WHITE PAPER AP3
DATA, CONTENT, AND MEDIA

Abstract

Smartphones, smart buildings, smart factories, smart cities, autonomous vehicles, and other smart environments and devices such as 2D and 3D acquisition systems, are filled with digital sensors, all of them creating an abundance of data. Governments and health-care entities collect, generate, and use data in an unprecedented quantity. This availability of a huge amount of data, has pushed various disciplines and technologies towards cooperation with the aim of devising ever better models, methods, and algorithms for data acquisition, processing, analysis, visualization, and interpretation.

In this context, the research activities carried-on in the AP "Data, Content, and Media" contribute both to advance methods and technologies and to discover piece of knowledge for a better understanding of individual and collective phenomena and behaviors and for the construction of intelligent and autonomous systems in challenging domains.

The main research and development challenges concern: the **modelling, analysis, and visualization of data** that cannot be processed with traditional methods (Big Data); the **extraction of knowledge and learning predictive models from multi-dimensional, multi-sources, networked, and dynamic data** based on artificial intelligence, data mining and network science methods; the **intelligent processing of image, audio, and audio-visual content** for the development of applications based on content recognition; the **analysis and comparison of digital content for 3D models**, and more generally, multi-dimensional representations; the **development of applied ontologies of socio-technical systems and semantic technologies** for their treatment based on the languages of the semantic web (Linked Data) and for semantic interoperability; the **natural interaction with computer systems** based on multimodal paradigms that make it accessible and usable.

The **main research topics** addressed by the AP include database and semantic web technologies, knowledge representation and management, data visualization, data mining and pattern recognition, machine learning, and artificial intelligence, complex system theory and network science, information retrieval and text mining, statistics and applied mathematics, natural language processing, computer vision and computer graphics, user modelling and cognitive computing.

The AP research and development activities involves 15 CNR Institutes (CNR-ISTI, CNR-IMATI, CNR-ITC, CNR-IIT, CNR-ISTC, CNR-IREA, CNR-IEIIT, CNR-ICAR, CNR-IASI, CNR-IAC, CNR-ITIA, CNR-IFAC, CNR-IGI, CNR-IRC, CNR-ISTEC), **for a total of around 600 person-months per year**.

1. STATE OF THE ART OF THE RELEVANT SCIENTIFIC AREA

Digital technology is ubiquitous and very much part of public and private organizations and of individuals' lives. People and things are becoming increasingly interconnected. Smartphones, smart buildings, smart factories, smart cities, autonomous vehicles and other smart environments and devices are filled with digital sensors, all of them creating an abundance of data including both visual data (2D images, 2D and 3D videos, 3D data) and multimodal and multidimensional signals from environmental and personal monitoring systems. The consequence is the need for methods to extract high-level information from data, including techniques for feature extraction, shape description, matching, classification, and segmentation.

Knowledge Extraction and Semantic enrichment have become a key semantic technology that allows us to produce structured knowledge from unstructured or semi-structured sources. Although basic Natural Language Processing tasks (e.g., word sense disambiguation, named entity recognition) have been configured

for Semantic Web tasks (including ontology learning, linked data population), the problem of extracting knowledge is still only partly solved. Being able to automatically and quickly produce quality linked data and ontologies from an accurate and reasonably complete analysis of unstructured contents would be a breakthrough: it would enable the development of applications that automatically produce machine-readable information from Web content as soon as it is edited and published by generic Web users.

Big Data analytics, at the convergence of data mining, machine learning, statistical modelling, and complex systems science, is capable to transparently monitor the quality of data and results of analytical processes. The complexity of machine-learnt models and their widespread use requires **novel algorithmic solutions**, **aimed at rendering fast and scalable** both the learning phase and the use of the learnt models in large-scale applications and aspects, such as distributed and cooperative learning, security, and resilience. The training process of both supervised and unsupervised models needs to cope with huge training datasets and latency constraints needed to keep the prediction models fresh and updated. To facilitate and optimize Big Data infrastructures, novel methods need to investigate for distributed indexing, processing, and management, thus going beyond textual compression and including heterogeneous, highly dynamic and semantically-enriched data. Other important aspects are the use of formalisms for explicitly representing knowledge, in order to reason about that knowledge, to make inferences, and to assert new knowledge.

