



University of Pisa
Department of Computer Science



Research Projects

Pisa, June 12 – 13, 2003

Research areas

20 current projects - Annual Research Report 2002

- Algorithms and Data Structures
- Computer Architecture and Networking
- Artificial Intelligence and Robotics
- Data Bases and Information Retrieval
- Computational Mathematics
- Programming Languages
- Software Methodology and Engineering
- Operations Research

Research projects

- Proper mix of approaches
 - Fundamental research
 - Methodologies
 - Technologies
 - Applications

in view of the evolution of Information Technologies :
convergence of various areas, large scale distributed
computing infrastructures, telecommunications, multimedial
technologies, ...

- Growing impact of research and innovation on advanced applications of social and industrial interest
- Experience of the “Research Evaluation Exercise”, 1999

Applications

Adaptive and Web Computing (G. Attardi, M. Simi)

Technologies

Tools and Methodologies for Data and Knowledge Engineering (F. Turini, D. Pedreschi)

Methods for Requirements Capture and Software Architecture (V. Ambriola, E. Börger, C. Montangero)

Design and Management of Parallel, Distributed and Mobile Systems (M. Bonuccelli)

Analysis of Security and Performance for Concurrent and Mobile Processes (P. Degano)

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Fundamentals

Financing sources

- **European Community**
- **MIUR (Ministry of Education, University and Research)**
- **CNR (National Research Council)**
- **Industries and public institutions**

- 2-year / 3-year projects in 2001-2004

- Whole financing: about 6.400.000 €

- In several projects, the central coordinator is a professor of the Computer Science Department

European Community Projects

- Mainly IST 2001
+ other coordination initiatives, Working Groups, Networks of Excellence, RTN Networks, ...
- Whole financing: about 1.200.000 €
- Main topics:
 - Global Computing
 - Machine Learning & Healt (Woman)

Ambriola
Börger
Corradini
Degano
Ghelli
Manca
Mancarella
Montanari
Starita
Turini

European Community Projects

Information Society Technologies (IST)

Future and Emerging Technologies (FET)

Global Computing Initiative

- Global Computing: co-operation of autonomous and mobile entities in dynamic environments
 - Coordination of Department groups around a common objective:
 - Montanari, Corradini (PROFUNDIS, AGILE)
 - Ambriola-Börger-Montangero, Degano (DEGAS)
 - Mancarella, Turini (SOCS)
- other national groups (FI, TO, VE, BO, TR, ISTI-CNR)

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Fundamentals

MIUR Projects

FIRB (Basic Research Support Funds)
National Research Programme 2001-2003

Strategic Projects: Enabling Technologies for Inform. Society

- **Grid Computing:**
 - *GRID.IT*: enabling platforms for high-performance computational grids oriented to Scalable Virtual Organizations
- **Partners:** CNR (proponent), INFN, CNIT, ASI + large participation of associated Universities
- **National coordinator:** M. Vanneschi
- **MIUR financing:** 8.100.000 €
- **Financing to Dipartimento di Informatica:** 850.000 € (ISTI-CNR contract)

MIUR Projects

Strategic Projects, L 449/97
("5%")

Attardi
Danelutto
Montanari
Pallottino
Scutellà
Simi
Turini
Vanneschi

- **Strong valence of technological research:**
 - Complex Enabling Platforms and Grid Computing
 - Software Architectures and Global Computing
 - Web Computing
- **Proponent institution: CNR**
- **National coordinators: Attardi, Montanari, Vanneschi**
- **Whole financing: about 850.000 €**

Strategic Projects MIUR “5%” and FIRB on Complex Enabling Platforms and Grid Computing

- Coordination of several groups of Department around a common objective:
 - High-performance Platforms and Programming Tools (Vanneschi, Danelutto)
 - Data Mining and Knowledge Engineering (Turini, Pedreschi)
 - Web Mining and Question Answering (Attardi, Simi)
 - DB and Information Management (Albano, Ghelli)
 - Search Engines on Semi-structured Data (Luccio, Ferragina)
 - Retrieval Services (Starita)

other national groups (CS, NA, PA, BA, LE, Roma I-II, AQ, PD, GE, MI, FI, SI)
and institutions (CNR, INFN, CNIT, ASI)
- Common Laboratories with ISTI-CNR, Pisa
 - High-performance Systems and Applications (Laforenza)
 - Knowledge Engineering (Giannotti)

