Twitter, Sensors and UI: Robust Context Modeling for Interruption Management

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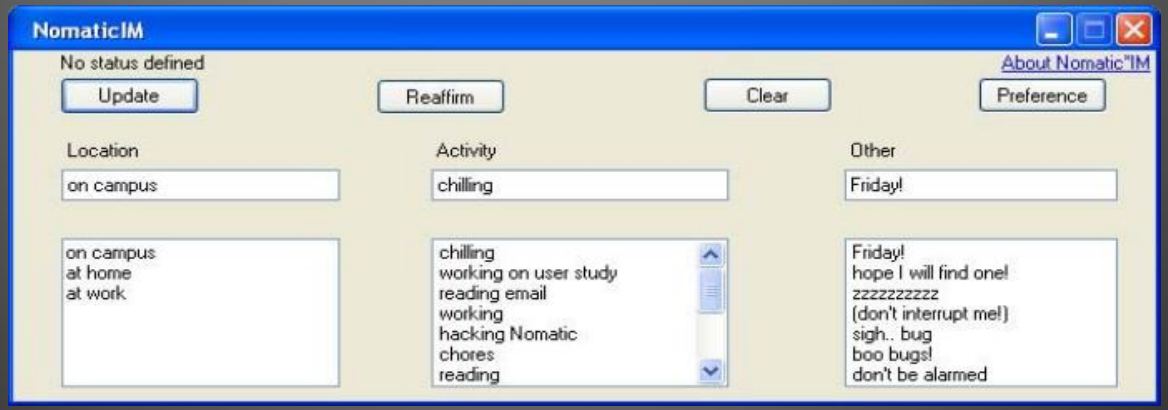
Presented by Arthur Nishimoto

Overview: Nomatic*IM

- A graphical interface to update one's status
- Reminder 'interruptions' triggered by sensor data collected from mobile laptop
  - Wifi changes, IP changes, etc.



Background

- Interruptions are common given widespread online tools and social resources
- Can be negative by breaking concentration or sense of control while working
- Can also be positive by gaining new/critical information

Definitions

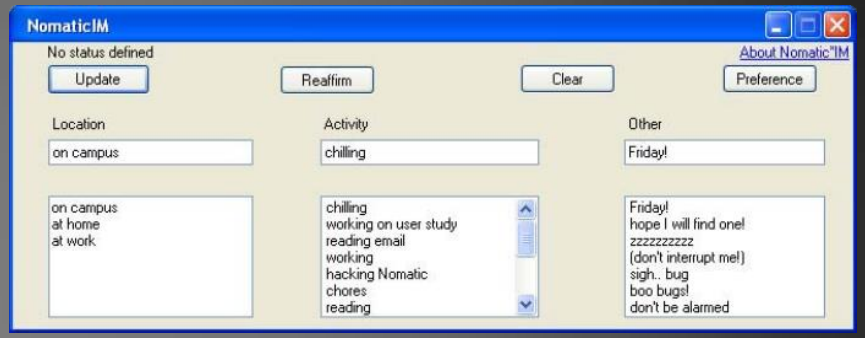
- External Interruptions
  - Phone call, coworker enters room, instant message (IM) pop up
  - Generally negative (breaks concentration, feelings of loss of control)
- Internal Interruptions
  - Remembering a task, self-realization of fatigue, sudden insight
  - Easier to accommodate as the degree of response is under the interruptee's control

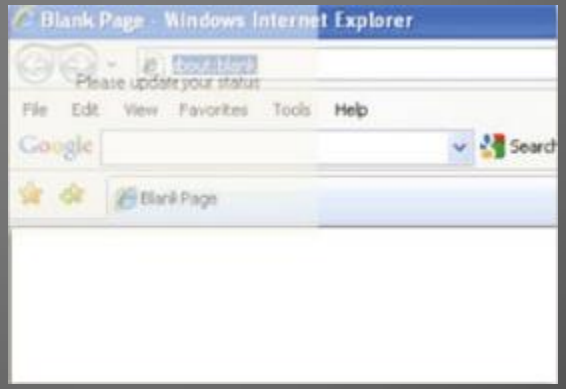
Contribution

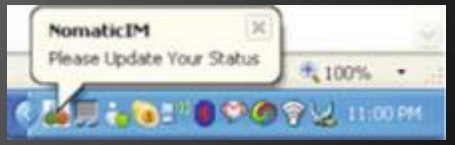
- Use Twitter status as a virtual sensor in conjunction with other sensors as input into a context modelling algorithm
- A novel algorithm based on Kullback-Leibler Divergence (KLD) to detect changes in context
- Study different user interface (UI) interruption techniques (typically external) and make them handled like internal interruptions.

