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Getting the Information You Need, When You Need It: A Context-aware Q&A System for Collaborative Learning

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Abstract. Keeping up with the rapid development in their fields is a problem for many employees nowadays, particularly when the new information is meant to be used for problem solving. Collaborative approaches such as forums and question and answering (Q&A) systems managed to only partly mitigate this problem in cases where time constraints and user mobility are of no crucial concern.
We present an enhancement to conventional Q&A applications which relies on user activity detection and question forwarding towards the available users. Our approach obtains a 90% precision in a garage experiment, proving itself as a viable solution for car technicians' time and mobility constraints.

Keywords: smartphone sensing, collaborative learning, context

1 Introduction

Due to the rapid technical advancement in many fields, workers find it difficult to keep up with the required knowledge. Furthermore, in jobs that consist mainly of practical tasks and problem solving, one requires experience within similar problems more than theoretical knowledge.

Under these circumstances, colleague support is essential. However, traditional methods, like asking a colleague in person or over the phone pose a series of disadvantages. They generally limit employees to asking only the colleagues they have had previous contact with and carry the risk of interrupting colleagues during important tasks.

Therefore, question and answering (Q&A) systems offer a great opportunity for finding colleague support and sharing information. At the moment, however, they offer only limited help for certain fields where online communities are small and timely answers are crucial.

In this paper we present an approach meant to help car technicians by routing their questions to their available colleagues. Our concept could be used to implement similar systems for all kinds of technicians, from plumbers to airline technicians.

We base our concept on an user study carried out on 168 car technicians working in multiple garages in Germany. A third of the respondents reported often needing help, while the other two thirds found themselves only rarely needing external help. Results showed furthermore that 90% of the respondents are happy to help their colleagues. However, their willingness to help varied significantly based on their current activity: most respondents agreed to help during working hours, but fewer conceded to be interrupted from ongoing tasks and even fewer were willing to use their breaks for helping colleagues. Detailed results of the study can be found in [1].

Our paper is structured as follows: in Section 2 we look into the related approaches. Section 3 introduces our concept and Section 4 presents its implementation. We continue with the evaluation results in a real-life setting in Section 5. Finally, we present our conclusions and outlook in Section 6.

2 Related Work

Question and answering systems have been a quickly developing topic lately, both in research and in industry (Stack Overflow, Yahoo! Answers, etc.). One popular direction includes the analysis of the factors that influence the success of specific Q&A system. White et al [2] study the effects of community size and contact rate in social Q&A systems, while Mamykina et al [3] study the factors and characteristics that led to Stack Overflow's indisputable achievement of having about 92% of their questions answered in an average of eleven minutes.

A major direction, to which our work subscribes, is Q&A systems improvement. Shah et al [4] attempt to create an automated Q&A system from the existing knowledge base. Other solutions focus on capturing and reusing the expertise [5].

The other direction of our work concerns mobile sensing and user activity detection. Applications which make use of environment sounds include music and genre classification [6], event detection [7], cough detection [8] and phone position classification [9].

Our previous work [10] proposed a concept for a context-aware Q&A system using GPS and accelerometer data, as well as information from the smartphone's applications to detect user's activity. In contrast to that, our current approach employs audio recordings, fundaments its concept in a user study and has a real-world evaluation to prove our results. To the best of our knowledge, there are no other approaches for Q&A systems forwarding questions depending on user's current activity.

3 Concept

The backbone of our system is a Q&A infrastructure, that allows users to send and receive questions, as well as receive answers via multiple channels: smartphone app, web form, email, SMS. We thus comply with the technicians' mobility and different availabilities of the communication channels in their daily activities.

The car technicians' disponibility to help their colleagues varies across their daily activities. Therefore, each technician has to decide for himself if he is available or interruptible during each type of activity. We distinguish between availability as the state of a user that is willing and able to help during a certain activity and interruptibility, as the state of a user that is principally unwilling to help during his current activity, but could take a break for an urgent open question.

