Analyze and predict the 2022 World Happiness Report based on the past year's dataset

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| *Article history*  Received: 7 July 2014  Revised: 28 August 2014  Accepted: 2 September 2014  \*Corresponding Author:  Zhang, Yifei  School of Physics Science, University of Liverpool, Liverpool, United Kingdom  Email:zhangyifei0728@outlook.com | ***Abstract:*** **Through the impact of the COVID-19, the people around the world have been affected to various degrees. Thus, it is more interesting to compare the Happiness reported between the 2022/2021 and before 2019. This article concludes 5 years Happiness Scores data including Family, GDP, Health, Freedom, Generosity Trust, and Dystopia Residual.** **Happiness scores are considered appropriate indicators to measure the progress of social development. This work presents two Linear Regression models to predict happiness scores across countries in 2022. Data is sourced from the World Happiness Report dataset from 2015 to 2021, available open source. Preliminary exploratory data analysis was carried out to select the most appropriate variables to include in the models. The models’ accuracy was tested by comparing the output values to the true 2022 World Happiness Report data. The experiment results show that the Linear regression achieved an RMSE = 0.236, and MSE = 0.056 for 2022.**  **Keywords:** World Happiness Report, Linear Regression, Data Analysis, Machine Learning |

# **Introduction**

Measuring Happiness is challenging due to varied definitions of Happiness. The world has suffered from the global COVID-19 Pandemic for three years, producing unusual results in recent happiness measurements – especially the 2021-2022 Happiness Scores, which represent pandemic struggles, and are not indicative of previous global Happiness Trends.

Motivated by happiness scores of this author’s homelands, the author sought to understand how happiness is quantified and how the UN measures happiness, and what countries have a higher score.

Through the history, the first scientist tries to measure the happiness as a mathematic quantity was Bhutan in the 1970s, who calculating his country’s Gross National Happiness (GHN) instead of Gross National Product (GNP) and the key core of his calculating is that Bhutan believed that the spirit and material improvement are both important for the development of the human society [1]. Then several international organizations were latter build their own happiness index like U.N the World Happiness Report.

The first World Happiness Report was published in 2012 by the United Nations, which compared the happiness of people in 156 countries and regions around the world [2]. According to the world happiness official website, there are six variables: Economic production (gross domestic product, or GDP); Social Support; Life Expectancy; Freedom; Absence of Corruption; and Generosity, all of which contribute to each country’s Happiness Score also referred to as a Ladder Score.

The World Happiness Report is essential for both governments and the public as it provides information that is difficult to quantify in the real world. For the government, happiness scores can provide evidence of their population’s wellbeing. For the civilization, it provides understanding of their actual life quality for many aspects including health care, work environment and education [3]. Hence it is necessary to study and analyze the data.

In the work of [4], the authors have used nine different ways to predict the Quality of Life through the World Happiness Index including Lasso Regression, Multiple Linear Regression, LSTM, Random Forest Regressor, Support Vector Regression, Gradient Boosting Regressor, XGboost Regressor, MLP Regressor and AdaBoost Regressor. The performance to evaluate the models is MAE, MSE, RMSE, and (the definition of which, is in section 4). The data from 2015 to 2021 has been collected and divided for training (2015-2020) and testing (2021). Their results show that the best performance is achieved using the Lasso Regression with a 0.8954 score and 0.0656 RMSE.

However, the above paper is mainly focused on the overall happiness scores but not on how the variables such as GDP, and health influence the World Happiness Scores. It is more interesting to find out which variables will influence the World Happiness Score more rapidly and how it will influence.

The author aims to analyze the data about the World Happiness Report from 2021 and 2022, the distribution of the region for these countries, and the relationship between different variables on the Ladder Score. By using Linear Regression, this study will predict Ladder Scores using each country’s GDP and provide the best fit linear equation. These analyses will be carried out in Python.

In the next section, the author will explore some other authors’ work applied the various machine-learning algorithms on predicting the data. In the third section, the author will give some basic background information to help the reader understand the World Happiness Report and analyze the 2021-2022 World Happiness Report. In the fourth section, the author will explain the methodology which will be used in the following section. In the fifth section，the author discusses how to build the model and shows the result by Python. In the sixth section, the result is analyzed and discussed. Finally, conclusion and next research scopes are developed in the last section.

# **Literature Review**

In research presented in [5], the authors identified the essential issues in using data from the importance of the variables included in the dataset. The research uses various Machine Learning Methods such as NN (Neural Network), RF (Random Forest), and GB (XGboost) to classify the GDP as one of the primary indicators of life happiness scores. Also, the insight gained from the study is that high life expectancy may lead to a higher Happiness Score by classifying as the first rule, while the use of OneR classification methods and its results by evaluating different performance indicators increases the finding reinforcement.

