CURRICULUM VITAE

Franco Bagnoli

Personal data

- Born in Florence (Italy) the 16th June 1961,
- Italian citizenship,
- Military service absolved (civil service),
- 2 daughters: (Elena Bagnoli, 25/9/1997 and Margherita Bagnoli, 11/10/2000).
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Education

30/7/1980 General certificate of education in science (maturità scientifica). Mark 60/60.

13/7/1989 Master degree (Laurea) in Physics of the University of Florence Mark 110/110 with honors. Director of thesis: Prof. S. Ruffo. Title: *Aspetti teorici legati alla simulazione di modelli fisici tramite automi cellulari* (Theoretical aspects related to the simulation of physical models by means of cellular automata).

19/5/1994 Diplôme d'Étude Approfondi (DEA) of the University Pierre et Marie Curie (Paris 6).

16/6/1997 PhD in Theoretical Physics of the University Pierre et Marie Curie (Paris 6). Director: Nino Boccara. Mark *Très Honorable*. Title of thesis: *Etude de quelques modèles discrets en physique et biologie*

15/9/1997 Equivalence with the Italian PhD by Ministero della Università e Ricerca Scientifica.

Schools

17-24/9/1987 Advanced School on Programming Methodologies (I.A.S.I. – Roma).

9-18/9/1991 Sexta escuela mexicana de fisica estadistica (Guanajuato, Mexico).

10/5-5/6/1993 Ecole de physique de la matière condensée (Beg-Rohu, Francia).

15/6-15/7/1995 Ecole de physique de la matière condensée (Beg-Rohu, Francia).

Research topics

My main field of investigation concerns fully discrete systems, also known as cellular automata. A cellular automaton is a dynamical systems defined on a lattice, where time, space and dynamical variables are discrete. Many classical models, like the Ising model, or integration schemes of partial differential equations, may be reformulated in terms of cellular automata, eventually with continuous variables (i.e., coupled map lattices). The dynamical rule of cellular automata may be deterministic or stochastic, and therefore one can investigate their properties using tools from dynamical systems or statistical mechanics. Cellular automata and, to a good extent, coupled map lattices, fir very well with a computer architecture. So, another way of considering these model is the following: instad of formulating a problem using continuous variables (i.e., partial differential equations), and then find a scheme to approximately compute the evolution of these equations on a computer, one can start from a microscopic model that fits well with the computer architecture and that, in the macroscopic limit, leads to the desired equations. One such scheme is applied to hydrodynamics. Lattice gas cellular automata are discrete models that are exactly computable and that, averaged over space, lead to a hydrodynamical description. Starting from such a model one can find a Boltzmann approximation (lattice boltzmann equation) that is particularly efficient in computational terms, still retaining many of the advantages of cellular automata (for instance, flexibility in choosing boundary conditions).

Cellular automata may be used to model physical systems, or as mathematical models by itself. One of the main motivations for this study is to investigate the origin of complexity in extremely simplified systems.

Finally, cellular automata and similar schemes (for instance, using nonhomogeneus rules, disordered lattices, etc.) are also well suited to investigate biological systems.

In particular the main research themes that I am developing are:

- A unified view of phase transitions with absorbing states (directed percolation) and synchronization of spatially extended systems, including definition of unpredictability in discrete (or stable) systems, definition of Lyapunov exponents for discrete systems and theirs relation with entropy.
- Role of competition in speciation and in coevolution of ecosystems (in particular virus and immune system).
- Opinion formation in simple societies, with simple and complex individuals and networks. Connections between genetics and sociology in spreading of epidemics.
- Distance learning, automatic quiz management, detachable learning objects.

Mathematical and statistical properties of cellular automata

During my master thesis (director S. Ruffo), I developed (after a project of N. Cabibbo and in collaboration with A. Francescato) a special-purpose computer for high-speed simulation of cellular automata [46, 48]. Using this machine and also a CAM-1 (by T. Toffoli), I've studied the statistical behavior of a classical model (Game of life) [2]. During this study I developed the concept of Boolean derivatives [5], applied to the Taylor development of Boolean functions [6]. The minimization of Boolean functions

is a classical NP problem, so a general result cannot be obtained. Nevertheless, my formalism, that exploits in a natural way the non-forcing properties of the XOR function, seems to give good results for many practical purposes, e.g. in the development of microcode for integrated circuits. Moreover, it has a physical meaning and may be used to extend the idea of Lyapunov exponents to discrete systems [9, 55, 57, 59, 68], and to apply the concept of replica symmetry breaking to nonequilibrium systems [12].

This replica symmetry breaking transition (damage spreading) may be included in the general framework of nonequilibrium phase transitions in systems with one or more absorbing states. These systems exhibit phase transitions also in one spatial dimensions and with short-range interactions due to the presence of one or more states at infinite negative energy, that act as absorbing states. I've studied such systems using renormalization group techniques [7, 54], and investigated the critical properties of symmetric absorbing states [22, 66]. Another technique to promote nonequilibrium phase transition is to add, to an equilibrium system, a nonconservative external field [8].

