Universitat Autònoma de Barcelona

2018/2019

Edge Computing

Code: 44025
ECTS Credits: 6

Degree	Type	Year	Semester
4316624 Internet of Things for e-Health	OT	0	2

Contact

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Use of languages

Principal working language: catalan (cat)

Prerequisites

It is recommended to have basic knowledge on Linux and Cloud Computing (concepts & practice).

Objectives and Contextualisation

This course will explore research, frameworks, and applications in Edge Computing. The course will begin with a review of the problems of current big data at Cloud Computing and the student will then explore frameworks for computing over edge devices and cloud. Students will also create a lab project of their choosing that leverages edge and cloud computing technologies.

Skills

- Apply basic research tools in the area of IoT in health.
- Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
- Continue the learning process, to a large extent autonomously.
- Design, develop, manage and evaluation mechanisms of certification, compression and security guarantees in the processing of and access to information in a local or distributed processing system.
- Develop and adapt geo-distributed services and apps on mobile devices aimed at the Cloud and Edge computing infrastructures.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use and implement methods, techniques, specific use programmes, norms and standards in the development of mobile apps/wearables and social networks in the area of health.

Learning outcomes

1. Analyse and plan an optimal distributed solution in a mixed Clouds/Edge infrastructure according to the devices available in eHealth environments, taking advantage of geo-distributed system capabilities.
2. Apply basic research tools in the area of IoT in health.
3. Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
4. Continue the learning process, to a large extent autonomously.
5. Design and evaluate an Edge Computing application prototype regarding its necessary infrastructure and costs.
6. Implement energy-efficient mobile-computing solutions through apps and services.

7. Implement secure solutions in Edge environments.
8. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

Content

Brief outline of course topics and schedule.

- **Lecture 1:** Introduction to Edge Computing
- **Lecture 2:** The Cloud Computing analytics pipeline: problems & solutions
- **Lectures 3-4:** Distributed Computing and Microservices
- **Lecture 5-6:** Edge Architectures
- **Lectures 7-8:** Algorithms for Sensor Networks
- **Lecture 9**: Edge Computing Applications
- **Lectures 10-12**: Frameworks & Platforms (Apache Edgent, Cloudy, Microservices, OpenIO, IOTracks, OpenFog, etc.)

Methodology

The course will be developed in classes, lab sessions and seminars with discussion groups & students presentations.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lab	12	0.48	2, 5, 6, 7
Lectures	26	1.04	1, 2, 4, 5, 6, 7
Type: Autonomous			
Collaborative work	20	0.8	1, 2, 3, 4, 8
Individual (personal work)	40	1.6	1, 2, 4, 5, 7, 8
Preparation and study	48	1.92	1, 2, 3, 4, 5, 8

Evaluation

The evaluation will be made by developing the proposed case studies using the tools presented in the lectures sessions and laboratory. Group work and interaction will also be assessed.

Academic Integrity
If the student use someone else's work (code, figures, research publications, etc.) to produce any work for this course, the student must:

1. indicate how this work was used,
2. acknowledge this work in a bibliography section.

Violation of these policies will be considered a breach of academic integrity, and the student will be subject to penalties outlined by the MsC studies coordination at the **School of Engineering.** The student is subject to the rights and responsibilities that includes an academic (grade) penalty administered by the professor and/or disciplinary action through the UAB judicial process by plagiarism responsabilitities.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Cases Studies: Analysis & Development	100	4	0.16	1, 2, 3, 4, 5, 6, 7, 8

Bibliography

General

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- Edge-centric Computing: Vision and Challenges
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- Computing on the Edge: A Platform for Replicating Internet Applications
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- Cloud-Based Augmentation for Mobile Devices: Motivation, Taxonomies, and Open Challenges
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- Fog Computing in the Internet of Things: Intelligence at the Edge 2018.
- Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security Paperback. Perry Lea. 2018

Specific:

- CloneCloud: elastic execution between mobile device and cloud
  Chun, Byung-Gon and Ihm, Sunghwan and Maniatis, Petros and Naik, Mayur and Patti, Ashwin. Eurosys 2011
- ThinkAir: Dynamic resource allocation and parallel execution in cloud for mobile code offloading
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- Just-in-timeprovisioning for cyber foraging
  Ha, Kiryong and Pillai, Padmanabhan and Richter, Wolfgang and Abe, Yoshihisa and Satyanarayanan, Mahadev. ACM MobiSys 2013
- Tactical Cloudlets: Moving Cloud Computing to the Tactical Edge
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- OpenStack++ for Cloudlet Deployment
  Kiryong Ha, Mahadev Satyanarayanan. CS Techreport CMU-CS-15-123, August 2015
- The role of cloudlets in hostile environments.
  Mahadev Satyanarayanan et al. Proceeding of the fourth ACM workshop on Mobile cloud computing and services (MCS '13)

- A Survey of Computation Offloading for Mobile Systems
  Kumar, Karthik and Liu, Jibang and Lu, Yung-Hsiang and Bhargava, Bharat. Journal Mobile Networks and Applications Volume 18 Issue 1, February 2013

Edge Architecture, Services

- ECC: Edge Cloud Composites
  Bhardwaj, Ketan and Sreepathy, Sreenidhy and Gavrilovska, Ada and Schwan, Karsten. MobileCloud 2014
- Cloud4Home. Enhancing Data Services with @Home Clouds
  Sudarsun Kannan, Ada Gavrilovska, Karsten Schwan. CDCS 2011
- ParaDrop: Enabling Lightweight Multi-tenancy at the Network's Extreme Edge
  P. Liu, D. Willis and S. Banerjee. IEEE/ACM Symposium on Edge Computing (SEC), 2016
- AppSachet: Distributed app delivery from the edge cloud
  Bhardwaj, Ketan and Agarwal, Pragya, Gavrilovska, Ada and Schwan, Karsten. EAI International Conference on Mobile Computing, Applications and Services, 2015
- Databox Project
- Apache Edgent
- Cloudy Project
- Microservices
- IOTracks
- EdgeFoundry
- DC/OS
- StreamSets
- OpenFog Consortium
- OpenEdge Computing

IoT

- An Operating System for the Home
  Colin Dixon (IBM Research) Ratul Mahajan Sharad Agarwal A.J. Brush Bongshin Lee Stefan Saroiu Paramvir Bahl. NSDI 2012
- IoT-MAP: IoT mashup application platform for the flexible IoT ecosystem
  S. Heo, S. Woo, J. Im and D. Kim. 5th International Conference on the Internet of Things (IOT), 2015
- Smart LaBLEs: Proximity, Autoconfiguration, and a Constant Supply of Gatorade
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- The Cloud is Not Enough: Saving Iot from the Cloud
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- The Internet of Things Has a Gateway Problem
  Zachariah, Thomas and Klugman, Noah and Campbell, Bradford and Adkins, Joshua and Jackson, Neal and Dutta, Prabal
  HotMobile '15

Device Clouds, Edge Sensor Systems

- STRATUS: Assembling Virtual Platforms from Device Clouds
  Minsung Jang, Karsten Schwan. IEEE Cloud 2011
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- A Hybrid Edge-cloud Architecture for Reducing On-demand Gaming Latency
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