RECoSMA -

Research & Education project to develop a join formation in Applied Mathematics and Computer Science with a research specility in Complex Systems Modeling and Applications

Sulaimania University
Kurdistan, region of Iraq

Vers. May 21, 2010

Contents

Chapter 1
Global Vision of the Project

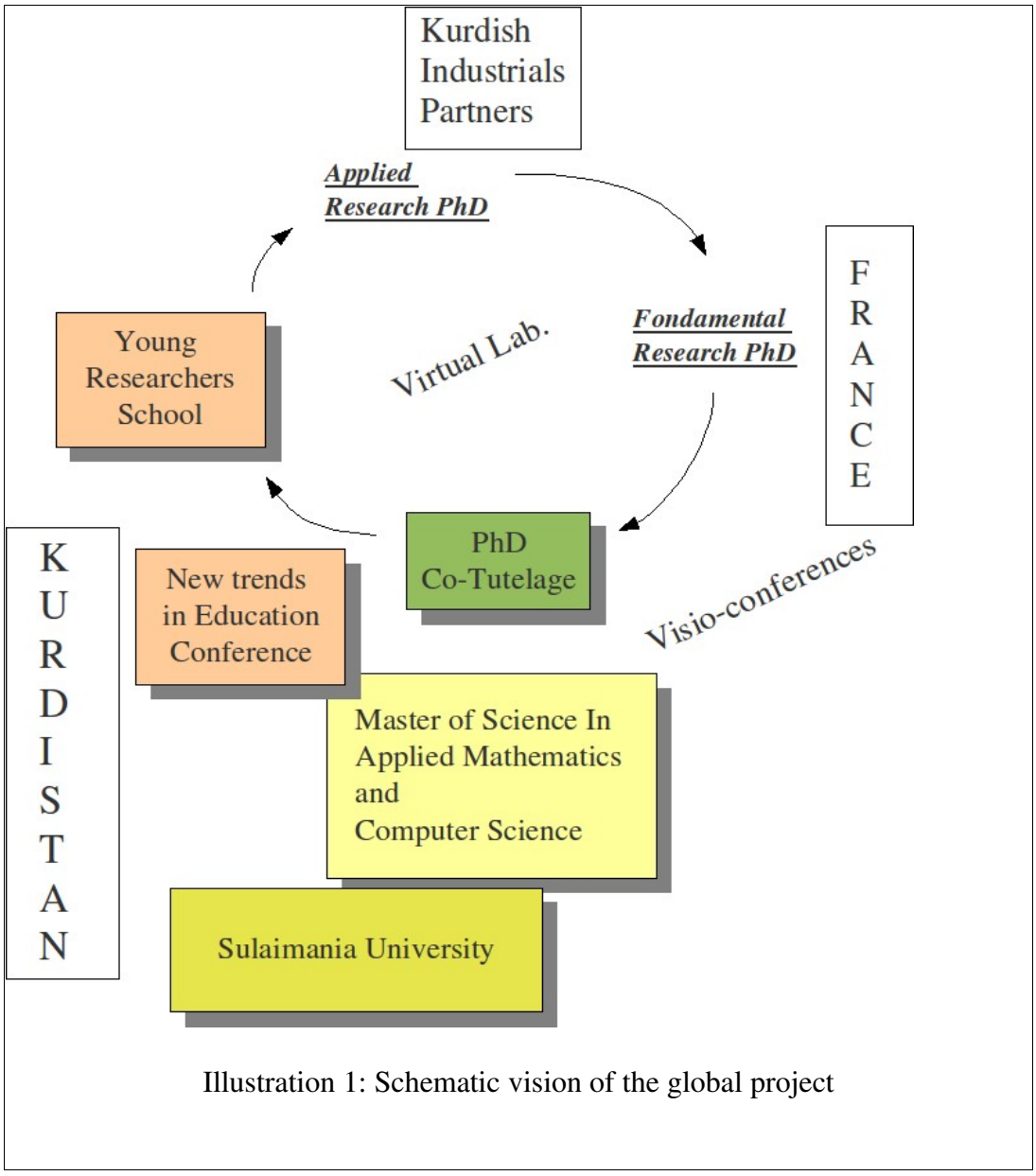

Illustration 1: Schematic vision of the global project

The objective of this project is to develop a framework for education and research between some French Universities (Le Havre, Paris 13 and Rouen) and some Kurdish Universities (Sulaimania University, for example) concerning applied mathematics and computer sciences, with a research speciality in complex systems modelling.

This framework is mainly based on the creation of a Bachelor of Science and a Master of Science with a join formation in Applied Mathematics and Computer Science called "REcoMAS".

This formation will be integrated into the diploma delivered by the Kurdish Universities. The French partners Universities will participate to the Master of Science and will give lectures and will make some thesis advising. Evaluations and improvements of the Master of Science formation will be made by all the participants and will lead to the organisation each two years of an international conference on "New Trends in Education". Visio-conferences will be developed using advanced new technologies and will help for the development of an efficient interaction with all the partners countries.

Co- tutelage PhD will be initiated between Kurdistan and France partners, using a virtual laboratory which links research groups from the participant countries, based on NTIC and Internet. Each two-years a "Young Researchers School" will be organized in Kurdistan allowing to present the progress of the PhD students and to manage the whole project with all the PhD advisors from Kurdistan and France partners.

1.1. Coordination Committee

The coordination and management of the project are under the responsability of the following committee:

- Prof Habid Abdulrab, INSA Rouen, France
- Prof. Gérard H.E. Duchamp, Paris XIII University, France
- Prof. Cyrille Bertelle, Le Havre University, France
- Dr. Luaï Jaff (KESCC President)

1.2. Local coordination and participation

Are listed below the actors which are already involved in the management of the project:

- **Sulaimania University (Kurdistan)**
- **Le Havre University (France)**
- **Paris 13 University (France)**
- **Rouen University and INSA (France):**

1.3. Kurdish Industrial Partners

The implication of local industrial partners is important for the visibility of the Master. We have already the following list of companies:

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1.4. Provisional planning

In the following, a first and rough draft of the timetable:

1.4.1. Bachelor of Science Formation Implantation (from 20yy)

1.4.2. Master of Science Formation Implantation (from 20zz)

- French teachers travel to Kurdistan
- Training period for students in France
- Training period for students in industrial groups (featuring following applied research PhD)

1.4.3. Ph.D. Co-tutelage Implantation (from 2012)

- PhD students in French Universities
- Applied research Ph.D. with industrial convention: co-financing Companies-Universities (CIFRE French model)

1.4.4. CIMPA Schools / New trends in Education Conference and Young Researchers Schools (fall 20xx)

Chapter 2
Bachelor of Sciences & Master of Science Development

We propose the creation of a Bachelor of Science and a Master of Science in join formation in Applied Mathematics and Computer Science to be implemented in Sulaimania University. This project presents formations with applicative courses but with a solid theoretical background. This allows the best students to prepare a PhD degree after the Master. However, not all the students will be involved in the PhD process (only the best and willing ones), so that the Master formation RECoSMA will be intended to provide as well added value competence for employment.

