2024 International Mathematical Modeling Challenge (IM²C)®

The 10th annual International Mathematical Modeling Challenge (IM²C)® culminated with two Outstanding Teams. Congratulations to these teams and all the teams that participated in the 2024 contest. IM²C sponsored a Summit and The 2024 Awards Ceremony in China Hong Kong (SAR).

The IM²C continues to be a rewarding experience for students, advisors, schools, and judges. A total of 68 teams, with up to 4 students each, representing 38 countries/regions competed in this year's international round.

The purpose of the IM²C is to promote the teaching of mathematical modeling and applications at all educational levels for all students. It is based on the firm belief that students and teachers need to experience the underlying power of mathematics to help better understand, analyze, and solve real world problems outside of mathematics itself—and to do so in realistic contexts. The Challenge has been established in the spirit of promoting educational change.

For many years there has been an increased recognition of the importance of mathematical modeling from universities, government, and industry. Modeling courses have proliferated in undergraduate and graduate departments of mathematical sciences worldwide. Several university modeling competitions are flourishing. Yet at the school level, even amid signs of the growing recognition of modeling's centrality, there are only a few such competitions with many fewer students participating. One important way to influence secondary school culture, and teaching and learning practices, is to offer a high-level prestigious secondary-school contest that has both national and international recognition. With this in mind, we founded the International Mathematical Modeling Challenge (IM²C) in 2014 and launched the 1st annual Challenge in 2015.

The IM²C is a true team competition held over a number of days, with students able to use any inanimate resources. Real problems require a mix of different kinds of mathematics for their analysis and solution. And, real problems take time and teamwork. The IM²C provides students with a deeper experience of how mathematics can explain our world, and the satisfaction of applying mathematics to a real world problem to develop a model and solution.

Plans for 2025

We invite countries to enter up to two teams, each with up to four students and one teacher/faculty advisor. The contest will begin on February 3 and end on April 28. During that timeframe, teams will choose five (5) consecutive days to work together on the problem. The faculty advisor must then submit the paper and certify that students followed the contest rules.

The International Expert Panel will judge the papers in early June and will announce winners by late June. Papers will be designated as Out-standing, Meritorious, Honorable Mention, and Successful Participant with appropriate plaques and certificates given in the name of students, their advisor, and their schools.

Plans for the 2025 awards are still being finalized. Complete information about IM²C is available at **www.immchallenge.org**

IM²C Funding

Funding for planning and organizational activities is provided by IM²C co-founders and co-sponsors: *Consortium for Mathematics and its Applications* (COMAP), a not-for-profit company dedicated to the improvement of mathematics education, and *NeoUnion ESC Organization* in China Hong Kong (SAR).

The IM²C International Organizing Committee

The 2024 IM²C Problem: Picking the Perfect Pet

Background

Throughout history, humans and animals have coexisted, relying on each other for aid and comfort. Fromoffering companionship, to serving as hunting partners or providing other manual labor, our connection with animals runs deep. Recent estimates suggest that more than half of people worldwide have a pet of some kind in their household, from the more conventional dogs and cats to birds, rodents, and even the more exotic species such as snakes and amphibians. Whether they walk, fly, swim, or crawl; furry, feathered (orscaled) friends continue to support and comfort people across the globe.

During the height of the COVID-19 pandemic, countries and regions around the world saw a substantial increase in the number of households with pets, highlighting the comfort and companionship pets offer in challeng- ing times. The surge in pet ownership, however, also underscored the com-plexities of pet-human relationships. Unprepared or uninformed new owners often lead to pets being returned to shelters orabandoned, contributing to the substantial number of stray animals across the world. This leads to potentially difficult living situations for the animal while also posing health risks to humans and other animals.

Your Task:

The International Mission for the Maintenance and Care of Animals (IMMC-A), an organization concerned with the well-being of all potential pets, is asking your team to help them develop a quantitatively focused approach to pet ownership that benefits both animals and humans. More specifically, the IMMC-A needs your assistance in building mathematical models to determine which households are prepared to own a pet, how many households are pet-ready, and to forecast future pet ownership.

