FE 422 FOOD PRODUCTION MANAGEMENT

Forecasting

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Demand Management

- Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. A commonplace example might be estimation for some variable of interest at some specified future date. Prediction is a similar, but more general term. Both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods.
- The purpose of demand management is to coordinate and control all of the sources of demand so the productive system can be used efficiently and the product delivered on time.

Categories of forecasting methods

Qualitative vs. Quantitative Methods

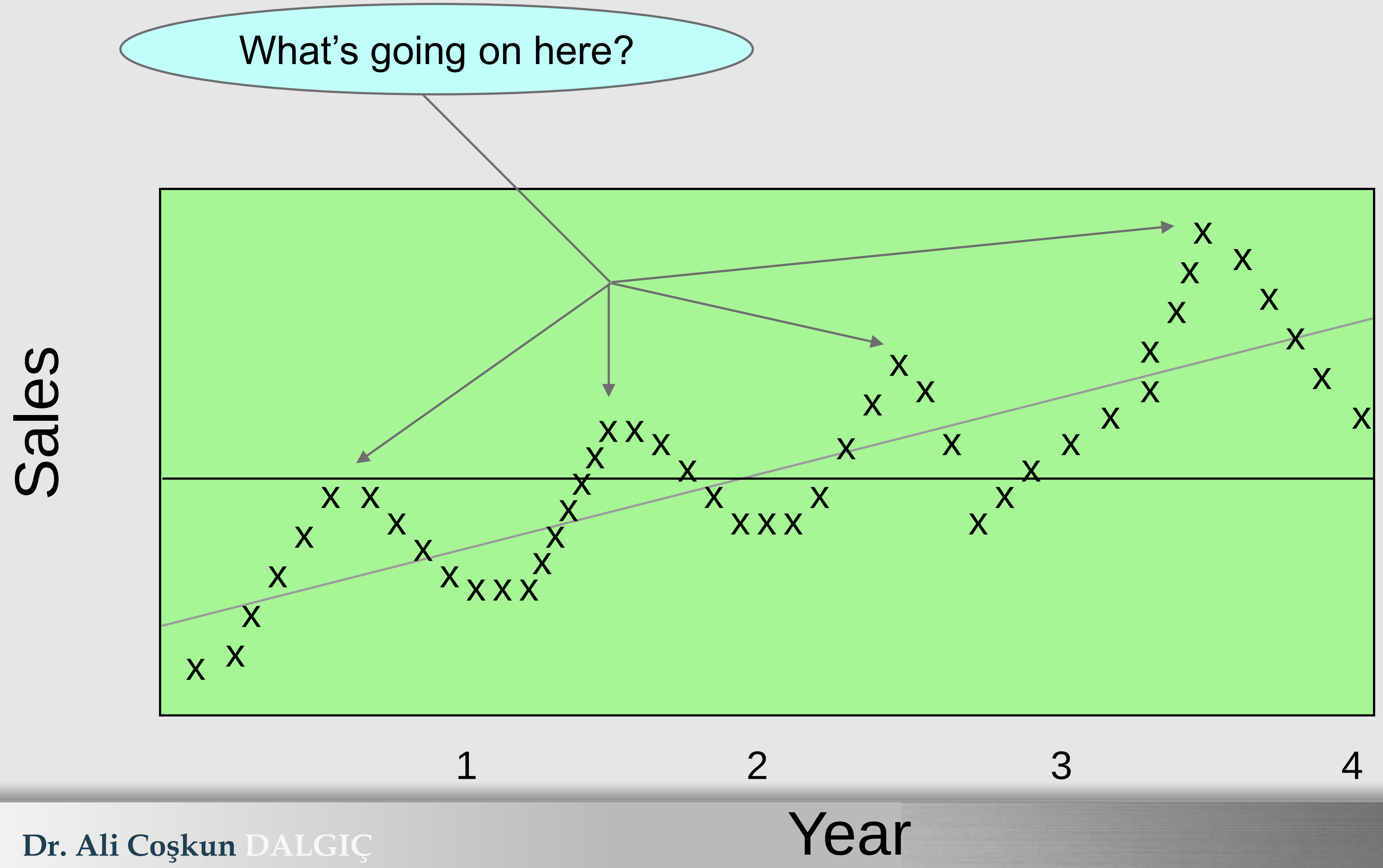
Qualitative forecasting techniques are subjective, based on the opinion and judgment of consumers, experts; appropriate when past data is not available. It is usually applied to intermediate-long range decisions.

