

# **Statistics for Computing**

(CSC 502 0.0)  
**MSc in Computer Science**

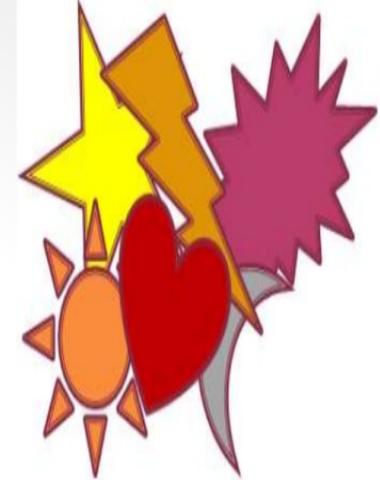
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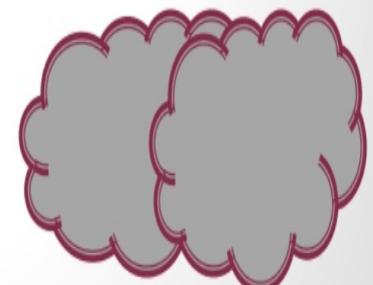
# Will it rain tomorrow?...

Will



To make a prediction

I think it will rain  
tomorrow



1. What stocks are going to go up tomorrow?
2. How can I predict tomorrow's stock market?

*I wonder if I can predict the stock prices for tomorrow*



*Well, you can actually do  
that with Time Series  
Forecasting*



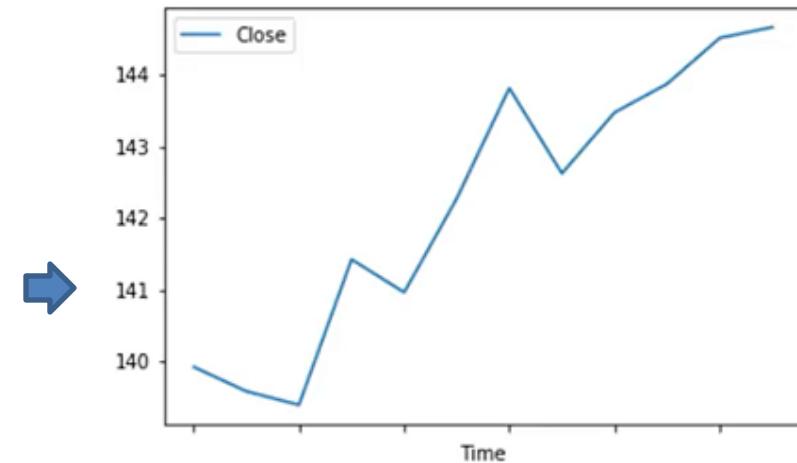
What is a  
time series?

What are its  
applications?

# What is Time Series?

- A time series is a sequence of measurements done over time, usually obtained at equally spaced intervals, be it
  - daily,
  - monthly,
  - quarterly
  - or yearly.

	A	B
1	Date	Close
2	1/4/2017	139.92
3	2/4/2017	139.58
4	3/4/2017	139.39
5	4/4/2017	141.42
6	5/4/2017	140.96
7	6/4/2017	142.27
8	7/4/2017	143.81
9	8/4/2017	142.62
10	9/4/2017	143.47
11	10/4/2017	143.87
12	11/4/2017	144.51
13	12/4/2017	144.66



The stock prices  
change  
everyday!

