Internet of Things

Second Edition (2021)

G. Anastasi, C. Vallati, F. Righetti

Dept. of Information Engineering

University of Pisa

Credits

- Credits: 9
  - Lectures: 65 hours
  - Practical Activities: 25 hours

- Prerequisites
  - Computer Architecture
  - Operating Systems
  - Concurrent Programming
  - **Computer Networking**

Goals

- Theoretical background on the IoT
- Basic methodologies for developing IoT applications
- Design and implementation of applications based on the IoT paradigm
  - smart cities
  - smart buildings
  - smart grid
  - smart industry
  - …

Topics

- Preliminary Concepts
- Smart objects
- Low-power and Lossy Networks (LLNs)
- IoT protocols
- IoT Platforms
- Industrial IoT (IIoT)
- Applications

- Practical activities

Roadmap

- **Preliminary Concepts**
  - Introduction to Smart Objects
  - Introduction to the Internet of Things
  - IoT Architecture & Protocol Stack

- **Smart objects**
  - RFID, sensors, sensor/actuator nodes
  - Hardware Architecture
  - Operating Systems for Smart Objects
  - Energy Management

Roadmap

- **Low-power and Lossy Networks (LLN)**
  - Definition
  - Communication technologies for LLNs
    - ⇨ Bluetooth, IEEE 802.15.4
    - ⇨ PLC
    - ⇨ …
- **IoT protocols**
  - IPv6 for LLNs
  - 6LowPAN Adaptation Layer
  - Routing Protocol for LLNs (RPL)
  - Constrained Application Protocol (COAP)
- **IoT Platforms**
  - IoT/M2M
  - OneM2M

Roadmap

- **Industrial IoT (IIoT)**
  - Requirements
  - Communication technologies for Industrial Applications (TSCH, …)
  - Limits of the IoT architecture
  - 6TiSCH Architecture

- **Applications**
  - IoT-based applications in different application domains
    - ⇨ Smart cities (pollution monitoring, smart lighting, …)
    - ⇨ Smart mobility (smart parking
    - ⇨ Smart home (energy efficiency)
    - ⇨ Industry 4.0

Roadmap

- **Practical activities**
  - Hands-on activities using IoT nodes and computers (or student's personal computer) in the IT classroom
    - ⇨ based on material provided by the teacher
  - Contiki Operating System
  - Programming smart objects
    - ⇨ based on Contiki OS
  - Design and implementation of IoT-based applications

Assessment

- The student will be assessed on her/his demonstrated ability to understand and put into practice the main contents illustrated during the course. During the oral exam the student must demonstrate her/his knowledge of the course material and present concepts with an appropriate terminology
- The student will also be assessed on her/his ability to put into practice the concepts illustrated during the course. To this end, she/he is required to design and implement a simple system/application and to report on this activity during the oral exam

- Lab project + oral test
- Lab project
  - will consists in the design and implementation of an IoT-based application

References

- J.-P. Vasseur, A. Dunkels. **Interconnecting Smart Objects with IP: The Next Internet**. Morgan Kaufmann, 2010
- Class presentations, papers and other material made available by the instructors
  - Course materials will be made available through TEAMS

Contact Information

- **Prof. Giuseppe Anastasi**

  Dept. of Information Engineering, University of Pisa

  Address: Largo Lucio Lazzarino 1, Pisa

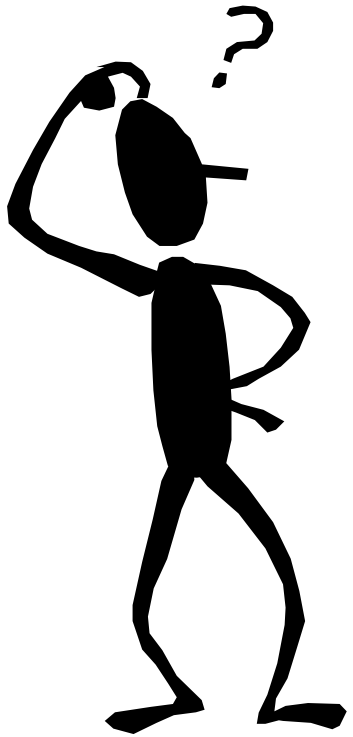
  Phone: 050 2217 559

  E-mail: giuseppe.anastasi@unipi.it

  Skype: giuseppe.anastasi

  Office Time: Wednesday, 15:30 – 18:30

Questions



Industry 4.0 Curriculum

This course is part of the Industry 4.0 learning path

UNIVERSITÀ DI PISA

Dipartimento di Eccellenza

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

This is to certify that Ms.

