

Project Milestone 4 – Algorithm Refinement and Final Deliverable

Instructions

1. Read this document carefully. You are responsible for following all instructions in this document.
2. Read the Learning Objectives at the end of the document to understand how your work will be graded.
3. Use professional language in all written responses and format all plots for technical presentation. See EPS01 and EPS02 for guidelines.
4. Good programming standards apply to all m-files.
5. Submit deliverables to Gradescope. Name your files to match the format in the table below, where *SSS_TT* is your section and team ID (e.g., 001_03 is Section 001, Team 3)

Item	Deliverables
M4 Answer Sheet	M4_AnswerSheet_SSS_TT.pdf
M4 Algorithm	M4_Algorithm_SSS_TT.m
M4 Main Function	M4_Main_SSS_TT.m
Technical Brief	M4_TechnicalBrief_SSS_TT.pdf

See submission requirements on the last page of this answer sheet.

6. Complete the Assignment Header before starting the answer sheet.

Assignment Header

Section and Team ID (SSS_TT): 019-24

Team Member Name	Purdue Career Account Login
Seena Pourzand	spourzan
Sergio Monge	smonge
Nathan Thorson	njthorso
Gregory Szymchack	gszymcha

Role of Each Team Member

In this section, put each team member's name who worked on this milestone. In the Detailed Description of Work, each person on the team should write their own description of how they contributed to this milestone. Be very detailed here. Then in the last column, your team should estimate the percentage of the work that each team member did on the milestone. This column needs to add up to 100%. We know that on any given milestone that this will vary, but one person in the team should not be doing significantly more than the others throughout the whole project. Use this column as a way for you to make sure your workload is balanced throughout the project.

Team Member Name	Detailed Description of Work	Percent of Work
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Seena Pourzand	Work on technical brief procedure, worked with improvements in M4 algorithm to get desired results, contributed to improvement plan on answer sheet.	25%
Sergio Monge	Worked on the Answer sheet, mainly on the feedback and improvements sections. Helped with the resume insert and genral revision of the technical brief.	25%
Nathan Thorson	Worked on interpretation, results, and helped on resume insert	25%
Gregory Szymchack	Introduction on Technical brief, References on technical brief, general grammar fixes on Answer sheet & technical brief, resume insert	25%

Part 0: M3 Feedback Review

Reflect on your M3 feedback for the purpose of improvement. Your reflection should provide a clear, useful summary of your M3 feedback and provide a clear and practical plan to address the issues. Complete Table 1 below.

Table 1. Feedback summary and plan

<p>Part A: Based on your feedback from M3, identify at least one strength and one limitation of your team's work in M3. Consider how the feedback you received on M3 could lead to improvements in your work.</p> <p>One strength for our algorithm based on M3 was that we were remarkably close to the reference values for the PGO-X50 given by the company, so we know that our algorithm works well and gives out close values. In addition, our SSE in M3 for the PGO data was actually lower than that of the reference values, indicating our values better fit our graph.</p> <p>One of our limitations for our M3 work was that it was difficult to read our plots for the correlation curves. It was suggested that we made them a little bit easier for the user to read, specifically, reduce the amount out data and only show enough so that the user can see that our V0s are appropriate.</p> <p>Although this was not included in our M3 feedback, we were also told by Professor Branco to avoid averaging our values with the duplicates as we don't know if the data is consistent and the averaging could lead to inaccuracy in our v0s identification.</p>
<p>Part B: Explain how you will incorporate the M3 feedback to improve your parameter identification (do not just reword your response from Part A; include concrete actions you will take).</p> <p>We can easily incorporate our feedback from M3 into our M4 algorithm by changing the range of value for all the different concentrations. When reducing this, the graph should naturally expand the</p>

display of the V0 tangent lines. We can also work on ideas in about our figure display. Although we already talked about it in previous milestones, we believe that it may be a good idea to quickly revisit our decision process for that area due to the fact it is one of our things we have to improve upon. Removing the code to average the duplicates is very easy as well.

Part 1: Algorithm Improvements Plan

Respond to each of the prompts below in the space provided. Your goal is to introduce the **two improvements** to your M3 algorithm. Use your ideas from Part 3 of M3 to help formulate ideas. Briefly describe, in words (not code), the nature of the improvements you will implement in your MATLAB code. Provide a brief, but thoughtful, description of your refinement, using evidence-based rationales for why the refinement is necessary and should improve your solution. Read the rest of this document carefully **before** you begin your work on this milestone. Once you are ready to begin Part 1, put your refinements and your rationale in Table 2.

