TE Connectivity Sales Forecasting

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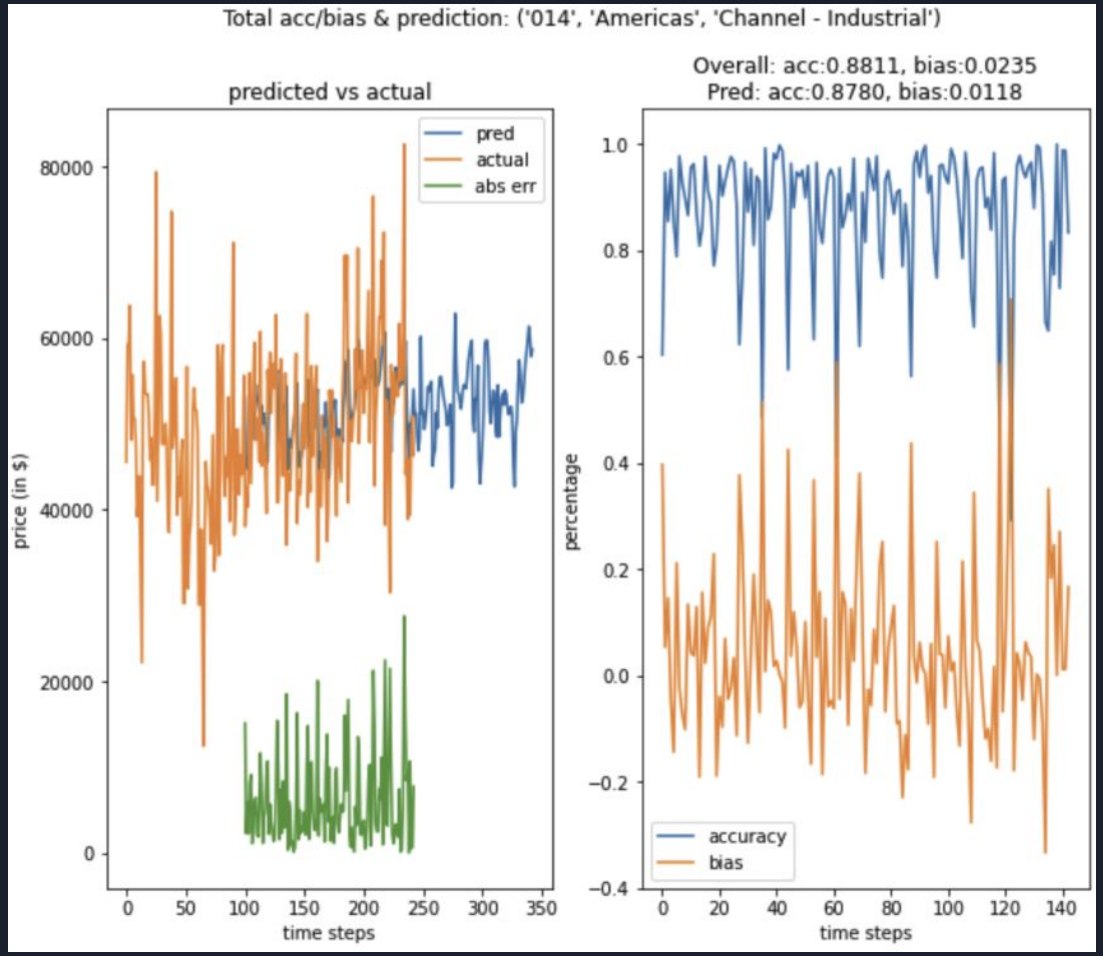
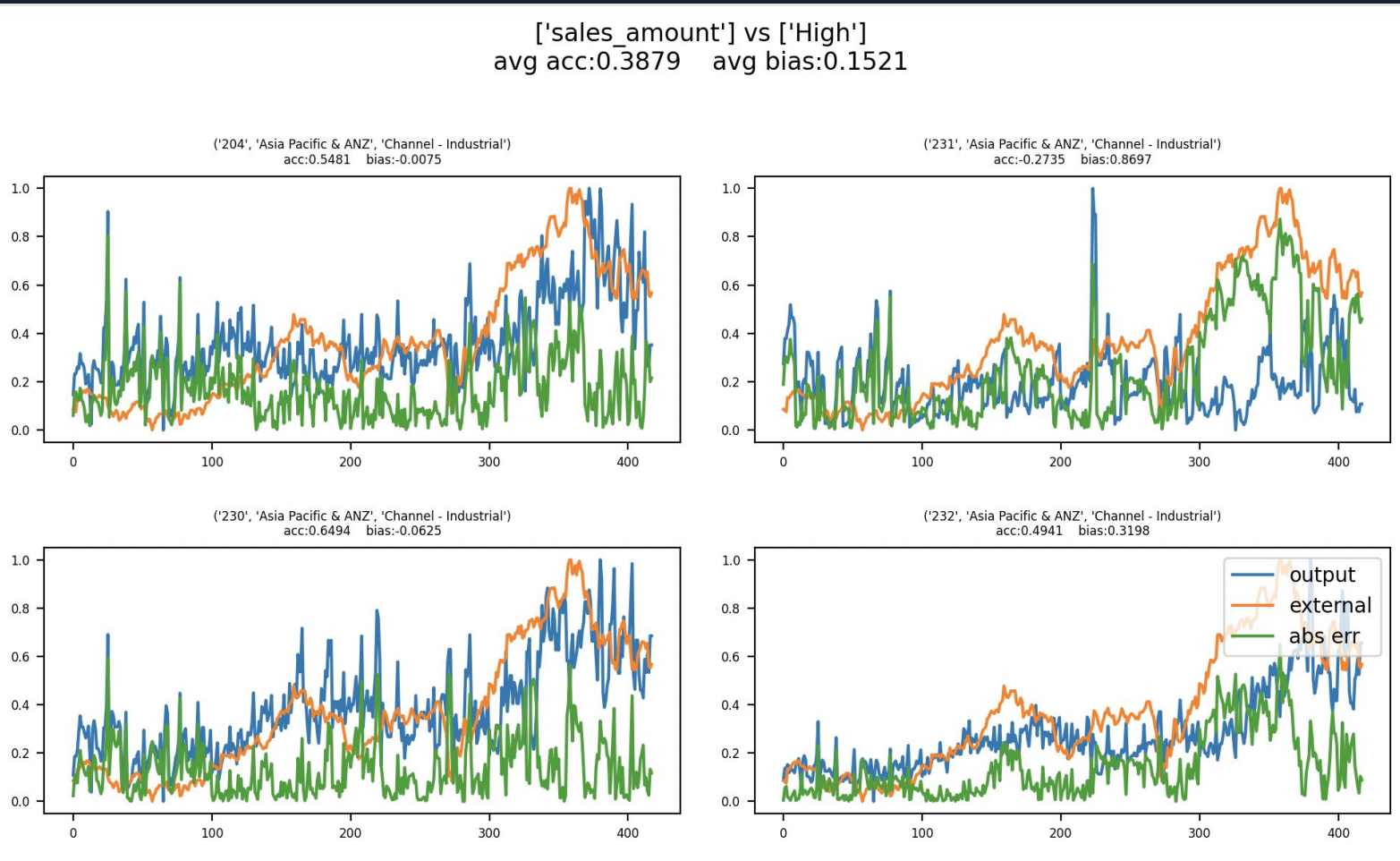
Overview

