Dancing with the Stars: A Fairness-Engagement Equilibrium Model

Team #XXXXXX

Problem Overview

We analyze 34 seasons of *Dancing with the Stars* (DWTS) to determine whether the show's voting system—combining judges' scores with fan votes—produces fair outcomes that also maintain audience engagement.

Core Findings

- **Fan Vote Estimation:** Using Bayesian MCMC inference with Bottom-k constraints, we estimated latent fan vote shares $f(i, w)$ for 2,777 contestant-week observations with **95.6% prediction accuracy**.

- **Rank vs. Percentage Methods:** Rank-based aggregation produces more meritocratic outcomes (JFI = 0.727) while Percentage-based favors fans more (FFI = 0.788). Champion changed in only 3/34 seasons between methods.

- **Extreme Events:** We identified 2 instances where fan voting overrode judges in Top-3 placements (e.g., Bobby Bones S27, Bristol Palin S11).

- **Pro Dancer Effect:** Professional partners explain 38% of judge score variance; "Star Makers" like Derek Hough provide +8.1 point lift.

Recommended Rule: Dynamic Log-Weighting + Judges' Save

$$\boxed{Score = \alpha(w) \cdot J\% + (1 - \alpha(w)) \cdot \log(1 + F\%)}$$

where $\alpha(w)$ increases from **50% to 70%** over the season:

- Weeks 1–3: 50% judge weight (build audience engagement)

- Weeks 4–7: Gradual increase to 70%

- Weeks 8+: 70% judge weight (merit-focused finale)

Judges' Save Mechanism: When 2 contestants are in bottom, judges can save the one with higher cumulative dance scores.

Key Metrics Summary

Metric	Rank Method	Pct Method
Judge-Favor Index (JFI)	0.727	0.374
Fan-Favor Index (FFI)	0.767	0.788
Fan-Elasticity	0.137	0.122
Kendall τ (final vs. judge)	-0.105	-0.133
Top-3 Overlap	2.76/3 (Jaccard $= 0.912$)	

Expected Impact of Reform

- **Fairness:** 60–70% reduction in "fan override" controversies

- **Engagement:** Fan voting remains meaningful; FFI stays above 0.6

- **Historical Fix:** Bobby Bones (S27) would not have won; Bristol Palin (S11) eliminated before Top 3