Activity Report 2017

EXEMPLE

Analysis and Control of Unsteady Models for Engineering Sciences

RESEARCH CENTER
Sophia Antipolis - Méditerranée

THEME

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EXEMPLE

Keywords:

1. Personnel

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2. Overall Objectives

2.1. Overall Objectives

ACUMES aims at developing a rigorous framework for numerical simulations and optimal control for transportation and buildings, with focus on multi-scale, heterogeneous, unsteady phenomena subject to uncertainty. Starting from established macroscopic Partial Differential Equation (PDE) models, we pursue a set of innovative approaches to include small-scale phenomena, which impact the whole system. Targeting applications contributing to sustainability of urban environments, we couple the resulting models with robust control and optimization techniques.

Modern engineering sciences make an important use of mathematical models and numerical simulations at the conception stage. Effective models and efficient numerical tools allow for optimization before production and to avoid the construction of expensive prototypes or costly post-process adjustments. Most up-to-date modeling techniques aim at helping engineers to increase performances and safety and reduce costs and pollutant emissions of their products. For example, mathematical traffic flow models are used by civil engineers to test new management strategies in order to reduce congestion on the existing road networks and improve crowd evacuation from buildings or other confined spaces without constructing new infrastructures. Similar models are also used in mechanical engineering, in conjunction with concurrent optimization methods, to reduce energy consumption, noise and pollutant emissions of cars, or to increase thermal and structural efficiency of buildings while, in both cases, reducing ecological costs.

Nevertheless, current models and numerical methods exhibit some limitations:

- Most simulation-based design procedures used in engineering still rely on steady (time-averaged) state models. Significant improvements have already been obtained with such a modeling level, for instance by optimizing car shapes, but finer models taking into account unsteady phenomena are required in the design phase for further improvements.
- The classical purely macroscopic approach, while offering a framework with a sound analytical basis, performing numerical techniques and good modeling features to some extent, is not able to reproduce some particular phenomena related to specific interactions occurring at lower (possibly micro) level. We refer for example to self-organizing phenomena observed in pedestrian flows, or to the dynamics of turbulent flows for which large scale / small scale vortical structures interfere. These flow characteristics need to be taken into account to obtain more precise models and improved optimal solutions.
- Uncertainty related to operational conditions (e.g. inflow velocity in aerodynamics), or models (e.g. individual behavior in crowds) is still rarely considered in engineering analysis and design, yielding solutions of poor robustness.

This project focuses on the analysis and optimal control of classical and non-classical evolutionary systems of Partial Differential Equations (PDEs) arising in the modeling and optimization of engineering problems related to safety and sustainability of urban environments, mostly involving fluid-dynamics and structural mechanics. The complexity of the involved dynamical systems is expressed by multi-scale, time-dependent phenomena, possibly subject to uncertainty, which can hardly be tackled using classical approaches, and require the development of unconventional techniques.

3. Research Program

3.1. Research directions

The project develops along the following two axes:

- modeling complex systems through novel (unconventional) PDE systems, accounting for multi-scale phenomena and uncertainty;
- optimization and optimal control algorithms for systems governed by the above PDE systems.

These themes are motivated by the specific problems treated in the applications, and represent important and up-to-date issues in engineering sciences. For example, improving the design of transportation means and civil buildings, and the control of traffic flows, would result not only in better performances of the object of the optimization strategy (vehicles, buildings or road networks level of service), but also in enhanced safety and lower energy consumption, contributing to reduce costs and pollutant emissions.

3.1.1. PDE models accounting for multi-scale phenomena and uncertainties

Dynamical models consisting of evolutionary PDEs, mainly of hyperbolic type, appear classically in the applications studied by the previous Project-Team Opale (compressible flows, traffic, cell-dynamics, medicine, etc). Yet, the classical purely macroscopic approach is not able to account for some particular phenomena related to specific interactions occurring at smaller scales. These phenomena can be of greater importance when dealing with particular applications, where the "first order" approximation given by the purely macroscopic approach reveals to be inadequate. We refer for example to self-organizing phenomena observed in pedestrian flows [77], or to the dynamics of turbulent flows for which large scale / small scale vortical structures interfere [97].

Nevertheless, macroscopic models offer well known advantages, namely a sound analytical framework, fast numerical schemes, the presence of a low number of parameters to be calibrated, and efficient optimization procedures. Therefore, we are convinced of the interest of keeping this point of view as dominant, while completing the models with information on the dynamics at the small scale / microscopic level. This can be achieved through several techniques, like hybrid models, homogenization, mean field games. In this project, we will focus on the aspects detailed below.

The development of adapted and efficient numerical schemes is a mandatory completion, and sometimes ingredient, of all the approaches listed below. The numerical schemes developed by the team are based on finite volumes or finite elements techniques, and constitute an important tool in the study of the considered models, providing a necessary step towards the design and implementation of the corresponding optimization algorithms, see Section 3.1.2.

3.1.1.1. Micro-macro couplings

Modeling of complex problems with a dominant macroscopic point of view often requires couplings with small scale descriptions. Accounting for systems heterogeneity or different degrees of accuracy usually leads to coupled PDE-ODE systems.

In the case of heterogeneous problems the coupling is "intrinsic", i.e. the two models evolve together and mutually affect each-other. For example, accounting for the impact of a large and slow vehicle (like a bus or a truck) on traffic flow leads to a strongly coupled system consisting of a (system of) conservation law(s) coupled with an ODE describing the bus trajectory, which acts as a moving bottleneck.The coupling is realized through a local unilateral moving constraint on the flow at the bus location, see [53] for an existence result and [41], [52] for numerical schemes.

If the coupling is intended to offer higher degree of accuracy at some locations, a macroscopic and a microscopic model are connected through an artificial boundary, and exchange information across it through suitable boundary conditions. See [45], [70] for some applications in traffic flow modelling, and [63], [67], [69] for applications to cell dynamics.

The corresponding numerical schemes are usually based on classical finite volume or finite element methods for the PDE, and Euler or Runge-Kutta schemes for the ODE, coupled in order to take into account the interaction fronts. In particular, the dynamics of the coupling boundaries require an accurate handling capturing the possible presence of non-classical shocks and preventing diffusion, which could produce wrong solutions, see for example [41], [52].

We plan to pursue our activity in this framework, also extending the above mentioned approaches to problems in two or higher space dimensions, to cover applications to crowd dynamics or fluid-structure interaction.

3.1.1.2. Micro-macro limits

Rigorous derivation of macroscopic models from microscopic ones offers a sound basis for the proposed modeling approach, and can provide alternative numerical schemes, see for example [46], [55] for the derivation of Lighthill-Whitham-Richards [85], [96] traffic flow model from Follow-the-Leader and [64] for results on crowd motion models (see also [78]). To tackle this aspect, we will rely mainly on two (interconnected) concepts: measure-valued solutions and mean-field limits.

