Modeling and Simulating Fan Participation at Large Scale Sporting Events

Blue Jays Unlimited

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Overview

The Importance of Cheering in Sports

- A loud and supportive home crowd is the ultimate home team advantage for sports teams
- Home crowd advantage affects the result of the game, shown by past research:
  - In US professional sporting leagues, home teams can win approximately 60% of the time [1]
  - In US college athletics, home teams can win approximately 66% of games played [2]
- Home crowd can also improve the ambiance of a sporting event

What is Cheering?

- Can show support and enhancing the atmosphere by "cheering":
  - Chanting the school fight song
  - Waving a rally towel
  - Doing the wave
  - Clapping in general
- Cheering is essential at collegiate sporting events; improves experience for both teams and the fans

The Johns Hopkins Blue Jays

- The Blue Jays have amassed 47 national championships and 187 conference titles [3]
- The Blue Jays have excelled at many sports including:
  - The Men's Lacrosse team has won 44 national championships, most recently in 2007 [3]
  - The Men's Swimming team won 32 conference championships, including a streak of 28 consecutive conference championships from 1971-1998 [3]
  - The Men's Football and Baseball teams were each conference champions for three consecutive years from 2009-2011 [3]

Who are Blue Jays Unlimited?

- Blue Jays Unlimited (BJU) was established in 1995 [4] by a volunteer group of alumni, friends, and staff
- Has more than 3000 active members dedicated to supporting and promoting Johns Hopkins University (JHU) athletics [4]
- Official booster club for JHU athletics [4]

The logo of Blue Jays Unilimited. *Courtesy of:*

http://www.hopkinssports.com/bluejays-unlimited/

What Does BJU do for Hopkins?

- Raised more than $4 million in funds to improve experience for JHU student athletes and fans alike [4]
- Funds provide money for capital projects as well as scholarships and operational endowments [4]
- Past projects include renovation of the Newton H. White Athletic Center and recognition banners for championship teams [4]

The Newton H. White Athletic Center after renovations. *Courtesy of: http://events.jhu.edu/WhiteAthleticCenter#.UHhNK1GRWSo*

BJU at Sporting Events

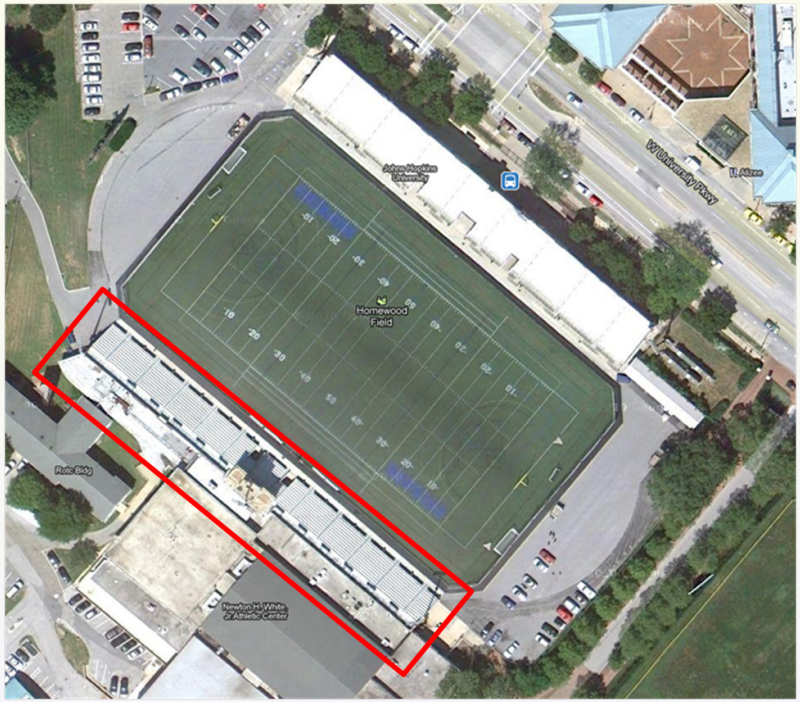
- BJU is present at nearly all major JHU sporting events
- Encourage fans to cheer on their Blue Jays to victory in a vociferous and family-friendly manner
- BJU is interested in maximizing the amount of fan participation in cheering at sporting events to provide the ultimate advantage: a spirited home crowd
- They believe they can increase fan participation in cheering events by strategically placing student-volunteer "cheer starters" in the crowd.