Interface Details

- Interruption Techniques
  - PopUp-Window-UI
  - Cursor-Change-UI
  - Fading-Window-UI
  - Systray-Balloon-UI
  - Audio-Interrupt-UI







Context Change Detection

- Prior work by authors used a rule-based system to detect changes to a user's context (location/movement)
  - Time based (effective)
  - Changes in IP address (less effective)
    - Hypothesis that a change in IP -> change in location
    - Connection loss, switching WiFi access points, DNS credentials can trigger a change in IP, not associated with movement
  - Patterson, D.J., Ding, X., Kaufman, S.J., Liu, K., Zaldivar, A.: An ecosystem for learning and using sensor-driven IM messages. IEEE Pervasive Computing 8(4), 42–49 (2009)

- WiFi-MAC-Change-R
  - Laptop connects to new WiFi access point
- Local-IP-Change-R
  - Local net IP address changes
- Remote-IP-Change-R
  - Remote/internet visible IP address changes
- Stale-R
  - User does not change status for 2 hours
- Start-Up-R
  - User does not change status for 3 minutes after startup

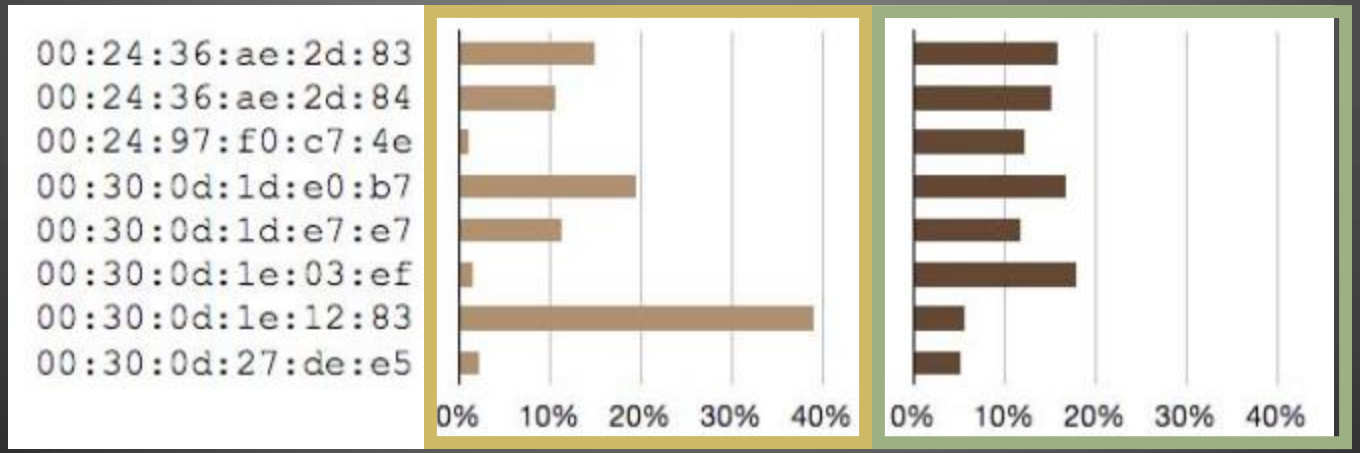
For conditions 1-5 of the context change algorithm, did the authors provide any details on why these specific items were chosen?
- Jesse

Robust Context Change Detection

$$D_{\mathrm{KL}}(X \| Y) = \sum_i X(i) \log_2 \frac{X(i)}{Y(i)}$$

- Based on Kullback-Leibler Divergence (KLD)
  - Measures how similar two multinomial probability distributions are
  - Non–negative, normalized distributions
  - Higher value -> Greater divergence in distributions

X: Historic MAC addresses when user reported ‘at home’



Y: Current MAC addresses from last user reported ‘at home’

Robust Context Change Detection

- Input
  - Captured every 60 seconds or on status update
  - Current time, network/display parameters, WiFi configuration, UI activity, and active processes
  - Light, sound, accelerometer, location (if applicable)
  - Status message
    - No sematic content (keystrokes, IM content, browser URLs)

If the point of this paper is to remind users to update their status, how much harder would it be to infer high-level availability from these sensors and meter the interruptions??
- Andrew

