this argumentation has a dialectical structure in which two sides are represented.

It was especially interesting in the Pluto case that the definition that was put forward and accepted was actually debated by a scientific body, and decided by majority vote. As shown in the analysis above, arguments were put forward by both sides, and these arguments were shown to have a definite structure as a sequence of reasoning based on argumentation schemes. Both the definition that was accepted and the main alternative definition that it was opposed to during the debates were based on criteria that could at least potentially be measured, or specified by numerical scientific criteria. Thus although both were scientific definitions, and may partly be classified as precisising definitions, as well as theoretical definitions, the way they were used in the context of the debate showed that they also have an aspect of persuasion. The defeasible nature of the IAU definition was made clear by the rule that it will remain in place for the next three years, and by the fact that it was subject to such a concerted opposition by its opponents who are even engaged in putting on an international online forum they hope will lead to an alternative definition.

The most important conclusion to be drawn from the case and its analysis above is how the argumentation in the case has been shown to be based on reasoning of a certain kind. Most importantly the argumentation schemes for argument from definition to verbal classification and argument from criteria to verbal classification were shown to have a precise logical structure showing the premises and conclusion of each type of argument. The schemes, along with the argument diagramming methodology used to show how they fit into a chain of reasoning in a given case, are the tools needed to analyze such arguments. To evaluate them, the two methods illustrated are the use of counter-arguments, like

the one displayed in the argument diagram in figure 4, and the method of applying a set of critical questions specifically appropriate for a particular argumentation scheme. Remarkably, the best critical questions for argument from criteria to a verbal classification developed so far are those of Hastings (1969). They fit the argumentation in the Pluto case very well by posing questions about the criteria on which the definition is based, exceptions or qualifications for the definition and criteria, the existence of other criteria, whether the characteristics described meet the criteria, and whether the entity in question could be classified differently and placed into a different category.

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