

SELF-AFFINE CHARACTERISTICS OF INTERNET USERS WORLDWIDE

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ABSTRACT: This paper sought to investigate the self-affinity of the data through fractal analysis of the 187 countries in the world based on the Internet World Stats 2019 data. The data is found on the population and its penetration of people and internet users' percentage per country in the region. Fractal analysis was conducted to determine a pattern of self-similarity and ruggedness of internet users in different countries. The data has a fractional dimension of 1.26, a mean of 0.043, and a median of 0.006. A scale of 0.000-0.007, 0.01-0.05, and 0.2-0.8 was used to determine the self-affine characteristics of countries. The results revealed that the extent of self-similarity is low. Ninety-three countries have internet usage percentages higher than 0.006 while 93 countries have internet usage percentages lower than 0.006. This shows that there are still many countries that have low internet connectivity. The study suggests that global internet usage should ideally be of the same density regardless of its global economic status.

Keywords: self-affine, internet users, fractal dimension, fractal analysis

INTRODUCTION

An internet user is an individual who uses the internet; using a computer or mobile device. An internet user must have available access to an internet connection point and must have the basic knowledge required to use the web technology. These can be classified as the Geek- who are expert in using the internet, and the Social Butterfly- who knows the latest in celebrity gossip and like to use the internet for the basics, such as social media, sending emails, and shopping online, the Entertainment Buff, or the Worker and Learner who continually use the internet to upload and download documents, email, and stream calls. More and more people are going online. They use the Internet for all kinds of tasks. They visit social networking sites like Facebook, communicate with friends and family, take part in forum discussions, do their banking online, read the news, book trips, write blog articles, look for information to make decisions, and stay or become informed [1].

According to the recent report by Statista Research Department, as of April 2022, there were five billion internet users worldwide. As of January 2022, China ranked first among the countries with the most internet users worldwide with 1.02 billion internet users, more than triple the amount of the third-ranked United States, with just around 307 million internet users next to India. In December 2017, there were only approximately 772 million internet users in China. However, broadband internet usage is not equally present in many countries, and due to infrastructure reasons, developing online markets rely strongly on mobile connections. According to Internetlivestats.com, there is an average of 5.4 billion internet users worldwide. The highly developed economies 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, it is suspected that the number of internet users worldwide is fractal.

Others confirmed the six basic user types, differing significantly based on their dominant internet use principles [2]. These can be identified as 1) active versatile internet users; 2) Practical work-oriented internet users; 3) Entertainment oriented active Internet users; 4) practical information oriented small-scale internet users; 5) Entertainment and communication oriented small-scale Internet users, and 6) small-scale internet users. Internet usage has diffused globally at unequal rates, particularly in developed versus developing countries [3]. Easier access

to computers, the modernization of countries around the world, and increased utilization of smartphones have given people the opportunity to use the internet more frequently and with more convenience. However, internet penetration often pertains to the current development regarding communications networks. In many third-world countries, the same Internet connection may be shared by many individual users. Due to this reason, internet users generally outnumber the amount of internet access subscribers and also outnumber the telephone lines available in each country.

In the Philippines, the main problem associated with the use of the internet is lagging in terms of internet speed. It is more expensive compared to other countries in Asia according to an article published in Yugatech. Most Filipinos have smartphones and tablets and rely on 3G and 4G LTE networks to stay connected. However, despite telcos advertising that they have the capacity and coverage in central areas, quality is not always consistent. Another prevalent issue is hacking, even in powerful countries like US and China. Cyberbullying and social media flogging are also internet problems today. Social media is a powerful tool for exposing abusive individuals, especially those in power. However, people have also used this as a platform to bully or troll other people. Online scams or internet fraud is also an ongoing issue, especially in the Philippines. There are emails and text messages that claim to be from a royal family from another country, letting you know that you have inherited their fortune. These fake online merchants disappear after you send them a payment, fake lovers on social media sites, and online sextortion syndicates.

