Transfer learning with LundNet

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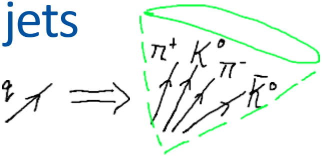
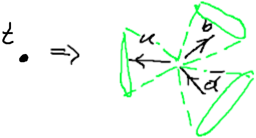
Tagging boosted jets

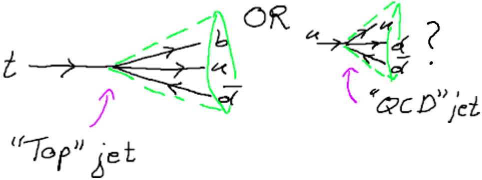
- jets are collimated sprays of final state hadrons



- for example, a top quark can decay into three jets

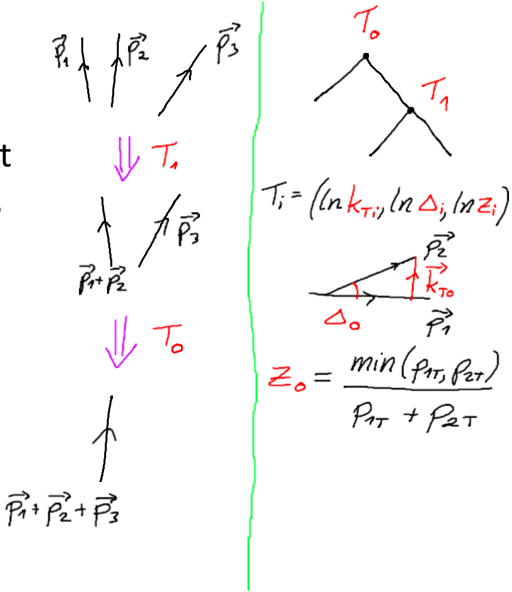


- if the quark is moving ultrarelativistically, the three decay products merge into a single jet

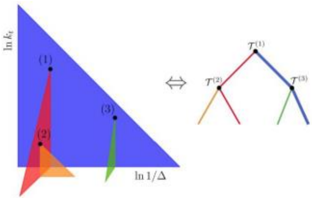


Lund Tree

- the resultant single jet can be represented as a graph with node values related to each emission
- the variables chosen at the nodes let us easily differentiate between types of emissions

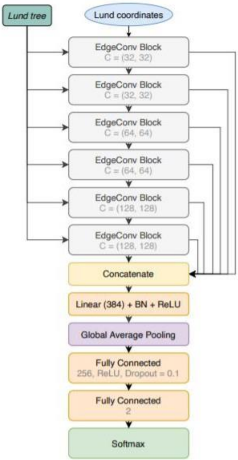


LundNet - GNN on a Lund Tree



A theory motivated structure of the input

F. Dreyer, H. Qu, 2012.08526



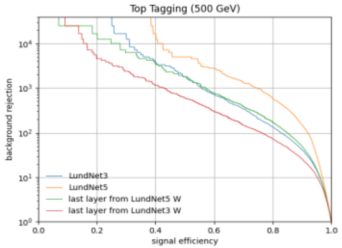
Transfer learning

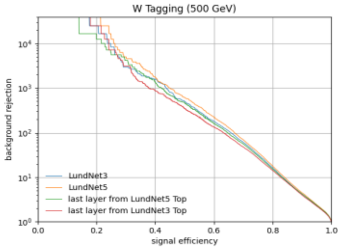
- Understand whether the operations carried out by EdgeConv blocks offer general insights into jet substructure
- Future taggers could be trained more quickly/on smaller datasets

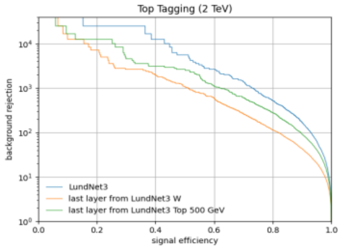
Types of transfer:

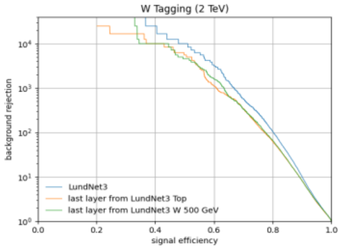
- W tagger ↔ Top quark tagger
- different p_t cuts

Results - last layer retrained

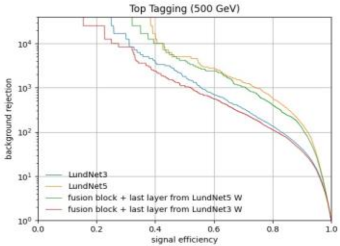


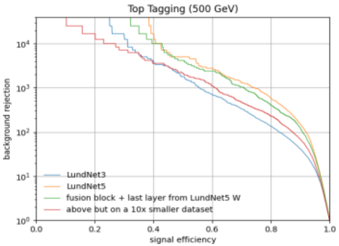






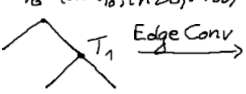
Further results



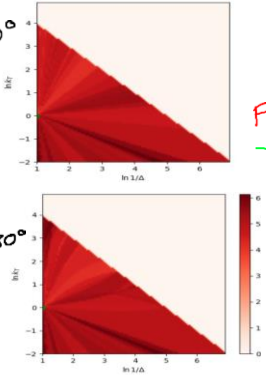


Attempts at visualising EdgeConv in the Lund Plane

$T_0 = (\ln k_{T_0}, \ln \Delta_0, \ln z_0)$ $\quad$ $T_0' = (a_1, \dots, a_{32})$

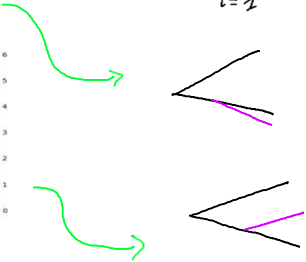


$\varphi = 0°$



$\varphi = 180°$

Pixel value = $\left(\sum_{i=1}^{32} a_i^2\right)^{1/2}$



- Sensitivity to φ for $z \to \frac{1}{2}$
- Some sensitivity to m?

Summary

- efficient taggers with different cuts/definitions of signal can be trained by retraining only the last layers of LundNet
- the output of 6 EdgeConv operations gives a graph with node information that can be processed by simple neural networks for general jet substructure purposes