-TEAM MEMBERS: Justin, Jared, Dylan, Max, Adnan

1. **Why might a customer consider buying a mobile phone warranty along with their new phone? What are the benefits of a warranty?**

   A customer may consider buying a mobile phone warranty in the event that something happens to their phone that causes damage or makes it no longer work. This gives an extra layer of safety and guarantees you'll still be able to keep your device without purchasing a new one.
   The benefit is that your phone is protected no matter what.

2. **Why might a customer think buying a warranty could be a bad idea when buying their new mobile phone?**

   They could be paying unnecessarily and wasting money if nothing ever happens to their phone. It also may seem like a lot of money to add to an already expensive device.

3. **What are some things the customer might want to consider in determining whether they should buy a phone warranty along with their purchase of a new phone?**

   If they are a clumsy person, how much the phone cost, how much the warranty costs, how much time they are going to keep the phone, if they have a case, how fragile the phone is, how long they plan to use it.

You are a consulting actuary brought in to support Alpha Co., an insurance company that is considering providing an insurance policy, or "warranty," to customers who purchase the new Zest phone. The new Zest 2 mobile phone cost $700.

4. **Alpha Co. is exploring creating policies that would replace a lost phone or repair a damaged phone. What are the main factors your company should consider in setting the policy price, or "premium," for your mobile phone warranty?**

The premium for a warranty including lost phones would have to be more expensive, as it is the user's fault for it being lost and isn't the result of the manufacturer. They must also consider the price of the phone, as completely replacing it loses inventory for a fraction of the price of a new device. For repairs, the company would have to also consider past records of breaking phones on a person-to-person basis. This is because there would be a higher chance of them breaking a phone in the future, meaning the premium must be higher.

5. **Alpha Co. has already sold insurance policies for the Zest 1 phone. The cost of the Zest 1 phone was $500. From those policies, they know that the average cost to repair the Zest 1 was $100. They also know the likelihood of Zest 1 customers losing or break their phones, as noted in the chart below. Using the data from the Zest 1 phone policies, what is the average, expected payout that Alpha Co. will have to pay on its Zest 2 phone policies?**

Cause of Loss	**Probability**
Replace phone due to extreme damage.	0.02
Replace phone due to loss or theft.	0.03
Repair phone due to damage.	0.45

700/5= 140 Repair cost of Zest 2

5% chance they have to replace * $700 = $35

45% chance they have to repair * $140 = $63

$35+$63 = $98

6. **What assumptions is Alpha Co. making in using the probabilities from their Zest 1 warranty policies to project the expected loss for their Zest 2 phone policies?**

They made the assumption that the repair cost is one-fifth of the cost of the phone. We are also assuming that the probabilities for repairing and replacing will be the same for Zest 1 and Zest 2.

Wow, this is actuary really good

7. Your boss at Alpha Co. wants to maintain a 20% profit margin on the insurance policies. Based on the expected loss calculation, at what price do you need to set your policy premium to meet this requirement?

$122.50

8. Is this an acceptable premium to meet your boss's 20% profit requirement on its Zest 2 warranties? What else should you consider in pricing the premium?

You should consider if there is an increased price of the Zest 2 repair/replace compared to the Zest 1.

9. The "Loss Ratio" for an insurance policy is the percentage of the policy premium that is paid out (or expected to be paid out) based on the policy terms. What is the Loss Ratio for Alpha Co.'s Zest 2 policy if the premium is set at $100?

98%

10. Alpha Co. has provided you with additional information about its expenses, including operational expenses, and a commission it expects to pay to Zest Phones for every warranty they sell through the Zest stores. Your boss tells you that Alpha Co. has operational expenses of $10 per policy and pays Zest a 5% commission on each policy. With this new information, what is the expected profit on a Zest 2 phone warranty?

((122.50*0.95)-10)-98 = $8.38

11. The "Combined Ratio" for an insurance policy is the sum of the expected loss and all of the expenses divided by the premium. What is the combined ratio for these Zest 2 phone warranties?

(98+10+(122.5*0.05))/122.5 = 0.932

Insurance companies may include Deductibles and Co-pays on policies. To help mitigate the possibilities of insuring high-risk policy holders. A Deductible is an amount the policy holder must pay before the insurance company will pay for losses. A Co-pay is a portion of the loss that the policyholder must pay for each loss, while the insurance company pays the remainder of the loss.

12. If you include a $10 co-pay on your Zest 2 warranty for any loss or repair, what is the new combined ratio for the policy?

(98+10+(122.5*0.05)-10)/122.5 =0. 85

13. Your boss at Alpha Co. has now asked you to determine what co-pay would allow them to have an 80% combined ratio (the equivalent of a 20% profit margin) on their Zest 2 phone warranty policies. What is this co-pay assuming you keep the premium at $100?

(98+10+(122.5*0.05)-c)/122.5 = 0.80 c=$16.13

(98+10+(100*0.05)-c)/100 =0.80 c=$33

14.Your boss at Alpha Co. tells you that they want to explore a $50 co-pay to help ensure the policy holders have enough "skin in the game" to affect their behavior and not let them be careless with their phones. He also wants to maintain a 95% Combined Ratio on the policy (the company's expected loss + expenses all divided by the premium). Assuming that the expenses remain at $10 per policy, and the commission remains at 5% of the premium, what is the appropriate Premium to charge in this situation?

