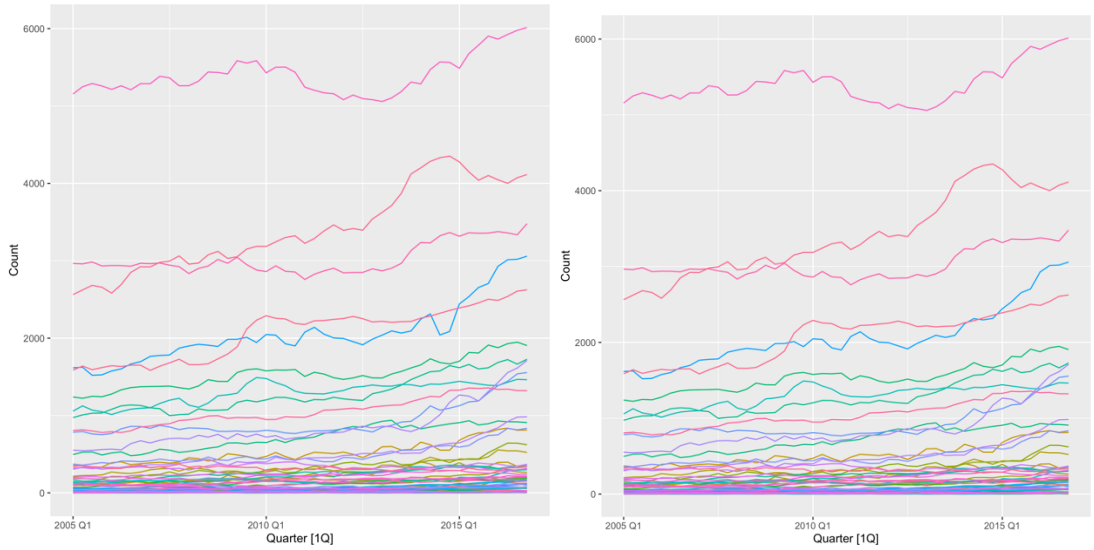
Changes:

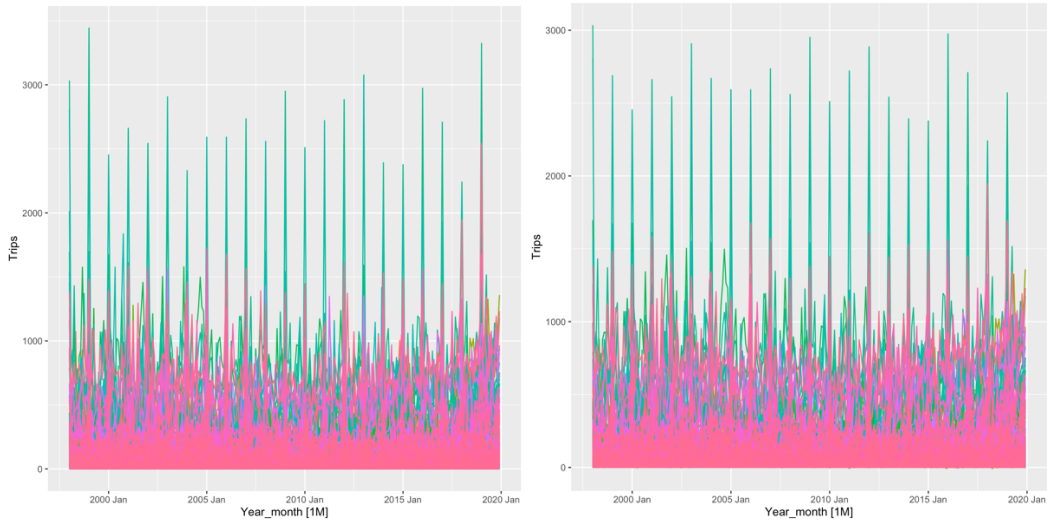
1. Data Cleaning for all datasets
2. Wikipedia dataset – hierarchy structure changed based of the paper, Total X Access X Agent X Language X Purpose X Article

