Towards a Multi-fidelity Hemodynamic Model Pipeline for the Analysis of Cardiovascular Flow Under Uncertainty
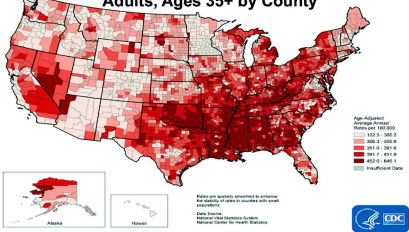
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(1) Sandia National Laboratories, (2) Notre Dame, (3) Stanford University

Heart Disease Death Rates, 2008-2010 Adults, Ages 35+ by County

Age-Adjusted Average Annual Rates per 100,000
- 102.5 – 306.2
- 396.3 – 350.9
- 351.0 – 391.6
- 391.7 – 451.9
- 452.0 – 846.1
- Insufficient Data

Rates are spatially smoothed to enhance the stability of rates in counties with small populations

Data Source
National Vital Statistics System
National Center for Health Statistics

CDC

Center for Disease Control and Prevention, AHA Statistics Report 2014

- ► Cardiovascular disease is the **leading cause of death worldwide**
- ► Hearth disease costs the United States $500 **billion every year**
- ► Need for **numerical simulations**... and **UQ**
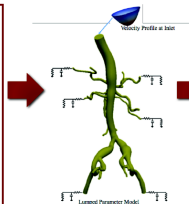- ► A short time-to-solution is crucial

Uncertain Inputs
- Noise in image data
- Clinical data
- Boundary conditions
- Physiologic assumptions
- Material properties

Input parameter uncertainty
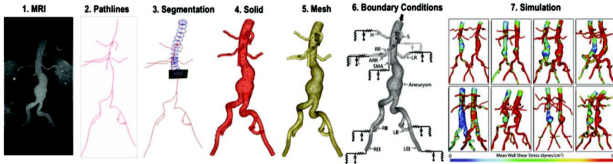
Velocity Profile at Inlet

Lumped Parameter Model

Uncertain Outputs
- Wall shear stress
- Oscillatory shear index
- Cardiac work
- Oxygen delivery
- Pressure levels
- Flow rates
- Residence Time

Output QoI distribution

SimVascular Pipeline

1. MRI
2. Pathlines
3. Segmentation
4. Solid
5. Mesh
6. Boundary Conditions
7. Simulation

SMA
Aneurysm

Mean Wall Shear Stress (dynes/cm²)

In this poster

3D Model   1D Model   0D Model