2.1. Bachelor and Master of Science RECoSMA

To do

2.2. Bachelor of Sciences RECoSMA

2.3. Master of Science RECoSMA

The Master degree will propose two potential orientations for its applicative courses:

- Modeling and Simulation (for computer and network systems, city planning engineering and geomatics, applied Mathematics and Physics)
- Decision Sciences and Economic Modelling

At the beginning of each year, the students have to make a pedagogic registration which consist of proposing all the modules they want to follow, respecting one course chosen. Each pedagogic registration will be verified by a pedagogic committee leaded by the advisor and the PIs (Principal Investigators) of the master. If needed, some adaptations can be processed from the classical courses, according to specific professional or research projects of some students. The whole package of proposed modules can help in designing individual course respecting a coherent formation.

In complement with the applicative courses, a solid background formation in Mathematics and Computer Science will be needed to allow fondamental and applied PhD course for the best students. This solid background needs the development of some modules on the following topics:

- Complex system modelling
- Modeling and simulation
- Modern Computation Techniques
- Dynamical Systems

Both this solid background and the potential orientations allow to propose some applied PhD

continuation with several industrial partners from Kurdistan.

2.4. Study Plan for Master of Science RECoSMA

The study plan is composed of 2 years. The first year corresponds to a classical background in Computer Science and also Applied Mathematics and Modelling. It can be part or evolution of existing modules already present in the existing Master of Science in Kurdish Universities. The second year is expected to be a specialisation year which leads to teaching specialisations in the thematic (Complex systems) and allows the students to get an applied knowledge of this thematic in one of the orientations proposed. In this second year, the basic knowledge for a possible continuation with a PhD in France and Europe has to be teached by the French or European partners participants. This allows a good preparation for PhD in the last year.

2.4.1. Structure of the Master RECoSMA

The Master of Sciences RECoSMA is composed of 2 years. Each year is decomposed in two semesters of 15 weeks. Some possibilities to propose an additional summer semester between these two years will be examined each year, with respect to the availability of the teachers.

2.4.1.1. 1st year

A list of modules will be proposed for a amount of 45h each. Each module corresponds to 3 credit hours.

1st year	
Semester 1	3 modules (3 credit hours each)
Semester 2	3 modules (3 credit hours each)
Total (Credit hours)	18

Each student has to choose 3 modules in each semester. This choice should respect the course orientation selected by the student. The whole set of modules chosen by each student must be validated by a pedagogic committee led by the Advisor and the PIs of the Master.

2.4.1.2. 2nd year

Two grades are proposed: the High Grade Master degree (including a master thesis) and the Master degree (without master thesis). The selection of students for the high grade will be made by a pedagogic committee led by the Advisor and the PIs of the master.

2nd year (High grade Master degree)	
Semester 1	7 modules (1.5 credit hours each)
Semester 2	Master Thesis (6 credit hours)
	2 modules (1.5 credit hours each)
Total (Credit hours)	19.5

2nd year (Master degree)	
Semester 1	7 modules (1.5 credit hours each)
Semester 2	2 modules (3 credit hours each)
	2 modules (1.5 credit hours each)
Total (Credit hours)	19.5

Common modules
Each student has to choose 7 modules of 1.5 credit hours for the first semester and 2 modules of 1.5 credit hours for the second semester. In that way, each student for the two grades has to chose 9 common modules of 1.5 credit hour in a list which will be describe in the section 3.3.4.

Master Thesis and Additional modules
- For the high grade degree, the students have to develop a master thesis (6 credit hours) on the second semester.
- For the ordinary grade degree, the students have to take 2 additional modules for a amount of 45h each and a 3 credit hours each. These additionnal modules will be proposed by Sulaimania University (see section 3.3.4.4)

The choice of each student from the two grades must respect a course orientation proposed. The whole set of modules chosen by each student must be validated by a pedagogic committee led by the Advisor and the PIs of the Master.

2.4.2. First year in Sulaimania University

Sulaimania University will propose the following applicative courses:

- Modeling and Simulation (for computer and network systems, city planning engineering and geomatics, applied Mathematics and Physics)
- Decision Sciences and Economic Modelling

The modules proposed to the students of the RECoSMA Master in Sulaimania University, are the following. As described previously, each student will have to choose 6 modules inside the following list, respecting one of the courses describe below.

- **MB101: Theory of algorithms**
- **MB102: Artificial Intelligence and expert systems**
- **MB103: Data Base systems**
- **MB104: Operating systems**
- **MB105: Computer Networks**
- **MB106: Software reliability and testing**
- **MB107: Image Processing and Computer Graphics**
- **MB108: Mathematical modeling**
- **MB109: Codes, cryptography and security**
- **MB110: Advanced computer architecture and parallel computing**
- **MB111: Object-Oriented Programming & Java**
- **MB112: Simulation methods**

In the following table, we describe the modules associated to each course. A minimal number of modules has to be followed by the students who are inscribed in a specific course. In these tables, the crosses show the obligatory modules attached to each course. In each course, the students have to complete with optional modules chosen inside all the modules proposed in the

Master of Science RECoSMA. The last column of these tables indicates the number of options that the students of the modules have to choose in addition to the obligatory modules.

In the following, we describe the detail program of each course

	First year												
Cursus	**MB101**	**MB102**	**MB103**	**MB104**	**MB105**	**MB106**	**MB107**	**MB108**	**MB109**	**MB110**	**MB111**	**MB112**	**nb. Op**
Modeling & Simulation	X	X						X			X	X	1
Decision Sc and Econ Mod	X	X							X		X	X	1

Illustration 2: course organisation for the first year in Sulaimania University

2.4.2.1. MB101: Theory of algorithms

Learning outcome:
- Basics of Algorithms,
- Analysis of Algorithms,
- NP-complete problems,
- Models of computation,
- Merging, Sorting Searching,
- Generating permutation,
- Matrix Operation,
- Graph-Theory problems,
- Decision and Optimization problems,
- Selected applications are also covered,
- Case study.

Bibliography:
- R. Sedgewick, "Algorithms in Java, part 1-4: Fundamentals Data Structure, Sorting, Searching", Addison-Wesley, 2002
- T.H. Cormen et al., "Introduction to algorithms", The MIT Press, 2001
- A.V. Aho, J.D. Ullman, J.E. Hopcroft, "Data Structures and Algorithms", Addison-Wesley, 1983

2.4.2.2. MB102: Artificial intelligence and expert systems

Learning outcome:
This module introduces the basics of AI such as
- knowledge representation,
- Reasoning and search techniques.

The module also covers advanced topics such as
- nonmonotonic reasoning,
- truth maintenance systems,
- Expert systems,
- machine learning
- artificial neural networks.

