Context as Implicit Input

Explicit input → Context-Aware System → Explicit output

Context:
- state of the user
- state of the physical environment
- state of the computing system
- history of user-computer interaction
- ...
What is Context?

- Identity (user, others, objects)
- Location
- Date/Time
- Environment
- Emotional state
- Focus of attention
- Orientation
- User preferences
- Calendar (events)
- Browsing history
- Behavioral patterns
- Relationships (phonebook, call history)

... the elements of the user’s environment that the computer knows about...

Examples of Context

- Identity (user, others, objects)
- Location
- Date/Time
- Environment
- Emotional state
- Focus of attention
- Orientation
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Relevance of Context Information

- Trying to arrange lunch meeting
- Going to a job interview
- Going home after work and making evening plans
- Shopping
- Tourist
- ...
Scene 2

Examples

• Smartphone adjusts the screen to the orientation of the device
• Apple Watch turns on display if arm lifted/rotated
• Orientation is determined by using both a gyroscope and an accelerometer.

Examples

• Phone display adjusts the brightness of the display based on the surrounding area
• Uses a light sensor
Examples
• Device uses GPS to display the user’s location
  • Can use to find nearby stores
  • Get directions
  • Location-specific status updates on social media

Examples
• The time is displayed on the phone.
  • Time zone change
  • Daylight savings time

Examples
• Device disables touch screen when the user speaks on the phone
  • Uses a proximity sensor (infrared signal travel time)
Examples

• Active Badge location system
  • One of the first context-aware applications
  • **Context = location**
  • Call-forwarding system
  • Issues
    • Private call forwarding to a public room
    • Call is forwarded to important meeting

Examples

• Schneider trucking trackers
  • Uses GPS to track loads
  • Sends a notification when a load nears its destination
  • Sends emergency notifications when conditions are met

Types of Context: Train Booking App

• Customer provides customer# and booking details (**explicit input**)
• Location, time are required and can be automatically derived from context information (**implicit input**)
• Additional information: current temperature, number of people around you, what you wear, heart rate, …
Types of Context

- **Time Context** (current time, day of week, etc.)
- **Physical Context** (location, temperature, etc.)
- **User Context** (characteristics, habits, history, etc.)
- **Computational Context** (user input, customer history from database, network status, etc.)

Definitions of Context

- “Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves” [Dey et al. 2001]
- Most common definition

Definitions of Context

- **Functionality & Relevance:**
  - Context characterizes the actual situation in which the application is used.
  - This situation is determined by information which distinguishes the actual usage from others, in particular characteristics of the user (her location, task at hand, etc.) and interfering physical or virtual objects (noise level, nearby resources, etc.).
  - Thereby, we only refer to information as context that can actually be processed by an application (relevant information), but that is not mandatory for its normal functionality (auxiliary information).

context information = relevant and auxiliary
Classification

- **External (physical)**
  - Context that can be measured by hardware sensors
  - Examples: location, light, sound, movement, touch, temperature, air pressure, etc.

- **Internal (logical)**
  - Mostly specified by the user or captured monitoring the user’s interaction
  - Examples: the user’s goal, tasks, work context, business processes, the user’s emotional state, etc.

Why Use Context?

- **Reduce cognitive load of user**
- **Proactivity**
  - Set up environment according to user’s preferences/history
  - Auto-completion of forms (location, time in timetable)
  - Reminders
- **Search and filter information** according to user’s needs
- **Avoid interrupting** the user in inappropriate situations
- **Smart environments**
  - Turn devices on/off, start applications, … depending on location, time, situation (lecture, meeting, home cinema, …)
  - Discover and use nearby interaction devices

Proximate Selection/Contextual Information

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Table 2: UI Techniques for Proximate Selection
Proximate Selection/Contextual Information

Automatic Contextual Reconfiguration
• Add, remove, or alter components based on context
• Smart notifications on phone (ring, vibrate, autoresponse)

Contextual Commands
• Users can parameterize commands with context-filtered values; execution changes based on context
• Example: universal remote control
Context-Triggered Actions

- Simple if-then condition-action rules, automatically invoked
- Reminder: if I step into the car on weekday morning and don’t have suitcase with me, remind me to get it

Context-Awareness: Risks

- Context-awareness helps technology to “get it right”
- But context is hard to sense (quantity, subtleness)
- Computers are not self-aware like humans

- Problems:
  - When the system does the wrong thing
  - auto-locking car doors
  - screen saver during presentation
  - microphone amplifying a whisper

Context-Awareness: Risks

- Context data must be coupled with the ability to interpret it, but computers are bad at “common sense”.
- More rules ≠ intelligence
- More rules = more complexity, harder to understand

- “Human in the Loop”:
  - computers can detect, aggregate, portray information
  - allow human users to interpret and act on it
  - is this a good strategy for all context-aware systems?
Challenges & Issues

• Developers have little experience with devices that gather the data (e.g., gyroscopes).
• Data gathered from a sensor must be interpreted correctly in order for it to be useful.
• Context comes from various sources and in order for this data to be useful it must be combined correctly (i.e., the gyroscope and accelerometer working together to determine orientation).
• The context changes constantly in real time.

Challenges & Issues

• Increasing usability or decreasing control?
  • Automation reduces the amount of work that users have to do
  • Users like the idea of a device that completes tasks on their behalf
  • However, when users use these devices they feel a loss of control if a device has a high level of automation

Challenges & Issues

• Privacy issues
  • Should law enforcement be able to access the history of a user?
  • Context recognition is not always correct
  • Errors fusing data
  • Detection errors
  • Interpretation errors
• Application becomes too complex
  • Reduces accuracy of the application
Challenges & Issues

- User preferences may not match what the device does!
  - Everyone is different!
  - What is your idea of “nighttime”?
  - What is your idea of “warm”? Or “loud”?
- Information overload
  - Can overwhelm the user

Solutions

- Keep an appropriate level of automation (avoid uncertainty)
  - The more automation we have, the less control we have over what is happening.
  - What happens if we give all control to machines?
  - Would you trust your phone to give you a dose of medicine?
  - Keep a balance between uncertainty and automation.

Solutions

- Avoid unnecessary interruptions
  - Phone flashes a notification every 30 seconds
  - Eventually the user will ignore it!
- Avoid information overload
  - Too much information can overwhelm the user, and bog down the device
  - Example: Walking down a busy street a user’s device is bombarded with suggestions of places to shop
Solutions

• Be sure the user feels in control of the application
  • Too many automated actions = loss of control
  • A balance between automation and user control needs to be found
  • Example: Smart Actions App

Solutions

• Keep an appropriate level of system status visibility
  • Allow the user to see what action the device is taking
  • Be sure the user understands why the device is performing the action
  • Account for the impact of Social Context
  • A loud alert is not ideal for all situations
  • Allow for the personalization of individual needs
  • Allow user to change location names (set a location name to “home” for example)
Solutions

• Secure the user’s privacy
• Selling information to advertisers…is this right?
• Giving information to the police, when does this cross the line?
• Sharing context information with others—Facebook location