

Bayesball

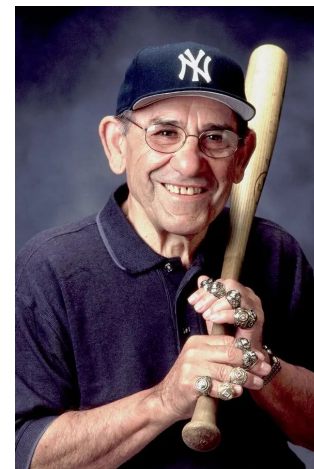
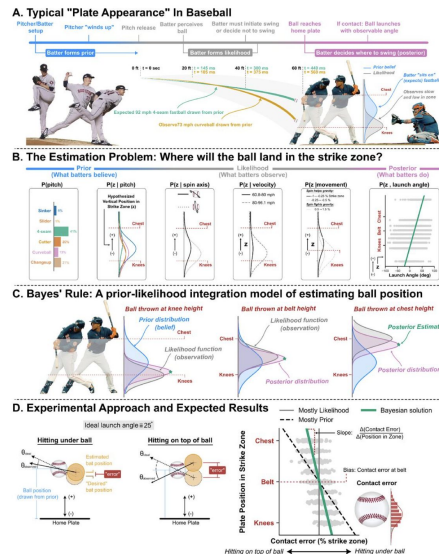
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Source: Chat GPT (only for this picture I promise)

Brantley & Körding (2022)

- “You can’t think and hit at the same time”
— Yogi Berra
- Would a batter be Bayesian?
 - Making decision with posterior that comes from integrating prior and likelihood



Three special cases

1. Pitch tipping
 - Narrower prior -> narrower posterior
2. Knuckleball
 - Wide prior, wide likelihood
 - Likelihood is still more informative than prior
 - Posterior relied on likelihood
3. Eephus
 - Wide prior, narrow likelihood -> narrow posterior



Knuckleball (source: Tread Athletics)

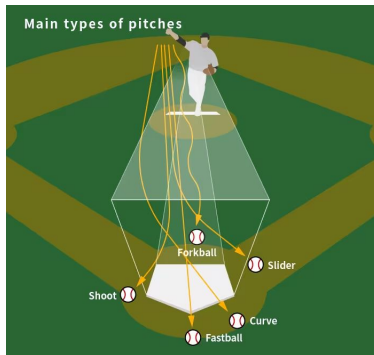


The issue

- Uncommon!
- Only considering the vertical distance above the plate (z-axis)

Motivation/Goals

1. Try to visualize the decision-making process on the strike zone plane (both x-axis and z-axis)
2. “What kind of pitch is coming?”
 - Uncertainty in the pitch type of the incoming pitch
 - Explore it using bayesian framework



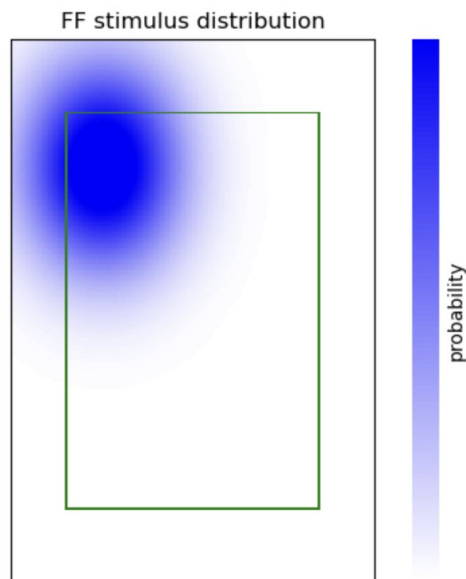
Case 1: only fastball

- In-lab (batting cage) experiment
 - With technologies to track movements of the ball & the swing
- A finely calibrated pitching machine
 - Gives us access to the stimulus distribution
- Feed the stimulus distribution to the batter
 - Artificially create his prior
 - In reality, we won't have access to the batter's prior (Brantley & Körding, 2022)

