

# A Review of Privacy in Agent Based Meeting Scheduling

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**Abstract :** Scheduling meetings between a group of people is seen as a very difficult job. However, it is also one of the many tasks that can be done with minimal human intervention. Many different approaches using agents for scheduling the meeting are known. One common discussion is how much information should an agent reveal about its user's calendar when a meeting is to be scheduled. Discussions on this aspect of the scheduling process are almost inevitable as agents will need to exchange information to agree on a solution. This paper discusses different results found in this area.

**IndexTerms - Meeting Scheduling, Agent Based, Distributed Meeting Scheduling, Privacy, Scheduling**

## I. INTRODUCTION

Scheduling a meeting is a very common and important task which is performed by everyone. When many people have to come together for a meeting, there is often the use of an agent who performs the scheduling process on behalf of the user. One of the most important considerations during this is how much information is divulged by a user's agent when scheduling a meeting. During the negotiation part of the scheduling process, an agent will inevitably have to share information with either the host or the other agents. Some users want their agents to share very little information while others might be fine with sharing everything available. The level of privacy exercised is a very important factor in this process. This paper mainly focuses on the aspect of information exchange in the scheduling scenario.

The paper is divided into the following sections.

Section 2 discusses some papers to outline the need for privacy and how privacy is maintained in them. Section 3 reviews three papers in depth in which privacy is one of the main factors considered. For each paper, its overview, how privacy is considered, experimental setup, and results are discussed. Some of the metrics used are also mentioned, but not in detail. Sections 4 and 5 wrap up the paper with discussions and conclusions.

## II. LITERATURE REVIEW

There are many papers written keeping in view privacy in the meeting scheduling process. Some papers are based on implementations of a system while others are analyses done on tradeoffs, etc. Such papers are discussed in brief here. Papers about activity scheduling are also discussed in the interest of having a broader scope.

[1] presents a meeting scheduling system that does not use a central database as this invades the privacy of the users. Each user is instead, assigned an agent(meeting scheduling agent or MSA) that takes care of its user's calendar and exchanges information whenever necessary.

In [2], an optimal solution to negotiation between agents is sought. It states how it tries to mimic real life, in the sense that the preferences are not available to others. The preference of agents is not known beforehand and is estimated based on the interaction between agents during negotiation.

In [3], Chronos, a multi agent system whose main task is to assist with meeting scheduling, is presented. In order to maintain privacy, a user's calendar is not presented to others. Each user has an agent(termed as Organizer agent), which supports its user by learning from the user and from its interactions with others.

The privacy issue in the context of activity scheduling in mobile devices is discussed in [4]. It recognizes that privacy is an important factor as users don't want to exchange private information with others. Solutions to the scheduling problem that maintains privacy are discussed in this paper.

In [5], the loss of privacy during meeting scheduling is taken into account. Privacy loss measures include positive and negative information and open slots. The paper recognizes that agents want to keep the information as private as possible, hence tradeoffs between privacy loss, efficiency, and quality of solution are considered.

[6] states that the meeting scheduling process should be "Privacy preserving"[6]. Here privacy is in terms of basing one's own decisions less on information acquired from other agent's individual nature. Three mechanisms are also presented. Again, the mechanism involving a centralized database doesn't maintain user privacy while a distributed mechanism does, at the cost of higher complexity.

### III. REVIEW OF PRIVACY

In [7], privacy is one of the three main factors considered in the scheduling process. Also, the paper focuses on the efficacy of the chosen slot rather than the efficiency of the scheduling process, i.e. how good the slot is rather than how quickly it is chosen.

Four different levels of privacy are considered by the authors, with a different protocol followed for each level. The two protocols (which are not optimal) tested are discussed below:

When agents only share times when the user is free, the Voting Protocol is used.

When agents disclose neither free times nor preferences, the Suggestion Protocol is used.

Different agent behaviors are also explored for the suggestion protocol. An egotist agent is one who always tries to keep the meetings at a time most preferred by it, even if it means giving more information. A laconic agent prefers privacy more, and hence shares lesser information, sometimes leading to a lesser preferred slot. When information must be provided, it gives the slot it most prefers. A deceiving agent is a laconic agent who chooses a random slot as its preferred slot whenever asked for information so that no one can infer its preference.

The parameters are the participant count, solution count, and each agent's preference range.