Data mining algorithms for automated pattern discovery highlight the structure hidden in massive data sets, such as the clusters of consumers with similar behavior emerging from large user bases, or the modules of proteins with similar functions emerging from the biological networks of protein-to-protein interactions. **Machine learning** - including “deep learning” - methods exploit large “training” datasets of examples to learn general rules and models to classify data and predict outcomes (e.g., classify a taxpayer as fraudulent, a consumer as loyal, a patient as affected by a specific disease, an image as representing a specific object, a post on a social media as expressing a positive emotion).

Neural networks and **deep learning methods**, and more specifically **deep convolutional neural networks** have recently become state-of-the-art approaches for many computer vision tasks, such as image classification, image retrieval object detection, and object recognition. We expect artificial intelligence and neural networks, in particular, to guide the innovation in Multimedia Information Retrieval and Computer Vision for the next 10 years. Thus, there is a need for further research in artificial intelligence on these specific topics. The most significant open issues are: **adversarial machine learning, large scale deep learning, relational learning, multimodal learning, and cross-media learning**.

Network science has unveiled the magic of shifting from the statistics of populations to the statistics of interlinked entities, connected by the ties of their mutual interactions; this change of perspective reveals the universal patterns underlying complex social, economic, technological and biological systems, and is beginning to understand the dynamics of how opinions, epidemics, or innovations spread in our society, as well as the mechanisms behind complex systemic diseases, such as cancer and metabolic disorders and to reveal hidden relationships between them.

Visual and multidimensional data, and multimedia (e.g., images, 3D models, 2D and 3D videos, cartographic digital maps) are among the most popular and pervasive information and communication media, with applications to education, engineering, geographic information systems, bio-medicine, bioinformatics, art, advertisement, entertainment, gaming, cultural heritage, and many others. The increasing interest on **multimedia** and **multi-dimensional data processing and visualization** is due to emerging applications, to the proliferation of multimedia devices, and to the huge impact of audio and visual information on daily life. For instance, **augmented and virtual reality technologies** are becoming widespread and crucial in several fields such as industry, maintenance, health, training, rehabilitation, and leisure. **Geo-referenced** (i.e., associated with a geolocation on the Earth surface or implicitly expressed by place names, points of interest) **devices and data** are of great importance to develop location-based services for the most diverse fields, such as urban monitoring and planning, tourism and environmental and social sciences. The resulting generation of

high-quality data has boosted research in color image processing, image and 3D data analysis, perceptual image evaluation and 3D visualization, spatiotemporal techniques, such as denoising, enhancement, segmentation, and compression methods, specifically defined for processing the input video as a 3D data with emphasis on motion estimation and analysis.

Visual data and media are typically stored as collections and archives of visual, multidimensional, heterogeneous data, and multimedia, which need methods and tools to **navigate these catalogues** on the web and facilities for searching, browsing, clustering, interacting, and visualizing different kinds of visual data and related information (e.g., geo information) and to **automatically extract features able to describe (semantic) contents** of the visual/textual data and to effectively/efficiently query the archives, by flexibly considering different granularities and scales, objectives, and regions of interest. Important aspects are the **development of best practices for the management of heterogeneous data**; e.g., metadata for the input data (e.g., identification, aggregation, versioning, annotation, authorization, embargo), their formats, and the processes applied to data (e.g., for archiving of workflow descriptions, archiving of descriptions of services involved in workflows, archiving of code involved in workflows).

2. CONTRIBUTION TO THE RELEVANT SCIENTIFIC AREA

DATA

Line1: Big data Sensing and Management

The common situation with Big Data is that information come from several data sources of different nature, form (e.g., structured, unstructured) and quality level, resulting in heterogeneous data flows that are difficult to integrate. Major contributes focus on methods for analytical crawling, crowdsensing and crowdsourcing for sensing data from social media and mobile devices, object detection and recognition for sensing data from smart camera networks; for compressing, indexing, and managing massive big data;(e.g., RTI images, images, videos, 3D models).

Line2: Knowledge Representation, Reasoning and Engineering

Knowledge representation goes hand in hand with automated reasoning because one of the main purposes of explicitly representing knowledge is to be able to reason about that knowledge, to make inferences, assert new knowledge, clearly an inference engine as part of the system.