Systems with continuous phase transitions exhibit a critical state (extremely long correlations, slow dynamics, power-law behavior) in the vicinity of the critical point. However, the critical value of the control parameter has to be finely adjusted and is very sensitive to external perturbations. However, many natural systems behaves as if they were at the critical point, with automatic fine-tuning of parameters. Another point of view is that the role of control and order parameter is reversed, since in principle is much easier to keep the order parameter pinned to its critical value (usually zero) and let the control parameter adjust to its critical value. For such systems the term "self-organized criticality" has been forged. A classical example is the sandpile model, that in the fixed-energy version shows nontrivial behavior [27]. An interesting application of Boolean analysis is that it is possible to transform a critical system into a self-organized one [13].

Synchronization transitions

Somewhat related to phase transitions with absorbing states, I've studied the problem of synchronization of extended systems. Chaoticity is related by the divergence of trajectories; however, both direct coupling or common noise may favor the synchronization of chaotic systems. In spatially extended systems (i.e., system described by partial differential equations, or coupled map lattices or cellular automata), synchronization between two replicas of the same system may occur in many different ways. The synchronized state of two identical system cannot be abandoned and therefore act as an absorbing state. However, a conjecture by Grassberger states that the critical properties of the transitions are different is this absorbing state is stable against perturbations or not. In the first case the transition has the character of directed percolation, and in the second it is related to the Kardar-Parisi-Zhang roughening transition. With P. Palmerini (master in Physics under my direction), L. Baroni (PhD student under the direction of R. Livi) F. Cecconi and R. Rechtman, we have investigated this problem in the context of chaotic systems [18]. We have also shown that a related phenomena is present in non-chaotic systems, like stable coupled maps [23] and cellular automata [19], contributing to the definition of unpredictability in non-chaotic system. Actually, unpredictability in extended system has two origins: local chaoticity, i.e. production of

information, present in chaotic systems, and propagation of information, present also in some non-chaotic system. We also showed that synchronization is useful in defining unpredictability and complements the usual definition based on chaoticity (i.e., positivity of Lyapunov exponents).

Modelling of physical systems

During my master thesis, I've spend some time studying experimentally (under the guide of S. Ciliberto) the Rayleigh-Bènard convection in an annular cell [1], and then I've tried to interpret some related experimental data using a cellular automaton model [47, 49].

After master thesis, I've collaborated with some researcher in Geneva and Mons, and applied cellular automata modeling to physical systems in the study of fast ionic conductors [4] and catalysers [3, 51].

A more classic approach (numerical computation of impact probabilities) has been used in the modelling of a radon detector [20, 25], getting result in good agreement with experimental data.

I've also developed (with C. Guardiani) a very simple model for polymer stretching [37] (see next section).

Fluid systems may also be studied using lattice cellular automata, although their thermal properties may be quite unusual [56, 52, 10]. At present, R. Rechtman and myself are studying the chaotic properties of such systems and their connection with entropy [82].

These models can be used to study the relationship between dynamic properties (Lyapunov exponents and Kolmogorov-Sinai entropy) and statistical properties (thermodynamic entropy) [43]. This correspondence should have a general validity.

A generalization of lattice cellular automata, the lattice Boltzmann equation (LBE), can be successfully applied to model fluids in complex geometries, or with thermal effects. During his master thesis (under my supervision), Luca Sguanci investigated the possibility of using LBE for modeling sand transportation. We found that the large difference in density between sand and water caused large shocks, so that LBE cannot be approximated by linear terms, inducing numerical instabilities. We prefer to use a simpler phenomenological CA model for sand transportation, that reproduces some of the characteristics of ripple formation with a very efficient coding [80].

A joint study with the Laboratory of solar energy in Temixco, Mexico (R. Rechtman) is in progress about modelling of thermal properties of fluids and transport of particles using LBE.

Finally, I've started studying granular systems, in connection with experiments performed at CINVESTAV, Merida (Mexico) with C. Ruiz and the experimental facilities of the Institute of Complex Systems (CNR, Florence) and the Center for the Study of Complex System (CSDC, University of Florence). In this field I'm also collaborating with A. Guarino, of the university of French Polynesia.

Biology

Many of the techniques used in theoretical physics may be successfully applied to biology, which is a rapidly growing research field.

My main contribution to this field are the studies, fist performed with a PhD student under the direction of Roberto Livi, M. Bezzi, and then with L. Sguanci (who completed his master and PhD studies under my direction), C. Guardiani (master studies under my direction) and P. Lió (lecturer in computer science in Cambridge, UK) about the role of competition in promoting sympatric speciation [58, 11, 14, 15, 21]. This idea complements well with that of quasispecies to explain patterns of viral evolution [64, 36, 30, 77, 81] and the emergence of typical speciation patterns [32, 33]. The basic idea is that quasispecies form around maxima of fitness, with a width that depends on the curvature of the maximum and the mutation rate. However, the fitness of a given species depends not only on the characteristics of that species, but also on the ecosystem population, through predation, feeding and competition. In particular, an individual competes strongly with other individuals of the same species, with which the sharing of resources is maximum. This simple ingredient allows to justify speciation events in extremely structureless and homogeneous environments.

With P. Lió and G. Guasti (who performed part of her master thesis under my direction), we have also studied codon usage in bacteria [11, 58].