- Informed opinion and judgment
- Delphi method
- Market research
- Historical life-cycle Analogy.

Quantitative forecasting models are used to estimate future demands as a function of past data; appropriate when past data is available. It is usually applied to short-intermediate range decisions.

- Last period demand
- Arithmetic Average
- Simple Moving Average (N-Period)
- Weighted Moving Average (N-period)
- Simple Exponential Smoothing
- Multiplicative Seasonal Indexes

Components of Demand



Simple Moving Average

Week	Demand
1	650
2	678
3	720
4	785
5	859
6	920
7	850
8	758
9	892
10	920
11	789
12	844

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + \ldots + A_{t-n}}{n}$$

- *Let's develop 3-week and 6-week moving average forecasts for demand.*
- Assume you only have 3 weeks and 6 weeks of actual demand data for the respective forecasts

Week	Demand	3-Week	6-Week
1	650		
2	678		
3	720		
4	785	682.67	
5	859	727.67	
6	920	788.00	
7	850	854.67	768.67
8	758	876.33	802.00
9	892	842.67	815.33
10	920	833.33	844.00
11	789	856.67	866.50
12	844	867.00	854.83

Weighted Moving Average

$$F_t = w_1 A_{t-1} + w_2 A_{t-2} + w_3 A_{t-3} + \ldots + w_n A_{t-n}$$

$$\sum_{i=1}^{n} w_i = 1$$

Week	Demand
1	650
2	678
3	720
4	

Determine the 3-period weighted moving average forecast for period 4.

Weights:

t-1	.5
t-2	.3
t-3	.2

Solution

Week	Demand	Forecast
1	650	
2	678	
3	720	
4		693.4

$F_4 = .5(720)+.3(678)+.2(650)$

Exponential Smoothing (Averaging)

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$
$$F_t = \alpha A_{t-1} + (1-\alpha)F_{t-1}$$

- ***Premise***--The most recent observations is normally a better predict the next observation than are older observations.
- Therefore, we should give more weight to the more recent time periods when forecasting

F_t IS AN EXPONENTIALLY WEIGHTED MOVING AVERAGE OF ALL PAST ACTUAL VALUES

$$F_t = \alpha A_{t-1} + (1-\alpha)F_{t-1}$$

$$F_{t-1} = \alpha A_{t-2} + (1-\alpha)F_{t-2}$$

$$F_{t-2} = \alpha A_{t-3} + (1-\alpha)F_{t-3}$$

$$F_{t-3} = \alpha A_{t-4} + (1-\alpha)F_{t-4}$$

THEREFORE:

$$F_t = (1-\alpha)^0 \alpha A_{t-1} + (1-\alpha)^1 \alpha A_{t-2} + (1-\alpha)^2 \alpha A_{t-3} + (1-\alpha)^3 \alpha A_{t-4} + (1-\alpha)^4 \alpha A_{t-5} + (1-\alpha)^5 \alpha A_{t-6} + (1-\alpha)^6 \alpha A_{t-7} + (1-\alpha)^7 \alpha A_{t-8} + (1-\alpha)^8 \alpha A_{t-9} + (1-\alpha)^9 \alpha A_{t-10} + \text{Ad Infinitum}$$

ASSUME ALPHA = .5

$F_t = (1-\alpha)^0 \alpha A_{t-1} + (1-\alpha)^1 \alpha A_{t-2} + (1-\alpha)^2 \alpha A_{t-3} + (1-\alpha)^3 \alpha A_{t-4} + (1-\alpha)^4 \alpha A_{t-5} + (1-\alpha)^5 \alpha A_{t-6} + (1-\alpha)^6$ + Ad Infinitum

