FINDING THE HIDDEN DIMENSION OF GLOBAL INTERNET USAGE THROUGH FRACTAL ANALYSIS

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ABSTRACT

Statistics revealed that the number of internet users in the world is increasing due to technological advancements. Technological advancement, on the other hand, is a function of the national economy. Highly developed nations, therefore, are expected to have more internet users than less developed economies. Fractal analysis is a contemporary method of applying nontraditional mathematics to patterns that defy understanding with traditional Euclidean concepts. This study employed a descriptive method of research and made use of secondary data from 198 countries (internet users) of 2014. Fractal analysis was used to determine the fractal characteristic of the given data. The histogram of the logarithm of the Internet Users across the world appears to be normally distributed. The phenomenon of observed internet users has already departed from the natural state. Analysis of the fractal observations revealed a tendency to diffuse towards uniformity in the use of internet all over the world so that cyber-communication will become the norm or standard through which countries will eventually exchange information.

Keywords: internet, fractal analysis, fractal dimension, internet users

Introduction

The worldwide statistics of internet users revealed that the number of internet users in the world is increasing. The increased numbers of internet users are affected by technological changes. Technological change, on the other hand, is a function of the national economy. Highly developed economies, therefore, are expected to have more internet users than less developed economies. There are more or less developed economies in the world than highly developed ones. Thus, we suspect that the number of internet users in the world is fractal.

It may seem incredible to think it, but back in 2000, there were a mere 394 million internet users scattered across the world. Fast forward to 2014 and that number has grown to almost 3 billion that's nearly 40 percent of all people on Earth (McCarthy, 2014). The latest statistics from an analyst at eMarketer (January 2014) confirmed what everyone in the know has been saying for years: the mobile Web is massive. That does not mean they will all exclusively use mobile to access the Web (though plenty will be mobile only), nor does it mean they are all heavy users (eMarketer counts anyone who uses a mobile browser or app to access the Web at least once a month) (Mobithinking, 2014).

Mobile Internet users in the developing world would double from 1.5 billion in 2013 to 3 billion by 2020, rising from 25% today to 45% of the developing world population that will be accessing Internet services and consuming mobile data for everything from email and web browsing, to social networking and online gaming (Wayan Vota, 2014). The digital world passed another huge milestone today, 2014 has seen steady growth in internet usage, with current trends suggesting that global users are increasing by more than 5% year-on-year. Critically, Statistics reports that roughly three-quarters of the world's 3 billion users access the internet via mobile devices, and this portion is steadily increasing as data connections become more accessible in developing nations (Simon Kemp, 2014).

Releasing new statistics today, the United Nations International Telecommunications Union (ITU) announced that by the end of 2014, there will be nearly three billion Internet users – two-thirds of them from the developing world – with mobile-broadband penetration approaching 32 percent. Moreover, people from developing countries make up for more than 90 percent of those who are not yet using the Internet (CircleID Reporter, 2014).

Based on the literature reviewed, it is seen that in 2014 there is a steady growth in internet usage and an increasing number of global internet users. Most of the global internet users access the internet through a mobile device. Internet connections become more accessible to developing nations and internet users are increasing in highly developed economies. The gap between the number of countries with lower internet usage and those with higher internet access appears to be fractal. These fractal characteristics imply that there are hidden dimensions which explain why internet usage across the world varies as such. This is the main focus of this investigation.

Conceptual Framework

Fractal analysis is a contemporary method of applying nontraditional mathematics to patterns that defy understanding with traditional Euclidean concepts. It is now widely used in all areas of science. An important limitation of the fractal analysis is that arriving at an empirically determined fractal dimension does not necessarily prove that a pattern is fractal; rather, other essential characteristics have to be considered. A common feature of all types of fractal analysis is the need for benchmark patterns against which to assess outputs. These can be acquired with various types of fractal generating software capable of generating benchmark patterns suitable for this purpose, which generally differ from software designed to render fractal art. In essence, it measures complexity using the fractal dimension (Mandelbrot, 1982).

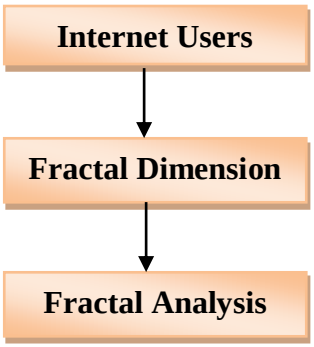

Figure 1. Schematic Diagram of the Study

A fractal dimension is a ratio providing a statistical index of complexity comparing how the detail in a pattern (strictly speaking, a fractal pattern) changes with the scale at which it is measured. Fractal dimension has turned out to be a powerful tool. Now mathematicians are able to measure forms which were previously immeasurable. Fractal dimension indicates the degree of detail or crinkliness in the object and how much space it occupies between the Euclidean dimensions. It is easy to find the fractal dimension by simply reading the exponent.

