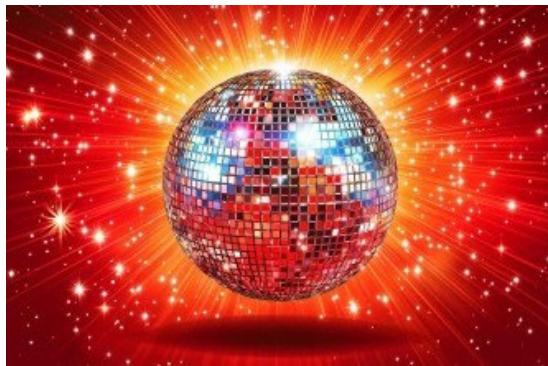


2026 MCM
Problem C: Data With The Stars



Dancing with the Stars (DWTS) is the American version of an international television franchise based on the British show “Strictly Come Dancing” (“Come Dancing” originally). Versions of the show have appeared in Albania, Argentina, Australia, China, France, India, and many other countries. The U.S. version, the focus of this problem, has completed 34 seasons.

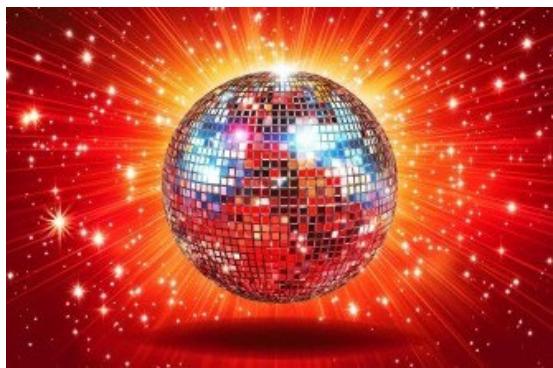
Celebrities are partnered with professional dancers and then perform dances each week. A panel of expert judges scores each couple’s dance, and fans vote (by phone or online) for their favorite couple that week. Fans can vote once or multiple times up to a limit announced each week. Further, fans vote for the star they wish to keep, but cannot vote to eliminate a star. The judge and fan votes are combined in order to determine which couple to eliminate (the lowest combined score) that week. Three (in some seasons more) couples reach the finals and in the week of the finals the combined scores from fans and judges are used to rank them from 1st to 3rd (or 4th, 5th).

There are many possible methods of combining fan votes and judge scores. In the first two seasons of the U.S. show, the combination was based on ranks. Season 2 concerns (due to celebrity contestant Jerry Rice who was a finalist despite very low judge scores) led to a modification to use percentages instead of ranks. Examples of these two approaches are provided in the Appendix.

In season 27, another “controversy” occurred when celebrity contestant Bobby Bones won despite consistently low judges scores. In response, starting in season 28 a slight modification to the elimination process was made. The bottom two contestants were identified using the combined judge scores and fan votes, and then during the live show the judges voted to select which of these two to eliminate. Around this same season, the producers also returned to using the method of ranks to combine judges scores with fan votes as in seasons one and two. The exact season this change occurred is not known, but it is reasonable to assume it was season 28.

Judge scores are meant to reflect which dancers are technically better, although there is some subjectivity in what makes a dance better. Fan votes are likely much more subjective, influenced by the quality of the dance, but also the popularity and charisma of the celebrity. Show producers might actually prefer, to some extent, conflicts in opinions and votes as such occurrences boost fan interest and excitement.

2026 MCM
问题C：带星号的数据



《与星共舞》（DWTS）是美国版的国际电视节目，改编自英国《舞林争霸》（原名《来跳舞》）。该节目已在阿尔巴尼亚、阿根廷、澳大利亚、中国、法国、印度等众多国家播出。作为本问题焦点的美国版，已播出34季。

明星与专业舞者组成搭档，每周进行舞蹈表演。由专家组成的评审团会对每对组合的舞蹈进行评分，粉丝则通过电话或在线方式投票选出当周最喜爱的组合。粉丝每周可投票一次或多次，但需遵守每周公布的投票上限。此外，**粉丝只能为心仪的明星投票，无法对明星淘汰投票。评委与粉丝的投票结果将合并计算，以确定当周淘汰的组合（总分最低者）。**三对组合（部分季数更多）进入决赛，决赛当周将综合评委与粉丝的评分，按总分从高到低排名前三（或第四、5th）。

将粉丝票和评委评分相结合的方法有很多。在美国版《美国达人秀》的前两季中，评分是根据排名来计算的。第二季由于明星选手**杰瑞·赖斯（Jerry Rice）**的出现（尽管评委评分很低，他还是进入了决赛），评分方式被修改为用百分比代替排名。这两种方法的例子见附录。

