

BIOLOGY LABORATORY RECORD

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Ecology

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*Every honest researcher I know admits he's just a professional amateur.
He's doing whatever he's doing for the first time. That makes him an
amateur. He has sense enough to know that he's going to have a lot of
trouble, so that makes him a professional.*

— Charles F. Kettering (1876-1958) (Holder of 186 patents)

ACKNOWLEDGEMENTS

INSTRUCTOR

Here I've taken the liberty to write more than conventionally accepted. Biology is amongst the subjects I was certain I can never enjoy till class XII. Yet today, I can claim that it is this practical (1 credit course) for which I have spent maximum time this semester, second only to the Physics course on Thermodynamics (3 credits). I mention this since there exists only one reason for such a significant direction of effort into a direction formerly known to be un-interesting and 'voodoo'; Dr. N.G. Prasad.

Saying, I express my sincere gratitude to Dr. N.G. Prasad, for bringing the subject to life and helping us discover, in depth, the science behind the procedures, would be an astounding understatement. I hope you can however imagine the emotion I am trying to communicate, without me attempting to explicitly state it.

I had for a semester, started to believe that optimizing for marks is a good idea. However I now realize that I can *only learn* if I learn because I *want to learn*. I am unable to restrict my learning in accordance with the syllabus or the time constraints. I thus had a conflict this semester about having to put in a disproportionate amount of time in a one credit course because of which I even cursed the design of the laboratory course. And today I am glad to tell you, its all worth it, for at the end, you need to aim at excellence, not success, especially if you *want to be* successful. So I credit this realization to Dr. N.G. Prasad, for this is perhaps amongst the most important stepping stone in my learning process. Which is not to say he is the only one, but he is certainly amongst the finest, to whom I owe a lot of my *true* education.

TEAM MEMBERS

Our team consisted of Ritu, Prashansa, Evelyn, Biplob and Me. I am very thankful for every single member for their work, unique insight, team spirit and most importantly, curiosity.

I would like to specifically thank Ritu and Prashansa, who have gone out-of the way to do things right, to keep the standard of working high and consequently kept me motivated, even at low moments. They have worked extremely hard¹, have shown exceptional patience, for I now know that for certain that evolution/ecology experience can require that in excess, and have helped keep the team together, even during hostile disagreements.

¹ We'd monitored everyone's contribution in terms of time and they were the amongst the highest scorers. This was done for a period of about two weeks when the activity was rather high

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LISTINGS

ACRONYMS

Part I

EXPERIMENTS

‘BIRD WATCHING’

January-April, 2013

1.1 PRIOR AIM

To observe the species, time and location of birds for the period of January-April, 2013; with sufficiently spread observations in accordance with the time of the day and the day of the week, for all weeks.

1.2 OBSERVATIONS

The data collected was enormous and has been made publicly available at the following link:

<https://docs.google.com/spreadsheet/ccc?key=0Aptbew0byE3xdDJnMUVyNU1UYkhNWG91WGx3UTMwTFE#gid=0>

The sailient observations have been given in [Table 1](#) and further details are given in [Table 5](#).

Table 1

Date	All
------	-----

Row Labels	Count of Bird Group Size (1 for solitary)	Sum of Bird Group Size (1 for solitary)
(blank)	99	254
?	14	26
Alexandriane Parakeet	2	2
Banded-Bay Cuckoo	3	3
Bat	1	10
Bee Eater*	4	5
Black Drongo	9	12
Black Kite	24	30
Black Shouldered Kite	13	13
Blue-Rock Pigeon	12	38
BlueThroat*	1	1
Brown Eagle	2	3
Brown Kite	3	3
Brown Rock Chat	1	2
Brown Stone Chat	1	2
Bulbul	3	4
Cattle Egret	19	35
Coucal	7	10
Crow	26	233
Crow-billed Drongo	2	2
Dove	1	2
Drongo	7	11
Eagle	2	2
Egret	2	2
Eurasian Collared Dove	2	3
Flycatcher	2	2
Great Black Woodpecker	1	2
Greater Coucal	6	7
Greater Spotted Eagle	2	2
Grey Francolin	3	6

