BIM for existing infrastructure
BIM for **future** constructions – 3D design

**Design software:** Autodesk, SolidWorks, CloudCompare, Blender

**Staffordshire case study**

As-Built Point Cloud

Designed IFC model
BIM for future constructions – Geometry checker

Progress monitoring – use BIM’s temporal dimension

Staffordshire case study
BIM for existing infrastructure
BIM for **existing infrastructure**
Reverse-engineer 3D design

Images courtesy of 3D ATA, Slovenia

As Built 3D Model, Fabiani Bridge
Reverse-engineer 3D design

Images courtesy of 3D ATA, Slovenia

As Built 3D Model, Fabiani Bridge
Reverse-engineer 3D design

3D point cloud

Manual work

3D BIM

2D CAD drawings
Reverse-engineer 3D design

Time consuming and error prone
Reverse-engineer 3D design

Automated approach: Machine learning

3D point cloud
Reverse-engineer 3D design

Automated approach: Machine learning

3D point cloud

traditional

modern

BIM

As Built 3D Model, Fabian Bridge
Traditional machine learning approach

- **Input point cloud**
- **Feature extraction**
- **Voxel-wise classification/segmentation**
  - User-defined features
- **Output**
- **Part/model fitting: non-rigid ICP**
- **Smoothing: Dense CRF**
Traditional machine learning approach

Input point cloud

Feature extraction

Voxel-wise classification/segmentation

Library of parts

User-defined features

Output

Part/model fitting: non-rigid ICP

Smoothing: Dense CRF
Machine learning = Training

Library of parts

Training (labelled) set
Parts in context

Classification & segmentation
Training data: Labelled real point clouds

M11 (11 scans)

10 classes
- deck
- column
- pier
- abutment
- wing-wall
- parapet
- handrail
- road
- vegetation
- noise
Training data: Labelled real point clouds

Addenbrooke’s bridge (14 scans)
Training data: Synthetic models (3D Warehouse)
The future of data modelling: Deep learning

Input point cloud → Feature extraction → Voxel-wise classification/segmentation

User-defined features

Output → Part/model fitting: non-rigid ICP → Smoothing: Dense CRF

CSIC Cambridge Centre for Smart Infrastructure and Construction
The future of data modelling: Deep learning

Input point cloud

Feature extraction

Voxel-wise classification/segmentation

User-defined features

Output

Part/model fitting: non-rigid ICP

Smoothing: Dense CRF
The future of data modelling: Deep learning

Feature learning

Voxel-wise classification/segmentation

End-to-end optimisation

Deep artificial neural networks
The future of data modelling: Deep learning

- Feature learning
- Voxel-wise classification/segmentation
- End-to-end optimisation

Deep artificial neural networks

- ~20% accuracy increase
- Sometimes better than humans
- Large number of training examples
BIM adoption – highly dependent on its implementation for existing infrastructure
• Current manual modelling methods are overly expensive; costs vs. benefits
• Object recognition systems based on deep learning surpass humans
• Need large amount of training data
• Joint efforts to collect data (point clouds, 3D CAD models)
Parallel projects

Mobile system for fast scanning (Prof. Kenichi Soga)

As-built bridge modelling and change detection (Dr. Ioannis Brilakis)

IFC converter and dedicated tools for bridge design (Prof. Campbell Middleton)

Condition monitoring (Dr. Ioannis Brilakis)