PhD Open Days

Disentangling and Quantifying Jet Quenching with Generative Deep Learning

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DEAF

Quark-Gluon Plasma

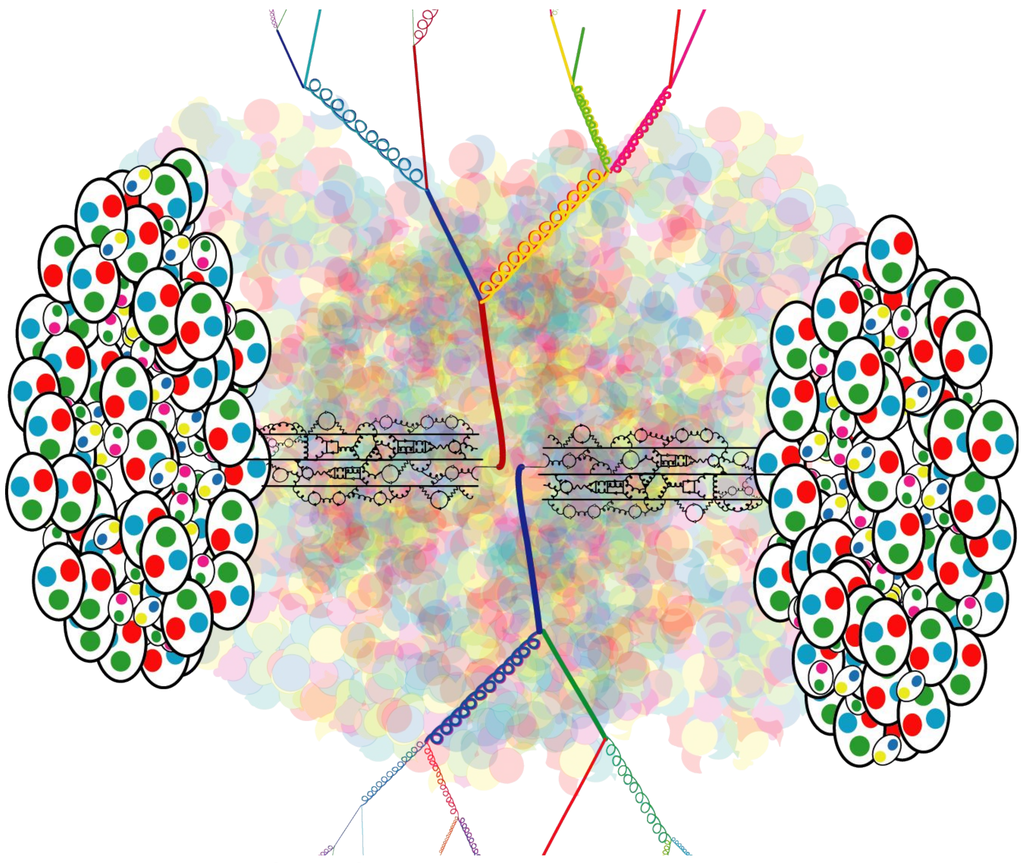

Fig. 1 - Doodle of jets forming in a heavy-ion collision.

The main goal of this work is to aid the study of a state of matter that was detected a few decades ago at RHIC, the Quark Gluon Plasma or QGP. To study this state of matter we study jets and their quenching in led-led (PbPb) collisions, relative to proton-proton (pp) collisions. These objects are under well theoretical and experimental control in pp and their fragmentation pattern is expected to be modified by the strong force when they are traversing the medium, since their constituents are color charged. We wish to be able to classify a jet as modified or unmodified in a per-jet basis.