- **Semantics Web Technologies and Languages** such as OWL 2 and RDFS, have been extended with Fuzzy Logic and corresponding reasoning tools (Fuzzy OWL 2 and fuzzyDL).
- **Conceptual modelling and Ontology engineering** developed within several domains including: cultural heritage, natural language, health, software security, public administration, smart cities, agriculture manufacturing, domotics, maritime.
- **Semantic Database** through a valid reference architecture for an RDF store that plays the role of backbone to support large-scale semantic applications, with multiple users.
- **Semantic Search and Retrieval** enabled by ontology-based similarity and relatedness mechanisms.

Line3: Knowledge Extraction and Semantic enrichment

Knowledge Extraction has become a key semantic technology that allows us to produce structured knowledge from unstructured or semi-structured sources). Objects to be enriched range from short posts published on online social network (e.g., texts, tags, pictures, video and audio files) to spatiotemporal data (georeferenced by the GPS receiver of the user)recording the movement of an object in time and space.

- **Entity linking** aimed at identifying in texts the mentions referring to concepts or entities (e.g., Dexter (http://www.dxtr.it/).
- **Linked Open Data**, design and development of linked data, semantic technologies, metadata models, together with standardization efforts (e.g., W3C, RDA), which provide the tools for maximizing interoperability between services, such as data catalogs, e-Infrastructures, e-Government settings, and virtual research environments. (e.g., Framester - Linguistic Linked Data Hub).

- **Semantic enrichment of movement data:** pure movement data are enriched with multiple heterogeneous contextual aspects extracted from heterogeneous sources and interconnected by different relations.
- **Semantic analysis and management of 3D and multi-dimensional data:** and more generally, of web resources exposed following the Linked Data paradigm.

CONTENT

Line 4: Data Mining and Machine Learning

The focus is on novel data mining and supervised/unsupervised learning algorithms and their application to specific forms of data, such text, images, multimedia, spatial, temporal, spatiotemporal, graph in order to extract accurate models to rank results of queries, predict the evolution of complex phenomena, classify data items, provide personalized and context-aware recommendations in online and mobile environments, and understand human behavior. The models are the basic break of **intelligent autonomous systems** for ambient assisted living, autonomous driving, predictive maintenance, and personal driver assistant.

- **Foundations and algorithms for data mining and machine learning**: pattern discovery, rule generation, motif discovery, clustering (time series, transactional, co-evolutionary), statistical learning, decision trees, convolutional neural networks, reinforcement learning, adversarial learning, causal inference, anomaly/intrusion.
- **Text and Sentiment Mining**: classifying the generated content (UGC – e.g., a tweet, a product review, a post on a social networking service) according to the sentiment it conveys (or opinion it expresses) about a certain entity, also in multilingual and multi-domain scenarios.
- **Mobility Data Mining**: a stack of spatial, and spatiotemporal algorithms from basic one as trajectory pattern mining, flocks and clustering to richer one as future location prediction, mobility profile discovery, activity recognition, transfer learning among different territories, functional area detection.
- **Neural Networks for Question-Answering**: neural networks-based information retrieval and paragraph ranking methods capable to better identify text paragraph candidate to contain the answer to a given question; new text encoding methods and neural network architectures and models having better performances in extracting entities and text passages that constitutes the answer to a given question.
- **Large Scale Data Mining and Machine Learning** based on Intelligent sampling and pruning methods, mapping learning on CPU's characteristics with a novel bit-vector representation of tree-based models, model reduction in case of multiscale parameter distributed systems. data. Applications are mainly focused on the analysis and/or modelling of combustion engines instabilities, flames dynamics and fronts dynamics in forest fires by making use of IR images and/or GIS data.

Line 5: Network Analysis

A world in a continuous evolution requires methods and framework capable of sensing the complexity of the relationships of individuals and adapting at the changes of the evolutionary patterns and models.

- **Foundation and algorithms for social network analysis** models for dynamic and multilayer networks, link prediction, methods for **community discovery, models for information diffusion and epidemics spreading, novel topological measures and predictive models.**
- **Online Social Networks analysis** focused on characterizing the properties that ego networks exhibit in Online Social Networks and on understanding how these properties impact on important processes such as trust and information diffusion.

Line 6: Behavior Analysis

- **Behavior analytics** aimed at predicting what kind of event will take place at what time in the future. Who are the innovators, the leaders? On the base of information diffusion, hidden factors of influence propagation on the base of personal experience to the aim of improving user experience within a specific situation by understanding the patterns governing the user's choices.

