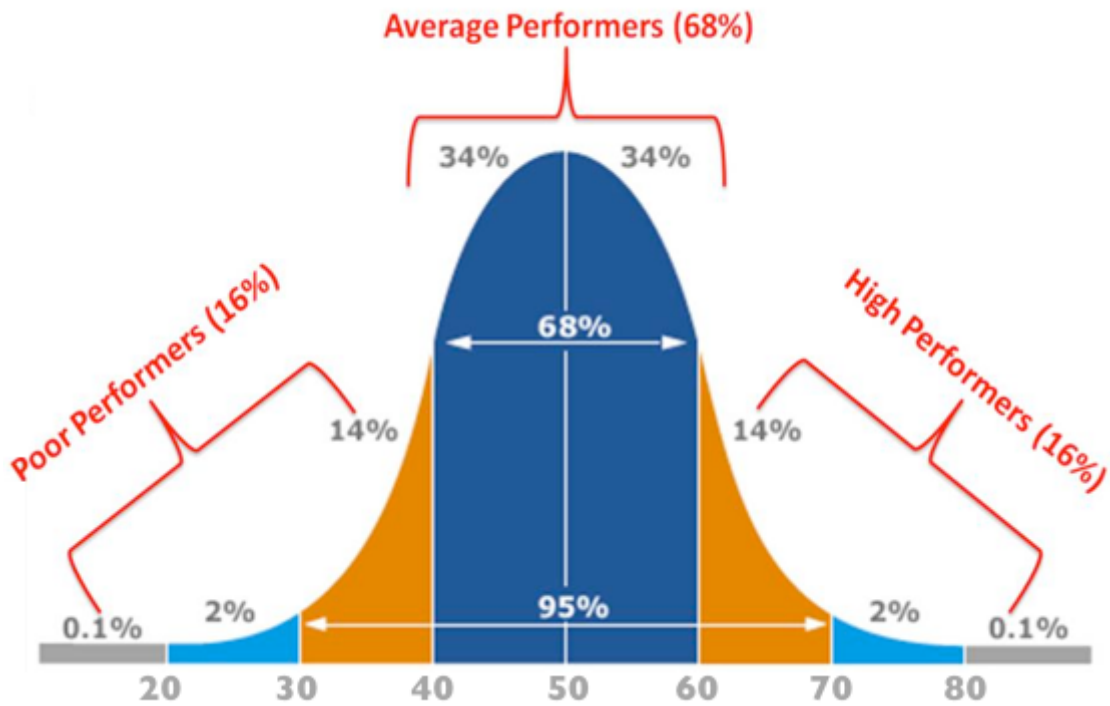
Bell Curve : Ring The Alarm Bell

Why This Document

World runs on zero sum game model. In vanilla English that translates into - resources are limited : someones win will always be someones loss. Modern system of economy is predominantly non socialist - thus - there is a tendency for winner to take it all - a conclusion that raised many movements - most notably the socialist ones - now a vague history fallen out of favor with the fall of the C.C.C.P.

Closer to home, this phenomenon raises - a problem in the workplace - while reviewing employee performance. How would you rate an employee such that it is "justified" - such that appreciating one does not automatically make others unhappy?

As far as history goes, from 1980s ill fated and ill application of massively abused notion of bell curve dominated the market standard - that a workforce can be fit into the bell curve performance wise. Here is a visual representation:



It roughly states 1/6th of the employee are high performers, 1/6th are low performers and rest are average performers.

And this notion is archaic - and to be honest - an everlasting shame that shames any statistician to the core - because anyone with a doctoral degree in Statistical sciences would simply respond with - "almost no distribution is a normal distribution" or a bell curve. Every book published after 2000 makes this fact abundantly clear.

Hence, in this document we ask the questions - to try to get some answers about:

1. What is this bell curve?
2. How it came to existence and antiquity ?
3. Why it is so popular into the minds of the people who are not into the science of data?
4. How this curve was almost singlehandedly responsible for creating an incredibly toxic culture of back stabbing in the workplace?

We will go through all of it - but then again - this will be a whirlwind tour. It would not only be about talking theory or doing mathematics or analysis.

It will be a story of intellectual achievement of mankind : discovery, economics, game theory and an intriguing story of application of all biological ideas into the pretty interesting subject colorfully called - "performance appraisal".

As we shall see - truth indeed is stranger than fiction.

But before that let me inadvertently apologies to all the readers - because I am an Engineer, and I probably am a better Historian than one Engineer - and not a great story teller as such.

So readers, with this warning here we begin.

We have to go to the beginning - we have to go the history of the bell curve.

History of the Bell Curve

Luck : Making the Fat Lady Sing : Probability

How important is luck in success? There are folks who imagine that it is not really that much important - and there are folks who argues - luck is everything. The fact is if you are a gambler - luck has to be there in your side to win.

But can we game luck itself? Can we make the fat lady sing?

This ideas, purely obtrusive ideas - generated a whole branch of mathematical philosophies - currently known as the probability theory. For any sophomore of mathematics - probability - in modern form was created by Andrei Kolmogorov which set a basis of measure theory - and now is formally part of what mathematicians call - Analysis.

Coin Toss : Bernoulli Trials : Expectations

But it had the begging in gambling. Most simple gambling is that of a coin tossing. We imagine fairness in coin tossing by imagining that a "fair" coin - is one which somehow has a "chance" of producing head and tail in "equal probability". Like always ancient Greeks started thinking about this idea.

We are not going to go deep into this - because there are incredibly formal definitions for the terms - but one thing is for certain - even in 1700 no one imagined that coins are fair.

So, they imagine there will be different chances for head and tail.

A coin toss is termed in the spirit of Jacob Bernoulli - Bernoulli trials.

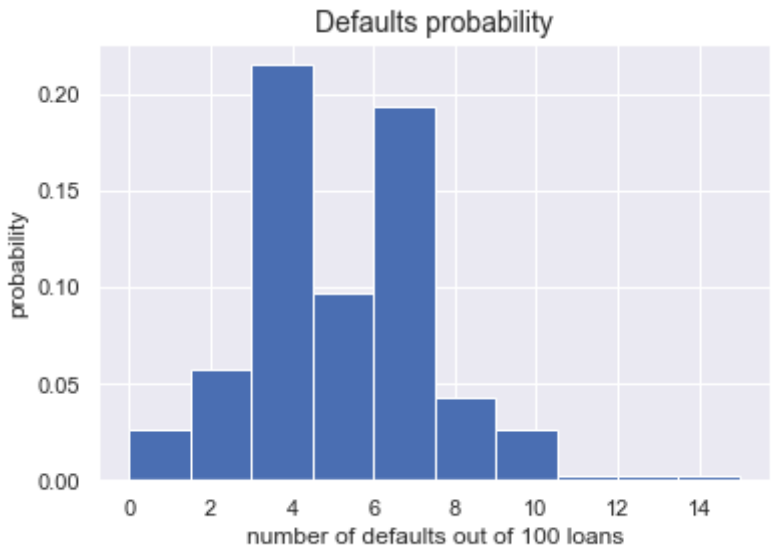
How gambling comes in?

Suppose one toss a coin and if head appears - then one gets 1$.

And tail appears one has to give away 1$.

What would happen if you play the game say 10 times? 20 times?

Will you win some money? Will you lose some? What about loans given by Banks? Sometimes it will paid and sometimes it will be defaulted, right?



