

Wisdom is not the product of schooling but the lifelong attempt to acquire it. - Albert Einstein

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# **Context-Aware Systems**

The 'Right' Information, at the 'Right' Time, in the 'Right' Place, in the 'Right' Way, to the 'Right' Person

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#### **University of Milan, February 2012**

#### **Overview**

- Motivating Examples
- Context and Context-Awareness
- Problems Addressed by Context-Aware Systems
- Exploring Particular Aspects of Context-Aware Systems
- L3D's Research in Context Aware Systems
- Implications and Future Research

## The Basic Challenge

"the interaction between people and computers requires essentially the same interpretive work that characterizes interaction between people, but with **fundamentally different resources** available to the participants Suchman, L. A. (1987) *Plans and Situated Actions,* Cambridge University Press,

 a major research objective of human-centered computing (HCC): to create a synergy between human and computational resources with socio-technical environments

## The 'Old' Days — The Human-Computer Dyad:

Human and Computer connected by a narrow explicit communication channel



#### **Knowledge-Based HCC:**

#### **Broader Explicit and Additional Implicit Communication Channel**



### **Understandability, Learnability and Common Ground**



## Information Delivery and Intrusiveness: Inferring from Gestures and Behavior



#### **Context Awareness in Todays World?**

Timeline = Share and highlight your most memorable posts, photos and life events on your timeline

# 34 of your friends have signed up for timeline.

Get Timeline















Daniel Spikol

Daniele Petrone

Anika Van Eaton

Jesse Koehler

Ricki Goldman

Jenny McNeice

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Andrea Forte











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8

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## Context

#### determining factors:

- the people involved (including their background knowledge and their intentions)
- the objective of the interaction (including the task to be carried out)
- $\circ$  the time and place where the interactions take place

#### challenges

- o how to obtain information relevant for the context
- o how to represent context information
- how to use context information

#### **Problems Addressed by Context-Aware Systems**

#### information overload and human attention

- "What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate efficiently among the overabundance of information sources that might consume it." — Herbert Simon
- see also: Simon's example of the U.S. State Department's misanalysis of printing bottlenecks
- unarticulated design intent
- providing information "to anyone, at any time and at any place" → the five 'Rights'

# The 'Right' Information, at the 'Right' Time, in the 'Right' Place, in the 'Right' Way to the 'Right' Person

<<'right' is in quotes because in most cases there is no simple 'right' or 'wrong'>>

- the 'right' information requires task modeling (and can be inferred from partial constructions in design, from interests derived from previous actions (e.g.: books bought, movies watched) or described via specification components)
- the 'right' time addresses intrusiveness of information delivery (e.g.: when to notify a user about the arrival of a e-mail message, when to critique a user about a problematic design decision); it requires to balance the costs of intrusive interruptions against the loss of context-sensitivity of deferred alerts
- *the 'right' place* takes location-based information into account

#### .....in the 'Right' Way to the 'Right' Person

- the 'right' way differentiates between multi-model representations; e.g.: by using multimedia channels to exploit different sensory channels is especially critical for users who may suffer from some disability
- the 'right' person requires user modeling; e.g.: as it is exploited in recommender systems and in intelligent tutoring systems

#### **Exploring Particular Aspects of Context**

- Location-based information systems have focused on a narrow notion of context: how to capture location automatically by hardware and software sensors
- Recommender systems have explored techniques for recommending various products or services to individual users based on the knowledge of users' tastes and preferences as well as users' past activities (such as: previous purchases, previous articles read, previous search commands issued)

## **Exploring Particular Aspects of Context**

- Ambient Intelligence research has analyzed environments with many embedded devices where these devices can recognize the situational context of users and exploit the additional information for personalization and customization
- L3D's research focused on design activities and high-functionality environments, specifically exploring unique aspects of context aware systems such as:
  - articulating *design intent* with *specification components* (examples: specification component in kitchen design (Kumiyo Nakakoji), drawing an equilateral triangle)
  - o critiquing systems (generic, specific, and interpretive)
  - o information access and delivery (example: passive and active help systems)
  - o intrusiveness (spelling correctors, notifications, passive versus active systems)
  - synergy between adaptive and adaptable components (example: sliders (Tammy Sumner), Auto-Correct in MS-Word)

#### **Drawing an Equilateral Triangle**

Intention of the Designer



Procedure Written by the Designer

to triangle repeat 3 [forward 100 right 60] end

#### **Creating More Context by Articulating Design Intentions**

Intention of the Designer



Procedure Written by the Designer

to triangle repeat 3 [forward 100 right 60] end

Feedback from the Environment

"Intent" Articulated to the system closed figure

## L3D Research in Context-Aware Systems

#### Information Sharing: Access ("Pull") and / or Delivery ("Push")

	access ("pull")	delivery ("push")
examples	browsing, search engines, bookmarks,	Microsoft's "Tip of the Day",
	passive help systems	broadcast systems, critiquing,
		active help systems, agent-
		based systems
strengths	non-intrusive, user controlled	serendipity, creating
		awareness for relevant
		information, rule-enforcement
weaknesses	task relevant knowledge may remain hidden	intrusiveness, too much
	because users can not specify it in a query	decontextualized information
major	supporting users in expressing queries,	context awareness (intent
system	better indexing and searching algorithms	recognition, task models, user
design		models, relevance to the task-
challenges		at-hand)

