Short-Term Predictions of Streamflow Using Graph Networks

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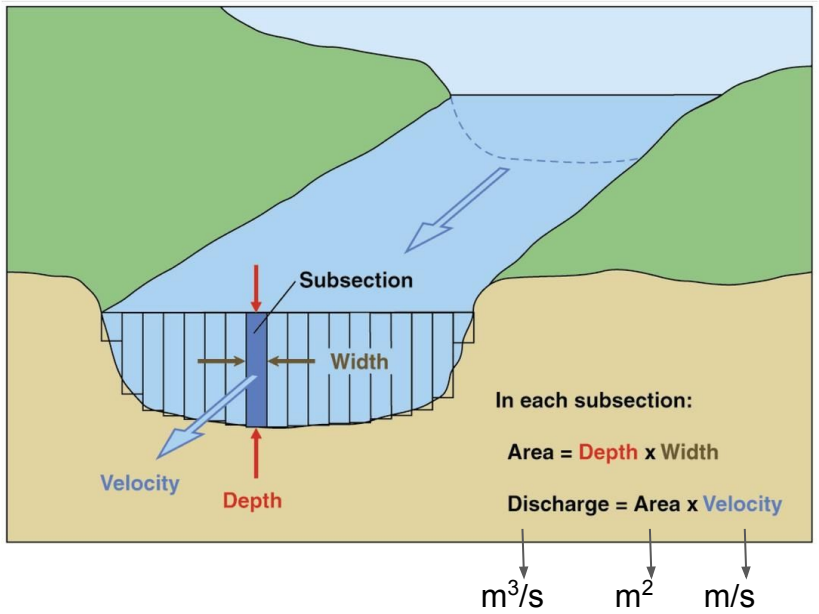
What is Streamflow?

Streamflow (or discharge m^3/s) is volume of water moving down a stream or river per unit of time.