Random Walk : Gamblers Ruin

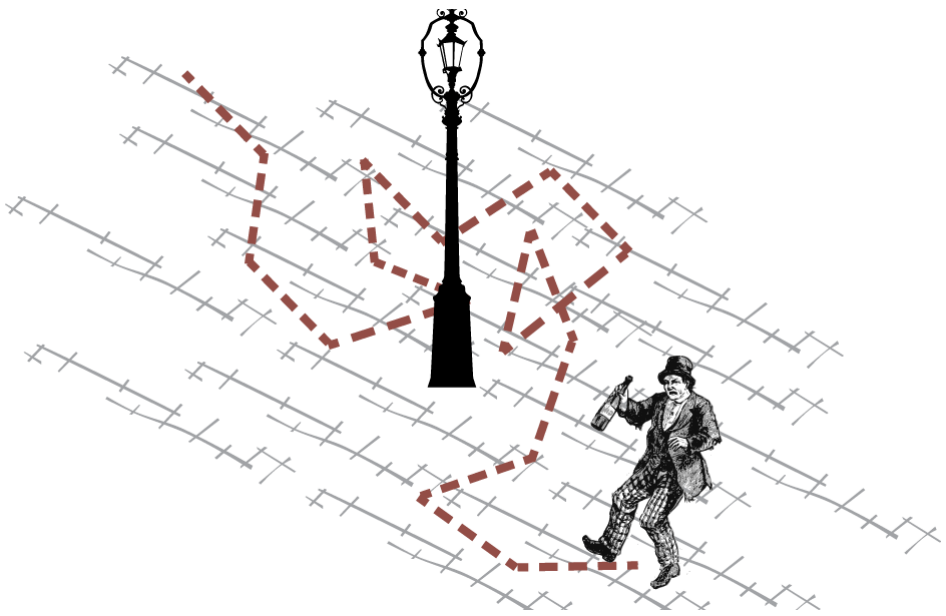
Turns out there is something called expectation and that value defines the "expected" outcome for the same after any number of trials and naturally it depends on the chance of head or tail.

With same chance and same value in win and lose (namely 1$ only) - the expected value is 0, as expected.

What is expected when you have a bit bias? Say instead of equal chance of head or tail - the bias tilts the coin to be more heads than tail? How much you win then?

How much a gambler will win is given by what colorfully known as "Drunken Walk" .

There is also a mathematical theorem that - it does not matter - if you play the game long enough you will always eventually hit 0. This is called the gamblers ruin - a certainty. Unless head was a certainty - a random walk always visits 0 again. Nature is rigged against gamblers.



Remember this, in a later section we shall come back to this result and find out why "culling under performers" is borderline terrible idea.

Too many Steps : Normal Approximation : Central Limit

It is really hard to follow the footstep for the drunk - or random walk - because it is step by step. Someone genius had a better idea. If the number of steps are large enough - a genius named as Carl Frederich Gauss - the greatest mathematician ever born - found out that the total no of heads is given by - what is known as the bell curve.

Hence in mathematics it is known as the Gaussian curve.

But the story is not complete yet.

There was another interesting observation and theorem.

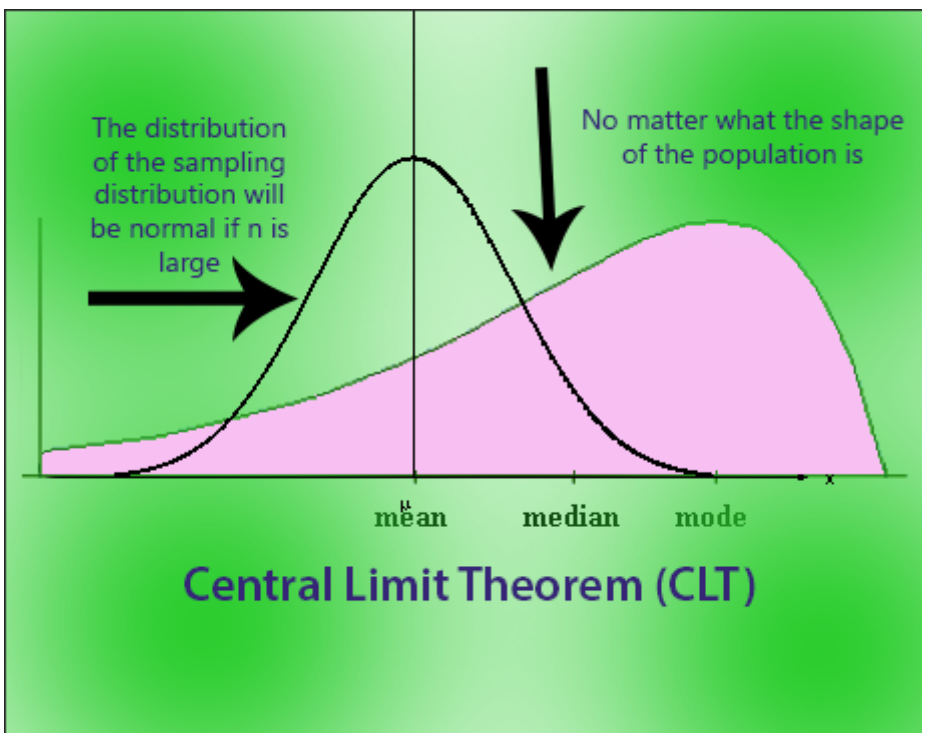
Instead of coin toss one can start asking question about what is the chance that someone is over 6 ft hight? That someone has more than 40 Kg of weight?

Obviously the mechanism is not as simple like tossing a coin. A lot of different attributes and process together comes in and generates the height of the person.

All of these different attributes are also like tossing various type of die and coins! But the big bad theorem of probability showed - these aggregated final curve - the sampled average becomes a bell curve.

This is fascinating. That the cause might be anything. Anything. But when you try to somehow aggregate all the causes - the result slowly and steadily start becoming a bell curve, and that is called the central limit theorem - one of the guiding principles of statistical science.

Coin tossing is not alone.



Almost all attribute of things that supposed to be natural - if it is a result of aggregation - then the sampled average follows Bell Curve!

In very precise form - it goes like this. Suppose there are different population with different averages. The mixed sample will have an average - whose sampling will follow the bell curve. The average of averages must be normal - and that is the precise formulation of the Normal distribution.

The term average of averages should already ring some alarms, because after all, what about things which can never be averaged? More on these will follow a bit later.

Glory Days and Applications into Human Processes

Into the Rabbit Hole

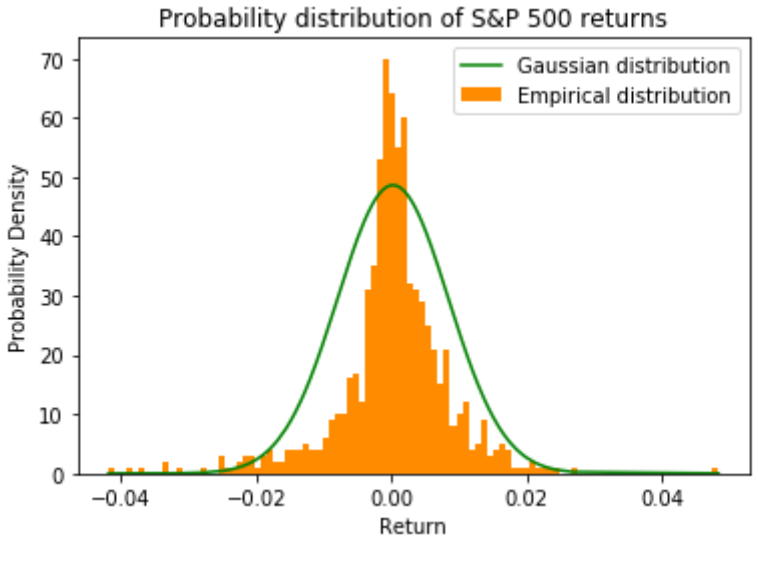
Once the miraculous result was well known - almost everyone in every discipline started fitting the normal curve into their daily life. It became a proverbial hammer - once one has it, everyone imagines that everything else is a nail - one has to use it everywhere.