I'm also interested in the topological and metric structure of genotype space [24, 26], and in the interplay between sociology and genetics in epidemics[79]

Moreover, in Florence I'm collaborating with the experimentalists of CSDC and ISC, in particular in experiments concerning Atomic Force Microscopy (AFM). In this context I developed (with C. Guardiani) a simple model of polymer stretching [37] that illustrates well the role of entropy in the interpretation of AFM experiments.

Sociophysics

I've started an activity of modelling of opinion formation in social systems [69, 78], using techniques similar to that used in biological modeling, in collaboration with R. Rechtman (Temixco, Mexico), D. Fanelli (now at Manchester University), T. Carletti (University of Notre Dame de la Paix), A. Guarino (University of French Polynesia) and A. Guazzini (PhD student in Nonlinear Systems and Complex Dynamics, Univ. Florence).

I also developed a model of individual [31], that can be applied as a datamining instrument in many fields. [72].

It is interesting to investigate the role of perception of disease in epidemic spreading [79]: usual model of epidemics when applied to social networks (of scale-free or small-world character) give immediate spreading, which is rather inconsistent with observation. By including psychology, one can recover more plausible patterns.

Distance teaching

I actively develop software for distance teaching, in particular I designed and installed (with the help of F. Franci, a former PhD student of myself), the system WebTeach [70, 71, 73]. A main point of this system is WebCheck, a management system for mathematical quiz that includes paper handling and parametric quiz generation.

At present, I'm developing techniques based on detachable learning objects (web pages that can be used without Internet connection) and teaching by digital TV.

Other activities

- I am part of the Center for the Study of Complex Dynamics (CSDC).
- I'm the Italian organizer of the Italy-Greece agreement about researcher exchange on "The structure of internet as a complex network: virus spreading and immunization techniques (2007-2008).
- I am the coordination of the Cultural Agreement between the University of Florence and the University of Gdansk (Poland).

Conferences

10/1986 *Nonlinear Dynamics and Stochastic Processes* Roma, Italy, oral presentation *A Cellular Automata Generator* [46].

4/1987 *Convegno di fisica teorica di struttura della materia*, Fai della Paganella, Italy.

9/1987 *Measure of Complexity*, Roma.

10/1987 *Chaos and Complexity* ISI, Torino, Italy, oral presentation *Cellular Automata Model for a Fluid Experiment* [47].

8/1988 *Molecular Dynamics and Dynamical Sistems* Orsay-Paris, France, oral presentation *A Cellular Automata Machine.*

26/9-7/10/1988 *Computer Symulations of Cellular Automata* C.E.C.A.M. – Paris, France, oral presentation *A Cellular Automata Machine.*

1/1989 *XVIII Statistical Physics Winter Meeting*, Oaxtepec, Mexico.

2/1989 *Cellular Automata and Modeling of Complex Physical Systems*, Les Houches, Francie, oral presentation *A Cellular Automata Machine* [48], oral presentation *Phase Transitions in Convection Experiments* [49], oral presentation *Periodic Orbits in a Coupled Map Lattice Model* [50].

6/1989 *Nonlinear Dynamics and Stochastic Processes*, Sammommè, Italy.

6/1989 *Cellular Automata Applications in Physical Chemistry*, Université de l'Etat, Mons, Belgium, oral presentation *Kinetic Phase Transitions in a Surface Reaction Model with Local Interactions.*

6-15/3/1990 *Complexity and Evolution*, Les Houches, France.

15/4-15/5/1990 *Complexity and Evolution*, ISI, Torino, Italy.

7-13/6/1990 *Microscopic Aspect of Non-Linearity in Condensed Matter*, Firenze, Italy, poster *A Model of Catalytic Reaction with Local Interactions* [51].

22/6-2/7/1992 *Cellular Automata and Cooperative Systems*, Les Houches, France, oral presentation *Renormalization Group Analysis of Directed Models* [54], oral presentation *Maximal Lyapunov Exponent for 1D Boolean Cellular Automata* [55].

10-13/1/1993 *Lectures on Thermodynamics and Statistical Mechanics*, Cuernavaca, Mexico, oral presentation *Lyapunov Exponents for Cellular Automata* [57].

3/10/1993 *Statistical Methods for Space-Time Chaos*, Prato, Italy, oral presentation *Maximal Lyapunov Exponent for 1D Boolean Cellular Automata.*

2/1994 *Forecasting and Modelling for Chaotic and Stochastic Systems*, Roma, Italy, oral presentation *Chaos and Synchronization in Cellular Automata* [59].

4/1996 *Automates cellulaires et systèmes écologiques*, Les Houches, France.

19-22/8/1997 *Nonlinear cooperative phenomena in biological systems* Adriatico Research Conference, Trieste, Italy, poster *Speciation by competition is a smooth fitness landscape* [61].

26-29/8/1997 *The dynamics of complexity*, Adriatico Research Conference, Trieste, Italy.

31/8-3/9/1997 *la matematizzazione della biologia: storia e problematiche attuali*, Arcidosso, Italy, oral presentation *Species formation in simple ecosystems* [64].

5-10/4/1998 *Extended Systems: Control, Learning and Self-Organization* Madeira Tecnopolo-Funchal, Madeira, Portugal, invited presentation *Species formation in simple ecosystems.*

14-25/1998 *Complexity and Chaos* ISI, Torino, Italy.

