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Borongajska cesta 83d

10000 Zagreb

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Kristina Šekrst

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nadseminarsko izlaganje kao prijedlog sinopsisa i istraživanja

Cilj je istraživanja pronaći temeljne klasifikacije pojmova, odnosno koncepata, te takve kategorije dobiti na temelju analize karakteristika većine poznatih jezičnih skupina. Uvidom u jezičnu raznolikost moći će se pokazati koje su temeljne klase pojmova, koja su stupnjevanja u njihovoj apstrakciji ili posvojnosti vezane uz različite otuđivosti pojmova te koliko konceptualizacija ovisi o jezičnoj okolini. U drugome koraku istraživanja teži se pronaći mehanizme učenja takvih pojmova, koji će ležati na klasičnim ili neklasičnim logikama, ovisno o jezičnim skupinama i rezultatima. U trećemu koraku predložit će se mehanizmi usvajanja pojmova kod učenika i učitelja u različitim varijantama, kao što su usvajanje jezika ili strojno učenje, uz adekvatne formalizacije. Cilj je rada prikazati kako učenje pojmova ovisi o jezičnoj okolini te kako bilo kakve formalizacije i automatizacije moraju uzeti u obzir kontekstualnu lingvističku pozadinu i specifičnosti govornikove okoline, koje su usko vezane uz kognitivnolingvističke i tipološke jezične osobitosti.[1]

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Sažetak

Ovo će se izlaganje prikazati kao uvod u konceptualnu klasifikaciju i probleme učenja te usvajanja specifične klase koncepata u prirodnome jeziku i strojnome učenju. Spomenute su pozadinske teorije kao mogući putevi istraživanja te problemi s apstrakcijom koji se čine kritičnima u učenju prirodnoga jezika, ali i u strojnome učenju.

Summary

This article is an introduction to the conceptual classification and the problems of learning and acquiring specific classes of concepts in natural language and in machine learning. Various underlying theories are mentioned as possible pathways, and issues of abstraction are considered as crucial in natural language learning or in machine learning.

1. Concept: introduction, definitions, and structure

A concept[2] is a certain abstraction from experience, where the result is either a new concept which encompasses its instances, or a transformation of existing ideas or other concepts. Abstraction is a conceptual process where one can derive a generalization from specific examples. The product of this process is a concept that acts as a super-categorical noun or a superset (or even a power set) for all subordinate concepts, which are its subsets.

Regarding the structure of the concepts, the classical or empiricist theory of concept can be traced back to Aristotle (Gregory 2002), which talks about the concepts as

[2] Latin *conceptus*, from *concipere* = "to conceive", borrowed in English via French, first meaning was "a fetus", then metaphorically "the thing that the mind delivers", popularized by Aquinas.

definitions, which are structured as a list of features, and features entailed by this definition ought to be both necessary and sufficient for a thing to be a member of the class of that concept. This theory has been subjected to lots of criticism, but the biggest problem is that there are too few examples of successful definitional and uncontroversial analyses (Margolis & Laurence 2014).[3] The other problems include the famous Quine's (1951) argument against analyticity and the fact that psychological experiments show little evidence that we use concepts as strict definitions (Margolis & Laurence 2014).

With the development of cognitive linguistics, there was a strong tendency to view our conceptualization as a fuzzy process, which does not specify necessities, rather than probabilities. The prototype theory states that concepts specify properties that members of that class have a tendency to possess, rather than an obligation to possess them (Stanojević 2013). There was a similar trend in philosophy. i.e. with Wittgenstein, who talked about *family relationship* between concepts: the same way we look alike, that does not mean we all have to possess the same qualities: for example, a man can still be a man without a leg or an arm. That means that instead of a definitional structure we have a probabilistic structure:[4] something falls under a class of a certain concept if it satisfies a sufficient number of properties of that class (*ibid.*). Eleanor Rosch confirms this probabilistic structure with psychological experiments, where we categorize objects on the basis of it being a typical example of a certain prototype (Rosch 1973), or an untypical example: categorization is a comparison process (Rosch 1978).

[3] One of the most famous arguments against definitional analysis is Gettier's refutal of the classical definitional analysis of knowledge as justified true belief.

[4] A great way for formalization would be to use fuzzy or probabilistic logics to address these conceptual types.