1. **Task description**
2. Framework (dvc / mlflow)
3. External Indicators
4. Results

1.0 Predict Sales for ~1300 products for 18 months



1.1 External Indicators



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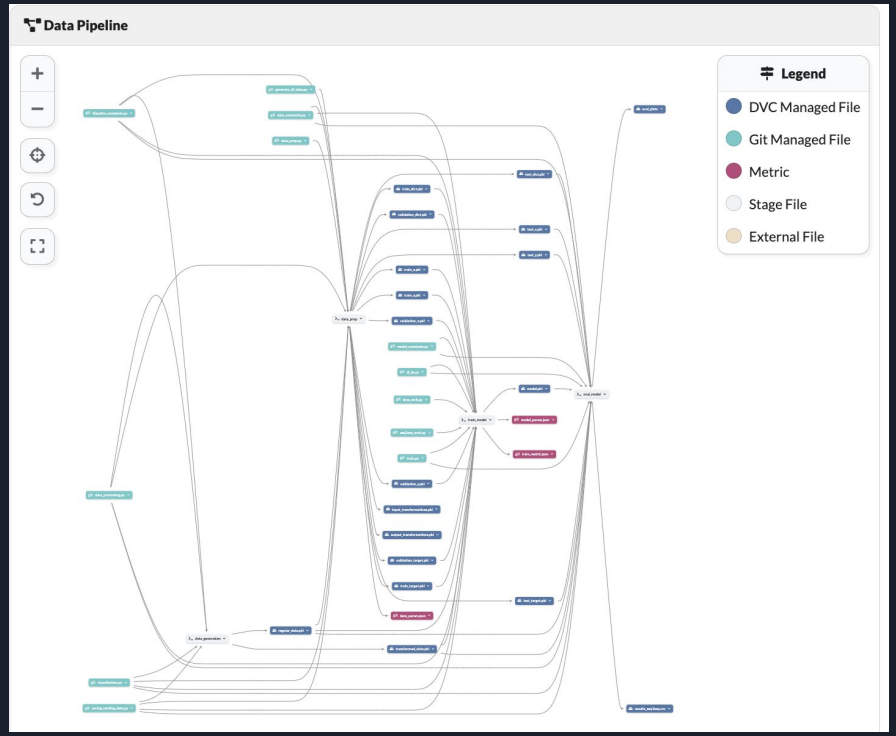
2.1 Framework: DVC / MLFLOW



DVC:

- Store data / models in DVC
- Store code / small files in git

MLFLOW:

- Track experiments using different models, hyper params
- Reproducible experiments

Allow for **standardized, trackable** testing environment.

