Urban Water Quality Prediction based on Multi-task Multi-view Learning

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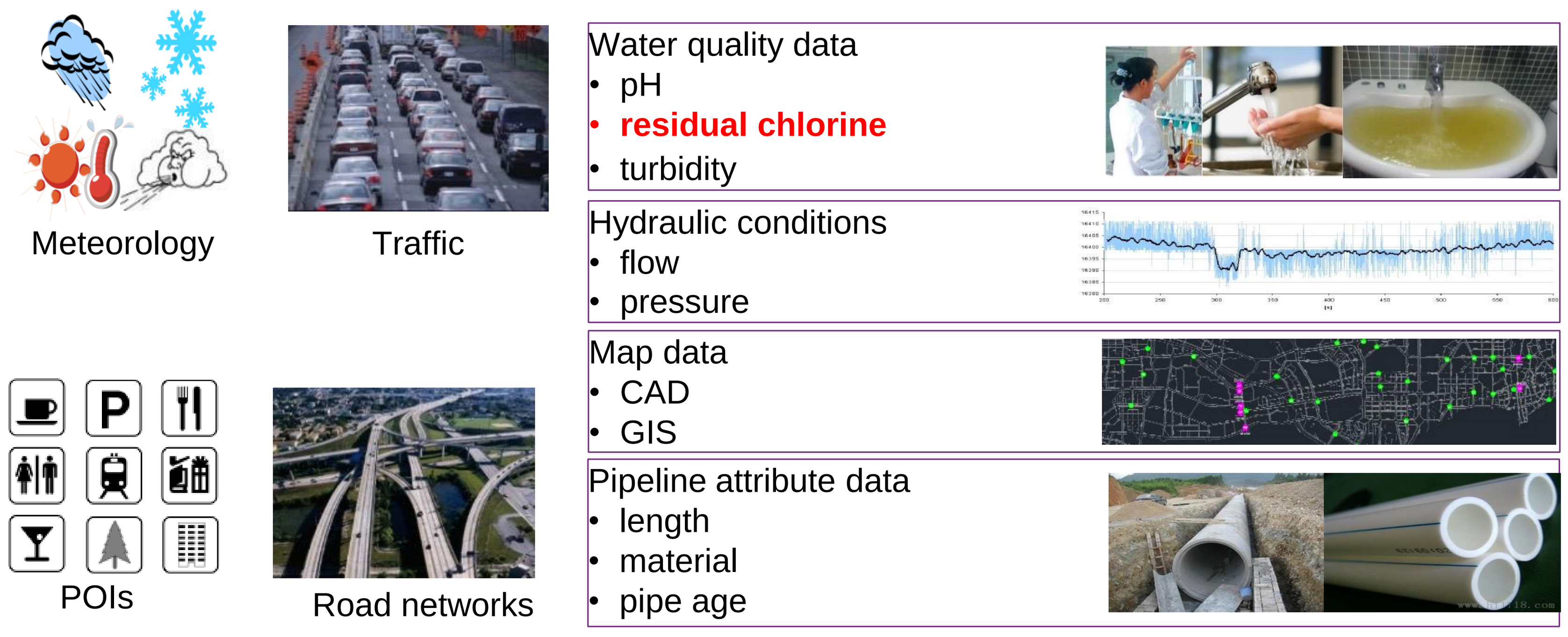
Code Released

Motivation

- Urban water quality is of great importance to our daily lives.
- Predicting the urban water quality plays an essential role in
  - Informs waterworks' decision making
  - Affects governments' policy making
  - Provides maintenance suggestions

