Modeling and Simulating Fan Participation at Large Scale Sporting Events

Blue Jays Unlimited

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The Importance of Cheering in Sports

- A loud and supportive home crowd is the ultimate home team advantage for sports teams
- Home crowd advantage effects the result of the game, shown by past research:
    - In US professional sporting leagues, home teams can win approximately 60% of the time [4]
    - In US college athletics, home teams can win approximately 66% of games player [5]

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Importance of Cheering

What is Cheering?

- Home crowd can also improve the ambiance of a sporting event
- 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 [1] 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 [1]

- Official booster club for JHU athletics [1]

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 [1]

- Funds provide money for capital projects as well as scholarships and operational endowments [1]

- Past projects include renovation of the Newton H. White Athletic Center and recognition banners for championship teams. [1]

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 "cheer starters"–student volunteers who lead and urge other fans around them to cheer

Problem Statement Background: Why is Cheering Important?

- A loud and supportive home crowd is the ultimate home team advantage to any collegiate sports team.

- Fan participation in events such as chanting the school fight song, waving a rally towel, doing the wave, or general applause, show support for the home team as well as enhance the general atmosphere of a sporting event.

- Note that we will hence refer to all these activities as "cheering".

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Official Problem Statement

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

Objective Statements

- Our task is to provide BJU with a simple model of fan participation in cheering at Homewood Field

- We will also provide simulation results from the model which determine if their belief about cheer starters is accurate

- If cheer starters are effective, and time permitting, we will provide BJU with details about the quantity and location at which cheer starters should be placed in order to maximize cheering

Important Details To Consider

- Homewood Field's capacity is approximately 8500 spectators [2]

- 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*

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Important Details to Consider

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

Official Objectives

- Our task is to provide BJU with a simple model of fan participation in cheering at Homewood Field in the home team bleachers as well as simulation results from the model which determine if their belief about cheer starters is accurate.

- If cheer starters are found to be effective, we will attempt to provide BJU with more details about the quantity and location 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 the number of people cheering around the given fan and how long the surrounding people have been cheering.

- The greater the number of people surrounding a fan who are cheering, and the longer the surrounding people have been cheering, the more likely that fan will start to cheer.

- The innate support level a fan has for the team also influences the willingness of that fan to start cheering.

- 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 arbitrary sized $n \times m$ matrix,

- X, to represent a nm sized crowd.

- X_{ij} represents fan ij. Each element in X corresponds to fan's innate support level for the team. Innate support level was 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 2: Determinining 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', with each element in X' is initially assigned a value of 1, if the corresponding element in X had a value which was greater than or equal to the initial threshold, otherwise the element is given a value of 0. See (2).

- X' is the matrix used to keep track of who is cheering. (1 = cheering, 0= not cheering).

$$X'_{ij} = 1 \text{ if } X_{ij} \geq T_{init}, \ X'_{ij} = 0 \text{ if } X_{ij} < T_{init} \qquad (2)$$

Step 3: Including the Influence of Surrounding Fans

- S is a $n \times m$ 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', all of which store different model values for the same individual fan.

- Define a round, r, to be the passing of an arbitrary time interval (approximately 3-5 seconds, in this case).

- Y is an $n \times m$ matrix compute the individual elements of Y according to (3).

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

Note:By computing Y as shown in (3), the likelihood of a fan starting to cheer increases with the number of surrounding fans who are cheering as well as with the length of time those fans have been cheering(greater R value).

Step 4: Updating Matrices and Comparing to Absolute Threshold

- Each element in Y represents an individual fan and has corresponding elements in X, X', and S, with the same row and column indices.

- Elements in Y are compared to an absolute threshold, $T_{absolute}$.
  - If an individual's score in Y is greater than or equal to the absolute threshold, the individual will begin to cheer, and we set the corresponding element in X' equal to 1. This is shown in (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. Setup matrices with appropriate initial conditions (i.e. randomly assign innate support levels to each fan and choose quantity and location of cheer starters)

2. Check to see if any new fans join cheering

3. Update matrices (i.e. X' and Y)

4. Repeat for R rounds

Final Parameters

- 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)

Monte Carlo Simulation

- For a given CS value, the CS cheer starters were randomly placed in the crowd. The crowd simulation was then ran 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 final percentage of the crowd cheering increases, and the p-value decreases
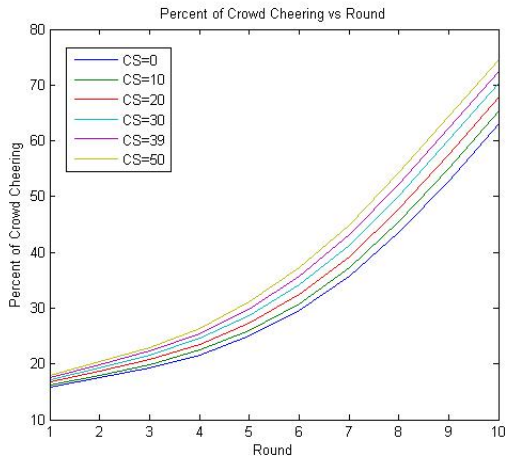
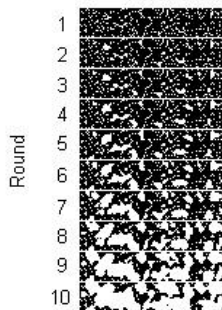# Final Percent of Crowd Cheering vs Number of Cheer Starters
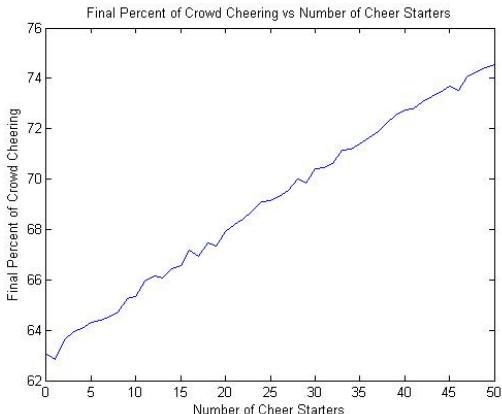
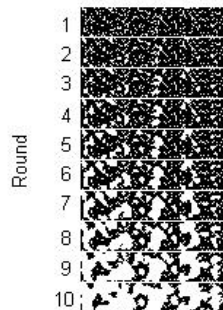Final cheering percentage for various CS values.

Percent of Crowd Cheering Over Time For Various CS

Visualization of Cheering

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

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

Deliverables

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

Deliverables

From Team to Sponsor:

- MATLAB R2009b and R combination package. The model will be coded in MATLAB but a complete set of documentation will be provided in R. We will also generate some test scripts that can be used to reproduce our numerical and simulation test results

- 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

- Technical report and presentations summarizing the work

Deliverables

From Sponsor to Team:

- Timely responses to inquiries

Timeline of Milestones

- Work Statement due date, Sep 28, 2012.
- Midterm Presentation due date, Oct 17, 2012.
- Progress Report due date, Oct 26, 2012.
- Final Presentation due date, Nov 16, 2012.
- Final Report due date, Nov 30, 2012.

Remaining Work

- Begin coding the model in MATLAB.

- Run simulations using the model.

- Time permitting, try to find patterns in cheer starter setups which maximize cheering.

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.

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Questions?

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