Analysis of Residential Electricity Usage in California

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Weather – Residential Electricity Usage
2,494 Data Frames by individual Customer

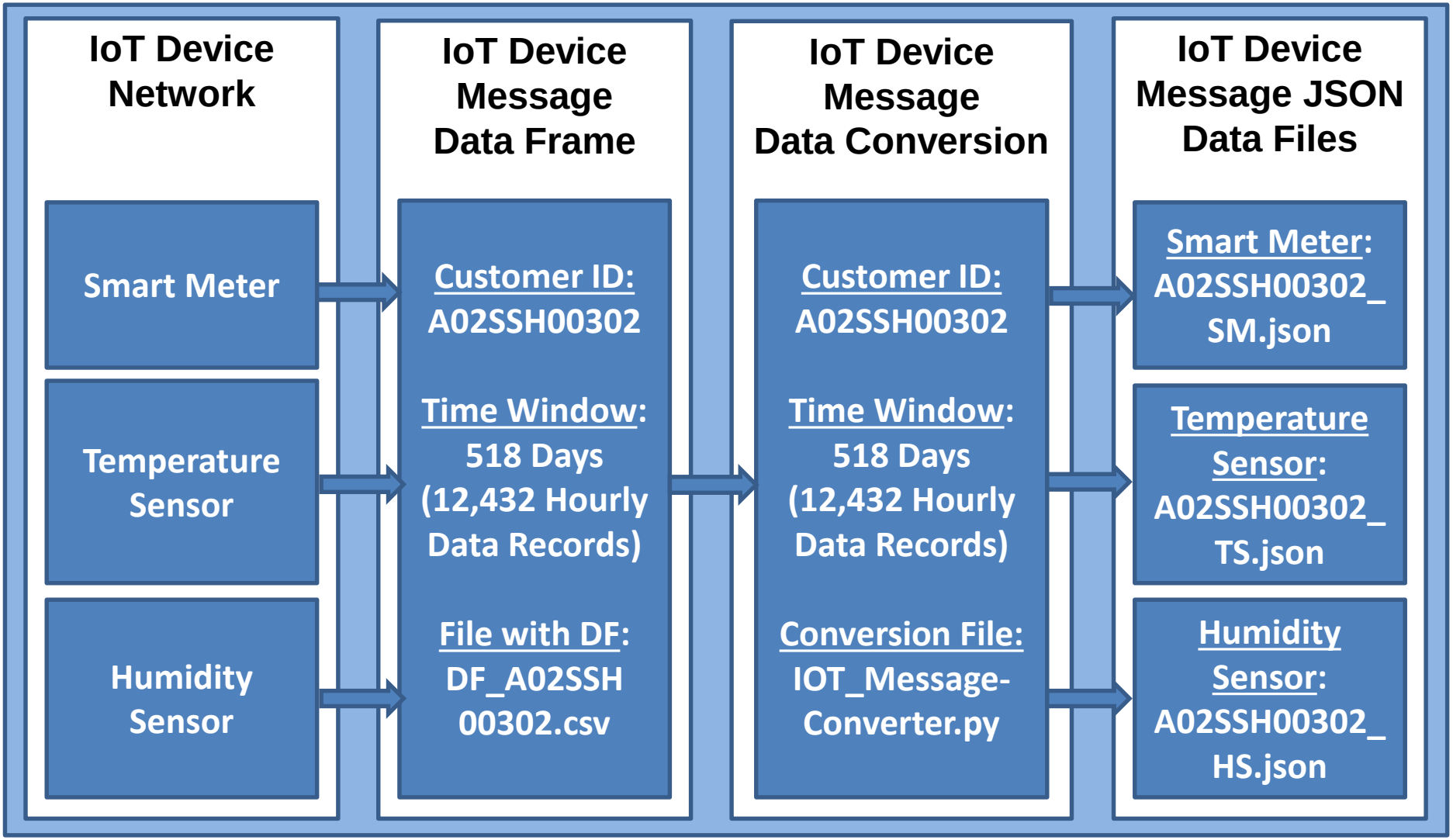
Data Frame – Customer 1

Customer ID	Date	Time	Temp	Hum	Electricity Usage
A01PMA 00102	Day 1	12 AM	T	H	U
A01PMA 00102	Day 1	1 AM	T	H	U
…	…	…	…	…	…
A01PMA 00102	Day 1	11 PM	T	H	U
A01PMA 00102	Day 2	12 AM	T	H	U
…	…	…	…	…	…
A01PMA 00102	Day 576	12 AM	T	H	U
…	…	…	…	…	…
A01PMA 00102	Day 576	11 PM	T	H	U