Data Before and After Cleaning

Prison

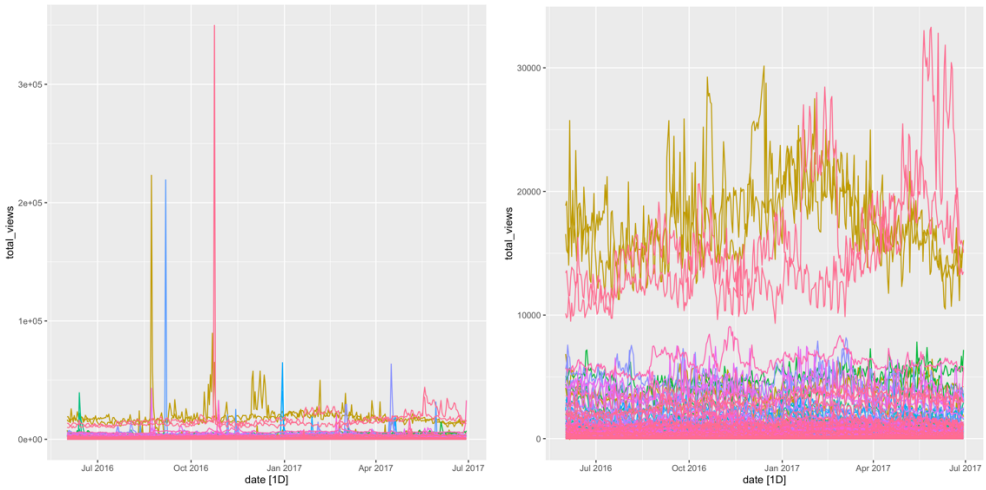


Tourism



Labour

Wikipedia



Summary Data and Results

Dataset	Frequency	Horizon	Number of Samples	Minimum training sample length	Number of levels	Number of total time series
Prison	4 (quarterly)	8	3	24	5	121
Tourism	12 (monthly)	12	10	144	3	85
Wikipedia	7 (weekly)	7	10	324	6	1095
Labour	4 (quarterly)	12	5	68	4	57

Error calculation

- Step 1 – For each time series in the hierarchy calculate the error metric (MSE, MAPE)
- Step 2 – Calculate the mean error across the time series in each level (this gives the mean error for each level)
- Step 3 – Calculate the overall error by getting the mean error across all time series errors we have in Step 1
- Step 4 – Repeat step 1-3 for all samples
- Step 5 – Calculate the mean error for each level and overall, across the samples
- Step 6 – Calculate the percentage improvement for each level and overall

Results Across Samples – Latest

Full Horizon

Base Errors (MSE) - Overall

Dataset	ARIMA	ETS	DeepAR	WaveNet
Prison	52548.6	49629.380	121514.997	1.836182e+08
Tourism	70573.5	65806.981	75410.124	117250.810
Labour	1231.7	2313.894	3221.896	1922.840
Wikipedia	3.477905e+05	2.862994e+05	4.503426e+05	8.904260e+05

Best Approach from Reconciliation

Dataset	ARIMA	ETS	DeepAR	WaveNet
Prison	OLS Best ML Rank – 4 (Case 2 Lambda 0.1-0.9)	Case 1 Lambda 0. 1-0. 9 No skip / Case 1 Lambda 1	Bottom-UP Best ML Rank – 5 (Case2 Lambda 0.1, 0.9)	BottomUp Best ML Rank – 2 (Case 1 Lambda 1-4)
Tourism	OLS Best ML Rank – 3 Case 1 Lambda 0.01-5	OLS Best ML Rank- 2 Case 2 Lambda 1	MintShrink Best ML Rank -4 (Case 1 Lambda 0.1-0.9)	Case 2 Lambda 0.01-5
Labour	OLS Best ML Rank – 4 (Case 2 Lambda 0.1-0.9)	Case 2 Lambda 0.01-0.09	Case 1/2 Lambda 0.01-0.09	MintShrink Best ML Case – 4 (Case 2 Lambda 0.01-0.09)
Wikipedia	Case 1 Lambda 0.01-0.09 / Case 2 Lambda 1-4	Bottom-Up Best ML Rank – 4 (Case 1 Lambda 0.01-5)	WLS Best ML Case – 5 (Case 2 Lambda 1-4)	Case 2 Lambda 1-4

Short Horizon

Base Errors (MSE)

