Karlsruhe Institute of Technology

Exploring the Potential of Machine-Learning Methods
Operational Flood Forecasting in Baden-Württemberg

Institute of Water and Environment, KIT

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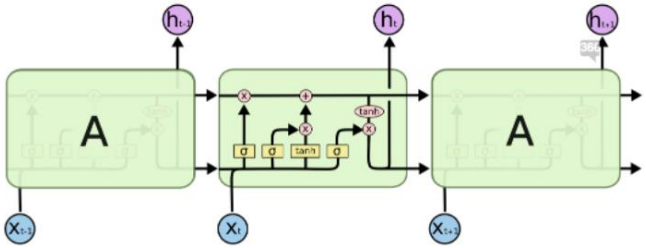
Dr. Ralf Loritz, KIT
Dr. Ingo Haag, HYDRON
Ute Badde, LUBW

Master Thesis – Outline

- **Continuous Simulations**
  - Independent model for each catchment
  - Pretrained model and finetuning
- **Operational Pseudoforecast**
  - Recursive LSTM
  - Multi-LSTM
  - Up to 72 hours forecast depth

Models

Long Short-Term Memory (LSTM)



colah.github.io, 2015

Dataset

Time	P	R	T
1			
2			
3			
4			
5			
6			
7			

Input Sequence

Target

Time	Q
1	
2	
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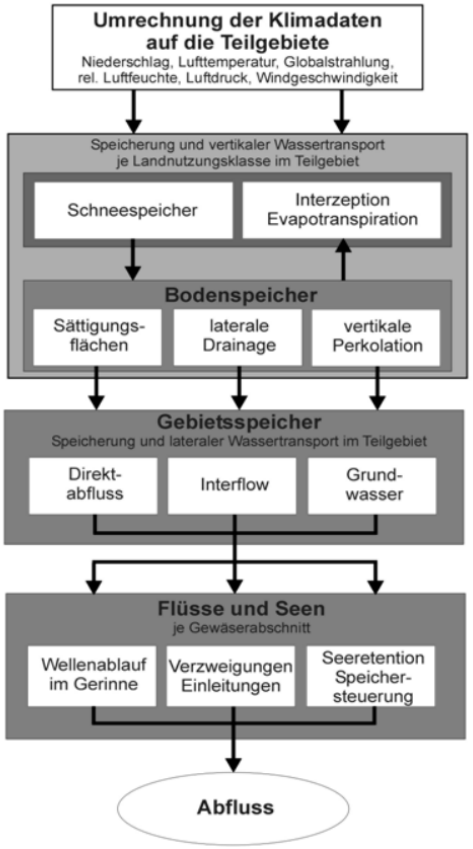
Benchmark Model: LARSIM



Das Wasserhaushaltsmodell LARSIM, 2022

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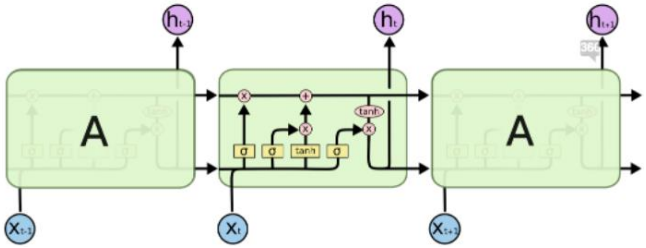