Table 2. Algorithm refinement plans

Refinement 1
<p>Parameter(s) Targeted: V0s</p> <p>Description</p> <p>Our V0s values were off by small amount for all the concentrations. Although we are satisfied how close we were to the actual values, we know that there are certain areas in our V0 calculation that could bring our numbers closer to the reference values.</p>
<p>Rationale for Refinement</p> <p>Our team assumed that our V0s were off by a small margin because we were using more points than required to calculate our values. All our values were off by a similar amount, which made us believe this error originated in some part of our loops. Due to how large the data size is, we landed on 100 as our number of times we would repeat our calculation of the slope to get an accurate V0. However, it turns out that when we reduce the number from 100 to 55, we fall into the desired range of values, meaning our hypothesis was right and we were using points that should not be considered for the V0 calculation.</p>
Refinement 2
<p>Parameter(s) Targeted: vMax & Km</p> <p>Description</p> <p>In our past algorithms, we would always average the v0s we found for one concentration with its corresponding duplicate test. However, in our current algorithm, we have decided to abandon this approach. This averaging ended up slightly affecting our vMax and Km parameters as the v0s used in</p>

the calculations of v_{max} and K_m ended being skewed due to the averaging due to the data being inconsistent at some times.

Rationale for Refinement

The primary reason for the decision to stop averaging the duplicates with the original data is that we are not certain if the data in the duplicates is consistent with that of the original tests, running the risk of ruining our data if the duplicate is inconsistent. Had we had access much more duplicates, perhaps in the range of 20 sets of duplicates as opposed to our current 1 duplicate, we could perhaps be more confident in averaging as the data would likely be much more consistent as it many more data values.

Part 2: Algorithm Refinements Implementation

Before you make any changes to your code, resave your M3 code files as

- M4_Algorithm_SSS_TT.m
- M4_Main_SSS_TT.m

Implement improvements in M4_Algorithm_SSS_TT.m. **Clearly comment where you made improvements within the code, using the text 'Improvement 1' or 'Improvement 2' and a concise, meaningful description of the change for each improvement.**

Do not delete any code as you implement the improvements: comment out unnecessary code and comment on the change. Clearly indicate where new code is added with the commenting described above.

Evaluate the improvements in your algorithm by using the data for the reference enzyme PGO-X50 from M3. Compare the parameters identified for the PGO-X50 data using the algorithm you submitted in M3 and your refined algorithm for M4. This step ensures that you can compare the error of your algorithm to a known error in the data. Report your results in Table 3. Use appropriate decimal places.

Table 3. Algorithm refinement comparison

Parameter ($\mu\text{M/s}$)	PGO-X50 Reference Values	M3_Algorithm	M4_Algorithm
v_{0_1}	0.025	0.0199	0.0227
v_{0_2}	0.049	0.0394	0.0457
v_{0_3}	0.099	0.0788	0.0913
v_{0_4}	0.176	0.1431	0.1566
v_{0_5}	0.329	0.2767	0.3066
v_{0_6}	0.563	0.4828	0.5239
v_{0_7}	0.874	0.7521	0.7991
v_{0_8}	1.192	1.0772	1.1090
v_{0_9}	1.361	1.2618	1.2989
$v_{0_{10}}$	1.603	1.4769	1.4683
V_{max}	1.806	1.6625	1.7648
K_m (μM)	269.74	309.0708	269.7026

SSE ($\mu\text{M/s}$) ²	0.0048	0.0042	0.0013
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Next, use your M4 algorithm to analyze the full 100 enzyme test data sets and obtain the parameters V_{max} and K_m . Here you will run your M3 algorithm and your updated M4 algorithm on the full data set. You may need to make adjustments to both algorithms to account for the replicate data sets and 5 enzymes. In Table 4, record your results from both your M3 and M4 algorithm. Use appropriate decimal places.

Table 4. M3 and M4 algorithm comparison of experimental data parameters

Enzyme	M3 Algorithm			M4 Algorithm		
	Enzyme Parameters		SSE ($\mu\text{M/s}$) ²	Enzyme Parameters		SSE ($\mu\text{M/s}$) ²
	V_{max} ($\mu\text{M/s}$)	K_m (μM)		V_{max} ($\mu\text{M/s}$)	K_m (μM)	
NextGen-A	1.0068	208.4336	0.0049	0.9501	173.6767	0.0015
NextGen-B	0.8365	366.5812	0.0022	0.8442	357.7180	0.0020
NextGen-C	1.3603	278.3039	0.0209	1.2861	218.0345	0.0134
NextGen-D	1.5209	347.1196	0.0097	1.4339	292.8052	0.0148
NextGen-E	1.6838	255.0328	0.0003	1.5470	190.2243	0.0067

In Table 5, include any references you used throughout this answer sheet for Parts 0-2. Use APA format. Make sure there is an in-text citation for all references listed and vice versa. 0.00768(new) vs 0.0076

Table 5. References used in Parts 0-2 (if any)

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Part 3: Technical Brief

Consult the M4 memo from NaturalCatalysts, Inc. for the details concerning your technical brief. Use the provided template M4_TechnicalBrief_template.docx to respond to the memo. You may find the original introduction memo and the project background documents helpful when composing your technical brief.

Part 4: Résumé Insert

In response to the opportunity presented in the NaturalCatalysts memo, create an insert for your résumé by completing the following on this answer sheet:

Guidance:

Summarizing your ENGR 132 project for your résumé

Choose a header and specific language to describe your project. Possible Headers for Engineering 132 Project Descriptions include: Engineering Projects, Design Projects, Related Experience, Engineering Experience. The specific language should be "action" oriented and highlight both the project and your contributions to it. Your project title should be something that describes this project.

