Dr. Bernat Font

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Research interests

computational fluid dynamics; machine learning; turbulence modelling; numerical methods; high-performance computing.

Experience

Assistant Professor, Ship Hydromechanics section, Technische Universiteit Delft, Netherlands. 2024–

Focus: Data-Informed CFD, i.e. data exploitation to improve current CFD methods:

- Acceleration of scale-resolving simulations using generative methods
- Data-driven wall models for non-equilibrium turbulent boundary layers
- Active flow control using reinforcement learning
- Discovery of governing equations from raw data

Postdoctoral Researcher, Large-scale Computational Fluid Dynamics group, Barcelona Supercomputing Center, Spain. 2021–2023

Topics:

- NextSim EU project – Next generation of industrial aerodynamic simulation code
- Machine learning for CFD: wall models and active flow control
- Turbulence modelling in high-order scale-resolving simulations

Researcher, Mathematical Institute, Oxford University, UK. 2020–2021

Topic: Transport of porous particles in fluid flow.

Visiting PhD Researcher, Institute of High-Performance Computing, A*STAR, Singapore. 2017–2020

Education

Ph.D. Computational Fluid Dynamics, University of Southampton, UK. 2015–2021

Thesis: Modelling of Flow Past Long Cylindrical Structures. (eprint)

Supervisors: Prof. G.D. Weymouth, Prof. O.R. Tutty, Dr. V.-T. Nguyen.

Visiting Researcher: Research attachment funded by the ARAP mobility scheme, Institute of High-Performance Computing, A*STAR, Singapore.

M.Sc. Computational Fluid Dynamics, Cranfield University, UK. 2014–2015

Thesis: High-order Shock-capturing Schemes for Micro Shock Tubes. (eprint)

Supervisor: Dr. L. Könözsy.

Double Degree with Enginyeria Superior in Aeronautical Engineering.

Enginyeria Superior Aeronautical Engineering, Universitat Politècnica de Catalunya, Spain. 2012–2015

Mentor: Prof. C.-D. Pérez-Segarra.

Equivalent to Master of Engineering.

Enginyeria Tècnica Aeronautical Engineering, Universitat Politècnica de Catalunya, Spain. 2009–2012

Equivalent to Bachelor of Engineering.

Publications

Peer-reviewed journal articles

9. Cutz, L., Misar, S., Font, B., Al-Naji, M., and de Jong, W. (2025). Hydrothermal liquefaction of spanish crude olive pomace for biofuel and biochar production. *Journal of Analytical and Applied Pyrolysis*, 188:107050. (doi, eprint)
8. Font, B., Alcántara-Ávila, F., Rabault, J., Vinuesa, R., and Lehmkuhl, O. (2025). Deep reinforcement learning for active flow control in a turbulent separation bubble. *Nature Communications*, 16(1):1422. (doi, eprint)
7. Weymouth, G.D. and Font, B. (2024, submitted). WaterLily.jl: A differentiable and backend-agnostic Julia solver to simulate incompressible viscous flow and dynamic bodies. (eprint)
6. Suárez, P., Álcantara Ávila, F., Rabault, J., Miró, A., Font, B., Lehmkuhl, O., and Vinuesa, R. (2024, submitted). Active flow control for drag reduction through multi-agent reinforcement learning on a turbulent cylinder at $Re_D = 3900$. (eprint)
5. Suárez, P., Álcantara Ávila, F., Rabault, J., Miró, A., Font, B., Lehmkuhl, O., and Vinuesa, R. (2024, submitted). Flow control of three-dimensional cylinders transitioning to turbulence via multi-agent reinforcement learning. (eprint)
4. Radhakrishnan, S., Calafell, J., Miró, A., Font, B., and Lehmkuhl, O. (2024). Data-driven wall modeling for les involving non-equilibrium boundary layer effects. *International Journal of Numerical Methods for Heat & Fluid Flow*, 34(8):3166–3202. (doi, eprint)
3. Varela, P., Suárez, P., Alcántara-Ávila, F., Miró, A., Rabault, J., Font, B., García-Cuevas, L.M., Lehmkuhl, O., and Vinuesa, R. (2022). Deep reinforcement learning for flow control exploits different physics for increasing reynolds number regimes. *Actuators*, 11(12). (doi, eprint)
2. Font, B., Weymouth, G.D., Nguyen, V.-T., and Tutty, O.R. (2021). Deep learning of the spanwise-averaged Navier–Stokes equations. *Journal of Computational Physics*, 434:110199. (doi, eprint)
1. Font, B., Weymouth, G.D., Nguyen, V.-T., and Tutty, O.R. (2019). Span effect on the turbulence nature of flow past a circular cylinder. *Journal of Fluid Mechanics*, 878:306–323. (doi, eprint)