Official Problem Statement

- BJU wants to know if "cheer starters" can actually increase cheering and wants a simple model of fan participation in cheering.

Important Details to Consider

- Homewood Field's capacity is approximately 8500 spectators [5]
- Long rectangular section of the bleachers in the lower left is traditionally reserved for Blue Jays' fans and seats approximately 4000 fans



A satellite image of Homewood Field. The home team bleachers are highlighted in red. *Courtesy of: www.google.com*

Important Details to Consider

- Home bleachers are usually filled to capacity for all major Hopkins sporting events
- Because of how fans normally sit, BJU is specifically interested in maximizing cheering in the home team bleachers

Objective Statements

- Provide BJU with a simple model of fan participation in cheering at Homewood Field
- Provide simulation results from the model which determine if cheer starters are effective in increasing cheering
- If cheer starters are effective, and time permitting, we will provide BJU with details about the quantity and locations at which cheer starters should be placed in order to maximize cheering

Simplifications and Assumptions

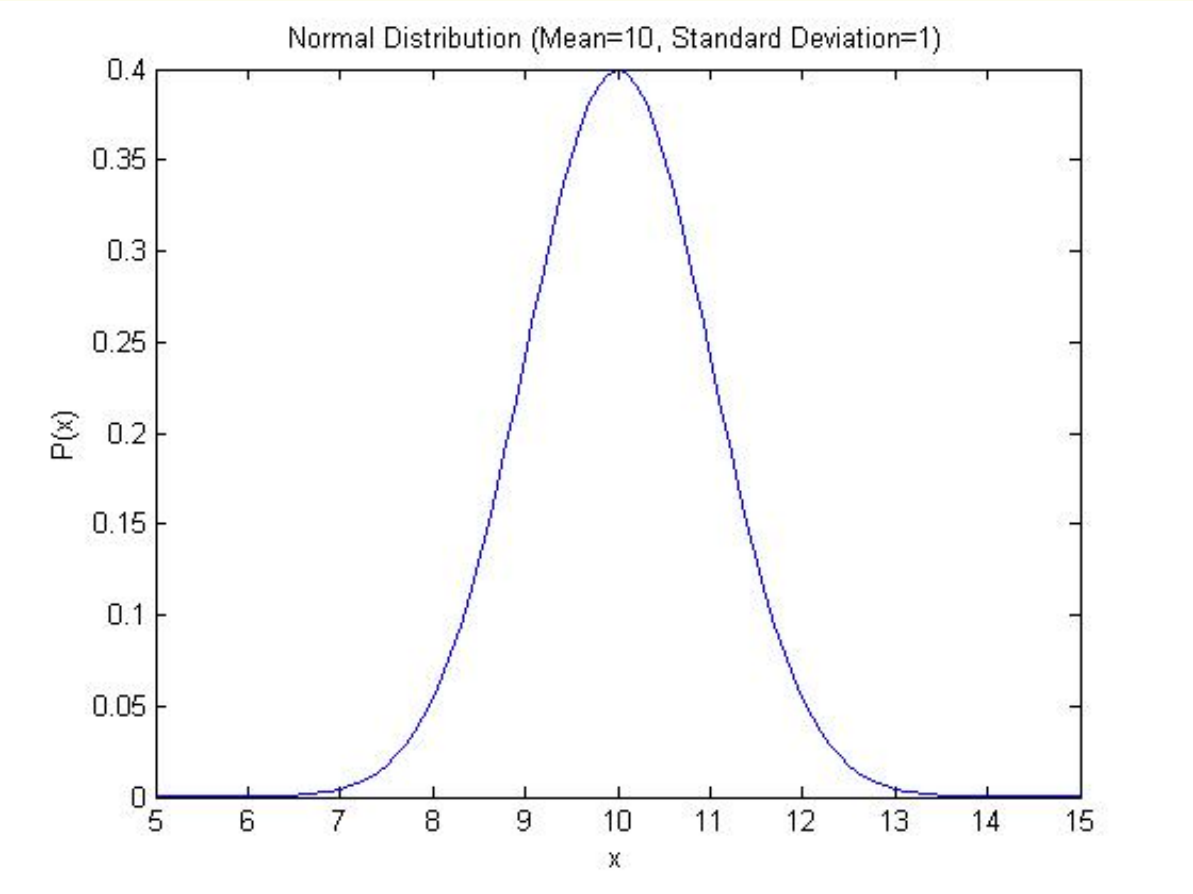
- The willingness of a fan in a crowd to cheer depends on:
  - Number of people cheering around the fan
  - Cheering duration
  - Innate support level
- A cheering fan continues cheering until the end of the simulation
- The performance of the sports team does NOT influence cheering

