Some Game Theory and Baseball

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Three Topics

1. How does a runner on third base affect pitching and batting strategies?
2. When is bunting for a base hit optimal?
3. How can you catch a baseball at a game?

Methodology: Game Theory

- Game theory is the study of strategic interaction.
- An environment is strategic if how I behave affects your welfare and how you behave affects my welfare.

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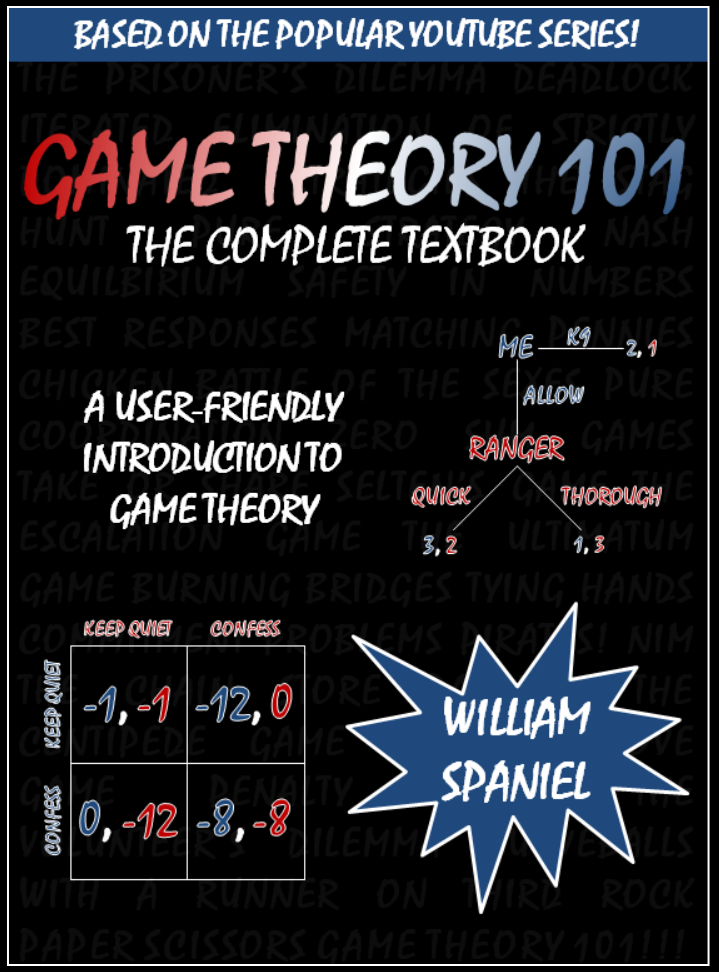
- Game theory is the study of strategic interaction.
- An environment is strategic if how I behave affects your welfare and how you behave affects my welfare.
  - Example: The type of pitch you throw affects my ability to hit, and the type of pitch I anticipate affects your ability to stop a hit.

Methodology: Game Theory

- Game theory is the study of strategic interaction.
- An environment is strategic if how I behave affects your welfare and how you behave affects my welfare.
- Game theory gives us tools to find how players optimally act and react to each other.

Who Am I?

- William SPANIEL
- PhD student in political science.
- gametheory101.com
- YouTube: Game Theory 101
- Game Theory 101: The Textbook



Who Am I?

- Bottom line: I am an evangelical game theorist.
- My goal in life is to make game theory clear to people who don't spend their entire lives studying it.

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- Today, I will be horribly unclear. Sorry.

