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(54) Title: SYSTEMS AND METHODS FOR QUANTIFIABLE SIGNALING IN MULTI-USER ENVIRONMENTS

(57) Abstract: In various embodiments, activities are scheduled for and/or resources are allocated to participants each having a budget for signaling penalties for non-compliance.

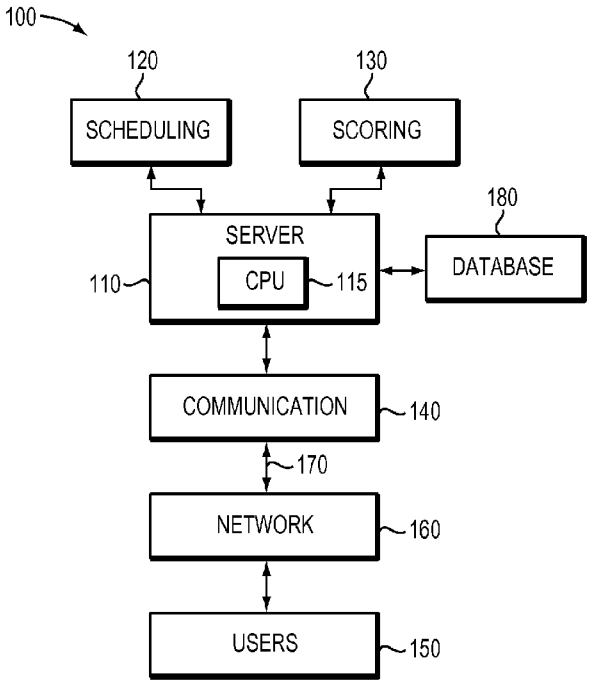

FIG. 1

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SYSTEMS AND METHODS FOR QUANTIFIABLE SIGNALING IN MULTI-USER ENVIRONMENTS

Related Application

This application claims the benefit of and priority to U.S. Provisional Patent Application No. 61/837,843, filed June 21, 2013, the entire disclosure of which is hereby incorporated herein by reference.

Technical Field

[0001] In various embodiments, the present invention relates to event scheduling and resource allocation, in particular to such activities utilizing user-specified penalties for nonperformance.

Background

[0002] A plethora of techniques and systems exist for the scheduling of events and/or the allocation of resources among users. While such techniques involve obtaining user responses indicating intent to attend an event or to reserve a resource, it is difficult to quantify such intent in a manner that enables optimized scheduling and resource allocation. For example, while a user may signal an initial intent to participate, it remains difficult to predict actual attendance or utilization without requiring an up-front monetary deposit or detailed historical information about the behavior of users. Another existing approach is to punish all users who fail to participate in the same way, for example, through a monetary penalty. Such schemes are often difficult to implement and involve arbitrary, organizer-specified punishment systems that discourage user participation. Thus, there is a need for techniques and systems that enable quantitative measures of user intent without undermining user interest or enthusiasm, as well as incentivize users to fulfill their pledges to participate. Such systems may lead to schedules and allocations that are agreeable to more users, and may also reduce waste caused by misuse of time and resources.

Summary

[0003] In accordance with various embodiments of the present invention, the intent of participants (or "users") in, for example, an event or other scheduled activity, is provided in a quantitative manner via user-determined penalties for noncompliance. Various embodiments enable credible signals to be placed by participants such that a penalty is incurred by a participant only if an intended outcome does not occur, and thus the payment acts as a penalty for nonperformance. The amount and character of the penalty is generally set by the user, for example, through a bidding or auction-like system. The proposed payments (or "signaling penalties"), which may be monetary or based on another quantifiable metric, may signal intensity of belief on the part of the user that an intended outcome will occur, and thus these quantified signals may be utilized for optimization of, for example, event scheduling and/or resource allocation. The signaling penalty, in other words, provides a measure of participation likelihood that may be used to estimate an overall participation rate across users, but the user's own control over the penalty lessens its punitive appearance and consequent potential to discourage participation. In some embodiments, a minimum penalty may be required of the users.

[0004] In an aspect, embodiments of the invention feature a computer-implemented method for scheduling an activity for a plurality of participants each having a budget for signaling penalties. A database of users is provided, and the database includes or consists essentially of a storage medium (i.e., a non-transitory storage medium) populated with stored computer records. The records specify, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties. An electronic invitation to participate in the activity is transmitted, by a communication interface over a computer network, to a computational device of each of a plurality of the users. The electronic invitation includes a plurality of scheduling times for the activity. An electronic response is received via the communication interface from at least some of the user devices over the computer network. The response includes, for each scheduling time, (a) a signaling penalty for non-attendance or (b) a refusal to attend. An optimal scheduling time is computed, by a computer processor, from the plurality of scheduling times based at least in part on the received responses. A communication specifying the scheduled time for the activity is

transmitted to the computational device of each of the responding users via the communication interface. A determination is made when the activity has been completed, and, for each responding user who did not attend the activity and did not respond with a refusal to attend at the scheduled time, the user's record in the database is modified to deduct the signaling penalty corresponding to the scheduled time from the budget for signaling penalties of the user.

[0005] Embodiments of the invention may include one or more of the following in any of a variety of combinations. The signaling penalty for non-attendance may be limited to a predetermined maximum value. In the electronic response, each scheduling time may default to a refusal to attend in the absence of input from the user. Before the optimal scheduling time is computed, electronic invitations may be transmitted to one or more user devices and electronic response may be received from one or more user devices one or more additional times. The optimal scheduling time may be computed by the computer processor to maximize user attendance. A scheduling time corresponding to a maximum total of signaling penalties received from responding users may be selected by the computer processor as the optimal scheduling time. Attendance of the activity by one or more responding users may be determined by the computer processor. Attendance may be determined via self-reporting received via a communication interface from the one or more responding users. An indication of attendance or non-attendance may be transmitted, via a communication interface, to the one or more responding users, and a verification of the indication may be received from one or more of the users.

[0006] The communication interface may include or consist essentially of an e-mail, an SMS text message, or a webform. The records in the database may contain, for each user, a reputation score based at least in part on at least one of (a) attendance of previous activities, (b) non-attendance of previous activities, or (c) signaling penalties received from the user. The optimal scheduling time may be computed based in part on reputation scores of one or more responding users. Transmitting the electronic invitation to the devices of the plurality of users may include or consist essentially of advertising availability of the activity to the devices. Users may be prevented from including, within the electronic response, a signaling penalty having a value less than a predetermined minimum value. A responding user may be electronically prevented (e.g., via omission from an attendee list or cancellation or non-issuance of attendance

credentials) from attending the activity if the responding user provided, within the electronic response, a refusal to attend at the scheduled time. Preventing the responding user from attending the activity may include or consist essentially of removing, by a computer processor, the responding user from an attendee list stored in a memory in communication with the computer processor.

