How to Use r and LaTeX to Write a Dynamic Report

An Enthusiastic of $\int\!\!\int\!\!\int_{Birth}^{Life} Learning\, dy\, dm\, dt$

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Contents

1 Data Definition

Reference [3], Reference [2] and Reference [1]

Following Table 1 is the definition for the data used in this LaTeX Dynamic Report.

```
> ## Num = number of flights combined
> ## K = the Kth data ie. the Kth Aircraft Series Number
> seekdata <- function (workDir = "C://simplifiedthesis/data", Num = 4, K = 3) {
+ pattern <- paste("comb_", Num, sep = "")
+ filez <- list.files(path = workDir, pattern = pattern, full.names = TRUE)
+ faultStatus <- substr(filez[K], 44, 51)
+ Dat <- read.csv(filez[K])
+ Dat <- Dat[which(Dat[,2] < 9.999 & Dat[,2] > -9.999), ]
+ Dat <- ts(Dat[,2])
+ return(Dat)
+ }
> seekarima <- function (workDir = "C://simplifiedthesis/data",
+                         Num1 = 4, K1 = 3, AR = 12, MA = 4) {
+ Dat <- seekdata(workDir, Num = Num1, K = K1)
+ Dat.fit <- arima(diff(Dat), order =c(AR,0,MA), optim.method="Nelder-Mead")
+ return(Dat.fit)
+ }
> ## if Positive faultSTATUS == 1
> faultstatus <- function ( workDir = "C://simplifiedthesis/data", Num2 = 4, K2 = 3) {
+ pattern <- paste("comb_", Num2, sep = "")
+ filez <- list.files(path = workDir, pattern = pattern, full.names = TRUE)
+ faultSTATUS <- length(grep("Positive", (filez[K2])))
+ return(faultSTATUS)
+ }
```

Table 1: Defination code for data used for this report.

2 Data Exploratory: ts, diff, acf and pacf - 1

Fllowing Figure 1 demostrates how the R codes would work here.

```
[1] "For 7-Combined-Flights data; Aircraft 3th in ASN."
```

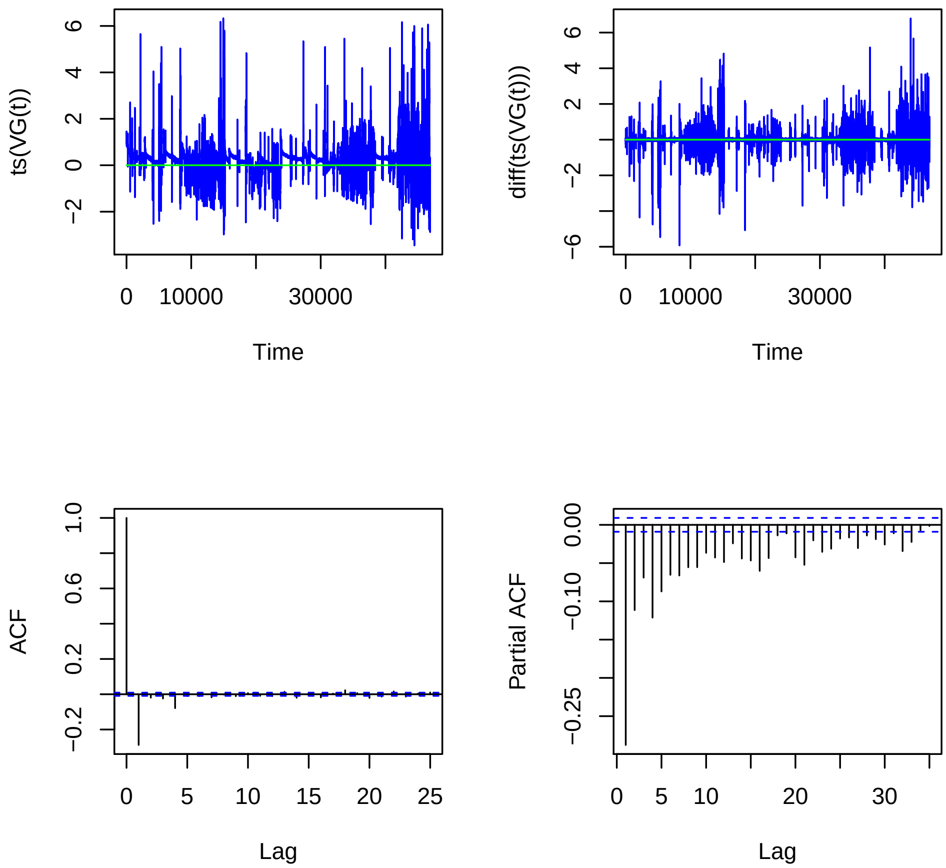

Figure 1: The ts(VG(t)), diff(ts), acf(diff(ts) and pacf(diff(ts))).

