Final C++ and FEM Project

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Mehdi

IOWA STATE UNIVERSITY

SSHT

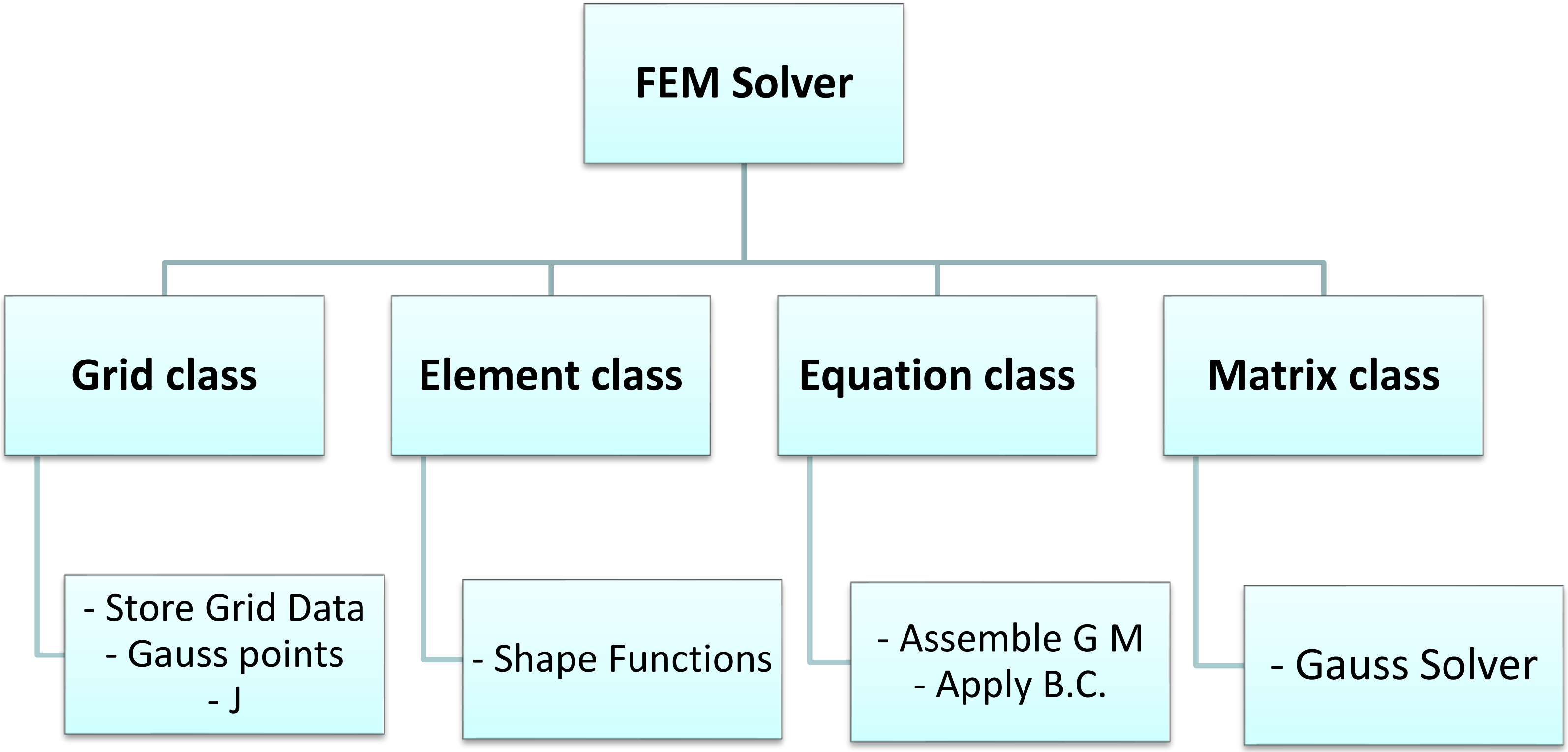
Heat Transfer Equation (1D):

