

On Categorization

INF5020 – Philosophy of Information L5, slide set #2

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From
George Lakoff, "Women, Fire, and Dangerous
Things: What Categories Reveal About the Mind"
University of Chicago Press, 1990

Importance of Categorization #1

- Categorization is basic to thought, perception, action, and speech.
- Every time we see something as a kind of a thing, we are categorizing.
- Not only things, we also categorize actions (motor activities).



Importance of Categorization #2

- Categorization is automatic and unconscious, except for problematic cases.
- This leads to the impression that every thing in the world (spoon, cup, monitor, glasses, etc.) comes in natural kinds, and our categories of mind naturally fit this categorization inherent in the world.
- The problem is that we also categorize abstract entities, and an accurate theory should account for *all* of our categories.

Importance of Categorization #3

- Almost everything we do involves categories. Think of any utterance: categories of speech sounds, of words, of phrases and clauses, as well as conceptual categories.
- Reasoning is also closely tied to categorization.
- Thus understanding of how we categorize is central to any understanding of how we think, reason and how we function.

Classical Categorization Theory

- “Things are in the same category if and only if they have certain properties in common. These properties define the category.”
- The classical view is not an empirically grounded theory, but it was taken for granted, from Aristotle to late Wittgenstein. Until recently, it wasn't even considered a theory, it was taken to be a definitional truth.
- It is not entirely wrong. We often do categorize things on the basis of shared apparent properties, but it is only part of the story.

And the other side of the story will come shortly...

Disembodied Reasoning and Classical Categorization Theory

- The view of reason as disembodied symbol-manipulation implicitly assumes classical categorization theory. (Mind-as-Computer Metaphor)
- “Symbols get their meaning through their capacity to correspond to things in the world”
- implies -
“Category symbols get their meaning through a capacity to correspond to categories in the world (real or some possible one).”
- Thus classical theory fits in, since disembodied reasoning calls for categories existing in the world independent of human capabilities, i.e., the capabilities of the categorizer.



Last Decades' Developments

- Collecting previous studies that suggest problems related to classical view of categorization under one perspective, Eleanor Rosch's pioneering work made categorization theory a major field of study.
- Some of studies that lead Rosch to formulate prototype theory follow, then we'll talk about Rosch's work.

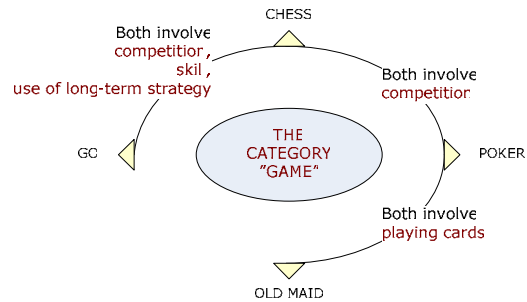
Wittgenstein

- Wittgenstein is generally acknowledged to be the first to become aware of the cracks in classical view.
- His famous example is the category of "games", and he makes the observation that there are no common properties shared by all games.
- Wittgenstein explains the category of games by what he calls family resemblances: the members of a family resemble to one another in various ways, such as hair color, facial features, eye color, but usually not all of them!

Wittgenstein's Family Resemblances

- There are no properties shared by all members!
- The boundaries are extendable (video games recently introduced).
- Some games are better examples of the category: there are central and non-central members.

(Dice is not very representative of a game)



J.L. Austin's Work on Meaning of Words

- Various senses of a word can be seen as forming a category.
- The senses of a word usually **do not** share a fixed set of properties, whereas they are related to one another in various ways. (Similar to Wittgenstein's family resemblances)
- Austin: "The adjective 'healthy': when I talk of a healthy body, and again of a healthy complexion, of health exercise: the word is *not* just being used *equivocally*. . . . There is what we may call a *primary nuclear sense* of 'healthy': the sense in which 'healthy' is used of a healthy body: I call this nuclear because it is 'contained as a part' in the other two senses which may be set out as 'productive of healthy bodies' and 'resulting from a healthy body'. . . . Now are we content to say that the exercise, the complexion, and the body are all called 'healthy' because they are similar?" (**metonymy**)
- Austin: "When A:B::X:Y then A and X are often called by the same name, e.g., the foot of a mountain and the foot of a list. Here there is good reason for calling the things both "feet" but are we say they are "similar"? Not in any ordinary sense. We may say that the relations in which they stand to B and Y are similar relations. Well and good: but A and X are not the relations in which they stand." (**metonymy and metaphor**)