Dataset	ARIMA	ETS	DeepAR	WaveNet
Prison	16240.217	15644.543	56893.103	1.861848e+08
Tourism	67303.917	60432.873	77717.717	129727.399
Labour	603.014	689.654	1285.324	1154.330
Wikipedia	2.835496e+05	2.140000e+05	3.452034e+05	9.779535e+05

Best Approach from Reconciliation

Dataset	ARIMA	ETS	DeepAR	WaveNet
Prison	Case 1 Lambda 0.1-0.9	Case 2 Lambda 0.01-0.09	Bottom-UP Best ML Rank – 5 (Case2 Lambda 0.1, 0.9)	Bottom-UP Best ML Rank 2 (Case 1 Lambda 1-4)
Tourism	OLS Best ML Rank – 3 Case 2 Lambda 0.01-5	Case 2 Lambda 1	Case 1 Lambda 0.01-0.09	Case 2 Lambda 0.01-5
Labour	OLS Best ML Rank – 3 (Case 2 Lambda 0.01-5)	Case 1 Lambda 0.01-5	Case 1 Lambda 0.01-0.09	Case 1 Lambda 0.1-0.9
Wikipedia	Case 1 Lambda 0.1-0.9	Case 2 Lambda 1-4	OLS Best ML Rank – 5 (Case 2 Lambda 1-4)	MinTShrink Best ML Rank 2 (Case 2 Lambda 1-4)

Results Across Samples

Full Horizon (*In the full horizon ML reconciliation performs best for most 3 out of datasets when the base model is ETS. However, when the base forecasts are from ARIMA the ML reconciliation performs best only for the Tourism dataset*)

Dataset	**ARIMA**	**ETS**
Prison	OLS Best ML Rank – 4 (Case 1 Lambda 1-4)	Case 1 Lambda 0.01-0.09
Tourism	Case 1 Lambda 0.01-5	Case 2 Lambda 1
Labour	OLS Best ML Rank – 4 (Case 2 Lambda 1)	Case 1 Lambda 0.01-0.09
Wikipedia	OLS Best ML Rank – 5 (Case 2 Lambda 0.1-0.9)	OLS Best ML Rank – 5 (Case 2 Lambda 1)

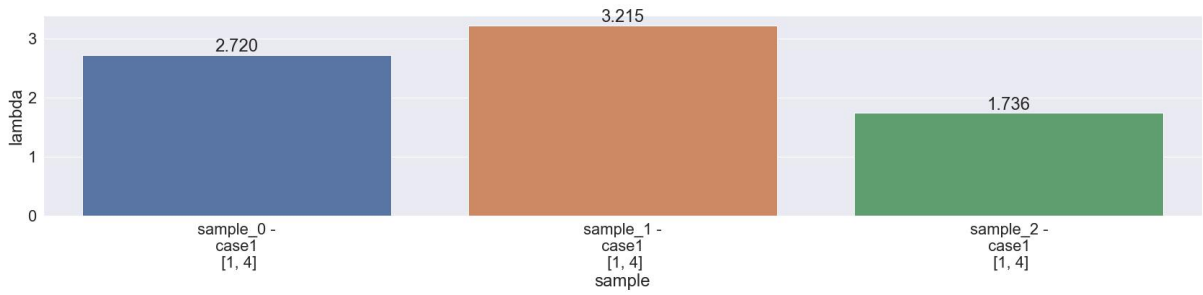
Short Horizon (*In the short horizon ML reconciliation performs best for most 3 out of datasets when the base model is ETS – similar observation as the full horizon. When the base forecasts are from ARIMA the ML reconciliation performs best for Prison and Tourism datasets*)

Dataset	**ARIMA**	**ETS**
Prison	Case 1 Lambda 1-4	Case 1 Lambda 0.01-0.09
Tourism	Case 2 Lambda 0.01-5	Case 1 Lambda 1-4
Labour	OLS Best ML Rank – 2 (Case 2 Lambda 1)	Case 1 Lambda 0.01-0.09
Wikipedia	OLS Best ML Rank – 5 (Case 2 Lambda 0.1-0.9)	OLS Best ML Rank – 5 (Case 2 Lambda 0.01-5)

