Radicals as Ontologies: Concept Derivation and Knowledge Representation of Four-Hoofed Mammals as Semantic Symbols

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Research on linguistic ontology can shed light on how human beings conceptualize as well as provide powerful tools for knowledge engineering. We show in this paper that the linguistic ontology of Chinese is conventionalized by the radical/semantic symbol of its writing system and a study of this conventionalized system leads to many interesting theoretical discoveries. The *Shuowen Jiezi* (Xu Shen 121), the oldest preserved dictionary of Chinese, is organized according to the radical forms as semantic symbols. Our hypothesis is that for characters sharing the same radical, their meanings must be related to the basic concept of the semantic symbol in a systemic way. In this current research, we focus on the small semantic field of four-hoofed mammals: 羊 ‘caprid’, 鹿 ‘cervid’, 牛 ‘bovine’ and 马 ‘equine’. We describe the relations between the derived characters and each basic concept to construct a conventionalized ontology, headed by basic concepts expressed by the semantic symbols. Our analysis of the semantic symbol ontologies for these four-hoofed mammals shows that they have similar conceptual structures, which are strongly motivated by their functions in human society. In particular, we show that the conceptual dependencies between the basic concept of a radical and the meanings of the derived characters can be explained by an enriched version of the generative lexicon.

Key words: ontology, radical, generative lexicon

1. Introduction

The system of radicals (yìfú, often directly translated as ‘semantic symbols’) in the Chinese writing system offers a unique opportunity for a systematic and comprehensive comparison between formal and linguistic ontologies. Previous studies adopt either a WordNet-based representation (Wong & Pala 2002, and Hsieh 2006) or a SUMO (The Suggested Upper Merged Ontology)-based mapping (Chou 2005). In one study, Chou & Huang (2010) suggest that the family of Chinese characters sharing the same radical can be linked to a basic concept by qualia relations, as formalized in Pustejovsky’s
(1995) generative lexicon theory based on the original definitions of Aristotle. The four original qualia aspects which form the basis of our analysis are formal, constitutive, agentive, and telic. This approach has great implications of accounts for radicals as a linguistically conventionalized ontology. In this paper, we take this approach further and try to account for each group of words sharing the same radical as representing a domain ontology headed by one basic concept. In particular, we examine in detail four animal radicals: 羊 (yáng, CAPRID), 麂 (lù, CERVID), 牛 (niú, BOVINE) and 馬 (mǎ, EQUINE). Among these four animals, 羊, 牛, and 馬 are domesticated and serve specific functions in human society. They are highly related to the daily lives of human beings. One interesting research issue is to see if the derived concepts of these four animal radicals reflect the differences in interaction between the various animals and human.

In this paper, it is crucial to differentiate between the distinct denotations of three related terms: radical, semantic symbol, and basic concept. By radical, we refer to the form-meaning pair that serves as the essential component of the Chinese writing system. The form of a radical is the semantic symbol, while the meaning is the basic concept. In Saussure’s terms, the basic concept is the signified, the semantic symbol is the signifier, while the radical is the sign composed of both the signifier and the signified. It is important to note that the difference between radicals and semantic symbols is not well conventionalized and they are often used interchangeably. However, for our study, such a difference is crucial.

Our theoretical foundation is Pustejovsky’s (1995) qualia structure, while we refer to the Shuowen Jiezi 説文解字 (Xu Shen, 121 CE) as empirical evidence for our analyses whenever possible. In the Shuowen Jiezi, Chinese characters are classified into 540 radicals according to the editor Xu Shen’s ideas. In this study, we assume that each radical represents a basic concept and that all derived characters are conceptually dependent on that basic concept. Our study aims at accounting for the exact nature of these conceptual dependencies. Combined with previous work, we suggest that conceptual extensions from the basic concept encoded by a radical can be classified into seven main types: formal, constitutive, telic, participant, participating, descriptive (static/active) and agentive.

