

MTFC Scenario Quest 2023-24

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Team ID #	16420
Proposal Topic Title	Self-Driving Car Accidents

Mission 1 Ski Resort Prompts

These prompts can be found on pages 11-12 of the Scenario Quest. Additional information on Data Identification and Analysis can be found on pages 11-22 of the [Actuarial Process Guide](#).

Responses:

- 1.1 Investors and customers are both at risk because of the climate change noted in the scenario description. Investors will lose money because customers will stop going to the resorts, while customers are at risk because of increased icy conditions (which are more dangerous than snowy conditions). However, while investors are in danger of losing money, the customers are at danger of bodily harm and even death. After all, icy conditions are far more dangerous to

be on than snowy conditions, mostly because of the lack of traction and odd frictional behavior. There are many stories of skiers tearing or shattering their knees because of icy conditions where they tried to turn and were not able to.

- 1.2 The first and most obvious risk for these resorts is the possible monetary loss from fewer customers. With increased dangerous routes come decreased customer numbers, which will of course lead to fewer customers; after all, nobody wants to put themselves in danger when they don't need to. The next way these resorts are at risk is also a monetary risk, because the resorts will not be able to stay open for as long. If the overall global temperature is lower, snow will come earlier and go later, meaning that the resorts can be open for a good period of time. If the global temperature increases, this window of time will shorten, meaning that resorts will have shorter operating times. Finally, there is a risk of litigation involved. If the ski resorts are unable to provide safe conditions for skiers and snowboarders, they will need to protect themselves more in the safety waivers that people sign because the conditions of the slopes are not as good.

- 1.3 Of the three methods to mitigate losses, each one has its own merits. With insurance, the ski resorts could get insurance to cover them if they don't get a certain number of customers in a certain time frame; for example, if the ski resort gets fewer than 600 customers in a day, the insurance pays them \$10,000. For behavior change, the resorts could start generating more snow. While this will cost them money, they will be able to maintain their customer base. And finally, for modifying outcomes, the easiest way to do this would be to do something like padding the sides of the dangerous areas of the slope with the netting they use. That way, it may be expensive, but the skiers and snowboarders would not be injured as much even if they fall on the ice.

Mission 1 - Team Project Proposal Prompt

- 1 - Project Proposal
 - 1.1 We plan to investigate the proliferation of self-driving cars and the resulting consequences. With the widespread use of cars capable of driving themselves and their passengers, safety is becoming more and more of a concern. It's crucial to ensure that everyone stays safe while these robot-powered vehicles travel on main roads.
 - 1.2 There are many risky areas related to self-driving cars. To start, pedestrians and other people on the road are at increased risk with these vehicles, as there may or may not be someone present behind the wheel to take over in case there is a malfunction. This also puts governmental bodies and companies in a tough spot, because they must now be responsible for passing new laws and restrictions for vehicle safety. Finally, the owners of these self-driving cars are in danger as well, because they may be in legal/ethical/moral trouble if anything is to happen with their car.
 - 1.3 Risk Mitigation Strategies:
 - Insurance
 - Life insurance, which most people have, can help compensate for some of the cost of the human deaths; however, you can never truly put a value on human life. Looking at

- Behavior
 - By improving the performance of the cars – reaction times, programming, hardware, etc. – stopping time and similar practices can be improved, thereby increasing safety.
- Modifying Outcomes
 - By improving people’s situational awareness and ability to react properly, we can reduce the chances of robot crashes being uncontrolled by people.

Mission 2 Ski Resort Prompts

These prompts can be found on pages 18-19 of the Scenario Quest. Additional information on Data Identification and Analysis can be found on pages 23-29 of the [Actuarial Process Guide](#).


Responses:

- 2.1
 - What aspects of ski resorts suffer due to climate change?
 - How does climate affect the rate of snowfall and the rate at which snow, real and artificial melt?
 - What past/current actions do ski resorts take and how does it affect their profits?

