2025 International Mathematical Modeling Challenge (IM^{2}C)®

The 11th annual International Mathematical Modeling Challenge (IM²C) culminated with two Outstanding Teams. Congratulations to these teams and all the teams that participated in the 2025 IM²C.

The Meritorious Award winners were invited to the 2025 IM²C International Summit and Award Ceremony held July 21-25, 2025, in China Hong Kong (SAR). The event was accommodated and hosted on campuses of The Chinese University of Hong Kong, The Hong Kong University of Science and Technology, and The University of Hong Kong. At the event, IM²C teams, members of the Expert Panel and Organizing Committee, educators, policymakers, schoolteachers, students, and industry leaders from around the world met to celebrate achievement in mathematical modeling. From among the ten Meritorious teams, the Outstanding Award winners were announced at the event.

The IM²C continues to be a rewarding experience for students, advisors, schools, and judges. A total of 69 teams, with up to 4 students each, representing 39 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

Plans for 2026

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 Outstanding, 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 2026 awards are still being finalized. Complete information about IM^{2}C is available at www.immchallenge.org

IM^{2}C Funding

Funding for planning and organizational activities is provided by IM^{2}C 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 IM^{2}C International Organizing Committee

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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.

The 2025 IM²C Problem: Global Sports League

Background

Fair competition in sports requires a balance of logistics, equity, and practicality, especially when organizing sporting competitions on an international scale. The International MultiContinental Matchmaking Committee (IMMC) seeks your expertise to develop a scheduling system for their upcoming Global Sports League (GSL). This league will feature teams from around the world, emphasizing geographic diversity, competitive equity, and logistical feasibility. The IMMC also values economic and environmental sustainability, wants to ensure fair matchups and requires the league to include 20 teams with at least two teams from each continent (excluding Antarctica). The GSL season runs between 8 and 9 months.

While the IMMC has outlined key criteria for the league, they have not yet determined the sport to be played in the GSL. Some sports already have an established international presence, while others have limited global reach. The IMMC is open to considering any **team sport**, provided your team can demonstrate its potential for global expansion within the GSL framework. This is where your expertise is needed.

Your team is invited to select a sport you are passionate about, develop a model that produces a fair and effective schedule for the GSL, and test how well your scheduling model adapts to changes in the league.

Requirements

1. Identify key factors

a) What is the sport? The GSL is a **team sport** competition (see Glossary for details).

b) Who are the teams and where are they located? Identify 20 teams to participate, ensuring at least two teams represent each continent (excluding Antarctica). Clearly explain the criteria used to select these teams.

c) What aspects need to be considered when building a league schedule? The IMMC expects the schedule to consider travel distance, the number of games played and equitable matchups, but they are unsure of other components that may be of importance. Identify any additional key components that should be considered when developing a fair GSL schedule and discuss trade-offs involved in balancing these factors.

2. Develop the initial schedule

Build a mathematical model to construct a fair and practical schedule for the 20 team GSL. At the very least, ensure your scheduling model accounts for:

- Fair distribution of games across teams,
- Equitable travel time and distance,
- Balanced competitiveness of matchups.

Use your model to create a full season league schedule for your selected sport and provide evidence that demonstrates how it achieves IMMC goals of fairness, sustainability, and geographic representation. Additionally, determine the number of games each team must play to reasonably declare a league winner at the conclusion of the season.

3. Expand the GSL and extend the model

a) Add four teams to the Global Sports League. Clearly explain the criteria used to select these teams.

b) Evaluate how this expansion impacts the league schedule. Make sure to address fairness, sustainability, and geographic representation.

c) Assess how the addition of four teams impacts the number of games that need to be played by each team in order to reasonably declare a league winner.

d) Analyze how changes to key constraints (e.g., travel distances change in home location of a team, number of league games) impact your model.

4. Generalize the model

In two pages or less, discuss how one could adapt your model to different team sports with distinct rules, game lengths, and team dynamics.

5. Communicate your solution to a non-technical audience.

a) Write a one-page letter to the IMMC summarizing your findings. In your letter, explain how your model aligns with the IMMC's goals for the league. Ensure your explanation is accessible to a non-technical audience.

b) Provide a **visual graphic** of the initial 20-team GSL schedule on a separate page.

Your PDF submission should consist of:

- One-page Summary Sheet.
- One-page Table of Contents.
- One-page *Letter to the Decision Makers* with your recommendation (as noted in question 5a).

  Write a one-page letter to the IMMC summarizing your findings. In your letter, explain how your model aligns with the IMMC's goals for the league. Ensure your explanation is accessible to a non-technical audience.
- One-page Visual Graphic of the initial 20-team GSL schedule (as noted in question 5b).
- 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 towards the 24-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 24 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 **team sport** is a sport in which multiple players collaborate to achieve a common objective, ultimately leading to victory in a game or match. To qualify for potential inclusion in the GSL, the sport must require a minimum of five players per team actively participating on the field, court, or playing area at all times throughout the match.

