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| **Teammate FNs:** | Micah | Peter | | | Alex | | Colin |
| **Purdue Logins:** | huffma11 | pswales | | | apieprzy | | cjamison |
| **Section Number:** | 014 | |  | **Team Number:** | | 05 | |

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| **Instructions:**   1. Save this technical brief template file as **M4\_TechBrief\_*sss*\_*tt*.docx** where ***sss*** is your section number (07, 14, or 15) and ***tt*** is your team number (e.g., 03 for team 3).    * Make sure all teammates have copies of all submitted project files at all times. 2. As a team, write sections each week of your technical brief **draft**. Keep all red text in this template in case you need to make edits. Submit each section with the associated Milestone document *each week* to the individual Milestone Dropbox. See each Milestone for *specific* instructions. 3. Your **final** technical brief must be 2 pages, although graphs and/or tables showing results may be included on a 3rd page. Din your **final** brief, delete all red text from this template and this Instructions box just before your final submission. 4. Submit your final **M4\_TechBrief\_*sss*\_*tt*.docx** to the M4 drop box on Bb prior to Class 29.  * Only one submission is required per team. * Only last submission will be graded; make sure all docs are submitted at the same time.  1. Cite your sources in APA format with (1) an in-text citation where referenced in the body of the text **and** (2) a full citation in the Reference section of this Milestone. As a reminder, it would be an example of **Academic Dishonesty** if you don’t include in-text citations and references. |

***Template starts here.***

To: President Frank O. Simpson

From: Section 014, Team 05

RE: FOS Project

Date: Class 31

**Part 1, Introduction**

1. **DUE WITH M1**: In your own words, describe the problem in 2-3 sentences. This should include your team’s consensus on what FOS needs in terms of the deliverable, its function, the criteria for success (indicators of a working solution), and any constraints (what was provided to guide the design solution).

Our task, as we understand it, is to perform a quality analysis on five new thermocouple designs to determine what the Quality Assurance branch of your company can honestly and ethically claim to customers about these new designs, and with our algorithm as an aid, we aim to provide accurate and easily understandable information to QA through graphs and figures along with a detailed explanation, among these being an error analysis to judge how accurate our information and how successful your product truly is. Our work will also play a key role for the company and client financially, as fast-responding thermocouples are typically more expensive than slow-responding ones, which can also be easily deduced from our algorithm. In terms of constraints, they are as follows: the algorithm must appropriately handle ‘noisy’ data from both heating and cooling processes, the algorithm must be fully-automated, the algorithm must be our own original design, the final technical brief for our project must be ready by April 28, 2017.

1. **DUE WITH M2**: Provide an overarching description of your algorithm in 1-2 sentences. This should emphasize the key features included in the algorithm. Be specific.

Our algorithm receives inputs of thermocouple data and calculates the max, min, time step, and tau. This algorithm is fully-automated and can handle both heating and cooling thermocouple data.

C1 **DUE WITH M3**: Summarize the process that your team has followed up to this point. Include your reflections on the steps of method generation, development, handling noise, and data analysis. Include both your evidence-based rationales and justifications for decisions you made.

Thus far, our process for developing our algorithm has been as follows: brainstorm techniques for parameter identification, create two unique algorithms using generalized parameter identification methods in the code to accommodate all possible data sets, solidify and improve one algorithm, create an executive function from which the entire operation can be executed, and create a regression program to determine the relationship between tau and the price of the thermocouple. Through several group meetings, we were able to, as a team, develop sound methods for identifying desired parameters using clean data. The difficulty arose once we began experimenting with ‘noisy’ data. To accommodate for the slightly erratic data, we developed two algorithms, one that would essentially smooth the data, eliminating the ‘noise’, and proceed as with clean data and one that would determine the range of data points in which to average the ‘noise’ and make the curve smooth. Through several trials of noisy data, we determined that our smoothing algorithm took much too long to identify the parameters of the data, albeit producing accurate parameter values, but the other algorithm executed quickly and produced accurate parameter values. From then on, we decided to pursue the algorithm that made use of the moving average, since its method for parameter identification relied heavily on repetitive, simple calculations that the computer could process within a short amount of time.

C2 **DUE WITH M4**: Continue to summarize the process that your team has followed regarding regression and refinement. Include both your evidence-based rationales and justifications for decisions you made and how the accuracy of your model was enhanced during the process.

<insert your text here>

**Part 2, Procedure (parameter identification) – DUE WITH M2**

**Describe the steps** of your algorithm in plain English. Provide sample calculations and explanations for steps that may be more difficult to understand or replicate.