2.2 Repo Structure:

Motivation: A **Robust, Modular,** testing environment for time-series forecasting with **any** data

Evaluation:

```
VISUALIZATION_VERBOSE = False  # verbose mode for visua
PREDICT_ALL_FORCAST = True  # prediction: check if you
PREDICT_MODEL_FORCAST = False  # prediction: check if y
PREDICT_RECURSIVELY = False  # control how you want to
PERCENT_DISPLAY_MODEL_FORCAST = 0.1  # display if great
PREDICT_DISPLAY_COUNT = 10  # number of times you will
SAVE_EVAL_PLOTS = True
EVAL_PLOTS_DPI = 72
```

Architecture:

```
class MODEL_CHOICE(Enum):
    SEQ2SEQ = 0
    BASIC_LSTM = 1
    TIME_TRANSFORMER = 2
    DEEP_ESN = 3
    TFT = 4


ARCH_CHOICE = MODEL_CHOICE.TFT
```

Data:

```
DATA_FILTER = ["Asia Pacific & ANZ", "Industrial"]
# data_filter = ["Asia Pacific & ANZ"]
# collumns of interest
INPUT_DATA_COLS = ["sales_amount", "sales_quantity",
                   "Price"]  # add features to end to make itself
OUTPUT_DATA_COLS = ["sales_amount"]
TEST_TRAIN_SPLIT = 0.8  # test-train split percentage
PERCENT_TRAIN_DATA = 0.7
PERCENT_TEST_DATA = 0.1
PERCENT_VALID_DATA = 1 - PERCENT_TRAIN_DATA - PERCENT_TEST_DATA
LOOKBACK = 10  # number of units used to make prediction
PREDICT = 10  # number of units that will be predicted

new *
class prediction_time(Enum):
    MONTHLY = 1
    DAILY = 2

PREDICTION_TYPE = prediction_time.DAILY
```