Categorization is here, therefore, a similarity comparison process, and it is computed as a function of a certain number of constituents that two concepts hold in common. For example, regarding the concept *fruit*, the concept of *apple* shares more constituent than *tomato*. A number of research in cognitive linguistics deals with the way different cultures have different typical examples of a category. For example, in Croatia, a typical example of a fruit would be an apple, while in Kenya would be a banana – where the speaker's surroundings carry a huge weight regarding language classification. The problems that this theory encounters is in the case of more reflective judgments, such as if a person is asked whether a dog that is surgically altered to look like a raccoon, the most of us would answer that it is still a dog, rather than a raccoon (Margolis & Laurence 2014). One solution to this objection could be that the prototype is just a part of the structure of a certain concept, and that a concept can have its core, where we store the relevant information to more reflective judgements.

The third theory, which does a lot better regarding elaborate judgements, is the so-called *theory theory*, where the concepts stand in relation to one another the same way the terms of a certain scientific theory do, and categorization functions as scientific theorizing. It involves a certain number of essential properties, which even children can recognize, and this theory can help to explain conceptual development, i.e. the studying of concepts and the process of conceptualization in childhood, which seems to follow the same pattern as the change of theories in science (*ibid.*). It is close to a certain naive theory of psychology – *folk psychology* – where it describes the human development of understanding the outside world. The common objection against this theory is that it allows people to have the same concepts, for it is a holistic theory, and the concept's content is determined by its role in a theory, not by its constituents, which entails the problem of us not being able to compare the same mental states, which are likely to be different, rather than essentially the same.

In linguistics, the concepts have been studied from their semantic and pragmatic viewpoint, and after the phonology, morphology and syntax found a way to break down its units to smaller constituents, there was a tendency in linguistics structuralism to the same with meaning, and to try to find how a certain concept is constituted. For example, Pottier[5] tried to analyze the concept of a chair in this way: *chai*r: *{s1, s2, s3, s4} ("to sit on, on legs, for one person, with a backrest")*, and some chairs could have these features and could lack some of them, so the meaning can be analyzed in term of differences, through the presence or absences of semes (as units of meaning).

After the semantic analysis, the componential analysis has been introduced by anthropologists to describe kinship relations in various cultures, using a set of components as semantic features, which was later adopted by linguists as well (Coseriu 1976), where these semantic features were forming the first semantic metalanguage in linguistics.

For example, kinship relations could be analyzed like this:

concept	HUMAN	MALE	ADULT
woman	+	-	+
boy	+	+	-
girl	+	-	-

[5] He took inspiration from Louis Hjelmslev's *Prolegomena*, and was the first to call the semantice features of lexemes as *semes*.

child	+		-

The main difference with the mentioned semantic analysis is the fact that these components can include contextual information as well, for example, one could include a feature like DEROGATORY, DEMINUTIVE or DIALECTAL (for example English *lad* would have a +DIALECTAL component).

A radical alternative is the so-called conceptual atomism (Fodor 1998) where lexical concepts have no semantic structure, and its concept is determined by its relation to the world rather than to other concepts. This view is similar to modern cognitive science tendencies, where the surroundings builds up our understanding, and therefore our concepts (Belaj and Feletar 2014).

2. Concepts: classification

In natural languages concepts are on the highest level divided into abstract and concrete concepts. Concrete concepts have physical referents, and refer to objects or events that are available to us using our senses, while abstract concepts denote those that do not possess physical referents, for example *apple* is different from *freedom*. The next division includes general and specific concepts, where general concepts refer to groups and specific concepts refer to individuals. This is not an antonymic relation, as in the case of abstract and concrete concepts, but a gradient one. For example, a general term could be *furniture*, a more specific one could be *chair*, but an even more specific one could be a *rocking chair*, and we can go further.[6]

In comparative linguistics one can reconstruct concrete and abstract terms, for example in Proto-Indo-European, we can reconstruct all of these terms as well, and see their development historically, and the change of meaning, where some terms can switch categories: become abstract terms from concrete ones or vice versa, or become more general and more specific.

In linguistics and philosophy there has been a strong claim that meaning always changes historically from concrete to abstract and from general to specific, but that does not have to be the case. For example, English *deer*[7] once meant "an animal" in general sense today denotes mammals from the family *Cervidae*, while *fowl*[8] once denoted a bird in general, but today denotes *Galloanserae*. English *meat* once denoted *food* in general, while today means "animal flesh". Traditional classifications of lexical semantic change include restriction as in mentioned cases, extension as in *arrive*[9] which first meant "come to

[6] A fuzzy logic would be useful in formalization of these kinds of concepts.

