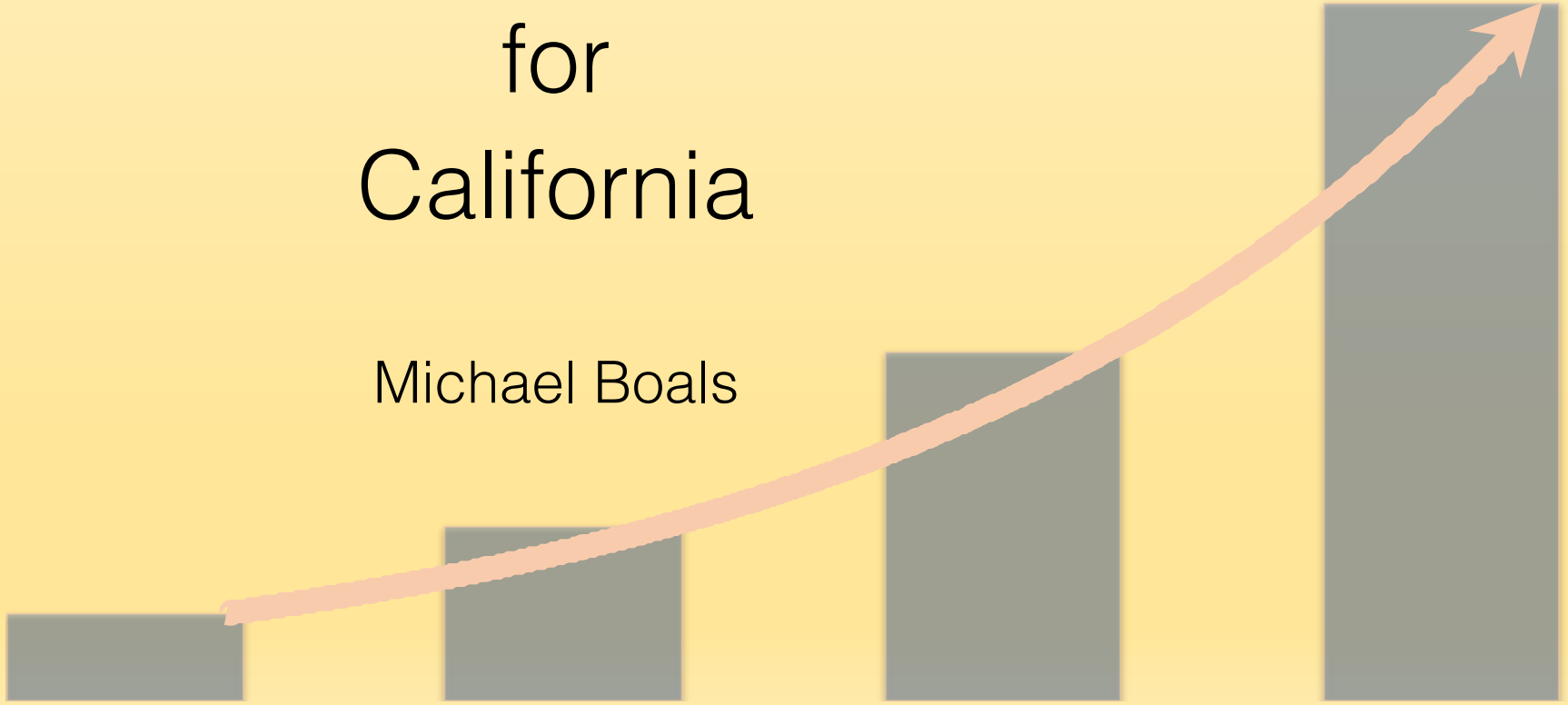
Electricity Demand Forecasting

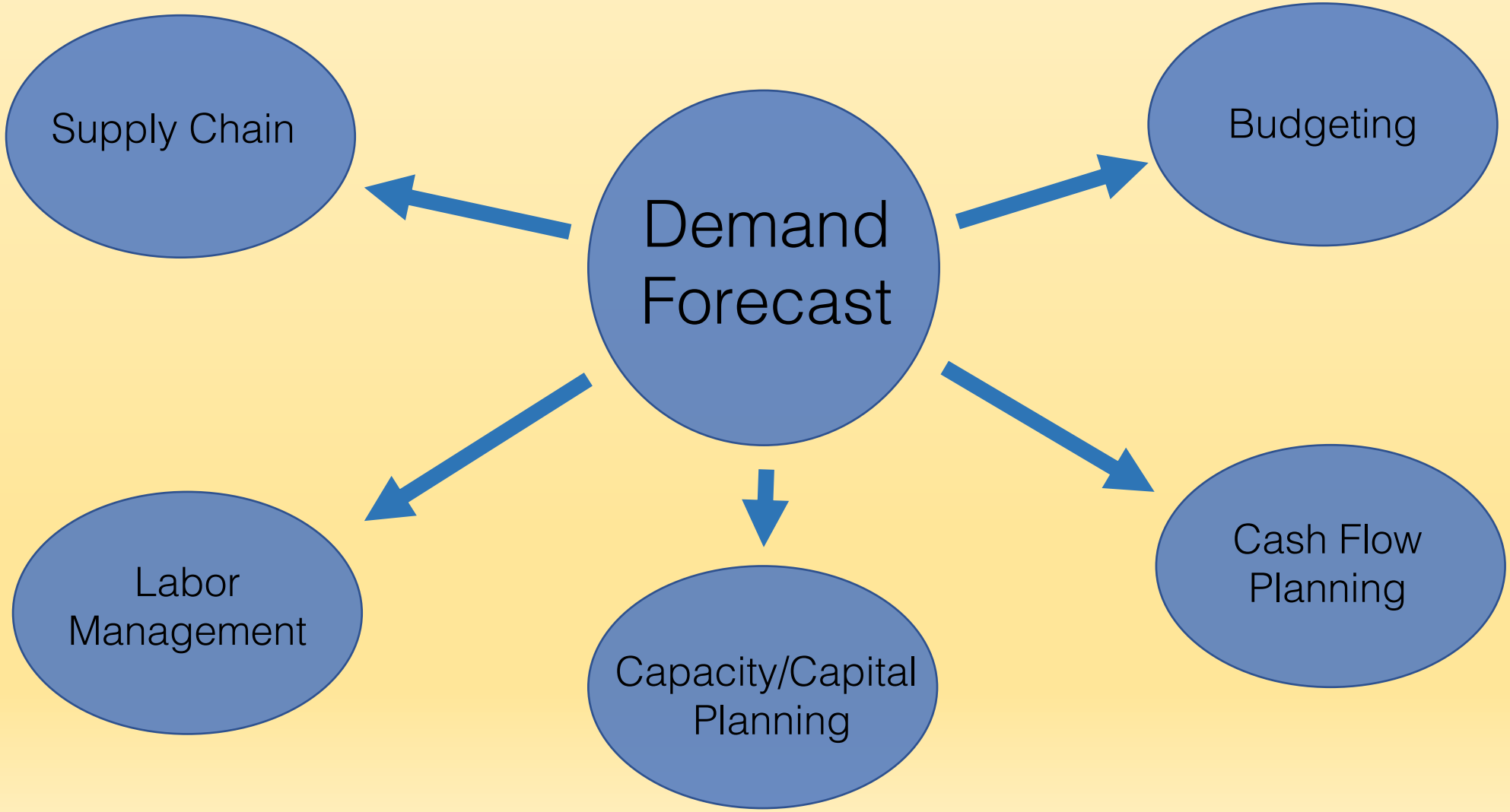
for

California

Michael Boals



Value of Accurate Demand Forecasts

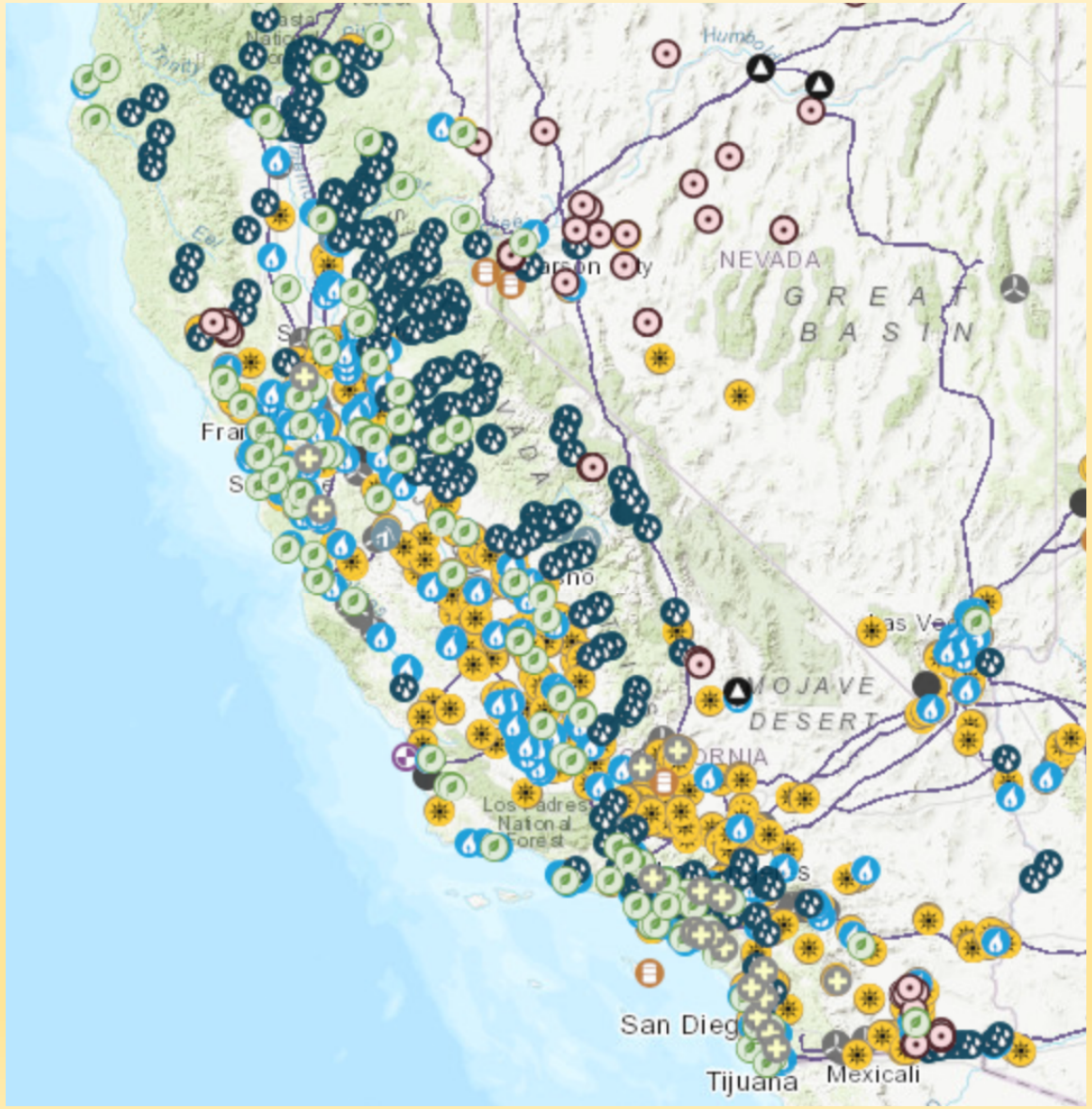