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4. Past work / results

3.0 Source of Indicators

Sources: Bloomberg, Google Finance, Yahoo Finance

Gathered about 400-500 indicators

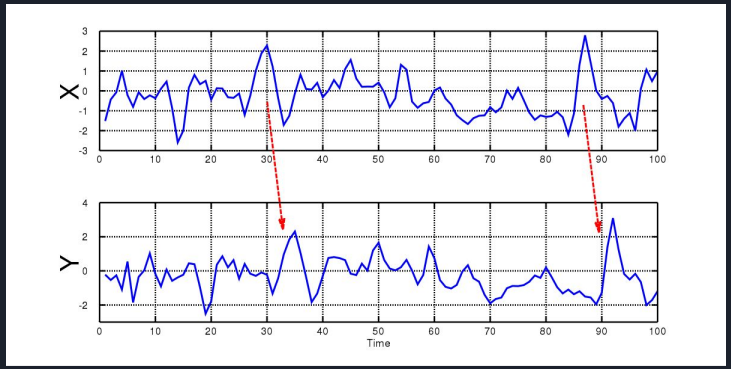
Bloomberg

Google Finance

3.1 External Indicator Analysis

Correlation Analysis, Granger Causality Test

1339 Unique Product Codes, Business Unit Name, Region Name



sales_amc	0.71_Imports (USD bn, sa)	0.69_canada_df_Nominal GDP	0.68_JOLTS Job Openings (yoy %)	fiscal_yea	fiscal_qua	fiscal_mor	fiscal_wee	business_u	company_	product_li	product_li	product_li	sales_quar	Price
122731.8	233.11	1984.3	3.7	2015	1	1	2	Channel - I	Asia Pacifi	9	9	Miscellane	39344.25	3.119433
147278.1	233.11	1984.3	3.7	2015	1	1	3	Channel - I	Asia Pacifi	9	9	Miscellane	47213.1	3.119433
142368.8	233.11	1984.3	3.7	2015	1	1	4	Channel - I	Asia Pacifi	9	9	Miscellane	45639.33	3.119433
116698.5	225.837	1984.3	3.7	2015	1	2	5	Channel - I	Asia Pacifi	9	9	Miscellane	60584.4	1.926214
136148.3	225.837	1984.3	3.7	2015	1	2	6	Channel - I	Asia Pacifi	9	9	Miscellane	70681.8	1.926214
123181.8	225.837	1984.3	3.7	2015	1	2	7	Channel - I	Asia Pacifi	9	9	Miscellane	63950.2	1.926214
149114.8	225.837	1984.3	3.7	2015	1	2	8	Channel - I	Asia Pacifi	9	9	Miscellane	77413.4	1.926214
129665	225.837	1984.3	3.7	2015	1	2	9	Channel - I	Asia Pacifi	9	9	Miscellane	67316	1.926214
80534.77	241.004	1984.3	3.6	2015	1	3	10	Channel - I	Asia Pacifi	9	9	Miscellane	49719.84	1.619771
80534.77	241.004	1984.3	3.6	2015	1	3	11	Channel - I	Asia Pacifi	9	9	Miscellane	49719.84	1.619771
93957.23	241.004	1984.3	3.6	2015	1	3	12	Channel - I	Asia Pacifi	9	9	Miscellane	58006.48	1.619771
80534.77	241.004	1984.3	3.6	2015	1	3	13	Channel - I	Asia Pacifi	9	9	Miscellane	49719.84	1.619771
44672.16	232.923	1984.92	3.8	2015	2	4	14	Channel - I	Asia Pacifi	9	9	Miscellane	20526.66	2.1763
95726.05	232.923	1984.92	3.8	2015	2	4	15	Channel - I	Asia Pacifi	9	9	Miscellane	43985.7	2.176299
89344.32	232.923	1984.92	3.8	2015	2	4	16	Channel - I	Asia Pacifi	9	9	Miscellane	41053.32	2.1763
89344.32	232.923	1984.92	3.8	2015	2	4	17	Channel - I	Asia Pacifi	9	9	Miscellane	41053.32	2.1763
101392.2	230.42	1984.92	3.8	2015	2	5	18	Channel - I	Asia Pacifi	9	9	Miscellane	42752.38	2.371615
115218.4	230.42	1984.92	3.8	2015	2	5	19	Channel - I	Asia Pacifi	9	9	Miscellane	48582.25	2.371615
106000.9	230.42	1984.92	3.8	2015	2	5	20	Channel - I	Asia Pacifi	9	9	Miscellane	44695.67	2.371615
64522.3	230.42	1984.92	3.8	2015	2	5	21	Channel - I	Asia Pacifi	9	9	Miscellane	27206.06	2.371615
78348.51	230.42	1984.92	3.8	2015	2	5	22	Channel - I	Asia Pacifi	9	9	Miscellane	33035.93	2.371615
91354.19	233.937	1984.92	3.6	2015	2	6	23	Channel - I	Asia Pacifi	9	9	Miscellane	35310.24	2.587187
91354.19	233.937	1984.92	3.6	2015	2	6	24	Channel - I	Asia Pacifi	9	9	Miscellane	35310.24	2.587187
100054.6	233.937	1984.92	3.6	2015	2	6	25	Channel - I	Asia Pacifi	9	9	Miscellane	38673.12	2.587187
147906.8	233.937	1984.92	3.6	2015	2	6	26	Channel - I	Asia Pacifi	9	9	Miscellane	57168.96	2.587187

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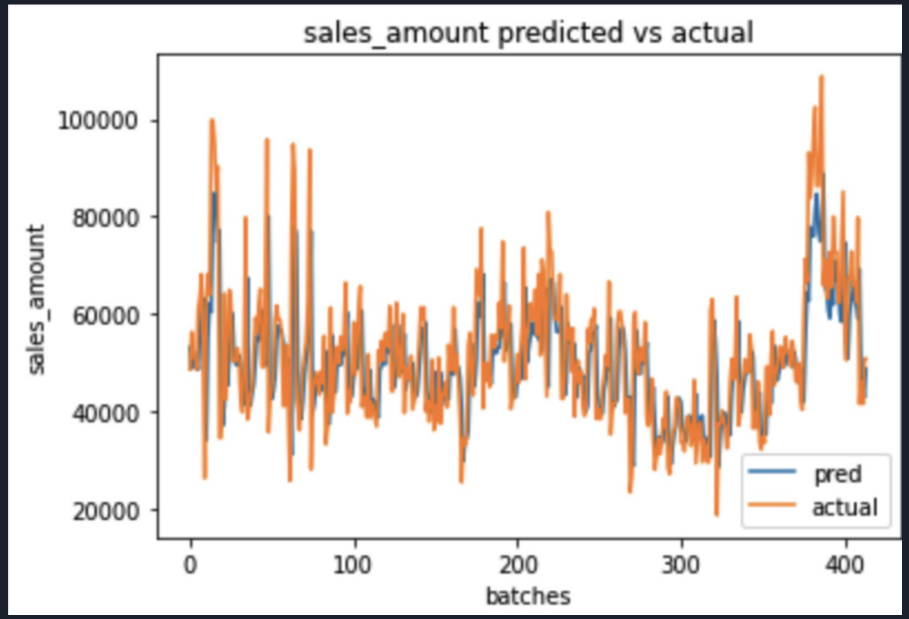
4.0 LSTM

