Baseball's Unprecedented Half-innings and Other Insights from Markov Chains

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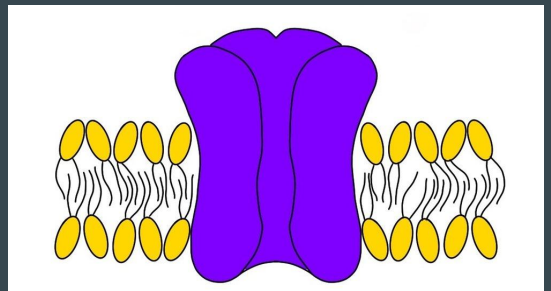
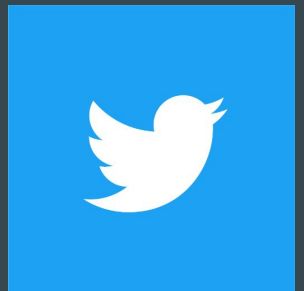
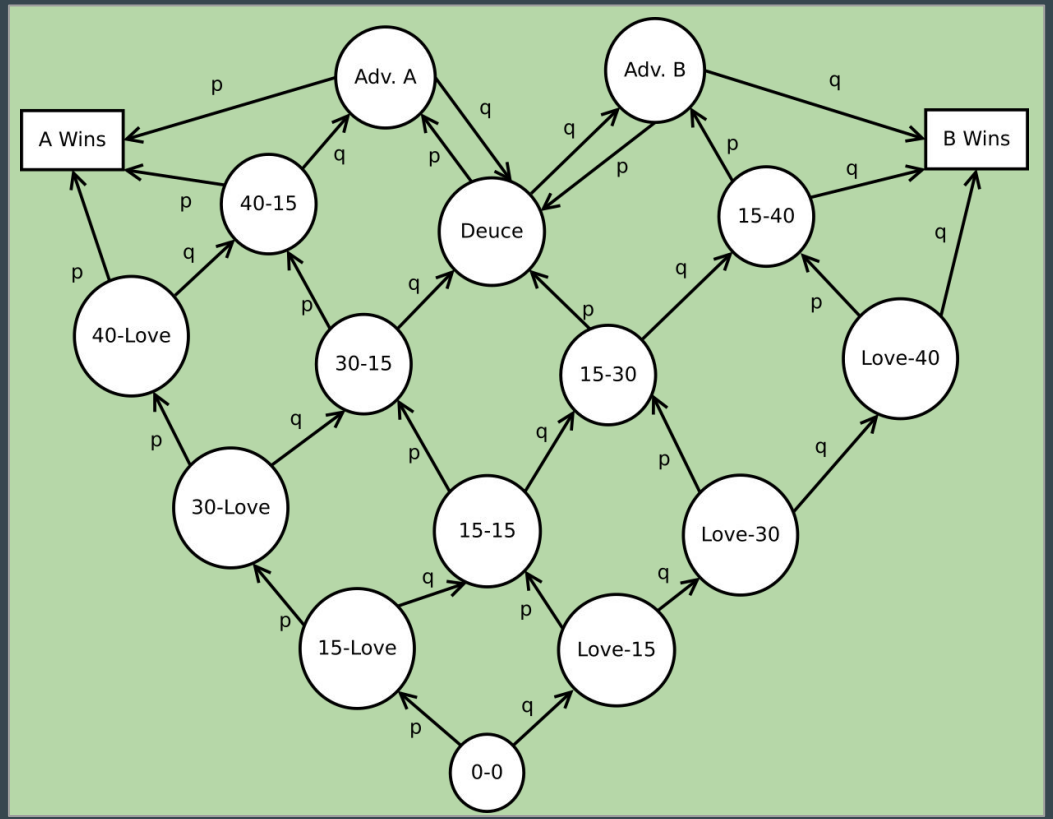
Sean G. Carver, Ph.D.

