

Complexity Results for Manipulation in Judgment Aggregation

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Judgment Aggregation (JA)

Combining individual opinions on logically related issues into a group opinion.

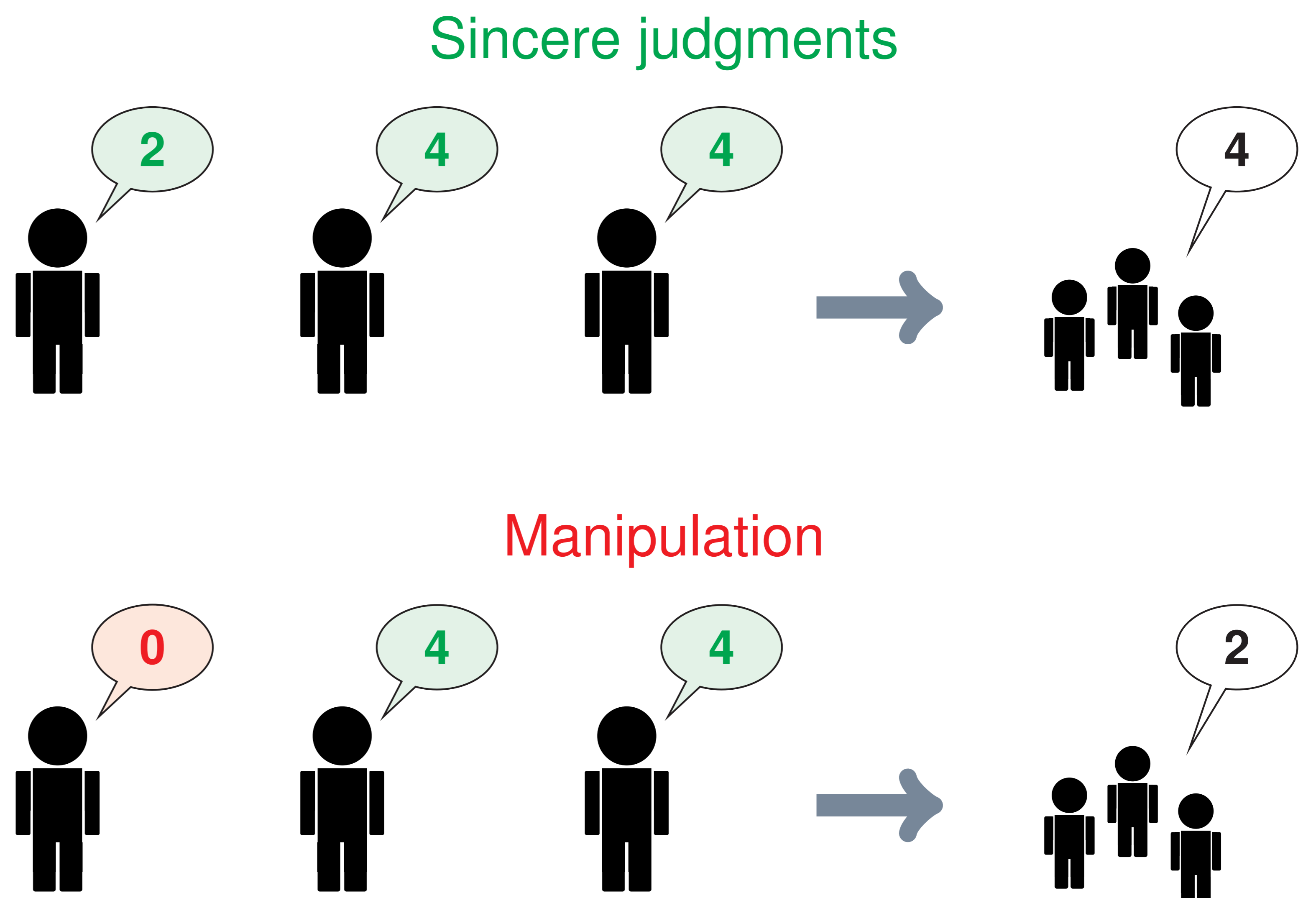
- ▶ **Issues:** propositional variables, x_1, \dots, x_n
- ▶ **Integrity constraint:** logic formula Γ , e.g., $\Gamma = x_1 \leftrightarrow (x_2 \wedge x_3)$
- ▶ **Feasible opinions:** assignments to x_1, \dots, x_n that satisfy Γ
- ▶ **Profile:** a list of feasible opinions
- ▶ **Judgment aggregation procedure:** takes a profile as input, and outputs a set of feasible opinions (**outcomes**)

Kemeny rule: outcomes are the feasible opinions that minimize the cumulative Hamming distance to the profile

