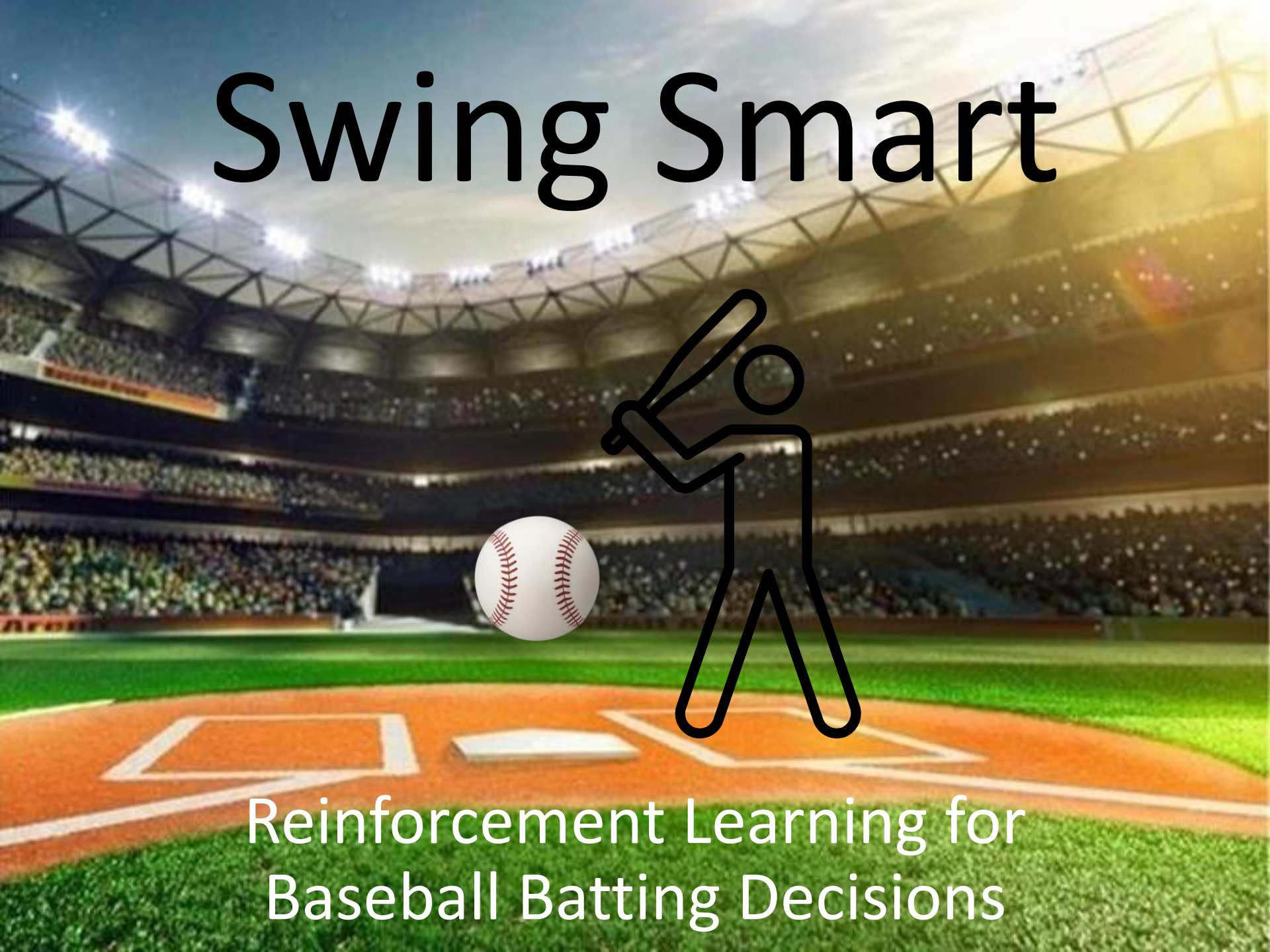
Swing Smart



Reinforcement Learning for Baseball Batting Decisions

Project Overview

- Reinforced Learning agent that can simulate baseball batting decisions.

- Count-aware pitch sequencing and pitcher profiling

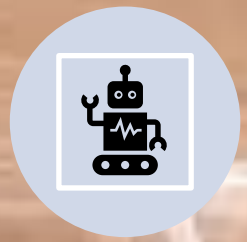
- Batter action optimization and statistical tracking

- Goal: Develop increasingly realistic and performant hitting agent.

Problem Statement & Motivation

- MLB HITTING IS COMPLEX AND HIGHLY SITUATIONAL.

- PITCHERS HAVE MANY DIFFERENT TECHNOLOGY ADVANCEMENTS TO BECOME BETTER PITCHERS.



- NEED FOR REALISTIC RL ENVIRONMENT INCORPORATING COUNT, PITCHERS, AND RUNNERS.