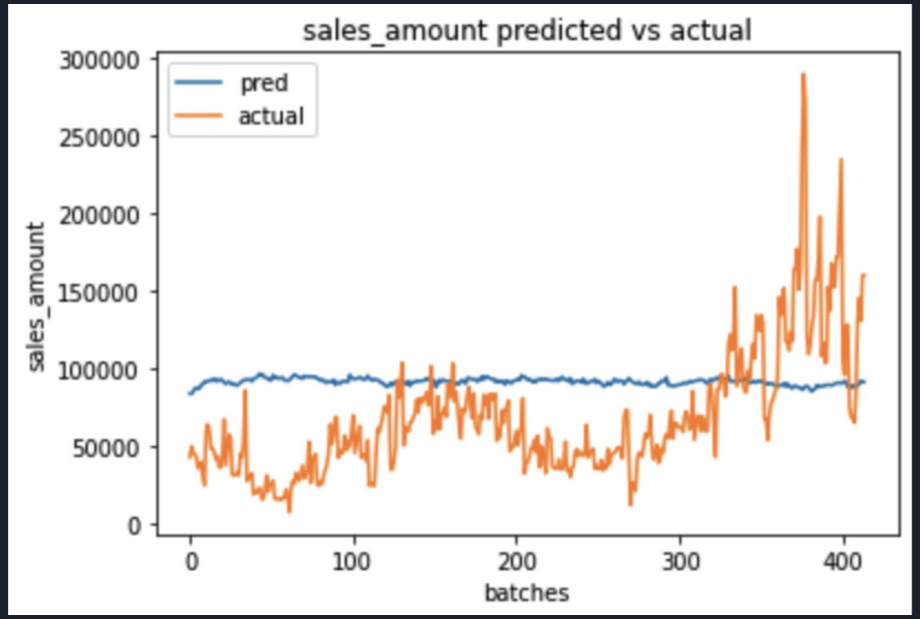
Pros: Predicts accurately at low forecast horizon

Cons: Cannot capture patterns with larger forecast horizons

Ex: History: 78, Forecast: 1



actual value for model input (y)