- **(Visual) Cognitive Computing** delivers personalized guidance systems, in particular Virtual Personal Assistants through user profiling to model behavioral and psychological data underlying a successful interaction with the users, adaptive coaching content and message delivery strategies, and user engagement through a rich and unobtrusive user experience.
- **Social Media Analysis**: How does people discuss on online social networks? Who are online social network users that take part i political debate? What is the structure of their social network? What topics are discussed on online debates. Is content fake? The aim is to study how opinions form and spread on line and detect fake news and fake users.
- **Profiling and personalization:** at the base of any form of automatic recommendation and suggestion represent a fundamental tool to characterize user's interest and habits with the ingestion and analysis of users generated huge amounts of contents.

MEDIA

Line 7. Acquisition, modelling, and analysis of images, videos, 3D and multidimensional data

- **Algorithms and tools for the acquisition, and modelling of images, videos, static and time-varying 3D data** (e.g., complex scenes, deformable/articulated objects from 3D and 4D scans), which are typically acquired by multiple and/or low-cost acquisition devices with different resolutions and applied to virtual/augmented/mixed reality, engineering (e.g., retrofit and regeneration interventions of the built environment), security (e.g., video surveillance), digital restoration of archive material (e.g., digital copies of prints, photographs, books, movies) using human perception rules, robotics and bio-medicine, biometrics (e.g., iris tracking), health (e.g., rehabilitation, smart ageing, assistive technologies).
- **Algorithms and tools for processing and analysis of 3D data**, where the main research activities and challenges range from the study of representation methods and of geometric analysis tools for **3D shape acquisition and fabrication, modelling, classification and recognition**, to **knowledge formalization** about the shape and the context where it is embedded and used. Specific research activities include the combination of heterogeneous data properties (e.g., shape, color, 2D textures, measured material properties) for patterns' and features' recognition, user-driven data exploration and **similarity assessment, data indexing and learning.**
- **Deep Learning for Multimedia and multimodal Information Retrieval and Analysis:** to analyze images in real time to perform recognition and classification tasks with very high performance and produce high quality interpretations of their content and to perform a broader and contextual analysis of the scene leveraging on the recognized objects/persons/actions and using knowledge based and databases to infer and interpret the scene as a whole.

Line 8. Multimodal Interaction and Accessibility

- **Multi-Modal Interfaces design**: methods and tools to support user interface designers, software developers, and end users in obtaining systems that can be accessed from different contexts of use (devices, users, physical and social environments) in such a way to improve usability, accessibility, and user experience to provide most suitable and natural way of interaction also using wearable and specialized devices. In particular, the work focuses on Adaptive Interfaces, Interfaces for Ubiquitous Applications, MultiModal Interfaces (**involving gestures, voice, graphic, vibrotactile-feedback, eye tracking, virtual and augmented reality, brain signal, etc**), Tools for Accessibility validation, Usability Evaluation and Models for HCI.

3. IMPACT

Impact on research

Open Science paradigm

Previous research activities provide a solid framework to handle many different data sources, ranging from traditional structured data to multimedia data, social networks and spatiotemporal data. Many methods and datasets are made available in conformity with the **Open Science paradigm**, fostering science advance by

means of cross-fertilizing collaborations of researchers, data scientists and practitioners, creating a heterogeneous ecosystem to create new vision on data and knowledge discovery.

Transfer and weakly supervised learning

In those situations where supervised datasets are difficult to collect, we envisage the extension of current learning methods to transfer rules and models learned in a context to other novel scenarios with similar characteristics. Weakly supervised and self-supervised learning are also mandatory in order to leverage on the enormous amount of multimedia information nowadays available on the web and on social media in particular. Finally, another important aspect tis the development of scalable methods and algorithms for reducing the time required to train and operate machine learning and deep learning solutions.

3D Data management and visualization

Fundamental research in computer graphics, geometry processing (e.g., MeshLab tool), massive 3D data compression and distribution, and multiresolution efficient rendering, web-based visualization of multimedia data (3DHOP platform & Visual Media Service), 3D fabrication technologies for small-scale series production, computational design of objects based on customizable materials, drone-based 2D/3D sampling, and HDR and RTI images.