- MOTIVATION: EXPLORE DECISION-MAKING AND IMPROVE HITTING PERFORMANCE.

```
"""
One episode = many PAs for a single batter in game-like situations.
The program tracks:
  - balls/strikes
  - base runners (1B, 2B, 3B)
  - outs (reset bases + outs after 3 outs, like an inning change)

Actions (5):
  0 = Take
  1 = Contact-oriented swing (high contact, more ground/line)
  2 = Normal swing (balanced)
  3 = Power swing (more fly/line)
  4 = Max power swing (most fly balls & HR risk)
```

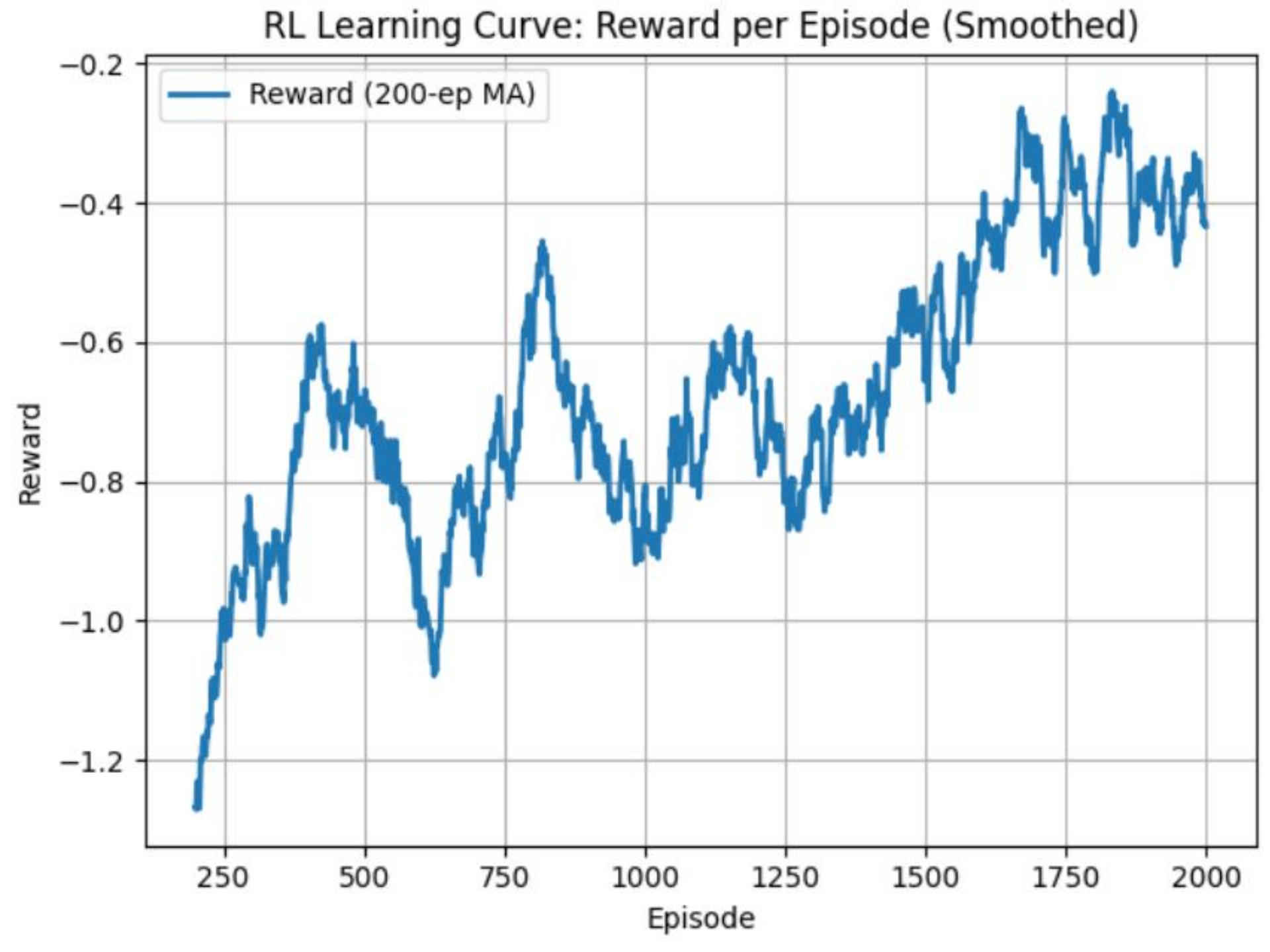
Portion of project code from Google Collab

