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PREMIERE

AMCG

Foundational neural networks for urban physics problems with data assimilation, design and control

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Presentation to HP2 6th January 2025

fluidity

ICFERST

PREMIERE, RELIANT, COTRACE, TRACK, PROTECT, COVAIR, TAPAS, RECLAIM

AI-RESPIRE

INHALE

Airflow modelling using AI4PDEs: South Kensington area

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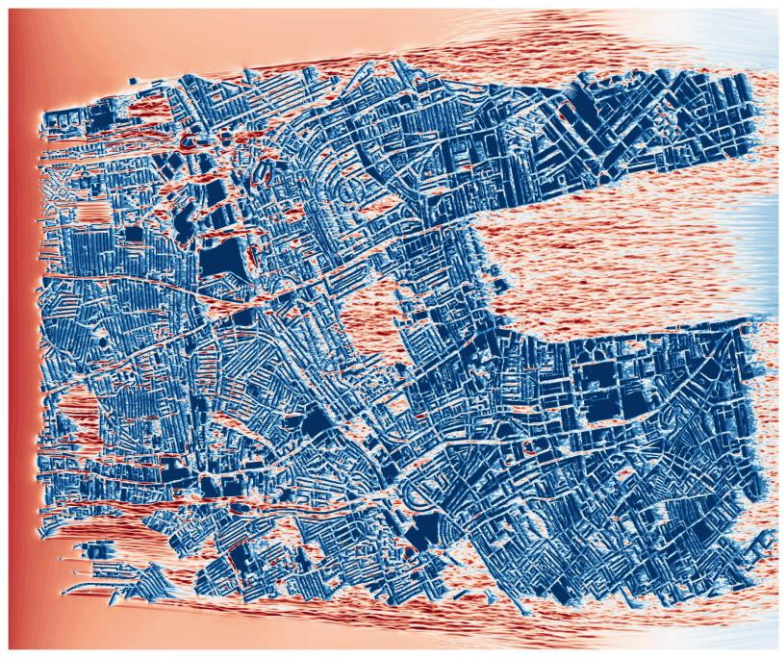
- 3D South Kensington area (5km x 4km)
- One-hour computational time → 5 hours
- Uniform inflow speed (from left to right) – 1 m/s
- 2 Billion nodes London – 4 A100 GPUs

Schematic diagram of the area



Airflow speed (m/s)

2D Flooding modelling using AI4PDEs: shallow water equation

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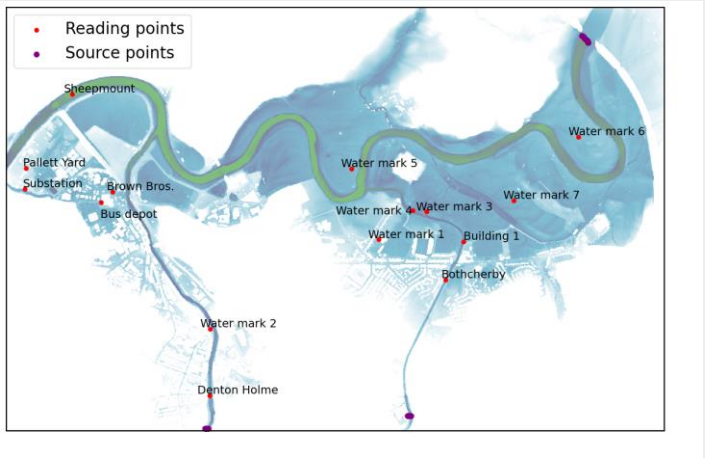
- 2D Carlisle 2005 flooding event
- 68-hour real time simulation
- Three water sources (Eden, Cladew and Petteril)

