The generalized Ghosh equations for n militaries

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Abstract

In this paper, I describe the generalized Ghosh equations.
The paper ends with "The End"

Introduction

In a previous paper, I've described the Ghosh combat model which generalizes the Lanchester combat model by taking into account both growth and attrition of two militaries A and B and described the closed-form solution to the Ghosh equations.
In this paper, I describe the generalized Ghosh equations for n militaries.

The generalized Ghosh equations for n militaries

For $n \geq 3$ militaries, the Ghosh equations can be written in matrix notation as

$$\begin{pmatrix} \frac{\partial}{\partial t}A_1(t) \\ \frac{\partial}{\partial t}A_2(t) \\ \vdots \\ \frac{\partial}{\partial t}A_n(t) \end{pmatrix} = \begin{pmatrix} a_{1,1} & a_{1,2} & ... & a_{1,n} \\ a_{2,1} & a_{2,2} & ... & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n-1,1} & a_{n-1,2} & ... & a_{n-1,n} \\ a_{n,1} & a_{n,2} & ... & a_{n,n} \end{pmatrix} \begin{pmatrix} A_1(t) \\ A_2(t) \\ \vdots \\ A_n(t) \end{pmatrix}$$

where

$1 \leq i \leq n$, $1 \leq j \leq n$

$A_i(t)$ is the **strength** of the i^{th} military as a function of time

$\frac{\partial}{\partial t}A_i(t)$ is the time derivative of the **strength** of the i^{th} military

$a_{i,j}$ is the **contribution** of the j^{th} military to the i^{th} military

Classification of the j^{th} military by the i^{th} military

For $1 \leq i \leq n$, $1 \leq j \leq n$,

If $a_{i,j} > 0$, the j^{th} military is **an ally** of the i^{th} military.

If $a_{i,j} = 0$, the j^{th} military is **neutral** to the i^{th} military.

If $a_{i,j} < 0$, the j^{th} military is **an enemy** of the i^{th} military.

The role of diplomacy

Since the **classification of the i^{th} military by the j^{th} military** can **also** be done using the mathematical logic above, the role of diplomacy is to prevent militaric incidents in the presence of propaganda, asymmetric information and incomplete information between the i^{th} and j^{th} militaries.

Closed-form solution

For $n = 3$ and $n = 4$, the closed-form solutions to the generalized Ghosh equations are **known** and **available upon request**.

The End