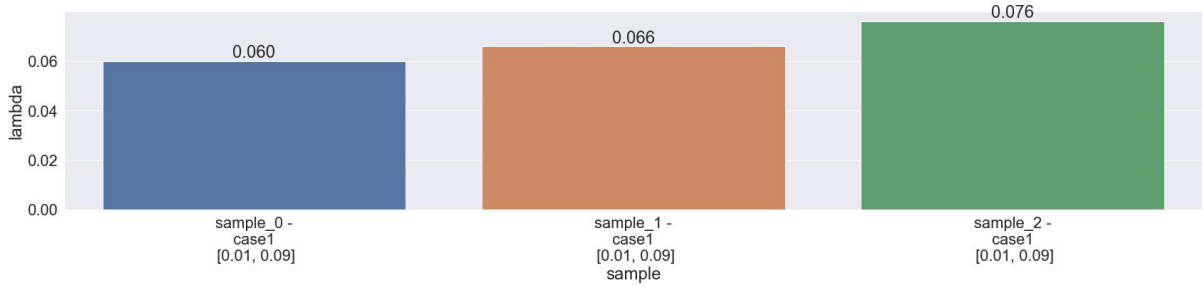
Lambda Ranges – Lambda value for each sample from the overall best ML method

Prison

ARIMA

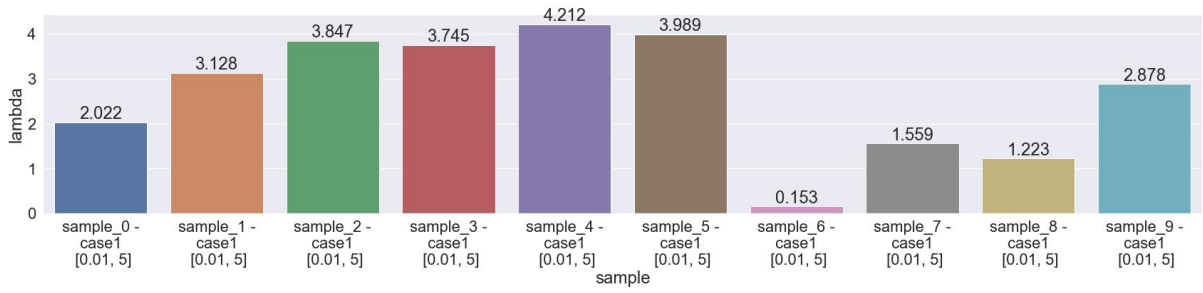


ETS

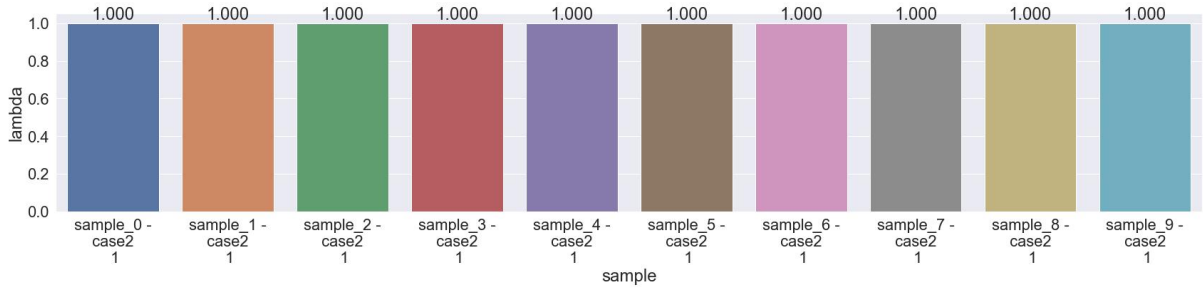


