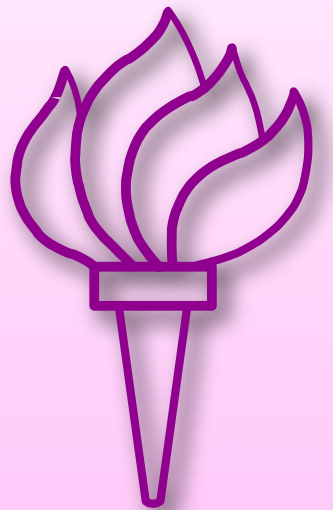
Using SFrame and PROOF



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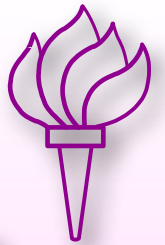
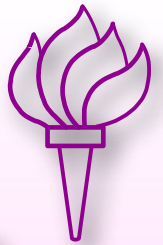
Overview



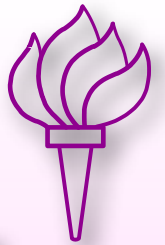
- A history of SFrame
- A quick overview of PROOF
- Writing analysis code in the SFrame “framework”
- Running an SFrame analysis

The "SFrame history"



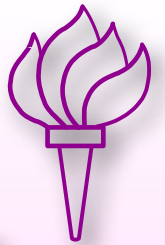
- Around 2006 the CAT physics groups were formed.
- Needed a common framework for ntuple analysis for our group.
  - Accessing input variables
  - Writing histograms/ntuples
  - Providing some sort of configurability for the code