$F_t = (.5)^0 * .5At_{-1} + .5^1 * .5A_{t-2} + (.5)^2 .5A_{t-3} + (.5)^3 * .5A_{t-4} + (.5)^4 * .5A_{t-5} + (.5)^5 * .5A_{t-6} + (.5)^6 * .5A_{t-7} + (.5)^7 * .5A_{t-8} + (.5)^8 * .5A_{t-9} + (.5)^9 * .5A_{t-10} +$

$F_t = .5At_{-1} + .25A_{t-2} + .125A_{t-3} + .0625A_{t-4} + .03125A_{t-5} + \ldots +$

Seasonal Exponential Smoothing

$$F_t = F_{t-S} + \alpha(A_{t-S} - F_{t-S})$$

$$F_t = \alpha A_{t-S} + (1-\alpha)F_{t-S}$$

- ***Premise***--The seasonally most recent observations might have the highest predictive value.
- Therefore, we should give more weight to the more recent seasonal time periods when forecasting

Exponential Smoothing Example

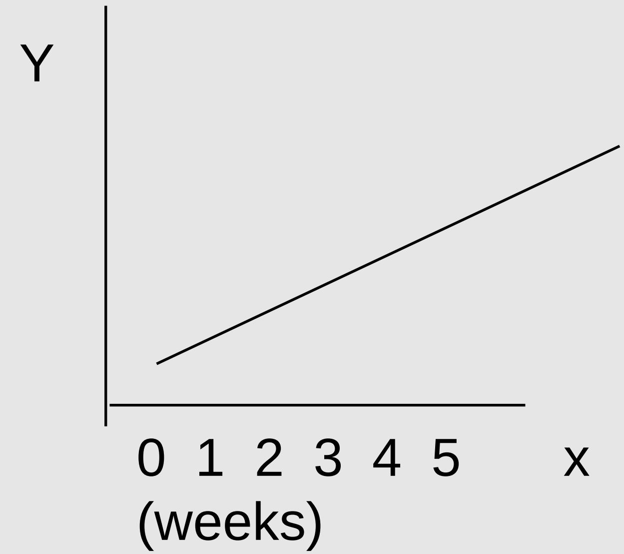
Week	Demand
1	820
2	775
3	680
4	655
5	750
6	802
7	798
8	689
9	775
10	

- Determine exponential smoothing forecasts for periods 2-10 using α=.10 and α=.60.
- Let $F_1 = A_1$

Week	Demand	*0.1*	*0.6*
1	820	820.00	820.00
2	775	820.00	820.00
3	680	815.50	820.00
4	655	801.95	817.30
5	750	787.26	808.09
6	802	783.53	795.59
7	798	785.38	788.35
8	689	786.64	786.57
9	775	776.88	786.61
10		776.69	780.77

Simple Linear Regression Model

$$Y_t = a + bx$$

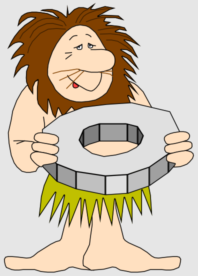


- b is similar to the slope. However, since it is calculated with the variability of the data in mind, its formulation is not as straight-forward as our usual notion of slope

Calculating a and b

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\sum xy - n(\bar{y})(\bar{x})}{\sum x^2 - n(\bar{x})^2}$$