The notion of **measure-valued solutions** for conservation laws was first introduced by DiPerna [56], and extensively used since then to prove convergence of approximate solutions and deduce existence results, see for example [65] and references therein. Measure-valued functions have been recently advocated as the appropriate notion of solution to tackle problems for which analytical results (such as existence and uniqueness of weak solutions in distributional sense) and numerical convergence are missing [32], [66]. We refer, for example, to the notion of solution for non-hyperbolic systems [71], for which no general theoretical result is available at present, and to the convergence of finite volume schemes for systems of hyperbolic conservation laws in several space dimensions, see [66].

In this framework, we plan to investigate and make use of measure-based PDE models for vehicular and pedestrian traffic flows. Indeed, a modeling approach based on (multi-scale) time-evolving measures (expressing the agents probability distribution in space) has been recently introduced (see the monograph [49]), and proved to be successful for studying emerging self-organised flow patterns [48]. The theoretical measure framework proves to be also relevant in addressing micro-macro limiting procedures of mean field type [72], where one lets the number of agents going to infinity, while keeping the total mass constant. In this case, one must prove that the *empirical measure*, corresponding to the sum of Dirac measures concentrated at the agents positions, converges to a measure-valued solution of the corresponding macroscopic evolution equation. We recall that a key ingredient in this approach is the use of the *Wasserstein distances* [104], [105]. Indeed, as observed in [91], the usual L^1 spaces are not natural in this context, since they don't guarantee uniqueness of solutions.

This procedure can potentially be extended to more complex configurations, like for example road networks or different classes of interacting agents, or to other application domains, like cell-dynamics.

Another powerful tool we shall consider to deal with micro-macro limits is the so-called **Mean Field Games (MFG)** technique (see the seminal paper [84]). This approach has been recently applied to some of the systems studied by the team, such as traffic flow and cell dynamics. In the context of crowd dynamics, including the case of several populations with different targets, the mean field game approach has been adopted in [37], [38], [57], [83], under the assumption that the individual behavior evolves according to a stochastic process, which gives rise to parabolic equations greatly simplifying the analysis of the system. Besides, a deterministic context is studied in [93], which considers a non-local velocity field. For cell dynamics, in order to take into account the fast processes that occur in the migration-related machinery, a framework such the one developed in [51] to handle games "where agents evolve their strategies according to the best-reply scheme on a much faster time scale than their social configuration variables" may turn out to be suitable. An alternative framework to MFG is also considered. This framework is based on the formulation of -Nash- games constrained by the **Fokker-Planck** (FP, [30]) partial differential equations that govern the time evolution of the probability density functions -PDF- of stochastic systems and on objectives that may require to follow a given PDF trajectory or to minimize an expectation functional.

3.1.1.3. Non-local flows

Non-local interactions can be described through macroscopic models based on integro-differential equations. Systems of the type

$$\partial_t u + \mathrm{div}_{\mathbf{x}} F(t, \mathbf{x}, u, W) = 0, \qquad t > 0,\ \mathbf{x} \in \mathbb{R}^d,\ d \geq 1, \tag{1}$$

where $u = u(t, \mathbf{x}) \in \mathbb{R}^N$, $N \geq 1$ is the vector of conserved quantities and the variable $W = W(t, x, u)$ depends on an integral evaluation of u, arise in a variety of physical applications. Space-integral terms are considered for example in models for granular flows [27], sedimentation [34], supply chains [74], conveyor belts [75], biological applications like structured populations dynamics [90], or more general problems like gradient constrained equations [28]. Also, non-local in time terms arise in conservation laws with memory, starting from [50]. In particular, equations with non-local flux have been recently introduced in traffic flow modeling to account for the reaction of drivers or pedestrians to the surrounding density of other individuals, see [40], [42], [100]. While pedestrians are likely to react to the presence of people all around them, drivers will mainly adapt their velocity to the downstream traffic, assigning a greater importance to closer vehicles. In particular, and in contrast to classical (without integral terms) macroscopic equations, these models are able to display finite acceleration of vehicles through Lipschitz bounds on the mean velocity and lane formation in crossing pedestrian flows.

General analytical results on non-local conservation laws, proving existence and eventually uniqueness of solutions of the Cauchy problem for (1), can be found in [29] for scalar equations in one space dimension ($N = d = 1$), in [43] for scalar equations in several space dimensions ($N = 1$, $d \geq 1$) and in [25], [44], [47] for multi-dimensional systems of conservation laws. Besides, specific finite volume numerical methods have been developed recently in [25], and [82].

Relying on these encouraging results, we aim to push a step further the analytical and numerical study of non-local models of type (1), in particular concerning well-posedness of initial - regularity of solutions, boundary value problems and high-order numerical schemes.

3.1.1.4. Uncertainty in parameters and initial-boundary data

Different sources of uncertainty can be identified in PDE models, related to the fact that the problem of interest is not perfectly known. At first, initial and boundary condition values can be uncertain. For instance, in traffic flows, the time-dependent value of inlet and outlet fluxes, as well as the initial distribution of vehicles density, are not perfectly determined [39]. In aerodynamics, inflow conditions like velocity modulus and direction, are subject to fluctuations [76], [89]. For some engineering problems, the geometry of the boundary can also be uncertain, due to structural deformation, mechanical wear or disregard of some details [59]. Another source of uncertainty is related to the value of some parameters in the PDE models. This is typically the case of parameters in turbulence models in fluid mechanics, which have been calibrated according to some reference flows but are not universal [98], [103], or in traffic flow models, which may depend on the type of road, weather conditions, or even the country of interest (due to differences in driving rules and conductors behaviour). This leads to equations with flux functions depending on random parameters [99], [102], for which the mean and the variance of the solutions can be computed using different techniques. Indeed, uncertainty quantification for systems governed by PDEs has become a very active research topic in the last years. Most approaches are embedded in a probabilistic framework and aim at quantifying statistical moments of the PDE solutions, under the assumption that the characteristics of uncertain parameters are known. Note that classical Monte-Carlo approaches exhibit low convergence rate and consequently accurate simulations require huge computational times. In this respect, some enhanced algorithms have been proposed, for example in the balance law framework [88]. Different approaches propose to modify the PDE solvers to account for this probabilistic context, for instance by defining the non-deterministic part of the solution on an orthogonal basis (Polynomial Chaos decomposition) and using a Galerkin projection [76], [81], [86], [107] or an entropy closure method [54], or by discretizing the probability space and extending the numerical schemes to the stochastic components [24]. Alternatively, some other approaches maintain a fully deterministic PDE resolution, but approximate the solution in the vicinity of the reference parameter values by Taylor series expansions based on first- or second-order sensitivities [94], [103], [106].