(98+10+(p*0.05)-50)/p =0. 95

98+10+(0.05p)-50 =0. 95p

98+10-50 =0. 90p

58=0.90p

p=$64.45

Think of 3 social/society issues topics that interest you: 1. Racism 2. Wage Discrimination 3. Anti-Semitism	Think of 3 environmental topics that interest you: 1. Deforestation 2. Clean Energy (Electricity) 3. Air pollution
Think of 3 health/psychology topics that interest you: 1. Imposter Syndrome 2. Depression 3. Bipolar Disorder	Think of 3 topics of your choice that interest you that haven't fit into any other category or overflow: 1. AI and robotics 2. Accessibility 3. Aerospace Engineering

Topic	Possible Risks	What parties are at risk?	Risk mitigation strategies
Aerospace Engineering	- Combustion - Crashes - Overbooking - Broken luggage - Lost/Stolen luggage	- Pilots, - Passengers - Investors - Companies	- Correctly estimating when overbooking - Security checks for luggage - Locks for luggage - Cameras
Clean Energy	- Underproduction - Expensive - Malfunctions - Reliability - Bad weather conditions	- Energy production companies - Energy users	- Insurance - safely designed systems - optimal placement for energy production
AI and Robotics	- They take over the world - Unemployment - Misinformation - Malfunctions - Academic dishonesty	- Humans - Workers	- Unionization protecting jobs - Keeping them in check

Now, Alpha Co. Insurance has given you a little more information about their Zest 1 Phone policies upon which you're to base your recommendations for the new Zest 2 policies. The additional information is that female policy holders are slightly less risky than male policy holders. The breakdown of the probabilities for loss are included in the table below. The overall average is the same as before, but now there is additional information based on gender.

	Male Prob.	Female Prob.	Avg. Prob.	Cost of loss
Replacing due to extreme damage	0.03	0.01	0.02	$700
Replacing due to theft or loss	0.05	0.01	0.03	$700
Repairing phone due to damage	0.45	0.45	0.45	$100

15. **If the premium is kept the same at $100 for all policy holders, what is the difference in expected loss for the Zest 2 policies between male and female holders?**

$59 women

$101 - men

Difference = $42

16. **State in words how Alpha Co. could improve its pricing of the Zest 2 phone policies so that its Loss Ratio is the same for female and male policy holders?**

The Zest 2 phone policy should be increased for men to make the ratio between the expected payout and the premium the same for men and women.

17. **Your boss at Alpha Co. has recently learned that there is another insurance company, Bravo Co. that is going to offer policies on the Zest 2 phone. Bravo Co. is offering males a policy with a premium of $120, and offering females a policy of $80. If Alpha Co. keeps its policies for everyone at a $100 premium, what will happen to their customer base as more and more people choose between Alpha and Bravo Co. warranties?**

More males will choose to be insured by Alpha Co. and more females will choose Bravo Co.

18. **If Alpha Co. keeps the female policyholder premium at $100, what should the male premium be to have the same loss ratio?**
    We should raise the price for the men's policy to $171.19 in order to make the loss ratio the same for females and males.
19.
20. **If Alpha Co. wants to keep an 80% loss ratio on both male and female policies, what should the premiums be priced at?**
    Women - $73.75

    Men - $126.25

21. **Adverse Selection is when a company's policy holder portfolio becomes riskier over time. This happens when one company's policies are not segmented as well as another's. Adverse selection is bad for insurance companies because it means that higher risk customers are buying policies from them, and lower risk customers are buying policies from other companies. What other data could Alpha Co. use to help segment its policy pricing better and avoid adverse selection?**

- Past usage of phone insurance / history of needing repair/replace
- Case or tracking device (include in insurance package)
- Age
- Location
- Occupation
- Education

22. **Beyond policy segmentation, what else could cause adverse selection between two different insurance company policies?**

    Different data sources

- Advertising
- Product pricing

1.3

Topic: Airlines Overbooking

Directions: Find at least 3 sources with credible research, information, data, etc. related to your topic. Questions to consider for each source:

- What kind of information is in this source?
- How much data is available? Is there sufficient time frame or history to the data?
- Does this source address frequency or severity (or both)? You'll need at least one source addressing frequency and one addressing severity to be able to adequately quantify risk.

Source #1:

- Source Link: https://www.britannica.com/story/why-do-airlines-overbook-seats-on-flights

- Summary: Airlines overbook flights because empty seats aren't profitable, so they want to make the most money they can. They overbook to make up for the profit lost for cancellations and people who don't show up for their flights. The "no-show rate" helps airlines determine how many extra tickets they should sell. However, when airlines oversell tickets and there are more people than spots, they have to wait at the gate until passengers give up their spot for another flight or give them reward points or cash. If data suggests that an average of x passengers don't show up for their flight, then x amount of extra tickets will be sold.

Source #2:

- Source Link: https://www.getgoing.com/blog/why-do-airlines-overbook/#:~:text=The%20point%20of%20all%20this,most%20flights%20are%20undoubtedly%20overbooked.
- Summary: Travel experts estimate that for every 100 seats on a flight the airline sells 150 tickets. British Airways reported that a single oversold 500,000 seats and forced 24,000 passengers to rebook. Negative effects include United Airlines had to pay $140 million in compensation to a physician who had to be dragged off a plane; it hurt the company's reputation. 0.09% of all air passengers have to be rebooked due to overbooking.
- **In the U.S.** If you have to be involuntarily rebooked on a later flight that

gets you to your final destination within one hour of your originally scheduled arrival time, then you are not eligible for compensation. For a two-hour delay, the airline must pay you at least an amount equal to 200% of the single fare to your final destination that day or $775, whichever is less. For more than two hours (or four hours internationally), this compensation is 400% of the one-way fare or $1,550, whichever is less.