The IMMC-A acknowledges the diverse range of animals considered pets across

different cultures, including species traditionally seen as farm or work animals in some countries/ regions. This diversity presents unique challenges in defining what constitutes a pet. Therefore, your team will need to establish a clear definition of 'pet' that will inform your analysis and modeling.

1. **Warm up** (with cats). Develop a mathematical model that can be utilized by an animal shelter, pet store, or similar entity to evaluate a house-hold's readiness for cat ownership. In other words, your model needs to be able to receive information from a given household and determine if the household is prepared to own a cat.

   [Please note that the IMMC-A values user-friendly models. Thus, to promote utilization, your model cannot require more than ten input factors from a household. Justification of your team's choices will play an important role in your model's viability. Additionally, you should create a diagram that clearly explains your model's decision-making process.]

   a. What does a cat-ready household 'look like'? Validate your model's ability to capture the diversity of households that could have a cat as a pet. Provide at least three examples of households that qualify for cat ownership in a country/ region of your choosing and at least three that do not qualify. Be sure to choose examples that highlight the factors, or combination of factors, that your model associates most readily with households that qualify for cat ownership.

   b. Assess your model on a broader scale (and/or adjust it if necessary) by using it to determine the current number of households that are prepared to own a cat in three countries/ regions of your choosing.

2. **Generalize your model** from question #1 (i.e., re-use, adjust or alter as needed) so that it still accepts ten (or fewer) inputs but now returns output that addresses a household's pet preparedness for cats as well as *four additional pet species* of your choice.

   a. Demonstrate your model's utility by reviewing the pet preparedness of at least six households located in the same country / region you originally considered in question #1a. You may choose to analyze the same households you used earlier, but make sure to discuss the significance of the examples you've chosen to highlight.

   b. Some households possess multiple pets. How does your model address this situation?

3. **The future of pet ownership.** Using your previous model(s) as a tool for potential pet ownership, project future pet demographics. Specifically, develop a mathematical model that projects pet ownership and retention (i.e., pets kept in their original household) in five, ten and 15 years by pet species. Consider the same three countries/ regions you identified in question #1b and the same five pet species (cats plus your four pet choices) you used in question #2.

Your PDF submission should consist of:

- One-page Summary Sheet.
- One-page Letter to the Decision Makers with your recommendation.

- o Write a one-page letter to the Directors of the IMMC-A with your recommendation for how potential pets should be matched with humans and why this will result in a positive change in the overall health of dom esticated animals and people worldwide. The IMMC-A Directors are familiar with the problem of having many homeless former pets and crowded animal shelters (and have just read your Summary Sheet so do not restate or repeat this). They are interested in a humane solution that promotes pet ownership but decreases pet abandonment. Keep in mind that the purpose of the letter is to provide essential information to the decision makers, communicating key details of your full recommendation as stated in your solution paper.
- One-page Table of Contents.
- Your complete solution. Twenty pages (maximum) communicating essential aspects of your solution.
- Reference List.
- AI Use Report (if used).
- The following items do not count toward the 23-page limit: Reference List and Appendices (including AI Use Report).

Note: There is no specific required minimum page length for a complete IM²C submission. We permit the careful use of AI such as ChatGPT, although it is not necessary to create a solution to this problem. If you choose to utilize a generative AI, you must follow the IM²C AI use policy. This will result in an additional AI use report that you must add to the end of your PDF solution file and does not count toward the 23 total page limit for your solution.

Your PDF submission paper must be typed and in English using A4, margins at least 1.5cm (OR) Letter, margins at least 0.6in with at least 12-point font size. For detailed information about IM²C submission guidelines and the general expectations for each portion of your solution please review the Full Submission Guidelines.

Glossary

- A household is classified as either:
  a. A one-person household, defined as an arrangement in which one person makes provision for his or her own food or other essentials for living without combining with any other person to form part of a multi-person household or
  b. A multi-person household, defined as a group of two or more people living together who make common provision for food or other essentials for living.
- A biological species is a group of living organisms that can reproduce with one another in nature and produce fertile offspring.