3 Data Exploratory: ts, diff, acf and pacf - 2

Fllowing Figure 2) demostrates how the R codes would work here.

```
[1] "For 7-Combined-Flights data; Aircraft 18th in ASN."
```

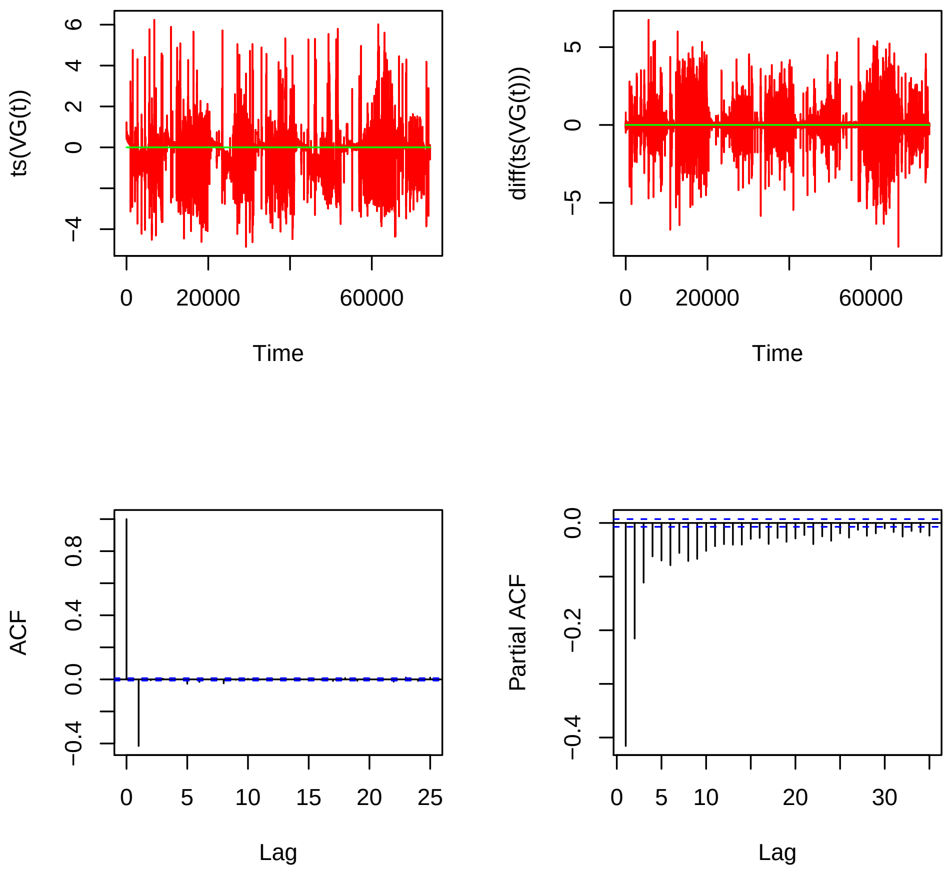

Figure 2: The ts(VG(t)), diff(ts), acf(diff(ts) and pacf(diff(ts))).

4 Mathmatical Equations

$$X_t = \delta + AR_1 X_{t-1} + AR_2 X_{t-2} + \cdots + AR_p X_{t-p} + A_t - MA_1 A_{t-1} - MA_2 A_{t-2} - \cdots - MA_q A_{t-q} \quad (1)$$

Where $X_t = X(t) = diff(ts(VG(t)))$ is the first order differenced value of the ts transformed VG data at the time , $AR_i$is the AutoRegression (AR) coefficient, and MA_j is the Moving Average (MA) coefficient. This model is denoted as $arima(p, 0, q)$.

$$p(CompressorStall|N_{CombinedFlights}) = \beta_0 + \sum_{i=1}^{p} \beta_i * AR_i + \sum_{j=1}^{q} \beta_{j+p} * MA_j + \epsilon) \quad (2)$$