Our objective regarding this topic is twofold. In a pure modeling perspective, we aim at including uncertainty quantification in models calibration and validation for predictive use. In this case, the choice of the techniques will depend on the specific problem considered [33]. Besides, we plan to extend previous works on sensitivity analysis [59], [87] to more complex and more demanding problems. In particular, high-order Taylor expansions of the solution (greater than two) will be considered in the framework of the Sensitivity Equation Method [35] (SEM) for unsteady aerodynamic applications, to improve the accuracy of mean and variance estimations. A second targeted topic in this context is the study of the uncertainty related to turbulence closure parameters, in the sequel of [103]. We aim at exploring the capability of the SEM approach to detect a change of flow topology, in case of detached flows. Our ambition is to contribute to the emergence of a new generation of simulation tools, which will provide solution densities rather than values, to tackle real-life uncertain problems. This task will also include a reflection about numerical schemes used to solve PDE systems, in the perspective of constructing a unified numerical framework able to account for exact geometries (isogeometric methods), uncertainty propagation and sensitivity analysis w.r.t. control parameters.

3.1.2. Optimization and control algorithms for systems governed by PDEs

The non-classical models described above are developed in the perspective of design improvement for real-life applications. Therefore, control and optimization algorithms are also developed in conjunction with these models. The focus here is on the methodological development and analysis of optimization algorithms for PDE systems in general, keeping in mind the application domains in the way the problems are mathematically formulated.

3.1.2.1. Sensitivity VS adjoint equation

Adjoint methods (achieved at continuous or discrete level) are now commonly used in industry for steady PDE problems. Our recent developments [95] have shown that the (discrete) adjoint method can be efficiently applied to cost gradient computations for time-evolving traffic flow on networks, thanks to the special structure of the associated linear systems and the underlying one dimensionality of the problem. However, this strategy

is questionable for more complex (e.g. 2D/3D) unsteady problems, because it requires sophisticated and time-consuming check-pointing and/or re-computing strategies [31], [73] for the backward time integration of the adjoint variables. The sensitivity equation method (SEM) offers a promising alternative [58], [79], if the number of design parameters is moderate. Moreover, this approach can be employed for other goals, like fast evaluation of neighboring solutions or uncertainty propagation [59].
Regarding this topic, we intend to apply the continuous sensitivity equation method to challenging problems. In particular, in aerodynamics, multi-scale turbulence models like Large-Eddy Simulation (LES) [97] , Detached-Eddy Simulation (DES) [101] or Organized-Eddy Simulation (OES) [36], are more and more employed to analyse the unsteady dynamics of the flows around bluff-bodies, because they have the ability to compute the interactions of vortices at different scales, contrary to classical Reynolds-Averaged Navier-Stokes models. However, their use in design optimization is tedious, due to the long time integration required. In collaboration with turbulence specialists (M. Braza, CNRS - IMFT), we aim at developing numerical methods for effective sensitivity analysis in this context, and apply them to realistic problems, like the optimization of active flow control devices. Note that the use of SEM allows computing cost functional gradients at any time, which permits to construct new gradient-based optimization strategies like instantaneous-feedback method [80] or multiobjective optimization algorithm (see section below).

3.1.2.2. Multi-objective descent algorithms for multi-disciplinary, multi-point, unsteady optimization or robust-design

n differentiable optimization, multi-disciplinary, multi-point, unsteady optimization or robust-design can all be formulated as multi-objective optimization problems. In this area, we have proposed the *Multiple-Gradient Descent Algorithm (MGDA)* to handle all criteria concurrently [60] [61]. Originally, we have stated a principle according which, given a family of local gradients, a descent direction common to all considered objective-functions simultaneously is identified, assuming the Pareto-stationarity condition is not satisfied. When the family is linearly-independent, we dispose of a direct algorithm. Inversely, when the family is linearly-dependent, a quadratic-programming problem should be solved. Hence, the technical difficulty is mostly conditioned by the number m of objective functions relative to the search space dimension n. In this respect, the basic algorithm has recently been revised [62] to handle the case where $m > n$, and even $m \gg n$, and is currently being tested on a test-case of robust design subject to a periodic time-dependent Navier-Stokes flow.

The multi-point situation is very similar and, being of great importance for engineering applications, will be treated at large.

Moreover, we intend to develop and test a new methodology for robust design that will include uncertainty effects. More precisely, we propose to employ MGDA to achieve an effective improvement of all criteria simultaneously, which can be of statistical nature or discrete functional values evaluated in confidence intervals of parameters. Some recent results obtained at ONERA [92] by a stochastic variant of our methodology confirm the viability of the approach. A PhD thesis has also been launched at ONERA/DADS.

Lastly, we note that in situations where gradients are difficult to evaluate, the method can be assisted by a meta-model [108].

3.1.2.3. Bayesian Optimization algorithms for efficient computation of general equilibria

Bayesian Optimization -BO- relies on Gaussian processes, which are used as emulators (or surrogates) of the black-box model outputs based on a small set of model evaluations. Posterior distributions provided by the Gaussian process are used to design acquisition functions that guide sequential search strategies that balance between exploration and exploitation. Such approaches have been transposed to frameworks other than optimization, such as uncertainty quantification. Our aim is to investigate how the BO apparatus can be applied to the search of general game equilibria, and in particular the classical Nash equilibrium (NE). To this end, we propose two complementary acquisition functions, one based on a greedy search approach and one based on the Stepwise Uncertainty Reduction paradigm [68]. Our proposal is designed to tackle derivative-free, expensive models, hence requiring very few model evaluations to converge to the solution.

3.1.2.4. Decentralized strategies for inverse problems

Most if not all the mathematical formulations of inverse problems (a.k.a. reconstruction, identification, data recovery, non destructive engineering,...) are known to be ill posed in the Hadamard sense. Indeed, in general, inverse problems try to fulfill (minimize) two or more very antagonistic criteria. One classical example is the Tikhonov regularization, trying to find artificially smoothed solutions close to naturally non-smooth data.

We consider here the theoretical general framework of parameter identification coupled to (missing) data recovery. Our aim is to design, study and implement algorithms derived within a game theoretic framework, which are able to find, with computational efficiency, equilibria between the "identification related players" and the "data recovery players". These two parts are known to pose many challenges, from a theoretical point of view, like the identifiability issue, and from a numerical one, like convergence, stability and robustness problems. These questions are tricky [26] and still completely open for systems like e.g. coupled heat and thermoelastic joint data and material detection.