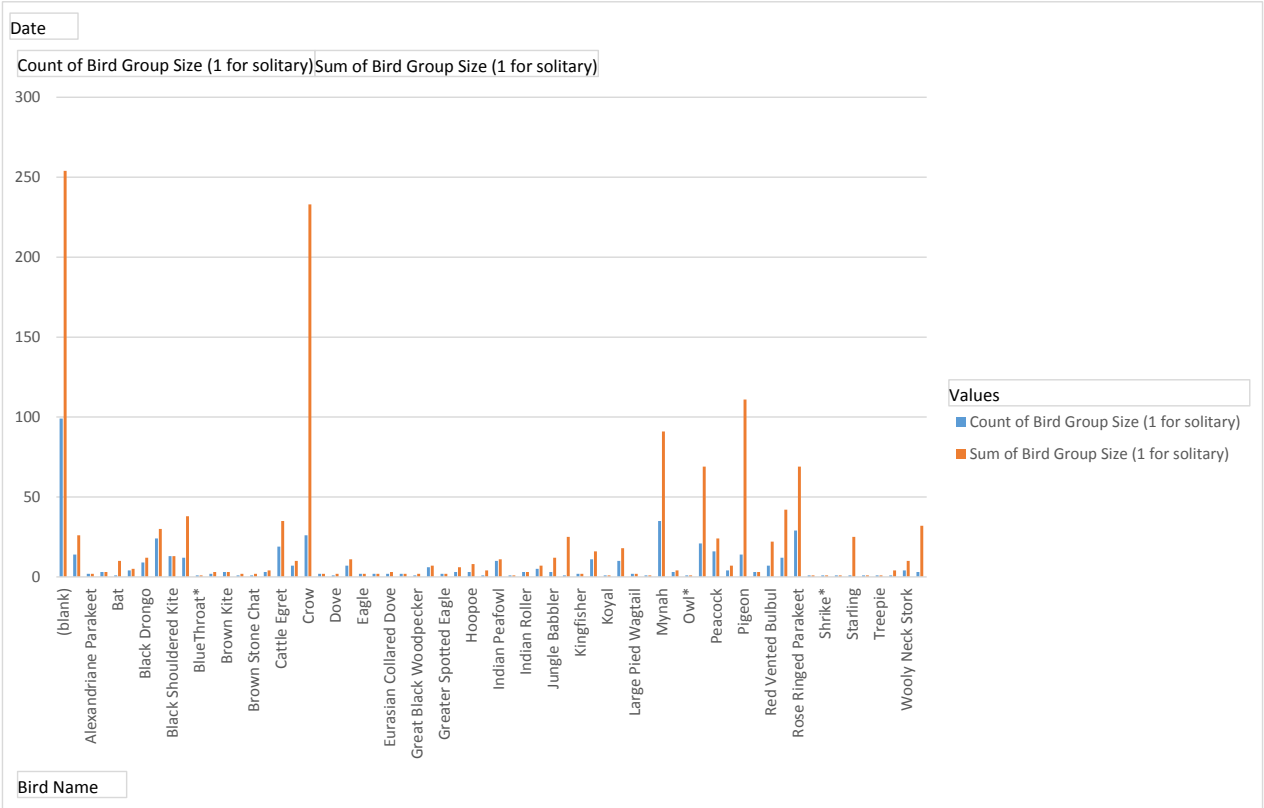
Table 1

Hoopoe	3	8
Indian Grey Hornbill	1	4
Indian Peafowl	10	11
Indian Pond Heron	1	1
Indian Roller	3	3
Indian Treepie	5	7
Jungle Babbler	3	12
Jungle Crow	1	25
Kingfisher	2	2
Kite	11	16
Koyal	1	1
Lapwing	10	18
Large Pied Wagtail	2	2
Moorhen	1	1
Mynah	35	91
Owl	3	4
Owl*	1	1
Parakeet	21	69
Peacock	16	24
Peahen	4	7
Pigeon	14	111
Pipit*	3	3
Red Vented Bulbul	7	22
Red Wattled Lapwing	12	42
Rose Ringed Parakeet	29	69
Shrike	1	1
Shrike*	1	1
Sparrow	1	1
Starling	1	25
Stonechat	1	1
Treepie	1	1
Warbler	1	4
Wooly Neck Stork	4	10

Table 1

Yellow Footed Green Pigeon	3	32
Grand Total	487	1357

Table 1



1.3 ACKNOWLEDGEMENTS

For this experiment, in addition to our existing team, we had Yosman Bapatdhar, Vivek Sagar, and S. Shwetha pool in their observations to form a large enough data bank. Everyone's dedicated effort has been the heart to this experiment's success.