Zadeh's Fuzzy Set Theory

- Fuzzy Set Theory: A form of set theory to model graded categories.
- In a classical set, everything is either in the set (has membership value 1) or not (has membership value 0).
- In a fuzzy set, elements can have membership values between 0 and 1.
- The operations in the original version of the fuzzy set theory are the following. Suppose element x has membership value v in fuzzy set A and membership value w in fuzzy set B .
 - Intersection: The value of x in $A \cap B$ is the minimum of v and w
 - Union: The value of x in $A \cup B$ is the maximum of v and w
 - Complement: The value of x in the complement of A is $1 - v$
- Other definitions of intersection and union was suggest after these originals.

Lounsbury's Work on American Indian Kinship Systems

- The field he works in is called *cognitive anthropology*.
- The rules of naming relatives shows that cognitive categories can also be defined by some central elements plus generation rules (**Generative categories**: Generator plus "something else")
- For example, he found the following rules:
 - *Skewing rule*: Anyone's father's sister, as a linking relative, is equivalent to that person's sister.
 - *Merging rule*: Any person's sibling of the same sex, as a linking relative, is equivalent to that person himself.
 - *Half-sibling rule*: Any child of one of one's parents is one's sibling.

Berlin and Kay's Basic Color Terms

- They challenged the classical view that different languages could carve up the color spectrum in arbitrary ways.
- They found that some color terms appeared to be basic:
 - They had less number of morphemes
 - They are not contained in another color (Scarlet and red)
 - They are not restricted to a small number of objects (blonde)
 - They must be common and generally known
- They found that the categories the basic color terms can attach to are the equivalents of English color categories named by *black*, *white*, *yellow*, *green*, *blue*, *brown*, *purple*, *pink*, *orange*, and *gray*.
- Some languages have fewer basic color categories, and when a basic color category covers more than one of the above, for example say *grue* covering *green* and *blue*, the typical color (*focal color*) for this category is not turquoise, but either focal blue or focal green.

Kay and McDaniel's Work on Explaining Berlin-Kay Findings

- They used DeValois et.al. work on neurophysiology of color vision.
- DeValois et.al. identified six types of cells:
 - One pair for the perception of blue and yellow
 - One pair for the perception of red and green
 - One pair for the perception of light intensity
- Kay and McDaniel fitted a fuzzy set model to DeValois results, with partial success.
- Their finding suggest that the basic color categories are a product of both neurophysiology and cognitively real operations that can be partially modeled by fuzzy set intersection and union.

Brown and Berlin's Basic Level Categories

- Brown: Objects have many names of different level of detail: animate being, quadruped, *dog*, boxer, Fido ☺. Of all the possible names in a category hierarchy, a particular name, at a particular level of categorization, "has a superior status." It feels the *real* name of the thing.
- Brown: This "first level" categorization has the following properties:
 - It is the level of distinctive actions (we think of playing with the dog, not the quadruped)
 - It is the level which is learned earliest and at which things are first named
 - It is the level at which names are shortest and used most frequently
 - It is a natural level of categorization, as opposed to a level created by "achievements of the imagination"
- Berlin and his students and associates found evidences of such basic level classification by studying folk classification of plants and animals in speakers of Tzeltal (a Mexican local language).

Eleanor Rosch

- She's the first to provide a general perspective on all these special cases.
- The theory has come to be called "the theory of prototypes and basic-level categories" or "**prototype theory**".
- She focused on two implications of the classical view on categorization:
 - "If the categories are defined only by properties that all members share, then no members should be better examples of the category than any other members.
 - If categories are defined only by properties inherent in the members, then categories should be independent of the peculiarities of any beings doing the categorizing; that is they should not involve such matters as human neurophysiology, human body movement, and specific human capacities to perceive, to form mental images, to learn and remember, to organize the things learned, and to communicate efficiently.

