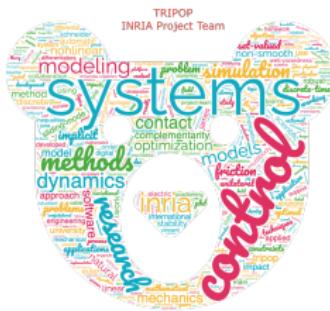


TRIPOP Project-team

Vincent Acary, Inria

Inria, centre de l'Université Grenoble Alpes. Laboratoire Jean Kuntzmann -



 Inria



TRIPOP INRIA project team (LJK)

Research object:

Modeling, Simulation and Control of Nonsmooth Dynamics.

Main application:

Natural environmental risks in mountains.

- ▶ Research Scientists
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 - ▶ Bernard Brogliato (INRIA, LJK)
 - ▶ Franck Bourrier (INRAE LJK & IGE)
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 - ▶ Thierry Faug (INRAE IGE)
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 - ▶ Mattéo Oziol (G-INP 2023–2026)
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 - ▶ Henry Leroy (UGA, 2025–2028)
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 - ▶ Guillaume Mestdagh (INRIA 2025–2026)

Nonsmooth



Dynamics



- ▶ nonsmooth = lack of differentiability ($\notin \mathcal{C}^1$),
- ▶ graphs with peaks, kinks, jumps.

- ▶ systems that evolves with time,
- ▶ branch of mechanics concerned with the motion of objects.

Where is nonsmoothness?

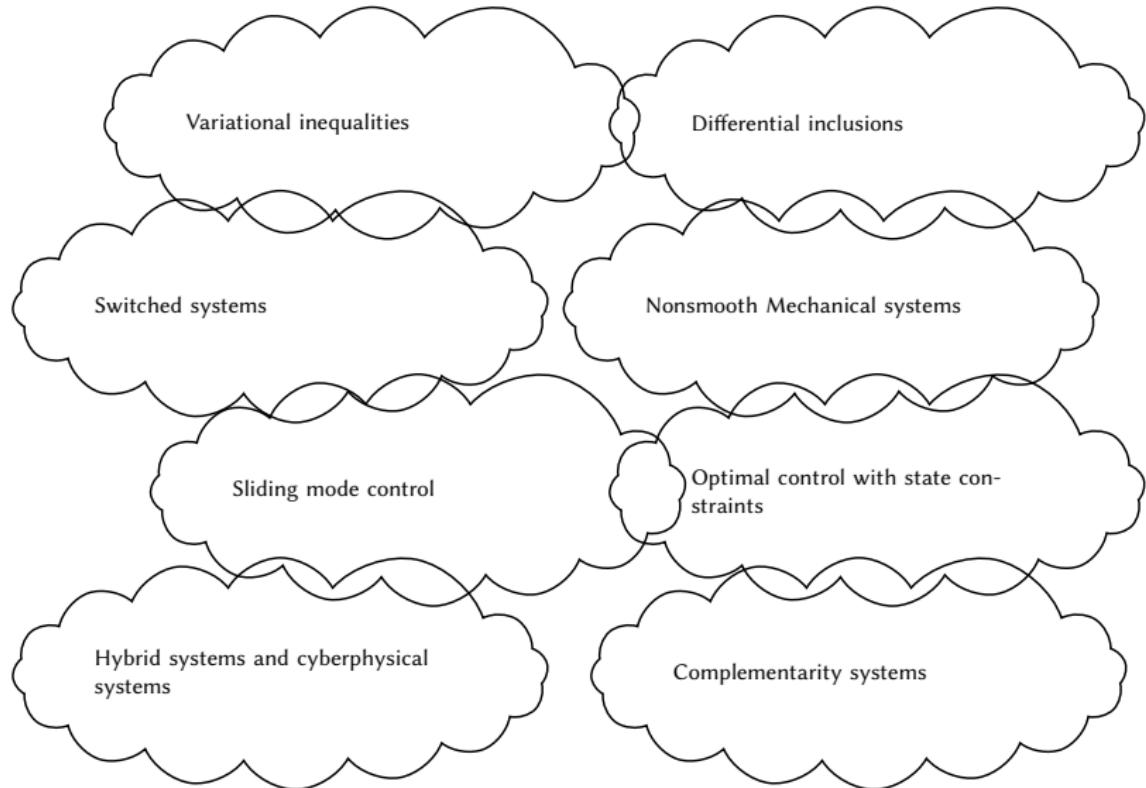
- ▶ nonsmooth solutions in time and space:
 - continuous, functions of bounded variations, measures and distributions.
- ▶ nonsmooth modeling of constitutive laws:
 - set-valued mapping, inequality constraints, complementarity, impact laws,
 - ODE with discontinuous r.h.s, differential inclusion, measure equation.



Scientific pairs: M. Jean, J.J. Moreau, M. Schatzman & C. Lemaréchal.

Our reference (bedside) books

- ▶ Moreau, J. J. (1966). *Fonctionnelles convexes*. Séminaire Jean Leray, Collège de France.
- ▶ Rockafellar, R.T. (1970). *Convex Analysis*. Princeton UP.
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- ▶ Brézis, H. (1973). *Opérateurs maximaux monotones et semi-groupes de contractions dans les espaces de Hilbert*. Math. Studies.
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- ▶ Moreau, J. J. (1973) *On Unilateral Constraints, Friction and Plasticity*. Springer, 2011.
- ▶ Moreau, J. J., & Panagiotopoulos, P. D. (Eds.). (1988). *Nonsmooth mechanics and applications*. Springer.
- ▶ Cottle, R. W., Pang, J. S., & Stone, R. E. (1992). *The linear complementarity problem*. SIAM.
- ▶ Hiriart-Urruty, J.-B., & Lemaréchal, C. (1996). *Convex analysis and minimization algorithms*. Springer.
- ▶ Brogliato, B. (1999). *Nonsmooth mechanics*. Springer.
- ▶ Nguyen, Q. S. (2000). *Stability and nonlinear solid mechanics*. Wiley.
- ▶ Facchinei, F. & Pang J. S. (2003). *Finite-dimensional variational inequalities and complementarity problems*. Springer.
- ▶ Rockafellar, R. T., & Wets, R. J. B. (2009). *Variational analysis* (Vol. 317). Springer.



Elasto-dynamics with plasticity, contact and impact.

A second order sweeping process

$$\left\{ \begin{array}{ll} v^+ = \dot{q}^+ & \text{(velocity of bounded variations)} \\ M(q)dv + F(q, v^+)dt + B^\top \sigma dt = \iota & \text{(differential measure)} \\ \dot{\sigma} = E(Bv - \dot{\varepsilon}^p) & \text{(elasticity)} \\ \dot{\varepsilon}^p \in N_C(\sigma) & \text{(plasticity)} \\ -\iota \in N_{T_M(q)}(v^+ + ev^-) & \text{(impact and contact)} \end{array} \right.$$