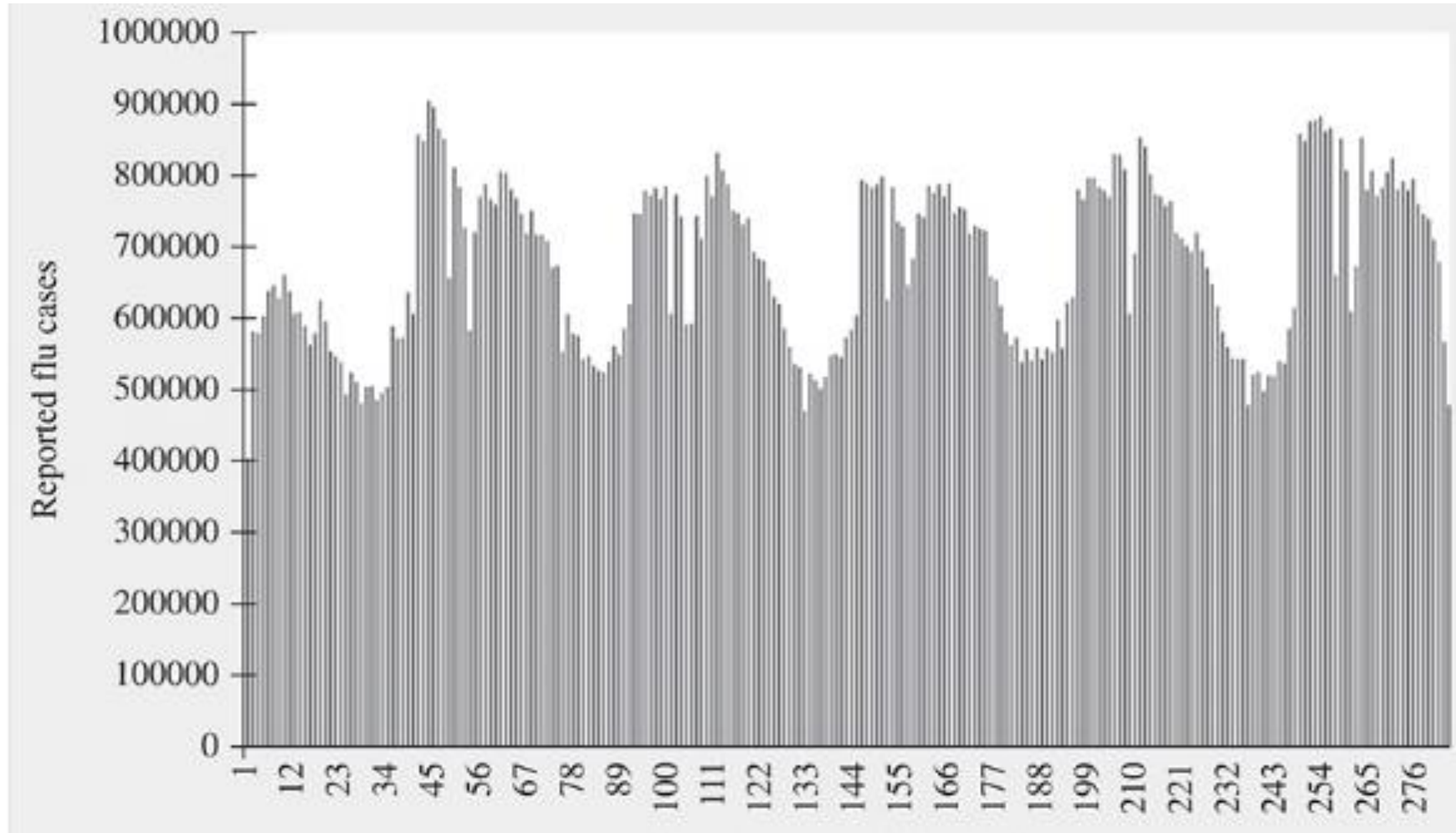


Demand Forecasting

Forecasting

- Every year , millions of Indians are impacted by the flu
- Especially as far as Infants, the elderly and other vulnerable population groups are concerned, the flu can be a matter of life or death
- During flu period, patients with flu flood the emergency of hospitals and demand medical services and demand Pharma Products

Patients visit the hospital with flu over the time period from 2014 to 2020



Imagine you were in-charge of forecasting the number of flu cases for hospital or pharma company.

