Consistency Rules for Classification Schemes (or how to organize your beanie babies)

Abstract: A classification scheme is more predictable—and, thus, more effective—if it has a consistent structure. In this paper, a number of (defeasible) consistency rules for constructing classification schemes are identified (e.g., division by a single type of attribute, division at a single level of abstraction, horizontal consistency, vertical consistency). An explicit statement of these rules, not all of which have been explicitly codified in the library and information science literature, should be useful to the developers of retrieval systems. In addition, some preliminary suggestions are made regarding how these rules might be used to define a measure of the consistency of a classification scheme.

1. Predictability and Consistency

The goal of a retrieval system is to allow users to retrieve items that they want quickly and easily. The success of a retrieval system depends largely on how these items are organized (i.e., on the classification scheme that is used to organize the collection). In particular, a retrieval system is likely to be successful if the items in the collection are organized in a way that the users of the system would expect them to be organized. In other words, the retrieval system should be predictable (cf. Mann, 1993, 121-127).

In order for a retrieval system to be predictable, the items in the collection should be organized in a consistent manner. Webster's third new international dictionary defines consistency as "agreement or harmony of parts, traits, or features; uniformity among a number of things" (Gove, 1981, 484). There are at least two ways in which such "uniformity" can enhance the predictability of a retrieval system. For one thing, we can adopt rules for placing items in the classification scheme and apply these rules in a consistent manner. This sort of consistency allows users to predict, for example, that books on the same topic will always be found in the same location in the classification scheme. There have been a number of studies on how well catalogers consistently apply such rules (see, e.g., Mann, 1997).

In addition, we can adopt rules for constructing classification schemes that help to ensure that a scheme will have a consistent structure (cf. Kelley, 1988, 17-19). This sort of consistency allows users to predict, on the basis of their experience with one part of the scheme, the structure of other parts of the scheme. The focus of this paper will be on such consistency rules that tend to increase the "uniformity" of a classification scheme. Such rules are an important subset of the "criteria that classification schemes should meet" (Rowley, 1992, 176).

Most classification schemes actually obey most of the rules that we will discuss in this paper most of the time. Even so, not all of these rules have been explicitly codified in the library and information science literature. An explicit statement of these rules should be useful to the developers of retrieval systems. In addition, an explicit statement of these rules is the first step toward defining a measure of the consistency of classification schemes.

The rules we discuss in this paper are applicable to any kind of classification scheme. Library and information scientists make a distinction between classification—which linear orders a collection—and subject analysis. In addition, they make a distinction between
enumerative classification schemes and faceted classification schemes (see Rowley, 1992, 179). However, in all of these areas, the goal is to produce a system of categories that will facilitate retrieval. As a result, these consistency rules are applicable in all of these areas.

Furthermore, these consistency rules are applicable to classification schemes for any collection of items. For instance, they do not just apply to classification schemes for collections of information-bearing entities. In fact, in this paper, these rules will be illustrated using a collection of beanie babies (see Ty, 2000). Beanie babies are small beanbags, which come in the shapes of a variety of different animals. Beanie babies have a number of different properties. For example, each beanie baby is a particular species of animal (e.g., bear, flamingo, crab, etc.), is a particular color, and has a date of birth.

2. Other Rules for Classification Schemes

It should be noted at the outset that these consistency rules are not the only considerations that the designers of classification schemes should take into account. For one thing, consistency rules are clearly defeasible. That is, in order to meet the expectations of the users, consistency will sometimes have to be sacrificed. Also, even if they are not overridden, consistency rules rarely determine exactly which categories should be included in a classification scheme for a particular domain of entities. As a result, the designers of classification schemes will also want to follow rules of saliency, essentiality, mutual exclusivity, etc.

When constructing a classification scheme, it is important to use categories that are salient to the intended users. In addition, “classify[ing] according to essential attributes of the things we are sorting” (Kelley, 1988, 19) is a good rule to follow. For example, according to David Kelley, “because a fundamental attribute underlies and explains many of a thing’s superficial attributes, things that are fundamentally similar will probably have many attributes in common; things that share a superficial, nonessential attribute may well have nothing else in common” (Kelley, 1988, 20). As a result, if we classify by essential attributes, we will automatically group together items that share many nonessential attributes as well. In other words, we will reduce the amount of scattering (see, e.g., Mann, 1993, 21-22) in the classification scheme and enhance its predictability.

Despite initial appearances, the rule of mutual exclusivity is not a consistency rule. We can consistently divide our collection of beanie babies into categories that overlap. For example, we can consistently divide them into the category of animals that live on land and the category of animals that live in the water even though Smoochy the frog fits in both categories. However, like consistency rules, the rule of mutual exclusivity enhances the predictability of a classification scheme. This is because the user does not have to wonder about where Smoochy might have been placed if Smoochy only fits in one category. In addition, this rule is like the consistency rules in that it applies to the concepts that identify the categories in the classification scheme and not to the items in the collection that happen to fall under those concepts. For example, we are not in compliance with the rule of mutual exclusivity simply because there are no beanie baby amphibians in our current collection. Ideally, given the meanings of these concepts, it must not even be possible for something to fit into more than one subcategory of a division.

