Roller Coaster Ranking Method

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Problem Statement

Rollercoasters are the main attraction for almost every amusement park. Therefore, attendees tend to want to ride the most “exciting” roller coasters possible.

While many online roller coaster ranking exist, they heavily depend on descriptive data based on users’ experiences. The objective of this project was to develop an algorithm that creates a rating system for roller coasters only based on quantitative data, like speed, duration, drop height, or length. We were given a set of data to use that includes roller coasters currently in operation and that have a height, speed, and/or drop height above the worldwide average of operating coasters.

Assumptions

What makes a roller coaster "exciting?"

1. The feeling of not having control
2. Jerks
3. Height of drop
4. Inversions
5. Negative g-force

Assumptions:

1. We need at least 90% of rows filled before calculating assumptions
2. A higher ranking means a higher amount of excitement
3. Data provided is accurate and only based on objective research

Missing Data

After counting how many empty data cells there were:

- Vertical angle was missing 209 data points (30% of data)
- G-force was missing 217 data points (28% of data)
- Duration was missing 76 data points (75% of data)
- Drop height was missing 158 data points (47% of data)

Determine what factors influence roller coaster excitement most based on current rankings

- Material
- Height
- Length
- Speed
- Inversions

- Compare the average of each value of top ranking roller coasters to the average of all roller factors

Top 10 roller coasters were used as benchmark – used the results of a study that compared 3 online ranking websites