Can you perfectly predict the number of flu patients in 2021?.

Perfect forecast is typically impossible

Forecasting – the process of creating statements about outcomes of variables that presently are uncertain and will only be realized in the future.



- Does watching an octopus having lunch qualify as forecasting?
- The Zookeepers clearly had a process in place because they had marked the food boxes and had agreed on how to interpret Paul's behaviour.
- The outcomes of the matches were uncertain at the time of Paul's food choice
- The outcomes of the matches were realized in the future

What makes a forecast a quality forecast

The quality of a forecast can only be assessed after the real outcomes have been observed.

How to Evaluate the Quality/Accuracy of a Forecast

Forecast error – the difference between a forecasted value and the realized value.

Unbiased forecast – a forecast that is correct on average, thus an average forecast error equal to zero.

Biased forecast – a forecast that is wrong on average, thus an average forecast error different from zero.

Mean squared error (M S E) – a measure evaluating the quality of a forecast by looking at the average squared forecast error.

Mean absolute error (M A E) – a measure evaluating the quality of a forecast by looking at the average absolute value of the forecast error.

Mean absolute percentage error (M A P E) – a measure does not look at the forecast errors in absolute terms, but in relative terms, this is achieved by dividing the forecast errors by the actual demand.

Forecast Accuracy Metrics

$$\text{MAD} = \frac{\sum |\text{Actual}_t - \text{Forecast}_t|}{n}$$

$$\text{MSE} = \frac{\sum (\text{Actual}_t - \text{Forecast}_t)^2}{n}$$

$$\text{MAPE} = \frac{\sum \frac{|\text{Actual}_t - \text{Forecast}_t|}{\text{Actual}_t} \times 100}{n}$$

Example

Imagine you work for an emergency department that wants to get ready for the flu season. You are asked to forecast the number of flu cases showing up to the emergency department over the course of the next four weeks. Before you start looking at any old data, you decide to seek advice from some experts, so went to four doctors, who given you their forecast for the next four weeks.

Four Forecasts for the Number of Flu-Related patients coming to the emergency department in the next four weeks

	Doctor 1	Doctor 2	Doctor 3	Doctor 4
Week 1	70	50	29	43
Week 2	55	32	52	44
Week 3	40	48	62	54
Week 4	80	60	47	49

Which forecast should you use?
Which forecast is the best one?

Four Forecasts for the number of Flu-Related patients counting to the emergency department in the next four weeks and the true demand data.

	Doctor 1	Doctor 2	Doctor 3	Doctor 4	True Demand
Week 1	70	50	29	43	38
Week 2	55	32	52	44	49
Week 3	40	48	62	54	59
Week 4	80	60	47	49	44

Forecast error (FE)

FE: The difference between a forecasted value and realized value.

FE for doctor 1:

Forecast error in week 1 = Actual value for week 1 - Forecast for week 1 = 38 - 70 = -32

Forecast error in week 2 = Actual value for week 2 - Forecast for week 2 = 49 - 55 = -6

Forecast error in week 3 = Actual value for week 3 - Forecast for week 3 = 59 - 40 = 19

Forecast error in week 4 = Actual value for week 4 - Forecast for week 4 = 44 - 80 = -36

Comparison of Doctor 1 and Doctor 2

	True Demand	Forecast Doc1	Forecast Doc2	FE Doc 1	FE Doc 2
Week 1	38	70	50	-32	-12
Week 2	49	55	32	-6	17
Week 3	59	40	48	19	11
Week 4	44	80	60	-36	-16
Average	47.5	61.25	47.5	-13.75	0

Compare Doctor 2 and Doctor 3

	True Demand	Forecast Doc2	Forecast Doc3	FE Doc 2	FE Doc 3
Week 1	38	50	29	-12	9
Week 2	49	32	52	17	-3
Week 3	59	48	62	11	-3
Week 4	44	60	47	-16	-3
Average	47.5	47.5	47.5	0	0

Mean squared error (M S E) – a measure evaluating the quality of a forecast by looking at the average squared forecast error.