The internet has introduced improvements in technology, communication, and online entertainment. It has become a more critical as well as a powerful tool in the world that is preferred by everyone. Everybody needs the internet for some or other purposes. Students need the internet to search for information related to exams, curriculum, results, etc. However, others claimed that the internet has and is still improving their academic research and that the use of the internet has not enhanced their academic study and learning [4].

Kim, *et.al* suggested that future research should be directed toward identifying with greater specificity what background characteristics of internet users and their motives for using the internet [5]. From the perspective of income, Internet users with higher income are more likely to use privacy protection tools and services, while more likely to trust the firms on their privacy policies [6].

Demographic characteristics related to education level, income, and a number of information sources played a key role in discriminating between Internet users, and non-users [7].

The internet continues to be one of the most important vessels for the progression of society. It has become nearly ubiquitous, but it's not perfect. From dial-up connections to 4G networks and endless options for free wifi at public establishments is its kind of digital paradise. However, according to Data Science Central, one of the biggest problems facing the development of the internet is global inconsistencies in internet availability. Many African countries like Chad, Niger, and Somalia have single-digit percentages of their respective populations with internet access, and internet speeds vary wildly from country to country. The ever-rising demand for bandwidth is where the consumers are hungry for more bandwidth, want higher-definition movies, faster and more frequent points of information retrieval, and more advanced user interfaces for favorite apps and websites. Unexpected fluctuations in use during late at night and early in the morning, few people are accessing content online, but during peak working hours and prime time, people stream large volumes. To have the possible use and benefit of the internet, there is a need to take measures to ensure the most significant number of people from countries all over the world have reliable access.

This paper sought to investigate the self-affinity of the data through fractal analysis of the 187 countries in the world based on the Internet World Stats 2019 data. The status is found on the population and the penetration of people and internet users percentage per country in the region. The gap between the number of countries with lower internet usage and those with higher internet access appears to be fractal [8]. This is the main focus of this investigation. The fractal dimension is computed to quantify the self-affinity and scale invariance. The enablers, barriers, factors, and conditions of internet users by region will be discovered. The degree of self-affinity and scale invariance will be the basis of identifying the country's best practices and technological advancement.

The evolution of internet platforms and their growing presence in the internet economy has an enormous effect on society, innovation, and the economy. Despite rapid change in access networks and the total service environment offered by the internet, there is a trouble of growing societal dependencies on a handful of powerful economic actors. The risk is magnified by exceptional economic power. Moreover, the internet has become an easy passage to challenging issues affecting the economy, society, and governance. These issues, ranging from fake news to anti-competitive practices, are found across the applications, services, and access domains of the Internet economy. Internet Society recognizes the impact of consolidation and concentration on the internet economy and the open, interoperable, and global internet are difficult to gauge. Countries in the world have adopted different strategies. Some have a higher tolerance for the risk of dominance if it also delivers internet access and services, while others have a traditionally lower tendency to regulate. European countries are mobilizing concerted, cross-agency responses, which often span competition, consumer protection, and data protection regulators.

A common feature of all 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 on software designed to render fractal art. The schematic diagram. [9]. Internet users are people with access to the worldwide network. The attribute variation in a fractal object can be described through the fractal dimension, a measure of the roughness, or fragmentation, of the thing. More jagged-looking things have larger fractal dimensions. It is said that the higher the fractal dimension is, the squigglier the thing that is inside the square [10]. 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 that explain why internet usage varies across the world. Fractal analysis, by all means, is the best instrument for determining the roughness of data [11].

CONCEPTUAL FRAMEWORK

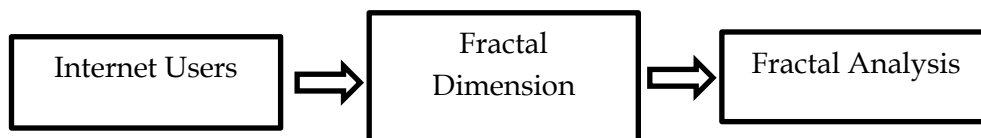


Figure 1. Schematic Diagram of the Study

METHODOLOGY

This study utilizes Fractal Analysis. It is used to describe the self-similarity of the data across all scales. Self-affinity and fractional dimension are vital characteristics of fractal data. If the data, on more minor scales, look the same as on a larger scale, then the data has a self-affinity characteristic.