- 2.2 Delving into potential outcomes, the factors influencing people's choices in selecting a resort and the contribution of first-time skiers to overall profit need exploration. Assessing potential losses, understanding the upkeep of fake snow, the financial implications of increased maintenance, and the role of technology in cost reduction are key considerations. Lastly, examining the impact of light snowfall on profits and how it correlates with growing population and shorter resort seasons provides valuable insights.
- 2.3 Sample size and data types describe the characteristics of the data. The center of the data like mean and median provides context of where the data gathers around, and measures of spread such as range or standard deviation explain the variability within the dataset. Plotted graphs give context to the data set and allow people to visualize the trends in the data.

Mission 2 - Team Project Proposal Prompt

- 2 - Project Proposal
 - Identify Driving Research Questions for Your Topic
 - What are the leading issues with electric cars?
 - Why do electric cars get into accidents?

- Are electric car accidents worse than similar gas-powered car crashes?
- Identify the Type of Data You Hope to Find
 - Historical Trends in order to find out what areas are commonly problems.
 - Projected future trends to figure out what areas may develop into larger issues and which facets may become less detrimental.
 - Potential Outcomes to learn how best to mitigate them.
 - Severity of potential losses to understand how we need to prepare and what the best way to do so is.
- Identify Potential Data Sources for Your Topic
 -  Copy of Tesla Deaths (tesladeaths.com)
 - Although this website is not largely known, it provides a hugely comprehensive list, and upon researching some of the accidents, the information seemed correct.
 - This would mainly be for analysis, not graphical representation. If we were planning to show it graphically, it would probably be a large table.
 - This data set does not seem to have a need for cleaning before use.
 - [Electric vehicles Review for the Road Safety Observatory](#)
 - This is a source from the Road Safety Observatory, which – from lateral reading and other research – seems to be a reputable source.
 - This source is less of a source for numerical data and more of a collection of other data sources. It has other articles and similar data.

- This data set will need to be sorted through for relevant information.
- [Referenced Data Sources from This Article](#)
 - This source is reputable because it's a published, peer-reviewed article.
 - This source would be displayed in graphs and charts, as it discusses crash statistics in Norway.
 - This data seems to have already been cleaned up; they already present it in the forms of graphs and charts, so it would probably stay that way.
- [Insurance Report - Noncrash fire losses](#)
 - This is an insurance report about fire losses not fully related to crashes. Although it seems unrelated, it is still relevant because EVs have increased risks of fire damage due to their large batteries.
 - This would be used in tables as a reference for any insurance plans that may be relevant moving forward.
 - This data does not need to be cleaned up before use.

Mission 3 Ski Resort Prompts

These prompts can be found on pages 24-26 of the Scenario Quest. Additional information on Data Identification and Analysis can be found on pages 30-31 of the [Actuarial Process Guide](#).

Responses:

3.1

Listed below are some articles that we found after searching for websites containing both relations to ski resorts and climate change. These articles discuss varying topics including what ski resorts are in danger due to global warming resulting in snow melting earlier and falling later, in addition to less snow falling in general.

- [Climate change exacerbates snow-water-energy challenges for European ski tourism](#)
 - Many European ski resorts are at risk due to global warming
 - The researchers suggest that resorts invest to combat this. These investments may include obtaining more efficient snowmaking systems, reducing the overall energy usage of the resort, and including business activities that are not reliant on snow. An example of this may be an indoor water park, which some ski resorts already have.
- <https://www.sciencedirect.com/science/article/pii/S0048969721021240>
 - The number of days without sufficient snowfall may increase dramatically during this century because of rising global temperatures.
 - Internal climate variability – affecting localized areas like the ski resorts themselves – will also impact the amount of snow present.
- <https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wcc.8>
 - This discusses regional climate models (RCM), which are tools that are generally used to understand and predict climate change.
 - RCMs operate with the same principle as global climate models (GCMs) but with finer-tuned equations to work with smaller areas.