Google Map

Water depth from 0 to 40 hours

Reading and source points



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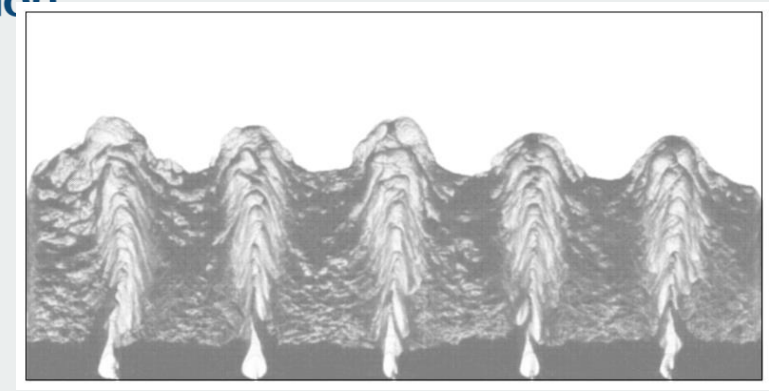
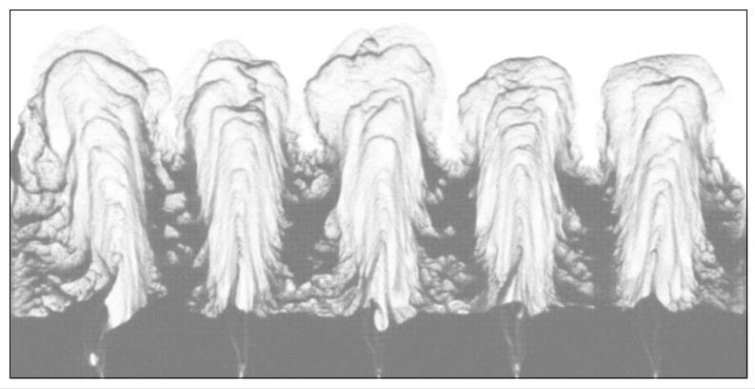
Fluidised bed flow modelling – AI4Sytems (AI4PDEs + DEM)

