Development Of Testing Suite For Event Biasing

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About Myself

Kyungseop Yoon (Kevin)

• Citizenship: South Korea

• Education:
  • University of California, Irvine
  • Physics, Bachelor of Science

• CERN Summer Studentship:
  • EP-SFT
  • Next step: apply to PhD programs in the U.S.
  • Literally cherishing every part & moment of it :)
What is GEANT4?

"Software toolkit for the simulation of the passage of particles through matter"

- C++ Framework
- Tracking
- Geometry
- Material
- Physics Models
- Hits
- Visualization
- Etc.

Global collaboration

https://geant4.web.cern.ch/

Application

- HEP Experiments
- Medical Physics
- Radiation Protection
- Astrophysics
- Space Engineering
Event Biasing

Algorithms to simulate rare events accurately and efficiently

Example simulation of a "rare event"

Without event biasing, you need to simulate LOTS of events to get a good result.

Other Examples

- $D^0 \rightarrow K + \pi$ (@ LHCB)
- Forced interactions in thin detectors
- Neutrino interactions
- Cosmic rays in astrophysics
- Low energy neutrons (CPU-draining) (@ CMS)
Event Biasing: Cloning/Killing

A simple example of a biasing technique

A track entering the next cell is cloned into 2
However, the 2 tracks are assigned half the weight

Multiply tracks:
\[ \times 2 \quad \times 2 \quad \times 2 \quad \times 2 \quad \times 2 \quad \times 2 \\]
Assign weights:
\[ 1/2 \quad 1/4 \quad 1/8 \quad 1/16 \quad 1/64 \quad 1/128 \]

If the track enters from the opposite side, it is killed with ½ probability.

The probability of interaction increases, but the total outcome is preserved.

Generate less events to get the same results!

\[
\text{(Probability of interaction)} \propto (\# \text{ of tracks})
\]
\[
\text{tally} = (\# \text{ of tracks}) \times (\text{weight})
\]

For large number of events, the results of biasing and non-biasing simulations should be almost identical to each other.
No Biasing (1 event)

Biasing (1 event)

Assigned weights: 1 ½ ¼ ... \( \cdots \frac{1}{2^{17}} \)

Neutron, 100 MeV
Concrete Cylinder (18 cells)
Example: Energy deposited per cell
(1500 events / method)
Area of Need: Visual Comparison Tool

Event Biasing ToolKit used for development, debugging, validation, and users.

Extended Functionality

Plan for next 3 weeks :)
Conclusion

• Event biasing techniques are used to achieve better efficiency in simulating rare events.
• In Geant4, event biasing options exist but need validation & comparison tools.
• In my remaining weeks, I will develop a generic toolkit for developers and users.