DATA ANALYTICS

Unit 3: Croston’s Forecasting Method for Intermittent Demand

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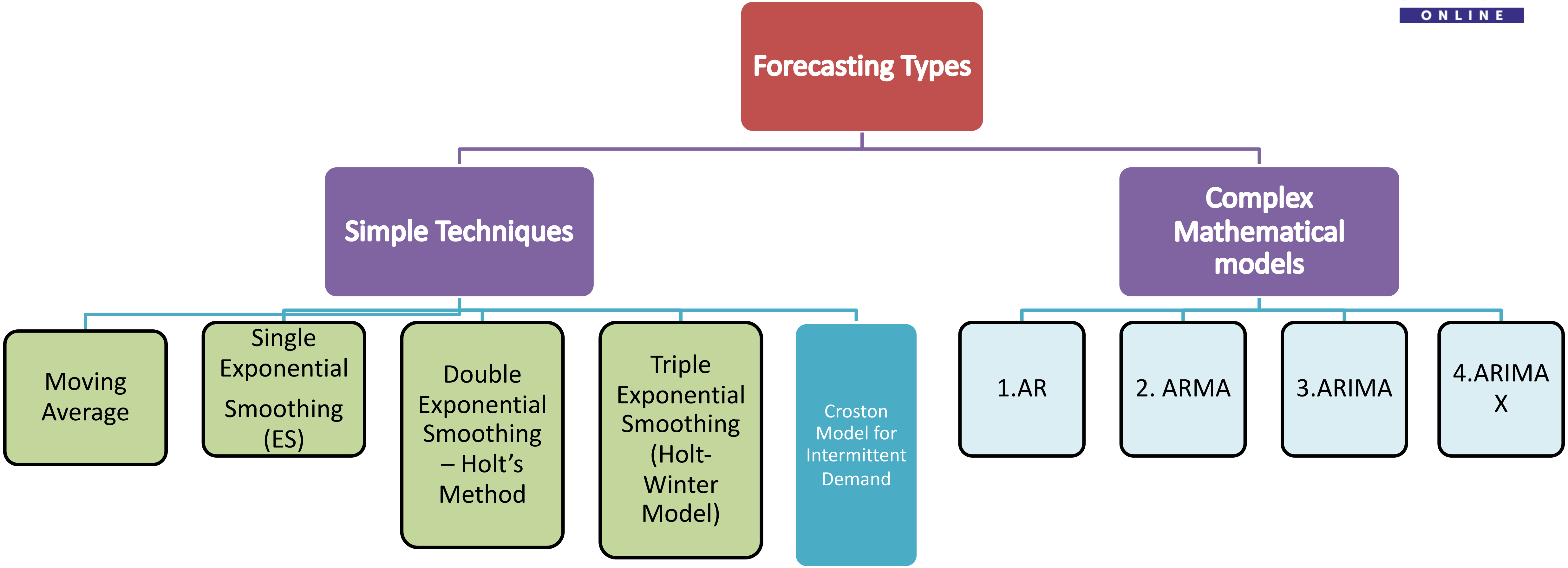
CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND



CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

What is Intermittent Demand?
When a customer calls for that product item that almost no one ever asks for, do you have it?
If your answer is no, it could cost you a sale, or even a customer.
Equally important, if *that* item is only occasionally requested, do you have too many units of the product on-hand to avoid stocking out of it?
If your answer is yes, then excess inventory is probably costing you money.

Forecasting intermittently demanded, "slow-moving" product items or parts is a problem that is especially well-known to managers in service parts organizations and companies in the capital goods industries, among others.

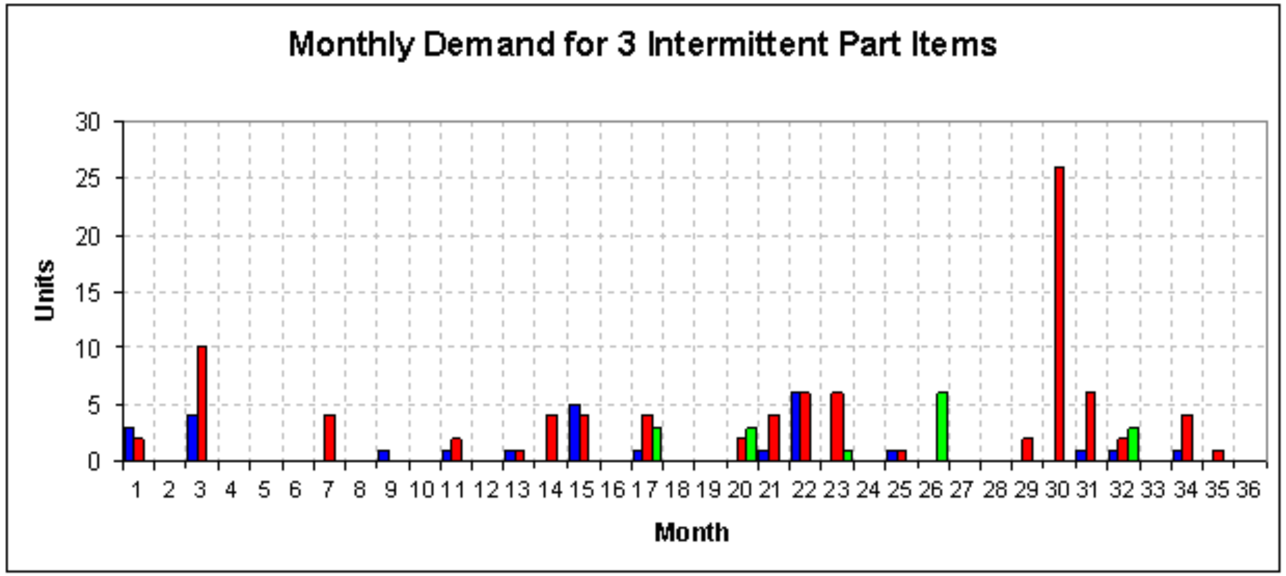
Traditional forecasting methods, such as exponential smoothing and moving averages, that are designed for normal, high-volume demand just don't work well with intermittent demand.