To see the full problem statement go to: **https://immchallenge.org/Contests/2024/2024_IMMC_Problem.pdf**

The 2024 IM²C Judges' Commentary

Ben Galluzzo, Jill Brown, Irene Ferrando

Introduction

What makes a household ready to own a pet? The 2024 IM²C problem, "Picking the Perfect Pet," challenged teams to explore this question and develop models to evaluate household readiness for pet ownership. Teams were asked to create a model that could assess whether a household is prepared to adopt a cat, generalize this model to include other species, and adapt it to address the complexities of multi-pet households. Additionally, teams were tasked with forecasting future pet ownership trends across multiple regions, considering cultural differences and societal dynamics.

Pet ownership is a deeply ingrained aspect of human life, providing companionship, emotional support, and practical benefits. During the COVID-19 pandemic, there was a surge in pet adoptions, highlighting both the rewards and challenges of pet ownership. Unprepared owners often face difficulties that lead to pet abandonment or returns to shelters, contributing to significant issues for animal welfare organizations worldwide. The International Mission for the Maintenance and Care of Animals (IMMC-A), a fictional organization concerned with the well-being of pets, posed this year's problem to address these challenges, focusing on humane and sustainable solutions to improve outcomes for both pets and their owners.

The problem emphasized the importance of developing user-friendly models that could be utilized by animal shelters, pet stores, and similar organizations. Teams were required to limit their models to ten input factors and clearly justify their choices, ensuring accessibility and practicality. Judges were particularly impressed by teams that balanced mathematical rigor with clarity and usability, crafting models that were innovative, adaptable, and actionable.

USA Participation

In the USA, we invite all teams that successfully compete in the HiMCM contest and are awarded a designation of Meritorious or above (Meritorious, Finalist, or Outstanding) to compete in the IM²C. From these participants, U.S. Judges select the two top teams to move on and represent the USA in the IM²C international round. To participate in HiMCM in November 2025, visit: **www.comap.org**

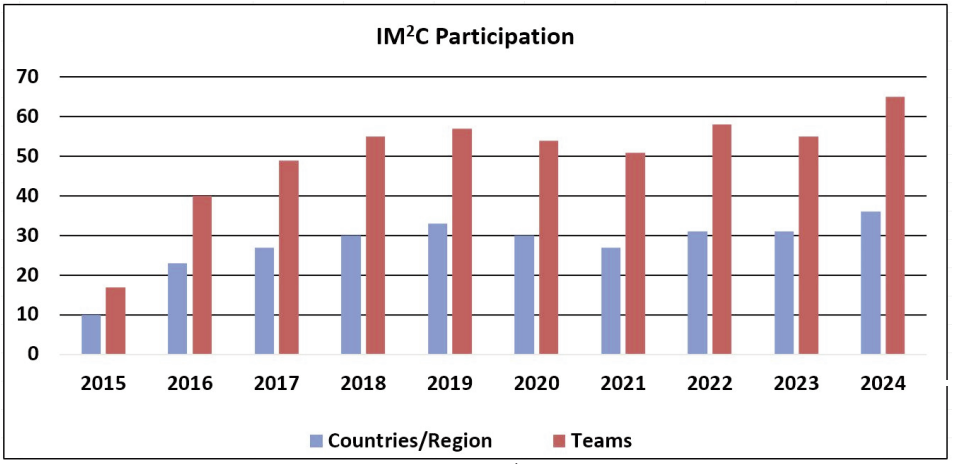
The problem requirements of this year's IM²C asked teams to:

- Build a model to evaluate household readiness for cat ownership and validate it using diverse examples.
- Generalize their model to evaluate readiness for additional pet species and address multi-pet households.
- Use their models to forecast future pet demographics for multiple regions, considering cultural diversity.

This year's problem challenged teams to integrate mathematical reasoning with real-world considerations, pushing them to think critically about human-animal relationships. Judges were impressed by the range of approaches taken, from creative visualizations and intuitive scoring systems to advanced simulations and multi-criteria decision-making frameworks. The following commentary highlights the strengths and innovations of this year's submissions and provides advice for future teams tackling similar challenges.