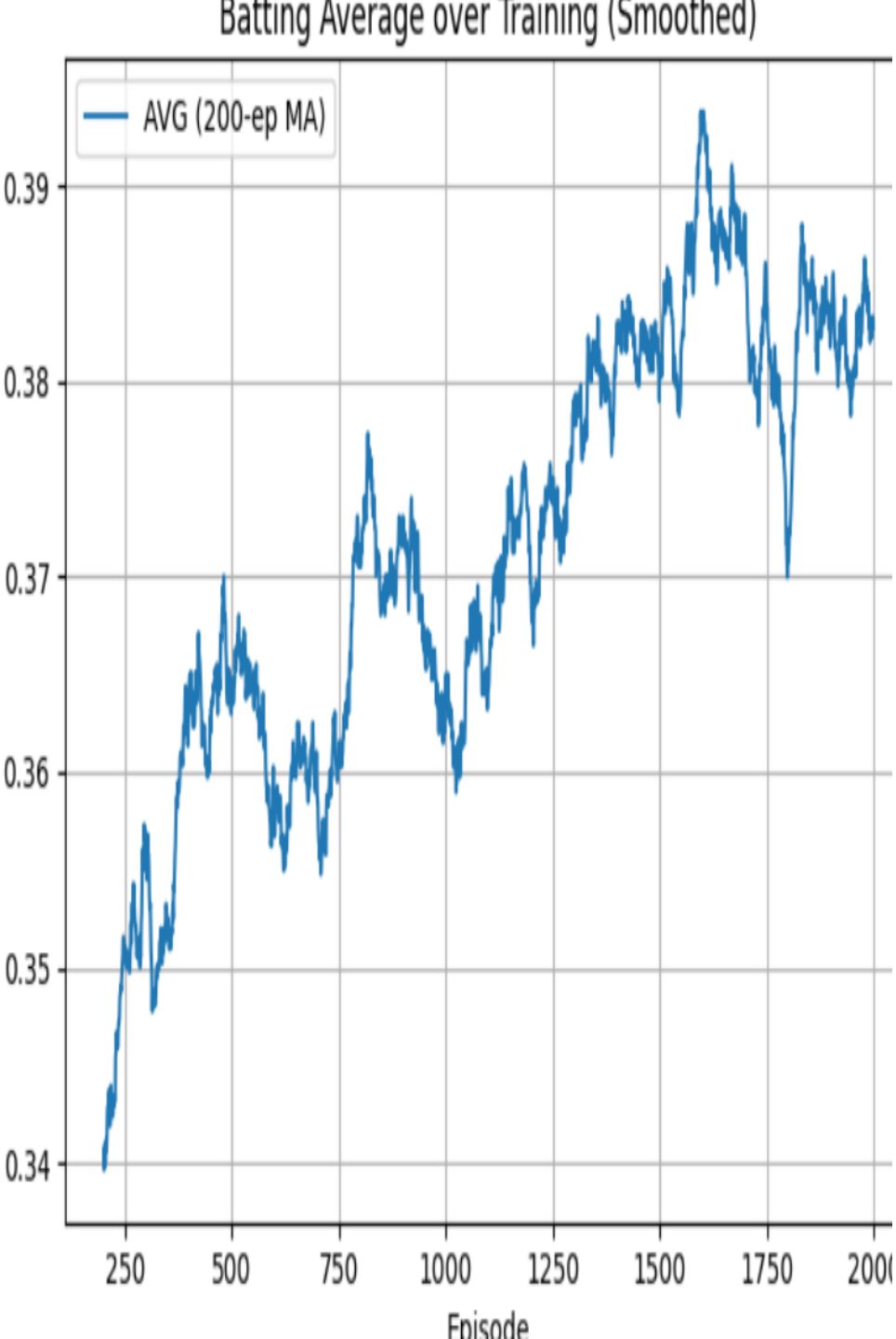
Methodology & Approach

- Developed a custom MLB hitting environment
- Batter actions include:
  - Take
  - Contact Swing
  - Normal Swing
  - Power Swing
  - Max Power Swing
- Reward shaping encourages discipline and effective hitting

Results & Analysis

- RL Agent Learning Curve
- Batting Average over Training
- Plate Discipline over Training
- Strikeout Rates over Training
- Run Production over Training
- Per-pitcher performances
- Strike Zone Analysis


RL Learning Curve: Reward per Episode (Smoothed)
Reward (200-ep MA)
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
Reward
250
500
750
1000
1250
1500
1750
2000
Episode


Batting Average over Training (Smoothed)
AVG (200-ep MA)
0.39
0.38
0.37
0.36
0.35
0.34
250
500
750
1000
1250
1500
1750
Episode