	True Demand	Forecast Doc2	Forecast Doc3			MSE Doc 2	MSE Doc 3
Week 1	38	50	29	-12	9	144	81
Week 2	49	32	52	17	-3	289	9
Week 3	59	48	62	11	-3	121	9
Week 4	44	60	47	-16	-3	256	9
Average	47.5	47.5	47.5	0	0	202.5	27

Mean absolute error (M A E) – a measure evaluating the quality of a forecast by looking at the average absolute value of the forecast error.

	True Demand	Forecast Doc2	Forecast Doc3		FE Doc 2	FE Doc 3	MSE Doc 2	MSE Doc 3	MAE Doc 2	MAE Doc 3
Week 1	38	50	29		-12	9	144	81	12	9
Week 2	49	32	52		17	-3	289	9	17	3
Week 3	59	48	62		11	-3	121	9	11	3
Week 4	44	60	47		-16	-3	256	9	16	3
Average	47.5	47.5	47.5		0	0	202.5	27	14	4.5

Mean absolute percentage error (M A P E) – a measure does not look at the forecast errors in absolute terms, but in relative terms, this is achieved by dividing the forecast errors by the actual demand.

$$\text{MAPE} = \frac{\text{Absolute Deviation}}{\text{True Demand}} * 100$$

Metrics	Doc 1	Doc 2	Doc 3	Doc 4
MSE	679.25	202.5	27	25
MAE	23.25	14	4.5	5
MAPE	52.61924898	30.3201323	10.4274	10.80005

Forecasting Approaches

- **Qualitative Forecasting**

- Qualitative techniques permit the inclusion of *soft* information such as:
 - Human factors
 - Personal opinions
 - Hunches

- **Quantitative Forecasting**

- These techniques rely on *hard* data
- Quantitative techniques involve the projection of historical data

- Case – LL Bean



1918 MAINE HUNTING SHOE

THE IDEAL shoe for hunting and snow-shoeing. Light as a moccasin with the protection of a heavy hunting boot. Made on a swing last in four widths so as to fit any foot from C to EE.

Vamp and sole are extra high grade gum rubber, the only material made that will not wet through while tramping in melting snow, or freeze stiff in cold-weather.

The tops are soft tan water elk that do not grow hard by wetting and drying, and come in three widths so as to fit slim ankles as well as medium and stout.

After years of experimenting we are convinced that it is impossible to make a rubber shoe perfect without stiffening the shank. Therefore, all 1918 Hunting Shoes, except the five and six and one-half inch, will be fitted with our Maine Arch Innersole, as described on another page of this catalog. If not satisfactory after five days' trial, these innersoles may be returned and we will refund 85c.

Outside of your gun, nothing is so important to your outfit as your footwear. You cannot expect success hunting big game if your feet are not properly dressed.

For those hunters who go just before the first snow, it is next to impossible to find footwear that is adapted to both bare ground and snow hunting. The Maine Hunting Shoe is perfect for both. For bare ground its extreme light weight and Arch Innersole keep it from drawing the feet, while the rubber sole keeps it from slipping. For snow, by using a heavier stocking, you have warm, light, dry footwear that is ideal for still hunting or snow-shoeing.

If you do snow-shoeing, order shoes with snow-shoe loops, as shown below.

With every pair I give a can of dressing and temporary repair patches that will mend a cut or snag in three minutes. Delivered free anywhere in the United States. Prices and sizes on back of this sheet.

MAINE HUNTING SHOE
GUARANTEE
We guarantee this pair of shoes to give satisfaction in every way. If the rubber breaks or the tops grow hard, return them, together with this guarantee tie and we will replace them free of charge.

