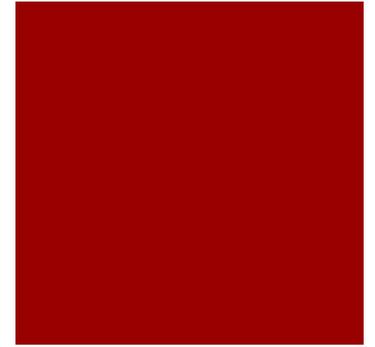


Fine-Tuned for What?

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NYU
The Physics of Fine Tuning
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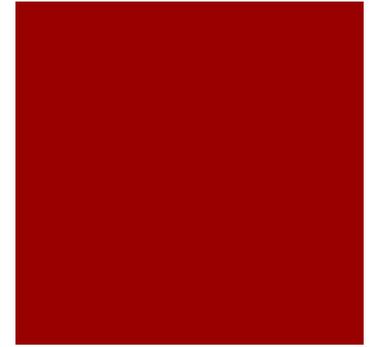
Teleological Explanation

- One of the characteristic consequences of the Scientific Revolution in general and the Mechanical Philosophy in particular was to cast doubt on teleological explanations in science.
- Aristotle had characterized a certain class of scientific explanations as articulating “that for the sake of which” something occurs.
- A standard example was explaining the structure of a house by reference to what a house is for (providing shelter from the elements).



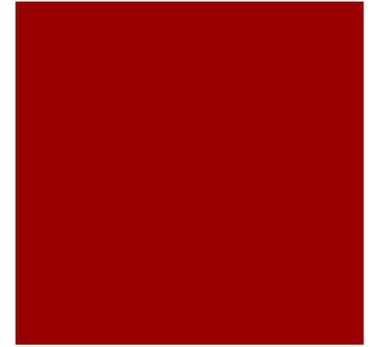
Intentional and Biological

- Aristotle's examples of "for the sake of" explanations referred to either intentional human actions and their products (the structure of the house) or biological items and actions (the brain is for the sake of cooling blood, the leaves for the sake of protecting fruit, the nest for the sake of protecting the eggs).
- By understanding the *purpose* one understands the *structure*, which comprises the form and the matter.



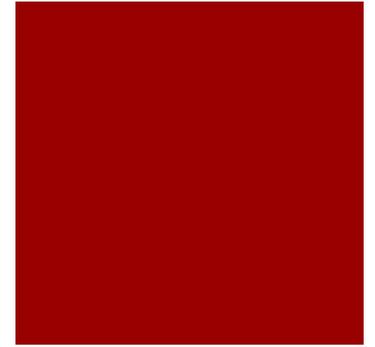
Intentional Explanation

- One form of such a teleological explanation tacitly adverts to the beliefs and desires of the agent who made the object.
- The builder *wants* a solid protection from the elements and *believes* that a certain architectural form will achieve the end desired.
- Note: in this form of explanation it is not required that the product actually *have* the desired characteristic. “Hans used Doramad Radioactive Toothpaste for the sake of a brighter smile.”



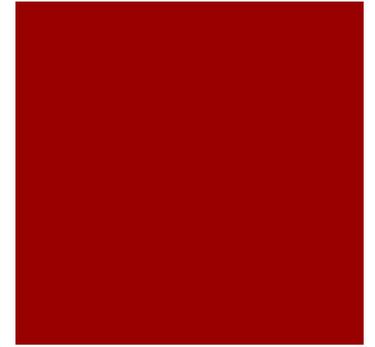
The Evidential Problem

- Clearly, determining the intended purpose of an artifact can be a tricky business. What were the lustral basins in Knossos for? We may never be certain.
- The more intelligent the creator, the greater the evidence that can be inferred from what the artifact actually does, and conversely the stupider the creator the less can the actual properties justify a theory of the purpose.