Researchers in [6] found that it is different for a human being get the value of happiness from the family and friends. The research team found that there is a discrepancy between the three evaluations that must take into account.

Authors in [7] used machine learning methods to divide the UN World Happiness dataset into training set and test set, which used K-Means cluster to reach.

Researchers in [8] use various approaches based on the scope of Machine Learning to analyze Global Happiness. The Principal Component Analysis (PCA) was used to analyze gender equality and life satisfaction. In the feature, selection trees were used as well as for life satisfaction prediction. The findings of this study are key characteristics of life expectancy, incoming distribution and freedom summarized using permutation tests. The results show happiness in life in the form of a visual map.

The paper [9] aimed to find the most accurate model to predict Ladder Scores based on the dataset for the top 30 countries and regions in the world. The traditional linear regression model has been used to show that it is risky to be used because of the correlation between various explanatory variables. Ridge regression LASSO regression and elastic net based on Machine Learning are applied to get an accurate prediction and the elastic net model has been found to be the most accurate model in this paper.

Authors in [10] mainly focus on three methods: ANN (Artificial Neuron Network), SVM (Support Vector Machine), and RT (Regression Tree). The most significant prediction method is the ANN # 3 6-20-1 model which has an accuracy of 83.68%, and the significant test for SVM2 is found as R 0.15 and RMSE 0.5454. The regression of the Tree2 model has significant testing of error RMSE 0.57815 that the lowest and enclosed 0. The author has indicated that SVM is simpler to apply than ANN but the first choice of option for the prediction of the World Happiness Score is ANN.

The paper [11] studies various factors to determine their importance in GDP growth and develops a forecasting model to forecast the future using Gaussian Process, Decision Table, Random Tree, Multilayer Perception, and Random Tree and achieved an MAE of 1.801% using Linear Regression.

It can be concluded that research about world happiness prediction applied various Machine Learning methods to analyze the results. Most used ML algorithms are LR, SVM, RF, and NN such as LR is used in the context. However, each paper is based on a unique dataset and applies the different methods to predict which might need a high-level knowledge about Machine Learning, this paper is focused on the basic Linear Regression methods in Machine Learning to help beginners in Machine Learning study to analyze the Happiness Score data.

**Background**

Before proceeding with the analysis of the dataset, the author provides some brief intuition to the reader, to understand the world happiness report on 2021-2022. Figure 2, it has shown the Happiness Score 2022 for the countries and regions in the dataset which has been used through a world map.

Fig. 2: 2022 Happiness Score distribution

地图

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In Figure 3, it has shown the Happiness Score 2021 for the countries and regions in the data set which has been used through a world map.

Fig. 3: 2021 Happiness Score distribution

地图

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It seems like no countries and regions have dramatic changes between 2021-2022. The happiness scores are distributed to similar scores in different states. Figure 4 shows the details about different regions on the happiness scores.

Fig. 4: Happiness Score for different regions

图表, 条形图

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Next, the author explores the dataset to search for drastic changes between these two years, shown in Figure 5.

Figure 5: Density distribution for Happiness Score between 2021-2022, blue representing 2021 and orange 2022.

图表, 直方图

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From Figure 5, what can be concluded is that the basic distribution line is not changed in a dramatic way. The mean happiness score for 2022 is higher than the 2021 Happiness Score. The score intersection between 5-7 has a noticeable increase.

For the 6 variables Economic production (GDP), Social Support, Life Expectancy, Freedom, Absence of Corruption, and Generosity, the next step is to figure out which will influence the Ladder Scores more rapidly. Thus, the next step is constructing a heat map to get a clear view of the relationship between these 6 variables and the Ladder Score which will be shown in Figure 5.

Fig. 6: The heat map of each parameter’s correlations

图表

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As the Fig.6 has shown, the most essential variable that will influence the Happiness Score is the Economy (GDP per Capital) and the Family and it has the highest correlation with Happiness Score which is 0.78 and 0.76. The least important variable is generosity which only has a correlation with happiness score of 0.18. To have a clearer view, the next step is constructing the plot diagram (Fig. 7) for every two variables.

Fig. 7: Scatter diagram of the distribution between each parameter

图表

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So, the author chooses the Economy (GDP per Capital) to be the key variable to predict the Happiness Scores.

# **Methodology**

*Data Availability*

The database for this research is from Kaggle World Happiness Report [12] which is an essential tool to analyze global happiness. This dataset ranks 155 countries and regions in their Ladder Scores. According to the different survey respondents,

Table 1. data sample

their happiness scores were rated on a scale from 0 to 10 marks to show their best possible life. Besides the dataset includes several insights from variables that will influence the scores.

*Describing the Dataset*

The dataset features rely on daily life experiences from respondents based on their considerations of the most persuasive lives and the worst lives. These features are described in detail below.

