UNIVERSITY OF CAMBRIDGE

Digital Theme
Digital Roads Prosperity Partnership

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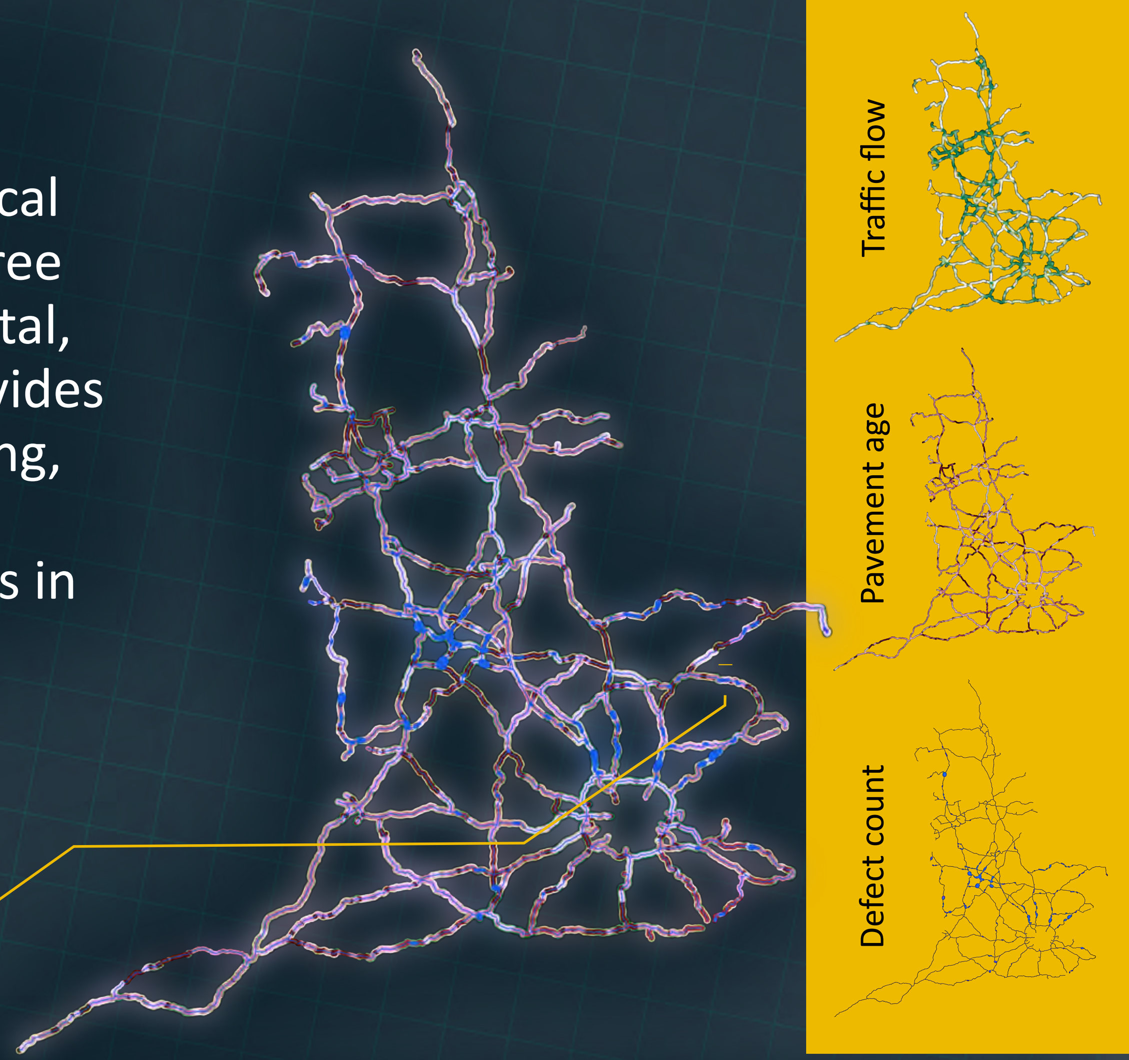
Introduction. The Digital Roads Prosperity Partnership aims to revolutionise highway maintenance by integrating advanced physical and digital technologies; it comprises three interconnected themes: Physical, Digital, and Impact. The Digital theme provides the forecasting, process modelling, and digital communication between other components in the partnership.

