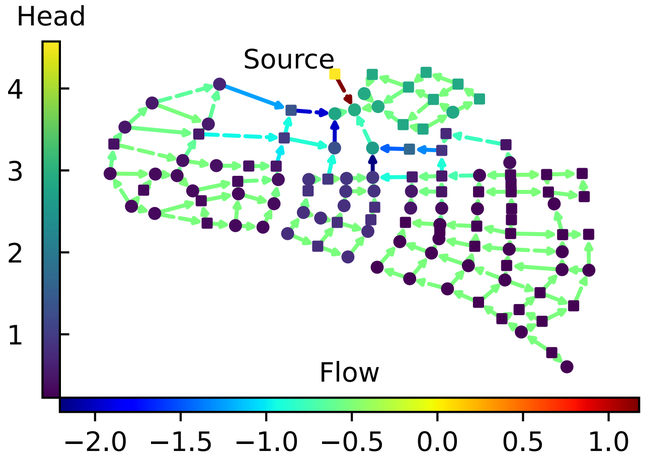
State estimation in water supply networks

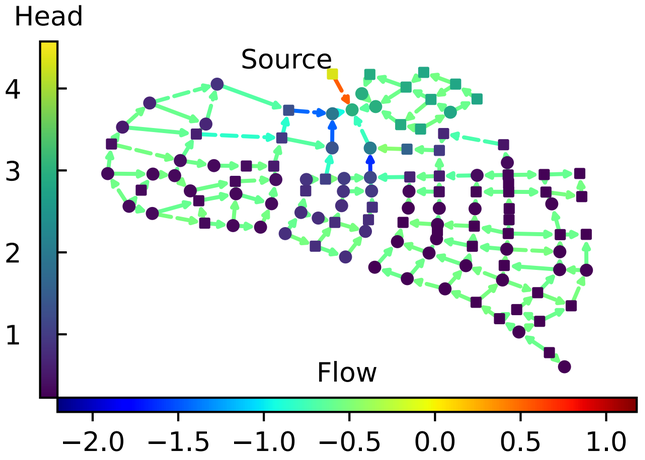
Based on the node-edge joint GPs

$$\mathbf{B}_1^\top \mathbf{f}_0 = \bar{\mathbf{f}}_1 := \mathrm{diag}(\mathbf{r})\mathbf{f}_1^{1.852}$$

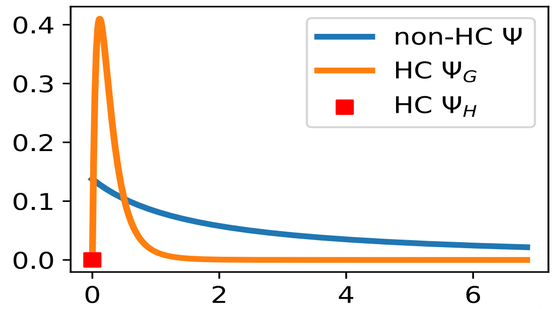
$$\begin{pmatrix} \mathbf{f}_0 \\ \bar{\mathbf{f}}_1 \end{pmatrix} \sim \mathrm{GP}\left(\mathbf{0}, \begin{pmatrix} \mathbf{K}_0 & \\ & \mathbf{K}_1 = \mathbf{B}_1^\top \mathbf{K}_0 \mathbf{B}_1 \end{pmatrix} \right)$$



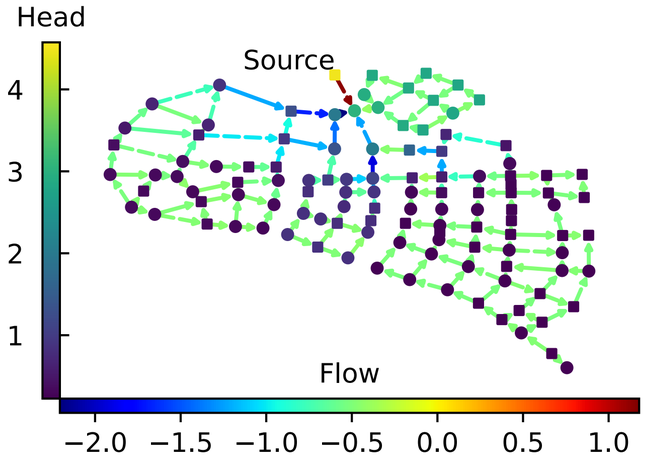
Original



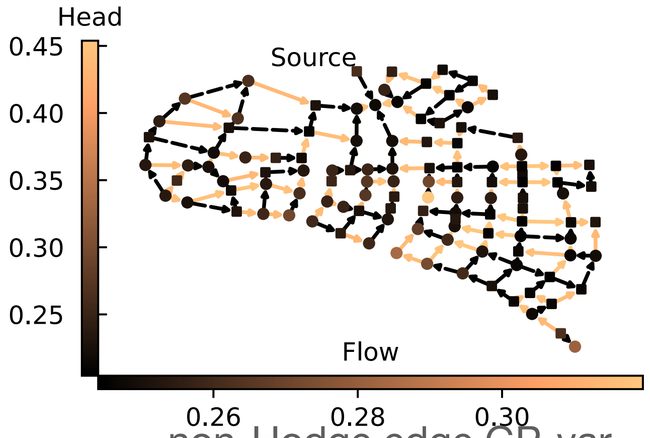
non-Hodge edge GP



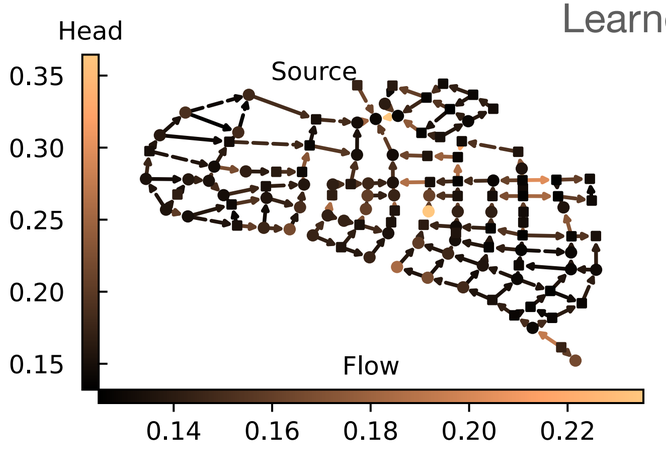
Learned kernel



Hodge edge GP



non-Hodge edge GP, var



Hodge edge GP, var

Summary

Graph, topology, calculus — signal processing, machine learning

- Edge flows (simplicial signals): smoothness, Fourier transform, Hodge thm.

  Gradient part + Curl part + Harmonic part

- Processing and learning based on convolutional filters
- Statistical learning via Gaussian process modeling
- Geometry is not included, computer graphics, shape analysis …
- Other domains: TDA, numerical methods… continuous analogies (vector fields) …