View Reviews

Paper ID
5599

Paper Title
Sybil-proof Answer Querying Mechanism

Track Name
IJCAI2020

Reviewer #1

Questions

1. Overall score
Accept (good paper. I can argue for accepting it)

4. Comments to authors
The paper looked at Sybil-proof and incentive compatible answer querying mechanism. The mechanism is running on a network which is rooted at the requester. The answer is held by some notes from the tree. The goal is to get the answer. There is some reward to be shared among the notes participated in the querying process. Since the requester is only connected to a few notes in the network, so the requester needs to first find a way propagate the query to the notes holding the answer. Secondly, the requester has to find a way to reward the notes for receiving the answer such that they will not create fake notes (Sybil-proof) or collude together (collusion-proof) to get more rewards.

The paper first show that Sybil-proof and collusion-proof cannot be achieved at the same time. This seems intuitive because Sybil-proof says pretending to be more notes will not gain more reward, while collusion-proof says multiple notes pretend to be one note also doesn't create more reward. Therefore, the only case to satisfy both is when the reward is equal no matter how many notes we have, which can only hold if the mechanism is so called two-headed (Theorem 1). This is the case for path mechanisms, it would be interesting to know what else we can get for non-path mechanisms.

Then the authors characterised a class of mechanism called double geometric mechanism. They analysed the conditions to satisfy different combinations of properties. I found the paper is technical strong and have proposed some nice mechanisms. It would be interesting to get some further insights from the analysis and to guide the design of other non-path mechanisms.

5. Why should this paper be presented at IJCAI-PRICAI 2020?
It has show some nice insights about designing a mechanism for Sybil-proof, diffusion incentive and collusion-proof.

Reviewer #2

Questions

1. Overall score
Strong Accept (I don't see how it could be rejected)

4. Comments to authors
Summary of the Paper:
The paper considers Sybil- and collusion-proof mechanisms for motivating honest question propagation, when an agent does not know the answer, and honest answering, when she does.

The paper concentrates on path mechanisms that are mechanisms where

only the answering path agents receive rewards, and only the depth of
an agent on the path determines her reward. The paper defines the following
payment mechanisms properties: incentive compatibility (IC), (strong) individual
rationality ((S)IR), budget constrainedness (BC) and Sybil-proofness (SP).
They neatly which characterise Sybil-proofness. Then, they also define mechanisms
which are \lambda-collusion proof (\lambda-CP) and \rho-split secure.
Having defined the mechanism properties, they prove that under SIR, Sybil-
proofness contradicts collusion-proofness. However, under IR, SP and CP
characterise two-headed mechanisms, a class they define.

Next, they define the main class of this paper, double geometric mechanisms
(DGM). They define \rho-base mechanisms and characterise DGM as the only
IC, SIR, BC, SP, 2-CP and \rho-SS mechanism which is also \rho-base.
Having characterise DGM as described, they define \beta-appoximate CP
and prove that (1 + \epsilon)-approximate CP is impossible, assuming
IC, SIR, BC, SP, 2-CP, \rho-SS and \rho-base property, while a DGM can
be CP, approximate in the exponential of the number of agents who collude.
Finally, they define a minimum cost mechanism and time-critical mechanisms.
Then, they prove that $(1/2, \delta)$-DSM is the only path mechanism
of the minimum cost over the time-critical path machanisms, which is
IS, SIR, BC, SP, 2-CP, \rho-SS and x(1, 1) = \delta.

Constructive Comments to Improve the Paper

Contents wise:

1) You speak about the query tree. Do you assume that an agent rejects
helping if asked the question by two different neighbours?

2) After Definition 1, you mention that concentrating on path mechanisms
is w.l.o.g.; however, other agents may have contributed too. Intuitively, it
is fine, but it would be nice to formally prove that restriction to path
mechanisms does not lose generality.

3) It would be nice to explain, why you define strong IR, but not strong IC.
As you say in the 1st paragraph of column 1 on page 3, IR is satisfies by
not rewarding at all, but this holds for IC as well.

4) You say the only relevant Sybil attacks are pretending to be agents
between the parent and the children. What about pretending to be agents
somewhere else in the tree? I guess, an explanation of how an agent can
pretend would benefit the paper.

5) In the proof of the converse of Proposition 1, the inequality with
binomial coefficients should be proven inductively.

6) In the proof of the other direction of Theorem, the 2nd sentence
says "From Proposition 2 we know that
the mechanism with both SP and CP is λ-CP for any λ > 1."
Since CP is λ-CP, it is not what you mean, so please fix it.

7) In the formulation of Theorem 2, I would mention BC by δ.

8) Does Definition 9 assume there exists a given minimum here, or is there simply no minimum cost mechanism, if there exists no such minimum? More importantly, you define the minimum over all n simultaneously, right?

Typos and small suggestions:

1) In the 6th paragraph on the 2nd column of page 2, the 2nd sentence should contain a semicolon before "otherwise, the query".

2) In the first sentence in the proof of Proposition 1, "the Inequality (1)" --> "Inequality (1)".