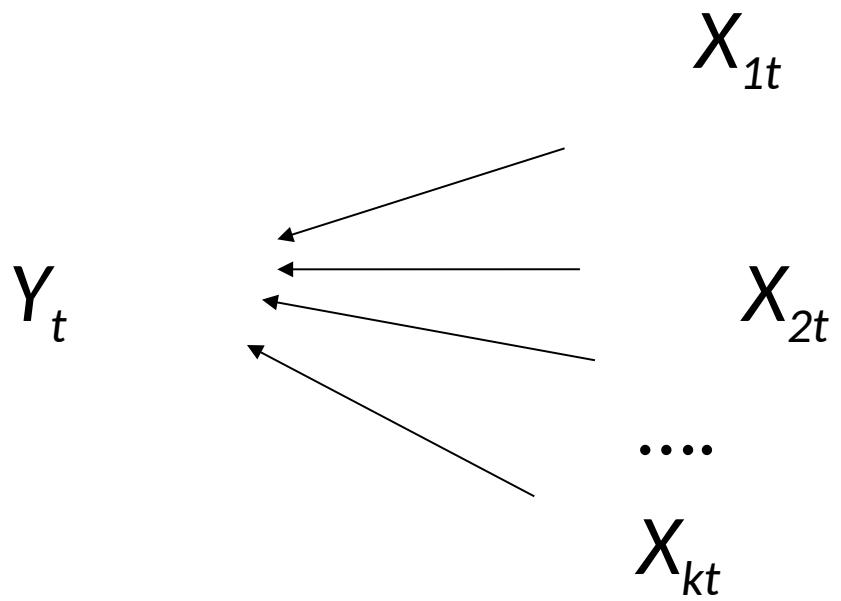
# Introduction to Time Series Analysis

- A **Time Series** is a collection of observations made sequentially, usually in *time*, but the observations may be collected in other domain as well, in another kind of *distance*.
- We denote a Time Series of a variable  $X$  as follows

$$X = (X_1, X_2, \dots, X_t, \dots)$$

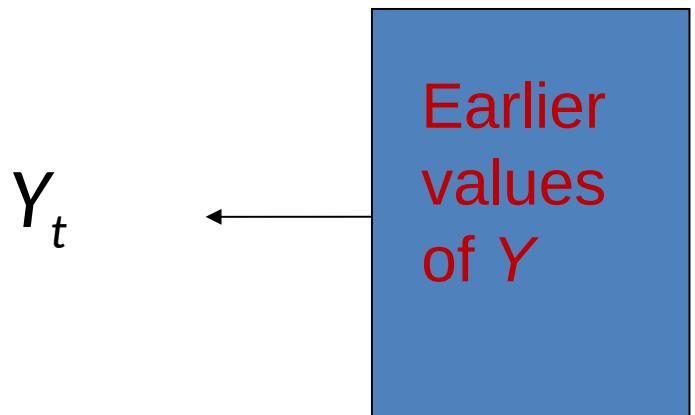
$$X = \{X_t\}_{t=1,2,\dots}$$

## Multiple regression



*Observations coming at the same time or time is not important*

## Time series analysis



*observations with timorder  
(time is important)*

# Time Series Analysis and Applications

- Time Series Analysis is used for many applications such as:
  1. Economic and Financial Time Series (**Economic Forecasting**)  
(Inflation/ GDP/ Unemployment)
  2. Physical Time Series  
(rain fall/ temperature)
  3. Marketing Time Series  
(Demand/ Sale)
  4. Demographic Time Series  
(Annual population rate)



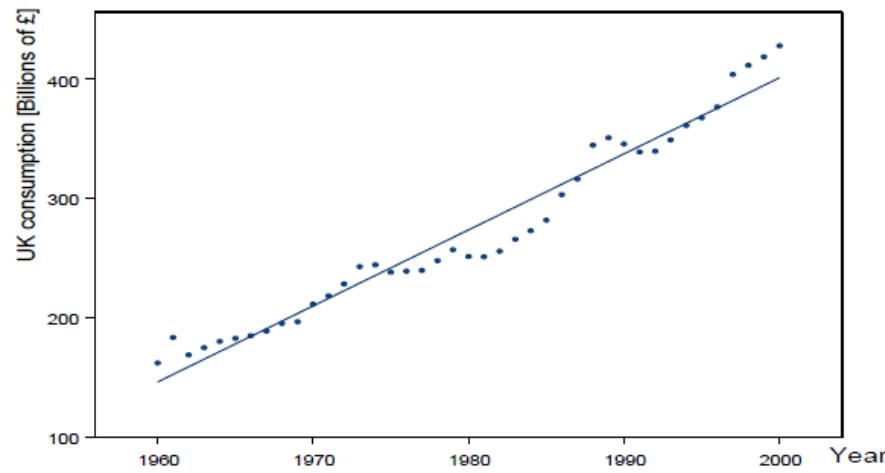
# Components of a Time Series

The major components or pattern that are analyzed through time series are:

- Trend
- Seasonal variations
- Cyclical variations
- Irregular Variation / Random variations.