MINOU MANAFI VARKIANI

has successfully completed the

INDUSTRY 4.0 LEARNING PATH

including the following classes

Data Mining (9 ECTS)

Networking Embedded Systems (9 ECTS)

Pervasive and Mobile Computing (6 ECTS)

within the Master's Degree in COMPUTER ENGINEERING

The Chair of the Degree Programme Board

The Head of the Department

CROSSLAB Innovation for industry 4.0

Department of Excellence

CROSSLAB
Innovation for industry 4.0

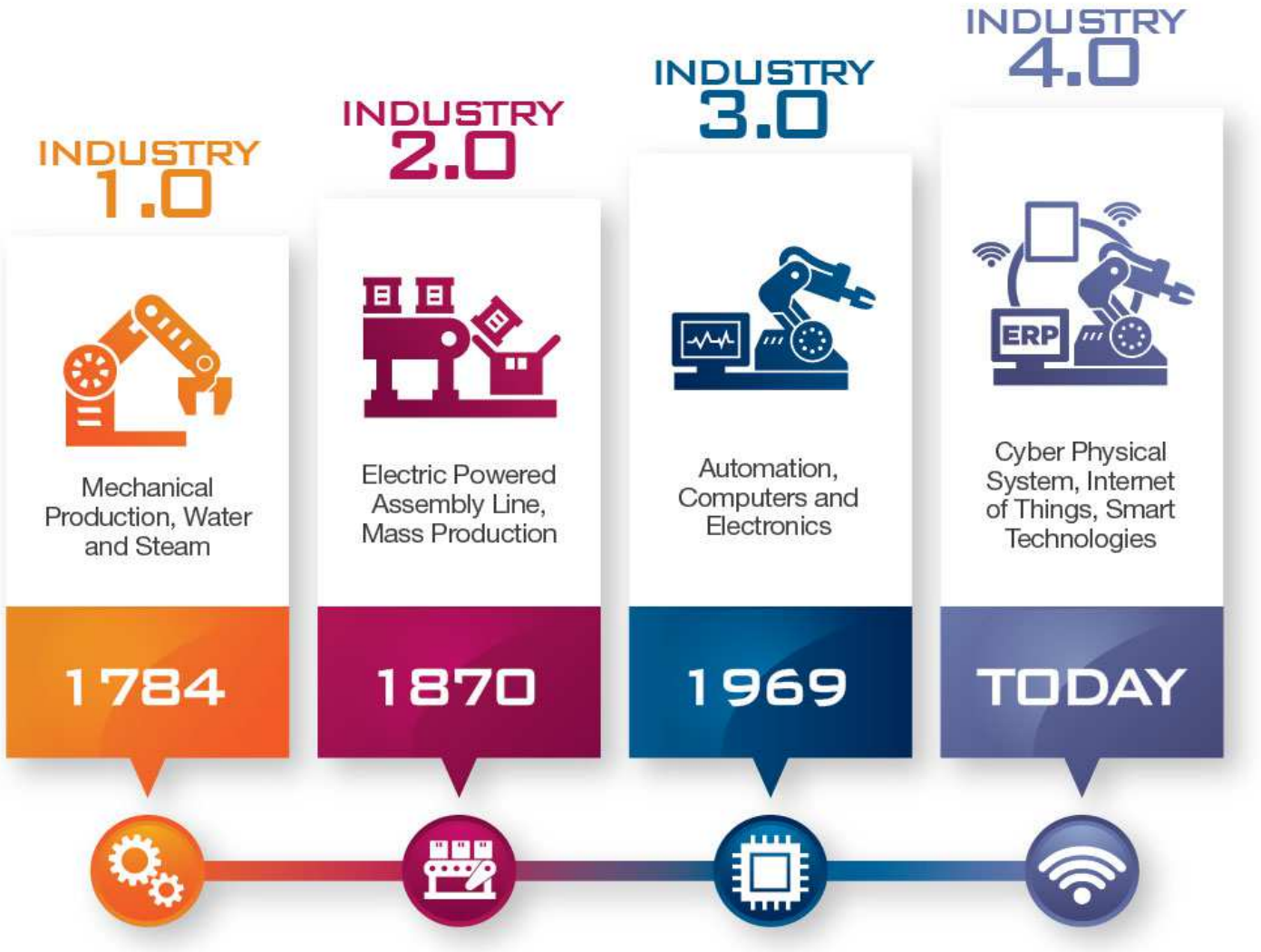
Interdisciplinary, Integrated and Opens Labs for INDUSTRY 4.0

UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

CROSSLAB Innovation for industry 4.0

Industry 4.0


INDUSTRY 1.0
Mechanical Production, Water and Steam
1784
INDUSTRY 2.0
Electric Powered Assembly Line, Mass Production
1870
INDUSTRY 3.0
Automation, Computers and Electronics
1969
INDUSTRY 4.0
ERP
Cyber Physical System, Internet of Things, Smart Technologies
TODAY

The CrossLab project

Research & Technology Transfer

- 5 new interdisciplinary and integrated labs (CrossLabs)
- Research activities on Industry 4.0
- CrossLab are open to industrial cooperation

Education

- New Masters on
  - ⇨ Artificial Intelligence & Data Engineering (AIDE)
  - ⇨ Cybersecurity
- Special short curriculum on *Industry 4.0* in each Master
- New PhD program on *Smart Industry*
- Special curriculum on *Industry 4.0* in the PhD program on IT

CrossLabs are

- Interdisciplinary

  Each CrossLab includes competences from different disciplines, including social and human sciences

- Integrated

  Activities of different CrossLab are strictly integrated

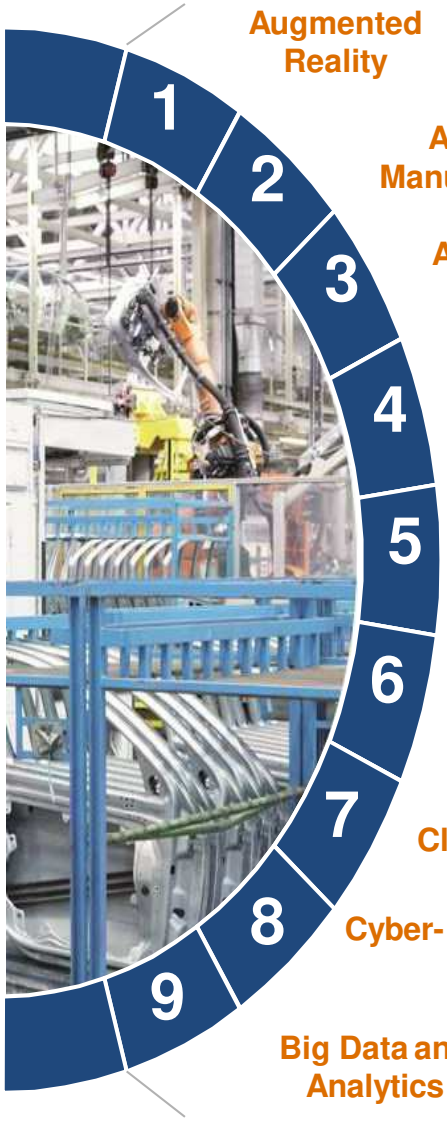
  They can be regarded as a single Lab on Industry 4.0

- Open

  CrossLabs are open to industry collaboration

  Industries can use CrossLab infrastructures and take advantage of the available know how

