Laboratory of Advanced Analytics on Complex Data

Mission

ADA Lab conducts research in the area of Behavior Computing, a discipline aimed at modelling and analysing the behavior of heterogeneous entities in their environment. Behavior Computing is an important topic in different contexts including: consumer analytics, social computing, fraud detection, and group decision-making. The goal of ADA Lab in this context is twofold.

First, defining mathematical models that allow to analyse, understand, and predict actions made by entities in their environment. ADA Lab devises novel techniques that can be applied on a broad spectrum of data models including graphs, trees, unstructured data, and sensor/stream data.

Second, turning these abstract models into computational models able to deal with the volume, variety and velocity of complex data. ADA Lab will devise efficient algorithms to be instantiated in scalable data processing solutions (e.g., Distributed/Parallel Systems, the Cloud) capable of handling Big Data.

The expected outcome will be a general and scalable approach to support decision making, which will be tested in two concrete scenarios:

-Security, where the lab will contribute to novel approaches for terrorist prevention, access/management of sensitive information, and intrusion/fraud/anomaly detection.

-Complex System Analysis and Optimization, where the lab will devise techniques to analyse, optimize and make predictions about the structure of

complex systems. Examples include: social networks, where the objective is to optimise the user's experience; business process management systems, where the objective is to monitor and improve the way a process is enacted within an organization; knowledge graphs, where the goal is to provide improved information filtering mechanisms.

ADA Lab expected results include the dissemination of research findings in high impact conferences and journals, the release of open source software libraries, and the possible filing of patents.

Fields of application

- Tourism: Tools for promoting services and enhancing users experience
- Smart Grids: Autonomous and self-aware Energy management systems based on intelligent data analysis
- Resource Management: Providing users with advanced services for effectively producing/sharing resources and for working coordinatively, while ensuring privacy and protection.
- Cybersecurity and Homeland Security: Supporting monitoring and mass surveillance through knowledge discovery
- E-Commerce and Viral Marketing: Modeling and measuring the effect that actors in a market have on each others purchasing decisions.

Research themes

- **Descriptive/Predictive Analytics**
  Methods and techniques for the formalization and forecast of phenomena based on historical data. Research topics:

  - RFM Analysis;
  - Behavioral Clustering e Lifetime Value Detection;
  - Fraud/ Intrusion/Anomaly Detection;
  - Risk /Churn Analysis;
  - Semistructured Data Analysis for pattern extraction.

- **Social e Knowledge Network Analysis/Querying**
  Research topics:

  - Knowledge Querying/Discovering, querying and knowledge discovery from knowledge graphs
  - User Profiling, user behavioral discovery;
  - Community Detection, identification of social communities;

- Link Prediction, study of the evolution of a network;
- Information Diffusion/Influence Propagation, modeling of the spread of information and influence;
- Sentiment Analysis, discovery of user feeling by analising messages;
- Knowledge Querying/Discoverying,querying and knowledge discovery from knowledge graphs.

- **Process Mining**
  Methods to analyze/optimize organizational processes, based on data produced by activity tracing systems. Research topics:

  - Process Discovery;
  - Activity Mining/Abstraction;
  - Process Log Summarization;
  - Process Prediction (estimating performances/risks for ongoing process instances);
  - Compliance Checking (modeling and verifying non-functional business constraints).

- **Recommender Systems**
  Recommendation is a special form of information filtering, which extends the concept of research via the modeling and understanding of user preferences. Research topics:

  - Probabilistic models for data analysis of preferences;
  - Adoption Explanation;
  - Cold Start;
  - Social Contagion.

- **Scalable Data Mining.**
  Parallel and distributed algorithms and techniques that aim at analysing Big Data using distributed architectures (e.g., Cloud Computing).
  Research topics:

  - Techniques for sampling and query-based sampling based on Map-Reduce;
  - Classification and clustering using distributed bio-inspired algorithms;
  - Real-time analysis of data streams using ensemble techniques;
  - Techniques for the offloading of mobile device in Cloud architectures.