Bibliography:
- S.J. Russell, P. Norvig, "Artificial Intelligence: a modern approach", Prentice Hall, 2002
- J.M. Alliot et al., "Intelligence artificielle & Informatique theorique", Cepadues ed., 2002

- K. W. Tracy, P. Bouthoorn, "Object-oriented artificial intelligence using C++",Computer Science Press, 1997

2.4.2.3. MB103: Data Base systems

Learning outcome:
Advanced Database topics such as
- Database Models,
- Relational Data Models,
- Relational Database Design Theory,
- E-R Model,
- Object oriented Database,
- Temporal Database,
- Data mining and warehousing,
- Database Security,
- Concurrence Control in DBMS,
- Recovery and Distributed DBMS, Case study.

Bibliography:

- J.D. Ullman, J. Widon, "A first course in Database Systems", Prentice Hall, 2001
- S. Wagner Dietrich, S. D. Urban, "An Advanced Course In Database Systems: Beyond Relational Databases", Prentice Hall, 2004

2.4.2.4. M104: Operating systems

Learning outcome:
- Process Synchronization,
- Language Mechanism for concurrence,
- Deadlock,
- Virtual Memory,
- Distributed Systems (Distributed Concurrence Control, Deadlock and Recovery),
- Computer Security,
- Queuing Models of Computer Systems,
- Parallelism and Scheduling,
- Case Study.

Bibliography:

- A. Tanenbaum, "Modern Operating Systems", Prentice Hall, 2001

2.4.2.5. MB105: Computer Networks

Learning outcome:
- Reference Models (OSI, TCP / IP)
- Framing, Error control, Flow Control
- Error Detection and Correction, Data Link Protocols
- Channel Allocation Problem ALOH, CSMA
- Bluetooth Architecture and applications.
- Routing Algorithms
- Congestion Control Algorithms and Quality of Services
- IP Addressing
- Case study.

Bibliography:
- A. Tanenbaum, W. Day, S. Waller, "Computer Networks", Prentice Hall, 2002

2.4.2.6. MB106: Software reliability and testing

Learning outcome:
- Overview of Software Reliability Engineering
- Overview of SRE activities, roles and artefacts.
- Operational profiles.
- Applying failure data to guide decisions
- Review of Software Reliability Models
- Software Reliability Growth Models
- Computer Aided Software Reliability Estimation (CASRE) Tool
- Overview of Software Testing
- Types of Testing
- Preparing for Test
- Executing Test
- Students also are required to present a case study in S.E.

Bibliography:
- Software Reliability Engineering, John D. Musa, (391 p.), McGraw-Hill (Computer Science Series), 1998.
- Handbook of Software Reliability Engineering, Michael R. Lyu (Editor), McGraw Hill (1996).
- Effective Methods for Software Testing, William E. Perry, 2nd edition, John Wiley and Sons (2000).
- Metrics and Models in Software Quality Engineering, Stephen H. Kan, 2nd ed. (560 p.), Addison-Wesley Professional (2002).

2.4.2.7. MB107: Image Processing and Computer Graphics

Learning outcome:
- Techniques of digital image processing.
- Processing in the image and spatial frequency domains;
- Fourier and other transforms,
- Continuous and discrete convolution and filtering;
- Grey-level transforms, feature identification,
- Image encoding,
- Image enhancement;
- Applications to models of human and machine vision,
- An overview of two dimensional concepts and methods,
- Detailed treatment of three-dimensional topics: concepts, representations, and transformation, hidden-surface methods, shading and coloring models, modeling methods,
- Graphics standards (GKS and PHIGS),
- Case study.

Bibliography:
- J. Foley et al., "Computer Graphics", Addison-Wesley pub., 1995

2.4.2.8. MB108: Mathematical modeling

Learning outcome:
- The modelling process

- Differential modeling
  * From natural phenomenon to mathematical model
  * Differential models building
  * Application to Mathematical Ecology
  * Phase plane, equilibrium and linearization
  * Stability and chaos transition
- Discrete modeling
- Basis on numerical methods
  * Numerical linear algebra
  * Curve fitting, interpolation
  * Least square approximation for model identification
  * Numerical differentiation and integration
- Optimization models

Bibliography:

- R. Haberman, "Mathematical models", SIAM edition, 1998
- F. Giordano, M. Weir, W. Fox, "A first course in Mathematical Modeling"
- W. Meyer, "Concepts of Mathematical Modeling"

2.4.2.9. MB109: Codes, cryptography and security

Learning outcome:
Fundamentals of Coding theory and Encryption:
- Essentials of error-detecting and error-correcting codes,
- The study of methods for efficient and accurate transfer of information,
- Perfect and related codes,
- Cyclic codes,
- BCH codes,
- Crypt and decrypt methods
- Analysis, cryptography: modes of operation, protocols and transactions, applications,
- Computer security and basic cryptography topics,
- Introduction to the mathematical principles of data security,
- Information security,
- Public-key encryption,
- Digital signatures,
- The data encryption standard (DES),
- Key-safeguarding schemes vulnerabilities,
- Policy formation,
- Control
- Protection methods,
- Access night,
- Encryption,
- Authentication technologies,
- Host-based and network-based security issues,
- Internet security,
- Personnel and physical security issues,
- Case study

Bibliography:

- P. B. Garrett, "The Mathematics of Coding Theory: Information, Compression, Error Correction, and Finite Fields", Prentice Hall, 2003
- D. R. Stinson, "Cryptography: Theory and Practice", Chapman&Hall, 2002

2.4.2.10. MB110: Advance Computer Architecture & Parallel Computing

Learning outcome:
- Pipeline systems and RISC machines,
- Share Memory Multiprocessor Systems,
- Multiprocessor Systems and Programming,
- Single bus Multiprocessor Systems,
- Interconnection Networks,
- Multiprocessor Systems Without Shared Memory,
- Message passing Multiprocessor Systems,
- Multiprocessor Systems using the Data Flow Mechanism.

Bibliography:

- S.G. Shiva, "Advances Computer Architectures", CRC Press, 2005
- L.R. Scott, T. Clark, B. Bagheri, "Scientific Parallel Computing", Princeton University Press, 2005

2.4.2.11. MB111: Objet-Oriented Programming & Java

Learning outcome:
- Foundations of object orientation
- Objects and class, understanding class definitions
- Object interaction (constructor, methods)
- Grouping objects (collection, arrays)
- Well-behaved objects (testing, debugging)
- Improving structure with inheritance
- Further abstraction techniques (abstract classes, multiple inheritance, interfaces)
- Handling errors (Exception)
- Designing applications
- Case study

Bibliography:

- S. Sahni "Data Structures, Algorithms and Applications in Java", Mc Graw Hill, 2000
- K. Arnold, J. Gosling, "The Java Programming Language", Addison-Wesley, 1998
- C.S. Horstmann, G. Cornell, "Core Java", Sun Microsystem Inc., 1999
- D.J. Barnes, M. Kölling, "Objects first with Java, a practical introduction using BlueJ", Prentice Hall, 2003

2.4.2.12. MB112: Simulation Methods

Learning outcome:
- Fundamentals of Modeling and Simulation Languages,
- Methods,
- Simulation of Practical Problems Using Finite Difference and Finite Element Methods,
- Digital Simulation of Environmental Problems,
- General Application of Simulation in Computer System,
- Stability and Convergence,
- Case study.

