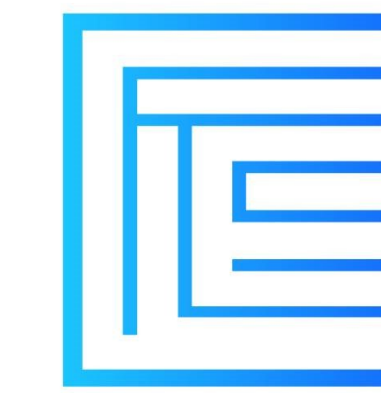


TRUTHFUL INFORMATION ELICITATION WITHOUT VERIFICATION FROM HYBRID CROWD

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An Important Problem

A weather center wants to predict tomorrow's weather based on information from crowd. Different types of agents receive different information and have different beliefs (i.e. continuous or cardinal signal for experts and discrete or ordinal signal for non-experts). Given the center does not know agent's private signal, identity, or ground truth, how can the center incentivize agents to report their signals truthfully and aggregate the signals for prediction?

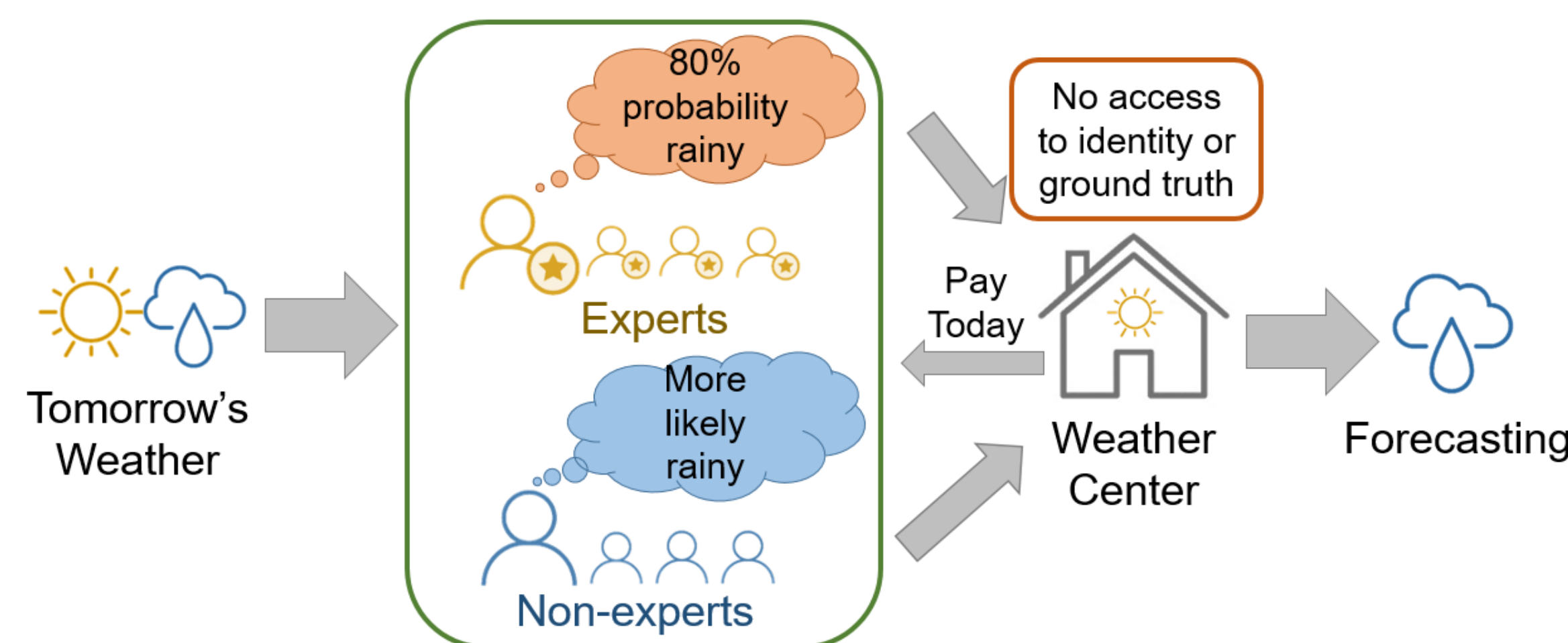


Fig. 1: Illustration for weather forecasting problem

Previous works usually assume agents to be homogeneous and ask them to give same form of reports [3, 4]. However, if we ignore heterogeneity in expertise, the aggregate prediction can be inefficient or wrong. Figure 2 illustrates two cases where this happens: 1) in an all-ordinal mechanism where information is lost for experts aggregation is inefficient 2) in an all-cardinal mechanism where non-experts need a priori knowledge to generate reports aggregation can be wrong. Therefore mechanism needs to incentivize agents to choose their most suitable signal type.

