# Brown Mathematical Contest in Modeling (BMCM)
# Solutions due Sunday, November 17 at 5pm ET

Choose one of the two problems proposed below. Submit your model report (and letter or flier) to christine_tseng@brown.edu by **Sunday, November 17 at 5pm ET**. Reports received after this time will not be considered.

Your report should start with a cover sheet that includes the following information: names of your team members, title of your report, and which problem you chose to solve. The rest of the pages in your report **should NOT include your team members' names OR your undergraduate institution(s)**. Remember to cite your sources.

# Problem 1: Luck vs Skill in College Basketball [1]

Many athletes train to play sports in college and professionally for their entire lives. As fans, it is exciting to watch these athletes compete and put their carefully-honed skills to the test. But wins and losses are rarely the result of skill alone. There are a myriad of other factors that may affect the outcome of any game. Some of those factors often come down to luck. This balance between skill and luck is part of what makes sports so engaging to watch. While in some games you may be able to predict a clear winner, many games and their outcomes are not so straightforward. A sports newspaper is interested in exploring this question quantitatively for their readership, and your team is in charge of this project.

Previous work (as described in this article) has quantified the interplay of luck and skill in several professional sports [1]. This was based on the idea that ability-based activities tend to have more predictive value. In other words, if you are good at a skill (e.g., bicycle riding) on a particular day, you will most likely also be good at it the next day. But if an activity you participate in is based on luck (e.g., winning a raffle), what you get one day does not anticipate what you would get the next day.

The unpredictability of sports is most prominently on display during March Madness, the NCAA Division 1 Men's Basketball Championship Tournament, where upsets are common. Your team has been charged with developing a model to assess the roles of skill and luck in Men's College Basketball. You were provided access to data from the 2024 season for all teams in the March Madness Tournament. The dataset can be found at this link. **Your task is to develop a mathematical model that predicts the winning team in a basketball game based on some combination of luck and skill-based factors.**

Your dataset contains win/loss information as well as exact game scores. You want to use these datasets and your model to give a prediction of skill vs luck in college basketball. In particular, you may consider whether incorporating the margin of victory in each game can change your model predictions of the contributions of ability and chance to the sports outcomes. You may also assess how accurately your model could predict the outcome of the 2024 March Madness Tournament.

Write a detailed technical report to explain your model and findings to the analytics team at your newspaper. In addition to this report, write a one-page letter to the newspaper chief editor, explaining the main results of the report and suggesting findings that can be communicated with the basketball fans reading the newspaper.

[1] Suggested by Nic Lam (University of Canterbury)

# Problem 2: Spotted Lantern Fly Invasion

While the spotted lanternfly originates from a few countries in Asia, the species was first "spotted" in Pennslyvania in 2014. These colorful planthoppers may look intriguing, but their feeding patterns have threatened the ecosystems of several states in the U.S. [2]. Their sharp mouths damage the host plants that they feed on. Moreover, they excrete a sugary, partially digested waste called honeydew that attracts other troublesome insects such as wasps [3]. This honeydew can also lead to the growth of multiple types of fungi that further impact host plants. The tree-of-heaven, an invasive species of deciduous trees, is a hot spot for these pests. Since other host plants include grapes, maple trees, and other profitable plants, the spotted lanternfly has a strong detrimental economic impact on our communities. Additionally, the damage to these habitats could affect the lives of other animals in the area. There have been multiple methods used to reduce the spread, like those listed on page 6 of this APHIS report [4]. However, the spotted lantern flies continue to spread.

**A joint board of political representatives and leaders in the wine and timber industries from the affected states have requested that you develop a model for strategies to reduce the growth of this invasive species.** This mathematical model must look at the populations of lantern flies in the U.S. and consider the effect of at least one of the intervention strategies mentioned in the APHIS report to that population. Provided below are some of the methods from the APHIS report that you may consider:

- Tree-of-heaven removal strategies
- Egg mass scraping
- Public outreach campaigns

Write a detailed technical report describing your model, the management strategies you considered, the anticipated risk of population growth, and related costs of your recommended approach. In addition to the report, you are asked to prepare an accessible flier to inform the public about your strategy, including a summary about your suggested adaptations to curb the spread.

# References

[1] Anette Hosoi. Feeling lucky? the relative roles of skill and chance in sports. *SIAM News Collections*, 57(08), 2024.

[2] U.S. Fish & Wildlife Service. Stopping the spotted lanternfly in its tracks. https://www.fws.gov/story/stopping-spotted-lanternfly-its-tracks, 2024.

[3] PA Government website. Spotted lanternfly. https://www.pa.gov/en/agencies/pda/plants-land-water/spotted-lanternfly.html, 2024.

[4] Animal and Plant Health Inspection Service. Final environmental assessment: Expanded spotted lanternfly control program in select states in the midwest, northeast, and mid-atlantic regions of the united states. https://www.regulations.gov/document/APHIS-2023-0004-0005, 2023.