20M particles in 2D – running on one single GPU

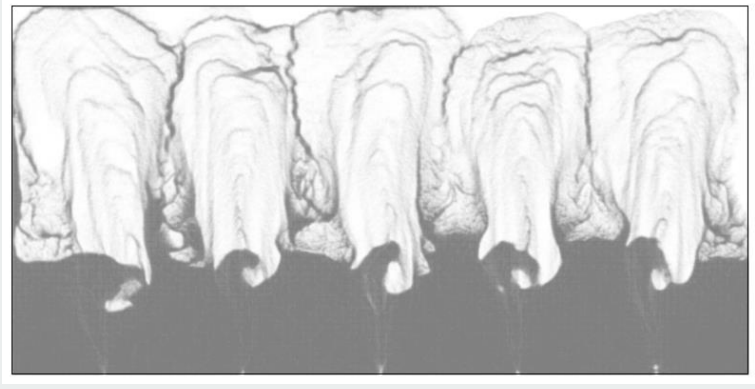
T1



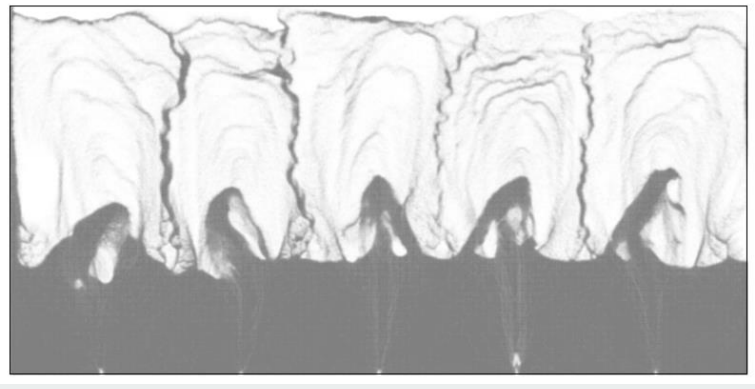
T2



T3



T4



Flow past building – data assimilation

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