CURRICULUM VITAE et STUDIORUM

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Data

Born in Pavia on 29^{th} July 1973.
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Academic degrees

28^{th} January 2002:
Ph.D. graduated in Mathematics at the University of Milano, thesis on "Analysis of numerical methods devoted to the advection-diffusion problem", advisor: Prof. Franco Brezzi;

15^{th} January 1997:
B.S. graduated (cum laude) in Mathematics at the University of Pavia.

Past and present posts

1/2016–present:
Full Professor in Numerical Analysis at the University of Pavia, Italy.

11/2005–1/2016:
Associate Professor in Numerical Analysis at the University of Pavia, Italy.

7/2001–10/2005:
Researcher, Instituto di Matematica Applicata e Tecnologie Informatiche "E. Magenes" – C.N.R., Pavia.

Temporary visiting positions (longer than one month)

- since 2004, I have visited the Institute for Computational Engineering and Sciences (ICES) in Austin (TX, USA) (including a 9 months visit in 2004-2005);
- I visited the Institute for Scientic Computation, Texas A.&M. University, College Station, TX (USA), in October 2001.
- I visited the Oxford University Computing Laboratory, Oxford (UK), in April-May 1999.

Participation to committees

- member of the scientific committee of the World Congress on Computational Mechanics XI – European Conference on Computational Mechanics V – European Conference on Computational Fluid Dynamics VI, 20–25 July 2014, Barcelona (Spain) ;
- since 2011: member of the ECCOMAS Computational Applied Mathematics Committee;
- since 2010: member of the teaching committee of the I.U.S.S. Ph.D. program "Computational mechanics and advanced materials";
- 2010–2013: member of Consiglio Direttivo G.I.M.C.

Organization of congresses, symposia and courses

- 2017 co-organizer of IGA2017 in Pavia.
- co-organizer of several minisymposia at international congresses.
- 18–23/6/2012: co-organizer of the CIME School in "Isogeometric Analysis", Cetraro, Italy;

- 27-29/6/2011: member of the scientific committee and co-organizer of the ECCOMAS Thematic Conference "Higher Order Finite Element and Isogeometric Methods" (HOFEIM 2011) in Krakow, Poland;
- 29/6/2010-2/7/2010: co-organizer of the workshop "Non-Standard Numerical Methods for PDEs", in Pavia;
- 9/2009: member of the scientific committee and co-organizer of the international congress *Numerical Methods for Multi-material Fluids and Structures* in Pavia;

Teaching at graduate level

- 7–2017: CIME summer school on "Splines and PDEs: Recent Advances from Approximation Theory to Structured Numerical Linear Algebra", Cetraro (Italy);
- 2014 & 2016: ECCAM advanced school on "Isogeometric Analysis Fundamentals and Applications"
- 2013: EWM summer school on "Isogeometric Analysis", I.C.P.T. Trieste (Italy);
- 2007–2011: course on "Metodi numerici per le equazioni differenziali", for the PhD program in "Matematica per le Tecnologie Industriali e la Finanza", Scuola Normale Superiore di Pisa;
- 2010 and 2012: advanced school on "Nonlinear Computational Solid & Structural Mechanics" (lecturers: F. Auricchio, M. Bischoff, F. Brezzi, A. Reali, G. Sangalli and R.L. Taylor) in Pavia;
- 2003: master in "Elementi Finiti per la Meccanica del Continuo e delle Strutture" and "Problemi Variazionali in Meccanica del Continuo e delle Strutture" in Pavia.

Teaching at undergraduate level

- 2013–present: Elementi Finiti for students in Mathematics at Pavia;
- 2010–present: Metodi Elementi Finiti ed Applicazioni for students in Engineering at Pavia;
- 2006–present: various courses of Mathematical Analysis and Calculus for students in Engineering at Pavia.