Where Nindicates number of flights data used, currently, $N = 1, 2, ..., 7$. AR_i is the AR coefficients ($i = 1, 2, ..., p$) and MA_j is the MA coefficients ($j = 1, 2, ..., q$). This Probability Model of Compressor Stall Fault Event is based on the data as described below:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_m \\ y_{m+1} \\ \vdots \\ y_n \end{pmatrix} \sim \begin{pmatrix} AR_{1_1} & AR_{2_1} & \ldots & AR_{p_1} & MA_{1_1} & MA_{2_1} & \ldots & MA_{q_1} \\ AR_{1_2} & AR_{2_2} & \ldots & AR_{p_2} & MA_{1_2} & MA_{2_2} & \ldots & MA_{q_2} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ AR_{1_n} & AR_{2_n} & \ldots & AR_{p_n} & MA_{1_n} & MA_{2_n} & \ldots & MA_{q_n} \end{pmatrix} \quad (3)$$

5 ARIMA Coefficients

For the sample data as of Figure 3, the coefficients of $arima(12,0,4)$ is calculated as Table 2.

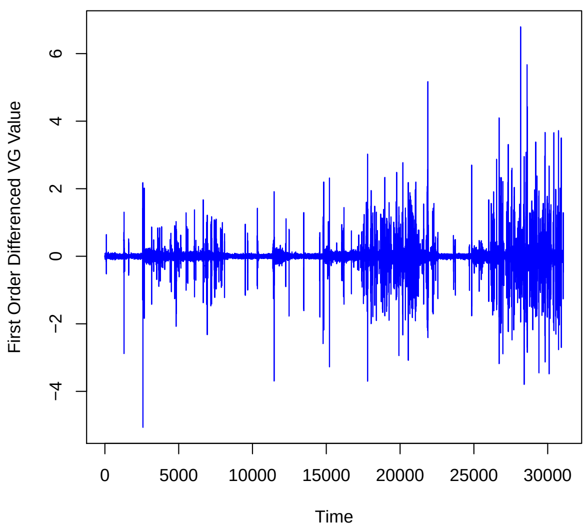

Figure 3: First order differenced values of ts transformed VG data for a 4-Combined-Flights.

```
[1] "For 4-Combined-Flights data; Aircraft 3th in ASN; arima(12,0,4) model."

         ar1          ar2          ar3          ar4          ar5          ar6
-0.181470271  0.000238739  0.015003603  0.032469898  0.029538878 -0.002240709
         ar7          ar8          ar9         ar10         ar11         ar12
 0.057590585  0.040496339  0.006446809  0.011284292  0.012444539  0.021522452
         ma1          ma2          ma3          ma4
-0.050258616  0.046497112  0.020957831 -0.013201263
```

Table 2: Coefficients of $arima(12,0,4)$ for a 4-Combined-Flights data.

(-0.1815, 0.0002387, 0.01500, 0.03247, 0.02954, -0.002241, 0.05759, 0.04050, 0.006447, 0.01128, 0.01244, 0.02152, -0.05026, 0.04650, 0.02096, -0.01320)

6 Linear Regression Model Adequacy

$fit.lm < -lm(Fault\ ., data = DATA, na.action = NULL)$

$R^2 = summary(fit.lm)\$r.squared$

$R^2_{adj} = summary(fit.lm)\$adj.r.squared$

$StandardError = summary(fit.lm)\$sigma$

$Model_{p-value} = pf(x[1], x[2], x[3], lower.tail = FALSE)$

Where $x < -summary(fit.lm)\$fstatistic$, $pfstats$ is the built-in F probability distribution function in R programming.

The examination of Linear Regression Model (LRM) adequacy based on various arima(p,0,q) are shown in Figure [**??**], Figure [**??**] and Figure [**??**].

7 Fit Goodness of ARIMA-LRM

(codes and plots here)

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References

[1] S. Ganguli, S. Deo, and D. Gorinevsky. "Parametric Fault Modeling and Diagnostics of a Turbofan Engine". In: *IEEE CCA/ISIC/CACSD*. Taipei, Taiwan, 2004.

[2] Luca Marinai, Rita Singh , Barry Curnock, and Douglas Probert. "Detection and Prediction of the Performance Deterioration of a Turbofan Engine". In: *Proceedings of the International Gas Turbine Congress*. Tokyo, Japan, 2003.

[3] Field Engineering Unit/H564 Northrop Electronics Division. *Field Engineering A-10 TEMS Software Handbook, A-10 Turbine Engine Monitor System, for Version 54.1 and 56.1 software, section 3.1.4 VG Schedule*. 2010.