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MIUR Projects: cofunded initiatives

- Co-funded researches of national interest
- Whole financing (MIUR part): about
230.000 €

Ambriola
Barbuti
Bellia
Bonuccelli
Börger
Capovani
Degano
Ferrari
Levi
Luccio
Montanari
Montangelo
Romani
Starita

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CNR Projects “Agenzia 2000”

Frangioni
Montanari
Pallottino
Starita
Turini
Vanneschi

- National coordination on basic research themes and new technologies
- In some cases the central coordinator is from Computer Science Department
- Whole financing: about 90.000 €

Industries and other institutions

- Application and verification of the new solutions, methodologies and technologies produced by the research
- Opportunities for new researches
- Contribution to the realization of advanced services for the community
- Contribution to the correct definition and realization of common projects University-Industry; e.g., L488 on industrial research

Industries and other institutions

Whole financing: about 3.200 K€

- Microsoft Attardi, Montanari (213 K€)
- K-Solutions Turini, Attardi (190 K€)
- Tiscali Attardi (150 K€)
- SEMA Schlumberger Vanneschi (1.130 K€)
- ASI (Italian Space Agency) Danelutto (150 K€)
- Regione Toscana Ambiola, Pedreschi (70 K€)
- Consorzio Pisa Ricerche Turini (113 K€)
- Assoc. It. contro le Leucemie Starita (15 K€)
- IBM Award Ambriola (25 K€)
- ETS, AGF, NES Molè (1.130 K€)

Evolution of projects in view of the 6th FP of EC

- Possible unifying topics, considering the current research activities and the strategic choices of EC:
 - Grid Computing
 - Global Computing
 - Ubiquitous Computing
- Methodologies
- Technologies
- Applications

Research products

- About 500 publications, 2000-2002
- Referees of the Research Evaluation Exercise:
 - “... it is clear that the department has a distinguished role in Italy, by the number and the quality of its students and the level of its international connections. The global publication record is excellent, with presence in journals and conferences with the highest scientific standards ...”
- Growing realization of prototypes, applications and advanced research products, also available to the community

Laboratories and young people

- Labs: fundamental support for research *and* for the training of young researchers and high-level technicians / designers
- The most part of research funds is utilized for **contracts to young people**
- Labs: more “stable” forms are necessary: University spin-offs.

Multimedia (10)

High-performance computing (12)

Software Engineering (4)

Data Bases (4)

NeoroLab (4)

Global Computing (2)

Applications for PA (2)

Security (1)

Summaries
of
Research Projects

Rigorous Methods for Requirements Capture and Software Architecture

Vincenzo Ambriola, Egon Börger, Carlo Montangero

Research theme 1

Capturing requirements and expressing them in abstract architectural models

Research theme 2

Refining abstract architectural models into specific architectures and code designs

Current sponsored projects

- CIRCE: *Cooperative Integrated Requirement Centric Environment*
IBM Eclipse Innovation Award 2003
- DEGAS: *Design Environments for Global Applications*
IST Programme, FET pro-active initiative VI.2.2 “Global computing, cooperation of autonomous and mobile entities in dynamic environments” 2002-2004
- SAHARA: *Software Architectures for Heterogeneous Access networks infRAstructures*
COFIN MIUR 2001-2003

Gruppo Medialab



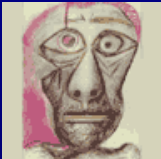
CodeBricks

- Generative and Multistage programming



IXE Search Engine

- C++ library for indexing and search, based on template metaprogramming
- Online at [La Repubblica](#)



PiQASso Question Answering

- Finding answers to natural language queries
- ECD
 - Web Mining and Participatory Search
- BestBets
 - Recommending documents of interest to users

Gruppo Medialab

Topic	Institution	€
Enhanced Content Delivery	5% CNR	90.100
Web Search	Tiscali	150.000
Generative Programming	Microsoft	90.000
Web Switching	FIRB	135.000
ClickWorld	KataWeb	100.000
Parallel Question Answering	5% CNR	30.000

Specification and verification of distributed systems

R. Barbuti, A. Maggiolo Schettini

Purpose of the project is to tackle the problem of designing distributed systems

- mobile
- real-time

Study of formalisms with adequate semantics to support :

- specification
- implementation
- verification

Applications to

- verification of safety and security properties
- development of software tools for this purpose.