Knowledge management form visual and multi media

Extraction and representation of **knowledge** from text, images, audio, video, 3D data, such as visual attributes or keywords, in a seamless and transparent way to the user. The final aim is to support **data and semantic enrichment methodologies and mechanisms** to add, complete, and verify data, through quality requirements, users' feedbacks (e.g., in geo-information) and user reliability. Main platforms include the MIDB system (http://arm.mi.imati.cnr.it/midb) and the VISIONAIR System (http://visionair.ge.imati.cnr.it/).

Impact on society

The development of pervasive and distributed intelligent systems can unlock the potential of the data that is routinely collected by cameras and other sensors, with a wide impact on several sectors, such as:

- **support to policy making**, novel ways of producing high-quality and high-precision statistical information, empower policy makers with the means to gain a better understanding of complex socio-economic systems;
- **modern cities** are the perfect example of environments that are densely traversed by large data flows (user-generated including networked smart cameras): urban planning, public transportation, reduction of energy consumption, ecological sustainability, safety and management of mass events;
- **environmental and structure monitoring**, for automatic inspection of areas e.g. by the use of swarm of drones or of other autonomous vehicles;
- **data ethics and privacy** enhancing technologies: the development of complex analytical processes is intertwined with the responsibility of their impact on personal privacy violation;
- **understanding societal debates.** Social online debate, public opinion and issue mapping solutions help organizations understand the people and patterns behind the topics that matter to them most;
- **improvement of accessibility and inclusion**. Innovative HCI methods (gesture/touch/voice/speech recognition, eye tracking, virtual and augmented reality, brain signal, etc.) to provide most suitable and natural way of interaction also using wearable and specialized devices.

Impact on industry

Web-companies: the capability of managing, searching, and extracting information from visual and social media information and multimedia material on a very large scale, is a strategic competence that has applications in many fields ranging from security to news production, from marketing analysis to edutainment.

Manufacturing and production: with industry's growing investments into Industry 4.0 and smart factories with sensor-equipped machinery that is both intelligent and networked (Internet of Things, Cyber-Physical Systems), the production sectors in 2020 will be one of the major producers of (real-time) data. 3D fabrication technologies have an important impact on industry and the handcraft market. Italy has possibly the most respected design community worldwide, with "made in Italy" products known for their quality, functionality and elegance. Still, Italy is not as competitive as overseas economies in the large-scale manufacturing of products. 3D digital fabrication techniques are bound to change all of that, shifting the manufacturing landscape from the **production of many copies of identical objects to a market for unique, personalized designs**.

Sport and gaming industry: the striking proliferation of sensing technologies and IoT in sports have attracted the attention of the scientific community. In this context, **the combination of powerful analytics, visual data and multimedia with new interactive technologies**, is transforming many sports: soccer, tennis, biking, etc. are increasingly using data analytics to support training, tactical and strategic game planning (injury prediction, performance evaluation, etc). Gaming industry is pushed by the development of augmented and virtual environments that with higher visual fidelity is resulting in less physical drawbacks, and supports a more pleasant experience and a more effective stimulation, with a faster acquisition of new skills, a save of time and costs (e.g., in the field of rehabilitation from chronic pathologies).

Material design for fabrication and 3D printing

While printing hardware is evolving rapidly, design software is not taking advantage of these new capabilities. One of the challenges is the design of surfaces with patterns of predictable appearance and mechanical properties. Scalable algorithms and open source software to accomplish the design task would largely impact on manufacturing, since the inherent advantages of 3D printing hardware, and in particular the ability to mix materials at a sub-millimeter scale, would then be available to designers.

Visual and sensors' data analysis and understanding

Development of new methods for the analysis and understanding of visual data (2D images, MRI images, and 3D data) based on concepts from geometry processing, computational topology and geometry, shape analysis. The methods include techniques for MRI image segmentation and morphological analysis of 3D faces and humans, to find landmarks, facial correlates of cardio-metabolic risk factors. Geometrical and topological methods are also used to analyze time-series of multimodal signals from environmental sensor monitoring, for example to monitor human occupancy in smart buildings.

4. EMERGING RESEARCH CHALLENGES

Main challenges are

- **a decentralized user centric model for personal data based on block chain and digital identity,** where individuals track, recollect, and provide access to their own data to external actors only on request for specific tasks;
- **the explainability/accountability of Machine Learning Models** to support automated decision, guarantee the reliability of ML methods against training bias, and embed ethical values into autonomous systems;
- **the protection of digital citizens from misinformation in on-line debates**, through semantic dissonance detection between headlines and contents in published news, integration of effective fact-checking methods from knowledge bases/crowdsourcing;
- **the development of interactive systems** that are mobile and interactive, support additional senses (voice, gestures, virtual/augmented visualization, vibrotactile-feedback, eye tracking), have a higher accuracy and quality experiences, incorporate bio or environmental sensors.

