The Reliability of Testimonial Norms in Academic Communities

Conor Mayo-Wilson

Models and Simulations
July 9th, 2013
Regardless of discipline, we (academics) rely on others outside our area of expertise for information.
Regardless of discipline, we (academics) rely on others outside our area of expertise for information.

How should we determine who to trust and what to believe on the basis of their testimony?
Immediate Answer: Trust an expert!
● Immediate Answer: Trust an expert!
● Which one(s) should I trust if there is disagreement?
Experts

- Lehrer-Wagner Model (1981): All other things equal, take a poll of experts.

Goldman (2011): Do not poll. There are a variety of procedures to determine which experts are most reliable. Of course, there are a number of other issues surrounding expert testimony...
Lehrer-Wagner Model (1981): All other things equal, take a poll of experts.

Goldman (2011): Do not poll. There are a variety of procedures to determine which experts are most reliable.
Experts

- Lehrer-Wagner Model (1981): All other things equal, take a poll of experts.
- Goldman (2011): Do not poll. There are a variety of procedures to determine which experts are most reliable.
- Of course, there are a number of other issues surrounding expert testimony . . .
We often learn from non-experts - for example:

- Newspapers,
- Magazines,
- Blogs,
- High-school teachers,
- College Professors (philosophers excluded, of course).
We often learn from non-experts - for example:
- Newspapers,
- Magazines,
- Blogs,
- High-school teachers,
- College Professors (philosophers excluded, of course).

Who should we trust?
Trust testimonial evidence only if there is positive evidence for speaker’s reliability and honesty.
Believing what one is told, depends on believing the teller trustworthy . . . belief in the teller’s trustworthiness needs to be empirically grounded. There is no general epistemic entitlement to trust any teller.

Elizabeth Fricker. “Second-Hand Knowledge.”
Non-reductionists

Trust testimonial evidence in absence of negative reasons to doubt it.
[E]ven if you do not have the opportunity to rationally persuade me of the truth of what you believe, and even if I have little or no information about your evidence, abilities, circumstances or history of reliability and hence have no basis for granting you specialized authority, it is nonetheless reasonable for me to regard your opinions as having a measure of \textit{prima facie intellectual credibility}.

Traditional debates focus on **justification**.
Traditional debates focus on *justification*.

But they are implicitly motivated by concerns about the reliability of various *rules* for changing one's beliefs in light of others' claims.
Traditional debates focus on justification.

But they are implicitly motivated by concerns about the reliability of various rules for changing ones beliefs in light of others claims.

Call such rules testimonial norms.
A Non-Reductionist Norm: “Believe others so long as there is no conflicting information.”
Testimonial Norms

- **A Non-Reductionist Norm**: “Believe others so long as there is no conflicting information.”
- **A Reductionist Norm**: “Believe others if and only if you have positive reasons to trust them.”
A Non-Reductionist Norm: “Believe others so long as there is no conflicting information.”

A Reductionist Norm: “Believe others if and only if you have positive reasons to trust them.”

The Reductionism Debate: Motivated by the recognition that the former norm is reliable in some contexts but not others.
Testimonial Norms

- **A Non-Reductionist Norm:** “Believe others so long as there is no conflicting information.”

- **A Reductionist Norm:** “Believe others if and only if you have positive reasons to trust them.”

- **The Reductionism Debate:** Motivated by the recognition that the former norm is reliable in some contexts but not others. Similarly, the latter norm might prohibit one from learning in contexts in which individuals are honest and reliable.
Similar remarks apply to debates concerning expert testimony.
Central Questions:

- Which testimonial norms are “epistemically best”?
Central Questions:

- Which testimonial norms are “epistemically best”?
- What factors influence the “epistemic performance” of testimonial norms?
Central Questions:

- Which testimonial norms are “epistemically best”? 
- What factors influence the “epistemic performance” of testimonial norms?
Central Thesis: Evaluation of various testimonial norms ought to pay close attention to
Central Thesis: Evaluation of various testimonial norms ought to pay close attention to

- the possibility of miscommunication
Central Thesis: Evaluation of various testimonial norms ought to pay close attention to

- the possibility of *miscommunication*
- the *social structure* of epistemic communities, which dictate how information is disseminated.
My Methodology:

1. Develop a formal model of communal inquiry
My Methodology:

1. Develop a formal model of communal inquiry
   - The model is most applicable to scientific communities, but it is general enough to capture other communities as well.
My Methodology:

1. Develop a formal model of communal inquiry
   - The model is most applicable to scientific communities, but it is general enough to capture other communities as well.

