# 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

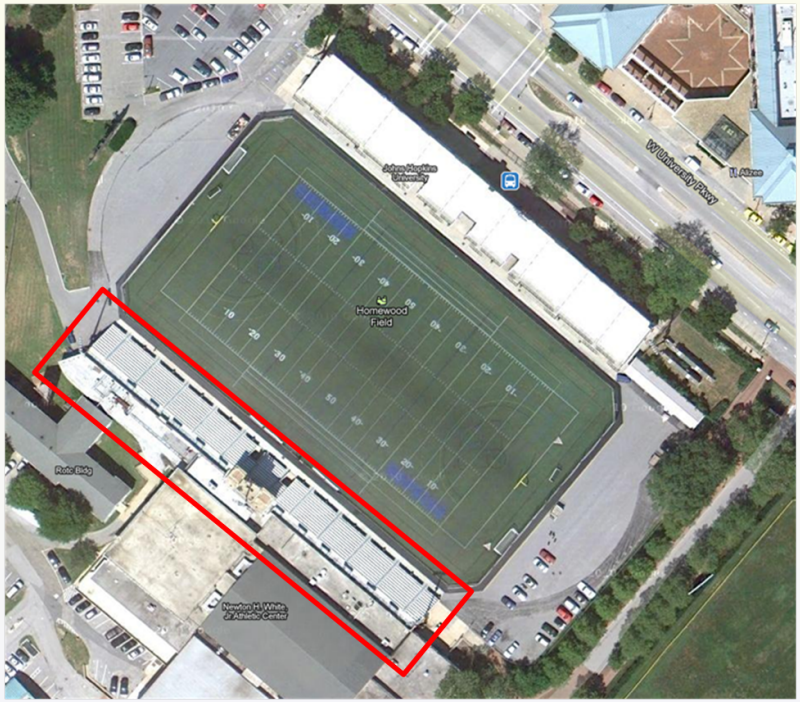
- BJU is present at nearly all major JHU sporting events
- Encourage fans to cheer on their Blue Jays to victory in a vociferous and family-friendly manner
- BJU is interested in maximizing the amount of fan participation in cheering at sporting events to provide the ultimate advantage: a spirited home 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

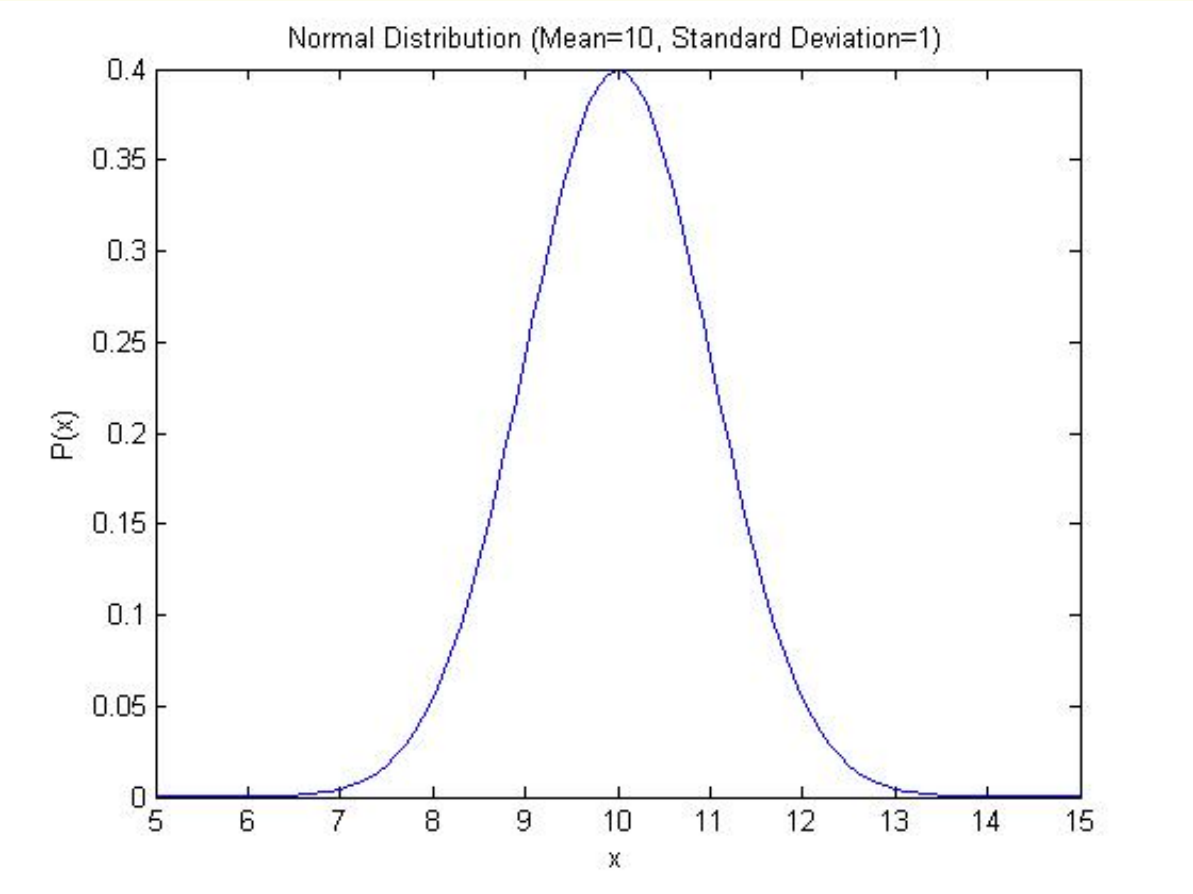
- The willingness of a fan in a crowd to cheer depends on:
  - Number of people cheering around the fan
  - Cheering duration
  - Innate support level
- A cheering fan continues cheering until the end of the simulation
- The performance of the sports team does NOT influence cheering