September 12, 2019

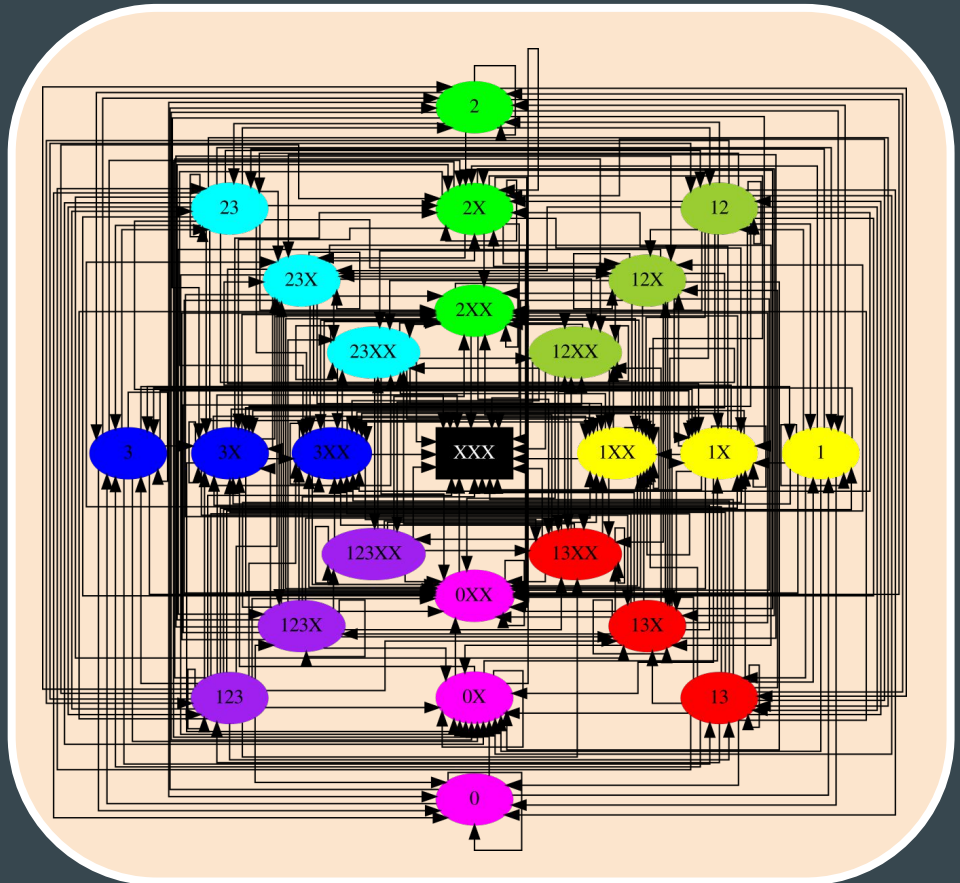




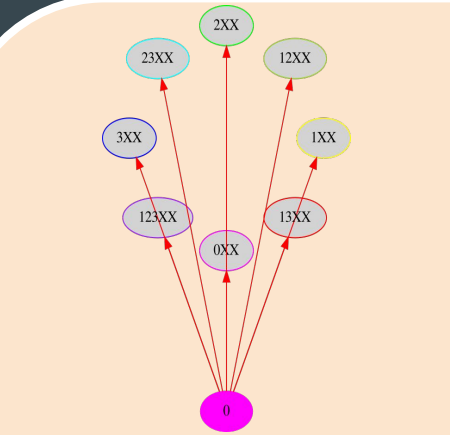
What is a Markov Chain?