Funds: MIUR Cofin 2001, 48500 euros

Reduction Machines for Combinatory Languages

- **Aims:** integration of imperative and applicative programming methodologies for handling events, communications and mobility
- M. Bellia (assoc. prof. Pisa Univ.), M.E. Occhiuto (assoc. prof. Genova Univ.)
- **Grants:** Univ. of Pisa - project INQUEST: Interoperability with QoS of Distributed Software Components.

Design and Management of Parallel, Distributed and Mobile Systems (M. Bonuccelli)

Problems:

Message and Process Scheduling, Clock Synchronization, Algorithmic Skeletons, Fault Diagnosis and Self-Diagnosis, Failure Recovery, Routing, Dependable Data Storage and Retrieval, Cooperation Enforcement, Video Transcoding

Techniques:

Algorithms and Complexity, Graph Theory, Coding Theory, Game Theory

Design and Management of Parallel, Distributed and Mobile Systems

National and International Projects:

- Nat. Project IS-MANET on "Infrastructures for Mobile ad-hoc Networks"
- Nat. Project VICOM on "Virtual Immersive Communication"
- Nat. Project on "Resource Allocation in Wireless Networks"
- EEC Project "ALCOM"
- EEC Network of Excellence "ARACNE"

Project title: Software adaptation

Project leader: Antonio Brogi

- The objective of the project is to contribute to address the issues raised by the ever-increasing need of integrating heterogeneous software components to form distributed applications
- The project focuses on the development of formal methodologies and tools for the adaptation and coordination of software elements presenting mismatching interaction behaviours
- The work embraces both theoretical aspects (formal methods, languages, semantics) and experimental issues (prototype implementation and assessment)
- Cooperation with the University of Málaga (Spain) and with the University of Namur (Belgium)
- *Keywords:* adaptation, components, coordination, distributed systems, formal methods

Analysis and Synthesis of Numerical Algorithms

M. Capovani, F. Romani, O. Menchi, R. Bevilacqua,
E. Bozzo, G. Del Corso.

- The techniques used for solving numerical problems are an *irreplaceable source of algorithms*, with distinctive concreteness, understandability and implementability features.
- By studying numerical algorithms it is possible to detect problems and methods present in various fields of mathematics and computer science.
- An analysis of numerical algorithms gives important suggestions for better implementing machine arithmetics; algorithms analysis is itself a source for suggesting various possible redefinitions of computer structure.

Ongoing research

Reliability, efficiency, complexity of algorithms and their applications in the following fields.

- ❑ Solution of large dimensional linear systems arising in P.D.E.'s, in queueing theory, in computer algebra.
- ❑ Computational properties of matrix algebras, relation between matrix algebras and displacement formulas.
- ❑ Problems from image processing and image restoration.
- ❑ Mixed algebraic-numerical approaches for solving linear algebra problems involving structured matrices.
- ❑ Use of programming language JAVA to investigate algorithms for problems with structured matrices.

Financial support:

Inverse Problems in Medical Imaging MURST-COFIN 2000 MM01111258

Inverse Problems in Medical Imaging MURST-COFIN 2002 2002013422_003

P. Degano

Research Topics

- Security:
 - *Languages oriented to*
 - *Static Analysis and Dynamic Techniques*
- Qualitative and Quantitative Analyses of Global Applications:
 - *Probabilistic and*
 - *Stochastic information for Performance.*
- Systems Biology, as **Global Computing**

Process
Algebras

+

Enhanced
Operational
Semantics

Active Projects

- **DEGAS** (Design Environments for Global ApplicationS) funded by EU as a FET project.
 - Specification in UML and
 - Qualitative and Quantitative Analysis of Global Applications
- Metodi Formali per la Sicurezza (**MEFISTO**) funded by MIUR. Theoretical foundations for:
 - the Analysis and
 - the Project of Secure Systems.