3.2. LaTeX Test Page

Exemples d'équations :

- Equation en mode “mathématique” :
  $y = x^2$
- Equation en environnement “equation” :

$$P\begin{pmatrix}\theta_1\\ \vdots\\ \theta_r\end{pmatrix} = Q + R, \tag{2}$$

- Equation en environnement “displaymath” :

$$\sum_0^\infty y = x^4$$

- Autre exemple :

$$\forall f \in C^\infty\left(\left[-\frac{T}{2};\frac{T}{2}\right]\right), \forall t \in \left[-\frac{T}{2};\frac{T}{2}\right], f(\tau) = \sum_{k=-\infty}^{+\infty} e^{2i\pi\frac{k}{T}t} \times \underbrace{\frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)e^{-2i\pi\frac{k}{T}t}dt}_{a_k=\widetilde{f}\left(\nu=\frac{k}{T}\right)}$$

Exemple de caractères spéciaux :
math pi : π
lettres : æ Æ à À â Â ä Ä ç Ç é É è È ê Ê ë Ë î Î ï Ï ô Ô ö Ö ù Ù û Û ü Ü ÿ þ Þ

Exemples d'images :

- Image en jpeg : voir image 1
- Image en eps : voir figure 2
- Image en pdf : voir image 3

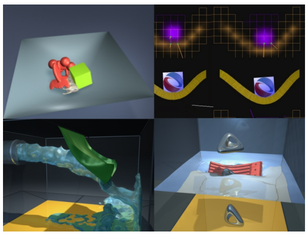

Figure 1. An example of a jpeg image

Figure 2. An example of an eps file

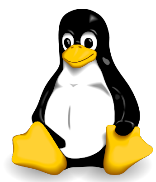

Figure 3. An example of a pdf file

4. Application Domains

4.1. Domain 1

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

6. New Software and Platforms

6.1. Platforms

6.1.1. Platform A

...

6.1.2. Platform B

...

7. New Results

7.1. New result 1

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.2. Bilateral Grants with Industry

9. Partnerships and Cooperations

9.1. Regional Initiatives

...

9.2. National Initiatives

9.2.1. Project BOUM

G. Costeseque holds a BOUM (SMAI) project on *"Mathematical homogenization techniques for traffic flow models"* with W. Salazar and M. Zaydan (LMI, INSA Rouen) and J.A. Firozaly (CERMICS, Ecole des Ponts ParisTech and LAMA, Université Paris-Est Créteil).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. TraM3

Title: Traffic Management by Macroscopic Models

Programm: FP7

Duration: October 2010 - March 2016

Coordinator: Inria

Inria contact: ___CONTACTInria???___

'We propose to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. In fact, even if the continuum hypothesis is clearly not physically satisfied, macroscopic quantities can be regarded as measures of traffic features and allow to depict the spatio-temporal evolution of traffic waves. Continuum models have shown to be in good agreement with empirical data. Moreover, they are suitable for analytical investigations and very efficient from the numerical point of view. Therefore, they provide the right framework to state and solve control and optimization problems, and we believe that the use of macroscopic models can open new horizons in traffic management. The major mathematical difficulties related to this study follow from the mandatory use of weak (possibly discontinuous) solutions in distributional sense. Indeed, due to the presence of shock waves and interactions among them, standard techniques are generally useless for solving optimal control problems, and the available esults are scarce and restricted to particular and unrealistic cases. This strongly limits their applicability. Our scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design. This will allow to elaborate reliable predictions and to optimize traffic fluxes. To achieve this goal, we will move from the detailed structure of the solutions in order to construct ad hoc methods to tackle the analytical and numerical difficulties arising in this study. The foreseen applications target the sustainability and safety issues of modern society.'

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.3. Collaborations with Major European Organizations

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Other IIL projects

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) (EECS) - Alexandre M. Bayen

Start year: 2015

See also: http://www-sop.inria.fr/members/Paola.Goatin/ORESTE/index.html

This project focuses on traffic flow modeling and optimal management on road networks. Based on the results obtained during the first three years, we aim at further develop a unified macroscopic approach for traffic monitoring, prediction and control. In particular, we aim at investigating user equilibrium inference and Lagrangian controls actuations using macroscopic models consisting of conservation laws or Hamilton-Jacobi equations.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

9.4.3.2. Informal International Partners

9.4.4. Participation in Other International Programs

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

9.5.2.2. Explorer programme

9.5.2.3. Research Stays Abroad

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. General Chair, Scientific Chair

10.1.1.2. Member of the Organizing Committees

10.1.2. Scientific Events Selection

10.1.2.1. Chair of Conference Program Committees

10.1.2.2. Member of the Conference Program Committees

10.1.2.3. Reviewer

10.1.3. Journal

10.1.3.1. Member of the Editorial Boards

10.1.3.2. Reviewer - Reviewing Activities

10.1.4. Invited Talks

10.1.5. Leadership within the Scientific Community

10.1.6. Scientific Expertise

10.1.7. Research Administration

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

10.2.2. Supervision

10.2.3. Juries

10.3. Popularization

https://wiki.inria.fr/mecsci/Cadrage:MecsciCaracterisation

11. Bibliography

Publications of the year

Articles in International Peer-Reviewed Journals

[1] B. ABOU EL MAJD, O. OUCHETTO, J.-A. DÉSIDÉRI, A. HABBAL. *Hessian transfer for multilevel and adaptive shape optimization* , in "International Journal for Simulation and Multidisciplinary Design Optimization", 2017, vol. 8, 18 p. p. [*DOI :* 10.1051/SMDO/2017002], https://hal.inria.fr/hal-01440209

[2] R. ABOULAICH, R. ELLAIA, S. EL MOUMEN, A. HABBAL, N. MOUSSAID. *The Mean-CVaR Model for Portfolio Optimization Using a Multi-Objective Approach and the Kalai-Smorodinsky Solution*, in "MATEC Web of Conferences", 2017, vol. 105, 4 p. [*DOI :* 10.1051/MATECCONF/201710500010], https://hal.inria.fr/hal-01575730

[3] A. BENKI, A. HABBAL, G. MATHIS. *A metamodel-based multicriteria shape optimization process for an aerosol can*, in "Alexandria Engineering Journal", 2017, 12 p. [*DOI :* 10.1016/J.AEJ.2017.03.036], https://hal.inria.fr/hal-01575721

[4] M. L. DELLE MONACHE, P. GOATIN. *Stability estimates for scalar conservation laws with moving flux constraints*, in "Networks and Heterogeneous Media", June 2017, vol. 12, n^o 2, pp. 245–258 [*DOI :* 10.3934/NHM.2017010], https://hal.inria.fr/hal-01380368

[5] P. GOATIN, F. ROSSI. *A traffic flow model with non-smooth metric interaction: Well-posedness and micro-macro limit*, in "Communications in Mathematical Sciences", 2017, vol. 15, n^o 1, pp. 261 - 287 [*DOI :* 10.4310/CMS.2017.V15.N1.A12], https://hal.archives-ouvertes.fr/hal-01215944