2/12/1998 *Le attività della Facoltà di Ingegneria e del CESVIT per l'innovazione tecnologica*, Firenze, Italy, oral presentation *Uno studio sull'editoria virtuale per la comunicazione scientifica e didattica.*

23-24/1/1999 *Statistical Mechanics and Biological Evolution*, Zoologisches Institut, Monaco, Germany, invited presentation *Species formation in simple ecosystems.*

26-29/1/1999 *Evolutionary Biology*, Genève, Switzerland.

8-9/3/1999 *Scienze cognitive e Complessità* IASG, Firenze, Italy.

22-25/6/1999 Theoretical Approaches to Biological and Soft Systems The Fourth Claude Itzykson Meeting, Saclay, France.

25-28/3/2001 *XX Convegno di Fisica Teorica e Struttura della Materia*, Fai della Paganella, Italy, oral presentation *introduzione alla dinamica evolutiva delle popolazioni.*

29-31/5/2001 *VI Convegno nazionale di fisica statistica e dei sistemi complessi*, Parma, Italy, oral presentation *Dinamica evolutiva delle popolazioni: spunti di discussione.*

9-13/7/2001 VII Latin american workshop on nonlinear phenomena: extended and out of equilibrium systems LAWNP01, Cocoyoc, Morelos, Mexico, oral presentation *Synchronization of non-chaotic dynamical system*, poster *Opinion formation and phase transitions in a probabilistic cellular automaton with two absorbing states*, poster *Small-world effects in evolution.*

24-28/6/2002 INFMmeeting Bari, poster *Lattice Boltzmann Numerical Simulation and Experimental Test Case*, poster *A cellular automata model for pattern formation in bacterial colony: the case of vegetative mycelial growth in Streptomyces.*

15-16/10/2002 *Synchronization, collective behavior, and complex phenomena in chaotic systems*, International Workshop of the Società Italiana Caos e Complessità (SICC), Firenze, Italy, oral presentation *Pinching synchronization and stable chaotic systems.*

9 - 11/10/2002 Fifth International Conference on Cellular Automata for Research and Industry ACRI 2002, Genève, Switzerland, oral presentation *Opinion Formation and Phase Transitions in a Probabilistic Cellular Automaton with Two Absorbing Phases* [69].

24/1/2003 *Impatto dell'e-learning sulla didattica: esperienze e prospettive dell'ateneo fiorentino*, Convegno di ateneo dell'università di Firenze, Firenze, Italy, poster *WebTeach*.

25 - 27/10/ 2004 *From individual to collective behaviour*, Sixth International conference on Cellular Automata for Research and Industry (ACRI2004), Amsterdam, Holland. oral presentation *Sympatric Speciation Through Assortative Mating in a Long-Range Cellular Automaton* [77], oral presentation *Chaos in a Simple Cellular Automaton Model of a Uniform Society* [78].

20 - 23/9/ 2006 *Modelling, Analysis and Emergent Computation*, Seventh International conference on Cellular Automata for Research and Industry (ACRI2006), Perpignan, France, oral presentation *A model of dune formation* [80]).

4-8/12/2006 XV Conference on Nonequilibrium Statistical Mechanics and Nonlinear Physics (MEDYFINOL 06), Mar de Plata, Argentina, invited presentation *The influence of risk perception in epidemics*.

27-29/9/2007 PPAM 2007 Seventh International Conference on Parallel processing and Applied Mathematics, Gdansk, Poland, invited presentation *Entropy and Chaos in a Reversible Lattice Gas Cellular Automaton*.

27-29/8/2007 13TH International Workshop on Cellular Àutomata, The Fields Institute, Toronto, Canada, oral presentation *Boolean Derivatives, Chaos and Synchronization in Cellular Automata*.

6-9/1/2008 XXXVIII Winter Meeting on Statistical Physics, Taxco, Guerrero, Mexico, invited presentation *Thermodynamic Entropy and Chaos in a Discrete Hydrodynamical System*.

23-25/6/2008 XIII Convegno Nazionale di Fisica Statistica e dei Sistemi Complessi, Parma, Italy, poster *Entropy and Chaos in an Hydrodynamic model*.

10-12/9/2008 Biophys08, Biology and beyond, Arcidosso, Italy oral presentation *Data mining in high throughput data*.

23-26/9/2008 *Cellular Automata*, 8th International Conference on Cellular Automata for Reseach and Industry, ACRI 2008, Yokohama, Japan, oral presentation *Entropy and chaos in cellular automata* [82]).

25-28/5/2009 System Theory: Modeling, Analysis and Control, Fes (Morocco), invited presentation *Synchronization and control of cellular automata*.

22-24/6/2009 Summer Solstice 2009 International Conference on Discrete Models of Complex Systems, Danzig (Poland), invited presentation *Small world bifurcations in an opinion model*.

Recent stages

27/7-12/9/2006 Collaboration stage with A. Guarino in Tahiti (French Polynesia). *Modeling of water circulation in a lagoon*.

28/11/2006 Centro de investigacíon en energía (UNAM, Temixco, Mor. Mexico) *Influencia de la perceptión del riesgo en las epidemias* (invited seminar).

