0. Two Given Styles Of Lectures

1. The Ampere/Voltage/Ohm

2. The Gödel Numbers

3. The Turing Machine

4. The Nash Equilibrium

5. More than Analogy

6. The Greek Example

*0. Two Given Styles Of Lectures*

There are two lectures, which are confidently designed for the listener. One is extremely short and to the point, and actually has some hope of being understood in real time. These are “do” lectures. The other one is extremely long and will have to be absorbed over time, and contains hints of things yet to come. These are “think” lectures; both of these are badly done because training a lecture to do this is not an immediate process.

And who knows, you might actually learn something, even if the lecture is disabled.

Obviously this is the second kind of lecture, and the lecturer does not think that all you who will get it will not get right way. In fact I would be surprised if any of them got it, though one or two of you just might. Given that this is a long lecture, and does not come with an immediacy of understanding, it means that you will take time to really understand. So let us begin, first with the obvious parallel to a battery, then by going through the three talking points, then closing with a distinct problem – and some questions.

As I said, you are not going to get this at once. But that is all right, because now that you know the information: you can digest at your own pace, and not rush to produce it on a test. You are at the point of having to digest at your own pace, and not by the cycles of semester or quarterly information. While not everyone will treat you as grown-up, I will, and it takes you days or weeks or months to get this, that is all right by me. After all it took me a great deal of time to come up with this, so it is going to take you time to understand it.

First of all, though, I would like to thank everyone involved in giving these lectures, because it is tough to get together a lecture that will be understood. And each and every one involved deserves a hand. And I would also like to thank all of you for attending these lectures, because they are not easy to absorb.

*1. The AVO*

By now we know what AVO is: an Ampere driven by a Volt, against a resistance of one Ohm. And if we do not there are a large number of websites willing to explain this for you. We do not need to know everything about physics, just where to find that stuff that we do not know when to know it. The AVO is the basic unit of electricity, and everything about electricity can be expressed by it, or by numbers which come the same thing, usually with a square somewhere in the calculation. Is so basic and so obvious that it will take four years to just know what you are looking for, and another five or so to actually make a contribution to the field of EE.

What this means, if you think about it, this field is rich in density with possibility, and produces interactions that are complex and extraordinary. You can spend your entire life working with just such equations and workings out of the field. Airplanes, automobiles, trains, and all manner of appliances – from very large to the very small screen out for just a little nudge of EE. This means that a triangle of forces is at work in any complete electrical circuit. Even if Ohms is zero, because after all zero is a number.

When first you start experimenting with electricity, everything seems novel – and if you will excuse the expression, shocking. That is because electricity goes where it wants to, rather than where you wanted it to go. And that means you have to learn the language of electricity if you want it to go anywhere. But there is a saving grace – and that is, it will ignore, most of the time, detours which do not interest it. Compare this with water, which will squeeze out any little gap and come flushing out of every pore if you give it a chance – and even if you do not think there is anything to squeeze. Water will find a way – whereas electricity will not.

What makes electricity so useful is that it provides a framework for introducing a novel concept: GTN as a unit of measurement. Because if you think about it, it is basically the same concept: you have a way of current running on a system which will work if the current times the system is over the backlog. But what has not been made clear to everyone is what GTN actually works out to being.

So let us take a moment to review the AVO, and then introduce the information equivalent. This way if you get lost in the world of GTN, you can slip back to an old standby and reason by analogy. So what is AVO?

Let us start with amperage, and what it is actually doing. Amperage is the amount of electrical current present at a given point, When it is expressed the current is in Amps, whereas the charge accumulated is measured in coulombs. But that basically means that a charge will not move anywhere unless there is voltage which is expressed as kilogram meters squared over Amperes times seconds cubed. In other words a weight times a distance over seconds cube. This is more easily expressed as Watts over Amperes. Now here is where physicists divide from electronic engineers. Physicist will know that there is some conversion factor which he will remember two digits of, or look up if more precise is needed – where as the electronic engineer will know the precise nine digit, and have them memorized. And if you look at their phone, it will be (xxx) 483-5979. They will even take issue with the water flow analogy, because everyone in the EE space knows that water flow is not the same thing.