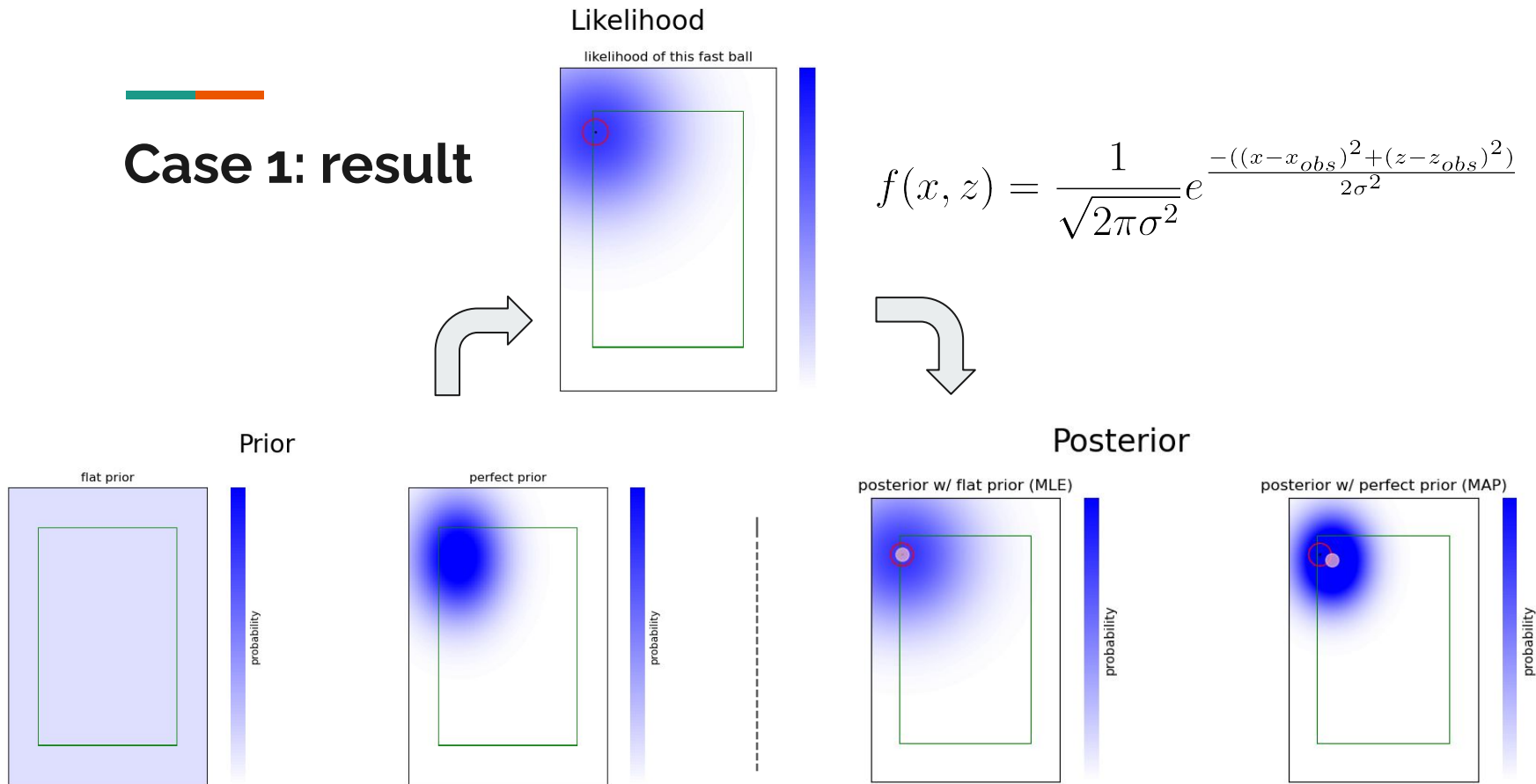
$$p(x) \sim \mathcal{N}(\mu_x, \sigma_{s,x}^2)$$

