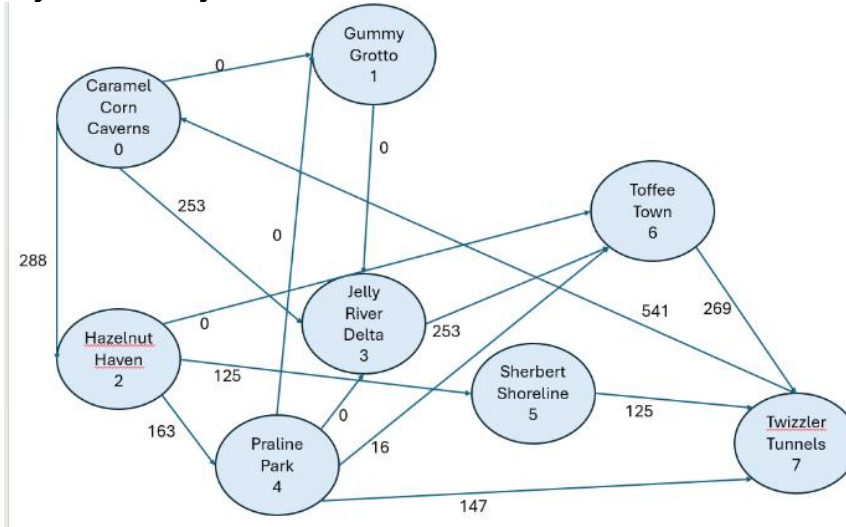


# Module 07 – Maximal Flow

## Exploratory Data Analysis



## 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.

MAX: X70

Subject to:

$$+X70-X01-X02-X03=0$$

$$+X01+X41-X13=0$$

$$+X02-X24-X26-X27=0$$

$$+X03+X13+X43-X6=0$$

$$+X24-X41-X43-X46-X47=0$$

$$+X25-X57=0$$

$$+X26+X36+X46-X67=0$$

$$+X47+X57+X67-X70=0$$

Nonnegativity Constraints

$$X_i \geq 0$$

## Model Optimized for Maximal Flow

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

	Maximal Flow ->		541								
Units of Flow	Links		Upper Bound						Supply / Demand		
	From	To		Nodes	Inflow	Outflow	Net Flow				
0	0 Caramel Corn Caverns	1 Gummy Grotto	498	0 Caramel Corn Caverns	541	541	0	0			
288	0 Caramel Corn Caverns	2 Hazelnut Haven	288	1 Gummy Grotto	0	0	0	0			
253	0 Caramel Corn Caverns	3 Jelly River Delta	429	2 Hazelnut Haven	288	288	0	0			
0	1 Gummy Grotto	3 Jelly River Delta	121	3 Jelly River Delta	253	253	0	0			
163	2 Hazelnut Haven	4 Praline Park	163	4 Praline Park	163	163	0	0			
125	2 Hazelnut Haven	5 Sherbet Shoreline	168	5 Sherbet Shoreline	125	125	0	0			
0	2 Hazelnut Haven	6 Toffee Town	167	6 Toffee Town	269	269	0	0			
253	3 Jelly River Delta	6 Toffee Town	253	7 Twizzler Tunnels	541	541	0	0			
147	4 Praline Park	7 Twizzler Tunnels	400								
0	4 Praline Park	1 Gummy Grotto	175								
0	4 Praline Park	3 Jelly River Delta	72								
16	4 Praline Park	6 Toffee Town	59								
125	5 Sherbet Shoreline	7 Twizzler Tunnels	147								
269	6 Toffee Town	7 Twizzler Tunnels	269								
541	7 Twizzler Tunnels	0 Caramel Corn Caverns	99999								

## Model with Stipulation

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

Units of Flow	Links		Upper Bound
	From	To	
0	0 Caramel Corn Caverns	1 Gummy Grotto	498
288	0 Caramel Corn Caverns	2 Hazelnut Haven	288
253	0 Caramel Corn Caverns	3 Jelly River Delta	429
0	1 Gummy Grotto	3 Jelly River Delta	121
163	2 Hazelnut Haven	4 Praline Park	163
125	2 Hazelnut Haven	5 Sherbet Shoreline	168
0	2 Hazelnut Haven	6 Toffee Town	167
253	3 Jelly River Delta	6 Toffee Town	253
147	4 Praline Park	7 Twizzler Tunnels	400
0	4 Praline Park	1 Gummy Grotto	175
0	4 Praline Park	3 Jelly River Delta	72
16	4 Praline Park	6 Toffee Town	59
125	5 Sherbet Shoreline	7 Twizzler Tunnels	147
269	6 Toffee Town	7 Twizzler Tunnels	269
541	7 Twizzler Tunnels	0 Caramel Corn Caverns	99999

The model is recommending the amount of units that should travel between different locations to maximize units that can flow through network. All networks highlighted in green are bottlenecks because you can't increase units of flow because they are already at capacity. To increase optimal solution you'd have to increase capacity of green highlighted to maximize after you get red maximized.

- Using a copy of the network, show how many units pass through each edge
- Identify the edges that are underutilized and those that are at capacity with different colors (you can also color the nodes **RED** for underutilized and **GREEN** for at capacity)
  - An edge is underutilized if edges go to it that aren't at capacity
  - An edge is at capacity when it has edges that are at capacity (especially if they are all at capacity)
- Write a brief statement on what would help increase the optimal solution