Source #3:

- Source Link: https://time.com/6197994/airlines-overbook-flights-negotiate/
- Summary: Airlines want to make sure that every flight is as full as possible in case travelers cancel their tickets at the last minute or don't show up—a common occurrence for airlines, since weather delays often force travelers to miss connecting flights. Airlines resort to overselling flights as a way to recover the costs of those empty seats.
- Between January and March 2022, 7,143 people who held confirmed reservations were involuntarily denied boarding from a flight because of overselling
- Roughly 34% of those travelers were flying on Frontier Airlines, 32% on Southwest Airlines and 14% on American Airlines, according to the latest Air Travel Consumer Report.

Proposed Research Questions For Study: List some open-ended but driving research questions you have about the topic.	**Research Questions:** 1. How do they calculate how many seats to book over the max per flight 2. What factors can make the amount of tickets they decide to sell more accurate? 3. How much do airlines make/lose each year on oversold flights? 4. How much should airlines overbook by so that loss can be minimized 5. How can flights pay less of a payout for overbooked flights (loopholes)

The first thing you are tasked with is to conduct some basic mathematical analysis of the reports the farmers gave. This will help us understand what has happened in the past 20 years.

https://docs.google.com/spreadsheets/d/1IEtc37z2lOzPamd6CSQErGuqd4OYEG_OK5uLFNfmpmE/edit?usp=sharing

1. Using the data from the past 20 years, calculate the probabilities of each type of weather that the farmers reported.

Total 42 typical weather, 6 storms, 12 dry / 60 days

42/60= 70% chance typical

6/60=10% chance storm

12/60 = 20% chance dry

2. Compare the average profits for each of the three farms across all years and all weather categories. Which farm had the highest average profit?

Barton had the highest average profit of 74.65

3. Compare the standard deviations of the profits for each of the three farms across all years and all weather categories. Which farm had the greatest variability?

Barton had the highest variability of 23.58

4. Is the farm with the overall highest average profit that you identified in question #2, the farm with the highest average profit for each type of weather? Identify which farm had the highest profits for each of the three weather types.

No, Barton doesn't have the highest average profit for each type of weather:

- Dry highest average profit - Abbington
- Storm highest average profit - Barton
- Typical highest average profit - Barton

5. Construct a 95% confidence interval for the mean profit for Barton Farm during typical weather years. What are the upper and lower bounds on the farm's profit for typical weather?

89 +- 1.442 (+-1.6%)

[87.558-90.442]

6. Calculate the probability of exactly two storms in the next ten years.

.1^2*.9^8*10*9 = 38.74 - .1^3*.9^7*10*9*8 = 4.305%

7. Calculate the probability of at least two storms in the next ten years.

.1^2*.9^8*10*9 = 38.74

8. Calculate the probability that the second storm from now will happen in the tenth year from now

.9^9*.1*9 = 34.87% * 10% = 3.49%

9. How quickly is each farm growing during "typical" weather years? Calculate the least-squares linear regression for each of the three farms' typical weather annual profits. Create a graph plotting the profits and the trend line for each of the three farms. Which farm is growing the fastest in typical weather years?

Abbington: 0.0133*x + 53.3 *$0.0133* each year.

Calistoga: 0.875*x + -1678 *$0.875*

Barton: -0.078*x + 246 *-$0.078*

Calistoga is growing the fastest during typical years.

10. All three farms indicated there were two stormy years over the past two decades (2004, and 2013). Which farm was affected by these storms the most? Using the expected values from your linear regression for typical weather, what was the average profit lost for each farm due to stormy weather?

Abbington

- Expected 2004: 79.9532
- Expected 2013: 80.0729
- Average loss: $59.51305

Calistoga

- Expected 2004: 75.5
- Expected 2013: 83.375

- Average loss: $63.4375

Barton Expected:

- Expected 2004: 89.688
- Expected 2013: 88.968
- Average loss for storm: $53.978

11. Use least-squares linear regression on typical weather years only to predict the profit for Calistoga Farm in 2020 (assuming that 2020 also has typical weather).

89.9

12. If the year 2020 has a 10% chance of being stormy, a 20% chance of dry weather, and a 70% chance of being typical, what is the expected value of each farm's profit for the year 2020? Use the average loss due to stormy and dry weather from the past 20 years to calculate the expected value of each farm's profit for 2020.

