

# Real World Use Case: Structural Health Monitoring (SHM)

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# Motivation

# Why do we need SHM ?.

- Time-based maintenance
  - Preventative maintenance schedules
  - Too early or too late



Japan tunnel collapse 2012



Minneapolis bridge collapse 2007



Italy bridge collapse 2018

- Increase productivity and extend asset life.

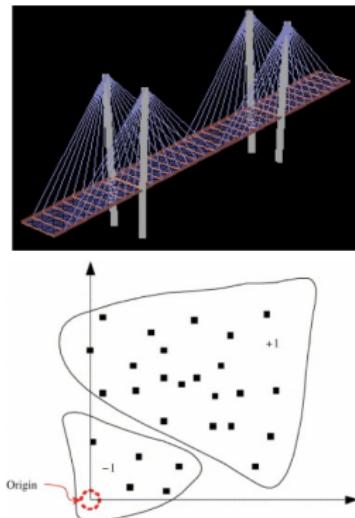
# Levels of Damage Identification.

- Level 1 (Detection) : Is damage present?
- Level 2 (Localization) : Where is damage?
- Level 3 (Assessment) : How severe is damage?
- Level 4 (Prediction) : When will the structure fail?



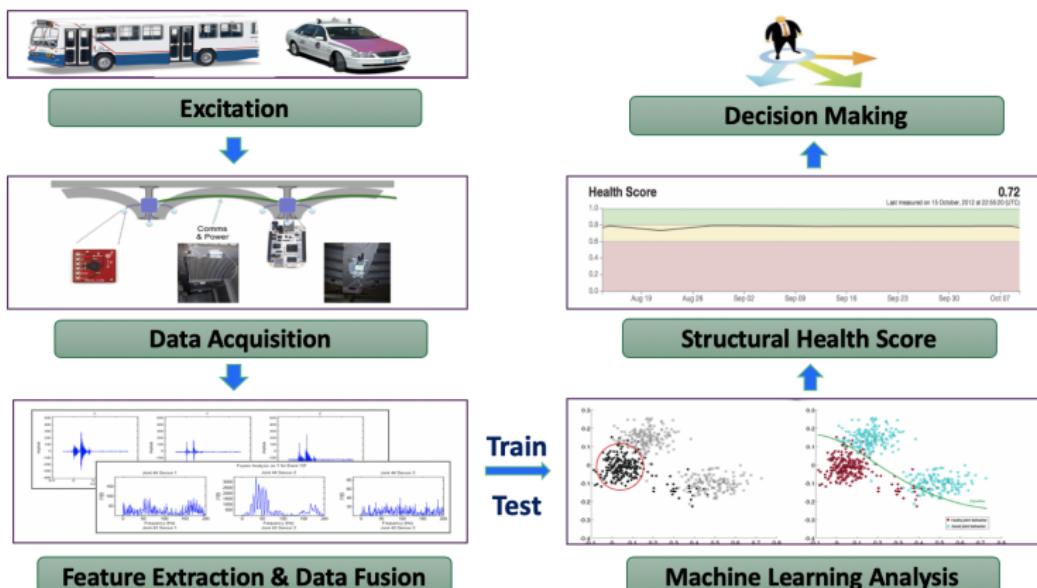
# Damage Identification Techniques.

- Model-driven vs data-driven approach
  - Numerical model may not be available or accurate
  - Data-driven approach establishes a model from data.
- Our approach using deep models
  - Data corresponding to damage are often not available.
  - Only healthy data is available.
  - Challenge: Data drift.



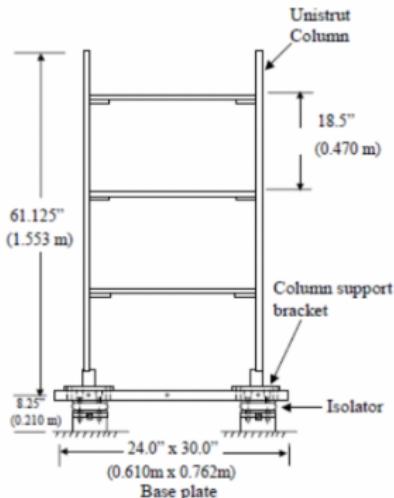
# SHM

# SHM : Machine Learning Flowchart.



# Case studies

# Real and Laboratory-based structures



## Sydney Harbour Bridge

- 3 sensors
- Sampling at 400Hz
- Damage in 1 location

## Lab-based bridge specimen

- 6 sensors
- Sampling at 500Hz
- Crack with different lengths

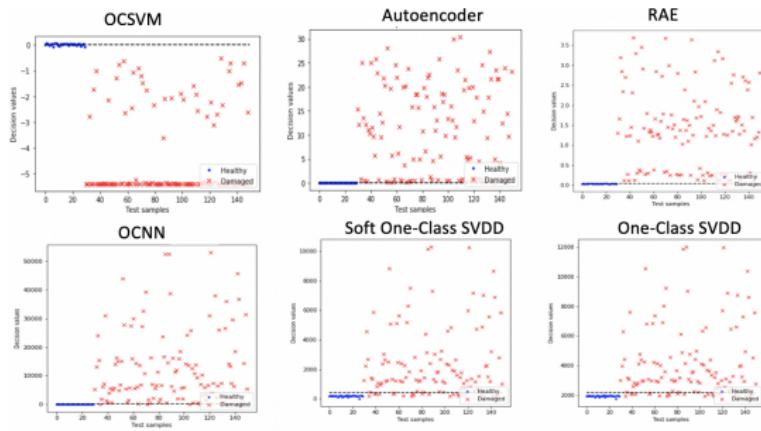
## Lab-based building

- 24 sensors
- Sampling at 1600Hz
- Damage in 2 locations

# Experiments

- Datasets: 2-Joints, BookShelf
- 900 for FFT features, 1800 for raw features
- Methods
  - Autoencoder (AE)
  - Robust Autoencoder (RAE)
  - One-Class Deep Support Vector Data Description (SVDD)
  - One-Class Neural Network (OCNN)

# Results



	Two Joints		BookShelf	
	AUC	ACC	AUC	ACC
OCSVM	0.99	0.96	0.99	0.89
(OCNN)	0.95	0.90	0.99	0.95
One-Class SVDD	0.98	0.86	0.90	0.87
Soft One-Class SVDD	0.97	0.87	0.90	0.87
Robust Autoencoder (RAE)	0.98	0.97	0.99	<b>0.98</b>
Autoencoder (AE)	<b>0.98</b>	<b>0.98</b>	0.99	0.96

(b) Evaluation Metrics

# Conclusion

- Deep learning-based techniques slightly better than OCSVM for Sydney Harbour Bridge dataset.
- Bookshelf data, the deep learning-based models outperform the traditional OCSVM model.
- Deep learning-based models as a good alternative on high-dimensional SHM data.