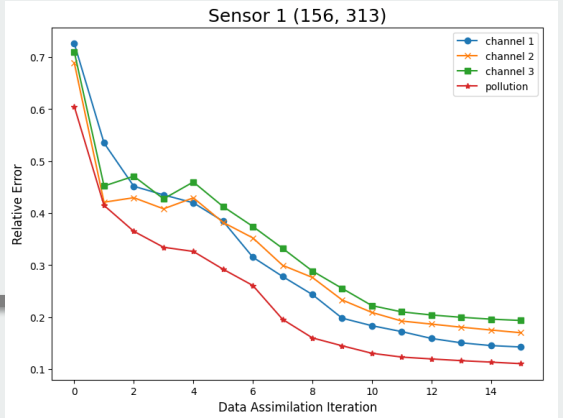
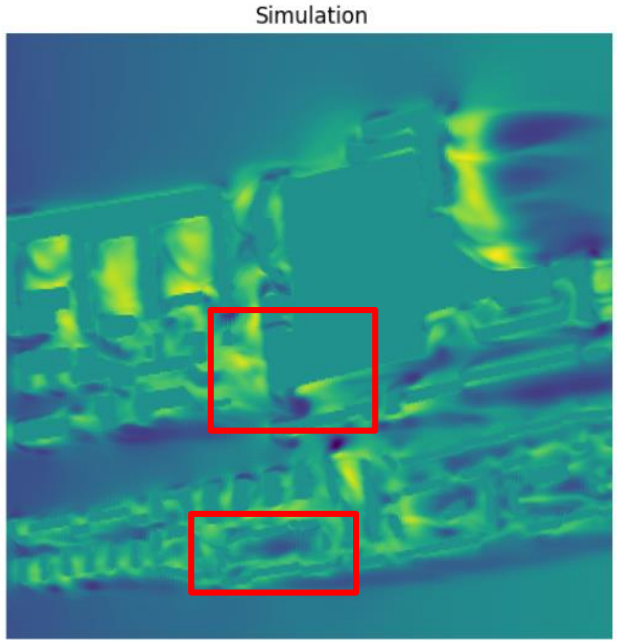
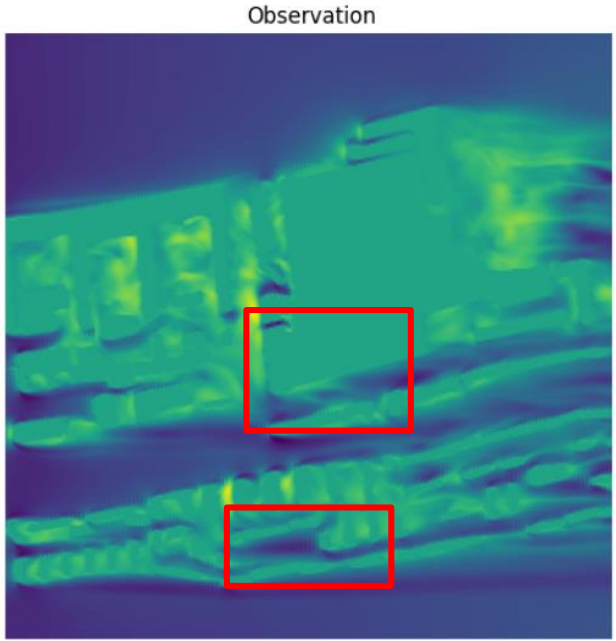
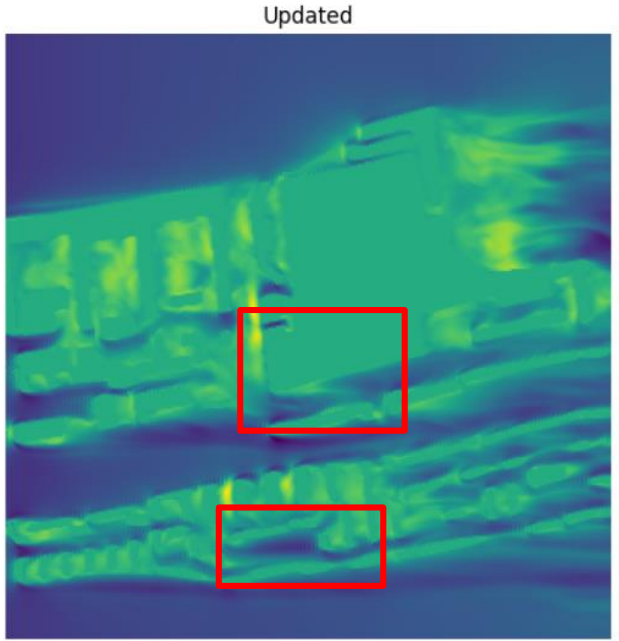
(Velocity Field in x-direction at 1-Meter Height)