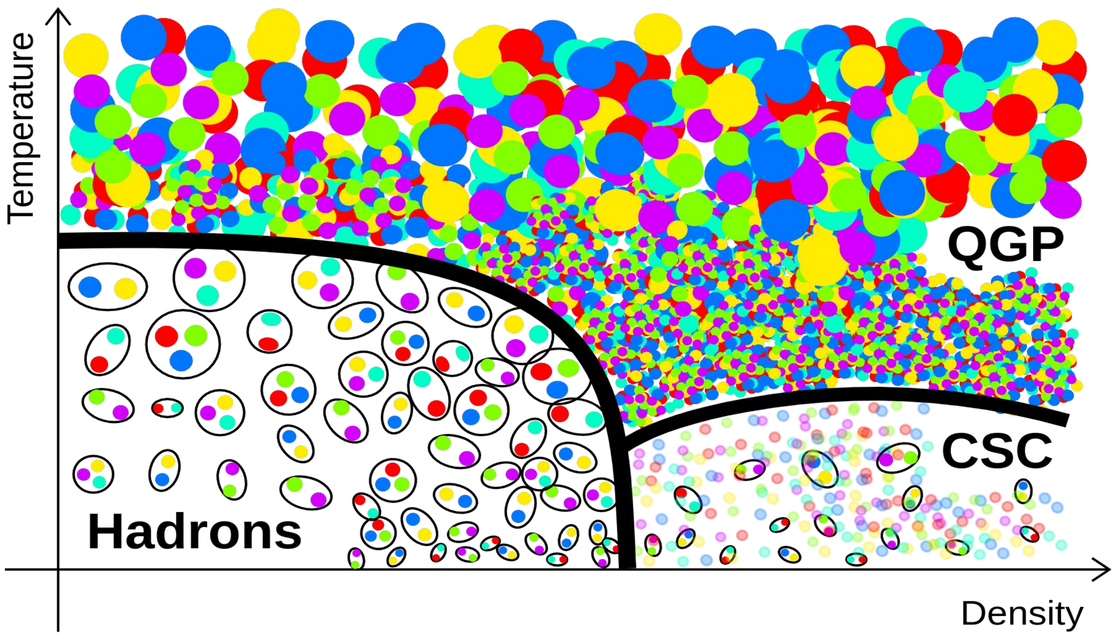

Fig. 2 - Doodle of the QCD phase diagram.

Transformers

The Transformer was first introduced in 2017. This architecture is the base for generative models such as BERT and GPT-2 for language tasks and MuseNet for music generation. These were first based on an encoder-decoder-like architecture, gearing towards translation tasks without the use of recursive structures in the network. Our model contains the encoder part of the transformer followed by a DNN feed forward model for classification.

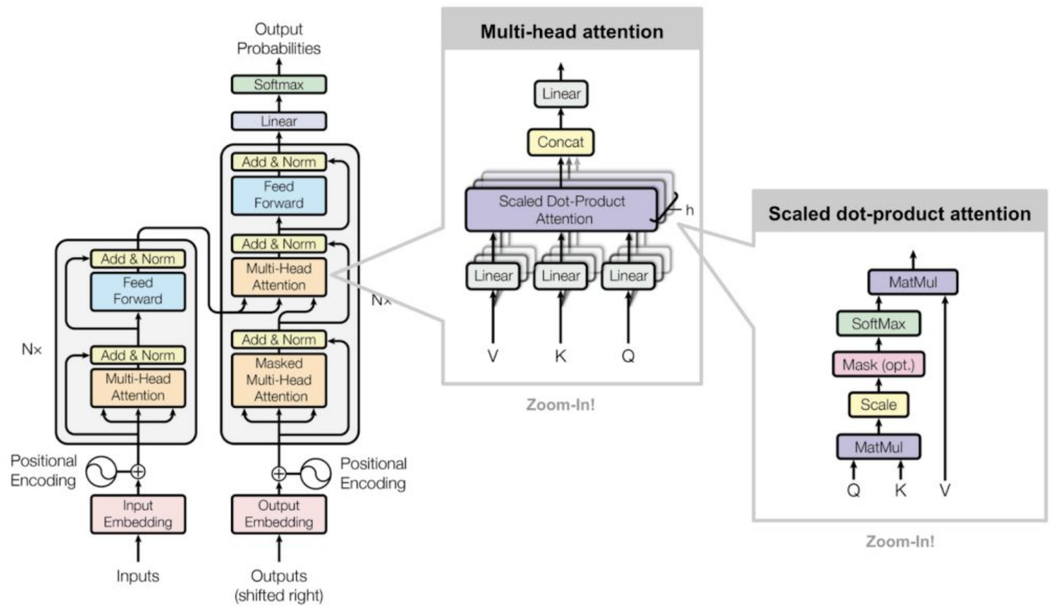

Fig. 3 - Transformer architecture scheme.

