Take Home Final Exam Winter 2019

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On Free Will and Determinism

Free will and the omniscience of God are mutually exclusive ideas. If God is truly omniscient then He already knows what the outcomes of our lives will be, thereby making our eventual destiny deterministic, predestined, unavoidable. If this is the case, how can anyone argue for the existence of an omniscient God who has created beings with free will?

Humans crave meaning. Throughout history, we have devised methods to describe and make sense of the universe around us and our place in it. We began first with gods to explain the unknown forces shaping the world around us. Eventually, insightful men and women realized that these forces were not random. They could be quantified, measured, and to an extent, predicted. This led scientists to develop a deterministic view of the universe. French scientist Pierre-Simon Laplace is even reported to have said something along the lines of the following:

> An intellect which at any given moment knew all the forces that animate Nature and the mutual positions of the beings that comprise it, if this intellect were vast enough to submit its data to analysis, could condense into a single formula the movement of the greatest bodies of the universe and that of the lightest atom: for such an intellect nothing could be uncertain; and the future just like the past would be present before our eyes.

Obviously this computation would be incredibly complex, but Laplace and others held that it would be theoretically possible. What they may have not anticipated was how these discoveries would begin to conflict with their previous notions about the nature of God. Does a deterministic mathematical and scientific view of the world lead to the removal of the necessity of deity?

Mathematics can be described as the language of the universe. Using mathematics as a foundation, the sciences of physics, biology, chemistry, etc have been able to create a magnificent description of the natural world around us. But what is mathematics grounded in? This is one of the questions at the foundations of number and computational theory, and still a hotly debated topic. One could make the argument that our understanding of the universe could stem from our understanding of mathematics. If mathematics is a construction of humankind's intuition or simple philosophical view of the world, does that indicate that we have locked *ourselves* in a potentially deterministic box? On the other hand, if the foundation of mathematics can be found in logic or Platonism, how does one reconcile the inferred determinism

of these models with free will? Furthermore, is mathematics itself "trivial", or does it require a "deeper" intelligence to understand and expand?

William Byers describes the difference between "trivial" and "deep" mathematics in his book *How Mathematicians Think*. He concludes that "trivial" and "deep" mathematics can be separated by the idea of verification. It is trivial to verify that a logical proposition is true; it requires almost no knowledge or background information to do, and can be easily fed to a computer to verify. On the other hand, true understanding is nontrivial. It requires mathematics that not only can easily be shown to be true, but also provides insight into why it is true [0]. While a mechanical computer is quite capable of performing simple verification problems, it is not capable of this higher form of complex thought. Byers concludes:

> If mathematics includes the mathematician, then it is reasonable to see intelligence as an essential ingredient of mathematics. Mathematics is a form of intelligence in action; that is, it is not only the objective result of an act of intelligence but rather a demonstration of the nature of intelligence itself. It is a major way in which intelligence functions. When we study mathematics we are not so much absorbing some predetermined set of facts as we are studying the manner in which the mind works — the manner in which it produces mathematics.

Kurt Gödel showed, quite paradoxically, that no consistent set of axioms can

be algorithmically listed which would be capable of proving all arithmetic truths. This leads to the undeniable conclusion that there exist some truths, which though known to be true, cannot be proven as such. The implications of this conclusion are massive and thought-provoking. For instance, it shows that mathematics itself is nontrivial!

Gödel's work when paired with the work of mathematicians Alonso Church and Alan Turing showed that with only a finite logical system, not only can we never programmatically describe all truths, but that we can not even know the output of all the programs we create [1]. As Rudy Rucker so eloquently described in his essay *The Ocean of Truth*, if this were not the case, every human activity would be listable and computable. This would imply that we are stuck in a finite, deterministic universe where every action you make could be pre-calculated. Every person's life could be entirely reduced down to a mathematical equation. You would like to become a computer scientist? Here are the exact steps *you* must follow to become one. Building off this idea, it would be theoretically possible to reduce the entire universe and every action that takes place in it down to a single computation. One master equation, that while perhaps far too complex to ever truly understand, would ultimately determine the entire outcome of the universe. Perhaps this is God's true form? Thankfully due to the work of Gödel and others, we know this is not the case.

This nondeterministic view is further backed up by quantum theory. In Dr. Stephen Hawking's essay *Does God Play Dice?*, he delves into this very

question about determinism and free will [2]. His conclusion from a physicist's perspective is that the universe is not deterministic. He ends his essay with the following:

> To sum up, what I have been talking about, is whether the universe evolves in an arbitrary way, or whether it is deterministic. The classical view, put forward by Laplace, was that the future motion of particles was completely determined, if one knew their positions and speeds at one time. This view had to be modified, when Heisenberg put forward his Uncertainty Principle, which said that one could not know both the position, and the speed, accurately. However, it was still possible to predict one combination of position and speed. But even this limited predictability disappeared, when the effects of black holes were taken into account. The loss of particles and information down black holes meant that the particles that came out were random. One could calculate probabilities, but one could not make any definite predictions. Thus, the future of the universe is not completely determined by the laws of science, and its present state, as Laplace thought. God still has a few tricks up his sleeve.

What then, does a nondeterministic universe imply for the concept of an omniscient God? If our universe is nondeterministic, how then can there exist a God with a knowledge of our past, present, and future without con-

tradicting the laws He supposedly created? While I do not claim to have **the** answer to this question, I do have some thoughts and insights that I believe are worth discussing.