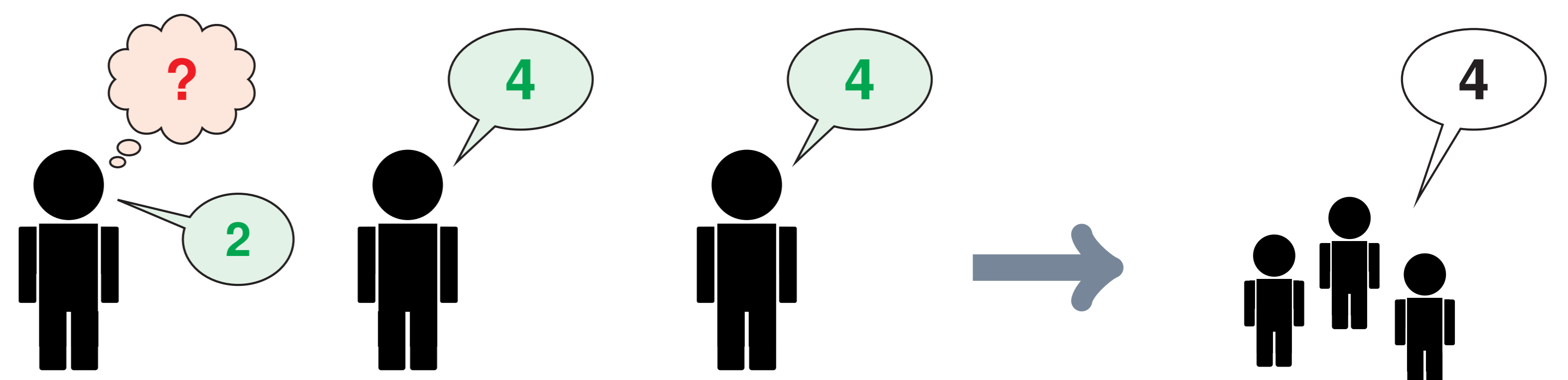
- ▶ Hamming distance $d(r, r')$ between r and r' : # of issues on which r and r' disagree

Manipulation

An individual **reporting an insincere opinion** so that the resulting **group opinion is closer to their true opinion**.



Intractability as barrier to manipulation



(Logical context: only nonnegative, even numbers)

Manipulation Problems

For JA procedures that produce multiple possible outcomes:

PESSIMISTIC-MANIPULATION(F)	OPTIMISTIC-MANIPULATION(F)	SUPER-OPTIMISTIC-MANIPULATION(F)
Input: issues x_1, \dots, x_n , an integrity constraint Γ , and a profile $\bar{r} = (r_1, \dots, r_p)$.	Input: issues x_1, \dots, x_n , an integrity constraint Γ , and a profile $\bar{r} = (r_1, \dots, r_p)$.	Input: issues x_1, \dots, x_n , an integrity constraint Γ , and a profile $\bar{r} = (r_1, \dots, r_p)$.
Question: is there a feasible opinion r'_1 such that for all $r_{new}^* \in \text{KEMENY}(r'_1, r_2, \dots, r_p)$ and for all $r_{old}^* \in \text{KEMENY}(\bar{r})$ it holds that $d(r_{new}^*, r_1) < d(r_{old}^*, r_1)$?	Question: is there a feasible opinion r'_1 and some $r_{new}^* \in \text{KEMENY}(r'_1, r_2, \dots, r_p)$ such that for all $r_{old}^* \in \text{KEMENY}(\bar{r})$ it holds that $d(r_{new}^*, r_1) < d(r_{old}^*, r_1)$?	Question: is there a feasible opinion r'_1 , some $r_{new}^* \in \text{KEMENY}(r'_1, r_2, \dots, r_p)$ and some $r_{old}^* \in \text{KEMENY}(\bar{r})$ such that $d(r_{new}^*, r_1) < d(r_{old}^*, r_1)$?

“Can I force **each** new outcome to be better than **each** old outcome?”

“Can I force **some** new outcome to be better than **each** old outcome?”

“Can I force **some** new outcome to be better than **some** old outcome?”

Computational Complexity

PESSIMISTIC-MANIPULATION(KEMENY), OPTIMISTIC-MANIPULATION(KEMENY), and SUPER-OPTIMISTIC-MANIPULATION(KEMENY) are:

Σ_2^P -complete

Discussion

Manipulation is possible, but in the worst case it is **computationally very expensive**.

Future work:

- ▶ Look at **more JA procedures**.
- ▶ Look at **group manipulation**.
- ▶ Do these intractability results also work in a **parameterized complexity** setting?

Questions?

Talk to me and ask me!