Research grants and contracts

- 2014–2019: principal investigator of the ERC FP7 Ideas Consolidator Grant "HIGEOM – Highly accurate Isogeometric Method".
- 2010–2014: principal investigator of the FIRB (highly-selective young investigator Italian MIUR grant) project "Isogeometric Discretizations in Continuum Mechanics";
- 2012–2016: principal investigator of the industrial research program TOTAL–DS–2753 "Isogeometric Analysis for large deformation incompressible problem" funded by Hutchinson S.A. – Total S.A. (France);
- 2010–2015: team member of the ERC FP7 Ideas Starting Grant "ISOBIO";
- 2011–2014: team member of the Small or medium-scale focused research project (STREP) Factories of the Future FP7-2011-NMP-ICT-FoF "TERRIFIC", coordinated by SINTEF (Norway) and in collaboration with Alenia Aeronautica S.p.A.;
- 2008–2012: team member of the ERC FP7 Ideas Starting Grant "GeoPDEs";
- 2001–2013: team member of various PRIN (Italian MIUR) projects.

Selected lectures

- 5–7/04/2017: Semi-plenary lecture at the "19h International Conference on Finite Elements in Flow Problems - FEF 2017" Roma;
- 5–10/06/2016: Semi-plenary lecture at the "ECCOMAS Congress 2016" Crete;
- 23–28/6/2016, Plenary lecture at the "9th International Conference on Mathematical Methods for Curves and Surfaces", in Tonsberg, Norway.
- 12–14/10/2015, Plenary lecture at GDSPM 2015, in Salt Lake City (USA).
- 24–27/02/2013: invited (keynote) lecture at the "Advances in Computational Mechanics (ACM 2013) – A Conference Celebrating the 70th Birthday of Thomas J.R. Hughes", San Diego, USA;
- 6–10/02/2012: invited (1h) lecture at the workshop "High-Order Numerical Approximation for Partial Differential Equations", Bonn, Germany;
- 19–23/09/2011: invited (1h) lecture at the conference "Modern Techniques in the Numerical Solution of Partial Differential Equations", Heraklion, Greece;
- 5–9/9/2011 and 6–11/9/2009: two invited (1h) lectures at the workshop "Mathematical Physics and PDEs", Levico Terme, Italy;
- 25–28/07/2011: (keynote) lecture at USNCCM-11, Minneapolis (USA);
- 79/4/2010: invited (1h) lecture at the international workshop: "Variational PDEs and level set methods in image processing and shape optimization", Obergurgl (Austria);
- 17–21/5/2010: four invited (1h) lectures at: "New frontiers in CAGD", Bertinoro, Italy;
- 2–8/11/2003: invited (1h) lecture at "Finite Elements and Layer-Adapted Meshes" , Mathematisches Forschungsinstitut, Oberwolfach (Germany).

