Mathematical Modeling and Consulting

Sponsor

Sponsor Name

Final Report

Insurance Redlining

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Abstract

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Analysis

Because this model is based on qualitative observation it is imperative to clearly define simplifications and assumpitions we have made in the model.

Simplifications and Assumptions

- The willingness of an individual member of a crowd to cheer depends on the number of people cheering around the individual.
- The performance of a team does NOT influence cheering.
- The cheering of the individual depends on the innate support level the individual has for the team.
- Once a fan starts to cheer, he/she continues cheering until the end of the simulation.

Computational Simulation Using MATLAB, we start by generating an arbitrary sized $n\ x\ m$ matrix X to represent a nm sized crowd. The number of rows, n, and columns, m, can be changed based on the user's liking. The generated matrix represents a crowd where each element represents an individual in the crowd. The first matrix generated was filled randomly with each fans innate support level, C_{innate}. Each fans innate support level was generated by sampling from a normal random distribution with the mean set to 10 and the standard deviation of 1 as shown in (1). We can use a normal random variable because we can consider cheering to be an introduced innovation [**?**]. In general, the mean and standard deviation is intrinsic to each crowd. However, in this model the mean was set to 10 and the standard deviation was set to 1 to ensure that it is highly unlikely that a fan was assigned a negative innate support level. (i. e. it is very unlikely to sample a number from this distribution that is more then 10 standard deviations from the mean.) This makes the math much easier when considering the dependence on the surrounding members, as it will be revealed later.

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

Next, we set an initial threshold, T_{init}, to be 11, one standard deviation above the mean of the normal distribution. The initial threshold is used to determine which of the fans in the matrix are *initially* cheering. Another nxm matrix, X' was then created. Each element in X' is assigned a value of 1, if the corresponding element in X exceeded the initial threshold, otherwise the element is given a value of 0. X' is the matrix used to keep track of who is cheering.

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

$$Let\ Y_{ij}\ be\ the\ element\ of\ the\ new\ boolean\ matrix$$

then,

$Y_{ij} = \theta(X_{ij} \geq 11),\ where\, \theta(...) = 1\, if\ argument\ is\, TRUE\ and\ = 0\, if\ argument\ is\, FALSE$

The following step is to simulate the model and its dependence on the number of people cheering around the individual and the number of rounds. We define a round to be an arbitrary time interval (approximately 3-5 seconds, in this case). We then take snapshots of the crowds by running rounds. We update the base cheer number for each individual based on the following general qualitative formula:

Let S define the number of surrounding cheering fans,
Let R define the round number,
Let X' define the updated cheering number,
Let Y' define the updated boolean element,

$$X'_{ij} = X_{ij} * S + R$$
$$Y'_{ij} = \theta(X'_{ij} \geq 11)$$

The final output is a graphical representation of of the cheering behavior over a R rounds.

Appendix A

Lemmas

Appendix B

Glossary

Glossary

Cheer starters. the equatorial plane in a northerly direction.

Cheer number. A frame of reference whose origin is the center of the earth and which does not rotate with respect to inertial space.

Earth-centered rotating frame. A frame of reference whose origin is the center of the earth but which rotates with the earth.

Footprint. The intersection of a visibility cone with the surface of the earth.

Great circle of arc. The shortest path between two points on the surface of the earth.

Groundtrack.The location of the center of a visibility cone footprint on the surface of the earth.

Inclination. The angle between the normal to the orbit plane and the normal to the equatorial plane.

LEO. An orbit with an altitude approximately below 2,000 km.

Molniya orbit. A highly elliptical orbit with an orbital period of half a day.

Projection distance. The distance between the center of the visibility cone footprint and a point of interest projected onto the plane orthogonal to the vector defining the visibility cone center and tangent to the earth surface.

Right ascension of the ascending node. The angle between the unit vector $\boldsymbol{X}$ and the point where the satellite crosses the ascending node, measured counterclockwise when viewed from the north side of the equatorial plane.

Appendix C

Abbreviations

ECI. Earth-centered inertial frame

ECR. Earth-centered rotating frame

LEO. Low Earth Orbit

RAAN. Right ascension of the ascending node

Selected Bibliography Including Cited Works

[1] V. Bos and S. Mauw. *A LaTeX macro package for Message Sequence Charts—Maintenance document—Describing version* , June 2002. Included in MSC macro package distribution.

[2] V. Bos and S. Mauw. *A LaTeX macro package for Message Sequence Charts—Reference Manual—Describing version* , June 2002. Included in MSC macro package distribution.

[3] V. Bos and S. Mauw. *A LaTeX macro package for Message Sequence Charts—User Manual—Describing version* , June 2002. Included in MSC macro package distribution.

[4] Michel Goossens, Sebastian Rahtz, and Frank Mittelbach. *The LaTeX Graphics Companion*. Addison-Wesley, 1997.

[5] ITU-TS. ITU-TS Recommendation Z.120: Message Sequence Chart (MSC). Geneva, 1997.

[6] L. Lamport. *LaTeX—A Document Preparation System—User's Guide and Reference Manual*. Adsison-Wesley, 2nd edition, 1994. Updated for LaTeX 2_ε.

[7] E. Rudolph, P.Graubmann, and J. Grabowski. Tutorial on message sequence charts (MSC'96). In *FORTE*, 1996.