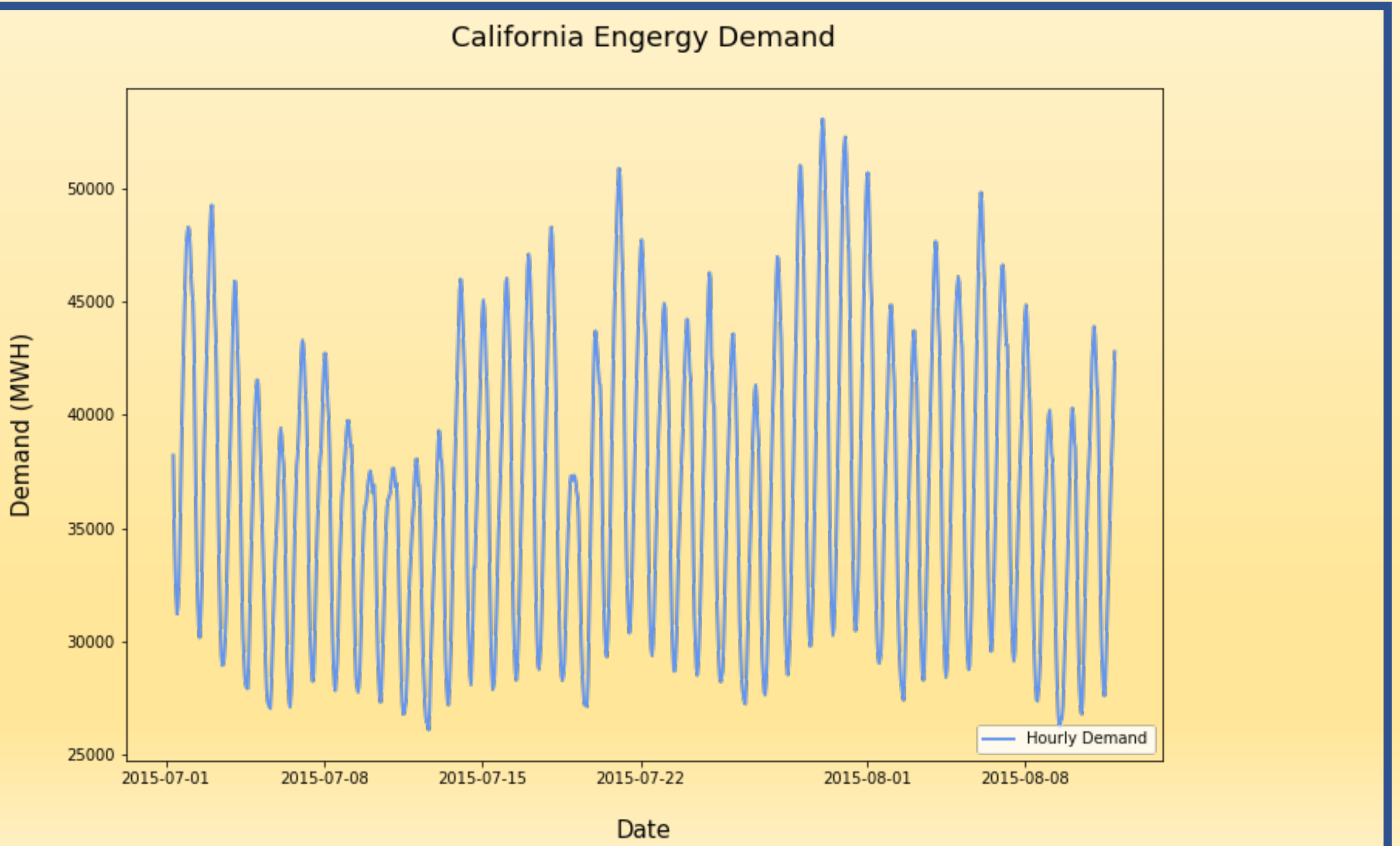
Goals

- Evaluate Different Time Series Modeling Techniques
- Accurately Predict Electricity Demand
  - Include Weather Temperature Forecast
  - Include State Population Forecast

Data

- California Demand from EIA
- Weather from Dark Sky
- Number of Households from Census Bureau – American Community Survey




California Engergy Demand
Demand (MWH)
50000
45000
40000
35000
30000
25000
2015-07-01
2015-07-08
2015-07-15
2015-07-22
2015-08-01
2015-08-08
Date
Hourly Demand

Model Options

- Seasonal Autoregressive Integrating Moving Average (ARIMA/SARIMAX)
- Autoregressive Conditional Heteroscedasticity (ARCH)
- Vector Autoregression (VAR)
- Long Short Term Memory (LSTM)
- Prophet Forecasting Model

