Course Syllabus

SCHEDULE, TOPICS and GOALS

http://www.cs.unibo.it/difelice/

Context-aware systems

Prof. Marco Di Felice
Department of Computer Science and Engineering
University of Bologna
Mobile, Context-aware & Pervasive Systems

Technologies, methodologies and patterns to design, deploy, and evaluate mobile & context-aware software services
How did everything start?

1. \( \nabla \cdot \mathbf{D} = \rho_v \)
2. \( \nabla \cdot \mathbf{B} = 0 \)
3. \( \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \)
4. \( \nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J} \)

Maxwell Equations

Shannon Equation
(Channel Capacity)

\[ C = B \log_2 \left( 1 + \frac{S}{N} \right) \]
CA Systems course: Who?

Marco Di Felice

Associate Professor in Computer Science
Email: marco.difelice3@unibo.it, difelice@cs.unibo.it
Department of Computer Science and Engineering, University of Bologna
Via M. Anteo Zamboni 7, Bologna
Office hours: Wednesday, 10-12 am

TEACHING ACTIVITIES:

✧ Basi di dati (Bachelor Degree)
✧ Data Analytics (Master Degree)
✧ Internet of Things (Master Degree)
✧ Context-aware Systems (Master Degree)
CA Systems course: Who?

Marco Di Felice

Associate Professor in Computer Science
Email: marco.difelice3@unibo.it, difelice@cs.unibo.it
Department of Computer Science and Engineering, University of Bologna
Via M. Anteo Zamboni 7, Bologna
Office hours: Wednesday, 10-12 am

RESEARCH INTERESTS:

✧ Internet of things, D2D communication, UAV & wireless sensors
✧ Mobile applications & context-aware computing
✧ Self-organizing mobile systems
CA Systems course: Who?

Marco Di Felice

Associate Professor in Computer Science
Email: marco.difelice3@unibo.it, difelice@cs.unibo.it
Department of Computer Science and Engineering, University of Bologna
Via M. Anteo Zamboni 7, Bologna
Office hours: Wednesday, 10-12 am
CA Systems course: Who?

Context-aware Course

- 6 cfu (credito formativo universitario)
- Master Degree in Computer Science
- Teaching hours: 50

EVALUATION

- **Individual Seminar** → Mandatory, dates will be defined (during the semester)
- **Team Project** → Mandatory, submit the project when ready

**Voto Finale** = \( \frac{1}{3} \times \text{Voto Scritto/Seminario} + \frac{2}{3} \times \text{Voto Progetto} \)
CA Systems course: When?

**Weakly Schedule**

✧ Wednesday, **13.00**-15.30, Aula Bombelli  
✧ Thursday, **16.00**-18.30, Aula Ercolani 1

**Teaching Semester:**  
✧ September 2019 – December 2019
CA Systems course: What?

Computability Theory

Which class of problems can be solvable by machines ...
CENTRALIZED COMPUTING

“Computers in the future may weigh no more than 1.5 tons.”

*Popular Mechanics, 1949*


ENIAC (1954)
The MainFrame Age

DEC VT100 Terminal (1974)
80x24 text display

- Centralized computing.
  - Computation performed at a central unit.
  - Terminals are attached to the main elaborator.
  - Multiple processes/users accessing the same resources in time-sharing.

"Computers in the future may weigh no more than 1.5 tons."

*Popular Mechanics, 1949*

CA Systems course: What?

CENTRALIZED COMPUTING   DISTRIBUTED COMPUTING

“There is no reason anyone would want a computer in their home.”
Ken Olsen, 1977 (Digital Equipment Corporation)

IBM 5150 (1980)
The Personal Computers Age

ARPANET (1969-1990)
Different entities are able to communicate via a network infrastructure.

CONTEXT-AWARE SYSTEMS– SYLLABUS, TOPICS, GOALS
MARCO DI FELICE
CA Systems course: What?

“Cellular phones will absolutely not replace local wire systems.”

Martin Cooper

Motorola Dyna-TAC (1983)
Weight: 1 Kg, Autonomy: 60 minutes, Cost: 4000$

Palm Pilot 1000 (1996)
First Commercial PDA LCD Tactical Panel

✧ Computational entities are portable.

✧ Services and connectivity are maintained while the device is moving.


CONTEXT-AWARE SYSTEMS—SYLLABUS, TOPICS, GOALS

MARCO DI FELICE
CA Systems course: What?

- Centralized Computing
- Distributed Computing
- Mobile Computing
- Context-Aware Computing

First definition in 1994 appeared on a paper by Schilit and Theimer.

- System able to provide context-relevant information and services to user.

- **Context** → where you are, who you are with, and what resources are nearby.

Active Badge Location System (1992)  Location-aware system
Gerontology (since 1990)  Fall Detection System (1998)

CA Systems course: What?

- CENTRALIZED COMPUTING
- DISTRIBUTED COMPUTING
- MOBILE COMPUTING
- CONTEXT-AWARE COMPUTING
- UBIQUITOUS COMPUTING

✧ ICT services that enable information and services to be made available everywhere, anytime.
✧ Innovative & Smart Human-Computer Interaction (HCI).
✧ Seamless smart-device integration & communication.

Mark Weiser (XEROX) CALM Technology (1995)
Dangling String Natalie Jeremijenko (1995)
CA Systems course: What?

Today’s Mobile & CA Computing

Cisco Forecasts 49 Exabytes per Month of Mobile Data Traffic by 2021

Mobile Data Traffic per Device

Cisco Forecasts 49 Exabytes per Month of Mobile Data Traffic by 2021

Mobile Data Traffic per Device
CA Systems course: **What?**

**Today’s Mobile & CA Computing**

[Image: Author: U.S. Department of Transportation]

[Image: Author: Don Ramey Logan]

CA Systems course: What?