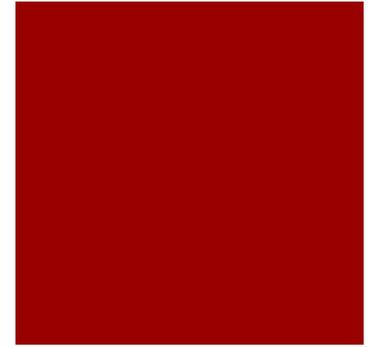


Biological Form

- The structure and function of biological organisms was famously used to argue for an intentional creation via the Design Argument.
- Evolution was then found to afford completely naturalistic explanations of biological forms without appeal to intentional design.



Replacement of Intention



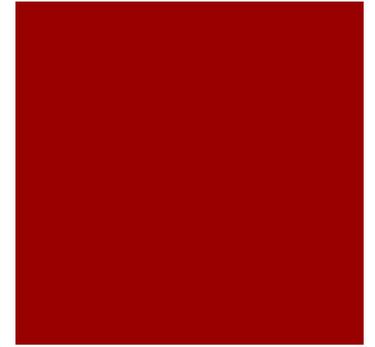
- If the design argument had worked, the origin of the biological form would be an intentional act, reducing the “for” to “intended for”.
- Darwin understood that the biological forms could be accounted for in an entirely different way through variation and natural selection.
- Via feedback through fitness, selection pressure could drive the gene distribution and corresponding phenotype distribution in certain directions.

Selected For

- This scenario allows one to ask what a certain biological trait was selected for, if anything.
- Showing what a trait or structure was selected for requires doing more than showing that it presently benefits the organism.
- For example, having a heartbeat is presently advantageous for humans as an aid to diagnosis, but producing a heartbeat is not what the heart was selected for.
- In evolutionary history, no selection pressure depended on the heartbeat.



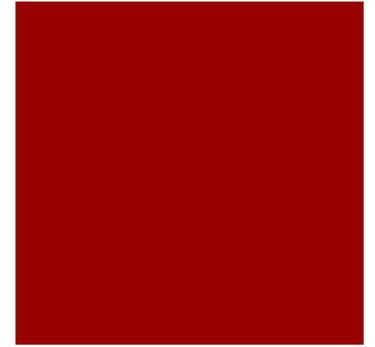
Selection Over Time



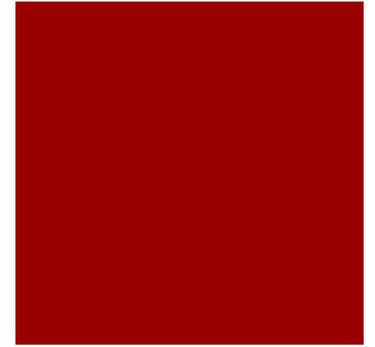
- Selection pressure requires some time to work. The inclusive fitness of individuals with different phenotypes must differ due to the pressure. Slowly the gene pool will evolve in the direction of producing more offspring with the phenotype and hence with the underlying genotype.
- Unlike the case of intentional action, the biological individual must actually have the phenotype being selected for.

Difficulties in Identification

- Determining what, if anything, a biological trait or structure was selected for is therefore a difficult task.
- The Stegosaurus had large plates on its spine. What were they for?
- They might have been for defense. They might have been for cooling the body. Etc.
- Evidence for an answer requires showing both that the trait had the property, and that the presence of the property increased inclusive fitness.

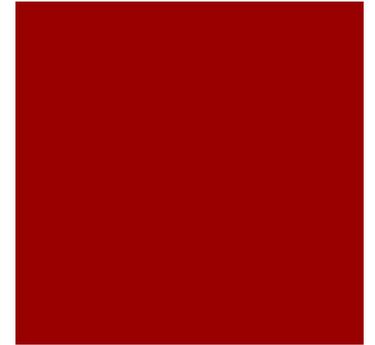


Explanation and Causation



- In each of these cases, the relevant explanation of why the entity has a certain property depends on the existence of a novel cause, either in the selection pressure or in the mind of the observer.
- It is by reference to these causes that a property or object can be said to exist *for* something.
- Many properties of an object do not exist for anything in either of these senses. The “for the sake of” properties are few and far between