The fractional dimension measures the extent of self-similarity or self-affinity of fractal data.

The probability density function (fractal distribution) of a fractal, denoted by $f(x)$, is given by

$$f(x) = \frac{\lambda-1}{\theta} \left(\frac{x}{\theta}\right)^{-\lambda}, \lambda > 1, x > \theta > 0, \quad (1)$$

respect to the total population in a region. In this study, data of 187 countries are used.

Percentage of Internet Users

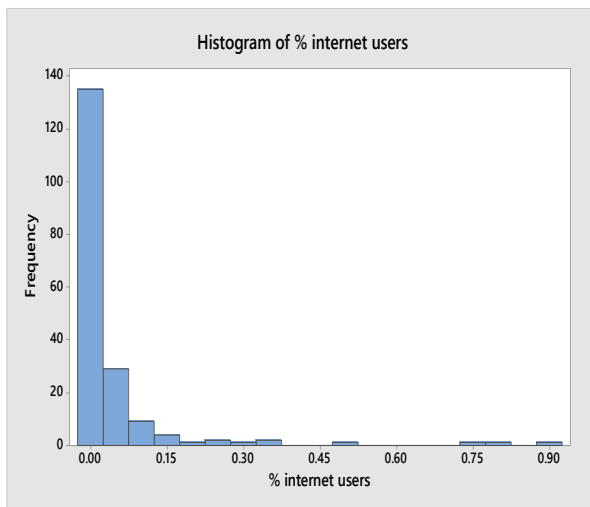


Figure 2. Histogram of Internet Users

Figure 1 displays the histogram of the data. The histogram has one big spike on the left side, and the rest have minor frequencies. Taking the logarithm of the data gives us the distribution to be exponential. Hence, data on the percentage of internet usage is fractal. This indicates that most of the countries have a low percentage of internet usage while only a few got a high rate of internet usage. Furthermore, countries with common internet usage are countries like Bermuda, Cambodia, and Kosovo.

Where λ is the fractional dimension of the data, θ is the minimum of the data, and $\frac{\lambda-1}{\theta}$ is the scale. This means that large values of data x will have smaller chances of occurrence while small values of data x will have larger probabilities of occurrence. Also, the function (1) is scale-invariant if it retains the same shape at all scales, that is,

$$f(ax) = a^{-\lambda}f(x), a^{-\lambda} \text{ is constant.} \quad (2)$$

By maximum likelihood estimation, the fractal dimension λ is given by

$$\hat{\lambda} = 1 + \frac{1}{\frac{\sum_{i=1}^n \log \frac{x_i}{\theta}}{n}} \quad (3)$$

where θ is the minimum of the x_i . If the fractal dimension is high, then the self-similarity of the data is more evident at any scale.

Data on the percentage of internet usage in its region population of 187 countries will be taken from Internet World Stats. These data will be examined through fractal analysis. If it is fractal data, data will be scaled in such a way that self-affinity is satisfied.

On a scale 1, these are countries having low internet usage. 55% of the countries have no or shallow internet usage due to low internet connectivity. In Asia, these are the countries

