Google's Revenue and Stock Price Prediction and Analysis

Pratistha Chand

November 2022

1 Abstract

Revenue and stock prices are two indicators that give important insights into a company or a business. The purpose of this project was to forecast the future quarterly revenue and closing stock market prices of Alphabet Inc. (Google) using the past data available on the internet. I used a Deep Learning algorithm called Long Short-Term Memory (LSTM) for my code. With the predictions I got, I performed SWOT analysis on Google to better understand its business model and studied the correlation between its revenue and stock market prices.

1.1 About Google

1.1.1 Introduction

Google LLC, previously Google Inc., is the company initially founded to market what is now the most dominating search engine in the world, Google. Google has 92.37% [1] search engine market share worldwide as of September 2022 while its holding company, Alphabet Inc. had revenues worth $257.6 billion [2] just for the year 2021. The company underwent a phase of rapid growth as they ventured into other online platforms such as Google News, Gmail, Google Maps, Google Chrome, and many other products. Though these platforms certainly help, $209 [2] million which equates to 81.3% of Google's revenue was generated through its ads in 2021.

1.1.2 History

The founders of Google, Larry Page and Sergey Brin met as doctoral students in the computer science program in Stanford University, California. While working on his doctoral thesis, Page created BackRub [3], a system that would discover pages and then make it possible to see who was linking to any given page on the Web. Brin got involved later and together they created PageRank, a ranking methodology that made more popular sites rise to the top of the search list and less popular sites at the bottom. Page and Brin created a basic search tool and named it Google after the mathematical term Googol (the number 1 followed by 100 zeroes). This first version of Google was released in August 1996 on Stanford's Website. Later, they published a paper called "The Anatomy of a Large-Scale Hypertextual Web Search Engine" [4] still as Stanford students. While their initial goal was to license their technology to other search engines, no one wanted to do so. They met with Andy Bechtolsheim, who on seeing their real potential invested $100,000[5] in the company. Thus, Google Inc. was formally incorporated on September 1998 with Page as its CEO and Brin as its President.

1.1.3 Global Presence

Google currently has more than 70 offices in 50 countries. Its global headquarters, called the Googleplex, is in Mountain View, California, U.S.A. With over 8.5 billion daily searches, Google's has become an integral part of searcher's everyday life. Google's impact on the world economy is indisputable. Google has helped businesses grow by creating jobs and saving time and money. In just 2021, Google helped provide $617 billion [6] of economic activity for millions of American businesses, nonprofits, publishers, creators, and developers alone. In 2019, Google's products supported at least €177 billion [7]in economic activity for businesses, developers, creators and publishers right across Europe. The same year, Australia generated $35 [8] billion in total business benefits. Each year, the numbers have only grown.

2 Methodology

2.1 Data source

For the google stocks dataset, I used one with data from 2004 to 2022 that was available in Kaggle [9]. As for the revenue of Google, the data published in Statista website [10] was used to get Google's quarterly (every 3

months) revenue generated from the $1^{s}t$ quarter of 2008 till the $2^{n}d$ quarter of 2022. I extracted the date and corresponding revenue and made my own dataset in .csv form to use.

2.2 Algorithm used

I used LSTM is my algorithm. Long Short Term Memory (LSTM) is a special kind of Recurrent Neural Network that is favored for prediction problems due to its property of selectively remembering patterns for long durations of time.

2.2.1 Architecture and Math of the LSTM model

LSTM network consists of different memory blocks called cells. These are the rectangular boxes seen below.
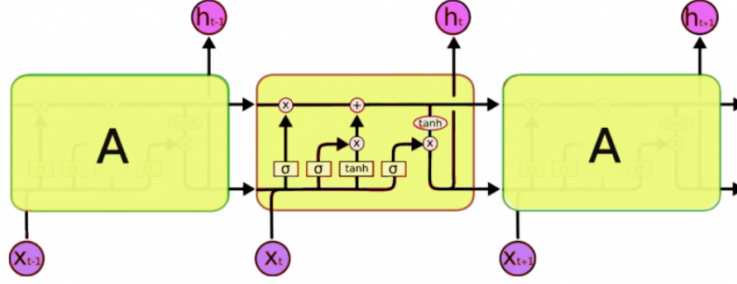

Figure 1: LSTM Cells

LSTM has a cell state which is known as Long term memory. The cell state allows the model to capture memory that are further back in the past. It is the horizontal line represented by C (t-1) and C (t) in the diagram below.