Bibliography:

- M. S. Obaidat and G. I. Papadimitriou," Applied System Simulation," Kluwer, 2003.
- B. P. Zeigler, T. G. Kim et H. Praehofer, " Theory of Modeling and Simulation ", Academic Press, 2000.
- F. Kuhl, J. Dahmann et R. Weatherly, "Creating Computer Simulation Systems: An

Introduction to the High Level Architecture", Prentice Hall, 1999.

2.4.3. Second year

As described in the section 3.3.1, the second year proposes 2 grades: the High Grade Master degree and the Master degree.

For these two grades, each student has to follow 9 common modules of 1.5 credit hours each chosen in the list of common modules described below.

The student in the High Grade Master degree have to complete their master with a master thesis.

The student in the Master degree have to follow 2 additionnal modules proposed by each Jordanian University and describe below (see section 3.3.4.4).

2.4.3.1. List of the Common modules

The common modules are modules of specialisation which are mainly proposed to be teached by the French or European partners participants, but also by Sulaimania University. These modules will allow to give the basic knowledge of the Master of Science thematic on Complex Systems modeling and Complexity in Computer Science. They also prepare the students to possible PhD course in France or in Europe.

Each proposed module is composed of a total amount of 20 hours teached in front of the students and represent 1.5 credit hours. Each module will be associated with an individual project that each student has to develop inside the course thematic. The project will be supervised using Internet communications fro french or european supervisoring.

French or European partners teachers will give their lectures on the basis of one or two weeks in front of the students. A one-week intervention consists in 5 days of 4 hours each. A two-weeks intervention consists in 10 days of 2 hours each. During their weeks of teaching, the French or European partners teachers will meet the students who want to buid a specific research project corresponding to the proposed modules. Such project will consist of discussion about an individual proposition of master thesis with possibilities for continuation in PhD.

In the following, there is the list of all the proposed common modules.

Common modules proposed by the French participants (8 common modules):

- **MF201: Complex systems modelling**
- **MF202: Complexity in Computer Science**
- **MF203: Non linearity, dynamical systems and applications**
- **MF204: Multi-agent systems and Distributed Computing**
- **MF205: Advanced Discrete Simulation**
- **MF206: VIsualization of discrete structures and applications**
- **MF207: Cognitive sciences, decision suppot systems and economical modeling**
- **MF208: Artificial intelligence and theoretical computer sciences**

Common modules proposed by Sulaimania Universities (2 common modules):

- **MB210: Applied Mathematics & Computing**

- **MP211: Data Mining and Data Warehousing**

In the following table, we describe the modules associated to each course. A minimal number of modules has to be followed by the students who are inscribed in a specific course. In these tables, the crosses show the obligatory modules attached to each course. In each course, the students have to complete with optional module chosen inside all the modules proposed in the Master of Science RECoSMA. The last column of these tables indicates the number of options that the students of the course have to choose in addition to the obligatory modules.

Some of the modules (M201 and M202) proposed are the basis of the aim of the general orientation of the Master RECoSMA which is founded on complex systems modelling. For this reason, this modules are included in all course.

	Second year							
Cursus	**MF201**	**MF202**	**MF203**	**MF204**	**MF205**	**MF206**	**MF207**	**MF208**
Modeling & Simulation	X	X	X	X	X	X		
Decision sc and Econ Mod	X	X		X	X	X	X	X

Illustration 3: course organisation for the second year (part 1)

2.4.3.2. Detail Programs of the Common modules

Common modules proposed by the French participants (8 common modules):

MF201 - Complex systems modelling

Teachers : C. Bertelle & M. Aziz-Alaoui

- Overview of complexity in natural, social and industrial modelling
- Conceptual models for complex systems
  - Mathematical and computerized Modelling
  - Open systems, self-organization and adaptive systems
  - Evolutionary systems
- Methodology and complex systems simulation
  - General methodology for modelling and simulation
  - Discrete events and models
  - Continuous models
  - Discontinuous models

Bibliography

- L. Bertalanffy, "General system theory", Georges Braziller inc., New York, 1968
- T. Bossomaier and D. Green ed., "Complex systems", Cambridge university press, 2000
- R. Axelrod and D. Cohen, "Harnessing complexity", The freepress, New York, 1999
- F. Capra, "The web of life", Anchor books, 1996
- P. Bak, "How nature works", Springer Verlag, 1996
- J. Holland "Hidden order", Perseus Book, 1995

MF202 - Complexity in Computer Science

Teachers : G. Duchamp & E. Laugerotte

- Sequential, parallel and continuous coding, concatenation and independence.
- Automata (Boolean and multiplicity)
- Grammars and languages
- Functions and levels of complexity
- Implementation and automatic processing

Bibliography

- Alfred V Aho, Jeffrey D Ullman, "Fundations of computer science: C edition" ; W. H. Freeman ed. (1994)
- Donald E. Knuth, The Art of Computer Programming, Volume 1, Fascicle 1 : MMIX -- A RISC Computer for the New Millennium (Paperback), Addison-Wesley Professional (February 14, 2005)
- Donald E. Knuth, The Art of Computer Programming, Volume 4, Fascicle 2, Addison-Wesley Professional (February 14, 2005)
- M. Lothaire, "Combinatorics on Words", Cambridge University Press, 2002
- J. Gerhard, J. Von Zur Gathen, "Modern Computer Algebra", Cambridge University Press, 2003
- D. E. Knuth, "The Art of Computer Programming", Addison-Wesley, 1998.
- Eilenberg, "Automata, Languages and Machines", Vol A and B, Academic Press, 1976
- W. Oevel, F. Postel, I. Gerhard, "Mupad Tutorial: A Version and Platform Independent Introduction", Springer-Verlag, 2000
- Andreas Sorgatz, "Dynamic modules", Springer, 1998

MF203 - Non linearity, dynamical systems and applications

Teachers : M. Aziz-Alaoui

- Dynamic Behaviour of non- linear problems
- Dynamic analysis of ODE (Ordinary Differential Equations)
- Numerical treatment of differential systems: Lyapunov exposants and dimension, fractal dimension, bifurcation diagrams
- Application to reliability in electronic circuits, synchronization and secure communications

Bibliography

- N.F. Britton, " Essential of Mathematical Biology ", Springer, 2003
- J. Guckenheimer, P. Holmes, " Nonlinear Oscillations, Dynamical Systems and Bifurcation of Vector Fields ", Springer-Verlag,

MF204 - Multi-Agent Systems and Distributed Computing

Teachers : C. Bertelle & D. Olivier

- From objects to agents
- Decentralized programming
- Individual-Base Modelling and theirs applications