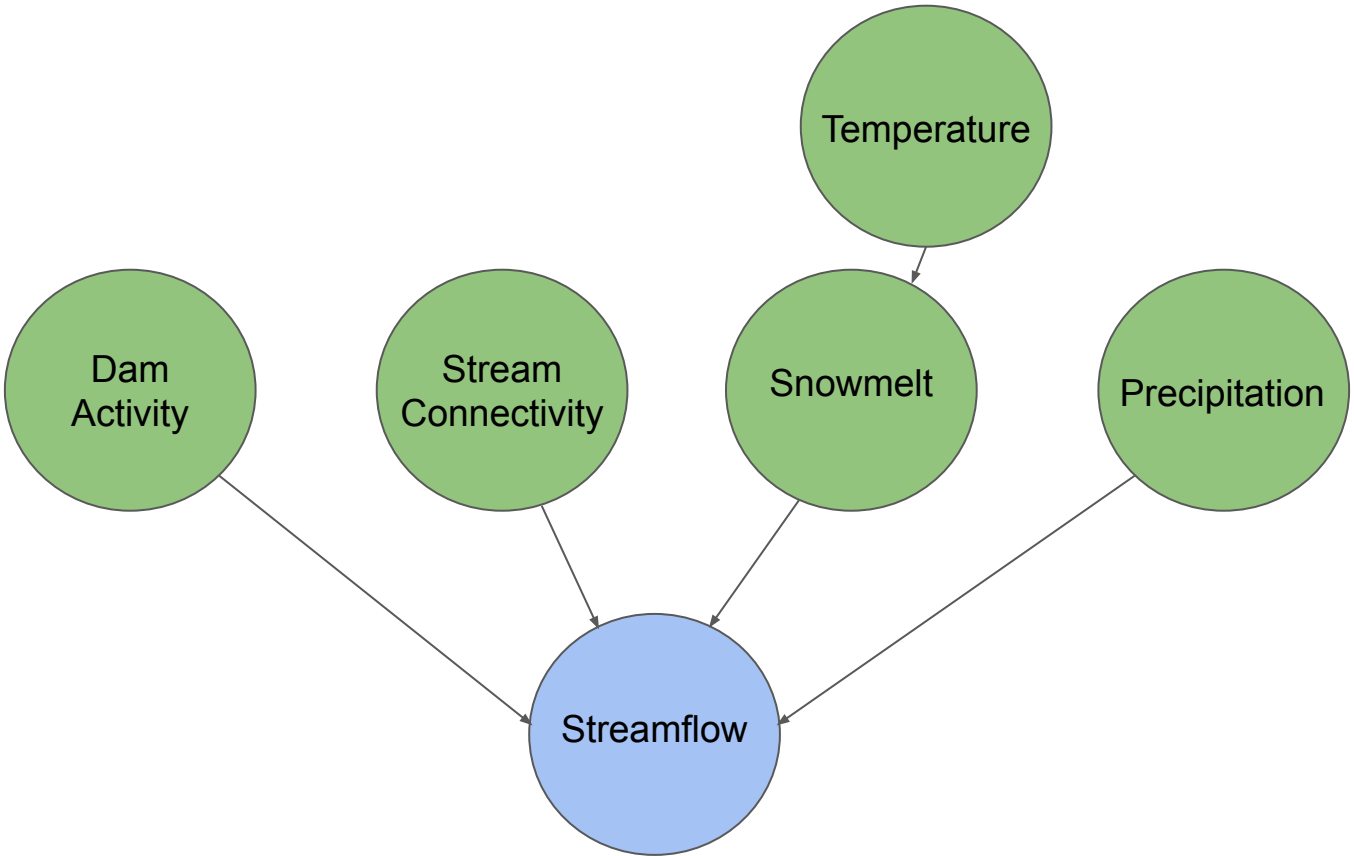


Applications of Streamflow Prediction

- Flood prediction
- Water management and allocation
- Engineering design and research

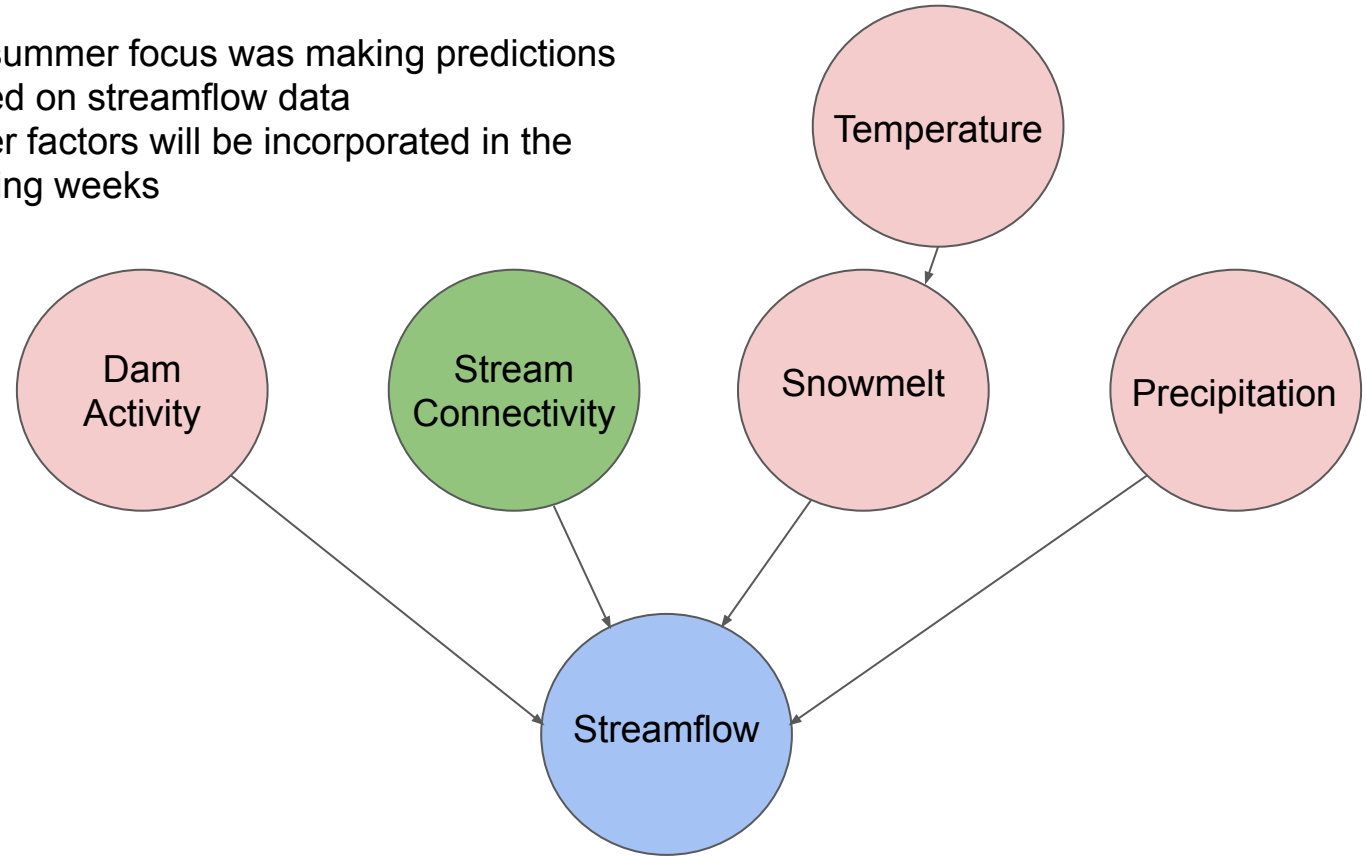
This slide was adapted from a slide created by Leo Pham