Research activity

Isogeometric Analysis (IGA) constitutes today my main scientific interest. IGA is an extension of the Finite Element Method (FEM), one of the main numerical methodologies for the approximate solution of Partial Differential Equations (PDEs). IGA is having a rapidly growing impact on many engineering fields, and some FEM codes already include (limited) isogeometric features, e.g., LS-DYNA (`http://www.ls-dyna.com/`) or FEAP (`http://www.ce.berkeley.edu/feap`). Not only academia but also industry is also showing a strong and growing interest for IGA (see, e.g., my research program in collaboration with Total S.A.)
IGA was introduced in 2005 by T.J.R. Hughes and collaborators in ICES (Austin, TX, USA) with the motivation of improving the interoperability between PDEs solver and Computer Aided Design (CAD). The aim was to drastically reduce the error in the representation of the computational domain and simplify the re-meshing procedure by incorporating the exact CAD geometry directly at the coarsest level of discretization. This is achieved by using B-Splines or Non Uniform Rational B-Splines (NURBS) for the geometry description as well as for the PDE discretization. The latter step is typically performed by an isoparametric representation of the unknown vector fields.
The use of splines or NURBS functions within IGA not only serves the purpose described above, but also paves the way to numerical schemes enjoying features that would be extremely hard to achieve within a standard FEM. Indeed splines and NURBS functions easily allow global smoothness beyond the classical C^0-continuity of FEMs. The high accuracy per degree-of-freedom of the so called k-method, based on p-degree splines with C^{p-1} global smoothness, was already recognized in the first IGA papers (e.g., [30]). The rigorous mathematical analysis of this behaviour is difficult and only preliminary results have been obtained (see [13]). It is also known (see [21]) that the k-method enjoys a uniform convergence of the full spectrum of the differential operators, that is, the eigenvalues relative error converges to zero as the degree p is increased. This is clearly seen for the "one-dimensional Laplace" operator but a complete understanding is missing, especially in higher dimension. This behaviour is in contrast with the behavior of high-degree FEMs (where only the low portion of the spectrum converges) and has tremendous implications in different contexts, from the construction of linear algebra solvers to the design of explicit time integration methods.
Smoothness plays a key role in the design of innovative IGA elements. Fundamental results have been obtained in electromagnetics ([11] and [18]). Another framework is the one of incompressible elasticity: here, it is possible to get discrete solutions that exactly fulfill the incompressibility constraint, at least in the small deformation regime. This is also an important contribution ([15] and [24]) which, in my opinion, is representative of the state-of-the-art of the research activities in the field: IGA opens new horizons, and its deep comprehension is now the condition for further improvements and consolidation.

My other research interests have been centered on FEMs. I dealt with stabilization techniques for FEMs since the beginning of my PhD program addressing a-priori (see, e.g., [36] and [41]) and a-posteriori (see, e.g., [40]) error estimates for convection-dominated problems. The modern viewpoint on stabilized FEMs is based on the multiscale paradigm, that has been the subject of my activity on multiscale numerical methods, not only in the context of convection-dominated problems (e.g., [20] and [27]) but also for the interesting case of elliptic problems with highly oscillating coefficients [38]. I have also dealt with domain decomposition methods; this has not been my main research activity (I co-authored the three papers [23], [28], [46]) but I have a solid background on the field.

PAPERS (see also `http://www.researcherid.com/rid/B-7186-2011`)

[1] Collin, Annabelle; Sangalli, Giancarlo; Takacs, Thomas; *Analysis-suitable G^1 multi-patch parametrizations for C^1 sogeometric spaces*, Computer Aided Geometric Design, Vol. 47, pp. 93-113, 2016

[2] Sangalli, Giaricarlo; Takacs, Thomas; Vazquez, Rafael; *Unstructured spline spaces for isogeometric analysis based on spline manifolds*, Computer Aided Geometric Design, Vol. 47, pp. 61-82, 2016

[3] P. Antolin, A. Buffa, F. Calabro, M. Martinelli, G. Sangalli, *Efficient matrix computation for tensor-product isogeometric analysis: The use of sum factorization*, Computer Methods in Applied Mechanics and Engineering, Vol. 285, pp.817-828, 2015

[4] Hector Gomez, Alessandro Reali and G. Sangalli, *Accurate, efficient, and (iso)geometrically flexible collocation methods for phase-field models*, Journal of Computational Physics, Vol. 262, pp. 153-171, 2014

[5] A. Buffa, G. Sangalli, and R. Vazquez, *Isogeometric Methods for Computational Electromagnetics: B-spline and T-spline discretizations*, Journal of Computational Physics, Vol. 257(B), pp. 1291-1320, 2014

[6] A. Buffa, H. Harbrecht, A. Kunoth, G. Sangalli, *BPX-preconditioning for isogeometric analysis*, Computer Methods in Applied Mechanics and Engineering, Vol. 265, pp. 63-70, 2013

[7] L. Beirao da Veiga, A. Buffa, G. Sangalli, R. Vazquez, *Analysis-suitable T-splines of arbitrary degree: definition, linear independence and approximation properties,* Math. Models Methods Appl. Sci., Vol. 23(11), 2013, DOI: 10.1142/S0218202513500231