The years 1800 to 1900 saw a massive boom of using Normal Curve in almost every field of life.

The definition of "normal" took over - and if something fits into the curve - that is "normal" and the curve got a name - not only because it is normalised form of some other one, but because normally that is the curve everything was fitted into.

Economic, Social, Health

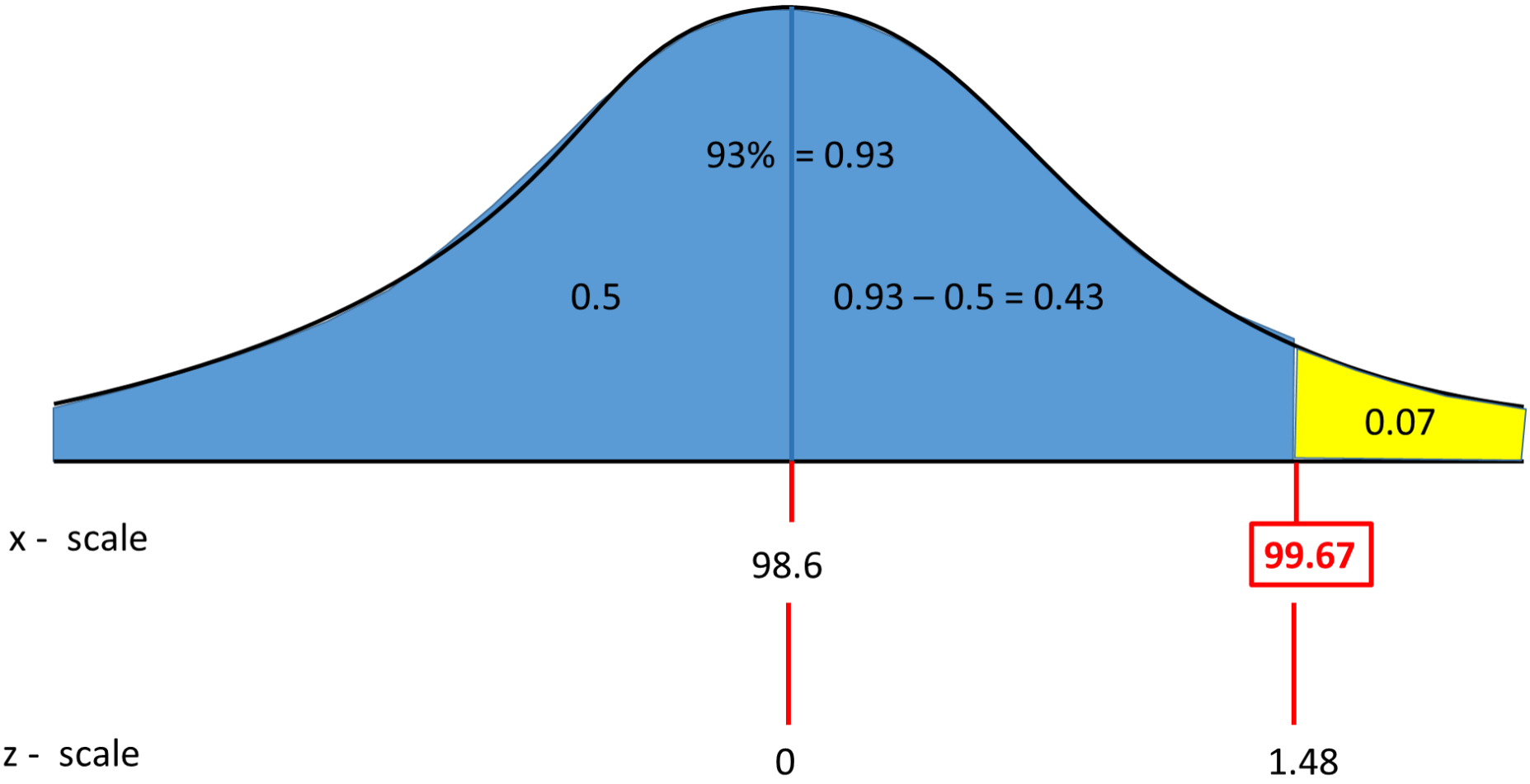
Initial applications were immediate to the field of economics. Companies financial data , countries by profit and loss, all of these data were put under the normal curve - and the results were "satisfactory".



Thousands of papers were written to classify section of society into poor, middle class and rich. That is of course coming from Normal distribution.

That is economy and social for you.

Even medical practitioners picked up the practice. All numbers were fit into this magical distribution thereby giving the most known "medical parameter" known to mankind - the "normal body temperature" for a person - 98.6 degree Fahrenheit.



In health it had way more interesting implication. Eyesight, body mass, height - blood glucose level - everything started fitting into this curve.

Cat is Out in the Open

Normal curve was everywhere - the proverbial cat was out of the bag - and it it did not stop.

Any data that did not fit into the normal curve was rejected - because it did not fit in. As Einstein famously quipped - "if experiment does not match the theory - throw that experiment out". And that was happening in the 1900s.

