

TEXAS RANGERS BIOMECHANICS EXERCISE

You have been provided with two CSV files. One contains full signal kinematic and kinetic data of a pitcher, whereas the other contains discrete data. The dataset is comprised of pitches from the 1st and 7th innings. Please provide all code and resources along with your answers to these questions to cwatkins@texasrangers.com prior to **Tuesday, October 1st**. LIMIT ANSWERS TO 200 WORDS

1. Calculate and provide the averages and standard deviations for each inning and pitch type, returned in a table format (preferably generated using a coding method) for:
 - Pitch velocity
 - Maximum shoulder external rotation
 - Maximum elbow varus torque
 - Peak pelvis rotational velocity
 - Peak trunk rotational velocity
 - Peak elbow extension velocity
 - Peak shoulder internal rotation velocity
 - Both the Metric and Signal CSV files contain the same pitches. The difference is, the Metric file is discrete data, giving pitch characteristics along with different angular positions at key event markers. Please keep in mind that this means each row is its own pitch. Whereas the Signal file is continuous data, giving different angular positions at each frame for the length of the pitch.
 - This Signal file is normalized data starting from FRAME 1 or ZERO_TIME (first move) until the follow thru phase of the delivery.
 - Please pay close attention to what this question is specifically looking for, and be sure you have looked at the Sign Conventions page for further context if necessary.
2. Plot the kinematic sequencing velocities (listed above) for only fastballs using their averages and +/- 1 SD. Provide 2 plots, one for each inning. The data is normalized from peak leg lift to the follow thru.
 - If you have done Question #1 correctly, this step should be relatively easy. Doing this question first may actually benefit you for answering Question #1.
 - The results of this question should have two graphs: one for inning 1 and one for inning 7.
 - Each graph should contain each kinematic sequencing velocity listed in Question #1.
 - Hint: If you are unsure what a Kinematic Sequencing graph looks like, it's advised looking at published research.
3. Using your answers from Question #1, is there a statistical difference between the first and last inning of work that would raise any red flags for this pitcher for any signals / metrics or anything else? Explain why or why not.
4. Are there any other metrics / signals from this data set that you would use / create that you feel would be valuable and why?
5. Are there any metrics that you would target for development of this pitcher? Using published research; explain why the metrics selected may improve this pitcher's performance and / or injury risk.
6. Is there anything in the data that stands out to you that you would like to investigate further? What else could be done using information like this given more time and resources / potential research avenues?
7. Please choose one hitter or pitcher to break down mechanically. Include the videos used, and brief summary of strengths / opportunities and / or areas you would like more information.

SIGN CONVENTIONS

- PITCH DATA

- RELEASE_SPEED – Pitch Velocity in mph
- SPIN_RATE – Spin Rate in rpm
- PITCH_RELEASE_COORDINATES_X – 1B (+) / 3B (-) in ft
- PITCH_RELEASE_COORDINATES_Z – Height from Ground in ft
- EXTENSION – Distance from Rubber in ft
- HORIZONTAL_BREAK – Glove Side (+) / Arm Side (-) in inches
- INDUCED_VERTICAL_BREAK – In inches

- POSITIONAL DATA

- ELBOW_X – Flexion (+) / Hyperextension (-)
 - 0 Fully Extended / 90 Field goal Post in deg
 - Process of extending would be negative
- FOOTPOS_IN – Open Stride (+) / Closed Stride (-) in inches
- FRONTKNEE_X – Hyperextension (+) / Flexion (-)
 - 0 Fully Extended / -90 Lunge position in deg
 - Process of extending would be positive
- PELVIS_Z – 0 Perpendicular to Rubber / 90 Parallel to Rubber in deg
- SHOULDER_X – Horizontal Adduction (+) / Horizontal Abduction (-) in deg
- SHOULDER_Y – 0 Arm Down at Side / 90 Arm Parallel with Ground in deg
- SHOULDER_Z – Internal Rotation (+) / External Rotation (-) in deg
- STRIDELENGTH100 – Stride Length Percentage of Height in %
- TRUNK_X – Extension (+) / Flexion (-) in deg
- TRUNK_Y – Glove Side (+) / Arm Side (-) in deg
- TRUNK_Z -- 0 Perpendicular to Rubber / 90 Parallel to Rubber in deg
- BACKHIP_Z – Internal Rotation (+) / External Rotation (-)
- BACKKNEE_X -- Same as FRONTKNEE_X
- MODEL_COG_LAB_X – 3B (+) / 1B (-)
- MODEL_COG_LAB_Y – HP (+) / 2B (-)
- MODEL_COG_LAB_Z – Sky (+) / Ground (-)
- ELBOWFORCE_X – Lateral (+) / Medial (-)
- ELBOWMOMENT_Y – Varus (+) / Valgus (-)

- EVENTS

- BR – Ball Release
- MER – Max External Rotation
- FP – Footplant