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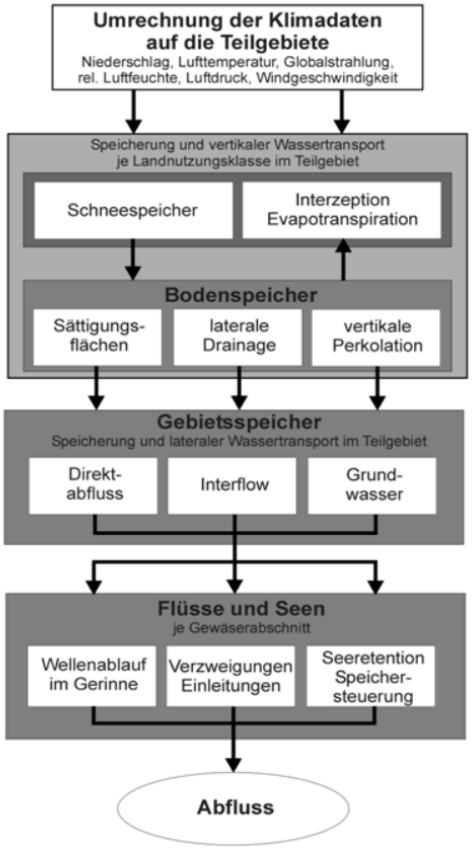
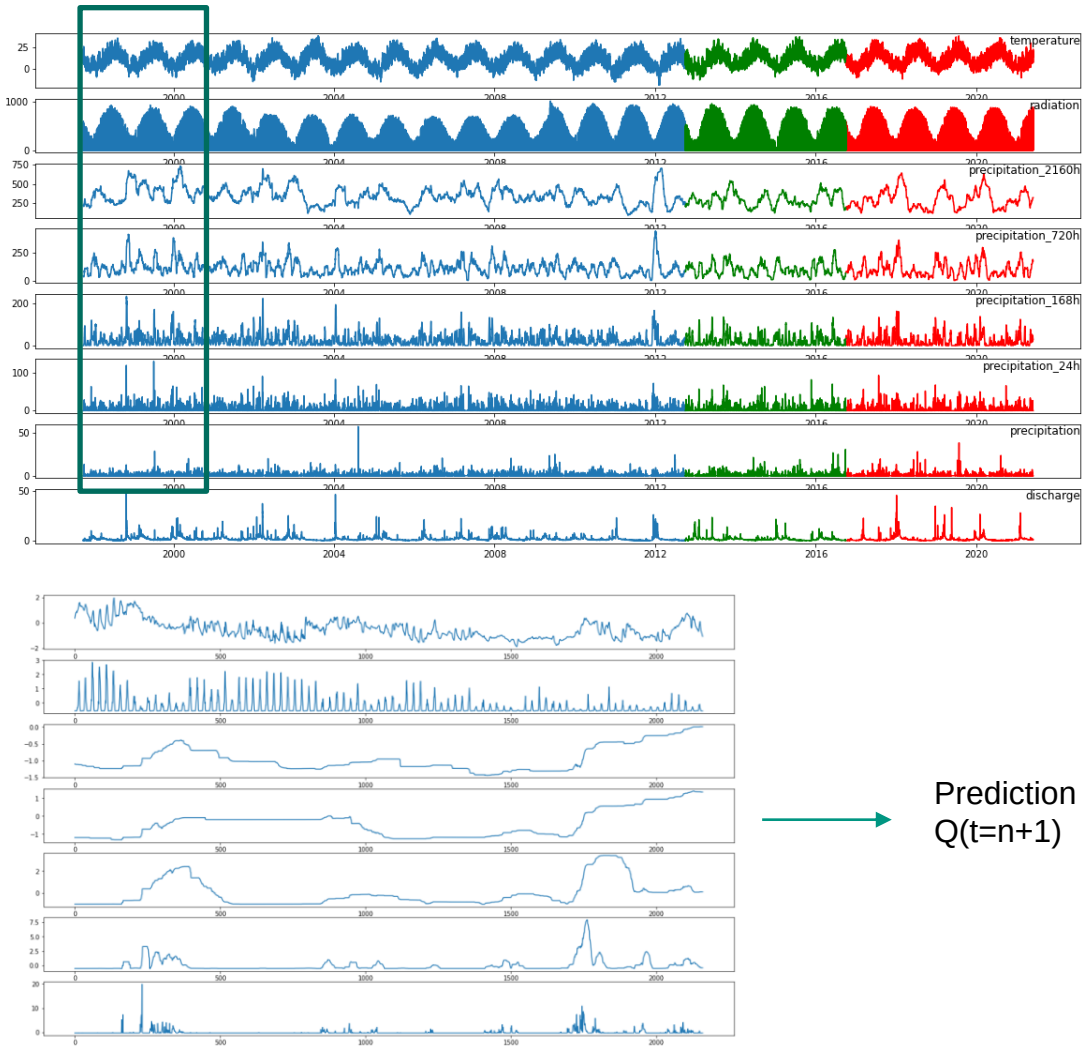