March 7, 2013

2.1 PRIOR AIM

To study the co-relation between the flower colour and bee flower selection. Figure out if the flower colour affects the behaviour of bees?

2.2 MOTIVATION

In plants, we observe either self-fertilisation/pollination or cross fertilisation. Insects play an important role in the pollination process for certain plants.

Behaviour of Pollinators in general depends on, visual cues and olfactory cues. The plants 'allegedly' use colour and fragrance to attract pollinators and 'reward' them in return for pollination, with nectar and pollen (these are eaten to gain lipids).

2.3 PROPOSED TECHNIQUES

The following are the techniques can be employed:

1. Focal Animal Sampling:

In this method all occurrences of the specified action of one individual are recorded for a predetermined interval of time.

2. Activity Scans:

An individual's activities are recorded at regular intervals, for example, every 30 seconds. It provides the percent of time spent in a particular activity. Instantaneous scan sampling is best done with a sample interval as small as possible and an easily identifiable behaviour.

In this experiment we used the method of focal animal sampling.

2.4 PROCEDURE

The procedure was as follows:

1. Located a suitable region, viz. a region with multiple coloured flowers of the same species
2. Ensured the pollinators we're about to follow are bees and not 'copy-cats'
3. Started an audio recorder
4. Narrated suitably the actions of one bee for as long as possible
5. Repeated the procedure for over 6 bees and 2 regions

2.5 ANALYSIS

2.5.1 *Brief of the Statistics*

To see if the difference in the average duration is statistically significant, we perform a two tailed t test as the sample size is extremely small and the t-test depends only on the the degrees of freedom of the system being analysed. If we can relate our means and variances with this distribution, it becomes simply a matter of looking up values to find the probability of their occurrence, assuming the Null hypothesis to be true. We now define a less than 5% probability of occurrence to mean that the means are too different to belong to the same population, and thus the null hypothesis must be rejected. We've found experimentally, m_1 , m_2 , s_1 , s_2 , n_1 and n_2 , which are means, variances and degrees of freedom respectively. We find the t value using the following equation

$$t = \frac{m_1 - m_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}} \quad (1)$$

Also, we find the degrees of freedom, given by

$$df = (N_1 - 1) + (N_2 - 1) = (N_1 + N_2 - 2) \quad (2)$$

Now all we have to do is look up the value in a t-table corresponding to 0.050 and df as calculated. If $t_{\text{calculated}} > t_{\text{table}}$, then the Null hypothesis is rejected. Else, the null hypothesis can not be rejected.

2.5.2 *Implementation*

The basic idea here is to find out if there's a co-relation between the flower colour and bee flower selection. Our method is, as stated earlier, focal animal sampling. So we have to do the following multi-stage analysis to get the desired result. We analysed this data on excel, and the commands used have been casually hinted at for reconstruction should the need arise.

1. Collected the raw data and converted it into a table, 'CroppedCollected' with the headings 'Bee Number ID', 'Colour of Flower' and 'Time Spent on Colour', ensuring that each bee was followed for roughly the same period of time.
2. Using a Pivot Table, converted 'CroppedCollected' into a table that gives the total time spent on each colour, in a given Time Sample (viz. for a given bee). The table was then converted to an ordinary table, with fields 'Bee Number (ID)', 'Colour of Flower' and 'Sum of Duration', given in [Table 7](#)
3. Next converted this into a Pivot table with 'Colour of Flower' in the Rows, and in the Values, 'Average of the Sum of Duration' and 'Count of Flower'. The corresponding graph for this is given in [Table 2](#).
4. On the basis of this graph, categorized the 'Colours' to a 'Family' and created a table for the same. [Table 3](#)
5. Using this final table, created another Pivot Table with Rows 'Family' and Values were 'Average of Sum of Duration', 'StdDev of Sum of Duration' and 'Count of Flower'. The data is given in [Table 4](#)

2.6 RESULT

We can't reject the Null Hypothesis, viz. The bees select between the different colour families randomly.