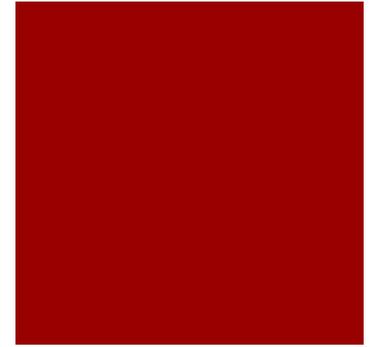
Fine-Tuned For



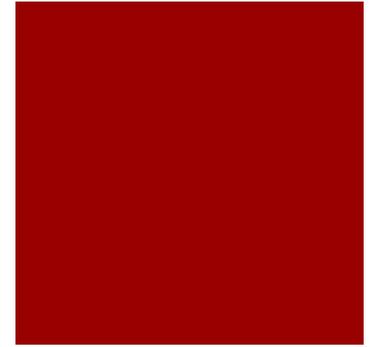
- Some main questions of this conference are:
- 1) What, if anything, are the laws of physics, or the fundamental constants of nature, or the initial condition of the universe fine-tuned for?
- 2) What implications for our understanding of the cosmos does the answer to 1 have?

Familiar Fine-Tuning

- The old-fashioned notion of fine-tuning is a combination of intentional action and variation and selection.
- The fine-tuner is a agent who wants to achieve a certain end. In order to achieve this, small variations to some degree of freedom of a system (“tweaks”) are made, and the results are assessed for progress toward the goal. Improving tweaks are kept and degrading ones undone until the goal is achieved.



Fine-Tuning in Cosmology



- It is essential to distinguish the meaning of “The universe is fine-tuned for X” or “The constants of nature are fine-tuned for X” or “The laws of physics are fine-tuned for X” from either of the “for” locutions we have examined.
- “A is fine-tuned for X” means: were the parameters that characterize A *slightly different* then X would not have existed.
- Everything in the condition is perfectly clear save for *slightly different*.

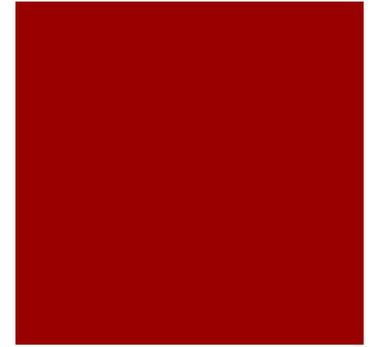
Slightly Different

- In order to get a handle on this issue we need to make judgments about the relative sizes of regions in the parameter space. If we had an exact measure over the parameter space then everything would go through fine. But we don't.
- Nonetheless, in some cases the need for an exact measure does not seem bothersome. If I say that the Sahara Desert is overwhelmingly made of sand it sort of misses the point to ask: by what measure?



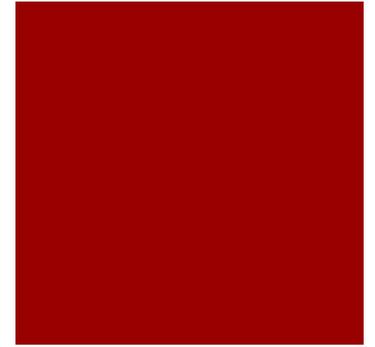
An Example

- Our first example is a structure that the universe was certainly very, very, very fine-tuned for in any reasonable sense. The laws of nature, constants, and initial conditions had to be *just as they are* for this entity to come into existence. Any reasonable measure on the phase space yields this result. In sum, the universe was perfectly fine-tuned for....
- me.