2. From Hantology to radical-driven ontologies

Our research relies crucially on the accessibility of HANTOLOGY (Chou 2005, and Chou & Huang 2010), which allows us to search for characters according to radicals or ontological concepts. HANTOLOGY is a system expressing the relation of HANZI and meaning clusters (http://hantology.sinica.edu.tw). Our radical-driven ontology system extended the basic structure of HANTOLOGY, which maps the meanings of 540 radicals
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in *Shuowen Jiezi* with IEEE SUMO. We use the results from analyzing derivative concepts to construct an ontology for each radical. Our current working interface allows easy querying of the existing database as well as recording of new entries.

### 2.1 Matching radical with ontological concepts

The radical-concept map in Hantology can be retrieved in two ways:

(i) Search the SUMO concepts classification. Choose a SUMO concept, and then this concept and its lower SUMO concepts will show up on the interface.

(ii) Search by semantic symbols, the form of radicals. Key in a radical form, and users can get the data of that radical directly.

![Figure 1: Radical search in the semantic ontology system](image-url)

### 2.2 Basic concept

We consult the definitions of each radical in the *Shuowen Jiezi* and analyze the meanings of the characters derived from the same radical to posit the basic concept for each radical. In addition to being compatible with the meaning defined in the *Shuowen Jiezi*, we also expect that the meanings of all derived characters must be derivable with a small set of semantic relations from this basic concept. For example, the basic concept of 羊 is ‘mammal with hoofs’. This interpretation of the radical system allows for the possibility that the concept represented by the semantic symbol differs from the concept it stands for as an independent character. This possibility will be well supported and illustrated by the examples discussed later in this paper.
2.3 Description of concept derivation

Based on the definition in the *Shuowen Jiezi*, we attempt to discover generalizations of the relationship between the meanings of derived characters and the basic concept of a radical. We use Pustejovsky’s qualia structure as our framework and add new relations only when the analysis based on the definitions in the *Shuowen Jiezi*, cannot be satisfactorily characterized. The result is that the concept derivation of HANZI radicals falls under seven categories, expanded from the original four qualia aspects, i.e. formal, constitutive, agentive, and telic:

(i) Formal: related by *kind of* relation and can be further divided into five sub-categories: ‘sense’, ‘material’, ‘characteristic’, ‘proper name’ and ‘atypical’. The ‘sense’ category can be further divided into five sub-categories: ‘sight’, ‘hearing’, ‘touch’, ‘smell’, and ‘taste’.
(ii) Constitutive: related by *part of* relation and can be further divided into three sub-categories: ‘part’, ‘member’, and ‘group’.
(iii) Telic: meaning of a character related to the basic concept in terms of function or usage.
(iv) Participant: a character is classified into this category when its meaning as defined in the *Shuowen Jiezi* refers to the basic concept as a participant involved in a specific event.
(v) Event participating: according to different events, concepts are divided into six smaller categories: ‘action’, ‘state’, ‘purpose’, ‘function’, ‘tool’, and ‘other’. This category differs from the category of ‘participants’ in that the concepts refer to a (sub-) event and not to a participant. The concepts of this category describe the properties of the events referred to, but do not refer directly to proper sub-events or participants.
(vi) Descriptive: the concepts of this category are related by broad descriptions which do not refer to a specific event and can be further divided into two categories: ‘active’ and ‘static’ according to the target of description.
(vii) Agentive: the meaning of the character is related to the basic concept by virtue of how it comes into being (e.g. being born or being produced).

2.4 Concept derivation with multiple concepts

We discovered that a character meaning can be derived from more than one basic concept, in a way different from the traditional category of *huiyi* 會意 ‘meaning association’, where meaning is established through the inference of a relation. In other words, a character may contain more than one semantic symbol. Under ‘telic’ and
‘participating’, we add a column for ‘related semantic symbol’ to show and link the related derivation concepts. For example, the character 羌 is explained as ‘西戎羊穜人也’ (‘people of Xirong who herd CAPRIDS’ (goats/sheep)) and involves two basic concepts that are represented in the character: CAPRID and HUMAN, since the Chinese character form of 羌 contains both 羊 (CAPRID) and 人 (HUMAN). Our ontology system links 羌 with its related semantic symbol 人 to offer cross-referencing in order to build a more realistic ontology of the conceptual convention.

Figure 2: The classification of HANZI semantic symbols
3. Domain ontologies of four-hoofed animals as conventionalized by radicals

Among the 540 radicals of the Shuowen Jiezi, there are 12 radicals representing hoofed mammals, 5 with sizable domains, still productive in Modern Chinese, and 7 with very small or 'single element' domains, not used productively any more.