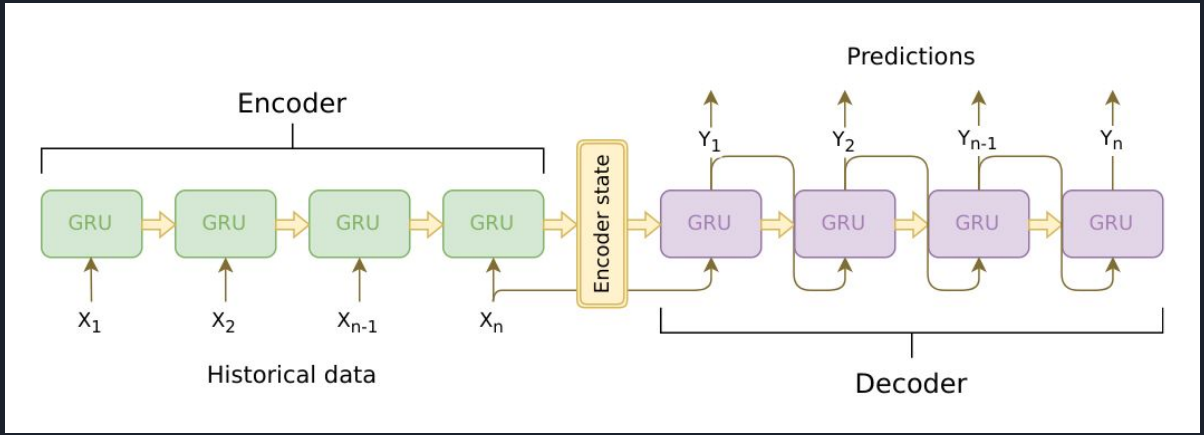
predicted value (y-hat) for model input

4.1 Seq2Seq

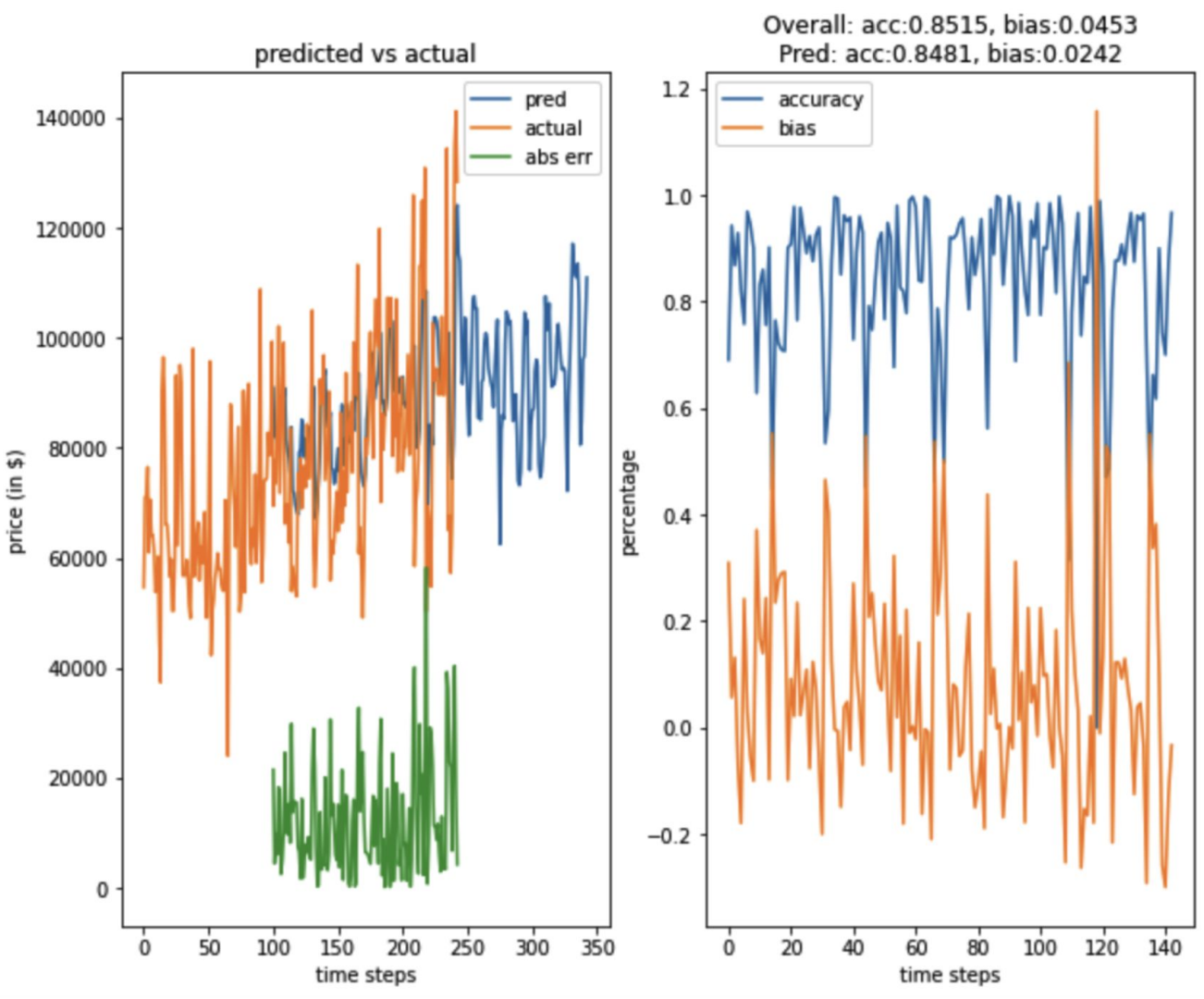
	Accuracy	Bias
Monthly forecast (18 steps)	0.8383	-0.776
Weekly forecast (72 steps)	0.8136	0.0717

Design choices:

- Use LSTM's for encoder and decoder
- Train with mixed teacher forcing



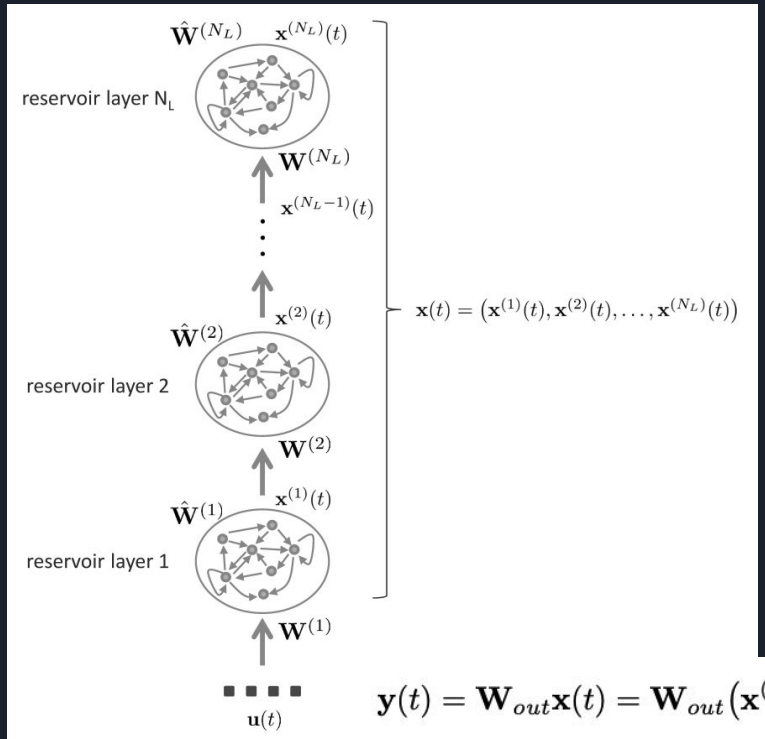
4.1 Seq2Seq


predicted vs actual
pred
actual
abs err
price (in $)
time steps
Overall: acc:0.8515, bias:0.0453
Pred: acc:0.8481, bias:0.0242
accuracy
bias
percentage
time steps

