Pitch Quantification

qop™ - Quality Of Pitch™ and The Greiner Index

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Acknowledgments

- Jarvis Greiner
- Joel Pixler & Rebecca Lee (Research Assistants)
- John Verhooven (Former MLB pitcher)

Pitch Quantification

- 2014 Cy Young Award
- 2014 League MVP
- 1.77 Regular Season E.R.A.
- 7.82 Post Season E.R.A.
- Poor Pitching? Or Great Hitting?

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2. Problems with current pitch analysis

- No objective system to rate breaking pitches (Fastball – MPH, Breaking ball- ?)
- Subjective: ‘Nasty’ Curveball or a ‘Filthy’ Slider?
- Deficiencies with results-based analysis (hitter-quality, umpire, environment, luck)
- No objective way to track improvement / decline in game / season / career
- No objective way to compare the quality of breaking balls between pitchers

→ Remove subjective factors from evaluation

→ Quantify pitches on a standardized scale

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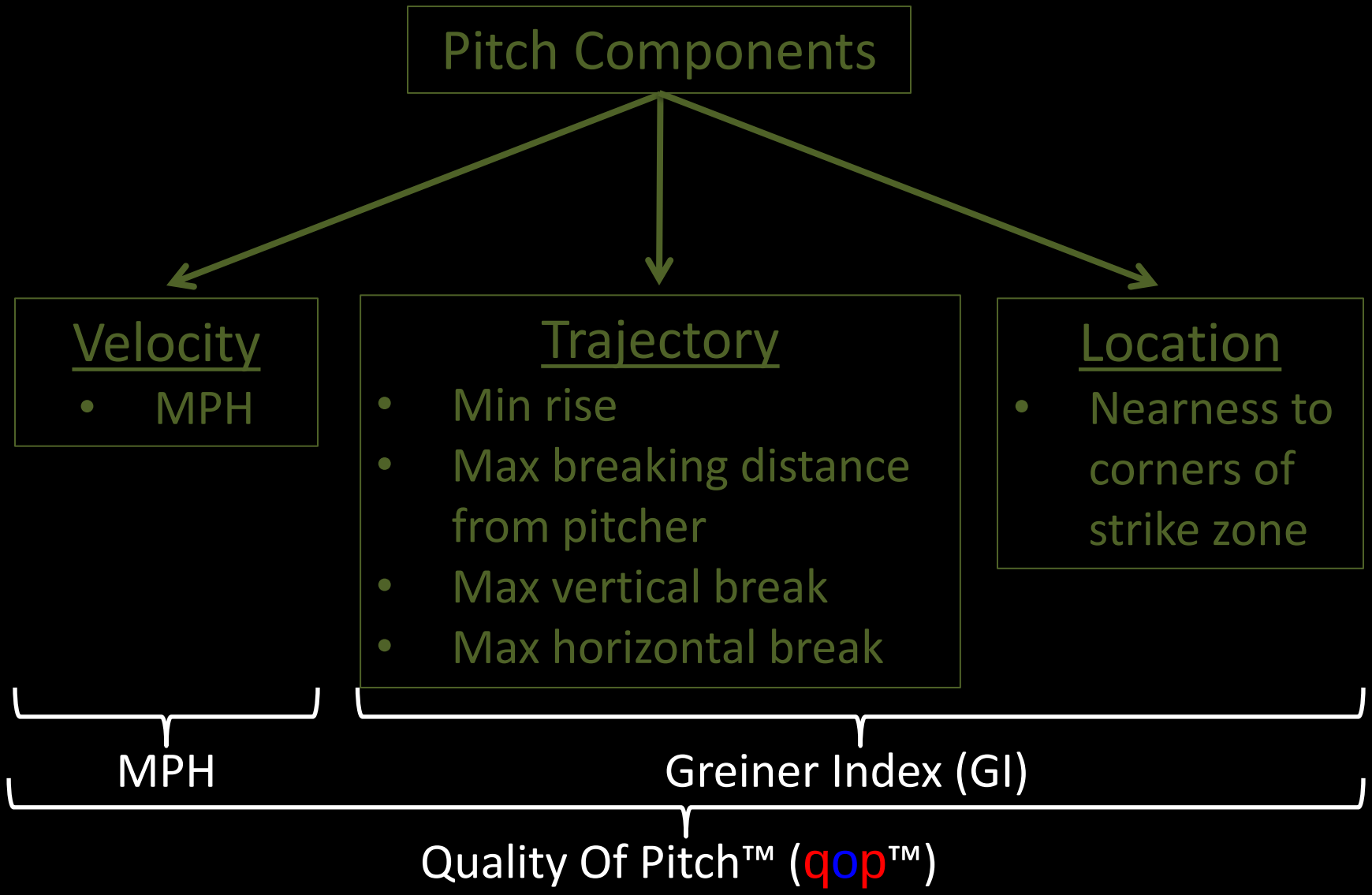
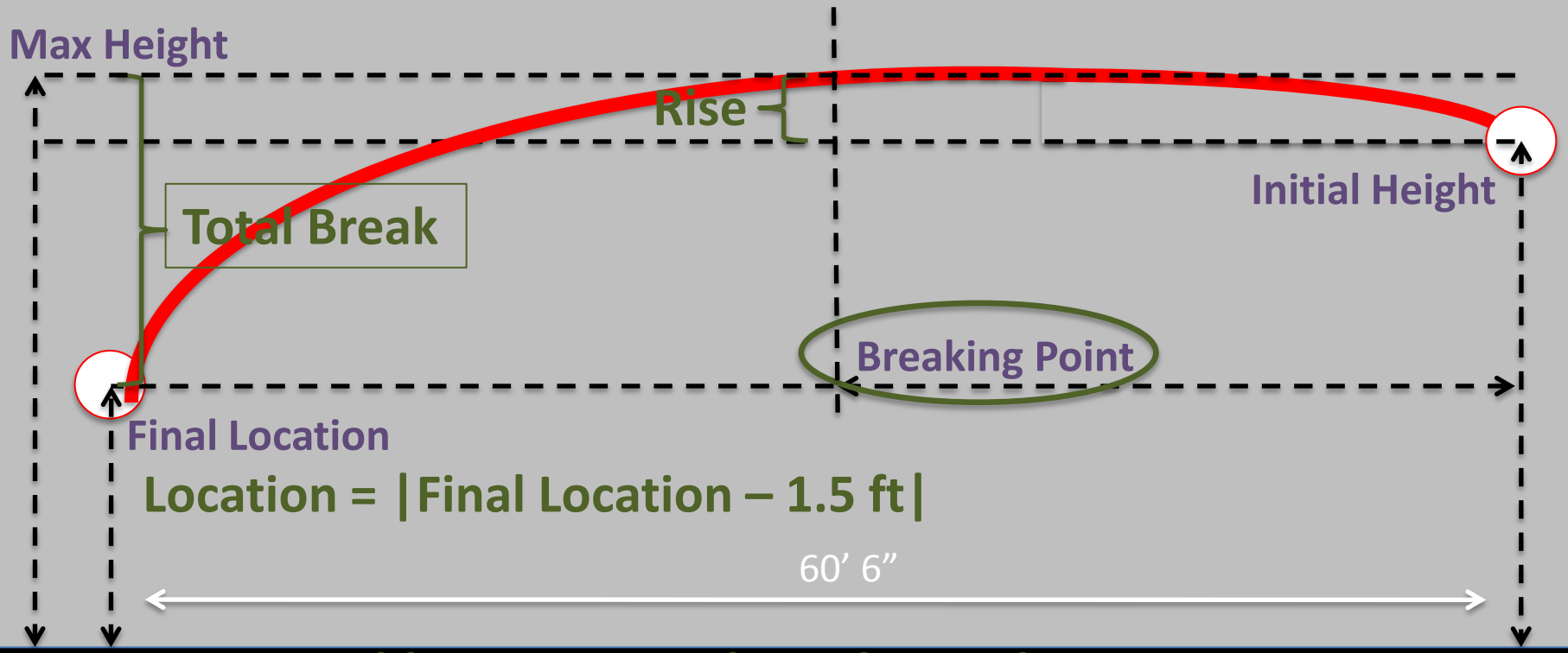
3. Task: Assign a measurement to a pitch
Criteria: Difficulty of hitting the ball



3. Early Work: Curveballs Only

Wilson, Jason and Jarvis Greiner. 2014. A Curveball Index: Quantification of Breaking Balls for Pitchers. *CHANCE*. 27:3, p. 34-40.