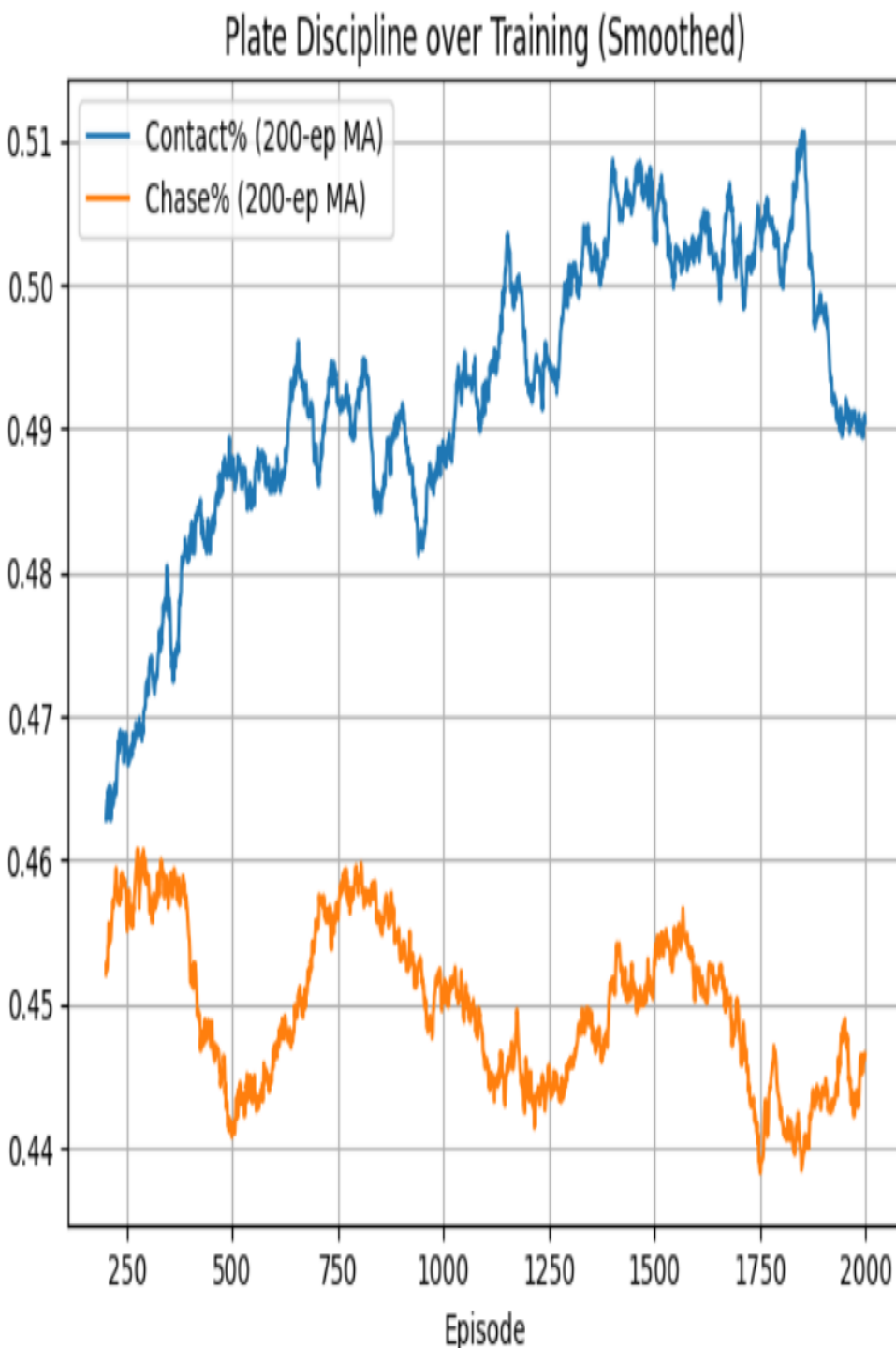
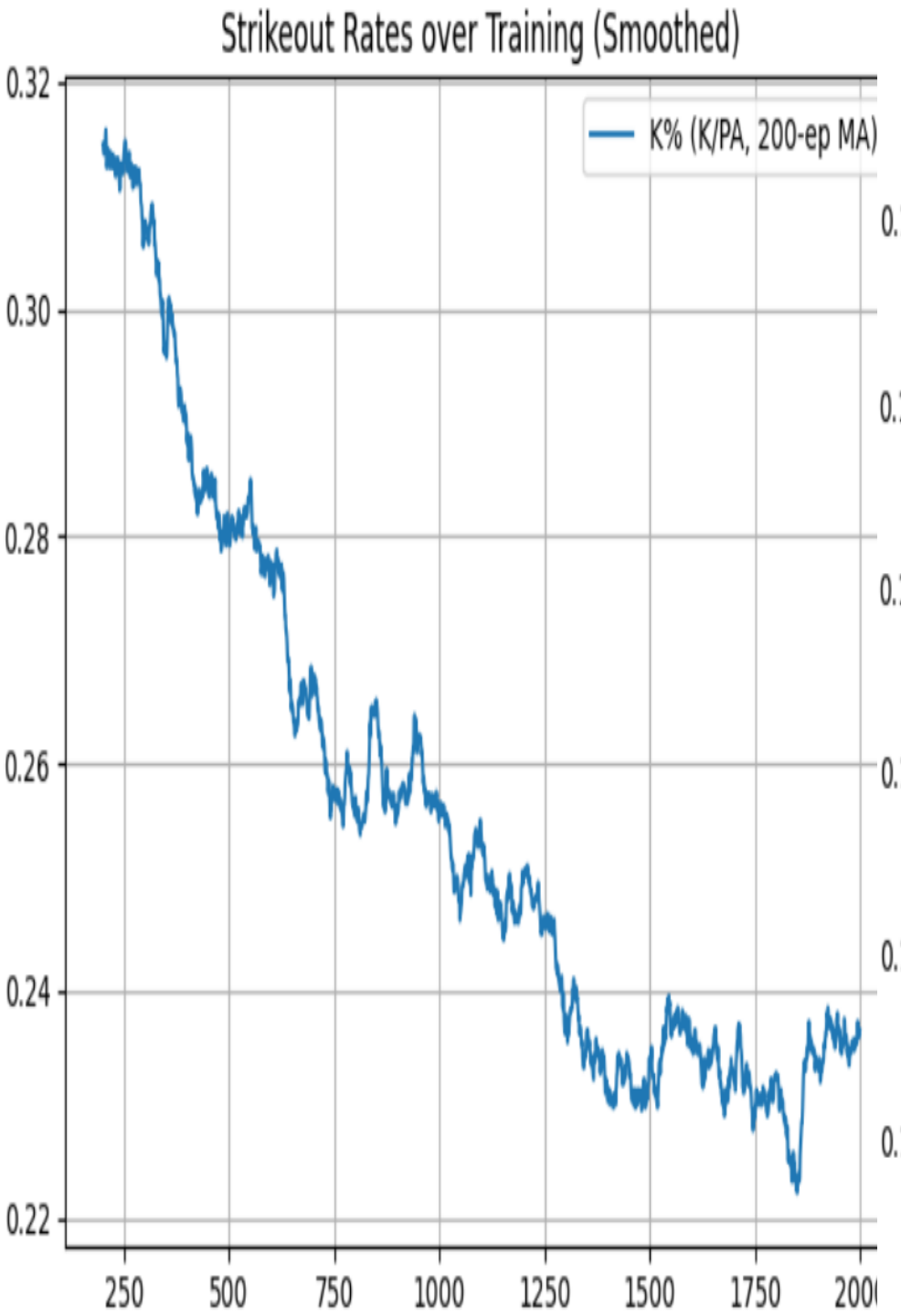
