

STA457TUT3

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Part a

```
#read the file into a vector:
```

```
ground_water<-scan(file="anatolia_hati.txt")  
str(ground_water)
```

```
## num [1:360] 34.4 34.5 34.7 34.8 34.9 ...
```

```
#Convert the string into a time series, starting at 1975,ending at 2004.Since we have 360 observations,
```

```
ground_water<-ts(ground_water,start=1975,frequency=12)  
str(ground_water)
```

```
## Time-Series [1:360] from 1975 to 2005: 34.4 34.5 34.7 34.8 34.9 ...
```

```
#We test whether the interpretation is accurate.
```

```
end(ground_water)
```

```
## [1] 2004 12
```

```
#print the time series
```

```
print(ground_water)
```

```
##      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec  
## 1975 34.36 34.45 34.70 34.80 34.88 35.16 35.60 35.86 35.86 35.70 35.48 35.28  
## 1976 35.22 35.18 34.98 35.20 35.51 35.32 34.45 34.54 34.39 34.18 33.92 33.73  
## 1977 33.40 32.94 32.55 32.03 31.62 31.60 31.72 31.60 31.55 31.22 30.85 30.61  
## 1978 30.35 30.26 30.10 29.90 29.94 30.00 30.34 30.83 30.97 30.84 30.73 30.67  
## 1979 30.56 30.45 30.45 30.42 30.66 30.78 31.52 32.41 32.96 32.85 32.57 32.41  
## 1980 32.33 32.20 31.94 31.77 31.60 31.84 32.42 33.12 33.33 33.00 32.65 32.23  
## 1981 31.99 31.79 31.44 30.96 30.76 30.68 31.15 31.52 31.70 31.45 31.12 30.88  
## 1982 30.73 30.60 30.58 30.40 30.88 31.10 31.96 33.33 33.58 33.32 33.19 33.09  
## 1983 33.00 32.95 32.92 32.92 33.54 33.86 35.23 36.14 36.36 36.00 35.68 35.44  
## 1984 36.44 36.06 34.90 34.84 34.90 36.10 36.94 37.84 38.04 37.79 37.34 36.98  
## 1985 36.77 36.54 36.39 36.39 37.61 38.60 39.39 40.16 40.06 39.57 39.09 38.76  
## 1986 38.52 38.35 38.37 38.81 39.34 39.81 40.85 41.92 42.20 41.50 40.93 40.50  
## 1987 40.16 39.84 39.64 39.43 40.12 41.39 42.73 43.58 43.49 44.18 44.94 45.53  
## 1988 46.06 46.42 46.78 39.42 39.96 40.58 41.20 41.70 41.52 40.88 40.49 40.24  
## 1989 40.18 40.12 39.81 39.84 40.64 40.90 41.86 41.84 41.82 41.60 40.70 40.10  
## 1990 39.95 39.89 39.38 39.07 40.16 42.50 43.20 44.11 43.79 43.34 42.61 41.92  
## 1991 41.44 40.85 40.74 40.52 41.27 42.11 43.88 45.09 45.06 44.22 43.16 42.48  
## 1992 42.42 41.46 40.82 40.82 41.73 42.19 43.26 44.49 44.28 43.54 42.05 42.48  
## 1993 42.13 41.66 41.28 41.29 42.33 43.40 44.88 45.73 45.78 45.16 44.62 43.93  
## 1994 43.34 42.93 42.62 43.04 44.69 45.77 46.63 47.68 47.72 47.24 47.18 47.12  
## 1995 47.06 47.00 46.40 44.53 45.63 47.58 48.16 49.31 49.42 49.36 49.30 49.24
```

