Genie

Event Library

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Overview

- Concept of the event library
  - Necessary inputs and desired output
- how this has been used in the past
  - How it worked
  - How it failed
- Possible development lines
- All the technicalities I'm going to mentioned are described in the manual

Event library concept

- We bring to the extreme consequences the concept of spline
  - splines = precalculated integrated cross sections
- If a user can provide the integrated cross sections and enough events for the various energies
  - GENIE can simply pick up random events for a given energy
    - Sampling the energy according to the energy distribution of the cross sections
- The usual GENIE spline rules apply
  - We need a spline for every combination of
    - neutrino flavour
    - target
    - “Process”
- In the event library we are relaxing the concept of process
  - GENIE can be completely agnostic about the content of the used events
- This process is compatible with our geometry drivers!
  - This can be possible solution for easy tests of other generators and BSM physics in our detectors

Inputs

- The input is a ROOT file
  - Divided in directories
    - target isotope/cc/neutrino_flavour
    - target isotope/nc/nu or nu_bar
  - Each directory must contain
    - TGraph xsec - units of 10^{-38} cm^2 as a function of the energy in GeV
    - TTree records

- The TTree is a simple structure:
  - Enu
  - prod_id
  - nparts
  - pdg[nparts]
  - E[nparts], px[nparts], py[nparts], pz[nparts]

- One entry for each neutrino interaction

Outputs

- Spline generation
  - `$ gmkspl -p 14 -t 1000060120 -o evtlibxsec.xml --tune EX00_00a_00_000`
- Event generation
  - `$ gevgen -e 1,3 -f 1 -p 14 -t 1000060120 --tune EX00_00a_00_000 --cross-sections /path/to/evtlibxsec.xml`
  - of course all the experiment specific applications can be used too
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- The combination of flavour, CC/NC, target and energy of the interacting neutrino is generated
  - based on the flux and cross section convolution
    - As usually done with the generator
- The event with the closest energy is picked from the records
  - A random rotation around the beam is applied
- The metadata of the event are very poor
  - We can only fill what information is in the record

(Current) Limitations

- We don’t have the scattering type
  - Unless stored the prod_id
    - its meaning will be obscure anyway for GENIE and most likely for all downstream code
- We cannot store relation between mother-daughters
  - Decays are not well represented in this model
  - The assumption being that all decays are not visible by the detector
- No reweight handles
  - the lack of information in the Interaction and in the particle stack might create issues for possible reweight modules
  - You can only act based on the particle content
  - Dedicated reweight modules needs to be written to extract the correct information and then reweight

(Known) Use cases

- This tool was developed by NOvA collaborators
  - Their goal was to use it to interface with NuWro
  - This was also how the tool was developed and tested
- SBND attempted to use it with GIBUU
  - Unfortunately it was a failure
    - GIBUU produces weighted events and the library does not handle weights when selecting the events
- No known attempts were made in the context of BSM physics
  - They do know of the tool, we haven't got a formal feedback about how it has been used
  - But there are probably limitations due to tool itself
    - Limitation to CC and NC process only
      - To move forward we may need some inputs here

Possible developments

- Adding the possibility to including weight in the search of the library
  - Help interface with GIBUU
- Make the structure more flexible
  - We are not limited to CC and NC
  - We can add additional and optional categories
    - This might be useful for BSM physics
- The GENIE resources for this project are very limited
  - But external collaborators are always welcome