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CONCEPT, TYPES AND ASPECTS OF DISTINCTIVENESS

Not things are important, but the relations between them
E. T. Bell[1]

Summary

Distinctive means "differentiated, distinguished". However, what can be distinguished and in relation to what? In this article, we will think about the meaning of this concept – the types and scopes of various (defined, discussed and explained here) types of distinctiveness.

1. Introduction

The concept of distinctiveness has been present in Polish science for some time now. It occurs in different fields of science, however, in different meanings, in relation to different categories (objects, sets of objects, properties, sets of properties; it is discussed in different perspectives – between objects, between sets; within the entire universe or only in certain characteristic subset of a universe, etc.).

In order not to get lost in this tangle of meanings, which at the same time are often defined ambiguously, the need to provide a proper work that would systemise and unify everything arose. This work will serve to discuss the concept of distinctiveness ignoring its meaning in specific scientific fields, so eventually it is possible to describe this concept and all its properties in general terms.

The work presented here is important because so far the concept of distinctiveness as such has not been the subject of many publications (in Poland, in recent times, such works have been conducted in Poznan – see works [2], [3] and [4]), while the very concept (from the point of view of methodology of sciences) is extremely essential (because – as A. Grzegorczyk states – "general views concerning the entire reality (…) systemise knowledge and can facilitate further development"[2]).

In this work:

1) in § 2, methodology of reality description will be presented – description of sets, their elements as a whole and individually, with the use of properties, paying special attention to distinctive properties. Earlier results of the author will be presented without their wider explanation and justification,
2) in § 3, the dictionary definition of distinctiveness will be given and discussed, followed by the author's wide analysis of various aspects of this concept performed based on the definition,
3) finally, in § 4, the concept of distinctiveness discussed here will be considered with the use of recently popular OntoClean methodology.

2. Methodology of reality description

2.1. Description of objects of a specific set – distinctiveness of objects in a specific set

We deal with various kinds of sets in many fields of science. We are often interested in getting a *description* of such a set by obtaining such *characteristics* of all its objects which will allow for their distinction. We are achieving that by specifying the value of each element in such a set based on a proper number of correctly selected so-called *dimensions*. A dimension can have numerous *values* (e.g. in the case of "colour", it can be for example "red", "green", etc.), which makes it possible to

[1] After [1] page 226
[2] [5], page 23

guarantee unanimous division of the entire set (i.e. into many subsets). Sets of values for different dimensions do not have to be disjunctive, because such dimensions as “width” and “height” have numerical values, which in a given set of elements can turn out to be identical (i.e. width of one object can be equal to height of another object). Moreover, in our study, we assume that we are able to explicitly specify (empirically or based on the information obtained from a specialist in a given field) the value of every dimension of every object in a set used to describe this set (therefore, receiving its characteristics). Such a description of a discussed set (or characteristics of all its elements) allows us to explicitly describe (and at the same time specify) any object among all elements of a given set. This way every object is distinctive, i.e. distinguishable in a set (because it is different form other elements of the same set thanks to a collection of values of a particular dimension, which is characteristic = unique for this object in a specific set).

2.1.1. Selection of dichotomous dimensions to describe objects of a particular set

In this work, objects of a given set will be described only by means of a set of *dichotomous* dimensions, i.e. such which will allow us to divide the set into two subsets. Such a dimension is for example “black” (as compared to “object’s colour”) in which case the answer is either “yes” or “no”, and not the name of one of many colours (as in the case of the example in brackets). Therefore, confirming (expressed by either *yes, 1* or +) or negating (expressed by either *no, 0* or -) the statement expressed by its name is the value of a dichotomous dimension.

Such an approach does not prevent us from making descriptions, in which non-dichotomous dimensions appear, because every time we have to deal with such a kind of dimension we can replace it with a set of dichotomous dimensions. It can be usually done by using various methods. Due to methodological issues (data analysis, including research of correlations between different results) it is intentional to divide each non-dichotomous dimension into as many dichotomous dimensions as there are values of one dimension (e.g. based on the example above – specification of all possible colours). Therefore, if the initial dimension has a non-discrete number of potential results, or a discrete but large number of results, then it is intentional to firstly divide a specific and small number of intervals for the value results, and after that to carry out their dichotomisation.