[0007] In another aspect, embodiments of the invention feature a system for scheduling an activity for a plurality of participants each having a budget for signaling penalties. The system includes or consists essentially of a database of users, a communication module, a computer processor, a scheduling module, and a scoring module. The database includes or consists essentially of a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties. The communication module (i) transmits electronic invitations to users to participate in activities, each invitation including a plurality of potential scheduling times for the activity, (ii) receives electronic responses from users each including or consisting essentially of, for each potential scheduling time for each activity, (a) a signaling penalty for non-attendance or (b) a refusal to attend, and (iii) transmits communications specifying scheduled times for activities. The scheduling module is executable by the computer processor and (i) computes, for each activity, an optimal scheduling time from the plurality of potential scheduling times based at least in part on responses received from users, and/or (ii) determines when scheduled activities have been completed. The scoring module is executable by the computer processor and deducts signaling penalties from records in the database corresponding to responding users who (i) do not attend scheduled activities without responding with refusals to attend and (ii) provide the signaling penalties to be deducted.

[0008] In yet another aspect, embodiments of the invention feature a computer-implemented method for scheduling an activity for a plurality of participants each having a budget for signaling penalties. A database of users is provided. The database includes or consists essentially of a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties. An electronic

invitation to participate in the activity is transmitted, by a communication interface over a computer network, to a computational device of each of a plurality of the users. The electronic invitation includes or consists essentially of a plurality of scheduling times for the activity. An electronic response is received via the communication interface from at least some of the user devices over the computer network. The electronic response includes or consists essentially of, for each scheduling time, (a) a signaling penalty for non-attendance or (b) a refusal to attend. An optimal scheduling time is computed, by a computer processor, from the plurality of scheduling times based at least in part on the received responses. A communication specifying the scheduled time for the activity is transmitted to the computational device of each of the responding users via the communication interface. A rate of participation in the activity is predicted, with the computer processor, based at least in part on the received responses.

[0009] In another aspect, embodiments of the invention feature a computer-implemented method for allocating a plurality of resources to a plurality of participants each having a budget for signaling penalties. A database of users is provided. The database includes or consists essentially of a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties. An electronic invitation to utilize one or more resources is transmitted, by a communication interface over a computer network, to a computational device of each of a plurality of the users. An electronic bid for each of one or more of the resources is received via the communication interface from at least some of the user devices. Each bid includes or consists essentially of a signaling penalty for non-use of the resource. An allocation to a user for each resource for which a bid is received is computed, by a computer processor, based at least in part on the received bids. A communication specifying the allocation is transmitted via the communication interface to the computational device of each of the responding users to whom a resource is allocated. Each allocated resource has a scheduled time of use. For each allocated resource, after the scheduled time of use, the user's record in the database is modified to deduct the bid corresponding to the allocated resource from the budget for signaling penalties of the user only if the user did not use the allocated resource at the scheduled time.

[0010] Embodiments of the invention may include one or more of the following in any of a variety of combinations. After a resource is allocated to a user, bids for one or more other resources received from the user may be disregarded. The signaling penalty for non-use of the resource may be limited to a predetermined maximum value. Before the allocation is computed, electronic invitations may be transmitted to one or more user devices and electronic bids may be received from one or more user devices one or more additional times. The allocation to the user may be computed by the computer processor to maximize usage of all allocable resources. Usage of one or more allocated resources by one or more responding users to whom the resources were allocated may be computationally determined (e.g., by the computer processor). Usage may be determined via self-reporting received via a communication interface from the one or more responding users. An indication of usage or non-usage may be transmitted, via a communication interface, to the computational devices of one or more responding users. A verification of the indication may be received from the computational devices of one or more responding users. The communication interface may include or consist essentially of at least one of an e-mail, an SMS text message, or a webform. The records in the database may contain, for each user, a reputation score based at least in part on (a) usage of previously allocated resources, (b) non-usage of previously allocated resources, and/or (c) signaling penalties received from the user. The allocation may be computed based in part on reputation scores of one or more responding users. Transmitting the electronic invitation to the devices of the plurality of users may include or consist essentially of advertising availability of the plurality of resources to the devices.

[0011] In yet another aspect, embodiments of the invention feature a system for allocating a plurality of resources to a plurality of participants each having a budget for signaling penalties. The system may include or consist essentially of a database of users, a communication module, a computer processor, a scheduling module, and a scoring module. The database includes or consists essentially of a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties. The communication module (i) transmits electronic invitations to users to utilize resources and (ii) receives electronic bids for resources, each bid including or consisting essentially of a signaling

penalty for non-use of the resource. The scheduling module is executable by the computer processor and allocates resources to bidding users based at least in part on received bids. Each allocated resource has a scheduled time of use. The scoring module is executable by the computer processor and deducts signaling penalties from records in the database corresponding to users (i) to whom resources are allocated, (ii) who do not use allocated resources at their scheduled times, and (iii) who provide the signaling penalties to be deducted.

[0012] These and other objects, along with advantages and features of the present invention herein disclosed, will become more apparent through reference to the following description, the accompanying drawings, and the claims. Furthermore, it is to be understood that the features of the various embodiments described herein are not mutually exclusive and may exist in various combinations and permutations. As used herein, the terms "approximately" and "substantially" mean ±10%, and in some embodiments, ±5%. The term "consists essentially of" means excluding other materials that contribute to function, unless otherwise defined herein. As used herein, a "user" or "participant" may be an individual or a group of individuals (e.g., an organization, team, or club). For example, a group "user" may be composed of multiple individuals whose decisions, resource usage, scheduling preferences, etc. may be tracked and considered together.

Brief Description of the Drawings

[0013] In the drawings, like reference characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments of the present invention are described with reference to the following drawings, in which:

[0014] Figure 1 is a block diagram of a system for scheduling activities and/or allocating resources to multiple users in accordance with various embodiments of the present invention;

[0015] Figure 2 is a flowchart of a method for scheduling an activity for participants having budgets for signaling penalties in accordance with various embodiments of the present invention; and

[0016] Figure 3 is a flowchart of a method for allocating resources to participants having budgets for signaling penalties in accordance with various embodiments of the present invention.