Table 1: List of radicals related to hoofed mammals in the SWJZ

<table>
<thead>
<tr>
<th>Radical</th>
<th>SW-Rad. No.</th>
<th>Derived Hanzi in SWJZ¹</th>
<th>Zoological kinds represented in the SW²</th>
<th>Corresponding radical No. in Kangxi Zidian (1715)</th>
</tr>
</thead>
<tbody>
<tr>
<td>马 mǎ</td>
<td>370</td>
<td>Det. 115+8</td>
<td>7</td>
<td>187</td>
</tr>
<tr>
<td>牛 niú</td>
<td>19</td>
<td>Det. 45+1</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>犛 lí, máo</td>
<td>20</td>
<td>Rad. 3+1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>奴 sì</td>
<td>367</td>
<td>P 1+1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>犰 sì</td>
<td>114</td>
<td>Det. 26+2</td>
<td>19</td>
<td>123</td>
</tr>
<tr>
<td>叡 huán</td>
<td>376</td>
<td>P(?) 1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>豕 shǐ</td>
<td>362</td>
<td>Det. 22+1</td>
<td>12</td>
<td>152</td>
</tr>
<tr>
<td>豚 yì</td>
<td>363</td>
<td>Det. 5+5</td>
<td>1</td>
<td>153</td>
</tr>
<tr>
<td>嘎 jī</td>
<td>364</td>
<td>Rad. 5</td>
<td>-</td>
<td>58</td>
</tr>
<tr>
<td>潼 tún</td>
<td>365</td>
<td>2+1</td>
<td>S</td>
<td>-</td>
</tr>
<tr>
<td>驢 lù</td>
<td>372</td>
<td>Det. 26+6</td>
<td>14</td>
<td>198</td>
</tr>
<tr>
<td>豆 zhǐ</td>
<td>371</td>
<td>Rad. 4+2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The five important basic concepts represented by the radicals above are EQUINE (mǎ 马), BOVINE (niú 牛), CAPRID, i.e. sheep or goat (yáng 羊), PORCINE (and boar) (shǐ 獬) and CERVID (lù 鹿). The minor domains represented are unicorn (zhǐ 豆); rhinoceros (sì 奴), yak (lí, máo 犛), mountain CAPRID (huán 叡), wild boar (yì 豬), and young pig (tún 潼).

¹ We would like to thank an anonymous reviewer for providing the complete table and for agreeing to let us include this table in our paper. Any remaining errors are our own.
² As according to Guo, Needham & Cheng (1999:119-120).
In our study, we deal with four of the five productive radicals representing hoofed animals. As pig/boar (shǐ 豨) plays a central role in the domestic life of Chinese, we intend to deal with it separately. Our study involves the classification of the relation between character meanings and the basic concepts of characters as well as a subsequent generalization of the domain ontology after all conceptual relations have been mapped.

3.1 CAPRID domain ontology conventionalized by the radical 羊

The basic concept of 羊 derives a range of character meanings in only five relations, namely ‘formal’, ‘participating’, ‘constitutive’, ‘agentive’, and ‘telic’. Among these five classes, the most prevalent conceptual derivation is ‘formal’, which in turn contains three dominant sub-classes: ‘sense’, ‘characteristic’ and ‘proper name’. Two-thirds of the characters with the radical 羊 are derived from this conceptual relation.

Figure 3 is the concept deriving illustration of the radical 羊, with the top concept of CAPRID.

We observe the following generalizations:

(i) The concept cluster belonging to ‘formal’ mainly describes the age, color, and sex of CAPRIDS. For example, ‘羔，羊未足歲也’ (zhào lamb): ‘CAPRID which is less than one year old’) expresses a concept involving the age of the CAPRID. ‘羱，黃腹羊也’ (fàn (Mongolian gazelle): ‘CAPRID which has a yellow/brown belly’) involves both the constitutive part of a CAPRID’s belly and its visual attribute. Mainly for domesticated animals, gender is also an important concept, e.g., ‘羱，牡羊也’ (fēn (ram): ‘male CAPRID’) and ‘羱，牝羊也’ (zāng (ewe): ‘female CAPRID’).

