Ana Gegeshidze

Doctoral Student of Georgian Technical University

gegeana@gmail.com

+995 598 17 82 02

# Mental entropy as a classification of diversity

## Introduction

What is Mental Entropy? Every time we solve a problem, we seem to generate a new set of questions. In a way it is like climbing a mountain. With every ten feet climbed you see new horizons and gain new perspectives on existing ones that reshape your understanding.

Richard Feynman, the celebrated Nobel laureate, started his lectures on physics by telling his students that if they were going to be physicists, they would have a lot to study, and he reminded them of two hundred years of rapidly developing knowledge. He went on to reassure them by telling them: “In spite of the tremendous amount of work that has been done for all this time it is possible to condense the enormous mass of results to a large extent – that is, to find laws which summarize all our knowledge”. This is a good example of controlling the entropy vector. However, Professor Feynman went further by promising to provide the students with a map or outline of the relationship of physics to the rest of the sciences, the relations of the sciences to each other and the meaning of science. It is no wonder that Professor Feynman was considered one of the most brilliant teachers of physics. This approach would provide a logical filing system for his students to lodge the information that he would go on to give them. The quality of this filing system was fundamental to their ability to recall and use information; it would help them to convert information into knowledge by providing signposts and by guiding their thinking and hence ultimately their understanding.

Simply filing information does not increase the amount you have. What it does is to keep the information together in a way that gives you a better chance of using it effectively. And by filing logically, by employing some science to the task, we reduce the entropy and increase the efficiency of the process.

**The computer as a rescue object in memory and analytics:**

If all dot-com companies generate huge wealth for their founders and entropyvector.com can be formed, then Handscombe and Patterson will be wealthy. The argument is as formally valid as the earlier one but we know it isn't true. We have lived through the dot-com crash. The problem is simple, the major premise is not true and thus the conclusion is false. The dot-com experience taught us that the important thing about e-business is the business. The important thing about logic and syllogism is to make sure the basics are right.

Logic consequences arise from the combination of basic propositions and, in theory, these basic propositions together with some general classification system give us the tools to store knowledge on any subject. In practice, it usually proves impossible to store all the basic propositions and to remember how to work from them.

It is also pretty annoying when this approach is used in everyday life, for it is just too slow for comfort and normally we memorise some secondary information, simply because we find it convenient to have immediate access to facts and information most frequently needed in the daily exercise of our profession. If you ask a builder for quote on roofing the garage you want him to work from a rule of thumb that tiles overlap each other by a third rather than sit down with his calculator and consider the rate of flow of moisture between two adjacent surfaces.

We mentioned Richard Feynman and the value of filing logically. This is a crucial point. Although the volume of factual information has expanded continuously as civilization has expanded, its total volume is not so important because of our increasing application of theoretical understanding. But it is an impossible task – the faster we climb the mountain, the more new horizons we see.

Training can improve both kinds of learning but of learning but the kind of training employed needs to be based on the culture of the system. For example, Chinese and Japanese students have good memories because their tradition is one of continuous training of memory. Yet there are limits. No matter how temping the memorizing route might be, there is little chance these days of being able to memorize all the knowledge is your chosen field. So, we come back to the need for theoretical science and logical structures in addition to some memorizing. In short, we

need an entropy vector that leads us successfully between the unmanageable volume of facts and the unacceptable tardiness of an approach from first principles.

There is also the issue of understanding and we would argue that a key distinction of a true university is that it provides the environment and opportunity for its students to gain a solid understanding of their subjects.

If we have learned nothing else so far, we should have learned that. There is no escape from the second law. The balance between memory and analysis changes with increasing knowledge and with increasing technology. With the incredible growth in computer memory, in software sophistication and in artificial intelligence, it is reasonable to suspect that society is close now to when all the memorizing, sorting and calculating can be done in computers and done faster, bigger, better than humans can do it. A senor communications executive said recently that his company's predictions are that the computer 'brain' which is as big as fast as a human brain. It is comfortable to shut our minds to this prospect and to continue to do what we are used to, but by doing that we are allowing our entropy vector to drift too close to low entropy axis – the controlled, constrained, ordered, systematized approach. It may be comfortable down there but we are better than electronic machines, programmed to do well-established and well-defined tasks. We can and must 'think out of the box', laterally and creatively.

How does society get the balance right? It needs to support basic research so as to develop new generations of computer hardware and software; it needs to provide training so its workforce can use the new technology efficiently and thus contribute to national economic competitiveness, and it needs to provide basic teaching and learning opportunities so that we are given the skills and confidence to know how to think.

We'd be lost without the computer and its ability to store and organize data for us, but it is our tool and not our master. We should not be seduced into working in a similar way and restrict ourselves to collecting, ordering, reordering and presenting information. We need to do more than this. We can be certain of chance and opportunity; our responsibility is to do the mental preparation by clear thinking and hard questioning so that we are ready.