Flight of the Curveball



Regression Variables: Rise, Total Break, Breaking Point, Location

Dependent Variable: Score of pitching coach on 0 to 100 scale

3. Regression Output

- y = -2.51*rise + 0.51*tot.break + 1.88*break.point – 0.47*loc
- quadratic & interaction terms were insignificant

```
Coefficients:
             Estimate  Std. Error t value Pr(>|t|)
rise          -2.50900    0.62227  -4.032  0.00043 ***
total break    0.51122    0.06905   7.403 7.33e-08 ***
breakpoint     1.87705    0.23530   7.977 1.87e-08 ***
location      -0.47095    0.17489  -2.693  0.01224 *
---
Residual standard error: 8.289 on 26 degrees of freedom
Multiple R-squared: 0.9749,     Adjusted R-squared: 0.73
F-statistic:   252 on 4 and 26 DF,  p-value: < 2.2e-16
```

- Ex: rise = 3 in; tot.break=48 in; break.point=21.5 in; loc=8 in

  GI = -2.51*3 + 0.51*48 + 1.88*21.5 – 0.47*8 = 53.6

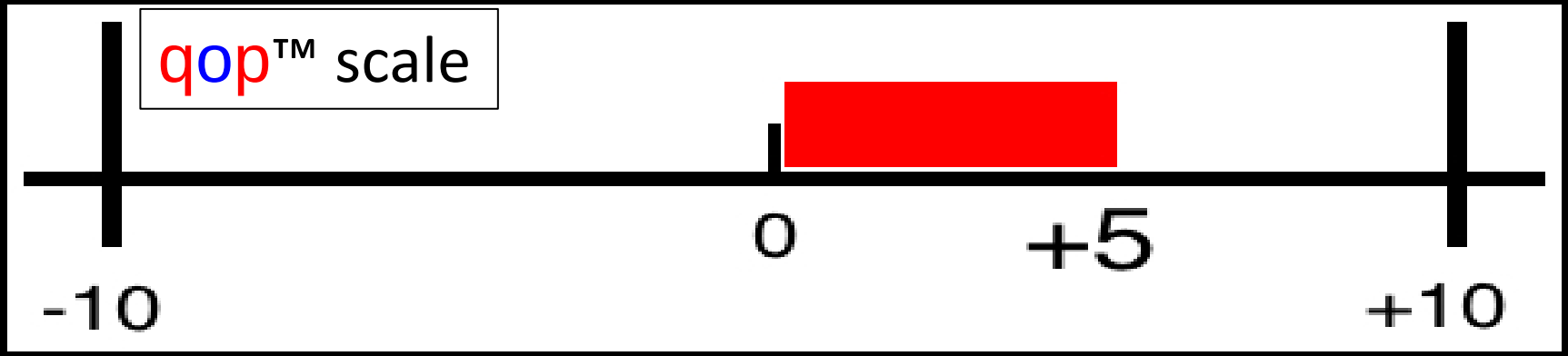
- Model fit was excellent (normal residuals, common variance, no problem with multicollinearity)

3. Extensions in Current Work

1. Horizontal break
2. Improved location parameter
3. ALL pitches
4. PITCHf/x data (feet, not inches)
5. MPH

Greiner Index (GI)

qop™



(-) variables heavily outweigh (+)

(+) and (–) variables are balanced

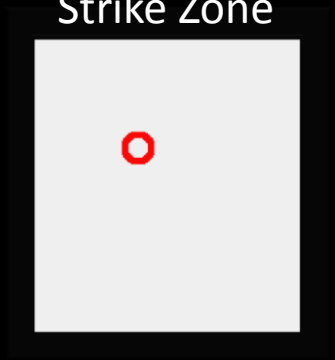
Quality MLB pitch

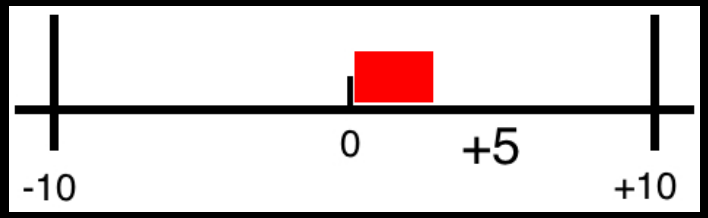
Minimal (-) variables

Normal MLB pitches are -10 to 10, but exceptional pitches can go outside range

Clayton Kershaw – June 18/14 vs COL – Fastball

- Good Velocity – 92mph
- No break
- Poor Location
- 2.96 qop™
- Below Average Quality

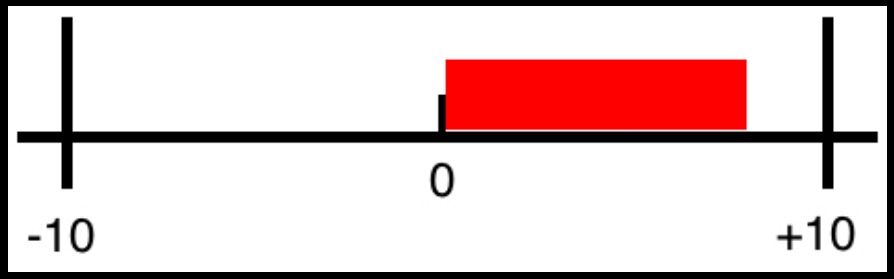




Hyun-Jin Ryu – May 26/14 – vs CIN - Curveball

- Decent Break
- Very Late Break
- Very Good Location
- 8.09 qop™
- Above Average Quality

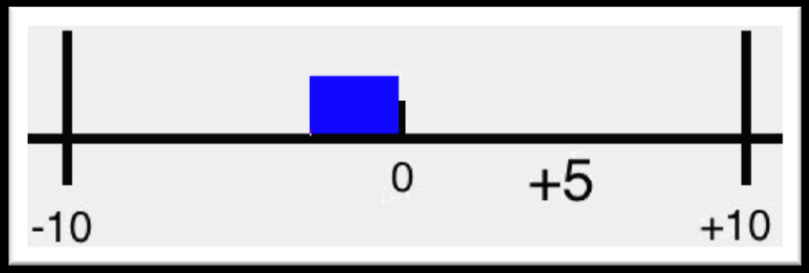
Strike Zone



Josh Beckett – May 25/14 vs PHI – Change Up

- Poor Velocity – 85mph
- Very Poor Location
- -2.49 qop™
- Well Below Average Quality

Strike Zone



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4. Case Study in Current Work

- LA Dodgers, 2014
- Team record of 1,373 strikeouts
- Kershaw – 7.71 K/BB
- What can we learn from their qop™?

