Who, What, and When:
Supporting Interpersonal Communication over Instant Messaging

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ABSTRACT
Instant Messaging (IM) is growing in popularity for personal and work-related communication. The limited awareness provided by current IM systems, combined with the ease of initiating communication, result in messages often arriving at inopportune times. The goal of this research is to alleviate some of the shortcomings of IM through the understanding and modeling of IM interaction in the context in which it takes place. This work uses three complementary steps: Accurate predictions of responsiveness to IM (*when*), observations and predictions of interpersonal relationships (*who*), and automatic content-driven transcript segmentation to support learning and analysis (*what*).

Categories and Subject Descriptors
K4.3 [**Computers and Society**]: Organizational Impacts – *Computer Supported Collaborative Work.*

General Terms
Design, Human Factors, Experimentation

Keywords
Responsiveness, awareness, Instant Messaging, predictive models.

1. INTRODUCTION
Interpersonal communication through Instant Messaging, or IM, is growing in popularity. In its early days, IM gained its widest use supporting social communication. More recently, organizations are recognizing the value of IM and its benefits as a light-weight communication medium for both co-located and distributed teams, with uses ranging from quick questions and clarifications, coordination and scheduling, to discussions of complex work (e.g., [7, 9]). Still, IM suffers from a number of shortcomings. For example, the limited awareness of receivers' state, combined with the ease of initiating communication, often result in messages arriving at inconvenient or disruptive moments.

The goals of this work are to provide a better understanding of factors affecting IM interaction in its context, and to use this understanding to support IM communication through the creation of predictive statistical models (Figure 1). In order to achieve these goals, we use three complementary steps:

1. Create accurate models that successfully predict responsiveness to incoming IM and investigate the factors affecting responsiveness (*when*).
2. Investigate the effect of interpersonal relationships on IM interaction, and use this knowledge to create statistical models that predict relationships (*who*).
3. Develop a method for automatic content-driven transcript segmentation to support learning and content analysis (*what*).

2. DATA COLLECTION
My work is founded on the collection and analysis of naturally occurring IM interaction in its context. I have created a data collection mechanism, implemented as a custom plug-in module for Trillian Pro, a commercial IM client. This module records all IM and desktop events on a participant's computer. This approach allows for the collection of high volumes of field data over extended time periods. In an ongoing data collection effort, we have collected approximately 5,200 hours of data, with nearly 90,000 instant messages. These messages were exchanged between 16 participants and over 400 buddies.

2.1 Privacy of Data
I have taken a number of measures to preserve, as much as possible, the privacy of participants and their buddies. Unless we receive specific permission, the text of messages is not recorded, and messages are masked. For example, the message "my PIN is 1234 :-)" is recorded as "AA AAA AA DDDD :-)". When a participant opens a message window to a buddy for the first time (and that buddy is online), an alert is sent to the buddy notifying them of the participation in the study. Furthermore, participants (who provided permission to record the text of messages) and their buddies are able to temporarily mask messages. Finally, we create a unique ID for each buddy (using an MD5 cryptographic hash) and store the ID instead of the buddy-name itself.

3. RESPONSIVENESS *(WHEN)*
Research shows that even short interruptions, such as incoming messages, can be disruptive to ongoing work (e.g., [4]). Predicting *responsiveness* -- whether a user is likely to respond to an incoming message within a certain time period -- may be used to reduce disruptions and unsuccessful communication. Using the collected data, I created a set of models that are able to predict, with accuracy as high as 90.1%, a user's responsiveness to incoming instant messages [1]. Specifically, these models predict whether a user will respond to a buddy's attempt to start a new session within 0.5, 1, 2, 5, and 10 minutes. (While related work, such as [5] and [6], presented predictive models of interruptibility and busyness based on participants' *self-reports*, my models are based on participants' *actual behavior*.)

