



Statistics and Actuarial Science Seminar

Title: Quantifying Intransitive Dominance Relations Using Static Co-variates

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Abstract: Pairwise comparison data arise in sports, consumer surveys and animal behaviour, and are routinely used to rank the entities being compared. The standard statistical models give each entity a single latent strength and therefore assume transitivity: if A tends to beat B and B tends to beat C, then A tends to beat C. Real data, however, often contain rock–paper–scissors cycles that no ranking can reproduce. A classic example is a flock of canaries observed by Shoemaker (1939): males generally dominate females, but in the breeding season a female tends to dominate her own mate, and the recorded fights contain cycles that no ordering of the birds can match. This raises a natural question: how much of such intransitive dominance can be explained by observed attributes of the individuals and of the pairs?

In this talk, I will introduce a Bayesian model to address this question. Building on the combinatorial Hodge decomposition, the advantage of one entity over another is split into two non-overlapping parts: a hierarchical part, which a ranking can express, and a cyclic part, which it cannot. Each part is further divided into a component explained by observed characteristics that do not change over time (static covariates) and a component that remains unexplained. The model leans towards 'no cycles' unless the

data say otherwise, so it works whether or not a ranking exists, and every estimated part comes with a measure of its uncertainty. It also gives the probability that the entities can be ranked at all, and offers ways to summarise the comparisons when no ranking exists. I will illustrate the method with real dominance data, including the canary flock.