Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

**Physics of Inference**

ZOLTAN TOROCZKAI, Department of Physics, University of Notre Dame, USA

Jaynes' maximum entropy method provides a family of principled models that allow the prediction of a system's properties as constrained by empirical data (observables). However, their use is often hindered by a degeneracy problem characterized by spontaneous symmetry breaking, where predictions fail. Here we show that degeneracy appears when the corresponding density of states function is not log-concave, which is typically the consequence of nonlinear relationships between the constraining observables. We illustrate this phenomenon on several examples, including from complex networks, combinatorics and classical spin systems (e.g., Blume-Emery-Griffiths lattice-spin models). Exploiting these nonlinear relationships we then propose a solution to the degeneracy problem for a large class of systems via transformations that render the density of states function log-concave. The effectiveness of the method is demonstrated on real-world network data. Finally, we discuss the implications of these findings on the relationship between the geometrical properties of the density of states function and phase transitions in spin systems.

1Supported in part by grant No. FA9550-12-1-0405 from AFOSR/DARPA and by grant No. HDTRA 1-09-1-0039 from DTRA.

2Co-author: Szabolcs Horvat, Department of Physics, University of Notre Dame, USA and INSERM U846, Bron, France.