espn.go.com

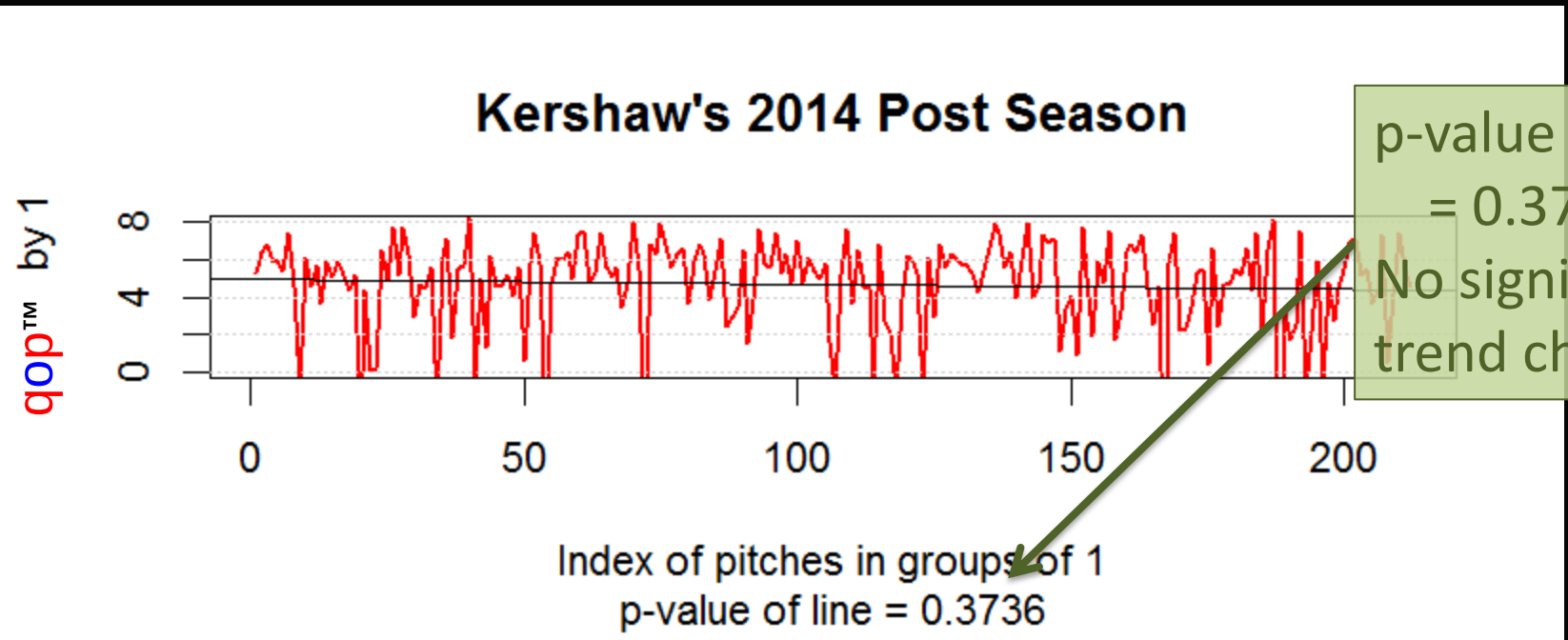
4. Stats Overview

p-value = the probability that the difference from what is expected is due to chance

- Usual benchmark is 0.05
  → If p-value < 0.05, result is "statistically significant"
- Ex. 1: Kershaw's Regular Season MPH = 92.96
  Post Season MPH = 93.38

p-value<0.0001
Diff. unlikely due to chance; Kershaw threw faster in Post

- Ex. 2: Trend of qop™



p-value
= 0.37 > 0.05
No significant trend change

#1 – Objective Pitcher Comparison

1. Rate and compare pitcher ability
   - Scouting, drafting, salary determination
   - Removing subjective factors: competition, age, environment, etc.
2. Which game featured the better pitching performance?

boston.cbslocal.com

Josh Beckett
May 25th @ Phi

Two 2014 Dodger no-hit games

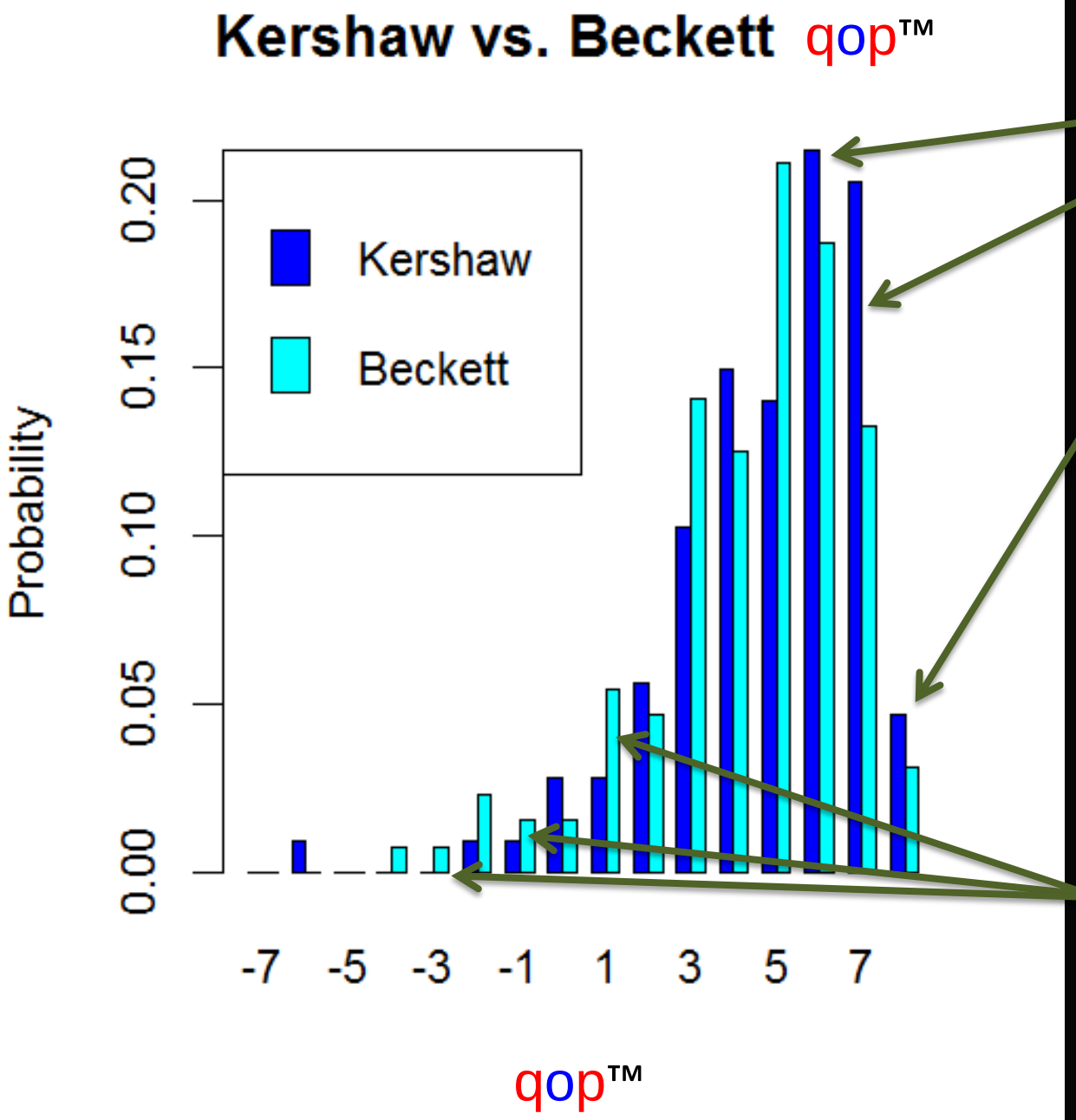
articles.chicagotribune.com

Clayton Kershaw
June 18th vs. Col

Traditional Statistics

Player	Date	Team	BB	K	BF	PIT	STR	STL	STS	GB	FB	LD	PU
Josh Beckett	May 25	Phi	3	6	30	128	80	29	13	10	11	3	3
Clayton Kershaw	June 18	Col	0	15	28	107	79	18	22	9	4	1	0