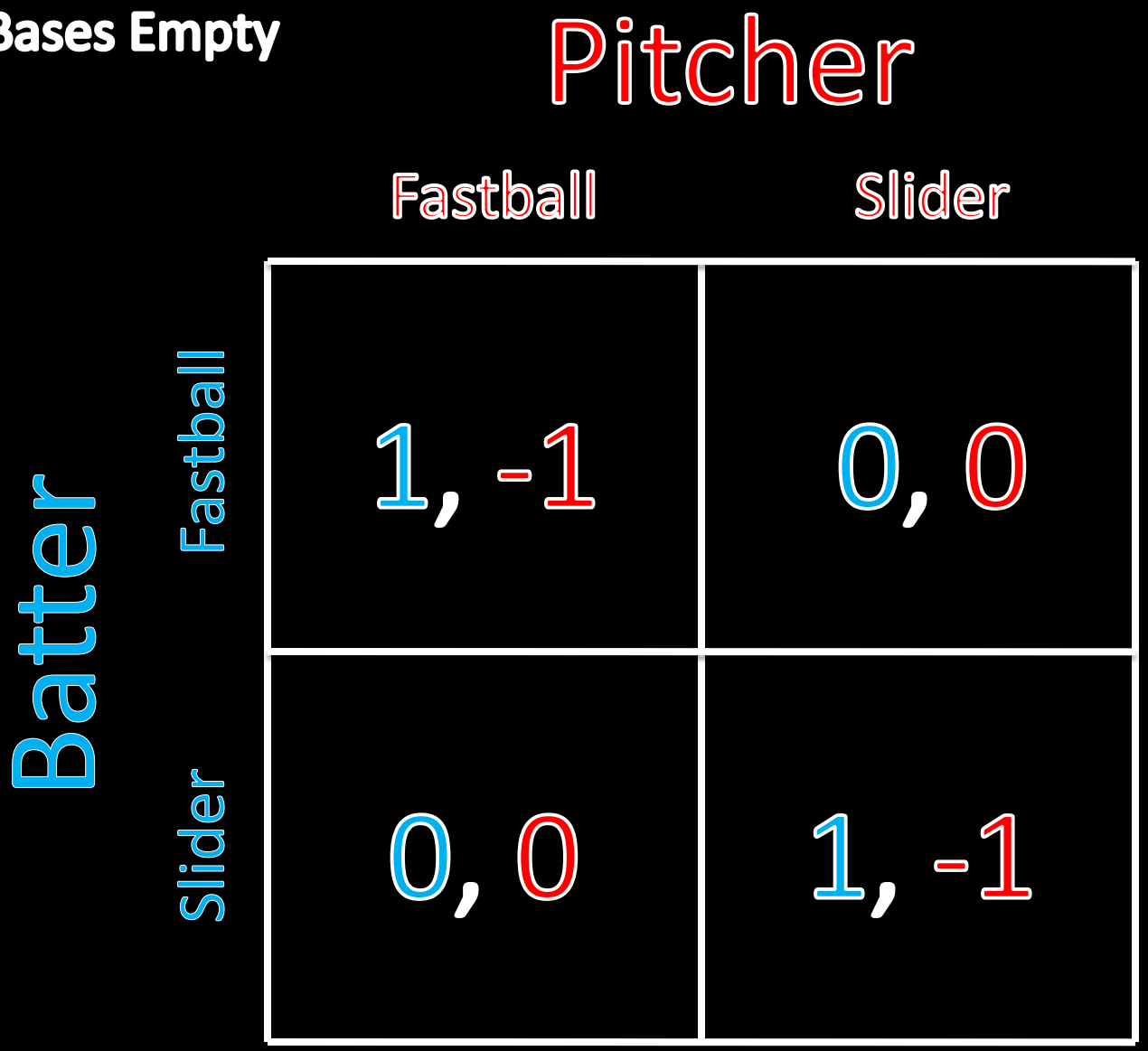
Three Topics

1. How does a runner on third base affect pitching and batting strategies?
   - "Breaking Balls with a Runner on Third" *Baseball Research Journal* (Spring 2012)
2. When is bunting for a base hit optimal?
3. How can you catch a baseball at a game?