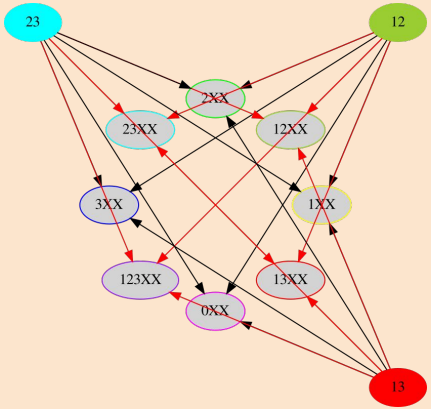


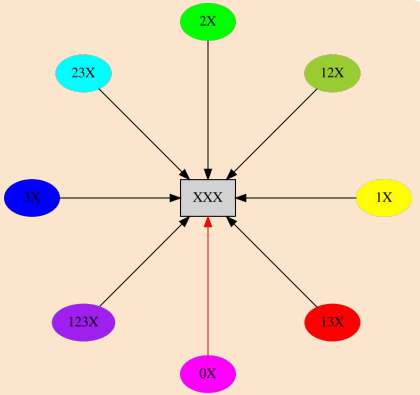
Baseball's Graph as a Markov Chain

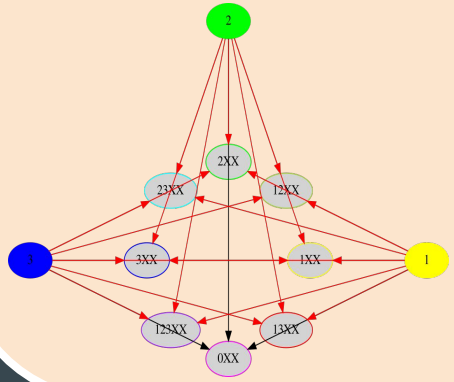


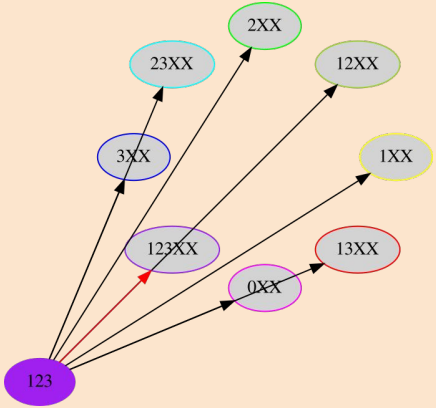
Visualizing Baseball's Graph (Double and Triple Plays)

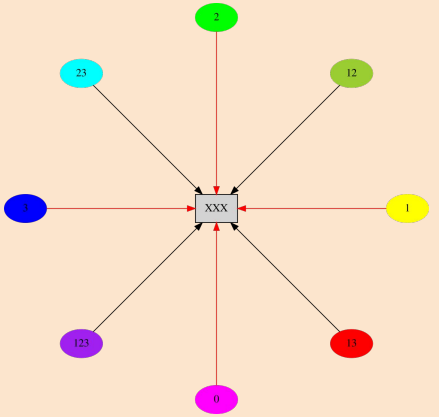




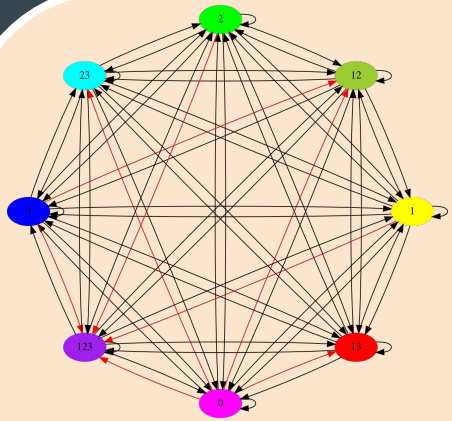


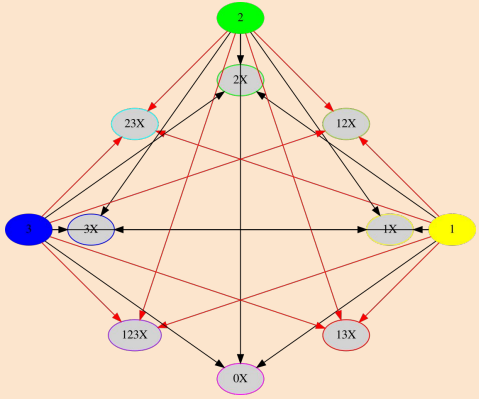


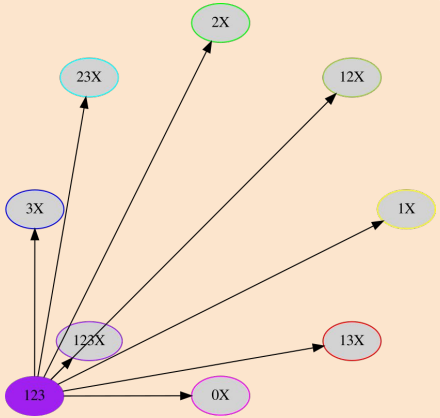


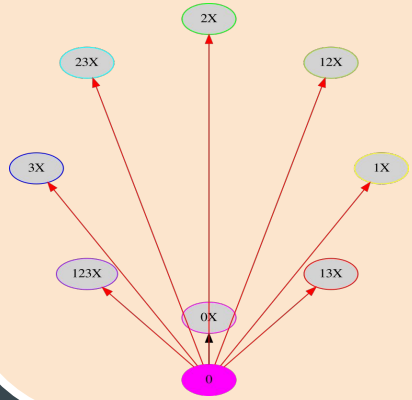


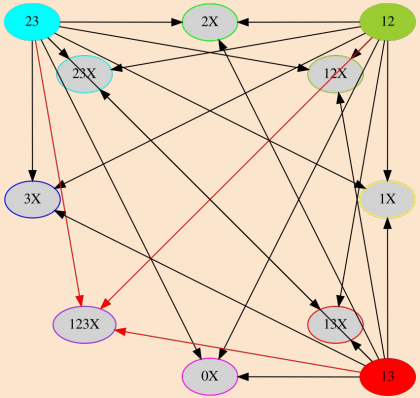
Visualizing Baseball's Graph (Clean and Single Plays)

