Urbain Vaes

Curriculum Vitae

6 et 8 avenue Blaise Pascal
Cité Descartes – Champs sur Marne
77455 Marne la Vallée Cedex 2, France
+44 (0)7 842 184 774
urbain.vaes@inria.fr

Current position

Since 10/2021 **Researcher (Inria Starting Faculty Position)**, *MATHERIALS team*, Inria, France
- *Title of research project*: Sampling in high dimensions: from mathematical analysis to practical algorithms.
- *Teaching*: I was a tutor for the course *Analysis and Scientific Computing* at École des Ponts in Fall 2021, and supervised a second year project (MOPSI) in Spring 2022.

Since 01/2022 **Lecturer in Mathematics (fixed term)**, *NYU Paris*, France
- Responsible for teaching all the lectures and recitations for the course *Numerical Analysis*.

Postdoctoral experience

2020 - 2021 **Postdoctoral researcher**, *MATHERIALS team*, Inria and CERMICS (École des Ponts), France
- *Main postdoc adviser*: Prof. Gabriel Stoltz.
- Funding from the *Fondation Sciences Mathématiques de Paris*.
- Research focus: Variance reduction methods for the calculation of transport coefficients in computational statistical physics.
- *Teaching*: I was a tutor for a group of three first-year students at the École des Ponts ParisTech for their first-year project, on the subject of spectral methods for Fokker–Planck equations (28h).

2019 – 2020 **Research Associate**, *Imperial College London*, United Kingdom
- *Postdoc advisers*: Prof. G.A. Pavliotis and Prof. J.A. Carrillo.
- *Research group*: Applied and Numerical Analysis.
- *Teaching*: I was responsible for teaching the course "Computational Stochastic Processes" (30h) in the Spring term of 2020. My duties included writing lecture notes to supplement the course material available from the previous years, as well as devising problems classes, an assessed project and the exam.
- *Research interests*: Numerical methods for Fokker–Planck–Kolmogorov equations; Stochastic methods in molecular dynamics; Mean-field equations for interacting diffusions; Derivative-free methods for inverse problems.

Education

2014 – 2019 **Ph.D. in Applied Mathematics**, *Imperial College London*, United Kingdom
- *Supervisors*: Prof. G.A. Pavliotis and Prof. S. Kalliadasis.
- *Thesis title*: Topics in multiscale modeling: numerical analysis and applications.
- *Teaching*: I was a graduate teaching assistant for the following courses: *Real analysis* (2015), *Probability and statistics* (2015), *Differential equations* (2016) and *Introduction to numerical analysis* (2016).

2013 – 2014 **MRes in Mathematical Sciences**, *Imperial College London*, United Kingdom
- *Specialization*: Scientific computation.
- *Thesis*: Simulation of stochastic equations with multiple scales, supervised by Prof. G.A. Pavliotis.
- *Grade*: distinction (Taught component: 91/100, Research component: 96/100).

2011 – 2013 **MSc in Mechanical Engineering**, *Université catholique de Louvain*, Belgium
- *Specialization*: Numerical methods for solid and fluid mechanics.
- *Thesis*: Discontinuous Galerkin method for the simulation of 4^{th} order partial differential equations, supervised by Prof. J.-F. Remacle.
- *Grade*: Summa cum laude.

2011 – 2012 **Erasmus exchange**, *Delft University of Technology*, the Netherlands
- *Grade*: 9/10.

2008 – 2011 **BSc in Electrical and Mechanical Engineering**, *Université catholique de Louvain*, Belgium
- *Grade*: Summa cum laude.

Awards

2015 **Prize for excellence in support of teaching and learning**
Faculty of Natural Sciences, Imperial College London

2008, 2013 **Plus grande distinction avec les félicitations du jury**
École polytechnique de Louvain

Published and accepted papers

In all my publications except [AVPK19], the authors are in alphabetical order. The paper [AVPK19] is the result of a collaboration within the department of chemical engineering at Imperial College London; B. Aymard and I contributed equally, and the project was supervised by S. Kalliadasis and M. Pradas. The following papers are all either published or accepted for publication:

[**APV17**] A. Abdulle, G. A. Pavliotis, and **U. Vaes**. Spectral methods for multiscale stochastic differential equations. *SIAM/ASA J. Uncertain. Quantif.*, **5**(1):720–761, 2017