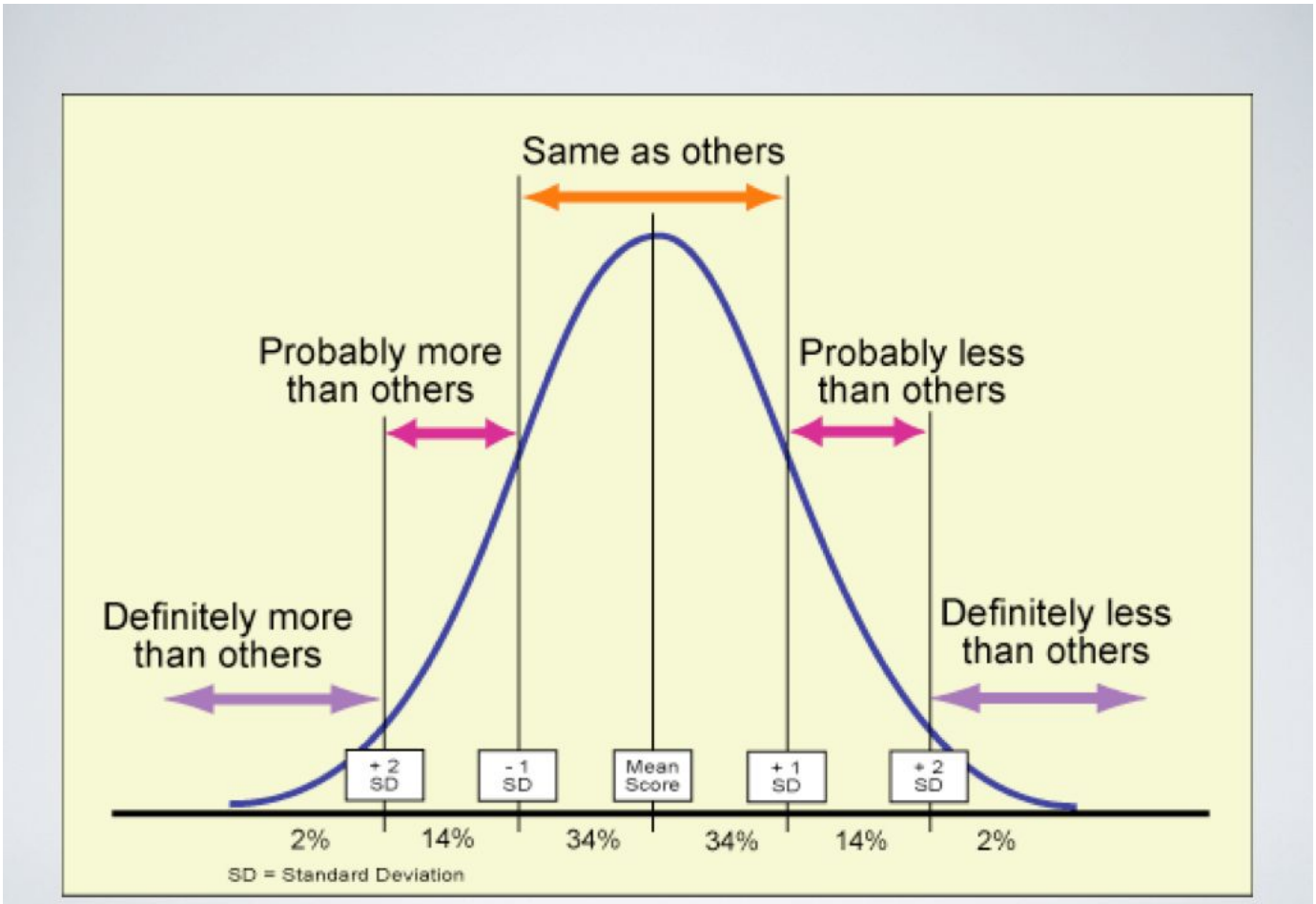
But the story of this is not yet far from over. The worst thing men ever did to men is also due to this Normal Distribution.

A tool for Injustice ?

Intelligent Quotient

Humans has tremendous fascination with intelligence. And this is primarily not because they are smart - to be really honest ask any biologists - humans are way dumb than they should be. With less brain matter a crow or a gray parrot is much smarter - so is an octopus - but because they believe that they are the "Designated Species that Owns Earth" (Nothing can be further from the factual truth, by the way, as biologists are finding it out).

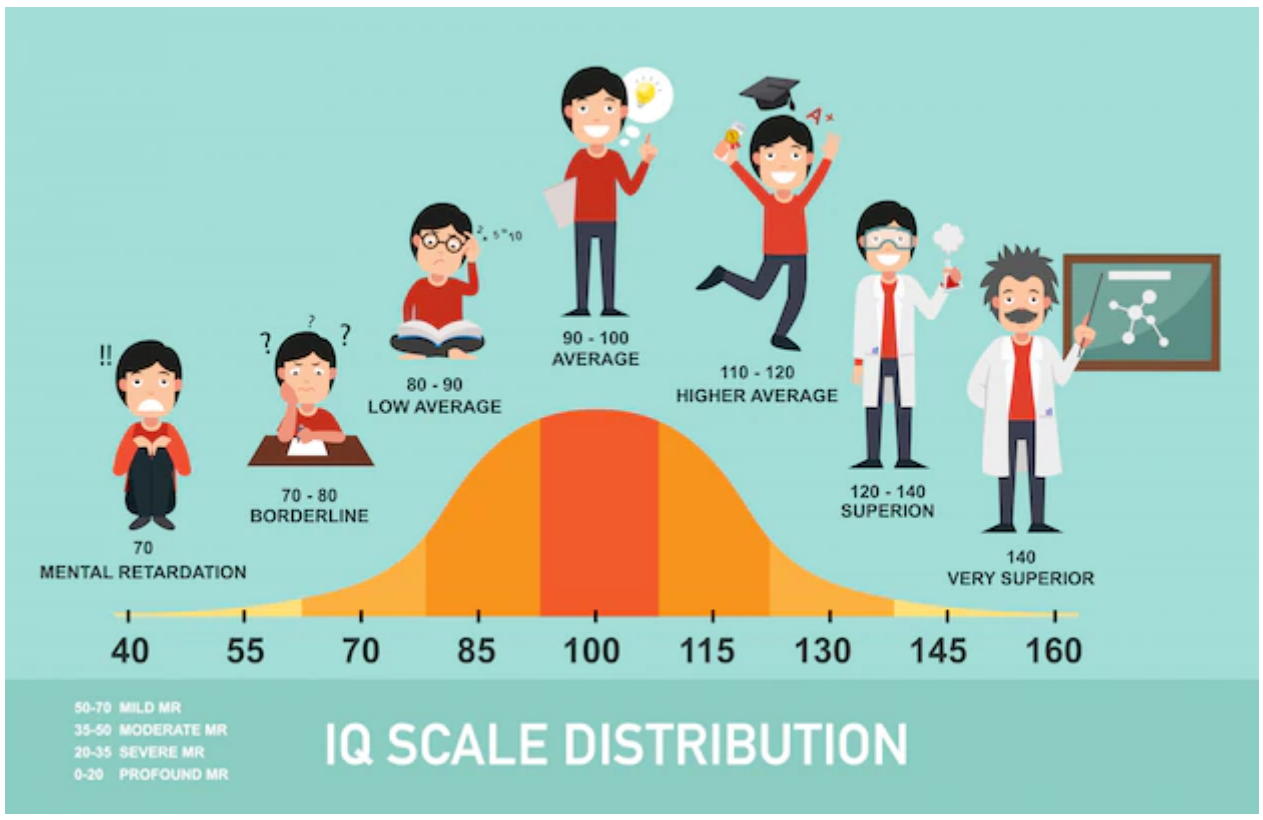
The idea that someone is better than someone in intellect has to be shown in some curve and voila! the curve was already there!



All people needed to do is to create an experiment and questionnaire and clearly the marks must follow normal distribution!

And they did, that they did.

This questionnaire - later wildly known as "standardized IQ test" - was the first trigger of the conclusion of this section.



They figured out that the bell curve must have an average. They chose to call it 100. A person having 100 IQ is just average. More than 100 is above average and less than 100 is below average.

Social Darwinism

IQ brought about the next phase into the story of Bell curve. What to do with kids - and people who are below 70? They were termed "retards" - and will be put into a different social system. In 1900 the empathy was not a thing - as is of today - it brought about a disaster.

They were not perfect. They are not socially acceptable and thus.. everyone stopped caring for them.

This brought about the idea of social darwinism - they are unfit to survive - thus they are not meant to survive and whats wrong in that?

The situation was already dynamite.

Something - something from philosophy added a spark to it.