Detailed Description

[0017] As depicted in Figure 1, preferred embodiments of the present invention are implemented via a system 100 featuring a server 110 that includes a computer processor 115 and utilizes various program modules such as, e.g., (i) a scheduling module 120 for scheduling events and/or allocating resources based on responses or bids received from users, as well as determining when scheduled activities have been completed, and (ii) a scoring module 130 for deducting signaling penalties from the budgets of users who determined the penalties for nonperformance and then did not perform or attend. The system 100 may also include a communication module 140 for communicating with users 150 over a computer network 160 via one or more communication interfaces 170. For example, electronic mail or an SMS text message may be sent to each user 150, or a page (or "webform") on a website hosted by communication module 140 may offer the opportunity for interested users 150 to signal their intended participation and/or interest in an allocable resource without being specifically invited by an event organizer (therefore, as utilized herein, "transmitting an invitation" includes not only active identification and targeting of specific invitees, but also more passive advertisements of availability, such as webforms, that are open to a specific group of people (e.g., a student body) or the general public, members of which initiate the initial contact with the server 110). As used herein, a "computer network" is any wired and/or wireless configuration of intercommunicating computational nodes, including, without limitation, computers, switches, routers, personal wireless devices, etc., and including local area networks, wide area networks, the Internet, and telecommunication and public telephone networks. Communication interfaces 170 may operate over the Internet, an intranet, extranet, Ethernet, the wireless telecommunications infrastructure, or any other system that provides communications. Furthermore, various components of the system 100 may communicate via wired or wireless paths or a combination of wired and wireless paths.

[0018] As also shown in Figure 1, the server 110 is communicatively connected to a database 180 utilized to store information specific to each user 150, e.g., name, address, other

personal information, e-mail address, and/or other identifiers (or "user attributes"), as well as the current state of the user's signaling budget (i.e., a "signaling score"). Such information is utilized, for example, to elicit responses to queries such as scheduling requests.

[0019] Program modules may include or consist essentially of computer-executable instructions that are executed by a conventional computer. Generally, program modules include routines, programs, objects, components, data structures, etc. that performs particular tasks or implement particular abstract data types. Those skilled in the art will appreciate that embodiments of the invention may be practiced with various computer system configurations, including multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, mainframe computers, and the like. Embodiments of the invention may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote computer-storage media including memory storage devices.

[0020] Thus, systems in accordance with embodiments of the present invention may include or consist essentially of a general-purpose computing device in the form of a computer including a processing unit (or "computer processor"), a system memory, and a system bus that couples various system components including the system memory to the processing unit. Computers typically include a variety of computer-readable media that can form part of the system memory and be read by the processing unit. By way of example, and not limitation, computer readable media may include computer storage media and/or communication media. The system memory may include computer storage media in the form of volatile and/or nonvolatile memory such as read only memory (ROM) and random access memory (RAM). A basic input/output system (BIOS), containing the basic routines that help to transfer information between elements, such as during start-up, is typically stored in ROM. RAM typically contains data and/or program modules that are immediately accessible to and/or presently being operated on by processing unit. The data or program modules may include an operating system, application programs, other program modules, and program data. The operating system may be or include a variety of operating systems such as Microsoft WINDOWS operating system, the

Unix operating system, the Linux operating system, the Xenix operating system, the IBM AIX operating system, the Hewlett Packard UX operating system, the Novell NETWARE operating system, the Sun Microsystems SOLARIS operating system, the OS/2 operating system, the BeOS operating system, the MACINTOSH operating system, the APACHE operating system, an OPENSTEP operating system or another operating system of platform.

[0021] Any suitable programming language may be used to implement without undue experimentation the functions described above. Illustratively, the programming language used may include assembly language, Ada, APL, Basic, C, C++, C*, COBOL, dBase, Forth, FORTRAN, Java, Modula-2, Pascal, Prolog, Python, REXX, and/or JavaScript for example. Further, it is not necessary that a single type of instruction or programming language be utilized in conjunction with the operation of systems and techniques of the invention. Rather, any number of different programming languages may be utilized as is necessary or desirable.

[0022] The computing environment may also include other removable/nonremovable, volatile/nonvolatile computer storage media. For example, a hard disk drive may read or write to nonremovable, nonvolatile magnetic media. A magnetic disk drive may read from or writes to a removable, nonvolatile magnetic disk, and an optical disk drive may read from or write to a removable, nonvolatile optical disk such as a CD-ROM or other optical media. Other removable/nonremovable, volatile/nonvolatile computer storage media that can be used in the exemplary operating environment include, but are not limited to, magnetic tape cassettes, flash memory cards, digital versatile disks, digital video tape, solid state RAM, solid state ROM, and the like. The storage media are typically connected to the system bus through a removable or non-removable memory interface.

[0023] The processing unit that executes commands and instructions may be a general-purpose computer processor, but may utilize any of a wide variety of other technologies including special-purpose hardware, a microcomputer, mini-computer, mainframe computer, programmed micro-processor, micro-controller, peripheral integrated circuit element, a CSIC (Customer Specific Integrated Circuit), ASIC (Application Specific Integrated Circuit), a logic circuit, a digital signal processor, a programmable logic device such as an FPGA (Field Programmable Gate Array), PLD (Programmable Logic Device), PLA (Programmable Logic Array), RFID

processor, smart chip, or any other device or arrangement of devices that is capable of implementing the steps of the processes of embodiments of the invention.

[0024] As mentioned above, embodiments of the present invention gauge the intent of users or participants via user-defined penalties, or "signals," that will be incurred in the event of non-compliance by the user. For example, in the context of an event that is scheduled for a given time, the user may signal that the intended outcome is that he or she attends the event. In this case no payment is made by the user. But, if the user does not attend, then the user-defined payment is collected. In this manner, scheduled events may remain nominally free (i.e., no-cost, at least in advance of the event), but credible signals relating to user attendance may be collected. Moreover, different signals may be collected from a user for different possible scheduling times (i.e., potential dates and times at which an event may be scheduled). In various embodiments of the invention, larger signals (i.e., higher prospective penalties for nonperformance) represent higher levels of commitment on the part of the user to attend if the event is scheduled at that time. Thus, the different signal levels allow for tradeoffs to be made and enable selection of an optimal scheduling time for the event. Moreover, in preferred embodiments of the invention users may signal their unwillingness and/or inability to attend at various possible scheduling times (e.g., by bidding zero) and thus not incur a penalty for events scheduled at such times.

[0025] In an illustrative example, an activity is to be scheduled for either Monday or Tuesday. Each user may signal how likely he or she is to attend on Monday by committing a monetary value, and similarly for Tuesday. Using these signals from all users (and, in some embodiments, past user signals and actions), the date that maximizes participation may be determined. If a user participates in the activity, then no payment is made by the user. But, if the user does not attend, then the user-defined payment corresponding to the scheduled date is collected.

[0026] In accordance with various embodiments, each user has a budget for signaling penalties from which incurred penalties are deducted. The budget may correspond to an amount of money pre-paid by the user, or each user in a particular environment or collection of users may have the same initial budget that is diminished when penalties are incurred. In some embodiments, each user has a different initial budget. A group of users may also share the same

budget, and conditions may be established for replenishing the budget. As mentioned above, the current state of signaling-penalty budgets may be stored in database 180 in records linked to individual users or groups.

