

# Justice and Computation

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## Introduction

In my research, I often take concepts originating in the Humanities or the Social Sciences and look at them from an algorithmic perspective.

### Why?

- *Useful* for applications in Computer Science
- *Interesting* in its own right

### Plan for this talk:

- Two examples where philosophical ideas related to *justice* give rise to exotic *computational complexity* results

## Reducing Inequality in Resource Allocation

**Scenario:** We need to allocate several *resources* to several *agents*. Each has a *utility function*, mapping sets of resources to numbers.

**Aim:** We want to *reduce inequality* amongst the agents.

Not obvious what this means, but suppose we want to at least satisfy the *Pigou-Dalton Principle* (reduce inequality between *pairs* of agents).

**Theorem:** *Even for additive utilities, there is no polynomial algorithm to compute Pigou-Dalton improvements (unless  $NP = coNP$ ).*

U. Endriss. Reduction of Economic Inequality in Combinatorial Domains. *Proc. 12th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS-2013)*.

H. Buhrman, B. Loff, and L. Torenvliet. Approximation Algorithms and Hardness of Approximation for Knapsack Problems. Manuscript, CWI/ILLC, 2012.

## Agenda Safety in Judgment Aggregation

**Scenario:** Three *judges* have to agree on a common *verdict*.

	$p$	$p \rightarrow q$	$q$
Judge 1:	True	True	True
Judge 2:	True	False	False
Judge 3:	False	True	False

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**Aim:** Avoid *paradoxical* outcomes, however individual judges vote. This will depend on the *aggregator* and the *agenda* (set of formulas).

**Theorem:** *Deciding whether the agenda is safe for the majority rule (i.e., whether outcomes cannot be inconsistent) is  $\text{coNP}^{\text{NP}}$ -complete.*

U. Endriss, U. Grandi, and D. Porello. Complexity of Judgment Aggregation. *Journal of Artificial Intelligence Research (JAIR)*, 45:481–514, 2012.

## Conclusion

We have seen two examples where abstract notions of justice have given rise to interesting algorithmic questions.  $\rightsquigarrow$  Message:

- Ideas from *Philosophy* can inspire research in *Computer Science*
- Computational perspective on philosophical questions: what if a *philosophically attractive* solution is *intractable* to implement?