[7] Old English *deor*, cognate to German *Tier*, from PIE **dhew*- = "to breathe", literally "the one which breathes", cf. Slavic *dihati, disati* (my etymologies).

[8] Cognate to german *Vogel*, literally "a flyer", from PIE **plek*- = "to fly", from **plew*- = "to flow", cf. Slavic "*plivati* or Latin *pluvialis*.

[9] Vulgar Latin **arripare*, from Latin **ad ripam*, "to the shore".

shore", pejoration as in *silly*[10] which meant "blessed" at first and amelioration as *nice*[11] meaning "silly" and other culturally-related changes (classification from Bloomfield 1933).

3. Problems in natural language

The ease in Indo-European languages of expressing abstract ideas is not the case with Indian languages, where most of these are most concrete in their formative expression. For example, we can say *the eye is the organ of sight*,[12] and the Indian may not be able to form the expression *the eye*, since he or she has to define to whom the eye belongs: a specific person or an animal. These languages may not be able to generalize the concept of an eye and see it as a representative of the whole class of objects, since they would have to pinpoint it and have a specialized expression like this eye here. They would also have to express the term *organ* as something like *the instrument of seeing*, so the whole sentence would be of form similar to *An indefinite person's eye is his means of seeing*.

The speakers of these languages rarely talk about abstract ideas, since all abstract terms appear always with possessive elements. In these languages there is a strong tendency

[10] Old English *gesælig* meaning "happy", cognate to German *selig* and Greek *hilaros*.

[11] Old French *nice* = "careless", "silly", from Latin *nescius* = "ignorant" (from *ne* + *scire*).

[12] See: *Dictionary of Daily Life of Indians of the Americas*.

to go towards specialized terms, such as “to be seated” in Kwakiutl[13] would be expressed as “seated on the floor of the house”, “seated on the beach”, “seated on this chair” etc.

Similar are the languages with the case of evidentials, which are obligatory grammatical features that state the nature of evidence for a given statement – whether the evidence exists and what kind (Aikhenvald 2004). Usually, there are two types of evidentials, first-hand ones (visual, auditory etc.) or second-hand ones or reported ones. In these languages one cannot say *the dog is running*, one must add an obligatory grammatical affix stating something like *the dog is running – I can see it*, *the dog is running – I can hear it*, *the dog is running – someone told me* etc. while the sentence *the dog is running* itself would be ungrammatical and would not convey any meaning.[14] Speakers of evidential languages often have problems with abstract terms, since there are no evidentials to put with these terms, because these are generalized concepts without specific instances.

However, not only the speakers of indigenous languages encounter the same problem. For example, one study (Rana et al. 2007) has shown that students face problems while making inference between one or more abstract concepts, and they found it easy to solve when they used examples to solve the question. This is the same way as teaching often works: after a definition is given, students require instances or examples, to grasp the concept.

[13] Kwak'wala or Kwakiutl is an indigenous language in northern Canada, of the Wakashan language family. There are fewer than 200 fluent speakers today.

[14] For more info see Šekrst, Kristina (2014): *Formalizacija, aksiomatizacija i klasifikacija primijenjene logike opravdanja: slučaj evidencijala*, master thesis, philosophy (in Croatian), Croatian studies, University of Zagreb.

4. Problems in machine learning

The process of learning and acquiring abstract concepts is difficult for computers as well. However, there is a certain strategy in machine learning. Deep neural networks are based on a set of algorithms that attempt to model high-level abstractions (Šnajder and Dalbelo Bašić 2014). It is a branch of machine learning based on hierarchies, and researchers make attempts to make better representations and create models to learn these representations from unlabeled data. DNNs are inspired by the brain, and deep-learning algorithms are based on the underlying assumption that the observed data is generated by the interaction of various factors organized in layers, and these correspond to different levels of abstraction or composition. Higher-level concepts and more abstract ones are learned from lower-level ones. Recently, models such as deep belief network have been constructed, which is a probabilistic generative model, as a composition of simple learning modules that make up each layer. However, learning abstract concepts is getting better when the datasets used are being bigger, and there are even more layers added (*ibid.*).

