LSE Data Analytics Online Career Accelerator

DA301: Advanced Analytics for Organisational Impact

Assignment 3

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# Background/context of the business

Turtle Games is a games manufacturer and retailer. To improve overall global sales performance, this analysis provides recommendations on:

- The optimal price Lego products should be sold for based on the number of Lego pieces in the set and the age of the customer that the product is most likely to be purchased by
- The customer group that will most likely leave a review on the products they have purchased
- The most expensive product purchased by a particular group of customers
- The general sentiment of customers across all e-store products
- The predicted global sales for the next financial year

# Analytical approach

The analytical approach to addressing the key business objectives is summarised in Table 1.

## Pre-processing

All data files were imported into the respective Python and R programs as csv files and libraries needed for the analyses were loaded (Table 1). Following this step, data files were explored to determine the number of observations, columns available, data types present, and summary statistics. The data files were also assessed for any missing values. The specific steps used to prepare and run each analysis are grouped by business objectives below.

## Determine the optimal price at which they should sell Lego products based on the number of Lego pieces in the Lego set and the age of the customer that the product is most likely to be purchased by

The relationship between piece_count and list_price was examined through simple linear regression. The dependent variable was defined as list_price and the independent variable was defined as piece_count. The data was split into train and test data sets. Linear regression was run on both subsets. The R-squared, intercept, and coefficient values of the train and test data were compared, alongside scatterplot visualisations (Figures 4-7). All values and visualisations closely matched, signifying the strength of the model.

**Figure 4. Linear regression R-squared values**

| Train Subset (n=8,583) | Test Subset (n=3, 678) |
|---|---|
| 0.764 | 0.736 |

*R-squared indicates the proportion of variance in the dependent variable that can be explained by the independent variable*

**Figure 5. Linear regression intercept values**

| Train Subset (n=8,583) | Test Subset (n=3, 678) |
|---|---|
| 17.022 | 18.043 |

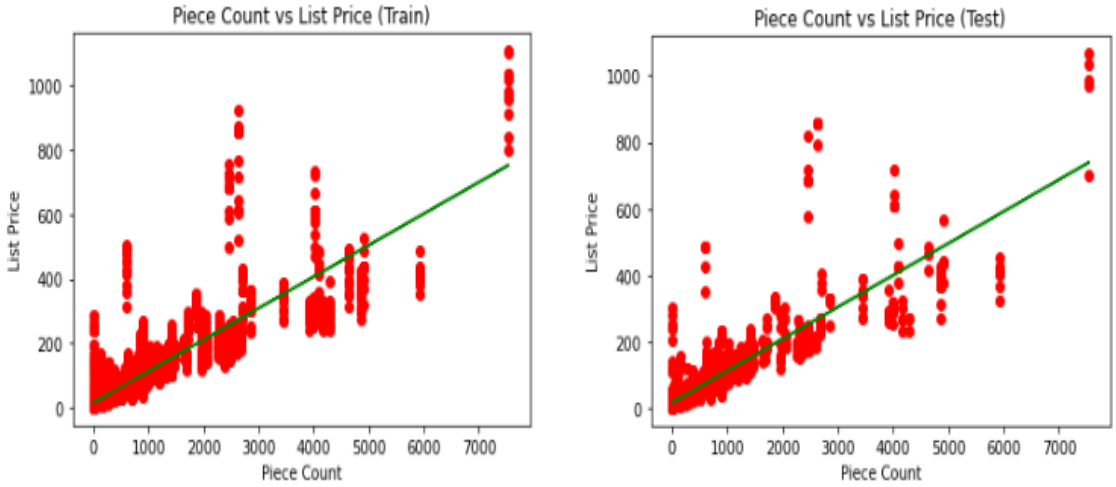
*Intercept indicates where the function crosses the y-axis*

**Figure 6. Linear regression coefficient values**

| Train Subset (n=8,583) | Test Subset (n=3, 678) |
|---|---|
| 0.097 | 0.096 |

*The coefficient value signifies the among the dependent variable changes for a unit increase in the independent variable*

**Figure 7. Linear regression scatterplot comparisons**




The relationship between piece_count, ages, and list_price was examined through multiple linear regression (MLR). The dependent variable was defined as list_price and the independent variables were defined as piece_count and ages. Data was split into train and test data sets. The R-squared, intercept, and coefficient values of the train and test data were compared (Figures 8-10). All values closely matched, signifying the strength of the model.

**Figure 8. MLR R-squared values**

| Train Subset (n=8,583) | Test Subset (n=3, 678) |
|---|---|
| 0.764 | 0.736 |

*R-squared indicates the proportion of variance in the dependent variable that can be explained by the independent variables*

**Figure 9. MLR intercept values**

| Train Subset (n=8,583) | Test Subset (n=3, 678) |
|---|---|
| 16.840 | 16.840 |

*Intercept indicates where the function crosses the y-axis*

**Figure 10. MLR coefficient values**

| Train Subset (n=8,583) | | Test Subset (n=3, 678) | |
|---|---|---|---|
| piece_count | ages | piece_count | ages |
| 0.097 | 0.011 | 0.097 | 0.011 |

*The coefficient value signifies the among the dependent variable changes for a unit increase in the independent variables*

Multicollinearity and heteroscedasticity were also assessed but were not present, thus providing greater confidence in the model.