Das Wasserhaushaltsmodell LARSIM, 2022

LSTM – Training, Validation and Test

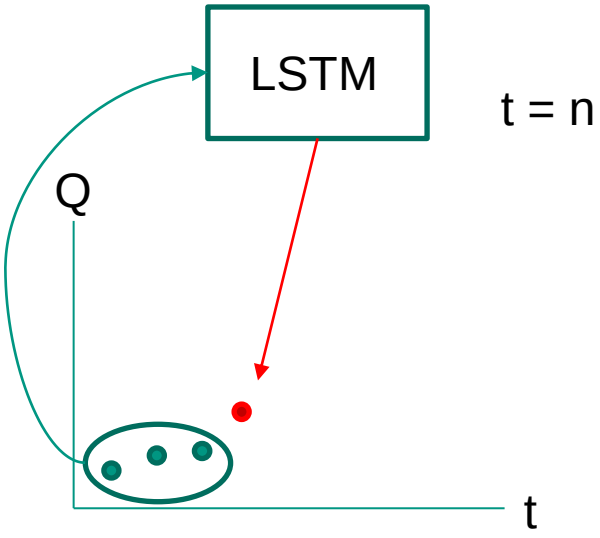
- Input (1h resolution)
  - Temperature
  - Radiation
  - Precipitation
  - Aggregated precipitation (1d,1w,1m,3m)
- Process
  - Model is trained by training data and the aim is minimum error
  - Validation data to prevent overfitting
  - Test data for performance evaluation



Operational Pseudoforecast - Methods

- LSTM Structure
  - Predictors: Temperature, Radiation, Precipitation (1h,1d,1w,1m,3m), Discharge
  - Model Types:
    - Recursive LSTM (classical approach)
    - Multiple models for each station – Multi-LSTM (new approach)

Recursive Model



Multi-LSTM

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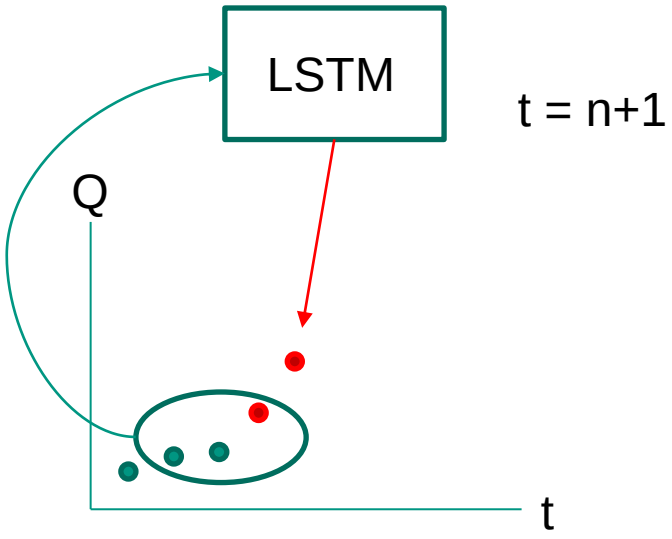

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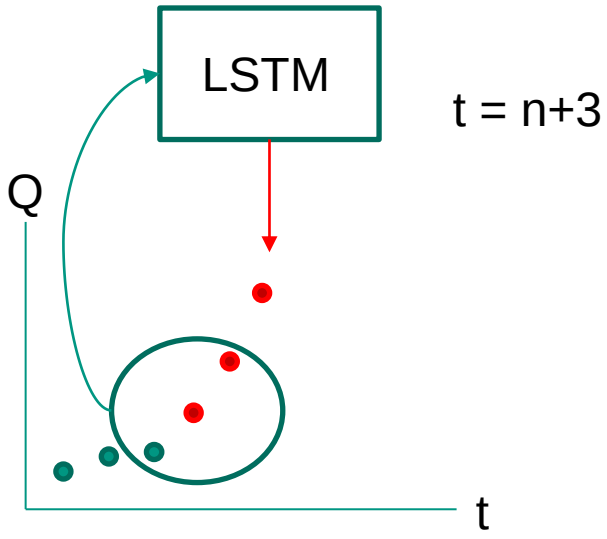

