Hi all,

Here's what you folks might find interesting today.

Anomaly Detection at the LHC

Towards anomaly detection searches for new physics signatures including Higgs bosons with weakly supervised machine learning

This one is directly in your wheelhouse, Aritra. The HAXAD framework extends weakly supervised anomaly detection by anchoring searches on a Higgs boson, combining ML-based feature embedding, background estimation, and weakly supervised classification into a single pipeline. The paper introduces two new embedding strategies and, crucially, develops a full inference framework that yields both signal-agnostic and signal-specific cross section limits -- completing the statistical machinery needed for real-data application. The expanded set of benchmark signal models shows that HAXAD matches or exceeds cut-based limits across a wide variety of topologies. **Benjamin Nachman** is among the authors. Jingjing, you might also find the normalizing-flow-based background estimation and the statistical inference framework relevant to your interests in ML-enabled analysis workflows.

ML for Fast Simulation and Background Estimation

De^+e^-ffusion: Capturing the Beam-Beam Physics of e^+e^- Collisions with Diffusion Models

This might be interesting for you, Jingjing. The paper trains a denoising diffusion probabilistic model as a permutation-equivariant, set-valued surrogate for fast simulation of incoherent pair creation backgrounds at FCC-ee, achieving near-four-orders-of-magnitude speedup over Geant4. The fidelity is validated not only at the kinematic level but also at the detector level using a transformer-based two-sample classifier (AUC ~0.55, indicating good agreement). While this is generative ML rather than simulation-based inference per se, the permutation-equivariant set architecture and the two-sample classifier validation strategy are methodologically adjacent to your interests in ML for particle physics simulation tasks.

Search for new scalars via $X \rightarrow SH \rightarrow b\bar{b}b\bar{b}$ in proton-proton collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector

This ATLAS search is worth a look, Jingjing, primarily for its background estimation methodology. The dominant multijet and $t\bar{t}$ backgrounds are modeled using a hierarchical framework combining Gaussian processes and normalizing flows -- a principled ML approach to density estimation for background modeling in a high-dimensional final state. While this is not a Di-Higgs search, the $X \to SH$ topology with paired scalar decays to $b\bar{b}$ pairs shares structural similarities with HH analyses, and the normalizing-flow-based background technique could inform ML-enhanced HH search strategies.

That's all for today -- a lighter haul than usual, but the HAXAD paper in particular is a significant step forward for anomaly detection at colliders.

Back tomorrow with more!

P.S. In the most recent submission window: hep-ph: 46 papers hep-ex: 16 papers hep-th: 31 papers