Publications on peer reviewed journals

[1] S. Ciliberto, F. Bagnoli and M. Caponeri, *Pattern Selection in Thermal Convection in an Annulus*, Nuovo Cimento **12**, 781 (1990).

[2] F. Bagnoli, R. Rechtman and S. Ruffo, *Some Facts of Life*, Physica A **171**, 249 (1991) (impact factor 1.369) , doi:10.1016/0378-4371(91)90277-J.

[3] F. Bagnoli, B. Sente, M. Dumont and R. Dagonnier, *Kinetic Phase Transitions in a Surface Reaction Model with Local Interactions*, J. Chem. Phys. **94**, 777 (1991) (impact factor 3.044) , doi:doi:10.1063/1.460346.

[4] F. Bagnoli, M. Droz and L. Frachebourg, *Ordering in a One dimensional Driven Diffusive System with Parallel Dynamics*, Physica A **179**, 269 (1991) (impact factor 1.369) , doi:10.1016/0378-4371(91)90064-J.

[5] F. Bagnoli, R. Rechtman and S. Ruffo, *General Algorithm for Two-Dimensional Totalistic Cellular Automata,* J. Comp. Phys. **101**, 176 (1992) (impact factor 2.372) , doi:10.1016/0021-9991(92)90051-Y.

[6] F. Bagnoli, *Boolean Derivatives and Computation of Cellular Automata*, Int. J. Mod. Phys. C, **3**, 307 (1992) (impact factor 1.099) , doi:10.1142/S0129183192000257, arXiv:cond-mat/9912353.

[7] F. Bagnoli, R. Bulajich, R. Livi and A. Maritan, *Phenomenological Renormalization Group for Cellular Automata*, J. Phys. A **25**, L1071 (1992) (impact factor 1.886) , doi:10.1088/0305-4470/25/17/010.

[8] F. Bagnoli, B. Chopard, M. Droz and L. Frachebourg, *Critical Behavior of a Diffusive Model with One Absorbing State*, J. Phys. A **25**, 1085 (1992), doi:10.1088/0305-4470/25/5/016.

[9] F. Bagnoli, R. Rechtman and S. Ruffo, *Damage Spreading and Lyapunov Exponents in Cellular Automata*, Phys. Lett. A **172**, 34 (1992) (impact factor 1.454) , doi:10.1016/0375-9601(92)90185-O, arXiv:cond-mat/9811159.

[10] F. Bagnoli, R. Rechtman and D. Zanette, *Termodinamica de modelos de gases en redes con velocidades discretas*, Revista Mexicana de Fisica Estadistica **39**, 763 (1993).

[11] F. Bagnoli and P. Lió, *Selection, Mutations and Codon Usage in a Bacterial Model*, J. Theor. Biol. **173**, 271 (1995) (impact factor 2.323) , doi:10.1006/jtbi.1995.0062, arXiv:cond-mat/9808317.

[12] F. Bagnoli, *On Damage Spreading Transitions*, J. Stat. Phys. **85** 151–164 (1996) (impact factor 1.605) , doi:10.1007/BF02175559, arXiv:cond-mat/9508106.

[13] F. Bagnoli, P. Palmerini and R. Rechtman, *Algorithmic Mapping Criticality into Self Organized Criticality*, Phys. Rev. E **55**, 3970 (1997) (impact factor 2.352) , doi:10.1103/PhysRevE. arXiv:cond-mat/9605066.

[14] F. Bagnoli and M. Bezzi, *Speciation as Pattern Formation by Competition in a Smooth Fitness Landscape*, Phys. Rev. Lett. **79**, 3302 (1997) (impact factor 7.218) , doi:10.1103/PhysRevLett.79.3302, arXiv:cond-mat/9708101.

[15] F. Bagnoli and M. Bezzi, *Competition in a Fitness Landscape*, Fourth European Conference on Artificial Life, P. Husbands and I. Harvey (eds.), The MIT Press (Cambridge, Massachussets, 1997) p. 101, arXiv:cond-mat/9702134.

[16] F. Bagnoli and M. Bezzi, *Species Formation in Simple Ecosystems*, Int. J. Mod. Phys. C **(**9), 555 (1998) (impact factor 1.099) , doi:10.1142/S0129183198000467, arXiv:cond-mat/9804036.

[17] F. Bagnoli and M. Bezzi, *Eigen's Error Threshold and Mutational Meltdown in a Quasispecies Model*, Int. J. Mod. Phys. C **9**, 999 (1998) (impact factor 1.099) , doi:10.1142/S0129183198000935, arXiv:cond-mat/9807398.

[18] F. Bagnoli, L. Baroni and P. Palmerini, *Synchronization and directed percolation in coupled map lattices*, Phys. Rev. E **59**, 409 (1999) (impact factor 2.352) , doi:10.1103/PhysRevE.59.409 arXiv:cond-mat/9807279.

[19] F. Bagnoli and R. Rechtman, *Synchronization and Maximum Lyapunov Exponent in Cellular Automata*, Phys. Rev. E **59**, R1307 (1999) (impact factor 2.352) , doi:10.1103/PhysRevE.5 arXiv:cond-mat/9809275.