2.1.2. Definitions and properties of distinctiveness used to describe objects of a particular set

In the article [4], based on the deliberations therein, series of definitions of dimensions and sets of dimensions were prepared in order to allow for the specification (defining or describing) of elements in a particular set. Because these issues have already been presented in the article (by the author of this work himself), we will restrict ourselves only to giving their definitions as well as properties and interrelations between the concepts introduced. The definitions are as follows:

For a particular set A of objects:

- *set of W_1 dimensions is I-type distinctive* (or simply distinctive), because it allows for unanimous division of elements of this set,
- *set of W_2 dimensions is II-type distinctive*, if it is I-type distinctive, and at the same does not have dimensions of constant value on A set elements (non-distinctive dimensions, i.e. irrelevant = insignificant),
- *set of W_3 dimensions is III-type distinctive*, when it is II-type distinctive and none of the dimensions can be deleted without reducing the distinctiveness between elements of this set,
- *set of W_4 dimensions is IV-type distinctive*, when it is III-type distinctive, and at the same time it has a minimum power among all III-type distinctive sets,
- *set of W_5 dimensions is V-type distinctive*, when it is the only set of IV-type distinctive dimensions (if no set of dimensions meets the requirement of being the only one, then the V-type distinctive set of dimensions does not exist),
- for 1 ≤ and ≤ 5, by $\mathscr{W}_i$ we will indicate a set of all sets (which have just been defined) of *i* type dimensions (where *i* is expressed with a Roman numeral).

On the other hand, among all dimensions defining the A set, *a single dimension is called distinctive:*

- *of I type*, when it is one of the dimensions of at least one III-type distinctive set (set of all I-type dimensions is expressed with the symbol C_1),

- *of II type*, when it is a dimension in every III-type distinctive set (set of all II-type dimensions is expressed with the symbol C_2),
- *of III type*, when it is one of the dimensions of at least one IV-type distinctive set (set of all III-type dimensions is expressed with the symbol C_3),
- *of IV type*, when it is a dimension in every IV-type distinctive set (set of all IV-type dimensions is expressed with the symbol C_4),
- *of V type*, when it is one of the dimensions of V-type set of dimensions (set of all V-type dimensions is expressed with the symbol C_5).

Straight from the definition of sets $\mathscr{W}_1$ – $\mathscr{W}_5$, we have received the following interrelation between these sets: $\mathscr{W}_5 \subset \mathscr{W}_4 \subset \mathscr{W}_3 \subset \mathscr{W}_2 \subset \mathscr{W}_1$. At the same time, for a non-empty set A, sets $\mathscr{W}_1$ – $\mathscr{W}_4$ are non-empty, and set $\mathscr{W}_5$ is non-empty in a special case (specified by the conditions from $\mathscr{W}_5$ set definition).

As far as a general interrelation between sets of dimensions of particular types is concerned (that is C_1 – C_5 sets), directly from their definitions we obtain the following interrelations between these sets: $C_4 \subset C_3$ and $C_2 \subset C_1$.

2.2. Description of objects and sets of objects

As in § 2.1, when describing objects of a set and dealing with dimensions and their values, we will talk about properties of objects and sets when describing them. So as not to describe the concept of distinctiveness here, we will conduct our research in the following order:

- we will begin with distinguishing a general name from an individual name,
- then, we will define the concept of *object distinctiveness,*
- then, we will deal with the issue of proper definition of a set (expressed as a general name),
- then, we will define the concept of name content,
- finally, based on the results obtained so far, we will define the concept of *distinctiveness of a set of objects.*

2.2.1. Individual names and general names

We distinguish individual names and general names. *Individual names* are names given to particular, specific and individual items. On the other hand, *general names* are names which we give to items due to the properties an object possess, even if there is only one such object or even if no object with the particular set of properties exists.

2.2.2. Distinctiveness of objects

Let us think for a moment when we are able to say that a specific object in a specific universe is *distinctive.* We assume that it is possible when it is distinguished by one of its properties, i.e. when it has a particular property, which other objects in the same universe do not have, and the property is both significant and explicit in the given universe (e.g. black sheep among the remaining white sheep in a flock). We need to pay attention to the fact that we are not relating to the name of this object, because (as we have already said above) it has no significant meaning in this case. It is worth noticing that the concept of distinctiveness of objects in a given universe defined in such a way is compatible with our intuition when we say or think that a given object is distinctive in this universe due to a particular property (which it has in comparison to other objects of the same universe).

2.2.3. Description of a set of objects

To describe a set of objects means to provide such criteria (properties of this set), which define it and make it distinctive in a given universe.

