

## Diversity versus Structure: A Fundamental Axis of Variation in Evolution?

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There's a common misbelief that fecundity is the objective function of the unsupervised learning strategy we call "evolution." Perhaps a better perspective is that *persistence* is what "wins" in evolution; fecundity tends to trade off with the probability of persistence of any individual, and across species and even individuals we see a great diversity of strategies along this axis of variation.

Another basic trait for which we see a great deal of variation in nature is intelligence, by which here I mean the capacity of an individual to vary its behaviour in response to ecological opportunity. If we look at how microbes handle the challenges of even routine changes in circumstance, e.g. the ambient temperature outside and inside of mammals, what tends to happen is that there is an array of phenotypes with small, commonly-elicited modifications to genotype, some of which are better adapted to each of the common contexts. When the context changes (e.g. if a fruit they are resident on gets eaten by something warm-blooded), a vast majority of a population is exterminated, but the remainder quickly breeds up a new population adapted to the current context. When the situation changes at the other end of the gastrointestinal tract, the process repeats.

Evolvability is often seen as assuming more predictive power than nature affords, but really it is like all selected traits based in successful responses to regular variations in the opportunities an ecosystem affords. It is only one way to handle such regularity. Another is to increase the complexity of the individual, such that it can detect and respond to the different contexts. Since we observe both strategies in nature, again we should assume there are some tradeoffs with respect to the cost of structure, in addition to the obvious issues of the probability ( $\sim$  temporal cost) of discovering such structures in the first place. The costs of exploiting diversity – the loss of individuals in some contexts – are more obvious and easily quantified.

Detection of and response to ecological opportunities does not need to be conscious, cognitive, or even neurological, but obviously in some organisms we find extremely interesting, they are. Particularly in the present context of the ecologically-recent extension of human intelligence by technology (AI), we should ask whether there are any problems that require maintaining the strategy of diversity, or whether we should accept and accommodate to processes apparently attractive to government, that seem designed to reduce individual variation and enforce conformity for easier regulation.

I believe there are at least two categories of problems that are not reducible to repeated patterns, and therefore motivate ensuring the maintenance of opportunities for varied populations. First, certainly the universe and arguably biology are constructing generally-increasing (rather than oscillating) complexity. Third-generation stars produce more complex elements in greater abundance than second-generation stars, and arguably the rate of diversity recovery shown in life on earth has increased. Second, there is a problem almost definitionally unsolvable by life, which is carrying capacity. Where an ecosystem varies faster than evolution can innovate, populations will sometimes find themselves in contexts where living is easy, and other times where the full population cannot survive. The times of ease also offer opportunities for innovation, the times of hardship are necessarily selection events. Particularly in light of the first category which ensures constant change in opportunities, exploiting periods affording innovation to allow the acceleration of evolution (by Fisher's law) in periods of stress may therefore be permanently an important strategy for ultimate survival.