Digital communication

[CDE-201]

[5 ETCS]

[30h lectures + 15h TD/TP]

Overview

This course gives the basic principles of digital communications including baseband transmission, modulation techniques, spread spectrum signaling, orthogonal frequency-division multiplexing (OFDM), optimum reception, adaptive equalization, synchronization, fading channels, and diversity techniques.

Objectives

To know how to design a digital communication chain, estimating the performance in function of the technique and the various parameters in order to reach an objective under various constraints.

Course outline

- Baseband Transmission
- Single-Carrier Transmission
- Multicarrier Transmission
- Spread Spectrum Signaling
- Fading Channels and Diversity

Activities

30 h for lectures, 15h for TD/TP

Coordinator and pedagogical team

- Coordinator: Jocelyn Fiorina
- Pedagogical team: Jocelyn Fiorina, Pierre Duhamel, Nguyen Linh Trung

Evaluation

Written exam

Materials:

1. S. Benedetto, E. Biglieri, *Principles of Digital Transmission with Wireless Applications*, Kluwer Academic Plenum Publishers, 2002
2. J. Proakis, *Digital Communications*, McGraw-Hill, 2007
3. S. Haykin, *Communication Systems*, Wiley, 2009
4. D. Tse, P. Viswanath, *Fundamentals of Wireless Communications*, Cambridge University Press, 2005

Prerequisites:

1. Course "Mathematical Basis for Communications" or equivalent
2. Course "Information theory" or equivalent

Mobile networks

[CDE-202]

[3 ETCS]

[21h lectures + 9h TD/TP]

Overview

This course starts from a "complete system" vision (mobile and networks), to go to the different communication protocols. It addresses the issues related to a wireless technology (mobility, radio link, data transfer performance), all of which brings with it strong protocol constraints.

Objectives

The objective of this course is to present all wireless technologies (GSM/ GPRS/ EDGE/ 3G/ Wifi).

Course outline

- GSM
- GPRS
- EDGE
- UMTS
- Wifi (802.11)

Activities

21 h for lectures, 9h for TD/TP

Coordinator and pedagogical team

- Coordinator: Patrick Altman
- Pedagogical team: Patrick Altman, Amer Bdeoui, Nguyen Nam Hoang, Lam Sinh Cong

Evaluation

Written exam

Materials:

1. Ajay R. Mishra, *Fundamentals of Network Planning and Optimisation 2G/3G/4G: Evolution to 5G*, Wiley, 2018
2. Stefania Sesia, Issam Toufik ,Matthew Baker Wiley, *LTE "The UMTS Long Term Evolution, from Theory to Practice*, Wiley, 2011

Prerequisites:

1. Course "Digital communications" or equivalent
2. Course "Electronics systems for telecoms" or equivalent

Internet

[CDE-203]

[5 ETCS]

[24h lectures + 21h TD/TP]

Overview

Introduction to the main principles of networks by studying the architecture and protocols of the Internet.

Objectives

Acquire an understanding of the basic mechanisms and protocols implemented in telecommunications networks.

Course outline

- Introduction to the Internet
- IPv4, IPv6, NAT, subnetting
- Advanced TCP
- TCP and congestion control. Other transport protocols: CUBIC, SCTP, MPTCP, TCP Compound
- HTTP2.0, HTTP3.0, Multicast
- Quality of service
- Standard applications
- Multimedia Applications and Over the Top

Activities

24h for lectures, 21h for TD/TP

Coordinator and pedagogical team

- Coordinator: Veronique Veque
- Pedagogical team: Veronique Veque, Sahar Hoteit, Hoang Xuan Tung

Evaluation

Written exam

Materials:

1. J. F. Kurose and K. W. Ross, *"Computer Networking, A Top-Down Approach Featuring the Internet"*, Addison Welsey, 2013
2. Tanenbaum, *"Computer Networks"*, Pearson; 2013
3. William Stallings, *"Data & Computer Communications"*, Pearson; 2013
4. Peter L Dordal, *"An Introduction to Computer Networks"*, Loyola University Chicago, edition 2.0.1. online.
5. Olivier Bonaventure, *"Computer Networking: Principles, Protocols and Practice"*, Ed. 2019. Online.
6. W. R. Stevens, *TCP/IP Illustrated, protocols*, Addison Wesley, 2011

