Exp 8

Que 1 Ratio to moving average

```
library(zoo)
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
d52 = c(23,39,82,17,18,16,20,17,12,22,20,18)
d53 = c(25,26,105,20,22,20,26,18,23,29,15,16)
d54 = c(32,36,93,21,21,22,29,21,15,27,27,21)
d55 = c(32,42,99,24,24,23,29,24,21,32,28,21)
d = c(d52,d53,d54,d55)
y = rollmean(d,k=12)
z = rollmean(y,k=2)
x = rep(0,6)
t = c(x,z,x)
v = (d/t)*100
s52 = c(v[1:12])
s53 = c(v[13:24])
s54 = c(v[25:36])
s55 = c(v[37:48])
s52[1:6] = 0
s55[7:12] = 0
s1 = (s53+s54+s55)/3
s2 = (s52+s53+s54)/3
s = c(s1[1:6],s2[7:12])
si = s*(1.005636)
data.frame(s52,s53,s54,s55,s,si)
```

```
##         s52       s53       s54       s55         s        si
## 1   0.00000  90.90909 108.62801 100.00000  99.84570 100.40843
## 2   0.00000  93.55322 121.17812 130.73930 115.15688 115.80591
## 3   0.00000 371.13402 315.25424 304.61538 330.33455 332.19631
## 4   0.00000  68.86657  72.20630  72.81922  71.29736  71.69920
## 5   0.00000  75.53648  71.18644  72.27102  72.99798  73.40940
## 6   0.00000  69.36416  72.82759  69.17293  70.45489  70.85198
## 7  78.68852  89.52654  95.34247   0.00000  87.85251  88.34765
## 8  68.11352  60.50420  68.47826   0.00000  65.69866  66.06894
## 9  47.29064  77.52809  48.12834   0.00000  57.64902  57.97393
## 10 83.14961  99.28673  85.60106   0.00000  89.34580  89.84935
## 11 74.76636  51.35521  84.92792   0.00000  70.34983  70.74632
## 12 66.46154  54.70085  65.71056   0.00000  62.29098  62.64206
```

Que 2 Gompertz Curve

```
year = 1920:1952
Y = c(8.7,19.8,24.7,32.5,42.2,58.2,60.6,100.0,100.1,131.5,
      117.9,157.3,152.0,211.3,194.8,252.1,297.6,267.1,
      247.1,359.8,388.7,452.4,468.8,494.2,539.1,602.4,
      666.5,729.3,846.7,782.7,955.5,865.4,845.0)
t = 1:33
y = log(Y)
data.frame(year,Y,t,y)
```

```
##    year     Y  t        y
## 1  1920   8.7  1 2.163323
## 2  1921  19.8  2 2.985682
## 3  1922  24.7  3 3.206803
## 4  1923  32.5  4 3.481240
## 5  1924  42.2  5 3.742420
## 6  1925  58.2  6 4.063885
## 7  1926  60.6  7 4.104295
## 8  1927 100.0  8 4.605170
## 9  1928 100.1  9 4.606170
## 10 1929 131.5 10 4.879007
## 11 1930 117.9 11 4.769837
## 12 1931 157.3 12 5.058155
## 13 1932 152.0 13 5.023881
## 14 1933 211.3 14 5.353279
## 15 1934 194.8 15 5.271973
## 16 1935 252.1 16 5.529826
## 17 1936 297.6 17 5.695750
## 18 1937 267.1 18 5.587623
## 19 1938 247.1 19 5.509793
## 20 1939 359.8 20 5.885548
## 21 1940 388.7 21 5.962808
## 22 1941 452.4 22 6.114567
## 23 1942 468.8 23 6.150176
## 24 1943 494.2 24 6.202940
## 25 1944 539.1 25 6.289901
## 26 1945 602.4 26 6.400922
## 27 1946 666.5 27 6.502040
## 28 1947 729.3 28 6.592085
## 29 1948 846.7 29 6.741346
## 30 1949 782.7 30 6.662749
## 31 1950 955.5 31 6.862235
## 32 1951 865.4 32 6.763192
## 33 1952 845.0 33 6.739337
```

```
m = 11
s1 = sum(y[1:11])
s2 = sum(y[12:22])
s3 = sum(y[23:33])
b = ((s2-s3)/(s1-s2))^(1/m)
A = ((s1-s2)*(1-b))/(b*(1-b^m)^2)
a = exp(A)
K = (s1*s3-s2^2)/(m*(s1-2*s2+s3))
k = exp(K)
```

```r
Trend = function(t){k*(a^(b^t))}
# Trend value in 1930
Trend(11)
```

```
## [1] 118.8252
```

```r
# Trend value in 1940
Trend(21)
```

```
## [1] 399.0587
```

```r
# Trend value in 1960
Trend(41)
```

```
## [1] 1356.276
```