

Fast sensitivity analysis for cardiovascular models

Alessandro Melis

✉ amelis1@sheffield.ac.uk

Dr. A. Marzo
Prof. R.H. Clayton

The University of Sheffield
Department of Mechanical Engineering

**Workshop on Computationally Efficient Modelling
&
Simulation and its Applications**

Sheffield Teaching Hospitals 
NHS Foundation Trust

INSIGNI
Institute for *in silico* Me

Halifax Hall, Sheffield, UK
12 October 2016

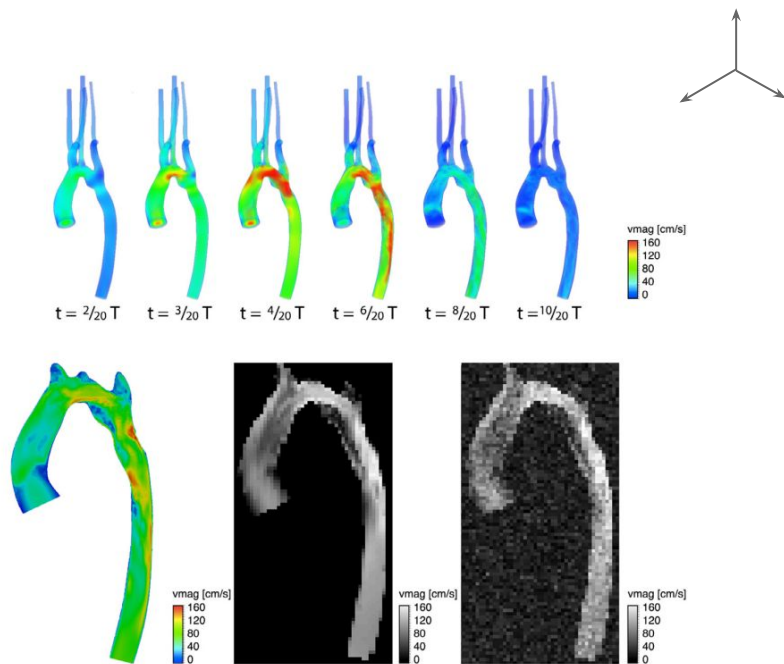


The
University
Of
Sheffield.

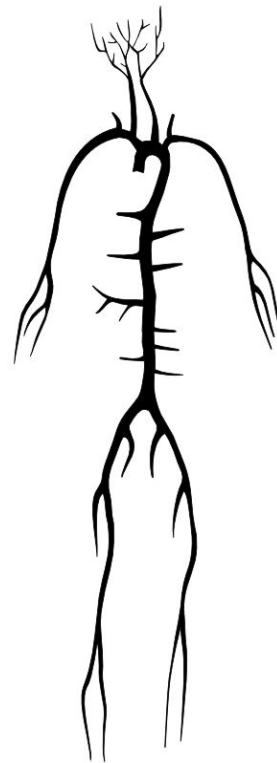
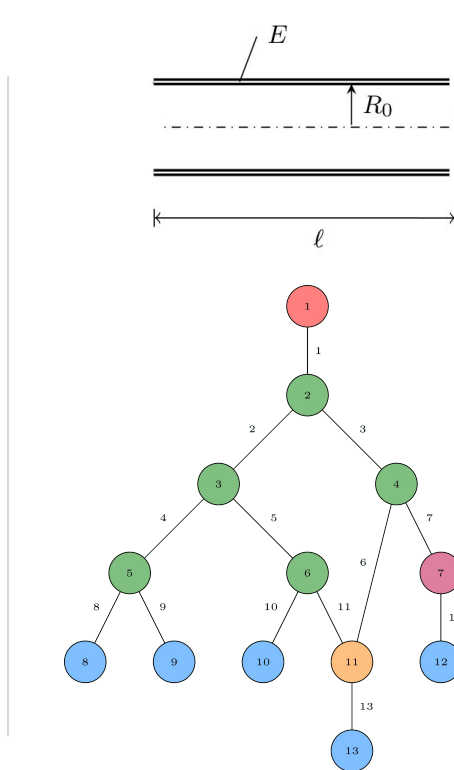
Outline

- Vascular models
- Pulse waveform analysis
- Sensitivity analysis
- The *curse of dimensionality*
- Gaussian process
- Results
- Conclusions

