Automated Weight Windows for Global MC Transport Calculations

Abstract

- Method provides flux solution over entire system (not just at detectors)
- Uses weight window
  - Distributes MC particles uniformly throughout system
    - All subregions are adequately sampled
    - Particle weights are controlled, even far from the source.
  - Constructed from forward transport solution
    - More appropriate for global problems.
    - Does not use adjoint.
  - Can be used with Eddington factors from deterministic solutions to update weight windows for MC.

Introduction

- Previous methodology for VR was applied to local flux solutions with detectors.
- Problems with global flux solution
  - Only have survival biasing as a form of VR
    - Large statistical errors occur away from source regions.
    - long run times
- New method
  - Is general, can be applied to neutrons, photons, charged-particles
  - Especially adept for neutrons with deep penetration (where flux varies by OOM)
    - Classically done with survival biasing and weights, but ends up with large variances.
  - Utilizes forward transport problem generated weight window
    - Not adjoint.
    - Distributes the MC particles uniformly throughout the system.
    - Improves the point wise FOM.
    - Generated with diffusion solution
      - Diffusion is faster than other deterministic methods
      - MC is slow, and errors in MC can bias weights away from interesting areas.
      - Not Sn or PN, as accuracy is not required to generate WWs, they are expensive, and Sn are susceptible to ray effects.
  - Quasi-diffusion method
    - Used to improve accuracy of initial diffusion WW.
      - MC process can be used to obtain estimates of Eddington factors¿ can be used in quasi-diffusion method to improve flux estimates¿ improves WW.
    - Better accuracy than traditional diffusion, but faster than Sn or Pn.

- Two types of Weight Windows
  - Isotropic
    - Computed only from scalar fluxes
    - Russian Roulette and splitting performed independently of particle direction and flight
  - Angular
    - Employs scatter fluxes and currents
    - Russian Roulette and splitting performed based of particle direction and flight
    - Implemented in MCNP using AVATAR method.