Peer-reviewed symposium proceedings

3. Font, B., Alcántara-Ávila, F., Rabault, J., Vinuesa, R., and Lehmkuhl, O. (2024). Active flow control of a turbulent separation bubble through deep reinforcement learning. volume 2753, page 012022. IOP Publishing. (doi, eprint)
2. Radhakrishnan, S., Gyamfi, L.A., Miró, A., Font, B., Calafell, J., and Lehmkuhl, O. (2021). A data-driven wall-shear stress model for les using gradient boosted decision trees. In *ISC High Performance Computing Conference*, pages 105–121. Springer International Publishing. (doi, eprint)
1. Font, B., Weymouth, G.D., Nguyen, V.-T., and Tutty, O.R. (2020). Turbulent wake prediction using deep convolutional neural networks. In *33rd Symposium on Naval Hydrodynamics*. Office of Naval Research, US. (eprint)

Conference proceedings

5. Cabral, M., Font, B., and Weymouth, G.D. (2024). ϕ–flow: A novel physics-constrained architecture to enforce incompressibility and boundary conditions for fast and accurate flow predictions. In *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics*, WCCM 2024. CIMNE. (doi, eprint)
4. Montalà, R., Font, B., Lehmkuhl, O., Vinuesa, R., and Rodriguez, I. (2024). Towards active flow control strategies through deep reinforcement learning. In *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics*, WCCM 2024. CIMNE. (eprint, url)
3. Suárez, P., Alcántara-Ávila, F., Miró, A., Rabault, J., Font, B., Lehmkuhl, O., and Vinuesa, R. (2023). Active flow control for three-dimensional cylinders through deep reinforcement learning. In *14th International ERCOFTAC Symposium on Engineering, Turbulence, Modelling and Measurements*. (eprint)
2. Weymouth, G.D. and Font, B. (2023). WaterLily.jl: A differentiable fluid simulator in Julia with fast heterogeneous execution. In *ParCFD 2023, Cuenca (Ecuador)*. (eprint)
1. Font, B., Weymouth, G.D., and Tutty, O.R. (2017). Analysis of two-dimensional and three-dimensional wakes of long circular cylinders. In *OCEANS 2017*. IEEE. (doi, eprint)