Global funding per year: ~ 212 KEuro

Models & Algorithms for Transportation & Logistics

Operations Research Group (G. Gallo, S. Pallottino)

- *Mathematical Models of Real-World Problems*
 - *Transportation* (airline crew rostering, dynamic transportation models, equilibrium transit models, network design)
 - *Logistics* (location and distribution problems)
 - *Management* (utilities, public sector)
- *Algorithmic Approaches*
 - *Flow and path algorithms* (shortest path, min-cost flow, reoptimization)
 - *Combinatorial Optimization* (heuristics, polyhedral approaches)
 - *Linear and NonLinear Optimization* (nondifferentiable optimization, interior-point methods, multicriteria optimization)
- *Optimization Software Standardization & Development*
 - Flow and path algorithms, very-large neighborhood search, nondifferentiable optimization, network design, interior-point methods ...

Models & Algorithms for Transportation & Logistics

Operations Research Group

- *Problemi di Flusso per Applicazioni nei Trasporti (MIUR, 14000)*
- *Software di Simulazione ed Ottimizzazione su Reti (MIUR, 15000)*
- *Algoritmi efficienti per problemi di localizzazione (Cofin. Ateneo, 13500)*
- *Metodi e algoritmi per l'ottimizzazione di flussi su reti (MIUR, 13750)*

Database group

- Members:
 - Antonio Albano, Giorgio Ghelli (faculty)
 - Paolo Manghi, Carlo Sartiani, Dario Colazzo, Giovanni Conforti
- Main projects:
 - GRID XML DBMS
 - TQL
 - A type system for XQuery
 - A native XQuery DBMS

GRID XML DBMS

- A DBMS designed to operate on the GRID and keep XML data
- Issues:
 - Dynamicity of the computational context
 - Security issues
 - Data model, query language, protocols

TQL

- A language to query semistructured data based on the ambient logic
 - High expressive power
 - The same logic can be used to express queries, types, and constraints; this paves the way for correctness checks and optimizations

A type system for XQuery

- XQuery is the standard query language for XML proposed by W3C
- Its current type system computes an approximation of the result type of a query
- We are studying a type system with:
 - better ability to point out errors
 - more precise inference of result types

A native XQuery DBMS

- We are designing and implementing a native XML DBMS supporting XQuery
- The research focus is on query optimization based on a detailed cost model to predict the evaluation cost of physical operators

G. Levi

Research Topics

- Semantics and Probabilistic Extensions:
 - *Logic and Functional programming languages,*
 - *Concurrent Constraint programming.*
- Static Analysis and Verification of Program Properties:
 - *Semantics-based technique: Abstract Interpretation, Control-Flow analysis, Type Systems.*
- Security:
 - *Probabilistic and Approximate Non-Interference,*
 - *Static analysis via Probabilistic Abstract Interpretation.*

Active Project

- Metodi Formali per la Sicurezza (**MEFISTO**) funded by MIUR.
Theoretical foundations for:
 - the **Analysis** and
 - the **Project** of Secure Systems.

Research group on Algorithms and Data Structures

Full professors

- **Fabrizio Luccio**^{1,2,3}
- **Linda Pagli**^{1,2,3}

Associate professors

- Paolo Ferragina^{1,2}
- Roberto Grossi^{1,2}

Ph.D. student

- Gianni Franceschini¹

Researchers

- Anna Bernasconi³
- Roberto Marangoni²

Postdocs

- Valentina Ciriani^{1,3}
- Nadia Pisanti²
- Giuseppe Prencipe¹

-
1. *Indexing, compression and fast search on large data sets*
 2. *Combinatorial algorithms for pattern matching and biology*
 3. *A new approach to the synthesis of Boolean functions*

Ugo Montanari

Languages and Models for Open Distributed Systems

- **Systems**
 - composed of autonomous computational entities where activity is not centrally controlled
 - operate with incomplete information about the (network) environment
 - the computational entities are mobile, and configuration varies over time.
- Focus of the research: fundamental studies with experimental activities
- **Research issues:**
 - Specification and design
 - Reasoning about behaviour
 - Property Certification
 - Models of computations
 - Programming abstractions
 - System development and non functional requirements (security, QoS, etc)

