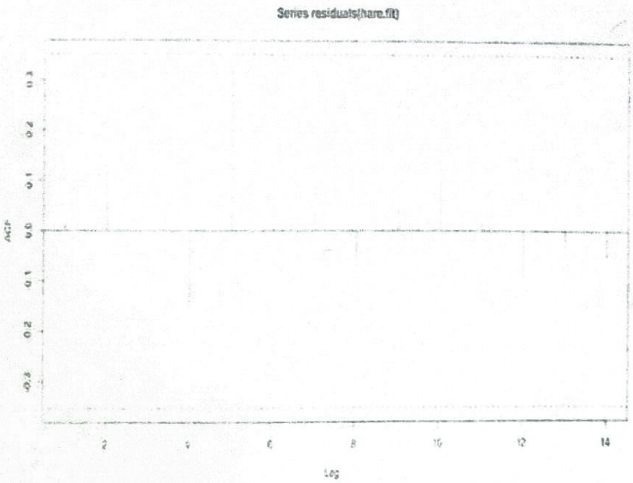
8.7 Fit an AR(3) model by maximum likelihood to the square root of the hare abundance series (filename hare).

(a) Plot the sample ACF of the residuals. Comment on the size of the correlations.

```
> hare.sqr=(hare)^0.5
> hare.fit=arima(hare.sqr,order=c(3,0,0))
> acf(residuals(hare.fit))
```



(b) Calculate the Ljung-Box statistic summing to K = 9. Does this statistic sup- port the AR(3) specification?

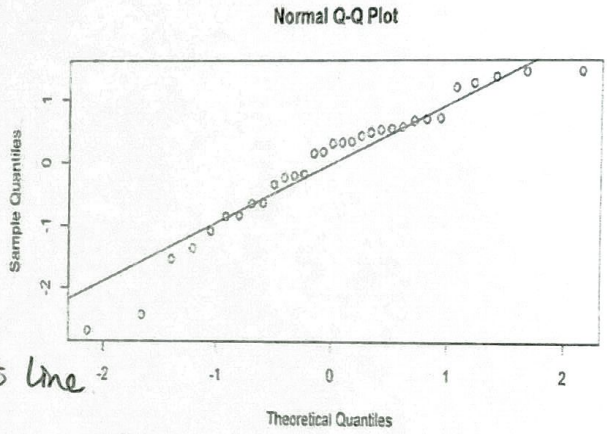
```
> LB.test(hare.fit,lag=9)

        Box-Ljung test

data:  residuals from  hare.fit
X-squared = 6.2475, df = 6, p-value = 0.396
```

(c) Perform a runs test on the residuals and comment on the results.

```
> runs(residuals(hare.fit))
$pvalue
[1] 0.602
$observed.runs
[1] 18
$expected.runs
[1] 16.09677
$n1
[1] 13
$n2
[1] 18
$k
[1] 0
```

(d) Display the quantile-quantile normal plot of the residuals. Comment on the plot.

```
> qqnorm(residuals(hare.fit))
> qqline(residuals(hare.fit))
```



the residuals are placed in a straight line

(e) Perform the Shapiro-Wilk test of normality on the residuals.

```
> shapiro.test(residuals(hare.fit))

        Shapiro-Wilk normality test

data:  residuals(hare.fit)
W = 0.93509, p-value = 0.06043
```

due to p-value is larger than 0.05.

There is a strong evidence that residuals normally distributed.