[20] F. Bagnoli, F. Bochicchio, S. Bucci, *Sensitivity of a LR-115 based radon dosemeter*, Rad. Meas. **31**, 347–350 (1999) (impact factor 0.82) , doi:10.1016/S1350-4487(99)00165-1.

[21] F. Bagnoli and M. Bezzi, *An evolutionary model for simple ecosystems*, Ann. Rev. Comp. Phys. Vol. VII, edited by D. Stauffer (World Scientific, Singapore 2000), p. 265, arXiv:cond-mat/9906164.

[22] F. Bagnoli, N. Boccara and R. Rechtman, *Nature of phase transitions in a probabilistic cellular automaton with two absorbing states* Phys. Rev. E **63**, 46116 (2001) (impact factor 2.352) , doi:10.1103/PhysRevE.63.046116, arXiv:cond-mat/0002361 .

[23] F. Bagnoli and F. Cecconi, *Synchronization of non-chaotic dynamical systems* Phys. Lett. A **260**, 9-17 (2001) (impact factor 1.454) , doi:10.1016/S0375-9601(01)00154-2, arXiv:cond-mat/9908127.

[24] F. Bagnoli and M. Bezzi, *Small world effects in evolution*, Phys. Rev. E **64**, 021914 (2001) (impact factor 2.352) , doi:10.1103/PhysRevE.64.021914 arXiv:cond-mat/0007458.

[25] F. Bagnoli, F. Bochicchio and S. Bucci, *Further studies on sensitivity of a LR-115 based radon dosemeter*, Rad. Meas. **34**, 207-210 (2001) (impact factor 0.82) , doi:10.1016/S1350-4487(01)00153-6.

[26] F. Bagnoli and M. Bezzi, *Is the "Small World" Effect Relevant to Evolution?*, Rivista di Biologia 94, 487 (2001).

[27] F. Bagnoli, F. Cecconi, A. Flammini, A. Vespignani, *Short period attractors and non-ergodic behavior in the deterministic fixed energy sandpile model*, Europhys. Lett. **63**, 512–519 (2003) (impact factor 2.206) ; arXiv:cond-mat/0207674. doi:10.1209/epl/i2003-00561-8

[28] F. Bagnoli, F. Bignone, F. Cecconi and A. Politi, *Information, complexité et biologie*, in *L'hèritage de Kolmogorov en physique*, R. Livi and A. Vulpiani (eds), (Belin, Paris 2003) p. 133–156

[29] F. Bagnoli, F. Bignone, F. Cecconi and A. Politi, *Information, Complexity and Biology*, in *The Kolmogorov Legacy in Physics*, R. Livi and A. Vulpiani (eds), (Lecture Notes in Physics **636**, Springer, Berlin 2004) pp. 123–146. doi:10.1007/b93809.

[30] Franco Bagnoli, Carlo Guardiani, *A microscopic model of evolution of recombination*, WSEAS Transactions on Biology and Biomedicine **4**, 416–421 (2004).

[31] F. Bagnoli, A. Berrones and F. Franci, *De gustibus disputandum (forecasting opinions by knowledge networks)*, Physica A **332**, 509–518 (2004) (impact factor 1.369) , doi:10.1016/j.physa.2003.09.065, arXiv:cond-mat/0306431.

[32] F. Bagnoli, C. Guardiani, *A microscopic model of evolution of recombination*, Physica A **347**, 489–533 (2005) (impact factor 1.369) , doi:10.1016/j.physa.2004.08.067, arXiv:q-bio/0408020.

[33] F. Bagnoli, C. Guardiani, *A model of sympatric speciation through assortive mating*, Physica A **347**, 534–574 (2005), doi:10.1016/j.physa.2004.08.068, arXiv:q-bio/0402038.

[34] F. Bagnoli, F. Franci and R. Rechtman, *Phase transitions of extended-range probabilistic cellular with two absorbing states*, Phys. Rev. E **71**, 046108 (2005) (impact factor 2.352) , doi:10.1103/PhysRevE.71.046108, arXiv:arXiv:cond-mat/0405604.

[35] F. Bagnoli, R. Rechtman, *Synchronization universality classes and stability of smooth coupled map lattices*, Phys. Rev. E **73**, 026202 (2006) (impact factor 2.352) , doi:10.1103/PhysRevE.73.026202, arXiv:cond-mat/0507205.

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Other publications and proceedings

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[75] F. Bagnoli, C. Guardiani, M. Vassalli, L. Casetti *Polymer stretching: experimental setup and simple Monte Carlo simulations*, poster in the *Lectures in Complex Systems*, (Firenze 6–8/10/2004).

[76] F. Bagnoli, C. Guardiani *A microscopic model of evolution of recombination and sympatric speciation*, poster in the *Lectures in Complex Systems*, (Firenze 6–8/10/2004), arXiv:q-bio.PE/0408020.

[77] F. Bagnoli, C. Guardiani *Sympatric Speciation Through Assortative Mating in a Long-Range Cellular Automaton* in *Cellular Automata*, proceedings of the 6th International Conference on Cellular Automata for Research and Industry ACRI2004, Amsterdam, The Netherlands, October 25–28, 2004, P. Sloot, B. Chopard and A. Hoekstra, editors, (Lecture Notes in Computer Science LNCS 3305, Springer, Berlin 2004) pp. 405–414, doi:10.1007/b102055.