Conference abstracts

15. Font, B. and Weymouth, G.D. (2024). WaterLily.jl: A fast and flexible CFD solver with heterogeneous execution. In *JuliaCon 2024, Eindhoven (Netherlands)*. (url)
14. Font, B., Alcántara-Ávila, F., Rabault, J., Vinuesa, R., and Lehmkuhl, O. (2024). Turbulent separation bubble control using deep reinforcement learning in pre-exascale machines. In *ECCOMAS Congress 2024, Lisbon (Portugal)*. (url)
13. Cabral, M., Font, B., and Weymouth, G.D. (2024). ϕ–flow: A novel physics-constrained architecture to enforce incompressibility and boundary conditions for fast and accurate flow predictions. In *ECCOMAS Congress 2024, Lisbon (Portugal)*. (url)
12. Montalà, R., Font, B., Lehmkuhl, O., Vinuesa, R., and Rodriguez, I. (2024). Towards active flow control strategies through deep reinforcement learning. In *ECCOMAS Congress 2024, Lisbon (Portugal)*. (url)
11. Cabral, M., Font, B., and Weymouth, G.D. (2023). The effect of physical constraints on the loss function landscapes of deep learning. In *76th APS Division of Fluid Dynamics Meeting Abstracts, Washington DC (US)*. (url)
10. Alcántara-Ávila, F., Font, B., Rabault, J., Vinuesa, R., and Lehmkuhl, O. (2023). Deep reinforcement learning for active separation control in a turbulent boundary layer. In *76th APS Division of Fluid Dynamics Meeting Abstracts, Washington DC (US)*. (url)
9. Weymouth, G.D. and Font, B. (2023). WaterLily: A fast differentiable CPU/GPU flow simulator in Julia. In *76th APS Division of Fluid Dynamics Meeting Abstracts, Washington DC (US)*. (url)
8. Alcántara-Ávila, F., Sanchis, M., Gasparino, L., Muela, J., Font, B., Rabault, J., Lehmkuhl, O., and Vinuesa, R. (2023). Separation control in adverse-pressure-gradient turbulent boundary layers. In *European Turbulence Conference 18th, Valencia (Spain)*
7. Suárez, P., Alcántara-Ávila, F., Miró, A., Rabault, J., Font, B., Lehmkuhl, O., and Vinuesa, R. (2023). Active flow control on three-dimensional cylinders through deep reinforcement learning. In *First International Conference Math 2 Product, Taormina (Italy)*
6. Font, B., Miró, A., and Lehmkuhl, O. (2023). On the entropy-viscosity method for flux reconstruction. In *2nd Spanish Fluid Mechanics Conference, Barcelona (Spain)*. (eprint)
5. Font, B., Naddei, F., and Lehmkuhl, O. (2022). Progress in high-order large-eddy simulation of aeronautical flows using the integral-length scale approximation turbulence model. In *3rd High-Fidelity Industrial LES/DNS Symposium, Brussels (Belgium)*
4. Font, B., Naddei, F., and Lehmkuhl, O. (2022). Turbulence models assessment using finite-volume and high-order methods for aeronautical applications. In *ECCOMAS Congress 2022, Oslo (Norway)*
3. Font, B., Weymouth, G.D., Nguyen, V.-T., and Tutty, O.R. (2019). Deep learning the spanwise-averaged wake of a circular cylinder. In *72nd APS Division of Fluid Dynamics Meeting Abstracts, Seattle (US)*, pages L17–005. (url)
2. Font, B., Weymouth, G.D., Nguyen, V.-T., and Tutty, O.R. (2019). Turbulence dynamics transition of flow past a circular cylinder and the prediction of vortex-induced forces. In *17th European Turbulence Conference, Torino (Italy)*. (eprint)
1. Font, B., Weymouth, G.D., and Tutty, O.R. (2016). A two-dimensional model for three-dimensional symmetric flows. In *UK Fluids Conference, London (UK)*. (eprint)

Invited Talks

12. Interdisciplinary Scientific Computing Laboratory, Pennsylvania State University, US (2024). (url)
11. Fluids AI Special Interest Group series, TU Delft, Netherlands (2024)
10. Julia for HPC minisymposia, JuliaCon2024, Netherlands (2024). (url)
9. Julia for HPC course, High Performance Computing Center Stuttgart (HLRS), Germany (2023)
8. PPPL Computer Science Department's Machine Learning seminar, Princeton University, US (2021)
7. Engineering Mind Podcast (2021). (url)
6. Applied Mathematics in Aerospace Engineering seminar, Universidad Politecnica de Madrid, Spain (2021)