Let us take a look at universe U with objects and a set of properties C defining them. We say that *set* $A \subset U$ *is well-definable* only when there exists such a set of properties C which allows for distinction of such values (due to the fact that they are dichotomous properties, i.e. positive or negative properties), and that the set of all objects which have the properties specifies this particular set A. If a given set cannot be defined, it is *not definable well,* and its distinction from the universe is artificial and not compatible with the syntactics of definition of these objects.

The concept of good definability is important because thanks to it, sets of objects forming a particular category are defined, and it is possible to give them a common general name due to a certain set of properties they possess. Therefore, with the use of properties, sets specifying concepts are described by means of general names.

General names describe all items possessing a particular and defined set of properties. This definition is not entirely precise due to homonyms and synonyms. If we have a defined set of properties, then objects which possess such properties can be given many synonymous names. The name we select is not important now. We simply have to decide on one name which we want to use. If we have a specific general name then – due to homonyms – it can relate to objects with different sets of common properties. That is why in this research we decide on one of them and we will use "given" or "particular".

By the expression *scope of a general name,* we mean a set of all objects – its referents to a given meaning. On the other hand, *general name content* (or its *meaning* or *connotation)* will mean such a set of property values which defines the scope of the name (that has just been defined). General name content is established by a well-definable set (scope of its name).

Every object with a given general name has usually many properties assigned to all objects with the same name and given meaning. Every object has the properties and only such an object has all the properties. All the properties are called *full content* of the given general name.

It is possible that the omission of some of the properties will not affect the scope of the name at all. Then, the reduced full content will form the so-called *characteristic content of the name* (sometimes referred to as *connotation).* The properties forming the content are called *characteristic properties*, while the properties complementing the full content – *accidental properties.* In other words, characteristic content of a given name is formed by such properties (characteristic) which are enough to explicitly define the referents of the name. Selection of the properties is not unambiguous. The set of accidental properties is not defined easily either (however, with defined characteristic content, it is explicitly set by the content).

A *non-pleonastic set* is a set in which none of the characteristic properties can be deleted in order to be able to define / specify the same general name with the use of the remaining properties. A set of characteristic properties of a name optimised to a non-pleonastic set is called *constitutive content* of the name, and the properties included in the set are *constitutive properties.* Remaining properties common to all referents of a given name are called *consecutive properties.* Similarly to the situation above, selection of constitutive properties is not unambiguous, but a given set of constitutive properties always and in an explicit way defines a set of consecutive properties. Similarly to the situation when a set of characteristic properties of a given name is enough to explicitly define referents of the name, a set of consecutive properties of a given name is enough to explicitly define referents of this name (which means that none of the properties can be deleted from the content of a consecutive name without changing its scope). Ambiguity of selecting a set of consecutive properties can result in a fact that it can have different power in particular cases.

In [6], under the expression "Characteristic property (content)", we read[3]:

> *Consecutive content consists of only <u>significant</u> characteristic properties, i.e. the <u>relevant ones</u>, e.g. the consecutive content of the name square are such properties as rectangularity and being equilateral; the consecutive content of the name phoneme are the <u>distinctive properties</u> of sounds.*
>
> [underlined by the author – W.L.]

Therefore: consecutive property = relevant (significant) property = distinctive property.

The expression "significant" used here can be approached in the following ways:

- semantically – then the properties have to be significant due to a superior reason (e.g. as easily noticeable, tangible, or verifiable),
- or syntactically – then the properties are significant due to a distinction of a given class of objects in a system.

The condition of syntacticity above is necessary, while the condition of semanticity is only desired.

Therefore, distinctive properties are consecutive properties. Their conjunction is necessary and enough to define an expression of general name. When doing so, all properties are necessary (i.e.

[3] [6], page 82

removing any of the properties will cause inadequacy of this expression's definition). However, the set of properties is not defined explicitly, and as a consequence – neither is its power.

The special case of constitutive content is lexical / dictionary content or linguistic content:

- first of the above terms (*lexical / dictionary content*) refers to the fact that such name content consists of the properties which are used in the explanation of a lexical / dictionary definition (putting simply, the part defining the meaning of a given name),
- the second of the above terms *(linguistic content)* consists of the properties which are enough for a person using a given name correctly to identify its referent, irrespective of his/her level of knowledge [4] (i.e. a user identifies this referent based on its basic properties, not based on any specific knowledge about it – e.g. a square is not identified as a tetragon with a maximum area taking particular circumference into account, but as a tetragon with equal sides and right angles).

Obviously, both definitions (equivalent) describe the same situation but from a different perspective.

