Comparison of GENIE and NuWro models for neutrino-Ar interaction.

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Introduction

• GENIE is the model we use as prediction.

• NuWro is fake data we assumed. It describes the true universe of neutrino interaction in Argon.

• The GENIE model does not describe the true universe (NuWro, measurement), and will tune its parameters to match the true universe.

-Difference between model and measurement is visible.
-We want to search a case in which they are in a level of agreement.
Introduction

The purpose:
- To tune Genie and make sure that Genie and NuWro match well for Ar
- To apply the two model comparison for CH target.

“tuned” GENIE model
• There are 68 parameters in GENIE which we should vary to make model match the measurement.

• We first tried scanning of 6 parameters that demanded a lot of time. We changed a sampling method of all 68 parameters to MCMC effectively.
MCMC sampling method

- MCMC sampling method can reduce computing time a lot, and provides a finer result than scanning by hand.

- With MCMC, we can find the most preferred values of parameters statistically.

- The following is a trial with 10 parameters to see if it works well.

Graph of grid scanning of only 6 parameters. (This is not an example of the best fitted case.)

Motivate alternative method for 68 parameters.
The MCMC method provides the preferred values of 10 parameters. We can obtain a two-model difference graph with the selected values.
MCMC sampling method
-10 parameters

- The result with preferred values of 10 parameters

- The method was working well, so we moved to next step by extending the number of parameters to 68.
MCMC sampling method
-68 parameters

-This is the result of using all 68 parameters.

- The same values of parameters selected in the fitted GENIE (Ar) are adopted for the model comparison in CH case.
MCMC sampling method - apply to CH

• NuWro-GENIE comparison for the neutrino interaction with Ar (left) vs. CH (right), when we apply the results of Ar fitting. → Even though tuned the GENIE model matches well with nu-Ar interaction, the validity is not guaranteed to nu-CH interaction.
MCMC sampling method
-apply to CH

• Conclusion
-It would be difficult to tune GENIE model to match NuWro in Ar case.
back up
MCMC sampling method

- Metropolis–Hastings algorithm
  - Obtaining a random value generated and the probability is obtained with Gaussian approximation in each bin. At each iteration, it picks a candidate for the next sample value based on the current sample value. Then, with some probability, the candidate is either accepted (in which case the candidate value is used in the next iteration) or rejected.

For each iteration $t$:

- **Generate**: Generate a candidate $x'$ for the next sample by picking from the distribution $g(x'|x_t)$.

- **Calculate**: Calculate the acceptance ratio $\alpha = f(x')/f(x_t)$, which will be used to decide whether to accept or reject the candidate. Because $f$ is proportional to the density of $P$, we have that $\alpha = f(x')/f(x_t) = P(x')/P(x_t)$.

- **Accept or Reject**:
  - Generate a uniform random number $u$ on $[0,1]$.
  - If $u \leq \alpha$ accept the candidate by setting $x_{t+1} = x'$.
  - If $u > \alpha$ reject the candidate and set $x_{t+1} = x_t$, instead.

- This algorithm proceeds by randomly attempting to move about the sample space, sometimes accepting the moves and sometimes remaining in place.