SAM Metadata

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SAM

- Data handling system used by Run II experiments and Minos
- Provides
  - Metadata catalogue – "what is in the data files?"
  - Location catalogue – "where are the files?"
  - Data delivery service – "give me my files"
- As much as possible, frees experiments from dealing with the specific details of their data
  - Paths, copying from tape to disk, …
  - Focus on the content rather than the technicalities

SAMWeb

- SAM has been around for all of Run II
- For the Intensity Frontier, we are rewriting the interface layer
  - Benefits of operational experience
  - Based on latest standard technologies
  - Bring security up to date
- Keep fundamentals the same
  - Those familiar with the old system will recognise much, although things look a bit different

Purpose of metadata

- Metadata is data about data
- The data is the raw data, root trees,…
- The metadata is the stuff that describes this
- Includes "physical" metadata: file size, checksum
- But also "physics" metadata: for example, run number, detector configuration, simulation parameters
  - Much of this is very experiment dependent
- Since metadata is used to catalogue the data you want to add it early; updating it after the fact can be painful

Metadata in the SAM database

- Every file stored in SAM must have metadata associated with it
  - Some types of file need very little
- Metadata is normally uploaded when the file is first added to the database
- Assumption is that metadata is normally static
  - Set once and not modified much (or at all)
- SAM metadata is essentially key/value pairs
- Some metadata fields are predefined in the SAM database
- You can also define your own fields

Predefined metadata fields

- https://cdcvs.fnal.gov/redmine/projects/sam-web/wiki/Metadata_format
- **file_name**, **file_size**, crc, ***file_type***, *file_format*, *group*, *data_tier*, application, *parents*, event_count, first_event, last_event, start_time, end_time, file_partition, *data_stream*, runs, lum_block_ranges
- Fields in **bold** are required for all files
- Fields in *italics* require values to be previously defined in the database before they can be used

Basic file information

file_name, **file_size**, crc [checksum]

file_type – suggested for "high-level" type of file (real data, MC, archived logfile, ...)

file_format – type of file: roottuple, histogram, custom binary format, ...

group – SAM work group for the file

Data tiers and file lineage

data_tier, application, *parents*

- Experiments usually have a workflow which sends the raw data through a series of processing steps
- Raw → reconstructed → analysis tuples → papers
- SAM refers to these stages as data tiers
- Each processing stage can also track the parent (input) files and program versions used to create it
  - Can be used to answer questions like "what version of the reconstruction was used to create this file?", and "which raw files do *not* have children produced by version X?"

Example of history

http://samweb.fnal.gov:8480/sam/dzero/api/files/name/all_3_0000272806_059.raw/lineage/descendants?format=plain

```
recoT_all_3_0000272806_059.raw_p20.18.05_diesburg_d0mino05.fnal.gov_110508_6247_fnpcosg1.fnal.gov
    recoT_all_3_0000272806_mrg_059-063.raw_p20.18.05
        CSskim-MUinclusive-20110709-004859-8979101_p21.22.00
            CAF-CSGv1-CSskim-MUinclusive-20110709-004859-8979101_p21.22.00_061010_p21.22.00.root
            CAF-CSGv1-CSskim-MUhigh-20110709-004859-8979101_p21.22.00_061049_p21.22.00.root
                SKIM_MUTAU_RunIIb4_run2b4-18.05__CAF-CSGv1-CSskim-MUhigh-20110528-190312-8429373_p21.22.00_220057_p21…
                SKIM2_MUTAU_RunIIb4_run2b4-18.05__CAF-CSGv1-CSskim-MUhigh-20110522-231759-8338789_p21.22.00_000924_p21…
            TMBfix-20110710-115446-8998448_p20.18.00e
            TMBfix-20121012-071220-11589505_p20.18.05e
        CSskim-TAUTRIG-20110709-012459-8979601_p21.22.00
            CAF-CSGv1-CSskim-TAUTRIG-20110709-012459-8979601_p21.22.00_062315_p21.22.00.root
        CSskim-NP-20110709-012459-8979619_p21.22.00
            CAF-CSGv1-CSskim-NP-20110709-010710-8979619_p21.22.00_063916_p21.22.00.root
        CSskim-3JET-20110709-004140-8979282_p21.22.00
            CAF-CSGv1-CSskim-3JET-20110709-004140-8979282_p21.22.00_081721_p21.22.00.root
        CSskim-EMinclusive-20110709-011130-8979582_p21.22.00
            CAF-CSGv1-CSskim-EMinclusive-20110709-011130-8979582_p21.22.00_070509_p21.22.00.root
                icrSkim_CSG_CAF_EMinclusive_PASS6_p21.22.00_p20.18.05_all_part8_CAF-CSGv1-CSskim-EMinclusive-2011070…
                CAF-CSGv1-CSskim-EMinclusive-20110709-011130-8979582_p21.22.00_070509_p21.22.00.root_eleciso.root
                VJETS-RunIIb4-EMinclusive-v03.00.00_CAF-CSGv1-CSskim-EMinclusive-20110813-021407-9340715_p21.22.00…
                CAF-CSGv1-CSskim-EMinclusive-20110711-104526-9010901_p21.22.00_121129_p21.22.00_eminclusive.root
            WMASSskimRUN2B_3and4-EMJET-EMinclusive-PASS6-p21.22.00-p20.18.05_112_8_of_19
                WMASSskimRUN2B_3and4-EMJET-EMinclusive-PASS6-p21.22.00-p20.18.05_112_8_of_19.root
```