Top 10

Steel Dragon 2000

Kingda Ka

Millenium Force

Top Throll Dragster

Phantom's Revenge

Ten ring Roller Coaster

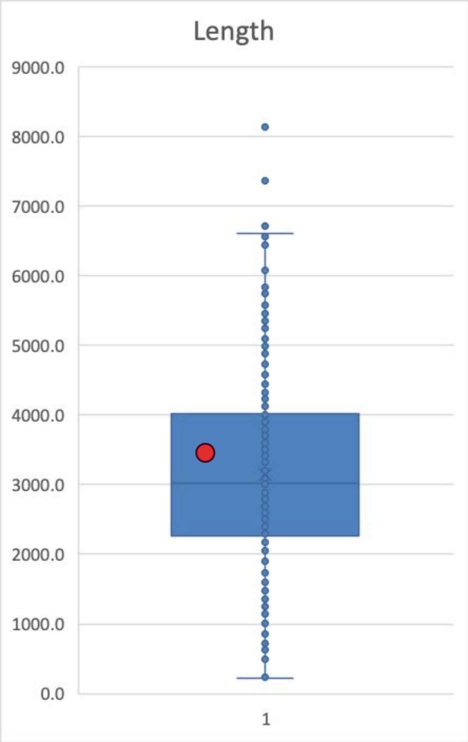
Tower of Terror II

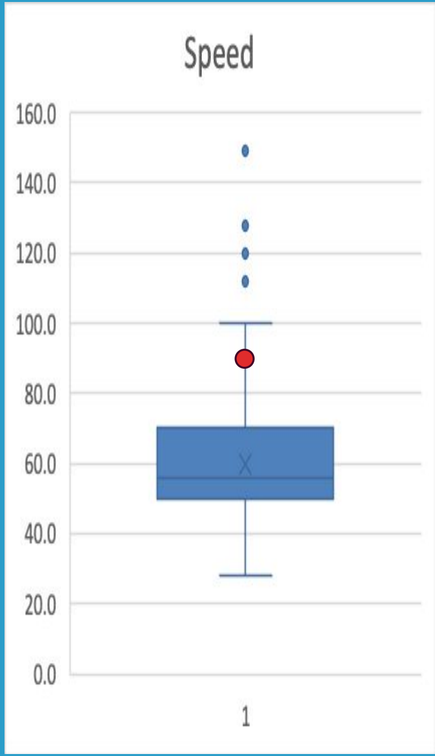
Dodonpa

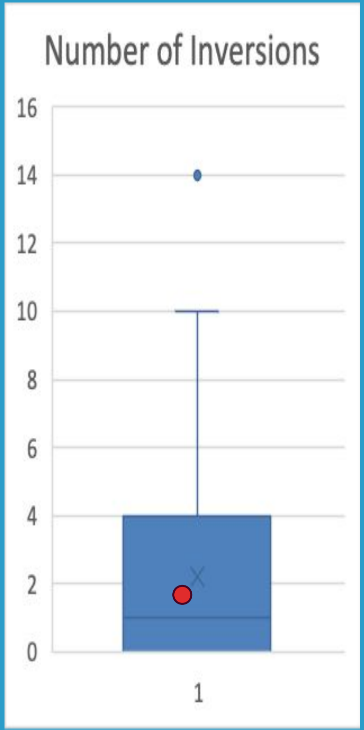
Superman The Escape

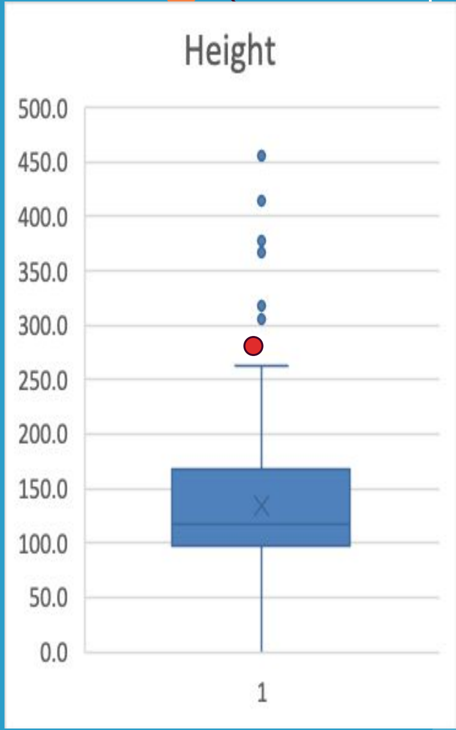
Goliath

(Liu, 2019)