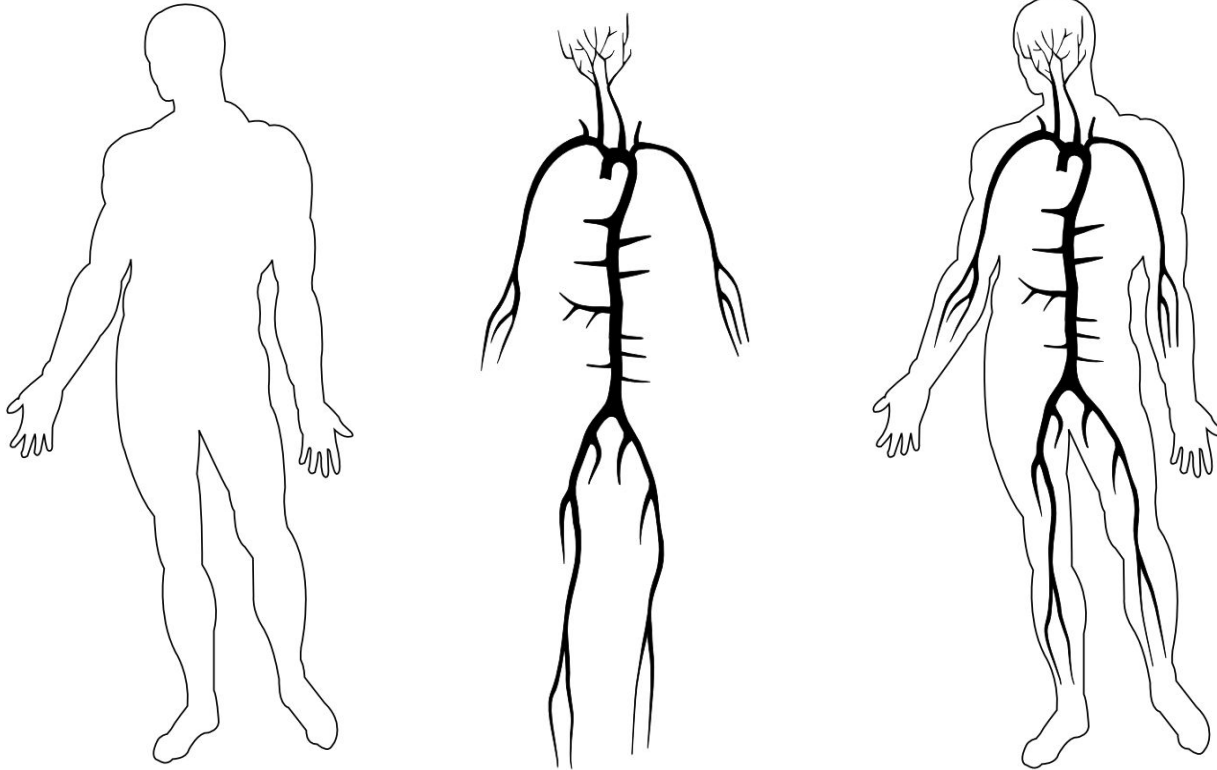
Cardiovascular models



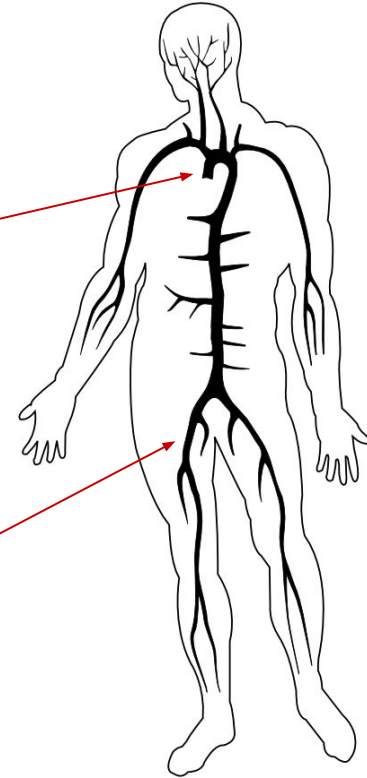
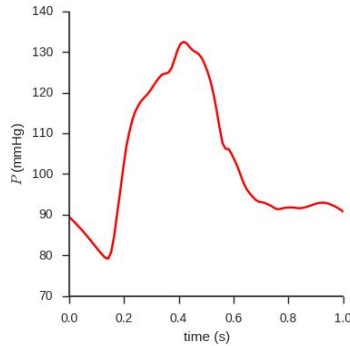
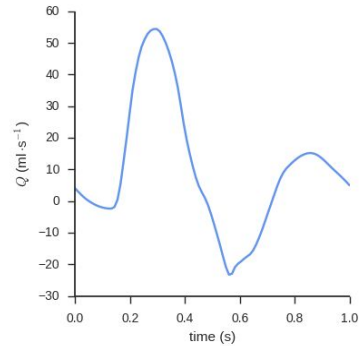
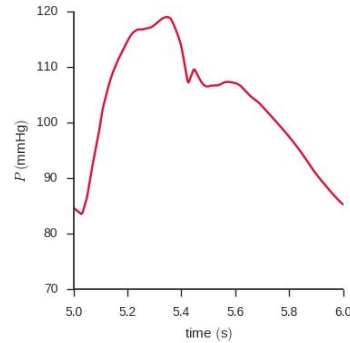
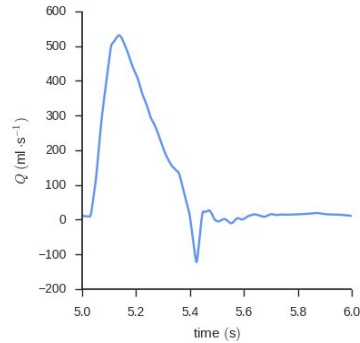
Donati et al. (2015)