[**AVPK19**] B. Aymard, **U. Vaes**, M. Pradas, and S. Kalliadasis. A linear, second-order, energy stable, fully adaptive finite element method for phase-field modeling of wetting phenomena. *J. Comput. Phys. X*, **2**:100010, 2019

[**GPV20**] S. N. Gomes, G. A. Pavliotis, and **U. Vaes**. Mean field limits for interacting diffusions with colored noise: Phase transitions and spectral numerical methods. *Multiscale Model. Simul.*, **18**(3):1343–1370, 2020

[**CV20**] J. A. Carrillo and **U. Vaes**. Wasserstein stability estimates for covariance-preconditioned Fokker–Planck equations. *Nonlinearity*, **34**(4):2275–2295, 2021

[**PStoV21**] G. A. Pavliotis, G. Stoltz, and **U. Vaes**. Scaling Limits for the Generalized Langevin Equation. *J. Nonlinear Sci.*, **31**(1):Paper No. 8, 2021

[**PStuV21**] G. A. Pavliotis, A. M. Stuart, and **U. Vaes**. Derivative-Free Bayesian Inversion Using Multiscale Dynamics. *SIAM J. Appl. Dyn. Syst.*, **21**(1):284–326, 2022

[**CHSV21**] J. A. Carrillo, F. Hoffmann, A. M. Stuart, and **U. Vaes**. Consensus-based sampling. *Stud. Appl. Math.*, **148**(3):1069–1140, 2022

Submitted papers

[**CTV21**] J. A. Carrillo, C. Totzeck, and **U. Vaes**. Consensus-based optimization and ensemble Kalman inversion for global optimization problems with constraints. *arXiv preprint*, **2111.02970**, 2021

[**PSV22**] G. A. Pavliotis, G. Stoltz, and **U. Vaes**. Mobility estimation for Langevin dynamics using control variates. *arXiv preprint*, **2206.09781**, 2022

Presentations and posters

07/2022 **Conference presentation**, *Mobility estimation for Langevin dynamics using control variates*, 15th International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing, Johannes Kepler University, Linz

06/2022 **Workshop presentation**, *Mobility for Langevin-like dynamics in a periodic potential: scaling limits and efficient numerical estimation*, LMS-Birmingham Workshop on S/PDE: Analysis and Computations, University of Birmingham

06/2022 **Workshop presentation**, *Consensus-based sampling*, Synergies between Data Science and PDE Analysis, Hausdorff Center for Mathematics, Bonn

05/2022 **Conference presentation**, *Consensus-based sampling*, PDE-constrained Bayesian inverse UQ, Erwin Schrödinger International Institute for Mathematical Physics (Online)

04/2022 **Conference presentation**, *Consensus-based sampling*, Frontiers in kinetic equations for plasmas and collective behaviour, Isaac Newton Institute, Cambridge

12/2021 **Conference presentation**, *The generalized Langevin equation: long-time behavior and diffusive transport in a periodic potential*, CECAM workshop on generalized Langevin equations, Sorbonne Université

10/2021 **Seminar presentation**, *Consensus-based sampling*, Rencontres Inria-LJLL, Inria Paris

10/2021 **Working group presentation**, *Derivative-free Bayesian inversion using multiscale dynamics*, Working group on consensus-based optimization and sampling, Simons Institute (Online)

07/2021 **Conference presentation**, *Derivative-free Bayesian inversion using multiscale dynamics*, 31st European Conference on Operational Research, Online

06/2021 **Conference presentation**, *Derivative-free Bayesian inversion using multiscale dynamics*, EnKF workshop, Online

12/2020 **Conference presentation**, *Mean field limits for interacting diffusions with colored noise: phase transitions and spectral numerical methods*, Congrès d'Analyse Numérique pour les Jeunes - 2020

11/2020 **Seminar presentation**, *Derivative-free Bayesian inversion using multiscale dynamics*, Séminaire d'Analyse Numérique et Calcul Scientifique, Laboratoire de Mathématiques de Besançon

02/2020 **Seminar presentation**, *The generalized Langevin equation: long-time behavior and diffusive transport in a periodic potential*, Applied PDEs seminar, Imperial College London