Step 1: Generating Innate Support Level

- We generate an arbitrarily sized n x m matrix,
- X, to represent an nm sized crowd
- X_{ij} represents fan ij. Each element in X corresponds to fan's innate support level for the team
- Generated by sampling from a normal random distribution with a mean of 10 and a standard deviation of 1 as shown in (1)

$$X_{ij} \sim Norm(10, 1),\ \forall\ i \in [1, n],\ j \in [1, m] \tag{1}$$

Step 1: Generating Innate Support Level



A Normal Distribution with mean 10 and standard deviation 1

Step 2: Determining Which Fans are Initially Cheering

- Set an initial threshold, T_{init} to determine which of the fans in the matrix are *initially* cheering
- A new n x m matrix X' is used to keep track of who is cheering
- Elements in X' assigned according to (2) where 1=cheering and 0=not cheering

$$X'_{ij} = 1 \; if \; X_{ij} \geq T_{init}, \; X'_{ij} = 0 \; if \; X_{ij} < T_{init} \tag{2}$$

Step 3: Including the Influence of Surrounding Fans

- S is a n x m matrix stores how many people surrounding a given fan are cheering at a given time
- Each element in S has corresponding elements with the same row and column indices in both X and X'
- Define a round, r, to be the passing of an arbitrary time interval (approximately 3-5 seconds, in this case)

Step 3: Including the Influence of Surrounding Fans

- Y is an n x m matrix constructed according to (3)
- Each element in Y represents an individual fan and has corresponding elements in X, X', and S, with the same row and column indices.

$$Y_{ij} = X_{ij}S_{ij} + r, \ \forall \ i \in [1, n], \ j \in [1, m] \tag{3}$$

- By computing Y as shown in (3), the likelihood of a fan starting to cheer increases with the number of surrounding cheering fans and their cheering duration.

Step 4: Compare Y to Absolute Threshold and Update Matrices

- Elements in Y are compared to an absolute threshold, $T_{absolute}$
  - We update X' according to (4)

$$X'_{ij} = 1 \; if \; Y_{ij} \geq T_{absolute} \tag{4}$$

  - If the individual's score in Y is less than the absolute threshold, corresponding element in X' remains 0

Step 5: Repeating Rounds

To simulate the passing of time:

1. Check to see if any new fans join cheering
2. Update matrices (i.e. X' and Y)
3. Repeat steps 2 and 3 for R rounds

Final Parameter Values

- Rows, $n = 20$
- Columns, $m = 100$
- Initial Threshold, $T_{init} = 11$
- Absolute Threshold, $T_{absolute} = 46$
- Rounds, $R = 10$
- Number of Cheer Starters, CS (Variable)

Testing Values for T_{init} and $T_{absolute}$

Round	1	2	3	4	5	6	7	8	9	10
$T_{init} = 10$, $T_{abs} = 46$	49.7	74.2	87.15	93.8	97.4	98.85	99.95	99.95	99.95	99.95
$T_{init} = 11$, $T_{abs} = 65$	15.1	15.1	15.15	15.15	15.2	15.35	15.4	15.55	15.65	15.75
$T_{init} = 11$, $T_{abs} = 60$	15.95	16.1	16.15	16.2	16.3	16.4	16.45	16.65	16.75	17.05
$T_{init} = 11$, $T_{abs} = 40$	15.5	21.2	29.15	39.35	52	65.15	76.85	85.5	91.4	95.35
$T_{init} = 11$, $T_{abs} = 46$	15.5	16.65	18.05	20	23.15	27.8	34	42.2	52.2	63.8

Percent of cheering crowd over rounds for some combinations of T_{init} and $T_{absolute}$ values.

