Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Statistical Thermodynamics of Populations THEMIS MATSOUKAS, Pennsylvania State University — Suppose a population of M individuals forms N groups such that group i contains n_i individuals. Form all possible partitions of M into N and select distributions from this ensemble with selection bias $W[\{n_i\}]$, where W is a functional of distribution $\{n_i\}$. We develop the thermodynamics of this ensemble and its most probable distribution for arbitrary bias W. We obtain the temperature of the ensemble and its relationship to the microcanonical and canonical partition functions; and (ii) show that, depending on the bias functional W, the population may exhibit the equivalent of a phase transition, manifested as the coexistence of two distinct subpopulations in equilibrium with each other. We apply this theory to binary clustering with special interest in conditions that result in the emergence of a single dominant group that overtakes all smaller coexisting groups when the number of groups N is decreased. We show the emergence of the dominant group represents a formal phase transition that is governed by the maximization of the free energy of the ensemble. We provide closed analytical solutions for the special case that the merging probability between two groups is proportional to the product of the number of members in each group.

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Date submitted: 05 Nov 2012 Electronic form version 1.4