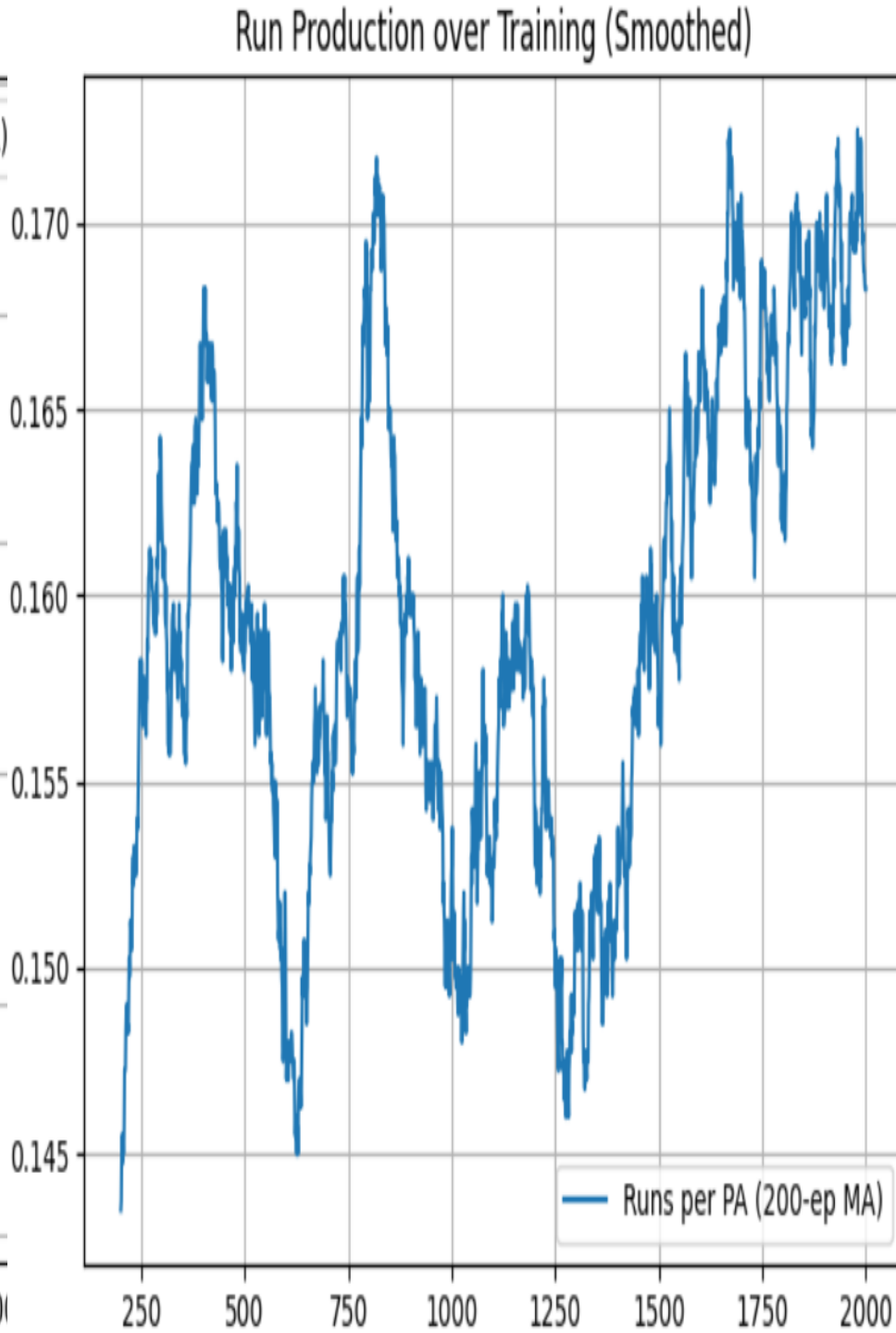


