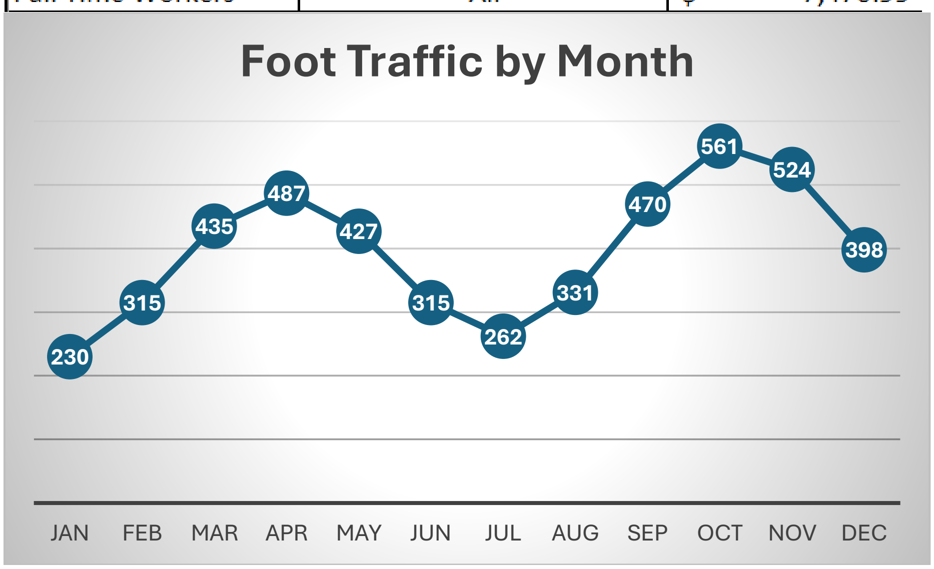
Module 08 – Scheduling Problem

Exploratory Data Analysis
In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:

- *Make a table (similar to the textbook example) showing the temporary agency data*
- *Run summary statistics on the sample of Full-Time employee salaries. Record the Mean to use in our model*
- *Make a line graph showing foot traffic over the next 12 months. Call out any seasonality or trend you may see.*

Agency	Months ON	Wage
The Gobstopper Grove	Mar, Apr, May	$ 8,412.00
Nifty Nougats	Feb, Mar, Apr	$ 7,556.00
Snap & Crackle Sweets	Jan, Feb, Mar	$ 8,771.00
Bubble Burst Bonbons	Sep, Oct, Nov	$ 10,073.00
Taffy & Tales	Dec, Jan, Feb	$ 8,936.00
The Sassy Taffy	Jun, Jul, Aug	$ 10,955.00
Full Time Workers	All	$ 7,470.99



Model Formulation
Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints.

Decision Variables:
The decision variables are the Workers Scheduled column, as that is what Solver optimizes. It is also dependent on the available column (mutually exclusive) because the Sum Product for available includes the decision column.
<u>Cells: O6:O12</u>

Objective Function:
The physical objective function is the Sum Product of Workers Scheduled and Wages per Worker. The change I made to the Wages/worker column is to multiply each of the given values by the duration of service for each respective agency. This reflects an accurate wage for solver to grasp for an optimized solution.

MIN= 8412X1 + 7556X2 + 8771X3 + 10073X4 + 8936X5 + 10955X6 + 7470.99X7

Constraints:

0X1 + 0X2 + 1X3 + 0X4 + 1X5 + 0X6 + 1X7 [>=] 230 January
0X1 + 1X2 + 1X3 + 0X4 + 1X5 + 0X6 + 1X7 [>=] 315 February
1X1 + 1X2 + 1X3 + 0X4 + 0X5 + 0X6 + 1X7 [>=] 435 March
1X1 + 1X2 + 0X3 + 0X4 + 0X5 + 0X6 + 1X7 [>=] 487 April
1X1 + 0X2 + 0X3 + 0X4 + 0X5 + 0X6 + 1X7 [>=] 427 May
0X1 + 0X2 + 0X3 + 0X4 + 0X5 + 1X6 + 1X7 [>=] 315 June
0X1 + 0X2 + 0X3 + 0X4 + 0X5 + 1X6 + 1X7 [>=] 262 July
0X1 + 0X2 + 0X3 + 0X4 + 0X5 + 1X6 + 1X7 [>=] 331 August
0X1 + 0X2 + 0X3 + 1X4 + 0X5 + 0X6 + 1X7 [>=] 470 September
0X1 + 0X2 + 0X3 + 1X4 + 0X5 + 0X6 + 1X7 [>=] 561 October
0X1 + 0X2 + 0X3 + 1X4 + 0X5 + 0X6 + 1X7 [>=] 524 November
0X1 + 0X2 + 0X3 + 0X4 + 1X5 + 0X6 + 1X7 [>=] 398 December

