Biodiversity

Ambiguity Between Science and Society

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Outline

1. Ambiguity in science (and in language)
2. The study of ambiguity in organizational choice
   - 2.1 The good side
   - 2.2 The bad side
3. A taxonomy, and some promising paths for studying it

The take-home: Biodiversity is almost **necessarily** ambiguous – so we need to evaluate those ambiguities and their normative valence.

Thanks!

Max Bautista Perpinyà, Beckett Sterner, Oliver Lean

Ambiguity in Science

A Balance

The concept of biodiversity has to be:

- Larger than just single (charismatic) species (to capture ecological relations)
- Smaller than "life itself" (to give us something that it is possible to conserve)

In Science: Already Ambiguous

- species richness (most common)
- diversity of traits or characters
- diversity of ecological communities (structural)
- diversity of ecological niches
- genetic diversity

One Response: Fundamentalism

In the biological and biomedical sciences, what we will call the Definitional Consensus Principle has dominated the design of data discovery and integration tools:

> **Definitional Consensus Principle (DCP):** The design of a formal classificatory system for expressing a body of data should be grounded in a consensus about the definitions of the entities that are being classified. (Sterner et al. 2020, p. 2)

One Response: Fundamentalism

We may, then, start from the observations there made [in the *Poetics*], and the stipulation that language to be good must be clear, as is proved by the fact that speech which fails to convey a plain meaning will fail to do just what speech has to do. (*Rhetoric* 1404b1, Aristotle 1984)

Another Response: Skepticism

Put bluntly, the position that this paper will argue for is that biodiversity is to be (implicitly) defined as what is being conserved by the practice of conservation biology. (Sarkar 2002, p. 132)

Another Response: Skepticism

Put
bio
by

Save the planet: eliminate biodiversity

Carlos Santana

But what if…

…ambiguity was actually sometimes a good thing?

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A growing literature: it could be!

- **In science:** Star and Griesemer (1989) on boundary objects; Brigandt (2010, 2012), Waters (2014), and Neto (2020) on concepts and epistemic goals; McMahan and Evans (2018) on publication and engagement; Sterner (2022) on data in biology
- **In politics:** Page (1976)
- **In strategic vision statements:** Gioia (2012)
- …

A New Question

Most of this literature is about **scientific objects and knowledge,** and exchange between **scientific disciplines.**

But biodiversity also works at the interface between science, government, NGOs, the public, the media…

A New Question

How can we **evaluate** the use of ambiguity in **genuinely ambiguous** scientific concepts, when they **move beyond the scientific community?**

Ambiguity in Organizational Choice

The overemphasis on clarity and openness in organizational teaching and research is both non-normative *and* not a sensible standard against which to gauge communicative competence or effectiveness. People in organizations confront multiple situational requirements, develop multiple and often conflicting goals, and respond with communicative strategies which do not always minimize ambiguity, but may nonetheless be effective. (Eisenberg 1984, p. 228)

…pragmatic ambiguity is a practical solution to the difficulties of collaborative action in situations where different points of view and conflicting interests could lead to organizational paralysis. (Giroux 2006, p. 1254)

The Good

- Allows for multiple representations of a goal to exist despite underlying disagreement
- Enables responses for change in shifting environments (Eisenberg 1984)
- Encourages "signing up" to a higher-level meaning of a goal that doesn't contradict our interests
- Enables agreement about action despite differences of interpretation (Jarzabkowski et al. 2010)

The Bad

- Permits for plausible deniability of unwanted consequences
- Used to re-entrench existing power differentials (Eisenberg 1984)
- Enables proliferation of multiple meanings, which obscures action (Jarzabkowski et al. 2010)
- Permits the appearance of decisions that don't actually resolve any problems (Cohen et al. 1972)

A Taxonomy for Ambiguity

A Taxonomy

Strategic ambiguity as a rhetorical resource for enabling multiple interests

Paula Jarzabkowski
Aston University, UK

John AA Sillince
Strathclyde University, UK

Duncan Shaw
Aston University, UK

A Taxonomy

Rhetoric can be either:

- **situated** — particular to a group, constructed in terms of their position and interests
- **accommodative** — adopting a position that accommodates the interests of others

A Taxonomy

And it can ascribe meanings to ambiguous concepts that are either:

- **narrow** — minimally ambiguous, single-perspective
- **wide** — explicitly recognize divergent or conflicting interests and goals

A Taxonomy

- **situated-narrow rhetoric:** scientific journal articles on biodiversity, internal corporate reports, etc.
- **situated-wide rhetoric:** arguments *in favor* of one view against the others; disputes between parties (internal communications?)
- **accommodative-wide rhetoric:** mission and vision statements, multi-stakeholder reports (IPBES, IPCC)
- **accommodative-narrow rhetoric:** temporary clarification of broad goals to enable collective action (local biodiversity actions?)