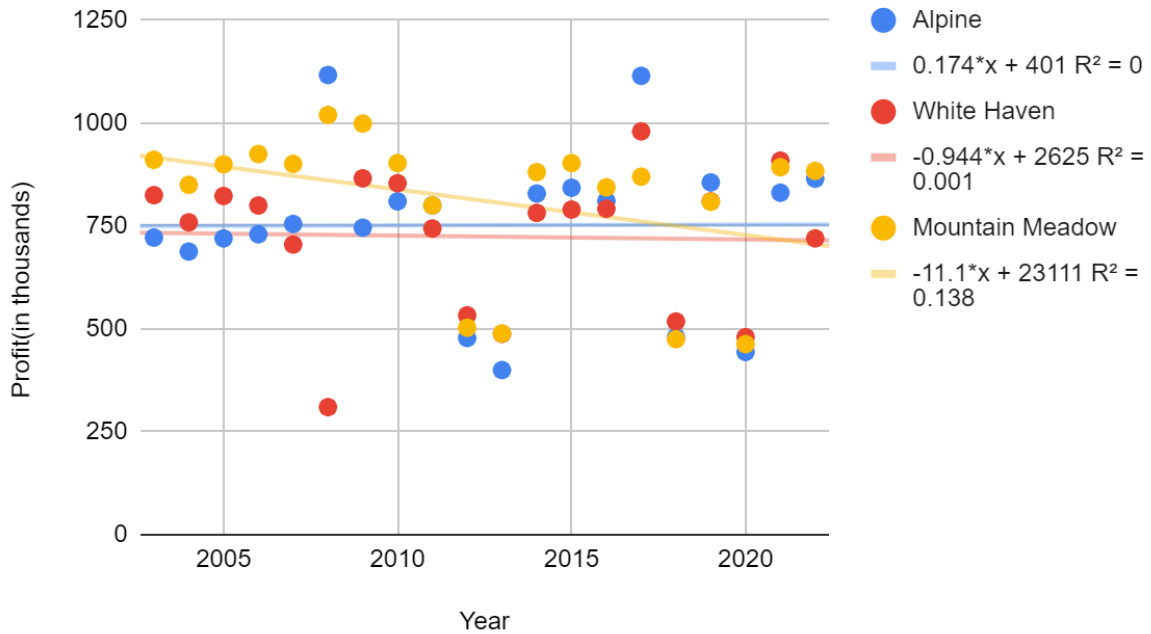
- These have many limitations, such as cost, uncertainty in boundary conditions, and uncertainty in parameterizations – that is, uncertainty in the equations used to model sub-grid sized areas.

3.2 Light snowfall years have lower mean profits than typical and heavy snowfall years.

	Alpine Area			Mountain Meadows			White Haven		
	Typical	Heavy	Light	Typical	Heavy	Light	Typical	Heavy	Light
Prob Dist	0.7	0.1	0.2	0.7	0.1	0.2	0.7	0.1	0.2
Mean Profit	786.14 28571	1116	450.5	828.1	945	482.5	798.5	645	504.75
Expected Value	550.3	111.6	90.1	579.7	94.5	96.5	558.95	64.5	100.95

3.3

Profit vs Year



The Mountain meadow resort is projected to lose more money as its trendline has a negative slope, meaning that its profits are going down over time.

Assumptions:

Heavy snow years have higher profits.

The amount of snowfall in a given year is random.