3) In the paragraph after Proposition 2, "Secion" --> "Section".

4) In the 2nd sentence of the proof of Theorem 2, "query to all" --> "query all". The same appears in the last sentence on page 4.

5) In the last sentence on page 4, "she will" --> "she would".

6) The 2nd sentence after Definition 9 requires rephrasing, even from the grammatical perspective.

5. Why should this paper be presented at IJCAI-PRICAI 2020?
The paper suggests important notions and proves interesting, important and crisp results. The work is well-written and enjoyable to read.

Reviewer #3

Questions

1. Overall score
Accept (good paper. I can argue for accepting it)

4. Comments to authors
SUMMARY

The authors propose a path mechanism to reward a query protocol. In this protocol, agents are connected to other through a network. Requests are propagated through this network until an answer is returned to the requester, and a reward is distributed among the agents that where on the winning path. In order to prevent selfish agents to artificially increase the path and to incite honest agents to propagate the requests, the authors propose a geometric mechanism that exponentially reduce the reward with respect to the length of the winning path, and the agents' place into this path. They show this mechanism satisfy many interesting properties but is only 2-CP. However, they also show that no mechanism can satisfy the desired properties while being 3-CP (or more). Finally, they show their mechanism is the only kind of mechanism that satisfies the desired properties.

MAIN COMMENTS.

The article is interesting, well-written and sound. The authors give all steps to understand their problem and they find the good mechanism with the SIR constraint. I agree with the authors that strong individual rationality is an important property as soon as we want to deal with selfish agents without enforcement mechanism.

We can question the underlying hypothesis (such as that the correct answer is verifiable, or all members of a collusion trust themselves for sharing the reward) but those hypothesis seem natural. However, there is one hypothesis that is interesting to be discussed: it seems the authors assume there is a single shortest winning path. What happen when there are multiple shortest winning paths? The question is important because, if a reward is distributed independently to several winning path, a malicious agent which have the answer may use a Sybil attack to generate winning paths.

MINOR COMMENT.

In Section 1, the authors alternatively used the term collusion-proof or collapse-proof. Both terms seems interchangeable but the authors should restrict themselves to a single term.

Section 1.1 is the only subsection within Section 1, which is a bit strange.

At the beginning of Section 2, it is really useful to precise that agents are people? I guess it may be kept abstract.

In proof of Proposition 1, the authors may add explicitly (=>) and (<=) as they did for Theorem 1.

After Proposition 2, "Secion 4" should be "Section 4".

5. Why should this paper be presented at IJCAI-PRICAI 2020?
The paper present a new strong individuallly rational path mechanism which is 2-CP and which is shown to be the only possible mechanism.

Reviewer #4

Questions

1. Overall score
Weak Accept (marginally above the acceptance threshold. Rejecting it would not be that bad)

4. Comments to authors
The paper deals with the diffusion of a question over a network. An agent has a question and is willing to find an answer from another agent of the social network. The paper presents a mechanism to incentivize agents to answer to the question (if they have the answer) or to broadcast the question to their neighbors in the social network. This mechanism relies on payments that are given to the agents on the path from the agent who asks the question and the agent who answer to that question. This mechanism aims also at preventing sybil attacks i.e., manipulations by the agents by creating fake identities that participate to the mechanisms (and collect multiple payments on the path). The paper presents an impossibility result that shows that some strict requirements are incompatible (SIR, SP and lambda-CP for lambda >=3). The paper also presents a two-headed mechanism (providing only payments to the first and the last agents on the path), which is IR, SP and CP, and show that it is the only one with these properties. Finally, the paper provides another family of mechanism, called double geometric, which are IC, SIR, BC, SP, 2-CP (weaker than lambda-CP for lambda >= 3) and rho-SS and they show that they are the only mechanisms with all that properties under some conditions on the payment function.
The paper deals with mechanism design issues which are clearly in the scope of computational social choice and therefore AI. The issues raised by the paper seems to be new, as far as I checked. The results are interesting, and the proofs seem to be sound (even if they contain multiple typos and are not always well written). The paper provides multiple (two) mechanisms and describe their properties.
However, as explained above, the proofs are not always very well written, and contain multiple typos (but are still