[6] S. ROY, A. BORZÌ, A. HABBAL. *Pedestrian motion modeled by FP-constrained Nash games*, in "Royal Society Open Science", 2017 [*DOI :* 10.1098/RSOS.170648], https://hal.inria.fr/hal-01586678

[7] M. SACHER, F. HAUVILLE, R. DUVIGNEAU, O. LE MAÎTRE, N. AUBIN, M. DURAND. *Efficient optimization procedure in non-linear fluid-structure interaction problem: Application to mainsail trimming in upwind conditions*, in "Journal of Fluids and Structures", February 2017, vol. 69, pp. 209 - 231 [*DOI :* 10.1016/J.JFLUIDSTRUCTS.2016.12.006], https://hal.inria.fr/hal-01589317

[8] B. YAHYAOUI, M. AYADI, A. HABBAL. *Fisher-KPP with time dependent diffusion is able to model cell-sheet activated and inhibited wound closure*, in "Mathematical Biosciences", 2017, vol. 292, pp. 36-45 [*DOI :* 10.1016/J.MBS.2017.07.009], https://hal.inria.fr/hal-01575717

International Conferences with Proceedings

[9] E. BERRINI, B. MOURRAIN, R. DUVIGNEAU, M. SACHER, Y. ROUX. *Geometric model for automated multi-objective optimization of foils*, in "Marine 2017", Nantes, France, VII International Conference on Computational Methods in Marine Engineering, MARINE 2017, May 2017, pp. 473-484, https://hal.archives-ouvertes.fr/hal-01524287

[10] C. CHALONS, R. DUVIGNEAU, C. FIORINI. *Sensitivity analysis for the Euler equations in Lagrangian coordinates*, in "FVCA - 8th International Symposium on Finite Volumes for Complex Applications", Lille, France, June 2017, https://hal.inria.fr/hal-01589307

[11] A. GDHAMI, R. DUVIGNEAU, M. MOAKHER. *Méthode de Galerkin Discontinue : Cas de l'analyse isogéométrique*, in "TAM-TAM 2017 - Tendances dans les Applications Mathématiques en Tunisie, Algérie et Maroc", Hammamet, Tunisia, May 2017, https://hal.inria.fr/hal-01589293

[12] M. SACHER, M. DURAND, E. BERRINI, F. HAUVILLE, R. DUVIGNEAU, O. LE MAITRE, J. A. ASTOLFI. *Flexible hydrofoil optimization for the 35th America's cup with constrained Ego Method*, in "INNOVSAIL International Conference on Innovation in High Performance Sailing Yachts", Lorient, France, P. BOT (editor), INNOVSAIL 2017, 4th Edition, CVET and Ecole Navale, June 2017, pp. 193-206, https://hal.archives-ouvertes.fr/hal-01583591

Conferences without Proceedings

[13] R. DUVIGNEAU. *High-Order Taylor Expansions for Compressible Flows*, in "SIAM Optimization", Vancouver, Canada, May 2017, https://hal.inria.fr/hal-01589254

[14] R. DUVIGNEAU, A. GDHAMI, M. MOAKHER. *Isogeometric Analysis for Hyperbolic Conservation Laws using a Discontinuous Galerkin Method*, in "International Conference on Isogeometric Analysis", Pavia, Italy, September 2017, https://hal.inria.fr/hal-01589270

[15] C. FIORINI, R. DUVIGNEAU, C. CHALONS. *Sensitivity Analysis for Hyperbolic Systems of Conservation Laws*, in "SIAM Optimization", Vancouver, Canada, May 2017, https://hal.inria.fr/hal-01589247

[16] A. GDHAMI, R. DUVIGNEAU, M. MOAKHER. *Isogeometric analysis for hyperbolic PDEs using a Discontinuous Galerkin method*, in "Congrès SMAI", La Tremblade, France, June 2017, https://hal.inria.fr/hal-01589278

[17] M. SACHER, R. DUVIGNEAU, O. LE MAITRE, M. DURAND, E. BERRINI, F. HAUVILLE, J. A. ASTOLFI. *Surrogates and Classification Approaches for Efficient Global Optimization (EGO) with Inequality Constraints*, in "SIAM Optimization", Vancouver, Canada, May 2017, https://hal.inria.fr/hal-01589262

Scientific Books (or Scientific Book chapters)

[18] J.-A. DESIDERI, R. DUVIGNEAU. *Parametric optimization of pulsating jets in unsteady flow by Multiple-Gradient Descent Algorithm (MGDA)*, in "Numerical Methods for Differential Equations, Optimization, and Technological Problems, Modeling, Simulation and Optimization for Science and Technology", J. PÉRIAUX, W. FITZGIBBON, B. CHETVERUSHKIN, O. PIRONNEAU (editors), January 2017, https://hal.inria.fr/hal-01414741

Other Publications

[19] F. BERTHELIN, P. GOATIN. *Particle approximation of a constrained model for traffic flow*, January 2017, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01437867

[20] C. CHALONS, R. DUVIGNEAU, C. FIORINI. *Sensitivity analysis and numerical diffusion effects for hyperbolic PDE systems with discontinuous solutions. The case of barotropic Euler equations in Lagrangian coordinates*, July 2017, Pre-print submitted to SIAM Scientific Computing., https://hal.inria.fr/hal-01589337

[21] F. A. CHIARELLO, P. GOATIN. *Global entropy weak solutions for general non-local traffic flow models with anisotropic kernel*, July 2017, working paper or preprint, https://hal.inria.fr/hal-01567575

[22] R. DUVIGNEAU. *Isogeometric analysis for compressible flows using a Discontinuous Galerkin method*, February 2017, Pre-print submitted to Computer Methods in Applied Mechanics and Engineering, https://hal.inria.fr/hal-01589344

[23] O. KOLB, G. COSTESEQUE, P. GOATIN, S. GÖTTLICH. *Pareto-optimal coupling conditions for a second order traffic flow model at junctions*, June 2017, working paper or preprint, https://hal.inria.fr/hal-01551100

References in notes

[24] R. ABGRALL, P. M. CONGEDO. *A semi-intrusive deterministic approach to uncertainty quantification in non-linear fluid flow problems*, in "J. Comput. Physics", 2012

[25] A. AGGARWAL, R. M. COLOMBO, P. GOATIN. *Nonlocal systems of conservation laws in several space dimensions*, in "SIAM Journal on Numerical Analysis", 2015, vol. 52, n^o 2, pp. 963-983, https://hal.inria.fr/hal-01016784

[26] G. ALESSANDRINI. *Examples of instability in inverse boundary-value problems*, in "Inverse Problems", 1997, vol. 13, n^o 4, pp. 887–897, http://dx.doi.org/10.1088/0266-5611/13/4/001