## Determine the customer group that will most likely leave a review on the products they have purchased

Following cleaning steps to remove outliers (see Table 1), the data was aggregated by age using dplyr and purrr. This allowed the number of reviews to be plotted in ggplot by age.

## Determine the most expensive products purchased by a particular group of customers

Data was filtered to customers aged 25 and over. 'List_price' was plotted on ggplot to identify the price of the most expensive product.

## Determine the general sentiment of customers across all e-store products

The data for 'games_reviews.csv' was cleaned according to the steps outlined in Table 1 to enable it to be run through the nltk packages for natural language processing. Polarity scores were generated to identify the top 20 positive and negative reviews. The distribution of the sentiment was visualised in kde and boxplots.

## Determine the predicted global sales for the next financial year

The data for 'games_sales' was assessed to determine whether it was normally distributed through 'qqnorm' plots (Figures 11-13) and evaluation of skewness values (Figure 14). Because it was outside the scope of this study, the data was not normalised. However, it is highly recommended that this be done in the future before running further statistical analyses.

**Figure 11. Qqnorm plot- Global sales**

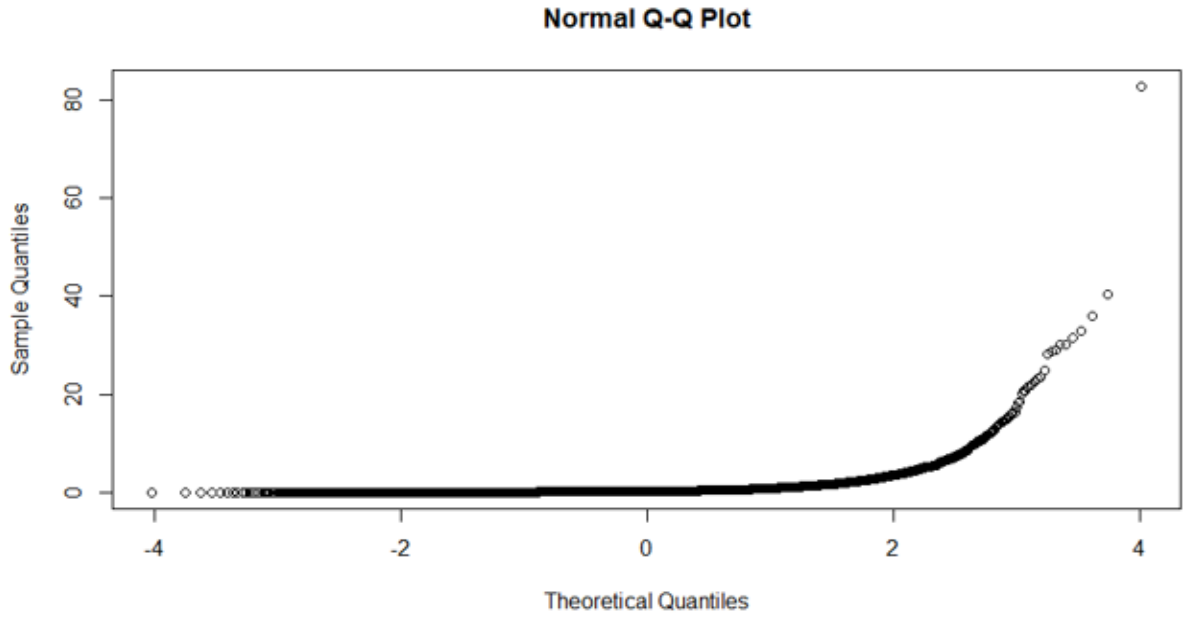


**Figure 12. QQnorm plot – North American sales**

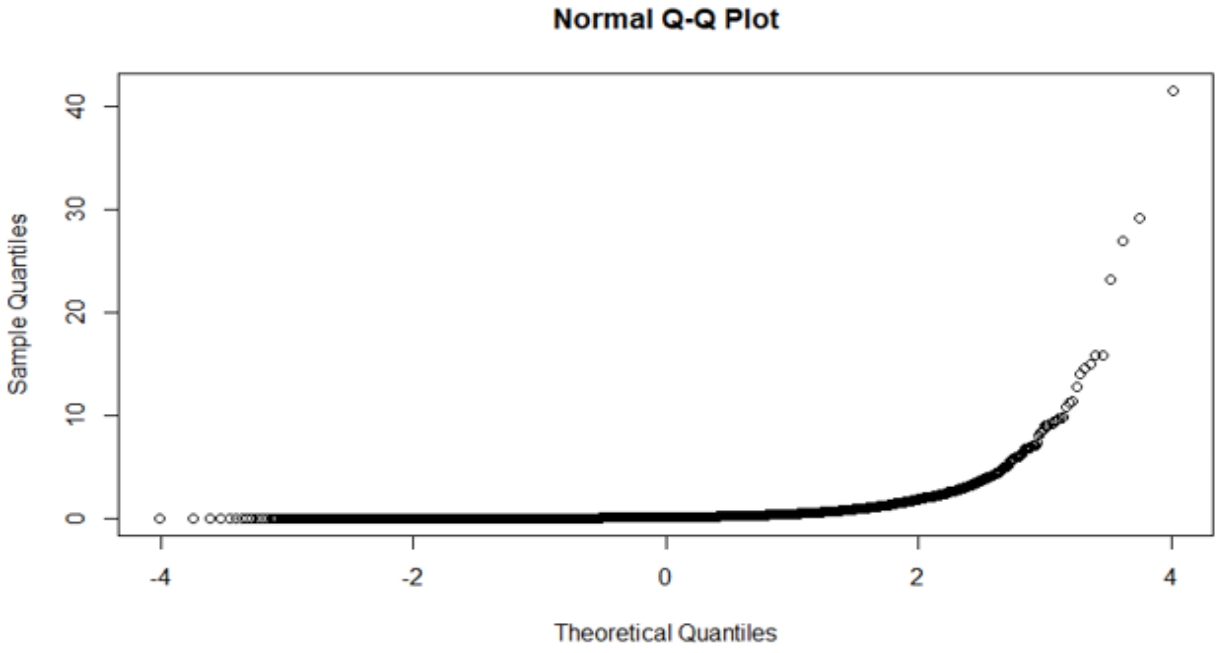



**Figure 13. QQnorm plot – European sales**

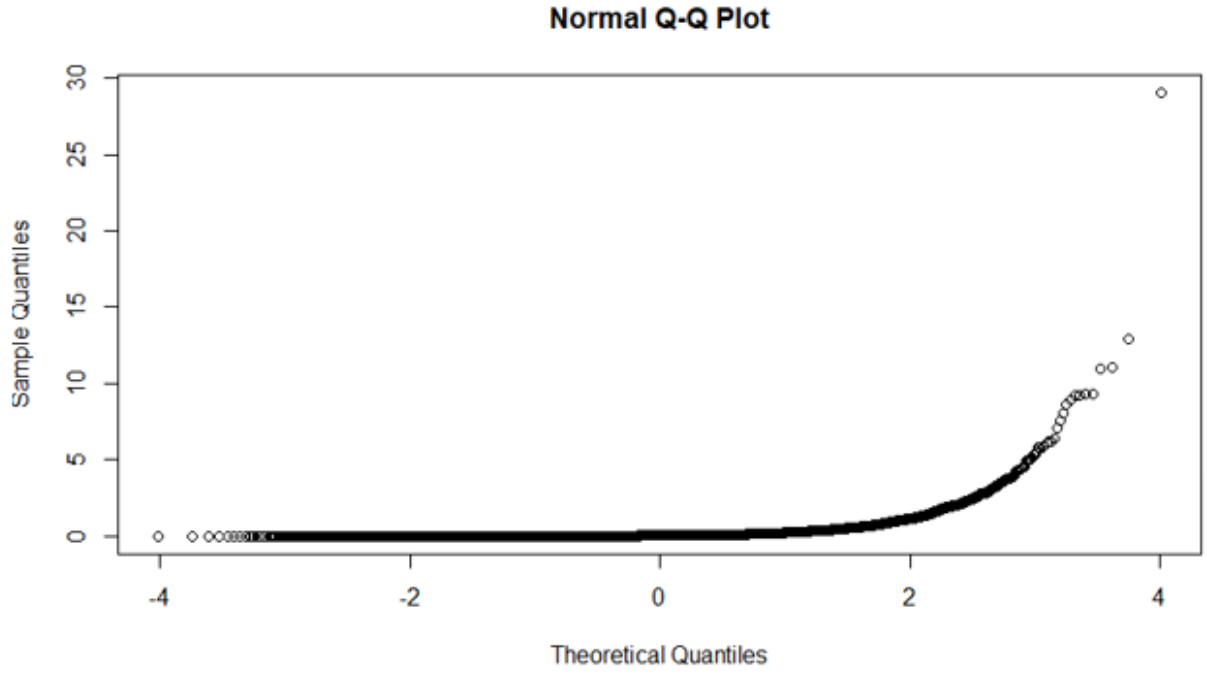


**Figure 14. Skewness values**

| Global sales | North American sales | European sales |
|---|---|---|
| 17.399 | 18.798 | 18.874 |

*These values indicate a very high positive skew*

MLR models were created to predict global sales based on Europe and North American sales. The model using both Europe and North American sales to predict global sales was used based on its high R-squared value. A linear relationship was found between current global sales and predicted global sales (Figure 16).

