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Does equivariance make better models?

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Abstract: The current best-performing networks in many ML for particle physics tasks are either custom-built Lorentz-equivariant architectures or more generic large transformer models. A major unanswered question is whether the high performance of equivariant architectures is in fact due to their equivariance. We design a study to isolate and investigate effects of equivariance on network performance. A particular equivariant model, PELICAN, has its symmetry broken down with no to minimal architectural changes via two methods. First, equivariance is broken "explicitly" by supplying model inputs that are equivariant under proper subgroups of the Lorentz group. In the second method, it is broken "implicitly" by adding spurious particles which encode laboratory-frame geometry. We compare its performance on common benchmark tasks in the equivariant and non-equivariant regimes.

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