```
## 1996 49.18 46.20 45.46 45.00 45.30 45.67 46.73 48.08 48.92 48.45 46.55 45.88
## 1997 45.00 44.15 43.40 42.86 43.65 44.45 44.80 46.74 47.23 46.66 45.77 45.22
## 1998 44.86 44.40 44.03 43.55 43.91 44.90 45.45 47.96 48.93 48.55 47.40 46.74
## 1999 46.41 45.80 45.57 45.02 45.90 47.87 49.02 49.89 49.83 50.59 49.56 48.79
## 2000 48.07 47.75 47.26 46.84 47.73 48.24 50.98 51.71 52.38 52.39 51.42 50.67
## 2001 50.11 49.35 49.19 49.93 51.79 52.79 52.92 55.62 56.80 56.64 55.45 54.78
## 2002 54.07 53.46 52.99 52.49 52.08 54.65 55.27 56.76 57.68 56.25 55.20 54.19
## 2003 53.32 52.48 51.37 51.07 50.71 52.78 54.35 55.46 56.52 55.70 54.47 54.21
## 2004 53.08 52.41 51.71 51.66 52.84 54.11 55.28 56.11 57.02 55.96 55.55 54.83
```

```
time(ground_water)
```

```
##           Jan           Feb           Mar           Apr           May           Jun           Jul           Aug
## 1975 1975.000 1975.083 1975.167 1975.250 1975.333 1975.417 1975.500 1975.583
## 1976 1976.000 1976.083 1976.167 1976.250 1976.333 1976.417 1976.500 1976.583
## 1977 1977.000 1977.083 1977.167 1977.250 1977.333 1977.417 1977.500 1977.583
## 1978 1978.000 1978.083 1978.167 1978.250 1978.333 1978.417 1978.500 1978.583
## 1979 1979.000 1979.083 1979.167 1979.250 1979.333 1979.417 1979.500 1979.583
## 1980 1980.000 1980.083 1980.167 1980.250 1980.333 1980.417 1980.500 1980.583
## 1981 1981.000 1981.083 1981.167 1981.250 1981.333 1981.417 1981.500 1981.583
## 1982 1982.000 1982.083 1982.167 1982.250 1982.333 1982.417 1982.500 1982.583
## 1983 1983.000 1983.083 1983.167 1983.250 1983.333 1983.417 1983.500 1983.583
## 1984 1984.000 1984.083 1984.167 1984.250 1984.333 1984.417 1984.500 1984.583
## 1985 1985.000 1985.083 1985.167 1985.250 1985.333 1985.417 1985.500 1985.583
## 1986 1986.000 1986.083 1986.167 1986.250 1986.333 1986.417 1986.500 1986.583
## 1987 1987.000 1987.083 1987.167 1987.250 1987.333 1987.417 1987.500 1987.583
## 1988 1988.000 1988.083 1988.167 1988.250 1988.333 1988.417 1988.500 1988.583
## 1989 1989.000 1989.083 1989.167 1989.250 1989.333 1989.417 1989.500 1989.583
## 1990 1990.000 1990.083 1990.167 1990.250 1990.333 1990.417 1990.500 1990.583
## 1991 1991.000 1991.083 1991.167 