5. Applied Math Colloquium, University North Carolina, US (2021)
4. Ocean Engineering, University Rhode Island, US (2021)
3. Fluid Dynamics Group at the Institute of High Performance Computing (A*STAR), Singapore (2020)
2. Fluid Structure Interactions Group Seminar series, University of Southampton, UK (2020)
1. Fluid Structure Interactions Group Seminar series, University of Southampton, UK (2017)

Grants

1. DEAREL: Large-scale deep reinforcement learning for active flow control in wings. EuroHPC Regular Access call (2024). Awarded 90,000 node-hours on MareNostrum5 (EHPC-REG-2024R01-038)

Student supervision

Mentored and supervised students at different stages of their educational program such as Undergraduate students, MSc students, and most recently a PhD student. As a mentor, the goal is to motivate students to pursue an interesting scientific topic while providing guidance throughout the process of learning and achieving. The supervision involves regular meetings to assess their progress, and answering technical questions when needed.

PhD students

- Wall-modelled large-eddy simulation for wind-assisted ships, TU Delft 2025–
- P. Muñoz, Non-equilibrium wall modelling using machine learning, Barcelona Supercomputing Center 2024–
- M. Cabral, Physics-based machine learning of marine hydrodynamics, TU Delft 2023–

MSc projects

- Algebraic multi-grid solver optimization, TU Delft 2025
- Tandem Flettner rotors modelling, TU Delft 2025
- Prediction of hydrofoil ventilation onset using temporal forecasting, TU Delft 2025
- Machine-learning wall model for bluff bodies forces calculation, University of Southampton 2019
- Accurate flow interpolation using optimal transport theory, University of Southampton 2018

Undergraduate projects

- Discovering new scaling laws in turbulent boundary layers via multi-expression programming, Universitat Politècnica de Catalunya (url) 2021
- Discovering new expressions for the vortex trajectories and velocity profiles of synthetic jets, Universitat Politècnica de Catalunya (url) 2021

Teaching

Lecturer at TU Delft. Also, served as demonstrator and marker of multiple modules during my PhD. Demonstration-related tasks involved preparing and delivering the laboratory sessions which included a theory part and an experimental part. Additionally, served as lecturer of the BSC summer school on AI and HPC delivering a lecture on AI for CFD.

Lecturer at TU Delft 2024–

- Instructor at Hydromechanics (MT2461): Hydrofoils
- Invited lecturer at Numerical Ship Hydrodynamics (MT44025): Turbulence modelling

Lecturer at the PUMPS+AI Summer School, Barcelona Supercomputing Center 2022

- Machine learning for computational fluid dynamics (url)

Demonstrator, University of Southampton 2015–2017

- Aerodynamics: Nozzle lab

- Propulsion: Ramjet, turbojet and rocket engine labs
- Aerothermodynamics: Marking of lab reports

Software

Programming languages: Fortran (including MPI), Julia, Python (including PyTorch, Keras, and Tensorflow), C, Java, Matlab.

Tools: Git, LaTeX, Inkscape, Paraview.

Selection of popular repositories:

- Font, B. (2024). SmartSOD2D: A machine-learning framework for the SOD2D CFD solver using SmartSim. (`url`)
- Weymouth, G.D. and Font, B. (2023). WaterLily.jl: Fast CFD Julia solver based in the finite-volume and immersed boundary methods with backend-agnostic execution (CPU and GPU). (`url`)
- Font, B. (2020). SANSpy: Spanwise-averaged Navier-–Stokes modelling through convolutional neural networks. (`url`)
- Font, B. (2019). F2Py-Sockets: A minimal working example on how to use sockets to transfer data from Fortran to Python and viceversa. (`url`)
- Font, B. (2018). NuatsBot: Technical analysis trading bot. (`url`)
- Font, B. (2016). PostProc: A post-processing package for my PhD CFD simulations. (`url`)

Open science statement

I advocate for open science. Most of my papers have an e-print version that can be downloaded for free either on arXiv or my website. The codes I write are also open-source, and you can find them in my Github repository.