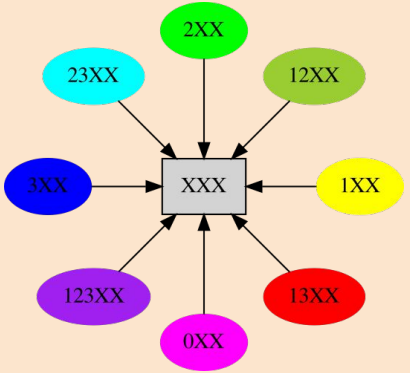




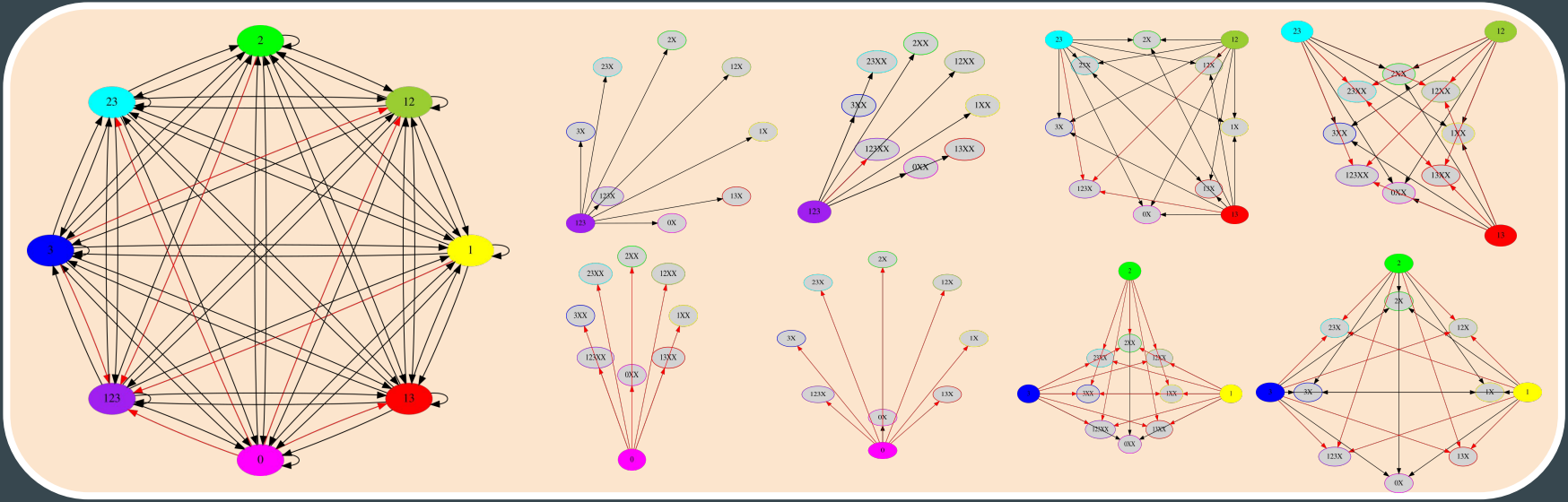








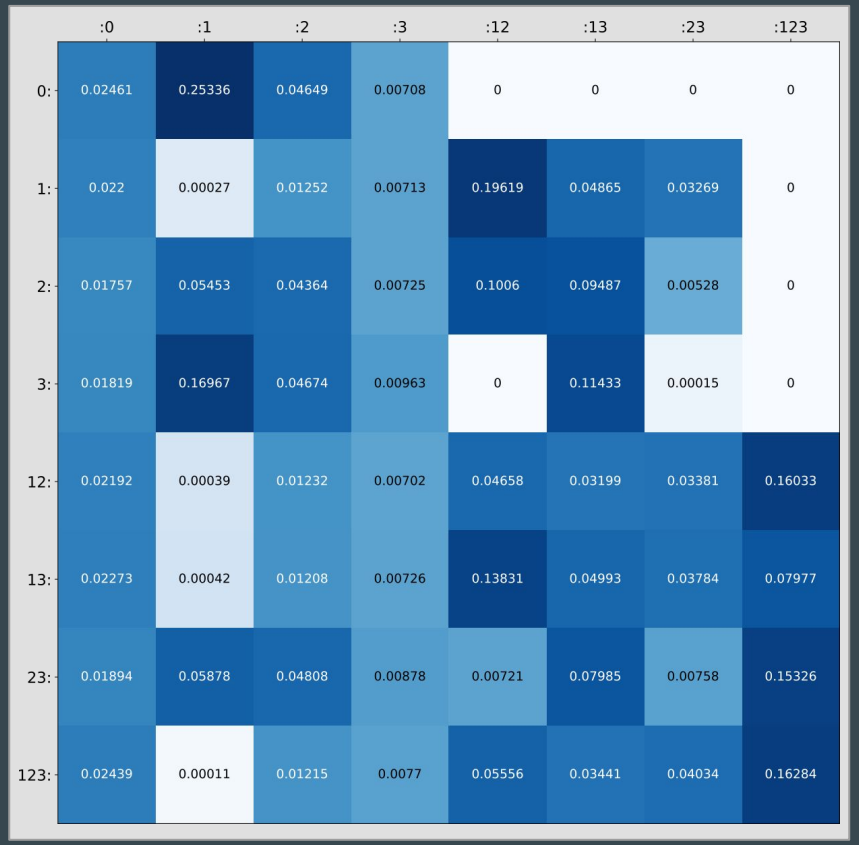
Symmetry and Asymmetry in Baseball's Graph



Rules of symmetric & real baseball: Δ Outs ≥ 0 AND 0 ≤ Runners-on-base ≤ 3
Δ Runners-on-base = 1 - Δ Outs - Δ Score
Δ Score ≥ 0