Some of the different metrics used are average optimization, average rank, and adjusted user satisfaction (see [7] for further details on the metrics)

When the voting protocol is tested, only 12% of the time, the protocol could not return the best time, and 3% of the times it does not return the 2nd best time. For the suggestion protocol, better efficacy is seen for egotistic agents. In both homogeneous and heterogeneous groups, the egotistic strategy is better. Adopting a laconic or deceiving strategy bears less fruit in terms of adjusted satisfaction in heterogeneous groups. The protocol is also free of coalition problems and sees no improvement if agents learn the scheduling preferences of other agents.

In [8], a multi agent meeting scheduling system is implemented where the agents have to agree upon 3 parameters: day, start time, and city of the meeting.

The time to reach one city from another is shown in the form of arcs with the distance also specified.

Information exchange can be split into two cases. The first case is when the agent divulges no additional information about its schedule but only replies through acceptance or rejection. This is the best-case scenario in terms of the privacy of the user.

The second case can be split into 2 types.

- The agent reveals only 1 conflict that it has with the current proposal, even if there are more conflicts.
- The agent reveals all the conflicts that it has with the current proposal.

The experiments are measured on efficiency and loss of privacy (see [8] for further details on the metrics).

The setup is done using 3 agents, with meetings in each agent's calendar filled such that there is at least one common free slot acceptable to all agents.

When experimental runs are done, the initial number of meetings in the agent's calendar is the only variable that is altered.

The paper concludes that when privacy is a very important factor, it is best to convey the least information possible. When efficiency also is a factor, better efficiency is seen when agents start making inferences about other agent's schedules, not just when they share more information. Increased efficiency is also achievable when agents give less information (only one conflict) and only one of the three agents is involved in the use of inferences.

In [9], agents try to negotiate with each other to schedule the meeting. Each agent knows only the preference and calendar of its user. Agents need to agree on a value for a date, start time, and duration. In addition to this, agents need to also maximize its user's preferences.

Privacy is varied in two ways:

- Agents share their entire calendar (total calendar) or only a part of it (partial calendar)
- Agents inform the preference value of each interval proposed (public preference) or only of the interval that will be scheduled (private preference)

The number of proposals and joint quality is measured against calendar density (see [9] for further details on the metrics).

Three agents are considered. 3 days, with 3 hours per day are considered.

Calendar density(number of busy hours) is varied for each run, and each possible calendar for a given density is considered.

The paper concludes that the quality of the meeting is not majorly impacted when partial calendars are used as opposed to total calendars. The performance is also better when partial calendars are traded. Changes to preference privacy also do not vary the efficiency too much, when partial calendars are used. The paper considers this result interesting as even in real life, people are reluctant to give out details about their calendars and preferences.

#### IV. DISCUSSION

There are many important results that the papers provide when it comes to privacy considerations. Three interesting observations are presented below as they seem to be more widely applicable.

Firstly, the implementation using agents is interesting as most papers involve the use of agents that help a user schedule a meeting. Agent based approaches with a negotiation process allow for more flexibility in varying privacy in terms of information exchange. This is not possible if a central database is used as the concept of privacy is almost non-existent.

Second, the results of all three referred papers suggest that lesser information shared need not always mean a worse off schedule for a meeting. Efficiency may sometimes take a hit, but from a user's standpoint, maintaining privacy while scheduling can be considered equally, if not more important, as long as the end result of the scheduling process is good enough.

Finally, many solutions consider making the agents smarter rather than using implementations that just exchange more information. This helps not only from the privacy front but also makes advances in creating agents that can negotiate better. This is also easier in the current day and age given the vast advancement in agent based technology.

#### V. CONCLUSIONS

At the time of writing this paper, there are many issues regarding user privacy. It is very common to see a new privacy related issue in the media every other day. Companies are continuously trying to update their methods and policies to ensure that the privacy of the users is in no way violated. The increase in data over the past decade or so only alleviates the importance of the matter under consideration. With more and more data being generated, exchanged, and consumed, any new software developed has privacy as one of its most important concerns. Combining this with users who are more aware of what data applications use and how they use it, it is very unlikely that solutions that do not keep in mind user privacy will succeed in today's market.

Also, privacy is not just about keeping one's information private. Some of the social implications, like those suggested in [7] also play a big role in increasing the importance of privacy aware solutions.

With all the factors mentioned above, the results of this paper and all the referred papers carry more importance. It is also clear that more and more studies will be performed to get better results by using lesser information about a user in the meeting scheduling domain. Privacy might also take some new definitions in the future and not just be limited to data that is exchanged. Research done in this domain will always carry importance in the future.

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