L. L. BEAN, Inc., Freeport, Me.

With Tie to Attached to Shoe



You refuse to carry a heavy gun, why wear heavy shoes that make you leg-weary in a few hours?

The Maine Hunting Shoe is the lightest sporting shoe made.

L. L. Bean, Freeport, Me.

Dear Sir:

I used your Maine Hunting Shoe moon-hunting in New Brunswick in 5 or 6 inches of snow and it was the most satisfactory shoe I have ever worn. The lightness appealed to me particularly.

Very truly yours,

Whitinsville, Mass., Jan. 18d., 1914

L. L. Bean, Freeport, Me.

Dear Sir:

I wish to state that your Maine Hunting Shoe is nearly perfect to my way of thinking. Was in the north woods 22 days and never had a wet foot or a blister.

I remain yours,

Ann Harbor, Mich., Jan. 4th, 1914

L. L. Bean, Freeport, Me.

Dear Sir:

I like your shoes very much, they are so light and can be dried out so easily.

Yours truly,

Medford, Mass., Jan. 7th, 1914

Anthony, R. L., Jan. 17th, 1914

Bean's Red and Black Hunting Coat

Is the same as the Maine Hunting Coat shown on page 38 except cloth is not quite as high grade wool and the color is red and black. For those hunters who insist on the protection offered by a red coat we recommend this as the highest grade red and black coat we ever offered.

Free bloodproof game bag same as shown on page 62. Length 34". Size 36 to 50. Price \$9.50 postpaid. Send for free sample.

Maine Guide Shirt

Heavy, all wool flannel. A good roomy all around garment for men or ladies.

Two colors: Black and Red Buffalo Plaid as shown, also Black and White Buffalo Plaid. Size 14 to 19. Price \$3.85 postpaid.

Be sure and send for free samples.

Bean's Reversible Hunting Cap

\$1.50



Red side out

Manufactured by

L. L. Bean Inc., Freeport, Maine
(Fall 1919)

After years of experimenting we have finally perfected an ideal Cap for Deer and Duck Hunting. The crown is red on one side and brown khaki on the other. The visor is brown leather and the whole cap is trimmed with leather. It can be turned in a second. The fit and general appearance is the same either side out. Weight 3½ ounces. Price \$1.25 postpaid. With earflaps \$1.50. Size 6½ to 7½. Send for free sample of red and khaki cloth.



Khaki side out

Bean's Leather Hunting Cap

Made of best mahogany Elk leather with red leather band and wool ear flaps. Gives much better protection than a cloth cap, will not catch or brush off in thick bushes; is water-proof and will last a lifetime.

We want you to see this cap. Order one and return it after your trip, if you are not more than satisfied.

Weight, 5 ounces. Send for free sample of leather. Made-to-order in Black with Red band.

Manufactured and Sold by

L. L. BEAN, FREEPORT, MAINE

\$2.50
Postpaid



Showing ear flaps down

Bean's Camp Kits

Every camper must have a fry pan, plates, cups, coffee pot, knife, fork, and spoon. It is important that Kit be carried in a container. Our outfits are packed in a high grade brown duck bag of our own manufacture with separate bag for Fry Pan.

Outfit No. 11 as shown below consists of 11 pieces and makes package only 10" x 10" x 2½". Price \$2.45 postpaid.

Outfit No. 25 consists of 25 pieces, Pail, Fry Pan, 4 heavy white enamel Cups, 4 Grill Plates, Coffee Pot, 4 Knives, 4 Forks, 4 Spoons, Salt and Pepper Shakers, and round carrying bag as shown below. Price \$4.90 postpaid.



No. 11 Outfit. 10" Fry Pan with folding handle, 4 heavy aluminum cups, 4 plates, Salt and Pepper Shakers, and flat canvas carrying bag. Extra cups 13c. Extra plates 20c. Extra fry pans 65c. Postpaid.

Showing heavy round duck bag with double action puckering string in which we pack outfit No. 25.



Knife, Fork and Spoon

Used in our No. 25 Outfit is a heavy, durable U. S. Army set that will last a lifetime. Knife has steel blade. This set is much more practical than an ordinary silver set.