[78] F. Bagnoli, F. Franci and R. Rechtman, *Chaos in a Simple Cellular Automaton Model of a Uniform Society* in *Cellular Automata*, proceedings of the 6th International Conference on Cellular Automata for Research and Industry ACRI2004, Amsterdam, The Netherlands, October 25–28, 2004, edited by Peter Sloot, Bastien Chopard and Alfons Hoekstra (Lecture Notes in Computer Science LNCS 3305, Springer, Berlin 2004) pp. 513–522, arXiv:nlin.AO/0511002, doi:10.1007/b102055.

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[88] F. Bagnoli, *Evolutionary Models for Simple Biosystems* in *Handbook of biological systems*, S. Boccaletti, V. Latora, and Y. Moreno, eds., World Scientific Lecture Notes in Complex Systems - Vol. 10. ISBN: 978-981-283-879-7 (World Scientific, 2010) pp. 329-372.

Jobs

1986-1990 Sofware consultant c/o Soluzioni EDP srl.

4/2/1991-31/10/2001 Technical position in the Department of Applied Mathematics, University of Florence, Via S. Marta, 3 I-50139 Firenze, Italy.

since 1/11/2001 Researcher in the Department of Energy, University of Florence, Via S. Marta, 3 I-50139 Firenze, Italy.

Teaching

2001/2002 Assistent (20 hours) of the course "Physics 1 (Mechanics, 4 credits, 48 hours), holder S. Ruffo, first year of Environmental Engineering (first cycle, 19 ans), 87 students.

Holder of the course Physics 2 (Thermodynamics), first year of Environmental Engineering, 3 credits (36 hours), 87 students.

2002/2003 Holder of the course Physics 1 (Mechanics, 4 credits, 48 hours), first year of Environmental Engineering, 51 students.

Holder of the course Physics 2 (Thermodynamics), first year of Environmental Engineering, 3 credits (36 hours), 51 students.

2003/2004 Holder of the course Mechanics and Thermodynamics (ex Physics 1 and 2, 7 credits, 84 hours), first year of Environmental Engineering, 69 students.

Holder of the course Statistical Physics and Diffusive Phenomena (Course opened after my request, 5 credits, 50 hours), first year of the master in Environmental Engineering, 8 students. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems (4 students).

2004/2005 Holder of the course Mechanics and Thermodynamics (7 credits, 84 hours), first year of Environmental Engineering, 62 students.

Holder of the course Statistical Physics and Diffusive Phenomena (5 credits, 50 hours), first year of the master in Environmental Engineering, 8 students. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems (3 students).

2005/2006 Holder of the course Mechanics and Thermodynamics (7 credits, 84 hours), first year of Environmental Engineering, 37 students.

Holder of the course Statistical Physics and Diffusive Phenomena (5 credits, 50 hours), first year of the master in Environmental Engineering, 40 students. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems (6 students).

2006/2007 Holder of the course General Physics 1 (ex Mechanics and Thermodynamics, 6 credits, 72 hours), first year of Environmental Engineering, 32 students.

Holder of the course Statistical Physics and Diffusive Phenomena (5 credits, 50 hours), first year of the master in Environmental Engineering, 88 students. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems (4 students).

2007/2008 Holder of the course General Physics 2 (Electromagnetism, 6 credits, 72 hours), first year of Environmental Engineering, 32 students.

Holder of the course Statistical Physics and Diffusive Phenomena (5 credits, 50 hours), first year of the master in Environmental Engineering, 88 students. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems (4 students).

2008/2009 Statistical Physics and Diffusive Phenomena (5 credits, 50 hours), first year of the master in Environmental Engineering. The course is part of the curriculum of the PhD school in Nonlinear Dynamics and Complex Systems.

Other activities

- I'm part of the certification commettee of the course (first cycle) of Environmental Engineering.
- With S. Ruffo, D. Fanelli, A. Guarino, we developed a series of popular conferences about "physics in everyday life".
- I collaborate with the second Italian channel of Swiss radio "Impulso Web" `http://www.rtsi.ch/trasm/impulsoweb/`.
- Development of *WebTeach*, a web system for exam scheduling, remote assistance and automatic quiz management.
- Co-head (with S. Ruffo) of the "FiSiCo" (Physics of Complex Systems) laboratory, in the department of Energy, University of Florence.

Research coordination tasks

since 2005: Local coordinator (Florence) of TO61 INFN experiment (Physics and Biology).

1994 Supervisor (70%, with S. Ruffo) of the master thesis in Physics (Florence) of Giovanna Guasti *Dynamics of Ising models and Protein Syntesis in Bacteria* [58].

1995 Supervisor (90%, with M. Buiatti) of the master thesis in Biology (Florence) of Mauro Romanelli *Two Models using Discrete Variables of the Mithotic Dynamics in Cellular Populations.*

1996 Supervisor (100%) of the master thesis in Physics (Florence) of Paolo Palmerini *Numerical and Analitical Methods for the Study of the Critical Properties of Probabilistic Discrete Systems* [13, 18, 60, 66].