The 2024 IM²C Outstanding Teams

School, Location	Advisor	Team Members
Pui Kiu College China Hong Kong (SAR)	CHIU Chun Yin Eric	TAM Siu Hoi Dominic FAN Alex To Han CHEUNG Kai Hin CHEUNG Yau Ho
Shenzhen Middle School China Mainland	Feng Liu	Le Li Ziming Ye Bingyi Wu Zeming Zhao



Numbers of Participating Countries/Regions and Teams 2015-2024

The 2024 IM²C Expert Panel

Problem Solutions

The teams' reports included a summary sheet, a restatement of the problem from their own perspective and in their own words, a thorough discussion and justification of their choice of mathematical modeling processes, and an analysis of their results. Most teams identified the strengths and weaknesses of their models, providing a conclusion to summarize their findings. Additionally, teams wrote a letter to decision-makers at the IMMC-A, presenting their recommendations for improving pet ownership practices. The detailed elements of the problem solution with commentary are included below:

Summary: The best submissions began with a clear and concise summary that introduced the problem, described the team's approach to solving it, and highlighted key results. Successful summaries provided an overview of the team's model, its assumptions, and the primary conclusions drawn from their analysis, offering judges an accessible entry point into the paper. Some teams, however, struggled with balance in this section, offering either too much technical detail or too little substance. It's important to catch readers' attention! The most effective summaries were engaging, informative, and invited the reader to explore the report in greater depth, setting a strong foundation for the team's work.

Problem Restatement: A number of teams restated the problem in their own words, offering a glimpse into how they interpreted the challenge. This section served as a useful tool for judges to understand the team's orga-

nizational approach and their specific focus areas. The problem of evaluating pet ownership readiness, while seemingly straightforward, required teams to navigate several complex issues, such as defining what constitutes "readiness" for pet ownership and ensuring the model could generalize across different species and regions. Restating the problem is an important part of mathematical modeling as it helps a team have a common understanding of the problem they are trying to solve.

Mathematical Modeling Process: This year's problem required teams to build a model to evaluate household readiness for owning a cat and then extend their model to account for other pet species, multi-pet households, and future pet ownership trends. While teams were given flexibility in their modeling approaches, they were tasked with addressing the following challenges:

- Define "readiness" for pet ownership in a way that incorporates no more than ten input factors, ensuring that the model is user-friendly and practical for use by animal shelters, pet stores, or similar entities.

  Adapt the model to evaluate household readiness for additional species, reflecting the distinct needs of each pet type.

- Address the complexities of multi-pet households, considering factors like compatibility between pets and shared resources.

- Develop a model to project pet ownership demographics over 5, 10, and 15 years in multiple regions, incorporating factors such as population growth, income distribution, and cultural differences. In problem three, teams needed to utilize their model to explore ownership trends of the pets they had previously considered in the countries/regions they had investigated.

The definition of "readiness" often reflected the factors teams chose to incorporate into their models and how they justified these choices. Many teams focused on variables such as household income, available space, time availability, and family size. A critical challenge for all teams was selecting and limiting factors while maintaining a meaningful and interpretable model. Some teams failed to justify the variables or presented them incompletely, it is important to specify the range of factors to be considered in the model and to define them precisely. Strong submissions provided clear justifications for their assumptions and factor selection, tying them directly to the problem context.

Judges valued models that were mathematically rigorous, clearly communicated, accessible, and user-friendly. Teams that explicitly stated their assumptions, explained their methods step-by-step, and justified their modeling choices stood out. Visual aids, such as flowcharts, radar charts, and decision trees, were particularly effective in clarifying complex processes and enhancing usability for non-technical audiences. The judges emphasized that all models, regardless of the method used – whether a custom-built approach or an adaptation of existing techniques – were considered equally, provided they were well-explained and justified. Models that balanced sophistication with practical application were highly valued, as they aligned with the problem's emphasis on creating tools that could be easily implemented by animal shelters, pet stores, or policymakers. While specific examples of good modeling are highlighted later in this commentary, the strongest papers demonstrated innovation, practicality, and thoughtful evaluation, ensuring their solutions could make a real-world impact that was clearly communicated to readers, including the judges.