Then everything slips in two places, the average does the work, the voltaic is the hurdle to cross, andOhm is the resistance between two points on a conductor. Thus Voltage, Amper, and Ohmage are nice neat one-for-one equations.

But there is a small catch: it took a little over 100 years to do this. Which seems a bit long for some rather simple equations, not one of them uses more than cubed. Which brings me to what is new here, not defining one cell by a current, but by information.

So for the moment hold on to Ampere, Volt, and Ohm in a triangle which is the position in current space.

*2. In the Beginning, There was Gödel*

First it is unclear why one would even need to do this, but Cantor showed us that it was necessary at least in terms of mathematics. It did not occur to anyone that this would have practical possibilities, at least so far as the word willing to publish, or even quoted. Now if I were relating all of the history of this idea I would begin with Cantor, move on to bring Principia Mathematic by the pair of misguided geniuses Whitehead and Russell, then take a moment to admire the foundation of the rules of the game by von Neumann and Morgenstern, and tell all of those odd quirks of personality. This is what one gets by thinking about probability vectors such as P and Q and a positive number that will solve an equation that is complementary to pT (A- lB)q = 0.

But since a great many of people are doing this, and much better than I can, I will restrain myself to the three main characters of my drama. The first of these is a man who wandered on to the scene at 23, and proved that what was impossible was in fact required: Gödel.

In 1931, he began with the assertion that “the development of mathematics has been in the direction of greater exactness has – as is well known – lead to large tracts of it becoming well formalized, so that proves again be carried out according to a new mechanical rules, the most comprehensive formal systems yet set up are, on the one hand, the system of PM, and on the other hand, the system for set theory by Zermelo-Fraekel (later extended by von Neumann).” I will note that this is not the last time that von Neumann is referenced. I will also mention the 1997 extract by Schwalbe and Walker as a good summary of Zermelo role in all of this, by Harvard University, with input from numerous inputs, including Kuhn.1

Rather than delaying until he has a proof that he is going to show is false, he asks directly the question which others had taken on in large volumes - and replies that it is not the case. He then says that it is obvious, which is like a beer tromping through the woods with a picnic basket in its mouth, everyone will wonder who made it, because it was not the bear.

He then sets off a proof with one free variable, which can be any natural number. And denotes Bew X as being a provable formula for X. from here he directly attacks the provability of Bew. While the proof is by no means the easiest one to prove, each of the ones that come after it know that it is already too be proved and simply are trying to form a better solution to something already proven. The thing about Gödel proof is that he was not sure that he was going to do this.

What now follows is quite tricky, he sets up a series of proofs that means that a, insert cases, is neither confirmable nor deniable within the system, which is, as is noted, equivalent to a PM system. In other words certain a are not provable nor disprovable in any finite number of steps. One can do this proof more simply, and I allow you to try your hand at it, because I did, as did several others. But there is something about this original proof, which stands up to the test of time.

One thing about it is that it is on the backside of one to one proof. There may be proofs that are shorter, but there is no proof, which is easier to explain then the original. This is partially because every proof is recursive, and that means that you simply have to go down the proof, until you hit the bottom. In other words it not only proves its point, but also proves the next two pieces have to be there as well. That is to say: Turing and Nash. And this is all in a very short book. You would be well advised to purchase “On Formally Undecidable Propositions of Principia Mathematica and Related Systems”2, and run through it yourselves, because as Newton's three principles of motion, and a universal gravity, were in its day, this is one of the seminal moments of ours.

This proof then turns on the uniqueness of prime numbers; it translates into primes, and builds from there into a GN version, which will be unique. It then says for any proof system one of three things is possible:

1. The system is finite, and will cast out all of the proofs which would create disharmonies.

2. The system is finite or infinite with a fixed number of axioms, but will have disharmonies within it.

3. The system is infinite in its number of axioms.

One might think, but not to quickly mind you, that a system which is finite and casts out all of the proofs would be preferable. Humanity got along just fine without them, or so it appears. After all classical logic has only two variables, and a virtual plot of eliminating the obvious from the conclusion. “Whatever is left, however improbable, is the truth,” says Sherlock. But the things that you have to give up are tremendous. Such as multiplication, that is right 3 x 3 is right out. Sherlock may get by without multiplication, but the rest of us need it, for buying milk, and so on.