Examples of eligible sports (non-exhaustive): football (soccer), basketball, cricket, rugby, American football, volleyball, handball, water polo, and lacrosse.

A **visual graphic** is a visual representation of information, data, or ideas, typically combining images, text, and design elements to communicate a message effectively.

IM²C Full Submission Guidelines

Teams may use any inanimate source of data, materials, computers, software, references, websites, books, etc. Be sure to credit all sources used.

Teams may not use any person (other than team members) to discuss or obtain ideas for solving their problem **nor may they seek help in obtaining an answer from the teams' advisor or anyone else**. Any team that discusses the problem with anyone in a position to supply them with information reflecting experience or professional expertise will be disqualified. The relevant issue is one of intent: each team of students is expected to develop all of its substantive analysis without the help of others.

Partial solutions are acceptable. There is no passing or failing cutoff score, nor will numerical scores be assigned. The IM²C judges are primarily interested in a teams' approach and methods.

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 2026, visit: **www.comap.org**

The solution must consist entirely of written text and possibly figures, charts, or other written material only. No non paper support such as computer disks or applications will be accepted.

Each page of the solution should contain the team control number and the page number at the top of the page; we suggest using a page header on each page for example: Team # 2024000 page 6 of 13.

The names of the students, advisor, or institution must not appear on any page of the solution.

The solution must not contain any identifying information other than the team Control Number.

Teams should keep in mind the following guidelines while preparing their solution papers:

- Conciseness and organization are extremely important. Key statements should present major ideas and results.
- Present a clarification or restatement of the problem as appropriate.
- Present a clear exposition of all variables, assumptions, and hypotheses.
- Present an analysis of the problem, motivating or justifying the modeling to be used.
- Include a design of the model. Discuss how the model could be tested.
- Discuss any apparent strengths or weaknesses to your model or approach.
- Incorporate lengthy derivations, computations, or illustrative examples in appendices. Summarize these in the main report. Results must be explicitly stated in the body of the report.

Your PDF solution should include:

- **One page Summary Sheet.**

  The Audience for the summary sheet is anyone unfamiliar with the problem. Hence, in your own words briefly outline the problem, the main solution approach, and your conclusion.

  To write a good summary, imagine that a reader may choose whether to read the body of the paper based on your summary. Thus, a summary should clearly describe your approach to the problem and, most prominently, what your most important conclusions were. The summary should inspire a reader to learn the details of your work. Your concise presentation of the summary should inspire a reader to learn the details of your work.

- **One page Table of Contents.**

  This allows the reader to easily find various parts of your solution, especially if they chose not to read though in order (as is typical when reading long reports).

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

  Addressed to the Directors of the IMMC, this letter should concisely present your recommendation for developing a scheduling system for the Global Sports League (GSL) based on your chosen sport. Since the audience is already familiar with the problem and has reviewed your Summary Sheet, avoid repetition and focus on essential insights from your solution. Clearly communicate key details of your proposed scheduling model, emphasizing its alignment with the IMMC's goals. The letter should be concise, persuasive, and easily understandable, ensuring decision-makers can quickly grasp the strengths of your approach found in your full report.

- **One-page Visual Graphic**

  The one-page visual graphic should be clear, engaging, and designed for a non-technical audience, supporting the ***Letter to the Decision Makers*** by visually summarizing key insights from your initial 20-team GSL schedule. The goal is to present as much relevant information as possible in a visually intuitive way, ensuring that stakeholders, including the Directors of the IMMC, can quickly grasp the impact and effectiveness of your scheduling model.

- **Twenty-page** (maximum) **report** communicating the essential aspects of your solution.

- The specifications of a complete solution:

- A4, margins at least 1.5cm (OR) Letter, margins at least 0.6in • Papers must be typed and in English.

- At least 12-point font size.

- **Note that (excluding references and appendices, see below) you have a maximum of 24 pages to communicate your solution.** Your summary sheet, letter to the decision makers, visual graphic, and your table of contents all count towards the 24-page limit (excluding references and appendices) of your solution.

Compliance: *Failure to meet these specifications or attempts to circumvent them may result in a lower designation or disqualification.*

- **Reference List, Appendices, and AI Use Report.**

  A list of references, any appendices, and the AI Use Report, ***do not count*** toward the 24page limit and should appear after your completed solution. You should not make use of unauthorized images and materials whose use is restricted by copyright laws. Ensure you cite the sources of all ideas and materials (data, images, etc.) so it is clear to the reader what ideas and mathematical work was completed by your team and where you are building in ideas of others.

Use of Large Language Models and Generative AI Tools in the IM²C

This policy is motivated by the rise of large language models (LLMs) and generative AI assisted technologies. The policy aims to provide greater transparency and guidance to teams, advisors, and judges. This policy applies to all aspects of student work, from research and development of models (including code creation) to the written report. Since these emerging technologies are quickly evolving, IM²C will refine this policy as appropriate.