The above consideration concerning name's content can be shortly described using the scheme below:

<table>
<tr><td colspan="2">Name's full content – set of all properties common to all its referents</td></tr>
<tr><td>Name's characteristic content – set of characteristic properties
(enough to explicitly define the name;
can be pleonastic)</td><td>Other properties:
accidental properties</td></tr>
<tr><td>Name's consecutive content (=connotation of the name) – set of characteristic properties (enough to explicitly define the name; characteristic but not pleonastic properties; in other words: relevant, distinctive properties)</td><td>Other properties:
consecutive properties</td></tr>
<tr><td>Special case: linguistic content,
in other words: lexical / dictionary content</td><td></td></tr>
</table>

Similarly to § 2.1, where distinctive properties served to DIFFERENTIATE (elements of a set), here – distinctive properties serve to DISTINGUISH (as set from a universe), and in the special case (described in § 2.2.1) - distinguish a 1-element set (according to the explanation given) identified with this object.

2.3. Summary

We can talk about distinctiveness in relation to properties (or dimensions), their sets, elements of sets and sets of elements. It results in many definitions of the same term; however, they correlate closely with each other. An element is distinctive in a given set only if it has a property in it. A distinctive property is both a relevant (significant) property as well as constitutive. Based on distinctive dimensions, elements of a set are distinguished, and based on distinctive properties, a set is distinguished from a universe (then, we talk about distinctiveness correlated with good definability of a set). Optimisation of distinctive properties of a set is the aim – both in quantitative as well as qualitative terms (linguistic content).

3. Analysis of dictionary definition of the term distinctiveness and theoretical considerations on distinctiveness

Internet "Dictionary of foreign languages" (at: http://swo.pwn.pl/haslo.php ?id=6526, December 2006) gives the following definition:

distinctive
differentiated, distinguished
ling. ***distinctive property*** *property necessary to identify a linguistic unit*
<Eng. distinctive, Fr. distinctif>

[4] after [6], page 613 – term: content (of a name, expression)

Therefore, two meanings of the word “distinctive” are provided:

1) *differentiated,*
2) *distinguished,*

as well as:

3) the use most often associated with the word:
   ling. ***distinctive property*** *property necessary to identify a linguistic unit.*
4) the dictionary signals that the word is an international word (it is spelt similarly in different natural languages).

Because the above definition states that a distinctive property is necessary for identification of a linguistic unit, and a single element (sound) or a set of such elements (phoneme – sound class) can be such a unit, then we can conclude that <u>distinctiveness – besides properties – refers to both single objects and their sets.</u> A set (in this case a phoneme) is “of system origin”, i.e. it is specified by a particular property or conjunction of particular properties of discussed objects (in the case of a phoneme it is connected with the conjunction with additional conditions).

In this situation, we can decide on the following:

1) to provide a distinction of this set from the entire universe – we deal with a description of a set of elements then,
2) to distinguish particular (individual) elements of this set, and the ability to distinguish every element allows us to automatically distinguish them against one another within the confines of a given universe.

This way:

	Distinctiveness can refer to	then we talk about
1.	properties	distinctiveness of properties
2.	a set of objects distinguished by them (this set is treated as a whole, which needs to be described /distinguished/ in the context of the entire universe)	distinctiveness of a set of objects
3.	elements of a set distinguished in this way (in order to allow for distinction between each other)	distinctiveness of objects of sets

Below, we will deal with all of the three references of distinctiveness (they are identical with the ones specified in the previous paragraph, however, now we will not refer to a methodological description of reality, but only to the structure of such a description). Individual reference to the issue described in § 2.2.1 will be an exception (in § 3.3) here.

3.1. Primary (fundamental) distinctiveness of properties and sets of objects

a) distinctiveness of properties (issue I)

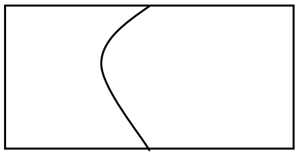
If we have a given defined universe of objects U and a particular property C which distinguishes set A of objects possessing the property in this universe (or symmetrically: not possessing it), then:

1) if the property is assigned to every (or is not assigned to any) object in the set U, it does not divide it;
2) if the property is assigned to only a part of the elements in this set (i.e. part of the elements possess it, the remaining - do not), then the property divides the set into two subsets and we can call it *distinctive*, because it DIFFERENTIATED the two subsets from each other);
3) if – as in the case above – the property is assigned to only a part of the elements in the set (i.e. part of the elements possess it, the remaining - do not), but the subset A of the entire set U created by the property does not refer to the remaining part of the set (U\A), but to the entire set U – then we can call this property *distinctive*, because it DISTINGUISHES this subset against the entire set of objects.