Prerequisites:

4G-5G networks

[CDE-204]

[3 ETCS]

[15h lectures +15h TD/TP]

Overview

This course presents the so-called 4th and 5th generations of mobile networks (4G, 5G). New radio transmission techniques and network architectures will be highlighted. The course will provide an overview of the flagship technologies on which the LTE network is based, its evolution LTE Advanced, and 5G.

Objectives

This course explains the structure of the 4th generation of mobile networks, and the evolution towards 5G.

Course outline

- Introduction
- Architecture
- Radio interface
- A core network
- Evolution towards 5G

Activities

15h of lectures, 15h of TD/TP

Coordinator and pedagogical team

- Coordinator: Patrick Altman
- Pedagogical team: Amer Bdeoui, Patrick Altman, Dinh Thi Thai Mai

Evaluation

Writing exam

Materials:

1. Stefania Sesia, Issam Toufik, Matthew Baker, *LTE-the UMTS long term evolution*, John Wiley & Sons, 2011
2. Chris Johnson, *5G new radio in bullets*, Independently Published, 2019
3. Harri Holma, Antti Toskala, Takehiro Nakamura. *5G Technology*, John Wiley & Sons, 2020

Prerequisites:

1. Course "Digital Communications" or equivalent"
2. Course “Mobile Network" or equivalent

Advanced data mining

[CDE-205]

[5 ETCS]

[24 lectures+21h TD/TP]

Overview

The course presents a set of algorithms for transforming, modeling, and interpreting data that can be directly applied to Data Science tasks, or can be necessary as a pre-processing step, before the data can be presented to an, e.g., machine learning task.

Objectives

The course focuses on the algorithms involved in data-related tasks, collectively grouped under the concept of “data mining”.

Course outline

- Introduction (basic ML and data science)
- Data mining algorithms
- Applications of data mining
- Data stream mining
- Reinforcement Learning, Multi-Armed Bandits
- Graphical Models/Bayesian Networks
- Gaussian Processes

Activities

24 h for lectures + 21h for TD/TP

Coordinator and pedagogical team

- Coordinator: Silviu Maniu
- Pedagogical team: Silviu Maniu, Emmanuel Vazquez, Tran Trong Hieu, Nguyen Viet Anh

Evaluation

Written exam

Materials:

1. J. Leskovec, A. Rajaraman, J. Ullman. *Mining of Massive Datasets*, Cambridge University Press, 2014
2. S. Abiteboul, I. Manolescu, P. Rigaux, M.-C. Rousset, P. Senellart. *Web Data Management*, Cambridge University Press, 2012
3. R. Sutton, A. Barto. *Reinforcement Learning*, MIT Press, 2017
4. T. Lattimore, C. Szepesvári. *Bandit Algorithms*, Cambridge University Press, 2020
5. C.A. Rasmussen, C. Williams. *Gaussian Processes for Machine Learning*., MIT press, 2005
6. D. Koller, N. Friedman. *Probabilistic Graphical Models*. MIT press, 2009

Prerequisites:

Algorithms, Programming (Python/C/Java)

IoT and cloud computing

[CDE-206]

[5 ETCS]

[27h lectures + 18h TD/TP]

Overview

The course contains 2 parts. Part 1 (Cloud computing) addresses the major features of current cloud systems, namely virtualization, storage, security, elasticity, programming models, optimal allocation of resources. Part2 (IoT) presents an overview of the technologies used in the IoTs, recalls the different wireless technologies currently available to achieve them and then detailed Lora technology.

Objectives

The objectives of the cloud-computing part are to enable the students to gain a deep understanding of the software implementation concepts of a cloud so that they can be users - expert developers but also administrators or contributors for such infrastructures. Second part about IoTs, offers students a complete and detailed landscape on the different protocols and technologies that will be used to realize the new system in which we are going to evolve.