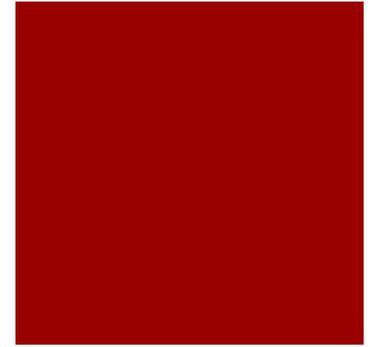
The Argument

- Given the meaning of “fine-tuned”, this result is trivial. Had any law of nature been different in any way, had the mass of the electron been ever so slightly different, had a single proton been displaced by a centimeter shortly after the Big Bang, I would not exist.
- The entire universe in all its detail was perfectly fine-tuned for my existence.

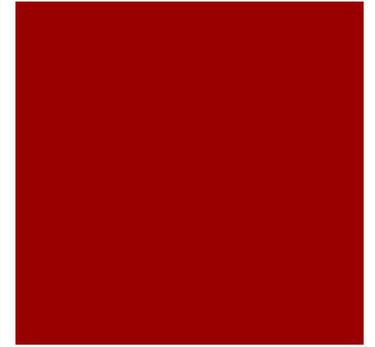


So What?

- If the manifest fact that the universe is fine-tuned for me implied that the universe was *designed* for me or *selected* for me, this would be quite an amazing discovery. But as it stands, nothing very interesting follows from the fact that the universe is fine-tuned for me.
- As you have already realized, it is equally true that the universe is perfectly fine-tuned for your existence, and Donald Trump's existence. It is also fine-tuned, but not so severely, for the existence of earthworms and volcanoes and asteroids and black holes.



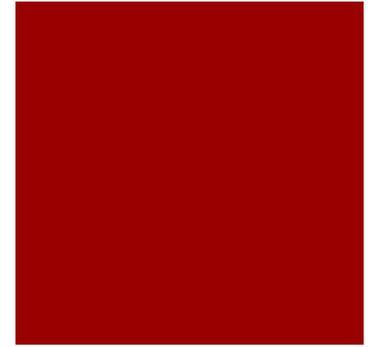
Accidental Existence



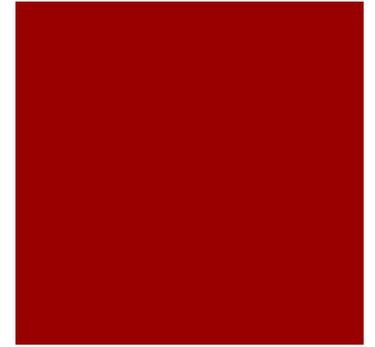
- Just because the universe is fine-tuned for my existence it does not follow that the universe or any of its parts, or the laws of nature, or the constants of nature exists *for the sake of* my existence.
- All that follows is that my existence is, from a physical point of view, a very, very fragile thing.
- The rather grandiose sounding fact that the universe is perfectly fine-tuned for me is equivalent to the much more depressing fact that my existence is a cosmological accident.

Failure of Science?

- Does the fact that the universe is fine-tuned for me imply any sort of *prima facie* incompleteness of inadequacy of the laws of nature as we understand them? After all, physics classes make no mention of me, and I play this central role in things!
- Obviously not. The observation that my existence is the result of a long series of unlikely outcomes in no way suggests that the outcomes were not, in fact, highly unlikely.
- My existence is merely accidental. As Aristotle would have said, it is due to chance.



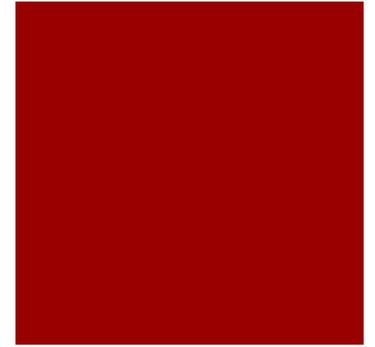
When is Chance Intolerable?