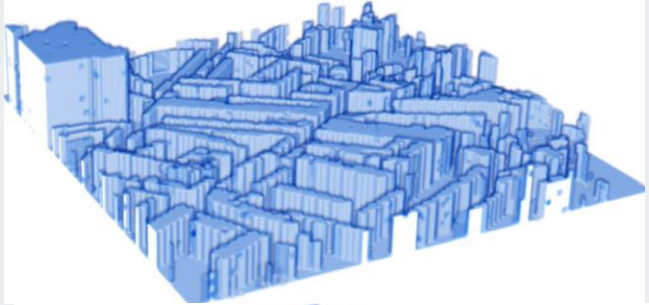


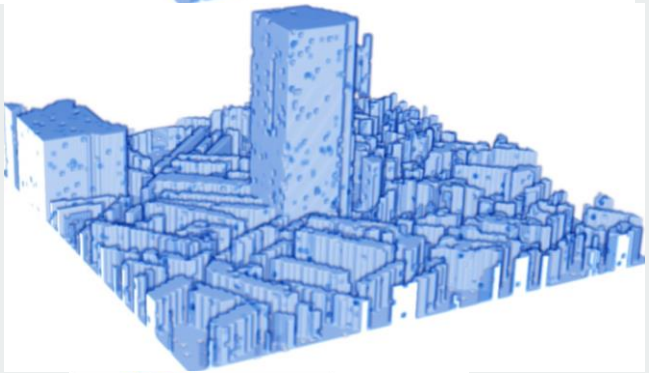


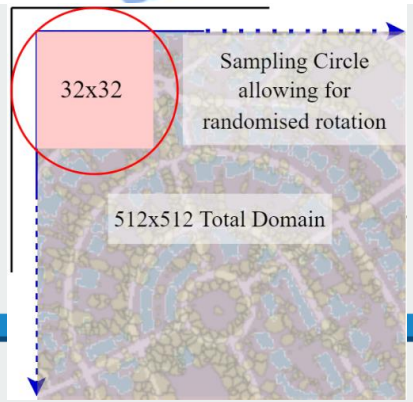


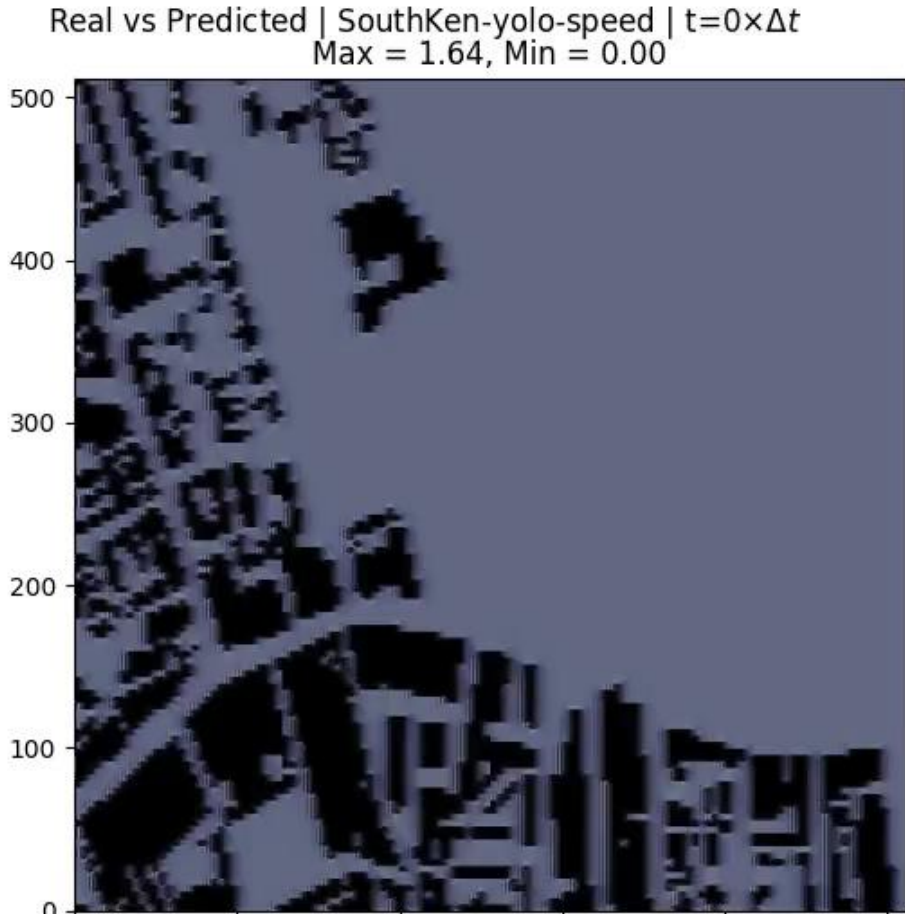


Generators (Buildings+Greening – left) and AI surrogate (10K x faster CFD & trained for car flow - right)









