PETSc

A brief tutorial

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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

parallel/petsc/hello.c

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

Variable types

- <u>PetscInt</u>: usually 32-bit integer, can be configured for 64-bit integer which is needed for large meshes

- <u>PetscErrorCode</u>: integer return type from Petsc functions

- <u>PetscMPIInt</u>: use this to pass to MPI functions, e.g., to get rank, size, etc.

- <u>PetscReal</u>: usually real double

- <u>PetscScalar</u>: usually real double, can be complex double 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

Arrays from Vectors

- Useful for working with Cartesian/structured grids

- VecGetArray and VecRestoreArray

- VecGetArrayRead and VecRestoreArrayRead

- VecPlaceArray

- DMDAVecGetArrayDOF and DMDAVecRestoreArrayDOF

- DMDAVecGetArrayDOFRead and DMDAVecRestoreArrayDOFRead

cfdlab/petsc

- convect1d

- burger1d

- convect2d

- euler2d/ssprk.c

- euler2d/ts.c

- euler2d/fdweno.c

BVP: Tutorial examples

- ex2: 2-D Poisson equation
  https://petsc.org/release/src/ksp/ksp/tutorials/ex2.c.html

- ex46: 2-D Poisson equation, using DM
  https://petsc.org/release/src/ksp/ksp/tutorials/ex46.c.html