Regression Equation Example

Week	Sales
1	150
2	157
3	162
4	166
5	177

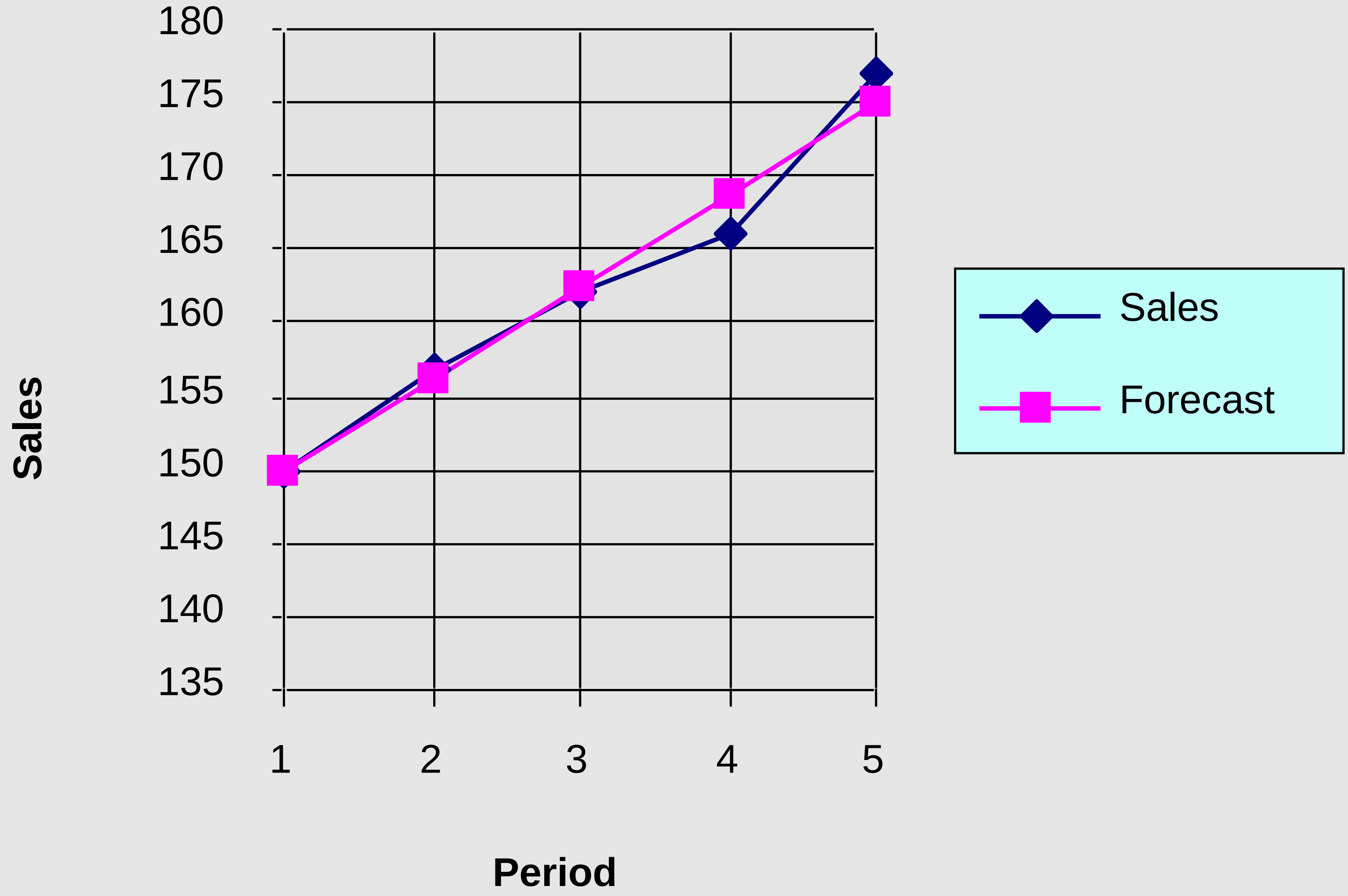
Develop a regression equation to predict sales based on these five points.

Week	Week*Week	Sales	Week*Sales
1	1	150	150
2	4	157	314
3	9	162	486
4	16	166	664
5	25	177	885
3	*55*	*162.4*	*2499*
Average	Sum	Average	Sum

$$b = \frac{\sum xy - n(\bar{y})(\bar{x})}{\sum x^2 - n(\bar{x})^2} = \frac{2499 - 5(162.4)(3)}{55 - 5(9)} = \frac{63}{10} = \mathbf{6.3}$$

$$a = \bar{y} - b\bar{x} = 162.4 - (6.3)(3) = \mathbf{143.5}$$

$y = 143.5 + 6.3t$



180
175
170
165
160
155
150
145
140
135
Sales
1
2
3
4
5
Period
Sales
Forecast