LSTM research

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LSTM

- RNN with long and short term memory.
- Long term memory not possible in ordinary RNN's because of vanishing gradients.
- Long term memory is very important for runoff modelling, as some features take a long time to impact. Snow for example.

EA-LSTM

- Paper [2] introduces the EA-LSTM (Entity Aware), which is a modified version of the LSTM designed to better with this this problem.
- Beneficial for hydrological modelling because it is able to process information about the current catchment that it is modelling (?).

Usage of existing code

- Notebook tutorial for using LSTM used in paper [1] can be found at `https://github.com/kratzert/pangeo_lstm_example`
  - This repository includes a binder link for running the notebook in browser.
  - Notebook shows easy to understand examples of how to use Pytorch and how to load the CAMELS dataset.
- Code for paper [2] can be found at `https://github.com/kratzert/ealstm_regional_modeling`
  - This github page contains links to datasets used as well as pre trained models.
  - Need stronger computer to recreate the models, but should hopefully be possible to used the pre trained models from laptop.
- Code for paper [3] can be found at `https://github.com/kratzert/lstm_for_pub`
- Spend most time on the first paper in the beginning, it is important to actually understand how an LSTM model works (not to mention RNNs in general!).

Purely data driven model

- A lot of code already exists
- First thing to try is to explicitly provide snow data (which is not done by papers cited in this document).
- Possibly unreliable as we have less physical intuition, but unsure if a hybrid model performs better.
- LSTM or EA-LSTM

Hybrid model

- Could be more intuitive, possibly also more reliable.
- Trained using Shyft in the training process. Using the output from Shyft as an input for instance.
- Probably more difficult to train.
- LSTM or EA-LSTM

References

[1] F. Kratzert, D. Klotz, C. Brenner, K. Schulz, and M. Herrnegger, "Rainfall–runoff modelling using long short-term memory (lstm) networks," *Hydrology and Earth System Sciences*, vol. 22, no. 11, pp. 6005–6022, 2018.

[2] F. Kratzert, D. Klotz, G. Shalev, G. Klambauer, S. Hochreiter, and G. Nearing, "Towards learning universal, regional, and local hydrological behaviors via machine learning applied to large-sample datasets," *Hydrology and Earth System Sciences*, vol. 23, no. 12, pp. 5089–5110, 2019.

[3] F. Kratzert, D. Klotz, M. Herrnegger, A. K. Sampson, S. Hochreiter, and G. S. Nearing, "Toward improved predictions in ungauged basins: Exploiting the power of machine learning," *Water Resources Research*, vol. n/a, no. n/a.