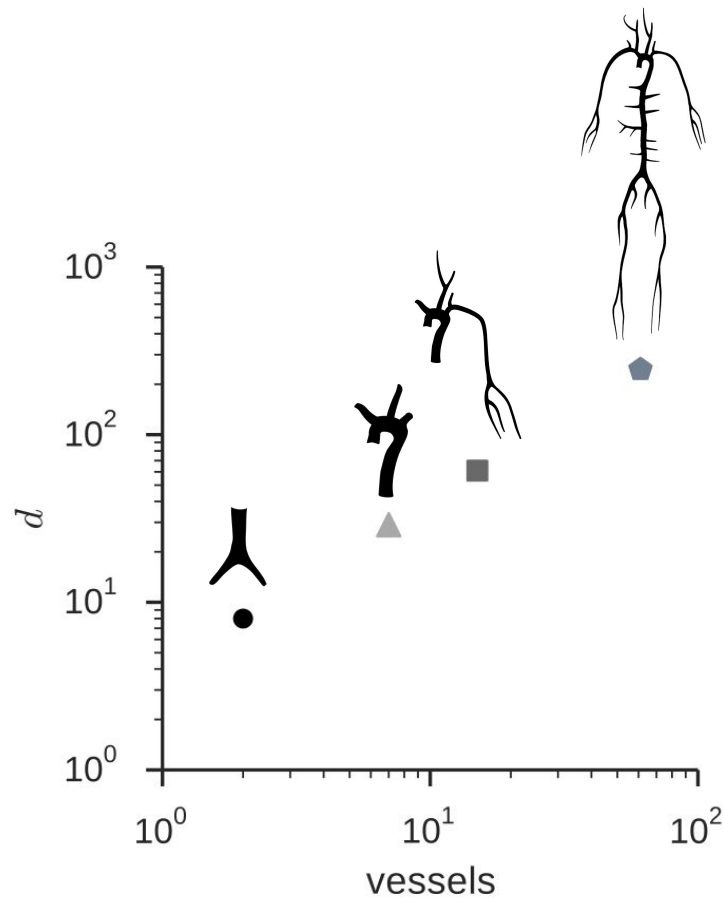
Patient specific model



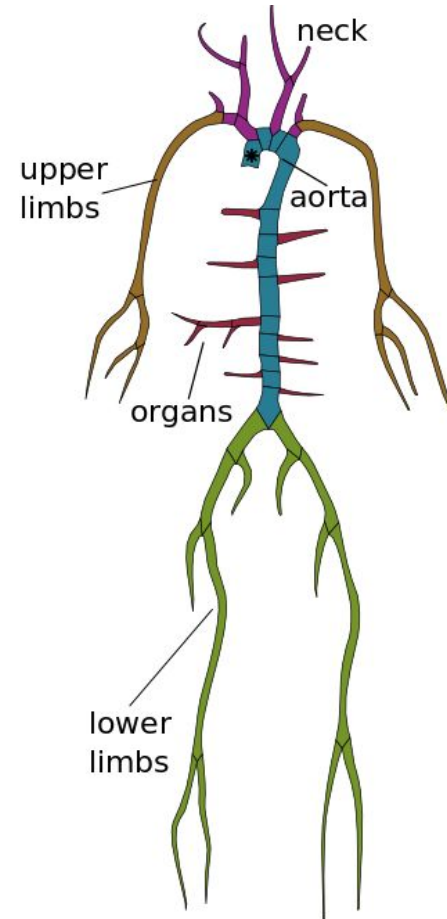
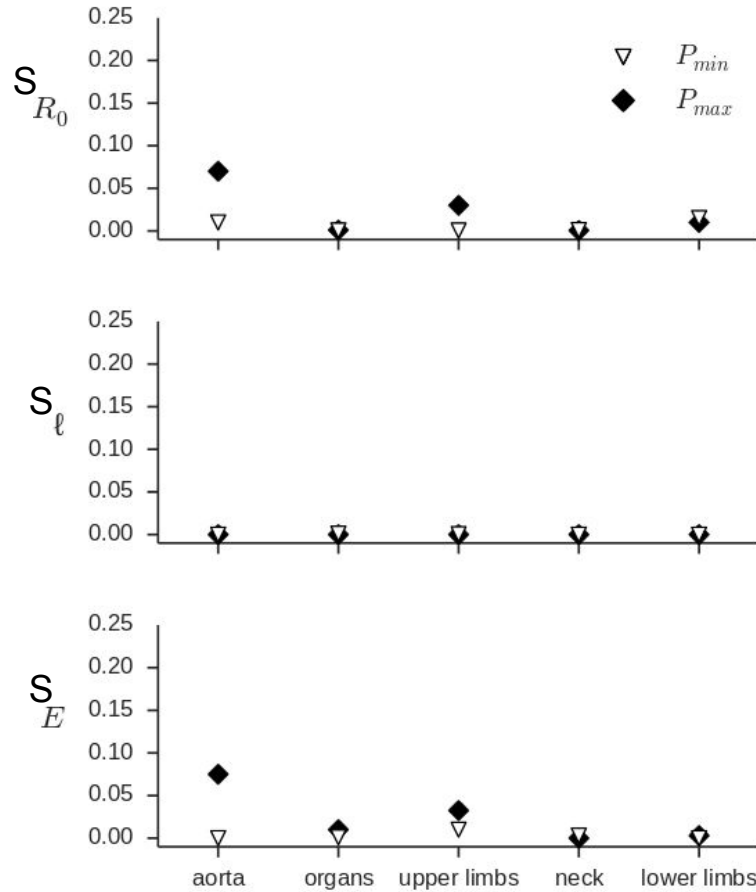
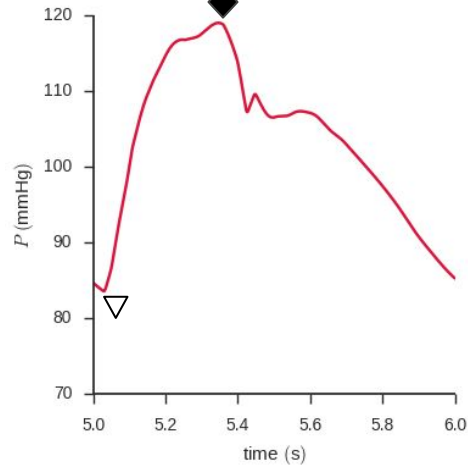
Pulse waveform analysis