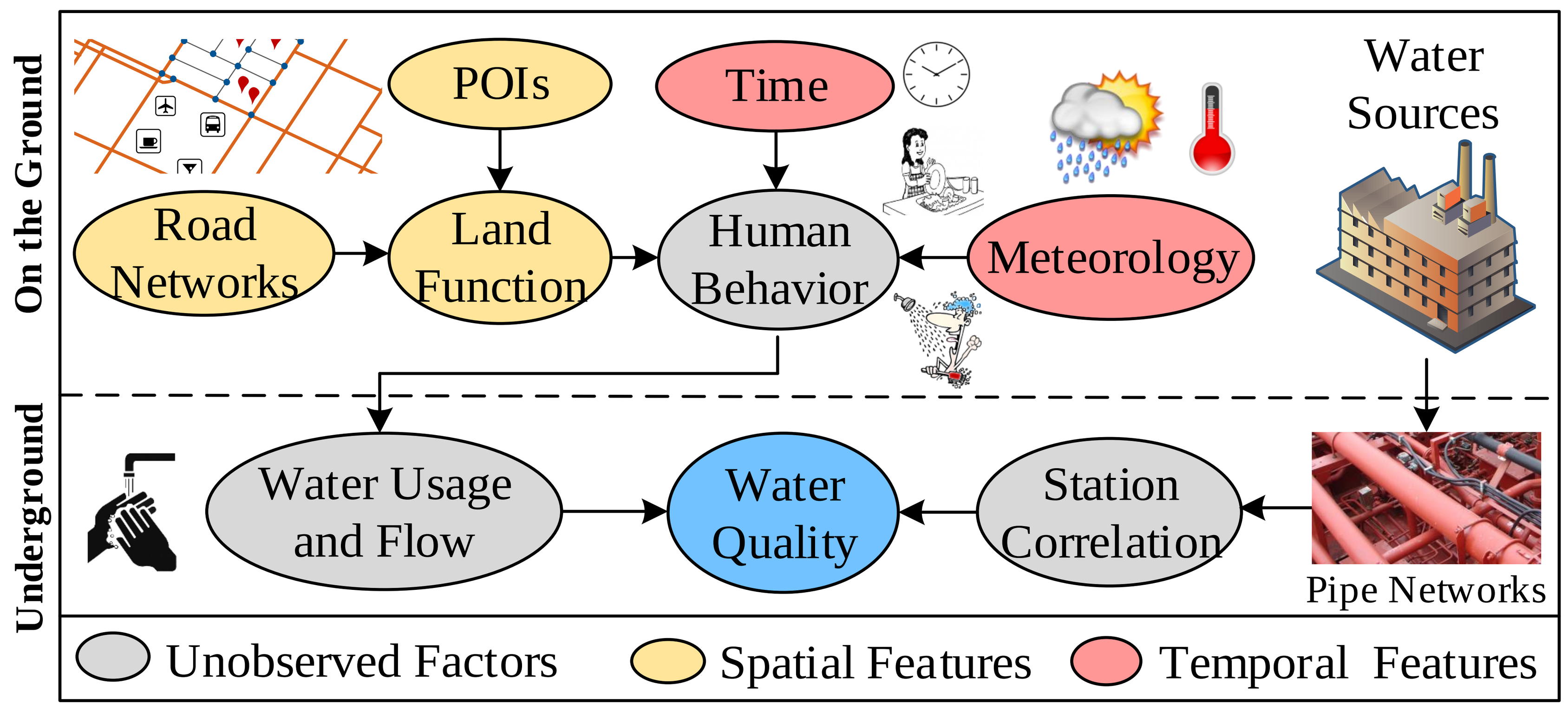
Goal

- Predicting urban water quality from multi-sources urban data

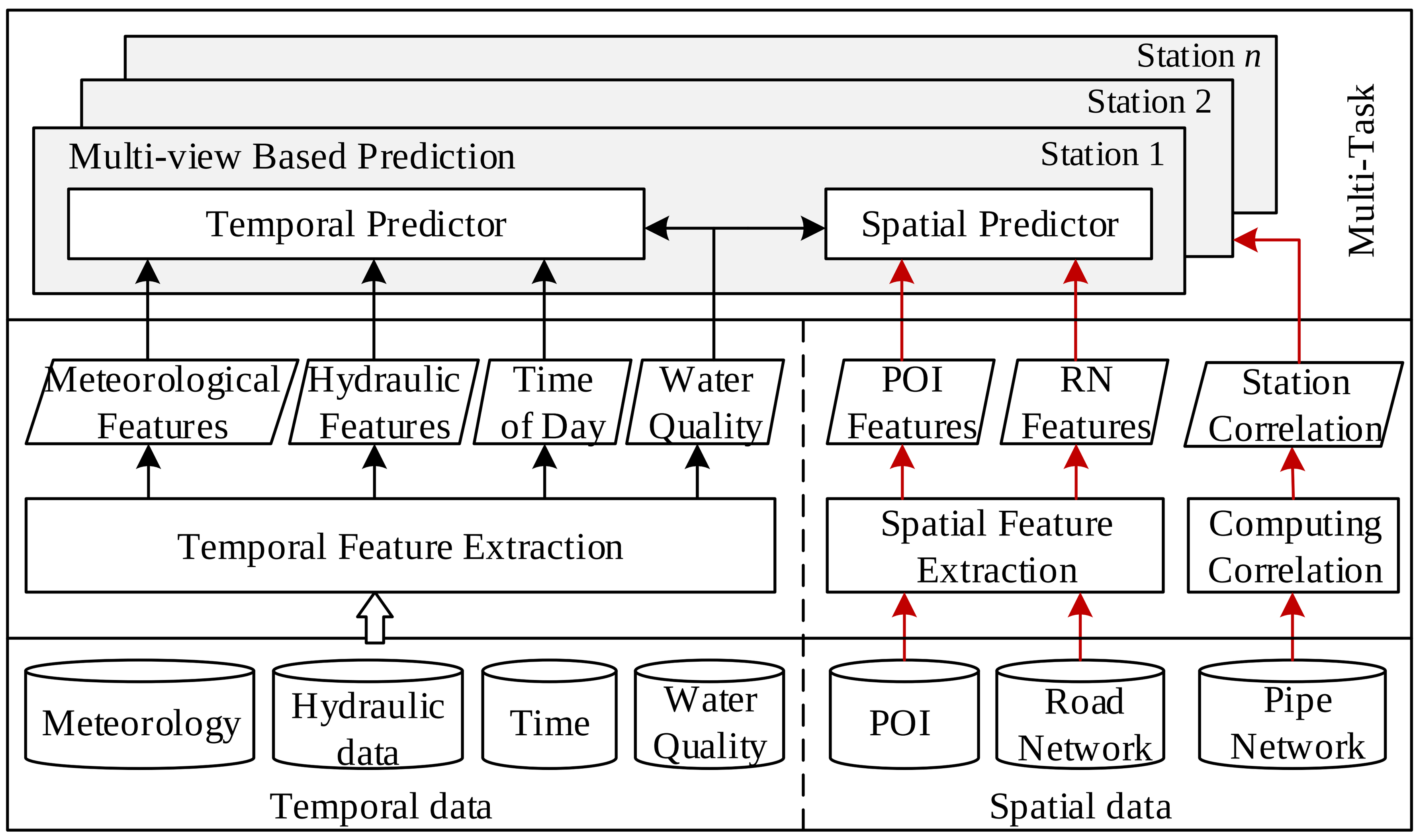


Insight

Urban water quality is impacted by usage patterns and structure of pipes

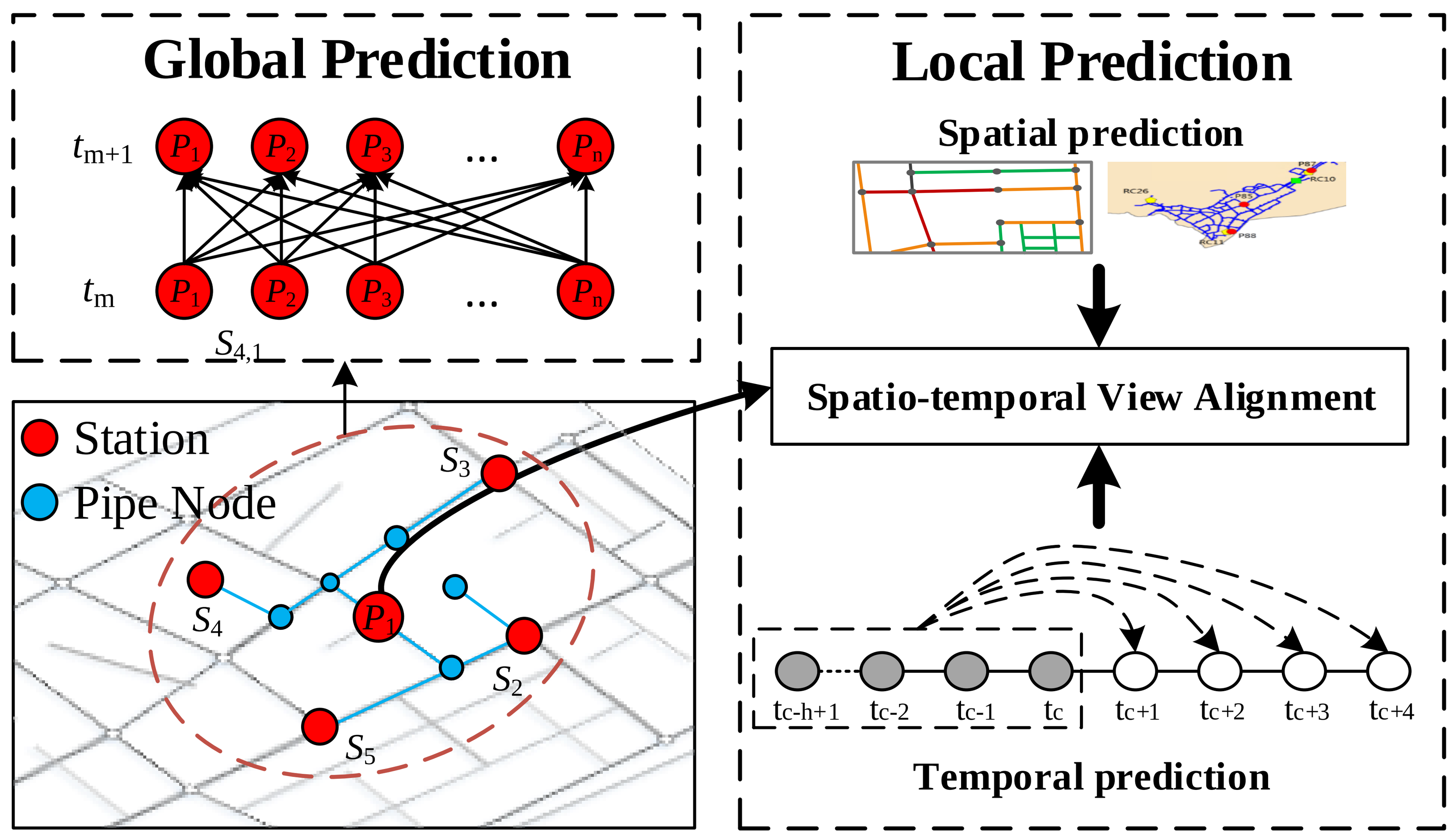


Overview



Methodology

- **Multi-task Multi-view Learning**
  - **Multi-View:** For each station, there are two views
    - ✦Spatial view: predictions based on its neighbors
    - ✦Temporal view: predictions based on its own history
    - ✦Alignment between two views $\|\mathbf{X}_l^s\mathbf{w}_l^s - \mathbf{X}_l^t\mathbf{w}_l^t\|_2^2$
  - **Multi-Tasks:**
    - The prediction at each station is a task
    - All stations do the co-prediction
    - Alignments among multiple tasks $\sum_{l,m=1}^{M} C_{l,m}\|\mathbf{w}_l - \mathbf{w}_m\|_2^2$