These situations are presented in the below scheme, in which (by analogy as in the text above):
U – means the discussed universe,
A – means a set of objects possessing a particular property C.

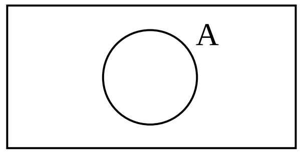
U (U=A or U=A’)

Situation 1:
non-distinctive;
lack of distinction of elements from set U by property C



U A

Situation 2:
distinctive – “differentiation”;
division of U set, lack of preferences for any of the subsets



U

Situation 3:
distinctive – “distinction”;
division of set U, preferences for set A in the entire set

This way, for the second time in this article, we distinguish terms specifying distinctiveness: differentiation and distinction (for the first time in § 2.2).

b) distinctiveness of objects (issue II)

Above, we have discussed distinctiveness of properties. Distinctive properties make the sets defined by them distinctive. In the situation 2 above – not only is the property C distinctive, but *also every subset created by this property is distinctive* (A and U\A), because we can DIFFERENTIATE them with the use of properties. On the other hand, in the situation 3 above – not only the property C but also *the subset A is distinctive*, because it is DISTINGUISHED by the property C from the universe U.

3.2. Comprehensive distinctiveness of properties and sets of objects

When operating with dichotomous properties (i.e. binary ones), we are able to make dichotomous (binary) divisions of sets (if they are distinctive, we deal with situations 2 or 3, if not – with situation 1). Wanting to divide a universe into more than 2 subsets, we need to use a larger number of such properties (each of distinctive character). When analysing the situation from another perspective, we will say that the properties (jointly!) DISCRIMINATE particular subsets of a researched universe. Then, we will also be talking about *distinctiveness*, however, not of particular properties, but of a given set of properties (because thanks to them those subsets are discriminated between each other). This way we have a new aspect of distinctiveness (besides differentiation and distinction) – *discrimination*. It is different from the other two aspects by being definable only by many dichotomous properties. It is also possible to use this aspect in operations on more than two subsets of a universe.

Selection of distinctive properties, as a matter of fact, always comes down to specifying the smallest set of such properties. Researching this matter can start by specifying such properties (defining properties to describe a set of objects), which the recommendations below prove:

<u>Recommendation 1</u>

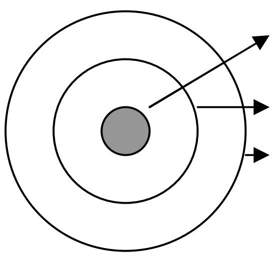
When describing a set of objects, identical properties (being a man / being a man) equivalent to (being a man / being a representative of homo sapiens species) or complementing (being a man / not being a man) can always be reduced to only one (random) property.

On the other hand, if we want to describe a given set, it is natural to use the following recommendation, which allows for reduction of the properties describing it:

<u>Recommendation 2</u>

If particular two properties participate in a description of a given set of objects, and one of them covers the set in a wider scope than the other property – then any of them (as excessive) can be deleted from the description of this set; obviously, it is optimum if the property of narrower scope is taken into account.

This situation is presented in the picture below.



3.3. Mutual discrimination of elements of a given set

By analogy to the paragraph above, when we were able to discriminate sets by means of distinctive property, we can discriminate single objects as well. However, when doing so, we need to be very careful. Due to the remarks in § 2.2.1, properties of specific elements, having their own names, are not assigned to them because of these names, as was the case with general names whose referents were well-definable sets. Based on that, these objects need to be researched both systematically as well as "individually", and the properties assigned to them should be specified in the same way. Therefore, if we have for example a set of given fruit, then the systematic properties will be connected with the kind of fruit we are dealing with (e.g. dichotomous property of having a pear-like shape), while "individual" properties will serve to discriminate fruit of a given kind (e.g. being bruised, being maggoty, being dirty, etc.). Obviously, such "individual" properties refer to the elements of this specific set and at a given moment (dirt can be washed, hard fruit can become softer).