Teams must be open and honest about all their uses of AI tools. The more transparent a team and its submission are, the more likely it is that their work can be fully trusted, appreciated, and correctly used by others. These disclosures aid in understanding the development of intellectual work and in the proper acknowledgement of contributions. Without open and clear citations and references of the role of AI tools, it is more likely that questionable passages and work could be considered plagiarism and disqualified.

Solving the problems does not require the use of AI tools, although their responsible use is permitted. The IM²C recognizes the value of LLMs and generative AI as productivity tools that can help teams in preparing their submission; to generate initial ideas for a structure, for example, or when summarizing, paraphrasing, language polishing etc.

If, for example, you are writing your IM²C article in a language other than English and translating to English using LLMs or reading an article in English and translating into another language for understanding in your AI report please state, "we used LLMs for translation purposes."

However, there are many tasks in model development where human creativity and teamwork is essential, and where a reliance on AI tools introduces risks. Therefore, we advise caution when using these technologies for tasks such as model selection and building, assisting in the creation of code, interpreting data and results of models, and drawing scientific conclusions.

It is important to note that LLMs and generative AI have limitations and are unable to replace human creativity and critical thinking. IM²C advises teams to be aware of these risks if they choose to use LLMs:

- Objectivity: Previously published content containing racist, sexist, or other biases can arise in LLM-generated text, and some important viewpoints may not be represented.

- Accuracy: LLMs can 'hallucinate' i.e. generate false content, especially when used outside of their domain or when dealing with complex or ambiguous topics. They can generate content that is linguistically but not scientifically plausible, they can get facts wrong, and they have been shown to generate citations that don't exist. Some LLMs are only trained on content published before a particular date and therefore present an incomplete picture.

- Contextual understanding: LLMs cannot apply human understanding to the context of a piece of text, especially when dealing with idiomatic expressions, sarcasm, humor, or metaphorical language. This can lead to errors or misinterpretations in the generated content.
- Training data: LLMs require a large amount of high-quality training data to achieve optimal performance. In some domains or languages, however, such data may not be readily available, thus limiting the usefulness of any output.

Guidance for teams

Teams are required to:

1. Clearly indicate the use of LLMs or other AI tools in their report, including which model was used and for what purpose. Please use inline citations and the reference section. Also append the Report on Use of AI (described below) after your 23-page solution.

2. Verify the accuracy, validity, and appropriateness of the content and any citations generated by language models and correct any errors or inconsistencies.

3. Provide citation and references, following guidance provided here. Double-check citations to ensure they are accurate and are properly referenced.

4. Be conscious of the potential for plagiarism since LLMs may reproduce substantial text from other sources. Check the original sources to be sure you are not plagiarizing someone else's work.

Citation and Referencing Directions

Think carefully about how to document and reference whatever tools the team may choose to use. A variety of style guides are beginning to incorporate policies for the citation and referencing of AI tools. Use inline citations and list all AI tools used in the reference section of your 24-page solution.

IM^{2}C will take appropriate action when we identify submissions likely prepared with undisclosed use of such tools.

Whether or not a team chooses to use AI tools, the main solution report is still limited to 24 pages. If a team chooses to utilize AI, following the end of your report, add a new section titled Report on Use of AI. This new section has no page limit and will not be counted as part of the 24-page solution. Examples (this is not exhaustive – adapt these examples to your situation):

Report on Use of AI

1. OpenAI ChatGPT (Nov 5, 2023 version, ChatGPT-4)

   Query1: <insert the exact wording you input into the AI tool>

   Output: <insert the complete output from the AI tool>

2. OpenAI Ernie (Nov 5, 2023 version, Ernie 4.0)

   Query1: <insert the exact wording of any subsequent input into the AI tool>

   Output: <insert the complete output from the second query>

3. Github CoPilot (Feb 3, 2024 version)

   Query1: <insert the exact wording you input into the AI tool>

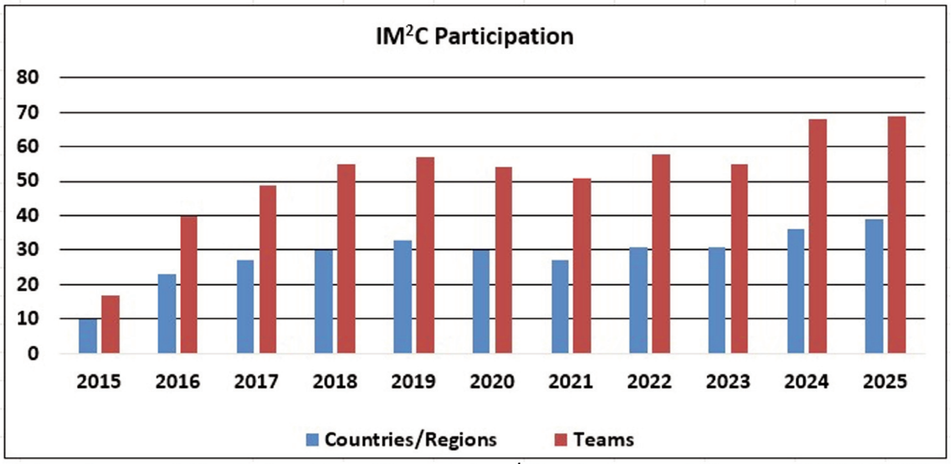
   Output: <insert the complete output from the AI tool>

