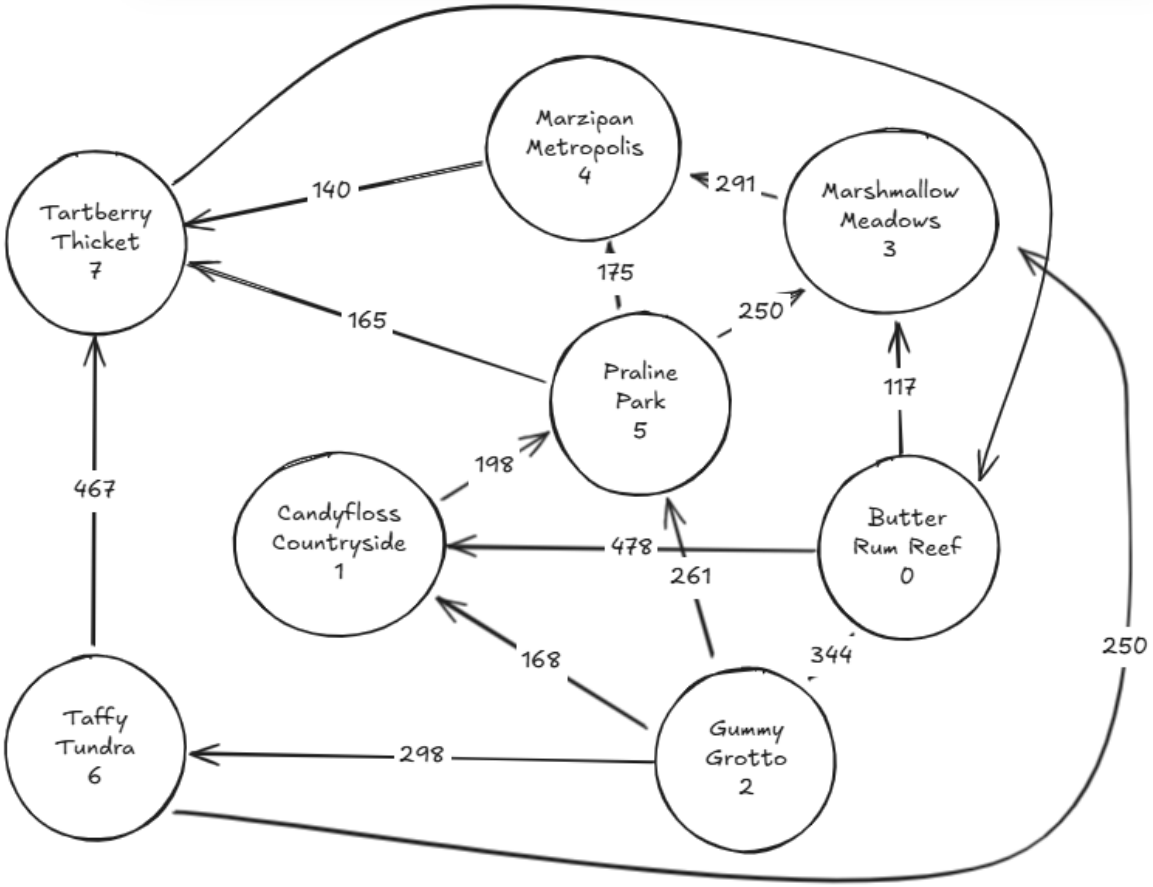
Module 07 – Maximal Flow

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 visual graph of your data like what we saw for the sample problem*
  - https://excalidraw.com
  - https://mermaid.live
  - https://dreampuf.github.io/GraphvizOnline
  - Powerpoint/Word



Model Formulation

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

Max = X_{70}

$+X_{70} -X_{01} -X_{02} -X_{03} = 0$
$+X_{01} +X_{21} -X_{15} = 0$
$+X_{02} -X_{21} -X_{25} - X_{26} = 0$
$+X_{03} + X_{53} +X_{63} -X_{34} = 0$
$+X_{34} +X_{54} -X_{47} = 0$
$+X_{15} -X_{57} -X_{54} -X_{53} = 0$
$+X_{26} -X_{67} -X_{63} = 0$
$+X_{47} +X_{57} +X_{67} -X_{70} = 0$