2. Evaluate the “epistemic performance” of community when the various testimonial norms are adopted
My Methodology:

1. Develop a formal model of communal inquiry
   - The model is most applicable to *scientific* communities, but it is general enough to capture other communities as well.

2. Evaluate the “epistemic performance” of community when the various testimonial norms are adopted
   - Do all agents *eventually* hold true beliefs?
My Methodology:

1. Develop a formal model of communal inquiry
   - The model is most applicable to scientific communities, but it is general enough to capture other communities as well.

2. Evaluate the “epistemic performance” of community when the various testimonial norms are adopted
   - Do all agents eventually hold true beliefs?
   - If so, how quickly do they acquire true beliefs?
My Methodology:

1. Develop a formal model of communal inquiry
   - The model is most applicable to scientific communities, but it is general enough to capture other communities as well.

2. Evaluate the “epistemic performance” of community when the various testimonial norms are adopted
   - Do all agents eventually hold true beliefs?
   - If so, how quickly do they acquire true beliefs?
   - If not, how well do they avoid error?
A Model of Communal Scientific Inquiry

Results

- Convergence
- Miscommunication and Error
- Identifying Experts
Overview of Model
Overview of Model
Overview of Model
Formally: Unknown parameters $\mu_1, \mu_2, \ldots, \mu_n \in \mathbb{R}$
Formally: Unknown parameters $\mu_1, \mu_2, \ldots, \mu_n \in \mathbb{R}$

$\mu_k \geq 0 \Rightarrow$ Drug $k$ is salutary.
Formally: Unknown parameters $\mu_1, \mu_2, \ldots, \mu_n \in \mathbb{R}$

- $\mu_k \geq 0 \Rightarrow$ Drug $k$ is salutary.
- $\mu_k < 0 \Rightarrow$ Drug $k$ is harmful.
Scientists are interested in the efficacy of all drugs, but...
Scientists are interested in the efficacy of all drugs, but each scientist studies only one drug (due to financial constraints, time constraints, specialized training, etc.).
Scientists are interested in the efficacy of all drugs, but each scientist studies only one drug (due to financial constraints, time constraints, specialized training, etc.). Scientists must learn about the efficacy of some drugs from others.
Hence, in my model, scientists learn about the efficacy of pills in two ways:
Hence, in my model, scientists learn about the efficacy of pills in two ways:

- They learn from data (about their own pill)
Hence, in my model, scientists learn about the efficacy of pills in two ways:

- They learn from **data** (about their own pill)
- They learn from **others** (about other pills).
Learning from data
LEARNING FROM DATA
Learning from data
Learning from data
Formally - Each scientist draws a sample point from a normal distribution with unknown mean $\mu_i$ and unknown variance $\sigma_i^2$. 
Within her own field: Each scientist uses a significance test to determine whether the drug she studies is effective.

Scientists use all available data, including that acquired from their peers who study the same drug.
Communication

Nodes = Scientists

Colors = Pill the scientist studies

Edges = Which scientists can share information.
Nodes = Scientists
Colors = Pill the scientist studies
Nodes = Scientists
Colors = Pill the scientist studies
Edges = Which scientists can share information.
Neighborhoods

$g_0$’s neighborhood
If scientists study the same drugs, they can share their data.
If scientists study the same drugs, they can share their data. Otherwise, they can share only their qualitative beliefs concerning which drugs are effective.
Agents employ different testimonial norms to learn from qualitative information, where a testimonial norm is simply a (random) function from what is said by one's neighbors to beliefs.
Agents employ different testimonial norms to learn from qualitative information, where a testimonial norm is simply a (random) function from what is said by one's neighbors to beliefs.

A group testimonial norm (GTN) specifies a testimonial norm for each agent in a network.
Example testimonial norms

Outside of one’s field:

- Reidian - Adopt the belief of a randomly chosen neighbor.
- Expert Truster - Adopt the belief of an expert neighbor if one exists. Otherwise, trust a random neighbor.
- Proximitist - Adopt the belief of a neighbor who is least distant from an expert in the network.
Outside of one’s field:

- **Reidian** - Adopt the belief of a randomly chosen neighbor.
- **Expert Truster** - Adopt the belief of an expert neighbor if one exists. Otherwise, trust a random neighbor.
- **Proximitist** - Adopt the belief of a neighbor who is least distant from an expert in the network.
Outside of one’s field:

- Reidian - Adopt the belief of a *randomly* chosen neighbor.
- Expert Truster - Adopt the belief of an *expert* neighbor if one exists. Otherwise, trust a random neighbor.
- Proximitist - Adopt the belief of a neighbor who is *least distant* from an expert in the network.
Outside of one’s field:

- **Reidian** - Adopt the belief of a *randomly* chosen neighbor.
- **Expert Truster** - Adopt the belief of an *expert* neighbor if one exists. Otherwise, trust a random neighbor.
- **Proximitist** - Adopt the belief of a neighbor who is *least distant* from an expert in the network.
Proximitists try to “get information from the source.”
Outside of one’s field:

- Majoritarian Reidian - Poll all neighbors.
- Majoritarian E-Truster - Poll all expert neighbors if any exist. Otherwise, poll all neighbors.
- Majoritarian Proximitist - Poll those neighbors who are least distant from an expert in the network.
Example testimonial norms

Outside of one’s field:

- Majoritarian Reidian - Poll all neighbors.
- Majoritarian E-Truster - Poll all expert neighbors if any exist. Otherwise, poll all neighbors.
- Majoritarian Proximitist - Poll those neighbors who are least distant from an expert in the network.
Example testimonial norms

Outside of one’s field:

- Majoritarian Reidian - Poll all neighbors.
- Majoritarian E-Truster - Poll all expert neighbors if any exist. Otherwise, poll all neighbors.
- Majoritarian Proximitist - Poll those neighbors who are least distant from an expert in the network.
Outside of one’s field:

- **Majoritarian Reidian** - Poll all neighbors.
- **Majoritarian E-Truster** - Poll all expert neighbors if any exist. Otherwise, poll all neighbors.
- **Majoritarian Proximitist** - Poll those neighbors who are least distant from an expert in the network.
## Example testimonial norms

<table>
<thead>
<tr>
<th></th>
<th>Single Agent</th>
<th>Majoritarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reidian</td>
<td>Random</td>
<td>Poll All</td>
</tr>
<tr>
<td>E-Truster</td>
<td>Expert</td>
<td>Poll Experts</td>
</tr>
<tr>
<td>Proximitist</td>
<td>Proximate Neighbors</td>
<td>Poll Proximate Neighbors</td>
</tr>
</tbody>
</table>
1 A Model of Communal Scientific Inquiry

2 Results
   - Convergence
   - Miscommunication and Error
   - Identifying Experts
Truth - Which $\text{GTN}$, if adopted, lead researchers to develop all and only true beliefs about the world?
Say an \textit{GTN} is \textit{convergent} if

- whenever a network employs said \textit{GTN},
Say an \texttt{GTN} is \textit{convergent} if

- whenever a network employs said \texttt{GTN},
- and whatever the truth happens to be,
Say an GTN is **convergent** if

- whenever a network employs said GTN,
- and whatever the truth happens to be,
- with probability one,
Say an \( \text{GTN} \) is convergent if

- whenever a network employs said \( \text{GTN} \),
- and whatever the truth happens to be,
- with probability one,
- there is some stage of inquiry at which every agent has all and only true beliefs, and
Convergence

Say an GTN is convergent if

- whenever a network employs said GTN,
- and whatever the truth happens to be,
- with probability one,
- there is some stage of inquiry at which every agent has all and only true beliefs, and
- their beliefs remain true from that stage onward.
**Theorem**

Any mixture of Reidianism, e-trusting, proximitism, and majoritarian proximitism is convergent. No mixture containing either of the other two are convergent.
In fact, almost any realistic norm satisfying basic rationality requirements converges.
Finite Memory

Say an agent $g$ is employing a testimonial norm with finite memory if there is some finite number $n$ such that $g$’s beliefs depend only the last $n$ stages.
Suppose an agent $g$ has finite memory of length $n$. 
Suppose an agent $g$ has finite memory of length $n$.

Say $g$ employs a stable testimonial norm just in case

- If there has been consensus in $g$’s neighborhood that $\varphi$ for $n$ stages, then $g$ believes $\varphi$ with probability one.
Suppose an agent $g$ has finite memory of length $n$. 
Suppose an agent $g$ has finite memory of length $n$. 

Say $g$ employs a sensitive testimonial norm just in case
- for any area of expertise, there is some $\epsilon > 0$ and some set of $g$’s neighbors who are more proximate to an expert such that, if every agent in the set believes $\varphi$, then $g$’s probability of believing $\varphi$ is at least $\epsilon$. 