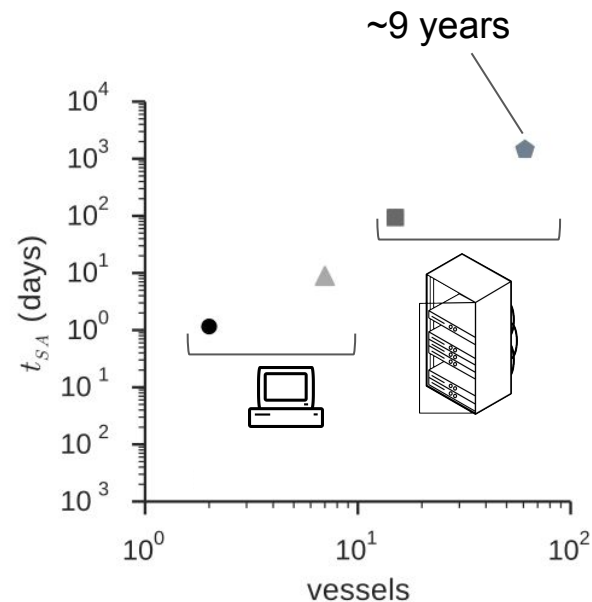
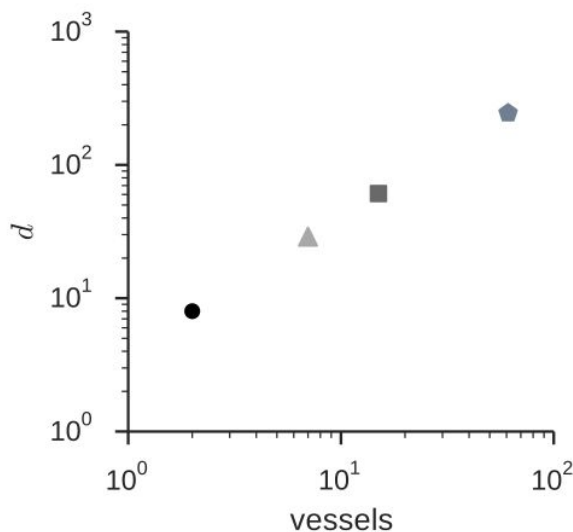
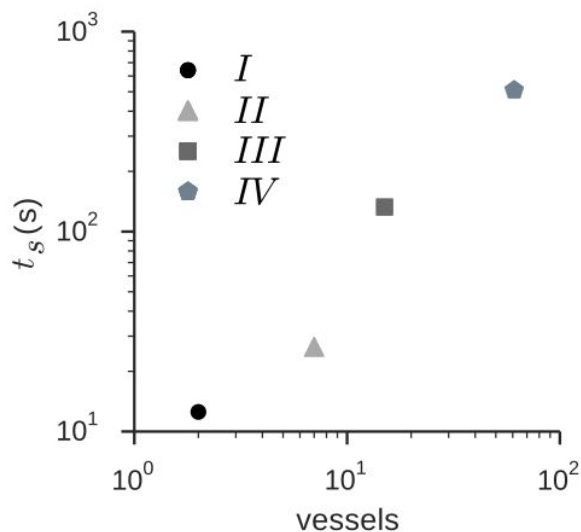
However...



Sensitivity analysis



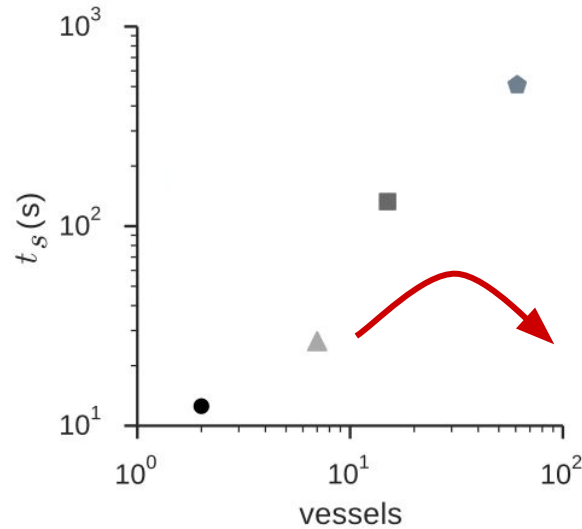
The curse of dimensionality



Number of simulations = $d \times 1000$

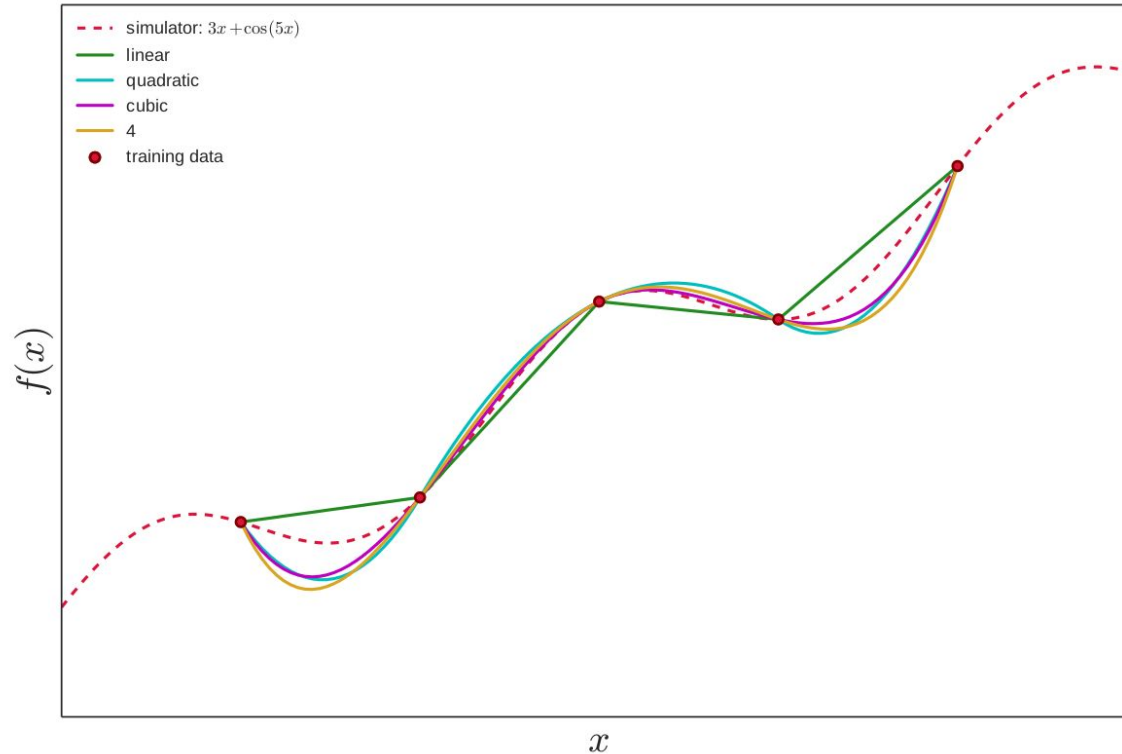
Saltelli (2001)

