

Instruction for Assignment 1

EE214
(2025 Spring)

March 24, 2025

1 Overview

In this assignment, you will practice fundamental machine learning workflows using classical algorithms which are covered in our lectures. The assignment is structured in three parts as below. You are allowed and encouraged to use AI tools (e.g., ChatGPT) to help with coding and understanding, but you must verify all answers and document your usage of AI. The goal is to ensure you learn the concepts and not rely on AI to do everything. The assignment includes:

- **Part 1: Fill-in-the-Blanks:** Complete a provided Jupyter Notebook with key ML tasks.
- **Part 2: Coding Task:** Tackle a more open-ended coding problem requiring deeper understanding and creativity.
- **Part 3: Report:** Write a short report explaining your approach, results, and how you used AI, including what was helpful and what limitations you encountered.

Each part builds on the previous one in difficulty. By the end, you will have experience with a full ML pipeline and reflection on the problem-solving process.

Using AI tools: You may ask ChatGPT or other AI for help (e.g., debugging code, explaining concepts, suggesting approaches). However, the final work must be your own:

- Do not blindly copy AI outputs, always test and understand any code or answers given.
- Document in your report exactly how you used AI (which tasks, what it helped with, where it failed).
- Keep in mind that AI can be wrong or incomplete. Part of your grade is evaluating AI's answers critically.

This approach is designed to enhance learning: reflecting on your thought process and AI's role can deepen your understanding. By explaining challenges and how you overcame them, you engage in higher-level thinking that AI cannot do for you.

2 Report

You will write a report describing your work and your use of AI. This report is a crucial component of the assignment for reflecting on what you learned and ensuring a fair evaluation and transparency in using AI for academic work.

2.1 What to Include in the Report:

Approach and Solution Outline: Describe in *your own words* how you tackled Part 2 (and Part 1, if relevant). This should be a narrative of what you did, step by step. For example, discuss how you set up the experiment, how you decided on which degrees to try, and any adjustments you made along the way. If you encountered bugs or issues, mention how you identified and resolved them. Essentially, imagine explaining to a classmate how you solved the problem and why you solved it that way. Keep this section concise but informative.

Results and Analysis: Summarize the key findings from Part 2. Highlight the optimal model configuration and performance, as well as the evidence of underfitting/overfitting you observed. You should already have written detailed answers in Part 2, so here you can briefly recapitulate the most important points. Focus on the interpretation: what did you learn about the relationship between model complexity and performance from this exercise? This section shows that you understand the outcome of your experiments.

Use of AI: This is a *mandatory* disclosure of any AI assistance you used while completing Parts 1 and 2. Be specific about:

- **Which tools or platforms have you used?**
- **For what tasks did you use AI and how?** Did you use it to get hints on syntax, generate a snippet of code, debug an error message, or explain a concept you were unsure about?
- **How you integrated the AI's suggestions into your work.** It's important to clarify that you didn't just copy blindly.
- **Any instances where AI was wrong or not directly helpful.** It's valuable to mention if the AI gave incorrect advice that you caught or if you decided not to use an AI suggestion.
- **Citation of AI content:** If you have any code or text in your submission that was significantly generated by AI, cite it. You can do this informally in this report. Formal citation format is not required, but clarity is. If you used AI for brainstorming or minor phrasing, just acknowledge it generally. The key is transparency.

Remember, using AI is permitted in this assignment, but you must disclose it. We are grading you on your understanding and the work you did around the

AI tools, not just on raw code. Unreported AI usage that is later detected will be treated as a violation of academic integrity. On the other hand, the well-documented use of AI (even if it contributed a lot) will be viewed as additional credit as you leverage resources effectively and ethically.

2.2 Report format:

- **Aim for a clear, well-organized report of about 1-3 pages.** Quality matters more than length. You can integrate your answers to the analysis questions into the narrative, but ensure all points are addressed.
- **The report can be submitted as a PDF document.** If you're writing in the Jupyter Notebook, you can compile your markdown answers into a PDF. Just make sure it's readable.
- **Be honest and specific when describing AI use.** This report is not only graded but also serves as a record of your ethical use of AI. Being truthful here will not negatively affect your grade; on the contrary, thorough documentation of AI use is part of the grading criteria.
- **Write in complete sentences and your own voice.** This is not a formal essay – it can be somewhat conversational – but it should be well-written and clear. Avoid just bulleting answers without context.