CrossLabs



Augmented Reality

Additive Manufacturing

Advanced Manufact. Solutions

Simulation

Horizontal/ Vertical Integration

Industrial Internet

Cloud

Cyber- security

Big Data and Analytics

Augmented Reality

Additive Manufacturing

Robotics & Advanced Manufacturing

Industrial Internet of Things

Cloud, Big Data & Cybersecurity

CROSSLAB
Innovation for industry 4.0

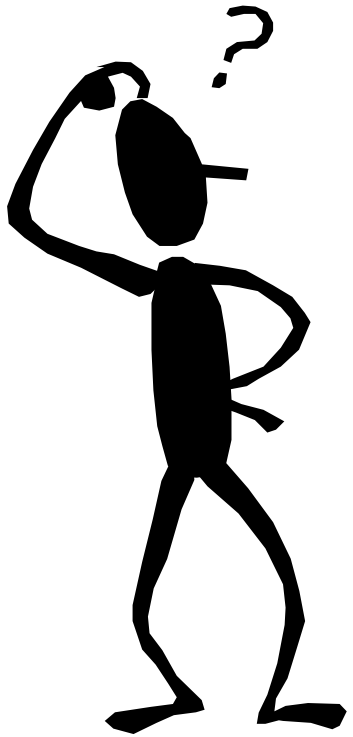
Information Technology & Society

Impact of Information Technology on the Society

- ⇨ Ethical issues
- ⇨ Sociological issues
- ⇨ Economic issues
- ⇨ Legal issues
- ⇨ Psychological issues
- ⇨ …

CrossLab

National & International Links



National Links

Partner of the

- **CINI Smart Cities National Lab**

http://www.consorzio-cini.it/index.php/it/laboratori-nazionali/smart-cities

- E-health
- Food
- Smart Energy & Smart Buildings
- Mobility, Transports, & Logistics
- E-tourism & E-culture
- E-education
- E-government
- E-inclusion
- Urban Security

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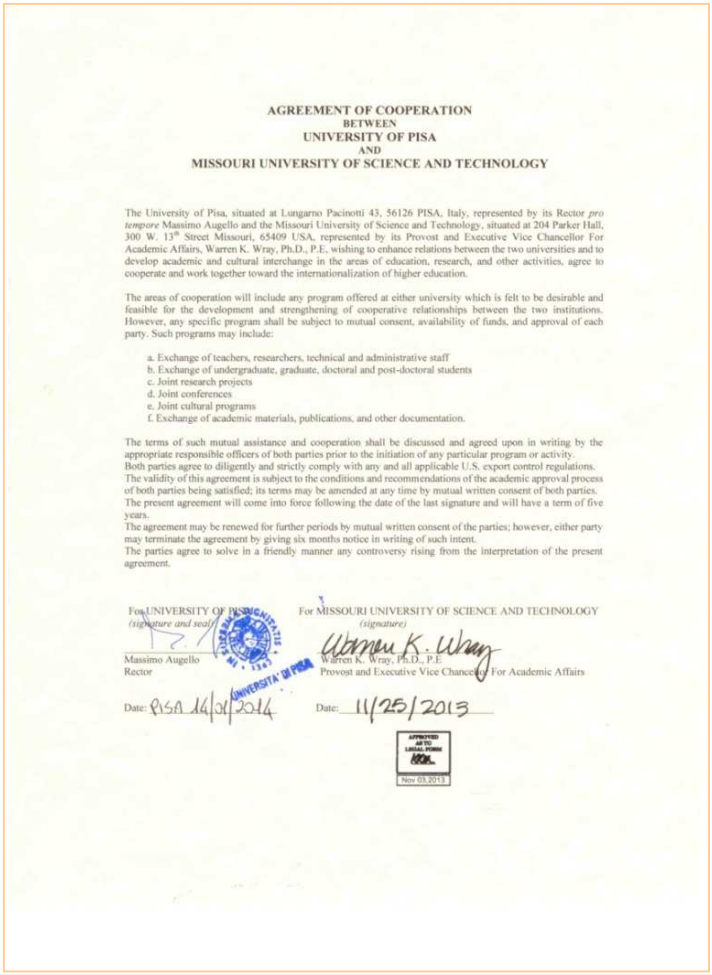
International Links

- Formal Cooperation Agreement
  - Missouri University of Science & Technology (MST)
  - Ref. Prof. Sajal K. Das

    Past Director, Dept. of Computer Science

    http://en.wikipedia.org/wiki/Sajal_K._Das



AGREEMENT OF COOPERATION
BETWEEN
UNIVERSITY OF PISA
AND
MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

The University of Pisa, situated at Lungarno Pacinotti 43, 56126 PISA, Italy, represented by its Rector *pro tempore* Massimo Augello and the Missouri University of Science and Technology, situated at 204 Parker Hall, 300 W. 13th Street Missouri, 65409 USA, represented by its Provost and Executive Vice Chancellor For Academic Affairs, Warren K. Wray, Ph.D., P.E, wishing to enhance relations between the two universities and to develop academic and cultural interchange in the areas of education, research, and other activities, agree to cooperate and work together toward the internationalization of higher education.