Education must help lever up our entropy vector from a constrained, well-organized, computer like approach. It must do more than provide students with the necessary tools and

understanding to make sense of and organize existing information. The role model must be more challenging than a super-computer. We need to progress and, to do this, we need a more enquiring, more creative approach.

Theoretical science had given us the potential for continuous improvement. Logical, careful, thoughtful work on the shop floor produces dividends. Deviations from the expected can be investigated and corrective action taken. As a result, productivity increases. Perversely, however, as Karl Popper reminded us, the greatest strides in knowledge are made when a logically derived proposition is refuted by experiment, not when it is confirmed.

Theoretical science has given us a craving for logical order and we have seen that there is value in having some logical frameworks. They help us make sense of things more easily – the office runs more efficiently, the shop floor is more productive, the market research is more effective. By organizing our thought processes we are better able to spot opportunities and take advantage of them. As Louis Pasteur said: “Chance favours only the prepared mind”.

The more we discover about the behavior of nature, the more we discover how irrational it is. From the earliest times humans have been challenged to understand their environment and they have attempted to develop theories to explain what they see. The risk is, we begin to convince ourselves that nature works to our ‘rules’ rather than believing that the rules are our best way of understanding nature. These are not new thoughts. Immanuel Kant talked about imposing laws on nature rather than inferring laws from nature. Perhaps we do this because our brains are too simple to appreciate the full complexity and diversity of nature.

In passing, we should remember that we must take care not to consider change to be just change. Aristotle classically analysed change into various forms, but a trip to the ice-cream counter of our local store will reveal bigger and smaller versions of what we saw last year. We can note, too, that the ice-cream van that pulls up across the street means that we need not the store at all. As ever, we need to understand clearly what we mean by the words we use. The expression ‘the management of change’ might tempt us into thinking that change was a single entity. It is not and we stand a good chance of increasing the disorder if in attempting to manage change we consider only one of its dimensions.

**What is the "Zero's paradox" in Mental Entropy?**

If we let ourselves be seduced by the importance of measurement, then we risk losing touch with the real object. One of us spent some time in his early career in the control room of a continuous glass fibre making plant. The control room, then with those wonderful circular charts and ink-spitting pens, was fed information from the raw material batch feeder, from the furnace itself and from the forehearths – very carefully controlled troughs that prepared the glass prior to its being pulled through fine orifices to from fibres. With all those charts, instruments and information was there any need to go out onto the hot dusty plant? One of the favourite stories during the early morning hours of a long shift was how, on one distant occasion, the control room engineers spent an hour trying everything to get the forehearth temperatures back to normal but to no avail.

The complication that this paradox relies on is that if one refers only to an instant of time it is impossible to distinguish between rest and motion. There is a difference between being in a place and moving through a palace, but restricted logical analysis does not allow that difference and hence the paradox and confusion. It is a paradox worth remembering, for the second law dictates that we are moving through rather than being at.

We have looked at mental entropy and advocated an entropy vector that steers a course between the disorder of unmanaged facts and the constraints of pure theory, logic and methodology. The argument is for a vector that recognizes both sides of its path. Major disocveries do occur by accident and a great deal of learning is possible in schools, in higher education and in continuing professional development by encouraging experimentation and thinking 'outside the box'. However, the successful vector is one that also takes in some basic logical rules, some grounding in science and measurement and some intellectual frameworks such that our minds are prepared for serendipity and we are able to make continuous improvements – to our knowledge and to our activities – by logical extrapolation from what we know.

Galileo Galilei was born in Pisa, Italy, in 1564 and became a professor of mathematics there at age of 25. His experiments, developments and observations revolutionized science. Science was about measurement and his arguments in favour of the earth and other planets being in motion around the sun, based on his measurements with his telescope, got him into some serious

trouble with the Church authorities. There is little doubt, however, that enormous scientific advances, for example in the field of astronomy, were the result of meticulous measurement.

The danger is in taking the comment 'science is measurement' and applying it broadly. Scientific theories are particularly useful as they are grounded in measurement, which means they can be tested and we can be confident of their reproducibility. They involve discrete, distinct concepts amenable to logical shifting. Wherever they can be applied they give insight and clear understanding, but they have limited application. Indeed, Karl Popper argued that there is a very clear distinction between scientific theories and non-scientific ones. He suggested that a scientific theory is not one which explains everything that can possibly happen. On the contrary, he claims that it rules out most of what could possibly happen and is therefore ruled out itself if what it rules out does happen. According to Popper, 'A scientific theory places itself permanently at risk'. The ability to be falsified, to be proved wrong because what it says should happen doesn't, is the criterion of demarcation between science and non-science. Only if it is testable is it scientific.