3. Local Consistency Requirements

Classification schemes (e.g., Bliss, Colon, Dewey Decimal, and Library of Congress) can be represented as a tree (or hierarchy) in the sense of graph theory. Each node in the tree represents a category in the classification scheme. Each branching of the tree represents a division of a category into subcategories. Thus, the descendants of each node (i.e., category) represent the subcategories of that category. The root of the tree represents the category that encompasses the entire domain of the classification scheme. The first few consistency rules
that we will discuss identify local consistency requirements on classification schemes. That is, these rules govern how a single division of a category into subcategories should be carried out.

The first local consistency requirement is that, all other things being equal, each division should divide by a single type of attribute (i.e., by a single facet—see, e.g., Rowley, 1982, 183). For example, we could divide our collection of beanie babies by animal species (i.e., into the subcategory of mammals, the subcategory of reptiles, etc.). Similarly, we could divide our collection of beanie babies by color, by date of birth, or by the environment in which they live. However, we should not use more than one type of attribute in a single division. For example, we should not divide our collection of beanie babies into the subcategory of animals that live in the water and the subcategory of animals that are brown.

Even though this rule significantly enhances the predictability of a classification scheme, it can be overridden in certain circumstances. It is sometimes the case that a division by a single attribute produces categories that do not meet the expectations of the intended users. This can happen, for example, if the users are only aware of an inconsistent division of a particular category. For example, if our classification scheme is intended for the use of young children, we may want to divide our collection of beanie babies into the subcategory of mammals, the subcategory of reptiles, and the subcategory of fish—plus-Splash the orca whale—plus-Echo the dolphin. This is because young children might expect whales and dolphins to be categorized with the fish rather than with the mammals.

In addition to dividing by a single type of attribute, we should, all other things being equal, divide by this type of attribute at a single level of abstraction. For example, if we wish to divide our collection of beanie babies by color, we could divide them into the subcategory of animals that are brown, the subcategory of animals that are red, etc. We should not divide our collection of beanie babies into the subcategory of animals that are brown and the subcategory of animals that are fire engine red. Similarly, if we wish to divide our collection of beanie babies by date of birth, we could divide them into the subcategory of beanie babies born in 1997, the subcategory of beanie babies born in 1998, etc. However, we should not divide our collection of beanie babies into the subcategory of animals that were born in 1997 and the subcategory of animals that were born in November of 1998.

The rule of division by a single type of attribute at a single level of abstraction enhances predictability in two ways. First, such divisions tend to fit better with the pre-existing expectations of users about the logic of hierarchies. For example, people expect fine-grained categories of color, such as fire engine red, to appear at a lower level of the hierarchy than primary colors. Second, such divisions allow the users to predict how things will be organized based on their previous experience with the scheme. So, for example, they will expect to be able to look up beanie babies born in 1998, based on their previous experience with looking up a beanie babies born in 1997.

4. Global Consistency Requirements

So far, we have looked at consistency rules that govern a single division of a category into subcategories. Classification schemes, however, consist of a huge number of such divisions. In order for a classification scheme to be predictable, these divisions should not only be internally consistent, but they should be consistent with each other. Thus, in addition to local consistency requirements, a classification scheme should, all other things being equal, meet certain global consistency requirements.

The first global consistency requirement is horizontal consistency. Divisions that are the same distance from the root of the tree are at the same level of the classification scheme. According to the rule of horizontal consistency, divisions that are at the same level should, all other things being equal, divide by the same type of attribute at the same level of abstraction. For example, suppose that we divide our collection of beanie babies by animal species.
However, if there are still too many beanie babies in each category, we will want to further subdivide some of these categories. Suppose that we subdivide the beanie baby mammals into the subcategory of brown mammals, the subcategory of gray mammals, the subcategory of yellow mammals, etc. In that case, horizontal consistency requires that we divide each of the other species by the same facet. For example, we should divide the beanie baby reptiles into the subcategory of brown reptiles, the subcategory of gray reptiles, the subcategory of yellow reptiles, etc.

This particular consistency rule is especially important because it ensures that a user's past experience with one part of the classification scheme will appropriately set her expectations with regard to other parts of the classification scheme. Even so, there are many cases where this rule will need to be broken in order to meet the expectations of users. For example, we may want to divide the beanie baby reptiles into the subcategory of poisonous reptiles and the subcategory of non-poisonous reptiles. This division would not make much sense in the case of birds, however (since all of them would end up in the "non-poisonous" category). It would make more sense to divide the beanie baby birds into the subcategory of flying birds and the subcategory of non-flying birds (such as Stretch the ostrich).

Another global consistency requirement is vertical consistency. According to vertical consistency, as we continue to subdivide categories at lower and lower levels of the classification scheme, we should continue to divide by the same facet—just at a finer and finer grain (cf. Aristotle, 1941, On the parts of animals, 643b). For example, suppose that we divide our collection of beanie babies by color, but that there are still too many beanie babies in each subcategory. In this case, we could make a finer-grained subdivision of each subcategory. For example, we could divide the gray beanie babies into the subcategory of light gray beanie babies and the subcategory of dark gray beanie babies.