**Theorem**

If a GTN is any mixture of finite-memory norms that are stable and sensitive, then it is convergent.
In other words, GTNs converge as long as they satisfy basic conditions of

- realism (i.e., finite memory)
- normative adequacy (i.e. stability and sensitivity)
**Moral:** If one’s goal is to eventually obtain true beliefs, then one has a variety of testimonial norms from which to choose.
Epistemic Goals

- Which GTNs are convergent?
Epistemic Goals

- Which GTNs are convergent?
- Which GTNs converge quickly?
Simulations

- Varied
  - Number of scientists
  - Number of edges
  - Difficulty of the problem
  - Testimonial norm (Reidian, E-trusting, Proximitist, and Majoritarian Proximitist)
Varied

- Number of scientists
- Number of edges
- Difficulty of the problem
- Testimonial norm (Reidian, E-trusting, Proximitist, and Majoritarian Proximitist)

Recorded

- Number of elapsed stages before all agents’ beliefs were true (and remained true for 15 stages).
Simulations

- Varied
  - Number of scientists
  - Number of edges
  - Difficulty of the problem
  - Testimonial norm (Reidian, E-trusting, Proximitist, and Majoritarian Proximitist)

- Recorded
  - Number of elapsed stages before all agents’ beliefs were true (and remained true for 15 stages).

- Analyzed the data using a series of statistical tests (ANOVA)
Simulation Results

Size

Ease

Use of Testimony

Connectivity

Time to True Belief
Dissemination and Discovery

As the problem becomes more difficult, the time taken to discover an adequate answer dwarfs the time taken to disseminate it.

\[
\text{Time for discovery of principles of flight } \approx 2500 \text{ years.} \\
\text{Time to disseminate such knowledge } \approx 1 \text{ year.}
\]

\[
2500 \gg 1.
\]
As the problem becomes more difficult, the time taken to 
discover an adequate answer dwarfs the time taken to 
disseminate it.

Time for discovery of principles of flight $\approx 2500$ years.
As the problem becomes more difficult, the time taken to discover an adequate answer dwarfs the time taken to disseminate it.

- Time for discovery of principles of flight $\approx 2500$ years.
- Time to disseminate such knowledge $\approx 1$ year.
As the problem becomes more difficult, the time taken to discover an adequate answer dwarfs the time taken to disseminate it.

- Time for discovery of principles of flight $\approx 2500$ years.
- Time to disseminate such knowledge $\approx 1$ year.
- $2500 \gg 1$. 
Testimonial norms only influence dissemination.
Testimonial norms only influence dissemination.

So testimonial norms have only a trivial influence on total convergence time when the problem is difficult.
Most intuitively plausible policies are convergent.
1. Most intuitively plausible policies are convergent.
2. Use of testimony is independent of speed of acquisition of true belief.
But I have ignored miscommunication entirely . . .
Imagine agents mishear, mispeak, or misunderstand their neighbors with some fixed probability \( \epsilon > 0 \).
Imagine agents mishear, mispeak, or misunderstand their neighbors with some fixed probability $\epsilon > 0$.

Which testimonial norms are convergent?
Theorem

No mixture of finite memory norms is convergent.
However, evaluating various testimonial norms is not hopeless . . .
Fix a network, an \texttt{GTN}, and a set of true answers.

- Let $e_n$ be the \textit{expected proportion} of all researchers’ beliefs that are erroneous on stage $n$. 
Fix a network, an GTN, and a set of true answers.

- Let $e_n$ be the expected proportion of all researchers’ beliefs that are erroneous on stage $n$.
- On first glance, the number $e_n$ could fluctuate wildly from one stage of inquiry to the next.
Fix a network, any mixture of the six GTNs, and a set of true answers.
Fix a network, any mixture of the six GTNs, and a set of true answers.

**Theorem**

\[ e_n \text{ approaches a fixed value } e \text{ as } n \to \infty. \text{ Moreover, } e \text{ does not depend upon agents’ initial beliefs.} \]
Fix a network, any mixture of the six GTNs, and a set of true answers.

**Theorem**

\[ e_n \text{ approaches a fixed value } e \text{ as } n \to \infty. \text{ Moreover, } e \text{ does not depend upon agents' initial beliefs.} \]

Call \( e \) the **error rate** of the fixed GTN in the fixed network.
Evaluating testimonial norms

In the presence of miscommunication, we can evaluate GTNs by comparing their error rates in various networks.
In every network, for questions of any level of difficulty, the error rates of the four convergent testimonial norms are ordered (not necessarily strictly) from highest to lowest as follows:

1. Reidanism
2. E-trusting
3. Proximitism
4. Majoritarian Proximitism
However, the error rates are not constant across all network structures.
Insularity

Left: A Non-Insular
Right: An Insular Network

Called homophily by economists and sociologists - Golub and Jackson [2012], Young [2011]
Left: A Non-Insular
Right: An Insular Network
Called **homophily** by economists and sociologists - Golub and Jackson [2012], Young [2011]
**Agent insularity** = the proportion of her neighbors of the same color.

