2019-20 Project Guide

A program of The Actuarial Foundation

Modeling The Future Challenge
2019-20 MTF Challenge Project Overview

During the Project Phase of the Modeling the Future Challenge teams that have passed the qualifying phase create their own modeling reports related to this year's theme: agriculture, water, and climate change.

Teams identify a project topic, define the best data sources, develop mathematical models to project future trends, identify risks, and write recommendations. Teams are supported by an actuarial mentor who will provide advice and guidance to the students. The project phase results in the submission of the team's report through the online competition portal.
The 2019–20 Modeling the Future Challenge is conducted in three phases. The first phase is a qualifying program to help ensure that all teams moving forward have the adequate mathematical knowledge to be successful. The Project Phase is the main program where students complete their own self-directed research and reports. The final phase is the concluding in-person symposium and awards ceremony.

1. Qualifying Phase: Scenario Response Topics

3 scenarios are posted; however, teams only need to respond to one scenario to qualify. Each scenario includes between 20-30 questions in four sections:

- **Level 1 is “Mathematical Basics”** and includes questions covering fundamental mathematics related to actuarial science primarily in areas of statistics and probability.
- **Level 2 is “Projecting Trends”** and focuses on modeling future trends based on existing data. Questions include higher level math modeling techniques including statistics and probability to project future trends and correlations between data.
- **Level 3 is “Analyzing Risks”** and highlights questions requiring students to identify and quantify risks from the data set.
- **Level 4 is “Making Recommendations”** and includes questions that require logical reasoning and critical thinking to analyze risk and make a recommendation about how an organization should respond to the projected trends and risks.

2. Project Phase: Research and Reports

Teams qualified for the Project Phase are invited to submit a “Modeling the Future Report” in which you will research the data, make a mathematical model projecting future trends, identify and characterize risks, and make recommendations on how to respond to them. Actuary mentors will meet with the teams for two 1-hour sessions (virtually) to guide their teams on this process. The full details about these sessions are in the Mentor Process Timeline on the following page.

3. Finalist Phase: Symposium Presentations

All Finalists will have additional time to update their report and prepare for the MTF Symposium presentation. MTF Finalists will then attend the Symposium and present live in front of a panel of expert judges. Judges will review teams and select the MTF Challenge’s “Modeling the Future Scholars” who will receive the scholarship awards.
The 2019-20 Modeling the Future Challenge theme is *Agriculture, Water, and Climate Change*. Changing temperatures, droughts, floods, and other severe weather events will cause major upheavals to many industries across the country, but perhaps none more so than the agricultural industry.

According to the US Department of Agriculture (USDA), the agricultural industry accounts for approximately 40% of our nation’s water use (but significantly more in some western states). Many groundwater and surface reservoirs across the US are becoming increasingly depleted due to over extraction of water and not enough precipitation to replenish them. Some farms across the western US have already had to cut the number of crops they are producing due to a lack of water availability.

At a high level, teams are responding to this challenge statement:

*How will climate change and water access affect the agricultural industry in the coming decades? What insurance or public policy changes could help mitigate or respond to the projected risks to the industry?*

Teams are tasked with analyzing historic crop insurance data and making mathematical models to project how changes to climate and water access could affect the agricultural industry in a region of the country they select. Teams then analyze the risks they have identified and make recommendations on how the industry and government can respond to help mitigate and manage the potential risks.

**Review these pages of the website for additional information:**

About the Theme:  
https://www.mtfchallenge.org/how-it-works/theme/

About the Data Sets:  
All teams accepted into the Project Phase of the competition are connected with an actuary mentor to help guide the team in creating their project. Actuary mentors are very valuable at providing high-level guidance and advice to help your team get on a good path; however, do not expect the mentors to do the work for you. Mentors serve as guides to help you understand what kinds of questions to ask and what kinds of mathematics and analysis might be valuable in a project like you are proposing. Mentors are not experts in the data sets provided, but all mentors are experts at the actuarial process and report structure for your project. Mentors will provide guidance and feedback, but will not provide exact step-by-step instructions to the team.

1. **Introductions – December 12th to 22nd, 2019**
   The MTF Challenge staff will send an introductory email to the teams and mentors. Team members should then follow up with their mentor to setup their first meeting in early/mid January.

2. **First Meeting – December 15th to January 13th, 2020**
   Your first meeting with your mentor (most meetings are done virtually) will focus on helping you get started. Your team should prepare a set of questions that you hope the mentor could assist you with. Having a project topic in mind by the time you have your first meeting will also be very valuable. Ask the mentor questions to help you create a good process and structure for your project. Make sure to coordinate an appropriate time for this meeting with your mentor.

