

Predicting the Probability of Winning Basketball Games Using Differential Equations

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Outline

- Background
- Goals
- Assumptions
- Variables & Parameters
- Equations/Model
- Results
- Next Steps
- Works Cited

Background

- The use of sports analytics has become increasingly important for coaches and teams to gain a competitive edge.
- Traditional statistical methods such as regression analysis have been used to analyze game data, but they have limitations in predicting game outcomes.
- The development of mathematical models using differential equations can provide more accurate probability estimates for a team's chances of winning a game.

Goal



Goal



- Identify valuable parameters to determine win probability.
- Create a set of differential equations to track changes in efficiencies during basketball games.
- Generate a time dependent equation that measures the win probability based on the efficiencies calculated above.

Assumptions

- Each game does not go into overtime (40 minute games).
- Point differential, offensive efficiency, and defensive efficiency are the only components that contribute to win probability.
- Offensive and defensive efficiencies are based only on shooting percentage, assists, turnovers, steals, and rebounds.

Parameters

Parameter	Definition	Value
$as(t)$	Assist rate at time t	$[0, 1]$
$s(t)$	Shooting percentage at time t	$[0, 1]$
$tn(t)$	Turnover rate at time t	$[0, 1]$
$dr(t)$	Defensive rebounding rate at time t	$[0, 1]$
$or(t)$	Offensive rebounding rate at time t	$[0, 1]$
$st(t)$	Steal rate at time t	$[0, 1]$
w	Natural return to average	0.3
$pw(t)$	Point weight at time t	$[0, 1]$
$ow(t)$	Offensive efficiency weight at time t	$[0, 0.5]$
$dw(t)$	Defensive efficiency weight at time t	$[0, 0.5]$

Variables

Variable	Definition
oe_a	Offensive efficiency of team A
oe_b	Offensive efficiency of team B
oed	Offensive efficiency difference
de_a	Defensive efficiency of team A
de_b	Defensive efficiency of team B
ded	Defensive efficiency difference
sc_a	Score of team A
sc_b	Score of team B
scd	Score difference
$wp(t)$	Probability of winning at time t

Equations

$$\frac{doea}{dt} = (s_a(t) + as_a(t) + or_a(t) - tn_a(t)) * oea - \left(\frac{oea - 1.15}{0.2} \right) * weight$$

$$\frac{doeb}{dt} = (s_b(t) + as_b(t) + or_b(t) - tn_b(t)) * oeb - \left(\frac{oeb - 1.15}{0.2} \right) * weight$$

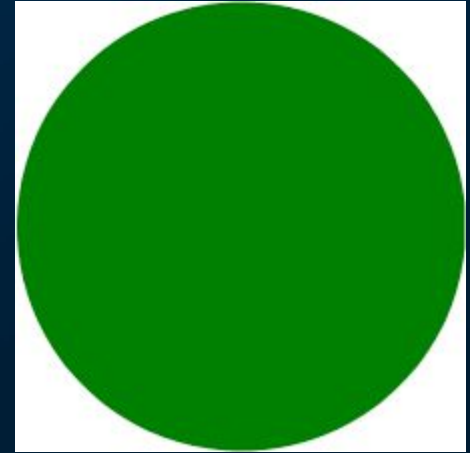
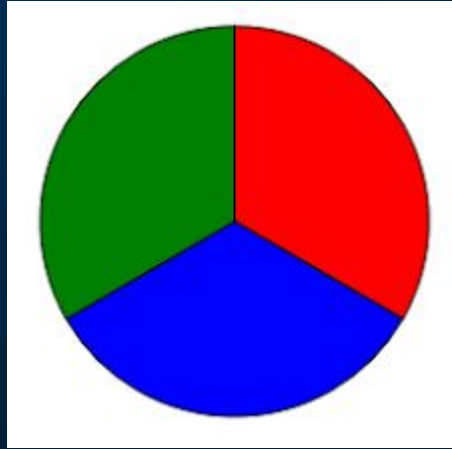
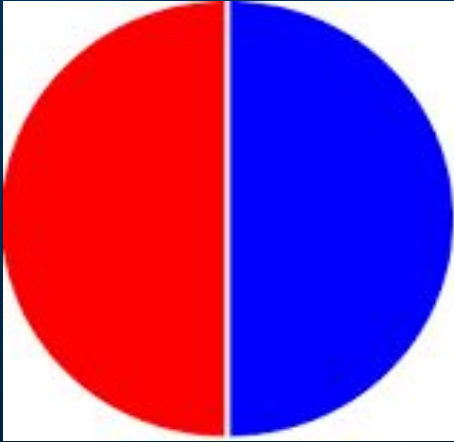
$$\frac{ddea}{dt} = ((1 - s_b(t)) + st_a(t) + dr_a(t) + tn_b(t)) * dea - \left(\frac{dea - 1.15}{0.2} \right) * weight$$

