MATH0461-2 Introduction to numerical optimization

Faculty of Applied Science

Randomized Condorcet Voting System

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1 Model

1.1 Implementation of the model in linear programming

In order to to compute the winning distribution law of the RCVS, one can implement a linear formulation of the model. The linear formulation is based on the following variables:

- A the voting matrix where $A_{i,j}$ represents the results of a duel between the i-th and j-th candidates. The elements of the matrix are computed following this rule : for each voter, if the i-th canditate is ranked higher than the j-th candidate the element $A_{i,j}$ is incremented and the element $A_{j,i}$ is decremented.
- p the probability vector where p_i represents the probability that the i-th candidate wins.

The linear formulation of the model is the following:

$$\begin{aligned} &\min_p \sum p^T A \\ \text{s.t. } &p^T 1 = 1 \\ &p \geq 0 \\ &p^T A \geq 0 \end{aligned}$$

1.2 Application of the RCVS to an example

1.3 Discussion of the dual variables and optimal dual basis

1.4 Solution of the linear in a linear system

1.5 *Bonus* : Comparaison of the RCVS with an alternative voting system

2 Linear Robust Formulation

3 Quadratic Robust Formulation