5. CONCLUSIONS

Smartphones, smart buildings, smart factories, smart cities, autonomous vehicles, 2D and 3D acquisition systems and other smart environments and devices are filled with digital sensors, all of them creating an abundance of data (e.g., images, 3D models, 2D and 3D videos, cartographic digital maps). Governments and health-care entities collect, generate and use data in an unprecedented quantity. **This availability of a huge amount of data,** has pushed various disciplines and technologies towards cooperation with the aim of devising ever better models, methods, and algorithms for data processing, analysis, visualization, and interpretation. Such technologies are a significant component of what is meant by **Artifcial Intelligence** nowdays.

In this context, the research activities carried-on in the AP “Data Content and Media” contribute to advancing the methods and technologies for data, content, and media (i.e., from data acquisition, to data modelling, representation, analysis, query, and visualization) and to discovering piece of knowledge needed to build intelligent and autonomous systems in challenging domains.

These activities are made possible by the involvement of extremely different skills: database technology and semantic technologies, data mining, machine learning and artificial intelligence, data visualization, computer vision and computer graphics, complex system theory and network science, statistics and statistical physics, information retrieval and text mining, natural language processing, computer science, applied mathematics.

The AP activities are in line with the main European and international activities, as specified by several Call of the H2020 Work Program and in line the preliminary aspects of FP9. In particular the activities are central with the document of G7 2017 "Data Science: a game changer for science and innovation", the G7 2018 on “**The digital future”**, with the EC statement of 25th April 1018 titled “Artificial Intelligence for Europe. Finally, the AP activities are linked with other CNR DIITET APs, such as the AP Cyber Security, the AP Cultural Heritage, the AP Health and Well-Being, and the AP Applied Mathematics.

The AP activities, together with the involved CNR Institutes and research groups, is an international reference point in the various research and development sectors, as demonstrated by the large number of European, international, national, and regional projects, the important collaboration with industries and universities, the results on patents and dissemination activities.

Finally, **the AP research and development activities involves 15 CNR Institutes** (CNR-ISTI, CNR-IMATI, CNR-ITC, CNR-IIT, CNR-ISTC, CNR-IREA, CNR-IEIIT, CNR-ICAR, CNR-IASI, CNR-IAC, CNR-ITIA, CNR-IFAC, CNR-IGI, CNR-IRC, CNR-ISTEC), **for a total of around 600 person-months per year**.

PROJECT AREA 3: DATA, CONTENT AND MEDIA

Editorial team and Contact person (CP)	**Institute**	**Email**
BARONTI STEFANO	IFAC	s.baronti@ifac.cnr.it
BOLDRINI CHIARA	IIT	chiara.boldrini@iit.cnr.it
BORDOGNA GLORIA	IREA	bordogna.g@irea.cnr.it
BUZZI CLAUDIA	IIT	claudia.buzzi@iit.cnr.it
COLANTONIO SARA	ISTI	sara.colantonio@isti.cnr.it
DE FELIS ITALIA	IAC	i.defelis@iac.cnr.it
GAGLIARDI ISABELLA	IMATI	isabella@mi.imati.cnr.it
GIANNOTTI FOSCA **(CP)**	ISTI	fosca.giannotti@isti.cnr.it
MANDUCHI GABRIELE	IGI	gabriele.manduchi@igi.cnr.it
MARA DE JOANNON	IRC	m.dejoannon@irc.cnr.it
MUSELLI MARCO	IEIIT	marco.muselli@ieiit.cnr.it
PADULA MARCO	ITC	m.padula@itc.cnr.it
PATANE' GIUSEPPE **(CP)**	IMATI	giuseppe.patane@ge.imati.cnr.it
PIZZUTI CLARA	ICAR	clara.pizzuti@icar.cnr.it
PRESUTTI VALENTINA	ISTC	valentina.presutti@istc.cnr.it
GUARINO NICOLA	ISTC	nicola.guarino@istc.cnr.it
TAGLINO FRANCESCO	IASI	francesco.taglino@iasi.cnr.it
TERKAJ WALTER	STIIMA	walter.terkaj@cnr.it