An Empirical Observation

All constituents used all types of rhetoric over the three years, rather than converging on one position or the other over time. Constituents were able to shift between the [types of rhetoric] as they saw fit to justify and validate their own, colleagues' and organizational interests and actions, often adopting positions [of each type] during the same passage of speech, interview, or meeting. (Jarzabkowski et al. 2010, p. 240)

Normative Questions

Not a question of **normatively privileging** any one class of rhetoric – that would be impossible!

What can we say about the **contexts** in which each of these kinds of engagements occurs? We should be able to develop **norms for engagement** in these discussions.

Worries

Ambiguity is about communication, which is about signal transfer: so we need information about **the communicator's goals, their linguistic choices,** and **the receiver's interpretation** of their utterances. (Eisenberg 1984)

Worries

It's not clear that we have **the data we need** to study this empirically. Sterner (2022) argues this is true even in the case of the *science* of biodiversity and taxonomy, it's surely *worse* for the science/society interface.

Empirical Analyses

As a result, it is possible to formulate empirically testable generalizations relating three key aspects of a term's usage: how often and in what contexts the term is used, the communicative goal being prioritized, and circumstantial factors of its use, including the specific linguistic and social context available and the background knowledge of participants. (Sterner 2022, p. 12)

Sterner's Proposal

Analyze "partial synonym networks" – like 'function', 'evolutionary function', and 'biochemical function' – and quantify their ambiguity as their **expected entropy across contexts**

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$$H[M \mid C] = -\sum_{c \in C} P(c) \sum_{m \in M} P(m \mid c) \log P(m \mid c)$$

Topic-Modeling Approach

★ **Rank Speculation Alert** ★

Topic-Modeling Approach

A topic model automatically splits a corpus into "contexts" in Sterner's sense, via a machine-learning approach, but with some advantages (or at least distinctive features):

- Document-level, rather than word-level (could help provide more info, *unless* authors are using multiple contexts or comparing contexts)

- Documents can *mix* topics; topic membership is probabilistic

- Well-known analyses of robustness of results exist

- Topics are (or tend to be) *interpretable*

Topic-Modeling Approach

Intuitively, if "biodiversity" appears in many different topics that are about wildly different things, then it is *either* (1) carrying **different meanings,** which can be explored by exploring the relevant topics, or (2) serving as a **bridge between different topics**

Topic-Modeling Approach

How exactly to quantify this?

The topic model induces a non-orthogonal k-dimensional vector space over the corpus that (local-optimally) models each document as a k-dimensional vector. Each basis vector is a probability distribution over all the words in the corpus.

Topic-Modeling Approach

Easy: Cosine distances between either the *k* basis vectors or between the vectors for each document ("how similar are the topics/documents?")

Easy: How important is a given word ('biodiversity') in a given topic (i.e., $\Pr(w \mid t)$ – elements of each basis vector)? How important is a given topic for a given document (i.e., $\Pr(t \mid d)$ – elements of each document vector)?

Topic-Modeling Approach

So we want to ask: to what extent is a word used in topics that are radically different from one another? Pick a "central" topic t, the topic for which w is most likely: $c = \max_k^t [Pr(w \mid t)]$. Then:

$$A(w) = \sum_k^t Pr(w \mid t) \text{Cos}(t, c)$$

An Example

I don't have a relevant corpus to test 'biodiversity' on this with. So I took another random topic model that I already had, of *Proceedings of the Royal Society B* from 1907 until 2014, and tried the analysis out.

An Example

Hey, nice!

$$A(\text{cause}) \approx 0.01 > A(\text{evolution}) \approx 0.03 \gg A(\text{nucleic}) \approx 0.002$$

Questions

Is this justified from first principles? I have no idea!

Is it sensitive to the choice of similarity measure, or the choice of "central topic"? Not in my (very, very limited) testing.

Does this fail in some kind of important way that I haven't yet seen? Probably! I derived this algorithm while **extremely** tired.

Back to Biodiversity

Lastly: **What corpus should we use** if we want to try analyzing biodiversity in this kind of way? I really don't know.

We would like to capture the various meanings of the term to be able to say something about them in comparison. But if the differences between documents in the corpus are too large, then all the topic model will do is classify documents by type.

Questions?

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