Research Design

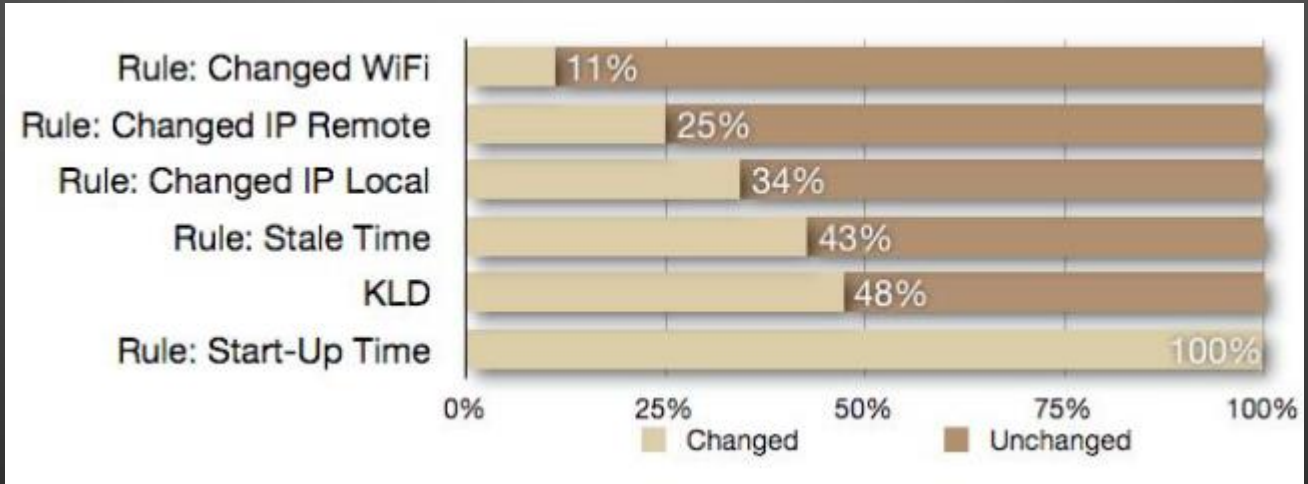
- Within-subject study over 2 months
- 15 participants, University of California – Irvine community via email, mailing lists, other advertisements
  - Windows XP/Vista laptop users using Skype, Facebook, and/or Twitter
  - Self-reported as using laptop in two physical locations via WiFi
  - Compensated $1.00/day for up to $42.00
- Participants used laptop as normal other than setting their using Nomatic*IM

Research Design

- Two variables
  - UI element (Interruption technique)
  - Context Change Detection Algorithm
    - 5 prior work rules + KLD
- On alert
  - Notification of why
  - 5-point Likert scale question on ‘how intrusive’
  - Additional question if user responded later than 3 minutes

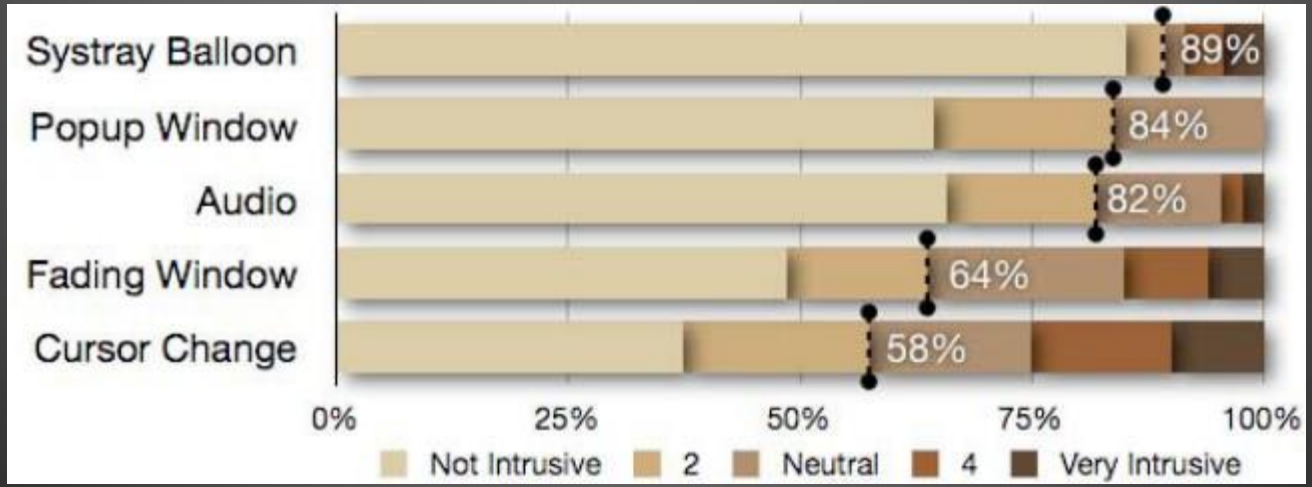
Analysis

- Effectiveness of context change techniques
  - User changed/not changed their status in response to the alert
  - All of the results showed a statistically significant difference from KLD-R ($p < 0.05$)
  - KLD outperforms all non-trivial rules