Tourism

ARIMA

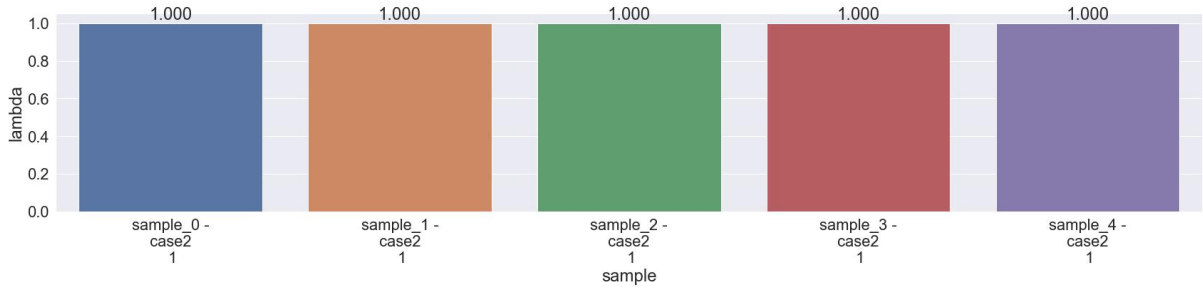


ETS

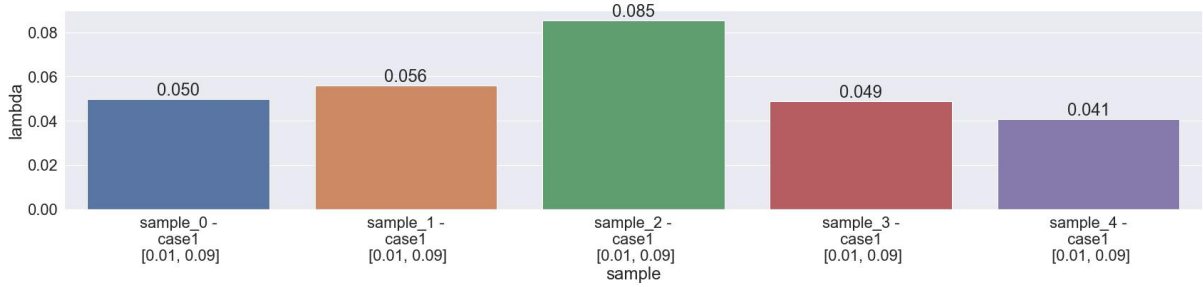


Labour

ARIMA

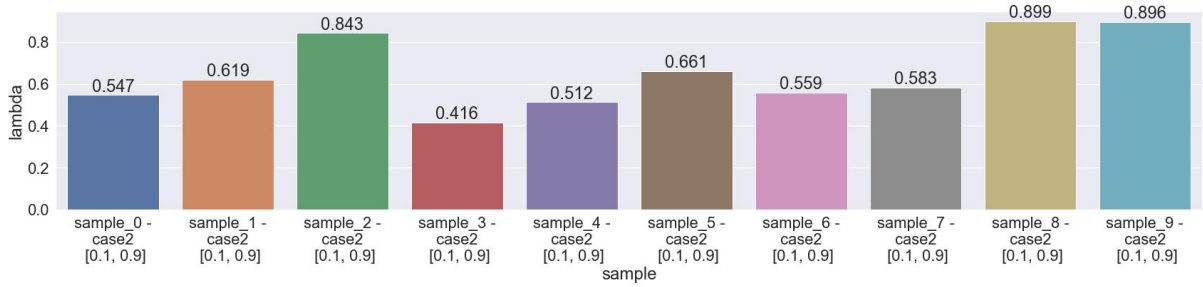


ETS

