



An Effective Display of PMPML Bus Time Table: Use of Stem and Leaf Plot

Amita A. Dharmadhikari^{#1}, Sonia S. Joshi^{#2}

Department of Statistics,

P. E. Society's Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-411016, India.

1amita.dharma@gmail.com 2soniajoshee@gmail.com

Abstract: Good public transport facility is very essential for quality life in cities. The allied information like proper display of time tables of such facility is a basic need of commuters. In this article an attempt is made to use a simple but effective statistical tool viz. Stem and Leaf chart for this purpose. This type of display at every city bus stop will be very useful.

Keywords : Public transport, Stem and Leaf chart, Back to Back Stem and Leaf chart, Android app.

I. INTRODUCTION

Public transport of a city is like a nervous system of human body. Hence poor public transport leads to hurdle in the growth of the city. Pune city is very well known as the Oxford of East, an auto industry hub and an IT industry hub. Thousands of people relocate to Pune for higher education and good jobs. Consequently the population of Pune has increased exponentially during last few years. Housing has become very costly so people have to stay at such places which are far away from their work place. So travelling is an integral and unavoidable part of day to day life. Even school going children have to travel long distances daily. To cater this need, city requires a strong public transport system, preferably city bus, local trains, metro etc.

In Pune and suburbs PMPML (Pune Mahanagar Parivahan Mahamandal Limited) provides bus service through 365 routes having around 22,000 trips per day. PMPML buses run from Manjari to Hinjwadi in east-west direction and from Katraj to Vishrantwadi in south-north direction. About 10 to 12 lakh people depend on this facility for commuting. Generally these include senior citizens, lower middle class people and school and college students. Unfortunately, it is the general public opinion that PMPML service is not so efficient. It is the general

observation that Pune's bus route and services seem to be chaotic due to lack of information regarding 1) bus routes 2) bus numbers 3) bus timings.

Objective of this research article is to provide a more appropriate and effective way of displaying bus time tables at each bus stop of each route which will facilitate the commuters. We propose to use a basic statistical graph to display the time tables. These are easy to read even for less educated people.

Every bus route requires a definite time table. It is the right of the commuters to have clearly visible display of the bus time table not only at the destinations but also at the intermediate bus stops. Generally it is the complaint of the commuters that most of the bus stops do not have time tables of the buses plying from there. In this article we propose to construct a graphical display named "Stem and Leaf chart" which will effectively display the bus time table.

II. STEM AND LEAF CHART

A stem and leaf display is a device for presenting the quantitative data in a graphical format. It got evolved from Arthur Bowley's work in early 1900 [1]. These plots became more commonly used in the 1980's after the publication of John Tukey's book on "Exploratory data analysis" [2]. Sever [3] and Elliott et.al.[4] have used graphical techniques for data related to social studies.

A. Simple stem and leaf plot:

It refers to plotting a matrix of Y values onto a common X axis and identifying the common X values with vertical line and individual Y values with symbols on the line. A basic stem and leaf display contains two columns separated by a vertical line. The left column contains the stems and the right column contains the leaves.



Construction:

Step 1) The given observations are arranged in ascending order.

Step 2) Determine what the stem will represent and what the leaves will represent.

Step 3) In case of very large numbers, data values may be rounded to a particular place value that will be used for the leaves. The remaining digits to the left of the rounded place value are used as stems.

Step 4) The smallest leaves are placed closet to the stem and larger leaves are further away.

Illustration: Consider the following set of sorted observations, 44,46,51,63,66,72,75,81, 84,88,106.

Stem	Leaves
4	4 6
5	1
6	3 6
7	2 5
8	1 4 8
10	6

Fig. 1 Stem and leaf chart:

Key: 6|3 =63 , leaf unit= 1.0, stem unit=10.0

B. Back to Back Stem and Leaf plot:

It gives the ability to take two separate data sets and put them on the same plot. It has two sets of leaves, one on the right side of the stem and the other on the left side of the stem.

Illustration:

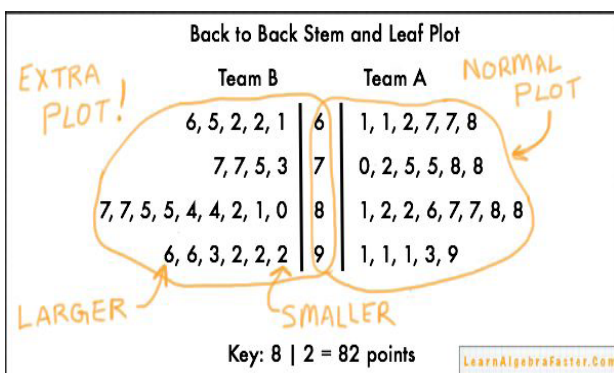


Fig. 2 [5]

III. DATA COLLECTIN AND GRAPHICAL DISPLAY

For using stem and leaf chart for PMPML bus time table , we consider one bus route. The details are as under:

Bus route No. 21; Origin: Swargate; Destination : Sangavi

Total distance: 13 km. ; estimated travel time: 60 min.