- Distributed Artificial Intelligence and Problem solving
- Architectures : reactive agents, cognitive agents, layered architectures
- Agents communications
- From systems to organizations
- Collective intelligence algorithms and applications to engineering
- Introduction to mobile computing
- Mobile architectures and protocols
- User mobility and mobile application

Bibliography

- E. Bonabeau, M. Dorigo et G. theraulaz, « Swarm intelligence », Oxford university press, 1999
- G. Weiss ed., "Multiagent systems", The MIT Press, 1999
- J. Ferber, "Multi-agent systems", Addison-Wesley, 1999
- M. Wooldridge, "An introdution to multiagent systems", Wiley, 2002
- C. Langton, "Artificial life", The MIT Press, 1995
- D. DeAngelis and L. Gross ed., "Individual-based models", Chapman & Hall, 1992
- J. Schiller, " Mobile Communications ", Addison-Wesley, 2003.
- D. Milojicic, F. Douglis and R. Wheeler, " Mobility : Processes, Computers, and Agents ", ACM Press, 1999.
- C. E. Perkins, " Mobile IP Design Principles and Practices ", Addison-Wesley, 1998.
- A. A. Helal, B. Haskell, J. L. Carter, R. Brice, D. Woelk, M. Rusinkiewicz, " Any Time, Anywhere Computing: Mobile computing concepts and technology ", Kluwer Academic, 1999.

MF205 - Advanced Discrete Simulation

Teachers : H. Abdulrab & M. Itmi

- General principles : concepts, study steps for simulation
- Mathematical models and computer sciences approaches
- Distributed simulation: introduction to HLA and to multiagent simulation
- Logical programming with constraints and simulation
- Logical inference
- Problem solving with constraints: finite domains, arithmetic constraints. Applications to scheduling and ressources management
- Results analysis: input/output, verification and validation for simulation model
- Applications of logical programming with constraints for discret simulation

Bibliography

- J.W. Lloyd, " Foundations of Logic Programming ", Springer Verlag, 1984.
- P. Van Hentenryck, " Constraint Satisfaction in Logic Programming ", MIT Press, Cambridge, London, 1989.
- B. P. Zeigler, T. G. Kim et H. Praehofer, " Theory of Modeling and Simulation ", Academic Press, 2000.
- F. Kuhl, J. Dahmann et R. Weatherly, "Creating Computer Simulation Systems: An Introduction to the High Level Architecture", Prentice Hall, 1999.

MF206 - Visualization of discrete structures and Applications

Teachers : G. Duchamp & C. Tollu

- Introduction to MuPAD : generalities, primitives, structure and functions

- Graphic processing library. Functions: boxplot, contour, copy, data (points, lines with or without points, splines, samples), ellipse2d, clouds of points (squares, variable surface, candles),
- Discrete function representation in 2d and 3d , piechart (2d et 3d), bars, broken lines.
- Application : Visualization of data extracted from web sites like Boursorama and Smart-money.
- Internal representation of formulas by DAG, equivalence.
- Transformation and simplification.
- Business Rules and RETE algorithm

Bibliography

- Donald E. Knuth, The Art of Computer Programming, Volume 1, Fascicle 1 : MMIX -- A RISC Computer for the New Millennium (Paperback), Addison-Wesley Professional (February 14, 2005)
- Donald E. Knuth, The Art of Computer Programming, Volume 4, Fascicle 2, Addison-Wesley Professional (February 14, 2005)
- M. Lothaire, "Combinatorics on Words", Cambridge University Press, 2002
- J. Gerhard, J. Von Zur Gathen, "Modern Computer Algebra", Cambridge University Press, 2003
- D. E. Knuth, "The Art of Computer Programming", Addison-Wesley, 1998.
- Eilenberg, "Automata, Languages and Machines", Vol A and B, Academic Press, 1976
- W. Oevel, F. Postel, I. Gerhard, "Mupad Tutorial: A Version and Platform Independent Introduction", Springer-Verlag, 2000
- Andreas Sorgatz, "Dynamic modules", Springer, 1998

MF207 - Cognitive sciences, decision support systems and economical modeling

Teachers : C. Bertelle

- Knowledge classification and reasoning modalities
- Modelling the knowledge representation
- Cognitive agent and multiagent system for decision support system
- Analysis of decisional processing: psychological background and behaviour aspects for human decision making
- Adaptive, artificial and cognitive systems
- Cooperation/competition modelling in economical simulation
- Game theory and adaptive automata models

Bibliography

- G. Weiss ed., "Multiagent systems", The MIT Press, 1999
- R. Axelrod, "The complexity of cooperation", Princeton University Press, 1997
- H.Maturana and F.Varela, "The Tree of Knowledge",Shambhala/New Science Library, Boston, 1987

MF208 - Artificial intelligence and theoretical computer sciences

Teachers: G. Duchamp & C. Bertelle

- History and problematic of Artificial Intelligence
- Mathematical logic and resolution (Propositional calculus, Inference and rewriting rules, Complitness)

- Elements of theoritical computer science
- Technnic of Artificial Intelligence
- Languages for AI
- Learning methods

Bibliography

- J.M. Alliot, T. Shiex, P. Brisset and F. Garcia, "Intelligence Artificielle & Informatique Théorique", Cépaduès ed., 2002
- Alfred V Aho, Jeffrey D Ullman, "Fundations of computer science: C edition" ; W. H. Freeman ed. (1994)
- Donald E. Knuth, The Art of Computer Programming, Volume 1, Fascicle 1 : MMIX -- A RISC Computer for the New Millennium (Paperback), Addison-Wesley Professional (February 14, 2005)
- Stuart Russel, P.Norvig, "Artificial Intelligence, a modern approach", Prentice Hall, 2003

Common modules proposed by Sulaimania university (4 common modules):

MB210: Applied Mathematics & Computing

Learning outcome:

- Matlab introduction
- Advanced numerical methods
- Finite element methods
- Finite volume methods
- Fluid flow simulation
- Fourier and wavelet transform methods
- Some understanding example: Traffic flow modelisation

Bibliography:

- R. Haberman, "Mathematical models", SIAM edition, 1998
- J. Mathews, K Fink,ƒ"Numerical Methods using Matlab", Prentice Hall, 2003
- L. Fausett, "Applied Numerical Methods", Prentice Hall, 1999
- W. Yang, W. Cao, T. Chung, J. Morris, "AppliedNumerical methods using Matlab" , Wiley, 2005
- G. Bachmann, L. Narici, E. Beckenstein,ƒ"Fourier and Wavelet Analysis", Springer, 2002
- S.V. Patankar, "Numerical Heat Transfer and Fluid Flow", Mc Graw Hill, 1980

MP211: Data Mining and Data Warehousing

Learning outcome:

Part 1. Data Warehousing:

- Introduction to Data Warehousing: Heterogeneous information; the integration problem; the Warehouse Architecture; Data Warehousing; Warehouse DBMS.
- Aggregations: SQL and aggregations; aggregation functions; grouping.
- Data Warehouse Models and OLAP Operations: Decision support; Data Marts; OLAP vs OLTP; the Multi-Dimensional data model; Dimensional Modelling; ROLAP vs MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting.
- Some Issues in Data Warehouse Design: monitoring; wrappers; integration; data cleaning; data loading; materialised views; warehouse maintenance; OLAP servers; metadata.