   Submit a draft of your report to your mentor. Mentors will then be able to review this to provide you feedback and guidance during your second meeting. Having specific questions about sections of the report you would like guidance on will be helpful for their review. If you are not sure you have calculated risks properly, mention that. If you are concerned about the mathematical model, mention that. This will help your mentor provide valuable feedback.

4. **Second Meeting – February 3rd to 17th, 2020.**
   The second meeting with your mentor will focus on reviewing your draft report including the data sources, mathematical methodology, risks, and recommendations you are exploring. Mentors will give guidance on what may be missing or need more work to help improve your report. Make sure to coordinate a time for this meeting with your mentor early. Get it set on both your calendars so you can plan ahead!
There are four main parts to the MTF Challenge project that teams should work through. However, this is not a linear process. Many teams will need to change their project topic, or the questions they are focusing on as they learn more about the data. You will start by identifying your own project topic within the theme and then begin the process of researching the data, building your models, and conducting an analysis.

**Part 1: Background Research and Project Selection**

First frame your project by selecting a specific agricultural region of the country and a specific crop(s) or livestock(s) in that region to study. Make sure you have a well-defined topic for your project and that you are not trying to tackle too much by studying too large of an area, or too many crops or livestock in the region. Having a well-defined research question upon which you can build your project will help you get started. For example, a research question could be something like, “how is the expected climate change going to affect grape and wine production in California’s central valley?”

**Part 2: Data Analysis and Mathematical Modeling**

Teams must use the USDA RMA’s crop insurance data in their project; however, there are also several “supporting data sets” provided on the MTF website’s data sources page. Use as many or as few of these sources as you like. You should consider questions like what types of agricultural data might correlate with various climate factors (precipitation, heat, max temperatures, min temperatures, drought index, etc) in your region. You should also identify from existing climate forecasts how scientists expect these factors to change in the future and explore how that would affect the USDA crop insurance data for the future. You will have to make some assumptions and focus on a few relationships to build your models upon. Remember not to try to do too much!

**Part 3: Projecting Trends and Quantifying Risks**

Once you have developed a model defining the potential relationships between climate factors and agriculture for your project, start to project the future trends and quantify risks to the agricultural industry based on the potential losses in the future. Teams must include analysis of the USDA Risk Management Agency’s crop insurance data to help quantify your risks.

Use your mathematical models to quantify the severity, frequency, and probability of future losses to the agricultural industry due to changes in relevant climate factors. This part of the project should result in projecting trends in agricultural production and/or expected losses through 2050 based on the expected changes in the climate for your project’s region.

**Part 4: Making Recommendations**

The final part to the project is to make recommendations to help the agricultural industry in your region mitigate or otherwise manage the expected risks. You must identify what can be done in two areas: (1) insurance, and (2) public policy to either mitigate the risks or make opportunities from them.

The final recommendations are to be written as though the team is addressing the United States Department of Agriculture’s Risk Management Agency and should identify specific, quantifiable recommendations to help the agricultural industry in their region.
Reports must identify at least one factor of climate change or water access that teams believe, through their analysis will affect the agricultural industry in the region they are studying. You must characterize that change through mathematical models and make recommendations on how organizations affected by the change should respond to it.

**Report Structure:**

Reports are 25 pages maximum and must be organized following this structure.

1. **Title Page (not included in page count)**

2. **Introductory Sections (3 pages max):**
   - **Executive Summary.** A 1 page write up summarizing the key points of the material in the report.
   - **Background Information.** A section that describes information about the theme of the report and includes background information on what is known about the topic and datasets.

3. **Modeling Sections (12 pages max):**
   - **Data Methodology.** Descriptions of what data was used and why.
   - **Mathematics Methodology.** Descriptions of how the mathematical model was developed, what is the model, what math was used to project the future trends.
   - **Results.** Descriptions of the resulting analysis from the model. What were the results of how the data projects future trends? What are the probabilities, likelihoods, etc. of what will change in the future based on the model?

4. **Analysis Sections (10 pages max):**
   - **Risk Analysis.** Description of what risks may be associated with the projected changes in the future. What organizations may be at risk? Why? And How? What are the risks, can they be quantified based on the projections from the model?
   - **Recommendations.** Description of how the organizations with risks associated with the projected changes could best adapt to the changes. How can the organizations either (1) best mitigate the risks (i.e. changes to insurance policies, government regulations, or corporate procedures), or (2) create opportunity from the projected changes.

