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SMALL THINKS BIG: A JOURNEY WITH TRANSFORMERS. GENERALIZATION IN KM3NeT/ORCA FOR NEUTRINO EVENT RECONSTRUCTION

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KM3NeT is a new research infrastructure housing the next generation of neutrino telescopes in the Mediterranean deep sea. This facility comprises two detectors: KM3NeT/ARCA and KM3NeT/ORCA, consisting of vertical arranged detection units, 230 and 115, respectively, each equiped with 18 digital optical modules. The photomultipliers within each optical module detect Cherenkov light emitted by charged particles propagating in the seawater. KM3NeT/ARCA is optimized for the search of astrophysiscal neutrino sources in the range of TeV to PeV; whereas KM3NeT/ORCA is used to study the neutrino oscillation phenomena in the GeV energy range.

The current size of the detector limits the reconstruction of neutrino events in the telescope. This study demonstrates the efficacy of transformer models as large representation models and their ability to retain valuable information from the full detector when evaluating data from various smaller KM3NeT/ORCA configurations. Beginning with models trained on simulations of the complete KM3NeT/ORCA detector, composed by 115 detection units, fine-tuning on smaller configurations yields remarkable improvements over models trained from scratch on these configurations with very limited data. These comparisons across different setups, as well as the final configuration, also enable an estimation of the detector sensitivity as it grows in size.

Primary author: MOZUN MATEO, Ivan (LPC CAEN / CNRS / IN2P3)

Presenter: MOZUN MATEO, Ivan (LPC CAEN / CNRS / IN2P3)

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