Introduction to SU² Code Structure

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• Why Object Oriented?
  
  – Easy to add new capabilities
  
  – Easy to leverage a lot of existing capabilities.
SU² Modules

- **SU2_CFD** – The main PDE solution module
- **SU2_DDC** – The Domain Decomposition Code
- **SU2_MAC** – The Mesh Adaptation Code
- **SU2_MDC** – The Mesh Deformation Code
- **SU2_PBC** – The Periodic Boundary Condition Code
- **SU2_SMC** – The Sliding Mesh Code
SU2_CFD Module

1a) Read Input
   Class: CConfig
   • Read the config file

1b) Read Mesh
   Class: CGeometry
   • Read the mesh file
   • Set up multigrid meshes

2) Solve Equations
   Pick Solver
   Class: CSolution
   • Euler Equations: CEulerSolution
   • Plasma Equations: CPlasmaSolution
   • Adjoint Equations: CEulerAdjSolution
   • And others...

3) Write Output
   Class: COutput
   • Print on screen
   • Write solution file
   • Write restart file
   • Write history file

Store Flow Variables
   Class: CVariable
   • Stores variables at every mesh node.
   • Declare & store all flow variables
     • CEulerVariable: Density, energy etc.
     • CNSVariable: + Viscosity
     • CAdjVariable: Adjoint variables
     • And others...

Discretization
   Class: CNumerics
   Spatial Discretization
   • Convective Flux, Jacobian
     ▪ CNumerics:: Roe/JST/etc.
   • Viscous Flux, Jacobian
     ▪ CNumerics:: Avg_Grad/etc.
   • Source Terms, Jacobian
     ▪ CNumerics:: PieceWiseConst.
   Temporal Discretization
   • Explicit Euler/ Runge-Kutta
   • Implicit Time Integration

Solve Linear System
   Class: CSparseMatrix
   • BiCSTAB
   • GMRES
   • LU-SGS
   • Preconditioners
     ▪ Linelet
     ▪ Jacobi
   • Update solution vector
CGeometry Class

Files in Common/include:
- geometry_structure.hpp
- geometry_structure.inl

In Common/src
- geometry_structure.cpp
CSolution Class

Files in SU2_CFD/include:
- solution_structure.hpp
- solution_structure.inl

In SU2_CFD/src:
- solution_direct_mean.cpp
- solution_adjoint_mean.cpp
- solution_direct_plasma.cpp
- solution_direct_template.cpp
- etc.

Parent Class: CSolution

- CEulerSolution
- CTurbSolution
- CPlasmaSolution
- CWaveSolution
- CLevelSetSolution
- CAdjEulerSolution
- CAdjTurbSolution
- CAdjPlasmaSolution
- CAdjLevelSetSolution
- CNSSolution
- CTurbSASolution
- CTurbSSTSolution
- CTemplateSolution
- New Turbulence Model
- CAdjNSSolution

1) Read Input
   - Class: CConfig
     - Read the config file
     - File: config_structure.cpp

2) Solve Equations
   - Class: CMultGridIntegration
     - Use multigrid method
   - CSolution
     - Euler Equations: CEulerSolution
     - Plasma Equations: CPlasmaSolution
     - Turbulence Models: CTurbSolution
     - And others...

3) Write Output
   - Class: COutput
     - Print on screen
     - Write solution file
     - Write restart file
     - Write history file
     - File: output_structure.cpp

Store Flow Variables
- CVariable
  - Declare & store all flow variables
    - CVariable: Density, energy etc.
    - CVariable: Viscosity
    - CVariable: Eddy viscosity
    - And others...

Discretization
- CNumerics
  - Convective Flux, Jacobian
    - CNumerics: Roe/BT/etal.
    - Viscous Flux, Jacobian
    - CNumerics: Diffusion
    - Source Terms, Jacobian
    - CNumerics: PieceWiseConst.
    - Temporal Discretization
      - Explicit Euler/Runge-Kutta
      - Implicit Time integration

Solve Linear System
- CSparseMatrix
  - CGAES
  - LU-SGS
  - Preconditioners
    - Ulinelet
    - Jacobi
  - Update solution vector
CVariable Class

Parent Class: CVariable

- CEulerVariable
- CTurbVariable
- CPlasmaVariable
- CWaveVariable
- CLevelSetVariable
- CAdjEulerVariable
- CAdjTurbVariable
- CAdjPlasmaVariable
- CAdjLevelSetVariable
- CTemplateVariable
- CNSVariable
- CTurbSAVariable
- CTurbSSTVariable
- CAdjNSVariable
- New Turbulence Model

Files in SU2_CFD/include
- variable_structure.hpp
- variable_structure.inl
- variable_direct.cpp
- variable_adjoint.cpp
- variable_template.cpp
- etc.

Files in SU2_CFD/src
- variable_direct.cpp
- variable_adjoint.cpp
- variable_template.cpp
- etc.
# CNumerics Class

## Parent Class: CNumerics

- Roe’s Scheme
- JST Scheme
- AUSM Scheme
- HLLC Scheme
- Steger-Warming Scheme
- Roe-Turkel for low Mach
- Lax-Friedrich Scheme
- Upwinding for Turb Scalar
- Template Convective Terms

- Average Gradient
- Galerkin
- Average Gradient Corrected
- Template Viscous Terms

- Piecewise Constant Source
- Plasma Source
- Gravity Source
- Electrical Source
- Turbulence Source
- Transition Source
- Axisymmetric Source
- Rotational Frame Source
- Free Surface Source
- Template Source Terms
More here...

- **SU² Paper:**
  Stanford University Unstructured (SU2): An open-source integrated computational environment for multiphysics simulation and design. *AIAA 2013-0287*

- **Developers contact:**
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Thank you