Results

We wish to improve upon the results obtained in [1], where a ROC AUC ~75% was obtained. High level features, such as jet images, lund planes and high order variables were used. In contrast, we use the minimal bias representation of jets: a list of four-momenta corresponding to its constituents. In the previous work, it has been shown that classifying pp vs PbPb jets and imposing a high enough cut on the model output, yields at the very least unbalanced jets, as expected for modified jets. The separation is still not optimal and some of these jets are indeed not modified, but unbalanced pp jets, meaning the classification as to be improved so a purely modified jet sample becomes feasible.

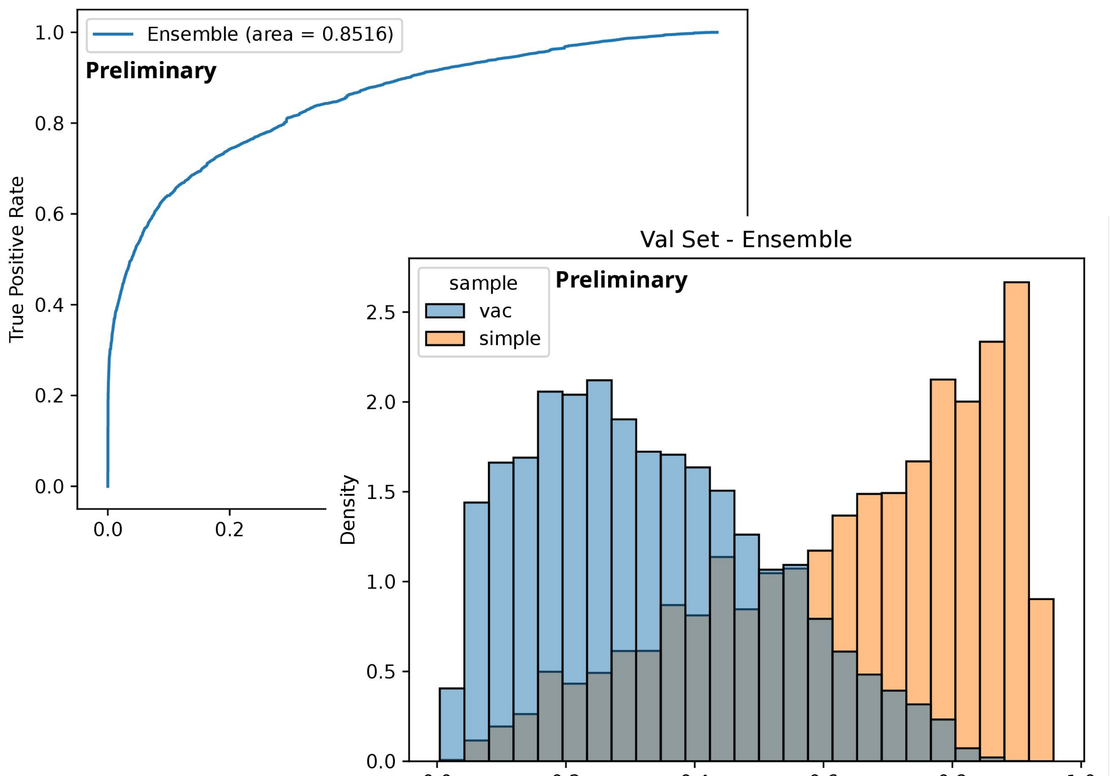

Fig. 4 - ROC curve for ensemble of models and model output.

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[1] L. Apolinário, N. Castro, M. Romão, J. Milhano, R. Pedro, arXiv:2106.08869