$$\frac{ddeb}{dt} = ((1 - s_a(t)) + st_b(t) + dr_b(t) + tn_a(t)) * deb - \left(\frac{deb - 1.15}{0.2} \right) * weight$$

$$wp(t) = pw(t) * scd(t) + ow(t) * oed(t) + dw(t) * ded$$

Win Probability Equation

$$wp(t) = pw(t)*scd(t) + ow(t)*oed(t) + dw(t)*ded$$



Game Time



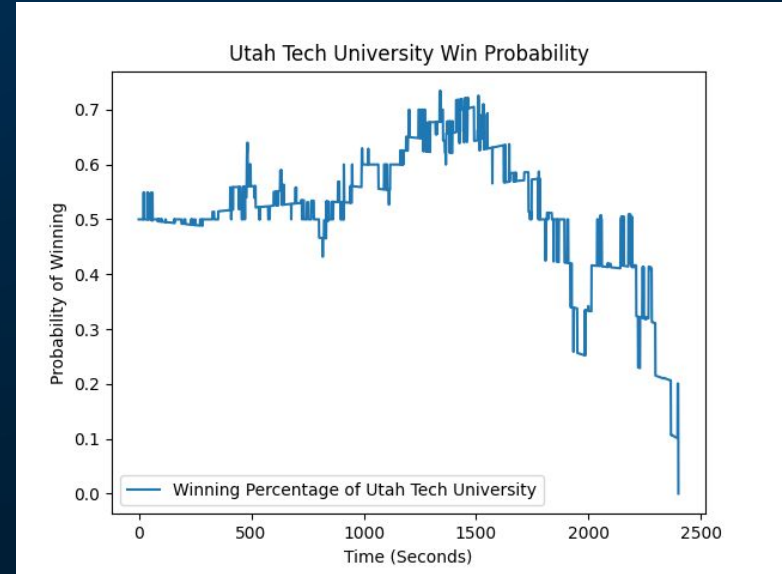
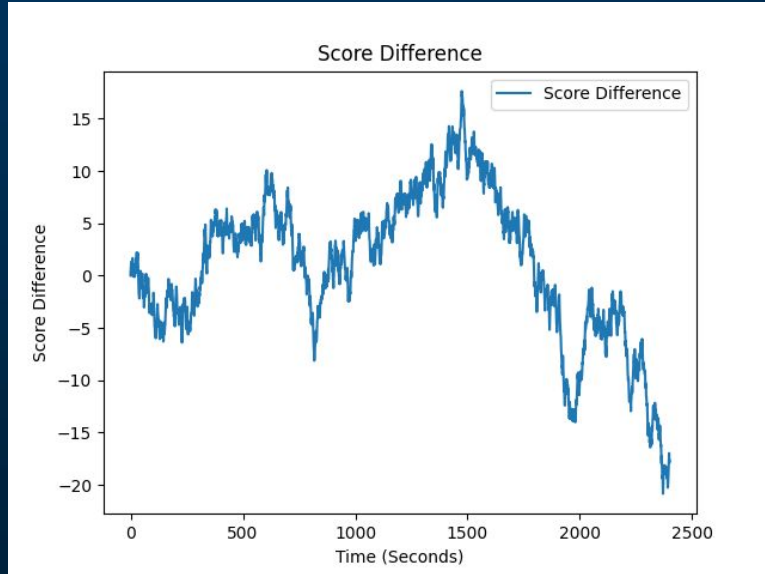
VS



Game 1

	UTU	SUU
Initial Win Percentage	50%	50%
Initial Offensive Efficiency	1.15	1.15
Initial Defensive Efficiency	1.15	1.15
Initial Score	0	0