[27] D. AMADORI, W. SHEN. *An integro-differential conservation law arising in a model of granular flow*, in "J. Hyperbolic Differ. Equ.", 2012, vol. 9, n^o 1, pp. 105–131

[28] P. AMORIM. *On a nonlocal hyperbolic conservation law arising from a gradient constraint problem*, in "Bull. Braz. Math. Soc. (N.S.)", 2012, vol. 43, n^o 4, pp. 599–614

[29] P. AMORIM, R. COLOMBO, A. TEIXEIRA. *On the Numerical Integration of Scalar Nonlocal Conservation Laws*, in "ESAIM M2AN", 2015, vol. 49, n^o 1, pp. 19–37

[30] M. ANNUNZIATO, A. BORZÌ. *A Fokker-Planck control framework for multidimensional stochastic processes*, in "Journal of Computational and Applied Mathematics", 2013, vol. 237, pp. 487-507

[31] A. BELME, F. ALAUZET, A. DERVIEUX. *Time accurate anisotropic goal-oriented mesh adaptation for unsteady flows*, in "J. Comput. Physics", 2012, vol. 231, n^o 19, pp. 6323–6348

[32] S. BENZONI-GAVAGE, R. M. COLOMBO, P. GWIAZDA. *Measure valued solutions to conservation laws motivated by traffic modelling*, in "Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.", 2006, vol. 462, n^o 2070, pp. 1791–1803

[33] E. BERTINO, R. DUVIGNEAU, P. GOATIN. *Uncertainties in traffic flow and model validation on GPS data*, 2017

[34] F. BETANCOURT, R. BÜRGER, K. H. KARLSEN, E. M. TORY. *On nonlocal conservation laws modelling sedimentation*, in "Nonlinearity", 2011, vol. 24, n^o 3, pp. 855–885

[35] J. BORGGAARD, J. BURNS. *A {PDE} Sensitivity Equation Method for Optimal Aerodynamic Design*, in "Journal of Computational Physics", 1997, vol. 136, n^o 2, pp. 366 - 384 [*DOI :* 10.1006/JCPH.1997.5743], http://www.sciencedirect.com/science/article/pii/S0021999197957430

[36] R. BOURGUET, M. BRAZZA, G. HARRAN, R. EL AKOURY. *Anisotropic Organised Eddy Simulation for the prediction of non-equilibrium turbulent flows around bodies*, in "J. of Fluids and Structures", 2008, vol. 24, n° 8, pp. 1240–1251

[37] M. BURGER, M. DI FRANCESCO, P. A. MARKOWICH, M.-T. WOLFRAM. *Mean field games with nonlinear mobilities in pedestrian dynamics*, in "Discrete Contin. Dyn. Syst. Ser. B", 2014, vol. 19, n° 5, pp. 1311–1333

[38] M. BURGER, J. HASKOVEC, M.-T. WOLFRAM. *Individual based and mean-field modelling of direct aggregation*, in "Physica D", 2013, vol. 260, pp. 145–158

[39] A. CABASSI, P. GOATIN. *Validation of traffic flow models on processed GPS data*, 2013, Research Report RR-8382, https://hal.inria.fr/hal-00876311/file/RR-8382.pdf

[40] J. A. CARRILLO, S. MARTIN, M.-T. WOLFRAM. *A local version of the Hughes model for pedestrian flow*, 2015, Preprint

[41] C. CHALONS, M. L. DELLE MONACHE, P. GOATIN. *A conservative scheme for non-classical solutions to a strongly coupled PDE-ODE problem*, 2015, Preprint

[42] R. M. COLOMBO, M. GARAVELLO, M. LÉCUREUX-MERCIER. *A CLASS OF NONLOCAL MODELS FOR PEDESTRIAN TRAFFIC*, in "Mathematical Models and Methods in Applied Sciences", 2012, vol. 22, n° 04, 1150023 p.

[43] R. M. COLOMBO, M. HERTY, M. MERCIER. *Control of the continuity equation with a non local flow*, in "ESAIM Control Optim. Calc. Var.", 2011, vol. 17, n° 2, pp. 353–379

[44] R. M. COLOMBO, M. LÉCUREUX-MERCIER. *Nonlocal crowd dynamics models for several populations*, in "Acta Math. Sci. Ser. B Engl. Ed.", 2012, vol. 32, n° 1, pp. 177–196

[45] R. M. COLOMBO, F. MARCELLINI. *A mixed ODEâPDE model for vehicular traffic*, in "Mathematical Methods in the Applied Sciences", 2015, vol. 38, n° 7, pp. 1292–1302

[46] R. M. COLOMBO, E. ROSSI. *On the micro-macro limit in traffic flow*, in "Rend. Semin. Mat. Univ. Padova", 2014, vol. 131, pp. 217–235

[47] G. CRIPPA, M. LÉCUREUX-MERCIER. *Existence and uniqueness of measure solutions for a system of continuity equations with non-local flow*, in "Nonlinear Differential Equations and Applications NoDEA", 2012, pp. 1-15

[48] E. CRISTIANI, B. PICCOLI, A. TOSIN. *How can macroscopic models reveal self-organization in traffic flow?*, in "Decision and Control (CDC), 2012 IEEE 51st Annual Conference on", Dec 2012, pp. 6989-6994

[49] E. CRISTIANI, B. PICCOLI, A. TOSIN. *Multiscale modeling of pedestrian dynamics*, MS&A. Modeling, Simulation and Applications, Springer, Cham, 2014, vol. 12, xvi+260 p.

[50] C. M. DAFERMOS. *Solutions in L^∞ for a conservation law with memory*, in "Analyse mathématique et applications", Montrouge, Gauthier-Villars, 1988, pp. 117–128

[51] P. DEGOND, J.-G. LIU, C. RINGHOFER. *Large-scale dynamics of mean-field games driven by local Nash equilibria*, in "J. Nonlinear Sci.", 2014, vol. 24, n^o 1, pp. 93–115, http://dx.doi.org/10.1007/s00332-013-9185-2

[52] M. L. DELLE MONACHE, P. GOATIN. *A front tracking method for a strongly coupled PDE-ODE system with moving density constraints in traffic flow*, in "Discrete Contin. Dyn. Syst. Ser. S", 2014, vol. 7, n^o 3, pp. 435–447

[53] M. L. DELLE MONACHE, P. GOATIN. *Scalar conservation laws with moving constraints arising in traffic flow modeling: an existence result*, in "J. Differential Equations", 2014, vol. 257, n^o 11, pp. 4015–4029

[54] B. DESPRÉS, G. POËTTE, D. LUCOR. *Robust uncertainty propagation in systems of conservation laws with the entropy closure method*, in "Uncertainty quantification in computational fluid dynamics", Lect. Notes Comput. Sci. Eng., Springer, Heidelberg, 2013, vol. 92, pp. 105–149