Everlasting Shame of Mankind

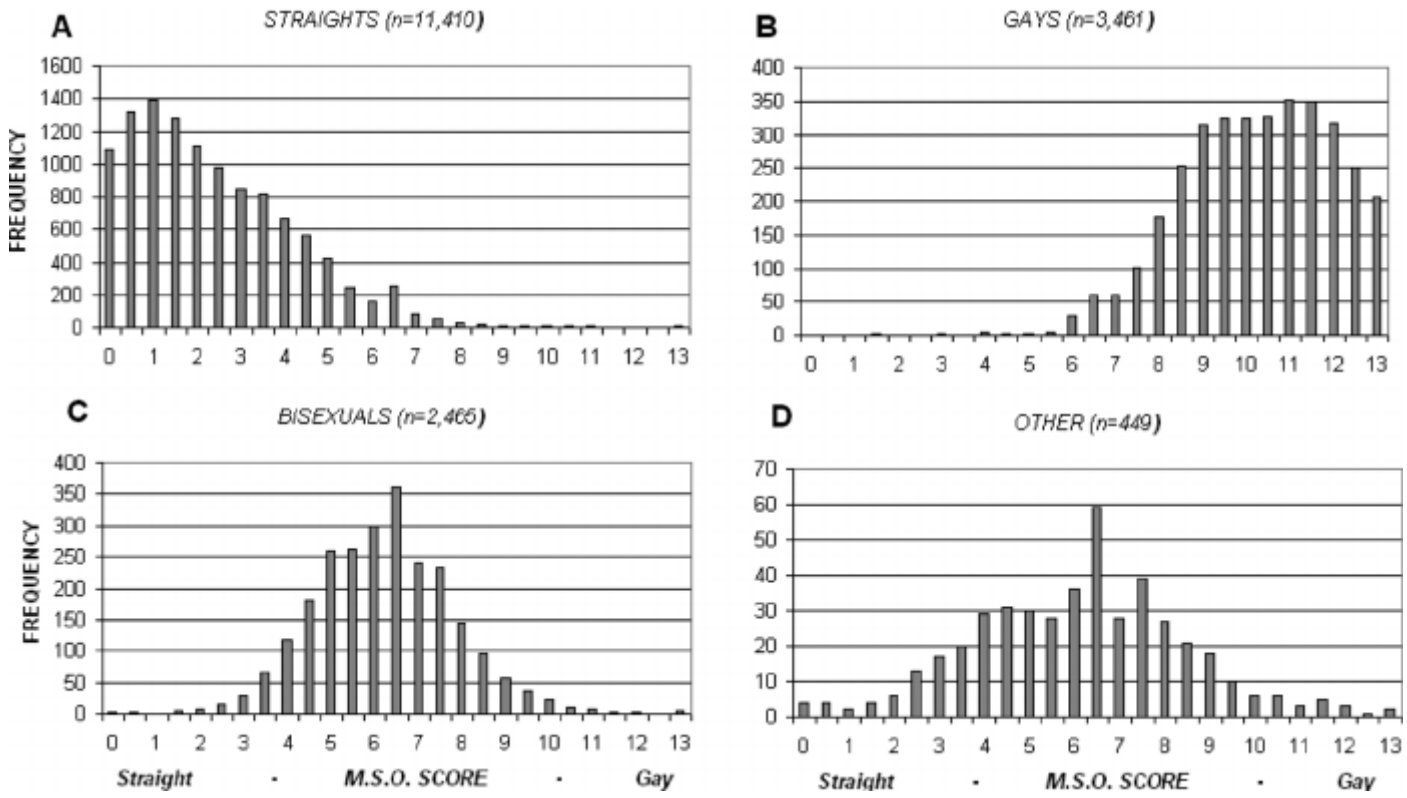
Nietzsche was a genius - a troubled genius but genius never the less. He never imagined his idea of Ubersmencsh - will bring about the worst possible thing human species can do unto itself.

Races tried to prove against each other who are smarter, better - purer using the normal distribution - the bell curve - and Nazis took to extreme so did the Russia.

People who were less than 90 IQ were simply killed - as if they are not worthy of living. Exterminated - like insects. As if they were not worthy of life.

Under UN law this can not called a genocide because people who were killed of multiple race, gender and languages - but it was extermination - via Gas tank or at gun point. In thousands. Their relatives were ashamed - they were not even allowed love because they were the abomination.

Because LGBT data was that much accessible - they also did not fit into the Normal spetrum - so they were to be eliminated too.



They are not allowed to be live. A better world can not have retards - "Ab-normal" - that was the motto.

And this, I believe is the pick of human arrogance as to understand it's insignificant place in the nature of the being.

Human arrogance of believeing that they know better than the nature.

All we can do is simply spend some tears for all those died in the name of human improvements. May be some of them could have been father of mother of many Einsteins - we shall never know.

All we can do - is to ensure this injustice never repeats.

Who Bells the Cat ?

Negative Results

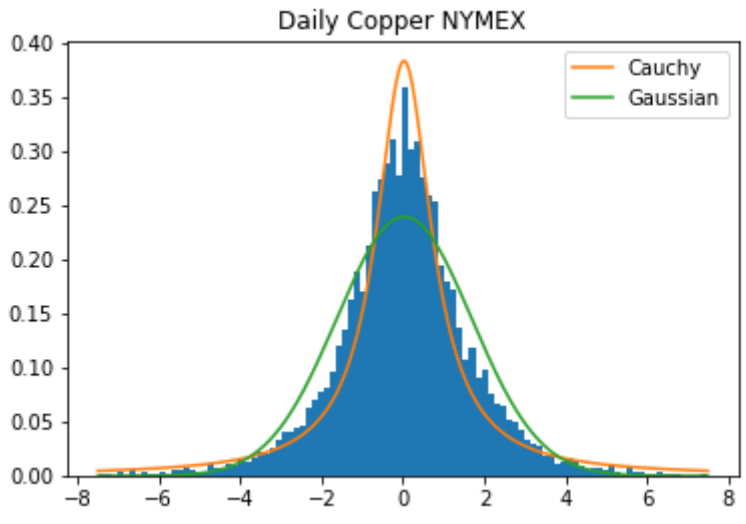
Humans have a nice tendency of contradicting themselves. This creates red tape - the basis of democracy. Lots of human actually believe that democracy is a thing - but by what? By total acceptance or by maximal or majority rules? Some people are never happy - and they find issues in the system.

Sometimes they are just nuisense - and sometimes they became the pillar of the human history.

From it's inception - people were figuring out world does not really follow normal distribution. There are things that was known to deviate from it - and massively so.

One such phenomenon known as time between two carriages. It was not following Normal distribution at all. In the advent of telegraph and telephony one figured out the number of calls made do not follow normal distribution.

Even the stock market returns- things returning were not normal - they follow Cauchy distribution!



Humans are warring animals - so quipped Nietzsche. A war on normal distribution started. The more data we accumulated since there were now calculating machines - even mechanical one - the more it was clear that Normal is NOT the normal of nature!

Nature is a Strange Lady - Nash And Evolutionary Stable Strategy

If Social Darwinism caused the everlasting shame of mankind then the theory of empathy comes from his descendant - Maynard Smith whose work is based on - incidentally John Nash - the genius who would not be allowed to survive because he would not fit into Normal Curve. Nash had schizophrenia - people put people to death for less. Nash was mad.

But Smith solved a fantastic problem using Nash's theorem - if Nietzsche Ubermensch is a thing - then why the animal kingdom just DO NOT fight and fight and fight and die? Why they collaborate at all?

Animals are fighting for zero sum game - why collaborate?

Why not kill and bully everyone and move along?

Whole social science was to be changed by the paper - the nature of animal conflict.

Smith proved that collaboration without ego runs the animal society. Not intellect or muscle power.