No. of stages :35 (including origin and destination)

The traditional display of time table would be as follows:

*TABLE I
(From Swargate)*

5.20	5.35	5.45	6.00	6.15	6.25	6.40	6.55
7.05	7.20	7.35	7.45	8.00	8.15	8.25	8.40
8.55	9.05	9.20	9.35	9.45	10.00	10.15	10.25
10.40	11.05	11.25	11.45	12.00	12.15	12.30	12.45
12.55	13.10	13.25	13.35	14.15	14.30	14.40	14.55
15.10	15.20	15.35	15.50	16.00	16.15	16.30	16.40
16.55	17.10	17.20	17.35	17.50	18.00	18.15	18.30
18.40	18.55	19.10	19.20	19.35	20.00	20.20	20.45
21.00	21.10	21.25	21.40	21.50	22.05	22.20	22.35

*TABLE II
(From Sangavi)*

6.00	6.20	6.40	6.55	7.10	7.25	7.40	7.55
8.05	8.20	8.35	8.45	9.00	9.10	9.25	9.40
9.55	10.05	10.20	10.35	10.45	11.00	11.15	11.25
11.40	12.05	12.25	12.45	13.00	13.10	13.25	13.40
13.50	14.05	14.20	14.30	15.15	15.30	15.40	15.55
16.10	16.20	16.35	16.50	17.00	17.15	17.30	17.40
17.55	18.10	18.20	18.35	18.50	19.00	19.15	19.30
19.40	19.55	20.10	20.20	20.35	21.00	21.20	21.40
21.55	22.05	22.20	22.35	22.45	23.00	23.15	23.30



TABLE III

Hour	Min.				
5	20	35	45		
6	15	25	40	55	
7	05	20	35	45	
8	00	15	25	40	55
9	05	20	35	45	
10	00	15	25	40	
11	05	25	45		
12	00	15	30	45	55
13	10	25	35		
14	15	30	40	55	
15	10	20	35	50	
16	00	15	30	40	55
17	10	20	35	50	
18	00	15	30	40	55
19	10	20	35		
20	00	20	45		
21	00	10	25	40	50
22	05	20	35		

Simple stem and leaf plot for Swargate-Sangavi route

TABLE IV

Back to back stem and leaf plot for Swargate-Sangavi-Swargate route

Sangavi ←					Hour	→ Swargate				
		45	35	20	5	-	-	-	-	-
	55	40	25	15	6	20	40	55		
	45	35	20	05	7	10	25	40	55	
55	40	25	15	00	8	05	20	35	45	
	45	35	20	05	9	00	10	25	40	55
	40	25	15	00	10	05	20	35	45	
		45	25	05	11	00	15	25	40	
55	45	30	15	00	12	05	25	45		
		35	25	10	13	00	10	25	40	50
	55	40	30	15	14	05	20	30		
	50	35	20	10	15	15	30	40	55	
55	40	30	15	00	16	10	20	35	50	
	50	35	20	10	17	00	15	30	40	55
55	40	20	15	00	18	10	20	35	50	
		35	20	10	19	00	15	30	40	55
		45	20	00	20	10	20	35		
50	40	25	10	00	21	00	20	40	55	
		35	20	05	22	05	20	35	45	
					23	00	15	30		

A glance at the above traditional and stem and leaf plot display leads to the following comparisons :

TABLE V
Comparison

Traditional Display	Stem and leaf plot display
It looks clumsy.	It looks attractive and is easy to read.
Not able to show how frequently the bus leaves origin during a given hour.	Easily shows how frequently the bus leaves origin during a given hour
It is really hard to detect any pattern	Easy to detect pattern.
Hour digits are repeated over and over.	Hour digits are not repeated over and over and minute digits can be stacked.

We recommend,

- Back to back stem and leaf display at the origin and destination,
- Simple stem and leaf display at every intermediate bus stop appropriately.

IV. RELATED WORK

- In the last 3-4 years, the android apps like ‘Pune Bus Info’, ‘p-indicator’[6] etc. have been devised to provide information about bus routes and time tables. From the reviews we read from Google, it seems that these apps have very limited utility even for those who use them. More importantly the commuters of PMPML are mostly school going children, senior citizens and people from low income group. Most of these people do not have access to smart phones and hence proper display of time tables is very much needed for them.
- In Mumbai, more people travel by public transport than in Pune. Their bus service viz. BEST [7] is supposed to be good. But they also display the time tables only at origin and destinations in the traditional way.
- Stem and leaf display is used in Japan[8] for displaying the local train time tables.

V. CONCLUSIONS

PMPML is the major public transport system in Pune city. Its utility can be increased in several ways. Time table display in the form of stem and



leaf chart at each bus stop is one way of doing this.

If PMPML authorities implement the decision of applying the simple but effective technique described in this article, existing commuters will be certainly benefitted.

More number of commuters may get attracted towards PMPML. This will be a good service to the society from academicians.

ACKNOWLEDGMENT

We want to thank the Management of Progressive Education Society, Principal and other authorities of P.E.Society's Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-16 for providing the facilities required to carry out this work.

REFERENCES

- [1] Arthur Bowley L. "Elements of Statistics", 1920
- [2] Tukey John W. "Exploratory data analysis" , Pearson's publication, 1977
- [3] Wild C. and Sever G. "A first course in data analysis and inference", John Wiley and Sons, 2000
- [4] Elliott, Jane, Catherine Marsh, "Exploring data-An Introduction to data analysis for social scientists" , Polity press, 2008.
- [5] <http://learnalgebrafaster.com>
- [6] www.pmpml-bus-guide.android.informer.com
- [7] www.bestundertaking.com/route.asp
- [8] https://commons.wikimedia.org/.../File:Stem-and-leaf_time_tables_in_Japanese_train_stations.jpg