**Report for Garments Sequencing Problem 11.3.2024**

**Problem description and comments:**

Based on constraints (2) in Mr. Yepez’s paper and the conversation with Mr. Klug, I think they have **eliminated the concept of orders** and focused on groups of garments.

A number of orders will be accumulated into a batch, the staff will synthesize all the garments (belonging to many groups and containing many different sizes) and put them into the conveyor at the same time. The optimization problem starts from this point. We will determine the sequences of garments put in the conveyor (in my opinion, more specifically the sequences of groups) to balance the workload.

Each sequence only contains garments of one group (C2 Mr. Yepez’s paper); however, **each group can be in many sequences** (I cannot open the csv file you sent, but according to my memory this matches the data Mr. Klug gave). **Therefore constraints (C4) are reasonable.**

After running the model based on the initial constraints (C1 – C9), I noticed that the garments of a group are likely to be in sequences that are far apart from each other. I think the idea behind constraints (C5) is to avoid the sizes of a garment not being packaged in the same sequences, slowing down the packaging process in the next step. Therefore, I also propose an additional constraint to ensure that sequences of the same group will be consecutive.

**Overview my models:**

I created test data (data.csv) containing 70 different SKUs in 6 groups. Each garment has a maximum of 7 sizes. There are 3 pickup locations (each with 4 lanes). Therefore, the maximum capacity for each sequence is 12 different SKUs.

I have created two models. Model 1 uses the objective function in Mr. Yepez’s paper (minimum the **cumulative mean squared errors** between real workload and expected workload). Model 2's objective function is to minimize **mean squared errors**. Both of these objective functions are quadratic. I'm having some problems with the objective function to minimize total abs deviation.

In the two models mentioned, **the number of sequences will be represented by an integer variable n, so that it is not fixed**. Because Gurobi does not allow division by variables and multiplication of more than two variables, some auxiliary variables are added. I have attached the solution in the email.

**Models with constraints from (C1) to (C9) have a few problems.** First, the sequence numbers do not start from 1 and are consecutive. I think the values of the sequences will affect the value of the objective function (for model 1). Second, sequences in the same group are not consecutive to each other. Therefore, I propose some constraints to solve this problem. I have added comments for explanation in my code.

Where is total number of SKUs belonging to group .

I still haven't found the reason, but **removing the constraints (C5, C6, C9)** from the model makes the calculation time much slower. I couldn't find the optimal solution within 3 hours, while the normal time is about 600s.

**Model 1 (CMSE):**

**Model 2 (MSE):**

with is binary variables whether sequence is used or not.A graph showing current and value

Description automatically generated Gaps in both models decrease slowly in the first period and very quickly in the later period.A graph with a blue line

Description automatically generated

Model 1 (CMSE)

Model 2 (MSE)

**Questions:**

1. Do you think I understand the definitions of the problem correctly? I still don't really understand the meaning of "balance workload" that Mr. Klug mentioned. Do we need to add variables for each picking location?
2. What role does the concept of picking point in Mr. Yepez’s paper play in the solving process?
3. Can the Gini coefficient be used to compare models with different objective functions?
4. Can you recommend some papers on sequencing problems?
5. Can you send me the data from Mr. Klug again? I can't open the files you sent. I need it to check how the model matches the actual data.
6. Is a remote desktop access at university possible? My laptop is actually quite weak for these problems. I just need a remote desktop with limited power and permissions.