# 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.

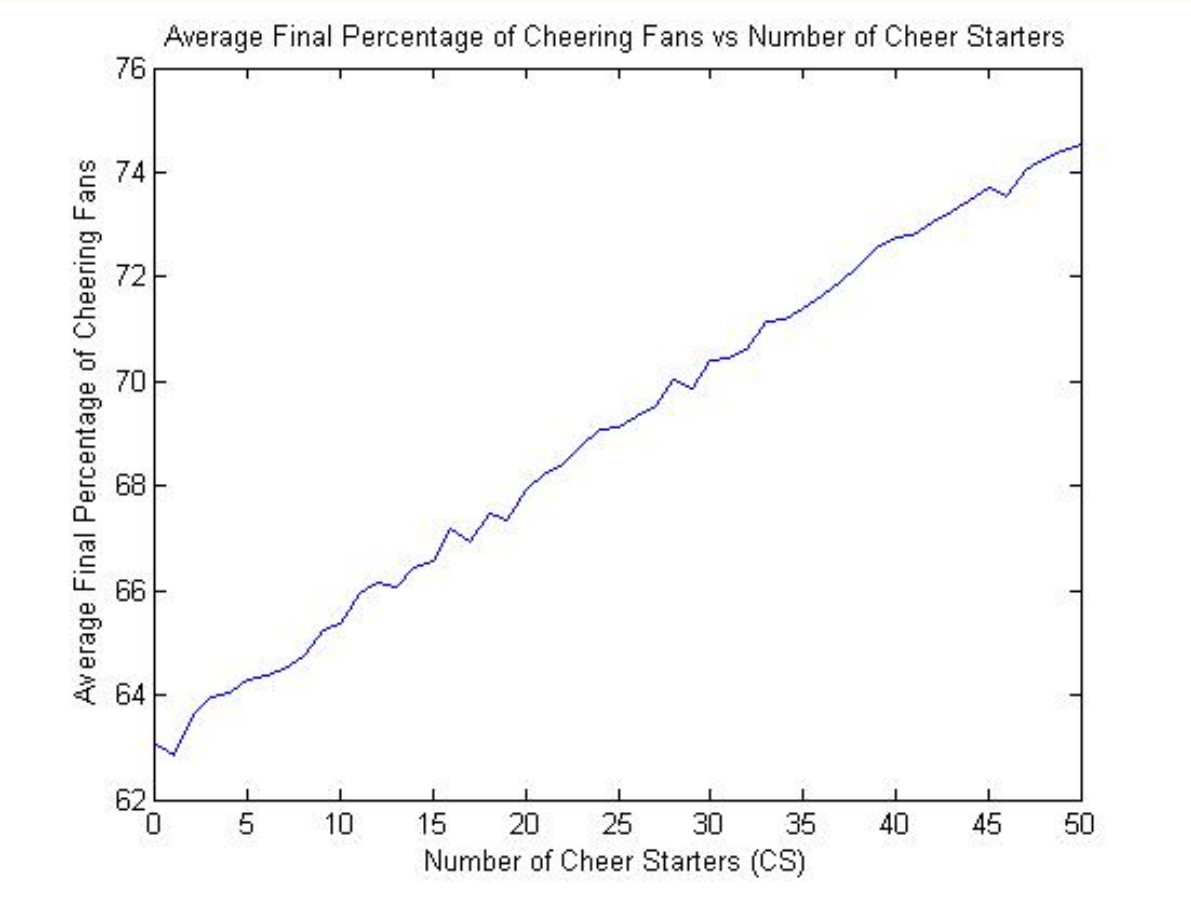
# Monte Carlo Simulation

- 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



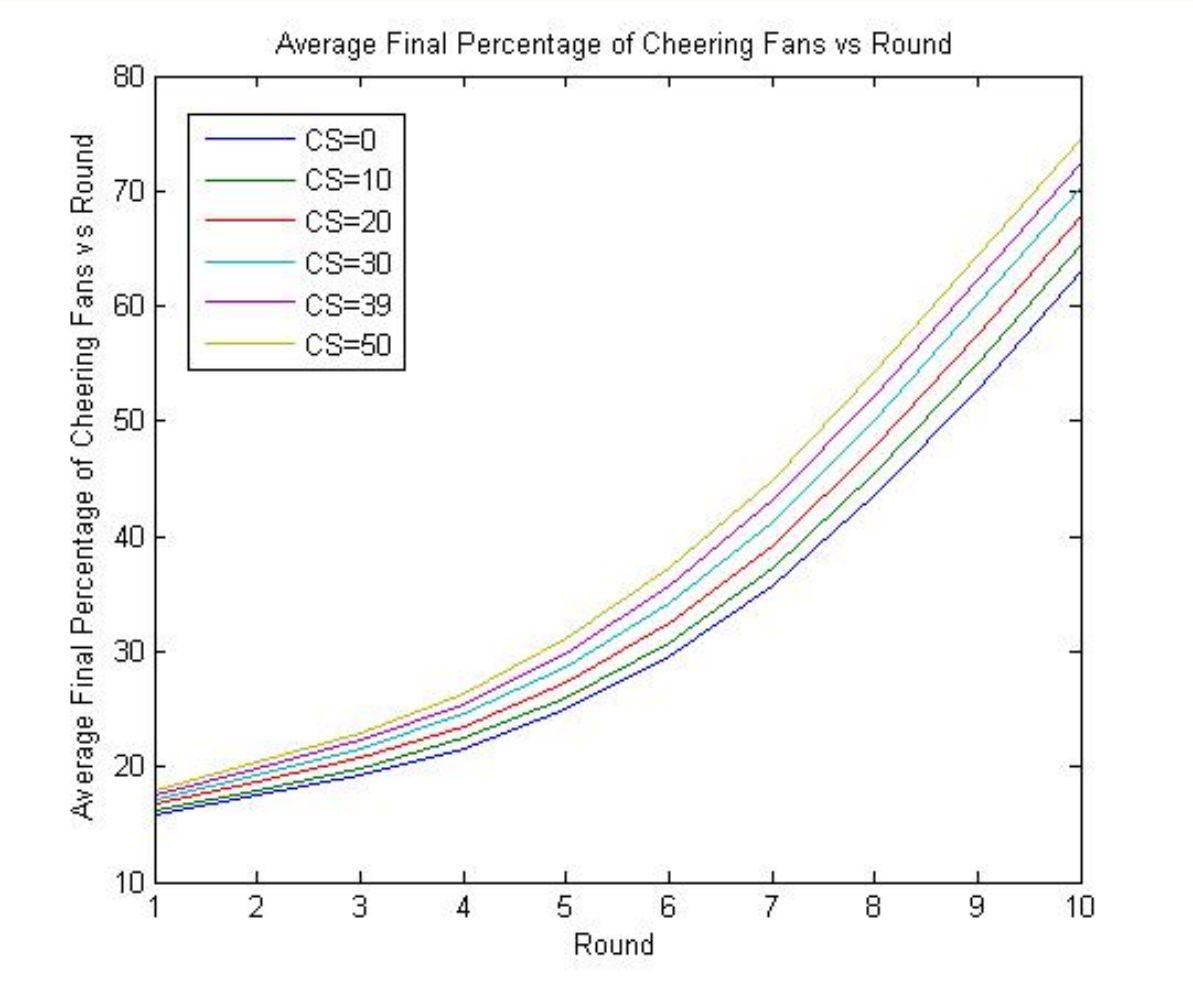

Average final percentage of cheering fans for various $CS$ values.

# 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 $CS$



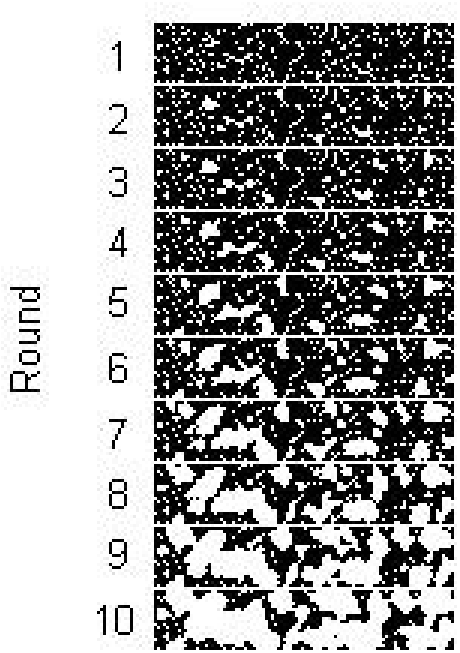