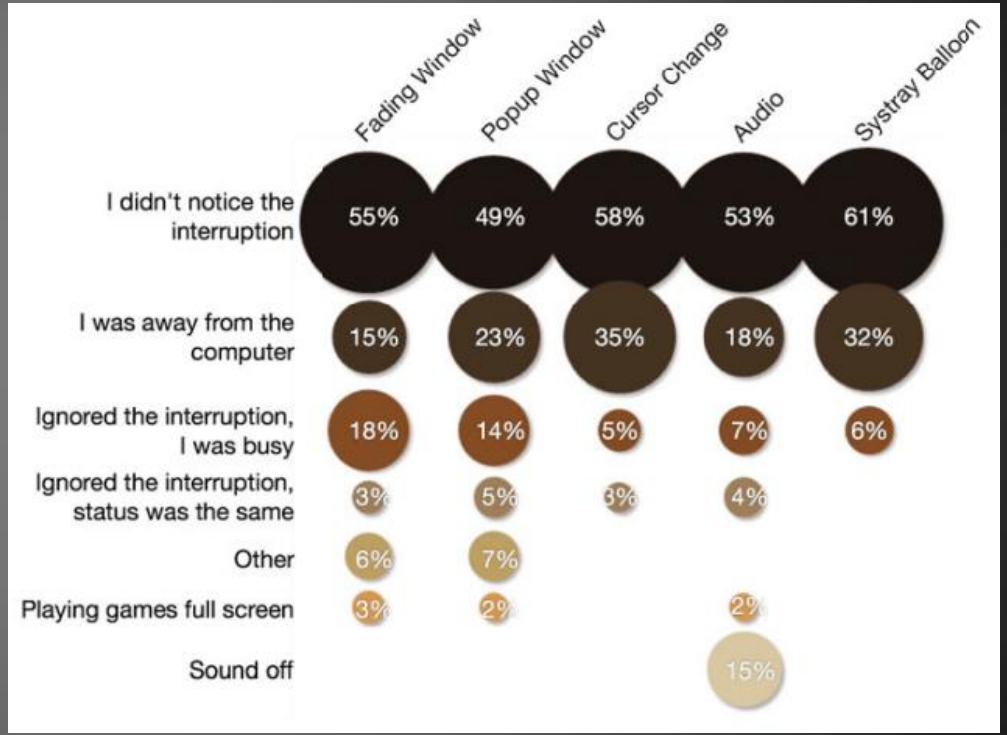
Analysis

- Intrusiveness of interface techniques
  - 5-point Likert scale
  - 1 or 2 acceptable (low intrusiveness)
  - Difference between Audio and Fading Window statistically significant ($p < 0.05$)



Analysis

- Long Response



For the presented reasons for delayed responses to the alerts, the authors mention that mobile users are not as focused on their computer and that is the reason for high scoring “I didn’t notice the interruption.” This reason seems to have overlap with the “I was away from the computer” reason. What refinements could be done to better categorize the underlying reason for the delay?
- Jesse

Critique

Large number on sensors mentioned all aggregated into a single location context changed via a machine learning algorithms this is more detailed in previous paper. Small detail mentioned in previous paper that is left vague in this one

it would be great utility tool if the tool could capture the reference of the external events like natural disasters or personal events like meeting close friend. They could have more meaningful status messages? I am not sure if I understand the utility of the tool in the context that has been explained, but that could just be my perspective, why would I want to post that I am working in the library at 2am ?
- Aditi

I feel like the abstract of this paper doesn't do a great job at really communicating what the paper will be about. I still didn't really know after reading just the abstract.
- Andrew

The authors have elaborate visualizations but not all are useful. I may have missed this but which visualization showed the most effective UI? The results were not very surprising. Although the authors only looked into how would they alert the users about the context change and were not looking into how the users used the tool but the idea of using context to enable status update is unique and might be useful if extended.
- Aditi

The authors are attempting to address a very essential issue faced by a large section of office workers. I find the idea, of contextualizing interruptions in relation to the work the users are doing, interesting.
- Harish

Context Change Detection

1) WiFi-MAC-Change-R
   - Laptop connects to new WiFi access point
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   - Remote/internet visible IP address changes
4) Stale-R
   - User does not change status for 2 hours
5) Start-Up-R
   - User does not change status for 3 minutes after startup
6) KLD-R
   - Detects a change in WiFi access point MAC address changes and compares distribution of current MAC addresses to historical