Application of the Model and Modifications

This year's problem posed a challenge by requiring teams to generalize a cat ownership model to accommodate various pet species, including dogs, birds, and exotic pets. Successful teams adapted their models by modifying factor weights to reflect species-specific needs, such as space requirements for dogs versus birds, while maintaining usability as required by the problem. Some teams also made their models flexible enough to incorporate different pet characteristics, ensuring that their frameworks could work across species.

Another challenge was the inclusion of multi-pet households, which added complexity in areas like time management, space utilization, and pet compatibility. Teams responded by creating separate readiness scores for each pet or adjusting their models based on household dynamics. This allowed them to better account for the additional factors that influence a household's ability to care for multiple pets, such as resource sharing and compatibility between species.

Additionally, teams were tasked with projecting future trends in pet ownership, requiring them to incorporate demographic, economic, and cultural factors into their models. Techniques like Monte Carlo simulations and time series forecasting helped teams predict future pet demographics, while sensitivity analyses tested the robustness of their projections.

Sensitivity, Strengths, Weaknesses, Conclusions, and References

Sensitivity analysis is a critical component of mathematical modeling, serving as a diagnostic tool to assess and validate the robustness and reliability of a model's predictions. By systematically varying the input parameters of a model (within a range deemed suitable to the context), sensitivity analysis reveals how changes in these inputs can impact the model's outputs. This is

invaluable for several reasons. First, it helps to identify which parameters have the most significant influence on the results, allowing modelers to prioritize data collection or refinement in these areas. Second, it underscores the uncertainties inherent in modeling, ensuring that stakeholders have a comprehensive understanding of the potential variability in predictions. Moreover, in decision-making contexts such as this year's Challenge problem, sensitivity analysis can be pivotal in assessing the impact of specific characteristics for pet ownership and their relative priorities, as it provides a range of possible outcomes based on the variability of input parameters. While a full sensitivity analysis may not be possible due to time constraints, some teams were able to investigate the sensitivity of their models to parameters that they identified as important. The best teams also provided thoughtful discussions of their model's limitations. For example, some noted that their models might not generalize well across different cultural contexts, while others recognized the difficulty in quantifying certain factors, such as the emotional readiness of a household for pet ownership.

Citing all resources used to develop a model increases the credibility of the modelers' work and is a required practice in all scholarly work. The majority of teams included a list of resources and references in their submission. While the IM²C doesn't require a specific reference style; it's recommended you use a consistent style.

One-page Letter to Leaders and planners: Teams were required to write a one-page letter to the Directors of the IMMC-A, summarizing their recommendations for matching pets with potential owners. Like the summary, good letters were clear and concise. However, a good letter differs from the summary by avoiding technical jargon and instead focusing on providing actionable advice to the IMMC-A based on the team's model. Teams that clearly communicated the benefits of their model, while addressing potential challenges such as pet abandonment, wrote the most compelling letters.

Goals of the Challenge and the Roles of the Judges

The purpose of the IM²C is to promote the teaching of mathematical modeling and applications at all educational levels for all students. By offering an opportunity to engage in mathematical modeling, the IM²C hopes to inspire student modelers to make appropriate assumptions that lead to viable approaches, use inventive and creative ideas as needed, and apply the mathematics they know in the models they build and implement. By accomplishing these goals during the IM²C, students develop new skills in modeling and refine and practice the capabilities they already possess. This year's IM²C teams were able to demonstrate their modeling skills by making appropriate choices for their models and successfully implementing their models to inform decisions related to pet ownership, an issue that affects households worldwide. Most teams utilized some form of a weighted function as the basis for their primary model, although specific approaches varied greatly. Choosing when and how to use computational tools is often an important decision for modelers. While not required, some teams wrote computer code to expedite calculations associated with their models. Since IM²C does not require inclusion of the computer code in the report, a description of the code, a flowchart, or a simplified pseudocode were good ways to explain their model in the report. More generally, it is important for participants to understand that the appendix serves as supplementary material and may not be taken into account. All key information, including explanations of the model, the rationale behind its development, and the results, should be included in the main report. That is, while some teams included their code in an appendix, the judges did not necessarily read the code and instead focused their attention on the main body of the report. More important than the code for the IM²C is the model itself and the steps taken in developing the model and determining the results.