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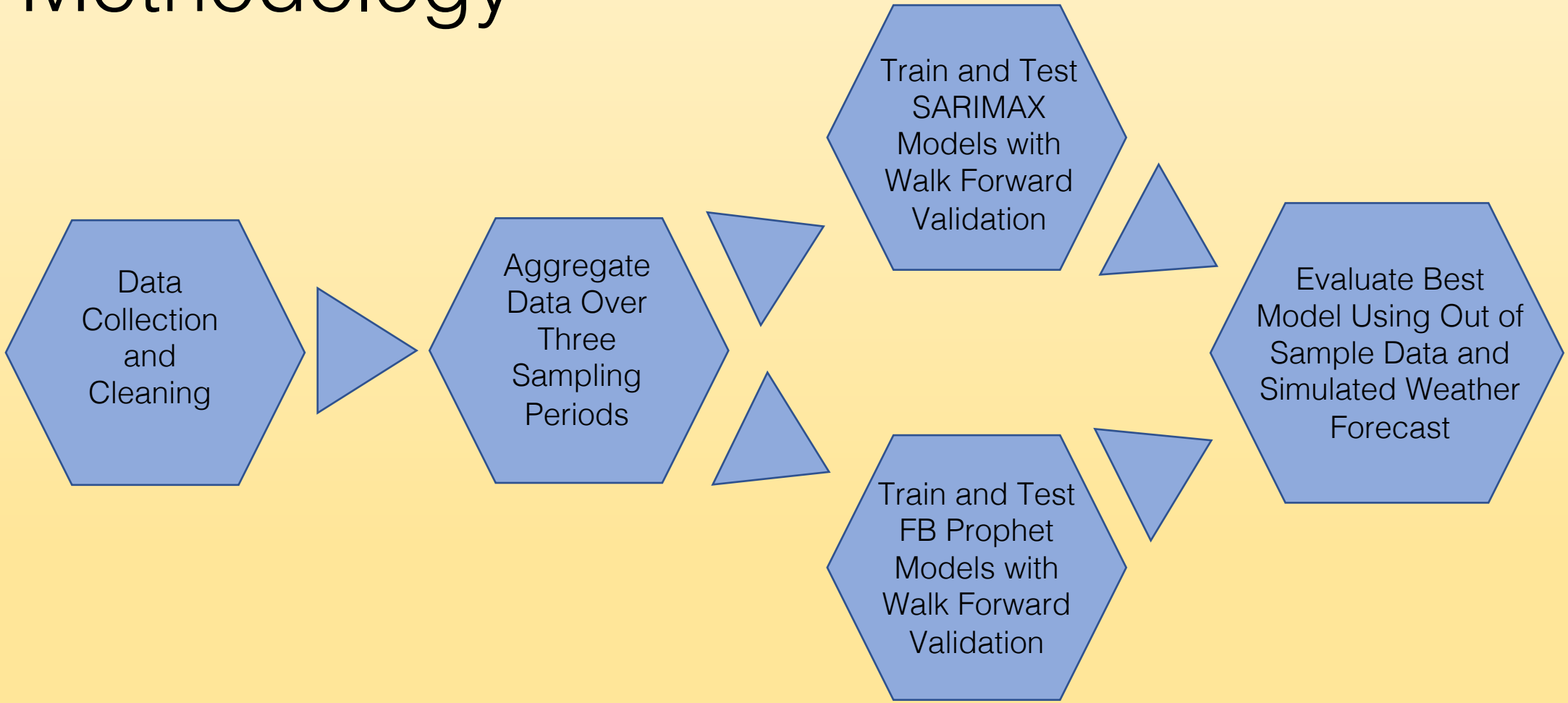
Methodology



Performance Metrics

- Evaluate Forecasting Performance Using:

Three Week Demand Mean of Absolute Percentage Error (MAPE)

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - Ft}{A_t}\right|$$

Model Selection

	3 Week Forecast Walk Forward Validation MAPE Scores		
	Step 1	Step 2	Step 3
SARIMAX			
Hourly	5.6	7.5	7.5
Daily	13.14	11.7	7.0
Weekly	8.2	7.5	4.9
Prophet			
Hourly	14.5	11.4	6.3
Daily	8.7	2.9	5.16
Weekly	6.8	8.3	8.3