Price per set, in canvas case, 25c postpaid. Part of Outfit No. 25.



Showing heavy gauge 3-qt. aluminum Coffee Pot with double collapsible handles, strainer spout and long bail for open fire. Also 4-qt. aluminum Pail which is just the right size for Coffee Pot to nest into. Price: Coffee Pot 80c, Pail 70c postpaid.

Enamel Cups 20c each, 4 for 70c, Part of Outfit No. 25



Spun Aluminum Salt and Pepper Shakers

New modern design and finish—Simple two part construction—Easy to clean—Will not corrode. Black Bakelite base with perforated letters "S" and "P" on top as shown above. We also have new design with spill-proof closing top as shown at right. Very practical—specify set wanted.

Heavy, 7" aluminum basin that nests with either Outfit 18c extra.

L. L. Bean Inc., Freeport, Maine
(Fall 1919)



BEAN'S BROOK TROUT FLIES

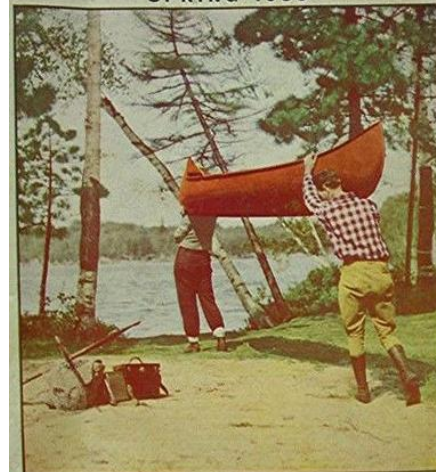


BEAN'S SALMON FLIES



Tied By L. L. BEAN, INC., FREEPORT, MAINE

SPRING 1938



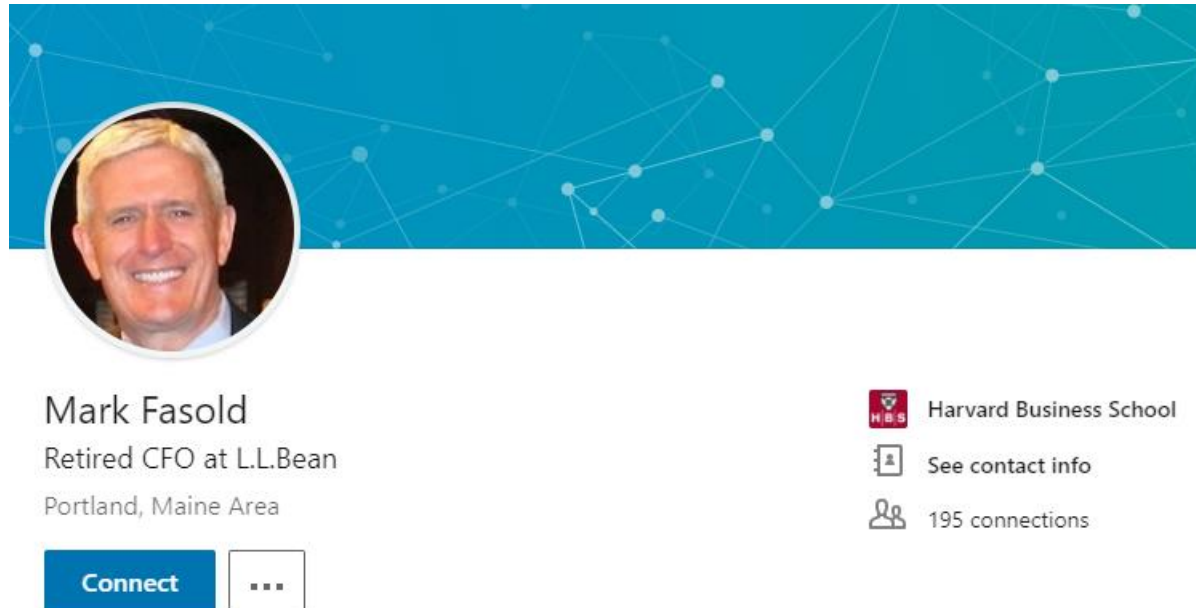
L.L.BEAN Inc. MANUFACTURED IN MAINE

LL Bean iconic products such as the Bean Boot, **Maine Hunting Shoe**, dog beds, Boat and Totes, leather belts