Data Frame – Customer 2,494

Customer ID	Date	Time	Temp	Hum	Electricity Usage
R08PSL 20703	Day 1	12 AM	T	H	U
R08PSL 20703	Day 1	1 AM	T	H	U
…	…	…	…	…	…
R08PSL 20703	Day 1	11 PM	T	H	U
R08PSL 20703	Day 2	12 AM	T	H	U
…	…	…	…	…	…
R08PSL 20703	Day 576	12 AM	T	H	U
…	…	…	…	…	…
R08PSL 20703	Day 576	11 PM	T	H	U

IoT Device Message Data Provision by Customer (Example: Customer ID A02SSH00302)



IoT Device Message Data Processing and Analysis by Customer (Example: Customer ID A02SSH00302)

Sending of IoT Device Messages from JSON Files
(Terminal Window 3)

- Smart Meter: A02SSH00302_SM.json
- Temp Sensor: A02SSH00302_TS.json
- Hum Sensor: A02SSH00302_HS.json

Processing and Analyzing of IoT Device Messages from JSON Files
(Terminal Window 2)

- Smart Meter Data Processing & Analysis: Kafka-direct-iotmsg-power-meter.py
- Temp Sensor Data Processing & Analysis: Kafka-direct-iotmsg-temp-sensor.py
- Hum Sensor Data Processing & Analysis: Kafka-direct-iotmsg-hum-sensor.py

Results of Processing and Analyzing IoT Device Messages from JSON Files
(Displayed in Terminal Window 2)

Results of Data Processing & Analysis

Unsorted Usage	Sorted Usage	Statistical Load Parameters
2.73kW … 0.56kW	0.225kW … 5.155kW	Min: 0.225kW Max: 5.155kW

