Introduction and Restatement of the Problem:

Online ranking and rating sites for roller coasters rely on a lot of subjective inputs to determine the rating of a particular roller coaster, but don't take many objective measures into account. This poses the issue that there are not many accurate roller coaster rating lists, as most rely on subjective scores that can differ between people.

To solve this problem, we looked at data for a subset of roller coasters whose characteristics—height, speed, and drop — are higher than those of the average roller coaster worldwide. From the data, we developed a quantitative algorithm to create a list of the top ten roller coasters using objective evaluations. After putting together our top ten list, we compared our list with some found online to see if it is somewhat similar. In addition, we created the concept and design for an app that implements our algorithm to help users find a roller coaster to ride based on their choices. We also wrote a news release that describes our new algorithm, results, and our app idea.

Assumptions and Justifications:

In order to develop our algorithm, we had to assume some parameters first:

- The speed refers to the roller coaster's top speed.
- The G-force and vertical angle data points were not considered because there were too few data points. Many of the roller coasters did not have data for these categories, so we decided that it would not be helpful in developing our algorithm.
- The duration of a roller coaster ride does not affect the thrill of a roller coaster. Duration is not a good measure of thrill and length of track is better for measuring structure than duration would be.
- The thrill of a roller coaster relies more on its inversions, speed, etc. Objectively, the thrill of a roller coaster comes from the physics of the ride, which includes its inversions, drops, and its speed rather than structural elements.

Model and Solution:

This quantitative algorithm ranks rollercoasters by objectively quantifying its thrill and structure.

For thrill, drop ft, max height, highest speed, number of inversions, and track length are considered. Higher values in these categories correlate with higher thrill. Higher drops and height increase potential energy, which also corresponds with higher speeds. Inversions determine intensity and track length determines duration.

For structure, the type of rollercoaster, its construction, and its year opened are considered. The type of rollercoaster shows the complexity of it and its construction material can represent the smoothness of the ride. Steel rollercoasters tend to have smoother rides than wooden ones. The year opened corresponds to how modern the structure is.

First, we normalized the data so that each column of data we used in our ranking system fit within a scale of 0-1. Without normalizing the data, the larger numerical data such as height and speed will immediately dominate the ranking. By fitting all the values between 0 and 1, each factor will contribute proportionally to the overall scoring. To normalize the data, we found the minimum and maximum value in each column and then used the formula: $X_{normalized} = (X - X_{min})/(X_{max} - X_{min})$ where X is the value in each cell.

Category	**Max Value**	**Min Value**
# of Inversions	14	0
Height (ft)	456	28.956
Speed	149.1	28
Year	2018	1924
Drop (ft)	418	27
Length (ft)	8133.2	215

For the construction material of rollercoasters, which is under quantifying structure, we labeled wooden rollercoasters as 0 and steel rollercoasters as 1 because steel rollercoasters are commonly known for being smoother while wooden roller coasters are known for being more bumpy. Steel structures often include longer track lengths and steeper slopes, adding to the complexity of the structure.

For the type of roller coaster, there were 6 categories: Sit down, Stand up, Wing, Flying, Inverted, Suspended. We ranked these between 0-1 in increments of 1/5. Sit down roller coasters are the simplest, with straight forward and backward motion. Stand up rollercoasters are a bit more complex as they have to accommodate for the safety of standing up passengers. Inverted is more intricate because the track is above the riders, and suspended coasters have swinging cars that move beneath the track. Wing coasters feature seats extending out of the track, making it more complicated. Flying is the most complex, as it has rotating mechanisms and harnesses for passengers. Rollercoasters with increased complexity were given higher values as shown below:

Type	**Value**
Sit down	0
Stand Up	0.2

Inverted	0.4
Suspended	0.6
Wing	0.8
Flying	1

Then, we weighed each criteria in both thrill and structure to quantify the proportion of each category (height, speed, etc.).

For thrill, because drop height had many missing values, we made two weighing systems. These serve as defaults for our top ten list, but in an app, users would be able to choose how the categories are weighed.
The number of inversions and speed were weighed higher for thrill because these contribute a lot to the intensity of the ride. We decided to weigh length the least because it doesn't necessarily correspond to more thrill as much as other categories. That's also why when drop height was missing, height was weighed more. We weighed drop as less because it has many missing values so it isn't as consistent as other data categories.

Thrill Weights

Category	Weight
Drop	0.15
Height	0.15
Speed	0.3
# of Inversions	0.3
Length	0.1

Category	Weight
Height	0.3
Speed	0.3
# of Inversions	0.3
Length	0.1

For structure, we weighed the construction as the most because steel vs wooden rollercoasters have a bigger impact on structure. Then, we weighed the year opened as the next highest because it correlates to how modern the ride is.