1998 Co-tutor (30%, supervisor R. Livi) of the PhD in Physics (Florence) of Lucia Baroni *noise, Chaos and Synchronization in Dynamical Systems with Many Degrees of Freedom* (Chapter 4: *Stochastic Synchronization in Spatially Extended Systems*) [18, 60].

1999 Co-tutor (30%, supervisor R. Livi) of the PhD in Physics (Bologna) of Michele Bezzi *Modeling biology by cellular automata* (chapter 2: *A cellular automata model for a simple ecosystem*) [14, 16, 21, 62].

2000 Supervisor (90%, with M. Buiatti) of the master thesis in Biology (Florence) of Carlo Guardiani *A Theoretical Model for the Evolution of Quasi-Species* [77, 30, 32, 33].

2003 Supervisor (100%) of the master thesis in Environmental Engineering (Florence) of Luca Sguanci *Interaction between a Fluid Phase and a Granular Medium: Applicability of the Lattice Boltzmann Method* [80].

2004 Supervisor (60%, with S. Ruffo) of the PhD in Nonlinear Dynamics and Complex Systems (Florence) of Fabio Franci *Models of Social Phenomena.*

2005 Supervisor (10%, with G. Manfrida, A. Barbaro and F. Giovannini) of the master thesis in Environmental Engineering (Florence) of Valentina Lapolla *Analysis, Application, Evaluation and Comparison of Diffusive Models in Complex Landscapes: a Case Study in Sambuca, Tavarnelle V.P..*

2006 Supervisor (100%) of the PhD in Nonlinear Dynamics and Complex Systems (Florence) of Luca Sguanci *Modeling infective diseases: from viral coevolution to risk perception.*

2008 Supervisor (100%) of the master (second level) in Scientific Journalism for Biomedical Sciences (Florence) of Michele Viti *Sciences in the Valley: a project of cultural animation in the Mugello.*

2008 Supervisor (80% with L. Solari and L. Cappietti) of the master thesis in Environmental Engineering (Florence) of Giulio Mariotti *Modello Idromorfodinamico Lattice Boltzmann finalizzato allo studio di fenomeni erosivi localizzati.*

2009 Supervisor (100%) of the PhD in Nonlinear Dynamics and Complex Systems (Florence) of Andrea Guazzini *Computational Models of Cognitive Activity:from Neural to Social Dynamics.*

2009 Co-tutor (10%) of the PhD in Nonlinear Dynamics and Complex Systems (Florence) of Francesca Di Patti *Finite-Size Effects in Stochastic Models of Population Dynamics: Applications to Biomedicine and Biology.*

Organization of schools, workshops, congresses and seminars.

5-6/1996 *Dynamical Modeling in Biotechologies*, F. Bagnoli, S. Ruffo, F. Celada and F. Bignone, (ISI-Villa Gualino – Torino) [65].

11-18/1/2000 *Linear and nonlinear analysis of complex data*, F. Bagnoli, S. Ruffo, P. Poggi, H. Kantz, SOCRATES Intensive Programme 2000 (Villa Agape – Firenze).

dal 1997 *Coffee talks* (with A. Torcini e S. Lepri) (INO/Dip. Mat. Appl./Dip. Fisica – Firenze)
http://www.dma.unifi.it/seminari/coffeetalk/index.html.

17-18/12/1999 *Linux meeting* (with others) (Facoltà di Ingegneria – Firenze), http://meeting.firenze.linux.it/flug-meeting-99/.

dal 2000 *Seminari tecnici del FLUG* (Dipartimento di Matematica Applicata – Firenze), http://www.firenze.linux.it/seminari.

12/4/2000 *Comportamento caotico dei sistemi NON caotici* (Dipartimento di Fisica – Firenze).

12-14/2/2002 Miniscuola di biologia 1: Le Basi della Biologia Molecolare (con L. Casetti - Firenze)
`http://www.complex.unifi.it/scuole/miniscuola1`

3-5/2/2003 Miniscuola di biologia 2: I Sistemi Biologici, (con M. Bezzi, L. Casetti, A. Torcini – Firenze)
`http://www.complex.unifi.it/scuole/miniscuola2`

6-8/10/2004 Lectures in Complex Systems (con L. Casetti, A. Torcini, R. Livi – Firenze).

5-6/9/2008 Extreme events in Urban Dynamics (with F. Semboloni and S. Ruffo – Firenze), `http://www.csdc.unifi.it/upload/sub/ExtremeEvents/index.html`

Other items

- Good knowledge of many operating systems (Unix/Linux/MacOSX, MS-Windows, VMS), programming languages and utilities (C, C++, Java, FORTRAN, MPI, JavaScript, Perl, Bash, Matlab, NetLogo, Mathematica), network protocols (like e.g. tcp/ip, http, ftp), markup languages (XML/HTML, TeX/LaTeX, PostScript), and of programming/numerical elements (lists, queues, hashes, numerical algorithms, etc.)
- Referee for Phys. Rev. E, Phys. Rev. Lett., Physica A, J. Comp. Phys., J. Stat. Mech., Communications in Nonlinear Sciences and Numerical Simulations, Computers and Mathematics with Applications.
- Good knowledge of Italian (mother tongue), English, French and Spanish.

Florence, 7 marzo 2010 Franco Bagnoli