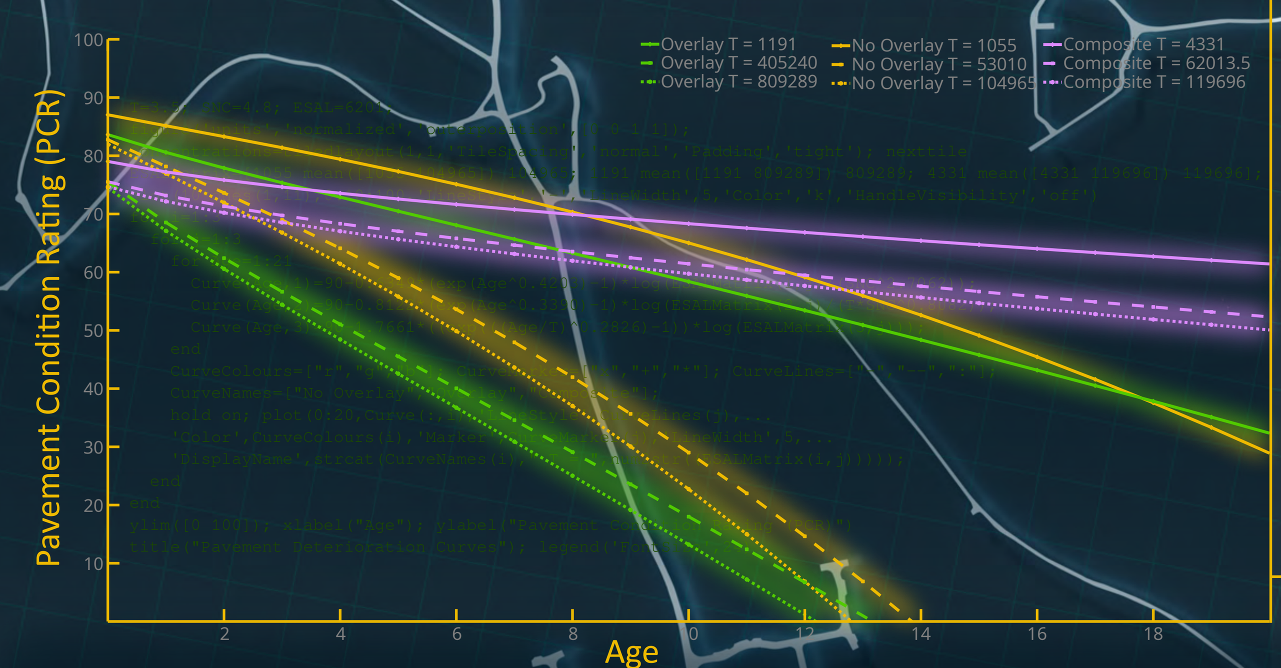


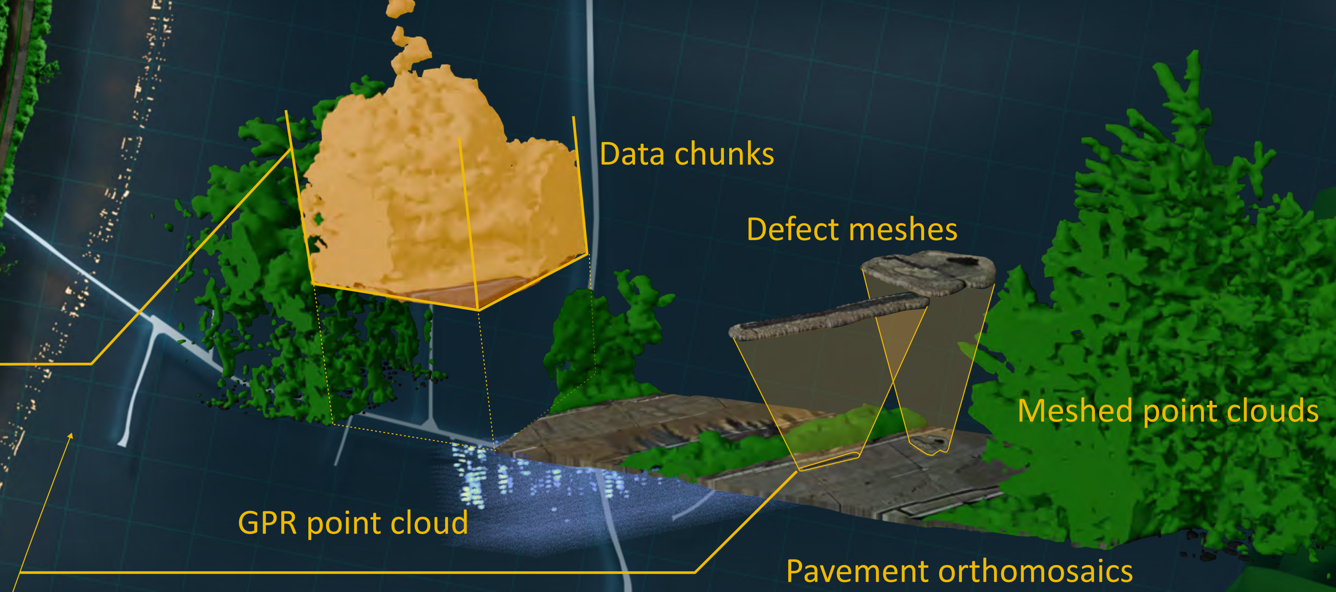
Visualising the Digital Twin creates dynamic, virtual replicas of our physical road networks. Using automatic mesh generation scripts, we accurately generate pavement meshes, traffic signs (below, right), and other data. We study how simulated cycling (above) scenarios can model dangerous or expensive scenarios to provide ways to improve cycling experience. In the future we will further develop the DT Visualisation tools to simulate roadside repair processes as well as enhanced interfaces with other objects, helping planners and engineers evaluate safety, efficiency, and sustainability of DTs.

Spatial Modelling. An extensive data fusion task is being carried out, combining data sources from National Highways (P-AMS, Confirm, SWIS) with public data (Met Office, DfT) into a comprehensive dataset based on the Strategic Road Network model (table below).

Site	Easting (m)	Northing (m)	Surface material	Age (yrs)	Thickness (mm)	Length (m)	Lanes	AADF (counts per m)	Rainfall (mm)	Average temp. (°C)
0100A4 /551	377412	166506	HR Asphalt	27.50	50	529	2	3.976	TBC	12.5

In the next step, this will be crucial for modelling relationships between inputs such as traffic flow (map above, top right) or pavement age (middle), and outputs such as defect counts (bottom) or pavement condition. This will be implemented via spatial smoothing and has applications to prioritisation, decision-making, and predictive maintenance.





Forecasting the life cycle of existing pavements through monitoring factors exhibited from Data Science can be presented as a series of deterioration curves (above left) that show what the expected road condition is at the current point in time and a forecast of its future[1]. The percentage of cracks in observed sections will factor into creating future curves that create a direct correlation between the current road condition and how long they can be expected to remain fit for purpose.

[1] Katicha, Samer W., et al. Development of enhanced pavement deterioration curves. No. VTRC 17-R7. Virginia Transportation Research Council (VTRC), 2016.

Digital Twins act as a nexus for data flow and storage. Our DR:DT twin now encompasses the CAMHighways[2] dataset, presenting the components (above) into chunks for processing. Several prototype processes apply the twin to visualisation (poster center), vegetation pruning, as well as defect identification and exploration. The twin is implemented in PostGIS and Postgres; processes are modelled in Python. Next year, the DT will be extended to communicate with the Automated Repair Vehicle as well as encompass the Reference Data Library, driven by the requriments gathered from industry.

[2] A. Marie d'Avigneau et al. CAMHighways: The Cambridge Highways Dataset, 2024.

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