12/2019 **Conference presentation**, *A multiscale derivative-free approach to Bayesian inverse problems*, SIAM Conference on Analysis of Partial Differential Equations, Imperial College London

11/2019 **Seminar presentation**, *The generalized Langevin equation: long-time behavior and diffusive transport in a periodic potential*, Junior Applied Mathematics Seminar (JAMS), Imperial College London

06/2019 **Conference presentation**, *Optimal control for equations of Fokker–Planck type*, The 28$^{\text{th}}$ Biennial Numerical Analysis Conference, University of Strathclyde

06/2019 **Seminar presentation**, *The generalized Langevin equation in a periodic potential*, Applied Mathematics Seminar, École Nationale des Ponts et Chaussées

11/2016 **Conference presentation**, *Comparison between the molecular dynamics and Cahn-Hilliard-Navier-Stokes approaches for the simulation of droplet coalescence and wetting phenomena*, Annual Meeting of the APS Division of Fluid Dynamics

02/2016 **Seminar presentation**, *Hermite spectral method for multiscale SDEs and application to multiscale SPDEs*, Applied Mathematics Seminar, École Nationale des Ponts et Chaussées

02/2016 **Conference poster**, *Hermite spectral method for multiscale SDEs*, COSMOS workshop: Computational Statistics and Molecular Simulation, École Nationale des Ponts et Chaussées

12/2015 **Conference presentation**, *Hermite spectral method for multiscale SDEs*, Workshop on Challenges in Statistical Mechanics: from Mathematics to Molecular Dynamics to Technological Applications, Imperial College London

Other workshops attended

06/2015 *New Perspectives in Markov Chain Monte Carlo*, Universidad de Valladolid.

07/2014 *Summer School on Stochastic Dynamics*, University of Warwick.

Research visits

12/2019 Collaboration with Andrew Stuart, *California Institute of Technology.*

06/2019 Collaboration with Gabriel Stoltz, *École Nationale des Ponts et Chaussées.*

02/2016 Collaboration with Gabriel Stoltz, *École Nationale des Ponts et Chaussées.*

06/2015 Collaboration with Assyr Abdulle, *École polytechnique fédérale de Lausanne.*

Scientific software

- *A Python library for the Hermite spectral method.*

  `https://github.com/urbainvaes/hermipy`.

  Hermipy is a Python library that allows automating most of the operations involved in implementing a Hermite spectral method. The library uses the data structures provided by the NumPy library for linear algebra, and it also depends on Sympy for symbolic calculations. Computationally intensive parts of the computations, such as Hermite transforms, are handed over to a C++ compiled component, and Boost is used for efficient exchange of data with Python. The library was developed and employed for producing numerical results in three of my publications.

- *A FreeFem++ solver for the Cahn-Hilliard equation.*

  `https://github.com/urbainvaes/cahn-hilliard`

  This is a high-level framework for the numerical solution of the Cahn–Hilliard equation, implementing a number of semi-implicit numerical methods in FreeFem++ and offering users the means to rapidly define the initial and boundary conditions of the problem, run a particular numerical method with appropriate parameters, and post-process the solution. Both two and three-dimensional settings are supported, and the geometry of the domain is read in files generated by the Gmsh mesh-generator.

- *A Python library implementing derivative-free optimization and sampling methods.*
  `https://github.com/urbainvaes/bayesicle`

  Bayesicle is a Python library implementing several interacting particle methods for sampling and optimization, particularly in the context of Bayesian inverse problems. These methods include consensus-based optimization/sampling, ensemble Kalman inversion/sampling, and other methods studied and developed in my research.

- *A Julia code for calculating the mobility of Langevin dynamics.*
  `https://github.com/urbainvaes/Langevin-self-diffusion`

  This is a collection of Julia scripts implementing a variance reduction technique based on control variates for the calculation of the effective diffusion coefficient associated with Langevin dynamics. The code serves as proof of concept in my current postdoctoral work with Gabriel Stoltz.

Languages skills

Native	French
Fluent	English
Intermediate	Dutch, Spanish

Software skills

Proficient	Python, C, C++, java, MATLAB, git, LaTeX, GNU Make
Intermediate	HTML, php, gmsh, mpi, FreeFem++, julia, bash