Spatio temporal data

Spatio Temporal . ODSC east

- Technical challenges ⇒ Pics ①
- Non Euclidian geometry ②
- Traffic forecasting ③
- Spatial Dependence
- Graph Convolution

Image ⇒ Graph nodes

(EigenValue) Expensive

so

↓

- Diffusion Convolution
- RNN {temporal part}

- Diffusion Convolution GRU
- Long term forecasting
  Scheduled Sampling - Model learn from the mistakes.

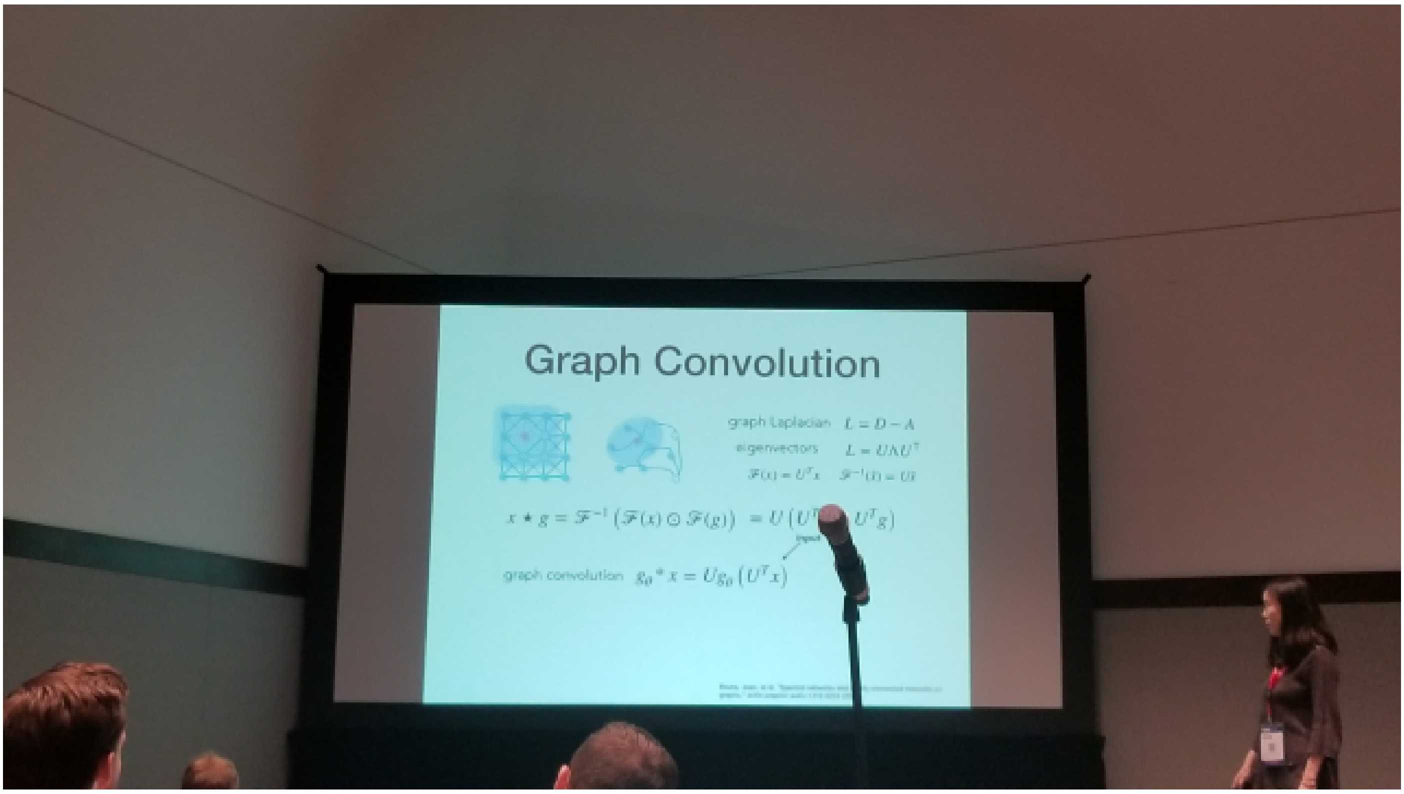
$\boxed{\text{Diffusion Convolution GRU}}$