Additional asymmetries in real baseball: Three outs and it's over!
3:12 (3X:12X, ...) impossible---runners cannot retreat!

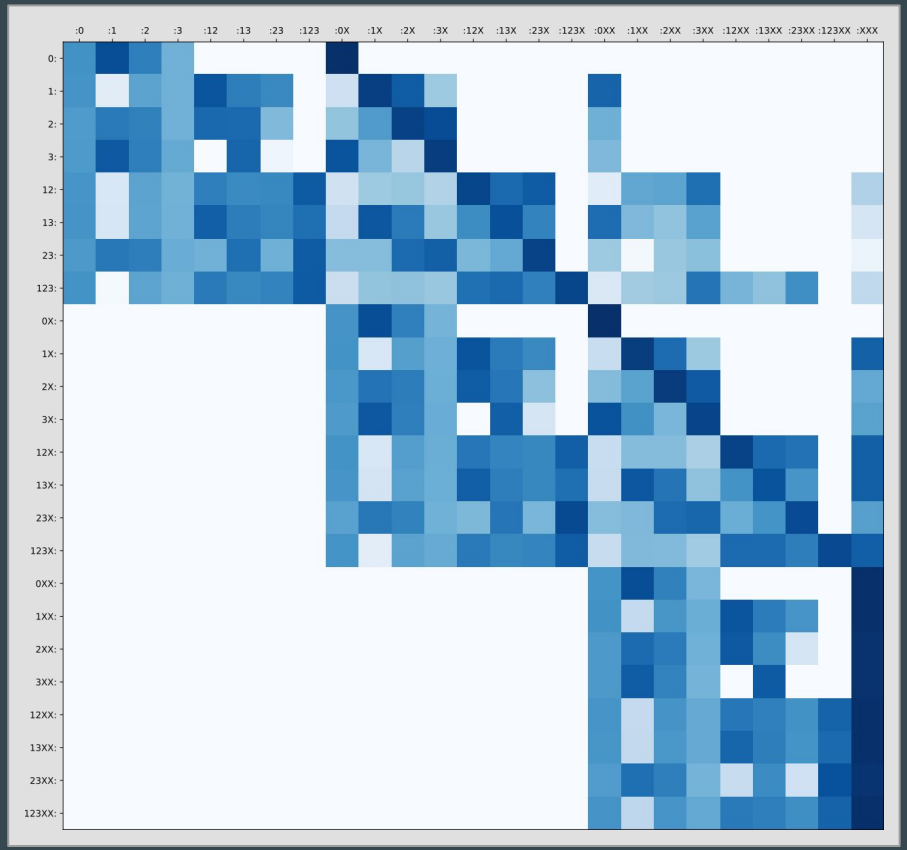
Transition Probability Matrix -- Clean Plays, No Outs



$$\text{Prob.} = \frac{\#\,(\text{From} \rightarrow \text{To})}{\#\,\text{From}}$$