In this article, it will use the World Happiness Report 2021 as an example to show the top 10 countries' specific data in table 1.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| RANK | Country | Happiness Score | Dystopia Residual | Economy  (GDP per Capita) | Family | Health (Life Expectancy) | Freedom | Generosity | Trust (Government Corruption) |
| 1 | Finland | 7.821 | 2.518 | 1.892 | 1.258 | 0.775 | 0.736 | 0.109 | 0.534 |
| 2 | Denmark | 7.636 | 2.226 | 1.953 | 1.243 | 0.777 | 0.719 | 0.188 | 0.532 |
| 3 | Iceland | 7.557 | 2.32 | 1.936 | 1.32 | 0.803 | 0.718 | 0.27 | 0.191 |
| 4 | Switzerland | 7.512 | 2.153 | 2.026 | 1.226 | 0.822 | 0.677 | 0.147 | 0.461 |
| 5 | Netherlands | 7.415 | 2.137 | 1.945 | 1.206 | 0.787 | 0.651 | 0.271 | 0.419 |
| 6 | Luxembourg\* | 7.404 | 2.042 | 2.209 | 1.155 | 0.79 | 0.7 | 0.12 | 0.388 |
| 7 | Sweden | 7.384 | 2.003 | 1.92 | 1.204 | 0.803 | 0.724 | 0.218 | 0.512 |
| 8 | Norway | 7.365 | 1.925 | 1.997 | 1.239 | 0.786 | 0.728 | 0.217 | 0.474 |
| 9 | Israel | 7.364 | 2.634 | 1.826 | 1.221 | 0.818 | 0.568 | 0.155 | 0.143 |
| 10 | New Zealand | 7.2 | 1.954 | 1.852 | 1.235 | 0.752 | 0.68 | 0.245 | 0.483 |

The Machine Learning algorithm has been used to predict the data is Linear Regression. Various python packages were used to accomplish different purposes during the research.

NumPy [13] (Numerical Python) is an extensive library of the Python language, which supports a large number of dimensional array and matrix operations, and also provides a large number of mathematical functions libraries for array operations.

Pandas [14] is an open source, BSD-licensed library that provides high-performance, easy-to-use data structures, and data analysis tools.

Sklearn [15] (Scikit-Learn) is a powerful Machine Learning library that covers everything from data preprocessing to model training.

Seaborn [16] is a data visualization library based on Matplotlib. It builds on Matplotlib with a higher level of API encapsulation to make drawing easier and refined without a lot of tweaking.

In order to evaluate the performance of these models several metrics have been used, which are:

* Mean Absolute Error (MAE) is a measure of errors that corresponds to standard L1 and measures the average of the absolute difference between the actual and predicted values [12].
* Mean Squared Error (MSE) is a criterion that measures the mean square error of the mismatch between predicted and real values [12].
* Root-Mean-Square Error (RMSE) is the square root of Mean Squared Error [12].

The author used these metrics to evaluate the proposed models. They are defined as follows:

Where represents the total number of elements of the test data,  is the predicted value and  is the corresponding true value of the sample.

For the Linear Regression, the author set our target equation to be where is the GDP value and is the Happiness Score of the sample.

# **Results**

Through the data from Kaggle, the author collected 6 years data which are the World Happiness Report from 2016-2021 [17].

The total number of the data is 1084 and will be divided into 3 group: the training set, testing set, comparing test. The author selected 75% data as the training set and the remaining 15% for testing and 10% for comparing.

The resulting model is shown in Figure 8.

Fig. 8: Distribution of the training model

图表, 散点图

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Through our training the author obtains the results that:

= 0.28465782843416604

= -0.6227407645545371

The target equation will be:

From 75% of the data, we fit a line which best describes the data and in order to test the level of the fitness 15% of the data is be used to test the given target equation.

Subsequently, the next 15% of the data, used for testing, is shown (the green points) in Figure 9. It can be verified that the test data is in fact evenly distributed on both sides of the target line.

Figure 10: The training and test data distribution.

图表, 散点图

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Finally, the author set the remaining 10% of the dataset is used to predict the Happiness Score through the target line. The results of the validation are shown in Fig. 10, where it shows that the data is appropriately fitted by the Linear Regression model which has been generated.

Fig. 11: Testing the model with comparison between predicted and actual values for 2022 Happiness Scores

图表, 散点图

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After applying the algorithms to the data, three performance equations have been chosen which mentioned earlier to evaluate our model. The results obtained are the following:

MAE: 0.1954020331

MSE: 0.0562180722

RMSE: 0.236332901

**Discussion:**

From the above result, MAE, RMSE, and MSE are all expected to be as small as possible. In [10], the author gets the other authors' results about the RMSE, MSE, and MAE which have been cited above which is RMSE=0.5454.