Table 2

Row Labels	Average of Sum of DURATION	Count of FLOWER
Dark Purple	29.0	3
Faded Blue	23.0	1
Faded Purple	9.0	2
Light Pink	18.5	2
Light Violet	13.0	1
Pink	37.0	4
Violet	28.0	1
White	40.0	1
White Purple	12.3	4
Grand Total	23.3	19

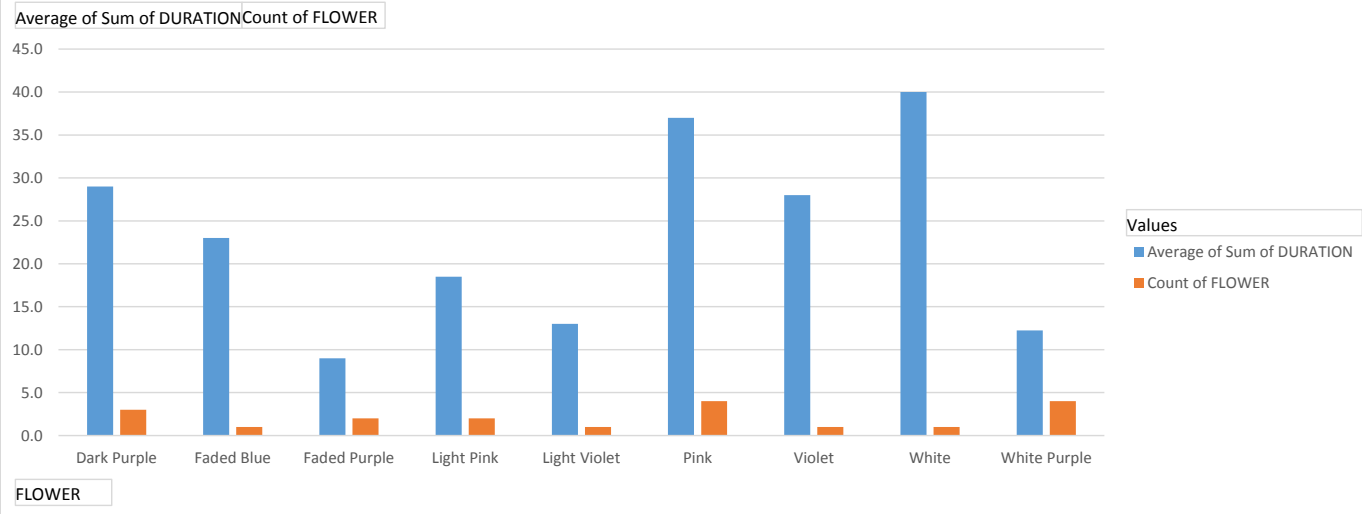
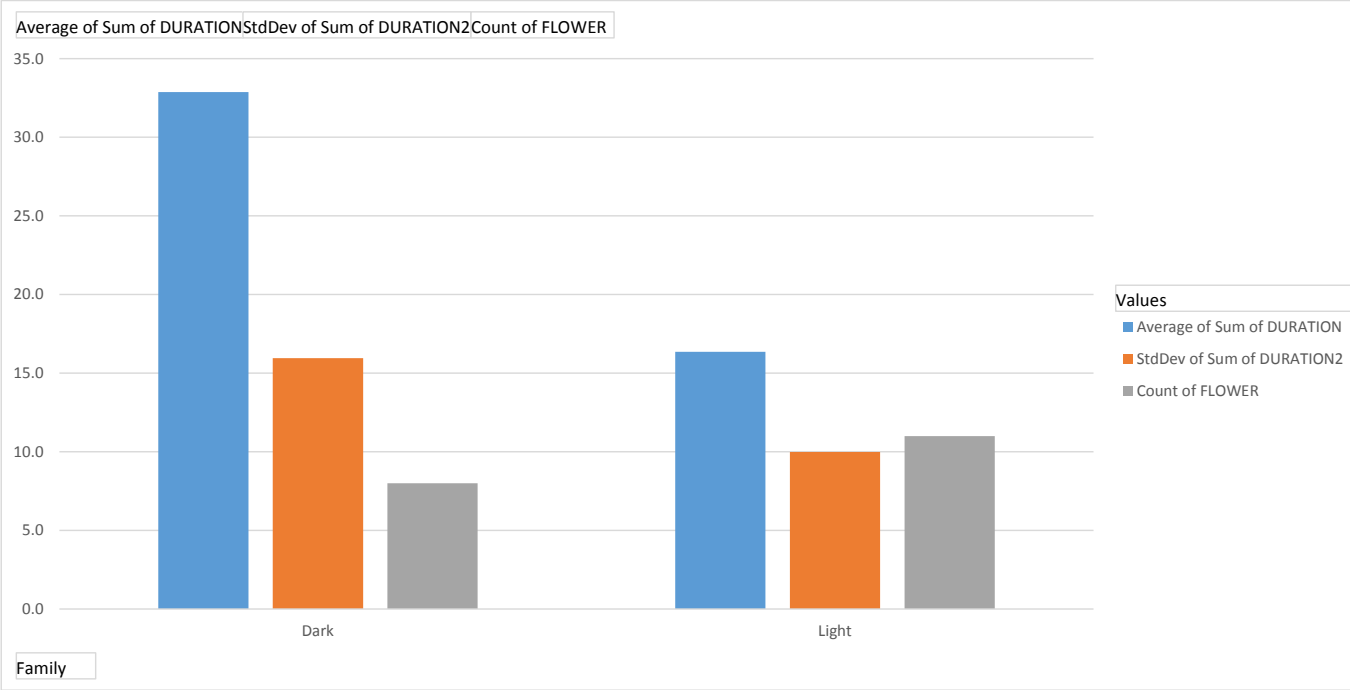