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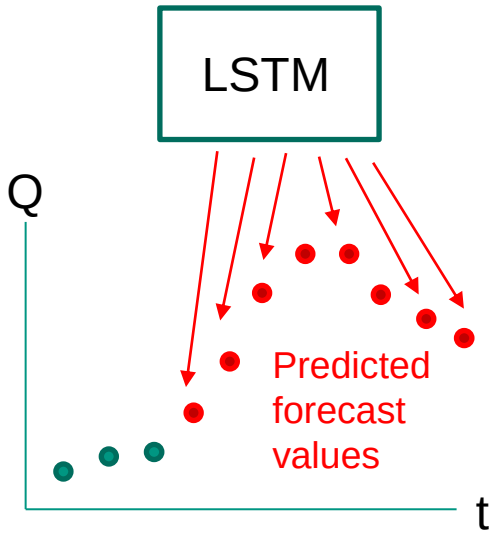

\+ Continuous prediction

\- Error propagation

\- Tendency to over or underestimate

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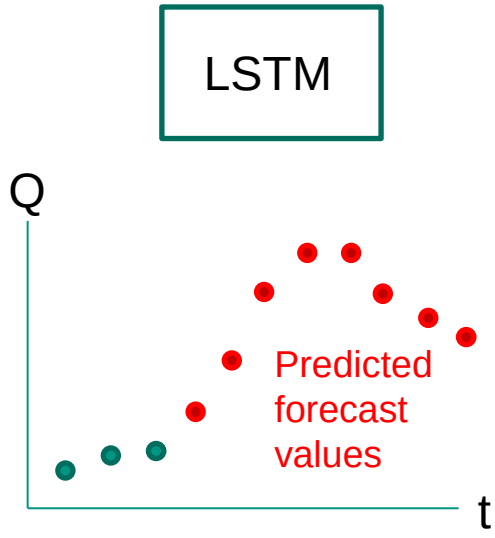

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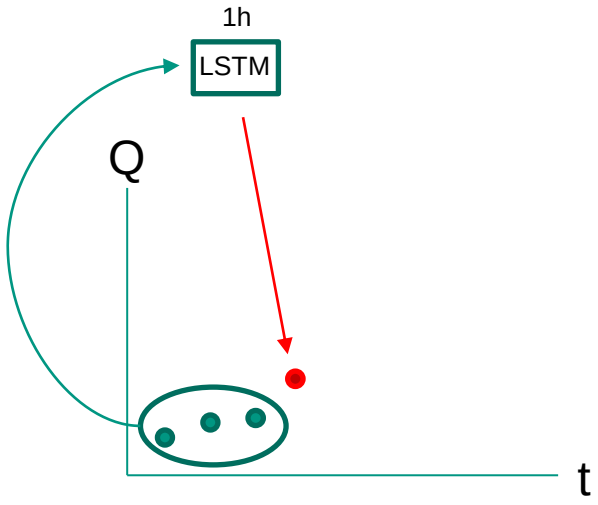

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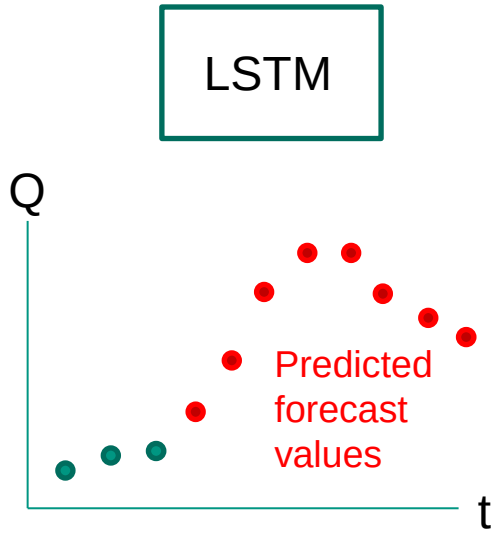