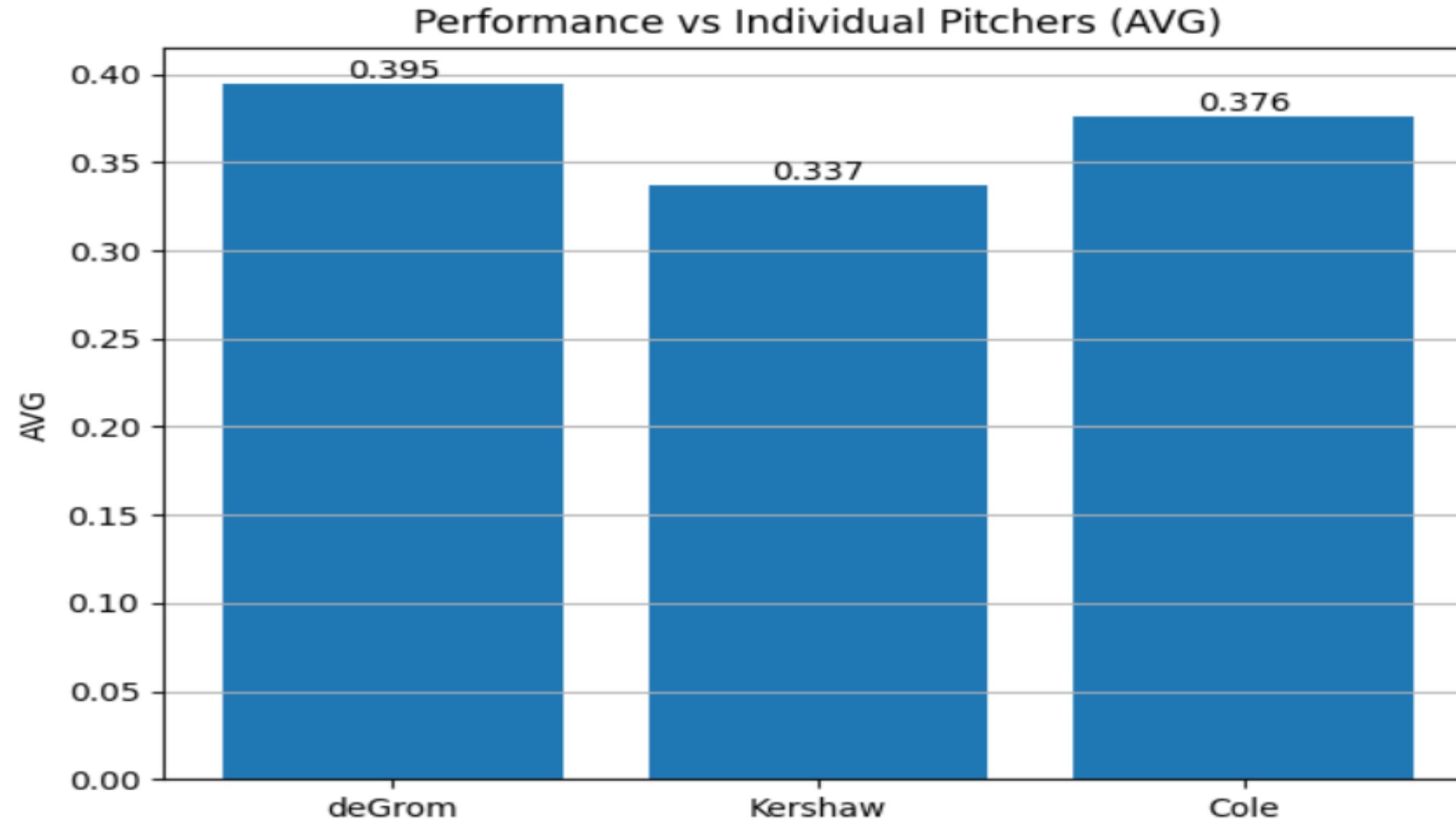
Plate Discipline over Training (Smoothed)
Contact% (200-ep MA)
Chase% (200-ep MA)
0.51
0.50
0.49
0.48
0.47
0.46
0.45
0.44
250
500
750
1000
1250
1500
1750
2000
Episode