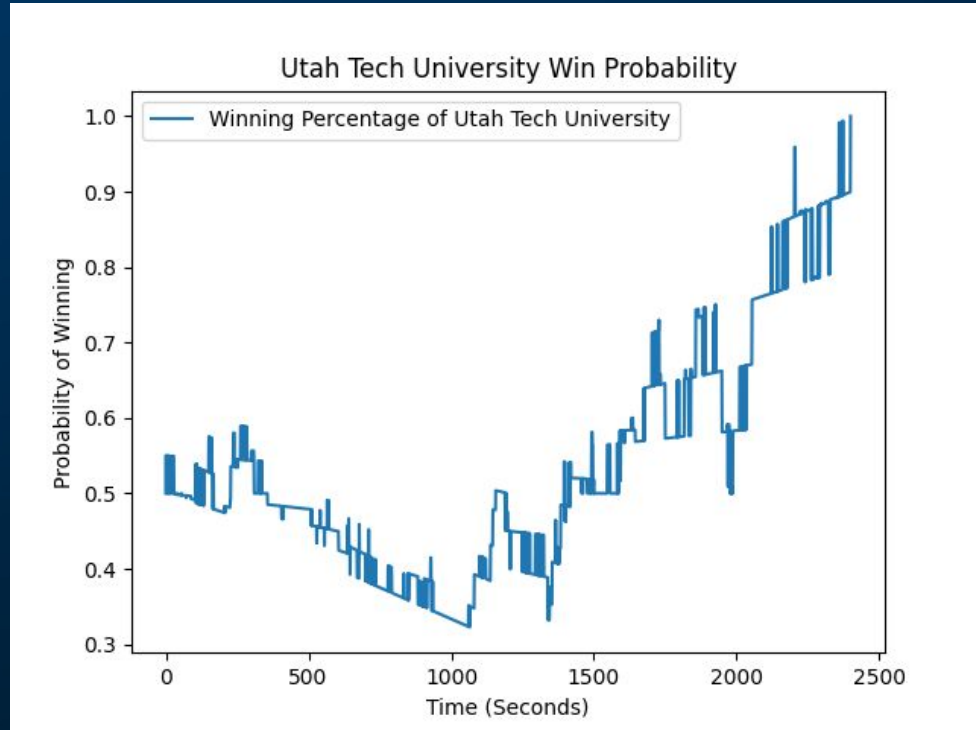
Results



Game 2

	UTU	SUU
Initial Win Percentage	50%	50%
Initial Offensive Efficiency	1.25	1.18
Initial Defensive Efficiency	1.30	1.25
Initial Score	0	0

Results



ScoreBoard



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VS

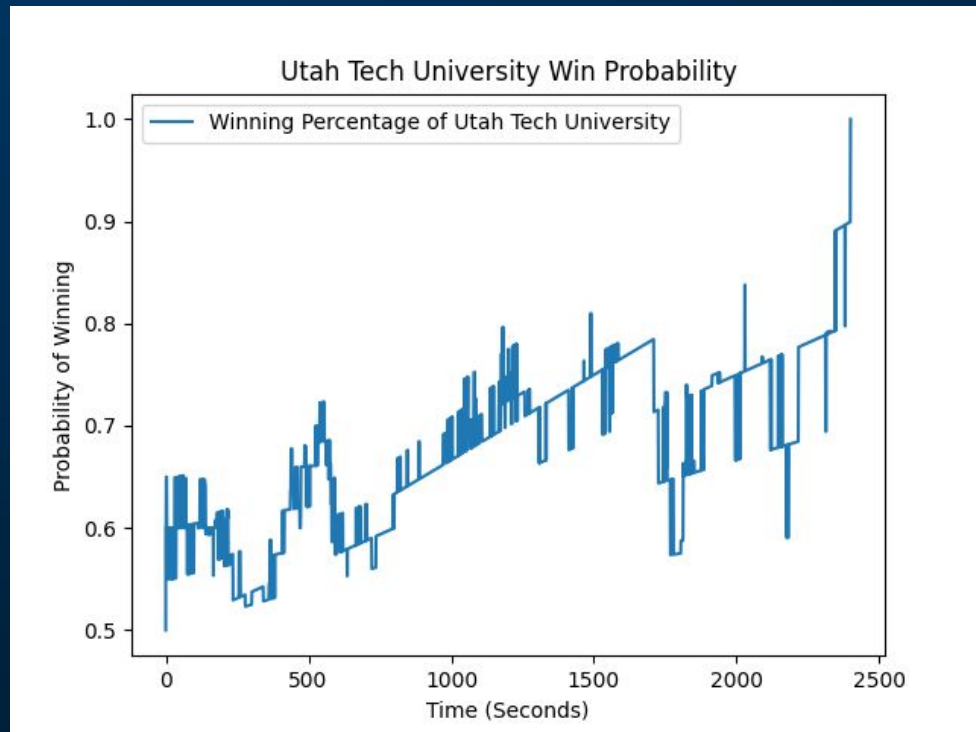


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Game 3

	UTU	SUU
Initial Win Percentage	60%	40%
Initial Offensive Efficiency	1.4	1.1
Initial Defensive Efficiency	1.35	1.27
Initial Score	0	0

Results



Winner!!



Next Steps

- Add additional variables that would impact win percentage.
- Create weighted changes to variables based on historical data.
- Test different weights to find optimal weight distribution that maximizes accuracy.
- Connect to basketball data via API and run simulations on real time data.

Works Cited

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Thank You!