Computed with respect to a population of transitions

Full Transition Probability Matrix

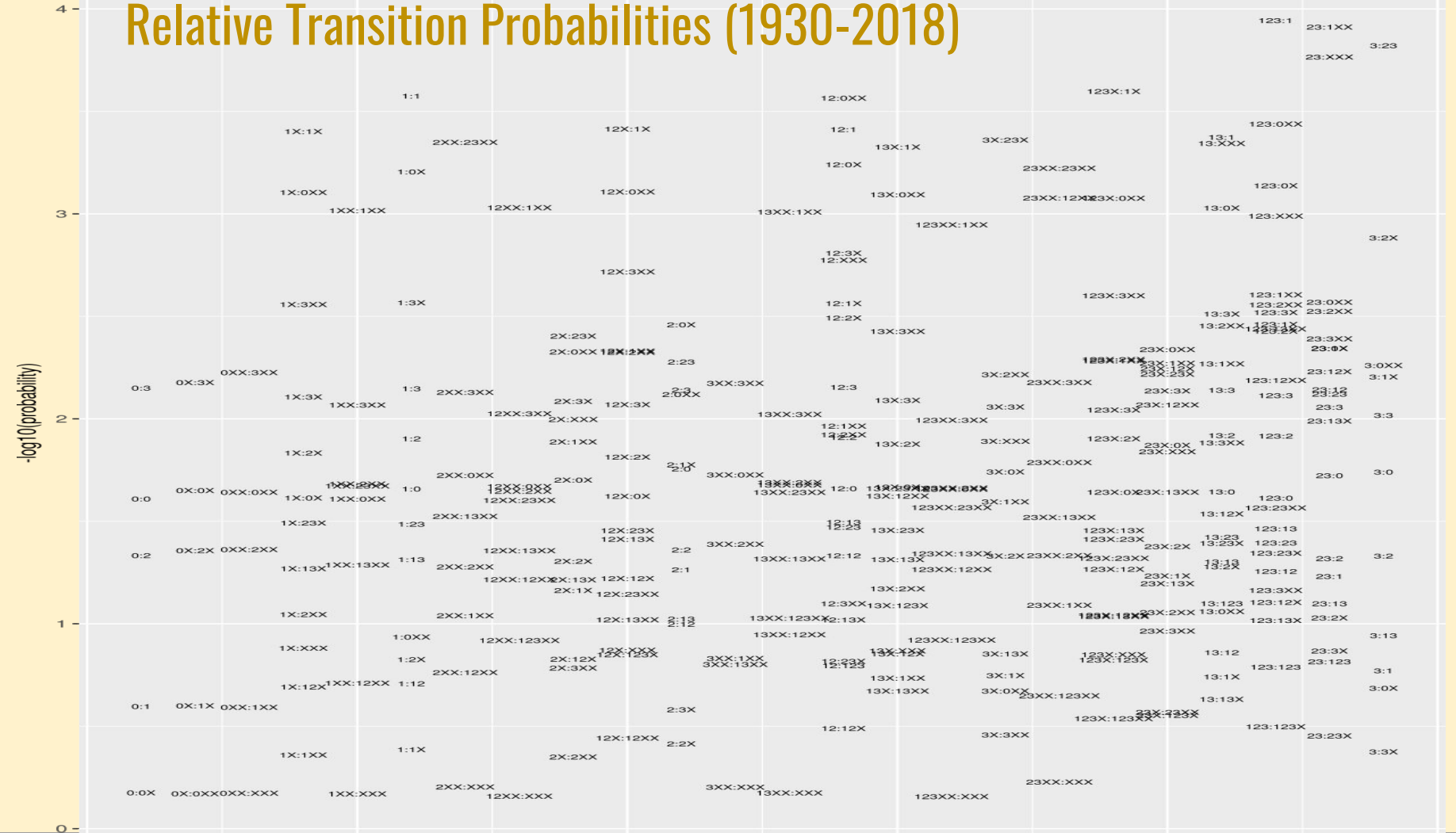


Population:
All MLB teams, 1930-2018,
Regular season

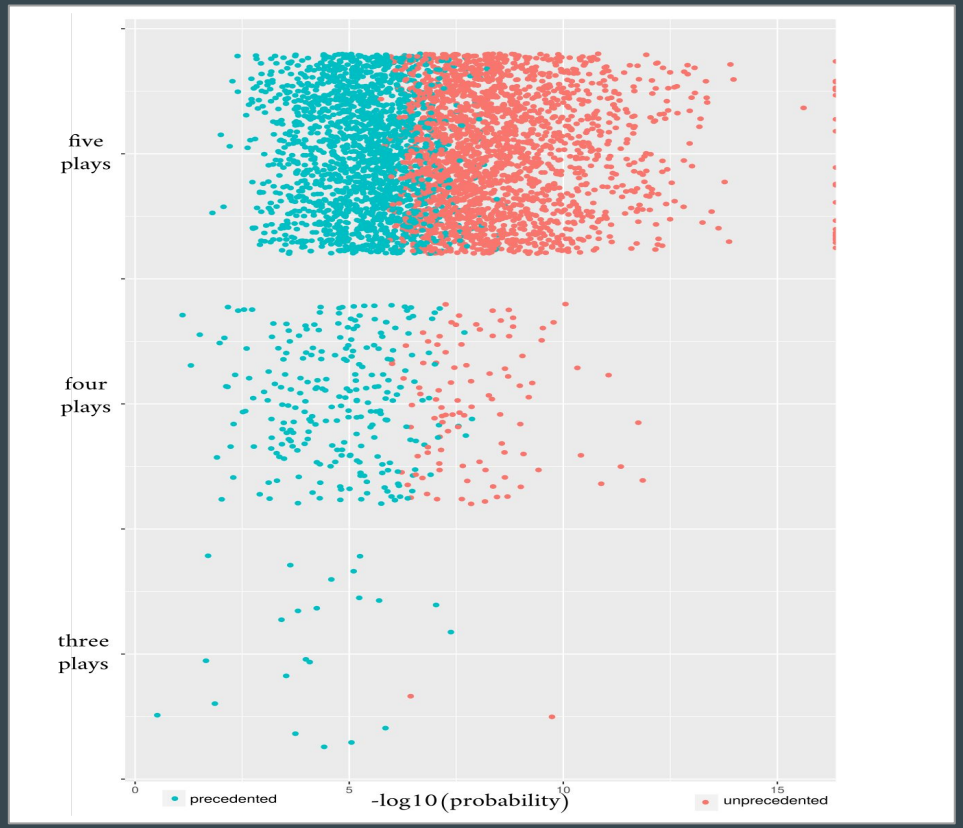
Many More Probabilities Are Zero for Subpopulations