LSTM also has a hidden state which is known as Short term memory. It is the horizontal line represented by h (t-1) and h (t) in the diagram below.
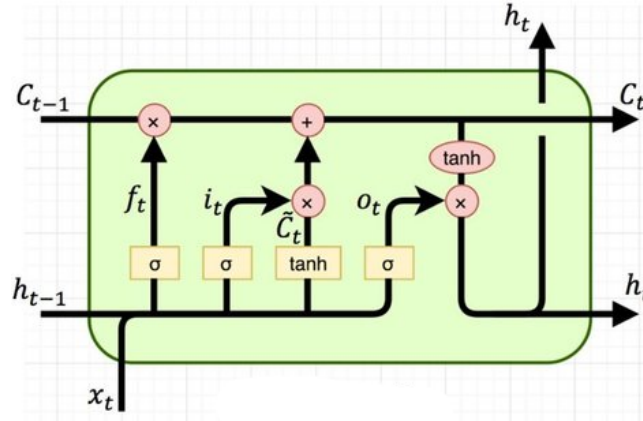

Figure 2: Single LSTM Cell

The hidden state contains the information of previous inputs (from the cell state) and the current input - X(t). We use our knowledge of the hidden state and the current input to change the cell state (i.e. the memory). This is done using gates.

Gates regulate the flow of information. It allows us to remove, modify or add information to the cell state. There are 3 kinds of gates:

1. Forget gate: This gate allows us to decide whether to keep information from the previous timestamp or forget it.

$$f_t = \sigma \left(x_t * U_f + H_{t-1} * W_f \right) \tag{1}$$

Where,
x_t = current input
U_f = weight of the input (The weight shows the effectiveness of a particular input. More the weight of input, more it will have impact on network.)
H_{t-1} = hidden state of previous timestamp
W_f = weight matrix of the hidden state

Applying the Sigmoid function (σ) *over* f$_t$ makes it have a value between 0 and 1. Then this f_t is multiplied with the cell state i.e. C_{t-1} of the previous timestamp.

$$C_{t-1} \star f_t = 0 \quad \ldots if \ f_t = 0 \ (forget \ everything)$$
$$C_{t-1} \star f_t = C_{t-1} \ldots if \ f_t = 1 \ (forget \ nothing) \tag{2}$$

2. Input gate: This gate quantifies the importance of the new information in the input.

$$i_t = \sigma \left(x_t \star U_i + H_{t-1} \star W_i \right) \tag{3}$$

Where,
x_t = current input
U_i = weight matrix of the input
H_{t-1} = hidden state of previous timestamp
W_i = weight matrix of input associated with the hidden state

Applying the Sigmoid function (σ) *over* i$_t$ makes it have a value between 0 and 1. Then, using the calculated i_t, the input gate determines whether new information should be saved in the cell state or forgotten and saves this decision as N_t.

$$N_1 = \tanh \left(x_t {}^\star U_c + H_{t-1} {}^\star W_c \right) (new \ information) \tag{4}$$

The activation function i.e. tanh function causes the value of the new information to be between -1 and 1.

If N_t is negative, the information is not added to the cell state. If N_t is positive, the information is added to the cell state at the current timestamp i.e. C_{t-1} using the equation below.

$$C_t = f_t \star C_{t-1} + i$$

$\star N_t (updating \ cell \ state)(5)$

3. Output gate: This gate selects useful information from the current cell state and shows it as the output.

$$O_t = \sigma \left(x_t \star U_0 + H_{t-1} \star W_0 \right) \tag{6}$$

Where,
U_o = weight matrix of the output
W_o = weight matrix of output associated with the hidden state