[8] A. Bressan, G. Sangalli, *Isogeometric discretizations of the Stokes problem: stability analysis by the macroelement technique,* IMA Journal of Numerical Analysis, Vol.33, pp. 629-651, 2013

[9] F. Auricchio, Francesco Calabrò, T.J.R. Hughes, A. Reali, G. Sangalli, *A Simple Algorithm for Obtaining Nearly Optimal Quadrature Rules for NURBS-based Isogeometric Analysis,* Computer Methods in Applied Mechanics and Engineering, Vol. 249-252, pp. 15-27, 2012

[10] F. Auricchio, L. Beirao da Veiga, T.J.R. Hughes, A. Reali, G. Sangalli, *Isogeometric collocation for elastostatics and explicit dynamics,* Computer Methods in Applied Mechanics and Engineering, Vol. 249-252, pp. 2-14, 2012

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[12] L. Beirao da Veiga, A. Buffa, C. Lovadina, M. Martinelli and G. Sangalli, *An isogeometric method for the Reissner-Mindlin plate bending problem,* Computer Methods in Applied Mechanics and Engineering, Vol. 209-212, pp.45-53, 2012

[13] L. Beirao da Veiga, D. Cho and G. Sangalli, *Anisotropic NURBS approximation in Isogeometric Analysis,* Computer Methods in Applied Mechanics and Engineering, Vol. 209-212, pp.1-11, 2012

[14] A. Buffa, J. Rivas, G. Sangalli, and R. Vazquez, *Isogeometric Discrete Differential Forms in Three Dimensions,* SIAM J. Numer. Anal. Vol. 49, pp. 818-844, 2011

[15] L. Beirao da Veiga, A. Buffa, D. Cho, and G. Sangalli, *Isogeometric analysis using T-splines on two-patch geometries,* Computer Methods in Applied Mechanics and Engineering, Vol. 200 (21-22), pp.1787-1803, 2011

[16] L. Beirao da Veiga, A. Buffa, J. Rivas, G. Sangalli, *Some estimates for h-p-k-refinement in Isogeometric Analysis,* Numerische Mathematik Vol. 118 (2), pp.271-305, 2011

[17] D. Asprone, F. Auricchio, G. Manfredi, A. Prota, A. Reali, G. Sangalli, *Particle Methods for a 1D Elastic Model Problem: Error Analysis and Development of a Second-Order Accurate Formulation,* CMES - Computer Modeling in Engineering and Sciences, Vol. 62, pp. 1-22, 2010

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[19] F. Auricchio, L. Beirao da Veiga, T.J.R. Hughes, A. Reali, and G. Sangalli, *Isogeometric Collocation Methods,* Math. Models Methods Appl. Sci., Vol. 20(11), pp. 2075-2107, 2010.

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[21] A. Buffa, G. Sangalli, R. Vazquez, *Isogeometric analysis in electromagnetics: B-splines approximation,* Computer Methods in Applied Mechanics and Engineering, Vol. 199 (17-20), pp. 1143-1152, 2010

[22] T.J.R. Hughes, A. Reali, G. Sangalli, *Efficient Quadrature for NURBS-based Isogeometric Analysis,* Computer Methods in Applied Mechanics and Engineering, Vol. 199 (5-8), pp. 301-313, 2010

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[30] T.J.R. Hughes, G. Sangalli, *Variational Multiscale Analysis: the Fine-scale Green's Function, Projection, Optimization, Localization, and Stabilized Methods,* SIAM J. Numer. Anal., Vol. 45 (2), pp. 539-557, 2007.

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[48] M.I. Asensio, B. Ayuso, G. Sangalli, *Time-space & space-time elements for unsteady advection-dominated problems,* (Proceedings of ENUMATH 2005, September 18-22, 2005, Santiago de Compostela, Spain), in: Numerical mathematics and advanced applications, pp. 328–335, Springer, Berlin, 2006.

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