Washington Nationals, batting at home, 2018

Relative Transition Probabilities (1930-2018)



Baseball's Unprecedented Half-innings

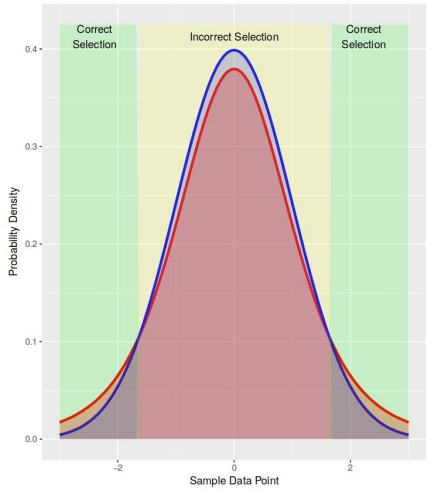


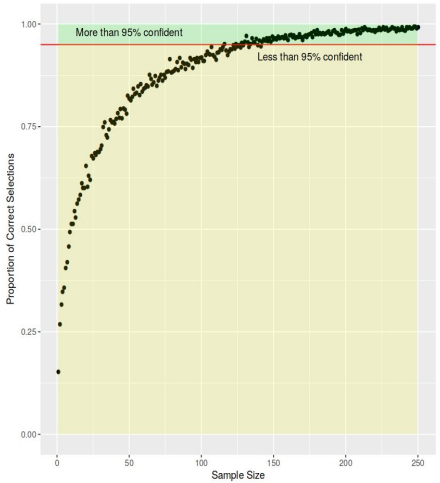
The most unlikely unprecedented half-innings:

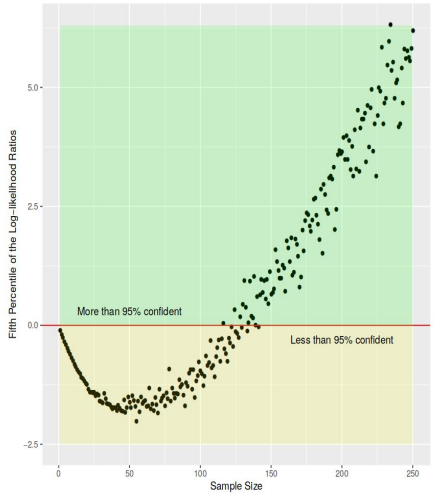
sequence	-log10(probability)
Three Plays	
0:3:13:XXX	6.43509767499117
0:3:23:XXX	9.73543779430501
Four Plays	
0:2:3:23:XXX	11.0579993507313
0:0:3:23:XXX	11.3442887847059
0:3:3:23:XXX	11.7519898723546
0:3:23:23:XXX	11.855734799529
Five Plays	
0:3:23:3:23:XXX	15.6122744428876
3XX:23XX	Infinity

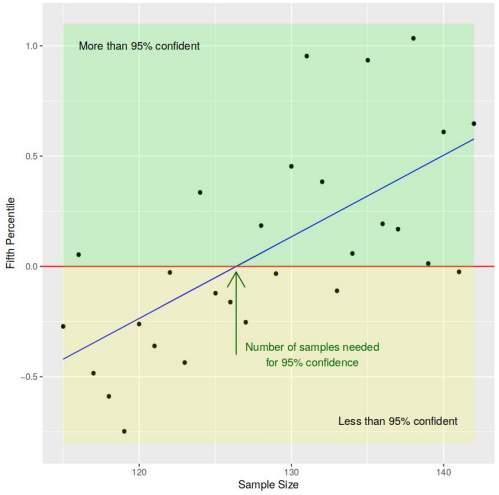
log10(number of half-innings played) = 6.45

Quantifying the Similarity Between Model Baseball Teams









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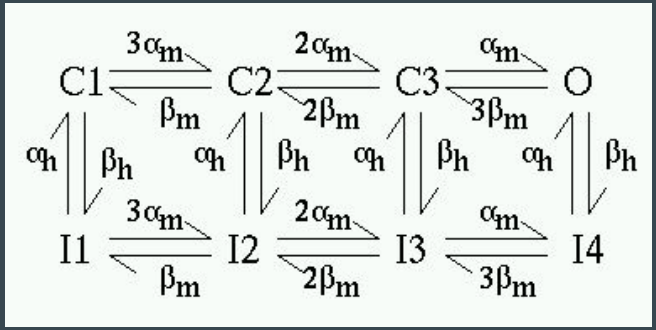
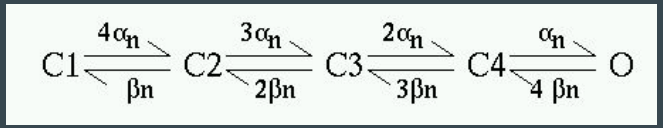
Result: it takes 30±1 half-innings, simulated from the 2011 Baltimore Orioles model, to reject, with 95% confidence, the statement that these half-innings were sampled from the 2011 New York Yankees model.

Making Half-inning History and Markov Transition Probabilities Easily Accessible to All

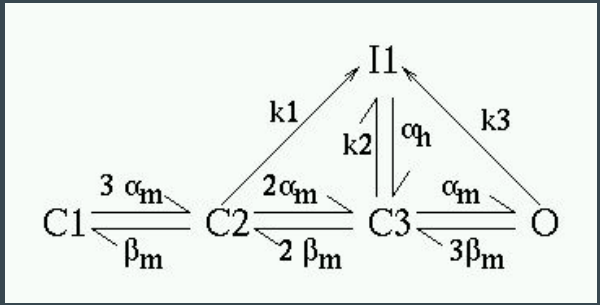
Beyond Sports



Hodgkin-Huxley Sodium Channel



Potassium Channel



Modern Model of Sodium Channel

Exposure
Incubation
Transmission
Immunity

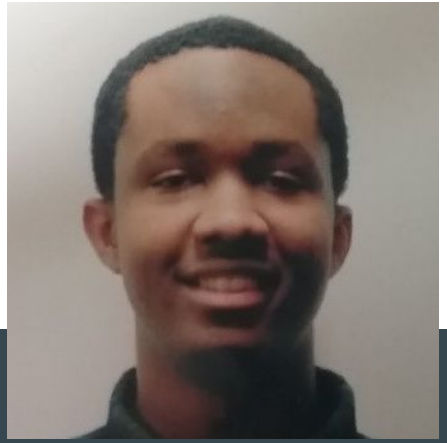
Collaborators on Related Projects

Jacob Ward

Formerly Professorial Lecturer, American University

Jake Berberian

Class of 2022, American University



Kingsley Iyawe

Masters Student, American University, expected graduation: May 2020