By reading the papers, the judges evaluated the teams' modeling processes and determined how well the student teams:

- Created and justified (i.e., through assumptions) their models and parameter values.
- Demonstrated creativity in the different elements of the model.
- Communicated their model to the reader.

The judges had the opportunity to read many excellent submissions that developed innovative approaches for using quantitative methods to better connect pets and potential owners. The judges commend all the participating teams for dedicating time and effort to truly engage in mathematical modeling.

Some Examples of Good Modeling

Of the 68 papers submitted, 23 were judged "Successful," 37 were awarded "Honorable Mention," six achieved "Meritorious," and two were judged "Outstanding". The strongest teams demonstrated an understanding of the processes and structures involved in the problem and utilized their knowledge to build viable models. Some of the characteristics found in the best papers, including a few innovative approaches, are described below:

- Several teams included dynamic environmental factors in their models, such as noise levels, to reflect the real-world challenges of owning pets in urban settings. These teams used geographic data or defined noise thresholds to evaluate the suitability of households. This approach demonstrated how external conditions,

often overlooked, could be integral to understanding household compatibility with pet ownership.

- One team used a fixed grid system to evaluate household readiness by spatially analyzing available living space, creating a visual model to represent how different households fared in terms of readiness.
- Several teams developed "unsuitability assessments" to filter out households that were not compatible with pet ownership. These assessments identified critical disqualifying factors, such as inappropriate housing types or previous negative experiences with pets. Many teams effectively presented their findings using diagrams and charts, offering actionable insights for pet adoption organizations and decision-makers.
- Radar charts were utilized by a few teams to display how a household's characteristics matched with an "ideal" pet ownership profile. Whan applied appropriately, this visualization approach made models more accessible to the general reader and allowed users to interpret results quickly. Some teams expanded this technique to forecast regional pet ownership trends and incorporated sensitivity analyses to test the impact of changing key factors, such as income or household size.
- Monte Carlo simulations were used by several teams to predict pet readiness and ownership trends across regions. These teams generated data for thousands of hypothetical households to statistically estimate the proportion of pet-ready households. This method enabled them to explore the scalability of their models and provided robust forecasts of future pet ownership trends.
- Simplified scoring systems were developed by some teams to evaluate pet readiness, often grouping factors into "positive" and "negative" categories and calculating a composite readiness score. These models struck a balance between simplicity and functionality, making them accessible while still yielding meaningful insights. Teams that conducted sensitivity analyses on their scoring systems were able to demonstrate the robustness and adaptability of their models under different scenarios.
- A few teams employed advanced weighting techniques, such as the Fuzzy Analytic Hierarchical Process (FAHP), to prioritize key factors in their models. The teams that did this most effectively provided detailed justifications for their chosen weights and demonstrated how nuanced prioritization could improve the accuracy of their results. However, the clarity of explanations varied, with some teams excelling in making their complex methods accessible.
- The complexities of multi-pet households were addressed by several teams who adapted their models to incorporate factors like pet compatibility and household time management. Some teams used separate readiness scores for each pet type, while others developed integrated metrics that adjusted based on household characteristics. Another team developed a novel approach for multi-pet households, creating a weighting system that adjusted readiness scores based on the number and compatibility of pets in the household. These approaches showcased creativity and flexibility in handling the added complexity of multiple pets.
- Another innovative approach included using differential equations to model the evolution of pet ownership over time. Teams that adopted this technique considered variables such as population growth, income trends, and housing availability to predict pet ownership rates in various regions. These models often featured well-labeled graphs and clear explanations, ensuring that complex mathematical concepts were understandable to a broader audience.

These examples highlight the diversity of approaches teams took in addressing this year's problem. By combining creativity, mathematical rigor, and practical application, teams demonstrated how models can be used to tackle real-world challenges effectively.