Part II. Data mining:

- Introducing Data Mining: Why data mining?; What is data mining?; A View of the KDD Process; Problems and Techniques; Data Mining Applications; Prospects for the Technology.
- The CRISP-DM Methodology: Approach; Objectives; Documents; Structure; Binding to Contexts; Phases, Task, Outputs.
- Data Mining Inputs and Outputs: Concepts, Instances, Attributes; Kinds of Learning; Providing Examples; Kinds of Attributes; Preparing Inputs. Knowledge Representations; Decision Tables and Decision Trees; Classification Rules; Association Rules; Regression Trees and Model Trees; Instance-Level Representations.
- Data Mining Algorithms: One-R; Naïve Bayes Classifier; Decision Trees; Decision Rules; Association Rules; Regression; K-Nearest Neighbour Classifiers.
- Evaluating Data Mining Results: Issues in Evaluation; Training and Testing Principles; Error Measures, Holdout, Cross Validation; Comparing Algorithms; Taking Costs into Account; Trade-Offs in the Confusion Matrix.

Bibliography:

- M. Jarke, M. Lenzerini, Y. Vassiliou, P. Vassiliadis (ed.), Fundamentals of Data Warehouses, Springer-Verlag, 1999.
- Ralph Kimball, The Data Warehouse Toolkit, Wiley 1996.
- I. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations, Morgan Kaufman, 1999. (This is the one that lectures notes are most closely based on.)
- J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufman, 2000. (This is more database-centred, in contrast to Witten and Frank, who takes a machine-learning viewpoint of data mining. It is also useful in covering data warehouses too, to some extent.)
- D. Hand, H. Mannila and P. Smyth. Principles of Data Mining, MIT Press, 2001. (This takes yet another viewpoint on data mining, viz., the statistical one. In this sense, it is the least related to the approach followed in this part of the course.)
- M. H. Dunham. Data Mining: Introductory and Advanced Topic. Prentice Hall, 2003. (This has yet another slight shift in emphasis, as it more or less favours an algorithmic viewpoint and is, in this sense, a core computer-science view of the issues.)

2.4.3.3. Complement for High Grade Master degree: Master thesis and Research orientation

As described in the section 3.3.1, the High Grade Master degree students have to do a Master thesis (6 credit hours). The master thesis will be supervised by at least a team of two teachers, one from France or european partners and the other from Kurdistan. New technologies of information and communications will be used to follow from France or Europe the project and viso-conferences sessions will be organized to facilitate the following and the co-advising.

The students who want to choose a research orientation and whish to continue in the PhD process have to contact at the beginning of the 2nd year, the reseachers-teachers who will come to give lectures. With the Advisor and the PIs of the master, an adapted choice of optional modules will be defined corresponding to the research project of each student.

2.4.3.4. Complement for Master degree: Additional modules proposed by Sulaimania University

MB217 Evolutionary Computation and Soft Computing

Learning outcome:
- Introduction to Evolutionary Computations (EC)
- When should we use EC?
- Software Tools of Evolutionary Computation
- Introduction to Genetic Algorithms
- Introduction to Genetic Programming
- Introduction to Evolutionary Strategies
- Multi-Objective Optimization Problems
- Constrained Optimization Problems
- Engineering Applications
- Computer Science Applications
- What are soft computing techniques?
- Gradient descent optimization: least squares methods
- Fuzzy Reasoning; Fuzzy Inference
- Applications of Fuzzy Logic
- Neural Networks
- Applications of Neural Networks
- Case-Based Reasoning: nearest neighbour, explanation-based learning, case selection, case adaptation
- Hybrid Systems: ANFIS, Fuzzy Filtered NN & Neural Fuzzy Systems
- Case studies.

Bibliography:

- Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1996.
- Wolfgang Banzhaf, Peter Nordin, Robert E. Keller, and Frank D. Francone, Genetic Programming: An Introduction, Academic Press/Morgan Kaufmann, 1998.
- Lee Spector, William B. Langdon, Una-May O'Reilly, and Peter J. Angeline (eds.), Advances in Genetic Programming 3, MIT Press, 1999.
- L. Spector, E. Goodman, A. Wu, W.B. Langdon, H.-M. Voigt, M. Gen, S. Sen, M. Dorigo, S. Pezeshk, M. Garzon, and E. Burke (eds.), Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2001. Morgan Kaufmann, 2001.
- J.-S.R. Jang, C.-T. Sun, E. Mizutani “Neuro-Fuzzy and Soft Computing” ,Prentice Hall, 1997
- I. Watson ,“Applying Case-Based Reasoning”, Morgan Kaufman Publishers, 1997

MB218 Parallel and Grid Computing

Learning outcome:
- Introduction to parallel computing
- Complexity and models
- PRAM model and basic algorithms
- Sorting and selection networks
- Sorting on a 2D mesh or torus
- Other hypercubic architectures
- Emulation and scheduling
- Parallel computing software
- Grid Architecture, Technologies and Resource Allocation
- Peer to Peer Computing
- Security Issues
- Grid computing software
- Grid Applications

Bibliography:

- Parhami, B., Introduction to Parallel Processing: Algorithms and Architecture, Plenum, 1999
- Dally, W.J. and B.P. Towles, Interconnection Networks: Principles and Practices, Morgan Kaufmann, 2004
- Berman, Fran., Fox, Geoffery., and Hey, Tony. (2003). (Eds.) Grid Computing: Making the Global Infrastructure a Reality. Chichester: John Wiley
- Foster I., Kesselman C. (1998). The Grid: Blueprint for a New Computing Infrastructure. Morgan Kaufmann Publishers Inc

MP219 Genetic Algorithms and Neural Networks

Learning outcome:
- Introduction to AI - Search Methods.
- ANN - Single-Layer Perceptions; ADALINE; Perception Learning.
- Multi-Layer Feed Forward NN - Supervised Learning; Back propagation.
- Unsupervised and Competitive Learning - Kohonen's Self Organising Maps (SOM); Radial Basis Function Networks.
- Introduction to Genetic Algorithms - GA Terminology and Operators (crossover, mutation, inversion)
- Theory of GA - Schema properties; Implicit Parallelism; GA - Evolutionary Computing.
- Selection, Replacement and Reproduction Strategies ('roulette wheel', elitism) - Fitness proportional selection; Premature convergence; Representation.
- GA - advantages, disadvantages and applications; GA and NN.

Bibliography:

- P. Picton, Neural Networks, Palgrave, 2000.
- I. Nabney, NETLAB Algorithms for Pattern Recognition, Springer, 2002.
- A. Zilouchian and M. Jamshidi, Intelligent Control Systems Using Soft Computing Methodologies, CRC Press, 2001.
- Z. Michalewicz, Genetic Algorithms and Data Structures = Evolution Programs, Springer-Verlag, 1999.
- M. Mitchell, An Introduction to GA, MIT Press, 1996.
- A. Engelbrecht, Computational Intelligence, John Wiley and Sons, 2002.
- S. Hykin, Neural Networks, Prentice-Hall 1999.