# 1. Trend

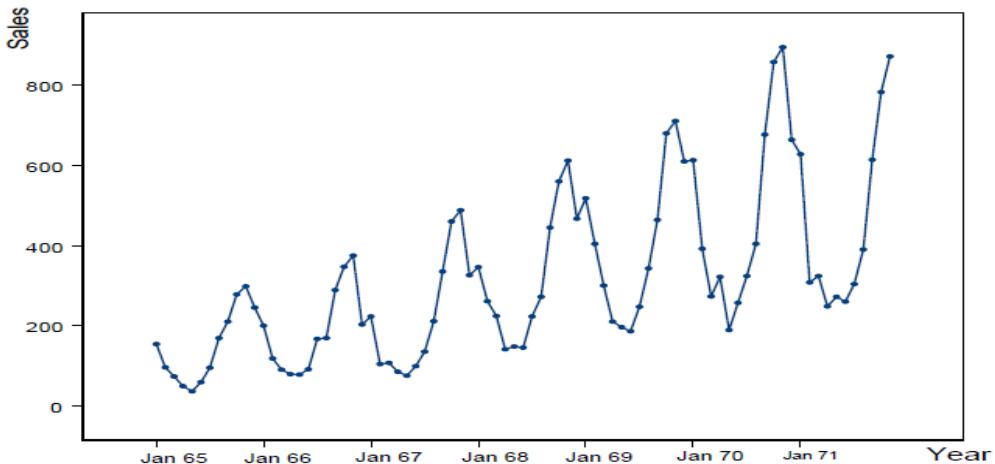
- Trend is the increase or decrease in the series over a period of time, it persists over a long period of time.
- Measure the average change in the variable per unit time (How much time Series will Change in a Unit).
- This trend may show the growth or decline in a time series over a long period



TS and a linear trend for the UK consumption data,

# Seasonal Variations

- These are **short term movements occurring in a data due to seasonal factors** (Periodic variations that recur with some degree of regularity with a year or shorter).

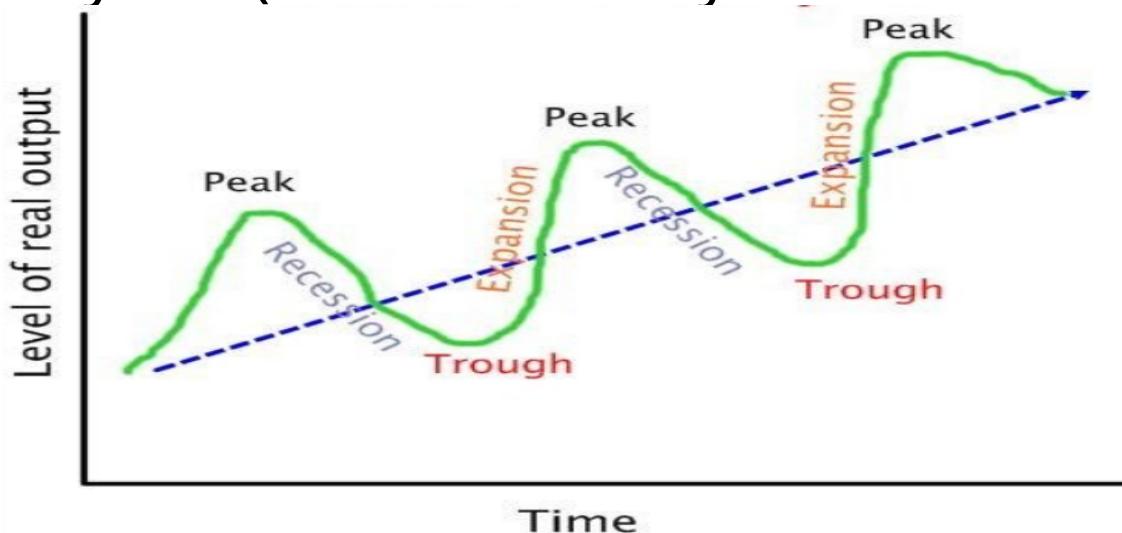


Sales of an industrial heater; monthly data starting from January 1965 till December 1971.