[55] M. DI FRANCESCO, M. D. ROSINI. *Rigorous Derivation of Nonlinear Scalar Conservation Laws from Follow-the-Leader Type Models via Many Particle Limit*, in "Archive for Rational Mechanics and Analysis", January 2015 [*DOI :* 10.1007/s00205-015-0843-4]

[56] R. J. DIPERNA. *Measure-valued solutions to conservation laws*, in "Arch. Rational Mech. Anal.", 1985, vol. 88, n^o 3, pp. 223–270

[57] C. DOGBÉ. *Modeling crowd dynamics by the mean-field limit approach*, in "Math. Comput. Modelling", 2010, vol. 52, n^o 9-10, pp. 1506–1520

[58] R. DUVIGNEAU. *A Sensitivity Equation Method for Unsteady Compressible Flows: Implementation and Verification*, Inria Research Report No 8739, June 2015

[59] R. DUVIGNEAU, D. PELLETIER. *A sensitivity equation method for fast evaluation of nearby flows and uncertainty analysis for shape parameters*, in "Int. J. of Computational Fluid Dynamics", August 2006, vol. 20, n^o 7, pp. 497–512

[60] J.-A. DÉSIDÉRI. *Multiple-gradient descent algorithm (MGDA) for multiobjective optimization*, in "Comptes Rendus de l'Académie des Sciences Paris", 2012, vol. 350, pp. 313-318, http://dx.doi.org/10.1016/j.crma.2012.03.014

[61] J.-A. DÉSIDÉRI. *Multiple-Gradient Descent Algorithm (MGDA) for Pareto-Front Identification*, in "Numerical Methods for Differential Equations, Optimization, and Technological Problems", Modeling, Simulation and Optimization for Science and Technology, Fitzgibbon, W.; Kuznetsov, Y.A.; Neittaanmäki, P.; Pironneau, O. Eds., Springer-Verlag, 2014, vol. 34, J. Périaux and R. Glowinski Jubilees

[62] J.-A. DÉSIDÉRI. *Révision de l'algorithme de descente à gradients multiples (MGDA) par orthogonalisation hiérarchique*, Inria, April 2015, n^o 8710, https://hal.inria.fr/hal-01139994

[63] R. ERBAN, M. B. FLEGG, G. A. PAPOIAN. *Multiscale stochastic reaction-diffusion modeling: application to actin dynamics in filopodia*, in "Bull. Math. Biol.", 2014, vol. 76, n^o 4, pp. 799–818, http://dx.doi.org/10.1007/s11538-013-9844-3

[64] R. ETIKYALA, S. GÖTTLICH, A. KLAR, S. TIWARI. *Particle methods for pedestrian flow models: from microscopic to nonlocal continuum models*, in "Math. Models Methods Appl. Sci.", 2014, vol. 24, n^{o} 12, pp. 2503–2523

[65] R. EYMARD, T. GALLOUËT, R. HERBIN. *Finite volume methods*, in "Handbook of numerical analysis, Vol. VII", Handb. Numer. Anal., VII, North-Holland, Amsterdam, 2000, pp. 713–1020

[66] U. FJORDHOLM, R. KAPPELI, S. MISHRA, E. TADMOR. *Construction of approximate entropy measure valued solutions for systems of conservation laws*, Seminar for Applied Mathematics, ETH Zürich, 2014, n^{o} 2014-33

[67] M. B. FLEGG, S. HELLANDER, R. ERBAN. *Convergence of methods for coupling of microscopic and mesoscopic reaction-diffusion simulations*, in "J. Comput. Phys.", 2015, vol. 289, pp. 1–17, http://dx.doi.org/10.1016/j.jcp.2015.01.030

[68] F. FLEURET, D. GEMAN. *Graded learning for object detection*, in "Proceedings of the workshop on Statistical and Computational Theories of Vision of the IEEE international conference on Computer Vision and Pattern Recognition (CVPR/SCTV)", 1999, vol. 2

[69] B. FRANZ, M. B. FLEGG, S. J. CHAPMAN, R. ERBAN. *Multiscale reaction-diffusion algorithms: PDE-assisted Brownian dynamics*, in "SIAM J. Appl. Math.", 2013, vol. 73, n^{o} 3, pp. 1224–1247, http://dx.doi.org/10.1137/120882469

[70] M. GARAVELLO, B. PICCOLI. *Coupling of microscopic and phase transition models at boundary*, in "Netw. Heterog. Media", 2013, vol. 8, n^{o} 3, pp. 649–661

[71] P. GOATIN, M. MIMAULT. *A mixed system modeling two-directional pedestrian flows*, in "Math. Biosci. Eng.", 2015, vol. 12, n^{o} 2, pp. 375–392

[72] P. GOATIN, F. ROSSI. *A traffic flow model with non-smooth metric interaction: well-posedness and micro-macro limit*, 2015, Preprint, http://arxiv.org/abs/1510.04461

[73] A. GRIEWANK. *Achieving logarithmic growth of temporal and spatial complexity in reverse automatic differentiation*, in "Optimization Methods and Software", 1992, vol. 1, pp. 35-54

[74] M. GRÖSCHEL, A. KEIMER, G. LEUGERING, Z. WANG. *Regularity theory and adjoint-based optimality conditions for a nonlinear transport equation with nonlocal velocity*, in "SIAM J. Control Optim.", 2014, vol. 52, n^{o} 4, pp. 2141–2163

[75] S. GÖTTLICH, S. HOHER, P. SCHINDLER, V. SCHLEPER, A. VERL. *Modeling, simulation and validation of material flow on conveyor belts*, in "Applied Mathematical Modelling", 2014, vol. 38, n^{o} 13, pp. 3295 - 3313

[76] X. HAN, P. SAGAUT, D. LUCOR. *On sensitivity of RANS simulations to uncertain turbulent inflow conditions*, in "Computers & Fluids", 2012, vol. 61, n^{o} 2-5

[77] D. HELBING, P. MOLNAR, I. J. FARKAS, K. BOLAY. *Self-organizing pedestrian movement*, in "Environment and planning B", 2001, vol. 28, n^{o} 3, pp. 361–384

[78] S. P. HOOGENDOORN, F. L. VAN WAGENINGEN-KESSELS, W. DAAMEN, D. C. DUIVES. *Continuum modelling of pedestrian flows: From microscopic principles to self-organised macroscopic phenomena*, in "Physica A: Statistical Mechanics and its Applications", 2014, vol. 416, n^o 0, pp. 684 - 694