Factors Influencing Streamflow



Factors Influencing Streamflow

- My summer focus was making predictions based on streamflow data
- Other factors will be incorporated in the coming weeks



Stream Connectivity

- Challenge: Account for spatio-temporal relationships between gauges
  - The streamflow at one point in a river will be affected by streamflow upriver
  - Disconnected streams may be correlated due to impact of e.g. weather
- The relationship between stream gauges is often ignored in previous work
- Solution: Impose graph structure on data and use graph convolution

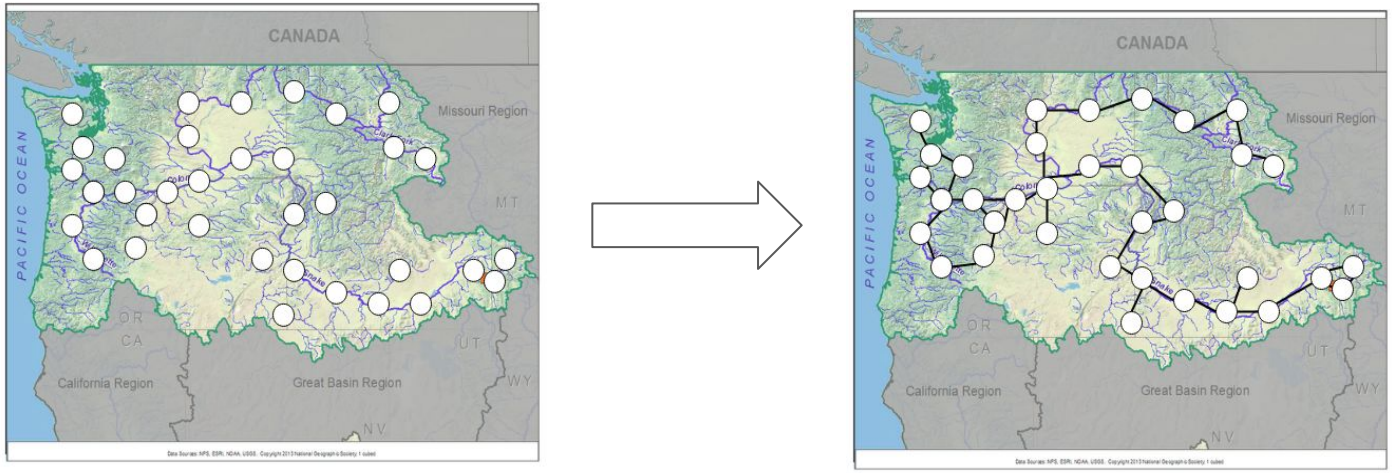
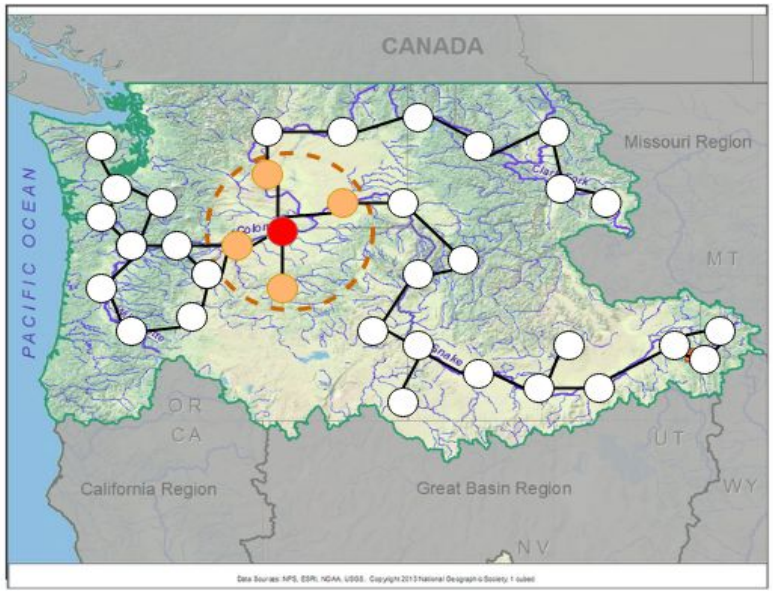