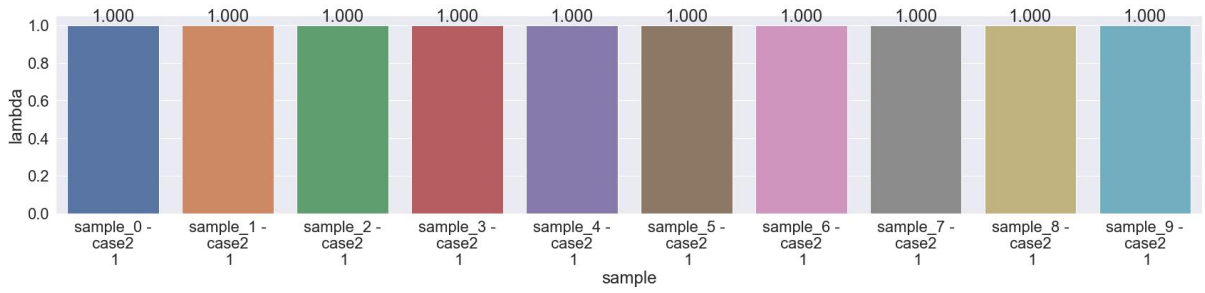


Wikipedia

ARIMA



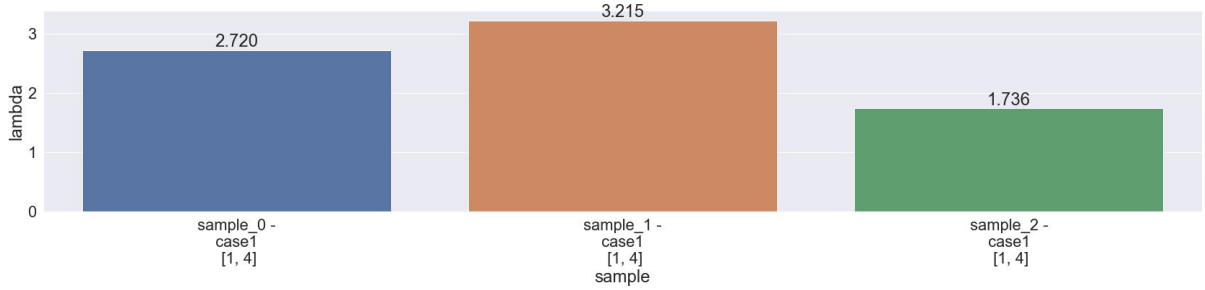
ETS



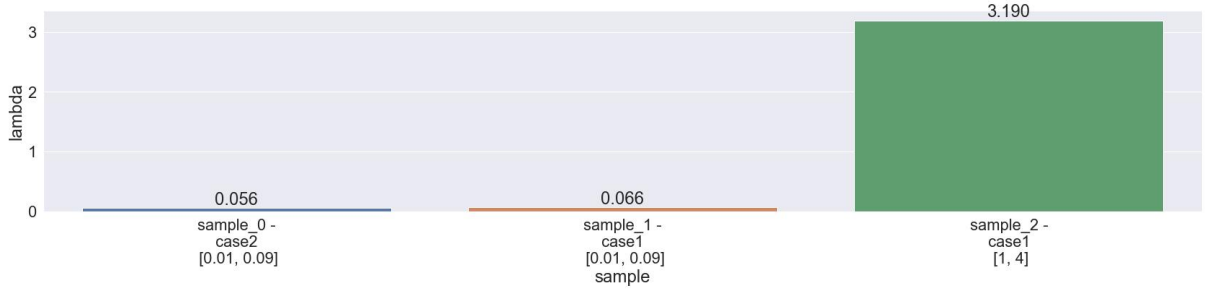
Lambda Ranges – Lambda value and the best ML method per sample