**Conclusion**

So, what is mental entropy? We conclude by asking the same question that we asked at the beginning of the theme. We used the expression to address the question of efficient and effective thinking and mental entropy can be seen to be a measure of wasteful brain-work. In developing our thinking here, we have seen that to arrive at a valuable vector for mental entropy – where mental outputs are efficient yet not rigidly fixed – a number of factors need to apply.

Managers talk of calculated risk, but rarely on the basis of having done a calculation, and even if they have, would we know how to check their calculation? The implication is that if we can be coaxed into believing that things can be measured, then, because science is measurement, the 'thing' must be grounded in science and be 'right'. This is fool's gold. The danger is that we end up believing either that measurement is everything or that because we can measure something we actually understand what is going on.

On the other hand, simply introducing 'non-science' to balance the approach and to increase the value of the entropy vector is not to be recommended. As Popper observed, the demarcation between science and non-science is not the same as that between sense and nonsense.

The challenge is to choose carefully. We have spoken earlier about the difference between woolly and creative thinking. Both introduce entropy into a process but they are not synonymous. If we add a creative person to our logical, scientific and methodological team, then we stand a chance of progress and improvement. If we choose woolliness, then at best we get the status quo if our initial team is capable of defending its systems, but more likely we get deterioration and decline.

One needs education to provide students with the necessary tools and understanding to make sense and organize existing information and to encourage creativity and enquiry. Training is required to improve both kinds of learning and to give practice in extending thinking beyond conventional boundaries. A scientific approach is important to enable a logical and systematic filing of information, as well as a non-science element to give team work and motivation. This is asking a lot of a single person but such gems exist.

More broadly, it gives a steer to those who are responsible for developing and managing teams, for in assembling a team there is a need to incorporate diverse skills and attitudes to achieve the desired cumulative mental entropy. Variety is important, but the selection must not be random, for this would add an unwanted and unnecessary extra source of entropy. Mental processes are capable of generating more than enough without such assistance.

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## რეზიუმე

გონებრივი ენტროპიის ღირებულ ვექტორამდე მისასვლელად, საჭიროა მთელი რიგი ფაქტორების გამოყენება. ეს ფაქტორები კი გულისხმობს მენტალური ენტროპიის გადახედვას, რომელიც მართავს მთელ რიგ კურსს თეორიაში, ლოგიკაში და მეთოდოლოგიაში. მენტალური ენტროპიის ვექტორის ამაღლებით ორგანიზაციამ სწორად და გამართულად უნდა იმუშაოს. ენტროპიის ვექტორის ამაღლება კი ეხმარება სტუდენტებს არსებული ინფორმაციის სწორად გაანალიზებაში. საჭიროა წინსვალა ყველა სფეროში, რაშიც გვეხმარება მენტალური ენტროპიის ვექტორის გათვიცნობიერება, ამისთვის კი უფრო კრეატიულები უნდა ვიყოთ და უფრო მომთხოვნები. თემაში მიმოხილულია, რიჩარდ ფეინმანის და კარლ პოპერის ნაშრომები. ფეიმანი  ამტკიცებს, რომ ფაქტობრივი ინფორმაციის მოცულობა განუწყვეტლივ იზრდება ცივილიზაციის გაფართოებასთან ერთად, მისი მთლიანი მოცულობა კი ძალზედ მნიშვნელოვანია. მრავალფეროვნება და კრეატიულობა მნიშნვნელოვანია, მაგრამ არ უნდა იყოს შერჩევითი, რადგან ეს შექმნის ენტროპიის არასასურველ და არასაჭირო დამატებით წყაროს, მაგალითად, გუნდის შეკრებისას საჭიროა მრავალფეროვანი უნარებისა და დამოუკიდებლობის ჩართვა სასურველი შედეგის მისაღწევად ანუ გონებრივი ენტროპიის მისაღწევად.

საბოლოოდ, რა არის გონებრივი ენტროპია? ესაა ეფექტურად და ხარისხიანად მოგვარება ამა თუ იმ საკითხის, გინდ სამეცრიენრო ან არასამეცნიერო სფეროში. გონებრივი ენტროპიით ვითარდება ჩვენი აზროვნება, ყალობდება მენტალიტეტი ჩვენში, ადამიანს ეძლევა უფრო სწრაფად და სწორად მიიღოს გადაწყვეტილებები. აქ კი კარლ პოპერი ამბობს, ცოდნაში უდიდესი ნაბიჯების მიიღწევაა მაშინ, როდესაც ლოგიკურად მიღებული წინადადებები ექსპერიმენტით დასტურდება.



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In developing our thinking here, we have seen that to arrive at a valuable vector for mental entropy – where mental outputs are efficient yet not rigidly fixed – a number of factors need to apply. We have looked at mental entropy and advocated an entropy vector that steers a course between the disorder of unmanaged facts and the constraints of pure theory, logic and methodology.

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