Abbington:

- Expected loss for stormy: $8.3375
- Expected loss for dry: $16.9084975
- Total expected loss: $25.25
- Expected Profit in 2020:$54.916

Barton:

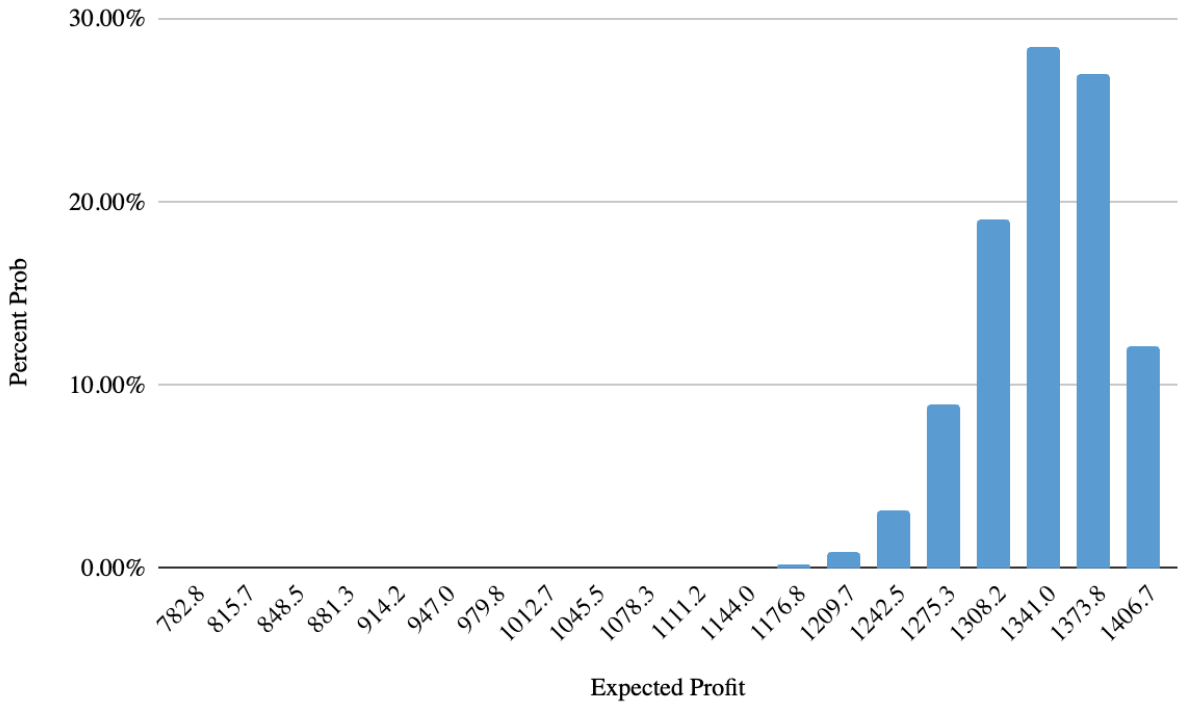
- Expected loss for stormy: $5.3978
- Expected loss for dry: $8.2667
- Total expected loss: $13.66
- Expected Profit in 2020: $74.78

Calistoga:

- Expected loss for stormy: $6.34375
- Expected loss for dry: $7.50625
- Total expected loss: $13.85
- Expected Profit in 2020: $75.65

In order to alleviate the risk from severe weather, Abbington Farm is considering an insurance company that offers an annual policy for a $3,000 premium that would pay $20,000 in case of a severe storm.

13. Construct a probability distribution for the expected profit using the average profit for the 20 years of historical data if Abbington Farm buys this insurance policy.



14. Calculate the expected value of Abbington's profit and the standard deviation of the expected profit with insurance.

0 Storms: 73.333*20 + 40.5 * 0 - 60 =1406.66

Average Non-storm = 73.33333333

Average Storm = 20.5 with insurance = 20.5 + 20 = 40.5

The standard deviation of Abbington's insurance profits is 10.18627378

The expected value of Abbington's profit is 67.05 thousand, which was found by multiplying each expected profit by the probability of that happening, summing it and dividing by 20 years.

15. For Abbington Farm, compare your answers to #2 and #14 and interpret the values for the different profits in context.

In #2, Barton had the highest average profit of 74.65

In #14, the expected value of Abbington's profit is 67.05

Barton was still found to have a higher profit than abbington even when abbington had insurance and barton did not.

16. For Abbington Farm, compare your answers to #3 and #14 and interpret the values for the different standard deviation calculations in context.

In #3, Barton had the highest variability of 23.58

In #14, The standard deviation of Abbington's profit is 10.18627378.

The standard deviation of abbingtons profit is much less than Barton's and its own values without insurance. This shows that abbingtons profit with insurance was much more consistent when it had insurance.

17. What is the expected profit for the insurance company on its policy for Abbington Farms?

For each storm they make 20,000, 3,000 per year over the course of 20 years is 60,000

-10% chance of a storm each year

Because the probability of a storm is 10% per year, there will be one expected storm per year. If the farm pays 3,000 for insurance for 10 years, the insurance will make $30,000. The insurance company will expect to lose $20,000 for the one storm over 10 years, so they will expect to make $10,000 every 10 years. The expected annual profit will then be $1,000.

18. Give a mathematical reason why the insurance policy could be considered a good idea by the farmer.

It could be considered a good idea mathematically as the odds of a storm happening, although constant at 10%, is relatively high and one year would result in very little profit. Having the insurance plan would protect the farm and ensure it doesn't lose as much money as it would without it. In the 28.52% chance that there were 2 storms over ten years, the farm would gain $10,000 from the insurance plan, as they would be paying $30,000 for insurance and gaining $40,000 from the storm insurance.

19. Give a mathematical reason why the insurance policy might NOT be considered a good idea for the farmer.

They are paying $30,000 every ten years, expecting to gain $20,000 in the one storm year. Therefore, Abbington Farm should expect to lose $10,000 in a typical 10-year cycle, or $1,000 per year.