The percentage of cheering fans over time for various $CS$ values.

# Percentage of Cheering Fans Over Time For Various $CS$

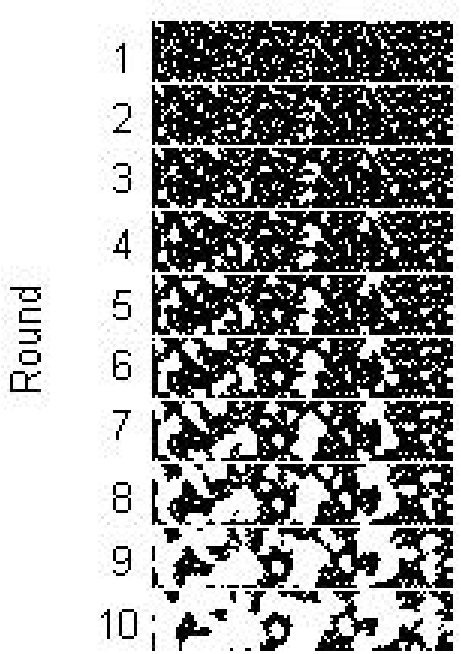
| **Round** | 1 | 3 | 7 | 10 |
|---|---|---|---|---|
| **CS=0** | 15.875 | 19.285 | 35.67 | 63.069 |
| **CS=10** | 16.266 | 19.936 | 37.307 | 65.346 |
| **CS=20** | 16.686 | 20.717 | 39.246 | 67.919 |
| **CS=30** | 17.13 | 21.53 | 41.284 | 70.409 |
| **CS=39** | 17.519 | 22.261 | 43.088 | 72.533 |
| **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.
Accessed: 10/12/2012.

# Acknowledgements

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# Questions?

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