# Sydney group update

**Australian ATLAS Meeting**: August 18, 2021


# Introduction: Four Tops Analysis

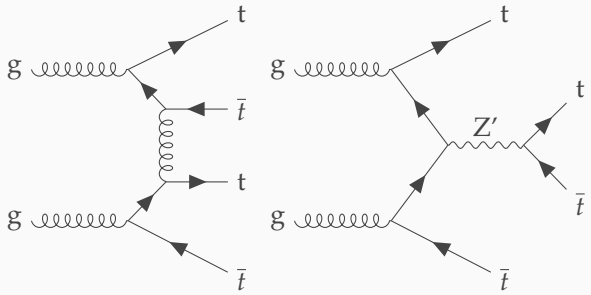


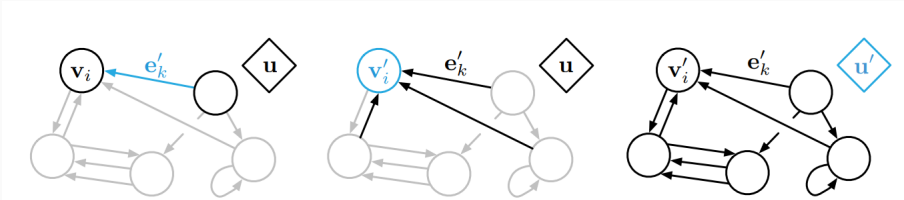

**Figure 1:** $t\bar{t}t\bar{t}$ production Feynman diagrams for left) Standard Model right) BSM Top-Philic model

- Within the SM, the 4-top production mode is extremely rare ($\sigma = 12.6^{+5.6}_{-5.2}$fb) and occurs predominantly through gluon fusion.
- Some BSM physics models predict a boosting of this cross-section due to modified top quark couplings or the presence of some heavy resonance (Figure 1).

# Introduction: Four Tops Analysis

- Tops originating from a resonance are expected to be highly boosted and produce fat-jets.
- The analysis group uses these jets in single lepton decay modes to produce reclustered jets (RC-jets).
- The idea is to explore the use of Graph Neural Networks (GNNs) to identify jets originating from resonance tops.
- This data science technique has gained a lot of attention recently in HEPP.
- For instance, at Berkeley a group used GNNs to attribute jets to a common parent in the $ttH$ production mode.

# What is a Graph Neural Network?




(a) Edge update (b) Node update (c) Global update

- A Graph Neural Network is a generalized deep learning technique similar to a conventional Neural Network (Deep Layers, Aggregation, Convolution, Pooling etc.)
- What makes a GNN unique is that, inherently non-euclidean data can be encoded on graph like data structures where;
  - Nodes - Some object (Particle, Jets) that has attributes ($\eta$, $\phi$, $p_T$, ...)
  - Edges - Some relation between objects; $\Delta$r, Inv Mass, $\Delta$(*).
  - Graph - Some global properties of the graph; Collision Energy, Missing $p_T$, $\phi$...