Model Optimized for Maximal Flow

Implement your formulation into Excel and be sure to make it neat. This section should include:

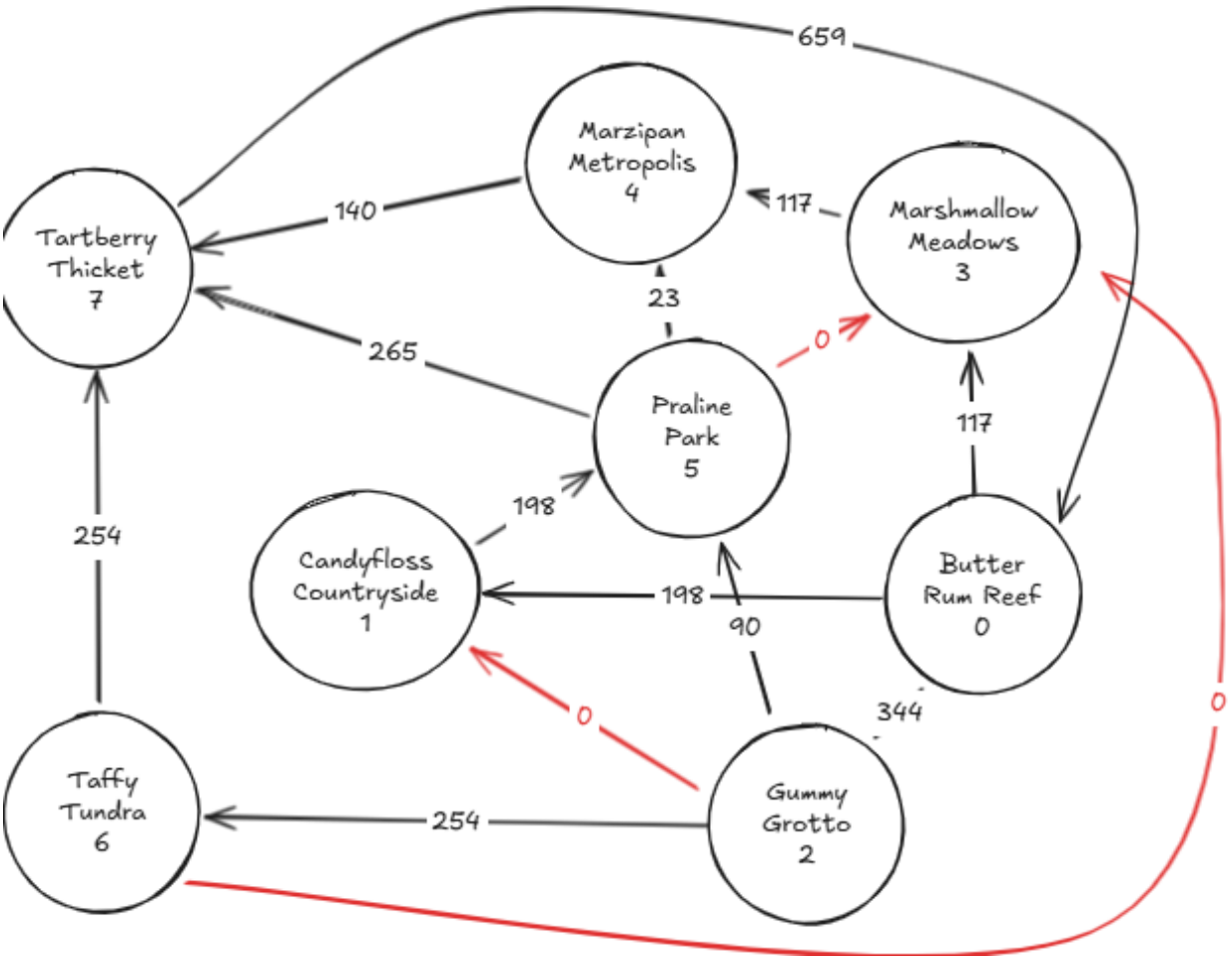
- *A screenshot of your optimized final model (formatted nicely, of course)*
- *A text explanation of what your model is recommending, especially any identified bottlenecks*
- *Update your graph from the EDA section to bold/color the links being used (and show how much is going through that link)*