(ii) A smaller cluster denotes events that involve CAPRIDS and is classified as ‘participating’, e.g., ‘羱，西戎羊穜人也’ (Qiāng: ‘people of Xirong who herd CAPRIDS’). The concept of a particular type of human being is defined by referring to their relation with CAPRIDS. We categorize this as participant-goal. Note that it could be argued that the basic concept should be HUMAN because 羸 combines two semantic
symbols 羊 and 人. However, as mentioned earlier, we made a commitment to describe
the concept classification according to the *Shuowen Jiezi* unless it can be proven to be
incorrect.

(iii) There is a small ‘agentive’ cluster, describing the event and manner of ‘birth’.
For example, ‘羜，五月生羔也’ (zhù (5-month(s)-lamb): ‘lamb born in May’). In
addition, there are characters related to castration, such as ‘羠，騬羊也’ (yi (stag):
‘castrated CAPRID’). We classify this as ‘agentive’ since it describes an event at the birth
of the CAPRID.

**Figure 3:** The CAPRID Domain Ontology Conventionalized by the Radical 羊
3.2 Cervid domain ontology conventionalized by the radical 鹿

Table 3: Distribution in all the relation categories under the radical CERVID

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal</td>
<td>24</td>
</tr>
<tr>
<td>Participating</td>
<td>1</td>
</tr>
<tr>
<td>Total Number of Characters</td>
<td>25</td>
</tr>
</tbody>
</table>

There are only 25 characters in the clusters of the radical 鹿. It is not very productive compared with the other three radicals in the current study. It should be observed that CERVIDS were not domesticated and hence were much less linked to direct human experience in ancient Chinese society. This is reflected by the fact that the concept clusters conventionalized by the radical 鹿 belong predominantly to the ‘formal’ class with only one debatable case of ‘participating’.

Figure 4: CERVID domain ontology conventionalized by the radical 鹿
Some generalizations are given below.

(i) Among the dominant conceptual relations of ‘formal’, most belong to the ‘proper name’ and ‘characteristic’ sub-classes, e.g., ‘麋，鹿屬’ ‘mí (moose): is a kind of CERVID’ (proper name) and ‘麋：牝麋也’ (yōu (hind) ‘female CERVID’), which describes the sex of the animal and belongs to the ‘characteristic’ sub-class. There are also concepts combining both the ‘proper name’ and ‘characteristic’ sub-classes. For example, ‘麋，麋牡者’ (chén (male moose) ‘male moose’) describes both the sub-kind (moose) and the gender of the animal.

(ii) There is also an ‘atypical’ category in the concepts derived from the radical ‘鹿’, e.g., ‘麋，山羊而大者細角’ ‘yán (Siberian Ibex): ‘big (mountain) goat with thin horns’). A goat is not a kind of CERVID, so this could be a miss-classification, either by convention or by Xu Shen.

(iii) There is a single example of a concept derived from ‘participating’: ‘麗，旅行也’ (lì (beautiful, elegant): ‘traveling’). However, etymology and conceptual convention of this character cannot be clearly defined.

3.3 BOVINE and EQUINE domain ontologies conventionalized by the radicals 牛 and 馬

The BOVINE and EQUINE domain ontologies are much richer than the CAPRID and CERVID domain ontologies, which shows that these two animals are more central to ancient Chinese society and play salient roles in direct human experience. The typical concepts related to BOVINIES is being used to till the land and the concept related to EQUINES is being used in transportation. Because of the close and rich first hand information, there are also descriptive events referring to experiences involving these two animals. For instance, the concepts of ‘to scare’ and ‘being scared’ are represented by 驚 (jīng) and derived from the drastic and vivid event involving the startling of a horse.
3.3.1 BOVINE domain ontology conventionalized by the radical 牛

Table 4: Distribution in all the relation categories under the radical BOVINE

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal</td>
<td>22</td>
</tr>
<tr>
<td>Participating</td>
<td>10</td>
</tr>
<tr>
<td>Constitutive</td>
<td>4</td>
</tr>
<tr>
<td>Telic</td>
<td>2</td>
</tr>
<tr>
<td>Agentive</td>
<td>1</td>
</tr>
<tr>
<td>Formal + Constitutive</td>
<td>3</td>
</tr>
<tr>
<td>Formal + Participating</td>
<td>1</td>
</tr>
<tr>
<td>Descriptive + Participating</td>
<td>1</td>
</tr>
<tr>
<td>Total Number of Characters</td>
<td>44</td>
</tr>
</tbody>
</table>