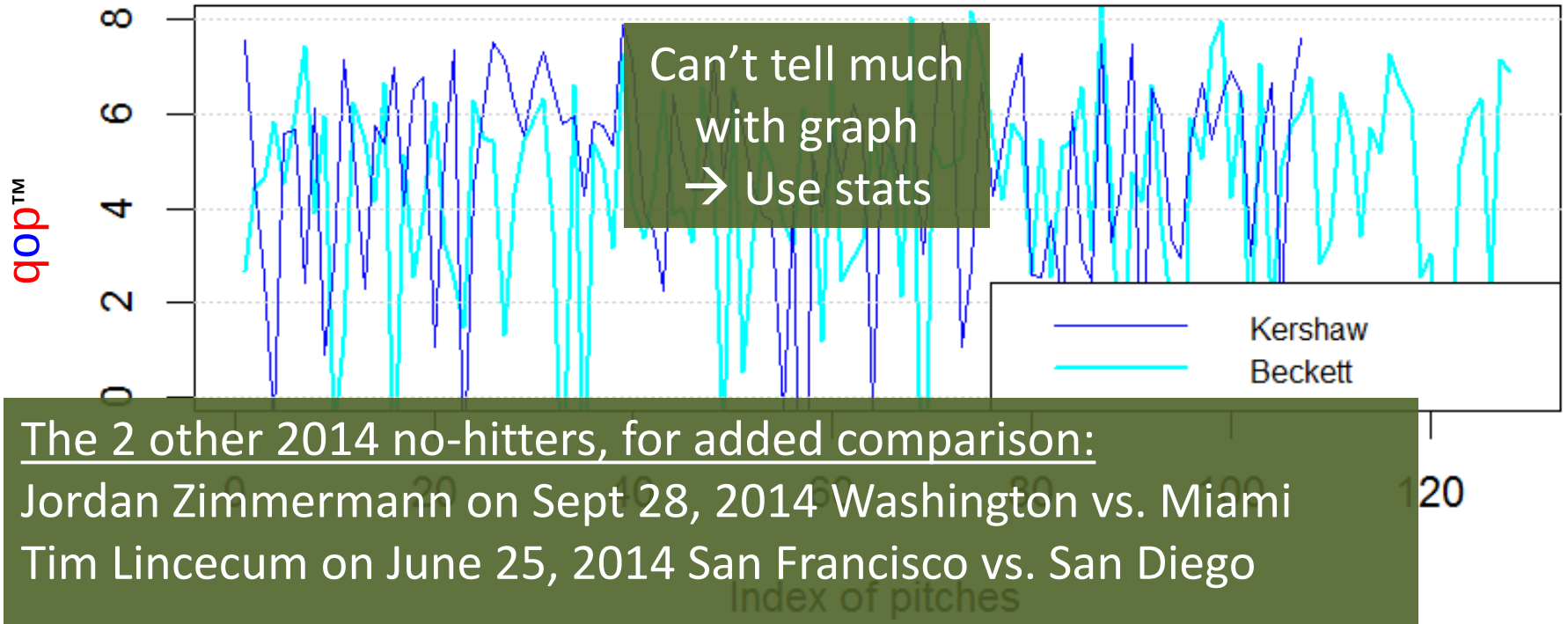
Philadelphia batting average at home: .239
Colorado batting average on the road: .228



Kershaw has more high qop™

Kershaw has fewer low qop™

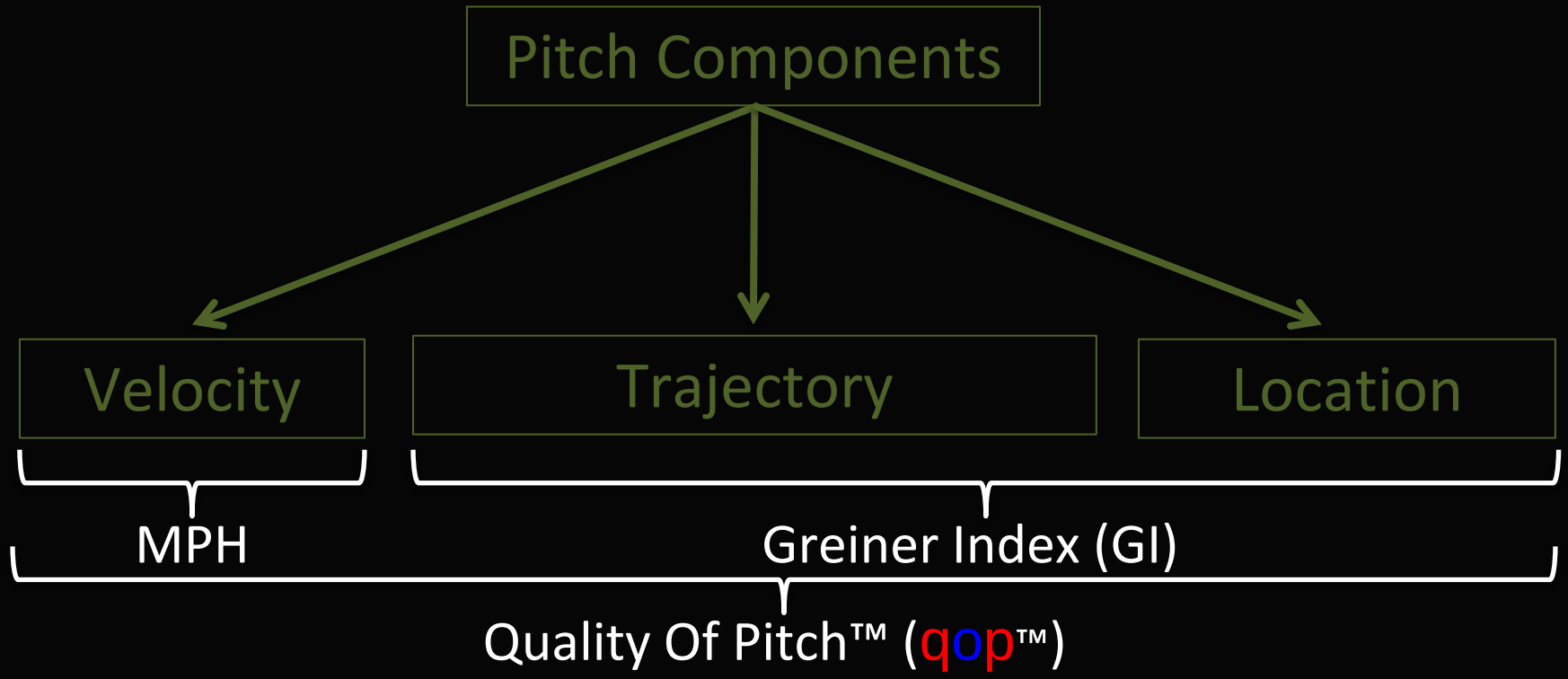
Kershaw & Beckett 2014 No-Hitters



Can't tell much with graph → Use stats

The 2 other 2014 no-hitters, for added comparison:
Jordan Zimmermann on Sept 28, 2014 Washington vs. Miami
Tim Lincecum on June 25, 2014 San Francisco vs. San Diego

MPH:	Lin (83.48)	<	Beck (84.59)	<	Ker (87.89)	< Zim (91.29)
GI.offspeed:	Zim (2.63)	=	Ker (2.63)	<	Lin (2.76)	< Beck (2.80)
GI.fastball:	Zim (1.41)	<	Beck (1.79)	<	Lin (1.97)	< Ker (2.13)
qop™:	Beck (4.34)	<	Zim (4.38)	<	Lin (4.48)	< Ker (4.76)



MPH = speed; GI = trajectory + location; QOP combines all 3 → Adds info!