Course outline

Part1: Cloud computing:

- Introduction
- Principle of cloud computing
- Fog and edge computing
- Future of cloud (serverless computing)

Part2: IoT

- Introduction to IoT: vision and trend
- Architecture and challenges
- Technology Solution for IoT End Devices
- IoT Edge Devices/Gateways
- Proximity Communications Between Objects and Edges: ZigBee, Thread, BT LE
- Long Range Communication with IoT gateways: LoRa, SigFox, NB-IoT
- End to End Data Gathering: Publish-Subscribe Model: MQTT, AMQP, Stromp
- Open IoT platforms and open initiatives
- Security and Privacy issues in IoT (energy, commerce, industry, transportation, healthcare, ...)
- Research activities in IoT (scalability, rate, energy, data mining, data analytics, cost).

Activities

27 h for lectures + 18h for TD/TP

Coordinator and pedagogical team

- Coordinator: Nazim Agoulmine (IoT), Bruno Defude (cloud)
- Pedagogical team: Nazim Agoulmine (IoT), Bruno Defude (cloud), Pham Manh Linh (cloud), Nguyen Hoai Son (IoT)

Evaluation

Written exam

Materials:

1. Perry Lea, *Internet of Things for Architects*, Packt Publishing Ltd, 2018
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, *IoT fundamentals*, Cisco Press, 2017
3. Nayan B. Ruparelia, *Cloud computing*, MIT Press, 2016
4. Michael J. Kavis, *Architecting the cloud*, John Wiley & Sons, 2014
5. Kevin Jackson, Cody Bunch, Egle Sigler, James Denton, *OpenStack Cloud Computing Cookbook*, Packt Publishing Ltd, 2018

Prerequisites:

1. Basic knowledge on "Operating systems","Computer Network" and " "Relational database management system"
2. Programming language (Java/C ++)

Research seminars

[CDE-207]

[4 ETCS]

[6h lectures + 30h presentations]

Overview

Each year new seminars will be proposed to the students. The topics covered by the seminars are up-to-date subjects currently under studies and development by the presenters.

Objective

The objective is to help students understand current research activities in the domains of wireless communications and networking, 5G and 6G systems, applications of machine learning, as well as other research topics... The second objective is to train student how to search for relevant information, how to read and summarize scientific papers.

Activities

- Seminars

Coordinator and pedagogical team

- Coordinator: Pierre Duhamel
- Pedagogical team: Pierre Duhamel, Le Sy Vinh, Dinh Trieu Duong, Nguyen Linh Trung, Luu Manh Ha

Evaluation

Materials:

Specialized articles, updated textbook in the field of telecommunications, networking, data science analysis,...

Prerequisites:

Law, workplace and project management

[CDE-208]

[4 ETCS]

[36h lectures]

Overview

- The course contains 2 parts.
- Part1 (law, workplace) addresses the introduction to law, regulation of business including protection of intellectual property rights and professional ethics, science and technology law, cyber law, contract law…..
- Part2 gives an overview of the principles of project management, difficulties encountered when implementing software project.

Objectives

- Part 1 (law, workplace) objectives are to enable students in understanding what is law, have some skills and knowledge about the main contents of the legal business environment including protection of intellectual property rights, business and professional ethics, contract, cyber law and science-technology law.
- Part 2 (project management): are to enable the students to gain understanding of the practices and skills needed to succeed in an entry-level project management role, learn how to create effective project documentation and artifacts throughout the various phases of a project. It also requires student to practice strategic communication, problem-solving, and stakeholder management through real-world scenarios.