在第27季节目中，名人选手**鲍比·博恩斯**尽管评委评分持续偏低却意外夺冠，再次引发争议。为此，从第28季开始对淘汰机制进行了微调：通过综合评委评分与观众票数确定最后两名选手，随后在直播环节由评委投票决定淘汰哪位。同一季中，制作方还恢复了第一、二季采用的排名制，将评委评分与观众票数相结合。虽然具体是第28季实施了这一调整，但可以合理推测是该季的改革。

评委评分旨在体现舞者的技术水平，但舞蹈优劣的评判标准往往带有主观性。粉丝投票则更具主观性，既取决于舞蹈质量，也受明星人气与魅力影响。节目制作方有时甚至偏爱意见分歧和票数争议，因为这类现象能有效激发粉丝的热情与期待。

Data with judges scores and contestant information is provided and described below. You may choose to include additional information or other data at your discretion, but you must completely document the sources. Use the data to:

- Develop a mathematical model (or models) to produce estimated fan votes (which are unknown and a closely guarded secret) for each contestant for the weeks they competed.
 - Does your model correctly estimate fan votes that lead to results consistent with who was eliminated each week? Provide measures of the consistency.
 - How much certainty is there in the fan vote totals you produced, and is that certainty always the same for each contestant/week? Provide measures of your certainty for the estimates.
- Use your fan vote estimates with the rest of the data to:
 - Compare and contrast the results produced by the two approaches used by the show to combine judge and fan votes (i.e. rank and percentage) across seasons (i.e. apply both approaches to each season). If differences in outcomes exist, does one method seem to favor fan votes more than the other?
 - Examine the two voting methods applied to specific celebrities where there was “controversy”, meaning differences between judges and fans. Would the choice of method to combine judge scores and fan votes have led to the same result for each of these contestants? How would including the additional approach of having judges choose which of the bottom two couples to eliminate each week impact the results? Some examples you might consider (there may also be others you identified):
 - season 2 –Jerry Rice, runner up despite the lowest judges scores in 5 weeks.
 - season 4 – Billy Ray Cyrus was 5th despite last place judge scores in 6 weeks.
 - season 11 – Bristol Palin was 3rd with the lowest judge scores 12 times.
 - season 27 – Bobby Bones won the despite consistently low judges scores
 - Based on your analysis, which of the two methods would you recommend using for future seasons and why? Would you suggest including the additional approach of judges choosing from the bottom two couples?
- Use the data including your fan vote estimates to develop a model that analyzes the impact of various pro dancers as well as characteristics for the celebrities available in the data (age, industry, etc). How much do such things impact how well a celebrity will do in the competition? Do they impact judges scores and fan votes in the same way?
- Propose another system using fan votes and judge scores each week that you believe is more “fair” (or “better” in some other way such as making the show more exciting for the fans). Provide support for why your approach should be adopted by the show producers.
- Produce a report of no more than 25 pages with your findings and include a one- to two-page memo summarizing your results with advice for producers of DWTS on the impact of how judge and fan votes are combined with recommendations for how to do so in future seasons.

以下提供并描述了包含评委评分与参赛者信息的数据。您可根据自身判断选择是否纳入其他信息或数据，但必须完整记录数据来源。请利用该数据：

- 建立数学模型（或多个模型），用于估算每位参赛者在比赛期间各周的预估粉丝票数（该数据未知且属于严格保密信息）。
 - 您的模型能否准确预测导致每周淘汰结果一致的粉丝投票？请提供一致性评估指标。
 - 你所生成的粉丝投票总数具有多少确定性？这种确定性是否在每位参赛者/每周都保持一致？请提供你对这些估计值的确定性度量。
- 将您的粉丝投票预估数据与其他数据结合使用，以：
 - 对比分析节目采用的两种方法（即排名法与百分比法）在跨季整合评委与观众投票结果时的表现（即对每个季度均采用两种方法）。若结果存在差异，是否表明其中一种方法更倾向于偏向观众投票？
 - 请分析两种投票方式在涉及“争议”的明星案例中的应用情况，即评委与粉丝意见存在分歧的情形。若采用评委评分与粉丝票数相结合的投票方式，是否能确保每位参赛者获得相同结果？若增加评委每周筛选淘汰排名最后两位选手的环节，会对最终结果产生何种影响？可参考以下示例（您可能还发现了其他案例）：
 - 第二季——杰瑞·莱斯虽获得评委五周内最低分，却仍斩获亚军。
 - 第四季——尽管比利·雷·塞勒斯在六周内获得评委最低分，他仍位列第五。
 - 第11赛季——布里斯托尔·佩林以12次获得最低裁判评分的成绩位列第三。
 - 第27季——尽管评委评分持续偏低，鲍比·博恩斯仍成功夺冠
 - 根据您的分析，您会推荐在未来的赛季中采用哪种方法？为什么？您是否建议增加评委从排名最后的两对选手中进行选择的额外方式？
- 利用包含粉丝投票预估的数据，建立一个模型来分析不同职业舞者的影响，以及数据中可获得的名人特征（如年龄、行业等）。这些因素对名人参赛表现的影响程度如何？它们是否以相同方式影响评委评分和粉丝投票？
- 建议采用每周通过粉丝投票和评委评分来评选更“公平”（或以其他方式更“出色”，例如让节目更吸引粉丝）的系统。请说明为何该方案值得节目制作方采纳。
- 撰写一份不超过25页的报告，阐述你的研究发现，并附上1至2页的备忘录，总结研究成果，为DWTS制作人提供关于裁判与观众票数结合方式影响的建议，并提出未来赛季的实施建议。