4. Google Bard (Feb 2, 2024 version)

   Query: <insert the exact wording of your query>

The 2025 IM^{2}C Outstanding Teams

School, Location	Advisor	Team Members
Macleans College **New Zealand**	Carl Fourie	Wai Lap (Alston) Yam Jay (Zixuan) Zhao Bruce Zhang Zhiwei (Michael) Lu
Korean Minjok Leadership Academy **South Korea**	Junwoo Kim	Minseo Park Junsu Park Jeyoon Lee Jaehyun Won



Numbers of Participating Countries/Regions and Teams 2015-2025

Output: <insert the complete output from the AI tool>

5. GitHub CoPilot (Jan 16, 2024 version) Auto-completions for code used in preparing our models.

The 2025 IM²C Judges' Commentary

Benjamin Galluzzo

Introduction

What does it take to build a fair, sustainable, and globally representative sports league? The 2025 IM²C problem, **"Global Sports League,"** challenged teams to grapple with this ambitious question by designing a full mathematical framework for an international league. Students were asked to select an appropriate team sport, identify 20 teams from at least six continents, construct a fair and feasible scheduling model, expand the league to include four additional teams, and generalize their approach to accommodate other sports. In doing so, teams had to balance a variety of issues that may factor into the development of such a league including but not limited to geography, competitive integrity, sustainability, and sport specific logistical constraints.

In an era of rapid globalization, international competitions such as the World Cup, major esports tournaments, and multi-country professional leagues have highlighted both the promise and the challenges of organizing play across vast distances. Travel costs, time-zone differences, venue limitations, and competitive fairness all place pressure on scheduling bodies. The fictional International Multi-Continental Matchmaking Committee (IMMC) posed this year's problem to explore these complexities, encouraging teams to develop humane, sustainable, and globally mindful approaches to league design that support athletes, fans, and organizers alike.

The problem stressed the importance of creating clear, practical, and justifiable models that could realistically guide scheduling decisions for a global league. Teams were required to articulate and defend assumptions, limit their models to manageable inputs, and communicate their structures in ways accessible to sport administrators and non-technical audiences. Judges were especially impressed by teams that blended mathematical rigor with clarity and usability, producing models that were not only technically sound but also adaptable, interpretable, and actionable.

This year's IM²C asked teams to:

- Select a team sport and justify its suitability for a global league structure.
- Identify 20 representative teams across six continents and construct a fair, sustainable, and realistic schedule.
- Expand the league to 24 teams, analyzing how additional teams affect fairness and feasibility.
- Generalize their scheduling model so that it could apply to other sports with different structures or constraints.

The 2025 problem pushed teams to incorporate mathematical insight with authentic logistical challenges, encouraging them to think critically about what makes competition equitable and feasible on a global scale. Judges were impressed by the diversity of approaches; from visually rich travel analyses and intuitive fairness metrics to sophisticated, but well explained, optimization schemes, multicriteria decision-making models, and creative designs for both physical and digital sports. The following commentary highlights the strengths and innovations of this year's submissions and offers guidance for future teams approaching similarly open-ended, interdisciplinary modeling challenges.

Problem Solutions

The teams' reports included a summary sheet, a restatement of the problem from their own perspective and in their own words, a clear discussion and justification of their choice of sport, and a thorough explanation of the mathematical modeling processes they used to design a global sports league. Most teams constructed and analyzed schedules, evaluated fairness and sustainability, and justified their selection of teams from multiple continents. Many identified the strengths and limitations of their approaches, providing a conclusion to synthesize their findings. Additionally, teams presented a visual graphic of their initial 20-team league schedule and wrote a non-technical letter to the decision-makers at the IMMC, offering recommendations for structuring a fair, sustainable, and globally representative league. The detailed elements of the problem solution, along with commentary, are included below:

Summary

Each report began with an executive summary outlining the team's overall approach, key modeling choices, and major findings. The most effective summaries clearly introduced the selected sport, articulated the criteria used to choose the 20 teams, and highlighted the central ideas behind the scheduling model. While concise, these summaries provided enough detail to orient the reader to the structure of the solution and the mathematical tools employed, serving as a roadmap for the rest of the paper. Strong summaries balanced clarity and completeness, avoiding unnecessary technical notation while still conveying how the model addressed fairness, sustainability, and global representation. The best summaries grab the attention of the reader so that they want to learn more about the team's solution. Summaries that were overly brief or that simply restated the problem tended to leave the reader without a clear sense of the team's perspective or contribution. Overall, the summaries played a significant role in setting the tone for each report and demonstrated the teams' ability to communicate complex ideas effectively.