[0027] In some embodiments, the signaling budget does not correspond to actual monetary currency and instead indicates a level of virtual currency such as "karma," reputation points, and so forth. Any scoring system corresponding to a penalty meaningful to users of a given system may be employed.

[0028] Embodiments of the present invention may also provide additional benefits. First, a reputation score (that may be public and thus visible to other users or simply utilized within a system to guide decisions and/or access to resources) may be developed for each user, with reputation increasing in the event that a costly commitment was entered into by a user and fulfilled, or decreasing in the event that it was not fulfilled. Second, a predictive model may be developed for each user as to whether or not the user is likely to achieve an intended outcome (e.g., attend an event, utilize an allocated resource, or complete a work item or job on time.) This predictive model may be trained on the basis of the history of commitments that users have entered into and fulfilled or not fulfilled, and may optionally utilize known attributes of users such as gender, demographic, interests, and so forth. Thus, users' reputation scores may be utilized either apart from or together with the bids or responses of various users when scheduling events or allocating resources. The reputation score, when made public (or at least known to the user), may also incentivize users to follow through on their commitments.

[0029] Bids or responses need not indicate only binary measures of performance and nonperformance. Rather, responses may include multi-valued outcomes for which the user may report an associated penalty cost (i.e., signaling penalty) for each outcome. For example, when signaling intent to attend an event such as a meeting at a particular time, a user may include different signaling penalties for (1) not attending, (2) being fewer than 10 minutes late, or (3) being more than 10 minutes late.

[0030] In accordance with various embodiments of the invention, an activity may be scheduled for multiple participants 150 each having a budget for signaling penalties as illustrated in the method 200 of Figure 2. User information, including but not limited to the budget for the

user's signaling penalties, is provided in database 180 per step 210 of method 200. In step 220, one or more of the users 150 is invited to participate in an activity and provided with possible scheduling times for the activity. Such invitations may be transmitted over the computer network 160 via any of several possible communication interfaces 170, as detailed above. In step 230, users 150 then provide responses to the invitation that include, for each scheduling time, either a signaling penalty for non-attendance or a refusal (e.g. unwillingness or inability) to attend. A set of possible values for signaling penalties may be predetermined within the invitation or a form for the response, or the signaling penalties may be determined, within the limit of the current value of the user's signaling budget, by the user 150. A user 150 may be limited to a maximum signaling penalty for any particular scheduling time, for example, to prevent attempts to increase reputation scores in a short period of time. In some embodiments, a default response to the possible scheduling times is a refusal, thereby decreasing the chances of erroneous indications of ability to attend and concomitant signaling-penalty loss. The signaling by the users 150 may be performed multiple times, iteratively, based on, for example, the responses received from other users, as indicated in Figure 2 by the optional branch back to the invitation step 220. In various embodiments of the invention, the ability of users 150 to alter initial signals is limited by rules incorporated within the system. The various responses may be transmitted to the central server 110 over the computer network 160 via, for example, one or more communication interfaces 170, and, in step 240, an optimal scheduling time for the event is determined at least in part on the responses received from the users 150. For example, the event may be scheduled when the largest number of users 150 has the ability to attend, regardless of the levels of the signaling penalties associated with that time, or a time may be selected when the total amount of user-specified signaling penalties is maximized (thus signaling greater chances of higher attendance). As shown in Figure 2, in optional step 245, a prediction of the rate of participation by the invited users 150 may be made by server 110 based at least in part on the responses (and associated signaling penalties) received from the users 150. The actual participation rate (which may be determined as described below) may be provided to server 110 and/or database 180 (for example, individual user participation and/or participation rate may be associated with the record of a user 150 in database 180) and may be utilized to predict participation rates when scheduling future activities. After

scheduling is complete, in step 250, the scheduled time for the event is then transmitted to each responding user 150 via a communication interface 170 on the computer network 160.

[0031] In step 260 of method 200, the determination is made whether or not the activity has been completed. As shown, after the scheduled time has passed and the event has been held or the activity has been completed, signaling budgets of users 150 are adjusted, in step 270, at least in part according to the user's signals provided in step 230 and the attendance or non-attendance of users 150. Users 150 who attended are not penalized (and may even be rewarded via, e.g., increased reputation score, as discussed herein). Likewise, users 150 who signaled a refusal to attend at the scheduled time are not penalized. However, for users 150 who did not attend or participate, their user-specified signaling penalties are deducted from their budgets or they are charged in some other fashion in step 270. There are several ways to determine whether or not a user 150 participates in an event in accordance with embodiments of the present invention. For example, user sign-ins or ticket scans may be transmitted over the computer network 160 and participation determined and even linked to the user records in the database 180. In other embodiments, users 150 self-report attendance or non-attendance via, e.g., a communication interface 170 such as e-mail, mobile device check-in, or a webform. (Non-responding users 150 may be assumed to have attended in order to reduce the chances of erroneous penalties being incurred.) Alternatively, the organizer, other event representative, or one or more other users 150 may report user attendance, e.g., via a communication interface 170. Users 150 may be sent a follow-up query to verify the accuracy of the attendance report. The mode of attendance verification may be established when an event is planned and may even be indicated on the invitations to the event sent to users 150 in step 220.

[0032] Embodiments of the present invention may also be utilized for the allocation of resources, for example shared resources such as facilities (e.g., meeting rooms or sports facilities like tennis courts) or tickets to a variety of different events. For example, sports facilities such as tennis courts are often freely available for usage in environments such as public parks or educational facilities (e.g., universities), and charging fees for usage and/or reservation of such facilities may not be appropriate. However, it may be appropriate to charge a fee for failure to utilize an allocated time slot. In accordance with various embodiments of the invention, potential

users place requests (or "bids") for resources that contain user-determined signaling penalties for non-utilization of the resource (either at all, or, if use was tied to a particular time or reservation, for non-use at the specified time). Such signaling penalties enable the efficient and optimized allocation of the resources. As mentioned above, users may also indicate an unwillingness or inability to utilize resources, e.g., at particular times, and thus the corresponding resource will generally not be allocated to the user (or, if allocated, will not be associated with a penalty for nonuse).

[0033] Figure 3 depicts a method 300 in which resources (each resource associated with, for example, multiple time slots such as for squash courts or shared cars) are allocated to a plurality of users 150 each having a budget for signaling penalties in accordance with embodiments of the present invention. As described above, a central server 110 may access and utilize a database 180 of the users 150 that contains, for each user record, a signaling score corresponding to a current amount of an available budget for signaling penalties, as well as one or more identifiers and/or other user-specific information, as shown in step 310. In step 320, invitations to one or more of the users 150 to utilize one or more of the available resources are transmitted over the computer network 160 via one or more communication interfaces 170 such as e-mail, SMS text message, or webform.