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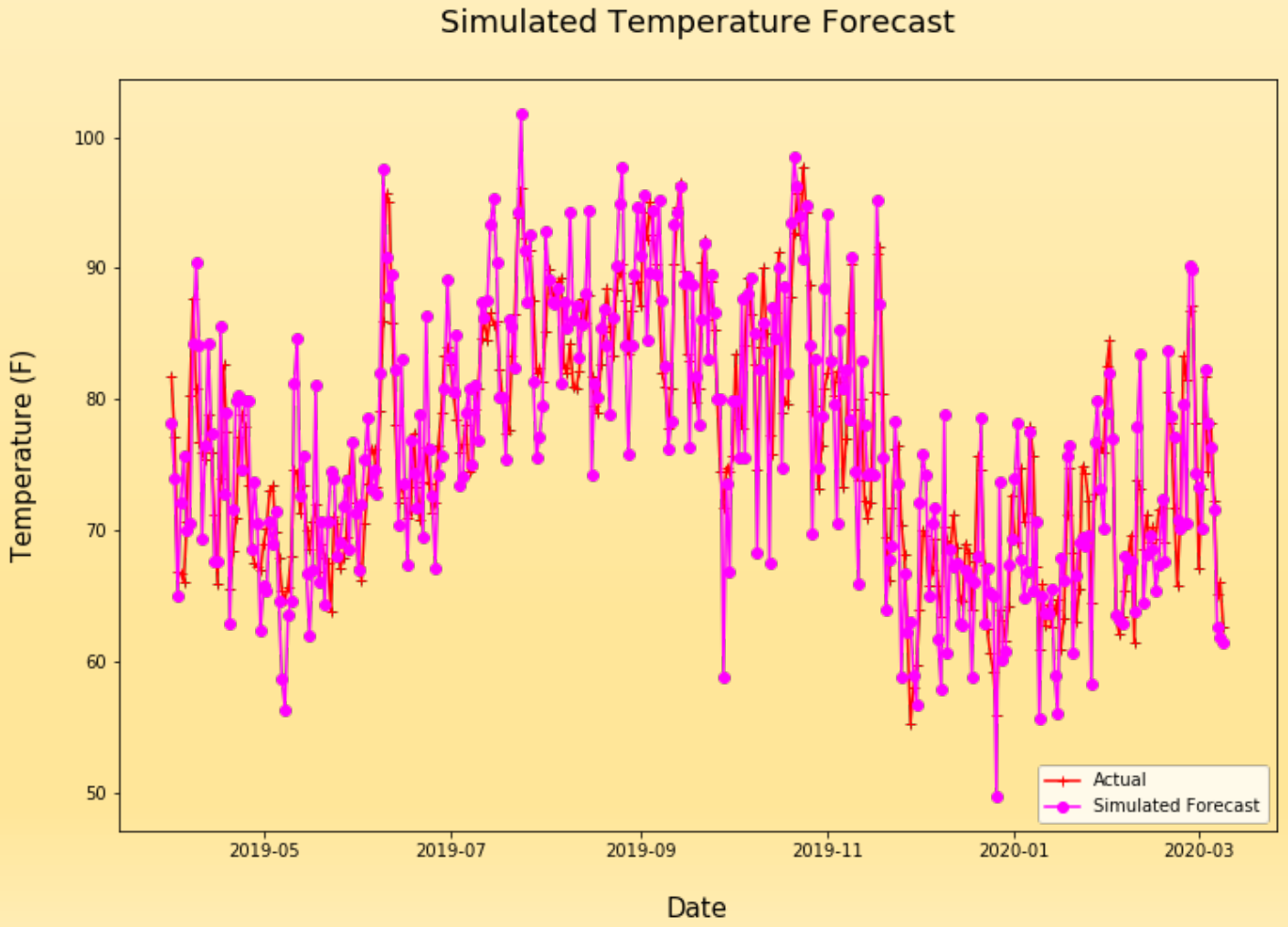