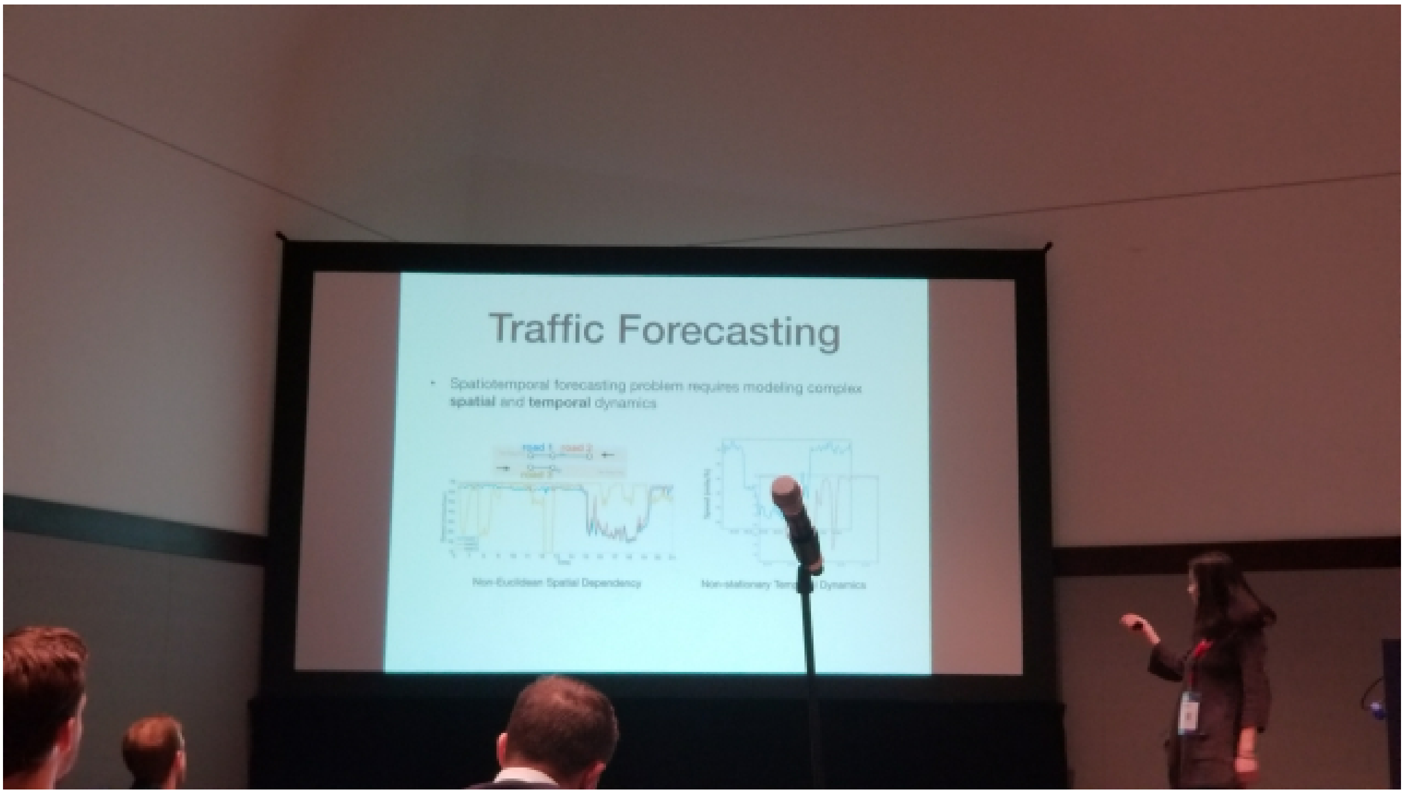
LA → Spider → Graph
SF → COI → Easy

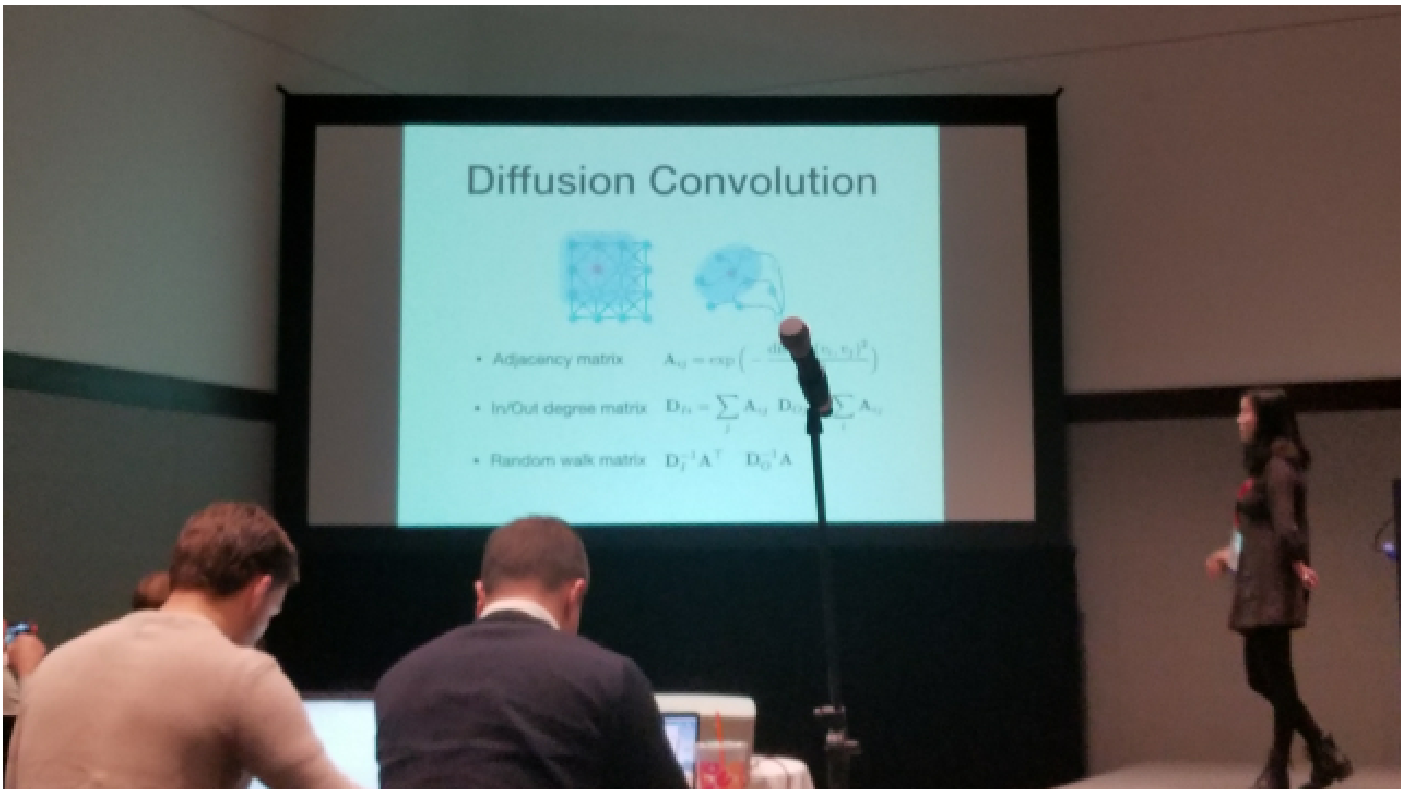
