

Statistics and Data Analysis

Unit 06 – Lecture 02 Notes

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Topic

Smoothing techniques for time series (moving average, exponential smoothing).

Learning Outcomes

- Explain why smoothing is used (noise reduction)
- Describe moving average and its window effect
- Describe exponential smoothing and alpha effect
- Discuss responsiveness vs smoothness trade-off

Detailed Notes

These notes are designed to be read alongside the slides. They expand each slide bullet into plain-language explanations, small worked examples, and common pitfalls. When a formula appears, emphasize (1) what each symbol means, (2) the assumptions needed to use it, and (3) how to interpret the final number in the problem context.

Moving Average

- Average last k points
- Larger $k \rightarrow$ smoother but more lag
- Good for trend visualization

Exponential Smoothing

- Weighted average with decay
- Alpha near 1 \rightarrow responsive
- Alpha near 0 \rightarrow smooth

Exercises (with Solutions)

Exercise 1: Window effect

Increase window from 3 to 15: what happens?

Solution

- Smoother, more lag.

Exercise 2: Alpha

If $\alpha=0.9$, smoothing is strong or weak?

Solution

- Weak smoothing (very responsive).

Exercise 3: Too much smoothing

Why can too much smoothing harm forecasting?

Solution

- It can hide real changes and add lag.

Exit Question

What is one sign that your smoothing window is too large?

Demo (Python)

Run from the lecture folder:

```
python demo/demo.py
```

Output files:

- `images/demo.png`
- `data/results.txt`

References

- Montgomery, D. C., & Runger, G. C. *Applied Statistics and Probability for Engineers*, Wiley.
- Devore, J. L. *Probability and Statistics for Engineering and the Sciences*, Cengage.
- McKinney, W. *Python for Data Analysis*, O'Reilly.