

Hyperparameter Tunning

OVERVIEW

searched for the best “all-features” network settings by

1. Defining a search space (hyperparameters definition)

- **Architecture:** number of hidden layers (1–3) and units per layer (32, 64, 128)
- **Regularization:** dropout rate (0–0.4) and L2 weight penalty (1e-5 to 1e-2)
- **Optimizer:** Adam with learning rates {1e-3, 3e-4, 1e-4}

2. RandomSearch

20 trials × 2 repeats each

using Keras-Tuner, with early stopping on validation MSE (patience = 5).

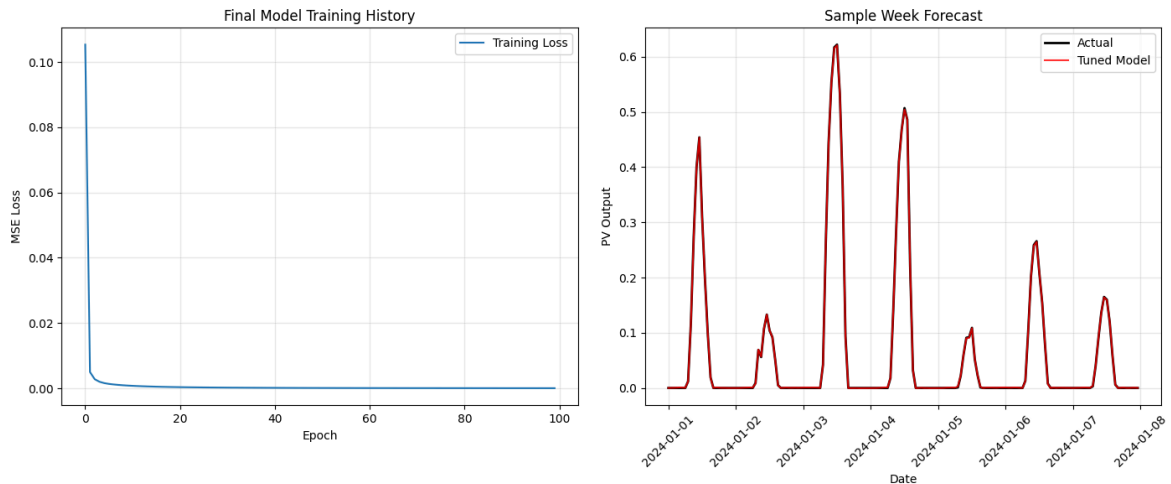
3. Selecting the best hyperparameter set

- a. minimized validation loss
- b. then rebuilding and retraining that configuration on the full training data (year 2024)

4. Evaluating

comparing against the time-only and weather-only baselines

RESULT-PLOTS



TUNING RESULTS ANALYSIS

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Best hyperparameters found:

n_layers: 2

units: 32

dropout: 0.0

l2_regularization: 1.578675138066154e-05

learning_rate: 0.0003

/Users/rvieira/Library/Caches/pypoetry/virtualenvs/vt2-optimization-datamod
saveable.load_own_variables(weights_store.get(inner_path))

Best model architecture:

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 32)	1,024
dropout (Dropout)	(None, 32)	0
dense_1 (Dense)	(None, 32)	1,056

dropout_1 (Dropout)	(None, 32)	0
dense_2 (Dense)	(None, 1)	33

Total params: 2,113 (8.25 KB)

Trainable params: 2,113 (8.25 KB)

Non-trainable params: 0 (0.00 B)

Top 3 trials:

Trial 1: Loss = 0.000052

n_layers: 2

units: 32

dropout: 0.0

l2_regularization: 1.578675138066154e-05

learning_rate: 0.0003

Trial 2: Loss = 0.000092

n_layers: 2

units: 128

dropout: 0.0

l2_regularization: 1.342764508669909e-05

learning_rate: 0.001

Trial 3: Loss = 0.000370

n_layers: 1

units: 128

dropout: 0.1

l2_regularization: 1.606494946330764e-05

learning_rate: 0.0003

FINAL EVALUATION ON TEST SET

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FINAL RESULTS (1-year test - year 2024):
Time-only baseline  MAE=0.015, RMSE=0.029
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Weather-only baseline MAE=0.085, RMSE=0.103

Tuned all-features MAE=0.001, RMSE=0.001

IMPROVEMENTS:

vs Time-only: MAE +96.2%, RMSE +97.1%

vs Weather-only: MAE +99.3%, RMSE +99.2%

HYPERPARAMETER TUNING SUMMARY REPORT

Experiment completed at: 2025-05-30 23:38:00.978868

Total tuning time: 17.7 minutes

Trials evaluated: 20

Test period: 2024-01-01 00:00:00 to 2024-12-31 23:00:00

Best hyperparameters:

n_layers: 2

units: 32

dropout: 0.0

l2_regularization: 1.578675138066154e-05

learning_rate: 0.0003

Final performance:

MAE: 0.001

RMSE: 0.001

Baseline comparisons:

Time-only baseline beaten: ✓

Weather-only baseline beaten: ✓

Key improvements achieved:

vs Time-only: +96.2% MAE, +97.1% RMSE

vs Weather-only: +99.3% MAE, +99.2% RMSE

TUNING COMPLETE