$$\nabla^2 u = -\pi^2 \sin(\pi x)$$
$$u = 0; \qquad on\ \partial x$$

Galerkin Form:

$$\int [N_{i_{,x}} N_{j_{,x}}] u_i dx = \int N_i f dx$$

Implementation of SSHT



Implementation of SSHT

Calculating Local Stiffness Matrices:

```
for (int elem_ID = 0; elem_ID < p_grid.elem_num; elem_ID++) {
   for (int k = 0; k < p_grid.gauss_pts; k++) {

      double detJxW = p_grid.detJxW(elem_ID);
      double force = -1 * M_PI * M_PI * sin(M_PI * p_grid.x_gs_pts[elem_ID][k]);

      for (int i = 0; i <= 1; i++) {
            for (int j = 0; j <= 1; j++) {

                  e.Ae[i][j] += (-1) * fe.dN(i, elem_ID) * fe.dN(j, elem_ID) * detJxW;
            }
         e.be[i] += fe.N(i, k) * force * detJxW;
      }
   }
```

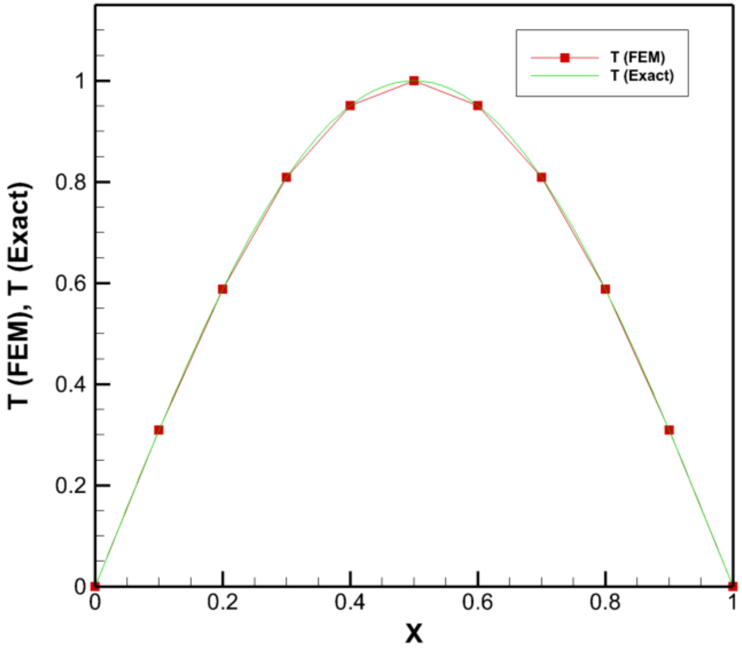
Implementation of SSHT

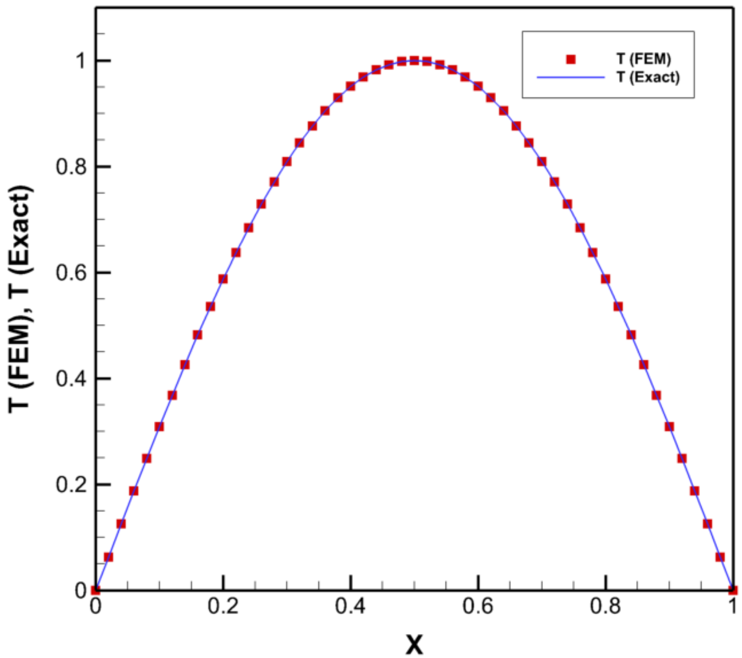
Assembling Global Stiffness Matrix:

```
void equation::assemble(Matrix &A, Matrix &b, grid &g, element &e ) {

    for (int i = 0; i < e.nbf; i++){
      for (int j = 0; j < e.nbf; j++){
        A.mat[g.conn[elem_ID][i]][g.conn[elem_ID][j]] += Ae[i][j];
        Ae[i][j] = 0;
      }
      b.vec[g.conn[elem_ID][i]] += be[i];
     be[i] = 0;
    }
}
```