- The CAT SUSY group started working on a project called "SFrame" (as in "SUSY Frame")
- To save time/effort, many from the CAT Top group joined in using/developing it.

SFrame evolution



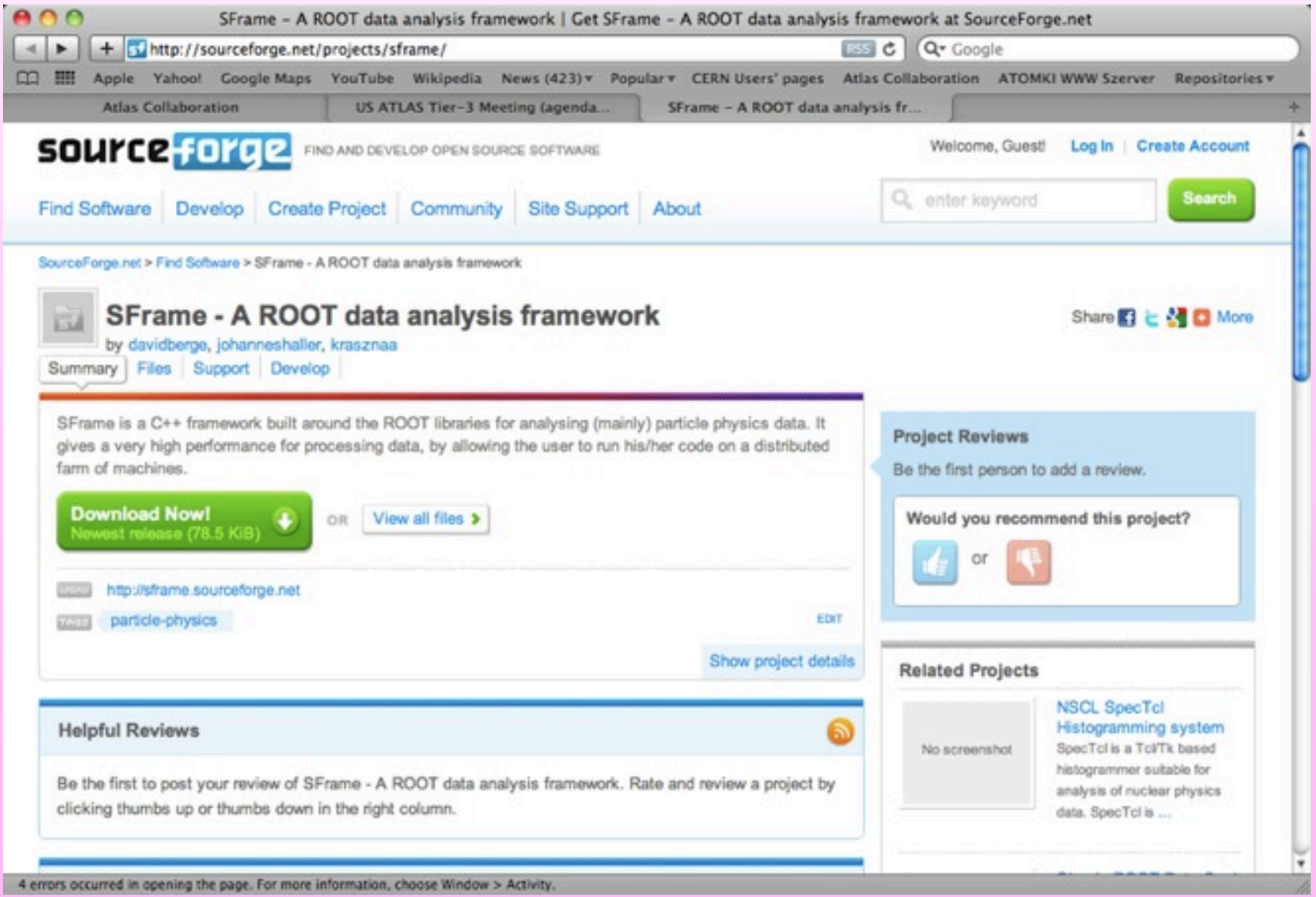
- Started out as a thin layer above TTree::MakeClass(), with configurability from an XML file
- First major capability: Correct weighting of events
- In the CSC analyses ntuple processing speed became a big issue
  - Nearly everybody was using huge EV ntuples for analysis
  - A “MakeClass analysis” was typically 1-200 Hz in speed
- Streamlined the ntuple reading to achieve 5-10 kHz speeds in the same analyses.