Template:**Design Projects****Enzyme Analysis Algorithm, Purdue University***Spring 2021*

- Power Verb (Skill) + Identifiable task + Purpose/Method/or Result
- Power Verb (Skill) + Identifiable task + Purpose/Method/or Result
- Power Verb (Skill) + Identifiable task + Purpose/Method/or Result

Example:**DESIGN PROJECTS****Autonomous Lawn Mower, Purdue University***Spring 2020*

- Improved sensor technology resulting in increased safety and reduced cost
- Developed MATLAB code to optimize sensor performance and to perform constraint analysis
- Constructed and tested a functional prototype that surpassed industry standards

Things to keep in mind:

- Headers should stand out (Bold/Underlined/Larger Font and/or CAPS).
- Do not use “Engineering 132” Project as the project title. Prospective employers will not know what that title means. Give the project a descriptive name.
- Differentiate between project title and location using style change or location variance.
- Separate the location and the date of the project. Placing the date on the right side of the page is common, but not required.
- Your 3-5 bulleted statements should all maintain the *same tense* (past if previously completed, or present if currently working on).
- Begin each bullet with a different power verb.
- For these 3-5 statements, try to answer the questions “What did you do?”, “How did you do it?”, and “What was your result?”

Resumé Text: In the space below, write a **summary of your project suitable for inclusion on your resumé**. Be sure to use the guidelines above regarding formatting and language. A resumé typically includes 3-5 bullet items describing a project. The stems for your bullet points should be power verbs that convey what you did on the project (i.e., implemented, led, developed, analyzed, etc.). Use your individual versions from the video activity to create a team version here.

Data Analysis and Algorithm Creation Project Purdue University*Spring 2021*

Analyzed a given data set and reduced noise in the data for a better analysis.

Created Algorithms in MATLAB to meet the needs of a client and output desired information accurately.

Tested output data to ensure that the results were precise and accurate.

Formed organized figure displays to reinforce the client's understanding of the given data and results of algorithm.

Finally, you should each add this insert or your individual one from the video activity into your own resumé.

How to Submit

1. Save this answer sheet as a PDF named **M4_AnswerSheet_SSS_TT.pdf** where **SSS** is your section number (e.g., 001 for section 001) and **TT** is your team number (e.g., 07 for team 7).
2. Save your technical brief document as a PDF named **M4_TechnicalBrief_SSS_TT.pdf**.
3. Select one person to submit the deliverables for the team. That person should
 - a. Log into Gradescope and submit all deliverables to the **M4** assignment.
 - i. M4_AnswerSheet_SSS_TT.pdf
 - ii. M4_Algorithm_SSS_TT.m
 - iii. M4_Main_SSS_TT.m
 - iv. M4_TechnicalBrief_SSS_TT.pdf
 - b. Select all team members for the group assignment and submit.
 - c. Double-check that all team members are assigned to the submission.
4. Each team member should confirm that they are part of the submission.
5. After submission, distribute the submitted files to all team members. *Ensure all members of the team have copies of the submitted files.*

Learning Objectives

Teamwork (TW)

Contribute to team products and discussions

TW02. Document all contributions to the team performance with evidence that these contributions are significant.

Process Awareness (PA)

Reflect on both personal and team's problem solving/design approach and process for the purpose of continuous improvement.

PA01. Identify strengths in the approach used.

PA02. Identify limitations in the approach used.

PA03. Identify potential behaviors to improve approach in future problem solving/design projects.

Idea Fluency (IF)

Generate ideas fluently. Take risks when necessary.

IF03. Generate testable prototypes (including process steps) for a set of potential solutions.

Evidence-Based Decision Making (EB)

Use evidence to develop and optimize solution. Evaluate solutions, test and optimize chosen solution based on evidence.

EB01. Test prototypes and analyze results to inform comparison of alternative solutions.

EB03. Clearly articulate reasons for answers with explicit reference to data to justify decisions or to evaluate alternative solutions.

EB05. Present findings from iterative testing or optimization efforts used to further improve aspect or performance of a solution.

EB06. Clearly articulate reasons for answers when making decisions or evaluating alternative solutions.

Solution Quality (SQ)

Design final solution to be of high technical quality. Design final solution to meet client and user needs.

SQ01. Use accurate, scientific, mathematical, and/or technical concepts, units, and/or data in solutions.

Information Literacy (IL)

Seek, find, use and document appropriate and trustworthy information sources.

IL04. Include citations within the text (in-text citations) that show how the references at the end of the text are used as evidence to support decisions.

IL05. Format reference list of used sources that is traceable to original sources (APA or MLA are recommended)

Engineering Professional Skills

PC05. Fully address all parts of assignment by following instructions and completing all work.

EPS01. Use professional written and oral communication.

EPS02. Format plots for technical presentation.

Programming

MAT01. Develop code that follows good programming standards.

- MAT05. Create and use MATLAB scripts and functions.
- MAT08. Debug scripts and functions to ensure programs execute properly, perform all required tasks, and produce expected results.