

Master Program in **Business Informatics**  
Courses Offered in English

March 26, 2012

# 1 Subjects from the Business Intelligence Area

## **Decision Support Information Systems (426AA) (12 ECTS)**

*Semester* 1, 2

*Contact Person* Prof. Antonio ALBANO (albano@di.unipi.it)

### *Objectives*

Each organization uses the historical data accumulated with the operational system to produce summary information to facilitate appropriate decision-making processes and make them more quick and objectives. The course presents the main approaches to the problem and the characteristics of mathematical tools and computer based information systems used. The course is divided into two modules. The first presents the approach that involves the use of specific databases, the Data Warehouse, to produce synthetic data interactively. It also describes the new requirements that these problems pose to the DBMS technology to enable rapid interactive analysis of large amounts of data. The second module discusses the decision process and criteria to make rational decisions using corporate information assets. It introduces the theory of decisions, according to the classical approach of the criterion of maximization of expected value. Then some methods of forecasting and optimization are introduced, in particular, Bayesian methods and dynamic programming. Finally, some typical examples are presented of application of these principles and methods in the economic-business area.

### *Syllabus*

#### Module 1: Decision Support Data Bases

- Information systems and computer-based information systems in organizations.
- Decision Support System Based on Data Warehouses.
- Data Models for Data Warehouses and On-line Analytical Processing.
- Conceptual and logical design in Data Warehouses.
- Algorithms for Selecting Materialized Views.
- Data Warehouse Systems Technology: Indexes, Star Query Optimization, Physical Design, Query Rewrite Methods to Use Materialized Views.
- Case studies.

#### Module 2: Model-Driven Decision-Making Methods

- Data Analysis for Business Decisions.
- Bayesian Methods for Classification and Prediction.
- Applications of Linear and Logistic Regression.
- Decision Trees. Decision Theory and Game Theory.
- Dynamic Programming.
- Estimation of investments value.

## **Data Mining (420AA) (12 ECTS)**

*Semester* 1, 2

*Contact Person* Prof. Dino PEDRESCHI (pedre@di.unipi.it)

### *Objectives*

Recent tremendous technical advances in processing power, storage capacity, and interconnectivity are creating unprecedented quantities of digital data. Data mining, the science of extracting useful knowledge from such huge data repositories, has emerged as an interdisciplinary field in computer science. Data mining techniques have been widely applied to problems in industry, science, engineering and government, and it is believed that data mining will have profound impact on our society. The course is divided into two modules. The first presents an introduction to the basic concepts of data mining and the knowledge discovery process, and associated analytical models and algorithms. The second module provides an account of advanced techniques for analysis and mining of novel forms of data, and the main application areas and prototypical case studies.

### *Syllabus*

#### Module 1: Foundations

- Concepts of Data Mining and the Knowledge Discovery Process.
- Data Preprocessing and Exploratory Data Analysis.
- Frequent Patterns and Associations Rules.
- Classification: Decision Trees and Bayesian Methods.
- Cluster Analysis: Partition-based, Hierarchical and Density-based Clustering.
- Experiments with Data Mining Toolkits.

#### Module 2: Advanced topics and applications

- Mining Time-Series and Spatio-Temporal Data.
- Mining Sequential Data, Mining Large Graphs and Networks.
- Advanced Association, Correlation and Frequent Pattern Analysis.
- Advanced Classification, Cluster Analysis and Outlier Detection.
- Visual Analytics.
- Data Mining Languages, Standards and System Architectures.
- Social Impact of Data Mining.
- Privacy-Preserving Data Mining.
- Applications: Retail Industry, Marketing, CRM, Telecommunication Industry, Financial Data Analysis, Risk Analysis, Fraud Detection, Mobility and Transportation, Public Administration and Health.

## **Business Performance Analysis (417AA) (12 ECTS)**

*Semester* 1, 2

*Contact Person* Prof. Salvatore RUGGIERI (ruggieri@di.unipi.it)

### *Objectives*

The course presents techniques for Business Analytics according to two views: The process-driven view of Business Process Modeling and the data-driven view of Business Intelligence. The two views are dealt with in the two modules of the course. The first presents the main concepts and problematic issues related to the process management, where processes are understood as workflow over some basic activities, and to show some of the languages, conceptual models and tools that can help to handle the main problems in a proper way. The second module presents technologies and systems for data access, for building and analyzing data warehouses, for reporting, and for knowledge discovery in databases. The accent of the module is on the use of tools and on the analysis of application problems by means of non-trivial samples and case studies. The student will be aware and able to manage the main technologies of Business Intelligence, specifically software products for effective decision support.

### *Syllabus*

#### Module 1: Business Process Modeling

- Introduction to Key Issues in Business Process Management.
- Terminology and Classification.
- Process Modeling. Conceptual Models and Levels of Abstraction.
- Rigorous Workflow Models: Petri Nets and Workflow Nets.
- Tool-supported Workflow Design and Analysis: Experimentation with Integrated Tools for Business Process Design, Analysis and Verification.