**Figure 16. Relationship between current and predicted global sales**

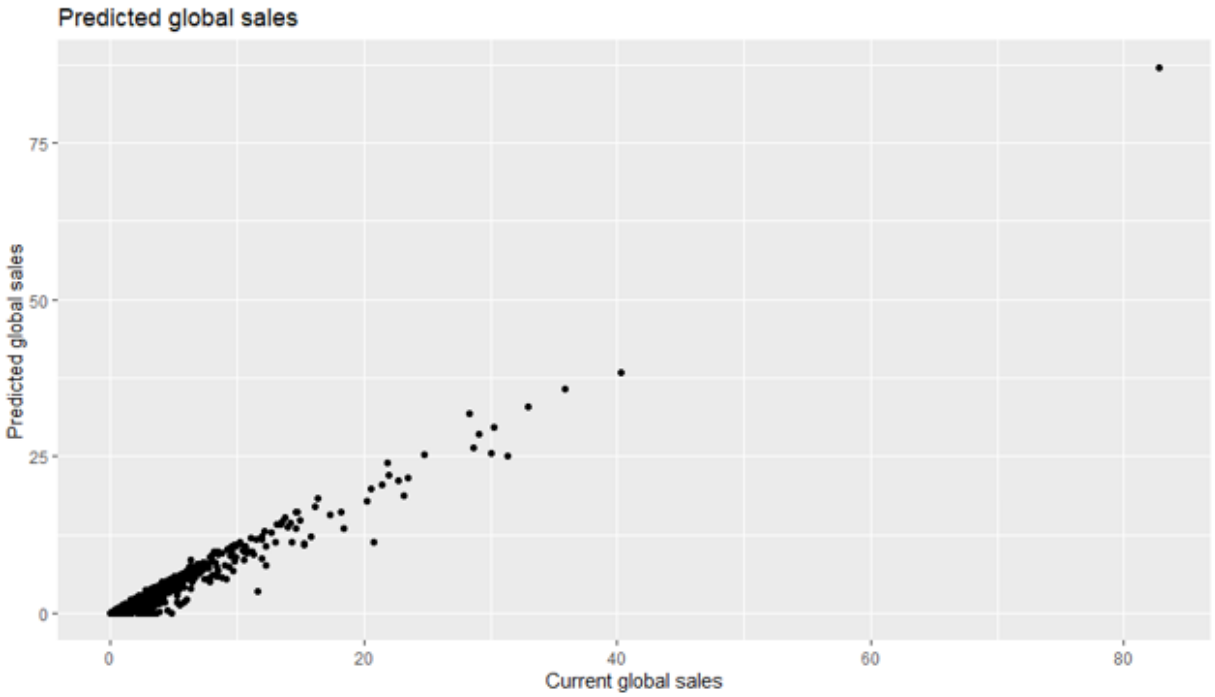


**Table 1. Analytical approach summary**

| Data set used | Business objective | Business question | Statistical software | Libraries | Method | Additional checks/cleaning |
|---|---|---|---|---|---|---|
| lego | Determine the optimal price at which Turtle Games should sell Lego products based on the number of Lego pieces in the Lego set and the age of the customer that the product is most likely to be purchased by | What price should be set for the Lego sets that have 8,000 Lego pieces? | Python | Numpy: used to statistical calculations<br>Pandas: used for data manipulation and analysis<br>Statsmodels: used to get OLS to fit a regression line and to calculate variance inflation factor<br>Sklearn: used to calculate simple and multiple linear regression<br>Matplotlib: used for plotting<br>Seaborn: used for plotting | Simple linear regression: models the relationship between two continuous variables | |
| lego | Determine the optimal price at which Turtle Games should sell Lego products based on the number of Lego pieces in the Lego set and the age of the customer that the product is most likely to be purchased by | What price should be set for all the Lego sets that have 8,000 Lego pieces and are most likely to be purchased by customers who are 30 years old? | Python | Numpy: used to statistical calculations<br>Pandas: used for data manipulation and analysis<br>Statsmodels: used to get OLS to fit a regression line and to calculate variance inflation factor<br>Sklearn: used to calculate simple and multiple linear regression<br>Matplotlib: used for plotting<br>Seaborn: used for plotting | Multiple linear regression: uses two or more independent variables to predict the outcome of a dependent variable | Data split into train and test subsets to avoid overfitting: when a statistical model fits so closely with its training data that the algorithm cannot make accurate predictions on unseen data. Split 70% train; 30% test – rationale: we want the training data set to be as large as possible while retaining enough observations to have a reasonable sized test data set |

| Data set used | Business objective | Business question | Statistical software | Libraries | Method | Additional checks/cleaning |
|---|---|---|---|---|---|---|
| | | | | | | Multicollinearity: when there are strong correlations between two or more independent variables; assessed by calculating the variance inflation factor (VIF) of the independent variables<br><br>Heteroscedasticity: when there are uneven variances in the residuals, which can result in biased and skewed results; assessed by running Breusch-Pagan test |
| lego | Determine the customer group that will most likely leave a review on the products they have purchased | Which age group submits the most reviews? | R | Tidyverse: packages used to read-in, explore, transform, and visualise data | Data aggregation | A qplot boxplot revealed two outliers above 300, which were removed by filtering the data |
| lego | Determine the most expensive products purchased by a particular group of customers | What is the cost of the most expensive Lego set purchased by customers who are at least 25 years old? | R | Tidyverse: packages used to read-in, explore, transform, and visualise data | Data sub-setting by filtering for those aged 25 and over | |
| games_reviews | Determine the general sentiment of customers across all e-store products | What is the general sentiment of customers across all products? | Python | Numpy: used to statistical calculations<br>Pandas: used for data manipulation and analysis | Natural language processing | Missing values removed for reviewText and data extracted from this column<br><br>Sentences converted to lowercase, punctuation |