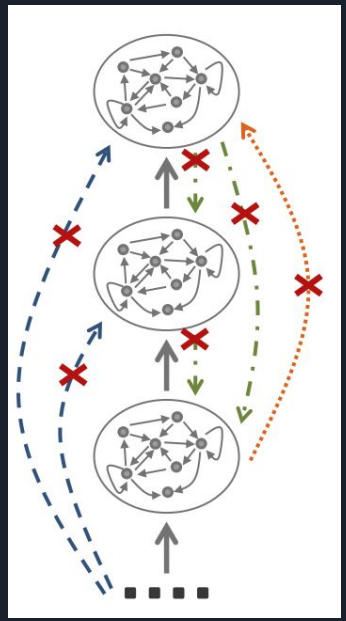
4.2 DeepESN

	Accuracy	Bias
Monthly forecast (18 steps)	0.7359	0.0346
Weekly forecast (72 steps)	0.6203	0.0236

Reservoir



$$\mathbf{y}(t) = \mathbf{W}_{out}\mathbf{x}(t) = \mathbf{W}_{out}\left(\mathbf{x}^{(1)}(t), \ldots, \mathbf{x}^{(N_L)}(t)\right),$$

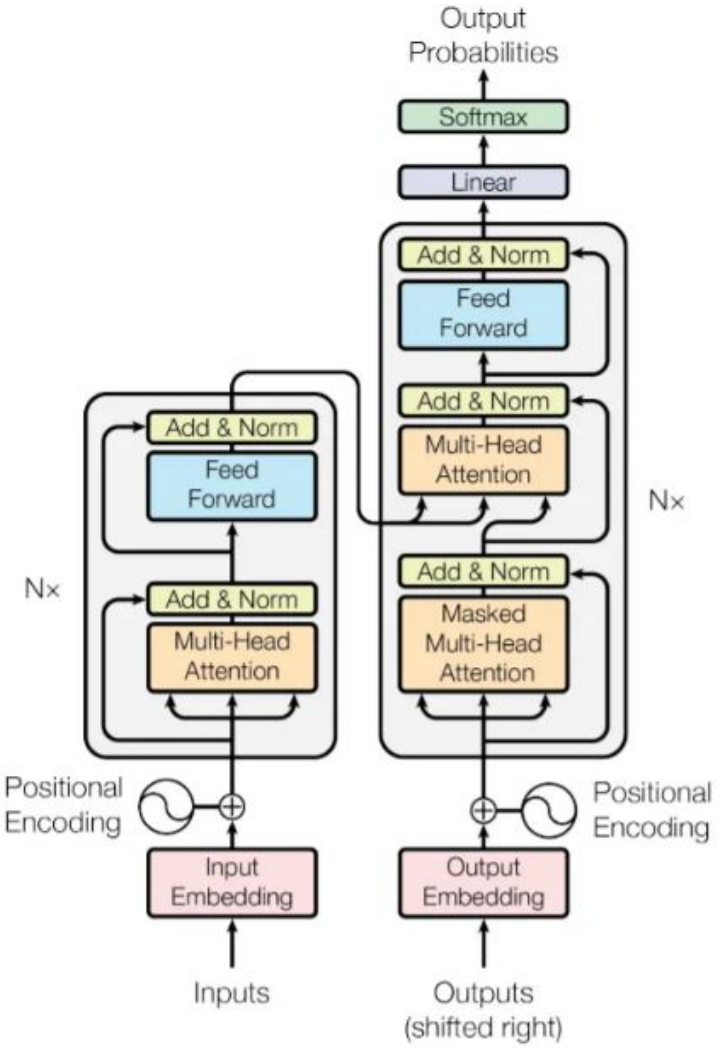


4.3 time-transformer

- Seq-2-seq model with MHA
- Use LSTMs for encoder / decoder

Progress:

- Have architecture / datapipeline ready
- Have bug where values blow up after first input sequence...



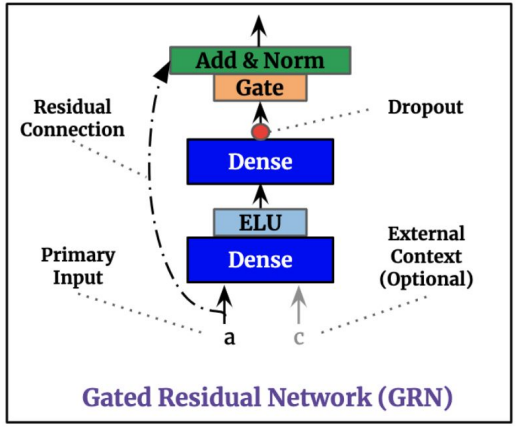
4.4 temporal fusion transformer (TFT)