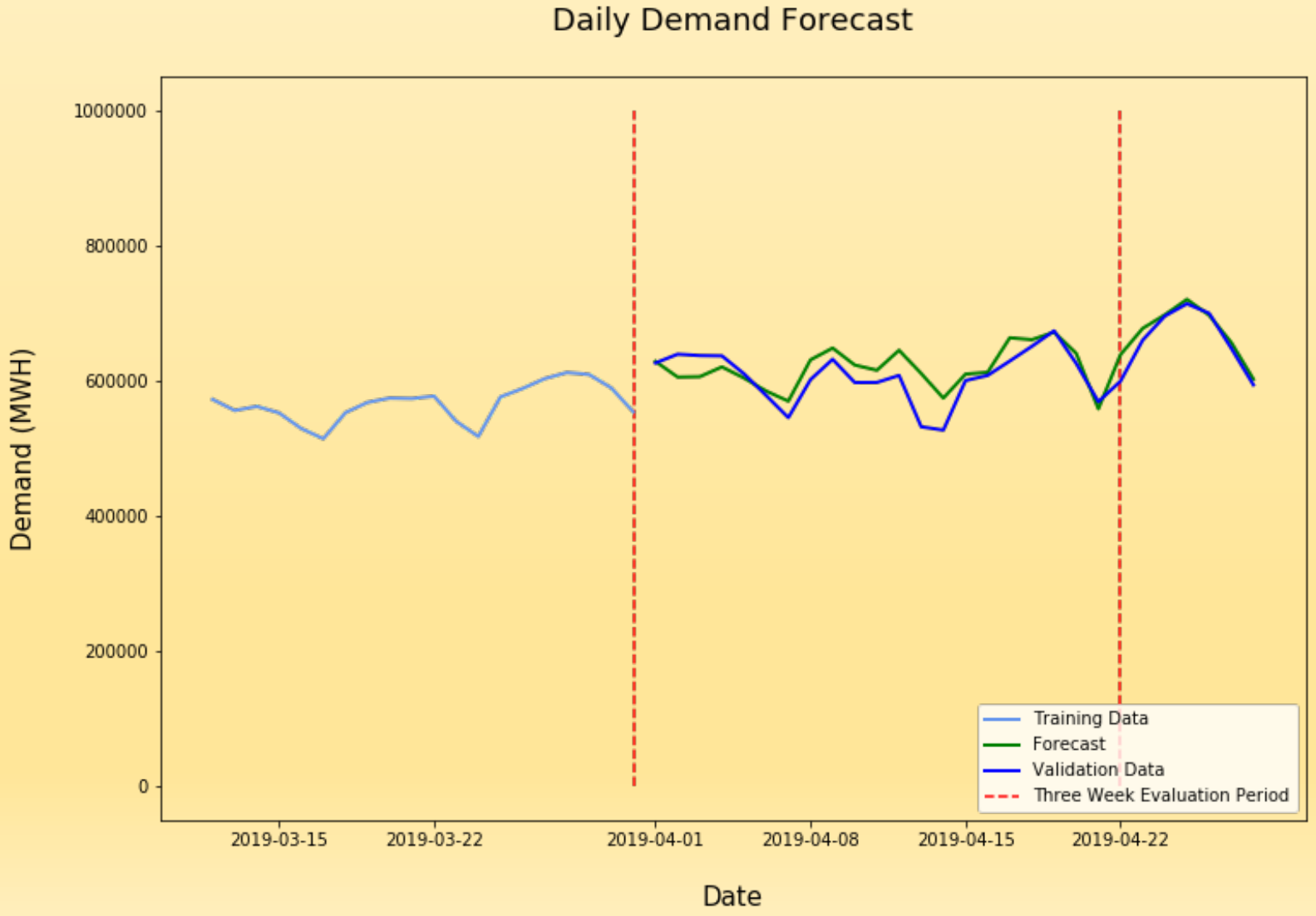
Exogenous Forecast Data