The third choice offers attractions which have yet to be explored, but will require things like Goldbach Postulate will have to be included, things on which nothing else relies upon. This is quite a drag on the system, and it will have to have a new sort of mathematics to engage in, there might not be anything wrong with that, and one of you might discover it.

For this reason, the second, is why Codd and Date needed variables which were undecided in their Relational Database System, a direct descendent of what we are talking about.

One major difference between a Gödel numbered system and a current is that generally it is the GN, which is to be found, either because it is unknown, or it is being hidden by the party who wants not to reveal what they are doing. This means that GN is often worked backwards from a von Neumann position, the proof of which is the problem to be set up.

One example of this is from my friend Scott Kominers3, of the Harvard Society of Fellows. The key determiner of a patent troll, called in the language of art a “Non-Practicing Entity”, is the difference in the target company. In a normal lawsuit there is harm that is alleged to have been done, and a lawsuit is filed against the holder of the patent. In a NPE lawsuit however there is a direct correlation between the ability to pay, and the likelihood that such a lawsuit will be filed. Even if the money does not come from the patent.

This, and other examples, means that the GN is only a fraction of the story, and for all practical purposes is the endpoint not the beginning. One often finds this in the sciences: first one needs to find out where there is a problem. But it also means that the problem exists and no way of solving it has yet appeared. It is a problem that is discovered first.

But when a problem appears, most people do not think of how to solve the problem in general, but attack the problem in detail; which clutters the literature with innumerable small examples. But a few pioneers see a larger question, and set themselves to work. Once a current has been made, in our electoral example, then one needs a voltage and resistance. In the same way, in informational space, one needs a machine, and a limit. These two followed quickly because once the problem was determined to be informational, it was only a matter of time and brilliance. Because let us remember that even the failures were brilliant, and even more so the two successes.

*3. The Turing Machine*

But on the ground, there is a problem, which is looming in the thoughts of the participants: they see problems everywhere, and there seems to be nothing to relate them. It is a fog that no one can see their way out of. A large part of the problem is that no one realizes that the mechanics of a new generation are fundamentally different from those in the past. This was the same with light and electricity, because no one knew what the difference was. And once it was found it took 50 years to discover the means by which it was enforced by nature. Now of course the Higgs will be known to all, but it was not that way for decades.

In the information space, the idea that it was a machine was not even in people's mind. Except one, who had been working on cleaning up the mathematics of Gödel, and he discovered a seemingly bizarre creation. Remember that no one had thought of it as a machine, even though the concept had turned up in Ancient Greece, in Renaissance France, and in Victorian England. But each time it had been dismissed, and the machines slumbered quietly until someone picked up the pieces.4

The man of course was Turing, who was at the right place with the right brain power. Because there were people who saw the signs and ignored them. As Winston Churchill said, they hit upon the truth and get up on their way as if nothing happened.

But Turing was working on the machines, and saw a formula, which would work: an unlimited memory, a scanned symbol, and a simple set of instructions. And that is all that needs to be accomplished. All of the rest of the computer hardware that we possess is towards making it run better. He invented this in 1936, a few years after the GN was invented. Almost nobody else even thought of a machine for this problem.

But what this did is simply astonishing, partially because it solves the riddle of the Enigma – whose German scientists thought it to be unbreakable. Yet when the machine was perfected, that is a real machine, it was able to break things on and enigma code machine almost in real time. But it was a problem known to David Hilbert, and put on his list in 1900, called, appropriately enough, the “Hilbert's Problems”. Thus the uncrackable problem was indeed cracked by a simple machine. Remember that the mathematics behind this question was quite exact: first of all was the mathematics complete, second of all was the mathematics consistent, and third of all was the mathematics decidable?

Then on a day in Grantchester Turing had what he needed, because he knew that this problem was related to a universal machine. Once he had that concept, it was just working out what the machine had to do. And Turing had been the one man who was determined to see that a typewriter was far more than a mechanical device to produce letters.