understandable). There is a need to polish them. The paper contains hidden assumptions. Indeed, it is assumed that fake identities are necessarily neighbors in the social networks and should appear contiguously on the path from the agent who asks the question to the agent who answers to the question. Why such an assumption is necessary true? Or do the results could be extended to the case where fake identities can appear anywhere on the social network? Furthermore, there is almost no discussion on the agents' strategies to broadcast a question only to a subset of their neighbors. This is not completely clear if such a strategy could be beneficial or not. Finally, it is claimed in the paper that double geometric mechanisms are the only mechanisms that have all the good properties listed above. However, this is only true under a strong technical assumption that fixes one of the values of the payment schema, a fact which has a strong consequence on the other payment values. A completely general result (or a larger family of mechanisms) would be more interesting. Last comment: the two-headed mechanism does not seem very practical since the non-neighbors who does not have the answer have no real incentive to broadcast the question (because in any case they will receive nothing).
Minor comments:
• “if there are multiple agents offered the answer, we choose the one with the smallest depth”: and what about if there are multiple agents that have the answer with the same depth?
• “A reward mechanism M: T->R^{|V|-1}”: isn’t it R^{V\{r}} instead?
• About equation (1): isn’t it \sum_{k=0}^m x’_{i_j^k} instead of \sum_{k=0}^m x_{i_j^k}
• “s.t.”: such that
• About the proof of Lemma 1: this is not clear that you are doing a proof by contradiction. Please add a sentence of the type “We assume by contradtion that…”.
• The inequation right before Equation 3 appears only in the proof of Proposition 1 and is not really useful here.
• In the proof of Theorem 1
o “From Proposition 2 we know that…”: I believe that this is from the definition of CP
o “Then from the proof of Lemma 1”: there is a need to explain better
• In the proof of Theorem 2
o “\sum_{j=1}^n (\frac{1-\alpha}{\alpha})^k”: “\sum_{j=1}^n (\frac{1-\alpha}{\alpha})^j” instead
• About Theorem 3: IC and BC do not seem necessary conditions (only consequences of the others).
• Why is Lemma 2 is a lemma? A lemma should be used to prove something. Isn’t it a proposition?
• About the proof of Theorem 4: this not completely clear that you are first deriving an inequation that is equivalent to the first one (definition of (\alpha, \delta)-DGM) and then show that this equivalent inequality is true. Could you please make it clear?
• In the proof of Theorem 5
o notation R^n is not completely clear. Index n looks like an exponent. R_n would be better.
o “Then we can derive that …”: there is a need to say that this is due to Theorem 3 somehow.

5. Why should this paper be presented at IJCAI-PRICAI 2020?
This is a first step toward a characterization of mechanisms that have good properties to incentivize the broadcast of question over a social network. The paper provides two interesting payment schemes.

Reviewer #5

Questions

1. Overall score
Weak Accept (marginally above the acceptance threshold. Rejecting it would not be that bad)

4. Comments to authors
The paper considers answer querying networks and mechanism on such, focusing on Sybil-proofness (i.e. protection against an agent claiming to be multiple agents) and dominant strategies.
There has been quite a number of previous papers in the area, but seemingly on Nash eq.
They show that in general you cannot get SIR (strong individual rationality), Sybil-proof (SP) and collusion-proof (CP - i.e. protection against multiple agents claiming to be 1) and then show that some mechanisms get most of that: E.g. IR, SP and CP can be done and also IC, SIR, 2-CP (where you only get protection against 2 agents claiming to be 1). The latter satisfies a few other constraints such as budget constrained (i.e. you ensure to pay a bounded amount in

the worst case) and p-split secure and approximate CP. They also try to argue that it is the mechanism with those properties that minimizes the payments (there are some issues in the related proof though).

While this is not my area, I think it seemed like a nice set of results that seems to show something interesting.
Because I do not know so much of the area, I decided to verify their proofs instead.
I have verified all proofs except for the proof of Theorem 5 and am certain they are correct (barring minor errors).
I am unsure if Theorem 5 is correct, in particular, I was not able to verify the lines from "Hence, x(1,3)..." until "("<=")" - assuming that part is correct, I was able to verify the rest (but think the <= part could have been better written). There are some problems in the proof at least and it should either be changed to be correct or removed from the paper.
Still, even without Theorem 5 (showing that their mechanism is the one that ensures the least payment), I still feel that the paper could be accepted.

Problems with the proof of Theorem 5:
The x(1,3)+x(3,3)\geq part is wrong! x(1,3) and x(3,3) scale with delta as a factor, but changing delta does not change epsilon or p which are the only variables on the right hand side. I was also not able to see how you got the expression in the first case, so I would like you to add slightly more details there.

You also cheat with the induction. Your argument is basically 1 is true, 2 is true, 3 is true, therefore all larger numbers are true.

Minor comments:
Page 1 related work: eligible -> negligible
Proof of theorem 2, showing BC, line before "Hence, (alpha,delta)-DGM is BC": Last < should be \leq, since you have equality for n=2.

I would remove the <= and the => part of Theorem 5 by just arguing that
x(1,n+1)=x(2,n+1)=...=x(n+1,n+1)=1/(n+1) R^{n+1}, because of your induction,
thus, 2n/(n+1) R^{n+1}=R^n for n\geq 2 (by the first display equality of Theorem 5). Since R^1=R^2=delta, you get that
R^{n}=delta n/2^(n-1) - one can just write it like that without argument, because it is easy to verify - and thus (by your induction), x(j,n)=2^(1-n) delta, which is (1/2,delta)-DGM.
That is shorter and I feel somewhat clearer.

In case you do not want to do that: Proof of theorem 5, => part: "which is same to the the" -> "which is the same as for the"

Also, please change R^n to R_n. The other looks like R to the n.

5. Why should this paper be presented at IJCAI-PRICAI 2020?
While I have some doubts about Theorem 5, I think the rest is strong enough to maybe get in. Still, this is not my area, so take it with a grain of salt.