Missing value imputation

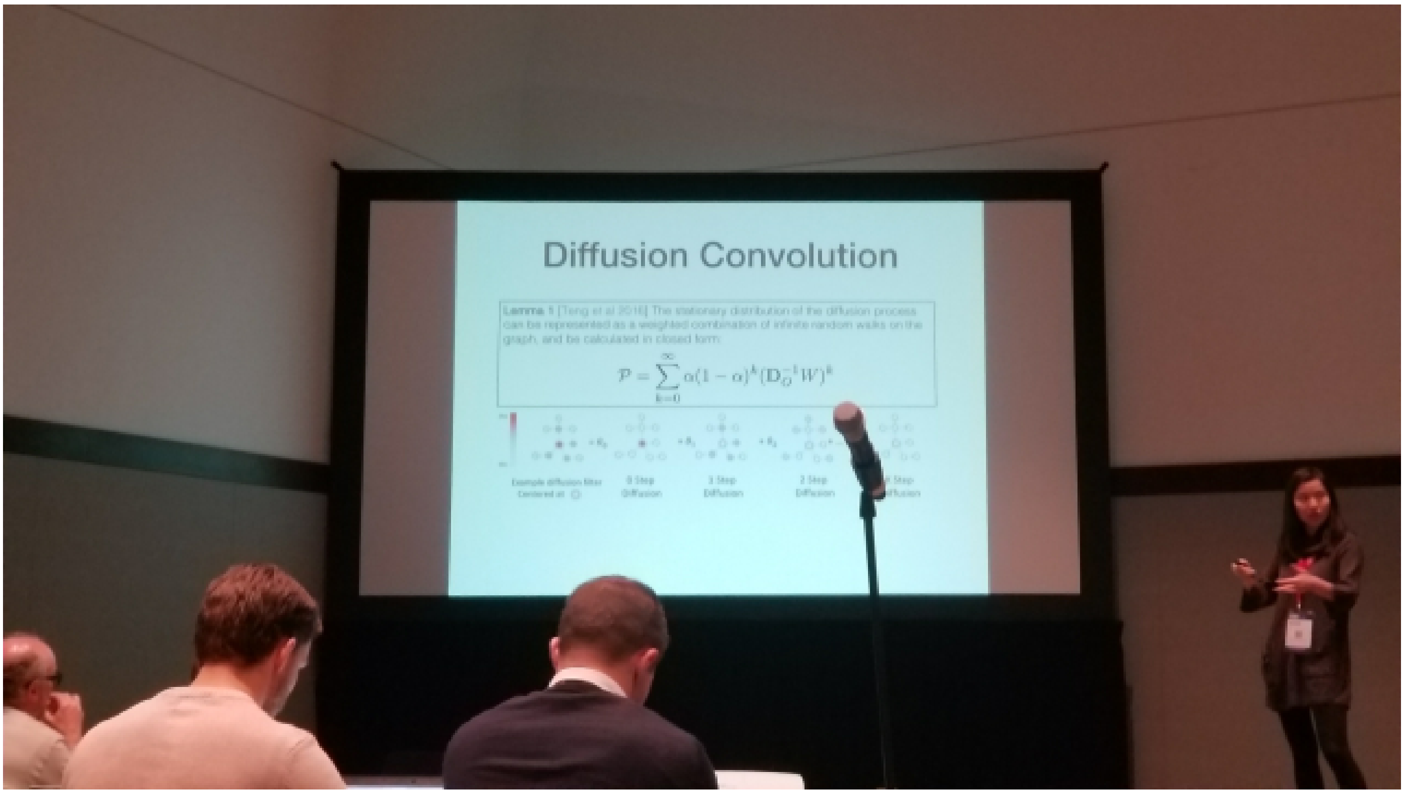

Technical Challenges
irregular grid
missing values
sensors deployed on an irregular grid
sensors failure, transmission problem
hard to represent
dirty data