Problem Restatement

Teams were also expected to restate the problem in their own words, demonstrating a clear understanding of the goals and structure of the Global Sports League challenge. This portion of the report provides a valuable opportunity for teams to articulate their perspective and to clarify how they intend to approach the modeling task. Effective restatements distilled the multifaceted nature of the problem into its essential components: selecting an appropriate team sport, identifying twenty teams that fairly represent at least six continents, defining meaningful measures of fairness and sustainability, and developing a scheduling model that reflects real-world logistical constraints. Restatements that simply echoed the original wording or overlooked major components made it more difficult for readers to understand the team's overarching approach. The most thoughtful restatements established a clear problem-solving foundation, allowing students to differentiate their perspective and set the stage for the modeling work that followed.

Mathematical Modeling Process:

This year's problem required teams to design a mathematical framework for creating a fair and sustainable Global Sports League. While teams had flexibility in their approaches, they were expected to address several key modeling tasks:

- Identify 20 globally representative teams, clearly explaining the criteria used for team selection, as required in the problem statement.
- Define the factors that determine a fair schedule, including the IMMC's required components—fair distribution of games, equitable travel time and distance, and balanced competitiveness—and justify any additional considerations relevant to their chosen sport.
- Develop a scheduling model that incorporates the IMMC's required components and produces a complete season-long schedule for the 20-team league, accompanied by a visual graphic summarizing the structure and flow for a non-technical audience.

In this year's challenge, the initial choice of sport played a central role in shaping the modeling process, as different sports impose different logistical constraints, fairness considerations, scheduling structures, and data availability. Teams who thoughtfully justified their sport selection, whether based on accessibility, competitive balance, sustainability, global reach, or structural suitability for a league format, were able to build models that aligned naturally with the characteristics of their chosen sport.

The definition of fairness and the factors incorporated into each team's models varied widely by sport and by perspective. Some teams emphasized distance minimization, fatigue reduction, and travel emissions; others focused on competitive balance, match diversity, viewer engagement, or time-zone equity. A central challenge was selecting and limiting factors while still producing a meaningful and interpretable model. In some cases, teams did not fully justify their factor choices or presented them incompletely. It is important to clearly specify the range of factors considered, justify their relevance, and in many cases, it helps to ground them in the context of the chosen sport.

Judges valued models that were mathematically sound, clearly communicated, and well aligned with the real-world complexities of coordinating a global sports league. Many teams this year developed sophisticated scheduling approaches, ranging from integer linear programming and constraint solvers to clustering algorithms, simulations, and scoring systems, while others constructed simpler but well-reasoned frameworks. Regardless of mathematical techniques utilized, the strongest papers explicitly stated their assumptions, explained their methods step-by-step, and justified how their chosen factors reflected the realities of international competition. Graphics and visual aids such as fairness matrices, distance maps, optimization flowcharts, and easy to read season-long schedule diagrams were particularly effective in helping readers understand complex processes. As in past years, the judges emphasized that no single mathematical approach was preferred; instead, the most successful papers demonstrated a clear connection between their modeling choices and the goals of fairness, sustainability, and global representation.

Application of the Model and Modifications:

Once teams developed their core scheduling models, they were required to apply them to produce a full season schedule for the 20-team Global Sports League and then modify their models to evaluate changes in league structure. Strong papers demonstrated how their models functioned in practice, clearly explaining how matchups were generated, how fairness criteria were applied, and how constraints such as travel time, geographic representation, and competitive balance influenced weekly assignments. Many teams also provided clear visualizations, such as week-by-week grids, flow diagrams, or geographic travel maps—that helped non-technical audiences interpret the resulting schedule.

Teams were further expected to explore how the model behaved under modifications, particularly when expanding the league from 20 to 24 teams. Effective solutions revisited their team-selection criteria, analyzed how the additional teams affected fairness metrics, and discussed whether new constraints introduced scheduling challenges. Several papers recalculated travel matrices, re-evaluated clustering decisions, or ran updated optimization routines to show how expansion altered both structure and outcomes. In some cases, teams compared multiple expansion scenarios to determine which additions minimized disruption to the existing schedule.

Beyond expansion, strong papers examined how their schedules responded to changes in key inputs—including shifts in team locations, adjustments to the number of matches played, or alternative fairness priorities. Sensitivity analyses, though varied in depth, helped illustrate model robustness and clarified which design choices were most influential. Judges especially appreciated when teams identified trade-offs revealed through these analyses, such as balancing travel minimization with opponent diversity or weighing competitive parity against geographic equity.