SFrame and PROOF

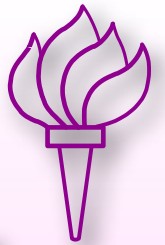


- Late 2007/early 2008: Port the good ntuple reading speed into the PROOF framework.
- -> Created the SFrame-PROOF code
- Kept the interface of SFrame almost entirely intact -> It was easy to port old code to use PROOF
- Kept the same configurability, weighting of events, etc.
- Recently merged the SFrame-PROOF branch back into the trunk of the code.
- Current code location is here

SFrame location

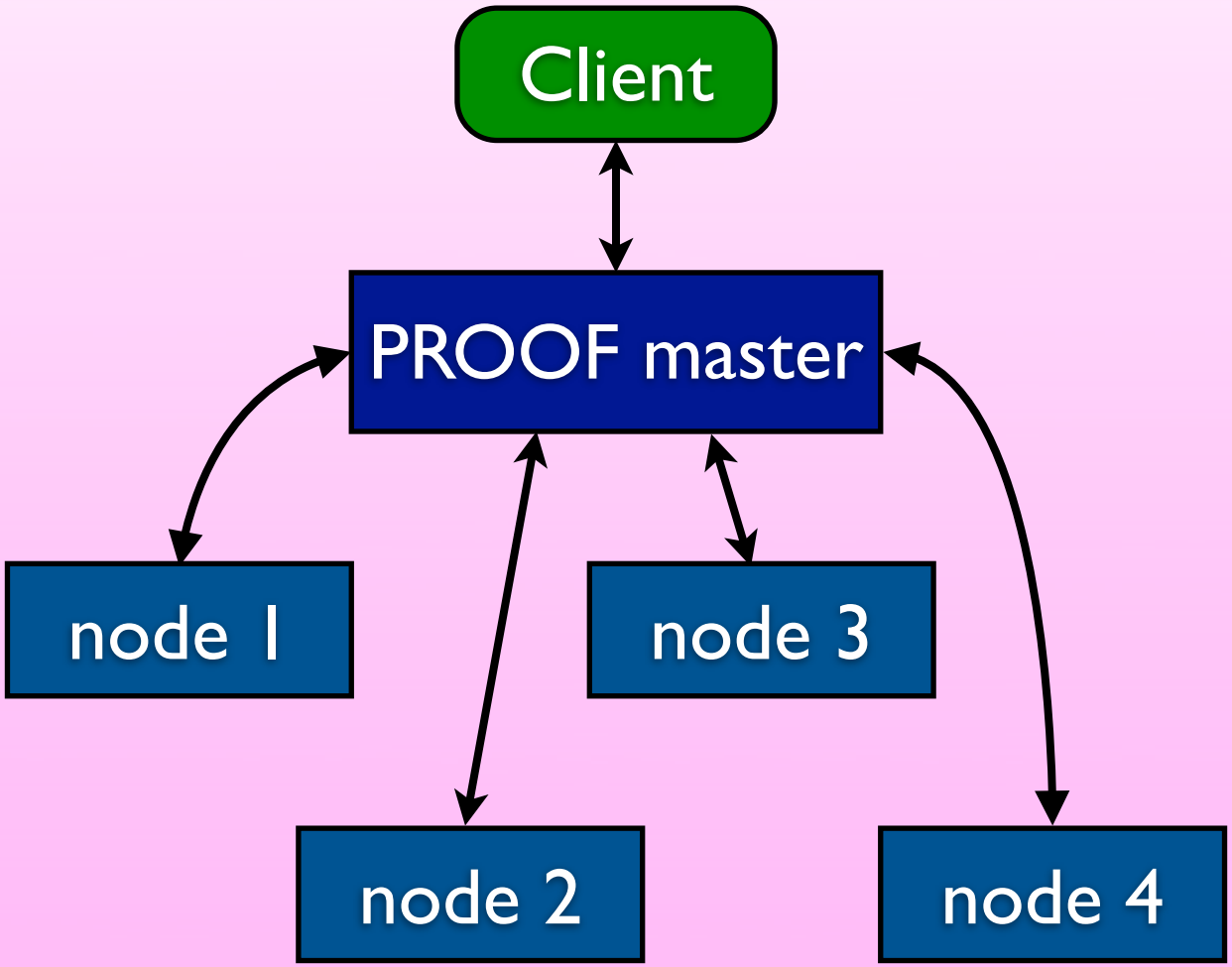


PROOF basics