Structure Weights

Category	Weight
Type of Roller	0.2

coaster	
Construction	0.5
Year opened	0.3

To get the total score for thrill and the total score for structure for each roller coaster, the normalized value in each category is multiplied by its respective weighting and summed up.

Thrill: 0.15 * Drop + 0.15 * Height + 0.3 * Speed + 0.3 * # of inversions + 0.1 * Length
- Drop, Height, Speed, # of inversions, Length → all the normalized values (0-1)

Structure: 0.2 * Type of roller coaster + 0.5 * construction + 0.3 * year opened
- Type, construction, and year opened → normalized values (0-1)

Then, to get the total score for the rollercoaster, we weigh the thrill score and the structure score and sum that. To stay neutral, we weighed each 0.5, but users in an app could adjust that.

Total score = 0.5 * thrill score + 0.5 * structure score
We used this formula with its default values to get our Top Ten List:

Our Top 10 Roller Coasters:
1. Kingda Ka
2. Gatekeeper
3. Eejanaika
4. Dinoconda
5. Soaring Dragon & Dancing Phoenix
6. Top Thrill Dragster
7. Red Force
8. Tatsu
9. Formula Rossa
10. Fury 325

ViaTravelers' Top 10 Roller Coasters:
1. Formula Rossa
2. Red Force
3. Kinda Ka
4. Dueling Dragons
5. Taron
6. Steel Dragons 2000
7. Intimidator 305

8. Superman: Escape from Krypton
9. Coney Island Cyclone
10. Do-Donpa

[Top 10 Roller Coasters in the World for Every Thrill Seeker]

We share Formula Ross, Red Force, and Kinda Ka with this list. They based their rating on special, one-of-a-kind experiences. The writer does not detail the specifics of the rating system, but it is likely based on their own experiences. Formula Rossa and Kinda Ka are widely known roller coasters for their intense speeds and drops, but data would not indicate that they are as highly ranked as the website says. Unlike ViaTravelers, we attempted to make our ranking based on data instead of opinions on uniqueness because everybody has different ideas of the "best" roller coaster.

Captain Coasters Top 10 List:

1. Steel Vengeance
2. Zadra
3. Iron Gwazi
4. VelociCoaster
5. Eejanaika
6. Hakugei
7. Ride to Happiness
8. Taiga
9. ArieForce One
10. Stardust Racers (Green)

[CaptainCoasters Top 10 List]

We share Eejanaika with this list. The website CaptainCoaster was created for users to choose different aspects they want to see in roller coasters, and rank them. This list is based on the most highly rated roller coasters in the world, so Steel Vengeance is the most highly ranked roller coaster on their website. This takes into account many people's inputs but is still subjective because people will have different opinions on what makes a good roller coaster. Just because a roller coaster is highly ranked does not necessarily mean it is the most thrilling roller coaster ever.

User-friendly App Concept and Design:

The main purpose of this app is to recommend the best roller coasters for the users based on their personal preferences and how much importance they give to certain characteristics of these rides. At its core, the app will follow a similar structure to the solution outlined in our model, but include more user input to ensure the resulting list of roller coasters is tailored to the user's specific needs.

First, the users will be asked if they want the best roller coasters in a certain area or if they just want the best roller coasters for them. If they say they want to contain their Top 10 List to a certain area, then they will be promoted to select which area. Based on that information, the app would then filter out all the roller coasters within that area and perform the necessary calculations on only these roller coasters.

The users will then be prompted to indicate how much importance they put on structure and thrill when deciding the best roller coaster. They do this by assigning a certain percentage to each category. The sum of the percentage allotted to structure and the percentage allotted to thrill needs to equal 100.

Next the users will be prompted to select the weight of each of the criteria within the two main categories. The criteria for thrill are drop height, max height, speed, number of inversions, and length. The user can select the percentage for each of these criteria, but the sum here should also add up to 100. A similar process will happen for the structure category, where the sum of the percentages assigned to each criteria should be 100.

The app would then use the normalized data from the provided dataset and the user's inputs to generate a personalized Top 10 Roller Coaster List for each person.

Analysis:

Sensitivity Analysis:

For our sensitivity analysis we decided to see how drastically the Top 10 Roller Coaster list changes if we had decided to include the G Force and Vertical Angle of the Roller Coasters.

Both G force and the Vertical Angle were added to the Thrill part of our standard model, and the Thrill would still be 50% of the roller coaster's final score. In order to incorporate both new characteristics into the equation we changed the percentages for each criteria within the Thrill category to:

- Drop FT = 10%
- Max Height = 10%
- Vertical Angle =10%
- Speed = 25%
- Number of Inversions = 25%
- G-Force = 10%
- Length = 10%

The percentages for all the criteria within the Structure category remained unchanged. When these new values a put into the mathematical model, our new Top 10 List is:

- Takabisha
- Crazy Bird
- Cannibal
- Timber Drop
- Saw-The Ride
- Fahrenheit

- Fluch von Novgorod
- Adrenaline Peak
- Goliath
- Tower of Terror II

The new list is drastically different from our original Top 10 List. This shows how severely having missing data in the calculation can skew the results. In the future our model could be improved to ensure that minor changes in the model doesn't skew the results.