Mission 3 - Team Project Proposal Prompt

- 3 - Project Proposal
 - The search for “driving safety math model” yields research articles with a lot of equations derived from observations and data. To refine the search, we used the keywords vehicles, computational models, and decision making. We also switched to google scholar which resulted in articles which go deeper into one topic instead of focusing on the big picture. Some unfamiliar math topics that we found in the research articles include matrices and partial derivatives.
 - Upon doing further research, it seems logical to break down the project into three sections. The first section would be to analyze the user and how they might contribute to an accident. The second would be to analyze the software aspect of the electrical cars and how processing errors occur. The last section would be analyzing the mechanical components, and how they can malfunction.
 - A mathematical model would enable us to analyze risks and see trends within data to understand the implications of decisions we can make as a group. It could help predict the impacts of different decisions over time and see what risks are associated with different factors. This could help navigate any struggles in the future to make the most informed decision with the least drawbacks.

Mission 4 Ski Resort Prompts

These prompts can be found on pages 31-32 of the Scenario Quest. Additional information on Data Identification and Analysis can be found on pages 32-33 of the [Actuarial Process Guide](#).

Responses:

- 4.1

There are 3 outliers within the data for atypical years, 2 within light snowfall years, and 1 within heavy snowfall years. These outliers were calculated by subtracting $1.5 \times \text{IQR}$ from Q1 and adding it to Q3 to get a range of values which are to be expected, values outside this range are outliers. One year with heavy snowfall profits were much lower, this may be because snowfall in that region was heavy to the point of many road closures which also explains why it did not affect the other resorts that year. In the light years, we had one low outlier and one that was high, both in different years. The low year could be explained because such a location might have more ice which may make skiing conditions unsafe, the higher value may be because of the opposite being in a lower altitude region which may have low levels of snow allow for skiing.

2008	Alpine Arena	heavy	1117	Q1:	897.5
2017	Alpine Arena	heavy	1115	Q3:	1091.25
2008	Mountain Meac	heavy	1020	1.5*IQR	290.625
2017	Mountain Meac	heavy	870	Lower:	606.875
2008	White Haven	heavy	310	Upper:	1381.875
2017	White Haven	heavy	980		
2012	Alpine Arena	light	478	Q1:	472
2013	Alpine Arena	light	400	Q3:	492.5
2018	Alpine Arena	light	480	1.5*IQR	30.75
2020	Alpine Arena	light	444	Lower:	441.25
2012	Mountain Meac	light	503	Upper:	523.25
2013	Mountain Meac	light	489		
2018	Mountain Meac	light	475		
2020	Mountain Meac	light	463		
2012	White Haven	light	533		
2013	White Haven	light	488		
2018	White Haven	light	518		
2020	White Haven	light	480		

Dataset for calculating outliers

- 4.2.1

The data does not provide insight into frequency loss because even if there is atypical weather the resorts still expect this. They only lose money when there are outliers within the data, and the probability distribution does not explain this.

- 4.2.2

The mean profits do provide insight towards frequency loss. This data shows a decrease in profit for light snow years and we can see the amount of money the resorts are making. This means that the resorts make less money overall in light snow years than heavy snow years, but some of the resorts are also impacted more heavily than others.

- 4.2.3

We can measure loss by comparing the true mean values and the expected values. If the mean values within that category are lower than the expected value we can calculate the average loss

by subtracting the expected by the mean to calculate the residual. This residual value is the average loss.

Mission 4 - Team Project Proposal Prompt

- 4 - Project Proposal
 - It seems that behavior change would be the best method to solve this problem. The other two options may also work, but they're flawed. Insurance is an afterthought, where the damage has already been done; whether the victims get money from it or not, the possible property damage and loss of life – especially the latter – would not be equalized. With modifying outcomes, while we can do our best to mitigate the risks in case of an accident, it still would not be as effective as preventing the accidents from happening, which would best be done with behavior change; i.e. making sure that drivers do their due diligence to ensure safety for all. This may include alertness tests or something similar.
 - Without any intervention, this problem will probably still start to mitigate itself through company-side improvements. However, this process would go much faster if

the product users focused on similar ideals. The goal of this strategy would be to lower the chances of damages – especially death or injury – as much as possible.