Grading and Evaluation Criteria

Your submission will be evaluated based on both correctness and your demonstrated understanding of the material. The assignment is worth a total of 100 points, distributed among the three parts as follows:

Grading Rubric Summary

- **Part 1 (15 pts):** 3 code completions (5 pts each).
 - Full: Code passes all tests.
 - Partial: Minor errors; concept is correct.
 - Zero: Blank or completely incorrect.
- **Part 2 Code (20 pts):**
 - Model Training: 10 pts.
 - Metrics Calculation: 5 pts.
 - Code Clarity: 5 pts.
- **Part 2 Analysis (25 pts):**
 - Identification of Best Model: 5 pts.
 - Under/Overfitting Identification: 5 pts.
 - Bias–Variance Explanation: 5 pts.
 - Real-World Applicability Analysis: 5 pts.
 - Alternative Basis Function Analysis: 5 pts.
- **Part 2 Rigor (10 pts):** Range of experiments, reproducibility, and thoughtful iteration.
- **Part 3 Clarity (10 pts):** Well-organized, all required sections.
- **Part 3 Depth (10 pts):** Detailed reflection on process and learning.
- **Part 3 AI Documentation (10 pts):** Complete and honest disclosure of AI usage.
- **Bonus:** Up to 5 pts for exceptional work.

Part 1: Fill-in-the-Blanks Code (15 pts)

- Each coding blank or sub-task is allocated approximately 5 points. We will automatically grade this section by running your completed code against expected outputs.
- **Full Credit:** Awarded when your code passes all tests (e.g., correct train/test split, accurate MSE calculation, proper polynomial feature generation).
- **Partial Credit:** May be given if your approach is on the right track but contains minor bugs or syntax errors. TAs will review any failing cases.
- **Evaluation Focus:**
 - Correct completion of the code as required.
 - Whether the code produces the expected result on sample tests.

Part 2: Coding Task & Analysis (55 pts)

This part is assessed both on the code you implement and the conceptual analysis you provide.

Code Implementation (approximately 20 pts)

- **Model Training (10 pts):**
 - Proper training of polynomial regression models and Gaussian basis regression models for the required degrees.
 - Full credit if all specified degrees are tried and the code clearly works; partial credit if some degrees are missing or there is a mistake in training.
- **Metric Calculation (5 pts):**
 - Correct computation of performance metrics (MSE on training and test sets). Note that common mistakes include calculating test error on the training data or vice versa.
- **Code Clarity and Adherence (5 pts):**
 - Use of methods taught in class (and avoidance of banned techniques).
 - Readability, proper commenting, and elimination of extraneous code. AI-generated code must be cleaned up and integrated correctly.

Results & Conceptual Analysis (approximately 25 pts)

- **Identification of Best Model (5 pts):**
 - Correctly identify which basis function and degree achieved the best performance, providing supporting error values.
- **Underfitting/Overfitting Identification (5 pts):**
 - Clearly indicate examples of underfitting (e.g., a low-degree model with high errors) and overfitting (e.g., a high-degree model with near-zero training error but high test error).
- **Bias–Variance Tradeoff Explanation (5 pts):**
 - Provide a clear explanation linking your results to the concepts of bias and variance. For example, explain how low-degree models have high bias and high-degree models exhibit high variance.
- **Real-World Applicability Analysis (5 pts):**
 - Clearly explain the practical advantages and disadvantages of each basis function in real-world regression scenarios.
- **Alternative Basis Functions Analysis (5 pts):**
 - Clearly explain a basis function other than polynomial or Gaussian ones, from the perspectives of the bias-variance tradeoff and the pros and cons in real-world regression problems.

Experimental Rigor & Iteration (approximately 10 pts)

- **Range of Experiments:**
 - Tested a sufficient range of model complexities to demonstrate the bias–variance tradeoff.
 - For full credit, experiments should span enough degrees (e.g., testing degrees 1 through 10 or even 1 through 20) to clearly show both underfitting and overfitting.
- **Reproducibility:**
 - Use of fixed random seeds (e.g., `random_state=42`) to ensure consistent results.
- **Investigation of Anomalies:**
 - If results seem unexpected (e.g., test error decreasing monotonically), a brief discussion or investigation is expected.

Part 3: Report & AI Documentation (30 pts)

- **Clarity and Organization (10 pts):**

- The report should be well-structured with clear sections (approach, results, AI usage, and reflection).
- Points may be deducted for disorganized writing or missing sections.

- **Depth of Reflection (10 pts):**

- Provide a meaningful discussion of your problem-solving process, including challenges, decisions, and learning outcomes.
- Superficial or generic reflections (e.g., “everything went well”) will receive partial credit.

- **AI Usage Documentation (10 pts):**

- Explicitly document all instances of AI assistance (e.g., naming the tools used, the specific help received, and how you integrated the responses).
- Full credit for comprehensive and honest documentation; failure to mention AI usage when evidence exists will result in significant penalties.

Bonus: Quality of Insights (+ up to 5 pts)

- Extra points may be awarded for exceptionally innovative analysis, extra experiments that add value, or particularly thoughtful insights in your reflections.