[0034] Interested users 150 may then provide bids (e.g., electronic bids over the computer network 160) requesting use of one or more of the resources in step 330; each bid includes a user-specified signaling penalty corresponding to the penalty incurred for non-use of the resource if it is allocated to the user 150. The bids are similar to the invitation responses detailed above but not necessarily provided in response to a specific invitation; rather, the bids may be in response to an open advertisement of availability of the resources. That is, step 320 of method 300 may correspond to the resources being made openly available to users 150 rather than to specific invitations being proactively sent to the users 150. One or more, or even all, of the resources are then allocated to responding users 150 based at least in part on the received bids in step 340. For example, a particular resource may be allocated to the user 150 signaling the largest penalty amount corresponding to the resource (e.g., a time slot for a shared facility), and that user's other bids may be disregarded in favor of other users 150. In step 350, the users 150 to whom resources

have been allocated are then informed via, e.g., a communication interface 170 over the computer network 160. Each allocation may have a scheduled time of use, e.g., the time of a ticketed activity (where the ticket is the allocated resource) or a reserved time slot for a shared resource or facility.

[0035] In step 360 of method 300, the determination is made whether or not the scheduled time of use for one or more of the allocated resources has passed. As shown, after the scheduled time has passed (if applicable), signaling budgets of users 150 are adjusted, in step 370, at least in part according to the user's signals provided in step 330 and the utilization or non-utilization of resources by users 150. For each allocated resource, the user's compliance with the utilization of the resource may be determined, e.g., as described above (for example, self-reporting, ticket scanning, etc.) after the scheduled time of use (if applicable). Users 150 that utilized their allocated resource are not penalized (and may even be rewarded via, e.g., increased reputation score) and no signaling penalty is deducted from the budgets of such users 150. Likewise, users 150 that signaled a refusal or did not bid are not penalized. However, for users 150 that did not attend or participate, their user-specified signaling penalties are deducted from their budgets.

[0036] Embodiments of the present invention may also discourage false signaling that is used in order to manipulate the outcome of a decision mechanism. For example, false signaling may arise from having decisions that exhibit monotonicity. In particular, a decision function is monotonic if whenever a user increases his signal s1 for some time slot t1, or some resource, this action can only weakly increase the probability that the time slot is selected by, or the resource is allocated to, the user. Because of this, a user may only effect a change in outcome from one slot t2 to slot t1 if he increases the signal s1 associated with slot t1 sufficiently so that slot t1 is selected over slot t2. However, in accordance with embodiments of the invention, as the user increases the amount of the signal, the incurred penalty to the user increases in the event that he or she does not follow through with the intended outcome (e.g., attend the event, or use the allocated time slot). Hence the user generally will only signal a sufficiently large signal s1 if he or she has a real interest in the associated decision.

[0037] Embodiments of the invention also prevent a user from choosing to signal a null penalty (e.g., zero dollars), which is different from a refusal that signals an unwillingness or

inability to attend. For example, a user might be fairly indifferent across different times, or figure that the amount indicated for a time will end up not being pivotal in the scheduling or allocation decision, in the sense that it will not change the decision. In this case, such a user might prefer to just indicate zero penalty everywhere, in order to avoid any risk of needing to make a payment if for some reason the user does not show up to the event, or utilize the allocated resource. Thus, embodiments of the invention prevent users from bidding or responding with penalties corresponding to scheduling times or particular resources that have little or no value (i.e., an incurred penalty of zero or insufficient value – e.g., in the view of an event organizer who bears the economic consequences of nonparticipation). Moreover, embodiments of the invention may also take steps to prevent users that signal a refusal for a specific scheduling time to actually attend if an event is scheduled for that time (by, e.g., removal of the user from a permitted attendee list or simply not informing the user of the scheduled time of the event).

[0038] Various embodiments of the invention also address false signaling by incorporating public reputation scores for users, which may be stored in each user's record in database 180 and determined by the system 100 (e.g., by the scoring module 130) based on the user's bids, responses, signaling penalties, performance, and nonperformance. For example, a user 150 may gain more points for signaling a large penalty and fulfilling that commitment; conversely a user 150 may be penalized more for signaling a large penalty but not performing. In various embodiments, the reputation score does not change for user performance in accordance with penalties with a zero amount. In this manner, user behavior may be influenced and better predicted.

[0039] Embodiments of the invention may also include a user-specific reliability metric that may also be stored in the record in database 180 for each user 150. The reliability metric indicates the intent of a user 150 and enables optimal decision-making on behalf of the organizer of an event or the entity responsible for allocating a resource. The reliability metric may be a private metric, i.e., internal to the system and hidden from all users, and may even be different from public reputation scores of users. The reliability metric and/or public reputation score (if different from the reliability metric) may be public to all users or may be made available only to the user to whom the metric and/or score applies. As mentioned above, such user knowledge of

the metric and/or score may advantageously influence user behavior and encourage participation or resource usage.

[0040] In an embodiment, the reliability metric is determined by tracking a series of past signals and actions, {(s1; a1); (s2; a2); … (sn; an)}, where si is the signaling penalty determined by the user for a scheduled event (i.e., the penalty associated with the time for which the event is scheduled) or allocated resource, and where ai = 1 if the commitment is fulfilled and ai = 0 when the user does not perform. Thus, for each user u, a mapping fu: s → [0,1] linking user-determined signaling penalties with probability of performance may be determined; that is, the probability that a user will perform an intended outcome may be determined at least in part by the signaling penalties received from the user. For example, a logistic regression model, as understood by those of skill in the art, may be determined for the probability that a user will attend an event. Although such functions may be user-specific, information may flow across users via common priors, as is common to statistical machine learning approaches. Additional information about users may be used as features or attributes within such learning approaches, for example, age, gender, and location. Additional features about the events or the resources that are allocated may also be utilized. If a user is new, then a prior distribution, which might be itself learned from empirical data from a population of users, may be utilized.

[0041] In accordance with various embodiments of the invention, events may be scheduled based on user-specified signaling penalties but also in accordance with other objectives (i.e., in enabling optimal decision making). For example, scheduling times may be selected to maximize the total number of participants or to ensure at least a minimum number of people will attend. In an embodiment, for user i and scheduling time t, Xit is the Bernoulli random variable that is 1 if the user i attends the event at time t and 0 otherwise. The probability of Xit = 1 is denoted Pit and determined from database records indicating past performance or nonperformance of the user. If a scheduling time is to be selected to maximize the total number of participants, then the scheduling module may select the scheduling time $t \in \arg\max_t \sum_i P_{it}$, i.e., the time that maximizes the expected number of participants. If the scheduling time is to be selected to ensure at least a minimum number of people x will attend, then the scheduling module may select the scheduling time $t \in \arg\max_t \Pr(\sum_i X_{it} \geq x)$, i.e., the time that maximizes the probability that at

least some threshold number x will attend. An event organizer may select one or more of such additional criteria in accordance with which scheduling decisions may be made.