The rule of vertical consistency will need to be broken in even more cases than the rule of horizontal consistency. In fact, unless users are solely interested in retrieving items on the basis of a single type of attribute, vertical consistency will have to be broken. Even so, following this rule—to whatever degree we can—does increase the consistency of the classification scheme.

So far, we have looked at consistency requirements for a single hierarchy. However, in organizing a collection of items, we may wish to use more categories than can be included in a single hierarchy. For example, suppose that we divide our collection of beanie babies by animal species and then subdivide each of the animal species by color. In this case, the category of animals that are brown and the category of animals that are gray will not be part of our classification scheme. However, these categories can be added to the retrieval system if we create surrogates for—or have multiple copies of—each of the items in the collection. For example, we can create several catalog cards for each beanie baby. In that case, one of the catalog cards for Seaweed the otter can be placed with the catalog cards for the other mammals. Another of the catalog cards for Seaweed can be placed with the catalog cards for the other brown animals. These additional categories need to obey the same consistency requirements as the categories in the original hierarchy.

5. Measuring Consistency

The consistency of a classification scheme is clearly important to the predictability and, thus, the overall effectiveness of the scheme. Unfortunately, it is rather difficult to significantly improve the consistency of classification schemes that have been used extensively over long periods of time (such as Dewey Decimal and Library of Congress). It is extremely expensive and difficult to change these schemes and any changes will produce a lack of consistency between the old schemes and the revised schemes. Even so, many new classification schemes (i.e., of the material on the Internet) are currently being developed and
they should have a consistent structure. An explicit statement of consistency rules should facilitate this. 8

Even so, in order for the developers of these schemes to gain maximum benefit from these consistency rules, we need to turn these consistency rules into a measure of consistency of classification schemes. Such a measure will allow these developers to measure the consistency of particular classification schemes. In addition, it will allow us to empirically determine exactly how important the consistency of its classification scheme is to the success of a retrieval system.

While an explicit statement of consistency rules is the first step, at least two things still need to be done in order to define a measure of consistency for classification schemes. First, for each consistency rule, we need a way to measure the degree of consistency of a classification scheme. While the above rules (collectively) characterize what it means for a classification scheme to be consistent, consistency is not an all or nothing affair. Consider the rule of dividing at a single level of abstraction. If any of the subcategories in a division are at different levels of abstraction, then the division is inconsistent. However, some possible divisions are more inconsistent than other divisions. It is possible to measure the degree of consistency of a division—with respect to level of abstraction—by looking at how many subcategories deviate from the average (e.g., median) level of abstraction and how far they deviate from this level of abstraction.

Second, we need a way to combine the different consistency rules into a single measure of the consistency of a classification scheme. Some of these consistency rules are clearly more important to the effectiveness of a scheme than others. As a result, these various types of consistency should probably not get the same weight when we measure the overall consistency of a classification scheme. For example, vertical consistency—since, as we noted above, it only meets the needs of users in certain circumstances—should probably get much less weight than horizontal consistency. In addition, we will need to determine the relative importance of local consistency (i.e., at each division) as compared with global consistency (i.e., between divisions).

While we have not offered a precise measure of the consistency of classification schemes, we have laid some of the groundwork for the development of such a measure.

Notes
1. These are essentially the same two ways in which consistency can enhance the predictability of a legal system. In order to be predictable, the law needs to have a consistent structure and it needs to be consistently applied (cf. Nozick, 1993, 3-12).
2. For a project that is somewhat related to ours, see (Fischer, 1991) on consistency rules for the construction of thesauri. For example, if a is listed as a broader term (BT) for b in a thesaurus, then b should be listed as a narrower term (NT) for a.
3. There are certainly exceptions. For example, Dewey Decimal Classification does not always obey the rule of division by a single type of attribute (see Rowley, 1992, 180).
4. There are actually a few beanie babies that are not animals (e.g., a snowman and a ghost), but we will ignore this complication here.
5. Several of the rules that we will discuss in this paper go as far back as Aristotle. For example, the rule of mutual exclusivity is implicit in Aristotle’s assertion that, when constructing a classification scheme, “no ultimate group must be included in more than a single division” (Aristotle, 1941, On the parts of animals, 643a).
6. This rule is implicit in Aristotle’s recommendation that, when dividing a category, we should not “characterize one branch by a colour, the other by a mode of progression” (Aristotle, 1941, On the parts of animals, 643a). Jorge Luis Borges describes a classification scheme in a (mythical) Chinese Encyclopedia which illustrates the confusion that can result if this rule is not obeyed (see Kelley, 1988, 18).
7. We might want to consistently divide our collection by animal species in order to teach children the correct classification. But, in that case, we are using the classification scheme as a pedagogical tool as well as a retrieval tool. In this paper, we are focusing on classification for purposes of retrieval.

8. It should be noted that we have not necessarily given an exhaustive list of consistency rules for classification schemes.

References