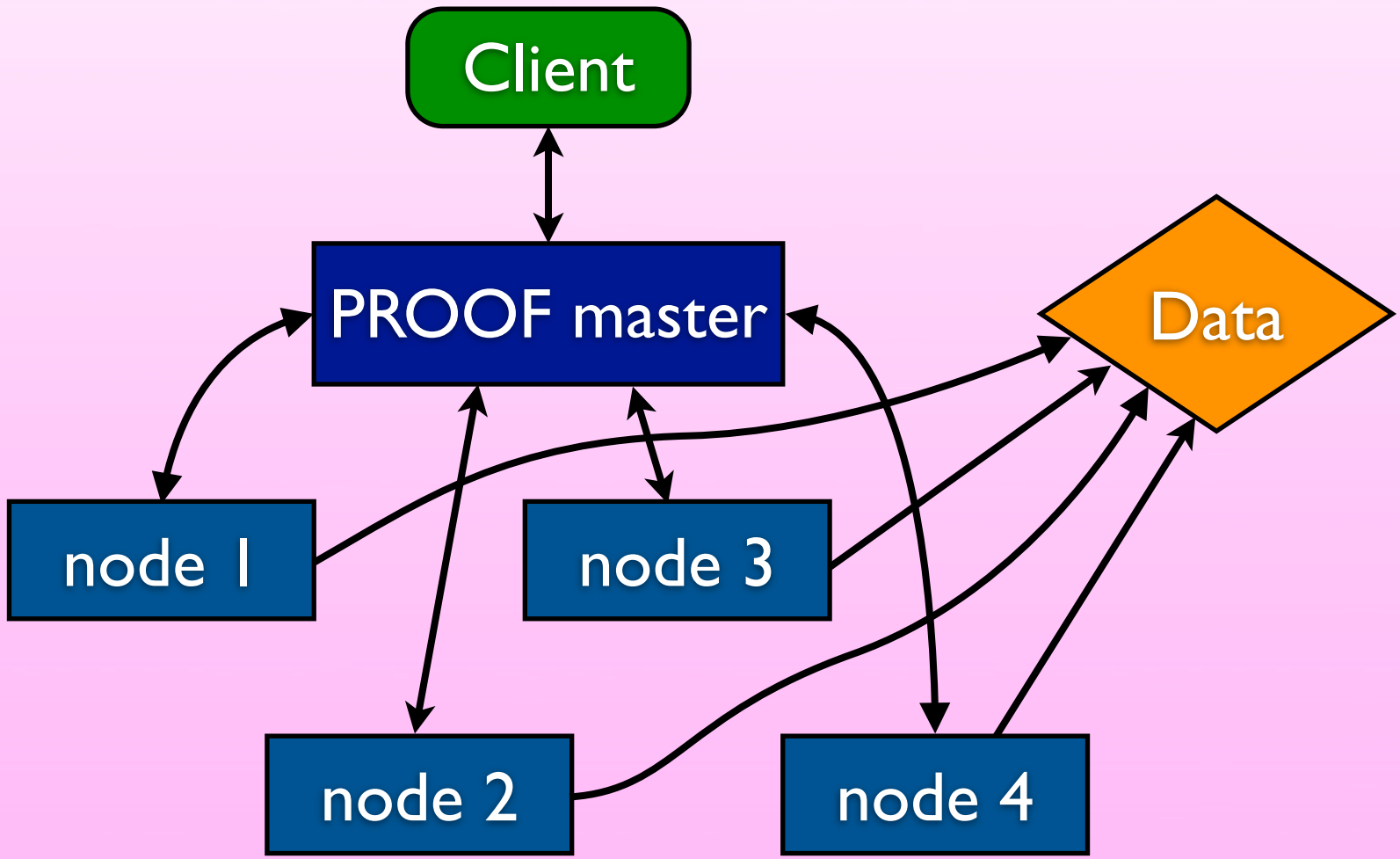


- PROOF is an extension of ROOT for enabling parallel execution of analysis codes on multiple processors
- Very similar in concept as SFrame was –> Develop a class inheriting from a common base class, implementing some virtual functions.
- Instantiates as many of the user's class as many worker nodes are defined, which communicate over the network. –> Possible to create large PROOF clusters
- After all workers are done, the master node collects the output objects (histograms, ntuples, etc.)

