INTRODUCTION TO STATKRAFT'S HYDROLOGIC FORECASTING TOOLBOX

Providing a framework for hydrologic forecasting in operational environments

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Developers: Burkhart, Matt, Abdella, Helset, Skavhaug
Statkraft’s global presence – modeling challenges

Installed capacity
19 080 MW
97% renewable energy

Power production
63 TWh
3 500 employees

- Norway: 13 769 MW
- Sweden: 1 977 MW
- Germany: 2 694 MW
- Turkey: 122 MW
- Brazil: 257 MW
- Peru: 442 MW
- Chile: 213 MW
- UK: 152 MW
- France: 72 MW
- USA: San Francisco
- Netherlands: 14 MW
- India: 136 MW
- Nepal: 34 MW
- THE NETHERLANDS: 14 MW
- UK: 152 MW
- FRANCE: 72 MW
- ALBANIA: 72 MW
- TURKEY: 122 MW
- NEPAL: 34 MW
- USA: San Francisco

Installed capacity
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Shyft is a C++ and Python based toolbox designed to:

• provide a **flexible** hydrologic forecasting toolbox built for operational environments

• enable highly **efficient** calculations of hydrologic response at the regional scale

• use the multiple working hypothesis to obtain an **optimal** catchment forecast

• rapid implementation of **improvements** identified through research activities

⇒ Give us control of the sensitivity and uncertainty of model and the forcings
Method of multiple configuration testing

By keeping the hydrologic model simple, and using a flexible API, SHyFT enables us to evaluate uncertainty and sensitivity resulting from multiple forecast system configurations:

- Which model provides greatest fidelity to our forecast?
- What forcing datasets provide the best inflow forecasts?
- What is the impact of choice of calibration routine?
- Can we calibrate using remote sensing data?
- Energy balance or degree day?
- What is the appropriate scale?
"SHyFT is *not* a model!"

"SHyFT *is* a platform, with an API!"

```python
from shyft import api

params = api.pt_gs_k.PTGSKParameter()
model = api.pt_gs_k.PTGSKModel(cell_data_vector, params)
model.run_cells()
```
True flexibility is gained in evaluation of multiple configurations

### Uncertainty/Sensitivity Stems From:
- choice of model
- forcing input
- objective function
- observation uncertainty
The hydrological model in SHyFT

‘Model Stacks’ allow us to address uncertainty and sensitivity due to model selection by providing a simple collection of routines for hydropower inflow forecasting.
Shyft allows for multiple working hypothesis

Models:
- PTGSK
- PTHSK
- PTSSK
Computational efficiency allows for testing of a large number of model configurations.

Models:
- PTGSK
- PTHSK
- PTSSK

Parameters:
- Param 1
- Param 2
- ...
Forcing data represents the «truth», but what is the correct forcing?

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<th>Forecast Input</th>
<th>Input Processing</th>
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<th>Routing</th>
<th>Calibration</th>
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</tbody>
</table>
Repository concept allows for fast analysis of different data sources

Models:
- PTGSK
- PTHSK
- PTSSK
- SeNorge
- ECMWF
- ...
Model spread resulting from various sources of uncertainty and sensitivities

Model spread from uncertainty in:
- Model structure
- Model parameters
- Model forcing data

![Graph showing model spread from uncertain sources](https://example.com/graph)
Operational forecasting with uncertainty

Forcing data:
gridded data from a weather generator
Horizon: 200 days
Simulation time resolution: hourly
Simulation spatial resolution: 2x2 km
THANK YOU

SHyFT is available from:
https://github.com/statkraft/shyft

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