4. **References (not included in page count).**

Review this page of the website for additional information on the project process and report structure:

https://www.mtfchallenge.org/how-it-works/project-process/
Data for this year’s challenge is abundant and one issue teams may face is how to not get overwhelmed with the amount and diversity of available data. To help with this we have organized data into “Primary Sources” and “Supporting Sources.” The Primary Data Set is required to be used in all MTF Challenge Projects. The Supporting Sources are optional and you may determine on your own whether you want to include them in your analysis.

**Primary Data Set: USDA Risk Management Agency**

The Risk Management Agency of the USDA provides publicly accessible information about federal crop insurance policies including details on cause of loss, liability, subsidy, indemnity, and more. MTF Challenge Teams should use this information to model how future losses could be affected by changes in the climate or water access.

**Supporting Data Sets:**

Several data sets have been identified to support this year’s Modeling the Future Challenge projects. The most important of these that most teams will probably use is the background data about climate change forecasts. You are not expected to model any climate change factors yourself, but you should rather take information from existing forecasts to help make your own models about how the USDA RMA data might change in the future based on the forecast changes to the climate.

Review this page of the website for additional information about the data sets and tutorials on their use:

Suggested Team Process

We recommend following this process for submitting your project report. However, it is important to note that this is not necessarily a linear process. Some teams may find that after searching the data sources, you may want to go back and redefine the climate change or water factors that you think will have the most impact on agriculture in their region. Or after doing some analysis you may realize you need more data or different data from the crop insurance information. Each of these steps is important to creating a competitive report for the MTF Challenge; however they are not specific requirements. Do what works best for your team.

1. **Define the Question.**
   First, identify what region and crops or livestock you are most interested in researching and analyzing. You should be able to come up with questions about how existing climate change forecasts may affect agriculture in that region. Make sure to have good questions or hypotheses down before you dive into the data.

2. **Identify Data.**
   Strong data is key to a successful submission to the Modeling the Future Challenge. We have provided suggestions to help get started, but don’t feel limited to these links. Understand what data is valuable to answer the questions you have posed. You do not need to use all types of data; it is more important to have a good reasoning to tell the right story than just using a lot of data and math.

3. **Do the Analysis.**
   Create mathematical models that project trends and changes to potential agricultural production for your project topic. Use the USDA RMA crop insurance data to quantify potential crop losses in the future. Identify what mathematics and what data you should use to create the best model for what those changes and risks will be.

4. **Make Your Recommendations.**
   Does the data show that there will be certain negative effects for any type of business, government agency, or people? What could be done to mitigate those effects? How would the insurance industry, government, or agricultural sector respond to these expected changes in the future to help mitigate the risks?

5. **Write the Report.**
   Finally, after you have completed the analysis and identified the risks and recommendations you would make, you will be ready to write your report. The reports should be clear and concise to tell a strong story about the future changes you have modeled, the risks you see to the industry, and the recommendations to mitigate those risks.
Challenge Timeline

Preliminary Milestones

• Throughout August – Educator Virtual Training Grant sessions
• August 22nd – Educator Introductory Webinar 2
• September 23rd – Registration Opens
• November 22nd – Registration Closes

Scenario Response Milestones

• September 23rd – Scenario Responses released
• December 6th – Scenario Responses due
• December 13th – Scenario Response reviews complete and semi-finalists announced.

Research & Report Milestones

• December 13th – all mentors connected with teams.
• January – Team Mentor meeting 1 (exact dates to be determined between the team and mentor)
• February – Team Mentor meeting 2 (exact dates to be determined between the team and mentor)
• February 28th – Reports due
• March 16th - Judging concludes and finalists announced.

MTF Symposium & Final Presentation Milestones

• April 17th – Finalist report updates due.
• April 23rd - April 24th – MTF Symposium and final award recipients announced.
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The mission of The Actuarial Foundation is to enhance mathematics education and financial literacy through the talents and resources of actuaries. Its’ vision is an educated public in pursuit of a secure financial future.

The Modeling the Future Challenge is the cornerstone educational program of the Foundation. Built upon two years of pilot programs, the MTF Challenge is now poised to become one of the premier academic competitions for high school students. In 2016, the Foundation engaged the Institute of Competition Sciences – a leading academic challenge design firm – to help make this vision a reality and ensure that the MTF Challenge has a lasting impact on students across the nation.

Learn more about The Actuarial Foundation and the MTF Challenge at:

www.actuarialfoundation.org
www.mtfchallenge.org

For questions about the MTF Challenge or project process:

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