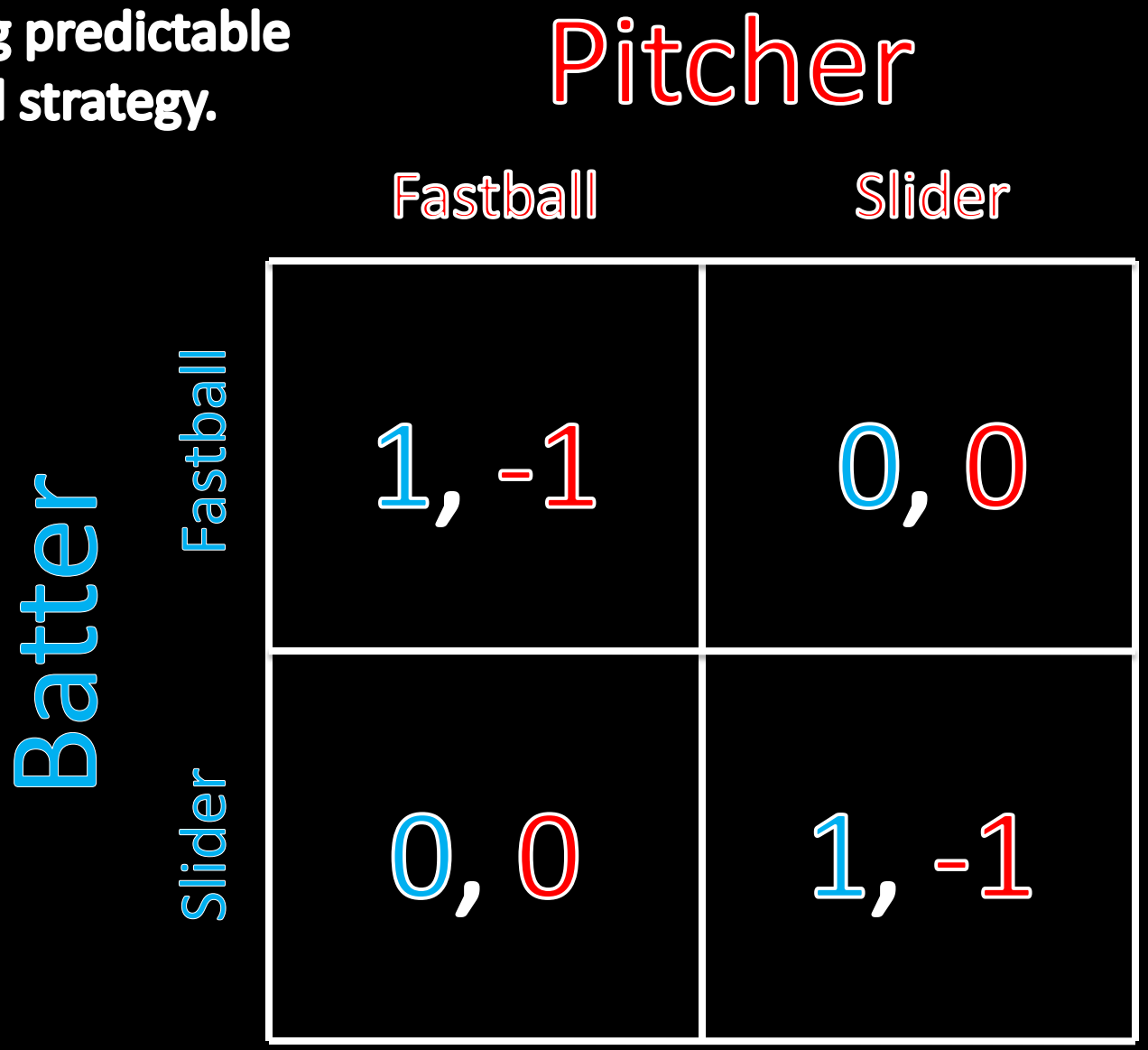
A Simple World

- Bases empty.
- Pitcher can throw two pitches: fastball or slider.
- Batter can anticipate fastball or slider.
- Batter wants to guess correctly; pitcher wants to make the batter guess incorrectly.