MP220 Multimedia Systems Technology

Learning outcome:
- Introduction: What is multimedia; Multimedia systems; Quality of service; Synchronization and orchestration; Standards; Convergence; Value chain;
- Hardware: Multimedia computers; Video and graphics; Audio; Telephone, videoconference, and networks; CD and DVD; USB and FireWire; Processors; Video for Windows, DirectX, and ActiveMovie.
- Software: Introduction; Browser based software architecture; Distributed software; Servers; Network Terminals.
- Audio and Video I: Introduction; Digital audio; Psychoacoustics; Digital presentation of sound Digital images; JPEG.
- Audio and Video II: Video signal; Camera sensors; Colors; Color television; Equipment; Compression systems; Basics of video compression; Methods; Algorithms.
- Interchange Formats: Introduction; Application areas; Requirements; Track and object model Real-time transfer; Different transfer formats; Comparison.
- Authoring Tools: Introduction; Production process; Tools; Barriers; Development areas
- Communications: QoS; ATM; QoS implementations; Integrated Services; Differentiated Services.
- Multicast: Introduction; Group control; Routing; Real-time transfer and control protocols;

Resource reservation; Session control; MBone .
- Video Conference: Introduction; Standards; Products; Internet telephony; CTI (Computer Telephony Integration).
- Access Networks: Introduction; Cable television; Digital subscriber lines; UMTS; Digital television; Conclusions.

Bibliography:

- Chan-Hwa Wu and J. David Irvin, Emerging Multimedia Computer Communication Technologies, Prentice Hall, 1998.

2.4.4. Teachers Team

The entire team is composed of xx members from the different universities. This list is the first teachers engaged and involved in the project building. During the development of the project, other participants will be involved and will join this team.

From French Universities:

- Prof. Habib Abdulrab
- Prof. Moulay Aziz-Aaoui
- Prof. Cyrille Bertelle
- Prof. Gérard H.E. Duchamp
- Dr. Mhamed Itmi
- Dr. Eric Laugerotte
- Dr. Damien Olivier
- Dr. Christophe Tollu

From Sulaimanya University:

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2.5. New Trends in Education Conference

Each two years, a international conference "New Trends in Education" will be organized.
(to be completed)

2.6. Students Flux

2.7. Logistic and Financial Support

2.7.1. IT Equipment

- Computers and networks
- Video-conference equipment :

Chapter 3
Research network animation & Invited academic Professor

3.1. Young Researchers Schools

We propose to institute a Young Researchers School with the following objectives:

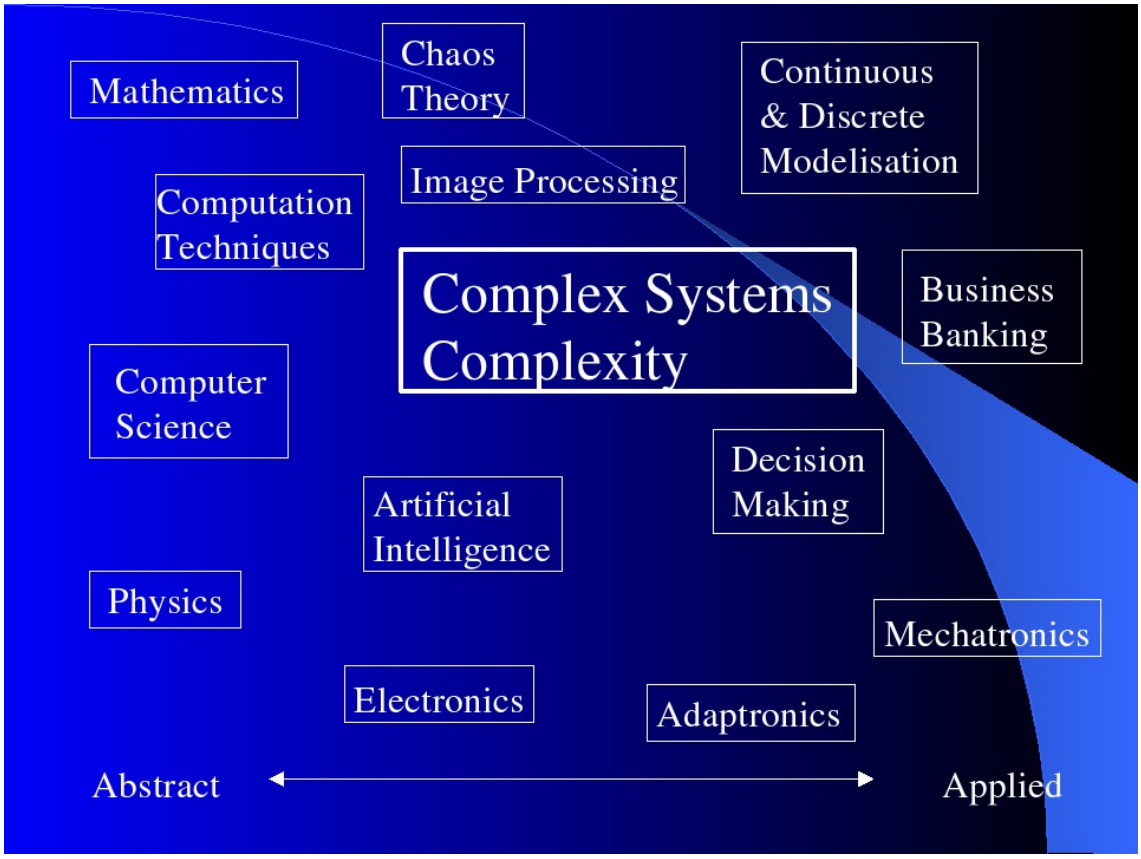
- Allow for each PhD student in the co-tutelage process to present the state of the art in his/her specific research field. Each student will present his recent research results in the course of her/his Ph.D. dissertation.
- Allow to propose some meeting and public discussion with the boarder team of PhD students. These meeting will allow to coordinate all the research directions and to preserve a global coherence.
- Allow to the industrial partners to follow the major development concerning the research orientation of each PhD.
- Allow to the industrial partners which manage some convention for studies concerning PhD students, to explain the effective impact of the research activities in the industrial world.
- Promote competition among young researchers by selecting bests paper awards which may include recognition plaques and some monetary prizes.

3.2. Academic invitation of professors

Each year, one or two professors from Sulaimania university will be invited in French Universities with grants from these Universities (Paris 13 and Le Havre)

Chapter 4
Scientific appendix

4.1. Map of Concepts



4.2. Complex systems concepts and some applications

What are the similarities between brain, financial market, human society, flow-production chains, ant colonies? All are sets of many interactive constituants. Their global behavior is the result of the whole interaction system.