MPH:	Lin (83.48)	<	Beck (84.59)	<	Ker (87.89)	< Zim (91.29)
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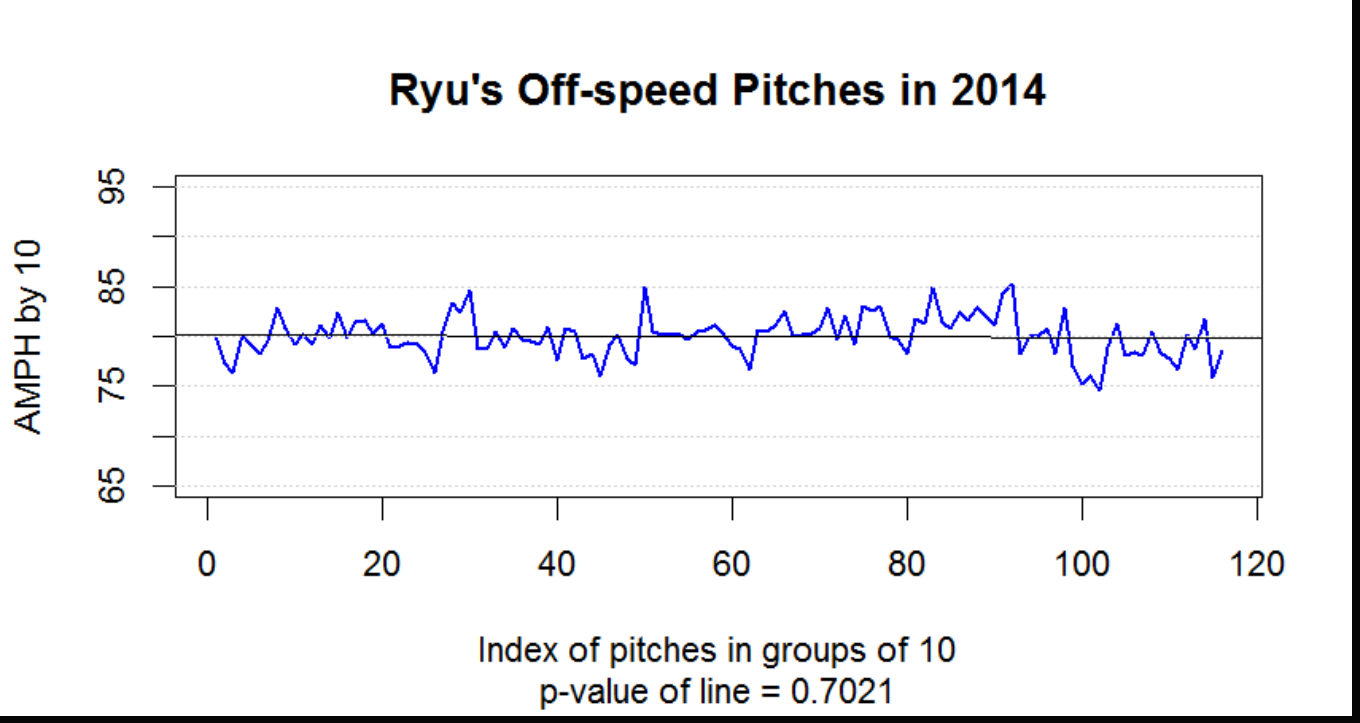
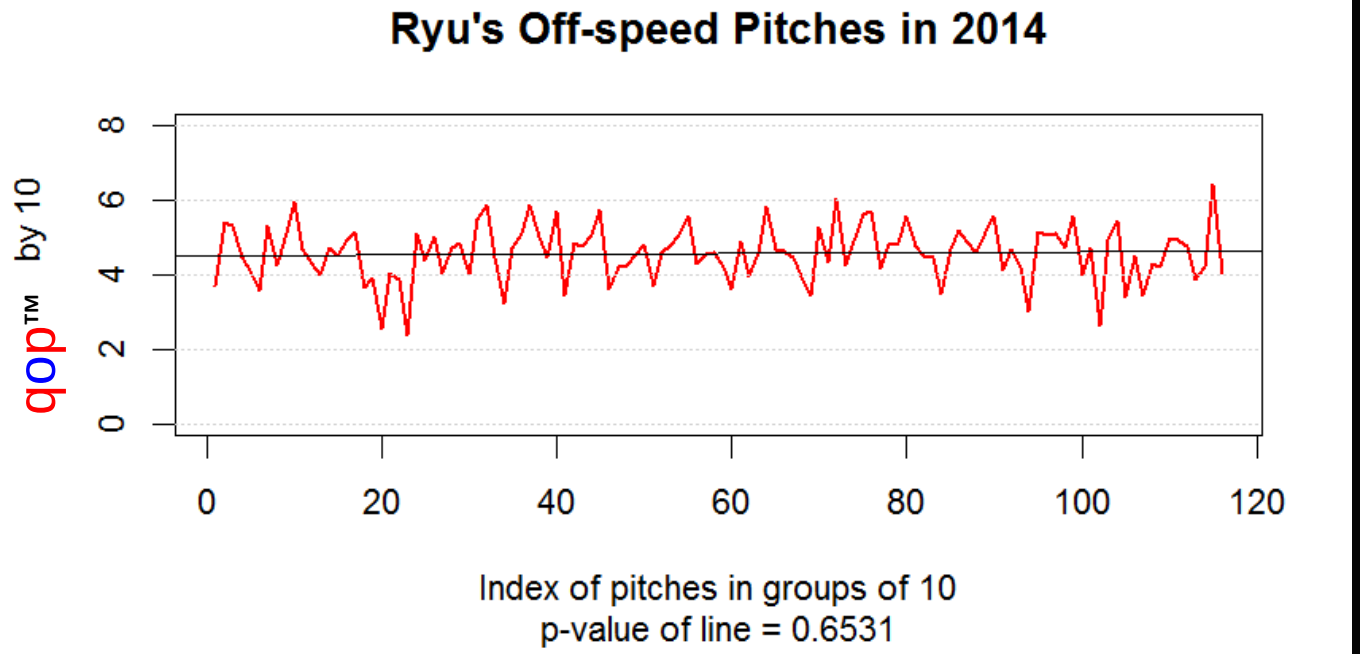
qop™:	Beck (4.34)	<	Zim (4.38)	<	Lin (4.48)	< Ker (4.76)

#2 – In Game Evaluation

1. Analysis of a pitcher's in game performance
2. Can we detect a decline in pitch quality that could have determined alternate pitch selection and/or influence managerial decisions?

Hyun-Jin Ryu vs. CIN, May 26th, 2014





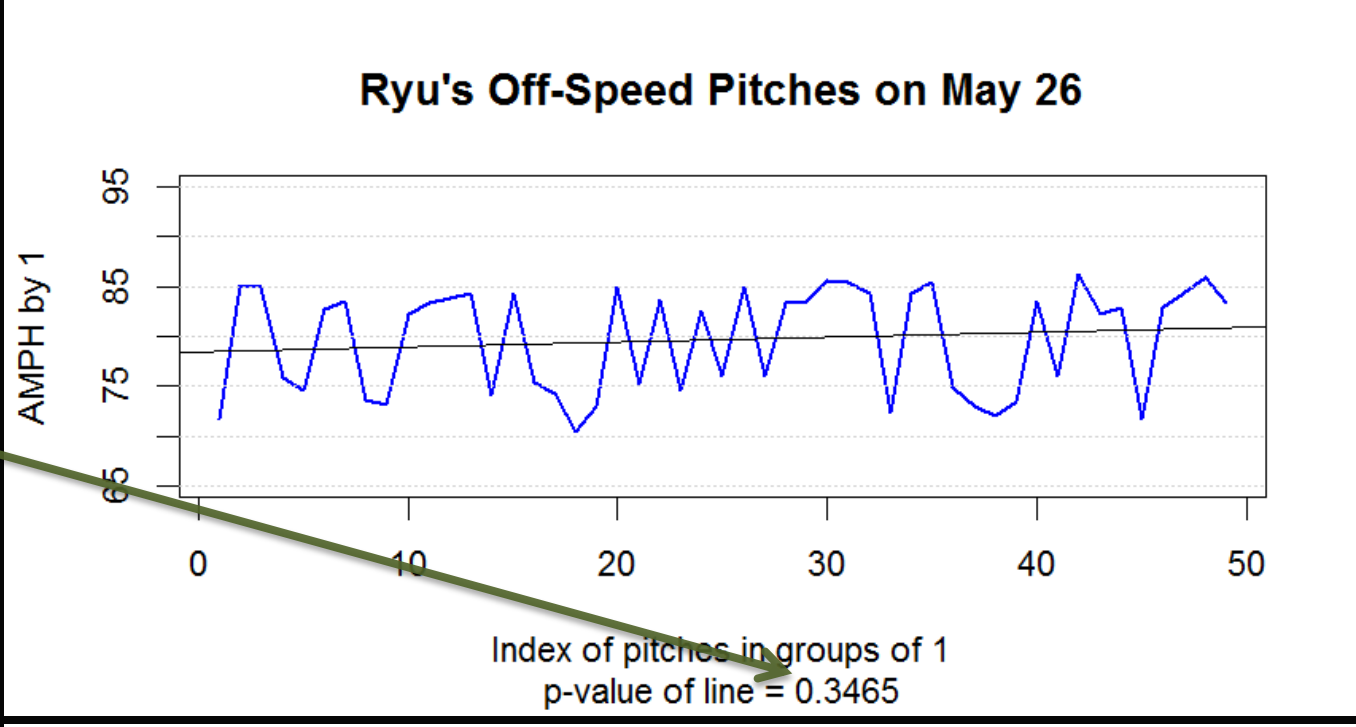
For the Season, Ryu's off-speed MPH and qop™ were steady