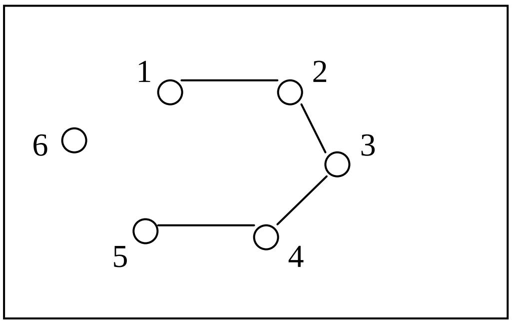
We still need to address the issue of reducing properties to strictly distinctive ones (i.e. properties which are included in the distinctive set of III-type set of dimensions defined in § 2.1.2).

1) The first easily noticeable thing is the fact that recommendations analogous to the ones given in the previous paragraph are used to discriminate elements of a given set.

2) Secondly, we need to pay attention to the term correlational property. Based on [6][5], *correlational property* is such a distinctive property which is the only one discriminating two objects. Intuitively, it seems obvious that when describing a set of objects by means of a strictly distinctive property, every element has its own property discriminating it from other elements, i.e. the correlational property. However, it is not the case, which can be proved by the below counterexample:

3)

		Properties			
		A	B	C	D
Objects	1	1	0	1	1
	2	1	0	0	1
	3	1	1	0	1
	4	1	1	0	0
	5	0	1	0	0
	6	0	1	1	1



In the example above (table on the left), all the properties are necessary (they are strictly distinctive) – deletion of any of them would cause that discrimination of certain two objects out of six would become impossible (they would be defined identically). In this case, every object is discriminated by one property against at least one of the remaining objects, except for object 6, which is discriminated by at least two properties from any of the remaining objects (the scheme of discriminating by only property has been presented on the right.

3.4. Discrimination of sets and discrimination of elements in a set

This problem has already been addressed at the beginning of the previous paragraph. Adding to what we have learned so far, we will look at the situation presented there from another perspective. Discrimination of elements in a set can be identified with discrimination of 1-element sets, however, after prior identification of these 1-element sets with their elements. Then, the properties assigned to all elements of a given 1-element set are identical with the properties assigned to the only element of this set.

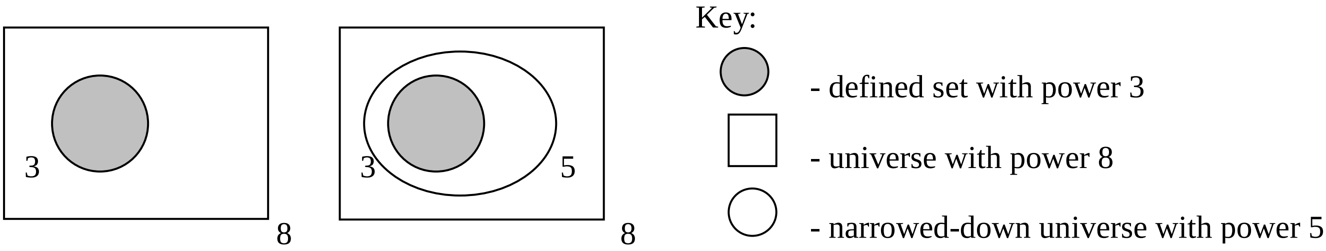
This situation has a specific character when we are selecting two elements from a particular universe, because we can treat it as a selection of these two elements and at the same time as a selection of two 1-element sets. The peculiar specificity refers to the fact that, in such a situation, we can talk about "classic" terms of distinctiveness definition: differentiation and distinction (see

[5] [6], page 82

beginning of this chapter), because they relate to a dichotomous division (in this case, of a 2-element set into two elements).

3.5. Additional remarks concerning a narrowed-down universe

Defining sets on the entire universe (as in the picture below on the left) usually differs from defining on a certain narrowing-down (as in the picture below on the right).



It may be easier to define a given set on a narrowed-down universe. If such a narrowing-down is an indication of an imperative expression specified by a genus proximum property, then – in order to define it – it is enough to simply indicate a differentia specifica property. Instead of “differentiation” or “distinction”, the word “define” has been used on purpose because the expressions "genus proximum" and "differentia specifica" refer to it.

3.6. Summary

Distinctive means differentiated, distinguished and (not included in the dictionary) discriminated. Which of the expressions one needs to use depends on how many properties we are using in a certain situation (one or more), if the operations concern elements or sets, and what the relation of results of this operation is: coordinated (we talk about discrimination) or imperative (we talk about differentiation). We are interested in the reduction of distinctive properties (the matter of optimisation!). Doing so we can use certain (given here) recommendations, however, we can also come across specific restrictions (such as for example inability to select correlational distinctive properties in some cases). In spite of the fact that elements are not separated by names due to their properties, we can still describe them without any problems according to (at a given moment) the properties assigned to them, and through that, discriminate them between one another.