All that was to be done is calculating the equivalent of Ohms. But again remember that the people at the time did not see this at all, because what they thought of as problems – rather than thinking of solutions – gripped their minds tightly. So we now move on to Nash, and one of the most brilliant papers of all time, and one of the most surprising.

So even as you play with Google, realize there is a long fight from 1900 when Hilbert enunciated the question, until you find what you are looking for by typing in a view words into a box.

*4. The Nash Equilibrium*

Each type of genius is unique to itself. Gödel took two seemingly unrelated things, improved they were related to each other. He did this even though two geniuses of field tried to do things the opposite way – and Whitehead and Russell were geniuses. Turing was, for all intensive purposes, a mystic – seeing things in a completely different fashion, even though the objects that he reached with were right there. They just thought of them as machines, whereas he understood them to be computers. Finally, we reach Nash, whose gift was to see things in place site. Remember that Gödel himself see this though he was a resident at Princeton at the time, but did recognize for what was. It can easily be said that genius has the gift of a complex mind, but is trumped by a genius with a simple mind. So let us get to Nash simple genius, which is often overlooked next to the complex geniuses that surround him.

Though I would like to mention that in 1951 he was hired by this institution, to be a C. L. E. Moore instructor in the mathematics faculty, and eventually a full professorship.5

So what exactly does he prove with his famous Nash Equilibrium? Is only a few simple steps, and it proves two things: first that the group that is a Nash equilibrium is concave rather than convex, and second one does not prove it forward but backwards. Everything else in the group is devoted to one of these two concepts. You might think that anyone can prove this, and you would be right. Anyone can do this once knows that it has been proved, but no one can prove this if he does not know that the proof is sitting right there in front of them. Only one person could figure that out, even Gödel did not figure that out.

Now we have we have to ask: why is this important?

Let us examine the proof, looking for the key texts, which are important.

First he finds an equilibrium point such that if and only if for every individual high there is only one option, for every strategy that the others choose on. That is, whatever your opponents choose, there is only one choice for you, as opposed to one choice in that they choose one way, and a different choice if they choose a different way. This is powerful, because you do not have to concern yourself with what they are deciding. It means that in best case for doing well, and in worst case you are losing least.

Then says that an equilibrium point it can be expressed as pairs of use functions. By this he equates a single equilibrium point to its group on a line. So an equilibrium point stands in for a set of values, which is hard to grasp at first, but settles in your mind once have grasped. Again I will remind you that this will be grasped only with time. That a single point can stand in a curve is not to grasp.

Then he makes a leap into two unknowns, based on Kakutani generalized fixed point theorem. Though cleans it up by making reference to Brouwer. Then he proceeds to show that all of the equilibrium points are connected.

First he shows that every finite game has an equilibrium point. This is obvious, until you actually try and prove it. Then a web comes over you. What Nash proves is that the top part of the equation is the s part with pi as the numerator, over 1 plus the whole amount. Which is hardly obvious.

What he then must show is that the fixed points of the mapping are also equilibrium points, which looks non-trivial, but has a solution. He shows that under Brouwer, the cell must have at least one fixed point which also means it is an equilibrium point. This does not show that all equilibrium points are accessible from one strategy, however. It just proves that there is an equilibrium point for each strategy, but what he needs to prove is that all of the equilibrium points will yield to the same step.6

This makes it provable that any finite game has a *symmetric* equilibrium point. Which means that it is not random, and it is not a sphere of pointsthat are related: but a curve of points that have a symmetric relationship. This is one half of the problem, because instead of a random series of points, he has shown that they lie on a curve. What he now needs to show is that there is one curve that dominates all of the others, if it exists. Remember it does not have to; there are unsolvable games, but if they are solvable then, they are solvable on a plane. This means that there are no strategies which have a myriad of unrelated points. Either they are solvable on a curve or they are not solvable at all. This means if you have a position which is insoluble in any way, you do not have to look for any other examples. Similarly, if you find a solution to a problem, that means that the solution exists on any curve. This is unexpected, and the proof, while simple, is hard to get through.