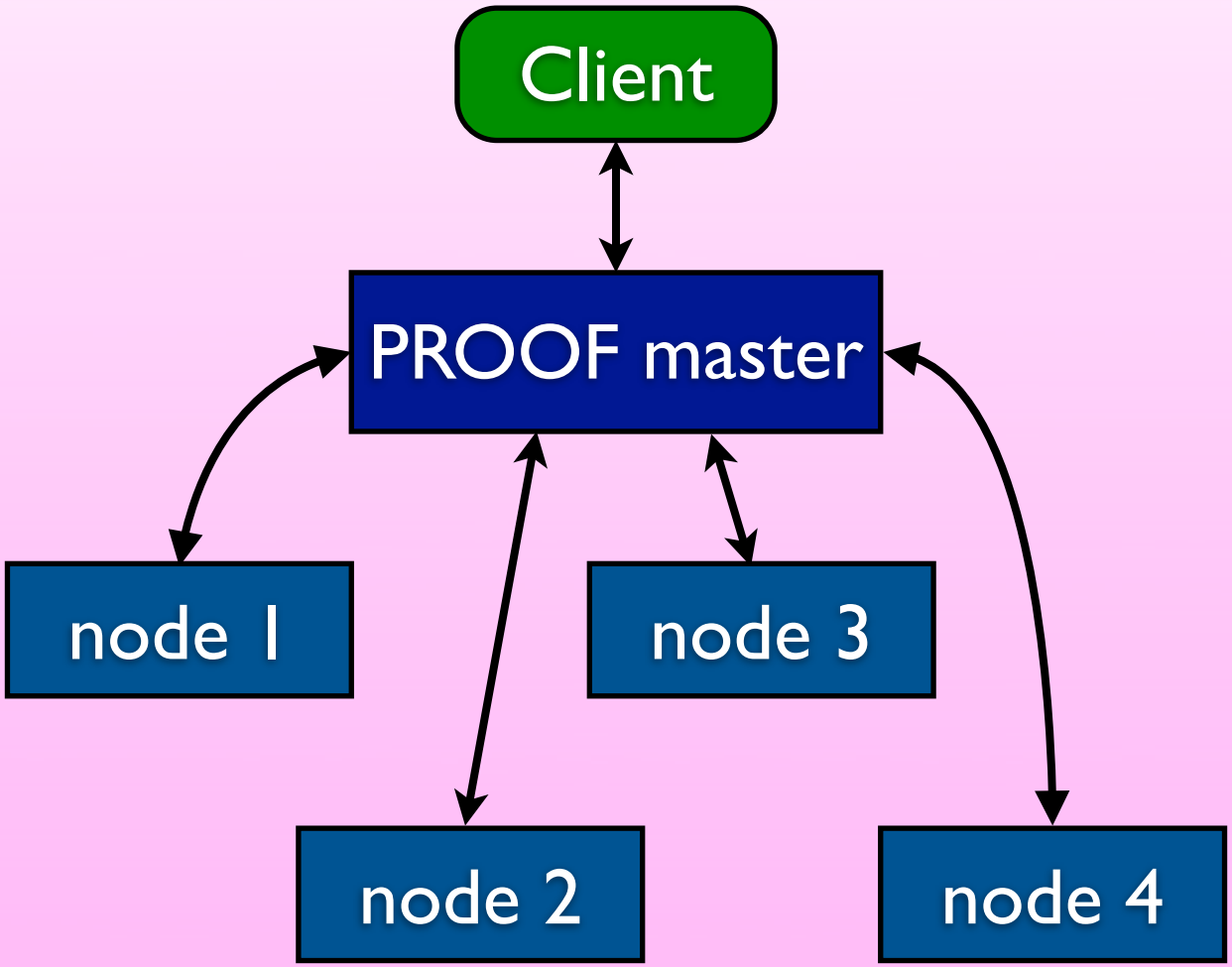
PROOF at work



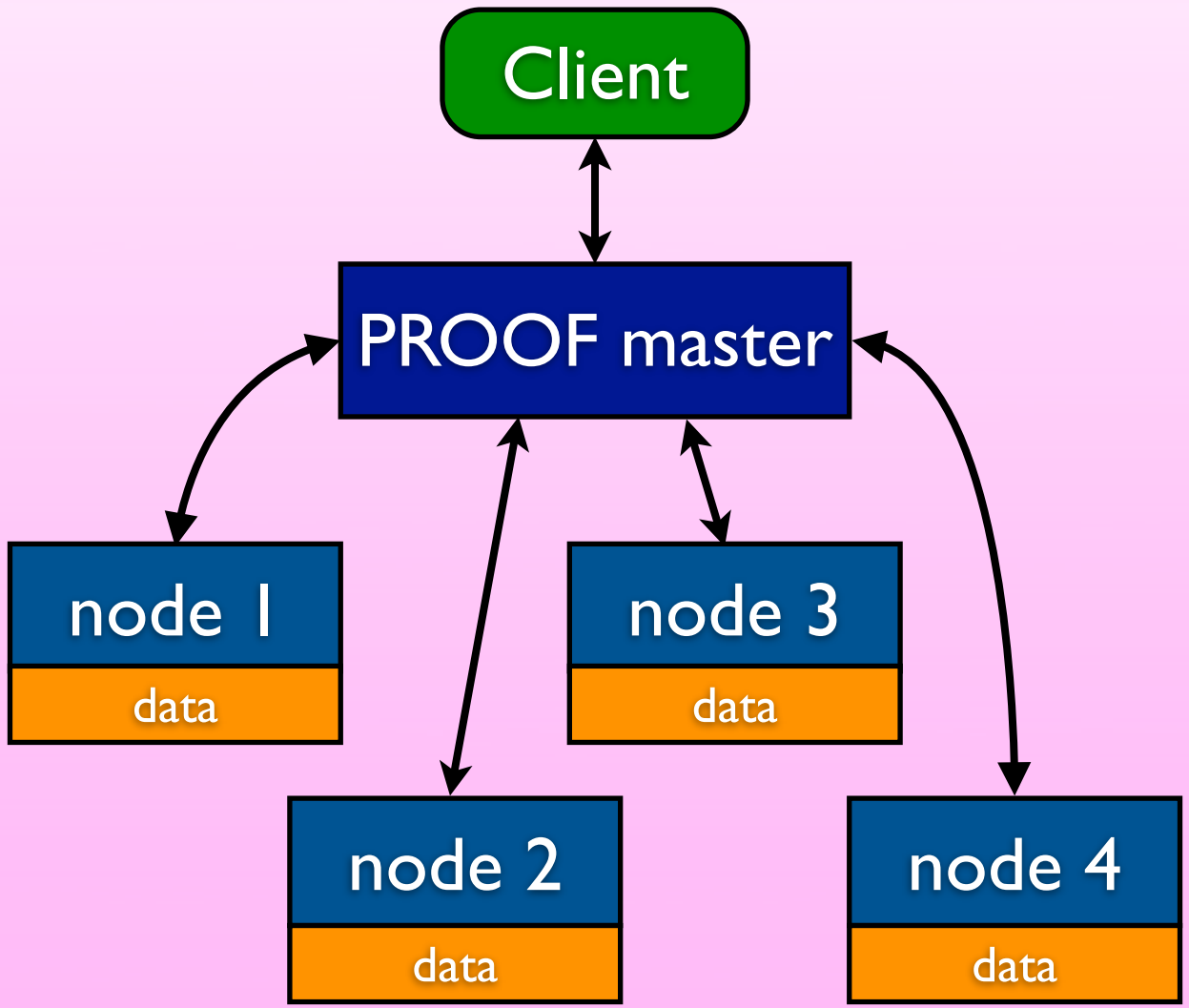
PROOF at work



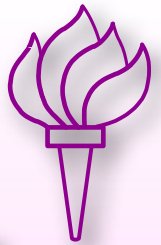
PROOF at work



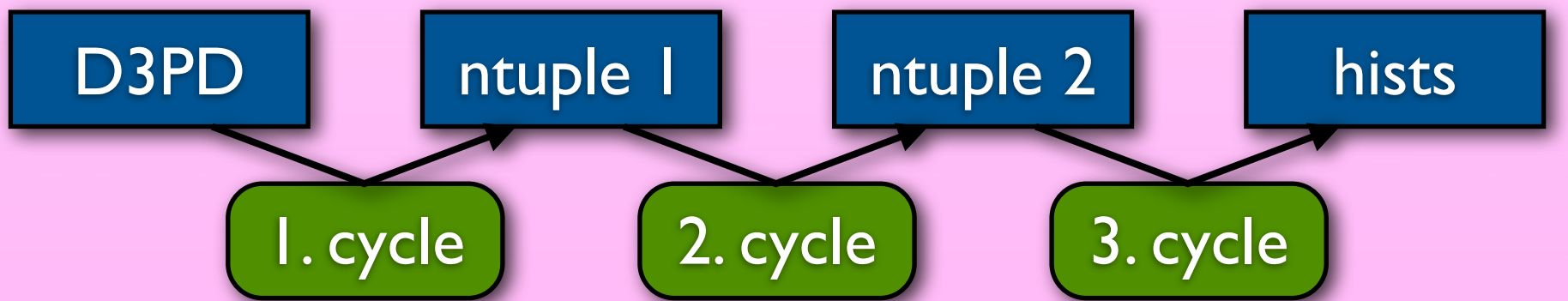
PROOF at work



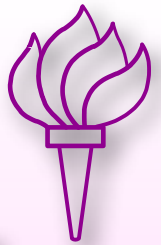
An SFrame analysis



- Analyses are usually executed in “cycles”. E.g.:
  - 1. cycle: Select the interesting events and write a reduced set of event variables
  - 2. cycle: Calculate some new event-level variables and add them to the events in new output files
  - 3. cycle: Create the final histograms from the previously selected events

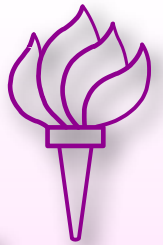


An SFrame cycle



```
class FirstCycle : public SCycleBase {

public:
   FirstCycle();
   ~FirstCycle();

   virtual void BeginCycle() throw( SError );
   virtual void EndCycle() throw( SError );