By comparing these two models, our model's RMSE is smaller than the ANN model in [10].

The results the author obtain and 6 is of a satisfactory range.

However, it remains uncertain whether GDP is the best variable to predict the Happiness Score. From the heat map in Figure 6, it can be observed that the variable of Family also displays a high correlation to Happiness Score. Thus, the author constructs another Linear Regression model utilizing family as the predictive feature and assess how this model performs in comparison to the one made using GDP.

Figure 12 shows the distribution between happiness scores and Family. The gradient of this target line is positive. Thus, with the increase of the Family Score, the Happiness Score should increase with the Family Score which is the same as the GDP. However, the distribution for the Family Score exhibits more dispersion than the GDP.

Fig. 12: The training data distribution for Family Score

图表, 散点图

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The gradient of the Linear Regression model is and the y-intersection is equal to which will give the equation of the target line:

Subsequently, 15% of the data will be used to test the model. The green points will be the test points and give a clear information that the test points have evenly distributed on both sides of the line which is also similar to the results of GDP which will be shown in Figure 13.

Fig. 13: Test points distribution for Test points.

图表, 散点图

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Last but not the least, from the python the author got RMSE, MSE, and MAE to evaluate the accuracy of the prediction, obtaining the following results:

Compared to the numbers above in the paper, three numbers are all increased which means the prediction for the Happiness Score is not as accurate as the prediction by GDP. In that way, using GDP gives us the best variable to predict the Happiness Scores.

During the research, the key question is to determine which of the six variables influences the Happiness Scores most or which of the parameter can predict the Happiness Score most accurately. Through the methodology, heat maps are drawn to show the correlation between each parameter and the Happiness Score. Two parameters that have a higher correlation coefficient will be considered as the target parameters. However, a higher correlation coefficient doesn’t mean having the ability to predict the Happiness Score better. Through our results, the Family variable has the highest correlation coefficient 0.78. However, when utilizing this variable to build a Linear Regression model, the RMSE for the Family model is greater than the RMSE for the GDP.

In conclusion, GDP is the best parameter to predict the Happiness Score when using a Linear Regression model.

However, the limitation of Linear Regression is also obvious. For a given target line, if one country’s GDP is greater than another country our model will predict its Happiness Score must be greater than another country which is not a certain result. Because there are another 5 variables to determine the Happiness Score it might have some special circumstances for example Singapore and Hong Kong. In 2022, Singapore and Hong Kong are third and ninth rank in GDP but only get twenty-seven and eighty-one in Happiness rank. Their Dystopia Residuals are not high enough to support them to get higher marks though the GDP has contributed a lot.

Thus, a machine learning method that includes more variables should be considered for further research to get a more accurate result.

# **Conclusion**

Happiness research remains a challenge for researchers concerned with this aspect of societal development. The use of data science tools to model and analyze happiness predictions can be very useful in addressing the challenges associated with this subject matter, and aid in future research.

The limitations of using machine learning methods to predict the happiness score also exist. A number of outstanding events have not been taken into account during the process of the predictions, which will undoubtedly have a significant influence on the happiness scores of specific countries.

In this article, the author delves into the literature related to this concept from a data science perspective, where machine learning and deep learning algorithms are used. In this paper, a brief analysis of the comparison of World Happiness Reports between 2021 to 2022 is given. The Happiness Scores do not have a dramatic change between these two years. The author proposed an experimental approach to explore the potential of Linear Regression models in predicting happiness Scores and then compared their performances. The performance is achieved with an MAE: 0.195, MSE: 0.056 and RMSE: 0.236. A comparison group is constructed by using another important factor Family to predict the Happiness Score. The result gives that MAE: 0.214, MSE: 0.066, RMSE: 0.258. All three metrics of error are larger in the Family model compared to the GDP model, which asserts that GDP is the best variable to predict the Happiness Score in a Linear Regression model.

Using these techniques, readers can study, predict, and model happiness accurately by discovering the most highly correlated variable: GDP.

For future research, additional types of models to predict happiness scores such as ANN and SVM can be used. For further study, the research team can combine the other variables like Social Support, Life Expectancy, Freedom, Absence of Corruption, and Generosity, to contribute to the prediction more accuracy by adding more layers to reduce the dimension which can be based on the research [18], the researchers considered the multiplies variables.

Furthermore, more complex linear models can be used to describe the data such as Multiple linear regression, Support Vector Regression and Lasso Regression.

1. Multiple linear regression: a regression model which applies multiple independent variables and one dependent variable [19].
2. Support Vector Regression: a regression model applies on predictive regression problems, SVR uses an s-insensitive loss function that specifies a tolerance degree to errors [20].
3. Lasso Regression: a regression model stands for Least Absolute Shrinkage and Selection Operator. It is a regression that uses shrinkage as a regularization technique [21].

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