Overall, this portion of the problem rewarded teams that treated their models not as static tools but as flexible frameworks. The strongest submissions demonstrated how a well-constructed model can adapt to new constraints, reveal structural weaknesses, and provide insight into how real-world leagues might manage expansion, scheduling disruptions, or evolving definitions of fairness.

Sensitivity, Strengths and Weaknesses, Conclusions, and References:

A well-constructed mathematical model should not only produce results but also allow teams to examine how those results change when assumptions or inputs vary. This year's problem encouraged students to explore those dependencies, and many papers conducted sensitivity analyses to assess the robustness of their scheduling models. Common approaches included varying team locations, adjusting fairness weights, altering travel distances, or modifying the number of games in the season. These analyses helped illustrate which aspects of a model were stable and which required caution, particularly when balancing factors such as travel minimization, competitive diversity, and sustainable scheduling. Judges valued sensitivity studies that were clearly explained, directly tied to model components, and used to inform meaningful interpretation of results.

Most papers also addressed the strengths and weaknesses of their approaches, demonstrating an awareness of the limitations inherent in modeling a global sports league. Strong reflections acknowledged trade-offs, such as prioritizing sustainability at the expense of opponent diversity, or achieving competitive balance while increasing travel, and recognized where certain assumptions (e.g., fixed team locations, constant team strength, idealized travel times) might limit real-world applicability. Some teams noted areas where additional data or more sophisticated constraints could improve their models, while others reflected on the challenges of generalizing fairness concepts across different sports. Judges appreciated when teams connected these reflections to the choices they made earlier in the report, reinforcing a coherent modeling narrative.

In their conclusions, teams summarize their key findings and emphasized how their models aligned with the IMMC's goals of fairness, sustainability, and geographic representation. Effective conclusions synthesized the results of the scheduling, expansion, and generalization components, highlighting the most important outcomes without repeating earlier text. Many teams also restated the major insights uncovered through sensitivity analysis or discussed how their work might guide future scheduling decisions for international sports organizations. A well-written conclusion left readers with a clear understanding of the solution's value and limitations.

Finally, teams provided references to support their data sources, background research, and use of mathematical techniques. High-quality papers cited geographic and performance data, methodological references for optimization or clustering tools, and sources used to define sport-specific considerations. Judges noted that accurate, transparent referencing was particularly important this year given the increasing use of online sources and AI-assisted tools. Clear citations not only strengthened the credibility of the models but also allowed readers to verify assumptions and follow the reasoning behind key decisions.

One-page letter to the IMMC:

Teams were required to write a one-page letter to the Directors of the IMMC, summarizing their recommendations for developing a fair and sustainable schedule for the Global Sports League. As with the summary, the strongest letters were clear, concise, and purposeful. However, an effective letter differed from the summary by avoiding technical language and instead emphasizing actionable guidance grounded in the team's modeling insights. The most compelling letters highlighted how their proposed schedule aligned with the IMMC's goals—such as fair competition, equitable travel demands, and global representation—while also acknowledging practical considerations like time-zone challenges, travel logistics, or environmental impact. Teams that communicated these ideas in a direct, accessible manner, and that clearly articulated the advantages and limitations of their approach, produced letters that would be genuinely useful to league decision-makers.

Goals of the Challenge and the Roles of the Judges:

The purpose of the IM²C is to promote the teaching and practice of mathematical modeling at all educational levels and for all students. Complex problems are best solved by teams of people who bring a range of knowledge and expertise to understanding, solving, and communicating key aspects of the solution process for others. By providing an opportunity to work collaboratively on an open-ended, authentic modeling task, the IM²C encourages students to make appropriate assumptions, select meaningful variables, design viable modeling approaches, and apply the mathematics they know to complex real-world problems. Through the experience of working on the Global Sports League challenge, student teams strengthened existing modeling skills and developed new ones, from structuring decision-making frameworks to implementing scheduling algorithms and evaluating fairness in a global context.

This year's IM²C problem gave students significant flexibility in constructing their models. Teams were asked to design a fair, sustainable, and geographically representative schedule for an international league, requiring them to integrate quantitative methods with practical logistical considerations. Many teams used optimization methods, scoring systems, clustering approaches, simulations, or other computational techniques to implement their models. Some teams wrote computer code to generate schedules or evaluate matchups, while others built models primarily through analytical reasoning. Because the IM²C does not require the inclusion of full code, clear explanations, supported by diagrams, flowcharts, or pseudocode, were often the most effective way to communicate how the model operated, and particularly when computer code was used as part of the solution process. As always, participants were reminded that appendices serve only as supplementary material and may not be reviewed by judges; essential explanations, assumptions, rationale, and results must appear in the main report.

When evaluating the papers, the judges focused on the quality of the modeling process and considered how well student teams:

- Created and justified their models, making explicit assumptions and explaining parameter choices.
- Demonstrated creativity and thoughtful decision-making in structuring the elements of their model.
- Communicated their work clearly, enabling readers to understand the methods, reasoning, and results.

