PETSc

A brief tutorial

Praveen Chandrashekar

PETSc resources

- http://www.petsc.org
- Manual pages
- Notes by Matt Knepley
- Book by Ed Bueler: PETSc for Partial Differential Equations: Numerical Solutions in C and Python
  Codes from the book: https://github.com/bueler/p4pdes
- PETSc has many examples: see
  http://cpraveen.github.io/teaching/petsc.html
  and
  https://petsc.org/release/tutorials/guide_to_examples

parallel/petsc/hello.c

```
make hello
./hello -help intro
./hello -help
./hello
mpirun -n 4 ./hello
mpiexec -n 4 ./hello
```

Variable types

- PetscInt: usually 32-bit integer, can be configured for 64-bit integer which is needed for large meshes
- PetscErrorCode: integer return type from Petsc functions
- PetscMPIInt: use this to pass to MPI functions, e.g., to get rank, size, etc.
- PetscReal: usually real double
- PetscScalar: usually real double, can be complex number also. It is used for the scalar field in a vector space and for entries of vectors and matrices.

Printing

- `PetscPrintf`: similar to printf in C
- `PetscPrintf(PETSC_COMM_WORLD, …)`
  prints only on rank=0 process
- `PetscPrintf(PETSC_COMM_SELF, …)`
  prints on every rank

p4pdes/c/ch1/e.c

- Compute the value of e in parallel
  $$e = \sum_{n=0}^{\infty} \frac{1}{n!}$$
- Each rank computes one term in the sum
- If total ranks = r, we compute
  $$e \approx \sum_{n=0}^{r-1} \frac{1}{n!} = 1 + 1 + \frac{1}{2!} + \ldots + \frac{1}{(r-1)!}$$
- rank = n computes $\dfrac{1}{n!}$
- Accuracy increases as number of ranks increase

Creating DMDA

- DMDACreate1D
- DMDACreate2D
- DMDACreate3D
- DMBoundaryType
- DMDAStencilType

DMDA info

- DMDAGetInfo: get full mesh sizes
- DMDAGetCorners: get range of locally owned grid
- DMDAGetGhostCorners: get range of local grid including ghost points
- All of above info can be obtained together using: DMDALocalInfo and DMDAGetLocalInfo

Vectors

- Global vector: distributed vector without ghost values
- Local vector: has ghost values
- DMCreateGlobalVector and DMGetGlobalVector
- DMCreateLocalVector and DMGetLocalVector
- VecSetValues
- VecAssemblyBegin and VecAssemblyEnd

cfdlab/petsc

- convect1d
- burger1d
- convect2d
- euler2d/ssprk.c
- euler2d/ts.c
- euler2d/fdweno.c