Thoughts on Geometric Contact Flows framework by Leonel Ronzo

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Ever seen a model go completely off the rails? This can be catastrophic when modeling or controlling physical systems.

Black-box models often struggle with the physics of the real world, leading to... "creative" but wrong predictions. When a model doesn't understand the underlying energy and geometric constraints of a system, it can't generalize or act reliably. We cannot really trust it!

This is where "Geometric Contact Flows" (GCF) comes in, and it's a game-changer. GCF doesn't just learn from data—it preserves the energy properties of complex physical systems and extrapolates accordingly. To achieve this, GCF leverages Riemannian and Contact Geometry as energy-based inductive biases.

Here’s the rundown:

🔹 It starts with a simple (stable) latent dynamic model.

🔹 It uses special transformations, Contactomorphisms, to adapt this simple model to complex, real-world dynamics, all while preserving the crucial geometric (energy-based) structure.

🔹 It knows what it doesn’t know. An ensemble of models quantifies uncertainty, identifying areas where the model is likely to be wrong.

🔹 It uses that uncertainty to act smarter. GCF actively guides the system toward "safe" data-rich regions.

The results are incredible, spanning from quantum dynamics to spring-mesh simulations. But coolest thing is seeing it in action with robots. The GCF framework was used to teach a robot complex, real-world interaction tasks, including a "Wrap-and-Pull" task and even loading a dishwasher. Critically, GCF leverages its energy-based formulation to stop safely when it encounters unexpected forces.

Do you want to learn what Contact Geometry is ? How does this relate to non-conservative systems? How do we use it to model and control physical systems via flows?

Well, check out our ICML2025 paper: "Geometric Contact Flows: Contactomorphisms for Dynamics and Control", fantastic work led by the awesome Andrea Testa from the Bosch Center for Artificial Intelligence (BCAI), in collaboration with Søren Hauberg, Tamim Asfour! Such a cool group of nice and smart people to work with

A diagram of a complex system

Description automatically generated with medium confidence

# References

[1] [Linkedin post by Leonel Ronzo, 6/25/25](https://www.linkedin.com/posts/activity-7343525958789869568-J7SJ?utm_source=share&utm_medium=member_desktop&rcm=ACoAAAFZfUoBgPoGUucdnvtwuzPv79P8VHj6uvk)

[2] [Geometric Contact Flows: Contactomorphisms for Dynamics and Control, Andrea Testa et al, 2025](https://github.com/dimitarpg13/dynamical_systems_and_ergodicity/blob/main/literature/articles/geometric_contact_flows/Geometric_Contact_Flows-Contactomorphisms_for_Dynamics_and_Control_Testa_2025.pdf)

[3] [Geometric Contact Flows: Contactomorphisms for Dynamics and Control, ICML 2025 Poster](https://sites.google.com/view/geometric-contact-flows)