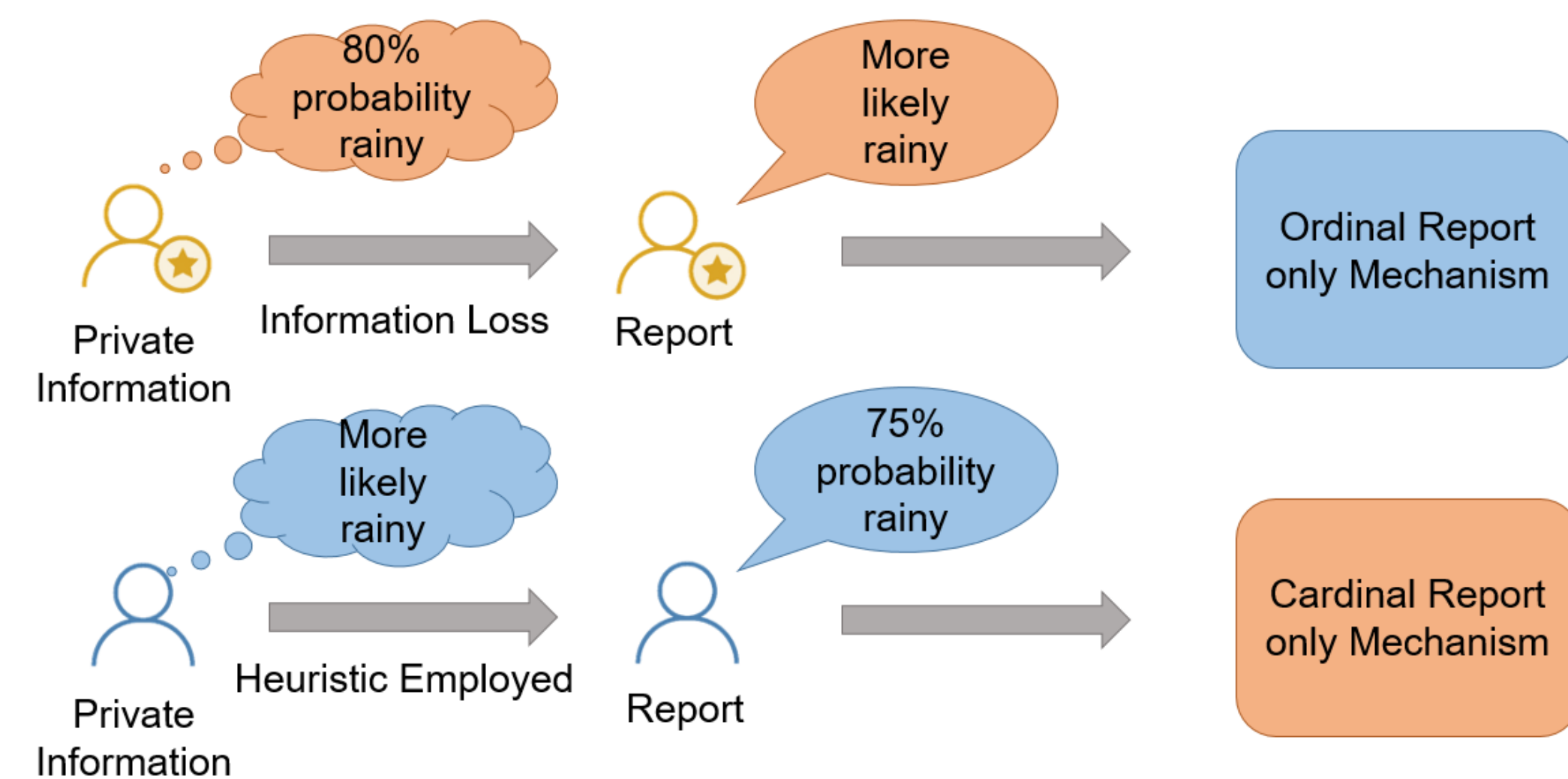


Fig. 2: Failure of ignoring the heterogeneity in crowds.

Goal

Our goal is to design **truthful** mechanisms, where

- Every expert gives a truthful continuous report.
- Every non-expert gives a truthful discrete report.