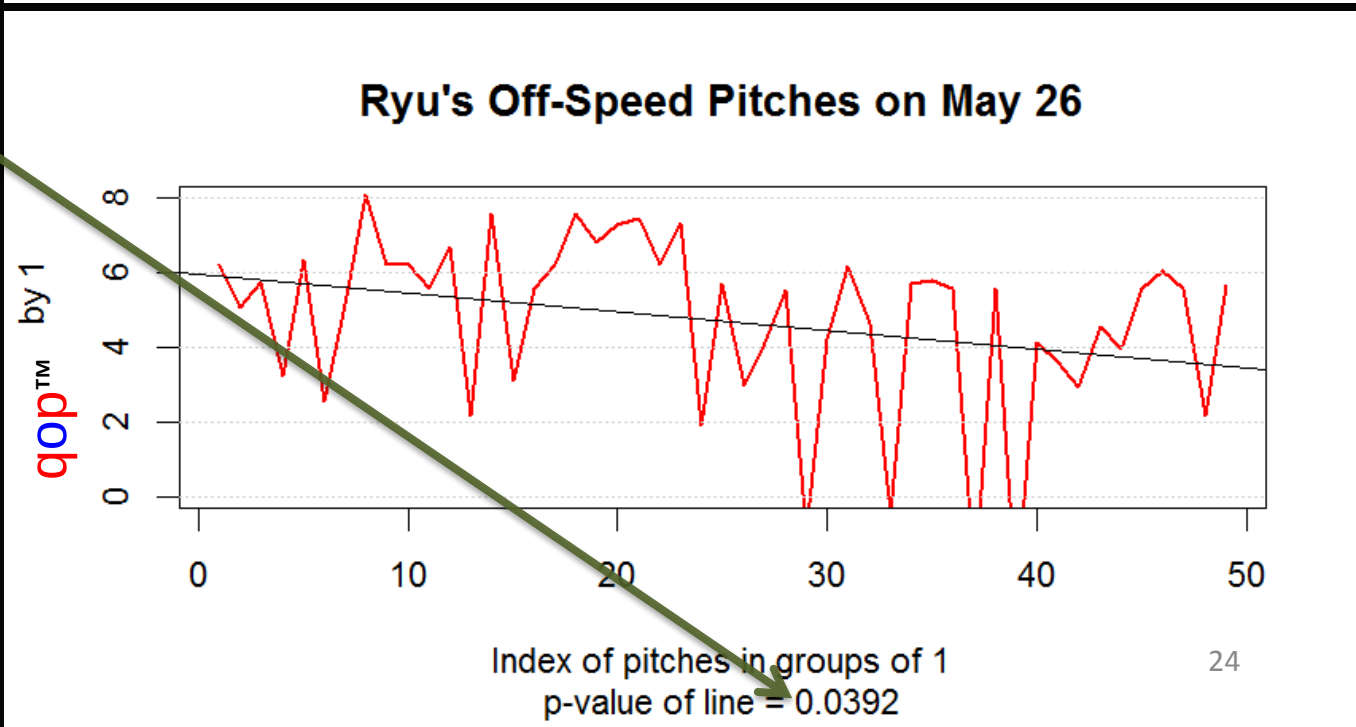
(fastballs got faster, not shown)

Off-speed MPH flat p-value>.05
(fastballs similar, not shown)

Off-speed qop™ declined P-value<.05
(fastballs did not, not shown)

→ MPH = speed, qop™ gives additional info





#3 - Injury Prevention

1. Analysis of a pitcher's season performance
2. Can we prevent injury by identifying pitch deterioration patterns using qop™ data?
   - A proactive approach with players instead of passively waiting for player feedback

