A FEASIBILITY STUDY OF UPPER-LAYER RESERVOIR OPERATION FOR HYDRO POWER GENERATION IN JAPANESE DAMS

A PREPRINT

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ABSTRACT

Traditionally, the uncertainty in reservoir inflow forecast have lead dam operators to adopt conservative operation strategies. However two factors come to challenge this status quo: First, as both fossile fuel and atomic plant receive increased criticism for social and environmental xxx,

Keywords Dam Reservoir Operation · Hydro Power Generation · Discharge Forecast · Reinforcement Learning · Machine Learning

1 Introduction

Japanese power generation situation.

Summary of contributions:

- Data operational
- Operational models for reservoir input flow
- Methodolody: Vertical integration.
- Open-source everything with easy-to-use tutorials for researchers to join.

Limitations

- No multi-purpose
- No multi-dam

Nevertheless, we hope it's useful.

2 Related Work

Dam operation. Discharge prediction.

3 Methodolody

Show Figure.

3.1 Overview

3.2 Meteorological model

3.3 Hydrological Model

3.4 Dam Model

3.5 Grid Response

The grid response model defines the reward r obtained for a given power production P at a given time t:

$$r = f(P, t)$$

This reward can be though of as a profit in a free-market economy, and is the sum of two terms:

$$r = r_n + r_p$$

The positive quantifies the benefit of energy produced. Currently, we use $f(x) = x$, considering constant value over time of the generated power. However, hydro's value lies in its non-intermittence to supplement intermittent sources. It would be interested to couple this with actual demand response simulations in the future.

The negative price quantifies the cost of a dam failure. We considered this price to be the sum over This means that the negative impact of a single dam failure over the whole period of activity would outweight the benefits of full power production of the whole dam operation.

3.6 Dam Operation Model

4 Proposed Dataset

5 Optimal Dam Operation

We start by optimizing the dam without any uncertainty.

5.1 Baseline

5.2 Optimal Operator

5.3 Operation Under Uncertainty

5.4 Experiment

- Answers the following question:

1. What is the forecast horizon needed in order to keep the dam from overflowing? -> Show as input distribution.

2. Impact of state design on RL baseline.

3. Show the ideal model is brittle. How?

6 Hydrological Uncertainty

In this section, we use assimilated data, no forecast.

6.1 Hydrological Models

Use Camaflood, conceptual rainfall runoff, linear, non-linear and deep machine learning models.

Table 1: Model accuracy

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

6.2 Experiments

6.2.1 Discharge prediction

Show accuracy of different models.

6.2.2 Dam operation

Show reward of different models.

7 Meteorological Uncertainty

7.1 Meteo Data

7.2 Experiments

Use different data source.

7.3 Meteorological Uncertainty

8 Limitations

- No multi-purpose
- No multi-dam
- No explicit evaporation modeling
- Heuristic dimensioning.
- No river and snow gauge.

9 Conclusion

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