#### Module 2: Business Intelligence Laboratory

- Introduction: Tools for Business Intelligence.
- Data Access. Location, Format and API for Accessing Data in Text Files. Standards for RDBMS Data Connectivity.
- Extract Transform and Load. Tool for ETL. Case studies.
- Data Warehousing and OLAP. Tools for Dimensional Modeling. Case Studies.
- Tools for Reporting and Multidimensional Browsing. Case Studies
- Data Mining. Tools for Knowledge Discovery. Case Studies.

## **Business Intelligence and Performance Management (566AA) (6 ECTS)**

*Semester 1*

*Contact Person* Prof. Nicola CIARAMELLA (ciaramella@noesis-research.com)

### *Objectives*

The course presents a conceptual framework and a repertoire of methods for maximizing profit together with a few realistic examples. The key concept is building up a model for forecasting the market demand of company's products and a strategy for fixing sales prices and volumes. The company collects data about its customers and builds up a data repository for analyzing it, applies data mining and machine learning methods and creates a forecasting model for customers behavior, applies optimization algorithms and makes decisions about sales strategy, gets feedback from the market and repeats the cycle. A part of the course will be dedicated to a set of case studies.

### *Syllabus*

- Decision theory:  
Rational decisions, limited rationality and heuristics..
- Business Intelligence:  
Client behaviors, demand forecasting, market segmentation.
- Data Mining and Machine Learning:  
Applications to Business Intelligence.
- Sale price and volume optimization:  
Algorithms and heuristics.
- Case study: Flight reservations,  
product recommendation, web advertising optimization.

## 2 Subjects from the Informatics Area

### **Database Structures and Algorithms (411AA) (6 ECTS)**

*Semester 2*

*Contact Person* Prof. Antonio ALBANO (albano@di.unipi.it)

#### *Objectives*

Database systems occupy a central position in our information-based society, and computer scientist and database application designers should have a good knowledge about both the theoretical and the engineering concepts that underline these systems to ensure the application performance desired. The student who completes the course successfully will be able to demonstrate advanced knowledge of the main issues related to the implementation of classical centralized relational database systems in order to be a sophisticated user of database technology and a high-performance applications developer.

#### *Syllabus*

- Architecture of a DBMS:  
The Relational and Storage Engines.
- Permanent Memory Manager and Buffer Manager.
- Storage Structures Manager:  
Heap and Sequential Organizations;  
Primary and Secondary (Index) Organizations.
- Access Method Manager: The Storage Engine Interface.
- Query Manager:  
Physical Operators for Relational Operators;  
Physical Query Plan Generation;  
Query Optimization.
- Transaction and Concurrency Managers.
- Physical Database Design and Tuning.

## **ICT Risk Analysis (416AA) (6 ECTS)**

*Semester 2*

*Contact Person* Prof. Fabrizio BAIARDI (baiardi@di.unipi.it)

### *Objectives*

The course is divided into two parts. The first one introduces the concepts underlying the risk management of an ICT system and the analysis that have to be implemented to assess and manage this risk. The approach extends to ICT system classical risk management strategies. The second parts of the course introduces cloud systems, their enabling technologies and the economic advantages they enable. Then, the security of cloud system is evaluated to show how they change the traditional approach to increase the security of an ICT system.

### *Syllabus*

#### Risk Analysis of an ICT System

- Vulnerability of a System.
- Vulnerability Analysis of ICT Systems: Analysis of Standard Components, Analysis of Non Standard Components.
- Threat Analysis.
- Attack Analysis: Complex Attacks and their Formal Description, Automated Attacks (Virus and Worms).
- Impact Analysis.
- Risk Assessment and Management.
- Countermeasures: Encryption, Intrusion Detection Systems, Firewall, Secure Programming.

#### Security of Cloud Systems

- Enabling Technologies.
- Architectural Models.
- Deployment Models.
- Threats of Cloud System.
- Attack against Cloud.
- Countermeasures for Cloud Systems.

## **Peer-to-Peer Systems (261AA) (6 ECTS)**

*Semester 2*

*Contact Person* Dr Laura RICCI (ricci@di.unipi.it)

### *Objectives*

The course presents the main methodologies and techniques for the project and the implementation of P2P systems. Both unstructured and structured overlays will be analysed. Any technique will be exemplified by a set of real applications. The course will introduce a set of tools for the simulations and the implementation of P2P systems.

### *Syllabus*

- P2P Systems: Classification and General Characteristics.
- Unstructured P2P Overlay Networks.
- Proximity Aware Overlays: Internet Coordinate Systems.
- Cooperative Content Distribution.
- Tools for P2P Network Simulation and Implementation.