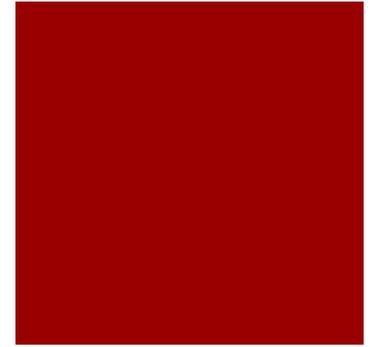
- As we move from particular individuals to more generic features the degree of fine-tuning falls.
- The universe is fine-tuned for my existence, and is less fine-tuned for human existence, and life, and volcanoes.
- As we move to these more generic features of our universe, the fine-tuning gets milder and milder.
- But at the same time, the appeal to chance feels less and less plausible and adequate.

Alternatives to Chance

- There are several different alternatives to relegating a fact to mere chance including:
- Design—which requires a designer, whose structure in turn demands explanation.
- Evolution—which requires a structure of variation and selection.
- Multiverse—Blind multiplicity without a selection mechanism for evolution. Vast multiplicity plus the Weak Anthropic Principle.



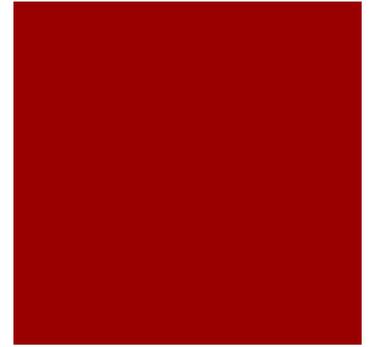
The Generic Character of Our World



- It has been pointed out that the universe is fine-tuned for life, for intelligent life, for humans, for moral beings who can ponder their fate, etc., etc.
- Is it acceptable to regard any of these features of our universe as merely accidental and coincidental, undeserving of further explanation?
- The more generic the characteristic is, the harder to dismiss as merely accidental. This suggests a question.

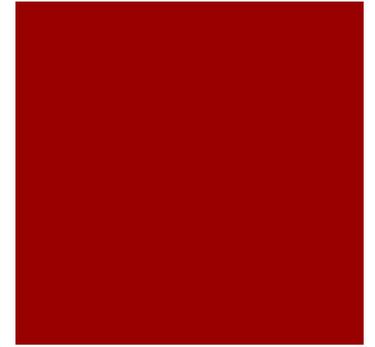
A Critical Question

- What is the most generic characteristic of the universe such that having posited *it*, all of the other more specific features that the universe possesses can be accepted as merely accidental and not requiring further explanation?



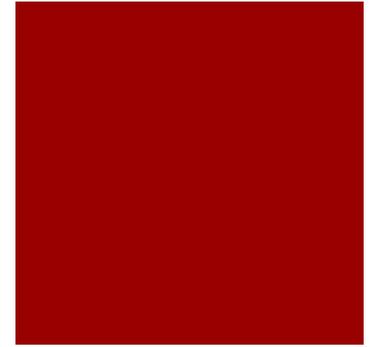
Proposed Answer

- Complexity.
- Given the physical possibility of sufficient complexity and enough time, space and matter, it seems that the rest of the features—volcanoes, life, intelligent life and morally significant behavior—can be regarded as simply arising by chance. Some of these would arise rather robustly and inevitably in these conditions, and those that wouldn't (e.g. me) can be dismissed as mere accidents.



In More Detail

- Our universe permits a vast variety of distinct stable molecules, from which a huge variety of stable substances with diverse chemical properties may be formed. Such stable complexity is a fundamental requirement for the tremendous wealth and assortment of geological and biological forms that surround us.
- In sum, if we can account for the existence of chemistry, the higher levels of complexity may be generated through variation and selection or through pure chance. But the cosmos does appear to be fine-tuned for chemical complexity.



Is Complexity Miraculous?

- For me, the most striking fine-tuning arguments are the arguments that the universe is fine-tuned for complexity.
- Once one has the right physical principles so that a complex universe becomes generic, it seems scientifically acceptable to regard all the further features of it as due to chance.
- If this is right, then we at least have a target for our discussions.