Advice to Future Teams

Mathematical modeling is a powerful tool for solving real-world problems, and participating in the IM^{2}C provides a unique opportunity to refine these skills. One such set of skills requires students to work together to navigate a challenging problem. Teams should organize themselves effectively, dividing responsibilities to focus both on solving the problem and clearly communicating their work in a report. Budgeting time is critical, as a well-structured and concise report is just as important as developing a strong model. Judges are not necessarily looking for the most sophisticated mathematics but rather for thoughtful, justified approaches that demonstrate a clear understanding of the problem. Use mathematics you know and can explain, and, as time allows, refine your model to increase precision or adjust assumptions to broaden applicability. Throughout your report, make it easy for readers to follow your modeling process, assumptions, and results. Below are specific recommendations for future teams, some of which relate directly to this year's problem statement:

- **Organize your variables clearly.** Avoid overwhelming readers with a single page of variables at the beginning of the report. Instead, introduce variables as they appear in your model, making it easier for judges to follow your logic and equations. Some judges noted that tables summarizing variables are helpful but should be introduced contextually to avoid confusion.
- **Explain your modeling choices.** Judges appreciated teams that explicitly connected their assumptions to their models. For example,

one team carefully justified the use of a specific noise level (80 dB) based on their own experience with pets in urban areas. Providing such context for decisions helps demonstrate the real-world applicability of your model.

- **Address all parts of the problem.** If you choose not to use certain data or neglect specific elements of the problem, clearly explain your reasoning. Some teams excelled by justifying their focus on subsets of species or household types. However, judges noted that failing to explain omissions can detract from the report's overall quality.
- **Clearly explain advanced methods.** If you use a complex modeling approach, such as multi-criteria decision-making techniques or statistical simulations, ensure that you explain the methods and their relevance to the problem in simple terms. Judges noted that while some teams employed sophisticated methods, their lack of clarity in presenting these approaches made it difficult to evaluate their relevance and correctness.
- **Highlight sensitivity analysis.** Testing how changes in key parameters affect your model's output is an essential step. This analysis demonstrates the robustness of your model and provides insight into which factors are most influential. For example, one team's sensitivity analysis revealed the impact of weight adjustments in their multi-criteria decision-making framework, strengthening their conclusions.
- **Communicate effectively with visuals.** Diagrams, charts, and tables are excellent tools for explaining your model and results. Ensure your visuals are well-labeled, clear, and directly tied to the discussion in your text.
- **Write a letter to decision-makers for decision-makers.** In your letter to the intended audience, avoid technical jargon and focus on actionable insights. Some of the strongest letters provided clear, concise recommendations, using accessible language to communicate the model's key findings and their implications. Judges appreciated letters that avoided duplicating the summary and instead emphasized practical advice.
- **Consider usability and accessibility.** Judges noted that while some teams developed highly complex models, the most successful submissions often prioritized usability. A simple model that is well-justified and easy to interpret can be more impactful than a sophisticated model that lacks clarity or practical application.
- **Communication is critical.** Think about the report you will write by documenting your modeling activities throughout the entire process. This approach will facilitate a well communicated and complete report and help ensure your group is on track to complete your solution as best you can within the allotted time. At the start of each group meeting, review what you have written so far to ensure it accurately reflects your group's thinking to date. Keep your audience in mind and ask yourselves: *Does this clearly convey our mathematical modeling to an international audience?*

Additionally, judges encourage teams to reflect on their modeling process. Discussing the strengths and limitations of your model, as well as areas for potential improvement, shows maturity and critical thinking. Finally, remember that mathematical modeling is as much about the journey as the destination. Judges value creativity, critical thinking, and clear communication, so focus on presenting your work in a way that showcases these qualities. By engaging deeply with the problem and demonstrating your thought process, you contribute to the growing field of applied mathematics and set a strong example for future IM²C participants.

Conclusion

The IM²C judges value not only the solutions you present but also the approaches you employ to reach those solutions. This year's submissions showcased a wide range of creative and insightful applications of mathematical modeling. The judges, experienced modelers and educators from diverse backgrounds and countries/regions, commend all teams for their hard work and dedication. We extend our gratitude to the schools, teachers, and advisors who supported student participation. We wish all participants continued success in their future mathematical and modeling pursuits.

For more information about the IM²C, including the complete 2015–2024 results and sample papers, visit

www.immchallenge.org