#### Computing User- and Task-Relevant Information Delivery in a High-Functionality Environment (HFE)



#### Adaptation Mechanism to Control Different Critiquing Rule Sets and Different Intervention Strategies (Tammy Sumner)



#### A Comparison between Adaptive and Adaptable Systems

	Adaptive	Adaptable
Definition	dynamic adaptation by the system itself to current task and current user	user changes the functionality of the system
Knowledge	contained in the system; projected in different ways	knowledge is extended
Strengths	little (or no) effort by the user; no special knowledge of the user is required	user is in control; user knows her/his task best;
Weaknesses	user has difficulty developing a coherent model of the system; loss of control	systems become incompatible; user must do substantial work; complexity is increased (user needs to learn the adaptation component)
Mechanisms	models of users, tasks, and dialogs;	support for meta-design
Required	incremental update of models	
Application	active help systems, critiquing	end-user modifiability, tailorability,
Domains	systems, recommender systems	definition of filters, design in use

#### **Design Trade-Offs for Context-Aware Systems**

- filter bubbles / group think **versus** making all voices heard
- making information relevant to the task at hand versus serendipity
- intrusiveness versus reacting too late
- remembering versus forgetting
  - o Bell, G., & Gemmell, J. (2009) Total Recall
  - Mayer-Schönberger, V. (2009) Delete the Virtue of Forgetting in the Digital Age
  - Bannon, L. J. (2006) "Forgetting as a Feature, Not a Bug: The Duality of Memory and Implications for Ubiquitous Computing," in *CoDesign*
  - privacy versus decontextualized systems
  - control by the systems versus control by the user



#### **Book Description**

THE TOTAL RECALL REVOLUTION IS INEVITABLE. IT WILL CHANGE WHAT IT MEANS TO BE HUMAN.IT HAS ALREADY BEGUN.

What if you could remember everything? Soon, if you choose, you will be able to conveniently and affordably record your whole life in minute detail. You would have Total Recall. Authors Gordon Bell and Jim Gemmell draw on experience from their MyLifeBits project at Microsoft Research to explain the benefits to come from an earth-shaking and inevitable increase in electronic memories. In 1998 they began using Bell, a luminary in the computer world, as a test case, attempting to digitally record as much of his life as possible. Photos, letters, and memorabilia were scanned. Everything he did on his computer was captured. He wore an automatic camera, an arm-strap that logged his bio-metrics, and began recording telephone calls. This experiment, and the system created to support it, put them at the center of a movement studying the creation and enjoyment of e-memories.

Since then the three streams of technology feeding the Total Recall revolution-digital recording, digital storage, and digital search, have become gushing torrents. We are capturing so much of our lives now, be it on the date--and location--stamped photos we take with our smart phones or in the continuous records we have of our emails, instant messages, and tweets--not to mention the GPS tracking of our movements many cars and smart phones do automatically.



#### **Book Description**

Delete looks at the surprising phenomenon of perfect remembering in the digital age, and reveals why we must reintroduce our capacity to forget. Digital technology empowers us as never before, yet it has unforeseen consequences as well. Potentially humiliating content on Facebook is enshrined in cyberspace for future employers to see. Google remembers everything we've searched for and when. The digital realm remembers what is sometimes better forgotten, and this has profound implications for us all.

In *Delete*, Viktor Mayer-Schönberger traces the important role that forgetting has played throughout human history, from the ability to make sound decisions unencumbered by the past to the possibility of second chances. The written word made it possible for humans to remember across generations and time, yet now digital technology and global networks are overriding our natural ability to forget-the past is ever present, ready to be called up at the click of a mouse. Mayer-Schönberger examines the technology that's facilitating the end of forgetting-digitization, cheap storage and easy retrieval, global access, and increasingly powerful software--and describes the dangers of everlasting digital memory, whether it's outdated information taken out of context or compromising photos the Web won't let us forget. He explains why information privacy rights and other fixes can't help us, and proposes an ingeniously simple solution--expiration dates on information-that may.

*Delete* is an eye-opening book that will help us remember how to forget in the digital age.

## **Filter Bubbles**

 source: E. Pariser. (2011). Beware online "filter bubbles" (TED Talk). http://www.ted.com/talks/eli\_pariser\_beware\_online\_filter\_bubbles.html

#### • the design trade-off:

- no person can afford to pay attention to more than a very small fraction of new things produced ("demassification")
- a culture can not survive long unless all of its members paid attention to at least a few of the same things ("massification")

#### **Context-Awareness: Apps on the I-Phone**

Iocal traffic reporting + Siri (intelligent assistant) + ..... . . . . . .





#### **Context-Awareness and Human-Centered Computing**

- Human-Centered Computing should serve the benefit of users
- the design of context-aware systems must take into account the importance and influence of social contexts to make the technical systems desirable, usable, useful, meaningful at a personal and social level
- basic message of this presentation:

create a **generic conceptual/theoretical framework** for context aware systems based on the **lessons learned** with L3D's research efforts over the last two decades