Identitas: A Better Way To Be Meaningless

Nizal Alshammry [1], [2]*and Phillip Lord [1]

[1]School of Computing Science, Newcastle University NE1 7RU, United Kingdom
[2]Department of Computing Science, Northern Borders University, Saudi Arabia

ABSTRACT

It is often recommended that identifiers for ontology terms should be semantics-free or meaningless. In practice, ontology developers tend to use numeric identifiers, starting at 1 and working upwards. Here we describe a number of significant flaws to this scheme, and the alternatives to them which we have implemented in our library, identitas.

Software is available from `https://github.com/phillord/identitas`.

During the years that ontologies have moved to becoming a standard part of the biomedical chain, a set of standard practices have build up which are used to enable their good management, including the addition of standardised metadata about each ontology term, including labels, definitions, editorial status and so forth.

One key piece of metadata is the identifier. For most ontological technologies this is in the form of an IRI (Internationalized Resource Identifer), or something that is convertable into one. Much has been written about the nature of identifier and how they should be chosen. The percieved wisdom is that identifiers should be *semantics-free* or meaningless. The key aim here is to enable persistence of access to a term [4]; an identifier which is based on some semantics associated with the term may need to be changed when that aspect changes, even if the change does not reflect a change in the ontological semantics.

As an example, OBO Foundry principles [6] provide guidelines for identifiers; these include both management principles ("The ID-space / prefix must be registered with the OBO library in advance."), syntactic constraints ("The URI should be constructed from a base URI, a prefix that is unique within the Foundry (e.g. GO, CHEBI, CL) and a local identifier (e.g. 0000001)."), in addition to a strong commitment to semantics-free IDs ("The local identifier should not consist of labels or mnemonics meaningful to humans."). No specific advice is given on the form of the local identifier; however, in practice OBO identifiers use numeric IDs, 8 numerals long, approximately increasing monotonically.

While semantics-free identifiers have their advantages there are distinct disadvantages as well, especially for humans. They are poorly mnemonic, hard to differentiate from each other and relatively difficult to read. For this reason, for example, many bioinformatics databases provide both semantic-free *accession numbers* (which are essentially the same thing as an identifer in ontology terminology), and an *identifier* (which is rather like a compressed, syntactically predicatable label). It is also interesting to note that, with software development, programmers emphasise the use importance of semantically-meaningful identifiers, and use other techniques to manage change.

In this paper, we ask whether it is possible to overcome these and some related issues with monotonic, numeric identifiers while remaining semantics-free. We describe our solutions, along with the identitas library which implements these.

Racing: One unusual aspect of ontological identifiers is that they are usually monotonically increasing. This causes a significant race condition if two developers are building a single ontology in parallel. If both attempt to add a new term, they both must *coin* a new identifier, which must be unique. This is impossible to achieve without some degree of co-ordination. One typical strategy is for developers have to pre-coordinate to build the ontology by using pre-allocation schema. For example, one developer allocated with the IDs from 1 to 1000, another allocated with 1000 to 2000 and so on. This approach is effective, however it requires developers to manage the ID space accurately, and also reduces the overall ID space since preallocated IDs cannot be used elsewhere. Another approach is to just-in-time co-ordinate; for example, the URIGen [2] server enables this approach in Protege. ́ Projects such as EFO (Experimental Factor Ontology) and SWO (Software Ontology) use this to manage their namespace. A final approach is to use temporary IDs, and then allocate final IDs at a single, co-ordinated point in the development process; URIGen also does this to enable off-line working.

We propose a much simpler approach which is to simply use random IDs not just as temporary identifiers. While randomness does not *a priori* completely remove the potential race condition, given a large enough identifier space, the chances of collision can be reduced to provide world (or universe) uniqueness. This approach is commonly used with random UUIDs (Universal Unique Identifiers) being perhaps the most common example.

Pronouncing: The use of randomness raises a secondary issue. These identifiers are likely to be relatively long, exacerbatting the problems of memorability and pronounceability. One solution to this problem is to just not show the identifiers to humans. With tools like Protege ́ this is possible, of course, because it has a view which may be different from the underlying model. With text file-formats, including OBO format, the various OWL serialisations or the Tawny-OWL [3] programmatic representation, this is rather harder (although the latter does provide an mechanism for achieving this). It is also difficult to do this for programmers developing tools like Protege, ́ who are themselves using general tools such as IDEs, debuggers and version control systems.