Our goal is to detect the technicians' current activities and, based on them, their availability and the interruptibility. Our centralized server would keep track of all the employees' availabilities and, when a new question arrives, it would select a few available technicians to whom it would forward the question. One of the precautions would be to prefer users that received or answered less questions during that day, so that the system does not burden the same few experts while leaving all the other colleagues out of the loop.

Another reason for which we need to know the user's current activity is so that we can use an appropriate communication channel (that he has assigned himself for that particular activity). For instance, a user cannot read and type into an app while driving, but can listen to a voice mail and record an answer to the question. Table 1 shows a sample mapping between the users' activities, their availabilities and interruptibilities, as well as the preferred communication channels.

Activity	Availability	Interruptibility	Communication channel
Car repairment in the garage	false	true	app/SMS
Car repairment on the street	false	false	-
Other work in the garage	true	true	app/SMS
Driving for work purposes	true	true	voicemail
Meeting	false	false	-
Break	false	true	app/SMS
Commute to/from work	true	true	voicemail
Other activity	true	true	app/SMS

Table 1. Car technicians' main activities

In order to detect the technicians' activities, we use their smartphones to record short audio samples. These are sent to our server, where they are classified. Thus, the samples undergo windowing, feature extraction and then classification.

4 Implementation

The Q&A system itself uses Microsoft SharePoint as a server, the questions being represented as threads in the message board. Questions can be submitted and answered both via a web interface and a web client. For managing notifications we use Redis, a pub/sub system.

Besides the main Android app, we also use a background service for gathering the audio recordings. This uses a wakelock to record sound samples at a given time and with a given duration.

On the server side, the sampled audio signal is first split into equally sized windows. Our implementation supports rectangular, Hamming and Hanning windows. Afterwards we apply a fast Fourier transform to convert each window to the frequency domain. In the next step we extract the feature vector for each window. We use four types of features: MFCC (Mel-Frequency Cepstrum Coefficients), Delta MFCC, Powerspectrum and Band Energy. As classifiers we use K-Nearest Neighbours (KNN), Decision Trees (DT), Random Forest (RF), Gaussian Naive Bayes (GNB) and Gaussian Mixture Model (GMM). The results of the classification concern the user's current activity, which is then mapped according to his previous personal settings to a availability and interruptibility status.

5 Evaluation of Activity Detection

To validate our approach to detect the activity, we carried out an experiment during which two car technicians used our application during their whole working time for two weeks. They both used Samsung Galaxy S4 phones, which could support a 44.1 kHz audio sampling rate. In order to collect our ground truth, the two technicians filled in separate daily forms, where they would specify all their activities and their corresponding time slots.

5.1 Comparison Between Classifiers

In what follows, we will present and compare our classification results, using as measures the precision, recall and F_1 score. Figure 1 shows the performance of all combinations of feature vectors and classifiers that we used. As expected, MFCC and DMFCC yield the best results as far as feature vectors are concerned, as they are derived from the spectrum of the spectrum.

Random Forest, K-Nearest Neighbours and Decision Trees are the best performing classifiers. The clustered nature of the data, together with the overlapping of sounds and situations, like in the case of repairing a car outside versus in a garage, leads to Random Forest and K-Nearest Neighbours outperforming Decision Trees.

5.2 The Activity Classification in Detail

Next, we will analyze in depth the best classification results, which were provided by Random Forest Classifier together with MFCC features. Table 2 shows the precision, recall, F_1 score and support for each of the situations and for the overall classification. The overall precision of 90% could be achieved thanks to the distinct acoustic patterns of the situations. This also led to a clustering of data, which caused Random Forest to outperform other classifiers.