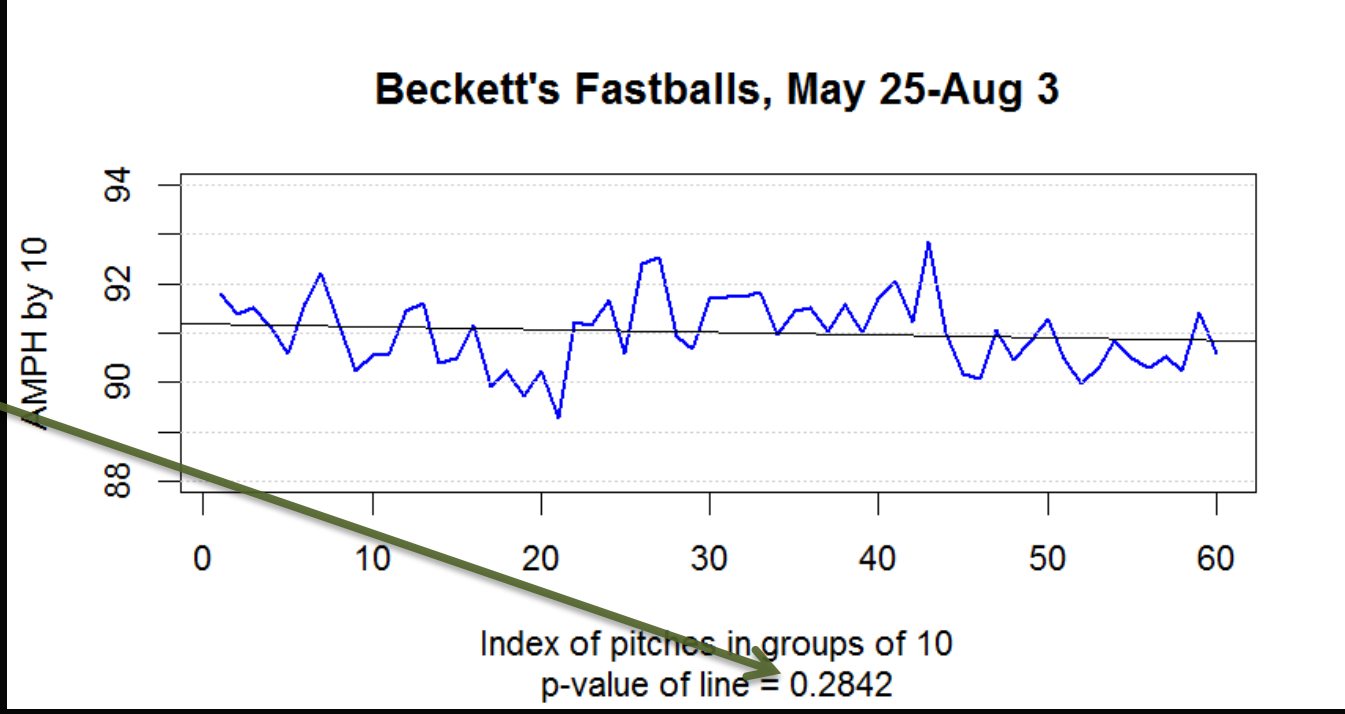
Josh Beckett vs. CHC
August 3rd, 2014

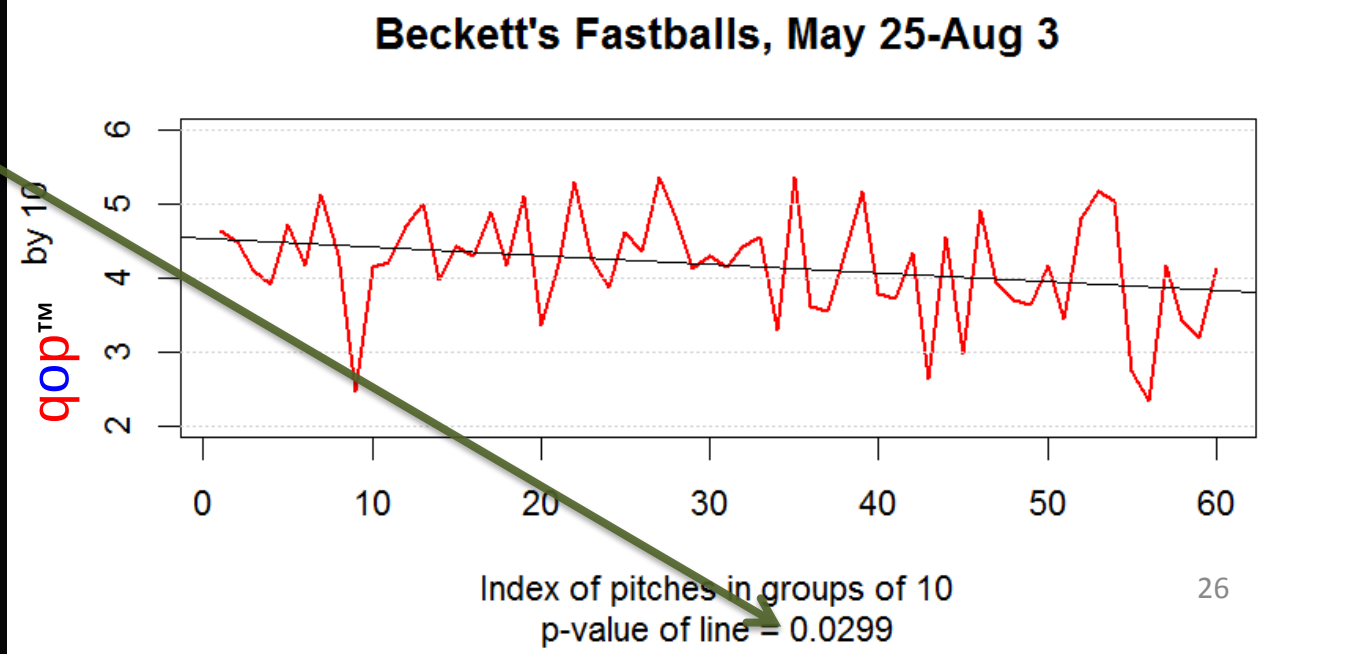
Fastball MPH flat p-value>.05
(off-speeds similar, not shown)

Fastball qop™ declined p-value<.05
(off-speeds did not, not shown)

Cross-game decline discovered with qop™, but not MPH

→ MPH = speed; qop™ adds info





#4 – Hitter Evaluation

1. Analysis of hitter's performance against different pitchers
   - Hitter's with higher/lower batting averages facing higher/lower quality pitches
     → Identify under/over valued players
   - Confirm or refute of statistical anomalies
   - Check validity of higher/lower than average success rates of hitters against certain pitchers, and vice versa

2. Can qop™ give insight into why one hitter succeeds while another fails against the same pitcher?

Adam Dunn vs.
Clayton Kershaw

	Dunn vs. Kershaw	Overall 2008-2014	p-value
Kershaw AMPH	91.56	88.68	<0.0001
Kershaw qopa™	4.63 (5.20 On Hits)	4.49	0.503
Dunn Batting Avg.	0.615	0.225	0.001
Dunn HR/AB	4/13 = 0.308	224/3529 = 0.063	0.003
Dunn Slugging %	1.692	0.490	--

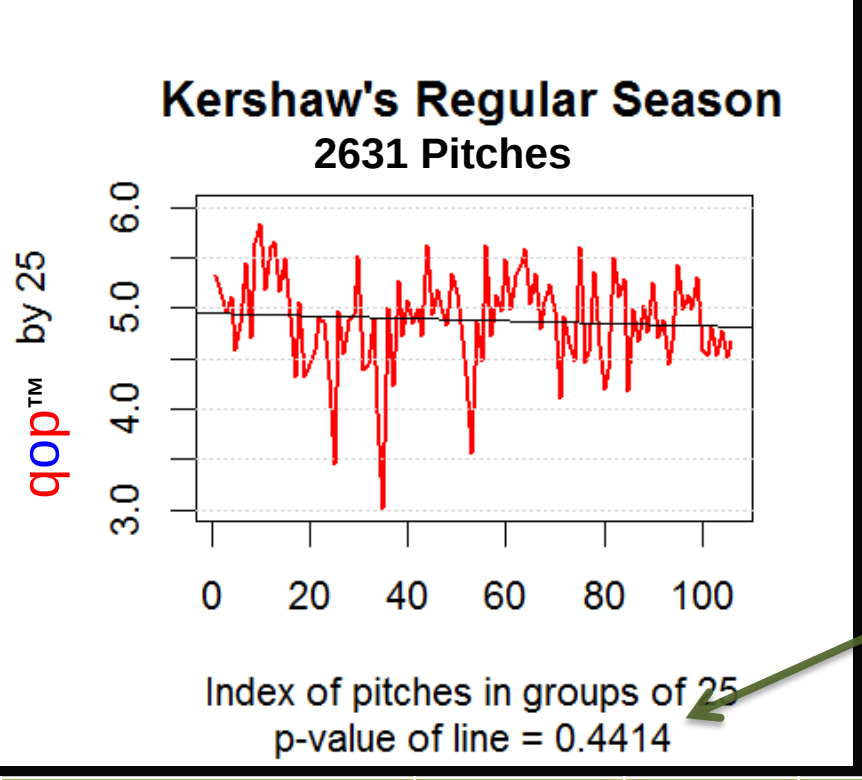
- Kershaw's pitches are average (qop™) or better (MPH)
- Dunn's batting is significantly better