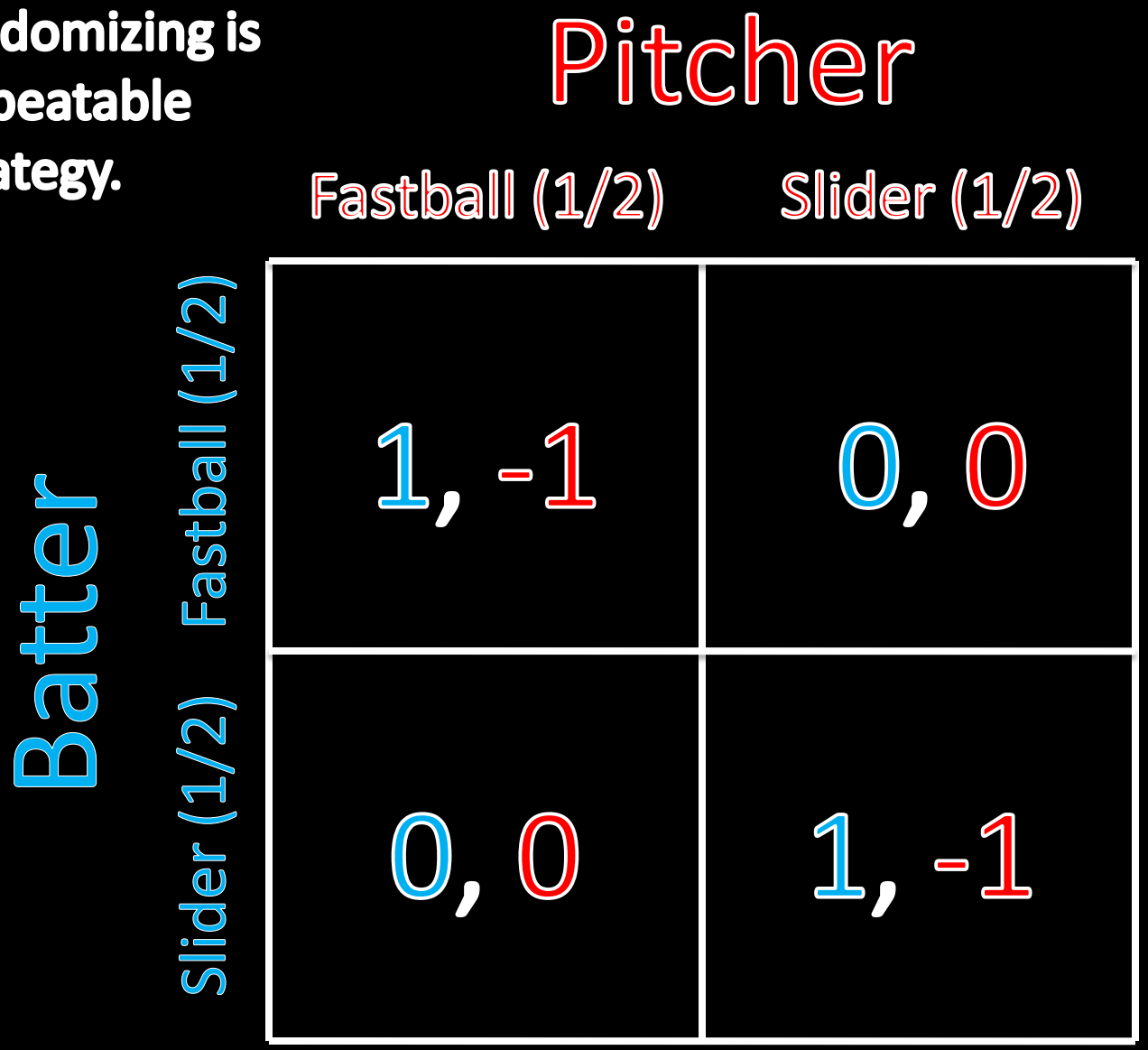
With the Bases Empty



Fact: Being predictable is a bad strategy.



Fact: Randomizing is an unbeatable strategy.



With a Runner on Third

- But what if a runner is on third base?
- Throwing a slider becomes risky.
  - If the ball goes past the catcher, the runner on third will score even though the player did not record a hit.
- The pitcher should throw sliders less frequently.