1.4 Draft the Problem Statement

The problem statement should be no more than 100 words and must include information covering three items (See the Actuarial Process Guide and Data Sources Guide for examples):

1. What is the risk your project is analyzing?

2. Who is at risk?

3. What are the possible risk mitigation strategies you are evaluating?

Problem Statement:

We are analyzing the risks that airlines take when overbooking their flights. The airline company is at risk of losing money and reputation if there are not enough seats for everyone who booked a ticket. Meanwhile, the passengers are at risk if there are not enough seats on the plane and they are unable to reach their destination. The risk mitigation strategies we are evaluating include determining a safe amount of tickets the airline can overbook without losing money and calculating the probability that a passenger won't show up for their flight.

Mission One Ski resort Prompts

1.1 - Who is at Risk?

One group that is at risk for loss because of climate change affecting ski resort times are the skiers and snowboarders who plan on attending the resort. The ski resort customers will rent or buy their equipment and potentially reserve housing. If the ski resort ends up not opening, the consumers will lose money by not being able to use the equipment and housing that they paid for. Another group that is at risk is the vendors that sell things at or near the ski resort. These include nearby restaurants, hotels, and vendors who sell equipment. They would lose profits with decreased customers coming to the resort.

1.2

- Net yearly profit
- Snowfall
- # of customers
- # of employees on payroll
    - Part time vs full-time employees
    - Their wages

One way to measure risk is the net yearly profit, as a decrease in profit would represent a loss. As well, the number of customers will show how well the ski resort is doing. Snowfall can be a measure of risk as decreased snowfall results in a decrease in customers and the

amount of time the resort can operate. The number of employees can be measured as an increase in layoffs would show a loss. Also, a decrease in wages could show loss too.

1.3

Insurance would decrease the risk as if the resort paid a certain amount of money to the insurance company, their loss would be insured by the company and it would not be as much as if they did not have insurance. A behavior change would reduce risk as if skiers are more conscious about protecting the mountain, the resort could stay open for longer. As well, if skiers just come for food instead of to ski, they could make revenue even when the mountain can not be opened. Modifying Outcomes would decrease risk as the ski resort could take action to make snow.

Mission 1 Proposal Topic Prompt

- Our project will be to analyze and define the overbooking of plane tickets. This problem is important because airline companies lose a lot of money while making payouts to passengers that they do not have enough seats on flight to fit. As well, it is important to passengers as being removed from their flight can cause scheduling issues and cost the passenger a lot of time and money.
- The topic has seen a recent increase in popularity as videos and stories have gone viral on the internet detailing passengers who were forcibly removed from their flight, such as a doctor being removed from a flight to his patients in dire need of care by force.
- This topic affects all airline companies, as well as other businesses that rely on air travel or future space travel. Furthermore, it affects all passengers and customers who are refused their flight, and may have to take another flight at a later date.

- For airline companies, the risk would be the possibility of having to give payouts to passengers pushed out of their flights and a decrease in reputation and customer base. For individuals, they can be pushed out of needed trips due to the overbooking of plane tickets. As a worst-case scenario, if everyone who bought a ticket showed up for the flight, it can cause doctors (like in the example above) to miss out on treating patients in critical condition who are in desperate need of treatment or cause someone to miss out on a loved one's funeral. This would also

cause a loss of money for airlines, as they have to pay those pushed out of flights, and they run the risk of being sued if they push the wrong person out of a flight.

- Insurance: Airline companies could pay for insurance, so that they don't have to pay, or have to pay less money to passengers who are refused a flight. This would lessen this risk for loss.
- Behavior change: If less people book flights airlines would be overbooked less often. As well, if more people do not show up for their flights, airlines would have enough seats for everybody more often.
- Modifying outcomes: Airline companies could offer less seats to purchase per flight. This would avoid overbooking and having to pay passengers who do not show up.

https://www.transportation.gov/sites/dot.gov/files/2023-03/February%202023%20ATCR.pdf

https://www.transportation.gov/sites/dot.gov/files/2023-10/October%202023%20ATCR_0.pdf

Part 2:

Data Sources 2.1 Identify Data Sources

Some data sources may have already been identified in your background research. The links found on the Modeling the Future website under Data Sources have a well-curated resource of possible data sources. As noted in The Actuarial Process Guide, other potential data sources could include government resource websites, company resources, collecting data yourself, or industry associations.

The description of your data sources should be no more than 200 words.

● List the data sources you would consider using for your project.

● Describe the value you expect each data source will bring to your project.

● What will it help you determine in your analysis, how will it help you characterize your risks, or how will it help you evaluate risk mitigation strategies?

List of Data Sources:

- https://www.transportation.gov/sites/dot.gov/files/2023-10/October%202023%20ATCR_0.pdf page 41-43
- https://www.transportation.gov/sites/dot.gov/files/2023-03/February%202023%20ATCR.pdf page 51
- https://www.transportation.gov/sites/dot.gov/files/2023-01/December%202022%20ATCR.pdf July-Sept 2022, page 45

Data Sources Description

- Our data is coming from the United States Department of Transportation. They post their Air Travel Consumer Report in which they outline different metrics measured about consumer air travel. In these documents, they include a section on overbooking and specific statistics about the number of people denied boarding in different scenarios.
-

Mission 2

2.1

1. By how much is the snow decreasing each year
2. Ratio of skiers spend at the resort per year
3. How many skiers attend per year

2.2

1. Which of the five data types identified in the Actuarial Process Guide are provided in this dataset and what valuable information is the data able to tell us?