Next, to understand the role that buddy-identity plays in predicted responsiveness, I created a second set of models that use only information about the participant, excluding any information about the buddy who initiated the session (*buddy-independent*). In an application, buddy-independent models will predict, at any

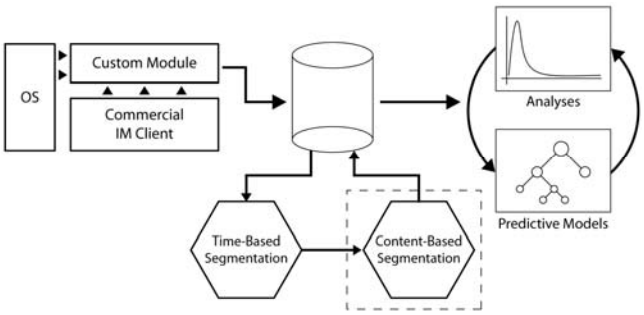

Figure 1. Process illustration: Data collection, processing, analysis and modeling.

given moment, a single level of responsiveness, while the first set of models could predict different responsiveness levels to different buddies. To our surprise, the buddy-independent models performed nearly as well as the first set of models (as high as 89.3%), and the differences were not found to be significant.

4. RELATIONSHIPS *(WHO)*

A receiver's availability and responsiveness to communication may often depend on the identity or role of the communication partner. As more and more people use IM for social as well as work-related communication, we wanted to investigate the effect of relationship on basic characteristics of IM communication. Previous research (e.g., [3]) showed that interpersonal relationship type has significant effects on different aspects of communication, including the quality, purpose and perceived value of the communication. An analysis of my data showed the significant effect of relationship, independent of message content, on a number of basic communication characteristics (e.g., session duration, message length, etc.) [2]. For example, buddies in a social relationship had significantly longer sessions than buddies in a work relationship, exchanged more messages, and took more turns. Surprisingly, however, message exchange rate was significantly lower for buddies in a social relationship compared to mixed relationship (both work and social) (M=4.6 vs. M=6.2 messages per minute; p=.003) and marginally significant compared to work relationship (M=4.6 vs. M=6.0 messages per minute; p=.078). A possible explanation is that users focus less of their attention on conversations with social buddies but give more attention to conversations with buddies with whom they work.

Next I examined the ability to use these findings for the creation of statistical models that predict the relationship between users. One such model was able to predict, with accuracy of nearly 80%, whether a user and a buddy are in a work or social relationship. Predictions are done using only basic communication characteristics, without any use of message content.

5. CONTENT SEGMENTATION *(WHAT)*

For the final stage of my dissertation, I propose to use content analysis to provide automatic segmentation of IM transcripts. Transcript segmentation without use of content (e.g., using time only [1, 2, 7]), may result in a number of problems for analyses and predictive models. For example, a late reply may not represent the start of a new session, rather a part of the previous one. To date, the few works available on the analysis of chat and IM transcripts typically assume that a single transcript represents a single conversation (e.g., [8]). This is not a reasonable assumption for dialogues as those found in my data.

In order to achieve reliable identification of conversation boundaries, I plan to employ the following *superset-pruning* approach. First, delay between messages is used to segment the data into an overly large set of boundaries. Next, content analysis is used to identify and remove incorrectly identified boundaries. I plan to use a number of techniques, including assignment of dialogue-act labels, identifying use of pronouns, and the use of cue phrases. I will evaluate this process by comparing its results to manual coding of segment boundaries and also examine whether reliable segmentation leads to improved predictive models.

Successful content-driven segmentation will be beneficial in a number of ways. First, it will provide an accurate basis for analyses of communication patterns. It may also improve predictive models of responsiveness and relationships. Finally, other work on content analysis (such as topic boundary detection) may benefit from initial segmentation into conversations.

6. CONCLUSIONS

This work's contribution to the HCI field spans both theoretical and applied aspects. From a theoretical point of view, this work provides insights into the factors that influence interpersonal communication patterns and responsiveness. At the applied level, this work provides predictive statistical models that can be used in many useful applications. Finally, this work promotes the creation of predictive models based on naturally occurring behavior.

7. ACKNOWLEDGMENTS

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