[0042] Embodiments of the present invention may also be utilized in more general settings in which a larger goal of a group of users or participants is composed of a set of multiple tasks (which may be overlapping) that collectively fit together to accomplish the larger goal. For example, each user may respond to a solicitation for bids on particular tasks with a signaling penalty in the event of nonperformance of the task(s). The system may then optimize the allocation of tasks to particular users based at least in part on, e.g., the received bids and the reputation scores (based on, for example, prior performance and task completion) of the users.

[0043] The terms and expressions employed herein are used as terms and expressions of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof. In addition, having described certain embodiments of the invention, it will be apparent to those of ordinary skill in the art that other embodiments incorporating the concepts disclosed herein may be used without departing from the spirit and scope of the invention. Accordingly, the described embodiments are to be considered in all respects as only illustrative and not restrictive.

What is claimed is:

1. A computer-implemented method for scheduling an activity for a plurality of participants each having a budget for signaling penalties, the method comprising:

providing a database of users, the database comprising a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties;

transmitting, by a communication interface over a computer network, an electronic invitation to a computational device of each of a plurality of the users to participate in the activity, the electronic invitation including a plurality of scheduling times for the activity;

receiving, via the communication interface from at least some of the user devices over the computer network, an electronic response comprising, for each scheduling time, (a) a signaling penalty for non-attendance or (b) a refusal to attend;

computing, by a computer processor, an optimal scheduling time from the plurality of scheduling times based at least in part on the received responses;

transmitting, to the computational device of each of the responding users via the communication interface, a communication specifying the scheduled time for the activity;

determining when the activity has been completed; and

for each responding user who did not attend the activity and did not respond with a refusal to attend at the scheduled time, modifying the user's record in the database to deduct the signaling penalty corresponding to the scheduled time from the budget for signaling penalties of the user.

2. The method of claim 1, wherein the signaling penalty for non-attendance is limited to a predetermined maximum value.

3. The method of claim 1, wherein, in the electronic response, each scheduling time defaults to a refusal to attend in the absence of input from the user.

4. The method of claim 1, further comprising, before computing the optimal scheduling time, transmitting electronic invitations to one or more user devices and receiving electronic responses from one or more user devices one or more additional times.

5. The method of claim 1, wherein the optimal scheduling time is computed by the computer processor to maximize user attendance.

6. The method of claim 1, wherein a scheduling time corresponding to a maximum total of signaling penalties received from responding users is selected by the computer processor as the optimal scheduling time.

7. The method of claim 1, further comprising determining, by the computer processor, attendance of the activity by one or more responding users.

8. The method of claim 7, wherein attendance is determined via self-reporting received via a communication interface from the one or more responding users.

9. The method of claim 7, further comprising (i) transmitting via a communication interface an indication of attendance or non-attendance to the one or more responding users, and (ii) receiving therefrom a verification of the indication.

10. The method of claim 1, wherein the communication interface comprises at least one of an e-mail, an SMS text message, or a webform.

11. The method of claim 1, wherein (i) the records in the database contain, for each user, a reputation score based at least in part on at least one of (a) attendance of previous activities, (b) non-attendance of previous activities, or (c) signaling penalties received from the user, and (ii) the optimal scheduling time is computed based in part on reputation scores of one or more responding users.

12. The method of claim 1, wherein transmitting the electronic invitation to the devices of the plurality of users comprises advertising availability of the activity to the devices.

13. The method of claim 1, further comprising preventing users from including, within the electronic response, a signaling penalty having a value less than a predetermined minimum value.

14. The method of claim 1, further comprising electronically preventing a responding user from attending the activity if the responding user provided, within the electronic response, a refusal to attend at the scheduled time.

15. The method of claim 14, wherein preventing the responding user from attending the activity comprises removing, by a computer processor, the responding user from an attendee list stored in a memory in communication with the computer processor.

16. A system for scheduling an activity for a plurality of participants each having a budget for signaling penalties, the system comprising:

a database of users, the database comprising a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties;

a communication module for (i) transmitting electronic invitations to users to participate in activities, each invitation including a plurality of potential scheduling times for the activity, (ii) receiving electronic responses from users each comprising, for each potential scheduling time for each activity, (a) a signaling penalty for non-attendance or (b) a refusal to attend, and (iii) transmitting communications specifying scheduled times for activities;

a computer processor;

a scheduling module, executable by the computer processor, for (i) computing, for each activity, an optimal scheduling time from the plurality of potential scheduling times based at least in part on responses received from users, and (ii) determining when scheduled activities have been completed; and

a scoring module, executable by the computer processor for deducting signaling penalties from records in the database corresponding to responding users who (i) do not attend scheduled activities without responding with refusals to attend and (ii) provide the signaling penalties to be deducted.

17. A computer-implemented method for scheduling an activity for a plurality of participants each having a budget for signaling penalties, the method comprising:

providing a database of users, the database comprising a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties;

transmitting, by a communication interface over a computer network, an electronic invitation to a computational device of each of a plurality of the users to participate in the activity, the electronic invitation including a plurality of scheduling times for the activity;

receiving, via the communication interface from at least some of the user devices over the computer network, an electronic response comprising, for each scheduling time, (a) a signaling penalty for non-attendance or (b) a refusal to attend;

computing, by a computer processor, an optimal scheduling time from the plurality of scheduling times based at least in part on the received responses;

transmitting, to the computational device of each of the responding users via the communication interface, a communication specifying the scheduled time for the activity; and

predicting, with the computer processor, a rate of participation in the activity based at least in part on the received responses.

18. A computer-implemented method for allocating a plurality of resources to a plurality of participants each having a budget for signaling penalties, the method comprising:

providing a database of users, the database comprising a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties;

transmitting, by a communication interface over a computer network, an electronic invitation to a computational device of each of a plurality of the users to utilize one or more resources;

receiving, via the communication interface from at least some of the user devices, an electronic bid for each of one or more of the resources, each bid comprising a signaling penalty for non-use of the resource;

computing, by a computer processor, an allocation to a user for each resource for which a bid is received based at least in part on the received bids;

transmitting via the communication interface, to the computational device of each of the responding users to whom a resource is allocated, a communication specifying the allocation, each allocated resource having a scheduled time of use; and

for each allocated resource, after the scheduled time of use, modifying the user's record in the database to deduct the bid corresponding to the allocated resource from the budget for signaling penalties of the user only if the user did not use the allocated resource at the scheduled time.