| Data set used | Business objective | Business question | Statistical software | Libraries | Method | Additional checks/cleaning |
|---|---|---|---|---|---|---|
| | | | | NLTK: used for symbolic and natural language processing in English | | removed, duplicates dropped, and index reset<br><br>Text converted into tokens and stopwords removed |
| games_reviews | Determine the general sentiment of customers across all e-store products | Based on the popularity of the sentiment, what are the top 20 positive and top 20 negative reviews? | Python | Numpy: used to statistical calculations<br>Pandas: used for data manipulation and analysis<br>NLTK: used for symbolic and natural language processing in English | Natural language processing | Missing values removed for reviewText and data extracted from this column<br><br>Sentences converted to lowercase, punctuation removed, duplicates dropped, and index reset<br><br>Text converted into tokens and stopwords removed<br><br>Data sorted by descending positive and negative scores |
| games_sales | Determine the predicted global sales for the next financial year | What are the predicted global sales for the next financial year based on current sales from Europe and North America? | R | Tidyverse: packages used to read-in, explore, transform, and visualise data | Multiple linear regression: uses two or more independent variables to predict the outcome of a dependent variable | R-squared values compared for different models to choose model with highest R-squared value<br><br>Relationship between chosen model and current global sales plotted to examine linearity |

## Visualisation and insights

Insights are grouped by key business questions below.

### What price should be set for the Lego sets that have 8,000 Lego pieces?

Turtle Games should charge $782.94.

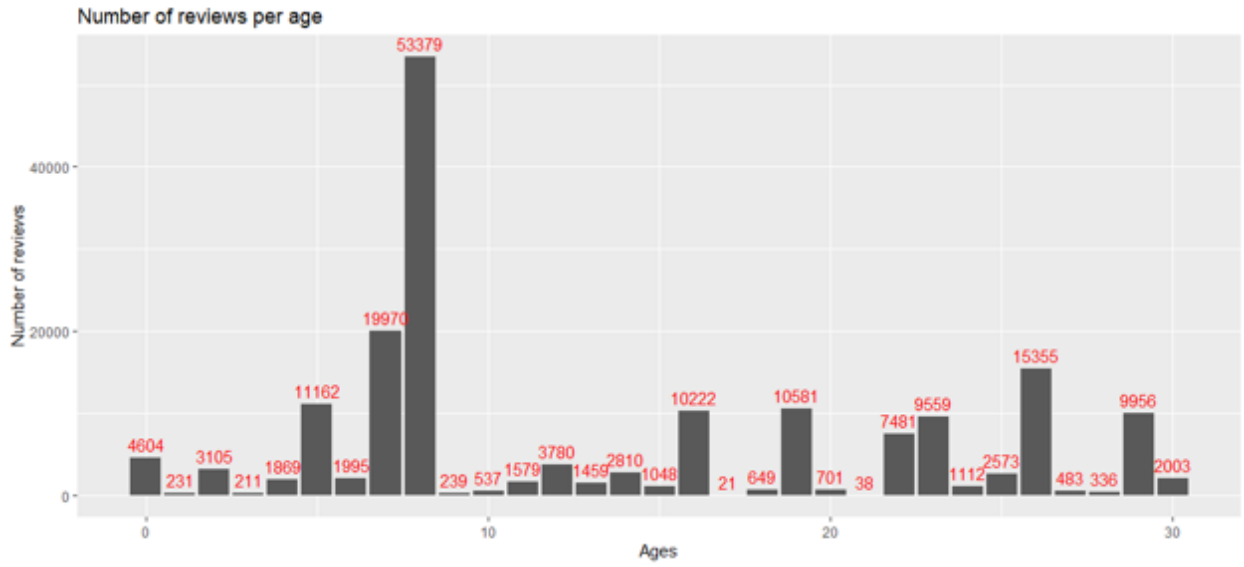
### What price should be set for all the Lego sets that have 8,000 Lego pieces and are most likely to be purchased by customers who are 30 years old?

Turtle Games should charge $796.79.

### Which age group submits the most reviews?

The most reviews are submitted for those aged 8, with 53,379 reviews (Figure 17).