Again, the Sigmoid function causes o_t to have a value between 0 and 1. Finally, the current hidden state i.e. H_t is calculated.
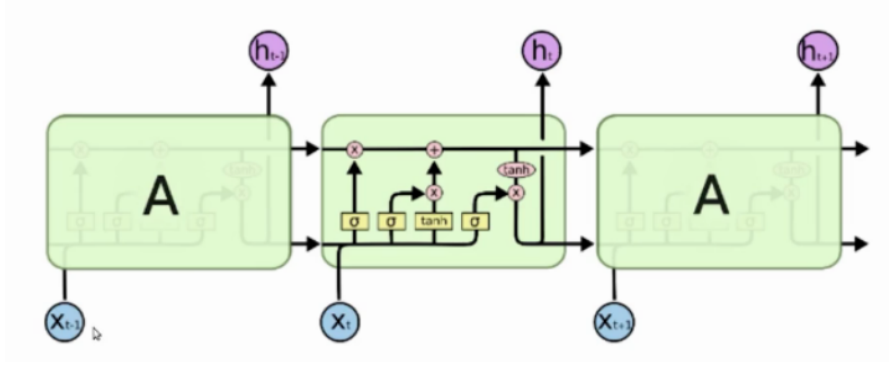
$$H_t = o_t \star \tanh \left(C_t \right) \tag{7}$$

Figure 3: Final diagram of the sequential LSTM model

3 Results and Analysis

3.1 Forecasted revenue and stock prices

In my project, I forecasted the value of Google's daily stock prices from September 19, 2022 to September 18, 2023 and Google's quarterly revenue from June 2022 to June 2024. The pictures below show the forecast.

Figure 4: Graph of Google's closing stock price against the date

| index	Date	Close
350	2023-09-04 00:00:00	120.4952392578125
351	2023-09-05 00:00:00	119.5825424194336
352	2023-09-06 00:00:00	118.39549255371094
353	2023-09-07 00:00:00	117.21866607666016
354	2023-09-08 00:00:00	116.09638977050781
355	2023-09-09 00:00:00	114.9404296875
356	2023-09-10 00:00:00	113.77465057373047
357	2023-09-11 00:00:00	112.91383361816406
358	2023-09-12 00:00:00	112.12843322753906
359	2023-09-13 00:00:00	111.71577453613281
360	2023-09-14 00:00:00	111.54312133789062
361	2023-09-15 00:00:00	111.0003890991211
362	2023-09-16 00:00:00	110.33349609375
363	2023-09-17 00:00:00	109.4141616821289
364	2023-09-18 00:00:00	108.72936248779297

Figure 5: Stock prices nearing the end of the forecasting period
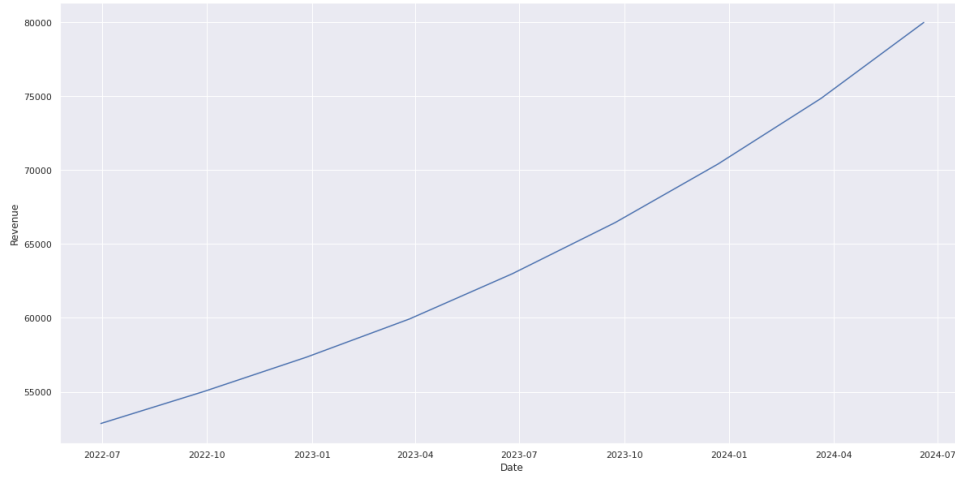
Figure 6: Graph of Google's quarterly revenue against the date