Table 3

Colour	Family
Pink	Dark
Violet	Dark
Dark Purple	Dark
Faded Blue	Light
Faded Purple	Light
Light Pink	Light
White Purple	Light
Light Violet	Light
White	Light

Table 4

Row Labels	Average of Sum of DURATION	StdDev of Sum of DURATION2	Count of FLOWER
Dark	32.9	16.0	8
Light	16.4	10.0	11
Grand Total	23.3	15.0	19



Part II

APPENDIX

BIRD DATA

A.1 BIRD OBSERVATIONS

The observations were made over a period of two and a half months, with a frequency of once in two days at least. The details have been listed in [Table 5](#).

Table 5

Observation Trip #	Temperature (*C)	Time Start	Time End	Sunny (1 if yes, else it's considered no)	Foggy	Rainy	Cloudy	Windy	Humid	Humidity	Wind Speed	Date
1	4 to 6	6:45:00	8:00:00			1		1	1	1	3 km/hr	1/20/2013
2		14:30:00	16:00:00	1					1			1/20/2013
3		6:15:00	8:00:00	0	0	0	0	0	1	0		1/21/2013
4		14:15:00	17:00:00	1	0	0	0	0	1	0		1/27/2013
5		15:15:00	16:45:00	1	0	0	0	0	0			1/23/2013
6	6 to 8	7:09:00	8:30:00	0	0	0	0	0	0	1	0.42 0 km/hr	1/27/2013
7		21:30:00	22:45:00	0	1	0	0	0	1	0		1/23/2013
8	19	15:27:00	16:44:00	hazy sunshine	0	0	1	0	0	0	0.39 6km/hr	1/30/2013
9												
10												
11	6	6:55:00	8:05:00	1	0	0	0	0	0	1	NE at 5 0.84 Km/Hr	2/7/2013
12	7	7:05:00	8:21:00	1	0	0	0	0	0	1	E at 8 0.58 Km/Hr	2/9/2013
13		15:30:00	16:30:00	1	0	0	0	0	1	0		2/6/2013
14	9	7:45:00	9:15:00	1	0	0	0	0	0	1	E at 8 0.53 Km/Hr	2/10/2013
15	8 to 11	7:25:00	9:07:00	0	1	0	15% cloud 0 cover	0	0	1	0.91 0km/hr	2/10/2013
16		14:30:00	17:00:00	1	0	0	0	0	1	0		2/10/2013
17	21 to 13	17:40:00	17:40:00	1	0	0	0	0	1	0	0.67 W 6 km/hr	2/9/2013
18												2/1/2013
19		22:30:00	23:30:00	0	1	0	0	1	1	0		2/10/2013
20	8	7:00:00	8:05:00	1	0	0	0	0	0	1	NE at 11 0.44 Km/Hr	2/11/2013