[79] H. HRISTOVA, S. ETIENNE, D. PELLETIER, J. BORGGAARD. *A continuous sensitivity equation method for time-dependent incompressible laminar flows*, in "Int. J. for Numerical Methods in Fluids", 2004, vol. 50, pp. 817-844

[80] S. JEON, H. CHOI. *Suboptimal feedback control of flow over a sphere*, in "Int. J. of Heat and Fluid Flow", 2010, n^o 31

[81] O. KNIO, O. L. MAITRE. *Uncertainty propagation in CFD using polynomial chaos decomposition*, in "Fluid Dynamics Research", September 2006, vol. 38, n^o 9, pp. 616–640

[82] A. KURGANOV, A. POLIZZI. *Non-Oscillatory Central Schemes for a Traffic Flow Model with Arrehenius Look-Ahead Dynamics*, in "Netw. Heterog. Media", 2009, vol. 4, n^o 3, pp. 431-451

[83] A. LACHAPELLE, M.-T. WOLFRAM. *On a mean field game approach modeling congestion and aversion in pedestrian crowds*, in "Transportation Research Part B: Methodological", 2011, vol. 45, n^o 10, pp. 1572 - 1589

[84] J.-M. LASRY, P.-L. LIONS. *Mean field games*, in "Jpn. J. Math.", 2007, vol. 2, n^o 1, pp. 229–260

[85] M. J. LIGHTHILL, G. B. WHITHAM. *On kinematic waves. II. A theory of traffic flow on long crowded roads*, in "Proc. Roy. Soc. London. Ser. A.", 1955, vol. 229, pp. 317–345

[86] G. LIN, C.-H. SU, G. KARNIADAKIS. *Predicting shock dynamics in the presence of uncertainties*, in "Journal of Computational Physics", 2006, n^o 217, pp. 260-276

[87] M. MARTINELLI, R. DUVIGNEAU. *On the use of second-order derivative and metamodel-based Monte-Carlo for uncertainty estimation in aerodynamics*, in "Computers and Fluids", 2010, vol. 37, n^o 6

[88] S. MISHRA, C. SCHWAB, J. SUKYS. *Multi-level Monte Carlo finite volume methods for uncertainty quantification in nonlinear systems of balance laws*, in "Lecture Notes in Computational Science and Engineering", 2013, vol. 92, pp. 225–294 [*DOI :* 10.1007/978-3-319-00885-1_6]

[89] W. OBERKAMPF, F. BLOTTNER. *Issues in Computational Fluid Dynamics code verification and validation*, in "AIAA Journal", 1998, vol. 36, pp. 687–695

[90] B. PERTHAME. *Transport equations in biology*, Frontiers in Mathematics, Birkhäuser Verlag, Basel, 2007, x+198 p.

[91] B. PICCOLI, F. ROSSI. *Transport equation with nonlocal velocity in Wasserstein spaces: convergence of numerical schemes*, in "Acta Appl. Math.", 2013, vol. 124, pp. 73–105

[92] F. POIRION. *Stochastic Multi Gradient Descent Algorithm*, ONERA, July 2014

[93] F. S. PRIULI. *First order mean field games in crowd dynamics*, in "ArXiv e-prints", February 2014

[94] M. PUTKO, P. NEWMAN, A. TAYLOR, L. GREEN. *Approach for uncertainty propagation and robust design in CFD using sensitivity derivatives*, in "15th AIAA Computational Fluid Dynamics Conference", Anaheim, CA, June 2001, AIAA Paper 2001-2528

[95] J. REILLY, W. KRICHENE, M. L. DELLE MONACHE, S. SAMARANAYAKE, P. GOATIN, A. M. BAYEN. *Adjoint-based optimization on a network of discretized scalar conservation law PDEs with applications to coordinated ramp metering*, in "J. Optim. Theory Appl.", 2015, vol. 167, n^{o} 2, pp. 733–760

[96] P. I. RICHARDS. *Shock waves on the highway*, in "Operations Res.", 1956, vol. 4, pp. 42–51

[97] P. SAGAUT. *Large Eddy Simulation for Incompressible Flows An Introduction*, Springer Berlin Heidelberg, 2006

[98] J. SCHAEFER, T. WEST, S. HOSDER, C. RUMSEY, J.-R. CARLSON, W. KLEB. *Uncertainty Quantification of Turbulence Model Closure Coefficients for Transonic Wall-Bounded Flows*, in "22nd AIAA Computational Fluid Dynamics Conference, 22-26 June 2015, Dallas, USA.", 2015

[99] V. SCHLEPER. *A hybrid model for traffic flow and crowd dynamics with random individual properties*, in "Math. Biosci. Eng.", 2015, vol. 12, n^{o} 2, pp. 393-413

[100] A. SOPASAKIS, M. A. KATSOULAKIS. *Stochastic modeling and simulation of traffic flow: asymmetric single exclusion process with Arrhenius look-ahead dynamics*, in "SIAM J. Appl. Math.", 2006, vol. 66, n^{o} 3, pp. 921–944 (electronic)

[101] P. R. SPALART. *Detached-Eddy Simulation*, in "Annual Review of Fluid Mechanics", 2009, vol. 41, pp. 181-202

[102] S. TOKAREVA, S. MISHRA, C. SCHWAB. *High Order Stochastic Finite Volume Method for the Uncertainty Quantification in Hyperbolic Conservtion Laws with Random Initial Data and Flux Coefficients*, 2012, Proc. ECCOMAS

[103] É. TURGEON, D. PELLETIER, J. BORGGAARD. *Sensitivity and Uncertainty Analysis for Variable Property Flows*, in "39th AIAA Aerospace Sciences Meeting and Exhibit", Reno, NV, Jan. 2001, AIAA Paper 2001-0139

[104] C. VILLANI. *Topics in optimal transportation*, Graduate Studies in Mathematics, American Mathematical Society, Providence, RI, 2003, vol. 58, xvi+370 p.

[105] C. VILLANI. *Optimal transport*, Grundlehren der Mathematischen Wissenschaften [Fundamental Principles of Mathematical Sciences], Springer-Verlag, Berlin, 2009, vol. 338, xxii+973 p. , Old and new

[106] R. WALTER, L. HUYSE. *Uncertainty analysis for fluid mechanics with applications*, ICASE, February 2002, n^{o} 2002–1

[107] D. XIU, G. KARNIADAKIS. *Modeling uncertainty in flow simulations via generalized Polynomial Chaos*, in "Journal of Computational Physics", 2003, n^{o} 187, pp. 137-167

[108] A. ZERBINATI, A. MINELLI, I. GHAZLANE, J.-A. DÉSIDÉRI. *Meta-Model-Assisted MGDA for Multi-Objective Functional Optimization*, in "Computers and Fluids", 2014, vol. 102, pp. 116-130, http://www.sciencedirect.com/science/article/pii/S0045793014002576#