Pros and Cons:

Some pros of our model is that it considers most of the information provided to us in the data set when ranking the roller coaster. Even though the dataset had some columns missing a significant amount of information, our model doesn't let the missing data skew the ranking list, instead assigning the missing percentage to another criteria. Some cons of our model include the fact that our ranking system might not be completely objective. While our app design aims to make the ranking list more objective by making it personal to the users, our model still doesn't completely remove bias from the developer. The model also only takes into account a certain amount of criteria, and users using our app might think another element of a roller coaster contributes highly to their definition of thrill.

Implication of Work:

Our model and app concept design transforms the way thrill-seekers plan their theme park visits, allowing them to tailor experiences to their own tastes, rather than relying on the generic top roller coaster rankings. With our app design, someone who prioritizes high G-forces in their roller coasters would be directed to roller coasters with higher accelerations, while someone who prefers a larger drop height could find rides better suited to them. This personalization enhances user satisfaction, ensuring the time they spend at these parks doesn't go to waste and encouraging the exploration of lesser-known rides. For amusement parks, our model and app design would provide valuable insights from a data science perspective, helping them identify what aspects of roller coasters are more exciting and make better decisions about designs and marketing strategies. Additionally it could create a community of coaster enthusiasts who can share reviews, thrill ratings, and ride experiences, further amplifying engagement. Overall, our model would merge data analytics, personalization and entertainment in a way that changes how people perceive roller coasters.

Conclusion:

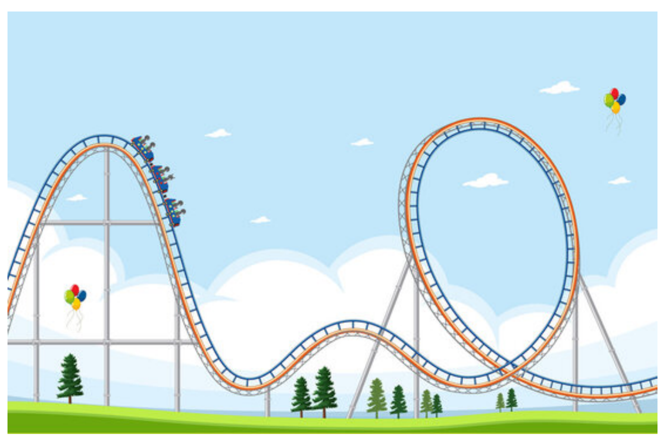
In this problem, our group came up with an objective ranking system for roller coasters. To do this, we first normalized the data to be on a scale of 0 to 1 so that the ranking is appropriately proportionate. We sectioned our score for each coaster into a thrill score and a structure score. For each criteria in the thrill/structure, we gave an appropriate weight and summed up the values times their respective weight to get the thrill/structure score. We came up with an app concept that allows users to make changes to the weight of each trait of the ride to get their own personalized coaster ranking. In the future, the app could be developed and more data points could be included, especially for G-force and vertical angle so that these criteria could also be added into the ranking system.

Non-Technical Document (News Release):

BREAKING NEWS!!!!!!!!!

NEW OBJECTIVE ALGORITHM FOR RANKING ROLLER COASTERS HAS BEEN DEVELOPED!!! 🤯🤯

Have you ever wondered which roller coaster in the entire world deserves the #1 spot? For decades, roller coaster rankings have relied on subjective opinions from riders, but those opinions don't really reflect those of all riders. An incredibly intelligent team of individuals has toiled and put in hours of labor to ultimately develop an algorithm to rate and rank roller coasters using objective measures, as many existing rankings rely on subjective input.



Using factors like height, speed, drop distance, number of inversions, and more, the algorithm calculates a "thrill score" and "structure score" for each coaster. Then, these scores are combined to get an overall ranking that objectively measures excitement without personal bias.

The brilliant team's Top 10 list features roller coasters from across the globe like Kingda Ka and Gatekeeper which show strong similarities with some existing global rankings online. Additionally, there are some surprising and different roller coasters on the ranking, compared to online lists, but this goes to show that the team's list relies on data-driven insights.

With even more exciting news, the ingenious team created a concept for a user-friendly app that will allow the biggest thrill-seekers to personalize their own rankings. Users can adjust how much they value different factors and filter rides by location to help them discover rides that align with their preferences. Whether you thirst for intense drops and insane inversions, or slow, smooth rides, the app can find you the perfect coaster.

With this breakthrough, theme park fanatics can choose their next adventure with ease. The incredible team's work finally gives radical roller coaster fans a way to seek their next ride without doubt on how it was rated!

Reference List:

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AI-Use Report:

We did not use A.I. for this project.