Flow	From		To		Upper Flow Capacity
198	0	Butter Rum Reef	1	Candyfloss Countryside	478
344	0	Butter Rum Reef	2	Gummy Grotto	344
117	0	Butter Rum Reef	3	Marshmallow Meadows	117
198	1	Candyfloss Countryside	5	Praline Park	198
0	2	Gummy Grotto	1	Candyfloss Countryside	168
90	2	Gummy Grotto	5	Praline Park	261
254	2	Gummy Grotto	6	Taffy Tundra	298
117	3	Marshmallow Meadows	4	Marzipan Metropolis	291
140	4	Marzipan Metropolis	7	Tartberry Thicket	140
265	5	Praline Park	7	Tartberry Thicket	265
0	5	Praline Park	3	Marshmallow Meadows	250
23	5	Praline Park	4	Marzipan Metropolis	175
254	6	Taffy Tundra	7	Tartberry Thicket	467
0	6	Taffy Tundra	3	Marshmallow Meadows	250
659	7	Tartberry Thicket	0	Butter Rum Reef	9999

	Location	Inflow	Outflow	Netflow	Demand
0	Butter Rum Reef	659	659	0	0
1	Candyfloss Countryside	198	198	0	0
2	Gummy Grotto	344	344	0	0
3	Marshmallow Meadows	117	117	0	0
4	Marzipan Metropolis	140	140	0	0
5	Praline Park	288	288	0	0
6	Taffy Tundra	254	254	0	0
7	Tartberry Thicket	659	659	0	0

Maximal Flow
659

- *The model suggests the use of all edges except for 2-1, 5-3, and 6-3. The model has some bottlenecks at node 0, 2, 3, 5, 6*



-

Model with Stipulation

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

Let's demonstrate the "Flow Aggregation" special consideration that was discussed in the textbook and the Follow Along – Model Formulation video. Please follow these steps:

- *Identify an edge that is not used with your current solution*
  - *If by chance all your edges are in use, then apply the next step to an under-utilized edge*
- *Add a lower bound (LB) constraint to that edge (i.e. there must be a non-zero flow to the edge)*
  - *The LB should be 10% of the capacity of that edge (i.e. if the unused edge supports 500-unit flow, then we should had a LB of 50 units through that edge)*
- *Discuss the changes to the optimal solution with this change and how it impacts the model formulation*

The edges that are capacity need to be raised to the amount necessary, so all edges are at capacity.

Flow		From		To	Upper Flow Capacity
198	0	Butter Rum Reef	1	Candyfloss Countryside	478
344	0	Butter Rum Reef	2	Gummy Grotto	344
117	0	Butter Rum Reef	3	Marshmallow Meadows	117
198	1	Candyfloss Countryside	5	Praline Park	198
0	2	Gummy Grotto	1	Candyfloss Countryside	168
90	2	Gummy Grotto	5	Praline Park	261
254	2	Gummy Grotto	6	Taffy Tundra	298
117	3	Marshmallow Meadows	4	Marzipan Metropolis	291
140	4	Marzipan Metropolis	7	Tartberry Thicket	140
265	5	Praline Park	7	Tartberry Thicket	265
0	5	Praline Park	3	Marshmallow Meadows	250
23	5	Praline Park	4	Marzipan Metropolis	175
254	6	Taffy Tundra	7	Tartberry Thicket	467
0	6	Taffy Tundra	3	Marshmallow Meadows	250
659	7	Tartberry Thicket	0	Butter Rum Reef	9999

	Location	Inflow	Outflow	Netflow	Demand
0	Butter Rum Reef	659	659	0	0
1	Candyfloss Countryside	198	198	0	0
2	Gummy Grotto	344	344	0	0
3	Marshmallow Meadows	117	117	0	0
4	Marzipan Metropolis	140	140	0	0
5	Praline Park	288	288	0	0
6	Taffy Tundra	254	254	0	0
7	Tartberry Thicket	659	659	0	0
8	Donutville	0	0	0	1

Maximal Flow
659