4. Concept of distinctiveness from the point of view of OntoClean methodology

OntoClean is a methodology for analyzing ontologies based on formal, domain-independent properties of classes (the metaproperties) due to Nicola Guarino and Chris Welty. The methodology has been developing since 2000 as the first attempt to formalize notions of ontological analysis for information systems.[6] In this situation, it is purposeful to examine and describe the concept of distinctiveness from the point of view of this methodology as well.

In order to do so, let us look at the example below.

		Properties					
		A	B	C	D	E	
Objects (form set X)	1	0	0	0	1	0	set Z
	2	0	0	1	1	1	set Y
	3	0	0	1	1	0	
	4	0	0	1	0	0	
	5	0	1	1	1	0	set Z’
	6	0	1	0	0	0	
	7	0	1	0	1	0	

[6] Quotation after http://en.wikipedia.org/wiki/Ontoclean

Objects 2 – 4 form a well-defined set Y by conjunction of properties B=0 and C=1 on the objects of set X. The very set X has a common for all its elements property A=0, which (as we can conclude) distinguishes it from a wider universe U (all elements from U\X will have A=1). Although, as has been given above, in the universe limited to the set X, set Y is specified by properties B=0 and C=1, in order to separate it from the entire universe, their conjunction with the condition A=o is also essential.

Besides the constant property in set X A=0, all other properties in it serve to discriminate elements. Among them, properties B and C additionally distinguish set Y, where other properties (D and E) serve to discriminate objects.

We need to compare this example to the contents which recommendations of two sentences (definitions of 2 terms establishing relations between them) have [8][7]:

> *Rule of common analogy* states that “any two things considered on a proper but the same level of accuracy must be similar to one another taking many significant differences are concerned, because they are parts of the same system reality”. (…) Obviously, in order not to disturb the balance, such thinking should be compensated by simultaneous acceptance of complementary *rule of common difference*, which states that “any two parts of the same whole must differ from each other as regards certain significant reasons”.

Both these rules are present in the above example. All objects of set X are similar because they have the identical property A=0, and elements of set Y in set X are similar due to the same properties B=0 and C=1 (by conjunction of these properties, set Y has been distinguished from set X). On the other hand, elements of set Y differ due to properties D and E (these properties differentiate / discriminate these objects in set Y).

This way, set X – through property A=0 – is well defined in a certain universe U (distinctive towards set U\X), which also makes property A distinctive. By analogy, set Y – through properties B=0 and C=1 – is well defined in set X (distinctive in relation to elements of set X\Y), which also makes properties B and C distinctive. In this case, we talk about *“distinguishing”* distinctiveness (of both sets X and Y, as well as all the properties mentioned). In OntoClean, such well-defined sets are called “sortals”. The formal definition of this term is as follows: A sortal is a class all of whose instances are identified in the same way.[8] In OntoClean having a particular property means being an elements specified by it, which implies that objects forming a given class must have at least one common property. Having identical values of certain properties of all objects of a given sortal determines their identity in this scope.

On the other hand – in the considered example – in set X, properties B, C, D and E *discriminate* its elements, and in set Y – properties D and E serve this purpose. Therefore, properties D and E play another distinctive function (discriminating) than compared to properties B and C described in the previous paragraph (distinguishing in set Y).

However, it is possible to distinguish sets to allow for their *discrimination between each other*. Again, distinctive properties will serve the said distinctive function here. This way, in our example, sets differ from one another by means of pairs:

- set Y is distinguished from X by conjunction of properties B=0 and C=1,
- set Z is distinguished from X by conjunction of properties B=0 and C=0,
- set Z’ is distinguished from X by property B=1.

Therefore (in this case), we have made an additional division of set X into 3 subsets.

In the three paragraphs above, we deal with the change of function of distinctive properties as far as the level of relation of these properties is concerned:

1) Constant properties on elements of sets distinguish these sets from a given universe (in the example above: property A=0 distinguishes set X from universe U), or distinguish them from a given set (in the example above: properties B=0 and C=1 distinguish set Y from set X). For these properties, their distinctiveness means that they are constant in given sets. However, if we want them to be distinctive, i.e. differentiate these sets, they cannot be constant in the entire universe. On the other hand, this being constant on a set specified by them causes that they do not allow for discrimination of elements of this set.