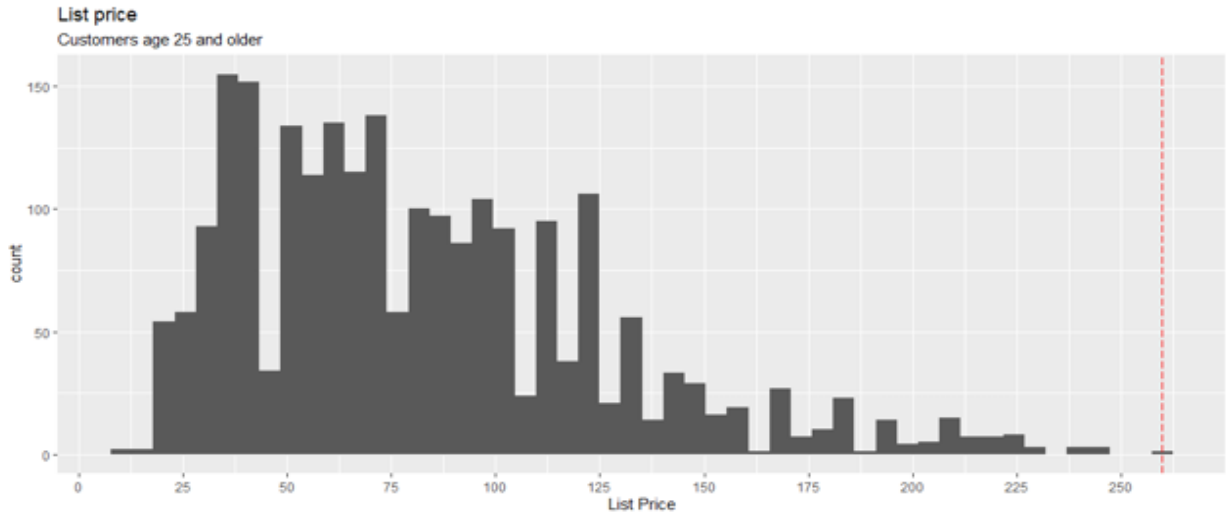
**Figure 17. Reviews by age**




### What is the cost of the most expensive Lego set purchased by customers who are at least 25 years old?

The cost of the most expensive Lego set purchased by customers who are at least 25 years old is $259.87 (Figure 18).

**Figure 18. List price – subset: those aged 25 and over**

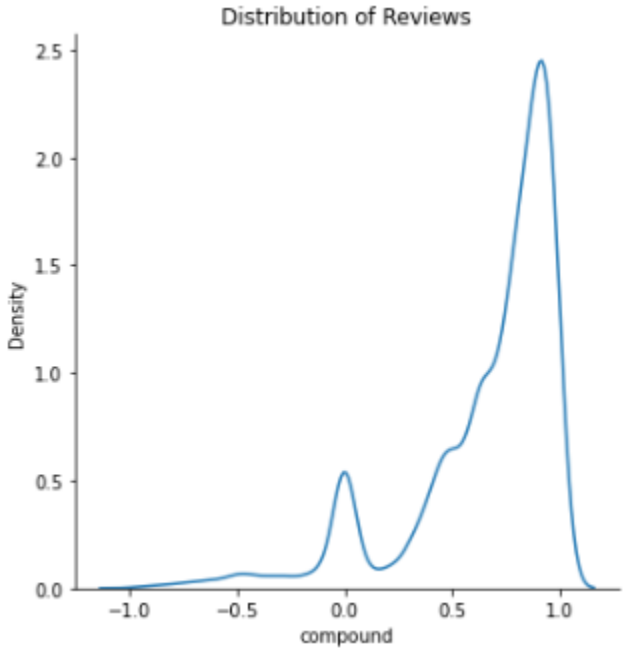



*The data has already been filtered to those aged 25 and older, so there are limited visualisations that can be used to show the single variable of interest (list_price). The red line indicates the most expensive product, at the end of the distribution.*

## What is the general sentiment of customers across all products?

The general sentiment of customers is positive, as indicated by a high peak in Figure 19 that is close to 1. There is also a smaller peak of neutral reviews (0.0) and fewer negative reviews (represented by negative values).

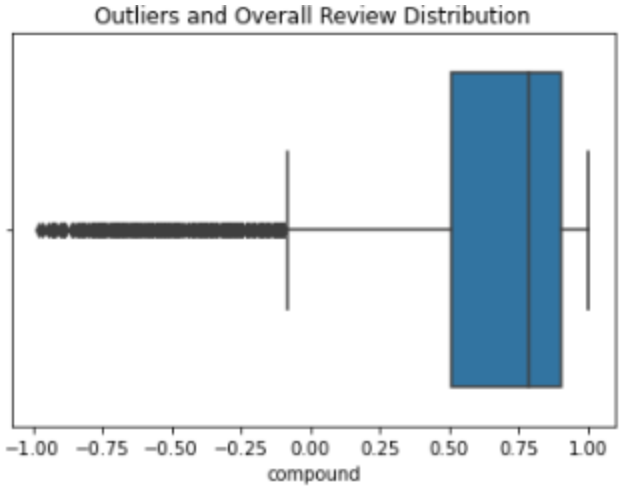
**Figure 19. Distribution of reviews – KDE plot**




*Compound score generated from subtracting negative scores from positive scores. Negative compound sentiments are generally negative, positive compound sentiments are generally positive, and neutral compound sentiments are closer to 0.*

There also many negative outliers (Figure 20). If these outliers were removed, it would push the distribution even closer to having more positive reviews.

**Figure 20. Distribution of reviews - boxplot**




*Compound score generated from subtracting negative scores from positive scores. Negative compound sentiments are generally negative, positive compound sentiments are generally positive, and neutral compound sentiments are closer to 0.*

## Based on the popularity of the sentiment, what are the top 20 positive and top 20 negative reviews?

The top 20 positive reviews (Figure 21) reveal that customers are happy with Turtle Games' products as gifts and that they are perceived as being fun. The top 20 negative reviews (Figure 22) reveal that customers are dissatisfied with certain features of the products.