   Data that defines historical trends

Data that separates potential outcomes

Data that defines the severity of potential losses

2. What additional data would be valuable in conducting a risk analysis and mitigation project for this scenario?

   Number of skiers per year. Snowfall rate and amount. Prices for admission.

2.3

1. Ski resorts are super cool and awesome. n represents the sample size of the data. Categorical or numeric data represents whether the data is measuring numeric values or values that are classified as one type of thing or the other. The center of the data can be measured based on m
2. mean, and median, depending on whether or not the data is skewed. The spread can be measured based on standard deviation or range based on the data given and if the data is skewed or not.

Plotted graphs and charts help visualize the data, show the spread of data, and can show you which type of measure of center to use. It also can help you to see how different values are categorized and the percentage present of each value.

Mission 2 Team Topic Prompt

1. Research questions that we need to mitigate the risk of Airplane overbooking payouts
   a. How much do airlines lose each year because of removed passengers?
   b. Are there any trends in the number of passengers that have been removed from their flight?
   c. Are certain flights more likely to have cancellations?
   d.
2. An ideal dataset would include profit for each major airline How much each flight is overbooked, How many passengers had to be removed from a plane, payout amounts to the removed passengers, total profits, and removal frequency

   https://www.transportation.gov/sites/dot.gov/files/2023-10/October%202023%20ATCR_0.pdf page 41-43
   https://www.transportation.gov/sites/dot.gov/files/2023-03/February%202023%20ATCR.pdf page 51

https://www.transportation.gov/sites/dot.gov/files/2023-01/December%202022%20ATCR.pdf July-Sept 2022, page 45
https://www.usatoday.com/story/travel/columnist/2023/05/10/airline-overbooking-bumped-flight-cruising-altitude/70199667007/

3.
   a. One data source is the department of transportation, as they give data on airline profits, passenger overbooking, and profit loss. This is a credible source because it comes from government reports. It defines historical trends and defines severity of losses. Another data source is . The source shows how much payouts are for the passengers removed from their flights. It defines the severity of losses . 098
   b. The other data source is USAtoday because they give data on how much airlines are required to pay passengers if they are overbooked. This is a credible source because it is a reputable news source.

Mission 3 Model

3.1

This provides a bunch of Research Articles. Some keywords provided are Ski tourism, Climate change, Internal climate variability, Large-ensemble, Snow modeling, Ski Areas, Regional Climate, Simulations, Meteorological parameters

Some of the mathematical concepts used are several different kinds of graphs, tables, maps. Flowcharts were also used.

It was helpful to look at what mathematical papers look like and the different kinds of techniques we can use for our project. Everything was comprehensible with our math levels.

3.2.1.

Typical = 42/60 = 70% probability

Light = 12/60 = 20%

Heavy = 6/60 = 10%

3.2.2.

Alpine Arena:

Typical: 786

Heavy: 1116

Light: 450

Mountain Meadows:

Typical: 886

Heavy: 945

Light: 482

White Haven:

Typical: 799

Heavy: 645

Light: 505

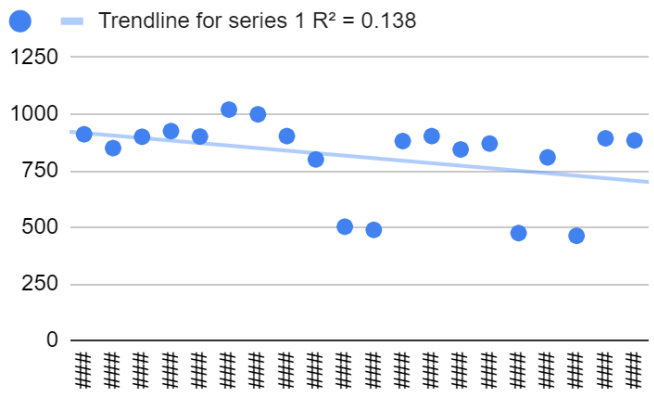
3.2.3.

Alpine Airline: 822

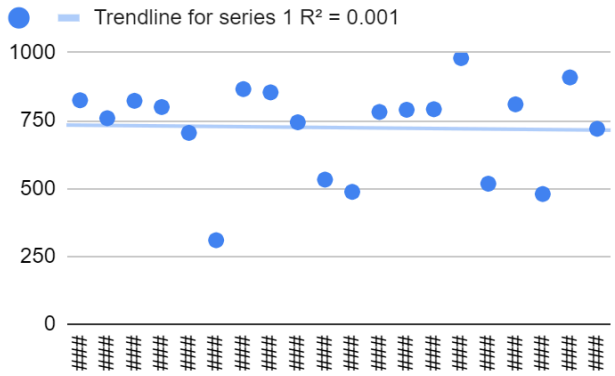
Mountain Meadows: 868

White Haven: 800

Alpine Area



Mountain Meadows



White Haven

Mountain Meadows seems to have a much more decreasing rate in profits, so it might be in a riskier profit projection than the others.

We assume that during heavy snowfall, people are more likely to go to

Mission 3 Team Topic

https://docs.google.com/spreadsheets/d/181_lkrOvlledjAIczgXYm2yS2H03XKN7OZq9Yg60vds/edit#gid=0

Airline overbookings

3.1. Most of our data is from official government transportation reports, since it is a credible source and contains lots of valuable information. Some helpful models we could use are graphs and charts.

What kind of results, published papers, and credible literature does this yield?