Eleanor Rosch Prototype Effects

- Her early studies were on color categorization in speakers of Dani (a New Guinea language).
- In Dani, there are only two basic color terms: *mili* (for dark-cool, incl. black, green, and blue) and *mola* (for light-warm, incl. white, red, yellow).
- Her hypothesis was if language alone determined color categorization, then the Dani should have equal difficulty learning new words for colors, no matter whether the color ranges had primary color at the center or a nonprimary color.
- Her studies provided empirical evidence that primary color categories were psychologically real for speakers of Dani, and focal colors had a "special cognitive status", which would correspond to what she will call *cognitive reference points* or *prototypes* in her later research.

Eleanor Rosch Prototype Effects (continued)

- Among the experimental paradigms she used are:
 - **Direct rating:** how good an example of a category (e.g. bird) various members are (e.g. a robin, a chicken, etc.)
 - **Reaction time:** Subjects asked to press a button to answer true/false questions of the form "An [example] is a [category name]" (e.g., "A chicken is a bird.")
 - **Production of examples:** Subjects were asked to list or draw examples of category members. It was more likely that more representative examples were drawn.
 - **Asymmetry in similarity ratings:** Less representative examples are often considered to be more similar to more representative examples than the converse. In one study (involving Americans), subjects considered Mexico to be more similar to the US than the US is to Mexico.

Eleanor Rosch Prototype Effects (continued)

- Continuing the experimental paradigms she used:
 - ...
 - **Asymmetry in generalization:** Information about a representative member is more likely to be generalized to non-representative members than the reverse. In one study (Rips 1975) the subjects believed that a disease was more likely to spread from robins to ducks than ducks to robins.
 - **Family resemblances:** Rosch showed that there was a correlation between the family resemblances, which were a priori philosophical speculation, and the numerical ratings of best examples in various studies.

Eleanor Rosch Prototype Effects (continued)

BEWARE!

- As Rosch herself had put it in her later works, the prototype effects do not constitute a theory of cognitive categorization. There is nothing called a prototype, what exists is our observation of degree of prototypicality.

Eleanor Rosch Basic-Level Effects

- Extending Berlin's work on Tzeltal plant and animal taxonomies, Rosch and her associates found that the psychologically most basic level is in the middle of the taxonomic hierarchies.
- They found that basic level is:
 - The highest level at which category members have similarly perceived overall shapes
 - The highest level at which a single mental image can reflect the entire category (try imagining a representative image for "a furniture", and then "a chair")
 - The highest level at which a person uses similar motor actions for interacting with the category members
 - The level at which subjects are fastest at identifying category members

Eleanor Rosch Basic-Level Effects (continued)

- They found that basic level is:
 - ...
 - The level with the most commonly used labels for category members
 - The first level named and understood by children
 - The first level to enter the lexicon of a language
 - The level with the shortest primary lexemes
 - The level at which terms are used in neutral contexts ("There's a mammal on the porch." needs special context, whereas using dog would not)
 - The level at which most of our knowledge is organized. Most attributes of category members are stored at this level. Most of this knowledge is organized as part-whole relations, and interactions with those parts (affordances) (Tversky and Hemenway 1984)

Eleanor Rosch Priority of Categorization

- At the outset, Rosch believed that the attributes of things were inherent in the real world, “given an organism that had sensory equipment capable of perceiving the attributes” (Rosch 1978). Thus they grounded their system in reality using attributes listed by their subjects as perceived attributes. But
 - Some attributes, such as “seat” for the “chair” appear to have names not meaningful prior to the knowledge of object as “chair”
 - Some attributes such as “large” for object “piano” seems to have meaning only with respect to a superordinate category: it is large for furniture but small compared to another object such as building.
 - Some attributes such as “you eat on it” for the object “table” are functional attributes that suggest possession of knowledge about humans, their activities, and the real world in order to be understood.
- Thus the analysis of objects into attributes is rather a sophisticated activity that the subjects of Rosch’s study might have been considered to be able to impose only *after* the development of a system of categories.
- Thus the notion of a “property” is not something objectively out there in the world independent of any being.