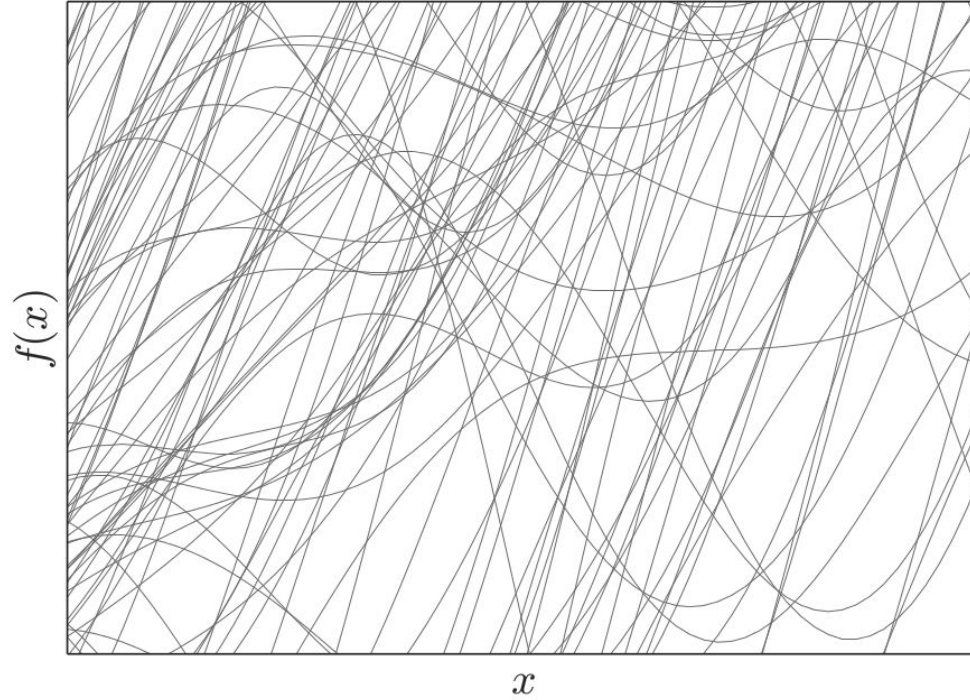
Faster code...