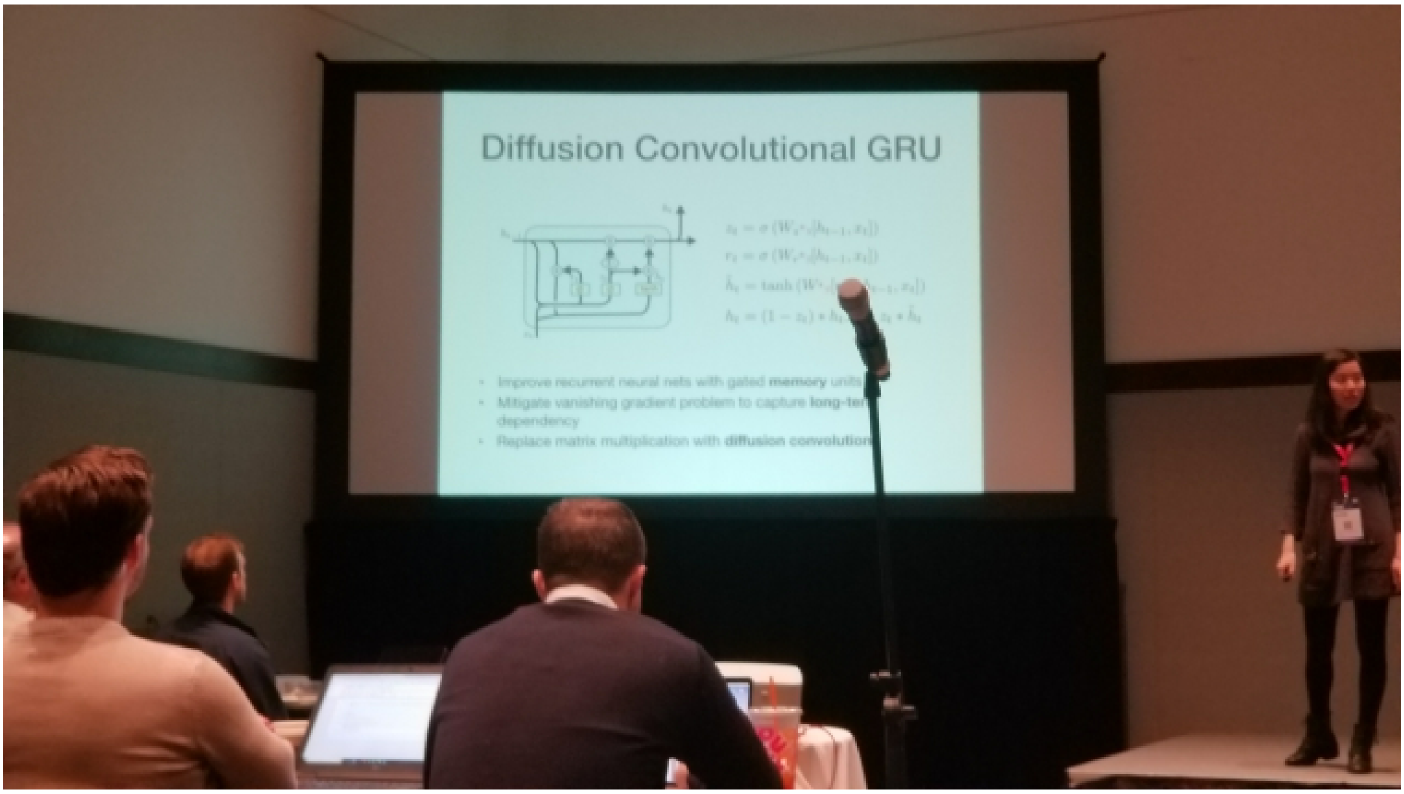

Technical Challenges
error cascading
multi-resolution
predictions are sequential
space and time at different scales
error propagate
complex hierarchy

