Demystifying Warranty Analytics

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Automotive Industry Use cases

- R& D for Design Process
- Transportation optimization
- Inventory Management
- Schedule Optimization
- Process Optimization
- Workforce Optimization
- Process Control
- Customer Segmentation
- Targeted Marketing
- Warranty period analytics
- Fraud Detection
- Predictive Maintenance

Original equipment manufacturers work closely with carmakers to build parts used in manufacturing and repairing of new vehicles

Approach To Warranty Analytics

Theory

- Past return history can be used to predict future returns (for a population or failure mode(s))

Methodology

- Statistical Warranty Forecasting using a failure time distribution
- Regress time to failure data to find a model w/ good fit
- Use the model to predict out future time periods

Assumptions

- Failure Rate is not constant over time ,Past customer behaviour is representative of future behaviour
- Failed units are replaced with new units with similar field quality, Lag time to install & use is negligible

Failure distribution & prediction terms

- The failure distribution, f(t), can be described with either of this distribution
  - Weibull Distribution
  - Gamma Distribution
  - Lognormal Distribution

- "Hazard Rate", h(t) is the Function that describes the "instantaneous failure rate over time"
  - –Represents the likelihood to fail in the next instant given that it hasn't failed yet

Hazard Rate

$$h(t) = \frac{f(t)}{1 - F(t)} = \frac{f(t)}{R(t)}.$$

- h(t) = Hazard Rate
- f(t) = PDF or Failure Function. Likelihood of a failure at this point in time (t)
- F(t) = Cumulative Failure Distribution. Probability of failure before time t
- R(t) = Reliability Function. Probability of no failure before time t

Typical Warranty Forecasting Models

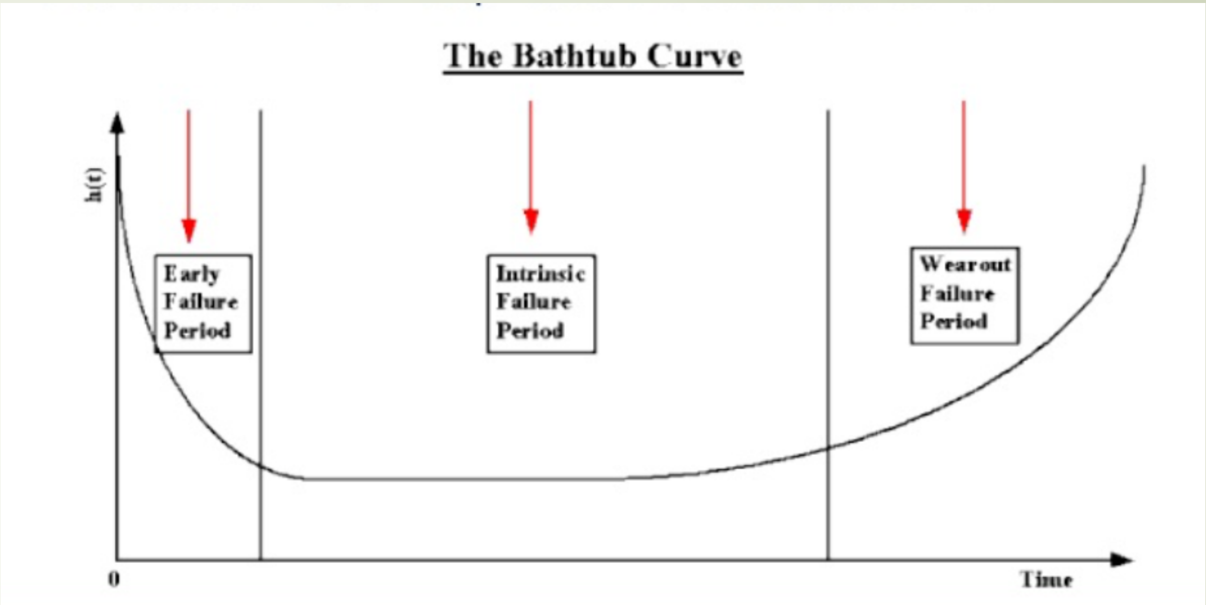
Variable Hazard Rate:

F(t)= Weibull Distribution

$$f(x) = \alpha\beta^{-\alpha}x^{\alpha-1}\exp\left[-\left(\frac{x}{\beta}\right)^{\alpha}\right]$$

with $\alpha > 0$ and $\beta > 0$ and $0 < x < \infty$

Weibull is a flexible life model that can be used to characterize failure distributions in all three phases of the bathtub curve. This is applied when probability of failure changes over time.