19. The method of claim 18, further comprising, after a resource is allocated to a user, disregarding bids for one or more other resources received from the user.

20. The method of claim 18, wherein the signaling penalty for non-use of the resource is limited to a predetermined maximum value.

21. The method of claim 18, further comprising, before computing the allocation, transmitting electronic invitations to one or more user devices and receiving electronic bids from one or more user devices one or more additional times.

22. The method of claim 18, wherein the allocation to the user is computed by the computer processor to maximize usage of all allocable resources.

23. The method of claim 18, further comprising computationally determining usage of one or more allocated resources by one or more responding users to whom the resources were allocated.

24. The method of claim 23, wherein usage is determined via self-reporting received via a communication interface from the one or more responding users.

25. The method of claim 23, further comprising (i) transmitting via a communication interface an indication of usage or non-usage to the computational devices of one or more responding users, and (ii) receiving therefrom a verification of the indication.

26. The method of claim 18, wherein the communication interface comprises at least one of an e-mail, an SMS text message, or a webform.

27. The method of claim 18, wherein (i) the records in the database contain, for each user, a reputation score based at least in part on at least one of (a) usage of previously allocated resources, (b) non-usage of previously allocated resources, or (c) signaling penalties received from the user, and (ii) the allocation is computed based in part on reputation scores of one or more responding users.

28. The method of claim 18, wherein transmitting the electronic invitation to the devices of the plurality of users comprises advertising availability of the plurality of resources to the devices.

29. A system for allocating a plurality of resources to a plurality of participants each having a budget for signaling penalties, the system comprising:

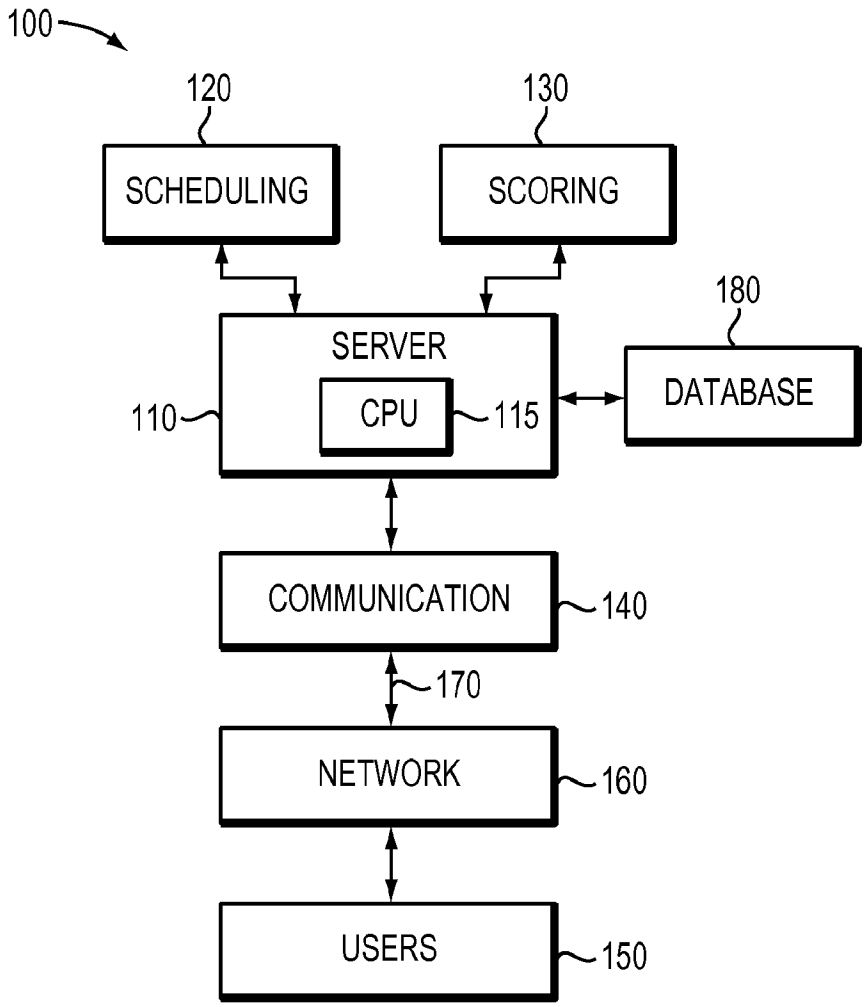
a database of users, the database comprising a storage medium populated with stored computer records specifying, for each of a plurality of users, (i) an identifier associated and facilitating electronic communication with the user, and (ii) a signaling score comprising a budget for signaling penalties;

a communication module for (i) transmitting electronic invitations to users to utilize resources and (ii) receiving electronic bids for resources, each bid comprising a signaling penalty for non-use of the resource;

a computer processor;

a scheduling module, executable by the computer processor, for allocating resources to bidding users based at least in part on received bids, each allocated resource having a scheduled time of use; and