L. L. Bean	Stat
1967	Sales 4.75\$ million,
	Employee – 200
	Mailing List – 600,000 people
1991	Sales 528\$ million, + 71\$ million from retail store
	Active Customer 6 million
2015	Sales - 1.6\$ billion
	Employee – 5000 + 10, 000 winter seasonal
	Active Customer – 9.3 million

- Mark Fasold, Vice President – Inventory Management



A LinkedIn profile card for Mark Fasold. The header features a blue background with a white network graph pattern. On the left is a circular profile picture of Mark Fasold, a middle-aged man with short grey hair, smiling. Below the picture, his name 'Mark Fasold' is displayed in bold, followed by 'Retired CFO at L.L.Bean' and 'Portland, Maine Area'. To the right of the profile picture, there are three items: a Harvard Business School logo with the text 'Harvard Business School', a contact icon with the text 'See contact info', and a people icon with the text '195 connections'. At the bottom left, there is a blue 'Connect' button and a white button with three dots.

Mark Fasold

Retired CFO at L.L.Bean

Portland, Maine Area

Connect

...

Harvard Business School

See contact info

195 connections

<https://www.maa.org/careers/career-profiles/business-management/rol-fessenden>



Rol Fessenden

BA Mathematics
SUNY,
Binghamton

MA Geology,
SUNY,
Binghamton

Director of
Inventory Control
L.L. Bean

Have you or anyone in your family ever placed an order with L.L. Bean? You might be surprised at how difficult it is to ensure that we have your specific item, color, and size when you order it.

You may remember in 1988, on Sunday before the Republican primary in New Hampshire, that the pollsters predicted Bob Dole would win. Two days later, George Bush won instead, and the rest is history.

At L.L. Bean we have thousands of items, and tens of thousands of colors and sizes. Nine months in advance, we have to predict for each one, how many our customers will want. If professional pollsters can be wrong about the New Hampshire primary two days before it occurs, imagine how wrong we can be nine months in advance on 50,000 predictions.

I graduated in 1969 from the State University of New York at Binghamton with a BA in Mathematics, and in 1974 I received an MA in Geology. Before coming to Bean, I was a geologist, a scientific system designer, and a small business manager. In all these occupations mathematics played a key role. I developed models for surface runoff, models of heat transfer in complex, high temperature environments, and statistical profiles of accounts receivable. I have used sophisticated statistical procedures to gain insight into glacial landforms.

My current interests are in customer testing and in mathematical modeling of the merchandising process. In mathematical terms, there are clear analogies between inventory management and previous areas of my expertise such as heat transfer. The insights I have as a result of previous work