We have considered using a dictionary-based approach, to replace numeric identifiers with English words. However, this approach raises the probability of selecting a word which is inappropriate or unfortunate – consider the Sonic Hedgehog gene mutations which causes holoprosencephaly in humans. Instead, we are investigating a solution in the form of the *proquint* [7]. This is a library build to encode numbers as a set of strings of alternating consonants and vowels. Each consonant provide four bits of information, each

*To whom correspondence should be addressed: N.K.E.Alshammry2@newcastle.ac.uk vowel only two bits, as shown in Figure 1. Thus, sixteen bits can be represented using five letters (3 consonants, 2 vowels).

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Four-bits as a consonant:
0 1 2 3 4 5 6 7 8 9 A B C D E F
b d f g h j k l m n p r s t v z

Two-bits as a vowel:
0 1 2 3
a i o u
```

Fig. 1. Encoding bits as a proquint.

For example a numeric identifier 10 associated with some term in a given ontology would be translated to `babab-babap`, 11 would be translated to `babab-babar` by using proquint function which is quite readable, spellable and pronounceable string. In practice, if used to represent random numbers, the proquints would rarely be so close in alphabetic space. Note that proquints map directly to a single number, so can be freely converted in either direction, and that they are alphabetically ordered. Mappings between integer values are shown in Figure 2.

Integer	Equivalent string
0	”babab-babab”
1	”babab-babad”
2	”babab-babaf”
3	”babab-babag”
4	”babab-babah”
5	”babab-babaj”
Integer/MIN_VALUE	”mabab-babab”
Integer/MAX_VALUE	”luzuz-zuzuz”

Fig. 2. Integer to Proint(string).

In a simple extension, to the original algorithm, we have also provided conversions from the Java short and long data types which provides either a larger identifier space, or less typing; conversions are shown in Figure 3.

Short - Long	Equivalent string
0	”babab”
1	”babad”
2	”babaf”
0	”babab-babab-babab-babab”
1	”babab-babab-babab-babad”
Long/MIN_VALUE	”mabab-babab-babab-babab
Long/MAX_VALUE	”luzuz-zuzuz-zuzuz-zuzuz

Fig. 3. Short and Long Convertion.

We note that the short range at 2^{16} numbers is large enough for most ontologies current in operation. However, it is far too small when combined with randomness as due to the birthday problem is very likely to result in collisions even for small ontologies [1]. The long range, meanwhile at 2^{64} numbers is likely to cope for all ontological applications where the identifiers are allocated as a result of human action; it has half the bit-length of a UUID (which has a 2^{128} range).

Checking: We note that monotonic numeric ideas suffer from a final problem. As well as being unmnenomic, if a numeric ID is misunderstood, it is very likely that the incorrect ID is stil actually a valid one; for instance, OBI:0001440 (“all pairs design”) and OBI:0001404 (“genetic characteristics information”) are IDs which differ in one one number.

A solution to this problem is well-understood with the use of a checksum. For the identitas library, we use the Damm algorithm [5]. This algorithm is design to operate on numbers, but it will work on proquints also, as they can be converted to numbers. Examples of valid or invalid numbers are shown in Figure 4.

Random number	Validation True or False
5724	valid
231	invalid
0	valid
222	invalid

Fig. 4. Validating generated IDs

Of course, the Damm algorithm incorporates a checksum so reduces the total space of valid identifiers, in this case by an order of magnitude, which will have implications if combined with randomness. Under these circumstances, the larger numeric spaces (int or long) are likely to be necessary.

In this paper we present a critique of current ontology semantics-free identifiers; monotonically increasing numbers have a number of significant usability flaws which make them unsuitable as a default option, and we present a series of alternatives. We have provide an implementation of these alternatives which can be freely combined. We are now starting to integrate these into ontology development environments such as Tawny-OWL [3], and will later provide an implementation for Proteǵe´ This form of identifier space could significantly improve the management of ontologies with very little cost.

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