Load Forecast Methodology Description

Thalia

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Model Descriptions

Following the approach used by Hyndman & Fan (2009),the forecasting model consists of two sub-models: ***annual*** demand growth sub-model based on economic and demographic variables, and ***monthly*** weather-demand sub-model based on weather variables. The model can be written as follows:

$$ln(y_{t,p}) = f_p(w_t) + \sum_{j=1}^{J} C_j Z_{j,t} + n_t \tag{1}$$

Where:

$y_{t,p}$: monthly eletricity load on year t and month $p = 1, 2, 3, ..., 12$

$f_p(w_t)$: all weather effects

$Z_{j,t}$: the annual demographic and economic variable at time t and its imopact on monthly demand

n_t: the demand which is left unexplained by the model(the model residuals) at time t

Function(1) can also be written in the form:

$$ln(y_{t,p}) = ln(\overline{y_t}) + ln(\dot{y_{t,p}}) \tag{2}$$

That is:

$$y_{t,p} = \overline{y_t} \cdot \dot{y_{t,p}} \tag{3}$$

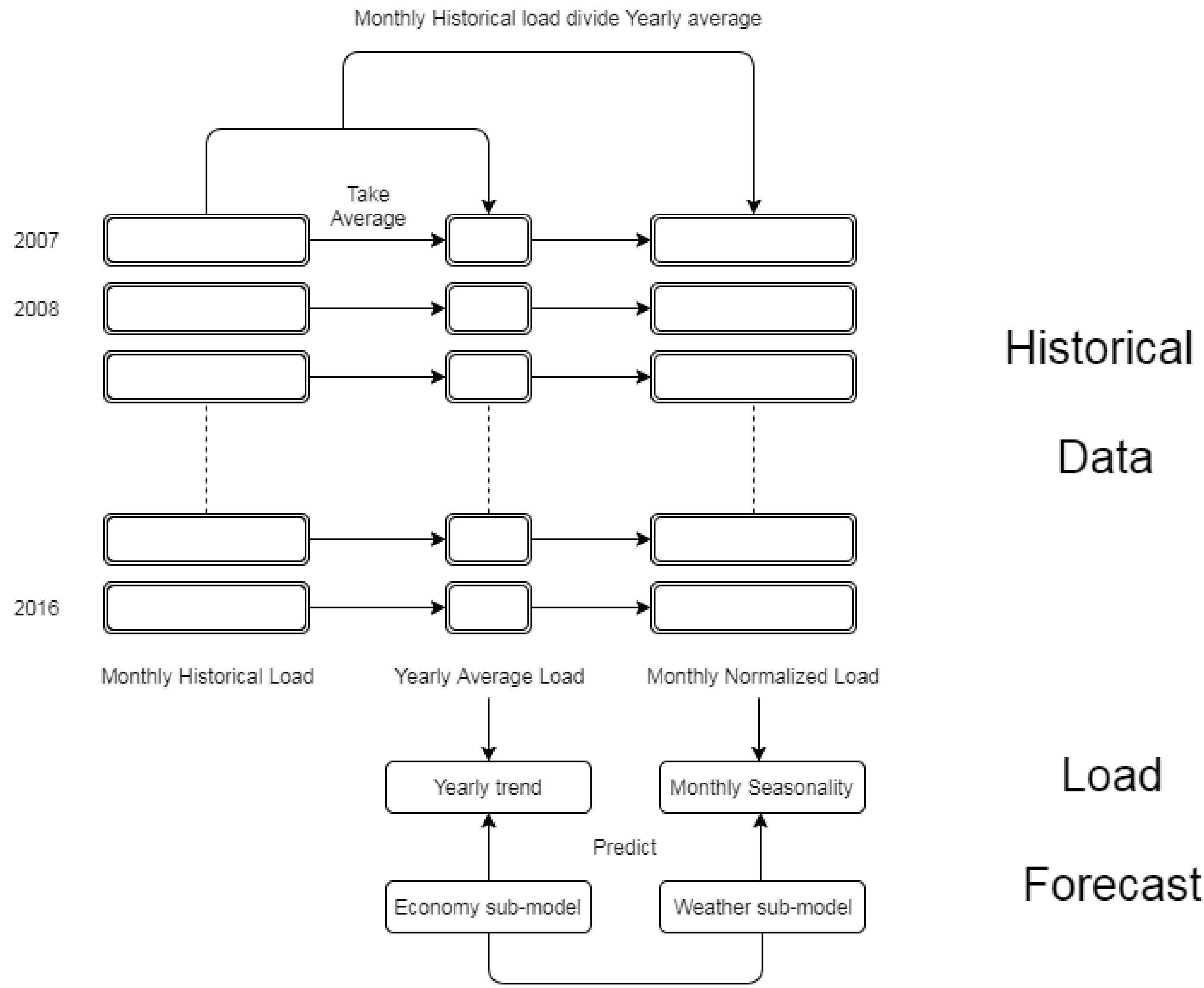
Where:

$\overline{y}_t$: the annual average electricity sales for year t in GWh

$\dot{y}_{t,p}$: the normalized demand for year t in month p

According to this form, two sub-models were generated in order to estimate $\overline{y}_{t,p}$ and $\dot{y}_{t,p}$ seperately. Once the estimation of $\overline{y}_{t,p}$ and $\dot{y}_{t,p}$ is obtained, their multiplication will be the load forecast we need.

General idea of decomposition



The monthly weather-demand sub-model

This model describes the impact of weather on normalized electricity demand:

$$ln(\dot{y}_{t,p}) = f_p(w_t) + n_t$$

For the weather factor $f_p(w_t)$, we can use the regression model:

$$f_p(w_t) = \beta_0 + \sum_{p=1}^{12} \beta_p W_{p,t}$$

Where:

$W_{p,t}$: exlanatory weather variables which are nonlinear functions of historical weather parameters

β_0 and β_p: regression coefficients

The exlanatory weather variables $W_{p,t}$ used in this regression model is listed below:

Table 1: Summary of monthly weather-demand sub-model

Dependent variables	Independent Variables
MOnthly normalized Electricity Load	Monthly Maximum Temperature
	Monthly Minimum Temperature
	Monthly Mean Temperature
	Monthly CDD
	Monthly HDD
	Monthly Average Humidity

Heating degree day HDD is a measurement designed to quantify the demand for energy needed to heat a building. HDD is derived from measurements of outside air temperature. A similar measurement, cooling degree day CDD, reflects the amount of energy used to cool a home or business. The monthly CDD and HDD were conputed for the 2007 to 2016 period using the following formulas:

$$HDD = \sum_{0days}^{idays} (T_{ref} - T_{dailymean})$$

$$CDD = \sum_{0days}^{idays} (T_{dailymean} - T_{ref})$$

The annual economic-demand sub-model

This model describes the impact of economic and demographic on electricity growth:

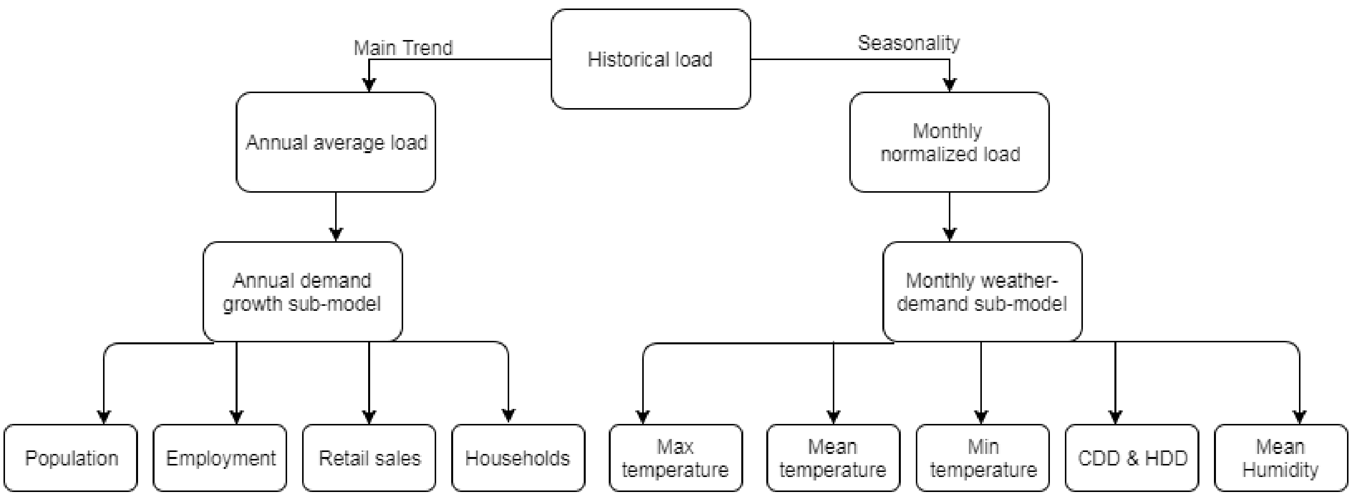
$$ln(\overline{y_t}) = \sum_{j=1}^{J} C_j Z_{j,t}$$

The exlanatory economic variables used in this regression model is listed below:

Table 2: Summary of annual demand growth submodel

Dependent variables	Independent Variables
Annual Average Electricity Load	Total Population
	Total Employment
	Total Households
	Total Retail Sales

Flow Chart of the methodology



Model fitting

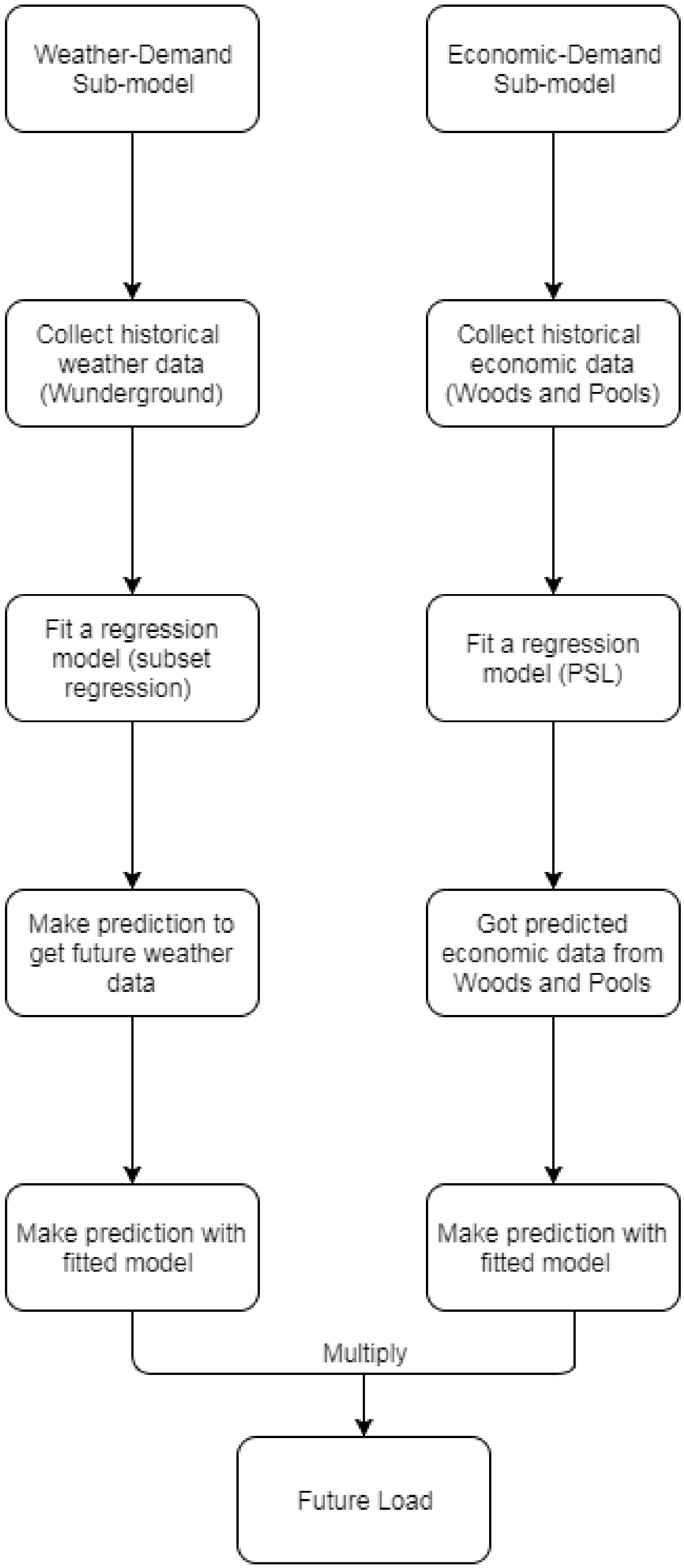
Historical weather and economic data is used to fit regression models. To find the best combination of independent variables, subset regression method is used.

Load Forecast

To make prediction with the fitted model, future value of input variables are required,i.e. temperature and economic data. The long-term forecasts for economic data is obtained from Woods and Poole.To simulate the temperatures, we use the normalized weather data to perserve any seasonal or trend patterns.

Load Forecast Result

Once the new input data is obtained, we can make prediction with the fitted sub-models. By multiplying the obtained results, we can get predicted future value.


Weather-Demand Sub-model
Economic-Demand Sub-model
Collect historical weather data (Wunderground)
Collect historical economic data (Woods and Pools)
Fit a regression model (subset regression)
Fit a regression model (PSL)
Make prediction to get future weather data
Got predicted economic data from Woods and Pools
Make prediction with fitted model
Make prediction with fitted model
Multiply
Future Load