Prison

ARIMA

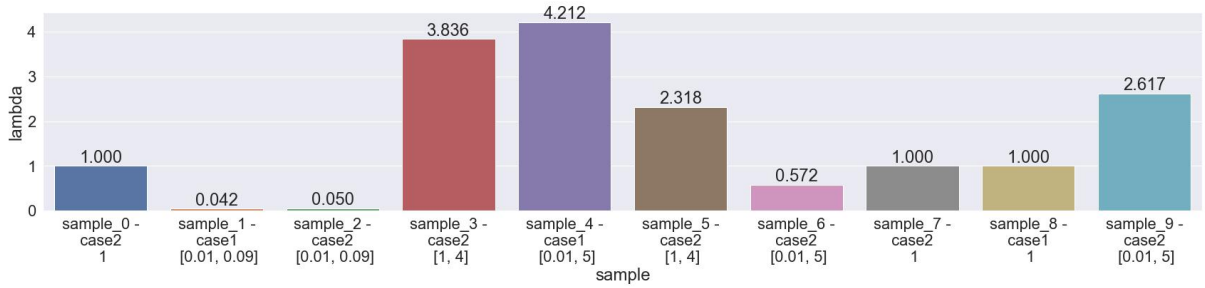


ETS

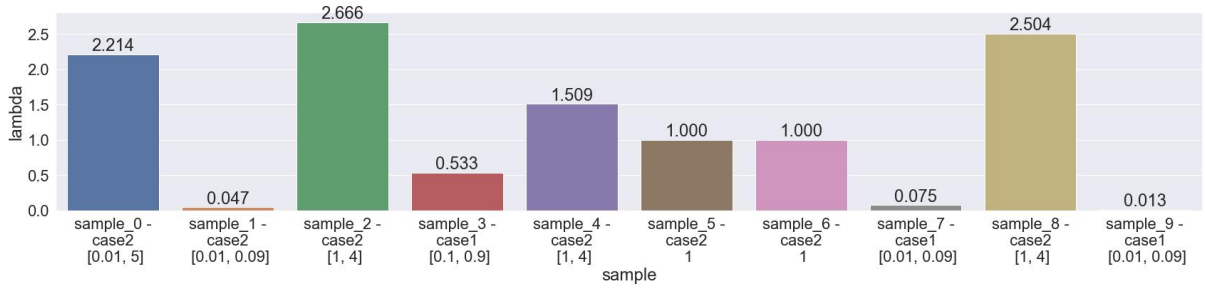


Tourism

ARIMA

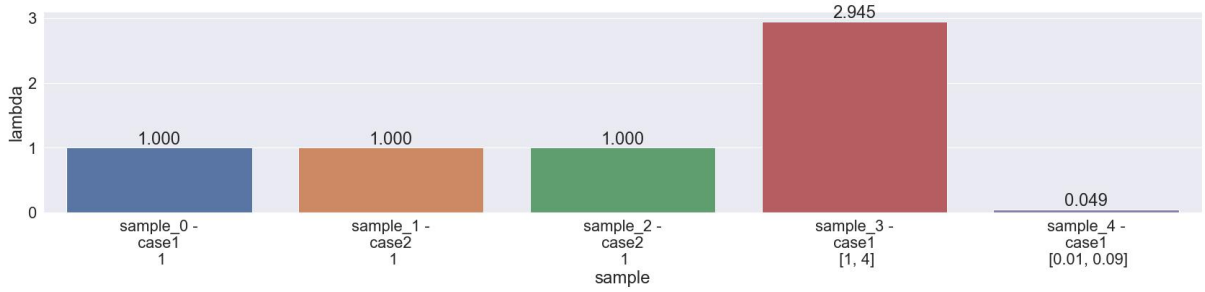


ETS

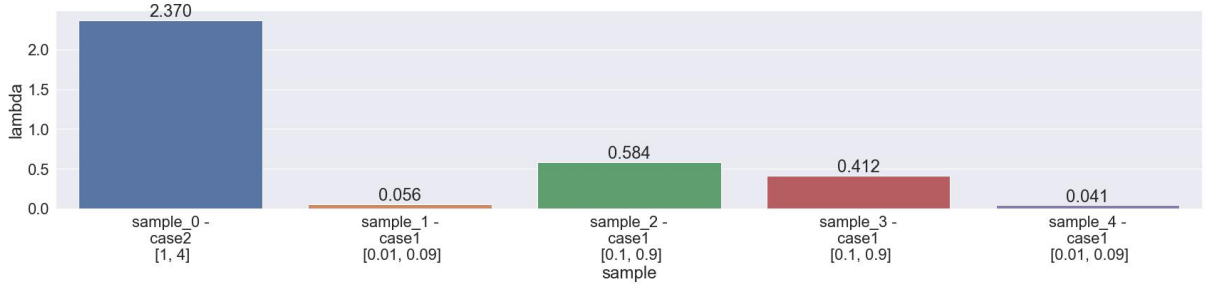


Labour

ARIMA

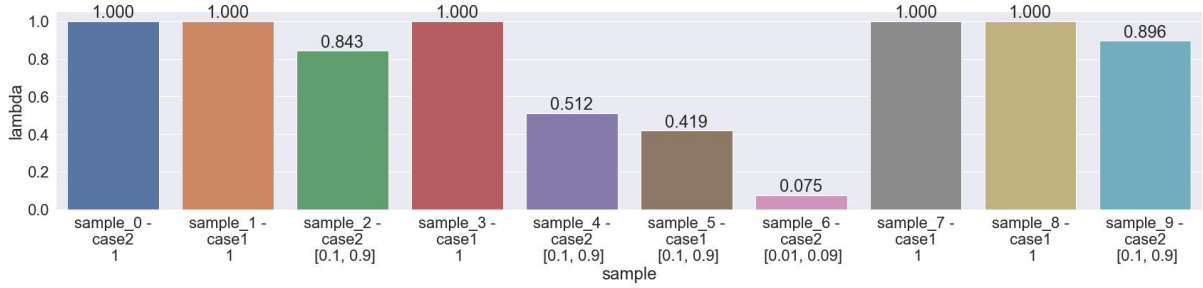


ETS



Wikipedia

ARIMA



ETS