roto 2.0: The Robot Tactile Olympiad

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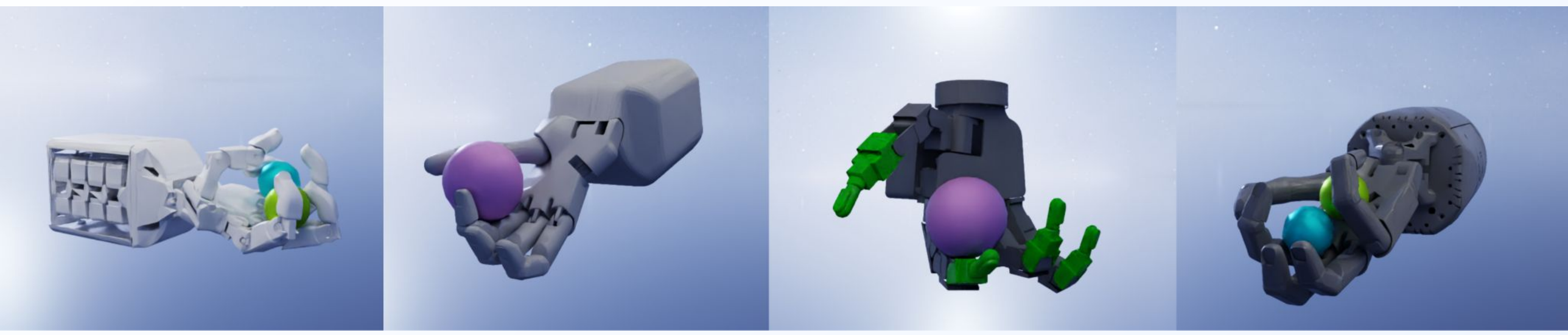
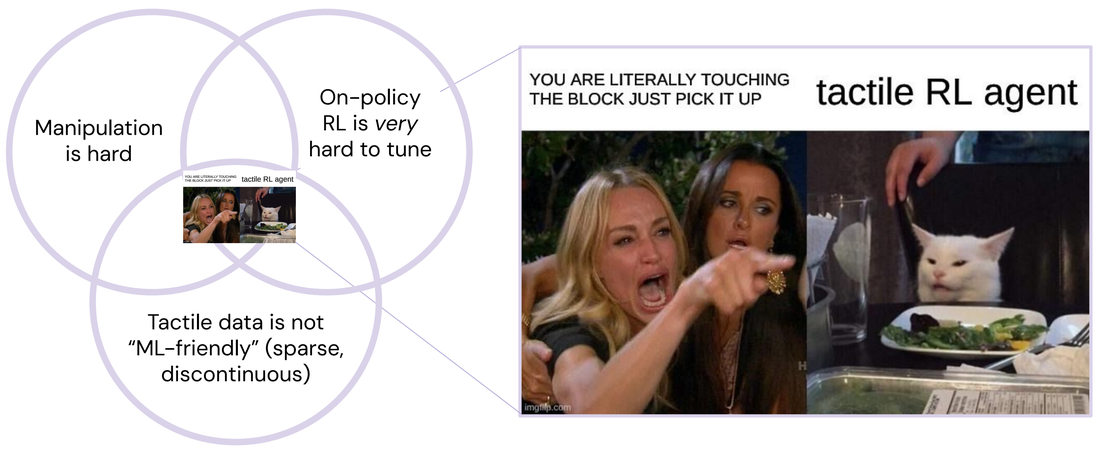


Why is tactile RL so hard???



To further complicate things...

Most labs work on unique combinations of sensors and robots, hard to cross-validate

Most results are for in-hand reorientation, leaving the utility of tactile feedback across broader tasks unknown

Lack of standardised tactile-RL benchmarks across tasks and robot morphologies

New benchmark: roto 2.0

- **5 robot embodiments: 4x hands + 1x arm** (Allegro Hand, ORCA Hand, Shadow Dexterous Hand, Shadow Dexterous Hand Lite, Franka)
- **3 tactile-diverse tasks (and counting):** Find an object , ball bouncing, and Baoding ball rotation
- ❗ **Hyperparameter optimisation** ❗ (essential but often missing component)
- We provide **well tuned baselines** (sweep with 40 trials) that achieve state-of-the-art speeds in sim

By open-sourcing our environments and tuned baselines, we hope to reduce the tactile-RL barrier to entry and enable researchers to prioritise fundamental algorithmic challenges over tedious RL tuning.