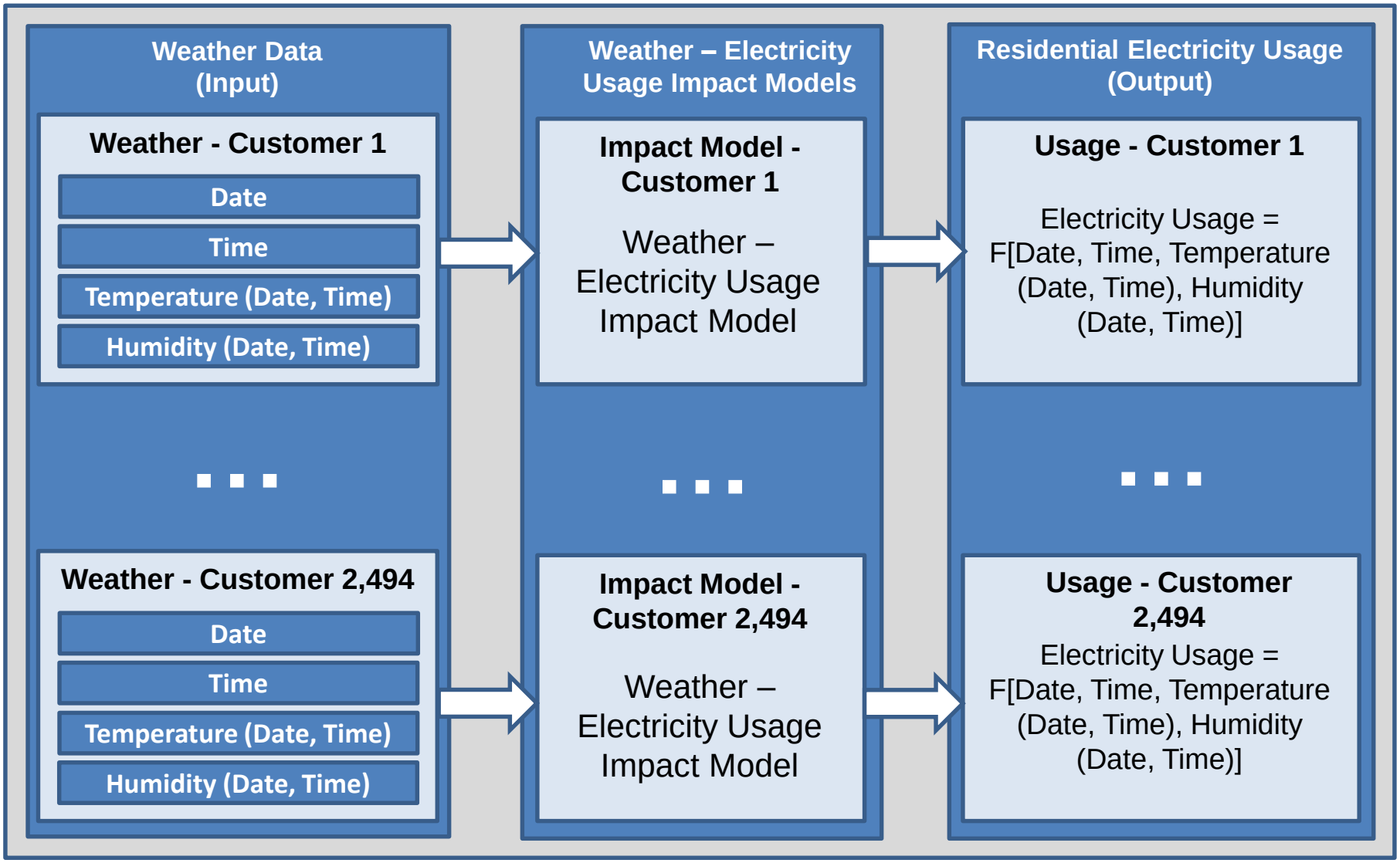
Results of Data Processing & Analysis

Unsorted Temp	Sorted Temp	Statistical Temp Parameters
75F … 49F	35F … 94F	Min: 35F Max: 94F

Results of Data Processing & Analysis

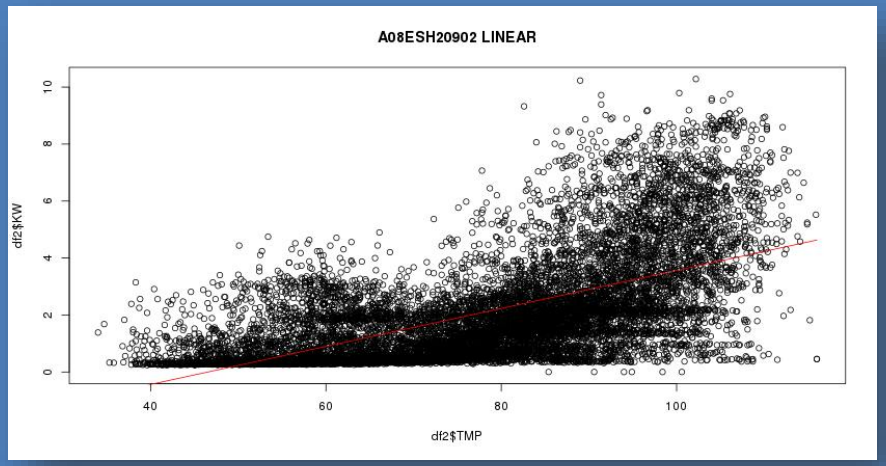
Unsorted Hum	Sorted Hum	Statistical Hum Parameters
35% … 91%	10% … 100%	Min: 10% Max: 100%

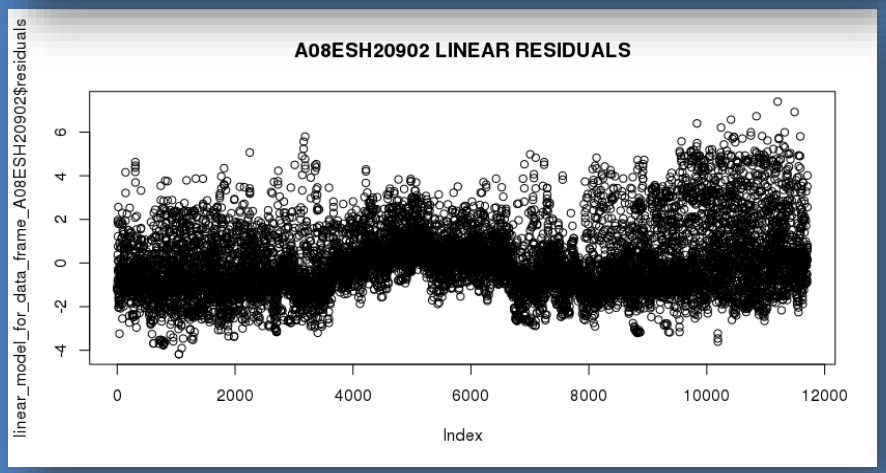
Weather – Residential Electricity Usage Input – Output Data Model



Modelling of Weather Impact on Residential Customer Electricity Usage: SCE Customer