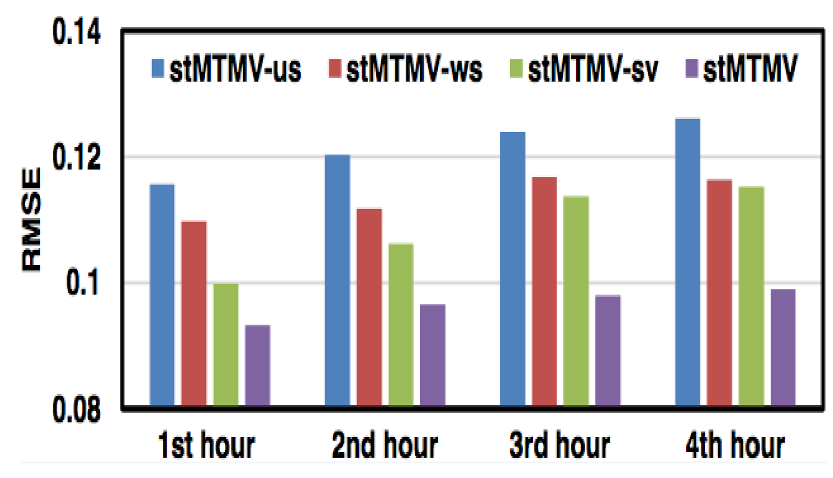


$$\min_{\mathbf{W}} \quad \frac{1}{2}\sum_{l=1}^{M}\|\mathbf{y}_l - \frac{1}{2}\mathbf{X}_l\mathbf{w}_l\|_2^2 + \lambda\sum_{l=1}^{M}\|\mathbf{X}_l^s\mathbf{w}_l^s - \mathbf{X}_l^t\mathbf{w}_l^t\|_2^2$$
$$+\gamma\sum_{l,m=1}^{M} C_{l,m}\|\mathbf{w}_l - \mathbf{w}_m\|_2^2 + \theta\|\mathbf{W}\|_{2,1},$$

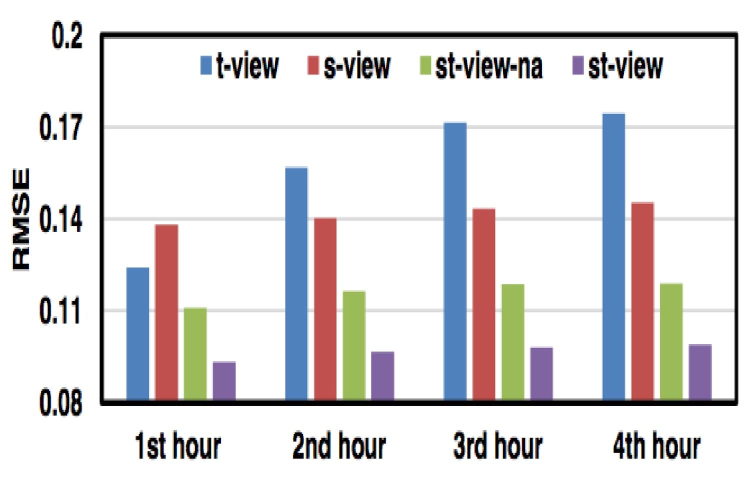
Evaluations

Models	1 hour	2 hour	3 hour	4 hour
RC Decay Model	3.51e-1	3.53e-1	3.59e-1	3.68e-1
ARMA	1.86e-1	2.18e-1	2.46e-1	2.78e-1
LR	1.68e-1	1.99e-1	2.09e-1	2.10e-1
LASSO	1.23e-1	1.42e-1	1.52e-1	1.56e-1
MRMTL	1.32e-1	1.48e-1	1.56e-1	1.58e-1
regMVMT	1.06e-1	1.15e-1	1.18e-1	1.19e-1
stMTMV	**9.33e-2**	**9.66e-2**	**9.80e-2**	**9.90e-2**

Performance comparison among various approaches



Model components comparison



Views comparison