Image modified from https://www.treeflow.info

Graph Convolution

Graph convolution computes a weighted sum over neighborhoods of the graph



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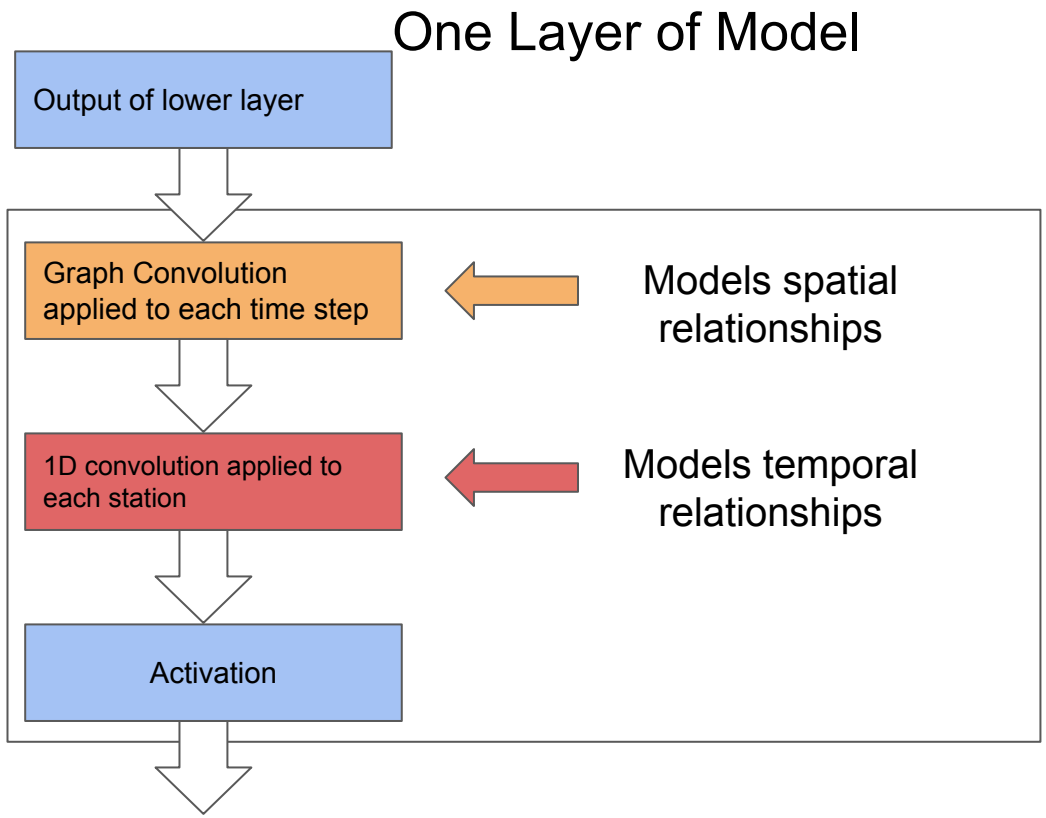
Simple approach to convolving signal X with filter W where A is adjacency matrix:

$$X * W = AXW$$

Proposed Graph Convolution Model

Use deep neural network consisting of multiple stacked layers



Data

- Focus on Pacific Northwest watershed from 2009-2018
- Predict streamflow 3 hours in the future
- Use 348 stations with < 5% missing data
- Predictions for a given station are based on
  - Streamflow data at a given station and its neighbors
  - Observations from past 9 hours
- Data collected from the United States Geologic Survey website[1]

