

Statistics and Data Analysis

Unit 04 – Lecture 04: Polynomial Regression and Logistic Regression

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<https://github.com/tali7c/Statistics-and-Data-Analysis>

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Learning Outcomes

- Explain polynomial features for modeling curvature

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- Recognize overfitting risk with high degree
- Write logistic regression probability model (sigmoid)
- Compute precision and recall from a confusion matrix

Polynomial Regression: Key Points

- Add features x, x^2, x^3, \dots

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- Choose degree using validation

Logistic Regression: Key Points

- Outputs probability in $(0,1)$

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- Threshold converts probability to class label
- Evaluate using confusion matrix / ROC

Logistic Regression: Key Formula

$$P(y = 1 \mid x) = \frac{1}{1 + e^{-(\beta_0 + \beta^T x)}}$$

Exercise 1: Polynomial features

For degree-2 polynomial, what features do we use from x ?

Solution 1

- Use $1, x, x^2$ (intercept + linear + quadratic).

Exercise 2: Precision/recall

TP=30 FP=10 FN=20 TN=40. Compute precision and recall.

Solution 2

- $\text{Precision} = 30 / (30 + 10) = 0.75$
- $\text{Recall} = 30 / (30 + 20) = 0.60$

Exercise 3: Threshold effect

If threshold increases from 0.5 to 0.8, what tends to happen to precision and recall?

Solution 3

- Precision often increases, recall often decreases.

Mini Demo (Python)

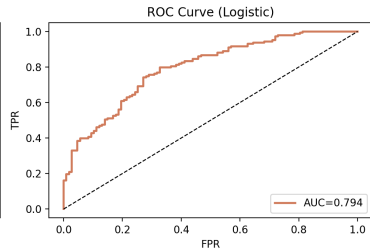
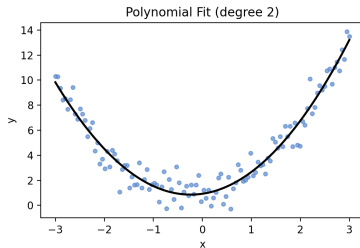
Run from the lecture folder:

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

Outputs:

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

Demo Output (Example)



Summary

- Key definitions and the main formula.

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- How to interpret results in context.

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- Key definitions and the main formula.
- How to interpret results in context.
- How the demo connects to the theory.

Exit Question

Why is ROC curve useful when classes are imbalanced?