Complex system theory was born on the fact that from many applicative domains, we can find similar processes linking emergent global behavior and interaction network of constituants. The global behavior of complex systems is generally not accessible using classical analytics methods like differential or difference systems.

In classical analytic methods, the global behavior of the system is included in the description of the equations. The resolution of the equations only consists of computing the trajectory of a predefined behavior.

In complex system modeling, we have to modelize the constituants of the system and the interaction network which links these constituants, using a decentralized approach. So the global behavior of the system is not described in the description of each constituant. In complex system modeling, the global behavior is an emergent property of the interaction network.

Sharing the knowledge of such systems from different applicative domains, allows to extract general concepts from one application to another. Evolutive processes from natural genetic can bring efficient methods for optimisation problems in engineering. The behavior of insect societies like ants can give operative models for the control of decentralized computer networks. In that way, complex systems are novative concepts which find their roots in modelization, simulation, optimization and computation. New approaches to implement these systems, using decentralized computing and able to manage in automatic processes the emergent properties of the system, constitute a promising novative research topic.

Various systems in natural or artificial domains use analytic models based on differential systems of equations. The complexity of the present problems finds limits in the qualitative approaches that allow this standard modelisation.

Concerning the ecological environment, local understanding of some phenomenon is not enough and now, we need to understand the planetary equilibrium and its perturbation under the effect of the development of the industrial sites all over the world. The whole equilibrium must be managed and can be reduced in the study of the evolution of local sub-systems. Multi-scale ecosystems modeling must be developped and the huge interation network between all the evolved constituants must be taken into account. Analytical approaches as reductionist methods are not sufficient. Complex systems modeling is a new methodology which deals with multi-scale modeling and interaction between these different levels.

Complex systems for economic modeling

Concerning economical modeling or management, analytic decomposition is not enough efficient to follow the increasing world-wide development of the industries or firms. Complex systems must be used for that purpose and a better understanding of their concepts and of how implemention of them must be done.

Agent modeling is a recent topic in research activities. Generic and efficient implementation for agent behavior is still in progress. The computation of automatic process for the detection of organisation which is one of the major goal of such modeling is a recent research work and given automatic processes to manage the detected organizations are not usually presented. We propose in this domain to build an efficient model based on automata to answer these novative problems.

Complex systems modeling for geomatic

Geomatic finds its roots in numeric geographic information. One of the most adequat support for this information is geographical data bases which have to involve, using a conceptual model, geometric data and semantic data. In most of these geographic data bases, a system of layers allows to separate the nature of semantic informations stored. The constant evolution of the real

world which must be represented in such geographical data bases needs to frequently update the data. The knowledge of updating is generally associated with the concerned semantic layer. Each semantic layer has its own updating frequency which can differ from one layer to another. The basic operation of an updating process is the transaction which is a set of sequences of elementary modifications over the constitutive objects of the Geographical Data Base.

A major aspect concerning geographical data bases updating is the consistency maintenance. The consistency can be described as the integration of different kinds of constraints. The proposed model used to represent these constraints consists in their decomposition in terms of structural constraints, temporal constraints, spatial constraints and semantic constraints. The different objects of the geographical data base are involved in many of these geographical constraints called G-constraints. The updating processus described by a transaction generates a composition of elementary operators to realize over a set of geographical objects which are linked by a set of G-constraints. In that way, the updating processus can be conceptualy modelized as an emergent property from the consistency maintenance over the interaction network representing the geographical objets linked by G-constraints.

4.3. Publications of the Participants

(to be completed)

4.4. General additional bibliography

- M. Lothaire, "Combinatorics on Words", Cambridge University Press, 2002
- J. Gerhard, J. Von Zur Gathen, "Modern Computer Algebra", Cambridge University Press, 2003
- D. E. Knuth, "The Art of Computer Programming", Addison-Wesley, 1998.
- Eilenberg, "Automata, Languages and Machines", Vol A and B, Academic Press, 1976
- W. Oevel, F. Postel, I. Gerhard, "Mupad Tutorial: A Version and Platform Independent Introduction", Springer-Verlag, 2000
- Andreas Sorgatz, "Dynamic modules", Springer, 1998
- L. Bertalanffy, "General system theory", Georges Braziller inc., New York, 1968
- T. Bossomaier and D. Green ed., "Complex systems", Cambridge university press, 2000
- R. Axelrod and D. Cohen, "Harnessing complexity", The freepress, New York, 1999
- F. Capra, "The web of life", Anchor books, 1996
- P. Bak, "How nature works", Springer Verlag, 1996
- J. Holland "Hidden order", Perseus Book, 1995
- N.F. Britton, " Essential of Mathematical Biology ", Springer, 2003
- J. Guckenheimer, P. Holmes, " Nonlinear Oscillations, Dynamical Systems and Bifurcation of Vector Fields ", Springer-Verlag,
- E. Bonabeau, M. Dorigo et G. theraulaz, « Swarm intelligence », Oxford university press, 1999
- G. Weiss ed., "Multiagent systems", The MIT Press, 1999
- J. Ferber, "Multi-agent systems", Addison-Wesley, 1999
- M. Wooldridge, "An introdution to multiagent systems", Wiley, 2002
- C. Langton, "Artificial life", The MIT Press, 1995
- D. DeAngelis and L. Gross ed., "Individual-based models", Chapman & Hall, 1992
- J.P. Aubin, P. Nepomiastchy, A.M. Charles « Méthodes explicites de l'optimisation », Dunod, 1982.
- J.F. Bonnans, J.C. Gilbert, C. Lemaréchal, C. Sagastigabel « Optimisation numérique,

aspects théoriques et applications », Springer, 1997.
- M. Minoux « Programmation mathématique », tome 1, Bordas, 1983.
- R. Axelrod, "The complexity of cooperation", Princeton University Press, 1997
- H.Maturana and F.Varela, "The Tree of Knowledge",Shambhala/New Science Library, Boston, 1987
- J.W. Lloyd, " Foundations of Logic Programming ", Springer Verlag, 1984.
- P. Van Hentenryck, " Constraint Satisfaction in Logic Programming ", MIT Press, Cambridge, London, 1989.
- B. P. Zeigler, T. G. Kim et H. Praehofer, " Theory of Modeling and Simulation ", Academic Press, 2000.
- F. Kuhl, J. Dahmann et R. Weatherly, "Creating Computer Simulation Systems: An Introduction to the High Level Architecture", Prentice Hall, 1999.
- J. Schiller, " Mobile Communications ", Addison-Wesley, 2003.
- D. Milojicic, F. Douglis and R. Wheeler, " Mobility : Processes, Computers, and Agents ", ACM Press, 1999.
- C. E. Perkins, " Mobile IP Design Principles and Practices ", Addison-Wesley, 1998.
- A. A. Helal, B. Haskell, J. L. Carter, R. Brice, D. Woelk, M. Rusinkiewicz, " Any Time, Anywhere Computing: Mobile computing concepts and technology ", Kluwer Academic, 1999.