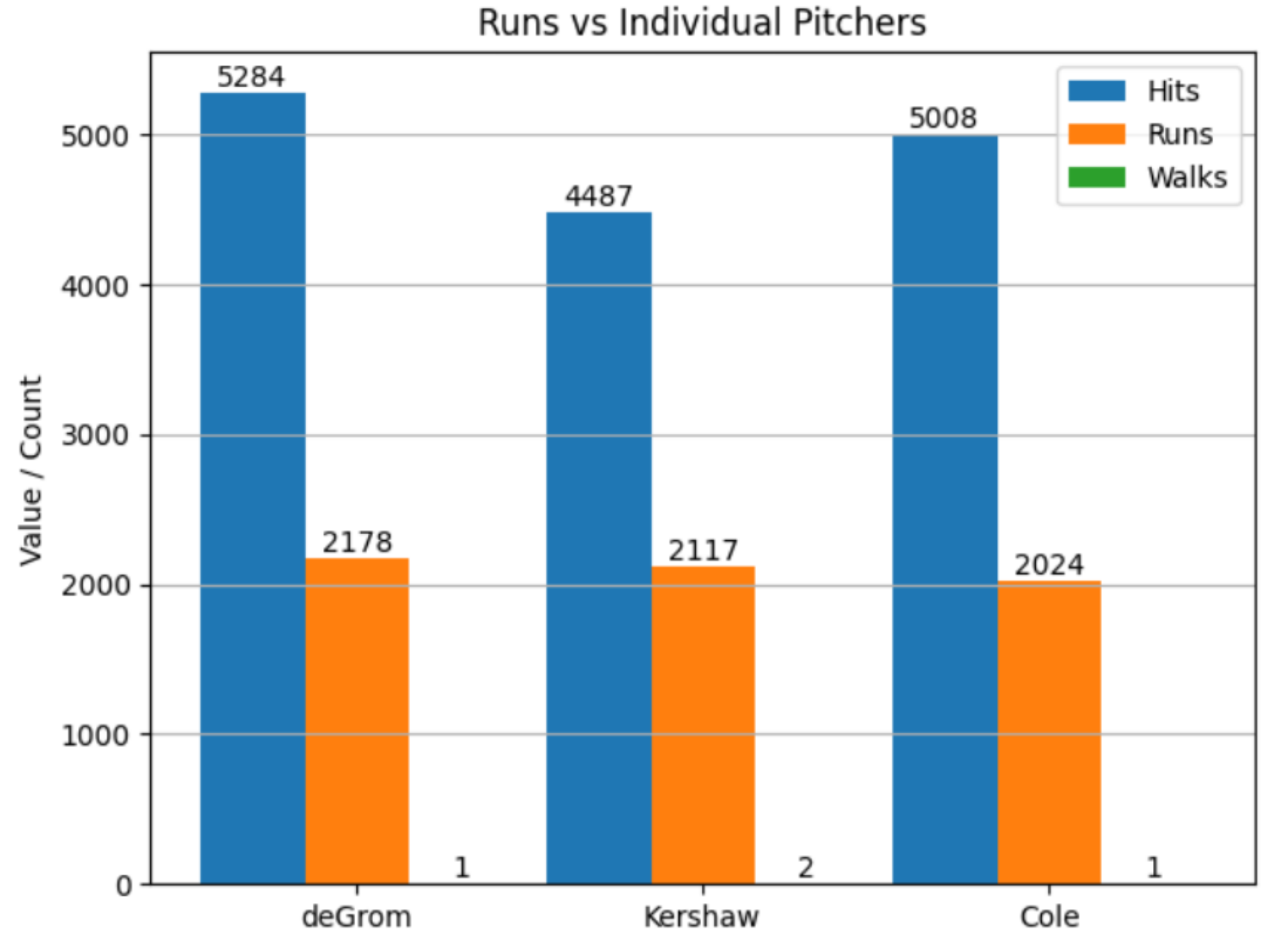

Strikeout Rates over Training (Smoothed)
K% (K/PA, 200-ep MA)
0.32
0.30
0.28
0.26
0.24
0.22
250
500
750
1000
1250
1500
1750

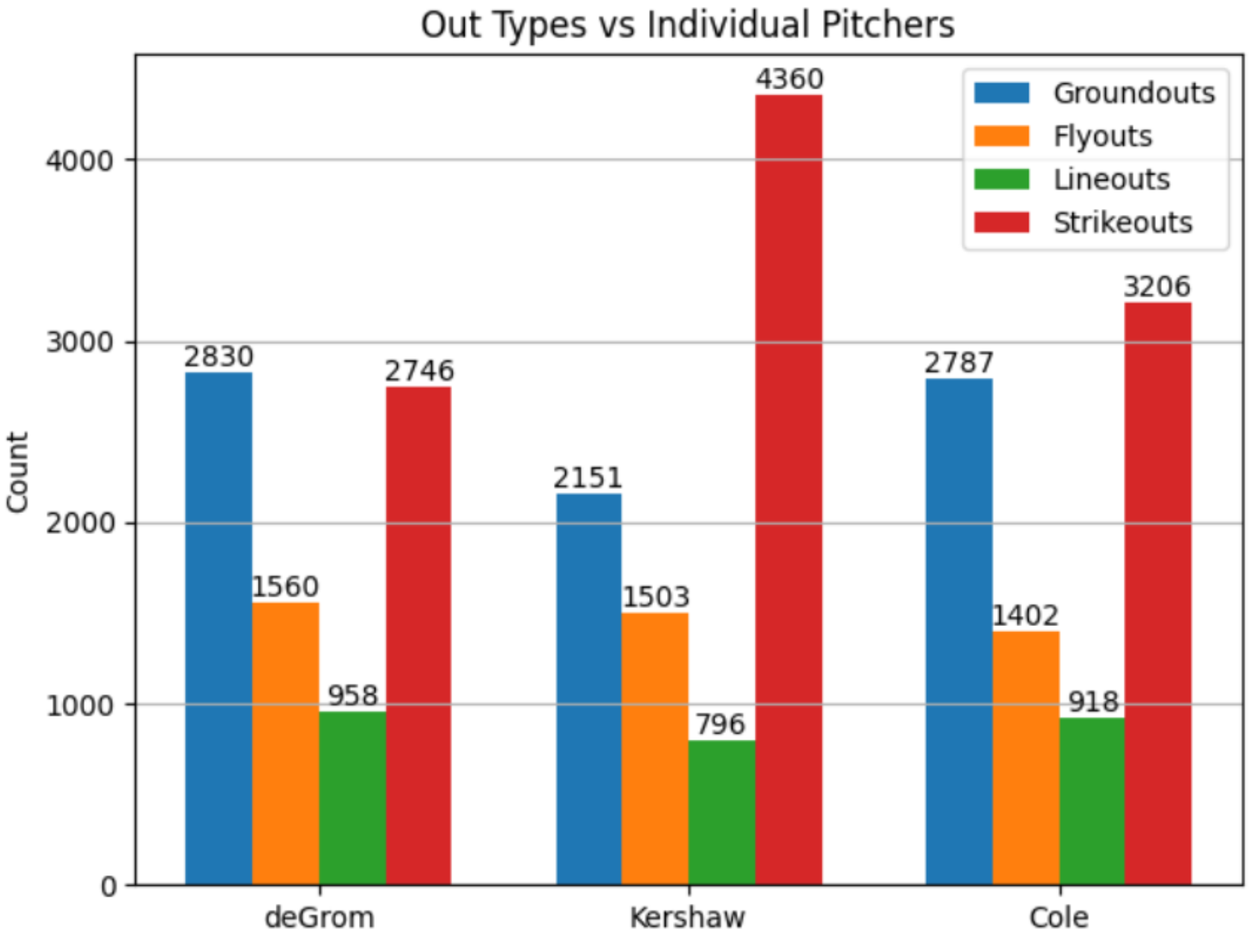

Run Production over Training (Smoothed)
Runs per PA (200-ep MA)
0.170
0.165
0.160
0.155
0.150
0.145
250
500
750
1000
1250
1500
1750
2000