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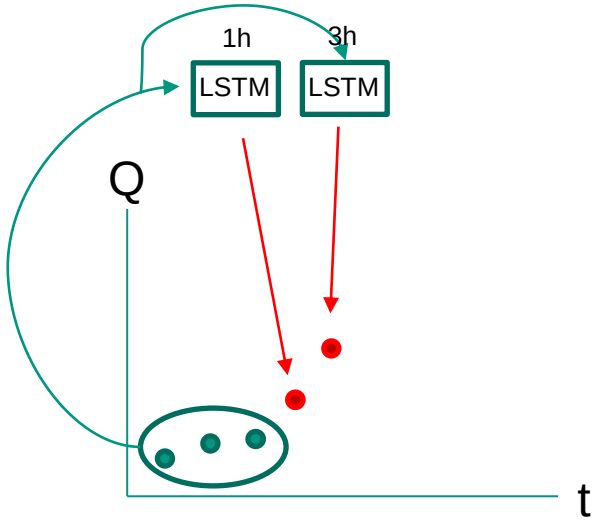

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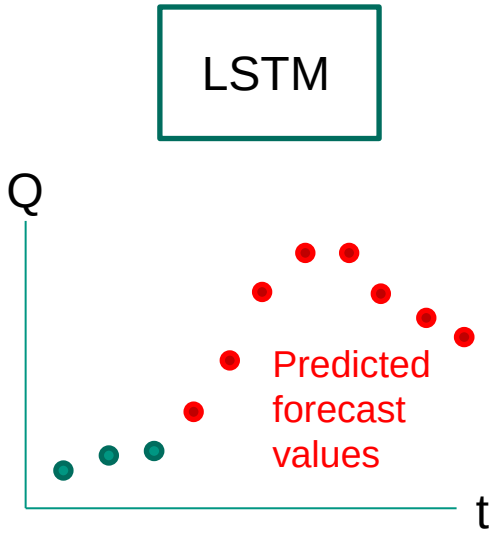

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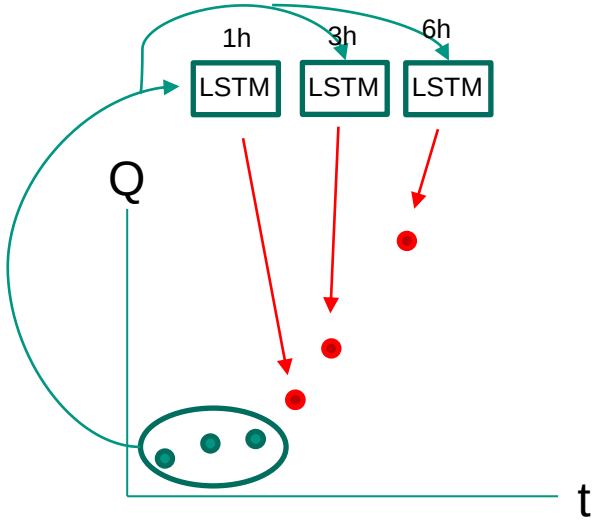