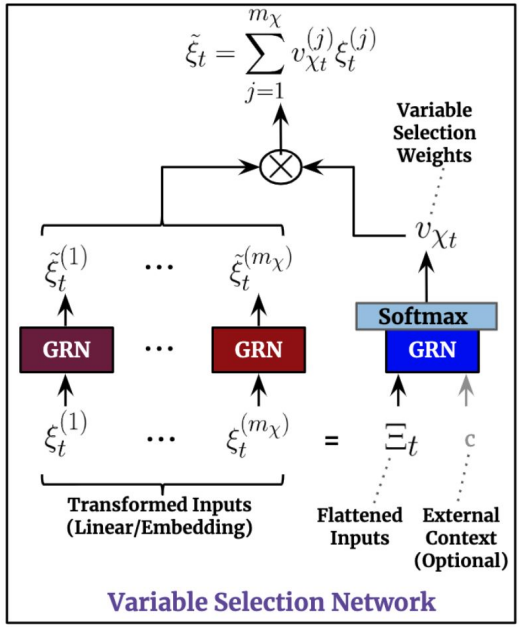
Features:

- **GRN**
- **VSN**
- Interpretable MHA
- Static Enhancement

Progress:

- Have architecture / data pipeline ready (MHA, GRN, VSN, LSTMs, Add & Norm residual layers...)
- TODO: redo data pipeline to handle multiple types of inputs

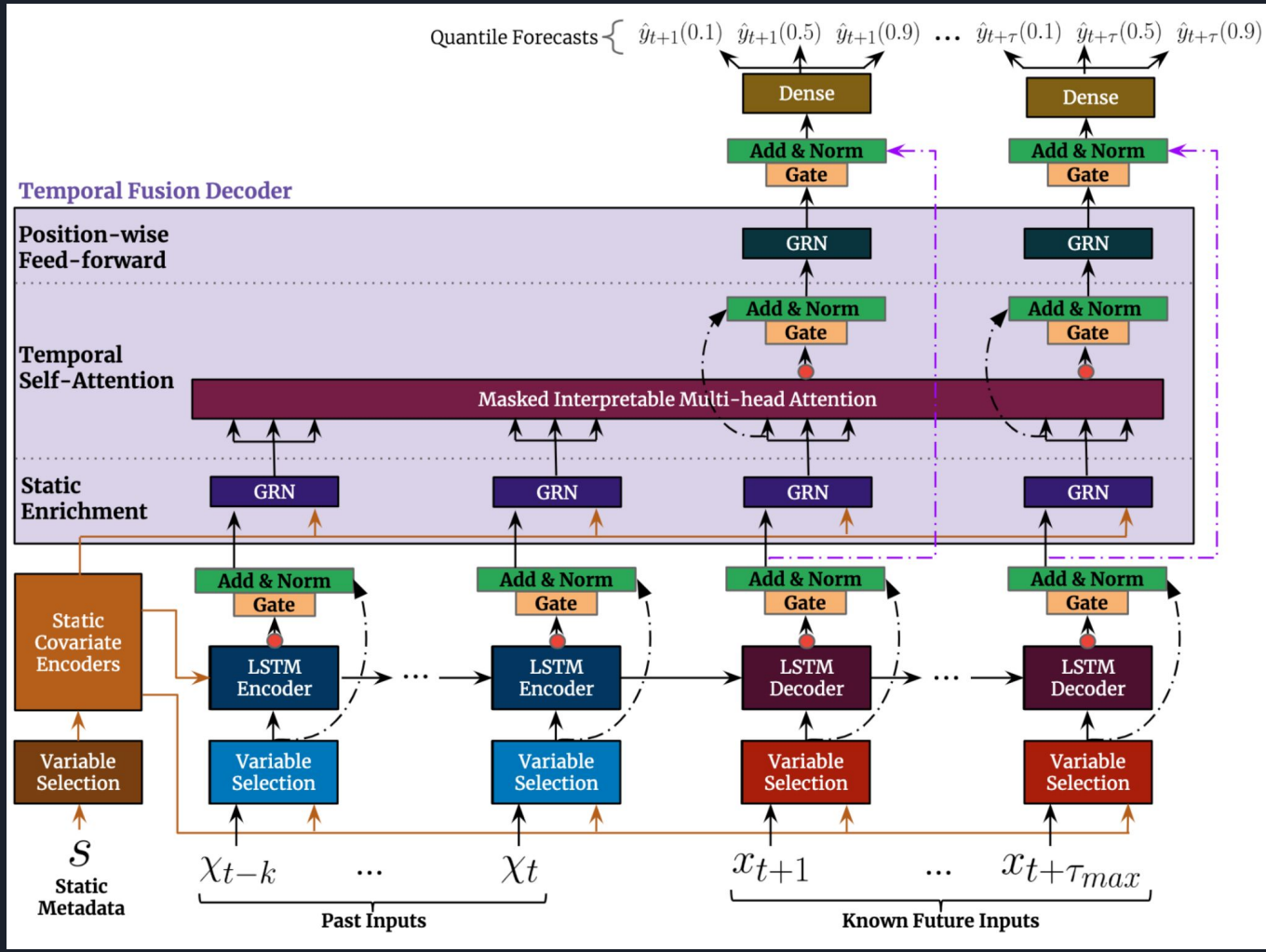




4.4 TFT

Features (cont)

- GRN
- VSN
- **Interpretable MHA**
- **Static Enhancement**



Thanks!

questions?