My instinct is to follow a traditional line of thinking put forward by theologians like C.S. Lewis, which is that God exists on a plane outside of time where he observes all of our time at once. In his book *Mere Christianity*, Lewis expounds with the following [3]:

> But suppose God is outside and above the Time-line. In that case, what we call "tomorrow" is visible to Him in just the same way as what we call "today". All the days are "Now" for Him. He does not remember you doing things yesterday, He simply sees you doing them: because, though you have lost yesterday, He has not. He does not "foresee" you doing things tomorrow, He simply sees you doing them: because, though tomorrow is not yet there for you, it is for Him. You never supposed that your actions at this moment were any less free because God knows what you are doing. Well, He knows your tomorrow's actions in just the same way—because He is already in tomorrow and can simply watch you. In a sense, He does not know your action till you have done it: but then the moment at which you have done it is already "Now" for Him.

An answer along these lines, while not stemming from any concrete logical

deduction or proof, does seem to align nicely with the doctrine often repeated in Holy Writ that God's course is "one eternal round." Through this view, God is omniscient not because He knows exactly what choices we will make in our lives, but because he sees our entire life as one complete whole. We are still free to choose, and He will know the outcome, but not because He determined it to be so.

On Disobedience to Higher Laws

"Law is the simple application of truth." - N. Eldon Tanner [4]

Why does it seem that advanced intelligences are free to disobey the higher laws set forth by God? I would argue that they are not.

God has put forth both spiritual and physical laws to govern our universe. As physical beings, we are bound to obey, one way or the other, the physical laws of the universe God has set forth. We cannot simply "choose" to disregard gravity. The law has hold on us, whether we like it or not. To disregard it is to invite physical peril into our lives. I believe the same holds with the spiritual laws God has set forth.

Yes, it may seem that many men and women disregard the laws of God seemingly without consequence, but we have been repeatedly taught that there is a day of reckoning coming, a day when all men will be held accountable for their deeds, whether good or evil. Just like choosing to disregard the law of gravity may lead to serious physical injury or death, disregard-

ing the spiritual laws of God will result in spiritual harm and death. The consequence may not be immediate, but it will come nonetheless.

It seems we have come into this world with bodies which understand and willingly obey the physical laws of the universe. This provides us with a level of **computational output** to operate from. However, our main purpose in coming here has been to learn to freely obey the spiritual laws God has set forth, further increasing our output. Perhaps this can be viewed as a step on the hierarchy of languages. A regular language has some computational power, but like our obedience to the physical laws, is limited in what its computational power can produce. Learning to obey the spiritual laws would move us up the language heirarchy to a sphere which is more computationally powerful.

Deciding a Halting Problem

What is the program computing?

This program is an implementation of Conway's PRIMEGAME which is a method to generate prime numbers. The program uses FRACTRAN (a Turing-complete language) to generate the prime powers of 2.

How does it do it?

OEIS provides a great write up of how the PRIMEGAME works, which I will paraphrase here [5].

Given a sequence of 14 rational numbers,

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((frac 17 91)
 (frac 78 85)
 (frac 19 51)
 (frac 23 38)
 (frac 29 33)
 (frac 77 29)
 (frac 95 23)
 (frac 77 19)
 (frac 1 17)
 (frac 11 13)
 (frac 13 11)
 (frac 15 14)
 (frac 15 2)
 55)
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starting with i = 2, find the first number in the sequence that when multiplied by i produces an integer. Set i to that integer. This will generate a sequence such that when the binary logarithm of n is an integer, it will be a prime number (checking if it is an integer is handled nicely by 'math-

integer-log2). This then generates the noncomposite powers of 2, or in other words, the prime powers of two.

I would like to quote directly from the OEIS wiki page, as I think it provides perhaps a clearer insight into how one could think of this program as a machine.

> It may be helpful to think of the "machine" as an actual machine, with an intake on one end and an outtake on the other end. A workpiece, in this case, a power of 2, is fed into the intake, the machine is activated and after making some noise and shaking, the workpiece comes out the other end transformed into another power of 2. And of course we can take this new power of 2 and put it into the intake once again.

Will it ever terminate?

With this machine sequence, no the program will never halt. The last number in the machine sequence is the whole number 55. This guarantees that if none of the previous numbers in the sequence multiplied by i produces an integer, the 55 will (remember that i only gets changed when it is multiplied by one of the fractions to produce a new integer). This is quite elegant, because as we know, there is an infinite number of primes. It therefore seems appropriate that a program designed to produce the prime powers of 2 would also never halt.

Final Thoughts

As this is the final assignment of my undergraduate degree, I felt it appropriate to share some thoughts with you, the teacher who has had the greatest influence on my mind the past 4 years.

I have truly enjoyed my journey from Discrete Mathematics I through Computational Theory. The four "DM" classes have been the most challenging, thought provoking, and rewarding classes I have taken during my undergraduate degree. I never would have believed that I would be able to understand the concepts that I am now able to explain clearly and plainly to my friends and family. I came to this university with a desire to learn, and more than any other classes, the "DM" classes have fulfilled that desire. I am excited to continue down this path of knowledge and discovery you have set me on in my future endeavors. Thank you for believing in and supporting me through the last year and a half of my schooling. I hope that I have been as rewarding a student to teach as you have been a teacher to learn from. I will always remember the lessons that you taught me, and espouse the comforts of elisp to all those willing to hear.

Adieu

References

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2. *The Ocean of Truth*, Rudy Rucker, https://rickneff.github.io/the-ocean-of-truth.pdf

3. *Does God Play Dice?*, Stephen Hawking, http://www.hawking.org.uk/does-god-play-dice.html

4. *Mere Christianity*, C.S. Lewis, MacMillan Pub. Co., New York

5. *The Laws of God*, N. Eldon Tanner, https://www.lds.org/general-conference/1975/10/the-laws-of-god?lang=eng

6. *Conway's PRIMEGAME*, OEIS Wiki, https://oeis.org/wiki/Conway's_PRIMEGAME

7. *A007542*, OEIS.org, http://oeis.org/A007542