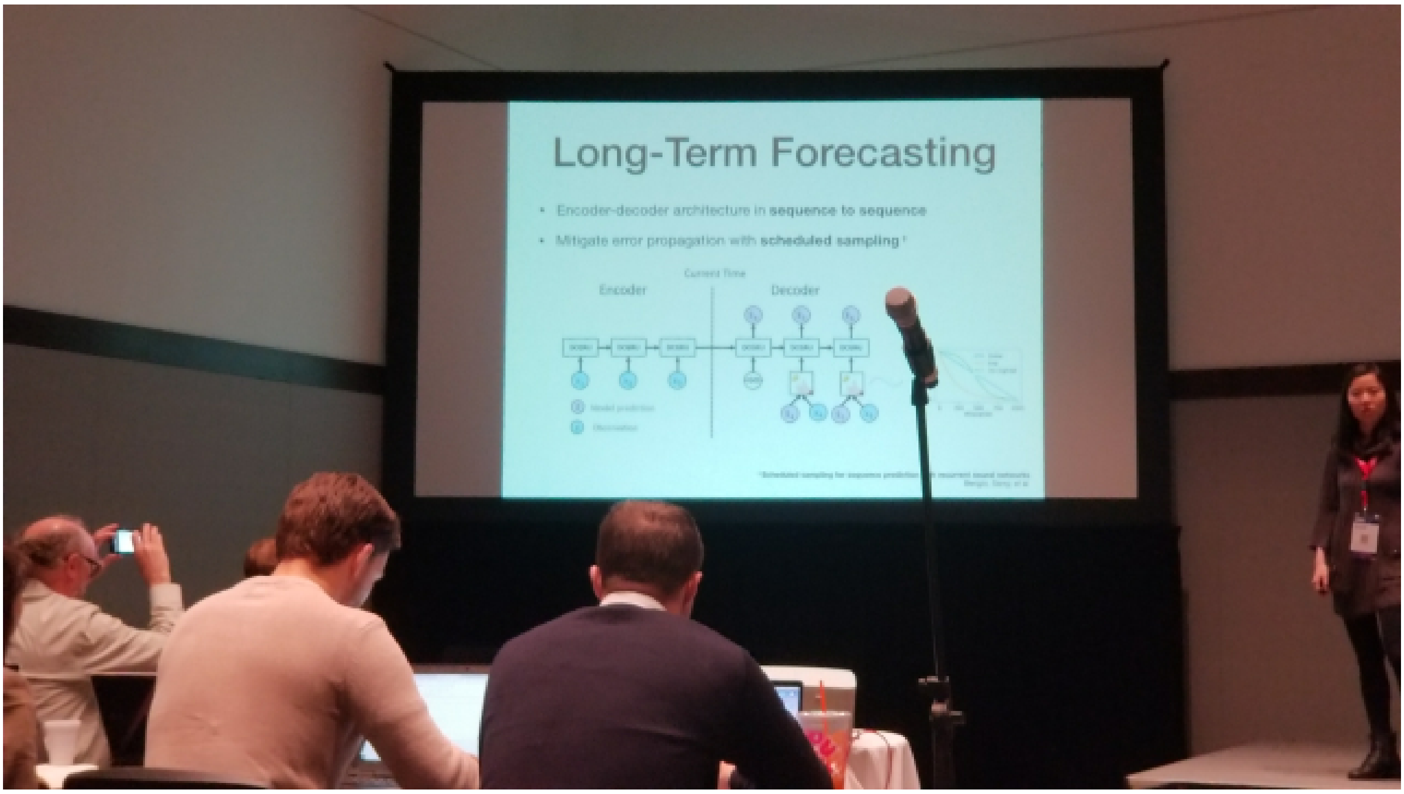

Graph Convolution
graph Laplacian $L = D - A$
eigenvectors $L = U\Lambda U^T$
$x \star g = \mathcal{F}^{-1}(\mathcal{F}(x) \odot \mathcal{F}(g))$
graph convolution $g_\theta * x = U g_\theta (U^T x)$


Traffic Forecasting
• Spatiotemporal forecasting problem requires modeling complex **spatial** and **temporal** dynamics
road 1
road 2
road 3
Non-Euclidean Spatial Dependency


Diffusion Convolution
Adjacency matrix
In/Out degree matrix
Random walk matrix


Diffusion Convolution
Lemma 1 [Teng et al 2016] The stationary distribution of the diffusion process can be represented as a weighted combination of infinite random walks on the graph, and be calculated in closed form:
$\mathcal{P} = \sum_{k=0}^{\infty} \alpha(1-\alpha)^k (\mathbf{D}_O^{-1} W)^k$
0 Step Diffusion
1 Step Diffusion
2 Step Diffusion


Diffusion Convolutional GRU
Improve recurrent neural nets with gated memory units
Mitigate vanishing gradient problem to capture long-term dependency
Replace matrix multiplication with diffusion convolution


Long-Term Forecasting
Encoder-decoder architecture in sequence to sequence
Mitigate error propagation with scheduled sampling
Encoder
Current Time
Decoder

Last modified: 11:03 PM