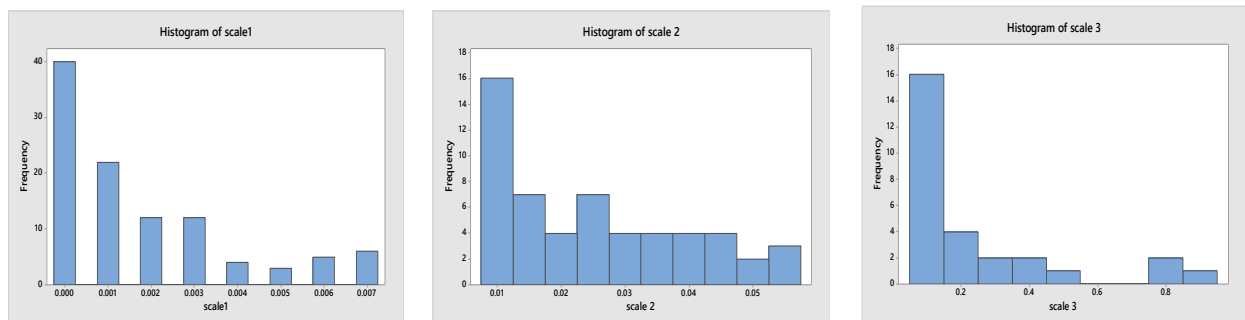


Figure 3. The scale of countries having self-affine characteristics

The data has a fractional dimension of 1.26. this indicates that the extent of self-similarity is low. It is embedded in a size between 1 and 2. 63% of the space (global internet connectivity) is occupied by internet usage.

The data has a mean of 0.043, and its median is 0.006. Ninety-three countries have internet usage percentages higher than 0.006 while 93 countries have internet usage percentages lower than 0.006. This shows that there are still many countries that have low internet connectivity.

Next, we scale the countries having self-affine characteristics with internet usage from 0.000-0.007, 0.01-0.05, and 0.2-0.8.

Afghanistan, Tajikistan, Turkmenia, Mongolia, and Laos. In Europe, a sample country with low internet connectivity is Albania, San Marino, Man Isle of Monaco, Gibraltar, and the Faroe Islands. Countries in South America with self-affine characteristics are French Guiana, Falkland Island, Suriname, Guyana, and Uruguay. In North America, countries like ST. Pierre and Bermuda. Oceania, these are the countries like Terres Australes, Smaller Territories, Pitcairn Islands, Wallis & Futuna, and Tuvalu. The table shows the group of countries with low internet usage

Table 2. Countries with low internet usage

LOW Internet Usage			
Wallis & Futuna	Kyrgystan	Cook Islands	Hong Kong *
Vatican City State	Kiribati	Cocos (Keeling) Is.	Grenada
Tuvalu	Guyana	Christmas Island	Cambodia
Tokelau	Georgia	Brunei Darussalam	Azerbaijan
Timor-Leste	Cyprus	Bhutan	Albania
St.Pierre & Miquelon	British Virgin Islands	Bermuda	Afghanistan
St. Barthélemy (FR)	Bonaire, St.Eustatius, Saba	Antarctica	Moldova
San Marino	Armenia	Andorra	Lithuania
Palau	American Samoa	Svalbard & Jan Mayen	Bosnia-Herzegovina
Norfolk Island	Tonga	Terres Australes	Antigua & Barbuda
Niue	St. Kitts & Nevis	Smaller Territories (4)	Guam
Nauru	Slovenia	Pitcairn Islands	Croatia
Monserat	Singapore	Australia, Ext. Terr.	Aruba
Monaco	North Macedonia	Turks & Caicos	Slovakia
Man, the Isle of	Micronesia	Turkmenistan	Saint Lucia
Maldives	Latvia	Tajikistan	Kazakhstan
Macao *	Kosovo	Suriname	Ireland
Liechtenstein	Estonia	St. Martin (FR)	Bulgaria
Korea, North	Dominica	Sint Maarten (NL)	Uzbekistan
Jersey	Cayman Islands	Northern Marianas	Norway
Iceland	Belize	Montenegro	Nepal
Guernsey & Alderney	Vanuatu	Mongolia	French Polynesia
Greenland	US Virgin Islands	Marshall Islands	Finland
Gibraltar	St. Vincent & Grenadines	Malta	Curacao
French Guiana	Sri Lanka	Luxembourg	
Faroe Islands	Solomon Islands	Laos	
Falkland Islands	Samoa		

The second scale ranges from 0.01 to 0.05 of the global internet connectivity per capita. 23% of 187 countries, or 1/3 of the citizens worldwide, have relatively better internet connectivity. Thus, citizens can access the internet. Countries in Asia with better internet connectivity are Malaysia, the Philippines, Bangladesh, Pakistan, and Vietnam. In Europe, self-affine countries are Sweden, Belgium, Netherlands, Romania, and Austria. In Oceania, are countries like Guam, New Caledonia, Fiji, and Papua New Guinea. Self-affine countries in the Middle East regarding internet usage are Bahrain, Qatar, Oman, Kuwait, and Lebanon. Most of these countries with moderate internet usage have free wifi.