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

What is Intermittent Demand?

Figure 1 below shows the challenge demand planners face. It plots the demand over 36 months for three intermittent part items (shown in red, blue and green),.

Many months had no demand at all (zero values), and when demand did appear, its value varied erratically.



Croston's method(CR) is a classic method that specifically dealing with intermittent demand, it was developed base upon the Simple Exponential Smoothing method.

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

- Products such as spare parts may have intermittent demands.
- Exponential smoothing models discussed so far in the chapter will produce biased estimate when used for intermittent demand.
- Croston (1972) developed a model that uses two separate exponential smoothing equations for predicting mean time between demands and the magnitude of demand whenever the demand occurs.

- That is, Croston's method has two components:

  (a) Predicting time between demand and

  (b) magnitude of the demand.

- The primary objective of Croston's method is to forecast mean demand per period.

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

Y_t = Demand at time t (Y_t may take value 0)

F_t = Forecasted demand

TD_t = Time between the latest and the previous non-zero demand in period t

FTD_t = Forecasted time between demand at period t

The following steps are used for forecasting demand:

$$\text{If } Y_t = 0 \text{ then } F_{t+1} = F_t \text{ and } FTD_{t+1} = FTD_t \tag{13.24}$$

$$\text{If } Y_t \neq 0 \text{ the } \mathrm{F}_{t+1} = \alpha \times \mathrm{Y}_t + (1-\alpha)\mathrm{F}_t \text{ and } \mathrm{FTD}_{t+1} = \beta \times \mathrm{TD}_t + (1-\beta) \times \mathrm{FTD}_t \tag{13.25}$$

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

- *α and β* are smoothing constants for forecasted demand and forecasted time between demands, respectively
- Once the forecasted demand and time between demands are known, then the mean demand per period D_{t+1}, is given by

$$D_{t+1} = \frac{F_{t+1}}{FDT_{t+1}} \qquad (13.26)$$

CROSTON’S FORECASTING METHOD FOR INTERMITTENT DEMAND

- Quarterly demand for spare parts of avionics system of an aircraft
- Use the demand during the quarters 1 to 4 as training data to forecast demand for periods 5 to 16 using Croston’s method.

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND-

Example 13.2: Quarterly demand for spare parts of avionics system of an aircraft is shown in Table 13.8. Use the demand during the quarters 1 to 4 as training data to forecast demand for periods 5 to 16 using Croston's method.

Quarter	1	2	3	4	5	6	7	8
Demand	20	12	0	18	16	0	20	22
Quarter	9	10	11	12	13	14	15	16
Demand	0	28	0	0	30	26	0	34

TABLE 13.8 Quarterly demand for avionic system spares

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

- Procedure used for starting values of F_t and FTD_t is shown in the table here:
- TD_4 = 2 since the elapsed time from the previous demand and current demand period is 2 (4 – 2).
- The forecasted time between demand is the average TD_t values up to t = 4.
- So, FTD_4 = (1+2)/2 = 1.5.
- The forecasted demand F_4 for t = 4 is

  (20 + 12 + 18)/3 = 16.67.
- Note that the total value is divided by 3 (not 4) since only 3 quarters had non-zero demand.

Quarter	Demand	TD_t	FTD_t	F_t
1	20			
2	12	1		
3	0			
4	18	2	1.5	16.67

So, the starting values for Croston's method are.

$TD_4 = 2$, $FTD_4 = 1.5$, and $F_4 = 16.67$

Let $\alpha = \beta = 0.2$. Then

$$F_5 = 0.2 \times 18 + (1 - 0.2) * 16.67 = 16.936$$

$$FTD_5 = 0.2 \times 2 + (1 - 0.2) \times 1.5 = 1.6$$

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

- Forecasted demand for periods 5 to 16 using Croston's method.