Incidentally himself a descendant of Darwin - Smith gave the world the tool that is required to create a non fighting collaborative human society - "we are great together - we will win together" - which brought about the end of the Social Darwinism.

It made people believe to check the not so obvious - the efficacy of LGBT genes - while work is under way we now know they fit a different model which is important for the genes to survive.

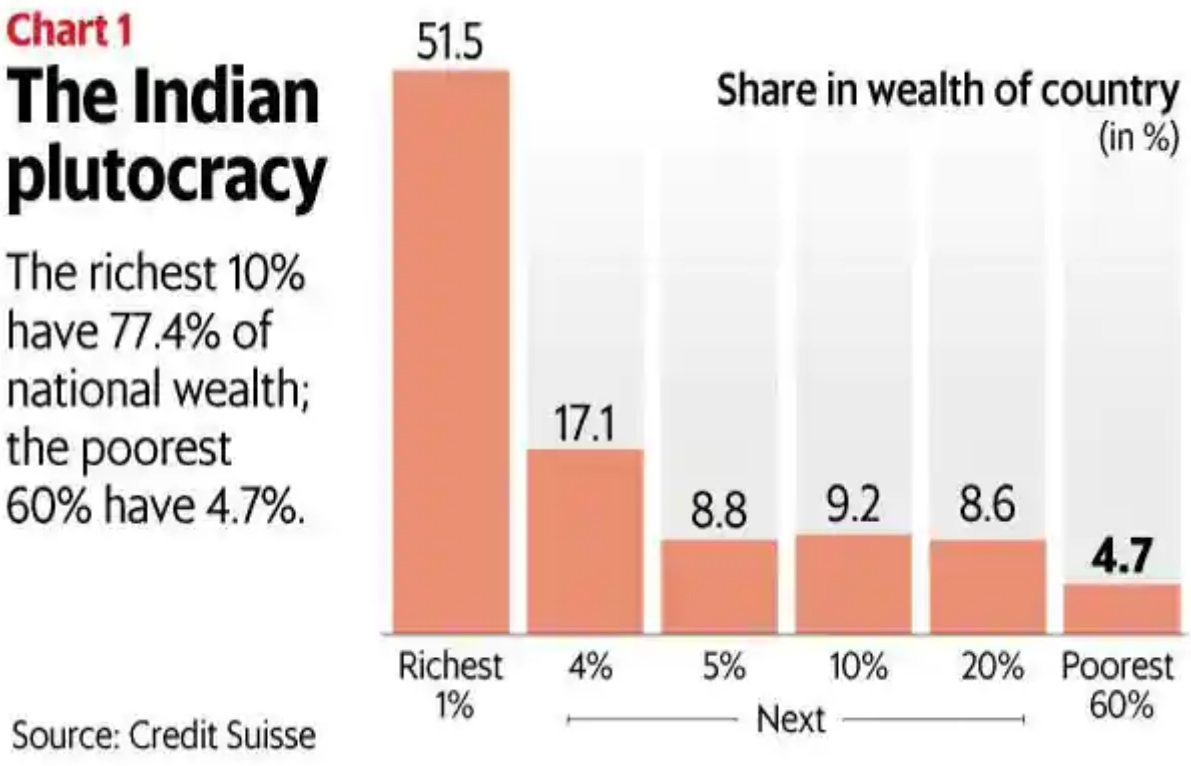
No one is abnormal in nature. Everything, everybody has it's place.

And interestingly this collaboration does not follow any bell curve. It follows something different, something mindbogglingly awesome and in some respect clear skew.

Distribution of Wealth - A Tale of Long Tail

Wealth can not be amassed by oneself. One has to collaborate with lot of people to gather wealth. Same happens in corporate world - collaborate to get something done. So what happens when we plot households with income?

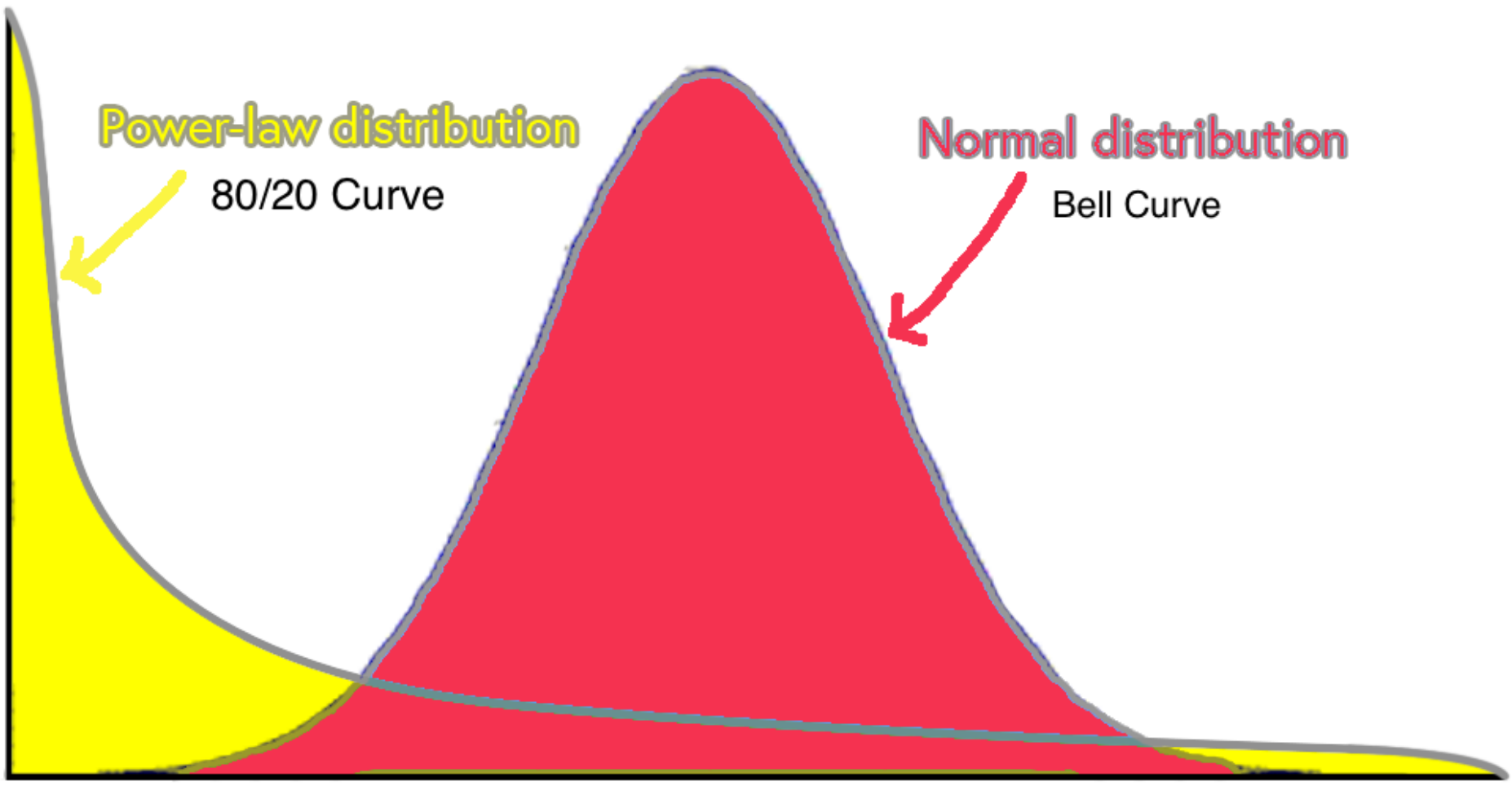
Turns out this was a disaster. By 1950s humans figured out that this not only NOT follow bell curve - it actually does not follow anything that the mathematicians were ready for.