- Example:
  - consumption of ice-cream during summer us generally high and hence sales of an ice-cream dealer would be higher in some months of the year while relatively lower during winter months.
  - Sales of greeting cards and fire-work are subjected to large variation during festivals like Valentine's Day, Eid, Christmas, New Year etc.

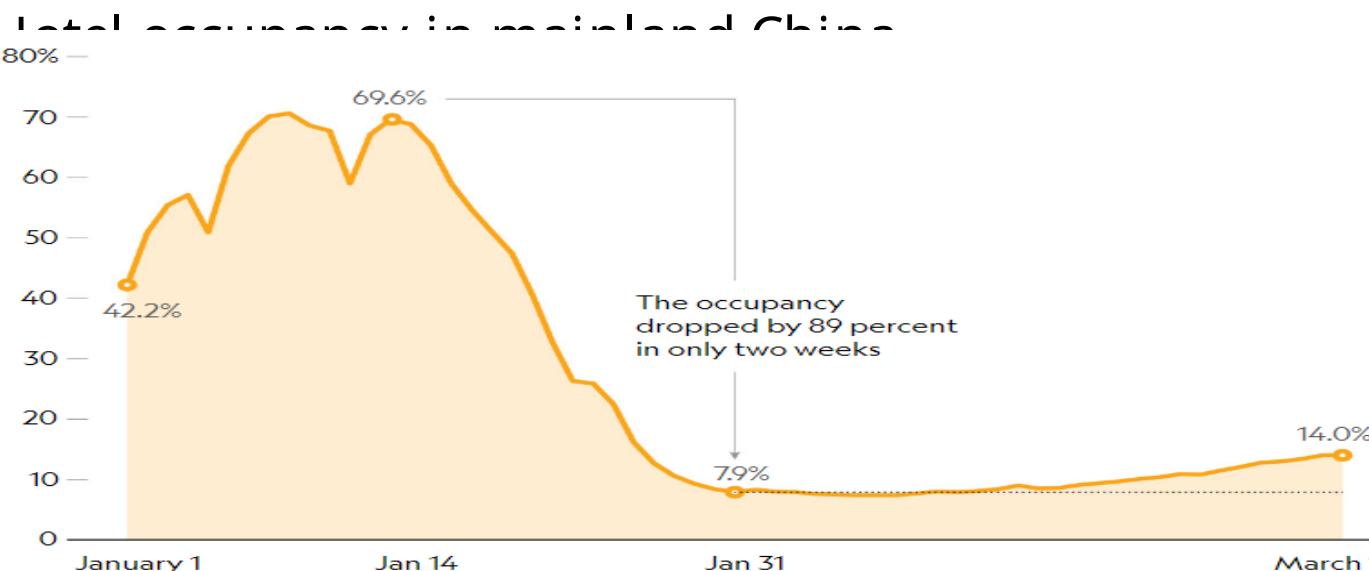
## Cyclical Variation

- Cyclical variations are due to the ups and downs recurring after a period from time to time.
- These oscillations are mostly observed in economics data and the periods of such oscillations are generally extended from five to twelve years or more.
- These oscillations are associated to the well-known business cycles (or economic cycle or boom-bust cycle) .