To begin, our algorithm accepts a time vector and a temperature vector for the data given. This data is parsed within the executive function so that it may be passed accordingly. Next, the first 100 temperature values of the data are placed in a variable, *tempFirst100.* The time step never occurs during the first 100 data points, so this can be assumed to be an approximate value for the temperature before the time step. This value is just used to initialize the variable called *avgPrior*, which is the average temperature of all the data points before a given data point *n*. The algorithm then enters a loop that tests every 5th data point to see if the average of the following 50 temperatures (*avgAfter*) is greater than *avgPrior* by 1 degree. To account for both heating and cooling data sets, a variable *avgDiff* is set to equal the difference between *avgPrior* and *AvgAfter*. Once this difference is greater than 1, it can be assumed that the data has rapidly risen or decreased after that data point *n*, at which time the loop ends and the time of data point *n* is taken to be the time step. The value of the initial temperature *ymin* is found by taking the average of all the temperatures that are recorded before time step. The final temperature *ymax* is then found by taking the average of the last 50 data points. The code then has an if statement that is true if the data set is cooling instead of heating, and then accordingly changes some factors that will be used to calculate tau and swaps the values of *ymin* and *ymax*. To calculate the value of tau, we first find the temperature at which tau occurs by using the equation *tauTemp* = *(ymax - ymin) \* fac1 + ymin*, with *fac1* being 0.632 if the data is heating and 0.368 if it is cooling. In order to get the the value of tau, the algorithm runs through a loop that tests very data point from the time step until after 5 degrees greater or less (heating or cooling) than the temperature at tau. If the temperature of the data point *nNew* is within 0.4 degrees of the temperature at tau, that data’s temperature is added to a variable *tauTimeTot* and the loop also counts how many values satisfy the condition. Once every value has been tested, *TauTimeTot* is divided by the number of data points used to calculate it in order to obtain an average, which is the approximate value of tau.

**Part 3, Results – DUE WITH M3**

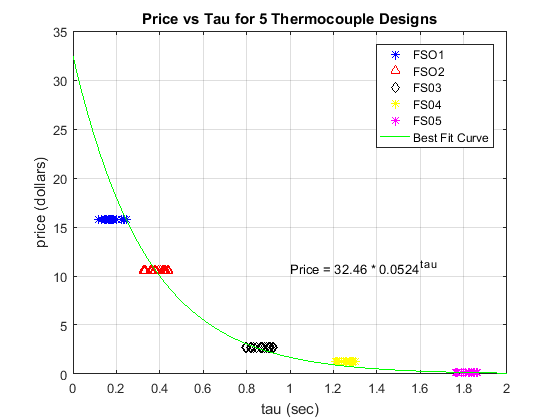
**Present results** of applying the algorithm to the specified datasets in the form requested. Results should be formatted for technical presentation; they should not be copied from MATLAB or Excel without cleanup. Consider using tables or graphs to present your results more concisely. Be sure to describe your results clearly.

After running our algorithm for 5 sets of 20 trials of thermocouple data, we generated the following figures below. Qualitatively, table 1 (below) shows how each thermocouple model compares in terms of the mean values for tau. As you can see, FOS-5 has a much larger mean tau value than FOS-1, meaning it takes thermocouple model FOS-5 to heat up or cool down. The average sum of the squares of error of our calculations can be seen in the third column of table 1. These values are very low, which means our calculations are reliable. Figure 1 (below) depicts the price of a given thermocouple model as a function of the thermocouple model’s tau value. Clearly, the model shows an exponential relationship between price and tau. That is to say, as the value of tau becomes smaller for a given thermocouple model, the price of the thermocouple increases exponentially. This explains why thermocouple model FOS-5 with an average tau value of 1.8171 is much less expensive than FOS-1 with a mean tau value of 0.1822. These results are supported by the value of the coefficient of determination of our model (R^2) shown in table (below). With an R^2 value of 0.97, our model very accurately represents the relationship between tau and the price of a thermocouple, given that as R^2 comes closer to 1, the model is a better representation of the relationship of the data.

**Table 1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Number** | **τ Characteristics** | | **Mean SSEmod** |
| **Mean** | **Standard Deviation** |
| FOS-1 | 0.1822 sec | 0.0399 | 2.2443 |
| FOS-2 | 0.3826 sec | 0.0375 | 1.3680 |
| FOS-3 | 0.8665 sec | 0.0407 | 1.0563 |
| FOS-4 | 1.2595 sec | 0.0302 | 1.0342 |
| FOS-5 | 1.8171 sec | 0.0330 | 1.2678 |

**Figure 1**



**Table 2**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| SSE | 0.8883 |
| SST | 35.2168 |
| r2 | 0.9748 |

**Part 4, Interpretation – DUE WITH M4**

In no more than 2 paragraphs, address the two questions of primary interest to FOS:

* How can you characterize the error in this process? Please comment on the quality of the experiments themselves, and also on your parameter identification algorithm. Use evidence to support your case, including specific data from your analysis and outside references as appropriate.
* What can FOS honestly say about our products in terms of their performance, pricing, and manufacturing consistency?

<insert your text here>

**Part 5, References – DUE WITH M4**

If you have any references, list them here in APA format.

<List references in APA format>

**REFERENCES (written in APA format – see Word>reference>manage sources>new tab)**

List all your References.

|  |
| --- |
| Example (reference for an internet source):  Author Last, X. (year). Title xxxx xxx xxxx. Retrieved from http://www.url.xxx/xxxx/xxxx |
| No external sources used |

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**ELECTRONIC – upload TechBrief and Milestone to Bb by each even-numbered Class**

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