Active Projects

- **Agile and Profundis** funded by EU (FET Global Computing Initiative)
- **Cometa and Napoli** funded by MIUR
- **Napi** funded by Microsoft Research
- **Architetture Software ad Alta Qualita' di Servizio per Global Computing su Cooperative Wide Area Networks** funded by CNR
- **SEGRAVIS EU RTN Network.**

EU Global Computing Initiative

*EU Information Society Technologies
Future and Emerging Technologies (FET)*

**Global Computing: co-operation of
autonomous and mobile entities in
dynamic environments**

(2002-2004)

<http://www.cordis.lu/ist/fetgc.html>

Scientific goals

- To develop models, frameworks, methods, and algorithms for constructing open distributed systems that are flexible, dependable, secure, robust, and efficient.

The EU FET-GC Projects

DBGlobe

Mikado

MyThs

Secure

Flags

Degas

Profundis

MRG

Cressco

Agile

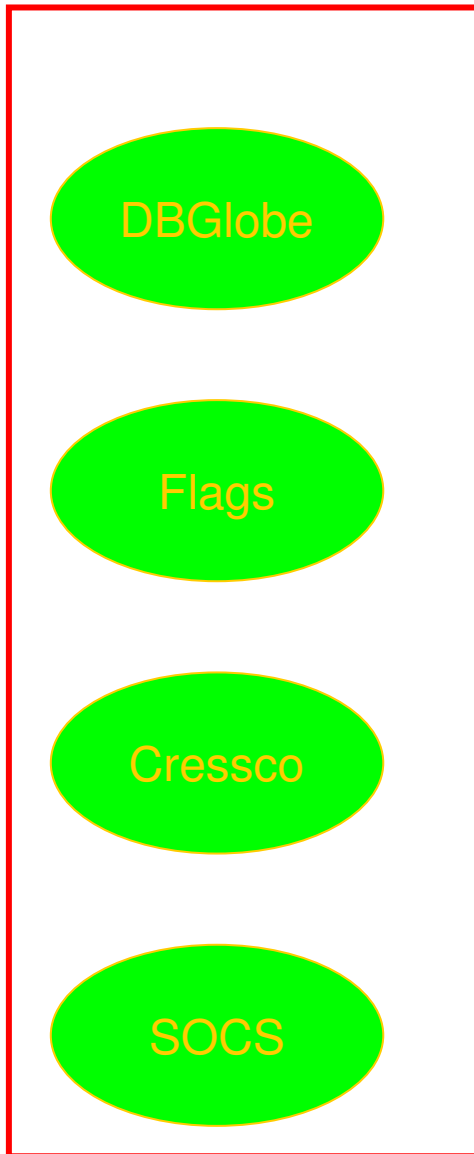
Pepito

Dart

SOCS

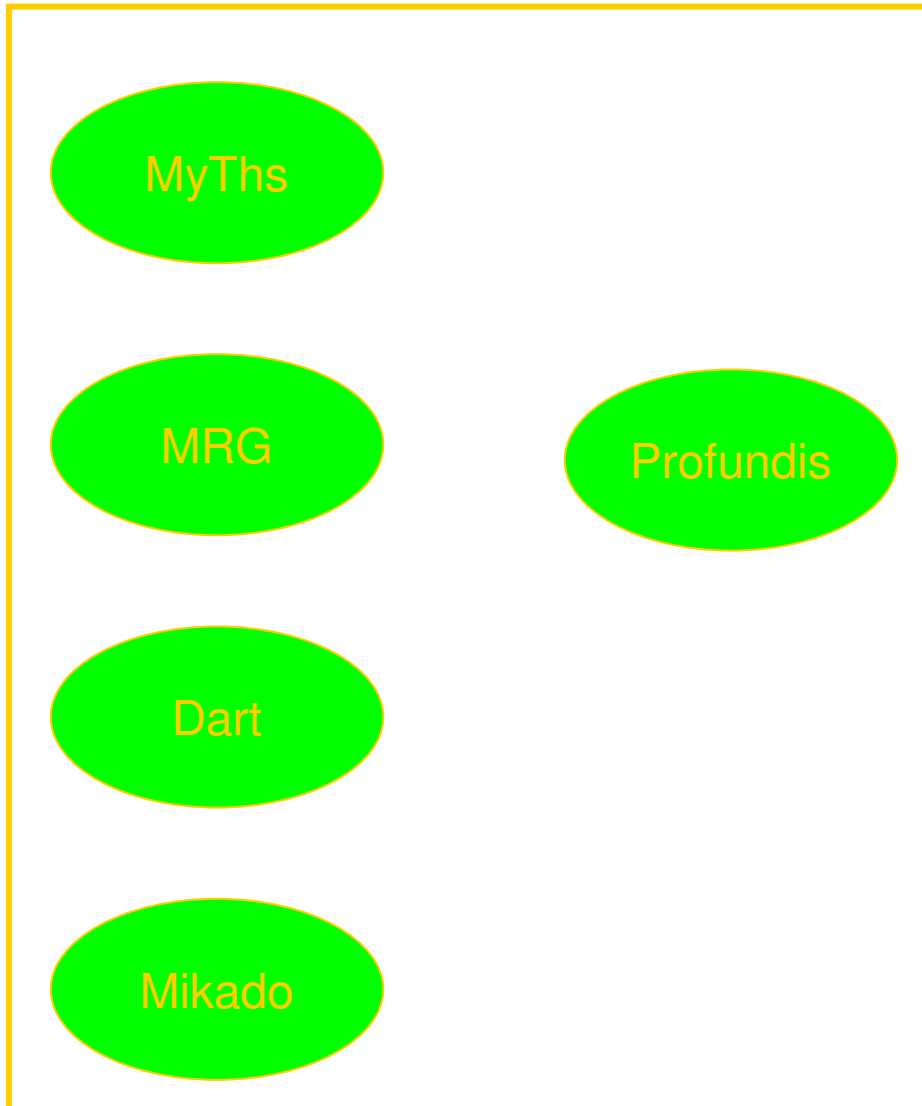
The EU FET-GC Projects

Programming Languages and Environments

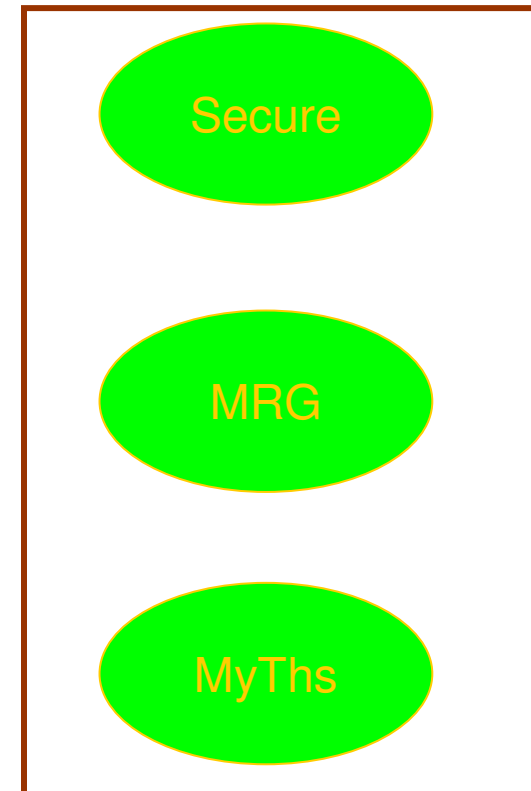


Large Distributed Environments

The EU FET-GC Projects



Security



Resource Analysis and Sys. Manag.