Today’s Mobile & CA Computing


CONTEXT-AWARE SYSTEMS– SYLLABUS, TOPICS, GOALS
MARCO DI FELICE
CA Systems course: What?

Today’s Pervasive & CA Computing

FITBIT

SMARTWATCH

SMART BIKINI
http://www.spinali-design.com/

TESLA AutoPilot

SMART LIGHTING
(Philips Hue)

GOOGLE Nest

CONTEXT-AWARE SYSTEMS—SYLLABUS, TOPICS, GOALS
MARCO DI FELICE
CA Systems course: What?

Today’s Pervasive & CA Computing

UNDERWATER ACUSTIC SENSOR NETWORKS
Source: http://www.ece.neu.edu/wineslab/

UNDERGROUND SENSOR NETWORKS

WEARABLE SENSORS
Source: http://computingcage.com/iot-clothing-smart-shirt/
CA Systems course: What?

Today’s Pervasive & CA Computing

Iris (motion) sensor
Pressure sensor
Accelerometer
Barometer
Fingerprint sensor
Gyro sensor
Geomagnetic sensor
Hall sensor
HR sensor
Proximity sensor
RGB Light sensor

Fingerprint Sensor
G-Sensor
Gyroscope Sensor
Compass
Ambient Light Sensor
Proximity Sensor
Hall Sensor
Barometer
Infrared Remote Control

CA Systems course: What?

Today’s Pervasive & CA Computing

LOCATION-BASED SERVICES


AFFECTIVE and EMOTION- AWARE COMPUTING

- https://developer.affectiva.com

Emotion API
Our cloud based API can be used to process media in the cloud

LEARN MORE
CA Systems course: What?

MOBILE, CONTEXT-AWARE & UBIQUITOUS SYSTEMS

LEARNING GOALS

✧ Present the **enabling** technologies
✧ Present **software architectures** and available tools
✧ Discuss some unique **research challenges**
✧ Describe **applications** & business opportunities
MACRO-TOPIC 1: CONTEXT-AWARE COMPUTING

 Definitions: what is a context, what is context-aware computing

 Use-cases (technologies and architectures):

- Location-aware services
- Activity-aware services
- Emotion-aware services
- Neighbour-aware services
CA Systems course: What?

CONTEXT-AWARE SCENARIOS

LOCATION-BASED SERVICES

LOCALIZATION TECHNIQUES and ALGORITHMS

FRAMEWORK and MAPPING APIs

GEODATA & SPATIAL DATABASE

\[ \sqrt{(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 + ct_1} = d_1 \]
\[ \sqrt{(x - x_2)^2 + (y - y_2)^2 + (z - z_2)^2 + ct_2} = d_2 \]
\[ \sqrt{(x - x_3)^2 + (y - y_3)^2 + (z - z_3)^2 + ct_3} = d_3 \]
\[ \sqrt{(x - x_4)^2 + (y - y_4)^2 + (z - z_4)^2 + ct_4} = d_4 \]
CA Systems course: What?

CONTEXT-AWARE TECHNOLOGIES

<table>
<thead>
<tr>
<th>Context type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Current local time</td>
</tr>
<tr>
<td>Location</td>
<td>Latitude and longitude</td>
</tr>
<tr>
<td>Place (Deprecated)</td>
<td>Place, including place type</td>
</tr>
<tr>
<td>Activity</td>
<td>Detected user activity (walking, running, biking)</td>
</tr>
<tr>
<td>Beacons</td>
<td>Nearby beacons matching the specified namespace</td>
</tr>
<tr>
<td>Headphones</td>
<td>Are headphones plugged in?</td>
</tr>
<tr>
<td>Weather (Deprecated)</td>
<td>Current weather conditions</td>
</tr>
</tbody>
</table>

https://developers.google.com/awareness
CA Systems course: What?

LOCATION INTELLIGENCE

https://medium.com/locale-ai/the-five-most-unheard-applications-of-location-analytics-for-businesses-ab9947784330
CA Systems course: What?

**MACRO-TOPIC 2: CONTEXT-AWARE COMPUTING**

- **Context Acquisition**
- **Context Dissemination**
- **Context Modeling**
- **Context Reasoning**

THE CONTEXT CYCLE
Research issue: **Privacy** on Context Data

https://medium.com/google-developers/using-the-awareness-api-for-android-a185b05e7254
CA Systems course: What?

MACRO-TOPIC 3: MOBILE COMPUTING

🔹 *Protocols, patterns and frameworks* to enable *mobile services*

🔹 Architectures for *network mobility*

🔹 *Issue: Service Discovery*

🔹 *Issue: Mobile Data Synchronization, Data replication & Mobile Cloud*

🔹 *Middleware* for Mobile Computing
CA Systems course: How?

**COURSE PRE-REQUISITES**

- Database systems
- Network systems
- Web programming (JavaScript)
- Mobile programming (Android)
CA Systems course: How?

Richard Ferraro, Murat Aktihanoglu

Location Aware Applications

Manning Editions
CA Systems course: How?

Stefan Posland

Ubiquitous Computing: Smart Devices, Environments And Interactions

Wiley Edition
CA Systems course: How?

- CLASSROOM LECTURES
- DEMOS & HACKATHONS
- EXAM: SEMINAR
- EXAM: TEAM PROJECT

CONTEXT-AWARE SYSTEMS—SYLLABUS, TOPICS, GOALS
MARCO DI FELICE
CA Systems course: How?

✧ Research-oriented course
✧ Seminar class format
✧ Online coding exercises

- Be motivated
- Be curious
- Be active

Thesis & internships

CONTEXT-AWARE SYSTEMS– SYLLABUS, TOPICS, GOALS
MARCO DI FELICE