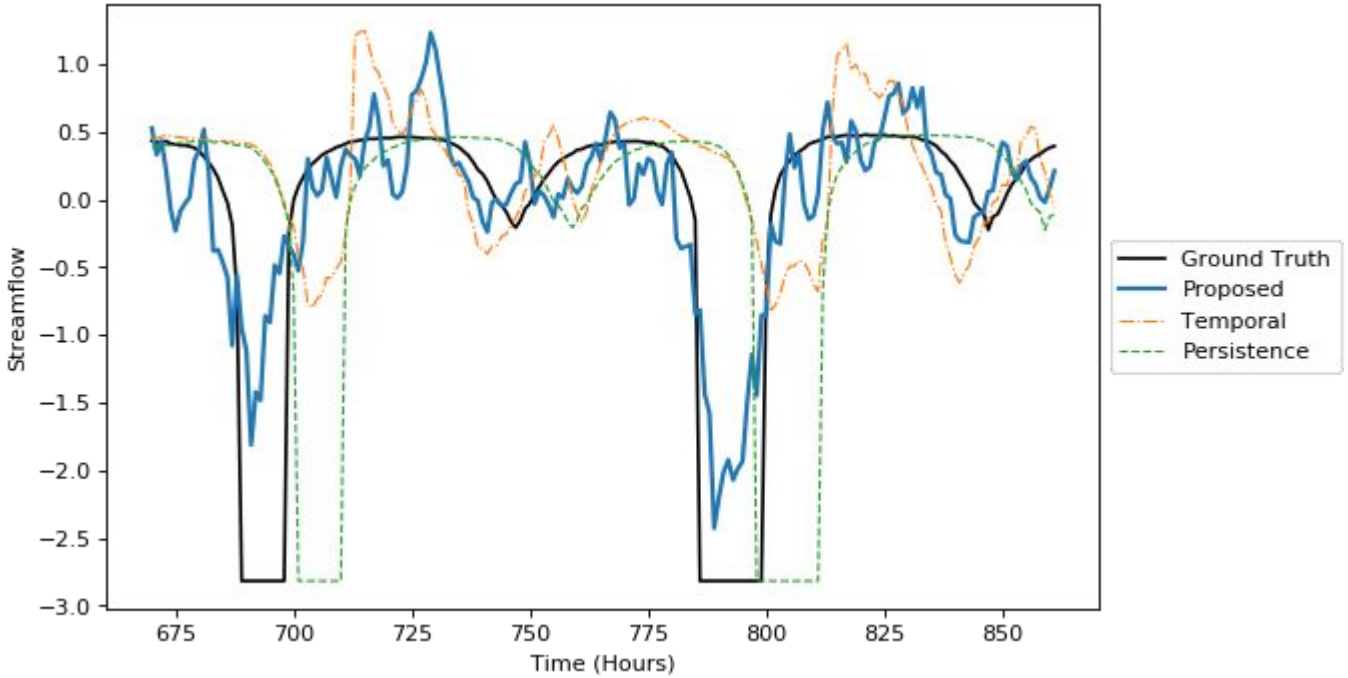
[1] https://waterservices.usgs.gov/

Results

- Compared against two baselines:
  - Persistence model assumes streamflow is constant
  - Temporal model uses convolution on local historical streamflow data only

Model	Test MSE (lower is better)
Persistence	0.0188
Temporal Model	0.0169
Proposed Graph Model	**0.0137**

Analyzing Predictions



Next Steps

- Incorporate other predictors like precipitation, snow melt, etc.
  - This is an interesting research question because different locations measure different phenomena
- Shift focus to extreme events
  - More important application
  - Will incentivize the model to better utilize predictors (i.e. predicting persistence becomes worse)
  - Can be accomplished with quantile regression, flooding classification, other techniques
- Peer reviewed paper submission

Questions?