It does not even have an average! Let that sink in. There is no average household income anywhere. Of course one can find the average - but that average keeps on changing as more data comes out.

The average does not eventually stabilize in any point!

People gave this a new name - the long tailed distribution - where less than 10% of the folks owns all wealth and rest are all poor.



The notion of middle class, suddenly seemed archaic.

The distributions which were earlier found to be "normal" was indeed bell curve but not normal - they were Cauchy distribution - which also does not have any average! It looked like a normal curve, felt like a normal curve, it was not a normal curve.

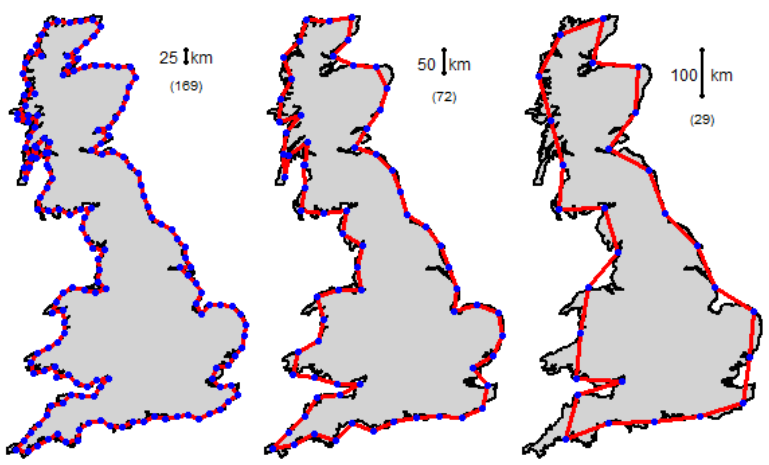
Turns out almost no samples actually gives in to normal distribution - averages do not exists apparently in nature - and thus average of averages is a pretty moot concept in almost everywhere where it mattered.

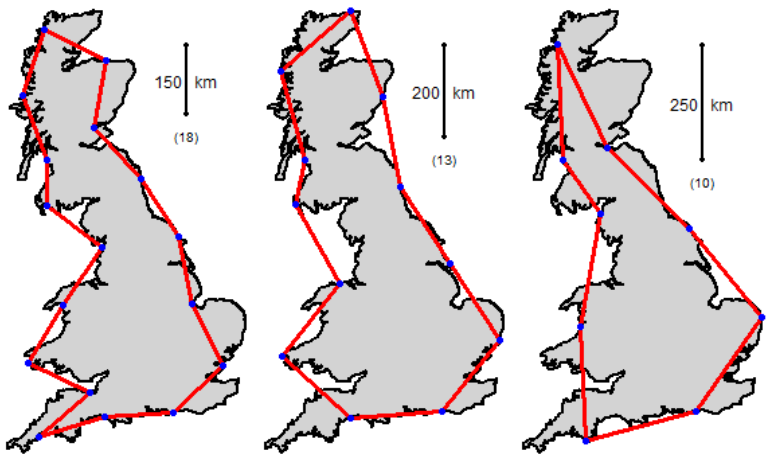
Humankind wake up into a different class of nightmare - one no one was prepared for. Nature abhors the term called average!

A Brave New World of Chaos - Mirror to Fractals

Mandelbrot is widely sighted as the father of "Chaos Theory". It is heavy name of systems with very simple properties. Many readers know it - they call it Butterfly Effect. Later Lorenz shown that it is impossible to predict weather for more than 7 days - even NOW, and it will always be.

Mandelbrot asked a simple question. What is the size of coastline of Britain? Turns out just like the average of the previous section it does not have a fixed answer! As we zoom more and more into the map - it grows and grows.





In the language of complex systems - such a curve is called a fractal.

And now economists found out - distribution of wealth distribution is a fractal. It does not have any theoretical average.

Worse was about to hit the economists.

There is no difference between household wealth distributions and company wages.

Nature while not believing in "averages" but nature surely does believe in "Self Similarity" - because it has to believe in it - because nature is literally applying some known pattern over input again and again - this in colorful language is termed as "Fixed Point Iteration".

So what defines "average hike" and "average wage" ?

Curve Fitting in Appraisal System - Corporate Darwinism?

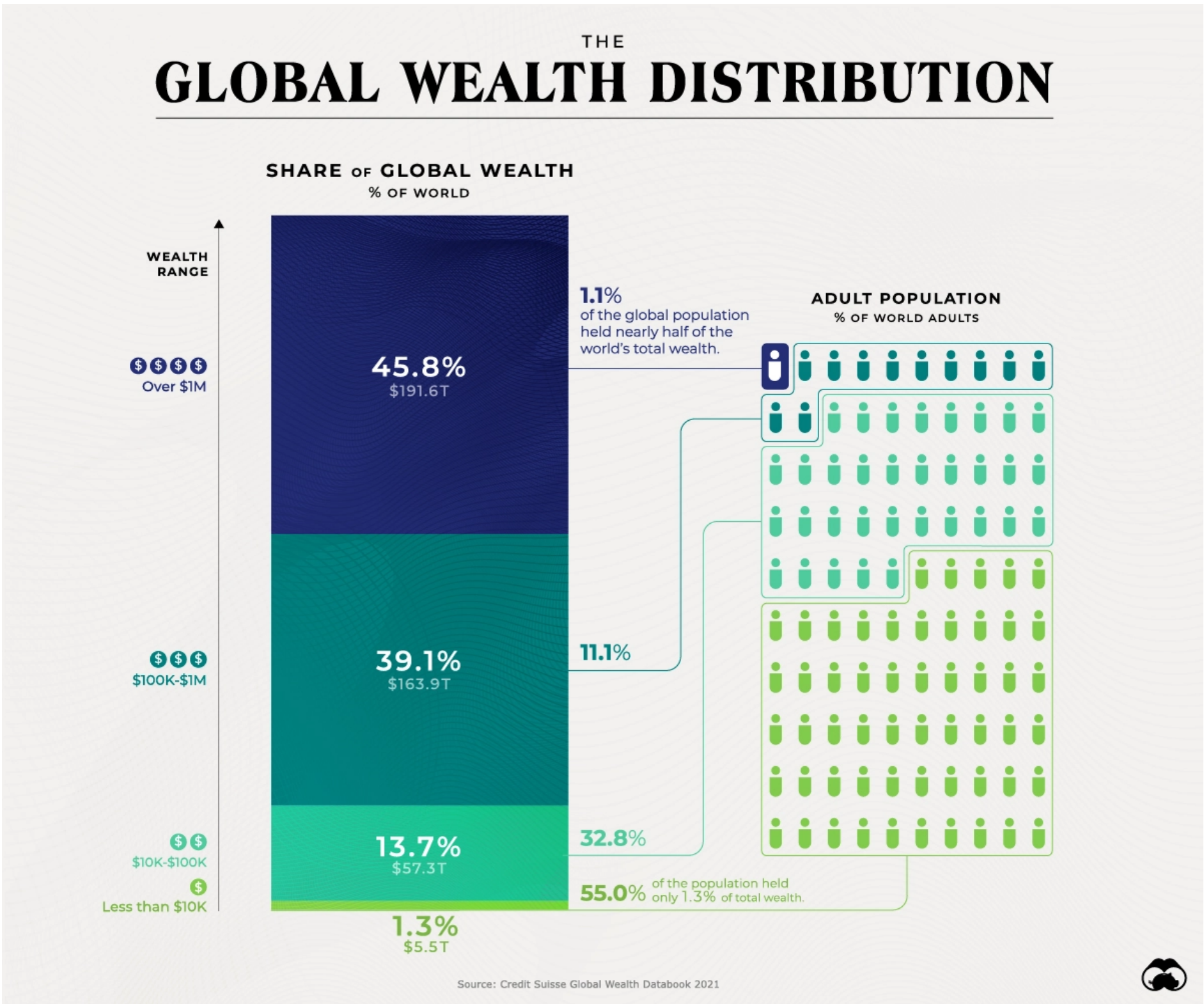
In 1940s people wrote papers about how to incorporate (wrongly) bell curve into the wage system. There will be some top workers and some bottom workers and some middle level workers. In 1980s that became the norm due to someone not understanding the basics.