$$p(z) \sim \mathcal{N}(\mu_z, \sigma_{s,z}^2)$$

$$p(x, z) = p(x) * p(z)$$

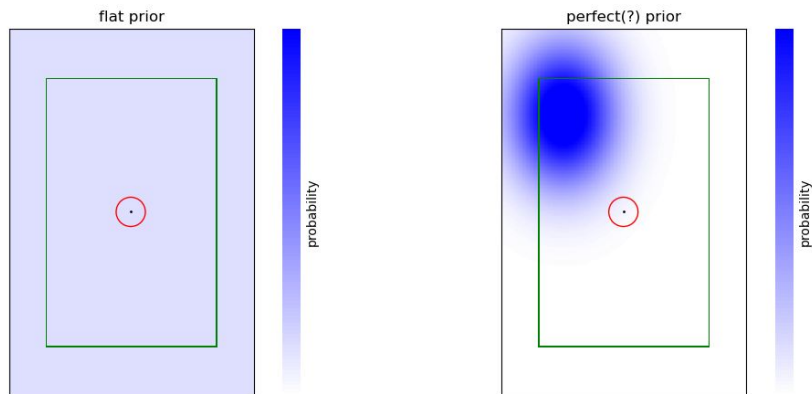


Case 1: result



Case 1: surprise pitch

Prior, with a ball landing at the very centre



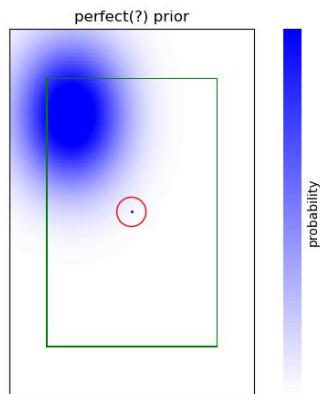
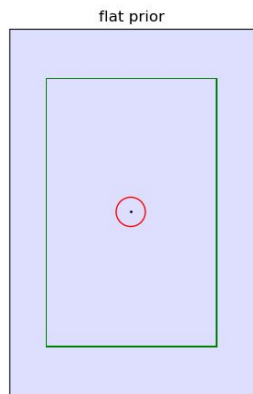
OR



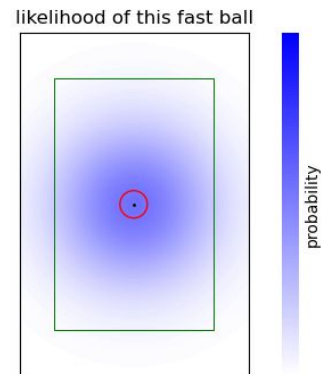
?

surprise pitch - result

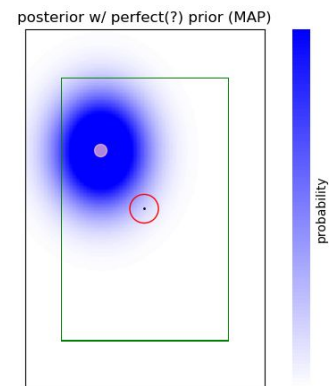
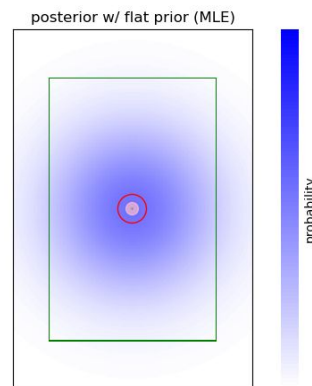
Prior, with a ball landing at the very centre