index	Date	Revenue
0	2022-06-30 00:00:00	52858.11328125
1	2022-09-28 00:00:00	55019.2109375
2	2022-12-27 00:00:00	57347.4375
3	2023-03-27 00:00:00	59927.68359375
4	2023-06-25 00:00:00	62987.87890625
5	2023-09-23 00:00:00	66449.1796875
6	2023-12-22 00:00:00	70411.1796875
7	2024-03-21 00:00:00	74842.7109375
8	2024-06-19 00:00:00	79984.578125

Figure 7: Forecasted quarterly revenue

3.2 Correlation between Revenue and Stock Price

Revenue is the total amount of income generated by the sale of goods or services related to the company's primary operations. Stock price is the amount it would cost to buy one share in a company. The relationship between revenue and stock price is complex and requires great depth of study to understand completely. However, strong earnings (revenue) generally result in the stock price moving up (and vice versa). Thus, to keep things simple, they can be assumed to have a directly proportional relationship (which is shown by the Pearson Correlation Coefficient test below).

3.2.1 Pearson Correlation Coefficient

The Pearson correlation coefficient [11] is used to measure the strength of a linear association between two variables, where the value r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2} \sqrt{(Y - \bar{Y})^2}}$$

Where,
$\bar{X}$ = mean of X variable
$\bar{Y}$ = mean of Y variable

To see the correlation between the quarterly revenue and the stock prices, I am taking the data corresponding to dates from 2019 to 2022 that are available in both the quarterly revenue and stock prices dataset.

S.N.	Date	Stock Price	Quaterly Revenue (in millions of $)
1	3/29/2019	58.665501	36032
2	6/28/2019	54.045502	38674
3	9/30/2019	60.950001	40225
4	12/30/2019	66.806999	45812
5	3/30/2020	57.341	40975
6	6/30/2020	70.680496	37998
7	9/30/2020	73.480003	46017
8	12/30/2020	86.975998	56704
9	3/30/2021	102.777	55225
10	6/30/2021	125.316	61695
11	9/30/2021	133.2655	64874
12	12/30/2021	146.0025	74941
13	3/30/2022	142.6445	67293
14	6/30/2022	109.3725	69117

Figure 8: Retrieved data from 2019 to 2022

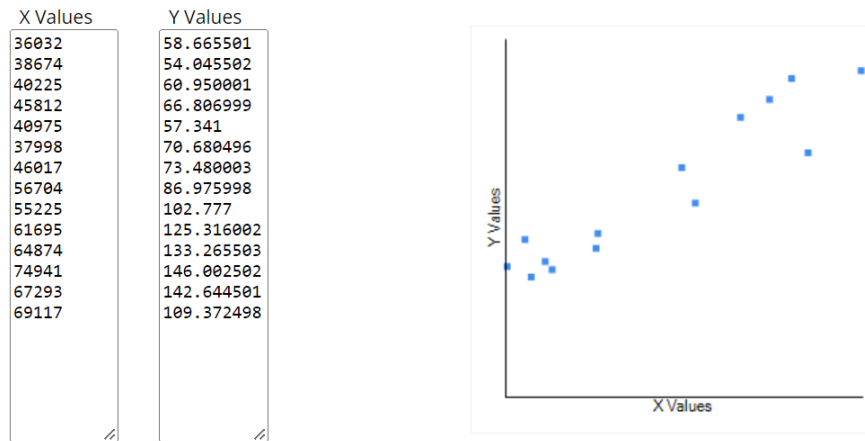Taking quarterly revenue as X and stock price as Y, I obtained the following results:

Figure 9: Graph showing correlation between quarterly revenue and stock prices

r= 0.9437

This is a strong positive correlation, which means that high X variable scores go with high Y variable scores (and vice versa). Thus, it can be concluded that Google's revenue and stock prices have a strong positive correlation.