With a Runner on Third

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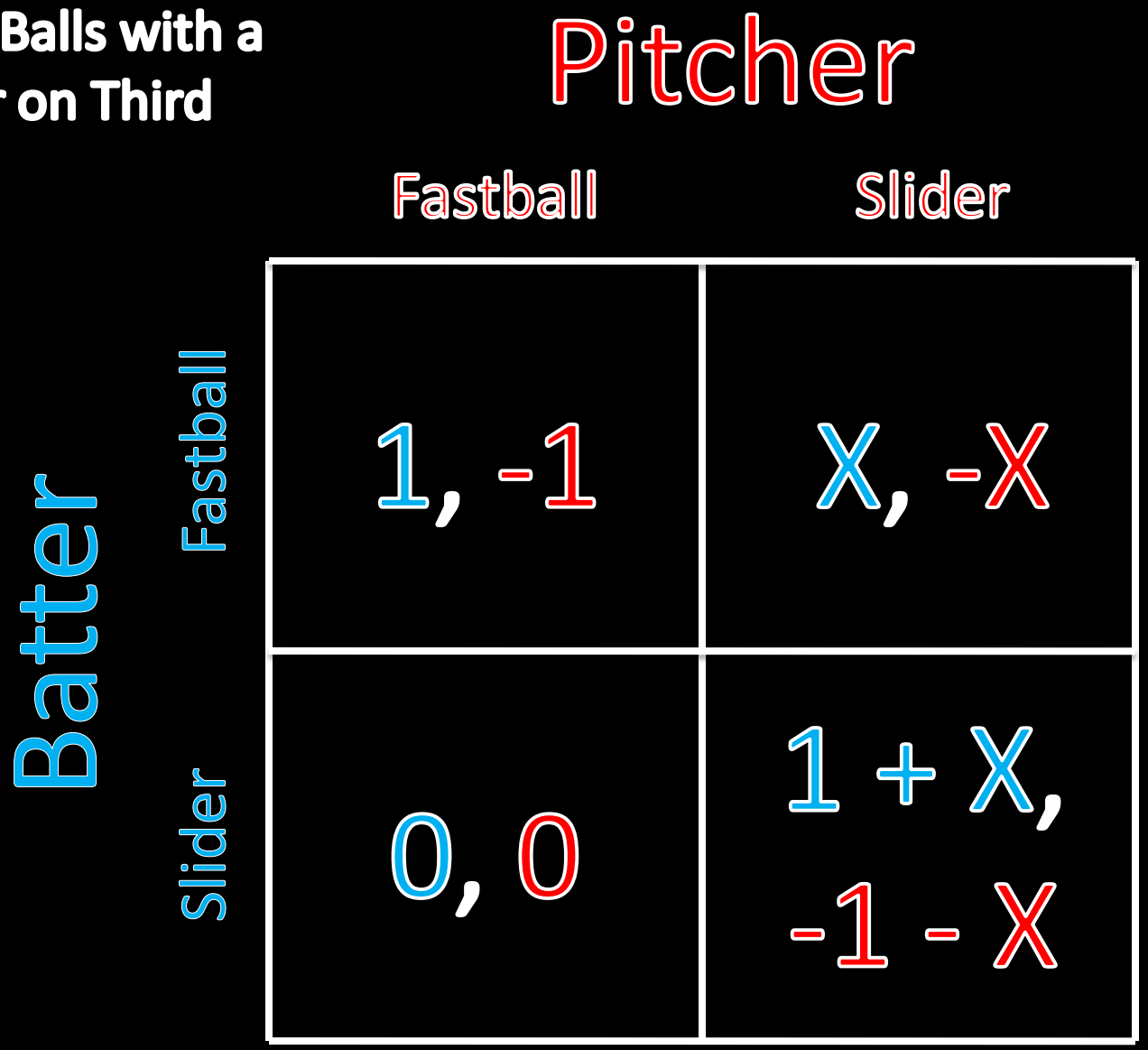
- Throwing a slider becomes risky.
  - If the ball goes past the catcher, the runner on third will score even though the player did not record a hit.
- The pitcher should throw sliders less frequently. *Right?*

Breaking Balls with a Runner on Third



Batter's Payoff for Guessing FB

- Let p = Pr(Throw FB)
- Hitter earns 1 with probability p.
- Hitter earns X with probability 1 – p
- (1)(p) + (1 – p)(X)

	Fastball	Slider
Fastball	1, -1	X, -X
Slider	0, 0	1 + X, -1 - X

Batter's Payoff for Guessing Slider

- Let p = Pr(Throw FB)
- Hitter earns 0 with probability p.
- Hitter earns 1 + X with probability 1 – p
- (p)(0) + (1 – p)(1 + X)

	Fastball	Slider
Fastball	1, -1	X, -X
Slider	0, 0	1 + X, -1 - X

Optimal Pitching Strategy

- The pitcher's strategy is "unbeatable" if:
  - $(1)(p) + (1 - p)(X) = (1 - p)(1 + X)$
  - $p + X - pX = 1 + X - p - pX$
  - $2p = 1$
  - $p = ½$
    - That is, when the pitcher throws a fastball just as frequently as he throws a slider!

What the Frak?

- Why does the pitcher still throw sliders even though they are risky?
  - Suppose he threw fastballs more frequently then before.
  - The batter can respond by zeroing in on fastballs. Even though wild pitches aren't a problem, the pitcher gets hammered anyway.
  - The pitcher therefore maintains his same randomizing strategy with a runner on third.