Historical Data

- Obtain Time-To-Failure Data
- Fit a distribution which best fits the data & estimate parameters (Using a statistical software package of your choice Python, SAS,SPSS)

Part A1 | The historical data of warranty Claims for Part A1

Warranty Claim Mon-Year

Car Sold Mon-Year	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14
Jan-14	1	1	0	0	0	1	0	0
Feb-14		8	1	4	1	2	1	0
Mar-14			1	1	0	1	2	2
Apr-14				1	51	9	0	0
May-14					33	1	0	0
Jun-14						0	3	2
Jul-14							0	0
Aug-14								0

Time to Failure Diagonals

Car Sold Mon-Year	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14
Jan-14	1	1	0	0	0	1	0	0
Feb-14		8	1	4	1	2	1	0
Mar-14			1	1	0	1	2	2
Apr-14				1	51	9	0	0
May-14					33	1	0	0
Jun-14						0	3	2
Jul-14							0	0
Aug-14								0

Lowest Diagonal = The number of warranty claims for part A1 in the first month after sell

=1+8+1+1+33+0+0+0=44

Next Diagonal = The number of warranty claims for part A1 in the second month after sell

=1+1+1+51+1+3=58

And so on….for 36 months of warranty period

Data to Model

Months on Road	Claims Received
1	44
2	58
3	15
4	2
.	.
.	.
.	.
.	.
36	23

- Car Types/Geography/Parts
- No censored data
- 36 months History as warranty period was 36 months
- For all 3600 parts in the car
- and such tables to model
- Training/Testing
- Validation
- Deployment

Model

- Python - library Reliability
- Function fit_everything-
    - Weibull, Gamma, Lognormal, loglogistic and many such distributions to your data and selects best among them for you.
- Most softwares use Maximum Likelihood Estimation to estimate the parameters and Goodness of fitness test like
    - AIC - Akaike Information Criterion (goodness of fit statistic)
    - BIC - Bayesian Information Criterion (goodness of fit statistic)

Output for Part A1 & Final Cost

	Warranty Claim Mon-Year							
Car Sold Mon-Year	**Sep-14**	**Oct-14**	**Nov-14**	**Dec-14**	**Jan-15**	**Feb-15**	**Mar-15**	**Apr-15**
Jan-14	2	3	3	3	3	3	3	3
Feb-14	1	1	1	1	1	2	1	1
Mar-14	5	3	1	4	5	3	2	4
Apr-14	12	12	14	12	13	15	14	12
May-14	24	20	21	22	20	20	22	21
Jun-14	8	7	8	9	6	7	8	6
Jul-14	9	6	5	7	8	6	7	6
Aug-14	11	12	12	11	14	13	12	11
	72	**64**	**65**	**69**	**70**	**69**	**69**	**64**

- Final Report – Using Prediction accumulate all the parts per month which will fail with its quantity and multiply it by each part's cost to get the total claims and claim amount
- Actual Cost – Sum (each part's claims*part cost) for all parts + (labour, time etc)

Benefits of Warranty Analytics

- Increased customer satisfaction, product quality & brand reputation
- Tremendous impact on the bottom line due to early issues identification
- Optimized warranty policies for maximum financial performance,
- Increase efficiency of support logistics such as optimum stocking of replacement parts or deployment of technicians.
- Identify the patterns of claims (based on season, mileage, etc)
- Predicting fraudulent claims(particular dealer always filing warranty claims, the life of an item is very long, but those parts are frequently coming for a warranty claim, etc)
- Investigating the association between different types of claims (the two spare parts that gets used same time has the same failure time)
- What-if analysis such as if we increase the mileage what will impact on warranty costs

THANK YOU

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