4 SWOT Analysis of Google

SWOT analysis is a fundamental technique that helps companies develop a full awareness of all the factors involved in making a business decision. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats.

4.1 Strengths

4.1.1 Domination in Search Engine Market

With more than a 100,000 searches per second, Google has become the best global search engine for internet users. As of October 2022, Google had 92.37% [1] search engine market share worldwide. Bing followed next with just 3.57% [1] search engine market share. As technology develops and people gain more and more access to the internet, Google has become the first choice for a search engine due to its high-quality and efficient searches.

4.1.2 Digital Advertising

Google's core business model is online advertising. $209 million[2] which equates to 81.3% of Google's revenue was generated through its ads in 2021. Through its cloud-based services and search engine, Google gathers information on users and utilizes this to craft better targeted ads in order to generate maximum revenue. With such an extensive reach, it is no surprise that Google has been the market leader in online advertising for well over a decade.

4.1.3 Rapid growth and continuous innovation

Google is one of the fastest-growing companies in the world. Google keeps innovating and investing in new ideas which has made it a continuously changing organization. While many companies start off on the right foot, the lack of ability to adapt stops their growth. Large investment in research and development has helped Google avoid this. Google's self-driving car project 'Waymo' [12] is an example of Google's innovation and ability to experiment. Waymo's mission is to make it safe and easy for people to drive. With no human in the driver's seat, it leaves no possibility of human error causing road accidents. Investing in such technologies that aim for social welfare has also gained a strong brand recognition for Google.

4.2 Weaknesses

4.2.1 Privacy concerns

Google has been suspected and accused multiple times of collecting data about Internet users through their search history, incognito browsing mode, and tools like Google Play Services and Gmail. Fear of sensitive information, such as the user's address, leaking or being unethically used has led to Google facing investigations from European Union, and even lawsuits from different states of United States of America. On 14th November 2022, Google agreed to pay $391.5 million settlement to 40 states over allegations of tracking people's location even after their devices location tracking was turned off [13]. This privacy case not only hurt Google financially, but also questioned its ethics, brand values and policies.

4.2.2 Over-dependency on ad-revenue model

As said before, most of Google's revenue comes from its online advertisements. While Google still dominates the advertisement space, it must be prepared for competitors such as Meta, Alibaba, Bytedance and Amazon. Not only this, Google's "cost-per-click" (CPC) ad model is itself risky. Advertisers switching to platforms such as Instagram and Facebook can decrease the CPC which in turn declines Google's profit. Google knows this and is focused on developing other business models as well.

4.2.3 High employee turnover rate

Employee turnover rate is the measurement of the number of employees who leave an organization during a given time period. According to a study done by Resume.io [14], Google's average employee tenure is just 1.3 years. This may even seem beneficial for Google as there is always new, fresh, enthusiastic minds at work. However, continuous loss of critical leaders and top talent reflects a larger issue. In March 2022, Google fired AI researcher Satrajit Chatterjee after he led a team of scientists to challenge the claims made by a paper Google published [15] and questioned if the technology mentioned there had been tested. Such controversial exits have that raised questions to Google's workplace environment, commitment to ethics and diversity.

4.3 Opportunities

4.3.1 Android Operating System

Google's Android Operating System (OS) is a major competitor of Apple's iOS. As of October 2022, Android OS leads with 42.37% [16] OS Market Share Worldwide. There is room for a lot of expansion and Google knows this. At CES 2022 [17], Google revealed its plans of making Android work better with devices that run Wear OS, Chrome OS, Windows and Matter. With the advantage of being more customizable that iOS, Google plans to make Android easier and straightforward to use.

4.3.2 Google Cloud Platform

Google Cloud Platform (GCP) provides multiple Cloud Computing services such as compute, storage, networking and much more. Google provides 15 gigabytes of free storage in Google Drive and Google Photos and charges $1.99 per month for expand that storage space. With Google's reliability, more and more people have started using GCP. However, Amazon Web Services (AWS) dominated the Cloud Market currently with 34%

shares in the third quarter of 2022. Microsoft's Azure is second with and 21% cloud market shares and Google is third with 11% [18]. Google recognizes that this is an expandable market and works to dominate it in the future.