1991.250 1991.333 1991.417 1991.500 1991.583
## 1992 1992.000 1992.083 1992.167 1992.250 1992.333 1992.417 1992.500 1992.583
## 1993 1993.000 1993.083 1993.167 1993.250 1993.333 1993.417 1993.500 1993.583
## 1994 1994.000 1994.083 1994.167 1994.250 1994.333 1994.417 1994.500 1994.583
## 1995 1995.000 1995.083 1995.167 1995.250 1995.333 1995.417 1995.500 1995.583
## 1996 1996.000 1996.083 1996.167 1996.250 1996.333 1996.417 1996.500 1996.583
## 1997 1997.000 1997.083 1997.167 1997.250 1997.333 1997.417 1997.500 1997.583
## 1998 1998.000 1998.083 1998.167 1998.250 1998.333 1998.417 1998.500 1998.583
## 1999 1999.000 1999.083 1999.167 1999.250 1999.333 1999.417 1999.500 1999.583
## 2000 2000.000 2000.083 2000.167 2000.250 2000.333 2000.417 2000.500 2000.583
## 2001 2001.000 2001.083 2001.167 2001.250 2001.333 2001.417 2001.500 2001.583
## 2002 2002.000 2002.083 2002.167 2002.250 2002.333 2002.417 2002.500 2002.583
## 2003 2003.000 2003.083 2003.167 2003.250 2003.333 2003.417 2003.500 2003.583
## 2004 2004.000 2004.083 2004.167 2004.250 2004.333 2004.417 2004.500 2004.583
##           Sep           Oct           Nov           Dec
## 1975 1975.667 1975.750 1975.833 1975.917
## 1976 1976.667 1976.750 1976.833 1976.917
## 1977 1977.667 1977.750 1977.833 1977.917
## 1978 1978.667 1978.750 1978.833 1978.917
## 1979 1979.667 1979.750 1979.833 1979.917
## 1980 1980.667 1980.750 1980.833 1980.917
## 1981 1981.667 1981.750 1981.833 1981.917
## 1982 1982.667 1982.750 1982.833 1982.917
## 1983 1983.667 1983.750 1983.833 1983.917
## 1984 1984.667 1984.750 1984.833 1984.917
## 1985 1985.667 1985.750 1985.833 1985.917
```

```
## 1986 1986.667 1986.750 1986.833 1986.917
## 1987 1987.667 1987.750 1987.833 1987.917
## 1988 1988.667 1988.750 1988.833 1988.917
## 1989 1989.667 1989.750 1989.833 1989.917
## 1990 1990.667 1990.750 1990.833 1990.917
## 1991 1991.667 1991.750 1991.833 1991.917
## 1992 1992.667 1992.750 1992.833 1992.917
## 1993 1993.667 1993.750 1993.833 1993.917
## 1994 1994.667 1994.750 1994.833 1994.917
## 1995 1995.667 1995.750 1995.833 1995.917
## 1996 1996.667 1996.750 1996.833 1996.917
## 1997 1997.667 1997.750 1997.833 1997.917
## 1998 1998.667 1998.750 1998.833 1998.917
## 1999 1999.667 1999.750 1999.833 1999.917
## 2000 2000.667 2000.750 2000.833 2000.917
## 2001 2001.667 2001.750 2001.833 2001.917
## 2002 2002.667 2002.750 2002.833 2002.917
## 2003 2003.667 2003.750 2003.833 2003.917
## 2004 2004.667 2004.750 2004.833 2004.917
```