The EU FET-GC Projects

DBGlobe

Mikado

MyThs

Secure

Flags

Degas

Profundis

MRG

DIPISA

DIPISA

Cressco

Agile

Pepito

Dart

DIPISA

SOCS

DIPISA

The EU FET-GC Projects

DBGlobe

Mikado

MyThs

Secure

Firenze
Torino

Venezia

Flags

Degas

Profundis

MRG

DIPISA
Trento

DIPISA

Cressco

Agile

Pepito

Dart

Genova
Torino

SOCS

DIPISA
Firenze
ISTI-CNR

DIPISA
Bologna

Advanced methodologies in Machine Learning and Computational Intelligence (A. Starita)

- The main research interests are:
 - To study the open problems in machine learning with particular attention to the extension of existing methodologies to structured domains;
 - to pursue improvements of current technologies for integration of the symbolic and sub-symbolic paradigms;
 - to extend the computational capabilities of neural networks for the treatment of data structures as well as issues concerning more general Machine Learning Methodologies in Pattern Recognition and in the emerging Evolutionary Computation paradigm;
 - to define computational frameworks, for the development of intelligent systems in different application fields, able to describe and to exploit all the significant obtained results of Computational Intelligence and Machine Learning, including their integration with symbolic methodologies.
- Application fields:
 - Treatment of chemical structures QSAR/QSPR, machine learning methods for search in the Web, pattern recognition, image processing, development of intelligent systems in medicine, advanced robotics.

Research Projects

- ‘Development of a telematic, multimedial tool for the rehabilitation of people with language disturbances’, funded by Italian CNR 2001/2003, € 10.000.
- ‘A Web-Based System for physiatrists of the Locomotor Apparatus’, funded by Italian CNR 2001/2003, € 15.000.
- ‘WOMAN II’, European Project IST-2001-32672 for 2002/2003, in Health Telematics, € 106.000.
- ‘Neural Networks for Learning in Structured Domains: Methods and Applications’, Cofin 2000/2001, jointly funded by the University of Pisa and MURST, € 44.000.
- ‘Interdisciplinary integrated design of active biological systems for biomedical and pharmacological applications’, Cofin 2001/2002, jointly funded by the University of Pisa and MURST, € 50.000.
- ‘Tools based on Machine Learning methodologies for structural and functional genomics’, Cofin 2002/2003, jointly funded by the University of Padova and MURST.
- ‘An intelligent informative system for studying Leukemia’, 2002/2004, funded by AIL(Italian Association on Leukemia), € 27.000.
- Participation to the NoE ‘Biopattern Analysis’ accepted by EU within FP6.

Tools and Methodologies for Data and Knowledge Engineering

Principal Investigators:

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Franco Turini

Joint work with a group in ISTI-CNR led by:

Amedeo Cappelli

Fosca Giannotti

Research Topics

- Knowledge Discovery Support Environment-Data Mining Query Languages:
 - *logic based and XML based approaches*
 - *high performance (grid based) implementations*
- Web Mining and Content Delivery:
 - *selected test-bed for data mining algorithms and knowledge discovery environments*
- Natural Language Processing and Text mining
- Geographic Knowledge Discovery and Reasoning
- Logic-based cooperative computing

Active Projects

- Technologies and Services for Enhanced Contents Delivery (MIUR-CNR): *web mining*.
- KNet (EU): *basic principles of knowledge discovery*.
- Dedugis (Esprit4-LTR, UE): *spatio-temporal reasoning*.
- Piattaforma abilitante complessa ad oggetti e ad alte prestazioni (MIUR-CNR): *high performance knowledge discovery environments*.
- FIRB: Piattaforme abilitanti per griglie computazionali a elevate prestazioni orientate a organizzazioni virtuali scalabili (MIUR): *grid based knowledge discovery environments*.
- SOCS (IST-EU): *logic based cooperative computing*.
- Industrial projects (KSolutions, Consorzio Pisa Ricerche): *knowledge discovery applications*.

Global funding per year: 270 KEuro

High-Performance Platforms and Programming Tools

- M. Vanneschi
- F. Baiardi, M. Danelutto
- L. Ricci
- M. Coppola, M. Aldinucci
- C. Zoccolo, S. Campa
- Laboratory of Parallel Architectures (12 people)

Research Topics

- Programming environments for parallel, distributed and Grid enabling platforms
- Static and run-time tools for high-performance component technology
- Resource management for Grid programming environments
- Adaptive and irregular applications

Active Projects, 2001-2004

- Italian Space Agency: 150 K€
- MIUR Strategic Projects (“5%”): 565 k€
- MIUR FIRB Project *Grid.it*: 450 K€
- CNR Agenzia 2000: 25 K€
- SEMA Schlumberger, SAIB Project: 1.130 K€