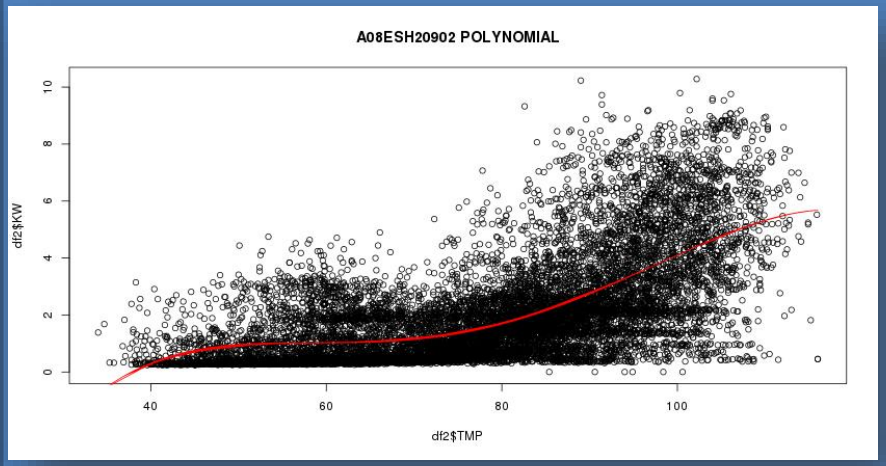
Linear Regression Model

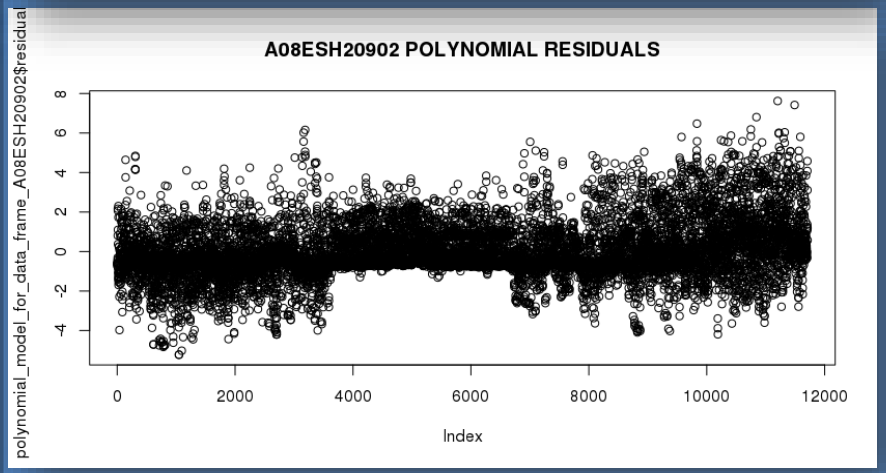




$$R^2_{Multiple} = 0.3704;\ R^2_{Adjusted} = 0.3703$$

Polynomial Regression Model





$$R^2_{Multiple} = 0.4407;\ R^2_{Adjusted} = 0.4405$$

Modelling of Weather Impact on Residential Customer Electricity Usage: SCE Customer

Linear Regression Model

$$Usage_{kW} = 0.0666825 \times Temp_F - 3.1035150$$

Regression Statistics - Coefficients

No.	Variable	Linear Coefficient	Likelihood (Probability) of Insignificance	Significance Code
1	Intercept	-3.1035150	< 2e-16 (very small)	***
2	$Temp_F$	0.0666825	< 2e-16 (very mall)	***

$$R^2_{Multiple} = 0.3704;\ R^2_{Adjusted} = 0.3703$$

Polynomial Regression Model

$$Usage_{kW} = -31.22 + 1.891 \times Temp_F$$
$$-0.04039 \times Temp_F^2 + 0.0003679 \times Temp_F^3$$
$$-1.177 \times 10^{-6} \times Temp_F^4$$

Regression Statistics - Coefficients

No.	Variable	Linear Coefficient	Likelihood (Probability) of Insignificance	Significance Code
1	Intercept	-31.22	< 2e-16 (very small)	***
2	$Temp_F$	1.891	< 2e-16 (very small)	***
3	$Temp_F^2$	-0.04039	< 2e-16 (very small)	***
4	$Temp_F^3$	0.0003679	< 2e-16 (very small)	***
5	$Temp_F^4$	-1.177e-06	< 2e-16 (very small)	***

$$R^2_{Multiple} = 0.4407;\ R^2_{Adjusted} = 0.4405$$

Conclusions

- Linear multivariable regression is not well suited for modeling daily electricity load curves.
- Polynomial multivariable regression is not so well suited for modeling.
- The quality of fit of linear and polynomials regression models very much depends on the specific customer.
- Electricity usage has more significant impact from temperature than from humidity. Note: Temperature and humidity are not independent.
- In order to get a better reflection of the dynamic customer behavior in terms of electricity usage discrete time series models must be used.

Thank you!