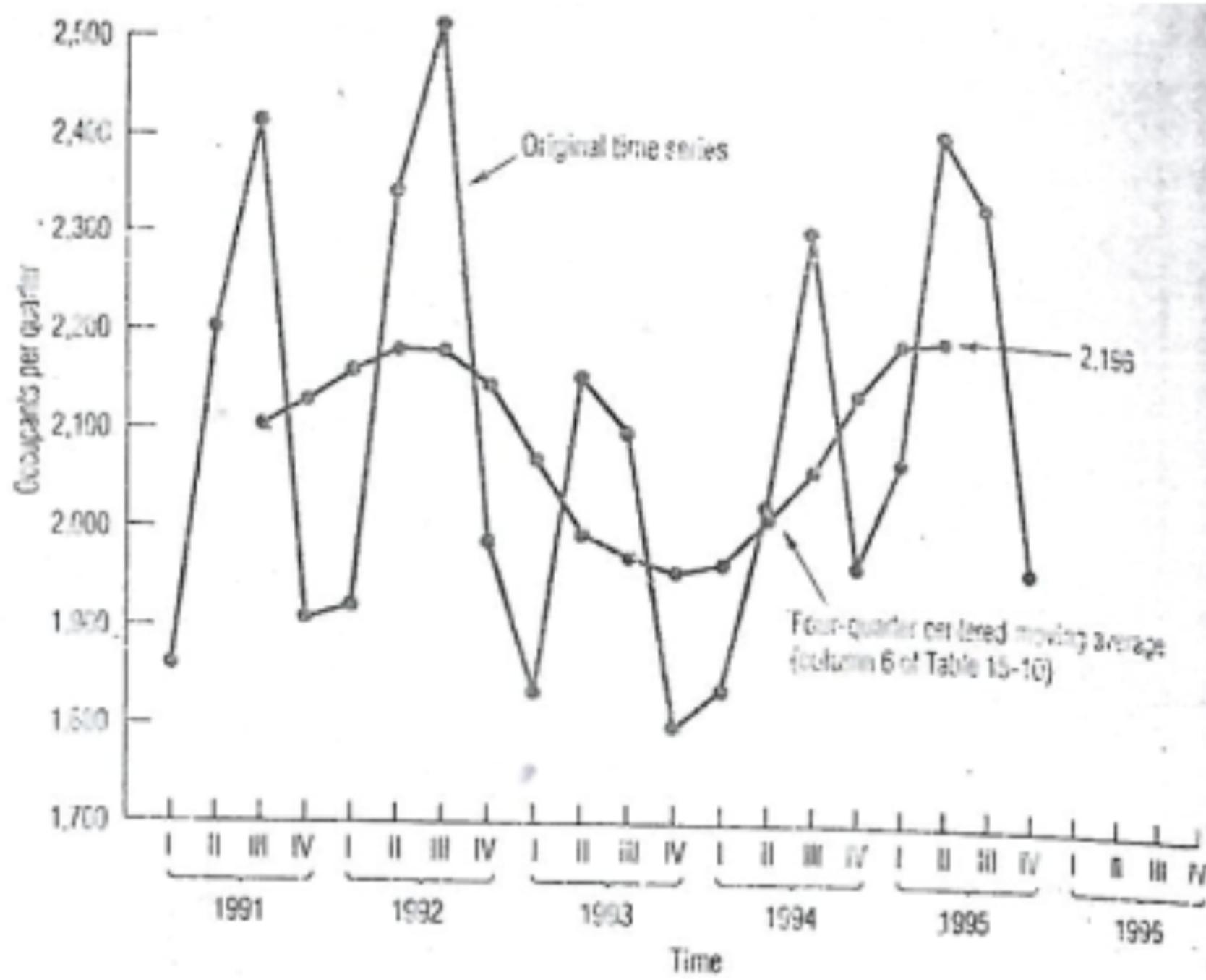
# Irregular Variation

- These are sudden changes occurring in a time series which are unlikely to be repeated, it is that component of a time series which cannot be explained by trend, seasonal or cyclic movements.
- Example:
  - Floods, fires, earthquakes, revolutions, epidemics and strikes etc.,
  - Hotel occupancy in mainland China



- Example: Time series for monthly income (\$)

Year	Quarter			
	I	II	III	IV
1991	1861	2203	2415	1908
1992	1921	2343	2514	1986
1993	1834	2154	2098	1799
1994	1837	2025	2304	1965
1995	2073	2414	2339	1967



# A Problem involving all four components of a Time Series

- For a problem that involves all four components of a time series, we turn to a firm that specializes in producing recreational equipment.
- The procedure for describing this time series will consist of three stages:
  1. Deseasonalizing the time series
  2. Developing the trend line
  3. Finding the cyclical variation around the trend line

- Example :

Year	Quarter			
	I	II	III	IV
1991	16	21	9	18
1992	15	20	10	18
1993	17	24	13	22
1994	17	25	11	21
1995	18	26	14	25