Six categories of concepts are derived from the basic concept of 牛. They are ‘formal’, ‘descriptive’, ‘participating’, ‘constitutive’, ‘telic’, and ‘agentive’. About half of the characters with the radical 牛 belong to the category ‘formal’. Characters in the categories of ‘participating’, ‘telic’, and ‘agentive’ describe the events BOVINES are associated with in Chinese society and human experiences. We observe the following generalizations:

(i) The concept cluster belonging to ‘formal’ describes the color, age, gender, and the sound of BOVINES. For example, ‘犥，牛黃白色’ (piǎo: ‘BOVINE which is yellow/brown and white’) describes the color of a BOVINE. ‘犫，四歲牛’ (sì: ‘BOVINE at the age of four’) describes the age of a BOVINE. The examples of the concept of gender are ‘牡，畜父’ (mǒu (male BOVINE): ‘father of livestock’) and ‘牝，畜母’ (pǐn (female BOVINE): ‘mother of livestock’). Besides visual characteristics, auditive features are also observed by human beings and reflected in characters: ‘哞，牛鳴也’ (móu: ‘the voice of a BOVINE’). BOVINES are domesticated and people live in close contact with them, so it is not uncommon to hear the sound of BOVINES.
Figure 5: BOVINE domain ontology conventionalized by the radical 牛
(ii) The concept cluster in the ‘participating’ class reveals the role BOVINES play in Chinese society: ‘犁，耕也’ (lí: ‘till the land’) indicates that the function the BOVINE serves in human society is to till the land; ‘犓，以芻莝養圈牛也’ (chú: ‘feed BOVINE with forage’) and ‘牿，牛馬牢也’ (gù: ‘BOVINE and EQUINE pen’) indicate that BOVINES are domestic animals.

(iii) Another important role BOVINES play in Chinese human society is being sacrificed for religious purposes, e.g., ‘牲，牛全也’ (shēng (sacrificial animal): ‘the whole, intact BOVINE [used for offering]’). This function can be found in the ‘telic’ category.

(iv) There is one example in the ‘agentive’ class: ‘犘，騬牛也 (牛被割掉睾丸)’ (jiè (bullock/ox): ‘castrated BOVINE’). In order to manage the BOVINES more conveniently and easily, farmers castrate them.

3.3.2 EQUINE domain ontology conventionalized by the radical 馬

| Table 5: Distribution in all the relation categories under the radical EQUINE |
|---------------------------------|---------|
| Formal                          | 39      |
| Descriptive                     | 20      |
| Participating                   | 21      |
| Constitutive                    | 3       |
| Telic                           | 2       |
| Agentive                        | 3       |
| Formal + Constitutive           | 20      |
| Formal + Participating          | 5       |
| Constitutive + Participating    | 1       |
| Total Number of Characters      | 114     |

The domain ontology of EQUINE is quite similar to the domain ontology of BOVINE. The concept cluster conventionalized by the radical 馬 falls into six classes, ‘formal’, ‘descriptive’, ‘participating’, ‘constructive’, ‘telic’, and ‘agentive’. The basic difference between BOVINES and EQUINES is their function. BOVINES are used for farming and religious offerings while EQUINES are used for transportation.
Figure 6: EQUINE domain ontology conventionalized by the radical 馬

Five generalizations are given below.

(i) About two-fifths of the characters with the radical 馬 can be classified by the
relation ‘formal’. The concept clusters belonging to ‘formal’ mainly describe the color, age, and characteristics of a horse, e.g., ‘駸，馬深黑色’ (lí (black): ‘dark black horse’), and ‘騾，黃馬黑喙’ (guā: ‘brown horse with black mouth’). There are many examples crossing the ‘formal’ and ‘constitutive-part’ categories. ‘駞，馬二歲’ (jū (yearling): ‘two-year-old horse’) is an example describing the age of horses. Some characters describe the qualities of horses, such as strong, good, wild, and fat. ‘騏，馬彊也’ (zhī: ‘horse which is strong’) and ‘騏，良馬也’ (xiāo: ‘good horse’) are two of the examples.