Likelihood

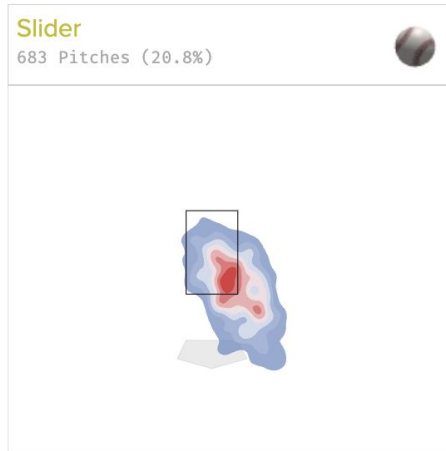


Posterior



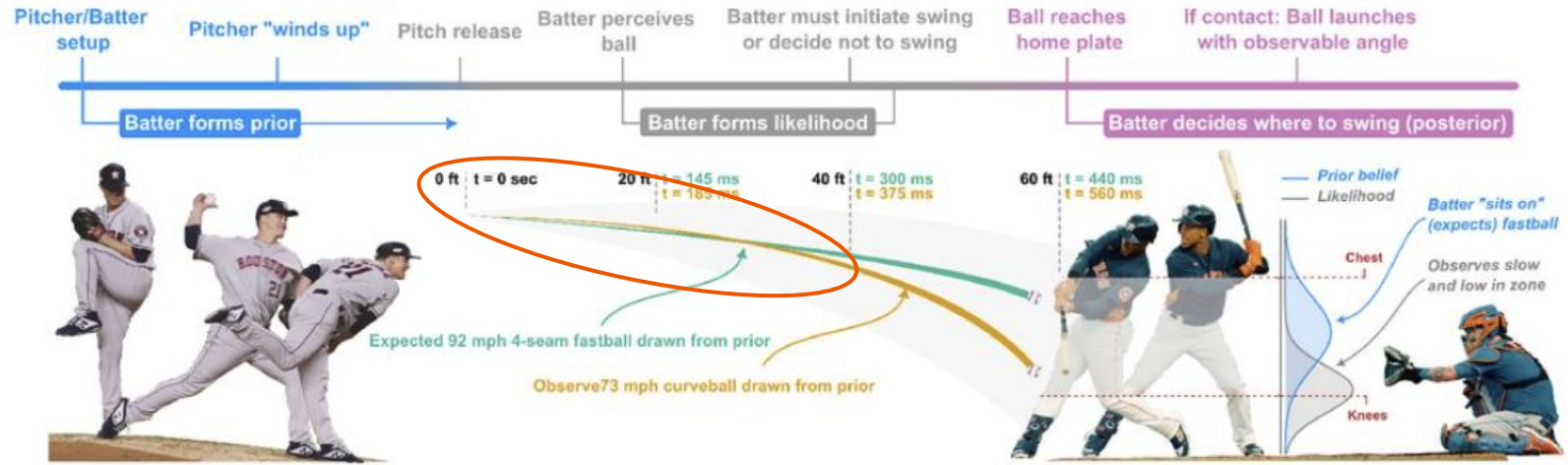
About Prior

- Powerful when there is some level of measurement uncertainty
 - But can be misleading if incorrect
- Actually, if only fastballs, an elite batter may have a lot narrower likelihood
 - Pulls the posterior closer to the observation even if it is a surprise pitch
 - Would be interesting to run in the lab
- In reality, is not necessarily Gaussian
 - Can just be a probability matrix —>
 - Do the pointwise multiplication w/ likelihood
 - Happens in the batter's brain - not measurable



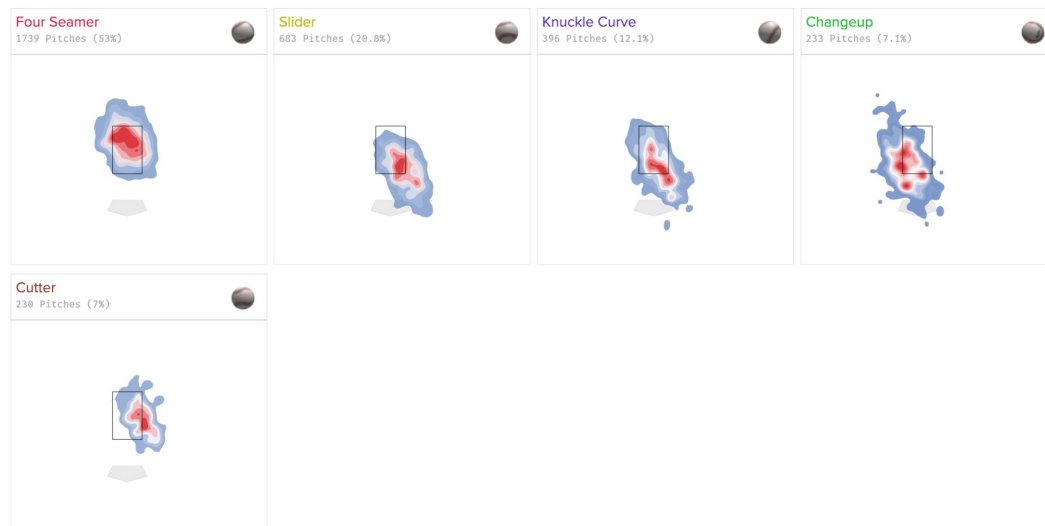
Timeline of a fastball (Brantley & Körding, 2022)

A. Typical "Plate Appearance" In Baseball



Case 2: uncertainty in pitch type

Cole relies on 5 pitches: **Four Seamer** (53.0%) **Slider** (20.8%) **Knuckle Curve** (12.1%) **Changeup** (7.1%) **Cutter** (7.0%)





(some of the) Concerns/Future Directions

- This model is confined to a 2D plane
 - Good: easy to visualize & understand
 - Bad:
 - Cannot consider swing timing
 - inference happens during the flight of the pitch; not on the strike zone plane
 - Contact not only happens on the strike zone plane; inaccurate when calculating response distribution/utility
 - A 3D model can be built if possible
- Data gathering
 - Using technologies e.g. HitTrax, high speed camera, radar
- When using launch angle to find the sigma (using max log likelihood)
 - Motor noise is not differentiated from it
 - How significant is the motor noise, given that swinging involves movement from multiple joints