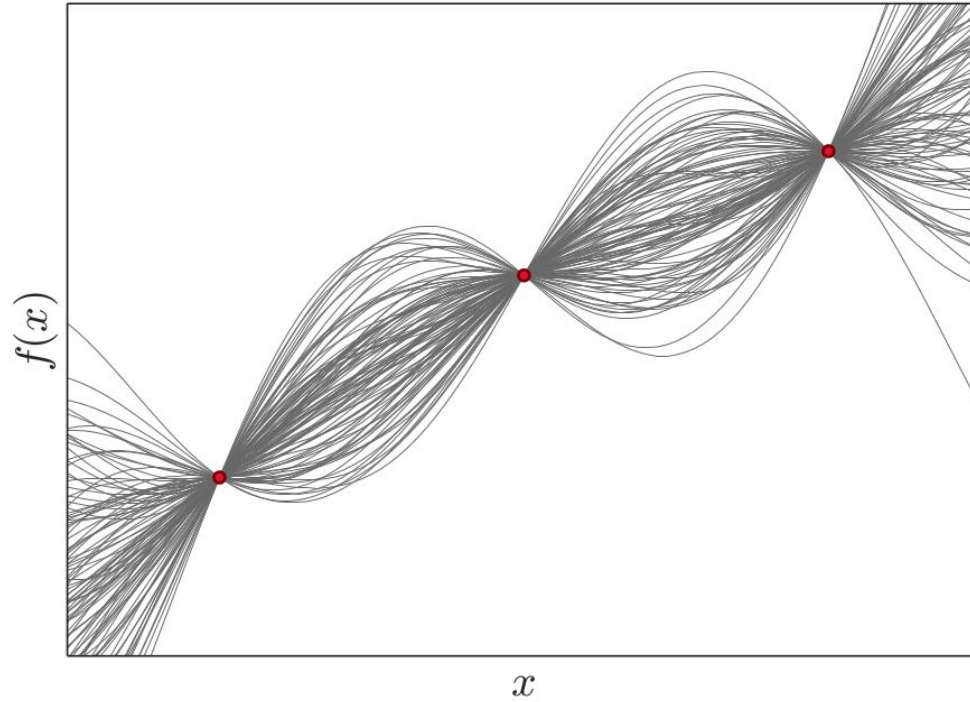


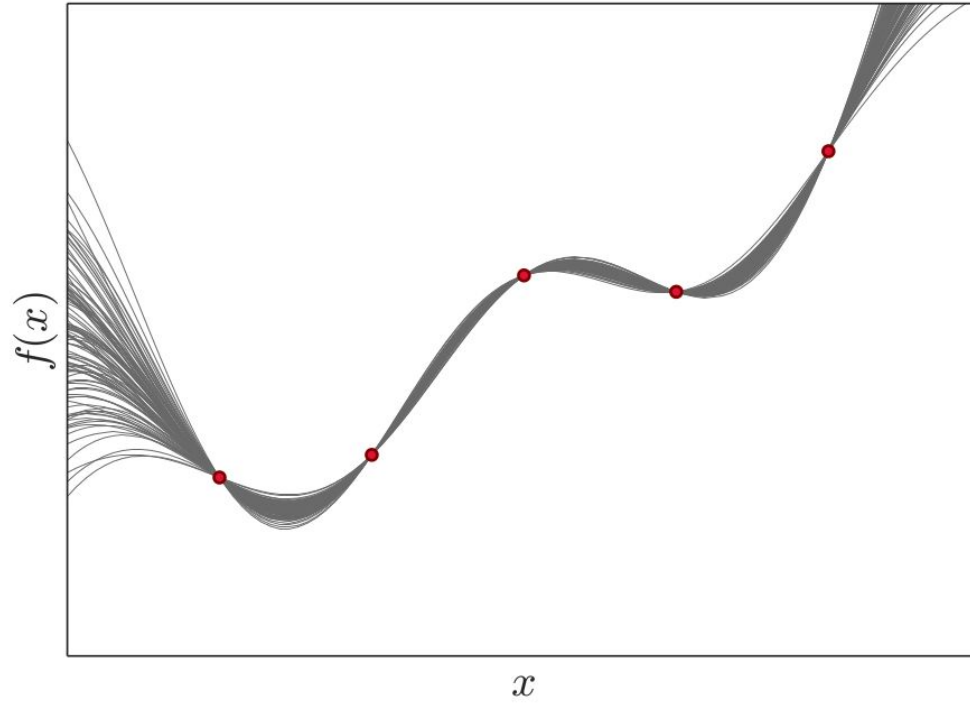
...or fewer
simulations?