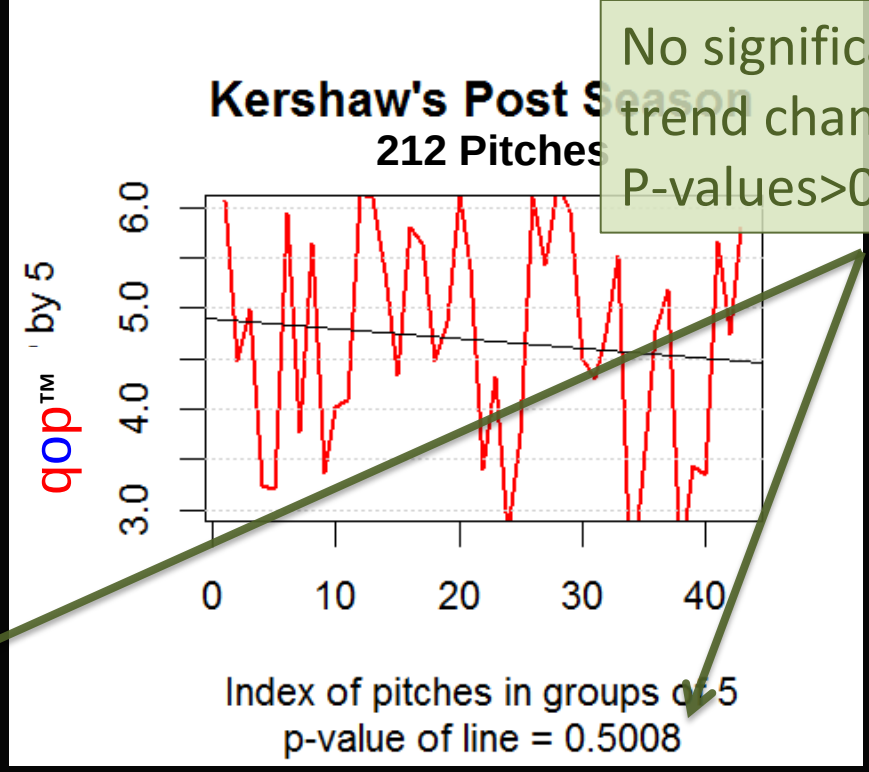
→ MPH & qop™ provide complimentary info

#5 – Confirmation or Refutation of Results Based data

1. Provide additional quantitative information for use with other measures
2. Does qop™ confirm a change in pitch quality between a successful regular season and a disappointing postseason?

Clayton Kershaw
2014 Season





No significant trend changes
P-values>0.05

	Regular	Post	p-value
MPH, all pitches	88.64	88.17	0.478
MPH, off-speed	83.11	82.32	0.360
MPH, fastballs	92.96	93.38	<0.0001
St. Dev of MPH	6.54	7.27	0.060
qop™, all pitches	4.88	4.65	0.523
qop™, off-speed	4.65	4.35	0.971
qop™, fastballs	5.06	4.92	0.357
St. Dev of QOP	2.32	2.69	0.386

- Tiny performance declines
- Not stat. sig., p-values>.05
- Except MPH (sig. increase)

→ Results likely due to other factors, e.g. Batters

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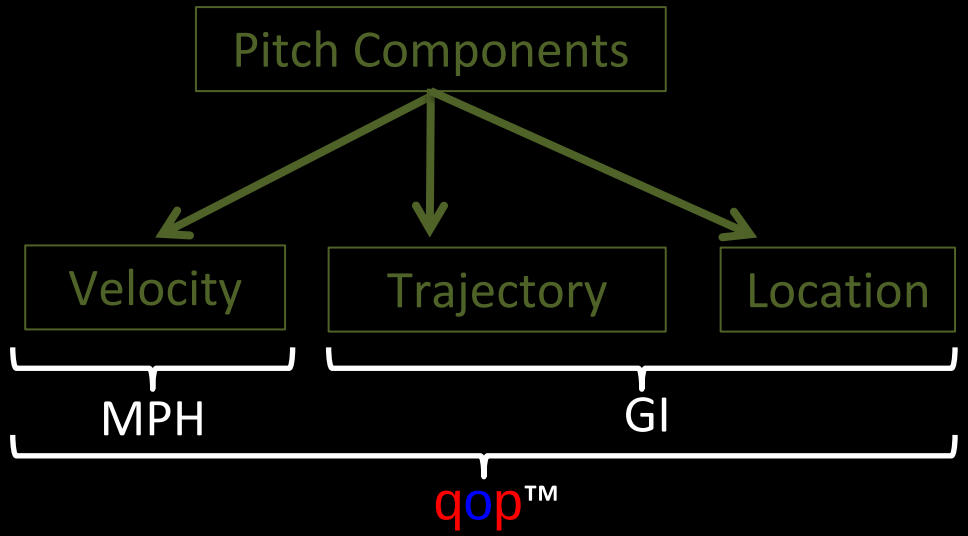
5. Conclusion



1. GI & qop™ provide valuable new insights into pitching
2. Vision
   - International standardization of pitch evaluation
   - Change how kids see and train for the game
   - Open the door to new discoveries: medical, analytical, pitcher-training, and beyond
3. For further research
   - Model refinement with MLB pitching coaches
   - Applications: medical, analytical, pitcher-training
   - Park effects, weather effects, etc.

Questions?

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- Wayne Greiner – greiner@telusplanet.net
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  - Cell – 1.780.910.1307

Available Data

- Spring 2015
- Historical qopa™ by pitch type (2008-2014)
- Historical qopa™ by MLB team (2008-2014)
- Current qop™ by player (2015)
- Current qopa™ by player (2015)

2014 qopa

Pitch	4Seam	2Seam	Change	Curveball	Cutter	Sinker	Slider	Knuckle
Max	10.00	10.07	9.49	9.35	9.59	10.31	9.15	8.52
Avg	4.67	5.04	4.27	4.59	4.48	5.05	4.2	4.24

Year		qopa
2008	Max	10.07
	Avg	4.47
2009	Max	9.98
	Avg	4.51
2010	Max	10.31
	Avg	4.46
2011	Max	10.21
	Avg	4.47
2012	Max	10.03
	Avg	4.57
2013	Max	10.00
	Avg	4.57
2014	Max	9.92
	Avg	4.57

qop™

qopbaseball.com™

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6. GI Model Output

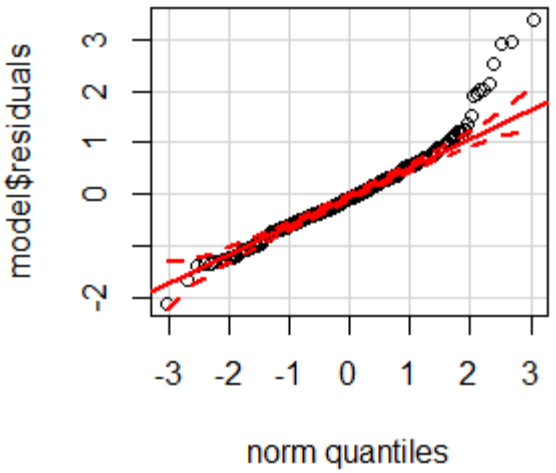
```
Residuals:
    Min      1Q  Median      3Q     Max
-2.1066 -0.4282 -0.0656  0.3274  3.3782

Coefficients:
                   Pr(>|t|)
Rise               0.00519
Breakpoint         < 2e-16
Vertical break     < 2e-16
Location           < 2e-16
Horizontal break   6.1e-05

Residual standard error: 0.6724 on 419 degrees of freedom
Multiple R-squared:  0.9578,  Adjusted R-squared:  0.9573
F-statistic:  1903 on 5 and 419 DF,  p-value: < 2.2e-16
```

Actually 0.92, adjusting for no-intercept model

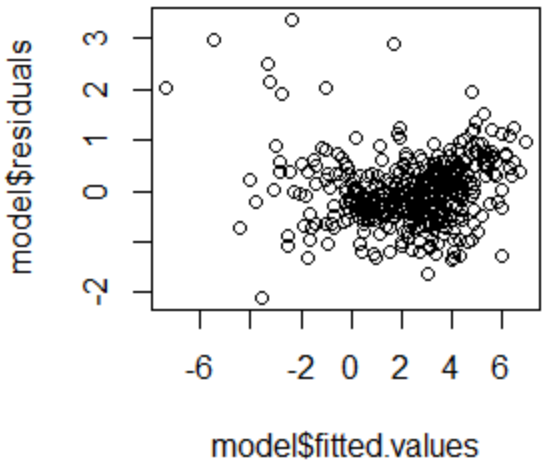
6. Diagnostic Statistics

1. Residuals close to normal
2. Common variance holds
3. Multicollinearity not a problem

1. **Normal-QQ Plot of Residuals**



2. **Residuals vs. Fitted Values**



3. Name	Value(s)	Remark
Condition Number	124.2	Way below 1,000
Variance Inflation Factors	8.5, 7.4, 4.9, 4.2, 2.0	All below 10
Singular Values	120, 72, 36, 8, 1	Minimum value small, indicating possible removal of one parameter