Contributions

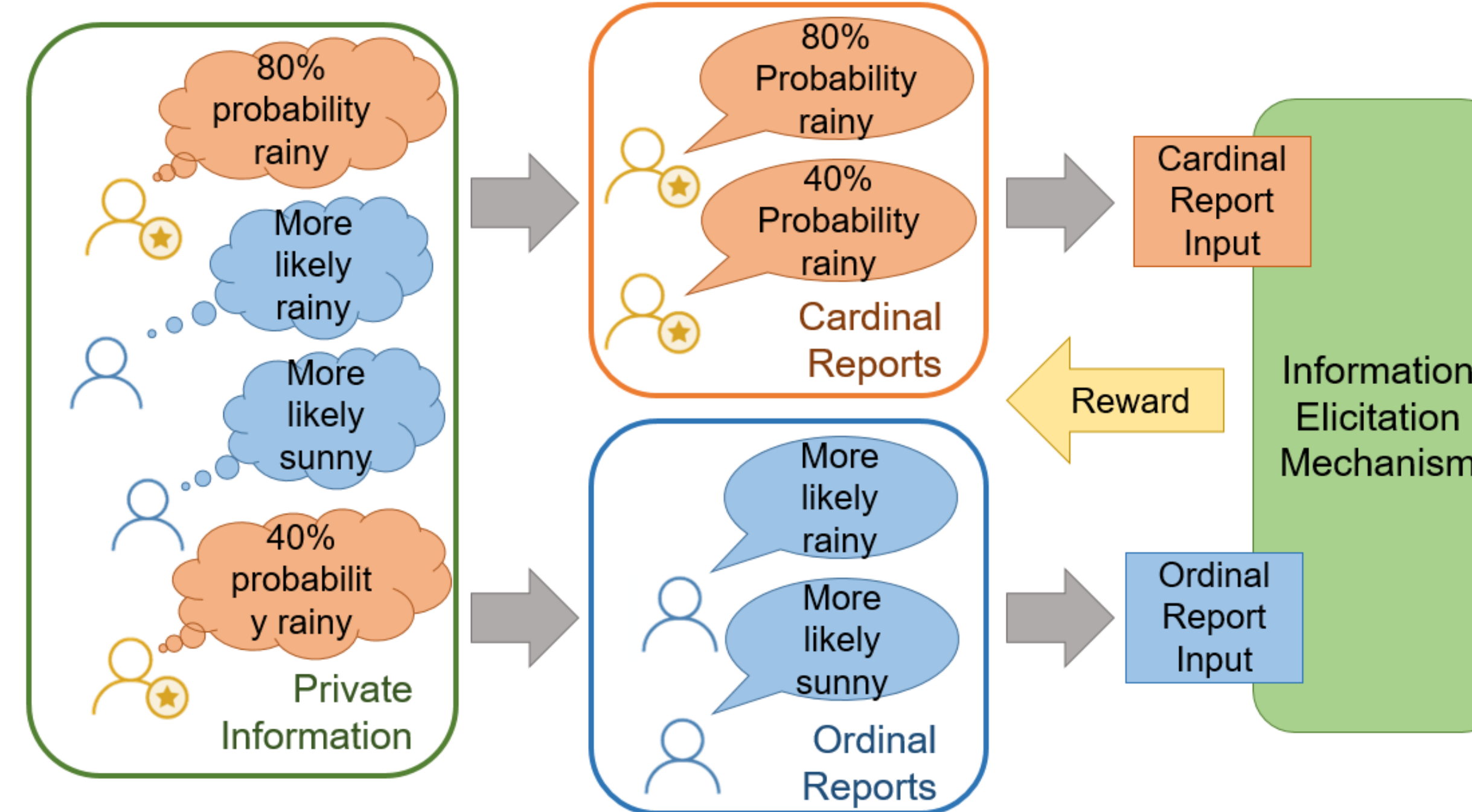


Fig. 3: The illustration of Truthfulness.

We design two *truthful* mechanisms: *composite elicitation mechanism* and *mutual-information-based mechanism*. Both mechanisms assume knowledge of prior distribution, signal distributions and threshold set.

Composite Elicitation Mechanism

- The payment for a continuous-report agent is calculated by Extended Common Ground Mechanism, which is a natural extension of Common Ground Mechanism [2].
- The payment for a discrete-report agent is calculated by Shifted Peer Prediction Mechanism [1] applied by a set of linear transformations.

Mutual-Information-Based Mechanism

- The payment for a continuous-report agent is calculated by Extended Common Ground Mechanism plus the "cross" mutual information between her continuous report and an discrete report.
- The payment for a discrete-report agent is calculated by Shifted Peer Prediction Mechanism plus the "cross" mutual information between her discrete report and a continuous report.

