Data Assimilation for Cardiovascular Modeling with Applications to Optimal Flow Control

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MOTIVATION & INTRODUCTION

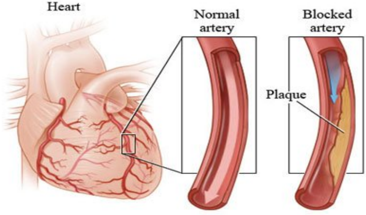

Figure: Normal and blocked artery

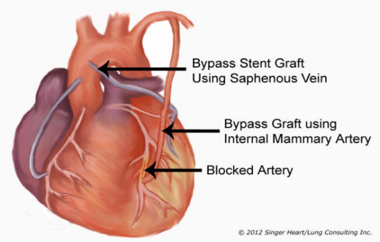

Figure: Bypass grafts

RESEARCH WORK

- Geometry reconstruction and mesh generation from CT scan or MRI.
- Solving the mathematical model,

$$a\left(\boldsymbol{v}\left(\boldsymbol{\mu}\right), \boldsymbol{w}\right) + b\left(\boldsymbol{w}, p\left(\boldsymbol{\mu}\right)\right) = \langle f, \boldsymbol{w} \rangle \ \forall \ \boldsymbol{w} \in H$$

  subject to the constraint,

$$b\left(\boldsymbol{v}\left(\boldsymbol{\mu}\right), q\right) = \langle g, q \rangle \ \forall \ q \in Q$$

  and appropriate boundary conditions, using finite-element and reduced-order methods for velocity ($\boldsymbol{v}\left(\boldsymbol{\mu}\right) \in H$) and pressure ($p\left(\boldsymbol{\mu}\right) \in Q$), of the blood.
- Solving an optimal flow control problem:
  For $\boldsymbol{\mu} \in \mathcal{D} \subset \mathbb{R}$, find $y\left(\boldsymbol{\mu}\right) = \left(\boldsymbol{v}\left(\boldsymbol{\mu}\right), p\left(\boldsymbol{\mu}\right)\right) \in Y_{ad} = H_{ad} \times Q_{ad}$, $u\left(\boldsymbol{\mu}\right) \in U_{ad}$ such that,

$$\mathcal{J}\left(y\left(\boldsymbol{\mu}\right), u\left(\boldsymbol{\mu}\right)\right) \text{ is minimized, subject to } \mathcal{F}\left(y\left(\boldsymbol{\mu}\right), u\left(\boldsymbol{\mu}\right)\right) = 0$$

  using one-shot approach, to address the clinical queries.

THANK YOU!