Computational Social Choice

Ulle Endriss
Institute for Logic, Language and Computation
University of Amsterdam

**Classic Example: The Condorcet Paradox**

*Social Choice Theory* asks: how should we aggregate the preferences of the members of a group to obtain a “social preference”?

- Expert 1: ○ ≻ ○ ≻ ○
- Expert 2: ○ ≻ ○ ≻ ○
- Expert 3: ○ ≻ ○ ≻ ○
- Expert 4: ○ ≻ ○ ≻ ○
- Expert 5: ○ ≻ ○ ≻ ○

Marie Jean Antoine Nicolas de Caritat (1743–1794), better known as the **Marquis de Condorcet**: Highly influential Mathematician, Philosopher, Political Scientist, Political Activist. Observed that the *majority rule* may produce inconsistent outcomes (“Condorcet Paradox”).
Classic Result: Arrow’s Impossibility Theorem

In 1951, K.J. Arrow published his famous *Impossibility Theorem*:

Any preference aggregation mechanism for *three* or more alternatives that satisfies the axioms of *unanimity* and *IIA* must be *dictatorial*.

- Unanimity: if everyone says $A \succeq B$, then so should society.
- Independence of Irrelevant Alternatives (IIA): if society says $A \succeq B$ and someone changes their ranking of $C$, then society should still say $A \succeq B$.

Modern Applications of Social Choice Theory

Social choice-like problems arise in many applications. Examples:

- **Job Markets**: allocate junior doctors to hospitals, etc.
- **Search Engines**: determine the most important sites based on links ("votes") + to aggregate the output of several search engines
- **Semantic Web**: aggregate information from distinct sources in a consistent manner

But not all of the classical assumptions will fit these new applications. So we need to develop *new models* and *ask new questions*. 
Computational Methods in Social Choice

*Vice versa*, techniques from computer science are useful for advancing the state of the art in social choice. Examples:

- **Algorithms and Complexity**: to develop algorithms for (complex) voting procedures + to understand the hardness of “using” them

- **Knowledge Representation**: to compactly represent the preferences of individual agents over large spaces of alternatives

- **Logic and Automated Reasoning**: to formally model problems in social choice + to automatically verify (or discover) theorems
Session Overview

Computational Social Choice =

*looking at social choice through the “computational lens”, aiming for (computational) applications*

Rest of the programme:

1. Britta Dorn (Ulm)
   *Multivariate Algorithmics for Voting*

2. Jérôme Lang (Paris)
   *Voting in Combinatorial Domains*

3. Ioannis Caragiannis (Patras)
   *Computational Challenges in Fair Division*

4. Francesca Rossi (Padova)
   *Automated Design of Social Choice Mechanisms*

5. Péter Biró (Budapest)
   *Matching Schemes in Practice*