Utilizing Unsupervised Machine Learning In BSM Physics Searches At The LHC

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- This is partially because we do not know the particular standard model extension that nature has chosen, and as such it is very difficult to conduct a search.
- For example there are virtually infinite supersymmetric theories that could be chosen.

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5. Determine statistical significance.

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- This means that you can't find something unless you already know what to look for.
- This is a problem when there are an infinite number models to test.
- We want to be able to detect a signal without making any assumptions about it.

Unsupervised Machine Learning and Anomaly Detection

The Dark Machines Research Collective

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darkmachines.org
@dark_machines on twitter

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- We can then pass in any given event and the algorithm will assign a measure of anomalousness to it.
- If we assume that the signal is kinematically different from the background, this allows us to create a method of detecting a signal without making any further assumptions about it.

The Anomaly Detection Algorithm

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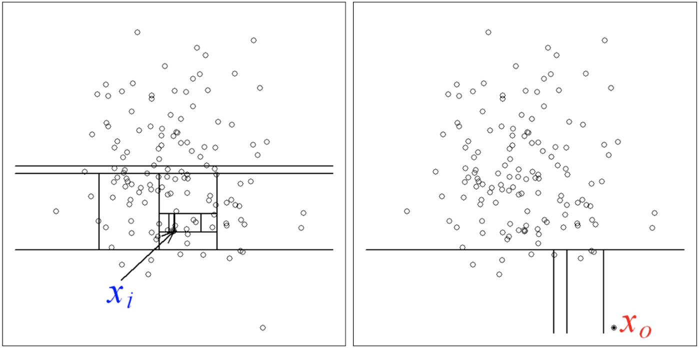
- The isolation forest works by creating trees which randomly slice the dataset until an event is isolated.
- The anomaly score of a given event is then inversely proportional to the tree depth, or how many times the dataset needs to be sliced in order to isolate that event. A highly anomalous event should take fewer slices to isolate than a totally typical event.

The Anomaly Detection Algorithm



Some Results

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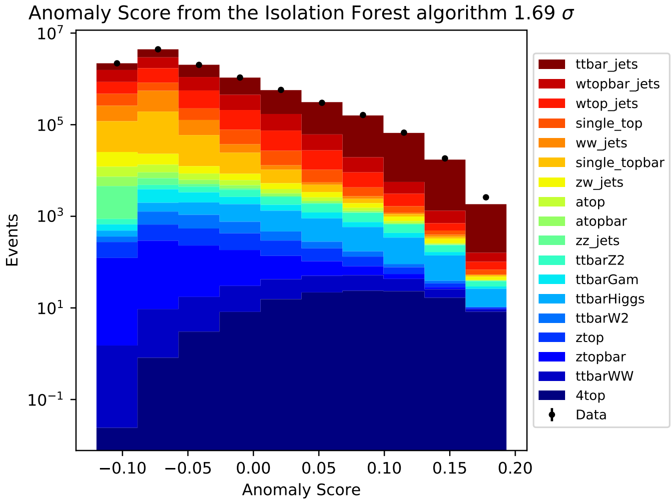
- Note that it does not matter what this signal is, as this model is signal independent.

Isolation Forest on Gluino Production



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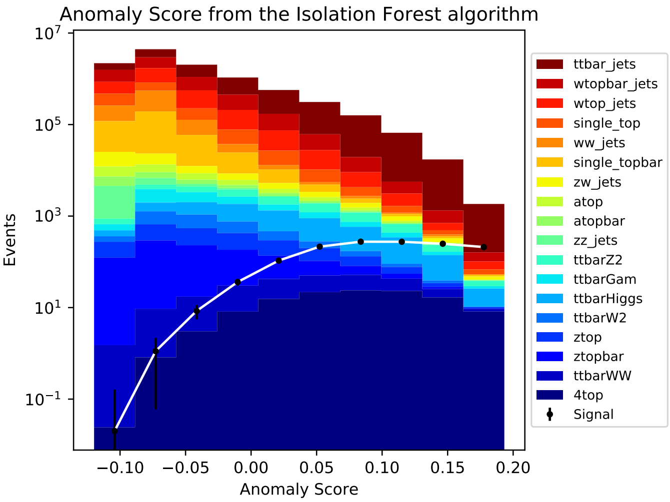

The Signal

The next signal we will look at is a 404 GeV supersymmetric top signal.

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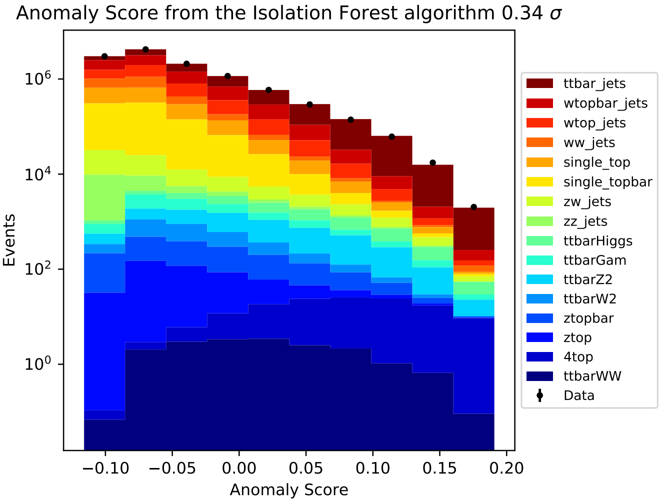
- This is a bit of a challenge as it's kinematics are very similar to the top quark.

Isolation Forest on Stop Production



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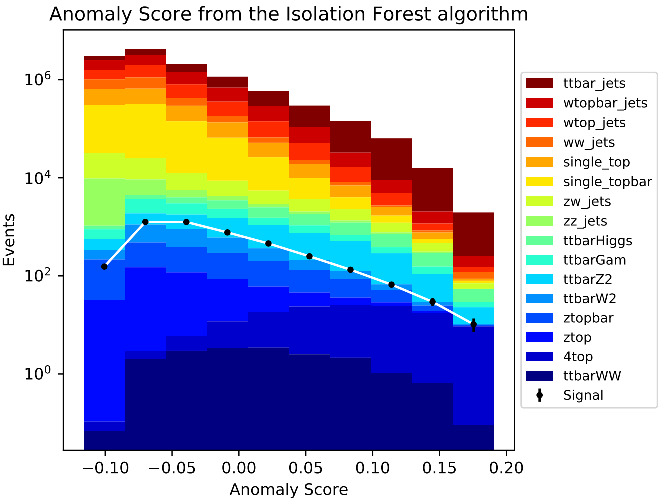

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- We, alongside Dark Machines have developed a technique that is able to differentiate signal from background without making any assumptions about the signal.
- This technique is not enough to discover a signal on its own but provides a powerful tool that can be used to determine signal regions to explore further.

End