4.4 Threats

4.4.1 Tensions with China

In 2010, Google pulled out its search market from China to protest the country's censorship and online hacking. Google also suspended business with Huawei, a giant Chinese phone maker, after Trump administration's ban in 2020 based on national security concerns of being spied on through Huawei's products. Google is eager to be a part of the Chinese market again but finds itself walking a political tightrope, caught in the tensions between the US and China.

4.4.2 Rise in competitors

With the internet and technology's growth, Google faces more competitors than ever. Old competition such as Apple, Amazon and Facebook threaten Google's dominance because of their new innovation and growing popularity. Now, Google also has to look out for search competitors like Baidu from China and Yandex from Russia [19] which can prove to be dangerous for Google due to their popularity in their regional market. Web searching habits are evolving as well. Instead of Google which returns results from the entire internet, people prefer vertical search engines which focuses on a specific segment of online content. For example, while searching for travel packages, one might prefer Expedia instead of Google. This rise in use of vertical search engines poses great threat to Google.

4.4.3 Fall in share prices

Falling share prices are another indicator of U.S.'s economic recession. At the end of October 2022, Google shares reported year-to-date losses of about 35% [20]. This is majorly due to slowing advertising revenues, which has also resulted in Google's weak third quarter earnings this year. Investors are questioning whether Google's days of growth are over and call upon the parent company Alphabet to cut cost per employee by letting some employees go.

5 Conclusion

To sum everything up, here are the important sections this project dealt with.

5.1 Algorithm used

I used Long Short Term Memory (LSTM) Algorithm as my algorithm because of their ability to learn multiple past observations and thus the context to forecast the result.

5.2 Dataset used

I used a readily available .csv dataset in Kaggle [9] for stock price prediction and made my own .csv dataset from graph published in Statista [10] for the quarterly revenue prediction.

5.3 Training procedure of the model

5.3.1 For stocks:

• I made a new dataset with only the training data which is the date and its closing prices
• For data pre-processing, I applied MinMaxScaler to normalize the closing stock price to a range of 0 to 1.
• Then, I decided to use 14 number of past days' closing price (which we labelled as trainX) to predict the future i.e. the next day's closing price (labelled as trainY)
• The model was fit with 5 epochs, batch size 16 and validation split 0.1.
• For forecasting, I predicted a year (365 days) into the future

5.3.2   For revenue:

• For data pre-processing, I applied MinMaxScaler to normalize the quarterly revenue to a range of 0 to 1.
• Then, I decided to use 20 number quarterly revenues (which we labelled as trainX) to predict the future i.e. the next quarterly revenue (labelled as trainY)
• The model was fit with 10 epochs, batch size 16 and validation split 0.1.
• For forecasting, I predicted 8 future quarterly revenues (making up 2 years).

5.4   Results

5.4.1   Main forecast

• In 2023-09-18 (one year later), Google's stock prices will be $108.729.
• In 2024-06-19 (two years later), Google's revenue will be $79,984 million.

5.4.2   Derivation from forecast

• On September 19, 2022, Google's closing stock price was $103.85 which means a year later (as per my forecast), there will just be a 4.698% of increase in the closing stock price. This is low but as per the trend of Google's falling stock prices, as seen by the closing price dipping to $97.80 just a month later, it seems entirely possible.
• Google's second quarterly revenue of 2022 was $69,117 million and two years later, its predicted revenue is $79,984 million, an increase of 15.72%, which can be an indicator of the regressive economy and threats that loom over Google.

6   References

[1]   (2022).   Search engine market share worldwide (no date) StatCounter Global Stats.   Available at: https://gs.statcounter.com/search-engine-market-share (Accessed: November 22, 2022).

[2]   Goog 10-K Q4 2021 - Alphabet Inc.. (no date). Available at:
https://abc.xyz/investor/static/pdf/20220202$_a$lphabet$_1$0K.pdf?cache = fc81690(Accessed : November23, 2022).