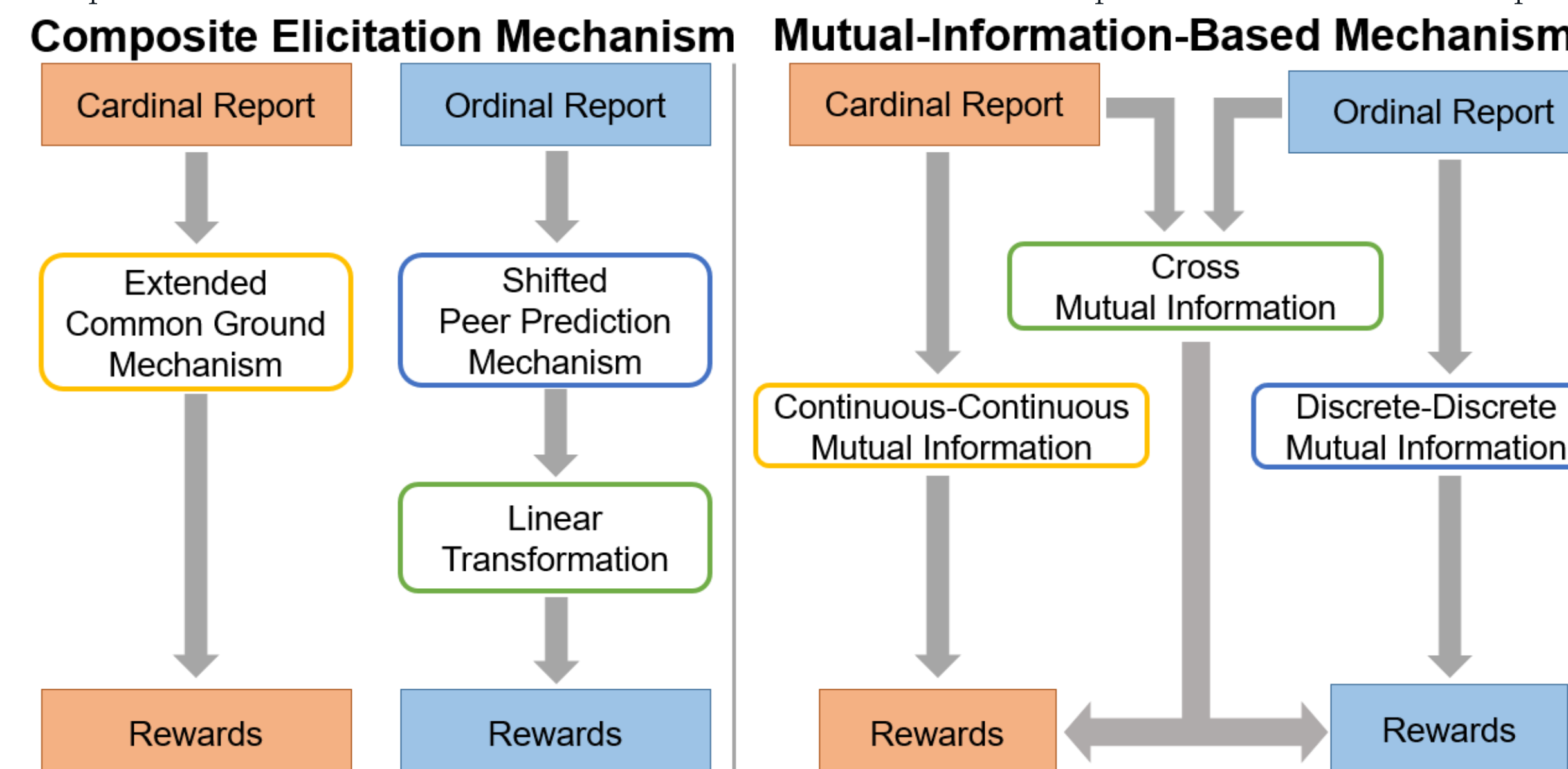


Fig. 4: The illustration of two mechanisms.

MTurks Experiment

Sample question set–

- Who do you think will win the 2020 US Presidential Election? (Binary choice question)–Options are Donald Trump and Joe Biden
- Around how many electoral votes will Donald Trump get? (Multiple choice question)–Options are < 250 (large margin loss), 250–270 (close loss), 270–290 (close win), > 290 (large margin win)
- Exactly how many electoral votes will Donald Trump get? (Fully cardinal question)–Expected answer is an integer $\in [0, 538]$.