Interpolation

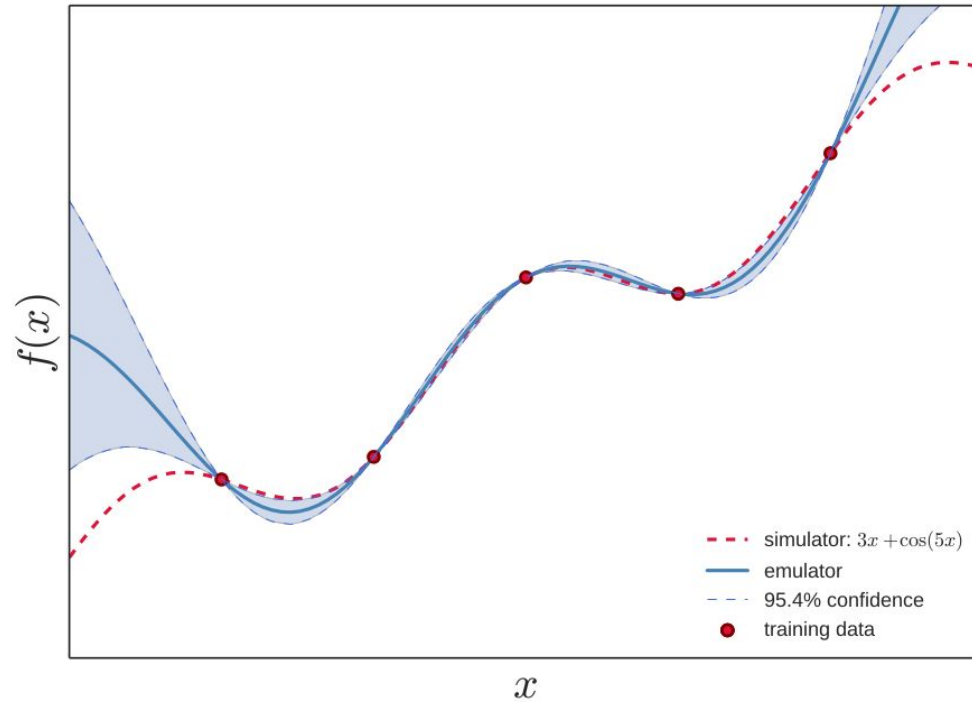




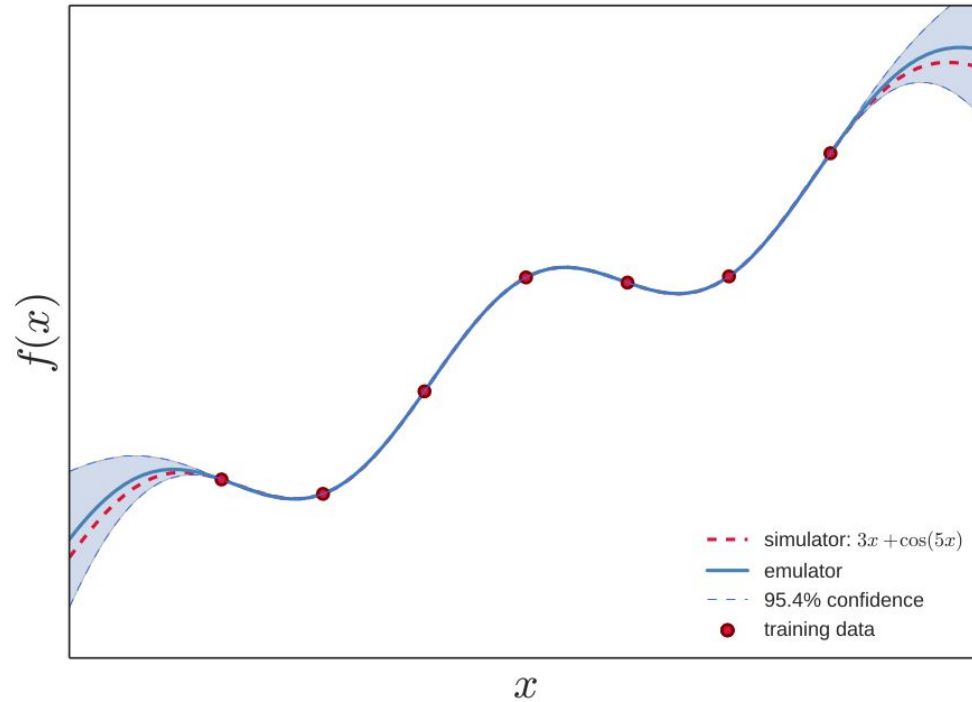




Gaussian process



Gaussian process

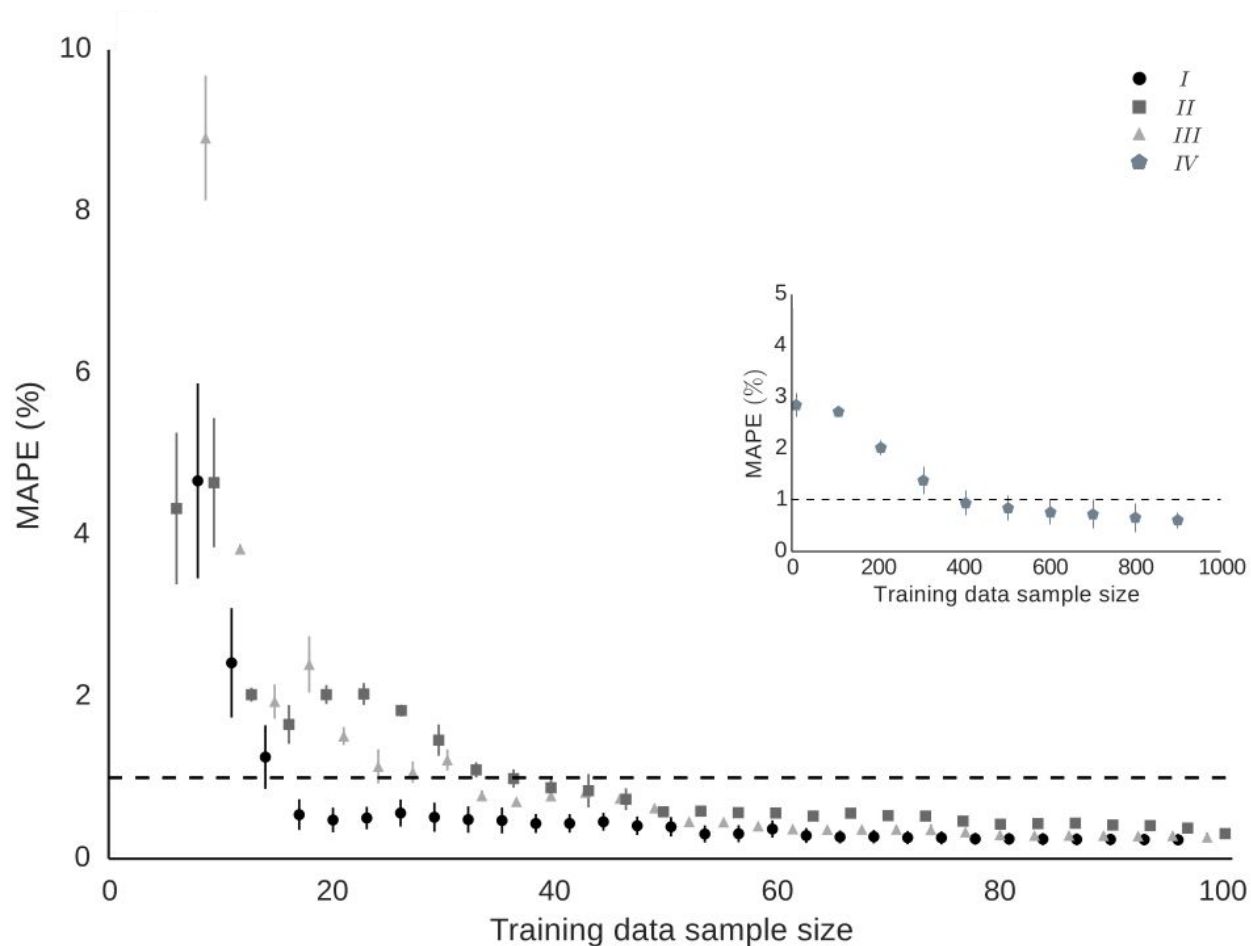


Prediction error

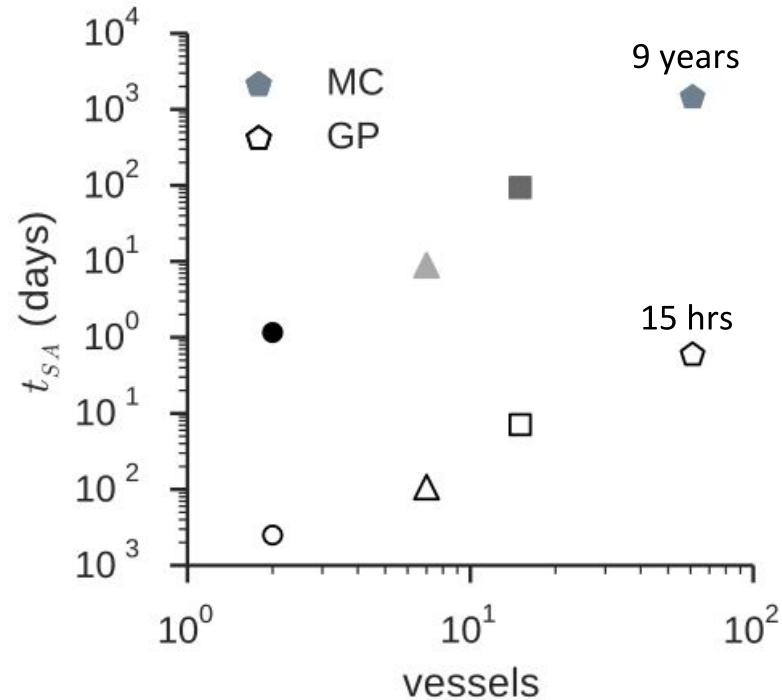
	d	N_{GP}	N_{MC}
I	8	17	8000
II	29	34	29000
III	61	47	61000
IV	245	500	245000



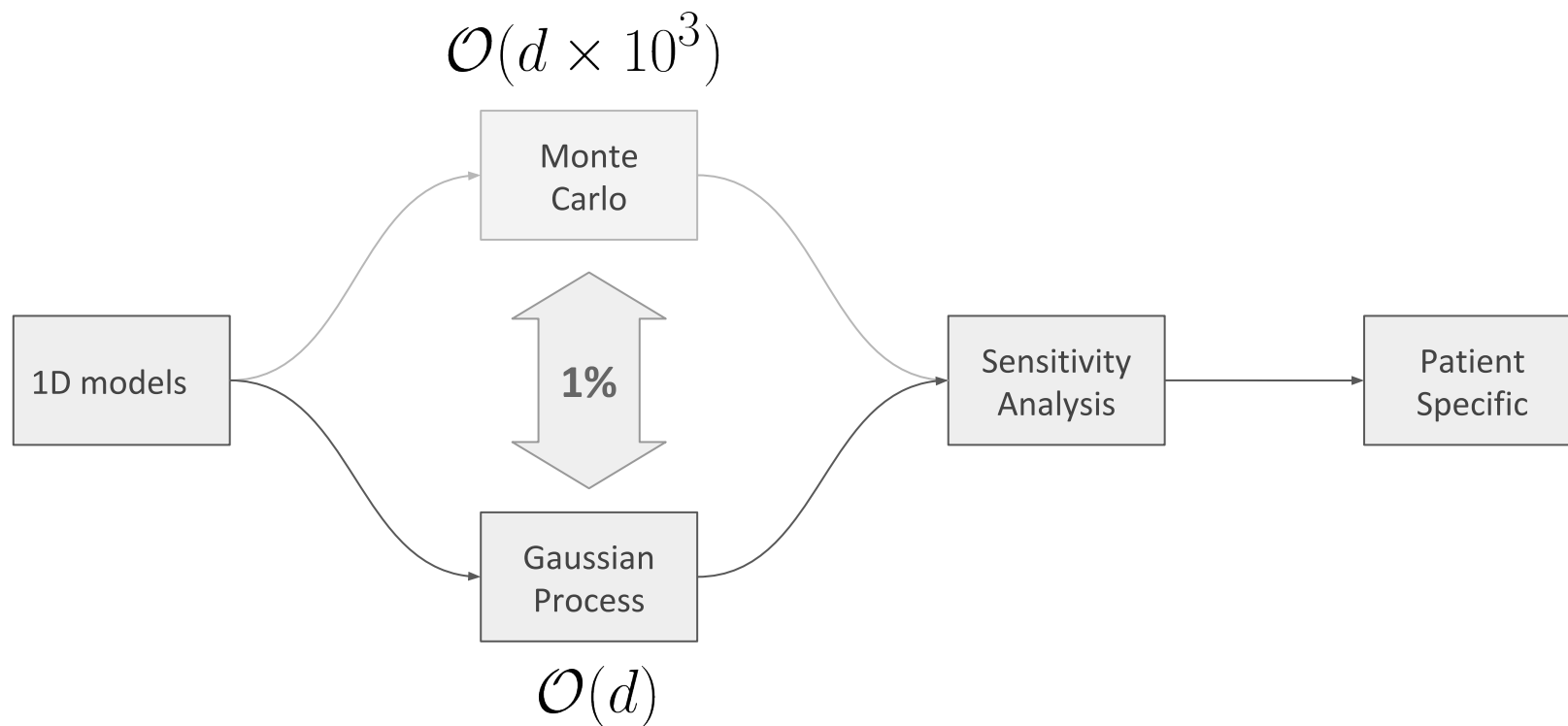
$$\mathcal{O}(d \times 10^3) \rightarrow \mathcal{O}(d)$$



Running time



Conclusions



Thank you

Alessandro Melis

✉ amelis1@sheffield.ac.uk

Dr. A. Marzo
Prof. R.H. Clayton

Sheffield Teaching Hospitals 
NHS Foundation Trust

INSIGNI
Institute for *in silico* Me

The University of Sheffield
Department of Mechanical Engineering

**Workshop on Computationally Efficient Modelling
&
Simulation and its Applications**



The
University
Of
Sheffield.