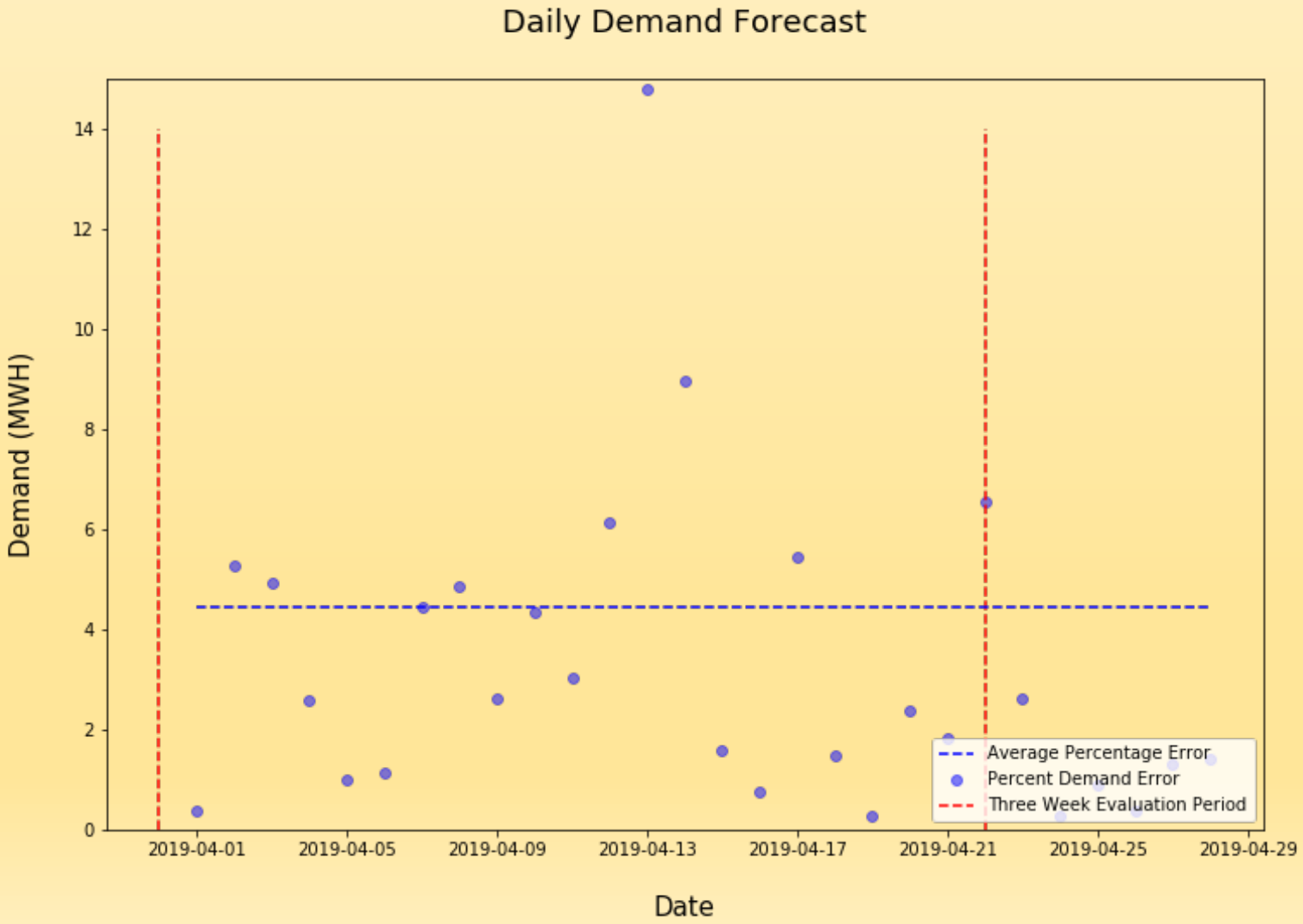
- Need to simulate weather forecast
- Add normal random offset mean of 5 F



Final Prediction Performance



Final Prediction Error



Final MAPE = 3.5

Take Away

- Both SARIMAX and Prophet Provide Similar Short-Term Results
- Prophet Performed Slightly Better
- Prophet Trains Faster
- Prophet Predictions Are More Accurate Further Into The Future

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Thank You!

Appendix:

Model Equations

- Seasonal Autoregressive Integrating Moving Average (ARIMA/SARIMAX)

  SARIMAX Equation

$$y_t = \beta x_t + \varphi_1 y_{t-1} + \cdots + \varphi_p y_{t-p} - \theta z_{t-1} - \ldots - \theta_q z_{t-q} + z_t$$

  x_t = exogenous regressors
  z_t = error/noise

- Prophet Forecasting Model

$$y_t = g_t + s_t + h_t + \varepsilon_t$$

  g_t = trend function
  s_t = seasonal periodic changes
  h_t = holiday schedules
  $\boldsymbol{\varepsilon}_t$ = idiosyncratic changes not included in the model

Seasonal Decomposition