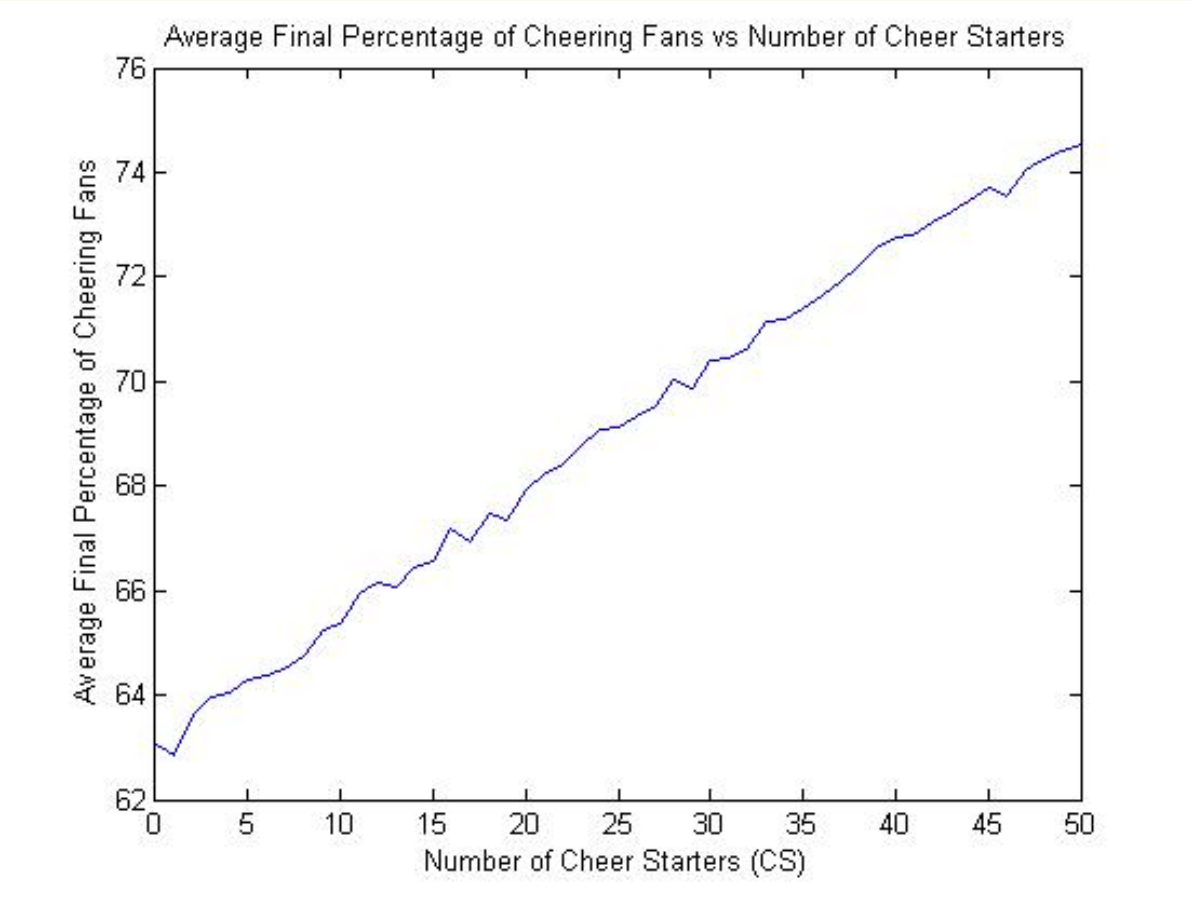
Monte Carlo Simulation

- For a given CS value, the CS cheer starters were randomly placed in crowd. The crowd simulation was run and the final percentage of cheering fans after 10 rounds was computed as previously described.
- For a given CS value this was procedure was repeated for 1000 trials (Monte Carlo Simulation) and the average final percentage of cheering fans after 10 rounds over the 1000 trials was computed.
- Repeated this for $1 \leq CS \leq 50$.
- The average final percentage of cheering fans for each CS value was compared to that of when $CS = 0$ using a t-test.

$CS \geq 39$ Produces Statistically Significant Increase in Cheering

- When $CS \geq 39$, there is a statistically significant $(p < 0.05)$ increase in the average final percentage of the crowd who are cheering.
- If CS is increased further, the average final percentage of the cheering fans increases, and the p-value decreases.