Pitcher's Payoff for Throwing FB

- Let q = Pr(Guess FB)
- Pitcher earns -1 with probability q.
- Pitcher earns 0 with probability 1 – q
- (-1)(q) + (1 – q)(0)

	Fastball	Slider
Fastball	1, -1	X, -X
Slider	0, 0	1 + X, -1 - X

Pitcher's Payoff for Throwing Slider

- Let q = Pr(Guess FB)
- Pitcher earns -X with probability q.
- Pitcher earns -1 – X with probability 1 – q
- (-X)(q) + (1 – q)(-1 – X)

	Fastball	Slider
Fastball	1, -1	X, -X
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Optimal Batting Strategy

- The batter's strategy is "unbeatable" if:
  - $(-1)(q) + (1 - q)(0) = (-X)(q) + (1 - q)(-1 - X)$
  - $-q = -qX - 1 - X + q + qX$
  - $2q = 1 + X$
  - $q = (1 + X)/2$
- The batter guesses fastball more frequently!
  - He plays it safe—even if he guesses fastball incorrectly, the runner will sometimes score anyway.

Three Topics

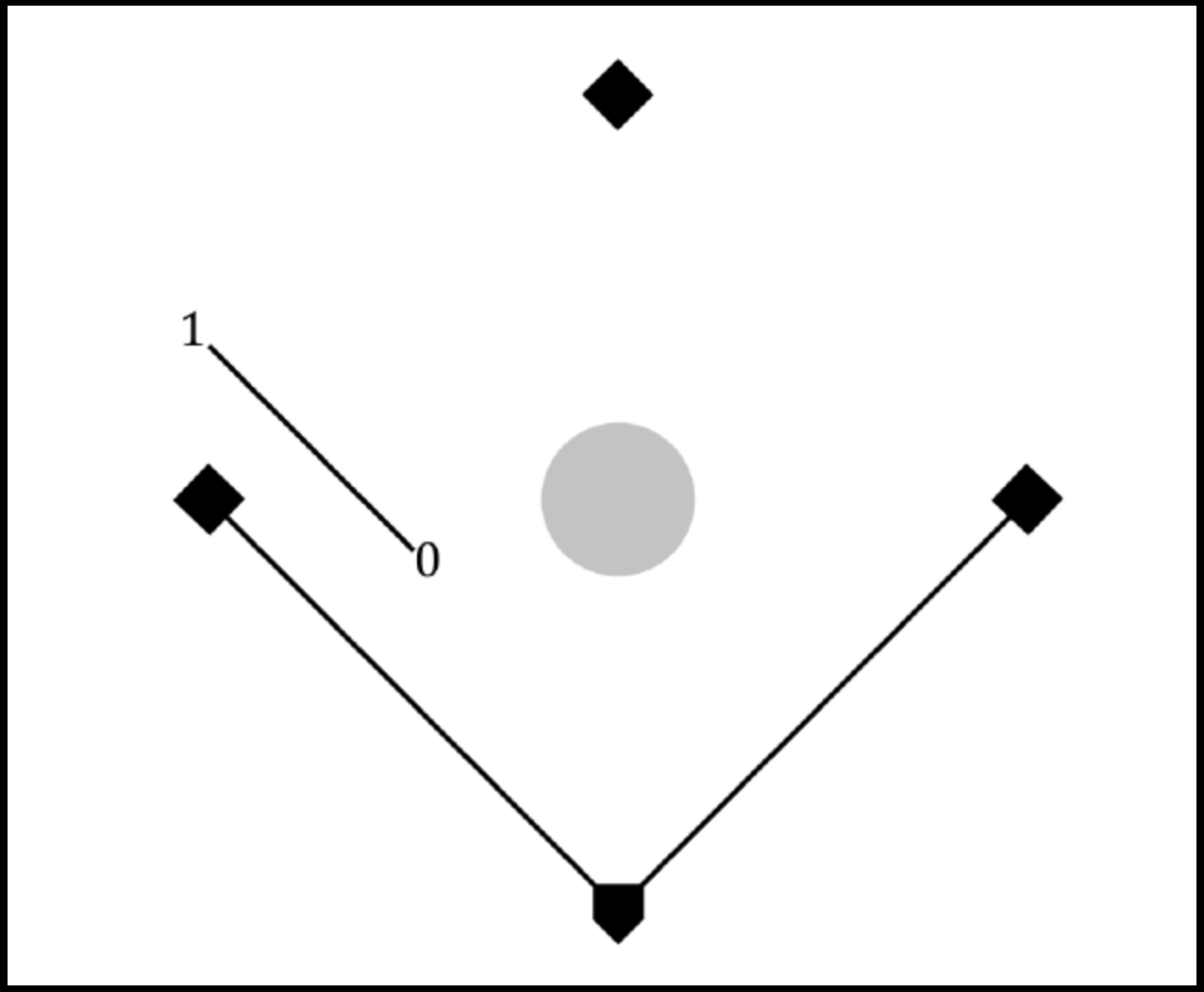
1. How does a runner on third base affect pitching and batting strategies?
2. When is bunting for a base hit optimal?
   - "To Bunt or not to Bunt: Optimal Batting Strategy during a No-Hitter" (Working paper; Google it.)
3. How can you catch a baseball at a game?