Course outline

Part1: Law, Workplace

- Introduction to Law
- Protection of Intellectual Property Rights
- Business and professional ethics
- Contract law
- Cyber law
- Science and technology law

Part2: Workplace and Project management

- Introduction to Project Management
- Project planning
- Resource estimation
- Scheduling/Monitoring
- Change management/ Human management
- Project management

Activities

- Part1: 18h for lectures and case studies
- Part2: 18h for lectures

Coordinator and pedagogical team

- Coordinator: Phan Quoc Nguyen, Truong Ninh Thuan
- Pedagogical team: Phan Quoc Nguyen, Truong Ninh Thuan

Evaluation

- Written exam

Materials:

1. Sở hữu Trí tuệ và Chuyển giao Công nghệ phục vụ Đổi mới Sáng tạo, Phan Quoc Nguyen, NXB Bách khoa Hà Nội, 2020
2. Giáo trình Sở hữu Trí tuệ, Chuyển giao Công nghệ và Khai thác thông tin Sáng chế, Phan Quoc Nguyen, NXB Bách khoa Hà Nội, 2016
3. Mann & Roberts, Smith & Roberson's Business Law, 14th Ed., South-Western Cengage Learning, 2009
4. Kathy Schwalbe, Information Technology Project Management, Revised, 6th edition, Course Technology, 2010
5. Murali K. Chemuturi and Thomas M. Cagley Jr., Mastering Software Project Management: Best Practices, Tools and Techniques, J. Ross Publishing, 2010

Prerequisites:

Source and channel coding

[CDE-209]

[5 ETCS]

[36h lectures + 9h TD/TP]

Overview

In the first part of the course, we remind students of the basics of the algebraic coding theory for conventional binary-input output-symmetric memoryless channels. The second part of the course is devoted to sparse graph codes. We review in detail code construction aspects, iterative decoding, and mathematical tools for design optimization. We then expound the principles of non-binary coding for the Gaussian channel and show how and why coded modulations can also benefit from sparse-graph codes optimized for binary-input channels and iterative decoding.

Objectives

The first objective is to understand the basics of source coding (without memory, with memory, …). The second is to understand the basics of algebraic coding (linear codes, polynomial, convolutional, cyclic, BCH, Reed-Solomon, ...) on channels with binary inputs without memory.

Course outline

- Introduction to error-correcting codes; TD1 on error-correcting codes
- Linear cyclic codes; TD2 on Algebraic decoding
- Linear convolutional codes
- Performance of linear codes under MLD
- Factor graphs and the sum-product algorithm
- Sparse-graph codes : LDPC codes ; TD3 on LDPC codes
- Sparse-graph codes: Density evolution, Code design optimization under iterative decoding; TD4 on turbo codes
- Sparse-graph codes: Ensemble enumerators, Code design optimization under MLD
- Source coding; TD5 on source coding

Activities

36h for lectures + 9 h for TD/TP

Coordinator and pedagogical team

- Coordinator: Antoine Berthet
- Pedagogical team: Antoine Berthet, Pierre Desesquelles (source), Pierre Duhamel (channel), Tran Thi Thuy Quynh (source), Le Vu Ha (source), Nguyen Linh Trung (channel)

Evaluation

Written exam

Materials:

1. R. GAZI, O., Polar codes: *A non-trivial approach to channel coding*, Springer, 2019.
2. DECLERCQ D., FOSSORIER M., and BIGLIERI E., *Channel Coding: Theory, Algorithms, and Applications*, Academic Press Library, 2014
3. RICHARDSON, T. and URBANKE, R., *Modern Coding Theory*, Cambridge, 2008.
4. SCHLEGEL, C.B. and PEREZ, L.C., *Trellis and Turbo Coding*, Wiley, 2004
5. Duhamel, Pierre, and Michel Kieffer. *Joint source-channel decoding: A cross-layer perspective with applications in video broadcasting.* Academic Press, 2009
6. T. Cover, *Elements of Information Theory*, John Wiley, 1991.
7. F.J. MacWilliams, N.J.A. Sloane, *Theory of Error-Correcting Codes*, North Holland Publishing, 1977.
8. R.J. McEliece, *Finite Fields for Computer Scientists and Engineers*, Kluwer Academic Publishers, 1987.
9. W.E. Ryan, S. Lin, *Channel Codes*, Cambridge University press, 2009
10. A.J. Viterbi, J.K. Omura, *Principles of Digital Communications and Coding*, McGraw Hill, 1979
11. K. Sayood, *Introduction to data compression*, Morgan Kaufmann, 2012
12. R.G. Gallager, *Information Theory and Reliable Communications*, John Wiley, 1968.

