

Addendum to “Entropy as Disorder”: Entropy as Freedom

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My paper “Entropy as Disorder: History of a Misconception” [*The Physics Teacher*, volume 57, pages 454–458 (October 2019); erratum volume 58, page 5 (January 2020)] shows that “disorder” is a poor metaphor for entropy. So what should be used instead?

A good question.

The analogy for entropy that I like is “freedom”. The word freedom (like the word disorder) is emotionally loaded, so perhaps it’s not the best word, but here’s the analogy: If a club (or a church, or a college, etc.) has strict rules, then there are few ways for you to behave and still be welcome as a member of the club. Whereas for a club with lax rules there are many ways for you to behave and still be welcomed into the club. The club is analogous to the macrostate, the individual behavior is analogous to the microstate. If there are more microstates corresponding to the macrostate, the macrostate has a larger entropy. So a club granting its members more freedom (lax rules) is analogous to a macrostate with higher entropy.

This analogy is preferable to “disorder” because it focuses on the connection between macrostate and microstate, whereas the disorder analogy invites you to focus on a particular microstate and judge it to be messy or neat. Microstates don’t have entropy, only macrostates do.

The reason that the “entropy as disorder” analogy works sometimes (not always) is because there are usually more ways to be messy than there are to be neat.

In *A Student’s Guide to Entropy* (Cambridge University Press, New York, 2013), Don Lemons uses a similar analogy, which he calls “entropy as possibility”.

In *Rule Makers, Rule Breakers* (Scribner, 2018), Michele Gelfand classifies communities according to how tightly or loosely their members adhere to social norms. Although this book doesn’t use the word “entropy”, a “tight” community corresponds to a low entropy macrostate, a “loose” community to a high entropy macrostate.