Costs involved in the L. L. Bean Case

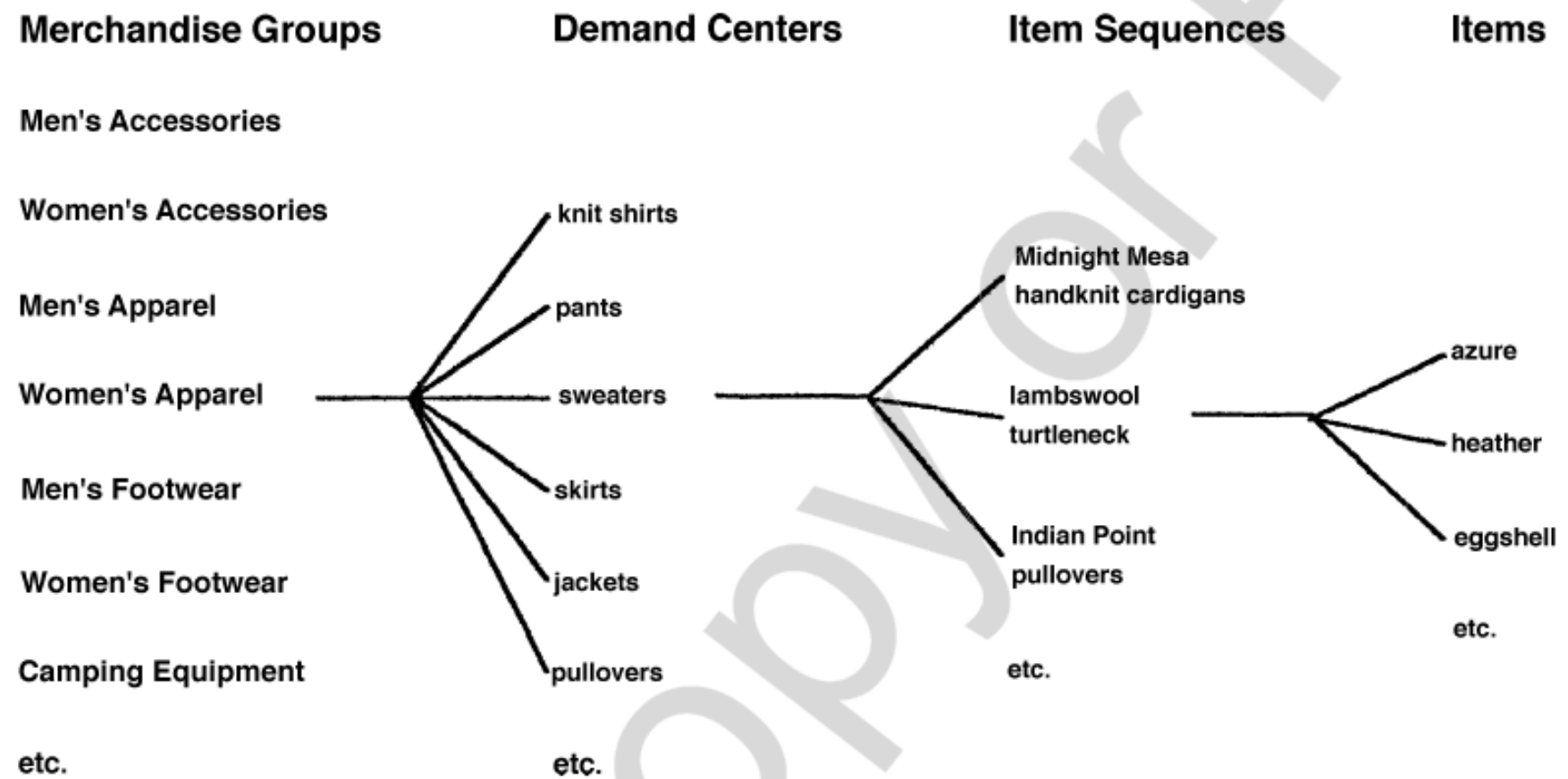
No Stock

- Demand Persisting in the market
- Runaway customer

Excess stock – end of season

- Buying cost from vendors
- Marketing Cost
- Carrying cost / Holding cost
- Salvage cost

Product Line (More than 6000 items)



LL Bean Catalogs

- Major Catalogs (Spring, Summer, fall and Christmas)
 - Full Catalogs – 116 to 152 pages – Regular Customers
- Prospect Catalogs for potential customers
- Speciality Catalogs like spring weekend, summer camp, fly fishing etc.

Timeline of Product Forecast

- When the initial conceptualization happen ?
- When the preliminary forecast happen ?
- When the product manager starts forecasting by book ?
- When the layout and pagination begins?
- When the initial commitment given to the vendor?
- When they frozen forecast for each item?
- When the black and white version of layout was available?
- At what point the product managers handled off the product line to the inventory manager?
- When the complete fall 1991 catalogs were in the hands of customer?
- Active period of catalogs?

Forecast Problem of L. L. Bean

- Wide dispersion in forecast errors for Never out items and New items.
- More Lead Time and inventory cost.

Problem in ITEM TO FORECASTING

- New Item
- Never out item

- Thank you