And till early 2000 no one asked questions about it - much.

Because the economy of the world was not so much that one can see there are multiple billionaires.

But in 2000 it was up for a change.

World knew wealth distribution is only possible from a fractal perspective.



World knew there is a disparity in wages. And people did not like it.

A forced curve fitting using Bell Curve did only increase the gap - the divide - did not mend it.

Worse, it ensures the top performers to leave the firm - because they got great hikes somewhere else.

All because Bell curve has average. And a wealth curve does not.

All because, it is a fact that only 10% or less employee are adding value to any work.

Because the actual productivity curve fits into a power law distribution. It shows hyper performers and it shows, there are no average worker.

More interestingly the distribution is self similar - and hence fractal in nature. Nature loves self similarity - in a stochastic way!

A Modern Analysis

Modern Theory of Wages

Modern theory of wages make use of tournament theory. There are exponential jumps between levels - and this is explained by the next promotion is the tournament you want to attain.

This has some plus and mostly negative connotations. Generally it produces what is called promotion driven development.

A system built to game the people - will be gamed itself by the very people it supposed to gamify.

Many, many people top companies has been found wanting in this regard - people being promoted on irrelevant stuff that does not add any value because one can not measure the value added by those people.

Eventual result is companies failure - and people moving to another one.

Shirking and S/S Model

So what would be a better alternative? What about people strictly ensure that does not happen and because there is a fixed budget - put a cut off on how much one can spend on the hike? Unfortunately this is the one that is naively gets followed most.

Because Stiglitz and Shapiro came up with a wage model using this idea. Later it was found out in a terrific influential paper that - the moment you incorporate socialism into the mix - people act like socialists.

They stop performing at the level they can - because there is no ROI in it.

In colorful language it is called Shirking.

SS found out - in a large company no one works - everyone shirks because outstanding achievers do not get outstanding rewards. Why they should work?

If you ask Messi to play for 100$ why Messi would even play?

Cutting the Tail

Does that mean people did not know about it before? Sure they do. Some organizations ignore the top tier and only focus on the bottom 10%. They are the tail. There will be a tail and a very long one. They cut the tail. By that they let go the bottom 10% year on year.

It seemed fascinatingly correct in the first sight. Even in the 2nd sight. It started becoming fuzzy into the 3rd sight.

Why?

If you remove the tail - someone else is the tail. You can be the tail. You MAY be the tail.

Sometimes great evil are done by folks who imagine they are doing a charitable work.

Cutting the tail is evil - plain and simple. Why again?

We go back again to the problem of coin toss.

Either you will be in the bottom 10% or you will not be. Call being in bottom 10% getting a tail.

Eventually you always will be in the bottom 10%.

And you will be let go.

Is it not only possible - it is guaranteed.

The theorem is very clear. There is will be arbitrary number of consecutive tails in an infinite coin toss.

Who is king today will become a popper and popper will be the king. One who lives by sword must die by sword.

Companies will lose great minds - because someone ignorant decided to cut the tail.

Most vile evils are done in ignorance.

Justice can never be Done - but Here is some Advise from Anthropology

A bunch of British officers on the path to Jerusalem imagined they can solve one of the worst geopoltical conflicts of our time. But after 7 days into the city one wrote the journal entry - "Justice can never be done, only injustice - the only choice we have is to choose how much and to whom!"

Truer lines were never been spoken before.

Should a wrong hire be culled? Who is a wrong hire?

Is it ok to burn out your top Employee?

Is it ok to ensure almost all of your Employees slack?

Is it ok to have one person earning 10 X of another person at the same level?

These questions are what drives the appraisal of performances - regretfully no one knows any answer for these. There is high chance no one ever will, because they stem from ethics and morality - and evolutionary anthropologists are only recently breaking into the such formal domains, based on ESS.

As Harari remarks in his seminal book - Sapience - "Justice is a human concept" and he goes on mentioning that "Nature has no place for it". Dawkins in his seminal book added way before - "Nature does not care" - he went on calling it : "The Blind Watchmaker".

But an organization can not act like nature. It is unnatural to think that way, it goes against human moral values. Only questions follow then.

How would you treat a company of geniuses? How can you handle a misfit?

By realizing everyone has a place in the Universe.

We do not ensure extinction. We can not do so. We become humane - if nature did not, then we must.

I reject nature!

In the immortal words of Skipper - "I reject Nature!".

But we already know that empathy is natural - it is part of nature.

One has to figure out the minds of the top performers as well as be mindful of the folks who are consistently lagging behind - perhaps they are misfit - but it is organizational responsibility never the less.

If someone is a mishire - the organization is as much responsible as the candidate.

Mis-hire goes in both directions. PIP is inhumane.

One does not keep a Hurracan in Amazon Rain Forest.

The top performers must understand the limits, and so should the bottom too. There is no middle way.

Thus I end with the a thousand year old quote : "When human ego will vanish - they will find it's place in Nature".

Epilogue

Humans are thinking animal - and I am paid to think - I think. I am an Engineer and a problem solver. Thus I am very well aware that almost no problem has solutions and very little problems can be solved by even approximation. In the colorful language of measure theory, human solvable problems are of measure null. The curve fitting haunted me, personally, for only 1 time - long long ago. But it was more than enough for me to start digging deeper. Who bells the cat ? The answer was evident - I must.

And I searched and looked and looked for more than a decade. And here I am with a whirlwind tour of the history of Bell Curve. Am I accurate? May be not. Am I factually correct? Approximately yes, I think.

I am no mathematician or statistician. Thus,

Am I ignorant? Almost surely. Am I doing any evil? I think I am trying to sop an evil. But there is no guarantee that it will not bring about another evil.

It is up to the reader to interpret - and I am not going to force people into choosing a side. A war between sides is automatically won when one figures out there is no side to chose from.

I will end with one of the least famous story from the celebrated Indian Epic Mahabharata.

Duryodhana the key villain gets asked by Lord Krishna - the supreme lord in the mythology -

"Why you do what you do? Can not you see I am the supreme truth and I am against your side?"

Duryodhana answers humbly : "My lord - I am doing what you exactly want me to do - because there is not a even a leaf drops on the floor without your wish - so I must be following your wish only!"

Ancient Indian mythology had a nice way to get into your head and ask the proverbial question : "What is REAL NEO?" .

You have to see the matrix yourself. Chose the pill, wisely.

Have a nice day.

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