**Figure 21. Top 20 positive reviews**

| | neg | neu | pos | compound |
|---|---|---|---|---|
| adorable | 0.0 | 0.0 | 1.0 | 0.4939 |
| cute love | 0.0 | 0.0 | 1.0 | 0.8020 |
| good value | 0.0 | 0.0 | 1.0 | 0.6486 |
| fine | 0.0 | 0.0 | 1.0 | 0.2023 |
| best | 0.0 | 0.0 | 1.0 | 0.6369 |
| fascinating | 0.0 | 0.0 | 1.0 | 0.5423 |
| entertaining | 0.0 | 0.0 | 1.0 | 0.4404 |
| nice gift | 0.0 | 0.0 | 1.0 | 0.6908 |
| super great love | 0.0 | 0.0 | 1.0 | 0.9217 |
| awesome better | 0.0 | 0.0 | 1.0 | 0.7906 |
| awesome great fan | 0.0 | 0.0 | 1.0 | 0.8885 |
| fun fun fun | 0.0 | 0.0 | 1.0 | 0.8720 |
| wonderful | 0.0 | 0.0 | 1.0 | 0.5719 |
| adorable gift | 0.0 | 0.0 | 1.0 | 0.7269 |
| perfect holiday | 0.0 | 0.0 | 1.0 | 0.7506 |
| gift | 0.0 | 0.0 | 1.0 | 0.4404 |
| great entertainment | 0.0 | 0.0 | 1.0 | 0.7845 |
| inspiring creativity | 0.0 | 0.0 | 1.0 | 0.6597 |
| amazing | 0.0 | 0.0 | 1.0 | 0.5859 |
| exciting | 0.0 | 0.0 | 1.0 | 0.4939 |

**Figure 22. Top 20 negative reviews**

| | neg | neu | pos | compound |
|---|---|---|---|---|
| difficult | 1.000 | 0.000 | 0.0 | -0.3612 |
| crazy | 1.000 | 0.000 | 0.0 | -0.3400 |
| limited | 1.000 | 0.000 | 0.0 | -0.2263 |
| missing | 1.000 | 0.000 | 0.0 | -0.2960 |
| disappointment | 1.000 | 0.000 | 0.0 | -0.5106 |
| stupid | 1.000 | 0.000 | 0.0 | -0.5267 |
| gross | 1.000 | 0.000 | 0.0 | -0.4767 |
| scary | 1.000 | 0.000 | 0.0 | -0.4939 |
| disgusting | 1.000 | 0.000 | 0.0 | -0.5267 |
| missing horrible product | 0.851 | 0.149 | 0.0 | -0.6908 |
| nothing great fair | 0.840 | 0.160 | 0.0 | -0.6435 |
| found poor unclear | 0.836 | 0.164 | 0.0 | -0.6249 |
| hate elf disgusting hate life leave shelf alone | 0.824 | 0.176 | 0.0 | -0.9186 |
| waterproof dangerous | 0.756 | 0.244 | 0.0 | -0.4767 |
| small disappointed | 0.756 | 0.244 | 0.0 | -0.4767 |
| broke soon | 0.737 | 0.263 | 0.0 | -0.4215 |
| button lame | 0.737 | 0.263 | 0.0 | -0.4215 |
| wasnt fun | 0.730 | 0.270 | 0.0 | -0.4023 |
| delivery many missing disappointed | 0.726 | 0.274 | 0.0 | -0.6486 |
| glue messy | 0.714 | 0.286 | 0.0 | -0.3612 |

## What are the predicted global sales for the next financial year based on current sales from Europe and North America?

The predicted global sales for the next year are shown for the for the first 20 ranked products in Figure 23. Due to the large product list (n=16,598), it is recommended that the total product list be viewed in the accompanying Rscript.

**Figure 23. Predicted global sales for the top 20 ranked products (USD)**

| Rank | Name | Platform | Year | Genre | Publisher | NA_Sales | EU_Sales | Global Sales | Predicted Global Sales |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Wii Sports | Wii | 2006 | Sports | Nintendo | 41.49 | 29.02 | 82.74 | 86.96 |
| 2 | Super Mario Bros. | NES | 1985 | Platform | Nintendo | 29.08 | 3.58 | 40.24 | 38.31 |
| 3 | Mario Kart Wii | Wii | 2008 | Racing | Nintendo | 15.85 | 12.88 | 35.82 | 35.67 |
| 4 | Wii Sports Resort | Wii | 2009 | Sports | Nintendo | 15.75 | 11.01 | 33.00 | 33.02 |
| 5 | Pokemon Red/Pokemon Blue | GB | 1996 | Role-Playing | Nintendo | 11.27 | 8.89 | 31.37 | 25.01 |
| 6 | Tetris | GB | 1989 | Puzzle | Nintendo | 23.20 | 2.26 | 30.26 | 29.76 |
| 7 | New Super Mario Bros. | DS | 2006 | Platform | Nintendo | 11.38 | 9.23 | 30.01 | 25.59 |
| 8 | Wii Play | Wii | 2006 | Misc | Nintendo | 14.03 | 9.20 | 29.02 | 28.60 |
| 9 | New Super Mario Bros. Wii | Wii | 2009 | Platform | Nintendo | 14.59 | 7.06 | 28.62 | 26.35 |
| 10 | Duck Hunt | NES | 1984 | Shooter | Nintendo | 26.93 | 0.63 | 28.31 | 31.85 |
| 11 | Nintendogs | DS | 2005 | Simulation | Nintendo | 9.07 | 11.00 | 24.76 | 25.33 |
| 12 | Mario Kart DS | DS | 2005 | Racing | Nintendo | 9.81 | 7.57 | 23.42 | 21.55 |
| 13 | Pokemon Gold/Pokemon Silver | GB | 1999 | Role-Playing | Nintendo | 9.00 | 6.18 | 23.10 | 18.74 |
| 14 | Wii Fit | Wii | 2007 | Sports | Nintendo | 8.94 | 8.03 | 22.72 | 21.17 |
| 15 | Wii Fit Plus | Wii | 2009 | Sports | Nintendo | 9.09 | 8.59 | 22.00 | 22.10 |
| 16 | Kinect Adventures! | X360 | 2010 | Misc | Microsoft Game Studios | 14.97 | 4.94 | 21.82 | 23.92 |
| 17 | Grand Theft Auto V | PS3 | 2013 | Action | Take-Two Interactive | 7.01 | 9.27 | 21.40 | 20.62 |
| 18 | Grand Theft Auto: San Andreas | PS2 | 2004 | Action | Take-Two Interactive | 9.43 | 0.40 | 20.81 | 11.42 |
| 19 | Super Mario World | SNES | 1990 | Platform | Nintendo | 12.78 | 3.75 | 20.61 | 19.80 |
| 20 | Brain Age: Train Your Brain in Minutes a Day | DS | 2005 | Misc | Nintendo | 4.75 | 9.26 | 20.22 | 18.01 |