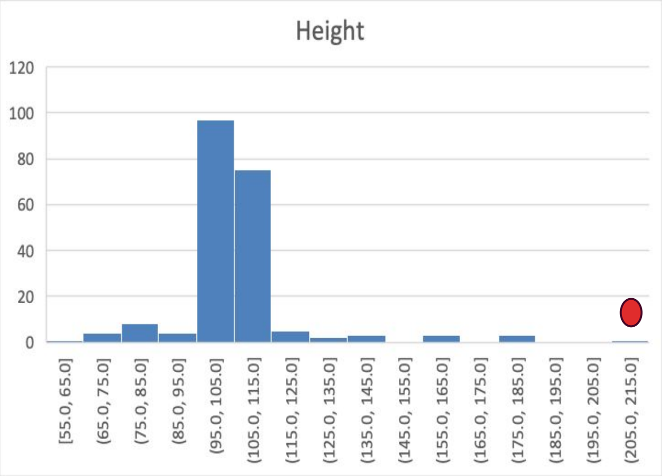


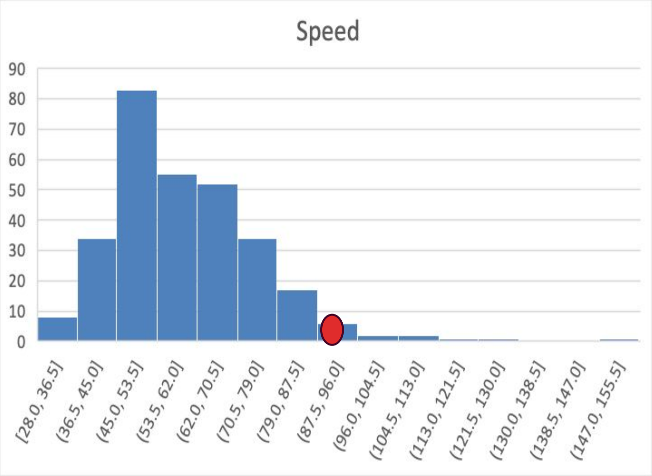




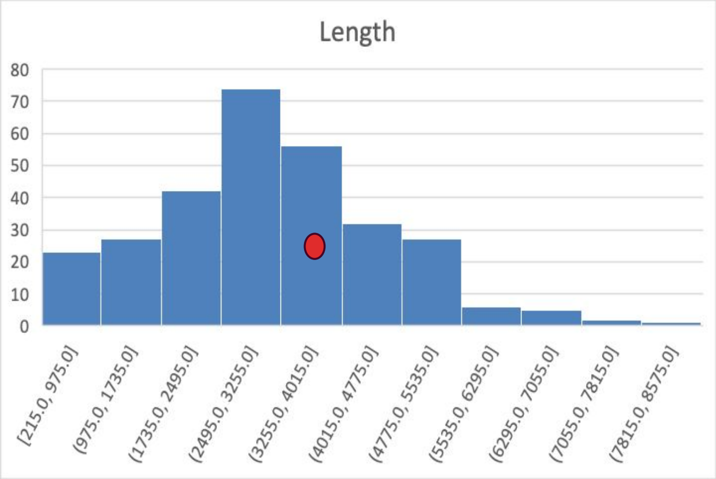


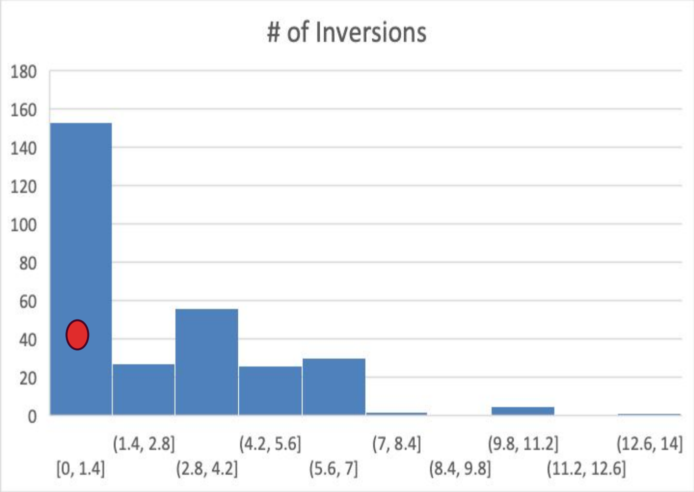
Average value of Top 10 ranking roller coasters





1. Height varies most between the top and all RC
2. Speed is on the higher end
3. Inversions and length is in the median range





Determine what factors influence roller coaster excitement most based on current rankings

3	1	4	2	5
Material	**Height**	**Length**	**Speed**	**Inversions**
9/10 top RC were made of steel, leading to the assumption that steel is better than wood	Highest weight when ranking	4th importance when ranking	2nd highest weight when ranking	Least important when ranking

Weight of Ranking

1. **Height**
2. **Speed**
3. **Materials**
4. **Length**
5. **Inversions**

Now we must find the weight of each ranking. We used the entropy method to find the weight of each category.

The entropy method is a weighting method that measures the amount of information and the weights of decision indicators.

Step 1: Normalize the Data/Address Missing Values

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$$

The first step of the entropy method is to normalize the data.

Normalizing the data makes all of the data values fall between 0 and 1, which allows us to compare them better. It eliminates the variation.

We filled in missing data with the average of the column

After Normalization

Name	Height (feet)	Height Normal	Speed (mph)	Speed Normal	Length (feet)	Length Normal	Number of Inversions	Inversions Normal
10 Inversion Roller Coaster	98.4	0.002432	45.0	0.002514	2788.8	0.002951	10	0.0149925

We normalized the data in order to better compare each category. Since each category varied widely, it was important to be able to compare the data between 0 and 1.

Ranking Roller Coasters Against Each Other

Weighted Average

- Since each factor influences excitement differently, develop weighted ranking system
- Higher height and speed influence ranking more than inversions and length

Roller Coaster Index

- Each RC will receive a unique index
- Index = weighted average of each of the factors
- Future steps: assign each factor a value based on research

Step 2: Calculate Weight Vector

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n} (1 - e_j)}, \quad j = 1, 2, \ldots, n$$

Descriptive Data → Quantitative

Steel > Wood

- Assign steel a greater value than wood based on research from various sources
- Steel = 1
- Wood = 0.5

Future Steps

- Do more research to determine accurate value for each material and provide mathematical reasoning

(Liu, 2019)

Final Calculations

		Height			Speed			Length		
entropy sum		-5.597423			-5.669687			-5.594215		
Entroppy value		0.98135276			0.994022			0.9807903		
degree of diversification		0.01864724			0.005978			0.0192097		
Weight Vector		0.4253992			0.1363703			0.4382305		
height				speed				len		
max	456.0			max	149.1	12.11		max	8133.2	
min	29.0			min	28.0			min	215.0	791.82
		42.7								
	1	2	3	4	5	6	7	8	9	10
height	29-71.7	71.7-114.4	114.4-157.1	157.1-199.8	199.8-242.5	285.2	327.9	370.6	413.3	456
speed	40.11	52.22	64.33	76.44	88.55	100.66	112.77	124.88	136.99	149.1
len	1006.82	1798.64	2590.46	3382.28	4174.1	4965.92	5757.74	6549.56	7341.38	8133.2

Ranking System

	x	x	x	x	x
Roller Coaster X Index	Height	**Speed**	**Material**	Length	Inversions

Future steps:

- Fill in missing data
- Assign each factor a weighted value
- Calculate RC Index for each RC (weighted average of each factor)
- Sort based on highest to lowest RC
- Verify results based on online ranking lists

Sources

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