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Developing a Declarative Analysis Language: LINQToROOT

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The HEP community is preparing for the LHC's Run 3 and 4. One of the big challenges for physics analysis will be developing tools to efficiently express an analysis and able to efficiently process the x10 more data expected. Recently, interest has focused on declarative analysis languages: a way of specifying a physicists' intent, and leaving everything else to the underlying system. The underlying system takes care of finding the data - powering the event processing loop –and even exactly how to most efficiently apply a desired jet selection. If this works, this would allow an analyzer to test their algorithm on a small amount of data on their GPU-less laptop and then run it on a large amount of data on a server with multiple large GPU's without having to alter their code. The LINQToROOT project, started almost seven years ago, fits this model. It has been used and tested in three ATLAS published analyses. LINQToROOT is based on the Language Integrated Query system built into the cross-platform C# language. It enables writing strongly-typed queries on a ROOT's TTree's data, and transcribes the data to a C++ algorithm that can run in ROOT. Recent work on this system has had two goals: improving analysis efficiency and better understanding the requirements of a declarative analysis language. For example, a good analysis language should be able to abstract away the backend –recent work has increased the possible back ends from formerly the single Windows ROOT backend to one that runs on Linux, the Windows Linux-subsystem, and an experimental one that allows for PROOF like parallel processing –all done with almost no change to the analysis code itself. Any analysis language must also be rich enough to support an experiment's data model. To test this, some experiments with the full ATLAS xAOD data model have been performed. All of this has been done while attempting to keep the project close to its original goals: quick turn around for real ATLAS physics analysis. This work will be discussed in some detail along with thoughts and lessons that have helped shape our thinking about an Analysis Language and perhaps our approach to future physics analysis employing declarative analysis.

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