"Sorry, No Kerosene" -
Maybe better forecasting can prevent this!
(The *BAYES* adaptive forecasting system)

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Occasionally one hears that a particular commodity has 'disappeared' from the market. The consequences are familiar: housewives hunt from shop to shop, other people rush around in panic, prices keep rising till the legislature rings with the shouts of the oppposition.

Ocassionally the non-availablity of a commodity is a situation deliberately created by a few traders in order to make a quick buck. This is the case particularly just before the annual Union Budget. Even a mathematical model is helpless here!

At other times, however, it can happen that there is a sudden spurt in demand and local stocks are exhausted before fresh supplies arrive. This kind of situation ought to - and can - be avoided to large extent, by using a technique called <u>forecasting</u>. Forecasting can be used to predict the demand during a particular period in future.

For example, in the month of April we could forecast the likely demand for rice and wheat from ration shops in each town during the month of May, and place movement orders accordingly with FCI. If the forecast is accurate, the people in each town will get their needs - while at the same time no excess amount will have been moved. 'Forecasting' is also needed, for example, from bank branch managers before the busy season, so that credit can be properly allocated by the Head Office to all the needy areas.

In the most commonly used method of forecasting, the past trend is captured or guessed and is then projected into the future. The mathematical models employed can be 'tuned' so as to be sensitive enough to take into account very small changes from the average. Unfortunately, this usually means that even random fluctuations will register as important changes. On the other hand, the mathematical models can be adjusted to ignore all but very large changes (and, therefore, to react very slowly).

Neither of these is good enough for commodity forecasting. Ideally we would like the mathematical model to give us an early warning, i.e. **to respond to small changes, while still ignoring random fluctuations**. To take care of this, Systems Research Institute has deveoped a forecasting system which is contained in a set of comptuer programs. These programs have been designed to monitor trends in commodity consumption, pricies, and similar phenomena which fluctuate over time.

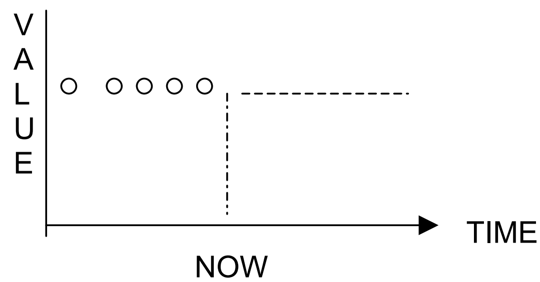
The system, which has been given the name, **BAYES**, has the capacity to overlook very short term fluctuations. Indeed it makes an effort to 'recognise' (and ignore) what it regards as 'normal' behaviour. It can also, therefore, immediately <u>detect when the pattern of behaviour has changed from normal</u>, even though the change may be quite small.

For example, the sudden but short-lived increase in consumption of diesel fuel during a festival is noted but ignored in future forecasts. On the other hand, the longer term drop in consumption of petrol due to a price increase would be taken into consideration in forecasting future demands.

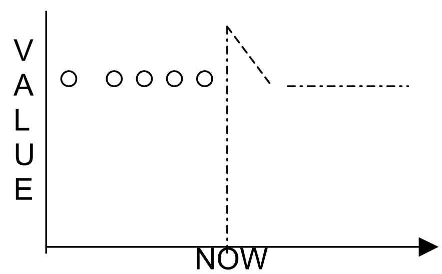
How does BAYES work? In very simple terms, **BAYES works on the basis of bringing uptodate a set of probabilities depending upon the latest value of the variable being observed.** Let me explain this a bit more.

Any variable is taken to be in one of the following four states after observing the current value at a point in time. Example:

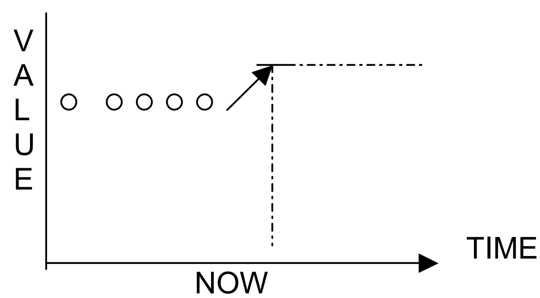
1. No Change



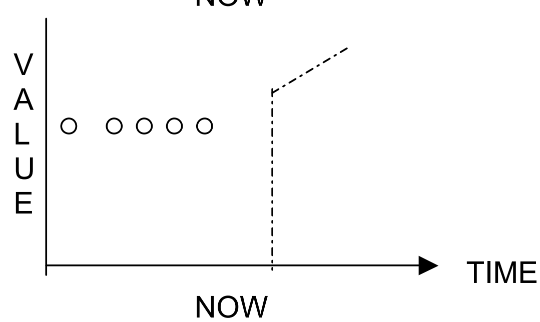
2. Random Fluctuations



3. New Level



4. New Slope



At each point of time, **BAYES** compares the value of the variable to the earlier values and assigns certain probabilities to the likelihood of the next point following each of the above 4 paths.

Based upon these probabilities, BAYES then computes a projected value for the next data point.

When the actual value is observed at the next point of time, BAYES revises the probabilities and again projects ahead ... and so on.