People with access to the worldwide network are called "Internet Users". Global Internet Users' data will be used to determine the fractal dimension of this study. This fractal dimension determines the gap between the number of countries with lower internet usage and those with higher internet access. These fractal characteristics imply that there are hidden dimensions which explain why internet usage would vary across the world.

Methodology

This study employed a descriptive method of research and made use of secondary data from 198 countries (internet users) of 2014. Fractal analysis is used to determine the fractal characteristic of the given data. The analysis proceeds as follows:

The histogram of the raw observations was constructed to determine if the hypothesis of fractality is well-founded. Higher frequencies for lower values of the data indicate fractality. In order to test this suspicion, the logarithm of the observations was obtained and the corresponding histogram was likewise constructed. If the histogram of the logarithm of the data appears to be exponential, then the hypothesis of fractality is accepted. Formal statistical test for exponentiality may also be undertaken using the Ryan-Joiner test or Kolmogorov-Smirnov test.

Two possibilities exist after analysis of the distributional form of the data. If it turns out that the data obey a fractal distribution, then the statistical inference about the future behavior of internet usage may be done. On the other hand, if the data more likely follow a non-fractal distribution, then the fractal component of the histogram is isolated from the rest. The remaining non-fractal observations are analyzed separately to determine the causes or possible reasons for the non-fractality of the observations. Departures from fractality imply that the state of the phenomenon under consideration has significantly shifted away from its natural state of order.

Results and Discussion

Figures 2 and 3 display the histograms of the number of Internet Users across the globe and its logarithm, respectively.

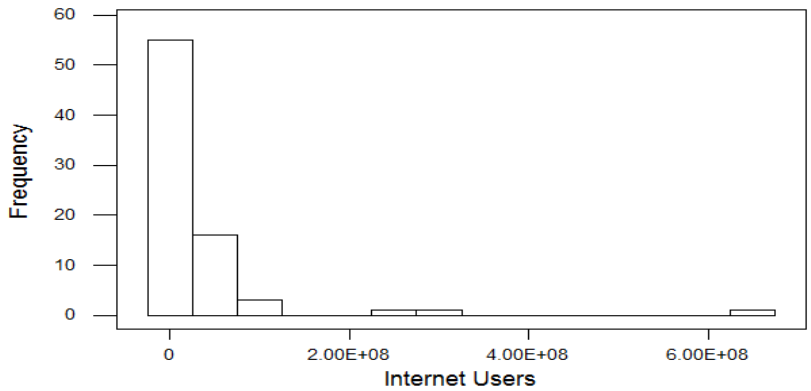

Figure 2. Histogram of the number of Internet Users across the globe

Figure 2 shows the histogram of the number of internet users across the globe. It confirms that there are more countries with fewer internet users. However, because the tail of the probability distribution appears to diminish, we hypothesize that the number of internet users of the 198 countries is not likely fractal but is likely different from its natural state. The presence of a few but significant numbers of countries with a large number of internet users appeared to have destroyed the fractality of the observations. If all the countries after the first spike in the graph were removed, then we would have obtained a perfectly fractal configuration. In order to confirm if the observations as they stand were fractal or not, we obtained the logarithm of the observations and constructed the histogram as reflected in Fig. 3.

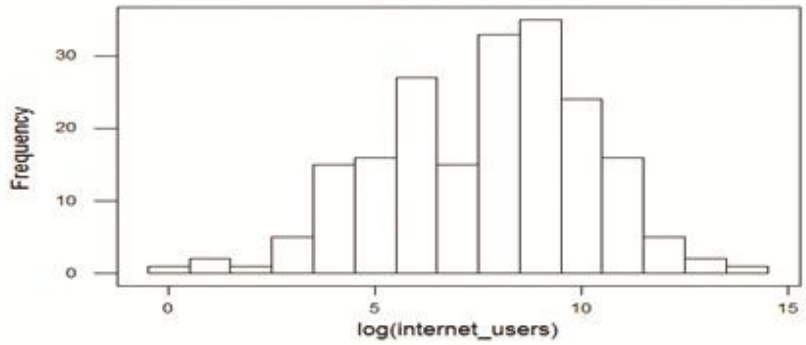

Figure 3. Histogram of the Logarithm of Internet Users

The histogram of the logarithm of the data appeared symmetric and closely resembled a normal distribution with mean located in the center. Thus, it may be said that the logarithm of the data obeys a lognormal distribution. Without a formal test of hypothesis, one can easily see that the histogram is not exponential and hence, that the original data is not fractal. A Kolmogorov-Smirnov test for normality confirmed our hypothesis ($p < .05$).

