Quantifying Pitch Tunneling Effects on Swing Decisions

Problem: Stuff models do a solid job evaluating pitch quality in isolation, but we don't have great tools for measuring the marginal contribution of sequencing. This project isolates the performance gain from visual deception, independent of the underlying pitch quality.

Approach:

- Built a pipeline processing five seasons of Statcast data (2021-2025), engineered 3D trajectory features from raw tracking inputs and physics outputs
- Developed "Decision Angular Separation" (DAS): measures visual angle between pitch trajectories from a modeled batter's eye position at the decision-commitment window (~175ms from contact)
- Target variable controls for pitcher quality, pitch type, count, and location via residuals against a batter-adjusted spatial grid to ensure isolation of the tunneling effect from other features that induce swinging strikes of individual pitches

Key Results:

- Visual deception shows a consistent, measurable impact on whiff rates for specific sequence types, separate from velocity/movement differentials
- Adding DAS improved out-of-sample R^2 compared to baseline models using only pitch characteristics
- Effect is strongest in the Shadow zone, as tight tunnels expand the effective chase zone by forcing earlier commit decisions
- SHAP values show context matters: tunneling provides significant lift on fastball-breaking sequences but acts as a secondary factor for offspeed-led pairs

Tools: Python (pandas, scikit-learn, XGBoost), SHAP, Plotly, Streamlit

Note: This is active and ongoing research