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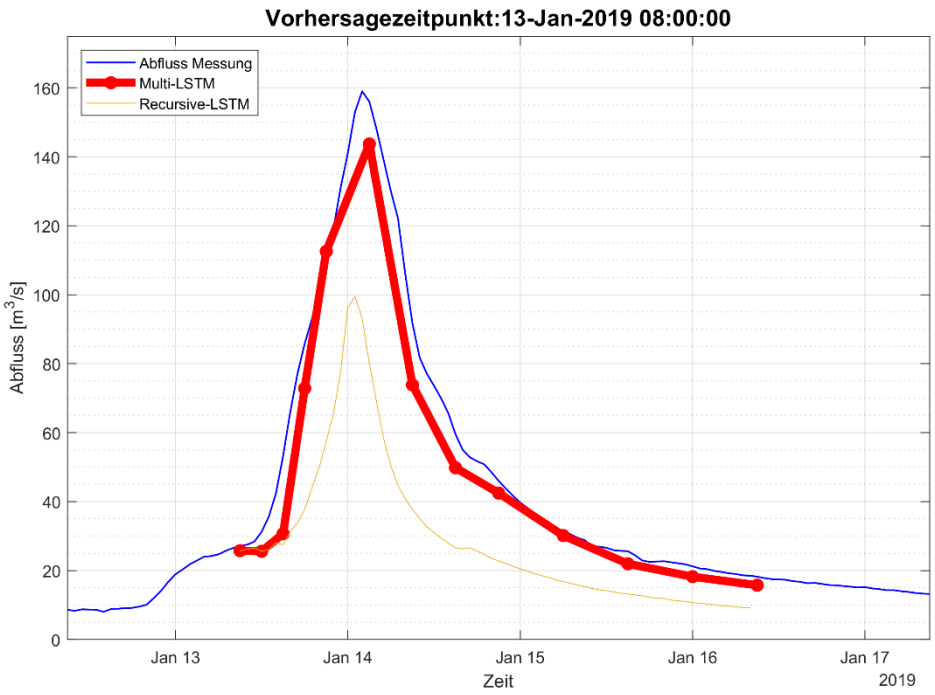