The areas of cooperation will include any program offered at either university which is felt to be desirable and feasible for the development and strengthening of cooperative relationships between the two institutions. However, any specific program shall be subject to mutual consent, availability of funds, and approval of each party. Such programs may include:

a. Exchange of teachers, researchers, technical and administrative staff
b. Exchange of undergraduate, graduate, doctoral and post-doctoral students
c. Joint research projects
d. Joint conferences
e. Joint cultural programs
f. Exchange of academic materials, publications, and other documentation.

The terms of such mutual assistance and cooperation shall be discussed and agreed upon in writing by the appropriate responsible officers of both parties prior to the initiation of any particular program or activity.
Both parties agree to diligently and strictly comply with any and all applicable U.S. export control regulations.
The validity of this agreement is subject to the conditions and recommendations of the academic approval process of both parties being satisfied; its terms may be amended at any time by mutual written consent of both parties.
The present agreement will come into force following the date of the last signature and will have a term of five years.
The agreement may be renewed for further periods by mutual written consent of the parties; however, either party may terminate the agreement by giving six months notice in writing of such intent.
The parties agree to solve in a friendly manner any controversy rising from the interpretation of the present agreement.

For UNIVERSITY OF PISA
(signature and seal)
Massimo Augello
Rector
Date: Pisa 14/01/2014

For MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY
(signature)
Warren K. Wray, Ph.D., P.E.
Provost and Executive Vice Chancellor For Academic Affairs
Date: 11/25/2013

International Links

Facing the Challenges of Industry 4.0

Dr. Giuseppe Anastasi

Dr. Carlo Vallati

University of Pisa, Italy

Monday, February 15th, 10:00 AM CST

Zoom link at: https://umsystem.zoom.us/j/91226409145

Password: 1234

International Links

- Informal Cooperation
  - Research Institute of Sweden (RISE)
    - ⇨ Former Swedish Institute for Computer Science (SICS)
  - Ref. Prof. Thiemo Voigt

    https://www.ri.se/en/thiemo-voigt

RI. SE

Contiki

The Open Source OS for the Internet of Things

International Links

- Informal Cooperation
  - Research Institute of Sweden (RISE)
    - ⇨ Former Swedish Institute for Computer Science (SICS)
  - Ref. Dr. Marco Tiloca

    https://www.ri.se/en/marco-tiloca

International Links

- Informal Cooperation
  - Hong Kong Polytechnic University
    - ⇨ Internet and Mobile Computing Lab
  - Ref. Prof. Jiannong Cao

    Past Director, Dept. of Computing

    http://www4.comp.polyu.edu.hk/~csjcao/

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

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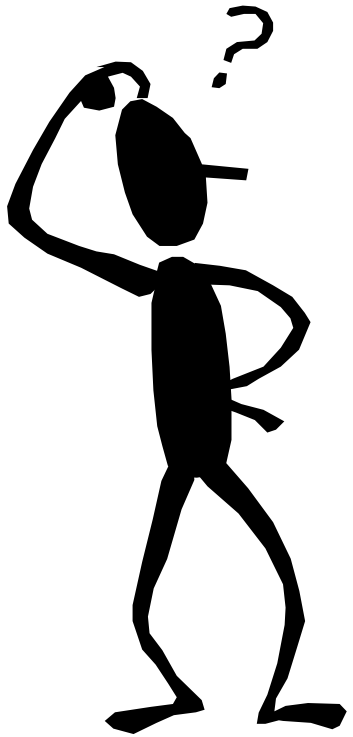
Questions



Online Registration

https://docs.google.com/forms/d/e/1FAIpQLSflNqQVKxzyrpb_UhXbK_5LsobEH75Y5R8-6NvV6WVArwxPrA/viewform

- Email Address
- Family Name
- Given Name
- Master's Degree
  - Computer Engineering
  - Artificial Intelligence & Data Engineering
  - Embedded Computing Systems
  - Other (please specify)