(ii) Characters in the ‘descriptive-active’ category mainly describe the manner of an EQUINE when it runs or walks, e.g., ‘駸，馬疾步也’ (zòu (fast, sudden): ‘a horse which walks fast’) and ‘騭，馬亂馳也’ (wù (gallop, rush about): ‘a horse runs without following certain directions’). Characters in the ‘descriptive-state’ class describe the posture or manner of an EQUINE, e.g., ‘騛，馬立也’ (zhù (stop, be stationed at): ‘a horse which stands’) and ‘騛，馬順也’ (xún (tame): ‘a horse which is tame’).

(iii) Because of the close relationship between EQUINES and HUMANS, there are many events involving a horse in the ‘participating’ class. ‘騃，驅馳’ (qū (to whip, to run a horse): ‘to gallop a horse’) describes an event where the horse is ridden by a person who causes the horse to gallop. ‘騽，馬載重難也’ (zhēn: ‘a horse carrying a heavy load and having difficulty walking’) indicates that the horse is involved in the carrying event.

(iv) From characters in the ‘telic’ class, we can see that the main function the EQUINE served in human society of Ancient China was transportation, e.g., ‘騊，置騎也’ (yì (posting house): ‘a place where riders are given their mounts’).

4. Conclusion

We found that the semantic primitives differentiating the basic concepts of these hoofed mammals involve descriptions of the appearance of these animals:

(a) 羊 CAPRID represents the shape of (an animal with) four legs and a tail.
(b) 牛 BOVINE represents the shape of (an animal with) horns that triangulate with a tail.
(c) 馬 EQUINE represents the shape of (an animal with) a head with a mane, tail, and four legs.
(d) 麂 CERVID represents the shape of (an animal with) horns and four legs.
Based on the source of their meanings, it is natural that the concepts derived from the four characters are predominantly classified under the ‘formal’ aspect, especially in the ‘vision’ and ‘characteristic’ sub-categories. Note that there are also many examples which straddle two categories, ‘formal’ and ‘constitutive part’, reflecting the fact that the basic concept definitions involve constitute parts.

Among the four radicals, the CERVID radical derives the least number of diverse concepts. This is a direct reflection of the human experience of the speaking community when Chinese characters were conventionalized. At that time, BOVINE, CAPRID (both goat and sheep) and EQUINE have already been domesticated and figured prominently in people’s daily lives. Hence there were many more objects and events which were related to these animals or which can be described based on people’s shared experience with these animals. We can say that the concept system of the characters also reflects the social and cultural structure of the speakers at the time of its conventionalization.

Indeed, the distribution of the concepts derived from each radical differs. For example, the BOVINE and EQUINE radicals both have a distribution that covers ‘formal’, ‘descriptive’, ‘participating’, ‘constitutive’, ‘telic’, and ‘agentive’. However, CAPRID is different, perhaps owing to the fact that the CAPRID were domesticated mostly for food, while BOVINES and EQUINES served functions in farming and transportation and were thus involved in more human activities.

It is also important to note that religion and rituals played a central role in human experience at that time. This can be observed from the definitions of the derived concepts. We observe these functions from the ‘telic’ category and find that people used BOVINES when making religious offerings, e.g., ‘牲・牛完全也’ (shēng: ‘whole, perfect BOVINE’ (used for offerings)). Horses, however, did not seem to be offered as sacrifices but rather belong to a developed system of transportation, e.g., in ‘驛・著騎也’ (yì (posting house): ‘a place where riders are given their mounts’).

In conclusion, our study of the four types of hoofed mammals supports our original thesis that the basic concepts as conventionalized by radicals represent domain ontologies of a cluster of concepts derived and marked by that radical. It is important to note that these conventionalized ontologies reflect human experience and knowledge at the time of conventionalization. Hence we see that the domain ontologies of domesticated and non-domesticated animals differ from each other, while further distinctions can be made between animals used for food and those for labor. This direct experience and knowledge are reflected in the qualia used to derive these concepts.
References


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