Breakthrough blind performance

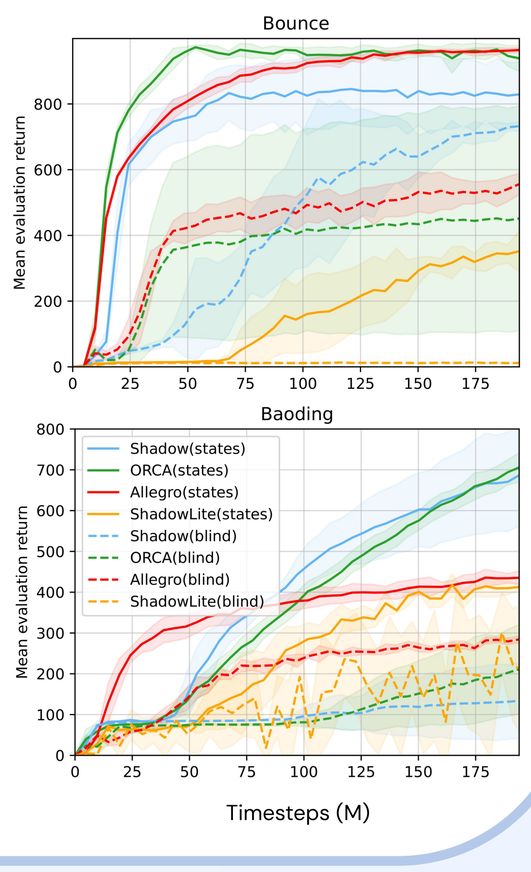
*Agents: **Blind** (tactile/proprioception only) & **State-based** (+ object pos/vel)*

Bounce

- State-based agents approach the **100-bounce maximum in 10s**; blind agents reach upto **80 bounces** by 200M
- Performance is consistent across morphologies despite unique strategies (except Shadow Lite)

Baoding

- Large gap in success; state-based hits **35 rotations in 10s**, lucky seeds for blind agents reach max **13 rotations**
- High variance and failure in blind seeds highlight the difficulty of **tactile feature extraction** [1]



Promising research directions

- **More complex tasks:** While blind policies succeed in simple tasks like bouncing, complex & multi-object manipulation remains an open frontier
- **Richer tactile info & sim2real:** Binary contacts enable sim2real transfer [2]. Future work should focus on bridging the gap for continuous pressure and shear forces
- **Feature extraction**: Developing novel ML methodologies with inductive biases tailored to process tactile signals [1]
- **Scaling sensing area:** Expanding tactile coverage beyond fingertips to the entire hand and humanoid body [3]

We strongly welcome community contributions to **roto** to accelerate the arrival of the `locomotion moment" for robotic touch.

roto

RoTO is an open-source Reinforcement Learning benchmark environment designed to standardise and promote future research in tactile-based manipulation.

Python ☆ 31 6

Star roto on GitHub! ⭐

github.com/elle-miller/roto

[1] E. Miller, T. McInroe, D. Abel, O. Mac Aodha, and S. Vijayakumar, "Enhancing tactile-based reinforcement learning for robotic control," in NeurIPS, 2025.

[2] Y. Yuan, H. Che, Y. Qin, B. Huang, Z.-H. Yin, K.-W. Lee, Y. Wu, S.C. Lim, and X. Wang, "Robot synesthesia: In-hand manipulation with visuotactile sensing," in ICRA, 2024.

[3] C. Sferrazza, D.-M. Huang, X. Lin, Y. Lee, and P. Abbeel, "Humanoid-bench: Simulated humanoid benchmark for whole-body locomotion and manipulation," 2024.