Average Final Percentage of Cheering Fans vs Number of Cheer Starters



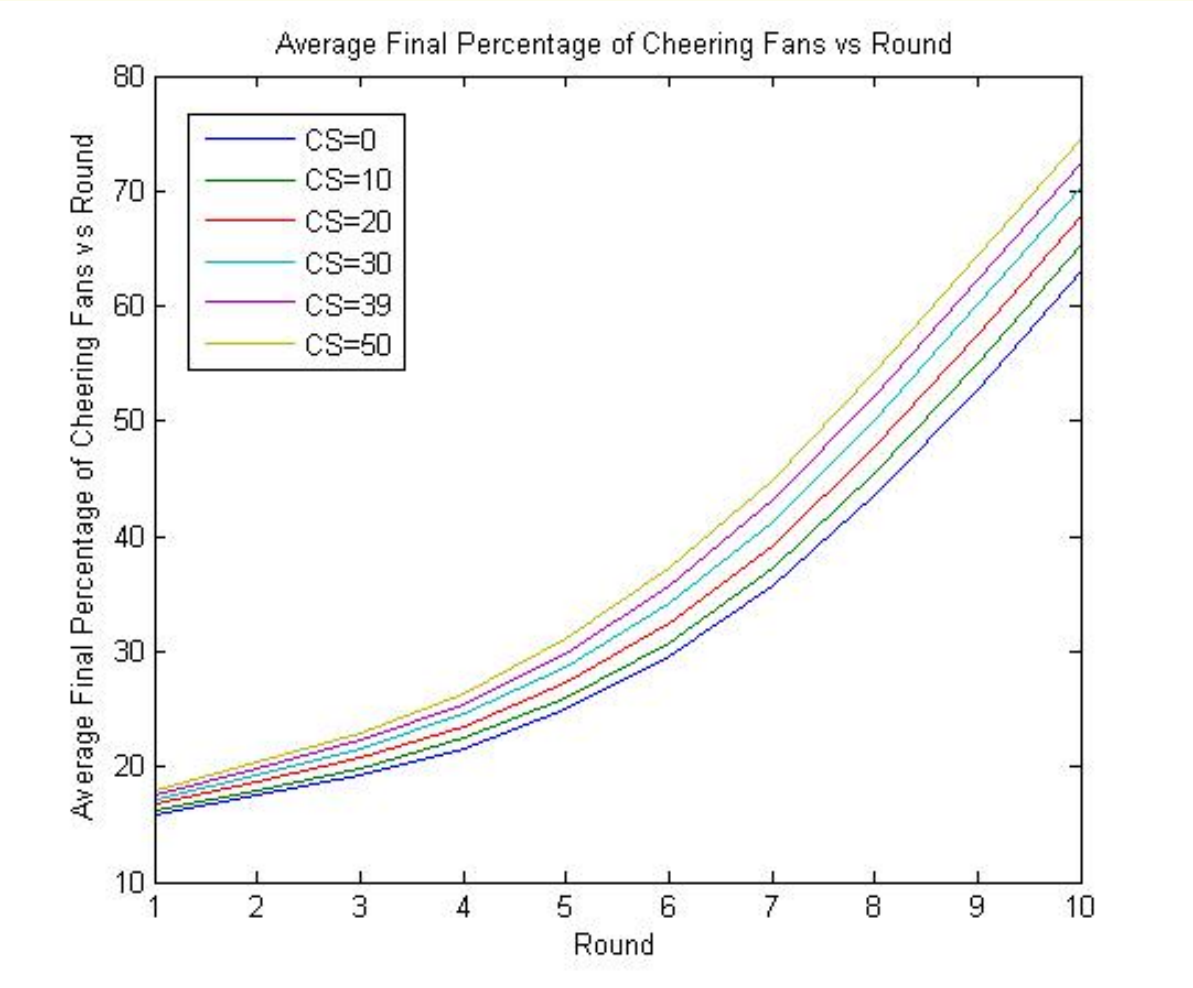
Average final percentage of cheering fans for various CS values.

Average Final Percentage of Cheering Fans vs Number of Cheer Starters

Number of Cheer Starters	0	10	20	30	39	50
Average Final Percentage of Cheering Fans	63.069	65.346	67.919	70.409	72.533	74.544
P-value	0.5	0.34413	0.19637	0.097951	0.047687	0.021585

Average final percentage of cheering fans for various CS values.

