Introduction to MOOSE

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Introduction

- Multiphysics Object Oriented Simulation Environment
- Knowledge you need:
  - Finite Element Method.
  - C++ (OOP) :(
- Resources:
  1. mooseframework.inl.gov
  2. Google users group

Finite Element Method

- First, the PDE is formulated in an integral form, by multiplying by a test function and then integrating.
- Partition your computational domain into small non-overlapping subdomains (finite elements).
- The solution is approximated by a weighted sum of piece-wise functions.

$$\phi(r) \approx \sum_{i=1}^{N} c_i f_i(r)$$

- Get a system of nonlinear equations, where the coefficients c_i are the unknowns.

Examples of shape function $\rightarrow$ *here*

Model problem: Neutron Diffusion Equation

$$\boxed{-\nabla.D\nabla\phi + \Sigma_a\phi = S}$$

- multiply be test function u and integrate over the problem domain

$$\overbrace{-\int_\Omega u(\nabla.D\nabla\phi)}^{①} + \int_\Omega u\Sigma_a\phi - \int_\Omega uS = 0$$

$$① \rightarrow -\int_\Omega u\nabla.D\nabla\phi = -\int_\Omega \nabla.(uD\nabla\phi) + \int_\Omega \nabla u.D\nabla\phi$$

- apply divergence theorem :

$$\int_\Omega \nabla.(uD\nabla\phi) = \int_{d\Omega} uD\nabla\phi.n$$

Model problem: Neutron Diffusion Equation

$$\overbrace{\int_\Omega \nabla u . D \nabla \phi}^{diffusion\ \ kernel} d\Omega - \cancelto{0}{\int_{d\Omega} u . D \nabla \phi . n d\Omega} + \overbrace{\int_\Omega u \Sigma_a \phi d\Omega}^{absorption\ \ kernel} - \overbrace{\int_\Omega u S d\Omega}^{source\ \ kernel} = 0$$

- these kernels are what you input to MOOSE.

MOOSE input

1. Mesh

   Built-in mesh generation for lines, rectangles, and rectangular (more on mesh)
2. Variables

   Define the variable to solve for, the order and type of the shape function.
3. Kernels

   Different terms of the weak form derived above.
4. Boundary Conditions

   Dirichlet, Neumann, custom boundary conditions boundary name.
5. Executioner

   Steady, transient, ...
6. Post Processing (optional)

Build your own application

1. ./moose/scripts/stork.sh "your application name"
2. create your application (source and include files)
3. make -j n
4. ./yourApplication-opt -i your-input-file.i

$\boxed{\textit{OR}}$

using peacock:

peacock -i your-input-file.i

Spectral Method Solution