The judges had the privilege of reviewing a wide range of thoughtful and well-crafted submissions, many of which introduced inventive quantitative strategies for designing a global sports league. Students explored fairness, travel considerations, sustainability, and competitive balance through a variety of mathematical perspectives, illustrating the many ways modeling can illuminate complex decision-making. Throughout this process, teams demonstrated notable dedication to refining their ideas and presenting them clearly. The judges applaud all participating teams for their hard work, curiosity, and commitment to engaging deeply with mathematical modeling in this year's challenge.

Some Examples of Good Modeling

Among the 69 submissions received this year, 17 were identified as "Successful," 42 were awarded "Honorable Mention," eight achieved "Meritorious," and two were judged "Outstanding". The strongest papers demonstrated creativity, clarity, and practical insight in addressing the Global Sports League challenge. The examples below highlight characteristics found in the most effective submissions across these categories.

These teams showed a deep understanding of the complexities involved in designing a global sports league and used mathematical modeling to build practical scheduling frameworks. While the choice of sport did not make a paper inherently stronger or weaker, it often influenced the direction and creativity of the modeling. Football (soccer) was the most popular choice, but other sports (basketball, volleyball, ultimate frisbee, handball, tug-of-war, and esports) led to diverse approaches. Certain sports led teams to emphasize geographic clustering, competitive balance, or established league structures, while others encouraged teams to consider factors such as match formats, gender representation, time-zone alignment, or digital latency. This diversity provided fertile ground for a wide range of thoughtful and innovative modeling approaches. Examples of particularly effective modeling approaches and techniques are highlighted on the following page:

- Fairness frameworks. Several papers translated qualitative notions of equity into quantitative, computable measures. One team (2025076, Meritorious) developed a fairness score using AHP weighting and applied it consistently across scheduling decisions. Team 2025003 (Meritorious) built a fairness matrix scoring matchups by time-zone differences, opponent diversity, and travel efficiency. Others incorporated rest periods, competitive parity metrics, or travel efficiency scores to ensure fairness was reflected explicitly in the model. These approaches showed an appreciation for the many dimensions that shape equitable international competition.

- Clustering for sustainability. Some teams used algorithms like k-means or hierarchical clustering to reduce travel distances and create geographically coherent league structures. Team 2025006 (Outstanding) combined clustering with simulated annealing to optimize group assignments and minimize travel. While some others used distance-based grouping to maintain geographic balance without unnecessary increases in total games. These approaches reflected careful consideration of the trade-offs inherent in global scheduling.

- Optimization for scheduling. Several teams (2025003, Meritorious, among others) implemented integer linear programming, matching algorithms, or constraint solvers (e.g., Google OR-Tools, CP-SAT solver), or matching algorithms to generate schedules that minimized travel or maximized fairness. The best papers explained constraints clearly, step-by-step, included flowcharts, and discussed trade-offs across alternative formats. This helps readers to understand how constraints and objectives were translated into a working schedule.

- Composite scoring systems. Some teams created intuitive indices to select their 20 teams, combining competitive strength, league quality, geographic representation, and sustainability into composite scores. These were often validated through sensitivity tests or visual comparisons, reinforcing credibility. A few teams (such as 2025024, Meritorious) applied AHP or hybrid weighting methods (e. g., EWM-Based TOPSIS) to prioritize criteria.

- Simulation and scenario analysis. Monte Carlo simulations or controlled variations of key assumptions (e. g. travel distances or match frequency) were used to test schedule robustness and explore uncertainty (evaluating season outcomes, or test how changes in key assumptions, such as travel distances, match load, or competitive balance, might impact their models results). Team 2025048 (Honorable Mention) simulated thousands of schedules to evaluate fairness and sustainability trade-offs. These analyses helped teams interpret fairness under different scenarios and strengthened their conclusions.

- Visual communication. Some teams produced clear and engaging schedule graphics or travel distance maps that allowed non-technical readers to grasp league structure quickly. Others used flowcharts to explain their scheduling algorithms or illustrated trade-offs using well-designed tables and graphs. Team 2025080 (Honorable Mention) produced an outstanding schedule diagram that made complex structures easy to interpret. Judges valued visuals that clarified reasoning rather than those that simply serve as decoration.

- Sport-specific innovations. A few papers introduced innovative or sport-specific considerations in their modeling. One incorporated time-zone fairness and server latency for an esports league (Team 2025076), adapting traditional scheduling ideas to a digital environment. Another used historical and structural features of its chosen sport to justify competitive balance measures, while others incorporated sustainability metrics (e.g., carbon footprint) or fairness adjustments based on time-of-day scheduling (incorporating jet lag recovery and climate considerations for physical sports, Team 2025006).