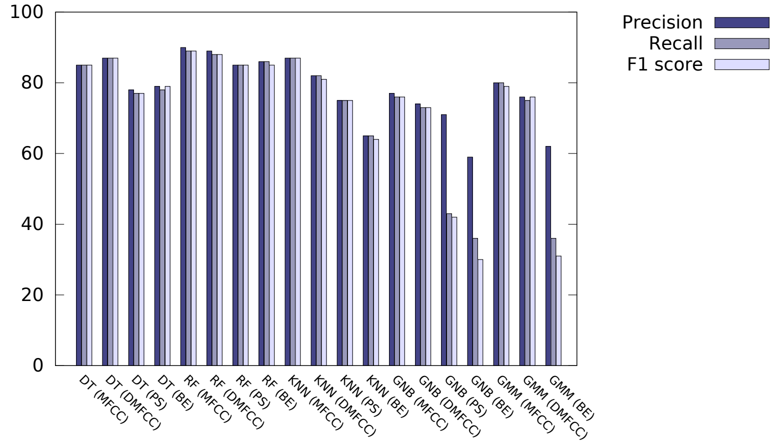

Fig. 1. Comparison of the performances of all the combinations of feature types and classifiers

Two apparently close situations, repairing a car in the garage and repairing it outside of the garage are distinguished remarkably well too. While a technician might perform similar tasks when repairing a car, regardless of the location, when a car is repaired in the garage there will often be more then one technician working there. Thus, most of the recordings taking place inside the garage contain the overlapping sounds of more cars being repaired, while the recordings of cars being repaired on the street correspond to sounds of only one car being repaired.

Class	Precision	Recall	F_1 score	Support
Break in the garage	0.95	0.85	0.90	212
Meeting	0.87	0.95	0.91	724
Repairment in the garage	0.86	0.90	0.88	298
Repairment outside of the garage	0.95	0.84	0.89	390
Other work in the garage	0.8	0.21	0.33	19
Overall	0.90	0.89	0.89	1643

Table 2. Evaluation of the classification results of Random Forest and MFCC

6 Conclusions

We have presented our approach for a context-aware Q&A system. Our concept has been motivated by a thorough user study. We have evaluated our activity detection approach with real-life data gathered in garages and and achieved a 90% precision.

Our next step would be to carry out an extensive user study in order to evaluate the system as a whole and not only the accuracy of the activity detection. Another important future improvement will be the implementation of the classifier on the phone, in order to alleviate privacy and user data protection concerns.

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References

1. Rensing, C., Diaconita, I.: A Q&A System Considering Employees? Willingness to Help Colleagues and to Look for Help in Different Workplace-related Situations. In: Proceedings of the IEEE International Conference on Advanced Learning Technologies. (2014)
2. White, R.W., Richardson, M., Liu, Y.: Effects of Community Size and Contact Rate in Synchronous Social Q&A. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. (2011)
3. Mamykina, L., Manoim, B., Mittal, M., Hripcsak, G., Hartmann, B.: Design Lessons from the Fastest Q&A Site in the West. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. (2011)
4. Shah, C., Oh, J.S., Oh, S.: Exploring Characteristics and Effects of User Participation in Online Social Q&A Sites. First Monday (2008)
5. Budzik, J., Hammond, K.: Q&A: A system for the Capture, Organization and Reuse of Expertise. In: Proocedings of the Annual Meeting - American Society for Information Science. (1999)
6. Wang, A.: An Industrial Strength Audio Search Algorithm. In: Proceedings of the 4th Symposium Conference on Music Information Retrieval. (2003)
7. Rossi, M., Feese, S., Amft, O., Braune, N., Martis, S., Troster, G.: AmbientSense: A Real-Time Ambient Sound Recognition System for Smartphones. In: Proceedings of the International Conference on Pervasive Computing and Communications Workshops. (2013)
8. Larson, E.C., Lee, T., Liu, S., Rosenfeld, M., Patel, S.N.: Accurate and Privacy Preserving Cough Sensing Using a Low-cost Microphone. In: Proceedings of the 13th International Conference on Ubiquitous Computing. (2011)
9. Diaconita, I., Reinhardt, A., Englert, F., Christin, D., Steinmetz, R.: Do You Hear What I Hear? Using Acoustic Probing to Detect Smartphone Locations. In: Proceedings of the International Conference on Pervasive Computing and Communications Workshops. (2014)
10. Diaconita, I., Rensing, C., Tittel, S.: Context-aware question and answering for community-based learning. In: Die 11. E-Learning Fachtagung Informatik der Gesellschaft für Informatik e.V. (2013)