NPRE 397: Independent Study

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May 13 – August 16

Functional expansion tallies (FETs) are a high-order technique for tallying reaction rates in Monte Carlo solvers. By expanding the tally of interest (e.g., fission power deposition) in orthogonal polynomials, spatially-varying solutions can often be captured with fewer tallies, resulting in runtime savings. FETs are particularly attractive for multiphysics simulation, where data is passed between two different solvers (e.g., a Monte Carlo solver sends a power distribution to a heat conduction solver, which then passes a temperature field back to the Monte Carlo solver to update cross sections). By only passing a few degrees of freedom (DOFs) representing the coefficients in the polynomial sum, data communication costs can potentially be drastically reduced, improving runtime. However, one major shortcoming of existing FET implementations is restrictions to a limited set of polynomials (Legendre, Zernike, spherical harmonics) that are only orthogonal on the unit line, disc, and sphere, respectively. This geometric limitation thereby limits FETs to simple geometries. This project aims to greatly improve the geometric fidelity of FETs by adopting polygonal orthogonal functions in OpenMC.

**Deliverables:**

* Determine whether polygonal orthogonal functions which map from polygons to the unit disc (Zernike) can be used for expanding general functions of space.
* If the above is possible, implement these polygon functions in OpenMC for tallying and study the convergence properties of these polynomials.

**Stretch Goals:**

* Publication of research findings in a nuclear engineering conference, such as M&C (Denver, April 2025), the ANS student conf. (April, 2025), or the ANS annual conf. (Chicago, June 2025)

**Other info:**

* This position is in addition to a paid, 8-hour/week summer research position.
* Research credit will be provided for the fall 2024 semester for all hours in excess of the 8 hours/week for paid effort. The student shall record the hours/week worked, which shall be converted to research credit using the formula: (total hours worked) / 3 / 15, rounding to the nearest integer.