It gives us equations and useful diagrams/graphs to help us envision our mathematical model. They also show us how other people went about tackling this problem and provide more background information in the abstract and introduction sections.

What are some keywords used in the articles you find?

Booking level - the upper bound for reservations that minimizes expected costs

Bumping - term used for kicking passengers out when airlines overbook.

No-shows - Passengers who fail to show up to their flight with no notice or cancellations

Overbooking - The sale of more tickets than available seats

What is helpful in what you found? What was unfamiliar or beyond the math you are familiar with?

It was helpful to see examples and gain more ideas about how we will create our model. It was also helpful to learn more background information on the current systems in place and the reasons why airlines overbook. Some of the math equations are very complex and would require us to do further research on them.

What kind of mathematical analysis seems to be fruitful to pursue in the Project Pase for your proposed topic.

Graphing the potential profit of the airline. The graph shows more tickets will increase revenue, but eventually they will lose money as they have to compensate bumped passengers.

Provide a summary of your findings with links and identify how this informs your next steps in mathematical analysis

They taught us mathematical methods to use to calculate the probabilities of everyone showing up for flights and the odds that someone will have to be paid out. It also taught us how to break down the overarching problem into sections that help us understand each aspect independently. We also learned distributions we can use to represent our data.

https://math.stackexchange.com/questions/2426604/binomial-probability-of-airline-overbooking

https://online.hbs.edu/blog/post/why-airlines-overbook-using-toy-models-to-maximize-revenues

https://www.jstor.org/stable/25767604?seq=1

Describe what you hope a mathematical model would be able to do for you? How could it help you identify the frequency & severity of risk and the changes over time or other elements that will help you characterize risk?

A mathematical model should be able to provide a binomial probability distribution of expected profit produced by various plans of controlled overbooking so that we can determine which plan would yield the best average expected profit.

4.1 Risk Mitigation

In the brainstorming and research that you completed in Part 1: Project Description, you've already identified risks, parties affected, and possible risk mitigation strategies. Your problem statement was more geared toward the general topic description and risks associated. In the project phase of the MTFC, the risk mitigation strategies will inform and guide the recommendations made in the concluding sections of the project. The recommendation is "the whole point" of the project as completing work without actionable recommendations is not useful in the real world. For the proposal, you are identifying (at a high level) what risk mitigation strategies you anticipate studying in greater detail - you will not be making recommendations yet in the proposal. This is a roadmap helping you identify where you should go with the project where you will be making recommendations.

The description of your risk mitigation strategies should be no more than 200 words.

● Describe the potential risk mitigation strategies that you think your team will evaluate for your project.

● Descriptions should be high-level to show a general concept of what possible strategies you have identified.

To reduce the risk of airline companies having to pay out money to remove passengers because of overbookings, this mathematical model will identify the likelihood of having to remove a passenger from a plane based on the number of tickets sold and the number of the seats each airplane has available. The model will also find how much money airlines lose in proportion to the number of tickets sold greater than the number of seats on the flight. Using that information, it will calculate the optimal amount of overbookings to make as much of a profit as possible and reduce the losses at a maximum (modifying outcomes). We will also mitigate risk by finding the optimal way to compensate removed passengers while abiding to federal regulations and minimizing loss. We will mitigate risk by finding the optimal amount to charge passengers who do not show up for their flight and how this will affect the frequency in which passengers do not show up for their flight (behavior change). These statistics will be found out using the data provided to us by our sources which will tell us no show frequency, monetary loss, payout rates, and bumping frequency for different airlines.

-"Change your flight and get up to $200 back" - Mrs. Burns

4.1 Quest Mission

In 3-5 sentences, address the following and explain your reasoning: •

- Are there any significant outliers in atypical snowfall years?

Yes -310 is an outlier because it is significantly less than other heavy snowfall years, which are around 1,000.

• If yes, what could be an explanation for this profit outlier in light of the snowfall? Does this outlier affect all ski resorts equally? Justify your explanation logically and mathematically.

It could be an unusual amount of snow that they get that year, so their profit will be different from typical years. There could also be other external factors, such as user preferences, competition, and malfunctions with the ski resort.

• If no, explain why not and offer a logical and mathematical case for your reasoning.

There are outliers, so the answer is yes.

4.2 Mission Quest

4.2.1: Consider the probabilities computed in Prompt 3.2.1 regarding Mountain Meadows.

Typical = 42/60 = 70% probability

Light = 12/60 = 20%

Heavy = 6/60 = 10%

• Are these probabilities providing insight into the frequency or the severity of loss? Why? What does this tell you about the distribution of risks? Provide a logical and mathematical explanation in 1-2 sentences.

These probabilities show how often you should expect to have each type of snowfall per year. Lighter snowfall will result in a lower profit, while heavier snowfall will increase the profit. Using the probabilities for each type of snowfall, you can imagine the probability of having a typical, lower, or greater profit in a given year.

• 4.2.2: Consider the mean profits at Mountain Meadows computed in Prompt 3.2.2.

• Are these mean profits providing insight into the frequency or the severity of loss for Mountain Meadows? Why? What does this tell you? Explain in 1-2 sentences.

These mean profits provide insight into the severity of loss for Mountain Meadows because they show the differences in profits between light, typical and heavy snowfall. When there is lighter snowfall, there is expected to be slightly more than half as much expected profit.

• 4.2.3: Consider the expected value of PROFITS for Mountain Meadows computed in Prompt 3.2.3.