Of course, the computer package, BAYES, is much more complex than it appears from the explanation given here. For instance, the whole exercise mentioned above is fine-tuned to adjust for seasonality' by studying the long term past behaviour of the data. **With each new data point fed in, as many as 50 parameters are updated within the mathematical mode. BAYES is therefore much more complicated in its operation than the usual 'moving average' or 'exponential smoothing; approach to forecasting.**

a. **<u>Demand Forecasting</u>**: In an exacting test, the HSD (High Speed Diesel) offtake at the Ambala depot of Indian Oil Co. was **analysed for the drought year 1974**. In this year, the rains were scanty and ended early. As a result, HSD offtake (to run the irrigation pumps) in the month of **September jumped to 11024 KL** (Kilolitre), as against **Indian Oil's own estimate, made on August 26 of 6500 KL** for September, from offtake of 5294 KL during August.

In contrast to this, the BAYES system generated a **forecast for September of 7800 KL on August 16**, which was **updated to 10,200 KL on September 1** (when August data became available). The 8% overshoot of 800 KL would have posed no problem for the oil company, compared with the panic caused by the gap of 4500 KL which actually occured.

<u>Ambala Depot 1974 HSD offtake (L)</u>

	Actual Offtake	Forecasted by Oil Co.	Forecasted by BAYES	Error for BAYES
May	6696	n.a.	6698	0%
June	5273	n.a.	5328	+ 1%
July	5142	n.a.	4530	- 14%
August	**5296**	**5000**	**4423**	**- 20%**
September	**11024**	**6500**	**10209**	**- 8%**
October	6372	n.a.	8079	+ 21%

b. **<u>Back-casting</u>**: Senior officials concerned with economic policymaking in government have suggested that what the country needs more than **fore**casting is what can only be termed **back**casting', that is, a clear interpretation of what actually happened in the past. Often this is disguised in a mass of data which is in any case only available with a considerabe time lag. The BAYES system is ideally suited for a continuous back casting' exercise.

The BAYES system was, for nstance, used to analyse the published tme series of various commodities like Vanaspati, sugar and Pic Iron. The actual monthly production and the BAYES system's estimate of the Trend Value for the pig iron series 1964-71 are presented in the reproduced computer output. Whereas the actual reported monthly production exhibits quite a substantial fluctuation, the BAYES results clear this up. For policy-making purposes, we are more interested in knowing about broad trends.

As an example of the capability of the BAYES system let us consider the discontinuity in the slope (a gradual change from a downward trend to an upward trend) which appears in early 1968. It would have been very difficult, at that time, to pinpoint the occurrence of such a change by a mere inspecton of the 'actuals' series. However, by studying the parameters internally updated by BAYS we see that a **change is signalled in December** and the **new slope is established finally by March**. The table below gives the values of the different parameters corresponding to months from October 1967 to April 1968

Month	Actual Production (‘000 T)	Estimated ‘true’ trend value (‘000 T)	Computed Parameters within the Model				
			Computed Tangential Slope	Ratio of Current Probabilities of a State to a priori state probability			
				Steady State	Tran- sient	Step Change	Slope Change
Oct ‘67	519.3	563.5	- 1.2	**L**	U	U	L
November	557.6	**562.1**	- 1.3	**L**	U	U	**H**
December	614.9	**561.2**	- 1.4	**H**	L	L	**H**
Jan. ‘68	615.9	**561.4**	- 0.8	**L**	U	U	**H**
February	573.8	**562.4**	- 0.3	**L**	U	U	L
March	624.6	571.0	+ 1.7	U	U	U	L
April	577.5	574.8	+ 1.3	H	L	L	U

L = Low
U = Uncertain
H = High

From this table we immediately see that

(a) the trend values after deseasonalising and elimination of random fluctuations show a valley from November to February, marking the change from a downward to an upward slope.

(b) the ‘no change' state is reported with a low probability in October, November, and January and February, indicating that a change is underway then. In December it has high probability (because the curve has bottomed out) and again in March and April.

(c) the slope-change probability is consistently high in November, December and January marking the detection of a change which is fully established in March.

This demonstration back-casting indicates that two or three months after the event, this computer program would have been able to detect the change in tempo of pig iron production, despite the very large month-to-month fluctuations.

In the case of esential commodities such as edible oils fodgrains, kerosene, etc., it is esential to detect such changes quite soon perhaps with weekly or fortnightly data points - while discounting short run transients due to festivals, etc

Where can it be useful?

As evident from the dscription and examples given above, the use of BAYES has certain pre-requisites:

(a) Data should be available fairly soon after the relevant time period is over

(b) Forecasting should be required only on a one-period-ahead basis. ***This approach cannot be used to generate long term forecasts.***

(c) In cases where the data fluctuates widely, this model works better than others.

We would like to indicate some of the more useful areas for application of this forecasting technique.

Milk supply and milk demand could be prime targets of accurate short term forecasting, both in order to adjust prices and to change the product mix. Milk is an important vehicle for rural development.

Drugs and Pharmaceuticals - Certain drugs are very costly or scarce, and may also have a short shelf-life, requiring that location-wise demand forecasts be made carefully.

Coal production, mine-wise, the availability of railway wagons at major yards, cargo handled at a port, electricity generated at different stations, and electricity consumption region-wise, are some logistical data where BAYES could be utilised for operational planning and for monitoring

This mathematical model can also be used as an "information-filtering" device to reduce the burden on any central monitoring cell. BAYES can be used to process monthly production reports from major industries. It would ignore minor fluctuations and flag only significant changes in level for detailed attention. Such a tool is especially useful for the public sector where mere profit does not sufficiently serve as a control device. Agencies such as the Bureau of Public Enterprises, the Ministries and the Planning Commission could make use of BAYES in their monitoring system. BAYES can also be used as an 'early wrning' detector of trends in the large seasonal swings of credit in the banking system so as to give credit managers better control over their funds.