5. The process of learning different kinds of concepts

There were experiments with the Kwakiutl language of the Vancouver Island, where researchers (see: *Dictionary of Daily Life of Indians of the Americas*) tried to develop the idea of abstract term in the mind of the Indian, and they succeeded in isolating the terms such as *love*, which usually occurs in possessive forms such as *my love for you*. The same way of reasoning using layers and example is used in machine learning, and the process used is to show various instances of a certain concepts and try to find a feature (or multiple features) that is common to these objects. As the speakers of indigenous languages have succeeded in acquiring abstract terms, the same way the computer tries to derive the concept of love from common semantic features of various specific instances of love.[15]

The underlying model or theory for future research in this area would suggest a certain mixture of traditional theories. The *theory-theory* would be great to explain the cultural context and the change of belief and paradigm – as it is the case with the Kwakiutl speaker acquiring a new way of understanding the world. On the other hand, semantic features found in componential analysis and prototype theory would explain the way we hold this knowledge, and how we connect various concepts in our mind regarding our cultural context.

The basis of future research would be to address these issues in natural languages – specifically, evidential ones and Indian languages – and to address the similar issue in machine learning, and to see how one can derive the generalized notion of learning these concepts and formalizing the process with modal logics of justification, belief, knowledge and probability.

[15] For example, the evidential speakers I have talked to during my master thesis research over the Internet, had no trouble in acquiring abstract concepts in English, after some years of learning and noticing the common pattern.

Bibliography

1. Aikhenvald, Alexandra Y. (2004). *Evidentiality*. Oxford: Oxford University Press.
2. Belaj, Branimir i Goran Feletar (2014): *Kognitivna gramatika hrvatskoga jezika. Knjiga prva, Imenska sintagma i sintaksa padeža*. Zagreb: Disput.
3. Bloomfield, Leonard *(1933)*: *Language*. New York: Allen & Unwin.
4. Coseriu, Eugenio (1976): "*L'Étude fonctionnelle du vocabulaire"*, in: *Précis de lexématique*, *Cahiers de lexicologie*, no. 27.
5. *Dictionary of Daily Life of Indians of the Americas, A to Z, Volume* 1. Newport Beach, CA: American Indian Publishers.
6. Fodor, John (1998): *Concepts: Where Cognitive Science Went Wrong*. New York: Oxford University Press.
7. Friedlander, K. J. (n.d): "Abstract, Concrete, General, and Specific Terms", in: *The Guide to Grammar and Writing*: <http://grammar.ccc.commnet.edu/grammar/composition/abstract.htm />.
8. Laurence, Stephen and Eric Margolis (1999): *Concepts and Cognitive Science. in Concepts: Core Readings*. Massachusetts: Massachusetts Institute of Technology.
9. Margolis, Eric and Stephen Laurence (2014): "Concepts", in: *The Stanford Encyclopedia of Philosophy* (Spring 2014 Edition), Edward N. Zalta (ed.): <http://plato.stanford.edu/archives/spr2014/entries/concepts/>.
10. Murphy, Gregory (2002). *The Big Book of Concepts.* Massachusetts: Massachusetts Institute of Technology.
11. Pottier, Bernard (1978): "Vers une sémantique moderne", in: *Travaux de linguistique et de littérature*, Strasbourg: 107–137.

12. Quine, W.V.O. (1951): “Two Dogmas of Empiricism”, in: *The Philosophical Review* 60: 20–43.
13. Rosch, E.H. (1973). “Natural categories”, in: *Cognitive Psychology* 4 (3): 328–50.
14. Rosch, Eleanor (1978): “Principles of Categorization”, in: *Cognition and Categorization* (E. Rosch & B. Lloyd (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates.
15. Weng, Juyang (2011): “Why Have We Passed ‘Neural Networks Do not Abstract Well'?”, in: *Natural Intelligence: the INNS Magazine*, vol. 1, no.1, pp. 13–22, 2011.
16. Rana, Zeeshan A., Yasser Hashmi and Muhammad A. Iqbal (2007): “Problems in Understanding Abstract Concepts Related to Regular and Context-Free Languages”, in: *6th WSEAS International Conference on EDUCATION and EDUCATIONAL TECHNOLOGY*, Italy, November 21-23, 2007.
17. Stanojević, Mateusz-Milan (2013): *Konceptualna metafora:* temeljni pojmovi, teorijski pristupi i metode. Zagreb: Biblioteka Srednje Europe.
18. Šnajder, Jan i Bojana Dalbelo Bašić (2012): *Strojno učenje*, skripta. Zagreb: Sveučilište u Zagrebu, Fakultet elektrotehnike i računarstva.