Discussion

The histogram of the logarithm of the Internet Users across the world appears to be normally distributed. The phenomenon of observed Internet Users has already departed from the natural state (from few internet users to increasing number of internet users spread across the world). The histogram further suggests that countries belonging to the lower half of the histogram account for the observed non-fractality of the current observation. The fractal dimension calculated amounted to 1.13023 which means that there are least two (2) reasons which can be discovered from an analysis of the countries in the lower half of the histogram.

An examination of the observations found in the lower half of the histogram revealed that these were the countries that used to be unable to access the internet because of its prohibitive cost. In other words, these were countries considered as underdeveloped or developing barred from using the worldwide web through the internet because of cost. Developments in communication and information technology, however, have made access to the internet far more affordable even to struggling nations. In other words, low cost coupled with easy access to mobile phones has made the internet accessible to a far wider range of audience.

In the future, it is surmised that even greater access and cheaper costs of computers can be made available, resulting in a uniform distribution of internet users globally. This will make the field of information technology an "even playing field" for most people of varying nationalities. Indeed, a global information village is possible where even the very notion of "citizenry" will evolve into a cyber-nation where every participant is a "netizen". Information flow becomes borderless and the concept of geographic boundaries becomes all but blurred.

The prospect of a global information village has far-reaching implications in almost all aspects of human endeavor. In education, specifically, the traditional concept of a classroom-based learning will be replaced by a cyberspace-based learning: the teacher's role becomes one of facilitating the information exchange between man and machine rather than as a dispenser of knowledge. Infrastructures are built not to house lectures but to provide a venue for formal man-machine interaction. While education today is considered an expensive investment for the citizens of a nation, it will become almost free in the future because everyone will have free access to the internet. Knowledge virtually becomes available at everyone's fingertips.

While a uniform access to the internet by the rich and the poor nations has its upside, it also has its own downside. With free and virtual information easily accessible to everyone, harmful information also becomes available to everyone. Such information can be used for nefarious purposes by some people so that we also anticipate that the various countries benefitting from this development will invest in their own systems of protecting their citizens from the ill-effects of free information flow.

Flow of Internet Usage to Uniformity

The lognormal distribution has a mean of 7.678 (in logarithmic scale) with a standard deviation of 1.2797 (in logarithmic scale) which shows that the rate at which the logarithm of internet users diffuse to uniformity is about 1.2797 per unit time. That is, those countries with a lower number of internet users will grow at this logarithmic rate per unit time to eventually level up to the mean of 7.678 per unit time. In terms of the original data scale, this means that within this century, the global information village scenario will have taken place.

Conclusion

Global internet usage can be characterized as lognormal distributed rather than fractal. However, certain countries, when properly isolated, are shown to follow a fractal distribution. These countries account for the observed non-fractality of internet usage globally. This increased number of utilization could be due to the increasing affordability of internet use, and easy access to mobile phones and other technological devices. Both reasons allow even less developed countries and underdeveloped nations to access the internet. The long-term trend of internet usage globally is for the number of internet users to be uniformly the same in terms of density across different countries regardless of their global economic status.

References

Kemp, (2014).*Internet Users Pass 3 Billion Mark* retrieved from wearesocial.net

Mandelbrot, B. (1982). *The Fractal Geometry of Nature.* W.H. Freeman & Co. Retrieved from http://ordinatous.com/pdf/The_Fractal_Geometry_of_Nature.pdf

McCarthy, (2014).*Giant Chart: Global Internet Usage by Numbers* retrieved from www.Forbes.com

Mobithinking, (2014).*Four out of five global internet users in 2014 will be mobile Web user: eMarketer* retrieved from mobiForge.com

Vota, (2014).*Digital Inclusion, ICT works, Inveneo,* San Francisco

CircleID Reporter. (2014). *Three Billion Internet users by end of 2014, Two – Thirds from developing World*. Retrieved from www.circleid.com

Appendix I

List of 10 Countries with the highest internet users

No.	Country	No. of internet users
1	China	641,601,070
2	United States	279,834,232
3	India	243,198,922
4	Japan	109,252,912
5	Brazil	107,822,831
6	Russia	84,437,793
7	Germany	71,727,551
8	Nigeria	67,101,452
9	United Kingdom	57,075,826
10	France	55,429,382

Appendix II

List of 10 Countries with lowest internet users

No.	Country	No. of internet users
1	Samoa	26,977
2	Maldives	16,645
3	San Marino	16,631
4	Kiribati	12,156
5	Timor-Leste	11,472
6	Caribbean Netherlands	10,233
7	Tuvalu	3,768
8	Cook Islands	1,378
9	Marshall Islands	1,246
10	Niue	617