[3] $McAlone, N.(nodate)The true story behind Google's hilarious first name : Backrub, BusinessInsider.BusinessInsider. Available at : https : //www.businessinsider.com/the - true - story - behind - googles - first - name - backrub - 2015 - 10(Accessed : November23, 2022).$

[4] $Brin, S., Page, L.(1998).The anatomy of a large - scale hypertextual Web search engine. Computer Networks ISDN Systems, 30(1–7), 107. https : //doi.org/10.1016/S0169 - 7552(98)00110 - X$

[5] $Andreas von Bechtolsheim amp; Family(nodate)Forbes.Forbes Magazine.Available at : https : //www.forbes.com/profile/andreas - von - bechtolsheim/?sh = 143bce2f1461(Accessed : November23, 2022).$

[6] $National numbers at a glance(nodate)Google Economic Impact.Google. Available at : https : //economicimpact.google.com/(Accessed : November23, 2022).$

[7] $Europe – google impact report(2019)Public First.Available at : https : //googleimpactreport.publicfirst.co.uk/europe/(Accessed : November23, 2022).$

[8] $Google Economic Impact - Australia(2019).Available at : https : //alphabeta.com/wp - content/uploads/2019/09/ab006_google_business_web - 1.pdf(Accessed : November23, 2022).$

[9] $Chauhan, A.(2022)Google : Stock market analysis : Founding years, Kaggle. Available at : https : //www.kaggle.com/datasets/whenamancodes/google - stock - market - analysis - founding - years(Accessed : November23, 2022).$

[10] $Published by Statista Research Department and1, A.(2022)Google : Quarterly revenue2022, Statista.Available at : https : //www.statista.com/statistics/267606/quarterly - revenue - of - google/(Accessed : November23, 2022).$

[11] $Admin(2021)Karl Pearson coefficient of correlation : Examples, methods, Formula, BYJUS.BYJU'S.Available at : https : //byjus.com/commerce/karl - pearson - coefficient - of - correlation/(Accessed : November23, 2022).$

[12] *Waymo driver (no date) Waymo. Available at : https : //waymo.com/waymo−driver/(Accessed : November 23, 2022).*

[13] *Korn, J. (2022) Google agrees to $392 million settlement with 40 states over location tracking practices | CNN business, CNN. Cable News Network. Available at : https : //edition.cnn.com/2022/11/14/tech/google−location − tracking − settlement/index.html (Accessed : November 23, 2022).*

[14] *Rijswijk, L.van (2022) The companies employees don't want to leave, Resume.io. Available at : https : //resume.io/blog/the−companies−employees−dont−want−to−leave (Accessed : November 23, 2022).*

[15] *Mirhoseini, A., Goldie, A., Yazgan, M.et al. A graph placement methodology for fast chip design. Nature 594, 207–212 (2021). https : //doi.org/10.1038/s41586 − 021 − 03544 − w*

[16] *Operating system market share worldwide (2022) StatCounter Global Stats. Available at : https : //gs.statcounter.com/os − market − share (Accessed : November 23, 2022).*

[17] *Holland, P. (2022) At CES 2022, Google shares a plethora of new features to make all your devices, Android and otherwise, work better together, CNET. CNET. Available at : https : //www.cnet.com/tech/services−and−software/google−vision − android − ces − 2022 − promises − one − of − apple − best − qualities/(Accessed : November 23, 2022).*

[18] *Richter, F. (2022) Infographic : Amazon, Microsoft amp; Google Dominate Cloud Market, Statista Infographics. Available at : https : //www.statista.com/chart/18819/worldwide − market − share − of − leading − cloud − infrastructure − service − providers/(Accessed : November 23, 2022).*

[19] *O'Brien, M. (2019) Google, Yandex and Baidu : Strategies for Expanding Your Search Marketing, ClickZ. Available at : https : //www.clickz.com/google−yandex−baidu−expanding−search−marketing/213908/(Accessed : November 23, 2022).*

[20] *Google stock split : Where next for GOOGL shares? (2022) Google Stock Split | Where Next for GOOGL Shares? Available at : https : //capital.com/google − stock − split (Accessed : November 23, 2022).*