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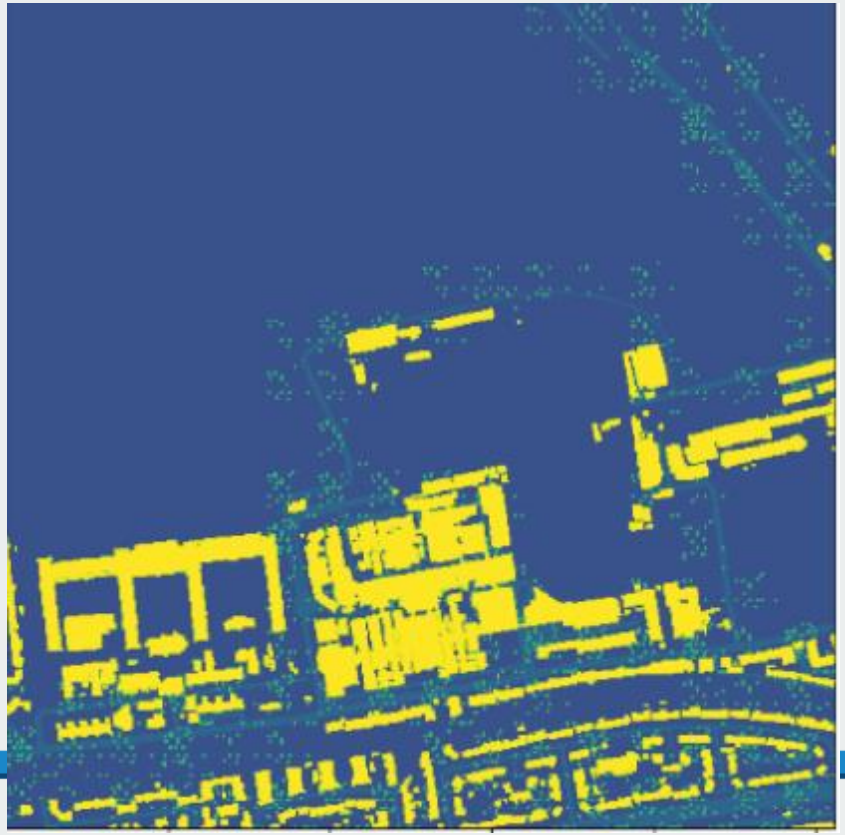
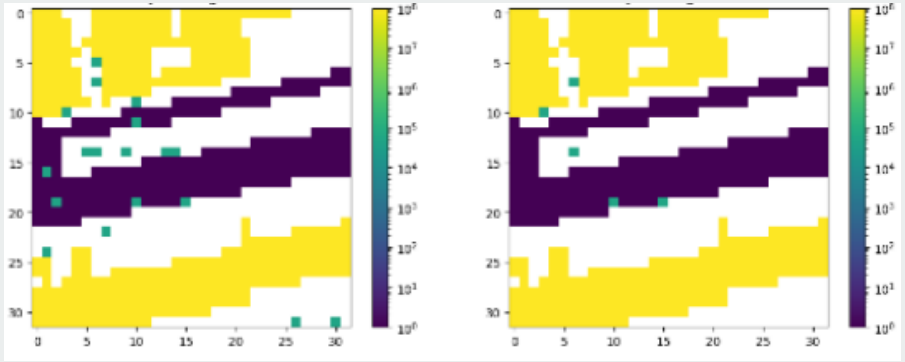
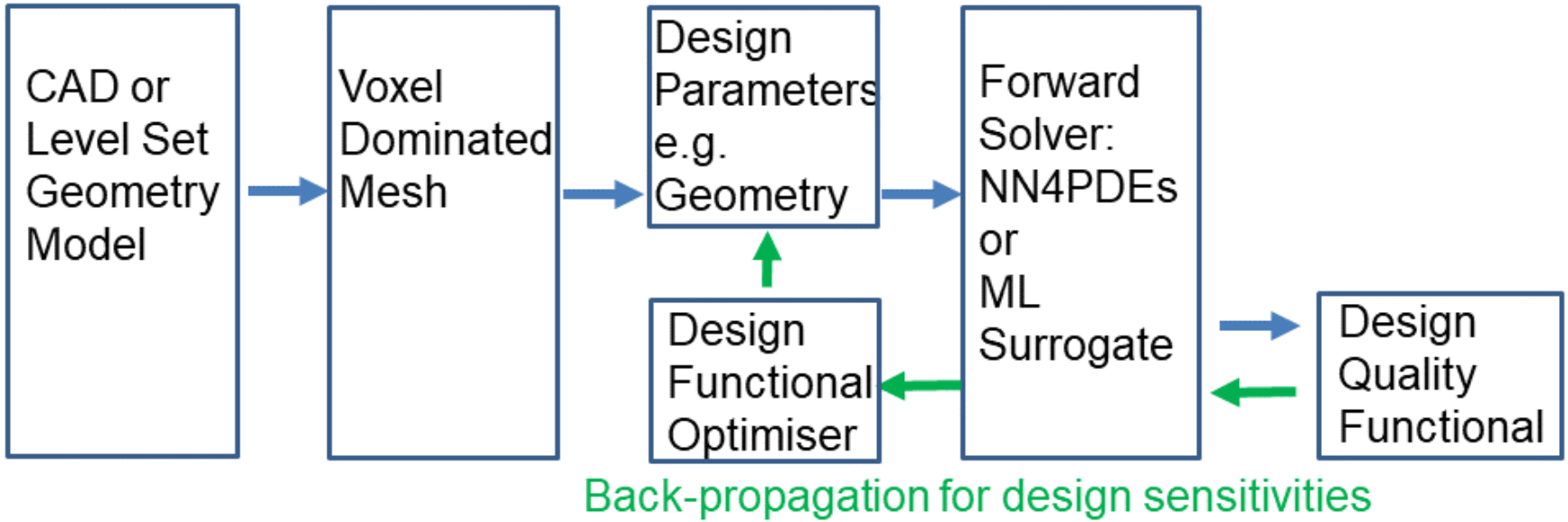
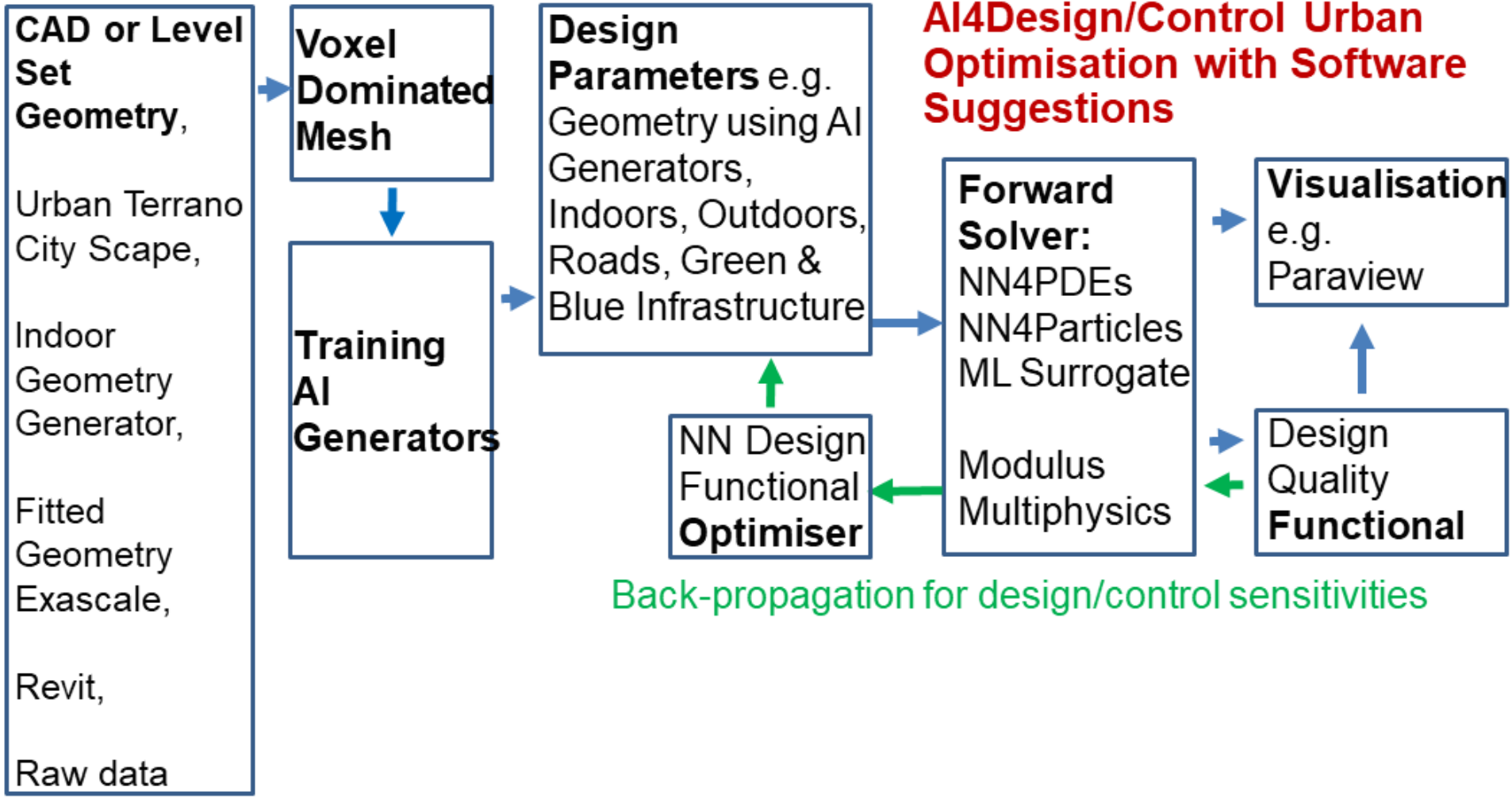
Generators Buildings+Greening+Roads optimized with Neural Networks – Greening optimized to reduce peoples exposure to pollution – AI4PDE forwards model





Approach to design optimisation




CAD or Level Set Geometry,
Urban Terrano City Scape,
Indoor Geometry Generator,
Fitted Geometry Exascale,
Revit,
Raw data
Voxel Dominated Mesh
Training AI Generators
Design Parameters e.g. Geometry using AI Generators, Indoors, Outdoors, Roads, Green & Blue Infrastructure
AI4Design/Control Urban Optimisation with Software Suggestions
Forward Solver:
NN4PDEs
NN4Particles
ML Surrogate
Modulus Multiphysics
Visualisation e.g. Paraview
Design Quality Functional
NN Design Functional Optimiser
Back-propagation for design/control sensitivities