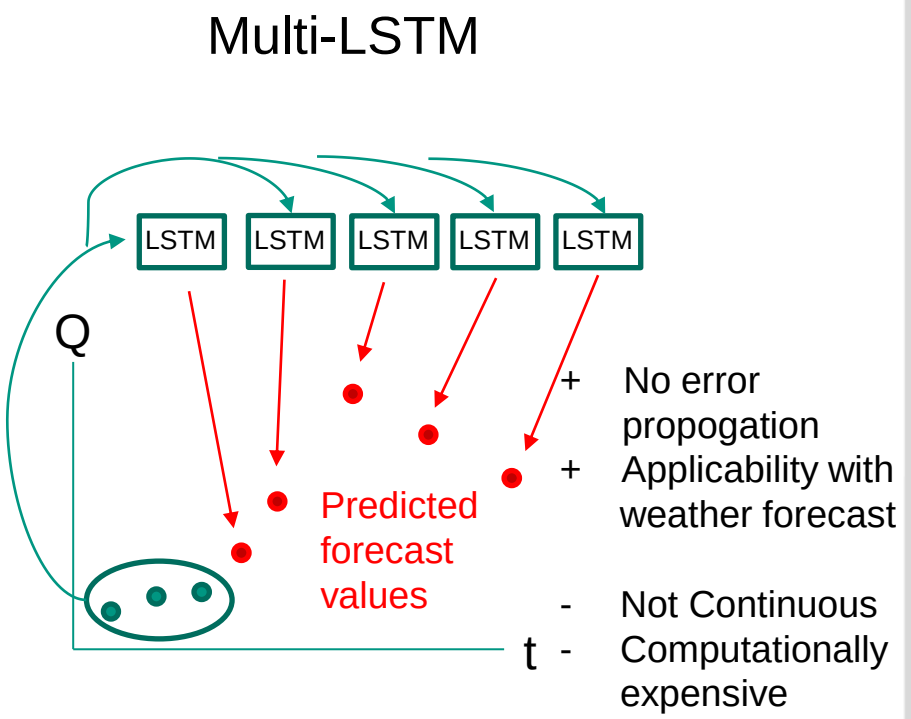
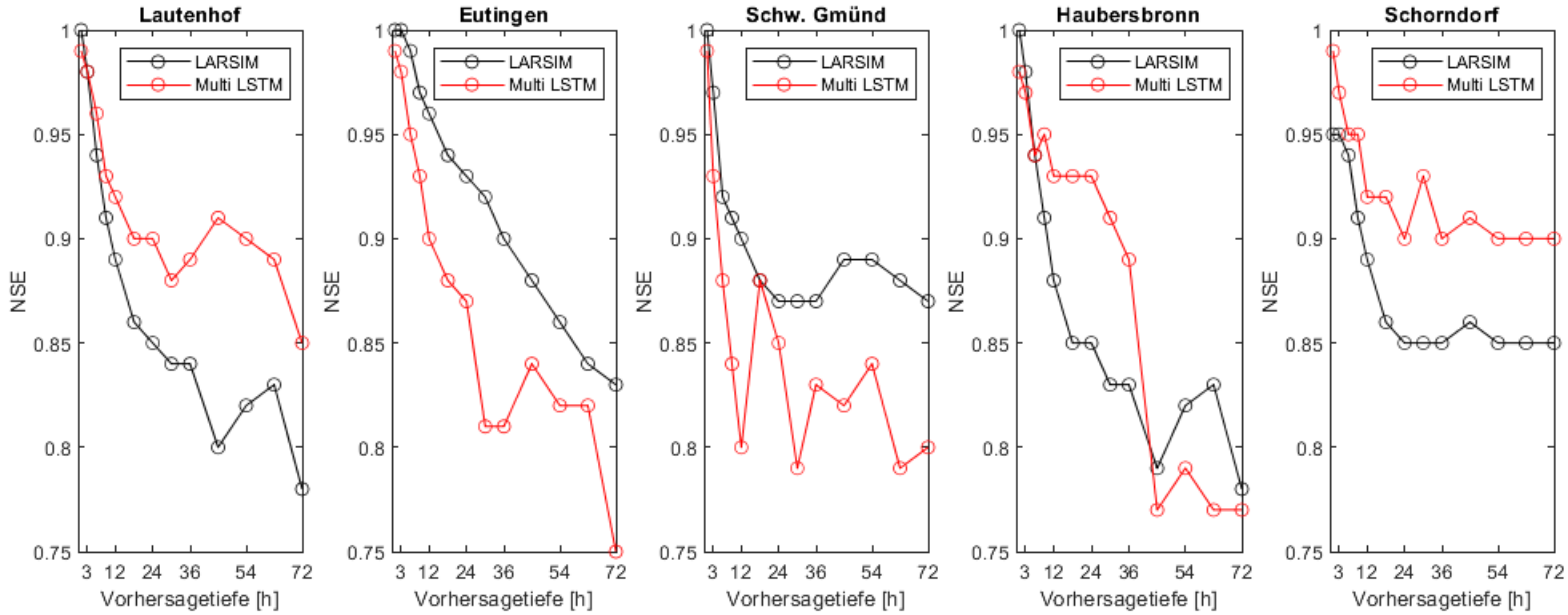