Prerequisites:

Sound knowledge in Probability, Random processes, and Linear algebra

Network security

[CDE-210]

[5 ETCS]

[24 h lectures + 21h TD/TP]

Overview

This course provides an overview of various theoretical and practical aspects of network security. After completing this course, the students should be able to identify and assess current and anticipated security risks and vulnerabilities in an information system, develop a network security plan and policies. The acquired competencies include establishing a firewall with ACL, deploying a virtual private network, working with SSH tunnels and management of X.509 certificate life cycle.

Objectives

The course is intended to provide a solid understanding of modern cryptography, and its application in network protocols.

Course outline

- Methods and algorithms of modern cryptography.
- Network encryption and authentication protocols on various OSI layers.
- Practical and infrastructural aspects of network security.

Activities

24 h for lectures, 21h for TD/TP

Coordinator and pedagogical team

- Coordinator: Pavel Kalouguine
- Pedagogical team: Pavel Kalouguine, Nguyen Dai Tho

Evaluation

Written exam

Materials:

1. Keith M. Martin, *Everyday cryptography*, Oxford University Press, 2012
2. Al Sweigart, *Cracking Codes with Python*, No Starch Press, 2018.
3. Bryan Sullivan and Vincent Liu, *Web Application Security*, McGraw-Hill Osborne Media, 2011
4. John R. Vacca (ed), *Computer and Information Security Handbook*, Morgan Kaufmann, 2017
5. Michael Schwartz and Maciej Machulak, *Securing the Perimeter*, Apress, 2018
6. Evan Gilman and Doug Barth, *Zero Trust Networks*, O'Reilly, 2017

Prerequisites:

1. Mastering of communication protocols (TCP-IP, ICMP, ARP)
2. Basic probability theory and discrete mathematics (knowledge of basic abstract algebra and number theory is recommended, but not formally required)
3. Beginner level Python+ SQL

Advanced machine learning and IoT data analytics

[CDE-211]

[5 ETCS]

[30h lectures + 15h TD/TP]

Overview

The first part of the course is carried out from practical work intended to learn how to apply machine learning algorithms and statistical pattern recognition on real data. The practical know-how necessary to train and evaluate model performances are teach through examples of implementation on real data.
The second part is on the principles of machine learning in general and deep learning in particular. We will explore both the fundamentals advances in the area of deep learning and the recent applications to the field of IoT and in general communications. Our focus will be on recent applications of deep learning to perform data analytics on the Internet of Things (IoT) communications, including neural networks, auto-encoders, convolutional neural networks and recurrent networks. We will also consider well-known probabilistic graphical models, including undirected models and directed models that have recently shown promise (e.g. Boltzmann machines, Deep Belief Nets).

Objectives

This course provides knowledge of advanced machine learning, deep learning and using such techniques in real application using IoT data.

Course outline

Supervised learning (regression, classification)
Unsupervised learning (clustering, dimensionality reduction)
Introduction to Neural Networks
Advanced Neural Networks
Variations on auto-encoders and probabilistic Graphical Models
Modern architectural variations for communications and IoT data analytics

Activities

30h for lectures, 16h for TD/TP

Coordinators and pedagogical team

- Coordinators: Cecile Mallet and Pablo Piantanida
- Pedagogical team: Cecile Mallet, Emmanuel Vazquez, Florence Alberge, Tran Quoc Long, Nguyen Hong Thinh

Evaluation

Written exam

Materials:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning,* MIT Press, 2016
2. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
3. Tom M. Mitchell, *Machine Learning*, McGraw-Hill Education, 1997
4. Li Deng and Dong Yu, *Deep Learning - Methods and Applications*, Now publishers, 2014
5. Christopher M. Bishop, *Pattern recognition and machine learning*, Springer, 2006
6. Simon Haykin, *Neural Networks and Leaning Machines,* Pearson, 2009

Prerequisites:

1. Course "Information theory" or equivalent
2. Course "Probability " or equivalent