LUMINOSITY-AWARE ANALYSIS

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Contents

Cross section

$$N_{sig} = A \cdot \epsilon \cdot l \cdot p \cdot f \cdot \mathcal{L} \cdot \sigma$$

- N_{sig} : observed minus background events
- A: acceptance
- ε : trigger and offline selection efficiency
- l : livetime
- p : L1,L2,L3 triggers prescales factor
- f : any additional correction factor
- L : luminosity
- σ : cross section

Luminosity

- Beam luminosity: measured by several experiments
  - Roman Pots, LHC Machine parameters, LUCID, etc.
- Estimated for each luminosity block
- Can vary as a function of LB
- Stored in databases for each LB for
  - Monte Carlo (TopMix runs) luminosity
  - Online luminosity
  - Offline luminosity (fake for cosmics)

Trigger

- Dead-time (within LB):
  - programmable (few bunch crossings following each L1 decision), or busy signal from/to CTP, etc.
  - can be different for each trigger, for each LB
- Prescales:
  - all 3 trigger levels can be prescaled
  - can be different for each trigger, for each LB
- Stored in online trigger database for each LB
- Note: we always analyze data after it came through a trigger system!

Integrated luminosity calculation

- For each LB we calculate and integrate
- NOTE: this is independent of any event selection!
- RULE: if you 'looked at' events from a LB you MUST count in that LB! Even if you selected 0 events!

<u>Dead-time and prescale corrected integrated luminosity:</u>

$$L_{tot}^{cor} = \sum_{i}^{lumiblocks} \mathcal{L}_i \cdot \Delta t_i^{Trig} / (P_{L1,i} \cdot P_{L2,i} \cdot P_{L3,i})$$

Lumi estimate Trigger livetime Trigger prescales

Athena based AOD analysis use case

- Every AOD has a "MetaData", which contains the list of run and LB numbers of the events within
- List contents of the MetaData of an AOD file: https://twiki.cern.ch/twiki/bin/view/Atlas/CoolLumiCalc#Sidenote_how_to_list_the_content
- LumiBlock/LumiBlockComps main package processes MetaData information
  - LumiBlockMetaDataTool: LB bookkeeping in ESD/AOD files
  - LumiCalcSvc: Integrated lumi calculation inside Athena

Athena based AOD analysis use case

- Bookkeep in your event loop base analysis:
  - which LBlocks were processed completely
  - which LBlocks were processed incompletely
- Apply Data Quality filtering with GoodRunsLists
- Output xml/ROOT file with list of run+LBs
- Grid: n subjobs
  - n output xml/ROOT files ➔ merge

Athena based AOD analysis use case

- LumiCalcSvc:
  - Athena service class
  - accumulates luminosity (see formula)
  - reports it to screen
- iLumiCalc.exe:
  - command line executable, same engine
  - can have inputs:
    - full command line run+LB number, trigger specification
    - xml
    - ROOT (flat ntuples – attached xml string to TTree)
    - TAG

Literature

- "Report from the Luminosity Task Force"

http://cdsweb.cern.ch/record/970678

- LumCalc twiki:

https://twiki.cern.ch/twiki/bin/view/Atlas/CoolLumiCalcTutorial

- GoodRunsLists twiki:

https://twiki.cern.ch/twiki//bin/view/Atlas/GoodRunsListsTutorial

IMPORTANT NOTES

- Even if you plan to apply the DQ and trigger selections at the ntuple level only, and not in your athena jobs, you should **always have the LumiBlockMetaDataTool turned on** so that the processed lumiblock collections or xml-strings get propagated to your ntuples!
- **NEVER throw away output ntuples with no events!** They still contain LumiBlock collections for the luminosity calculation!
- Merging of the xml-string with the flat ntuple should always be done.
- You should always retrieve the produced luminosity-block xml-files from a grid ntuple job!