Optimal Defensive Positioning

- Infield positioning affects optimal hitting strategies.
  - If the infielders are really close, bunting is bad.
  - If the infielders are really far away, bunting is good.
- What is the optimal defensive positioning? What is the optimal hitting strategy in response to that positioning?

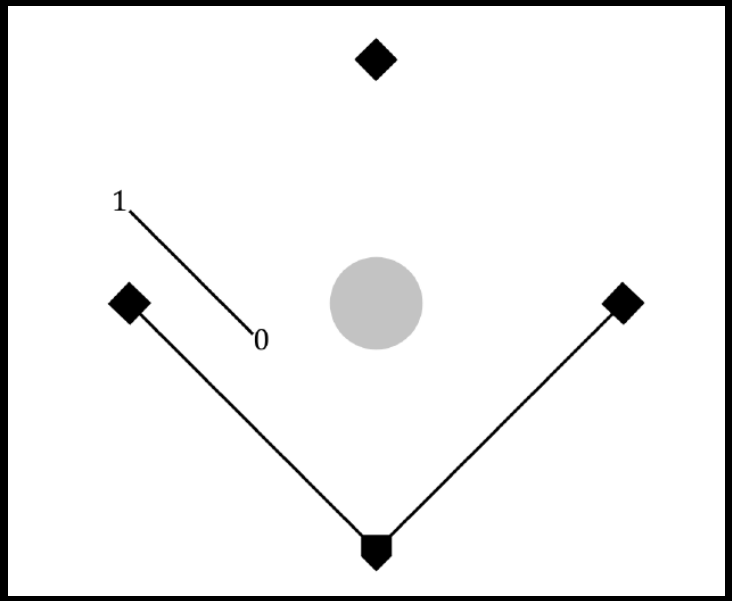
The Interaction

- A simple two move game:
  1. Infielders pick a position.
  2. Batter sees their positioning and chooses whether to swing or bunt.
- For simplicity, consider just the third baseman's strategy.


1
0

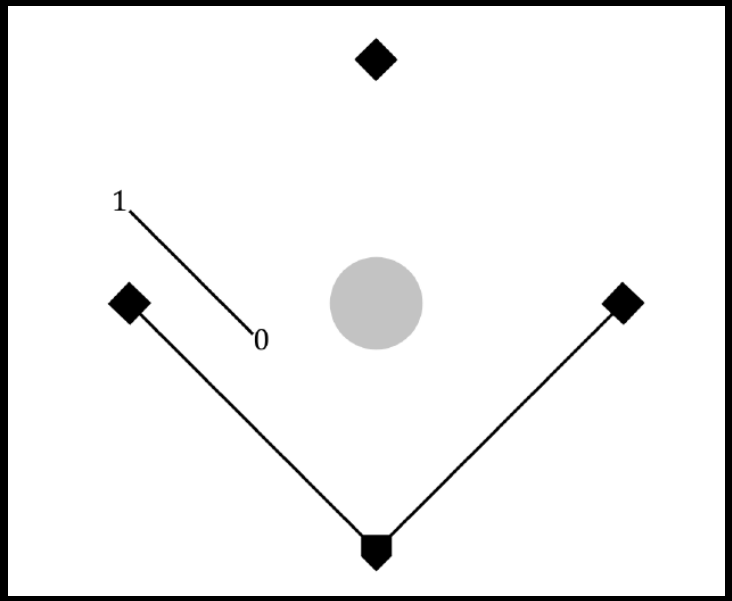
Some Logic

- Suppose the batter wants to bunt if the fielder is at 1 and wants to swing if the batter is at 0.