Your PDF solution of no more than 25 total pages should include:

- One-page Summary Sheet.
- Table of Contents.
- Your complete solution.
- One- to two-page memo.
- References list.
- [AI Use Report](#) (If used does not count toward the 25-page limit.)

Note: There is no specific required minimum page length for a complete MCM submission. You may use up to 25 total pages for all your solution work and any additional information you want to include (for example: drawings, diagrams, calculations, tables). Partial solutions are accepted. 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 [COMAP 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 25 total page limit for your solution.

Data File: [2026_MCM_Problem_C_Data.csv](#) – contestant information, results, and judges scores by week for seasons 1 – 34. The data description is provided in **Table 1**.

Table 1: Data Description for 2026_MCM_Problem_C_Data.csv

Variables	Explanation	Example
celebrity_name	Name of celebrity contestant (Star)	Jerry Rice, Mark Cuban, ...
ballroom_partner	Name of professional dancer partner	Cheryl Burke, Derek Hough, ...
celebrity_industry	Star profession category	Athlete, Model, ...
celebrity_homestate	Star home state (if from U.S.)	Ohio, Maine, ...
celebrity_homecountry/region	Star home country/region	United States, England, ...
celebrity_age_during_season	Age of the star in the season	32, 29, ...
season	Season of the show	1, 2, 3, ..., 32
results	Season results for the start	1st Place, Eliminated Week 2, ...
placement	Final place for the season (1 best)	1, 2, 3, ...
weekX_judgeY_score	Score from judge Y in week X	1, 2, 3, ...

Notes on the data:

1. *Judges scores for each dance are from 1 (low) to 10 (high).*
 - a. *In some weeks the score reported includes a decimal (e.g. 8.5) because each celebrity performed more than one dance and the scores from each are averaged.*
 - b. *In some weeks, bonus points were awarded (dance offs etc); they are spread evenly across judge/dance scores.*
 - c. *Team dance scores were averaged with scores for each individual team member.*
2. *Judges are listed in the order they scored dances; thus “Judge Y” may not be the same judge from week to week, or season to season.*

您的PDF解决方案总页数不得超过25页，应包含：

- 单页摘要表。
- 目录
- 您的完整解决方案。
- 1-2页备忘录。
- 参考文献列表。
- [AI使用报告](#) (如使用，不计入25页的限制。)

注意：完整的MCM提交文件没有强制要求的最低页数限制。您可使用最多25页来展示全部解决方案及附加信息（例如图纸、图表、计算过程、表格等）。部分解决方案可接受。我们允许谨慎使用ChatGPT等生成式AI工具，但无需为此问题创建完整解决方案。若选择使用生成式AI，必须遵守[COMAP AI使用政策](#)。此操作将生成额外的AI使用报告，需添加至PDF解决方案文件末尾，且不计入25页的总页数限制。

数据文件：[2026_MCM_Problem_C_Data.csv](#)——第1-34季每周参赛者信息、比赛结果及评委评分。数据说明详见**表1**。

表1： 2026_MCM_Problem_C_Data.csv数据描述

变量	说明	样例
名人名	明星选手姓名 (Star)	杰里·赖斯、马克·库班、...
舞厅伴侣	专业舞伴姓名	Cheryl Burke、Derek Hough、...
名人产业	明星职业分类	运动员，模特
名人宅邸	原籍国 (若来自美国)	俄亥俄州、缅因州
名人家乡国/地区	母国/地区	美国、英格兰、...
名人年龄与赛季	季龄	32, 29, ...
季节	节目播出季	1, 2, 3, ..., 32
后果	起始赛季成绩	第一名，第二周淘汰 ...
安置	本赛季排名最后 (1名最佳)	1, 2, 3, ...
周X法官Y评分	第X周Y法官评分	1, 2, 3, ...

数据说明：

1. 评委对每支舞蹈的评分范围为1分 (低分) 至10分 (高分)。
 - a. 在某些周次的评分报告中包含小数 (例如8.5)，这是因为每位明星表演了多个舞蹈项目，且各项目得分取平均值。
 - b. 在某些周次中，会颁发额外积分 (如舞蹈淘汰赛等)；这些积分会均匀分配至评委评分/舞蹈评分中。
 - c. 团队舞蹈得分与每位团队成员的得分取平均值。
2. 评委名单按舞蹈评分顺序排列；因此“评委Y”可能每周或每季不同。