   virtual void BeginInputData( const SInputData& ) throw( SError );
   virtual void EndInputData  ( const SInputData& ) throw( SError );
   virtual void BeginMasterInputData( const SInputData& ) throw( SError );
   virtual void EndMasterInputData  ( const SInputData& ) throw( SError );
   virtual void BeginInputFile( const SInputData& ) throw( SError );
   virtual void ExecuteEvent( const SInputData&, Double_t weight ) throw( SError );

private:
   ...
};
```

Various common tasks



- Declare a cycle property:

```
DeclareProperty( “D3PDTreeName”, m_treeName );
```

- Read a variable from a TTree:

```
ConnectVariable( “d3pd”, “el_pt”, m_el_pt );
```

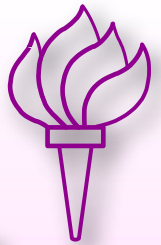
- Write a variable to the output file:

```
DeclareVariable( m_el_selected, “el_selected” );
```

- Create a new histogram in the output file:

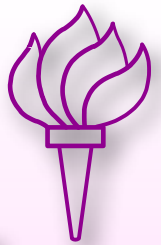
```
Book( TH1D( “ElHist”, “Electron histogram”, 100,
            0.0, 100.0 ), “Hists” );
```

Configuring a cycle



```
<JobConfiguration JobName="TestJob" OutputLevel="DEBUG">

   <Library Name="libGenVector" />
   <Library Name="libSFrameUser" />
   <Package Name="SFrameUser.par" />

   <Cycle Name="FirstCycle" TargetLumi="12.3" RunMode="PROOF" ProofServer="lite"
          ProofWorkDir="" OutputDirectory="./" PostFix="" >
      <InputData Type="MC" Version="Zee_1" Lumi="0." NEventsMax="2000" NEventsSkip="3000" >

         <In FileName="MyD3PD.root" Lumi="123.4" />

         <InputTree Name="FullRec0" />
         <InputTree Name="CollectionTree" />
         <OutputTree Name="FirstCycleTree" />

      </InputData>
      <UserConfig>
         <Item Name="D3PDTreeName" Value="FullRec0" />
      </UserConfig>
   </Cycle>

</JobConfiguration>
```