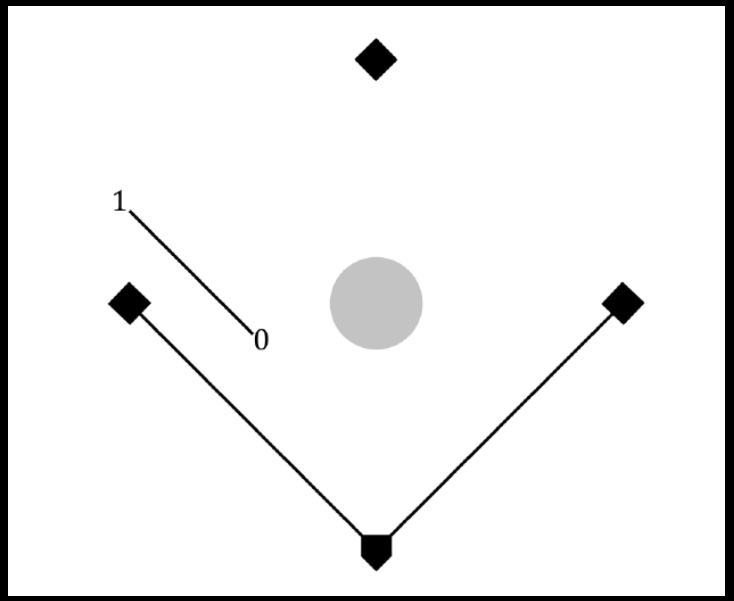
Some Logic

- If the batter bunts, his win percentage is increasing as the fielder moves closer to 1.
- If the batter swings, his win percentage is increasing as the fielder moves closer to 0.



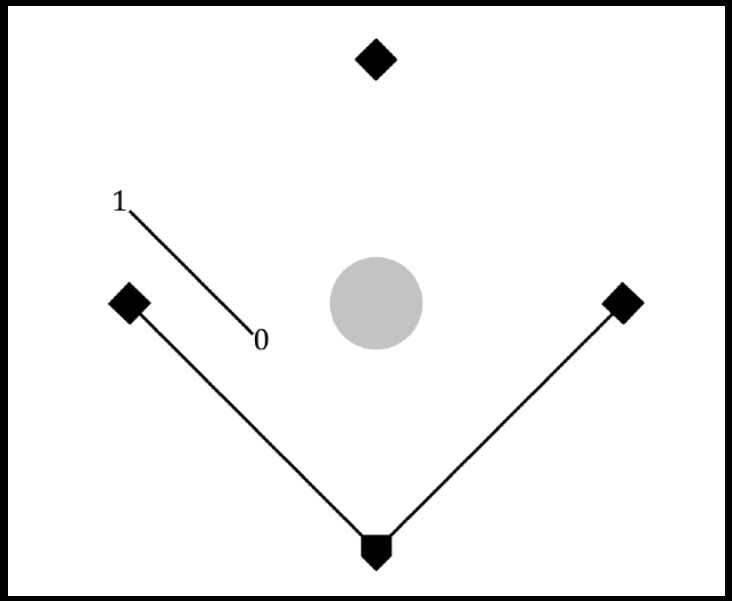
Some Logic

- Intermediate value theorem: there is a unique fielding position at which the batter is indifferent between bunting and hitting.



Some Logic

- This is the optimal fielding position.
  - If the fielder moves closer, the hitter swings, and the fielder loses more frequently.
  - If the fielder moves further away, the hitter bunts, and the fielder loses more frequently.



Interesting Facts

- The fielder has a *uniquely optimal* fielding position.
  - Any other position is bad strategy.
- When the fielder plays this position, *it doesn't matter* whether the hitter bunts or swings.

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ANGELS

Catching Baseballs Is Easy If…

- you are a nubile girl.
- you are under the age of 7.
- a player accidentally soaks you with beer.
- you know how to say “could you give me a ball please?” in obscure languages that some random baseball player speaks.

Catching Baseballs Is Easy If…

- you are a nubile girl.
- you are under the age of 7.
- a player accidentally soaks you with beer.
- you know how to say “could you give me a ball please?” in obscure languages that some random baseball player speaks.
- you know what you are doing.

Tip #1

- Go where they aren’t.

Upper Deck

Lower Deck

Field

10%

Upper Deck



90%

Field

Tip #1

- Survey the possible areas that balls could go and how frequently they will go there.
- Note where people are congregating.
- Go to the place where the most balls go divided by the number of people there.

Tip #2

- Box out your neighbor.

Upper Deck


Upper Deck

Upper Deck


Upper Deck

Upper Deck

Upper Deck


Upper Deck


Upper Deck

Thanks!

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