Quarter	Demand	TD_t	FTD_t	F_t	$D_t = (F_t/FTD_t)$
1	20				
2	12	1			
3	0				
4	18	2	1.5000	16.67	11.11333
5	16	1	1.6000	16.936	10.585
6	0		1.4800	16.7488	11.31676
7	20	2	1.4800	16.7488	11.31676
8	22	1	1.5840	17.39904	10.98424
9	0		1.4672	18.31923	12.48585
10	28	2	1.4672	18.31923	12.48585
11	0		1.5738	20.25539	12.8707
12	0		1.5738	20.25539	12.8707
13	30	3	1.5738	20.25539	12.8707
14	26	1	1.8590	22.20431	11.94417
15	0		1.6872	22.96345	13.61034
16	34	2	1.6872	22.96345	13.61034

CROSTON'S FORECASTING METHOD FOR INTERMITTENT DEMAND

- **Example: lubricant sales**
- Several years ago, an oil company requested forecasts of monthly lubricant sales
- One of the time series is shown in the table below.
- The data contain small counts, with many months registering no sales at all, and only small numbers of items sold in other months.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	2	0	1	0	11	0	0	0	0	2	0
2	6	3	0	0	0	0	0	7	0	0	0	0
3	0	0	0	3	1	0	0	1	0	1	0	0

- There are 11 non-zero demand values in the series, denoted by q.
- The corresponding arrival series a is also shown in the following table.

i	1	2	3	4	5	6	7	8	9	10	11
q	2	1	11	2	6	3	7	3	1	1	1
a	2	2	2	5	2	1	6	8	1	3	2

- Applying Croston's method gives the demand forecast 2.750 and the arrival forecast 2.793.
- So the forecast of the original series is $\hat{y}_{T+h|T} = 2.750/2.793 = 0.985$

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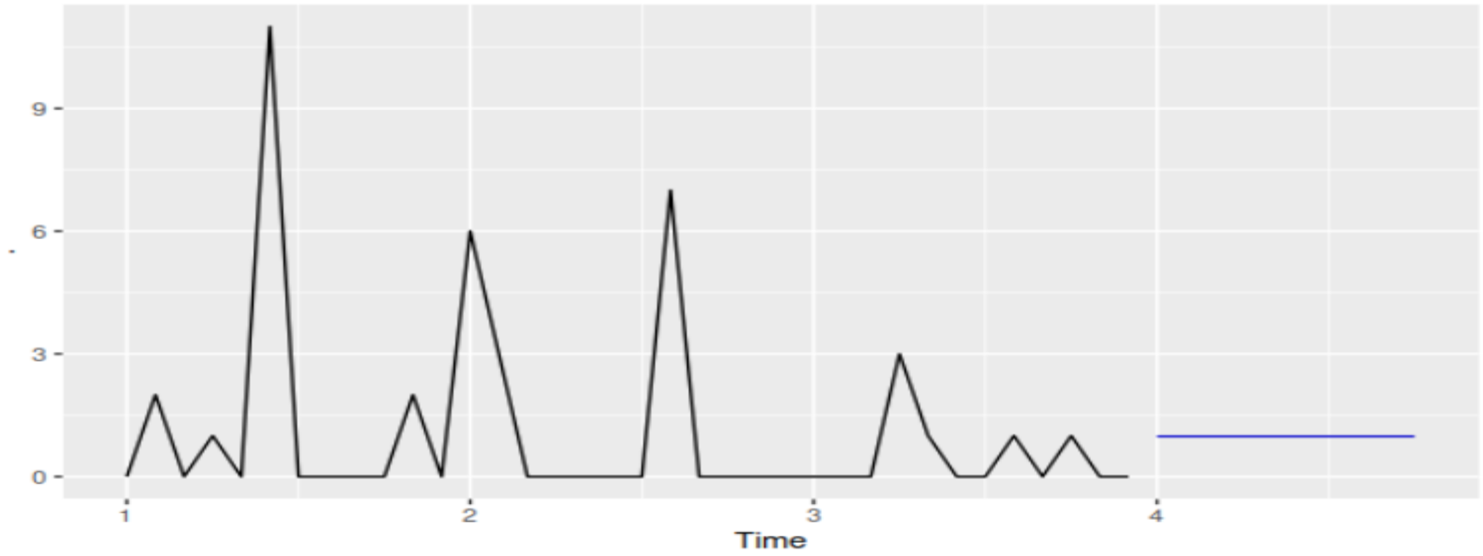

- An implementation of Croston's method with more facilities (including parameter estimation) is available in the **tsinterminant package** for R.
- Forecasting models that deal more directly with the count nature of the data are described in Christou & Fokianos (2015).

References

Text Book:

"Business Analytics, The Science of Data-Driven Making", U. Dinesh Kumar, Wiley 2017 Chapter-13.7-13.9

Image and Case Study

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THANK YOU

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