Results

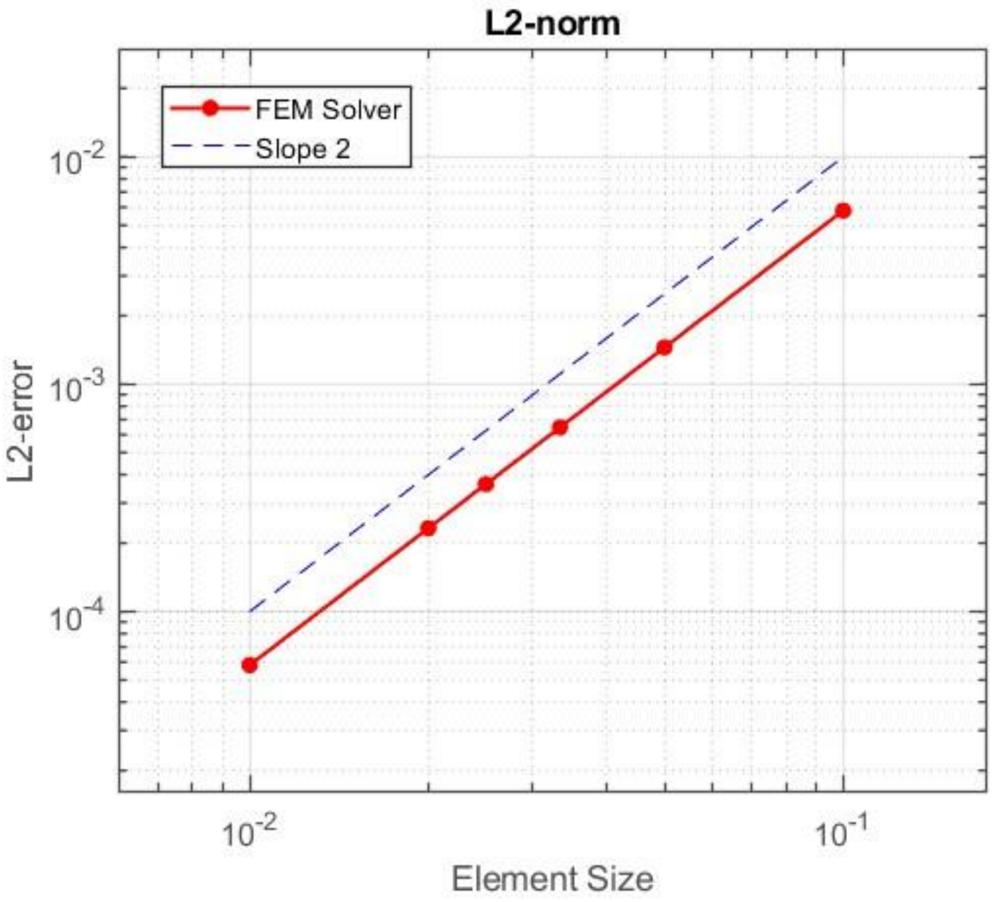




No. of Elements = 10

No. of Elements = 50

Convergence study of SSHT



Element Size = [0.1, 0.05. 0.033, 0.025, 0.02, 0.01]