Percent of Cheering Fans Over Time For Various CS



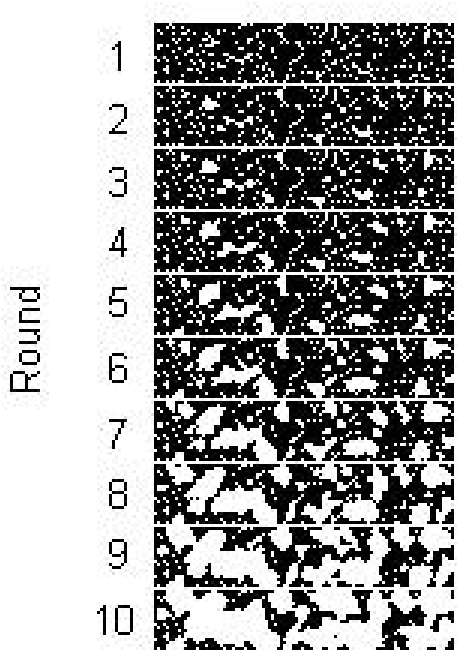
The percentage of cheering fans over time for various CS values.

Percentage of Cheering Fans Over Time For Various CS

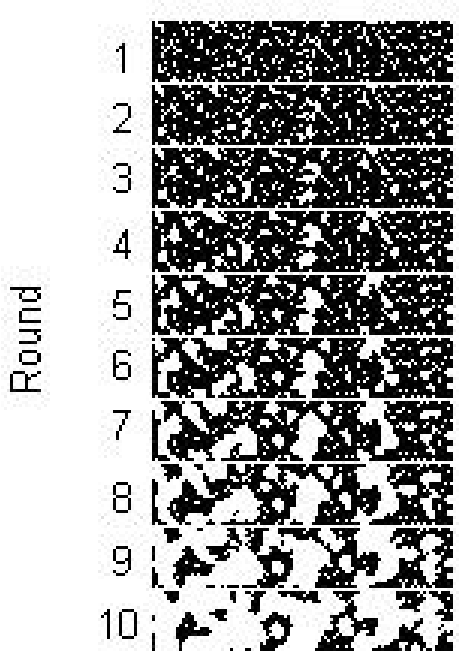
Round	1	3	7	10
CS=0	15.875	19.285	35.67	63.069
CS=10	16.266	19.936	37.307	65.346
CS=20	16.686	20.717	39.246	67.919
CS=30	17.13	21.53	41.284	70.409
CS=39	17.519	22.261	43.088	72.533
CS=50	17.908	23.002	44.936	74.544

The percentage of cheering fans over time for various CS values.

Visualization of Cheering



Cheering over time when $CS = 0$. White indicates cheering.



Cheering over time when $CS = 39$. White indicates cheering.

Deliverables

The model was coded on MATLAB R2009b. All computations were performed on a Intel Core i7 Desktop PC.

Checklist of Deliverables

From Team to Sponsor:

- MATLAB R2009b and R combination package with test scripts that can be used to reproduce our numerical and simulation test results (In Final Stages)
- Technical report and presentations summarizing the work (In Final Stages)
- If time permits, a list of patterns of cheer starter setups (i.e. the number of cheer starters and location of them) that maximize fan cheering (Future Research Recommendations)

Checklist of Deliverables

From Sponsor to Team:

- Timely responses to inquiries (Responses have been timely)

Timeline of Milestones

- Final Presentation due Nov 28, 2012
- Final Report and Deliverables due Dec 20, 2012

Remaining Work

- Finalize Matlab/R combination package
- Finish Final Report

Recommendations for Future Research

- It would be interesting to see if this model could be applied to other social events (concerts, college lectures, theaters, etc.) where there are large crowds and applause is relevant
- Attempt to find patterns in cheer starter placements which maximize cheering

References I

[1] J. P. Jamieson, "The Home Field Advantage in Athletics: A Meta-Analysis," *Journal of Applied Social Psychology*, vol. 40, no. 7, pp. 1819–1848, 2010.

[2] E. Snyder and D. Purdy, "The Home Advantage in Collegiate Basketball," *Sociology of Sport Journal*, vol. 2, no. 4, pp. 352–356, 1985.

[3] "Johns Hopkins Tradition." `http://www.hopkinssports.com/trads/conference-champs.html`. Accessed: 11/02/2012.

[4] "Blue Jays Unlimited - Johns Hopkins Official Athletics Site." `http://www.hopkinssports.com/bluejays-unlimited/`. Accessed: 10/12/2012.

References II

[5] "Homewood Field."
http://en.wikipedia.org/wiki/Homewood_Field.
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Questions?

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