Alpine Airline: 822

Mountain Meadows: 868

White Haven: 800

• Since Mountain Meadows did not report negative profits in any given year, what is a measure of "loss"? How can you define loss for a resort even when they have positive profits? Explain in 2-3 sentences.

You can consider a “loss” when the profit is less than the expected mean profit. This means that the ski resort made less money than they usually would, showing that they “lost” money that year.

We believe modifying outcomes to be the most viable system to prevent losses due to overbooking by airlines. This is because insurance requires payment by airline companies, which could further losses, and behavior change doesn’t seem as viable as people have flights they must take and it would be difficult to deter people from taking flights. This does not really change our perspective on the approach as we were already leaning toward this solution path.

If no interventions are made to the airline booking system, airlines will continue to overbook flights and have to pay much more than they were paid for tickets. This will result in the airlines beginning to operate at a much lower window of income than possible. Our hope with our risk mitigation strategy is to lower the losses incurred by airline companies and the inconvenience on customer’s behalf as they are pushed out of their seats.

https://docs.google.com/spreadsheets/d/181_IkrOvlledjAIczgXYm2yS2H03XKN7OZq9Yg60vds/edit?usp=sharing

Mission 5 ski resort prompt 5.1

- Currently, Mountain Meadows is losing money each year, at an average rate of $11,000 of loss per year. This is seen through our trendline, which can be used to predict an estimated income for Mountain Meadows each year. With no intervention, Mountain Meadows will continue to lose $11,000 per year.

Mission 5 ski resort prompt 5.2

- Risk Mitigation Strategy: Behavior Change
    - 3 Behavior changes that could be incorporated by Mountain Meadows to help reduce their loss in profits due to Global Warming are: a fine given to people who pollute the mountain, more sustainable packaging, and a mountain bus or encouraged carpooling to reduce the carbon footprint of everyone using cars to get to the mountain
    - Possible drawbacks to using the suggested methods to reduce pollution are that it is going to be hard to force people to pay if they pollute, and extra staff will have to be hired, which can cost more money. Also, having more sustainable packaging may be more expensive than the current packaging. Finally, having a Mountain Bus means drivers will need to be hired, as well as paying for fuel and other expenses. Furthermore, having to organize times and go to places far away will not be efficient.
- Risk Mitigation Strategy: Modifying Outcomes
    - Things that Mountain Meadows could do to keep their profits is fabricate snow. They could have places to collect water each time it rains instead of snow and make snow out of it. Another way to modify the outcomes is by offering other activities like climbing, snowshoeing, hikes, etc.
- Risk Mitigation Strategy: Insurance
    - Insurance would benefit Mountain Meadows by protecting the company from consumer injury, as well as the land and buildings on the property from excessive snowfall that could cause damages. These damages or injuries would be expensive for the resort to pay out of pocket, so a lack of insurance could bankrupt or cause severe losses to Mountain Meadows.

Mission 5 ski resort prompt 5.3

With Insurance	Mean Profit	Probability

Heavy	915	0.1
Typical	855.9285714	0.7
Light	552.5	0.2

- WITH INSURANCE: Expected value = 801.15 Standard Deviation = 134.12057075632

  WITHOUT INSURANCE: Expected Value = 799.12 Standard Deviation = 171.855542535

- The expected value with insurance is slightly higher with the insurance, meaning that the cost for buying the insurance every year as you will make money with the money the insurance company provides. Standard deviation is less when you have insurance, meaning that profit is more consistent with insurance and they are not losing as much money.
- It addresses the risks for Mountain Meadows by increasing their expected profit across all years and providing more consistent profit so that some years the resort is not short on money.

Mission 5 Airline Bookings

Risk Mitigation Strategy: Modifying Outcomes

- 2 ways to modify outcomes are to offer fewer seats to purchase per flight. This would result in less chances for the flight having more passengers than seats. Another way to modify outcomes is by charging customers who do not show up for their flights. This would incite passengers to show up and would provide more money for the airline company if they don't show up because they'll have to pay for their ticket and the no-show fee.

Modifying outcomes is the most fruitful option as it will allow airlines to limit the out-of-pocket payments involved with the overbookings of flights, as well as the splitting up of passenger groups.

When deciding which risk mitigation strategy to use, we needed to analyze which provided the most upside and least downside for the airline, as we are looking at this problem from their point of view. Insurance may not work very well as it would require a higher ticket payment for customers so airlines can cover the cost, resulting in fewer bookings for that airline company. Behavior change may not work well either as we would charge customers if they don't show up to their flights, causing fewer bookings from customers. For an alternative behavior change, we could pay customers who do show up

to their flights, but this would require an even higher charge so this mitigation strategy is not one we should move forward with.

- Possible drawbacks to offering fewer seats to purchase per flight are that planes might not be full, which would result in less profit being made per flight and having to pay for the same amount of fuel for flights that are and are not full. Possible drawbacks to making passengers pay when they don't show up to their flight is having to charge them, and that people might be less likely to want to go with that certain airline

Hopefully, this model will recommend the optimal number of tickets to be sold per flight according to the number of seats on the plane and make airline companies lose less money. If airline companies follow this model, they will be able to maximize their profits by having the most number of passengers on each plane flight and minimize their losses because of not having to pay passengers who are denied access to their flight and maximizing the use of fuel. Additionally, this model will improve the overall quality of air travel for consumers by minimizing the number of passengers removed from flights.