Parts of the configuration

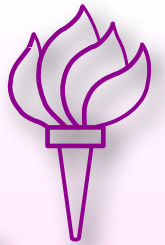


- Libraries and “packages”
  - Load a library needed for the analysis cycle:
    `<Library Name="libMyLibrary" />`
  - Compile and load a package on PROOF:
    `<Package Name="MyLibrary.par" />`
- Define a cycle:
  `<Cycle ...>` and `<UserConfig>` nodes
  - Can change the execution mode (PROOF, PROOF-Lite or no PROOF) with changing some items
- Define the data to run on:
  `<InputData ...>` nodes, defining all the important properties of the input files

Running a cycle

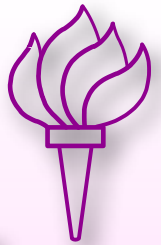
```
[bash][agh228]:config > sframe_main FirstCycle_config.xml 2>&1 | tee test.log
 ( INFO  )  SCycleController   : Initializing
 ( INFO  )  SCycleController   : Deleting all analysis cycle algorithms from memory
 ( INFO  )  SCycleController   : read xml file: 'FirstCycle_config.xml'
 ( INFO  )  SCycleController   : Created cycle 'FirstCycle'
 ( INFO  )  FirstCycle         : Initializing...
 ( INFO  )  FirstCycle         : Reading SInputData: MC
 ( INFO  )  FirstCycle         : Reading SInputData: MC
 ( INFO  )  SCycleConfig       : ============================================================
 ( INFO  )  SCycleConfig       :                      Cycle configuration
 ( INFO  )  SCycleConfig       :   - Running mode: PROOF
 ( INFO  )  SCycleConfig       :   - PROOF server: lite
 ( INFO  )  SCycleConfig       :   - Target luminosity: 1
 ( INFO  )  SCycleConfig       :   - Output directory: ./
 ( INFO  )  SCycleConfig       :   - Post-fix:
 ( INFO  )  SInputData         :  ------------------------------------------------------------
 ( INFO  )  SInputData         :  Type                : MC
 ( INFO  )  SInputData         :  Version             : Zee_1
 ( INFO  )  SInputData         :  Total luminosity    : 209.8pb-1
 ( INFO  )  SInputData         :  NEventsMax          : 2000
 ( INFO  )  SInputData         :  NEventsSkip         : 3000
 ( INFO  )  SInputData         :  Input SFiles        : '/afs/cern.ch/atlas/maxidisk/d181/SFrame/
StacoTau1p3p__dcache-pythiazeeSUSYView_1.AAN.root' (file) | '209.8' (lumi)
 ( INFO  )  SInputData         :  Input tree          : 'FullRec0'
 ( INFO  )  SInputData         :  Input tree          : 'CollectionTree'
 ( INFO  )  SInputData         :  Output tree         : 'FirstCycleTree'
 ( INFO  )  SInputData         :  ------------------------------------------------------------
 ( INFO  )  SInputData         :  ------------------------------------------------------------
 ( INFO  )  SInputData         :  Type                : MC
 ( INFO  )  SInputData         :  Version             : Zee_2
 ( INFO  )  SInputData         :  Total luminosity    : 209.8pb-1
```

Summary



- SFrame provides a nice interface for developing analysis code locally that can be sent to a PROOF cluster with just modifying a configuration file
- The code is used routinely by a large number of groups by now. (Including NYU of course.)
- Possible future development: Smarter handling of input files/datasets
- The framework seems capable enough to handle the ATLAS data just around the corner.

Further material



- Write-up on SFrame: http://sourceforge.net/apps/mediawiki/sframe/
- Configuring a small PROOF cluster: http://sourceforge.net/apps/mediawiki/sframe/index.php?title=SFrame-PROOF#Example_setup_of_a_small_PROOF_cluster