[7] [8], page 32
[8] Quotation after http://en.wikipedia.org/wiki/Ontoclean

2) In turn, properties discriminating elements in a given set must also differ (in order to be distinctive for elements of this set), however, it also required that they should be “constant” – invariable; otherwise, they would make these objects identical on these properties.
   In § 3.4 (when discriminating elements of a given set), it was required that in order to discriminate elements of a set we need to use system properties first, followed by individual properties if it is not possible to make a division of the set into single elements. We do so because individual properties refer to elements of a given set, at a given moment, and we want them to be constant (as in the case of system properties). Therefore, we are interested in using as many system properties as possible, and as few individual properties as possible, or in using no individual properties at all.
3) Analogous remarks which were presented in point 1) concern the issue of discrimination of sets (discusses in the previous paragraph).

However, on each of the levels we deal with the requirement that distinctive properties should be constant.

In the example considered above, all the remaining properties in set X, except for A, are necessary to discriminate all the seven elements. However, it does not have to be the case all the time. Usually we have a certain number of excessive properties, which can be deleted without reducing the possibility to discriminate object of a given set. When selecting them (taking optimisation into account), we will also try to choose the properties which are both <u>significant</u> and <u>explicit</u> in a given universe (we have already discussed it when describing distinctiveness of objects in § 2.2.2).

Analogous properties, which define a certain set, can also be optimised, but this time it is required (as in § 2.3 when defining set of objects) that only <u>significant</u> distinctive properties are left, which means:

- semantically – the properties have to be significant due to a superior reason (e.g. as easily noticeable, tangible, or verifiable),
- syntactically – the properties must be significant due to a distinction of a given class of objects in a system.

Jointly, we can say that at a given level a distinctive property must always be absolute (constant), relevant (significant), contrastive (characteristic) and objective (condition which does not need to be commented on).

Below – in the second part of this paragraph – we will demonstrate that the conditions correlate with the OntoClean requirements.

Identity

The most important concept in OntoClean is “identity”. Identity serves / refers to distinguish / discriminate units (objects or their sets) as identical or different. It is made by a certain number of <u>basic</u> properties (distinctive – discriminating). All the objects which have an identical set of values and thus belong to the same class of objects are identical. The criteria defining a class of objects should be <u>semantically significant</u> – they should allow for easy differentiation of one set from other sets (or make it possible to distinguish it from other objects). The criteria should indicate that they are the basis for a given class of objects. A widely presented condition of identity is compatible with the requirements of OntoClean methodology.

Moreover, this methodology assumes that it is possible to belong to different classes at the same time, because the classes can be established based on conjunction of various properties. Distinctive properties meet this requirement as well – in our example, object 6 belongs to {6,7} class due to conjunction of properties B=1 and C=0, and at the same time to {4,6} class due to property D=0.

Unity

Another concept discussed in OntoClean is “unity”. It indicates that all objects of a given set must form a whole, therefore must be in a certain relation towards other parts of this set (and not only a part of a mereological sum). Unity allows for identification what an object’s part is and how it creates a system unity.

Distinctive properties meet this condition, because they indicate parts of an object (set) – discriminate them as well as distinguish this set from a wider universe (as a well defined set it forms a sortal, which we have discussed in the first part of this paragraph).

Essence & rigidity

The other two main concepts present in OntoClean are "essence" and "rigidity". Essence means essential association of a given property to defined objects (irrespective of the flow of time). It is necessary for an object to be what it is (a sponge is not hard throughout its entire existence, while a hammer is!). Essence is what a given object MUST ALWAYS have. It is a very categorical requirement. If we require this property from all objects of a given set, then we talk about rigidity. In other words, rigidity takes place when essence is present for all objects of a discussed set. An additional condition is used at the same time to make rigidity relate only to significant properties. It means that the property is significant only if it is invariable (in other words, the expressions "be significant" and "be invariable" are positively correlated).

In OntoClean, only properties such as rigidity can be involved in identity. In the first part of this paragraph (in point 2 when describing identity), we have showed that we strive to obtain such results in the case of distinctive properties. In OntoClean, it is required to consider properties rigid – resistant to individual changes, and in the fragment above we have ascertained that when describing elements of a set we strive to use only system properties, therefore, not to use individual properties at all.

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Three texts from the Internet used when compiling this work:

1. http://super-women.blog.pl/ (December 2006)
2. http://www.pedagogium.pop.pl/logika-nazwy.htm (December 2006)
3. http://en.wikipedia.org/wiki/Ontoclean (December 2007)