- Handling expansions. Extensions to the 24-team league were particularly well done in some submissions. Strong papers (such as Team 2025003) recomputed fairness metrics, re-evaluated geographic clusters, or re-optimized their schedules, and compared multiple expansion scenarios to minimize disruption and maintain sustainability A few teams compared multiple expansion scenarios to determine which additions would create the fewest disruptions. One team used clustering combined with K-means to avoid exponential growth in the number of games.

These examples highlight how thoughtful modeling (whether through simple, well-justified methods or advanced techniques explained clearly) can provide actionable insights for designing fair and sustainable global competitions. They also reinforce that, because multiple suitable models can address the same real-world problem, all aspects of the modeling process should be clearly communicated.

Common Pitfalls Observed

While many teams produced strong, well-structured models, judges also noted recurring issues that weakened some submissions. These included:

- Overly advanced mathematics without justification or explanation: Some papers introduced concepts far beyond the expected level (e.g., Banach space operators, neural networks, or abstract algebraic structures) without explaining the ideas clearly, describing why they were chosen (including what motivated that choice), or integrating them meaningfully into the model.

- Over formalization of simple steps: Using heavy notation or unnecessary complexity for tasks that could be handled with simpler, clearer methods.

- Lack of connection between assumptions and models: Several reports listed assumptions but failed to show how they influenced the modeling process.

- Incomplete coverage of the problem: Omitting key components such as expansion to 24 teams or generalization without explanation.

- Poor visual integration: Figures that were unlabeled, unclear, or disconnected from the text, making interpretation difficult.

These challenges underscore a key lesson: clarity and coherence matter more than sophistication for its own sake. The most successful papers prioritized transparency, usability, and practical applicability—principles that future teams should keep in mind.

Advice to Future Teams

Mathematical modeling is a powerful tool for exploring complex real-world questions, and participating in the IM²C gives students a unique opportunity to practice these skills in an authentic, open-ended setting. This advice reflects both the strengths and challenges observed in this year's submissions.

One essential part of this process is effective teamwork: organizing responsibilities, balancing model development with communication, and working together to manage time well. A well-structured, clearly written report is as important as the model itself. Judges are not looking for the most advanced mathematics but for thoughtful, well-justified approaches that show a deep understanding of the problem. Use the mathematics you know and can explain, refine your model as time allows, and make your assumptions and reasoning transparent. Throughout your report, present your ideas clearly and link each step of your modeling process to the goals of the problem.

Based on this year's challenge, the judges offer the following recommendations for future teams:

- Organize your variables and assumptions clearly. Introduce variables in context rather than listing them all at the beginning of the report. Connect assumptions to fairness definitions, travel constraints, or scheduling decisions.

- Define fairness thoughtfully and justify your modeling choices. Explain why specific factors (e.g., time zones, rest periods, emissions, match diversity) were included and how they align with your chosen sport. Providing this context helps readers see the real-world relevance of your decisions.

- Address all components of the problem. If you simplify or omit parts (e.g., expansion or generalization), explain why.

- Use advanced methods only when justified and explain them clearly. Sophisticated methods can be very effective, but only if their purpose and integration are transparent. Simple, well explained models often outperform complex ones that lack clarity.

- Include sensitivity analysis. Test how changes in assumptions affect results to demonstrate robustness or not (and hence the need to revise a model).

- Communicate effectively with visuals. Use clear, well-labeled diagrams, maps, and tables that support your explanation.

- Write a letter for decision-makers, not mathematicians. Avoid technical jargon in the letter; focus on actionable insights.

- Balance sophistication with usability. Prioritize interpretability and practical value over complexity.

- Communicate continuously. Revisit earlier sections, refine explanations, and ensure consistency throughout the report.

Finally, judges encourage teams to reflect on their modeling process. Because all models used to solve complex real-world problems will have flaws, it is critical to recognize these limitations and make them transparent for the reader. Discussing the strengths and limitations of your model and identifying areas for improvement shows maturity and awareness of the challenges inherent in real-world modeling. Remember that modeling is iterative: it involves exploration, decision-making, and revision. Judges value creativity, clear reasoning, and thoughtful communication. By engaging deeply with the problem and articulating your ideas clearly, you contribute meaningfully to the IM²C community and help set a standard for future participants.

Conclusion

This year's IM²C highlighted the many ways mathematical modeling can illuminate complex, real-world decisions by posing a challenge to create a Global Sports League. Judges were impressed not only by the schedules and analyses teams produced, but also by the creativity, perseverance, and thoughtful reasoning evident throughout the submissions.

The judging panel, composed of educators and modelers from around the world, applauds all participating teams for their dedication and hard work. We are also grateful to the teachers, advisors, family members, mentors, and schools who supported these efforts. We hope students will carry forward the skills and confidence gained through this experience, and we look forward to seeing their continued growth as mathematical modelers, applying creativity and rigorous reasoning to future challenges.

For more information about the IM^{2}C, including the complete 2015–2025 results and sample papers, visit

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