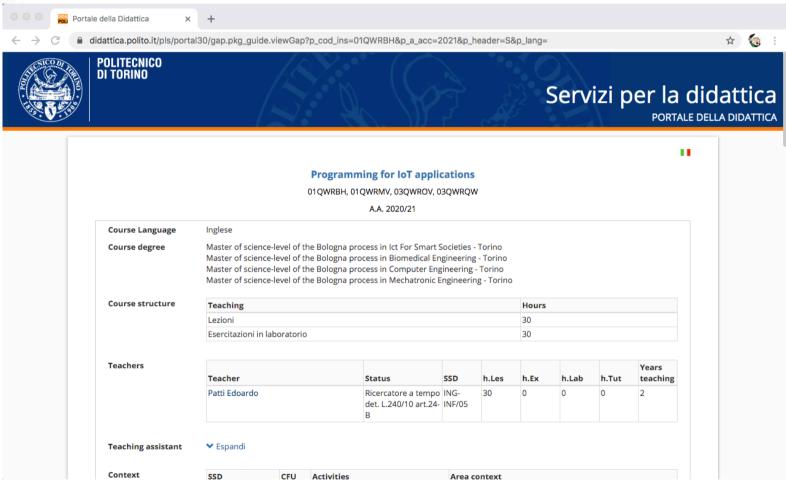# Programming for IoT Applications

Edoardo Patti

Lecture 0

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Course Description

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Internet of Things indicates a variety of devices connected via the Internet, including wearable devices, sensors deployed on buildings, industrial plants, production and distribution energy systems and in general on cyber-physical systems. IoT technology is widely adopted in many application domains, such as smart factories, buildings and districts for energy monitoring or surveillance, environment monitoring and control of natural phenomena, within transport systems for traffic management and finally within medical devices.

In this context, the aim of the course is to give the student ability to program embedded devices connected to the network using programming paradigms for distributed, parallel and object oriented systems. The ultimate goal will be the ability of programming in the Internet-of-Things and Cyber-Physical-Systems world. Students must acquire the ability to deploy and use of web services and middleware tools and related protocols (MQTT, REST).

The student will also acquire the ability to program according paradigms publish / subscribe. The student will explore the concepts and tools for interoperability between heterogeneous devices, protocols, Machine-to-Machine, operating systems-oriented smart objects and programming with real-time constraints and energy consumption. Finally, it will be handled aspects related to IoT data processing using machine learning techniques such as recurrent neural networks.

During the course will be presented case studies related to monitoring systems within smart cities and smart factories and includes a series of laboratory exercises where the student will implement the concepts of programming networked embedded devices equipped with sensors and actuators, and allowing remote interaction with these devices.

Expected Learning Outcomes

Expected Learning Outcomes

The course aims to provide students with the knowledge of object oriented programming and tools for its implementation in Python. Knowledge of the protocols for implementing web service oriented communication paradigms. Knowledge of the main tools for programming environment in real-time and in the presence of sensors and actuators. Tools for data analysis using machine learning.

The student will learn how to design a complete IoT system (microservice-based) and deploy it in a realistic application domain, starting data collection on IoT devices, data organization on the host, data processing, visualisation and user interaction

Course purposes

- How to design distributed software platform for dealing with IoT devices

- How to communicate with IoT devices

- How to get data from sensors and give commands to actuators

- How to write distributed applications to manage data from devices

Organization and Exam

- Organization
  - 30 h classes
  - 30 h labs and classroom exercises
- Exam
  - Written text: 12/30
    - 45 minutes
    - Multiple choice and open questions
    - One coding question
    - To pass the exam you must obtain at least 4 points in the theory plus 3 points in coding
  - Project discussion (videos + presentation + code): 18/30
    - Project discussion date is flexible (no time constraints, even in another session
    - **Project material must be submitted at least 5 days before discussion**
    - More info about project requirements will be given during the course

Projects

- Projects will be proposed by students
- Project team
  - members: 4
  - team building: autonomous
  - 1 raspberry kit for each team
- Lab dates (tentative):
  - 15/10/2020
  - 29/10/2020
  - 05/11/2020
  - 12/11/2020
  - 10/12/2020
  - 14/01/2021

Course contents

- Introduction to the Internet of Things
- Introduction to object oriented programming in Python
- Introduction to common data formats for information exchange (i.e. XML, JSON)
- IoT devices, communication paradigms and protocols
  - Request/Response communication paradigms
  - RestFULL Web Services (GET, PUT, POST, DELETE methods)
  - Programming distributed objects using Web Services
  - Publish/subscribe
  - MQTT
- Microservices and Middleware programming
  - Microservice design pattern
  - Middleware
  - Dockers
- IoT Platforms and middleware
  - Software requirements
  - Design and development of distributed IoT platforms
  - Linksmart
  - Thingspeak, Amazon, IBM Bluemix
- Design and development of services for different context domains

Course contents

- Labs
  1. Python programming
     - Basics, OOP
  2. Web programming I
     - Basic REST Web services and static web-pages management
  3. Web programming II
     - Advanced REST Web services
  4. Asyncronous Comminocation
     - MQTT protocol and simulation of IoT devices
  5. Management of IoT devices and services
  6. Cloud systems and applications

Course material

- Slides and notes
  - Available on-line, on the course page

- Reference book
  - None ☹

- Additional material
  - Internet ☺

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