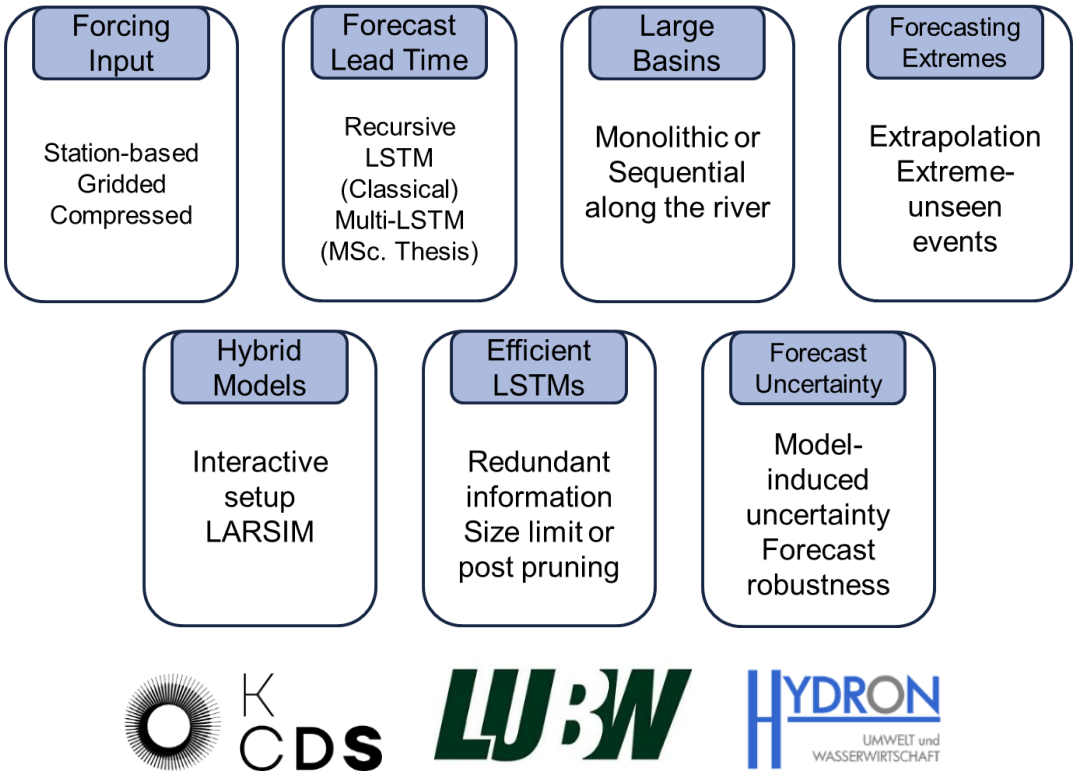


Operational Pseudoforecast - Results

- Multi-LSTM vs LARSIM – High Flow Events NSE comparison

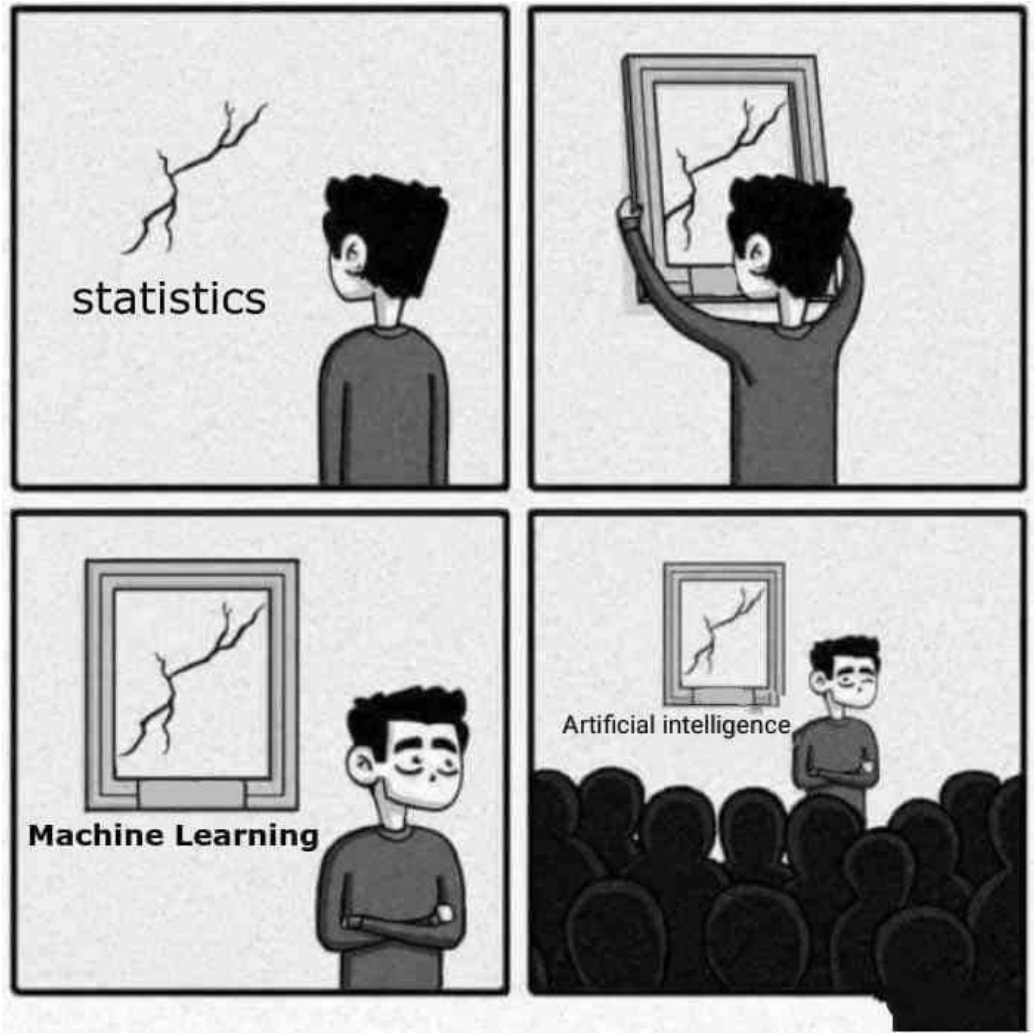


EPOforHYDRO – E4H



- Tanrikulu, Ehret, Haag, Loritz, Badde (2024) Untersuchungen zum Potential maschineller Lernverfahren für die hydrologische Simulation und Vorhersage am Beispiel von LSTM und LARSIM in Baden-Württemberg
- Accepted for publication in Hydrologie & Wasserbewirtschaftung

Thank you!



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