Then we scaled the countries with high internet connectivity, which ranges from 0.2-0.8. 17% are countries worldwide with connected citizens. Countries in Asia with high internet usage are China, India, and Indonesia. In Europe are countries like Russia, Germany, Turkey, the United Kingdom, and France. In Oceania are Australia and New Zealand. In the Middle East are Iran, Saudi Arabia, and Iraq.

Table 3. Countries with moderate internet usage

Moderate Internet Usage		
New Caledonia	Sweden	Bolivia
Myanmar	Martinique	Panama
Denmark	Czech Republic	Vietnam
Serbia	Belgium	Pakistan
Bahrain	Bahamas	Lebanon
Uruguay	Qatar	Honduras
Taiwan	Fiji	El Salvador
Belarus	Palestine (State of)	Philippines
Barbados	Romania	Papua New Guinea
Switzerland	Paraguay	Syria
Portugal	Korea, South	Costa Rica
Malaysia	Oman	Israel
Guadeloupe	Netherlands	Poland
Greece	Nicaragua	Bangladesh
Austria	Kuwait	Ecuador
Hungary	Thailand	Yemen
Trinidad & Tobago	Japan	Chile
Jordan	United Arab Emirates	Venezuela
Ukraine		

Table 3. Countries with high internet usage

High Internet Usage	
Spain	Germany
Guatemala	Iraq
Jamaica	Puerto Rico
Peru	Argentina
Indonesia	Russia
Italy	New Zealand
France	Saudi Arabia
United Kingdom	India
Haiti	Cuba
Turkey	Dominican Republic
Colombia	Iran
Canada	China *
Mexico	Brazil
United States	Australia

According to Statista.com, in 2020, 70.6% of the population in China will be internet users since the internet is available all over the country. Its internet usage has been driven by an increase in people who are watching short-form videos. These internet users have migrated from text and still images to videos and mobile-friendly content. China has a broadband speed of 196.57 Mbps with a mobile speed of 165.38 Mbps. In the same year, 53.7% of the population in Indonesia are internet users. According to Speedtest Global Index, as of March 2019, its mobile internet speed is 10.51 Mbps, and its fixed broadband speed of 16.65 Mbps. In 2019, 41.0% of the population in India was inter-users, 89.4% in the United States, and 73.9% in Brazil. 42% of internet users in India have an average internet connection speed of above 4 Mbit/s, 19% have a speed of over 10 Mbit/s, and 10% enjoy speeds over 15 Mbit/s. the United States, on the other hand, ranks number 1 in the world with 7, 000 Internet Service Providers (ISPs) according to the CIA. The United States has the 15th-fastest mobile speeds at 110.07 Mbps, and the 13th-fastest broadband speeds at 203.81 Mbps, though average internet download speeds vary substantially from state to state. Lastly, most Brazilian states achieved median download speeds between 42.00 Mbps and 52.00 Mbps over fixed broadband. Brazil's Federal District achieved the fastest median fixed broadband speed among Brazilian states at 75.71 Mbps in 2021.

CONCLUSION AND RECOMMENDATIONS

Statistics revealed that the increasing number of internet users in the world is due to technological advancements. The Internet has touched all aspects of people's lives, and has played a pivotal role in driving the engine to run unexploited markets of the country, and push the frontiers where the benefits of globalization does not only affect the first-world economies but the emerging countries as well. ½ of the internet users worldwide cannot access it because of low internet usage. China, India, the United States, Indonesia, and Brazil, among others, are the top internet users in the world. These countries have increased utilization due to the increasing affordability of internet use, and easy access to mobile phones and other technological devices. Both reasons allow less developed countries and underdeveloped nations to access the internet. The study suggests that global internet usage should ideally be of the same density regardless of its global economic status.

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