But it has repercussions, because it means that to solve any problem which has a solution, one has to start at the end and work backwards. This is a general plan: start with the end.

But then proves that for any game which is soluble, regardless of number of players or their strategies, the same rule applies: if it is solvable, work backwards. He called this the “Geometrical Form Of Solutions”. And they had the property of Dominance and Contradiction Methods”.

*5. More Than an Analogy*

At this point, I am going to say that I fibbed, a little bit. I once said that it was an analogy, but actually it is more than that. The current space technology is one of two positional spaces, which together add up to a single positional space. Unfortunately, I do not have the time to recount the Higg's space side of the equation, partially because the work has not been completely established.7 But the information space is the other road to this, so what I have actually been doing is matching Gödel to amperage, Turing to voltage, and Nash to ohmage. That means that this is not just a mathematical concept, which some hints in Nash might have given you the clue. One can show actual real meaning to this concept. Just as AVO is related to current space, GTN is related to informational space. Now you might think, so what? But that is where three values not two enter the equation. Because there are three values, then the left half of space, the one that current space is a part of, will intersect with informational space. And in between these two spaces, there is a space, which is one nor the other. In positional space current is known, and Ohm is, generally, unknown. It is quite the reverse for informational space: generally Nash is known, while Gödel is, generally, unknown. There are exceptions to these, as with any physical realities.

But what this generally means is that the Nash Equilibrium is the starting point, and then one calculates the Turing Machine to arrive back at the Gödel Number. Of being a triangle, it can be from any one of the three, but the Nash Equilibrium will generally be the start, because it is the easiest one to find. And in science, if you can find a quantity, then naturally that will be your starting point. And the Nash Equilibrium, by joining the Gödel Number and the Turing Machine, one being opaque, and the other not be decided upon, is the only point where one has the advantage of being able to discern.

Thus the normal process is to find out the Nash Equilibrium, just as with the AVO the first part is to determine the voltage or the amperage, since in current space those are usually the easiest points to discern. In current space Ohm is not measurable, but amperage or voltage is, by the fact that current is mainly about electrons, which means you just need to place a voltmeter and measure. This is a difference between current space and informational space. And it might seem odd, and then dismissed.

Until you realize that current space and information space really rely on each other, and that means that there is a grouping of the two. So if I divide current space from informational space, and join them, it is obvious – in that way that mathematicians speak of obvious – that there is a set which is neither true nor false. This, remember, is from Gödel, that your two spaces are conjoined, there needs to be a third space which is neither true nor false, but indeterminate. This will lead you to Codd and Date, who are the informational engineers, as opposed to the mathematicians. One of the important differences, is the mathematician looks at the problem, solves it, and goes on. The engineer actually has to build a working object. Think of it as a fight between the scientists and the engineers over which is more important: the discovery that it could work, or the actual working object. This too, is part and parcel of the decisions you will make.

*6. The Greek Example*

Instead of poker, I prefer politics. And after all, politics is a way of people making choices which affect their lives. And it is a natural laboratory for GTN. With real consequences. Let me take the current turmoil in Greece as an example.

Do not understand Greece? That is all right, you are with a great deal of company, including people who really ought to know better. But what if the papers today were a giant remark by a negotiator for the Germans. Basically he said: "Why do not you just leave?"

And that remark gave everyone who thought they had a clue, a real point to start at the end and work backwards. It was just the smart people who knew what was going on, it was the people who listened very closely, which is a larger number than before. You just have to know what the signs are, and use something called "Game Theory".

Game theory was invented, to remind everyone, by Morgenstern and John von Neumann, with von Neumann one of the finest mathematicians in the 20th century. The game that they started was littered with the best of minds in the field, many of them great mathematicians themselves. And three of the brightest are already mentioned: Gödel, Turing, and Nash. What the three of them did was essentially invent the idea of informational space, and, though separately, introduced the idea that there was something like a current running through this. Later on, engineers realized that it was not just theoretical, it was also practical.