## Patterns and predictions

Insights are grouped by business objectives below.

### Determine the optimal price at which they should sell Lego products based on the number of Lego pieces in the Lego set and the age of the customer that the product is most likely to be purchased by

The number of pieces in a Lego set is a stronger predictor of list price than age, although both have a linear relationship with list price. Generally, as the number of pieces increases and the age of the target customer increases, the price charged should also rise.

### Determine the customer group that will most likely leave a review on the products they have purchased

The greatest number of reviews are left for those between the ages of 8-9. This could be an indicator of the age range customers are buying the most products for and, if so, could help Turtle Games in determining their target consumer profile.

### Determine the most expensive products purchased by a particular group of customers

The cost of the most expensive product bought by customer aged 25 and over is $259.87. However, more customers within this age bracket purchase products that are around $35.00 and very few purchase products at the highest prices. Turtle Games may wish to examine the distributions in Figure 18 to determine the price point that generates the most sales overall.

### Determine the general sentiment of customers across all e-store products

Customer sentiment tends to be high on e-store products. The top 20 positive reviews point toward products being ideal gifts and “fun.” This could help in future marketing campaigns. Meanwhile, the top 20 negative reviews tend to be associated with certain product characteristics, which could help in making product improvements.

### Determine the predicted global sales for the next financial year

North American and European sales are strong indicators for global sales. Therefore, closely monitoring sales in these regions at regular intervals will help Turtle Games in predicting the performance of their overall global sales.

### Future actions

The data within the lego and games_sales data sets is highly skewed. It is recommended that this data be normalised in order to increase the statistical strength of the analyses.

In addition, the accuracy of the insights could be improved by merging the data sets with product information. For example, knowing what products have positive or negative sentiments would help in marketing campaigns and product improvement initiatives.

# Appendix 1. Metadata

## lego.csv

| Column | Sample value | Interpretation of columns |
|---|---|---|
| ages | 19 | The age the Lego product caters to |
| list_price | 29.99 | Price of the Lego product (in US dollars) |
| num_reviews | 2 | Number of reviews |
| piece_count | 277 | Number of Lego pieces in the product |
| play_star_rating | 4 | Star rating by players/customers (0 to 5 stars) |
| review_difficulty | 0 | The difficulty level of the product |
| country | 20 | Number of countries the product is sold in |

## games_reviews.csv

| Column | Sample value | Interpretation of columns |
|---|---|---|
| overall | 2 | Overall ratings the customer has given the product (out of 5) |
| verified | FALSE | If the review is verified by Turtle Games, TRUE<br>If the review is not verified by Turtle Games, FALSE |
| reviewTime | 09 22, 2016 | Date that the review was submitted in the format of MM DD, YYYY |
| reviewerID | A1IDMI31WEANAF | Unique ID of the reviewer |
| reviewerName | Mackenzie Kent | Name of the customer/reviewer |
| reviewText | When it comes to a DM's screen, the space on the screen itself is at an absolute premium. The fact that 50% of this space is… | Feedback/review submitted by customers who purchased and used the products |
| summary | The fact that 50% of this space is wasted on art (and not terribly | Summary of the feedback/review |

| | | |
|---|---|---|
| | informative or needed art ... | |
| unixReviewTime | 1474502400 | Time taken to write the review (in seconds)<br>[Note: The time is unix time, which is a way of representing a timestamp as the number of seconds since January 1st, 1970 at 00:00:00 UTC.] |
| image | — | Image of the product |

## games_sales.csv

| Column | Sample value | Interpretation of columns |
|---|---|---|
| Rank | 1 | World ranking of the game |
| Name | Wii Sports | Name of the video game |
| Platform | Wii | Video game console on which the game was launched |
| Year | 2006 | Year of launch |
| Genre | Sports | Genre of the video game |
| Publisher | Nintendo | Company that published the game |
| NA_Sales | 41.49 | Number of games sold in North America (in millions of units) |
| EU_Sales | 29.02 | Number of games sold Europe (in millions of units) |
| Global_Sales | 82.74 | Total sales in the world (which is a sum of EU_Sales, NA_Sales and online sales) (in millions of units) |