Non-Negativity: Decision variables [>=] 0 and Decision variables [=] Integer
Available workers [>=] Required

Model Optimized for Min Costs to Cover Store Foot Traffic
Implement your formulation into Excel, and be sure to make it neat. This section should include:
- *A screenshot of your optimized final model (formatted nicely, of course)*
- *A text explanation of what your model is recommending*

	Days On = 1, Days Off = 0												Workers	
Agency	1	2	3	4	5	6	7	8	9	10	11	12	Scheduled	Wages per Worker
The Gobstopper Grove	0	0	1	1	1	0	0	0	0	0	0	0	96	$ 25,236
Nifty Nougats	0	1	1	1	0	0	0	0	0	0	0	0	60	$ 22,668
Snap & Crackle Sweets	1	1	1	0	0	0	0	0	0	0	0	0	0	$ 26,313
Bubble Burst Bonbons	0	0	0	0	0	0	0	0	1	1	1	0	230	$ 30,219
Taffy & Tales	1	1	0	0	0	0	0	0	0	0	0	1	67	$ 26,808
The Sassy Taffy	0	0	0	0	0	1	1	1	0	0	0	0	0	$ 32,865
Full-Time	1	1	1	1	1	1	1	1	1	1	1	1	331	$ 89,652
Available	398	458	487	487	427	331	331	331	561	561	561	398		
Required	230	315	435	487	427	315	262	331	470	561	524	398	Total ->	$ 42,204,047

My model, simply put, is arranged to minimize the total wage expense with the given information on worker demand and their schedules. Setting up the model, I accounted for the available workers by fulfilling the demand of workers in mind (given information). We know the wages of each worker (based on their schedule), however, we are looking for the optimal # of workers scheduled for each shift. We also have the salaries of full-time workers, which I made a row for and found the average of all employee salaries. The objective function here, next to Total, is what is minimized. My objective function is the Sum Product of Workers Scheduled and Wages per Worker. The change I made to the Wages/worker column is to multiply each of the given values by the duration of service for each respective agency. This reflects an accurate wage for solver to grasp for an optimized solution.

Making informed, data-driven decisions is imperative in an area as variable as scheduling, and this model does exactly that. Although this won't account for any sudden changes in scheduling demand (catering a wedding for restaurants, or something fun like COVID protocols), it will provide management with a solid grasp on possible changes/implementation.

Model with Stipulation

Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution.

Please do both of the following:

1. *Unfortunately, leadership wishes to have a reduction in workforce. While the monthly salary for full-time employees is cheaper than temporary workers, there are other costs associated with full time employees that they wish to cut. Add a constraint to your model that takes your first model's recommended number of full-time employees and constrains it to be only 80% of it. Add a text explanation of the change in the optimal value as well as any other changes noticed between the models.*

I chose to find 80% of the solver optimized # of workers for full-time employees (originally 331, 331*0.8=264.8, rounded down to 264 for the 0.8 of a person), then add a constraint that the Full-Time worker cell, cannot exceed 264. I know there may be other ways of going about this, but this method I found simplistic, yet effective. Since adding this constraint, the TOTAL experienced an increase of roughly 1.7 million. Cutting down on full-time workers will result in an increased part-time worker load, directly increasing costs.

2. *Alternatively, leadership would like to see what the average monthly salary for an employee would need to be to cut out all temporary workers as they believe that will help negate excess spending. Convert your model (or do the math out yourself) to figure out what monthly salary you would need to pay your full-time employees to only have full-time workers at the same optimal cost as the original model.*

I chose the latter, completing the math myself on the side. Taking the average wage per full-time worker, multiplied by 12 for the months of the year (table data), times 561 (the highest required). I took this figure and subtracted the 42 million that was optimized from it. I took this smaller figure (still in the millions) and divided that same 561. This yields the value <u>$14,421.97</u>, that represents the amount that would have to be pay the full-time employees <u>less</u>. So the full-time wage figure in my table is $89,625 (calculated for the year). If I subtract this value, we end up with <u>$75,203.03.</u> Which is what the full-time workers would have to be paid.

3. *Considering trends and seasonality of this business, what would you recommend leadership to do? Feel free to play with the model and recommend something else.*

There are plenty of potential changes to be made in this imaginary, candy-based company. I think something rather obvious would be adjusting the need for seasonal staff based on the provided foot traffic trends (and realistically, spending and other attributes will be relevant). There is a drop in the December→January front and another drop mid-year around June. These are areas of serious improvement. Also, increasing full-time worker capacity by hiring could reduce the heavy reliance on these outside agencies for providing part-timers.
Another thought would be to improve exiting or create retention practices to maintain the full-time employees in place, addressing turnover.