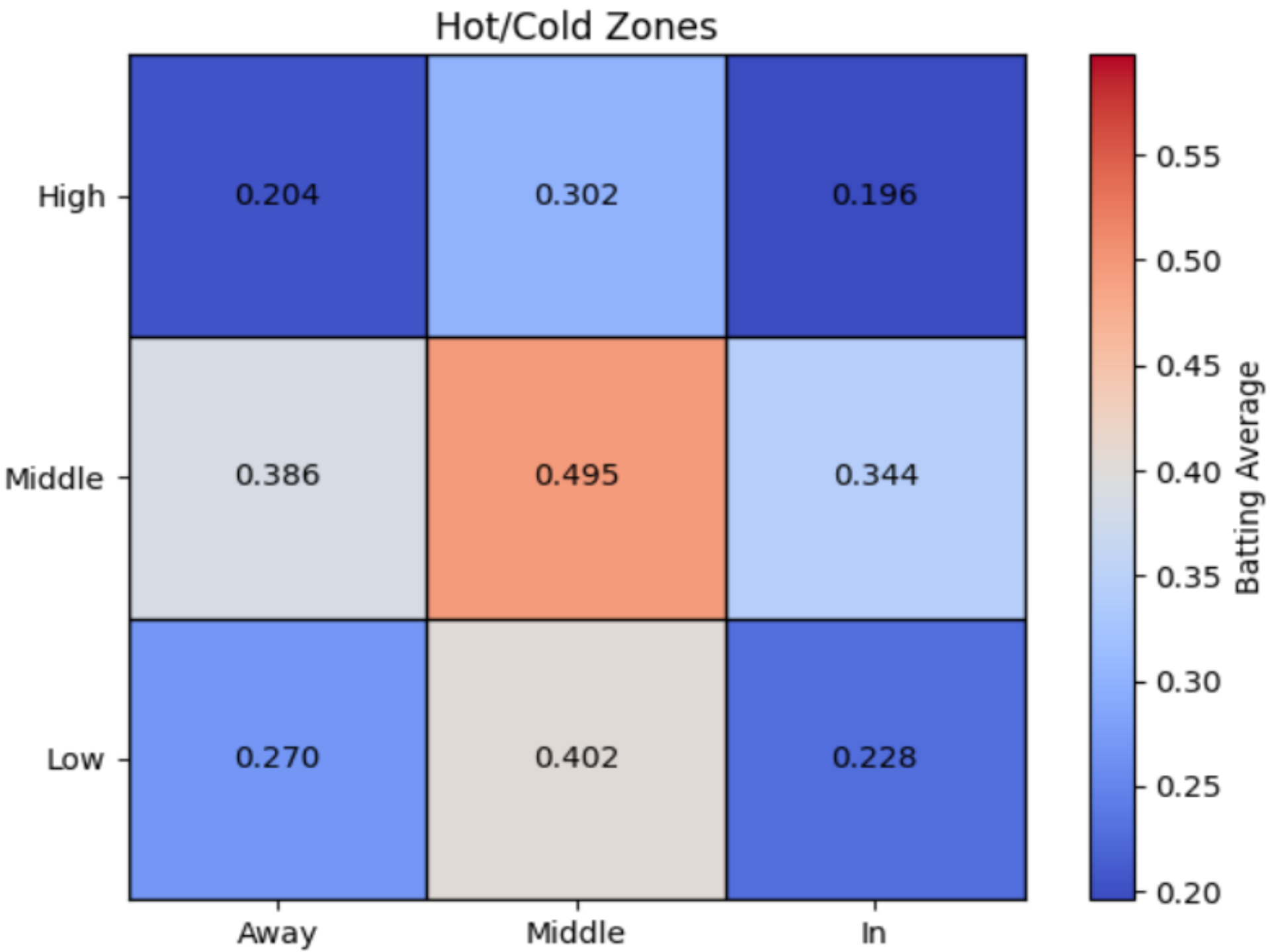
Per Pitcher Summary Stats

	PA	AB	H	1B	2B	3B	HR	BB	K	GO	FO	LO	R	AVG	SLG
deGrom	13379	13378	5284	3014	1205	460	605	1	2746	2830	1560	958	2178	0.395	0.689
Kershaw	13299	13297	4487	2372	1070	362	683	2	4360	2151	1503	796	2117	0.337	0.626
Cole	13322	13321	5008	2881	1151	402	574	1	3206	2787	1402	918	2024	0.376	0.652




Runs vs Individual Pitchers
Hits
Runs
Walks
Value / Count
0
1000
2000
3000
4000
5000
5284
2178
1
4487
2117
2
5008
2024
1
deGrom
Kershaw
Cole


Out Types vs Individual Pitchers
Groundouts
Flyouts
Lineouts
Strikeouts
Count
0
1000
2000
3000
4000
2830
1560
958
2746
2151
1503
796
4360
2787
1402
918
3206
deGrom
Kershaw
Cole


Hot/Cold Zones
High
Middle
Low
0.204
0.302
0.196
0.386
0.495
0.344
0.270
0.402
0.228
Away
Middle
In
Batting Average
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20

Conclusion:

- RL agent adapted to realistic, dynamic MLB environment.
- Demonstrated improved selectivity and hitting outcomes.

Future Work:

- Add reinforced learning tendencies to the pitchers.
- Add batter variability, like left and right-handed hitting.