Table 5

98% cloud											
21	13 to 15	9:25:00	10:50:00	0	0	0 cover	1	1	0.86	E at 6km/hr	2/17/2013
22	10	14:53:00	17:55:00	1	0	0	1	0	1	0.84	8 Km/Hr 2/17/2013
23	9	7:41:00	8:57:00	0	0	0	1	0	0	0.45	6 Km/Hr 2/19/2013
24	19	14:41:00	15:39:00	1	0	0	0	0	1	0.58	10 Km/Hr 2/24/2013
12% cloud											
E NE											
25	15 to 14	9:50:00	11:30:00	1	0	0 cover	0	1	0.49	2km/hr	2/24/2013
2:00 pm and											
26	17	6:30 pm		0	0	0	0	0	1	0.76	2/25/2013
27	17 to 20	10:04:00	11:45:00	1	0	0	0	0	1	0.84	0 3/3/2013
28	17 to 21	7:00:00	8:00:00	0	0.5	0	0	0.5	0		0 3/4/2013
29	23	16:30:00	18:30:00	1	0	0	0	0	0.5	0.5	0 3/23/2013
30											
0 % cloud											
0 cover											
31	16 to 22	7:19:00	9:00:00	1	0	0	0	1	0.88	1 km/hr NE	17/3/2013
32	17-23	16:00:00	16:50:00	1	0	0	0	0.5	0		13/2/2013
33		23:00:00	23:45:00	0	0.25	0	0	0	0		17/2/2013
34		16:30:00	17:30:00	1	0	0	0	0.5	0		20/02/2013
35		15:30:00	16:30:00	1	0	0	0	0	0		6/3/2013
36		9:30:00	9:40:00	1	0	0	0	0	0		24/2/2013
37	15-20	6:45:00	7:45:00	1	0	0	0	0			2/4/2013

BEE DATA

B.1 OBSERVATIONS

The cropped data for the analysis has been listed in [Table 6](#). The data after grouping the durations of time spent on a particular flower for a given period, is given in [Table 7](#).

Table 6

FILE	FLOWER	DURATION
	6 Dark Purple	25
	7 Dark Purple	46
	9 Dark Purple	16
	7 Faded Blue	7
	7 Faded Blue	16
	5 Faded Purple	5
	9 Faded Purple	13
	1 Light Pink	13
	8 Light Pink	10
	8 Light Pink	4
	8 Light Pink	10
	5 White Purple	10
	9 White Purple	20
	2 Light Violet	4
	2 Light Violet	9
	1 Pink	5
	1 Pink	41
	2 Pink	16
	2 Pink	10
	4 Pink	60
	8 Pink	16
	1 Violet	28
	5 White	25
	5 White	11
	5 White	4
	6 White Purple	5
	6 White Purple	8
	8 White Purple	6

Table 6

FILE	FLOWER	Sum of DURATION
	1 Light Pink	13
	1 Pink	46
	1 Violet	28
	2 Light Violet	13
	2 Pink	26
	4 Pink	60
	5 Faded Purple	5
	5 White	40
	5 White Purple	10
	6 Dark Purple	25
	6 White Purple	13
	7 Dark Purple	46
	7 Faded Blue	23
	8 Light Pink	24
	8 Pink	16
	8 White Purple	6
	9 Dark Purple	16
	9 Faded Purple	13
	9 White Purple	20
(blank)	(blank)	

Table 7

FILE	FLOWER	Sum of DURATION
1	Light Pink	13
1	Pink	46
1	Violet	28
2	Light Violet	13
2	Pink	26
4	Pink	60
5	Faded Purple	5
5	White	40
5	White Purple	10
6	Dark Purple	25
6	White Purple	13
7	Dark Purple	46
7	Faded Blue	23
8	Light Pink	24
8	Pink	16
8	White Purple	6
9	Dark Purple	16
9	Faded Purple	13
9	White Purple	20

COLOPHON

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The style was inspired by Robert Bringhurst's seminal book on typography "*The Elements of Typographic Style*".

The latest version of this document is available online at:

https://github.com/toAtulArora/IISER_repo