Mission 5 Ski Resort Prompts

These prompts can be found on pages 36-38 of the Scenario Quest. Additional information on Data Identification and Analysis can be found on pages 34-35 of the [Actuarial Process Guide](#).

Responses:

- 5.1 Based on Mountain Meadows' current state, if nothing is done to fix their trajectory, they will be on a decline. This is because there is a 20% chance of them having light snow, and they make far less money in years with light snow than years with heavy snow. Because of this intrinsic link between the snowfall amount and the resort's profits, they need to do something or they will not be able to sustain themselves. This issue is exacerbated because with the climate change scenario we are dealing with, years with light snow will likely become more common, further decreasing Mountain Meadows' profits.
- 5.2

- Insurance
 - One way Mountain Meadows could implement an insurance plan is through a similar strategy to what we discussed in 1.3, namely that it could buy a plan to insure their profits in case not enough customers arrive. For example, if the ski resort gets fewer than 600 customers in a day, the insurance company pays them \$10,000.
- Behavior Change
 - Mountain Meadows could implement behavior change by encouraging people to come to their resort; for example, they could give slight discounts and coupons to people. For example, if the ticket normally costs \$80, maybe they could give \$15 off to anyone who brings a friend with them. This way, they still make money, but the customers also have an incentive to visit the resort.
 - Another method they could implement is a cheaper ski and snowboard rental program, assuming they already have one. If not, they could start one. It would encourage people to come because it is a much smaller investment to make than buying a pair of skis or a snowboard with all the accompanying gear. It would also make people more likely to bring their children, ensuring repeat customers for many years.
- Modifying Outcomes
 - The resort could be prepared to make more artificial snow throughout the season. Although it is not as good as fresh, natural snow, it is still far better to have a good layer of artificial snow than almost no snow at all. These preparations may include routing more hoses to spray water in different areas of the mountains.

With Insurance	Mean Profit	Probability
Light	\$604,750	20%
Typical	\$768,500	70%
Heavy	\$615,000	10%

- Expected profit: \$720,400
- Standard Deviation (with insurance): \$91,725
- The standard deviation for Mountain Meadows with insurance is \$91,725, and the standard deviation without insurance is \$251,711. Because the standard deviation without insurance is much higher, the resort should prefer going with insurance because their profits will be much more consistent (their profit variability will be much lower).
- The risk mitigation strategy described in the problem – that is, buying insurance – will help Mountain Meadows keep their profits within a smaller range. This means that they can always plan ahead for future investments and plans because they have a better idea about how much money they’ll receive from one season. This will also ensure that they do not lose as much money in light snow years because they receive \$100,000 from the insurance during those years.

Mission 5 - Team Project Proposal Prompt

- 5 - Project Proposal Prompt
 - A possible recommendation for risk mitigation is a well-being check to be able to use the self-driving feature. A possibility for this is a camera within the cabin to check the driver's fatigue or lack of attention to the road, which would address the mitigation strategy of evaluating drivers' state of mind.
 - One such metric would be cost. While systems to investigate the wellbeing of drivers may solve the problem, it may not be affordable for some people. There is a similar issue with insurance in that the money must be paid somehow; whether this was private insurance for the health of the civilians or public insurance for the town's infrastructure, the funding for the insurance bills has to come from somewhere, and it will likely be the people living within the area.
 - One potential pitfall of the strategy about evaluating drivers prior to their driving is that it's difficult to do. There isn't really a concrete method right now to do so. We could definitely come up with one, but as of the present time, there is not a good method to do so. Another issue is with the mitigation factor about targeting the quality of manufacturing processes. Without appropriate legal measures, it could be very difficult to get a company to let you into their factories to monitor these factors.
 - Overall, we hope that our project would lead to safer road conditions for all people, whether they are pedestrians or drivers, when self-driving cars are on the road. This is a crucial stage in the development of these vehicles because safety is always the number one priority when on the road. If people do not feel safe, the entire

transportation infrastructure will come crashing down because nobody will use the roads anymore.