[… truncated because DZero has very complicated file histories …]

Other predefined fields

event_count, first_event, last_event – the latter two are helpful for searching for the file containing a particular event

start_time, end_time – makes sense for raw data; less so for other types

data_stream – stream for the file

runs – a list of run numbers and run types

file_partition – hold-over from DZero; an integer value

lum_block_ranges – another DZero concept; a list of pairs of integers

Experiment defined fields

- Each experiment can define its own fields (called *parameters* in SAM terminology).
- Each parameter has a category and a name, which must be defined in advance
- Values may be anything
  - Current limitation – all values are treated as strings, so querying on ranges doesn't work well for numbers
    - Intend to fix this
- Can be used to store any data relevant to the file

Examples of parameters

Chosen at random from various existing experiment databases

- Beam.HornCurrent
- cosmic.magicsquarex
- generated.ranseed1
- generated.technipioprimemass
- NuclearTargets.CryoTargetStatus
- Online.triggerconfig
- Online.TriggerCtrlID
- pythia.higgsmass

What parameters do you need?

- Parameters must be defined in advance of use
- Two main tasks
  - Providing values to query to retrieve the files later
  - Annotating useful information about the file
- SAM is file based
  - Not an efficient substitute for configuration database, trigger database, etc
    - May want to cross-reference with such databases
- No need to decide all possible parameters now; new ones can be added easily enough
  - Updating existing files is not so easy, so try to decide what you want before uploading them

Querying on metadata

- Once you've defined metadata for the files, you will want to retrieve them later
- SAM has a simple (compared to SQL) query language for this

```
run_number 1000-2000 and data_tier raw and
detector.quality good

data_tier raw and not isparentof:(data_tier
reconstructed and version X)
```

- https://cdcvs.fnal.gov/redmine/projects/sam-web/wiki/Dimension_Syntax for more details

Processing files

- Once you've come up with a query that produces the files you want, you can save it as a *dataset definition*.
- Then you can start a task processing that dataset definition (a *project* in SAM terms).
- The project will retrieve the files if needed and tell the analysis process where the file is located.
- You don't have to explicitly list the file names, and you don't have to know exactly where the files are.
- Multiple processes can run for the same project, sharing the files between them automatically.

Summary

- Metadata is an important part of SAM
- Used carefully it can make cataloguing your data much easier
- Datasets can be defined in terms of the metadata, allowing you to retrieve the files you want
- Benefit to deciding early what metadata you want to store
  - Can only get out what you put in
  - Should be driven by requirements of processing/analysis
  - Once files have been archived on tape and off disk, going back and rereading them to update the database becomes a major operation