And one of the greatest ideas came from Nash; that was, do not go forward, go backwards. This way you will know what each participant wants, and how best to conserve it. In this way you could show by game theory what they would do, and what they would do by min maxing their position, whatever their opponents did.

This was not just theoretical, Nash showed it by using poker as an example, but its main use is with real people and the choices that they make. Once you look backwards, you will see that the logical choices, if any, will be there. And sometimes they will not be there as you would expect.

Take for example: Greece. It might seem that there are only two players: a Greek player, and a European player. From this viewpoint, the Greeks want out, and the Europeans want in, that is of the euro. So the Europeans punish the Greeks to bend them to their will. But there is not two but three players in the game: the rich Greek people, the poor Greek people, and the Europeans. The Europeans and the poor Greek people both want for Greece to go on the drachma. But the rich Greek people, who control all that is worth anything, want to stay, so they can move out of the country whenever is worth moving. They are the people who want to stay.

With this in mind, it then becomes very simple to see why the condition of the country is what it is. The rich Greek people are hiding money, leaving exposed public goods to be taken; because after all they do not care about public goods, only private ones. The poor Greek people, who have some allotment of public goods, even if it is just to get some to lose money, do not have this advantage. That is why the rich Greekocrockes do not care about public goods, and are happy to waste them in order to keep the private goods which they can shuffle back and forward.

But more than that, there are other rich elites wanting to stay on the euro, whatever the cost is to their poor brethren. Such as Ireland. All of these elites want to stay on the euro to have transportability of their money, while the poor do not really care. At least not enough to take the whipping from the bloodless Eurocrats.

So next time you see the results of what is going on in Europe, realize that the parliament is controlled by rich people, and the poor are increasingly out on the street. And the rich Eurocrats do not have a clue as to how to play the game. What they should do is go after the rich of the country, not the poor. For example taxing money going out of the country. Why? Because to them this is a sideshow, and what is really important is not Greece, but Italy, Spain, and Germany.8

But that would leave the Eurocrats in the position of caring for ordinary people. Which they would not rather do. I will leave as an exercise how many people in Britain actually elect the government.

And that is surprising, because we started out with a mathematical concept, which seemed to have nothing to do with physical laws. But here it is doing physical things, such as play computer games, which some of you think I do not notice. But you would do well to notice that I am up here, and you are down there, and there is an informational space disparity, which does not exactly favor you. Just noting that.

So what have we discovered in this little talk? We discovered that there is a numbering system, which is called the Gödel Numbers, based on how primes are distributed. Then we moved to the Turing Machine, and found that it could manipulate these numbers, and decide which of them are useful in the present case. Finally we discussed Nash Equilibrium, which was the resistance to manipulating Turing machines. Finally we took this trio of mechanisms – let us call it GTN – and found that there was a connection to current space. Obviously this is only the beginning of the story, and whether one works on it, uses it, or decides to run screaming from and only then encounter it in an app, you are stuck with it as a feature of our time. There will be other times, and some of you will go on to make your mark: as these three young men did in their early 20s to early 30s.

But remember, there is lot to think about, and the digestion will take some time, and require more reading from you. You may find that there is some mark that you can make in this lecture, and some future lecturer may take a moment to recognize this. Realize you are getting close to making your mark. And if I am alive, I will be very interested in the direction you will take, because it is the new which is exciting, and strange, and will take some time to get your head around, as Someone by the name of Guth9 did for me.

Footnotes

1 “Zermelo and the Early History of Game Theory”

2 Actually: “Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme I.”

3 “Enhancing Patent Quality: Screening Out Low-Quality Patents And Trolling Litigation”, National Bureau of Economic Research Working Paper Number 20322

4 From the Antikythea mechanism, through Pascal's calculator, to Babbage's computer.

5 That is: MIT.

6 You can read up on Brouwer proof and a number of different variations on https://en.wikipedia.com/wiki/Brouwer\_ fixed-point\_theorem

7 At the same time my grandfather, Sterling Price Newberry, was actually involved in mining the Higgs Boson, though it was not called that, from electrons, were it exists, in to x-rays, where it does not exist; at GE.

8 With some fine work by Ian Welsh.

9Cosmology at MIT.

Books

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