a scoring module, executable by the computer processor, for deducting signaling penalties from records in the database corresponding to users (i) to whom resources are allocated, (ii) who do not use allocated resources at their scheduled times, and (iii) who provide the signaling penalties to be deducted.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USERS
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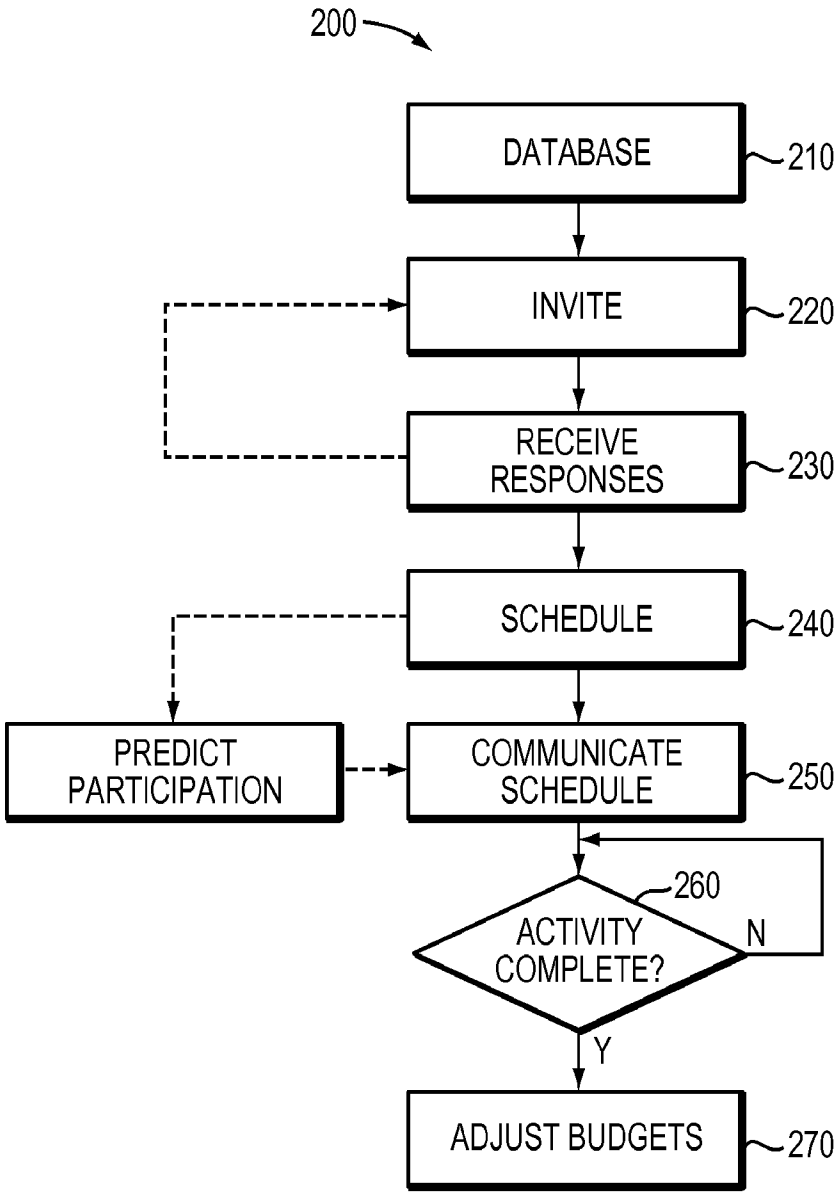
FIG. 1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INVITE
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SCHEDULE
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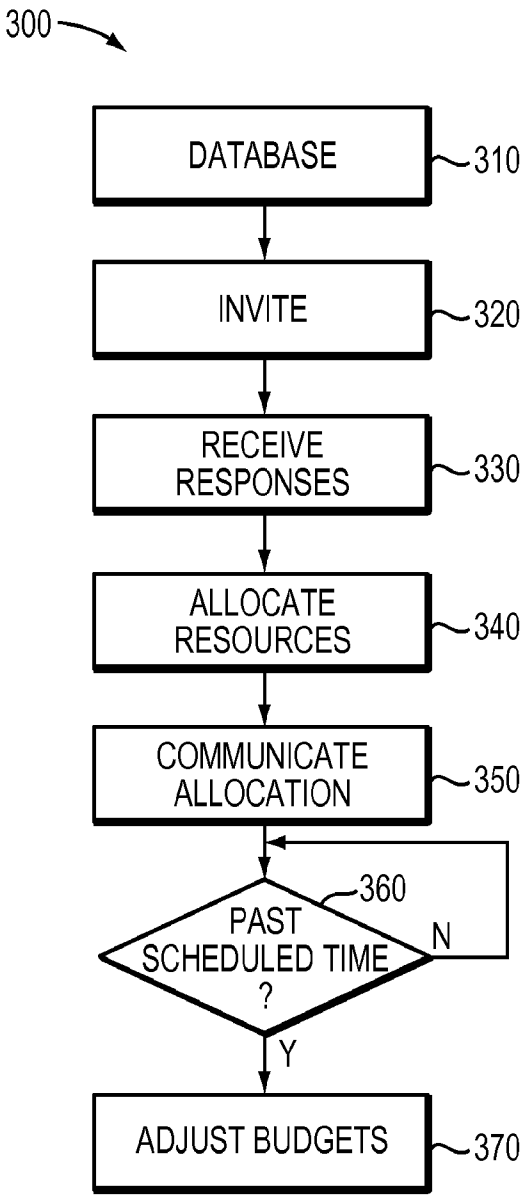
260
ACTIVITY COMPLETE?
N
Y
ADJUST BUDGETS
270

FIG. 2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RECEIVE RESPONSES
330
ALLOCATE RESOURCES
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COMMUNICATE ALLOCATION
350
360
PAST SCHEDULED TIME ?
N
Y
ADJUST BUDGETS
370

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/42268

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 9/50; G06Q 10/04, 10/06 (2014.01)
CPC - G06Q 10/06311, 10/06313, 10/06314
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) Classifications: G06F 9/50; G06Q 10/04, 10/06 (2014.01)
CPC Classifications: G06Q 10/06311, 10/06313, 10/06314; USPC Classifications: 705/7.13, 7.23, 7.24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); ProQuest; IP.com; Google; schedule, event, allocate, designate, resource, penalty, penalize, non-compliance, attend, join, fail, refuse, report

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2012/082173 A1 (TOURNIER, J et al.) June 21, 2012; figure 1; page 2, lines 23-33; page 4, lines 32-34; page 5, lines 1-11; page 7, lines 24-34; page 8, lines 24-33; page 9, lines 1-32	1-29
Y	US 2013/0073324 A1 (LIU, A) March 21, 2013; paragraphs [0036], [0038], [0044], [0045], [0050]	1-29
Y	US 2007/0021997 A1 (HAYES, K et al.) January 25, 2007; abstract; figures 4, 5; paragraphs [0018], [0019], [0047]-[0055]	3, 5, 6, 11
Y	US 7937287 B2 (GAIA, C et al.) May 3, 2011; figure 2; column 3, lines 29-42	8, 24
Y	US 8353705 B2 (DOBSON, M et al.) January 15, 2013; abstract; figures 1, 3, 5; column 2, lines 8-18	9
Y	US 2010/0280908 A1 (BENZ, J et al.) November 4, 2010; abstract; paragraph [0031]	12
Y	US 6480719 B1 (SCHLOEMER, J et al.) November 12, 2002; column 9, lines 57-60	13
Y	US 2003/0154116 A1 (LOFTON, J) August 14, 2003; paragraphs [0051], [0115], [0116]	14, 15
Y	US 8429276 B1 (KUMAR, K et al.) April 23, 2013; column 14, lines 43-50	19
Y	US 8204770 B2 (SUSSMAN, A et al.) June 19, 2012; column 9, lines 23-30	21
Y	US 8364802 B1 (KEAGY, J et al.) January 29, 2013; figure 25; column 19, lines 37-41; column 33, lines 12-17; column 46, lines 56-67; column 47, lines 1-17	22, 23, 27

☒ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 September 2014 (24.09.2014)	22 OCT 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/42268

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/0180115 A1 (MAITLAND, J) July 12, 2012; abstract; figure 8a; paragraph [0056]	25
Y	US 7953625 B2 (HIRSCHENBERGER, S et al.) May 31, 2011; figure 6; column 9, lines 6-9	28