```
cycle(ground_water)
```

```
##      Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 1975   1   2   3   4   5   6   7   8   9  10  11  12
## 1976   1   2   3   4   5   6   7   8   9  10  11  12
## 1977   1   2   3   4   5   6   7   8   9  10  11  12
## 1978   1   2   3   4   5   6   7   8   9  10  11  12
## 1979   1   2   3   4   5   6   7   8   9  10  11  12
## 1980   1   2   3   4   5   6   7   8   9  10  11  12
## 1981   1   2   3   4   5   6   7   8   9  10  11  12
## 1982   1   2   3   4   5   6   7   8   9  10  11  12
## 1983   1   2   3   4   5   6   7   8   9  10  11  12
## 1984   1   2   3   4   5   6   7   8   9  10  11  12
## 1985   1   2   3   4   5   6   7   8   9  10  11  12
## 1986   1   2   3   4   5   6   7   8   9  10  11  12
## 1987   1   2   3   4   5   6   7   8   9  10  11  12
## 1988   1   2   3   4   5   6   7   8   9  10  11  12
## 1989   1   2   3   4   5   6   7   8   9  10  11  12
## 1990   1   2   3   4   5   6   7   8   9  10  11  12
## 1991   1   2   3   4   5   6   7   8   9  10  11  12
## 1992   1   2   3   4   5   6   7   8   9  10  11  12
## 1993   1   2   3   4   5   6   7   8   9  10  11  12
## 1994   1   2   3   4   5   6   7   8   9  10  11  12
## 1995   1   2   3   4   5   6   7   8   9  10  11  12
## 1996   1   2   3   4   5   6   7   8   9  10  11  12
## 1997   1   2   3   4   5   6   7   8   9  10  11  12
## 1998   1   2   3   4   5   6   7   8   9  10  11  12
## 1999   1   2   3   4   5   6   7   8   9  10  11  12
## 2000   1   2   3   4   5   6   7   8   9  10  11  12
## 2001   1   2   3   4   5   6   7   8   9  10  11  12
## 2002   1   2   3   4   5   6   7   8   9  10  11  12
## 2003   1   2   3   4   5   6   7   8   9  10  11  12
## 2004   1   2   3   4   5   6   7   8   9  10  11  12
```

Part b

```
frequency(ground_water)
```

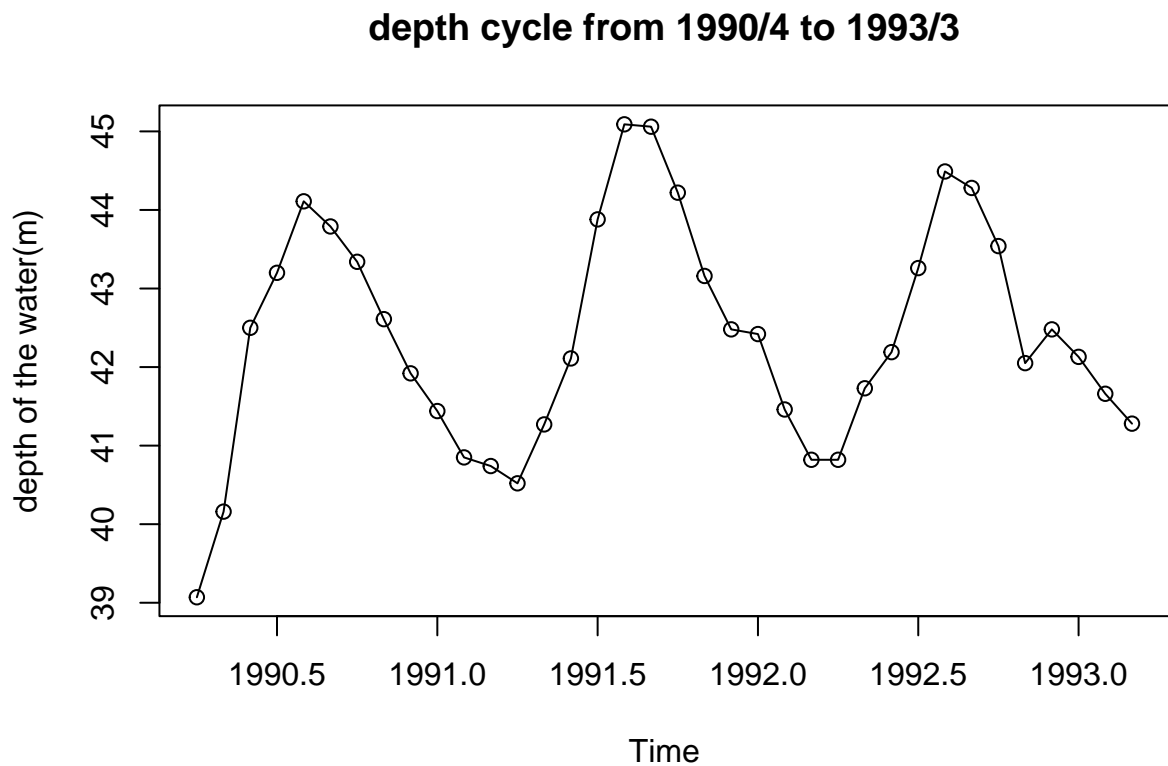
```
## [1] 12
```

```
deltat(ground_water)
```

```
## [1] 0.08333333
```

Part c

```
plot(window(ground_water,start=c(1990,4),end=c(1993,3)),type="o",ylab="depth of the water(m)",main="dep
```



The annual behaviour is similar for 3 years: goes up from January, reach highest at May and June, goes down for the whole second half of the year.