Algorithm and Method for Automated Processing of Medical E-mails

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Abstract - We describe an algorithm and method for an Intelligent Personal Assistant (IPA) for a health care practitioner such that the IPA can automatically schedule appointments with patients, automatically schedule appointments with colleagues and for other third party events, and automatically respond to routine communications from patients, from colleagues and from other third parties. The algorithm was implemented using a commercially available cloud architecture, commercial scheduling system, and commercial voicemail to e-mail conversion system. This algorithm and method has the potential to automate many of the personal assistant tasks required in a medical practice and to correspondingly lower the cost of health care.

Keywords: Intelligent Personal Assistant, AI Assistant

E-mails are increasingly becoming a routine feature of medical practice. Medical e-mails may be received from patients [1], from other colleagues, from assistants, from laboratories, from medical marketing, as well as from non-medical sources. Time spent by the health care practitioner in responding to e-mails, is time that is in short supply and must be rationed with patients [2].

Intelligent Personal Assistants (‘IPA’s) are software agents that can provide some or many of the tasks an individual requires in managing one’s life, or in the case of a health care practitioner, in managing a medical practice, such as scheduling time with patients, scheduling time with colleagues and third party contacts (eg, educational events), and responding to routine phone calls and e-mails. Work has been done on IPAs for the last several decades, with the resultant systems becoming more interactive and arguably useful as time has progressed [3,4,5,6]. However, at the time of this writing, no IPA commercially available can actually meet the ‘reasonable personal assistant’ needs of a health care practitioner, which we can define as follows:

1. Automatically schedule appointments with patients
2. Automatically schedule appointments with colleagues and other third party events
3. Automatically respond to routine communications from patients
4. Automatically respond to routine communications from colleagues and other third parties

We describe a successful algorithm and method of providing the above defined ‘reasonable personal assistant’ needs of a health care practitioner. Steps 5 and 6 of the algorithm below make use of another algorithm [7] which allows automated acquisition of medical histories.

The main algorithm the system uses is as follows:

1. Obtain Input Data: Receive e-mails or convert voicemails/phone calls to e-mail.
2. Context Awareness: An attempt to make assumptions about a sender’s message (rather than the usual environmental interpretation of context, eg, Yan et al [8] versus Dey [9]) : Parse e-mail k times (initial value adjusted by a supervised learning algorithm depending on the health care practitioner’s satisfaction of the result in the overall handling of a communication) and select the parsed version which maximizes a score with regard to the version being in the context of:
   - a patient requesting an appointment/change
   - a colleague/third party requesting a meeting/change
   - a communication from a patient requiring a medical response
   - a communication from a colleague/third party requiring a medical response
   - an ‘other’ e-mail (which includes e-mails explicitly stating that a human response is required)

The algorithm has access to the e-mail contact list of the health care practitioner as well as the medical records of the health care practitioner in order to best calculate this contextual score.
3. If #2 ‘Context Awareness’== ‘patient requesting an appointment/change’ then the following will occur: 
   i. If ‘no urgency’ then: An appointment will be given at the next available normal empty appointment slot for the health care practitioner. Feedback will be asked of the patient – if patient responds that the appointment is ok or does not respond then the algorithm terminates, or if patient responds that a different time or date is required, then an alternative appointment will be given to the patient and feedback is again asked of the patient.
   ii. If ‘urgency’ detected in #2 then: The original e-mail will be forwarded to the health care practitioner, and the algorithm terminates.

4. If #2 ‘Context Awareness’== ‘colleagues/third parties requesting an appointment/change’ then the following will occur:
   i. If ‘no urgency’ then: Similar to 3i.
   ii. If ‘urgency’ detected in #2 then: Similar to 3ii.

5. If #2 ‘Context Awareness’== ‘routine communications from patients’ then the following will occur:
   i. If the patient does not exist in the health care practitioner’s medical records database then a message is sent to the patient that it is not possible to directly respond until the sender becomes an official patient of the health care practitioner and instructions how to do so.
   ii. If a patient is an existing patient then the same probe questionnaire that is used in clinic by the automated medical acquisition history system (ie, 2016 Schneider and Xie [7]) is sent to the patient, and in response to the patient’s responses follow-up questionnaires are sent until either an ‘action plan/learning questionnaire’ is sent to the patient or the questionnaire data and e-mail are forwarded to the health care practitioner for human response, and the algorithm terminates.

6. If #2 ‘Context Awareness’== ‘routine communications from colleagues/third parties’ then the following will occur: Similar to 5i but a colleague/third party probe questionnaire is used to better determine the exact request of the colleague/third party.

7. If #2 ‘Context Awareness’== ‘other e-mail’ then the following will occur:
   i. If an alternative external IPA system is being used, then the original e-mail is submitted to the alternative external IPA system, and this algorithm terminates.
   ii. If no alternative external IPA system is being used, then the original e-mail is submitted to the health care practitioner for manual processing, and this algorithm terminates.

The system was implemented with a cloud architecture (Google App Engine) with a commercially available scheduling system (Google Calendar). A commercially available voicemail to e-mail conversion system was used (Vonage). At the time of this writing the system is being used in a general psychiatry clinic with most but not all modules above implemented. For example, there is no external IPA being used. At the time of this writing the system is able to replace greater than 70% of the labor spent by a human assistant in a full-time position in a similar role in a medical practice. This algorithm and method has the potential to automate many of the personal assistant tasks required in a medical practice and to correspondingly lower the cost of health care.

References