**Network insularity** = average agent insularity
Error Rates and Social Structure

Error Rates vs. Insularity
with 1% Miscommunication Rate

- Reidianism
- ETrusting
- Proximitism
- Majoritarian Proximitism
Convergence Time vs. Insularity in Easy Problems

Speed of Discovery and Social Structure
Moral: Insular scientific communities make discoveries more quickly, but the dissemination of such knowledge is often less reliable.
Moral: Insular scientific communities make discoveries more quickly, but the dissemination of such knowledge is often less reliable.

(At least for the testimonial norms studied here . . .)
Misidentifying Experts

- **Objection:** Wait Conor! You assume that scientists can identify the experts in their neighborhood.
**Objection:** Wait Conor! You assume that scientists can identify the experts in their neighborhood.

It’s not like scientists wear little green hats that say “I am a green pill expert.”
Objection: Wait Conor! You assume that scientists can identify the experts in their neighborhood.

It’s not like scientists wear little green hats that say “I am a green pill expert.”

Identifying who is an expert can be very difficult.
Suppose that all, on stage \( n \), each agent correctly identifies which of her neighbors are experts (or are most proximate to an expert) with some probability \( p_n \leq 1 \).
Suppose that all, on stage $n$, each agent correctly identifies which of her neighbors are experts (or are most proximate to an expert) with some probability $p_n \leq 1$.

**Theorem**

Suppose that the sum $\sum_{n \in \mathbb{N}} p_n^k$ diverges for all natural numbers $k$. Then in the absence of miscommunication, any mixture of Reidians, e-trusting, proximitism and majoritarian proximitism is convergent. Neither majoritarian Reidianism nor majoritarian e-trusting is.
Theorem

In the presence of constant miscommunication and constant expert misidentification, all sensitive finite memory norms still have some asymptotic error rate.
Expert misidentification has no effect on the convergence results, even if agents’ ability to recognize experts decreases (and approaches zero accuracy!) as time goes on (e.g. let $p_n = \frac{1}{\log n}$ in the previous theorem).
Expert misidentification has no effect on the convergence results, even if agents’ ability to recognize experts decreases (and approaches zero accuracy!) as time goes on (e.g. let \( p_n = \frac{1}{\log n} \) in the previous theorem).

Whether or not the error rates are ordered in the same way remains to be tested: I conjecture they are if expert misidentification is sufficiently rare.
In the absence of miscommunication,
- Most intuitively plausible policies converge to true belief.
In the absence of miscommunication,

- Most intuitively plausible policies converge to true belief.
- Use of testimony is independent of speed of acquisition of true belief.
Conclusions

- In the absence of miscommunication,
  - Most intuitively plausible policies converge to true belief.
  - Use of testimony is independent of speed of acquisition of true belief.
- In the presence of miscommunication,
  - Most testimonial norms do not converge to true belief.
Conclusions

In the absence of miscommunication,
- Most intuitively plausible policies converge to true belief.
- Use of testimony is independent of speed of acquisition of true belief.

In the presence of miscommunication,
- Most testimonial norms do not converge to true belief.
- Testimonial norms interact with social structure to determine error rate.
Conclusions

In the absence of miscommunication,
- Most intuitively plausible policies converge to true belief.
- Use of testimony is independent of speed of acquisition of true belief.

In the presence of miscommunication,
- Most testimonial norms do not converge to true belief.
- Testimonial norms interact with social structure to determine error rate.
- Insularity of network increases error rate by the “telephone-game” effect.
Questions for Future Research

- Dissemination of *arguments* and not just single propositions [Betz, 2012].

⇒ Model more complex and nuanced testimonial norms.

"Collaborative" rather than Parallel Research
Dynamic networks - What is "dynamic insularity"?
Questions for Future Research

- Dissemination of arguments and not just single propositions [Betz, 2012].
  - ⇒ Model more complex and nuanced testimonial norms.
Questions for Future Research

- Dissemination of arguments and not just single propositions [Betz, 2012].
  - ⇒ Model more complex and nuanced testimonial norms.
- “Collaborative” rather than Parallel Research
Questions for Future Research

- Dissemination of arguments and not just single propositions [Betz, 2012].
  - \( \Rightarrow \) Model more complex and nuanced testimonial norms.
- “Collaborative” rather than Parallel Research
- Dynamic networks - What is “dynamic insularity”? 
Questions?

Comments?