## **Software Services (389AA) (6 ECTS)**

*Semester 2*

*Contact Person* Prof. Antonio BROGI (brogi@di.unipi.it)

### *Objectives*

The course presents the main aspects in the design and implementation of software services. After introducing the currently adopted standards for Web services, the course centers on service-oriented architectures and on the techniques for developing applications by discovering, composing and adapting existing services. The use of languages supporting the definition and the implementation of business processes via workflows is discussed. The course also describes some of the techniques employed for guaranteeing non-functional properties of services, such as quality of service and security properties. The last part of the course discusses the role of software service engineering in the more general context of service economy (and of the so-called “service science”), by illustrating the interplay between engineering and economic aspects (business models, service contracts) of services, as well as the relevance of the separation of concerns in the design of services.

### *Syllabus*

- Protocols and Architecture of Software Services.
- Basic Standards of Web Services.
- Service-oriented Architectures.
- Introduction to the Design and Implementation of Software Services.
- Discovery, Composition and Adaptation of Software Services.
- Definition and Implementation of Business Processes via Workflows.
- Business Process Execution Languages.
- Management and Analysis of Non-functional Properties (Quality of Service, Security).
- Role of Service Engineering in the Context of the Service Economy.

## **Technologies for Web Marketing (537AA) (6 ECTS)**

*Semester 1*

*Contact Person* Prof. Salvatore RUGGIERI (ruggieri@di.unipi.it)

### *Objectives*

The course presents an overview of the tools provided by the Web by explaining the technologies and strategies that govern their functioning, to show how it is possible to exploit these tools to implement marketing strategies to improve the visibility, understanding the users opinion about the products and influence opinions and purchasing behaviour.

### *Syllabus*

- Calculation of the importance of a web page by search engines and the possibility of influencing their result.
- Sorting the results shown by search engines in response to a query.
- Choice of the allocation of advertising slots on search engines and new media.
- Mechanisms that regulate online auctions and their objectives.
- Identifying individuals most influential in the social network in order to predict and influence the trend of these networks.
- Analysis of social media to determine the users opinions about products or brands.
- Customization and optimization recommendations for new products in online commerce sites.
- Strategies used on websites to attract and retain visitors.

## **Web Mining and Social Network Analysis (427AA) (6 ECTS)**

*Semester 2*

*Contact Person* Prof. Dino PEDRESCHI (pedre@di.unipi.it)

### *Objectives*

The course presents the main analysis techniques of Web-related data: Web content data, Web link/structure data, Web usage data, and relation network (graph) data from social networking and online collaboration, according to the Web 2.0 paradigm. The course also focusses on the analysis tools for large complex networks.

### *Syllabus*

#### Web mining

- Static and Dynamic Ranking of Web Pages.
- Link Analysis.
- Web Usage Mining.
- Web Spam Advertisement in Search Engines.

#### Complex network analysis

- Taxonomy of Complex Networks (social, technological, economic, informational, biological).
- Measures: Diameter, Connected Components, the “Small World” Effect, Clustering Coefficient, Degree Distribution, Power Laws.
- Network Generation Models: Random Graphs, Small-world Models, Preferential Attachment Models, Affiliation Networks.
- Graph Mining and Evolutionary Network Patterns.

### **3 Subjects from the Operation Research Area**

#### **Logistics (255AA) (6 ECTS)**

*Semester* 1

*Contact Person* Prof. Maria Grazia SCUTELLÀ (scut@di.unipi.it)

#### *Objectives*

The course presents the structure and functions of logistics systems, analyzing major decision problems arising in the medium/long term (tactical/strategic decisions). After an introduction to the main characteristics of logistics systems, with emphasis on distribution logistics, optimization models for decision support are discussed. Some relevant models and methods are then illustrated with the aid of appropriate software tools, and logistics case studies are presented.

#### *Syllabus*

- Introduction to Supply Chain.
- Models and Methods for Location Problems.
- Models and Methods for Transportation Problems.
- Models and Methods for the Design and Management of Distribution Centers.
- Models and Methods for Inventory Management.

## **Network Optimization Methods (433AA) (6 ECTS)**

*Semester 2*

*Contact Person* Prof. Maria Grazia SCUTELLÀ (scut@di.unipi.it)

### *Objectives*

The course presents the main modeling techniques and the main algorithmic methodologies for managing communication networks both at a design and at an operational level. Relevant design and operational problems for communication networks will be considered, such as QoS routing problems, location problems and resiliency problems. Then, modeling techniques and algorithmic approaches will be considered for both basic problems and NP-Hard problems.

### *Syllabus*

- Basic network optimization problems: Models and Algorithms, Minimum Cost Flow, Multicommodity Flows.
- NP-Hard Network Optimization Problems: Models and Algorithms, Routing Models, Network Design Models. Main Heuristic Techniques, Exact Approaches.
- Applications: QoS Routing, Location Problems, Resiliency Problems.