Every participant answer all questions and then choose the question that they believe is their best estimate.

We plot MSE for each question as function of possible ground truth values. MSE plots were compared between all agents against agents who chose 'exact answer question', 'multiple choice question' and binary question' as their best estimate.

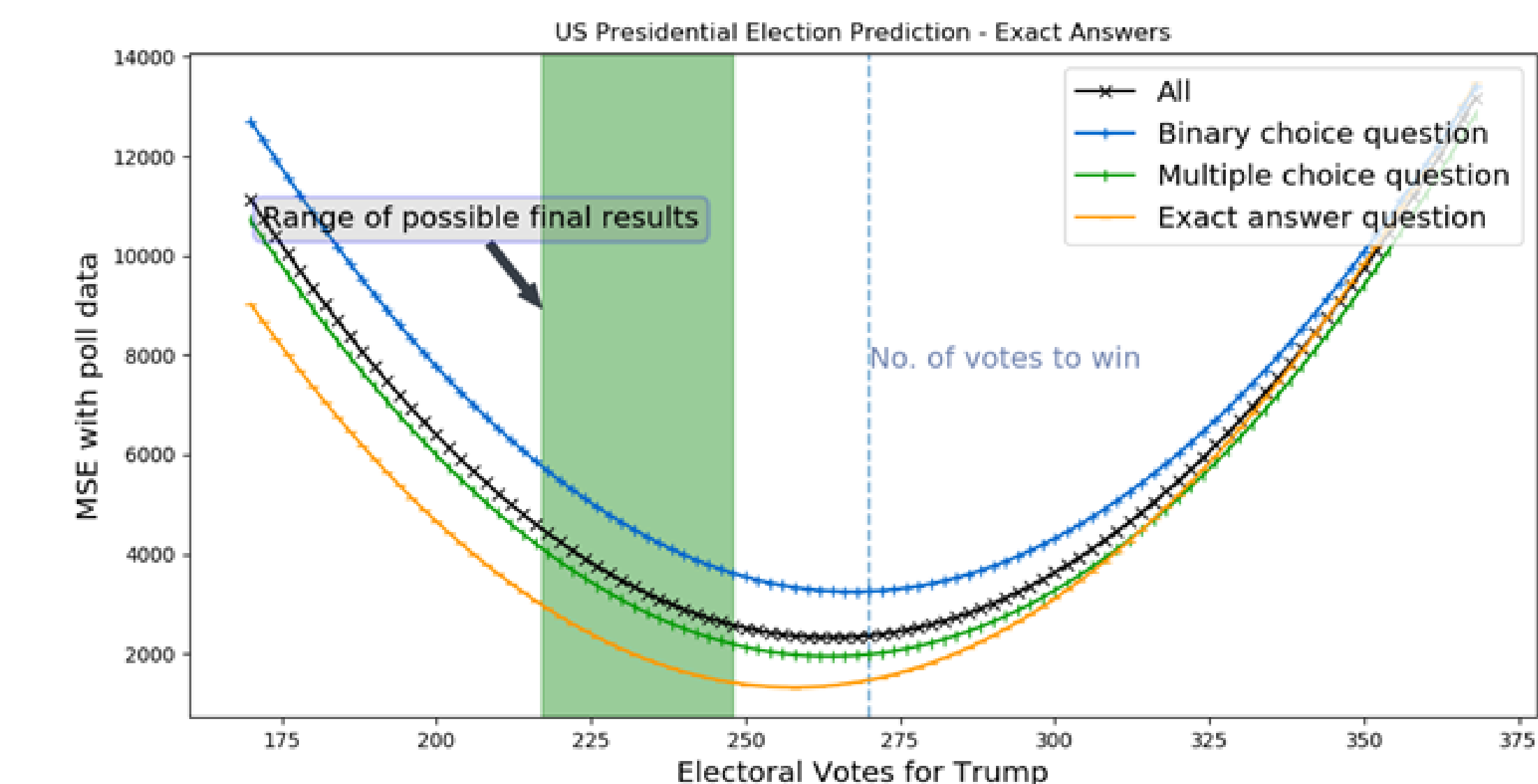


Fig. 5: MSE of different group of turkers.

Results:

- Participants who chose 'exact' or 'multiple' have better MSE than overall MSE, while those who chose 'binary' have poorer MSE. (p -value<0.01).
- Presenting different types of questions to users and discriminating between them depending on question type has merit.

References

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