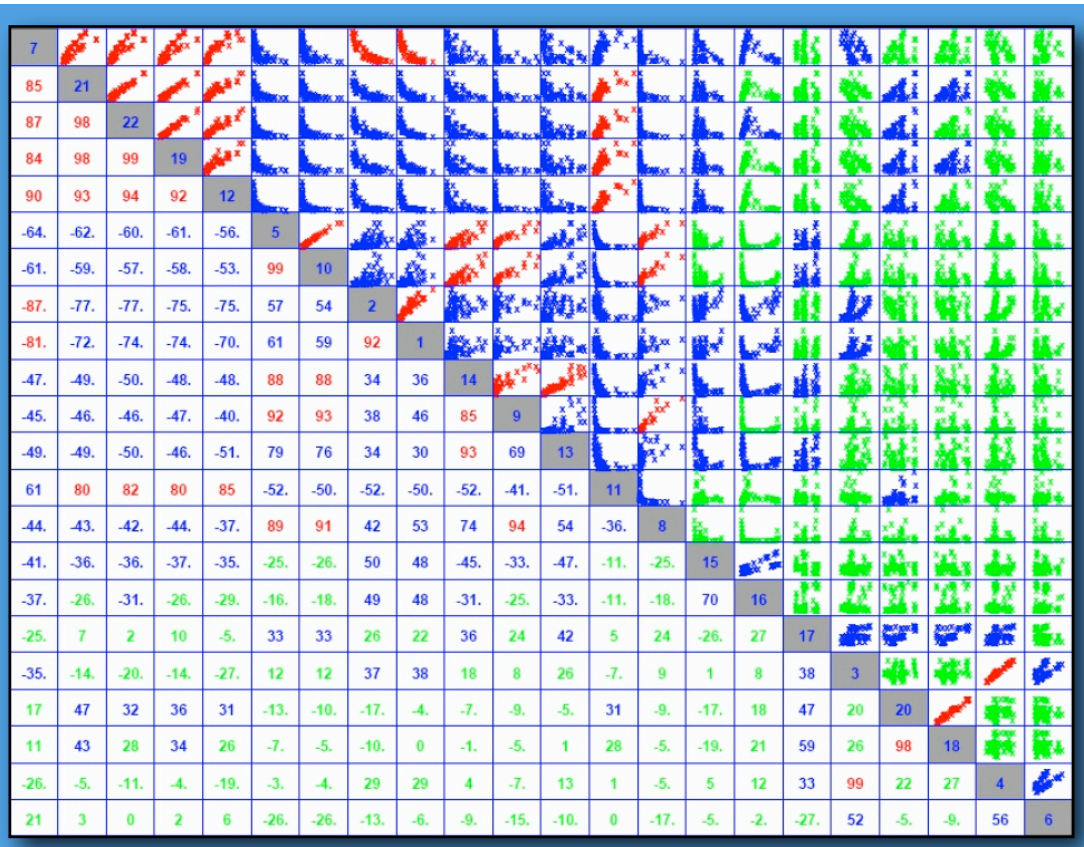
James Filliben

Kevin Mills

complex systems IMAGE OF THE MONTH April

Reducing Dimensions in Multi-Dimensional Response Vectors of Complex Systems



From Chapter 4 - Sensitivity Analysis of MesoNetHS - in a forthcoming NIST Special Publication: *Modeling and Simulation Study of Proposed Replacement Congestion-Control Mechanisms for the Internet*, 2009

Combined Scatter Plot-Correlation Matrix revealing mutual correlations among 22 pairs of responses from a large network simulation. The diagonal is ordered by decreasing absolute value of average mutual correlation. Cells are highlighted according to the absolute value of correlations: > 0.8 (red); >= .3 and < .8 (blue); < .3 (green). Correlation groups may be discerned visually in the matrix. This visualization was generated with public-domain Dataplot software developed and distributed by NIST.

Abstract: We consider whether the response vector from a complex network simulation can be reduced from 22 dimensions. We compute correlations for 231 response pairs and then construct a combined scatter plot-correlation matrix to identify potential groupings of mutual correlation. We apply a correlation threshold to reduce the number of significant correlations to 81 and then use index-index plots to identify seven clear correlation groups. Two groups contain one member each (i.e., are uncorrelated with other responses) and three groups contain two members each. The remaining two groups contain 28 and 50 instances of significant mutual correlation. Our findings enable us to achieve three objectives. First, we can investigate the causes underlying correlation groupings in order to verify proper operation of our simulation model. Second, we can develop and then investigate hypotheses stating that responses within the same groupings should be influenced by the same model parameters. Third, we can select seven model responses to capture and analyze in future simulations; thus, reducing the response vector to one-third its original size.

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The Complex Systems Program is part of the National Institute of Standards and Technology's Information Technology Laboratory. Complex Systems are composed of large interrelated, interacting entities which taken together, exhibit macroscopic behavior which is not predictable by examination of the individual entities. The Complex Systems program seeks to understand the fundamental science of these systems and develop rigorous descriptions (analytic, statistical, or semantic) that enable prediction and control of their behavior.

Program information at: `www.itl.nist.gov/ITLPrograms/ComplexSystems`